D-Link®
Building Networks for People

Network Security Firewall User Manual

DFL-210/ 800/1600/ 2500
DFL-260/ 860

Ver. 1.05

Network Security Solution http://www.dlink.com

NetDefend

User Manual

DFL-210/260/800/860/1600/2500
NetDefendOS version 2.12

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Preface

Intended audience

The target audience for this reference guide is Administrators who are responsible for configuring and managing D-Link Firewalls which are running the NetDefendOS 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 subsections. Numbered subsections 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 section" link (such as: see) 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 is 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 this will appear in a box with a gray background:

```
gw-world:/>
```

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

Examples

Examples in the text are denoted by the header **Example** and appear with a gray background as shown below. They contain a CLI example and/or a Web Interface example as appropriate. (The accompanying "CLI Reference Guide" documents all CLI commands).

Example 1. Example notation

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

CLI
The Command Line Interface example would appear here. It would start with the command prompt followed by the command:

```
gw-world:/> somecommand someparameter=somevalue
```

Web Interface
The Web Interface actions for the example are shown here. They are typically a numbered list showing what items in the tree-view list at the left of the interface or in the menu bar or in a context menu need to be opened followed by information about the data items that need to be entered:

1. Go to **Item X > Item Y > Item Z**
2. Now enter:
   - **DataItem1:** datavalue1
   - **DataItem2:** datavalue2

Notes to the main text

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

Note

This indicates some piece of information that is an addition to the preceding text. It may concern something that is being emphasised 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. Product Overview

This chapter outlines the key features of NetDefendOS.

1.1. About D-Link NetDefendOS

D-Link NetDefendOS is the firmware, the software engine that drives and controls all D-Link Firewall products.

Designed as a network security operating system, NetDefendOS 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, NetDefendOS 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 NetDefendOS 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.

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

IP Routing

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

Address Translation

For functionality as well as security reasons, NetDefendOS 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*.

Firewalling

At the heart of the product, NetDefendOS features stateful inspection-based firewalling for common protocols such as TCP, UDP and ICMP. As an administrator, you have the possibility to define detailed firewalling policies based on source and destination network and interface, protocol, ports, user credentials, time-of-day and much more. Section 3.5, “The IP Rule-Set”, describes how to use the firewalling aspects of NetDefendOS.

Intrusion Detection and Prevention

To mitigate application-layer attacks towards vulnerabilities in services and applications, NetDefendOS 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 NetDefendOS, please see Section 6.3, “Intrusion Detection and Prevention”.

Anti-Virus

NetDefendOS features integrated gateway anti-virus functionality. Traffic passing through the gateway can be subjected to in-depth scanning for viruses, and attacking hosts can be blocked and black-listed at your choice. Section 6.4, “Anti-Virus”, provides more information about how to use the integrated anti-virus feature.

Web Content Filtering

NetDefendOS 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, please see Section 6.5, “Web Content Filtering”.

Virtual Private Networking

A device running NetDefendOS is highly suitable for participating in a Virtual Private Network (VPN). NetDefendOS 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. Virtual Private Networking is covered in detail by Chapter 9, *Virtual Private Networks*.

Traffic Management

With the support of Traffic Shaping, Threshold Rules and Server Load Balancing features, NetDefendOS is optimal for traffic management. The Traffic Shaping feature enables fine-granular limiting and balancing of bandwidth; Threshold Rules allows for implementing various types of thresholds where to alarm or limit network traffic, and Server Load Balancing enables a device running NetDefendOS to distribute network load to multiple hosts. Chapter 10, *Traffic Management*, provides more detailed information on the various traffic management capabilities.

Operations and Maintenance

To facilitate management of a NetDefendOS device, administrative control is enabled through a Web-based User Interface or via the Command Line Interface. In addition, NetDefendOS provides very detailed event and logging capabilities and support for monitoring using standards such as SNMP. For more information, please see Chapter 2, *Operations and Maintenance*.

ZoneDefense

NetDefendOS can be used to control D-Link switches using the ZoneDefense feature.

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

- The NetDefendOS CLI Guide which details all NetDefendOS console commands.
- The NetDefendOS Log Reference Guide which details all NetDefendOS log event messages.

These documents together form the essential documentation for NetDefendOS operation.

Note

High Availability, Anti-Virus, Web Content Filtering and ZoneDefense are not available with some models as specified in the chapters relating to those features.

1.2. NetDefendOS Architecture

1.2.1. State-based Architecture

The NetDefendOS 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 basically eliminates any possibility to detect and analyze complex protocols and enforce corresponding security policies.

A NetDefendOS device, on the contrary, will inspect and forward traffic on a per-connection basis. In other words, NetDefendOS is able to detect when a new connection is being established, and then keeps a small piece of information, a "state", for the entire life-length of that connection. By doing this, NetDefendOS is able to understand the context of the network traffic, which enables the device to perform in-depth traffic scanning, apply bandwidth management and much more. In addition, this approach provides high throughput performance with the added advantage of a design that is highly scalable.

1.2.2. NetDefendOS Building Blocks

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

Interfaces are the doorways for network traffic passing through, to or from the system. Without interfaces, a NetDefendOS 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.

The NetDefendOS 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 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 , representing specific protocol and port combinations. Also important objects are the Application Layer Gateway (ALG) objects, used for defining additional parameters on specific protocols such as HTTP, FTP, SMTP and H.323.

Finally, the various *rule-sets* are used for actually implementing the policies in the system. The most fundamental rule-set is the IP Rules, which is 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 IPS Rules controls the behavior of the intrusion prevention engine and so forth.

1.2.3. Basic Packet Flow

This section outlines the basic flow for packets received and forwarded by a NetDefendOS device. Please note that this description is simplified to ease the understanding 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 NetDefendOS Consistency Checker. The consistency checker performs a number of sanity checks on the packet, including validation of checksums, protocol flags, packet length and so forth. If the consistency checks fail, the packet gets dropped and the event is logged.

4. NetDefendOS 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, IP protocol and so forth.

   If a match cannot be found, a connection establishment process starts which includes steps 5 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. Also, the Virtual Routing Rules are 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. Basically, the following parameters are part of the matching process: Source and destination interfaces, source and destination network, IP protocol (TCP, UDP, ICMP etc), TCP/UDP ports or ICMP types and schedule (time-of-day).

   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 NetDefendOS 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 NetDefendOS 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, NetDefendOS 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, NetDefendOS 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 forth, to further analyze or transform the traffic.

    - If the contents of the packet is encapsulated (i.e. being IPsec, L2TP/PPTP or some other type of tunneled traffic), 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 NetDefendOS 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.

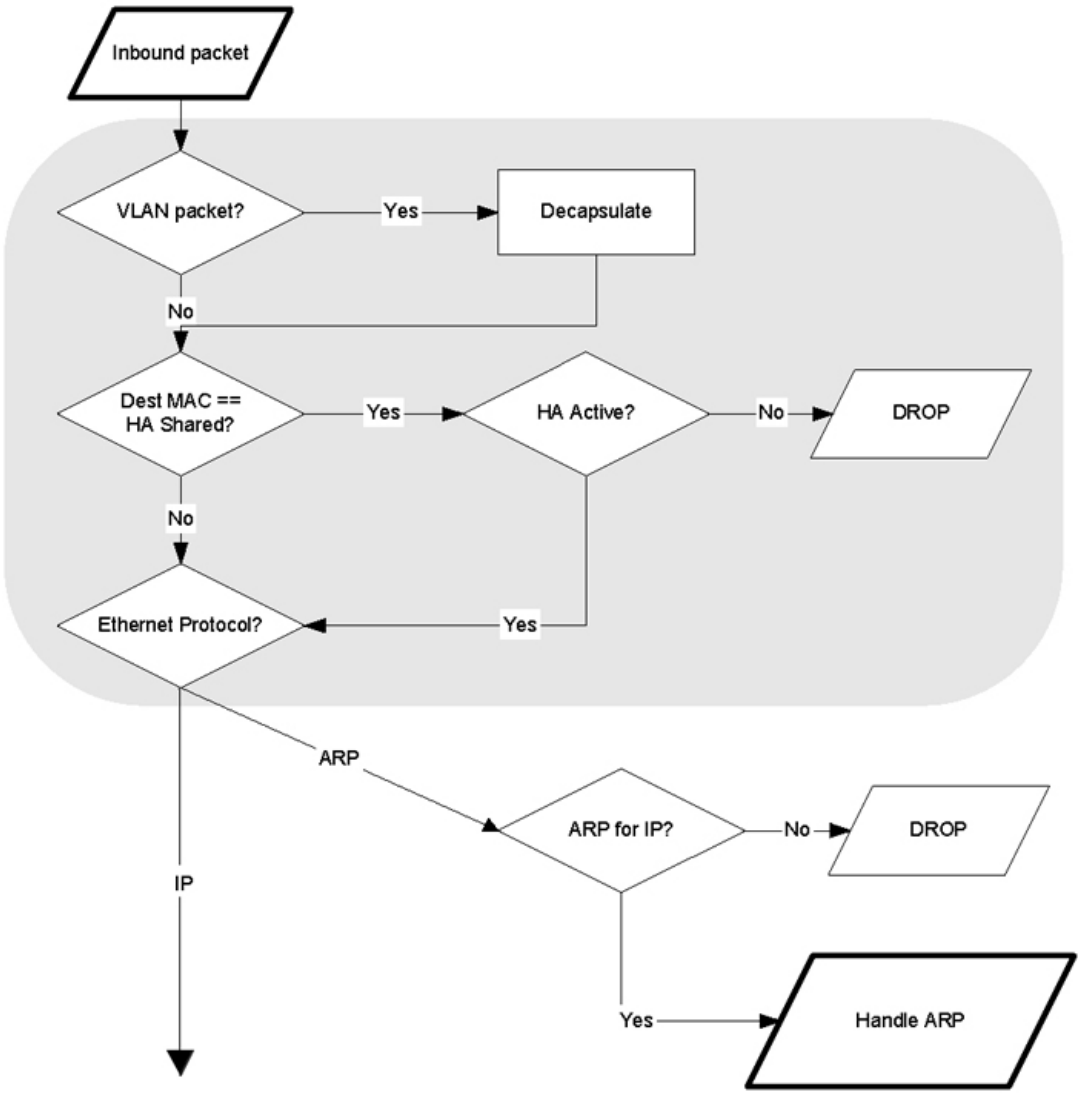
12. Eventually, the packet will be forwarded out on the destination interface according to the state. If the destination interface is a tunnel interface or a physical sub-interface, additional processing such as encryption, and encapsulation and so forth might occur.

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

1.3. NetDefendOS Packet Flow

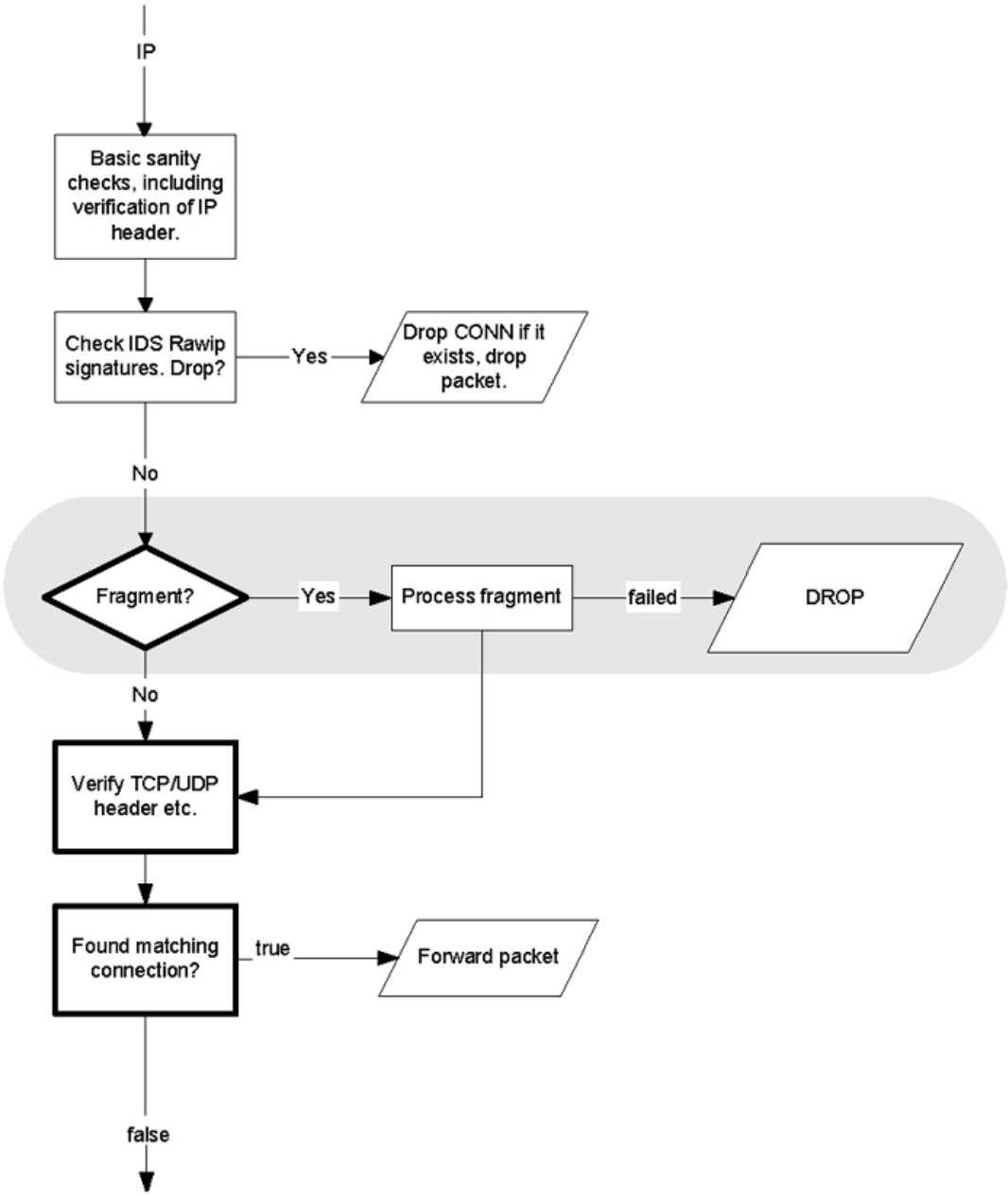
The diagrams in this section provide a summary of the flow of packets through the NetDefendOS state-engine. There are three diagrams, each flowing into the next.

Figure 1.1. Packet Flow Schematic Part I



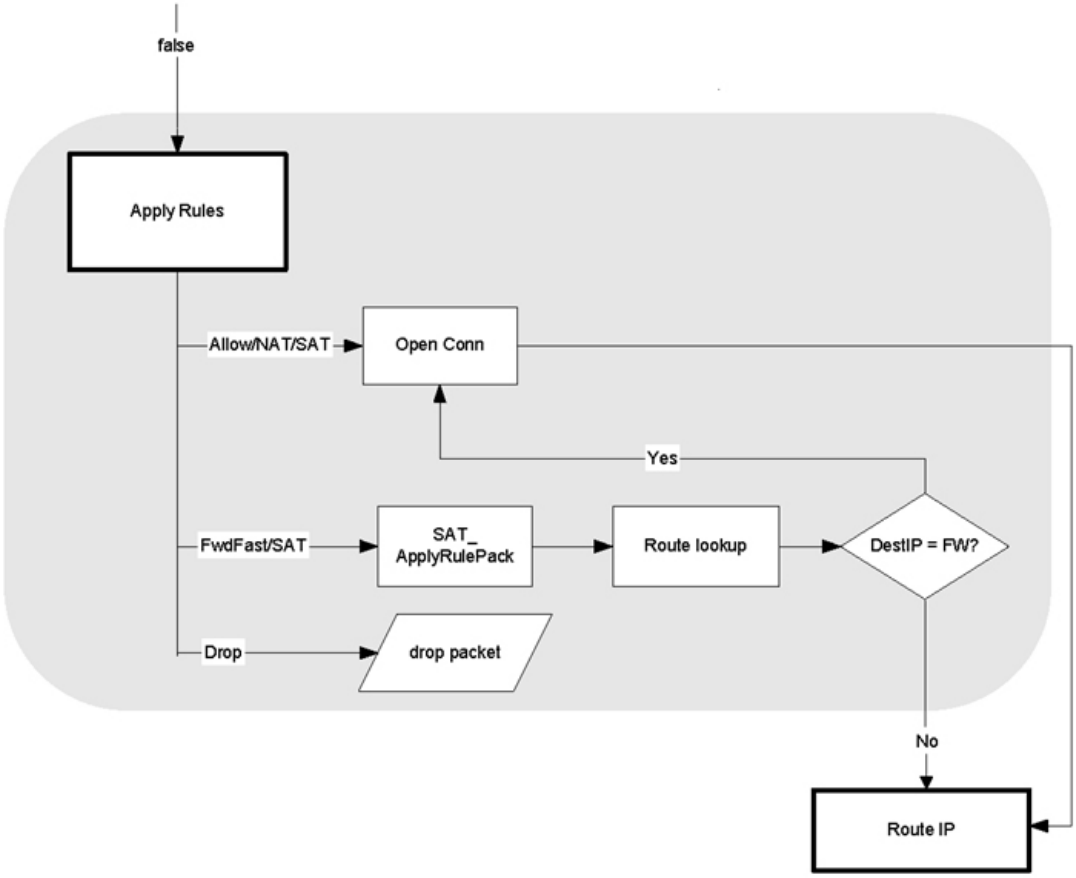
The packet flow is continued on the following page.

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



Chapter 2. Operations and Maintenance

This chapter describes the operations and maintenance related aspects of NetDefendOS.

2.1. Configuring NetDefendOS

2.1.1. Overview

NetDefendOS 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 NetDefendOS 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.

NetDefendOS provides the following management interfaces:

Web User Interface — The Web User Interface provides a user-friendly and intuitive graphical management interface, accessible from a standard web browser.

Command Line Interface (CLI) — The Command Line Interface, accessible locally via serial console port or remotely using the Secure Shell (SSH) protocol, provides the most fine-granular control over all parameters in NetDefendOS.

Note

Microsoft Internet Explorer and Firefox are the recommended web-browsers for the web interface. Other browsers may not provide full support.

Access to a management interface is regulated by a *remote management policy*, where you can restrict management access based on source network, source interface, credentials and so forth. The remote management policy provides a detailed and comprehensive control of all management capabilities. For instance, access to the web interface can be permitted to administrative users on a certain network, while at the same time allowing CLI access for a remote administrator connecting through a specific IPsec tunnel.

By default, Web User Interface access is enabled for users on the network connected via the LAN interface of the firewall (on products where more than one LAN interface is available, LAN1 is the default).

2.1.2. Default User Accounts

NetDefendOS offers several possibilities for storing user information, either using local user databases or external databases.

By default, NetDefendOS has a local user database, *AdminUsers*, with one user account pre-defined:

- Username *admin* with password *admin*.

The *admin* account has full administrative rights.

Important
For security reasons, it is highly recommended that you change the default password of the default account as soon as possible.

Extra user accounts can be created. These accounts can belong to the "Administrators" user group, in which case they have complete read/write access. Or a user can belong to the "Auditors" user group, in which case they have "read-only" access. For more detailed information about user authentication, please see Chapter 8, *User Authentication*.

2.1.3. Command Line Interface (CLI)

NetDefendOS provides a Command Line Interface (CLI) for administrators that prefer or require a command-line approach, or who need more granular control of system configuration. The CLI is available either locally through the serial console port, or remotely using the Secure Shell ("SSH") protocol.

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

For a complete reference to all CLI commands, please see the D-Link *CLI Reference Guide*.

2.1.3.1. CLI Access Methods

Serial Console Port

The serial console port is a RS-232 port that enables access to the CLI through a serial connection to a PC or terminal. To locate the serial console port on your D-Link system, please see the D-Link quickstart guide .

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

- A terminal or a (portable) computer with a serial port and the ability to emulate a terminal (i.e. using the Hyper Terminal software included in most Microsoft Windows installations). The serial console port uses the following default settings: *9600 baud, No parity, 8 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 NetDefendOS login prompt should appear on the terminal screen.

SSH (Secure Shell)

The SSH (Secure Shell) protocol can be used to access the CLI over the network from a remote host. SSH is a protocol primarily used for secure communication over insecure networks, providing strong authentication and data integrity.

NetDefendOS supports version 1, 1.5 and 2 of the SSH protocol.

SSH access is regulated by the remote management policy in NetDefendOS, and is disabled by default.

Example 2.1. Enabling SSH Remote Access

This example shows how to enable remote SSH access from the *lannet* network through the *lan* interface by adding a rule to the remote management policy.

CLI

```
gw-world:/> add RemoteManagement RemoteMgmtSSH ssh Network=lannet Interface=lan
            LocalUserDatabase=AdminUsers
```

Web Interface

1. Go to **System > Remote Management > Add > Secure Shell Management**
2. Enter a **Name** for the SSH remote management policy, e.g. ssh.
3. Select the following from the dropdown lists:
   - **User Database:** AdminUsers
   - **Interface:** lan
   - **Network:** lannet
4. Click **OK**.

2.1.3.2. Common CLI Operations

Logging on to the CLI

When access to the CLI has been established using one of the methods described in the earlier sections, you need to logon to the system before being able to execute any CLI command. This authentication step is needed to ensure that only trusted users can access the system, as well as providing user information for the audit mechanism.

The CLI uses the common user authentication mechanisms provided. In other words, local user databases as well as external user databases can be used to lookup user credentials for CLI access. For more information about user authentcation, please see section Chapter 8, *User Authentication*.

When accessing the CLI, the system will respond with the login prompt. Enter your username and press *Enter*, followed by your password and *Enter*. After a successful logon you will see the command prompt. If a welcome message has been set then it will be displayed directly after the logon:

```
gw-world:/>
```

For security reasons, it can be better to disable or anonymize the CLI welcome message.

Logging off from the CLI

After finishing working with the CLI, you should logout to avoid other people getting unauthorized access to the system. Log off by using the *exit* or the *logout* command.

2.1.4. Web Interface

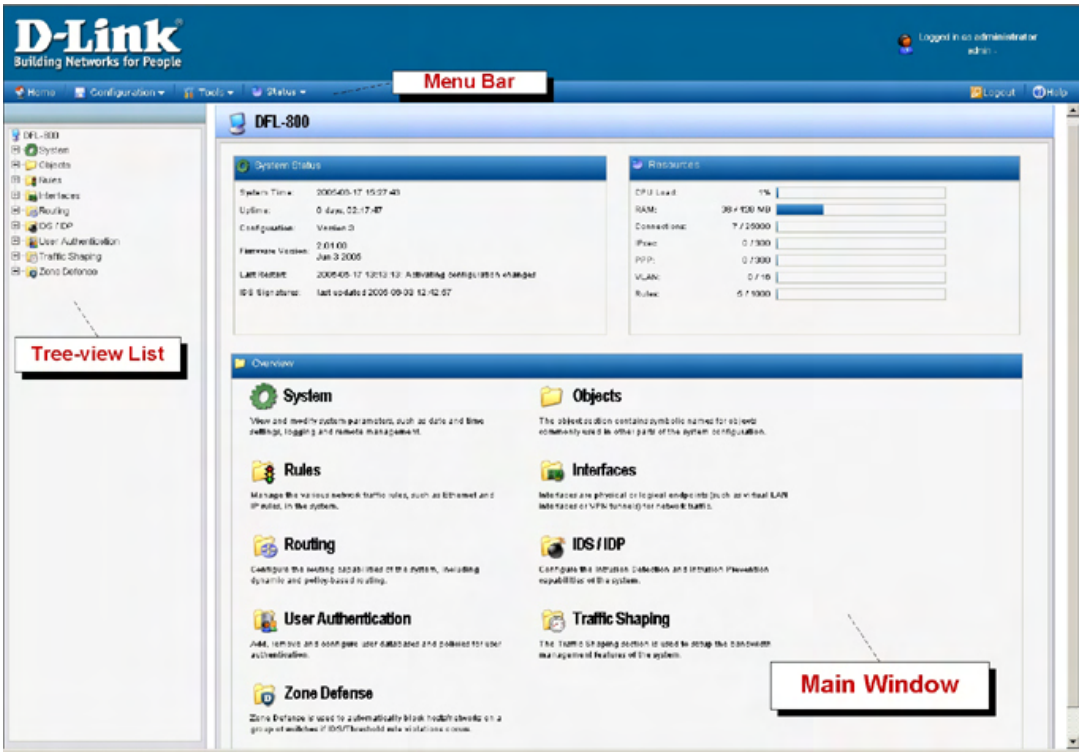
NetDefendOS provides a highly versatile web user interface for management of the system using a standard web browser. This allows you to perform remote management from virtually anywhere in the world without having to install any third-party clients.

2.1.4.1. Logging on to the Web Interface

To access the web interface, launch a standard web browser and point the browser at the IP address of the firewall. The factory default address for all D-Link Firewalls is *192.168.1.1*.

You MUST use **https://** as the protocol of the URL in the browser eg: **https://192.168.1.1** (https will protect the username and password with encryption when they are sent to NetDefendOS). A user authentication dialog like the one below will then be presented.

Enter your username and password and click the **Login** button. If the user credentials are correct, you will be transferred to the main web interface page. This page, with its essential parts highlighted, is shown below.



For information about the default user name and password, please see Section 2.1.2, “Default User Accounts”.

Note
Access to the web interface is regulated by the remote management policy. By default, the system will only allow web access from the internal network.

2.1.4.2. Interface Layout

The main web interface page is divided into three major sections:

Menu bar The menu bar located at the top of the web interface contains a number of buttons and drop-down menus that are used to perform configuration tasks as well as for navigation to various tools and status pages.

- **Home** - Navigates to the first page of the web interface.
- **Configuration**
  - **Save and Activate** - Saves and activates the configuration.
  - **Discard Changes** - Discards any changes made to the configuration during the current session.
  - **View Changes** - List the changes made to the configuration since it was last saved.
- **Tools** - Contains a number of tools that are useful for maintaining the system.
- **Status** - Provides various status pages that can be used for system diagnostics.
- **Maintenance**
  - **Update Center** - Manually update or schedule updates of the intrusion detection and antivirus signatures.
  - **License** - View license details or enter activation code.
  - **Backup** - Make a backup of the configuration to your local computer or restore a previously downloaded backup.
  - **Reset** - Restart the firewall or reset to factory default.
  - **Upgrade** - Upgrade the firewall's firmware.

Navigator The navigator located on the left-hand side of the web interface contains a tree representation of the system configuration. The tree is divided into a number of sections corresponding to the major building blocks of the configuration. The tree can be expanded to expose additional sections.

Main Window The main window contains configuration or status details corresponding to the section selected in the navigator or the menu bar.

2.1.4.3. Controlling Access to the Web Interface

By default, the web interface is accessible only from the internal network. If you need to enable access from other parts of the network, you can do so by modifying the remote management policy.

Example 2.2. Enabling remote management via HTTPS.

CLI

```
gw-world:/> add RemoteManagement RemoteMgmtHTTP https
            Network=all-nets Interface=any LocalUserDatabase=AdminUsers HTTPS=Yes
```

Web Interface

1. Go to **System > Remote Management > Add > HTTP/HTTPS Management**
2. Enter a **Name** for the HTTP/HTTPS remote management policy, e.g. https.
3. Check the **HTTPS** checkbox.
4. Select the following from the dropdown lists:
   - **User Database:** AdminUsers
   - **Interface:** any
   - **Network:** all-nets
5. Click **OK**.

Caution
The above example is provided for informational purposes only. It is never recommended to expose any management interface to any user on the Internet.

2.1.4.4. Logging out from the Web Interface

When you have finished working in the web interface, you should always logout to prevent other users with access to your workstation to get unauthorized access to the system. Logout by clicking on the **Logout** button at the right of the menu bar.

2.1.5. Working with Configurations

Configuration Objects

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 forth. 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 the web user interface the configuration objects are organized into a tree-like structure based on the type of the object.

In the CLI similar configuration object types are grouped together in a *category*. These categories are different from the structure used in the web user interface to allow quick access to the configuration objects in the CLI. The IP4Address, IP4Group and EthernetAddress types are, for instance, grouped in a category named *Address*, as they all represent different addresses. Consequently, Ethernet and VLAN objects are all grouped in a category named *Interface*, as they are all interface objects. The categories have actually no impact on the system configuration; they are merely provided as means to simplify administration.

Listing Configuration Objects

To find out what configuration objects exist, you can retrieve a listing of the objects.

Example 2.3. Listing Configuration Objects

This example shows how to list all service objects.

CLI

```
gw-world:/> show Service
```

A list of all services will be displayed, grouped by their respective type.

Web Interface

1. Go to **Objects > Services**
2. A web page listing all services will be presented.

A list contains the following basic elements:

- **Add Button** - Displays a dropdown menu when clicked. The menu will list all types of configuration items that can be added to the list.
- **Header** - The header row displays the titles of the columns in the list. The tiny arrow images next to each title can be used for sorting the list according to that column.
- **Rows** - Each row in the list corresponds to one configuration item. Most commonly, each row starts with the name of the object (if the item has a name), followed by values for the columns in the list.

A single row in the list can be selected by clicking on the row on a spot where there is no hyperlink. The background color of the row will turn dark blue. Right-clicking the row will bring up a menu where you can choose to edit or delete the object as well as modify the order of the objects.

Displaying a Configuration Object

The most simple operation on a configuration object is just to show its contents, in other words the values of the object properties.

Example 2.4. Displaying a Configuration Object

This example shows how to display the contents of a configuration object representing the *telnet* service.

CLI

```
gw-world:/> show Service ServiceTCPUDP telnet

          Property  Value
 -----------------  -------
             Name:  telnet
 DestinationPorts:  23
             Type:  TCP
      SourcePorts:  0-65535
         SYNRelay:  No
   PassICMPReturn:  No
              ALG:  (none)
      MaxSessions:  1000
         Comments:  Telnet
```

The Property column lists the names of all properties in the ServiceTCPUDP class and the Value column lists the corresponding property values.

Web Interface

1. Go to **Objects > Services**
2. Click on the **telnet** hyperlink in the list.
3. A web page displaying the telnet service will be presented.

Note

When accessing object via the CLI you can omit the category name and just use the type name. The CLI command in the above example, for instance, could be simplified to:

```
gw-world:/> show ServiceTCPUDP telnet
```

Editing a Configuration Object

When you need to modify the behavior of NetDefendOS, you will most likely need to modify one or several configuration objects.

Important

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

Example 2.5. Editing a Configuration Object

This example shows how to edit the *Comments* property of the *telnet* service.

CLI

```
gw-world:/> set Service ServiceTCPUDP telnet Comments="Modified Comment"
```

Show the object again to verify the new property value:

```
gw-world:/> show Service ServiceTCPUDP telnet

          Property  Value
 ----------------  -------
             Name:  telnet
 DestinationPorts:  23
             Type:  TCP
      SourcePorts:  0-65535
         SYNRelay:  No
   PassICMPReturn:  No
              ALG:  (none)
      MaxSessions:  1000
         Comments:  Modified Comment
```

Web Interface

1. Go to **Objects > Services**
2. Click on the **telnet** hyperlink in the list
3. In the **Comments** textbox, enter your new comment
4. Click **OK**

Verify that the new comment has been updated in the list.

Adding a Configuration Object

Example 2.6. Adding a Configuration Object

This example shows how to add a new *IP4Address* object, here using the IP address 192.168.10.10, to the Ad-

dress Book.

CLI

```
gw-world:/> add Address IP4Address myhost Address=192.168.10.10
```

Show the new object:

```
gw-world:/> show Address IP4Address myhost

              Property  Value
 --------------------  -------------
                  Name:  myhost
               Address:  192.168.10.10
       UserAuthGroups:  (none)
 NoDefinedCredentials:  No
             Comments:  (none)
```

Web Interface

1. Go to **Objects > Address Book**
2. Click on the **Add** button
3. In the dropdown menu displayed, select **IP4 Address**
4. In the **Name** text box, enter myhost
5. Enter 192.168.10.10 in the **IP Address** textbox
6. Click **OK**
7. Verify that the new IP4 address object has been added to the list

Deleting a Configuration Object

Example 2.7. Deleting a Configuration Object

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

CLI

```
gw-world:/> delete Address IP4Address myhost
```

Web Interface

1. Go to **Objects > Address Book**
2. Right-click on the row containing the **myhost** object.
3. In the dropdown menu displayed, select **Delete**.

The row will be rendered with a strike-through line indicating that the object is marked for deletion.

Undeleting a Configuration Object

A deleted object can always be restored until the configuration has been activated and committed.

Example 2.8. Undeleting a Configuration Object

This example shows how to restore the deleted IP4Address object shown in the previous example.

CLI

```
gw-world:/> undelete Address IP4Address myhost
```

Web Interface

1. Go to **Objects > Address Book**
2. Right-click on the row containing the **myhost** object.
3. In the dropdown menu displayed, select **Undo Delete**.

Listing Modified Objects

After modifying several configuration objects, you might want to see a list of the objects that were changed, added and removed since the last commit.

Example 2.9. Listing Modified Configuration Objects

This example shows how to list configuration objects that have been modified.

CLI

```
gw-world:/> show -changes

    Type           Object
    -------------  ------
 -  IP4Address     myhost
 *  ServiceTCPUDP  telnet
```

A "+" character in front of the row indicates that the object has been added. A "*" character indicates that the object has been modified. A "-" character indicates that the object has been marked for deletion.

Web Interface

1. Go to **Configuration > View Changes** in the menu bar.

A list of changes is displayed.

Activating and Committing a Configuration

When 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 NetDefendOS will attempt to initialize affected subsystems with the new configuration data.

Committing IPsec Changes

The adminstrator should be aware that if any changes that effect 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, NetDefendOS will wait for a short period (30 seconds by default) during which a connection to the administrator must be re-established. If the configuratin was activated via the CLI, a *commit* command must be issued within that period. If the connection could not be re-established or if the *commit* command was not issued, the system will revert to using the previous configuration. This is a powerful fail-safe mechanism as it will, amongst others things, prevent you from locking yourself out of the firewall when using a remote system.

Example 2.10. Activating and Committing a Configuration

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

CLI

```
gw-world:/> activate
```

The system will validate and start using the new configuration. When the command prompt is shown again:

```
gw-world:/> commit
```

The new configuration is now committed.

Web Interface

1. Go to **Configuration > Save and Activate** in the menu bar
2. Click **OK** to confirm

The web browser will automatically try to connect back to the web interface after 10 seconds. If the connection succeeds, this is interpreted by NetDefendOS that remote management is still working. The new configuration is then automatically committed.

Note

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 one of the most vital and fundamental features of a NetDefendOS system. Logging enables you not only to monitor system status and health, but also to audit the usage of your network as well as to assist you with debugging functionality.

NetDefendOS defines a number of *event messages*, which are generated as a result of corresponding system events. Examples of such events are establishment and teardown of connections, receiving malformed packets, dropping traffic according to filtering policies and so forth.

Whenever an event message is generated, it can be filtered and distributed to *Event Receivers* such as a Syslog receiver. . Multiple event receivers can be defined, with each event receiver having its own customizable event filter.

The sophisticated design of the event and logging mechanisms of NetDefendOS ensures that enabling logging is simple and straightforward, while it still allows a granular control of all the activities in the system for the more advanced deployments.

2.2.2. Event Messages

NetDefendOS 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 design, with attributes like category, severity, recommended actions and so forth. These attributes enable you to easily filter the event messages, either within NetDefendOS prior to sending them to an event receiver, or as part of the analysis taking place after logging and storing the messages on an external log server.

Note

A list of all event messages can be found in the Log Reference Guide. That guide also describes the design of event messages, and explains the various attributes available.

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.

NetDefendOS can distribute event messages using the following standards and protocols:

Memlog A D-Link Firewall has a built in logging mechanism known as the *Memory Log*. This retains all event log messages in memory and allows direct viewing of log messages through the web interface.

Syslog The de-facto standard for logging events from network devices. If you have other network devices logging to syslog hosts, you should consider using syslog from NetDefendOS as well to simplify your overall log administration.

2.2.3.1. Logging to Syslog Hosts

Syslog is a standardized protocol for sending log data to loghosts, although there is no standardized format of these log messages. The format used by NetDefendOS is well suited for automated processing, filtering and searching.

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

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, NetDefendOS 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 as the "Severity" field for D-Link Logger messages, however the ordering of the numbering is reversed.

Example 2.11. 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:

CLI

```
gw-world:/> add LogReceiverSyslog my_syslog IPAddress=195.11.22.55
```

Web Interface

1. Go to **System > Log and Event Receivers > Add > Syslog Receiver**
2. Specify a suitable name for the event receiver, for instance my_syslog.
3. Enter 195.11.22.55 in the **IP Address** textbox.
4. Select an appropriate facility in the **Facility** dropdown list. The facility name is commonly used as a filter parameter in most syslog daemons.
5. 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

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

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 NetDefendOS to implement user accounting.

The RADIUS protocol is based on a client/server architecture. The D-Link Firewall acts as the client of the RADIUS server, creating and sending requests to a dedicated server(s). In RADIUS terminology the firewall 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 NetDefendOS for user accounting. The benefits of having centralized servers are thus extended to user connection accounting. (For details of the usage of RADIUS for NetDefendOS authentication see Section 8.2, “Authentication Components”).

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 D-Link Firewall, NetDefendOS 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 NetDefendOS, acknowledging that the message has been received. The diagram below illustrates the message interaction.

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 NetDefendOS 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 NetDefendOS are:

- **Type** - Marks this AccountingRequest as signaling 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 D-Link Firewall.
- **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 NetDefendOS.

STOP Message Parameters

Parameters included in **STOP** messages sent by NetDefendOS 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 D-Link Firewall.
- **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 D-Link Firewall. 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 Ouput 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 NetDefendOS 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 NetDefendOS. Switching on the setting in NetDefendOS 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 NetDefendOS to deal with the event when the primary server is unreachable.

2.3.5. RADIUS Accounting Security

Communication between NetDefendOS 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 NetDefendOS 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 synched between the active and passive D-Link Firewalls. 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 lack of accounting information synching could occur if an active unit has an authenticated user for whom the associated connection times out before it is synched to 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 effected 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 (due to, for example, the accounting server will never be able to update its user statistics, but will most likely believe that the session is still active and this situation should be avoided.

In the case that the D-Link Firewall administrator issues a shutdown command while authenticated users are still online, the *AccountingRequest* **STOP** packet will potentially never be sent. To avoid this, NetDefendOS has the advanced setting **LogOutAccUsersAtShutdown**. This setting allows the administrator to explicitly specify that NetDefendOS 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'ed Networks

The User Authentication module in NetDefendOS 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 and which uses NAT to allow network access. This means that as soon as one user is authenticated, all users from the same network are also authenticated. NetDefendOS RADIUS Accounting will therefore gather statistics for all the users on the network together as though they were one user instead of individuals.

2.4. Maintenance

2.4.1. Reset to Factory Defaults

It is possible to apply the original defaults that existed when the D-Link Firewall was purchased. These defaults can be applied only to the current configuration or to the entire hardware unit. The latter option essentially restores the unit to the state it was in when it left the factory.

Example 2.12. Reset to Factory Defaults with the standard user interface

Web Interface

1. Go to **Maintenance > Reset**
2. Select **Reset the configuration to Factory Defaults** then confirm and wait for the restore to complete, OR
3. Select **Reset the entire unit to Factory Defaults** then confirm and wait for the restore to complete.

Reset alternative via the Serial Console

Connect the serial cable and connect with a console using a terminal emulator software product. If Microsoft Windows is being used, "HyperTerminal" can be used. Reset the firewall. Press a key when the "Press any key to abort and load boot menu" message appears at the console. When the boot menu appears, select the desired option then confirm and wait for the process to complete.

Reset alternative for the DFL-210/260/800/860 only

To reset the DFL-210/260/800/860 you must hold down the reset button at the rear panel for 10-15 seconds while powering on the unit. After that, release the reset button and the DFL-210/800 will continue to load and startup in default mode, i.e. with 192.168.1.1 on the LAN interface.

Reset alternatives for the DFL-1600 and DFL-2500 only

Press any key on the keypad when the "Press keypad to Enter Setup" message appears on the display. Select "Reset firewall", confirm by selecting "Yes" and wait for the process to complete.

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

2.4.2. Configuration Backup and Restore

The configuration of D-Link Firewalls can be backed up or restored on demand. This could, for instance, be used to recall the "last known good" configuration when experimenting with different configuration setups.

Example 2.13. Configuration Backup and Restore

Web Interface
To create a backup of the currently running configuration:

1. Go to **Tools > Backup**
2. **Download configuration**, select a name and begin backup.

To restore a configuration backup:

1. Go to **Tools > Backup**
2. In **Restore unit's configuration** browse and locate the desired backup.
3. Click **Upload configuration** and then choose to activate that configuration.

Note
Backups include only static information in the firewall configuration. Dynamic information such as the DHCP server lease database will not be backed up.

2.4.3. Auto-Update Mechanism

A number of the NetDefendOS 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 D-Link maintains a global infrastructure of servers providing update services for D-Link Firewalls. To ensure availability and low response times, NetDefendOS employs a mechanism for automatically selecting the most appropriate server to supply updates.

For more details on these features see the following sections:

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

Chapter 3. Fundamentals

This chapter describes the fundamental logical objects upon which NetDefendOS is built. These logical objects include such things as addresses, services and schedules. In addition, this chapter explains how the various supported interfaces work, it outlines how 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, a range of IP addresses or 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 forth. 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 *wwwsrv1* with IP address *192.168.10.16* to the Address Book:

CLI

```
gw-world:/> add Address IP4Address wwwsrv1 Address=192.168.10.16
```

Web Interface

1. Go to **Objects > Address Book > Add > IP address**
2. Specify a suitable name for the IP host, for instance wwwwsrv1.
3. Enter 192.168.10.16 in the **IP Address** textbox.
4. 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:

CLI

```
gw-world:/> add Address IP4Address wwwsrvnet Address=192.168.10.0/24
```

Web Interface

1. Go to **Objects > Address Book > Add > IP address**
2. Specify a suitable name for the IP network, for instance wwwsrvnet.
3. Enter 192.168.10.0/24 in the **IP Address** textbox.
4. 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*:

CLI

```
gw-world:/> add Address IP4Address wwwservers Address=192.168.10.16-192.168.10.21
```

Web Interface

1. Go to **Objects > Address Book > Add > IP address**
2. Specify a suitable name for the IP Range, for instance wwwservers.
3. Enter 192.168.10.16-192.168.10.21 in the **IP Address** textbox.
4. Click **OK**.

Example 3.4. Deleting an Address Object

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

CLI

```
gw-world:/> delete Address IP4Address wwwsrv1
```

Web Interface

1. Go to **Objects > Address Book**
2. Select and right-click the address object *wwwsrv1* in the grid.
3. Choose **Delete** in the menu.
4. Click **OK**.

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.

Example 3.5. Adding an Ethernet Address

The following example adds an Ethernet Address object named *wwwsrv1_mac* with a numerical MAC address of *08-a3-67-bc-2e-f2*:

CLI

```
gw-world:/> add Address EthernetAddress wwwsrv1_mac Address=08-a3-67-bc-2e-f2
```

Web Interface

1. Go to **Objects > Address Book > Add > Ethernet Address**
2. Specify a suitable name for the Ethernet Address object, e.g. wwwsrv1_mac.
3. Enter 08-a3-67-bc-2e-f2 in the **MAC Address** textbox.
4. Click **OK**.

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 forth. 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, two IP Address objects are pre-defined; one object for the IP address of the actual interface, and one object representing the local network for that interface.

Interface IP address objects are named *interfacename*_ip and network objects are named *interfacename*net. As an example, an interface named *lan* will have an associated interface IP object named *lan_ip* and a network object named *lannet*.

Default Gateway — An IP Address object named *wan_gw* is auto-generated and represents the default gateway of the system. The wan_gw object is used primarily by the routing table, but is also used by the DHCP client subsystem to store gateway address information aquired from an DHCP server. If a default gateway address has been provided during the setup phase, the wan_gw object will contain that address. Otherwise, the object will be left empty (i.e. the IP address being 0.0.0.0).

all-nets — The *all-nets* IP address object is initialized to the 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.

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 are simple objects in that they cannot carry out any action in the system on their own. Instead, Service objects are used frequently by the various system policies. 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 firewall. For more information on how service objects are being used in policies, please see Section 3.5, “The IP Rule-Set”.

A great number of Service objects comes pre-defined with the NetDefendOS. These include common services such as HTTP, FTP, Telnet and SSH. These pre-defined services can be used and also modified just like user-defined Services. However it is advisable not to make any changes to pre-defined services, but instead create new ones with the desired parameters.

Example 3.6. Listing the Available Services

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

CLI

```
gw-world:/> show Service
```

The output will look similar to the following listing:

```
ServiceGroup

   Name          Comments
   ------------  --------------------------------------------------
   all_services  All ICMP, TCP and UDP services
   all_tcpudp    All TCP and UDP services
   ipsec-suite   The IPsec+IKE suite
   l2tp-ipsec    L2TP using IPsec for encryption and authentication
   l2tp-raw      L2TP control and transport, unencrypted
   pptp-suite    PPTP control and transport

ServiceICMP
...
```

Web Interface

1. Go to **Objects > Services**

Example 3.7. Viewing a Specific Service

To view a specific service in the system:

CLI

```
gw-world:/> show Service ServiceTCPUDP echo
```

The output will look similar to the following listing:

```
          Property  Value
 -----------------  ----------------
```

```
            Name:  echo
 DestinationPorts:  7
            Type:  TCPUDP (TCP/UDP)
     SourcePorts:  0-65535
   PassICMPReturn:  No
             ALG:  (none)
     MaxSessions:  1000
        Comments:  Echo service
```

Web Interface

1. Go to **Objects > Services**
2. Select the specific service object in the grid control.
3. A grid listing all services will be presented.

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.

To define a TCP or UDP service in the D-Link Firewall, 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 forth. For this type of services, 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 not used just for destination ports. Source port definitions can follow the same conventions, although it is most usual that the source ports are left as their default values, namely 0-65535, which matches all possible source ports.

Example 3.8. Adding a TCP/UDP Service

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

CLI

```
gw-world:/> add Service ServiceTCPUDP MySQL DestinationPorts=3306 Type=TCP
```

Web Interface

1. Go to **Objects > Services > Add > TCP/UDP service**
2. Specify a suitable name for the service, for instance MySQL.
3. Now enter:
   - **Type:** TCP
   - **Source:** 0-65535
   - **Destination:** 3306
4. 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 D-Link Firewall 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, please see Section 6.2, “Application Layer Gateways”.

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 NetDefendOS 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.

NetDefendOS supports these types of IP protocols by the concept of *Custom IP Protocol Services*. Basically, 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 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 3.9. Adding a IP Protocol Service

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

CLI

```
gw-world:/> add Service ServiceIPProto VRRP IPProto=112
```

Web Interface

1. Go to **Objects > Services > Add > IP protocol service**
2. Specify a suitable name for the service, for instance VRRP.
3. Enter 112 in the **IP Protocol** control.
4. Preferably, enter Virtual Router Redundancy Protocol in the **Comments** control.
5. Click **OK**.

3.3. Interfaces

3.3.1. Overview

An **Interface** is one of the most important logical building blocks in NetDefendOS. 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).

NetDefendOS 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 NetDefendOS-based product. Thus, all network traffic that originates from or is terminated in the system will eventually pass through any of the physical interfaces.

NetDefendOS currently supports *Ethernet* as the only physical interface type. For more information about Ethernet interfaces, please 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*.

NetDefendOS 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, “Virtual LAN”.
- *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.

NetDefendOS 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 9.2.1, “IPsec Basics”.
- *PPTP/L2TP* interfaces are used as end-points for PPTP or

L2TP tunnels. For more information about PPTP/L2TP, please see Section 9.4, “PPTP/L2TP”.

Even though the various types of interfaces are very different in the way they are implemented and how they work, NetDefendOS treats all interfaces as logical IP interfaces. This means that all types of interfaces can be used almost interchangeably in the various subystems 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 NetDefendOS 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, NetDefendOS provides two special logical interfaces named **core** and **any**:

- **any** represents all possible interfaces including the **core** interface
- **core** indicates that it is NetDefendOS itself that will deal with the traffic. Examples of the use of **core** would be when the D-Link Firewall 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**, NetDefendOS will then know that it is itself that is the ultimate destination of the traffic.

3.3.2. Ethernet

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 a D-Link Firewall 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.

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 NetDefendOS.

3.3.2.1. Ethernet Interface Basics

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 inteface named wan and so forth.

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

The startup process will enumerate all available Ethernet interfaces. Each interface will be given a name of the form lanN, wanN and dmz, where N represents the number of the interface if your D-Link Firewall has more than one of these interfaces. In most of the examples in this guide lan is used for LAN traffic and wan is used for WAN traffic. If your D-Link Firewall does not have these interfaces, please substitute the references with the name of your chosen interface.

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”.

Tip

Multiple IP addresses can be specified for an Ethernet interface by using the ARP Publish feature. (See section Section 3.4, “ARP”).

In addition to the interface IP address, a *Network* address is also specified for the Ethernet interface. The Network address provides information to NetDefendOS about what IP addresses are directly reachable through the interface, i.e. residing on the same LAN segment as the interface itself. In the routing table associated with the interface, NetDefendOS will automatically create a direct route to the specified network over the actual interface.

Default Gateway

Optionally, a *Default Gateway* address can be specified for an Ethernet interface. This setting tells NetDefendOS how to reach hosts for which no routes exist. In other words, if a Default Gateway address has been specified, NetDefendOS will automatically create a default route (destination network 0.0.0.0/0) over the actual interface using the specified gateway. For natural reasons, only one Ethernet interface at a time can be assigned a default gateway.

3.3.2.2. Using DHCP on Ethernet Interfaces

NetDefendOS includes a DHCP client for dynamic assignment of address information. The information that can be set using DHCP includes the IP 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”.

Example 3.10. Enabling DHCP

CLI

```
gw-world:/> set Interface Ethernet wan DHCPEnabled=Yes
```

Web Interface

1. Go to **Interfaces > Ethernet**
2. In the grid, click on the ethernet object of interest.

3. Check the **Enable DHCP client** control.
4. Click **OK**.

3.3.3. Virtual LAN

NetDefendOS is fully compliant with the IEEE 802.1Q specification for Virtual LANs. On a protocol level, Virtual LANs work by adding a Virtual LAN identifier (VLAN ID) to the Ethernet frame header. The VLAN ID is a number from 0 to 4095 and is used to identify a specific Virtual LAN. In this way, Ethernet frames can belong to different Virtual LANs, but still share the same physical media.

The Virtual LAN support in NetDefendOS works by defining one or more *Virtual LAN interfaces*. Each Virtual LAN interface is interpreted as a logical interface by the system.

Ethernet frames received by the system are examined for a VLAN ID. If a VLAN ID is found, and a matching Virtual LAN interface has been defined, the system will consider that interface to be the receiving interface for the frame before further processing takes place.

Virtual LANs are useful in several different scenarios, for instance, when filtering is needed between different Virtual LANs in an organization, or when the number of interfaces needs to be expanded. For more information about the latter, please see the section Using Virtual LANs to expand firewall interfaces below.

Note

The number of Virtual LAN interfaces that can be defined in the system is determined by the particular product license you have.

Example 3.11. Defining a virtual LAN

This example defines a virtual LAN using 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.

CLI

```
gw-world:/> add Interface VLAN VLAN10 Ethernet=lan Network=all-nets VLANID=10
```

Web Interface

1. Go to **Interfaces > VLAN > Add > VLAN**
2. Specify a suitable name for the VLAN, for instance VLAN10.
3. Now enter:
   - **Interface:** lan
   - **VLAN ID:** 10
   - **Network:** all-nets
4. Click **OK**.

3.3.4. PPPoE

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 provider 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

3.3.4.1. Overview of PPP

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.

Authentication is an option with PPP. Authentication protocols supported are Password Authentication Protocol (PAP), Challenge Handshake Authentication Protocol (CHAP), 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 firewall needs to use one of the normal Ethernet interfaces to run PPPoE over. Each PPPoE Tunnel is interpreted as a logical interface by the NetDefendOS, 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 firewall 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 NetDefendOS 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 NetDefendOS 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 NetDefendOS 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 firewall 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 3.12. Configuring a PPPoE client on the wan interface with traffic routed over PPPoE.

CLI

```
gw-world:/> add Interface PPPoETunnel PPPoEClient EthernetInterface=wan
            Network=all-nets Username=exampleuser Password=examplepw
```

Web Interface

1. Go to **Interfaces > PPPoE > Add > PPoE Tunnel**
2. Then enter:
   - **Name:** PPPoEClient
   - **Physical Interface:** wan
   - **Remote Network:** all-nets (as we will route all traffic into the tunnel)
   - **Service Name:** Service name provided by the service provider
   - **Username:** Username provided by the service provider
   - **Password:** Password provided by the service provider
   - **Confirm Password:** Retype the password
   - **Authentication** You can specify exactly which authentication protocol to use. The default settings will be used if not specified.
   - **Enable dial-on-demand** Disable
   - **Advanced** If "Add route for remote network" is enabled, a new route is added for the interface.
3. 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. Interface Groups

Multiple NetDefendOS 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.

Example 3.13. Creating an Interface Group

CLI

```
gw-world:/> add Interface InterfaceGroup examplegroup Members=exampleif1,exampleif2
```

Web Interface

1. Go to **Interfaces > Interface Groups > Add > InterfaceGroup**
2. Enter the following information to define the group:
   - **Name:** The name of the group to be used later
   - **Security/Transport Equivalent:** 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
   - **Interfaces:** Select the interfaces to be in the group
3. 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 D, *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. A higher level protocols like IP uses IP addresses which are fundamentally different from a lower level hardware addressing scheme like the MAC address. ARP is used to get the Ethernet address of a host from its IP address. When a host needs to resolve an IP address to its 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 NetDefendOS

NetDefendOS provides not only standard support for ARP, but also adds a number of security checks on top of the protocol implementation. As an example, NetDefendOS 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".

NetDefendOS 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 NetDefendOS 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.

3.4.3. ARP Cache

The *ARP Cache* is the temporary table in NetDefendOS 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, NetDefendOS 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** spe-

cifies how long NetDefendOS is to remember addresses that cannot be reached. This is done to ensure that NetDefendOS does not continously request such addresses. The default value for this setting is 3 seconds.

Displaying the ARP Cache

Example 3.14. Displaying the ARP Cache

The contents of the ARP Cache can be displayed from within the CLI.

CLI

```
gw-world:/> arp -show
ARP cache of iface lan
  Dynamic 10.4.0.1      = 1000:0000:4009   Expire=196
  Dynamic 10.4.0.165    = 0002:a529:1f65   Expire=506
```

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 NetDefendOS 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, NetDefendOS 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 basically delete all dynamic ARP entries from the cache, thereby forcing NetDefendOS to issue new ARP queries.

Example 3.15. Flushing the ARP Cache

This example shows how to flush the ARP Cache from within the CLI.

CLI

```
gw-world:/> arp -flush
ARP cache of all interfaces flushed.
```

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 firewall, it might be necessary to adjust this value. This can be done by by modifying the Adavnced 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

NetDefendOS supports defining static ARP entries (static binding of IP addresses to Ethernet ad-

dresses) 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 3.16. 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:

CLI

```
gw-world:/> add ARP Interface=lan IP=192.168.10.15 Mode=Static
            MACAddress=4b-86-f6-c5-a2-14
```

Web Interface

1. Go to **Interfaces > ARP > Add > ARP**
2. Select the following from the dropdown lists:
   - **Mode:** Static
   - **Interface:** lan
3. Enter the following:
   - **IP Address:** 192.168.10.15
   - **MAC:** 4b-86-f6-c5-a2-14
4. Click **OK**.

Published ARP Entries

NetDefendOS supports *publishing* ARP entries, meaning that you can define IP addresses (and optionally Ethernet addresses) for an interface. NetDefendOS 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 NetDefendOS 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 NetDefendOS interface.

Another use is publishing multiple addresses on an external interface, enabling NetDefendOS 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

In the configuration of ARP entires, addresses may only be published one at a time. However, you can use the ProxyARP feature to handle publishing of entire networks (see Section 4.2.3, "Proxy ARP").

3.4.5. Advanced ARP 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. Most can be found in the WebUI by going to **ARP > 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 NetDefendOS 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 the firewall, 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, NetDefendOS 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, NetDefendOS will normally not allow this.

To make the behavior compliant with the RFC 826 specification, the administrator can modify the Adavnced Setting **ARPRequests**. Even if **ARPRequests** is set to "Drop", meaning that the packet is discarded without being stored, the system will, provided that other rules approve the request, reply to it.

Changes to the ARP Cache

NetDefendOS provides a few settings controlling how to manage changes to the ARP cache.

Possibly, a received ARP reply or ARP request would alter an existing item 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 NetDefendOS will not accept the new address until the previous ARP cache entry has timed out.

The Advanced Setting **ARPChanges** can be adjusted to change the behavior. The default behaviour is that NetDefendOS will allow changes to take place, but all such changes will be logged.

Another, similar, situation is where information in ARP replies or ARP requests would collide with static entries in the ARP cache. Naturally, this is never allowed to happen. However, changing the Adavnced Setting **StaticARPChanges** allow the administrator to specify whether or not such situations are to be logged.

Sender IP 0.0.0.0

NetDefendOS can be configured on 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. Normally, these ARP replies are dropped and logged, but the behavior can be changed by modifying the Advanced Setting **ARPQueryNoSenderIP**.

Matching Ethernet Addresses

By default, NetDefendOS 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. Change the behavior by modifying the Advanced Setting **ARPMatchEnetSender**.

3.5. The IP Rule-Set

3.5.1. Overview

Security policies designed by the administrator regulate the way in which network applications are protected against abuse and inappropriate use. NetDefendOS provides an array of mechanisms and logical constructs to help with the building of such policies for attack prevention, privacy protection, identification, and access control.

The IP Rule-set is at the heart of creating NetDefendOS security policies. The IP Rule-set determines the essential filtering functions of NetDefendOS, regulating what is allowed or not allowed to pass through the D-Link Firewall, and how address translation, bandwidth management and traffic shaping are applied to the traffic flow.

Once logical constructs such as Application Layer Gateways are created, they won't have any effect on traffic flow until they are used somewhere in the IP Rule-set. Understanding how to define the IP Rule-set is crucial to understanding how to create overall security policies. A good understanding is also important since ambiguous or faulty IP rules can lead to breaches in security.

There are two essential stances which describe the underlying philosophy of the IP Rule-set and NetDefendOS security policies in general:

- Everything is denied unless specifically permitted
- Everything is permitted unless specifically denied

In order to provide the highest possible security, **Drop** is the default policy of the IP Rule-set (everything is denied). The default of dropping packets can be achieved without an explicit IP rule that does this. For logging purposes however, it is recommended that the IP Rule-set has a **DropAll** rule with logging enabled placed as the last rule in the rule-set.

3.5.2. Rule Evaluation

When a new TCP/IP connection is being established through the D-Link Firewall, the list of IP rules are evaluated from top to bottom until a rule that matches the parameters of that new connection is found. Those parameters include, amongst others, the source IP address and the destination IP address plus the source interface and the destination interface. The rule's **Action** is then carried out by NetDefendOS.

If the action is **Allow** then the establishment of the new connection will be permitted. Furthermore, an entry or "state" representing that new connection is added to the NetDefendOS's internal "state table" which allows monitoring of opened and active connections passing through the firewall. If, instead, the action were **Drop**, the new connection will be refused.

The First Matching Principle

If several rules match the connections parameters, the first matching rule in the scan from top to bottom of the list, is the rule that decides what will happen with the connection (the exception to this being SAT rules).

After initial rule evaluation of the opening connection, subsequent packets belonging to a 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 connections, but also, by means of "pseudo-connections", to stateless protocols such UDP and ICMP as well. 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 performance.

3.5.3. IP Rule components

A rule consists of two logical parts: the connection parameters and the action to take if there is a match with those parameters.

Rule parameters are pre-defined and reusable network objects such as **Addresses** and **Services**, which can be used in any rule to specify the criteria for a match.

IP Rule Parameters

The following parameters are set for a single rule. There has to be a match with all parameters in a rule for that rule to be triggered.

Service	The protocol type to which the packet belongs. Services are defined as logical objects before configuring the rules.
Source Interface	An **Interface** or **Interface Group** where the packet is received on the firewall.
Source Network	The network that contains the source IP address of the packet.
Destination Interface	An **Interface** or an **Interface Group** from which the packet would leave the firewall.
Destination Network	The network to which the destination IP address of the packet belongs.

IP Rule Actions

When an IP rule is triggered by a match with its parameters any one of the following 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 firewall's "stateful inspection engine".
NAT	This functions like an **Allow** rule, but with dynamic address translation (NAT) enabled. See Section 7.1, “Dynamic Address Translation (NAT)”.
FwdFast	Let the packet pass through the firewall without setting up a state for it. This means that the stateful inspection process is bypassed and is therefore less secure than **Allow** or **NAT** rules. Packet processing is also slower than **Allow** rules as every packet is checked against the entire rule-set.
SAT	Tells NetDefendOS to perform static address translation. A **SAT** rule also requires a matching **Allow**, **NAT** or **FwdFast** rule further down the rule-set. See Section 7.2, “Static Address Translation (SAT)” for more information on this topic.
Drop	Tells NetDefendOS to immediately discard the packet.
Reject	Acts like **Drop**, but will return a "TCP RST" or "ICMP Unreachable message", informing the sending computer that the packet was disallowed.

Note

Packets not matching a rule in the rule-set and not having an already opened matching connection in the "state table" will be dropped.

3.5.4. Editing IP Rule-set Entries

After adding various rules to the rule-set editing any line can be achieved in the Web-UI by right clicking on that line.

A context menu will appear with the following options:

Edit This allows the contents of the rule to be changed.

Delete This will remove the rule permanently from the rule-set.

Disable/Enable This allows the rule to be disabled but left in the rule set. While disabled the rule-set line will not effect traffic flow and will appear grayed out in the user interface. It can be re-enabled at any time.

Move options The last section of the context menu allows the rule to be moved to a different position in the rule-set and therefore have a different precedence

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.

NetDefendOS 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 NetDefendOS are enabled or disabled.

A Schedule object gives 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

As schedules depend on an accurate date and time, it is very important that the system date and time are set correctly. 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, "Setting Date and Time".

Example 3.17. 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.

CLI

```
gw-world:/> add ScheduleProfile OfficeHours Mon=8-17 Tue=8-17 Wed=8-17 Thu=8-17
            Fri=8-17


gw-world:/> add IPRule Action=NAT Service=http SourceInterface=lan
            SourceNetwork=lannet DestinationInterface=any
            DestinationNetwork=all-nets Schedule=OfficeHours
            name=AllowHTTP
```

Web Interface

1. Go to **Objects > Schedules > Add > Schedule**
2. Enter the following:
   - **Name:** OfficeHours
3. Select 08-17, Monday to Friday in the grid.
4. Click **OK**.

1. Go to **Rules > IP Rules > Add > IPRule**
2. Enter the following:
   - **Name:** AllowHTTP
3. Select the following from the dropdown lists:

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

4. Click **OK**.

3.7. X.509 Certificates

NetDefendOS 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.

3.7.1. Overview

An X.509 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 phony key with the name and user ID of an intended recipient.

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 (CA).

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.

3.7.2. The Certification Authority

A certification 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 certification authority 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.

3.7.3. 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.

3.7.4. Certificate Revocation Lists

A Certificate Revocation List (CRL) contains a list of all certificates that have been cancelled before their expiration date. This 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. This could happen, for instance, if an employee has

left the company from whom the certificate was issued.

A CRL is regularly published on a server that all certificate users can access, using either the LDAP or HTTP protocols.

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.

The CA 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.

3.7.5. Trusting Certificates

When using certificates, the firewall 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.

3.7.6. Identification Lists

In addition to verifying the signatures of certificates, NetDefendOS 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.

3.7.7. X.509 Certificates in NetDefendOS

X.509 certificates can be uploaded to the D-Link Firewall for use in IKE/IPsec authentication, Webauth etc. There are two types of certificates that can be uploaded, self signed certificates and remote certificates belonging to a remote peer or CA server.

Example 3.18. Uploading an X.509 Certificate

The certificate may either be self-signed or belonging to a remote peer or CA server.

Web Interface

1. Go to **Objects > Authentication Objects > Add > Certificate**
2. Specify a suitable name for the certificate.
3. Now select one of the following:
   - **Upload self-signed X.509 Certificate**
   - **Upload a remote certificate**
4. Click **OK** and follow the instructions.

3.8. Setting Date and Time

Correctly setting the date and time is important for NetDefendOS to operate properly. Time scheduled policies, auto-update of IDP signatures, 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 occured. 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, NetDefendOS 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, NetDefendOS supports *Time Synchronization Protocols* in order to automatically adjust the clock, based on queries sent to special external servers.

3.8.1. General Date and Time Settings

3.8.1.1. Current Date and Time

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

Example 3.19. Setting the Current Date and Time

To adjust the current date and time, follow the steps outlined below:

CLI

```
gw-world:/> time -set YYYY-mm-DD HH:MM:SS
```

Where YYYY-mm-DD HH:MM:SS is the new date and time. Note that the date order is year, then month and then day. For example, to set the date and time to 9:25 in the morning on April 27th, 2007 the command would be:

```
gw-world:/> time -set 2007-04-27 09:25:00
```

Web Interface

1. Go to **System > Date and Time**
2. Click **Set Date and Time**.
3. Set year, month, day and time via the dropdown controls.
4. Click **OK**.

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

3.8.1.2. 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 NetDefendOS time zone setting reflects the time zone where the D-Link Firewall is physically located.

Example 3.20. Setting the Time Zone

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

CLI

```
gw-world:/> set DateTime Timezone=GMTplus1
```

Web Interface

1. Go to **System > Date and Time**
2. Select **(GMT+01:00)** in the **Timezone** drop-down list.
3. Click **OK**.

3.8.1.3. 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, NetDefendOS 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 3.21. Enabling DST

To enable DST, follow the steps outlined below:

CLI

```
gw-world:/> set DateTime DSTEnabled=Yes
```

Web Interface

1. Goto **System/Date and Time**
2. Check the **Enable daylight saving time** checkbox control.
3. Click **OK**.

3.8.2. Time Servers

The hardware clock which NetDefendOS 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*.

NetDefendOS 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 NetDefendOS will have its date and time aligned with other network devices.

3.8.2.1. Time Synchronization Protocols

Time Synchronization Protocols are standardised methods for retrieving time information from external Time Servers. NetDefendOS 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 NetDefendOS 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 accesible using SNTP.

3.8.2.2. 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. NetDefendOS 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 Lookup"). This is not needed if using server IP addresses.

Example 3.22. 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*.

CLI

```
gw-world:/> set DateTime TimeSynchronization=custom TimeSyncServer1=dns:ntp1.sp.se
            TimeSyncServer2=dns:ntp2.sp.se TimeSyncInterval=86400
```

Web Interface

1. Go to **System > Date and Time**
2. Check the **Enable time synchronization.**
3. Now enter:
   - **Time Server Type:** SNTP
   - **Primary Time Server:** ntp1.sp.se
   - **Seconadry Time Server:** ntp2.sp.se
4. Click **OK**.

Note

*If the **TimeSyncInterval** parameter is not specified when using the CLI to set the synchronization interval, the default of 86400 seconds (= 1 day) is used.*

Example 3.23. Manually Triggering a Time Synchronization

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

CLI

```
gw-world:/> time -sync
Attempting to synchronize system time...

Server time: 2007-02-27 12:21:52 (UTC+00:00)
Local time:  2007-02-27 12:24:30 (UTC+00:00) (diff: 158)

Local time successfully changed to server time.
```

3.8.2.3. 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 NetDefendOS 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 NetDefendOS 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 3.24. Modifying the Maximum Adjustment Value

CLI

```
gw-world:/> set DateTime TimeSyncMaxAdjust=40000
```

Web Interface

1. Go to **System > Date and Time**
2. For the setting **Maximum time drift that a server is allowed to adjust**, enter the maximum time drift in seconds that a server is allowed to adjust for
3. Click **OK**

Sometimes it might be necessary to override the maximum adjustment, for instance, if time synchronization has just been enabled and the inital 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 3.25. Forcing Time Synchronization

This example demonstrates how to force time synchronization, without respecting the maximum adjustment setting.

CLI

```
gw-world:/> time -sync -force
```

3.8.2.4. 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.

3.8.2.5. D-Link Time Servers

Using D-Link's own Time Servers is an option in NetDefendOS and this is the recommended way of synchronizing the firewall clock. These servers communicate with NetDefendOS using the SNTP protocol.

When the D-Link Server option is chosen, a pre-defined set of recommended default values for the synchronization are used.

Example 3.26. Enabling the D-Link NTP Server

To enable the use of the D-Link NTP server:

CLI

```
gw-world:/> set DateTime TimeSynchronization=D-Link
```

Web Interface

1. Go to **System > Date and Time**
2. Select the **D-Link TimeSync Server** radio button
3. Click **OK**.

As mentioned above, it is important to have an external DNS server configured so that the D-Link Time Server URLs can be resolved during the access process.

3.9. DNS Lookup

A DNS server resolves a textual URL address into a numeric IP address. This allows the actual physical IP address to change while the URL can stay the same.

URLs can be used in various areas of a NetDefendOS configuration where IP addresses are unknown, or where it makes more sense to make use of DNS resolution instead of using static IP addresses.

To accomplish DNS resolution, NetDefendOS has a built-in DNS client that can be configured to make use of up to three DNS servers.

Example 3.27. 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.

CLI

```
gw-world:/> set DNS DNSServer1=10.0.0.1 DNSServer2=10.0.0.2
```

Web Interface

1. Goto **System > DNS**
2. Enter the following:
   - **Primary DNS:** 10.0.0.1
   - **Secondary DNS:** 10.0.0.2
3. Click **OK**.

Chapter 4. Routing

This chapter describes how to configure IP routing in NetDefendOS.

4.1. Overview

IP routing capabilities belong to the most fundamental functionalities of NetDefendOS: 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 NetDefendOS system to function as expected.

Apart from basic *Static Routing*, NetDefendOS also supports *Virtual Routing* and *Dynamic Routing*. In addition, routes can be actively monitored to achieve route and link redundancy with fail-over capabilities.

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 NetDefendOS, please see Section 4.4, “Dynamic Routing”. 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 NetDefendOS.

The Principles of Routing

IP routing is essentially the mechanism in TCP/IP networks used for delivering IP packets from their source to their ultimate destination through a number of intermediary nodes, most often referred to as routers or firewalls. 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 in principle contains a destination network, an interface to forward the packet on and optionally the IP address of the next gateway in the path to the destination.

The images below illustrates a typical D-Link Firewall deployment and how the associated routing table would look like.

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	0.0.0.0/0	195.66.77.4

Basically, this 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 0.0.0.0/0 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 0.0.0.0/0 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.

4.2.1. Static Routing in NetDefendOS

This section describes how routing is implemented in NetDefendOS, and how to configure static routing.

NetDefendOS supports multiple routing tables. A default table called **main** is pre-defined and is always present in NetDefendOS. However, additional and completely separate routing tables can be defined by the administrator to provide alternate routing.

These user-defined extra routing toubles can be used to implement *Policy Based Routing* which means the administrator can set up rules in the IP rule-set which decide which of the routing tables will handle certain types of traffic. (see Section 4.3, “Policy-based Routing”).

Route Lookup Mechanism

The NetDefendOS 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 NetDefendOS, packets are forwarded with state-awareness, so the route lookup process is tightly integrated into NetDefendOS's 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 NetDefendOS.

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 NetDefendOS decides if the connection should be allowed or dropped. This design allows for a more fine-grained control in security policies.

Route Notation

NetDefendOS 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 NetDefendOS 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 NetDefendOS 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 gateways'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 NetDefendOS 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 NetDefendOS 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.

CLI

To see the configured routing table:

```
gw-world:/> cc RoutingTable main


gw-world:/main> show

Route

   #  Interface  Network   Gateway        Local IP
   -  ---------  --------  -------------  --------
   1  wan        all-nets  213.124.165.1  (none)
   2  lan        lannet    (none)         (none)
   3  wan        wannet    (none)         (none)
```

To see the active routing table enter:

```
gw-world:/> routes

Flags Network             Iface          Gateway         Local IP        Metric
----- ------------------- -------------- --------------- --------------- ------
      192.168.0.0/24      lan                                           0
```

```
      213.124.165.0/24   wan                                    0
      0.0.0.0/0          wan            213.124.165.1           0
```

Web Interface

To see the configured routing table:

1. Go to **Routing > Routing Tables**
2. Select and right-click the *main* routing table in the grid.
3. Choose **Edit** in the menu.

The main window will list the configured routes.

To see the active routing table, select the **Routes** item in the **Status** dropdown menu in the menu bar. The main window will list the active routing table.

Core Routes

NetDefendOS 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	

Basically, 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, i.e. intercepted by the system 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.

CLI

```
gw-world:/> 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
```

Web Interface
To see the core routes from the web interface, select the **Routes** item in the **Status** dropdown menu in the menu bar. Check the **Show all routes** checkbox and click the **Apply** button. The main window will list the active routing table including the core routes.

Tip
*For detailed information about the output of the CLI **routes** command. Please see the CLI Reference Guide.*

4.2.2. Route Failover

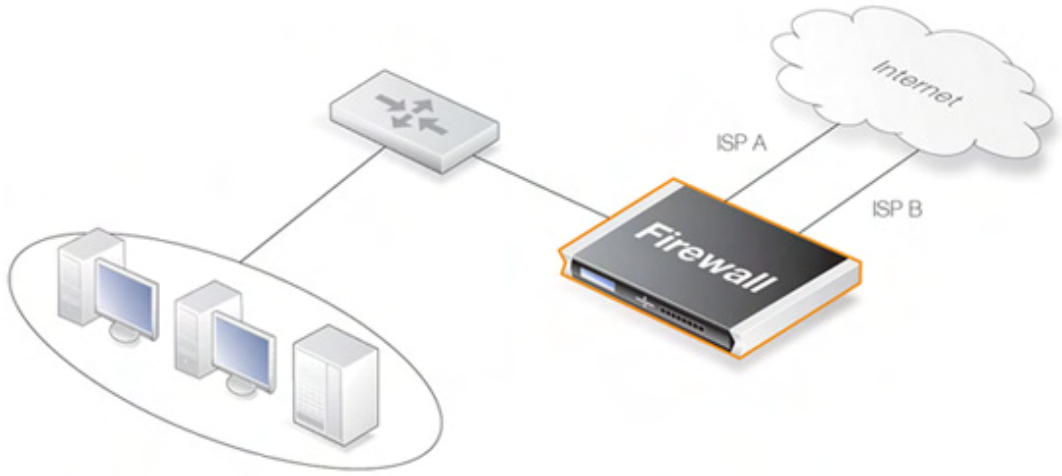
Overview

D-Link Firewalls 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, NetDefendOS provides a *Route Failover* capability so that should one route fail, traffic can automatically *failover* to another, alternate route. NetDefendOS implements Route Failover through the use of *Route Monitoring* in which NetDefendOS 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 NetDefendOS 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 D-Link Firewall. 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 D-Link Firewall 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, NetDefendOS 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 (eg."10"), and a secondary, failover route should have a higher Metric value (eg."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, NetDefendOS 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 0.0.0.0/0 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	0.0.0.0/0	195.66.77.1	10	On
2	wan	0.0.0.0/0	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 NetDefendOS, 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, NetDefendOS 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	0.0.0.0/0	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	0.0.0.0/0	195.66.77.1	10	On
2	dsl	0.0.0.0/0	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 3.3.5, “Interface Groups”.

Gratuitous ARP Generation

By default NetDefendOS 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 behaviour can

be controlled by the advanced setting **RFO_GratuitousARPOnFail**.

Host Monitoring

Overview

To provide a more flexible and configurable way to monitor the integrity of routes, NetDefendOS provides the additonal capability to perform *Host Monitoring* as a means to monitor a route. 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 D-Link Firewall which NetDefendOS will wait before starting Route Monitoring. This waiting period allows time for all network links to initialize once the firewall 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:

A host can be polled using a different protocol which can be one of:

- **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.
  - **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.
- **Interval** - The interval in milliseconds between polling attempts.

- **Sample** - The number of polling attempts used as a sample size for calculating the *Percentage Loss* and the *Average Latency*.
- **Max Number of Failed Attempts** - The maximum permissable 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 for a response to be received by the host. 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 NetDefendOS determines that any host with this option enabled is not reachable, Route Failover is initiated.

4.2.3. 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 D-Link Firewall, in between. In such a case, NetDefendOS itself can respond to ARP requests directed to the network on the other side of the D-Link Firewall 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 NetDefendOS responds to this ARP request instead of host B. The NetDefendOS 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 NetDefendOS 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 D-Link Firewall's Proxy ARP feature, where access between the parts needs to be controlled. In such a scenario NetDefendOS 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 is an extension to the standard approach to routing described previously. It offers administrators significant flexibility in implementing routing decision policies by be able to define *Policy-based Routing Rules*.

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 the routes chosen for traffic can be based on various parameters, such as the source address or service type.

NetDefendOS implements routing by not only looking at packets one by one, but by implementing it on a state or connection basis so that routing policy provides control on both the forward and return routing directions.

Policy-based Routing can also be applied on an application basis by allowing:

Source based routing	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	Policy-based Routing can route a given protocols such as HTTP, through transparent proxies such as Web caches.
Creating provider-independent metropolitan area networks	All users share a common active backbone, but each can use different ISPs, subscribing to different providers.

Policy-based Routing implementation in NetDefendOS consists of two elements:

- One or more user-defined alternate *Policy-based routing tables* in addition to the standard default **main** routing table.
- *Policy-based routing rules*, which determines which routing table to use depending on the traffic.

4.3.2. Policy-based Routing Tables

NetDefendOS, 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 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 with the alternate table in conjunction with the **main** table. This is described further in Section 4.3.5, “The *Ordering* parameter” below.

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 (eg. HTTP) 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. Policy-based Routing Table Selection

When a new connection is established the following is the way the decision is made as to which routing table is chosen:

1. Access Rules are checked first.
2. The source interface is looked up in the **main** routing table to find the packet's destination address.
3. A search is made for a Policy-based Routing rule that matches the source and destination interface. If a matching rule is found then this determines the routing table to use.
4. Once the correct routing table has been located, a final check is made to make sure that the source IP address *is* routed on the receiving interface. This is done by making a reverse lookup in the routing table using the source IP address. If this check fails then a **Default access rule** error message is generated.
5. 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.
6. The packet is finally forwarded and the new connection opened by NetDefendOS.

4.3.5. 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 behaviour is to first look up the connection's route in the **main** table. If no matching route is found, or the default route 0.0.0.0/0 is found, 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 behaviour 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 searched.
3. **Only** - This option ignores the existence of any other table except the alternate table. One application of this is to give the administrator a way to dedicate a single routing table to one 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 a route in the default main routing table with a destination interface of **all-nets**. The absence of an **all-nets** route will prevent Policy-based Routing Rules from functioning.*

Example 4.3. Creating a Policy-Based Routing table

In this example we create a Policy-based Routing table named "TestPBRTable".

Web Interface

1. Go to **Routing > Routing Tables > Add > RoutingTable**
2. 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 (0.0.0.0/0), 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, the lookup will not continue in the main routing table.
3. If **Remove Interface IP Routes** is enabled, the default interface routes are removed, i.e. routes to the *core* interface (which are routes to NetDefendOS itself).
4. Click **OK**.

Example 4.4. Creating the Route

After defining the routing table "TestPBRTable", we add routes into the table.

Web Interface

1. Go to **Routing > Routing Tables > TestPBRTable > Add > Route**
2. 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 firewall's interface IP address will be used.
   - **Metric:** Specifies the metric for this route. (Mostly used in route fail-over scenarios)
3. 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 1.2.3.0/24 belonging to "ISP A" and "2.3.4.0/24" belonging to "ISP B". The ISP gateways are 1.2.3.1 and 2.3.4.1, 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 D-Link Firewall.

In a provider-independent metropolitan area 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	1.2.3.0/24		wan1
lan1	2.3.4.0/24		wan1
wan1	1.2.3.1/32		wan1
wan2	2.3.4.1/32		lan1
wan1	0.0.0.0/0	1.2.3.1	

Contents of the named Policy-based Routing table r2:

Interface	Network	Gateway
wan2	0.0.0.0/0	2.3.4.1

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 (0.0.0.0/0).

Contents of the Policy-based Routing Policy:

Source Interface	Source Range	Destination Interface	Destination Range	Service	Forward VR table	Return VR table
lan1	1.2.3.0/24	wan2	0.0.0.0/0	ALL	r2	r2
wan2	0.0.0.0/0	lan1	2.3.4.0/24	ALL	r2	r2

To configure this example scenario:

Web Interface

1. Add the routes found in the list of routes in the main routing table, as shown earlier.
2. Create a routing table called "r2" and make sure the ordering is set to "Default".
3. Add the route found in the list of routes in the routing table "r2", as shown earlier.
4. Add two VR policies according to the list of policies shown earlier.
   - **Routing > Routing Rules > Add > RoutingRule**
   - 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. Dynamic Routing

4.4.1. Dynamic Routing overview

Dynamic routing is different to static routing in that the D-Link Firewall will adapt to changes of network topology or traffic load automatically. NetDefendOS first learns of all the directly connected networks and gets further route information from other routers. Detected routes are sorted and the most suitable routes for destinations are added into the routing table and this information is distributed to other routers. Dynamic Routing responds to routing updates on the fly but has the disadvantage that it is more susceptible to certain problems such as routing loops. In the Internet, two types of dynamic routing algorithm are used: the Distance Vector(DV) algorithm and the 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.

4.4.1.1. Distance Vector algorithms

The Distance vector (DV) algorithm 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 the route information only with its neighbor routers. The router will gradually learns the least-cost path by iterative computation and information exchange with its neighbors.

The Routing Information Protocol (RIP) is a well-known DV algorithm and involves sending regular update messages and 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"}. After updating its own routing table, the router immediately begins transmitting its entire routing table to neighboring routers to inform them of changes.

4.4.1.2. Link State algorithms

Different from the 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.

Open Shortest Path First (OSPF) is a widely used LS algorithm. 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 build a table of what the whole network looks like. With a complete routing table, each router can identify the subnetworks and routers that lead to any destination. Routers using OSPF only broadcast updates that 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 provide a great deal of control over the routing process since its parameters can finely tuned.

4.4.1.3. Comparing dynamic routing algorithms

Due to the fact that the global link state information is maintained everywhere in a network, Link State algorithms have a high degree of configuration control and scalability. Changes result in broadcasts of just the updated information to others routers which results in faster convergence and less possibility of routing loops. OSPF can also operate within a hierarchy, whereas RIP has no knowledge of sub-network addressing. NetDefendOS uses OSPF as its dynamic routing algorithm because of the advantages it offers.

4.4.1.4. Routing metrics

Routing metrics are the criteria a routing algorithm uses 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.

4.4.2. OSPF

4.4.2.1. OSPF Protocol Overview

Open Shortest Path First (OSPF) is a routing protocol developed for IP networks by the Internet Engineering Task Force (IETF). The NetDefendOS OSPF implementation is based upon RFC 2328, with compatibility to RFC 1583.

The way OSPF works is that it routes IP packets based only on the destination IP address found in the IP packet header. IP packets are routed "as is", that is they are not encapsulated in any further protocol headers as they transit the Autonomous System (AS). OSPF is a dynamic routing protocol, it quickly detects topological changes in the AS (such as router interface failures) and calculates new loop-free routes after a period of time.

OSPF is a link-state routing protocol that calls for the sending of link-state advertisements (LSAs) to all other routers within the same area. In a link-state routing protocol, each router maintains a database describing the Autonomous System's topology. This database is referred to as the link-state database. Each router in the same AS has an identical database. From the information in the link-state database, each router constructs a tree of shortest paths with itself as root. This shortest-path tree gives the route to each destination in the Autonomous System.

OSPF allows sets of networks to be grouped together, this is called an 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 subnetted network.

All OSPF protocol exchanges can be authenticated. This means that only routers with the correct authentication can join the Autonomous System. Different authentication schemes can be used, like none, passphrase or MD5 digest. It is possible to configure separate authentication methods for each Autonomous System.

4.4.2.2. OSPF Area Overview

The Autonomous System is divided into smaller parts called OSPF Areas. This chapter describes what an area is, and associated terms.

Areas An 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.

ABRs Routers that have interfaces in more than one area are called Area Border Routers (ABRs), 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 Router (ASBRs). They

advertise externally learned routes throughout the Autonomous System.

Backbone Areas All OSPF networks need to have at least the backbone area, that is the area with ID 0. This is the area that all other areas should be connected to, and the backbone make sure to distribute routing information between the connected areas. When an area is not directly connected to the backbone it needs a virtual link to it.

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 advertises 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 a area that is not directly connect to the backbone area.

4.4.2.3. Designated Router

Each OSPF broadcast network has a designated router and a backup designated router. The routers uses OSPF hello protocol to elect the DR and BDR for the network based on the priorities advertised by all the routers. If there already are a DR on the network, the router will accept that one, regardless of its own router priority.

4.4.2.4. Neighbors

Routers that are in the same area become neighbors in that area. Neighbors are elected via the Hello protocol. Hello packets are sent periodically out of each interface using IP multicast. Routers become neighbors as soon as they see themselves listed in the neighbor's Hello packet. This way, a two way communication is guaranteed.

The following *Neighbor States* are defined:

Down This is the initial stat of the neighbor relationship.

Init When a HELLO packet is received from a neighbor, but does NOT include the Router ID of the firewall in it, the neighbor will be placed in Init state. As soon as the neighbor in question receives a HELLO packet it will know the sending routers Router ID and will send a HELLO packet with that included. The state of the neighbors will change to *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 interfaces, the state will be changed to *Full*. On Broadcast interfaces, only the DR/BDR will advance to *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.

4.4.2.5. 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.

4.4.2.6. Virtual Links

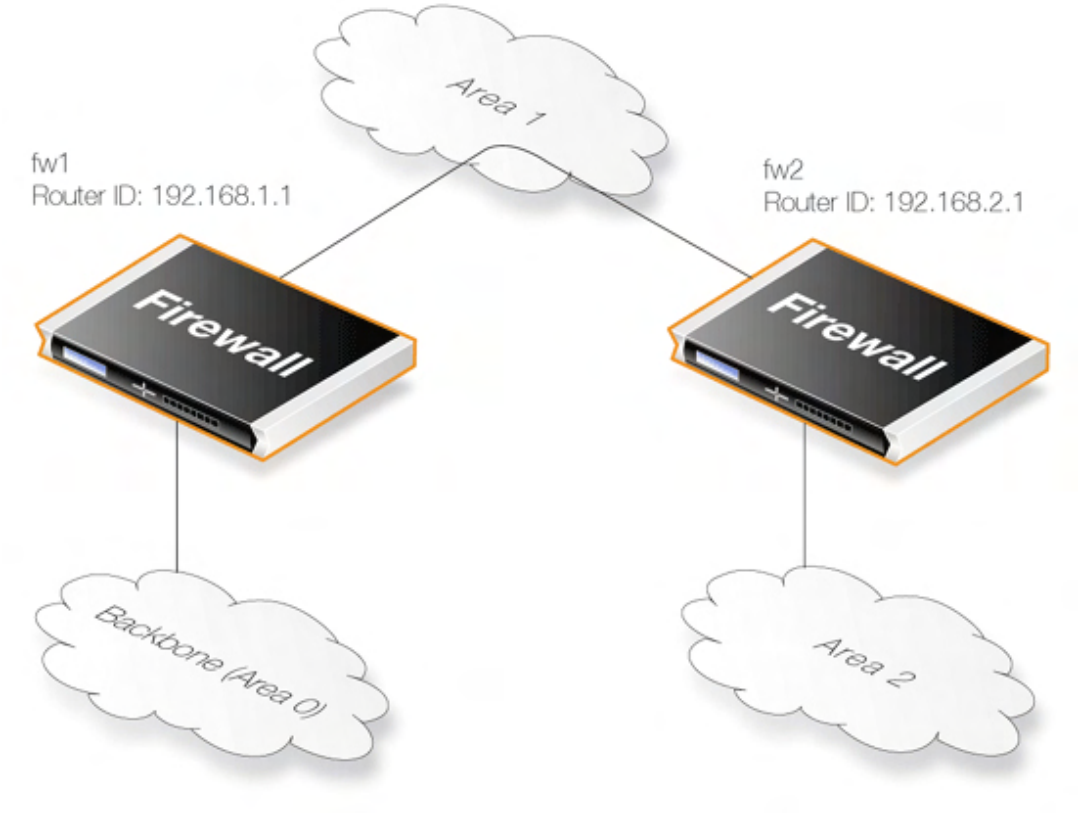
Virtual links are used for:

- Linking an area that does not have a direct connection to the backbone.
- Linking the backbone in case of a partitioned backbone.

Area without direct connection to the backbone

The backbone always need to be the center of all other areas. In some rare case where it is impossible to have an area physically connected to the backbone, a virtual link is used. This virtual link will provide that area with a logical path to the backbone area. This virtual link is established between two 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 4.2. Virtual Links Example 1

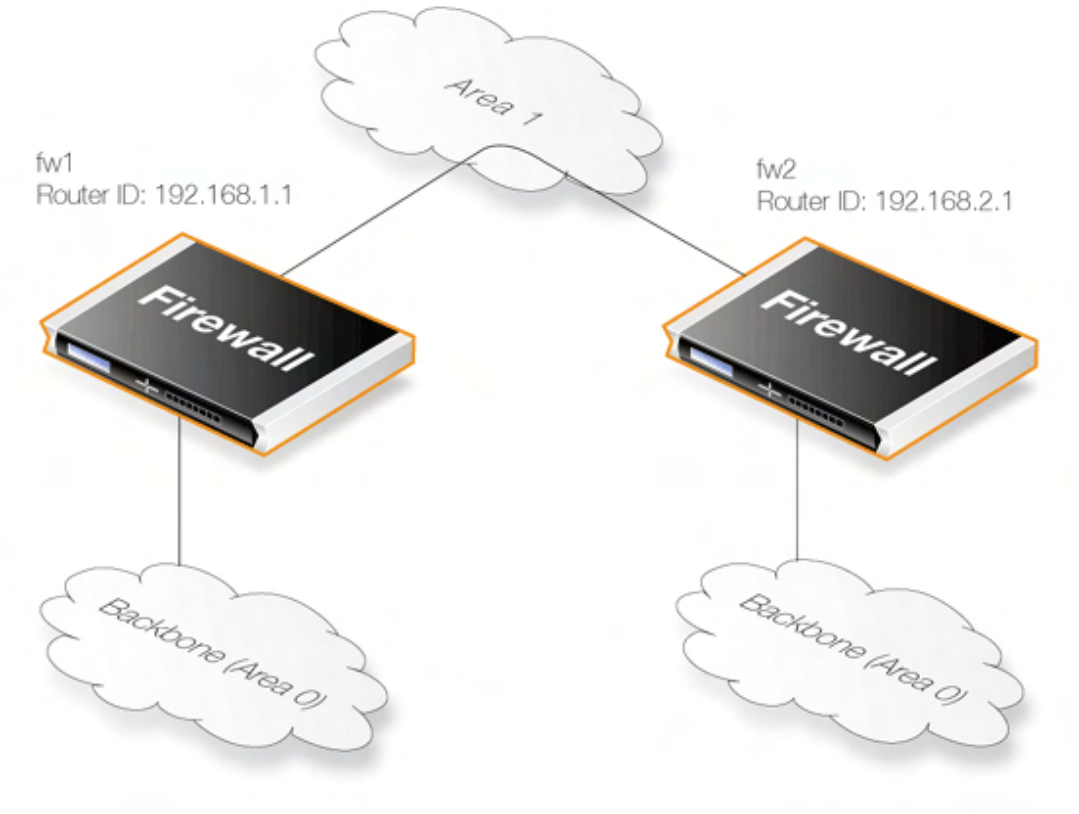


In the above example, the Virtual Link is configured between fw1 and fw2 on Area 1, as it is used as the transit area. In this configuration only the Router ID has to be configured. The diagram shows that fw2 needs to have a Virtual Link to fw1 with Router ID 192.168.1.1 and vice versa. These Virtual Links need to be configured in Area 1.

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 are from each side and having a common area in between.

Figure 4.3. Virtual Links Example 2



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 have 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 VLinks need to be configured in Area 1.

4.4.2.7. OSPF High Availability Support

There are some limitations in HA 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 firewall needs to have a broadcast interface with at least ONE neighbor for ALL areas that the firewall 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 two HA firewalls on the same broadcast network without any other neighbors (they won't form adjacency with each other because of the router priority 0). However it, based on scenario, may be possible to setup a point to point link between them instead. Special care must also be taken when setting up a virtual link to an HA firewall. The endpoint setting up a link to the HA firewall must setup 3 separate links: one to the shared, one the master and one to the slave router id of the firewall.

4.4.3. Dynamic Routing Policy

4.4.3.1. Overview

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 that parts of the routing database gets published to other routers.

For this reason, NetDefendOS provides a *Dynamic Routing Policy*, which is used to regulate the flow of dynamic routing information.

A Dynamic Routing Policy rule filters either statically configured or OSPF learned routes according to parameters like the origin of the routes, destination, metric and so forth. 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.

The most common usages of Dynamic Routing Policy are:

- Importing OSPF routes from an OSPF process into a routing table.
- Exporting routes from a routing table to an OSPF process.
- Exporting routes from one OSPF process to another.

Note

By default, NetDefendOS will not import or export any routes. In other words, for dynamic routing to be meaningful, it is mandatory to define at least one Dynamic Routing Policy rule.

4.4.3.2. Importing Routes from an OSPF AS into the Main Routing Table

In this example, the routes received using OSPF will be added into the main routing table.

Example 4.6. Importing Routes from an OSPF AS into the Main Routing Table

First of all a Dynamic Routing Policy filter needs to be created. The filter needs to have a name, in this example *ImportOSPFRoutes* is used, as it explains what the filter does.

The filter must also specify from what OSPF AS the routes should be imported. In this example, a pre-configured OSPF AS named *as0* is used.

Depending on how your routing topology looks like you might want to just import certain routes using the *Destination Interface/Destination Network* filters, but in this scenario all routes that are within the *all-nets* network (i.e. 0.0.0.0/0) are allowed.

CLI

```
gw-world:/> add DynamicRoutingRule OSPFProcess=as0 Name=ImportOSPFRoutes
            DestinationNetworkExactly=all-nets
```

Web Interface

1. Go to **Routing > Dynamic Routing Rules > Add > Dynamic routing policy rule**
2. Specify a suitable name for the filter, in this case ImportOSPFRoutes.
3. In the **Select OSPF Process**, make as0 selected.
4. Choose all-nets in the **...Exactly Matches** dropdown control.
5. Click **OK**.

The next step is to create a Dynamic Routing Action that will do the actual importing of the routes into a routing ta-

ble. Specify the destination routing table that the routes should be added to, in this case *main*.

CLI

```
gw-world:/> cc DynamicRoutingRule ImportOSPFRoutes


gw-world:/ImportOSPFRoutes> add DynamicRoutingRuleAddRoute
            Destination=MainRoutingTable
```

Web Interface

1. Go to **Routing > Dynamic Routing Rules**
2. Click on the recently created **ImportOSPFRoutes**
3. Go to **OSPF Routing Action > Add > DynamicRountingRuleAddRoute**
4. In the **Destination** control, add Main Routing Table to the **Selected** list.
5. Click **OK**.

4.4.3.3. Exporting the Default Route into an OSPF AS

In this example, the default route from the main routing table will be exported into an OSPF AS named as0.

Example 4.7. Exporting the Default Route into an OSPF AS

Add a dynamic routing policy filter that matches the main routing table and the default route:

CLI

```
gw-world:/> add DynamicRoutingRule OSPFProcess=as0 name=ExportDefRoute
            RoutingTable=MainRoutingTable DestinationInterface=wan
            DestinationNetworkExactly=all-nets
```

Web Interface

1. Go to **Routing > Dynamic Routing Rules > Add > Dynamic routing policy rule**
2. Specify a suitable name for the filter, for instance ExportDefRoute.
3. In the **From Routing Table**, make **Main Routing Table selected**.
4. Choose **wan** in the **Destination Interface** control.
5. Choose all-nets in the **...Exactly Matches** dropdown control.
6. Click **OK**.

Then, create an OSPF Action that will export the filtered route to the specified OSPF AS:

CLI

```
gw-world:/> cc DynamicRoutingRule ExportDefRoute


gw-world:/ExportDefRoute/> add DynamicRoutingRuleExportOSPF ExportToProcess=as0
```

Web Interface

1. Go to **Routing > Dynamic Routing Rules**

2. Click on the recently created **ExportDefRoute**.
3. Go to **OSPF Action > Add > DynamicRoutingRuleExportOSPF**.
4. In the **Export to process** control, choose **as0**.
5. Click **OK**.

4.5. Transparent Mode

4.5.1. Overview of Transparent Mode

Deploying D-Link Firewalls operating in Transparent Mode into an existing network topology can significantly strengthen security. It is simple to do and doesn't require reconfiguration of existing nodes. Once deployed, NetDefendOS can then allow or deny access to different types of services (eg. HTTP) and in specified directions. As long as users of the network are accessing permitted services through the D-Link Firewall they are not aware of its presence. Transparent Mode is enabled by specifying a **Switch Route** instead of a standard **Route.**

A typical example of Transparent Mode's ability to improve security is in a corporate environment where there might be a need to protect different departments from one another. The finance department might require access to only a restricted set of services (eg. HTTP) 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 network. By deploying a single D-Link Firewall between the two department's networks, transparent but controlled access can be achieved using the Transparent Mode feature.

Another example might be an organisation allowing traffic between the external internet and a range of public IP address' 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.

4.5.2. Comparison with Routing mode

The D-Link Firewall can operate in two modes: Routing Mode or Transparent Mode. In Routing Mode, the D-Link Firewall performs all the functions of a Layer 3 router; if the firewall is placed into a network for the first time, or if network topology changes, the routing configuration must therefore be thoroughly checked 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 mode works well when complete control over routing is desired.

In Transparent Mode, where **Switch Route** is used instead of **Route**, the firewall acts in a way that has similarities to a switch; it screens IP packets and forwards them transparently to the correct interface without modifying any of the source or destination information on the IP or Ethernet levels. Two benefits of Transparent Mode are:

- When a client moves from one interface to another without changing IP address, it can still obtain the same services as before (eg. HTTP, FTP) without routing reconfiguration.
- The same network address range can exist on several interfaces.

Note

*D-Link Firewalls need not operate exclusively in Transparent Mode but can combine Transparent Mode with Routing Mode to operate in a hybrid mode. That is to say, the firewall can have both **Switch Route**s as well as standard routes defined. It is also possible to create a hybrid case by applying address translation on otherwise transparent traffic.*

4.5.3. Transparent Mode implementation

In transparent mode, NetDefendOS allows ARP transactions to pass through the D-Link Firewall, and determines from this ARP traffic the relationship between IP addresses, physical addresses and interfaces. NetDefendOS 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 firewall's presence.

When beginning communication, a host will locate the target host's physical address by broadcasting an ARP request. This request is intercepted by NetDefendOS 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 NetDefendOS 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, NetDefendOS learns the source address information for both ends from the request and reply. NetDefendOS 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 firewall, 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, NetDefendOS knows that it should handle this packet in a transparent manner. If a destination interface and MAC address is available in the route, NetDefendOS 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 firewall will have to discover where the destination is located in the network. Discovery is done by NetDefendOS 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, NetDefendOS 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, NetDefendOS will rediscover destinations that may have been flushed.

4.5.4. Enabling Transparent Mode

Two steps are normally required to have NetDefendOS operate in Transparent Mode:

1. If desired, create a group of the interfaces that are to be transparent. Interfaces in a group can be marked as **Security transport equivalent** if hosts are to move freely between them.

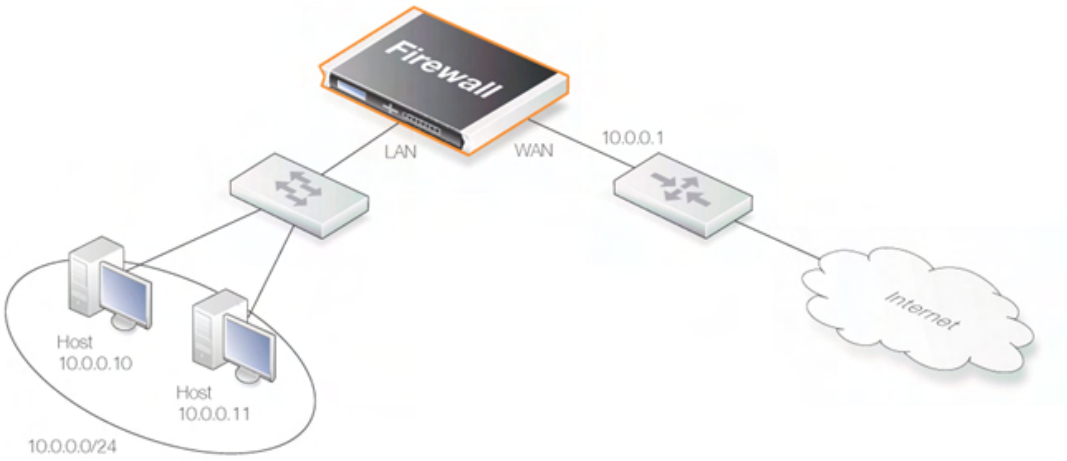
2. Create **Switch Route**s and if applicable use the interface group created earlier. For the **Network** parameter, specify the range of IP addresses that will be transparent between the interfaces. *When the entire firewall is working in Transparent Mode this is range is normally 0.0.0.0/0.*

4.5.5. Transparent Mode example scenarios

Scenario 1

The firewall 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 firewall 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 4.4. Transparent mode scenario 1



Example 4.8. Setting up Transparent Mode - Scenario 1

Web Interface
Configure the interfaces:

1. Go to **Interfaces > Ethernet > Edit (wan)**
2. Now enter:
   - **IP Address:** 10.0.0.1
   - **Network:** 10.0.0.0/24
   - **Default Gateway:** 10.0.0.1
   - **Transparent Mode:** Enable
3. Click **OK**.
4. Go to **Interfaces > Ethernet > Edit (lan)**
5. Now enter:
   - **IP Address:** 10.0.0.2
   - **Network:** 10.0.0.0/24
   - **Transparent Mode:** Enable
6. Click **OK**.

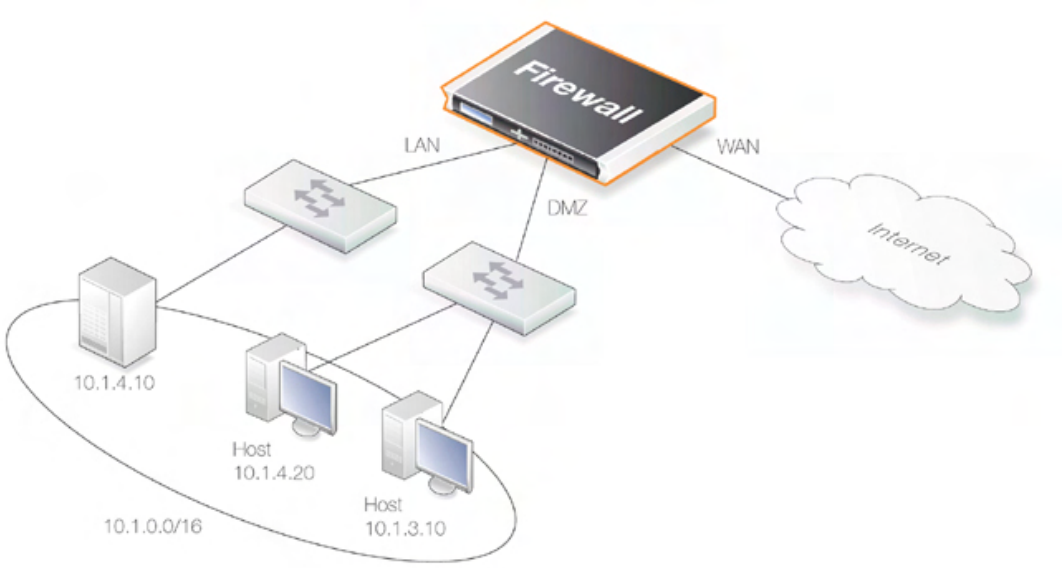
Configure the rules:

1. Go to **Rules > IP Rules > Add > IPRule**
2. Now enter:
   - **Name:** HTTPAllow
   - **Action:** Allow
   - **Service:** http
   - **Source Interface:** lan
   - **Destination Interface:** any
   - **Source Network:** 10.0.0.0/24
   - **Destination Network:** 0.0.0.0/0 (all-nets)

3. Click **OK**.

Scenario 2

Figure 4.5. Transparent mode scenario 2



Here the D-Link Firewall 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 firewall is transparent between the DMZ and LAN while traffic can subjected to the IP rule-set.

Example 4.9. Setting up Transparent Mode - 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).

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:

Similar as shown in the previous example. Set up the switch route with the new interface group created earlier.
Configure the rules:

1. Select the **Rules** section of the target system in the tree view of the Security Editor.
2. Choose **New Rule...** from the context menu, the **Rule Properties** dialog box 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 the **OK**.
7. Select the **Rules** section of the target system in the tree view of the Security Editor.
8. Choose **New Rule...** from the context menu, the **Rule Properties** dialog box 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:** wan_ip
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 the **OK**.
14. Select the **Rules** section of the target system in the tree view of the Security Editor.
15. Choose **New Rule...** from the context menu, the **Rule Properties** dialog box 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:** wan_ip
18. Under the **Service** tab, choose *http* in the **Pre-defined** control
19. Click the **OK**.

Web Interface
Configure the interfaces:

1. Go to **Interfaces > Ethernet > Edit (lan)**
2. Now enter:
   - **IP Address:** 10.0.0.1
   - **Network:** 10.0.0.0/24

- **Transparent Mode:** Disable
- **Add route for interface network:** Disable

3. Click **OK**.
4. Go to **Interfaces > Ethernet > Edit (dmz)**
5. Now enter:
   - **IP Address:** 10.0.0.2
   - **Network:** 10.0.0.0/24
   - **Transparent Mode:** Disable
   - **Add route for interface network:** Disable
6. Click **OK**.

Configure the interface groups:

1. Go to **Interfaces > Interface Groups > Add > InterfaceGroup**
2. Now enter:
   - **Name:** TransparentGroup
   - **Security/Transport Equivalent:** Disable
   - **Interfaces:** Select lan and dmz
3. Click **OK**.

Configure the routing:

1. Go to **Routing > Main Routing Table > Add > SwitchRoute**
2. Now enter:
   - **Switched Interfaces:** TransparentGroup
   - **Network:** 10.0.0.0/24
   - **Metric:** 0
3. Click **OK**.

Configure the rules:

1. Go to **Rules > IP Rules > Add > IPRule**
2. Now enter:
   - **Name:** HTTP-LAN-to-DMZ
   - **Action:** Allow
   - **Service:** http
   - **Source Interface:** lan
   - **Destination Interface:** dmz
   - **Source Network:** 10.0.0.0/24
   - **Destination Network:** 10.1.4.10
3. Click **OK**.
4. Go to **Rules > IP Rules > Add > IPRule**
5. Now enter:
   - **Name:** HTTP-WAN-to-DMZ

- **Action:** SAT
- **Service:** http
- **Source Interface:** wan
- **Destination Interface:** dmz
- **Source Network:** all-nets
- **Destination Network:** wan_ip
- **Translate:** Select Destination IP
- **New IP Address:** 10.1.4.10

6. Click **OK**.
7. Go to **Rules > IP Rules > Add > IPRule**
8. Now enter:
   - **Name:** HTTP-WAN-to-DMZ
   - **Action:** Allow
   - **Service:** http
   - **Source Interface:** wan
   - **Destination Interface:** dmz
   - **Source Network:** all-nets
   - **Destination Network:** wan_ip
9. Click **OK**.

Chapter 5. DHCP Services

This chapter describes DHCP services in NetDefendOS.

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.

A *DHCP Server* implements the task of assigning and managing IP addresses from a pre-defined address pool to DHCP clients. 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.

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 life cycle of the 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 its 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 by releasing the IP address. The lease time can be configured in the DHCP server by the administrator.

5.2. DHCP Servers

NetDefendOS has the ability to act as one or more logical DHCP servers. Filtering of DHCP client requests is based on interface, so each NetDefendOS interface can have, at most, one single logical DHCP server associated with it. In other words, NetDefendOS can provision DHCP clients using different address ranges depending on what interface they are located on.

A number of standard options 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.

In addition, *Custom Options* can be specified in order to have the DHCP servers hand out all types of options supported by the DHCP standard.

DHCP servers assign and manage the IP addresses taken the from specified address pool. NetDefendOS 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 NetDefendOS 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.

CLI

```
gw-world:/> add DHCPServer DHCPServer1 Interface=lan
            IPAddressPool=DHCPRange1 Netmask=255.255.255.0
```

Web Interface

1. Go to **System > DHCP > DHCP Servers >Add > DHCPServer**
2. 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

Web Interface

1. Select **DHCP Server** in the **Status** dropdown menu in the menu bar.

Tip
DHCP leases are remembered by the system between system restarts.

5.3. Static DHCP Assignment

Where the administrator requires a fixed relationship between a client and the assigned IP address, NetDefendOS 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.

CLI

First change to the *DHCPServer1* context:

```
gw-world:/> cc DHCPServer DHCPServer1
```

Now add the static DHCP assignment:

```
gw-world:/> add DHCPServerPoolStaticHost Host=192.168.1.1
                                                MACAddress=00-90-12-13-14-15
```

All static assignments can be listed and each is listed with an index number:

```
gw-world:/> show

   #  Comments
   -  -------
+  1  (none)
```

An individual static assignment can be shown using its index number:

```
gw-world:/> show DHCPServerPoolStaticHost 1

   Property  Value
-----------  -----------------
     Index:  1
      Host:  192.168.1.1
MACAddress:  00-90-12-13-14-15
  Comments:  (none)
```

The assignment could be changed later to IP address *192.168.1.12* with the following command:

```
gw-world:/> set DHCPServerPoolStaticHost 1 Host=192.168.1.12
                                                MACAddress=00-90-12-13-14-15
```

Web Interface

1. Go to **System > DHCP > DHCP Servers > DHCPServer1 > Static Hosts > Add > Static Host Entry**
2. Now enter:
   - **Host:** 19.168.1.1
   - **MAC:** 00-90-12-13-14-15
3. Click **OK**

5.4. DHCP Relaying

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 would always need to be in the same physical network area to be able to communicate. In a large Internet-like environment, this means there has to be a different server on every network. This problem is solved by the use of a DHCP relayer.

A DHCP relayer takes the place of the DHCP server in the local network to act as the link between the client and the 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 to the client. The DHCP relayers follow the BOOTP relay agent functionality and retain the BOOTP message format and communication protocol, and hence, they are often called 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 firewall 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". NetDefendOS will install a route for the client when it has finalized the DHCP process and obtained an IP.

CLI
Adding VLAN interfaces vlan1 and vlan2 that should relay to an interface group named as ipgrp-dhcp:

```
gw-world:/> add Interface InterfaceGroup ipgrp-dhcp Members=vlan1,vlan2
```

Adding a DHCP relay named as "vlan-to-dhcpserver":

```
gw-world:/> add DHCPRelay vlan-to-dhcpserver Action=Relay TargetDHCPServer=ip-dhcp
            SourceInterface=ipgrp-dhcp AddRoute=Yes ProxyARPInterfaces=ipgrp-dhcp
```

Web Interface
Adding VLAN interfaces vlan1 and vlan2 that should relay to an interface group named as ipgrp-dhcp:

1. Go to **Interface > Interface Groups > Add > InterfaceGroup**
2. Now enter:
   - **Name:** ipgrp-dhcp
   - **Interfaces**: select "vlan1" and "vlan2" from the **Available** list and put them into the **Selected** list.
3. Click **OK**.

Adding a DHCP relay named as "vlan-to-dhcpserver":

1. Go to **System > DHCP > Add > DHCP Relay**
2. Now enter:
   - **Name:** vlan-to-dhcpserver
   - **Action:** Relay
   - **Source Interface:** ipgrp-dhcp
   - **DHCP Server to relay to:** ip-dhcp
   - **Allowed IP offers from server:** all-nets
3. Under the **Add Route** tab, check **Add dynamic routes for this relayed DHCP lease**.
4. Click **OK**.

Chapter 6. Security Mechanisms

This chapter describes NetDefendOS security features.

6.1. Access Rules

6.1.1. Introduction

One of the principal functions of NetDefendOS is to allow only authorized connections access to protected data resources. Access control is primarily addressed by the NetDefendOS 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, NetDefendOS 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.

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 explicity 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 firewall'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 firewall 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 firewall is able to detect a DoS condition, it is hard to trace or stop it because of its nature.

VPNs provide one means of avoiding spoofing but where a VPN is not the 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 NetDefendOS 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 Action

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 NetDefendOS 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 astablishment, 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.

CLI

```
gw-world:/> add Access Name=lan_Access Interface=lan Network=lannet Action=Except
```

Web Interface

1. Go to **Rules > Access**
2. Select **Access Rule** in the **Add menu**.
3. Now enter:
   - **Name**: lan_Access
   - **Action**: Except
   - **Interface**: lan
   - **Network**: lannet
4. Click **OK**.

6.2. Application Layer Gateways

6.2.1. Overview

To complement low-level packet filtering, which only inspects packet headers in protocols such IP, TCP, UDP, and ICMP, D-Link Firewalls provide *Application Layer Gateways* (ALGs) which provide filtering at the higher application OSI level.

An ALG act as a mediator in accessing commonly used Internet applications outside the protected network, e.g. 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 service protocols and perform checks at the uppermost levels of the TCP/IP stack.

The following protocols are supported by NetDefendOS ALGs:

- HTTP
- FTP
- SMTP
- H.323

6.2.2. Hyper Text Transfer Protocol

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. The client, such as a Web browser, sends a request by establishing a TCP/IP connection to a particular 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 an error message.

The HTTP protocol faces particular issues because of the wide variety of web sites that can be accessed and the range of file types that can be downloaded as a result of such access. Two mechanisms that exist in NetDefendOS to specifically handle this are Web Content Flitering and Anti Virus scanning.

6.2.3. File Transfer Protocol

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 D-Link Firewall.

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 mode of FTP being used.

Modes

There are two modes, *active* and *passive*, describing the role of server in respect to opening the data channels.

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.

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.

FTP Security Issues

Both modes of FTP operation present problems for firewalls. Consider a scenario where an FTP client on the internal network connects through the firewall 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, NetDefendOS is not aware 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 firewall does not need to allow connections from the FTP server. On the other hand, NetDefendOS still does not know what port the FTP client tries 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 Solution

The FTP ALG solves this problem by fully reassembling the TCP stream of the command channel and examining its contents. Thus, the firewall knows what port to be opened for the data channel. Moreover, the FTP ALG also provides functionality to filter out certain control commands and provide a basic buffer overrun protection.

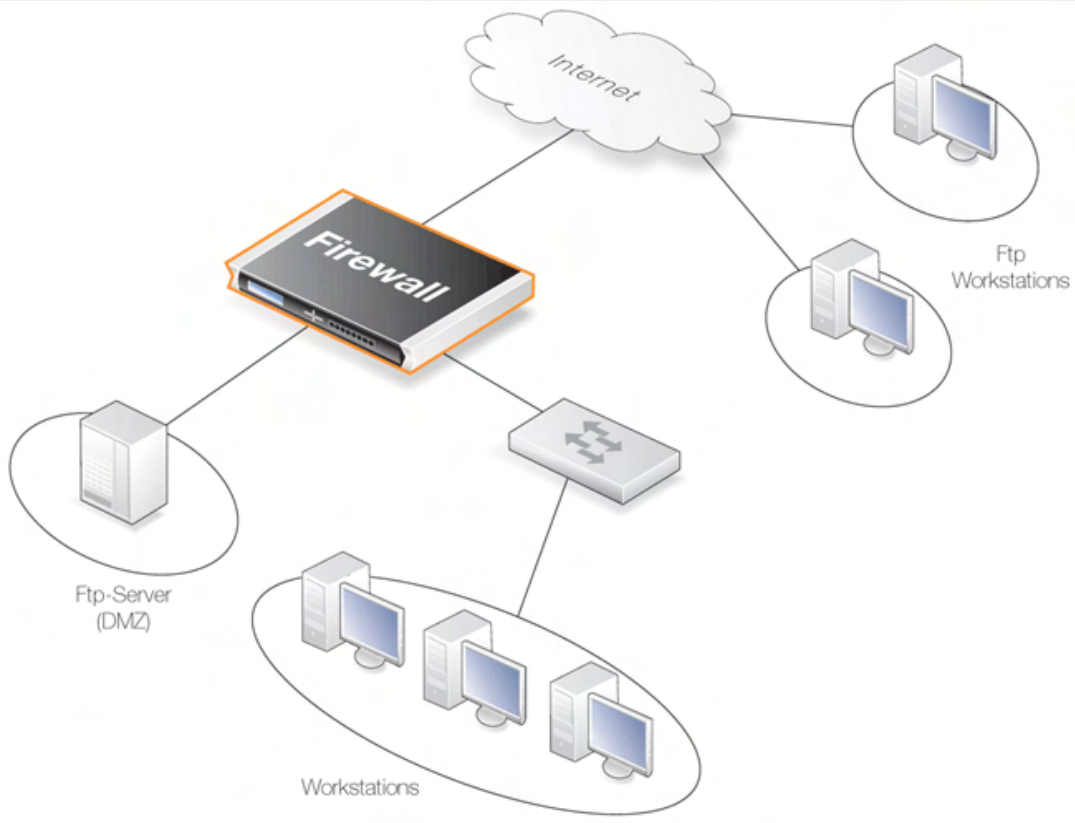
The most important feature of the FTP ALG is its unique capability to perform on-the-fly conversion between active and passive mode. The conversion can be described as follows:

- 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 D-Link Firewall will automatically and transparently receive the passive data channel from the FTP client and the active data channel from the server, and 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.

Example 6.2. Protecting an FTP Server with ALG

As shown, an FTP Server is connected to the D-Link Firewall 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:

Web Interface
Define the ALG:

1. Go to **Objects > ALG > Add > FTP ALG**
2. Enter **Name:** ftp-inbound
3. Check **Allow client to use active mode**
4. Uncheck **Allow server to use passive mode**
5. Click **OK**.

Define the Service:

- **Name:** ftp-inbound
- **Type:** select TCP from the dropdown list
- **Destination:** 21 (the port the ftp server resides on)
- **ALG:** select the "ftp-inbound" that has been created

1. Go to **Objects > Services > Add > TCP/UDP Service**
2. Enter the following:
3. Click **OK**.

Define the Rule - Allow connections to the public IP on port 21 and forward that to the internal FTP server:

1. Go to **Rules > IP Rules > Add > IPRule**
2. Now enter:

- **Name:** SAT-ftp-inbound
- **Action:** SAT
- **Service:** ftp-inbound

3. For **Address Filter** enter:
   - **Source Interface:** any
   - **Destination Interface:** core
   - **Source Network:** all-nets
   - **Destination Network:** wan_ip (assuming the external interface has been defined as this)
4. For **SAT** check **Translate the Destination IP Address**.
5. Enter **To: New IP Address:** ftp-internal (assume this internal IP address for FTP server has been defined in the Address Book object).
6. **New Port:** 21.
7. Click **OK**.

Traffic from the internal interface needs to be NATed:

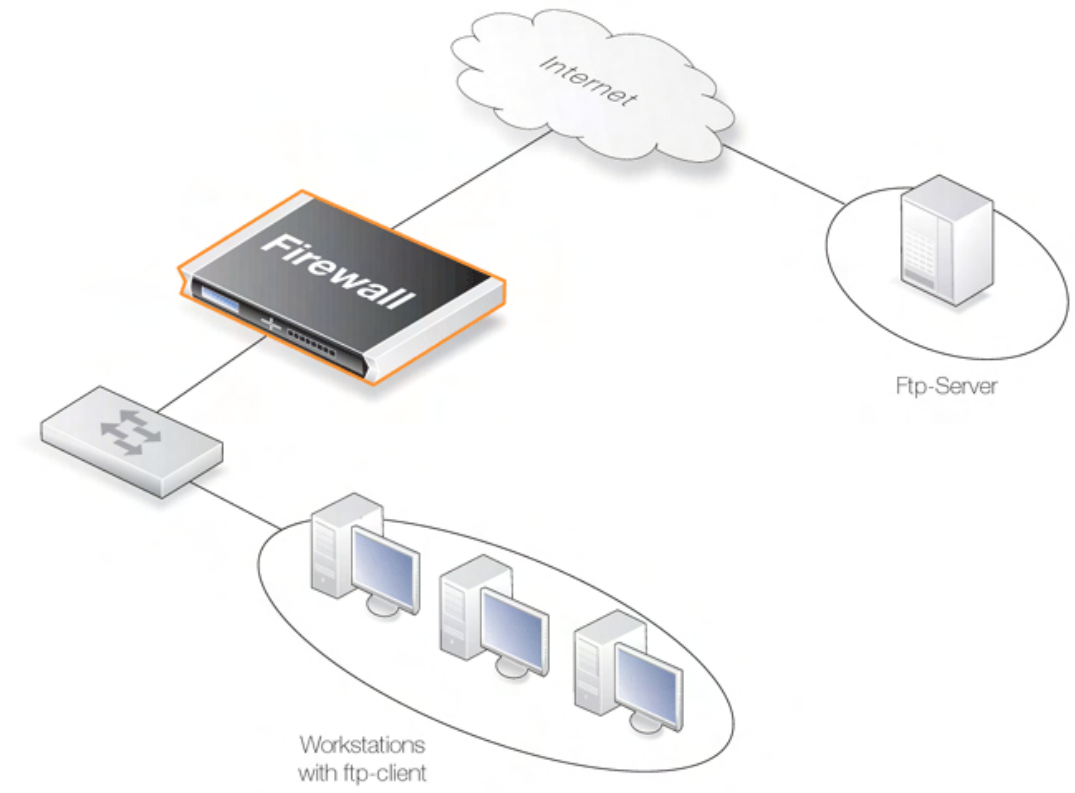
1. Go to **Rules > IP Rules > Add > IPRule**
2. Now enter:
   - **Name:** NAT-ftp
   - **Action:** NAT
   - **Service:** ftp-inbound
3. For **Address Filter** enter:
   - **Source Interface:** dmz
   - **Destination Interface:** core
   - **Source Network:** dmznet
   - **Destination Network:** wan_ip
4. For **NAT** check **Use Interface Address**.
5. Click **OK**.

Allow incoming connections (SAT needs a second Allow rule):

1. Go to **Rules > IP Rules > Add > IPRule**
2. Now enter:
   - **Name:** Allow-ftp
   - **Action:** Allow
   - **Service:** ftp-inbound
3. For **Address Filter** enter:
   - **Source Interface:** any
   - **Destination Interface:** core
   - **Source Network:** all-nets
   - **Destination Network:** wan_ip
4. Click **OK**.

Example 6.3. Protecting FTP Clients

In this scenario shown below the D-Link Firewall 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:

Web Interface
Create the FTP ALG:

1. Go to **Objects > ALG > Add > FTP ALG**
2. Enter **Name:** ftp-outbound.
3. Uncheck **Allow client to use active mode**.
4. Check **Allow server to use passive mode**.
5. Click **OK**.

Services:

1. Go to **Objects > Services > Add > TCP/UDP Service**
2. Now enter:
   - **Name:** ftp-outbound
   - **Type:** select TCP from the dropdown list
   - **Destination:** 21 (the port the ftp server resides on)
   - **ALG:** select the created "ftp-outbound"
3. 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.

Allow connections to ftp-servers on the outside:

1. Go to **Rules > IP Rules > Add > IPRule**
2. Now enter:
   - **Name:** Allow-ftp-outbound
   - **Action:** Allow
   - **Service:** ftp-outbound
3. For **Address Filter:** enter:
   - **Source Interface:** lan
   - **Destination Interface:** wan
   - **Source Network:** lannet
   - **Destination Network:** all-nets
4. Click **OK**.

Rules (Using Private IPs). If the firewall is using private IP's, the following NAT rule need to be added instead:

1. Go to **Rules > IP Rules > Add > IPRule**
2. Now enter:
   - **Name:** NAT-ftp-outbound
   - **Action:** NAT
   - **Service:** ftp-outbound
3. For **Address Filter** enter:
   - **Source Interface:** lan
   - **Destination Interface:** wan
   - **Source Network:** lannet
   - **Destination Network:** all-nets
4. Check **Use Interface Address**.
5. Click **OK**.

6.2.4. Simple Mail Transfer Protocol

Simple Mail Transfer Protocol (SMTP) is a text based protocol that is used for transferring email over the internet.

Key features of the SMTP ALG are:

- **Rate Limiting** - A maximum allowable rate of email messages can be specified.
- **Email address blacklisting** - A blacklist of email addresses can be specified so that mail from those addresses is blocked.
- **Email address blacklisting** - A whitelist of email addresses can be specified so that mail from those addresses is allowed to pass by the ALG.

- **MIME Checking** - Mail attachment file content can be checked against its filetype. A list of all filetypes checked can be found in Appendix C, *Anti-Virus MIME filetypes*.
- **Anti-Virus Scanning** - The NetDefendOS Anti-Virus module can scan email attachments searching for malicious code.
- Verify Sender Email - This option specifies that the source address in the SMTP protocol header and the SMTP data load header match.. Spamming programs can cause these to be different.

6.2.5. H.323

H.323 is a standard approved by the International Telecommunication Union 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).

H.323 Components

H.323 consists of four main components:

Terminals — Devices used for audio and optionally video or data communication. eg. phones, conferencing units, or "software phones" such as 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 them. 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 signaling 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 Signaling and Call Control (Setup) Signaling — Used for call signaling. It 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 D-Link Firewalls.

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 D-Link Firewall.

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 D-Link Firewall to let calls through.
- NAT and SAT rules are supported, allowing clients and gatekeepers to use private IP addresses on a network behind the D-Link Firewall.

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

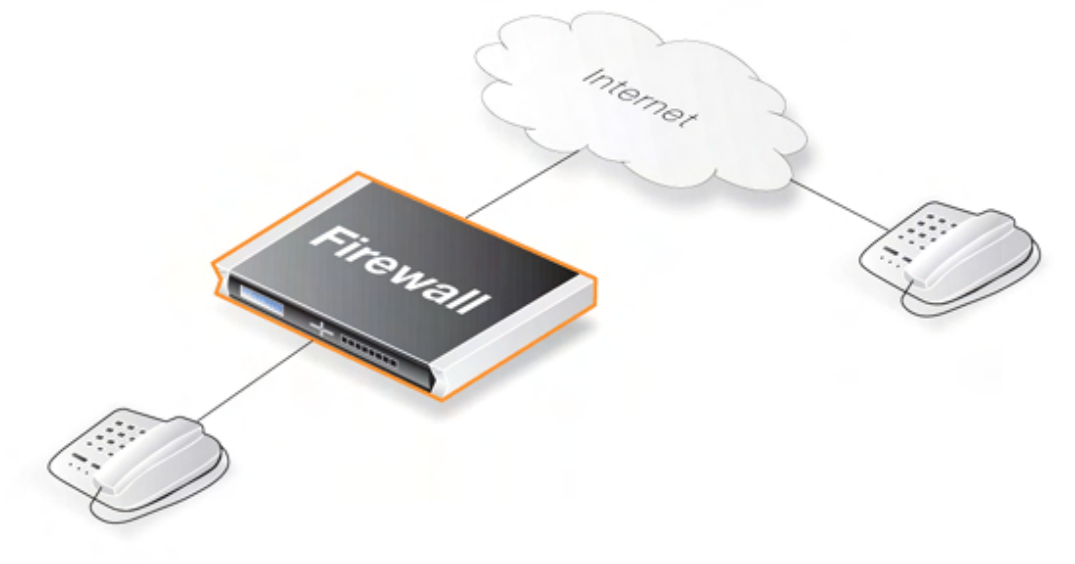
registration by clients with the gatekeeper and less probability of a problem if the network becomes unavailable and the client thinks it is still registered.

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 6.4. Protecting Phones Behind D-Link Firewalls

In the first scenario a H.323 phone is connected to the D-Link Firewall 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.



Web Interface
Outgoing Rule:

1. Go to **Rules > IP Rules > Add > IPRule**
2. Now enter:
   - **Name:** H323AllowOut
   - **Action:** Allow
   - **Service:** H323
   - **Source Interface:** lan
   - **Destination Interface:** any
   - **Source Network:** lannet
   - **Destination Network:** 0.0.0.0/0 (all-nets)
   - **Comment:** Allow outgoing calls

3. Click **OK**.

Incoming Rule:

1. Go to **Rules > IP Rules > Add > IPRule**
2. Enter the following:
   - **Name:** H323AllowIn
   - **Action:** Allow
   - **Service:** H323
   - **Source Interface:** any
   - **Destination Interface:** lan
   - **Source Network:** 0.0.0.0/0 (all-nets)
   - **Destination Network:** lannet
   - **Comment:** Allow incoming calls
3. Click **OK**

Example 6.5. H.323 with private IP addresses

In this scenario a H.323 phone is connected to the D-Link Firewall 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.

Web Interface
Outgoing Rule:

1. Go to **Rules > IP Rules > Add > IPRule**
2. Now enter:
   - **Name:** H323Out
   - **Action:** NAT
   - **Service:** H323
   - **Source Interface:** lan
   - **Destination Interface:** any
   - **Source Network:** lannet
   - **Destination Network:** 0.0.0.0/0 (all-nets)
   - **Comment:** Allow outgoing calls
3. Click **OK**

Incoming Rules:

1. Go to **Rules > IP Rules > Add > IPRule**
2. Enter the following:
   - **Name:** H323In
   - **Action:** SAT

- **Service:** H323
- **Source Interface:** any
- **Destination Interface:** core
- **Source Network:** 0.0.0.0/0 (all-nets)
- **Destination Network:** wan_ip (external IP of the firewall)
- **Comment:** Allow incoming calls to H.323 phone at ip-phone

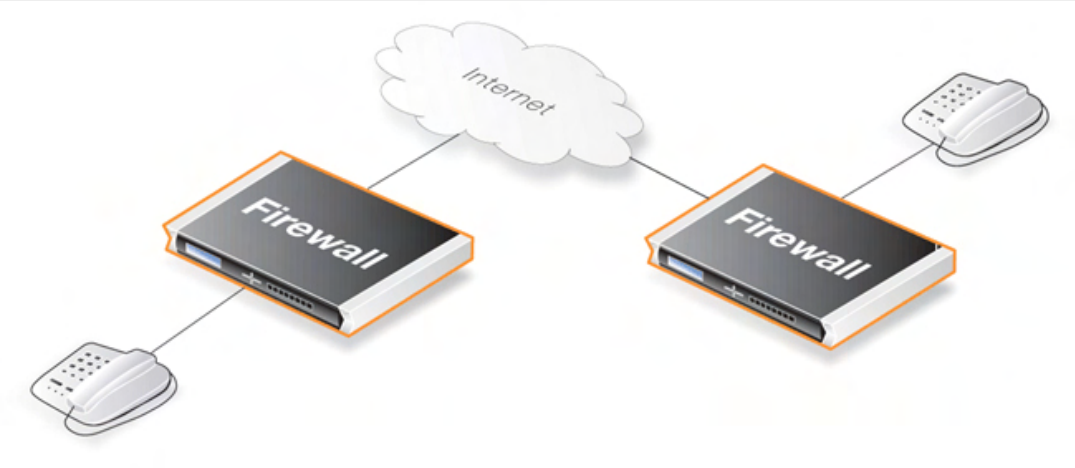
3. For **SAT** enter **Translate Destination IP Address:** To New IP Address: ip-phone (IP address of phone).
4. Click **OK**

1. Go to **Rules > IP Rules > Add > IPRule**
2. Now enter:
   - **Name:** H323In
   - **Action:** Allow
   - **Service:** H323
   - **Source Interface:** any
   - **Destination Interface:** core
   - **Source Network:** 0.0.0.0/0 (all-nets)
   - **Destination Network:** wan_ip (external IP of the firewall)
   - **Comment:** Allow incoming calls to H.323 phone at ip-phone
3. Click **OK**

To place a call to the phone behind the D-Link Firewall, place a call to the external IP address on the firewall. If multiple H.323 phones are placed behind the firewall, one SAT rule has to be configured for each phone. This means that multiple external addresses have to be used. However, it is preferred to use a H.323 gatekeeper as in the "H.323 with Gatekeeper" scenario, as this only requires one external address.

Example 6.6. Two Phones Behind Different D-Link Firewalls

This scenario consists of two H.323 phones, each one connected behind the D-Link Firewall 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 firewalls. Make sure there are no rules disallowing or allowing the same kind of ports/traffic before these rules.



Web Interface
Outgoing Rule:

1. Go to **Rules > IP Rules > Add > IPRule**
2. Now enter:
   - **Name:** H323AllowOut
   - **Action:** Allow
   - **Service:** H323
   - **Source Interface:** lan
   - **Destination Interface:** any
   - **Source Network:** lannet
   - **Destination Network:** 0.0.0.0/0 (all-nets)
   - **Comment:** Allow outgoing calls
3. Click **OK**.

Incoming Rule:

1. Go to **Rules > IP Rules > Add > IPRule**
2. Now enter:
   - **Name:** H323AllowIn
   - **Action:** Allow
   - **Service:** H323
   - **Source Interface:** any
   - **Destination Interface:** lan
   - **Source Network:** 0.0.0.0/0 (all-nets)
   - **Destination Network:** lannet
   - **Comment:** Allow incoming calls
3. Click **OK**

Example 6.7. Using Private IP Addresses

This scenario consists of two H.323 phones, each one connected behind the D-Link Firewall 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 firewall, 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 firewall.

Web Interface
Outgoing Rule:

1. Go to **Rules > IP Rules > Add > IPRule**
2. Now enter:
   - **Name:** H323Out
   - **Action:** NAT
   - **Service:** H323
   - **Source Interface:** lan
   - **Destination Interface:** any
   - **Source Network:** lannet
   - **Destination Network:** 0.0.0.0/0 (all-nets)
   - **Comment:** Allow outgoing calls
3. Click **OK**.

Incoming Rules:

1. Go to **Rules > IP Rules > Add > IPRule**
2. Now enter:
   - **Name:** H323In
   - **Action:** SAT
   - **Service:** H323
   - **Source Interface:** any
   - **Destination Interface:** core
   - **Source Network:** 0.0.0.0/0 (all-nets)
   - **Destination Network:** wan_ip (external IP of the firewall)
   - **Comment:** Allow incoming calls to H.323 phone at ip-phone
3. For **SAT** enter **Translate Destination IP Address:** To New IP Address: ip-phone (IP address of phone)
4. Click **OK**

1. Go to **Rules > IP Rules > Add > IPRule**
2. Now enter:
   - **Name:** H323In
   - **Action:** Allow
   - **Service:** H323
   - **Source Interface:** any
   - **Destination Interface:** core
   - **Source Network:** 0.0.0.0/0 (all-nets)
   - **Destination Network:** wan_ip (external IP of the firewall)

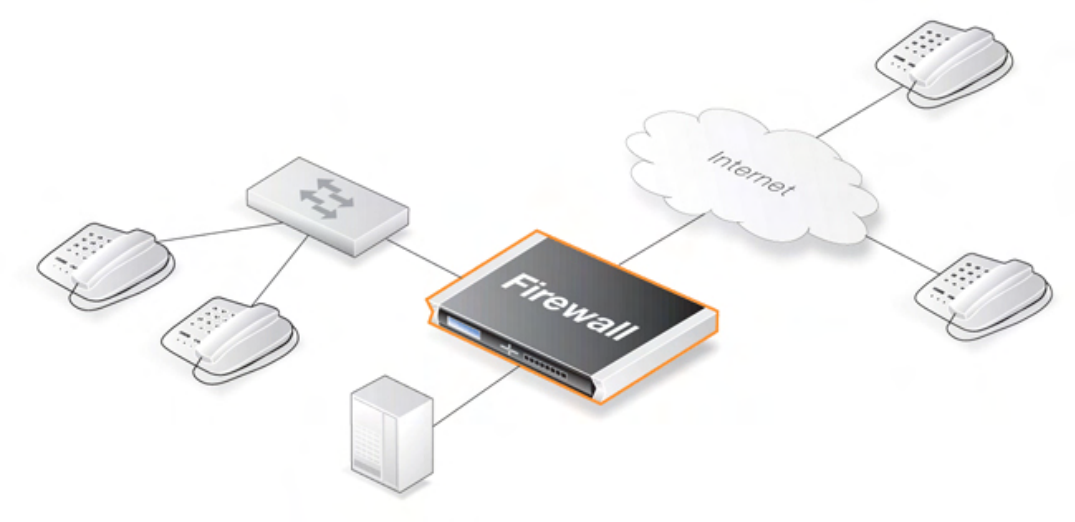
- **Comment:** Allow incoming calls to H.323 phone at ip-phone

3. Click **OK**.

To place a call to the phone behind the D-Link Firewall, place a call to the external IP address on the firewall. If multiple H.323 phones are placed behind the firewall, 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 as this only requires one external address.

Example 6.8. H.323 with Gatekeeper

In this scenario, a H.323 gatekeeper is placed in the DMZ of the D-Link Firewall. A rule is configured in the firewall 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 firewalls, make sure there are no rules disallowing or allowing the same kind of ports/traffic before these rules.



Web Interface
Incoming Gatekeeper Rules:

1. Go to **Rules > IP Rules > Add > IPRule**
2. Now enter:
   - **Name:** H323In
   - **Action:** SAT
   - **Service:** H323-Gatekeeper
   - **Source Interface:** any
   - **Destination Interface:** core
   - **Source Network:** 0.0.0.0/0 (all-nets)
   - **Destination Network:** wan_ip (external IP of the firewall)
   - **Comment:** SAT rule for incoming communication with the Gatekeeper located at ip-gatekeeper
3. For **SAT** enter **Translate Destination IP Address:** To New IP Address: ip-gatekeeper (IP address of gatekeeper).
4. Click **OK**

1. Go to **Rules > IP Rules > Add > IPRule**
2. Now enter:
   - **Name:** H323In
   - **Action:** Allow
   - **Service:** H323-Gatekeeper
   - **Source Interface:** any
   - **Destination Interface:** core
   - **Source Network:** 0.0.0.0/0 (all-nets)
   - **Destination Network:** wan_ip (external IP of the firewall)
   - **Comment:** Allow incoming communication with the Gatekeeper
3. Click **OK**

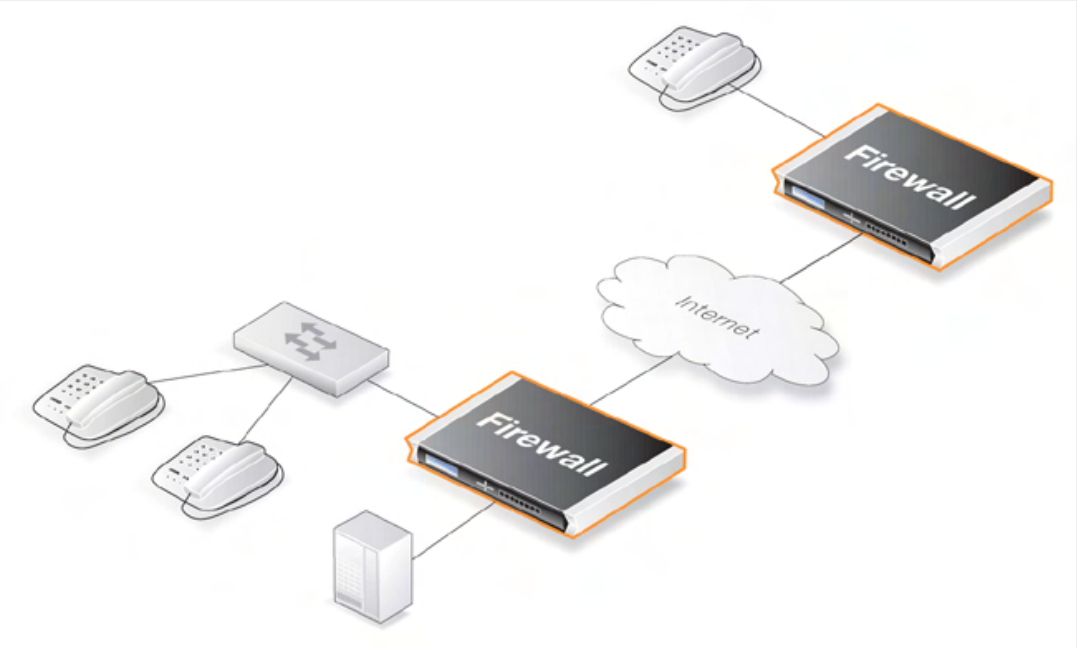
1. Go to **Rules > IP Rules > Add > IPRule**
2. Now enter:
   - **Name:** H323In
   - **Action:** Allow
   - **Service:** Gatekeeper
   - **Source Interface:** lan
   - **Destination Interface:** dmz
   - **Source Network:** lannet
   - **Destination Network:** ip-gatekeeper (IP address of the gatekeeper)
   - **Comment:** Allow incoming communication with the Gatekeeper
3. Click **OK**

Note

There is no need to specify a specific rule for outgoing calls. NetDefendOS 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 6.9. H.323 with Gatekeeper and two D-Link Firewalls

This scenario is quite similar to scenario 3, with the difference that the D-Link Firewall is protecting the "external" phones. The D-Link Firewall with the Gatekeeper connected to the DMZ should be configured exactly as in scenario 3 The other D-Link Firewall 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.



Web Interface

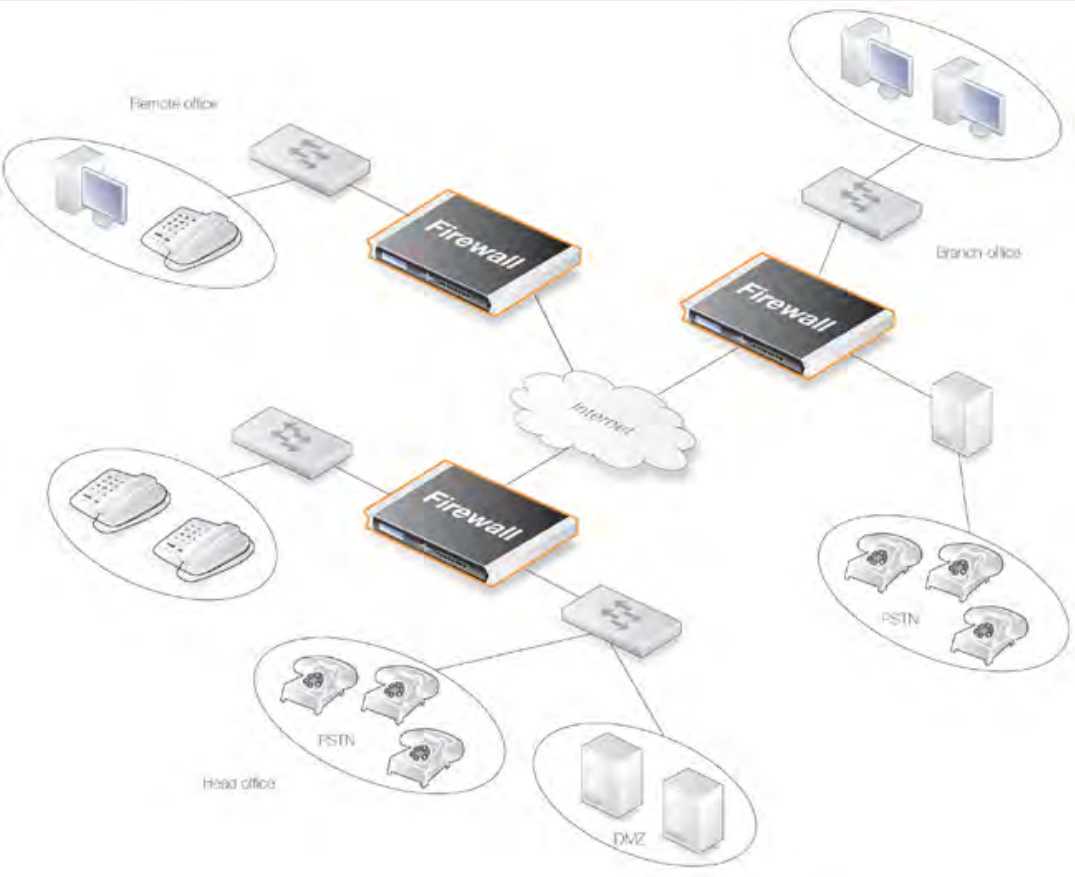
1. Go to **Rules > IP Rules > Add > IPRule**
2. Now enter:
   - **Name:** H323Out
   - **Action:** NAT
   - **Service:** H323-Gatekeeper
   - **Source Interface:** lan
   - **Destination Interface:** any
   - **Source Network:** lannet
   - **Destination Network:** 0.0.0.0/0 (all-nets)
   - **Comment:** Allow outgoing communication with a gatekeeper
3. Click **OK**

Note

There is no need to specify a specific rule for outgoing calls. NetDefendOS 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. 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 D-Link Firewall. This firewall should be configured as follows:

Web Interface

1. Go to **Rules > IP Rules > Add > IPRule**
2. Now enter:
   - **Name:** LanToGK
   - **Action:** Allow
   - **Service:** Gatekeeper
   - **Source Interface:** lan
   - **Destination Interface:** dmz
   - **Source Network:** lannet
   - **Destination Network:** ip-gatekeeper
   - **Comment:** Allow H.323 entities on lannet to connect to the Gatekeeper
3. Click **OK**.

1. Go to **Rules > IP Rules > Add > IPRule**
2. Now enter:
   - **Name:** LanToGK
   - **Action:** Allow
   - **Service:** H323

- **Source Interface:** lan
- **Destination Interface:** dmz
- **Source Network:** lannet
- **Destination Network:** ip-gateway
- **Comment:** Allow H.323 entities on lannet to call phones connected to the H.323 Gateway on the DMZ.

3. Click **OK**.

1. Go to **Rules > IP Rules > Add > IPRule**
2. Now enter:
   - **Name:** GWToLan
   - **Action:** Allow
   - **Service:** H323
   - **Source Interface:** dmz
   - **Destination Interface:** lan
   - **Source Network:** ip-gateway
   - **Destination Network:** lannet
   - **Comment:** Allow communication from the Gateway to H.323 phones on lannet
3. Click **OK**.

1. Go to **Rules > IP Rules > Add > IPRule**
2. Now enter:
   - **Name:** BranchToGW
   - **Action:** Allow
   - **Service:** H323-Gatekeeper
   - **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
3. Click **OK**.

1. Go to **Rules > IP Rules > Add > IPRule**
2. Now enter:
   - **Name:** BranchToGW
   - **Action:** Allow
   - **Service:** H323-Gatekeeper
   - **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

3. Click **OK**.

Example 6.11. 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 D-Link Firewalls in the remote and branch offices should be configured as follows: (this rule should be in both the Branch and Remote Office firewalls).

Web Interface

1. Go to **Rules > IP Rules > Add > IPRule**
2. Now enter:
   - **Name:** ToGK
   - **Action:** Allow
   - **Service:** H323-Gatekeeper
   - **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
3. Click **OK**

Example 6.12. Allowing the H.323 Gateway to register with the Gatekeeper

The branch office D-Link Firewall 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:

Web Interface

1. Go to **Rules > IP Rules > Add > IPRule**
2. Now enter:
   - **Name:** GWToGK
   - **Action:** Allow
   - **Service:** H323-Gatekeeper
   - **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
3. Click **OK**.

Note

There is no need to specify a specific rule for outgoing calls. NetDefendOS 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. Intrusion Detection and Prevention

6.3.1. Overview

Intrusion Definition

Computer servers can sometimes have vulnerabilites 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. NetDefendOS IDP provides an important line of defense against these threats.

Intrusion Detection and Prevention (IDP) is a NetDefendOS module that is designed to protect against these instrusion attempts. It operates by monitoring network traffic as it passes through the D-Link Firewall, searching for patterns that indicate an intrusion is being attempted. Once detected, NetDefendOS IDP allows steps to be taken to neutralize both the intrusion attempt as well as its source.

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 searched for in that traffic?
3. What action should be carried out when an intrusion is detected?

NetDefendOS IDP Components

NetDefendOS IDP addresses the above IDP 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 NetDefendOS IDP to the traffic that matches an IDP Rule as it streams through the firewall.
3. If NetDefendOS 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.

6.3.2. IDP Availability in D-Link Models

Maintenance and Advanced IDP

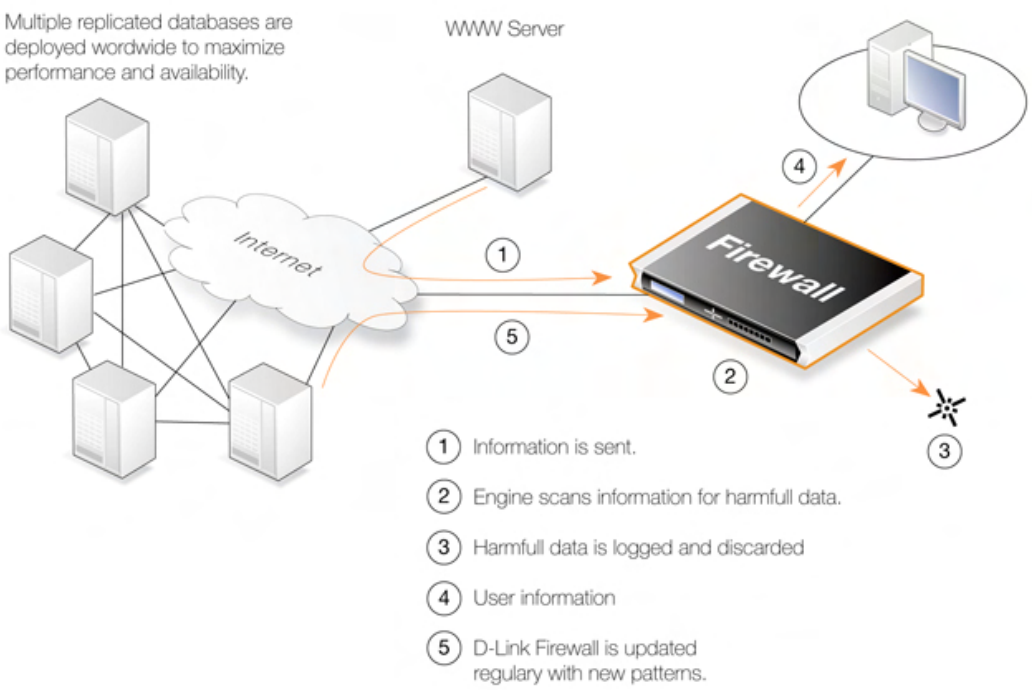
D-Link offers two types of IDP:

- **Maintenance IDP** is a basic IDP system included as standard with the D-Link DFL-210/800/1600/2500 firewalls. This is a simplfied IDP that gives basic protection against attacks. It is upgradeable to the professional level *Advanced IDP*.
- **Advanced IDP** is a subscription based IDP system with a much broader range of database signatures for professional installations. It is available on all D-Link firewalls. Maintenance IDP can be viewed as a restricted subset of Advanced IDP and the following sections describe how the Advanced IDP Service functions.

Subscribing to the D-Link Advanced IDP Service

Advanced IDP is purchased as an additional component to the base NetDefendOS license. It is a subscription service and the subscription means that the IDP signature database can be downloaded to a NetDefendOS 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 6.1. IDP Database Updating



A new, updated signature database is downloaded automatically by NetDefendOS system at a configurable interval. This is done via an HTTP connection to the D-Link server network which delivers the latest signature database updates. If the server's signature database has a newer version than the current local database, the new database will be downloaded, replacing the older version.

IDP, IPS and IDS

The terms Intrusion Detection and Prevention, Intrusion Prevention System and Intrusion Detection System are used interchangeably in D-Link literature.

6.3.3. 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. 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 firewall and NetDefendOS 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 eg. address translation, logging.

Checking Dropped Packets

The option exists in NetDefendOS IDP to look for intrusions in all traffic, even the packets that are rejected by the IP Rule-set check for new connections, as well as packets that are not part of an existing connection. This provides the firewall administrator with a way to detect any traffic that appears to be an intrusion. With this option the only possible IDP Rule Action is logging. Caution should of course be exercised with this option since the processing load can be much higher when all data packets are checked.

6.3.4. 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 futher 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, NetDefendOS automatically corrects the data stream by removing the extraneous data associated with the attack.

Insertion/Evasion Log Events

The Insertion/Evasion Attack subsystem in NetDefendOS can generate two types of log message:

- An **Attack Detected** log message, indicating an attack has been indentified and prevented.
- An **Unable to Detect** log message when NetDefendOS 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.

6.3.5. 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 NetDefendOS 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, D-Link 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, "unkown" 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 D-Link documentation but instead, are available on the D-Link website at:

http://security.dlink.com.tw

Advisories can be found under the "NetDefend IDS" option in the "NetDefend Live" menu.

IDP Signature types

IDP offers three signature types which offer differing levels of certainty with regard to threats:

- **Intrusion Protection Signatures (IPS)** - 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)** - 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** - detect different types of application traffic. They can be used to block certain applications such as filesharing applications and instant messaging.

6.3.6. 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 NetDefendOS search data using the least possible number of signatures.

Specifying Signature Groups

IDP Signature Groups fall into a three level hierarchical structure. The top level of this hierarchy is the siganture *Type*, the second level the *Category* and the third level the *Sub-Category*. The signature group called **POLICY_DB_MSSQL** illustrates this principle where **Policy** is the *Type*, **DB** is the *Category* and **MSSQL** is the *Sub-Category*. These 3 signature components are explained below:

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 eg. *MSSQL*. The Sub-Category may not be necessary if the *Type* and *Category* are sufficient to specify the group eg. **APP_ITUNES**.

Listing of IDP Groups

A listing of IDP groupings can be found in Appendix B, *IDP Signature Groups*. The listing shows groups 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.

IDP signature wildcarding

When selecting IDP signature groups, it is possible to use wildcarding to select more than one group. The"?" character can be used to wildcard for a single character in a group name. Alternatively, the "*" character can be used to wildcard for any set of characters of any length in a group name.

Caution against using too many IDP signatures

Do not use the entire signature database and avoid using signatures and signature groups unecessarily. 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 noticebly degrade performance. Using too many signatures during scanning can make the load on the firewall hardware unecessarily high, adversely effecting throughput.

6.3.7. 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 or switching on ZoneDefense 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 NetDefendOS. For more details of how blacklisting functions see Section 6.7, “Blacklisting Hosts and Networks”.

IDP ZoneDefense

The **Protect** action includes the option that the particular D-Link switch that triggers the IDP Rule can be de-activated through the D-Link *ZoneDefense* feature. For more details on how ZoneDefense functions see Chapter 12, *ZoneDefense*.

6.3.8. SMTP Log Receiver for IDP Events

In order to receive notifications via e-mail of IDP events, a SMTP Log receiver can be configured. This e-mail will contain a summary of IDP events that have occurred in a user-configurable period of time.

When an IDP event occurrs, the NetDefendOS will wait for **Hold Time** seconds before sending the notification e-mail. However, the e-mail will only be sent if the number of events occurred in this period of time is equal to, or bigger than the **Log Threshold**. When this e-mail has been sent, NetDefendOS will wait for **Minimum Repeat Time** seconds before sending a new e-mail.

Example 6.13. Configuring an SMTP Log Receiver

In this example, an IDP Rule is configured with an SMTP Log Receiver. Once an IDP event occurs, the Rule is triggered. At least one new event occurs within the Hold Time of 120 seconds, thus reaching the log threshold level (at least 2 events have occurred). This results in an e-mail being sent containing a summary of the IDP events. Several more IDP events may occur after this, but to prevent flooding the mail server, NetDefendOS will wait 600 seconds (10 minutes) before sending a new e-mail. An SMTP server is assumed to have been configured in the address book with the name **smtp-server**.

CLI
Adding an SMTP log receiver:

```
gw-world:/> add LogReceiver LogReceiverSMTP smt4IDP IPAddress=smtp-server
            Receiver1=youremail@yourcompany.com
```

IDP Rules:

```
gw-world:/> cc IDPRule examplerule
```

```
gw-world:/examplerule> set IDPRuleAction 1 LogEnabled=Yes
```

Web Interface
Adding an SMTP log receiver:

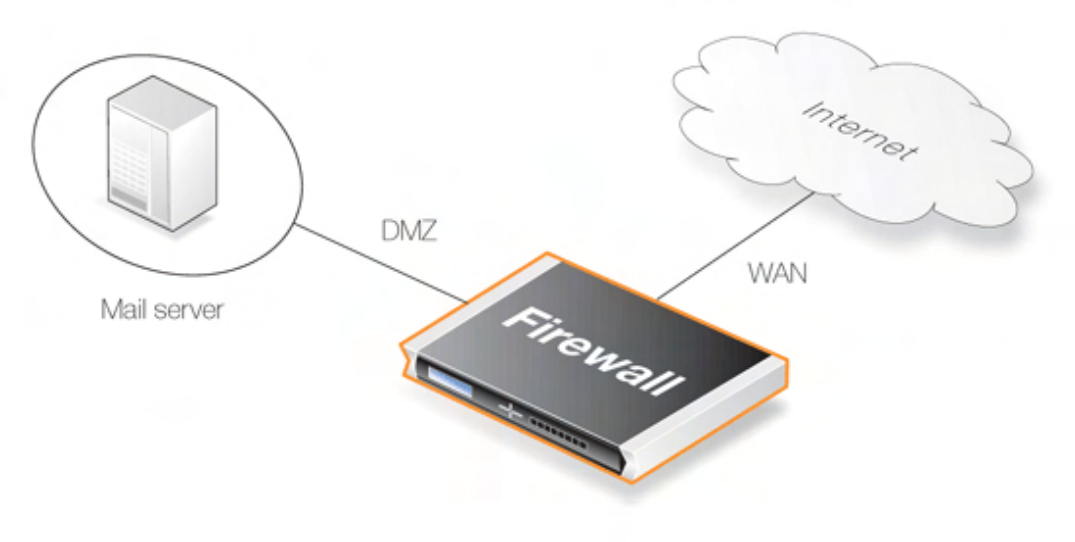
1. Go to **System > Log and Event Receivers > Add > SMTP Event Receiver**
2. Now enter:
   - **Name:** smtp4IDP
   - **SMTP Server:** smtp-server
   - **Server Port:** 25
   - Specify alternative e-mail addresses (up to 3)
   - **Sender:** hostmaster
   - **Subject:** Log event from NetDefendOS
   - **Minimum Repeat Delay:** 600
   - **Hold Time:** 120
   - **Log Threshold:** 2
   - Click **OK**.

IDP Rules:

1. Go to **IDP > IDP Rules**
2. Select a rule in the grid, right click and choose **Edit**.
3. Select the action you wish to log and choose **Edit**.
4. Check the **Enable logging** checkbox in the **Log Settings** tab.
5. Click **OK**.

Example 6.14. 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 firewall on the **WAN** interface as illustrated below.



CLI
Create IDP Rule:

```
gw-world:/> add IDPRule Service=smtp SourceInterface=wan SourceNetwork=wannet
            DestinationInterface=dmz DestinationNetwork=ip_mailserver
            Name=IDPMailSrvRule
```

Create IDP Action:

```
gw-world:/> cc IDPRule IDPMailSrvRule


gw-world:/IDPMailSrvRule> add IDPRuleAction Action=Protect
            IDPServity=All Signatures=IPS_MAIL_SMTP
```

Web Interface

Create IDP Rule:

This IDP rule will be called **IDPMailSrvRule**, and applies to the SMTP service. Source Interface and Source Network define 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 **IDP > IDP Rules > Add > IDP Rule**
2. Now enter:
   - **Name:** IDPMailSrvRule
   - **Service:** smtp
   - Also inspect dropped packets: In case all traffic matching this rule should be scanned (this also means traffic that the main rule-set would drop), the "Also inspect dropped packets" checkbox should be checked, which is the case in this example.
   - **Source Interface:** wan
   - **Source Network:** wannet
   - **Destination Interface:** dmz
   - **Destination Network:** ip_mailserver
   - Click **OK**.

If logging of intrusion attempts is desired, this can be configured in the **Log Settings** tab.

Create IDP Action:

When this IDP Rule has been created, an action must also be created, specifying what signatures the IDP should use when scanning data matching the IDP Rule, and what NetDefendOS should do in case an intrusion is discovered. Intrusion attempts should cause the connection to be dropped, so **Action** is set to **Protect**. **Severity** is set to **Attack**, in order to match all SMTP attacks. **Signatures** is set to **IPS_MAIL_SMTP** in order to use signatures that describe attacks from the external network, dealing with the SMTP protocol.

1. Go to **IDP > IDP Rules > IDPMailSrvRule > Add > IDP Rule Action**
2. Now enter:
   - **Action:** Protect
   - **Severity:** All
   - **Signatures:** IPS_MAIL_SMTP
   - Click **OK**

In summary, the following will occur: If traffic from the external network to the mail server occurs, IDP will be activated. If traffic matches any of the signatures in the **IPS_MAIL_SMTP** signature group, the connection will be dropped, thus protecting the mail server.

6.4. Anti-Virus

6.4.1. Overview

The NetDefendOS 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. NetDefendOS Anti-Virus scanning is designed to be a compliment to the standard virus 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 Anti-Virus scanning is, for some reason, not able to function.

Anti-Virus Availability on D-Link Models
Anti-Virus scanning is available on the D-Link DFL-260 and DFL-860 only.

6.4.2. Implementation

Streaming

As a file transfer is streamed through a D-Link Firewall, NetDefendOS 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 minmum amount of firewall 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 a D-Link Firewall. Once a virus is recognized in the contents of a file, the download can be terminated before it completes.

Types of Files Scanned

The NetDefendOS Anti-Virus module is able to scan the following types of downloads:

- HTTP, FTP or SMTP file downloads
- Any uncompressed file type transferred through these protocols
- If the download has been compressed, ZIP and GZIP files can be scanned

The adminstrator 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 D-Link Firewall. 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 Behaviour

Since Anti-Virus scanning is implemented through an Application Level Gateway (ALG), specific protocol specific features are implemented in NetDefendOS. 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. Activation

Association with an ALG

Activation of Anti-Virus scanning is achieved through an Application Layer Gateway (ALG) associated with the targeted protocol. For instance, an HTTP ALG with Anti-Virus enabled can be created for scanning HTTP downloads. The ALG must then be associated with a given Service which in turn is used by a particular rule defined in the IP Rule-set.

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

NetDefendOS Anti-Virus scanning is implemented by D-Link 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 NetDefendOS copy of the SafeStream database should therefore be updated regularly and this updating service is enabled as part of the subscription to the D-Link Anti-Virus subscription.

6.4.5. Subscribing to the D-Link Anti-Virus Service

The D-Link Anti-Virus feature is purchased as an additional component to the base D-Link 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 When **Enabled** Anti-Virus is active

Verify MIME type 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.

NetDefendOS can check that the file's contents matches the MIME type it claims to be. 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 C, *Anti-Virus MIME filetypes*.

Max download size The size of any single component in an single transfer can be limited.

Fail mode behaviour If a virus scan fails for any reason then the transfer can be dropped or allowed, with the event being logged.

2. File type blocking/allowing

Action When a particular download file type is encountered, the administrator can explicitly state if the file is to be allowed or blocked as a download.

File types The file type to be blocked or allowed eg. GIF, can be added into the list

If a filetype is on the allowed list then it should be noted that MIME matching will still take place even if MIME matching is switched off (providing the filetype is part of the list in Appendix C, *Anti-Virus MIME filetypes*). This is done to guard against an attack that tries to exploit the fact the filetype is on the allowed list.

3. 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.

4. Compression Ratio Limit

When scanning compressed files, NetDefendOS 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 NetDefendOS resources and noticeably slowdown throughput.

To prevent this situation, the adminstrator 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.

Example 6.15. Enabling 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 handle this traffic.

CLI
First, create an HTTP Application Layer Gateway (ALG) Object with Anti-Virus scanning enabled:

```
gw-world:/> set ALG ALG_HTTP anti_virus Antivirus=Protect
```

Then, create a Service object using the new HTTP ALG:

```
gw-world:/> add ServiceTCPUDP http_anti_virus Type=TCP DestinationPorts=80
            ALG=anti_virus
```

Finally, modify the NAT rule to use the new service:

```
gw-world:/> set IPRule NATHttp Service=http_anti_virus
```

Web Interface

A. First, create an HTTP Application Layer Gateway (ALG) Object:

1. Go to **Objects > ALG > Add > HTTP ALG**
2. Specify a suitable name for the ALG, for instance *anti_virus*
3. Click the **Antivirus** tab
4. Select **Protect** in the **Mode** dropdown list
5. Click **OK**

B. Then, create a Service object using the new HTTP ALG:

1. Go to **Local Objects > Services > Add > TCP/UDP service**
2. Specify a suitable name for the Service, for instance http_anti_virus
3. Select the **TCP** in the **Type** dropdown list
4. Enter **80** in the **Destination Port** textbox
5. Select the HTTP ALG you just created in the **ALG** dropdown list
6. Click **OK**

C. Finally, modify the NAT rule (called **NATHttp** in this example) to use the new service:

1. Go to **Rules > IP Rules**
2. In the grid control, click the NAT rule handling the traffic between **lannet** and **all-nets**

3. Click the **Service** tab
4. Select your new service, http_anti_virus, in the pre-defined **Service** dropdown list
5. Click **OK**

Anti-Virus scanning is now activated for all web traffic from **lannet** to **all-nets**.

6.5. Web Content Filtering

6.5.1. 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.

NetDefendOS 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.

6.5.2. 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.

NetDefendOS 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-malicous. 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 6.16. 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.

CLI

```
gw-world:/> set ALG ALG_HTTP content_filtering RemoveActiveX=Yes RemoveApplets=Yes
```

Web Interface

1. Go to **Objects > ALG**
2. In the grid, click on our HTTP ALG obejct, content_filtering.
3. Check the **Strip ActiveX objects (including flash)** control
4. Check the **Strip Java applets** control.
5. Click **OK**.

6.5.3. Static Content Filtering

NetDefendOS 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 a 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

Web content filtering URL blacklisting is a separate concept from Section 6.7, "Blacklisting Hosts and Networks".

Example 6.17. Setting up a white and blacklist

This example shows the use of static content filtering where NetDefendOS 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 D-Link website provides secure and necessary program files which should be allowed to download.

CLI

Start by adding an HTTP ALG in order to filter HTTP traffic:

```
gw-world:/> add ALG ALG_HTTP content_filtering
```

Then create a HTTP ALG URL to setup a blacklist:

```
gw-world:/> cc ALG ALG_HTTP content_filtering


gw-world:/content_filtering/> add ALG_HTTP_URL URL=*/*.exe Action=Blacklist
```

Finally, make an exception from the blacklist by creating a specific whitelist:

```
gw-world:/content_filtering/> add ALG_HTTP_URL URL=www.D-Link.com/*.exe
            Action=Whitelist
```

Web Interface

Start by adding an HTTP ALG in order to filter HTTP traffic:

1. Go to **Objects > ALG > Add > HTTP ALG**
2. Enter a suitable name for the ALG, for instance content_filtering.
3. Click **OK**.

Then create a HTTP ALG URL to setup a blacklist:

1. Go to **Objects > ALG**
2. In the grid, click on the recently created HTTP ALG, content_filtering and go to **Add > HTTP ALG URL.**
3. Select **Blacklist** in the **Action** dropdown control.
4. In the **URL** textbox, enter */*.exe
5. Click **OK**.

Finally, make an exception from the blacklist by creating a certain whitelist:

1. Go to **Objects > ALG**
2. In the grid, click on the recently created HTTP ALG, content_filtering and go to **Add > HTTP ALG URL.**
3. Select **Whitelist** in the **Action** dropdown control.
4. In the **URL** textbox, enter www.D-Link.com/*.exe
5. Click **OK**.

Simply continue adding specfic blacklists and whitelists until the filter satifies the needs.

6.5.4. Dynamic Content Filtering

6.5.4.1. Overview

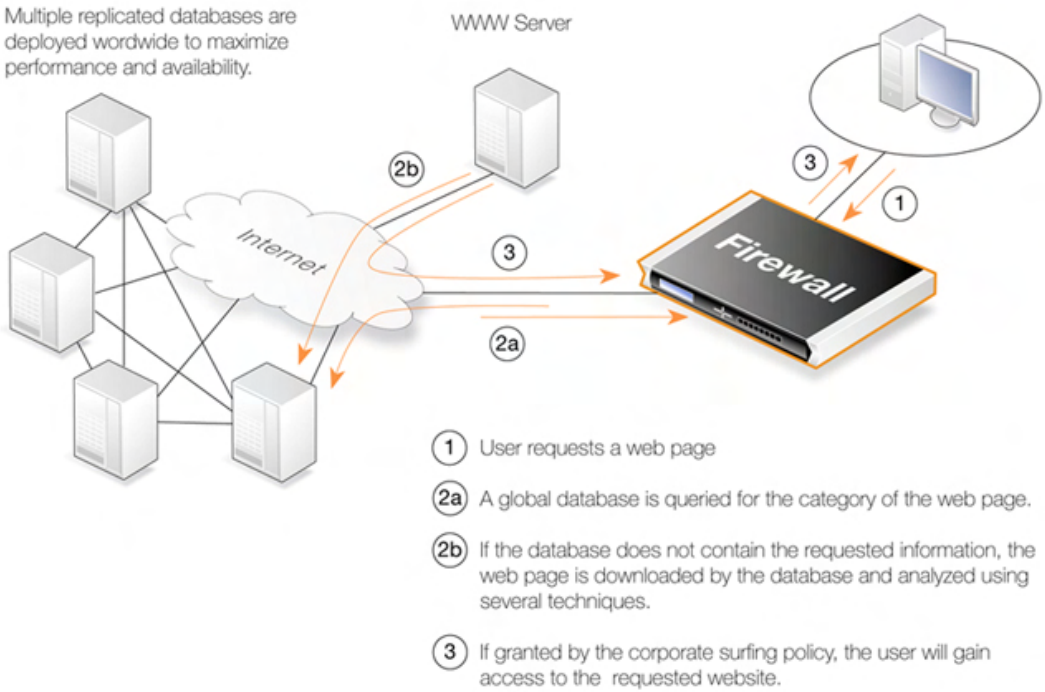
NetDefendOS supports *Dynamic Content Filtering* of web traffic, which enables an administrator to permit or block access to web pages based on the content of those web pages. This functionality is automated and it is not necessary to manually specify which URLs to block or allow. Instead, D-Link maintains 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.

Dynamic Web Content Filtering Availability on D-Link Models
Dynamic Content Filtering is available on the D-Link DFL-260 and DFL-860 only.

URL Processing Flow

When a user requests access to a web site, NetDefendOS 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 NetDefendOS 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 6.2. 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 D-Link'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 NetDefendOS receives the category for the URL. Dynamic Content Filtering therefore requires a minimum of administration effort.

Note

New, uncategorized URLs sent to the D-Link network are treated as anonymous submissions and no record of the source of new submissions is kept.

Categorizing Pages and Not Sites

NetDefendOS 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. NetDefendOS provides blocking down to the page level so that users may still access parts of websites that aren't blocked by the filtering policy.

Enabling Dynamic Content Filtering

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 NetDefendOS license. For complete details of subscription services please see Appendix A, *Subscribing to Security Updates*.

Once a subscription is taken out, content filtering is enabled through the HTTP Application Layer Gateway (ALG) in combination with Services and the IP rule-set. This makes possible the setting up of a detailed content 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".

Example 6.18. Enable Dynamic 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**.

CLI
(The NAT rule is called **NATHttp** for the CLI example)
First, create an HTTP Application Layer Gateway (ALG) Object:

```
gw-world:/> add ALG ALG_HTTP content_filtering WebContentFilteringMode=Enabled
                FilteringCategories=SEARCH_SITES
```

Then, create a Service object using the new HTTP ALG:

```
gw-world:/> add ServiceTCPUDP http_content_filtering Type=TCP DestinationPorts=80
                ALG=content_filtering
```

Finally, modify the NAT rule to use the new service:

```
gw-world:/> set IPRule NATHttp Service=http_content_filtering
```

Web Interface
First, create an HTTP Application Layer Gateway (ALG) Object:

1. Go to **Objects > ALG > Add > HTTP ALG**
2. Specify a suitable name for the ALG, for instance content_filtering

3. Click the **Web Content Filtering** tab.
4. Select **Enabled** in the **Mode** dropdown list.
5. In the **Blocked Categories** list, select **Search Sites** and click the **>>** button.
6. Click **OK**.

Then, create a Service object using the new HTTP ALG:

1. Go to **Local Objects > Services > Add > TCP/UDP service**
2. Specify a suitable name for the Service, for instance http_content_filtering
3. Select the **TCP** in the **Type** dropdown list.
4. Enter **80** in the **Destination Port** textbox.
5. Select the HTTP ALG you just created in the **ALG** dropdown list.
6. Click **OK**.

Finally, modify the NAT rule to use the new service:

1. Go to **Rules > IP Rules**
2. In the grid control, click the NAT rule handling your HTTP traffic.
3. Click the **Service** tab.
4. Select your new service, http_content_filtering, in the pre-defined **Service** dropdown 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.

6.5.4.2. 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 NetDefendOS 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 behaviour 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 6.19. Enabling Audit Mode

This example is based on the same scenario as the previous example, but now with audit mode enabled.

CLI
First, create an HTTP Application Layer Gateway (ALG) Object:

```
gw-world:/> add ALG ALG_HTTP content_filtering WebContentFilteringMode=Audit
                    FilteringCategories=SEARCH_SITES
```

Web Interface
First, create an HTTP Application Layer Gateway (ALG) Object:

1. Go to **Objects > ALG > Add > HTTP ALG**
2. Specify a suitable name for the ALG, for instance content_filtering
3. Click the **Web Content Filtering** tab.
4. Select **Audit** in the **Mode** dropdown list.
5. In the **Blocked Categories** list, select **Search Sites** and click the **>>** button.
6. Click **OK**.

The steps to then create a Service object using the new HTTP ALG and modifing the NAT rule to use the new service, are described in the previous example.

6.5.4.3. 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, NetDefendOS 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
Enabling override can result in a user being able to surf to sites that are linked to by the visited site.

6.5.4.4. 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. NetDefendOS 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 D-Link'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 6.20. 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.

CLI
First, create an HTTP Application Layer Gateway (ALG) Object:

```
gw-world:/> add ALG ALG_HTTP content_filtering WebContentFilteringMode=Enable
                    FilteringCategories=SEARCH_SITES AllowReclassification=Yes
```

Then, continue setting up the service object and modifing the NAT rule as we have done in the previous examples.

Web Interface
First, create an HTTP Application Layer Gateway (ALG) Object:

1. Go to **Objects > ALG > Add > HTTP ALG**
2. Specify a suitable name for the ALG, for instance content_filtering.
3. Click the **Web Content Filtering** tab.
4. Select **Enabled** in the **Mode** dropdown list.
5. In the **Blocked Categories** list, select **Search Sites** and click the **>>** button.
6. Check the **Allow Reclassification** control.
7. Click **OK**.

Then, continue setting up the service object and modifing 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.

6.5.4.5. Customizing the Block Web Page

The web page presented to the user can be customized to your needs by uploading a package of HTML pages to the system.

6.5.4.6. 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 (eg. a 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 advert-

isement 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, on-line 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, eg. 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.

6.6. 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 D-Link Firewall 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
- The 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.

NetDefendOS 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 the "Advanced Settings" section.

Ping of death will show up in NetDefendOS 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 attack. Many IP stacks have shown erratic behavior (excessive resource exhaustion or crashes) when exposed to overlapping fragments.

NetDefendOS protects fully against fragmentation overlap attacks. Overlapping fragments are never allowed to pass through the system.

Teardrop and its followers will show up in NetDefendOS 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 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.

NetDefendOS 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 NetDefendOS 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.

NetDefendOS 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 ser-

vices 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 NetDefendOS 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 NetDefendOS 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 NetDefendOS 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, NetDefendOS 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 at the ultimate victim side

Smurf, and its followers, are resource exhaustion attacks in that they use up Internet connection capacity. In the general case, the firewall 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 firewall.

However, NetDefendOS 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 NetDefendOS also help absorb some of the flood before it reaches protected servers.

6.6.8. TCP SYN Flood Attacks

The TCP SYN Flood attack works 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 machine until it is unable to respond to more SYN packets until the existing half-open connections have timed out.

NetDefendOS will protect against TCP SYN Flood attacks if **SynRelay** is enabled in the rule or service allowing the traffic. By default, this is the case for the **http-in**, **https-in**, **smtp-in**, and **ssh-in** services.

The "SynRelay" 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 do not occur nearly as easily in NetDefendOS due to much better resource management and lack of restrictions normally placed upon a full-blown operating system. While a normal operating system can exhibit problems with as few as 5 outstanding half-open connections, NetDefendOS can fill its entire state table (thousands or millions of connections, depending on your product model), before anything out of the ordinary happens. When the state table fills up, old outstanding SYN connections will be among the first to be dropped to make room for new connections.

TCP SYN Flood attacks will show up in NetDefendOS 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.

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.

NetDefendOS will protect completely against this attack. The first fragment will be enqueued, 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 NetDefendOS, the packets will not even get that far; they will be dropped immediately. Jolt2 attacks may or may not show up in NetDefendOS 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 favor university 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

NetDefendOS implements a *Blacklist* of host or network IP addresses which can be utilized to protect against traffic coming from specific internet sources.

Certain NetDefendOS modules, specifically the Intrusion Detection and Prevention (IDP) module, as well as Threshold Rules, can make use of the Blacklist when certain conditions are encountered, such as traffic triggering a Threshold Limit rule.

Adding a host or network to the Blacklist 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 (ie. 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 and the traffic from these sources is then blocked for a period of time. The Blacklist is maintained even if the D-Link Firewall shuts down or reboots.

Whitelisting

To ensure that "good" internet traffic sources are not blacklisted under any circumstances, a *Whitelist* is also maintained by NetDefendOS. It can be advisable to add the D-Link Firewall itself to the Whitelist as well as the IP addresses of all management workstations.

It is important to understand that although whitelisting prevents a source of network traffic being blacklisted, it still doesn't mechanisms such as Threshold Rules from dropping or denying connections from that source. All 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 6.3.7, “IDP Actions”, Section 10.2.8, “Threshold Rule Blacklisting” and Section 10.2, “Threshold Rules”.

Note

Content filtering blacklisting is a separate subject and uses a separate logical list (see Section 6.5, “Web Content Filtering”).

Chapter 7. Address Translation

This chapter describes NetDefendOS address translation capabilites.

NetDefendOS supports two types of address translation: Dynamic Address Translation (NAT) and Static Address Translation (SAT). Both types of translations are policy-based, and can thus be applied on any type of traffic through the system. Two specific types of rules, NAT and SAT rules, are used to specify address translation policies within the standard IP rule-set.

There are two main reasons for employing address translation:

- Functionality. Perhaps you use private IP addresses on your protected network and your protected hosts 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 of assistance.
- 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 your protected network and which machines are susceptible to attack. In the worst case scenario, employing address translation will mean that an intruders attack will take longer, which will also make him more visible in the firewalls log files. In the best-case scenario, the 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 what NAT and SAT rules can look like.

7.1. Dynamic Address Translation (NAT)

Dynamic Address Translation (hereinafter referred to as NAT) provides a method for translating the original source IP address to a different address. The most common usage for NAT is when you are using private IP addresses on one of your internal networks, and would like the outbound connections to appear as they are originating from the D-Link Firewall itself.

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, NetDefendOS will perform an automatic translation of the source port number as well. The source port used will be the next free port, usually one above 32768. This means that there is a limitation of about 30000 simultaneous connections using the same translated source IP address.

NetDefendOS 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 NetDefendOS 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 D-Link Firewall.

The following example illustrates how NAT is applied in practice on a new connection:

1. The sender, e.g. 192.168.1.5, sends a packet from a dynamically assigned port, for instance, port 1038, to a server, e.g. 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 D-Link Firewall, usually one above 32768. 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. NetDefendOS 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 Policy

To add a policy that will perform address translation for all HTTP traffic originating from the internal network, follow the steps outlined below:

CLI

```
gw-world:/> add IPRule Action=NAT Service=http SourceInterface=lan
            SourceNetwork=lannet DestinationInterface=any
            DestinationNetwork=all-nets Name=NAT_HTTP NATAction=UseInterfaceAddress
```

Web Interface

1. Go to **Rules > IP Rules > Add > IPRule**
2. Specify a suitable name for the rule, for instance NAT_HTTP.
3. Now enter:
   - **Action:** NAT
   - **Service:** http
   - **Source Interface:** lan
   - **Source Network:** lannet
   - **Destination Interface:** any
   - **Destination Network:** all-nets
4. Under the **NAT** tab, make sure that the **Use Interface Address** option is selected.
5. Click **OK**.

7.1.1. Which Protocols can NAT handle?

Dynamic address translation is able to handle the TCP, UDP and ICMP protocols with a good level of functionality since the algorithm knows of values that can be adjusted to become unique in the three protocols. For other IP level protocols, unique connections are identified by their sender ad-

dresses, 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, e.g. OSPF, L2TP, etc. They do not apply to "protocols" transported by TCP, UDP and ICMP such as telnet, FTP, HTTP, SMTP, etc. NetDefendOS 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. Static Address Translation (SAT)

NetDefendOS can translate entire ranges of IP addresses and/or ports. Such translations are transpositions, that is, 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. This functionality is known as Static Address Translation, hereinafter referred to as SAT.

Unlike NAT, a SAT policy requires more than a single SAT rule to function. NetDefendOS 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 system execute the static address translation.

7.2.1. Translation of a Single IP Address (1:1)

The simplest form of SAT is translation of a single IP address. A very common usage for this type of SAT is to enable external users to access a protected server having a private address. This scenario is also commonly referred to as *Virtual IP* or *Virtual Server* in other types of products.

Example 7.2. 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 D-Link Firewall is connected to the Internet using the wan interface with address object wan_ip (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.

CLI
First create a SAT rule:

```
gw-world:/> add IPRule Action=SAT Service=http SourceInterface=any
            SourceNetwork=all-nets DestinationInterface=core
            DestinationNetwork=wan_ip SATTranslate=DestinationIP
            SATTranslateToIP=10.10.10.5 Name=SAT_HTTP_To_DMZ
```

Then create a corresponding Allow rule:

```
gw-world:/> add IPRule action=Allow Service=http SourceInterface=any
            SourceNetwork=all-nets DestinationInterface=core
            DestinationNetwork=wan_ip Name=Allow_HTTP_To_DMZ
```

Web Interface
First create a SAT rule:

1. Go to **Rules > IP Rules > Add > IPRule**
2. Specify a suitable name for the rule, for instance SAT_HTTP_To_DMZ.
3. Now enter:
   - **Action:** SAT
   - **Service:** http
   - **Source Interface:** any
   - **Source Network:** all-nets
   - **Destination Interface:** core
   - **Destination Network:** wan_ip
4. Under the **SAT** tab, make sure that the **Destination IP Address** option is selected.
5. In the **New IP Address** textbox, enter 10.10.10.5
6. Click **OK**.

Then create a corresponding Allow rule:

1. Go to **Rules > IP Rules > Add > IPRule**
2. Specify a suitable name for the rule, for instance Allow_HTTP_To_DMZ.
3. Now enter:
   - **Action:** Allow
   - **Service:** http
   - **Source Interface:** any
   - **Source Network:** all-nets
   - **Destination Interface:** core
   - **Destination Network:** wan_ip
4. Under the **Service** tab, select **http** in the **Pre-defined** dropdown list.
5. 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	wan_ip	http SETDEST 10.10.10.5 80
2	Allow	any	all-nets	core	wan_ip	http

These two rules allow us to access the web server via the D-Link Firewall'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?

Well, 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 wan_ip 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 whatsoever. Both solutions work just as well.

However, suppose that we use another interface, ext2, in the D-Link Firewall 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	wan_ip	http SETDEST 10.10.10.5 80
2	Allow	wan	all-nets	core	wan_ip	http
3	Allow	ext2	ext2net	core	wan_ip	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	wan_ip	http SETDEST 10.10.10.5 80
2	NAT	lan	lannet	any	all-nets	All
3	Allow	any	all-nets	core	wan_ip	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 7.3. 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 D-Link Firewall'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	wan_ip	http SETDEST wwwsrv 80
2	Allow	any	all-nets	core	wan_ip	http

These two rules allow us to access the web server via the D-Link Firewall'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:

- wan_ip (195.55.66.77): a public IP address
- lan_ip (10.0.0.1): the D-Link Firewall'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 wan_ip to reach "www.ourcompany.com":
  10.0.0.3:1038 => **195.55.66.77:80**
- NetDefendOS 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 D-Link Firewall. 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	wan_ip	http SETDEST wwwsrv 80
2	NAT	lan	lannet	any	all-nets	All
3	Allow	any	all-nets	core	wan_ip	http

- PC1 sends a packet to wan_ip to reach "www.ourcompany.com":
  10.0.0.3:1038 => **195.55.66.77:80**
- NetDefendOS 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.

7.2.2. 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 of addresses, where the first original IP address will be translated to the first IP address in the translation list and so forth.

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 7.4. 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 D-Link Firewall 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.

CLI
Create an address object for the public IP addresses:

```
gw-world:/> add Address IP4Address wwwsrv_pub Address=195.55.66.77-195.55.66.81
```

Now, create another object for the base of the web server IP addresses:

```
gw-world:/> add Address IP4Address wwwsrv_priv_base Address=10.10.10.5
```

Publish the public IP addresses on the wan interface using ARP publish. One ARP item is needed for every IP address:

```
gw-world:/> add ARP Interface=wan IP=195.55.66.77 mode=Publish
```

Repeat for all the five public IP addresses. Create a SAT rule for the translation:

```
gw-world:/> add IPRule Action=SAT Service=http SourceInterface=any
            SourceNetwork=all-nets DestinationInterface=core
            DestinationNetwork=wwwsrv_pub SATTranslateToIP=wwwsrv_priv_base
            SATTranslate=DestinationIP
```

Finally, create a corresponding Allow Rule:

```
gw-world:/> add IPRule Action=Allow Service=http SourceInterface=any
            SourceNetwork=all-nets DestinationInterface=core
            DestinationNetwork=wwwsrv_pub
```

Web Interface
Create an address object for the public IP address:

1. Go to **Objects > Address Book > Add > IP address**
2. Specify a suitable name for the object, for instance wwwsrv_pub.
3. Enter 195.55.66.77-195.55.66.77.81 in the **IP Address** textbox.
4. Click **OK**.

Now, create another address object for the base of the web server IP addresses:

1. Go to **Objects > Address Book > Add > IP address**
2. Specify a suitable name for the object, for instance wwwsrv_priv_base.
3. Enter 10.10.10.5 in the **IP Address** textbox.
4. Click **OK**.

Publish the public adresses in the wan interface using ARP publish. One ARP item is needed for every IP address:

1. Go to **Interfaces > ARP > Add > ARP**
2. Now enter:
   - **Mode:** Publish
   - **Interface:** wan
   - **IP Address:** 195.55.66.77
3. Click **OK** and repeat for all the five public IP addresses.

Create a SAT rule for the translation:

1. Go to **Rules > IP Rules > Add > IPRule**
2. Specify a suitable name for the rule, for instance SAT_HTTP_To_DMZ.
3. Now enter:
   - **Action:** SAT
   - **Servce:** http
   - **Source Interface:**any
   - **Source Network:** all-nets
   - **Destination Interface:** core
   - **Destination Network:** wwwsrv_pub
4. Switch to the **SAT** tab.
5. Make sure that the **Destination IP Address** option is selected.
6. In the **New IP Address** dropdown list, select wwwsrv_priv.
7. Click **OK**.

Finally, create a corresponding Allow Rule:

1. Go to **Rules > IP Rules > Add > IPRule**
2. Specify a suitable name for the rule, for instance Allow_HTTP_To_DMZ.
3. Now enter:
   - **Action:** Allow
   - **Service:** http
   - **Source Interface:**any
   - **Source Network:** all-nets
   - **Destination Interface:** core
   - **Destination Network:** wwwsrv_pub
4. Click **OK**.

7.2.3. All-to-One Mappings (N:1)

NetDefendOS 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	core	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 0.0.0.0/0 is the destination, All-to-One mapping is always done.

7.2.4. Port Translation

Port Translation, also known as PAT (Port Address Translation), 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	core	wwwsrv_pub	TCP 80-85 SETDEST 192.168.0.50 1080

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 transation, a Custom Service must be used with the SAT Rule.

7.2.5. Which Protocols can SAT handle?

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 firewall 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*. NetDefendOS supports a number of such Application Layer Gateways and for more information please see Section 6.2, “Application Layer Gateways”.

7.2.6. Which SAT Rule is executed if several are matching?

NetDefendOS 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 firewall 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.

7.2.7. 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	wan_ip	http SETDEST wwwsrv 80
2	SAT	lan	wwwsrv	any	all-nets	80 -> All SETSRC wan_ip 80
3	FwdFast	any	all-nets	core	wan_ip	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 wan_ip: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 wan_ip:80. Correct.
- Internal traffic to wan_ip: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	wan_ip	http SETDEST wwwsrv 80
2	SAT	lan	wwwsrv	any	all-nets	80 -> All SETSRC wan_ip 80
3	NAT	lan	lannet	any	all-nets	All
4	FwdFast	any	all-nets	core	wan_ip	http
5	FwdFast	lan	wwwsrv	any	all-nets	80 -> All

What happens now?

- External traffic to wan_ip: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	wan_ip	http SETDEST wwwsrv 80
2	SAT	lan	wwwsrv	any	all-nets	80 -> All SETSRC wan_ip 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 wan_ip:80 will match rules 1 and 5, and will be sent to wwwsrv. Correct.
- Return traffic from wwwsrv:80 will match rules 2 and 3. Correct.
- Internal traffic to wan_ip:80 will match rules 1 and 4, and will be sent to wwwsrv. The sender address will be the D-Link Firewall's internal IP address, guaranteeing that return traffic passes through the firewall.
- Return traffic will automatically be handled by the D-Link Firewall's stateful inspection mechanism.

Chapter 8. User Authentication

This chapter describes how NetDefendOS implements user authentication.

8.1. Overview

Before any user service request is authorized by firewall's security policies, NetDefendOS needs to verify the identity of that user through a process of authentication.

8.1.1. Authentication Methods

The aim of the authentication process is to have the user prove their identity. What the user supplies as 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 as X.507 Digital Certificates, Passcard, or Public and Private Keys.

C. Something the user knows such as a password.

Method A requires some special devices to scan and read the feature presented, which is often expensive. Another problem is that the feature usually can't be replaced if becomes lost. Methods B and C are therefore the most common in network security. However these also can have drawbacks. Keys, for example, might be intercepted, cards might be stolen, people might choose weak passwords that are easily guessed, or they may be simply bad at keeping a secret. Methods B and C are therefore often combined. An example of this is a passcard that requires a password or pincode for use.

User authentication is frequently used in services, such as HTTP, FTP, and VPN. NetDefendOS uses a Username/Password combination as the primary authentication method, strengthened by encryption algorithms. More advanced and secure means of authentication include Public-Private Keys, X.509 Certificates, IPsec/IKE, IKE XAuth, and ID Lists.

8.1.2. Choosing Passwords

In attempting to penetrate networks and obtain user or administrator's privileges, passwords are often subject to attacks by guesswork or systematic searches. To counter this, a password 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

Passwords should also:

- Not be recorded anywhere in written form
- Never be revealed to anyone

- Changed on a regular basis

Good passwords help secure networks, including Layer 2 tunnels, which use passwords for encryption.

8.1.3. User Types

NetDefendOS has authentication schemes which support diverse user types. These can be:

- Administrators
- Normal users accessing a network
- PPPoE/PPTP/L2TP users using PPP authentication methods
- IPsec/IKE users - the entities authenticate during the IKE negotiation phases (implemented by Pre-shared Keys or Certificates).
- IKE XAuth users - an extension to IKE authentication, occurring between negotiation phase 1 and phase 2
- User groups - collections of users that are subject to same security restrictions

8.2. Authentication Components

NetDefendOS can either use a locally stored database, or a database on an external server to provide user authentication.

8.2.1. The Local User Database (UserDB)

The Local User Database is a built-in registry inside NetDefendOS which contains the profiles of authorized users and user groups. Users' names and passwords can be configured into this database, and users with the same privileges can be collected together into groups to make administration easier.

A user can be stored as a member into more than one group and any change made to the group propagates to each group member. Passwords are stored in the configuration using reversible cryptography. This is in order to be compatible with various challenge-response authentication methods such as CHAP. When the local user database is enabled, NetDefendOS consults its internal user profiles to authenticate the user before approving any user's request.

8.2.2. External Authentication Servers

In a larger network topology with a potentially large administration workload, it is preferable to have a central database on a dedicated server or cluster of servers to handle authentication information. When there is more than one D-Link Firewall in the network and thousands of users, the administrator then doesn't have to maintain separate authentication databases on each firewall. Instead, the external authentication server can validate usernames and passwords against its central database by responding to requests from each D-Link Firewall. To provide this feature, NetDefendOS supports the *Remote Authentication Dial-in User Service* (RADIUS) for server authentication.

NetDefendOS, acting as a RADIUS client, sends user credentials and connection parameter information in the form of a RADIUS message to a RADIUS server. The server authenticates and authorizes the request, and sends back a RADIUS message in response. RADIUS authentication messages are sent as UDP messages via UDP port 1812. One or more external servers can be defined in the firewall.

To provide security for RADIUS messages, a common *shared secret* is configured on both the RADIUS client and the server. This shared secret enables encryption of the user's password when the RADIUS message is transmitted from the RADIUS client to the server, and is commonly configured as a relatively long text string. This string can contain up to 100 characters and is case sensitive.

RADIUS uses PPP to transfer a username/password request between client and RADIUS server, as well as using PPP authentication schemes such as PAP and CHAP.

8.2.3. Authentication Agents

Four different agents built into NetDefendOS can be used to perform username/password authentication. They are:

- HTTP - Authentication via web browsing. Users surf to the firewall and login either through an HTML form or a "401 - Authentication Required" dialog.
- HTTPS - Authentication via secure web browsing. Similar to HTTP agent except that host and root certificates are used to establish the SSL connection to the firewall.
- XAUTH - Authentication during an IKE negotation in setting up an IPsec VPN tunnel if the tunnel has been configured to require XAUTH authentication.
- PPP - Authentication when PPTP/L2TP tunnels are set up (if the PPTP/L2TP tunnel has been configured to require user authentication).

8.2.4. Authentication Rules

A user authentication rule specifies:

- From where (i.e. receiving interface, source network) users are allowed to authenticate themselves at the firewall.
- Which agent will be used by NetDefendOS to prompt users for authentication.
- Where is the location of the database that NetDefendOS. consults to perform authentication. Is it the local database or from an external server?
- Timeouts that logout authenticated users automatically.

Note

When using XAUTH agent, there is no need to specify the receiving interface, or source network, as this information is not available at the XAUTH phase. For the same reason, only one XAUTH user authentication rule can be defined. XAUTH is only used to set up IPsec VPN tunnels.

8.3. Authentication Process

NetDefendOS performs user authentication in the following series of steps:

- A user creates a new connection to the firewall.
- NetDefendOS sees the new user connection on an interface, and checks the IP Rule-set to see if their is an authentication policy set for traffic on this interface and coming from this network.
- According to the authentication policy specified in the matching IP Rule, NetDefendOS prompts the user with an authentication request.
- The user replies by entering their identification information which could be a username/password pair.
- NetDefendOS validates the information with respect to the authentication source specified in the authentication rule. This will be either the local NetDefendOS database or an external database in a RADIUS server will be taken.
- If a matching entry in the database is found, NetDefendOS responds with an approval message, otherwise rejection.
- NetDefendOS then forwards the approved user's further service requests to their desired destinations, if the service is allowed by an IP rule explicitly and the user is a member of the user(s)/group(s) defined on the address object of that rule. Requests from those failing the authentication step are discarded.
- After a certain time period, the authenticated user will be automatically logged out according to the timeout restrictions defined in the authentication rule.

Example 8.1. Creating an authentication user group

In the example of an authentication address object in the Address Book, a user group "users" is used to enable user authentication on "lannet". This example shows how to configure the user group in the NetDefendOS database.

Web Interface

Step A

1. Go to **User Authentication > Local User Databases > Add > LocalUserDatabase**
2. Now enter:
   - **Name:** lannet_auth_users
   - **Comments:** folder for "lannet" authentication user group - "users"
3. Click **OK**

Step B

1. Go to **lannet_auth_users > Add > User**
2. Now enter:
   - **Username:** Enter the user's account name here, e.g. "user1"
   - **Password:** Enter the user's password
   - **Confirm Password:** Repeat the password

- **Groups:** One user can be specified into more than one group. Enter the group names here separated by comma, e.g. "users" for this example.

3. Click **OK**.
4. Repeat Step B. to add all the "lannet" users having the membership of "users" group into the **lannet_auth_users** folder.

Note

*There are two default user groups, the administrators group and the auditors group. Users that are members of the administrators group are allowed to change the NetDefendOS configuration, while users that belong to the auditors group are only allowed to view the configuration. Press the buttons under the **Groups** edit box to grant these group memberships to a user.*

Chapter 9. Virtual Private Networks

This chapter describes VPN usage with NetDefendOS.

9.1. VPN overview

9.1.1. The need for VPNs

Most networks today are connected to each other by the Internet. Business increasingly utilizes the Internet since it offers efficient and inexpensive communication. Issues of protecting local networks from Internet-based intrusion are being solved by firewalls, intrusion detection systems and other security investments.

Private as well as corporate communication requires a means for data to travel across 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 information, i.e. pretending to be someone else. VPNs meet this need, providing a highly cost efficient means of establishing secure links to parties that one wishes to exchange information with in a secure manner.

9.1.2. The basics of VPN Encryption

Cryptography provides the means to create VPNs across the Internet with no additional investments in connectivity. 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. Planning a VPN

An attacker wishing to make use of 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 on 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 a much easier task.

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

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.

A VPN connection should never be regarded as an integral part of a protected network. The VPN firewall should instead be located in a special DMZ or outside a firewall 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 firewall features an integrated VPN feature, it is usually possible to dictate the types of communication permitted. The NetDefendOS VPN module features such a facility.

9.1.3.1. Key Distribution

Key distribution schemes are best planned ahead of time. Issues that need to be addressed include:

- How will keys be distributed? Email is not a good idea. Phone conversations might be secure enough.
- How many different keys should be used? One key per user? One key per group of users? One key per LAN-to-LAN connection? One key for all users and one key for all LAN-to-LAN connections? You are probably better off using more keys than you think necessary today, since it becomes 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 firewall, 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. IPsec

9.2.1. IPsec Basics

9.2.1.1. Introduction to IPsec

IPsec, Internet Protocol Security, is a set of protocols defined by the IETF, Internet Engineering Task Force, 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.

9.2.1.2. IKE, Internet Key Exchange

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

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 cryptanalysis perspective.

The IPsec lifetime is generally shorter than the IKE lifetime. 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.

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 firewalls 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 too 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 intially 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 NetDefendOS 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 D-Link Firewalls 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 0.0.0.0/0, 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 D-Link Firewall, e.g. 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 D-Link 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 firewalls 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

D-Link Firewalls 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 NetDefendOS 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 NetDefendOS IPsec are:

- SHA1
- MD5

IKE DH (Diffie-Hellman) Group

This specifies the Diffie-Hellman group to use when doing key exchanges in IKE.

The Diffie-Hellman groups supported by D-Link Firewall VPNs are:

- DH group 1 (768-bit)
- DH group 2 (1024-bit)
- DH group 5 (1536-bit)

The security of the key exchanges increase as the DH groups grow larger, as does the time of the exchanges.

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.

PFS

With 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, Perfect Forwarding Secrecy, 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.

IPsec DH Group

This is a Diffie-Hellman group much like the one for IKE. However, this one is used solely for PFS.

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 D-Link Firewall 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 D-Link Firewall 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.

9.2.1.3. IKE Authentication Methods (Manual, PSK, Certificates)

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
D-Link Firewalls do not support 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.

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 en-

cryption/authentication key always, no anti-replay services, and it is not very flexible. There is also no way of assuring that the remote host/firewall 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.

Pre-Shared Keys

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.

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.

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 firewalls? 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 firewall 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.

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.

Disadvantages

Added complexity. Certificate-based authentication may be used as part of a larger public key infrastructure, making all VPN clients and firewalls 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.

9.2.1.4. IPsec Protocols (ESP/AH)

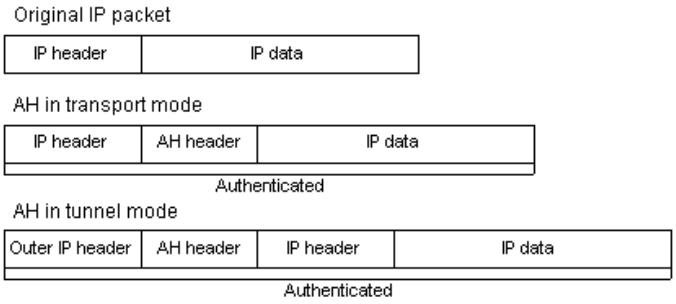
The IPsec protocols are the protocols used to protect the actual traffic being passed through the VPN. The actual protocols used and the keys used with those protocols are negotiated by IKE.

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. It 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.

Figure 9.1. The AH protocol



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.

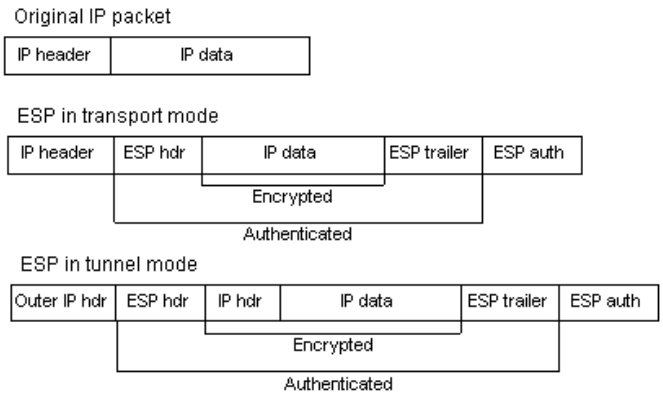
ESP (Encapsulating Security Payload)

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 9.2. The ESP protocol



9.2.1.5. 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. NetDefendOS 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. NetDefendOS 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 has support for it. For this purpose, NAT traversal aware VPNs send out a special "vendor ID", telling the other end that it understand NAT traversal, and which specific versions of the draft it supports.

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.

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 to 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.

Another problem NAT traversal resolves is that the ESP protocol is an IP protocol. There is no port information like in TCP and UDP, which makes it impossible to have more than one NATed client connected to the same remote gateway and the same time. Because of this, ESP packets are encapsulated in UDP. The 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 communications are done over port 4500. Keepalive packets are also being sent periodically to keep the NAT mapping alive.

NAT Traversal Configuration

Most NAT traversal functionality is completely automatic and in the initiating firewall no special configuration is needed. However for responding firewalls two points should be noted:

- On responding firewalls, 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 firewall 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 firewalls have the same external IP address.
  - **IP** - An IP address can be manually entered

- **DNS** - A DNS address can be manually entered
- **E-mail** - An email address can be manually entered

9.2.2. 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 firewall 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 firewall one after another until a matching proposal is found. Several proposal lists can be defined in NetDefendOS for different VPN scenarios. Two IKE proposal lists and two IPsec proposal lists are defined by default in NetDefendOS.

The ike-roamingclients and esp-tn-roamingclients proposal lists are suitable for VPN tunnels that are used for roaming VPN clients. These proposal lists are compatible with the default proposal lists in the D-Link VPN Client.

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.

CLI
First create a list of IPsec Algorithms:

```
gw-world:/> add IPsecAlgorithms esp-l2tptunnel DESEnabled=Yes DES3Enabled=Yes
            SHA1Enabled=Yes MD5Enabled=Yes
```

Then, apply the proposal list to the IPsec tunnel:

```
gw-world:/> set Interface IPsecTunnel MyIPsecTunnel IPsecAlgorithms=esp-l2tptunnel
```

Web Interface
First create a list of IPsec Algorithms:

1. Go to **Objects > VPN Objects > IKE Algorithms > Add > IPsec Algorithms**
2. Enter a name for the list eg. esp-l2tptunnel.
3. Now check the following:
   - **DES**
   - **3DES**
   - **SHA1**
   - **MD5**
4. Click **OK**

Then, apply the proposal list to the IPsec tunnel:

1. Go to **Interfaces > IPsec**
2. In the grid control, click the target IPsec tunnel
3. Select the recently created **esp-l2tptunnel** in the **IPsec Algorithms** control.
4. Click **OK**

9.2.3. 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.

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.

CLI
First create a Pre-shared Key:

```
gw-world:/> add PSK MyPSK Type=HEX PSKHex=<enter the key here>
```

Then, apply the Pre-shared Key to the IPsec tunnel:

```
gw-world:/> set Interface IPsecTunnel MyIPsecTunnel PSK=MyPSK
```

Web Interface

First create a Pre-shared Key:

1. Go to **Objects > Authentication Objects > Add > Pre-shared key**
2. Enter a name for the pre-shared key eg. MyPSK
3. Choose **Hexadecimal Key** and click **Generate Random Key** to generate a key to the **Passphrase** textbox.
4. Click **OK**

Then, apply the pre-shared key to the IPsec tunnel:

1. Go to **Interfaces > IPsec**
2. In the grid control, click the target IPsec tunnel object
3. Under the **Authentication** tab, choose **Pre-shared Key** and select **MyPSK**
4. Click **OK**

9.2.4. Identification Lists

When X.509 certificates are used as authentication method for IPsec tunnels, the D-Link Firewall will accept all remote firewalls 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 firewall 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 an X.509 certificate. Identification lists can thus be used to regulate what X.509 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.

CLI
First create an Identification List:

```
gw-world:/> add IDList MyIDList
```

Then, create an ID:

```
gw-world:/> cc IDList MyIDList


gw-world:/MyIDList> add ID JohnDoe Type=DistinguishedName
            CommonName="John Doe" OrganizationName=D-Link
            OrganizationalUnit=Support Country=Sweden
            EmailAddress=john.doe@D-Link.com


gw-world:/MyIDList> cc
```

Finally, apply the Identification List to the IPsec tunnel:

```
gw-world:/> set Interface IPsecTunnel MyIPsecTunnel AuthMethod=Certificate
            IDList=MyIDList RootCertificates=AdminCert GatewayCertificate=AdminCert
```

Web Interface
First create an Identification List:

1. Go to **Objects > VPN Objects > ID List > Add > ID List**
2. Enter a name for the identification list eg. MyIDList
3. Click **OK**

Then, create an ID:

1. Go to **Objects > VPN Objects > ID List**
2. In the grid control, click on **MyIDList**
3. Enter a name for the ID eg. JohnDoe.
4. Select **Distinguished name** in the **Type** control
5. Now enter:

- **Common Name:** John Doe
- **Organization Name:**D-Link
- **Organizational Unit:** Support
- **Country:** Sweden
- **Email Address:** john.doe@D-Link.com

6. Click **OK**.

Finally, apply the Identification List to the IPsec tunnel:

1. Go to **Interfaces > IPsec**
2. In the grid control, click on the IPsec tunnel object of interest.
3. Under the **Authentication** tab, choose **X.509 Certificate**
4. Select the appropriate certificate in the **Root Certificate(s)** and **Gateway Certificate** controls.
5. Select **MyIDList** in the **Identification List**.
6. Click **OK**

9.3. IPsec Tunnels

9.3.1. Overview of IPsec tunnels

An IPsec Tunnel defines an endpoint of an encrypted tunnel. Each IPsec Tunnel is interpreted as a logical interface by NetDefendOS, with the same filtering, traffic shaping and configuration capabilities as regular interfaces.

When another D-Link Firewall or D-Link VPN Client (or any IPsec compliant product) tries to establish a IPsec VPN tunnel to the D-Link Firewall, 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 NetDefendOS 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, NetDefendOS tries to find an established IPsec tunnel that matches the criteria. If not found, NetDefendOS will try to establish a tunnel to the remote firewall 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 firewall therefore does not need to be allowed in the rule-set. This behaviour can be changed in the **IPsec Advanced Settings** section.*

9.3.2. LAN to LAN tunnels with a Pre-shared Key

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 D-Link Firewall is therefore the implementor 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:

- Set up a Pre-shared Key or secret for the VPN tunnel.
- Set up the **VPN tunnel properties**.
- Set up the **Route** .
- Set up the **Rules** (2-way tunnel requires 2 rules).

9.3.3. 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 NetDefendOS 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 D-Link Firewall 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, irrspective 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 NetDefendOS.

9.3.3.1. PSK based client tunnels

Example 9.4. Setting up a PSK based VPN tunnel for roaming clients

This example describes how to configure an IPsec tunnel at the head office D-Link Firewall 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 firewall IP wan_ip.

Web Interface

A. Create a pre-shared key for IPsec authentication:

1. Go to **Objects > Authentication Objects > Add > Pre-Shared Key**
2. Now enter:
   - **Name:** Enter a name for the pre-shared key, SecretKey for instance
   - **Shared Secret:** Enter a secret passphrase
   - **Confirm Secret:** Enter the secret passphrase again
3. Click **OK**.

B. Configure the IPsec tunnel:

1. Go to **Interfaces > IPsec > Add > IPsec Tunnel**
2. Now enter:
   - **Name:** RoamingIPsecTunnel
   - **Local Network:** 10.0.1.0/24 (This is the local network that the roaming users will connect to)
   - **Remote Network:** all-nets
   - **Remote Endpoint:** (None)
   - **Encapsulation Mode:** Tunnel
3. For Algorithms enter:
   - **IKE Algorithms:** Medium or High
   - **IPsec Algorithms:** Medium or High
4. For Authentication enter:
   - **Pre-Shared Key:** Select the pre-shared key created earlier

5. Under the **Routing** tab:
   - Enable the option: **Dynamically add route to the remote network when a tunnel is established.**
6. Click **OK**.

C. Finally configure the IP rule-set to allow traffic inside the tunnel.

9.3.3.2. Self-signed Certificate based client tunnels

Example 9.5. 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 D-Link Firewall 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 firewall IP wan_ip.

Web Interface

A. Create a Self-signed Certificate for IPsec authentication:

1. Go to **Objects > Authentication Objects > Add > Certificate**
2. Click **OK**.

B. Import all the clients self-signed certificates:

1. Go to **Objects > Authentication Objects > Add > Certificate**
2. Click **OK**.

C. Create Identification Lists:

1. Go to **Objects > VPN Objects > ID List > Add > ID List**
2. Enter a descriptive **name**, in this example *sales*.
3. Click **OK**.
4. Go to **Objects > VPN Objects > ID List > Sales > Add > ID**
5. Enter the **name** for the client.
6. Select **Email** as **Type**.
7. In the **Email address** field, enter the email address selected when you created the certificate on the client.
8. 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 > Add > IPsec Tunnel**
2. Now enter:
   - **Name:** RoamingIPsecTunnel
   - **Local Network:** 10.0.1.0/24 (This is the local network that the roaming users will connect to)
   - **Remote Network:** all-nets
   - **Remote Endpoint:** (None)
   - **Encapsulation Mode:** Tunnel

3. For Algorithms enter:
   - **IKE Algorithms:** Medium or High.
   - **IPsec Algorithms:** Medium or High.
4. For Authentication enter:
   - Choose X.509 Certificate as authentication method
   - **Root Certificate(s):** Select all your client certificates and add them to the **Selected** list
   - **Gateway Certificate:** Choose your newly created firewall certificate
   - **Identification List:** Select your ID List that you want to associate with your VPN Tunnel. In our case that will be **sales**
5. Under the **Routing** tab:
   - Enable the option: **Dynamically add route to the remote network when a tunnel is established.**
6. Click **OK**.

E. Finally configure the IP rule-set to allow traffic inside the tunnel.

9.3.3.3. CA Server issued Certificates based client tunnels

Setting up client tunnels using a Certification Authority issued X.509 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 aquire 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, “X.509 Certificates”.

It is the responsibility of the administrator to aquire 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, “X.509 Certificates”.

Example 9.6. 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 D-Link Firewall 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 firewall IP wan_ip.

Web Interface

A. Create a Self-signed Certificate for IPsec authentication:

1. Go to **Objects > Authentication Objects > Add > Certificate**
2. Click **OK**.

B. Import all the clients self-signed certificates:

1. Go to **Objects > Authentication Objects > Add > Certificate**
2. Click **OK**.

C. Create Identification Lists:

1. Go to **Objects > VPN Objects > ID List > Add > ID List**
2. Enter a descriptive **name**, in this example *sales*.
3. Click **OK**.
4. Go to **Objects > VPN Objects > ID List > Sales > Add > ID**
5. Enter the **name** for the client.
6. Select **Email** as **Type**.
7. In the **Email address** field, enter the email address selected when you created the certificate on the client.
8. 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 > Add > IPsec Tunnel**
2. Now enter:
   - **Name:** RoamingIPsecTunnel
   - **Local Network:** 10.0.1.0/24 (This is the local network that the roaming users will connect to)
   - **Remote Network:** all-nets
   - **Remote Endpoint:** (None)
   - **Encapsulation Mode:** Tunnel
3. For Algorithms enter:
   - **IKE Algorithms:** Medium or High.
   - **IPsec Algorithms:** Medium or High.
4. For Authentication enter:
   - Choose X.509 Certificate as authentication method
   - **Root Certificate(s):** Select your CA server root certificate imported earlier and add it to the **Selected** list
   - **Gateway Certificate:** Choose your newly created firewall certificate
   - **Identification List:** Select your ID List that you want to associate with your VPN Tunnel. In our case that will be **sales**
5. Under the **Routing** tab:
   - Enable the option: **Dynamically add route to the remote network when a tunnel is established.**
6. Click **OK**.

9.3.4. Fetching CRLs from an alternate LDAP server

An X.509 root certificate usually includes the IP address or hostname of the Certificate Authority to contact when certificates or Certificate Revocation Lists need to be downloaded to the D-Link Firewall. 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 9.7. Setting up an LDAP server

This example shows how to manually setup and specify a LDAP server.

CLI

```
gw-world:/> add LDAPServer Host=192.168.101.146 Username=myusername
            Password=mypassword Port=389
```

Web Interface

1. Go to **Objects > VPN Objects > LDAP > Add > LDAP Server**
2. Now enter:
   - **IP Address:** 192.168.101.146
   - **Username:** myusername
   - **Password:** mypassword
   - **Confirm Password:** mypassword
   - **Port:** 389
3. Click **OK**

9.4. 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.

9.4.1. PPTP

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 D, *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 D-Link Firewall, 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 D-Link Firewall. 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 9.8. 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.

CLI

```
gw-world:/> add Interface L2TPServer MyPPTPServer ServerIP=lan_ip Interface=any
            IP=wan_ip IPPool=pp2p_Pool TunnelProtocol=PPTP AllowedRoutes=all-nets
```

Web Interface

1. Go to **Interfaces > L2TP Servers > Add > L2TPServer**
2. Enter a name for the PPTP Server e.g. MyPPTPServer.
3. Now enter:
   - **Inner IP Address:** lan_ip
   - **Tunnel Protocol:** PPTP
   - **Outer Interface Filter:** any
   - **Outer Server IP:** wan_ip
4. Under the **PPP Parameters** tab, select **pptp_Pool** in the **IP Pool** control
5. Under the **Add Route** tab, select **all_nets** from **Allowed Networks**
6. 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 will not be covered in this example.

9.4.2. L2TP

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 D-Link Firewall 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 9.9. 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.

CLI

```
gw-world:/> add Interface L2TPServer MyL2TPServer ServerIP=ip_l2tp
            Interface=l2tp_ipsec IP=wan_ip IPPool=L2TP_Pool TunnelProtocol=L2TP
            AllowedRoutes=all-nets
```

Web Interface

1. Go to **Interfaces > L2TP Servers > Add > L2TPServer**

2. Enter a suitable name for the L2TP Server, for instance MyL2TPServer.
3. Now enter:
   - **Inner IP Address:** ip_l2tp
   - **Tunnel Protocol:** L2TP
   - **Outer Interface Filter:** l2tp_ipsec
   - **Outer Server IP:** wan_ip
4. Under the **PPP Parameters** tab, select **L2TP_Pool** in the **IP Pool** control.
5. Under the **Add Route** tab, select **all_nets** in the **Allowed Networks** control.
6. 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 9.10. 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, e.g. 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.

1. Start with preparing a new Local User Database:

CLI

```
gw-world:/> add LocalUserDatabase UserDB


gw-world:/> cc LocalUserDatabase UserDB


gw-world:/UserDB> add User testuser Password=mypassword
```

Web Interface

1. Go to **User Authentication > Local User Databases > Add > Local User Database**
2. Enter a suitable for the user database, for instance UserDB
3. Go to **User Authentication > Local User Databases > UserDB > Add > User**
4. Now enter:
   - **Username:** testuser
   - **Password:** mypassword
   - **Confirm Password:** mypassword
5. 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, wan_ip. Furthermore, the IPsec tunnel needs to be configured to dynamically add routes to the remote network when the tunnel is established.

2. Continue setting up the IPsec Tunnel:

CLI

```
gw-world:/> add Interface IPsecTunnel l2tp_ipsec LocalNetwork=wan_ip
            RemoteNetwork=all-nets IKEAlgorithms=ike-roamingclients
```

```
            IPsecAlgorithms=esp-l2tptunnel PSK=MyPSK EncapsulationMode=Transport
            DHCPOverIPsec=Yes AddRouteToRemoteNet=Yes IPsecLifeTimeKilobytes=250000
            IPsecLifeTimeSeconds=3600
```

Web Interface

1. Go to **Interfaces > IPsec > Add > IPsec Tunnel**
2. Enter a name for the IPsec tunnel e.g. l2tp_ipsec.
3. Now enter:
   a. **Local Network:** wan_ip
   b. **Remote Network:** all-nets
   c. **Remote Endpoint:** none
   d. **Encapsulation Mode:** Transport
   e. **IKE Proposal List:** ike-roamingclients
   f. **IPsec Proposal List:** esp-l2tptunnel
4. Enter 3600 in the **IPsec Life Time seconds** control.
5. Enter 250000 in the **IPsec Life Time kilobytes** control.
6. Under the **Authentication** tab, select **Pre-shared Key**.
7. Select **MyPSK** in the **Pre-shared Key** control.
8. Under the **Routing** tab, check the following controls:
   - **Allow DHCP over IPsec from single-host clients**
   - **Dynamically add route to the remote network when a tunnel is established**
9. 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 lan_ip. 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.

3. Setup the L2TP Tunnel:

CLI

```
gw-world:/> add Interface L2TPServer l2tp_tunnel IP=lan_ip Interface=l2tp_ipsec
            ServerIP=wan_ip IPPool=l2tp_pool TunnelProtocol=L2TP
            AllowedRoutes=all-nets ProxyARPInterfaces=lan
```

Web Interface

1. Go to **Interfaces > L2TP Servers > Add > L2TPServer**
2. Enter a name for the L2TP tunnel e.g. l2tp_tunnel.
3. Now enter:
   - **Inner IP Address:** lan_ip
   - **Tunnel Protocol:** L2TP
   - **Outer Interface Filter:** l2tp_ipsec
   - **Server IP:** wan_ip
4. Under the **PPP Parameters** tab, check the **Use User Authentication Rules** control
5. Select **l2tp_pool** in the **IP Pool** control
6. Under the **Add Route** tab, select **all-nets** in the **Allowed Networks** control.

7. In the **ProxyARP** control, select the **lan** interface.
8. Click **OK**

In order to authenticate the users using the L2TP tunnel, a user authentication rule needs to be configured.

4. Next will be setting up the authentication rules:

CLI

```
gw-world:/> add UserAuthRule AuthSource=Local Interface=l2tp_tunnel
            OriginatorIP=all-nets LocalUserDB=UserDB agent=PPP TerminatorIP=wan_ip
            name=L2TP_Auth
```

Web Interface

1. Go to **User Authentication > User Authentication Rules > Add > UserAuthRule**
2. Enter aname for the rule e.g. L2TP_Auth
3. Now enter:
   - **Agent:** PPP
   - **Authentication Source:** Local
   - **Interface:** l2tp_tunnel
   - **Originator IP:** all-nets
   - **Terminator IP:** wan_ip
4. Under the **Authentication Options** tab enter **Local User DB:** UserDB
5. Click **OK**

When the other parts are done, all that is left is the rules. To let traffic trough from the tunnel, two certain IP rules should be added.

5. Finally, set up the rules:

CLI

```
gw-world:/> add IPRule action=Allow Service=all_services
            SourceInterface=l2tp_tunnel SourceNetwork=l2tp_pool
            DestinationInterface=any DestinationNetwork=all-nets name=AllowL2TP
```

```
gw-world:/> add IPRule action=NAT Service=all_services
            SourceInterface=l2tp_tunnel SourceNetwork=l2tp_pool
            DestinationInterface=any DestinationNetwork=all-nets name=NATL2TP
```

Web Interface

1. Go to **Rules > IP Rules > Add > IPRule**
2. Enter a name for the rule e.g. AllowL2TP
3. Now enter:
   - **Action:** Allow
   - **Service:** all_services
   - **Source Interface:** l2tp_tunnel
   - **Source Network:** l2tp_pool
   - **Destination Interface:** any
   - **Destination Network:** all-nets
4. Click **OK**

5. Go to **Rules > IP Rules > Add > IPRule**
6. Enter a name for the rule e.g. NATL2TP
7. Now enter:
   - **Action:** NAT
   - **Service:** all_services
   - **Source Interface:** l2tp_tunnel
   - **Source Network:** l2tp_pool
   - **Destination Interface:** any
   - **Destination Network:** all-nets
8. Click **OK**

Chapter 10. Traffic Management

This chapter describes how NetDefendOS can manage network traffic.

10.1. Traffic Shaping

10.1.1. Introduction

A weakness of the TCP/IP protocol is the lack of true *Quality of Service* (QoS) functionality. QoS in networks is the ability to be able to guarantee and limit bandwidth for certain services and users. Protocols such as the *Differentiated Services* (Diffserv) architecture have been designed to try and solve the QoS problem in large networks by using information in packet headers to provide network devices with QoS information. NetDefendOS provides support for Diffserv by forwarding 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.

However the use of architectures like Diffserv still falls short if applications themselves supply the network with QoS information. From a security standpoint, it is rarely acceptable that applications (ie. network users) decide the priority of their own traffic. In scenarios where the users cannot be trusted, it should be the network equipment that makes the decisions about priorities and bandwidth allocations.

In complex network topologies where different standards and different products exist, it is even more difficult to prioritize, guarantee or limit data traffic. The Internet is a good example of such a network topology. In a well-delimited network however, there are much better possibilities to use different methods in order to control traffic. A well-delimited network is defined mostly by the administrative limits, not the size of the network. The traffic in larger WANs could also be managed, assuming that the network is designed in a homogeneous way.

NetDefendOS provides QoS functionality by allowing the administrator to apply limits and guarantees to the network traffic itself, rather than trusting the applications and users to make these choices. This is well suited to managing bandwidth for a small LAN as well as in one or more bottlenecks in larger WANs.

10.1.2. Traffic Shaping Basics

The simplest way to obtain quality of service in a network, seen from a security as well as a functionality perspective, is to have the components in the network, not the applications, be responsible for network traffic control in well-defined bottleneck points.

Traffic shaping works by measuring and queuing IP packets, in transit, with respect to a number of configurable parameters. Different rate limits and traffic guarantees can be created as policies based on the source, destination and protocol, similar to the way IP rule-set policies are created. Traffic shaping works by:

- Applying bandwidth limits by queuing packets that would exceed configured limits, and sending them later when demand for bandwidth is lower.
- Dropping packets if the packet buffers are full. The packet to be dropped should be chosen from those that are responsible for the "jam".

- Prioritizing traffic according to the administrator's choice; if the traffic in a higher priority increases while a communications line is full, traffic in lower priorities should be temporarily limited to make room for the high-priority traffic.
- Providing bandwidth guarantees. This is typically accomplished by treating a certain amount of traffic (the guaranteed amount) as a higher priority, and traffic exceeding the guarantee as the same priority as "any other traffic", which then gets to compete with the rest of the non-prioritized traffic.

Well-built traffic shapers do not normally work by queuing up immense amounts of data and then sorting out prioritized traffic to send before sending non-prioritized traffic. Rather, they attempt to measure the amount of prioritized traffic and then limit the non-prioritized traffic dynamically so that it won't interfere with the throughput of prioritized traffic.

10.1.3. Traffic Shaping in NetDefendOS

NetDefendOS offers extensive traffic shaping capailities. Since any D-Link Firewall is a central and vital part of a network, there are many benefits of having it handle traffic control.

The D-Link traffic shaper has the following key features:

Pipe based

Traffic shaping in NetDefendOS is handled by a concept based on "pipes", where each pipe has several prioritizing, limiting and grouping possibilities. Individual pipes may be chained in different ways to construct bandwidth management units that far exceed the capabilities of one single pipe.

Close integration with the firewall rule-set

Each firewall rule may be assigned to one or more pipes, individually.

Traffic prioritizing and bandwidth limiting

Each pipe contains a number of priority levels, each with its own bandwidth limit specified in kilobits per second and/or packets per second. Limits may also be specified for the total of the pipe.

Grouping

Traffic through a pipe can be automatically grouped into *pipe users*, where each pipe user can be configured in the same way as the main pipe.

Traffic may be grouped with respect to a number of parameters, for instance source or destination IP network, IP address or port number.

Dynamic bandwidth balancing

The traffic shaper can be used to dynamically balance the bandwidth allocation of different pipe users if the pipe as a whole has exceeded its limits.

This means that available bandwidth is evenly balanced with respect to the chosen grouping for the pipe.

Pipe chaining

When pipes are assigned to rules, up to eight pipes may be connected to form a chain. This permits filtering and limiting to be handled in a very sophisticated manner.

Traffic guarantees

With the proper pipe configuration, traffic shaping may be used to guarantee bandwidth (and thereby quality) for traffic through the firewall.

IPsec integration

Bandwidth and priorities may be configured for IPsec VPN tunnels as well as for ordinary firewall rules.

10.1.4. Pipes Basics

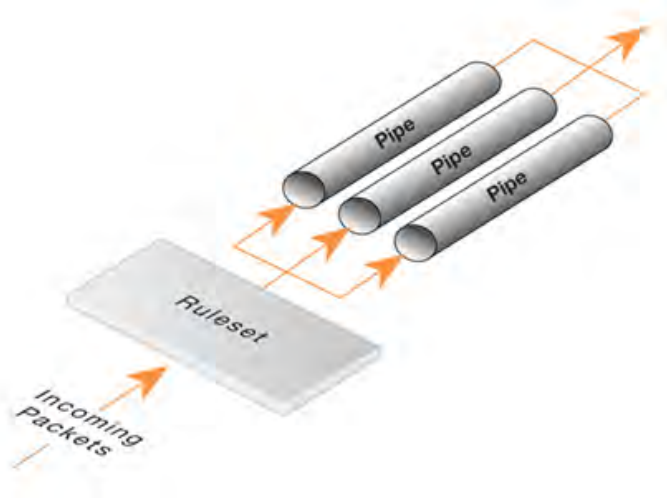
10.1.4.1. Definition of a Pipe

A Pipe is a central concept in the traffic shaping functionality of NetDefendOS and is the basis for all bandwidth control. Pipes are configured in the Pipes section of the firewall configuration.

Pipes are fairly simplistic, in that they do not know much about the types of traffic that pass through them, and they know nothing about direction. A pipe simply measures the traffic that passes through it and applies the configured limits in each precedence and/or user group.

Inbound network traffic is first filtered within the firewall IP rule-set, and is then passed to the pipe(s) specified in the matching rule. In the pipe, traffic is limited with respect to the configuration of the pipe and is then forwarded to its destination, or to the next pipe in a chain.

Figure 10.1. Packet flow through pipes



NetDefendOS is capable of handling hundreds of pipes simultaneously, but in reality, only a handful of pipes are required for most scenarios. The only time where you might end up with dozens and dozens of pipes are scenarios where you create individual pipes for each service (protocol, or client in ISP cases).

10.1.4.2. Simple Bandwidth Limit

The most basic use of pipes is simple bandwidth limits. This is also probably the only scenario that doesn't really require much planning.

In our first example, we will apply a bandwidth limit to only one direction, inbound traffic. This is the direction most likely to cause problems in an internet connection.

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.

CLI

```
gw-world:/> add Pipe std-in LimitKbpsTotal=2000
```

Web Interface

1. Go to **Traffic Management > Traffic Shaping > Pipes > Add > Pipe**
2. Specify a suitable name for the pipe, for instance std-in.
3. Enter 2000 in **Total** textbox.
4. Click **OK**.

However, simply creating the pipe will not accomplish much; traffic actually needs to be passed *through* the pipe. This is done by assigning the pipe to an IP rule.

We will use the above pipe to limit inbound traffic. This limit will apply to the 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.

CLI

```
gw-world:/> add PipeRule ReturnChain=std-in SourceInterface=lan
            SourceNetwork=lannet DestinationInterface=wan
            DestinationNetwork=all-nets Service=all_services name=Outbound
```

Web Interface

1. Go to **Traffic Management > Traffic Shaping > Pipes > Add > PipeRule**
2. Specify a suitable name for the pipe, for instance Outbound.
3. Now enter:
   - **Service:** all_services
   - **Source Interface:** lan
   - **Source Network:** lannet
   - **Destination Interface:** wan
   - **Destination Network:** all-nets
4. Under the **Traffic Shaping** tab, make std-in selected in the **Return Chain** control.
5. Click **OK**.

This setup limits all traffic from the outside (the Internet) to 2 megabits per second, much the same as if a 256 kbps Internet connection had been the bottleneck. No priorities are applied, nor any dynamic balancing.

10.1.4.3. Two-Way Bandwidth Limits

The previous example will only limit bandwidth in the inbound direction. We chose this direction simply because in most setups, it is the direction to first become full. Now, what if we want to limit bandwidth in both directions?

The answer is "simple! Apply the 2 Mbps limit in the forward direction as well!". Well, yes. But how?

Simply inserting "std-in" in the forward chain *will not work*. At least not the way you most likely want it to work. You probably want the 2 Mbps of outbound traffic to be separate from the 2 Mbps of inbound traffic, right?

So why doesn't the simple solution work? Well, as we've said before, pipes are simple things. If you try to pass 2 Mbps of outbound traffic through the pipe in addition to the 2 Mbps of inbound traffic, it would add up to 4 Mbps. Since the limit is at 2 Mbps, what you'd get is something like 1 Mbps in each direction.

However, you cannot just raise the total limit to 4 Mbps and hope for the best. Why? Again, pipes are simple things. This single pipe will not know that you mean 2 Mbps inbound and 2 Mbps outbound. You could just as well end up with 3 Mbps outbound and 1 Mbps inbound, since that, too, adds up to 4 Mbps.

Normally, the right way of controlling bandwidth in both directions is to use two pipes. One for inbound traffic and one for outbound traffic, each set to a 2 Mbps limit.

Example 10.2. Applying a Two-Way Bandwidth Limit

This example pre-assumes that you have gone through previous example.

Create a second pipe for outbound traffic:

CLI

```
gw-world:/> add Pipe std-out LimitKbpsTotal=2000
```

Web Interface

1. Go to **Traffic Management > Traffic Shaping > Pipes > Add > Pipe**
2. Specify a suitable name for the pipe, for instance std-out.
3. Enter 2000 in **Total** textbox.
4. Click **OK**.

When you've created your pipe for outbound bandwidth control, you simply add it to the forward pipe chain of the rule that you created in the previous example:

CLI

```
gw-world:/> set PipeRule Outbound ForwardChain=std-out
```

Web Interface

1. Go to **Traffic Management > Traffic Shaping > PipeRules**
2. Right-click on the piperule you created in the previous example and choose **Edit**
3. Under the **Traffic Shaping** tab, make std-out selected in the **Forward Chain** control.
4. Click **OK**.

This results in all outbound connections being limited to 2 Mbps in each direction, closely emulating a normal 256 kbps Internet connection.

Of course, using the same pipe in both directions is perfectly legal, if what you want is "2 Mbps total, divided any way between forward and return data". Internet connections like these do exist, but normally you buy the same amount of bandwidth in both directions, where data flow in one direction doesn't affect the other direction.

10.1.4.4. Using Chains to create Differentiated Limits

Now, in the previous examples, all we've done is apply a simple static traffic limit for all outbound connections. What if we want to limit surfing further than the rest of the traffic?

Here, we could set up two "surf" pipes; inbound and outbound. However, the fact is, we most likely won't need to limit outbound traffic a whole lot, simply because surfing usually consists of short outbound requests followed by long inbound answers.

So, let's just set up a special "surf" pipe for inbound traffic and leave it at that:

Now that we have the pipe defined, what do we do with it? Well, first we will need to set up a rule that covers surfing and place it before the rule that covers "everything else". This way we can get surfing traffic to go through the specific pipes that we want it to, but still let everything else be handled by the "default" pipes we created earlier.

Copy the forward chain settings from the rule covering all "Standard" protocols.

Now, we'll have to figure out how to pass the return traffic through the "surf-in" pipe that we defined.

First, passing the surf traffic through the "surf-in" pipe in the return chain would seem a good enough idea, so let's start by doing that.

However, unfortunately, this will likely not get you the desired effect.

You will now have inbound traffic passing through two pipes: one that will forward 256 kbps, and one that will forward 128 kbps, for a total of 384 kbps of inbound traffic.

So, how do we limit the surfing traffic to 128 kbps without upsetting the grand total limits?

Simple: pass the inbound surf traffic through the std-in pipe aswell.

Now, inbound surf traffic will first pass through the "surf-in" pipe, and get limited to 128 kbps. Then, it will get passed through the "std-in" pipe, along with the rest of the inbound traffic, which applies the 256 kbps total limit. So, if you're surfing for 128 kbps worth of bandwidth, those 128 kbps will occupy half of the std-in pipe, leaving only 128 kbps for the rest of the traffic, which is probably more along the lines of what you wanted.

If there is no surfing going on, all of the 256 kbps allowed through the std-in pipe will be available for all the rest of the traffic.

Note

This is not a traffic guarantee for web browsing. One could consider it a 128 kbps traffic guarantee for everything but web browsing, but for web browsing, the normal rules of first-come, first-served applies when competing for bandwidth. This may mean 128 kbps, but it may also mean the equivalent of a 2400 baud modem if your connection is sufficiently flooded.

10.1.5. Priorities and Guarantees

10.1.5.1. Precedences

Each pipe contains eight *precedences*, or priority levels, numbered from 0 to 7. Each precedence may be seen as a separate queue where network traffic may be controlled. Precedence 0 is the least important precedence. Precedence 7 is the most important one.

Figure 10.2. The Eight Pipe Precedences.

Note

The respective precedences are not "special" in any way. Their meaning is only defined by the limits and guarantees that you configure. The difference is only in relative importance: traffic in precedence 2 will be passed on before traffic in precedence 0, traffic in precedence 4 before 2 and 0, and so on.

In order to determine what precedence network traffic belongs to, each packet buffer is assigned a precedence number before it is sent into a pipe. The precedence assigned is controlled by the Rules section. This way, you can prioritize traffic by IP span, protocol number, port number, etc, the same way you normally filter traffic. This is described in greater detail later in this chapter.

When the pipe is configured, the number of precedences in the pipe can be defined by specifying a *Minimum precedence* and a *Maximum precedence*. The pipe will automatically adjust incoming packets to comply with these limits: a packet with a too low precedence is moved up to the minimum precedence. A packet with too high precedence is moved down to the maximum precedence. If a packet has no precedence, it is assigned the *Default precedence*.

The actual limiting of bandwidth is performed inside each precedence; separate bandwidth limits may be specified for each precedence. These limits may be specified in kilobits per second and/or packets per second.

The precedence defined as the minimum precedence has a special functionality within the pipe: it acts as a best effort precedence.

Note

Traffic that exceeds the limit of a higher precedence will automatically be transferred into the best effort precedence, as long as there is room in the best effort precedence.

Figure 10.3. A Pipe defined with minimum precedence and maximum precedence.

In addition to the limit per precedence, a limit for the pipe as a whole may also be specified, as you've seen in the previous example. When the total bandwidth through the pipe reaches the total limit, traffic will be prioritized depending on what precedence it belongs to. Higher precedences have a greater chance of making it through the pipe without queuing. However, if you are only using two precedences, choosing 4 and 6 rather than 0 and 2, or 0 and 6 if you like, will, of course, make no difference. The meaning of a precedence is only relative to traffic that passes in the other precedences, not to some external factor like, for instance, what is actually going on in the LAN outside the firewall, or on the other side of your Internet connection.

10.1.5.2. Applying Simple Priorities

Now, how can we use precedences to make some types of traffic more important than others? Let's continue work on our previous example, by giving SSH and Telnet traffic a higher priority than everything else passing through our pipes.

For this first example, we do not need to add or change anything in the Pipes section. First, we add a rule that covers SSH and Telnet traffic:

Copy the pipe settings from the "Standard" rule.

The default precedences of all pipes we have configured so far has been the lowest. To prioritize traffic above that, we instruct the rule to pass the packet to the pipe chains with a higher precedence. Let's choose 2.

Now, with this setup, SSH and Telnet traffic is simply prioritized before all other types of traffic. With these two low-throughput protocols, this behavior is likely not a problem.

However, if this had been real-time audio, it probably would have resulted in the audio streams using all available bandwidth and leaving none for surfing, DNS, FTP, and all the other protocols.

10.1.5.3. Simple Bandwidth Guarantees

Bandwidth guarantees aren't that much different from prioritizing certain types of traffic. All that really remains, is to limit the amount of high-priority bandwidth that may be used. The easiest but least flexible way of doing this is simply limiting how much gets to pass in the higher precedences of the default pipes.

To change the prioritized SSH and Telnet traffic from the previous example to a 96 kbps guarantee, you would simply change your *std-in*pipe to include a 96 kbps limit for precedence 2. Now, does this mean that your inbound SSH and telnet traffic is limited to 96 kbps? No, it does not.

As previously stated, excess traffic in precedences above the best-effort precedence gets passed to the best-effort precedence, which, in this example, is the lowest.

Again: Limits in precedences above the best-effort precedence will not actually limit the traffic. Such limits will only limit how much of the traffic gets to pass in that specific precedence.

So, in this case, the 96 kbps limit in precedence 2 means that you can pass up to 96 kbps worth of precedence 2 traffic to the *std-in* pipe, and this traffic will get through, unless there's traffic in even higher precedences.

If you attempt to pass more than 96 kbps of precedence 2 traffic, the excess traffic will have to compete with all the rest for the remaining bandwidth, and this competition is simple first-come, first-served, like any Internet connection. Grouping and balancing can improve this situation and these are discussed later.

10.1.5.4. Differentiated Bandwidth Guarantees

As mentioned earlier, there is a slight problem with the previous way of implementing bandwidth guarantees: they are not very flexible.

What if, for instance, 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 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 merely 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 as the lowest precedence only and hence compete for the 256 kbps of available bandwidth like any other traffic.

10.1.5.5. Problems in Priorities and Guarantees

Guarantees are not just "guarantees". Guarantees and prioritized traffic work by limiting everything that is not prioritized. How are these limits calculated? In each pipe, the limit of lower priorities is calculated from the total limit, minus the current throughput of higher precedences.

Set a total limit!

Bandwidth in lower precedences will not be throttled until a pipe thinks that it is full, i.e. passing as much traffic as the total limit states. After all, why should it throttle any sooner? If you have a 512 kbps pipe, passing 400 kbps of low priority traffic and 100 kbps of high priority traffic, there is no reason to throttle anything, since there is 12 kbps of bandwidth left.

So, in order to know how much to limit lower precedences, the pipe needs to know when it is full; it needs to know its total limit.

Your total limits cannot be higher than your available connection bandwidth

If pipe limits are set higher than the available bandwidth, the pipe will never know the connection is full. If you have a 512 kbps connection, but total pipe limits are set to 600 kbps, the pipe will think that it is not full. Therefore, it will not throttle the lower precedences.

Measuring and shaping at the entrance of a choke point

If you are protecting the "entrance" to a network bottleneck, i.e. outbound data in your firewall, you can probably set the total limit very close to the bandwidth of your connection.

Measuring and shaping at the exit of a choke point

If you're protecting the "exit" of a network bottleneck, i.e. inbound data in your firewall, you should probably set it a bit lower than the bandwidth of your connection. There are two risks involved in setting your limits so that they exactly match your inbound bandwidth:

- In the worst-case scenario, you could have a few stray packets per second consuming a fraction of your connection's bandwidth. As a result, your pipes will never think that they are full.
- There is also a much more real risk of having throttling adjustments taking too long a time, as the pipe will only see a "little" overload. If there is only a slight overload, then only slight adjustments will be made. This may result in very slow adaptations to new precedence distributions, possibly as slow as half a minute.
- Then, of course, there is the risk for connection overload. As you are shaping at the exit of the bottleneck, you have no control over what actually enters the bottleneck. As long as you are shaping well-behaved TCP, your traffic shaper will work, and even if internal clients stress the connection by sending phony ACKs, or whatever, they will not get much out of it, as the traffic shaper will just keep queuing packets destined for them.

However, shaping at the exit of a bottleneck does not protect against resource exhaustion attacks, such as DDoS or other floods. If someone is just bombarding you, they can overload your connection, and your traffic shaper cannot do anything about it. Sure, it will keep these extraneous packets from reaching the computers behind the shaper, but it will not protect your connection, and if your connection gets flooded, the attacker has won.

Some ISPs allow co-location, so if you believe that flooding is a realistic threat to you, you should consider co-locating your traffic shaper at the Internet side of your connection.

Bandwidth can't be guaranteed without knowing the available bandwidth

For any traffic shaper to work, it needs to know the bandwidth passing through the choke point that it is trying to "protect".

If you are sharing your internet connection with other users or servers that are not under the control of your firewall, it is nearly impossible to guarantee, prioritize or balance bandwidth, simply because the firewall won't know how much bandwidth is available for your network. Simple limits will of course work, but guarantees, priorities and dynamic balancing will not.

Watch for leaks!

If you set out to protect and shape a network bottleneck, make sure that all traffic passing through that bottleneck passes through your pipes.

If there's traffic going through your Internet connection that the pipes do not know about, they will not 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 your firewall without being measured by your pipes will have the same effect as bandwidth consumed by parties outside of your control but sharing the same connection as you.

10.1.6. Grouping Users of a Pipe

10.1.6.1. Overview

If pipes were restricted to the functionality described so far, traffic would be limited without respect to source or destination. This mode of operation is likely sufficient for managing simple traffic limits and guarantees.

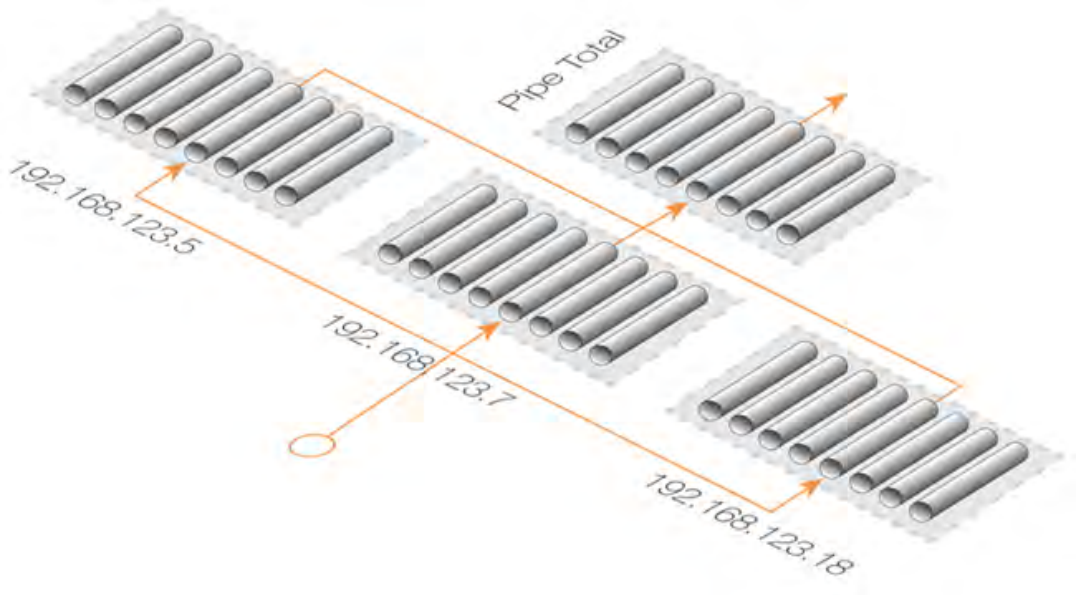
However the ability exists to group traffic within each pipe. This means that traffic will be classified and grouped with respect to the source or destination of each packet passing through the pipe.

Grouping may be performed on source network, source IP address, source port, destination network, destination IP address and destination port. In the network grouping cases, the network size may be specified. The port grouping cases also include the IP address, meaning that port 1024 of computer A is not the same "group" as port 1024 of computer B.

The benefit of using grouping is that additional bandwidth controls may be applied to each group. This means that if grouping is performed on, for example, IP address, the firewall can limit and guarantee bandwidth per IP address communicating through the pipe.

There are precedences in user groups, too. Bandwidth may be limited per precedence as well as for each group as a whole.

Figure 10.4. A pipe with traffic in one precedence, grouped per IP address.



Bandwidth control first occurs per user and then continues with the pipe as a whole. A pipe with grouping enabled is illustrated in the drawing below.

Note

In many cases, this text refers to groups as "users", regardless of the group representing a physical person, a single connection, or an entire class C network.

10.1.6.2. Applying Per-User Limits and Guarantees

Once the users of a pipe are grouped, you can apply limits and guarantees to each user the same way you apply them to the pipe as a whole.

To expand on the previous example, we could, for instance, limit how much guaranteed bandwidth

each inside user gets for inbound SSH traffic. This keeps one single user from using up all available high-priority bandwidth.

First, we will have to figure out how to group the users of the ssh-in pipe. What we want to do is apply our limits to each user on the internal network. Considering that we are working with inbound packets, we will want to group per destination IP, so we change the grouping for the "ssh-in" pipe to "Per DestIP".

When the grouping is set, we can set per-user limits. In this case, we will set the precedence 1 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 we wanted to, we could also limit the total bandwidth for each user to some value, maybe 40 kbps.

As you can see, we will run into problems if there are more than four users talking a lot of SSH simultaneously; 16 kbps times five 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 1 bandwidth the same way they have to compete for the lowest precedence bandwidth. Dynamic balancing can be used to improve this situation; more about that later.

For a better understanding of what is happening in a live setup, we recommed trying the "pipe -u <pipename>" console command. It will display a list of currently active users in each pipe.

10.1.6.3. Dynamic Bandwidth Balancing

As previously stated, per-user bandwidth may be limited by enabling grouping within a pipe. This may be used to ensure that one user cannot consume all of the available bandwidth.

But what if the bandwidth for the pipe as a whole has a limit, and that limit is exceeded?

In the previous example, the precedence 2 bandwidth limit per user is 16 kbps, and the precedence 2 limit for the pipe is 64 kbps. This means that up to four simultaneous users will get their fair share of high-precedence bandwidth.

If an additional user tries to talk SSH, the limit of 64 kbps will be exceeded. The results of this cannot be reliably predicted. Some users will still get their 16 kbps, some will not.

To prevent such situations, there is a feature called Dynamic Bandwidth Balancing. This algorithm ensures that the per-user bandwidth limits are dynamically lowered (and raised) in order to evenly balance the available bandwidth between the users of the pipe.

In the above sample, when the additional user begins to generate SSH traffic, the limit per user will be lowered to about 13 kbps (64 kbps divided by 5 users). Temporary restrictions such as these will be gradually removed, until the configured limit is reached, or until the pipe limits are exceeded, at which point the user limits will be lowered again. These dynamic adjustments take place 20 times per second, and will quickly adapt to changed bandwidth distributions.

Dynamic Bandwidth 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.

10.2. 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 NetDefendOS 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 D-Link Firewall per second.

Total Connection Limiting allows the administrator to put a limit on the total number of connections opened to the D-Link Firewall. 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 NetDefendOS will perform the associated rule Actions that match the condition that has occured. 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 *BeforeRules* settings can exempt certain types of connections for remote management from examination by the NetDefendOS rule-set. These settings will also exempt the connections from Threshold Rules.

10.2.7. Threshold Rules and ZoneDefense

Threshold Rules are used in the D-Link ZoneDefense feature to block the source of excessive connection attmepts from internal hosts. For more information on this refer to Chapter 12, *ZoneDefense*.

10.2.8. 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 NetDefendOS.

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 adminstrator 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

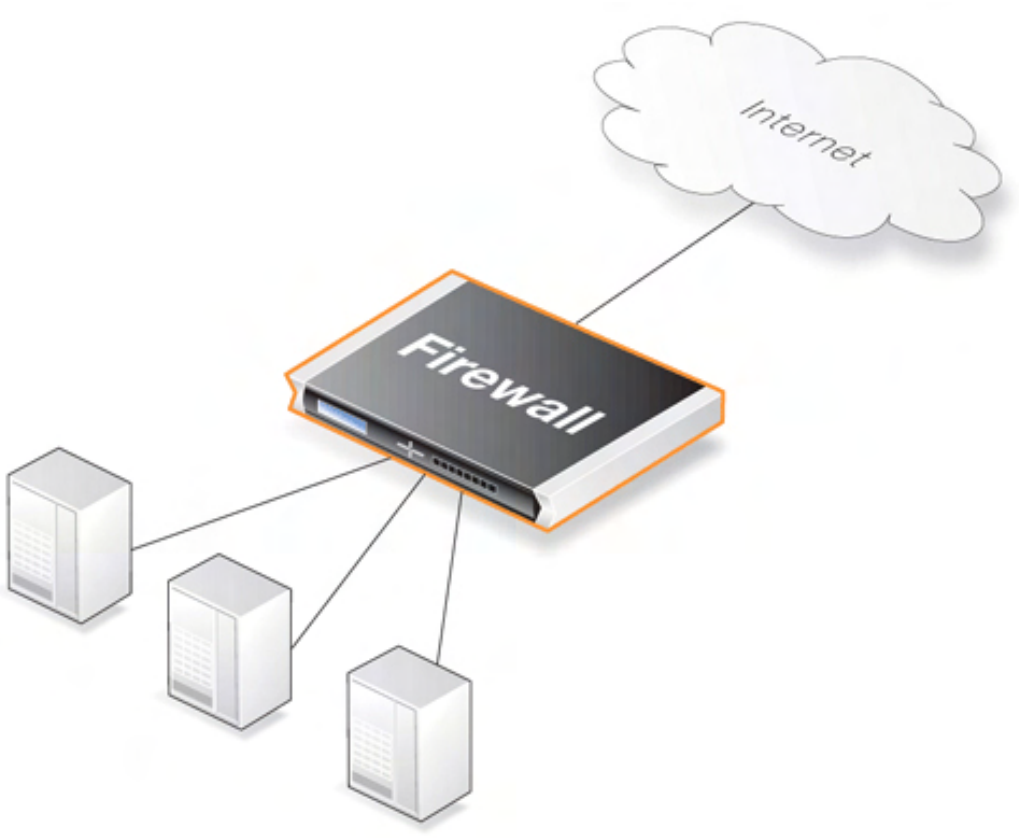
10.3.1. Overview

The *Server Load Balancing* (SLB) feature in NetDefendOS is a powerful tool that can improve the following aspects of network applications:

- Performance
- Scalability
- Reliability
- Ease of administration

SLB allows network service demands to be shared among multiple servers. This improves both the performance and the scalability applications by allowing a cluster of multiple servers (sometimes called a "server farm") to handle many more requests than a single server. The image below illustrates a typical SLB scenario, with internet access to applications being controlled by a D-Link Firewall.

Figure 10.5. A Server Load Balancing configuration



Besides improving performance, SLB increases the reliability of network applications by actively monitoring the servers sharing the load. 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 also means that network administrators can 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.

NetDefendOS SLB is implemented through the use of *SLB_SAT* rules in the IP Rule-set and these rules offer administrators a choice of several different algorithms to distribute the load. This allows the tailoring of SLB to best suit the needs of the network.

There are four issues to be considered when using SLB:

1. The target servers across which the load is to be balanced
2. The load distribution mode
3. The SLB algorithm used
4. The monitoring method

Each of these topics is discussed further in the sections that follow.

10.3.2. Identifying the Servers

The first step 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 vitual server by SLB must be specified.

10.3.3. The Load Distribution Mode

No single method of distributing the server load is ideal for all services. Different types of services have different needs. In the IP Rule-set the administrator can configure rules for specific services. SLB will then filter the packet flow according to these rules.

NetDefendOS SLB supports the following distribution modes:

Per-state Distribution — In this mode, SLB records the state of every connection. The entire session will then be distributed to the same server. This guarantees reliable data transmission for that session.

IP Address Stickiness — In this mode, all connections from a specific client will be sent to the same server. This is particularly important for SSL services such as HTTPS, which require a consistent connection to the same host.

Network Stickiness — This mode is similar to IP stickiness except that by using a subnet mask, a range of hosts in a subnet can be specified.

10.3.4. The Distribution Algorithm

There are several ways to determine how a load is shared across a server farm. NetDefendOS SLB supports the following algorithms:

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 al-

gorithm 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 certain timeframe. SLB sends the next request to the server that has received the lowest number of connections in that time. The administrator is able to specify the timeframe to use with this algorithm.

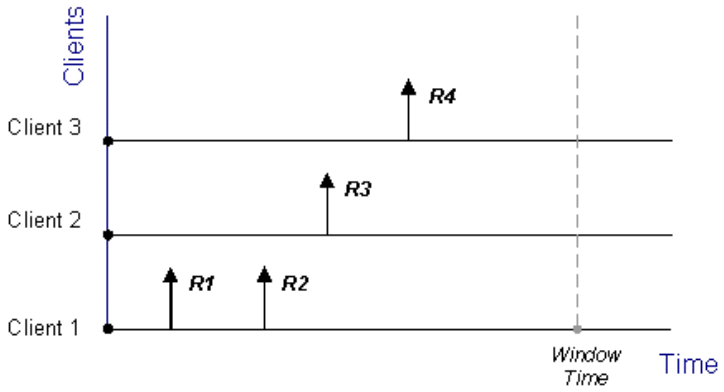
If the Connection Rate algorithm is used without stickiness, it will behave as a Round Robin algorithm that allocates new connections to servers in an orderly fashion. It will also behave as the Round Robin algorithm if there are always clients with a new IP address that make one connection.

The real benefit is when using Connection Rate together with stickiness and clients make multiple connections. Connection Rate will then ensure that the distribution of new connections is as even as possible among servers. Before the interval reaches the specified Idle Timeout of stickiness, new incoming connections from the same IP address as a previous connection are assigned to the same server. The connection with a new address will be redirected to a server with the lowest connection rate. The algorithm aims to minimize the new connection load for a server, but the distribution may get uneven if a client from a single IP is sending lots of new connections in a short time and the other servers do not get as many new connections.

In the management interface, the time window is variable for counting the number of seconds back in time to summarize the number of new connections for the connection-rate algorithm. As default value, 10 is used so that the number of new connections which were made to each server in the last 10 seconds will be remembered.

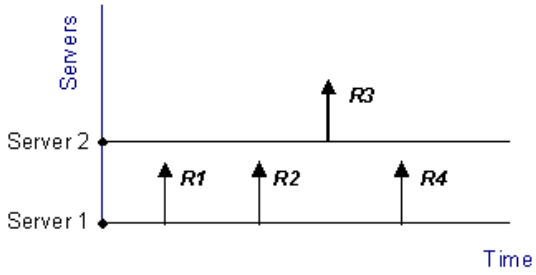
An example is shown in the figure below. In this example, the D-Link Firewall is responsible for balancing connections from 3 clients with different addresses to 2 servers. Stickiness is set.

Figure 10.6. Connections from Three Clients



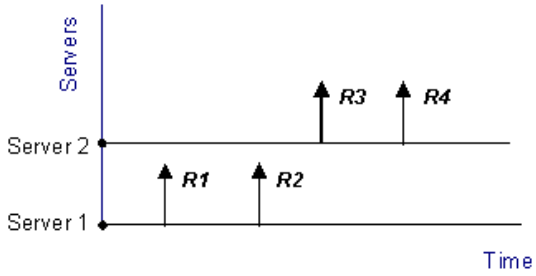
When the Round Robin algorithm is used, the first arriving requests R1 and R2 from Client 1 are both assigned to one sever, say Server 1, according to stickiness. The next request R3 from Client 2 is then routed to Server 2. When R4 from Client 3 arrives, Server 1 gets back its turn again and will be assigned with R4.

Figure 10.7. Stickiness and Round-Robin



If Connection Rate 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 10.8. 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 monitors different OSI layers to check the connection rate for each server as well as its current state. Regardless of the algorithm, if a server fails, SLB will not send any more requests until it the server recovers to full functionality.

SLB will use the default routing table unless the administrator sets a specific routing table location.

D-Link 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 a D-Link Firewall 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 NetDefendOS 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 D-Link Firewall

Chapter 11. High Availability

This chapter describes the high availability fault-tolerance feature in D-Link Firewalls.

11.1. Overview

High Availability (HA) is a fault-tolerant capability that is available on certain models of D-Link Firewalls. Currently the firewalls that offer this feature are the DFL-1600 and DFL-2500 models. D-Link offers an *active-passive* HA implementation.

D-Link High Availability works by adding a back-up D-Link Firewall to an existing firewall. The back-up firewall has the same configuration as the primary firewall. It will stay inactive, monitoring the primary firewall, until it deems that the primary firewall is no longer functioning, at which point it will become active and assume the active role in the cluster. When the other firewall regains full functionality, the backup will assume a passive role, monitoring the now active firewall.

The hardware of the back-up firewall does not need to exactly match the hardware of the primary firewall. However, as role switches are not done unnecessarily, either firewall may stay active for an extended time, regardless of which one was originally the primary firewall. It is therefore recommended to use hardware of similar performance to avoid throughput degradation when a less-capable unit assumes the active role.

Throughout this chapter, the phrases "master firewall" and "primary firewall" are used interchangeably, as are the phrases "slave firewall" and "back-up firewall".

What High Availability can do

D-Link High Availability will provide a redundant, state-synchronized firewall solution. This means that the state of the active firewall, i.e. connection table and other vital information, is continuously copied to the inactive firewall. When the cluster fails over to the inactive firewall, it knows which connections are active, and communication traffic can continue to flow uninterrupted.

The failover time is typically about one second; well within the scope for the normal TCP retransmit timeout, which is normally in excess of one minute. Clients connecting through the firewall will merely experience the failover as a slight burst of packet loss. TCP will, as it does in such situations, retransmit the lost packets within a second or two, and continue communication.

What High Availability can *not* do

Adding redundancy to D-Link Firewall installations will eliminate one of the single points of failure in the communication path. However, it is not a panacea for all possible communication failures.

Typically, the firewall is far from the only single point of failure. Redundancy for routers, switches, and Internet connections are also issues that need to be examined.

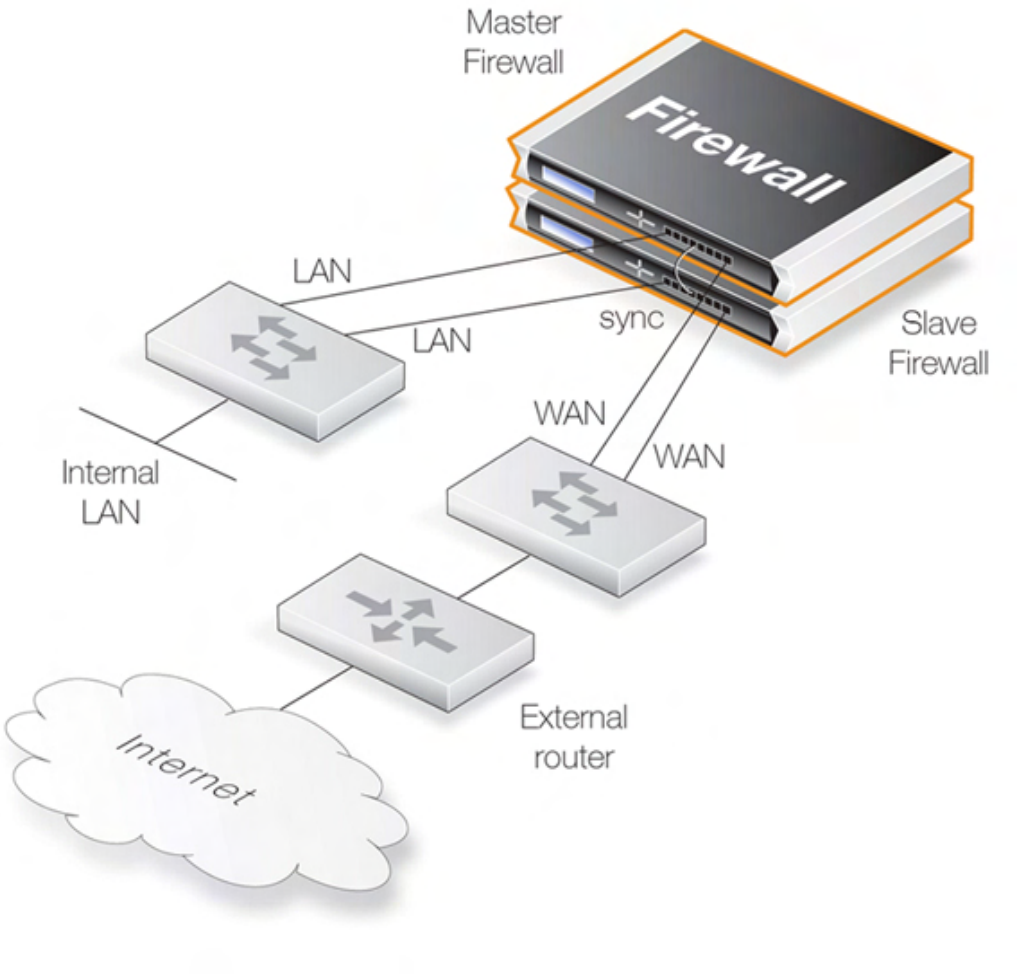
D-Link High Availability clusters will not create a load-sharing cluster. One firewall will be active, and the other will be inactive. Multiple back-up firewalls cannot be used in a cluster. Only two firewalls, a "master" and a "slave", are supported. As is the case with all other firewalls supporting stateful failover, D-Link High Availability will only work between two D-Link Firewalls. As the internal workings of different manufacturer's firewalls, and, indeed, different major versions of the same firewall, can be radically different, there is no way of communicating "state" to something which has a completely different comprehension of what "state" means.

Broken interfaces will not be detected by the current implementation of D-Link High Availability, unless they are broken to the point where the firewall cannot continue to run. This means that fail-over will not occur if the active firewall can communicate "being alive" to the inactive firewall through any of its interfaces, even though one or more interfaces may be inoperative.

High Availability Setup Example

In a high availability setup, all the interfaces of the primary firewall need to be present on the back-up firewall and be connected to the same networks. As previously mentioned, failover is not done unnecessarily, so either firewall may maintain the active role of the cluster for an extended period of time. Hence, connecting some equipment to only the "master" or only the "slave" firewall is bound to produce unwanted results. An example of a High Availibility setup is shown below.

Figure 11.1. High Availability Setup Example



In this illustration, both firewalls are connected to the internal as well as the external network. If there are more networks, for instance one or more demilitarized zones, or internal network segments, both firewalls will also have to be connected to such networks; just connecting the "master" to a network will most likely lead to a loss of connectivity for extended periods of time.

11.2. How rapid failover is accomplished

This section will detail the outward-visible characteristics of the failover mechanism, and how the two firewalls work together to create a high availability cluster with very low failover times.

For each cluster interface, there are three IP addresses:

- Two "real" IP addresses; one for each firewall. These addresses are used to communicate with the firewalls themselves, i.e. for remote control and monitoring. They should not be associated in any way with traffic flowing through the cluster; if either firewall is inoperative, the associated IP address will simply be unreachable.
- One "virtual" IP address; shared between the firewalls. This is the IP address to use when configuring default firewalls and other routing related matters. It is also the address used by dynamic address translation, unless the configuration explicitly specifies another address.

There is not much to say about the real IP addresses; they will act just like firewall interfaces normally do. You can ping them or remote control the firewalls through them if your configuration allows it. ARP queries for the respective addresses are answered by the firewall that owns the IP address, using the normal hardware address, just like normal IP units do.

11.2.1. Shared IP addresses and Failover

Both firewalls in the cluster 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, will be answered by the active firewall.

The hardware address of the shared IP address, and other published addresses for that matter, are not related to the hardware addresses of the firewall interfaces. Rather, it is constructed from the cluster ID, on the following form: 10-00-00-C1-4A-nn, where nn is the Cluster ID' configured in the Settings section.

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 firewall discovers that its peer is no longer operational, it will broadcast a number of ARP queries, using the shared hardware address as sender address, on all interfaces. This causes switches and bridges to re-learn where to send packets destined for the shared hardware address in a matter of milliseconds.

Hence, the only real delay in the failover mechanism is detecting that a firewall is no longer operational.

The activation messages (ARP queries) described above are also broadcast periodically to ensure that switches won't forget where to send packets destined for the shared hardware address.

Note

The shared IP address should not be used for remote management or monitoring purposes. When using, for example, SNMP for remote management of the D-Link Firewalls in an HA configuration, the individual IP addresses of the firewalls should be used.

11.2.2. Cluster heartbeats

NetDefendOS detects that the peer systen is no longer operational when it can no longer detect "cluster heartbeats" from its peer.

Currently, NetDefendOS will send five cluster heartbeats per second.

When three heartbeats are missed, i.e. after 0.6 seconds, the peer will be deemed inoperative.

So, why not make it even faster? Maybe send a hundred heartbeats per second and declare a firewall inoperative after missing only two of them? This would after all result in a 0.02-second failover time.

The problem with detection times less than one tenth of a second is that such delays may occur during normal operation. Just opening a file, on either firewall, could result in delays long enough to cause the inactive system to go active, even though the other is still active; a clearly undesirable situation.

Cluster heartbeats have the following characteristics:

- The source IP is the interface address of the sending firewall
- The destination IP is the shared IP address
- The IP TTL is always 255. If NetDefendOS receives a cluster heartbeat with any other TTL, it is assumed that the packet has traversed a router, and hence cannot be trusted at all.
- It is an UDP packet, sent from port 999, to port 999.
- The destination MAC address is the ethernet multicast address corresponding to the shared hardware address, i.e. 11-00-00-C1-4A-nn. Link-level multicasts were chosen over normal unicast packets for security reasons: using unicast packets would have meant that a local attacker could fool switches to route the heartbeats somewhere else, causing the peer system to never hear the heartbeats.

11.2.3. The synchronization interface

Both firewalls are connected to each other by a separate synchronization connection; normal network cards are used, although they are dedicated solely to this purpose.

The active system continuously sends state update messages to its peer, informing it of connections that are opened, connections that are closed, state and life time changes in connections, etc.

When the active system ceases to function, for whatever reason and for even a short time, the cluster heartbeat mechanism described above will cause the inactive system to go active. Since it already knows about all open connections, communication can continue to flow uninterrupted.

11.3. High Availability Issues

Even though a high availability cluster will behave like a single firewall in most respects, there are some things which should be kept in mind when managing and configuring it.

11.3.1. High Availability Configuration

When configuring High Availability clusters, there are a number of things to keep in mind in order to avoid pitfalls.

Changing the cluster ID

By changing the cluster ID, you actually doing two things:

- Changing the hardware address of the shared IPs. This 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 will have to have their ARP caches flushed.
- You will also break the connection between the firewalls in the cluster for as long as they are using different configurations. This will cause both firewalls to go active at the same time.

In short, changing the cluster ID unnecessarily is not a good idea.

After the configuration has been uploaded to both firewalls, the ARP caches of vital units will have to be flushed in order to restore communication.

Never use the unique IPs for live traffic

The unique IP addresses of the firewalls cannot safely be used for anything but managing the firewalls.

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 firewall it belongs to does.

Chapter 12. ZoneDefense

This chapter describes the D-Link ZoneDefense feature.

12.1. Overview

ZoneDefense allows a D-Link Firewall to control locally attached switches. It can be used as a counter-measure to stop a virus-infected computer in a local network from infecting other computers.

When hosts or clients on a network become infected with viruses or another form of malicious code, this can often show its presence through anomalous behaviour, often by large numbers of new connections being opened to outside hosts.

By setting up *Threshold Rules*, hosts or networks that are exceeding a defined connection threshold can be dynamically blocked using the ZoneDefense feature. Thresholds are based on either the number of new connections made per second, or on the total number of connections being made. The connections may be made by either a single host or all hosts within a specified CIDR network range (an IP address range specified by a combination of an IP address and its associated network mask).

When NetDefendOS detects that a host or a network has reached the specified limit, it uploads Access Control List (ACL) rules to the relevant switches and this blocks all traffic for the host or network displaying the unusual behaviour. Blocked hosts and networks remain blocked until the system administrator manually unblocks them using the Web or Command Line interface.

Note

ZoneDefense is available on the D-Link DFL-800/860/1600/2500 models.

12.2. ZoneDefense Switches

Switch information regarding every switch that is to be controlled by the firewall has to be manually specified in the firewall configuration. The information needed in order to control a switch includes:

- The IP address of the management interface of the switch
- The switch model type
- The SNMP community string (write access)

The ZoneDefense feature currently supports the following switches:

- D-Link DES 3226S (minimum firmware: R4.02-B14)
- D-Link DES 3250TG (minimum firmware: R3.00-B09)
- D-Link DES 3326S (minimum firmware: R4.01-B39)
- D-Link DES 3350SR (minimum firmware: R1.02.035)
- D-Link DES 3526 (minimum firmware: R3.01-B23)
- D-Link DES 3550 (minimum firmware: R3.01-B23)
- D-Link DGS 3324SR (minimum firmware: R4.10-B15)

Note

Make sure that the switches have the minimum required firmware versions before activating ZoneDefense.

12.3. ZoneDefense Operation

12.3.1. SNMP

Simple Network Management Protocol (SNMP) is an application layer protocol for complex network management. SNMP allows the managers and managed devices in a network to communicate with each other.

SNMP Managers

A typical managing device, such as a D-Link Firewall, uses the SNMP protocol to monitor and control network devices in the managed environment. The manager can query stored statistics from the controlled devices by using the *SNMP Community String*. This is similar to a userid or password which allows access to the device's state information. If the community string type is *write*, the manager will be allowed to modify the device's state.

Managed devices

The managed devices must be SNMP compliant, as are D-Link switches. They store state data in databases known as the Management Information Base (MIB) and provide the information to the manager upon receiving an SNMP query.

12.3.2. Threshold Rules

A threshold rule will trigger ZoneDefense to block out a specific host or a network if the connection limit specified in the rule is exceeded. The limit can be one of two types:

- **Connection Rate Limit** - This can be triggered if the rate of new connections per second to the firewall exceeds a specified threshold.
- **Total Connections Limit** - This can be triggered if the total number of connections to the firewall exceeds a specified threshold.

Threshold rules have parameters which are similar to those for IP Rules. These parameters specify what type of traffic a threshold rule applies to.

A single threshold rule has the parameters:

- Source interface and source network
- Destination interface and destination network
- Service
- Type of threshold: Host and/or network based

Traffic that matches the above criteria and causes the host/network threshold to be exceeded will trigger the ZoneDefense feature. This will prevent the host/networks from accessing the switch(es). All blocking in response to threshold violations will be based on the IP address of the host or network on the switch(es). When a network-based threshold has been exceeded, the source network will be blocked out instead of just the offending host.

For a general description of how Threshold Rules are specified and function, please see Section 10.2, “Threshold Rules”.

12.3.3. Manual Blocking and Exclude Lists

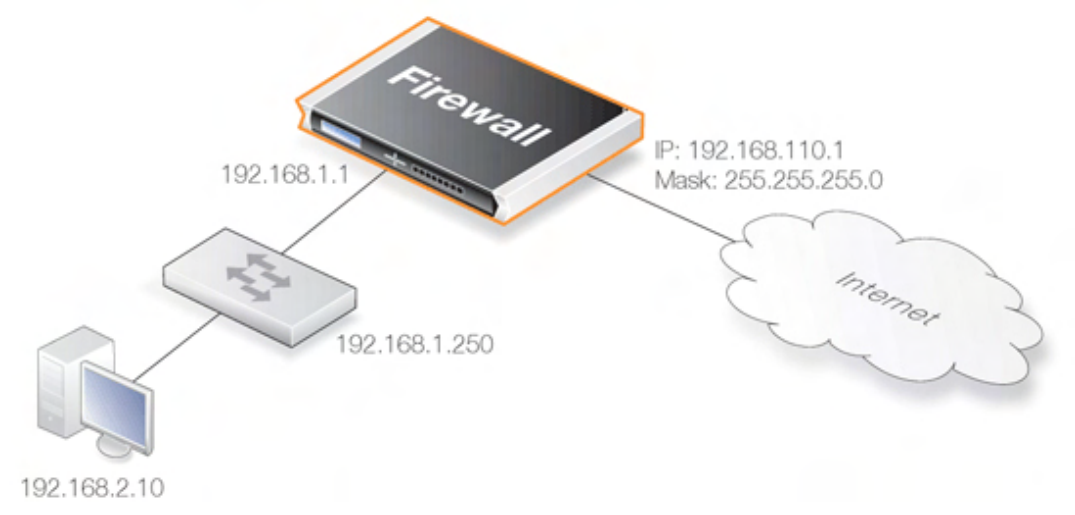
As a complement to threshold rules, it is also possible to manually define hosts and networks that are to be statically blocked or excluded. Manually blocked hosts and networks can be blocked by default or based on a schedule. It is also possible to specify which protocols and protocol port numbers are to be blocked.

Exclude Lists can be created and used to exclude hosts from being blocked when a threshold rule limit is reached. Good practice includes adding to the list the firewall's interface IP or MAC address connecting towards the ZoneDefense switch. This prevents the firewall from being accidentally blocked out.

Example 12.1. A simple ZoneDefense scenario

The following simple example illustrates the steps needed to set up ZoneDefense. It is assumed that all interfaces on the firewall have already been configured.

An HTTP threshold of 10 connections/second is applied. If the connection rate exceeds this limitation, the firewall will block the specific host (in network range 192.168.2.0/24 for example) from accessing the switch completely.



A D-Link switch model DES-3226S is used in this case, with a management interface address 192.168.1.250 connecting to the firewall's interface address 192.168.1.1. This firewall interface is added into the exclude list to prevent the firewall from being accidentally locked out from accessing the switch.

Web Interface

Add a new switch into ZoneDefense section:

1. Go to **Zone Defense > Switches > Add > ZoneDefense switch**
2. Now enter:
   - **Name:** switch1
   - **Switch model:** DES-3226S
   - **IP Address:** 192.168.1.250
3. For **SNMP Community** enter the *Write Community String* configured for the switch
4. Press **Check Switch** to verify the firewall can communicate with the switch and the community string is correct.
5. Click **OK**

Add the firewall's management interface into the exclude list:

1. Go to **Zone Defense > Exclude list**
2. For **Addresses** choose the object name of the firewall's interface address 192.168.1.1 from the **Available** list and put it into the **Selected** list.
3. Click **OK**.

Configure an HTTP threshold of 10 connections/second:

1. Go to **Traffic Management > Threshold Rules > Add > Threshold Rule**
2. For the **Threshold Rule** enter:
   - **Name:** HTTP-Threshold
   - **Service:** http
3. For **Address Filter** enter:
   - **Source Interface:** The firewall's management interface
   - **Destination Interface:** any
   - **Source Network:** 192.168.2.0/24 (or the object name)
   - **Destination Network:** all-nets
4. Click **OK**

Specify the threshold, the threshold type and the action to take if exceeded:

1. Go to **Add > Threshold Action**
2. Configure the **Theshold Action** as follows:
   - **Action:** Protect
   - **Group By:** Host-based
   - **Threshold:** 10
   - Set the units for the threshold value to be **Connections/Second**
   - Tick the **Use ZoneDefense** checkbox
   - Click **OK**

12.3.4. Limitations

There are some differences in ZoneDefense operation depending on switch model. The first difference is the latency between the triggering of a blocking rule to the moment when switch(es) actually starts blocking out the traffic matched by the rule. All switch models require a short period of latency time to implement blocking once the rule is triggered. Some models can activate blocking in less than a second while some models may require a minute or more.

A second difference is the maximum number of rules supported by different switches. Some switches support a maximum of 50 rules while others support up to 800 (usually, in order to block a host or network, one rule per switch port is needed). When this limit has been reached no more hosts or networks will be blocked out.

Important

ZoneDefense uses a range of the ACL rule-set on the switch. To avoid potential conflicts in these rules and guarantee the firewall's access control, it is strongly recommended that the administrator clear the entire ACL rule-set on the switch before executing the ZoneDefense setup.

Chapter 13. Advanced Settings

This chapter describes the configurable advanced setings for NetDefendOS. The settings are divided up into the following categories:

13.1. 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. NetDefendOS only accepts version 4 IP packets; everything else is discarded.

Default: *256*

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 NetDefendOS 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 firewall. These constitute an enormous security risk. NetDefendOS never obeys the source routes specified by these options, regardless of this setting.

Default: *DropLog*

IPOPT_TS

Time stamp options instruct each router and firewall 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. NetDefendOS 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 NetDefendOS 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 NetDefendOS 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 size specified by this setting.

Default: *65535 bytes*

13.2. 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. Packets containing maximum segment sizes below this limit are handled according to the next setting.

Default: *100 bytes*

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. Packets containing maximum segment sizes exceeding this limit are handled according to the next setting.

Default: *1460 bytes*

TCPMSSVPNMax

As is the case with TCPMSSMax, this is the highest Maximum Segment Size allowed. However, this settings only controls MSS in VPN connections. This way, NetDefendOS 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 bytes*

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 intafaces, in addition to TCPMSSMax.

Default: *Enabled*

TCPMSSLogLevel

Determines when to log regarding too high TCP MSS, if not logged by TCPMSSOnHigh.

Default: *7000 bytes*

TCPZeroUnusedACK

Determines whether NetDefendOS 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 NetDefendOS will handle window-scaling options. These are used to increase the size of the windows used by TCP; i.e. 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 NetDefendOS 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 NetDefendOS 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 NetDefendOS 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 NetDefendOS 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 NetDefendOS 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 NetDefendOS will handle connection count options.

Default: *StripLogBad*

TCPOPT_OTHER

Specifies how NetDefendOS will deal with TCP options not covered by the above settings. These options usually never appear on modern networks.

Default: *StripLog*

TCPSynUrg

Specifies how NetDefendOS 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 NetDefendOS 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 NetDefendOS 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 NetDefendOS 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 NetDefendOS 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 NetDefendOS 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 NetDefendOS 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 NetDefendOS 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 firewalls are unable to detect them.

Default: *DropLog*

13.3. ICMP Level Settings

ICMPSendPerSecLimit

Specifies the maximum number of ICMP messages NetDefendOS 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 per second*

SilentlyDropStateICMPErrors

Specifies if NetDefendOS 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*

13.4. ARP Settings

ARPMatchEnetSender

Determines if NetDefendOS 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 NetDefendOS 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 NetDefendOS 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, NetDefendOS will, provided that other rules approve the request, reply to it.

Default: *Drop*

ARPChanges

Determines how NetDefendOS 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 NetDefendOS will not accept the new address until the previous ARP table entry has timed out.

Default: *AcceptLog*

StaticARPChanges

Determines how NetDefendOS 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 a normal dynamic item in the ARP table is to be retained before it is removed from the table.

Default: *900 seconds (15 minutes)*

ARPExpireUnknown

Specifies how long NetDefendOS is to remember addresses that cannot be reached. This is done to ensure that NetDefendOS does not continuously request such addresses.

Default: *3 seconds*

ARPMulticast

Determines how NetDefendOS 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 NetDefendOS 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 entrys 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*

13.5. Stateful Inspection Settings

LogConnectionUsage

This generates a log message for every packet that passes through a connection that is set up in the NetDefendOS state engine. Traffic whose destination is the D-Link Firewall itself eg. NetDefendOS management traffic, is not subject to this setting.

The log message includes port, service, source/destination IP address and interface. This setting should only be enabled for diagnostic and testing purposes since it generates unwieldy volumes of log messages and can also significantly impair throughput performance.

Default: *Disabled*

ConnReplace

Allows new additions to NetDefendOS'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 NetDefendOS is to log the occurrence of such packets.

Default: *Enabled*

LogReverseOpens

Determines if NetDefendOS 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 NetDefendOS 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 NetDefendOS may keep open at any one time. Each connection consumes approximately 150 bytes RAM. When this settings is dynamic, NetDefendOS will try to use as many connections as is allowed by product.

Default: <*dynamic*>

LogConnections

Specifies how NetDefendOS, 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*

13.6. Connection Timeouts

The settings in this section specify how long a connection can remain idle, i.e. 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 long 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 seconds*

ConnLife_UDP

Specifies how long UDP connections may idle before being closed. This timeout value is usually low, as UDP has no way of signaling when the connection is about to close.

Default: *130 seconds*

ConnLife_Ping

Specifies how long a Ping (ICMP ECHO) connection can remain idle before it is closed.

Default: *8 seconds*

ConnLife_Other

Specifies how long connections using an unknown protocol can remain idle before it is closed.

Default: *130 seconds*

ConnLife_IGMP

Connection lifetime for IGMP

Default: *12 seconds*

13.7. Size Limits by Protocol

This section contains information about the size limits imposed on the protocols directly under IP level, i.e. 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 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 bytes*

MaxESPLen

Specifies the maximum size 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 bytes*

MaxAHLen

Specifies the maximum size 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 bytes*

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 NetDefendOS will log oversized packets.

Default: *Enabled*

13.8. Fragmentation Settings

IP is able to transport up to 65536 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. NetDefendOS 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 NetDefendOS 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, NetDefendOS 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.
- NetDefendOS 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 NetDefendOS 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 NetDefendOS 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 often not possible to set this limit too high. It is rarely the case that senders create very small fragments. However, a sender may 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 NetDefendOS 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, NetDefendOS is able to remember this for a short period of time in order to prevent further fragments, e.g. old duplicate fragments, of that packet from arriving.

Default: *20 seconds*

ReassIllegalLinger

Once a whole packet has been marked as illegal, NetDefendOS is able to retain this in its memory in

order to prevent further fragments of that packet from arriving.

Default: *60 seconds*

13.9. 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*

13.10. 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 NetDefendOS 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 NetDefendOS on the offered IP.

Default: *Disabled*

13.11. 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 NetDefendOS 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 leastime allowed through NetDefendOS, 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*

13.12. 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*

13.13. 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.

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, NetDefendOS 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 NetDefendOS directly to the IPsec engine without consulting the rule-set.

Default: *Enabled*

IPsecDeleteSAOnIPValidationFailure

Controls what happens to the SAs if IP validation in Config Mode fails. If Enabled, the SAs are dropped on failure.

Default: *Disabled*

13.14. Transparent Mode Settings

Transp_CAMToL3CDestLearning

Enable this if the firewall 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 firewall 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 seconds*

Transparency_ATSSize

Defines the maximum total number of ARP Transaction State (ATS) entries. Valid values are 128-65536 entries.

Default: *4096*

Note

Both Transparency_ATSExpire and Transparency_ATSSize can be used to tweak the ATS handling to be optimal in different environments.

13.15. Logging Settings

LogSendPerSecLimit

This setting limits how many log packets NetDefendOS 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 NetDefendOS 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 NetDefendOS 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 NetDefendOS sends every second, you avoid encountering such devastating bandwidth consuming scenarios.

Default: *3600 seconds, once an hour*

13.16. High Availability Settings

ClusterID

A (locally) unique cluster ID to use in identifying this group of HA D-Link Firewalls.

Default: *0*

HASyncBufSize

How much sync data, in KB, 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.

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*

13.17. 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*

13.18. DNS Client Settings

DNS_DNSServerIP1

Primary DNS Server.

Default: *none*

DNS_DNSServerIP2

Secondary DNS Server.

Default: *none*

DNS_DNSServerIP3

Tertiary DNS Server.

Default: *none*

13.19. HTTP Poster Settings

HTTPPoster_URL1, HTTPPoster_URL2, HTTPPoster_URL3

The URLs specified here will be posted in order when NetDefendOS is loaded.

HTTPPoster_RepDelay

Delays in seconds until all URLs are refetcd.

Default: *604800*

13.20. PPP Settings

PPP_L2TPBeforeRules

Pass L2TP traffic sent to the D-Link Firewall directly to the L2TP Server without consulting the rule-set.

Default: *Enabled*

PPP_PPTPBeforeRules

Pass PPTP traffic sent to the D-Link Firewall directly to the PPTP Server without consulting the rule-set.

Default: *Enabled*

13.21. IDP

IDP_UpdateInterval

The number of seconds between automatic IDP signature updates. A value of 0 stops automatic updates.

Default: *43200 (=12 hours)*

13.22. Hardware Monitor Settings

HWM_PollInterval

Polling intervall 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*

13.23. 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 sub-systems of such overlaps. The associated settings limit memory used by the re-assembly sub-system.

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*

13.24. Miscellaneous Settings

BufFloodRebootTime

As a final way out, NetDefendOS automatically reboots if it's buffers have been flooded for a long time. This setting specifies this amount of time.

Default: *3600*

HighBuffers

The number of buffers to allocate in RAM above the 1 MB limit.

Default: *3% of total RAM, with a lower limit of 1024+lowbuffers*

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 settings. For more information about pipes and pipe users, see chapter 10, Traffic Shaping.

Default: *512*

Appendix A. Subscribing to Security Updates

Introduction

The NetDefendOS Anti-Virus (AV) module, the Intrusion Detection and Prevention (IDP) module and the Dynamic Web Content Filtering module all function using external D-Link databases which contain details of the latest viruses, security threats and URL categorization. These databases are constantly being updated and to get access to the latest updates a D-Link Security Update Subscription should be taken out. This is done by:

- Purchasing a subscription from your local D-Link reseller.
- On purchase, you will receive a unique activation code to identify you as a user of the service.
- Go to **Maintenance** > **License** in the web interface of your D-Link Firewall system and enter this activation code. NetDefendOS will indicate the code is accepted and the update service will be activated. (Make sure access to the public internet is possible when' doing this).

Note
A step-by-step "Registration manual" which explains registration and update service procedures in more detail is available for download from the D-Link website.

Subscription renewal

In the Web-interface go to **Maintenance** > **License** to check which update services are activated and when your subscription is ends.

Caution
Renew your subscription in good time before your current subscription ends!

Monitoring database updates

In the Web-interface go to **Maintenance** > **Update** to configure the automatic database updating. You can also check when the last update was attempted and what the status was for that attempt.

In the same area of the Web-interface it is also possible to manually initiate updating by selecting **Update now** to download the latest signatures to the database.

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:

```
gw-world:/>  updatecenter -update IDP
```

An Anti-Virus update can similarly be initiated with the command:

```
gw-world:/>  updatecenter -update Antivirus
```

Querying Update Status

To get the status of IDP updates use the command:

```
gw-world:/>  updatecenter -status IDP
```

To get the status of AV updates:

```
gw-world:/>  updatecenter -status Antivirus
```

Querying Server Status

To get the status of the D-Link network servers use the command:

```
gw-world:/>  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

```
gw-world:/>  removedb IDP
```

To remove the Anti-Virus database, use the command:

```
gw-world:/>  removedb Antivirus
```

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

Anti-Virus database updates require a couple of seconds to be optimized once an update is downloaded. This will cause the firewall to momentarily pause in its operation. It can therefore be best to set the timing of updates to be at times of low traffic, such as in the early hours of the morning. Deleting a database can cause a similar pause in operation.

Appendix B. IDP Signature Groups

For IDP scanning, the following signature groups are available for selection. These groups are available only for the D-Link Advanced IDP Service. There is a version of each group under the three *Types* of **IDS**, **IPS** and **Policy**. For further information see Section 6.3, “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

Group Name	Intrusion Type
FTP_FORMATSTRING	Format string attack
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

Group Name	Intrusion Type
POP3_DOS	Denial of Service for POP
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

Group Name	Intrusion Type
TFTP_OPERATION	Operation Attack
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 C. Anti-Virus MIME filetypes

For Anti-virus scanning, the following MIME filetypes can be checked to make sure that the content matches the filetype of a file download. Checking is done only if the option is enabled as described in Section 6.4.6, “Anti-Virus Options”.

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
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

Filetype extension	Application
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-sequention 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
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

Filetype extension	Application
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
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

Filetype extension	Application
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 D. The OSI Framework

The Open Systems Interconnection Model defines a framework for intercomputer 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 D.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 canunderstand.

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.

Appendix E. D-Link worldwide offices

Below is a complete list of D-Link worldwide sales offices. Please check your own country area's local website for further details regarding support of D-Link products as well as contact details for local support.

Australia	1 Giffnock Avenue, North Ryde, NSW 2113, Australia. TEL: 61-2-8899-1800, FAX: 61-2-8899-1868. **Website: www.dlink.com.au**
Belgium	Rue des Colonies 11, B-1000 Brussels, Belgium. Tel: +32(0)2 517 7111, Fax: +32(0)2 517 6500. **Website: www.dlink.be**
Brazil	Av das Nacoes Unidas, 11857 – 14- andar - cj 141/142, Brooklin Novo, Sao Paulo - SP - Brazil. CEP 04578-000 (Zip Code) TEL: (55 11) 21859300, FAX: (55 11) 21859322. **Website: www.dlinkbrasil.com.br**
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Denmark	Naverland 2, DK-2600 Glostrup, Copenhagen Denmark. TEL: 45-43-969040, FAX: 45-43-424347. **Website: www.dlink.dk**
Egypt	47,El Merghany street,Heliopolis, Cairo-Egypt. TEL: +202-2919035, +202-2919047, FAX: +202-2919051. **Website: www.dlink-me.com**
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India	D-Link House, Kurla Bandra Complex Road, Off CST Road, Santacruz (East), Mumbai - 400098, India. TEL: 91-022-26526696/56902210, FAX: 91-022-26528914. **Website: www.dlink.co.in**
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	FAX: +972-9-9715601. **Website: www.dlink.co.il**
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