How To | Create A Secure Network With Allied Telesis Managed Layer 3 Switches

Introduction

Allied Telesis switches include a range of sophisticated security features at layer 2 and layer 3. This How To Note describes these features and includes brief examples of how to configure them.

The implementations shown in this How To Note should be thought of as industry-standard best practices.

Contents

For information about the AlliedWare firewall, see the *Firewall* chapter of your Software Reference, and the following How To Notes:

- *How To Configure Some Basic Firewall And VPN Scenarios*
- *How To Apply Firewall Policies And Rules*

How To Notes are available from www.alliedtelesis.com/resources/literature/howto.aspx.

Which products and software versions does this information apply to?

This How To Note applies to the following Allied Telesis switch series:

- AT-8600
- AT-8700XL
- AT-8800
- Rapier i
- SwitchBlade
- AT-9800
- AT-8948 and x900-48
- AT-9900
- AT-9900s and x900-24

Some features are only available on some switches and/or some software versions. Therefore, when this How To Note describes each feature, it lists the applicable switches and versions.

Securing the device

Products

All switches listed on page 2

Software Versions

All

The first step towards making a secure network is to secure the networking equipment itself.

There are two aspects to this. Firstly, physical security is vital—lock your networking equipment away.

Secondly, straight after powering up any new piece of networking equipment, change the default administrator user's password. On an Allied Telesis managed layer 3 switch, the default user is "manager". To change the password, use the following command:

```
set user=manager password=<new-password>
```

The default password is well-known. If you do not change it, anyone with physical or IP access could reconfigure the switch.

Protecting the network

This section describes layer 2 based methods for controlling the negative impact of misconfigured devices and misuse of the network. These solutions work at the Ethernet level of a packet and cause no degradation in the switch's throughput.

You can protect your network against the following:

- traffic storms ("Protecting against packet flooding" on page 3)
- excessive MAC address learning ("Protecting against rapid MAC movement" on page 6)
- unwanted multicast traffic ("Controlling multicast traffic" on page 7)

Protecting against packet flooding

Service providers are often vulnerable to traffic storms, primarily when incorrectly configured customer equipment is directly connected to the provider. Storms overwhelm a subnet, and all of the switches in that subnet, with traffic. Such misconfiguration can quickly lead to widespread outages and compromise guaranteed service levels.

Storms are a reality in any network. They can occur by accident, maliciously, or when a network device fails. They occur naturally in a network where switches are connected more than once to the same VLAN, so administrators must employ a method to prevent these switch loops.

Spanning Tree Protocol based solutions are the most common method of preventing loops. However, incorrect configuration or other network issues can cause STP to fail. For example, if a single switch in the VLAN does not have STP enabled, the STP tree will not converge properly. Spanning tree protocols can even fail if a broadcast storm drowns out STP messages.

Service providers need to prevent storms from disrupting services to customers. AlliedWare offers the following options for mitigating storms:

- limiting broadcasts and multicasts on a port ("Bandwidth limiting" on page 4)
- detecting a storm and disabling that port or VLAN ("Using QoS policy-based storm protection" on page 5)

Bandwidth limiting

Products

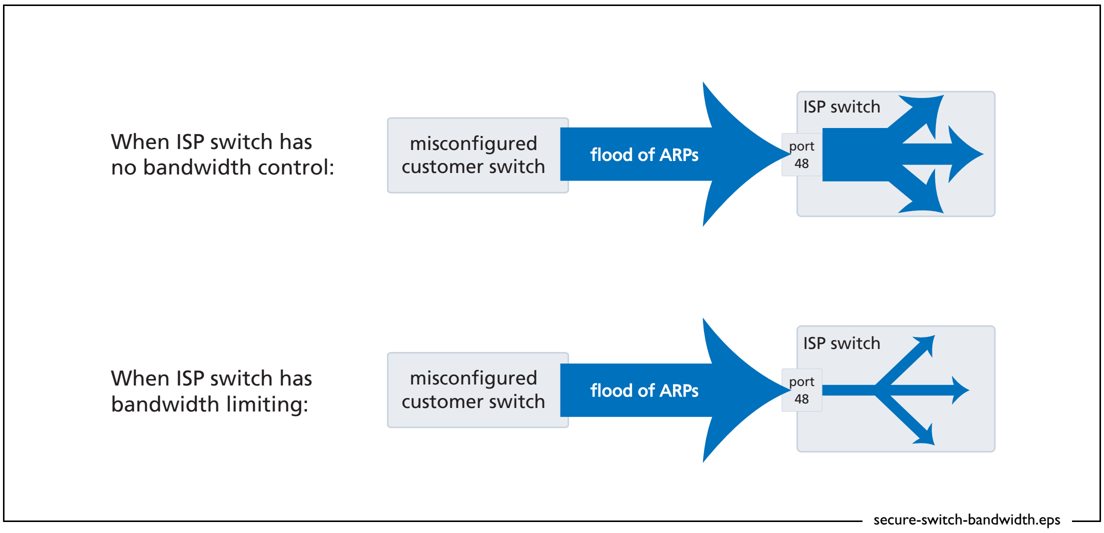
All switches listed on page 2

Software Versions

All

ARP packets are the most frequent trigger for broadcast storms. One ARP packet is flooded around and around a network, crowding out all other traffic.

You can use a simple Quality of Service (QoS) configuration to match ARP packets and make sure that when a broadcast storm occurs, the effect is minimised.


When ISP switch has no bandwidth control:
misconfigured customer switch
flood of ARPs
ISP switch
port 48
When ISP switch has bandwidth limiting:
misconfigured customer switch
flood of ARPs
ISP switch
port 48
secure-switch-bandwidth.eps

Configuration

To limit the bandwidth for ARPs:

1. Create a classifier to match ARP packets.
2. Create a QoS framework of policy, traffic class, and flow group. In the traffic class settings, specify the maximum bandwidth for ARP traffic.
3. Apply the policy—and therefore the bandwidth limit—to one or more ports.

Example

The following configuration limits ARP packets to 100kbps on port 48.

```
create classifier=1 protocol=0806 ethformat=ethii-untagged
create qos policy=1
create qos trafficclass=1 maxbandwidth=100
create qos flowgroup=1
add qos policy=1 trafficclass=1
add qos trafficclass=1 flowgroup=1
add qos flowgroup=1 classifier=1
set qos port=48 policy=1
```

Using QoS policy-based storm protection

Policy-based storm protection lets you specify one of a range of actions for the switch to take when it detects a broadcast storm. It is a part of the QoS functionality.

Policy-based storm protection is more powerful than simple bandwidth limiting. It lets you restrict storm damage to within the storming VLAN, and it gives you the flexibility to define what traffic rate makes a broadcast storm.

Products

AT-8948
x900-48 Series

AT-9900 Series

AT-9924Ts
x900-24 Series

Software Versions

2.8.1 and later

Configuration

To use storm protection:

1. Turn on the switch enhanced mode **qoscounters**, unless it is already enabled. After this, you need to restart the switch.
2. Create a classifier to match the desired traffic. To match all broadcast packets specify a destination MAC address of ff-ff-ff-ff-ff-ff.
3. Create a QoS traffic class and define the following storm protection settings in it:
   - Window (**stormwindow**) specifies how often the switch measures traffic to decide whether to activate storm protection (in seconds).
   - Rate (**stormrate**) specifies the amount of traffic per second that must be exceeded before the switch takes action.
   - Action (**stormaction**) specifies what the switch does when it detects a storm:
     Link Down (**linkdown**) makes the switch physically disable the port on which the storm is occurring, so that the link goes down.
     Port Disable (**portdisable**) makes the switch logically disable the port on which the storm is occurring, leaving the link up.
     VLAN Disable (**vlandisable**) makes the switch block traffic only on the VLAN on which the storm is occurring.
   - Timeout (**stormtimeout**) specifies the number of seconds that the port remains disabled for.
4. Create the rest of the QoS framework: a flow group and policy. Add the classifier to the flow group, the flow group to the traffic class, and the traffic class to the policy.
5. Apply the policy—and therefore the storm protection—to one or more ports.

The procedure above applies storm protection to classified traffic, and uses a classifier to select all broadcast traffic. This is the most common approach. If you want to, you can instead classify to select important non-broadcast traffic and apply storm protection to unmatched traffic. Unimportant or unwanted unicast and multicast traffic then counts towards the storm calculations.

To apply storm protection to unclassified traffic, configure storm protection on the default traffic class in the QoS policy settings. Use the parameters **dtcstormwindow**, **dtcstormrate**, **dtcstormaction**, and **dtcstormtimeout**.

Example The following example applies storm protection to classified broadcast traffic on port 1. If there is a storm, it takes the link down for 60 seconds.

```
set switch enhancedmode=qoscounters
```

Reboot after turning on enhanced mode.

```
create classifier=1 macdaddr=ff-ff-ff-ff-ff-ff
create qos trafficclass=1 stormstatus=enable stormwindow=100
  stormrate=100 stormaction=linkdown stormtimeout=60
```

The rest of the QoS configuration is as normal, so:

```
create qos flowgroup=1
add qos flowgroup=1 classifier=1
add qos trafficclass=1 flowgroup=1
create qos policy=1
add qos policy=1 trafficclass=1
set qos port=1 policy=1
```

You can view matching traffic at the port level with the command:

```
show qos port=1 count trafficclass
```

Protecting against rapid MAC movement

Rapid MAC movement protection detects excessive MAC address learning on a specific switch port. Once excessive learning is detected, the switch stops learning MAC addresses via the affected port.

Rapid MAC movement mostly occurs because of a broadcast storm, when one packet is storming around a layer 2 network. Rapid MAC movement protection is simpler to configure than QoS policy-based storm protection but is not guaranteed to stop all the varieties of broadcast storm.

Products

AT-8948
x900-48 Series

AT-9900 Series

AT-9924Ts
x900-24 Series

Software Versions

2.8.1 and later

Rapid MAC movement protection is on by default. The default action is to disable learning for 1 second. This gives the CPU of the switch some idle time, which may let a fast STP-type protocol converge. You can change the amount of idle time to suit your network, or select a different action.

Configuration on one or more ports To customise the protection:

1. Set the parameters in the following command:

```
set switch port=<ports> thrashaction={learndisable|linkdown|none|
  portdisable|vlandisable} thrashtimeout={none|1..86400}
  vlanstatustrap={on|off}
```

The parameter **thrashaction** specifies the switch's response to rapid MAC movement:

- **learndisable** makes the switch temporarily disable learning on the port.
- **linkdown** makes the switch physically disable the port, so that the link goes down.
- **portdisable** makes the switch logically disable the port, leaving the link up.
- **vlandisable** makes the switch block traffic on only the VLAN on which the rapid learning occurred.

2. Set the sensitivity in detecting rapid MAC movement, by using the following command to tell the switch how many times a MAC address can move ports in one second:

```
set switch thrashlimit=5..255
```

Configuration on trunk groups

Rapid MAC movement protection also works with trunk groups. If one switch in a trunk fails, the switches probably cannot negotiate STP or any other trunks that they belong to. This immediately causes a broadcast storm. Rapid MAC movement protection on the other switch in the trunk group detects such a storm because flooding of the same packet occurs on all trunk ports connected to the failed switch.

For a static trunk, to make use of rapid MAC movement protection, create the trunk and specify the optional **thrashaction** and **thrashtimeout** parameters:

```
create switch trunk=<name> port=<ports>
  thrashaction={learndisable|linkdown|none|portdisable|
  vlandisable} thrashtimeout={none|1..86400}
```

For a dynamic trunk using LACP, enable LACP, add ports, and set the optional **thrashaction** and **thrashtimeout** parameters:

```
enable lacp
add lacp port=<ports>
set lacp thrashaction={learndisable|linkdown|none|portdisable|
  vlandisable} thrashtimeout={none|1..86400}
```

Controlling multicast traffic

In a busy network, or one that has subscription-only access to multicast services, tight per-port control of multicast traffic is required. IGMP makes multicasting fairly efficient, but the extra control offered by AlliedWare helps increase efficiency.

When multicasting, it is essential to avoid filling the network with unnecessary multicast data and to make sure that the clients who join a group are entitled to receive it. It is also important to minimise delays in joining a group and to efficiently handle those who leave a group.

The following sections outline some of the IGMP controls that are particularly relevant for security. For detailed information on how to control IGMP in the network, see *How To Configure IGMP for Multicasting on Routers and Managed Layer 3 Switches*. This How To Note is available from www.alliedtelesis.com/resources/literature/howto.aspx.

IGMP snooping

IGMP snooping is enabled by default on Allied Telesis managed layer 3 switches. IGMP snooping monitors the streams and clients involved in each multicast group, independent from IP itself. A snooping switch ensures that only ports that are interested in a group are sent it. This basic level of management works in tandem with the subnetwork's IGMP querier and makes sure that the querier gets notified of any client who wants to join the group.

Products

All switches listed on page 2

Software Versions

All

IGMP filtering

Products

All switches listed on page 2 that support 2.7.5 or later

Software Versions

2.7.5 or later

IGMP filtering lets you dictate exactly which multicast groups a specific port can receive, by creating a filter list and applying it to the port. Different ports may have different filter lists applied to them.

If desired, you can select the type of message to filter. By default, filters apply to IGMP reports. You can create extra entries to also filter queries (**type=query**) and leave messages (**type=leave**).

Configuration

For each port:

1. Work out which groups you want users on the port to be able to join.
2. Create an IGMP filter.
3. Create entries to allow the appropriate groups (**action=include**).

Note: The order of entries in a filter is important. When IGMP tries to match a message to a filter, it performs a linear search of the filter to find a matching entry. It tries each entry in turn, and stops processing the filter after the first match it finds.

4. Create an entry to block all groups (**action=exclude**). Give this entry a higher entry number than entries for the included groups.
5. Apply the filter to the port.

Example

To stop the user attached to port 1 from joining any group except 224.12.13.14:

```
create igmp filter=1
add igmp filter=1 entry=1 group=224.12.13.14 action=include
add igmp filter=1 entry=2 group=224.0.0.0-239.255.255.255
  action=exclude
set switch port=1 igmpfilter=1
```

IGMP throttling

Products

All switches listed on page 2 that support 2.7.5 or later

Software Versions

2.7.5 or later

Throttling limits the number of multicast groups that an individual port can join.

Example

To limit port 2 to a total of 6 groups:

```
set switch port=2 igmpmaxgroup=6
  igmpaction=replace
```

Managing the device securely

In Ethernet and broadcast networks the privacy of traffic is not guaranteed. Hubs and networks outside the administrator's control may leak sensitive data to unwanted recipients. A hacker may even be able to force a switch to flood unicast traffic.

Because you cannot guarantee traffic privacy, you cannot be certain that management sessions are private. Therefore, you should always use encrypted sessions when remotely administering network equipment, even in networks that you know well. The simplest way to achieve this is with Secure Shell (SSH).

This section describes secure management:

- "Using Secure Shell (SSH)" on page 9
- "Using SSL for secure web access" on page 10
- "Using SNMPv3" on page 10

Then the section ends by describing how to limit telnet access if you need to use telnet instead of one of the recommended secure options ("Whitelisting telnet hosts" on page 12).

When you are using a secure management scheme, we recommend that you block all telnet access to the switch, by disabling the telnet server:

```
disable telnet server
```

Using Secure Shell (SSH)

The Secure Shell (SSH) protocol is most simply described as an encrypted form of Telnet.

Products

All switches listed on page 2

Software Versions

All

Configuration

1. Add a security officer to your switch's list of users.
2. Create encryption keys for SSH to use.
3. Enable the SSH server.
4. Add the security officer to the list of SSH users and specify a password for it. Only users in this list can use SSH to access the switch.
5. Enable system security.

Enabling system security makes telnet unavailable as an administrative interface—once you have configured SSH, you have to use it.

Example

To configure SSH access for the security officer called "secoff":

```
add user=secoff password=securepass privilege=security telnet=yes
  login=yes
create enco key=0 type=rsa length=1024 description="Host Key"
  form=ssh
create enco key=1 type=rsa length=768 description="Server Key"
  form=ssh
enable ssh server serverkey=1 hostkey=0 expirytime=1
  logintimeout=60
add ssh user=secoff password=sameordifferentpassword
enable system security
```

Using SSL for secure web access

If you prefer to configure the switch using the convenient web-based GUI, then this is unencrypted by default. SSL lets you use the GUI securely, by using HTTPS instead of HTTP.

Products

All switches listed on page 2, except AT-8948 and x900-48 Series which have no graphical user interface

Software Versions

All

Configuration

1. Add a security officer to your switch's list of users.
2. Create an encryption key for SSL to use.
3. Create a self-signed PKI certificate, or load a certificate generated by a Certificate Authority (CA) if you have one.
4. Add the certificate to the certificate database.
5. Turn security on for the HTTP server.
6. Enable system security.

Once you have configured SSL, HTTPS connections to the device are available only on port 443.

Example

To allow the security officer called "secoff" to browse securely to the GUI, using a self-signed certificate:

```
add user=secoff password=secoff privilege=securityofficer
  login=yes
create enco key=0 type=rsa length=1024
set system distinguishedname="cn=switch1,o=my_company,c=us"
create pki certificate=cer_name keypair=0 serialnumber=12345
  subject="cn=172.30.1.105,o=my_company,c=us"
add pki certificate=cer_name location=cer_name.cer trust=yes
set http server security=on sslkey=0 port=443
enable system security
```

Using SNMPv3

Traditionally, SNMP has been a popular but insecure way to monitor networks.

Allied Telesis devices are SNMPv3 compliant. By using SNMPv3, you can authenticate SNMP users and restrict their network access to parts of the network. SNMPv3 is very flexible, as the examples in this section show.

Products

All switches listed on page 2

Software Versions

2.6.4 and later

Configuration

1. Enable SNMP.
2. Set up one or more SNMP views. Views list the objects in the MIB that users can see.
3. Set up one or more groups and add the groups to the views. Each group is a collection of users who have the same access rights.
4. Set up one or more users and add them to the groups. Authentication parameters are set here.
5. Set up a traphost profile, for trap messages to be remotely sent to. This is not compulsory but we recommend it.

Examples To allow the user “steve” full read, write and notify SNMP access to the switch:

```
enable snmp
add snmp view=full oid=1.3.6.1 type=include
add snmp group=super-users securitylevel=authPriv readview=full
  writeview=full notifyview=full
add snmp user=steve group=super-users authprotocol=md5
  authpassword=cottonsox privprotocol=des privpassword=woollytop
```

To also give the user “jane” read and notify access to everything on the switch, add the following commands:

```
add snmp group=users securitylevel=authNoPriv readview=full
  notifyview=full
add snmp user=jane group=users authprotocol=md5
  authpassword=redjeans
```

To also give the user “paul” unauthenticated read access to everything on the switch **except** BGP, add the following commands:

```
add snmp view=restricted oid=1.3.6.1 type=include
# exclude bgp by specifying either mib=bgp or oid=1.3.6.1.2.1.15:
add snmp view=restricted mib=bgp type=exclude
add snmp group=restricted-users securitylevel=noAuthNoPriv
  readview=restricted
add snmp user=paul group=restricted-users
```

To also send traps securely to the PC with IP address 192.168.11.23 for user “steve” to see, add the following commands:

```
add snmp targetparams=netmonpc securitylevel=authPriv user=steve
add snmp targetaddress=nms ip=192.168.11.23 udp=162
  params=netmonpc
```

For more information about the above examples, see *How To Configure SNMPv3 On Allied Telesis Routers and Managed Layer 3 Switches*, available from www.alliedtelesis.com/resources/literature/howto.aspx. This How To Note also explains SNMPv3 concepts in detail, including users, groups and views.

Whitelisting telnet hosts

For any remote management of a network device, Allied Telesis recommends you use SSH, Secure HTTP (SSL), or SNMPv3. Therefore, we recommend you block **all** telnet access to the switch by disabling the telnet server. However, if you persist with telnet, you should make a whitelist of the hosts that are permitted to telnet to the switch. This does not make telnet secure, but it does reduce the associated risks.

Building a whitelist through layer 3 filters

On Rapier, Rapier i, AT-8800, AT-8700XL and AT-8600 Series switches, use layer 3 filters to build a whitelist.

Products

AT-8600 Series

AT-8700XL Series

Rapier i Series
Rapier Series

AT-8800 Series

Software Versions

All

Configuration

1. Create a filter match definition that specifies destination IP address, protocol and destination TCP port as the criteria that the filter will match. The switch automatically assigns this filter an ID of 1 (unless other layer 3 filters already exist).
2. Create a filter entry that specifies the switch's IP address as the destination address, TCP as the protocol and 23 as the port. Give it an action of **deny**.
3. Create another filter match definition with source and destination IP addresses, both with 32-bit masks.
4. Create filter entries for the second filter. In each entry, specify a permitted host as the source and the switch's IP address as the destination. Give the entries an action of **nodrop**.

The first filter blocks (**action=deny**) any incoming telnet packets with the switch's destination IP address. The second filter reverses the first filter by undoing the previous denial of IP access to the switch—but only for the permitted source IP addresses.

Example To permit only the host with IP address 172.30.1.144 to telnet to the switch 172.28.40.70:

```
add switch l3filter match=dipaddress,protocol,tcpdport dclass=32

add switch l3f=1 entry protocol=tcp dipaddress=172.28.40.70
  tcpdport=23 action=deny

add switch l3filter match=dipaddress,sipaddress sclass=32
  dclass=32

add switch l3filter=2 entry sipaddress=172.30.1.144
  dipaddress=172.28.40.70 action=nodrop
```

Building a whitelist through QoS

On AT-8948, AT-9900, AT-9900s, and x900 Series switches, use classifiers to build a whitelist and QoS to apply it.

Products

AT-8948
x900-48 Series
AT-9900 Series
AT-9924Ts
x900-24 Series

Software Versions

2.7.3 and later

Configuration

1. Create classifiers to match telnet traffic from permitted IP addresses to the switch's IP address.
2. Create a classifier to match all telnet traffic to the switch's IP address.
3. Create a flow group and add the classifiers for permitted traffic to it.
4. Create a second flow group with a higher ID number and add the classifier that matches all telnet traffic to it.
5. Create the rest of the QoS framework—traffic class and policy.
6. Apply the policy to all ports to stop telnet from all directions.

QoS is an incredibly versatile hardware-level packet filtering mechanism. For more information about setting up QoS on these switches, see *How To Configure QoS On AT-8948, AT-9900, AT-9900s And x900 Series Switches*. This How To Note is available from www.alliedtelesis.com/resources/literature/howto.aspx.

Example

To permit only the host with IP address 172.30.1.144 to telnet to the switch 172.28.40.70:

```
create classifier=1 ipsa=172.30.1.144/32 ipda=172.28.40.70/32
  tcpd=23
create classifier=2 ipda=172.28.40.70/32 tcpd=23
create qos flowgroup=1 action=forward
create qos flowgroup=2 action=discard
create qos trafficclass=1
create qos policy=1
add qos flowgroup=1 classifier=1
add qos flowgroup=2 classifier=2
add qos trafficclass=1 flowgroup=1
add qos trafficclass=1 flowgroup=2
add qos policy=1 trafficclass=1
set qos port=all policy=1
```

Identifying the user

This section describes methods for authorising and tracking users and preventing them from changing their identity on the network.

IP spoofing and tracking

Unknown users who attempt to change IP address—to circumvent billing or to hide their identity—can be a problem for administrators.

Changing IP address for malicious reasons is most commonly called IP spoofing, and is also known as ARP spoofing, ARP poisoning, and ARP poison routing (APR). The net result is the same for all of these: the victim ends up with false information in its ARP table.

The trouble with ARP

IP Spoofing takes advantage of the inherently insecure design of ARP. In an Ethernet network, a client may use a Gratuitous ARP (GARP), or merely send an ARP request or reply with false information, to announce a phoney identity to the local subnet.

A phoney announcement may be made in a number of ways for a number of reasons. The following table briefly explains these factors.

If the ARP or GARP packet contains...	Then...
MAC that does not exist on network and IP address that does not exist on network	the attacker may be trying to fill up the IP ARP table so that the subnet's router cannot learn more addresses. As a result, return (routed) traffic may not be forwarded.
MAC that is owned by attacker and IP address that does not exist on network	the attacker is using an IP address that the administrator has not assigned and so may be trying to avoid traceability.
MAC that is owned by attacker and IP address that is owned by another host	the attacker is trying to intercept traffic destined for this host.
MAC that is owned by attacker and IP address that is owned by the subnet router	the attacker is trying to intercept all traffic leaving the subnet.
MAC does not exist on network and IP address that exists on network	the attacker is trying to cause traffic to this IP address to flood to all hosts in the subnet. However, hosts disregard the flooded traffic because it is not addressed with any host's MAC address. This means that the attacker receives the traffic and its intended recipient ignores it.

The techniques for protecting the network are the same for all these phoney announcements: reject gratuitous ARPs, and control access to ports with DHCP snooping and ARP security. The following sections describe these solutions in detail.

Rejecting Gratuitous ARP (GARP)

Hosts can use GARP to announce their presence on a subnet. It is a helpful mechanism, particularly when there is a chance of duplicate addresses. However, attackers can use GARP to penetrate the network by adding themselves to the switch's ARP table.

Products

All switches listed on page 2

Software Versions

2.5.1 and later

You can configure Allied Telesis switches and routers to ignore GARP packets. Ignoring GARPs does not completely prevent IP spoofing, but it does shut down one easy avenue for an attacker.

Example To ignore GARPs on VLAN 1:

```
set ip interface=vlan1 gratuitousarp=off
```

Note: We do not recommend disabling GARP reception if a server with teamed network cards is attached to the switch. In a teamed-NIC redundancy set-up, another card takes over if a card fails. In many implementations, the NIC that takes over sends a GARP to inform the switch of the port and MAC address change.

DHCP snooping

The AlliedWare DHCP snooping feature is a series of layer 2 techniques. It works with information from a DHCP server to:

- track the physical location of hosts
- ensure that hosts only use the IP addresses assigned to them
- ensure that only authorised DHCP servers are accessible.

In short, DHCP snooping ensures IP integrity on an L2-switched domain.

With DHCP snooping, only a whitelist of IP addresses may access the network. You configure this whitelist at the switch port level, and the DHCP server manages the access control. Only specific IP addresses with specific MAC addresses on specific ports may access the IP network.

Products

AT-8600 Series

AT-8700XL Series

Rapier i Series
Rapier Series

AT-8800 Series

AT-8948
x900-48 Series

AT-9900 Series

Software Versions

2.7.6 and later

DHCP snooping also stops attackers from adding their own DHCP servers to the network. An attacker could set up a server to wreak havoc in the network or even control it.

There are a number of options for DHCP snooping. You can:

- let the switch snoop DHCP packets and decide who is authorised to access the IP network. See "Setting up DHCP snooping" on page 16.
- statically bind IP address and MAC combinations to switch ports. See "Using static binding for rigid control" on page 16.
- use option 82 to track users. See "Using DHCP snooping to track clients" on page 17.
- use ARP security to reject ARP messages unless they come from an IP address in the DHCP snooping database. See "Using ARP security" on page 17.

For more information about setting up DHCP snooping, see *How To Use DHCP Snooping, Option 82 and Filtering on Rapier, AT-8800 and AT-8600 Series Switches* or *How To Use DHCP Snooping, Option 82 and Filtering on x900 Series Switches*. These How To Notes are available from www.alliedtelesis.com/resources/literature/howto.aspx.

Setting up DHCP snooping

This section describes a minimal configuration for DHCP snooping. With this configuration, the switch snoops DHCP packets to build a database of allowed IP addresses, only sends DHCP messages to the port with the official DHCP server, and limits the number of clients attached to each port.

Configuration

1. Enable DHCP snooping.
2. Identify the port that your DHCP server is attached to, and configure this as a trusted port for DHCP snooping. The switch only sends DHCP discover and request packets to trusted ports. If a malicious user attaches a DHCP server to an untrusted port, that server will never receive DHCP requests. This prevents DHCP server spoofing.
3. Set the number of leases permitted on each port.
4. For AT-8948, x900-48, and AT-9900 switches, add classifiers and a quality of service (QoS) configuration to permit and filter addresses.

Example To limit each port on a 24-port switch to 1 lease, when the DHCP server is on port 24:

```
enable dhcpsnooping
set dhcpsnooping port=24 trusted=yes
set dhcpsnooping port=1-23 maxlease=1
```

On AT-8948, x900-48 and AT-9900 switches, also add the following commands:

```
create classifier=50 macsaddr=dhcpsnooping prot=ip
  ipsaddr=dhcpsnooping
create classifier=51 protocol=ip
create qos policy=1
create qos trafficclass=1
create qos flow=50 action=forward
create qos flow=51 action=discard
add qos policy=1 trafficclass=1
set qos port=1-23 policy=1
add qos trafficclass=1 flow=50
add qos trafficclass=1 flow=51
add qos flow=50 classifier=50
add qos flow=51 classifier=51
```

Using static binding for rigid control

If there is no DHCP server, or if there is a host with a static IP address, then you can bind the IP address to the port to which it is attached.

Example To specify that the host with MAC address 00-00-00-00-00-12 can legitimately use the IP address 172.16.0.12 on port 12, use the following command in addition to the configuration given in "Setting up DHCP snooping", above.

```
add dhcpsnooping binding=00-00-00-00-00-12 ip=172.16.0.12
  interface=vlan1 port=12
```

Using DHCP snooping to track clients

If your DHCP server supports it, you can use "option 82" to record more information about DHCP clients. This enhances your ability to track users. The switch can pass option 82 information to the DHCP server so that the server can record the switch MAC, switch port, VLAN number and subscriber-ID that the client is a member of.

Example To pass option 82 information to the server, including the information that port 1 is room 101, use the following commands in addition to the configuration given in "Setting up DHCP snooping" on page 16.

```
enable dhcpsnooping option82
set dhcpsnooping port=1 subscriberid="Room 101"
```

Using ARP security

When you enable ARP security, the switch drops ARP packets received on non-trusted (client) ports unless the packets originate from an IP address that is registered in the DHCP snooping database.

ARP security stops clients that are directly attached to the switch from using IP spoofing or ARP poisoning. It also protects directly-attached clients from IP spoofing and ARP poisoning.

Example To turn on ARP security, use the following command in addition to the configuration given in "Setting up DHCP snooping", above.

```
enable dhcpsnooping arpsecurity
```

Using 802.1x port authentication

Products

All switches listed on page 2

Software Versions

2.6.1 and later

With 802.1x port authentication, hosts must authenticate themselves when they attempt to access a network through an Ethernet port.

Unlike DHCP snooping, 802.1x only authenticates users when they access the port. It cannot track them afterwards.

A network controller, such as a RADIUS server, controls the authentication. The Allied Telesis switch facilitates the host to server communication and takes note of success or failure. Essentially, the host is completely denied access to the Ethernet until the switch sees the host successfully authenticate with the server. After that, the switch allows packets to and from the host to pass through the 802.1x controlled port.

802.1x can also dynamically assign the host to a VLAN.

Examples For examples of 802.1x authentication, see the following How To Notes:

- *How to Configure A Secure School Network Based On 802.1x*
- *How To Use 802.1x VLAN Assignment*
- *How To Use 802.1x EAP-TLS or PEAP-MS-CHAP v2 with Microsoft Windows Server 2003 to Make a Secure Network*
- *How To Use 802.1x Security with AT-WA7400 APs, AT-8624PoE Switches, and Linux's freeRADIUS and Xsupplicant*

Most of the above Notes describe how to configure the authentication server and the host, as well as the switch.

Protecting the user

This section describes the following methods of protecting users from other users on the network:

- "Using private VLANs" on page 18. This feature isolates switch ports in a VLAN from other switch ports in the same VLAN.
- "Using local proxy ARP and MAC-forced forwarding" on page 19. These features force all traffic in a network to go via an access router.
- "Using IPsec to make VPNs" on page 24. This feature creates secure tunnels through an insecure network.
- "Protecting against worms" on page 25. These methods reduce the damage worms do to users of the network.

Using private VLANs

Private VLANs are an excellent way of preventing hosts on a subnet from attacking each other. Essentially, each switch port is isolated from other ports in the VLAN, but can access another network through an uplink port or uplink trunk group. All traffic between private ports is blocked, not just Layer 2 traffic.

Products

AT-8600 Series

AT-8700XL Series

Rapier i Series
Rapier Series

AT-8800 Series

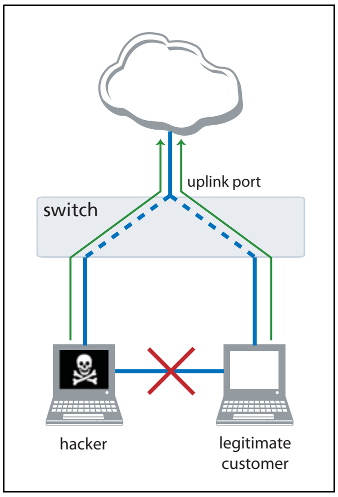
AT-8948
x900-48 Series

AT-9900 Series

AT-9924Ts
x900-24 Series

Software Versions

All



Private VLANs are reasonably flexible. A private port can be a member of multiple private VLANs. However, a port cannot be a private port in some VLANs and a non-private port in others.

On AT-8600, AT-8700XL, Rapier i and AT-8800 Series switches running 2.9.1 or later, each private VLAN can have multiple uplink ports. This allows you to use private VLANs on switches that are connected in a ring topology. Also, you can group private ports together on these switches, which allows the ports in a group to communicate with each other but not with other ports in the VLAN.

Note that ports are only isolated from ports on the same physical switch, not from ports on other switches reached through an uplink port.

Configuration

1. Create the VLAN, specifying that it is private.
2. Add the uplink port, or the ports in the uplink trunk group, to the VLAN. For a trunk group, the ports must already be trunked together, and you must specify all the ports in the trunk group. Note that on Rapier 48i and AT-8748XL switches, the uplink and private ports must be in the same switch instance. See the *Switching* chapter of the Software Reference for more information about switch instances.
3. Add the private ports to the VLAN.

Example To create a private VLAN with ports 2-6 in it, with an uplink trunk group of ports 24 and 25:

```
create vlan=example vid=2 private
add vlan=2 port=24-25 frame=tagged uplink
add vlan=2 port=2-6
```

To remove ports from the VLAN:

```
# remove port 4:
delete vlan=2 port=4
# remove all private ports and the uplink ports:
delete vlan=2 port=all
```

Using local proxy ARP and MAC-forced forwarding

Both these features ensure the integrity of ARP in your network and let you take granular control of IP traffic flows. They do this by forcing traffic that would have been dropped by private VLANs to go via an *access router.* Both features stop hosts from learning the MAC addresses of other hosts in their subnet—they learn the MAC address of the access router instead.

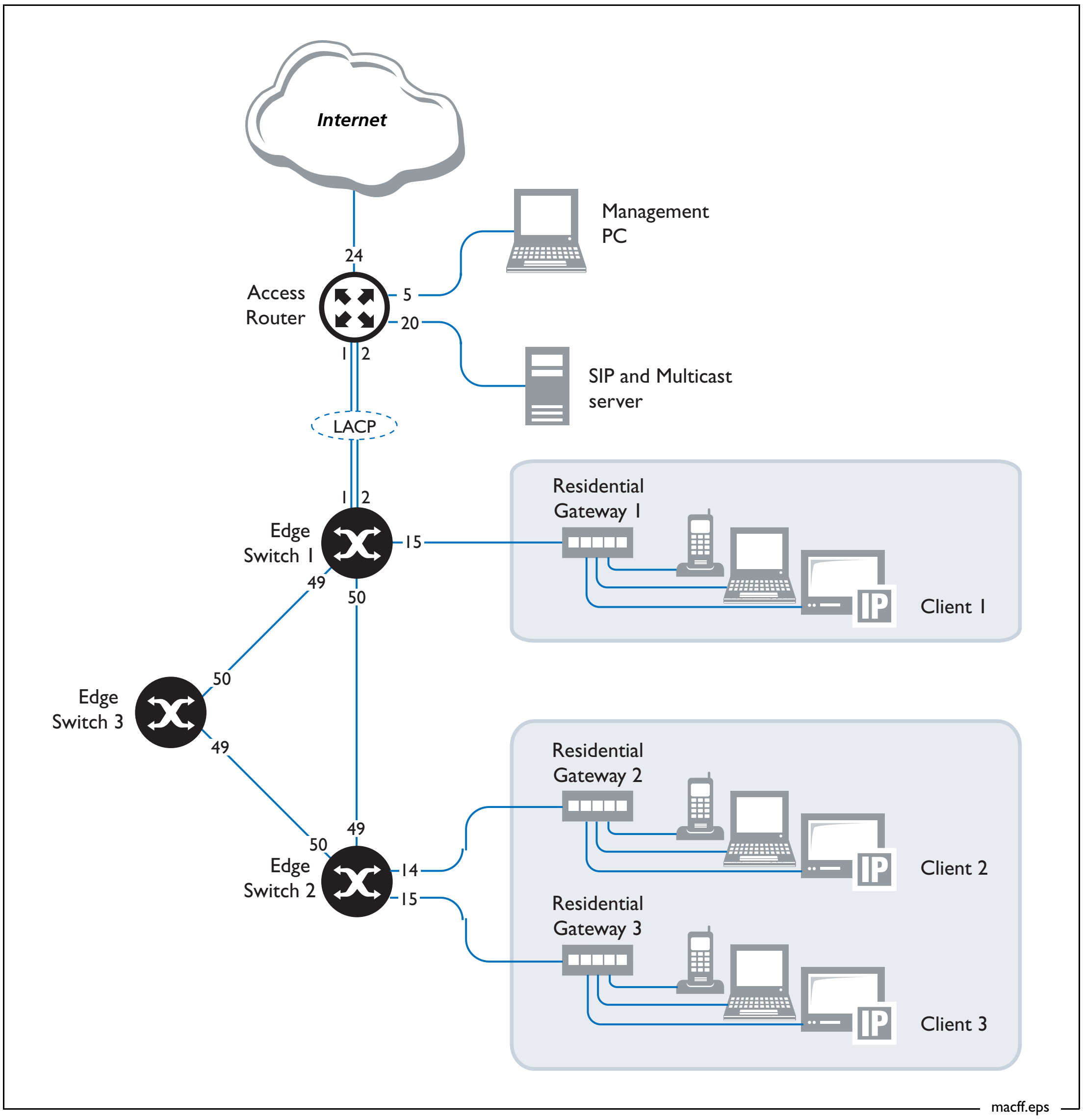
You can use these features, for example, to allow customers to use VoIP to telephone each other while blocking any video, data, or management traffic between customers.

MAC-forced forwarding (page 23) requires more configuration than local proxy ARP (page 20) but is more powerful. MAC-forced forwarding:

- ensures that all ARP replies are generated by the directly-connected switch (not the access router). This removes the ARP process from the access router, minimises the distance ARPs travel through the network, and protects against ARP Denial of Service attacks.
- dynamically determines the appropriate access router for a host by snooping DHCP packets.
- bypassing the access router for traffic between application servers and their clients.

With software versions 291-05 and later, you can use MAC-forced forwarding without configuring private VLANs. However, we recommend you use it with private VLANs for maximum security.

The following figure shows a network that can use either local proxy ARP or MAC-forced forwarding—the examples in both the following sections refer to this network.



Local proxy ARP

Products

All switches listed on page 2

Software Versions

2.9.1 or later

In a network configuration like the previous figure, each edge switch uses private VLANs to stop clients from talking directly to each other. Private VLANs stop the edge switch from flooding broadcast traffic, including clients' ARP requests. Instead, the switch sends ARP requests out its uplink port to the access router.

If local proxy ARP is configured on the access router, then the access router responds to ARP requests with its own MAC address, instead of the destination device's MAC address. This combination of private VLANs and local proxy ARP forces the clients to send all their traffic to the access router. When the access router sees traffic from a client, it checks a list of filters to determine whether to forward the traffic or drop it.

On each client residential gateway, you need to enable tagged VLANs on the connection to the edge switch for the VLANs that the client should be able to access.

Configuration of edge switches

1. Create the VLANs, specifying that they are private. Make a different VLAN for each type of traffic that you want to control differently.
2. Add the uplink and private ports to the VLANs as tagged ports.
3. Configure any other requirements, such as a management IP address.

Configuration of access router

1. Create the VLANs.
2. Add the ports to the VLANs as tagged ports.
3. Enable IP.
4. Give each VLAN an IP address and turn on local proxy ARP.
5. Create classifiers and filters to decide which traffic to block.
6. Configure any other required networking features.

Example

To allow VoIP (voice) but no other traffic between clients in the above network, use the following configuration for **edge switch 1** (an AT-8648 switch in this example):

```
ena stp=default
set stp=default mode=rapid

delete lacp port=3-50
enable lacp

create vlan="voice" vid=101 private
add vlan=101 port=1-2,49-50 uplink frame=tagged
add vlan=101 port=3-48 frame=tagged
create vlan="video" vid=102 private
add vlan=102 port=1-2,49-50 uplink frame=tagged
add vlan=102 port=3-48 frame=tagged
create vlan="data" vid=103 private
add vlan=103 port=1-2,49-50 uplink frame=tagged
add vlan=103 port=3-48 frame=tagged
create vlan="management" vid=104 private
add vlan=104 port=1-2,49-50 uplink frame=tagged
add vlan=104 port=3-48 frame=tagged

# Give the management VLAN an appropriate IP address
enable ip
add ip int=vlan104 ip=<address-in-192.168.4.0-subnet>
```

Use the following configuration for **edge switches 2 and 3** (AT-8648 switches in this example):

```
ena stp=default
set stp=default mode=rapid

create vlan="voice" vid=101 private
add vlan=101 port=49-50 uplink frame=tagged
add vlan=101 port=1-48 frame=tagged
create vlan="video" vid=102 private
add vlan=102 port=49-50 uplink frame=tagged
add vlan=102 port=1-48 frame=tagged
create vlan="data" vid=103 private
add vlan=103 port=49-50 uplink frame=tagged
add vlan=103 port=1-48 frame=tagged
create vlan="management" vid=104 private
add vlan=104 port=49-50 uplink frame=tagged
add vlan=104 port=1-48 frame=tagged

# Give the management VLAN an appropriate IP address
enable ip
add ip int=vlan104 ip=<address-in-192.168.4.0-subnet>
```

Use the following configuration for the **access router** (a Rapier 24i switch in this example):

```
delete lacp port=3-24
enable lacp

create vlan="voice" vid=101
create vlan="video" vid=102
create vlan="data" vid=103
create vlan="management" vid=104

add vlan=101 port=1-2 frame=tagged
add vlan=102 port=1-2 frame=tagged
add vlan=103 port=1-2 frame=tagged
add vlan=104 port=1-2 frame=tagged

enable ip
add ip int=vlan101 ip=192.168.1.254 proxy=local
add ip int=vlan102 ip=192.168.2.254 proxy=local
add ip int=vlan103 ip=192.168.3.254 proxy=local
add ip int=vlan104 ip=192.168.4.254 proxy=local
```

```
# Create a classifier to match all traffic in VLANs 101-104
create class=10 ipsa=192.168.0.0/16 ipda=192.168.0.0/16

# Create a classifier to match voice traffic
create class=100 ipsa=192.168.1.0/24 ipda=192.168.1.0/24

# Create a classifier to match management traffic
# The management PC is 192.168.4.250
create class=401 ipsa=192.168.4.0/24 ipda=192.168.4.250/32
create class=402 ipsa=192.168.4.250/32 ipda=192.168.4.0/24

# Create a filter to drop traffic within and between VLANs 101-104
add switch hwfilter classifier=10 action=discard

# Create filters to allow the exceptions (voice and management)
add switch hwfilter classifier=100 action=nodrop
add switch hwfilter classifier=401 action=nodrop
add switch hwfilter classifier=402 action=nodrop
```

MAC-Forced Forwarding (MACFF)

Products

AT-8600 Series

AT-8700XL Series

Rapier Series

AT-8800 Series

AT-8948

x900-48 Series

AT-9900 Series

Software Versions

2.9.1 or later

MAC-forced forwarding works in conjunction with DHCP snooping to give you full control over IP flows in a layer 2 network.

Like local proxy ARP, MACFF replies to a client's ARP request with the MAC address of an access router, instead of the real MAC address of the IP requested.

With MACFF, the edge switch generates the ARP reply. The edge switch works out which MAC address to reply with from information provided by DHCP snooping. DHCP snooping keeps a record of the client's IP, MAC and port assignment. It also records the router information that the client has been given by DHCP. DHCP snooping passes this information to MACFF, so that MACFF knows which router's MAC address to provide when it sees an ARP from that client.

For more information about how MACFF works, see *How To Use MAC-Forced Forwarding with DHCP Snooping to Create Enhanced Private VLANs*. This How To Note is available from www.alliedtelesis.com/resources/literature/howto.aspx.

Configuration of edge switches

1. Create a VLAN for each type of service (for example, voice, video, and data). With software versions 291-04 and earlier, the VLANs must be private VLANs. With software versions 291-05 and later, you can use non-private VLANs. However, we recommend you use private VLANs for maximum security.
2. Add the uplink and private ports to the VLANs as tagged ports.
3. Enable DHCP snooping and ARP security. ARP security ensures that ARP packets received on untrusted (client) ports are only forwarded if they originate from an IP in the DHCP snooping database of current valid entries.
4. Specify the trusted ports. Private VLAN uplink ports need to be trusted ports, so that they can forward DHCP packets.
5. Configure other aspects of DHCP snooping, such as static IP address bindings and the maximum number of leases for ports.
6. On AT-8948, AT-9900, and x900-48 Series switches, create classifiers for DHCP snooping.
7. Enable MAC-forced forwarding.
8. Configure any other requirements, such as a management IP address, STP and LACP.

Configuration of access router

1. Create the VLANs and add ports to them.
2. Enable IP and configure IP addresses on each VLAN.
3. Create classifiers to match the traffic that you need to control.
4. Create hardware filters to forward or drop the classified traffic.
5. Disable ICMP redirection.
6. Configure any other required networking features.

Example

How To Use MAC-Forced Forwarding with DHCP Snooping to Create Enhanced Private VLANs includes the full configuration for the network on page 19, including the three client residential gateways, the three edge switches, and the access router. For your convenience, we have reproduced the configuration scripts for the edge switches and the access router in "Appendix: Configuration scripts for MAC-forced forwarding example" on page 27.

Using IPsec to make VPNs

IPsec is a frequently-used secure remote access technology. It is particularly useful for connecting remote offices over long distances and for giving access to travelling employees. IPsec offers authentication, highly secure access, and highly granular access.

The AlliedWare IPsec implementation is RFC compliant and offers extensive options.

Products

Rapier i Series
Rapier Series

AT-8800 Series

Software Versions

All

Examples

For examples of the many ways to configure IPsec, see the following How To Notes:

- *How To Configure VPNs In A Corporate Network, With Optional Prioritisation Of VoIP*
- *How To Configure Microsoft® Windows 2000 Virtual Private Network (VPN) client interoperability without NAT-T support*
- *How To Configure Microsoft® Windows 2000 Virtual Private Network (VPN) client interoperability with NAT-T support*

- *How To Configure Microsoft® Windows XP Virtual Private Network (VPN) client interoperability without NAT-T support*
- *How To Configure Microsoft® Windows XP Virtual Private Network (VPN) client interoperability with NAT-T support*
- *How To Configure IPsec VPN Between Microsoft ISA Server 2004 and an Allied Telesyn Router Client*
- *How To Create a VPN between an Allied Telesis and a SonicWALL router, with NAT-T*
- *How To Create a VPN between an Allied Telesis and a NetScreen router*
- *How To Troubleshoot A Virtual Private Network (VPN)*

Protecting against worms

In the recent history of the Internet, the danger has shifted from viruses to worms. Viruses need humans to transfer them from system to system, for example, by downloading a program. Worms transfer themselves from system to system without human interaction. The most successful worms exploit Microsoft Windows vulnerabilities because of the prevalence of these operating systems. Commonly, a worm causes the same kind of damage to a system as a virus.

Worms and viruses generally exploit flaws in PC operating systems. There are no known worms that affect AlliedWare. In fact, you can configure Allied Telesis switches to protect your network PCs and servers from both internal and external attack from worms.

In an Allied Telesis switched network (where no hubs exist), the switches can forward or drop every packet on the basis of specific criteria. You can employ this packet inspection at no cost to network performance. Therefore, you can configure an Allied Telesis switch to check for packets that appear to exploit a TCP or UDP port that a known worm attacks.

An example of a worm that exploits a port-based vulnerability is the W32.Slammer worm. This worm caused significant denial of service problems several years ago. It propagates via UDP Port 1434, which is the port used by SQL server traffic. All network administrators should have patched their SQL Server 2000 systems against this worm, but we will use it as an example.

Blocking worms through classifier-based filters

On Rapier, Rapier i, AT-8800, AT-8700XL and AT-8600 Series switches, use classifier-based hardware filters to block traffic from a worm.

Products

AT-8600 Series

AT-8700XL Series

Rapier i Series
Rapier Series

AT-8800 Series

Software Versions

All

Configuration

1. Find out which UDP or TCP port the worm attacks.
2. Create a classifier to match traffic arriving at a target switch port, using that UDP or TCP port.

   Target switch ports must not be attached to clients who legitimately need to access the UDP or TCP port.
3. Create a filter that uses the classifier and discards matching traffic.

Example

To block the W32.Slammer worm on port 1, which does not have an SQL client or server attached to it:

```
create classifier=1 udpdport=1434 protocol=ip iport=1
add switch hwfilter classifier=1 action=discard
```

Blocking worms through QoS actions

On AT-8948, AT-9900, AT-9900s, and x900 Series switches, use QoS to block traffic from a worm.

Products

AT-8948
x900-48 Series

AT-9900 Series

AT-9924Ts
x900-24 Series

Software Versions

2.7.3 or later

Configuration

1. Find out which UDP or TCP port the worm attacks.
2. Create a classifier to match traffic using that UDP or TCP port.
3. Create a flow group with an action of discard and add the classifier to it.
4. Create the rest of the QoS framework—traffic class and policy.
5. Apply the policy to the target switch ports (but not to ports that are attached to clients who legitimately need to access the UDP or TCP port).

On these switches, AlliedWare classifiers offer a large range of matchable fields, including destination port, source port, IPX, interface, TOS, DSCP value, and MAC source or destination addresses. Once the classifier has selected a matched packet, what happens to it can vary from discarding or forwarding it, to marking the DSCP value, and many other alternatives.

Example

To block the W32.Slammer worm on port 1, which does not have an SQL client or server attached to it:

```
create class=1 udpd=1434
create qos flow=1 action=discard
create qos trafficclass=1
create qos policy=1
add qos flow=1 class=1
add qos trafficclass=1 flow=1
set qos port=1 policy=1
```

Appendix: Configuration scripts for MAC-forced forwarding example

In this example (from page 23), the edge switches can be any of the following switches:

- Rapier 16fi and Rapier 24i (but not Rapier 48i)
- AT-8724XL (but not AT-8748XL)
- AT-8824 and AT-8848
- AT-8624T/2M, AT-8624PoE, and AT-8648T/2SP

The access router is a Rapier 24i switch.

Edge switch 1

Edge switch 1 is directly connected to the access router.

```
set system name="Edge Switch 1"

create vlan=Voice vid=100 private
create vlan=Video vid=200 private
create vlan=Data vid=300 private
create vlan=Management vid=400 private
create vlan=EAN_Management vid=500 private
enable stp=default
set stp=default mode=rapid

add vlan=100 port=1-2,49-50 uplink frame=tagged
add vlan=100 port=15 frame=tagged
add vlan=200 port=1-2,49-50 uplink frame=tagged
add vlan=200 port=15 frame=tagged
add vlan=300 port=1-2,49-50 uplink frame=tagged
add vlan=300 port=15 frame=tagged
add vlan=400 port=1-2,49-50 uplink frame=tagged
add vlan=400 port=15 frame=tagged
add vlan=500 port=1-2,49-50 uplink frame=tagged
set stp=default port=3-48 edgeport=yes

enable dhcpsnooping
enable dhcpsnooping arpsecurity
enable dhcpsnooping option82
set dhcpsnooping port=1 trusted=yes
set dhcpsnooping port=2 trusted=yes
set dhcpsnooping port=49 trusted=yes
set dhcpsnooping port=50 trusted=yes
set dhcpsnooping port=15 maxleases=4

# Specify the static IP of the residential gateway
add dhcpsnooping binding=00-0d-da-00-0b-11 ip=172.16.4.201 interface=vlan400
   port=15 router=172.16.4.254

enable macff int=vlan100
enable macff int=vlan200
enable macff int=vlan300
enable macff int=vlan400
enable macff int=vlan500

enable ip
add ip int=vlan500 ip=172.16.5.101 mask=255.255.255.0
delete lacp port=3-50
enable lacp
```

Edge switch 2

Edge switch 2 is connected to port 50 of edge switch 1. The configuration is similar to edge switch 1—differences are in **bold**:

```
# System configuration
set system name="Edge Switch 2"

# VLAN general configuration
create vlan=Voice vid=100 private
create vlan=Video vid=200 private
create vlan=Data vid=300 private
create vlan=Management vid=400 private
create vlan=EAN_Management vid=500 private

# STP general configuration
enable stp=default
set stp=default mode=rapid

# VLAN port configuration
# ports 1 and 2 are not in any VLANs
add vlan=100 port=49-50 uplink frame=tagged
add vlan=100 port=15 frame=tagged
add vlan=100 port=14 frame=tagged
add vlan=200 port=49-50 uplink frame=tagged
add vlan=200 port=15 frame=tagged
add vlan=200 port=14 frame=tagged
add vlan=300 port=49-50 uplink frame=tagged
add vlan=300 port=15 frame=tagged
add vlan=300 port=14 frame=tagged
add vlan=400 port=49-50 uplink frame=tagged
add vlan=400 port=15 frame=tagged
add vlan=400 port=14 frame=tagged
add vlan=500 port=49-50 uplink frame=tagged

# STP port configuration
set stp="default" port=1-48 edgeport=yes

# DHCP Snooping configuration
enable dhcpsnooping
enable dhcpsnooping arpsecurity
enable dhcpsnooping option82
set dhcpsnooping port=14 maxleases=4
set dhcpsnooping port=15 maxleases=4
set dhcpsnooping port=49 trusted=yes
set dhcpsnooping port=50 trusted=yes
add dhcpsnooping binding=00-0d-da-00-00-37 ip=172.16.4.202 interface=vlan400
   port=14 router=172.16.4.254
add dhcpsnooping binding=00-0d-da-00-02-eb ip=172.16.4.203 interface=vlan400
   port=15 router=172.16.4.254

# IP configuration
enable ip
add ip int=vlan500 ip=172.16.5.102 mask=255.255.255.0

# MACFF configuration
enable macff int=vlan100
enable macff int=vlan200
enable macff int=vlan300
enable macff int=vlan400
enable macff int=vlan500
```

Edge switch 3

Edge switch 3 is connected to port 49 of edge switch 1. The configuration is similar to edge switch 1—differences are in **bold**:

```
# System configuration
set system name="Edge Switch 3"

# VLAN general configuration
create vlan=Voice vid=100 private
create vlan=Video vid=200 private
create vlan=Data vid=300 private
create vlan=Management vid=400 private
create vlan=EAN_Management vid=500 private

# STP general configuration
enable stp=default
set stp=default mode=rapid

# VLAN port configuration
# unlike switch 1, ports 1, 2 and 15 are not in any VLANs
add vlan=100 port=49-50 uplink frame=tagged
add vlan=200 port=49-50 uplink frame=tagged
add vlan=300 port=49-50 uplink frame=tagged
add vlan=400 port=49-50 uplink frame=tagged
add vlan=500 port=49-50 uplink frame=tagged

# STP port configuration
set stp=default port=1-48 edgeport=yes

# DHCP Snooping configuration
# unlike switch 1, there is no maxlease setting for port 15 or static bindings
enable dhcpsnooping
enable dhcpsnooping arpsecurity
enable dhcpsnooping option82
set dhcpsnooping port=49 trusted=yes
set dhcpsnooping port=50 trusted=yes

# IP configuration
enable ip
add ip int=vlan500 ip=172.16.5.103 mask=255.255.255.0

# MACFF configuration
enable macff int=vlan100
enable macff int=vlan200
enable macff int=vlan300
enable macff int=vlan400
enable macff int=vlan500
```

Access Router

```
set system name="Access Router"

# Create a VLAN for accessing the Internet, SIP server and multicast groups
create vlan=CoreNetwork vid=28

# Create the other VLANs
create vlan=Voice vid=100
create vlan=Video vid=200
create vlan=Data vid=300
create vlan=Management vid=400
create vlan=EAN_Management vid=500

add vlan=28 port=20,24
add vlan=500 port=5
add vlan=100 port=1-2 frame=tagged
add vlan=200 port=1-2 frame=tagged
add vlan=300 port=1-2 frame=tagged
add vlan=400 port=1-2 frame=tagged
add vlan=500 port=1-2 frame=tagged

enable stp=default
set stp=default mode=rapid
set stp=default port=3-23 edgeport=yes

enable ip
add ip int=vlan28 ip=172.28.40.60
add ip int=vlan100 ip=172.16.1.254 mask=255.255.255.0
add ip int=vlan200 ip=172.16.2.254 mask=255.255.255.0
add ip int=vlan300 ip=172.16.3.254 mask=255.255.255.0
add ip int=vlan400 ip=172.16.4.254 mask=255.255.255.0
add ip int=vlan500 ip=172.16.5.254 mask=255.255.255.0
add ip rou=0.0.0.0 mask=0.0.0.0 int=vlan28 next=172.28.0.1
disable ip icmp=redirect

# Create classifiers to match traffic in VLANs 100-500
create class=10 ipsa=172.16.0.0/16 ipda=172.16.0.0/16
create class=100 ipsa=172.16.1.0/24 ipda=172.16.1.0/24
create class=401 ipsa=172.16.4.0/24 ipda=172.16.5.250/32
create class=402 ipsa=172.16.5.250/32 ipda=172.16.4.0/24
create class=501 ipsa=172.16.5.0/24 ipda=172.16.5.250/32
create class=502 ipsa=172.16.5.250/32 ipda=172.16.5.0/24

# Create a filter to drop all traffic within and between VLANs 100-500
add switch hwfilter classifier=10 action=discard
# Create filters to allow the exceptions (voice traffic)
add switch hwfilter classifier=100 action=nodrop
add switch hwfilter classifier=401 action=nodrop
add switch hwfilter classifier=402 action=nodrop
add switch hwfilter classifier=501 action=nodrop
add switch hwfilter classifier=502 action=nodrop

# Configure IGMP for multicasting
enable ip igmp
enable ip igmp int=vlan28
enable ip igmp int=vlan200
enable ip igmp int=vlan300
```

```
# Configure PIM sparse mode for multicast routing
add pim interface=vlan28
add pim interface=vlan200
add pim bsrcandidate interface=vlan28
add pim rpcandidate group=224.0.0.0 mask=240.0.0.0 interface=vlan28
enable pim

# Configure the DCHP server
create dhcp poli=Voice_DHCP lease=7200
add dhcp poli=Voice_DHCP subn=255.255.255.0 router=172.16.1.254
   dnss=10.0.0.100,10.0.0.101 maskdiscovery=off masksupplier=off
create dhcp range=Voice_range poli=Voice_DHCP ip=172.16.1.200 number=5
add dhcp range=Voice_range ip=172.16.1.201 a=00-0d-da-00-0b-11
add dhcp range=Voice_range ip=172.16.1.202 a=00-0d-da-00-00-37
add dhcp range=Voice_range ip=172.16.1.203 a=00-0d-da-00-02-eb
create dhcp poli=Video_DHCP lease=3600
add dhcp poli=Video_DHCP subn=255.255.255.0 router=172.16.2.254
   maskdiscovery=off masksupplier=off
create dhcp range=Video_range poli=Video_DHCP ip=172.16.2.200 number=5
create dhcp poli=Data_DHCP lease=300
add dhcp poli=Data_DHCP subn=255.255.255.0 router=172.16.3.254
   dnss=10.0.0.100,10.0.0.101 maskdiscovery=off masksupplier=off
create dhcp range=Data_range poli=Data_DHCP ip=172.16.3.200 number=5
enable dhcp

delete lacp port=3-24
enable lacp
```