Introduction

This guide describes the firewall and NAT features on the Allied Telesis UTM Firewalls and Secure VPN Routers (AR-Series firewalls) and how to configure them.

The firewall feature on the AR-Series firewalls offers security, flexibility and ease of use. Unlike a traditional firewall, they will keep pace with rapid changes in Internet-based applications, enabling enterprises to see the benefits of web-based technology without costly security issues.

The AR-Series firewalls also supports Network Address Translation (NAT), allowing a single device to act as an agent between the public Internet and a local private network. With NAT, private (RFC1918) IPv4 addresses can be configured on devices located on the private side of the firewall. When those devices send traffic to the Internet, the firewall translates the private addresses to become one or more publicly-valid addresses. When the firewall receives traffic that is destined for those devices, it translates the public address back to the appropriate private address.

This document gives an overview of the firewall and NAT on AR-Series firewalls, followed by examples illustrating how to configure them in various network situations.
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Products and software version that apply to this guide

This Guide applies to the AR-Series firewalls running AlliedWare Plus version 5.4.5 or later:

- AR4050S UTM Firewall
- AR3050S UTM Firewall
- AR2050V Secure VPN Router
- AR2010V Secure VPN Router

Most features described in this document are supported from AlliedWare Plus 5.4.5 or later.

These changes apply in 5.4.8-0.x or later:

- New firewall rules are needed when DPI is enabled and the firewall is accessing external services, including Update Manager.

This feature is supported in 5.4.7-2.4 or later:

- Configurable HTTP and HTTPS ports

These features are supported in 5.4.7-1.x or later:

- Firewall connection logging
- Configurable TCP established session timeout

These features are available in version 5.4.7-0.1 or later:

- Subnet-based NAT
- Source and destination NAT
- Allowing partial sessions through a firewall (no state enforcement)

This feature is available in version 5.4.6-2.1 or later:

- Firewall with High Availability (VRRP)
Related documents

The following documents provide information about related features on AlliedWare Plus products:

- Getting Started with the UTM Firewall GUI Feature Overview Guide
- Getting Started with the VPN Firewall GUI Feature Overview Guide
- Application Awareness Feature Overview and Configuration Guide
- The product’s Datasheet
- The product’s Command Reference

These documents are available from the links above or on our website at alliedtelesis.com

Advanced Feature Licences

Flexible subscription licensing options make it easy to choose the right combination of security features to best meet your business needs. The Advanced Firewall license includes Application Control, Web Control and URL Filtering. The Advanced Threat Protection (ATP) license includes IP Reputation, stream-based Malware Protection and (on the AR4050S only) proxy-based Antivirus.
The Firewall

A firewall, at its most basic level, controls traffic flow between a trusted network (such as a corporate LAN) and an untrusted or public network (such as the Internet). The most commonly deployed firewalls nowadays are port-based or packet filtering. These traditional firewalls determine the allowed traffic versus the disallowed traffic based on many characteristics of the packets, including their destination and source IP addresses and TCP/UDP port numbers. However, traditional network security solutions have failed to keep pace with changes to applications, threats, and the network landscape.

AR-Series firewalls are designed for the challenges facing modern networks. In contrast to traditional firewalls that lack the intelligence to discern network traffic in a world where network boundaries are disintegrating and Internet applications are exploding, AR-Series firewalls no longer talk about packets, IP addresses and ports. Instead they focus on applications, users and content. It classifies traffic by the application’s identity in order to enable visibility and control of all types of application.

The AR-Series firewalls view the physical network in terms of zones, networks and hosts. Firewall rules can be applied to any level of this hierarchy, as shown in Figure 1 on page 6. See “Entities” on page 10 for entity definitions and usage.

When the firewall is enabled, its default policy is to drop all applications from anywhere to anywhere. If no rule is explicitly configured, all traffic moving through the firewall is blocked.

As data enters the firewall, it is first identified by the DPI application decoding engine. The firewall filters traffic by identifying applications. The application-centric traffic classification identifies specific applications flowing across the network regardless of the port and protocol in use.

The firewall identifies applications through a database of regularly updated application signatures. By default, this engine contains a library of a few dozen common Internet-based applications that it is capable of identifying. Deep Packet Inspection (DPI) is used by the firewall to match packets against these signatures and provide Layer 7 filtering for firewall rules. See “Applications” on page 9 for application definition and usage.
Figure 1: Firewall zones, networks, hosts

The firewall provides the following features:

- Stateful inspection maintains the status of active connections through the firewall to dynamically allow inbound replies to outbound connections.
- Robust application identification and inspection enables granular control of the flow of sessions through a firewall, based on the specific applications that are being used.
- Rules allow specified traffic to be matched and the appropriate action applied.
- Network Address and Port Translation permits multiple hosts on a LAN to be mapped to a single public IP address and hides details of the internal network.
- OpenVPN integration provides secure remote access to Intranet resources.
- Application Layer Gateway (ALG) inspects the application layer payload of a packet and understands the application control messages, and performs Network Address Translation processing if necessary.
- Logs allow retrieval of all event details for later analysis.
- Reports of network usage and statistics give network managers the information they need to effectively manage their networks.
Firewall GUI

If you want to you can use the Firewall GUI to monitor and configure your firewall.

The firewall GUI provides setup of the firewall, enabling the configuration of entities (zones, networks and hosts) and then creating firewall, NAT and traffic-control rules for managing traffic between these entities. Features such as the Intrusion Prevention System (IPS) and URL Filtering help protect the network, and manage website access.

The GUI also supports a DHCP server, interface management, VLAN management, system tools, a CLI window and a dashboard for network monitoring. The dashboard shows interface and firewall traffic, system and environmental information, and the security monitoring widget lets you view and manage rules and security features.

Accessing the Firewall GUI

If your AR-Series firewall came with the GUI pre-installed, perform the following steps to browse to the GUI:

1. Connect to any of the LAN switch ports
2. Open a web browser and browse to https://192.168.1.1. This is the pre-configured IP address of VLAN1. The default username is manager and the default password is friend.

If your AR-Series firewall did not come with the GUI pre-installed, perform the following steps through the command-line interface:

3. Create one or more IP interfaces and assign them IP addresses, including configuring WAN connectivity. For information about configuring PPP, see the PPP Feature Overview and Configuration Guide. For information about configuring IP, see the IP Feature Overview and Configuration Guide.

4. If you plan to enable the firewall functionality, first create firewall rules to allow both DNS and HTTPS traffic from the Update Manager to pass through the firewall. This is needed because AR-Series firewalls block all traffic by default. The following figure shows a recommended example configuration, when WAN connectivity is through ppp0:

```
zone public
  network wan
    ip subnet 0.0.0.0/0 interface ppp0
  host ppp0
    ip address dynamic interface ppp0

firewall
  rule 10 permit dns from public.wan.ppp0 to public.wan
  rule 20 permit https from public.wan.ppp0 to public.wan
  protect
```
5. Use the following command to download and install the GUI:
   \[
   \text{awplus\# update webgui now}
   \]

6. Enable the HTTP service:
   \[
   \begin{align*}
   &\text{awplus\# configure terminal} \\
   &\text{awplus(config)\# service http}
   \end{align*}
   \]

7. Log into the GUI.
   Start a browser and browse to the firewall’s IP address, using HTTPS. You can access the GUI via any reachable IP address on any interface.
   The GUI starts up and displays a login screen. Log in with your username and password.

**HTTP and HTTPS GUI listen ports**

By default, the Firewall GUI uses the HTTP server listen port 80. The default HTTPS server listen port is 443. You can change the HTTPS port. From AlliedWare Plus version 5.4.7-2.4 you can also change the HTTP port, and disable listening on either the HTTP or HTTPS port.

This allows you to remap the GUI to use other ports and allow traffic using these HTTP (80) and HTTPS (443) ports to be forwarded through the device to another server, if required, instead of being terminated on the device. You may wish to change the HTTP port if port 80 needs to be used by another service at the same IP address in your network.

To change or disable the HTTP listen port, use the command:
   \[
   \text{awplus(config)\# http port \{<1-65535>|none\}}
   \]

To restore the HTTP port to its default (port 80), use the command:
   \[
   \text{awplus(config)\# no http port <1-65535>}
   \]

To change or disable the HTTPS listen port, use the command:
   \[
   \text{awplus(config)\# http secure-port \{<1-65535>|none\}}
   \]

Setting the port to none disables HTTP or HTTPS management.

Note that changing or disabling the HTTPS trusted port is not supported when using Vista Manager. If you are using Vista Manager EX and need to change the HTTPS trusted port, you must use certificate-based authorization in Vista Manager EX. See the ‘Vista Manager EX Installation and User Guide’ for instructions.

To restore the HTTPS port to its default (port 443), use the command:
   \[
   \text{awplus(config)\# no http secure-port}
   \]

To check the settings for the HTTP and HTTPS (secure) ports, use the command:
   \[
   \text{awplus\# show http}
   \]
Applications

An application is a high level abstraction for the classification of packets being transported by network traffic. Traffic matching for applications can be achieved using several techniques, for example, matching packets to port numbers or searching for application signatures in flows of packets. The device recognizes the following kinds of applications:

- You can configure source port, destination port, protocol, ICMP code and ICMP type for the application. An application is invalid if its protocol, source or destination are not properly configured, for example, if an application has no protocol configured, or source and destination ports are applied to protocols that are not TCP, UDP or SCTP.
- By default, there are a number of predefined applications with protocols, source and destinations ports.
- There is a built-in library of many more applications that can be identified in traffic if Deep Packet Inspection (DPI) is enabled.
- The extensive up-to-date library of applications maintained by Procera is available by subscription. With DPI enabled, the device recognises these applications.

You can use the `show application` and `show application detail` commands to display the detail of these applications.

If applications have the same name, precedence in all application-aware features is:

1. user-configured applications
2. applications identified by DPI
3. built-in predefined list

For information about applications and application awareness, see the Application Awareness Feature Overview and Configuration Guide.

Application Layer Gateways (ALG)

To determine the protocol associated with a given packet, the firewall typically looks at the IP protocol number and/or the source and destination TCP/UDP port numbers. This works well for most protocols. However, there are some protocols which use different port/IP protocol numbers at different points during communication. An example of this is FTP, which uses the well-known port 21 for negotiation but either uses the well-known port 20 or ephemeral ports for the associated data transfer.

The Application Layer Gateway (ALG) identifies data streams associated with these protocols to be processed correctly by the firewall.
The following protocols are supported by the ALG and are included in the default (predefined) application list:

- FTP
- IRC
- PPTP

The following protocols are supported by the ALG but are not included in the default application list: SNMP, GRE, SCTP, TFTP, H323 and SIP.

The protocols not included on the default application list require that a custom application be created for them (application command and associated commands, see step 4 in "Configuring Firewall and NAT Rules for Entities" on page 20.)

Alternatively, with an Advanced Firewall subscription license, you can utilize the Application Control feature which adds automatic support for thousands of applications to the application list.

**Entities**

Allied Telesis UTM Firewalls and Secure VPN Routers support application and entity-based security policies. For example, firewall and Network Address Translation (NAT) rules are applied to applications among different zone entities.

An entity is a high level abstraction of an individual network device, an individual network, or a group of networks or subnets. It is the instance that firewall and NAT policies can be applied to. There are three types of entity:

- Zone
- Network
- Host

Zone is a high level abstraction for a logical grouping or segmentation of physical networks. This is the highest level of partitioning that firewall and NAT policy can be applied to. Zone establishes the security border of your networks. A zone defines a boundary where traffic is subjected to policy restrictions as it crosses to another region of your networks. The minimum zones normally implemented would be a trusted zone for the private network behind the firewall and an untrusted zone for the Internet. Other common zones are a Demilitarized Zone (DMZ) for publicly visible web servers and a Virtual Private Network (VPN) zone for remote access users or tunnels to other networks.

A network is a high level abstraction of a logical network in a zone. This consists of the IP subnets and interfaces over which it is reachable. Subnets are grouped into networks to apply a common set of rules among the subnets.
Host is a high level abstraction of a single node in a network. This is commonly used if a particular device, for example a server, has a static IP address that needs to be specified in a firewall policy.

In addition to supporting network address translation for TCP and UDP traffic, AR-Series firewalls also support VPN pass-through. Network services that use the following protocols can traverse a NAT device.

- ESP (Encapsulation Security Payload)
- PPTP (Point to Point Tunneling Protocol)
- L2TP (Layer 2 Tunneling Protocol)
- GRE (Generic Routing Encapsulation)

**Default Flow with Firewall Enabled**

The following section describes the default behaviors for various layer 2 and layer 3 data-plane and control-plane protocols.

If the firewall is enabled by the `protect` command, a default deny policy drops all traffic that does not match configured rules that is being processed via the firewall software.

**L3 data plane**

All Layer 3 IP data plane messages are subject to AR-Series firewall screening, so if the firewall is enabled and there are no firewall permit rules explicitly configured to allow the associated applications, Layer 3 data plane messages are dropped. This includes protocols like ICMP, general customer TCP, UDP and multicast network traffic.

**L3 control plane**

By default, the AR-Series firewall blocks both reception and transmission of Layer 3 control plane messages (L3CP) if corresponding firewall rules are not configured. This also includes remote management protocols like SSH and Telnet.

For IPv6 and IPv4 routing protocols to operate to allow transmission and reception via the reserved multicast address range, corresponding firewall permit rules must be configured. This applies to routing protocols such as PIM, BGP, OSPF, OSPFv3, RIP and RIPv2.

**L2 control plane**

However, Layer 2 control plane (L2CP) protocols (embedded within Ethernet frames) are processed shortly after ingress, before being processed by the firewall, so associated firewall permit rules are not required.

These L2CP frames include all of IEEE Std 802.1D and IEEE Std 802.1Q Reserved Addresses used by LACP, STP, LLDP, and 802.1x MAC control. To remain IEEE802.1 compliant, they do not typically ingress one interface and egress another. These protocols operate independently of the firewall—they continue to be transmitted and received whether or not the firewall is enabled unless the Layer 2 feature is explicitly disabled in the device configuration. The individual features themselves are, however, designed to detect and drop malformed control plane messages which might be used to form some kind of DOS attack, so there is still some inherent protection provided.
AMF messages

AMF messages are a special case, and the AR-Series firewall treats them as Layer 2 control plane messages processed independently of the firewall. AMF virtual link messages are however transported as IP UDP packets, so corresponding allow rules must be configured.

IPv4 ARP and IPv6 ND

With the firewall enabled, IPv4 ARP and IPv6 RA, RS, NA, and NS are all permitted without the need to configure firewall rules.

VRRP messages

From AlliedWare 5.4.6-2.x, VRRP behavior is under firewall control. High Availability uses VRRP. If High Availability is used, then firewall permit rules must be configured to allow VRRP multicast messages to be received. VRRP messages are still transmitted from the firewall without a corresponding firewall permit rule, but the incoming VRRP control plane IPv4/IPv6 messages will be blocked by the firewall before being processed by VRRP feature.

In AlliedWare Plus versions 5.4.6-1.x and earlier, incoming and outgoing VRRP messages bypass the firewall, so no corresponding firewall permit rules are required.

L2 bridged traffic

Additionally, Layer2 bridged Ethernet frames (bridged from one interface to another) are also not subject to the firewall application rules, so they will continue to flow unimpeded if the firewall is enabled. The bridge itself does, however, inspect the embedded IP data fields contained in the Layer 2 Ethernet frames, and so will also drop malformed packets if the encapsulated data is corrupt.

Firewall Filtering and Logging

This section describes the filtering and logging performed when the firewall feature on an AR-Series firewall is enabled. A firewall rule specifies the action (Table 1) to take for traffic that matches other parameters in the rule.

<table>
<thead>
<tr>
<th>ACTION</th>
<th>MEANING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permit</td>
<td>The matched packets are permitted to egress from the firewall.</td>
</tr>
<tr>
<td>Deny</td>
<td>The matched packets are silently dropped by the firewall. No explicit notification is sent to the source of the packets</td>
</tr>
<tr>
<td>Reject</td>
<td>The matched packets are rejected by the firewall and an attempt is made to cleanly close the connection. The source of the packets is notified where possible, for instance, a TCP RST packet is returned for a TCP session, or ICMP packets such as destination/port unreachable are sent to the source.</td>
</tr>
<tr>
<td>Log</td>
<td>The matched packets are logged, and will continue to be processed by subsequent firewall rules, which may eventually permit, deny or reject the packets.</td>
</tr>
</tbody>
</table>
Default filtering behaviour

When enabled, the firewall has some default attack protection and filtering rules installed that are not configurable by the user. When packets are dropped by these default filters, log messages are generated to record the reason for the drop. In order to prevent the device from being overloaded by generating log messages in response to an attack, the generation of logs is rate-limited, depending on the reason for the packet being dropped.

Smurf attack protection

The firewall has smurf attack protection enabled by default, and it cannot be disabled. A smurf attack is an ICMP ping that is sent with a broadcast IP address as the destination IP address. The firewall will silently discard all pings that are directed at the broadcast address and will not log the packet.

Invalid TCP flags

The firewall, when enabled, protects against TCP packets with illegal flag combinations set. When dropping these illegal packets, the firewall will generate at most one log message per second regardless of the number of packets dropped by the rule. The logs generated for these illegal TCP flag combinations will begin with the prefix:

    Firewall: DENY probe <illegal-flags>

followed by the packet data.

The firewall will also drop new TCP connections that have not been properly started with a SYN flag set. The prefix for these log messages is

    Firewall: DENY no SYN

with a maximum logging rate of one per second.

Connection tracking of permitted packets

The firewall performs stateful packet inspection as part of its general filtering process. TCP, UDP or ICMP packets that successfully match a PERMIT rule and are identified as matching an existing ESTABLISHED connection or are part of a NEW connection are subjected to flood protection filtering (see “Flood protection filtering” on page 14). If the permitted packets cannot be correctly matched to an existing connection, are not related to an existing connection, are invalid for starting a new connection, or invalid for another reason, the packets are considered to be invalid and will be dropped. Dropped invalid packets will produce a log with the prefix:

    Firewall: DENY INVALID

at a maximum rate of one log message per second.

Some criteria for packets to be considered invalid are:

- The total maximum number of connections has been exceeded. The maximum for each AR-Series firewall model is 100 000 connections.
- Packet is short/truncated/malformed or has a bad checksum.
For TCP packets:

- The sequence number is not as expected; for instance, an ACK is received for data that has not yet been transmitted.
- The connection tracking has become out of sync with the actions of the client and server; marking the packets as invalid and dropping will force the client to initiate a new connection.

**Configurable TCP established session timeout**

By default, when a TCP session is successfully established through the AR-Series firewall, when the session goes idle it automatically times out of the firewall connection tracking table after 3600 seconds. In some situations it may be beneficial to time out unused established TCP sessions earlier.

For example, in a busy environment where there is an excessive number of sessions being established, the firewall connection tracking table could become oversubscribed, with new connections being blocked until older sessions are timed out.

From release 5.4.7-1.x onwards, the following command is available to set a non-default TCP session timeout for established idle sessions:

```
ip tcp timeout established <1-31536000>
```

**Flood protection filtering**

Flood-protection filtering acts as an additional layer of defense, and applies only to traffic that has already been permitted by a firewall rule. The flood-protection rate-limiting depends on the model and protocol.

**Table 2: Flood-protection rate-limiting**

<table>
<thead>
<tr>
<th>MODEL</th>
<th>TCP SYN CONNECTIONS PER SECOND</th>
<th>SYN BURST</th>
<th>UDP CONNECTIONS PER SECOND</th>
<th>UDP BURST</th>
<th>ICMP CONNECTIONS PER SECOND</th>
<th>ICMP BURST</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR2010V</td>
<td>3333</td>
<td>6000</td>
<td>3333</td>
<td>6000</td>
<td>1000</td>
<td>2000</td>
</tr>
<tr>
<td>AR2050V</td>
<td>3333</td>
<td>6000</td>
<td>3333</td>
<td>6000</td>
<td>1000</td>
<td>2000</td>
</tr>
<tr>
<td>AR3050S</td>
<td>3333</td>
<td>6000</td>
<td>3333</td>
<td>6000</td>
<td>1000</td>
<td>2000</td>
</tr>
<tr>
<td>AR4050S</td>
<td>10 000</td>
<td>12 000</td>
<td>10 000</td>
<td>10 000</td>
<td>1000</td>
<td>2000</td>
</tr>
</tbody>
</table>

The filtering works as a standard single-rate traffic meter. The 'per second' figure is the number of new connection attempts per second that will be allowed to connect to the device on each individual UDP/TCP port or per ICMP type. When connection attempts exceed this rate, the excess packets will be matched against the 'burst' bucket until this is exhausted. When the per-second rate is exceeded and the burst bucket is exhausted, all excess packets will be dropped and a maximum of one log message per second will be generated regardless of the number of packets dropped. Logs generated when packets have been dropped by this process will be prefixed with one of:

- DENY UDPLIMIT reach.
DENY SYNLIMIT reach.
DENY ICMPLIMIT reach.

for UDP, TCP or ICMP packets respectively.

Default deny

If a packet is processed by the firewall and does not match any of the permit, deny or reject action rules, it will hit the final default deny rule, and produce a log with the prefix:

Firewall: DENY in policy

to a maximum rate of 20 log messages per second.

Logging for user-configured rules

There are two ways to log firewall events. The first is to configure the rule with the terminating log parameter. When packets are logged in this way, the action (deny, permit, or reject) is applied and a log message is also generated each time the rule is hit. The disposition for these log messages is ‘PERMIT’, ‘DENY’ or ‘REJECT’ according to the action of the rule.

The second way is to configure the firewall rule with log as the action. When packets are logged in this way, they continue to be processed by subsequent firewall rules, which may eventually permit, deny or reject the packets. The disposition for these log messages is ‘LOG’. Because this action does not affect the traffic, it may be more useful for diagnostic purposes.

Note that it is possible to configure both methods in one rule, but this would result in duplicated log messages.

Some log messages that should be generated when packets match these rules may be dropped by the system under heavy traffic loads.

Firewall log messages

Firewall log messages are logged with facility ‘kern’, and have severity level ‘info’ (6). The message part includes information in the following format:

Firewall [rule <rule>]: <action> IN=<input-interface> OUT=<output-interface> SRC=<source-ip> DST=<dest-ip> MARK=<mark> ...
Firewall connection logging

This feature is supported from AlliedWare Plus version 5.4.7-1.

Firewall connection logging can be enabled to provide additional logs that show the start and end of connections passing through the firewall. These messages are assigned facility local5. They have severity ‘info’ (6).

To enable logging of new connections, closed connections, or both passing through the firewall, use the commands:

```
awplus# configure terminal
awplus(config)# connection-log events {new|end|all}
```

To show the configuration of firewall connection logging, use the following command:

```
awplus# show connection-log events
```
New connection log messages includes information in the following format for a newly started firewall connection:

NEW proto={tcp|udp|icmp|...|<protocol-number>} orig_src={<ipv4-addr>|<ipv6-addr>} orig_dst={<ipv4-addr>|<ipv6-addr>} [orig_sport=<source-port>] [orig_dport=<dest-port>] reply_src={<ipv4-addr>|<ipv6-addr>} reply_dst={<ipv4-addr>|<ipv6-addr>} reply_sport=<source-port> reply_dport=<dest-port>

Closed connection log messages includes information in the following format for a firewall connection that has ended:

END proto={tcp|udp|icmp|...|<protocol-number>} orig_src={<ipv4-addr>|<ipv6-addr>} orig_dst={<ipv4-addr>|<ipv6-addr>} [orig_sport=<source-port>] [orig_dport=<dest-port>] orig_pkts=<packets> orig_bytes=<bytes> reply_src={<ipv4-addr>|<ipv6-addr>} reply_dst={<ipv4-addr>|<ipv6-addr>} reply_sport=<source-port> reply_dport=<dest-port> reply_pkts=<number> reply_bytes=<number>

Table 4: Elements in firewall connection log messages

<table>
<thead>
<tr>
<th>Message elements</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>proto={tcp</td>
<td>udp</td>
</tr>
<tr>
<td>orig_src={&lt;ipv4-addr&gt;</td>
<td>&lt;ipv6-addr&gt;}</td>
</tr>
<tr>
<td>orig_dst={&lt;ipv4-addr&gt;</td>
<td>&lt;ipv6-addr&gt;}</td>
</tr>
<tr>
<td>orig_sport=&lt;source-port&gt;</td>
<td>The source port number of the originating packet.</td>
</tr>
<tr>
<td>orig_dport=&lt;dest-port&gt;</td>
<td>The destination port number of the originating packet.</td>
</tr>
<tr>
<td>orig_pkts=&lt;packets&gt;</td>
<td>The total number of packets passed in the originating direction.</td>
</tr>
<tr>
<td>orig_bytes=&lt;bytes&gt;</td>
<td>The total number of bytes passed in the originating direction.</td>
</tr>
<tr>
<td>reply_src={&lt;ipv4-addr&gt;</td>
<td>&lt;ipv6-addr&gt;}</td>
</tr>
<tr>
<td>reply_dst={&lt;ipv4-addr&gt;</td>
<td>&lt;ipv6-addr&gt;}</td>
</tr>
<tr>
<td>reply_sport=&lt;source-port&gt;</td>
<td>The source port number of the returning packets.</td>
</tr>
<tr>
<td>reply_dport=&lt;dest-port&gt;</td>
<td>The destination port number of the returning packets.</td>
</tr>
<tr>
<td>reply_pkts=&lt;number&gt;</td>
<td>The total number of returning packets.</td>
</tr>
<tr>
<td>reply_bytes=&lt;number&gt;</td>
<td>The total number of returning bytes.</td>
</tr>
</tbody>
</table>
Note that the original source and destination addresses and ports may differ from the reply source address and destination addresses and ports depending on whether NAT is applied and the type of NAT.

Output 3: Example connection log messages for TCP connection

```
NEW proto=TCP orig_src=192.168.1.100 orig_dst=192.168.1.1 orig_sport=55532 orig_dport=80 reply_src=192.168.1.1 reply_dst=192.168.1.100 reply_sport=80 reply_dport=55532
END proto=TCP orig_src=192.168.1.100 orig_dst=192.168.1.1 orig_sport=55532 orig_dport=80 reply_dst=192.168.1.100 reply_sport=80 reply_dport=55532 reply_pkts=4 reply_bytes=811
```

Output 4: Example connection log messages for ICMP connection

```
NEW proto=ICMP orig_src=192.168.1.1 orig_dst=192.168.1.100 reply_src=192.168.1.100 reply_dst=192.168.1.1
END proto=ICMP orig_src=192.168.1.1 orig_dst=192.168.1.100 orig_pkts=2 orig_bytes=168 reply_src=192.168.1.100 reply_dst=192.168.1.1 reply_pkts=2 reply_bytes=168
```

To configure an AR-Series firewall to generate log messages for log events based on facility local5, including these firewall connection events, and send them to a syslog server at IP address 192.168.1.1, use the commands:

```
awplus# configure terminal
awplus(config)# log host 192.168.1.1 facility local5
```

For more information about logging on the AR-Series firewalls, see the following documents:

- Logging Feature Overview and Configuration Guide
- Log Message Reference for AlliedWare Plus™

**Network Address Translation (NAT)**

NAT, defined in RFC 1631, provides a solution to one of the major problems facing the Internet—IP address depletion. IP address space is limited and obtaining a large block of registered addresses is difficult. Although you can use private IP address (RFC 1918) in your internal network, private IP addresses are not routable through the Internet.

A router can act as an agent between the Internet and a local network. When you use NAT, you assign private IP addresses to hosts on the private side of the router. When those hosts send traffic, the router translates the private addresses to one or more public and valid addresses before routing the traffic. When the router receives traffic that is destined for those hosts, it translates the public addresses back to the appropriate private addresses.
AR-Series firewalls support two basic modes of NAT:

- **Masquerading:** Devices with non-global addresses are able to access the public network by sharing the IP address of an external facing interface. The source IP address of an outgoing packet is translated to the interfaces of external interface. The source port (TCP or UDP) is translated to a new value in order for the packet flow to be uniquely distinguishable.

- **Port Forwarding:** Servers on a private network are made accessible to the public network by aliasing an externally facing interface’s IP to the server’s IP address. The destination address of an incoming packets is translated from the external interface’s IP to the private server’s IP. This is an address-only translation.

AR-Series firewalls also support Enhanced NAT (ENAT) which gives you the ability to

- Configure the global address used in Masquerading and Port Forwarding.
- Perform port translations in Port Forwarding configurations.

AR-Series firewalls support the following additional methods of network address translation.

- **Static NAT:** This is a one-to-one, address-only translation. For packets originating in the private zone and destined for the public zone, the source IP address is translated. For packets originating in the public zone and destined for the NAT device’s globally routable address, the destination address is translated.

- **Static ENAT:** This is a one-to-one address and port translation for packet flows initiated by a host in a public zone that is mapped through to a host in a private zone. This has a number of possible uses. For example, a difference in destination port, with the same address in the public zone can be used to distinguish between two different servers in the private zone. For whatever reason, the server in the private zone may be listening on a different port to the one advertised in the public zone.

- **Dynamic ENAT:** This is a many-to-one address translation where multiple hosts in the private zone share a globally routable address in the public zone. Source-port translation is used to provide uniqueness in the connect tracking so that return packets can be forwarded to the correct host in the private zone.

By default, NAT is disabled. You can use the **enable (NAT)** command to explicitly enable this functionality. If firewall protection is enabled, you need to configure firewall rules that allow the application matching its source and destination entities to pass through the firewall. Portfwd rules (actions) are applied before any other firewall rules and masq rules (actions) are applied after any other firewall rules. To configure NAT rules, you can use the **rule (NAT)** command.
Configuring Firewall and NAT Rules for Entities

Firewall rules are constructed as follows:

```
rule [<1-65535>] {permit|deny|reject|log} <application-name> from <source-entity> to <destination-entity> [no-state-enforcement] [log]
```

Port forwarding and masquerade NAT rules are constructed as follows:

```
rule [<1-65535>] portfw <application-name> from <source-entity> [to <destination-host-entity>] with dst <destination-host-entity> [dport <1-65535>]
rule [<1-65535>] masq <application-name> from <source-entity> to <destination-entity> [with src <source-host-entity>]
```

The source and destination entities referenced within the rule can match a zone (zone), or a network nested within a zone (zone.network), or an individual host nested within a network (zone.network.host).

The following example shows you how to configure the firewall. The figure below shows the network topology and zone partition used by the example.

Figure 3: Network topology and zone partition
Step 1: Configure DMZ zone.

awplus#configure terminal
awplus(config)#zone dmz
awplus(config-zone)#network servers
awplus(config-network)#ip subnet 172.16.0.0/24 interface eth1
awplus(config-host)#host ftp
awplus(config-host)#ip address 172.16.0.2
awplus(config-host)#host web-server
awplus(config-host)#ip address 172.16.0.10

Step 2: Configure private zone.

awplus(config-host)#zone private
awplus(config-zone)#network lan
awplus(config-network)#ip subnet 192.168.1.0/24 interface vlan1

Step 3: Configure public zone.

awplus(config-host)#zone public
awplus(config-zone)#network internet
awplus(config-network)#ip subnet 0.0.0.0/0 interface eth2

Step 4: Configure application.

awplus(config)#application tftp
awplus(config-application)#protocol udp
awplus(config-application)#dport 69

Step 5: Configure firewall rules.

awplus(config)#firewall
awplus(config-firewall)#rule 100 permit ping from public to dmz
awplus(config-firewall)#rule 200 permit ping from private to dmz
awplus(config-firewall)#rule 300 permit ftp from public to dmz.servers.ftp
awplus(config-firewall)#rule 400 permit tftp from public to dmz.servers.ftp
awplus(config-firewall)#rule 500 permit http from public to dmz.servers.web-server
awplus(config-firewall)#rule 600 permit any from private to private
awplus(config-firewall)#rule 700 permit any from dmz to dmz
awplus(config-firewall)#rule 800 permit any from private to public
awplus(config-firewall)#rule 900 permit any from dmz to public

Step 6: Enable firewall protection.

Enable firewall protection and apply the firewall rules. This also ensures that the network administrator is not prematurely locked out of the device.

awplus(config-firewall)#protect
Step 7: Configure Network Address Translation (NAT) rules.

```config
awplus(config)#nat
awplus(config-nat)#rule 10 masq any from private to public
awplus(config-nat)#rule 20 masq any from dmz to public
awplus(config-nat)#rule 30 portfwd ftp from public with dst dmz.servers.ftp
awplus(config-nat)#rule 40 portfwd http from public with dst dmz.servers.web-server
```

Step 8: Enable NAT to apply the NAT rules.

```config
awplus(config-nat)#enable
```

Step 9: Configure interfaces.

```config
awplus(config)#interface eth2
awplus(config-if)#ip address 128.0.0.1/24
awplus(config-if)#interface eth1
awplus(config-if)#ip address 172.16.0.1/24
awplus(config-if)#exit
awplus(config)#vlan database
awplus(config-vlan)#vlan 1
awplus(config-vlan)#exit
awplus(config)#interface vlan1
awplus(config-if)#ip address 192.168.1.1/24
```

Step 10: Verify Firewall configuration.

```config
awplus#show running-config firewall
```

Output 5: Example output from the console

```
awplus#show running-config firewall
firewall
  rule 100 permit ping from public to dmz
  rule 200 permit ping from private to dmz
  rule 300 permit ftp from public to dmz.servers.ftp
  rule 400 permit tftp from public to dmz.servers.ftp
  rule 500 permit http from public to dmz.servers.web-server
  rule 600 permit any from private to private
  rule 700 permit any from dmz to dmz
  rule 800 permit any from private to public
  rule 900 permit any from dmz to public
  protect
  !
```
Step 11: Verify Entity configuration.

awplus#show entity

Output 6: Example output from the console:

<table>
<thead>
<tr>
<th>awplus#show entity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone: dmz</td>
</tr>
<tr>
<td>Network: dmz.servers</td>
</tr>
<tr>
<td>Subnet: 172.16.0.0/24 via eth1</td>
</tr>
<tr>
<td>Host: dmz.servers.ftp</td>
</tr>
<tr>
<td>Address: 172.16.0.2</td>
</tr>
<tr>
<td>Host: dmz.servers.web-server</td>
</tr>
<tr>
<td>Address: 172.16.0.10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>awplus#show entity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone: private</td>
</tr>
<tr>
<td>Network: private.lan</td>
</tr>
<tr>
<td>Subnet: 192.168.1.0/24 via vlan1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>awplus#show entity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone: public</td>
</tr>
<tr>
<td>Network: public.internet</td>
</tr>
<tr>
<td>Subnet: 0.0.0.0/0 via eth2</td>
</tr>
</tbody>
</table>

Step 12: Verify NAT configuration.

awplus#show nat rule

Output 7: Example output from the console:

<table>
<thead>
<tr>
<th>[* = Rule is not valid - see &quot;show nat rule config-check&quot;]</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID</td>
</tr>
<tr>
<td>-----</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
<td>30</td>
</tr>
<tr>
<td>40</td>
</tr>
</tbody>
</table>

Note that there is a configurable maximum of 500 NAT and/or Firewall rules combined. However, the practical limit may reduce as additional features are configured and used on the device, and depending on the system resources available.

NAT Rules with DPI

You can configure firewall rules to allow or deny specific application traffic to flow from one entity to another. And most commonly, when using DPI in combination with NAT, it is sufficient to configure a single rule to masq any traffic from LAN to WAN without the need to configure NAT rules for each application. You may also configure a few NAT port forwarding rules to allow external traffic from the Internet to the public IP address to be translated to reach the internal addresses of internal servers.

For example:

awplus(config)#nat
awplus(config-nat)#enable
However, if you configure NAT rules to selectively apply address translation to specific application traffic only, you may find that the application traffic matching the NAT rules will not be forwarded even with DPI enabled. This is because the DPI engine cannot positively identify the application until after the first few packets associated with the application flow have been seen. Therefore, NAT does not know what to do with the initial packets of a new flow, as they will not match any defined application-specific NAT rules.

There are two solutions to this problem:

- "Solution 1: Create a new custom definition" on page 24
- "Solution 2: Override the DPI definition" on page 25.

**Solution 1: Create a new custom definition**

The first alternative for allowing DPI-permitted traffic through NAT rules is to create a new custom definition for the application for the NAT rule.

**Step 1: Create a new custom application definition.**

Create a new custom definition for the application for the NAT rule. For example:

```
awplus(config)#application customapp
awplus(config-application)#protocol tcp
awplus(config-application)#sport 300 to 65535
awplus(config-application)#dport 45
```

**Step 2: Apply this application to NAT rules.**

```
awplus(config)#nat
awplus(config-nat)#enable
awplus(config-nat)#rule masq customapp from lan to wan
awplus(config-nat)#exit
```

Confirm that the NAT rules with the specified application are valid.
Solution 2: Override the DPI definition

The second alternative for allowing DPI-permitted traffic through NAT rules is to statically configure an application with the same name as the DPI application. The statically configured application overrides any previously defined DPI-based settings. For example:

\[
\text{awplus(config)#application mail} \\
\text{awplus(config-application)#protocol tcp} \\
\text{awplus(config-application)#sport 500 to 10000} \\
\text{awplus(config-application)#dport 50} \\
\text{awplus(config-application)#exit} \\
\text{awplus(config)#nat} \\
\text{awplus(config-nat)#rule masq mail from lan to wan} \\
\text{awplus(config-nat)#end}
\]

Confirm that the NAT rules with the specified application are valid.

Output 9:

\[
\begin{array}{|c|c|c|c|c|}
\hline
\text{ID} & \text{Action} & \text{From} & \text{With (dst/src) Entity} & \text{Hits} \\
\hline
\text{App} & \text{To} & \text{With dport} & \text{With dport} & \text{Hits} \\
\hline
10 & masq & lan & - & 0 \\
customapp & wan & - & & \\
\hline
\end{array}
\]

When DPI is enabled, because there is a user-defined application called ‘mail’, it will not be replaced by the DPI definition. The user-defined application has priority.

For more information about DPI, see the Application Awareness Feature Overview and Configuration Guide.
Firewall with Dynamic IP Addressing

A WAN interface may obtain its IP address dynamically. For example, this might be an Ethernet interface configured as a DHCP client, or a PPP interface.

Entities and their associated rules can be configured to allow for this.

The following firewall configuration extract shows how to allow ping traffic to originate from a PPPoE WAN that has been assigned an IP address dynamically.

```plaintext
! zone public
 network wan
  ip subnet 0.0.0.0/0 interface ppp1
  host router
    ip address dynamic interface ppp1
! firewall
  rule 10 permit ping from public.wan.router to public
    protect
! interface eth1
  encapsulation ppp 1
! interface ppp1
  ip address negotiated
! interface ppp1
  !
```

Configuring a Firewall Rule for External Services

In addition to forwarding packet flows between interfaces, AR-Series firewalls often need to initiate packets flows of their own to the Internet in order to provide various services. Some common examples are:

- DNS lookups and DNS relay
- Update Manager
- Web Control queries
- Routing protocols

When using the firewall, you will need rules that allow traffic from each of these services to egress the device. You can use one of these methods to permit this traffic:

- Configure a single firewall rule that allows any flow initiated from the device to egress. Flows initiated by the device can be trusted, so firewall rules for them do not need to be as selective as rules for other traffic. We recommend this method. Follow the configuration below.

```plaintext
  ! firewall
    rule 10 permit ping from public.wan.router to public
      protect
! interface eth1
  encapsulation ppp 1
! interface ppp1
  ip address negotiated
!
```

- Alternatively, you can configure specific rules to allow each protocol originating from the AR-Series firewall to egress. However, to do this you need to understand the protocols each service uses to operate, and some of these are proprietary. (For instance, for Update Manager traffic, see "Configuring Firewall Rules with Update Manager" on page 27.)
Also, from version 5.4.8-0.x onwards, flows initiated by the device are processed by DPI (when enabled) before being processed by the firewall. So if DPI is enabled, you also need a rule to allow the first ‘undecided’ packets in a locally initiated flow before DPI has identified their application.

**Step 1: Configure network entity.**

You can create a network entity for the services, which are located on the Internet, assuming that the Internet is reachable over interface ETH2.

```
awplus#configure terminal
awplus(config)#zone public
awplus(config-zone)#network INTERNET
awplus(config-zone)#ip subnet 0.0.0.0/0 interface eth2
```

**Step 2: Configure entity for the services' source traffic.**

You can create an entity for the services' source traffic, which is from the interface that connects to the Internet.

```
awplus(config)#zone ROUTER
awplus(config-zone)#network EXTERNAL
awplus(config-network)#ip subnet 49.1.2.0/24 interface eth2
awplus(config-host)#host EXTERNAL_INT
awplus(config-host)#ip address 49.1.2.3
awplus(config-host)#end
```

**Step 3: Configure a firewall rule.**

Then, to configure a rule to allow services originating from the AR-Series firewall to egress (with or without DPI), you can use a command like this:

```
awplus(config-firewall)# rule permit any from ROUTER.EXTERNAL.EXTERNAL_INT to public
```

**Configuring Firewall Rules with Update Manager**

The Update Manager is a tool to enable an AlliedWare Plus device to be kept up to date with the latest available software components and resources. The Update Manager service needs to initiate packets flows of its own to the Internet. When firewall protection is enabled, you can use one of these methods to permit this traffic:

- Create several firewall rules to selectively permit the Update Manager traffic to be sent from the AR-Series firewall, as described in this section.
- Use the simpler and less restrictive configuration described in "Configuring a Firewall Rule for External Services" on page 26.

For more information about the Update Manager, see the Update Manager Feature Overview and Configuration Guide.
Step 1: Configure network entity.
You can create a network entity for the Update Manager which is located on the Internet assuming that the Internet is reachable over interface ETH2.

awplus#configure terminal
awplus(config)#zone public
awplus(config-zone)#network INTERNET
awplus(config-zone)#ip subnet 0.0.0.0/0 interface eth2

Step 2: Configure entity for the Update Manager source traffic.
You can create an entity for the Update Manager source traffic which is from the interface that connects to the Internet.

awplus(config)#zone ROUTER
awplus(config-zone)#network EXTERNAL
awplus(config-network)#ip subnet 49.1.2.0/24 interface eth2
awplus(config-host)#host EXTERNAL_INT
awplus(config-host)#ip address 49.1.2.3
awplus(config-host)#end

Firewall rules

Step 3: Configure firewall rules.
The Update Manager traffic uses the HTTPS protocol. You can create a firewall rule to allow the HTTPS application.

awplus#configure terminal
awplus(config)#firewall
awplus(config-firewall)#rule permit https from ROUTER.EXTERNAL.EXTERNAL_INT to public

Similarly, you can create a rule to allow DNS resolution of the Update Server’s URL if the DNS server is reachable via the WAN interface.

awplus(config-firewall)#rule permit dns from ROUTER.EXTERNAL.EXTERNAL_INT to public

With DPI enabled

If Deep Packet Inspection (DPI) is enabled, then you will need to configure a rule to allow the initial ‘undecided’ traffic in a new flow before DPI has identified which application it belongs to:

awplus(config-firewall)#rule permit undecided from ROUTER.EXTERNAL.EXTERNAL_INT to public

DPI with built-in library

If DPI is enabled with the internal (built-in) library, then the IP traffic originating from the Update Manager will be classified as SSL. You will need a rule to permit the SSL traffic.

awplus(config-firewall)#rule permit ssl from ROUTER.EXTERNAL.EXTERNAL_INT to public
DPI with Procera

If DPI is enabled with the external library (the **provider procera** command), then the IP traffic from the Update Manager will initially be identified as TCP (from AlliedWare Plus version 5.4.8-0.1), then as SSL, and then as HTTPS. In addition to the rules above allowing HTTPS and DNS traffic, you will also need to allow this TCP and SSL traffic through the firewall. You can do this by one of these methods:

- Either, configure firewall rules to permit TCP and SSL traffic originating from the WAN interface:

  ```plaintext
  awplus(config-firewall)#rule permit tcp from ROUTER.EXTERNAL.EXTERNAL_INT to public
  awplus(config-firewall)#rule permit ssl from ROUTER.EXTERNAL.EXTERNAL_INT to public
  ```

- Or, configure a custom application for the Update Manager, and add TCP to it:

  ```plaintext
  awplus(config-host)#
  awplus#configure terminal
  awplus(config)#application update_manager
  awplus(config-application)# protocol tcp
  awplus(config-application)# dport 443
  awplus(config-application)#exit
  awplus(config)#firewall
  awplus(config-firewall)#rule permit update_manager from ROUTER.EXTERNAL.EXTERNAL_INT to public
  ```

For more information about Application Awareness and DPI, see [Application Awareness Feature Overview and Configuration Guide](#).

---

**Configuring Firewall Rules with Subscription Licensing**

AlliedWare Plus devices configured with features such as AMF and OpenFlow use subscription-based licensing. These devices could be located within a private firewall zone, accessing the subscription service located in the Internet, via the AR-Series firewall.

In order to allow access to the subscription licensing services from a private zone to the Internet, firewall allow rules need to be created. For more information about Subscription Licensing, see the [Licensing Feature Overview and Configuration Guide](#).

In order to allow the AR-Series firewall itself to access subscription licensing services, see "Configuring Firewall Rules with Update Manager" on page 27.

**Step 1:** **Configure an entity for the public zone attached to the Internet.**

Configure a public zone attached to the Internet, where the Internet is reachable over interface eth2.

```plaintext
awplus#configure terminal
awplus(config)#zone public
awplus(config-zone)#network INTERNET
```
Step 2: Configure an entity for the private zone
You can create a private zone, which is associated with the internal network accessed via interface vlan1

```
awplus(config)#zone private
awplus(config-zone)#network INTERNAL
awplus(config-network)#ip subnet 10.1.1.0/24 interface vlan1
```

Step 3: Configure firewall rules.
Subscription services are accessed using HTTPS protocol. You can create a firewall rule to allow HTTPS application to flow through the AR-Series firewall from the private to public zones.

```
awplus(config-host)#end
awplus#configure terminal
awplus(config)#firewall
awplus(config-firewall)#rule permit https from private to public
```

Similarly, you can create a rule to allow DNS resolution of the subscription service URL if the DNS server is reachable via the WAN interface from devices located within the private zone.

```
awplus(config-firewall)#rule permit dns from private to public
```

Firewall with High Availability
Firewall control of received IPv4 VRRP packets is supported from AlliedWare Plus version 5.4.6-2.1.

If you are using VRRP and you have the firewall enabled, you need to create a firewall rule to allow IPv4 VRRP packets. High Availability (HA) uses VRRP, so if you are using High Availability and the firewall, you also need to create a firewall rule to allow IPv4 VRRP packets.

The rule needs to permit packets to IP subnet 224.0.0.18/32, which is the VRRP multicast address. You can limit the rule so that it only applies to the VRRP application (protocol 112).

For example, if the firewall is enabled, and VRRP is configured on vlan1, and vlan1 has an IP address in the 172.20.10.0/24 subnet, the following configuration will allow VRRP packets to be received:

```
awplus(config-zone)#ip subnet 0.0.0.0/0 interface eth2
```

```
```
```
Note that the firewall only controls incoming VRRP packets. Outgoing VRRP packets are not processed by the firewall. They will be sent regardless of the firewall configuration.

### Configuring NAT Loopback with DMZ

NAT loopback can be used when private zone clients use an external DNS (no internal DNS) and wish to access services located within a DMZ as if they were outside the office.

This example shows a three-zone network (public, private and DMZ zones) with associated firewall and NAT rules. A client is located in a private zone, and the server is located in the DMZ.

Firewall rules 10, 20, 50 (Figure 6 on page 33) are configured to allow traffic from clients within the private zone to access the Internet and the DMZ zone. Firewall rule 40 is to allow only HTTP traffic from the Internet to reach the web server in the DMZ. Firewall rule 60 and 70 are included to allow HTTP traffic initiated from the web server access to the private zone and the public zone. If traffic is not initiated from the web server, then rules 60 and 70 are not required.

A client initiated DNS request to the domain name associated with the service resolves to the public IP address of the AR-Series firewall.

The client then sends its HTTP request to the public IP address of the AR-Series firewall. A static ENAT port forwarding rule (NAT rule 20 in Figure 6) is used to translate the destination IP address to become the IP address of the server located in the DMZ (*Static ENAT rule* on page 34).

The service is accessed by sending a request to the public IP address of the AR-Series firewall and that request is internally ‘looped back’ towards the DMZ server IP address via the destination address translation.

The internal IP address of the server located in the DMZ zone is also accessible when the user is physically located outside of the office and accesses the service directly from the Internet via the same ENAT port forwarding rule (NAT rule 20 in Figure 6).

The source IP of traffic to the Internet from clients located within the private zone are translated to become the public IP used on eth1 (NAT rule 40).
An optional dynamic ENAT masquerade rule (NAT rule 50 in Figure 6) can allow direct access from the server in the DMZ to hosts in the private zone. This optional rule can be used in the case where there is a need for connections to be initiated directly from a server located in the DMZ to reach private zone clients, and should not be required if the server only send reply traffic. ("Dynamic ENAT rule" on page 34).

Figure 4: Physical network

Figure 5: AR-Series firewall entity map

<table>
<thead>
<tr>
<th>Entity</th>
<th>Zone: PRIVATE VLAN1</th>
<th>Zone: PUBLIC eth1</th>
<th>Zone: DMZ VLAN2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network: LAN IP Subnet</td>
<td>192.168.1.0/24</td>
<td>Network: WAN IP Subnet</td>
<td>0.0.0.0/0</td>
</tr>
<tr>
<td>Host: http-server IP Address</td>
<td>192.168.10.10</td>
<td>Host: router IP Address</td>
<td>49.1.2.3</td>
</tr>
</tbody>
</table>
Figure 6: Configuration: NAT loopback with DMZ

```plaintext
zone dmz
network dmz
  ip subnet 192.168.10.0/24 interface vlan2
  ip subnet 49.1.2.3/32
host http-server
  ip address 192.168.10.10
host router
  ip address 49.1.2.3
!
zone private
network lan
  ip subnet 192.168.1.0/24 interface vlan1
!
zone public
network wan
  ip subnet 0.0.0.0/0 interface eth1
!
firewall
  rule 10 permit any from private.lan to public
  rule 20 permit any from private to private
  rule 40 permit http from public to dmz.dmz.http-server
  rule 50 permit any from private.lan to dmz.dmz
# rule 60 permit http from dmz.dmz.http-server to private
# rule 70 permit http from dmz.dmz.http-server to public
protect
!
nat
  rule 20 portfwd http from public with dst dmz.dmz.http-server
  rule 40 masq any from private.lan to public
  rule 50 masq any from dmz.dmz to public
enable
!
vlan database
  vlan 2 state enable
!
interface port1.0.2
  switchport access vlan 2
!
interface eth1
  ip address 49.1.2.3/24
!
interface vlan1
  ip address 192.168.1.254/24
!
interface vlan2
  ip address 192.168.10.254/24
!
ip route 0.0.0.0/0 49.1.2.100
```
Static ENAT rule

Also, Static ENAT (port-forwarding) NAT rule 10 is configured to allow traffic initiated from hosts located within the private zone to be able to access a Web Server located within the DMZ. This rule also matches and allows associated return traffic from the web server to reach the private hosts.

Figure 7: Configuration for static ENAT port forwarding option

```
# Allow HTTP traffic going from PRIVATE.LAN (192.168.1.0/24) to DMZ.DMZ.ROUTER (49.1.2.3),
# and forward to DIPA DMZ.DMZ.HTTP-SERVER (192.168.10.10)
rule 10 portfwd http from private.lan to dmz.dmz.router with dst dmz.dmz.http-server
```

Figure 8: Static ENAT—Port Forwarding

Dynamic ENAT rule

Additionally, dynamic ENAT (masquerade) NAT rule 30 can be optionally configured, to allow traffic directly initiated from the web server located in the DMZ to reach hosts in the private zone. This Dynamic ENAT rule is only required if traffic is initiated from the server. Server ‘reply’ traffic is matched by the preceding Static ENAT rule, making the Dynamic ENAT rule unnecessary for most situations.

Figure 9: Configuration for dynamic ENAT with masquerade option

```
# NAT HTTP traffic going from DMZ.DMZ.HTTP-SERVER (192.168.10.10) to PRIVATE.LAN (192.168.1.0/24)
# with SIPA DMZ.DMZ.ROUTER (49.1.2.3)
rule 30 masq http from dmz.dmz.http-server to private.lan with src dmz.dmz.router
```

Figure 10: Dynamic ENAT—Masquerade
Configuring Static NAT with Proxy ARP

In the following example, an AR-Series firewall is configured with a private zone and a public zone, and a web server is located in the private zone. The public eth1 interface of the firewall is configured with IP address 172.22.0.1/24. Web traffic from a client (10.1.1.1) located on the Internet is routed to a different IP address (172.22.0.3) in order to reach the web server. The eth1 WAN interface itself does not need to be configured with the public IP address (172.22.0.3) allocated to the Web server.

Via a port-forwarding NAT rule, traffic is then NATed in order to reach the internal IP address of the web server (172.22.200.3) located in the private zone. The port-forwarding rule 1:1 maps the external public IP address (172.22.0.3) to the actual private IP address (172.22.200.3) configured on the web server.

Since the public eth1 interface itself is not configured with the public IP address allocated for the server, the firewall is also configured to send proxy-ARP responses to ARP requests to the public web server IP address (172.22.0.3). And to restrict the public interface to only sending these proxy-ARP responses for a limited number of specified IP addresses, it uses the `ip limited-local-proxy-arp` command. The IP addresses to which it will respond are specified with the `local-proxy-arp <address>` command.

The proxy-ARP responses use the firewall’s own public interface MAC address (eth1).

Figure 11: Static NAT with proxy-ARP
Source-based NAT with Secondary IP Addresses

In the example below, the link between the AR-Series firewall and the ISP router is using a private IP subnet (192.168.73.0/24). This situation can arise if the ISP does not have enough public IPv4 addresses available that it can allocate to its customers, and has not yet upgraded to an IPv6 network infrastructure.

The ISP has allocated a single public IP address for use by the AR-Series firewall. To achieve this, the ISP’s router is configured to route traffic to the single public host IP address 10.0.22.13/32 via the private network address (192.168.73.253) allocated to the WAN address of the AR-Series firewall.

All traffic originating from the AR-Series firewall to the Internet needs to have its source IP address translated to appear to come from the public IP address 10.0.22.13 to be routable via the Internet.

In order to achieve this, the AR-Series firewall is configured with a NAT masquerade rule appended with the with src configuration option to translate the source IP address of all traffic egressing the eth1 WAN interface from the private IP address 192.168.73.253, to the public IP address 10.0.22.13.
Without this NAT rule, all traffic would use the private IP address allocated to the WAN interface of the AR-Series firewall. This rule allows traffic to be NATed to an address that is different to the configured WAN interface IP address.

**Figure 13: Example: source-based NAT**

**Figure 14: Configuration for source-based NAT**

```plaintext
! zone wan
  network eth1
    ip subnet 192.168.73.253/32
  network eth1-1
    ip subnet 10.0.22.13/32
! zone internet
  network wan01
    ip subnet 0.0.0.0/0 interface eth1
! nat
  rule 90 masq any from wan.eth1 to internet.wan01 with src wan.eth1-1
  enable
! interface eth1
  ip address 192.168.73.253/24
  ip address 10.0.22.13/32 secondary
! ip route 0.0.0.0/0 192.168.73.254
!```
Configuring Access to Multiple Internal Servers via PPPoE WAN

This section provides two examples showing how to configure access to multiple internal application servers via PPPoE WAN, protected by firewall with NAT. The topology uses an Allied Telesis UTM Firewall or Secure VPN Router (AR-Series firewall) providing Internet access via a PPPoE WAN link.

This topology uses firewall zones including:

- The public 'internet' zone, with the PPP interface in it.
- The ‘private’ zone, containing a LAN with host computers and a separate server network containing application servers.

The configuration provides access to the servers from clients located in either the private zone or in the Internet.

The two examples are:

- *Server access with external DNS* on page 39—No internal DNS server is used within the private customer network.
- *Server access with internal DNS* on page 44—There is an internal DNS server in the private zone that private clients can access directly without having to perform DNS requests to external DNS servers in the Internet.

The network topology shown below is the same for both examples.
Figure 15: Example network topology: multiple internal servers via PPPoE WAN

Server access with external DNS

This section contains:

- An explanation of the example, describing each aspect of the network, followed by
- An annotated configuration file, showing the commands to configure this example.

This example has a connection to the Internet via a PPPoE client WAN interface in the AR-Series firewall. It includes configuring a static IPv4 default route to the Internet via the AR-Series firewall PPP WAN link.

The ISP router (providing Internet connectivity) must also be configured to route traffic via its PPP interface to an entire public IPv4 subnet (10.1.1.0 mask 255.255.255.248) towards the AR-Series firewall PPP interface. This allows access from any clients to the range of public IP addresses (within the publicly allocated subnet) that are allocated for use by various application servers hosted at the user site.

External DNS servers (located in the Internet) resolve FQDN to the public IPv4 addresses allocated for use by the servers located at the customer site. No internal DNS server is used in this example.

The ISP router dynamically allocates a single /32 IPv4 host address to the AR-Series firewall PPPoE WAN interface via standard PPP IPCP negotiation. When the ISP router allocates this address via its PPP interface, the ISP router automatically creates a /32 IPv4 host route for this dynamically
allocated address, unless configured otherwise. You need to configure the PPP WAN interface of the AR-Series firewall to be in a public ‘internet’ zone.

Note that:

- You do not need to explicitly configure the PPP WAN interface of the AR-Series firewall itself for addresses within the public IPv4 subnet 10.1.1.0/29 that the ISP routes to.
- The /32 IPv4 host address that is dynamically allocated to the PPP WAN interface of the AR-Series firewall can be within the same subnet that is allocated for use by the servers, or it can be within a completely different subnet.
- On the AR-Series firewall, you do **not** need to configure the public IP subnet or public IP addresses allocated to each application server on the PPP WAN.

**Basic zones and rules**

Physically, the application servers (SMTP and SSH servers used in this example) are located in a private zone of the firewall, and you need to configure them with private IP addresses. Those private IP addresses cannot therefore be directly accessed from clients located on the Internet.

Instead, you need to configure NAT port-forwarding rules so that the AR-Series firewall 1:1 statically maps specific application traffic to specific public server IP addresses to the actual internal private IP addresses that the network administrator has allocated to each server.

Via NAT port-forwarding rules, inbound application traffic flows from a client to each public server IP address/application destination port has its destination IP translated to the private IP address of the application server. When the TCP connection is established through to the internal application server, the internal firewall connection tracker automatically tracks the associated state and details of the TCP session (protocol, IP addresses, ports, NAT translations).

Associated reply traffic from the application server (back to the client) matches the incoming flow originating from the client. And via connection flow association, the reply traffic automatically has its source IP address translated back to the server’s public IP address via the same NAT port-forwarding rules handling the inbound traffic flows.

You need to configure a VLAN within the ‘private’ zone, where the private client host computers are. You may optionally (as in this example) configure the PPPoE WAN interface to obtain DNS information via PPP IPCP negotiation from the ISP router. You need to configure DNS forwarding to allow DNS lookups from private hosts to be proxied, cached (stored) and forwarded through the AR-Series firewall to allow client DNS resolution.

**PPP options & DNS**

Optionally (as in this example), you may configure the AR-Series firewall with static DNS primary and secondary IP name-server addresses, if known. However, if `ppp ipcp dns request` is also configured on the PPP interface, the firewall will automatically use the DNS server address information (when learned via PPP) in preference to any static DNS address entries. The firewall will keep using the dynamically learned DNS server information as long as the PPP connection remains up.

To automatically detect if the PPP WAN connection to the ISP router fails, you can configure the PPP interface `keepalive` option (which enables regular PPP LCP echo request messaging via the
PPP interface). This allows the PPP link to automatically re-establish after the firewall detects a linkdown event due to a failure to receive keepalive responses (PPP LCP echo responses) from the ISP router.

You can configure TCP MSS clamping on the PPPoE connection (ip tcp adjust-mss <value> command), to avoid unnecessary TCP fragmentation issues occurring due to the additional PPP/PPPoE header encapsulations that are applied before transmission out the physical eth WAN interface.

Note that DNS requests to external DNS servers from private hosts in private VLANs resolve to the public IP addresses allocated for each of the servers. Traffic from private hosts are therefore sent to application server public IP addresses, not to internal private IP addresses configured on the servers. Also, traffic from those private hosts in vlan1 to application server IP addresses do not ingress the PPP WAN interface, as they are instead received via the private VLAN interface. Therefore, you need to configure a firewall zone labelled 'any', which is not associated with any interface, but which matches all traffic from all networks, including any traffic from the Internet as well as from clients in the private zone.

```
! zone any
 network all
   ip subnet 0.0.0.0/0
 !
```

Both the firewall allow rules and NAT port-forwarding rules use this zone named 'any', ensuring that client traffic from the Internet to the public application server IP addresses are NATed and forwarded to the internal application server IP addresses. Similarly, the same firewall and NAT port-forwarding rules ensure that traffic from private clients to the public application server IP addresses are automatically 'looped back', NATed and forwarded to the internal application server private IP addresses (NAT loopback).

In this example, note that the AR-Series firewall applies the rules (or more specifically, the rule actions) in the following order:

1. NAT port-forwarding rule actions, before any other firewall rule actions
2. Any other firewall rule actions
3. NAT masquerade rule actions, after any firewall rule actions

NAT port-forwarding rules will have already translated destination IP address(es) to become private IP address(es) based on the order of NAT and firewall rule processing. The firewall rules (allowing application traffic), are therefore configured to allow application traffic to reach destination internal private server IP addresses. This is instead of allowing access to the destination public server IP addresses as one might otherwise assume.
Figure 16: Complete device configuration for server access with external DNS example

```
! no service ssh
!
zone any  ← All traffic from all public or private networks matches this zone labeled 'any', as it's not interface specific.
  network all
   ip subnet 0.0.0.0/0
!
zone internet
  network server_public  ← Server traffic is sent to specific server host IP addresses within this public server subnet.
   ip subnet 10.1.1.0/29
   host smtp
   ip address 10.1.1.1
   host ssh
   ip address 10.1.1.2
  network wan  ← This network entity matches all traffic ingressing/egressing via the PPP link only, from the entire Internet.
   ip subnet 0.0.0.0/0 interface ppp0
   host ppp
   ip address dynamic interface ppp0  ← This command accounts for the PPP WAN IP address, which is dynamically assigned by the ISP router.
!
zone private
  network lan  ← This is the private LAN where network PCs are connected.
   ip subnet 192.168.1.0/24
  network server  ← This is the private server network where servers with private IP addresses are located.
   ip subnet 192.168.100.0/29
   host smtp_server
   ip address 192.168.100.1
   host ssh_server
   ip address 192.168.100.2
!
application smtp_app  ← Statically configure an application to match SMTP server traffic, if not already available in application list.
  protocol tcp
  # sport any  ← Command commented out because it is not required. If a specific source or destination port or port range is not explicitly configured, then by default port range any is automatically used.
  dport 25
!
application ssh_app  ← Statically configure an application to match SSH server traffic, if not already available in application list.
  protocol tcp
  # sport any  ← Command commented out because it is not required. If a specific source or destination port or port range is not explicitly configured, then by default port range any is automatically used.
  dport 22
```
firewall
rule 10 permit any from private to private ← Allow all private to private traffic flows.
rule 20 permit any from private to internet ← Allow all private to internet traffic flows.
rule 30 permit any from internet.wan.ppp to internet ← Allow traffic from PPP source IP address to access internet, e.g., for ping test to Internet or DNS lookups from the firewall.
rule 100 permit smtp_app from any to private.server.smtp_server ← Allow traffic from private vlan1 or from the Internet to reach the internal private IP address of the server.
rule 200 permit ssh_app from any to private.server.ssh_server ← Allow traffic from private vlan1 or from the Internet to reach the internal private IP address of the server.

# rule 300 permit smtp_app from any to internet.server_public.smtp ← Rule commented out because it’s not required. AR-Series firewalls apply firewall rules Series NAT port-forwarding address translation. (So destination IP address is already translated to private IP address, so rule 100 is configured instead.)
# rule 400 permit ssh_app from any to internet.server_public.ssh ← Rule commented out because it’s not required. AR-Series firewalls apply firewall rules Series NAT port-forwarding address translation. (So destination IP address is already translated to private IP address, so rule 200 is configured instead.)

protect ← Enable firewall protection.

!

nat
rule 10 masq any from private to internet ← Any traffic to internet originating from private zone has its source IP translated to become public IP allocated to PPP WAN. (Server reply traffic does not match this rule 10. Server reply traffic is matched by NAT rules 100/200 instead.)
rule 100 portfwd smtp_app from any to internet.server_public.smtp with dst private.server.smtp_server ← Any traffic to SMTP server wan host IP has its dest IP translated to become internal server IP.
rule 200 portfwd ssh_app from any to internet.server_public.ssh with dst private.server.ssh_server ← Any traffic to SSH server wan host IP has its dest IP translated to become internal server IP.

# rule 300 masq smtp_app from private.server.smtp_server to public with src internet.server_public.smtp ← Rule commented out because it’s not required. SMTP server ‘reply traffic’ automatically matches rule 100 above, by automatic inbound/outbound connection flow association via the internal firewall connection flow tracker. You don’t need this masquerade rule if there is a server initiating an outbound connection, and you need to modify the source IP address on egress to the Internet to use a different IP address than the one allocated on the WAN interface.
# rule 400 masq ssh_app from private.server.ssh_server to public with src internet.server_public.ssh ← Rule commented out because it’s not required. SSH server ‘reply traffic’ automatically matches rule 200 above, by automatic inbound/outbound connection flow association via the internal firewall connection flow tracker. You don’t need this masquerade rule if there is a server initiating an outbound connection, and you need to modify the source IP address on egress to the Internet to use a different IP address than the one allocated on the PPPoE WAN interface.

enable ← Enable NAT.

!

# ip name-server <address> ← You can configure Primary and Secondary DNS server IP addresses if known.
ip domain-lookup

!

vlan database
vlan 100 state enable

!
This section describes the differences in the firewall configuration necessary to support server access with internal DNS. Apart from changes to the firewall configuration the rest of the device configuration remains unchanged.

In this second example, there is an internal DNS server that is attached to an interface within the private zone of the firewall. DNS requests from private clients to the DNS server will typically resolve to the private internal application server IP address, not the public IP addresses of the application servers.

If this is the case, you can simplify the configuration of the firewall and NAT components of the device configuration contained in Table 16 as follows, with the zone any and associated configuration commented out.
Figure 17: Firewall (partial) configuration for server access with internal DNS

```
! # zone any # Zone and associated network entity configuration commented out because it’s not required. Client traffic no longer resolves to public IP address. # network all # ip subnet 0.0.0.0/0 !

zone internet
   network server_public # Server traffic from Internet clients only is sent to specific server host IP addresses within this public server subnet.
      ip subnet 10.1.1.0/29
      host smtp
         ip address 10.1.1.1
         host ssh
         ip address 10.1.1.2
   network wan # This network entity matches all traffic ingressing/egressing via the PPP link only.
      ip subnet 0.0.0.0/0 interface ppp0
      host ppp
         ip address dynamic interface ppp0 # This entry accounts for the PPP WAN IP, which is dynamically assigned by the ISP router.
! zone private
   network lan # This is the private LAN where network PCs are located.
      ip subnet 192.168.1.0/24
   network server # This is the private LAN where servers with private IP addresses are located.
      ip subnet 192.168.100.0/29
      host smtp_server
         ip address 192.168.100.1
      host ssh_server
         ip address 192.168.100.2
! firewall
   rule 10 permit any from private to private # Allow all private to private traffic flows. (This includes access from private client IP addresses to private server IP addresses.)
   rule 20 permit any from private to internet # Allow all private to Internet traffic flows.
   rule 30 permit any from internet.wan.ppp to internet # Allow traffic from PPP source IP to access internet, e.g., for ping test to the Internet or DNS lookups from the firewall.
   rule 100 permit smtp_app from internet.wan to private.server.smtp_server # Allow traffic to reach internal private IP of server, via PPP WAN from Internet
   rule 200 permit ssh_app from internet.wan to private.server.ssh_server # Allow traffic to reach internal private IP of server, via PPP WAN from Internet
   protect !
```
Diagnostics

You can use the following series of diagnostics commands to verify the solution.

To check if the traffic flows match the rules, use these commands to see rule hit counters:

```
awplus# show firewall rule
awplus# show nat rule
```

To see active session flows that are being connection-tracked (including NAT translations being applied), use the command:

```
awplus# show firewall connections
```

To check that firewall and NAT rules are correctly configured, use the commands:

```
awplus# show firewall rule config-check
awplus# show nat rule config-check
```

Other useful commands include:

- To see a list of available applications:
  
  ```
  awplus# show application [detail]
  ```

- To check the status of interfaces and associated interface counters and addresses:
  
  ```
  awplus# show interface [brief]
  ```

- With `term mon` enabled, to capture and investigate any PPP/PPPoE negotiation issues:
  
  ```
  awplus# debug ppp <options>
  ```

  Use this very carefully, as it can generate lots of data onto the CLI command shell screen.

- To see log messages, useful for detecting errors, such as PPP authentication failure due to incorrect PPP username/password:
  
  ```
  awplus# show log
  ```

---

Figure 17: Firewall (partial) configuration for server access with internal DNS (continued)

```bash
nat
You do **not** need any NAT rules from private LAN to server LAN. In this example, because of the internal DNS server, private clients access private server IP addresses directly (without NAT), instead of via public server IP addresses.

- **rule 10 masq any from private to internet** ← Any traffic from the private zone to internet has its source IP address translated to become the public IP address allocated to the PPP WAN. (Server reply traffic does not match this NAT rule 10.

- **rule 100 portfwd smtp_app from internet.wan to internet.server_public.smtp with dst private.server.smtp_server** ← Any traffic from Internet clients to the SMTP server WAN host IP address has its destination IP address translated to become the internal server IP address. SMTP server reply traffic matches this rule due to automatic internal connection tracker flow association.

- **rule 200 portfwd ssh_app from internet.wan to internet.server_public.ssh with dst private.server.ssh_server** ← Any traffic from Internet clients to the SSH server WAN host IP address has its destination IP address translated to become the internal server IP address. SSH server reply traffic matches this rule due to automatic internal connection tracker flow association.

   ```
   enable
   ```
   ```
```
To see status of DNS and cache entries:

```
awplus# show ip dns <options>
```

For a running capture of IP packets traversing an interface:

```
awplus# tcp dump <interface|options>
```

Use this very carefully, as it can generate lots of data onto the CLI command shell screen.

**IPoE vs PPPoE**

Note that if the WAN link were IP over Ethernet (IPoE) instead of PPPoE, then you would also need to configure Proxy ARP to ensure that the AR-Series firewall responds to ARP requests for the public server IP addresses. This would be necessary because the server public IP addresses or associated subnet are not physically configured on the WAN interface. (See "Configuring Static NAT with Proxy ARP" on page 35.)

As the WAN link in these examples is point-to-point, Proxy ARP does not apply and is not required. However, because the link is PPP, the ISP router must instead be configured with a route to reach the subnet containing public server IP addresses via its PPP interface.

## Configuring Network Address and Port Translation (NAPT)

This example shows how to configure an AR-Series firewall to perform Network Address and Port Translation (NAPT).

In this example:

- A public zone and a private zone are configured.
- The PPP WAN interface (whose public IP address is dynamically allocated) is located in the public zone.
- The vlan1 interface (statically configured with a private IP address) is located in the private zone.
- A webcam, located in the private zone, can be managed via HTTP from a host located in the Internet.

However, HTTP management traffic from a host sourced from the Internet arrives at the WAN interface of the AR-Series firewall, destined to a non-standard TCP listen port (5001).
To allow HTTP management traffic destined to the PPP WAN IP/non-default TCP port 5001 to reach the internal webcam, you need to:

- Configure a static application to match the TCP management traffic incoming from the Internet destined to the non-standard port number.
- Configure private and public zones.
- Then configure a NAT port-forwarding rule (rule 20 in Figure 19), to ensure the TCP application traffic destination IP address is translated to become the internal IP address of the webcam. Also, via the same rule, the destination port is translated to the internal HTTP port 80.

Note that firewall rule actions are applied after any NAT port-forwarding is applied. Therefore, since the firewall is also used, the firewall rule (rule 20) is configured to permit the post-NAPT translated HTTP application traffic sourced from the Internet to reach the internal webcam private IP address.

```
! application webcam_management
  protocol tcp
dport 5001
!
zone public
  network internet
    ip subnet 0.0.0.0/0 interface ppp1
    host router_wan
      ip address dynamic interface ppp1
!
zone private
  network lan
    ip subnet 192.168.1.0/24
    host webcam
      ip address 192.168.1.1
!
firewall
  rule 10 permit any from private to public
  rule 20 permit http from public to dst private.lan.webcam
  protect
```
Configuring Subnet-based NAT

Subnet-based NAT is supported from 5.4.7-0.1.

Subnet-based NAT translates just the network portion of a packet’s source or destination IP address to a different network address—the host portion of the address is unchanged. There is a one-to-one mapping from addresses in one subnet to the other. Subnet-based NAT allows a user to perform NAT translation on all hosts between two network entities. Configuring a NAT rule with the netmap option, you can modify the source subnet or destination subnet for a range of addresses, by using the following command:

```
rule [<1-65535>] netmap <application-name> from <source-subnet-entity> to <destination-subnet-entity> with {src|dst} <translated-subnet-entity>
```

For example, subnet-based NAT has been used in a network where all the LANs use the same subnet (192.168.1.0/24). The LAN in each of the premises has a corresponding 172.16.X.0/24 subnet that the device performs subnet-based NAT translation on.

For a two-device topology, the same entity configuration can be used. Firewall-B uses subnet-based NAT to translate the source IP addresses to appear as public.wan2. Firewall-B will change the destination IP addresses from public.wan1 to private.lan. This allows hosts on both 192.168.1.0/24 networks to communicate with remote premises. This example shows configuration to translate addresses for traffic from the client via Firewall-B to Firewall-A to the server.
In this example, each firewall has traffic for their 172.16.X.0/24 network routed to them for subnet-based NAT (netmap) translation.

The client (IP address 192.168.1.10) thinks it is connecting to 172.16.1.20. Packets sent by the client have:

- Source 192.168.1.10
- Destination 172.16.1.20

Firewall-B uses subnet-based NAT (netmap option) to translate the source address of this traffic from the 192.168.1.0/24 network to the 172.16.2.0/24 network. The traffic now has:

- Source 172.16.2.10
- Destination 172.16.1.20

Firewall-A uses subnet-based NAT (netmap option) to translate the destination address of this traffic from the 172.16.1.0/24 network to the 192.168.1.0/24 network. The traffic now has:

- Source 172.16.2.10
- Destination 192.168.1.20

The server (IP address 192.168.1.20) receives traffic from 172.16.2.10.

The return path traffic from the server to the client will be reverse-path translated by the connection tracking tables of Firewalls A and B. Bi-directional rules can be created to allow either side to initiate the traffic (see "Bi-directional configuration for subnet NAT" on page 52).
These rules will allow any 192.168.1.X hosts to masquerade as 172.16.2.X hosts when exiting
Firewall-B. When traffic to 172.16.1.X arrives at Firewall-A the destination IP address will be
changed to 192.168.1.X, allowing both client LANs to use the same local addressing.

Source and destination NAT and subnet-based NAT rules and translations can be verified by
checking the rule tables and firewall connection tables.

**Firewall-B#show nat rule**

<table>
<thead>
<tr>
<th>ID</th>
<th>Action</th>
<th>From</th>
<th>With (dst/src)</th>
<th>Entity</th>
<th>Hits</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>netmap-src</td>
<td>private.lan</td>
<td>public.wan2</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>any</td>
<td>public.wan1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The following two configurations include a second rule to allow bi-directional translation, so that traffic can be initiated from either end.

**Figure 23: Firewall-A configuration for bi-directional subnet NAT**

```
hostname Firewall-A
!
zone private
  network lan
    ip subnet 192.168.1.0/24
!
zone public
  network wan1
    ip subnet 172.16.1.0/24
  network wan2
    ip subnet 172.16.2.0/24
!
at
  rule 10 netmap any from private.lan to public.wan2 with src public.wan1
  rule 20 netmap any from public.wan2 to public.wan1 with dst private.lan
  enable
!
interface eth1
  ip address 10.0.0.1/24
!
interface eth2
  ip address 192.168.1.254/24
!
ip route 172.16.2.0/24 10.0.0.2
```
Allowing Partial Sessions through a Firewall

Firewall no-state-enforcement rules are supported from 5.4.7-0.1.

The no-state-enforcement rules illustrated by this example should only be used when asymmetric routing design causes the firewall to only see partial sessions, so that the firewall may otherwise block required traffic. When the firewall detects an out-of-sequence session, it permits the session from that point onwards.

This option only applies to firewall permit rules, and cannot be used with NAT rules.

**Stateful inspection**

During normal AR-Series firewall operation, application-based rules are used to identify the first packet in a connection, to permit matching connections to proceed and to deny other connections. Stateful inspection is used to permit packets for an already permitted connection to pass through the firewall. Packets are denied if they do not match a **permit** rule (that is, if they do not matching the application, **to** and **from** addresses and interfaces) or do not match an existing connection.

**Problem**

However, in some networks there may be a firewall that does not ‘see’ all the traffic in a connection. In this example, an enterprise network has multiple offices connected via multiple private VPN links. Traffic from office A to office B is routed via office C but traffic from office B to office A is routed via office D. Firewalls at C and D are also configured to secure office traffic and access to the Internet. Stateful inspection does not allow the firewalls at C and D to permit traffic transiting between offices A and B because they only ever see part of the connection traffic.

```
hostname Firewall-B
!
zone private
    network lan
        ip subnet 192.168.1.0/24
!
zone public
    network wan1
        ip subnet 172.16.1.0/24
    network wan2
        ip subnet 172.16.2.0/24
!
nat
    rule 10 netmap any from private.lan to public.wan1 with src public.wan2
    rule 20 netmap any from public.wan2 to public.wan1 with dst private.lan
    enable
!
interface eth1
    ip address 10.0.0.2/24
!
interface eth2
    ip address 192.168.1.254/24
!
ip route 172.16.1.0/24 10.0.0.1
```
**Solution**  The best solution for such a network is often to resolve the routing issues by changing the network topology to ensure the firewall can see and track sessions in their entirety to apply full stateful inspection. For cases where this is not possible, this example maintains the routing configuration and effectively disables stateful inspection for traffic matching particular firewall rules. A firewall rule is configured with a **no-state-enforcement** option to **permit** traffic from the connection source to the connection destination.

**Note:** This feature applies to firewall permit rules only. It can not be applied via NAT rules, as NAT requires full stateful tracking of the entire session in order to maintain network address and port translations for data flows.

**Figure 25: Example: partial sessions through firewall**
Figure 26: Example: partial sessions through firewall—configuration for Firewall C

```
zone Transit
  network 2
    ip subnet 10.0.0.0/8 interface vlan2
  network 4
    ip subnet 10.0.0.0/8 interface vlan4

firewall
  rule 10 permit any from Transit to Transit no-state-enforcement
  protect

interface vlan2
  ip address 10.0.2.2/24

interface vlan4
  ip address 10.0.4.2/24

ip route 10.0.0.0/8 10.0.4.1
```

Figure 27: Example: partial sessions through firewall—configuration for Firewall D

```
zone Transit
  network 3
    ip subnet 10.0.0.0/8 interface vlan3
  network 5
    ip subnet 10.0.0.0/8 interface vlan5

firewall
  rule 10 permit any from Transit to Transit no-state-enforcement
  protect

interface vlan3
  ip address 10.0.3.2/24

interface vlan5
  ip address 10.0.5.2/24

ip route 10.0.0.0/8 10.0.3.1
```
How it works
The following steps show the process of permitting and establishing the TCP connection between Host A at Office A and Server B at Office B.

4. Host A at Office A requests an HTTP URL from Server B at Office B.
5. Host A sends a TCP SYN from 10.1.1.100:1024 to 10.4.1.100:80.
6. Firewall A forwards the SYN to Firewall C.
7. Firewall C matches this TCP SYN to rule 10 (“permit any from transit to transit”).
8. Firewall C forwards the packet to Firewall B which routes it to Server B.
10. Firewall B forwards the SYN/ACK to Firewall D.
11. Firewall D matches this SYN/ACK packet to its rule 10, due to the no-state-enforcement option.
12. Firewall D forwards the SYN/ACK to Firewall B which forwards it to Host A.
13. Host A sends the ACK and HTTP request to Server B.
14. Firewall C counts this as a rule 10 match due to the no-state-enforcement option.
15. Server B responds with an ACK and HTTP response.
16. Firewall D permits this as a connection match for the traffic flow that was permitted by rule 10 in step 8.

Command summary
The firewall rule used to permit half-completed sessions supports the following:

- The syntax uses the **no-state-enforcement** option:

  ```
  rule [<1-65535>] permit <application> from <entity-1> to <entity-2> no-state-enforcement [log]
  ```

- Only the **permit** action is supported with no-state-enforcement rules.

- Rules are configured to permit traffic **from** the connection source **to** the connection destination.

- The **log** option can be configured with the **no-state-enforcement** option.

- Deep Packet Inspection (DPI) applications are not supported for **no-state-enforcement** rules.

- Other applications (not DPI) and entities can be specified as in other firewall rules.

- However, this rule is expected to be used to permit all traffic between interfaces on the firewall regardless of the state.
The following configuration extract illustrates these points:

```
zone Transit
    network 3
        ip subnet 10.0.0.0/8 interface vlan3
    network 5
        ip subnet 10.0.0.0/8 interface vlan5
!
firewall
    rule 10 permit any from Transit to Transit no-state-enforcement
```

The output displayed by the following commands on each of the devices Firewall-C and Firewall-D is as follows;

**For the return traffic, Firewall-D shows:**

```
Firewall-D#show firewall rule
ID    Action   App       From          To                   Hits
---------------------------------------------------------------------
10   permit    any       Transit       Transit              4
```

```
Firewall-D#show firewall connections
tcp CLOSE_WAIT src=10.4.1.100 dst=10.1.1.100 sport=80 dport=48348 packets=4
bytes=844 [UNREPLIED] src=10.1.1.100 dst=10.4.1.100 sport=80 dport=48348 packets=0 bytes=0
```

Note that the `show firewall rule` output displays more than one rule hit for every connection, where a normal connection-based rule would show 1 hit per connection.

**For the return traffic, Firewall-D shows:**

```
Firewall-D#show firewall rule
ID    Action   App       From          To                   Hits
---------------------------------------------------------------------
10   permit    any       Transit       Transit              4
```

```
Firewall-D#show firewall connections
tcp CLOSE_WAIT src=10.4.1.100 dst=10.1.1.100 sport=80 dport=48348 packets=4
bytes=844 [UNREPLIED] src=10.1.1.100 dst=10.4.1.100 sport=80 dport=48348 packets=0 bytes=0
```