Administrators Guide

Clavister® CorePlus™
Version 8.90.11

Clavister AB
Sjögatan 6J
SE-89160 Örnsköldsvik
SWEDEN

Phone: +46-660-299200
Fax: +46-660-12250

www.clavister.com

Published 2010-03-31

Administrators Guide
Clavister® CorePlus™
Version 8.90.11

Published 2010-03-31

Table of Contents

List of Figures

List of Examples

Preface

Intended Audience

The target audience for this reference guide is Administrators who are responsible for configuring and managing Clavister Security Gateways which are running the CorePlus operating system. This guide assumes that the reader has some basic knowledge of networks and network security.

Text Structure and Conventions

The text is broken down into chapters and sub-sections. Numbered sub-sections are shown in the table of contents at the beginning. An index is included at the end of the document to aid with alphabetical lookup of subjects.

Where a "See chapter/section" link (such as: see Chapter 9, *VPN*) is provided in the main text, this can be clicked to take the reader directly to that reference.

Text that may appear in the user interface of the product is designated by being in **bold case**. Where a term is being introduced for the first time or being stressed *it may appear in a italics*.

Where console interaction is shown in the main text outside of an example, it will appear in a box with a gray background.

```
Cmd>
```

Where a web address reference is shown in the text, clicking it will open the specified URL in a browser in a new window (some systems may not allow this).
For example: *http://www.clavister.com*.

Examples

Examples in the text are denoted by the header **Example** and appear with a gray background as shown below. They contain a Clavister FineTune™ example and/or a CLI example.

Example 1. Example Notation

Information about what the example is trying to achieve is found here, sometimes with an explanatory image.

Clavister FineTune

The Clavister FineTune example appears here and is described as a series of steps:

1. First step
2. Second step

The term *context menu* refers to the menu that appears by right-clicking a menu item.

Feedback

Despite all efforts, unintentional typographic errors, factual errors or omissions may regretably occur in documentation. Clavister appreciates all feedback pointing out such problems or any other suggestions for improvement of the content. Please email all feedback to *mailto:support@clavister.com*.

Highlighted Content

Special sections of text which the reader should pay special attention to are indicated by icons on the left hand side of the page followed by a short paragraph in italicized text. Such sections are of the following types with the following purposes:

Note
This indicates some piece of information that is an addition to the preceding text. It may concern something that is being emphasized, or something that is not obvious or explicitly stated in the preceding text.

Tip
This indicates a piece of non-critical information that is useful to know in certain situations but is not essential reading.

Caution
This indicates where the reader should be careful with their actions as an undesirable situation may result if care is not exercised.

Important
This is an essential point that the reader should read and understand.

Warning
This is essential reading for the user as they should be aware that a serious situation may result if certain actions are taken or not taken.

Chapter 1. CorePlus Overview

This chapter outlines the key features of CorePlus.

1.1. Features

Clavister CorePlus is the firmware, the software engine that drives and controls all Clavister Security Gateway products. CorePlus can also be deployed on the administrator's preferred choice of server hardware as a software only product.

Designed as a network security operating system, CorePlus features high throughput performance with high reliability plus super-granular control. In contrast to products built on standard operating systems such as Unix or Microsoft Windows, CorePlus offers seamless integration of all subsystems, in-depth administrative control of all functionality as well as a minimal attack surface which helps negate the risk of being a target for security attacks.

From the administrator's perspective the conceptual approach of CorePlus is to visualize operations through a set of logical building blocks or *objects*, which allow the configuration of the product in an almost limitless number of different ways. This granular control allows the administrator to meet the requirements of the most demanding network security scenario.

CorePlus is an extensive and feature-rich network operating system. The list below presents the most essential features:

IP Routing

CorePlus provides a variety of options for IP routing including static routing, dynamic routing, virtual routing, as well as multicast routing capabilities. In addition, CorePlus supports features such as Virtual LANs, Route Monitoring, Proxy ARP and Transparency. For more information, please see Chapter 4, *Routing*.

Firewalling Policies

CorePlus provides stateful inspection-based firewalling for a wide range of protocols such as TCP, UDP and ICMP. The administrator can define detailed firewalling policies based on source/destination network/interface, protocol, ports, user credentials, time-of-day and more. Section 3.5, “The IP Rule Set”, describes how to set up these policies to determine what traffic is allowed or rejected by CorePlus.

Address Translation

For functionality as well as security reasons, CorePlus supports policy-based address translation. Dynamic Address Translation (NAT) as well as Static Address Translation (SAT) is supported, and resolves most types of address translation needs. This feature is covered in Chapter 7, *Address Translation*.

VPN

CorePlus supports a range of Virtual Private Network (VPN) solutions. CorePlus supports IPsec, L2TP and PPTP based VPNs concurrently, can act as either server or client for all of the VPN types, and can provide individual security policies for each VPN tunnel. The details for this can be found in Chapter 9, *VPN* which includes a summary of setup steps in Section 9.2, “VPN Quick Start Guide”.

ALGs

CorePlus provides a range of Application Level Gateways (ALGs) which provide security features that examine traffic at higher OSI layers such checking if file download content agrees with the given filetype. Another example is the SIP ALG that is able to handle the SIP message exchanges that take place during the setup of peer to peer data exchanges. For detailed information, see Section 6.2, “ALGs”.

Anti-Virus Scanning

CorePlus features integrated anti-virus functionality. Traffic passing through the Clavister Security Gateway can be subjected to in-depth scanning for viruses, and virus sending hosts can be black-listed and blocked. For details of this feature, see Section 6.4, “Anti-Virus Scanning”.

Intrusion Detection and Prevention

To mitigate application-layer attacks towards vulnerabilities in services and applications, CorePlus provides a powerful Intrusion Detection and Prevention (IDP) engine. The IDP engine is policy-based and is able to perform high-performance scanning and detection of attacks and can perform blocking and optional black-listing of attacking hosts. For more information about the IDP capabilities of CorePlus, please see Section 6.5, “Intrusion Detection and Prevention”.

Web Content Filtering

CorePlus provides various mechanisms for filtering web content that is deemed inappropriate according to your web usage policy. Web content can be blocked based on category, malicious objects can be removed and web sites can be whitelisted or blacklisted in multiple policies. For more information on filtering, see Section 6.3, “Web Content Filtering”.

Traffic Management

CorePlus provides broad traffic management capabilites through Traffic Shaping, Threshold Rules and Server Load Balancing. Traffic Shaping enables limiting and balancing of bandwidth; Threshold Rules allow specification of thresholds for sending alarms and/or limiting network traffic; Server Load Balancing enables a device running CorePlus to distribute network load to multiple hosts. These features are discussed in detail in Chapter 10, *Traffic Management*.

User Authentication

A CorePlus device can be used for authenticating users before allowing access to protected resources. Multiple local user databases are supported as well as multiple external RADIUS servers, and separate authentication policies can be defined to support separate authentication schemes for different kinds of traffic. Chapter 8, *User Authentication*, provides detailed information about this feature.

Operations and Maintenance

Adminstrator management of CorePlus is possible through the Clavister FineTune PC based client as well as with console commands. CorePlus also provides detailed event and logging capabilities plus support for monitoring through SNMP. For more detailed information, see Chapter 2, *Management and Maintenance*.

High Availability

High Availability (HA) is supported through automatic fault-tolerant fail-over to a secondary Clavister Security Gateway device. The two devices act together as a *cluster*, with one being active while the other is passive but constantly mirroring the state of the active unit. This feature is described in more detail in Chapter 11, *High Availability*.

In addition to the above mentioned features, CorePlus includes a number of features such as accounting using RADIUS Accounting, providing DHCP services, protection against Denial-of-Service (DoS) attacks, support for PPPoE, GRE, dynamic DNS services and much more.

CorePlus Documentation

Reading through the available documentation carefully will ensure that you get the most out of your CorePlus product. In addition to this document, the reader should also be aware of the companion reference guides:

- The *Clavister FineTune Administrators Guide* which is the installation and reference guide for Clavister FineTune.
- The *CorePlus Log Reference Guide* which details all CorePlus log event messages.

Together, these documents form the essential reference material for CorePlus operation.

CorePlus Education and Certification

For details about classroom and online CorePlus education as well as CorePlus certification, visit the Clavister company website at *http://www.clavister.com* or contact your local sales representative.

1.2. CorePlus Architecture

1.2.1. State-based Architecture

The CorePlus architecture is centered around the concept of state-based connections. Traditional IP routers or switches commonly inspect all packets and then perform forwarding decisions based on information found in the packet headers. With this approach, packets are forwarded without any sense of context which eliminates any possibility to detect and analyze complex protocols and enforce corresponding security policies.

Stateful Inspection

CorePlus employs a technique called *stateful inspection* which means that it inspects and forwards traffic on a per-connection basis. CorePlus detects when a new connection is being established, and keeps a small piece of information or *state* in its *state table* for the lifetime of that connection. By doing this, CorePlus is able to understand the context of the network traffic, which enables it to perform in-depth traffic scanning, apply bandwidth management and much more.

The stateful inspection approach additionally provides high throughput performance with the added advantage of a design that is highly scalable. The CorePlus subsystem that implements stateful inspection will sometimes be referred to in documentation as the CorePlus *state-engine*.

1.2.2. CorePlus Building Blocks

The basic building blocks in CorePlus are interfaces, logical objects and various types of rules (or rule sets).

Interfaces

Interfaces are the doorways for network traffic passing through, to or from the system. Without interfaces, a CorePlus system has no means for receiving or sending traffic. Several types of interfaces are supported; Physical Interfaces, Physical Sub-Interfaces and Tunnel Interfaces. *Physical interfaces* corresponds to actual physical Ethernet ports; *physical sub-interfaces* include VLAN and PPPoE interfaces while *tunnel interfaces* are used for receiving and sending traffic in VPN tunnels.

Interface Symmetry

The CorePlus interface design is symmetric, meaning that the interfaces of the device are not fixed as being on the "insecure outside" or "secure inside" of a network topology. The notion of what is inside and outside is totally for the administrator to define.

Logical Objects

Logical objects can be seen as pre-defined building blocks for use by the rule sets. The address book, for instance, contains named objects representing host and network addresses. Another example of logical objects are services which represent specific protocol and port combinations. Also important are the Application Layer Gateway (ALG) objects which are used to define additional parameters on specific protocols such as HTTP, FTP, SMTP and H.323.

CorePlus Rule Sets

Finally, rules which are defined by the administrator in the various *rule sets* are used for actually implementing CorePlus security policies. The most fundamental set of rules are the *IP Rules*, which are used to define the layer 3 IP filtering policy as well as carrying out address translation and server load balancing. The Traffic Shaping Rules define the policy for bandwidth management, the IDP Rules control the behavior of the intrusion prevention engine and so on.

1.2.3. Basic Packet Flow

This section outlines the basic flow in the state-engine for packets received and forwarded by CorePlus. Please note that this description is simplified and might not be fully applicable in all scenarios. The basic principle, however, is still valid in all applications.

1. An Ethernet frame is received on one of the Ethernet interfaces in the system. Basic Ethernet frame validation is performed and the packet is dropped if the frame is invalid.

2. The packet is associated with a Source Interface. The source interface is determined as follows:

    - If the Ethernet frame contains a VLAN ID (Virtual LAN identifier), the system checks for a configured VLAN interface with a corresponding VLAN ID. If one is found, that VLAN interface becomes the source interface for the packet. If no matching interface is found, the packet is dropped and the event is logged.

    - If the Ethernet frame contains a PPP payload, the system checks for a matching PPPoE interface. If one is found, that interface becomes the source interface for the packet. If no matching interface is found, the packet is dropped and the event is logged.

    - If none the above is true, the receiving Ethernet interface becomes the source interface for the packet.

3. The IP datagram within the packet is passed on to the CorePlus Consistency Checker. The consistency checker performs a number of sanity checks on the packet, including validation of checksums, protocol flags, packet length and so on. If the consistency checks fail, the packet gets dropped and the event is logged.

4. CorePlus now tries to lookup an existing connection by matching parameters from the incoming packet. A number of parameters are used in the match attempt, including the source interface, source and destination IP addresses and IP protocol.

    If a match cannot be found, a connection establishment process starts which includes steps from here to 10 below. If a match is found, the forwarding process continues at step 11 below.

5. The source interface is examined to find out if the interface is a member of a specific routing table. Policy-based Routing Rules are also evaluated to determine the correct routing table for the connection.

6. The Access Rules are evaluated to find out if the source IP address of the new connection is allowed on the received interface. If no Access Rule matches then a reverse route lookup will be done. In other words, by default, an interface will only accept source IP addresses that belong to networks routed over that interface. If the Access Rules or the reverse route lookup determine that the source IP is invalid, then the packet is dropped and the event is logged.

7. A route lookup is being made using the appropriate routing table. The destination interface for the connection has now been determined.

8. The IP rules are now searched for a rule that matches the packet. The following parameters are part of the matching process:

    - Source and destination interfaces

    - Source and destination network

    - IP protocol (for example TCP, UDP, ICMP)

    - TCP/UDP ports

    - ICMP types

- Point in time in reference to a pre-defined schedule

If a match cannot be found, the packet is dropped.

If a rule is found that matches the new connection, the Action parameter of the rule decides what CorePlus should do with the connection. If the action is Drop, the packet is dropped and the event is logged according to the log settings for the rule.

If the action is Allow, the packet is allowed through the system. A corresponding state will be added to the connection table for matching subsequent packets belonging to the same connection. In addition, the Service object which matched the IP protocol and ports might have contained a reference to an Application Layer Gateway (ALG) object. This information is recorded in the state so that CorePlus will know that application layer processing will have to be performed on the connection.

Finally, the opening of the new connection will be logged according to the log settings of the rule.

> ***Note***
> *There are actually a number of additional actions available such as address translation and server load balancing. The basic concept of dropping and allowing traffic is still the same.*

9. The Intrusion Detection and Prevention (IDP) Rules are now evaluated in a similar way to the IP rules. If a match is found, the IDP data is recorded with the state. By doing this, CorePlus will know that IDP scanning is supposed to be conducted on all packets belonging to this connection.

10. The Traffic Shaping and the Threshold Limit rule sets are now searched. If a match is found, the corresponding information is recorded with the state. This will enable proper traffic management on the connection.

11. From the information in the state, CorePlus now knows what to do with the incoming packet:

    - If ALG information is present or if IDP scanning is to be performed, the payload of the packet is taken care of by the TCP Pseudo-Reassembly subsystem, which in turn makes use of the different Application Layer Gateways, layer 7 scanning engines and so on, to further analyze or transform the traffic.

    - If the contents of the packet is encapsulated (such as with IPsec, PPTP/L2TP or some other type of tunneled protocol), then the interface lists are checked for a matching interface. If one is found, the packet is decapsulated and the payload (the plaintext) is sent into CorePlus again, now with source interface being the matched tunnel interface. In other words, the process continues at step 3 above.

    - If traffic management information is present, the packet might get queued or otherwise be subjected to actions related to traffic management.

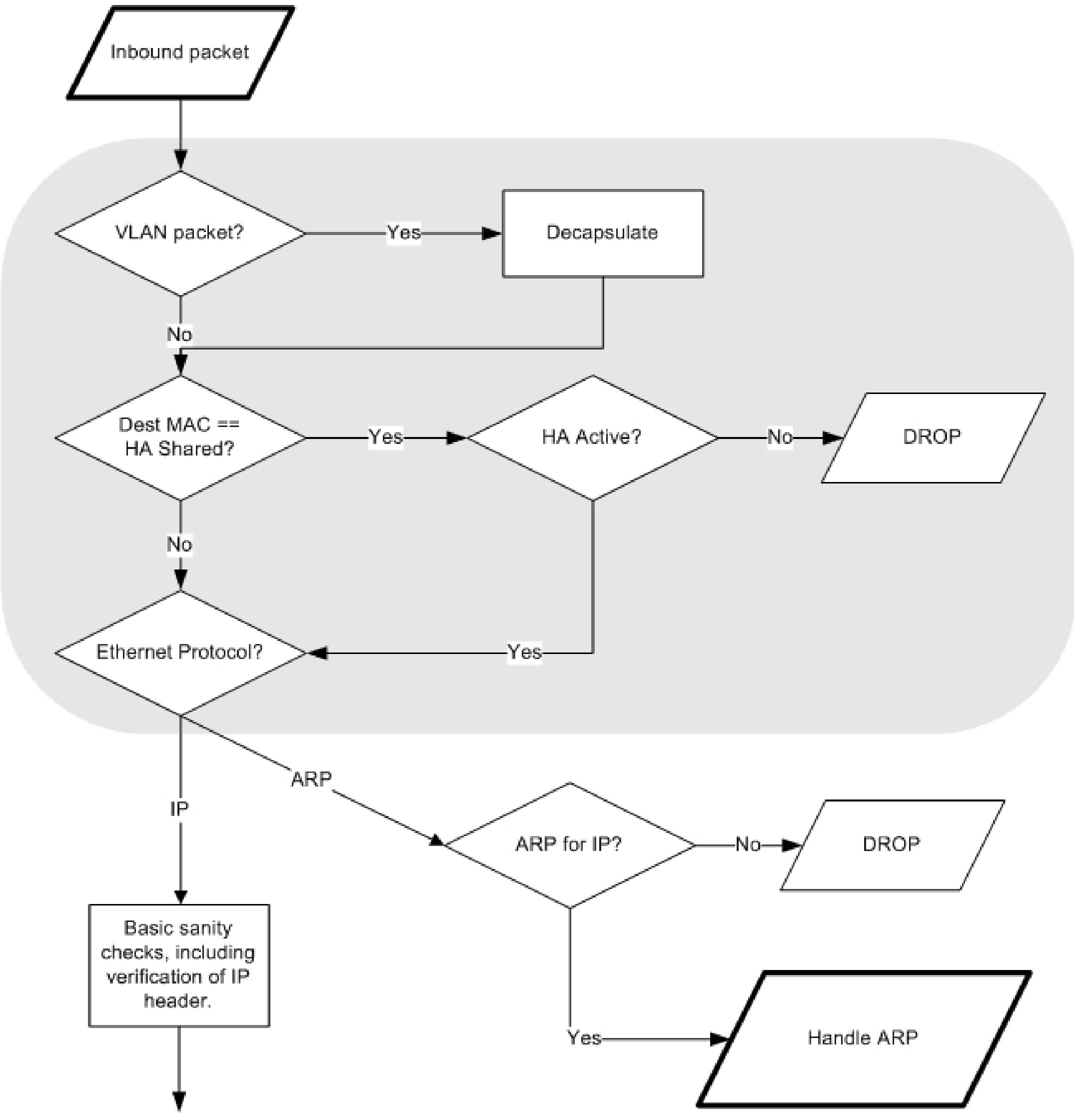
12. Eventually, the packet will be forwarded out on the destination interface according to the state. If the destination interface is a tunnel interface or a physical sub-interface, additional processing such as encryption or encapsulation might occur.

The following section provides a set of diagrams which illustrate the flow of packets through CorePlus.

1.3. CorePlus State Engine Packet Flow

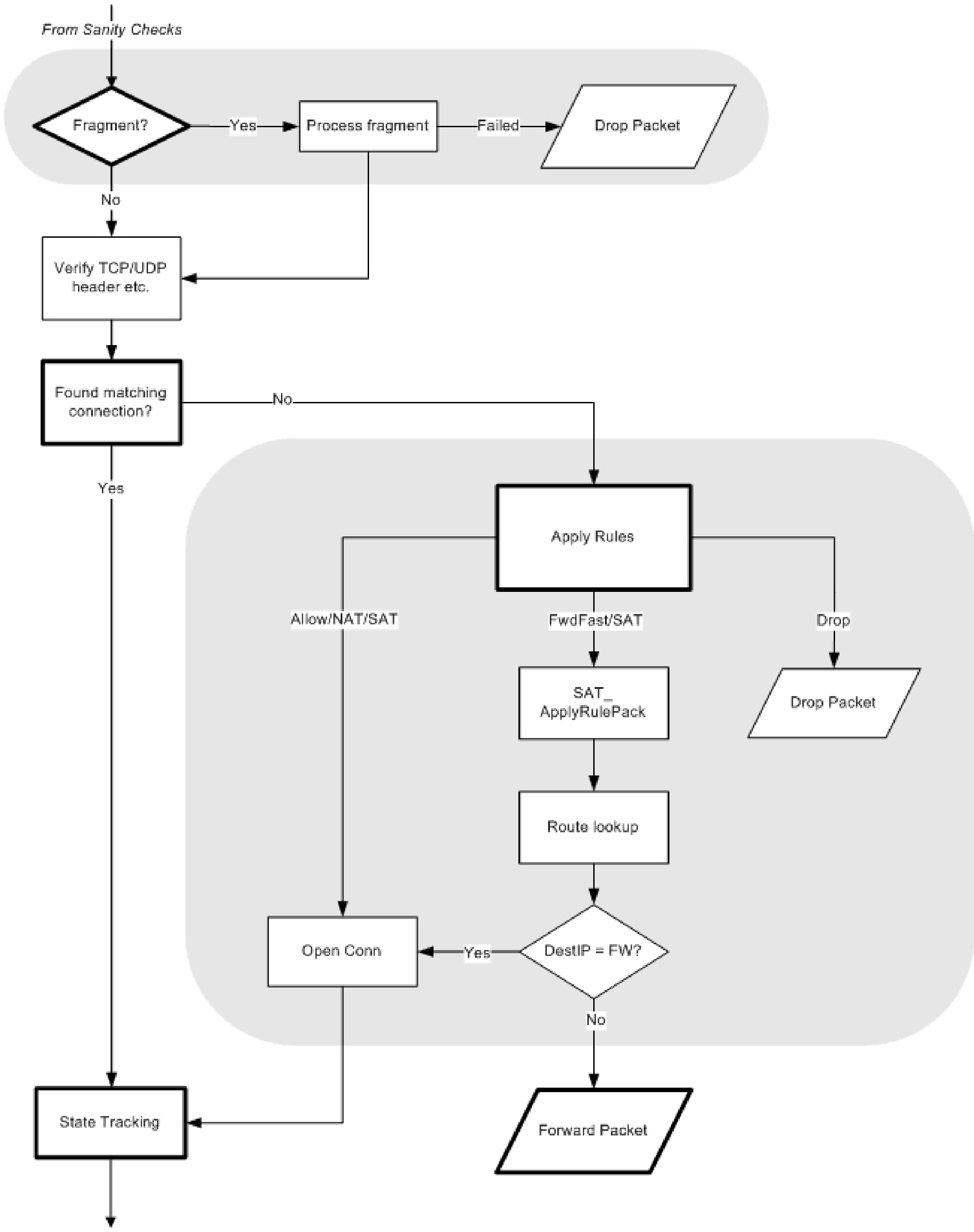
The diagrams in this section provide a summary of the flow of packets through the CorePlus state-engine. There are three diagrams, each flowing into the next.

Figure 1.1. Packet Flow Schematic Part I



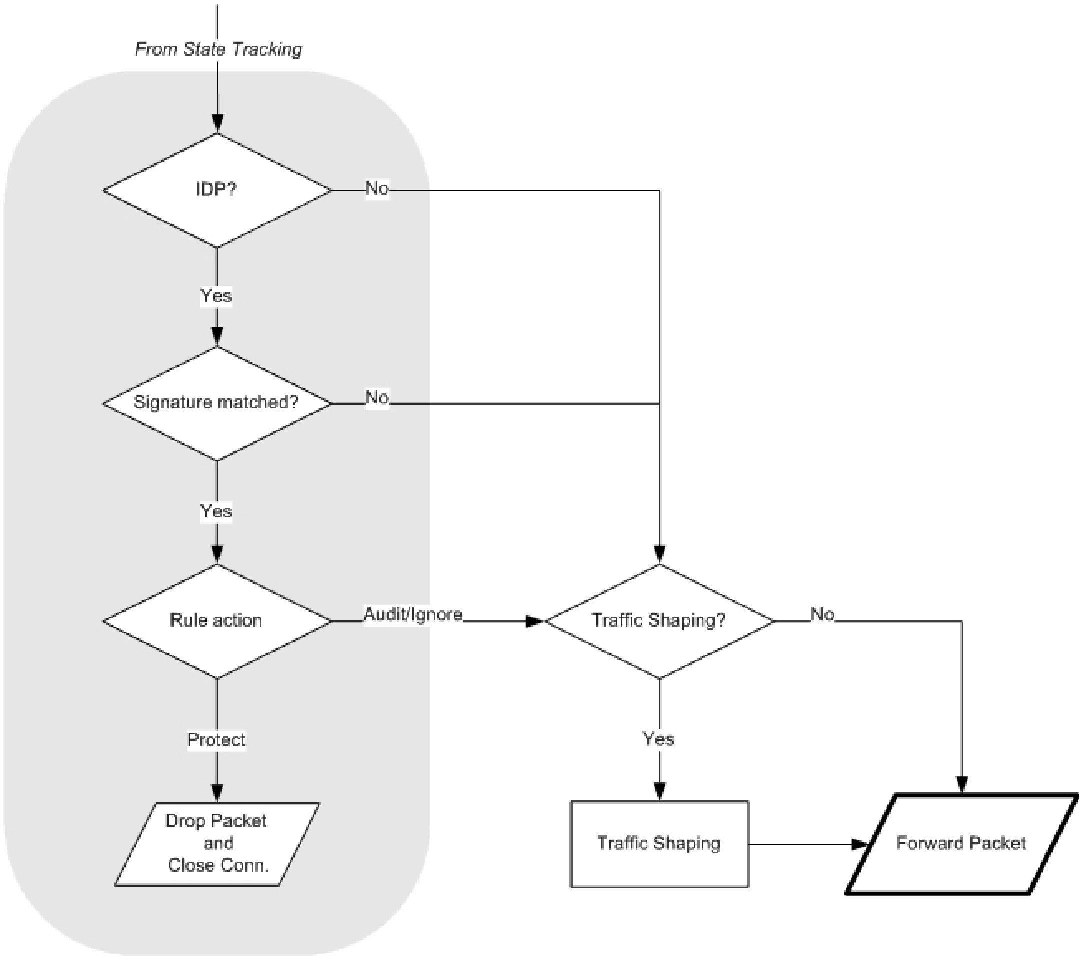
The packet flow is continued on the following page.

Figure 1.2. Packet Flow Schematic Part II



The packet flow is continued on the following page.

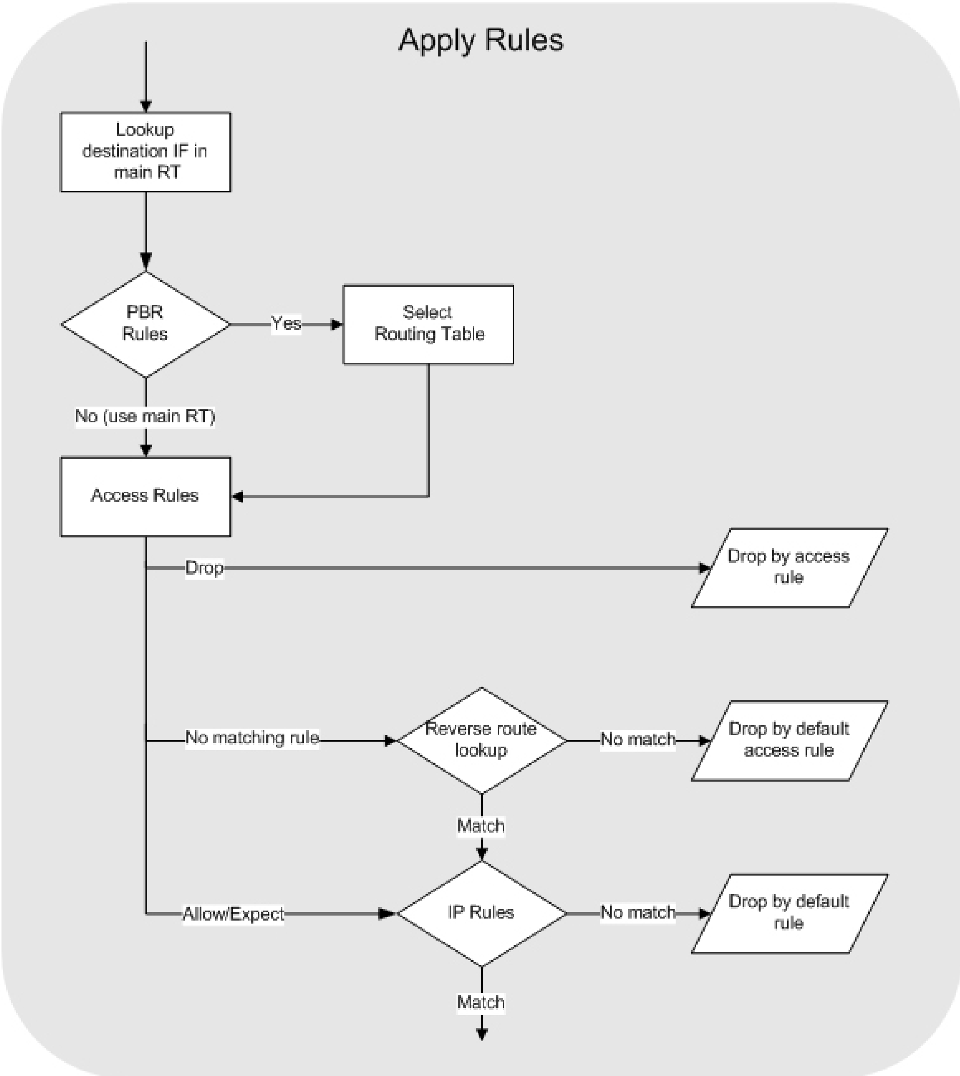
Figure 1.3. Packet Flow Schematic Part III



Apply Rules

The figure below presents the detailed logic of the *Apply Rules* function in Figure 1.2, “Packet Flow Schematic Part II” above.

Figure 1.4. Expanded *Apply Rules* Logic



Chapter 2. Management and Maintenance

This chapter describes the management, operations and maintenance related aspects of CorePlus.

2.1. Managing CorePlus

2.1.1. Overview

CorePlus is designed to give both high performance and high reliability. Not only does it provide an extensive feature set, it also enables the administrator to be in full control of almost every detail of the system. This means the product can be deployed in the most challenging environments.

A good understanding on how CorePlus configuration is performed is crucial for proper usage of the system. For this reason, this section provides an in-depth presentation of the configuration subsystem as well as a description of how to work with the various management interfaces.

Management Interfaces

CorePlus provides the following management interfaces:

Console Boot Menu
: Before CorePlus starts running, a console connected directly to the Clavister Security Gateway's RS232 port can be used to do basic configuration through the *boot menu*. This menu can be entered by pressing any console key between power-up and CorePlus starting. It is the *Clavister firmware loader* that is being accessed with the boot menu.

Clavister FineTune™
: Clavister FineTune is Microsoft Windows based software used for centralized management of several Clavister Security Gateways. Please refer to the separate Clavister FineTune user guide for a more detailed description of this tool.

Command Line Interface (CLI)
: The *Command Line Interface* (CLI) is accessible locally via the serial console port or remotely through Clavister FineTune or a separate Clavister utility called *fwctl*. Secure communication with CorePlus is achieved using the Clavister proprietary NetCon protocol. Please note that the current CorePlus version does not support configuration using the CLI.

Access to remote management interfaces can be regulated by a *remote management policy* so the administrator can restrict management access based on source network, source interface and credentials.

During the *Setup Base Configuration* phase, the administrator selects a management interface and provides IP address information for that interface. As a result, a remote management policy is added allowing NetCon access from hosts on the specified management network.

2.1.2. The Console Boot Menu

The Clavister *firmware loader* is the base software on top of which CorePlus runs and the administrator's interface to this loader is called the *console boot menu*. The boot menu is only accessible from the serial console located on the hardware chassis, and is only available if CorePlus has been shutdown or not yet started and power is on to the hardware. The boot menu provides a variety of commands to modify critical system settings and these are described below.

After powering up a brand new Clavister Security Gateway, a series of required configuration steps are displayed on the local console. On subsequent startups of the hardware there is a five second interval before CorePlus starts up in which time the message *Press any key to abort and load boot menu* is displayed on the console. If any console key is pressed during these 5 seconds then CorePlus startup pauses and the boot menu is displayed.

If a key is pressed during startup and a console password is set (and this must initially be done through Clavister FineTune) then the following two options are shown:

- **Login**
  This allows console login so the boot menu described below can be accessed.

- **Execute core**
  This allows CorePlus to startup.

Once startup is interrupted by a key press and console login is successfully completed then the boot menu will appear and the options accessible are as follows:

- **Execute core**
  This option starts CorePlus running after pausing startup to enter the boot menu..

- **Setup Base Configuration**
  This is used to setup a basic configuration to be able to communicate with the Clavister Security Gateway from Clavister FineTune. The first step consists of making a selection over which interface that should be used as a management interface. Next, the IP-address, Netmask and Gateway or DHCP need to be configured.

- **View Interface List**
  This is used to view the detected network cards in the system. If the driver is not auto-detected it's possible to enter one by hand.

- **System**
  This displays a new menu which is used to set/change various system specific parameters.

  - ***General Settings***
    This displays a new menu which is used to set/change various general parameters:

    - *SerialConsole* - Specifies whether serial Console should be enabled.

    - *SerialMonitor* - Specifies whether the serial display should be enabled.

    - *SerialConsoleComPort* - The COM port used for the serial console.

    - *SerialMonitorComPort* - The COM port used for the display.

    - *SerialConsoleBaudRate* - Specify the communication speed, make sure this is the same on the other end of the connection.

> **Note**
> *All these settings are read-only on non-Clavister hardware except for SerialConsoleBaudRate.*

- ***Time and Date***
  This is used to set the system Clock. Cursor left and right are used to select which element to modify and typing the desired value on the keyboard sets the element.

- ***Transfer System to other Boot Media***
  This is used to transfer the system to a new media. When the option is activated a list of available drives will be shown. After selecting a drive the system will be transferred to the new media after it has been completely reformatted. (This option will not seen when running CorePlus on non-Clavister hardware.

  > **Note**
  > *Make sure there is no vital/important data stored on the drive. The transfer is irreversible and all data on the new media will be lost.*

- ***Reset to Factory Defaults***
  This option will restore the hardware to its initial state. The operations performed if this option is selected are the following:

  - Restore default keys for NetCon communication with Clavister FineTune.
  - Remove the CorePlus configuration files.
  - Reset the loader settings.
  - Remove console security.
  - Restore default CorePlus and loader executables.

  > **Note**
  > *Resetting to factory defaults will not delete any auxiliary files that have been created in the Clavister Security Gateway memory. For instance, any files created by the pcapdump command won't be deleted. Files related to Anti-Virus or IDP also won't be deleted. If these auxiliary files need to be deleted then this must be done explicitly through the appropriate console command.*

  The reset to factory defaults option should also be used as part of the end of life precedure when a Clavister Security Gateway is taken out of operation and will no longer be used. As part of the decommissioning procedure, a reset to factory defaults should always be run in order to remove all sensitive information such as VPN settings.

- ***Revert to Default Remote Management Keys***
  This option will restore the remote management keys to default. This can also be done through Clavister FineTune.

- ***Set type to High Availability Master/Standalone***
  This is used during High Availability setup.

- ***Set type to High Availability Slave***
  This is also used during High Availability setup.

- **Advanced**
  This opens a submenu of advanced options:

  - ***Edit Firewall Configuration File***
    Starts the editor with the firewall configuration file loaded.

  - ***Display Latest Shutdown Message***
    This options display the latest shutdown message.

  - ***Text Editor***
    Starts the editor and asks for a file to be opened.

  - ***CLI (Command Line Interface)***
    Starts the command line interface (CLI) of the firewall loader.

- **Change Password**
  This is used to change the password of the default user. To initiate a password change, the user needs to submit the current password and the new password with verification. This option will not appear if the password has not yet been set through Clavister FineTune.

- **Logout Administrator**
  This option will logout the current user and enable the console security. This option will not appear if the password has not yet been set through Clavister FineTune.

2.1.3. The CLI

The CLI provides a set of number of commands used for management, monitoring and troubleshooting. The CLI is available either locally through the serial console port, or remotely though a window that can be opened in Clavister FineTune.

Note
The current implementation of CorePlus does not support configuration through the CLI.

The CLI provides a comprehensive set of commands that allow the display of configuration data as well as allowing runtime data to be displayed and allowing system maintenance tasks to be performed.

This section only provides a summary for using the CLI. For a complete reference for all console commands see Appendix B, *CLI Reference*.

Serial Console CLI Access

The serial console port is a local RS-232 port on the Clavister Security Gateway that allows direct access to the CorePlus CLI through a serial connection to a PC or dumb terminal. To locate the serial console port on your Clavister hardware, see the corresponding hardware installation guide.

To use the console port, you need the following equipment:

- A terminal or a computer with a serial port and the ability to emulate a terminal (such as using the *Hyper Terminal* software included in some Microsoft Windows editions). The serial console port uses the following default settings: *9600 bps, No parity, 8 data bits and 1 stop bit*.

- A RS-232 cable with appropriate connectors. An appliance package includes a RS-232 null-modem cable.

To connect a terminal to the console port, follow these steps:

1. Set the terminal protocol as described previously.

2. Connect one of the connectors of the RS-232 cable directly to the console port on your system hardware.

3. Connect the other end of the cable to the terminal or the serial connector of the computer running the communications software.

4. Press the *enter* key on the terminal. The CorePlus login prompt should appear on the terminal screen.

The NetCon Protocol

NetCon is a proprietary encrypted protocol that is used for secure remote access to CorePlus.

There are two primary methods of accessing the Clavister Security Gateway with the NetCon protocol:

The Remote Console This is a console which is part of Clavister FineTune. It has full access to the Clavister FineTune configuration database.

fwctl A stand-alone console command line tool. This is available in two versions, one for Linux and one for Microsoft Windows. **fwctl** was primarily designed for Linux environments and so follows Linux command line conventions (Appendix C, ***fwctl*** *Command Options* contains a full list of commands). It has the limitation that it does not have direct access to the Clavister FineTune configuration database, however it is able to upload complete configurations to the gateway as XML configuration files.

There is no specific remote management policy needed for CLI access using NetCon. As long as you are allowed to connect to the gateway using NetCon, CLI access will be granted as well.

> ***Note***
> *Where the hardware supports attachment of a VGA display and a keyboard, the CLI can also be accessed using such a console.*

The CLI Password

When accessing the CLI, the system will respond with a login prompt.

```
Cmd>
```

No password is initially required to access the CLI but the administrator can set a password by going to **Communication > Change Security Gateway Password** in Clavister FineTune. This password won't apply when using the console through Clavister FineTune but will be required when accessing the CLI through the console port.

2.1.4. Working with Configurations

The system configuration is built up by *Configuration Objects*, where each object represents a configurable item of any kind. Examples of configuration objects are routing table entries, address book entries, service definitions, IP rules and so on. Each configuration object has a number of properties that constitute the values of the object.

A configuration object has a well-defined type. The type defines the properties that are available for the configuration object, as well as the constraints for those properties. For instance, the *IP4Address* type is used for all configuration objects representing a named IPv4 address.

In Clavister FineTune, the configuration objects are organized into a tree-like structure based on the type of the object.

The following examples show how to manipulate objects.

Example 2.1. Listing Configuration Objects

To find out what configuration objects exist, you can retrieve a listing of the objects. This example shows how to list all service objects.

Clavister FineTune

1. Select the **Services** section of the target system in the tree view of the Security Editor.
2. A grid listing all services will be presented.

Example 2.2. Displaying a Configuration Object

The simplest operation on a configuration object is just to show its contents, in other words the values of the object properties. This example shows how to display the contents of a configuration object representing the *telnet* service.

Clavister FineTune

1. Select the **Services** section of the target system in the tree view of the Security Editor.
2. Select the **telnet** service object in the grid control.
3. Choose **Properties** from the context menu. The Service Properties dialog box will be displayed.

Example 2.3. Editing a Configuration Object

When you need to modify the behavior of CorePlus, you will most likely need to modify one or several configuration objects. This example shows how to edit the *Comments* property of the *telnet* service.

Clavister FineTune

1. Go to **Services**
2. Select the **telnet** service object
3. Choose **Properties** from the context menu and the Service Properties dialog will be displayed
4. In the **Comment** textbox, enter your new comment
5. Click **OK**

Important
Changes to a configuration object will not be applied to a running system until you activate and commit the changes.

Example 2.4. Adding a Configuration Object

This example shows how to add a new *IP4Address* object, here creating the IP address 192.168.10.10, to the Address Book.

Clavister FineTune

1. Go to **Hosts & Networks > New Host & Network**
2. The **Host & Network Properties** dialog will be displayed
3. Specify a suitable name for the object, for instance myhost
4. Choose **Host** in the **Type** control
5. Enter 192.168.10.10 in the **IP Address** textbox
6. Click **OK**

Example 2.5. Deleting a Configuration Object

This example shows how to delete the newly added IP4Address object.

Clavister FineTune

1. Go to **Hosts & Networks**
2. Right-click the row containing the **myhost** object
3. In the menu displayed, select **Delete**
4. Click **OK**

Activating and Committing a Configuration

After changes to a configuration have been made, the configuration has to be activated for those changes to have an impact on the running system. During the activation process, the new proposed configuration is validated and CorePlus will attempt to initialize affected subsystems with the new configuration data.

Committing IPsec Changes

The administrator should be aware that if any changes that affect the configurations of live IPsec tunnels are committed, then those live tunnels connections WILL BE TERMINATED and must be re-established.

If the new configuration is validated, CorePlus will wait for a short period (30 seconds by default) during which a connection to the administrator must be re-established. If a lost connection could not be re-established then CorePlus will revert to using the previous configuration. This is a fail-safe mechanism and, amongst others things, can help prevent a remote administrator from locking themselves out.

Example 2.6. Activating and Committing a Configuration

This example shows how to activate and commit a new configuration.

Clavister FineTune

1. Bring up the context menu for the target gateway
2. Choose **Check-in**
3. Enter a comment if required and confirm

Note

The configuration must be committed before changes are saved. All changes to a configuration can be ignored simply by not committing a changed configuration.

2.2. Events and Logging

2.2.1. Overview

The ability to log and analyze system activities is an essential feature of CorePlus. Logging enables not only monitoring of system status and health, but also allows auditing of network usage and assists in trouble-shooting.

CorePlus defines a number of *event messages*, which are generated as a result of corresponding system events. Examples of such events are the establishment and teardown of connections, receipt of malformed packets as well as the dropping of traffic according to filtering policies.

Log events are always generated for certain aspects of CorePlus such as buffer usage, DHCP clients, High Availability and IPsec. The generation of events for other CorePlus subsystems such as DHCP Relay, DHCP Servers and IP Rules can be enabled as needed.

Whenever an event message is generated, it can be filtered and distributed to a variety of *Event Receivers*, including Syslog and SNMP Trap receivers. Up to eight event receivers can be defined per Clavister Security Gateway, with each receiver having its own customizable event filter.

2.2.2. Event Messages

CorePlus defines several hundred events for which event messages can be generated. The events range from high-level, customizable, user events down to low-level and mandatory system events.

The *conn_open* event, for instance, is a typical high-level event that generates an event message whenever a new connection is established, given that the matching security policy rule has defined that event messages should be generated for that connection.

An example of a low-level event would be the *startup_normal* event, which generates a mandatory event message as soon as the system starts up.

All event messages have a common format, with attributes that include category, severity, recommended actions. These attributes enable easy filtering of messages, either within CorePlus prior to sending to an event receiver, or as part of the analysis after logging and storing messages on an external log server.

A list of all event messages can be found in the CorePlus *Log Reference Guide*. That guide also describes the design of event messages, the meaning of severity levels and the various attributes available. The severity of each event is predefined and it can be, in order of severity, one of:

Emergency
Alert
Critical
Error
Warning
Notice
Info
Debug

By default all messages of level **Info** and above are sent. The **Debug** category of designed for troubleshooting only and should only be turned on if required to try and solve a problem. Messages of all severity levels are found listed in the CorePlus *Log Reference Guide*.

2.2.3. Event Message Distribution

To distribute and log the event messages generated, it is necessary to define one or more event receivers that specify *what* events to capture, and *where* to send them.

CorePlus can distribute event messages in the following ways:

Syslog The de-facto standard for logging events from network devices. If other network devices are already logging to Syslog servers, using syslog with CorePlus messages can simplify overall administration.

FWLog The Clavister proprietary format for logging event messages, the FWLog format has a high level of detail and is suitable for analyzing large amounts of log data.

SNMP Traps Commonly used to collect and respond to critical alerts from network devices.

NetCon Real-time Log Event messages will always be distributed to any Real-time Log listeners that are connecting using the NetCon protocol.

2.2.3.1. Logging to Syslog Hosts

Overview

Syslog is a standardized protocol for sending log data although there is no standardized format for the log messages themselves. The format used by CorePlus is well suited to automated processing, filtering and searching.

Although the exact format of each log entry depends on how a Syslog receiver works, most are very much alike. The way in which logs are read is also dependent on how the syslog receiver works. Syslog daemons on UNIX servers usually log to text files, line by line.

Message Format

Most Syslog recipients preface each log entry with a timestamp and the IP address of the machine that sent the log data:

```
Feb 5 2000 09:45:23 gateway.ourcompany.com
```

This is followed by the text the sender has chosen to send.

```
Feb 5 2000 09:45:23 gateway.ourcompany.com EFW: DROP:
```

Subsequent text is dependent on the event that has occurred.

In order to facilitate automated processing of all messages, CorePlus writes all log data to a single line of text. All data following the initial text is presented in the format *name=value*. This enables automatic filters to easily find the values they are looking for without assuming that a specific piece of data is in a specific location in the log entry.

> ***Note***
> *The **Prio=** field in SysLog messages contains the same information as the **Severity** field for Clavister Logger messages, however the ordering of the numbering is reversed.*

Example 2.7. Enable Logging to a Syslog Host

To enable logging of all events with a severity greater than or equal to Notice to a Syslog server with IP address 195.11.22.55, follow the steps outlined below:

Clavister FineTune

1. Go to **Event Handling/Event Receivers > New Event Receiver**
2. The **Event Receiver Properties** dialog will be displayed

3. Specify a suitable name for the event receiver, for example *my_syslog*
4. Select **Syslog** as the **Type**
5. Enter *195.11.22.55* as the **IP Address**
6. Select an appropriate facility from the **Facility** list. The facility name is commonly used as a filter parameter in most syslog daemons.
7. Click **OK**

The system will now be logging all events with a severity greater than or equal to Notice to the syslog server at *195.11.22.55*.

Note: Syslog server configuration

The syslog server may have to be configured to receive log messages from CorePlus. Please see the documentation for your specific Syslog server software in order to correctly configure it.

2.2.3.2. Logging to the Clavister Logger

The *Clavister Logger* uses the proprietary Clavister *FWLog* message format for sending and storing log data. The FWLog format provides a high level of detail and is therefore very useful for troubleshooting. This logger is also referred to as the *FWLog Receiver*.

The Clavister Logger software runs as a service on a Microsoft Windows server, and is included with the CorePlus distribution packet as a standalone utility. For more information about setting up and configuring the Clavister Logger, please see the *Clavister Clavister FineTune™ Administration Guide*.

Example 2.8. Enabling Logging to Clavister Loggers

To enable logging of all events with a severity greater than or equal to *Notice* to the Clavister Logger (*FWLog Receiver*) with IP address *195.11.22.55* listening on port *999* (the default), follow the steps below:

Clavister FineTune

1. Go to **Event Handling/Event Receivers > New Event Receiver**
2. The **Event Receiver Properties** dialog box will be displayed
3. Specify a suitable name for the event receiver, for example *my_fwlog*
4. Select **FWLog** as the **Type**
5. Enter *195.11.22.55* as the **IP Address**
6. Click **OK**

The system will now be logging all events with a severity greater than or equal to *Notice* to the Clavister FWLogger at *195.11.22.55*.

2.2.3.3. SNMP Traps

The SNMP protocol

Simple Network Management Protocol (SNMP) is a means for communicating between a Network Management System (NMS) and a managed device. SNMP defines 3 types of messages: a *Read* command for an NMS to examine a managed device, a *Write* command to alter the state of a managed device and a *Trap* which is used by managed devices to send messages asynchronously to an NMS about a change of state.

SNMP Traps in CorePlus

CorePlus takes the concept of an SNMP Trap one step further by allowing *any* event message to be sent as an SNMP trap. This means that the administrator can set up SNMP Trap notification of events that you consider significant for the operation of a network.

The file *Clavister-TRAP.MIB* which is included under the *SNMP* directory in the CorePlus distribution, defines the SNMP objects and data types that are used to describe an SNMP Trap received from CorePlus.

There is one generic trap object called *OSGenericTrap*, that is used for all traps. This object includes the following parameters:

- *System* - The system generating the trap
- *Severity* - Severity of the message
- *Category* - What CorePlus subsystem is reporting the problem
- *ID* - Unique identification within the category
- *Description* - A short textual description
- *Action* - What action is CorePlus taking

This information can be cross-referenced to the *Log Reference Guide*.

Note

CorePlus sends SNMP Traps which are based on the SNMPv2c standard as defined by RFC1901, RFC1905 and RFC1906.

Example 2.9. Sending SNMP Traps to an SNMP Trap Receiver

To enable generation of SNMP traps for all events with a severity greater than or equal to Alert to an SNMP trap receiver with an IP address of 195.11.22.55, follow the steps outlined below:

Clavister FineTune

1. Go to **Event Handling/Event Receivers > New Event Receiver**
2. The **Event Receiver Properties** dialog will be displayed
3. Specify a name for the event receiver, for example *my_snmp*
4. Select **SNMP2c** as the **Type**
5. Enter 195.11.22.55 as the **IP Address**
6. Enter an SNMP **Community String** if needed by the trap receiver
7. Click **OK**

The system will now be sending SNMP traps for all events with a severity greater than or equal to Alert to an SNMP trap receiver at 195.11.22.55.

2.2.4. Customizing Log Messages

The sending of log messages can be customized to meet specific needs. This is done on a per log receiver basis. There are two types of customization that can be performed for a log receiver:

- Specific log messages or categories of log messages may be excluded from sending.
- The default severity of specific log messages or categories of log messages can be changed.

Log Message Categories

A log message is identified by a unique number. The first 3 digits of that number identify the *Category* to which the log message belongs. Categories relate to specific subsystems in CorePlus. For instance IPsec is such a subsystem and is identified by the category ID *018*. The CorePlus *Log Reference Guide* details all messages with their unique identifiers.

Changing the Default Severity Level

A log message has a default severity level, based on the importance of the event that caused the log message to be sent. However, this might differ between different installations. An event that is crucial in one scenario might not be of interest in another. For this reason it is possible to change the default severity level for a particular log message or for an entire category of messages.

Excluding a Log Message

A particular log message or category of messages can be excluded so that they will never be sent. This is useful if an event that is frequent causes a log message to be sent too often when it is of no interest to the administrator. An entire event category may similarly be of no interest to the administrator. The event ID or category can be identified from the CorePlus *Log Reference Guide*.

The Include/Exclude Mechanism

For each log receiver definition, a list of event and/or category *Includes* as well as *Excludes* can be created to define the messages that are to be sent or not sent to the receiver.

A specific message or messages may be included whereas the group is excluded. This means that only the included messages will be sent from the category. Likewise, only specific messages might be excluded from a category.

Example 2.10. Changing the Default Severity of a Category

In this example all messages of the *IPsec* category with category ID *018* are to be sent to the log receiver with a default severity level of *Error*. The exception is the log message *01802902* which will still be sent. We assume that a log receiver called *log_rec1* is already defined.

Clavister FineTune

1. Go to **Events & Logging > Log Receivers**
2. Double click *log-rec1* to bring up the log receiver's properties
3. Select the **Log Messages** tab
4. Click the + button and the Include/Exclude dialog will appear
5. Select **Include** from the drop-down list
6. Enter *018* in the **Category** field
7. Leave the ID field empty
8. Select **Error** from the severity drop-down list
9. Click **OK**
10. Click the + button and the Include/Exclude dialog will appear

11. Select **Exclude** from the drop-down list
12. Enter *018* in the **Category** field
13. Enter *02902* in the **ID** field
14. Click **OK**
15. Click **OK** again

Example 2.11. Disabling a Category

In this example all log messages of the category *SNMP* with category ID *031* are to be excluded from logging to the *log_rec1* server.

Clavister FineTune

1. Go to **Events & Logging > Log Receivers**
2. Double click *log-rec1* to bring up the log receiver's properties
3. Select the **Log Messages** tab
4. Click the + button and the Include/Exclude dialog will appear
5. Select **Exclude** from the drop-down list
6. Enter *031* in the **Category** field
7. Leave the ID field empty
8. Click **OK**
9. Click **OK** again

2.3. RADIUS Accounting

2.3.1. Overview

Within a network environment containing large numbers of users, it is advantageous to have one or a cluster of central servers that maintain user account information and are responsible for authentication and authorization tasks. The central database residing on the dedicated server(s) contains all user credentials as well as details of connections, significantly reducing administration complexity. The Remote Authentication Dial-in User Service (RADIUS) is an Authentication, Authorization and Accounting (AAA) protocol widely used to implement this approach and is used by CorePlus to implement user accounting.

RADIUS Architecture

The RADIUS protocol is based on a client/server architecture. The Clavister Security Gateway acts as the client of the RADIUS server, creating and sending requests to a dedicated server(s). In RADIUS terminology the gateway acts as the Network Access Server (NAS).

For user authentication, the RADIUS server receives the requests, verifies the user's information by consulting its database, and returns either an "ACCEPT" or "REJECT" decision to the requested client. In RFC2866, RADIUS was extended to handle the delivery of accounting information and this is the standard followed by CorePlus for user accounting. The benefits of having centralized servers are thus extended to user connection accounting. (For details of the usage of RADIUS for CorePlus authentication see Section 8.2, “Authentication Setup”).

2.3.2. RADIUS Accounting Messages

Statistics, such as number of bytes sent and received, and number of packets sent and received are updated and stored throughout RADIUS sessions. All statistics are updated for an authenticated user whenever a connection related to an authenticated user is closed.

When a new client session is started by a user establishing a new connection through the Clavister Security Gateway, CorePlus sends an *AccountingRequest* **START** message to a nominated RADIUS server, to record the start of the new session. User account information is also delivered to the RADIUS server. The server will send back an *AccountingResponse* message to CorePlus, acknowledging that the message has been received.

When a user is no longer authenticated, for example, after the user logs out or the session time expires, an *AccountingRequest* **STOP** message is sent by CorePlus containing the relevant session statistics. The information included in these statistics is user configurable. The contents of the **START** and **STOP** messages are described in detail below:

START Message Parameters

Parameters included in **START** messages sent by CorePlus are:

- **Type** - Marks this AccountingRequest as signalling the beginning of the service (START).
- **ID** - A unique identifier to enable matching of an AccountingRequest with Acct-Status-Type set to STOP.
- **User Name** - The user name of the authenticated user.
- **NAS IP Address** - The IP address of the Clavister Security Gateway.
- **NAS Port** - The port of the NAS on which the user was authenticated (this is a physical port and not a TCP or UDP port).
- **User IP Address** - The IP address of the authenticated user. This is sent only if specified on the

authentication server.

- **How Authenticated** - How the user was authenticated. This is set to either *RADIUS* if the user was authenticated via RADIUS, or *LOCAL* if the user was authenticated via a local user database.
- **Delay Time** - The time delay (in seconds) since the AccountingRequest packet was sent and the authentication acknowledgement was received. This can be subtracted from the time of arrival on the server to find the approximate time of the event generating this AccountingRequest. Note that this does not reflect network delays. The first attempt will have this parameter set to 0.
- **Timestamp** - The number of seconds since 1970-01-01. Used to set a timestamp when this packet was sent from CorePlus.

STOP Message Parameters

Parameters included in **STOP** messages sent by CorePlus are:

- **Type** - Marks this accounting request as signalling the end of a session (STOP).
- **ID** - An identifier matching a previously sent AccountingRequest packet, with Acct-Status-Type set to START.
- **User Name** - The user name of the authenticated user.
- **NAS IP Address** - The IP address of the Clavister Security Gateway.
- **NAS Port** - The port on the NAS on which the user was authenticated. (this is a physical port and not a TCP or UDP port).
- **User IP Address** - The IP address of the authenticated user. This is sent only if specified on the authentication server
- **Input Bytes** - The number of bytes received by the user. (*)
- **Output Bytes** - The number of bytes sent by the user. (*)
- **Input Packets** - The number of packets received by the user. (*)
- **Output Packets** - The number of packets sent by the user. (*)
- **Session Time** - The number of seconds this session lasted. (*)
- **Termination Cause** - The reason why the session was terminated.
- **How Authenticated** - How the user was authenticated. This is set to either *RADIUS* if the user was authenticated via RADIUS, or *LOCAL* if the user was authenticated via a local user database.
- **Delay Time** - See the above comment about this parameter.
- **Timestamp** - The number of seconds since 1970-01-01. Used to set a timestamp when this packet was sent from the Clavister Security Gateway. In addition to this, two more attributes are possibly sent:
- **Input Gigawords** - Indicates how many times the Input Bytes counter has wrapped. This is only sent if Input Bytes has wrapped, and if the Input Bytes attribute is sent.
- **Output Gigawords** - Indicates how many times the Output Bytes counter has wrapped. This is only sent if Output Bytes has wrapped, and if the Output Bytes attribute is sent.

> **Note**
> *The (*) symbol in the above list indicates that the sending of the parameter is user configurable.*

2.3.3. Interim Accounting Messages

In addition to **START** and **STOP** messages CorePlus can optionally periodically send *Interim Accounting Messages* to update the accounting server with the current status of an authenticated user. An Interim Accounting Message can be seen as a snapshot of the network resources that an authenticated user has used up until a given point. With this feature, the RADIUS server can track how many bytes and packets an authenticated user has sent and received up until the point when the last message was sent.

An Interim Accounting Message contains the current values of the statistics for an authenticated user. It contains more or less the same parameters as found in an AccountingRequest Stop message, except that the *Acct-Terminate-Cause* is not included (as the user has not disconnected yet).

The frequency of Interim Accounting Messages can be specified either on the authentication server, or in CorePlus. Switching on the setting in CorePlus will override the setting on the accounting server.

2.3.4. Activating RADIUS Accounting

In order to activate RADIUS accounting a number of steps must be followed:

- The RADIUS accounting server must be specified.
- A user authentication object must have a rule associated with it where a RADIUS server is specified.

Some important points should be noted about activation:

- RADIUS Accounting will not function where a connection is subject to a **FwdFast** rule in the IP rule set.
- The same RADIUS server does not need to handle both authentication and accounting; one server can be responsible for authentication while another is responsible for accounting tasks.
- Multiple RADIUS servers can be configured in CorePlus to deal with the event when the primary server is unreachable.

2.3.5. RADIUS Accounting Security

Communication between CorePlus and any RADIUS accounting server is protected by the use of a shared secret. This secret is never sent over the network but instead a 16 byte long *Authenticator code* is calculated using a one way MD5 hash function and this is used to authenticate accounting messages.

The shared secret is case sensitive, can contain up to 100 characters, and must be typed exactly the same for CorePlus and for the RADIUS server.

Messages are sent using the UDP protocol and the default port number used is 1813 although this is user configurable.

2.3.6. RADIUS Accounting and High Availability

In an HA cluster, accounting information is synchronized between the active and passive Clavister Security Gateways. This means that accounting information is automatically updated on both cluster members whenever a connection is closed. Two special accounting events are also used by the active unit to keep the passive unit synchronized:

- An **AccountingStart** event is sent to the inactive member in an HA setup whenever a response has been received from the accounting server. This specifies that accounting information should be stored for a specific authenticated user.
- A problem with accounting information synchronization could occur if an active unit has an authenticated user for whom the associated connection times out before it is synchronized on the inactive unit. To get around this problem, a special **AccountingUpdate** event is sent to the passive unit on a timeout and this contains the most recent accounting information for connections.

2.3.7. Handling Unresponsive Servers

A question arises in the case of a client that sends an *AccountingRequest* **START** packet which the RADIUS server never replies to. CorePlus will re-send the request after the user-specified number of seconds. This will however mean that a user will still have authenticated access while CorePlus is trying to contact to the accounting server.

Only after CorePlus has made three attempts to reach the server will it conclude that the accounting server is unreachable. The administrator can use the CorePlus advanced setting **AllowAuthIfNoAccountingResponse** to determine how this situation is handled. If this setting is enabled then an already authenticated user's session will be unaffected. If it is not enabled, any affected user will automatically be logged out even if they have already been authenticated.

2.3.8. Accounting and System Shutdowns

In the case that the client for some reason fails to send a RADIUS *AccountingRequest* **STOP** packet, the accounting server will never be able to update its user statistics, but will most likely believe that the session is still active. This situation should be avoided.

In the case that the Clavister Security Gateway administrator issues a shutdown command while authenticated users are still online, the *AccountingRequest* **STOP** packet will potentially never be sent. To avoid this, the advanced setting **LogoutAccUsersAtShutdown** allows the administrator to explicitly specify that CorePlus must first send a **STOP** message for any authenticated users to any configured RADIUS servers before commencing with the shutdown.

2.3.9. Limitations with NAT

The User Authentication module in CorePlus is based on the user's IP address. Problems can therefore occur with users who have the same IP address.

This can happen, for instance, when several users are behind the same network using NAT to allow network access through a single external IP address. This means that as soon as one user is authenticated, traffic coming through that NAT gateway IP address could be assumed to be coming from that one authenticated user even though it may come from other users on the same network. CorePlus RADIUS Accounting will therefore gather statistics for all the users on the network together as though they were one user instead of individuals.

Example 2.12. User Authentication Server Setup

This example shows configuring of a local RADIUS server known as *radius-accounting* with IP address *123.04.03.01* using port *1813*.

Clavister FineTune

1. Go to **User Authentication > Servers > New Server**

2. Now enter:
   - **Name:** radius-accounting
   - **Type:** RADIUS
   - **IP Address:** 123.04.03.01
   - **Port:** 1812
   - **Retry Timeout:** 2
   - **Shared Secret:***enter a password*
   - **Confirm Secret:***re-enter the password*
   - **Routing Table:** main
3. Repeat the above two steps to configure the standby AAA-server.

2.4. Monitoring

The real-time performance of CorePlus can be monitored in a number of ways which are described in this section. They are:

- Real-time Monitoring with Clavister Clavister FineTune™.
- CorePlus Real-time monitor alerts.
- The CorePlus Link Monitor.
- Monitoring through an SNMP client.

2.4.1. Monitoring with PinPoint™

PinPoint is a standalone software product specifically designed for real-time monitoring of one or more Clavister Security Gateways. It is a complement to the existing CorePlus monitoring tools.

PinPoint is a visual tool where the administrator can create *dashboards* which are made up of collections of different graphical monitoring objects. The objects might be in the form of graphs or gauges or might also be in the form of meters. Each object is assigned different CorePlus parameters to monitor, for instance a gauge might indicate overall throughout. PinPoint's emphasis is on providing immediate visual feedback of what different CorePlus modules and functions are doing at any point in time and to provide the administrator with a visual representation of overall system performance.

PinPoint is free to use and does not require additional licensing. It can be downloaded from the Clavister Customer Web and the user manual is included with the product as well as being available from the Clavister website.

PinPoint is typically installed on the same workstation as Clavister FineTune. If this is the case, the product can automatically read the Data Source files of the configured Clavister Security Gateways and be ready immediately to communicate with them.

2.4.2. Real-time Monitoring Counters

CorePlus status and operational statistics are available to Clavister FineTune for graphical display through the use of *Real-time Monitoring*. This achieved by Clavister FineTune routinely polling CorePlus to gather the latest values of operational parameters. The following counters are available through this feature:

Throughput Statistics

CPU – The percentage load on the gateway CPU.

Forwarded bps - The number of bits forwarded through the gateway per second.

Forwarded pps - The number of packets forwarded through the gateway per second.

Buf use – Percentage of gateway packet buffers used.

Conns – The number of connections opened via Allow or NAT rules. No connections are opened for traffic allowed via FwdFast rules; such traffic is not included in this statistic.

Timers – The amount of timers used by the system.

Total mem usage – Percentage of the RAM memory that is currently being used.

Connection Rate Statistics

Conns opened per sec – The number of connections opened per second.

Conns closed per sec – The number of connections closed per second.

State Engine Statistics

ICMP Connections - Total number of ICMP connections.

UDP Connections - Total Number of UDP connections.

OPEN TCP - Total number of open TCP connections.

TCP SYN - Total number of TCP connections in the SYN phase.

TCP FIN - Total number of TCP connections in the FIN phase.

Other - Total number of other connections types such as IPsec.

TCP Buffer Statistics

Total small receive window usage - The number of small TCP receive windows currently being used.

Total large receive window usage - The number of large TCP receive windows currently being used.

Total small send window usage - The number of small TCP send windows currently being used.

Total large send window usage - The number of large TCP send windows currently being used.

Rule Usage Statistics

Each of the rules in a rule set has a counter associated with it which has the same name as the rule type. These counters indicates the number of matches that have taken place for each rule. The rule sets that exist are:

- **IP Rules**
- **PBR Rules**
- **DHCP Rules**
- **User-authentication rules**

Interface/VLAN/VPN Statistics

Rx/Tx Ring counters - Some drivers support plotting of FIFO-errors, saturation, flooding and other values depending on the driver.

Pps counters – The number of packets received, sent and summed together.

Bbs – The number of bits received, sent and summed together.

Drops – The number of packets received by this interface that were dropped due to rule set decisions or failed packet consistency checks.

IP errors – The number of packets received by this interface that were mutilated so badly that they would have had difficulty passing through a router to reach to the Clavister Security Gateway. They are therefore unlikely to be the result of an attack.

Send Fails – The number of packets that could not be sent, either due to internal resource starvation caused by heavy loading or hardware problems or congested half-duplex connections.

Frags recieved – The number of IP packet fragments received by this interface.

Frag reass – The number of complete packets successfully reassembled from the fragments received.

Frag reass fail – The number of packets that could not be reassembled, either due to resource starvation, illegal fragmentation, or just packet loss.

Active SAs - Current active number of SAs in use (VPN only).

Pipe Statistics

Total Pipe Statistics

Num users – The current number of users, as defined by the grouping settings of each pipe, being tracked in the pipes system. Note that this value corresponds to the number of users active in each time slice of 1/20th of a second, and not to the number of users having "open" connections.

Per Pipe Statistics

Num Users - The current number of users as above but on a per pipe basis.

Current bps – The current throughput of the pipe, in bits per second, per precedence and as a sum of all precedences.

Current pps – The current throughput of the pipe, in packets per second, per precedence and as a sum of all precedences.

Reserved bps – The current bandwidth allocated to each precedence; lower precedences are not allowed to use this bandwidth. Note that there is no reserved bandwidth for precedence 0, as it is simply given what is left of the total limit after all higher precedence reservations are subtracted.

Dyn limit bps – The current bandwidth limit applied to the respective precedences. This is related to the *Reserved bps* statistic, but is usually higher, as it shows how much bandwidth is left after higher precedence reservations have been subtracted from the total limit.

Delayed Packets – The number of times packets have been delayed as a result of a pipe, precedence, or pipe user having used up its allotted bandwidth. Note that one single packet may be delayed several times; if a pipe is really full, this count may exceed the number of packets actually passing through the pipe.

Dropped Packets – The number of packets dropped. Packets are dropped when CorePlus is running out of packet buffers. This occurs when excessive amounts of packets need to be queued for later delivery. The packet dropped is always the one that has been queued the longest time globally, which means that the connection suffering from packet loss will be the one most overloading the system .

Dyn User Limit bps – The current bandwidth limit per user of the pipe. If dynamic bandwidth balancing is enabled, this value may be lower than the configured per-user limits.

DHCP Server Statistics

Total Rejected requests – Total number of rejected packets (all rules).

Per Rule Statistics

Usage – Number of used IPs in the pool.

Usage (%) – Above value calculated as a percentage.

Active Clients – Number of currently active clients (BOUND).

Active Clients (%) – Above value calculated as a percentage.

Reject requests – Number of rejected requests.

Total number of leases – Total number of leases in the pool.

DHCP Relay Statistics

Total active relayed clients - Number of active relays in the Clavister Security Gateway.

Ongoing transactions - DHCP transactions in the gateway.

Total rejected - Number of packets rejected by the DHCPRelay.

Active relayed clients - Number of active relays that uses this specific rule.

Rejected packets per rule - Number of packets rejected from clients using this rule.

General ALG Statistics

Total ALG sessions - Total number of ALG sessions.

Total connections - Total number of connections.

Total TCP Streams - Total number of TCP streams.

HTTP ALG, Web Content Filtering and Antivirus Statistics

Total requests - Total number of requests.

Total allowed - Total number allowed.

Total blocked - Total number of blocks.

URLs requested - Requests per URL category.

URLs allowed - Allowed requests per URL category.

URLs rejected - Rejected requests per URL category.

SMTP ALG DNSBL Statistics

Total Sessions Checked - Total number of URLs checked.

Total Sessions Spam - Total number of URLs found to be SPAM.

Total Sessions Dropped - Total number of sessions dropped.

SMTP ALG DNSBL Server Statistics

For each DNSBL server:

Total Sessions Checked - Total number of URLs checked by server.

Total Sessions Matched - Total number of URLs found to be SPAM by server.

Total Failed Checks - Total number of checks where no response was received.

User Authentication Statistics

PPP – Number of PPP authenticated users.

HTTPAuth – Number of HTTP authenticated users.

Secure HTTP – Number of secure HTTP authenticated users.

XAUTH – Number of XAUTH authenticated users.

Link Monitor Statistics

PPP – Number of PPP authenticated users.

Packets lost/sec – Number of packets lost per second in polling.

Short Term Loss – % of short term packet loss.

Hosts Up – % of hosts available.

Packet Reassembly Statistics

Input Drops – Number of packet drops on input.

Load Factor – Loading of reassembly subsystem.

Allowed Buffers – Allowed buffers per connection.

IP Pools Statistics

Prepared – Number of prepared IP addresses.

Free – Number of addresses free.

Used – Number of addresses used.

Misses – Number of requests not met.

High Availability Statistics

Interface Queue – Size of the queue used for the sync interface.

Queue Usage Packets – Amount of the queue used in packets.

Queue Usage Bytes – Amount of the queue used in bytes.

Packets Sent – Number of packets sent on Sync.

Resent Packets – Number of packets resent on Sync.

Hardware Statistics

Temperature – Internal temperature of the device.

Fan Status – Status of the devices fans.

> ***Note***
> *Hardware statistics are only available on the Clavister SG3100, SG4200 and SG4400 Series hardware.*

2.4.3. Real-time Monitor Alerts

Clavister Clavister FineTune™ allows a number of CorePlus statistical values to be graphically monitored through the Real-time Monitor feature as described in the previous section. In addition to specifying which statistical values to monitor, *Real-time Monitor Alert* thresholds can be specified for any of the monitored values so that they can have a maximum and/or a minimum numerical threshold.

Should a specified maximum or minimum threshold be crossed, CorePlus will automatically generate a log message which will be sent to all configured log receivers. All such log messages belong to the **DEVICEMONITOR** message category which has the identity number **54**. The log message identity will therefore take the form **054XXXXX** where **XXXXX** represents the position of the statistic generating the event in the list of alert rules. A log message with identity **05400003**, for example, identifies the third rule in the rule list.

Each Monitor Alert Rule consists of the following fields:

Name	User assigned name for the rule
Sample time	The interval in seconds between checking the statistic.

Low threshold The lower threshold (if specified).

High threshold A higher threshold (if specified).

Continuous This determines if an event is also generated when the threshold is crossed in the other direction. In other words, the statistic moves back to within acceptable limits. This field can be **Yes** or **No**.

Backoff The minimum number of seconds between consecutive Monitor Threshold Rule log messages. This value can be useful in preventing a flood of log messages when a statistic is repeatedly passing a threshold and then receding from it again.

2.4.4. The Link Monitor

The *Link Monitor* is a CorePlus feature that allows monitoring of one or more IP addresses external to the Clavister Security Gateway through routine ICMP "Ping" requests. If sufficient replies are not received to this polling, CorePlus makes the assumption that the common link to those IP address is down and can then initiate one of 3 configurable actions:

1. A CorePlus reconfigure.
2. A High Availability (HA) cluster failover.
3. An HA cluster failover followed by a CorePlus reconfigure.

The Link Monitor is useful in two distinct scenarios:

- An external device develops an occasional problem with its link to the Clavister Security Gateway and the physical link needs to be renegotiated. Such problems can occur sometimes with some older equipment such as ADSL Modems. For this scenario action **1. Reconfigure** should be selected.

  A reconfigure means that the CorePlus configuration will be reloaded. All connections and states are saved for the reconfiguration but reloading means all traffic is suspended for a short period and all interface links to external devices are renegotiated.

- In an HA cluster setup, the link from the master to the external Internet (or other part of a network) can be continually monitored so that should the link fail, the slave will take over (assuming that the slave has a different physical connection to the monitored address). The action chosen for HA should be either **2. Failover** or **3. Failover and reconfigure.**.

  If the first action option **1. Reconfigure** is chosen in an HA cluster, then the reconfigure will also cause a failover since it will temporarily suspend the master's operation while the reconfigure takes place and the slave will take over when it detects this inactivity. If reconfiguration with failover is desirable it is better to select the option **3. Failover and reconfigure.** since this does the failover first and is almost instantaneous with almost no traffic interruption. Reconfigure first is slower and results in some traffic interruption.

  To preserve all tunnels in a VPN scenario, it is recommended to choose the **2. Failover** option since a reconfiguration can cause some tunnels to be lost.

Link Monitoring with HA Clusters

The most common use for link monitoring is in the HA cluster scenario described above. It is important that the master and slave don't duplicate the same condition that triggered the Link Monitor. For example, if a particular router connected to the master Clavister Security Gateway was being "pinged" by Link Monitoring, the slave should not also be connected to that router. If it is, the continued triggering of a reconfiguration by the Link Monitor will then cause the slave to failover back to the master, which will then failover back to the slave again and so on.

If it is important to not allow a failover during reconfiguration of the active unit in an HA cluster then the advanced setting **ReconfFailoverTime** should be set to a value which is neither too low or too high.

ReconfFailoverTime controls how long the inactive unit will wait for the active unit to reconfigure before taking over. Setting this value too low will mean the inactive unit does not wait long enough. Setting the value too high could mean significant downtime if the active unit fails during reconfiguration and the inactive unit needs to take over.

More information on clusters can be found in Chapter 11, *High Availability*.

Link Monitoring Parameters

The Link Monitor takes the following parameters:

Action Specifies which of the 3 actions described above CorePlus should take.

Addresses Specifies a group of hosts to monitor. If at least half of them don't respond, CorePlus assumes that there is a link problem. A host's responses are ignored until CorePlus has been able to reach it at least once. This means that an unreachable host can be responsible for triggering an action once but not twice.

A group of three hosts where one has been unreachable since the last configuration will therefore be treated as a two-host group until the third host becomes reachable. (This also means that if a link problem triggers an action and the problem is not solved, CorePlus will not attempt to repeat the same action until the problem is solved and the hosts are again reachable).

Maximum Loss A single host is considered unreachable if this number of consecutive ping responses to that host are not replied to.

Grace Period Do not allow the link monitor to trigger an action for this number of seconds after the last reconfiguration. This avoids false positives during initial link negotiation. The default value is 45 seconds.

Send from Shared IP Address This option only appears in an HA cluster and should be used if individual public IP addresses are not available to the devices in a cluster.

2.4.5. SNMP Monitoring

Overview

Simple Network Management Protocol (SNMP) is a standardized protocol for management of network devices. An SNMP compliant client can connect to a network device which supports the SNMP protocol to query and control it.

CorePlus supports SNMP version 1 and version 2. Connection can be made by any SNMP compliant clients to devices running CorePlus. however only query operations are permitted for security reasons. Specifically, CorePlus supports the following SNMP request operations by a client:

- The *GET REQUEST* operation

- The *GET NEXT REQUEST* operation
- The *GET BULK REQUEST* operation (SNMP Version 2c only)

The CorePlus MIB

The *Management Information Base* (MIB) is a database, usually in the form of a file, which defines the parameters on a network device that an SNMP client can query or change. The MIB file for a device running CorePlus is distributed with the standard CorePlus distribution pack as a file with the name *CLAVISTER-MIB* and this should be transferred to the hard disk of the workstation that will run the SNMP client so it can be imported by the client software. When the client runs, the MIB file is accessed to inform the client of the values that can be queried on a CorePlus device.

Defining SNMP Access

SNMP access is defined through the definition of a CorePlus *Remote* object with a *Mode* value of *SNMP*. The Remote object requires the entry of:

- **Interface** - The CorePlus interface on which SNMP requests will arrive.
- **Network** - The IP address or network from which SNMP requests will come.
- **Community** - The community string which provides password security for the accesses.

The Community String

Security for SNMP Versions 1 and 2c is handled by the *Community String* which is the same as a password for SNMP access. **The Community String should be difficult to guess** and therefore be constructed in the same way that any other password, using combinations of upper and lower case letters with digits.

Enabling an IP Rule for SNMP

The advanced setting **SNMPBeforeRules** in the **RemoteAdmin** section controls if the IP rule set checks all accesses by SNMP clients. This is by default disabled and the recommendation is to always enable this setting.

The effect of enabling this setting is to add an invisible **Allow** rule at the top of the IP rule set which automatically permits accesses on port 161 from the network and on the interface specified for SNMP access. Port 161 is usually used for SNMP and CorePlus always expects SNMP traffic on that port.

Remote Access Encryption

It should be noted that SNMP Version 1 or 2c access means that the community string will be sent as plain text over a network. This is clearly insecure if a remote client is communicating over the public Internet. It is therefore advisable to have remote access take place over an encrypted VPN tunnel or similarly secure means of communication.

Preventing SNMP Overload

The advanced setting **SNMPReqLimit** restricts the number of SNMP requests allowed per second. This can help prevent attacks through SNMP overload.

Example 2.13. Enabling SNMP Monitoring

This example enables SNMP access through the internal **lan** interface from the network **mgmt-net** using the community string *Mg1RQqR*. (Since the management client is on the internal network we don't need to implement a VPN tunnel for it.)

Clavister FineTune

A. First create an SNMP *Remote* object.

1. Go to **Miscellaneous > Remotes > New Remote**
2. Now enter:
   - **Mode:** SNMP
   - **Interface:** lan
   - **Network:** mgmt-net
   - **Community:** Mg1RQqR
3. Click **OK**

B. Now enable the invisible SNMP rule in the IP rule set that allows SNMP traffic to pass through the IP rule set.

1. Go to **Advanced Setting > RemoteAdmin**
2. Enable **SNMPBeforeRules**

2.4.6. Hardware Monitoring

Certain Clavister hardware models allow the optional monitoring by CorePlus of various operational parameters such as temperatures and fan speeds. This feature is not supported on non-Clavister hardware and to determine it's availability on any Clavister hardware model, the *sysmsg* CLI command can be issued. The output will be similar to the following and the presence of the letters **HWM** indicates that hardware monitoring is possible.

```
Cmd> sysmsg

2006-06-03 12:22:23 HWM:
Via 686[A/B] found at dev[0x07], fun[0x04], base[0x00006000]
```

Caution

Using the HWM command by mistake on non-Clavister hardware can cause CorePlus to stop and require a restart.

Using the *hwm* Command

To get a list of all available sensors, the command *hvm -all -verbose* can be used. Some typical output from this command for the Clavister SG4200 Series is shown below (the command options have been abbreviated).

```
Cmd> hvm -a -v

4 sensors available
Poll interval time = 500ms

Name [type][number] = low_limit] current_value [high_limit (unit)
------------------------------------------------------------------------
```

```
SysTemp          [TEMP  ][0] =    15.000]    23.000 [   40.000 (C)
CPUTemp          [TEMP  ][1] =    20.000]    29.000 [   40.000 (C)
CPUFan           [FANRPM][0] =  6000.000]  6619.000 [ 7000.000 (RPM)
ChassisFan       [FANRPM][1] =  8000.000]  8511.000 [10000.000 (RPM)

Time to probe sensors: 0.208 milliseconds
```

Each physical attribute listed on the left is given a range within which it should operate. When the value returned after polling falls outside this range, CorePlus optionally generates a log message which is sent to the configured log servers.

Setting the Minimum and Maximum

The minimum and maximum values shown in the output from the *hvm* command can be set through Clavister FineTune by going to **Miscellaneous > Hardware Sensors.** As well as setting the range, the option to generate a log message when a value falls outside the range can also be enabled.

2.5. Diagnostic Tools

2.5.1. Overview

In the case of a serious system problem CorePlus provides some tools to aid in identifying the cause. These are:

- Diagnostic console commands
- The *pcapdump* console command

Both of these provide output which can be sent to support staff at Clavister to help identify the circumstances that led to the problem in question.

2.5.2. Diagnostic Console Commands

The *stat* Command

If a serious CorePlus problem is suspected then the first step should be to use the console command:

```
> stat
```

The **stat** command will indicate the date and time of the last system shutdown and can indicate if there has been a serious error in CorePlus operation. It should be remembered however that the buffer which *stat* uses is cleared by certain operations such a *reconfigure* and the output will not therefore show what occurred prior to buffer clearance.

The *dconsole* Command

The next step if to use the console command:

```
> dconsole
```

This can be abbreviated to:

```
> dcon
```

The **dconsole** command provides a list of important events in CorePlus operation and can help to establish the date, time and nature of events leading up to a serious problem occurring. The output might look similar like the following:

```
Showing diagnose entries since 2008-05-22:
2008-06-21 11:54:58                  Start (8.90.11-0:131)
2008-06-21 11:56:16                  Stop (RECONFIGURE)
2008-06-21 11:56:21                  Start (8.90.11-0:131)
2008-06-21 11:57:29                  Stop (RECONFIGURE)
2008-06-21 11:59:31                  Start (8.90.11-0:131)
2008-06-21 11:59:49                  Stop (NORMAL)
'
'
```

dconsole output above may include a dump of the system memory in the case of serious runtime errors. This will look similar like the following:

```

'
'
Reason: Exception 'DataAbort' occurred at address 0x7aaea34
```

```
Generation date/time: 2008-07-04 14:23:56 List of loaded PE-modules:
fwloader(1.07.04): BA:0x00100000, EP:0x00101028, SS:0x0, IS:0xe7000
fwcore(88.90.11-2336): BA:0x07761038, EP:0x0007c630 Register dump:
----------------------------------------------------
r0 : 0xe1a0003c, r1 : 0x07c685dc, r2 : 0x00000004, r3 : 0x50013700,
r4 : 0x06cb2d04, r5 : 0x0753a740, r6 : 0x050ce1f8, r7 : 0x00000000,
r8 : 0x0753a79c, r9 : 0x050ce1f8, r10: 0x00000000, r11: 0x0775ff34,
r12: 0x00000004, sp : 0x0775fcec, lr : 0x079de7e4 Stack dump:
5da89306 c33613f4 c330cfc5 04411507 45515a49 86619f8b c0db0a81
4e395861 cb25b796 e3108934 932766c5 4dcff9e9 711c3463 b9cd5d1e
52149961 9324dea3 d340dc25 15458610 63582ded 689a0c54 dfb43131
02c7d971 a0ebb72c bfaae832 db216923 08ba693b 95e4de97 98d121a2
'
'
```

Although **dconsole** output may be difficult to interpret by the administrator, it can be emailed to Clavister support representatives for further investigation. The **dconsole** command supersedes the **crashdump** command found in earlier versions of CorePlus.

2.5.3. The *pcapdump* Command

An valuable diagnostic feature is the ability to examine the packets that enter and leave the interfaces of a Clavister Security Gateway. For this purpose, CorePlus provides the console command **pcapdump** which not only allows the examination of packet streams entering and leaving interfaces but also allows the filtering of these streams according to specified criteria.

The packets that are filtered out by **pcapdump** can then be saved in a file of type *.cap* which is the defacto *libpcap* library file format standard for packet capture.

A Simple Example

An example of **pcapdump** usage is:

```
> pcapdump -size 1024 start int
> pcapdump stop int
> pcapdump show
> pcapdump write int cap_int.cap
> pcapdump cleanup
```

Going through this line by line we have:

1. Recording is started for the *int* interface using a buffer size of 1024 Kbytes

```
> pcapdump -size 1024 start int
```

2. The recording is stopped for the *int* interface

```
> pcapdump stop int
```

3. The dump output is displayed on the console in a summarized form.

```
> pcapdump show
```

4. The same information is written in its complete form to a file called *cap_int.cap*.

```
> pcapdump write int cap_int.cap
```

5. A final cleanup is performed and all memory taken is released.

```
> pcapdump cleanup
```

Re-using Capture Files

Since the only way to delete files from the Clavister Security Gateway is through the serial console, the recommendation is to always use the same filename when using the pcapdump **write** option. Each new write operation will then overwrite the old file.

Running on Multiple Interfaces

It is possible to have multiple *pcapdump* executions being performed at the same time. The following points describe this feature:

1. All capture from all executions goes to the same memory buffer.

   The command can be launched multiple times with different interfaces specified. In this case the packet flow for the different executions will be grouped together in different sections of the report.

   If a clearer picture of packets flowing between interfaces is required in the output then it is best to issue one **pcapdump** command with the interfaces of interest specified.

2. If no interface is specified then the capture is done on all interfaces.

3. The **stop** option without an interface specified will halt capture on all interfaces.

4. **pcapdump** prevents capture running more than once on the same interface by detecting command duplication.

Filtering

Seeing all packets passing through a particular interface often provides an excess of information to be useful. To focus on particular types of traffic the **pcapdump** command has the option to add an *filter expression* which has one of the following forms:

eth <addr> - Filter on source or destination MAC address.
ethsrc <addr> - Filter on source MAC address.
ethdest <addr> - Filter on destination MAC address.
ip <addr> - Filter source or destination IP address.
ipsrc <addr> - Filter on source IP address.
ipdest <addr> - Filter on destination IP address.
port <addr> - Filter on source or destination port number.
srcport <addr> - Filter on source port number.
destport <addr> - Filter on destination port number.
proto <id> - Filter on protocol where id is the decimal protocol id.
<protocolname> - Instead of the protocol number, the protocol name alone can be specified and can be one of *tcp*, *udp* or *icmp*.

Downloading the Output File

As shown in one of the examples above, the *write* option of **pcapdump** can save buffered packet information to a file on the Clavister Security Gateway.

This file can be downloaded to the local workstation using the *fwctl* utility. The console command line (outside of Clavister FineTune) would be:

```
> fwctl --filedownload <src_filename> <dest_filename> <gateway>
```

Where *<src_filename>* is the name of the *.cap* capture file specified in the **pcapdump** command and *<dest_filename>* is the name of the destination file on the local disk.

The *<gateway>* identifies the specific CorePlus from which to download the file. It is specified as *<data-source:gateway-name* where the data source is combined with the name of the Clavister Security Gateway separated by a ":" character (*fwctl* uses entries in the Windows registry to resolve these to file paths). Only the gateway name needs to be specified if it's name is unique across all data sources. Further details for this command can be found in Appendix C, ***fwctl** Command Options*.

Output File Naming Restrictions

The name of the file used for pcapdump output must comply with the following rules:

- Excluding the filename extension, the name may not exceed 8 characters in length.
- The filename extension can't exceed 3 characters in length.
- The filename and extension can only contain the characters A-Z, 0-9, "-" and "_".

Combining Filters

It is possible to use several of these filter expressions together in order to further refine the packets that are of interest. For example we might want to examine the packets going to a particular destination port at a particular destination IP address.

See also the *pcapdump* summary in Appendix B, *CLI Reference*.

Compatibility with Wireshark

The open source tool *Wireshark* (formerly called *Ethereal*) is an extremely useful analysis tool for examining logs of captured packets. The industry standard *.pcap* file format used by **pcapdump** with its *write* option means that it is compatible with Wireshark.

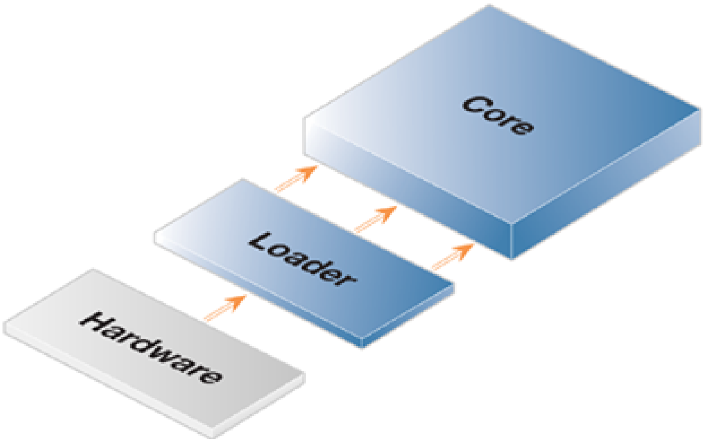
For more complete information see *http://www.wireshark.org*

2.6. Maintenance

2.6.1. Software Upgrades

Clavister Security Gateways are driven and controlled by CorePlus and this consists of two major components: the CorePlus *Core* and the CorePlus *Loader*. Usually it is the CorePlus Core which is the main concern of the administrator since this is the executable binary of CorePlus and contains all its principal components. The Loader, as described below, is a low level firmware loader used by the Core that is updated only with some major revisions of CorePlus.

Figure 2.1. CorePlus Firmware Structure



2.6.1.1. The *Core* Executable

Whenever new functionality is added to CorePlus, or when defects have been found and corrected, a new *Core* is produced which is the CorePlus executable binary. The new Core is packaged as a single file which is digitally signed and made available for download from the Clavister Customer Web. The Customer Web can be found at the URL: *https://clientweb.clavister.com*.

In the distribution of software upgrades, a Core file name will indicate that it is either a **Full** version designed for most hardware models or the file name will indicate a specific hardware model. If there is a Core file with a filename related to your hardware then use that file for upgrading, otherwise use the **Full** version.

> ***Important***
> *The Core files for some Clavister hardware models, for example the SG10 and SG50, are specific to these hardware models and such a model specific file will have a filename which includes the model number. Do* ***not*** *use the* ***Full*** *version for upgrading the SG10 and SG50 but instead use the model specific files.*

There are two types of CorePlus Core upgrades:

- Minor upgrades, for instance from version 8.81.01 to 8.81.02, include bug fixes and minor feature enhancements and are freely available to all customers who are licensed to run the major version.
- Major upgrades, for instance from version 8.80 to 8.81, are only available for customers that have hold a valid software subscription service contract.

2.6.1.2. Upgrading CorePlus

When initially installing Clavister products from the product CD-ROM or after downloading the CD-ROM contents from the Clavister website, installation is usually done using a controlling webpage that automatically appears when the CD is inserted into a drive or which appears after double-clicking the file *launch.exe*.

A program from Clavister called the *Upgrader* should be chosen from the install menu for installation on the management workstation PC. This installation also sets up a registry entry which links this program with the filetype *.eup*. When Clavister supplies CorePlus updates, they are packaged in .eup files.

An .eup file which is an upgrade has the name *csg_x.yy.zz_up.eup* where *x.yy* is the major revision of the upgrade and *zz* is the minor revision.

When an .eup file is double clicked, the Uploader program launches using the .eup file as input. The Upgrader will next ask for confirmation before an upgrade or full-install is performed. After confirmation is given by the user the Uploader proceeds with the task.

Important
Clavister FineTune should not be running when the Upgrader program is running. Close Clavister FineTune before double-clicking the .eup file.

If the file has the form *csg_x.yy.zz.eup* (without *_up* in the filename) then this is a complete install and not just an upgrade. Double-clicking this file will first uninstall any files already installed (apart from data sources). After the uninstall completes, the .eup must be double-clicked again to re-install all software including Clavister FineTune.

Once the upgrade or full-install has completed, Clavister FineTune should be started. The new CorePlus version will now be visible to Clavister FineTune and this can be uploaded by the administrator to the Clavister Security Gateway in the normal manner. The example below goes through the steps for doing this.

Warning: Open Connections Will Be Dropped
All open connections through the system will be dropped when the system is upgraded with a new Core.

Example 2.14. Upgrading the CorePlus Core

Clavister FineTune

1. Go to **Upgrade > CorePlus Core** from the **Action > Communication** menu. The **Upgrade CorePlus Core Wizard** will be displayed.
2. Select the Core that should be uploaded to the system and click the **Next** button.
3. If the required Core is not shown in the list, the **Browse** button can be used to browse the file system for a Core in another location.
4. When the Core has been uploaded, the system will perform a shutdown and then restart with the new Core.

Checking the *High Buffers* Setting

Make sure that the advanced setting **HighBuffers** is set to *dynamic* after an upgrade. This setting how memory is allocated for handling connections. The setting *dynamic* allocates memory automatically.

This setting requires a hardware restart for a new value to take effect. A reconfiguration is not sufficient.

Where CorePlus is handling tens of thousands of simultaneous connections then it may be necessary to manually set a value above the automatic value. If the **HighBuffers** value is set too high this may impact throughput latency.

2.6.1.3. Loader Upgrades

The CorePlus Loader can be viewed as a hardware abstraction layer that contains all the mechanisms for interfacing to the system hardware, as well as to low-level kernel functionality.

If upgrading of the CorePlus loader is required, it will be in conjunction with a new CorePlus version and the procedure will be documented in the CorePlus release notes.

The upgrade operation is similar to the CorePlus core upgrade procedure. First select the target Clavister Security Gateway in the tree view of Clavister FineTune, and then choose **Upgrade > Loader** from the **Action > Communication** menu. The *Communication Wizard* is used in the same way as when uploading a configuration.

2.6.2. Auto-Update Mechanism

A number of the CorePlus security features rely on external servers for automatic updates and content filtering. The Intrusion Prevention and Detection system and Anti-Virus modules require access to updated signature databases in order to provide protection against the latest threats.

To facilitate the Auto-Update feature Clavister maintains a global infrastructure of servers providing update services for Clavister Security Gateways. To ensure availability and low response times, CorePlus employs a mechanism for automatically selecting the most appropriate server to supply updates.

For more details on these features see the following sections:

- Section 6.5, “Intrusion Detection and Prevention”
- Section 6.4, “Anti-Virus Scanning”
- Section 6.3, “Web Content Filtering”
- Appendix A, *Subscribing to Security Updates*

2.6.3. Resetting to Factory Defaults

A *restore to factory defaults* can be applied so that it is possible to return to the original hardware state that existed when the Clavister Security Gateway was shipped by Clavister. When a restore is applied, data such as the IDP and Ant-Virus databases as well as *pcapdump* files are not deleted. These must be explicitly removed by using the appropriate command.

Reset via the Console Boot Menu

Connect the serial cable and connect with a console using a terminal emulator software product. The *HyperTerminal* application shipped with some Microsoft PCs can be used for this purpose. Restart the Clavister Security Gateway and press a key when the "Press any key to abort and load boot menu" message appears at the console. When the console boot menu appears, select the hardware reset option, then confirm and wait for the process to complete. Using the console boot menu is fully described in Section 2.1.2, “The Console Boot Menu”.

Warning
DO NOT ABORT THE RESET TO FACTORY DEFAULTS PROCESS. If aborted the Clavister Security Gateway can cease to function properly.

2.7. Licensing

2.7.1. Overview

To use CorePlus in a live environment, a CorePlus *license file* must be deployed to the Clavister Security Gateway. A unique license file is needed for each processor on which CorePlus runs and in the case of the multi-bladed systems, a different license file is required for each installed blade since these operate as autonomous Clavister Security Gateways.

The purpose of the license file is to define what the capabilities and limitations a CorePlus installation will have. Such capabilities include parameters such as the number of VPN tunnels allowed, the number of routing tables or the number of virtual interfaces. This manual does not discuss the pricing of licenses. Please refer to your local Clavister sales office for pricing information.

2.7.2. Evaluation Mode

Each installation of CorePlus requires a unique license, issued by Clavister, to have full functionality. Without correct licensing, CorePlus will only operate for 2 hours from hardware boot up. After 2 hours, CorePlus will cease to function and will output an expiry message to the local console.

The hardware must be re-booted to enable CorePlus for a further 2 hour period although there are no limits on how many times this can be done. The 2 hour limit is designed to allow a reasonable window of time for product evaluation. To remove the time limit, a valid license must be made available to the CorePlus by *binding* it to the installation.

2.7.3. License Purchase

A license is required for each of the two types of CorePlus usage:

1. A software-only license purchase is made and a License *Registration Key* is supplied to the licensee by Clavister. Delivery of the software-only registration key can be in one of 2 ways:

   - Software can be downloaded from the Clavister website and a registration key from a *Certificate of Authenticity* is then sent to the customer via email after purchase.

   - If preferred, a CD-ROM can be sent to the customer containing all software, along with the *Certificate of Authenticity* that bears a registration key. This can also be done in addition to email code notification if the customer requires it.

2. When purchasing Clavister hardware, the registration key is supplied in the following ways for different hardware:

   - For the SG10, SG50 and SG3100 units, the registration key is written on a label on the underside of the hardware unit. The MAC address of one of the interfaces is also written on this label.

   - For the SG4200 and SG4400 a *Certificate of Authenticity* bearing the registration key is packaged with the hardware.

   - For the SG5500, a separate Certificate of Authenticity is packaged with each Secure Blade Module (SBM) purchased since each blade is an autonomous processor running its own copy of CorePlus and each requires a separate license.

It should be noted that the registration key and the license number are different. The registration key may not be required again after initial registration but should be retained as proof of purchase. The license number has the form of 4 sets of 4 digits of the form: nnnn-nnnn-nnnn-nnnn.

HA Cluster Licensing

In a High Availability Cluster, two identical licenses must be purchased, one for the master and one for the slave unit. Both licenses must include the ability to allow HA clustering.

> ***Important***
> *In any installation with more than one Clavister Security Gateway it is important to always use the right license file for the right Clavister Security Gateway. If licenses are not matched correctly to the hardware, complex administrative problems can arise later which can cause delays in rectifying a hardware fault.*

2.7.4. The Clavister Customer Web

The Clavister Customer Web is found at *http://clientweb.clavister.com* and is used for the administration of CorePlus licenses. It can be used for first time license registration as well as allowing customers to download license updates and to get access to software upgrades. As explained below, some Customer Web functions such as registering a new license or downloading an updated license can also be accessed through Clavister FineTune™ instead of using a web browser.

Customer Web License Registration

Following purchase, the administrator can access the Clavister Customer Web to complete the registration process and obtain the corresponding license file. The first time it is accessed, the Customer Web requires that you enter your contact details, the registration key, as well the MAC address of one of the Ethernet ports of the hardware on which the license will be used. A user name and password must also be specified for subsequent Customer Web access. After successful registration a license file can then be downloaded. Registration on the Customer Web can alternatively be done through Clavister FineTune as described below.

2.7.5. License Files

A license file is a text file that defines all the capabilities allowed by the license plus a digital signature to ensure the file cannot be altered. It can be opened and read in a normal text editor and the file name is always the license number followed by a file type of *.lic*. Once the license file is available to a CorePlus installation, the 2 hour usage time limit disappears and functionality will be limited only by the usage limits specified by the license file, for example the number of VPN tunnels.

Importing a Downloaded License File

Installation of Clavister FineTune sets up a file association between the **.lic** file type so that double-clicking a downloaded license file will automatically start Clavister FineTune and the Clavister FineTune *Import License* dialog will be displayed in order to allow the customer to specify which CorePlus *data source* the license is to be imported into.

2.7.6. Alternative Registration with Clavister FineTune

An alternative to using the Customer Web through a browser for registration is registration through Clavister FineTune. First select the target gateway in the Clavister FineTune Security Editor and then select the menu options **Action > License > Register...**. This will open the *Registration Wizard* which will collect the same information that would be entered via the web interface. Clavister FineTune then connects to the Customer Web, registers the user and automatically downloads a license file and optionally deploys it directly to the Clavister Security Gateway. This is a more direct method of registration and is recommended over registration through a web browser.

2.7.7. Registering Additional Licenses

A licensee need register themselves only once on the Clavister Customer Web. After logging in they are shown a list of existing licenses and have the option to register additional licenses. Additional license registration requires only the new registration key with the associated MAC address. A license file for the new license can then be downloaded.

Changing MAC Addresses

The Customer Web also allows the option to change the MAC Address associated with a given license. This can only be done twice per license.

2.7.8. The Clavister License Tool

An important tool integrated into Clavister FineTune is the *License Tool* which can be used to manage license files. The License Tool dialog presents a table display of all licenses in all data sources available to Clavister FineTune. The License Tool allows the administrator to:

- Look at the contents of all licenses.
- Bind a license to a particular Clavister Security Gateway.
- Unbind a license from a particular Clavister Security Gateway (the gateway reverts back to the 2 hour demonstration mode).
- Connect to the Customer Web and download any license upgrades.

Just as with initial registration via Clavister FineTune, downloading updated licenses with the License Tool is recommended over download through a web browser since it removes some intermediate steps.

2.7.9. Lockdown Mode

CorePlus will enter a state known as *Lockdown Mode* if certain license violations occur. While in Lockdown Mode, only remote management traffic is allowed by the Clavister Security Gateway and all other traffic will be dropped. Unlike the two hour Demonstration Mode, there is no time limit on Lockdown Mode.

Lockdown Mode is usually caused by the license file bound to the Clavister Security Gateway being in some way invalid. Conditions that trigger Lockdown Mode include license date expiry, invalid MAC address or invalid license file signature. It is also triggered if the administrator tries to configure CorePlus beyond the limits of its license file. Trying to configure more VPN tunnels than the license allows is an example of this.

When Lockdown Mode in entered, the condition can be terminated by binding a valid License to CorePlus or removing the configuration violation that triggered the condition. Unbinding the license will cause it to enter the 2 hour demonstration mode from Lockdown Mode, and this may be necessary to allow traffic to flow to the Internet in order to download a new license file.

Chapter 3. Fundamentals

This chapter describes the fundamental logical objects upon which CorePlus is built. These objects include such items as addresses, services and schedules. In addition, the chapter explains how the various supported interfaces work, it outlines how security policies are constructed and how basic system settings are configured.

3.1. The Address Book

3.1.1. Overview

The Address Book contains named objects representing various types of addresses, including IP addresses, networks and Ethernet MAC addresses.

Using Address Book objects has three distinct benefits; it increases readability, reduces the danger of entering incorrect network addresses, and makes it easier to change addresses. By using objects instead of numerical addresses, you only need to make changes in a single location, rather than in each configuration section where the address appears.

3.1.2. IP Addresses

IP Address objects are used to define symbolic names for various types of IP addresses. Depending on how the address is specified, an IP Address object can represent either a host (a single IP address), a network or a range of IP addresses and even a DNS name.

In addition, IP Address objects can be used for specifying user credentials later used by the various user authentication subsystems. For more information on this, see Chapter 8, *User Authentication*.

The following list presents the various types of addresses an IP Address object can hold, along with what format that is used to represent that specific type:

Host
A single host is represented simply by its IP address.
For example: *192.168.0.14*

IP Network
An IP Network is represented using CIDR (Classless Inter Domain Routing) form. CIDR uses a forward slash and a digit (0-32) to denote the size of the network (netmask). */24* corresponds to a class C net with 256 addresses (netmask *255.255.255.0*), */27* corresponds to a 32 address net (netmask *255.255.255.224*) and so on. The numbers 0-32 correspond to the number of binary ones in the netmask.

For example: *192.168.0.0/24*

IP Range A range of IP addresses is represented on the form *a.b.c.d - e.f.g.h*. Please note that ranges are not limited to netmask boundaries; they may include any span of IP addresses.

For example: *192.168.0.10-192.168.0.15* represents six hosts in consecutive order.

Example 3.1. Adding an IP Host

This example adds the IP host *www_srv1* with IP address *192.168.10.16* to the Address Book:

Clavister FineTune

1. Go to **Hosts & Networks > New Host & Network**
2. The **Host & Network Properties** dialog will be displayed
3. Specify a suitable name for the event receiver, in this case *www_srv1*
4. Choose **Host** in the **Type** control
5. Enter *192.168.10.16* for the **IP Address**
6. Click **OK**

Example 3.2. Adding an IP Network

This example adds an IP network named *wwwsrvnet* with address *192.168.10.0/24* to the Address Book:

Clavister FineTune

1. Go to **Hosts & Networks > New Host & Network**
2. The **Host & Network Properties** dialog will be displayed
3. Specify a suitable name for the event receiver, in this case wwwsrvnet
4. Choose **Network** as the **Type**
5. Enter 192.168.10.0/24 as the **IP Address**
6. Click **OK**

Example 3.3. Adding an IP Range

This example adds a range of IP addresses from *192.168.10.16* to *192.168.10.21* and names the range *wwwservers*:

Clavister FineTune

1. Go to **Hosts & Networks > New Host & Network**
2. The **Host & Network Properties** dialog will be displayed
3. Specify a suitable name for the event receiver, in this case *wwwsrvnet*
4. Choose **Range** as the **Type**

5. Enter 192.168.10.16 as the **IP Low** value
6. Enter 192.168.10.21 as the **IP High** value
7. Click **OK**

Example 3.4. Deleting an Address Object

To delete an object named *wwwsrv1* in the Address Book, do the following:

Clavister FineTune

1. Go to **Hosts & Networks**
2. Select and right-click the address object *wwwsrv1*
3. Choose **Delete** from the context menu
4. Click **Yes**

3.1.3. Ethernet Addresses

Ethernet Address objects are used to define symbolic names for Ethernet addresses (also known as MAC addresses). This is useful, for instance, when populating the ARP table with static ARP entries, or for other parts of the configuration where symbolic names are preferred over numerical Ethernet addresses.

When specifying an Ethernet address the format *aa-bb-cc-dd-ee-ff* should be used. Ethernet addresses are also displayed using this format.

3.1.4. Address Groups

Address objects can be grouped in order to simplify configuration. Consider a number of public servers that should be accessible from the Internet. The servers have IP addresses that are not in a sequence, and can therefore not be referenced to as a single IP range. Consequently, individual IP Address objects have to be created for each server.

Instead of having to cope with the burden of creating and maintaining separate filtering policies allowing traffic to each server, an *Address Group* named, for instance, *Webservers*, can be created with the web server hosts as group members. Now, a single policy can be used with this group, thereby greatly reducing the administrative workload.

Address Group objects are not restricted to contain members of the same subtype. In other words, IP host objects can be teamed up with IP ranges, IP networks, with DNS names and so on. All addresses of all group members are combined, effectively resulting in a union of the addresses. As an example, a group containing two IP ranges, one with addresses *192.168.0.10 - 192.168.0.15* and the other with addresses *192.168.0.14 - 192.168.0.19*, will result in a single IP range with addresses *192.168.0.10 - 192.168.0.19*.

Keep in mind however that for obvious reasons, IP address objects can not be combined with Ethernet addresses.

3.1.5. Auto-Generated Address Objects

To simplify the configuration, several address objects are automatically generated when the system is run for the first time. These objects are being used by other parts of the configuration already from start.

The following address objects are auto-generated:

Interface Addresses
: For each Ethernet interface in the system, three IP Address objects are pre-defined; one object for the IP address of the actual interface, one for the broadcast address, and one object representing the local network for that interface.

  Interface IP address objects are named ip_*interfacename*, broadcast objects are named br_*interfacename* and network objects are named *interfacename*net. As an example, an interface named *lan* will have an associated interface IP object named *ip_lan*, a broadcast object named *br_lan* and a network object named *lannet*.

Default Gateway
: An IP Address object named *defaultgw* is auto-generated and represents the default gateway of the system. The defaultgw object is used primarily by the routing table, but is also used by the DHCP client subsystem to store gateway address information acquired from an DHCP server. The object will have an empty IP address (0.0.0.0), and you need to define the correct IP address for your default gateway unless you are using DHCP.

all-nets
: The *all-nets* IP address object is initialized to the IP address *0.0.0.0/0*, thus representing all possible IP addresses. This object is used extensively throughout the configuration.

3.2. Services

3.2.1. Overview

A **Service** object is a reference to a specific IP protocol with associated parameters. A Service definition is usually based on one of the major transport protocols such as TCP or UDP, with the associated port number(s). The HTTP service, for instance, is defined as using the TCP protocol with associated port 80.

However, service objects are in no way restricted to TCP or UDP. They can be used to define ICMP messages, as well as any user-definable IP protocol.

Services as Objects

Services are passive objects in that they cannot carry out any action in the system on their own. Instead, Service objects are used frequently in the various security policies defined by rule sets. For instance, a rule in the IP rule set can use a Service object as a filter to decide whether or not to allow certain traffic through the Clavister Security Gateway. For more information on how service objects are being used with IP rules, see Section 3.5, “The IP Rule Set”.

Pre-defined Services

A large number of Service objects come pre-defined with CorePlus. These include common services such as HTTP, FTP, Telnet and SSH. Pre-defined Services can be used and also modified just like user-defined Services. However, it is recommended *NOT* to make any changes to pre-defined services, but instead create new ones with the desired parameters.

Example 3.5. Listing the Available Services

To produce a listing of the available services in the system:

Clavister FineTune

1. Go to **Services**
2. A grid listing all services will be presented

Example 3.6. Viewing a Specific Service

To view a specific service in the system:

Clavister FineTune

1. Go to the **Services**
2. Select the specific Service object in the grid
3. Choose **Properties** from the context menu, the **Service Properties** dialog box will be displayed

3.2.2. TCP and UDP Based Services

Most applications are using TCP and/or UDP as transport protocol for transferring application data over IP networks.

TCP (Transmission Control Protocol) is a connection-oriented protocol that, among other things, includes mechanisms for reliable transmission of data. TCP is used by many common applications, such as HTTP, FTP and SMTP, where error-free transfers are mandatory.

For other types of applications where, for instance, performance is of great importance, such as streaming audio and video services, UDP (User Datagram Protocol) is the preferred protocol. UDP is connection-less, provides very few error recovery services, and give thereby much lower overhead traffic than when using TCP. For this reason, UDP is used for non-streaming services as well, and it is common in those cases that the applications themselves provide the error recovery mechanisms.

TCP and UDP Service Definition

To define a TCP or UDP service in the Clavister Security Gateway, a *TCP/UDP Service* object is used. This type of object contains, apart from a unique name describing the service, also information on what protocol (TCP, UDP or both) and what source and destination ports are applicable for the service.

Port numbers can be specified in several ways:

Single Port
For many services, a single destination port is sufficient. HTTP, for instance, uses destination port 80 in most cases. SMTP uses port 25 and so on. For these types of Service, the single port number is simply specified in the TCP/UDP Service object.

Port Ranges
Some services use a range of destination ports. As an example, the NetBIOS protocol used by Microsoft Windows uses destination ports 137 to 139. To define a range of ports in a TCP/UDP Service object, the format *mmm-nnn* is used. A port range is inclusive, meaning that a range specified as 137-139 covers ports 137, 138 and 139.

Multiple Ports and Port Ranges
Multiple ranges or individual ports may also be entered, separated by commas. This provides the possibility to cover a wide range of ports using only a single TCP/UDP Service object. For instance, all Microsoft Windows networking can be covered using a port definition specified as *135-139,445*. HTTP and Secure HTTP (HTTPS) can be covered by stating destination ports *80,443*.

Tip
The above methods of specifying port numbers are used not just for destination ports. Source port definitions can follow the same conventions, although it is most usual that the source ports are left as the default value which is 0-65535 and this corresponds to all possible source ports.

Example 3.7. Adding a TCP/UDP Service

This example shows how to add a TCP/UDP Service, using destination port 3306, which is used by MySQL:

Clavister FineTune

1. Go to **Local Objects > Services > New Service**
2. The **Service Properties** dialog box will be displayed.
3. Specify a suitable name for the service, for instance MySQL
4. Choose **TCP** as **Type**

5. Under the **TCP/UDP Parameters**, enter **Destination Port** as *3306*
6. Click **OK**

Apart from protocol and port information, TCP/UDP Service objects also contain several other parameters that are being described in more detail in other sections of this users guide:

SYN Flood Protection
A TCP based service can be configured to enable protection against *SYN Flood* attacks. For more details on how this feature works see Section 6.6.8, "TCP SYN Flood Attacks".

Passing ICMP Errors
If an attempt to open a TCP connection is made by a user application behind the Clavister Security Gateway and the remote server is not in operation, an ICMP error message is returned as the response. These ICMP errors can either be ignored or allowed to pass through, back to the requesting application.

Application Layer Gateway
A TCP/UDP Service can be linked to an *Application Layer Gateway* to enable deeper inspection of certain protocols. For more information see Section 6.2, "ALGs".

Max Sessions

An important parameter associated with a Service is *Max Sessions*. This parameter is allocated a default value when the Service is associated with an ALG. The default value varies according to the ALG it is associated with. If the default is, for example *100*, this would mean that only 100 connections are allowed in total for this Service across all interfaces.

For a Service involving, for instance an HTTP ALG, the default value can often be too low if there are large numbers of clients connecting through the Clavister Security Gateway. It is therefore recommended to consider if a higher value is required for a particular scenario.

3.2.3. ICMP Services

Internet Control Message Protocol (ICMP), is a protocol integrated with IP for error reporting and transmitting control information. The PING service, for example, uses ICMP to test an Internet connectivity.

ICMP messages is delivered in IP packets, and includes a *Message Type* that specifies the type, that is, the format of the ICMP message, and a *Code* that is used to further qualify the message. For example, the message type *Destination Unreachable*, uses the Code parameter to specify the exact reason for the error.

The ICMP message types that can be configured in CorePlus are listed as follows:

- Echo Request: sent by PING to a destination in order to check connectivity.
- Destination Unreachable: the source is told that a problem has occurred when delivering a packet. There are codes from 0 to 5 for this type:
    - Code 0: Net Unreachable
    - Code 1: Host Unreachable
    - Code 2: Protocol Unreachable
    - Code 3: Port Unreachable

    - Code 4: Cannot Fragment
    - Code 5: Source Route Failed

- Redirect: the source is told that there is a better route for a particular packet. Codes assigned are as follows:
    - Code 0: Redirect datagrams for the network
    - Code 1: Redirect datagrams for the host
    - Code 2: Redirect datagrams for the Type of Service and the network
    - Code 3: Redirect datagrams for the Type of Service and the host
- Parameter Problem: identifies an incorrect parameter on the datagram.
- Echo Reply: the reply from the destination which is sent as a result of the Echo Request.
- Source Quenching: the source is sending data too fast for the receiver, the buffer has filled up.
- Time Exceeded: the packet has been discarded as it has taken too long to be delivered.

3.2.4. Custom IP Protocol Services

Services that run over IP and perform application/transport layer functions can be uniquely identified by *IP protocol numbers*. IP can carry data for a number of different protocols. These protocols are each identified by a unique IP protocol number specified in a field of the IP header, for example, ICMP, IGMP, and EGP have protocol numbers 1, 2, and 8 respectively.

CorePlus supports these types of IP protocols by using the concept of *Custom IP Protocol Services*. A Custom IP Protocol service is a service definition giving a name to an IP protocol number. Some of the common IP protocols, such as IGMP, are already pre-defined in the CorePlus system configuration.

Similar to the TCP/UDP port ranges described previously, a range of IP protocol numbers can be used to specify multiple applications for one service.

> ***Note***
> *The currently assigned IP protocol numbers and references are published by the Internet Assigned Numbers Authority (IANA) and can be found at http://www.iana.org/assignments/protocol-numbers*

Example 3.8. Adding an IP Protocol Service

This example shows how to add an IP Protocol Service, with the Virtual Router Redundancy Protocol.

Clavister FineTune

1. Go to **Local Objects > Services > New Service**
2. The **Service Properties** dialog box will be displayed
3. Specify a suitable name for the service, for example *VRRP*
4. Choose **IPProto** from the **Type** list
5. Under the **IP Protocol Parameters** enter *112*
6. Click **OK**

3.2.5. Service Groups

A *Service Group* is, exactly as the name suggests, a CorePlus object that consists of a collection of services. This feature can be very useful when constructing IP rules that are the same except for the service. By defining a service group which contains all the relevant service objects, that group can then be used with a single IP rule to control that traffic.

Groups Can Contain Other Groups

When a group is defined then it too can be included in a new group. This feature should be used with caution since it can increase the complexity of a configuration and decrease the ability to understand any problems that arise.

Important: Groups should only reference preceding services

When creating a group, the services that are referenced in the group should be above the group in the entire list of service objects.

3.3. Interfaces

3.3.1. Overview

An **Interface** is one of the most important logical building blocks in CorePlus. All network traffic that passes through or gets terminated in the system is done so through one or several interfaces.

An interface can be seen as a doorway for network traffic to or from the system. Thus, when traffic enters the system through an interface, that interface would be referred to as the *receiving* interface (or sometimes *ingress* or *incoming* interface). Consequently, when traffic is leaving the system, the interface used to send the traffic is referred to as the *sending* interface (or sometimes *egress* interface).

CorePlus supports a number of interface types, which can be divided into the following four major groups:

Physical Interfaces

Each *physical interface* represents a physical port in a CorePlus-based product. Thus, all network traffic that originates from or is terminated in the system will eventually pass through any of the physical interfaces.

CorePlus currently supports *Ethernet* as the only physical interface type. For more information about Ethernet interfaces, see Section 3.3.2, “Ethernet”.

Physical Sub-Interfaces

Some interfaces require a binding to an underlying physical interface in order to transfer data. This group of interfaces is called *Physical Sub-Interfaces*.

CorePlus has support for two types of physical sub-interfaces:

- *Virtual LAN* (VLAN) interfaces as specified by IEEE 802.1Q. When routing IP packets over a Virtual LAN interface, they will be encapsulated in VLAN-tagged Ethernet frames. For more information about Virtual LAN interfaces, please see Section 3.3.3, “VLAN”.

- *PPPoE* (PPP-over-Ethernet) interfaces for connections to PPPoE servers. For more information about PPPoE, please see Section 3.3.4, “PPPoE”.

Tunnel Interfaces

Tunnel interfaces are used when network traffic is being tunneled between the system and another tunnel end-point in the network, before it gets routed to its final destination.

To accomplish tunneling, additional headers are added to the traffic that is to be tunneled. Furthermore, various transformations can be applied to the network traffic depending on the type of tunnel interface. When routing traffic over an IPsec interface, for instance, the payload is usually encrypted to achieve confidentiality.

CorePlus supports the following tunnel interface types:

- *IPsec* interfaces are used as end-points for IPsec VPN tunnels. For more information about IPsec VPN, please see Section 9.3, “IPsec Components”.

- *PPTP/L2TP* interfaces are used as end-points for PPTP or L2TP tunnels. For more information about PPTP/L2TP, please see Section 9.5, “PPTP/L2TP”.

- *GRE* interfaces are used to establish GRE tunnels. For more information about GRE, please see Section 3.3.5, “GRE Tunnels”.

Loopback Interfaces

A *loopback interface* is a special type of interface that will take all packets sent through it and pass them on out through the loopback interface configured as the one to loop to. These are almost exclusively used for *Virtual Routing* scenarios.

For more information about loopback interfaces, please see Section 3.3.6, “Loopback Interfaces”.

Even though the various types of interfaces are very different in the way they are implemented and how they work, CorePlus treats all interfaces as logical IP interfaces. This means that all types of interfaces can be used almost interchangeably in the various subsytems and policies. The result of this is a very high flexibility in how traffic can be controlled and routed in the system.

Each interface in CorePlus is given a unique name to be able to select it into other subsystems. Some of the interface types provide relevant default names that are possible to modify should that be needed, while other interface types require a user-provided name.

The *any* and *core* interfaces

In addition, CorePlus provides two special logical interfaces named **core** and **any**:

- **any** represents all possible interfaces including the **core** interface
- **core** indicates that it is CorePlus itself that will deal with the traffic. Examples of the use of **core** would be when the Clavister Security Gateway acts as a PPTP or L2TP server or is to respond to ICMP "Ping" requests. By specifying the **Destination Interface** of a route as **core**, CorePlus will then know that it is itself that is the ultimate destination of the traffic.

Switching Interfaces

In some circumstances, an administrator may need to switch interfaces. In other words, if we have two Ethernet interfaces on a Clavister Security Gateway called *if1* and *if2* then we may want all traffic now flowing through *if1* to flow through *if2* and all traffic flowing through *if2* to flow through *if1*.

Switching interfaces is simple to achieve because CorePlus processing uses a symbol lookup based on the textual interface name. A CorePlus configuration is contained within a text file which can be edited directly in order to change these interface symbols. Changing a configuration by direct editing is not normally recommended but in cases such as swapping interfaces it is the only way of achieving the objective.

The steps for switching are as follows:

1. For the security gateway in Clavister FineTune, select the **Edit Configuration in Text-mode** option from the **Edit** menu.
2. The configuration text file will open in a text editor.
3. Locate the *IFACES* section in the text file.
4. Rename *if1* to *if2* and *if2* to *if1*.
5. Save the text changes and exit.

6. Deploy the configuration.
7. If desirable, change the displayed interface names in Clavister FineTune in the **Ethernet** section of **Interfaces**.

The traffic flows are now switched between the two interfaces. Any interfaces can be switched in this way including the *Sync* interfaces of a high availability cluster.

3.3.2. Ethernet

CorePlus supports Ethernet, Fast Ethernet and Gigabit Ethernet interfaces as defined by the IEEE 802.3 standard.

The IEEE 802.3 Ethernet standard allows various devices to be attached at arbitrary points or "ports" to a physical transport mechanism such as a coaxial cable. Using the CSMA/CD protocol, each Ethernet connected device 'listens' to the network and sends data to another connected device when no other is sending. If 2 devices broadcast simultaneously, algorithms allow them to re-send at different times. Devices broadcast data as frames and the other devices "listen" to determine if they are the intended destination for any of these frames.

A frame is a sequence of bits which specify the originating device plus the destination device, the data payload along with error checking bits. A pause between the broadcasting of individual frames allows devices time to process each frame before the next arrives and this pause becomes progressively smaller as the transmission rates get faster from normal to Fast and then Gigabit Ethernet.

Each Ethernet interface in the Clavister Security Gateway corresponds to a physical Ethernet port in the system. The number of ports, their link speed and the way the ports are realized, is dependent on the hardware model. A smaller Clavister model will have a limited number of Fast Ethernet ports as integrated product components, while a more powerful unit designed for telecom applications might be expandable with separate port modules.

If CorePlus is being run on non-Clavister Intel x86 compatible server hardware, it is likely that the Ethernet hardware ports are implemented using common Ethernet PCI adapters.

Note
Some systems use an integrated layer 2 switch for providing additional physical Ethernet ports. Such additional ports are seen as a single interface by CorePlus.

Ethernet Interface Names

The names of the Ethernet interfaces are pre-defined by the system, and are mapped to the names of the physical ports; a system with a *wan* port will have an Ethernet interface named wan and so on.

The names of the Ethernet interfaces can be changed to better reflect their usage. For instance, if an interface named *dmz* is connected to a wireless LAN, it might be convenient to change the interface name to *radio*. For maintenance and troubleshooting, it is recommended to tag the corresponding physical port with the new name.

Note: Interace enumeration
The startup process will enumerate all available Ethernet interfaces. Each interface will be given a name of the form lan, wan and dmz or ifN or sfpN, geN and feN depending on your Clavister Security Gateway model, where N represents the number of the interface. In most of the examples in this guide lan is used for LAN traffic and wan is used for WAN traffic. If your Clavister Security Gateway does not have these interfaces, please substitute the references with the name of your chosen interface.

Ethernet IP Addresses

Each Ethernet interface is required to have an *Interface IP Address*, which can be either a static address or an address provided by DHCP. The interface IP address is used as the primary address for communicating with the system through the specific Ethernet interface.

The standard is to use IP4 Address objects to define the addresses of Ethernet interfaces. Those objects are normally auto-generated by the system. For more information, please see Section 3.1.5, “Auto-Generated Address Objects”. When the system is first started, all unconfigured Ethernet interfaces will be assigned default addresses from the *localhost* subnet (*127.0.0.0/8*).

> ***Tip: Specifying multiple IP addresses on an interface***
> *Multiple IP addresses can be specified for an Ethernet interface by using the ARP Publish feature. (For more information, see Section 3.4, “ARP”).*

In addition to the interface IP address, a *Broadcast* address is also specified for the Ethernet interface. The Broadcast address is the highest address available on the network. In the case of a 32-address network, the broadcast address is the network address +31, for example if the network has an address of 192.168.123.64 / 255.255.255.224, its broadcast address is 192.168.123.95. The broadcast address is the address to which information that is to reach all computers connected to the network is sent.

Multicast with Ethernet Interfaces

When setting up an Ethernet interface, the option exists to control the reception of multicast IP packets on that interface. There are three options available for multicast packet handling:

- **Off** - Multicast packets are silently dropped
- **On** - Multicast traffic can always be received by the interface.
- **Auto** - If an IP rule exists in the rule set which applies to a multicast packet's destination IP address, then the Ethernet interface is automatically enabled to receive multicast packets.

Auto is the default behavior.

> ***The all-nets IP address object***
> *The* ***all-nets*** *net object (IP address: 0.0.0.0/0) includes the multicast IP address range (224.0.0.0 => 239.255.255.255). For more information see Section 4.6, “Multicast Routing”.*

Specifying a Default Gateway

A *Default Gateway* address can optionally be specified for an Ethernet interface. This is a normally the address of a router and very often the router which is acts as the gateway to the Internet.

When CorePlus is started for the first time and configured through the serial console, the default gateway and its associated interface can be specified during console configuration. This automatically creates a route in the CorePlus routing table which has a destination network of *all-nets* so that any traffic which doesn't have a more specific matching route will be sent to the default gateway via the associated interface.

If, instead, a default gateway is specified for an interface using Clavister FineTune, then an *all-nets* route for the interface is not automatically added to the *main* routing table. In this case, the *all-nets* route must be explicitly added to the table.

Normally, only one default *all-nets* route to the default gateway needs to exist in the routing table.

Using DHCP on Ethernet Interfaces

CorePlus includes a DHCP client for dynamic assignment of address information. The information that can be set using DHCP includes the IP and broadcast address of the interface, the local network that the interface is attached to, and the default gateway.

All addresses received from the DHCP server are assigned to corresponding IP4Address objects. In this way, dynamically assigned addresses can be used throughout the configuration in the same way as static addresses. By default, the objects in use are the same ones as defined in Section 3.1.5, “Auto-Generated Address Objects”. However, you can specify your own set of address objects if you wish to modify this behavior.

Example 3.9. Enabling DHCP

Clavister FineTune

1. Go to **Interfaces > Ethernet**
2. Right-click on the ethernet object of interest and choose **Properties**
3. Click on the **DHCP** tab
4. Enable the **Enable DHCP Client** option
5. Click **OK**

3.3.3. VLAN

Overview

Virtual LANs (VLANs) are useful in several different scenarios, for instance, when filtering of traffic is needed between different VLANs in an organization, or for any other reason where the administrator would like to expand the number of interfaces.

Virtual LAN support in CorePlus allows the definition of one or more *Virtual LAN interfaces* to be associated with a particular physical interface. These are then considered to be logical interfaces by CorePlus and can be treated like physical interfaces in rule sets and routing tables.

VLAN Operation

CorePlus follows the IEEE 802.1Q specification for VLAN. On a protocol level, VLAN works by adding a *Virtual LAN Identifier* (VLAN ID) to Ethernet frame headers. The VLAN ID is a number from 0 up to 4095 which is used to identify the specific Virtual LAN to which the frame belongs. In this way, Ethernet frames can belong to different Virtual LANs, but can still share the same physical interface. With CorePlus, the VLAN ID must be unique for the physical interface and the same VLAN ID can be used on different physical interfaces.

Packets received through Ethernet frames on a physical interface by CorePlus, are examined for a VLAN ID. If a VLAN ID is found and a matching VLAN interface has been defined for that interface, CorePlus will use the VLAN interface as the source interface in further processing with rule sets.

If there is no VLAN ID attached to an Ethernet frame received on the physical interface then the frame is treated as being received on the physical interface and not on any VLAN interface that may be defined.

License Limitations

The number of VLAN interfaces that can be defined for a CorePlus installation is limited by the parameters of the license used. Some licenses may restrict the total number of VLANs allowed in a CorePlus installation. License upgrades can be purchased to increase this limit if required.

Summary of VLAN Setup

It's important to understand that the administrator should treat a VLAN interface just like a physical interface in that they require at least IP rules and routes to be defined in order to function. If, for instance, no **Allow** rule is defined in the IP rule set for a VLAN interface then packets arriving on that interface will be dropped. Below are the key steps for setting up a VLAN interface.

1. Assign a name to the VLAN interface.
2. Select the physical interface for the VLAN.
3. Assign a **VLAN ID** that is unique on the physical interface.
4. Optionally specify an IP address for the VLAN.
5. Optionally specify an IP broadcast address for the VLAN.
6. Create the required route(s) for the VLAN in the appropriate routing table.
7. Create rules in the IP rule set to allow traffic through on the VLAN interface.

Example 3.10. Defining a VLAN

This simple example defines a virtual LAN called *VLAN10* with a VLAN ID of *10*. Note that this Virtual LAN interface will use the IP address of the corresponding Ethernet interface, as no IP address is specified.

Clavister FineTune

1. Go to **Interfaces > Virtual LAN > New Virtual LAN**
2. The **Virtual LAN Properties** dialog box will be displayed
3. Enter a suitable name for the event receiver, in this case *VLAN10*
4. Now enter:
   - **Interface:** lan
   - **VLAN:** 10
5. Click **OK**

3.3.4. PPPoE

3.3.4.1. Overview

Point-to-Point Protocol over Ethernet (PPPoE) is a tunneling protocol used for connecting multiple users on an Ethernet network to the Internet through a common serial interface, such as a single DSL line, wireless device or cable modem. All the users on the Ethernet share a common connection, while access control can be done on a per-user basis.

Internet server providers (ISPs) often require customers to connect through PPPoE to their broadband service. Using PPPoE the ISP can:

- Implement security and access-control using username/password authentication

- Trace IP addresses to a specific user
- Allocate IP address automatically for PC users (similar to DHCP). IP address provisioning can be per user group

The PPP Protocol

Point-to-Point Protocol (PPP), is a protocol for communication between two computers using a serial interface, such as the case of a personal computer connected through a switched telephone line to an ISP. In terms of the OSI model, PPP provides a layer 2 encapsulation mechanism to allow packets of any protocol to travel through IP networks. PPP uses Link Control Protocol (LCP) for link establishment, configuration and testing. Once the LCP is initialized, one or several Network Control Protocols (NCPs) can be used to transport traffic for a particular protocol suite, so that multiple protocols can interoperate on the same link, for example, both IP and IPX traffic can share a PPP link.

PPP Authentication

PPP authentication is optional with PPP. Authentication protocols supported are *Password Authentication Protocol* (PAP), *Challenge Handshake Authentication Protocol* (CHAP) and *Microsoft CHAP* (version 1 and 2). If authentication is used, at least one of the peers has to authenticate itself before the network layer protocol parameters can be negotiated using NCP. During the LCP and NCP negotiation, optional parameters such as encryption, can be negotiated.

3.3.4.2. PPPoE Client Configuration

The PPPoE interface

Since the PPPoE protocol runs PPP over Ethernet, the gateway needs to use one of the normal Ethernet interfaces to run PPPoE over. Each PPPoE Tunnel is interpreted as a logical interface by the CorePlus, with the same routing and configuration capabilities as regular interfaces, with the IP rule set being applied to all traffic. Network traffic arriving at the gateway through the PPPoE tunnel will have the PPPoE tunnel interface as its source interface. For outbound traffic, the PPPoE tunnel interface will be the destination interface.

As with any interface, one or more routes are defined so CorePlus knows what IP addresses it should accept traffic from and which to send traffic to through the PPPoE tunnel. The PPPoE client can be configured to use a service name to distinguish between different servers on the same Ethernet network.

IP address information

PPPoE uses automatic IP address allocation which is similar to DHCP. When CorePlus receives this IP address information from the ISP, it stores it in a network object and uses it as the IP address of the interface.

User authentication

If user authentication is required by the ISP, the username and password can be setup in CorePlus for automatic sending to the PPPoE server.

Dial-on-demand

If dial-on-demand is enabled, the PPPoE connection will only be up when there is traffic on the PPPoE interface. It is possible to configure how the gateway should sense activity on the interface, either on outgoing traffic, incoming traffic or both. Also configurable is the time to wait with no activity before the tunnel is disconnected.

Example 3.11. Configuring a PPPoE client

This example shows how to configure a PPPoE client on the *wan* interface with traffic routed over PPPoE.

Clavister FineTune

1. Go to **Interfaces > PPPoEClients > New PPPoEClient**
2. The **PPPoEClient Properties** dialog will be displayed
3. Specify a suitable name for the object, for example *PPPoEClient*
4. Enter **Physical Interface:** wan
5. Enter **Remote Network:** all-nets (as we will route all traffic into the tunnel)
6. Click on **Authentication** tab and enter:
   - **Username:** Username provided by the service provider
   - **Password:** Password provided by the service provider
   - **Confirm Password:** Retype the password
   - **Service Name:** Service name provided by the service provider
   - **Authentication:** Specify which authentication protocol to use (the default settings will be used if not specified)
7. Under **Dial-on-demand** make sure that **Enable dial-on-demand** is NOT checked
8. Click **OK**

Note

To provide a point-to-point connection over Ethernet, each PPP session must learn the Ethernet address of the remote peer, as well as establish a unique session identifier. PPPoE includes a discovery protocol that provides this.

3.3.5. GRE Tunnels

Overview

The *Generic Router Encapsulation* (GRE) protocol is a simple, encapsulating protocol that can be used whenever there is a need to tunnel traffic across networks and/or through network devices. GRE does not provide any security features but this means that its use has extremely low overhead.

Using GRE

GRE is typically used to provide a method of connecting two networks together across a third network such as the Internet. The two networks being connected together communicate with a common protocol which is tunneled using GRE through the intervening network. Examples of GRE usage are:

- Traversing network equipment that blocks a particular protocol.
- Tunneling IPv6 traffic across an IPv4 network.
- Where a UDP data stream is to be multicast and it is necessary to transit through a network device which does not support multicasting. GRE allows tunneling though the network device.

GRE Security and Performance

A GRE tunnel does not use any encryption for the communication and is therefore not, in itself, secure. Any security must come from the protocol being tunneled. The advantage of GRE's lack of encryption is the high performance which is achievable because of the low traffic processing overhead. The lack of encryption can be acceptable in some circumstances if the tunneling is done across an internal network that is not public.

Setting Up GRE

Like other tunnels in CorePlus such as an IPsec tunnel, a GRE Tunnel is treated as a logical interface by CorePlus, with the same filtering, traffic shaping and configuration capabilities as a standard interface. The GRE options are:

- **IP Address** - This is the IP address of the sending interface. This is optional and can be left blank. If it is left blank then the sending IP address will default to *0.0.0.0*.

  Specifying an IP address can be advantageous for the following reasons:

  i. An ICMP *Ping* can be sent to this tunnel endpoint.

  ii. If log messages are sent with a source address of *0.0.0.0* then this will be dropped by network equipment as well as by the logging server.

  iii. If NAT is being used then it will not be necessary to set the source IP on the IP rule that NATs traffic through the tunnel.

- **Source IP** - It is possible to specify a particular IP address as the source interface IP for the tunnel. The tunnel setup will appear to be initiated by this IP address instead of the IP address of the interface that actually sets up the tunnel.

  This might be done if, for example, you are using ARP publishing and want the tunnel to be setup by an ARP published IP address.

- **Remote Gateway** - This is the IP address of the remote device which the tunnel will connect with.

- **Outer PBR Table** - This defines the routing table to be used for the tunnel itself and not the traffic that it is carrying. In other words: the table used to look up the tunnel endpoint.

- **Use Session Key** - A unique number can optionally specified for this tunnel. This allows more than one GRE tunnel to run between the same two endpoints. The *Session Key* value is used to distinguish between them.

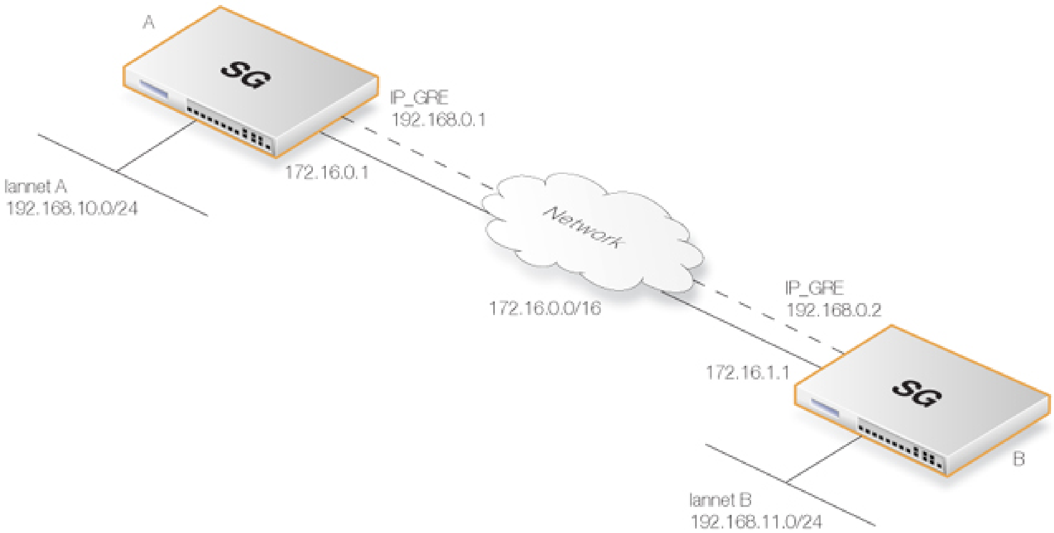
- **Additional Encapsulation Checksum** - The GRE protocol allows for an additional checksum over and above the IPv4 checksum. This provides an extra check of data integrity.

The **Virtual Routing** options are used as with any other interface such as an Ethernet interface (see Section 3.3.2, “Ethernet”). The routing tables specified here apply to the traffic carried by the tunnel and not the tunnel itself. The route lookup for the tunnel itself is specified in the earlier option **Outer PBR Table**.

GRE and the IP Rule Set

An established GRE tunnel does not automatically mean that all traffic coming from or to that GRE tunnel is trusted. On the contrary, network traffic coming from the GRE tunnel will be transferred to the CorePlus IP rule set for evaluation. The source interface of the network traffic will be the name of the associated GRE Tunnel. The same is true for traffic in the opposite direction, that is, going into a GRE tunnel. Furthermore a **Route** has to be defined so CorePlus knows what IP addresses should be accepted and sent through the tunnel.

An Example GRE Scenario



The diagram above shows a typical GRE scenario, where two Clavister Security Gateways **A** and **B** must communicate with each other through the intervening internal network *172.16.0.0/16*.

Any traffic passing between **A** and **B** is tunneled through the intervening network using a GRE tunnel and since the network is internal and not public there is no need for encryption.

Setup for Clavister Security Gateway *"A"*

Assuming that the network *192.168.10.0/24* is **lannet** on the **lan** interface, the steps for setting up CorePlus on **A** are:

1. In the address book set up the following IP objects:

   - **remote_net_B:** 192.168.11.0/24
   - **remote_gw:** 172.16.1.1
   - **ip_GRE:** 192.168.0.1

2. Create a GRE Tunnel object called **GRE_to_B** with the following parameters:

   - **IP Address:** ip_GRE
   - **Remote Network:** remote_net_B
   - **Remote Endpoint:** remote_gw
   - **Use Session Key:** 1
   - **Additional Encapulation Checksum:** Enabled

3. Define a route in the *main* routing table which routes all traffic to **remote_net_B** on the **GRE_to_B** GRE interface.

4. Create the following rules in the IP rule set that allow traffic to pass through the tunnel:

Name	Action	Src Interface	Src Network	Dest Interface	Dest Network	Service
To_B	Allow	lan	lannet	GRE_to_B	remote_net_B	All
From_B	Allow	GRE_to_B	remote_net_B	lan	lannet	All

Setup for Clavister Security Gateway *"B"*

Assuming that the network *192.168.11.0/24* is **lannet** on the **lan** interface, the steps for setting up CorePlus on **B** are as follows:

1. In the address book set up the following IP objects:
   - **remote_net_A:** 192.168.10.0/24
   - **remote_gw:** 172.16.0.1
   - **ip_GRE:** 192.168.0.2
2. Create a GRE Tunnel object called **GRE_to_A** with the following parameters:
   - **IP Address:** ip_GRE
   - **Remote Network:** remote_net_A
   - **Remote Endpoint:** remote_gw
   - **Use Session Key:** 1
   - **Additional Encapulation Checksum:** Enabled
3. Define a route in the *main* routing table which routes all traffic to **remote_net_A** on the **GRE_to_A** GRE interface.
4. Create the following rules in the IP rule set that allow traffic to pass through the tunnel:

Name	Action	Src Interface	Src Network	Dest Interface	Dest Network	Service
To_A	Allow	lan	lannet	GRE_to_A	remote_net_A	All
From_A	Allow	GRE_to_A	remote_net_A	lan	lannet	All

3.3.6. Loopback Interfaces

A *Loopback Interface* is an interface that will take all packets sent through it and pass them on out through the Loopback Interface configured as the one to loop to. These are mainly used in CorePlus for *Virtual Routing* scenarios. In Virtual Routing it is possible to divide up any Clavister Security Gateway's operation so that it can behave as multiple virtual gateways. This is done by having more than one routing table so each routing table handles the routing for a virtual gateway. In order to allow traffic to flow between one routing table and another, Loopback interfaces are needed.

Loopback Interfaces are configured with IP addresses, just as any other interface type but these IP addresses can be fictitious and don't need to be on the same network. The IP address given to a Loopback Interface is used for communicating with the system and as the source address for dynamically translated connections that are routed over the interface. If the interface will not be used for these purposes, it makes sense to set the IP address to an address in the range of the loopback IP addresses (127.0.0.0 - 127.255.255.255).

Example 3.12. Creating a Loopback Interface Pair

This example shows how to create a Loopback Interfaces pair.

Clavister FineTune

1. Go to **Interfaces >Loopback Interfaces > Create Loopback Interface Pair**
2. The **Create Loopback Interface Pair** dialog will be displayed
3. Specify a suitable name for the first loopback interface, for instance **main-vr1**
4. Specify 127.0.0.1 as IP address for the first Loopback Interface
5. Specify a suitable name for the second Loopback Interface, for instance *vr1-main*
6. Specify 127.0.0.2 as the IP address for the second loopback interface.
7. Click **OK**

Two interfaces have now been added; **main-vr1** and **vr1-main**. Packets being sent through the **main-vr1** interface will be received on the **vr1-main** interface and vice versa.

3.3.7. Interface Groups

Multiple CorePlus interfaces can be grouped together to form an *Interface Group*. Such a logical group can then be subject to common policies and be referred to using a group name in the IP rule set and User Authentication Rules.

A group can consist of regular Ethernet interfaces, VLAN interfaces, or VPN Tunnels and the members of a group need not be of the same type. A group might consist, for instance, of two Ethernet interfaces and four VLAN interfaces.

The *Security/Transport Equivalent* Option

When creating an interface group, the option *Security/Transport Equivalent* can be enabled (it is disabled by default). Enabling the option means that the group can be used as the destination interface in CorePlus rules where connections might need to be moved between two interfaces. For example, the interface might change with route failover or OSPF.

If a connection is moved from one interface to another within a group and *Security/Transport Equivalent* is enabled, CorePlus will not check the connection against the CorePlus rulesets with the new interface.

With the option disabled, a connection cannot be moved to another interface in the group and is instead dropped and must be reopened. This new connection is then checked against the CorePlus rulesets. In some cases, such as an alternative interface that is much slower, it may not be sensible to allow certain connections over the new interface.

Example 3.13. Creating an Interface Group

Clavister FineTune

1. Go to **Interfaces > Interface Group > New Interface Group**
2. The **Interface Group Properties** dialog will be displayed
3. Specify a suitable name for the interface group, for instance *examplegroup*
4. Check the **Security/Transport Equivalent:** option
   (If enabled, the interface group can be used as a destination interface in rules where connections might need to be moved between the interfaces - examples of such usage are Route Fail-Over and OSPF)
5. With **Interfaces**, use the plus and cross keys to add or remove interfaces to the group

6. Click **OK**

3.4. ARP

3.4.1. Overview

Address Resolution Protocol (ARP) is a protocol, which maps a network layer protocol address to a data link layer hardware address and it is used to resolve an IP address into its corresponding Ethernet address. It works at the OSI Data Link Layer (Layer 2 - see Appendix F, *The OSI Framework*) and is encapsulated by Ethernet headers for transmission.

A host in an Ethernet network can communicate with another host only if it knows the Ethernet address (MAC address) of that host. Higher level protocols such as IP make use of IP addresses which are fundamentally different from a lower level hardware addressing scheme like the MAC address. ARP is used to retrieve the Ethernet MAC address of a host by using its IP address.

When a host needs to resolve an IP address to the corresponding Ethernet address, it broadcasts an ARP request packet. The ARP request packet contains the source MAC address and the source IP address and the destination IP address. Each host in the local network receives this packet. The host with the specified destination IP address, sends an ARP reply packet to the originating host with its MAC address.

3.4.2. ARP in CorePlus

CorePlus provides not only standard support for ARP, but also adds a number of security checks on top of the protocol implementation. As an example, CorePlus will by default *not* accept ARP replies for which the system has not sent out a corresponding ARP query for. Without this type of protection, the system would be vulnerable to "connection hijacking".

CorePlus supports both dynamic ARP as well as static ARP, and the latter is available in two modes; Publish and XPublish.

Dynamic ARP is the main mode of operation for ARP, where CorePlus sends out ARP requests whenever it needs to resolve an IP address to an Ethernet address. The ARP replies are stored in the ARP cache of the system.

Static ARP is used for manually lock an IP address to a specific Ethernet address. This is explained in more detail in the sections below.

Clavister SG10 Ethernet Connection Limitations

With the Clavister SG10 Series hardware there is a limit to how many devices can be connected via the ethernet ports. This number is determined by the type of SG10 license purchased and the size of CorePlus ARP table that the license allows. There is no limitation on other Clavister hardware series.

3.4.3. ARP Cache

The *ARP Cache* is the temporary table in CorePlus for storing the mapping between IP and Ethernet addresses. The ARP cache is empty at system startup and will be populated with entries as needed.

The contents of a typical (minimal) ARP Cache looks similar to the following table:

Type	IP Address	Ethernet Address	Expire
Dynamic	192.168.0.10	08:00:10:0f:bc:a5	45
Dynamic	193.13.66.77	0a:46:42:4f:ac:65	136
Publish	10.5.16.3	4a:32:12:6c:89:a4	-

The first item in this ARP Cache is a dynamic ARP entry which tells us that IP address 192.168.0.10 is mapped to an Ethernet address of 08:00:10:0f:bc:a5. The second item dynamically maps the IP address 193.13.66.77 to Ethernet address 0a:46:42:4f:ac:65. Finally, the third item is a static ARP entry binding the IP address 10.5.16.3 to Ethernet address 4a:32:12:6c:89:a4.

The third column in the table, Expire, is used to indicate for how much longer the ARP entry will be valid. The first item, for instance, has an expiry value of 45, which means that this entry will be rendered invalid and removed from the ARP Cache in 45 seconds. If traffic is going to be sent to the 192.168.0.10 IP address after the expiration, CorePlus will issue a new ARP request.

The default expiration time for dynamic ARP entries is 900 seconds (15 minutes). This can be changed by modifying the advanced setting **ARPExpire**.

The setting **ARPExpireUnknown** specifies how long CorePlus will remember addresses that cannot be reached. This is done to ensure that CorePlus does not continuously request such addresses. The default value for this setting is 3 seconds.

Flushing the ARP Cache

If a host in your network has recently been replaced with a new hardware but keeping the same IP address, it is most likely to have a new Ethernet address. If CorePlus has an ARP entry for that host, the Ethernet address of that entry will be invalid, causing data sent to the host to never reach its destination.

Naturally, after the ARP expiration time, CorePlus will learn the new Ethernet address of the requested host, but sometimes it might be necessary to manually force a re-query. This is easiest achieved by *flushing* the ARP cache, an operation which will delete all dynamic ARP entries from the cache, thereby forcing CorePlus to issue new ARP queries.

Size of the ARP Cache

By default, the ARP Cache is able to hold 4096 ARP entries at the same time. This is feasible for most deployments, but in rare occasions, such as when there are several very large LANs directly connected to the gateway, it might be necessary to adjust this value. This can be done by modifying the advanced setting **ARPCacheSize**.

So-called "hash tables" are used to rapidly look up entries in the ARP Cache. For maximum efficiency, a hash should be twice as large as the table it is indexing, so if the largest directly-connected LAN contains 500 IP addresses, the size of the ARP entry hash should be at least 1000 entries. The administrator can modify the advanced setting **ARPHashSize** to reflect specific network requirements. The default value of this setting is 512.

The **ARPHashSizeVLAN** setting is similar to the **ARPHashSize** setting, but affects the hash size for VLAN interfaces only. The default value is 64.

3.4.4. Static and Published ARP Entries

CorePlus supports defining static ARP entries (static binding of IP addresses to Ethernet addresses) as well as publishing IP addresses with a specific Ethernet address.

Static ARP Entries

Static ARP items may help in situations where a device is reporting incorrect Ethernet address in response to ARP requests. Some workstation bridges, such as radio modems, can have such problems. It may also be used to lock an IP address to a specific Ethernet address for increasing security or to avoid denial-of-service if there are rogue users in a network. Note however, that such protection only applies to packets being sent to that IP address, it does not apply to packets being sent from that IP address.

Example 3.14. Defining a Static ARP Entry

This example will create a static mapping between IP address *192.168.10.15* and Ethernet address

4b:86:f6:c5:a2:14 on the *lan* interface:

Clavister FineTune

1. Go to **ARP > New ARP**
2. The **ARP Properties** dialog will be displayed
3. Select **Static** in the **Mode** dropdown list
4. Choose **lan** as the **Interface**
5. Enter 192.168.10.15 as the **IP Address**
6. Enter 4b:86:f6:c5:a2:14 as the **MAC Address**
7. Click **OK**

Published ARP Entries

CorePlus supports *publishing* ARP entries, meaning that you can define IP addresses (and optionally Ethernet addresses) for an interface. CorePlus will then provide ARP replies for ARP requests related to those IP addresses.

This can serve two purposes:

- To give the impression that an interface in CorePlus has more than one IP address.
- To aid nearby network equipment responding to ARP in an incorrect manner. This use is however less common.

The first purpose is useful if there are several separate IP spans on a single LAN. The hosts on each IP span may then use a gateway in their own span when these gateway addresses are published on the corresponding CorePlus interface.

Another use is publishing multiple addresses on an external interface, enabling CorePlus to statically address translate communications to these addresses and send it onwards to internal servers with private IP addresses.

There are two publishing modes; Publish and XPublish. The difference between the two is that XPublish "lies" about the sender Ethernet address in the Ethernet header; this is set to be the same as the published Ethernet address rather than the actual Ethernet address of the Ethernet interface. If a published Ethernet address is the same as the Ethernet address of the interface, it will make no difference if you select Publish or XPublish, the result will be the same.

Tip: Using Proxy ARP to publish networks

In the configuration of ARP entries, addresses may only be published one at a time. However, you can use the ProxyARP feature to handle publishing of entire networks (see Section 4.2.5, "Proxy ARP").

3.4.5. Using ARP Advanced Settings

This section presents some of the advanced settings related to ARP. In most cases, these settings need not to be changed, but in some deployments, modifications might be needed. For more information see Chapter 12, *Advanced Settings*.

Multicast and Broadcast

ARP requests and ARP replies containing multicast or broadcast addresses are usually never correct, with the exception of certain load balancing and redundancy devices, which make use of hardware layer multicast addresses.

The default behavior of CorePlus is to drop and log such ARP requests and ARP replies. This can however be changed by modifying the advanced settings **ARPMulticast** and **ARPBroadcast**.

Unsolicited ARP Replies

It is fully possible for a host on the LAN to send an ARP reply to CorePlus, even though a corresponding ARP request has not been issued. According to the ARP specification, the recipient should accept these types of ARP replies. However, because this can facilitate hijacking of local connections, CorePlus will normally drop and log such replies.

The behavior can be changed by modifying the advanced setting **UnsolicitedARPReplies**.

ARP Requests

The ARP specification states that a host should update its ARP Cache with data from ARP requests received from other hosts. However, as this procedure can facilitate hijacking of local connections, CorePlus will normally not allow this.

To make the behavior compliant with the RFC826 specification, the administrator can modify the setting **ARPRequests**. Even if this is set to *Drop* (meaning that the packet is discarded without being stored), CorePlus will, provided that other rules approve the request, reply to it.

Changes to the ARP Cache

CorePlus provides settings that control the management of changes to the ARP cache.

A received ARP reply or ARP request can possibly alter an existing entry in the ARP cache. Allowing this to take place may allow hijacking of local connections. However, not allowing this may cause problems if, for example, a network adapter is replaced, as CorePlus will not accept the new address until the previous ARP cache entry has timed out.

The advanced setting **ARPChanges** can be adjusted to change this behavior. The default is that CorePlus will allow changes to take place, but all such changes will be logged.

Another, similar, situation occurs when information in ARP replies or ARP requests could collide with static entries in the ARP cache. Naturally, this should never be allowed to happen. However, changing the setting **StaticARPChanges** allows the administrator to specify whether or not such situations are logged.

Sender IP 0.0.0.0

CorePlus can be configured for what to do with ARP queries that have a sender IP of *0.0.0.0*. Such sender IPs are never valid as responses, but network units that have not yet learned of their IP address sometimes ask ARP questions with an "unspecified" sender IP. Normally, these ARP replies are dropped and logged, but the behavior can be changed by modifying the setting **ARPQueryNoSenderIP**.

Matching Ethernet Addresses

By default, CorePlus will require that the sender address at Ethernet level should comply with the Ethernet address reported in the ARP data. If this is not the case, the reply will be dropped and logged. The behavior can be changed by modifying the setting **ARPMatchEnetSender**.

3.5. The IP Rule Set

3.5.1. Security Policies

Common Policy Characteristics

CorePlus Security *Policies* designed by the administrator, regulate the way in which traffic can flow through the Clavister Security Gateway. Policies in CorePlus are defined by different CorePlus *rule sets*. These rule sets share a common means of specifying filtering criteria which determine the type of traffic to which they will apply. This set of criteria consists of:

Source Interface An **Interface** or **Interface Group** where the packet is received at the Clavister Security Gateway. This can also be a VPN tunnel.

Source Network The network that contains the source IP address of the packet. This might be a CorePlus IP object which could define a single IP address or range of addresses.

Destination Interface An **Interface** or an **Interface Group** from which the packet would leave the Clavister Security Gateway. This can also be a VPN tunnel.

Destination Network The network to which the destination IP address of the packet belongs. This might be a CorePlus IP object which could define a single IP address or range of addresses.

Service The protocol type to which the packet belongs. Service objects define a protocol/port type. Examples might be **HTTP** or **ICMP**. Custom services can also be defined.(see Section 3.2, “Services” for more information.)

CorePlus Policy Rulesets

The principle CorePlus rule sets that define CorePlus security policies, and which use the same five filtering parameters described above (networks/interfaces/service), include:

- **IP rules**
  These determine which traffic is permitted to pass through the Clavister Security Gateway as well as determining if the traffic is subject to address transaltion. They are described below.

- **Pipe rules**
  These determine which traffic triggers traffic shaping to take place and are described in Section 10.1, “Traffic Shaping”.

- **Policy-based Routing rules**
  These determine the routing table ro be used by traffic and are described in Section 4.3, “Policy-based Routing”.

- **IDP rules**
  These determine which traffic is subject to IDP scanning and are described in Section 6.5, “Intrusion Detection and Prevention”.

- **Authentication rules**
  These determine which traffic triggers authentication to take place (source net/interface only) and are described in Chapter 8, *User Authentication*.

Specifying Any Interface or Network

When specifying the filtering criteria in any of the rule sets specified above there are three useful pre-defined options that can be used :

- For a Source or Destination Network, the **all-nets** option is equivalent to the IP address *0.0.0.0/0* which will mean that any IP address is acceptable.
- For Source or Destination Interface, the **any** option can be used so that CorePlus will not care about the interface which the traffic is going to or coming from.
- The Destination Interface can be specified as **core**. This means that traffic, such as an ICMP *Ping*, is destined for the Clavister Security Gateway itself and CorePlus will respond to it.

IP Rules and the Initial IP Rule Set

The *IP rule set* is the most important of these security policy rule sets. It determines the critical packet filtering function of CorePlus, regulating what is allowed or not allowed to pass through the Clavister Security Gateway, and if necessary, how address translations like NAT are applied.

There are two possible approaches to how traffic traversing the Clavister Security Gateway could be dealt with:

- Everything is denied unless specifically permitted
- **Or** everything is permitted unless specifically denied

To provide the best security, the first of these approaches is adopted by CorePlus. This means that when first installed and started, the CorePlus IP rule set drops all traffic. In order to allow any traffic to traverse the Clavister Security Gateway (including CorePlus responding to ICMP *Ping* requests), new IP rules must be defined by the administrator.

Traffic that doesn't match any rule in the IP rule set is, by default, dropped by CorePlus. For logging purposes it is nevertheless recommended that an explicit IP rule with an action of **Drop** for all source/destination networks/interfaces, and with logging enabled, is placed as the last rule in the IP rule set.

3.5.2. IP Rule Evaluation

When a new connection, such as a TCP/IP connection, is being established through the Clavister Security Gateway, the list of IP rules are evaluated from top to bottom until a rule that matches the parameters of the new connection is found. The rule's **Action** is then performed.

If the action allows it then the establishment of the new connection will go ahead. A new entry or *state* representing the new connection will then be added to the CorePlus internal *state table* which allows monitoring of opened and active connections passing through the Clavister Security Gateway. If the action is **Drop** or **Reject** then the new connection is refused.

Stateful Inspection

After initial rule evaluation of the opening connection, subsequent packets belonging to that connection will not need to be evaluated individually against the rule set. Instead, a highly efficient algorithm searches the state table for each packet to determine if it belongs to an established connection.

This approach is known as *stateful inspection* and is applied not only to stateful protocols such as TCP but also by means of "pseudo-connections" to stateless protocols such as UDP and ICMP. This approach means that evaluation against the IP rule set is only done in the initial opening phase of a connection. The size of the IP rule set consequently has negligible effect on overall throughput.

The First Matching Principle

If several rules match the same parameters, the first matching rule in a scan from top to bottom is the one that decides how the connection will be handled.

The exception to this is **SAT** rules since these rely on a pairing with a second rule to function. After encountering a matching **SAT** rule the search will therefore continue on looking for a matching second rule (see Section 7.3, “SAT” for more information on this).

Non-matching Traffic

Incoming packets that don't match any rule in the rule set and that don't have an already opened matching connection in the state table, will automatically be subject to a **Drop** action. For explicitness there should be a rule called **DropAll** as the final rule in the rule set with an action of **Drop** with Source/Destination Network *all-nets* and Source/Destination Interface *all*.

3.5.3. IP Rule Actions

A rule consists of two parts: the filtering parameters and the action to take if there is a match with those parameters. As described above, the parameters of any CorePlus rule, including IP rules are:

- Source Interface
- Source Network
- Destination Interface
- Destination Network
- Service

The *Service* in an IP rule is also important because if an *Application Layer Gateway* object is to be applied to traffic then it must be associated with a Service object (see Section 6.2, “ALGs”).

When an IP rule is triggered by a match then one of the following *Actions* can occur:

Allow The packet is allowed to pass. As the rule is applied to only the opening of a connection, an entry in the "state table" is made to record that a connection is open. The remaining packets related to this connection will pass through the CorePlus "stateful engine".

FwdFast Let the packet pass through the Clavister Security Gateway without setting up a state for it in the state table. This means that the stateful inspection process is bypassed and is therefore less secure than **Allow** or **NAT** rules. Packet processing time is also slower than **Allow** rules since every packet is checked against the entire rule set.

NAT This functions like an **Allow** rule, but with dynamic address translation (NAT) enabled (see Section 7.1, “NAT” in Chapter 7, *Address Translation* for a detailed description).

SAT This tells CorePlus to perform static address translation. A **SAT** rule always requires a matching **Allow**, **NAT** or **FwdFast** rule further down the rule set (see Section 7.3, “SAT” in Chapter 7, *Address Translation* for a detailed description).

Drop This tells CorePlus to immediately discard the packet. This is an "impolite" version of **Reject** in that no reply is sent back to the sender. It is often preferable since it gives a potential attacker no clues about what happened to their packets.

Reject This acts like **Drop**, but will return a "TCP RST" or "ICMP Unreachable message", informing the sending computer that the packet was disallowed. This is a "polite" version of the **Drop** action.

Bi-directional Connections

A common mistake when setting up IP Rules is to define two rules, one rule for traffic in one direction and another rule for traffic coming back in the other direction. In fact nearly all IP Rules types allow *bi-directional* traffic flow once the initial connection is set up. The **Source Network** and **Source Interface** in the rule means the source of the initial connection request. Once a connection is permitted and established traffic can then flow in either direction over it.

The exception to this bi-directional flow is **FwdFast** rules. If the **FwdFast** action is used then the rule will not allow traffic to flow from the destination back to the source. If bi-directional flow is required then two **FwdFast** rules are needed, one for either direction. This is also the case if a **FwdFast** rule is used with a **SAT** rule.

Using *Reject*

In certain situations the **Reject** action is recommended instead of the **Drop** action because a polite reply is required from CorePlus. An example of such a situation is when responding to the IDENT user identification protocol.

3.5.4. Multiple IP Rule Sets

Overview

CorePlus allows the administrator to define multiple IP rule sets which can both simplify and provide greater flexibility when defining security policies. The default IP rule set is known as *main* and is always present in CorePlus. Additional rule sets can be defined as needed and are given a name by the administrator.

Multiple IP rule sets offer many advantages, among them:

- The administrator can break a single large IP rule set into multiple, smaller, more manageable rule sets.
- A single named IP rule set can be associated with a routing table. This makes implementing Virtual Routing much simpler since each router can have a dedicated IP Rules-set associated with it. (See Section 4.4, “Virtual Routing” for more on this topic).

Searching Multiple rule sets

When multiple rule sets are defined, the way they are processed for a new connection is as follows:

- The primary *main* IP rule set is always searched first for matches of source/destination interface/network.
- User-defined rule sets are used in a rule look-up only when the action specified for a matching rule in *main* is **Goto**. The **Goto** action must have a named, administrator defined IP rule set associated with it and if the traffic matches the **Goto** rule then the rule look-up continues from the beginning of that named rule set.

  A **Goto** may never use the *main* rule set as its target.
- If the search in the named rule set finds no match then the connection is dropped.
- If a match is found in the named rule set then the action is executed. The action might be another **Goto** in which case the rule scanning jumps to the beginning of another named rule set.

  If the action is **Return** then the rule scanning resumes at the rule which follows the last **Goto** action (if there was no last **Goto** then the connection is dropped and rule scanning stops).

Loop Avoidance

It is conceivable that a sequence of **Goto** actions results in an infinite looping scanning sequence. CorePlus detects such logic when a configuration is initially uploaded. A new configuration is rejected along with an explanatory error message generated by Clavister FineTune if multiple IP rule set logic is detected that could potentially cause a loop condition.

The loop avoidance mechanism has to be efficient to enable fast configuration upload and for this reason it uses an algorithm that might sometimes find a fault in correct but complex logic. In this case it may be necessary to simplify the rule logic so the configuration can be uploaded.

A Usage Example

Below are two simple IP Rule set tables which illustrate how multiple rule sets might be used. The *main* rule set contains a first rule which has a **Goto** action which references the named administrator defined table called *ExtraRules*.

The administrator defined rule set *ExtraRules* contains a **NAT** and **SAT** rule. If neither are triggered then the final rule has a **Return** action which will cause the scanning process to go back to the rule in *main* which follows the **Goto** rule. In this case it will be the second rule in *main*.

The *main* IP rule set

#	Action	Src Iface	Src Net	Dest Iface	Dest Net	Service
1	Goto ExtraRules	any	all-nets	core	172.16.40.0/24	all
2	Allow	any	192.168.0.0/24	core	172.16.0.0/16	all

The *ExtraRules* IP rule set

#	Action	Src Iface	Src Net	Dest Iface	Dest Net	Service
1	SAT	any	all-nets	any	172.16.40.66	all
2	NAT	if2	176.16.0.0/16	any	all-nets	all
3	RETURN	if2	all-nets	any	all-nets	all

3.6. Schedules

In some scenarios, it might be useful to control not only what functionality is enabled, but also when that functionality is being used.

For instance, the IT policy of an enterprise might stipulate that web traffic from a certain department is only allowed access outside that department during normal office hours. Another example might be that authentication using a specific VPN connection is only permitted on weekdays before noon.

Schedule Objects

CorePlus addresses this requirement by providing *Schedule* objects, or simply *schedules*, that can be selected and used with various types of security policies to accomplish time-based control. This functionality is in no way limited to IP Rules, but is valid for most types of policies, including Traffic Shaping rules, Intrusion Detection and Prevention (IDP) rules and Virtual Routing rules. A Schedule object is, in other words, a very powerful component that can allow detailed regulation of when functions in CorePlus are enabled or disabled.

Multiple Time Ranges

A Schedule object also offers the possibility to enter multiple time ranges for each day of the week. Furthermore, a start and a stop date can be specified that will impose additional constraints on the schedule. For instance, a schedule can be defined as Mondays and Tuesdays, 08:30 - 10:40 and 11:30 - 14:00, Fridays 14:30 - 17:00.

Important: Set the system date and time

As schedules depend on an accurate system date and time, it is very important that the system date and time are set correctly. This is also important for some other features such as certificate usage in VPN tunnels.

Preferably, time synchronization has also been enabled to ensure that scheduled policies will be enabled and disabled at the right time. For more information, please see Section 3.8, "Date and Time".

Example 3.15. Setting up a Time-Scheduled Policy

This example creates a schedule object for office hours on weekdays, and attaches the object to an IP Rule that allows HTTP traffic.

Clavister FineTune

1. Go to **Schedule Profiles > New Schedule Profile**
2. The **Schedule Profile Properties** dialog will be displayed
3. Specify a suitable name for the schedule profile, for example *OfficeHours*
4. Select 08-17, Monday to Friday in the grid
5. Click **OK**

Now attach the object to an IP rule:

1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Specify a suitable name for the schedule profile, for example *OfficeHours*
4. Select the following from the drop-down lists:

- **Action:** NAT
- **Service:** http
- **Schedule:** OfficeHours
- **SourceInterface:** lan
- **SourceNetwork** lannet
- **DestinationInterface:** any
- **DestinationNetwork:** all-nets

5. Click **OK**

3.7. Certificates

3.7.1. Overview

X.509

CorePlus supports digital certificates that comply with the ITU-T X.509 standard. This involves the use of an X.509 certificate hierarchy with public-key cryptography to accomplish key distribution and entity authentication. References in this manual to a *certificate* means a *X.509 certificate*.

A certificate is a digital proof of identity. It links an identity to a public key in order to establish whether a public key truly belongs to the supposed owner. By doing this, it prevents data transfer interception by a malicious third-party who might post a fake key with the name and user ID of an intended recipient.

Certificates with VPN Tunnels

The main usage of certificates in CorePlus is with VPN tunnels. The simplest and fastest way to provide security between the ends of a tunnel is to use Pre-shared Keys (PSKs). As a VPN network grows so does the complexity of using PSKs. Certificates provide a means to better manage security in much larger networks.

Certificate Components

A certificate consists of the following:

- A public key: The "identity" of the user, such as name, user ID.
- Digital signatures: A statement that tells the information enclosed in the certificate has been vouched for by a Certificate Authority.

By binding the above information together, a certificate is a public key with identification attached, coupled with a stamp of approval by a trusted party.

Certifice Authorities

A *certificate authority* (CA) is a trusted entity that issues certificates to other entities. The CA digitally signs all certificates it issues. A valid CA signature in a certificate verifies the identity of the certificate holder, and guarantees that the certificate has not been tampered with by any third party.

A CA is responsible for making sure that the information in every certificate it issues is correct. It also has to make sure that the identity of the certificate matches the identity of the certificate holder.

A CA can also issue certificates to other CAs. This leads to a tree-like certificate hierarchy. The highest CA is called the root CA. In this hierarchy, each CA is signed by the CA directly above it, except for the root CA, which is typically signed by itself.

A certification path refers to the path of certificates from one certificate to another. When verifying the validity of a user certificate, the entire path from the user certificate up to the trusted root certificate has to be examined before establishing the validity of the user certificate.

The CA certificate is just like any other certificates, except that it allows the corresponding private key to sign other certificates. Should the private key of the CA be compromised, the whole CA, including every certificate it has signed, is also compromised.

Note
A CA is sometimes referred to as a "certification authority".

Validity Time

A certificate is not valid forever. Each certificate contains the dates between which the certificate is valid. When this validity period expires, the certificate can no longer be used, and a new certificate has to be issued.

Important
Make sure the CorePlus date and time are set correctly when using certificates.

Certificate Revocation Lists

A *Certificate Revocation List* (CRL) contains a list of all certificates that have been cancelled before their expiration date. They are normally held on an external server which is accessed to determine if the certificate is still valid. The ability to validate a user certificate in this way is a key reason why certificate security simplifies the administration of large user communities.

CRLs are published on servers that all certificate users can access, using either the LDAP or HTTP protocols. Revocation can happen for several reasons. One reason could be that the keys of the certificate have been compromised in some way, or perhaps that the owner of the certificate has lost the rights to authenticate using that certificate, perhaps because they have left the company. Whatever the reason, server CRLs can be updated to change the validity of one or many certificates.

Certificates often contain a CRL Distribution Point (CDP) field, which specifies the location from where the CRL can be downloaded. In some cases certificates do not contain this field. In those cases the location of the CRL has to be configured manually.

A CA usually updates its CRL at a given interval. The length of this interval depends on how the CA is configured. Typically, this is somewhere between an hour to several days.

Trusting Certificates

When using certificates, CorePlus trusts anyone whose certificate is signed by a given CA. Before a certificate is accepted, the following steps are taken to verify the validity of the certificate:

- Construct a certification path up to the trusted root CA.
- Verify the signatures of all certificates in the certification path.
- Fetch the CRL for each certificate to verify that none of the certificates have been revoked.

Identification Lists

In addition to verifying the signatures of certificates, CorePlus also employs identification lists. An identification list is a list naming all the remote identities that are allowed access through a specific VPN tunnel, provided the certificate validation procedure described above succeeded.

Reusing Root Certificates

In CorePlus, root certificates should be seen as global entities that can be reused between VPN tunnels. Even though a root certificate is associated with one VPN tunnel in CorePlus, it can still be reused with any number of other, different VPN tunnels.

3.7.2. Using CA Signed Certificates

When using CA signed Certificates the steps to follow are:

1. Use the *Certificate Request* feature to create a new request for a Gateway Certificate and generate the associated data sequence which defines the request.

2. Cut and paste this data and send it to the chosen CA in a formal request (this might be in an email or using a web based form depending on the CA).

3. The CA responds by issuing a *Gateway Certificate*.

4. Obtain a Root Certificate from the CA Server (usually by a simple download).

5. Import the Root and Gateway certificate files into Clavister FineTune. A match with be made with the pending Certificate Request and the status of the request will change to "OK".

6. For IPsec tunnels, associate both the Gateway and Root Certificates with the tunnel.

The steps described here should be applicable for most CA Servers but each, such as the Microsoft CA Server, may differ slightly in their use.

A number of other factors should be kept in mind when using certificates:

- If Certificate Revocation Lists (CRLs) are used, then the CRL distribution point is defined as a URL that must be resolved. Therefore a DNS server that can resolve the CRL distribution point should be defined in CorePlus.

- Make sure the CorePlus date and time are set correctly. Certificates have validity dates associated with them and therefore require a correct date and time to be set.

- In the case of external VPN clients or the other Clavister Security Gateway in a LAN to LAN tunnel, an attempt may be made to validate the Gateway Certificate by contacting the CA Server and these HTTP accesses should be allowed. If the CA Server is an internal server behind the Clavister Security Gateway, such accesses should be permitted in the gateway's IP rule set.

- Don't get the Gateway Certificate files and Root Certificate files mixed up. Although it is not possible to use a Gateway Certificate in CorePlus as a Root Certificate, it is possible to accidentally use a Gateway Certificate as a Root Certificate.

- Certificates have two files associated with them and these have the filetypes *.key* file and *.cer*. The filename of these files **must** be the same for CorePlus to be able to use them. For example, if the certificate is called *my_cert* then the files *my_cert.key* and *my_cert.cer*.

Example 3.16. Creating CA Request Data

Clavister FineTune

1. Go to **Certificates > New Certificate**
2. Enter a **Name** for the certificate
3. Select **Create Certificate Request**
4. Select the **Certificate Properties** tab
5. Enter the properties including at least **Common Name** and **DNS** and data required by the CA
6. Click **OK**
7. A progress dialog will appear and when complete this request will appear in the request table
8. Right click the request line in the table and select **View Certificate Request**

9. Cut the data presented in the dialog and send this to the CA

Example 3.17. Importing CA Certificates

Assuming the CA has now supplied the Root and Gateway Certificates they need to be now imported.

Clavister FineTune

1. Go to **Local Objects > Certificates > Import Certificate**
2. A file chooser dialog appears and this is used to select the certificate file
3. Pressing **Open** in the file chooser dialog imports the certificate
4. Repeat the above so both the Gateway and Root certificates are imported

Example 3.18. Associating Certificates with IPsec Tunnels

The next step is to associate the imported certificates with an IPsec tunnel.

Clavister FineTune

1. Go to **Interfaces > IPsec Tunnels > Tunnel Properties**
2. Select the **Authentication** tab
3. Select **X509 Certificate**
4. Select the correct **Gateway** and **Root** certificates
5. Click **OK**

3.8. Date and Time

3.8.1. Overview

Correctly setting the date and time is important for CorePlus to operate properly. Time scheduled policies, auto-update of the IDP and Anti-Virus databases, and other product features require that the system clock is accurately set. In addition, log messages are tagged with time-stamps in order to indicate when a specific event occurred. Not only does this assume a working clock, but also that the clock is correctly synchronized with other devices in the network.

To maintain current date and time, CorePlus makes use of a built-in real-time hardware clock. This clock is also equipped with a battery backup to guard against a temporary loss of power. In addition, CorePlus supports *Time Synchronization Protocols* in order to automatically adjust the clock, based on queries sent to special external servers.

3.8.2. Setting Date and Time

Current Date and Time

The administrator can set the date and time manually and this is recommended when a new CorePlus installation is started for the first time.

> ***Note***
> *A new date and time will be applied by CorePlus as soon as it is set.*

Time Zones

The world is divided up into a number of time zones with Greenwich Mean Time (GMT) in London at zero longitude being taken as the base time zone. All other time zones going east and west from zero longitude are taken as being GMT plus or minus a given integer number of hours. All locations counted as being inside a given time zone will then have the same local time and this will be one of the integer offsets from GMT.

The CorePlus time zone setting reflects the time zone where the Clavister Security Gateway is physically located.

Example 3.19. Setting the Time Zone

To modify the CorePlus time zone to be GMT plus 1 hour, follow the steps outlined below:

Clavister FineTune

1. Go to **Advanced Settings/Timesync**
2. In the **TimeSync_TimeZoneOffs** setting, enter the amount of minutes corresponding to the actual timezone. For instance, if the timezone is GMT+1 (GMT plus 60 minutes), the value of the setting should be 60.

Daylight Saving Time

Many regions follow *Daylight Saving Time* (DST) (or "Summer-time" as it is called in some countries) and this means clocks are advanced for the summer period. Unfortunately, the principles regulating DST vary from country to country, and in some cases there can be variations within the same country. For this reason, CorePlus does not automatically know when to adjust for DST. Instead, this information has to be manually provided if daylight saving time is to be used.

There are two parameters governing daylight saving time; the DST period and the DST offset. The DST period specifies on what dates daylight saving time starts and ends. The DST offset indicates the number of minutes to advance the clock during the daylight saving time period.

Example 3.20. Enabling DST

To enable DST, follow the steps outlined below:

Clavister FineTune

1. Go to **Advanced Settings/Timesync**
2. Check the **TimeSync_DSTEnabled** checkbox
3. In the **TimeSync_DSTOffs** setting, enter the DST offset in minutes
4. In the **TimeSync_DSTStartDate** and **TimeSync_DSTEndDate** settings, enter the dates that specify when the DST period starts and ends respectively

3.8.3. Time Servers

The hardware clock which CorePlus uses can sometimes become fast or slow after a period of operation. This is normal behavior in most network and computer equipment and is solved by utilizing *Time Servers*.

CorePlus is able to adjust the clock automatically based on information received from one or more Time Servers which provide a highly accurate time, usually using atomic clocks. Using Time Servers is highly recommended as it ensures CorePlus will have its date and time aligned with other network devices.

Time Synchronization Protocols

Time Synchronization Protocols are standardised methods for retrieving time information from external Time Servers. CorePlus supports the following time synchronization protocols:

- SNTP - Defined by RFC 2030, The Simple Network Time Protocol (SNTP) is a lightweight implementation of NTP (RFC 1305). This is used by CorePlus to query NTP servers.
- UDP/TIME - The Time Protocol (UDP/TIME) is an older method of providing time synchronization service over the Internet. The protocol provides a site-independent, machine-readable date and time. The server sends back the time in seconds since midnight on January first, 1900.

Most public Time Servers run the NTP protocol and are accessible using SNTP.

Configuring Time Servers

Up to three Time Servers can be configured to query for time information. By using more than a single server, situations where an unreachable server causes the time synchronization process to fail can be prevented. CorePlus always queries all configured Time Servers and then computes an average time based on all responses. Internet search engines can be used to list publicly available Time Servers.

Important

Make sure an external DNS server is configured so that Time Server URLs can be resolved (see Section 3.9, “DNS”). This is not needed if using server IP addresses.

Example 3.21. Enabling Time Synchronization using SNTP

In this example, time synchronization is set up to use the SNTP protocol to communicate with the NTP servers at the Swedish National Laboratory for Time and Frequency. The NTP server URLs are *ntp1.sp.se* and *ntp2.sp.se*.

Clavister FineTune

1. Go to **Advanced Settings > Timesync**
2. In the **TimeSync_ServerType** setting, select SNTP in the dropdown list
3. In the **TimeSync_TimeServerIP1** setting, enter ntp1.sp.se
4. In the **TimeSync_TimeServerIP2** setting, enter ntp2.sp.se

Example 3.22. Manually Triggering a Time Synchronization

Time synchronization can be triggered from the CLI. The output below shows a typical response.

CLI

```
Cmd> time -sync
Attempting to synchronize system time...

Server time: 2008-02-27 12:21:52 (UTC+00:00)
Local time:  2008-02-27 12:24:30 (UTC+00:00) (diff: 158)

Local time successfully changed to server time.
```

Maximum Time Adjustment

To avoid situations where a faulty Time Server causes the clock to be updated with a extremely inaccurate time, a *Maximum Adjustment* value (in seconds) can be set. If the difference between the current CorePlus time and the time received from a Time Server is greater than this Maximum Adjustment value, then the Time Server response will be discarded. For example, assume that the maximum adjustment value is set to 60 seconds and the current CorePlus time is 16:42:35. If a Time Server responds with a time of 16:43:38 then the difference is 63 seconds. This is greater than the Maximum Adjustment value so no update occurs for this response.

Example 3.23. Modifying the Maximum Adjustment Value

Clavister FineTune

1. Go to **Advanced Settings/Timesync**
2. In the **TimeSync_MaxAdjust** setting, enter the maximum time drift in seconds that a server is allowed to adjust for

Sometimes it might be necessary to override the maximum adjustment, for instance, if time synchronization has just been enabled and the initial time difference is greater than the maximum adjust value. It is then possible to manually force a synchronization and disregard the maximum adjustment parameter.

Example 3.24. Forcing Time Synchronization

This example demonstrates how to force time synchronization, overiding the maximum adjustment setting.

CLI

```
Cmd> time -sync -force
```

Synchronization Intervals

The interval between each synchronization attempt can be adjusted if needed. By default, this value is 86,400 seconds (1 day), meaning that the time synchronization process is executed once in a 24 hour period.

3.9. DNS

Overview

A DNS server can resolve a *Fully Qualified Domain Name* (FQDN) into the corresponding numeric IP address. FQDNs are unambiguous textual domain names which specify a node's unique position in the Internet's DNS tree hierarchy. FQDN resolution allows the actual physical IP address to change while the FQDN can stay the same.

A *Uniform Resource Locator* (URL) differs from an FQDN in that the URL includes the access protocol along with the FQDN. For example the protocol might be specified *http//:* for world wide web pages.

FQDNs are used in many aspects of a CorePlus configuration where IP addresses are unknown or where it makes more sense to make use of DNS resolution instead of using static IP addresses.

DNS with CorePlus

To accomplish DNS resolution, CorePlus has a built-in DNS client that can be configured to make use of up to three DNS servers. The are called the *Primary Server*, the *Secondary Server* and the *Tertiary Server*. For DNS to function at least the primary must be defined. It is recommended to have at least a primary and secondary defined so that there is a backup should the primary be unavailable.

Features Requiring DNS Resolution

Having at least one DNS server defined is vital for functioning of the following modules in CorePlus:

- Automatic time synchronization.
- Access to an external certificate authority server for CA signed certificates.
- UTM features that require access to external servers such as anti-virus and IDP.

Example 3.25. Configuring DNS Servers

In this example, the DNS client is configured to use one primary and one secondary DNS server, having IP addresses 10.0.0.1 and 10.0.0.2 respectively.

Clavister FineTune

1. Go to **Advanced Settings > DNSClient**
2. In the **DNS_DNSServerIP1** setting, enter 10.0.0.1.
3. In the **DNS_DNSServerIP2** setting, enter 10.0.0.2.

Chapter 4. Routing

This chapter describes how to configure IP routing in CorePlus.

4.1. Overview

IP routing capabilities belong to the most fundamental functionalities of CorePlus: any IP packet flowing through the system will be subjected to at least one routing decision at some point in time, and proper setup of routing is crucial for a CorePlus system to function as expected.

CorePlus offers support for the following types of routing mechanisms:

- Static routing.
- Dynamic routing.
- Virtual routing.

CorePlus additionally supports *route monitoring* to achieve route and link redundancy with fail-over capability.

4.2. Static Routing

The most basic form of routing is known as *Static Routing*. The term static refers to the fact that entries in the routing table are manually added and are therefore permanent (or static) by nature.

Due to this manual approach, static routing is most appropriate to use in smaller network deployments where addresses are fairly fixed and where the amount of connected networks are limited to a few. For larger networks however (or whenever the network topology is complex), the work of manually maintaining static routing tables will be time-consuming and problematic. As a consequence, dynamic routing should be used in those cases.

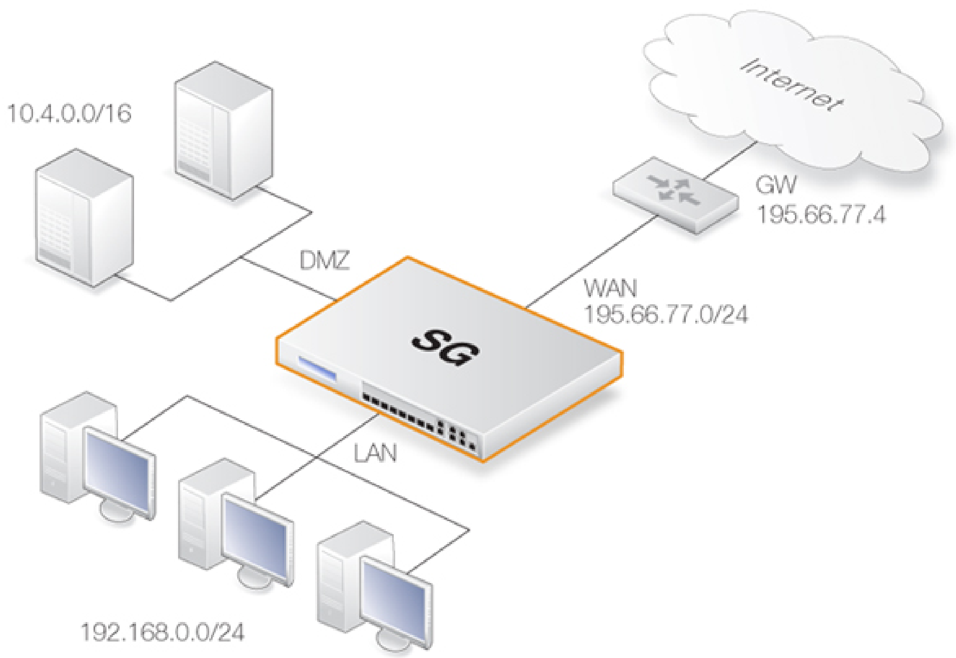
For more information about the dynamic routing capabilities of CorePlus, please see Section 4.5, “OSPF”. Note however, that even if you choose to implement dynamic routing for your network, you will still need to understand the principles of static routing and how it is implemented in CorePlus.

4.2.1. The Principles of Routing

IP routing is the mechanism used in TCP/IP based networks for delivering IP packets from their source to their ultimate destination through a number of intermediary nodes, most often referred to as routers or gateways. In each router, a *routing table* is consulted to find out where to send the packet next. A routing table usually consists of several *routes*, where each route consists of:

- A destination network.
- The interface to forward the packet on to reach that network.
- Optionally the IP address of the *gateway* which is the next router in the path to the destination.

The diagram below illustrates a typical Clavister Security Gateway deployment:



In the above diagram the **LAN** interface is connected to the network *192.168.0.0/24* and the **DMZ** interface is connected to the network *10.4.0.0/16*. The **WAN** interface is connected to the network *195.66.77.0/24* and the address of the ISP gateway to the public Internet is *195.66.77.4*.

The associated routing table for this would be as follows:

Route #	Interface	Destination	Gateway
1	lan	192.168.0.0/24	
2	dmz	10.4.0.0/16	
3	wan	195.66.77.0/24	
4	wan	all-nets	195.66.77.4

The above routing table provides the following information:

- Route #1: All packets going to hosts on the 192.168.0.0/24 network should be sent out on the lan interface. As no gateway is specified for the route entry, the host is assumed to be located on the network segment directly reachable from the lan interface.

- Route #2: All packets going to hosts on the 10.4.0.0/16 network are to be sent out on the dmz interface. Also for this route, no gateway is specified.

- Route #3: All packets going to hosts on the 195.66.77.0/24 network will be sent out on the wan interface. No gateway is required to reach the hosts.

- Route #4: All packets going to any host (the *all-nets* network will match all hosts) will be sent out on the wan interface and to the gateway with IP address 195.66.77.4. That gateway will then consult its routing table to find out where to send the packets next. A route with destination *all-nets* is often referred to as the *Default Route* as it will match all packets for which no specific route has been configured.

When a routing table is evaluated, the ordering of the routes is important. In general, a routing table is evaluated with the most *specific* routes first. In other words, if two routes have destination networks that overlap, the more narrow network will be evaluated prior to the wider one. In the above example, a packet with a destination IP address of 192.168.0.4 will theoretically match both the first route and the last one. However, the first route entry is a more specific match, so the evaluation will end there and the packet will be routed according to that entry.

4.2.2. Static Routing

This section describes how routing is implemented in CorePlus, and how to configure static routing.

CorePlus supports multiple routing tables. A default table called **main** is pre-defined and is always present in CorePlus. However, additional and completely separate routing tables can be defined by the administrator to provide alternate routing.

Extra user-defined routing tables can be used in two ways:

- **Virtual Routing** associates interfaces with a particular routing table. This enables a single physical Clavister Security Gateway to act as multiple virtual systems. Communication between these systems is achieved with *Loopback Interfaces* (see Section 4.4, “Virtual Routing” and also Section 3.3.6, “Loopback Interfaces”).

- **Policy Based Routing Rules** can be defined which decide which of the routing tables will deal with certain types of traffic (see Section 4.3, “Policy-based Routing”).

The Route Lookup Mechanism

The CorePlus route lookup mechanism has some slight differences to how some other router products work. In many routers, where the IP packets are forwarded without context (in other words, the forwarding is stateless), the routing table is scanned for each and every IP packet received by the router. In CorePlus, packets are forwarded with state-awareness, so the route lookup process is tightly integrated into the CorePlus stateful inspection mechanism.

When an IP packet is received on any of the interfaces, the connection table is consulted to see if there is an already open connection for which the received packet belongs. If an existing connection is found, the connection table entry includes information on where to route the packet so there is no need for lookups in the routing table. This is far more efficient than traditional routing table lookups, and is one reason for the high forwarding performance of CorePlus.

If an established connection cannot be found, then the routing table is consulted. It is important to understand that the route lookup is performed *before* the various rules sections get evaluated. As a result, the destination interface is known at the time CorePlus decides if the connection should be allowed or dropped. This design allows for a more fine-grained control in security policies.

CorePlus Route Notation

CorePlus uses a slightly different way of describing routes compared to most other systems but this way is easier to understand, making errors less likely.

Many other products do not use the specific interface in the routing table, but specify the IP address of the interface instead. The routing table below is from a Microsoft Windows XP workstation:

```
====================================================================
Interface List
0x1 ........................... MS TCP Loopback interface
0x10003 ...00 13 d4 51 8d dd ...... Intel(R) PRO/1000 CT Network
0x20004 ...00 53 45 00 00 00 ...... WAN (PPP/SLIP) Interface
====================================================================
====================================================================
Active Routes:
Network Destination        Netmask      Gateway     Interface Metric
          0.0.0.0          0.0.0.0  192.168.0.1  192.168.0.10     20
         10.0.0.0        255.0.0.0   10.4.2.143    10.4.2.143      1
       10.4.2.143  255.255.255.255    127.0.0.1     127.0.0.1     50
   10.255.255.255  255.255.255.255   10.4.2.143    10.4.2.143     50
     85.11.194.33  255.255.255.255  192.168.0.1  192.168.0.10     20
        127.0.0.0        255.0.0.0    127.0.0.1     127.0.0.1      1
      192.168.0.0    255.255.255.0 192.168.0.10  192.168.0.10     20
     192.168.0.10  255.255.255.255    127.0.0.1     127.0.0.1     20
    192.168.0.255  255.255.255.255 192.168.0.10  192.168.0.10     20
        224.0.0.0        240.0.0.0   10.4.2.143    10.4.2.143     50
        224.0.0.0        240.0.0.0 192.168.0.10  192.168.0.10     20
  255.255.255.255  255.255.255.255   10.4.2.143    10.4.2.143      1
  255.255.255.255  255.255.255.255 192.168.0.10  192.168.0.10      1
Default Gateway:       192.168.0.1
====================================================================
Persistent Routes:
None
```

The corresponding routing table in CorePlus is similar to this:

```
Flags Network            Iface    Gateway        Local IP  Metric
----- ------------------ -------- -------------- --------- ------
      192.168.0.0/24     lan                               20
      10.0.0.0/8         wan                               1
      0.0.0.0/0          wan      192.168.0.1              20
```

The CorePlus way of describing the routes is easier to read and understand. Another advantage with this form of notation is that you can specify a gateway for a particular route without having a route that covers the gateway's IP address or despite the fact that the route covers the gateway's IP address is normally routed via another interface.

It is also worth mentioning that CorePlus allows you to specify routes for destinations that are not aligned with traditional subnet masks. In other words, it is perfectly legal to specify one route for the destination address range 192.168.0.5-192.168.0.17 and another route for addresses 192.168.0.18-192.168.0.254. This is a feature that makes CorePlus highly suitable for routing in highly complex network topologies.

Displaying the Routing Table

It is important to distinguish between the routing table that is active in the system, and the routing table that you configure. The routing table that you configure contains only the routes that you have added manually (in other words, the static routes). The content of the active routing table, however, will vary depending on several factors. For instance, if dynamic routing has been enabled, the routing table will be populated with routes learned by communicating with other routers in the network. Also, features such as route fail-over will cause the active routing table to look different from time to time.

Example 4.1. Displaying the Routing Table

This example illustrates how to display the contents of the configured routing table as well as the active routing table.

Clavister FineTune
The configured routing table can be seen in Clavister FineTune:

1. Go to **Routing > Routes > Main**
2. A list of the currently configured routes in the *main* routing tabel will be displayed

Initial Static Routes

When the Clavister Security Gateway is configured for the first time, the routing table will initially be empty and it is necessary to enter at least one route for traffic to flow through the gateway

On initial setup of CorePlus through the console, it is however possible to enter an initial *Default Gateway* and this is usually done if the management workstation is at least one router hop away from the gateway. (If this is the case then the *Allowed Management Net* should also be entered via the console). This will automatically create the corresponding route in the routing table.

Core Routes

CorePlus automatically populates the active routing table with *Core Routes*. These routes are present for the system to understand where to route traffic that is destined for the system itself. There is one route added for each interface in the system. In other words, two interfaces named lan and wan, and with IP addresses 192.168.0.10 and 193.55.66.77, respectively, will result in the following routes:

Route #	Interface	Destination	Gateway
1	core	192.168.0.10	
2	core	193.55.66.77	

When the system receives an IP packet whose destination address is one of the interface IPs, the packet will be routed to the core interface. In other words, it is processed by CorePlus itself.

There is also a core route added for all multicast addresses:

Route #	Interface	Destination	Gateway
1	core	224.0.0.0/4	

To include the core routes when you display the active routing table, you have to specify an option to the routing command.

Example 4.2. Displaying the Core Routes

This example illustrates how to display the core routes in the active routing table using the console command *routes*.

```
Cmd> routes -all

Flags Network            Iface          Gateway         Local IP        Metric
----- ------------------ -------------- --------------- --------------- ------
      127.0.0.1          core           (Shared IP)                     0
      192.168.0.1        core           (Iface IP)                      0
      213.124.165.181    core           (Iface IP)                      0
      127.0.3.1          core           (Iface IP)                      0
      127.0.4.1          core           (Iface IP)                      0
      192.168.0.0/24     lan                                            0
      213.124.165.0/24   wan                                            0
      224.0.0.0/4        core           (Iface IP)                      0
      0.0.0.0/0          wan            213.124.165.1                   0
```

Tip
*For detailed information about the output of the CLI **routes** command, please see Appendix B, CLI Reference.*

4.2.3. Route Failover

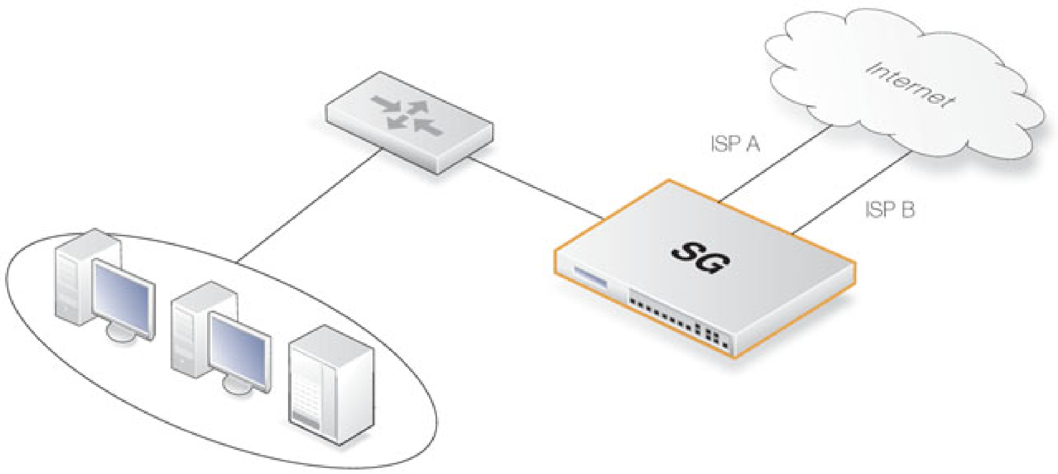
Overview

Clavister Security Gateways are often deployed in mission-critical locations where availability and connectivity is crucial. A corporation relying heavily on access to the Internet, for instance, could have their operations severely disrupted if an Internet connection fails.

As a consequence, it is quite common to have backup Internet connectivity using a secondary Internet Service Provider (ISP). The connections to the two service providers often use different access methods to avoid a single point of failure.

To facilitate a scenario such as multiple ISPs, CorePlus provides a *Route Failover* capability so that should one route fail, traffic can automatically *failover* to another, alternate route. CorePlus implements Route Failover through the use of *Route Monitoring* in which CorePlus monitors the availability of routes and switches traffic to an alternate route should the primary, preferred one fail.

Figure 4.1. A Route Failover Scenario for ISP Access



Setting Up Route Failover

Route Monitoring should be enabled on a per-route basis. To enable the Route Failover feature in a scenario with a preferred and a backup route, the preferred route will have Route Monitoring enabled, however the backup route does not require it to be enabled since it will usually have no route to failover to. For a route with Route Monitoring enabled, one of two Route Monitoring methods must be chosen:

Interface Link Status CorePlus will monitor the link status of the interface specified in the route. As long as the interface is up, the route is diagnosed as healthy. This method is appropriate for monitoring that the interface is physically attached and that the cabling is working as expected. As any changes to the link status are instantly noticed, this method provides the fastest response to failure.

Gateway Monitoring If a specific gateway has been specified as the next hop for a route, accessibility to that gateway can be monitored by sending periodic ARP requests. As long as the gateway responds to these requests, the route is considered to be functioning correctly.

Host Monitoring The first two options check the accessibility of components local to the Clavister Security Gateway. An alternative is to monitor the accessibility of one or more nominated remote hosts. These hosts might have known high availability and polling them can indicate if traffic from the local Clavister Security Gateway is reaching them. Host monitoring also provides a way to measure the network delays in reaching remote hosts and to initiate failover to an alternate route if delays exceed administrator-specified thresholds.

Setting the Route Metric

When specifying routes, the administrator should manually set a route's *Metric*. The Metric is a positive integer that indicates how preferred the route is as a means to reach its destination. When two routes offer a means to reach the same destination, CorePlus will select the one with the lowest Metric value for sending data (if two routes have the same Metric, the route found first in the routing table will be chosen).

A primary, preferred route should have a lower Metric (for example "10"), and a secondary, failover route should have a higher Metric value (for example "20").

Multiple Failover Routes

It is possible to specify more than one failover route. For instance, the primary route could have two other routes as failover routes instead of just one. In this case the Metric should be different for each of the three routes: "10" for the primary route, "20" for the first failover route and "30" for the second failover route. The first two routes would have Route Monitoring enabled in the routing table but the last one (with the highest Metric) would not since it has no route to failover to.

Failover Processing

Whenever monitoring determines that a route is not available, CorePlus will mark the route as disabled and instigate Route Failover for existing and new connections. For already established connections, a route lookup will be performed to find the next best matching route and the connections will then switch to using the new route. For new connections, route lookup will ignore disabled routes and the next best matching route will be used instead.

The table below defines two default routes, both having *all-nets* as the destination, but using two different gateways. The first, primary route has the lowest Metric and also has Route Monitoring enabled. Route Monitoring for the second, alternate route isn't meaningful since it has no failover route.

Route #	Interface	Destination	Gateway	Metric	Monitoring
1	wan	all-nets	195.66.77.1	10	On
2	wan	all-nets	193.54.68.1	20	Off

When a new connection is about to be established to a host on the Internet, a route lookup will result in the route that has the lowest Metric being chosen. If the primary WAN router should then fail, this will be detected by CorePlus, and the first route will be disabled. As a consequence, a new route lookup will be performed and the second route will be selected with the first one being marked as disabled.

Re-enabling Routes

Even if a route has been disabled, CorePlus will continue to check the status of that route. Should the route become available again, it will be re-enabled and existing connections will automatically be transferred back to it.

Route Interface Grouping

When using route monitoring, it is important to check if a failover to another route will cause the routing interface to be changed. If this could happen, it is necessary to take some precautionary steps to ensure that policies and existing connections will be maintained.

To illustrate the problem, consider the following configuration:

First, there is one IP rule that will NAT all HTTP traffic destined for the Internet through the **wan** interface:

#	Action	Src Iface	Src Net	Dest Iface	Dest Net	Parameters
1	NAT	lan	lannet	wan	all-nets	http

The routing table consequently contains the following default route:

Route #	Interface	Destination	Gateway	Metric	Monitoring
1	wan	all-nets	195.66.77.1	10	Off

Now a secondary route is added over a backup DSL connection and Route Monitoring is enabled for this. The updated routing table will look like this:

Route #	Interface	Destination	Gateway	Metric	Monitoring
1	wan	all-nets	195.66.77.1	10	On
2	dsl	all-nets	193.54.68.1	20	Off

Notice that Route Monitoring is enabled for the first route but not the backup, failover route.

As long as the preferred **wan** route is healthy, everything will work as expected. Route Monitoring will also be functioning, so the secondary route will be enabled should the **wan** route fail.

There are, however, some problems with this setup: if a route failover occurs, the default route will then use the **dsl** interface. When a new HTTP connection is then established from the **intnet** network, a route lookup will be made resulting in a destination interface of **dsl**. The IP rules will then be evaluated, but the original NAT rule assumes the destination interface to be **wan** so the new connection will be dropped by the rule set.

In addition, any existing connections matching the NAT rule will also be dropped as a result of the change in the destination interface. Clearly, this is undesirable.

To overcome this issue, potential destination interfaces should be grouped together into an *Interface Group* and the **Security/Transport Equivalent** flag should be enabled for the Group. The Interface Group is then used as the Destination Interface when setting policies. For more information on groups, see Section 3.3.7, “Interface Groups”.

Gratuitous ARP Generation

By default CorePlus generates a gratuitous ARP request when a route failover occurs. The reason for this is to notify surrounding systems that there has been a route change. This behavior can be controlled by the advanced setting **RFO_GratuitousARPOnFail**.

4.2.4. Host Monitoring for Route Failover

Overview

To provide a more flexible and configurable way to monitor the integrity of routes, CorePlus provides the additional capability to perform *Host Monitoring*. This feature means that one or more external host systems can be routinely polled to check that a particular route is available.

The advantages of Host Monitoring are twofold:

- In a complex network topology it is more reliable to check accessibility to external hosts. Just monitoring a link to a local switch may not indicate a problem in another part of the internal network.
- Host monitoring can be used to help in setting the acceptable Quality of Service level of Internet response times. Internet access may be functioning but it may be desirable to instigate route failover if response latency times become unacceptable using the existing route.

Enabling Host Monitoring

As part of *Route Properties* Host Monitoring can be enabled and a single route can have multiple hosts associated with it for monitoring. Multiple hosts can provide a higher certainty that any network problem resides in the local network rather than because one remote host itself is down.

In association with Host Monitoring there are two numerical parameters for a route:

Grace Period — This is the period of time after startup or after reconfiguration of the Clavister Security Gateway which CorePlus will wait before starting Route Monitoring. This waiting period allows

	time for all network links to initialize once the gateway comes online.
Minimum Number of Hosts Available	This is the minimum number of hosts that must be considered to be accessible before the route is deemed to have failed. The criteria for host accessibility are described below

Specifying Hosts

For each host specified for host monitoring there are a number of property parameters that should be set:

- **Method**
  The method by which the host is to be polled. This can be one of:
  - *ICMP* - ICMP "Ping" polling. An IP address must be specified for this.
  - *TCP* - A TCP connection is established to and then disconnected from the host. An IP address must be specified for this.
  - *HTTP* - A normal HTTP server request using a URL. A URL must be specified for this as well as a text string which is the beginning (or complete) text of a valid response. If no text is specified, any response from the server will be valid.
- **IP Address**
  The IP address of the host when using the **ICMP** or **TCP** option.
- **Port Number**
  The port number for polling when using the **TCP** option.
- **Interval**
  The interval in milliseconds between polling attempts. The default setting is 10,000 and the minimum value allowed is 100 ms.
- **Sample**
  The number of polling attempts used as a sample size for calculating the *Percentage Loss* and the *Average Latency*. This value cannot be less than 1.
- **Maximum Failed Poll Attempts**
  The maximum permissible number of polling attempts that fail. If this number is exceeded then the host is considered unreachable.
- **Max Average Latency**
  The maximum number of milliseconds allowable between a poll request and the response. If this threshold is exceeded then the host is considered unreachable. Average Latency is calculated by averaging the response times from the host. If a polling attempt receives no response then it is not included in the averaging calculation.

The *Reachability Required* option

An important option that can be enabled for a host is the **Reachability Required** option. When this is selected, the host must be determined as accessible in order for that route to be considered to be functioning. Even if other hosts are accessible, this option says that the accessibility of a host with this option set is mandatory.

Where multiple hosts are specified for host monitoring, more than one of them could have **Reachability Required** enabled. If CorePlus determines that any host with this option enabled is not reachable, Route Failover is initiated.

HTTP Parameters

If the **HTTP** polling method is selected then two further parameters can be entered:

- **Request URL**
  The URL which is to be requested.

- **Expected Response**

  The text that is expected back from querying the URL.

  Testing for a specific response text provides the possibility of testing if an application is offline. If, for a instance, a web page response from a server can indicate if a specific database is operational with text such as "*Database OK*", then the absence of that response can indicate that the server is operational but the application is offline.

A Known Issue When No External Route is Specified

With connections to an Internet ISP, an external network route should always be specified. This external route specifies on which interface the network which exists between the Clavister Security Gateway and the ISP can be found. If only an *all-nets* route is specified to the ISP's gateway, route failover may, depending on the connected equipment, not function as expected.

This issue rarely occurs but the reason why it occurs is that ARP queries arriving on a disabled route will be ignored.

4.2.5. Proxy ARP

As explained previously in Section 3.4, “ARP”, the ARP protocol facilitates a mapping between an IP address and the MAC address of a node on an Ethernet network. However, situations may exist where a network running Ethernet is separated into two parts with a routing device such as an installed Clavister Security Gateway, in between. In such a case, CorePlus itself can respond to ARP requests directed to the network on the other side of the Clavister Security Gateway using the feature known as Proxy ARP.

For example, host A on one subnet might send an ARP request to find out the MAC address of the IP address of host B on another separate network. The proxy ARP feature means that CorePlus responds to this ARP request instead of host B. The CorePlus sends its own MAC address instead in reply, essentially pretending to be the target host. After receiving the reply, Host A then sends data directly to CorePlus which, acting as a proxy, forwards the data on to host B. In the process the device has the opportunity to examine and filter the data.

The splitting of an Ethernet network into two distinct parts is a common application of Clavister Security Gateway's Proxy ARP feature, where access between the parts needs to be controlled. In such a scenario CorePlus can monitor and regulate all traffic passing between the two parts.

> ***Note***
> *It is only possible to have Proxy ARP functioning for Ethernet and VLAN interfaces.*

4.3. Policy-based Routing

4.3.1. Overview

Policy-based Routing (PBR) is an extension to the standard routing described previously. It offers administrators significant flexibility in implementing routing decision policies by being able to define rules so alternative routing tables are used.

Normal routing forwards packets according to destination IP address information derived from static routes or from a dynamic routing protocol. For example, using OSPF, the route chosen for packets will be the least-cost (shortest) path derived from an SPF calculation. Policy-based Routing means that routes chosen for traffic can be based on specific traffic parameters.

Policy-based Routing can allow:

Source based routing
A different routing table may need to be chosen based on the source of traffic. When more than one ISP is used to provide Internet services, Policy-based Routing can route traffic originating from different sets of users through different routes. For example, traffic from one address range might be routed through one ISP, whilst traffic from another address range might be through a second ISP.

Service-based Routing
A different routing table might need to be chosen based on the service. Policy-based Routing can route a given protocol such as HTTP, through proxies such as Web caches. Specific services might also be routed to a specific ISP so that one ISP handles all HTTP traffic.

User based Routing
A different routing table might need to be chosen based on the user identity or the *group* to which the user belongs. This is particularly useful in *provider-independent metropolitan area networks* where all users share a common active backbone, but each can use different ISPs, subscribing to different providers.

Policy-based Routing implementation in CorePlus is based on two building blocks:

- One or more user-defined alternate *Policy-based Routing Tables* in addition to the standard default **main** routing table.
- One or more *Policy-based routing rules* which determines which routing table to use for which traffic.

4.3.2. Policy-based Routing Tables

CorePlus, as standard, has one default routing table called **main**. In addition to the **main** table, it is possible to define one or more, additional alternate routing tables (this section will sometimes refer to these Policy-based Routing Tables as *alternate* routing tables).

Alternate routing tables contain the same information for describing routes as *main*, except that there is an extra parameter *ordering* defined for each of them. This parameter decides how route lookup is done using alternate tables in conjunction with the **main** table. This is described further in Section 4.3.6, “The *Ordering* parameter” below.

The total number of routing tables that can be created is limited only by the particular license that is used with a CorePlus installation. At minimum, there is a limit of 5 alternate tables in addition to the *main* table.

4.3.3. Policy-based Routing Rules

A rule in the Policy-based Routing rule set can decide which routing table is selected. A Policy-based Routing rule can be triggered by the type of Service (HTTP for example) in combination with the Source/Destination Interface and Source/Destination Network.

When looking up Policy-based Rules, it is the first matching rule found that is triggered.

4.3.4. PBR Table/Interface Association

If a particular routing table is to be always used for traffic from a given source interface, regardless of the service, then there is a way to achieve this.

It is possible to associate the source interface explicitly with a particular table using the **Group** membership parameter for that interface. This is sometimes referred to as *PBR Membership*.

The difference with this method of explicit association is that the administrator cannot specify the service, such as HTTP, for which the lookup will apply. PBR Rules allow a more fine-grained approach to routing table selection by being able to also select a service.

4.3.5. PBR Table Selection

When a packet corresponding to a new connection first arrives, the processing steps are as follows to determine which routing table is chosen:

1. The PBR Rules must first be looked up but to do this the packet's destination interface must be determined and this is always done by a lookup in the *main* routing table. It is therefore important a match for the destination network is found or at least a default **all-nets** route exists which can catch anything not explicitly matched.

2. A search is now made for a Policy-based Routing Rule that matches the packet's source/destination interface/network as well as service. If a matching rule is found then this determines the routing table to use.

3. If no matching PBR rule is found, a check is made to see if the source interface has an alternate routing table explicitly associated with it through the **Group** option. In other words, to see if the interface has *PBR membership* of a particular routing table. If there is no membership then the *main* table will be used.

4. Once the correct routing table has been located, a check is made to make sure that the source IP address in fact belongs on the receiving interface. The Access Rules are firstly examined to see if they can provide this check (see Section 6.1, “Access Rules” for more details of this feature). If there are no Access Rules or a match with the rules cannot be found, a reverse lookup in the previously selected routing table is done using the source IP address. If the check fails then a **Default access rule** log error message is generated.

5. At this point, using the routing table selected, the actual route lookup is done to find the packet's destination interface. At this point the *ordering* parameter is used to determine how the actual lookup is done and the options for this are described in the next section. To implement virtual systems, the *Only* ordering option should be used.

6. The connection is then subject to the normal IP rule set. If a SAT rule is encountered, address translation will be performed. The decision of which routing table to use is made before carrying out address translation but the actual route lookup is performed on the altered address. (Note that the original route lookup to find the destination interface used for all rule look-ups was done with the original, untranslated address.)

7. If allowed by the IP rule set, the new connection is opened in the CorePlus state table and the packet forwarded through this connection.

4.3.6. The *Ordering* parameter

Once the routing table for a new connection is chosen and that table is an alternate routing table, the

Ordering parameter associated with the table is used to decide how the alternate table is combined with the **main** table to lookup the appropriate route. The three available options are:

1. **Default** - The default behavior is to first look up the route in the **main** table. If no matching route is found, or the default route is found (the route with the destination **all-nets** - 0.0.0.0/0), a lookup for a matching route in the alternate table is done. If no match is found in the alternate table then the default route in the main table will be used.

2. **First** - This behavior is to first look up the connection's route in the alternate table. If no matching route is found there then the **main** table is used for the lookup. The default **all-nets** route will be counted as a match in the alternate table if it exists there.

3. **Only** - This option ignores the existence of any other table except the alternate table so the alternate table is the only one used for the lookup. One application of this is to give the administrator a way to dedicate a single routing table to one set of interfaces. **Only** is the option to use when creating virtual systems since it can dedicate one routing table to a set of interfaces.

The first two options can be regarded as combining the alternate table with the **main** table and assigning one route if there is a match in both tables.

Important - Ensuring all-nets appears in the main table

*A common mistake with Policy-based routing is the absence of the default route with a destination interface of **all-nets** in the default main routing table. If there is no route that is an exact match then the absence of a default **all-nets** route will mean that the connection will be dropped. The alternative of having interfaces associated explicitly with alternate routing tables through the **Group** option will also not function if the default route is missing.*

Example 4.3. Creating a Policy-based Routing Table

In this example we create a Policy-based Routing table named "TestPBRTable".

Clavister FineTune

1. Go to **Routing > Routes > New Policy-Based Routing Table**
2. The **Policy-Based Routing Table Properties** dialog will be displayed
3. Now enter:
   - **Name:** TestPBRTable
   - For **Ordering** select one of:
     - **First** - the named routing table is consulted first of all - if this lookup fails, the lookup will continue in the main routing table
     - **Default** - the main routing table will be consulted first, if the only match is the default route (*all-nets*), the named routing table will be consulted - if the lookup in the named routing table fails, the lookup as a whole is considered to have failed
     - **Only** - the named routing table is the only one consulted, if this lookup fails then the lookup will not continue in the main routing table
4. If **Remove Interface IP Routes** is enabled, the default interface routes are removed, that is to say routes to the *core* interface (which are routes to CorePlus itself).
5. Click **OK**

Example 4.4. Creating the Route

After defining the routing table "TestPBRTable", we add routes into the table.

Clavister FineTune

1. Go to **Routing > Routes > TestPBRTable > New Route**
2. The **Policy-Based Route Properties** dialog will be displayed.
3. Now enter:
   - **Interface:** The interface to be routed
   - **Network:** The network to route
   - **Gateway:** The gateway to send routed packets to
   - **Local IP Address:** The IP address specified here will be automatically published on the corresponding interface. This address will also be used as the sender address in ARP queries. If no address is specified, the gateway's interface IP address will be used.
   - Metric: Specifies the metric for this route. (Mostly used in route fail-over scenarios)
4. Click **OK**

Example 4.5. Policy-based Routing Configuration

This example illustrates a multiple ISP scenario which is a common use of Policy-based Routing. The following is assumed:

- Each ISP will give you an IP network from its network range. We will assume a 2-ISP scenario, with the network 10.10.10.0/24 belonging to "ISP A" and "20.20.20.0/24" belonging to "ISP B". The ISP gateways are 10.10.10.1 and 20.20.20.1, respectively.
- All addresses in this scenario are public addresses for the sake of simplicity.
- This is a "drop-in" design, where there are no explicit routing subnets between the ISP gateways and the Clavister Security Gateway.

In a provider-independent network, clients will likely have a single IP address, belonging to one of the ISPs. In a single-organization scenario, publicly accessible servers will be configured with two separate IP addresses: one from each ISP. However, this difference does not matter for the policy routing setup itself.

Note that, for a single organization, Internet connectivity through multiple ISPs is normally best done with the BGP protocol, where you do not need to worry about different IP spans or policy routing. Unfortunately, this is not always possible, and this is where Policy Based Routing becomes a necessity.

We will set up the main routing table to use ISP A, and add a named routing table, "r2" that uses the default gateway of ISP B.

Interface	Network	Gateway	ProxyARP
lan1	10.10.10.0/24		wan1
lan1	20.20.20.0/24		wan2
wan1	10.10.10.1/32		lan1
wan2	20.20.20.1/32		lan1
wan1	all-nets	10.10.10.1	

Contents of the named Policy-based Routing table r2:

Interface	Network	Gateway
wan2	all-nets	20.20.20.1

The table r2 has its Ordering parameter set to Default, which means that it will only be consulted if the main routing table lookup matches the default route (*all-nets*).

Contents of the Policy-based Routing Policy:

Source Interface	Source Range	Destination Interface	Destination Range	Service	Forward VR table	Return VR table
lan1	10.10.10.0/24	wan2	all-nets	ALL	r2	r2
wan2	all-nets	lan1	20.20.20.0/24	ALL	r2	r2

To configure this example scenario:

Clavister FineTune

1. Add the routes found in the list of routes in the main routing table, as shown earlier.
2. Create the Policy-based Routing table. Name the table "r2" and make sure the ordering is set to "Default".
3. Add the route found in the list of routes in the named policy routing table "r2", as shown earlier.
4. Add two routing policies according to the list of policies shown earlier.
   - Go to **Routing > Policy-Based Routing Rules > New Policy-based Routing Rule**
   - The **Policy-Based Routing Rule Properties** dialog will be displayed - enter the information found in the list of policies displayed earlier
   - Repeat the above to add the second rule

Note

Rules in the above example are added for both inbound and outbound connections.

4.4. Virtual Routing

4.4.1. Overview

Virtual Routing is a CorePlus feature that allows the creation of multiple, logically separated *virtual systems*, each with their own routing table. These virtual systems can behave as physically separated Clavister Security Gateways and nearly everything that can be done with separate gateways can be done with them, including running dynamic routing processes such as OSPF. Virtual systems are sometimes referred to as *Virtual Routers*

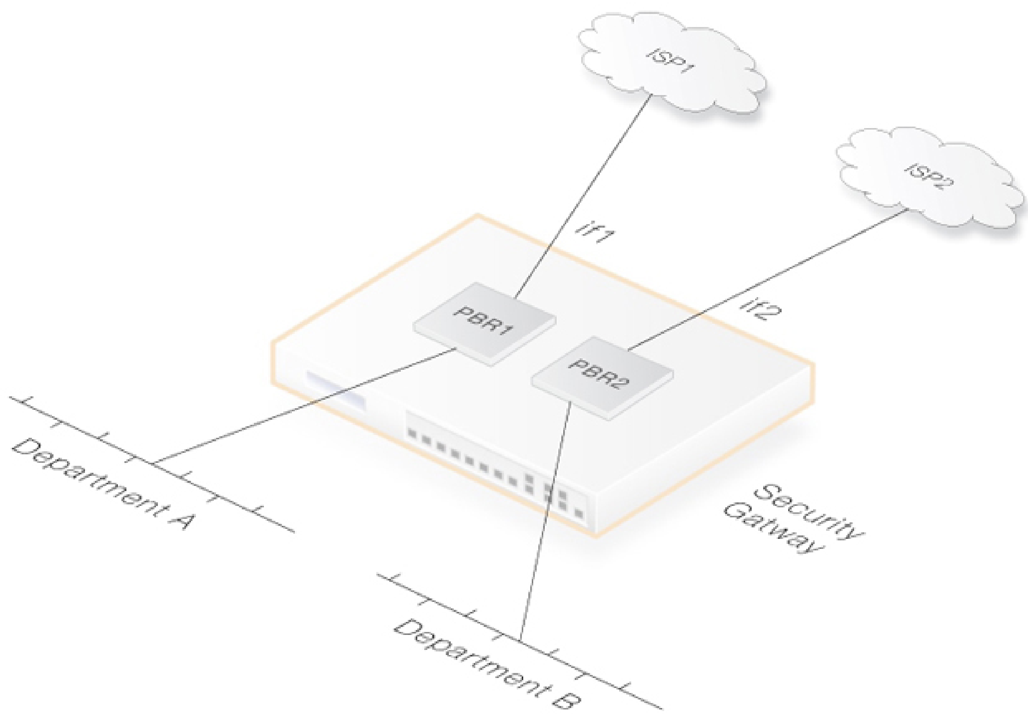
The CorePlus components involved in virtual routing are:

- Separate Policy-based routing tables for each virtual system.
- Per-interface policy-based routing table membership to make interface IP addresses reachable only using a particular routing table (this association can be also done by explicitly linking an interface with a specific routing table).
- Pairs of loopback interfaces for communication between virtual systems if required.

Virtual Routing is different from using *Policy-based Routing Rules* where a rule is used to define which routing table should be used. In virtual routing the table is chosen based only on the interface from which the traffic enters. The interface might be physical or it might be a virtual lan (VLAN).

4.4.2. A Simple Scenario

Consider a single Clavister Security Gateway connected to two external ISPs called A and B. ISP A services department C and connects via interface **if1**. ISP B services department D and connects via interface **if2**. For administration purposes, it is decided that the Clavister Security Gateway is to be broken into 2 virtual systems, one for each ISP.



This is done by creating two policy-based routing tables, *PBR1* to deal with ISP A to department C traffic and another *PBR2* to deal with ISP B to department D traffic. if1 will be a member of the first table but not the second. **if2** will be a member of the second table but not the first. It is this interface membership that determines which routing table will be used and which therefore keeps traffic totally separated. The *main* routing table could be used in this example as one of the two routing tables so that only one additional routing table needs to be created instead of two.

Associating an interface with a routing table is, as mentioned above, not necessarily done only through interface membership. CorePlus allows routing tables to be explicitly associated with a particular interface so that all traffic received on that interface is subject to one specific routing table.

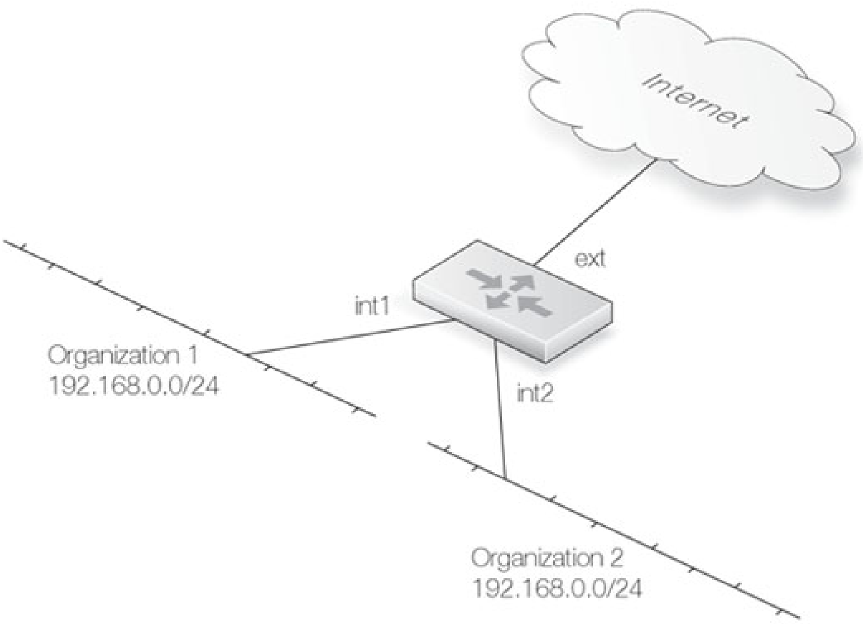
Additionally, VPN tunnels could be set up from the outside to the Clavister Security Gateway using the interfaces as the tunnel endpoints. The tunnels may be then separated logically so they use different routing tables.

In this simple example *loopback interfaces* were not used since there is no requirement for communication between the virtual systems. For example, department C doesn't need to communicate with department D. If inter-system communication is needed then an appropriate loopback interface pair would have to be defined to allow this.

One advantage of using separate routing tables on different interfaces is that IP address ranges could potentially be re-used on each interface.

4.4.3. Advantages Over PBR Rules

Using Policy-based Routing Rules can solve many of the problems that virtual routing can but complex configurations can become unwieldy for PBR rules. Consider a single Clavister Security Gateway being used as a firewall for two organizations, both using the same IP span.



In this case two routing tables could be used, one for each organization:

pbrtable1 routing table

	Interface	Network	Gateway
1	ext	all-nets	defaultgw
2	int1	192.168.0.0/24	

pbrtable2 routing table

	Interface	Network	Gateway
1	ext	all-nets	defaultgw
2	int2	192.168.0.0/24	

Getting traffic from each network to and from the Internet is straightforward. Assuming only outbound traffic, it takes two PBR rules. Assuming that each organization has a public IP address which maps to servers on the respective networks, outbound as well as inbound traffic is handled with four rules:

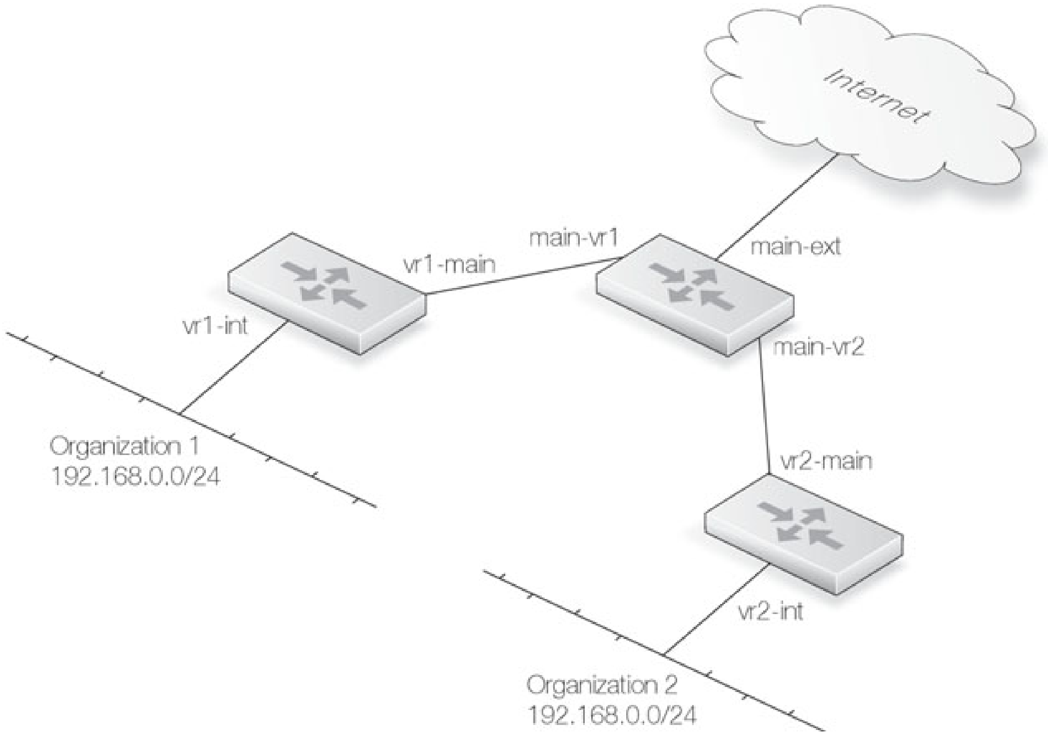
	Name	Source if	Source Net	Dest Net	Fwd PBR	Ret PBR
1	org1-in	ext	all-nets	pubip-org1	pbrtable1	pbrtable1
2	org1-out	int1	all-nets	all-nets	pbrtable1	pbrtable1
3	org2-in	ext	all-nets	pubip-org2	pbrtable2	pbrtable2
4	org2-out	int2	all-nets	all-nets	pbrtable2	pbrtable2

This works if the two organizations do not attempt to communicate with each other. If this happens the following two PBR rules are also needed, before the other four.

	Name	Source if	Source Net	Dest Net	Fwd PBR	Ret PBR
1	org1-org2	int1	all-nets	pubip-org2	pbrtable1	pbrtable2
2	org2-org1	int2	all-nets	pubip-org1	pbrtable2	pbrtable1

With two organizations, two PBR rules are enough for them to communicate. However, with three organizations, six are needed; with four, twelve are needed; with five, twenty are needed. The numbers continue: 30, 42, 56... and the administration task becomes unmanageable.

Virtual Routing can eliminate the all-to-all mappings described in the previous section. Using interface PBR table membership instead of PBR rules reduces the complexity by creating 3 virtual systems as shown above.



Each organization gets a virtual system of its own and both of these connect to "main", using pairs of loopback interfaces. First, we examine the routing tables:

main routing table

	Interface	Network	Gateway
1	main-ext	all-nets	defaultgw
2	main-vs1	pubip-vs1	
3	main-vs2	pubip-vs2	

vs1 routing table

	Interface	Network	Gateway
1	vs1-main	all-nets	
2	vs1-int	192.168.0.0/24	

vs2 routing table

	Interface	Network	Gateway
1	vs2-main	all-nets	
2	vs2-int	192.168.0.0/24	

Ethernet Interfaces

	Name	IP address	PBR table
1	main-ext	ip_main-ext	main
2	vs1-int	192.168.0.1	vs1
3	vs2-int	192.168.0.254	vs2

Loopback Interfaces

	Interface	IP address	Loop to	PBR table
1	main-vs1	ip_main-ext	vs1-main	main
2	vs1-main	pubip-vs1	main-vs1	vs1
3	main-vs2	ip_main-ext	vs2-main	main
4	vs2-main	pubip-vs2	main-vs2	vs2

For each connection between a pair of virtual systems, two loopback interfaces are used, one for each system. When traffic is sent through "main-vs1", it arrives on "vs1-main". When traffic is sent through "vs1-main", it is received on "main-vs1". This is exactly the same as with two Clavister Security Gateways: two interfaces, one on each, with a connection between them.

The PBR Table membership settings mean that if a connection arrives on an interface, it will be routed according to the PBR table that the interface is a member of.

Also note how the IP addresses of the internal interfaces of the virtual systems differ. If per-interface PBR table membership were not used, "core" routes for both IP addresses would be added in both routing tables, leading to 192.168.0.1 being unusable in "vs2" even though it shouldn't be, and 192.168.0.254 being unusable in "vs1". With per-interface routing table membership, interface IP addresses belonging to one virtual system will not interfere with other systems and loopback interfaces are not needed.

The IP addresses of the "main-vs1" and "main-vs2" interfaces are the same as the IP address of the external interface. They could also have been set to something nonsensical, like 127.0.0.1. Regular routing would still have worked since loopback interfaces are raw IP interfaces (the ARP protocol is not used over them). However, their IP addresses will be visible to users doing a traceroute from the inside, and also the issue exists of traffic originating from the Clavister Security Gateway itself to the internal networks, such as pings or logging. Such traffic is most often routed according to the main routing table, and will be sourced from the IP address of the nearest interface in the main routing table

4.4.4. IP Rules with Virtual Routing

The IP rule sets for different virtual systems can be split into separate rule sets using the CorePlus feature of creating multiple IP rule sets (see Section 3.5.4, “Multiple IP Rule Sets” for more detail on this feature).

IP Rules for different virtual systems need not be split up. Instead, the rules can reside together in the standard IP rule set. The benefit is being able to define "shared" or "global" rules that span over several virtual systems. For instance, if an aggressive worm attacks, it may be desirable to drop all communication on ports known to be used by the worm until counter-measures can be put into place. One single *Drop* rule placed at the top of the rule set can take care of this for all the virtual systems. Using the example of the previous section, this is how the IP rule set might look:

Interface Groups

	Name	Interfaces
1	main-vsifs	main-vs1, main-vs2
2	main-ifs	main-ext, main-vsifs
3	vs1-ifs	vs1-main, vs1-int
4	vs2-ifs	vs2-main, vs2-int

IP Rules

	Name	Action	Source if	Source Net	Dest if	Dest Net	Service
IP Rules for the "main" virtual system							
1	main-allowall	Allow	main-ifs	all-nets	Any	all-nets	All
IP Rules for the "vs1" virtual system							
2	vs1-http-in	SAT	vs1-ifs	all-nets	pubip-vs1	all-nets	http, SetDest 192.168.0.5
3	vs1-http-in	Allow	vs1-main	all-nets	Any	pubip-vs1	http
4	vs1-out	NAT	vs1-int	all-nets	Any	all-nets	All
IP Rules for the "vs2" virtual system							
5	vs2-smtp-in	SAT	vs2-main	all-nets	Any	pubip-vs2	All
6	vs2-smtp-in	Allow	vs2-main	all-nets	Any	pubip-vs2	smtp
7	vs2-http-out	NAT	vs2-int	192.168.0.4	vs2-main	all-nets	http

Note that SAT rules do not need to take into account that there are more organizations connected to the same physical unit. There is no direct connection between them; everything arrives through the same interface, connected to the "main" routing table. If this was done without virtual routing, the

Allow rules would have to be preceded by NAT rules for traffic from other organizations. Care would also have to be taken that such rules were in accordance with the security policy of each organization. Such problems are eliminated with virtual routing.

The source interface filters are very specific. "Any" is not used as the source interface anywhere, since such a rule would trigger regardless. Consider for instance what would happen if the "vs1-http-in" rules were to use "Any" as source interface. They would trigger as soon as packets destined to "pubip-vs1" were received on "main-ext". The destination address would be rewritten to 192.168.0.5, and passed on using the main routing table. The main routing table would not know what to do with 192.168.0.5 and pass it back out to the default gateway outside the Clavister Security Gateway.

If the same naming scheme as shown in this example is used, making sure the source interfaces are correct can be done quickly. All the rules concerning the "main" system have source interfaces beginning with "main-". All those concerning "vs1" have source interfaces beginning with "vs1-", and so on.

The destination interface filters, however, do not need to be as specific as the source interface filters. The possible destinations are limited by the routing tables used. If the "vs1" table only includes routes through "vs1-" interfaces, "Any" filters can only mean "through other interfaces in the same virtual system". It may however be sound practice to write tighter destination interface filters in case an error occurs elsewhere in the configuration. In this example, rule 1 might use "main-ifs", rule 4 might use "vs1-main". The SAT and corresponding Allow rules however are already fairly tight in that they only concern one single destination IP address.

4.4.5. Multiple IP rule sets

An alternative approach to having all the IP rules for different virtual systems in one rule set is to make use of *Multiple IP rule sets*.

Although all scanning of IP rules begins in the *main* rule set, it is possible to define a rule in *main* whose action is **Goto** so that scanning continues in a separate, named rule set. These extra rule sets can be defined as needed and one rule set can be created for each virtual system and its corresponding routing table.

More details on this subject can be found in Section 3.5.4, “Multiple IP Rule Sets”.

4.4.6. Trouble Shooting

- Make sure that the source interface filters are correct
- Double check interface PBR table membership. For all types of interfaces and tunnels
- Use "ping -p <pbrtable>" to source pings from different virtual systems
- Use "ping -r <recvif> -s <srcip>" to test the rule set, simulating that the ping was received on a given interface from a given IP address
- Use "arpsnoop -v <ifacenames>" to get verbose information about ARP resolution
- Use "route <pbrtable> -all" to view all route entries in a given table, including "core" routes
- Use "route -lookup <ipaddr> <pbrtable>" to make sure that a given IP address is routed the way you think in a given virtual system. (Hint: "-lookup" may be shortened to "-l".)
- Use "conn -v" to view verbose information about open connections. Both ends of a connection will be shown; before and after address translation. Also, the routing tables used in the forward and return direction will be shown.
- Enable logging and read the logs. In each virtual system, a separate rule decision is made, and a separate connection is established

4.5. OSPF

The feature called *Dynamic Routing* is implemented with CorePlus using the OSPF achitecture.

This section begins by looking generally at what dynamic routing is and how it can be implemented. It then goes on to look at how OSPF can provide dynamic routing followed by a description of how a simple OSPF network can be set up.

4.5.1. Dynamic Routing Overview

Dynamic routing is different to static routing in that a routing network device, such as a Clavister Security Gateway, can adapt to changes of network topology automatically.

Dynamic routing involves first learning about all the directly connected networks and then getting further route information from other routers specifying which networks they are connected to. All routing information is then sorted and the most suitable routes for destinations are added into the local routing table.

Dynamic routing responds to routing updates dynamically but has some disadvantages in that it can be more susceptible to certain problems such as routing loops. One of two types of algorithms are generally used to implement the dynamic routing mechanism:

- A *Distance Vector* (DV) algorithm.
- A *Link State* (LS) algorithm.

How a router decides the optimal or "best" route and shares updated information with other routers depends on the type of algorithm used. These two algorithm types will be discussed next.

Distance Vector Algorithms

One example of implementing dynamic routing is to use a *Distance vector* (DV) algorithm. This is a decentralized routing algorithm that computes the best path in a distributed way.

Each router computes the costs of its own attached links, and shares routing information only with its neighboring routers. Router determine the least-cost path by iterative computation and also by information exchange with its neighbors.

Routing Information Protocol (RIP) is a well-known DV algorithm and involves sending regular update messages and then reflecting routing changes in the routing table. Path determination is based on the "length" of the path which is the number of intermediate routers (also known as "hops") to the destination. After updating its own routing table, the router immediately begins transmitting its entire routing table to neighboring routers to inform them of changes.

Link State Algorithms

In contrast to DV algorithms, *Link State* (LS) algorithms enable routers to keep routing tables that reflect the topology of the entire network.

Each router broadcasts its attached links and link costs to all other routers in the network. When a router receives these broadcasts it runs the LS algorithm and calculates its own set of least-cost paths. Any change of the link state will be sent everywhere in the network, so that all routers keep the same routing table information and have a consistent view of the network.

Advantages of Link State Algorithms

Due to the fact that the global link state information is maintained everywhere in a network, LS algorithms, like that used in OSPF, offer a high degree of configuration control and scalability.

Changes result in broadcasts of just the updated information to other routers which means faster convergence and less possibility of routing loops. OSPF can also function within a hierarchy, whereas RIP has no knowledge of sub-network addressing.

The OSPF Solution

Open Shortest Path First (OSPF) is a widely used protocol based on an LS algorithm. Dynamic routing is implemented in CorePlus using OSPF.

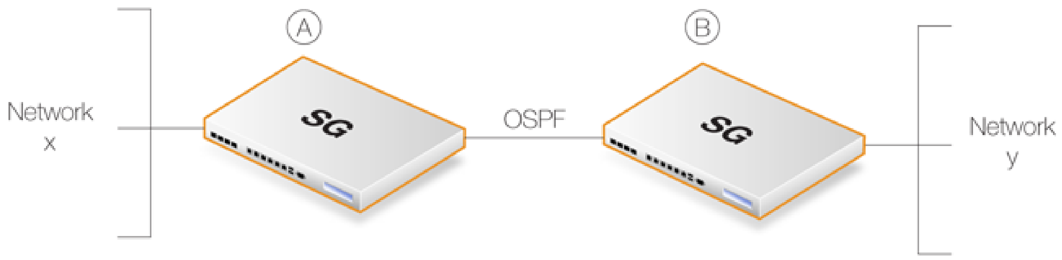
An OSPF enabled router first identifies the routers and subnets that are directly connected to it and then broadcasts the information to all the other routers. Each router uses the information it receives to add the OSPF learned routes to its routing table. With a complete routing table, each router can identify the subnetworks and routers that lead to any destination. Routers using OSPF then only broadcast updates to inform of changes and not the entire routing table.

OSPF depends on various metrics for path determination, including hops, bandwidth, load and delay. OSPF can also provide a high level of control over the routing process since its parameters can be finely tuned.

A Simple OSPF Scenario

The simple network topology illustrated below provides an excellent example for what OSPF can achieve. Here we have two Clavister Security Gateways **A** and **B** connected together and configured to be in the same OSPF area (the concept of *area* is explained later).

Figure 4.2. A Simple OSPF Scenario



OSPF allows security gateway **A** to know that to reach network **Y**, traffic needs to be sent to security gateway **B**. Instead of having to manually insert this routing information into the routing tables of **A**, OSPF allows **B**'s routing table information to be automatically shared with **A**.

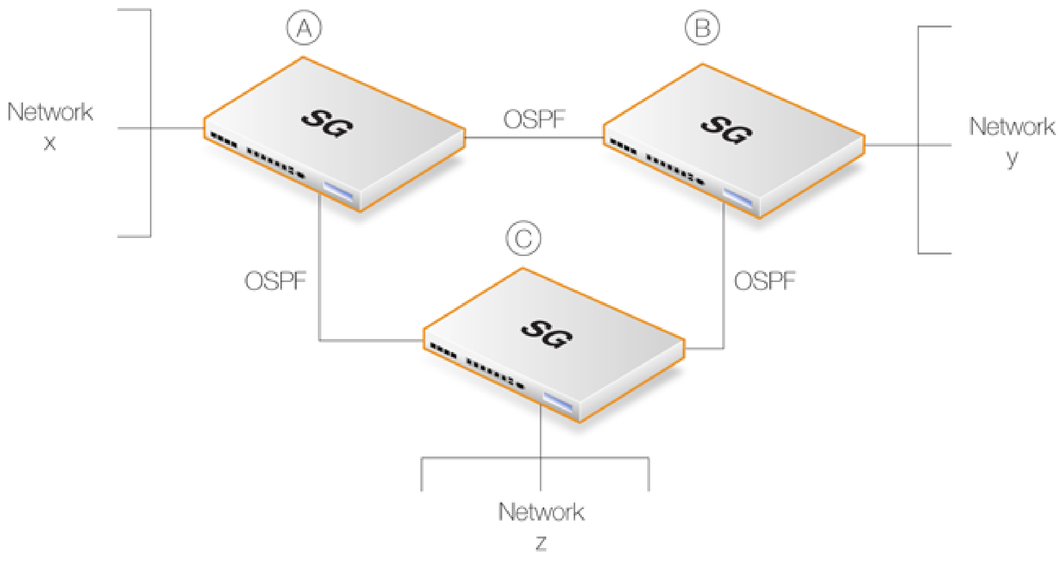
In the same way, OSPF allows security gateway **B** to automatically be aware that network **X** is attached to security gateway **A**.

Under OSPF, this exchange of routing information is completely automatic.

OSPF Provides Route Redundancy

If we now take the above scenario and add a third Clavister Security Gateway called **C** then we have a situation where all three security gateways are aware through OSPF what networks are attached to the other gateways. This is illustrated below.

Figure 4.3. OSPF Providing Route Redundancy



In addition, we now have route redundancy between any two of the security gateways. For example, if the direct link between **A** and **C** fails then OSPF allows both security gateways to know immediately that there is an alternate route between them via gateway **B**.

For instance, traffic from network **X** which is destined for network **Z** will be routed automatically through security gateway **B**.

From the administrators point of view, only the routes for directly connected networks need to be configured on each security gateway. OSPF automatically provides the required routing information to find neworks connected to other security gateways, even if traffic needs to transit several other gateways to reach its destination.

Tip: Rings always provide alternate routes

When designing the topology of a network that implements OSPF, arranging Clavister Security Gateways in a circular ring means that any security gateway always has two possible routes to any other. Should any one inter-gateway connection fail, an alternative path always exists.

A Look at Routing Metrics

In discussing dynamic routing and OSPF further, an understanding of *Routing Metrics* can be useful and a brief explanation is given here.

Routing metrics are the criteria that a routing algorithm will use to compute the "best" route to a destination. A routing protocol relies on one or several metrics to evaluate links across a network and to determine the optimal path. The principal metrics used include:

Path length The sum of the costs associated with each link. A commonly used value for this metric is called "hop count" which is the number of routing devices a packet must pass through when it travels from source to destination.

Item Bandwidth The traffic capacity of a path, rated by "Mbps".

Load The usage of a router. The usage can be evaluated by CPU utilization and throughput.

Delay The time it takes to move a packet from the source to the destination. The time depends on various factors, including bandwidth, load, and the length of the path.

4.5.2. OSPF Concepts

Overview

Open Shortest Path First (OSPF) is a routing protocol developed for IP networks by the *Internet Engineering Task Force* (IETF). The CorePlus OSPF implementation is based upon RFC 2328, with compatibility to RFC 1583.

OSPF functions by routing IP packets based only on the destination IP address found in the IP packet header. IP packets are routed "as is", in other words they are not encapsulated in any further protocol headers as they transit the *Autonomous System* (AS).

The Autonomous System

The term *Autonomous System* refers to a single network or group of networks with a single, clearly defined routing policy controlled by a common administrator. It forms the top level of a tree structure which describes the various OSPF components.

In CorePlus, an AS corresponds to a *OSPF Router* object. This must be defined first when setting up OSPF. In most scenarios only one OSPF router is required to be defined and it must be defined separately on each Clavister Security Gateway involved in the OSPF network. This CorePlus object is described further in *Section 4.5.3.1, "OSPF Router Process"*.

OSPF is a dynamic routing protocol as it quickly detects topological changes in the AS (such as router interface failures) and calculates new loop-free routes to destinations.

Link-state Routing

OSPF is a form of *link-state routing* (LS) that sends *Link-state Advertisements* (LSAs) to all other routers within the same area. Each router maintains a database, known as a *Link-state Database*, which maps the topology of the autonomous system (AS). Using this database, each router constructs a tree of shortest paths to other routers with itself as the root. This shortest-path tree yields the best route to each destination in the AS.

Authentication.

All OSPF protocol exchanges can, if required, be authenticated. This means that only routers with the correct authentication can join an AS. Different authentication schemes can be used and with CorePlus the scheme can be either a passphrase or an MD5 digest.

It is possible to configure separate authentication methods for each AS.

OSPF Areas

An ospf *Area* consists of networks and hosts within an AS that have been grouped together. Routers that are only within an area are called *internal routers*. All interfaces on internal routers are directly connected to networks within the area.

The topology of an area is hidden from the rest of the AS. This information hiding reduces the amount of routing traffic exchanged. Also, routing within the area is determined only by the area's own topology, lending the area protection from bad routing data. An area is a generalization of an IP sub netted network.

In CorePlus, areas are defined by *OSPF Area* objects and are added to the AS which is itself defined by an *OSPF Router* object. There can be more than one area within an AS so multiple *OSPF Area* objects could be added to a single *OSPF Router*. In most cases, one is enough and it should be defined seperately on each Clavister Security Gateway which will be part of the OSPF network.

This CorePlus object is described further in *Section 4.5.3.2, “OSPF Area”*.

OSPF Area Components

A summary of OSPF components related to an area is given below:

ABRs *Area Border Routers* are routers that have interfaces connected to more than one area. These maintain a separate topological database for each area to which they have an interface.

ASBRs Routers that exchange routing information with routers in other Autonomous Systems are called *Autonomous System Boundary Routers*. They advertise externally learned routes throughout the Autonomous System.

Backbone Areas All OSPF networks need to have at least the *Backbone Area* which is the OSPF area with an ID of 0. This is the area that other related areas should be connected to. The backbone ensures routing information is distributed between connected areas. When an area is not directly connected to the backbone it needs a virtual link to it.

OSPF networks should be designed by beginning with the backbone.

Stub Areas Stub areas are areas through which or into which AS external advertisements are not flooded. When an area is configured as a stub area, the router will automatically advertise a default route so that routers in the stub area can reach destinations outside the area.

Transit Areas Transit areas are used to pass traffic from an area that is not directly connected to the backbone area.

The Designated Router

Each OSPF broadcast network has a single *Designated Router* (DR) and a single *Backup Designated Router*. The routers use OSPF *Hello* messages to elect the DR and BDR for the network based on the priorities advertised by all the routers. If there is already a DR on the network, the router will accept that one, regardless of its own router priority.

With CorePlus, the DR and the BDR are automatically assigned.

Neighbors

Routers that are in the same area become neighbors in that area. Neighbors are elected by the use of *Hello* messages. These are sent out periodically on each interface using IP multicast. Routers become neighbors as soon as they see themselves listed in a neighbor's *Hello* message. In this way, a two way communication is guaranteed.

The following *Neighbor States* are defined:

Down This is the initial state of the neighbor relationship.

Init When a *Hello* message is received from a neighbor, but does NOT include the Router ID of the security gateway in it, the neighbor will be placed in *Init* state. As soon as the neighbor in question receives a *Hello* message it will know the sending router's *Router ID* and will send a *Hello* message with that included. The state of the neighbors will change to the *2-way* state.

2-Way In this state the communication between the router and the neighbor is bi-directional. On *Point-to-Point* and *Point-to-Multipoint* OSPF interfaces, the state will be changed to *Full*. On *Broadcast* interfaces, only the DR/BDR will advance to the *Full* state with their neighbors, all the remaining neighbors will remain in the 2-Way state.

ExStart Preparing to build adjacency.

Exchange Routers are exchanging Data Descriptors.

Loading Routers are exchanging LSAs.

Full This is the normal state of an adjacency between a router and the DR/BDR.

Aggregates

OSPF Aggregation is used to combine groups of routes with common addresses into a single entry in the routing table. This is commonly used to minimize the routing table.

To set this feature up in CorePlus, see *Section 4.5.3.5, “OSPF Aggregates”*.

Virtual Links

Virtual links are used for the following scenarios:

A. Linking an area that does not have a direct connection to the backbone area.

B. Linking backbone areas in case of a partitioned backbone.

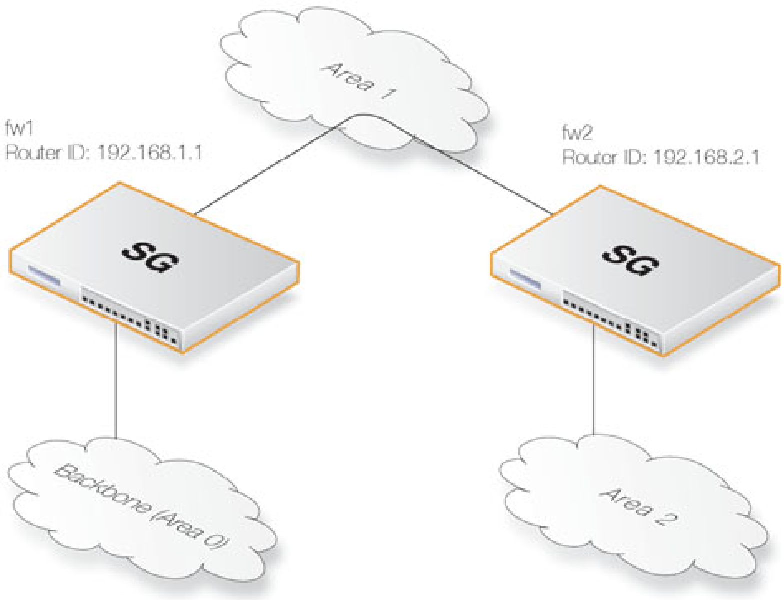
The two uses are discussed next.

A. *Linking areas without direct connection to the backbone*

The backbone area always needs to be the center of all other areas. In some rare cases where it is impossible to have an area physically connected to the backbone, a *Virtual Link* is used. A virtual link provides an area with a logical path to the backbone area.

This virtual link is established between two *Area Border Routers* (ABRs) that are on one common area, with one of the ABRs connected to the backbone area. In the example below two routers are connected to the same area (Area 1) but just one of them, *fw1*, is connected physically to the backbone area.

Figure 4.4. Virtual Links Connecting Areas

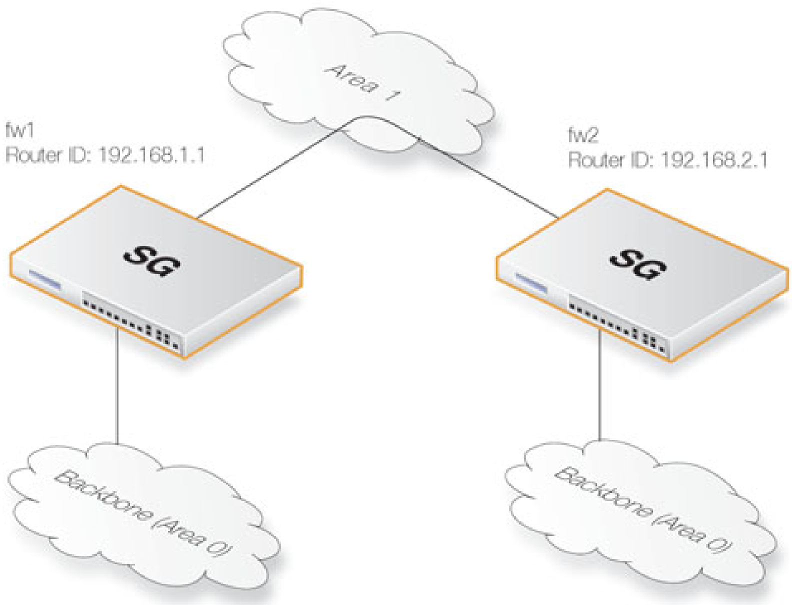


In the above example, a *Virtual Link* is configured between *fw1* and *fw2* on *Area 1* as it is used as the transit area. In this configuration only the *Router ID* has to be configured. The diagram shows that *fw2* needs to have a *Virtual Link* to *fw1* with Router ID *192.168.1.1* and vice versa. These virtual links need to be configured in *Area 1*.

B. *Linking a Partitioned Backbone*

OSPF allows for linking a partitioned backbone using a virtual link. The virtual link should be configured between two separate ABRs that touch the backbone from each side and have a common area in between.

Figure 4.5. Virtual Links with Partioned Backbone



The virtual link is configured between *fw1* and *fw2* on *Area 1* as it is used as the transit area. In the configuration, only the *Router ID* has to be configured, as in the example above show *fw2* need to have a virtual link to *fw1* with the Router ID *192.168.1.1* and vice versa. These virtual links need to be configured in *Area 1*.

To set this feature up in CorePlus, see *Section 4.5.3.6, "OSPF VLinks"*.

OSPF High Availability Support

There are some limitations in High Availability support for OSPF that should be noted:

Both the active and the inactive part of an HA cluster will run separate OSPF processes, although the inactive part will make sure that it is not the preferred choice for routing. The HA master and slave will not form adjacency with each other and are not allowed to become DR/BDR on broadcast networks. This is done by forcing the router priority to 0.

For OSPF HA support to work correctly, the Clavister Security Gateway needs to have a broadcast interface with at least ONE neighbor for ALL areas that the security gateway is attached to. In essence, the inactive part of the cluster needs a neighbor to get the link state database from.

It should also be noted that is not possible to put an HA cluster on the same broadcast network without any other neighbors (they will not form adjacency with each other because of the router priority 0). However, it may be possible, depending on the scenario, to setup a point to point link between them instead. Special care must also be taken when setting up a virtual link to an security gateway in an HA cluster. The endpoint setting up a link to the HA security gateway must setup 3 separate links: one to the shared, one to the master and one to the slave router id of the security gateway.

Using OSPF with CorePlus

When using OSPF with CorePlus, the scenario will be that we have two or more Clavister Security Gateways connected together in some way. OSPF allows any of these security gateway to be able to correctly route traffic to a destination network connected to another security gateway without having a route in its routing tables for the destination.

The key aspect of an OSPF setup is that connected Clavister Security Gateways share the information in their routing tables so that traffic entering an interface on one of the security gateways can be automatically routed so that it exits the interface on another gateway which is attached to the correct destination network.

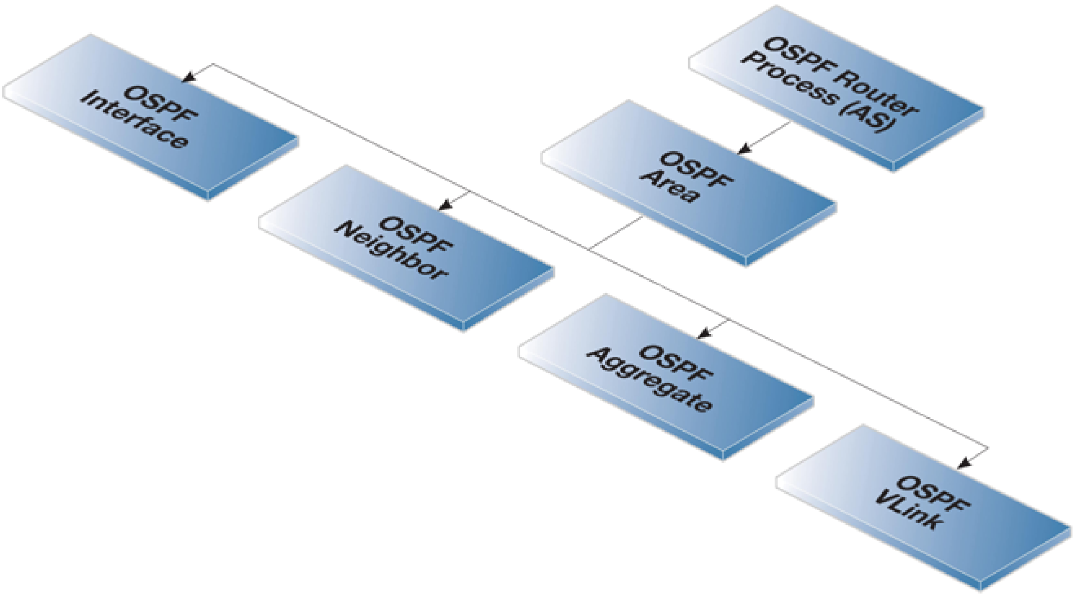
Another important aspect is that the security gateways monitor the connections between each other and route traffic by an alternate connection if one is available. A network topology can therefore be designed to be fault tolerant. If a connection between two security gateways fails then any alternate route that also reaches the destination will be used.

4.5.3. OSPF Components

This section looks at the CorePlus objects that need to be configured for OSPF routing. Defining these objects creates the OSPF network. The objects should be defined on each Clavister Security Gateway that is part of the OSPF network and should describe the same network.

An illustration of the relationship between CorePlus OSPF objects is shown below.

Figure 4.6. CorePlus OSPF Objects



4.5.3.1. OSPF Router Process

This object defines the *autonomous system* (AS) which is the top level of the OSPF network. A similar *Router Process* object should be defined on each Clavister Security Gateway which is part of the OSPF network.

General Parameters

Name
Specifies a symbolic name for the OSPF AS.

Router ID
Specifies the IP address that is used to identify the router in a AS. If no Router ID is configured, the security gateway computes the Router ID based on the highest IP address of any interface participating in the OSPF AS.

Reference Bandwidth
Set the reference bandwidth that is used when calculating the default interface cost for routes. If bandwidth is used instead of specifying a metric on an OSPF Interface, the cost is calculated using the following formula:

cost = reference bandwidth / bandwidth

RFC 1583 Compatibility
Enable this if the Clavister Security Gateway will be used in a environment that consists of routers that only support RFC 1583.

Debug

Protocol debug provides a troubleshooting tool by logging OSPF protocol specific information to the log.

- **Off** - Nothing is logged.
- **Low** - Logs all actions.
- **Medium** - Logs all actions that **Low** logs but with more detail.

- **High** - Logs everything with most detail.

Note

*When using the **High** setting, the security gateway will log a lot of information, even when just connected to a small AS. Changing the advanced setting **Log Send Per Sec Limit** may be required.*

Authentication

OSPF supports the following authentication options:

No (null) authentication No authentication is used for OSPF protocol exchanges.

Passphrase A simple password is used to authenticate all the OSPF protocol exchanges.

MD5 Digest MD5 authentication consists of a key ID and 128-bit key. When MD5 digest is used the specified key is used to produce the 128-bit MD5 digest.

Note

This does not mean that the OSPF packets are encrypted.

Important

If a passphrase or MD5 authentication is configures, the passphrase or authentication key must be the same on all OSPF Routers in that Autonomous System.

Advanced

Time Settings

SPF Hold Time Specifies the minimum time, in seconds, between two SPF calculations. The default time is 10 seconds. A value of 0 means that there is no delay. Note however that SPF can potentially be a CPU demanding process, so in a big network it might not be a good idea to run it to often.

SPF Delay Time Specifies the delay time, in seconds, between when OSPF receives a topology change and when it starts a SPF calculation. The default time is 5 seconds. A value of 0 means that there is no delay. Note however that SPF can potentially be a CPU demanding process, so in a big network it might not be a good idea to run it to often.

LSA Group Pacing This specifies the time in seconds at which interval the OSPF LSAs are collected into a group and refreshed. It's more optimal to group many LSAs and process them at the same time, instead of running them one and one.

Routes Hold Time This specifies the time in seconds that the routing table will be keept unchanged after a reconfiguration of OSPF entries or a HA failover.

Memory Settings

Memory Max Usage Maximum amount in Kilobytes of RAM that the OSPF AS process are allowed to use, if no value is specified the default is 1% of installed RAM. Specifying 0 indicates that the OSPF AS process is allowed to use all available ram in the security gateway.

4.5.3.2. OSPF Area

The Autonomous System (AS) is divided into smaller parts called an *Area*, this section explains how to configure areas. An area collects together OSPF interfaces, neighbors, aggregates and virtual links.

An OSPF area is a child of the OSPF router process and there can be many area objects defined under a single router process. In most simple networking scenarios, a single area is sufficient. Like the router process object, a similar area object should be defined on all the Clavister Security Gateways which will be part of the OSPF network.

General Parameters

Name Specifies the name of the OSPF Area.

ID Specifies the area id. If *0.0.0.0* is specified then this is the backbone area.

There can only be one backbone area and it forms the central portion of an AS. Routing information that is exchanged between different area always transits the backbone area.

Is stub area Enable this option if the area is a stub area.

Become Default Router It is possible to configure if the security gateway should become the default router for the stub area, and with what metric.

Import Filter

The import filter is used to filter what can be imported in the OSPF AS from either external sources (like the main routing table or a policy based routing table) or inside the area.

External Specifies the network addresses allowed to be imported into this area from external routing sources.

Interarea Specifies the network addresses allowed to be imported from other routers inside the area.

4.5.3.3. OSPF Interface

This section describes how to configure an *OSPF Interface* object. OSPF interface objects are children of OSPF areas. Unlike areas, they are not similar on each Clavister Security Gateway in the OSPF network. The purpose of an OSPF interface object is to describe a specific interface which will be part of an OSPF network.

General Parameters

Interface Specifies which interface on the security gateway will be used for this OSPF interface.

Network Specifies the network address for this OSPF interface.

Interface Type This can be one of the following:

- **Auto** - Tries to automatically detect interface type based on interface.
- **Broadcast** - The Broadcast interface is an interface that has native Layer 2 broadcast/multicast capabilities. The typical example of a broadcast/multicast network is an ordinary ethernet. When broadcast is used OSPF will send OSPF *Hello* packets to the IP multicast address *224.0.0.5*. Those packets will be heard by all other the OSPF routers on the network. That is why no configuration of *neighbor* objects is required for discovery of neighboring routers.
- **Point-to-Point** - The Point-to-Point interface type is used for point-to-point links. These are links which involve only two routers. A typical example of this is a VPN tunnel. The neighbor address of such a link is configured by defining a *Neighbour* object.
- **Point-to-Multipoint** - The Point-to-Multipoint interface type is a collection of Point-to-Point networks, where there is more then one router in a link that does not have Layer 2 broadcast/multicast capabilities.

Metric Specifies the metric for this OSPF interface. This represents the "cost" of sending packets over this interface. This cost is inversely proportional to the bandwidth of the interface.

Bandwidth If the metric is not specified, the bandwidth is specified instead. If the bandwidth is known then this can be specified directly instead of the metric.

Authentication

All OSPF protocol exchanges can be authenticated using a simple password or MD5 cryptograhpic hashes.

If **Use Default for Router Process** is enabled then the values configured in the router process properties are used. If this is not enabled then the following options are available:

- **No authentication**.
- **Passphrase**.
- **MD5 Digest**.

Advanced

Hello Interval Specifies the number of seconds between *Hello* packets sent on the interface.

Router Dead Interval If not *Hello* packets are received from a neighbor within this interval then that neighbor router will be considered to be out of operation.

RXMT Interval Specifies the number of seconds between retransmissions of LSAs to neighbors on this interface.

InfTrans Delay Specifies the estimated transmit delay for the interface. This value represents the maximum time it takes to forward a LSA packet trough the router.

Wait Interval Specifies the number of seconds between the interface brought up and the election of the DR and BDR. This value should be higher than the hello interval.

Router Priority Specifies the router priority, a higher number increases this routers chance of becoming a DR or a BDR. If 0 is specified then this router will not be eligible in the DR/BDR election.

> ***Note***
>
> *An HA cluster will always have 0 as router priority, and can never be used as a DR or BDR.*

Sometimes there is a need to include networks into the OSPF routing process, without running OSPF on the interface connected to that network. This is done by enabling the option:
No OSPF routers connected to this interface ("Passive").

This is an alternative to using a Dynamic Routing Policy to import static routes into the OSPF routing process.

If the **Ignore received OSPF MTU restrictions** is enabled, OSPF MTU mismatches will be allowed.

4.5.3.4. OSPF Neighbors

In some scenarios the neighboring OSPF router to a security gateway needs to be explicitly defined. The most common case is when the a VPN tunnel is used to connect two neighbors and this usage with IPsec tunnels is described further in *Section 4.5.5, “Setting Up OSPF”*.

CorePlus *OSPF Neighbor* objects are created within an *OSPF Area* and each object has the following property parameters:

Interface Specifies which OSPF interface the neighbor is located on.

IP Address The IP Address of the neighbor. This is the IP Address of the neighbors OSPF interface connecting to this router. For VPN tunnels this will be the IP address of the tunnel's remote end.

Metric Specifies the metric to this neighbor.

4.5.3.5. OSPF Aggregates

OSPF Aggregation is used to combine groups of routes with common addresses into a single entry in the routing table. If advertised this will decreases the size of the routing table in the security gateway, if not advertised this will hide the networks.

CorePlus *OSPF Aggregate* objects are created within an *OSPF Area* and each object has the following parameters:

Network The network consisting of the smaller routers.

Advertise If the aggregation should be advertised or not.

4.5.3.6. OSPF VLinks

All areas in an OSPF AS must be physically connected to the backbone area (the area with ID *0*). In some cases this is not possible and in that case a *Virtual Link* (VLink) can be used to connect to the backbone through a non-backbone area.

CorePlus *OSPF VLink* objects are created within an *OSPF Area* and each object has the following parameters:

General Parameters

Name	Symbolic name of the virtual link.
Neighbor Router ID	The Router ID of the router on the other side of the virtual link.

Authentication

Use Default For AS	Use the values configured in the AS properties page.

Note: Linking partioned backbones

If the backbone area is partitioned, a virtual link can be used to connect the different partitions.

4.5.4. Dynamic Routing Rules

4.5.4.1. Overview

The Final OSPF Setup Step is Creating Dynamic Routing Rules

After the OSPF structure is created, the final step is always to create a *Dynamic Routing Rule* on each Clavister Security Gateway which allows the routing information the OSPF AS delivers from remote security gateways to be added to the local routing tables.

Dynamic routing rules are discussed here in the context of OSPF, but can also be used in other contexts.

The Reasons for Dynamic Routing Rules

In a dynamic routing environment, it is important for routers to be able to regulate to what extent they will participate in the routing exchange. It is not feasible to accept or trust all received routing information, and it might be crucial to avoid parts of the routing database getting published to other routers.

For this reason, *Dynamic Routing Rules* are used to regulate the flow of routing information.

These rules filter either statically configured or OSPF learned routes according to parameters like the origin of the routes, destination, metric and so on. The matched routes can be controlled by actions to be either exported to OSPF processes or to be added to one or more routing tables.

Usage with OSPF

Dynamic Routing Rules are used with OSPF to achieve the following:

- Allowing the import of routes from the OSPF AS into local routing tables.
- Allowing the export of routes from a local routing tables to the OSPF AS.
- Allowing the export of routes from one OSPF AS to another OSPF AS.

OSPF Requires at Least an Import Rule

By default, CorePlus will not import or export any routes. For OSPF to function, it is therefore mandatory to define at least one dynamic routing rule which will be an *Import* rule.

This *Import* rule specifies the local *OSPF Router Process* object. This enables the external routes made available in the OSPF AS to be imported into the local routing tables.

Specifying a Filter

Dynamic routing rules allow a filter to be specified which narrows the routes that are imported based on the network reached. In most cases, the **Or is within** option should be specified as *all-nets* so that no filter is applied.

When to Use *Export* Rules

Although an *Import* rule is needed to import routes from the OSPF AS, the opposite is not true. The export of routes to networks that are part of *OSPF Interface* objects are automatic.

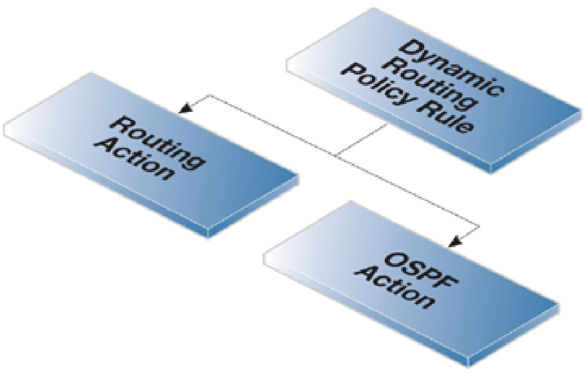
The one exception is for routes on interfaces that have a gateway defined for them. In other words, where the destination is not directly connected to the physical interface and instead there is a hop to another router on the way to the destination network. The *all-nets* route defined for Internet access via an ISP is an example of such a route.

In this case, a dynamic routing rule must be created to explcitly export the route to the OSPF AS.

Dynamic Routing Rule Objects

The diagram below shows the relationship between the CorePlus dynamic routing rule objects.

Figure 4.7. Dynamic Routing Rule Objects



4.5.4.2. Dynamic Routing Rule

This object defines a dynamic routing rule.

General Parameters

Name	Specifies a symbolic name for the rule.
From OSPF AS	Specifies the from which OSPF AS (in other words, an OSPF Router Process) the route should be imported from into either a routing table or another AS.

From Routing Table Specifies from which routing table a route should be imported into the OSPF AS or copied into another routing table.

Destination Interface Specifies if the rule has to have a match to a certain interface.

Destination Network

Exactly Matches Specifies if the network needs to exactly match a specific network.

Or is within Specifies if the network needs to be within a specific network.

More Parameters

Next Hop Specifies what the next hop (in other words, router) needs to be for this rule to be triggered.

Metric Specifies an interval that the metric of the routers needs to be in between.

Router ID Specifies if the rule should filter on *Router ID*.

OSPF Route Type Specifies if the rule should filter on the OSPF *Router Type*.

OSPF Tag Specifies Specifies an interval that the tag of the routers needs to be in between.

4.5.4.3. OSPF Action

This object defines an OSPF action.

General Parameters

Destination AS Specifies into which OSPF AS the route change should be imported.

Route Via If needed, specifies the IP to route via.

Tag Specifies a tag for this route. This tag can be used in other routers for filtering.

Route Type Specifies what the kind of external route type. Specify *1* if OSPF should regard external routes as *type 1 OSPF routes*. *Type 2* is the most significant cost of a route.

OffsetMetric Increases the metric of an imported route by this value.

Limit Metric To Limits the metrics for these routes to a minimum and maximum value. If a route has a higher or lower value than specified then it will be set to the specified value.

4.5.4.4. Routing Action

A *Routing Action* is used to manipulate and export routing changes to one or more local routing tables.

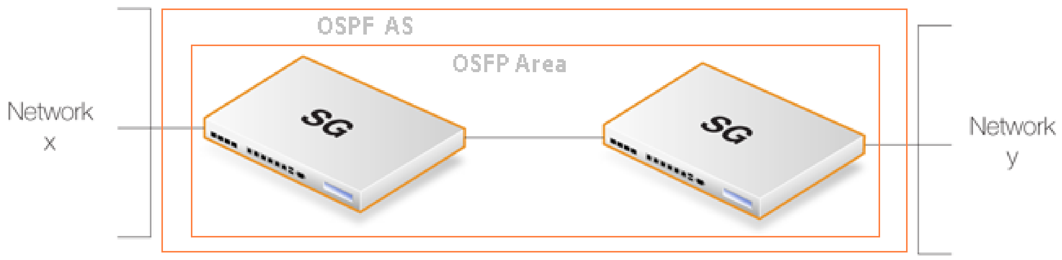
Destination	Specifies into which routing table the route changes to the OSPF AS should be imported.
Offset Metric	Increases the metric by this value.
Offset Metric Type 2	Increases the *Type 2* router's metric by this value.
Limit Metric To	Limits the metrics for these routes to a minimum and maximum value. If a route has a higher value than specified then it will be set to the specified value.
Static Route Override	Allows the override of the static routes.
Default Route Override	Allows the override of the default route.

4.5.5. Setting Up OSPF

Setting up OSPF can seem complicated because of the large number of configuration possibilites that OSPF offers. However, in many cases a simple OSPF solution using a minimum of CorePlus objects is needed and setup can be straightforward.

Let us examine again the simple scenario described earlier with just two Clavister Security Gateways.

Figure 4.8. Setting Up OSPF



In this example we connect together the two Clavister Security Gateways with OSPF so they can share the routes in their routing tables. Both will be inside a single OSPF area which will be part of a single OSPF autonomous system (AS). If you are unfamiliar with these OSPF concepts, refer to earlier sections for an explanation.

Beginning with just one of these security gateways, the CorePlus setup steps are as follows:

1. *Create an OSPF Router object*

Create a CorePlus *OSPF Router Process* object. This will represent an OSPF *Autonomous Area* (AS) which is the highest level in the OSPF hierarchy. Give the object an appropriate name. The **Router ID** can be left blank since this will be assigned automatically by CorePlus.

2. *Add an OSPF Area to the OSPF Router*

Within the *OSPF Router Process* created in the previous step, add a new *OSPF Area* object. Assign an appropriate name and use the value *0.0.0.0* for the *Area ID*.

An AS can have multiple areas but in many cases only one is needed. The ID *0.0.0.0* identifies this area as the *backbone area* which forms the central portion of the AS.

3. *Add OSPF Interfaces to the OSPF Area*

Within the *OSPF Area* created in the previous step, add a new *OSPF Interface* for each physical interface that will be part of the area.

The *OSPF Interface* object needs the following parameters specified in its properties:

- **Interface** - the physical interface which will be part of the OSPF area.
- **Network** - the network on the interface that will be part of the area.

  This does not need to be specified and if it is not, the network assigned to the physical interface is used. For example if *lan* is the interface then *lannet* will be the default network.
- **Interface Type** - this would normally be *Auto* so that the correct type is automatically selected.
- The advanced option **No OSPF routers connected to this interface** must be selected if the physical interface doesn't connect directly to another *OSPF Router* (in other words, with another Clavister Security Gateway that acts as an OSPF router). For example, the interface may only be connected to a network of clients, in which case the option would be enabled.

  The option must be disabled if the physical interface is connected to another security gateway which is set up as an *OSPF Router*. In this example, if this physical interface is connected to the other security gateway then this option should be disabled.

Note that an *OSPF Interface* is not the same as a physical interface although it is often associated with one. Other types of interfaces, such as VPN tunnels could instead be associated with an *OSPF Interface*.

4. *Add a Dynamic Routing Rule*

Finally, a *Dynamic Routing Rule* needs to be defined to deploy the OSPF network. This involves two steps:

i. A *Dynamic Routing Policy Rule* object is added. This rule should be an *Import* rule that enables the option **From OSPF Process** so that the previously defined *OSPF Router Process* object is selected. What we are doing is saying that we want to import all routes from the the OSPF AS.

   In addition, the optional **Or is within** filter parameter for the destination network must be set to be *all-nets*. We could use a narrower filter for the destination network but in this case we want all networks.

ii. Within the *Dynamic Routing Policy Rule* just added, we now add a *Routing Action* object. Here we add the routing table into the *Selected* list which will receive the routing information from OSPF.

   In most cases this will be the routing table called *main*.

There is no need to have a *Dynamic Routing Policy Rule* which exports the local routing table into the AS since this is done automatically for *OSPF Interface* objects.

The exception to this is if a route involves a gateway (in other words, a router hop). In this case the route **MUST** be explicitly exported. The most frequent case when this is necessary is for the **all-nets** route to the external public Internet where the gateway is the ISP's router. Doing this is discussed in the next step.

5. *Add a Dynamic Routing Rule for all-nets*

Optionally, a *Dynamic Routing Rule* needs to be defined if there is an *all-nets* route. For example, if the security gateway is connected to an ISP. This involves the following steps

i. A *Dynamic Routing Policy Rule* object is added. This rule should be an *Export* rule that enables the option **From Routing Table** with the *main* routing table moved to the **Selected** list.

   In addition, the optional **Or is within** filter parameter for the destination network must be set to be *all-nets*.

ii. Within the *Dynamic Routing Policy Rule* just added, we now add an *OSPF Action* object. Here set the **Export to process** option to be the *OSPF Router Process* which represents the OSPF AS.

6. *Repeat these steps on the other security gateway*

Now repeat steps **1** to **5** for the other Clavister Security Gateway that will be part of the OSPF AS and area. The *OSPF Router* and *OSPF Area* objects will be identical on each. The *OSPF Interface* objects will be different depending on which interfaces and networks will be included in the OSPF system.

If more than two security gateways will be part of the same OSPF area then all of them should be configured similarly.

OSPF Routing Information Exchange Begins Automatically

As the new configurations are created in the above steps and then deployed, OSPF will automatically start and begin exchanging routing information. Since OSPF is a dynamic and distributed system, it does not matter in which order the configurations of the individual security gateways are deployed.

When the physical link is plugged in between two interfaces on two different security gateways and those interfaces are configured with *OSPF Router Process* objects, OSPF will begin exchanging routing information.

Confirming OSPF Deployment

It is now possible to check that OSPF is operating and that routing information is exchanged.

We can do by listing the routing tables with a console command or through Clavister FineTune. In both cases, routes that have been imported into the routing tables though OSPF are indicated with the letter "**O**" to the left of the route description. For example, if we use the *routes* command, we might see the following output:

```
Cmd> routes

Flags Network         Iface       Gateway         Local IP     Metric
----- --------------- ----------- --------------- ------------ ------
      192.168.1.0/24  lan                                      0
      172.16.0.0/16   wan                                      0
O     192.168.2.0/24  wan         172.16.2.1                   1
```

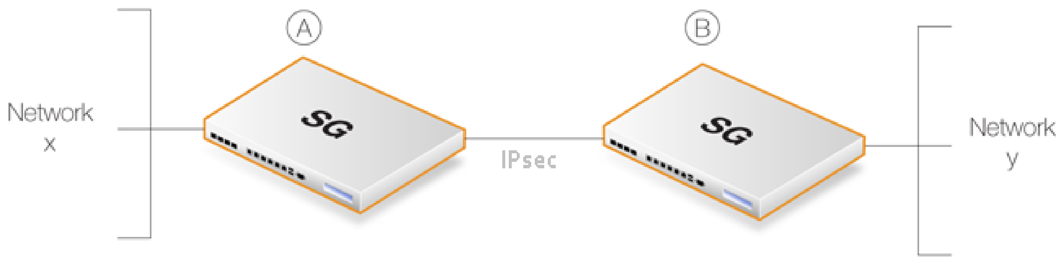
Here, the route for *192.168.2.0/24* has been imported via OSPF and that network can be found on the *WAN* interface with the gateway of *172.16.2.1*. The *gateway* in this case is of course the Clavister Security Gateway to which the traffic should be sent. That security gateway may or may not be attached to the destination network but OSPF has determined that that is the optimum route to reach it.

Connecting OSPF Routers with a VPN

In some cases, the link between two Clavister Security Gateways which are configured with *OSPF Router Process* objects may be insecure. For example, over the public Internet.

In this case, we can secure the link by setting up a VPN tunnel between the two security gateways and telling OSPF to use this tunnel for exchange of OSPF information. Next, we will look at how to set this up and assume that IPsec will be the chosen method for implementing the tunnel.

Figure 4.9. OSPF Over IPsec



To create this setup we need to perform the normal OSPF steps described above but with the following additional steps:

1. ***Set up an IPsec tunnel***

First set up an IPsec tunnel in the normal way between the two security gateways **A** and **B**. The IPsec setup options are explained in *Section 9.2, “VPN Quick Start Guide”*.

This IPsec tunnel is now treated like any other interface when configuring OSPF in CorePlus.

2. ***Choose a random internal IP network***

For each security gateway we need to choose a random IP network using internal IP addresses. For example, for security gateway **A** we could use the network *192.168.55.0/24*.

This network is used just as a convenience with OSPF setup and will never be associated with a real physical network.

3. ***Define an OSPF Interface for the tunnel***

Define an CorePlus *OSPF Interface* object which has the IPsec tunnel for the **Interface** parameter. Specify the **Type** parameter to be *point-to-point* and the *Network* parameter to be the network chosen in the previous step, *192.168.55.0/24*.

This *OSPF Interface* tells CorePlus that any OPSF related connections to addresses within the network *192.168.55.0/24* should be routed into the IPsec tunnel.

4. ***Define an OSPF Neighbor***

Next, we must explicitly tell OSPF how to find the neighbouring OSPF router. Do this by defining a CorePlus *OSPF Neighbor* object. This consists of a pairing of the IPsec tunnel (which is treated like an interface) and the IP address of the router at the other end of the tunnel.

For the IP address of the router, we simply use any single IP address from the network *192.168.55.0/24*. For example, *192.168.55.1*.

When CorePlus sets up OSPF, it will look at this *OSPF Neighbor* object and will try to send OSPF messages to the IP address *192.168.55.1*. The *OSPF Interface* object defined in the previous step tells CorePlus that OSPF related traffic to this IP address should be routed into the IPsec tunnel.

5. ***Set the Local IP of the tunnel endpoint***

To finish the setup for security gateway **A** there needs to be two changes made to the IPsec tunnel setup on security gateway **B**. These are:

i. In the IPsec tunnel properties, the **Local Network** for the tunnel needs to be set to *all-nets*. This setting acts as a filter for what traffic is allowed into the tunnel and *all-nets* will allow all traffic into the tunnel.

ii. In the routing section of the IPsec properties, the **Specify address manually** option needs to be enabled and the IP address in this example of *192.168.55.1* needs to be entered. This sets the tunnel endpoint IP to be *192.168.55.1* so that all OSPF traffic will be sent to security gateway **A** with this source IP.

The result of doing this is to "core route" OSPF traffic coming from security gateway **A**. In other words the traffic is destined for CorePlus.

6. ***Repeat the steps for the other security gateway***

What we have done so far is allow OSPF traffic to flow from **A** to **B**. The steps above need to be repeated as a mirror image for security gateway **B** using the same IPsec tunnel but using a different random internal IP network for OSPF setup.

Tip: Non-OSPF traffic can use the tunnel

If a VPN tunnel is used for OSPF traffic, the same tunnel can be used for other types of traffic. There is no requirement to dedicate a tunnel to OSPF traffic.

4.6. Multicast Routing

4.6.1. Overview

Certain types of Internet interactions, such as conferencing and video broadcasts, require a single client or host to send the same packet to multiple receivers. This could be achieved through the sender duplicating the packet with different receiving IP addresses or by a broadcast of the packet across the Internet. These solutions waste large amounts of sender resources or network bandwidth and are therefore not satisfactory. An appropriate solution should also be able to scale to large numbers of receivers.

Multicast Routing solves the problem by the network routers themselves, replicating and forwarding packets via the optimum route to all members of a group. The IETF standards that enable Multicast Routing are:

1. Class D of the IP address space which is reserved for multicast traffic. Each multicast IP address represent an arbitrary group of recipients.

2. The Internet Group Membership Protocol (IGMP) allows a receiver to tell the network that it is a member of a particular multicast group.

3. Protocol Independent Multicast (PIM) is a group of routing protocols for deciding the optimal path for multicast packets.

Multicast routing operates on the principle that an interested receiver joins a group for a multicast by using the IGMP protocol. PIM routers can then duplicate and forward packets to all members of such a multicast group, thus creating a *distribution tree* for packet flow. Rather than acquiring new network information, PIM uses the routing information from existing protocols, such as OSPF, to decide the optimal path.

A key mechanism in the Multicast Routing process is that of *Reverse Path Forwarding*. For unicast traffic a router is concerned only with a packet's destination. With multicast, the router is also concerned with a packets source since it forwards the packet on paths which are known to be downstream, away from the packet's source. This approach is adopted to avoid loops in the distribution tree.

By default multicast packets are routed by CorePlus to the **core** interface (in other words, to CorePlus itself). *SAT Multiplex rules* are set up in the IP rule set in order to perform forwarding to the correct interfaces. This is demonstrated in the examples which follow.

Note

*For multicast to function with an Ethernet interface on any Clavister Security Gateway, that interface must have multicast handling set to **On** or **Auto**. For further details on this see Section 3.3.2, "Ethernet".*

4.6.2. Multicast Forwarding using the SAT Multiplex Rule

The SAT Multiplex rule is used to achieve duplication and forwarding of packets through more than one interface. This feature implements multicast forwarding in CorePlus, where a multicast packet is sent through several interfaces. Note that, since this rule overrides the normal routing tables, packets that should be duplicated by the multiplex rule needs to be routed to the **core** interface.

By default, the multicast IP range **224.0.0.0/4** is always routed to **core** and does not have to be manually added to the routing tables. Each specified output interface can individually be configured with static address translation of the destination address. The **Interface** field in the **Interface/Net Tuple** dialog may be left empty if the **IPAddress** field is set. In this case, the output interface will be determined by a route lookup on the specified IP address.

The multiplex rule can operate in one of two modes:

Using IGMP The traffic flow specified by the multiplex rule must have been requested by hosts using IGMP before any multicast packets are forwarded through the specified interfaces. This is the default behavior of CorePlus.

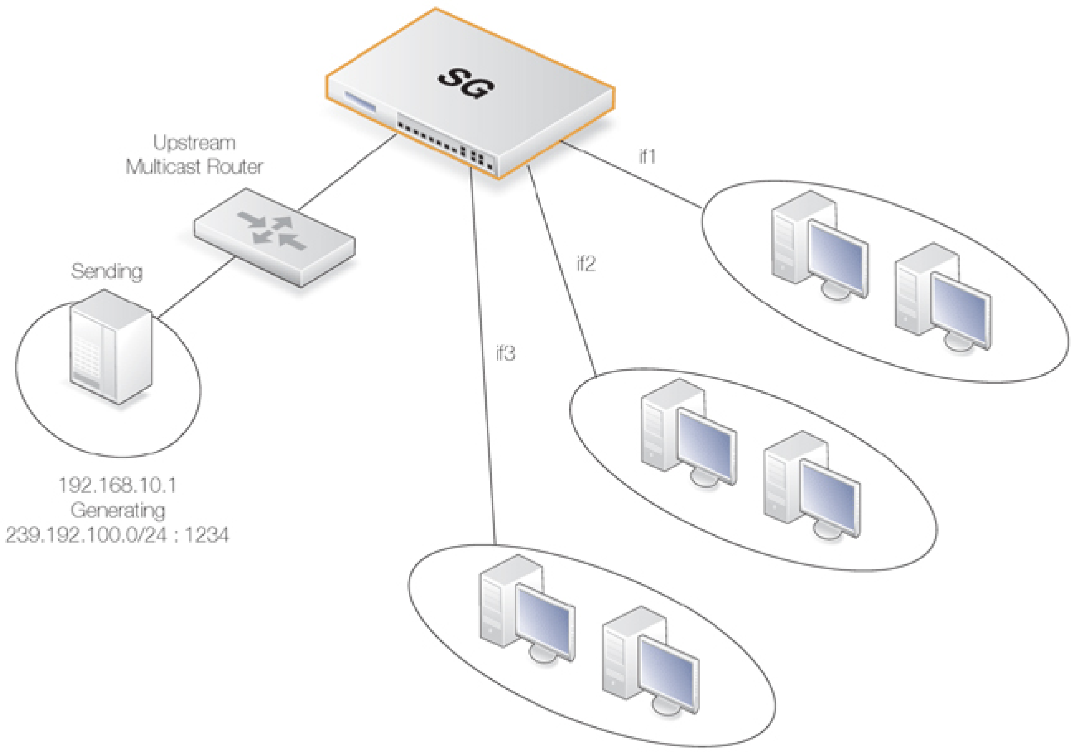
Not using IGMP The traffic flow will be forwarded according to the specified interfaces directly without any inference from IGMP.

> ***Note***
> *Since the Multiplex rule is a SAT rule, an Allow or NAT rule has to be specified together with the Multiplex rule.*

4.6.2.1. Multicast Forwarding - No Address Translation

This scenario describes how to configure multicast forwarding together with IGMP. The multicast sender is **192.168.10.1** and generates the multicast streams **239.192.10.0/24:1234**. These multicast streams should be forwarded from interface wan through the interfaces if1, if2 and if3. The streams should only be forwarded if some host has requested the streams using the IGMP protocol. The example below only covers the multicast forwarding part of the configuration. The IGMP configuration can be found below in Section 4.6.3.1, “IGMP Rules Configuration - No Address Translation”.

Figure 4.10. Multicast Forwarding - No Address Translation



> ***Note: SAT Multiplex rules must have a matching Allow rule***
> *Remember to add an Allow rule matching the SAT Multiplex rule.*

Example 4.6. Forwarding of Multicast Traffic using the SAT Multiplex Rule

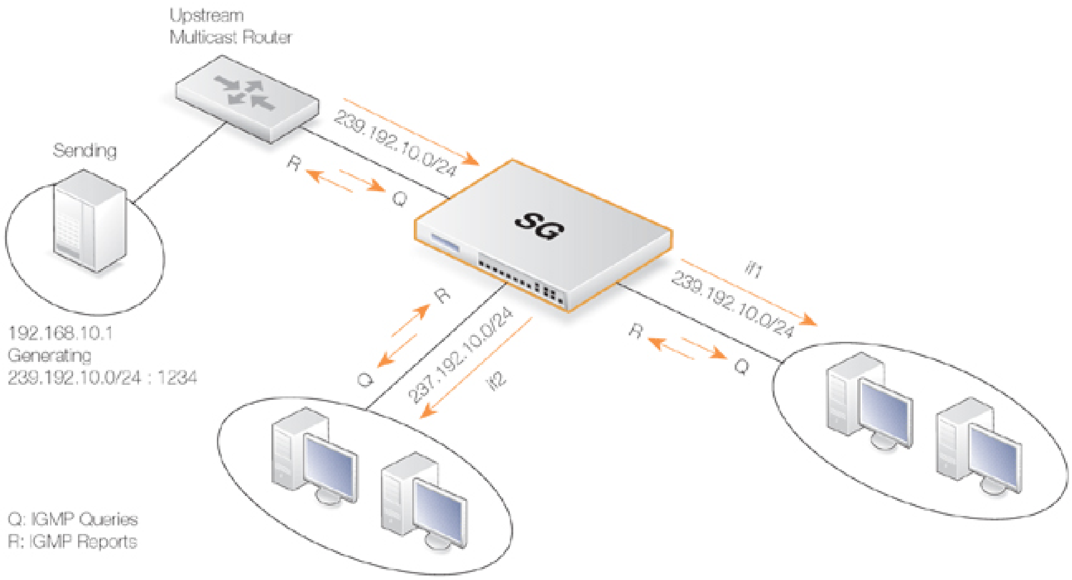
In this example, we will create a multiplex rule in order to forward the multicast groups **239.192.10.0/24:1234** to the interfaces if1, if2 and if3. All groups have the same sender **192.168.10.1** which is located somewhere behind the wan interface. The multicast groups should only be forwarded to the out interfaces if clients behind those interfaces have requested the groups using IGMP. The following steps need to be executed to configure the actual forwarding of the multicast traffic. IGMP has to be configured separately.

Clavister FineTune

1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Specify a suitable name for the rule, for example *Multicast_Multiplex*
4. Select **Multiplex_SAT** in the **Action** dropdown list
5. Select the following from the **Address Filter** dropdown lists:
   - **Source Interface:** wan
   - **Source Network:** 192.168.10.1
   - **Destination Interface:** core
   - **Destination Network:** 239.192.10.0/24
6. Under the **Service** tab, select **Custom** and **UDP** in the **Type** dropdown list. Specify port 1234 in the **Destination Port** field.
7. Under the **Address Translation** tab, click on the plus sign and add the output interfaces if1, if2 and if3 one at a time. For each interface, leave the **IPAddress** field blank since no destination address translation is wanted.
8. Make sure the **USE IGMP** checkbox is set.
9. Click **OK**

4.6.2.2. Multicast Forwarding - Address Translation Scenario

Figure 4.11. Multicast Forwarding - Address Translation



This scenario is based on the previous scenario but now we are going to translate the multicast group. When the multicast streams **239.192.10.0/24** are forwarded through the if2 interface, the multicast groups should be translated into **237.192.10.0/24**. No address translation should be made when forwarding through interface if1. The configuration of the corresponding IGMP rules can be found below in Section 4.6.3.2, “IGMP Rules Configuration - Address Translation”.

Caution
As previously noted, remember to add an Allow rule matching the SAT Multiplex rule.

Example 4.7. Multicast Forwarding - Address Translation

The following SAT Multiplex rule needs to be configured to match the scenario described above:

Clavister FineTune

1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Specify a suitable name for the rule, for instance Multicast_Multiplex
4. Select **Multiplex_SAT** in the **Action** dropdown list.
5. Select the following from the **Address Filter** dropdown lists:
   - **Source Interface:** wan
   - **Source Network:** 192.168.10.1
   - **Destination Interface:** core
   - **Destination Network:** 239.192.10.0/24
6. Under the **Service** tab, select **Custom** and **UDP** in the **Type** dropdown list
7. Specify port 1234 in the **Destination Port** field.
8. Under the **Address Translation** tab, click on the plus sign The **Interface/Net Tuple** dialog will be displayed
9. Add interface if1. Leave the **IPAddress** field empty and click OK.
10. Click on the plus sign again and add interface if2; this time, enter 237.192.10.0 in the **IPAddress** field and click OK
11. Make sure the **USE IGMP** checkbox is set.
12. Click **OK**

Note: Replace the Allow rule with a NAT rule for source translation
*If address translation of the source address is required, the **Allow** rule following the **SAT Multiplex** rule should be replaced with a **NAT** rule.*

4.6.3. IGMP Configuration

IGMP signalling between hosts and routers can be divided into two categories:

IGMP Reports Reports are sent from hosts towards the router when a host wants to subscribe to new multicast groups or change current multicast subscriptions.

IGMP Queries Queries are IGMP messages sent from the router towards the hosts in order to make sure that it will not close any stream that some host still wants to receive.

Normally, both these types of rules has to be specified for IGMP to work. One exception to this is if the multicast source is located on a network directly connected to the router. In this case, no query rule is needed.

A second exception is if a neighboring router is statically configured to deliver a multicast stream to the Clavister Security Gateway. In this case also, an IGMP query would not have to be specified.

CorePlus supports two IGMP modes of operation - Snoop and Proxy.

Figure 4.12. Multicast Snoop

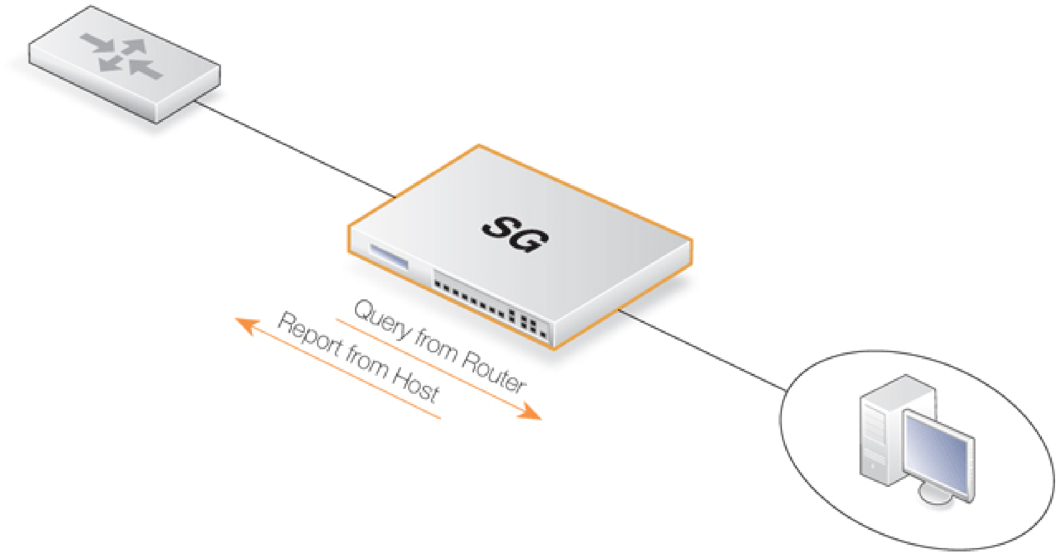
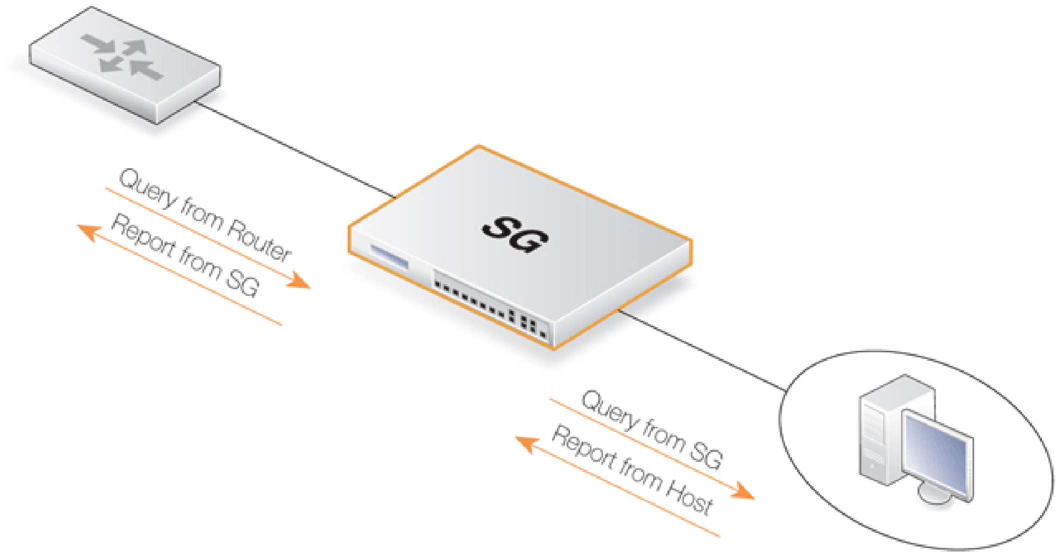


Figure 4.13. Multicast Proxy



In *Snoop Mode*, the Clavister Security Gateway will act transparently between the hosts and another IGMP router. It will not send any IGMP Queries. It will only forward queries and reports between the other router and the hosts.

In *Proxy Mode*, the security gateway will act as an IGMP router towards the clients and actively send queries. Towards the upstream router, the security gateway will be acting as a normal host, subscribing to multicast groups on behalf of its clients.

4.6.3.1. IGMP Rules Configuration - No Address Translation

This example describes the IGMP rules needed for configuring IGMP according to the No Address Translation scenario described above. We want the Clavister Security Gateway to act as a host towards the upstream router and therefore we configure IGMP to run in proxy mode.

Example 4.8. IGMP - No Address Translation

The following example requires a configured interface group IfGrpClients including interfaces if1, if2 and if3. The ip address of the upstream IGMP router is known as UpstreamRouterIP.
Two rules are needed. The first one is a report rule that allows the clients behind interfaces if1, if2 and if3 to subscribe for the multicast groups **239.192.10.0/24**. The second rule, is a query rule that allows the upstream router to query us for the multicast groups that the clients have requested. The following steps need to be executed to create the two rules.

Clavister FineTune

1. Go to **Routing > Multicast > IGMP Rules > New IGMP Rule**
2. The **IGMP Rule Properties** dialog will be displayed
3. Specify a suitable name for the rule, for instance Reports
4. Enter following:
   - **Type:** Report
   - **Action:** Proxy
   - **Relay Interface:** wan
   - **Source Interface:** IfGrpClients
   - **Source Network:** if1net, if2net, if3net
   - **Destination Interface:** core
   - **Destination Network:** auto
   - **Multicast Source:** 192.168.10.1
   - **Multicast Destination:** 239.192.10.0/24
5. Click **OK**
6. Choose **New IGMP Rule...** from the context menu, the **IGMP Rule Properties** dialog will be displayed
7. Specify a suitable name for the rule, for instance Queries
8. Enter following:
   - **Type:** Query
   - **Action:** Proxy
   - **Relay Interface:** IfGrpClients
   - **Source Interface:** wan
   - **Source Network:** UpstreamRouterIp
   - **Destination Interface:** core
   - **Destination Network:** auto
   - **Multicast Source:** 192.168.10.1
   - **Multicast Group:** 239.192.10.0/24
9. Click **OK**

4.6.3.2. IGMP Rules Configuration - Address Translation

The following examples illustrates the IGMP rules needed to configure IGMP according to the Address Translation scenario described above in Section 4.6.2.2, “Multicast Forwarding - Address Translation Scenario”. We need two IGMP report rules, one for each client interface. The interface if1 uses no address translation and if2 translates the multicast group to *237.192.10.0/24*. We also need two query rules, one for the translated address and interface, and one for the original address towards if1.

Two examples are provided, one for each pair of report and query rule. The upstream multicast router uses IP UpstreamRouterIP.

Example 4.9. Configuration if1

The following steps needs to be executed to create the report and query rule pair for if1 which uses no address translation.

Clavister FineTune

1. Go to **Routing > Multicast > IGMP Rules > New IGMP Rule**
2. The **IGMP Rule Properties** dialog will be displayed
3. Specify a suitable name for the rule, for instance *Reports_if1*
4. Enter following:
   - **Type:** Report
   - **Action:** Proxy
   - **Relay Interface:** wan
   - **Source Interface:** if1
   - **Source Network:** if1net
   - **Destination Interface:** core
   - **Destination Network:** auto
   - **Multicast Source:** 192.168.10.1
   - **Multicast Group:** 239.192.10.0/24
5. Click **OK**
6. Choose **New IGMP Rule** again
7. The **IGMP Rule Properties** dialog will be displayed
8. Specify a suitable name for the rule, for instance *Queries_if1*
9. Enter following:
   - **Type:** Query
   - **Action:** Proxy
   - **Relay Interface:** if1
   - **Source Interface:** wan
   - **Source Network:** UpstreamRouterIp
   - **Destination Interface:** core
   - **Destination Network:** auto
   - **Multicast Source:** 192.168.10.1
   - **Multicast Group:** 239.192.10.0/24

10. Click **OK**

Example 4.10. Configuration if2 - Group Translation

The following steps needs to be executed to create the report and query rule pair for if2 which translates the multicast group. Note that the group translated therefore the IGMP reports include the translated IP addresses and the queries will contain the original IP addresses.

Clavister FineTune

1. Go to **New IGMP Rule**
2. The **IGMP Rule Properties** dialog will be displayed
3. Specify a suitable name for the rule, for instance *Reports_if2*
4. Enter following:
   - **Type:** Report
   - **Action:** Proxy
   - **Relay Interface:** wan
   - **Source Interface:** if2
   - **Source Network:** if2net
   - **Destination Interface:** core
   - **Destination Network:** auto
   - **Multicast Source:** 192.168.10.1
   - **Multicast Group:** 237.192.100.0/24 *(this is the translated group IP)*
5. Under the **SAT** tab, enable **Translate the Multicast Group** and enter 239.192.10.0 in the **New IP Address** field.
6. Click **OK**
7. Go to **New IGMP Rule**
8. The **IGMP Rule Properties** dialog will be displayed
9. Specify a suitable name for the rule, for instance *Queries_if2*
10. Enter following:
    - **Type:** Query
    - **Action:** Proxy
    - **Relay Interface:** if2
    - **Source Interface:** wan
    - **Source Network:** UpStreamRouterIP
    - **Destination Interface:** core
    - **Destination Network:** auto
    - **Multicast Source:** 192.168.10.1
    - **Multicast Group:** 239.192.10.0/24
11. Under the **SAT** tab, enable **Translate the Multicast Group** and enter 237.192.10.0 in the **New IP Address** field.
12. Click **OK**

Advanced IGMP Settings

There are a number of IGMP advanced settings which are global and apply to all interfaces which do not have IGMP settings explicitly specified for them. These global settings can be found in Chapter 12, Advanced Settings. Individual IGMP settings are found in the IGMP section of the administration interface.

4.7. Transparent Mode

4.7.1. Overview

Deploying Transparent Mode

The CorePlus *Transparent Mode* feature allows a Clavister Security Gateway to be placed at a point in a network without any reconfiguration of the network and without hosts being aware of its presence. All CorePlus features can then be used to monitor and manage traffic flowing through that point. CorePlus can allow or deny access to different types of services (for example HTTP) and in specified directions. As long as users are accessing the services permitted, they will not be aware of the Clavister Security Gateway's presence.

Network security and control can therefore be significantly enhanced with deployment of a Clavister Security Gateway operating in Transparent Mode but while disturbance to existing users and hosts is minimized.

Switch Routes

Transparent Mode is enabled by specifying a *Switch Route* instead of a standard *Route* in reouting tables. The switch route usually specifies that the network *all-nets* is found on a specific interface. CorePlus then uses ARP message exchanges over the connected Ethernet network to identify and keep track of which host IP addresses are located on that interface (this is explained further below). There shouldn't be a normal non-switch route for that same interface.

In certain, less usual circumstances, switch routes can have a network range specified instead of *all-nets*. This is usually when a network is split between two interfaces but the administrator doesn't know exactly which users are on which interface.

Usage Scenarios

Two examples of Transparent Mode's usage are:

- **Implementing Security Between Users**

  In a corporate environment, there may be a need to protect the computing resources of different departments from one another. The finance department might require access to only a restricted set of services (HTTP for example) on the sales department's servers whilst the sales department might require access to a similarly restricted set of applications on the finance department's hosts. By deploying a single Clavister Security Gateway between the two department's physical networks, transparent but controlled access can be achieved.

- **Controlling Internet Access**

  An organisation allows traffic between the external Internet and a range of public IP addresses on an internal network. Transparent Mode can control what kind of service is permitted to these IP addresses and in what direction. For instance the only services permitted in such a situation may be HTTP access out to the Internet. This usage is dealt with in greater depth below in Section 4.7.2, “Enabling Internet Access”.

Comparison with Routing Mode

The Clavister Security Gateway can operate in two modes: *Routing Mode* using non-switch routes or *Transparent Mode* using switch routes. With non-switch routes, the Clavister Security Gateway performs all the functions of an *OSI Layer 3 Router*: if the Clavister Security Gateway is placed into a network for the first time, or if network topology changes, the routing configuration must therefore be checked and adjusted to ensure that the routing table is consistent with the new layout. Reconfiguration of IP settings may be required for pre-existing routers and protected servers. This works well when comprehensive control over routing is desired.

With **switch routes**, the Clavister Security Gateway operates in Transparent Mode and resembles a *OSI Layer 2 Switch*: it screens IP packets and forwards them transparently to the correct interface without modifying any of the source or destination information at the IP or Ethernet levels. This is done by CorePlus keeping track of the MAC addresses of the connected hosts and CorePlus allows physical Ethernet networks on either side of the Clavister Security Gateway to act as though they were a single logical IP network. (See Appendix F, *The OSI Framework* for an overview of the OSI layer model.)

Two benefits of Transparent Mode over conventional routing are:

- A user can move from one interface to another in a "plug-n-play" fashion, without changing their IP address (assuming their IP address is fixed). The user can still obtain the same services as before (for example HTTP, FTP) without any need to change routes.

- The same network address range can exist on several interfaces.

Note: Transparent and Routing Mode can be combined

Transparent Mode and Routing Mode can operate together on a single Clavister Security Gateway. Switch Routes can be defined alongside standard non-switch routes although the two types cannot be combined for the same interface. An interface operates in one mode or the other.

It is also possible to create a hybrid case by applying address translation on otherwise transparent traffic.

How Transparent Mode Works

In Transparent Mode, CorePlus allows ARP transactions to pass through the Clavister Security Gateway, and determines from this ARP traffic the relationship between IP addresses, physical addresses and interfaces. CorePlus remembers this address information in order to relay IP packets to the correct receiver. During the ARP transactions, neither of the endpoints will be aware of the Clavister Security Gateway.

When beginning communication, a host will locate the target host's physical address by broadcasting an ARP request. This request is intercepted by CorePlus and it sets up an internal ARP Transaction State entry and broadcasts the ARP request to all the other switch-route interfaces except the interface the ARP request was received on. If CorePlus receives an ARP reply from the destination within a configurable timeout period, it will relay the reply back to the sender of the request, using the information previously stored in the ARP Transaction State entry.

During the ARP transaction, CorePlus learns the source address information for both ends from the request and reply. CorePlus maintains two tables to store this information: the Content Addressable Memory (CAM) and Layer 3 Cache. The CAM table tracks the MAC addresses available on a given interface and the Layer 3 cache maps an IP address to MAC address and interface. As the Layer 3 Cache is only used for IP traffic, Layer 3 Cache entries are stored as single host entries in the routing table.

For each IP packet that passes through the Clavister Security Gateway, a route lookup for the destination is done. If the route of the packet matches a **Switch Route** or a Layer 3 Cache entry in the routing table, CorePlus knows that it should handle this packet in a transparent manner. If a destination interface and MAC address is available in the route, CorePlus has the necessary information to forward the packet to the destination. If the route was a **Switch Route**, no specific information about the destination is available and the gateway will have to discover where the destination is located in the network.

Discovery is done by CorePlus sending out ARP as well as ICMP (ping) requests, acting as the initiating sender of the original IP packet for the destination on the interfaces specified in the **Switch Route**. If an ARP reply is received, CorePlus will update the CAM table and Layer 3 Cache and forward the packet to the destination.

If the CAM table or the Layer 3 Cache is full, the tables are partially flushed automatically. Using the discovery mechanism of sending ARP and ICMP requests, CorePlus will rediscover destinations that may have been flushed.

Enabling Transparent Mode

The following steps are required to enable CorePlus Transparent Mode:

1. The interfaces that are to be transparent should be first collected together into a single *Interface Group* object. Interfaces in the group should be marked as **Security transport equivalent** if hosts are to move freely between them.

2. A **Switch Route** is now created in the appropriate routing table and the interface group associated with it. Any existing non-switch routes for interfaces in the group should be removed from the routing table.

   For the **Network** parameter in the switch route, specify *all-nets* or alternatively, specify the range of IP addresses that will be transparent between the interfaces.

3. Create the appropriate IP rules ín the IP rule set to allow the desired traffic to flow between the interfaces operating in Transparent Mode.

   If no restriction at all is to be initially placed on traffic flowing in transparent mode, the following single IP rule could be added but more restrictive IP rules are recommended.

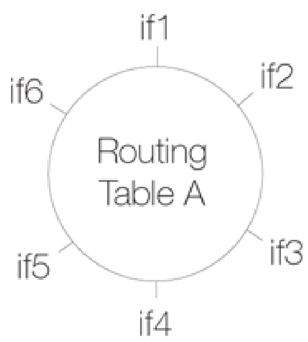
Action	Src Interface	Src Network	Dest Interface	Dest Network	Service
Allow	any	all-nets	any	all-nets	all

Multiple Switch Routes are Connected Together

The setup steps listed above describe placing all the interfaces into a single interface group object which is associated with a single switch route.

An alternative to one switch route is to not use a interface group but instead use an individual switch route for each interface. The end result is the same. All the switch routes defined in a single routing table will be connected together by CorePlus and no matter how interfaces are associated with the switch routes, transparency will exist between them.

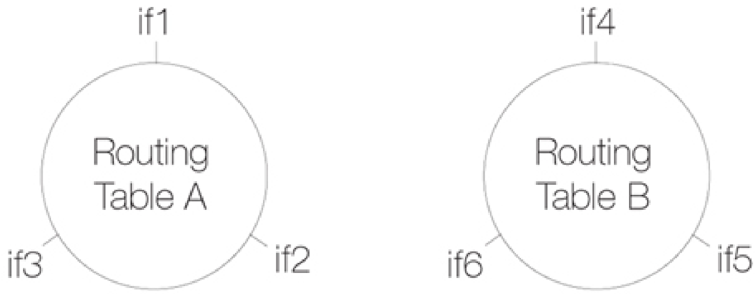
For example, if the interfaces *if1* to *if6* appear in a switch routes in routing table *A*, the resulting interconnections will be as illustrated below.



The connecting together of switch routes in this way only applies, however, if all interfaces are associated with the same routing table. The situation where they are not, is described next.

Creating Separate Transparent Mode Networks

If we now have two routing tables *A* and *B* so that interfaces *if1*, *if2*, *if3* appear in a switch route in table *A* and interfaces *if4*, *if5*, *if6* appear in a switch route in table *B*, the resulting interconnections will be as illustrated below.



The diagram above illustrates how switch route interconnections for one routing table are completely separate from the switch route interconnections for another routing table. By using different routing tables in this way we can create two separate transparent mode networks.

The routing table used for an interface is decided by the *PBR Membership* parameter for each interface (*PBR* is short for *Policy Based Routing* which is the CorePlus term used for multiple routing tables). To implement separate Transparent Mode networks, interfaces must have their *PBR Membership* reset.

By default, all interfaces have *PBR membership* set to be *all* routing tables. By default, one *main* routing table always exists and once an additional routing table has been defined, the *PBR membership* for any interface can then be set to be that new table.

Transparent Mode with VLANs

If transparent mode is being set up for all hosts and users on a single VLAN then the technique described above of using multiple routing tables also applies. A dedicated routing table should be defined for a single VLAN and one switch route should then be defined in that routing table which refers to an interface group. The interface group needs to contain all the interfaces involved in the VLAN.

High Availability and Transparent Mode

Switch Routes cannot be used with High Availability and therefore true transparent mode cannot be implemented with a CorePlus High Availability Cluster.

Instead of Switch Routes the solution in a High Availability setup is to use Proxy ARP to separate two networks. This is described further in Section 4.2.5, “Proxy ARP”. The key disadvantage with this approach is that firstly, clients will not be able to roam between CorePlus interfaces, retaining the same IP address. Secondly, and more importantly, their network routes will need to be manually configured for proxy ARP.

Transparent Mode with DHCP

In most Transparent Mode scenarios, the IP address of users is predefined and fixed and is not dynamically fetched using DHCP. Indeed, the key advantage of Transparent Mode is that these users can plug in anywhere and CorePlus can route their traffic correctly after determining their whereabouts and IP address through ARP exchanges.

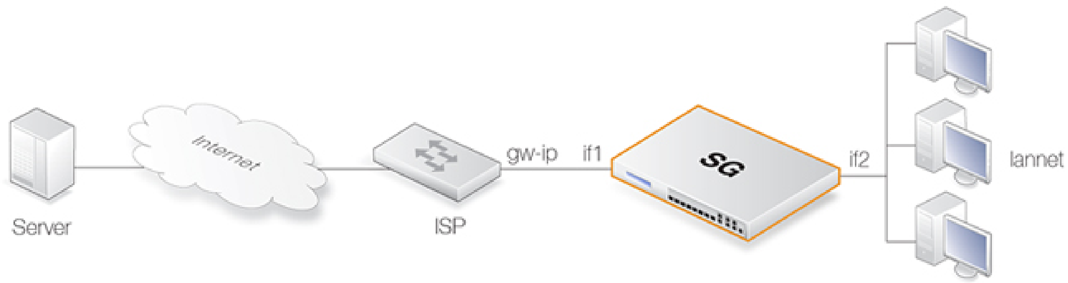
However, a DHCP server could be used to allocate user IP addresses in a Transparent Mode setup if desired. With Internet connections, it may be the ISP's own DHCP server which will hand out public

IP addresses to users. In this case, CorePlus **MUST** be correctly configured as a *DHCP Relayer* to forward DHCP traffic between users and the DHCP server.

4.7.2. Enabling Internet Access

A common misunderstanding when setting up Transparent Mode is how to correctly set up access to the public Internet. Below is a typical scenario where a number of users on an IP network called *lannet* access the Internet via an ISP's gateway with IP address *gw-ip*.

Figure 4.14. Non-transparent Mode Internet Access

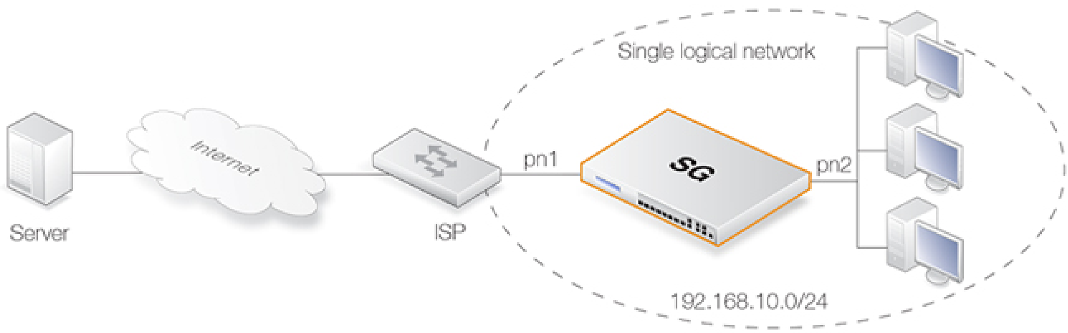


The non-switch route usually needed to allow Internet access would be:

Route type	Interface	Destination	Gateway
Non-switch	if1	all-nets	gw-ip

Now lets suppose the Clavister Security Gateway is to operate in transparent mode between the users and the ISP. The illustration below shows how, using switch routes, the Clavister Security Gateway is set up to be transparent between the internal physical Ethernet network (*pn2*) and the Ethernet network to the ISP's gateway (*pn1*). The two Ethernet networks are treated as a single logical IP network in Transparent Mode with a common address range (in this example *192.168.10.0/24*).

Figure 4.15. Transparent Mode Internet Access



In this situation, any "normal" non-switch *all-nets* routes in the routing table should be removed and replaced with an *all-nets* switch route (not doing this is a common mistake during setup). This switch route will allow traffic from the local users on Ethernet network *pn2* to find the ISP gateway.

These same users should also configure the internet gateway on their local computers to be the ISPs gateway address. In non-transparent mode the user's gateway IP would be the Clavister Security Gateway's IP address but in transparent mode the ISP's gateway is on the same logical IP network as the users and will therefore be *gw-ip*.

CorePlus May Also Need Internet Access

The Clavister Security Gateway also needs to find the public Internet if it is to perform CorePlus functions such as DNS lookup, Web Content Filtering or Anti-Virus and IDP updating. To allow this, individual "normal" non-switch routes need to be set up in the routing table for each IP address specifying the interface which leads to the ISP and the ISPs gateway IP address.

If the IP addresses that need to be reached by CorePlus are *85.12.184.39* and *194.142.215.15* then the complete routing table for the above example would be:

Route type	Interface	Destination	Gateway
Switch	if1	all-nets	
Switch	if2	all-nets	
Non-switch	if1	85.12.184.39	gw-ip
Non-switch	if1	194.142.215.15	gw-ip

The appropriate IP rules will also need to be added to the IP ruleset to allow Internet access through the Clavister Security Gateway.

Grouping IP Addresses

It can be quicker when dealing with many IP addresses to group all the addresses into a single group IP object and then use that object in a single defined route. In the above example, *85.12.184.39* and *194.142.215.15* could be grouped into a single object in this way.

Using NAT

NAT should not be enabled for CorePlus in Transparent Mode since, as explained previously, the Clavister Security Gateway is acting like a level 2 switch and address translation is done at the higher IP OSI layer.

The other consequence of not using NAT is that IP addresses of users accessing the Internet usually need to be public IP addresses.

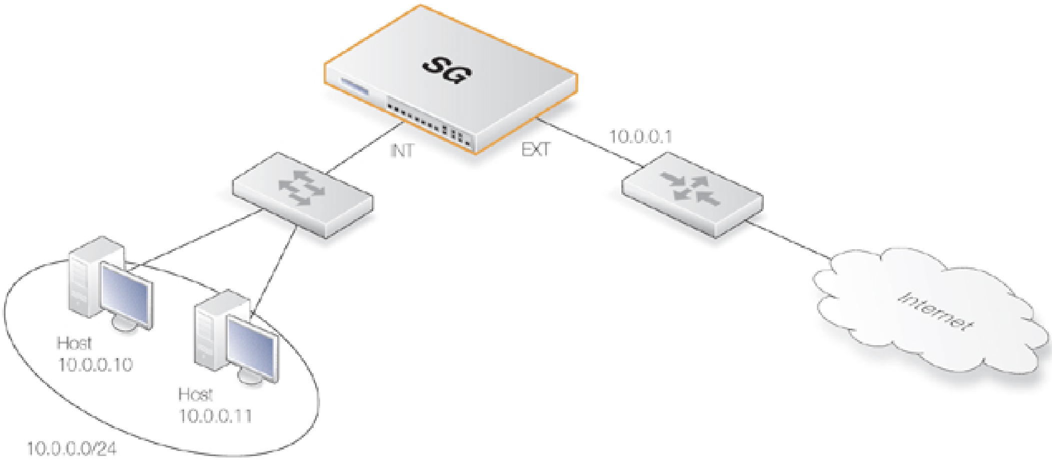
If NATing needs to be performed in the example above to hide individual addresses from the Internet, it would have to be done by a device (possibly another Clavister Security Gateway) between the *192.168.10.0/24* network and the public internet. In this case, internal IP addresses could be used by the users on Ethernet network *pn2*.

4.7.3. Transparent Mode Scenarios

Scenario 1

The gateway in Transparent Mode is placed between an Internet access router and the internal network. The router is used to share the Internet connection with a single public IP address. The internal NAT:ed network behind the gateway is in the 10.0.0.0/24 address space. Clients on the internal network are allowed to access the Internet via the HTTP protocol.

Figure 4.16. Transparent Mode Scenario 1



Example 4.11. Setting up Transparent Mode for Scenario 1

Clavister FineTune

Configure the interfaces:

1. Go to **Interfaces > Ethernet**
2. Right-click on the *wan*object and choose **Properties**, the **Ethernet Properties** dialog will be displayed
3. In the **IP Address** control, enter *10.0.0.2*
4. Click **OK**

1. Go to **Interfaces > Ethernet**
2. Right-click on the *lan*object and choose **Properties**, the **Ethernet Properties** dialog will be displayed.
3. In the **IP Address** control, enter 10.0.0.2
4. Click **OK**

Create an interface group:

1. Go to **Interfaces > Interface Groups > New Interface Group**
2. The **Interface Group Properties** dialog will be displayed
3. Specify a suitable name for the interface group, for instance *TransparentGroup*
4. In the **Interfaces** control, add *lan* and *wan*
5. Click **OK**

Add a Switch Route:

1. Got to **Routing > Routes > New Switch Route**
2. The **Switch Route Properties** dialog will be displayed
3. Specify a suitable name for the route, for instance *TransparentRoute*
4. Enter following:
   - **Interface:** TransparentGroup
   - **Network:** 10.0.0.0/24
   - **Metric:** 0

5. Click **OK**

Configure the rules:

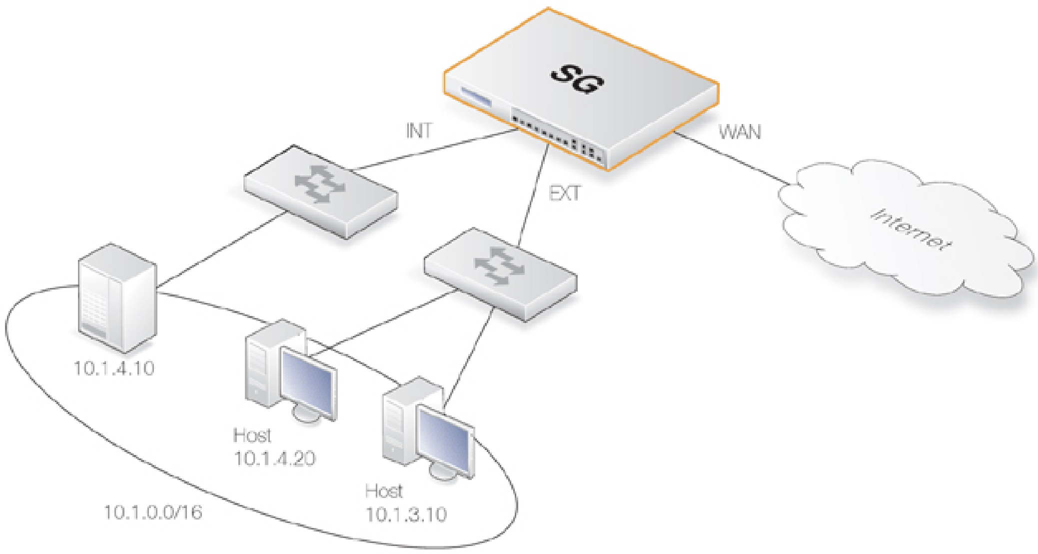
1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Specify a suitable name for the rule, for instance *HTTPAllow*
4. Enter following:
   - **Action:** Allow
   - **Source Interface:** lan
   - **Destination Interface:** TransparentGroups
   - **Source Network:** 10.0.0.0/24
   - **Destination Network:** all-nets (0.0.0.0/0)
5. Under the **Service** tab, choose *http* in the **Pre-defined** control
6. Click **OK**

Scenario 2

Here the Clavister Security Gateway in Transparent Mode separates server resources from an internal network by connecting them to a separate interface without the need for different address ranges.

All hosts connected to LAN and DMZ (the lan and dmz interfaces) share the *10.0.0.0/24* address space. As this is configured using Transparent Mode any IP address can be used for the servers, and there is no need for the hosts on the internal network to know if a resource is on the same network or placed on the DMZ. The hosts on the internal network are allowed to communicate with an HTTP server on DMZ while the HTTP server on the DMZ can be reached from the Internet. The Clavister Security Gateway is transparent between the DMZ and LAN while traffic can subjected to the IP rule set.

Figure 4.17. Transparent Mode Scenario 2



Example 4.12. Setting up Transparent Mode for Scenario 2

Configure a **Switch Route** over the LAN and DMZ interfaces for address range *10.0.0.0/24* (assume the WAN interface is already configured).

Clavister FineTune

Configure the interfaces:

Similar as shown in the previous example, first, we need to specify the involving interfaces *lan,* and *dmz* using the example IP addresses for this scenario.

Interface Groups:

Similar as shown in the previous example. Configure both interfaces *lan* and *dmz* into the same group.

Switch Route:

This step is similar to the previous example. Set up the switch route with the new interface group created earlier.

Configure the rules:

1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Specify a suitable name for the rule, for instance *HTTP-LAN-to-DMZ*
4. Enter following:
   - **Action:** Allow
   - **Source Interface:** lan
   - **Destination Interface:** dmz
   - **Source Network:** all-nets
   - **Destination Network:** 10.1.4.10
5. Under the **Service** tab, choose *http* in the **Pre-defined** control
6. Click **OK**
7. Go to **Rules > New Rule**
8. The **Rule Properties** dialog will be displayed
9. Specify a suitable name for the rule, for instance *HTTP-WAN-to-DMZ*
10. Enter following:
    - **Action:** SAT
    - **Source Interface:** wan
    - **Destination Interface:** dmz
    - **Source Network:** all-nets
    - **Destination Network:** ip_wan
11. Under the **Service** tab, choose *http* in the **Pre-defined** control
12. Under the **Address Translation** tab, choose *Destination IP Address* and enter *10.1.4.10* in the **New IP Address** control
13. Click **OK**
14. Go to **Rules > New Rule**
15. The **Rule Properties** dialog will be displayed
16. Specify a suitable name for the rule, for instance *HTTP-LAN-to-DMZ*
17. Enter following:

- **Action:** Allow
- **Source Interface:** wan
- **Destination Interface:** dmz
- **Source Network:** all-nets
- **Destination Network:** ip_wan

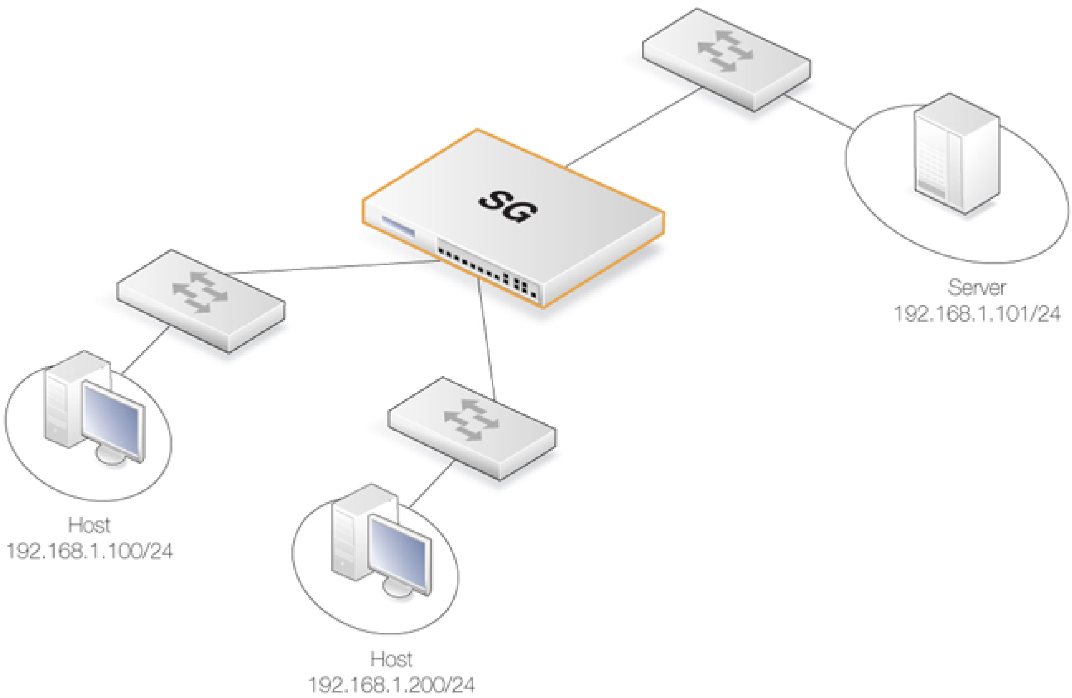
18. Under the **Service** tab, choose *http* in the **Pre-defined** control
19. Click **OK**

4.7.4. Spanning Tree BPDU Support

CorePlus includes support for relaying the Bridge Protocol Data Units (BPDUs) across the Clavister Security Gateway. BPDU frames carry Spanning Tree Protocol (STP) messages between layer 2 switches in a network. STP allows the switches to understand the network topology and avoid the occurrences of loops in the switching of packets.

The diagram below illustrates a situation where BPDU messages would occur if the administrator enables the switches to run the STP protocol. Two Clavister Security Gateways are deployed in transparent mode between the two sides of the network. The switches on either side of the gateway need to communicate and require CorePlus to relay switch BPDU messages in order that packets do not loop between the gateways.

Figure 4.18. An Example BPDU Relaying Scenario



BPDU Relaying Implementation

The CorePlus BDPU relaying implementation only carries STP messages. These STP messages can be of three types:

- Normal Spanning Tree Protocol (STP)
- Rapid Spanning Tree Protocol (RSTP)
- Multiple Spanning Tree Protocol (MSTP)
- Cisco proprietary PVST+ Protocol (Per VLAN Spanning Tree Plus)

CorePlus checks the contents of BDPU messages to make sure the content type is supported. If it isn't the frame is dropped.

Enabling/Disabling BPDU Relaying

BPDU relaying is disabled by default and can be controlled through the advanced setting **RelaySTP** (see Chapter 12, *Advanced Settings*). Logging of BPDU messages can also be controlled through this setting. When enabled, all incoming STP, RSTP and MSTP BPDU messages are relayed to all transparent interfaces in the same routing table, except the incoming interface.

4.7.5. MPLS Pass Through

Multi-protocol Label Switching (MPLS) is a standard that allows the attaching of *labels* to IP packets to provide information about the packet's eventual destination. The router that initially attached the MPLS label is known as the *ingress router*.

Network nodes that support MPLS can then use this attached information to route packets without needing to perform route lookups and therefore increase processing speed. In addition to overall faster traffic movement, MPLS also makes it easier to manage *Quality of Service* (QoS).

MPLS is considered to be "multi-protocol" because it works with the Internet Protocol, Asynchronous Transport Mode (ATM) and frame relay network. When considered in reference to the OSI network model, MPLS allows packets to be forwarded at the layer two level rather than at the layer three level and for this reason it is said to operate at the two and a half level.

CorePlus MPLS Support

CorePlus supports *MPLS Pass Through*. This is relevant in transparent mode scenarios where the MPLS labelled packets are allowed to traverse the Clavister Security Gateway. CorePlus can optionally validate the integrity of these MPLS packets and the administrator can change the advanced setting **RelayMPLS** to specify the specific action to be taken (see Chapter 12, *Advanced Settings*). The possible values for this setting are:

- **Ignore** - Verify packets and allow all verified MPLS labelled packets to pass silently. Packets that fail verification are logged.
- **Log** - Verify packets and allow all verified MPLS packets to pass as well as being logged. Packets that fail verification are also logged.
- **Drop** - Silently drop all MPLS packets without verification or logging.
- **Drop/Log** - - Drop all MPLS packets without verification and log these drops.

Chapter 5. DHCP Services

This chapter describes DHCP services in CorePlus.

5.1. Overview

DHCP (Dynamic Host Configuration Protocol) is a protocol that allows network administrators to automatically assign IP numbers to computers on a network.

IP Address Assignment

A *DHCP Server* implements the task of assigning IP addresses to DHCP clients. These addresses come from a pre-defined IP address pool which DHCP manages. When a DHCP server receives a request from a DHCP client, it returns the configuration parameters (such as an IP address, a MAC address, a domain name, and a lease for the IP address) to the client in a unicast message.

DHCP Leases

Compared to static assignment, where the client owns the address, dynamic addressing by a DHCP server leases the address to each client for a pre-defined period of time. During the lifetime of a lease, the client has permission to keep the assigned address and is guaranteed to have no address collision with other clients.

Before the expiration of the lease, the client needs to renew the lease from the server so it can keep using the assigned IP address. The client may also decide at any time that it no longer wishes to use the IP address it was assigned, and may terminate the lease and release the IP address.

The lease time can be configured in a DHCP server by the administrator.

5.2. DHCP Servers

CorePlus has the ability to act as one or more logical DHCP servers. Filtering of DHCP client requests to different DHCP servers can be based on the interface. Each CorePlus interface can have, at most, one single logical DHCP server associated with it. In other words, CorePlus can provision DHCP clients using different address ranges depending on what interface they are located on.

DHCP Server Options

A number of options which relate the client response can be configured for each DHCP server instance:

- **IP Address**
- **Netmask** - netmask sent to the DHCP Client.
- **Subnet**
- **Gateway Address** - what IP should be sent to the client for use as the default gateway. If 0.0.0.0 is specified the IP given to the client will be sent as the gateway.
- **Domain Name**
- **Lease Time** - the time, in seconds that a DHCP lease should be provided to a host after which the client must renew the lease.
- **DNS Servers**
- **WINS Servers**
- **Next Server** - the IP address of the next server in the boot process, this is usually a TFTP server.
- **Relayer IP Filter** - This is used when defining multiple DHCP servers and is described further below.

In addition, *Custom Options* can be specified in order to have the DHCP servers hand out all options supported by the DHCP standard.

DHCP servers assign and manage the IP addresses taken the from specified address pool. CorePlus DHCP servers are not limited to serving a single range of IP addresses but can use any IP address range that can be specified by a CorePlus address object.

Example 5.1. Setting up a DHCP server

This example shows how to set up a DHCP server called *DHCPServer1* which assigns and manages IP addresses from an IP address pool called *DHCPRange1*. This example assumes you have created an IP range for the DHCP Server.

Clavister FineTune

1. Go to **Miscellaneous > DHCP Server > New DHCP Server**
2. The **DHCP Server Properties** dialog will be displayed. Now enter:
   - **Name:** DHCPServer1
   - **Interface Filter:** lan
   - **IP Address Pool:** DHCPRange1
   - **Netmask:** 255.255.255.0

3. Click **OK**

Example 5.2. Checking the status of a DHCP server

Clavister FineTune

This is best done through the console command:

```
Cmd> dhcpserver
```

Real-time monitoring in Clavister FineTune™ can also be used to monitor DHCP server status.

Displaying IP to MAC Address Mappings

To display the mappings of IP addresses to MAC addresses that result from allocated DHCP leases, the following command can be used. It is shown with some typical output:

```
Cmd> dhcpserver -mappings

DHCP server mappings:
Client IP          Client MAC           Mode
---------------    -----------------    -------------
10.4.13.240        00-1e-0b-a0-c6-5f    ACTIVE(STATIC)
10.4.13.241        00-0c-29-04-f8-3c    ACTIVE(STATIC)
10.4.13.242        00-1e-0b-aa-ae-11    ACTIVE(STATIC)
10.4.13.243        00-1c-c4-36-6c-c4    INACTIVE(STATIC)
10.4.13.244        00-00-00-00-02-14    INACTIVE(STATIC)
10.4.13.254        00-00-00-00-02-54    INACTIVE(STATIC)
10.4.13.1          00-12-79-3b-dd-45    ACTIVE
10.4.13.2          00-12-79-c4-06-e7    ACTIVE
10.4.13.3         *00-a0-f8-23-45-a3    ACTIVE
10.4.13.4         *00-0e-7f-4b-e2-29    ACTIVE
```

The asterisk "*" before a MAC address means that the DHCP server does not track the client using the MAC address but instead tracks the client through a *client identifier* which the client has given to the server.

Tip
DHCP leases are remembered by CorePlus between system restarts.

5.3. Static DHCP Assignment

Where the administrator requires a fixed relationship between a client and the assigned IP address, CorePlus allows the assignment of a given IP to a specific MAC address.

Example 5.3. Setting up Static DHCP

This example shows how to assign the IP address *192.168.1.1* to the MAC address *00-90-12-13-14-15*. The examples assumes that the DHCP server *DHCPServer1* has already been defined.

Clavister FineTune

1. Go to **Miscellaneous > DHCP Server > DHCPServer1**
2. Select the **Static Hosts** tab in the properties dialog
3. For the new IP/MAC address combination:
    - Press the "**+**" button so a dialog appears and enter:
    - **IP address:** 192.168.1.1
    - **MAC address:** 00-90-12-13-14-15
    - Click **OK**
4. Click **OK**

5.4. DHCP Relaying

The Problem

With DHCP, clients send requests to locate the DHCP server(s) using broadcast messages. However, broadcasts are normally only propagated across the local network. This means that the DHCP server and client always need to be on the same physical network. In a large Internet-like network topology, this means there would have to be a different DHCP server on every network. This problem is solved by the use of a DHCP relayer.

The Relayer Solution

A DHCP relayer takes the place of the DHCP server in the local network and acts as the link between the client and a remote DHCP server. It intercepts requests from clients and relays them to the server. The server then responds to the relayer, which forwards the response back to the client. DHCP relayers use the TCP/IP *Bootstrap Protocol* (BOOTP) to implement relay functionality. For this reason they are sometimes referred to as *BOOTP relay agents*.

Example 5.4. Setting up a DHCP relayer

This example allows clients on VLAN interfaces to obtain IP addresses from a DHCP server. It is assumed the gateway is configured with VLAN interfaces, "vlan1" and "vlan2", that use DHCP relaying, and the DHCP server IP address is defined in the address book as "ip-dhcp". CorePlus will install a route for the client when it has finalized the DHCP process and obtained an IP.

Clavister FineTune

Add VLAN interfaces *vlan1* and *vlan2* that relay to an interface group called *ipgrp-dhcp*:

1. Go to **Interfaces > Interface Groups > New Interface Group**
2. The **DHCP Relay Properties** dialog will be displayed
3. Specify a suitable name for the Interface Group, for example *ipgrp-dhcp*
4. In **Interfaces** add "vlan1" and "vlan2" to the list
5. Click **OK**

Adding a DHCP relay named as "vlan-to-dhcpserver":

1. Go to **Routing > DHCP Relay > New DHCP Relay**
2. The **DHCP Relay Properties** dialog will be displayed
3. Specify a suitable name for the Interface Group, for example *vlan-to-dhcpserver*
4. Now enter:
   - **Action:** Relay
   - **Source Interface:** ipgrp-dhcp
   - **DHCP Server to relay to:** ip-dhcp
5. Under the **Add Route** tab, check **Add dynamic routes for this relayed DHCP lease**
6. Click **OK**

5.5. IP Pools

Overview

IP pools are used to offer other subsystems access to a cache of DHCP IP addresses. These addresses are gathered into a pool by internally maintaining a series of DHCP clients (one per IP). The DHCP servers used by a pool can either be external or be DHCP servers defined in CorePlus itself. External DHCP servers can be specified as the server on a specific interface or by a unique IP address. Multiple IP Pools can be set up with different identifying names.

The primary usage of IP Pools is with *IKE Config Mode* which a feature used for allocating IP addresses to remote clients connecting through IPsec tunnels. For more information on this see Section 9.4.3.4, “Using Config Mode”.

Basic IP Pool Options

The basic options available for an IP Pool are:

DHCP Server behind interface Indicates that the IP pool should use the DHCP server(s) residing on the specified interface.

Server filter Optional setting used to specify which servers to use. If unspecified any DHCP server on the interface will be used. The order of the provided address or ranges (if multiple) will be used to indicate the preferred servers.

Specify DHCP Server Address Specify DHCP server IP(s) in preferred ascending order to be used. Using the IP loopback address *127.0.0.1* indicates that the DHCP server is CorePlus itself.

Client IP filter Optional setting used to specify which offered IPs are valid to use. In most cases this will be set to the default of **all-nets**. Alternatively a set of IP ranges might be specified. The filter ensures that only certain IP addresses from DHCP servers are acceptable and is used in the situation where there might be a DHCP server response with an unacceptable IP address.

Advanced IP Pool Options

Advanced options available for IP Pool configuration are:

Routing table Policy routing table to be used for lookups when resolving the destination interfaces for the configured DHCP servers.

Receive interface "Simulated" receive interface. This can be used in policy based routing rules and/or used to trigger a specific DHCP server rule if the pool is using a DHCP server in CorePlus and the IP address of that server has been specified as the loopback interface.

MAC Range A range of MAC addresses that will be use to create "fake" DHCP clients. Used when the DHCP server(s) map clients by the MAC address. An indication of the need for MAC ranges is when the DHCP server keeps giving out the same IP for each client.

Prefetched leases Specifies the number of leases to keep prefetched. Prefetching will improve performance since there won't be any wait time when a system requests an IP (while there exists prefetched IPs).

Maximum free The maximum number of "free" IPs to be kept. Must be equal to or greater than the prefetch parameter. The pool will start releasing (giving back IPs to the DHCP server) when the number of free clients exceeds this value.

Maximum clients Optional setting used to specify the maximum number of clients (IPs) allowed in the pool.

Sender IP This is the source IP to use when communicating with the DHCP server.

Using Prefetched Leases

As mentioned in the previous section, the *Prefetched Leases* option specifies the size of the cache of leases which is maintained by CorePlus. This cache provides fast lease allocation and can improve overall system performance. It should be noted however that the entire prefetched number of leases is requested at system startup and if this number is too large then this can degrade initial performance.

As leases in the prefetch cache are allocated, requests are made to DHCP servers so that the cache is always full. The administrator therefore has to make a judgement as to the optimal initial size of the prefetch cache.

Example 5.5. Creating an IP Pool

This example shows the creation of an IP Pool object that will use the DHCP server on IP address *28.10.14.1* with 10 prefetched leases.

Clavister FineTune

1. Go to **Local Objects > IP Pool > New IP Pool**
2. Now enter **Name:** ip_pool_1
3. Select **Select Specify DHCP Server Address** and enter *28.10.14.1*
4. Select the **Advanced** tab
5. Set **Prefetched Leases** to *10*
6. Click **OK**

Chapter 6. Security Mechanisms

This chapter describes CorePlus security features.

6.1. Access Rules

6.1.1. Introduction

One of the principal functions of CorePlus is to allow only authorized connections access to protected data resources. Access control is primarily addressed by the CorePlus IP rule set in which a range of protected LAN addresses are treated as trusted hosts, and traffic flow from untrusted sources is restricted from entering trusted areas.

Before a new connection is checked against the IP rule set, CorePlus checks the connection source against a set of *Access Rules*. Access Rules can specify what traffic source is expected on a given interface and also to automatically drop traffic originating from specific sources. AccessRules can provide an efficient and targeted initial filter of new connection attempts.

The Default Access Rule

Even if the administrator doesn't explicitly specify any Access Rules, a basic access rule is always in place which is known as the *Default Access Rule*. This default rule always checks incoming traffic by performing a reverse lookup in the routing tables. This lookup validates that the incoming traffic is coming from a source that the routing tables indicate is accessible via the interface on which the traffic arrived. If this reverse lookup fails then the connection is dropped and a "Default Access Rule" log message will be generated.

For most configurations the Default Access Rule is sufficient and the administrator does not need to explicitly specify other rules. The default rule can, for instance, protect against IP spoofing, which is described in the next section. If Access Rules are explicitly specified, then the Default Access Rule is still applied if a new connection doesn't match any of the specified rules.

6.1.2. IP Spoofing

Traffic that pretends it comes from a trusted host can be sent by an attacker to try and get past a gateway's security mechanisms. Such an attack is commonly known as *Spoofing*.

IP spoofing is one of the most common spoofing attacks. Trusted IP addresses are used to bypass filtering. The header of an IP packet indicating the source address of the packet is modified by the attacker to be a local host address. The gateway will believe the packet came from a trusted source. Although the packet source cannot be responded to correctly, there is the potential for unnecessary network congestion to be created and potentially a Denial of Service (DoS) condition could occur. Even if the gateway is able to detect a DoS condition, it is hard to trace or stop because of its nature.

VPNs provide one means of avoiding spoofing but where a VPN is not an appropriate solution then Access Rules can provide an anti-spoofing capability by providing an extra filter for source address verification. An Access Rule can verify that packets arriving at a given interface do not have a source address which is associated with a network of another interface. In other words:

- Any incoming traffic with a source IP address belonging to a local trusted host is NOT allowed.
- Any outgoing traffic with a source IP address belonging to an outside untrusted network is NOT allowed.

The first point prevents an outsider from using a local host's address as its source address. The second point prevents any local host from launching the spoof.

6.1.3. Access Rule Settings

The configuration of an access rule is similar to other types of rules. It contains **Filtering Fields** as well as the **Action** to take. If there is a match, the rule is triggered, and CorePlus will carry out the specified Action.

Access Rule Filtering Fields

The Access Rule filtering fields used to trigger a rule are:

- **Interface**: The interface that the packet arrives on.
- **Network**: The IP span that the sender address should belong to.

Access Rule Actions

The Access Rule actions that can be specified are:

- **Drop**: Discard the packets that match the defined fields.
- **Accept**: Accept the packets that match the defined fields for further inspection in the rule set.
- **Expect:** If the sender address of the packet matches the **Network** specified by this rule, the receiving interface is compared to the specified interface. If the interface matches, the packet is accepted in the same way as an **Accept** action. If the interfaces do not match, the packet is dropped in the same way as a **Drop** action.

> ***Note***
> *Logging can be enabled on demand for these Actions.*

Turning Off *Default Access Rule* Messages

If, for some reason, the "Default Access Rule" log message is continuously being generated by some source and needs to be turned off, then the way to do this is to specify an Access Rule for that source with an action of **Drop**.

Troubleshooting Access Rule Related Problems

It should be noted that Access Rules are a first filter of traffic before any other CorePlus modules can see it. Sometimes problems can appear, such as setting up VPN tunnels, precisely because of this. It is always advisable to check Access Rules when troubleshooting puzzling problems in case a rule is preventing some other function, such as VPN tunnel establishment, from working properly.

Example 6.1. Setting up an Access Rule

A rule is to be defined that ensures no traffic with a source address not within the lannet network is received on the lan interface.

Clavister FineTune

1. Go to **Miscellaneous > Access > New Access**
2. The **Access Properties** dialog will be displayed
3. Specify a suitable name for the access rule, for example *lan_Access*
4. Now enter:
   - **Action:** Expect
   - **Interface:** lan
   - **Network:** lannet
5. Click **OK**

6.2. ALGs

6.2.1. Overview

To complement low-level packet filtering, which only inspects packet headers in protocols such as IP, TCP, UDP, and ICMP, Clavister Security Gateways provide *Application Layer Gateways* (ALGs) which provide filtering at the higher *application* OSI level.

An ALG object acts as a mediator in accessing commonly used Internet applications outside the protected network, for example web access, file transfer and multimedia transfer. ALGs provide higher security than packet filtering since they are capable of scrutinizing all traffic for a specific protocol and perform checks at the higher levels of the TCP/IP stack.

ALGs exist for the following protocols in CorePlus:

- HTTP
- FTP
- TFTP
- SMTP
- POP3
- SIP
- H.323

Deploying an ALG

Once a new ALG object is defined by the administrator, it is brought into use by first associating it with a *Service* object and then associating that Service with an IP rule in the CorePlus IP rule set.

Figure 6.1. Deploying an ALG Object

Maximum Connection Sessions

The Service associated with an ALG has a configurable parameter associated with it called *Max Sessions* and the default value varies according to the type of ALG. For instance, the default value for the HTTP ALG is *1000*. This means that a 1000 connections are allowed in total for the HTTP Service across all interfaces. The full list of default maximum session values are:

- HTTP ALG - *1000* sessions.
- FTP ALG - *200* sessions.
- TFTP ALG - *200* sessions.
- SMTP ALG - *200* sessions.
- POP3 ALG - *200* sessions.
- H.323 ALG - *100* sessions.
- SIP ALG - *200* sessions.

> ***Note***
> *This default value can often be too low for HTTP if there are large number of clients connecting through the Clavister Security Gateway and it is therefore recommended to consider using a higher value in such circumstances.*

6.2.2. The HTTP ALG

Hyper Text Transfer Protocol (HTTP) is the primary protocol used to access the *World Wide Web* (WWW). It is a connectionless, stateless, application layer protocol based on a request/response architecture. A client, such as a Web browser, sends a request by establishing a TCP/IP connection to a known port (usually port 80) on a remote server. The server answers with a response string, followed by a message of its own. That message might be, for example, an HTML file to be shown in the Web browser or an ActiveX component to be executed on the client, or perhaps an error message.

The HTTP protocol has particular issues associated with it because of the wide variety of web sites that exist and because of the range of file types that can be downloaded using the protocol.

HTTP ALG Features

The HTTP ALG is an extensive CorePlus subsystem consisting of the options described below:

- **Static Content Filtering** - This deals with *Blacklisting* and *Whitelisting* of specific URLs.
  - ***URL Blacklisting***
    Specific URLs can be blacklisted so that they are not accessible. Wildcarding can be used when specifying URLs, as described below.
  - ***URL Whitelisting***
    The opposite to blacklisting, this makes sure certain URLs are always allowed. Wildcarding can also be used for these URLs, as described below.

    It is important to note that whitelisting a URL means that it cannot be blacklisted and it also cannot be dropped by web content filtering (if that is enabled, although it will be logged). Anti-Virus scanning, if it is enabled, is always applied to the HTTP traffic even if it is whitelisted.

These features are described in depth in Section 6.3.3, “Static Content Filtering”.

- **Dynamic Content Filtering** - Access to specific URLs can be allowed or blocked according to policies for certain types of web content. Access to news sites might be allowed whereas access to gaming sites might be blocked.

  This feature is described in depth in Section 6.3.4, “Dynamic Web Content Filtering”.

- **Anti-Virus Scanning** - The contents of HTTP file downloads can be scanned for viruses. Suspect files can be dropped or just logged.

  This feature is common to a number of ALGs and is described fully in Section 6.4, “Anti-Virus Scanning”.

- **Verify File Integrity** - This part of the ALG deals with checking the filetype of downloaded files. There are two separate optional features with filetype verification: **Verify MIME type** and **Allow/Block Selected Types**, and these are described below:

  1. **Verify MIME type**

     This option enables checking that the filetype of a file download agrees with the contents of the file (the term *filetype* here is also known as the *filename extension*).

     All filetypes that are checked in this way by CorePlus are listed in Appendix E, *Verified MIME filetypes*. When enabled, any file download that fails MIME verification, in other words its filetype does not match its contents, is dropped by CorePlus on the assumption that it can be a security threat.

  2. **Allow/Block Selected Types**

     This option operates independently of the MIME verification option described above but is based on the predefined filetypes listed in Appendix E, *Verified MIME filetypes*. When enabled, the feature operates in either a *Block Selected* or an *Allow Selected* mode. These two modes function as follows:

     i. Block Selected

     The filetypes marked in the list will be dropped as downloads. To make sure that this is not circumvented by renaming a file, CorePlus looks at the file's contents (in a way similar to MIME checking) to confirm the file is what it claims to be.

     If, for example, *.exe* files are blocked and a file with a filetype of *.jpg* (which is not blocked) is found to contain *.exe* data then it will be blocked. If blocking is selected but nothing in the list is marked, no blocking is done.

     ii. Allow Selected

     Only those filetypes marked will be allowed in downloads and other will be dropped. As with blocking, file contents are also examined to verify the file's contents. If, for example, *.jpg* files are allowed and a file with a filetype of *.jpg* is found to contain *.exe* data then the download will be dropped. If nothing is marked in this mode then no files can be downloaded.

     Additional filetypes not included by default can be added to the Allow/Block list however these cannot be subject to content checking meaning that the file extension will be trusted as being correct for the contents of the file.

     ### *Note*

     *The **Verify MIME type** and **Allow/Block Selected Types** options work in the same way for the FTP, POP3 and SMTP ALGs.*

- **Download File Size Limit** - A file size limit can additionally be specified for any single download (this option is available only for HTTP and SMTP ALG downloads).

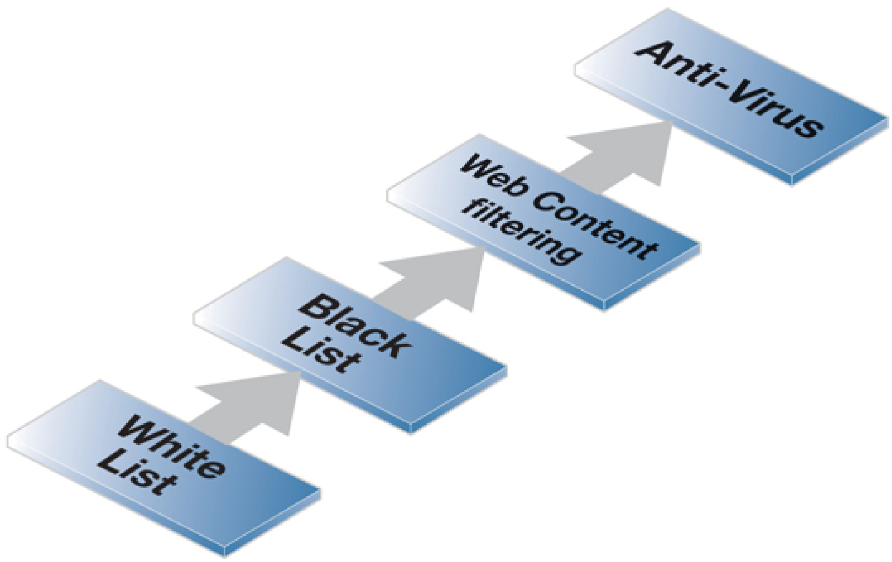
The Ordering for HTTP Filtering

HTTP filtering obeys the following processing order and is similar to the order followed by the SMTP ALG:

1. Whitelist.
2. Blacklist.
3. Web content filtering (if enabled).
4. Anti-virus scanning (if enabled).

As described above, if a URL is found on the whitelist then it will not be blocked if it also found on the blacklist. If it is enabled, Anti-virus scanning is always applied, even though a URL is whitelisted. If it is enabled, Web content filtering is still applied to whitelisted URLs but if instead of blocking, flagged URLs are only logged. If it is enabled, Anti-virus scanning is always applied, even though a URL is whitelisted.

Figure 6.2. HTTP ALG Processing Order



Using Wildcards in White and Blacklists

Entries made in the white and blacklists can make use of *wildcarding* to have a single entry cover a large number of potential URLs. The wildcard character "*" can be used to represent any sequence of characters.

For instance, the entry **.some_domain.com* will block all pages whose URLs end with *some_domain.com*.

If we want to now explicitly allow one particular page then this can be done with an entry in the whitelist of the form *my_page.my_company.com* and the blacklist won't prevent this page from being reachable since the whitelist has precedence.

Deploying an HTTP ALG

As mentioned in the introduction, the HTTP ALG object is brought into use by first associating it with a Service object and then associating that Service object with an IP rule in the IP rule set. A number of pre-defined HTTP Services could be used with the ALG. For example, the **http** service might be selected for this purpose. As long as the associated Service is associated with an IP rule then the ALG will be applied to traffic targeted by that IP rule.

The **https** Service (which is also included in the **http-all** Service) cannot be used with an HTTP ALG since HTTPS traffic is encrypted.

6.2.3. The FTP ALG

File Transfer Protocol (FTP) is a TCP/IP-based protocol for exchanging files between a client and a server. The client initiates the connection by connecting to the FTP server. Normally the client needs to authenticate itself by providing a predefined login and password. After granting access, the server will provide the client with a file/directory listing from which it can download/upload files (depending on access rights). The FTP ALG is used to manage FTP connections through the Clavister Security Gateway.

FTP Connections

FTP uses two communication channels, one for control commands and one for the actual files being transferred. When an FTP session is opened, the FTP client establishes a TCP connection (the control channel) to port 21 (by default) on the FTP server. What happens after this point depends on the FTP mode being used.

FTP Connection Modes

FTP operates in two modes: *active* and *passive*. These determine the role of the server when opening data channels between client and server.

- ***Active Mode***

  In active mode, the FTP client sends a command to the FTP server indicating what IP address and port the server should connect to. The FTP server establishes the data channel back to the FTP client using the received address information.

- ***Passive Mode***

  In passive mode, the data channel is opened by the FTP client to the FTP server, just like the command channel. This is the often recommended default mode for FTP clients though some advice may recommend the opposite.

A Discussion of FTP Security Issues

Both *active* and *passive* modes of FTP operation present problems for Clavister Security Gateways. Consider a scenario where an FTP client on the internal network connects through the security gateway to an FTP server on the Internet. The IP rule is then configured to allow network traffic from the FTP client to port 21 on the FTP server.

When active mode is used, CorePlus doesn't know that the FTP server will establish a new connection back to the FTP client. Therefore, the incoming connection for the data channel will be dropped. As the port number used for the data channel is dynamic, the only way to solve this is to allow traffic from all ports on the FTP server to all ports on the FTP client. Obviously, this is not a good solution.

When passive mode is used, the security gateway does not need to allow connections from the FTP server. On the other hand, CorePlus still does not know what port the FTP client will try to use for the data channel. This means that it has to allow traffic from all ports on the FTP client to all ports on the FTP server. Although this is not as insecure as in the active mode case, it still presents a potential security threat. Furthermore, not all FTP clients are capable of using passive mode.

The CorePlus ALG Solution

The CorePlus FTP ALG deals with these issues by fully reassembling the TCP stream of the FTP command channel and examining its contents. By doing this, the CorePlus knows what port to open for the data channel. Furthermore, the FTP ALG also provides functionality to filter out certain control commands and provide buffer overrun protection.

Hybrid Mode

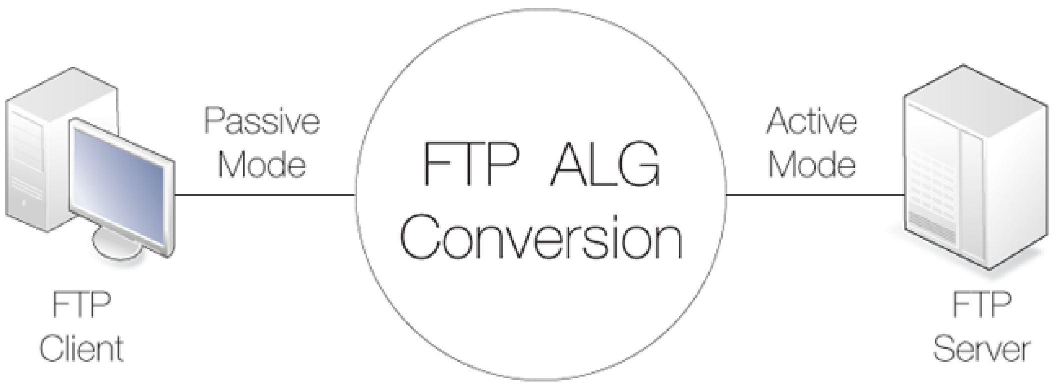
An important feature of the CorePlus FTP ALG is its automatic ability to perform on-the-fly conversion between active and passive mode so that FTP connection modes can be combined. Passive mode can be used on one side of the security gateway while active mode can be used on the other. This type of FTP ALG usage is sometimes referred to as *hybrid mode*.

The advantage of hybrid mode can be summarized as follows:

- The FTP client can be configured to use passive mode, which is the recommended mode for clients.
- The FTP server can be configured to use active mode, which is the safer mode for servers.
- When an FTP session is established, the Clavister Security Gateway will automatically and transparently receive the passive data channel from the FTP client and the active data channel from the server, and correctly tie them together.

This implementation results in both the FTP client and the FTP server working in their most secure mode. The conversion also works the other way around, that is, with the FTP client using active mode and the FTP server using passive mode. The illustration below shows the typical hybrid mode scenario.

Figure 6.3. FTP ALG Hybrid Mode



Note: Hybrid conversion is automatic

Hybrid mode does not need to enabled. The conversion between modes occurs automatically within the FTP ALG.

Connection Restriction Options

The FTP ALG has two options to restrict which type of mode the FTP client and the FTP server can use:

- **Allow the client to use active mode.**

  If this is enabled, FTP clients are allowed to use both passive and active transfer modes. With this option disabled, the client is limited to using passive mode. If the FTP server requires active mode, the CorePlus FTP ALG will handle the conversion automatically to active mode.

  A range of client data ports is specified with this option. The server will be allowed to connect to any of these if the client is using active mode. The default range is *1024-65535*.

- **Allow the server to use passive mode.**

  If this option is enabled, the FTP server is allowed to use both passive and active transfer modes. With the option disabled, the server will never receive passive mode data channels. CorePlus will handle the conversion automatically if clients use passive mode.

  A range of server data ports is specified with this option. The client will be allowed to connect to any of these if the server is using passive mode. The default range is *1024-65535*.

These options can determine if hybrid mode is required to complete the connection. For example, if the client connects with passive mode but this is not allowed to the server then hybrid mode is automatically used and the FTP ALG performs the conversion between the two modes.

Predefined FTP ALGs

CorePlus provides four predefined FTP ALG definitions, each with a different combination of the client/server mode restrictions described above.

- ***ftp-inbound*** - Clients can use any mode but servers cannot use passive mode.
- ***ftp-outbound*** - Clients cannot use active mode but servers can use any mode.
- ***ftp-passthrough*** - Both the client and the server can use any mode.
- ***ftp-internal*** - The client cannot use active mode and the server cannot use passive mode.

FTP ALG Command Restrictions

The FTP protocol consists of a set of standard commands that are sent between server and client. If the CorePlus FTP ALG sees a command it does not recognize then the command is blocked. This blocking must be explcitly lifted and the options for lifting blocking are:

- Allow unknown FTP commands. These are commands the ALG does not consider part of the standard set.
- Allow the *SITE EXEC* command to be sent to an FTP server by a client.
- Allow the *RESUME* command even if content scanning terminated the connection.

Note: Some commands are never allowed

Some commands, such as encryption instructions, are never allowed. Encryption would mean that the FTP command channel could not be examined by the ALG and the dynamic data channels could not be opened.

Control Channel Restrictions

The FTP ALG also allows restrictions to be placed on the FTP control channel which can improve the security of FTP connections. These are:

- **Maximum line length in control channel**

  Creating very large control channel commands can be used as a form of attack against a server by causing buffer overruns This restriction combats this threat. The default value is *256*

  If very long file or directory names on the server are used then this limit may need to be raised. The shorter the limit, the better the security.

- **Maximum number of commands per second**

  To prevent automated attacks against FTP server, restricting the frequency of commands can be useful. The default limit is *20* commands per second.

- **Allow 8-bit strings in control channel**

  The option determines if 8-bit characters are allowed in the control channel. Allowing 8-bit characters enables support for filenames containing international characters. For example, accented or umlauted characters.

Filetype Checking

The FTP ALG offers the same filetype verification for downloaded files that is found in the HTTP ALG. This consists of two separate options:

- **MIME Type Verification**

  When enabled, CorePlus checks that a download's stated filetype matches the file's contents. Mismatches result in the download being dropped.

- **Allow/Block Selected Types**

  If selected in blocking mode, specified filetypes are dropped when downloaded. If selected in allow mode, only the specified filetypes are allowed as downloads.

  CorePlus also performs a check to make sure the filetype matches the contents of the file. New filetypes can be added to the predefined list of types.

The above two options for filetype checking are the same as those available in the HTTP ALG and are more fully described in *Section 6.2.2, “The HTTP ALG”*.

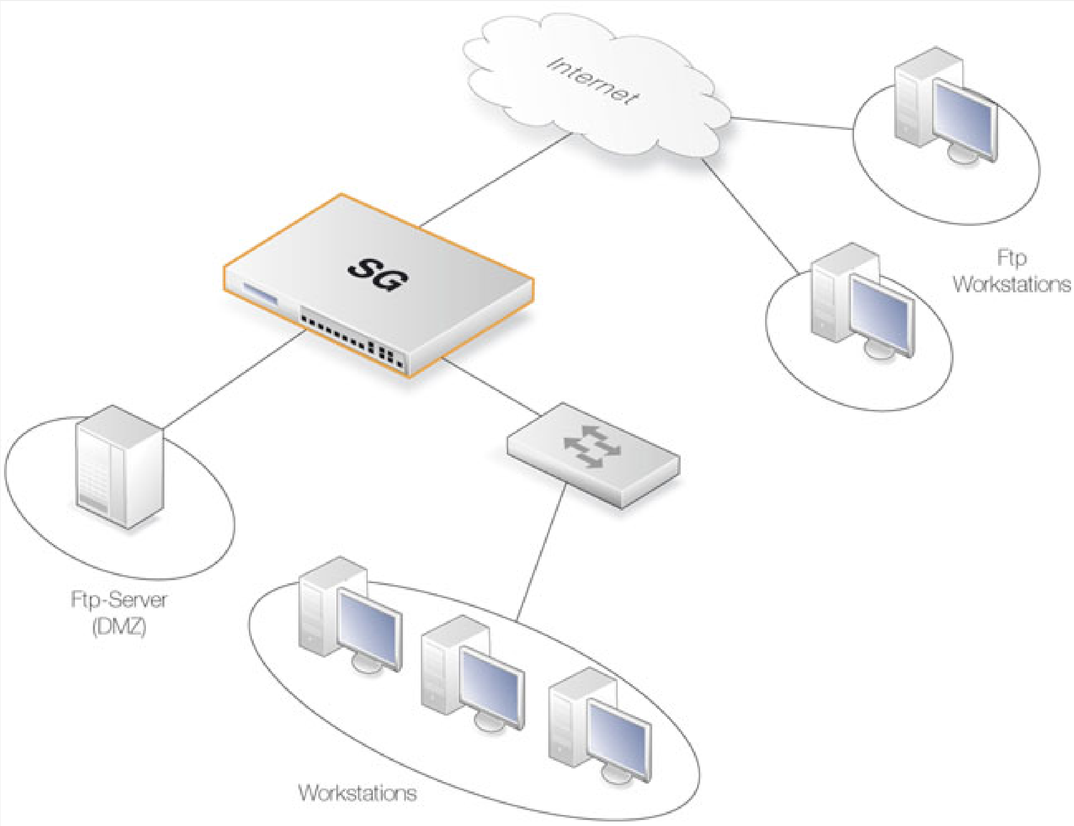
Anti-Virus Scanning

The CorePlus Anti-Virus subsystem can be enabled to scan all FTP downloads searching for malicious code. Suspect files can be de dropped or just logged.

This feature is common to a number of ALGs and is described fully in *Section 6.4, “Anti-Virus Scanning”*.

Example 6.2. Protecting an FTP Server with an ALG

As shown, an FTP Server is connected to the Clavister Security Gateway on a DMZ with private IP addresses, shown below:



To make it possible to connect to this server from the Internet using the FTP ALG, the FTP ALG and rules should be configured as follows:

Clavister FineTune

A. Define the ALG:

1. Go to **Local Objects > Application Layer Gateway > New Application Gateway Layer**
2. Specify a name for the ALG, for example *ftp-inbound*
3. Choose *ftp* as the **Type**
4. Click **Parameters**
5. Check **Allow client to use active mode**
6. Uncheck **Allow server to use passive mode**
7. Click **OK** in both dialogs

B. Define the Service:

1. Go to **Local Objects > Services > New Service**
2. The **Service Properties** dialog will be displayed.
3. Specify a name for the service, for example *ftp-inbound*
4. Choose *TCP* as the **Type**
5. Choose *ftp-inbound* as the **ALG**
6. For **TCP/UDP Service** enter 21 as **Destination Port**
7. Click **OK**

C. Define a rule to allow connections to the public IP on port 21 and forward that to the internal FTP server:

1. Go to **Rules > New Rule**

2. The **Rule Properties** dialog will be displayed
3. Now enter:
   - **Name:** SAT-ftp-inbound
   - **Action:** SAT
   - **Source Interface:** any
   - **Destination Interface:** core
   - **Source Network:** 0.0.0.0/0 (all-nets)
   - **Destination Network:** wan (assuming the external interface has been defined as this)
4. Under the **Service** tab, choose *ftp-inbound* in the **Pre-defined** control
5. Under the **Address Translation** tab, choose *Destination IP Address* and select *ftp-inbound* in the **New IP Address** control (assume this internal IP address for FTP server has been defined in the Address Book object)
6. Click **OK**

D.Traffic from the internal interface needs to be NATed:

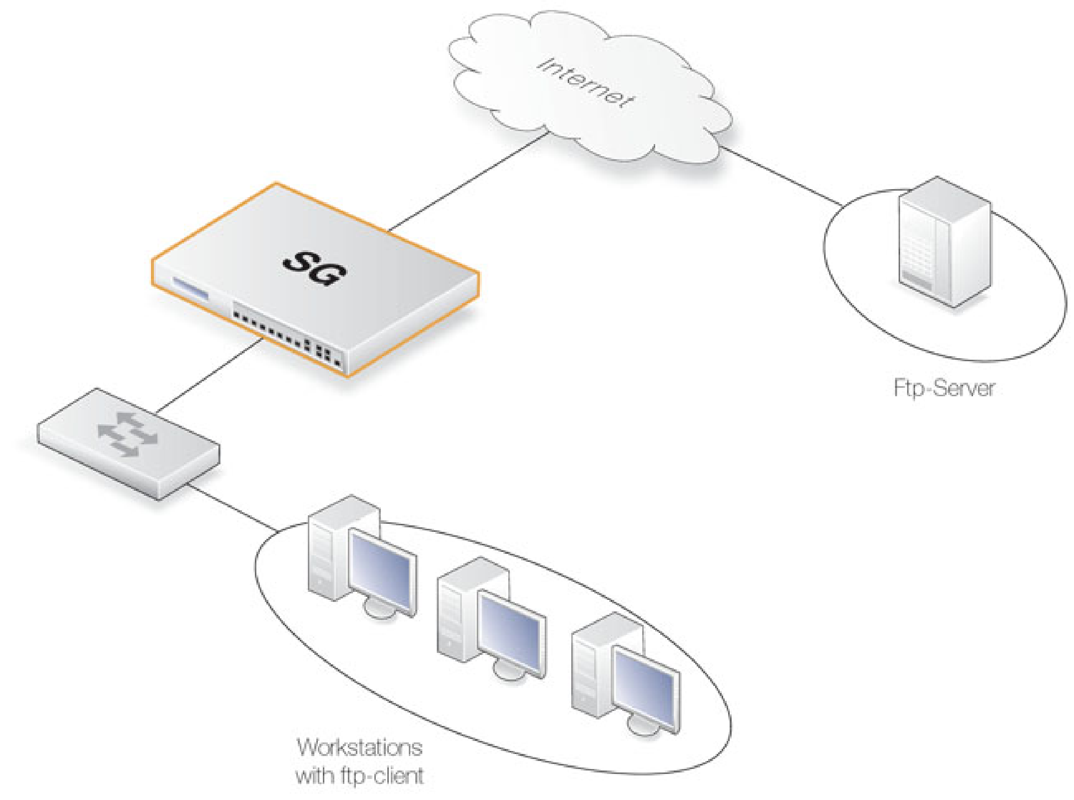
1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Now enter:
   - **Name:** NAT-ftp
   - **Action:** NAT
   - **Source Interface:** dmz
   - **Destination Interface:** core
   - **Source Network:** dmznet
   - **Destination Network:** ip_wan
4. Under the **Service** tab, choose *ftp-inbound* in the **Pre-defined** control
5. Under the **Address Translation** tab, choose *Use Interface Address* as action
6. Click **OK**

E. Allow incoming connections (SAT needs a second Allow rule):

1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Now enter:
   - **Name:** Allow-ftp
   - **Action:** Allow
   - **Source Interface:** any
   - **Destination Interface:** core
   - **Source Network:** all-nets
   - **Destination Network:** ip_wan
4. Under the **Service** tab, choose *ftp-inbound* in the **Pre-defined** control
5. Click **OK**

Example 6.3. Protecting FTP Clients

In this scenario shown below the Clavister Security Gateway is protecting a workstation that will connect to FTP servers on the Internet.



To make it possible to connect to these servers from the internal network using the FTP ALG, the FTP ALG and rules should be configured as follows:

Clavister FineTune

A. Create the FTP ALG:

1. Go to **Local Objects > Application Layer Gateway > New Application Gateway Layer**
2. The **Application Gateway Layer Properties** dialog will be displayed
3. Specify a suitable name for the object, for example *ftp-outbound*
4. Choose *ftp* as the **Type**
5. Click the **Parameters...** button
6. Uncheck **Allow client to use active mode**
7. Check **Allow server to use passive mode**
8. Click **OK** in both dialogs

B. Create the Service:

1. Go to **Local Objects > Services > New Service**
2. The **Service Properties** dialog will be displayed
3. Specify a suitable name for the service, for example *ftp-outbound*
4. Choose *TCP* as the **Type**
5. Choose *ftp-outbound* as the **ALG**

6. Under **TCP/UDP Service**, enter 21 as **Destination Port**
7. Click **OK**

Rules (Using Public IPs). The following rule needs to be added to the IP rules if using public IP's; make sure there are no rules disallowing or allowing the same kind of ports/traffic before these rules. The service in use is the *ftp-outbound*, which should be using the ALG definition *ftp-outbound* as described earlier.

C. Allow connections to FTP-servers on the outside:

1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Enter following:
   - **Name:** Allow-ftp-outbound
   - **Action:** Allow
   - **Source Interface:** lan
   - **Destination Interface:** wan
   - **Source Network:** lannet
   - **Destination Network:** all-nets
4. Under the **Service** tab, choose *ftp-outbound* as **Pre-defined**
5. Click **OK**

D. Rules (Using Private IPs). If the gateway is using private IP's, the following NAT rule needs to be added instead:

1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Enter following:
   - **Name:** NAT-ftp-outbound
   - **Action:** NAT
   - **Source Interface:** lan
   - **Destination Interface:** wan
   - **Source Network:** lannet
   - **Destination Network:** all-nets
4. Under the **Service** tab, choose *ftp-outbound* for **Pre-defined**
5. Under the **Address Translation** tab, choose *Use Interface Address* as the action
6. Click **OK**

Setting Up FTP Servers with Passive Mode

An important point about FTP server setup needs to be made if the FTP ALG is being used along with passive mode.

Usually, the FTP server will be protected behind the Clavister Security Gateway and CorePlus will *SAT-Allow* connections to it from external clients that are connecting across the public Internet. If FTP *Passive* mode is allowed and a client connects with this mode then the FTP server must return an IP address and port to the client on which it can set up the data transfer connection.

This IP address is normally manually specified by the administrator in the FTP server software and the natural choice is to specify the external IP address of the interface on the security gateway that connects to the Internet. This is, however, wrong if the FTP ALG is being used.

Instead, the local, internal IP address of the FTP server should be specified when setting up the FTP server.

6.2.4. The TFTP ALG

Trivial File Transfer Protocol (TFTP) is a much simpler version of FTP with more limited capabilities. Its purpose is to allow a client to upload files to or download files from a host system. TFTP data transport is based on the UDP protocol and therefore it supplies its own transport and session control protocols which are layered onto UDP.

TFTP is widely used in enterprise environments for updating software and backing up configurations on network devices. TFTP is recognised as being an inherently insecure protocol and its usage is often confined to internal networks. The CorePlus ALG provides an extra layer of security to TFTP in being able to put restrictions on its use.

General TFTP Options

Allow/Disallow Read The TFTP **GET** function can be disabled so that files cannot be retrieved by a TFTP client. The default value is *Allow*.

Allow/Disallow Write The TFTP **PUT** function can be disabled so that files cannot be written by a TFTP client. The default value is *Allow*.

Remove Request Option Specifies if options should be removed from request. The default is *False* which means "don't remove".

Block Unknown Options This option allows the blocking of any option in a request other than the blocksize, the timeout period and the file transfer size. The default is *False* which means "don't block".

TFTP Request Options

As long as the **Remove Request Option** described above is set to *false* (options aren't removed) then the following request option settings can be applied:

Maximum Blocksize The maximum blocksize allowed can be specified. The allowed range is 0 to 65464 bytes. The default value is 65464 bytes.

Maximum File Size The maximum size of a file transfer can be restricted. By default this is the absolute maximum allowed which 999,999 Kbytes.

Allow Directory Traversal This option can disallow directory traversal through the use of filenames containing consecutive periods ("..").

Allowing Request Timeouts

The CorePlus TFTP ALG blocks the repetition of an TFTP request coming from the same source IP address and port within a fixed period of time. The reason for this is that some TFTP clients might issue requests from the same source port without allowing an appropriate timeout period.

6.2.5. The SMTP ALG

Simple Mail Transfer Protocol (SMTP) is a text based protocol used for transferring email between mail servers over the Internet. Typically the local SMTP server will be located on a DMZ so that mail sent by remote SMTP servers will traverse the Clavister Security Gateway to reach the local server (this setup is illustrated later in Section 6.2.5.1, “DNSBL SPAM Filtering”). Local users will then use email client software to retrieve their email from the local SMTP server.

SMTP is also used when clients are sending email and the SMTP ALG can be used to monitor SMTP traffic originating from both clients and servers.

SMTP ALG Options

Key features of the SMTP ALG are:

Email Rate Limiting
: A maximum allowable rate of email messages can be specified. This rate is calculated on a *per source IP address* basis, in other words it is not the total rate that is of interest but the rate from a certain email source.

  This is a very useful feature to have since it is possible to put in a block against either an infected client or an infected server sending large amounts of malware generated emails.

Email address blacklisting
: A blacklist of sender or recipient email addresses can be specified so that mail from/to those addresses is blocked. The blacklist is applied after the whitelist so that if an address matches a whitelist entry it is not then checked against the blacklist.

Email address whitelisting
: A whitelist of email addresses can be specified so that any mail from/to those addresses is allowed to pass through the ALG regardless if the address is on the blacklist or that the mail has been flagged as SPAM.

Verify MIME type
: The content of an attached file can be checked to see if it agrees with its stated filetype. A list of all filetypes that are verified in this way can be found in Appendix E, *Verified MIME filetypes*. This same option is also available in the HTTP ALG and a fuller description of how it works can be found in Section 6.2.2, “The HTTP ALG”.

Block/Allow filetype
: Filetypes from a predefined list can optionally be blocked or allowed as mail attachments and new filetypes can be added to the list. This same option is also available in the HTTP ALG and a fuller description of how it works can be found in Section 6.2.2, “The HTTP ALG”. This same option is also available in the HTTP ALG and a fuller description of how it works can be found in Section 6.2.2, “The HTTP ALG”.

Anti-Virus Scanning
: The CorePlus Anti-Virus subsystem can scan email attachments searching for malicious code. Suspect files can be dropped or just logged. This feature is common to a number of ALGs and is described fully in Section 6.4, “Anti-Virus Scanning”.

The Ordering for SMTP Filtering

SMTP filtering obeys the following processing order and is similar to the order followed by the HTTP ALG except for the addition of SPAM filtering:

1. Whitelist.
2. Blacklist.
3. SPAM filtering (if enabled).
4. Anti-virus scanning (if enabled).

As described above, if an address is found on the whitelist then it will not be blocked if it also found on the blacklist. SPAM filtering, if it is enabled, is still applied to whitelisted addresses but emails flagged as SPAM will not be tagged nor dropped, only logged. Anti-virus scanning, if it is enabled, is always applied, even though an email's address is whitelisted.

Notice that either an email's sender or receiver address can be the basis for blocking by one of the first two filtering stages.

Figure 6.4. SMTP ALG Processing Order

Using Wildcards in White and Blacklists

Entries made in the white and blacklists can make use of *wildcarding* to have a single entry cover a large number of potential email addresses. The wildcard character "*" can be used to represent any sequence of characters.

For instance, the address entry **@some_domain.com* can be used to specify all possible email addresses for *some_domain.com*.

If, for example, wildcarding is used in the blacklist to block all addresses for a certain company called *my_company* then the blacklist address entry required could be **@my_company.com*.

If we want to now explicitly allow mails for just one department called *my_department* in *my_company* then this could be done with an entry in the whitelist of the form *my_department@my_company.com*.

Enhanced SMTP and Extensions

Enhanced SMTP (ESMTP) is defined in RFC 1869 and allows a number *extensions* to the standard SMTP protocol.

When an SMTP client opens a session with an SMTP server using ESMTP, the client first sends an *EHLO* command. If the server supports ESMTP it will respond with a list of the extensions that it supports. These extensions are defined by various separate RFCs. For example, RFC 2920 defines the SMTP *Pipelining* extension. Another common extension is *Chunking* which is defined in RFC 3030.

The CorePlus SMTP ALG does not support all ESMTP extensions including *Pipelining* and *Chunking*. The ALG therefore removes any unsupported extensions from the supported extension list that is returned to the client by an SMTP server behind the Clavister Security Gateway. When an extension is removed, a log message is generated with the text:

```
unsupported_extension
capability_removed
```

The parameter "*capa=*" in the log message indicates which extension the ALG removed from the server response. For example, this parameter may appear in the log message as:

```
capa=PIPELINING
```

To indicate that the *pipelining* extension was removed from the SMTP server reply to an *EHLO* client command.

Although ESMTP extensions may be removed by the ALG and related log messages generated, **this does not mean that any emails are dropped**. Email transfers will take place as usual but without making use of unsupported extensions removed by the ALG.

6.2.5.1. DNSBL SPAM Filtering

Unsolicited email, often referred to as *SPAM*, has become both a major annoyance as well as a security issue on the public Internet. Unsolicited email, sent out in massive quantities by groups known as *spammers*, can waste resources, transport malware as well as try to direct the reader to webpages which might exploit browser vulnerabilities.

Integral to the CorePlus SMTP ALG is a SPAM module that provides the ability to apply *spam filtering* to incoming email based on its origin. This can significantly reduce the burden of such email in the mailboxes of users behind the Clavister Security Gateway. CorePlus offers two approaches to handling SPAM:

- Dropping email which has a very high probability of being SPAM.
- Letting through but flagging email that has a moderate probability of being SPAM.

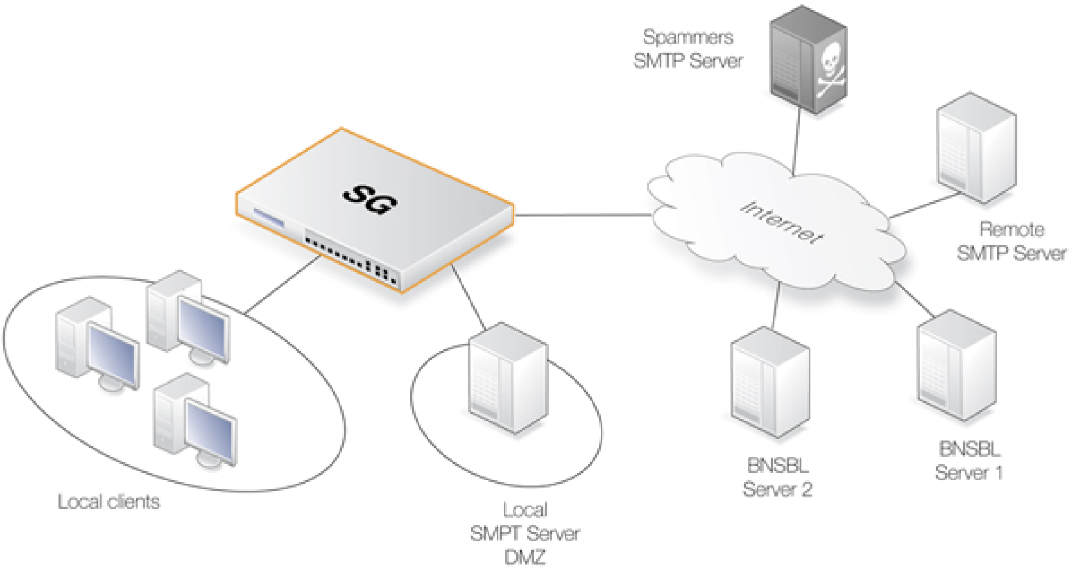
The CorePlus Implementation

SMTP functions as a protocol for sending emails between servers. CorePlus applies SPAM filtering to emails as they pass through the Clavister Security Gateway from a remote SMTP server to the local SMTP server (from which local clients will later download the emails). Typically the local SMTP server will be set up on a DMZ and there will usually be only one "hop" between the sending server and the local, receiving server.

A number of trusted organisations maintain publicly available databases of the origin IP address of known spamming SMTP servers and these can be queried over the public Internet. These lists are known as *DNS Black List* (DNSBL) databases and the information is accessible using a standardized query method supported by CorePlus. The image below illustrates all the components involved:

When the CorePlus SPAM filtering function is configured, the IP address of the email's sending server can be sent to one or more DNSBL servers to find out if any DNSBL servers think it is from a spammer or not (CorePlus examines the IP packet headers to do this). The reply sent back by a server is either a *not listed* response or a *listed* response. In the latter case of being listed, the DSNBL server is indicating the email might be SPAM and it will usually also provide information known as a *TXT* record which is a textual explanation for the listing.

Figure 6.5. DNSBL SPAM Filtering



The administrator can configure the CorePlus SMTP ALG to consult multiple DNSBL servers in order to form a consensus opinion on an email's origin address. As each new email arrives, servers are queried to assess the likelihood that the email is SPAM, based on its origin address. The CorePlus administrator assigns a weight greater than zero to each configured server so that a weighted sum can then be calculated based on all responses. The administrator can configure one of the following actions based on the sum calculated:

1. **Dropped**
   If the sum is greater than or equal to a pre-defined *Drop threshold* then the email is considered to be definitely SPAM and is discarded or alternatively sent to a single, special mailbox.

   If it is discarded then the administrator has the option that an error message is sent back to the sending SMTP server (this error message is similar to the one used with blacklisting).

2. **Flagged as SPAM**
   If the sum is greater than or equal to a pre-defined *SPAM threshold* then the email is considered as probably being SPAM but forwarded to the recipient with notifying text inserted into it.

A Threshold Calculation Example

As an example, lets suppose that three DNSBL servers are configured: *dnsbl1*, *dnsbl2* and *dnsbl3*. Weights of **3**, **2** and **2** are assigned to these respectively. The SPAM threshold is then set to be **5**.

If *dnsbl1* and *dnsbl2* say an email is SPAM but *dnsbl3* does not, then the total calculated will be **3+2+0=5**. Since the total of **5** is equal to (or greater than) the threshold then the email will be treated as SPAM.

If the *Drop threshold* in this example is set at **7** then all three DNSBL servers would have to respond in order for the calculated sum to cause the email to be dropped (**3+2+2=7**).

Alternative Actions for Dropped SPAM

If the calculated sum is greater than or equal to the *Drop threshold* value then the email is not forwarded to the intended recipient. Instead the administrator can choose one of two alternatives for dropped email:

- A special email address can be configured to receive all dropped email. If this is done then any *TXT* messages sent by the DNSBL servers (described next) that identified the email as SPAM can be optionally inserted by CorePlus into the header of the forwarded email.
- If no receiver email address is configured for dropped emails then they are discarded by CorePlus. The administrator can specify that an error message is sent back to the sender address along with the *TXT* messages from the DNSBL servers that failed the email.

Tagging SPAM

If an email is considered to be probably SPAM because the calculated sum is above the SPAM threshold but it is below the Drop threshold, then the *Subject* field of the email is changed and pre-fixed with a message and the email is forwarded on to the intended recipient. The tag message text is specified by the administrator but can be left blank (although that is not recommended).

An example of tagging might be if the original *Subject* field is:

```
Buy this stock today!
```

And if the tag text is defined to be "***** SPAM *****", then the modified email's *Subject* field will become:

```
*** SPAM *** Buy this stock today!
```

And this is what the email's recipient will see in the summary of their inbox contents. The individual user could then decide to set up their own filters in the local client to deal with such tagged emails, possibly sending it to a separate folder.

Adding X-SPAM Information

If an email is determined to be SPAM and a forwarding address is configured for dropped emails, then the administrator has the option to *Add TXT Records* to the email. A *TXT Record* is the information sent back from the DNSBL server when the server thinks the sender is a source of SPAM. This information can be inserted into the header of the email using the *X-SPAM* tagging convention before it is sent on. The X-SPAM fields added are:

- **X-Spam-Flag** - This value will always be *Yes*.
- **X-Spam-Checker-Version** - The CorePlus version that tagged the email.
- **X-Spam-Status** - This will always be *DNSBL*.
- **X-Spam-Report** - A list of DNSBL servers that flagged the email as SPAM.
- **X-Spam-TXT-Records** - A list of TXT records sent by the DNSBL servers that identified the email as SPAM.
- **X-Spam_Sender-IP** - IP address used by the email sender.

These fields can be referred to in filtering rules set up by the administrator in mail server software.

Allowing for Failed DNSBL Servers

If a query to a DNSBL server times out then CorePlus will consider that the query has failed and the weight given to that server will be automatically subtracted from both the SPAM and Drop thresholds for the scoring calculation done for that email.

If enough DNSBL servers don't respond then this subtraction could mean that the threshold values become negative. Since the scoring calculation will always produce a value of zero or greater (servers can't have negative weights) then all email will be allowed through if both the SPAM and Drop thresholds become negative.

A log message is generated whenever a configured DNSBL server does not respond within the required time. This is done only once at the beginning of a consecutive sequence of response failures from a single server to avoid unnecessarily repeating the message.

Verifying the Sender Email

As part of the Anti-SPAM module, the option to verify the email sender denies emails with a mismatch of the SMTP "From" address and the header "From" address. In other words, the source address in the SMTP protocol header and the SMTP data load header must be the same. Spamming can cause these to be different so this feature provides an extra check on email integrity.

Logging

There are three types of logging done by the SPAM filtering module:

- Logging of dropped or SPAM tagged emails - These log messages include the source email address and IP as well as its weighted points score and which DNSBLs caused the event.
- DNSBLs not responding - DNSBL query timeouts are logged.
- All defined DNBSLs stop responding - This is a high severity event since all email will be allowed through if this happens.

Setup Summary

To set up DNSBL SPAM filtering in the SMTP ALG, the following list summarizes the steps:

- Specify which DNSBL servers are to be used. There can be multiple and they can act both as backups to each other as well as confirmation of a sender's status.
- Specify a *weight* for each server which will determine how important it is in deciding if email is SPAM or not in the calculation of a weighted sum.
- Specify the threshold for designating an email as SPAM. If the weighted sum is equal or greater than this then an email will be considered to be SPAM.
- Specify a textual tag to prefix to the **Subject** field of email designated as SPAM.
- Specify the *Drop threshold*. If the weighted sum is equal or greater than this then an email will be dropped entirely. This threshold should be greater or equal to the SPAM threshold. If they are equal then the Drop threshold will have precedence so that all email will be dropped when that threshold is reached.
- Optionally specify an email address to which dropped email will be sent (as an alternative to simply discarding it). Optionally specify that the *TXT* messages sent by the DNSBL servers that failed are inserted into the header of these emails.

Caching Addresses for Performance

To speed processing CorePlus maintains a cache of the most recently looked-up sender addresses in local memory. If the cache becomes full then the oldest entry is written over first.

The *Address Timeout* value for the cache can be changed by the administrator. This determines how long any address will be valid for once it is saved in the cache. After this period of time has expired, a new query for a cached sender address must be sent to the DNSBL servers.

The cache is emptied at startup or reconfiguration and its size of this cache can be controlled by the administrator.

Real-time Monitoring

The following values for SPAM filtering are available through CorePlus Real-time Monitoring (and therefore also through the Clavister PinPoint™ product).

For the DNSBL subsystem overall:

- Number of emails checked.
- Number of emails SPAM tagged.
- Number of dropped emails.

For each DNSBL server accessed:

- Number of positive (is SPAM) responses from each configured DNSBL server.
- Number of queries sent to each configured DNSBL server.
- Number of failed queries (without replies) for each configured DNSBL server.

The *dnsbl* CLI Command

The **dnsbl** CLI command provides a means to control and monitor the operation of the SPAM filtering module. The **dnsbl** command on its own without options shows the overall status of all ALGs. If the name of the SMTP ALG object on which DNSBL SPAM filtering is enabled is *my_smtp_alg* then the output would be:

```
Cmd> dnsbl

DNSBL Contexts:

Name                      Status      Spam     Drop    Accept
------------------------  -------- -------- -------- --------
my_smtp_alg                 active      156       65    34299
alt_smtp_alg              inactive        0        0        0
```

The *-show* option provides a summary of the SPAM filtering operation of a specific ALG. It is used below to examine activity for *my_smtp_alg* although in this case, the ALG object has not yet processed any emails.

```
Cmd> dnsbl my_smtp_alg -show

Drop Threshold        : 20
Spam Threshold        : 10
Use TXT records       : yes
IP Cache disabled
Configured BlackLists : 4
Disabled BlackLists   : 0
Current Sessions      : 0
Statistics:
Total number of mails checked : 0
```

```
Number of mails dropped       : 0
Number of mails spam tagged   : 0
Number of mails accepted      : 0
BlackList                 Status   Value Total    Matches  Failed
------------------------- -------- ----- -------- -------- --------
zen.spamhaus.org          active      25        0        0        0
cbl.abuseat.org           active      20        0        0        0
dnsbl.sorbs.net           active       5        0        0        0
asdf.egrhb.net            active       5        0        0        0
```

To examine the statistics for a particular DNSBL server, the following command can be used.

```
Cmd> dnsbl smtp_test zen.spamhaus.org -show

BlackList: zen.spamhaus.org
Status       : active
Weight value : 25
Number of mails checked                     : 56
Number of matches in list                   : 3
Number of failed checks (times disabled)    : 0
```

To clean out the **dnsbl** cache for *my_smtp_alg* and to reset all its statistical counters, the following command option can be used:

```
Cmd> dnsbl my_smtp_alg -clean
```

Note
A list of DNSBL servers can be found at http://en.wikipedia.org/wiki/Comparison_of_DNS_blacklists.

6.2.6. The POP3 ALG

POP3 is a mail transfer protocol that differs from SMTP in that the transfer of mail is directly from a server to a user's client software.

POP3 ALG Options

Key features of the POP3 ALG are:

Block Clear Text Authentication
Block connections between client and server that send the username/password combination as clear text which can be easily read (some servers may not support other methods than this).

Hide User
This option prevents the POP3 server from revealing that a username does not exist. This prevents users from trying different usernames until they find a valid one.

Allow Unknown Commands
Non-standard POP3 commands not recognised by the ALG can be allowed or disallowed.

Fail Mode
When content scanning find bad file integrity then the file can be allowed or disallowed.

Verify MIME type
The content of an attached file can be checked to see if it agrees with its stated filetype. A list of all filetypes that are verified in this way can be found in Appendix E, *Verified MIME filetypes*. This same option is also available in the

HTTP ALG and a fuller description of how it works can be found in Section 6.2.2, “The HTTP ALG”.

Block/Allow filetype Filetypes from a predefined list can optionally be blocked or allowed as mail attachments and new filetypes can be added to the list. This same option is also available in the HTTP ALG and a fuller description of how it works can be found in Section 6.2.2, “The HTTP ALG”.

Anti-Virus Scanning The CorePlus Anti-Virus subsystem can optionally scan email attachments searching for malicious code. Suspect files can be dropped or just logged. This feature is common to a number of ALGs and is described fully in Section 6.4, “Anti-Virus Scanning”.

6.2.7. The SIP ALG

Session Initiation Protocol (SIP) is an ASCII (UTF-8) text based signalling protocol used to establish sessions between peers in an IP network. It is a request-response protocol that resembles HTTP and SMTP. A session might consist of a Voice-Over-IP (VoIP) telephone call or it could be a collaborative multi-media conference. Using SIP with VoIP means that telephony can become another IP application which can integrate into other services.

SIP does not know about the details of a session's content and is only responsible for initiating, terminating and modifying sessions. Sessions set up by SIP are typically used for the streaming of audio and video over the Internet using the UDP protocol but they might also involve traffic based on the TCP protocol. Although UDP based VoIP sessions are a common use, communication using other protocols such as TCP or TLS might be involved in a session.

SIP is defined by the IETF standard RFC 3261 and is becoming popular as the standard for VoIP. It is comparable to H.323 but a design goal with SIP is to make it more scalable that H.323. (For VoIP see also Section 6.2.8, “The H.323 ALG”.)

Note: Traffic shaping will not work with the SIP ALG

Any traffic connections that trigger an IP rule with a service object that uses the SIP ALG cannot be also subject to traffic shaping.

SIP Components

The following components are the logical building blocks for SIP communication:

User Agents These are the end points or "peers" that are involved in the peer-to-peer communication. These would typically be the workstation or device used in an IP telephony conversation. The word *peer* will often be used in this section in this context.

Proxy Servers These act as routers in the SIP protocol, performing both as peer and server when receiving peer requests. They forward requests to a peer's current location as well as authenticating and authorizing access to services. They also implement provider call-routing policies.

The proxy is typically located on the unprotected side of the Clavister Security Gateway and this is the proxy location supported by the CorePlus SIP ALG.

Registrars A server that handles SIP REGISTER requests is given the special name of Registrar. The Registrar server has the task of locating the host where the other peer is reachable.

The Registrar and Proxy Server are logical entities and my in fact reside in the same physical server.

SIP Media-related Protocols

SIP sessions make use of a number of sub-protocols:

SDP *Session Description Protocol* (RFC4566) is used for media session initialization.

RTP *Real-time Transport Protocol* (RFC3550) is used as the underlying packet format for delivering audio and video streaming via IP using the UDP protocol.

RTCP *Real-time Control Protocol* (RFC3550) is used in conjunction with RTP to provide out-of-band control flow management.

SIP Usage Scenarios

The CorePlus SIP ALG supports the following usage scenarios:

1. Internal to External The SIP session is between a peer on the protected side of a Clavister Security Gateway and a peer which is on the external, unprotected side. Communication typically takes place across the public Internet.

2. Same Network A refinement of the internal to internal scenario is the case where the two peers in a session reside on the same network.

In all these scenarios, the proxy server is assumed to be on the unprotected side of the Clavister Security Gateway.

SIP Configuration Options

The following options can be configured for a SIP ALG object:

Maximum Sessions per ID The number of simultaneous sessions that a single peer can be involved with is restricted by this value. The default number is *5*.

Maximum Registration Time The maximum time for registration with a SIP Registrar. The default value is *3600* seconds.

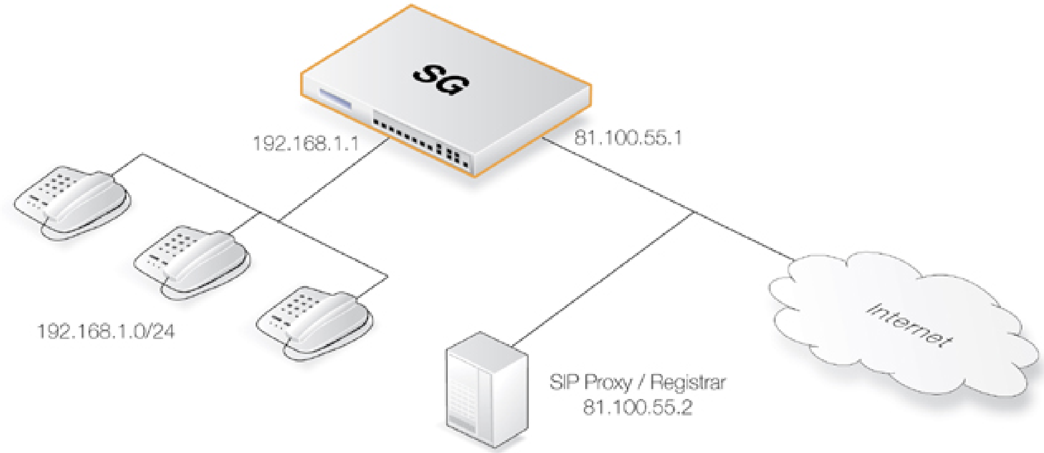
SIP Request-Response Timeout The maximum time allowed for responses to SIP requests. A timeout condition occurs after this wait. The default is *180 seconds*.

SIP Signal Timeout The maximum time allowed for SIP sessions. The default value is *43200 seconds*.

Data Channel Timeout The maximum time allowed for periods with no traffic in a SIP session. A timeout condition occurs if this value is exceeded. The default value is *120 seconds*

SIP Setup Summary

For setup we will assume a scenario where there is an office with VoIP users on a private internal network and the network's topology will be hidden using NAT. This scenario is illustrated below.



The SIP proxy in the above diagram could alternatively be located remotely across the Internet. The SIP proxy server should be configured with the feature **Record-Route Enabled** to insure all SIP traffic to and from the office peers will be sent through the SIP Proxy. This is recommended since the attack surface is minimimized by allowing only SIP signalling from the SIP Proxy to enter the local network. The steps to follow are:

> ***Note***
> *SIP User Agents and SIP Proxies should not be configured to employ NAT Traversal in a setup. For instance the Simple Traversal of UDP through NATs (STUN) technique should not be used. The CorePlus SIP ALG will take care of all traversal issues with NAT in a SIP setup.*

1. Define a *SIP ALG* object using the options described above.

2. A *Service* object is used for the ALG which has the above SIP ALG associated with it. The Service should have:

    - **Destination Port** set to *5060*.

    - **Type** set to *UDP*.

3. Define two rules in the IP rule set:

    - A **NAT** rule for outbound traffic from user agents on the internal network to the SIP Proxy Server located externally. The SIP ALG will take care of all address translation needed by the NAT rule. This translation will occur both on the IP level and the application level. Neither the user agents or the proxies need to be aware that the local users are being NATed.

    - An **Allow** rule for inbound SIP traffic from the SIP proxy to the IP of the Clavister Security Gateway. This rule will use **core** (in other words CorePlus itself) as the destination interface. The reason for this is due to the NAT rule above. When an incoming call is received, CorePlus will automatically locate the local receiver, perform address translation and forward SIP messages to the receiver. This will be executed based on the ALGs internal state.

    A **SAT** rule for translating incoming SIP messages is not needed since the ALG will automatically redirect incoming SIP requests to the correct internal user. When a SIP user agent behind a NATing Clavister Security Gateway registers with an external SIP proxy, CorePlus sends its own IP address as contact information to the SIP proxy. CorePlus registers the user-agent's local contact information and uses this to redirect incoming requests to the user. The ALG takes care of the address translations needed.

4. Ensure the peers are correctly configured. The SIP Proxy Server plays a key role in locating the current location of the other peer for the session. The proxy's IP address is not specified

directly in the ALG. Instead its location is either entered directly into the client software used by the peer or in some cases the peer will have a way of retrieving the proxy's IP address automatically such as through DHCP.

Handling Data Traffic

The setup steps above take care of the SIP communication for establishing peer-to-peer communications. The two IP rules are always needed so that peers can access the SIP proxy but no rules are needed to handle the actual data traffic involved in, for example, a VoIP call. The SIP ALG automatically takes care of establishing the CorePlus objects required for allowing the data traffic to traverse the Clavister Security Gateway and these are invisible to the administrator.

Tip

Make sure there are no preceding rules already in the IP rule set disallowing or allowing the same kind of traffic.

Depending on the SIP environment, the CorePlus SIP ALG can operate in hidden-topology environments with private IP addresses, as well as open environments with public IP addresses. SIP is a highly configurable protocol and the following describes the configuration required.

SIP and Virtual Routing

SIP is a complex protocol that requires that CorePlus maintains state information regarding active calls and registered users. The scope of the SIP state is uniquely defined by the SIP-service and its connected SIP-ALG. If multiple SIP domains are running concurrently but using different Policy-based Routing Tables then one SIP-ALG and one SIP-service object should be created for each table. Policy-based Routing Tables are described in detail in Section 4.4, “Virtual Routing”.

Example 6.4. External SIP Proxy with Hidden Clients

This example show how to implement the scenario described above.

The peer is assumed to be on the network *if1_net* connected to the interface *if1*. The SIP proxy is assumed to be on the IP address *proxy_ip* on the interface *ext*.

Clavister FineTune

A. Define the following IP objects:

- **if1_net:** 192.168.1.0/24
  (the internal network)
- **proxy_ip:** 81.100.55.2
  (the SIP proxy)
- **ip_wan:** 81.100.55.1
  (the Clavister Security Gateway's public IP address)

B. Define an SIP ALG object

1. Go to **Application Layer Gateways > New Application Layer Gateway**
2. The **Application Layer Gateway Properties** dialog will be displayed
3. Specify a name for the ALG eg. *sip_alg*
4. Choose *SIP* as the **Type**
5. Click **OK**

C. Define a custom *Service* object for SIP:

1. Go to **Local Objects > Services > New Service**
2. The **Service Properties** dialog will be displayed
3. Specify a name for the service, for example *sip_serv*
4. Choose *UDP* as the **Type**
5. Choose *sip-alg* as the **ALG**
6. Under **TCP/UDP Parameters** select **Destination Port** and enter *5060*
7. Click **OK**

D. Define the outgoing SIP traffic IP rule:

1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Now enter:
   - **Name:** sip_nat
   - **Action:** NAT
   - **Source Interface:** if1
   - **Source Network:** if1_net
   - **Destination Interface:** ext
   - **Destination Network:** proxy_ip
   - **Comment:** Allow outgoing SIP calls
4. Under the **Service** tab choose *sip_serv* from **Pre-defined**
5. Click **OK**

E. Define the incoming SIP traffic IP rule:

1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Now enter:
   - **Name:** sip_allow
   - **Action:** Allow
   - **Source Interface:** ext
   - **Source Network:** proxy_ip
   - **Destination Interface:** core
   - **Destination Network:** ip_wan
   - **Comment:** Allow incoming SIP traffic
4. Under the **Service** tab choose *sip_serv* from **Pre-defined**
5. Click **OK**

6.2.8. The H.323 ALG

H.323 is a standard approved by the International Telecommunication Union (ITU) to allow compatibility in video conference transmissions over IP networks. It is used for real-time audio, video and data communication over packet-based networks such as the Internet. It specifies the components, protocols and procedures for providing such multimedia communication, including Internet phone and voice-over-IP (VoIP). (For VoIP see also Section 6.2.7, “The SIP ALG ”.)

H.323 Components

H.323 consists of four main components:

Terminals Devices used for audio and optionally video or data communication, such as phones, conferencing units, or "software phones" such as the product "NetMeeting".

Gateways An H.323 gateway connects two dissimilar networks and translates traffic between them. It provides connectivity between H.323 networks and non-H.323 networks such as public switched telephone networks (PSTN), translating protocols and converting media streams. A gateway is not required for communication between two H.323 terminals.

Gatekeepers The Gatekeeper is a component in the H.323 system which is used for addressing, authorization and authentication of terminals and gateways. It can also take care of bandwidth management, accounting, billing and charging. The gatekeeper may allow calls to be placed directly between endpoints, or it may route the call signalling through itself to perform functions such as follow-me/find-me, forward on busy, etc. It is needed when there is more then one H.323 terminal behind a NATing device with only one public IP.

Multipoint Control Units MCUs provide support for conferences of three or more H.323 terminals. All H.323 terminals participating in the conference call have to establish a connection with the MCU. The MCU then manages the calls, resources, video and audio codecs used in the call.

H.323 Protocols

The different protocols used in implementing H.323 are:

H.225 RAS signalling and Call Control (Setup) signalling Used for call signalling. It is used to establish a connection between two H.323 endpoints. This call signal channel is opened between two H.323 endpoints or between a H.323 endpoint and a gatekeeper. For communication between two H.323 endpoints, TCP 1720 is used. When connecting to a gatekeeper, UDP port 1719 (H.225 RAS messages) are used.

H.245 Media Control and Transport Provides control of multimedia sessions established between two H.323 endpoints. Its most important task is to negotiate opening and closing of logical channels. A logical channel is, for instance, an audio channel used for voice communication. Video and T.120 channels are also called logical channels during negotiation.

T.120 A suite of communication and application protocols. Depending on the type of H.323 product, T.120 protocol can be used for application sharing, file transfer as well as for conferencing features such as whiteboards.

H.323 ALG features

The H.323 ALG is a flexible application layer gateway that allows H.323 devices such as H.323 phones and applications to make and receive calls between each other when connected via private networks secured by Clavister Security Gateways.

The H.323 specification was not designed to handle NAT, as IP addresses and ports are sent in the payload of H.323 messages. The H.323 ALG modifies and translates H.323 messages to make sure that H.323 messages will be routed to the correct destination and allowed through the Clavister Security Gateway.

The H.323 ALG has the following features:

- The H.323 ALG supports version 5 of the H.323 specification. This specification is built upon H.225.0 v5 and H.245 v10.
- In addition to support voice and video calls, the H.323 ALG supports application sharing over the T.120 protocol. T.120 uses TCP to transport data while voice and video is transported over UDP.
- To support gatekeepers, the ALG monitors RAS traffic between H.323 endpoints and the gatekeeper, in order to correctly configure the Clavister Security Gateway to let calls through.
- NAT and SAT rules are supported, allowing clients and gatekeepers to use private IP addresses on a network behind the Clavister Security Gateway.

H.323 ALG Configuration

The configuration of the standard H.323 ALG can be changed to suit different usage scenarios. The configurable options are:

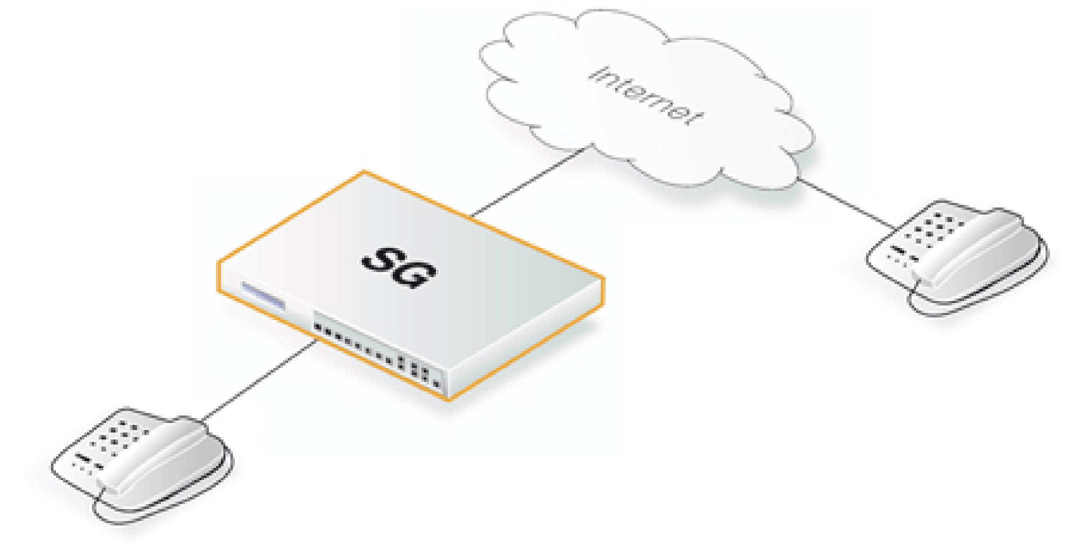
- **Allow TCP Data Channels** - This option allows TCP based data channels to be negotiated. Data channels are used, for instance, by the T.120 protocol.
- **Number of TCP Data Channels** - The number of TCP data channels allowed can be specified.
- **Address Translation** - For NATed traffic the **Network** can be specified, which is what is allowed to be translated. The **External IP** for the **Network** is specified which is the IP address to NAT with. If the **External IP** is set as *Auto* then the external IP is found automatically through route lookup.
- **Translate Logical Channel Addresses** - This would normally always be set. If not enabled then no address translation will be done on logical channel addresses and the administrator needs to be sure about IP addresses and routes used in a particular scenario.
- **Gatekeeper Registration Lifetime** - The gatekeeper registration lifetime can be controlled in order to force re-registration by clients within a certain time. A shorter time forces more frequent registration by clients with the gatekeeper and less probability of a problem if the network becomes unavailable and the client thinks it is still registered.

Presented below are some network scenarios where H.323 ALG use is applicable. For each scenario a configuration example of both the ALG and the rules are presented. The three service definitions used in these scenarios are:

- Gatekeeper (UDP ALL > 1719)
- H323 (H.323 ALG, TCP ALL > 1720)
- H323-Gatekeeper (H.323 ALG, UDP > 1719)

Example 6.5. Protecting Phones Behind Clavister Security Gateways

In the first scenario a H.323 phone is connected to the Clavister Security Gateway on a network (lannet) with public IP addresses. To make it possible to place a call from this phone to another H.323 phone on the Internet, and to allow H.323 phones on the Internet to call this phone, we need to configure rules. The following rules need to be added to the rule set, make sure there are no rules disallowing or allowing the same kind of ports/traffic before these rules.



Clavister FineTune
Outgoing Rule:

1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Now enter:
   - **Name:** H323AllowOut
   - **Action:** Allow
   - **Source Interface:** lan
   - **Destination Interface:** any
   - **Source Network:** lannet
   - **Destination Network:** all-nets
   - **Comment:** Allow outgoing calls
4. Under the **Service** tab, choose *H323* in the **Pre-defined** control
5. Click **OK**

Incoming Rule:

1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Now enter:
   - **Name:** H323AllowIn
   - **Action:** Allow
   - **Source Interface:** any
   - **Destination Interface:** lan

- **Source Network:** all-nets
- **Destination Network:** lannet
- **Comment:** Allow incoming calls

4. Under the **Service** tab, choose *H323* in the **Pre-defined** control
5. Click **OK**

Example 6.6. H.323 with private IP addresses

In this scenario a H.323 phone is connected to the Clavister Security Gateway on a network with private IP addresses. To make it possible to place a call from this phone to another H.323 phone on the Internet, and to allow H.323 phones on the Internet to call this phone, we need to configure rules. The following rules need to be added to the rule set, make sure there are no rules disallowing or allowing the same kind of ports/traffic before these rules. As we are using private IPs on the phone incoming traffic need to be SATed as in the example below. The object ip-phone below should be the internal IP of the H.323 phone.

Clavister FineTune

1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Now enter:
   - **Name:** H323Out
   - **Action:** NAT
   - **Source Interface:** lan
   - **Destination Interface:** any
   - **Source Network:** lannet
   - **Destination Network:** all-nets
   - **Comment:** Allow outgoing calls
4. Under the **Service** tab, choose *H323* in the **Pre-defined** control
5. Click **OK**

Incoming Rule:

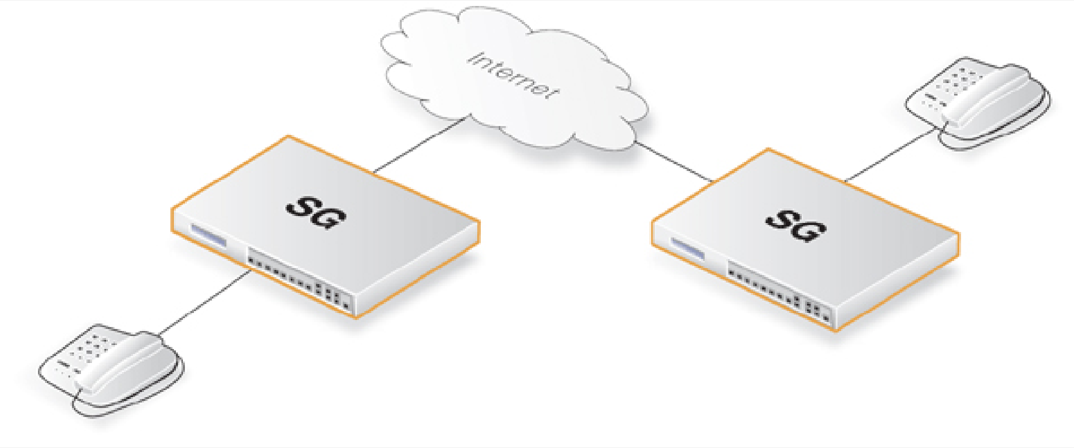
1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Now enter:
   - **Name:** H323In
   - **Action:** SAT
   - **Source Interface:** any
   - **Destination Interface:** core
   - **Source Network:** all-nets
   - **Destination Network:** ip_wan (external IP of the gateway)
4. Under the **Service** tab, choose *H323* in the **Pre-defined** control.
5. Under the **Address Translation** tab, choose *Destination IP Address* and enter *ip-phone* (IP address of phone) in the **New IP Address** control
6. Click **OK**

1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Now enter:
   - **Name:** H323In
   - **Action:** Allow
   - **Source Interface:** any
   - **Destination Interface:** core
   - **Source Network:** all-nets
   - **Destination Network:** ip_wan (external IP of the gateway)
   - **Comment:** Allow incoming calls to H.323 phone at ip-phone.
4. Under the **Service** tab, choose *H323* in the **Pre-defined** control.
5. Click **OK**

To place a call to the phone behind the Clavister Security Gateway, place a call to the external IP address on the gateway. If multiple H.323 phones are placed behind the gateway, one SAT rule has to be configured for each phone. This means that multiple external addresses have to be used. However, it is preferable to use a H.323 gatekeeper, as illustrated in the "H.323 with Gatekeeper" scenario, since this only requires one external address.

Example 6.7. Two Phones Behind Different Clavister Security Gateways

This scenario consists of two H.323 phones, each one connected behind the Clavister Security Gateway on a network with public IP addresses. In order to place calls on these phones over the Internet, the following rules need to be added to the rule listings in both gateways. Make sure there are no rules disallowing or allowing the same kind of ports/traffic before these rules.



Clavister FineTune
Outgoing Rule:

1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Now enter:
   - **Name:** H323AllowOut
   - **Action:** Allow

- **Source Interface:** lan
- **Destination Interface:** any
- **Source Network:** lannet
- **Destination Network:** all-nets
- **Comment:** Allow outgoing calls

4. Under the **Service** tab, choose *H323* from the **Pre-defined** list
5. Click **OK**

Incoming Rule:

1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Now enter:
   - **Name:** H323AllowIn
   - **Action:** Allow
   - **Source Interface:** any
   - **Destination Interface:** lan
   - **Source Network:** all-nets
   - **Destination Network:** lannet
   - **Comment:** Allow incoming calls
4. Under the **Service** tab, choose *H323* from the **Pre-defined** list
5. Click **OK**

Example 6.8. Using Private IP Addresses

This scenario consists of two H.323 phones, each one connected behind the Clavister Security Gateway on a network with private IP addresses. In order to place calls on these phones over the Internet, the following rules need to be added to the rule set in the gateway, make sure there are no rules disallowing or allowing the same kind of ports/traffic before these rules. As we are using private IPs on the phones, incoming traffic need to be SATed as in the example below. The object ip-phone below should be the internal IP of the H.323 phone behind each gateway.

Clavister FineTune

1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Now enter:
   - **Name:** H323Out
   - **Action:** NAT
   - **Source Interface:** lan
   - **Destination Interface:** any
   - **Source Network:** lannet
   - **Destination Network:** all-nets
   - **Comment:** Allow outgoing calls
4. Under the **Service** tab, choose *H323* from the **Pre-defined** list

5. Click **OK**

Incoming Rule:

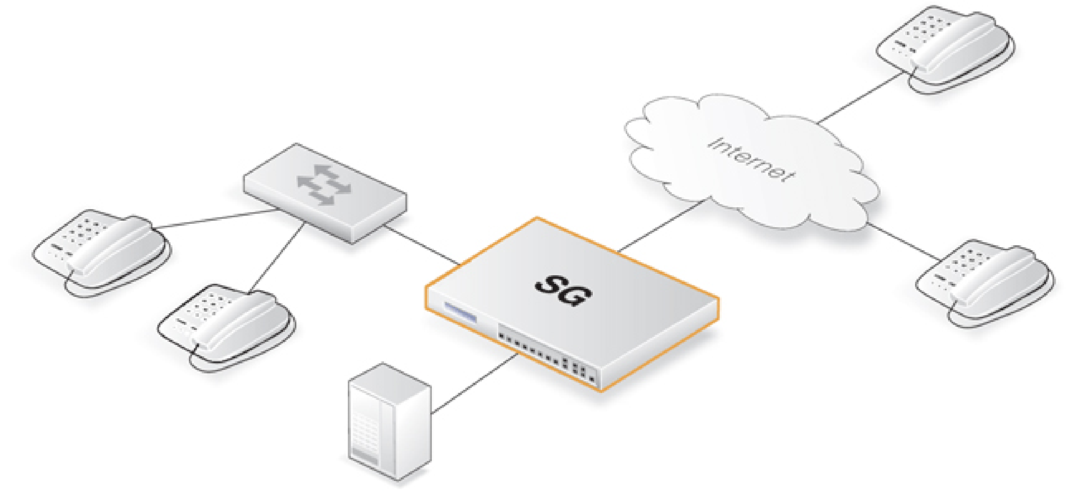
1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Now enter:
   - **Name:** H323In
   - **Action:** SAT
   - **Source Interface:** any
   - **Destination Interface:** core
   - **Source Network:** all-nets
   - **Destination Network:** ip_wan (external IP of the gateway)
4. Under the **Service** tab, choose *H323* from the **Pre-defined** list
5. Under the **Address Translation** tab, choose *Destination IP Address* and enter *ip-phone* (IP address of phone) in the **New IP Address** control
6. Click **OK**

1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Now enter:
   - **Name:** H323In
   - **Action:** Allow
   - **Source Interface:** any
   - **Destination Interface:** core
   - **Source Network:** all-nets
   - **Destination Network:** ip_wan (external IP of the gateway)
   - **Comment:** Allow incoming calls to H.323 phone at ip-phone.
4. Under the **Service** tab, choose *H323* from the **Pre-defined** list
5. Click **OK**

To place a call to the phone behind the Clavister Security Gateway, place a call to the external IP address on the gateway. If multiple H.323 phones are placed behind the gateway, one SAT rule has to be configured for each phone. This means that multiple external addresses have to be used. However, it is preferable to use an H.323 gatekeeper as this only requires one external address.

Example 6.9. H.323 with Gatekeeper

In this scenario, a H.323 gatekeeper is placed in the DMZ of the Clavister Security Gateway. A rule is configured in the gateway to allow traffic between the private network where the H.323 phones are connected on the internal network and to the Gatekeeper on the DMZ. The Gatekeeper on the DMZ is configured with a private address. The following rules need to be added to the rule listings in both gateways, make sure there are no rules disallowing or allowing the same kind of ports/traffic before these rules.



Clavister FineTune

Incoming Gatekeeper Rules:

1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Now enter:
   - **Action:** H323In
   - **Action:** SAT
   - **Source Interface:** any
   - **Destination Interface:** core
   - **Source Network:** 0.0.0.0/0 (all-nets)
   - **Destination Network:** ip_wan (external IP of the gateway)
   - **Comment:** SAT rule for incoming communication with the Gatekeeper located at ip-gatekeeper
4. Under the **Service** tab, choose *H323-Gatekeeper* from the **Pre-defined** list
5. Under the **Address Translation** tab, choose *Destination IP Address* and enter ip-gatekeeper (IP address of gatekeeper)
6. Click **OK**

1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Now enter:
   - **Name:** H323In
   - **Action:** Allow
   - **Source Interface:** any
   - **Destination Interface:** core
   - **Source Network:** all-nets
   - **Destination Network:** ip_wan (external IP of the gateway)
   - **Comment:** Allow incoming communication with the Gatekeeper
4. Under the **Service** tab, choose *H323-Gatekeeper* from the **Pre-defined** list
5. Click **OK**

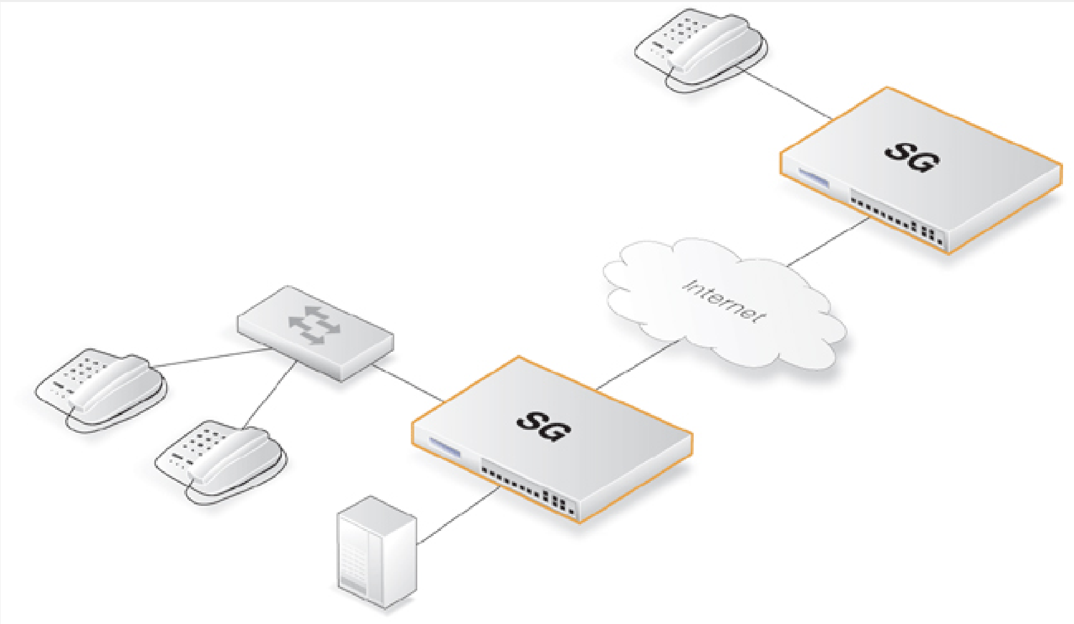
1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Now enter:
   - **Name:** H323In
   - **Action:** Allow
   - **Source Interface:** lan
   - **Destination Interface:** dmz
   - **Source Network:** lannet
   - **Destination Network:** ip-gatekeeper (IP address of the gatekeeper)
   - **Comment:** Allow incoming communication with the Gatekeeper
4. Under the **Service** tab, choose *Gatekeeper* from the **Pre-defined** list
5. Click **OK**

Note

There is no need to specify a specific rule for outgoing calls. CorePlus monitors the communication between "external" phones and the Gatekeeper to make sure that it is possible for internal phones to call the external phones that are registered with the gatekeeper.

Example 6.10. H.323 with Gatekeeper and two Clavister Security Gateways

This scenario is quite similar to scenario 3, with the difference that the Clavister Security Gateway is protecting the "external" phones. The Clavister Security Gateway with the Gatekeeper connected to the DMZ should be configured exactly as in scenario 3 The other Clavister Security Gateway should be configured as below. The rules need to be added to the rule listings, and it should be make sure there are no rules disallowing or allowing the same kind of ports/traffic before these rules.



Clavister FineTune

1. Go to **Rules > New Rule**

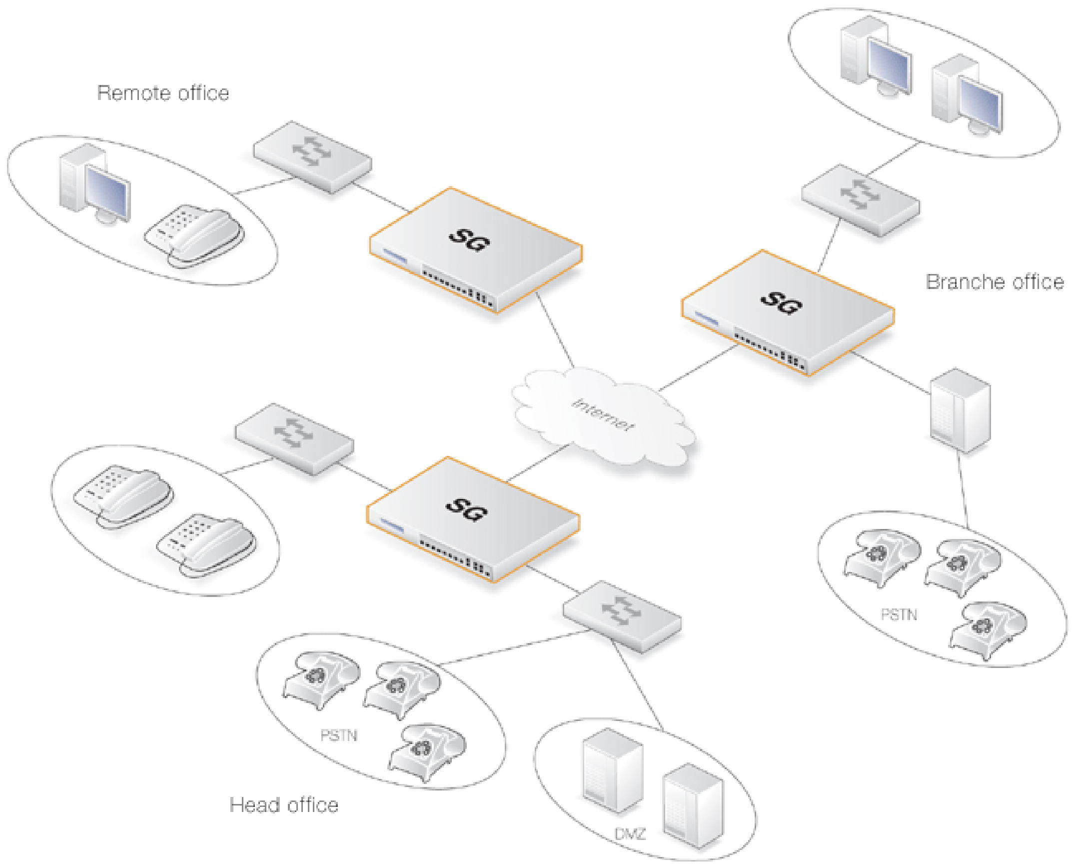
2. The **Rule Properties** dialog will be displayed
3. Now enter:
   - **Name:** H323Out
   - **Action:** NAT
   - **Source Interface:** lan
   - **Destination Interface:** any
   - **Source Network:** lannet
   - **Destination Network:** all-nets
   - **Comment:** Allow outgoing communication with a gatekeeper
4. Under the **Service** tab, choose *H323-Gatekeeper* from the **Pre-defined** list
5. Click **OK**

Note

There is no need to specify a specific rule for outgoing calls. CorePlus monitors the communication between "external" phones and the Gatekeeper to make sure that it is possible for internal phones to call the external phones that are registered with the gatekeeper.

Example 6.11. Using the H.323 ALG in a Corporate Environment

This scenario is an example of a more complex network that shows how the H.323 ALG can be deployed in a corporate environment. At the head office DMZ a H.323 Gatekeeper is placed that can handle all H.323 clients in the head-, branch- and remote offices. This will allow the whole corporation to use the network for both voice communication and application sharing. It is assumed that the VPN tunnels are correctly configured and that all offices use private IP-ranges on their local networks. All outside calls are done over the existing telephone network using the gateway (ip-gateway) connected to the ordinary telephone network.



The head office has placed a H.323 Gatekeeper in the DMZ of the corporate Clavister Security Gateway. This gateway should be configured as follows:

Clavister FineTune

1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Now enter:
   - **Name:** LanToGK
   - **Action:** Allow
   - **Source Interface:** lan
   - **Destination Interface:** dmz
   - **Source Network:** lannet
   - **Destination Network:** ip-gatekeeper (IP address of the gatekeeper)
   - **Comment:** Allow H323 entities on lannet to connect to the Gatekeeper
4. Under the **Service** tab, choose *H323-Gatekeeper* in the **Pre-defined** control
5. Click **OK**

1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Now enter:
   - **Name:** LanToGK
   - **Action:** Allow

- **Source Interface:** lan
- **Destination Interface:** dmz
- **Source Network:** lannet
- **Destination Network:** ip-gatekeeper (IP address of the gatekeeper)
- **Comment:** Allow H323 entities on lannet to call phones connected to the H.323 Gateway on the DMZ

4. Under the **Service** tab, choose *H323-Gatekeeper* from the **Pre-defined** list
5. Click **OK**

1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Now enter:
   - **Name:** GWToLan
   - **Action:** Allow
   - **Source Interface:** dmz
   - **Destination Interface:** lan
   - **Source Network:** ip-gateway (IP address of the gateway)
   - **Destination Network:** lannet
   - **Comment:** Allow communication from the Gateway to H.323 phones on lannet
4. Under the **Service** tab, choose *H323-Gatekeeper* in the **Pre-defined** control
5. Click **OK**

1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Now enter:
   - **Name:** BranchToGW
   - **Action:** Allow
   - **Source Interface:** vpn-branch
   - **Destination Interface:** dmz
   - **Source Network:** branch-net
   - **Destination Network:** ip-gatekeeper,ip-gateway
   - **Comment:** Allow communication with the Gatekeeper on DMZ from the Branch network
4. Under the **Service** tab, choose *H323-Gatekeeper* in the **Pre-defined** control
5. Click **OK**

1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Now enter:
   - **Name:** BranchToGW
   - **Action:** Allow
   - **Source Interface:** vpn-remote
   - **Destination Interface:** dmz

- **Source Network:** remote-net
- **Destination Network:** ip-gatekeeper
- **Comment:** Allow communication with the Gatekeeper on DMZ from the Remote network

4. Under the **Service** tab, choose *H323-Gatekeeper* from the **Pre-defined** list
5. Click **OK**

Example 6.12. Configuring remote offices for H.323

If the branch and remote office H.323 phones and applications are to be configured to use the H.323 Gatekeeper at the head office, the Clavister Security Gateways in the remote and branch offices should be configured as follows: (this rule should be in both the Branch and Remote Office gateways).

Clavister FineTune

1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Now enter:
   - **Name:** ToGK
   - **Action:** Allow
   - **Source Interface:** lan
   - **Destination Interface:** vpn-hq
   - **Source Network:** lannet
   - **Destination Network:** hq-net
   - **Comment:** Allow communication with the Gatekeeper connected to the Head Office DMZ
4. Under the **Service** tab, choose *H323-Gatekeeper* from the **Pre-defined** control
5. Click **OK**

Example 6.13. Allowing the H.323 Gateway to register with the Gatekeeper

The branch office Clavister Security Gateway has a H.323 Gateway connected to its DMZ. In order to allow the Gateway to register with the H.323 Gatekeeper at the Head Office, the following rule has to be configured:

Clavister FineTune

1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Now enter:
   - **Name:** GWToGK
   - **Action:** Allow
   - **Source Interface:** dmz
   - **Destination Interface:** vpn-hq
   - **Source Network:** ip-branchgw
   - **Destination Network:** hq-net

- **Comment:** Allow the Gateway to communicate with the Gatekeeper connected to the Head Office

4. Under the **Service** tab, choose *H323-Gatekeeper* from the **Pre-defined** list
5. Click **OK**

Note

There is no need to specify a specific rule for outgoing calls. CorePlus monitors the communication between "external" phones and the Gatekeeper to make sure that it is possible for internal phones to call the external phones that are registered with the gatekeeper.

6.3. Web Content Filtering

6.3.1. Overview

Web traffic is one of the biggest sources for security issues and misuse of the Internet. Inappropriate surfing habits can expose a network to many security threats as well as legal and regulatory liabilities. Productivity and Internet bandwidth can also be impaired.

Through the HTTP ALG, CorePlus provides three mechanisms for filtering out web content that is deemed inappropriate for an organization or group of users:

- *Active Content Handling* can be used to "scrub" web pages of content that the administrator considers a potential threat, such as ActiveX objects and Java Applets.
- *Static Content Filtering* provides a means for manually classifying web sites as "good" or "bad". This is also known as URL *blacklisting* and *whitelisting*.
- *Dynamic Content Filtering* is a powerful feature that enables the administrator to allow or block access to web sites depending on the category they have been classified into by an automatic classification service. Dynamic content filtering requires a minimum of administration effort and has very high accuracy.

Note

All Web Content Filtering is enabled via the HTTP ALG which is described in Section 6.2.2, "The HTTP ALG".

6.3.2. Active Content Handling

Some web content can contain malicious code designed to harm the workstation or the network from where the user is surfing. Typically, such code is embedded into various types of objects or files which are embedded into web pages.

CorePlus includes support for removing the following types of objects from web page content:

- ActiveX objects (including Flash)
- Java applets
- Javascript/VBScript code
- Cookies
- Invalidly formatted UTF-8 Characters (invalid URL formatting can be used to attack webservers)

The object types to be removed can be selected individually by configuring the corresponding HTTP Application Layer Gateway accordingly.

Caution

Care should be taken before enabling removal of objects from web content.

Many web sites use Javascript and other types of client-side code and in most cases, the code is non-malicious. Common examples of this is the scripting used to implement drop-down menus as well as hiding and showing elements on web pages.

Removing such legitimate code could, at best, cause the web site to look distorted, at worst, cause it to not work in a browser at all. Active Content Handling should therefore only be used when the consequences are well understood.

Example 6.14. Stripping ActiveX and Java applets

This example shows how to configure a HTTP Application Layer Gateway to strip ActiveX and Java applets. The example will use the content_filtering ALG object and presumes you have done one of the previous examples.

Clavister FineTune

1. Go to **Local Objects > Application Layer Gateways**
2. Right-click on the **content-filtering** object and choose **Properties**. The **Application Layer Gateway Properties** dialog will be displayed
3. Click the **Parameters...** button, the **HTTP Application Layer Gateway** dialog will be shown
4. Check the **Strip ActiveX objects (including flash)** control
5. Check the **Strip Java applets** control
6. Click **OK** in both of the open dialogs

6.3.3. Static Content Filtering

Through the HTTP ALG, CorePlus can block or permit certain web pages based on configured lists of URLs which are called *blacklists* and *whitelists*. This type of filtering is also known as *Static Content Filtering*. The main benefit with Static Content Filtering is that it is an excellent tool to target specific web sites, and make the decision as to whether they should be blocked or allowed.

Static and Dynamic Filter Ordering

Additionally, Static Content Filtering takes place *before* Dynamic Content Filtering (described below), which allows the possibility of manually making exceptions from the automatic dynamic classification process. In a scenario where goods have to be purchased from a particular on-line store, Dynamic Content Filtering might be set to prevent access to shopping sites by blocking the "Shopping" category. By entering the on-line store's URL into the HTTP Application Layer Gateway's whitelist, access to that URL is always allowed, taking precedence over Dynamic Content Filtering.

Wildcarding

Both the URL blacklist and URL whitelist support wildcard matching of URLs in order to be more flexible. This wildcard matching is also applicable to the path following the URL hostname which means that filtering can be controlled to a file and directory level.

Below are some good and bad blacklist example URLs used for blocking:

.example.com/ — **Good.** This will block all hosts in the *example.com* domain and all web pages served by those hosts.

www.example.com/* — **Good.** This will block the *www.example.com* website and all web pages served by that site.

***/*.gif** — **Good.** This will block all files with *.gif* as the file name extension.

www.example.com — **Bad.** This will only block the first request to the web site. Surfing to *www.example.com/index.html*, for instance, will not be blocked.

example.com/ — **Bad.** This will also cause *www.myexample.com* to be blocked since it blocks all sites ending with *example.com*.

Note: The hosts and networks blacklist is separate

Web content filtering URL blacklisting is a separate concept from Section 6.7, "Blacklisting Hosts and Networks".

Example 6.15. Setting up a white and blacklist

This example shows the use of static content filtering where CorePlus can block or permit certain web pages based on blacklists and whitelists. As the usability of static content filtering will be illustrated, dynamic content filtering and active content handling will not be enabled in this example.

In this small scenario a general surfing policy prevents users from downloading .exe-files. However, the Clavister website provides secure and necessary program files which should be allowed to download.

Clavister FineTune

1. Go to **Local Objects > Application Layer Gateways > New Application Layer Gateway**
2. The **Application Layer Gateway Properties** dialog will be displayed
3. Specify a suitable name for the ALG, for example *content_filtering*
4. Select **HTTP** in the **Type** dropdown list
5. Click the **Parameters...** button and the **HTTP Application Layer Gateway** dialog will be shown
6. Click the **URL Whitelist** tab.
7. In the whitelist control, enter *www.Clavister.com/*.exe*
8. Click the **URL Blacklist** tab.
9. In the blacklist control, enter **/*.exe*
10. Click **OK** in both of the open dialogs

Simply continue adding specific blacklists and whitelists until the filter satisfies the needs.

6.3.4. Dynamic Web Content Filtering

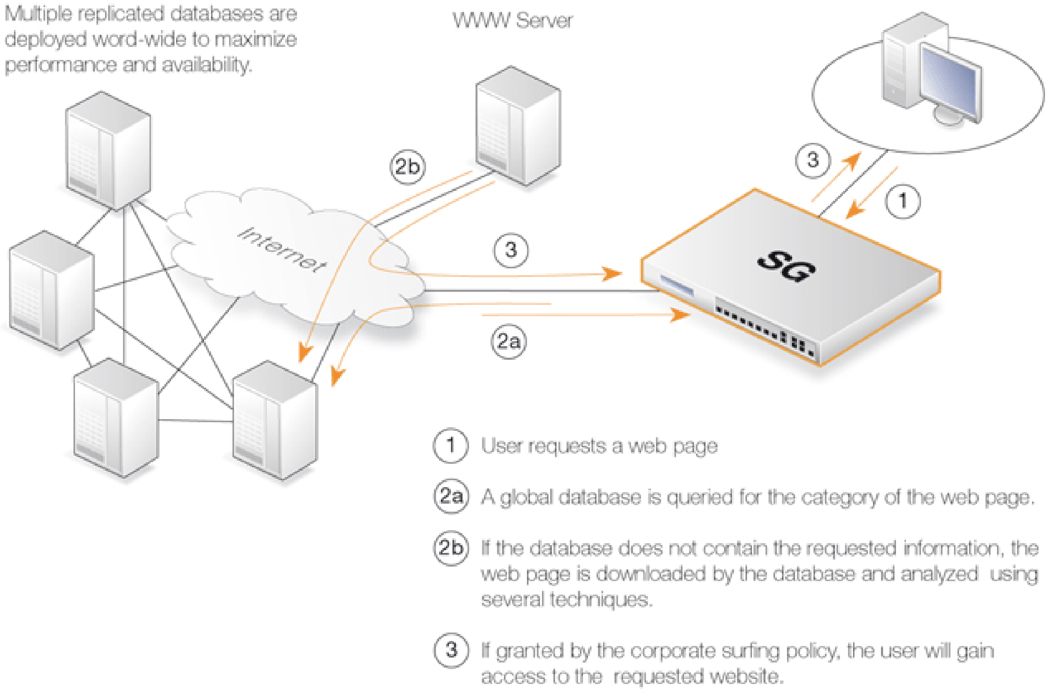
6.3.4.1. Overview

As part of the HTTP ALG, CorePlus supports *Dynamic Web Content Filtering* (WCF) of web traffic, which enables an administrator to permit or block access to web pages based on the content of those web pages. This functionality is automated and it is not necessary to manually specify which URLs to block or allow. Instead, Clavister maintains a global infrastructure of databases containing massive numbers of current web site URL addresses, grouped into a variety of categories such as shopping, news, sport and adult-oriented on so on. These databases are updated every hour with new, categorized URLs while at the same time older, invalid URLs are dropped. The database content is global, covering websites in many different languages and which are hosted in countries around the world.

URL Processing Flow

When a user requests access to a web site, CorePlus sends a query to these databases to retrieve the category of the requested site. The user is then granted or denied access to the site based on the filtering policy in place for that category. If access is denied, a web page will be presented to the user explaining that the requested site has been blocked. To make the lookup process as fast as possible CorePlus maintains a local cache of recently accessed URLs. Caching can be highly efficient since a given user community, such as a group of university students, often surfs to a limited range of websites.

Figure 6.6. Dynamic Content Filtering Flow



If the requested web page URL is not present in the databases, then the webpage content at the URL will automatically be downloaded to Clavister's central data warehouse and automatically analyzed using a combination of techniques including neural networks and pattern matching. Once categorized, the URL is distributed to the global databases and CorePlus receives the category for the URL. Dynamic Content Filtering therefore requires a minimum of administration effort.

Note: New URL submissions are done anonymously

New, uncategorized URLs sent to the Clavister network are treated as anonymous submissions and no record of the source of new submissions is kept.

Categorizing Pages and Not Sites

CorePlus dynamic filtering categorizes web pages and not sites. In other words, a web site may contain particular pages that should be blocked without blocking the entire site. CorePlus provides blocking down to the page level so that users may still access parts of websites that aren't blocked by the filtering policy.

WCF and Whitelisting

If a particular URL is whitelisted then it will bypass the WCF subsystem. No classification will be done on the URL and it will always be allowed. This applies if the URL has an exact match with an entry on the whitelist or if it matches an entry that makes use of wildcarding.

6.3.4.2. Setting Up Filtering

Activation

Dynamic Content Filtering is a feature that is enabled by taking out a separate subscription to the service. This is an addition to the normal CorePlus license.

Once a subscription is taken out, an HTTP Application Layer Gateway (ALG) Object should be defined with Dynamic Content Filtering enabled. This object is then associated with a Service object and the Service object is then associated with a rule in the IP rule set to determine which traffic should be subject to the filtering. This makes possible the setting up of a detailed filtering policy based on the filtering parameters that are used for rules in the IP rule set.

Tip

If you would like your content filtering policy to vary depending on the time of the day, make use of a schedule object in the corresponding IP rule. For more information, please see Section 3.6, "Schedules".

Setting Fail Mode

The option exists to set the HTTP ALG *fail mode* in the same way that it can be set for some other ALGs and it applies to WCF just as it does to functions such as Anti-Virus scanning. The fail mode setting determines what happens when dynamic content filtering cannot function and, typically, this is because CorePlus is unable to reach the external databases to perform URL lookup. Fail mode can have one of two settings:

- **Deny** - If WCF is unable to function then URLs are denied if external database access to verify them is not possible. The user will see an "Access denied" web page.
- **Allow** - If the external WCF database is not accessible, URLs are allowed even though they might be disallowed if the WCF databases were accessible.

Example 6.16. Enabling Dynamic Web Content Filtering

This example shows how to setup a dynamic content filtering policy for HTTP traffic from **intnet** to **all-nets**. The policy will be configured to block all search sites, and this example assumes that the system is using a single NAT rule for HTTP traffic from **intnet** to **all-nets**.

Clavister FineTune

First, create an HTTP Application Layer Gateway (ALG) Object:

1. Go to **Local Objects > Application Layer Gateways > New Application Layer Gateway**
2. The **Application Layer Gateway Properties** dialog will be displayed
3. Specify a suitable name for the ALG, for example *content_filtering*
4. Select **HTTP** as the **Type**
5. Click the **Parameters...** button and the **HTTP Application Layer Gateway** dialog will be shown
6. Select the **Dynamic Content Filtering** tab
7. Select **Enabled** as the **Mode**
8. In **Blocked Categories** select **Search Sites** and click the **>>** button
9. Click **OK** in both of the open dialogs

Then, create a Service object using the new HTTP ALG:

1. Go to **Local Objects > Services > New Service**
2. The **Service Properties** dialog will be displayed
3. Specify a suitable name for the Service, for example *http_content_filtering*
4. Make sure **TCP** is selected in the **Type** dropdown list

5. Select the HTTP ALG you just created in the **ALG** dropdown list
6. Click the **TCP/UDP Parameters** tab
7. Enter **80** as the **Destination Port**
8. Click **OK** in both of the open dialogs

Finally, modify the NAT rule to use the new service:

1. Go to **Rules**
2. Open the properties dialog for the NAT rule handling your HTTP traffic
3. Click the **Service** tab
4. Select your new service in the **Pre-defined** list
5. Click **OK**

Dynamic content filtering is now activated for all web traffic from lannet to all-nets. Validate the functionality by following these steps:

1. On a workstation on the lannet network, launch a standard web browser.
2. Try to browse to a search site, for instance www.google.com.
3. If everything is configured correctly, your web browser will present a web page that informs you about that the requested site is blocked.

Audit Mode

In *Audit Mode*, the system will classify and log all surfing according to the content filtering policy, but restricted web sites will still be accessible to the users. This means the content filtering feature of CorePlus can then be used as an analysis tool to analysis what categories of websites are being accessed by a user community and how often.

After running in Audit Mode for some weeks, it is then easier to have a good understanding of surfing behavior and also the potential time savings that can be made by enabling content filtering. It is recommended that the administrator gradually introduces the blocking of particular categories one at a time. This allows individual users time to get used to the notion that blocking exists and can avoid the widespread protests that might occur if everything is blocked at once. Gradual introduction also makes for better evaluation as to whether the goals of blocking are being met.

Example 6.17. Enabling Audit Mode

This example is based on the same scenario as the previous example, but now with audit mode enabled.

Clavister FineTune

First, create an HTTP Application Layer Gateway (ALG) Object:

1. Go to **Local Objects > Application Layer Gateways > New Application Layer Gateway**
2. The **Application Layer Gateway Properties** dialog will be displayed
3. Specify a suitable name for the ALG, for instance content_filtering
4. Select **HTTP** in the **Type** list
5. Click the **Parameters...** button and the **HTTP Application Layer Gateway** box will be shown
6. Click the **Dynamic Content Filtering** tab
7. Select **Audit** in the **Mode** list

8. In the **Blocked Categories** list, select **Search Sites** and click the **>>** button
9. Click **OK** in both of the open dialogs

The steps to then create a Service object using the new HTTP ALG and modifyng the NAT rule to use the new service, are described in the previous example.

Allowing Override

On some occasions, Active Content Filtering may prevent users carrying out legitimate tasks. Consider a stock broker dealing with on-line gaming companies. In his daily work, he might need to browse gambling web sites to conduct company assessments. If the corporate policy blocks gambling web-sites, he won't be able to do his job.

For this reason, CorePlus supports a feature called *Allow Override*. With this feature enabled, the content filtering component will present a warning to the user that he is about to enter a web site that is restricted according to the corporate policy, and that his visit to the web site will be logged. This page is known as the *restricted site notice*. The user is then free to continue to the URL, or abort the request to prevent being logged.

By enabling this functionality, only users that have a valid reason to visit inappropriate sites will normally do so. Other will avoid those sites due to the obvious risk of exposing their surfing habits.

Caution

If a user overrides the restricted site notice page, they are allowed to surf to all pages without any new restricted site message appearing again. The user is however still being logged. When the user has become inactive for 5 minutes, the restricted site page will reappear if they then try to access a restricted site.

Reclassification of Blocked Sites

As the process of classifying unknown web sites is automated, there is always a small risk that some sites are given an incorrect classification. CorePlus provides a mechanism for allowing users to manually propose a new classification of sites.

This mechanism can be enabled on a per-HTTP ALG level, which means that you can choose to enable this functionality for regular users or for a selected user group only.

If reclassification is enabled and a user requests a web site which is disallowed, the block web page will include a dropdown list containing all available categories. If the user believes the requested web site is wrongly classified, he can select a more appropriate category from the dropdown list and submit that as a proposal.

The URL to the requested web site as well as the proposed category will then be sent to Clavister's central data warehouse for manual inspection. That inspection may result in the web site being reclassified, either according to the category proposed or to a category which is felt to be correct.

Example 6.18. Reclassifying a blocked site

This example shows how a user may propose a reclassification of a web site if he believes it is wrongly classified. This mechanism is enabled on a per-HTTP ALG level basis.

Clavister FineTune

First, create an HTTP Application Layer Gateway (ALG) Object:

1. Go to **Local Objects > Application Layer Gateways > New Application Layer Gateway**

2. The **Application Layer Gateway Properties** dialog will be displayed
3. Specify a suitable name for the ALG, *content_filtering*
4. Select **HTTP** in the **Type** list
5. Click the **Parameters...** and the **HTTP Application Layer Gateway** dialog will be shown
6. Click the **Dynamic Content Filtering** tab
7. Select **Audit** in the **Mode** list
8. In the **Blocked Categories** list, select **Search Sites** and click the **>>** button
9. Check the **Allow Reclassification** control
10. Click **OK** in both of the open dialogs

Then, continue setting up the service object and modifyng the NAT rule as we have done in the previous examples.

Dynamic content filtering is now activated for all web traffic from lannet to all-nets and the user is able to propose reclassification of blocked sites. Validate the functionality by following these steps:

1. On a workstation on the lannet network, launch a standard web browser.
2. Try to browse to a search site, for instance www.google.com.
3. If everything is configured correctly, your web browser will present a block page where a dropdown list containing all available categories is included.
4. The user is now able to select a more proper category and propose a reclassification.

Event Messages

Dynamic Content Filtering utilizes the *url_request* event message to log its activities. The parameters of this event message will contain information on whether the request was allowed or blocked, and what categories the web site was classified as. Also, the message includes parameters specifying if audit mode or a restricted site notice were in effect.

> ***Note***
> *The url_request event message will only be generated if event message generation has been enabled in the "parent" IP Rule.*

6.3.4.3. Content Filtering Categories

This section lists all the categories used with Dynamic Content Filtering and describes the purpose of each category.

Category 1: Adult Content

A web site may be classified under the Adult Content category if its content includes the description or depiction of erotic or sexual acts or sexually oriented material such as pornography. Exceptions to this are web sites that contain information relating to sexuality and sexual health, which may be classified under the Health Sites Category (21). Examples might be:

- www.naughtychix.com
- www.fullonxxx.com

Category 2: News

A web site may be classified under the News category if its content includes information articles on recent events pertaining to topics surrounding a locality (for example, town, city or nation) or culture, including weather forecasting information. Typically this would include most real-time online news publications and technology or trade journals. This does not include financial quotes, refer to the Investment Sites category (11), or sports, refer to the Sports category (16). Examples might be:

- www.newsunlimited.com
- www.dailyscoop.com

Category 3: Job Search

A web site may be classified under the Job Search category if its content includes facilities to search for or submit online employment applications. This also includes resume writing and posting and interviews, as well as staff recruitment and training services. Examples might be:

- www.allthejobs.com
- www.yourcareer.com

Category 4: Gambling

A web site may be classified under the Gambling category if its content includes advertisement or encouragement of, or facilities allowing for the partaking of any form of gambling; For money or otherwise. This includes online gaming, bookmaker odds and lottery web sites. This does not include traditional or computer based games; refer to the Games Sites category (10). Examples might be:

- www.blackjackspot.com
- www.pickapony.net

Category 5: Travel / Tourism

A web site may be classified under the Travel / Tourism category if its content includes information relating to travel activities including travelling for recreation and travel reservation facilities. Examples might be:

- www.flythere.nu
- www.reallycheaptix.com.au

Category 6: Shopping

A web site may be classified under the Shopping category if its content includes any form of advertisement of goods or services to be exchanged for money, and may also include the facilities to perform that transaction online. Included in this category are market promotions, catalogue selling and merchandising services. Examples might be:

- www.megamall.com

- www.buy-alcohol.se

Category 7: Entertainment

A web site may be classified under the Entertainment category if its content includes any general form of entertainment that is not specifically covered by another category. Some examples of this are music sites, movies, hobbies, special interest, and fan clubs. This category also includes personal web pages such as those provided by ISPs. The following categories more specifically cover various entertainment content types, Pornography / Sex (1), Gambling (4), Chatrooms (8), Game Sites (10), Sports (16), Clubs and Societies (22) and Music Downloads (23). Examples might be:

- www.celebnews.com
- www.hollywoodlatest.com

Category 8: Chatrooms

A web site may be classified under the Chatrooms category if its content focuses on or includes real-time on-line interactive discussion groups. This also includes bulletin boards, message boards, online forums, discussion groups as well as URLs for downloading chat software. Examples might be:

- www.thetalkroom.org
- chat.yazoo.com

Category 9: Dating Sites

A web site may be classified under the Dating Sites category if its content includes facilities to submit and review personal advertisements, arrange romantic meetings with other people, mail order bride / foreign spouse introductions and escort services. Examples might be:

- adultmatefinder.com
- www.marriagenow.com

Category 10: Game Sites

A web site may be classified under the Game Sites category if its content focuses on or includes the review of games, traditional or computer based, or incorporates the facilities for downloading computer game related software, or playing or participating in online games. Examples might be:

- www.gamesunlimited.com
- www.gameplace.com

Category 11: Investment Sites

A web site may be classified under the Investment Sites category if its content includes information, services or facilities pertaining to personal investment. URLs in this category include contents such as brokerage services, online portfolio setup, money management forums or stock quotes. This category does not include electronic banking facilities; refer to the E-Banking category (12). Examples might be:

- www.loadsofmoney.com.au
- www.putsandcalls.com

Category 12: E-Banking

A web site may be classified under the E-Banking category if its content includes electronic banking information or services. This category does not include Investment related content; refer to the Investment Sites category (11). Examples might be:

- www.nateast.co.uk
- www.borganfanley.com

Category 13: Crime / Terrorism

A web site may be classified under the Crime / Terrorism category if its content includes the description, promotion or instruction in, criminal or terrorist activities, cultures or opinions. Examples might be:

- www.beatthecrook.com

Category 14: Personal Beliefs / Cults

A web site may be classified under the Personal Beliefs / Cults category if its content includes the description or depiction of, or instruction in, systems of religious beliefs and practice. Examples might be:

- www.paganfed.demon.co.uk
- www.cultdeadcrow.com

Category 15: Politics

A web site may be classified under the Politics category if its content includes information or opinions of a political nature, electoral information and including political discussion groups. Examples might be:

- www.democrats.org.au
- www.political.com

Category 16: Sports

A web site may be classified under the Sports category if its content includes information or instructions relating to recreational or professional sports, or reviews on sporting events and sports scores. Examples might be:

- www.sportstoday.com
- www.soccerball.com

Category 17: www-Email Sites

A web site may be classified under the www-Email Sites category if its content includes online, web-based email facilities. Examples might be:

- www.coldmail.com
- mail.yazoo.com

Category 18: Violence / Undesirable

A web site may be classified under the Violence / Undesirable category if its contents are extremely violent or horrific in nature. This includes the promotion, description or depiction of violent acts, as well as web sites that have undesirable content and may not be classified elsewhere. Examples might be:

- www.itstinks.com
- www.ratemywaste.com

Category 19: Malicious

A web site may be classified under the Malicious category if its content is capable of causing damage to a computer or computer environment, including malicious consumption of network bandwidth. This category also includes "Phishing" URLs which designed to capture secret user authentication details by pretending to be a legitimate organisation. Examples might be:

- hastalavista.baby.nu

Category 20: Search Sites

A web site may be classified under the Search Sites category if its main focus is providing online Internet search facilities. Refer to the section on unique categories at the start of this document. Examples might be:

- www.zoogle.com
- www.yazoo.com

Category 21: Health Sites

A web site may be classified under the Health Sites category if its content includes health related information or services, including sexuality and sexual health, as well as support groups, hospital and surgical information and medical journals. Examples might be:

- www.thehealthzone.com
- www.safedrugs.com

Category 22: Clubs and Societies

A web site may be classified under the Clubs and Societies category if its content includes information or services of relating to a club or society. This includes team or conference web sites. Examples might be:

- www.sierra.org
- www.walkingclub.org

Category 23: Music Downloads

A web site may be classified under the Music Downloads category if it provides online music downloading, uploading and sharing facilities as well as high bandwidth audio streaming. Examples might be:

- www.onlymp3s.com
- www.mp3space.com

Category 24: Business Oriented

A web site may be classified under the Business Oriented category if its content is relevant to general day-to-day business or proper functioning of the Internet, for example Web browser updates. Access to web sites in this category would in most cases not be considered unproductive or inappropriate.

Category 25: Government Blocking List

This category is populated by URLs specified by a government agency, and contains URLs that are deemed unsuitable for viewing by the general public by way of their very extreme nature. Examples might be:

- www.verynastystuff.com
- www.unpleasantvids.com

Category 26: Educational

A web site classified under the Educational category may belong to other categories but has content that relates to educational services or has been deemed of educational value, or to be an educational resource, by educational organisations. This category is populated by request or submission from various educational organisations. Examples might be:

- highschoolessays.org
- www.learn-at-home.com

Category 27: Advertising

A web site may be classified under the Advertising category if its main focus includes providing advertising related information or services. Examples might be:

- www.admessages.com
- www.tripleclick.com

Category 28: Drugs/Alcohol

A web site may be classified under the Drugs/Alcohol category if its content includes drug and alcohol related information or services. Some URLs categorised under this category may also be categorised under the Health category. Examples might be:

- www.the-cocktail-guide.com
- www.stiffdrinks.com

Category 29: Computing/IT

A web site may be classified under the Computing/IT category if its content includes computing related information or services. Examples might be:

- www.purplehat.com
- www.gnu.org

Category 30: Swimsuit/Lingerie/Models

A web site may be categorised under the Swimsuit/Lingerie/Models category if its content includes information pertaining to, or images of swimsuit, lingerie or general fashion models. Examples might be:

- www.vickys-secret.com
- sportspictured.cnn.com/features/2002/swimsuit

Category 31: Spam

A web site may be classified under the Spam category if it is found to be contained in bulk or spam emails. Examples might be:

- kaqsovdij.gjibhgk.info
- www.pleaseupdateyourdetails.com

Category 32: Non-Managed

Unclassified sites and sites that don't fit one of the other categories will be placed in this category. It is unusual to block this category since this could result in most harmless URLs being blocked.

6.3.4.4. Customizing Content Filtering HTML Pages

The web pages presented to the user with content filtering can be customized to an installation's needs by uploading a package of HTML pages to the system.

The local installation directory on the management workstation contains a folder called **HTTPALG HTML Root**. This contains a subfolder called **Sample Pages** which contains the default HTML pages used for content filtering. These files are also known as *banner files*. To customize these pages:

1. Create a new folder under **HTTPALG HTML Root**. This folder can be given any name, in this description lets call it **CustomizedHTML**.

2. Make a copy in **CustomizedHTML** of all the default HTML files in **Sample Pages**.

3. Make the required customization changes to the files in **CustomizedHTML**. Only the presentation should be changed. No changes should be made to the variables names used in the files.

4. Start (or restart) Clavister FineTune. Open the properties dialog for the relevant HTML ALG object and select the **Active Content Handling** tab. It will now be possible to select **CustomizedHTML** from the **HTML Directory** list.

5. Upload the new banner files to the Clavister Security Gateway through the
   Action > Communication > Upload > HTTP ALG html files
   option from the Clavister FineTune menubar.

The parameters that can be used in these HTML pages are:

- **%URL%** - The URL which was requested
- **%IPADDR%** - The IP address which is being browsed from
- **%REASON%** - The reason that access was denied

6.4. Anti-Virus Scanning

6.4.1. Overview

The CorePlus Anti-Virus module protects against malicious code carried in file downloads. Files may be downloaded as part of a web-page in an HTTP transfer, in an FTP download, or perhaps as an attachment to an email delivered through SMTP. Malicious code in such downloads can have different intents ranging from programs that merely cause annoyance to more sinister aims such as sending back passwords, credit card numbers and other sensitive information. The term "Virus" can be used as a generic description for all forms of malicious code carried in files.

Combining with Client Anti-Virus Scanning

Unlike IDP, which is primarily directed at attacks against servers, Anti-Virus scanning is focussed on downloads by clients. CorePlus Anti-Virus is designed to be a complement to the standard antivirus scanning normally carried out locally by specialised software installed on client computers. IDP is not intended as a complete substitute for local scanning but rather as an extra shield to boost client protection. Most importantly, it can act as a backup for when local client antivirus scanning is not available.

Enabling Through ALGs

CorePlus Anti-Virus is enabled on a per ALG basis. It is available for file downloads associated with the following ALGs and is enabled in the ALGs themselves:

- The HTTP ALG
- The FTP ALG
- The POP3 ALG
- The SMTP ALG

Hardware Acceleration

Anti-Virus performance, like IDP scanning performance, can be increased with an optional hardware acceleration upgrade on the SG50, SG4200 and SG4400 Security Gateways. Multiple streams are accelerated asynchronously in this optional hardware to boost overall throughput. The console command

```
Cmd> hwaccel
```

can be used to check if acceleration is installed. Note that Anti-Virus is not available on the discontinued SG30 model.

6.4.2. Implementation

Streaming

As a file transfer is streamed through the Clavister Security Gateway, CorePlus will scan the data stream for the presence of viruses if the Anti-Virus module is enabled. Since files are being streamed and not being read completely into memory, a minimum amount of memory is required and there is minimal effect on overall throughput.

Pattern Matching

The inspection process is based on *pattern matching* against a database of known virus patterns and can determine, with a high degree of certainty, if a virus is in the process of being downloaded to a user behind the Clavister Security Gateway. Once a virus is recognized in the contents of a file, the download can be terminated before it completes.

Types of File Downloads Scanned

As described above, Anti-Virus scanning is enabled on a per ALG basis and can scan file downloads associated with the HTTP, FTP, SMTP and POP3 ALGs. More specifically:

- Any uncompressed file type transferred through these ALGs can be scanned.
- If the download has been compressed, ZIP and GZIP file downloads can be scanned.

The administrator has the option to always drop specific files as well as the option to specify a size limit on scanned files. If no size limit is specified then there is no default upper limit on file sizes.

Simultaneous Scans

There is no fixed limit on how many Anti-Virus scans can take place simultaneously in a single Clavister Security Gateway. However, the available free memory can place a limit on the number of concurrent scans that can be initiated. The administrator can increase the default amount of free memory available to Anti-Virus scanning through changing the **AVSE_MAXMEMORY** advanced setting. This setting specifies what percentage of total memory is to be used for Anti-Virus scanning.

Protocol Specific behavior

Since Anti-Virus scanning is implemented through an *Application Level Gateway* (ALG), specific protocol specific features are implemented in CorePlus. With FTP, for example, scanning is aware of the dual control and data transfer channels that are opened and can send a request via the control connection to stop a download if a virus in the download is detected.

6.4.3. Activating Anti-Virus Scanning

Association with an ALG

Activation of Anti-Virus scanning is achieved through an ALG associated with the targeted protocol. An ALG object must first exist with the Anti-Virus option enabled. As always, an ALG must then be associated with an appropriate Service object for the protocol to be scanned. The Service object is then associated with a rule in the IP rule set which defines the origin and destination of the traffic to which the ALG is to be applied.

Creating Anti-Virus Policies

Since IP rule set rules are the means by which the Anti-Virus feature is deployed, the deployment can be *policy based*. IP rules can specify that the ALG and its associated Anti-Virus scanning can apply to traffic going in a given direction and between specific source and destination IP addresses and/or networks. Scheduling can also be applied to virus scanning so that it takes place only at specific times.

6.4.4. The Signature Database

SafeStream

CorePlus Anti-Virus scanning is implemented by Clavister using the "SafeStream" virus signature database. The SafeStream database is created and maintained by Kaspersky, a company which is a world leader in the field of virus detection. The database provides protection against virtually all known virus threats including trojans, worms, backdoor exploits and others. The database is also thoroughly tested to provide near zero false positives.

Database Updates

The SafeStream database is updated on a daily basis with new virus signatures. Older signatures are seldom retired but instead are replaced with more generic signatures covering several viruses. The local CorePlus copy of the SafeStream database should therefore be updated regularly and this updating service is enabled as part of the subscription to the Clavister Anti-Virus subscription.

6.4.5. Subscribing to the Clavister Anti-Virus Service

The Clavister Anti-Virus feature is purchased as an additional component to the base Clavister license and is bought in the form of a renewable subscription. An Anti-Virus subscription includes regular updates of the Kaspersky SafeStream database during the subscription period with the signatures of the latest virus threats.

To subscribe to the Anti-Virus service please refer to the details described in Appendix A, *Subscribing to Security Updates*.

6.4.6. Anti-Virus Options

When configuring Anti-Virus scanning in an ALG, the following parameters can be set:

1. General options

Mode
This must be one of:
A. Disabled - Anti-Virus is switched off.
B. Audit - Scanning is active but logging is the only action.
C. Protect - Anti-Virus is active. Suspect files are dropped and logged.

Fail mode behavior
If a virus scan fails for any reason then the transfer can be dropped or allowed, with the event being logged. If this option is set to *Allow* then a condition such as the virus database not being available or the current license not being valid will not cause files to be dropped. Instead, they will be allowed through and a log message will be generated to indicate a failure has occured.

2. Scan Exclude Option

Certain filetypes may be explicitly excluded from virus-scanning if that is desirable. This can increase overall throughput if an excluded filetype is a type which is commonly encountered in a particular scenario, such as image files in HTTP downloads.

CorePlus performs MIME content checking on all the filetypes listed in Appendix E, *Verified MIME filetypes* to establish the file's true filetype and then look for that filetype in the excluded list. If the file's type cannot be established from its contents (and this may happen with filetypes not specified in Appendix E, *Verified MIME filetypes*) then the filetype in the file's name is used when the excluded list is checked.

3. Compression Ratio Limit

When scanning compressed files, CorePlus must apply decompression to examine the file's contents. Some types of data can result in very high compression ratios where the compressed file is a small fraction of the original uncompressed file size. This can mean that a comparatively small compressed file attachment might need to be uncompressed into a much larger file which can place an excessive load on CorePlus resources and noticeably slowdown throughput.

To prevent this situation, the administrator should specify a *Compression Ratio* limit. If the limit of the ration is specified as **10** then this will mean that if the uncompressed file is 10 times larger than the compressed file, the specified Action should be taken. The Action can be one of:

- **Allow** - The file is allowed through without virus scanning
- **Scan** - Scan the file for viruses as normal
- **Drop** - Drop the file

In all three of the above cases the event is logged.

Verifying the MIME Type

The ALG **File Integrity** options can be utilized with Anti-Virus scanning to check that the file's contents matches the MIME type it claims to be.

The MIME type identifies a file's type. For instance a file might be identified as being of type *.gif* and therefore should contain image data of that type. Some viruses can try to hide inside files by using a misleading file type. A file might pretend to be a *.gif* file but the file's data will not match that type's data pattern because it is infected with a virus.

Enabling of this function is recommended to make sure this form of attack cannot allow a virus to get through. The possible MIME types that can be checked are listed in Appendix E, *Verified MIME filetypes*.

Selecting the Anti-Virus Engine

If hardware based Anti-Virus acceleration is not available then the CorePlus Anti-Virus module offers a choice of Anti-Virus software scanning engines. The advanced setting **AVSW_Engine** allows selection of the engine best suited to the environment in which it is running. The options for this setting are:

- **Auto** - Select the engine automatically.
- **DFA** - Use the engine which maximizes scanning speed.
- **NFA** - Use the engine which minimizes memory usage.

These options have no meaning if Anti-Virus hardware acceleration is being used.

Setting the Correct System Time

It is important that a CorePlus has the correct system time set if the auto-update feature in the Anti-Virus module can function correctly. An incorrect time can mean the auto-updating is disabled.

The console command

```
> updatecenter -status
```

will show the current status of the auto-update feature.

Updating in High Availability Clusters

Updating the Anti-Virus databases for both the Clavister Security Gateways in an HA Cluster is performed automatically by CorePlus. In a cluster there is always an *active* unit and an *inactive* unit. Only the active unit in the cluster will perform regular checking for new database updates. If a new database update becomes available the sequence of events will be as follows:

1. The active unit determines there is a new update and downloads the required files for the update.
2. The active unit performs an automatic reconfiguration to update its database.
3. This reconfiguration causes a failover so the passive unit becomes the active unit.
4. When the update is completed, the newly active unit also downloads the files for the update and performs a reconfiguration.
5. This second reconfiguration causes another failover so the passive unit reverts back to being active again.

These steps result in both Clavister Security Gateways in a cluster having updated databases and with the original active/passive roles. For more information about HA clusters refer to Chapter 11, *High Availability*.

Example 6.19. Activating Anti-Virus Scanning

This example shows how to setup an Anti-Virus scanning policy for HTTP traffic from **lannet** to **all-nets**. We will assume there is already a NAT rule defined in the IP rule set to NAT this traffic.

Clavister FineTune

A. Create a new HTTP ALG Object:

1. Go to **Local Objects > Application Layer Gateways > New Application Layer Gateway**
2. The **Application Layer Gateway Properties** dialog will be displayed
3. Specify a name for the ALG, for example *anti_virus*
4. Select **HTTP** from the **Type** list
5. Click the **Parameters...** button and the **HTTP Application Layer Gateway** dialog will be shown
6. Click the **Antivirus** tab
7. Select **Enabled** in the **Mode** dropdown list
8. Click **OK** for both of the open dialogs

B. Next, create a Service object using the new HTTP ALG:

1. Go to **Local Objects > Services > New Service**
2. The **Service Properties** dialog will be displayed
3. Specify a suitable name for the Service, for instance *http_anti_virus*
4. Make sure **TCP** is selected in the **Type** dropdown list
5. Select the HTTP ALG just created in the **ALG** dropdown list
6. Click the **TCP/UDP Parameters** tab
7. Enter **80** in the **Destination Port** textbox
8. Click **OK** in both of the open dialogs

C. Finally, modify the NAT rule to use the new service:

1. Go to **Rules**
2. Open the properties dialog for the NAT rule handling the HTTP traffic between **lannet** and **all-nets**
3. Click the **Service** tab
4. Select your new service in the **Pre-defined** dropdown list
5. Click **OK**

Anti-Virus scanning is now activated for all web traffic from **lannet** to **all-nets**.

6.5. Intrusion Detection and Prevention

6.5.1. Overview

Intrusion Definition

Computer servers can sometimes have vulnerabilities which leave them exposed to attacks carried by network traffic. Worms, trojans and backdoor exploits are examples of such attacks which, if successful, can potentially compromise or take control of a server. A generic term that can be used to describe these server orientated threats are *intrusions*.

Intrusion Detection

Intrusions differ from viruses in that a virus is normally contained in a single file download and this is normally downloaded to a client system. An intrusion manifests itself as a malicious pattern of Internet data aimed at bypassing server security mechanisms. Intrusions are not uncommon and they can constantly evolve as their creation can be automated by the attacker. CorePlus IDP provides an important line of defence against these threats.

Intrusion Detection and Prevention (IDP) is a CorePlus module that is designed to protect against these intrusion attempts. It operates by monitoring network traffic as it passes through the Clavister Security Gateway, searching for patterns that indicate an intrusion is being attempted. Once detected, CorePlus IDP allows steps to be taken to neutralize both the intrusion attempt as well as its source.

> ***Note***
> *IDP performance, like Anti-Virus scanning performance, can be increased with an optional hardware acceleration upgrade on the SG50, SG4200 and SG4400 Security Gateways. Multiple streams are accelerated asynchronously in this optional hardware to boost overall throughput. The console command* ***hwaccel*** *can be used to check if acceleration is installed. Also note that IDP is not available on the discontinued SG30 model.*

IDP Issues

In order to have an effective and reliable IDP system, the following issues have to be addressed:

1. What kinds of traffic should be analyzed?
2. What should we search for in that traffic?
3. What action should be carried out when an intrusion is detected?

CorePlus IDP Components

CorePlus IDP addresses the above issues with the following mechanisms:

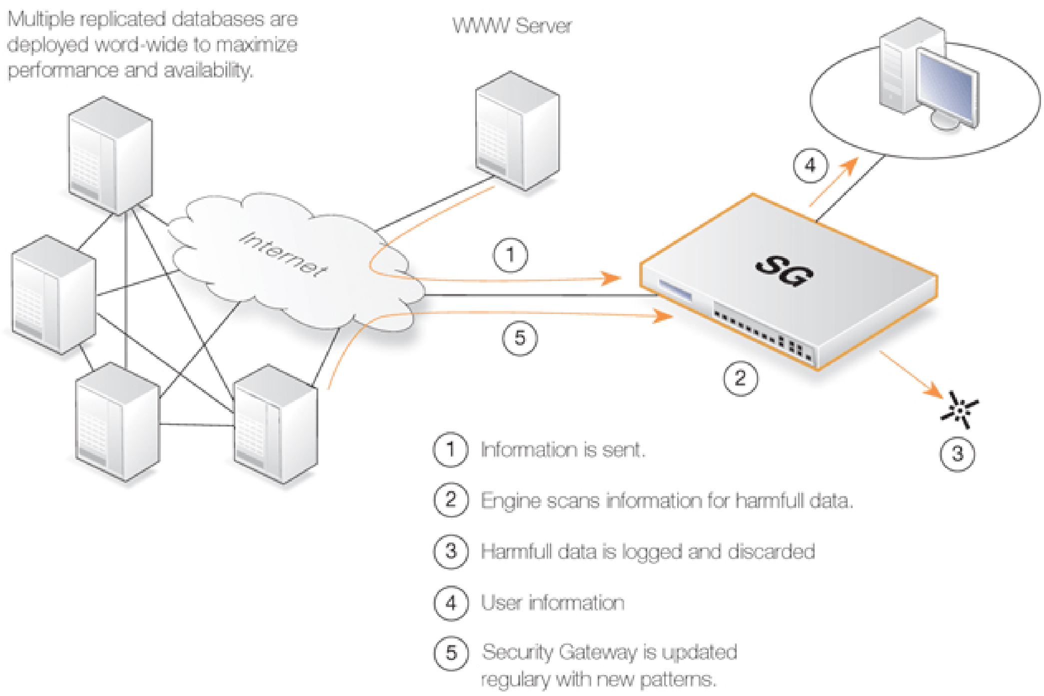
1. **IDP Rules** are defined up by the administrator to determine what traffic should be scanned.
2. **Pattern Matching** is applied by CorePlus IDP to the traffic that matches an IDP Rule as it streams through the gateway.
3. If CorePlus IDP detects an intrusion then the **Action** specified for the triggering IDP Rule is taken.

IDP Rules, Pattern Matching and IDP Rule Actions are described in the sections which follow.

6.5.2. Subscribing to Clavister IDP

Clavister IDP is purchased as an additional component to the base CorePlus license. It is a subscription service and the subscription means that the IDP signature database can be downloaded to a CorePlus installation and also that the database is regularly updated with the latest intrusion threats. For full details about obtaining the IDP service please refer to Appendix A, *Subscribing to Security Updates*.

Figure 6.7. IDP Database Updating



Automatic Updating

New attacks can be discovered on a daily basis, so it is important to have an up to date signature database in order to protect the network from the latest threats. Auto-update is an option that can be enabled or disabled by the administrator.

With auto-update enabled, signature database updates are downloaded automatically by CorePlus at a configurable interval. This is done via an HTTP connection to the Clavister server network which delivers the latest signature database updates. If the server's signature database has new signatures then new updates will be automatically downloaded, replacing any older versions. No reconfiguration is needed by the administrator to activate new signatures.

If auto-update is disabled then updates must be explicitly forced and the administrator needs to be aware of when new updates are available. However, this approach does help with more quickly detecting any false positives that new signatures might produce.

Setting the Correct System Time

It is important that a CorePlus has the correct system time set if the auto-update feature in the IDP module can function correctly. An incorrect time can mean the auto-updating is disabled.

The console command

```
> updatecenter -status
```

will show the current status of the auto-update feature.

Updating in High Availability Clusters

Updating the IDP databases for both the Clavister Security Gateways in an HA Cluster is performed automatically by CorePlus. In a cluster there is always an *active* unit and an *inactive* unit. Only the active unit in the cluster will perform regular checking for new database updates. If a new database update becomes available the sequence of events will be as follows:

1. The active unit determines there is a new update and downloads the required files for the update.
2. The active unit performs an automatic reconfiguration to update its database.
3. This reconfiguration causes a failover so the passive unit becomes the active unit.
4. When the update is completed, the newly active unit also downloads the files for the update and performs a reconfiguration.
5. This second reconfiguration causes another failover so the passive unit reverts back to being active again.

These steps result in both Clavister Security Gateways in a cluster having updated databases and with the original active/passive roles. For more information about HA clusters refer to Chapter 11, *High Availability*.

6.5.3. IDP Rules

Rule Components

An **IDP Rule** defines what kind of traffic, or service, should be analyzed. An IDP Rule is similar in makeup to an IP Rule. IDP Rules are constructed like other security policies in CorePlus such as IP Rules. An IDP Rule specifies a given combination source/destination interfaces/addresses as well as being associated with a Service object which defines which protocols to scan. A time schedule can also be associated with an IDP Rule. Most importantly, an IDP Rule specifies the **Action** to take on detecting an intrusion in the traffic targeted by the rule.

Initial Packet Processing

The initial order of packet processing with IDP is as follows:

1. A packet arrives at the gateway and CorePlus performs normal verification. If the packet is part of a new connection then it is checked against the IP rule set before being passed to the IDP module. If the packet is part of an existing connection it is passed straight to the IDP system. If the packet is not part of an existing connection or is rejected by the IP rule set then it is dropped.
2. The source and destination information of the packet is compared to the set of IDP Rules defined by the administrator. If a match is found, it is passed on to the next level of IDP processing which is pattern matching, described in step below. If there is no match against an IDP rule then the packet is accepted and the IDP system takes no further actions although further actions defined in the IP rule set are applied such as address translation and logging.

6.5.4. Insertion/Evasion Attack Prevention

Overview

When defining an IDP Rule, the administrator has the option to enable or disable the ability to "Protect against Insertion/Evasion attack". *Insertion/Evasion Attack* is a form of attack which is specifically aimed at IDP systems. It exploits the fact that in a TCP/IP data transfer, the data stream must often be reassembled from smaller pieces of data because the individual pieces either arrive in the wrong order or are fragmented in some way. *Insertions* or *Evasions* are designed to exploit this reassembly process.

Insertion Attacks

An Insertion attack consists of inserting data into a stream so that the resulting sequence of data packets is accepted by the IDP subsystem but will be rejected by the targeted application. This results is two different streams of data.

As an example, consider a data stream broken up into 4 packets: p1, p2, p3 and p4. The attacker might first send packets p1 and p4 to the targeted application. These will be held by both the IDP subsystem and the application until packets p2 and p3 arrive so that reassembly can be done. The attacker now deliberately sends two packets, p2' and p3', which will be rejected by the application but accepted by the IDP system. The IDP system is now able to complete reassembly of the packets and believes it has the full data stream. The attacker now sends two further packets, p2 and p3, which will be accepted by the application which can now complete reassembly but resulting in a different data stream to that seen by the IDP subsystem.

Evasion Attacks

An evasion attack has a similar end-result to the Insertion Attack in that it also generates two different data streams, one that the IDP subsystem sees and one that the target application sees, but it is achieved in the reverse way. It consists of sending data packets that are rejected by the IDP subsystem but are acceptable to the target application.

Detection Action

If an Insertion/Evasion Attack is detected with the Insertion/Evasion Protect option enabled, CorePlus automatically corrects the data stream by removing the extraneous data associated with the attack.

Insertion/Evasion Log Events

The Insertion/Evasion Attack subsystem in CorePlus can generate two types of log message:

- An **Attack Detected** log message, indicating an attack has been identified and prevented.
- An **Unable to Detect** log message when CorePlus has been unable to identify potential attacks when reassembling a TCP/IP stream although such an attack may have been present. This condition is caused by infrequent and unusually complex patterns of data in the stream.

Recommended Configuration

By default, Insertion/Evasion protection is enabled for all IDP rules and this is the recommended setting for most configurations. There are two motivations for disabling the option:

- **Increasing throughput** - Where the highest throughout possible is desirable, then turning the option off, can provide a slight increase in processing speed.

- **Excessive False Positives** - If there is evidence of an unusually high level of Insertion/Evasion false positives then disabling the option may be prudent while the false positive causes are investigated.

6.5.5. IDP Pattern Matching

Signatures

In order for IDP to correctly identify an attack, it uses a profile of indicators, or *pattern*, associated with different types of attack. These pre-defined patterns, also known as *signatures*, are stored in a local CorePlus database and are used by the IDP module to analyze traffic for attack patterns. Each IDP signature is designated by a unique number.

Consider the following simple attack example involving an exchange with an FTP server. A rogue user might try to retrieve the password file "passwd" from an FTP server using the FTP command **RETR passwd**. A signature looking for the ASCII text strings *RETR* and *passwd* would find a match in this case, indicating a possible attack. In this example, the pattern is found in plaintext but pattern matching is done in the same way on pure binary data.

Recognising Unknown Threats

Attackers who build new intrusions often re-use older code. This means their new attacks can appear "in the wild" quickly. To counter this, Clavister IDP uses an approach where the module scans for these reusable components, with pattern matching looking for building blocks rather than the entire complete code patterns. This means that "known" threats as well as new, recently released, "unknown" threats, built with re-used software components, can be protected against.

Signature Advisories

An *advisory* is a explanatory textual description of a signature. Reading a signature's advisory will explain to the administrator what the signature will search for. Due to the changing nature of the signature database, advisories are not included in Clavister documentation but instead, are available on the Clavister website at:

http://www.clavister.com/securityportal/advisories/

IDP Signature types

IDP offers three signature types which offer differing levels of certainty with regard to threats:

- **Intrusion Protection Signatures (IPS)** - These are highly accurate and a match is almost certainly an indicator of a threat. Using the **Protect** action is recommended. These signatures can detect administrative actions and security scanners.

- **Intrusion Detection Signatures (IDS)** - These can detect events that may be intrusions- They have lower accuracy than IPS and may give some false positives so that's recommended that the **Audit** action is initially used before deciding to use **Protect**.

- **Policy Signatures** - These detect different types of application traffic. They can be used to block certain applications such as file sharing applications and instant messaging.

6.5.6. IDP Signature Groups

Using Groups

Usually, several lines of attacks exist for a specific protocol, and it is best to search for all of them at the same time when analyzing network traffic. To do this, signatures related to a particular protocol are grouped together. For example, all signatures that refer to the FTP protocol form a group. It is best to specify a group that relates to the traffic being searched than be concerned about individual signatures. For performance purposes, the aim should be to have CorePlus search data using the least possible number of signatures.

1. Signature Group Type

The group type is one of the values *IDS*, *IPS* or *Policy*. These types are explained above.

2. Signature Group Category

This second level of naming describes the type of application or protocol. Examples are:

- BACKUP
- DB
- DNS
- FTP
- HTTP

3. Signature Group Sub-Category

The third level of naming further specifies the target of the group and often specifies the application, for example *MSSQL*. The Sub-Category may not be necessary if the *Type* and *Category* are sufficient to specify the group, for example **APP_ITUNES**.

Selecting Groups With Clavister FineTune

A selection of signature groups is possible through a hierarchical tree view of all signatures. The *Type is selected*, then the *Category* followed by the *Sub-Category*. Going down further into the tree-view will show the individual signatures in a group. These individual signatures can be turned off or on if desired so that a signature group can be changed to contain only those signatures which are relevant.

Listing of IDP Groups

A listing of IDP groupings can be found in Appendix D, *IDP Signature Groups*. The listing shows group names consisting of the *Category* followed by the *Sub-Category*, since the *Type* could be any of IDS, IPS or POLICY.

Processing Multiple Actions

For any IDP rule, it is possible to specify multiple actions and an action type such as **Protect** can be repeated. Each action will then have one or more signatures or groups associated with it. When signature matching occurs it is done in a top-down fashion, with matching for the signatures for the first action specified being done first.

Caution: Use the minimum IDP signatures necessary

Do not use the entire signature database and avoid using signatures and signature groups unnecessarily. Instead, use only those signatures or groups applicable to the *type of traffic you are trying to protect. For instance, using IDS_WEB*, IPS_WEB*, IDS_HTTP* and IPS_HTTP* IDP groups would be appropriate for protecting an HTTP server.*

IDP traffic scanning creates an additional load on the hardware that in most cases shouldn't noticeably degrade performance. Using too many signatures during scanning can make the load on the gateway hardware unnecessarily high, adversely affecting throughput.

6.5.7. IDP Actions

Action Options

After pattern matching recognises an intrusion in traffic subject to an IDP Rule, the Action associated with that Rule is taken. The administrator can associate one of three Action options with an IDP Rule:

- **Ignore** - Do nothing if an intrusion is detected and allow the connection to stay open.
- **Audit** - Allow the connection to stay open but log the event.
- **Protect** - This option drops the connection and logs the event (with the additional option to blacklist the source of the connection as described below).

IDP Blacklisting

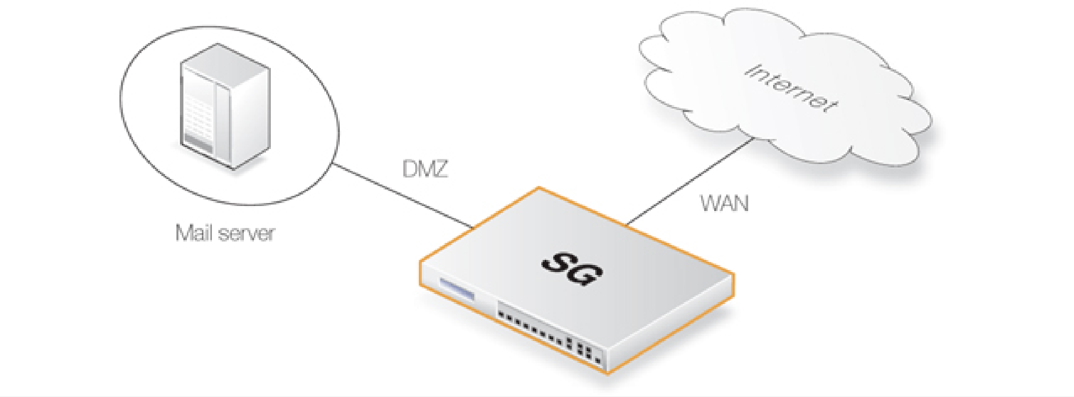
The **Protect** option includes the option that the particular host or network that triggers the IDP Rule can be added to a *Blacklist* of offending traffic sources. This means that all subsequent traffic coming from a blacklisted source with be automatically dropped by CorePlus. For more details of how blacklisting functions see Section 6.7, “Blacklisting Hosts and Networks”.

Tip

Any IP address that exists in the CorePlus whitelist can't be blacklisted. For this reason it is recommended that the IP address of the management workstation and the Clavister Security Gateway itself is added to the whitelist when using IDP.

Example 6.20. Setting up IDP for a Mail Server

The following example details the steps needed to set up IDP for a simple scenario where a mail server is exposed to the Internet on the **DMZ** network with a public IP address. The public Internet can be reached through the gateway on the **WAN** interface as illustrated below.



Clavister FineTune

Create IDP Rule:

An IDP rule called *IDPMailSrvRule* will be created, and the *Service* to use is the SMTP service. Source Interface and Source Network defines where traffic is coming from, in this example the external network. The *Destination Interface* and *Destination Network* define where traffic is directed to, in this case the mail server. *Destination Network* should therefore be set to the object defining the mail server.

1. Go to **Intrusion Prevention > Intrusion Prevention Rules > New Intrusion Prevention Rule**
2. The **Intrusion Prevention Rule Properties** dialog will appear
3. Now enter:
   - **Name:***IDPMailSrvRule*
   - **Source Interface:***wan*
   - **Source Network:***wannet*
   - **Destination Interface:***dmz*
   - **Destination Network:***ip_mailserver*
4. Select the **Service** tab and select the *smtp* service so this IDP rule will be used only on this service
5. Select the **Rule Actions** tab and select the IDP *SMTP_Server* signature group and the **Protect** option for this action

   Note that it is important to select the **minimum number of IDP signature groups that are applicable to the traffic that is to be scanned** to ensure reasonable performance throughput - selecting too many groups can degrade throughput

To summarize, the following will occur: If traffic from the external network, to the mail server is discovered, the IDP will scan the packets. In case the traffic matches any of the signatures in the *IPS_MAIL_SMTP* signature group, the connection will be dropped, thus protecting the mail server. *If the blacklist had been selected instead then the source IP or network would be blacklisted and all future traffic from there blocked.*

6.6. Denial-Of-Service (DoS) Attacks

6.6.1. Overview

By embracing the Internet, enterprises experience new business opportunities and growth. The enterprise network and the applications that run over it are business critical. Not only can a company reach a larger number of customers via the Internet, it can serve them faster and more efficiently. At the same time, using a public IP network enables companies to reduce infrastructure-related costs.

Unfortunately, the same advantages that the Internet brings to business also benefit the hackers who use the same public infrastructure to mount attacks. Attack tools are readily available on the Internet and development work on these tools is often split across groups of novice hackers — known as "script kiddies" or "larval hackers" — scattered across the globe, providing around-the-clock progression of automated attack methods. Many of the new attack methods utilize the distributed nature of the Internet to launch DoS attacks against organizations.

To be on the receiving end of a DoS attack is probably the last thing any network administrator wants to experience. Attacks can appear out of thin air and the consequences can be devastating with crashed servers, jammed Internet connections and business critical systems in overload.

This section deals with using the Clavister Security Gateway to protect organizations against DoS attacks.

6.6.2. DoS Attack Mechanisms

A DoS attack can be perpetrated in a number of ways but there are three basic types of attack:

- Consumption of computational resources, such as bandwidth, disk space, or CPU time.
- Disruption of configuration information, such as routing information.
- Disruption of physical network components.

One of the most commonly used method is the consumption of computational resources which means that the DoS attack floods the network and ties up critical resources used to run business critical applications. In some cases, vulnerabilities in the Unix and Windows operating systems are exploited to intentionally crash the system, while in other cases large amounts of apparently valid traffic are directed at sites until they become overloaded and crash.

Some of the most commonly used DoS attacks have been:

- The Ping of Death / Jolt attacks
- Fragmentation overlap attacks: Teardrop / Bonk / Boink / Nestea
- The Land and LaTierra attacks
- The WinNuke attack
- Amplification attacks: Smurf, Papasmurf, Fraggle
- TCP SYN Flood attack
- The Jolt2 attack

6.6.3. *Ping of Death* and *Jolt* Attacks

The "ping of death" is one of the earliest layer 3/4 attacks. One of the simplest ways to execute it is to run "ping -l 65510 1.2.3.4" on a Windows 95 system where 1.2.3.4 is the IP address of the intended victim. "Jolt" is simply a purpose-written program for generating such packets on operating systems whose ping commands refuse to generate oversized packets.

The triggering factor is that the last fragment makes the total packet size exceed 65535 bytes, which is the highest number that a 16-bit integer can store. When the value overflows, it jumps back to a very small number. What happens then is a function of how well the victim's IP stack is implemented.

CorePlus will never allow fragments through that would result in the total size exceeding 65535 bytes. In addition to that, there are configurable limits for IP packet sizes in Advanced Settings.

Ping of death will show up in CorePlus logs as drops with the rule name set to "LogOversizedPackets". The sender IP address may be spoofed.

6.6.4. Fragmentation overlap attacks: *Teardrop, Bonk, Boink and Nestea*

Teardrop and its followers are fragment overlap attacks. Many IP stacks have shown erratic behavior (excessive resource exhaustion or crashes) when exposed to overlapping fragments.

CorePlus protects fully against fragmentation overlap attacks. Overlapping fragments are never allowed to pass through the system.

Teardrop and its followers will show up in CorePlus logs as drops with the rule name set to "IllegalFrags". The sender IP address may be spoofed.

6.6.5. The *Land* and *LaTierra* attacks

The Land and LaTierra attacks works by sending a packet to a victim and making the victim respond back to itself, which in turn generates yet another response to itself, etc. This will either bog the victim's machine down, or make it crash.

The attack is accomplished by using the victim's IP address in the source field of an IP packet as well as in the destination field.

CorePlus protects against this attack by applying IP spoofing protection to all packets. In its default configuration, it will simply compare arriving packets to the contents of the routing table; if a packet arrives on an interface that is different from the interface where the system expects the source to be, the packet will be dropped.

Land and LaTierra attacks will show up in CorePlus logs as drops with the rule name set to "AutoAccess" by default, or, if you have written custom Access rules, the name of the Access rule that dropped the packet. The sender IP address is of no interest here since it is always the same as the destination IP address.

6.6.6. The *WinNuke* attack

The WinNuke attack works by connecting to a TCP service that does not have handlers for "out-of-band" data (TCP segments with the URG bit set), but still accepts such data. This will usually put the service in a tight loop that consumes all available CPU time.

One such service was the NetBIOS over TCP/IP service on Windows machines, which gave the attack its name.

CorePlus protects against this in two ways:

- With a careful inbound policy, the attack surface is greatly reduced. Only exposed services could possibly become victims to the attack, and public services tend to be more well-written than services expected to only serve the local network.
- By stripping the URG bit by default from all TCP segments traversing the system (configurable

via **Advanced Settings > TCP > TCPUrg**).

WinNuke attacks will usually show up in CorePlus logs as normal drops with the name of the rule in your policy that disallowed the connection attempt. For connections allowed through the system, "TCP" or "DROP" category (depending on the TCPUrg setting) entries will appear, with a rule name of "TCPUrg". The sender IP address is not likely to be spoofed; a full three-way handshake must be completed before out-of-band segments can be sent.

6.6.7. Amplification attacks: *Smurf, Papasmurf, Fraggle*

This category of attacks all make use of "amplifiers": poorly configured networks who amplify a stream of packets and send it to the ultimate target. The goal is excessive bandwidth consumption - consuming all of the victim's Internet connection capacity. An attacker with sufficient bandwidth can forgo the entire amplification stage and simply stream enough bandwidth at the victim. However, these attacks allows attackers with less bandwidth than the victim to amplify their data stream to overwhelm the victim.

- "Smurf" and "Papasmurf" send ICMP echo packets to the broadcast address of open networks with many machines, faking the source IP address to be that of the victim. All machines on the open network then "respond" to the victim.
- "Fraggle" uses the same general idea, but instead using UDP echo (port 7) to accomplish the task. Fraggle generally gets lower amplification factors since there are fewer hosts on the Internet that have the UDP echo service enabled.

Smurf attacks will show up in CorePlus logs as masses of dropped ICMP Echo Reply packets. The source IP addresses will be those of the amplifier networks used. Fraggle attacks will show up in CorePlus logs as masses of dropped (or allowed, depending on policy) packets. The source IP addresses will be those of the amplifier networks used.

Avoiding Becoming an Amplifier

Even though the brunt of the bandwidth stream is at the ultimate victim's side, being selected as an amplifier network can also consume great resources. In its default configuration, CorePlus explicitly drops packets sent to broadcast address of directly connected networks (configurable via **Advanced Settings > IP > DirectedBroadcasts**). However, with a reasonable inbound policy, no protected network should ever have to worry about becoming a smurf amplifier.

Protection on the Victim's Side

Smurf, and its followers, are resource exhaustion attacks in that they use up Internet connection capacity. In the general case, the gateway is situated at the "wrong" side of the Internet connection bottleneck to provide much protection against this class of attacks. The damage has already been done by the time the packets reach the gateway.

However, CorePlus may be of some help in keeping the load off of internal servers, making them available for internal service, or perhaps service via a secondary Internet connection not targeted by the attack.

- Smurf and Papasmurf floods will be seen as ICMP Echo Responses at the victim side. Unless "FwdFast" rules are in use, such packets are never allowed to initiate new connections, regardless of whether or not there are rules that allow the traffic.
- Fraggle packets may arrive at any UDP destination port targeted by the attacker. Tightening the inbound rule set may help.

The Traffic Shaping feature built into CorePlus also help absorb some of the flood before it reaches protected servers.

6.6.8. TCP SYN Flood Attacks

TCP SYN flood attacks work by sending large amounts of TCP SYN packets to a given port and then not responding to SYN ACKs sent in response. This will tie up local TCP stack resources on the victim's web server so that it is unable to respond to more SYN packets until the existing half-open connections have timed out.

CorePlus can protect against TCP SYN Flood attacks if the *Syn Flood Protection* option is enabled in a service object associated with the rule in the IP rule set that triggers on the traffic. This is also sometimes referred to as the *SYN Relay* option.

Flood protection is enabled automatically in the predefined services **http-in**, **https-in**, **smtp-in**, and **ssh-in**. If a new custom service object is defined by the administrator then the flood protection option can be enabled or disabled as desired.

The SYN Flood Defence Mechanism

Syn flood protection works by completing the 3-way handshake with the client before doing a second handshake of its own with the target service. Overload situations have difficulty occuring in CorePlus due to superior resource management and an absence of the restrictions normally placed on other operating systems. While other operating systems can exhibit problems with as few as 5 outstanding half-open connections, CorePlus can fill its entire state table before anything out of the ordinary happens. When the state table fills up, old outstanding SYN connections will be the first to be dropped to make room for new connections.

Spotting SYN Floods

TCP SYN flood attacks will show up in CorePlus logs as excessive amounts of new connections (or drops, if the attack is targeted at a closed port). The sender IP address is almost invariably spoofed.

ALGs Automatically Provide Flood Protection

It should be noted that SYN Flood Protection does not need to be explicitly enabled on a service object that has an ALG associated with it. ALGs provide automatic SYN flood protection.

6.6.9. The *Jolt2* Attack

The Jolt2 attack works by sending a steady stream of identical fragments at the victim machine. A few hundred packets per second will freeze vulnerable machines completely until the stream is ended.

CorePlus will protect completely against this attack. The first fragment will be queued, waiting for earlier fragments to arrive so that they may be passed on in order, but this never happens, so not even the first fragment gets through. Subsequent fragments will be thrown away as they are identical to the first fragment.

If the attacker chooses a fragment offset higher than the limits imposed by the **Advanced Settings > LengthLim** in CorePlus, the packets will not even get that far; they will be dropped immediately. Jolt2 attacks may or may not show up in CorePlus logs. If the attacker chooses a too-high fragment offset for the attack, they will show up as drops from the rule set to "LogOversizedPackets". If the fragment offset is low enough, no logging will occur. The sender IP address may be spoofed.

6.6.10. Distributed DoS Attacks

A more sophisticated form of DoS is the *Distributed Denial of Service* (DDoS) attack. DDoS attacks involve breaking into hundreds or thousands of machines all over the Internet to installs DDoS software on them, allowing the hacker to control all these burgled machines to launch coordinated attacks on victim sites. These attacks typically exhaust bandwidth, router processing capacity, or network stack resources, breaking network connectivity to the victims.

Although recent DDoS attacks have been launched from both private corporate and public institutional systems, hackers tend to often prefer university or institutional networks because of their open, distributed nature. Tools used to launch DDoS attacks include Trin00, TribeFlood Network (TFN), TFN2K and Stacheldraht.

6.7. Blacklisting Hosts and Networks

Overview

CorePlus implements a *Blacklist* of host or network IP addresses which can be utilized to protect against traffic coming from specific Internet sources.

Certain CorePlus subsystems have the ability to optionally blacklist a host or network when certain conditions are encountered. These subsystems are:

- Intrusion Detection and Prevention (IDP).
- Threshold Rules.

Blacklisting Options

The automatic blacklisting of a host or network can be enabled in IDP and in Threshold Rules by specifying the **Protect** action for when a rule is triggered. Once enabled there are three blacklisting options:

Time to Block Host/Network in seconds
The host or network which is the source of the traffic will stay on the blacklist for the specified time and then be removed. If the same source triggers another entry to the blacklist then the blocking time is renewed to its original, full value (in other words, it is not cumulative).

Block only this Service
By default Blacklisting blocks all Services for the triggering host.

Exempt already established connections from Blacklisting
If there are established connections that have the same source as this new Blacklist entry then they won't be dropped if this option is set.

IP addresses or networks are added to the list then the traffic from these sources is then blocked for the period of time specified.

Note: Restarts don't effect the blacklist
The contents of the blacklist is not lost if the Clavister Security Gateway shuts down and restarts.

Whitelisting

To ensure that Internet traffic coming from trusted sources, such as the management workstation, are not blacklisted under any circumstances, a *Whitelist* is also maintained by CorePlus. Any IP address object can be added to this whitelist

Tip: Important IP addresses should be whitelisted
It is recommended to add the Clavister Security Gateway itself to the whitelist as well as the IP address or network of the management workstation since blacklisting of either could have serious consequences for network operations.

It is also important to understand that although whitelisting prevents a particular source from being blacklisted, it still doesn't prevent CorePlus mechanisms such as Threshold Rules from dropping or denying connections from that source. What whitelisting does is prevent a source being added to a blacklist if that is the action a rule has specified.

For further details on usage see Section 6.5.7, “IDP Actions”, Section 10.2.7, “Threshold Rule Blacklisting” and Section 10.2, “Threshold Rules”.

Note: The content filtering blacklist is separate

Content filtering blacklisting is a separate subject and uses a separate logical list (see Section 6.3, “Web Content Filtering”).

Example 6.21. Adding a Host to the Whitelist

In this example we will add an IP address object called *white_ip* to the whitelist. This will mean this IP address can never be blacklisted.

Clavister FineTune

1. Go to **Miscellaneous > Whitelist > New Whitelist Item**
2. The **Whitelist Item Properties** dialog will appear
3. Now Enter:
    a. **IP Address:** Choose *white_ip* from the dropdown list
    b. **Protocol:** Select *all_tcp* from the dropdown list
4. Click **OK**

Chapter 7. Address Translation

This chapter describes CorePlus address translation capabilities.

The ability of CorePlus to change the IP address of packets as they pass through the Clavister Security Gateway is known as *address translation*. CorePlus supports two types of translation: *Dynamic Network Address Translation* (NAT) and *Static Address Translation* (SAT). Both translations are policy-based meaning that they can be applied to specific traffic based on source/destination network/interface as well as service. Two types of IP rules, *NAT rules* and *SAT rules*, are used to specify address translation within the IP rule set.

There are two main reasons for employing address translation:

- **Functionality**

  Perhaps private IP addresses are used on a protected network and protected hosts need to have access to the Internet. This is where dynamic address translation may be used. You might also have servers with private IP addresses that need to be publicly accessible. This is where static address translation may be the solution.

- **Security**

  Address translation does not, in itself provide any greater level of security, but it can make it more difficult for intruders to understand the exact layout of the protected network and which machines are susceptible to attack. In the worst case scenario, employing address translation will mean that an attack will take longer, which will also make it more visible in CorePlus log files. In the best-case scenario, an intruder will just give up.

This section describes dynamic as well as static address translation, how they work and what they can and cannot do. It also provides examples of configuring NAT and SAT rules.

7.1. NAT

Dynamic Network Address Translation (NAT) provides a mechanism for translating original source IP addresses to a different addresses. The most common usage for NAT is when using private IP addresses in an internal network and it is desirable that outbound connections appear as though they originate from the Clavister Security Gateway itself instead of the internal addresses.

Many-To-One Translation

NAT is a many-to-one translation, meaning that each NAT rule will translate several source IP addresses into a single source IP address. To maintain session state information, each connection from dynamically translated addresses must use a unique port number and IP address combination as its sender. Therefore, CorePlus will perform an automatic translation of the source port number as well. The source port number selected will be the next free port selected randomnly by CorePlus and will be above port 1,024. Ports are allocated randomly to increase security.

Limitations on the Number of Connections

There is a limitation of approximately 64,500 simultaneous NAT connections where each connection consists of a unique pair of IP addresses. The term *IP pair* means one IP address on a CorePlus interface and the IP address of some external host to which a connection is being made. If two different IP addresses on an external host are being connected to from the same NAT address on the security gateway then this will constitute two, unique IP pairs. The 64,500 figure is therefore not a limitation for the entire Clavister Security Gateway.

Translation Strategies

CorePlus supports two strategies for how to translate the source address:

Use Interface Address When a new connection is established, the routing table is consulted to resolve the egress interface for that connection. The IP address of that resolved interface is then being used as the new source IP address when CorePlus performs the address translation.

Specify Sender Address A specific IP address can be specified as the new source IP address. The specified IP address needs to have a matching ARP Publish entry configured for the egress interface. Otherwise, the return traffic will not be received by the Clavister Security Gateway.

The following example illustrates how NAT is applied in practice on a new connection:

1. The sender, for example 192.168.1.5, sends a packet from a dynamically assigned port, for instance, port 1038, to a server, for example 195.55.66.77 port 80.

   192.168.1.5:1038 => **195.55.66.77:80**

2. In this example, the Use Interface Address option is used, and we will use 195.11.22.33 as the interface address. In addition, the source port is changed to a free port on the Clavister Security Gateway and which is above port 1024. In this example, we will use port 32789. The packet is then sent to its destination.

   195.11.22.33:32789 => **195.55.66.77:80**

3. The recipient server then processes the packet and sends its response.

   195.55.66.77:80 => **195.11.22.33:32789**

4. CorePlus receives the packet and compares it to its list of open connections. Once it finds the connection in question, it restores the original address and forwards the packet.

   195.55.66.77:80 => **192.168.1.5:1038**

5. The original sender receives the response.

Example 7.1. Adding a NAT rule

To add a NAT rule that will perform address translation for all HTTP traffic originating from the internal network, follow the steps outlined below:

Clavister FineTune

1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Specify a suitable name for the rule, for instance NAT_HTTP
4. Now enter:

- **Action:** NAT
- **Source Interface:** lan
- **Source Network:** lannet
- **Destination Interface:** any
- **Destination Network:** all-nets

5. Under the **Service** tab, select **http** in the **Pre-defined** dropdown list
6. Under the **Address Translation** tab, make sure that the **Use Interface Address** option is selected
7. Click **OK**

Protocols Handled by NAT

Dynamic address translation is able to deal with the TCP, UDP and ICMP protocols with a good level of functionality since the algorithm knows which values can be adjusted to become unique in the three protocols. For other IP level protocols, unique connections are identified by their sender addresses, destination addresses and protocol numbers.

This means that:

- An internal machine can communicate with several external servers using the same IP protocol.
- An internal machine can communicate with several external servers using different IP protocols.
- Several internal machines can communicate with different external server using the same IP protocol.
- Several internal machines can communicate with the same server using different IP protocols.
- Several internal machines can *not* communicate with the same external server using the same IP protocol.

Note

These restrictions apply only to IP level protocols other than TCP, UDP and ICMP, such as OSPF, L2TP, etc. They do not apply to the protocols transported by TCP, UDP and ICMP such as telnet, FTP, HTTP, SMTP. CorePlus can alter port number information in the TCP and UDP headers to make each connection unique, even though such connections have had their sender addresses translated to the same IP.

Some protocols, regardless of the method of transportation used, can cause problems during address translation.

7.2. NAT Pools

Overview

As discussed in Section 7.1, “NAT”, NAT provides a way to have multiple internal clients and hosts with unique private internal IP addresses communicate to remote hosts through a single external public IP address. When multiple public external IP addresses are available then a *NAT Pool* object can be used to allocate new connections across these public IP addresses.

NAT Pools are usually employed when there is a requirement for huge numbers of unique port connections. The CorePlus Port Manager has a limit of approximately 65,000 connections for a unique combination of source and destination IP addresses. Where large number of internal clients are using applications such as file sharing software, very large numbers of ports can be required for each client. The situation can be similarly demanding if a large number of clients are accessing the Internet through a proxy-server. The port number limitation is overcome by allocating extra external IP addresses for Internet access and using NAT Pools to allocate new connections across them.

Types of NAT Pools

A NAT Pool can be one of three types, each allocating new connections in a different way:

- **Stateful**
- **Stateless**
- **Fixed**

These three types are discussed below.

Stateful NAT Pools

When the *Stateful* option is selected, CorePlus allocates a new connection to the external IP address that currently has the least number of connections routed through it with the assumption that it is the least loaded. CorePlus keeps a record in memory of all such connections. Subsequent connections involving the same internal client/host will then use the same external IP address.

The advantage of the stateful approach is that it can balance connections across several external ISP links while ensuring that an external host will always communicate back to the same IP address which will be essential with protocols such as HTTP when cookies are involved. The disadvantage is the extra memory required by CorePlus to track the usage in its state table and the small processing overhead involved in processing a new connection.

To make sure that the state table does not contain dead entries for communications that are no longer active, a **State Keepalive** time can be specified. This time is the number of seconds of inactivity that must occur before a state in the state table is removed. After this period CorePlus assumes no more communication will originate from the associated internal host. Once the state is removed then subsequent communication from the host will result in a new state table entry and may be allocated to a different external IP address in the NAT Pool.

The state table itself takes up memory so it is possible to limit its size using the *Max States* value in a NAT Pool object. The state table is not allocated all at once but is incremented in size as needed. One entry in the state table tracks all the connections for a single host behind the Clavister Security Gateway no matter which external host the connection concerns. If *Max States* is reached then an existing state with the longest idle time is replaced. If all states in the table is active then the new connection is dropped. As a rule of thumb, the *Max States* value should be at least the number of local hosts or clients that will connect to the Internet.

There is only one state table per NAT Pool so that if a single NAT Pool is re-used in multiple NAT IP rules they share the same state table.

Stateless NAT Pools

The *Stateless* option means that no state table is maintained and the external IP address chosen for each new connection is the one that has the least connections already allocated to it. This means two connections between one internal host to the same external host may use two different external IP addresses.

The advantage of a Stateless NAT Pool is that there is good spreading of new connections between external IP addresses with no requirement for memory allocated to a state table and there is less processing time involved in setting up each new connection. The disadvantage is that it is not suitable for communication that requires a constant external IP address.

Fixed NAT Pools

The *Fixed* option means that each internal client or host is allocated one of the external IP addresses through a hashing algorithm. Although the administrator has no control over which of the external connections will be used, this scheme ensures that the a particular internal client or host will always communicate through the same external IP address.

The Fixed option has the advantage of not requiring memory for a state table and providing very fast processing for new connection establishment. Although explicit load balancing is not part of this option, there should be spreading of the load across the external connections due to the random nature of the allocating algorithm .

IP Pool Usage

When allocating external IP addresses to a NAT Pool it is not necessary to explicitly state these. Instead a CorePlus *IP Pool* object can be selected. IP Pools gather collections of IP addresses automatically through DHCP and can therefore supply external IP addresses automatically to a NAT Pool. See Section 5.5, “IP Pools” for more details on this topic.

Proxy ARP Usage

Where an external router sends ARP queries to the Clavister Security Gateway to resolve external IP addresses included in a NAT Pool, CorePlus will need to send the correct ARP replies for this resolution to take place through its Proxy ARP mechanism so the external router can correctly build its routing table.

By default, the administrator must specify in NAT Pool setup which interfaces will be used by NAT pools. The option exists however to enable Proxy ARP for a NAT Pool on all interfaces but this can cause problems sometimes by possibly creating routes to interfaces on which packets shouldn't arrive. It is therefore recommended that the interface(s) to be used for the NAT Pool Proxy ARP mechanism are explicitly specified

Using NAT Pools

NAT Pools are used in conjunction with a normal NAT IP rule. When defining a NAT rule, the dialog includes the option to select a NAT Pool to use with the rule. This association brings the NAT Pool into use.

Example 7.2. Using NAT Pools

This example creates a NAT pool which will be applied the external IP address range 10.6.13.10 to 10.16.13.15 and then uses it in a NAT IP rule for HTTP traffic on the **Wan** interface.

Clavister FineTune

A. First create a Stateful NAT Pool object called *stateful_natpool* :

1. Go to **Local Objects > NAT Pools > New NAT Pool**
2. Now enter:
   - **Name:** stateful_natpool
   - **Address Range:** 10.6.13.10-10.16.13.15
     (a network eg 10.6.13.0/24 could be used here - the 0 and 255 addresses will be automatically removed)
   - **Type:** Stateful
3. Select **Proxy ARP** and select **WAN** as the interface
4. Click **OK**

B. Now define the NAT rule in the IP rule set

1. Go to **Rules > New Rule**
2. Now enter:
   - **Source Interface:** int
   - **Source Network:** int-net
   - **Destination Interface:** wan
   - **Destination Network:** all-nets
   - **Action:** NAT
3. Select **Service** and select **HTTP**
4. Select the **Address Translation** tab and now:
   - Enable **Use NAT Pool**
   - Select **stateful_natpool** from the drop-down list
5. Click **OK**

7.3. SAT

CorePlus can translate entire ranges of IP addresses and/or ports. Such translations are transpositions, each address or port is mapped to a corresponding address or port in the new range, rather than translating them all to the same address or port. In CorePlus this functionality is known as *Static Address Translation* (SAT).

Note: Port forwarding

*Some network equipment vendors use the term "**port forwarding**" when referring to SAT. Both terms are referring to the same functionality.*

SAT Requires Multiple IP Rules

Unlike NAT, SAT requires more than just a single IP rule to be defined. A *SAT* rule must first be added to specify the address translation but CorePlus does not terminate the rule set lookup upon finding a matching *SAT* rule. Instead, it continues to search for a matching *Allow*, *NAT* or *FwdFast* rule. Only when it has found such a matching rule does CorePlus execute the original *SAT* rule.

The *SAT* rule **only** defines the translation that is to take place. A second, associated rule, such as an *Allow* rule, must exist to actually allow the traffic to pass through the security gateway.

The Second Rule Must Trigger on the Untranslated Destination IP

An important principle to keep in mind when creating the IP rules for SAT is that the second rule, for example an *Allow* rule, **must** trigger on the **untranslated** destination IP address. A common mistake is to create a rule which triggers on the translated address given by the *SAT* rule.

For example, if a *SAT* rule translates the destination from *1.1.1.1* to *2.2.2.2* then the second associated rule should allow traffic to pass to the destination *1.1.1.1* and not *2.2.2.2*.

Only after the second rule triggers to allow the traffic, is the route lookup then done by CorePlus on the translated address to work out which interface the packets should be sent from.

7.3.1. Translation of a Single IP Address (1:1)

The simplest form of SAT usage is translation of a single IP address. A very common scenario for this is to enable external users to access a protected server having a private address. This scenario is also sometimes referred to as a *Virtual IP* or *Virtual Server* in some other manufacturer's products.

The Role of the DMZ

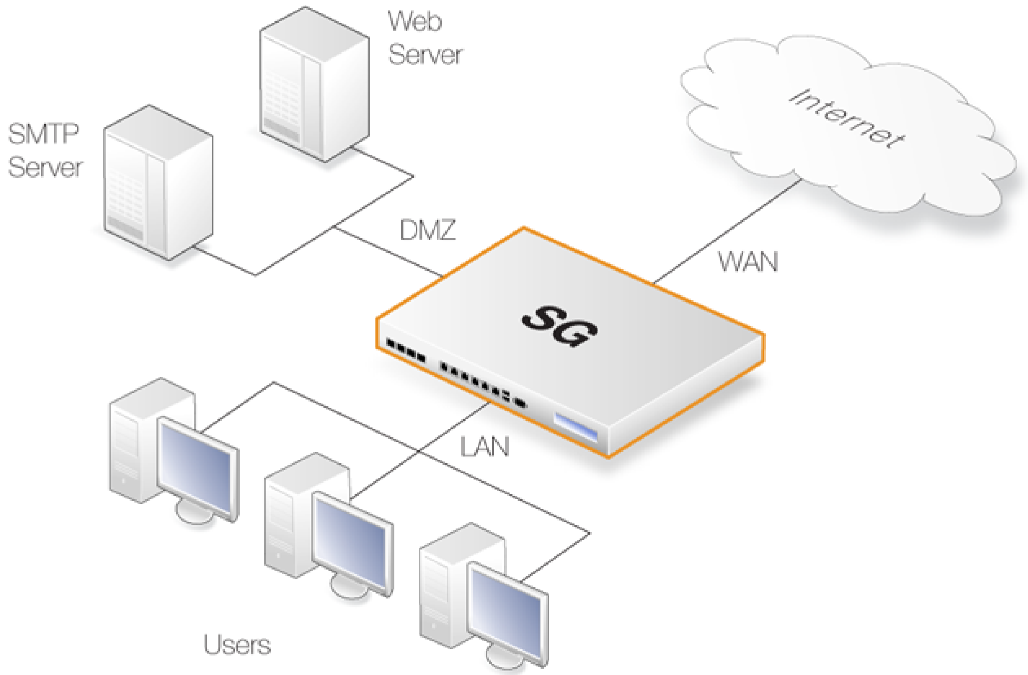
At this point in the manual, it's relevant to discuss the concept and role of the network known as the *Demilitarized Zone* (DMZ).

The DMZ's purpose is to have a network where the administrator can place those resources which will be accessed by external, untrusted clients and typically this access takes place across the public Internet. These servers will have the maximum exposure to external threats and therefore at most risk of being compromised.

By isolating these servers in the DMZ, we are creating a distinct separation from the more sensitive local, internal networks. This allows CorePlus to better control what traffic flows between the DMZ and internal networks and to better isolate any security breaches that might occur in DMZ servers.

The illustration below shows a typical arrangement with the Clavister Security Gateway mediating communications between the public Internet and servers in the DMZ, and between the DMZ and local clients on a network called *LAN*.

Figure 7.1. The Role of the DMZ



Note: The DMZ port could be any port

On some models of Clavister hardware, there is a specific Ethernet port which is marked as being for the ***DMZ*** *network. Although this is the port's intended use, it could be used for other purposes and any other Ethernet port could also be used instead for the DMZ.*

On hardware models without a specific DMZ port, any port could be used for this purpose.

Example 7.3. Enabling Traffic to a Protected Web Server in a DMZ

In this example, we will create a SAT policy that will translate and allow connections from the Internet to a web server located in a DMZ. The Clavister Security Gateway is connected to the Internet using the wan interface with address object ip_wan (defined as 195.55.66.77) as IP address. The web server has the IP address 10.10.10.5 and is reachable through the dmz interface.

Clavister FineTune
First create a SAT rule:

1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Specify a suitable name for the rule, for example *SAT_HTTP_To_DMZ*
4. Now enter:
    - **Action:** SAT
    - **Source Interface:** any
    - **Source Network:** all-nets
    - **Destination Interface:** core

- **Destination Network:** ip_wan

5. Under the **Service** tab, select **http** in the **Pre-defined** dropdown list
6. Switch to the **Address Translation** tab
7. Make sure that the **Destination IP Address** option is selected
8. In the **New IP Address** textbox, enter 10.10.10.5
9. Click **OK**

Then create a corresponding Allow rule:

1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Specify a suitable name for the rule, for example *Allow_HTTP_To_DMZ*
4. Now enter:
   - **Action:** Allow
   - **Sourice Interface:** any
   - **Source Network:** all-nets
   - **Destination Interface:** core
   - **Destination Network:** ip_wan
5. Under the **Service** tab, select **http** from the **Pre-defined** list
6. Click **OK**

The example results in the following two rules in the rule set:

#	Action	Src Iface	Src Net	Dest Iface	Dest Net	Parameters
1	SAT	any	all-nets	core	ip_wan	http SETDEST 10.10.10.5 80
2	Allow	any	all-nets	core	ip_wan	http

These two rules allow us to access the web server via the Clavister Security Gateway's external IP address. Rule 1 states that address translation can take place if the connection has been permitted, and rule 2 permits the connection.

Of course, we also need a rule that allows internal machines to be dynamically address translated to the Internet. In this example, we use a rule that permits everything from the internal network to access the Internet via NAT hide:

#	Action	Src Iface	Src Net	Dest Iface	Dest Net	Parameters
3	NAT	lan	lannet	any	all-nets	All

Now, what is wrong with this rule set?

If we assume that we want to implement address translation for reasons of security as well as functionality, we discover that this rule set makes our internal addresses visible to machines in the DMZ. When internal machines connect to ip_wan port 80, they will be allowed to proceed by rule 2 as it matches that communication. From an internal perspective, all machines in the DMZ should be regarded as any other Internet-connected servers; we do not trust them, which is the reason for locating them in a DMZ in the first place.

There are two possible solutions:

1. You can change rule 2 so that it only applies to external traffic.
2. You can swap rules 2 and 3 so that the NAT rule is carried out for internal traffic before the Allow rule matches.

Which of these two options is the best? For this configuration, it makes no difference. Both solutions work just as well.

However, suppose that we use another interface, ext2, in the Clavister Security Gateway and connect it to another network, perhaps to that of a neighboring company so that they can communicate much faster with our servers.

If option 1 was selected, the rule set must be adjusted thus:

#	Action	Src Iface	Src Net	Dest Iface	Dest Net	Parameters
1	SAT	any	all-nets	core	ip_wan	http SETDEST 10.10.10.5 80
2	Allow	wan	all-nets	core	ip_wan	http
3	Allow	ext2	ext2net	core	ip_wan	http
4	NAT	lan	lannet	any	all-nets	All

This increases the number of rules for each interface allowed to communicate with the web server. However, the rule ordering is unimportant, which may help avoid errors.

If option 2 was selected, the rule set must be adjusted thus:

#	Action	Src Iface	Src Net	Dest Iface	Dest Net	Parameters
1	SAT	any	all-nets	core	ip_wan	http SETDEST 10.10.10.5 80
2	NAT	lan	lannet	any	all-nets	All
3	Allow	any	all-nets	core	ip_wan	http

This means that the number of rules does not need to be increased. This is good as long as all interfaces can be entrusted to communicate with the web server. However, if, at a later point, you add an interface that cannot be entrusted to communicate with the web server, separate Drop rules would have to be placed before the rule granting all machines access to the web server.

Determining the best course of action must be done on a case-by-case basis, taking all circumstances into account.

Example 7.4. Enabling Traffic to a Web Server on an Internal Network

The example we have decided to use is that of a web server with a private address located on an internal network. From a security standpoint, this approach is wrong, as web servers are very vulnerable to attack and should therefore be located in a DMZ. However, due to its simplicity, we have chosen to use this model in our example.

In order for external users to access the web server, they must be able to contact it using a public address. In this example, we have chosen to translate port 80 on the Clavister Security Gateway's external address to port 80 on the web server:

#	Action	Src Iface	Src Net	Dest Iface	Dest Net	Parameters
1	SAT	any	all-nets	core	ip_wan	http SETDEST wwwsrv 80
2	Allow	any	all-nets	core	ip_wan	http

These two rules allow us to access the web server via the Clavister Security Gateway's external IP address. Rule 1 states that address translation can take place if the connection has been permitted, and rule 2 permits the connection.

Of course, we also need a rule that allows internal machines to be dynamically address translated to the Internet. In this example, we use a rule that permits everything from the internal network to access the Internet via NAT hide:

#	Action	Src Iface	Src Net	Dest Iface	Dest Net	Parameters
3	NAT	lan	lannet	any	all-nets	All

The problem with this rule set is that it will not work at all for traffic from the internal network.

In order to illustrate exactly what happens, we use the following IP addresses:

- ip_wan (195.55.66.77): a public IP address
- ip_lan (10.0.0.1): the Clavister Security Gateway's private internal IP address
- wwwsrv (10.0.0.2): the web servers private IP address
- PC1 (10.0.0.3): a machine with a private IP address

- PC1 sends a packet to ip_wan to reach "www.ourcompany.com":
  10.0.0.3:1038 => **195.55.66.77:80**
- CorePlus translates the address in accordance with rule 1 and forwards the packet in accordance with rule 2:
  10.0.0.3:1038 => **10.0.0.2:80**
- wwwsrv processes the packet and replies:
  10.0.0.2:80 => **10.0.0.3:1038**

This reply arrives directly to PC1 without passing through the Clavister Security Gateway. This causes problems. The reason this will not work is because PC1 expects a reply from 195.55.66.77:80, not 10.0.0.2:80. The unexpected reply is discarded and PC1 continues to wait for a response from 195.55.66.77:80, which will never arrive.

Making a minor change to the rule set in the same way as described above, will solve the problem. In this example, for no particular reason, we choose to use option 2:

#	Action	Src Iface	Src Net	Dest Iface	Dest Net	Parameters
1	SAT	any	all-nets	core	ip_wan	http SETDEST wwwsrv 80
2	NAT	lan	lannet	any	all-nets	All
3	Allow	any	all-nets	core	ip_wan	http

- PC1 sends a packet to ip_wan to reach "www.ourcompany.com":
  10.0.0.3:1038 => **195.55.66.77:80**
- CorePlus address translates this statically in accordance with rule 1 and dynamically in accordance with rule 2:
  10.0.0.1:32789 => **10.0.0.2:80**
- wwwsrv processes the packet and replies:
  10.0.0.2:80 => **10.0.0.1:32789**
- The reply arrives and both address translations are restored:
  195.55.66.77:80 => **10.0.0.3:1038**

This way, the reply arrives at PC1 from the expected address.

Another possible solution to this problem is to allow internal clients to speak directly to 10.0.0.2, which would completely avoid all the problems associated with address translation. However, this is not always practical.

7.3.2. Translation of Multiple IP Addresses (M:N)

A single SAT rule can be used to translate an entire range of IP addresses. In this case, the result is a transposition where the first original IP address will be translated to the first IP address in the translation list and so on.

For instance, a SAT policy specifying that connections to the 194.1.2.16/29 network should be translated to 192.168.0.50 will result in transpositions as per the table below:

Original Address	Translated Address
194.1.2.16	192.168.0.50
194.1.2.17	192.168.0.51
194.1.2.18	192.168.0.52
194.1.2.19	192.168.0.53
194.1.2.20	192.168.0.54
194.1.2.21	192.168.0.55
194.1.2.22	192.168.0.56
194.1.2.23	192.168.0.57

In other words:

- Attempts to communicate with 194.1.2.16 will result in a connection to 192.168.0.50.
- Attempts to communicate with 194.1.2.22 will result in a connection to 192.168.0.56.

An example of when this is useful is when having several protected servers in a DMZ, and where each server should be accessible using a unique public IP address.

Example 7.5. Translating Traffic to Multiple Protected Web Servers

In this example, we will create a SAT policy that will translate and allow connections from the Internet to five web servers located in a DMZ. The Clavister Security Gateway is connected to the Internet using the wan interface, and the public IP addresses to use are in the range of 195.55.66.77 to 195.55.66.81. The web servers have IP addresses in the range 10.10.10.5 to 10.10.10.9, and they are reachable through the dmz interface.

To accomplish the task, the following steps need to be performed:

- Define an address object containing the public IP addresses.
- Define another address object for the base of the web server IP addresses.
- Publish the public IP addresses on the wan interface using the ARP publish mechanism.
- Create a SAT rule that will perform the translation.
- Create an Allow rule that will permit the incoming HTTP connections.

Clavister FineTune

Create an address object for the public IP addresses:

1. Go to **Local Objects/Hosts & Networks > New Host & Network**
2. The **Host & Network Properties** dialog will be displayed
3. Specify a suitable name for the object, for example *wwwsrv_pub*
4. Select **Range** as the type
5. Now enter:
   - **IP Low:** 195.55.66.77
   - **IP High:** 195.55.66.81
6. Click **OK**

Now, create another address object for the base of the web server IP addresses:

1. Go to **Local Objects/Hosts & Networks > New Host & Network**
2. The **Host & Network Properties** dialog will be displayed
3. Specify a suitable name for the object, for example *wwwsrv_priv_base*
4. Select **Host** as type
5. Enter *10.10.10.5* as the **IP Address**
6. Click **OK**

Publish the public IP addresses on the wan interface using ARP publish. One ARP item is needed for every IP address:

1. Go to **Interfaces/ARP > New ARP**
2. The **ARP Properties** dialog will be displayed
3. Now enter:

- **Mode:** Publish
- **Interface:** wan
- **IP Address:** 195.55.66.77

4. Click **OK** and repeat for all the 5 public IP addresses

Create a SAT rule for the translation:

1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Specify a suitable name for the rule, for example *SAT_HTTP_To_DMZ*
4. Now enter:
   - **Action:** SAT
   - **Source Interface:** any
   - **Source Network:** all-nets
   - **Destination Interface:** core
   - **Destination Network:** wwwsrv_pub
5. Under the **Service** tab, select **http** in the **Pre-defined** dropdown list
6. Switch to the **Address Translation** tab
7. Make sure that the **Destination IP Address** option is selected
8. In the **New IP Address** list, select *wwwsrv_priv*
9. Click **OK**

Finally, create a corresponding Allow rule:

1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will be displayed
3. Specify a suitable name for the rule, for example *Allow_HTTP_To_DMZ*
4. Now enter:
   - **Action:** Allow
   - **Source Interface:** any
   - **Source Network:** all-nets
   - **Destination Interface:** core
   - **Destination Network:** wwwsrv_pub
5. Under the **Service** tab, select **http** in the **Pre-defined** list
6. Click **OK**

7.3.3. All-to-One Mappings (N:1)

CorePlus can be used to translate ranges and/or groups into just one IP address.

#	Action	Src Iface	Src Net	Dest Iface	Dest Net	Parameters
1	SAT	any	all-nets	wan	194.1.2.16-194.1.2.20, 194.1.2.30	http SETDEST all-to-one 192.168.0.50 80

This rule produces a N:1 translation of all addresses in the group (the range 194.1.2.16 - 194.1.2.20 and 194.1.2.30) to the IP 192.168.0.50.

- Attempts to communicate with 194.1.2.16, port 80, will result in a connection to 192.168.0.50
- Attempts to communicate with 194.1.2.30, port 80, will result in a connection to 192.168.0.50

> ***Note***
> *When all-nets is the destination, All-to-One mapping is always done.*

7.3.4. Port Translation

Port Translation, also known as *Port Address Translation* (PAT), can be used to modify the source or destination port.

#	Action	Src Iface	Src Net	Dest Iface	Dest Net	Parameters
1	SAT	any	all-nets	wan	wwwsrv_pub	TCP 80-85 SETDEST 192.168.0.50 1000

This rule produces a 1:1 translation of all ports in the range 80 - 85 to the range 1080 - 1085.

- Attempts to communicate with the web servers public address, port 80, will result in a connection to the web servers private address, port 1080.
- Attempts to communicate with the web servers public address, port 84, will result in a connection to the web servers private address, port 1084.

> ***Note***
> *In order to create a SAT Rule that allows port translation, a Custom Service must be used with the SAT Rule.*

7.3.5. Protocols handled by SAT

Generally, static address translation can handle all protocols that allow address translation to take place. However, there are protocols that can only be translated in special cases, and other protocols that simply cannot be translated at all.

Protocols that are impossible to translate using SAT are most likely also impossible to translate using NAT. Reasons for this include:

- The protocol cryptographically requires that the addresses are unaltered; this applies to many VPN protocols.
- The protocol embeds its IP addresses inside the TCP or UDP level data, and subsequently requires that, in some way or another, the addresses visible on IP level are the same as those embedded in the data. Examples of this include FTP and logons to NT domains via NetBIOS.
- Either party is attempting to open new dynamic connections to the addresses visible to that party. In some cases, this can be resolved by modifying the application or the gateway configuration.

There is no definitive list of what protocols that can or cannot be address translated. A general rule is that VPN protocols cannot usually be translated. In addition, protocols that open secondary connections in addition to the initial connection can be difficult to translate.

Some protocols that are difficult to address translate may be handled by specially written algorithms designed to read and/or alter application data. These are commonly referred to as *Application Layer*

Gateways or *Application Layer Filters*. CorePlus supports a number of such Application Layer Gateways and for more information please see Section 6.2, “ALGs”.

7.3.6. Multiple SAT rule matches

CorePlus does not terminate the rule set lookup upon finding a matching SAT rule. Instead, it continues to search for a matching Allow, NAT or FwdFast rule. Only when it has found such a matching rule does the gateway execute the static address translation.

Despite this, the first matching SAT rule found for each address is the one that will be carried out.

"Each address" above means that two SAT rules can be in effect at the same time on the same connection, provided that one is translating the sender address whilst the other is translating the destination address.

#	Action	Src Iface	Src Net	Dest Iface	Dest Net	Parameters
1	SAT	any	all-nets	core	wwwsrv_pub	TCP 80-85 SETDEST 192.168.0.50 1080
2	SAT	lan	lannet	all-nets	Standard	SETSRC pubnet

The two above rules may both be carried out concurrently on the same connection. In this instance, internal sender addresses will be translated to addresses in the "pubnet" in a 1:1 relation. In addition, if anyone tries to connect to the public address of the web server, the destination address will be changed to its private address.

#	Action	Src Iface	Src Net	Dest Iface	Dest Net	Parameters
1	SAT	lan	lannet	wwwsrv_pub	TCP 80-85	SETDEST intrasrv 1080
2	SAT	any	all-nets	wwwsrv_pub	TCP 80-85	SETDEST wwwsrv-priv 1080

In this instance, both rules are set to translate the destination address, meaning that only one of them will be carried out. If an attempt is made internally to communicate with the web servers public address, it will instead be redirected to an intranet server. If any other attempt is made to communicate with the web servers public address, it will be redirected to the private address of the publicly accessible web server.

Again, note that the above rules require a matching Allow rule at a later point in the rule set in order to work.

7.3.7. SAT and FwdFast Rules

It is possible to employ static address translation in conjunction with FwdFast rules, although return traffic must be explicitly granted and translated.

The following rules make up a working example of static address translation using FwdFast rules to a web server located on an internal network:

#	Action	Src Iface	Src Net	Dest Iface	Dest Net	Parameters
1	SAT	any	all-nets	core	ip_wan	http SETDEST wwwsrv 80
2	SAT	lan	wwwsrv	any	all-nets	80 -> All SETSRC ip_wan 80
3	FwdFast	any	all-nets	core	ip_wan	http
4	FwdFast	lan	wwwsrv	any	all-nets	80 -> All

We add a NAT rule to allow connections from the internal network to the Internet:

#	Action	Src Iface	Src Net	Dest Iface	Dest Net	Parameters
5	NAT	lan	lannet	any	all-nets	All

What happens now?

- External traffic to ip_wan:80 will match rules 1 and 3, and will be sent to wwwsrv. Correct.
- Return traffic from wwwsrv:80 will match rules 2 and 4, and will appear to be sent from ip_wan:80. Correct.

- Internal traffic to ip_wan:80 will match rules 1 and 3, and will be sent to wwwsrv. Almost correct; the packets will arrive at wwwsrv, but:
- Return traffic from wwwsrv:80 to internal machines will be sent directly to the machines themselves. This will not work, as the packets will be interpreted as coming from the wrong address.

We will now try moving the NAT rule between the SAT and FwdFast rules:

#	Action	Src Iface	Src Net	Dest Iface	Dest Net	Parameters
1	SAT	any	all-nets	core	ip_wan	http SETDEST wwwsrv 80
2	SAT	lan	wwwsrv	any	all-nets	80 -> All SETSRC ip_wan 80
3	NAT	lan	lannet	any	all-nets	All
4	FwdFast	any	all-nets	core	ip_wan	http
5	FwdFast	lan	wwwsrv	any	all-nets	80 -> All

What happens now?

- External traffic to ip_wan:80 will match rules 1 and 4, and will be sent to wwwsrv. Correct.
- Return traffic from wwwsrv:80 will match rules 2 and 3. The replies will therefore be dynamically address translated. This changes the source port to a completely different port, which will not work.

The problem can be solved using the following rule set:

#	Action	Src Iface	Src Net	Dest Iface	Dest Net	Parameters
1	SAT	any	all-nets	core	ip_wan	http SETDEST wwwsrv 80
2	SAT	lan	wwwsrv	any	all-nets	80 -> All SETSRC ip_wan 80
3	FwdFast	lan	wwwsrv	any	all-nets	80 -> All
4	NAT	lan	lannet	any	all-nets	All
5	FwdFast	lan	wwwsrv	any	all-nets	80 -> All

- External traffic to ip_wan:80 will match rules 1 and 5, and will be sent to wwwsrv.
- Return traffic from wwwsrv:80 will match rules 2 and 3.
- Internal traffic to ip_wan:80 will match rules 1 and 4, and will be sent to wwwsrv. The sender address will be the Clavister Security Gateway's internal IP address, guaranteeing that return traffic passes through the Clavister Security Gateway.
- Return traffic will automatically be handled by the Clavister Security Gateway's stateful inspection mechanism.

Chapter 8. User Authentication

This chapter describes how CorePlus implements user authentication.

8.1. Overview

In situations where individual users connect to protected resources through the Clavister Security Gateway, the administrator will often require that each user goes through a process of *authentication* before access is allowed. This chapter deals with setting up authentication for CorePlus but first the general issues involved in authentication are examined.

Proving Identity

The aim of authentication is to have the user prove their identity so that the network administrator can allow or deny access to resources based on that identity. Possible types of proof could be:

A. Something the user is. Unique attributes that are different for every person, such as a fingerprint.

B. Something the user has, such a passcard, a X.507 Digital Certificate or Public and Private Keys.

C. Something the user knows such as a password.

Method **A** may require a special biometric reader. Another problem is that the feature often can't be replaced if it is lost. Methods **B** and **C** are therefore the most common in network security. However, these have drawbacks: keys might be intercepted, passcards might be stolen, passwords might be guessable, or people may simply be bad at keeping a secret. Methods **B** and **C** are sometimes combined, for example in a passcard that requires a password or pincode for use.

Using Username/Passwords

This chapter deals specifically with user authentication through validation of username/password combinations manually entered by a user attempting to gain access to resources. Access to the Internet using the HTTP protocol through the Clavister Security Gateway is an example of this, where a username/password combination is the primary authentication method.

In using this approach, passwords are often subject to attacks by guesswork or systematic searches. To counter this, a password should be carefully chosen. Ideally it should:

- Be more than 8 characters with no repeats.
- Use random character sequences not commonly found in phrases.
- Contain both lower and upper case alphabetic characters.
- Contain both digits and special characters.

To remain secure, passwords should also:

- Not be recorded anywhere in written form.
- Never be revealed to anyone else.
- Changed on a regular basis such as every three months.

8.2. Authentication Setup

8.2.1. Setup Summary

The following list summarizes the steps for User Authentication setup with CorePlus:

- Set up a database of users, each with a username/password combination. This can exist locally in a CorePlus *User DB* object, or remotely on a RADIUS server and will be designated as the *Authentication Source*. Membership of an *Authentication Group* can optionally be specified for each user.
- Define a *User Authentication Rule* which describes which traffic is to be authenticated and which *Authentication Source* will be used.
- Define an IP object for the IP addresses of the clients that will be authenticated. Associate this with an Authentication Group if required.
- Set up IP rules to allow the authentication to take place and also to allow access to resources by the clients belonging to the IP object set up in the previous step.

The following sections describe the components of these steps in detail.

Authentication Sources

The database that an Authentication Rule uses to check a user's username/password combination can be one of the following types:

- A *Local Database* internal to CorePlus that is set up by the administrator.
- A RADIUS server which is external to the Clavister Security Gateway.

8.2.2. Local User Databases

Local User Databases are administrator defined registries internal to CorePlus which contain the profiles of authorized users and user groups. Combinations of usernames/password can be entered into these with passwords stored using reversible cryptography for security.

Group Membership

Each user entered into the Local Database can optionally be specified to be a member of one or more *Groups*. Authentication Groups are not pre-defined but rather entered as text strings. These text strings are case sensitive and must be always entered in exactly the same way. Authentication Groups have no relationship with Authentication Rules but are instead associated with IP objects which are then used in the IP rule set.

When specifying the Source Network for an IP rule, a user defined IP object can be used and a group can be associated with that IP object. This will mean that the IP rule will then only apply to logged-in clients who also belong to the Source Network's group.

The purpose of this is to restrict access to certain networks to a particular group by having IP rules which will only apply to members of that group. To gain access to a resource there must be an IP rule that allows it and the client must belong to the same group as the rule's Source Network group.

8.2.3. External RADIUS Servers

Reasons for External Servers

In a larger network topology with a larger administration workload, it is often preferable to have a central authentication database on a dedicated server. When there is more than one Clavister Security Gateway in the network and thousands of users, maintaining separate authentication databases on each device becomes problematic. Instead, an external authentication server can validate username/password combinations by responding to requests from CorePlus. To provide this, CorePlus supports the *Remote Authentication Dial-in User Service* (RADIUS) protocol.

RADIUS with CorePlus

CorePlus acts as a RADIUS client, sending user credentials and connection parameter information as a RADIUS message to a nominated RADIUS server. The server processes the requests and sends back a RADIUS message to accept or deny them. One or more external servers can be defined in CorePlus.

RADIUS Security

To provide security, a common *shared secret* is configured on both the RADIUS client and the server. This secret enables encryption of the messages sent from the RADIUS client to the server and is commonly configured as a relatively long text string. The string can contain up to 100 characters and is case sensitive.

RADIUS uses PPP to transfer username/password requests between client and RADIUS server, as well as using PPP authentication schemes such as PAP and CHAP. RADIUS messages are sent as UDP messages via UDP port 1812.

8.2.4. Authentication Rules

Authentication Rules are set up in a way that is similar to other CorePlus security policies, by specifying which traffic is to be subject to the rule. They differ from other policies in that the destination network/interface is not of interest but only the source network/interface. An Authentication Rule has the following parameters:

- **Interface** - The source interface on which the connections to be authenticated will arrive.
- **Source IP** - The source network from which these connections will arrive.
- **Authentication Source** - This specifies that authentication is to be done against a **Local** database defined within CorePlus or by using a **RADIUS** server (discussed in detail below).

  A further option, **Disallow**, can be used so that a negative rule can be created which says "never authenticate given these conditions". This option might be used, for instance, to never authenticate connections comming in on a particular interface. Typically, *Disallow* rules are located at the end of the authentication rule set.
- **Agent** - The type of traffic being authenticated. This can one of:
  - **HTTP** or **HTTPS** - Web connections to be authenticated via a pre-defined or custom web page (see the detailed HTTP explanation below).
  - **PPP** - L2TP or PPP tunnel authentication.
  - **XAUTH** - IKE authentication which is part of IPsec tunnel establishment.

Connection Timeouts

An Authentication Rule can specify the following timeouts related to a user session:

- **Idle Timeout** - How long a connection is idle before being automatically terminated (1800 seconds by default).

- **Session Timeout** - The maximum time that a connection can exist (no value is specified by default).

If an authentication server is being used then the option to **Use timeouts received from the authentication server** can be enabled to have these values set from the server.

Multiple Logins

An Authentication Rule can specify how *multiple logins* are handled where more than one user from different source IP addresses try to login with the same username. The possible options are:

- Allow multiple logins so that more than one client can use the same username/password combination.
- Allow only one login per username.
- Allow one login per username and logout an existing user with the same name if they have been idle for a specific length of time when the new login occurs.

8.2.5. Authentication Processing

The list below describes the processing flow through CorePlus for username/password authentication:

1. A user creates a new connection to the Clavister Security Gateway.
2. CorePlus sees the new user connection on an interface and checks the *Authentication rule set* to see if their is a matching rule for traffic on this interface, coming from this network and data which is one of the following types:
    - HTTP traffic
    - HTTPS traffic
    - IPsec tunnel traffic
    - L2TP tunnel traffic
    - PPTP tunnel traffic
3. If no Authentication Rule matches, the connection is allowed if the IP rule set permits it and nothing further happens in the authentication process.
4. Based on the settings of the matching authentication rule, CorePlus prompts the user with an authentication request.
5. The user replies by entering their identification information which is usually a username/password pair.
6. CorePlus validates the information against the *Authentication Source* specified in the authentication rule. This will be either a local CorePlus database or an external RADIUS database server.
7. CorePlus then allows further traffic through this connection as long as authentication was successful and the service requested is allowed by a rule in the IP rule set. That rule's Source Network object has either the **No Defined Credentials** option enabled or alternatively it is associated with a group and the user is also a member of that group.
8. If a timeout restriction is specified in the authentication rule then the authenticated user will be automatically logged out after that length of time without activity.

Any packets from an IP address that fails authentication are discarded (unless they are caught be another rule).

8.2.6. A Group Usage Example

To illustrate Authentication Group usage, lets suppose that there are a set of users which will login from a network 192.168.1.0/24 connected to the *lan* interface. The requirement is to restrict access to a network called *important_net* on the *int* interface to one group of trusted users, while the other less-trusted users can only access another network called *regular_net* on the *dmz* interface.

Assuming we have a CorePlus internal database already defined, we add the users to this database with appropriate username/password pairs and a specific **Group** string. One set of users would be assigned to the group *trusted* and the other to the group *untrusted*.

We now define two IP objects for the same network 192.168.1.0/24. One IP object is called *untrusted_net* and has its **Group** parameter set to the string *untrusted*. The other IP object is called *trusted_net* and its **Group** parameter is set to the string *untrusted*.

The final step is to set up the rules in the IP rule set as shown below.

	Action	Src Interface	Src Network	Dest Interface	Dest Network	Service
1	Allow	lan	trusted_net	int	important_net	All
2	Allow	lan	untrusted_net	dmz	regular_net	All

If we wanted to allow the *trusted* group users to also be able to access the regular network we could add a third rule to permit this:

	Action	Src Interface	Src Network	Dest Interface	Dest Network	Service
1	Allow	lan	trusted_net	int	important_net	All
2	Allow	lan	trusted_net	dmz	regular_net	All
3	Allow	int	untrusted_net	dmz	regular_net	All

8.2.7. HTTP Authentication

Where users are communicating through a web browser using the HTTP protocol then authentication can be done by presenting the user with HTML pages to retrieve required user information. This is sometimes referred to as *WebAuth* and the setup requires further considerations.

Agent Options

For HTTP and HTTPS authentication there is a set of options in Authentication Rules called **Agent Options**. These are:

- **Login Type** - This can be one of:

  - **FORM** - The user is presented with an HTML page for authentication which is filled in and the data sent back to CorePlus with a POST. An HTML pre-defined in CorePlus will be used but this can be customized as described below.

  - **BASICAUTH** - This sends a **401 - Authentication Required** message back to the browser which will cause it to use its own inbuilt dialog to ask the user for a username/password combination. A **Realm String** can optionally be specified which will appear in the browser's dialog.

  FORM is recommended over **BASICAUTH** because in some cases the browser might hold the login data in its cache

- If the **Agent** is set to *HTTPS* then the **Host Certificate** and **Root Certificate** have to be chosen from a list of certificates already loaded into CorePlus.

Customizing Authentication HTML Pages

The local installation directory on the management workstation contains a folder called **HTTPAuth HTML Root**. This contains a subfolder called **Sample Pages** which contains the default HTML pages used for authentication. These files are also known as *banner files*. To customize these pages:

1. Create a new folder under **HTTPAuth HTML Root**. This folder can be given any name, in this description lets call it **CustomizedHTML**.

2. Make a copy in **CustomizedHTML** of all the default HTML files in **Sample Pages**.

3. Make the required customization changes to the files in **CustomizedHTML**. Only the presentation should be changed. No changes should be made to the variables names used in the files.

4. Start (or restart) Clavister FineTune. Go to **Agent Options** in the relevant Authentication Rule. It will now be possible to select **CustomizedHTML** from the **HTML Directory** options.

5. Upload the new banner files to the Clavister Security Gateway by selecting the **Action > Communication > Upload > HTML Banner Files** option from the Clavister FineTune menubar.

The parameters that can be used in custom HTML pages are:

- **%USER%** - The user who is making the authentication request
- **%CHALLENGE MESSAGE%** - The challenge message
- **%IPADDR%** - The originating IP address
- **%REDIRURL%** - The redirection URL

Setting Up IP Rules

HTTP authentication can't operate unless a rule is added to the IP rule set to explicitly allow authentication to take place. If we consider the example of a number of clients on the local network *lannet* who would like access to the public Internet on the *wan* interface then the IP rule set would contain the following rules.

	Action	Src Interface	Src Network	Dest Interface	Dest Network	Service
1	Allow	lan	lannet	core	ip_lan	http-all
2	NAT	lan	trusted_users	wan	all-nets	http-all
3	NAT	lan	lannet	wan	all-nets	dns-all

The first rule allows the authentication process to take place and assumes the client is trying to access the *ip_lan* IP address, which is the IP address of the interface on the Clavister Security Gateway where the local network connects.

The second rule allows normal surfing activity but we cannot just use *lannet* as the source network since the rule would trigger for any unauthenticated client from that network. Instead, the source network is an administrator defined IP object called *trusted_users* which is the same network as *lannet* but has additionally either the Authentication option **No Defined Credentials** enabled *or* has an Authentication Group assigned to it (which is the same group as that assigned to the users).

The third rule allows DNS lookup of URLs.

Forcing Users to a Login Page

With this setup, when users that aren't authenticated try to surf to any IP except *ip_lan* they will fall through the rules and their packets will be dropped. To always have these users come to the authentication page we must add a **SAT** rule and its associated **Allow** rule. The rule set will now look like this:

	Action	Src Interface	Src Network	Dest Interface	Dest Network	Service
1	Allow	lan	lannet	core	ip_lan	http-all
2	NAT	lan	trusted_users	wan	all-nets	http-all
3	NAT	lan	lannet	wan	all-nets	dns-all
4	SAT	lan	lannet	wan	all-nets all-to-one 127.0.0.1	http-all
5	Allow	lan	lannet	wan	all-nets	http-all

The **SAT** rule catches all unauthenticated requests and must be set up with an all-to-one address mapping that directs them to the address *127.0.0.1* which corresponds to **core** (CorePlus itself).

Example 8.1. User Authentication Examples

Clavister FineTune

Assume we have a number of users on the *lannet* network who have to be authenticated before web surfing. Assume also that we have set up a customized set of login HTML files in the *BannerFiles* directory.

This example won't use *Authentication Groups* but instead will enable the **No Defined Credentials** option.

A. Set up a new local database.

1. Go to **Local Objects > User Database > New User Database**
2. Enter **Name:** *TrustedUsers*
3. Click **OK**

B. Enter users into the *TrustedUsers* database.

1. Go to **Local Objects > User Database > TrustedUsers > New User**
2. Enter:
   - **Name:** Username1
   - **Password:** mypassword
   - **Confirm Password:** mypassword
   - Click **OK**
3. Repeat the above steps for all users with different username/password pairs

C. Create the authentication rule.

1. Go to **User Authentication > Rules > New Rule**
2. Enter:
   a. **Name:** UserAuthLogin
   b. **Agent:** HTTP
   c. **Authentication Source:** Local
   d. **Interface:** LAN
   e. **Client Source IP:** lannet
3. Select **Agent Options**
4. For the **HTML Directory** choose *BannerFiles*
5. Click **OK**

D. Create the IP Rule that will allow authentication.

1. Go to **Local > New Rule**
2. Enter:
   a. **Name:** AuthRule
   b. **Action:** Allow
   c. **Source Interface:** lan
   d. **Source Network:** lannet
   e. **Destination Interface:** core

   f. **Destination Network:** all-nets

3. Click **OK**

E. Create an IP object for lannet that requires authentication.

1. Go to **Local Objects > Hosts & Networks**
2. Right click on the *lannet* object
3. Select **Copy** from the pop-up menu
4. Right click again and select **Paste**
5. A new object called *lannet_copy* will appear
6. Double click on the new object so the **Properties Dialog** appears
7. Set **Name** to be *trusted_users*
8. Select **User Authentication**
9. Enable the **No Defined Credentials** option
10. Click **OK**

F. Now use this new IP object when creating the IP Rule that allows surfing.

1. Go to **Rules > New Rule**
2. Enter:
   a. **Name:** AuthRule
   b. **Action:** Allow
   c. **Source Interface:** lan
   d. **Source Network:** trusted_users
   e. **Destination Interface:** wan
   f. **Destination Network:** all-nets
3. Click **OK**

As described in previous sections, a rule should also exist that allows DNS lookups.

Chapter 9. VPN

This chapter describes the *Virtual Private Network* (VPN) functionality in CorePlus.

9.1. Overview

9.1.1. VPN Usage

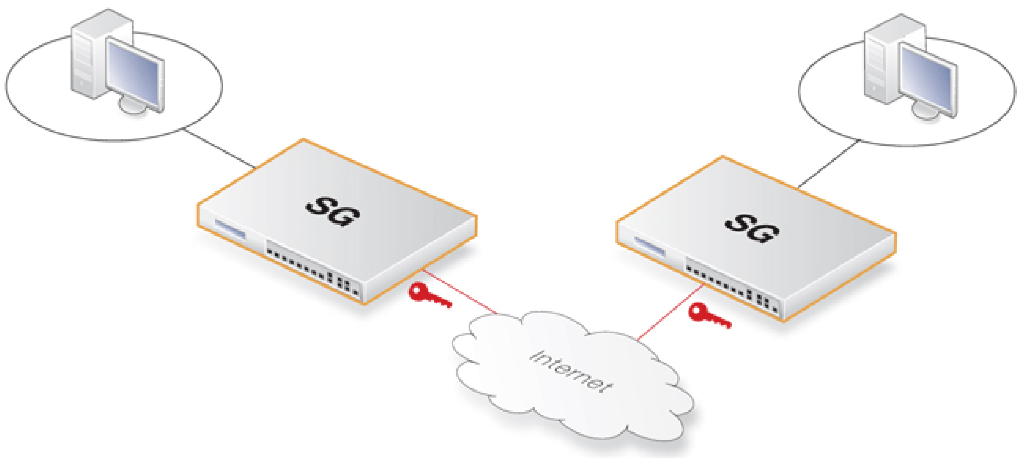
The Internet is increasingly used as a means to connect together computers since it offers efficient and inexpensive communication. The requirement therefore exists for data to traverse the Internet to its intended recipient without another party being able to read or alter it.

It is equally important that the recipient can verify that no one is falsifying data, in other words, pretending to be someone else. *Virtual Private Networks* (VPNs) meet this need, providing a highly cost effective means of establishing secure links between two co-operating computers so that data can be exchanged in a secure manner.

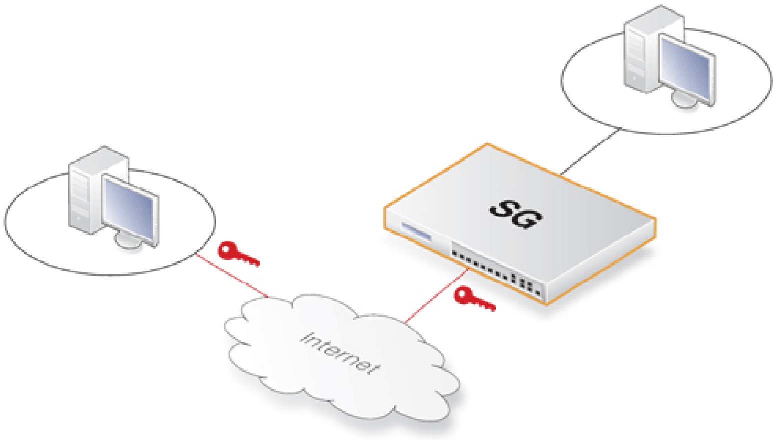
VPN allows the setting up of a *tunnel* between two devices known as *tunnel endpoints*. All data flowing through the tunnel is then secure. The mechanism that provides tunnel security is *encryption*.

There are two common scenarios where VPN is used:

1. **LAN to LAN connection** - Where two internal networks need to be connected together over the internet. In this case, each network is protected by an individual Clavister Security Gateway and the VPN tunnel is set up between them.



2. **Client to LAN connection** - Where many remote clients need to connect to an internal network over the internet. In this case, the internal network is protected by the Clavister Security Gateway to which the client connects and the VPN tunnel is set up between them.



9.1.2. VPN Encryption

Encryption of VPN traffic is done using the science of *cryptography*. Cryptography is an umbrella expression covering 3 techniques and benefits:

Confidentiality
: No one but the intended recipients is able to receive and understand the communication. Confidentiality is accomplished by encryption.

Authentication and Integrity
: Proof for the recipient that the communication was actually sent by the expected sender, and that the data has not been modified in transit. This is accomplished by authentication, often by use of cryptographic keyed hashes.

Non-repudiation
: Proof that the sender actually sent the data; the sender cannot later deny having sent it. Non-repudiation is usually a side-effect of authentication.

VPNs are normally only concerned with confidentiality and authentication. Non-repudiation is normally not handled at the network level but rather on a transaction (document-by-document) basis.

9.1.3. VPN Planning

An attacker targeting a VPN connection will typically not attempt to crack the VPN encryption since this requires enormous work. Rather, they will see VPN traffic as an indication that there is something worth targeting at the other end of the connection. Typically, mobile clients and branch offices are far more attractive targets than the main corporate networks. Once inside those, getting to the corporate network becomes easier.

In designing a VPN there are many non-obvious issues that need to be addressed. This includes:

- Protecting mobile and home computers
- Restricting access through the VPN to needed services only, since mobile computers are vulnerable
- Creating DMZs for services that need to be shared with other companies through VPNs
- Adapting VPN access policies for different groups of users
- Creating key distribution policies

Endpoint Security

A common misconception is that VPN-connections are equivalents to the internal network from a security standpoint and that they can be connected directly to it with no further precautions. It is important to remember that although the VPN-connection itself may be secure, the total level of security is only as high as the security of the tunnel endpoints.

It is becoming increasingly common for users on the move to connect directly to their company's network via VPN from their laptops. However, the laptop itself is often not protected. In other words, an intruder can gain access to the protected network through an unprotected laptop and already-opened VPN connections.

Placement in a DMZ

A VPN connection should never be regarded as an integral part of a protected network. The VPN gateway should instead be located in a special DMZ or outside a gateway dedicated to this task. By doing this, you can restrict which services can be accessed via VPN and modem and ensure that these services are well protected against intruders. In instances where the gateway features an integrated VPN feature, it is usually possible to dictate the types of communication permitted and CorePlus VPN has this feature.

9.1.4. Key Distribution

Key distribution schemes are best planned in advance. Issues that need to be addressed include:

- How will keys be distributed? Email is not good. Phone conversations might be secure enough.
- How many different keys should be used? One key per user? One per group of users? One per LAN-to-LAN connection? One key for all users and one key for all LAN-to-LAN connections? It is probably better using more keys than is necessary today since it will be easier to adjust access per user (group) in the future.
- Should the keys be changed? If so, how often? In cases where keys are shared by multiple users, you may want to consider overlapping schemes, so that the old keys work for a short period of time when new keys have been issued.
- What happens when an employee in possession of a key leaves the company? If several users are using the same key, it should be changed.
- In cases where the key is not directly programmed into a network unit, such as a VPN gateway, how should the key be stored? On a floppy? As a pass phrase to memorize? On a smart card? If it is a physical token, how should it be handled?

9.2. VPN Quick Start Guide

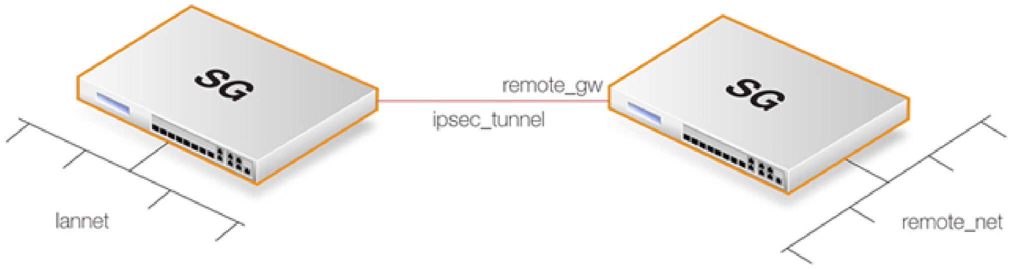
Later sections in this chapter will explore VPN components in detail. To help put those later sections in context, this section is a quick start summary of the key steps in VPN setup.

It outlines the individual steps in setting up VPNs for the most common VPN scenarios. These are:

- IPsec LAN to LAN with Pre-shared Keys
- IPsec LAN to LAN with Certificates
- IPsec Roaming Clients with Pre-shared Keys
- IPsec Roaming Clients with Certificates
- L2TP Roaming Clients with Pre-Shared Keys
- L2TP Roaming Clients with Certificates
- PPTP Roaming Clients

9.2.1. IPsec LAN to LAN with Pre-shared Keys

1. Create a **Pre-shared Key** object.
2. Optionally create a new **IKE Proposal List** object and/or an **IPsec Proposal List** object if the default list settings are not satisfactory. This will depend on the capabilities of the device at the other side of the tunnel.
3. In **Hosts & Networks** create IP objects for:
   - The remote VPN gateway which is the IP address of the network device at the other end of the tunnel (let's call this object *remote_gw*).
   - The remote network which lies behind the remote VPN gateway (let's call this object *remote_net*).
   - The local network behind the Clavister Security Gateway which will communicate across the tunnel. Here we will assume that this is the pre-defined address *lannet* and this network is attached to the CorePlus *lan* interface.



4. Create an **IPsec Tunnel** object (let's call this object *ipsec_tunnel*). Specify the following tunnel parameters:
   - Set **Local Network** to *lannet*.
   - Set **Remote Network** to *remote_net*.

- Set **Remote Gateway** to *remote_gw*.
- Set **Encapsulation mode** to *Tunnel*.
- Choose the IKE and IPsec proposal lists to be used.
- For **Authentication** select the **Pre-shared Key** object defined in step **(1)** above.

The **IPsec Tunnel** object can be treated exactly like any CorePlus *Interface* object in later steps.

5. Set up two IP rules in the IP rule set for the tunnel:

   - An **Allow** rule for outbound traffic that has the previously defined *ipsec_tunnel* object as the **Destination Interface**. The rule's **Destination Network** is the remote network *remote_net*.
   - An **Allow** rule for inbound traffic that has the previously defined *ipsec_tunnel* object as the *Source Interface*. The **Source Network** is *remote_net*.

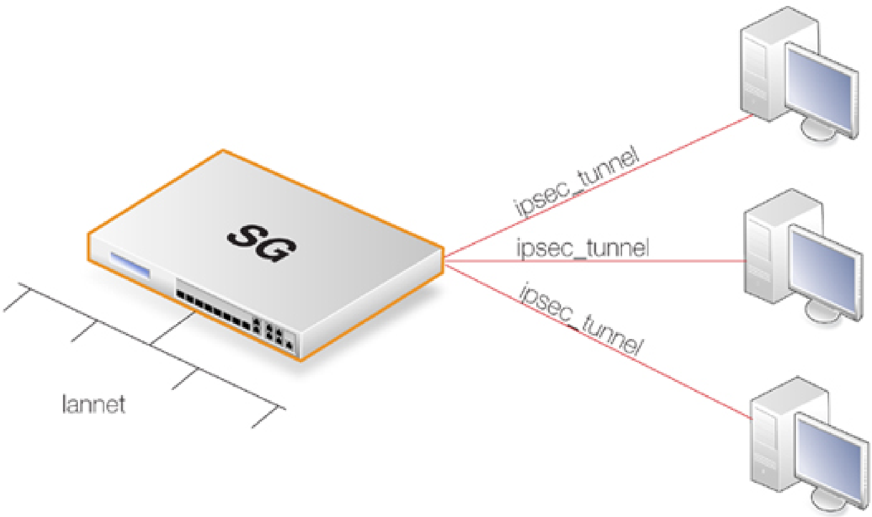
Action	Src Interface	Src Network	Dest Interface	Dest Network	Service
Allow	lan	lannet	ipsec_tunnel	remote_net	All
Allow	ipsec_tunnel	remote_net	lan	lannet	All

The Service used in these rules is *All* but it could be a predefined service.

6. Define a new CorePlus **Route** which specifies that the VPN Tunnel *ipsec_tunnel* is the Interface to use for routing packets bound for the remote network at the other end of the tunnel.

Interface	Network	Gateway
ipsec_tunnel	remote_net	

9.2.2. IPsec Roaming Clients with Pre-shared Keys



This section details the setup with roaming clients connecting through an IPsec tunnel with pre-shared keys. There are two types of roaming clients:

A. The IP addresses of the clients are already allocated.

B. The IP addresses of clients are not known beforehand and must be handed out by CorePlus as the clients connect.

A. IP addresses already allocated

The IP addresses may be known beforehand and have been pre-allocated to the roaming clients before they connect. The client's IP address will be manually input into the VPN client software.

1. Set up user authentication. *XAuth* user authentication is not required with IPsec roaming clients but is recommended (this step could initially be left out to simplify setup). The authentication source can be one of the following:

   - A **Local User DB** object which is internal to CorePlus.
   - An external authentication server.

   An internal user database is easier to set up and is assumed here. Changing this to an external server is simple to do later.

   To implement user authentication with an internal database:

   - Define a **Local User DB** object (let's call this object *TrustedUsers*).
   - Add individual users to *TrustedUsers*. This should consist of at least a username and password combination.

     The **Group** string for a user can be specified if its group's access is to be restricted to certain source networks. **Group** can be specified (with the same text string) in the **Authentication** section of an IP object. If that IP object is then used as the **Source Network** of a rule in the IP rule set, that rule will only apply to a user if their **Group** string matches the **Group** string of the IP object. (note: **Group** has no meaning in **Authentication Rule**s).

   - Create a new **User Authentication Rule** with the **Authentication Source** set to *TrustedUsers*. The other parameters for the rule are:

Agent	Auth Source	Src Network	Interface	Client Source IP
XAUTH	Local	all-nets	any	all-nets (0.0.0.0/0)

2. The **IPsec Tunnel** object *ipsec_tunnel* should have the following parameters:

   - Set **Local Network** to *lannet*.
   - Set **Remote Network** to *all-nets*
   - Set **Remote Gateway** to *all-nets*.
   - Set **Encapsulation mode** to *Tunnel*.
   - Set the IKE and IPsec proposal lists to match the capabilities of the clients.
   - No routes can be predefined so the option **Dynamically add route to the remote network when tunnel established** should be enabled for the tunnel object.
   - Enable the option **Require IKE XAuth user authentication for inbound IPsec tunnels**. This will enable a search for the first matching XAUTH rule in the authentication rules.

3. The IP rule set should contain the single rule:

Action	Src Interface	Src Network	Dest Interface	Dest Network	Service
Allow	ipsec_tunnel	all-nets	lan	lannet	All

Once an **Allow** rule permits the connection to be set up, bidirectional traffic flow is allowed which is why only one rule is used here. Instead of *all-nets* being used in the above, a more secure defined IP object could be used which specifies the exact range of the pre-allocated IP addresses.

B. IP addresses handed out by CorePlus

If the client IP addresses are not known then they must be handed out by CorePlus. To do this the above must be modified with the following:

1. If a specific IP address range is to be used as a pool of available addresses then:
   - Create a **Config Mode Pool** object (there can only be one associated with a CorePlus installation) and in it specify the address range.
   - Enable the **IKE Config Mode** option in the **IPsec Tunnel** object *ipsec_tunnel*.
2. If client IP addresses are to be retrieved through DHCP:
   - Create an **IP Pool** object and in it specify the DHCP server to use. The DHCP server can be specified as a simple IP address or alternatively as being accessible on a specific interface. If an internal DHCP server is to be used then specify the loopback address *127.0.0.1* as the DHCP server IP address.
   - Create a **Config Mode Pool** object (there can only be one associated with a CorePlus installation) and associate with it the IP Pool object defined in the previous step.
   - Enable the **IKE Config Mode** option in the **IPsec Tunnel** object *ipsec_tunnel*.

Configuring the IPsec Client

In both cases **(A)** and **(B)** above the IPsec client will need to configured with the URL of the Clavister Security Gateway as well as the pre-shared key.

9.2.3. IPsec Roaming Clients with Certificates

If certificates are used with IPsec roaming clients instead of pre-shared keys then no **Pre-shared Key** object is needed and the other differences in the setup described above are:

1. The CorePlus date and time must be set correctly since certificates can expire.
2. Load a *Gateway Certificate* and *Root Certificate* into CorePlus.
3. When setting up the **IPsec Tunnel** object, specify the certificates to use under **Authentication**. This is done by:
   a. Enable the **X.509 Certificate** option.
   b. Select the **Gateway Certificate**.
   c. Add the **Root Certificate** to use.
4. The IPsec client software will need to appropriately configured with the certificates and remote

IP addresses.

The step to set up user authentication is optional since this is additional security to certificates.

Also review Section 9.2.7, “CA Server Access” below, which describes important considerations for certificate validation.

9.2.4. L2TP Roaming Clients with Pre-Shared Keys

Due to the inbuilt L2TP client in Microsoft Windows, L2TP is a popular choice for roaming client VPN scenarios. L2TP is usually encapsulated in IPsec to provide encryption with IPsec running in *transport mode* instead of *tunnel mode*. The steps for L2TP over IPsec setup are:

1. Create an IP object (let's call it *l2tp_pool*) which defines the range of IP addresses which can be handed out to clients. The range chosen could be of two types:

    - A range taken from the internal network to which clients will connect. If the internal network is 192.168.0.0/24 then we might use the address range 192.168.0.10 to 192.168.0.20. The danger here is that an IP address might be accidentally used on the internal network and handed out to a client.

    - Use a new address range that is totally different to any internal network. This prevents any chance of an address in the range also being used on the internal network.

2. Define two other IP objects:

    - *ip_ext* which is the external public IP address through which clients connect (let's assume this is on the *ext* interface).

    - *ip_int* which is the internal IP address of the interface to which the internal network is connected (let's call this interface *int*).

3. Define a **Pre-shared Key** for the IPsec tunnel.

4. Define an *IPsec Tunnel* object (let's call this object *ipsec_tunnel*) with the following parameters:

    - Set **Local Network** to *ip_ext* (specify *all-nets* instead if CorePlus is behind a NATing device).

    - Set **Remote Network** to *all-nets*

    - Set **Remote Gateway** to *none*

    - For **Authentication** select the **Pre-shared Key** object defined in the first step.

    - Set **Encapsulation Mode** to *Transport*.

    - Select the IKE and IPsec proposal lists to be used.

    - Enable the IPsec tunnel routing option **Dynamically add route to the remote network when tunnel established**.

    - When *all-nets* is the destination network, as is the case here, the advanced setting option **Add route for remote network** must also be disabled. This setting is enabled by default.

5. Define an PPTP/L2TP Server object (let's call this object *l2tp_tunnel*) with the following parameters:

    - Set **Inner IP Address** to *ip_int*

    - Set **Tunnel Protocol** to *L2TP*

- Set **Outer Interface Filter** to *ipsec_tunnel*
- Set **Outer Server IP** to *ip_ext*
- Select the **Microsoft Point-to-Point Encryption** allowed. Since IPsec encryption is used this can be set to be *None* only, otherwise double encryption will degrade throughput.
- Set **IP Pool** to *l2tp_pool*.
- Enable Proxy ARP on the *int* interface to which the internal network is connected.
- Make the interface a member of a specific routing table so that routes are automatically added to that table. Normally the *main* table is selected.

6. For user authentication:

   - Define a **Local User DB** object (let's call this object *TrustedUsers*).
   - Add individual users to *TrustedUsers*. This should consist of at least a username and password combination.

     The **Group** string for a user can also be specified. This is explained in the same step in the *IPsec Roaming Clients* section above.
   - Define a User Authentication Rule:

Agent	Auth Source	Src Network	Interface	Client Source IP
PPP	Local	all-nets	l2tp_tunnel	all-nets (0.0.0.0/0)

7. To allow traffic through the L2TP tunnel the following rules should be defined in the IP rule set:

Action	Src Interface	Src Network	Dest Interface	Dest Network	Service
Allow	l2tp_tunnel	l2tp_pool	any	int_net	All
NAT	ipsec_tunnel	l2tp_pool	ext	all-nets	All

The second rule would be included to allow clients to surf the Internet via the *ext* interface on the Clavister Security Gateway. The client will be allocated a private internal IP address which must be NATed if connections are then made out to the public Internet via the Clavister Security Gateway.

8. Set up the client. Assuming Windows XP, the **Create new connection** option in **Network Connections** should be selected to start the **New Connection Wizard**. The key information to enter in this wizard is: the resolvable URL of the Clavister Security Gateway or alternatively its *ip_ext* IP address.

   Then choose **Network** > **Properties**. In the dialog that opens choose the L2TP Tunnel and select **Properties**. In the new dialog that opens select the **Networking** tab and choose **Force to L2TP**. Now go back to the L2TP Tunnel properties, select the **Security** tab and click on the **IPsec Settings** button. Now enter the pre-shared key.

9.2.5. L2TP Roaming Clients with Certificates

If certificates are used with L2TP roaming clients instead of pre-shared keys then the differences in the setup described above are:

1. The CorePlus date and time must be set correctly since certificates can expire.

2. Load a *Gateway Certificate* and *Root Certificate* into CorePlus.

3. When setting up the **IPsec Tunnel** object, specify the certificates to use under **Authentication**. This is done by:

   a. Enable the **X.509 Certificate** option.

   b. Select the **Gateway Certificate.**

   c. Add the **Root Certificate** to use.

4. If using the Windows XP L2TP client, the appropriate certificates need to be imported into Windows before setting up the connection with the **New Connection Wizard**.

The step to set up user authentication is optional since this is additional security to certificates.

Also review Section 9.2.7, “CA Server Access” below, which describes important considerations for certificate validation.

9.2.6. PPTP Roaming Clients

PPTP is simpler to set up than L2TP since IPsec is not used and instead relies on its own, less strong, encryption.

A major secondary disadvantage is not being able to NAT PPTP connections through a tunnel so multiple clients can use a single connection to the Clavister Security Gateway. If NATing is tried then only the first client that tries to connect will succeed.

The steps for PPTP setup are as follows:

1. In **Hosts & Networks** define the following IP objects:

   - A *pptp_pool* IP object which is the range of internal IP addresses that will be handed out from an internal network.

   - An *int_net* object which is the internal network from which the addresses come.

   - An *ip_int* object which is the internal IP address of the interface connected to the internal network. let's assume this interface is *int*.

   - An *ip_ext* object which is the external public address which clients will connect to (let's assume this is on the *ext* interface).

2. Define a **PPTP/L2TP** object (let's call it *pptp_tunnel*) with the following parameters:

   - Set **Inner IP Address** to *ip_net*.

   - Set **Tunnel Protocol** to *PPTP*.

   - Set **Outer Interface Filter** to *ext*.

   - Set **Outer server IP** to *ip_ext*.

   - For **Microsoft Point-to-Point Encryption** it is recommended to disable all options except *128 bit* encryption.

   - Set **IP Pool** to *pptp_pool*

   - Enable Proxy ARP on the *int* interface.

   - As in L2TP, enable the insertion of new routes automatically into the *main* routing table.

3. Define a User Authentication Rule, this is almost identical to L2TP:

Agent	Auth Source	Src Network	Interface	Client Source IP
PPP	Local	all-nets	pptp_tunnel	all-nets (0.0.0.0/0)

4. Now set up the IP rules in the IP rule set:

Action	Src Interface	Src Network	Dest Interface	Dest Network	Service
Allow	pptp_tunnel	pptp_pool	any	int_net	All
NAT	pptp_tunnel	pptp_pool	ext	all-nets	All

As described for L2TP, the **NAT** rule lets the clients access the public Internet via the Clavister Security Gateway.

5. Set up the client. For Windows XP, the procedure is exactly as described for L2TP above but without entering the pre-shared key.

9.2.7. CA Server Access

Where certificates are used, the two sides of a VPN tunnel exchange their certificates during the tunnel setup negotiation and either may then try to validate the received certificate by accessing a *CA server*. A certificate contains a URL (the *CRL Distribution Point*) which specifies the validating CA server and server access is performed using an HTTP *GET* request with an HTTP reply. (This URL is more correctly called an FQDN - *Fully Qualified Domain Name*.)

CA servers are of two types:

- A commercial CA server operated by one of the commercial certificate issuing companies. These are accessible over the public Internet and their FQDNs are resolvable through the public Internet DNS server system.
- A private CA server operated by the same organisation setting up the VPN tunnels. The IP address of a private server won't be known to the public DNS system unless it is explicitly registered. It also won't be known to an internal network unless it is registered on an internal DNS server.

The following considerations should be taken into account for CA server access to succeed:

- Either side of a VPN tunnel may issue a validation request to a CA server.
- For a certificate validation request to be issued, the FQDN of the certificate's CA server must first be resolved into an IP address. The following scenarios are possible:

    1. The CA server is a private server behind the Clavister Security Gateway and the tunnels are set up over the public internet but to clients that won't try to validate the certificate sent by CorePlus

       In this case, the IP address of the private server needs only be registered on a private DNS server so the FQDN can be resolved. This private DNS server will also have to configured in CorePlus so it can be found when CorePlus issues a validation request. This will also be the procedure if the tunnels are being set up entirely internally without using the public internet.

    2. The CA server is a private server with tunnels set up over the public internet and with clients that will try to validate the certificate received from CorePlus. In this case the following must be done:

a. A private DNS server must be configured so that CorePlus can locate the private CA server to validate the certificates coming from clients.

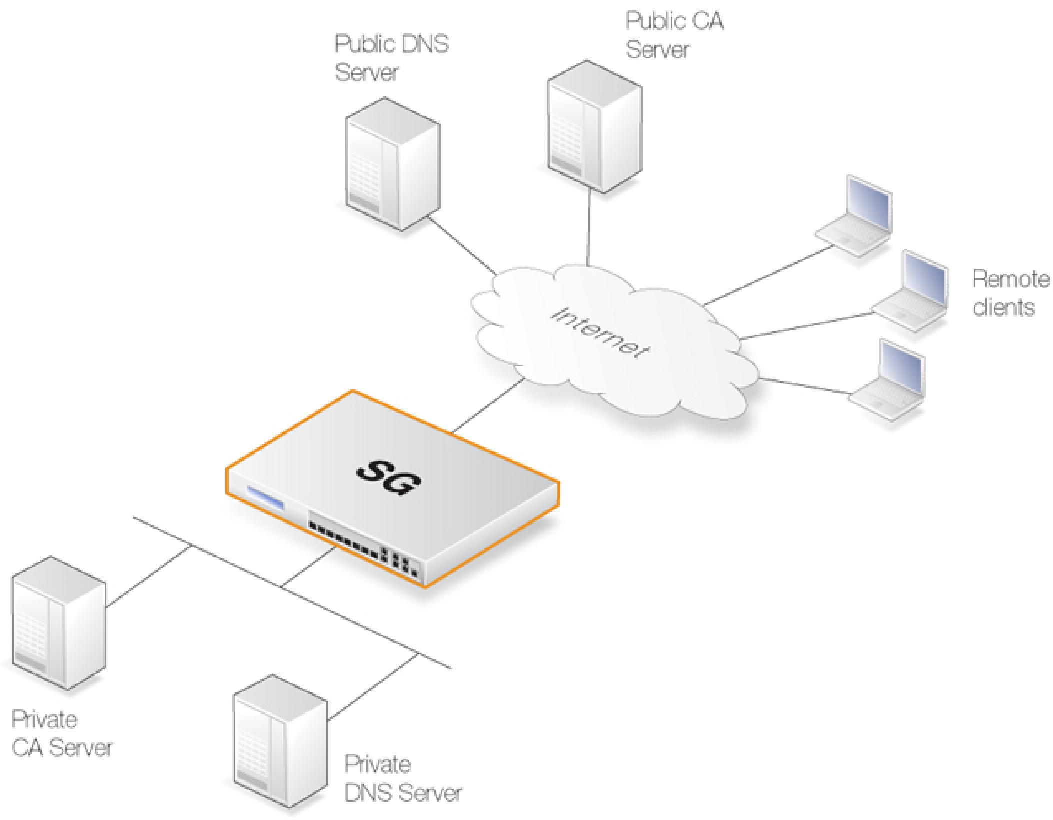
b. The external IP address of the Clavister Security Gateway needs to be registered in the public DNS system so that the FQDN reference to the private CA server in certificates sent to clients can be resolved. For instance, CorePlus may send a certificate to a client with an FQDN which is *ca.company.com* and this will need to be resolvable by the client to a public external IP address of the Clavister Security Gateway through the public DNS system.

The same steps should be followed if the other side of the tunnel is another gateway instead of being many clients.

3. The CA server is a commercial server on the public internet. In this, the simplest case, public DNS servers will resolve the FQDN. The only requirement is that CorePlus will need to have at least one public DNS server address configured to resolve the FQDNs in the certificates it receives.

- It must be also possible for an HTTP *PUT* request to pass from the validation request source (either the Clavister Security Gateway or a client) to the CA server and an HTTP reply to be received. If the request is going to pass through the Clavister Security Gateway, the appropriate rules in the CorePlus IP rule set need to be defined to allow this traffic through.

Figure 9.1. Certificate Validation Components



CA Server Access by Clients

In a VPN tunnel with roaming clients connecting to the Clavister Security Gateway, the VPN client software may need to access the CA server. Not all VPN client software will need this access. In the Microsoft clients prior to Vista, CA server requests are not sent at all. With Microsoft Vista validation became the default with the option to disable it. Other non-Microsoft clients differ in the way they work but the majority will attempt to validate the certficate.

Placement of Private CA Servers

The easiest solution for placement of a private CA server is to have it on the unprotected side of the Clavister Security Gateway. This however, is not recommended from a security viewpoint. It is better to place it on the inside (or preferably in the DMZ if available) and to have CorePlus control access to it.

As explained previously, the address of the private CA server must be resolvable through public DNS servers for certificate validation requests coming from the public internet. If the certificate queries are coming only from the Clavister Security Gateway and the CA server is on the internal side of the gateway then the IP address of the internal DNS server must be configured in CorePlus so that these requests can be resolved.

Turning Off FQDN Resolution

As explained in the troubleshooting section below, identifying problems with CA server access can be done by turning off the requirement to validate certificates. Attempts to access CA servers by CorePlus can be disabled with the **Disable CRLs** option for certificate objects. This means that checking against the CA server's revocation list will be turned off and access to the server won't be attempted.

9.2.8. VPN Troubleshooting

General Troubleshooting

In all types of VPNs some basic troubleshooting checks can be made:

- Check that all IP addresses have been specified correctly.
- Check that all pre-shared keys and usernames/passwords are correctly entered.
- Use ICMP *Ping* to confirm that the tunnel is working. With roaming clients this is best done by Pinging the internal IP address of the local network interface on the Clavister Security Gateway from a client (in LAN to LAN setups pinging could be done in any direction). If CorePlus is to able to respond to a Ping then the following rule must exist in the IP rule set.

Action	Src Interface	Src Network	Dest Interface	Dest Network	Service
Allow	vpn_tunnel	all-nets	core	all-nets	ICMP

- Ensure that another **IPsec Tunnel** definition isn't preventing the correct definition being reached. The tunnel list is scanned from top to bottom and a tunnel in a higher position with the **Remote Network** set to *all-nets* and the **Remote Gateway** set to *none* could prevent the correct tunnel being reached. A symptom of this is often an *Incorrect Pre-shared Key* message.
- Try and avoid duplication of IP addresses between the remote network being accessed by a client and the internal network to which a roaming client belongs.

  If a roaming client becomes temporarily part of a network such as a Wi-Fi network at an airport, the client will get an IP address from the Wi-Fi network's DHCP server. If that IP also belongs to the network behind the Clavister Security Gateway accessible through a tunnel, then Windows will still continue to assume that the IP address is to be found on the client's local network. Windows therefore won't correctly route packets bound for the remote network through the tunnel but instead route them to the local network.

The solution to this problem of local/remote IP address duplication is to create a new route in the client's Windows routing table that explicitly routes the IP address to the tunnel.

- If roaming client user authentication is not asking the users for their username/password then ensure that the following advanced settings are enabled:
  - **IPsecBeforeRules** for pure IPsec roaming clients.
  - **PPP_L2TPBeforeRules** for L2TP roaming clients.
  - **PPP_PPTPBeforeRules** for PPTP roaming clients.

  These settings should be enabled by default and they ensure that user authentication traffic between CorePlus and the client can bypass the IP rule set. If the appropriate setting is not enabled then an explicit rule needs to be added to the IP rule set to allow the authentication traffic to pass between roaming clients and CorePlus. This rule will have a destination interface of **core** (which means CorePlus itself).

Troubleshooting Certificates

If certificates have been used in a VPN solution then the following should be looked at:

- Check that the correct certificates have been used.
- Check that the certificate *.cer* and *.key* files have the same filename. For example, *my_cert.key* and *my_cert.cer*.
- Check that the certificates haven't expired.
- Check that the CorePlus date and time is set correctly and consider time-zone issues with newly generated certificates (the time of generation may not be the same as the CA server's system time).
- Disable CRL (revocation list) checking to see if CA server access could be the problem. CA server. CA Server issues are discussed further in Section 9.2.7, “CA Server Access”.

Troubleshooting IPsec Tunnels

A number of commands can be used to diagnose IPsec tunnels:

The *ipsecstat* console command

ipsecstat can be used to show that IPsec tunnels have correctly established. A representative example of output is:

```
> ipsecstat

--- IPsec SAs:

Displaying one line per SA-bundle

IPsec Tunnel    Local Net         Remote Net       Remote GW
------------    --------------    ------------     -------------
L2TP_IPSec      214.237.225.43    84.13.193.179    84.13.193.179
IPsec_Tun1      192.168.0.0/24    172.16.1.0/24    82.242.91.203
```

To examine the first IKE negotiation phase of tunnel setup use:

```
> ipsecstat -ike
```

To get complete details of tunnel setup use:

```
> ipsecstat -u -v
```

The *ikesnoop* console command

A common problem with setting up IPsec is a proposal list that is unacceptable to the device at the other end of the tunnel. The *ikesnoop* command is a useful tool for diagnosing incompatible proposal lists by showing the details of negotiations during tunnel setup. The basic form of this command is:

```
ikesnoop verbose
```

Once issued, an ICMP *ping* can be then sent to the Clavister Security Gateway from the remote end of the tunnel. This will cause *ikesnoop* to output details of the tunnel setup negotiation to the console and any proposal list incompatibilities can be seen.

If there are multiple tunnels in a setup or multiple clients on a single tunnel then the output from *ikesnoop verbose* can be overwhelming. It is therefore better to specify that the output comes from a single tunnel by specifying the IP address of the tunnel's endpoint (this is either the remote gateway IP or a client's IP address). The command takes the form:

```
ikesnoop verbose <ip-address>
```

Ikesnoop can be turned off with the command:

```
ikesnoop off
```

For a more detailed discussion of this topic, see Section 9.4.5, “Troubleshooting with *ikesnoop*”.

Management Interface Failure with VPN

If any VPN tunnel is set up and then the management interface no longer operates then it is likely to be a problem with the management traffic being routed back through the VPN tunnel instead of the correct interface.

This happens when a route is established in the main routing table which routes any traffic for **all-nets** through the VPN tunnel. If the management interface is not reached by the VPN tunnel then the administrator needs to create a specific route that routes management interface traffic leaving the Clavister Security Gateway back to the management subnet.

9.3. IPsec Components

9.3.1. Overview

Internet Protocol Security (IPsec), is a set of protocols defined by the Internet Engineering Task Force (IETF) to provide IP security at the network layer. An IPsec based VPN is made up by two parts:

- Internet Key Exchange protocol (IKE)
- IPsec protocols (AH/ESP/both)

The first part, IKE, is the initial negotiation phase, where the two VPN endpoints agree on which methods will be used to provide security for the underlying IP traffic. Furthermore, IKE is used to manage connections, by defining a set of Security Associations, SAs, for each connection. SAs are unidirectional, so there are usually at least two for each IPsec connection.

The second part is the actual IP data being transferred, using the encryption and authentication methods agreed upon in the IKE negotiation. This can be accomplished in a number of ways; by using IPsec protocols ESP, AH, or a combination of both.

The flow of events can be briefly described as follows:

- IKE negotiates how IKE should be protected
- IKE negotiates how IPsec should be protected
- IPsec moves data in the VPN

The following sections will describe each of these steps in detail.

9.3.2. Internet Key Exchange (IKE)

This section describes IKE, the Internet Key Exchange protocol, and the parameters that are used with it.

Encrypting and authenticating data is fairly straightforward, the only things needed are encryption and authentication algorithms, and the keys used with them. The Internet Key Exchange (IKE) protocol, IKE, is used as a method of distributing these "session keys", as well as providing a way for the VPN endpoints to agree on how the data should be protected.

IKE has three main tasks:

- Provide a means for the endpoints to authenticate each other
- Establish new IPsec connections (create SA pairs)
- Manage existing connections

IKE keeps track of connections by assigning a set of Security Associations, SAs, to each connection. An SA describes all parameters associated with a particular connection, such as the IPsec protocol used (ESP/AH/both) as well as the session keys used to encrypt/decrypt and/or authenticate/verify the transmitted data. An SA is, by nature, unidirectional, thus the need for more than one SA per connection. In most cases, where only one of ESP or AH is used, two SAs will be created for each connection, one describing the incoming traffic, and the other the outgoing. In cases where ESP and AH are used in conjunction, four SAs will be created.

IKE Negotiation

The process of negotiating session parameters consists of a number of phases and modes. These are described in detail in the below sections.

The flow of events can summarized as follows:

IKE Phase-1

- Negotiate how IKE should be protected

IKE Phase-2

- Negotiate how IPsec should be protected
- Derive some fresh keying material from the key exchange in phase-1, to provide session keys to be used in the encryption and authentication of the VPN data flow

IKE and IPsec Lifetimes

Both the IKE and the IPsec connections have limited lifetimes, described both in terms of time (seconds), and data (kilobytes). These lifetimes prevent a connection from being used too long, which is desirable from a crypto-analysis perspective.

The IPsec lifetime must be shorter than the IKE lifetime. The difference between the two must be a minimum of 5 minutes. This allows for the IPsec connection to be re-keyed simply by performing another phase-2 negotiation. There is no need to do another phase-1 negotiation until the IKE lifetime has expired.

It is recommended that the lifetime values are equal to or greater than the following values:

- IKE lifetime - 600 seconds (10 minutes).
- IPsec lifetime - 300 seconds (5 minutes).

If the administrator uses values which are less, CorePlus will accept them but a warning message will be presented when during the reconfiguration.

IKE Proposals

An IKE proposal is a suggestion of how to protect data. The VPN device initiating an IPsec connection, the initiator, will send a list of proposals, a proposal-list, suggesting different methods of how to protect the connection.

The connection being negotiated can be either an IPsec connection protecting the data flow through the VPN, or it can be an IKE connection, protecting the IKE negotiation itself.

The responding VPN device, upon receiving this proposal-list, will choose the most suitable proposal according to its own security policy, and respond by specifying which one of the proposal it has chosen.

If no acceptable proposal can be found, it will respond by saying that no proposal could be accepted, and possibly provide a reason why.

The proposals contain all parameters needed, such as algorithms used to encrypt and authenticate the data, and other parameters as described in section IKE Parameters.

IKE Phase-1 - IKE Security Negotiation

An IKE negotiation is performed in two phases. The first phase, phase-1, is used to authenticate the two VPN gateways or VPN Clients to each other, by confirming that the remote device has a matching Pre-Shared Key.

However, since we do not want to publish to much of the negotiation in plaintext, we first agree upon a way of protecting the rest of the IKE negotiation. This is done, as described in the previous section, by the initiator sending a proposal-list to the responder. When this has been done, and the responder accepted one of the proposals, we try to authenticate the other end of the VPN to make sure it is who we think it is, as well as proving to the remote device; that we are who we claim to be. A technique known as a *Diffie Hellman Key Exchange* is used to initially agree a shared secret between the two parties in the negotiation and to derive keys for encryption.

Authentication can be accomplished through Pre-Shared Keys, certificates or public key encryption. Pre-Shared Keys is the most common authentication method today. PSK and certificates are supported by the CorePlus VPN module.

IKE Phase-2 - IPsec Security Negotiation

In phase two, another negotiation is performed, detailing the parameters for the IPsec connection.

In phase-2 we will also extract new keying material from the Diffie-Hellman key exchange in phase-1, to provide session keys to use in protecting the VPN data flow.

If PFS, Perfect Forwarding Secrecy, is used, a new Diffie-Hellman exchange is performed for each phase-2 negotiation. While this is slower, it makes sure that no keys are dependent on any other previously used keys; no keys are extracted from the same initial keying material. This is to make sure that, in the unlikely event that some key was compromised, no subsequent keys can be derived.

Once the phase-2 negotiation is finished, the VPN connection is established and ready for use.

IKE Parameters

There are a number of parameters used in the negotiation process.

Below is a summary of the configuration parameters needed to establish a VPN connection. Understanding what these parameters do before attempting to configure the VPN endpoints is highly recommended, since it is of great importance that both endpoints are able to agree on all of these parameters.

When installing two Clavister Security Gateways as VPN endpoints, this process is reduced to comparing fields in two identical dialog boxes. However, it is not quite as easy when equipment from different vendors is involved.

Endpoint Identification

The *Local ID* is a piece of data representing the identity of the VPN gateway. With Pre-Shared Keys this is a unique piece of data uniquely identifying the tunnel endpoint.

Authentication using Pre-Shared Keys is based on the Diffie-Hellman algorithm.

Local and Remote Networks/Hosts

These are the subnets or hosts between which IP traffic will be protected by the VPN. In a LAN-to-LAN connection, these will be the network addresses of the respective LANs.

If roaming clients are used, the remote network will most likely be set to *all-nets*, meaning that the roaming client may connect from anywhere.

Tunnel / Transport Mode

IPsec can be used in two modes, tunnel or transport.

Tunnel mode indicates that the traffic will be tunneled to a remote device, which will decrypt/authenticate the data, extract it from its tunnel and pass it on to its final destination. This way, an eavesdropper will only see encrypted traffic going from one of VPN endpoint to another.

In transport mode, the traffic will not be tunneled, and is hence not applicable to VPN tunnels. It can be used to secure a connection from a VPN client directly to the Clavister Security Gateway, for example for IPsec protected remote configuration.

This setting will typically be set to "tunnel" in most configurations.

Remote Gateway

The remote gateway will be doing the decryption/authentication and pass the data on to its final destination. This field can also be set to "none", forcing the Clavister VPN to treat the remote address as the remote gateway. This is particularly useful in cases of roaming access, where the IP addresses of the remote VPN clients are not known beforehand. Setting this to "none" will allow anyone coming from an IP address conforming to the "remote network" address discussed above to open a VPN connection, provided they can authenticate properly.

The remote gateway is not used in transport mode.

Main/Aggressive Mode

The IKE negotiation has two modes of operation, main mode and aggressive mode.

The difference between these two is that aggressive mode will pass more information in fewer packets, with the benefit of slightly faster connection establishment, at the cost of transmitting the identities of the security gateways in the clear.

When using aggressive mode, some configuration parameters, such as Diffie-Hellman groups, and PFS, can not be negotiated, resulting in a greater importance of having "compatible" configurations on both ends.

IPsec Protocols

The IPsec protocols describe how the data will be processed. The two protocols to choose from are AH, Authentication Header, and ESP, Encapsulating Security Payload.

ESP provides encryption, authentication, or both. However, we do not recommend using encryption only, since it will dramatically decrease security.

More on ESP in ESP (Encapsulating Security Payload).

AH only provides authentication. The difference from ESP with authentication only is that AH also authenticates parts of the outer IP header, for instance source and destination addresses, making certain that the packet really came from who the IP header claims it is from.

More on AH in AH (Authentication Header).

Note

Clavister Security Gateways do not support AH.

IKE Encryption

This specifies the encryption algorithm used in the IKE negotiation, and depending on the algorithm, the size of the encryption key used.

The algorithms supported by CorePlus IPsec are:

- AES
- Blowfish
- Twofish
- Cast128
- 3DES
- DES

DES is only included to be interoperable with other older VPN implementations. Use of DES should be avoided whenever possible, since it is an old algorithm that is no longer considered secure.

IKE Authentication

This specifies the authentication algorithms used in the IKE negotiation phase.

The algorithms supported by CorePlus IPsec are:

- SHA1
- MD5

IKE DH Group

This specifies the Diffie-Hellman group to use for the IKE exchange. The available DH groups are discussed below.

IKE Lifetime

This is the lifetime of the IKE connection.

It is specified in time (seconds) as well as data amount (kilobytes). Whenever one of these expires, a new phase-1 exchange will be performed. If no data was transmitted in the last "incarnation" of the IKE connection, no new connection will be made until someone wants to use the VPN connection again. This value must be set greater than the IPsec SA lifetime.

PFS

With *Perfect Forwarding Secrecy* (PFS) disabled, initial keying material is "created" during the key exchange in phase-1 of the IKE negotiation. In phase-2 of the IKE negotiation, encryption and authentication session keys will be extracted from this initial keying material. By using PFS, completely new keying material will always be created upon re-key. Should one key be compromised, no other key can be derived using that information.

PFS can be used in two modes: the first is PFS on keys, where a new key exchange will be performed in every phase-2 negotiation. The other type is PFS on identities, where the identities are also protected, by deleting the phase-1 SA every time a phase-2 negotiation has been finished, making sure no more than one phase-2 negotiation is encrypted using the same key.

PFS is generally not needed, since it is very unlikely that any encryption or authentication keys will be compromised.

PFS DH Group
This specifies the DH group to use with PFS. This specifies the Diffie-Hellman group to use with PFS. The available DH groups are discussed below.

IPsec DH Group
This specifies the Diffie-Hellman group to use for IPsec communication. The available DH groups are discussed below.

IPsec Encryption
The encryption algorithm to use on the protected traffic.

This is not needed when AH is used, or when ESP is used without encryption.

The algorithms supported by Clavister Security Gateway VPNs are:

- AES
- Blowfish
- Twofish
- Cast128
- 3DES
- DES

IPsec Authentication
This specifies the authentication algorithm used on the protected traffic.

This is not used when ESP is used without authentication, although it is not recommended to use ESP without authentication.

The algorithms supported by Clavister Security Gateway VPNs are:

- SHA1
- MD5

IPsec Lifetime
This is the lifetime of the VPN connection. It is specified in both time (seconds) and data amount (kilobytes). Whenever either of these values is exceeded, a re-key will be initiated, providing new IPsec encryption and authentication session keys. If the VPN connection has not been used during the last re-key period, the connection will be terminated, and re-opened from scratch when the connection is needed again. This value must be set lower than the IKE lifetime.

Diffie-Hellman Groups

Diffie-Hellman (DH) is a cryptographic protocol that allows two parties that have no prior knowledge of each other to jointly establish a shared secret key over an insecure communications channel. The DH protocol is used to establish shared secret keys for IKE, IPsec and PFS which are listed above.

The Diffie-Hellman groups supported by CorePlus are as follows:

- DH group 1 (768-bits)

- DH group 2 (1024-bits)
- DH group 5 (1536-bits)

These are available for IKE, IPsec and PFS. The security of DH key exchanges increases as the number of DH group bits become larger, as does the processing overhead involved in the DH exchange.

9.3.3. IKE Authentication

Manual Keying

The "simplest" way of configuring a VPN is by using a method called "manual keying". This is a method where IKE is not used at all; the encryption and authentication keys as well as some other parameters are directly configured on both sides of the VPN tunnel.

Note

Clavister Security Gateways do not support Manual Keying.

Manual Keying Advantages

Since it is very straightforward it will be quite interoperable. Most interoperability problems encountered today are in IKE. Manual keying completely bypasses IKE and sets up its own set of IPsec SAs.

Manual Keying Disadvantages

It is an old method, which was used before IKE came into use, and is thus lacking all the functionality of IKE. This method therefore has a number of limitations, such as having to use the same encryption/authentication key always, no anti-replay services, and it is not very flexible. There is also no way of assuring that the remote host/gateway really is the one it says it is.

This type of connection is also vulnerable for something called "replay attacks", meaning a malicious entity which has access to the encrypted traffic can record some packets, store them, and send them to its destination at a later time. The destination VPN endpoint will have no way of telling if this packet is a "replayed" packet or not. Using IKE eliminates this vulnerability.

PSK

Using a Pre-shared Key (PSK) is a method where the endpoints of the VPN "share" a secret key. This is a service provided by IKE, and thus has all the advantages that come with it, making it far more flexible than manual keying.

PSK Advantages

Pre-Shared Keying has a lot of advantages over manual keying. These include endpoint authentication, which is what the PSKs are really for. It also includes all the benefits of using IKE. Instead of using a fixed set of encryption keys, session keys will be used for a limited period of time, where after a new set of session keys are used.

PSK Disadvantages

One thing that has to be considered when using Pre-Shared Keys is key distribution. How are the Pre-Shared Keys distributed to remote VPN clients and gateways? This is a major issue, since the security of a PSK system is based on the PSKs being secret. Should one PSK be compromised, the configuration will need to be changed to use a new PSK.

Certificates

Each VPN gateway has its own certificate, and one or more trusted root certificates.

The authentication is based on several things:

- That each endpoint has the private key corresponding to the public key found in its certificate, and that nobody else has access to the private key.
- That the certificate has been signed by someone that the remote gateway trusts.

Certificate Advantages

Added flexibility. Many VPN clients, for instance, can be managed without having the same pre-shared key configured on all of them, which is often the case when using pre-shared keys and roaming clients. Instead, should a client be compromised, the client's certificate can simply be revoked. No need to reconfigure every client.

Certificate Disadvantages

Added complexity. Certificate-based authentication may be used as part of a larger public key infrastructure, making all VPN clients and gateways dependent on third parties. In other words, there are more things that have to be configured, and there are more things that can go wrong.

9.3.4. IPsec Protocols (ESP/AH)

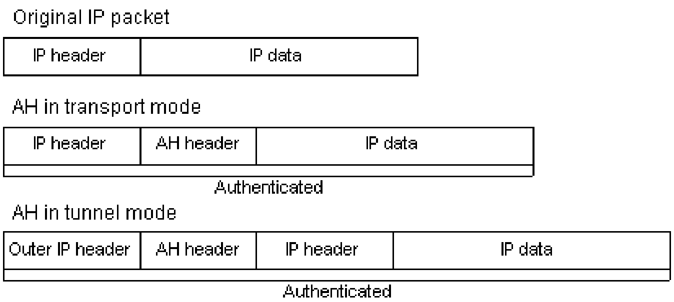
The IPsec protocols are the protocols used to protect the actual traffic being passed through the VPN. The actual protocols used and the keys used with those protocols are negotiated by IKE.

There are two protocols associated with IPsec, AH and ESP. These are covered in the sections below.

AH (Authentication Header)

AH is a protocol used for authenticating a data stream.

Figure 9.2. The AH protocol



AH uses a cryptographic hash function to produce a MAC from the data in the IP packet. This MAC is then transmitted with the packet, allowing the remote gateway to verify the integrity of the original IP packet, making sure the data has not been tampered with on its way through the Internet. Apart from the IP packet data, AH also authenticates parts of the IP header.

The AH protocol inserts an AH header after the original IP header, and in tunnel mode, the AH header is inserted after the outer header, but before the original, inner, IP header.

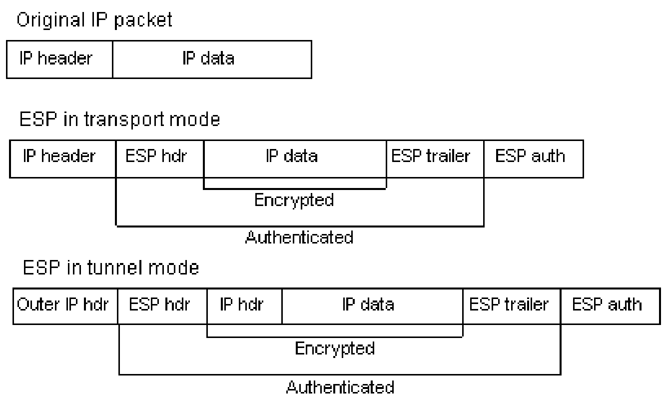
ESP (Encapsulating Security Payload)

The ESP protocol inserts an ESP header after the original IP header, in tunnel mode, the ESP header is inserted after the outer header, but before the original, inner, IP header.

All data after the ESP header is encrypted and/or authenticated. The difference from AH is that ESP also provides encryption of the IP packet. The authentication phase also differs in that ESP only authenticates the data after the ESP header; thus the outer IP header is left unprotected.

The ESP protocol is used for both encryption and authentication of the IP packet. It can also be used to do either encryption only, or authentication only.

Figure 9.3. The ESP protocol



9.3.5. NAT Traversal

Both IKE and IPsec protocols present a problem in the functioning of NAT. Both protocols were not designed to work through NATs and because of this, a technique called "NAT traversal" has evolved. NAT traversal is an add-on to the IKE and IPsec protocols that allows them to function when being NATed. CorePlus supports the RFC3947 standard for NAT-Traversal with IKE.

NAT traversal is divided into two parts:

- Additions to IKE that lets IPsec peers tell each other that they support NAT traversal, and the specific versions supported. CorePlus supports the RFC3947 standard for NAT-Traversal with IKE.
- Changes to the ESP encapsulation. If NAT traversal is used, ESP is encapsulated in UDP, which allows for more flexible NATing.

Below is a more detailed description of the changes made to the IKE and IPsec protocols.

NAT traversal is only used if both ends have support for it. For this purpose, NAT traversal aware VPNs send out a special "vendor ID", telling the other end that it understands NAT traversal, and which specific versions of the draft it supports.

Achieving NAT Detection

To achieve NAT detection both IPsec peers send hashes of their own IP addresses along with the source UDP port used in the IKE negotiations. This information is used to see whether the IP address and source port each peer uses is the same as what the other peer sees. If the source address and port have not changed, then the traffic has not been NATed along the way, and NAT traversal is not necessary. If the source address and/or port has changed, then the traffic has been NATed, and NAT traversal is used.

Changing Ports

Once the IPsec peers have decided that NAT traversal is necessary, the IKE negotiation is moved away from UDP port 500 to port 4500. This is necessary since certain NAT devices treat UDP packet on port 500 differently from other UDP packets in an effort to work around the NAT problems with IKE. The problem is that this special handling of IKE packets may in fact break the IKE negotiations,which is why the UDP port used by IKE has changed.

UDP Encapsulation

Another problem that NAT traversal resolves is that the ESP protocol is an IP protocol. There is no port information as we have in TCP and UDP, which makes it impossible to have more than one NATed client connected to the same remote gateway and at the same time. Because of this, ESP packets are encapsulated in UDP. ESP-UDP traffic is sent on port 4500, the same port as IKE when NAT traversal is used. Once the port has been changed, all following IKE communication is done over port 4500. Keep-alive packets are also sent periodically to keep the NAT mapping alive.

NAT Traversal Configuration

Most NAT traversal functionality is completely automatic and in the initiating gateway no special configuration is needed. However, for responding gateways two points should be noted:

- On responding gateways, the Remote Gateway field is used as a filter on the source IP of received IKE packets. This should be set to allow the NATed IP address of the initiator.
- When individual pre-shared keys are used with multiple tunnels connecting to one remote gateway which are then NATed out through the same address, it is important to make sure the *Local ID* is unique for every tunnel. The Local ID can be one of
  - **Auto** - The local ID is taken as the IP address of the outgoing interface. This is the recommended setting unless, in an unlikely event, the two gateways have the same external IP address.
  - **IP** - An IP address can be manually entered
  - **DNS** - A DNS address can be manually entered
  - **Email** - An email address can be manually entered

9.3.6. Proposal Lists

To agree on the VPN connection parameters, a negotiation process is performed. As the result of the negotiations, the IKE and IPsec security associations (SAs) are established. As the name implies, a proposal is the starting point for the negotiation. A proposal defines encryption parameters, for instance encryption algorithm, life times, etc., that the VPN gateway supports.

There are two types of proposals, IKE proposals and IPsec proposals. IKE proposals are used during IKE Phase-1 (IKE Security Negotiation), while IPsec proposals are using during IKE Phase-2 (IPsec

Security Negotiation).

A Proposal List is used to group several proposals. During the negotiation process, the proposals in the proposal list are offered to the remote VPN gateway one after another until a matching proposal is found. Several proposal lists can be defined in CorePlus for different VPN scenarios.

The *ike-roamingclients* and *esp-tn-roamingclients* proposal lists are suitable for VPN tunnels that are used for roaming VPN clients. As the name implies, the *ike-lantolan* and *esp-tn-lantolan* are suitable for LAN-to-LAN VPN solutions. These proposal lists are trimmed to include only AES and 3DES based proposals.

Example 9.1. Using a Proposal List

This example shows how to create and use an IPsec Proposal List for use in the VPN tunnel. It will propose 3DES and DES as encryption algorithms. The hash function SHA1 and MD5 will both be used in order to check if the data packet is altered while being transmitted. Note that this example does not illustrate how to add the specific IPsec tunnel object. It will also be used in a later example.

Clavister FineTune

First create a list of IPsec Algorithms:

1. Go to **Local Objects > VPN Settings > IPsec Proposal Lists**
2. Choose **New IPSEc Proposal List** and the **IPsec Proposal List Properties** dialog box will appear
3. Enter a name for the list, in this case **esp-l2tptunnel**
4. Select **Transport** as the **Encapsulation Mode**
5. Now check the following:
   - **DES**
   - **3DES**
   - **SHA1-96**
   - **MD5-96**
6. For **Kilobytes** enter 250000
7. For **Seconds** enter 3600
8. Click **OK**

Now apply the proposal list to the IPsec tunnel:

1. Go to **Interfaces > IPsec Tunnels**
2. Right-click the target IPsec tunnel, choose **Properties** and the **IPsec Tunnel Properties** dialog will appear
3. Select **esp-l2tptunnel** as the **IPsec Proposal List**
4. Click **OK**

9.3.7. Pre-shared Keys

Pre-Shared Keys are used to authenticate VPN tunnels. The keys are secrets that are shared by the communicating parties before communication takes place. To communicate, both parties prove that they know the secret. The security of a shared secret depends on how "good" a passphrase is. Passphrases that are common words are for instance extremely vulnerable to dictionary attacks.

Beware of Non-ASCII Characters in a PSK on Different Platforms!

If a PSK is specified as a passphrase and not a hexadecimal value, the different encodings on different platforms can cause a problem with non-ASCII characters. Windows, for example, encodes pre-shared keys containing non ASCII characters in UTF-16 while Clavister FineTune uses UTF-8. Even though they can seem the same at either end of the tunnel there will be a mismatch and this can sometimes cause problems when setting up a Windows L2TP client that connects to CorePlus.

Example 9.2. Using a Pre-Shared key

This example shows how to create a Pre-shared Key and apply it to a VPN tunnel. Since regular words and phrases are vulnerable to dictionary attacks, they should not be used as secrets. Here the pre-shared key is a randomly generated hexadecimal key. Note that this example does not illustrate how to add the specific IPsec tunnel object.

Clavister FineTune

First, create a Pre-shared Key:

1. Go to **Local Objects > VPN Settings > Pre-Shared Keys > New Pre-Shared Key**
2. The **Pre-shared Key Properties** dialog will appear
3. Enter a name for the pre-shared key, for example *MyPSK*
4. Choose **Hexadecimal Key** from the **Type** list
5. Click **Generate Random Key** to generate a key from the **Shared Secret** textbox
6. Click **OK**

Now apply the Pre-shared Key to the IPsec tunnel:

1. Go to **Interfaces > IPsec Tunnels**
2. Right-click on the target IPsec tunnel and choose **Properties** to display **IPsec Tunnel Properties**
3. In the **Authentication** tab, choose **Pre-Shared Key**
4. Select **MyPSK** in the **Pre-Shared key** dropdown list
5. Click **OK**

9.3.8. Identification Lists

When certificates are used as authentication method for IPsec tunnels, the Clavister Security Gateway will accept all remote gateways or VPN clients that are capable of presenting a certificate signed by any of the trusted Certificate Authorities. This can be a potential problem, especially when using roaming clients.

Consider the scenario of travelling employees being given access to the internal corporate networks using VPN clients. The organization administers their own Certificate Authority, and certificates have been issued to the employees. Different groups of employees are likely to have access to different parts of the internal networks. For instance, members of the sales force need access to servers running the order system, while technical engineers need access to technical databases.

Since the IP addresses of the travelling employees VPN clients cannot be known beforehand, the incoming VPN connections from the clients cannot be differentiated. This means that the gateway is unable to control the access to various parts of the internal networks.

The concept of Identification Lists presents a solution to this problem. An identification list contains one or more identities (IDs), where each identity corresponds to the subject field in a certificate. Identification lists can thus be used to regulate what certificates that are given access to what IPsec tunnels.

Example 9.3. Using an Identity List

This example shows how to create and use an Identification List for use in the VPN tunnel. This Identification List will contain one ID with the type DN, distinguished name, as the primary identifier. Note that this example does not illustrate how to add the specific IPsec tunnel object.

Clavister FineTune

First create an Identification List:

1. Go to **Local Objects > VPN Settings > Identification Lists > New Identification List**
2. The **Create Identification List** dialog will appear
3. Enter a name for the identification list, for example *MyIDList*
4. Click **OK**

Then, create an ID:

1. Go to **Local Objects > VPN Settings > Identification Lists > MyIDList**
2. Choose **New ID** from the context menu and the **ID Properties** dialog will appear
3. Select **DN** in the **Type** control
4. Now enter:
   - **Common Name:** John Doe
   - **Organization Name:** Clavister
   - **Organizational Unit:** Support
   - **Country:** Sweden
   - **Email Address:** john.doe@Clavister.com
5. Click **OK**

Finally, apply the Identification List to the IPsec tunnel:

1. Go to **Interfaces > IPsec Tunnels**
2. Right-click on the target IPsec tunnel object and choose **Properties** and the **IPsec Tunnel Properties** dialog will appear
3. In the **Authentication** tab, choose **X.509 Certificate**
4. Select **MyIDList** as the **Identification List**
5. Click **OK**

9.4. IPsec Tunnels

9.4.1. Overview

An IPsec Tunnel defines an endpoint of an encrypted tunnel. Each IPsec Tunnel is interpreted as a logical interface by CorePlus, with the same filtering, traffic shaping and configuration capabilities as regular interfaces.

When another Clavister Security Gateway or any IPsec compliant product tries to establish a IPsec VPN tunnel to the Clavister Security Gateway, the configured IPsec Tunnels are evaluated. If a matching IPsec Tunnel definition is found, the IKE and IPsec negotiations then take place, resulting in a IPsec VPN tunnel being established.

Note that an established IPsec tunnel does *not* automatically mean that all traffic from that IPsec tunnel is trusted. On the contrary, network traffic that has been decrypted will be transferred to the rule set for further evaluation. The source interface of the decrypted network traffic will be the name of the associated IPsec Tunnel. Furthermore, a Route or an Access rule, in the case of a roaming client, has to be defined to have the CorePlus accept certain source IP addresses from the IPsec tunnel.

For network traffic going in the opposite direction, that is, going into a IPsec tunnel, a reverse process takes place. First, the unencrypted traffic is evaluated by the rule set. If a rule and route matches, CorePlus tries to find an established IPsec tunnel that matches the criteria. If not found, CorePlus will try to establish a tunnel to the remote gateway specified by the matching IPsec Tunnel definition.

Note

*IKE and ESP/AH traffic are sent to the IPsec engine before the rule set is consulted. Encrypted traffic to the gateway therefore does not need to be allowed in the rule set. This behavior can be changed in the **IPsec advanced settings** section.*

9.4.2. LAN to LAN Tunnels with Pre-shared Keys

A VPN can allow geographically distributed Local Area Networks (LANs) to communicate securely over the public Internet. In a corporate context this means LANs at geographically separate sites can communicate with a level of security comparable to that existing if they communicated through a dedicated, private link.

Secure communication is achieved through the use of IPsec tunneling, with the tunnel extending from the VPN gateway at one location to the VPN gateway at another location. The Clavister Security Gateway is therefore the implementer of the VPN, while at the same time applying normal security surveillance of traffic passing through the tunnel. This section deals specifically with setting up LAN to LAN tunnels created with a Pre-shared Key (PSK).

A number of steps are required to set up LAN to LAN tunnels with PSK:

- If both local and remote gateways are Clavister Security Gateways, define the host and networks in the **Global Namespace**.
- Set up a Pre-shared Key or secret for the VPN tunnel.
- Set up the **VPN tunnel properties** and include the Pre-Shared key.
- Set up the **Route** in the routing table.
- Set up the **Rules** (2-way tunnel requires 2 rules).

Example 9.4. Setup a LAN to LAN VPN tunnel with PSK

Clavister FineTune

In this example, a LAN behind a local gateway called **Stockholm** will have a secure VPN tunnel defined to a LAN behind a remote gateway called **Helsinki**. The following are the steps to take on **Stockholm**. **Helsinki** must be configured to match these settings.

1. If both local and remote gateways are Clavister Security Gateways, go to **Edit > Move to namespace** to put **ip_wan** and **lannet** into the **Global Namespace**

2. Go to **File > New Pre-Shared Key** in the **Pre-Shared Key** section to create the **PSK**. A hexadecimal key could be created with the **Generate Random Key** button.

3. In the **VPN Tunnel properties** section in the **Interface** folder, set up the tunnel properties:

   - **Name**: *HelsinkiVPN* (use this name in **Access** and **Rules** sections)
   - **Local Network**: Stockholm_lannet
   - **Remote Network**: Helsinki_lannet
   - **Remote Gateway**: Helsinki_ip_wan

   Select the **IKE proposal** and **IPsec proposal** for the tunnel then, via the **Authentication** tab, select the **Pre-Shared Key** created previously.

4. In the **Routes** section in the **Routing** folder go to **File > New route**. **Helsinki_lannet** is routed through the **HelsinkiVPN**.

5. Create an outgoing traffic rule for internal LAN traffic going to the LAN behind the **Helsinki** gateway. The parameters would be:

   - **Action**: Allow
   - **Source Interface**: lan
   - **Source Network**: Stockholm_lannet
   - **Destination Interface**: HelsinkiVPN
   - **Destination Network**: Helsinki_lannet
   - **Service**: All

6. Create a rule for incoming traffic from the remote network on the VPN interface with parameters:

   - **Action**: Allow
   - **Source Interface**: HelsinkiVPN
   - **Source Network**: Helsinki_lannet
   - **Destination Interface**: any
   - **Destination Network**: Stockholm_lannet
   - **Service**: All

> ***Note***
>
> *In the example above, a **Destination Interface** value of any allows pinging of the internal IP of the gateway through the tunnel. A value of **lan** prevents this as its routed on the **core** interface. A pre-defined service could be used instead of **All**.*

9.4.3. Roaming Clients

An employee who is on the move who needs to access a central corporate server from a notebook computer from different locations is a typical example of a roaming client. Apart from the need for secure VPN access, the other major issue with roaming clients is that the mobile user's IP address is often not known beforehand. To handle the unknown IP address the CorePlus can dynamically add routes to the routing table as tunnels are established.

Dealing with Unknown IP addresses

If the IP address of the client is not known before hand then the Clavister Security Gateway needs to create a route in its routing table dynamically as each client connects. In the example below this is the case and the IPsec tunnel is configured to dynamically add routes.

If clients are to be allowed to roam in from everywhere, irrespective of their IP address, then the **Remote Network** needs to be set to **all-nets** (IP address: 0.0.0.0/0) which will allow all existing IPv4-addresses to connect through the tunnel.

When configuring VPN tunnels for roaming clients it is usually not necessary to add to or modify the proposal lists that are pre-configured in CorePlus.

9.4.3.1. PSK based client tunnels

Example 9.5. Setting up a PSK based VPN tunnel for roaming clients

This example describes how to configure an IPsec tunnel at the head office Clavister Security Gateway for roaming clients that connect to the office to gain remote access. The head office network uses the 10.0.1.0/24 network span with external gateway IP ip_wan.

Clavister FineTune

A. Create a pre-shared key for IPsec authentication:

1. Go to **Local Objects > VPN Settings > Pre-Shared Keys > New Pre-Shared key**
2. The **Pre-Shared Key Properties** dialog will appear
3. Now enter:
   - **Name:** Enter a name for the key, for example *SecretKey*
   - **Shared Secret:** Enter a secret passphrase
   - **Confirm Secret:** Enter the secret passphrase again
4. Click **OK**

B. Configure the IPsec tunnel:

1. Go to **Interfaces > IPsec Tunnels > New IPsec Tunnel**
2. The **IPsec Tunnel Properties** dialog will appear
3. Now enter:
   - **Name:** RoamingIPsecTunnel
   - **Local Network:** 10.0.1.0/24 (the local network that the roaming users will connect to)
   - **Remote Network:** all-nets
   - **Remote Endpoint:** none
     *(This Remote Endpoint must be given a value if the Remote Network is not **all-nets**)*
   - **Encapsulation Mode:** Tunnel
4. Select the **IKE Proposal List** for the tunnel.
5. Select the **IPsec Proposal List** for the tunnel.
6. In the **Authentication**tab select the pre-shared key created earlier.
7. Under the **Routing** tab enable the setting **Dynamically add route to the remote network when a tunnel is**

established.

8. Click **OK**

C. Finally configure the IP rule set to allow traffic inside the tunnel.

9.4.3.2. Self-signed Certificate based client tunnels

Example 9.6. Setting up a Self-signed Certificate based VPN tunnel for roaming clients

This example describes how to configure an IPsec tunnel at the head office Clavister Security Gateway for roaming clients that connect to the office to gain remote access. The head office network uses the 10.0.1.0/24 network span with external gateway IP ip_wan.

Clavister FineTune

A. Create a Self-signed Certificate for IPsec authentication:

1. Go to **Local Objects > Certificates > New Certificate**
2. The **Certificate Properties** dialog will appear
3. Enter a descriptive **name**, for example *MyCertificate*
4. Make sure the **Create self-signed certificate** option is selected
5. Proceed to the **Properties** tab
6. Enter values for the required fields
7. Make sure that the date in **Certificate Validity** is not set too early since this will make the gateway certificate useless.
8. Click **OK**

B. Import all the client's self-signed certificates:

1. Go to **Local Objects > Certificates > Import Certificate**
2. Locate your exported client certificate and click **Open** and **OK**
3. Continue to import all your client certificates according to the instruction in the previous step
4. Finally export your gateway certificate, since that certificate is going to be imported by remote clients:
   - Go to **Local Objects > Certificates**
   - Select your gateway certificate in the grid and from the context menu, select **Export Certificate**
   - Pick a name and location for the certificate and click **Save**

C. Create Identification Lists:

1. Go to **Local Objects > VPN Settings > Identification Lists > New Identification List**
2. The **Identification List Properties** dialog will appear
3. Enter a descriptive **name**, for example *sales*
4. Click **OK**
5. Select your created identification list, right-click and select **New ID...** and the **ID Properties** dialog will appear
6. Select **Email** as **Type**.
7. In the **Value** field, enter the email address selected when you created the certificate on the client
8. Click **OK**

9. Create a new ID for every client that you want to grant access rights according to the instructions above

D. Configure the IPsec tunnel:

1. Go to **Interfaces > IPsec Tunnels > New Ipsec Tunnel**
2. The **IPsec Tunnel Properties** dialog will appear
3. Now enter:
   - **Name:** RoamingIPsecTunnel
   - **Local Network:** 10.0.1.0/24 (the local network that the roaming users will connect to)
   - **Remote Network:** all-nets
   - **Remote Endpoint:** (None)
   - **Encapsulation Mode:** Tunnel
4. Select the **IKE Proposal List** for the tunnel
5. Select the **IPsec Proposal List** for the tunnel
6. In the **Authentication** tab choose X.509 Certificate as authentication method and select your newly created gateway certificate as **gateway Certificate**
7. Continue to add all your client certificates in the **Root Certificate(s)** section
8. Select your ID List that you want to associate with your VPN Tunnel under the **Identification List** section. In our case that will be *sales*
9. Under the **Routing** tab enable the setting **Dynamically add route to the remote network when a tunnel is established**
10. Click **OK**

E. Finally configure the IP rule set to allow traffic inside the tunnel.

9.4.3.3. CA Server issued Certificates based client tunnels

Setting up client tunnels using a CA issued certificate is largely the same as using Self-signed certificates with the exception of a couple of steps. Most importantly, it is the responsibility of the administrator to acquire the appropriate certificate from an issuing authority. With some systems, such as Windows 2000 Server, there is built-in access to a CA server (in Windows 2000 Server this is found in **Certificate Services**). For more information on CA server issued certificates see Section 3.7, “Certificates”.

It is the responsibility of the administrator to acquire the appropriate certificate from an issuing authority for client tunnels. With some systems, such as Windows 2000 Server, there is built-in access to a CA server (in Windows 2000 Server this is found in **Certificate Services**). For more information on CA server issued certificates see Section 3.7, “Certificates”.

Example 9.7. Setting up a CA Server issued Certificate based VPN tunnel for roaming clients

This example describes how to configure an IPsec tunnel at the head office Clavister Security Gateway for roaming clients that connect to the office to gain remote access. The head office network uses the 10.0.1.0/24 network span with external gateway IP ip_wan.

Clavister FineTune

A. Create a Self-signed Certificate for IPsec authentication:

1. Go to **Local Objects > Certificates > New Certificate**

2. The **Certificate Properties** dialog will appear
3. Enter a descriptive **name**, for example *MyCertificate*
4. Make sure the **Create self-signed certificate** option is selected
5. Proceed to the **Properties** tab
6. Type in the corresponding fields on your own choosing
7. Make sure that the dates in **Certificate Validity** is not set to "low" since this makes the gateway certificate useless
8. Click **OK**

B. Import CA servers root certificate:

1. Go to **Local Objects > Certificates > Import Certificate**
2. Locate your CA root certificate and click **Open** and **OK**
3. Finally export your gateway certificate, since that certificate is going to be imported by remote clients:
   - Go to **Local Objects > Certificates**
   - Select your gateway certificate in the grid and from the context menu, select **Export Certificate**
   - Pick a name and location for the certificate and click **Save**

C. Create Identification Lists:

1. Go to **Local Objects > VPN Settings > Identification Lists > New Identification List**
2. The **Identification List Properties** dialog will appear.
3. Enter a descriptive **name**, for example *sales*.
4. Click **OK**
5. Select your created identification list, right-click and select **New ID...** and the **ID Properties** dialog will appear
6. Select **DN** as **Type**
7. Type in the information entered earlier for the user certificate
8. Click **OK**
9. Create a new ID for every client that you want to grant access rights according to the instructions above

D. Configure the IPsec tunnel:

1. Go to **Interfaces > IPsec Tunnels > New Ipsec Tunnel**
2. The **IPsec Tunnel Properties** dialog will appear
3. Now enter:
   - **Name:** RoamingIPsecTunnel
   - **Local Network:** 10.0.1.0/24 (the local network that the roaming users will connect to)
   - **Remote Network:** all-nets
   - **Remote Endpoint:** (None)
   - **Encapsulation Mode:** Tunnel
4. Select the **IKE Proposal List** for the tunnel
5. Select the **IPsec Proposal List** for the tunnel
6. In the **Authentication** tab choose X.509 Certificate as authentication method and select your newly created gateway certificate as **gateway Certificate**
7. Continue to add your CA server root certificate in the **Root Certificate(s)** section

8. Select your ID List that you want to associate with your VPN Tunnel under the **Identification List** section. In our case that will be *sales*
9. Under the **Routing** tab enable the setting **Dynamically add route to the remote network when a tunnel is established**
10. Click **OK**

E. Finally configure the IP rule set to allow traffic inside the tunnel.

9.4.3.4. Using Config Mode

IKE Configuration Mode (Config Mode) is an extension to IKE that allows CorePlus to provide LAN configuration information to remote VPN clients. It is used to dynamically configure IPsec clients with IP addresses and corresponding netmasks, and to exchange other types of information associated with DHCP. The IP address provided to a client can be either be based on a range of predefined static IP addresses defined for Config Mode or it can come from DHCP servers associated with an *IP Pool* object.

An IP pool is a cache of IP addresses collected from DHCP servers and leases on these addresses are automatically renewed when the lease time is about to expire. IP Pools also manage additional information such as DNS and WINS/NBNS, just as an ordinary DHCP server would. (For detailed information on pools see Section 5.5, “IP Pools”.)

Defining the Config Mode Object

Currently only one Config Mode object can be defined in CorePlus and this is referred to as the *Config Mode Pool* object. The key parameters associated with it are as follows:

Use Pre-defined IP Pool Object The IP Pool object that provides the IP addresses.

Use a Static Pool As an alternative to using an IP Pool, a static set of IP addresses can be defined.

DNS The IP address of the DNS used for URL resolution (already provided by an IP Pool).

NBNS/WINS The IP address for NBNS/WINS resolution (already provided by an IP Pool).

DHCP Instructs the host to send any internal DHCP requests to this address.

Subnets A list of the subnets that the client can access.

Example 9.8. Setting Up Config Mode

In this example the Config Mode Pool object is enabled by associating with it an already configured IP Pool object called *ip_pool1*

Clavister FineTune

1. Go to **Local Objects > VPN Settings > Config Mode Pool**
2. The Config Mode Pool object properties dialog now appears
3. Select **Use a pre-defined IPPool object**
4. From the drop-down box choose the *ip_pool1* object

5. Click **OK**

After defining the Config Mode object, the only remaining action is to enable Config Mode to be used with the IPsec Tunnel.

Example 9.9. Using Config Mode with IPsec Tunnels

Assuming a predefined tunnel called *vpn_tunnel1* this example shows how to enable Config Mode for that tunnel.

Clavister FineTune

- Go to **Interfaces > IPsec Tunnels**
- Right click on *vpn_tunnel1* and the **IPsec Tunnel Properties** dialog appears
- Choose *ip_pool1* from the **Enable IKE Config Mode** list
- Click **OK**

IP Validation

CorePlus always checks if the source IP address of each packet inside an IPsec tunnel is the same as the IP address assigned to the IPsec client with IKE Config Mode. If a mismatch is detected the packet is always dropped and a log message generated with a severity level of **Warning**. This message includes the two IP addresses as well as the client identity.

Optionally, the affected SA can be automatically deleted if validation fails by enabling the advanced setting **IPsecDeleteSAOnIPValidationFailure**. The default value for this setting is *Disabled*.

9.4.4. Fetching CRLs from an alternate LDAP server

A Root Certificate usually includes the IP address or hostname of the Certificate Authority to contact when certificates or CRLs need to be downloaded to the Clavister Security Gateway. Lightweight Directory Access Protocol (LDAP) is used for these downloads.

However, in some scenarios, this information is missing, or the administrator wishes to use another LDAP server. The LDAP configuration section can then be used to manually specify alternate LDAP servers.

Example 9.10. Setting up an LDAP server

This example shows how to manually setup and specify a LDAP server.

Clavister FineTune

1. Go to **Local Objects > VPN Settings > LDAP > New LDAP Server**
2. The **LDAP Server Properties** dialog will appear
3. Now enter:
   - **IP Address:** 192.168.101.146
   - **Username:** myusername
   - **Password:** mypassword
   - **Port:** 389

4. Click **OK**

9.4.5. Troubleshooting with *ikesnoop*

VPN Tunnel Negotiation

When setting up IPsec tunnels, problems can arise because the initial negotiation fails when the devices at either end of a VPN tunnel try but fail to agree on which protocols and encryption methods will be used. The *ikesnoop* console command with the *verbose* option is a tool that can be used to identify the source of such problems by showing the details of this negotiation.

Using *ikesnoop*

The *ikesnoop* command can be entered in one of three ways: via the Clavister FineTune console, the RS232 Console or via the **fwctl** management tool.

To begin monitoring, the full command is:

```
Cmd> ikesnoop verbose
```

This results in ikesnoop output being sent to the console for every VPN tunnel IKE negotiation. The output can be overwhelming so to limit the output to a single IP address, for example the IP address *10.1.1.10*, the command would be:

```
Cmd> ikesnoop verbose 10.1.1.10
```

The IP address used is the IP address of the VPN tunnel's remote endpoint (either the remote gateway IP or the client IP). To turn off monitoring, the command is:

```
Cmd> ikesnoop off
```

The output from *ikesnoop verbose* can be troublesome to interpret by an administrator seeing it for the first time. Presented below is some typical *ikesnoop* output with annotations to explain it. The tunnel negotiation considered is based on Pre-shared Keys. A negotiation based on certificates is not discussed here but the principles are similar.

Complete *ikesnoop* command options can be found in Appendix B, *CLI Reference*.

The Client and the Server

The two parties involved in the tunnel negotiation are referred to in this section as the *client* and server. In this context, the word *client* is used to refer to the device which is the *initiator* of the negotiation and the *server* refers to the device which is the *responder*.

Step 1. Client Initiates Exchange By Sending Proposal

The *ikesnoop verbose* command output initially shows the proposal list that the client in the exchange first sends to the server detailing the protocols and encryption methods it can support. The purpose for the proposal is that the client is trying to find a matching set of protocols/methods supported by the server. The server examines the proposal and attempts to find a combination of the protocols/methods sent by the client which it supports.

```
IkeSnoop: Received IKE packet from 192.168.0.10:500 Exchange type :
        Identity Protection (main mode) ISAKMP Version : 1.0

Flags          :
Cookies        : 0x6098238b67d97ea6 -> 0x00000000
Message ID     : 0x00000000
Packet length  : 324 bytes
# payloads     : 8
Payloads:
  SA (Security Association)
    Payload data length : 152 bytes
    DOI : 1 (IPsec DOI)
      Proposal 1/1
        Protocol 1/1
          Protocol ID                : ISAKMP
          SPI Size                   : 0
          Transform 1/4
            Transform ID             : IKE
            Encryption algorithm     : Rijndael-cbc (aes)
            Key length               : 128
            Hash algorithm           : MD5
            Authentication method    : Pre-Shared Key
            Group description        : MODP 1024
            Life type                : Seconds
            Life duration            : 43200
            Life type                : Kilobytes
            Life duration            : 50000
          Transform 2/4
            Transform ID             : IKE
            Encryption algorithm     : Rijndael-cbc (aes)
            Key length               : 128
            Hash algorithm           : SHA
            Authentication method    : Pre-Shared Key
            Group description        : MODP 1024
            Life type                : Seconds
            Life duration            : 43200
            Life type                : Kilobytes
            Life duration            : 50000
          Transform 3/4
            Transform ID             : IKE
            Encryption algorithm     : 3DES-cbc
            Hash algorithm           : MD5
            Authentication method    : Pre-Shared Key
            Group description        : MODP 1024
            Life type                : Seconds
            Life duration            : 43200
            Life type                : Kilobytes
            Life duration            : 50000
          Transform 4/4
            Transform ID             : IKE
            Encryption algorithm     : 3DES-cbc
            Hash algorithm           : SHA
            Authentication method    : Pre-Shared Key
            Group description        : MODP 1024
            Life type                : Seconds
            Life duration            : 43200
            Life type                : Kilobytes
            Life duration            : 50000
  VID (Vendor ID)
    Payload data length : 16 bytes
    Vendor ID   : 8f 9c c9 4e 01 24 8e cd f1 47 59 4c 28 4b 21 3b
    Description : SSH Communications Security QuickSec 2.1.0
  VID (Vendor ID)
    Payload data length : 16 bytes
    Vendor ID   : 27 ba b5 dc 01 ea 07 60 ea 4e 31 90 ac 27 c0 d0
    Description : draft-stenberg-ipsec-nat-traversal-01
  VID (Vendor ID)
    Payload data length : 16 bytes
```

```
    Vendor ID   : 61 05 c4 22 e7 68 47 e4 3f 96 84 80 12 92 ae cd
    Description : draft-stenberg-ipsec-nat-traversal-02
  VID (Vendor ID)
    Payload data length : 16 bytes
    Vendor ID   : 44 85 15 2d 18 b6 bb cd 0b e8 a8 46 95 79 dd cc
    Description : draft-ietf-ipsec-nat-t-ike-00
  VID (Vendor ID)
    Payload data length : 16 bytes
    Vendor ID   : cd 60 46 43 35 df 21 f8 7c fd b2 fc 68 b6 a4 48
    Description : draft-ietf-ipsec-nat-t-ike-02
  VID (Vendor ID)
    Payload data length : 16 bytes
    Vendor ID   : 90 cb 80 91 3e bb 69 6e 08 63 81 b5 ec 42 7b 1f
    Description : draft-ietf-ipsec-nat-t-ike-02
  VID (Vendor ID)
    Payload data length : 16 bytes
    Vendor ID   : 7d 94 19 a6 53 10 ca 6f 2c 17 9d 92 15 52 9d 56
    Description : draft-ietf-ipsec-nat-t-ike-03
```

Explanation of Values

Exchange type : Main mode or aggressive mode
Cookies : A random number to identify the negotiation
Encryption algorithm : Cipher
Key length : Cipher key length
Hash algorithm : Hash
Authentication method : Pre-shared key or certificate
Group description : Diffie Hellman (DH) group
Life type : Seconds or kilobytes
Life duration : No of seconds or kilobytes
VID : The IPsec software vendor plus what standards are supported, e.g. NAT-T

Step 2. Server Responds to Client

A typical response from the server is shown below . This must contain a proposal that is identical to one of the choices from the client list above. If no match was found by the server then a "No proposal chosen" message will be seen, tunnel setup will fail and the *ikesnoop* command output will stop at this point.

```
IkeSnoop: Sending IKE packet to 192.168.0.10:500 Exchange type :
        Identity Protection (main mode) ISAKMP Version : 1.0

Flags          :
Cookies        : 0x6098238b67d97ea6 -> 0x5e347cb76e95a
Message ID     : 0x00000000
Packet length  : 224 bytes
# payloads     : 8
Payloads:
  SA (Security Association)
    Payload data length : 52 bytes
    DOI : 1 (IPsec DOI)
      Proposal 1/1
        Protocol 1/1
          Protocol ID              : ISAKMP
          SPI Size                 : 0
          Transform 1/1
            Transform ID           : IKE
            Encryption algorithm   : Rijndael-cbc (aes)
            Key length             : 128
            Hash algorithm         : MD5
            Authentication method  : Pre-Shared Key
```

```
            Group description        : MODP 1024
            Life type                : Seconds
            Life duration            : 43200
  VID (Vendor ID)
    Payload data length : 16 bytes
    Vendor ID   : 8f 9c c9 4e 01 24 8e cd f1 47 59 4c 28 4b 21 3b
    Description : SSH Communications Security QuickSec 2.1.0
  VID (Vendor ID)
    Payload data length : 16 bytes
    Vendor ID   : 27 ba b5 dc 01 ea 07 60 ea 4e 31 90 ac 27 c0 d0
    Description : draft-stenberg-ipsec-nat-traversal-01
  VID (Vendor ID)
    Payload data length : 16 bytes
    Vendor ID   : 61 05 c4 22 e7 68 47 e4 3f 96 84 80 12 92 ae cd
    Description : draft-stenberg-ipsec-nat-traversal-02
  VID (Vendor ID)
    Payload data length : 16 bytes
    Vendor ID   : 44 85 15 2d 18 b6 bb cd 0b e8 a8 46 95 79 dd cc
    Description : draft-ietf-ipsec-nat-t-ike-00
  VID (Vendor ID)
    Payload data length : 16 bytes
    Vendor ID   : cd 60 46 43 35 df 21 f8 7c fd b2 fc 68 b6 a4 48
    Description : draft-ietf-ipsec-nat-t-ike-02
  VID (Vendor ID)
    Payload data length : 16 bytes
    Vendor ID   : 90 cb 80 91 3e bb 69 6e 08 63 81 b5 ec 42 7b 1f
    Description : draft-ietf-ipsec-nat-t-ike-02
  VID (Vendor ID)
    Payload data length : 16 bytes
    Vendor ID   : 7d 94 19 a6 53 10 ca 6f 2c 17 9d 92 15 52 9d 56
    Description : draft-ietf-ipsec-nat-t-ike-03
```

Step 3. Clients Begins Key Exchange

The server has accepted a proposal at this point and the client now begins a key exchange. In addition, NAT detection payloads are sent to detect if NAT is being used.

```
IkeSnoop: Received IKE packet from 192.168.0.10:500 Exchange type :
        Identity Protection (main mode) ISAKMP Version : 1.0
Flags          :
Cookies        : 0x6098238b67d97ea6 -> 0x5e347cb76e95a
Message ID     : 0x00000000
Packet length  : 220 bytes
# payloads     : 4
Payloads:
  KE (Key Exchange)
    Payload data length : 128 bytes
  NONCE (Nonce)
    Payload data length : 16 bytes
  NAT-D (NAT Detection)
    Payload data length : 16 bytes
  NAT-D (NAT Detection)
    Payload data length : 16 bytes
```

Step 4. Server Sends Key Exchange Data

The Server now sends key exchange data back to the client.

```
IkeSnoop: Sending IKE packet to 192.168.0.10:500 Exchange type :
        Identity Protection (main mode) ISAKMP Version : 1.0
Flags          :
Cookies        : 0x6098238b67d97ea6 -> 0x5e347cb76e95a
Message ID     : 0x00000000
Packet length  : 220 bytes
# payloads     : 4
Payloads:
  KE (Key Exchange)
    Payload data length : 128 bytes
  NONCE (Nonce)
    Payload data length : 16 bytes
  NAT-D (NAT Detection)
    Payload data length : 16 bytes
  NAT-D (NAT Detection)
    Payload data length : 16 bytes
```

Step 5. Client Sends Identification

The initiator sends the identification which is normally an IP address or the *Subject Alternative Name* if certificates are used.

```
IkeSnoop: Received IKE packet from 192.168.0.10:500 Exchange type :
        Identity Protection (main mode) ISAKMP Version : 1.0
Flags          : E (encryption)
Cookies        : 0x6098238b67d97ea6 -> 0x5e347cb76e95a
Message ID     : 0x00000000
Packet length  : 72 bytes
# payloads     : 3
Payloads:
  ID (Identification)
    Payload data length : 8 bytes
    ID : ipv4(any:0,[0..3]=192.168.0.10)
  HASH (Hash)
    Payload data length : 16 bytes
  N (Notification)
    Payload data length : 8 bytes
    Protocol ID  : ISAKMP
    Notification : Initial contact
```

Explanation of Above Values

Flags : E means encryption (it is the only flag used).
ID : Identification of the client

The *Notification* field is given as *Initial Contact* to indicate this is not a re-key.

Step 6. Server ID Response

The server now responds with its own ID.

```
IkeSnoop: Sending IKE packet to 192.168.0.10:500 Exchange type :
        Identity Protection (main mode) ISAKMP Version : 1.0
Flags          : E (encryption)
Cookies        : 0x6098238b67d97ea6 -> 0x5e347cb76e95a
Message ID     : 0x00000000
Packet length  : 60 bytes
```

```
# payloads     : 2
Payloads:
  ID (Identification)
    Payload data length : 8 bytes
    ID : ipv4(any:0,[0..3]=192.168.10.20)
  HASH (Hash)
    Payload data length : 16 bytes
```

Step 7. Client Sends IPsec Proposal List

Now the client sends the IPsec proposal list to the server. It will also contain the proposed host/networks allowed in the tunnel.

```
IkeSnoop: Received IKE packet from 192.168.0.10:500 Exchange type :
        Quick mode ISAKMP Version : 1.0
Flags          : E (encryption)
Cookies        : 0x6098238b67d97ea6 -> 0x5e347cb76e95a
Message ID     : 0xaa71428f
Packet length  : 264 bytes
# payloads     : 5
Payloads:
  HASH (Hash)
    Payload data length : 16 bytes
  SA (Security Association)
    Payload data length : 164 bytes
    DOI : 1 (IPsec DOI)
      Proposal 1/1
        Protocol 1/1
          Protocol ID                : ESP
          SPI Size                   : 4
            SPI Value                : 0x4c83cad2
          Transform 1/4
            Transform ID             : Rijndael (aes)
            Key length               : 128
            Authentication algorithm : HMAC-MD5
            SA life type             : Seconds
            SA life duration         : 21600
            SA life type             : Kilobytes
            SA life duration         : 50000
            Encapsulation mode       : Tunnel
          Transform 2/4
            Transform ID             : Rijndael (aes)
            Key length               : 128
            Authentication algorithm : HMAC-SHA-1
            SA life type             : Seconds
            SA life duration         : 21600
            SA life type             : Kilobytes
            SA life duration         : 50000
            Encapsulation mode       : Tunnel
          Transform 3/4
            Transform ID             : Blowfish
            Key length               : 128
            Authentication algorithm : HMAC-MD5
            SA life type             : Seconds
            SA life duration         : 21600
            SA life type             : Kilobytes
            SA life duration         : 50000
            Encapsulation mode       : Tunnel
          Transform 4/4
            Transform ID             : Blowfish
            Key length               : 128
            Authentication algorithm : HMAC-SHA-1
            SA life type             : Seconds
            SA life duration         : 21600
```

```
            SA life type             : Kilobytes
            SA life duration         : 50000
            Encapsulation mode       : Tunnel
  NONCE (Nonce)
    Payload data length : 16 bytes
  ID (Identification)
    Payload data length : 8 bytes
    ID : ipv4(any:0,[0..3]=10.4.2.6)
  ID (Identification)
    Payload data length : 12 bytes
    ID : ipv4_subnet(any:0,[0..7]=10.4.0.0/16)
```

Explanation of Above Values

Transform ID : Cipher
Key length : Cipher key length
Authentication algorithm : HMAC (Hash)
Group description : PFS and PFS group
SA life type : Seconds or Kilobytes
SA life duration : no seconds or kilobytes
Encapsulation mode : Could be transport, tunnel or UDP tunnel (NAT-T)
ID : ipv4(any:0,[0..3]=10.4.2.6)

Here the first ID is the local network of the tunnel from the client's point of view and the second ID is the remote network. If it contains any netmask it is usually SA per net and otherwise it is SA per host.

Step 8. Client Sends Proposal List

The server now responds with a matching IPsec proposal from the list sent by the client. As in step **2** above, if no match can be found by the server then a "No proposal chosen" message will be seen, tunnel setup will fail and the *ikesnoop* command output will stop here.

```
IkeSnoop: Sending IKE packet to 192.168.0.10:500 Exchange type :
        Quick mode ISAKMP Version : 1.0
Flags           : E (encryption)
Cookies         : 0x6098238b67d97ea6 -> 0x5e347cb76e95a
Message ID      : 0xaa71428f
Packet length   : 156 bytes
# payloads      : 5
Payloads:
  HASH (Hash)
  Payload data length : 16 bytes
  SA (Security Association)
    Payload data length : 56 bytes
    DOI : 1 (IPsec DOI)
      Proposal 1/1
        Protocol 1/1
          Protocol ID              : ESP
          SPI Size                 : 4
            SPI Value              : 0xafba2d15
          Transform 1/1
            Transform ID             : Rijndael (aes)
            Key length               : 128
            Authentication algorithm : HMAC-MD5
            SA life type             : Seconds
            SA life duration         : 21600
            SA life type             : Kilobytes
            SA life duration         : 50000
            Encapsulation mode       : Tunnel
  NONCE (Nonce)
```

```
    Payload data length : 16 bytes
  ID (Identification)
    Payload data length : 8 bytes
    ID : ipv4(any:0,[0..3]=10.4.2.6)
  ID (Identification)
    Payload data length : 12 bytes
    ID : ipv4_subnet(any:0,[0..7]=10.4.0.0/16)
```

Step 9. Client Confirms Tunnel Setup

This last message is a message from the client saying that the tunnel is up and running. All client/server exchanges have been successful.

```
IkeSnoop: Received IKE packet from 192.168.0.10:500 Exchange type :
        Quick mode ISAKMP Version : 1.0
Flags          : E (encryption)
Cookies        : 0x6098238b67d97ea6 -> 0x5e347cb76e95a
Message ID     : 0xaa71428f
Packet length  : 48 bytes
# payloads     : 1
Payloads:
  HASH (Hash)
    Payload data length : 16 bytes
```

9.5. PPTP/L2TP

The access by a client using a modem link over dial-up public switched networks, possibly with an unpredictable IP address, to protected networks via a VPN poses particular problems. Both the PPTP and L2TP protocols provide two different means of achieving VPN access from remote clients. The most commonly used feature that is relevant in this scenario is the ability of CorePlus to act as either a PPTP or L2TP server and the first two sections below deal with this. The third section deals with the further ability of CorePlus to act as a PPTP or L2TP client.

9.5.1. PPTP Servers

Overview

Point to Point Tunneling Protocol (PPTP) is designed by the PPTP Forum, a consortium of companies that includes Microsoft. It is an OSI layer 2 "data-link" protocol (see Appendix F, *The OSI Framework*) and is an extension of the older Point to Point Protocol (PPP), used for dial-up Internet access. It was one of the first protocols designed to offer VPN access to remote servers via dial-up networks and is still widely used.

Implementation

PPTP can be used in the VPN context to tunnel different protocols across the Internet. Tunneling is achieved by encapsulating PPP packets in IP datagrams using Generic Routing Encapsulation (GRE - IP protocol 47). The client first establishes a connection to an ISP in the normal way using the PPP protocol and then establishes a TCP/IP connection across the Internet to the Clavister Security Gateway, which acts as the PPTP server (TCP port 1723 is used). The ISP is not aware of the VPN since the tunnel extends from the PPTP server to the client. The PPTP standard does not define how data is encrypted. Encryption is usually achieved using the Microsoft Point-to-Point Encryption (MPPE) standard.

Deployment

PPTP offers a convenient solution to client access that is simple to deploy. PPTP doesn't require the certificate infrastructure found in L2TP but instead relies on a username/password sequence to establish trust between client and server. The level of security offered by a non-certificate based solution is arguably one of PPTP's drawbacks. PPTP also presents some scalability issues with some PPTP servers restricting the number of simultaneous PPTP clients. Since PPTP doesn't use IPsec, PPTP connections can be NATed and NAT traversal is not required. PPTP has been bundled by Microsoft in its operating systems since Windows95 and therefore has a large number of clients with the software already installed.

Troubleshooting PPTP

A common problem with setting up PPTP is that a router and/or switch in a network is blocking TCP port 1723 and/or IP protocol 47 before the PPTP connection can be made to the Clavister Security Gateway. Examining the log can indicate if this problem occurred, with a log message of the following form appearing:

```
Error PPP lcp_negotiation_stalled ppp_terminated
```

Example 9.11. Setting up a PPTP server

This example shows how to setup a PPTP Network Server. The example assumes that you have already created certain address objects in the Address Book.

You will have to specify the IP address of the PPTP server interface, an outer IP address (that the PPTP server should listen to) and an IP pool that the PPTP server will use to give out IP addresses to the clients from.

Clavister FineTune

1. Go to **Interfaces > PPTP/L2TP Server**
2. Choose **New PPPT/L2TP Server** and the **PPPT/L2TP Properties** dialog will appear
3. Specify a name for the L2TP Server, for example *MyPPTPServer*
4. Now enter:
   - **Inner IP Address:** ip_lan
   - **Tunnel Protocol:** PPTP
   - **Outer Interface Filter:** any
   - **Outer Server IP:** ip_wan
5. Under the **PPP Parameters** tab, select **pptp_Pool** from the **IP Pool**
6. Under the **Add Route** tab, select **all_nets** from **Allowed Networks**
7. Click **OK**

9.5.2. L2TP Servers

Layer 2 Tunneling protocol (L2TP) is an IETF open standard that overcomes many of the problems of PPTP. Its design is a combination of Layer 2 Forwarding (L2F) protocol and PPTP, making use of the best features of both. Since the L2TP standard does not implement encryption, it is usually implemented with an IETF standard known as L2TP/IPsec, in which L2TP packets are encapsulated by IPsec. The client communicates with a Local Access Concentrator (LAC) and the LAC communicates across the Internet with a L2TP Network Server (LNS). The Clavister Security Gateway acts as the LNS. The LAC is, in effect, tunneling data, such as a PPP session, using IPsec to the LNS across the Internet. In most cases the client will itself act as the LAC.

L2TP is certificate based and therefore is simpler to administer with a large number of clients and arguably offers better security than PPTP. Unlike PPTP, it is possible to set up multiple virtual networks across a single tunnel. Being IPsec based, L2TP requires NAT traversal (NAT-T) to be implemented on the LNS side of the tunnel.

Example 9.12. Setting up an L2TP server

This example shows how to setup a L2TP Network Server. The example presumes that you have created some address objects in the Address Book. You will have to specify the IP address of the L2TP server interface, an outer IP address (that the L2TP server should listen to) and an IP pool that the L2TP server will use to give out IP addresses to the clients from. The interface that the L2TP server will accept connections on is a virtual IPsec tunnel, not illustrated in this example.

Clavister FineTune

1. Go to **Interfaces > PPTP/L2TP Server**
2. Choose **New PPPT/L2TP Server** and the **PPPT/L2TP Server Properties** dialog will appear
3. Specify a name for the L2TP Server, for example *MyL2TPServer*
4. Now enter:
   - **Inner IP Address:** ip_l2tp
   - **Tunnel Protocol:** L2TP

- **Outer Interface Filter:** l2tp_ipsec
- **Outer Server IP:** ip_wan

5. Under the **PPP Parameters** tab, select **L2TP_Pool** from the **IP Pool**
6. Under the **Add Route** tab, select **all_nets** from **Allowed Networks**
7. Click **OK**

Use User Authentication Rules is enabled as default. To be able to authenticate the users using the PPTP tunnel you also need to configure authentication rules, which is not covered in this example.

Example 9.13. Setting up an L2TP Tunnel

This example shows how to setup a fully working L2TP Tunnel and will cover many parts of basic VPN configuration. Before starting, you need to configure some address objects, for example the network that is going to be assigned to the L2TP clients. Proposal lists and PSK are needed as well. Here we will use the objects created in previous examples.

To be able to authenticate the users using the L2TP tunnel a local user database will be used.

A. Start by preparing a new Local User Database:

Clavister FineTune

1. Go to **Local Objects > User Databases**
2. Choose **New User Database** and the **User Database Properties** dialog will appear
3. Enter a name for the user database, for example *UserDB*
4. Enter the new user database and choose **New User** from the context menu. The **User Properties** dialog will appear
5. Now enter:
   - **Username:** testuser
   - **Password:** mypassword
   - **Confirm Password:** mypassword
6. Click **OK**

Now we will setup the IPsec Tunnel, which will later be used in the L2TP section. As we are going to use L2TP, the Local Network is the same IP the L2TP tunnel will connect to, ip_wan. Furthermore, the IPsec tunnel needs to be configured to dynamically add routes to the remote network when the tunnel is established.

B. Continue setting up the IPsec Tunnel:

Clavister FineTune

1. Go to **Interfaces > IPsec Tunnels**
2. Choose **New IPsec Tunnel** and the **IPsec Tunnel Properties** dialog will appear
3. Enter a name for the IPsec tunnel, for example *l2tp_ipsec*
4. Now enter:
   - **Local Network:** ip_wan
   - **Remote Network:** all-nets
   - **Remote Gateway:** none
   - **Encapsulation Mode:** Transport
   - **IKE Proposal List:** ike-roamingclients

- **IPsec Proposal List:** esp-l2tptunnel

5. Under the **Authentication** tab, select **Pre-shared Key**
6. Select **MyPSK** as the **Pre-shared Key**
7. Under the **Routing** tab, check the following:
   - **Allow DHCP over IPsec from single-host clients**
   - **Dynamically add route to the remote network when a tunnel is established**
8. Click **OK**

Now it is time to setup the L2TP Server. The inner IP address should be a part of the network which the clients are assigned IP addresses from, in this ip_lan. The outer interface filter is the interface that the L2TP server will accept connections on, this will be the earlier created l2tp_ipsec. Also a ProxyARP needs to be configured for the IP's used by the L2TP Clients.

C. Setup the L2TP Tunnel:

Clavister FineTune

1. Go to **Interfaces > PPTP/L2TP Servers**
2. Choose **New PPTP/L2TP Server** and the **PPTP/L2TP Properties** dialog will appear
3. Enter a name for the L2TP tunnel, for example *l2tp_tunnel*
4. Now enter:
   - **Inner IP Address:** ip_lan
   - **Tunnel Protocol:** L2TP
   - **Outer Interface Filter:** l2tp_ipsec
   - **Outer Server IP:** ip_wan
5. Under the **Authentication** tab, check **Use User Authentication Rules**
6. Select **l2tp_pool** from the **IP Pool**
7. Under the **Add Route** tab, select **all-nets** for **Allowed Networks**
8. For **ProxyARP** select the **lan**interface
9. Click **OK**

In order to authenticate the users using the L2TP tunnel, a user authentication rule needs to be configured.

D. Next will be setting up the authentication rules:

Clavister FineTune

1. Go to **User Authentication > Rules > New Rule**
2. The **Rule Properties** dialog will appear
3. Enter a name for the rule, for example *L2TP_Auth*
4. Now enter:
   - **Agent:** PPP
   - **Authentication Source:** Local
   - **Interface:** l2tp_tunnel
   - **Outer Source IP:** all-nets
   - **Outer Destination IP:** ip_wan
5. Click **OK**

When the other parts are done, all that is left is the rules. To let traffic through from the tunnel, two IP rules should be added.

E. Finally, set up the rules:

Clavister FineTune

1. Go to **Rules > New Rule**
2. The **Rule Properties** dialog will appear
3. Enter a name for the rule, for example *AllowL2TP*
4. Now enter:
   - **Action:** Allow
   - **Source Interface:** l2tp_tunnel
   - **Source Network:** l2tp_pool
   - **Destination Interface:** any
   - **Destination Network:** all-nets
5. Under the **Service** tab, select **All** from the pre-defined list
6. Click **OK**
7. Go to **Rules > New Rule**
8. The **Rule Properties** dialog will appear
9. Enter a name for the rule, for example *NATL2TP*
10. Now enter:
    - **Action:** NAT
    - **Source Interface:** l2tp_tunnel
    - **Source Network:** l2tp_pool
    - **Destination Interface:** any
    - **Destination Network:** all-nets
11. Under the **Service** tab, select **All** from the pre-defined list
12. Click **OK**

9.5.3. PPTP/L2TP Clients

The PPTP and L2TP protocols are described in the previous section. In addition to being able to act as a PPTP or L2TP server, CorePlus also offers the ability to act as a PPTP or L2TP clients. This can be useful if PPTP or L2TP is preferred as the VPN protocol instead of IPsec. One Clavister Security Gateway can act as a client and connect to another unit which acts as the server.

Client Setup

PPTP and L2TP shares a common approach to client setup which involves the following settings:

General Parameters

- **Name** - A symbolic name for the client
- **Interface Type** - Specifies if it is a PPTP or L2TP client.
- **Remote Gateway** - The IP address of the remote gateway.

Names of Assigned Addresses

Both PPTP and L2TP utilizes dynamic IP configuration using the *PPP LCP* protocol. When CorePlus receives this information, it is stored in symbolic host/network names. The settings for this are:

- **Inner IP Address** - The host name that is used for storing the assigned IP address. If this network object exists and has a value which is not *0.0.0.0* then the PPTP/L2TP client will try to get that one from the PPTP/L2TP server as the preferred IP.
- **Automatically pick name** - If this option is enabled then CorePlus will create a host name based on the name of the PPTP/L2TP interface, for example *ip_PPTPTunnel1*.
- **Primary/Secondary DNS Name** - This defines the DNS servers from a list of predefined network objects.

> ***Note***
> *A PPTP/L2TP server will not provide information such as gateway or broadcast addresses, as this is not used with PPTP/L2TP tunnels. When using PPTP/L2TP, the default route is normally routed directly across the PPTP/L2TP tunnel without a specified gateway.*

Authentication

- **Username** - Specifies the username to use for this PPTP/L2TP interface.
- **Password** - Specifies the password for the interface.
- **Authentication** - Specifies which authentication protocol to use.
- **MPPE** - Specifies if *Microsoft Point-to-Point Encryption* is used and which level to use.

If **Dial On Demand** is enabled then the PPTP/L2TP tunnel will not be set up until traffic is sent on the interface. The parameters for this option are:

- **Activity Sense** - Specifies if dial-on-demand should trigger on **Send** or **Recv** or both.
- **Idle Timeout** - The time of inactivity in seconds to wait before disconnection.

Using the PPTP Client Feature

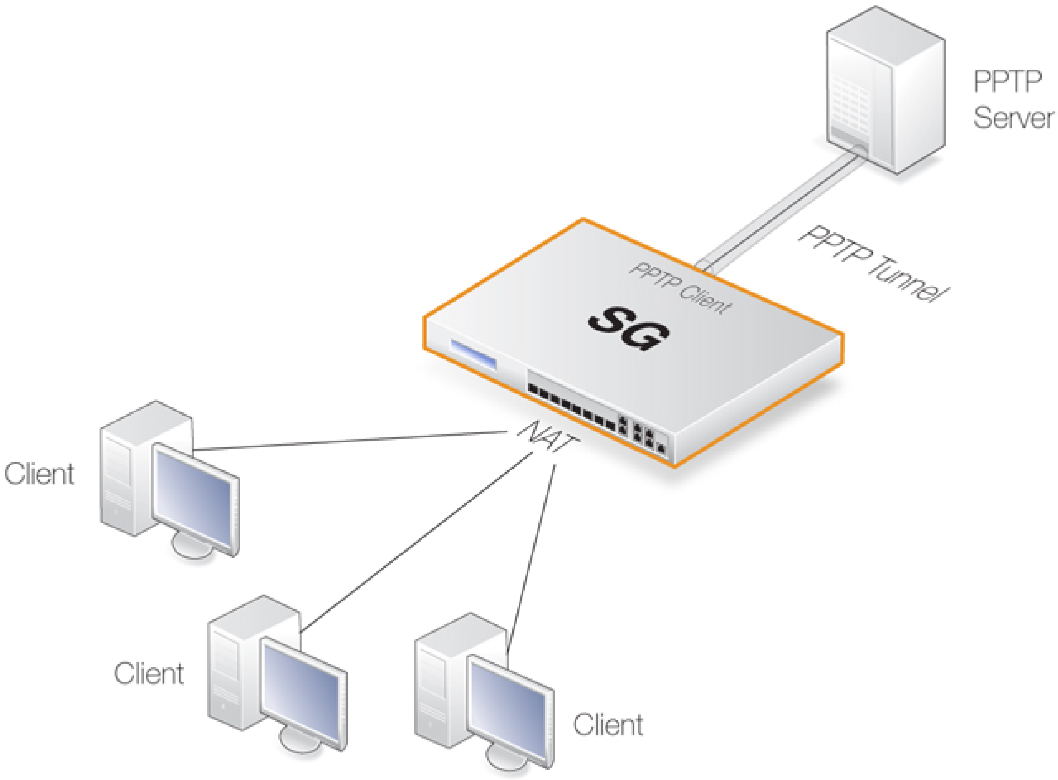
One usage of the PPTP client feature is shown in the scenario depicted below.

Here a number of clients are being NATed through CorePlus before being connected to a PPTP server on the other side of the Clavister Security Gateway. If more that one of the clients is acting as a PPTP client which is trying to connect to the PPTP server then this won't work because of the NATing.

The only way of achieving multiple PPTP clients being NATed like this, is for the Clavister Security Gateway to act as a PPTP client when it connects to the PPTP server. To summarize the setup:

- A PPTP tunnel is defined between CorePlus and the server.
- A route is added to the routing table in CorePlus which specifies that traffic for the server should be routed through the PPTP tunnel.

Figure 9.4. PPTP Client Usage



Chapter 10. Traffic Management

This chapter describes how CorePlus can manage network traffic.

10.1. Traffic Shaping

10.1.1. Introduction

QoS with TCP/IP

A weakness of TCP/IP is the lack of true *Quality of Service* (QoS) functionality. QoS is the ability to guarantee and limit network bandwidth for certain services and users. Solutions such as the *Differentiated Services* (Diffserv) architecture have been designed to try and deal with the QoS issue in large networks by using information in packet headers to provide network devices with QoS information.

CorePlus Diffserv Support

CorePlus supports the Diffserv architecture the following ways:

- CorePlus forwards the 6 bits which make up the Diffserv *Differentiated Services Code Point* (DSCP) as well as copying these bits from the data traffic inside VPN tunnels to the encapsulating packets.
- As described later in this chapter, DSCP bits can be used by the CorePlus traffic shaping subsystem as a basis for prioritizing traffic passing through the Clavister Security Gateway.

The Traffic Shaping Solution

Architectures like Diffserv however, fall short if applications themselves supply the network with QoS information. In most networks it is rarely appropriate to let the applications, the users of the network, decide the priority of their own traffic. If the users cannot be relied upon then the network equipment must make the decisions concerning priorities and bandwidth allocation.

CorePlus provides QoS control by allowing the administrator to apply limits and guarantees to the network traffic passing through the Clavister Security Gateway. This approach is often referred to as *traffic shaping* and is well suited to managing bandwidth for LANs as well as to managing the bottlenecks that might be found in larger WANs. It can be applied to any traffic including that passing through VPN tunnels.

Traffic Shaping Objectives

Traffic shaping operates by measuring and queuing IP packets with respect to a number of configurable parameters. The objectives are:

- Applying bandwidth limits and queuing packets that exceed configured limits, then sending them later when bandwidth demands are lower.

- Dropping packets if packet buffers are full. The packets to be dropped should be chosen from those that are responsible for the "jam".
- Prioritizing traffic according to administrator decisions. If traffic with a high priority increases while a communications line is full, traffic with a low priority can be temporarily limited to make room for the higher priority traffic.
- Providing bandwidth guarantees. This is typically accomplished by treating a certain amount of traffic (the guaranteed amount) as high priority. Traffic exceeding the guarantee then has the same priority as other traffic, and competes with the rest of the non-prioritized traffic.

Traffic shaping doesn't typically work by queuing up immense amounts of data and then sorting out the prioritized traffic to send before sending non-prioritized traffic. Instead, the amount of prioritized traffic is measured and the non-prioritized traffic is limited dynamically so that it will not interfere with the throughput of prioritized traffic.

Note: Traffic shaping will not work with the SIP ALG

Any traffic connections that trigger an IP rule with a service object that uses the SIP ALG cannot be also subject to traffic shaping.

10.1.2. Traffic Shaping in CorePlus

CorePlus offers extensive traffic shaping capabilities for the packets passing through the Clavister Security Gateway. Different rate limits and traffic guarantees can be created as policies based on the traffic's source, destination and protocol, similar to the way in which IP rule set policies are created.

The two key components for traffic shaping in CorePlus are:

- **Pipes**
- **Pipe Rules**

Pipes

A Pipe is the fundamental object for traffic shaping and is a conceptual channel through which packets of data can flow. It has various characteristics that define how traffic passing through it is handled. As many pipes as are required can be defined by the administrator. None are defined by default.

Pipes are simplistic in that they do not care about the types of traffic that pass through them nor the direction of that traffic. They simply measure the data that passes through them and apply the administrator configured limits for the pipe as a whole or for *Precedences* and/or *Groups* (these are explained below).

CorePlus is capable of handling hundreds of pipes simultaneously, but in reality most scenarios require only a handful of pipes. It is possible dozens of pipes may be needed in scenarios where individual pipes are used for individual protocols (or in ISP cases, clients).

Pipe Rules

Pipe Rules make up the *Pipe Rule set*. Each Rule is defined much like other CorePlus policies: by specifying the source/destination interface/network as well as the Service to which the rule is to apply. Once a new connection is permitted by the IP rule set, the Pipe rule set is always checked for matching rules and in the same way, by going from top to bottom. The first matching Pipe Rule, if any, is used for traffic shaping. The Pipe rule set is initially empty.

When a Pipe Rule is defined, the pipes to be used with that rule are also specified and they are placed into one of two lists in the Pipe Rule. These lists are:

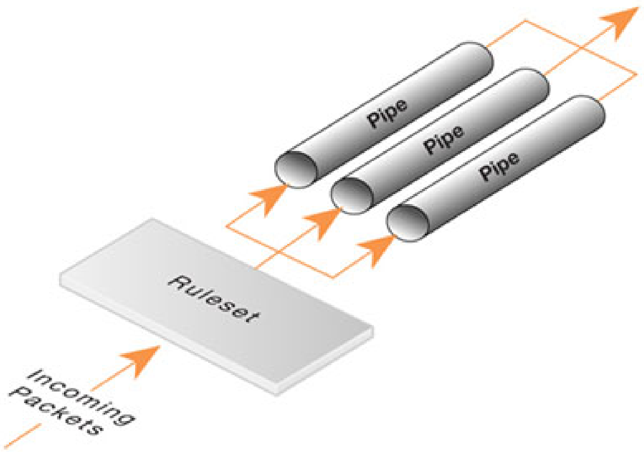
- **The Forward Chain**

  These are the pipes that will be used for outgoing (leaving) traffic from the Clavister Security Gateway. One, none or a series of pipes may be specified.

- **The Return Chain**

  These are the pipes that will be used for incoming (arriving) traffic. One, none or a series of pipes may be specified.

Figure 10.1. Pipe rule set to Pipe Packet Flow



Where one pipe is specified in a list then that is the pipe whose characteristics will be applied to the traffic. If a series of pipes are specified then these will form a *Chain* of pipes through which traffic will pass. A chain can be made up of at most 8 pipes.

If no pipe is specified in a list then traffic that matches the rule will not flow through any pipe but it will also mean that the traffic will not be subject to any other pipe rules found later in the rule set.

10.1.3. Simple Bandwidth Limiting

The simplest use of pipes is for bandwidth limiting. This is also a scenario that doesn't require much planning. The example that follows applies a bandwidth limit to inbound traffic only. This is the direction most likely to cause problems for Internet connections.

Example 10.1. Applying a Simple Bandwidth Limit

Begin with creating a simple pipe that limits all traffic that gets passed through it to 2 megabits per second, regardless of what traffic it is.

Clavister FineTune

1. Go to **Traffic Management/Traffic Shaping > Pipes > New Pipe**
2. The **Pipe Properties** dialog will be displayed
3. Specify a name for the pipe, for example *std-in*
4. Under **Pipe Limits** enter *2000* for the **total** (kilobits per sec.)
5. Click OK

Traffic needs to be passed through the pipe and this is done by using the pipe in a Pipe Rule.

We will use the above pipe to limit inbound traffic. This limit will apply to the actual data packets, and not the connections. In traffic shaping we're interested in the direction that data is being shuffled, not which computer initiated the connection.

Create a simple rule that allows everything from the inside, going out. We add the pipe that we created to the *return chain*. This means that the packets travelling in the *return direction* of this connection (outside-in) should pass through the *std-in* pipe.

Clavister FineTune

1. Go to **Traffic Management > Traffic Shaping > Pipe Rules > New Pipe Rule**
2. The **Pipe Rule Properties** dialog box will be displayed
3. Now enter:
   - **Name:** Outbound
   - **Source Interface:** lan
   - **Source Network:** lannet
   - **Destination Interface:** wan
   - **Destination Network:** all-nets
4. Under the **Service** tab, select **all** in the Pre-defined dropdown list
5. Under the **Traffic Shaping** tab, select the std-in pipe in **Return Chain** and click **Add**
6. Click **OK**

This setup limits all traffic from the outside (the Internet) to 2 megabits per second. No priorities are applied, nor any dynamic balancing.

10.1.4. Limiting Bandwidth in Both Directions

A single pipe doesn't care which direction the traffic through it is coming from when it calculates total throughout. Using the same pipe for both outbound and inbound traffic is allowed by CorePlus but it will not neatly partition pipe limits between the two directions. The following scenario clarifies this.

In the previous example only bandwidth in the inbound direction is limited. We chose this direction because in most setups, it is the direction that becomes full first. Now, what if we want to limit outbound bandwidth in the same way?

Just inserting **std-in** in the forward chain won't work since you probably want 2 Mbps limit for outbound traffic to be separate from the 2 Mbps limit for inbound traffic. If we try to pass 2 Mbps of outbound traffic through the pipe in addition to 2 Mbps of inbound traffic, it adds up to 4 Mbps. Since the pipe limit is 2 Mbps, you'd get something close to 1 Mbps in each direction.

Raising the total pipe limit to 4 Mbps won't solve the problem since the single pipe will not know that 2 Mbps inbound and 2 Mbps outbound was intended. 3 Mbps outbound and 1 Mbps inbound might be the result since that also adds up to 4 Mbps.

The recommended way to control bandwidth in both directions is to use two separate pipes one for inbound and one for outbound traffic. In the scenario under discussion each pipe would have a 2 Mbps limit to achieve the desired result. The following example goes through the setup for this.

Example 10.2. Limiting Bandwidth in Both Directions

Create a second pipe for outbound traffic:

Clavister FineTune

1. Go to **Traffic Management > Traffic Shaping > Pipe > New Pipe**
2. The **Pipe Properties** dialog box will be displayed
3. Specify a name for the pipe, for example *std-out*
4. Under **Pipe Limits**, enter 2000 in the **total** textbox (kilobits/sec) under **Pipe Limits**
5. Click **OK**

After creating a pipe for outbound bandwidth control, add it to the forward pipe chain of the rule created in the previous example:

Clavister FineTune

1. Go to **Traffic Management > Traffic Shaping > Pipe Rules**
2. Right-click the piperule created in the previous example and choose **Properties**. The **Pipe Rule Properties** dialog box will be displayed.
3. Under the **Traffic Shaping** tab, select the std-out pipe in **Forward Chain** and click **Add**
4. Click **OK**

This results in all outbound connections being limited to 2 Mbps in each direction.

10.1.5. Creating Differentiated Limits with Chains

In the previous examples a static traffic limit for all outbound connections was applied. What if we want to limit web surfing more than other traffic? We could set up two "surfing" pipes for inbound and outbound traffic. However, we most likely won't need to limit outbound traffic because surfing usually consists of short outbound requests followed by long inbound answers. Let's assume the total bandwidth limit is 250 kbps and 125 kbps of that is to be allocated to web surfing inbound traffic. A **surf-in** pipe is therefore setup for inbound traffic with a 125 kbps limit.

Next a new Pipe Rule is set up for surfing that uses the **surf-in** pipe and it is placed before the rule that directs "everything else" through the **std-in** pipe. That way surfing traffic goes through the **surf-in** pipe and everything else is handled by the rule and pipe created earlier.

Unfortunately this will not achieve the desired effect, which is allocating a maximum of 125 kbps to inbound surfing traffic as part of the 250 kbps total. Inbound traffic will pass through one of two pipes: one that allows 250 kbps, and one that allows 125 kbps, giving a possible total of 375 kbps of inbound traffic.

To solve this we create a *chain* of the **surf-in** pipe followed by the **std-in** pipe in the surfing traffic Pipe Rule. Inbound surf traffic will now first pass through **surf-in** and be limited to a maximum of 125 kbps. Then, it will pass through the **std-in** pipe along with other inbound traffic, which will apply the 250 kbps total limit. If surfing uses the full limit of 125 kbps, those 125 kbps will occupy half of the **std-in pipe** leaving 125 kbps for the rest of the traffic. If no surfing is taking place then all of the 250 kbps allowed through **std-in** will be available for other traffic.

This is not a bandwidth guarantee for web browsing but it is a 125 kbps bandwidth guarantee for everything except web browsing. For web browsing the normal rules of first-come, first-forwarded will apply when competing for bandwidth. This may mean 125 kbps, but it may also mean much slower speed if the connection is flooded.

Setting up pipes in this way only puts limits on the maximum values for certain traffic types. It does not give priorities to different types of competing traffic.

10.1.6. Precedences

All packets that pass through CorePlus traffic shaping pipes have a precedence. In the examples so far, precedences have not been explicitly set and so all packets have had the same default precedence of 0.

Eight precedences exist, numbered from 0 to 7. Precedence 0 is the least important and 7 is the most important. A precedence can be viewed as a separate traffic queue; traffic in precedence 2 will be forwarded before traffic in precedence 0, precedence 4 forwarded before 2.

The meaning of a precedence comes from the fact that it is either higher or lower than another precedence. If, for example, two precedences are used in a scenario, choosing 4 and 6 instead of 0 and 3 will makes no difference.

Figure 10.2. The Eight Pipe Precedences

Allocating Precedence

The way precedence is assigned to a packet is decided by the Pipe Rule that controls it and is done in one of three ways:

- Use the precedence of the first pipe - Each pipe has a *default precedence* and packets take the default precedence of the first pipe they pass through.
- Use the allocated precedence - The Pipe Rule explicitly allocates a precedence.
- Use the DSCP bits - Take the precedence from the DSCP bits in the packet. DSCP is a subset of the Diffserv architecture where the *Type of Service* (ToS) bits are included in the IP packet header.

Pipe Precedences

When a pipe is configured, a *Default Precedence*, a *Minimum Precedence* and a *Maximum Precedence* can be specified. The Default Precedence is the precedence taken by a packet if it is not explicitly assigned by a Pipe Rule as described in the preceding paragraph.

The minimum and maximum precedences define the precedence range that the pipe will handle. If a packet arrives with an already allocated precedence below the minimum then its precedence is changed to the minimum. Similarly, if a packet arrives with an already allocated precedence above the maximum, its precedence is changed to the maximum.

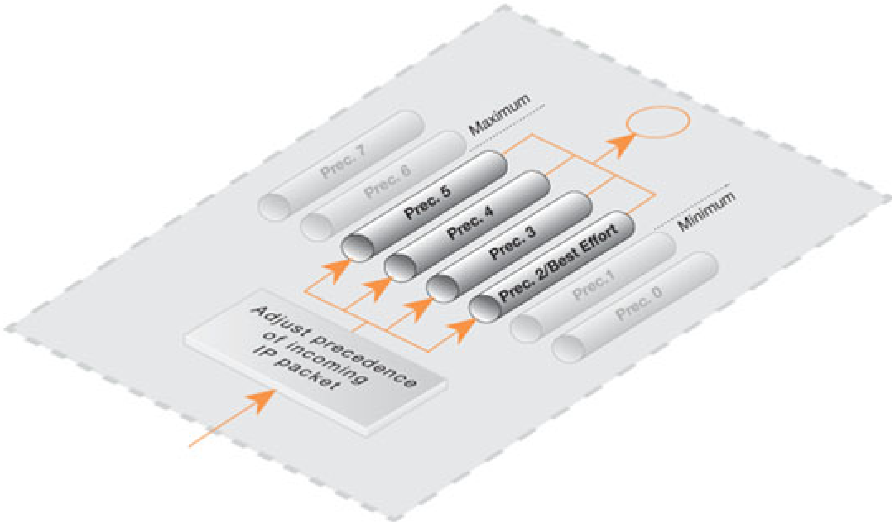
For each pipe, separate bandwidth limits may be optionally specified for each precedence level. These limits can be specified in kilobits per second and/or packets per second (if both are specified then the first limit reached will be the limit used). In precedences are used then the total limit for the pipe as a whole must be specified so the pipe knows when what its capacity is and therefore when precedences are used.

The *Best Effort* Precedence

The precedence defined as the minimum pipe precedence has a special meaning: it acts as the *Best Effort Precedence*. All packets arriving at this precedence will always be processed on a "first come, first forwarded" basis and cannot be sent to another precedence.

Packets with a higher precedence and that exceed the limits of that precedence will automatically be transferred down into this Best Effort precedence and they will no longer be treated differently from packets with lower priorities. This approach is used since a precedence limit is also a guarantees for that precedence.

Figure 10.3. Minimum and Maximum Pipe Precedence



Precedences have no effect until the total bandwidth allocated for a pipe is reached. In other words when the pipe is "full". At that point traffic is prioritized by CorePlus with higher precedence packets being sent before lower precedence packets. The lower precedence packets are buffered. If buffer space becomes exhausted then they are dropped.

Applying Precedences

Continuing from the previous example, we add the requirement that SSH and Telnet traffic is to have a higher priority than all other traffic. To do this we add a Pipe Rule specifically for SSH and Telnet and set the priority in the rule to be a higher priority, say 2. We specify the same pipes in this new rule as are used for other traffic.

The effect of doing this is that the SSH and Telnet rule sets the higher priority on packets related to these services and these packets are sent through the same pipe as other traffic. The pipe then makes sure that these higher priority packets are sent first when the total bandwidth limit specified in the pipe's configuration is exceeded. Lower priority packets will be buffered and sent when higher priority traffic uses less than the maximum specified for the pipe. The buffering process is sometimes referred to as "throttling back" since it reduces the flow rate.

The Need for Guarantees

A problem can occur however if the prioritized traffic is a continuous stream such as real-time audio, resulting in continuous use all available bandwidth and resulting in unacceptably long queuing times for other services such as surfing, DNS or FTP. A means is therefore required to ensure that lower priority traffic gets some portion of bandwidth and this is done with *Bandwidth*

Guarantees.

10.1.7. Guarantees

Bandwidth guarantees ensure that there is a minimum amount of bandwidth available for a given precedence. This is done by specifying a maximum limit for the precedence in a pipe. This will be the maximum amount of bandwidth that the precedence will accept and will send ahead of lower precedences. Excess traffic above this limit will be sent at the Best Effort precedence, behind traffic at precedences higher than Best Effort.

To change the prioritized SSH and Telnet traffic from the previous example to a 96 kbps guarantee, you set the precedence 2 limit for the *std-in*pipe to be 96 kbps.

This does not mean that inbound SSH and Telnet traffic is limited to 96 kbps. Limits in precedences above the Best Effort precedence will only limit how much of the traffic gets to pass in that specific precedence.

If more than 96 kbps of precedence 2 traffic arrives, any excess traffic will be moved down to the Best Effort precedence. All traffic at the Best Effort precedence is then forwarded on a first-come, first-forwarded basis.

Note
Setting a maximum limit for the lowest (Best Effort) precedence or any lower precedences has no meaning and will be ignored by CorePlus.

10.1.8. Differentiated Guarantees

A problem arises if you want to give a specific 32 kbps guarantee to Telnet traffic, and a specific 64 kbps guarantee to SSH traffic. You could set a 32 kbps limit for precedence 2, a 64 kbps limit for precedence 4, and pass the different types of traffic through each respective precedence. However, there are two obvious problems with this approach:

- Which traffic is more important? This question does not pose much of a problem here, but it becomes more pronounced as your traffic shaping scenario becomes more complex.
- The number of precedences is limited. This may not be sufficient in all cases, even barring the "which traffic is more important?" problem.

The solution here is to create two new pipes: one for telnet traffic, and one for SSH traffic, much like the "surf" pipe that we created earlier on.

First, remove the 96 kbps limit from the **std-in** pipe, then create two new pipes: **ssh-in** and **telnet-in**. Set the default precedence for both pipes to 2, and the precedence 2 limits to 32 and 64 kbps, respectively.

Then, split the previously defined rule covering ports 22 through 23 into two rules, covering 22 and 23, respectively:

Keep the forward chain of both rules as **std-out** only. Again, to simplify this example, we concentrate only on inbound traffic, which is the direction that is the most likely to be the first one to fill up in client-oriented setups.

Set the return chain of the port 22 rule to **ssh-in** followed by **std-in**.
Set the return chain of the port 23 rule to **telnet-in** followed by **std-in**.
Set the priority assignment for both rules to **Use defaults from first pipe**; the default precedence of both the **ssh-in** and **telnet-in** pipes is 2.

Using this approach rather than hard-coding precedence 2 in the rule set, you can easily change the precedence of all SSH and Telnet traffic by changing the default precedence of the **ssh-in** and **telnet-in** pipes.

Notice that we did not set a total limit for the **ssh-in** and **telnet-in** pipes. We do not need to since the total limit will be enforced by the **std-in** pipe at the end of the respective chains.

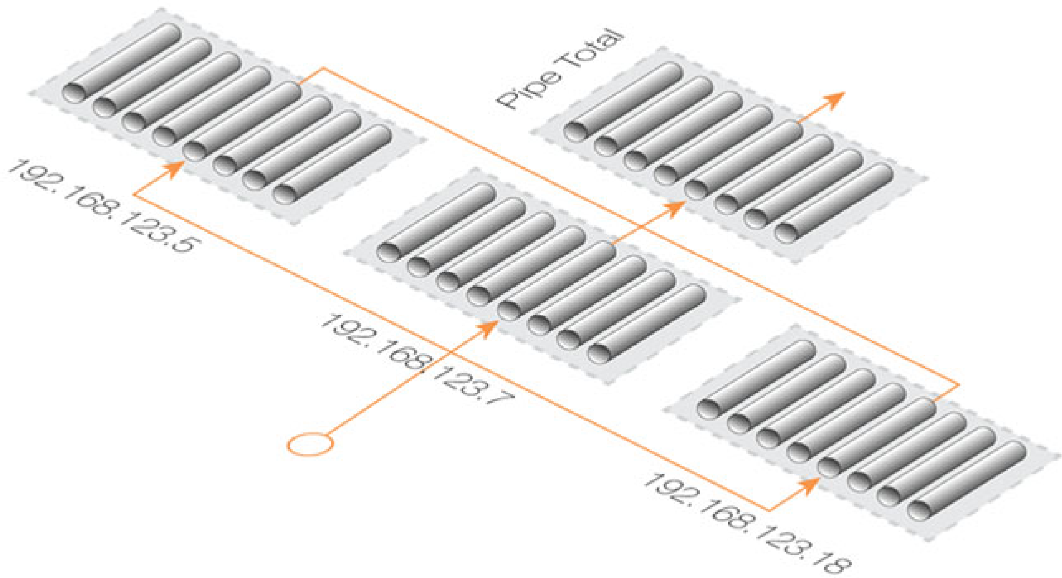
The **ssh-in** and **telnet-in** pipes act as a "priority filter": they make sure that no more than the reserved amount, 64 and 32 kbps, respectively, of precedence 2 traffic will reach **std-in**. SSH and Telnet traffic exceeding their guarantees will reach **std-in** as precedence 0, the best-effort precedence of the **std-in** and **ssh-in** pipes.

> ***Note***
> *Here, the ordering of the pipes in the return chain is important. Should **std-in** appear before **ssh-in** and **telnet-in**, then traffic will reach **std-in** at the lowest precedence only and hence compete for the 250 kbps of available bandwidth with other traffic.*

10.1.9. Groups

CorePlus provides further granularity of control within pipes through the ability to split pipe bandwidth according to either the packet's source/destination network, IP, port or interface. This is referred to as creating *Groups* where the members of a group, sometimes called the *users*, can have limits and guarantees applied to them. The most common usage of this division of traffic is to group by IP or interface.

Figure 10.4. Traffic grouped per IP address



If grouping by port is used then this implicitly also includes the IP address so that port 1024 of computer A is not the same as port 1024 of computer B and individual connections are identifiable. If grouping by network is chosen, the network size should be also be specified (this has the same meaning as the netmask).

A Simple Groups Scenario

If the total bandwidth limit for a pipe is 400 bps and we want to allocate this bandwidth amongst many destination IP addresses so no one IP address can take more then 100 bps of bandwidth, we select "Per DestIP" grouping and enter the total limit for the grouping as 100 bps. Bandwidth is then allocated on a "first come, first forwarded" basis but no one destination IP address can ever take more than 100 bps. No matter how many connections are involved the combined total bandwidth can still not exceed the pipe limit of 400 bps.

Instead of specifying a total group limit, the alternative is to enable the *Dynamic Balancing* option. This ensures that the available bandwidth is divided equally between all addresses regardless of how many there are and this is done up to the limit of the pipe. If a total group limit of 100 bps is also specified, as before, then no one user may take more than that amount of bandwidth.

Group Limits and Guarantees

In addition to specifying a total limit for group users, limits can be specified for each preference. If we specify a group user limit of 30 bps for precedence 2 then this means that users assigned a precedence of 2 by a Pipe Rule will be guaranteed 30 bps no matter how many users use the pipe. Just as with normal pipe precedences, traffic in excess of 30 bps for users at precedence 2 is moved down to the Best Effort precedence.

Continuing with the previous example, we could limit how much guaranteed bandwidth each inside user gets for inbound SSH traffic. This prevents a single user from using up all available high-priority bandwidth.

First we group the users of the **ssh-in** pipe so limits will apply to each user on the internal network. Since the packets are inbound, we select the grouping for the **ssh-in** pipe to be "Per DestIP".

Now we specify per-user limits by setting the precedence 2 limit to 16 kbps per user. This means that each user will get no more than a 16 kbps guarantee for their SSH traffic. If desired, we could also limit the group total bandwidth for each user to some value, such as 40 kbps.

There will be a problem if there are more than 5 users utilizing SSH simultaneously: 16 kbps times 5 is more than 64 kbps. The total limit for the pipe will still be in effect, and each user will have to compete for the available precedence 2 bandwidth the same way they have to compete for the lowest precedence bandwidth. Some users will still get their 16 kbps, some will not.

Dynamic balancing can be enabled to improve this situation by making sure all of the 5 users get the same amount of limited bandwidth. When the 5th user begins to generate SSH traffic, balancing lowers the limit per user to about 13 kbps (64 kbps divided by 5 users).

Dynamic Balancing takes place within each precedence of a pipe individually. This means that if users are allotted a certain small amount of high priority traffic, and a larger chunk of best-effort traffic, all users will get their share of the high-precedence traffic as well as their fair share of the best-effort traffic.

10.1.10. Recommendations

The importance of setting a pipe limit

Traffic shaping only comes into effect when a CorePlus pipe is *full*. That is to say, it is passing as much traffic as the total limit allows. If a 500 kbps pipe is carrying 400 kbps of low priority traffic and 90 kbps of high priority traffic then there is 10 kbps of bandwidth left and there is no reason to throttle back anything. It is therefore important to specify a total limit for a pipe so that it knows what its capacity is and the precedence mechanism is totally dependent on this.

Pipe limits for VPN

Traffic shaping measures the traffic inside VPN tunnels. This is the raw unencrypted data without any protocol overhead so it will be less than the actual VPN traffic. VPN protocols such as IPsec can add significant overhead to the data and for this reason it is recommended that the limits specified in the traffic shaping pipes for VPN traffic are set at around 20% below the actual available bandwidth.

Relying on the group limit

A special case when a total pipe limit isn't specified is when a group limit is used instead. The bandwidth limit is then placed on, for example, each user of a network where the users must share a fixed bandwidth resource. An ISP might use this approach to limit individual user bandwidth by specifying a "Per DestinationIP" grouping. Knowing when the pipe is full is not important since the only constraint is on each user. If precedences were used the pipe maximum would have to be used.

Limits shouldn't be higher than the available bandwidth

If pipe limits are set higher than the available bandwidth, the pipe will not know when the physical connection has reached its capacity. If the connection is 500 kbps but the total pipe limit is set to 600 kbps, the pipe will believe that it is not full and it will not throttle lower precedences.

Limits should be slightly less than available bandwidth

Pipe limits should be slightly below the network bandwidth. A recommended value is to make the pipe limit 95% of the physical limit. The need for this difference becomes less with increasing bandwidth since 5% represents an ever larger piece of the total.

The reason for the lower pipe limit is how CorePlus processes traffic. For outbound connections where packets leave the Clavister Security Gateway, there is always the possibility that CorePlus might slightly overload the connection because of the software delays involved in deciding to send packets and the packets actually being dispatched from buffers.

For inbound connections, there is less control over what is arriving and what has to be processed by the traffic shaping subsystem and it is therefore more important to set pipe limits slightly below the real connection limit to account for the time needed for CorePlus to adapt to changing conditions.

Attacks on Bandwidth

Traffic shaping cannot protect against incoming resource exhaustion attacks, such as DoS attacks or other flooding attacks. CorePlus will prevent these extraneous packets from reaching the hosts behind the Clavister Security Gateway, but cannot protect the connection becoming overloaded if an attack floods it.

Watching for Leaks

When setting out to protect and shape a network bottleneck, make sure that all traffic passing through that bottleneck passes through the defined CorePlus pipes.

If there is traffic going through your Internet connection that the pipes do not know about, they cannot know when the Internet connection is full.

The problems resulting from leaks are exactly the same as in the cases described above. Traffic "leaking" through without being measured by pipes will have the same effect as bandwidth consumed by parties outside of administrator control but sharing the same connection.

Monitoring

The Real-time monitoring function of Clavister FineTune provides a **Pipes** monitoring category which permits the graphical display of pipe traffic.

Troubleshooting

For a better understanding of what is happening in a live setup, the console command:

```
pipe -u <pipename>
```

can be used to display a list of currently active users in each pipe.

10.1.11. A Summary of Traffic Shaping

CorePlus traffic shaping provides a sophisticated set of mechanisms for controlling and prioritising network packets. The following points summarize its use:

- Select the traffic to manage through *Pipe Rules*.
- Pipe Rules send traffic through *Pipes*.
- A pipe can have a limit which is the maximum amount of traffic allowed.
- A pipe can only know when it is *full* if a limit is specified.
- A single pipe should handle traffic in only one direction (although 2 way pipes are allowed).
- Pipes can be chained so that one pipe's traffic feeds into another pipe.
- Specific traffic types can be given a *priority* in a pipe
- Priorities can be given a maximum limit which is also a guarantee. Traffic that exceeds this will be sent at the minimum precedence which is also called the *Best Effort* precedence.
- At the Best Effort precedence all packets are treated on a "first come, first forwarded" basis.
- Within a pipe, traffic can also be separated on a *Group* basis. For example, by source IP address. Each user in a group (for example, each source IP address) can be given a maximum limit and precedences within a group can be given a limit/guarantee.
- A pipe limit need not be specified if group members have a maximum limit.
- *Dynamic Balancing* can be used to specify that all users in a group get a fair and equal amount of bandwidth.

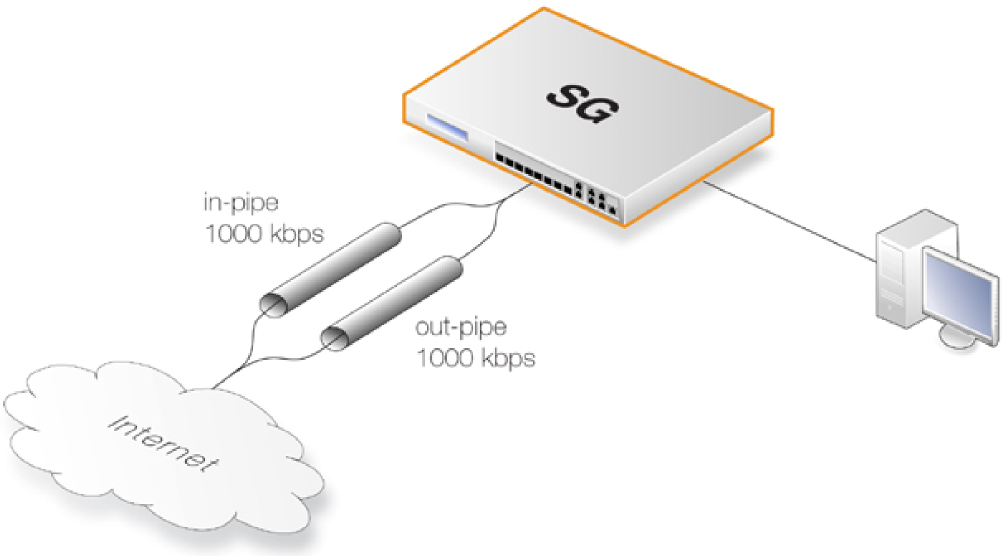
10.1.12. More Pipe Examples

This section looks at some more scenarios and how traffic shaping can be used to solve particular problems.

A Basic Scenario

The first scenario will examine the configuration shown in the image below in which incoming and outgoing traffic is to be limited to 1 megabit per second.

Figure 10.5. A Basic Traffic Shaping Scenario



The reason for using 2 different pipes in this case, is that these are easier to match to the physical link capacity. This is especially true with asynchronous links such as ADSL.

First, two pipes called *in-pipe* and *out-pipe* need to be created with the following parameters:

Pipe Name	Min Prec	Def Prec	Max Prec	Grouping	Net size	Pipe limit
in-pipe	0	0	7	PerDestIP	24	1000kb
out-pipe	0	0	7	PerSrcIP	24	1000kb

Dynamic Balancing should be enabled for both pipes. Instead of *PerDestIP* and *PerSrcIP* we could have used *PerDestNet* and *PerSrcNet* if there were several networks on the inside.

The next step is to create the following Pipe Rule which will force traffic to flow through the pipes.

Rule Name	Forward Pipes	Return Pipes	Source Interface	Source Network	Destination Interface	Destination Network	Service
all_1mbps	out-pipe	in-pipe	lan	lannet	wan	all-nets	all

The rule will force all traffic to the default precedence level and the pipes will limit total traffic to their 1 Mbps limit. Having **Dynamic Balancing** enabled on the pipes means that all users will be allocated a fair share of this capacity.

Using Several Precedences

We now extend the above example by allocating priorities to different kinds of traffic accessing the internet from a headquarters office.

Lets assume we have a symmetric 2/2 Mbps link to the internet We will allocate descending priorities and traffic requirements to the following users:

- **Priority 6** - VoIP (500 kpbs)
- **Priority 4** - Citrix (250 kpbs)
- **Priority 2** - Other traffic (1000 kpbs)

- **Priority 0** - Web plus remaining from other levels

To implement this scheme, we can use the *in-pipe* and *out-pipe*. We first enter the *Pipe Limits* for each pipe. These limits correspond to the list above and are:

- **Priority 6** - *500*
- **Priority 4** - *250*
- **Priority 2** - *1000*

Now create the *Pipe Rules*:

Rule Name	Forward Pipes	Return Pipes	Source Interface	Source Network	Destination Interface	Destination Network	Service	Prec
web_surf	out-pipe	in-pipe	lan	lannet	wan	all-nets	http_all	0
voip	out-pipe	in-pipe	lan	lannet	wan	all-nets	H323	6
citrix	out-pipe	in-pipe	lan	lannet	wan	all-nets	citrix	4
other	out-pipe	in-pipe	lan	lannet	wan	all-nets	All	2

These rules are processed from top to bottom and force different kinds of traffic into precedences based on the *Service*. Customized service objects may need to be first created in order to identify particular types of traffic. The *all* service at the end, catches anything that falls through from earlier rules since it is important that no traffic bypasses the pipe rule set otherwise using pipes won't work.

Pipe Chaining

Suppose the requirement now is to limit the precedence 2 capacity (other traffic) to 1000 kbps so that it doesn't spill over into precedence 0. This is done with *pipe chaining* where we create new pipes called *in-other* and *out-other* both with a *Pipe Limit* of 1000. The *other* pipe rule is then modified to use these:

Rule Name	Forward Pipes	Return Pipes	Source Interface	Source Network	Destination Interface	Destination Network	Service	Prec
other	out-other out-pipe	in-other in-pipe	lan	lannet	wan	all-nets	All	2

Note that *in-other* and *out-other* are first in the pipe chain in both directions. This is because we want to limit the traffic immediately, before it enters the *in-pipe* and *out-pipe* and competes with VoIP, Citrix and Web-surfing traffic.

A VPN Scenario

In the cases discussed so far, all traffic shaping is occurring inside a single Clavister Security Gateway. VPN is typically used for communication between a headquarters and branch offices in which case pipes can control traffic flow in both directions. With VPN it is the tunnel which is the source and destination interface for the pipe rules.

An important consideration which has been discussed previously, is allowance in the *Pipe Total* values for the overhead used by VPN protocols. As a rule of thumb, a pipe total of 1700 is reasonable for a VPN tunnel where the underlying physical connection capacity is 2 Mbps.

It is also important to remember to insert into the pipe all non-VPN traffic using the same physical link.

The *pipe chaining* can be used as a solution to the problem of VPN overhead. A limit which allows for this overhead is placed on the VPN tunnel traffic and non-VPN traffic is inserted into a pipe that matches the speed of the physical link.

To do this we first create separate pipes for the outgoing traffic and the incoming traffic. VoIP traffic will be sent over a VPN tunnel that will have a high priority. All other traffic will be sent at the *best effort* priority (see above for an explanation of this term). Again, we'll assume a 2/2 Mbps symmetric link.

The pipes required will be:

- **vpn-in**
  - *Priority 6:* VoIP 500 kpbs
  - *Priority 0:* Best effort

  Total: 1700
- **vpn-out**
  - *Priority 6:* VoIP 500 kpbs
  - *Priority 0:* Best effort

  Total: 1700
- **in-pipe**
  - *Priority 6:* VoIP 500 kpbs

  Total: 2000
- **out-pipe**
  - *Priority 6:* VoIP 500 kpbs

  Total: 2000

The following pipe rules are then needed to force traffic into the correct pipes and precedence levels:

Rule Name	Forward Pipes	Return Pipes	Src Int	Source Network	Dest Int	Destination Network	Service	Prec
vpn_voip_out	vpn-out out-pipe	vpn-in in-pipe	lan	lannet	vpn	vpn_remote_net	H323	6
vpn_out	vpn-out out-pipe	vpn-in in-pipe	lan	lannet	vpn	vpn_remote_net	All	0
vpn_voip_in	vpn-in in-pipe	vpn-out out-pipe	vpn	vpn_remote_net	lan	lannet	H323	6
vpn_in	vpn-in in-pipe	vpn-out out-pipe	vpn	vpn_remote_net	lan	lannet	All	0
out	out-pipe	in-pipe	lan	lannet	wan	all-nets	All	0
in	in-pipe	out-pipe	wan	all-nets	lan	lannet	All	0

With this setup, all VPN traffic is limited to 1700 kbps, the total traffic is limited to 2000 kbps and VoIP to the remote site is guaranteed 500 kbps of capacity before it is forced to best effort.

SAT with Pipes

If SAT is being used, for example with a web server or ftp server, that traffic also needs to be forced into pipes or it will escape traffic shaping and ruin the planned quality of service. In addition, server traffic is initiated from the outside so the order of pipes needs to be reversed: the forward pipe is the *in-pipe* and the return pipe is the *out-pipe*.

A simple solution is to put a "catch-all-inbound" rule at the bottom of the pipe rule. However, the external interface (*wan*) should be the source interface to avoid putting into pipes traffic that is coming from the inside and going to the external IP address. This last rule will therefore be:

Rule Name	Forward Pipes	Return Pipes	Source Interface	Source Network	Destination Interface	Destination Network	Service	Prec
all-in	in-pipe	out-pipe	wan	all-nets	core	all-nets	All	0

Note

If the SAT is from an ARPed IP address, the ***wan*** *interface needs to be the destination.*

10.2. Threshold Rules

10.2.1. Overview

The objective of a *Threshold Rule* is to have a means of detecting abnormal connection activity as well as reacting to it. An example of a cause for such abnormal activity might be an internal host becoming infected with a virus that is making repeated connections to external IP addresses. It might alternatively be some external source trying to open excessive numbers of connections. (A "connection" in this context refers to all types of connections, such as TCP, UDP or ICMP, tracked by the CorePlus state-engine).

A Threshold Rule is like a normal policy based rule. A combination of source/destination network/interface can be specified for a rule and a type of service such as HTTP can be associated with it. Each rule can have associated with it one or more **Action**s which specify how to handle different threshold conditions.

A Threshold has the following parameters:

- **Action** - The response to exceeding the limit: either **Audit** or **Protect**
- **Group By** - Either **Host** or **Network** based
- **Threshold** - The numerical limit which must be exceeded to trigger a response
- **Threshold Type** - Limiting connections per second or limiting total number of concurrent connections

These parameters are described below:

10.2.2. Connection Rate/Total Connection Limiting

Connection Rate Limiting allows an administrator to put a limit on the number of new connections being opened to the Clavister Security Gateway per second.

Total Connection Limiting allows the administrator to put a limit on the total number of connections opened to the Clavister Security Gateway. This function is extremely useful when NAT pools are required due to the large number of connections generated by P2P users.

10.2.3. Grouping

The two groupings are as follows:

- **Host Based** - The threshold is applied separately to connections from different IP addresses.
- **Network Based** - The threshold is applied to all connections matching the rules as a group.

10.2.4. Rule Actions

When a Threshold Rule is triggered one of two responses are possible:

- **Audit** - Leave the connection intact but log the event
- **Protect** - Drop the triggering connection

Logging would be the preferred option if the appropriate triggering value cannot be determined beforehand. Multiple Actions for a given rule might consist of **Audit** for a given threshold while the action might become **Protect** for a higher threshold.

10.2.5. Multiple Triggered Actions

When a rule is triggered then CorePlus will perform the associated rule Actions that match the condition that has occurred. If more than one Action matches the condition then those matching Actions are applied in the order they appear in the user interface.

If several Actions that have the same combination of **Type** and **Grouping** (see above for the definition of these terms) are triggered at the same time, only the Action with the highest threshold value will be logged

10.2.6. Exempted Connections

It should be noted that some advanced settings known as *Before Rules* settings can exempt certain types of connections for remote management from examination by the CorePlus rule set. These settings will also exempt the connections from Threshold Rules. They are documented in Chapter 12, *Advanced Settings*.

10.2.7. Threshold Rule Blacklisting

If the **Protect** option is used, Threshold Rules can be configured so that the source that triggered the rule, is added automatically to a *Blacklist* of IP addresses or networks. If several **Protect** Actions with blacklisting enabled are triggered at the same time, only the first triggered blacklisting Action will be executed by CorePlus.

A host based Action with blacklisting enabled will blacklist a single host when triggered. A network based action with blacklisting enabled will blacklist the source network associated with the rule. If the Threshold Rule is linked to a service then it is possible to block only that service.

When Blacklisting is chosen, then the administrator can elect that existing connections from the triggering source can be left unaffected or they can be dropped.

The length of time, in seconds, for which the source is blacklisted can also be set.

This option is discussed further in Section 6.7, “Blacklisting Hosts and Networks”.

10.3. Server Load Balancing

10.3.1. Overview

The *Server Load Balancing* (SLB) feature allows the administrator to spread client application requests over a number of servers through the use of IP rules with an *Action* of *SLB_SAT*.

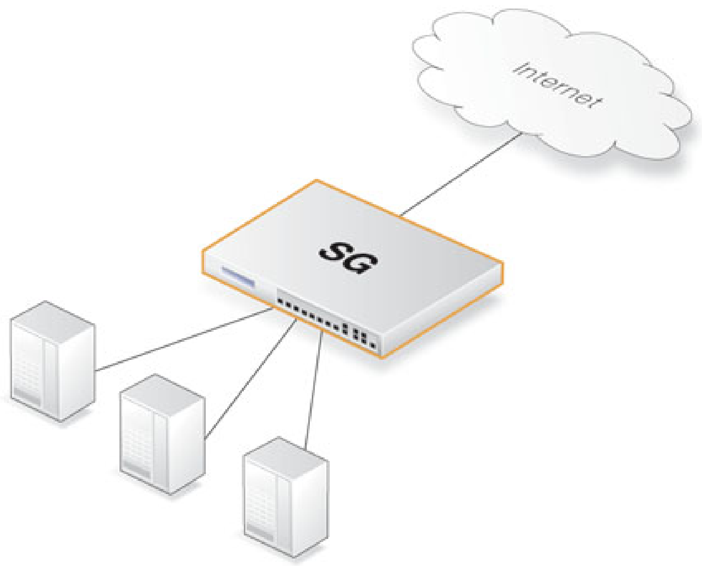
SLB is a powerful tool that can improve the following aspects of network applications:

- Performance
- Scalability
- Reliability
- Ease of administration

The principle SLB benefit of sharing the load across multiple servers can improve not just the performance of applications but also scalability by facilitating the implementation of a cluster of servers (sometimes referred to as a *server farm*) that can handle many more requests than a single server.

The illustration below shows a typical SLB scenario, with Internet access to internal server applications by external clients being managed by a Clavister Security Gateway.

Figure 10.6. A Server Load Balancing Configuration



Additional Benefits of SLB

Besides improving performance and scalability, SLB provides other benefits:

- SLB increases the reliability of network applications by actively monitoring the servers sharing the load. CorePlus SLB can detect when a server fails or becomes congested and will not direct any further requests to that server until it recovers or has less load.
- SLB can allow network administrators to perform maintenance tasks on servers or applications

without disrupting services. Individual servers can be restarted, upgraded, removed, or replaced, and new servers and applications can be added or moved without affecting the rest of a server farm, or taking down applications.

- The combination of network monitoring and distributed load sharing also provides an extra level of protection against *Denial Of Service* (DoS) attacks.

SLB Deployment Considerations

The following issues should be considered when deploying SLB:

- Across which servers is the load is to be balanced.
- Which SLB algorithm will be used.
- Will "stickiness" be used.
- Which monitoring method will be used.

Each of these topics is discussed further in the sections that follow.

Identifying the Servers

An important first step in SLB deployment is to identify the servers across which the load is to be balanced. This might be a *server farm* which is a cluster of servers set up to work as a single "virtual server". The servers that are to be treated as a single virtual server by SLB must be specified.

10.3.2. SLB Distribution Algorithms

There are several ways to determine how a load is shared across a set of servers. CorePlus SLB supports the following two algorithms for load distribution:

Round-robin
: The algorithm distributes new incoming connections to a list of servers on a rotating basis. For the first connection, the algorithm picks a server randomly, and assigns the connection to it. For subsequent connections, the algorithm cycles through the server list and redirects the load to servers in order. Regardless of each server's capability and other aspects, for instance, the number of existing connections on a server or its response time, all the available servers take turns in being assigned the next connection.

  This algorithm ensures that all servers receive an equal number of requests, therefore it is most suited to server farms where all servers have an equal capacity and the processing loads of all requests are likely to be similar.

Connection-rate
: This algorithm considers the number of requests that each server has received over a given period of time. This time period is known as the *Window Time*. SLB sends the next request to the server that has received the lowest number of connections during the last *Window Time* number of seconds.

  The *Window Time* is a setting that the administrator can change. The default value is *10* seconds.

10.3.3. Selecting Stickiness

In some scenarios it is important that the same server is used for a series of connections from the same client. This is achieved by selecting the appropriate *stickiness* option which can be used with either the round-robin or connection-rate algorithms. The stickiness options are as follows:

Per-state Distribution

This mode is the default and means that no stickiness is applied. Every new connection is considered to be independent from other connections even if they come from the same IP address or network. Consecutive connections from the same client may therefore be passed to different servers.

This may not be acceptable if the same server must be used for a series of connections coming from the same client. If this is the case then stickiness is required.

IP Address Stickiness

In this mode, a series of connections from a specific client will be handled by the same server. This is particularly important for TLS or SSL based services such as *HTTPS*, which require a repeated connection to the same host.

Network Stickiness

This mode is similar to IP stickiness except that the stickiness can be associated with a network instead of a single IP address. The network is specified by stating its size as a parameter.

For example, if the network size is specified as *24* (the default) then an IP address *10.01.01.02* will be assumed to belong to the network *10.01.01.00/24* and this will be the network for which stickiness is applied.

Stickiness Parameters

If either IP stickiness or network stickiness is enabled then the following stickiness parameters can be adjusted:

- **Idle Timeout**

  When a connection is made, the source IP address for the connection is remembered in a table. Each table entry is referred to as a *slot*. After it is create, the entry is only considered valid for the number of seconds specified by the *Idle Timeout*. When new connection is made, the table is searched for the same source IP, providing that the table entry has not exceeded its timeout. When a match is found, then stickiness ensures that the new connection goes to the same server as previous connections from the same source IP.

  The default value for this setting is *10* seconds.

- **Max Slots**

  This parameter specifies how many slots exist in the stickiness table. When the table fills up then the oldest entry is discarded to make way for a new entry even though it may be still valid (the *Idle Timeout* has not been exceeded).

  The consequence of a full table can be that stickiness will be lost for any discarded source IP addresses. The administrator should therefore try to ensure that the *Max Slots* parameter is set to a value that can accomodate the expected number of connections that require stickiness.

  The default value for this setting is *2048* slots in the table.

- **Net Size**

  The processing and memory resources required to match individual IP addresses when implementing stickiness can be siginificant. By selecting the *Network Stickiness* option these resource demands can be reduced.

  When the *Network Stickiness* option is selected, the *Net Size* parameter specifies the size of the network which should be associated with the source IP of new connections. A stickiness table lookup does not then compare individual IP addresses but instead compares if the source IP address belongs to the same network as a previous connection already in the table. If they belong to the same network then stickiness to the same server will result.

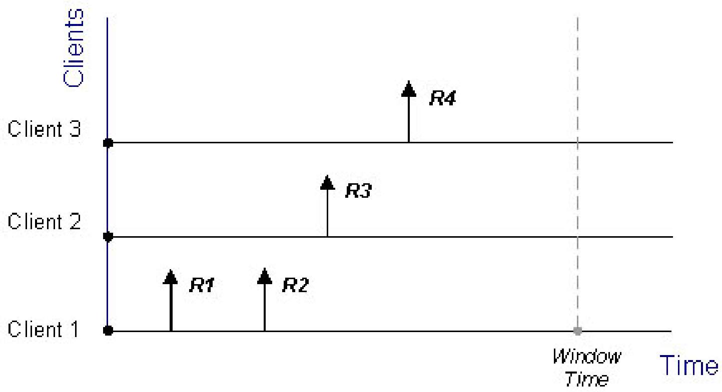
The default value for this setting is a network size of *24*.

10.3.4. SLB Algorithms and Stickiness

This section discusses further how stickiness functions with the different SLB algorithms.

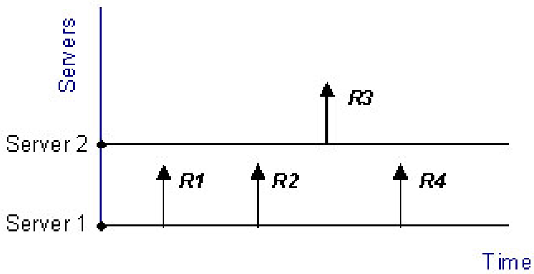
An example scenario is illustrated in the figure below. In this example, the Clavister Security Gateway is responsible for balancing connections from 3 clients with different addresses to 2 servers. Stickiness is enabled.

Figure 10.7. Connections from Three Clients



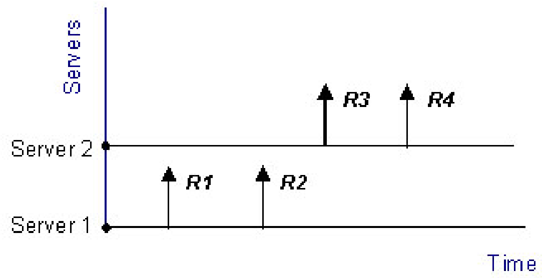
When the round-robin algorithm is used, the first arriving requests *R1* and *R2* from *Client 1* are both assigned to one sever, say *Server 1*, according to stickiness. The next request *R3* from *Client 2* is then routed to *Server 2*. When *R4* from *Client 3* arrives, *Server 1* gets back its turn again and will be assigned with *R4*.

Figure 10.8. Stickiness and Round-Robin



If the connection-rate algorithm is applied instead, *R1* and *R2* will be sent to the same server because of stickiness, but the subsequent requests *R3* and *R4* will be routed to another server since the number of new connections on each server within the Window Time span is counted in for the distribution.

Figure 10.9. Stickiness and Connection-rate



Regardless which algorithm is chosen, if a server goes down, traffic will be sent to other servers. And when the server comes back online, it can automatically be placed back into the server farm and start getting requests again.

10.3.5. Server Health Monitoring

SLB uses *Server Health Monitoring* to continuously check the condition of the servers in an SLB configuration. SLB can monitor different OSI layers to check the condition of each server. Regardless of the algorithms used, if a server is deemed to have failed, SLB will not open any more connections to it until the server is restored to full functionality.

SLB will use the default routing table unless the administrator sets a specific routing table location.

Clavister Server Load Balancing provides the following monitoring modes:

ICMP Ping This works at OSI layer 3. SLB will ping the IP address of each individual server in the server farm. This will detect any failed servers.

TCP Connection This works at OSI layer 4. SLB attempts to connect to a specified port on each server. For example, if a server is specified as running web services on port 80, the SLB will send a TCP SYN request to that port. If SLB does not receive a TCP SYN/ACK back, it will mark port 80 on that server as down. SLB recognizes the conditions *no response*, *normal response* or *closed port response* from servers.

10.3.6. SLB_SAT Rules

The key component in setting up SLB is the *SLB_SAT* rule in the IP rule set. The steps that should be followed are:

1. Define an Object for each server for which SLB is to be done.
2. Define a Group which included all these objects
3. Define an SLB_SAT Rule in the IP rule set which refers to this Group and where all other SLB parameters are defined.
4. Define a further rule that duplicates the source/destination interface/network of the SLB_SAT rule that allows traffic through. The could be one or combination of
   - ForwardFast
   - Allow
   - NAT

The table below shows the rules that would be defined for a typical scenario of a set of webservers behind the Clavister Security Gateway for which the load is being balanced. The **Allow** rule allows external clients to access the webservers.

Rule Name	Rule Type	Src. Interface	Src. Network	Dest. Interface	Dest. Network
WEB_SLB	SLB_SAT	any	all-nets	core	ip_ext
WEB_SLB_ALW	Allow	any	all-nets	core	ip_ext

If there are clients on the same network as the webservers that also need access to those webservers then an **NAT** rule would also be used:

Rule Name	Rule Type	Src. Interface	Src. Network	Dest. Interface	Dest. Network
WEB_SLB	SLB_SAT	any	all-nets	core	ip_ext
WEB_SLB_NAT	NAT	lan	lannet	core	ip_ext
WEB_SLB_ALW	Allow	any	all-nets	core	ip_ext

Note that the destination interface is specified as **core**, meaning CorePlus itself deals with this. The key advantage of having a separate **Allow** rule is that the webservers can log the exact IP address that is generating external requests. Using only a **NAT** rule, which is possible, means that webservers would see only the IP address of the Clavister Security Gateway

Example 10.3. Setting up SLB

In this example server load balancing is to be done between 2 HTTP webservers which are situated behind the Clavister Security Gateway. The 2 webservers have the private IP addresses *192.168.1.10* and *192.168.1.11* respectively. The default SLB values for monitoring, distribution method and stickiness are used.

A NAT rule is used in conjunction with the SLB_SAT rule so that clients behind the gateway can access the webservers. An **Allow** rule is used to allow access by external clients.

Clavister FineTune

A. Create an Object for each the webservers:

1. Go to **Hosts & Networks > New Host & Network**
2. Now enter:
   - **Name:** server1
   - **Type:** Host
   - **IP Address:** 192.168.1.10
3. Click **OK**
4. Repeat the above to create an object called *server2* for the *192.168.1.11* IP address.

B. Create a Group which contains the 2 webserver objects:

1. Go to **Hosts & Networks > New Host & Network**
2. Now enter:
   - **Name:** server_group
   - **Type:** Group
3. Use the **+** button to add *server1* and *server2* to the group
4. Click **OK**

C. Specify the **SLB_SAT** IP rule:

1. Go to **Rules > New Rule**

2. Enter:
   - **Name:** Web_SLB
   - **Action:** SLB_SAT
   - **Source Interface:** any
   - **Source Network:** all-nets
   - **Destination Interface:** core
   - **Destination Network:** ip_ext
3. Select tab **Service** and select *HTTP*
4. Select tab **Address Translation**
5. For **Servers** enter *server_group*
6. Click **OK**

D. Specify a matching **NAT** rule for internal clients:

1. Go to **Rules > New Rule**
2. Enter:
   - **Name:** Web_SLB_NAT
   - **Action:** NAT
   - **Source Interface:** lan
   - **Source Network:** lannet
   - **Destination Interface:** core
   - **Destination Network:** ip_ext
3. Select tab **Service** and select *HTTP*
4. Click **OK**

E. Specify an **Allow** rule for the external clients:

1. Go to **Rules > New Rule**
2. Enter:
   - **Name:** Web_SLB_ALW
   - **Action:** Allow
   - **Source Interface:** any
   - **Source Network:** all-nets
   - **Destination Interface:** core
   - **Destination Network:** ip_ext
3. Select tab **Service** and select *HTTP*
4. Select **OK**

Chapter 11. High Availability

This chapter describes the high availability fault-tolerance feature in Clavister Security Gateways.

11.1. Overview

HA Clusters

Clavister *High Availability* (HA) works by adding a back-up *slave* Clavister Security Gateway to an existing *master* gateway. The master and slave are connected together and make up a logical *HA Cluster*. One of the units in a cluster will be *active* when the other unit is *inactive* and on standby. Initially the slave will be inactive and will monitor the master. If the slave detects that the master is not responding, a *failover* takes place and the slave becomes active. If the master later regains full functionality the slave will continue to be active, with the master now monitoring the slave and failover only taking place if the slave fails. This is sometimes known as an *active-passive* HA implementation.

The *Master* and *Active* Units

It should be kept in mind that the *master* unit in a cluster is not always the same as the *active* unit. The *active* unit is the Clavister Security Gateway that is processing all traffic at a given point in time. This could be the *slave* if a failover has occurred because the *master*'s operation has been impaired.

Inter-connection

In a cluster, the master and slave units must be directly connected to each other by a synchronization connection which is known to CorePlus as the **sync** interface. One of the normal interfaces on the master and the slave are dedicated for this purpose and are connected together with a crossover cable.

Packets, known as *heartbeats*, are continually sent across the **sync** and all other interfaces from one unit to the other so that peer health can be monitored and this mechanism is discussed further in the section that follows. These packets are sent in both directions so that the passive unit knows about the health of the active unit and and the active knows about the passive.

Cluster Management

An HA Cluster of two Clavister Security Gateways is managed as a single unit with a unique cluster name which appears in the management interface as a single logical Clavister Security Gateway. Administration operations such as changing rules in the IP rule set are carried out as normal with the changes automatically being made to the configurations of both the master and the slave.

Load-sharing

Clavister HA clusters do not provide load-sharing since only one unit will be active while the other is inactive and only two Clavister Security Gateways, the master and the slave, can exist in a single cluster. The only processing role that the inactive unit plays is to replicate the state of the active unit and to take over all traffic processing if it detects the active unit is not responding.

Hardware Duplication

Clavister HA will only operate between two Clavister Security Gateways. As the internal operation of different security gateway manufacturer's software is completely dissimilar, there is no common method available to communicating state information to a dissimilar device.

It is also strongly recommended that the Clavister Security Gateways used in cluster have identical configurations. They must also have identical licenses which allow identical capabilities including the ability to run in an HA cluster.

Extending Redundancy

Implementing an HA Cluster will eliminate one of the points of failure in a network. Routers, switches and Internet connections can remain as potential points of failure and redundancy for these should also be considered.

Protecting Against Network Failures Using HA and Link Monitor

The CorePlus *Link Monitor* feature can be used to check connection with a host so that when it is no longer reachable an HA failover is initiated to a peer which has a different connection to the host. This technique is a useful extension to normal HA usage which provides protection against network failures between a single Clavister Security Gateway and hosts. This technique is described further in Section 2.4.4, “The Link Monitor”.

The following sections describe the High Availability feature in greater detail.

11.2. HA Mechanisms

Clavister HA provides a redundant, state-synchronized hardware configuration. The state of the active unit, such as the connection table and other vital information, is continuously copied to the inactive unit via the **sync** interface. When cluster failover occurs, the inactive unit knows which connections are active, and traffic can continue to flow.

The inactive system detects that the active system is no longer operational when it no longer detects sufficient *Cluster Heartbeats*. Heartbeats are sent over the **sync** interface as well as all other interfaces. CorePlus sends 5 heartbeats per second from the active system and when three heartbeats are missed (that is to say, after 0.6 seconds) a failover will be initiated. By sending heartbeats over all interfaces, the inactive unit gets an overall view of the active unit's health. Even if **sync** is deliberately disconnected, failover may not result if the inactive unit receives enough heartbeats from other interfaces via a shared switch, however the **sync** interface sends twice as many heartbeats as any of the normal interfaces. The administrator can disable heartbeat sending on any of the interfaces.

Heartbeats are not sent at smaller intervals because such delays may occur during normal operation. An operation such as opening a file, could result in delays long enough to cause the inactive system to go active, even though the other is still active.

Cluster heartbeats have the following characteristics:

- The source IP is the interface address of the sending gateway
- The destination IP is the broadcast address on the sending interface.
- The IP TTL is always 255. If CorePlus receives a cluster heartbeat with any other TTL, it is assumed that the packet has traversed a router and therefore cannot be trusted.
- It is a UDP packet, sent from port 999, to port 999.
- The destination MAC address is the ethernet multicast address corresponding to the shared hardware address. In other words, *11-00-00-C1-4A-nn*. Link-level multicasts are used over normal unicast packets for security: using unicast packets would mean that a local attacker could fool switches to route heartbeats somewhere else so the inactive system never receives them.

The time for failover is typically about one second which means that clients may experience a failover as a slight burst of packet loss. In the case of TCP, the failover time is well within the range of normal retransmit timeouts so TCP will retransmit the lost packets within a very short space of time, and continue communication. UDP does not allow retransmission since it is inherently an unreliable protocol.

Both master and slave know about the shared IP address. ARP queries for the shared IP address, or any other IP address published via the ARP configuration section or through Proxy ARP, are answered by the active system. The hardware address of the shared IP address and other published addresses are not related to the actual hardware addresses of the interfaces. Instead the MAC address is constructed by CorePlus from the Cluster ID in the following form: 10-00-00-C1-4A-nn, where nn comes from combining the Cluster ID configured in the Advanced Settings section with the hardware bus/slot/port of the interface. The Cluster ID must be unique for each cluster in a network.

As the shared IP address always has the same hardware address, there will be no latency time in updating ARP caches of units attached to the same LAN as the cluster when failover occurs.

When a cluster member discovers that its peer is not operational, it broadcasts gratuitous ARP queries on all interfaces using the shared hardware address as the sender address. This allows switches to re-learn within milliseconds where to send packets destined for the shared address. The only delay in failover therefore, is detecting that the active unit is down.

ARP queries are also broadcast periodically to ensure that switches don't forget where to send packets destined for the shared hardware address.

HA with Anti-Virus and IDP

If a CorePlus cluster has the Anti-Virus or IDP subsystems enabled then updates to the Anti-Virus signature database or IDP pattern database will routinely occur. These updates involve downloads from the external Clavister databases and they require CorePlus reconfiguration to occur for the new database contents to become active. Database updates cause the following sequence of events to occur in an HA cluster:

1. The active (master) unit downloads the new database files from the Clavister servers.

2. The active (master) node sends the new database file to the inactive peer.

3. The inactive (slave) unit reconfigures to activate the new database files.

4. The active (master) unit now reconfigures to activate the new database files causing a failover to the slave unit. The slave is now the active unit.

5. After reconfiguration of the master is complete, failover occurs again so that the master once again becomes the active unit.

11.3. HA Setup

This section provides a step-by-step guide for setting up an HA Cluster.

11.3.1. Hardware Setup

1. Start with two physically similar Clavister Security Gateways. Both may be newly purchased or one may have been purchased to be the back-up unit (in other words, to be the slave unit).

2. There should be two valid CorePlus cluster licenses, one for the master and one for the slave. These should have identical capabilities.

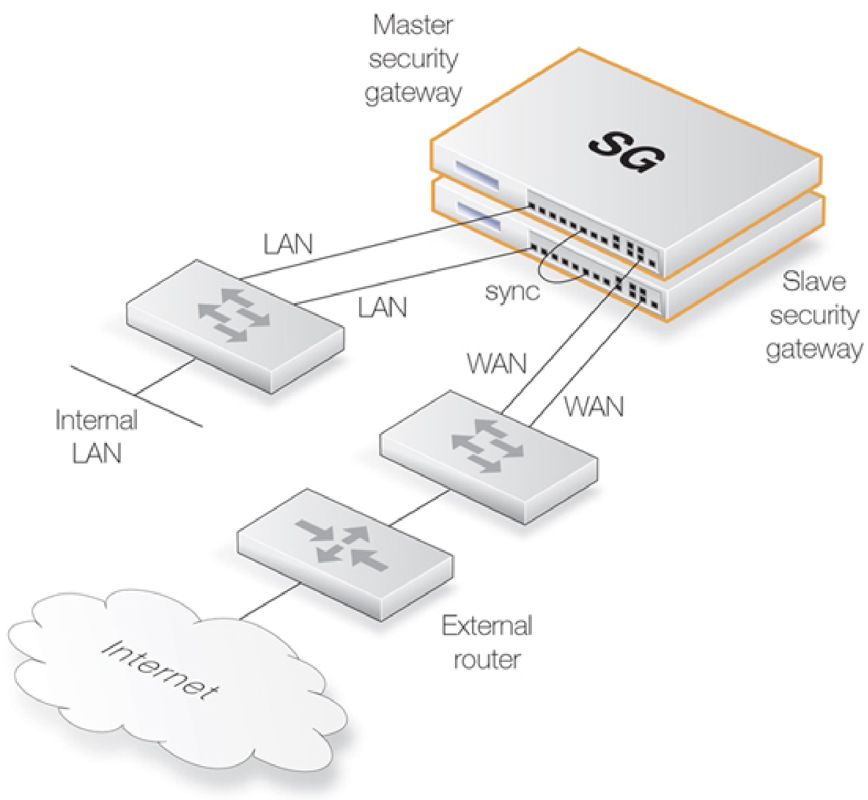
3. Make the physical connections:

   - Connect the matching interfaces of master and slave through separate switches or through individual switch domains in existing switches.

   - Select an interface on the master and slave which is to be used by the units for monitoring each other. This will be the CorePlus **sync** interface. It is recommended that the same interface is used on both master and slave, assuming they are similar systems. Connect the *sync* interfaces together directly with a crossover cable.

     Also keep in mind that there should be no CorePlus IP rules configured that include the *sync* interface.

Figure 11.1. High Availability Setup



Caution: The sync interface must be unique

*With some hardware an interface may be part of a switch fabric which joins a set of interfaces together (for instance the **lan** interfaces on the Clavister SG10 and SG50 Series). If such an interface is used for **sync** then the other interfaces connected to the same switch block cannot be used for other purposes.*

The illustration above shows the typical HA Cluster connections. All interfaces of the master would normally also be present on the slave and be connected to the same networks. This is achieved by connecting the same interfaces on both master and slave via a switch to other network portions. The **lan** interface on the master and the **lan** interface on the slave would be connected to the same switch which then connects to an internal network. Similarly the **wan** interface on the master and the **wan** interface would connect to a switch which in turn connects to the external Internet.

If the **lan** interface is connected to a switch block in the security gateway hardware then the other interfaces connected to the block should not be used.

The hardware of the slave does not need to exactly match the master, however it is recommended that hardware with similar performance is used in order to avoid any throughput degradation after a failover.

4. Decide on a shared IP address for each interface in the cluster. Some interfaces could have shared addresses only while others could also have a unique, individual IP address. The shared and individual addresses are used as follows:

   - The individual, non-shared IP addresses are optionally specified to allow remote management of each unit in a cluster. They can also be "pinged". If either unit is inoperative, its associated individual IP address will also be unreachable. These addresses are usually private addresses but must be public if management access from the public Internet is required.

     If an individual interface address is not specified then it will default to be a *localhost* address (from the *127.0.0.1/8* subnet).

     ARP queries for the individual IP addresses are answered by the gateway that owns the address, using the normal hardware address, just as with normal IP units.

   - One single shared IP address is used for routing and it is also the address used by dynamic address translation, unless the configuration explicitly specifies another address.

Note

The shared IP address can not be used for remote management or monitoring purposes. When using, for example, Netcon for remote management of the Clavister Security Gateways in an HA Cluster, the individual IP addresses of the gateway's interfaces must be used.

The software setup procedures are now divided into two sections. The next, first section is for two completely new Clavister Security Gateways. The second (Section 11.3.3, “CorePlus Setup With New Slave Only”) is for an existing gateway to which a new slave is added.

11.3.2. CorePlus Setup With New Master and Slave

This section assumes that two new Clavister Security Gateways have been purchased to create a cluster.

1. Set up the base configuration of the master Clavister Security Gateway normally using the serial console.

Do the same with the slave but before starting up CorePlus from the console boot menu, select the **System** menu option and choose **Select Type to High Availability Slave**. This is necessary to determine which unit will be the slave.

> ***Note***
> *At this point both master and slave will be in "demo" mode and will operate for 2 hours. If configuration with license upload isn't completed within that time both units must be restarted (both units will enter lockdown mode and power Off/On is the only course of action).*

2. Use Clavister FineTune to configure the cluster:

   - In Clavister FineTune create a **High Availability Cluster** object under the **Security Gateways** node.

   - From this **High Availability Cluster** object, use the **New** option to first designate one of the two Clavister Security Gateways to be the master and secondly the other to be the slave. The **New Security Gateway Wizard** will appear for each to configure the new device. The wizard will ask which interface is to be used as the **sync** interface and will also allow selection of the license.

3. The cluster configurations must be uploaded. In Clavister FineTune go to the **Action > Upload > Configuration** menu. Tick both the **Master** and **Slave** boxes and click **Next**. (Both may not need uploading but uploading both ensures everything is updated). Uploading of the configurations now commences. When uploading is complete the cluster is set up.

11.3.3. CorePlus Setup With New Slave Only

This section assumes that an existing Clavister Security Gateway, that is an already configured with CorePlus but not for HA, will become the master in a cluster. The slave is a new unit that has been purchased and will be added to create the cluster.

> ***Warning***
> *When an existing Clavister Security Gateway is 'promoted' to be the master unit, all old configurations for the unit will be lost and only the current configuration retained.*

1. In Clavister FineTune create a **High Availability Cluster** object under the **Security Gateways** node.

2. Right click the **High Availability Cluster** object and select the **Make Security Gateway a Cluster Member** option. A dialog appears which allows the designation of an existing Clavister Security Gateway as the master followed by a dialog to select which interface is to be used as the **sync** interface.

3. In **Hosts & Objects**, make sure that all the master's IP addresses are changed to be shared for all interfaces. At least one interface must have a unique, non-shared IP address for management as mentioned above.

4. Verify that management of the master is functioning by connecting to the designated management IP address. Also verify traffic flow, perhaps by sending a "Ping" to a known internet address from the master units console

5. Set up the base configuration of the slave Clavister Security Gateway as normal using the serial console. Before starting CorePlus in the console boot menu, select the **System** menu option and choose **Select Type to High Availability Slave**. This is necessary to determine which unit will be the slave.

> ***Note***
> *Since the cluster license is not deployed to the slave at this time, there will be a license mismatch after designating the slave. This will mean that the slave initially operates in "lockdown mode" where only management traffic is allowed. This is normal and the condition will be removed once the cluster setup is complete.*

6. From the **High Availability Cluster** object, use the **New** option to designate the new unit as the slave. The **New Security Gateway Wizard** now appears and is used to configure the slave. A dialog will appear with the wizard, asking which interface is to be used as the **sync** interface.

7. The cluster configurations must now be uploaded. In Clavister FineTune go to the **Action** > **Upload** > **Configuration** menu. Tick both the **Master** and **Slave** boxes and click **Next**. (Both may not need uploading but uploading both ensures everything is updated). Uploading of the configurations now commences. When upload is complete the cluster is set up.

11.3.4. Additional Advice for Cluster Setup

The following points are also relevant to cluster setup:

- It is recommended that the master and slave are similar in that they have matching interfaces but this is not a requirement in an HA Cluster. As long as the interfaces involved in the HA cluster have matching names, the number of total interfaces between the units can be different.

- Connecting matching interfaces from master and slave through a common switch is not absolutely necessary as the switch fabric in the Clavister Security Gateway itself can sometimes be used for this.

- If this is not the first cluster in a network then the advanced setting **ClusterID** must be changed to have a unique value (the default is 0). This makes sure the MAC address for the cluster is unique.

- Enabling the advanced setting **HAUseUniqueSharedMacAddressPerInterface** is also recommended so that each interface has its own MAC address. If this is not enabled, interfaces share a MAC address and this can confuse some switches.

  > ***Important***
  > *For UMA/GAN configurations this setting **must** be enabled.*

- Make sure that the advanced setting **HighBuffers** is set to *automatic* on all units in a cluster. This setting determines how memory is allocates by CorePlus for handling an increasing number of connections.

  Where a cluster has tens of thousands of simultaneous connections then it may be necessary to set a value above the automatic value. Much higher values have the disadvantage of possibly increasing throughput latency.

11.3.5. Reversing a Cluster Setup

Once an HA cluster is set up it may be necessary, in rare cases, to reverse the procedure and to revert back to a single standalone unit. Below is a description of how this is done based on the following assumptions:

- The master unit is to revert back to a standalone unit.

- The slave unit is to be disconnected completely from the cluster.

- The shared IP will become the IP address of the standalone unit.
- No live traffic is flowing during the reversal procedure.
- Clavister FineTune is initially closed.
- The CorePlus version is an *8.nn* version.

The steps to perform for HA reversal are as follows:

1. Go to the Clavister FineTune directory called where all the Clavister FineTune *datasource* for the cluster is stored. By default this will be the *Clavister FineTune* > *Default* installation directory.

   Open the file called *<master-name>.efw* in a text editor such as MS Notepad where *<master-name>* is the name previously assigned to the cluster master unit.

2. Remove the line in the file that begins *MEMBER_TYPE*.

3. Change the *ENTRYTYPE* value in the file from *CLUSTER_MEMBER* to *FIREWALL*.

4. Change the *PARENT* value in the file from the name of the HA cluster to *GLOBAL*.

5. Save the file and exit the editor.

6. Still in the Clavister FineTune datasources directory, make a copy of the latest HA configuration file. The latest file will have a name of the form *<cluster-name>.NNNNN.efc* where *NNNNN* is the latest version number of the cluster configuration.

   For example, the first version will be *00001*. If the cluster name is *Stockholm-HA* then the file would be called *Stockholm-HA.00005.efc* if *00005* is the latest version.

7. The file copy created in the previous step will become the configuration file for the standalone unit but must be first renamed.

   There will already be a *.efc* file for the standalone unit before it became part of the cluster. Identify the version of that file with the highest version number and rename the file copy just created to have the same name but with the version number incremented by one.

   For example, if the old standalone file had the name *Stockholm.00008.efc*, the file created in the previous step should be renamed *Stockholm.00009.efc*.

8. Now start Clavister FineTune so that these changes are read from the datasource files. The standalone unit will now appear in the navigation tree but possibly with an empty configuration.

9. Now close Clavister FineTune and edit the *<master-name>.efw* again with a text editor. A new line will have been added to this file by Clavister FineTune to contain the line *DBCONFIGVERSION N* where *N* is the last standalone version number. This needs to be changed to be the same number that appears in the *.efc* filename above.

   For example, if the *.efc* file is *Stockholm.00009.efc* then the line becomes *DBCONFIGVERSION 9*.

10. Now start Clavister FineTune and the master unit will now appear as a standalone security gateway with the same configuration that was used in the HA cluster.

11. Double check that the IP addresses for the Ethernet interfaces are correct in the configuration. Also make sure that the *Miscellaneous Remotes* section is correct in the configuration.

12. Rename the interface *Sync* to any other string.

13. If the slave unit is still operational, shut the power off to it and then disconnect it entirely from

the master and networks.

14. The configuration is now ready for deployment to the security gateway.

The master unit is now independent from the slave unit and can be managed through Clavister FineTune as a standalone security gateway.

The cluster definition will remain in the Clavister FineTune navigation tree but will now contain only the slave unit since what has been done is to remove the master unit from the cluster. By deleting the slave from the cluster and then the cluster itself, the HA configuration can be completely removed from Clavister FineTune.

ARP Cache Issues

When the new standalone configuration is deployed, the MAC addresses for all interfaces will have changes since the unit is no longer using shared MAC addresses. This could cause problems related to the ARP caches in network devices.

This can be solved in one of the following ways:

- Restarting the network devices so their ARP caches entries are renewed.
- Wait until the ARP cache entries in network devices expire which is usually in the order of 15 minutes.
- Use the CorePlus console command:

  ```
  arp -notify
  ```

  to send out a gratuitous ARP request from the security gateway that tells the network devices to renew their cache entries.

11.4. HA Issues

The following points should be kept in mind when managing and configuring an HA Cluster.

Real-time Monitoring

The Real-time Monitor will not automatically track the active Clavister Security Gateway. If a Real-time Monitor graph shows nothing but the connection count moving, then the cluster has probably failed over to the other unit.

SNMP

SNMP statistics are not shared between master and slave. SNMP managers have no failover capabilities. Therefore both gateways in a cluster need to be polled separately.

Logging

Log data will be coming from both master and slave. This means that the log receiver will have to be configured to receive logs from both. It also means that all log queries will likely have to include both master and slave as sources which will give all the log data in one result view. Normally, the inactive unit won't be sending log entries about live traffic so the output should look similar to that from one Clavister Security Gateway.

Using Individual IP Addresses

The unique individual IP addresses of the master and slave cannot safely be used for anything but management. Using them for anything else such as for source IPs in dynamically NATed connections or publishing services on them, will inevitably cause problems, as unique IPs will disappear when the gateway it belongs to does.

Failed Interfaces

Failed interfaces will not be detected unless they fail to the point where CorePlus cannot continue to function. This means that failover will not occur if the active unit can still send "am alive" heartbeats to the inactive unit through any of its interfaces, even though one or more interfaces may be inoperative.

Changing the Cluster ID

Changing the cluster ID in a live environment is not recommended for two reasons. Firstly this will change the hardware address of the shared IPs and will cause problems for all units attached to the local LAN, as they will keep the old hardware address in their ARP caches until it times out. Such units would have to have their ARP caches flushed.

Secondly this breaks the connection between the gateways in the cluster for as long as they are using different configurations. This will cause both gateways to go active at the same time.

Invalid Checksums in Heartbeat Packets

Cluster Heartbeats packets are deliberately created with invalid checksums. This is done so that they won't be routed. Some routers may flag this invalid checksum in their log messages.

Making OSPF work

If OSPF is being used to determine routing metrics then a cluster **cannot** be used as the *designated router*.

If OSPF is to work then there must be another *designated router* available in the same *OSPF area* as the cluster. Ideally, there will also be a second, backup designated router to provide OSPF metrics should the main designated router fail.

11.5. Uploading Upgrades or Configurations

When uploading a new CorePlus version or a new configuration to the Clavister Security Gateways in an HA cluster there are two alternative approaches:

- **Automatic Upload** using Clavister FineTune
- **Manual Upload** by issuing step by step console commands

11.5.1. Automatic Uploading

When done through Clavister FineTune, the upload process to both Clavister Security Gateways in a cluster is handled automatically. Clavister FineTune automatically uploads to one gateway, then invokes a failover for that unit before uploading to the other unit.

A disadvantage of automatic upgrading is that there is a longer period of delay for the changeover between the Clavister Security Gateways resulting in more traffic data packets being lost. To ensure a minimum of data loss, manual uploading is recommended.

11.5.2. Manual Uploading

Instead of allowing Clavister FineTune to do the complete upgrade automatically, the administrator can control the upgrade flow steps by issuing a series of console commands. This means that the user disruption is minimized and there is greater control and monitoring of the upgrade process.

The recommended sequence of commands should be as follows:

1. First issue an **ha** command to determine which Clavister Security Gateway is active. The console interaction will be similar to the following:

   ```
   > ha

   This device is an HA MASTER
   This device is currently ACTIVE (will forward traffic)
   HA cluster peer is PASSIVE
   ```

2. Upload to the inactive device in the cluster using Clavister FineTune. This is done by:

   a. Go to **Action** > **Communication** > **Upgrade** > **Core**

   b. Uncheck the option **Restart after uploading core**

   c. Now initiate the upload

   d. Restart the unit with the console command:

      ```
      > restart 1
      ```

3. After a period of time the device will have restarted and re-synched. A check of connection synchonization can be made with the conmsole command:

   ```
   > stat
   ```

   If IPsec tunnels are being used, the synchronization of these can be checked with the command (with typical output shown):

   ```
   > ipsecglobal -v
   ```

```
 License Status:
-----------------
 unique peers:             1/2000

 Policy Manager Statistics:
----------------------------
 num_p1_negs_active:       0
 num_p1_active:            15
 num_p1_aggr_mode_active:  0
 num_p1_done:              15
 num_p1_failed:            0
 num_qm_active:            0
 num_qm_done:              15
 num_qm_failed:            0

 Size of tunnel struct:  186
 Size of rule struct:    152
 Size of service struct: 51

 Engine Statistics:
--------------------
 active_flows:             15
 active_nexthops:          0
 active_rules:             29
 total_rules:              29
 active_transforms:        15
 total_transforms:         15
 total_rekeys:             0

 Number of IPsec SA:s                                           15
 Number of active IKE negotiations:                             0
 Number of active IKE SA:s:                                     15
 Number of failed IPsec negotiations:                           0
 Number of failed IKE SA:s:                                     0
 Number of rekeys that have been performed:                     0
 Total inbound packets received:                                0
 Total outbound packets sent:                                   0
 Total octets in inbound packets before decompression:          0
 Total octets in inbound packets before compression:            0
 Total octets in outbound packets before decompression:         0
 Total octets in outbound packets before compression:           0
 Total octets in outbound packets before decompression:         0
 Total octets in outbound packets before compression:           0

User Authentication
 ----------------------------------------------------------
 Number of active users:                                        15

IP pool
 ----------------------------------------------------------
 Number of free maintanined IP addresses :                      200
 Number of IP addresses used by subsystem:                      15
```

When examining this output for the cluster members the following values should be the same for each:
Number of IPsec SA:s
Number of active IKE SA:s
Number of active users
Number of free maintained IP addresses
Number of IP addresses used by subsystem

4. Run the command **ha activate** on the inactive unit in order to make it the active unit. Alternatively run **ha deactivate** on the active unit.

5. Now verify that traffic is passing through this unit, otherwise switch back to the other unit using **ha deactivate**.

6. Now upload to the currently inactive unit in the using Clavister FineTune in the same way that was described previously for the other unit in the cluster.

7. Again check that the state is synchronized for this unit and use the **ha deactivate** command again only if the inactive Clavister Security Gateway is to be made the active unit.

11.6. Using Link Monitoring

When using an HA configuration, it can be important to use redundant paths to vital resources such as the Internet. The paths through the network from the master device in an HA configuration may fail in which case it may be desirable to have this failure trigger a failover to the slave unit which has a different path to the resource.

Monitoring the availability of specific network paths can be done with the CorePlus *Link Monitor*. The Link Monitor allows the administrator to specify particular hosts whose reachability is monitored using ICMP "Ping" requests and therefore link status. If these hosts become unreachable then the link is considered failed and a failover to a slave can be initiated. Provided that the slave is using a different network link and also monitoring the reachability of different hosts, traffic can continue to flow.

When using the Link Monitor in a High Availability cluster the option **Send from Shared IP Address** will be visible during Link Monitor setup. This option can be used if individual public IP addresses are not available for each unit in an HA cluster.

This feature is described further in Section 2.4.4, “The Link Monitor”.

11.7. Replacing Cluster Hardware

In the event of a hardware failure in a cluster it will be necessary to swap out the faulty unit with a new unit. This section describes the steps necessary to do this. The major issues with installing a new unit in a cluster are:

- If the slave unit is being replaced, the new unit must be designated as a slave.
- The security keys used by Clavister FineTune™ for communication with the unit won't work anymore.
- The old license won't work because the hardware MAC addresses have changed.
- The revisions of CorePlus (both the core and the loader) in the master and slave units must be the same version.

The faulty hardware should be switched off and then physically disconnected from the other unit. When the new unit is available it should be first unpacked as a normal standalone unit and then the following steps should be followed:

1. Do not initially connect the master and slave together
2. Connect a console to the RS232 port on the new unit, power the unit on and the boot menu will appear on the console screen. Set the management IP address. If the new unit is a slave then it must be designated as such and to do this:
   - Select "No" when asked if you want to start the core.
   - From the menu select the option to make the unit the slave.
   - Now start the core.
3. In Clavister FineTune select the new unit in the tree view and go to **Action > Communication > Revert to Default Management Keys** to cause Clavister FineTune to renegotiate its connection with the new unit.

   For security, the management keys should then immediately be reset by going to **Action > Communication > Change Remote Management Keys**
4. The configuration must be now deployed to the new unit. Do this by selecting the unit in Clavister FineTune and clicking the **Deploy Configuration** button.
5. The existing license will not work with the new unit because the MAC addresses of the interfaces will have changed. The Clavister Customer Web system allows a license to be re-issued twice with a new MAC address. To do this follow the following steps:
   - Issue the **ifstat** command from the console of the new unit and make a note of one of the interface MAC addresses.
   - Log on to the Clavister Customer Web through an Internet browser and generate a new license for the unit with the new MAC address. Download this license to the management workstation. Make sure that the license is for the correct unit in the cluster.
   - Import the license file into Clavister FineTune by opening the **License Tool** and using the **Import** function in the **File** menu. Clavister FineTune will flag that the imported license conflicts with a license already in use and it will be necessary to indicate that the new license should be the one used.
6. Use the Clavister FineTune **Unbind** followed by the **Bind** function to associate the new license downloaded from the Customer Web with the new unit.
7. Verify that the CorePlus core and loader versions are the same on both master and slave. This

is done by issuing an **about** console command to get the core version and then a **sysmsg** command to get the loader version.

8. Now physically connect the master and slave as before. The slave will automatically sync with the master after a brief wait.

9. Verify that the cluster is performing correctly. Do this first with an **ha** command for each unit. The output will look similar to this for the master:

```
> ha

This device is an HA MASTER
This device is currently ACTIVE (will forward traffic)
HA cluster peer is ALIVE
```

   Then use the **stat** command to verify that both master and slave have about the same number of connections. The output should contain a line similar to this:

```
Connections 2726 out of 128000
```

   where the lower number is the current number of connections and the higher number is the connections limit of the license.

10. The ARP cache of connected switches will not be valid because of the changed MAC addresses in the new hardware. These ARP cache entries will be automatically updated after a timeout period or the switches can be reset manually. A better alternative is for CorePlus to explicitly update these entries with the following console command:

```
> arp -notify <if_ip>
```

   Where *<if_ip>* is the IP address of the interface on which the ARP notification is to be done.

At this point the installation of the new hardware is complete.

Issues with VLANs

If the management workstation connection to the new unit is via a VLAN then the new hardware will initially be unreachable since it will be start with factory defaults. This problem is dealt with through the following steps:

1. After unpacking the new unit, start it for the first time and enter the CorePlus boot menu. Set the IP address of the unit's management interface to the IP address on the VLAN that the old unit had for that interface.

2. Connect a cable directly between the management interface of the new unit and the Ethernet interface of the management workstation.

3. In FineTune, select the unit we are replacing in the navigation tree and go to **Action** > **Communication** and then select the option **Revert to Default Management Keys**. This will allow us to communicate with the new unit using the factory default NetCon keys.

4. In Clavister FineTune, go to **Advanced Settings** and open the **RemoteAdmin** settings. Change the **NetconBiDir** setting to *1000* (or some other high number). This will allow us time to change and upload a new configuration and then reconnect the device.

5. Deploy this new configuration to the new Clavister Security Gateway.

6. Reconnect the cables so they are the same as they were in the original HA cluster.

7. On the management workstation, go to the Windows **Control Panel** and open **Network Connections**. Right click the Ethernet connection to the VLAN and select the **Repair** option.

8. Clavister FineTune access to the new Clavister Security Gateway in the cluster will now be possible. Go back to the advanced settting **NetconBiDir** and change this back to the default value of *30*. Finally, deploy this new configuation.

9. Finally, go to **Action > Communication** for the new unit and select the option **Change Remote Management Keys** so the factory default keys are no longer used.

Chapter 12. Advanced Settings

This chapter describes the configurable advanced setings for CorePlus. The settings are divided up into the following categories:

Note

After an advanced setting is changed a reconfiguration must be performed in order for the new CorePlus configuration to be uploaded to the Clavister Security Gateway and the new value to take effect.

12.1. IP Level Settings

LogChecksumErrors

Logs occurrences of IP packets containing erroneous checksums. Normally, this is the result of the packet being damaged during network transport. All network units, both routers and workstations, drop IP packets that contain checksum errors. However, it is highly unlikely for an attack to be based on illegal checksums.

Default: *Enabled*

LogNonIP4

Logs occurrences of IP packets that are not version 4. CorePlus only accepts version 4 IP packets; everything else is discarded.

Default: *Enabled*

LogReceivedTTL0

Logs occurrences of IP packets received with the "Time To Live" (TTL) value set to zero. Under no circumstances should any network unit send packets with a TTL of 0.

Default: *Enabled*

Block0000Src

Block 0.0.0.0 as source address.

Default: *Drop*

Block0Net

Block 0.* as source addresses.

Default: *DropLog*

Block127Net

Block 127.* as source addresses.

Default: *DropLog*

BlockMulticastSrc

Block multicast both source addresses (224.0.0.0 - 255.255.255.255).

Default: *DropLog*

TTLMin

The minimum TTL value accepted on receipt.

Default: *3*

TTLOnLow

Determines the action taken on packets whose TTL falls below the stipulated TTLMin value.

Default: *DropLog*

DefaultTTL

Indicates which TTL CorePlus is to use when originating a packet. These values are usually between 64 and 255.

Default: *255*

LayerSizeConsistency

Verifies that the size information contained in each "layer" (Ethernet, IP, TCP, UDP, ICMP) is consistent with that of other layers.

Default: *ValidateLogBad*

IPOptionSizes

Verifies the size of "IP options". These options are small blocks of information that may be added to the end of each IP header. This function checks the size of well-known option types and ensures that no option exceeds the size limit stipulated by the IP header itself.

Default: *ValidateLogBad*

IPOPT_SR

Indicates whether source routing options are to be permitted. These options allow the sender of the packet to control how the packet is to be routed through each router and gateway. These constitute an enormous security risk. CorePlus never obeys the source routes specified by these options, regardless of this setting.

Default: *DropLog*

IPOPT_TS

Time stamp options instruct each router and gateway on the packet's route to indicate at what time the packet was forwarded along the route. These options do not occur in normal traffic. Time stamps may also be used to "record" the route a packet has taken from sender to final destination. CorePlus never enters information into these options, regardless of this setting.

Default: *DropLog*

IPOPT_OTHER

All options other than those specified above.

Default: *DropLog*

DirectedBroadcasts

Indicates whether CorePlus will forward packets which are directed to the broadcast address of its directly connected networks. It is possible to achieve this functionality by adding lines to the Rules section, but it is also included here for simplicity's sake. This form of validation is faster than entries in the Rules section since it is more specialized.

Default: *DropLog*

IPRF

Indicates what CorePlus will do if there is data in the "reserved" fields of IP headers. In normal circumstances, these fields should read 0. Used by OS Fingerprinting.

Default: *DropLog*

StripDFOnSmall

Strip the Don't Fragment flag for packets equal to or smaller than the number of bytes specified by this setting.

Default: *65535*

12.2. TCP Level Settings

TCPOptionSizes

Verifies the size of TCP options. This function acts in the same way as IPOptionSizes described above.

Default: *ValidateLogBad*

TCPMSSMin

Determines the minimum permissible size of the TCP MSS in bytes. Packets containing maximum segment sizes below this limit are handled according to the next setting.

Default: *100*

TCPMSSOnLow

Determines the action taken on packets whose TCP MSS option falls below the stipulated TCPMSSMin value. Values that are too low could cause problems in poorly written TCP stacks.

Default: *DropLog*

TCPMSSMax

Determines the maximum permissible TCP MSS size in bytes. Packets containing maximum segment sizes exceeding this limit are handled according to the next setting.

Default: *1460*

TCPMSSVPNMax

As is the case with TCPMSSMax, this is the highest Maximum Segment Size allowed in bytes. However, this setting only controls MSS in VPN connections. This way, CorePlus can reduce the effective segment size used by TCP in all VPN connections. This reduces TCP fragmentation in the VPN connection even if hosts do not know how to perform MTU discovery.

Default: *1400*

TCPMSSOnHigh

Determines the action taken on packets whose TCP MSS option exceeds the stipulated TCPMSSMax value. Values that are too high could cause problems in poorly written TCP stacks or give rise to large quantities of fragmented packets, which will adversely affect performance.

Default: *Adjust*

TCPMSSAutoClamping

Automatically clamp TCP MSS according to MTU of involved interfaces, in addition to TCPMSSMax.

Default: *Enabled*

TCPMSSLogLevel

Determines in bytes when to log regarding too high TCP MSS, if not logged by TCPMSSOnHigh.

Default: *7000*

TCPZeroUnusedACK

Determines whether CorePlus should set the ACK sequence number field in TCP packets to zero if it is not used. Some operating systems reveal sequence number information this way, which can make it easier for intruders wanting to hijack established connections.

Default: *Enabled*

TCPZeroUnusedURG

Strips the URG pointers from all packets.

Default: *Enabled*

TCPOPT_WSOPT

Determines how CorePlus will handle window-scaling options. These are used to increase the size of the windows used by TCP; that is to say, the amount of information that can be sent before the sender expects ACK. They are also used by OS Fingerprinting. WSOPT is a common occurrence in modern networks.

Default: *ValidateLogBad*

TCPOPT_SACK

Determines how CorePlus will handle selective acknowledgement options. These options are used to ACK individual packets instead of entire series, which can increase the performance of connections experiencing extensive packet loss. They are also used by OS Fingerprinting. SACK is a common occurrence in modern networks.

Default: *ValidateLogBad*

TCPOPT_TSOPT

Determines how CorePlus will handle time stamp options. As stipulated by the PAWS (Protect Against Wrapped Sequence numbers) method, TSOPT is used to prevent the sequence numbers (a 32-bit figure) from "exceeding" their upper limit without the recipient being aware of it. This is not normally a problem. Using TSOPT, some TCP stacks optimize their connection by measuring the time it takes for a packet to travel to and from its destination. This information can then be used to generate resends faster than is usually the case. It is also used by OS Fingerprinting. TSOPT is a common occurrence in modern networks.

Default: *ValidateLogBad*

TCPOPT_ALTCHKREQ

Determines how CorePlus will handle alternate checksum request options. These options were initially intended to be used in negotiating for the use of better checksums in TCP. However, these are not understood by any today's standard systems. As CorePlus cannot understand checksum algorithms other than the standard algorithm, these options can never be accepted. The ALTCHKREQ option is normally never seen on modern networks.

Default: *StripLog*

TCPOPT_ALTCHKDATA

Determines how CorePlus will handle alternate checksum data options. These options are used to transport alternate checksums where permitted by ALTCHKREQ above. Normally never seen on modern networks.

Default: *StripLog*

TCPOPT_CC

Determines how CorePlus will handle connection count options.

Default: *StripLogBad*

TCPOPT_OTHER

Specifies how CorePlus will deal with TCP options not covered by the above settings. These options usually never appear on modern networks.

Default: *StripLog*

TCPSynUrg

Specifies how CorePlus will deal with TCP packets with SYN (Synchronize) flags and URG (Urgent data) flags both turned on. The presence of a SYN flag indicates that a new connection is in the process of being opened, and an URG flag means that the packet contains data requiring urgent attention. These two flags should not be turned on in a single packet as they are used exclusively to crash computers with poorly implemented TCP stacks.

Default: *DropLog*

TCPSynPsh

Specifies how CorePlus will deal with TCP packets with SYN and PSH (Push) flags both turned on. The PSH flag means that the recipient stack should immediately send the information in the packet to the destination application in the computer. These two flags should not be turned on at the same time as it could pose a crash risk for poorly implemented TCP stacks. However, many Macintosh computers do not implement TCP correctly, meaning that they always send out SYN packets with the PSH flag turned on. This is why CorePlus normally removes the PSH flag and allows the packet through despite the fact that the normal setting should be dropping such packets.

Default: *StripSilent*

TCPFinUrg

Specifies how CorePlus will deal with TCP packets with both FIN (Finish, close connection) and URG flags turned on. This should normally never occur, as you do not usually attempt to close a connection at the same time as sending "important" data. This flag combination could be used to crash poorly implemented TCP stacks and is also used by OS Fingerprinting.

Default: *DropLog*

TCPUrg

Specifies how CorePlus will deal with TCP packets with the URG flag turned on, regardless of any other flags. Many TCP stacks and applications deal with Urgent flags in the wrong way and can, in the worst case scenario, cease working. Note however that some programs, such as FTP and MS SQL Server, nearly always use the URG flag.

Default: *StripLog*

TCPECN

Specifies how CorePlus will deal with TCP packets with either the Xmas or Ymas flag turned on. These flags are currently mostly used by OS Fingerprinting.

Note: an upcoming standard called *Explicit Congestion Notification* also makes use of these TCP flags, but as long as there are only a few operating systems supporting this standard, the flags should be stripped.

Default: *StripLog*

TCPRF

Specifies how CorePlus will deal with information present in the "reserved field" in the TCP header, which should normally be 0. This field is not the same as the *Xmas* and *Ymas* flags. Used by OS Fingerprinting.

Default: *DropLog*

TCPNULL

Specifies how CorePlus will deal with TCP packets that do not have any of the SYN, ACK, FIN or RST flags turned on. According to the TCP standard, such packets are illegal and are used by both OS Fingerprinting and stealth port scanners, as some gateways are unable to detect them.

Default: *DropLog*

TCPSequenceNumbers

Determines if the sequence number range occupied by a TCP segment will be compared to the receive window announced by the receiving peer before the segment is forwarded. TCP sequence number validation is only possible on connections tracked by the state-engine (not on packets forwarded using a **FwdFast** rule).

Possible values are:

Ignore - Do not validate. Means that sequence number validation is completely turned off.
ValidateSilent - Validate and pass on.
ValidateLogBad - Validate and pass on, log if bad.
ValidateReopen - Validate reopen attempt like normal traffic; validate and pass on.
ValidateReopenLog - Validate reopen attempts like normal traffic; validate, log if bad.
ReopenValidate - Do not validate reopen attempts at all; validate and pass on.
ReopenValidLog - Do not validate reopen attempts at all; validate, log if bad.

Default: *ValidateLogBad*

Notes on the *TCPSequenceNumbers* setting

The default *ValidateLogBad* (or the alternative *ValidateSilent*) will allow the de-facto behavior of TCP re-open attempts, meaning that they will reject re-open attempts with a previously used sequence number.

ValidateReopen and *ValidReopenLog* are special settings giving the default behavior found in older CorePlus versions where only re-open attempts using a sequence number falling inside the current (or last used) TCP window will be allowed. This is more restrictive than *ValidateLogBad*/*ValidateSilent*, and will block some valid TCP re-open attempts. The most significant impact of this will be that common web-surfing traffic (short but complete transactions requested from a relatively small set of clients, randomly occurring with an interval of a few seconds) will slow down considerably, while most "normal" TCP traffic will continue to work as usual.

Using either *ValidateReopen* or *ValidateReopenLog* is, however, not recommended since the same effect can be achieved by disallowing TCP re-open attempts altogether. These settings exist mostly for backwards compability.

ReopenValidate and *ReopenValidLog* are less restrictive variants than *ValidateLogBad* or *ValidateSilent*. Certain clients and/or operating systems might attempt to use a randomized sequence number when re-opening an old TCP connection (usually out of a concern for security) and this may not work well with these settings. Again, web-surfing traffic is most likely to be affected, although the impact is likely to occur randomly. Using these values instead of the default setting will completely disable sequence number validation for TCP re-open attempts. Once the connection has been established, normal TCP sequence number validation will be resumed.

12.3. ICMP Level Settings

ICMPSendPerSecLimit

Specifies the maximum number of ICMP messages CorePlus may generate per second. This includes ping replies, destination unreachable messages and also TCP RST packets. In other words, this setting limits how many Rejects per second may be generated by the Reject rules in the Rules section.

Default: *20*

SilentlyDropStateICMPErrors

Specifies if CorePlus should silently drop ICMP errors pertaining to statefully tracked open connections. If these errors are not dropped by this setting, they are passed to the rule set for evaulation just like any other packet.

Default: *Enabled*

12.4. ARP Settings

ARPMatchEnetSender

Determines if CorePlus will require the sender address at Ethernet level to comply with the hardware address reported in the ARP data.

Default: *DropLog*

ARPQueryNoSenderIP

What to do with ARP queries that have a sender IP of 0.0.0.0. Such sender IPs are never valid in responses, but network units that have not yet learned of their IP address sometimes ask ARP questions with an "unspecified" sender IP.

Default: *DropLog*

ARPSenderIP

Determines if the IP sender address must comply with the rules in the Access section.

Default: *Validate*

UnsolicitedARPReplies

Determines how CorePlus will handle ARP replies that it has not asked for. According to the ARP specification, the recipient should accept these. However, because this can facilitate hijacking of local connections, it is not normally allowed.

Default: *DropLog*

ARPRequests

Determines if CorePlus will automatically add the data in ARP requests to its ARP table. The ARP specification states that this should be done, but as this procedure can facilitate hijacking of local connections, it is not normally allowed. Even if ARPRequests is set to "Drop", meaning that the packet is discarded without being stored, CorePlus will, provided that other rules approve the request, reply to it.

Default: *Drop*

ARPChanges

Determines how CorePlus will deal with situations where a received ARP reply or ARP request would alter an existing item in the ARP table. Allowing this to take place may facilitate hijacking of local connections. However, not allowing this may cause problems if, for example, a network adapter is replaced, as CorePlus will not accept the new address until the previous ARP table entry has timed out.

Default: *AcceptLog*

StaticARPChanges

Determines how CorePlus will handle situations where a received ARP reply or ARP request would alter a static item in the ARP table. Of course, this is never allowed to happen. However, this setting does allow you to specify whether or not such situations are to be logged.

Default: *DropLog*

ARPExpire

Specifies how long in seconds a normal dynamic item in the ARP table is to be retained before it is removed from the table.

Default: *900* (15 minutes)

ARPExpireUnknown

Specifies in seconds how long CorePlus is to remember addresses that cannot be reached. This is done to ensure that CorePlus does not continuously request such addresses.

Default: *3*

ARPMulticast

Determines how CorePlus is to deal with ARP requests and ARP replies that state that they are multicast addresses. Such claims are usually never correct, with the exception of certain load balancing and redundancy devices, which make use of hardware layer multicast addresses.

Default: *DropLog*

ARPBroadcast

Determines how CorePlus is to deal with ARP requests and ARP replies that state that they are broadcast addresses. Such claims are usually never correct.

Default: *DropLog*

ARPCacheSize

How many ARP entries there can be in the cache in total.

Default: *4096*

ARPHashSize

So-called "hash tables" are used to rapidly look up entries in a table. For maximum efficiency, a hash should be twice as large as the table it is indexing, so if the largest directly-connected LAN contains 500 IP addresses, the size of the ARP entry hash should be at least 1000 entries.

Default: *512*

ARPHashSizeVLAN

So-called "hash tables" are used to rapidly look up entries in a table. For maximum efficiency, a hash should be twice as large as the table it is indexing, so if the largest directly-connected LAN contains 500 IP addresses, the size of the ARP entry hash should be at least 1000 entries.

Default: *64*

ARPIPCollision

Determines the behavior when receiving an ARP request with a sender IP address that collides with one already used on the receive interface. Possible actions: Drop or Notify.

Default: *Drop*

12.5. Stateful Inspection Settings

ConnReplace

Allows new additions to CorePlus's connection list to replace the oldest connections if there is no available space.

Default: *ReplaceLog*

LogOpenFails

In some instances where the Rules section determines that a packet should be allowed through, the stateful inspection mechanism may subsequently decide that the packet cannot open a new connection. One example of this is a TCP packet that, although allowed by the Rules section and not being part of an established connection, has its SYN flag off. Such packets can never open new connections. In addition, new connections can never be opened by ICMP messages other than ICMP ECHO (Ping). This setting determines if CorePlus is to log the occurrence of such packets.

Default: *Enabled*

LogReverseOpens

Determines if CorePlus logs packets that attempt to open a new connection back through one that is already open. This only applies to TCP packets with the SYN flag turned on and to ICMP ECHO packets. In the case of other protocols such as UDP, there is no way of determining whether the remote peer is attempting to open a new connection.

Default: *Enabled*

LogStateViolations

Determines if CorePlus logs packets that violate the expected state switching diagram of a connection, for instance, getting TCP FIN packets in response to TCP SYN packets.

Default: *Enabled*

MaxConnections

Specifies how many connections CorePlus may keep open at any one time. Each connection consumes approximately 150 bytes RAM. When this setting is dynamic, CorePlus will try to use as many connections as is allowed by product.

Default: *<dynamic>*

LogConnections

Specifies how CorePlus, will log connections:

- *NoLog* – Does not log any connections; consequently, it will not matter if logging is enabled for either Allow or NAT rules in the Rules section; they will not be logged. However, FwdFast, Drop and Reject rules will be logged as stipulated by the settings in the Rules section.

- *Log* – Logs connections in short form; gives a short description of the connection, which rule allowed it to be made and any SAT rules that apply. Connections will also be logged when they are closed.

- *LogOC* – As for Log, but includes the two packets that cause the connection to be opened and closed. If a connection is closed as the result of a timeout, no ending packet will be logged

- *LogOCAll* – Logs all packets involved in opening and closing the connection. In the case of TCP, this covers all packets with SYN, FIN or RST flags turned on
- *LogAll* – Logs all packets in the connection.

Default: *Log*

12.6. Connection Timeouts

The settings in this section specify how long a connection can remain idle, ie. no data being sent through it, before it is automatically closed. Please note that each connection has two timeout values: one for each direction. A connection is closed if either of the two values reaches 0.

ConnLife_TCP_SYN

Specifies how long a not yet been fully established TCP connection may idle before being closed.

Default: *60 seconds*

ConnLife_TCP

Specifies how long a fully established TCP connection may idle before being closed. Connections become fully established once packets with their SYN flags off have traveled in both directions.

Default: *262144 seconds*

ConnLife_TCP_FIN

Specifies how many seconds a TCP connection about to close may idle before finally being closed. Connections reach this state when a packet with its FIN flag on has passed in any direction.

Default: *80*

ConnLife_UDP

Specifies how many seconds UDP connections may idle before being closed. This timeout value is usually low, as UDP has no way of signalling when the connection is about to close.

Default: *130*

ConnLife_Ping

Specifies how many seconds a Ping (ICMP ECHO) connection can remain idle before it is closed.

Default: *8*

ConnLife_Other

Specifies how many seconds connections using an unknown protocol can remain idle before it is closed.

Default: *130*

ConnLife_IGMP

Connection lifetime in seconds for IGMP

Default: *12*

12.7. Size Limits by Protocol

This section contains information about the size limits imposed on the protocols directly under IP level, ie. TCP, UDP, ICMP, etc.

The values specified here concern the IP data contained in packets. In the case of Ethernet, a single packet can contain up to 1480 bytes of IP data without fragmentation. In addition to that, there is a further 20 bytes of IP header and 14 bytes of Ethernet header, corresponding to the maximum media transmission unit on Ethernet networks of 1514 bytes.

MaxTCPLen

Specifies the maximum size of a TCP packet including the header. This value usually correlates with the amount of IP data that can be accommodated in an unfragmented packet, since TCP usually adapts the segments it sends to fit the maximum packet size. However, this value may need to be increased by 20-50 bytes on some less common VPN systems.

Default: *1480*

MaxUDPLen

Specifies the maximum size of a UDP packet including the header. This value may well need to be quite high, since many real-time applications use large, fragmented UDP packets. If no such protocols are used, the size limit imposed on UDP packets can probably be lowered to 1480 bytes.

Default: *60000 bytes*

MaxICMPLen

Specifies the maximum size in bytes of an ICMP packet. ICMP error messages should never exceed 600 bytes, although Ping packets can be larger if so requested. This value may be lowered to 1000 bytes if you do not wish to use large Ping packets.

Default: *10000*

MaxGRELen

Specifies the maximum size in bytes of a GRE packet. GRE, Generic Routing Encapsulation, has various uses, including the transportation of PPTP, Point to Point Tunneling Protocol, data. This value should be set at the size of the largest packet allowed to pass through the VPN connections, regardless of its original protocol, plus approx. 50 bytes.

Default: *2000*

MaxESPLen

Specifies the maximum size in bytes of an ESP packet. ESP, Encapsulation Security Payload, is used by IPsec where encryption is applied. This value should be set at the size of the largest packet allowed to pass through the VPN connections, regardless of its original protocol, plus approx. 50 bytes.

Default: *2000*

MaxAHLen

Specifies the maximum size in bytes of an AH packet. AH, Authentication Header, is used by IPsec where only authentication is applied. This value should be set at the size of the largest packet allowed to pass through the VPN connections, regardless of its original protocol, plus approx. 50 bytes.

Default: *2000*

MaxSKIPLen

Specifies the maximum size of a SKIP packet.

Default: *2000 bytes*

MaxOSPFLen

Specifies the maximum size of an OSPF packet. OSPF is a routing protocol mainly used in larger LANs.

Default: *1480*

MaxIPIPLen

Specifies the maximum size of an IP-in-IP packet. IP-in-IP is used by Checkpoint Firewall-1 VPN connections when IPsec is not used. This value should be set at the size of the largest packet allowed to pass through the VPN connections, regardless of its original protocol, plus approx. 50 bytes.

Default: *2000 bytes*

MaxIPCompLen

Specifies the maximum size of an IPComp packet.

Default: *2000 bytes*

MaxL2TPLen

Specifies the maximum size of a Layer 2 Tunneling Protocol packet.

Default: *2000 bytes*

MaxOtherSubIPLen

Specifies the maximum size of packets belonging to protocols that are not specified above.

Default: *1480 bytes*

LogOversizedPackets

Specifies if CorePlus will log oversized packets.

Default: *Enabled*

12.8. Fragmentation Settings

IP is able to transport up to 65,536 bytes of data. However, most media, such as Ethernet, cannot carry such huge packets. To compensate, the IP stack fragments the data to be sent into separate packets, each one given their own IP header and information that will help the recipient reassemble the original packet correctly.

However, many IP stacks are unable to handle incorrectly fragmented packets, a fact that can be exploited by intruders to crash such systems. CorePlus provides protection against fragmentation attacks in a number of ways.

PseudoReass_MaxConcurrent

Maximum number of concurrent fragment reassemblies. To drop all fragmented packets, set PseudoReass_MaxConcurrent to 0.

Default: *1024*

IllegalFrags

Determines how CorePlus will handle incorrectly constructed fragments. The term "incorrectly constructed" refers to overlapping fragments, duplicate fragments with different data, incorrect fragment sizes, etc. Possible settings include:

- *Drop* – Discards the illegal fragment without logging it. Also remembers that the packet that is being reassembled is "suspect", which can be used for logging further down the track.
- *DropLog* – Discards and logs the illegal fragment. Also remembers that the packet that is being reassembled is "suspect", which can be used for logging further down the track.
- *DropPacket* – Discards the illegal fragment and all previously stored fragments. Will not allow further fragments of this packet to pass through during ReassIllegalLinger seconds.
- *DropLogPacket* – As DropPacket, but also logs the event.
- *DropLogAll* – As DropLogPacket, but also logs further fragments belonging to this packet that arrive during ReassIllegalLinger seconds.

The choice of whether to discard individual fragments or disallow the entire packet is governed by two factors:

- It is safer to discard the whole packet.
- If, as the result of receiving an illegal fragment, you choose to discard the whole packet, attackers will be able to disrupt communication by sending illegal fragments during a reassembly, and in this way block almost all communication.

Default: *DropLog – discards individual fragments and remembers that the reassembly attempt is "suspect".*

DuplicateFragData

If the same fragment arrives more than once, this can mean either that it has been duplicated at some point on its journey to the recipient or that an attacker is trying to disrupt the reassembly of the packet. In order to determine which is more likely, CorePlus compares the data components of the fragment. The comparison can be made in 2 to 512 random locations in the fragment, four bytes of each location being sampled. If the comparison is made in a larger number of samples, it is more likely to find mismatching duplicates. However, more comparisons result in higher CPU load.

Default: *Check8 – compare 8 random locations, a total of 32 bytes*

FragReassemblyFail

Reassemblies may fail due to one of the following causes:

- Some of the fragments did not arrive within the time stipulated by the ReassTimeout or ReassTimeLimit settings. This may mean that one or more fragments were lost on their way across the Internet, which is a quite common occurrence.
- CorePlus was forced to interrupt the reassembly procedure due to new fragmented packets arriving and the system temporarily running out of resources. In situations such as these, old reassembly attempts are either discarded or marked as "failed".
- An attacker has attempted to send an incorrectly fragmented packet.

Under normal circumstances, you would not want to log failures as they occur frequently. However, it may be useful to log failures involving "suspect" fragments. Such failures may arise if, for example, the IllegalFrags setting has been set to Drop rather than DropPacket.

The following settings are available for FragReassemblyFail:

- *NoLog* - No logging is done when a reassembly attempt fails.
- *LogSuspect* - Logs failed reassembly attempts only if "suspect" fragments have been involved.
- *LogSuspectSubseq - As LogSuspect, but also logs subsequent fragments of the packet as and when they arrive*
- *LogAll* - Logs all failed reassembly attempts.
- *LogAllSubseq* - As LogAll, but also logs subsequent fragments of the packet as and when they arrive.

Default: *LogSuspectSubseq*

DroppedFrags

If a packet is denied entry to the system as the result of the settings in the Rules section, it may also be worth logging individual fragments of that packet. The DroppedFrags setting specifies how CorePlus will act. Possible settings for this rule are as follows:

- *NoLog* – No logging is carried out over and above that which is stipulated in the rule set.
- *LogSuspect* - Logs individual dropped fragments of reassembly attempts affected by "suspect" fragments.
- *LogAll* - Always logs individual dropped fragments.

Default: *LogSuspect*

DuplicateFrags

If the same fragment arrives more than once, this can mean either that it has been duplicated at some point on its journey to the recipient or that an attacker is trying to disrupt the reassembly of the packet. DuplicateFrags determines whether such a fragment should be logged. Note that DuplicateFragData can also cause such fragments to be logged if the data contained in them does not match up. Possible settings are as follows:

- *NoLog* - No logging is carried out under normal circumstances.
- *LogSuspect* - Logs duplicated fragments if the reassembly procedure has been affected by "suspect" fragments.

- *LogAll* - Always logs duplicated fragments.

Default: *LogSuspect*

FragmentedICMP

Other than ICMP ECHO (Ping), ICMP messages should not normally be fragmented as they contain so little data that fragmentation should never be necessary. FragmentedICMP determines the action taken when CorePlus receives fragmented ICMP messages that are not either ICMP ECHO or ECHOREPLY.

Default: *DropLog*

MinimumFragLength

MinimumFragLength determines how small all fragments, with the exception of the final fragment, of a packet can be. Although the arrival of too many fragments that are too small may cause problems for IP stacks, it is usually not possible to set this limit too high. It is rarely the case that senders create very small fragments. However, a sender may send 1480 byte fragments and a router or VPN tunnel on the route to the recipient subsequently reduce the effective MTU to 1440 bytes. This would result in the creation of a number of 1440 byte fragments and an equal number of 40 byte fragments. Because of potential problems this can cause, the default settings in CorePlus has been designed to allow the smallest possible fragments, 8 bytes, to pass. For internal use, where all media sizes are known, this value can be raised to 200 bytes or more.

Default: *8 bytes*

ReassTimeout

A reassembly attempt will be interrupted if no further fragments arrive within ReassTimeout seconds of receipt of the previous fragment.

Default: *65 seconds*

ReassTimeLimit

A reassembly attempt will always be interrupted ReassTimeLimit seconds after the first received fragment arrived.

Default: *90 seconds*

ReassDoneLinger

Once a packet has been reassembled, CorePlus is able to remember this for a short period of time in order to prevent further fragments, for example old duplicate fragments, of that packet from arriving.

Default: *20 seconds*

ReassIllegalLinger

Once a whole packet has been marked as illegal, CorePlus is able to retain this in its memory in order to prevent further fragments of that packet from arriving.

Default: *60 seconds*

12.9. Local Fragment Reassembly Settings

LocalReass_MaxConcurrent

Maximum number of concurrent local reassemblies.

Default: *256*

LocalReass_MaxSize

Maximum size of a locally reassembled packet.

Default: *10000*

LocalReass_NumLarge

Number of large (over 2K) local reassembly buffers (of the above size).

Default: *32*

12.10. VLAN Settings

UnknownVLANTags

What to do with VLAN packets tagged with an unknown ID.

Default: *DropLog*

12.11. SNMP Settings

SNMPReqLimit

Maximum number of SNMP requests that will be processed each second by CorePlus. Should SNMP requests exceed this rate then the excess requests will be ignored by CorePlus.

Default: *100*

SNMPSysContact

The contact person for the managed node.

Default: *N/A*

SNMPSysName

The name for the managed node.

Default: *N/A*

SNMPSysLocation

The physical location of the node.

Default: *N/A*

SNMPifDescr

What to display in the SNMP MIB-II ifDescr variables.

Default: *Name*

SNMPifAlias

What to display in the SNMP ifMIB ifAlias variables.

Default: *Hardware*

12.12. DHCP Settings

DHCP_MinimumLeaseTime

Minimum lease time (seconds) accepted from the DHCP server.

Default: *60*

DHCP_ValidateBcast

Require that the assigned broadcast address is the highest address in the assigned network.

Default: *Enabled*

DHCP_AllowGlobalBcast

Allow DHCP server to assign 255.255.255.255 as broadcast. (Non-standard.)

Default: *Disabled*

DHCP_UseLinkLocalIP

If this is enabled CorePlus will use a Link Local IP (169.254.*.*) instead of 0.0.0.0 while waiting for a lease.

Default: *Disabled*

DHCP_DisableArpOnOffer

Disable the ARP check done by CorePlus on the offered IP. The check issues an ARP request to see if the IP address is already in use.

Default: *Disabled*

12.13. DHCPRelay Settings

DHCPRelay_MaxTransactions

Maximum number of transactions at the same time.

Default: *32*

DHCPRelay_TransactionTimeout

For how long a dhcp transaction can take place.

Default: *10 seconds*

DHCPRelay_MaxPPMPerIface

How many dhcp-packets a client can send to through CorePlus to the dhcp-server during one minute.

Default: *500 packets*

DHCPRelay_MaxHops

How many hops the dhcp-request can take between the client and the dhcp-server.

Default: *5*

DHCPRelay_MaxLeaseTime

The maximum leasetime allowed through CorePlus, if the DHCP server have higher leases this value will be shorted down to this value.

Default: *10000 seconds*

DHCPRelay_MaxAutoRoutes

How many relays that can be active at the same time.

Default: *256*

DHCPServer_SaveRelayPolicy

What policy should be used to save the relay list to the disk, possible settings are Disabled, ReconfShut, or ReconfShutTimer.

Default: *ReconfShut*

DHCPRelay_AutoSaveRelayInterval

How often should the relay list be saved to disk if DHCPServer_SaveRelayPolicy is set to ReconfShutTimer.

Default: *86400*

12.14. DHCPServer Settings

DHCPServer_SaveLeasePolicy

What policy should be used to save the lease database to the disk, possible settings are Disabled, ReconfShut, or ReconfShutTimer.

Default: *ReconfShut*

DHCPServer_AutoSaveLeaseInterval

How often should the leases database be saved to disk if DHCPServer_SaveLeasePolicy is set to ReconfShutTimer.

Default: *86400*

12.15. IPsec Settings

IKESendInitialContact

Determines whether or not IKE should send the "Initial Contact" notification message. This message is sent to each remote gateway when a connection is opened to it and there are no previous IPsec SA using that gateway.

Default: *Enabled*

IKESendCRLs

Dictates whether or not CRLs (Certificate Revocation Lists) should be sent as part of the IKE exchange. Should typically be set to ENABLE except where the remote peer does not understand CRL payloads.

Note that this setting requires a restart to take effect.

Default: *Enabled*

IKECRLValidityTime

A CRL contains a "next update" field that dictates the time and date when a new CRL will be available for download from the CA. The time between CRL updates can be anything from a few hours and upwards, depending on how the CA is configured. Most CA software allow the CA administrator to issue new CRLs at any time, so even if the "next update" field says that a new CRL is available in 12 hours, there may already be a new CRL for download.

This setting limits the time a CRL is considered valid. A new CRL is downloaded when IKECRLVailityTime expires or when the "next update" time occurs. Whichever happens first.

Default: *90000*

IKEMaxCAPath

When the signature of a user certificate is verified, CorePlus looks at the 'issuer name' field in the user certificate to find the CA certificate the certificate was signed by. The CA certificate may in turn be signed by another CA, which may be signed by another CA, and so on. Each certificate will be verified until one that has been marked trusted is found, or until it is determined that none of the certificates were trusted.

If there are more certificates in this path than what this setting specifies, the user certificate will be considered invalid.

Default: *15*

IPsecCertCacheMaxCerts

Maximum number of certificates/CRLs that can be held in the internal certificate cache. When the certificate cache is full, entries will be removed according to an LRU (Least Recently Used) algorithm.

Default: *1024*

IPsecBeforeRules

Pass IKE & IPsec (ESP/AH) traffic sent to CorePlus directly to the IPsec engine without consulting the rule set.

Default: *Enabled*

IPsecMaxTunnels

Specifies the total number of IPsec tunnels allowed. This value is initially taken from the maximum tunnels allowed by the license. The setting is used by CorePlus to allocate memory for IPsec. If it is desirable to have less memory allocated for IPsec then this setting can be reduced. Increasing the setting cannot override the license limit.

A warning log message is generated automatically when 90% of this value is reached.

Default: *According to the licensed limit*

IPsecMaxRules

This specifies the total number of IP rules that can be connected to IPsec tunnels. By default this is initially approximately 4 times the licensed **IPsecMaxTunnels** and system memory for this is allocated at startup. By reducing the number of rules, memory requirements can be reduced but making this change is not recommended.

IPsecMaxRules will always be reset automatically to be approximately 4 times **IPsecMaxTunnels** if the latter is changed. This linkage is broken once **IPsecMaxRules** is altered manually so that subsequent changes to **IPsecMaxTunnels** will not cause an automatic change in **IPsecMaxRules**.

Default: *4 times the license limit of IPsecMaxTunnels*

IPsecDPDwMetric

The amount of time in tens of seconds that the peer is considered to be alive (reachable) since the last received IKE message. This means that no DPD messages for checking aliveness of the peer will be sent during this time even though no packets from the peer have been received during this time.

In other words, the amount of time in tens of seconds that a tunnel is without traffic or any other sign of life before the peer is considered dead. If DPD is due to be triggered but other evidence of life is seen (such as IKE packets from the other side of the tunnel) within the time frame, no *DPD-R-U-THERE* messages will be sent.

For example, if the other side of the tunnel has not sent any ESP packets for a long period but at least one IKE-packet has been seen within the last *(10 x the configured value)* seconds, then CorePlus will not send more *DPD-R-U-THERE* message packets to the other side.

Default: *3* (in other words, 3 x 10 = 30 seconds)

IPsecDPDExpireTime

The length of time in seconds for which DPD messages will be sent to the peer. If the peer has not responded to messages during this time it is considered to be dead (in other words, un-reachable).

In other words, the length of time in seconds for which *DPD-R-U-THERE* (IKEv1 only) messages will be sent. If the other side of the tunnel has not sent a response to any messages then it is considered to be dead (not reachable). The SA will then be placed in the dead cache.

This setting is used with IKEv1 only and isn't used with IKEv2.

Default: *15*

IPsecDPDKeepTime

The amount of time in tens of seconds that a peer is assumed to be dead after CorePlus has detected it to be so. While the peer is considered dead, CorePlus will not try to re-negotiate the tunnel or send

DPD messages to the peer. However, the peer will not be considered dead any more as soon as a packet from it is received.

A more detailed explanation for this setting is that it is the amount of time in tens of seconds that an SA wil remain in the dead cache after a delete. An SA is put in the dead cache when the other side of the tunnel has not responded to *DPD-R-U-THERE* messages for *IPsecDPDExpireTime* x 10 seconds and there is no other evidence of life. When the SA is placed in the dead cache, CorePlus will not try to re-negotiate the tunnel. If traffic that is associated with the SA that is in the dead cache is received, the SA will be removed from the dead cache. DPD will not trigger if the SA is already cached as dead.

This setting is used with IKEv1 only and isn't used with IKEv2.

Default: *2* (in other words, 2 x 10 = 20 seconds)

12.16. Transparent Mode Settings

Transp_CAMToL3CDestLearning

Enable this if the gateway should be able to learn the destination for hosts by combining destination address information and information found in the CAM table.

Default: *Enabled*

Transp_DecrementTTL

Enable this if the TTL should be decremented each time a packet traverses the gateway in Transparent Mode.

Default: *Disabled*

Transparency_CAMSize

This setting can be used to manually configure the size of the CAM table. Normally *Dynamic* is the preferred value to use.

Default: *Dynamic*

Transparency_L3CSize

This setting can be used to manually configure the size of the Layer 3 Cache. Normally *Dynamic* is the preferred value to use.

Default: *Dynamic*

NullEnetSender

Defines what to do when receiving a packet that has the sender hardware (MAC) address in ethernet header set to null (0000:0000:0000). Options:

- *Drop* - Drop packets
- *DropLog* - Drop and log packets

Default: *DropLog*

BroadcastEnetSender

Defines what to do when receiving a packet that has the sender hardware (MAC) address in ethernet header set to the broadcast ethernet address (FFFF:FFFF:FFFF). Options:

- *Accept* - Accept packet
- *AcceptLog* - Accept packet and log
- *Rewrite* - Rewrite to the MAC of the forwarding interface
- *RewriteLog* - Rewrite to the MAC of the forwarding interface and log
- *Drop* - Drop packets
- *DropLog* - Drop and log packets

Default: *DropLog*

MulticastEnetSender

Defines what to do when receiving a packet that has the sender hardware (MAC) address in ethernet header set to a multicast ethernet address. Options:

- *Accept* - Accept packet
- *AcceptLog* - Accept packet and log
- *Rewrite* - Rewrite to the MAC of the forwarding interface
- *RewriteLog* - Rewrite to the MAC of the forwarding interface and log
- *Drop* - Drop packets
- *DropLog* - Drop and log packets

Default: *DropLog*

Transparency_ATSExpire

Defines the lifetime of an unanswered ARP Transaction State (ATS) entry in seconds. Valid values are 1-60 seconds.

Default: *3*

Transparency_ATSSize

Defines the maximum total number of ARP Transaction State (ATS) entries. Valid values are 128-65,536 entries.

Default: *4096*

> ***Note***
> *Both Transparency_ATSExpire and Transparency_ATSSize can be used to tweak the ATS handling to be optimal in different environments.*

RelaySTP

When set to **Ignore** all incoming STP, RSTP and MSTP BPDUs are relayed to all transparent interfaces in the same routing table, except the incoming interface. Options:

- *Ignore* - Let the packets pass but don't log
- *Log* - Let the packets pass and log the event
- *Drop* - Drop the packets
- *DropLog* - Drop packets log the event

Default: *Drop*

RelayMPLS

When set to **Ignore** all incoming MPLS packets are relayed in transparent mode. Options:

- *Ignore* - Let the packets pass but don't log
- *Log* - Let the packets pass and log the event
- *Drop* - Drop the packets
- *DropLog* - Drop packets log the event

Default: *Drop*

12.17. Logging Settings

LogSendPerSecLimit

This setting limits how many log packets CorePlus may send out per second. This value should never be set too low, as this may result in important events not being logged, nor should it be set too high. One situation where setting too high a value may cause damage is when CorePlus sends a log message to a server whose log receiver is not active. The server will send back an ICMP UNREACHABLE message, which may cause CorePlus to send another log message, which in turn will result in another ICMP UNREACHABLE message, and so on. By limiting the number of log messages CorePlus sends every second, you avoid encountering such devastating bandwidth consuming scenarios.

Default: *3600 seconds, once an hour*

12.18. High Availability Settings

ClusterID

A (locally) unique cluster ID to use in identifying this group of HA Clavister Security Gateways.

Default: *0*

HASyncBufSize

How much sync data, in Kbytes, to buffer while waiting for acknowledgments from the cluster peer.

Default: *1024*

HASyncMaxPktBurst

The maximum number of state sync packets to send in a burst.

Default: *20*

HAInitialSilence

The time to stay silent on startup or after reconfiguration.

When the active unit in an HA cluster believes the inactive unit is no longer reachable, it continues to send synchronization traffic normally for a period of one minute in the expectation that the inactive unit will again become reachable.

In order not to flood the network unnecessarily, after one minute has elapsed, the synchronization traffic is then only sent after repeated periods of silence. The length of this silence is this setting.

Default: *5*

RFO_GratuitousARPOnFail

Send gratuitous ARP on failover to alert hosts about changed interface ethernet and IP addresses. Possible values: TRUE or FALSE.

Default: *TRUE*

HADeactivateBeforeReconf

If enabled, this setting will make an active node failover to the inactive node before a reconfigure takes place instead of relying on the inactive node detecting that the active node is not operating normally and then taking over on its own initiative. Enabling this setting shortens the time where no node is active during configuration deployments.

Default: *Enabled*

12.19. Time Synchronization Settings

TimeSync_SyncInterval

Seconds between each resynchronization.

Default: *86400*

TimeSync_MaxAdjust

Maximum time drift that a server is allowed to adjust.

Default: *3600*

TimeSync_ServerType

Type of server for time synchronization, UDPTime or SNTP (Simple Network Time Protocol).

Default: *SNTP*

TimeSync_GroupIntervalSize

Interval according to which server responses will be grouped.

Default: *10*

TimeSync_TimeServerIP1

DNS hostname or IP Address of Timeserver 1.

Default: *none*

TimeSync_TimeServerIP2

DNS hostname or IP Address of Timeserver 2.

Default: *none*

TimeSync_TimeServerIP3

DNS hostname or IP Address of Timeserver 3.

Default: *none*

TimeSync_TimeZoneOffs

Time zone offset in minutes.

Default: *0*

TimeSync_DSTEnabled

Perform DST adjustment according to DSTOffs/DSTStartDate/DSTEndDate.

Default: *OFF*

TimeSync_DSTOffs

DST offset in minutes.

Default: *0*

TimeSync_DSTStartDate

What month and day DST starts, in the format MM-DD.

Default: *none*

TimeSync_DSTEndDate

What month and day DST ends, in the format MM-DD.

Default: *none*

12.20. DNS Client Settings

DNS_DNSServerIP1

Primary DNS Server.

Default: *none*

DNS_DNSServerIP2

Secondary DNS Server.

Default: *none*

DNS_DNSServerIP3

Tertiary DNS Server.

Default: *none*

12.21. Remote Administration Settings

NetConBiDirTimeout

When uploading a new configuration, CorePlus tries to establish bi-directional communication back to Clavister FineTune in order to guarantee Clavister Security Gateway reachability. This setting specifies how long to wait before CorePlus reverts to the previous configuration.

Default: *30 seconds*

NetConBeforeRules

For NetCon traffic to CorePlus: add an invisible rule to the IP rule set to allow Netcon traffic. If this setting is disabled then NetCon traffic will be subject to the IP rule set like any other traffic.

Default: *Enabled*

NetConMaxChannels

For NetCon traffic to CorePlus the following number of connections are guaranteed for each connection type:

- Consoles: 4
- Realtime loggers: 4
- Stat pollers: 4
- Receive contexts: 2
- Send contexts: 4

NetConMaxChannels is the maximum total allowed for all these connection types. This means that with the default value of 18, 2 extra connections are allowed and they can be of any of the above types.

Default: *18*

SNMPBeforeRules

For SNMP traffic to CorePlus: add an invisible rule to the IP rule set to verify SNMP traffic.

12.22. HTTP Poster Settings

HTTPPoster_URL1, HTTPPoster_URL2, HTTPPoster_URL3

The URLs specified here will be posted in order when CorePlus is loaded.

HTTPPoster_RepDelay

Delays in seconds until all URLs are refetcd.

Default: *604800*

12.23. Hardware Performance Settings

Ringsize_e1000_rx

Size of the rx buffer on e1000 cards.

Default: *64*

Ringsize_e1000_tx

Size of the tx buffer on e1000 cards.

Default: *256*

Ringsize_e100_rx

Size of the rx buffer on e100 cards.

Default: *32*

Ringsize_e100_tx

Size of the tx buffer on e100 cards.

Default: *128*

12.24. PPP/L2TP Settings

PPP_L2TPBeforeRules

Pass L2TP traffic sent to the Clavister Security Gateway directly to the L2TP Server without consulting the rule set.

Default: *Enabled*

PPP_PPTPBeforeRules

Pass PPTP traffic sent to the Clavister Security Gateway directly to the PPTP Server without consulting the rule set.

Default: *Enabled*

12.25. RADIUS Accounting Settings

AllowAuthIfNoAccountingResponse

If there is no response from a configured RADIUS accounting server when sending accounting data for a user that has already been authenticated, then enabling this setting means that the user will continue to be logged in.

Disabling the setting will mean that the user will be logged out if the RADIUS accounting server cannot be reached even though the user has been previously authenticated.

Default: *Enabled*

LogOutAccUsersAtShutdown

If there is an orderly shutdown of the Clavister Security Gateway by the administrator, then CorePlus will delay the shutdown until it has sent RADIUS accounting **STOP** messages to any configured RADIUS server.

If this option is not enabled, CorePlus will shutdown even though there may be RADIUS accounting sessions that have not be correctly terminated. This could lead to the situation that the RADIUS server will assume users are still logged in even though their sessions have been terminated.

Default: *Enabled*

MaxRadiusContexts setting

The maximum number of contexts allowed with RADIUS. This applies to RADIUS use with both accounting and authentication.

Default: *1024*

12.26. IDP

IDP_UpdateInterval

The number of seconds between automatic IDP signature updates. A value of 0 stops automatic updates.

Default: *43200 (=12 hours)*

12.27. Multicast Settings

AutoAddMulticastCoreRoute

This setting will automatically add core routes in all routing tables for the multicast IP address range 224.0.0.0/4. If the setting is disabled, multicast packets might be forwarded according to the default route.

Default: *Enabled*

IGMPBefore Rules

For IGMP traffic, by pass the normal IP rule set and consult the IGMP rule set.

Default: *Enabled*

IGMPMaxReqs

The maximum global number of IGMP messages to process each second.

Default: *1000*

IGMPRouterVersion

The IGMP protocol version that will be globally used on interfaces without a configured IGMP Setting. Multiple querying IGMP routers on the same network must use the same IGMP version. Global setting on interfaces without an overriding IGMP Setting.

Default: *IGMPv3*

IGMPLowestCompatibleVersion

IGMP messages with a version lower than this will be logged and ignored. Global setting on interfaces without an overriding IGMP Setting.

Default: *IGMPv1*

IGMPMaxReqsIf

The maximum number of requests per interface and second. Global setting on interfaces without an overriding IGMP Setting.

Default: *100*

IGMPreactToOwnQueries

The security gateway should always respond with IGMP Membership Reports, even to queries originating from itself. Global setting on interfaces without an overriding IGMP Setting.

Default: *Disabled*

IGMPRobustnessVariable

IGMP is robust to (IGMPRobustnessVariable - 1) packet losses. Global setting on interfaces without an overriding IGMP Setting.

Default: *2*

IGMPQueryInterval

The interval (ms) between General Queries sent by the device to refresh its IGMP state. Global setting on interfaces without an overriding IGMP Setting.

Default: *125,000 ms*

IGMPQueryResponseInterval

The maximum time (ms) until a host has to send a reply to a query. Global setting on interfaces without an overriding IGMP Setting.

Default: *10,000 ms*

IGMPStartupQueryInterval

The interval of General Queries (ms) used during the startup phase. Global setting on interfaces without an overriding IGMP Setting.

Default: *30,000 ms*

IGMPStartupQueryCount

The security gateway will send IGMPStartupQueryCount general queries with an interval of IGMPStartupQueryInterval at startup. Global setting on interfaces without an overriding IGMP Setting.

Default: *2*

IGMPLastMemberQueryInterval

The maximum time (ms) until a host has to send an answer to a group or group-and-source specific query. Global setting on interfaces without an overriding IGMP Setting.

Default: *5,000 ms*

IGMPUnsolicatedReportInterval

The time (ms) between repititions of an initial membership report. Global setting on interfaces without an overriding IGMP Setting.

Default: *1,000 ms*

12.28. Hardware Monitor Settings

HWM_PollInterval

Polling interval for Hardware Monitor which is the delay in milliseconds between reading of hardware monitor values. Minimum 100, Maximum 10000.

Default: *500 ms*

HWMMem_Interval

Memory polling interval which is the delay in minutes between reading of memory values. Minimum 1, Maximum 200.

Default: *15 mins*

HWMMem_LogRepetition

Should we send a log message for each poll result that is in the Alert, Critical or Warning level, or should we only send when a new level is reached. If True, a message is sent each time HWMMem_Interval is triggered If False, a message is sent when a value goes from one level to another.

Default: *False*

HWMMem_UsePercent

True if the memory monitor uses a percentage as the unit for monitoring, False if it uses Megabyte. Applies to HWMMem_AlertLevel, HWMMem_CriticalLevel and HWMMem_WarningLevel.

Default: *True*

HWMMem_AlertLevel

Generate an Alert log message if free memory is below this value. Disable by setting to 0. Maximum value is 10,000.

Default: *0*

HWMMem_CriticalLevel

Generate a Critical log message if free memory is below this value. Disable by setting to 0. Maximum value is 10,000.

Default: *0*

HWMMem_WarningLevel

Generate a Warning log message if free memory is below this value. Disable by setting to 0. Maximum value 10,000.

Default: *0*

AlarmRepeatInterval

The delay in seconds between alarms when a continuous alarm is used. Minimum 0, Maximum 10,000.

Default: *60 seconds*

12.29. Packet Re-assembly Settings

Packet re-assembly collects IP fragments into complete IP datagrams and, for TCP, reorders segments so that they are processed in the correct order and also to keep track of potential segment overlaps and to inform other subsystems of such overlaps. The associated settings limit memory used by the re-assembly subsystem.

Reassembly_MaxConnections

This setting specifies how many connections can use the re-assembly system at the same time. It is expressed as a percentage of the total number of allowed connections. Minimum 1, Maximum 100.

Default: *80*

Reassembly_MaxProcessingMem

This setting specifies how much memory that the re-assembly system can allocate to process packets. It is expressed as a percentage of the total memory available. Minimum 1, Maximum 100.

Default: *3*

12.30. Miscellaneous Settings

BufFloodRebootTime

As a final way out, CorePlus automatically reboots if its buffers have been flooded for a long time. This setting specifies this amount of time.

Default: *3600*

ScrSaveTime

The time in seconds before CorePlus automatically enables its screen saver for Software Series installation. The screen saver will automatically adapt its activity to the current CPU load of the system. During high loads, it will update once per second, consuming a fraction of a percent of CPU load.

Default: *300 seconds (5 minutes)*

HighBuffers

The number of buffers to allocate in RAM above the 1 MByte limit. When troubleshooting, raising this value can sometimes solve problems.

This setting requires a hardware restart for a new value to take effect. A reconfiguration is not sufficient.

Default: *3% of total available memory, with a lower limit of 1024*
Note that in addition to this there is always an extra 512 Kbytes allocated for buffers.

MaxPipeUsers

The maximum number of pipe users to allocate. As pipe users are only tracked for a 20th of a second, this number usually does not need to be anywhere near the number of actual users, or the number of statefully tracked connections. If there are no configured pipes, no pipe users will be allocated, regardless of this setting. For more information about pipes and pipe users, see chapter 10, Traffic Shaping.

Default: *512*

AVSW_Engine

Selects the Anti-Virus software scanning engine to use if hardware acceleration is not available.

Options:
Auto - Engine is selected automatically
DFA - Faster scanning engine
NFA - Engine that minimises memory usage

Default: *Auto*

Appendix A. Subscribing to Security Updates

Introduction

The CorePlus Intrusion Detection and Prevention (IDP) module, the Anti-Virus module, as well as the Web Content Filtering module, function by accessing the Clavister Service Provisioning Network. The following 3 CorePlus modules make use of this network:

- **Intrusion Detection and Prevention (IDP)** - A database of known threat signatures is stored locally in the Clavister Security Gateway. This local database needs to be updated regularly with the latest threat signatures by automatically downloading updates from the Clavister Service Provisioning Network.

- **Anti-Virus Scanning** - Like IDP, a database of known virus signatures is stored locally. This local database also needs to be updated regularly with the latest virus signatures by automatically downloading updates from the Clavister Service Provisioning Network.

- **Web Content Filtering** - accesses the database available on the Clavister Service Provisioning Network for each website accessed in order to categorize them and implement the chosen filtering policy. CorePlus caches already looked-up websites locally to maximise look-up performance.

To make use of any or all of these CorePlus features, a subscription for each one must be taken out. This an addition to the standard CorePlus license. This is done by:

1. Purchasing the required subscription from your Clavister reseller. A subscription can be purchased with a lifetime of 1 year or 3 years. Each subscription is recorded in the central Clavister customer license database and becomes associated with your overall Clavister license.

2. Once your purchase is logged, use the Clavister Customer Web or use the license management features of Clavister FineTune to update your Clavister Security Gateway license. This will cause the central Clavister database to be checked and your local Clavister Security Gateway license will be updated with the subscription information.

Important
Make sure that the DNS server addresses are set correctly so the Clavister Provisioning Network servers can be located by CorePlus.

Subscription renewal

When any subscription is approaching its expiry date, you will receive notification in the following ways:

- Clavister FineTune™ will display a reminder dialog.

- A reminder email will be sent by Clavister to the email address associated with the license.

- Providing a log server has been configured, a log message will be sent which indicates subscription renewal is required.

Renew the subscription in good time!
Make sure a subsscription is renewed well before the current subscription ends.

IDP and Anti-Virus Database Updating

These service operate by downloading "signature" patterns which are used by CorePlus to search for the most recently recognised security threats in Internet traffic as well as viruses in downloads.

New threats are being identified every day and the signature databases in these modules needs to be updated regularly. A subscription means that CorePlus will periodically access a central server and update the copy of the database on the local Clavister Security Gateway with the latest signatures. Database updates can involve as many as 20 signature changes or more in a single day.

By default CorePlus will check for updates every 12 hours. The frequency of checking for updates can be explicitly set. It can be set to zero if updates are not to be done automatically.

Database Console Commands

IDP and Anti-Virus (AV) databases can be controlled directly through a number of console commands.

Pre-empting Database Updates

An IDP database update can be forced at any time by using the command:

```
Cmd>  updatecenter -update idp
```

An Anti-Virus update can similarly be initiated with the command:

```
Cmd>  updatecenter -update av
```

Querying Update Status

To get the status of IDP updates use the command:

```
Cmd>  updatecenter -status idp
```

To get the status of AV updates:

```
Cmd>  updatecenter -status av
```

Querying Server Status

To get the status of the Clavister network servers use the command:

```
Cmd>  updatecenter -servers
```

Deleting Local Databases

Some technical problem in the operation of either IDP or the Anti-Virus modules may be resolved by deleting the database and reloading. For IDP this is done with the command

```
Cmd>  removedb idp
```

To remove the Anti-Virus database, use the command:

```
Cmd>  removedb av
```

Once removed, the entire system should be rebooted and a database update initiated. Removing the database is also recommended if either IDP or Anti-Virus is not used for longer periods of time.

Note: A pause can occur when updating

Anti-Virus database updates may require a couple of seconds to be optimized once an update is downloaded. This will cause the Clavister Security Gateway to sometimes momentarily pause in its operation. This behavior is normal. Deleting the databases can give rise to a similar pause.

Appendix B. CLI Reference

About

Brings up information pertaining to the version of the gateway core in use and a copyright notice.

Syntax: about

Example

```
Cmd> about
Clavister Security Gateway 8.50.00V
Copyright Clavister 2006. All rights reserved
SSH IPSEC Express SSHIPM version 5.1.1 library 5.1.1
Copyright 1997-2003 SSH Communications Security Ltd.
Build : Sep 22 2003
```

Access

Displays the contents of the Access configuration section.

Syntax: access

Example

```
Cmd> access
Source IP Address Access list (spoofing protection)
Default action is DROP
Symbolic Name  Action  Iface   Source Range
-------------  ------  ------  ------------------
ExpectIntnet   Expect  lan     192.168.123.0/24
ExpectExtnet   Expect  wan     194.2.1.0/24
ExpectWorld    Expect  wan     0.0.0.0/0
```

ARP

Displays ARP entries for the specified interface(s). Published, static as well as dynamic items are shown.

Syntax: arp [options] <interface pattern>

Options:
-ip <pattern> - Display only IP addresses matching <pattern>
-hw <pattern> - Display only hardware addresses matching <pattern>
-num <n> - Display only the first <n> entries per iface (default: 20)
-hashinfo - Display information on hash table health
-flush - Flush ARP cache of ALL interfaces
-flushif - Flush ARP cache of an iface

Example

```
Cmd>arp wan
ARP cache of iface wan
Dynamic 194.2.1.1 = 0020:d216:5eec Expire=141
```

ARPSnoop

Toggles the on-screen display of ARP queries. This command can be of great help in configuring the hardware, since it shows which IP addresses are heard on each interface.

Syntax: arpsnoop <interface pattern>

Toggle snooping on given interfaces.

Syntax: arpsnoop all

Snoop all interfaces.

Syntax: arpsnoop none

Disable all snooping.

Example

```
Cmd> arpsnoop all
ARP snooping active on interfaces: lan wan dmz
ARP on wan: gw-world requesting ip_wan
ARP on lan: 192.168.123.5 requesting ip_lan
```

Buffers

This command can be useful in troubleshooting;, for example if an unexpectedly large number of packets begin queuing or when traffic does not seem to be flowing for some inexplicable reason. By analyzing the contents of the buffers, it is possible to determine whether such traffic is making it to the Clavister Security Gateway at all.

Syntax: buffers

Brings up a list of most recently freed buffers.

Example

```
Cmd> buff
Displaying the 20 most recently freed buffers

RecvIf   Num Size Protocol Sender          Destination
------- ---- ---- -------- --------------- ----------------
wan     1224  121 UDP      192.168.3.183   192.168.123.137
lan      837  131 UDP      192.168.123.137 192.168.3.183
wan      474  112 UDP      192.168.3.183   192.168.123.137
wan      395   91 UDP      192.168.3.183   192.168.123.137
lan      419  142 UDP      192.168.123.137 192.168.3.183
wan      543  322 UDP      194.2.1.50      192.168.123.182
lan      962   60 UDP      192.168.123.182 194.2.1.50
lan      687   60 ARP      0080:ad87:e592  ffff:ffff:ffff
wan      268   88 UDP      192.168.3.183   192.168.123.137
lan      249  101 UDP      192.168.123.137 192.168.3.183
wan      219   60 TCP      193.12.33.105   192.168.123.12
lan      647   60 ARP      0010:a707:dd31  ffff:ffff:ffff
wan     1185   98 UDP      192.168.3.183   192.168.123.137
lan      912   98 UDP      192.168.123.137 192.168.3.183
wan      682  112 UDP      192.168.3.183   192.168.123.137
lan      544   60 TCP      192.168.123.12  194.2.1.50
lan      633   60 TCP      192.168.123.26  194.2.1.50
lan      447   60 TCP      192.168.123.25  194.2.1.50
lan      645   60 TCP      192.168.123.23  194.2.1.50
lan      643  123 UDP      192.168.123.137 192.168.3.183
```

Syntax: buffer <number>

Shows the contents of the specified buffer.

Example

```
Cmd> buff 1059
Decode of buffer number 1059
lan: Enet 0050:dadf:7bbf > 0003:325c:cc00 type 0x0800 len 1058
IP 192.168.123.10 -> 193.13.79.1 IHL:20
DataLen:1024 TTL:254 Proto:ICMP
ICMP Echo reply ID:6666 Seq:0
```

Syntax: buffer

Shows the contents of the most recently used buffer.

Example

```
Cmd> buff .
Decode of buffer number 1059
lan: Enet 0050:dadf:7bbf > 0003:325c:cc00 type 0x0800 len 1058
IP 192.168.123.10 -> 193.13.79.1 IHL:20
DataLen:1024 TTL:254 Proto:ICMP
ICMP Echo reply ID:6666 Seq:0
```

Certcache

Displays the contents of the certificate cache.

Syntax: certcache

CfgLog

Shows the results of the most recent reconfiguration or start up of the gateway. This text is the same as is shown on-screen during reconfiguration or start up.

Syntax: cfglog

Example

```
Cmd> cfglog
Configuration log:
Configuring from FWCore_N.cfg
Configuration done
Configuration "FWCore_N.cfg" (v153)
verified for bi-directional communication
```

Connections

Shows the last 20 connections opened through the Clavister Security Gateway. Connections are created when traffic is permitted to pass via Allow or NAT rules. Traffic permitted to pass under FwdFast is not included in this list. Each connection has two timeout values, one in each direction. These are updated when the gateway receives packets from each end of the connection. The value shown in the Timeout column is the lower of the two values.

Possible values in the State column include:
SYN_RECV TCP packet with SYN flag received
SYNACK_S TCP packet with SYN + ACK flags sent
ACK_RECV TCP packet with ACK flag received
TCP_OPEN TCP packet with ACK flag sent

FIN_RECV TCP packet with FIN / RST flag received
PING The connection is an ICMP ECHO connection
UDP The connection is a UDP connection
RAWIP The connection uses an IP protocol other than TCP, UDP or ICMP

Syntax: connections

Example

```
Cmd> conn
State Prot Source Destination Time
TCP_OPEN TCP wan:60.20.37.6:5432 dmz:wwwsrv:80 3600
SYN_RECV TCP wan:60.20.37.6:5433 dmz:wwwsrv:80 30
UDP_OPEN UDP lan:10.5.3.2:5433 dmz:dnssrv:53 50
```

Cpuid

Shows information regarding the CPU in the Clavister Security Gateway.

Syntax: cpuid

Example

```
Cmd> cpuid
Processor: Intel Pentium III, III Xeon, or Celeron
Brand ID: Intel Pentium III
Frequency: 996 Mhz
Family: 6
Model: 8
Stepping: 10
Vendor id: GenuineIntel
Type: Original OEM Processor
Feature flags:
fpu vme de pse tsc msr pae mce cx8 apic sep mtrr pge mca
cmov pat pse-36 psn mmx fxsr sse
Cache and TLB information:
0x01: Instruction TLB, 4K pages, 4-way set associative, 32 entries
0x02: Instruction TLB, 4M pages, fully associative, 2 entries
0x03: Data TLB, 4K pages, 4-way set associative, 64 entries
0x08: Instruction cache 16K, 4-way set associative, 32 byte line
0x04: Data TLB, 4M pages, 4-way set associative, 8 entries
0x0C: Data cache, 16K, 4-way set associative, 32 byte line size
```

Crashdump

Displays the contents of the file *crashdump.dmp* stored by CorePlus. The file contains critical diagnostic information which can help determine the reason for a critical system event.

Syntax: crashdump

For further explanation see Section 2.5.2, “Diagnostic Console Commands”.

Dconsole

Displays a list of event information that is useful in pinpointing the occurrence of critical system errors.

Syntax: dconsole

DHCP

Syntax: dhcp [options] <interface>

Options:
-renew - Force interface to renew its lease
-release - Force interface to release its lease

Example

```
Cmd> dhcp -renew wan
```

DHCPRelay

Show the contents of the DHCP-relay configuration section.

Syntax: dhcprelay [options]

Options:
-release ip - Releases the IP and removes associated routes from the Clavister Security Gateway.

Example

```
Cmd> dhcprelay
Content of the DHCP/BOOTP-relayer rule set; default action is IGNORE
# Act. Source HW-Filter Server Allowed
1 RELAY vlan1,vlan2.. * 192.168.0.10 192.168.0.100 - 192.168.0.120

Dynamically added routes for relayed DHCP leases
Iface Host-Route Local IP ProxyARP Expire
vlan2 192.168.0.101/32 internals 3539
vlan4 192.168.0.112/32 internals 3539
```

DHCPServer

Show the contents of the DHCP-server configuration section and active DHCP leases.

Syntax: dhcpserver [options]

Options:
-rules - Shows dhcp server rules
-leases - Shows dhcp server leases
-mappings - Shows dhcp server IP=>MAC mappings
-release - Releases an active or blacklisted IP

Example

```
Cmd> dhcpserver
Contents of the DHCP-Server rule set; default action is IGNORE
# Source Pool                    Gateway        DNS1           LTime
- ------ ----------------------- -------------- -------------- -----
1 lan    192.168.32.1-.39.1, ... 192.168.39.254 192.168.39.253 10800


Active DHCP sessions:
Rule Iface Client MAC     Client IP       Expire
---- ----- -------------- --------------  ------
1    lan   000f:3d0f:797a 192.168.32.212   10746
1    lan   0050:8df5:24a3 192.168.37.88    10700
1    lan   000f:3d3f:c409 192.168.34.96    10678
1    lan   000d:8802:61cd 192.168.34.175   10574
1    lan   000f:3d1f:a3cc 192.168.34.154   10549
1    lan   0030:f12e:587f 192.168.38.220   10529
```

Dnsbl

Enables monitoring and control of the DNSBL SPAM filtering subsystem in the SMTP ALG.

Syntax: dnsbl

Shows DNSBL status summary for all ALGs

Syntax: dnsbl -clean

Clears the DNSBL SPAM cache and processing statistics.

Syntax: dnsbl <alg_name> -clean

Clears the DNSBL SPAM cache and processing statistics for a specific ALG.

Syntax: dnsbl <alg_name> -show

Shows the DNSBL SPAM filtering status for a particular ALG.

DynRoute

Displays the dynamic routing policy filter rule set and current exports.

Syntax: dynroute [options]

Options:
-rules - Shows the dynamic policy filter rule set
-exports - Displays current exports

Frags

Shows the 20 most recent fragment reassembly attempts. This includes both ongoing and completed attempts.

Syntax: frags

Example

```
Cmd> frags
RecvIf Num State Source Destination Proto Next Timeout
lan 2 Done 10.5.3.2 26.23.5.4 ICMP 2000 58
wan 8 Accept 23.3.8.4 10.5.3.2 ICMP 1480 60
```

HA

Shows information about a HA cluster.

Syntax: ha

Example

```
Cmd> ha
This device is a HA SLAVE
This device is currently ACTIVE (will forward traffic)
HA cluster peer is ALIVE
```

HTTPPoster

Show the configured httpposter urls and status.

Syntax: httpposter [options]

Options:
-repost - Re-post all URLs now.

Example

```
Cmd> httpposter
HTTPPoster_URL1:
Host : ""
Port : 0
Path : ""
Post : ""
User : ""
Pass : ""
Status: (not configured)

HTTPPoster_URL2:
Host : ""
Port : 0
Path : ""
Post : ""
User : ""
Pass : ""
Status: (not configured)

HTTPPoster_URL3:
Host : ""
Port : 0
Path : ""
Post : ""
User : ""
Pass : ""
Status: (not configured)
```

Hwaccel

Shows which Anti-Virus/IDP acceleration hardware is installed (if any).

Syntax: hwaccel

Example

```
Cmd> hwaccel
Configured Hardware Accelerator
-------------------------------
Name:Lionic => Class:IPS => Driver:lc2350A =>> ID 0 -> Status = Run
-------------------------------
```

Ifacegroups

Shows the configured interface groups.

Syntax: ifacegroups <name pattern>

Example

```
Cmd> ifacegroups
Configured interface groups:
internals lan,vlan1,vlan2,vlan3
```

IfStat

Syntax: ifstat

Shows a list of the interfaces installed.

Example

```
Cmd> ifstat
Configured interfaces:
Iface IP Address     PBR membership  Interface type
----- ----------     --------------  ----------------------
core  127.0.0.1      <all>           Null (sink)
mgmt  10.9.0.36      <all>           Builtin e100 - Intel(R) 8255..
wan   172.16.87.252 <all>            Builtin e100 - Intel(R) 8255..
lan   192.168.121.1 <all>            Builtin e100 - Intel(R) 8255..
pptp  10.10.240.131 <all>            PPTP tunnel to 192.168.23.1
```

Syntax: ifstat <interface>

Shows hardware and software statistics for the specified NIC.

Example

```
Cmd> ifstat lan
Iface lan
Builtin e1000 - Intel(R) PRO/1000 T Server Adapter Slot 2/1 IRQ 5
Media : "1000BaseTx"
Speed : 1000 Mbps Full Duplex
MTU : 1500
Link Partner :
10BASE-T, 10BASE-T FD, 100BASE-TX, 100BASE-TX FD, 1000BASE-TX F
Bus Type : PCI 64-bit/33MHz
IP Address : 192.168.123.1
Hw Address : 00-03-47-ab-ea-25

Software Statistics:
Soft received : 193075 Soft sent : 212480 Send failures : 0
Dropped : 0 IP Input Errs : 0

Hardware statistics:
IN : packets= 193074 bytes=36524718 errors= 10 dropped= 10
OUT: packets= 212646 bytes=208065794 errors= 0 dropped= 0
Collisions : 0
In : Length Errors : 0
In : Overruns : 0
In : CRC Errors : 0
In : Frame Errors : 0
In : FIFO Overruns : 0
In : Packets Missed : 0
Out: Sends Aborted : 0
Out: Carrier Errors : 0
Out: FIFO Underruns : 0
Out: SQE Errors : 0
Out: Late Collisions : 0
```

The Dropped counter in the software section states the number of packets discarded as the result of structural integrity tests or rule set drops. The IP Input Errs counter in the software section specifies the number of packets discarded due to checksum errors or IP headers broken beyond recognition. The latter is most likely the result of local network problems rather than remote attacks.

Ikesnoop

Ikesnoop is used to diagnose problems with IPsec tunnels.

Syntax: ikesnoop

Display current ikesnoop status.

Syntax: ikesnoop off

Turn IKE snooping off.

Syntax: ikesnoop on [ipaddr]

Turn IKE snooping on, if an IP is specified then only IKE traffic from that IP will be shown.

Syntax: ikesnoop verbose [ipaddr]

Enable verbose output, if an IP is specified then only IKE traffic from that IP will be shown.

IPseckeepalive

Show the status of the configured IPsec keepalive connections.

Example

```
Cmd> ipseckeepalive
192.168.0.10->192.168.1.10: Consecutive lost: 0 sent: 908 lost: 2
192.168.1.10->192.168.0.10: Consecutive lost: 0 sent: 913 lost: 6
```

IPsectunnels

Display configured IPsec VPN connections.

Syntax: ipsectunnels

Example

```
Cmd>ipsectunnel
VPN Conns list
No Name Local Net Remote Net Remote GW
0 vpn-home 192.168.123.0/24 0.0.0.0/0 None
MAIN_MODE SA_PER_NET DONT_VERIFY_PAD IKE group: 2
IKE proplist: ike-default, IPsec proplist: esp-tn-roamingclients
```

IPsecstats

Display connected IPsec VPN gateways and remote clients.

Syntax: ipsecstats <options>

Options:
-u - Append SA usage
-num <n>

Example

```
Cmd> ipsecstats

--- IPsec SAs:

Displaying one line per SA-bundle

VPN Tunnel Local net        Remote net     Remote GW
---------- ---------------  -------------  --------------
```

```
vpn-home   192.168.123.0/24 192.168.1.2/32 192.168.1.2/32
```

Killsa

Kills all IPsec and IKE SAs for the specified IP-address.

Syntax: killsa <ipaddr>

Example

```
Cmd> killsa 192.168.0.2
Destroying all IPsec & IKE SAs for remote peer 192.168.0.2
```

License

Shows the content of the license-file. It is also possible to remove a license from a running system with this command, by doing a license remove.

Syntax: license [remove]

Example

```
Cmd> lic
Contents of the License file
----------------------------
Registration key: 1234-1234-1234-1234
Bound to MAC address: 00-48-54-00-3b-00
Company: Clavister AB
Registration date: 2002-11-20 00:00:00.000
Issued date: 2002-11-20 19:22:38
Last modified: 2002-11-20 19:22:27
New upgrades until: 2003-02-14 00:00:00.000
Ethernet Interfaces: 4
Max Connections: 128000
Max Routes: 2048
Max Rules: 16000
Max Throughput: 200
Max VPN Tunnels: 20
Max VLANs: 2048
```

Lockdown

Sets local lockdown on or off. During local lockdown, only traffic from admin nets to CorePlus itself is allowed. Everything else is dropped. Note: If local lockdown has been set by CorePlus itself due to licensing or configuration problems, this command will NOT remove the lock.

Syntax: lockdown [on | off]

Loghosts

Shows the list of log recipients CorePlus is configured to send log data to.

Syntax: loghosts

Example

```
Cmd> loghosts
Log hosts:
SysLog 192.168.123.10 Facility: local0
```

```
Usage logging in 3600 second intervals
```

Logout

Only works on the serial or local console, it is used to logout the current user and enable the password.

Syntax: logout

Memory

Displays core memory consumption. Also displays detailed memory use of some components and lists.

Syntax: memory

Netcon

Shows a list of users currently connected via the netcon protocol.

Syntax: netcon

Example

```
Cmd> netcon
Currently connected NetCon users:
Iface IP address port
lan 192.168.123.11 39495
```

Netobjects

Shows the contents of the Nets configuration section. If a Netobject is specified the output will show user authentication information associated with that object.

Syntax: netobjects [netobject]

Example

```
Cmd> netobjects
List of named network objects:
wannet 194.2.1.0/24
lannet 192.168.123.0/24
all-nets 0.0.0.0/0
ip_wan 194.2.1.2/32
br_wan 194.2.1.255/32
br_lan 192.168.123.255/32
ip_lan 192.168.123.1/32
gw-world 194.2.1.1/32
```

OSPF

Shows runtime information about the OSPF router processes) and is used to stop/start OSPF processes).

Syntax: ospf [<process name>] [<parameter>] [<argument>]

NOTE: <process name> is only required if there are more then one OSPF routing process

Options:
iface [<iface>] - Display interface information
area [<areaID>] - Display area information
neighbor [<if>:][<neiID>] - Display neighbor information
route, Display the internal OSPF process routingtable
database [verbose] - Display the LSA database
lsa <lsaID> - Display details for a specified LSA
snoop [on|off] - Display troubleshooting messages on the console
ifacedown <iface> - Takes specified interface offline
ifaceup <iface> - Takes specified interface online
stop - Stop OSPF process
start - Start OSPF process
restart - Restart OSPF process

Pcapdump

Enables packet capture on a specific interface. Packets can be dumped in a human readable form or saved to disk in PCAP format.

For further explanation see Section 2.5.3, “The pcapdump Command”.

Syntax: pcadump start [<interface>]

Start recording packets on the given interface.

Syntax: pcadump status

Show the status of the dump.

Syntax: pcapdump stop [<interface>]

Stop recording on the given interface.

Syntax: pcadump show [<interface>]

Show a captured packet summary.

Syntax: pcadump write [<filename>]

Send the output to a file in PCAP format.

Syntax: pcadump wipe

Remove all captured packets from memory.

Syntax: pcadump cleanup

Remove all captured packets, stop capture mode and delete all written capture files from disk.

Options:
-size <sizekb> - Size of buffer in Kbytes for captured packets. Default size is 512Kb.
-s <snaplen> - Maximum length of captured packets in bytes. Larger packets are truncated.
-o - Packet summary dumped to console in real-time.
-ou - Packet summary dumped to console in real-time without buffering.
-p - Set interface to promiscuous mode.

The **start** command may optionally include a *filter expression*. The filter expression can contain:

eth <addr> - a source or destination MAC address
ethsrc <addr> - a source MAC address
ethdest <addr> - a destination MAC address
ip <addr> - a source or destination IP address
ipsrc <addr> - a source IP address

ipdest <addr> - a destination IP address
port <addr> - a source or destination port number
srcport <addr> - a source port number
destport <addr> - a destination port number
proto <num> - Monitor a particular protocol where num is a protocol decimal number identifier.
<protocolname> - can be one of *tcp*, *udp* or *icmp*

Filter expressions may be combined on the command line to provide a multiple set of conditions.

Ping

Sends a specified number of ICMP Echo Request packets to a given destination. All packets are sent in immediate succession rather than one per second and this behavior is best suited for diagnosing connectivity problems. Pinging can optionally be done on specific ports using UDP or TCP.

Syntax: ping <IPAddr> [<options>] [<# of packets> [<size>]]

Options:
-r <recvif> - Run through the rule set, simulating that the packet was received by <recvif>
-s <srcip> - Use this source IP
-p <table> - Route using the specified PBR table
-v - Verbose ping
-t <ipaddress> -port <port> - Ping the specified IP address on the specified port using TCP
-u <ipaddress> -port <port> - Ping the specified IP address on the specified port using UDP

Example

```
Cmd> ping 192.168.12.1
Sending 1 ping to 192.168.12.1 from 192.168.14.19
using PBR table "main".
Echo reply from 192.168.12.1 seq=0 time= 10 ms TTL=255

Cmd> ping 192.168.12.1 -v
Sending 1 ping to 192.168.12.1 from 192.168.14.19
using PBR table "main".
... using route "192.168.12.0/22 via wan, no gw" in PBR table "main"
Echo reply from 192.168.12.1 seq=0 time=<10 ms TTL=255
```

Pipes

Shows the list of configured pipes; the contents of the Pipes configuration section, along with basic throughput figures of each pipe.

Syntax: pipes

Displays all configured pipes.

Example

```
Cmd>pipes
Configured pipes:
Name    Grouping   Bits/s Pkts/s Precedence
-----   ---------- ------------ -----------
std-in  Per DestIP               0 1 7
Current: 42.5 K 21.0
std-out Per SrcIP                0 1 7
Current: 89.1 K 21.0
```

Syntax: pipes <name>

Displays in-depth details about the given pipe.

Syntax: pipes -u <name>

Displays the 20 currently most active users of the given pipe.

Proplists

Lists the configured proposal lists.

Syntax: proplists [<vpnconn>]

Example

```
Cmd> propl
Displaying all configured proposal lists:
ike-default
Type : ISAKMP
Life : 5000KB, 43200s
Cipher : cast128-cbc
Hash : sha1
Type : ISAKMP
Life : 5000KB, 43200s
Cipher : cast128-cbc
Hash : md5
Type : ISAKMP
Life : 5000KB, 43200s
Cipher : 3des-cbc
Hash : sha1
Type : ISAKMP
Life : 5000KB, 43200s
Cipher : 3des-cbc
Hash : md5
esp-tn-lantolan
Type : ESP
Life : 50000KB, 21600s
Cipher : blowfish-cbc
Hmac : hmac-sha1-96
Type : ESP
Life : 50000KB, 21600s
Cipher : blowfish-cbc
Hmac : hmac-md5-96
Type : ESP
Life : 50000KB, 21600s
Cipher : cast128-cbc
Hmac : hmac-sha1-96
Type : ESP
Life : 50000KB, 21600s
Cipher : cast128-cbc
Hmac : hmac-md5-96
```

ReConfigure

Re-reads the FWCore.cfg file from disk. This process takes approximately one second if done from floppy disk, and approximately a tenth of a second from hard disk or flash disk. If there is a FWCore_N.cfg file present on the disk, this will be read instead. However, as there is no Clavister FineTune to attempt two-way communication with CorePlus, it will conclude that the configuration is incorrect and revert to FWCore.cfg after the bi-directional verification timeout period has expired (typically 30 seconds).

Syntax: reconfiure

Example

```
Cmd>reconfigure
Shutdown RECONFIGURE. Active in 1 seconds.
```

```
Shutdown reason: Reconfigure due to CLI command
```

Remotes

Shows the contents of the Remotes configuration section.

Syntax: remotes

Example

```
Cmd> remotes
Hosts/nets with remote control of gateway:
lan 192.168.0.12/32 Configure/Update Access
```

Routes

Displays information about the routing tables, contents of a (named) routing table or a list of routing tables, along with a total count of route entries in each table, as well as how many of the entries are single-host routes. Note that "core" routes for interface IP addresses are not normally shown, use the -all switch to show core routes also. In the "Flags" field of the routing tables, the following letters are used:
O: Learned via OSPF X: Route is Disabled
M: Route is Monitored A: Published via Proxy ARP
D: Dynamic (from, for example, DHCP relay, IPsec, L2TP/PPP servers, etc.)

Syntax: routes [<options>] [<table name>]

Options:
-all - Also show routes for interface addresses
-num <n> - Limit display to <n> entries (default: 20)
-nonhost - Do not show single-host routes
-tables - Display list of named (PBR) routing tables
-lookup <ip> - Lookup the route for the given IP address
-v - Verbose

Example

```
Cmd> routes
Flags Network          Iface  Gateway   Local IP Metric
----- ---------------- -----  --------- -------- -------
      192.168.12.0/22  lan                       0
      194.2.1.0/24     wan                       0
      0.0.0.0/0        wan    194.2.1.1          0

Cmd> routes -lookup 193.1.2.3
Looking up 193.1.2.3 in routing table "main":

Matching route: 0.0.0.0/0
Routing table : main
Send via iface: wan
Gateway : 194.2.1.1

Proxy ARP on :
Local IP : (use iface IP in ARP queries)
Metric : 0
Flags :
```

Rules

Shows the contents of the Rules configuration section.

Syntax: rules [<options>] [<range>]

Options:
-u - Append usage information
-l - Append logging information
-n - Append symbolic rule names
-p - Append pipe information
-a - Append all the information above

The range parameter specifies which rules to include in the output of this command.

Example

```
Cmd> rule -u 11-12
contents of rule set; default action is DROP
Act. Source Destination Protocol/Ports
1 Drop any:0.0.0.0/0 any:0.0.0.0/0 PORTS ALL > 135-139
Use: 0
2 Drop any:0.0.0.0/0 any:0.0.0.0/0 PORTS ALL > 445
Use: 0
```

Scrsave

Activates the screensaver included with CorePlus.

Syntax: scrsave

Example

```
Cmd>scr
Activating screen saver...
```

Services

Displays the list of named services. Services implicitly defined inside rules are not displayed.

Syntax: services [<name or wildcard>]

Settings

Shows the contents of the Settings configuration section.

Syntax: settings

Shows available groups of settings.

Example

```
Cmd>sett
Available categories in the Settings section:
IP - IP (Internet Protocol) Settings
TCP - TCP (Transmission Control Protocol) Settings
ICMP - ICMP (Internet Control Message Protocol) Settings
ARP - ARP (Address Resolution Protocol) Settings
State - Stateful Inspection Settings
ConnTimeouts - Default Connection timeouts
LengthLim - Default Length limits on Sub-IP Protocols
Frag - Fragmentation Settings
VLAN - VLAN Settings
```

```
SNMP - SNMP Settings
DHCP - DHCP (Dynamic Host Configuration Protocol) Settings
Log - Log Settings
Misc - Miscellaneous Settings
```

Syntax: settings <group_name>

Shows the settings of the specified group.

Example

```
Cmd> settings arp
ARP (Address Resolution Protocol) Settings
ARPMatchEnetSender : DropLog
ARPQueryNoSenderIP : DropLog
ARPSenderIP : Validate
UnsolicitedARPReplies : DropLog
ARPRequests : Drop
ARPChanges : AcceptLog
StaticARPChanges : DropLog
ARPExpire : 900 ARPExpireUnknown : 15
ARPMulticast : DropLog
ARPBroadcast : DropLog
ARPCacheSize : 4096 ARPHashSize : 512
ARPHashSizeVLAN : 64
```

Shutdown

Instructs CorePlus to perform a shutdown in a given number of seconds. It is not necessary to perform a shutdown before the system is powered off.

Syntax: shutdown <seconds>

If the <seconds> parameter is not specified then the default value is 5 seconds.

Example

```
Cmd> shutdown

Shutdown NORMAL. Active in 5 seconds.
Shutdown reason: Shutdown due to console command
```

Stats

Shows various vital stats and counters.

Syntax: stats

Example

```
Cmd> stats
Uptime : 10 days, 23:11:59
Last shutdown : Unknown reason ('shutdown.txt' is empty)
CPU Load : 6%
Connections : 4919 out of 32768
Fragments : 17 out of 1024 (17 lingering)
Buffers allocated : 1252
Buffers memory : 1252 x 2292 = 2802 KB
Fragbufs allocated : 16
Fragbufs memory : 16 x 10040 = 156 KB
Out-of-buffers : 0
```

```
ARP one-shot cache : Hits : 409979144 Misses : 186865338
Interfaces: Phys:2 VLAN:5 VPN:0
Access entries:18 Rule entries:75
Using configuration file "FWCore.cfg", ver 199
```

Sysmsgs

Show the contents of the OS sysmsg buffer.

Syntax: sysmsgs

Example

```
Cmd> sysmsg
Contents of OS sysmsg buffer:
2003-04-24 00:03:46 Boot device number is 0x80
2003-04-24 00:03:46 Available LowPoolMemory: 360424 Bytes
(LBlock: 360424 bytes)
2003-04-24 00:03:46 Available KernelPoolMemory: 1048560 bytes
(LBlock: 1048560 bytes)
2003-04-24 00:03:46 Available UserPoolMemory: 198868948 bytes
2003-04-24 00:03:46 Drive 0x00 present: (C/H/S/SC/M):
(0x50/0x2/0x12/0x24/0xb3f)
2003-04-24 00:03:46 Drive 0x80 present: (C/H/S/SC/M):
(0x3f2/0x10/0x33/0x330/0xc935f)
2003-04-24 00:03:46 Drive 0x80 is using a FAT-16 filesystem
2003-04-24 00:03:46 Firewall loader up and running!
```

Time

Displays the system date and time

Syntax: time <options>

Options:
-set <arg> - Set system local time (YYYY-MM-DD HH:MM:SS)
-sync - Synchronize time with timeserver(s) (specified in settings)
-force - Force synchronization regardless of the MaxAdjust setting

Uarules

Shows configured user authentication rules.

Syntax: uarules

Example

```
Cmd> uarules
Contents of the User Authentication rule set
#  Source Net         Agent    Auth source Authentication Server
-- ------------------ -------- ----------- ---------------------
1  lan:192.168.0.0/24 HTTPAuth RADIUS      FreeRadius
2  *:0.0.0.0/0        XAuth    RADIUS      IASRadius
```

Updatecenter

Displays Anti-Virus/IDP version and update information.

Syntax: updatecenter [options]

Options:
-update [av|idp] - force a database update now
-status [av|idp] - show update status
-removedb av|idp - delete the specified database
-servers - show information about autoupdate servers
-debugtestidp - invokes IDP test code (CAUTION: this sometimes may cause the hardware to freeze)

Example

```
Cmd>  updatecenter -status

Antivirus Signature Database
Database Version: 2 2008-01-22 15:02:27
HW Support: lc2350a
Hardware DB Version: Latest Full:2008-01-22 15:02:27 Patch:N/A
Status: Update server available
Next update scheduled for: 2008-01-25 05:11:00

IDP Signature Database
Database Version: 2 2006-10-04 10:13:18
HW Support: lc2350a
Hardware DB Version: Latest Full:2006-10-04 10:13:18 Patch:N/A
Status: Update server available
Next update scheduled for: 2008-01-25 05:11:00
```

Urlcache

Displays information related to the URL cache used by the Web Content Filtering function.

Syntax: urlcache [options]

Options:
-v - Verbose option to list all information
-c - Display the cache count
-hash - Display information regarding the hashing
-num <value> - List <value> entries in the cache
-serverstatus - Web Content Filtering server status
-connectserver - Connect to the Web Content Filtering Server. Provides a way to check connection.
-disconnectserver - Disconnect from the Web Content Filtering server. Provides a way to explicitly disconnect.

Userauth

Display information about authenticated users, known privileges.

Syntax: userauth [options]

Options:
-l - Displays a list of all authenticated users
-p - Displays a list of all known privileges (usernames and groups)
-r <ip> - Removes an authenticated user (=logout)

Example

```
Cmd> userauth -l
Currently authenticated users:
Login name: user1
User IP: 192.168.0.207 Idle Timeout: 1799
Privileges: members
```

```
Login name: user1
User IP: 192.168.0.214 Idle Timeout: 1800
Privileges: members

Login name: user2
User IP: 192.168.0.116 Idle Timeout: 1799
Privileges: members
```

Userdb

Syntax: Userdb <dbname> [<wildcard> or <username>]

Display user databases and their contents. If <dbname> is specified users configured in that user database will be shown. A wildcard can be used to only show users matching that pattern or if a username is specified information regarding that user will be shown.

Options:
-num - Displays the specified number of users (default 20)

Example

```
Cmd> userdb
Configured user databases:

Name       #users
---------- ------
LocalUsers      2

Cmd> userdb LocalUsers
Contents of user database LocalUsers:

Username  Groups  Static IP Remote Networks
--------- ------- --------- ---------------
bob       sales
alice     tech

Cmd> userdb LocalUsers bob
Information for bob in database LocalUsers:

Username : bob
Groups : sales
Networks :
```

VLan

Syntax: vlan

Shows information about configured VLANs.

Example

```
Cmd> vlan
VLANs:
vlan1 IPAddr: 192.168.123.1 ID: 1 Iface: lan
vlan2 IPAddr: 192.168.123.1 ID: 2 Iface: lan
vlan3 IPAddr: 192.168.123.1 ID: 3 Iface: lan
vlan4 IPAddr: 192.168.123.1 ID: 4 Iface: lan
```

Show information about specified VLAN.

Syntax: vlan <vlan>

Example

```
Cmd> vlan vlan1
VLAN vlan1
Iface lan, VLAN ID: 1
Iface : lan
IP Address : 192.168.123.1
Hw Address : 0003:474e:25f9
Software Statistics:
Soft received : 0 Soft sent : 0 Send failures : 0
Dropped : 0 IP Input Errs : 0
```

Appendix C. fwctl Command Options

A summary of the command options available for the **fwctl** console management tool is shown below. To use **fwctl** first open a console window in the local operating system, then type in the desired **fwctl** command. An example of command option usage is:

```
> fwctl --help
```

which would display the fwctl help text. This tool is available in versions for both Linux and Windows systems.

> ***Note***
> *Some later versions of **fwctl** may be named **fwctl**nn where "nn" indicates the tool's version number.*

Data Source options

```
       --adddsn       <dsn name> "<connect string>"
                      - Add a new datasource (directory).
       --rmdsn        <dsn name>
                      - Remove specified datasource.
       --listdsn      [--plain] [-d "<delim>"]
                      - List all available datasources.
   -l, --list         [--plain | -d "<delim>"] ["<pattern>"]
                      - List gateways.
   -d, --dumpdsn      <dsn name>
                      - Display contents of given DSN in tree view.
       --enabledsn      <dsn name>
                      - Enables datasource.
       --disabledsn      <dsn name>
                      - Disables datasource.
```

Upload/Download options

```
   -w, --cfgdownload  [-f <file>] <gateway>
                      - Download configuration file.
   -u, --cfgupload    [-v <version> | -f <file>] <gateway>
                      - Upload configuration file.
       --coreupload   <core file> <gateway>
                      - Upload (upgrade) gateway core.
       --fileupload   "<source>" "<destination>" <gateway>
                      - Upload any type of file.
       --uploadpkg    "<source>" <gateway>
                      - Uploads PKG package to gateway.
       --filedownload - Downloads specified file from gateway.
                      "<source>" ["<destination>"] <gateway>
```

> ***Note***
> *Note that **fwctl** is the only way to download files from the Clavister Security Gateway.*

Configuration management options

```
       --cfginfo      [-v <version>] <gateway>
```

```
                       - Display configuration information.
   -o, --checkout      <gateway>
                       - Mark gateway as "checked out"
   -t, --printcfg      [-v <version>] <gateway>
                       - Display most recent configuration file.
   -i, --checkin       [-c "<comments>"] <file> <gateway>
                       - Check in (save) given configuration file
       --undocheckout <gateway>
                       - Undo recent check out on given gateway.
       --checkoutlist [-u <user>] [-d "<delim>"]
                       - List checked-out gateways.
```

The gateway

```
       --changekeys    <gateway>
                       - Change gateway mgmt keys.
   -c, --console       [-t <secs>] <gateway>
                       - Open gateway console window.
   -r, --rtlog         <gateway>
                       - View real-time gateway log.
   -p, --ping          [-t <secs>] <gateway>
                       - Ping specified gateway.
   -e, --reconfigure   <gateway>
                       - Reconfigure specified gateway.
       --restart       [--nobidir] <gateway>
                       - Restart specified gateway.
       --reboot        <gateway>
                       - Hardware reboot of specified gateway.
   -s, --stats         --list [-d "<delim>">] <gateway>
                       - List available statistics entries.
   -s, --stats    [--count <n>] [--interval <secs>] [-d "<delim>"]
[--units]
                       [--nohdrs] [--rawcounters] <entries> <gateway>
                       - Display real-time gateway statistics.
```

Help options

```
   -v, --version       - Display version.
   -h, --help          - Display command summary.
```

Specifying which Clavister Security Gateway

When using **fwctl** for something such as a file download operation from the Clavister Security Gateway to the local Clavister FineTune™ workstation, it is necessary to specify which Clavister Security Gateway the command is being directed at. This is done by appending to the command line the option *<data-source>:<gateway-name>*. A file download operation might be:

```
> fwctl --filedownload remote.cap local.cap mydatasource:mygateway
```

It is necessary to specify the data source so that the Clavister Security Gateway can be uniquely identified and its management keys can also be found for secure communication.

The Clavister Security Gateway may be also specified using a unique path name to the *.efw* file for the Clavister Security Gateway.

```
> fwctl --filedownload remote.cap local.cap c:\pathto\mygateway.efw
```

The *.efw* contains all the management keys for the Clavister Security Gateway. It also tracks the checking-in and checking-out of the configuration.

Opening a Console

As listed above, the *--console* option will open a console window to the Clavister Security Gateway:

```
> fwctl --console mydatasource:mygateway
```

This console can then be used just as a Clavister FineTune console can.

Warning

Be careful with fwctl usage. Once the command is launched there is no "Undo" feature to roll back for example, an erroneous file upload and it will no ask for confirmation that files should be overwritten.

Appendix D. IDP Signature Groups

For IDP scanning, the following signature groups are available for selection. There is a version of each group under the three *Types* of **IDS**, **IPS** and **Policy**. For further information see Section 6.5, “Intrusion Detection and Prevention”.

Group Name	Intrusion Type
APP_AMANDA	Amanda, a popular backup software
APP_ETHEREAL	Ethereal
APP_ITUNES	Apple iTunes player
APP_REALPLAYER	Media player from RealNetworks
APP_REALSERVER	RealNetworks RealServer player
APP_WINAMP	WinAMP
APP_WMP	MS Windows Media Player
AUTHENTICATION_GENERAL	Authenticantion
AUTHENTICATION_KERBEROS	Kerberos
AUTHENTICATION_XTACACS	XTACACS
BACKUP_ARKEIA	Network backup solution
BACKUP_BRIGHTSTOR	Backup solutions from CA
BACKUP_GENERAL	General backup solutions
BACKUP_NETVAULT	NetVault Backup solution
BACKUP_VERITAS	Backup solutions
BOT_GENERAL	Activities related to bots, including those controlled by IRC channels
BROWSER_FIREFOX	Mozilla Firefox
BROWSER_GENERAL	General attacks targeting web browsers/clients
BROWSER_IE	Microsoft IE
BROWSER_MOZILLA	Mozilla Browser
COMPONENT_ENCODER	Encoders, as part of an attack.
COMPONENT_INFECTION	Infection, as part of an attack
COMPONENT_SHELLCODE	Shell code, as part of the attacks
DB_GENERAL	Database systems
DB_MSSQL	MS SQL Server
DB_MYSQL	MySQL DBMS
DB_ORACLE	Oracle DBMS
DB_SYBASE	Sybase server
DCOM_GENERAL	MS DCOM
DHCP_CLIENT	DHCP Client related activities
DHCP_GENERAL	DHCP protocol
DHCP_SERVER	DHCP Server related activities
DNS_EXPLOIT	DNS attacks
DNS_GENERAL	Domain Name Systems
DNS_OVERFLOW	DNS overflow attack
DNS_QUERY	Query related attacks
ECHO_GENERAL	Echo protocol and implementations
ECHO_OVERFLOW	Echo buffer overflow
FINGER_BACKDOOR	Finger backdoor
FINGER_GENERAL	Finger protocol and implementation
FINGER_OVERFLOW	Overflow for Finger protocol/implementation
FS_AFS	Andrew File System
FTP_DIRNAME	Directory name attack
FTP_FORMATSTRING	Format string attack

Group Name	**Intrusion Type**
FTP_GENERAL	FTP protocol and implementation
FTP_LOGIN	Login attacks
FTP_OVERFLOW	FTP buffer overflow
GAME_BOMBERCLONE	Bomberclone game
GAME_GENERAL	Generic game servers/clients
GAME_UNREAL	UnReal Game server
HTTP_APACHE	Apache httpd
HTTP_BADBLUE	Badblue web server
HTTP_CGI	HTTP CGI
HTTP_CISCO	Cisco Embedded Web Server
HTTP_GENERAL	General HTTP activities
HTTP_MICROSOFTIIS	HTTP Attacks specific to MS IIS web server
HTTP_OVERFLOWS	Buffer overflow for HTTP servers
HTTP_TOMCAT	Tomcat JSP
ICMP_GENERAL	ICMP protocol and implementation
IGMP_GENERAL	IGMP
IMAP_GENERAL	IMAP protocol/implementation
IM_AOL	AOL IM
IM_GENERAL	Instant Messenger implementations
IM_MSN	MSN Messenger
IM_YAHOO	Yahoo Messenger
IP_GENERAL	IP protocol and implementation
IP_OVERFLOW	Overflow of IP protocol/implementation
IRC_GENERAL	Internet Relay Chat
LDAP_GENERAL	General LDAP clients/servers
LDAP_OPENLDAP	Open LDAP
LICENSE_CA-LICENSE	License management for CA software
LICENSE_GENERAL	General License Manager
MALWARE_GENERAL	Malware attack
METASPLOIT_FRAME	Metasploit frame attack
METASPLOIT_GENERAL	Metasploit general attack
MISC_GENERAL	General attack
MSDTC_GENERAL	MS DTC
MSHELP_GENERAL	Microsoft Windows Help
NETWARE_GENERAL	NetWare Core Protocol
NFS_FORMAT	Format
NFS_GENERAL	NFS protocol/implementation
NNTP_GENERAL	NNTP implementation/protocol
OS_SPECIFIC-AIX	AIX specific
OS_SPECIFIC-GENERAL	OS general
OS_SPECIFIC-HPUX	HP-UX related
OS_SPECIFIC-LINUX	Linux specific
OS_SPECIFIC-SCO	SCO specific
OS_SPECIFIC-SOLARIS	Solaris specific
OS_SPECIFIC-WINDOWS	Windows specific
P2P_EMULE	eMule P2P tool
P2P_GENERAL	General P2P tools
P2P_GNUTELLA	Gnutella P2P tool
PACKINGTOOLS_GENERAL	General packing tools attack
PBX_GENERAL	PBX
POP3_DOS	Denial of Service for POP

Group Name	Intrusion Type
POP3_GENERAL	Post Office Protocol v3
POP3_LOGIN-ATTACKS	Password guessing and related login attack
POP3_OVERFLOW	POP3 server overflow
POP3_REQUEST-ERRORS	Request Error
PORTMAPPER_GENERAL	PortMapper
PRINT_GENERAL	LP printing server: LPR LPD
PRINT_OVERFLOW	Overflow of LPR/LPD protocol/implementation
REMOTEACCESS_GOTOMYPC	Goto MY PC
REMOTEACCESS_PCANYWHERE	PcAnywhere
REMOTEACCESS_RADMIN	Remote Administrator (radmin)
REMOTEACCESS_VNC-CLIENT	Attacks targeting at VNC Clients
REMOTEACCESS_VNC-SERVER	Attack targeting at VNC servers
REMOTEACCESS_WIN-TERMINAL	Windows terminal/Remote Desktop
RLOGIN_GENERAL	RLogin protocol and implementation
RLOGIN_LOGIN-ATTACK	Login attacks
ROUTER_CISCO	Cisco router attack
ROUTER_GENERAL	General router attack
ROUTING_BGP	BGP router protocol
RPC_GENERAL	RFC protocol and implementation
RPC_JAVA-RMI	Java RMI
RSYNC_GENERAL	Rsync
SCANNER_GENERAL	Generic scanners
SCANNER_NESSUS	Nessus Scanner
SECURITY_GENERAL	Anti-virus solutions
SECURITY_ISS	Internet Security Systems software
SECURITY_MCAFEE	McAfee
SECURITY_NAV	Symantec AV solution
SMB_ERROR	SMB Error
SMB_EXPLOIT	SMB Exploit
SMB_GENERAL	SMB attacks
SMB_NETBIOS	NetBIOS attacks
SMB_WORMS	SMB worms
SMTP_COMMAND-ATTACK	SMTP command attack
SMTP_DOS	Denial of Service for SMTP
SMTP_GENERAL	SMTP protocol and implementation
SMTP_OVERFLOW	SMTP Overflow
SMTP_SPAM	SPAM
SNMP_ENCODING	SNMP encoding
SNMP_GENERAL	SNMP protocol/implementation
SOCKS_GENERAL	SOCKS protocol and implementation
SSH_GENERAL	SSH protocol and implementation
SSH_LOGIN-ATTACK	Password guess and related login attacks
SSH_OPENSSH	OpenSSH Server
SSL_GENERAL	SSL protocol and implementation
TCP_GENERAL	TCP protocol and implementation
TCP_PPTP	Point-to-Point Tunneling Protocol
TELNET_GENERAL	Telnet protocol and implementation
TELNET_OVERFLOW	Telnet buffer overflow attack
TFTP_DIR_NAME	Directory Name attack
TFTP_GENERAL	TFTP protocol and implementation
TFTP_OPERATION	Operation Attack

Group Name	**Intrusion Type**
TFTP_OVERFLOW	TFTP buffer overflow attack
TFTP_REPLY	TFTP Reply attack
TFTP_REQUEST	TFTP request attack
TROJAN_GENERAL	Trojan
UDP_GENERAL	General UDP
UDP_POPUP	Pop-up window for MS Windows
UPNP_GENERAL	UPNP
VERSION_CVS	CVS
VERSION_SVN	Subversion
VIRUS_GENERAL	Virus
VOIP_GENERAL	VoIP protocol and implementation
VOIP_SIP	SIP protocol and implementation
WEB_CF-FILE-INCLUSION	Coldfusion file inclusion
WEB_FILE-INCLUSION	File inclusion
WEB_GENERAL	Web application attacks
WEB_JSP-FILE-INCLUSION	JSP file inclusion
WEB_PACKAGES	Popular web application packages
WEB_PHP-XML-RPC	PHP XML RPC
WEB_SQL-INJECTION	SQL Injection
WEB_XSS	Cross-Site-Scripting
WINS_GENERAL	MS WINS Service
WORM_GENERAL	Worms
X_GENERAL	Generic X applications

Appendix E. Verified MIME filetypes

Some CorePlus Application Layer Gateways (ALGs) have the optional ability to verify that the contents of a downloaded file matches the type that the filetype in the filename indicates. The filetypes for which MIME verification can be done are listed in this appendix and the ALGs to which this applies are:

- The HTTP ALG
- The FTP ALG
- The POP3 ALG
- The SMTP ALG

The ALGs listed above also offer the option to explicitly allow or block certain filetypes as downloads from a list of types. That list is the same one found in this appendix.

For a more detailed description of MIME verification and the filetype block/allow feature, see Section 6.2.2, “The HTTP ALG”.

Filetype extension	Application
3ds	3d Studio files
3gp	3GPP multimedia file
aac	MPEG-2 Advanced Audio Coding File
ab	Applix Builder
ace	ACE archive
ad3	Dec systems compressed Voice File
ag	Applix Graphic file
aiff, aif	Audio Interchange file
am	Applix SHELF Macro
arc	Archive file
alz	ALZip compressed file
avi	Audio Video Interleave file
arj	Compressed archive
ark	QuArk compressed file archive
arq	Compressed archive
as	Applix Spreadsheet file
asf	Advanced Streaming Format file
avr	Audio Visual Research Sound
aw	Applix Word file
bh	Blackhole archive format file
bmp	Windows Bitmap Graphics
box	VBOX voice message file
bsa	BSARC Compressed archive
bz, bz2	Bzip UNIX compressed file
cab	Microsoft Cabinet file
cdr	Corel Vector Graphic Drawing file
cgm	Computer Graphics Metafile
chz	ChArc compressed file archive
class	Java byte code
cmf	Creative Music file
core/coredump	Unix core dump

Filetype extension	Application
cpl	Windows Control Panel Extension file
dbm	Database file
dcx	Graphics Multipage PCX Bitmap file
deb	Debian Linux Package file
djvu	DjVu file
dll	Windows dynamic link library file
dpa	DPA archive data
dvi	TeX Device Independent Document
eet	EET archive
egg	Allegro datafile
elc	eMacs Lisp Byte-compiled Source Code
emd	ABT EMD Module/Song Format file
esp	ESP archive data
exe	Windows Executable
fgf	Free Graphics Format file
flac	Free Lossless Audio Codec file
flc	FLIC Animated Picture
fli	FLIC Animation
flv	Macromedia Flash Video
gdbm	Database file
gif	Graphic Interchange Format file
gzip, gz, tgz	Gzip compressed archive
hap	HAP archive data
hpk	HPack compressed file archive
hqx	Macintosh BinHex 4 compressed archive
icc	Kodak Color Management System, ICC Profile
icm	Microsoft ICM Color Profile file
ico	Windows Icon file
imf	Imago Orpheus module sound data
Inf	Sidplay info file
it	Impulse Tracker Music Module
java	Java source code
jar	Java JAR archive
jng	JNG Video Format
jpg, jpeg, jpe, jff, jfif, jif	JPEG file
jrc	Jrchive compressed archive
jsw	Just System Word Processor Ichitaro
kdelnk	KDE link file
lha	LHA compressed archive file
lim	Limit compressed archive
lisp	LIM archive data
lzh	LZH compressed archive file
md	MDCD compressed archive file
mdb	Microsoft Access Database
mid,midi	Musical Instrument Digital Interface MIDI-sequence Sound
mmf	Yamaha SMAF Synthetic Music Mobile Application Format
mng	Multi-image Network Graphic Animation
mod	Ultratracker module sound data
mp3	MPEG Audio Stream, Layer III
mp4	MPEG-4 Video file
mpg,mpeg	MPEG 1 System Stream , Video file

Filetype extension	Application
mpv	MPEG-1 Video file
Microsoft files	Microsoft office files, and other Microsoft files
msa	Atari MSA archive data
niff, nif	Navy Interchange file Format Bitmap
noa	Nancy Video CODEC
nsf	NES Sound file
obj, o	Windows object file, linux object file
ocx	Object Linking and Embedding (OLE) Control Extension
ogg	Ogg Vorbis Codec compressed WAV file
out	Linux executable
pac	CrossePAC archive data
pbf	Portable Bitmap Format Image
pbm	Portable Bitmap Graphic
pdf	Acrobat Portable Document Format
pe	Portable Executable file
pfb	PostScript Type 1 Font
pgm	Portable Graymap Graphic
pkg	SysV R4 PKG Datastreams
pll	PAKLeo archive data
pma	PMarc archive data
png	Portable (Public) Network Graphic
ppm	PBM Portable Pixelmap Graphic
ps	PostScript file
psa	PSA archive data
psd	Photoshop Format file
qt, mov, moov	QuickTime Movie file
qxd	QuarkXpress Document
ra, ram	RealMedia Streaming Media
rar	WinRAR compressed archive
rbs	ReBirth Song file
riff, rif	Microsoft Audio file
rm	RealMedia Streaming Media
rpm	RedHat Package Manager
rtf, wri	Rich Text Format file
sar	Streamline compressed archive
sbi	SoundBlaster instrument data
sc	SC spreadsheet
sgi	Silicon Graphics IRIS Graphic file
sid	Commodore64 (C64) Music file (SID file)
sit	StuffIt archives
sky	SKY compressed archive
snd, au	Sun/NeXT audio file
so	UNIX Shared Library file
sof	ReSOF archive
sqw	SQWEZ archive data
sqz	Squeeze It archive data
stm	Scream Tracker v2 Module
svg	Scalable Vector Graphics file
svr4	SysV R4 PKG Datastreams
swf	Macromedia Flash Format file
tar	Tape archive file

Filetype extension	Application
tfm	TeX font metric data
tiff, tif	Tagged Image Format file
tnef	Transport Neutral Encapsulation Format
torrent	BitTorrent Metainfo file
ttf	TrueType Font
txw	Yamaha TX Wave audio files
ufa	UFA archive data
vcf	Vcard file
viv	VivoActive Player Streaming Video file
wav	Waveform Audio
wk	Lotus 1-2-3 document
wmv	Windows Media file
wrl, vrml	Plain Text VRML file
xcf	GIMP Image file
xm	Fast Tracker 2 Extended Module , audio file
xml	XML file
xmcd	xmcd database file for kscd
xpm	BMC Software Patrol UNIX Icon file
yc	YAC compressed archive
zif	ZIF image
zip	Zip compressed archive file
zoo	ZOO compressed archive file
zpk	ZPack archive data
z	Unix compressed file

Appendix F. The OSI Framework

The Open Systems Interconnection Model defines a framework for inter-computer communications. It categorizes different protocols for a great variety of network applications into seven smaller, more manageable layers. The model describes how data from an application in one computer can be transferred through a network medium to an application on another computer.

Control of data traffic is passed from one layer to the next, starting at the application layer in one computer, proceeding to the bottom layer, traversing over the medium to another computer and then delivering up to the top of the hierarchy. Each layer handles a certain set of protocols, so that the tasks for achieving an application can be distributed to different layers and be implemented independently.

Figure F.1. The 7 layers of the OSI model

Layer number	Layer purpose
Layer 7	Application
Layer 6	Presentation
Layer 5	Session
Layer 4	Transport
Layer 3	Network
Layer 2	Data-Link
Layer 1	Physical

The different layers perform the following functions:

Application Layer
Defines the user interface that supports applications directly. Protocols: HTTP, FTP, DNS, SMTP, Telnet, SNMP, etc.

Presentation Layer
Translates the various applications to uniform network formats that the rest of the layers can understand.

Session Layer
Establishes, maintains and terminates sessions across the network. Protocols: NetBIOS, RPC, etc.

Transport Layer
Controls data flow and provides error-handling. Protocols: TCP, UDP, etc.

Network Layer
Performs addressing and routing. Protocols: IP, OSPF, ICMP, IGMP, etc.

Data-Link Layer
Creates frames of data for transmission over the physical layer and includes error checking/correction. Protocols: Ethernet, PPP, etc.

Physical Layer
Defines the physical hardware connection.

Alphabetical Index

D

E

F

G

T

U

W