Technical Guide

Switching

Feature Overview and Configuration Guide

Introduction

This guide gives an overview of Layers 1 and 2 Ethernet switching.

Layer 2 switches are used to connect multiple Local Area Network (LAN) segments together to form an extended LAN. Stations connected to different LANs can be configured to communicate with one another as if they were on the same LAN. They can also divide one physical LAN into multiple Virtual LANs (VLANs). Stations connected to each other on the same extended LAN can be grouped in separate VLANs, so that a station in one VLAN can communicate at Layer 2 with other stations in the same VLAN, but must go through higher layer routing protocols to communicate with stations in other VLANs.

Layer 2 switches appear transparent to higher layer protocols, transferring frames between the data link layers of the networks to which they are attached. A Layer 2 switch accesses each physical link according to the rules for that particular network. Access may not always be instant if a link's bandwidth is oversubscribed, so the switch must be capable of storing and forwarding frames.

Storing and forwarding enables the switch to examine both the VLAN tag fields and Ethernet MAC address fields in order to forward the frames to their appropriate destination. In this way, the switch can act as an intelligent filtering device, redirecting or blocking the movement of frames between networks.

Because switch ports can sometimes receive frames faster than it can forward them, the switch has Quality of Service (QoS) queues in which frames await transmission according to their priority. Such a situation could occur where data enters a number of input ports all destined for the same output port.

The switch can be used to:

- Increase both the physical extent and the maximum number of stations on a LAN. LANs are limited in their physical extent by the signal distortion and propagation delay characteristics of the media. The switch overcomes this limitation by receiving a frame on one LAN and then retransmitting it to another. The physical characteristics of the LAN media also place a practical limit on the number of stations that can be connected to a single LAN segment. The switch overcomes this limitation by joining LAN segments to form an extended LAN capable of supporting more stations than either of the individual LAN segments.

- Connect LANs that have a common data link layer protocol but different physical media, for example, Ethernet 10BASET, 100BASET, and 10BASEF.
- Increase the availability of LANs by allowing multiple redundant paths to be physically configured and selected dynamically, using the Spanning Tree algorithm.
- Reduce the load on a LAN or increase the effective bandwidth of a LAN, by filtering traffic.
- Prioritize the transmission of data with high Quality of Service requirements.

By using Virtual LANs (VLANs), a single physical LAN can be separated into multiple Virtual LANs. VLANs can be used to:

- Further improve LAN performance, as broadcast traffic is limited to LAN segments serving members of the VLAN to which the sender belongs.
- Provide security, as frames are forwarded to those stations belonging to the sender’s VLAN, and not to stations in other VLANs on the same physical LAN.
- Reduce the cost of moving or adding stations to function or security based LANs, as this generally requires only a change in the VLAN configuration.

Products and software version that apply to this guide

This guide applies to all AlliedWare Plus™ products, running version **5.4.5** or later.

However, feature support and implementation varies between products. To see whether a product supports a particular feature or command, see the following documents:

- The product’s Datasheet
- The product’s Command Reference

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

Most features described in this document are supported from AlliedWare Plus 5.4.5 or later. These features are available in later releases:

- Version 5.4.7-0.1 and later supports extended hardware switching on x310 Series switches
- Version 5.4.9-1.3 and later supports multiple storm control level types on x530 Series switches
- Version 5.5.1-0.1 and later supports jumbo frames for Layer 3 switched traffic and control packets on SBx908 GEN2 and x950 Series switches
- Version 5.5.1-0.1 and later supports port security on link aggregators
- Version 5.5.1-1.1 and later supports jumbo frames for Layer 3 switched traffic and control packets on x530 and GS980MX Series switches

Content

Switch Ports

The switch ports in the x-series switches support a number of features:

- Enabling and disabling of ports
- Auto negotiation of port speed and duplex mode, where supported by the port type
- Manual setting of port speed and duplex mode, where supported by the port type
- Link up and link down triggers
- Packet storm protection
- Port mirroring

Port numbering

A unique port number identifies each switch port on a device.

Ports are numbered using a 3 digit format **x.y.z** where:

- **x** is the **device number** (1 for a standalone device, or from 1 to 8 for a device in a VCStack™)
- **y** is a **module number** (for devices that have plugin line cards or other modules) or 0 for ports on the base device chassis.
- **z** is the **port number** within the module or on the base device chassis.

In an unstacked (standalone) configuration all device numbers are **1**. For example, **port1.0.37** represents device **1**, port **37** on the device chassis (i.e. not in a plug-in card), and **port1.2.6** represents device **1**, card **2**, port **6**.

In a VCStack, **port2.0.8** represents device 2, port 8 on the switch chassis.

Adding a description to an interface

You can add a description to an **interface** to help identify its purpose or position. For example, to add the description “connected to Nerv” to **port1.0.3**, use the commands:

```
awplus(config)#interface port1.0.3
awplus(config-if)#description connected to Nerv
```

Port ranges

Continuous

To configure properties of a continuous range of ports at the same time, enter the range in the format:

```
portx.y.z-portx.y.z
```

For example, to configure the same interface setting on **port1.0.1** to **port1.0.2**, enter the Global Configuration mode command:

```
awplus(config)#interface port1.0.1-port1.0.2
```

Non-continuous

To configure a non-continuous set of ports at the same time, enter a comma-separated list:

```
portx.y.z,portx.y.z
```

For example, to configure the same interface setting on **port1.0.1** and **port1.0.5**, enter the Global Configuration mode command:

```
awplus(config)#interface port1.0.1,port1.0.5
```

You can combine a hyphen-separated range and a comma-separated list. To configure the same setting on **port1.0.1** to **port1.0.3** and **port1.0.5**, enter the Global Configuration mode command:

```
awplus(config)#interface port1.0.1-port1.0.3,port1.0.5
```

Activating and deactivating switch ports

An active switch port is one that is available for packet reception and transmission. By default ports and VLANs are activated.

To deactivate (shutdown) a port or VLAN use the **shutdown** command. Use the **no** variant of this command to reactivate it.

Autonegotiation

Autonegotiation lets the port adjust its speed and duplex mode to accommodate the device connected to it. When the port connects to another autonegotiating device, they negotiate the highest possible speed and duplex mode for both of them.

By default, all ports autonegotiate. Setting the port to a fixed speed and duplex mode may be necessary when connecting to a device that cannot autonegotiate.

We recommend having autonegotiation enabled for link speeds of 1000 Mbps and above. For example, to apply a fixed speed of 1000 Mbps use the command, **speed auto 1000**.

Duplex mode

Ports can operate in full duplex or half duplex mode depending on the type of port it is. When in full duplex mode, a port transmits and receives data simultaneously. When in half duplex mode, the port transmits or receives but not both at the same time.

You can set a port to use either of these options, or allow it to autonegotiate the duplex mode with the device at the other end of the link. To configure the duplex mode, use these commands:

```
awplus#configure terminal
awplus(config)#interface port1.0.1
awplus(config-if)#duplex {auto|full|half}
```

Make sure that the configuration of the switch matches the configuration of the device at the far end of the link. In particular, avoid having one end autonegotiate duplex mode while the other end is fixed. For example, if you set one end of a link to autonegotiate and fix the other end at full duplex, the autonegotiating end cannot determine that the fixed end is full duplex capable. Therefore, the autonegotiating end selects half-duplex operation. This results in a duplex mismatch and packet loss. To avoid this, either fix the mode at both ends, or use autonegotiation at both ends.

Speed options

Before configuring a port's speed, check the hardware limit for the particular port type.

For the latest list of approved SFP transceivers either contact your authorized distributor or reseller, or visit alliedtelesis.com.

You can set a port to use one of multiple speed options, or allow it to autonegotiate the speed with the device at the other end of the link.

We recommend having autonegotiation enabled for link speeds of 1000 Mbps and above.

Configuring the port speed

To set port1.0.1 to auto-negotiate its speed at 1000 Mbps only, which will fix this port speed to 1000 Mbps, enter the following commands:

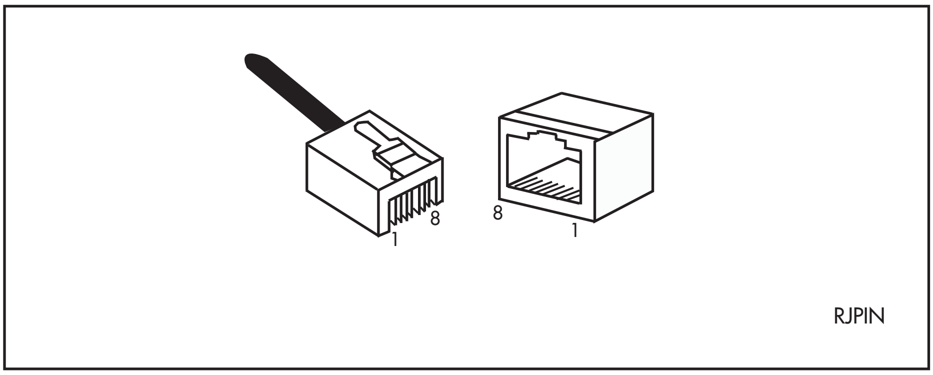
```
awplus#configure terminal
awplus(config)#interface port1.0.1
awplus(config-if)#speed auto 1000
```

MDI/MDIX connection modes

By default, copper 10Base-T, 100Base-T, and 1000Base-T ports on the switch automatically set the Media Dependant Interface mode to MDI or MDIX for successful physical connections. We recommend using this default setting. However, you can configure them to have either fixed MDI mode or fixed MDIX mode by using the polarity command. MDI/MDIX mode polarity does not apply to fiber ports.

Connections to 10BASE-T, 100BASE-T, and 1000BASE-T networks may either be straight though (MDI) or crossover (MDIX). The crossover connection can be achieved by using either a crossover cable or by integrating the crossover function within the device. In the latter situation, the connector is referred to as an MDIX connection. Refer to your switch's Installation Guide for more detailed information on physical connections cabling.

The IEEE 802.3 standard defines a series of Media Dependant Interface types and their physical connections. For twisted pair networking, the standard defines connectors that conform to the IEC 60603-7 standard. The following figure shows a connector of this type:



The Layer 2 Switching Process

The Layer 2 switching process comprises these related but separate processes:

- "The ingress rules" on page 8
- "The learning process" on page 11
- "The forwarding process" on page 12
- "The egress rules" on page 13

Here is a brief description for each of these processes:

- **Ingress rules** admit or discard frames based on their VLAN tagging.
- The **Learning process** learns the MAC addresses and VLAN membership of frames admitted on each port.
- The **Forwarding process** determines which ports the frames are forwarded to, and the Quality of Service priority with which they are transmitted.
- Finally, **Egress rules** determine for each frame whether VLAN tags are included in the Ethernet frames that are transmitted.

These processes assume that each station on the extended LAN has a unique Data Link Layer address, and that all data link layer frames have a header which includes the source (sender's) MAC address and destination (recipient's) MAC address.

The ingress rules

All frames, tagged and untagged, that a VLAN-aware switch receives must be classified into a VLAN. Each received frame is mapped to exactly one VLAN. If an incoming frame is tagged with a valid VLAN identifier (VID) then that VID is used. If an incoming frame is untagged or is priority tagged (a tagged frame with a VID of all zeros), then the switch uses internal VLAN association rules to determine the VLAN it belongs to.

Every port belongs to one or more VLANs so every incoming frame has a VID to show which VLAN it belongs to. The final part of the Ingress Rules depends on whether Ingress Filtering is enabled for the port. If Ingress Filtering is disabled, all frames are passed on to the Learning process, regardless of which VLAN they belong to. If Ingress Filtering is enabled (by default), frames are admitted only when they have the VID of a VLAN to which the port belongs. Frames are discarded when they do not have an associated VID matching the VLAN assigned to a port.

Ingress filtering cannot be disabled on IE200 Series switches. On these switches, frames are admitted only when they have the VID of a VLAN to which the port belongs. Frames are discarded when they do not have an associated VID matching a VLAN assigned to a port.

Determining the VLAN to associate with untagged (or priority tagged) frames

When a frame arrives at a port, and the frame does not carry a tag that specifies a VID, then the switch has to decide which VLAN to associate the frame with.

Depending on the configuration of the port, this decision might be trivial, or it might require evaluating a set of rules.

The possible association rules, in order of precedence, are:

- IP subnet/IPX network classification
- protocol classification
- port classification

The default VLAN classification is based upon the port on which the incoming frame (untagged, or priority tagged) was received. It is possible for an incoming untagged, or priority tagged, frame to match more than one of the association rules.

Let us consider a case where multiple VLANs have been configured on a switch, and see what happens when certain packets arrive at the port.

VLAN setup on the switch

The switch uses the following VLANs:

- ports 1 - 4 of the switch are untagged members of the port-based VLAN 2.
- ports 3 - 6 of the switch are untagged members of the subnet-based VLAN 3, which is configured for the subnet 192.168.1.0/255.255.255.0.
- port 4 is an untagged member of the protocol-based VLAN 4, which is configured for protocols IP and IPX.
- port 5 is a tagged member of VLAN 2.
- port 6 is a tagged member of VLAN 4.

This switch implementation also has the following rules:

1. Subnet-based VLANs take precedence over protocol-based VLANs, which take precedence over port-based VLANs.
2. If a tagged packet arrives at a port, it is only accepted if that port is a tagged member of the VLAN corresponding to the VID in the packet's tag.

Treatment of packets

Now let us look at certain packets arriving at the switch:

An untagged IPX packet arrives at port 1

Port 1 is **only** a member of VLAN 2, so the packet will be associated with VLAN 2. The switch will look at the forwarding table for VLAN 2. If the destination MAC address of the packet is in the forwarding table, the packet will be forwarded out the corresponding port in that table entry. If the destination MAC address is not in the forwarding table for VLAN 2, then the packet will be flooded out **all** other ports of VLAN 2. So, it will be sent as an untagged packet out ports 2-4, and as a tagged packet out port 5.

An untagged IP packet with source/dest IP address in the 192.168.1.0/ 255.255.255.0 subnet arrives at port 4

Port 4 is a member of a subnet-based VLAN 3 configured for the subnet 192.168.1.0/ 255.255.255.0. So, the packet will be associated to VLAN 3. The switch will look at the forwarding table for VLAN 3. If the destination MAC address of the packet is in the forwarding table, the packet will be forwarded out the corresponding port in that table entry.

If the destination MAC address is not in the forwarding table for VLAN 3, then the packet will be flooded out all other ports of VLAN 3. It will be sent as an untagged packet out ports 3, 5, and 6.

An untagged IP packet with source/dest IP address not in the 192.168.1.0/ 255.255.255.0 subnet arrives at port 4.

Port 4 is a member of a subnet-based VLAN 3 configured for the subnet 192.168.1.0/ 255.255.255.0, but the packet's addresses are not in that subnet. So, the packet will not be associated with VLAN 3.

The next VLAN type in the precedence order is the protocol-based VLAN. Port 4 is a member of the protocol-based VLAN 4, configured for IP and IPX. As this is an IP packet, it will be associated with VLAN 4.

The switch only has one other port in VLAN 4. The packet will be sent as a tagged packet out port 6.

An untagged AppleTalk packet arrives at port 4

The AppleTalk packet cannot be associated with the subnet-based or the protocol-based VLANs on port 4, so it must drop through to the port-based VLAN on port 4. So the packet is associated with VLAN 2. The switch will look at the forwarding table for VLAN 2. If the destination MAC address of the packet is in the forwarding table, the packet will be forwarded out the corresponding port in that table entry. If the destination MAC address is not in the forwarding table for VLAN 2, then the packet will be flooded out all other ports of VLAN 2. So, it will be sent as an untagged packet out ports 1-3, and as a tagged packet out port 5.

A tagged IPX packet arrives at port 4

Port 4 is an untagged member of the protocol-based VLAN 4, configured for IP and IPX. But, the packet is tagged, so it will be dropped.

A tagged packet with VID=10 arrives at port 5

Port 5 is a tagged member of VLAN 2. But the VID in the packet's tag does not match the VID of the VLAN (2), so the packet is dropped.

A tagged packet with VID=2 arrives at port 5

Port 5 is a tagged member of VLAN 2. The VID in the packet's tag matches the VID of the VLAN, so the packet is associated with VLAN 2.

The switch will look at the forwarding table for VLAN 2. If the destination MAC address of the packet is in the forwarding table, the packet will be forwarded out the corresponding port in that table entry. If the destination MAC address is not in the forwarding table for VLAN2, then the packet will be flooded out all other ports of VLAN 2. So, it will be sent as an untagged packet out ports 1-4.

Reasons why a Frame Might not be Accepted on a Port

- The port is in a spanning tree blocking or discarding state
- The port is blocked by storm control
- An ACL configured on the port drops the packet

Access and trunk modes

Each port on the switch can be configured to be one of two modes:

- only untagged frames - access mode
- VLAN-tagged frames - trunk mode

Access mode

This mode can be used to connect to VLAN unaware devices. Frames to and from access mode ports carry no VLAN tagging information.

Trunk mode

This mode is used to connect VLAN capable devices. All devices that connect using trunk mode ports must be VLAN aware.

A port in trunk mode is associated with one of more VLANs for which it will transmit and accept packets tagged with the VIDs of those VLANs.

You can specify a “native” VLAN on a trunk port. When the port receives untagged packets, it will tag the packets with the VID of the native VLAN. Note that packets from the native VLAN egress the port untagged.

To specify the native VLAN, use the **switchport trunk native vlan** command.

The learning process

The learning process uses an adaptive learning algorithm, sometimes called backward learning, to discover the location of each station on the extended LAN.

All frames admitted by the ingress rules on any port are passed on to the Layer 2 forwarding process when they are for destinations in the same VLAN. Frames destined for other VLANs are passed to a Layer 3 protocol, such as IP. For every frame admitted, the frame’s source MAC address and VID are compared with entries in the forwarding database for the VLAN (also known as a MAC Address table) maintained by the switch. When the frame’s source address is not in the forwarding database for the VLAN, the address is added and associated with the port on which the frame arrived, and an ageing timer for that entry is started. When the frame’s source address is already in the forwarding database, the ageing timer for that entry is restarted.

By default, switch learning is enabled. It can be disabled with the **no mac address-table acquire** command, and re-enabled using the **mac address-table acquire** command.

If the ageing timer for an entry in the forwarding database expires before another frame with the same source address is received, the entry is removed from the forwarding database. This prevents the forwarding database from being filled with information about stations that are inactive or have been disconnected from the network. It also ensures that entries for active stations are kept alive in the forwarding database.

By default, the ageing timer is enabled with a default ageing-time. The default for the MAC address-table ageing-time is 300 seconds (5 minutes) and can be modified by using the command **mac address-table ageing-time**. The **no mac address-table ageing-time** command will reset the ageing-time back to the default (5 minutes).

If switch learning is disabled and the ageing timer has aged out all dynamically learned filter entries, only statically entered MAC source addresses are present in the database. When the switch finds no matching entries in the forwarding database during the forwarding process, all switch ports in the VLAN are flooded with the packet, except the port that received it.

To set the mac address-table ageing-time to 1000 seconds:

awplus# `configure terminal`	Enter the config terminal mode
awplus(config)# `mac address-table ageing-time 1000`	Set the ageing time to 1000 seconds

To display general switch settings, including settings for switch learning and the switch ageing timer, use the **show system** command.

The forwarding process

After a VID is assigned to a frame using the ingress rules, the switch forwards it to the destination MAC address specified in the frame. To do this, the switch looks in the forwarding database (which has been populated by the learning process described above) and looks for an entry that relates to the packet's specific Destination MAC address and VID. Having found such an entry, the switch will forward the packet to the port associated with the entry. When an entry with the exact destination MAC address and VID is not found, the switch floods the frame on all ports that are members of the VLAN except the port on which the frame was received.

The forwarding database is indexed according to MAC address and VLAN identifier. This means a MAC address can appear more than once in the forwarding database having been learned on the same port but for different VLANs. This could occur for a number of reasons. For example, if a device is tagged in multiple VLANs, then it's MAC address will be associated with multiple VLANs. Or, if the ingress port has protocol-based and port-based classification rules, some packets from a given MAC might match the protocol classification rule, and some the port-based classification rules.

A frame might not actually be transmitted out the egress port, for a number of reasons:

- the destination port is in a spanning-tree blocking, discarding, listening, or learning state
- there is a static filter entry for the destination address set to discard (see "Layer 2 Filtering" on page 14). Otherwise, the frame is forwarded on the indicated port.
- storm control is currently blocking the port

The egress rules

After the forwarding process has determined from which ports and transmission queues to forward a frame to, the egress rules for each port determine whether the outgoing frame is VLAN-tagged with its numerical VLAN identifier (VID).

A port must belong to a VLAN at all times unless the port has been set as the mirror port for the switch.

A port can transmit VLAN-tagged frames for any VLAN to which the port belongs. A port can transmit untagged frames for any VLAN for which the port is configured, e.g. IP subnet-based or protocol-based, unless prevented by the port-based VLAN egress rules. A port that belongs to a port-based VLAN can transmit untagged packets for only one VLAN. For more information about VLANs and VLAN tagging, see the VLAN Feature Overview and Configuration Guide.

For more information on port tagging, see the following commands in your product's Command Reference:

- switchport mode access
- switchport mode trunk

The Command Reference is available on our website at alliedtelesis.com.

Layer 2 Filtering

Ingress filtering

The **ingress-filter** parameter of the **switchport mode trunk** command and the **switchport mode access** command enables or disables ingress filtering of frames entering the specified port (or port range).

Each port on the switch belongs to one or more VLANs. If ingress filtering is enabled, any frame received on the specified port is only admitted if its VID matches one for which the port is tagged. Any frame received on the port is discarded if its VID does not match one for which the port is tagged.

Untagged frames are admitted and are assigned the VLAN Identifier (VID) of the port's native VLAN. If a port is in trunk mode, and the native VLAN on the port has been explicitly set to none, and ingress filtering is enabled on the port, then untagged frames entering the port will be discarded. Ingress filtering can be turned off by setting the disable parameter of the above two commands. The default setting of the enable / disable parameter option is enable.

Ingress filtering cannot be disabled on IE200 Series switches. On these switches, any frame received on the specified port is only admitted if its VID matches one for which the port is tagged. Any frame received on the port is discarded if its VID does not match one for which the port is tagged.

Note: Enabling the **vlan-disable** parameter of the **thrash-limiting** command will also enable ingress filtering, and will override the setting of the switchport mode access, and trunk commands.

Discard entries in the MAC table

To explicitly prevent the Layer 2 forwarding of frames to certain MAC addresses on certain VLANs, it is possible to create static entries in the MAC table that have an action of Discard:

```
mac address-table static <mac-addr> discard interface <port> [vlan <vid>]
```

Storm Control

The packet storm-control feature enables you to set limits on the reception rate of broadcast, multicast frames and destination lookup failures. You can set separate limits beyond which each of the different packet types are discarded.

Note: A Destination Lookup Failure (DLF) is the event of receiving a unicast Ethernet frame with an unknown destination address.

Note: On most switches, it is possible to configure more than one limit type at a time.

For more information on applying storm-control, see the **storm-control level** command.

To apply storm-control by limiting broadcasts to 30% on **port1.0.4**:

awplus(config-if)# configure terminal	Enter Global Configuration mode.
awplus(config-if)# interface port1.0.4	Enter the Interface Configuration mode for the selected port.
awplus(config-if)# storm-control broadcast level 30	Configure the interface.

To turn off storm protection on **port1.0.4**:

awplus(config-if)# configure terminal	Enter Global Configuration mode.
awplus(config-if)# interface port1.0.4	Enter the Interface Configuration mode for the selected port.
awplus(config-if)# no storm-control broadcast level	Configure the interface.

Loop Protection

Loop protection is a general term that embraces several different methods you can apply to protect your network from effects such as broadcast storms that can result from data loops or equipment malfunction.

Two methods of loop protection are available in AlliedWare Plus:

- "Loop detection" on page 16
- "Thrash limiting" on page 17

Loop detection

Introduction

This feature is used to detect loops with a network segment. If a loop is detected then a selected protection mechanism is applied to limit the effect of the loop. The loop protection actions can be applied either to the port at which the loop is detected or to the VLAN within which the loop was detected.

Limiting actions

You can configure loop detection to apply one of the following mechanisms when a loop condition is detected:

- Block all traffic on the port (or aggregated link) that detected the loop, and take **down** the link.
- Block all traffic on the port (or aggregated link) that detected the loop, but keep the link in the **up** state.
- Block all traffic on a VLAN. Note that setting this parameter will also enable ingress filtering. This is the default action.
- Take no action, but log the details.
- Take no action.

Operation

To detect loops this feature operates by transmitting a series of Loop Detection Frames (LDFs) from each switch port out into the network. If no loops exist, then none of these frames should ever return. If a frame returns to its originating switch, the detection mechanism assumes that there is a loop somewhere in the network and offers a number of protective options.

Each LDF is a Layer 2 LLC frame that contains the following components:

- the source MAC address of the originating switch
- the destination MAC address of the non-existent end station 00-00-F4-27-71-01
- VLAN ID (where the port is a tagged member of a VLAN)
- a randomly generated LDF ID number

You can set the detection mechanism to remember the LDF ID of up to 5 of the most recently transmitted LDF frames. Each of the 5 most recently transmitted frames is compared with every frame that arrives at that same port.

Configuration

To enable loop protection and configure its basic parameters, you use the **loop-protection** command.

Example To enable the loop-detect mechanism, and generate loop-detect frames once every 5 seconds, use the command:

```
awplus(config)#loop-protection loop-detect ldf-interval 5
```

Note: LDFs are sent sequentially for each VLAN defined to a particular port. For example, if a particular port in this example is a member of 4 VLANs, then the LDFs will be sent from this port at the rate of 4 frames every 5 seconds.

You can now use the **loop-protection action** command configure the action that the switch will take if a loop is detected.

Example To disable an interface, and bring the link down, when a network loop is detected, use the command:

```
awplus(config-if)#loop-protection action link-down
```

Now decide how long you want the protective action to apply for. You configure this function by using the **loop-protection timeout** command.

Example To configure a loop protection action timeout of 10 seconds, use the command:

```
awplus(config-if)#loop-protection timeout 10
```

Example To configure a loop protection action delay time of 10 seconds, use the commands:

```
awplus(config-if)#loop-protection action-delay-time 10
```

Thrash limiting

MAC address thrashing occurs when MAC addresses move rapidly between one or more ports or trunks, for example, due to a network loop.

Thrash limiting enables you to apply actions to a port when thrashing is detected. It is supported on all port types and also on aggregated ports.

Limiting Actions

There are several different thrash actions that you can apply to a port when thrashing is detected. These actions are:

- **learnDisable**: MAC address learning is temporarily disabled on the port.
- **portDisable**: The port is logically disabled. Traffic flow is prevented, but the link remains up. The device at the other end does not notice that the port has changed status, and the link LEDs at both ends stay on.
- **linkDown**: The port is physically disabled and the link is down. This is equivalent to entering the **shutdown** command.
- **vlanDisable**: The port is disabled only for the VLAN on which thrashing has occurred. It can still receive and transmit traffic for any other VLANs of which it is a member.

When a MAC address is thrashing between two ports, one of these ports (the first to cross its thrashing threshold) is disabled. All other ports on the device will then have their threshold counters reset.

To set a thrash action for a port, use the **thrash-limiting** command.

To view the thrash action that is set for a port, use the **show interface switchport** command.

Re-enabling a port

When a port is disabled, either completely or for a specific VLAN, it remains disabled until it is manually re-enabled in any of the following ways:

- by using SNMP
- by rebooting the switch or stack
- by specifying a thrash timeout value along with the thrash action
- via the CLI

Support for Jumbo Frames

Jumbo frames are frames with more than 1500 bytes of payload. You can enable jumbo frame support on the switch to improve throughput and network utilization. Jumbo frame support allows you to put more data in each packet that the switch has to process.

Jumbo frame support for Layer 2 switched traffic

Once jumbo frame support is enabled, the maximum received packet size increases. See your device's datasheet for information about the maximum packet size.

The command to use to enable jumbo frame support varies between products, but is one of:

- **mru** <***mru-size***>
- **mru jumbo**
- **platform jumboframe**

To see which command your product supports, see the product's Command Reference on our website at alliedtelesis.com.

Note that on IE200 switches, and AR3050S and AR4050S AR-Series firewalls, we recommend having no more than two simultaneously running ports with jumbo frames enabled.

Jumbo frame support for Layer 3 switched traffic and control packets

Jumbo frames are supported for Layer 3 switched traffic and control packets from:

- version 5.5.1-0.1 SBx908 GEN2 and x950 Series switches
- version 5.5.1-1.1 x530 and GS980MX Series switches

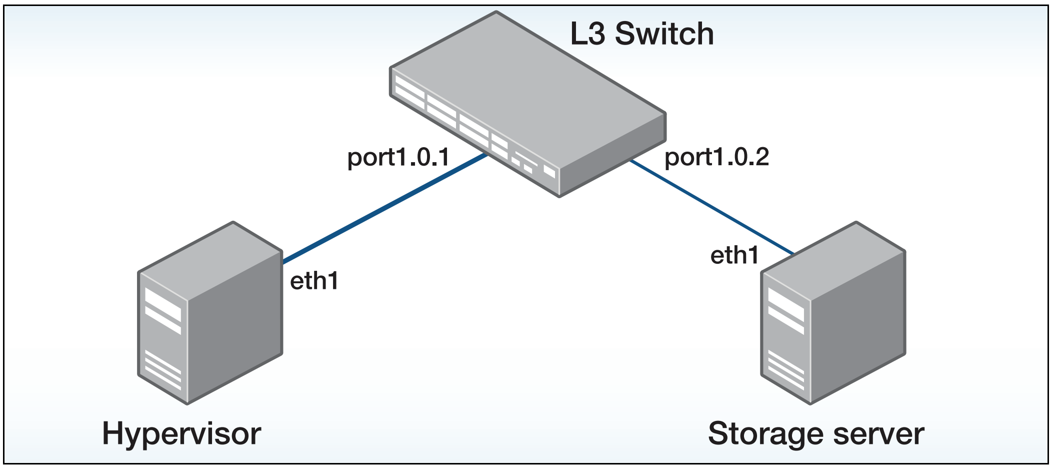
Jumbo frames for Layer 3 switching increases performance by reducing the amount of packet overhead relative to the amount of data transmitted.

Once jumbo frame support is configured for such traffic, the maximum packet size is 9216 bytes. This limit applies to both L3 switched traffic and control traffic that is processed by the switch's CPU.

To configure this, you need to:

- turn on jumbo frame support for Layer 2 traffic as above using the **mru** or **platform jumboframe** command for the required switchports, and
- increase the MTU value, using the **mtu** command for the required VLANs

For example, you could use jumbo frames in SAN (Storage Area Networks), which are dedicated networks used by servers to access block-level storage. SANs are typically seen in enterprise or commercial data center environments.



The configuration example below shows a configuration example if the L3 switch is an x950 Series switch:

```
interface port1.0.1
mru 9216
switchport
switchport mode access
switchport access vlan 101
!
interface vlan101
mtu 9216
ip address 192.168.1.1/24
ipv6 address 2001:db8:acad:1::1/64
!
interface port1.0.2
mru 9216
switchport
switchport mode access
switchport access vlan 102
!
interface vlan102
mtu 9216
ip address 192.168.2.1/24
ipv6 address 2001:db8:acad:2::1/64
```

The configuration example below shows a configuration example if the L3 switch is an x530 Series switch:

```
platform jumboframe
interface port1.0.1
switchport
switchport mode access
switchport access vlan 101
!
interface vlan101
mtu 9216
ip address 192.168.1.1/24
ipv6 address 2001:db8:acad:1::1/64
!
interface port1.0.2
switchport
switchport mode access
switchport access vlan 102
!
interface vlan102
mtu 9216
ip address 192.168.2.1/24
ipv6 address 2001:db8:acad:2::1/64
```

Port Security

The port security features provide administrators with MAC address-based control over which devices are allowed to be connected to switch ports.

These comprise:

- MAC address learn limits
- IEEE 802.1X

MAC address learn limits - switchport port-security

MAC address limiting is applied using the switchport port-security command. If enabled on a port or link aggregation group (LAG), the switch will learn MAC addresses up to a user-defined limit from 1 to 256, then lock out devices with any other MAC addresses.

For example, to enable port-security on port1.0.2, with a maximum of 1 MAC address, use the following commands:

```
awplus# configure terminal
awplus(config)# interface port1.0.2
awplus(config-if)# switchport port-security
awplus(config-if)# switchport port-security maximum 1
```

Important notes about LAG support

Note that:

- LAG support is available from AlliedWare Plus version 5.5.1-0.1 onwards. On earlier versions, you can only specify port-security for switch ports.
- On SBx81CFC960, port-security can be configured on a maximum of 30 aggregators.
- LAGs use the link local MAC address. On SBx81CFC960, x530, x530L, x320, and x220 Series switches, this address counts against the limit. On these switches, this means you need to allow port-security to learn the link local address as well as the MAC address of the devices you want to connect to the LAG. To do this, simply increase the limit by 1. For example, for a limit of 2 devices, set the limit to 3.

Static or dynamic operation

You can also configure static or dynamic operation.

Static operation

Any MAC address learned on a switch port or LAG will be statically installed into the MAC Address table. The addresses are also added to the device’s running configuration. Each entry then counts towards the maximum allowed addresses on the port, regardless of whether the device is still connected.

Use this if you want to allow only specific devices to access the port. For example, this can prevent a person from plugging an unauthorized laptop into your corporate LAN.

This is the default mode.

Dynamic operation

Any MAC addresses learned on a switch port or LAG will be dynamically installed into the MAC Address table. Unlike the static operation, no MAC addresses are added to the device's running configuration. If a device is disconnected, the 'Maximum MAC addresses' allowed on a port decreases by 1 (once the dynamic entry times out in the MAC Address table).

Use this if you want to allow only a limited number of devices to access the port, but you are not concerned about which specific devices have access. For example, this can prevent a person from plugging a switch into a port and creating an unauthorized internet cafe.

To use dynamic operation, enter the command switchport port-security aging:

```
awplus# configure terminal
awplus(config)# interface port1.0.2
awplus(config-if)# switchport port-security aging
```

Port-security violation modes

One of the following options can be specified for the action taken when an unknown MAC address is detected on a locked port:

- **Protect** - Discard the packet and take no further action. This is the default action.
- **Restrict** - Discard the packet and notify management with an SNMP trap.
- **Shutdown** - Discard the packet, notify management with an SNMP trap, and disable the port.

When modes restrict or shutdown are used, the administrator can also be alerted via an SNMP trap. To configure this, add the following command to the SNMP configuration:

```
awplus(config)# snmp-server enable trap nsm
```

For example, to enable port-security on port 1.0.2, with a maximum of 1, and the restrict option, use the following commands:

```
awplus# configure terminal
awplus(config)# interface port1.0.2
awplus(config-if)# switchport port-security
awplus(config-if)# switchport port-security maximum 1
awplus(config-if)# switchport port-security violation restrict
awplus(config-if)# exit
awplus(config)# snmp-server enable trap nsm
```

IEEE 802.1X

IEEE 802.1X restricts unauthenticated devices from connecting to the switch. After authentication is successful, traffic is allowed through the switch. For more information, see the AAA and Port Authentication Feature Overview and Configuration Guide.

Static MAC address

If a new MAC address is seen on a port with port security enabled and the MAC address is statically configured for another port, a violation is triggered. The maximum learn limit will be ignored and the specified intrusion action for the port will be carried out.

Extended hardware switching on x310 Series switches

From version 5.4.7-0.1 onwards, x310 Series switches can hardware-switch traffic to individual hosts in remote networks, if those remote networks are not covered by any routes in the hardware route table. This means the switch can hardware-switch to additional remote hosts when the hardware route table is full.

If the extended hardware switching is disabled (and in versions before 5.4.7-0.1), the switch processes traffic for each such host via the CPU every time it has to send traffic to the host. If the extended hardware switching is enabled, the switch only processes traffic via the CPU the first time it has to send traffic to the host. Then it copies the host into the switch's hardware host table and hardware-switches future traffic to it.

To enable the extended hardware switching, use the following command:

```
awplus(config)#fib cache-remote-host
```

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