SuperStack® 3
Switch 4200 Family Implementation Guide

Generic guide for units in the SuperStack 3 Switch 4200 Family:
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About This Guide

This guide describes the features of the units in the SuperStack® 3 Switch 4200 Family. It outlines how to use these features to optimize the performance of your network.

This guide is intended for the system or network administrator who is responsible for configuring, using, and managing the Switch. It assumes a working knowledge of local area network (LAN) operations and familiarity with communication protocols that are used to interconnect LANs.

ⓘ *For detailed descriptions of the web interface operations and the command line interface (CLI) commands that you require to manage the Switch please refer to the Management Interface Reference Guide supplied in HTML format on the CD-ROM that accompanies your Switch.*

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ⓘ *Please note that when this Guide states “the Switch”, this is a reference to all units in the SuperStack® 3 Switch 4200 Family.*

Conventions

Table 1 and Table 2 list conventions that are used throughout this guide.

Table 1 Notice Icons

Icon	Notice Type	Description
i	Information note	Information that describes important features or instructions
!	Caution	Information that alerts you to potential loss of data or potential damage to an application, system, or device
⚡	Warning	Information that alerts you to potential personal injury

Table 2 Text Conventions

Convention	Description
`Screen displays`	This typeface represents information as it appears on the screen.
`Syntax`	The word "syntax" means that you must evaluate the syntax provided and then supply the appropriate values for the placeholders that appear in angle brackets. Example: To change your password, use the following syntax: `system password <password>` In this example, you must supply a password for <password>.
`Commands`	The word "command" means that you must enter the command exactly as shown and then press Return or Enter. Commands appear in bold. Example: To display port information, enter the following command: **`bridge port detail`**
The words "enter" and "type"	When you see the word "enter" in this guide, you must type something, and then press Return or Enter. Do not press Return or Enter when an instruction simply says "type."
Keyboard key names	If you must press two or more keys simultaneously, the key names are linked with a plus sign (+). Example: Press Ctrl+Alt+Del
Words in *italics*	Italics are used to: ■ Emphasize a point. ■ Denote a new term at the place where it is defined in the text. ■ Identify menu names, menu commands, and software button names. Examples: From the *Help* menu, select *Contents*. Click *OK*.

Related Documentation

In addition to this guide, each Switch documentation set includes the following:

- *Getting Started Guide*

  This guide contains:

  - all the information you need to install and set up the Switch in its default state
  - information on how to access the management software to begin managing the Switch.

- *Management Interface Reference Guide*

  This guide contains information about the web interface operations and CLI (command line interface) commands that enable you to manage the Switch. It contains an explanation for each command and the different parameters available. It is supplied in HTML format on the CD-ROM that accompanies your Switch.

- *Management Quick Reference Guide*

  You can find this guide on the CD-ROM that accompanies your Switch. Supplied in PDF format, this guide contains:

  - A list of the features supported by the Switch
  - A summary of the web interface operations and CLI commands that enable you to manage the Switch.

- *Release Notes*

  These notes provide information about the current software release, including new features, modifications, and known problems.

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I Switch Features

1 SWITCH FEATURES OVERVIEW

This chapter contains introductory information about the SuperStack® 3 Switch management software and supported features. It covers the following topics:

- What is Management Software?
- Switch Features Explained

For detailed descriptions of the web interface operations and the command line interface (CLI) commands that you require to manage the Switch please refer to the Management Interface Reference Guide supplied supplied in HTML format on the CD-ROM that accompanies your Switch.

What is Management Software?

Your Switch can operate in its default state. However, to make full use of the features offered by the Switch, and to change and monitor the way it works, you have to access the management software that resides on the Switch. This is known as managing the Switch.

Managing the Switch can help you to improve its efficiency and therefore the overall performance of your network.

There are several different methods of accessing the management software to manage the Switch. These methods are explained in Chapter 3 of the Getting Started Guide that accompanies your Switch.

Switch Features Explained

The management software provides you with the capability to change the default state of some of the Switch features. This section provides a brief overview of these features — their applications are explained in more detail later in this guide.

For a list of the features supported by your Switch, please refer to the Management Quick Reference Guide supplied in PDF format on the CD-ROM that accompanies your Switch.

Automatic IP Configuration

By default the Switch tries to configure itself with IP information without requesting user intervention. It uses the following industry standard methods to allocate the Switch IP information:

- Dynamic Host Configuration Protocol (DHCP)
- Auto-IP — the Switch will configure itself with its default IP address 169.254.100.100 if it is operating in standalone mode, and/or no other Switches on the network have this IP address. If this default IP address is already in use on the network then the Switch detects this and configures itself with an IP address in the range 169.254.1.0 to 169.254.254.255.
- Bootstrap Protocol (BOOTP)

For ease of use, you do not have to choose between these three automatic configuration methods. The Switch tries each method in a specified order.

For more information about how the automatic IP configuration feature works, see Chapter 9 "Using Automatic IP Configuration".

Security

Your Switch has the following security features, which guard against unauthorized users connecting devices to your network:

- Network Login — controls user access at the network edge by blocking or unblocking access on a per-port basis.
- Rada (Radius Authenticated Device Access) — uses a device MAC address for authentication against a RADIUS server.
- Disconnect Unauthorized Device (DUD) — disables a port if an unauthorized device transmits data on it.

For more information about how the port security features work, see Chapter 10 "Making Your Network Secure".

Aggregated Links

Aggregated links are connections that allow devices to communicate using up to four links in parallel. On the Switch 4200 Family, aggregated links are supported on the 10/100/1000 Mbps ports and the GBIC or SFP ports. Aggregated links provide two benefits:

- They can potentially double, triple or quadruple the bandwidth of a connection.
- They can provide redundancy — if one link is broken, the traffic load can be shared amongst the remaining link(s).

Your Switch supports the IEEE 802.3ad Link Aggregation Control Protocol (LACP). This provides automatic, point-to-point redundancy between two devices (switch-to-switch or switch-to-server) that have full duplex connections operating at the same speed.

For more information about aggregated links, see Chapter 2 "Optimizing Bandwidth".

Auto-negotiation

Auto-negotiation allows ports to auto-negotiate port speed, duplex-mode (only at 10 Mbps and 100 Mbps) and flow control. When auto-negotiation is enabled (default), a port "advertises" its maximum capabilities — these capabilities are by default the parameters that provide the highest performance supported by the port.

For details of the auto-negotiation features supported by your Switch, please refer to the Management Quick Reference Guide supplied in PDF format on the CD-ROM that accompanies your Switch.

Ports operating at 1000 Mbps only support full duplex mode.

Duplex

Full duplex mode allows packets to be transmitted and received simultaneously and, in effect, doubles the potential throughput of a link.

Flow Control

All Switch ports support flow control, which is a mechanism that minimizes packet loss during periods of congestion on the network.

Flow control is supported on ports operating in half duplex mode, and is implemented using the IEEE 802.3x standard on ports operating in full duplex mode.

Smart Auto-sensing

Smart auto-sensing allows auto-negotiating multi-speed ports, such as 10/100 Mbps or 10/100/1000 Mbps, to monitor and detect high error rates, or problems in the "physical" interconnection to another port. The port reacts accordingly by tuning the link from its higher speed to the lower supported speed to provide an error-free connection to the network.

For more information about auto-negotiation and port capabilities, see Chapter 2 "Optimizing Bandwidth".

Multicast Filtering

Multicast filtering allows the Switch to forward multicast traffic to only the endstations that are part of a predefined multicast group, rather than broadcasting the traffic to the whole network.

The multicast filtering system supported by your Switch uses IGMP (Internet Group Management Protocol) snooping to detect the endstations in each multicast group to which multicast traffic should be forwarded.

For more information about multicast filtering, see Chapter 3 "Using Multicast Filtering".

Spanning Tree Protocol and Rapid Spanning Tree Protocol

Spanning Tree Protocol (STP) and Rapid Spanning Tree Protocol (RSTP) are bridge-based systems that makes your network more resilient to link failure and also provides protection from network loops — one of the major causes of broadcast storms.

STP allows you to implement alternative paths for network traffic in the event of path failure and uses a loop-detection process to:

- Discover the efficiency of each path.
- Enable the most efficient path.
- Disable the less efficient paths.
- Enable one of the less efficient paths if the most efficient path fails.

RSTP is an enhanced version of the STP feature and is enabled by default. RSTP can restore a network connection quicker than the STP feature. RSTP can detect if it is connected to a legacy device that only supports IEEE 802.1D STP and will automatically downgrade to STP on that particular port.

STP conforms to the IEEE 802.1D-1998 standard, and RSTP conforms to the IEEE 802.1w standard.

For more information about STP and RSTP, see Chapter 4 "Using Resilience Features".

Switch Database

The Switch Database is an integral part of the Switch and is used by the Switch to determine if a packet should be forwarded, and which port should transmit the packet if it is to be forwarded.

For more information about the Switch Database, see Chapter 5 "Using the Switch Database".

Traffic Prioritization

Traffic prioritization allows your network traffic to be prioritized to ensure that high priority data, such as time-sensitive and system-critical data is transferred smoothly and with minimal delay over a network.

Traffic prioritization ensures that high priority data is forwarded through the Switch without being delayed by lower priority data. Traffic prioritization uses the two traffic queues that are present in the hardware of the Switch to ensure that high priority traffic is forwarded on a different queue from lower priority traffic. High priority traffic is given preference over low priority traffic to ensure that the most critical traffic gets the highest level of service.

The traffic prioritization feature supported by your Switch using layer 2 information, is compatible with the relevant sections of the IEEE 802.1D/D17 standard (incorporating IEEE 802.1p).

For more information about 802.1D and traffic prioritization, see Chapter 6 "Using Traffic Prioritization".

Quality of Service

Traffic prioritization can be taken one step further by using the Quality of Service (QoS) feature. Quality of Service (QoS) enables you to specify service levels for different traffic classifications. This enables you to prioritize particular applications or traffic types.

The Switch uses a policy-based QoS mechanism. By default, all traffic is assigned the "normal" QoS policy profile. If needed, you can create other QoS policy profiles and apply them to different traffic types so that they have different priorities across the network.

For more information about Quality of Service, see Chapter 6 "Using Traffic Prioritization".

RMON

Remote Monitoring (RMON) is an industry standard feature for traffic monitoring and collecting network statistics. The Switch software continually collects statistics about the LAN segments connected to the Switch. If you have a management workstation with an RMON management application, the Switch can transfer these statistics to your workstation on request or when a pre-defined threshold is exceeded.

Event Notification

You can configure your Switch to send you notification when certain events occur. You can receive notification via email, SMS (Short Message Server), or pager.

For more information about RMON and Event Notification, see Chapter 7 "Status Monitoring and Statistics".

Broadcast Storm Control

Broadcast Storm Control is a system that monitors the level of broadcast traffic on that port. If the broadcast traffic level rises to a pre-defined number of frames per second (threshold), the broadcast traffic on the port is blocked until the broadcast traffic level drops below the threshold. This system prevents the overwhelming broadcast traffic that can result from network equipment which is faulty or configured incorrectly.

VLANs

A Virtual LAN (VLAN) is a flexible group of devices that can be located anywhere in a network, but which communicate as if they are on the same physical segment. With VLANs, you can segment your network without being restricted by physical connections — a limitation of traditional network design. As an example, with VLANs you can segment your network according to:

- Departmental groups
- Hierarchical groups
- Usage groups

For more information about VLANs, see Chapter 8 "Setting Up Virtual LANs".

Configuration Save and Restore

Configuration Save and Restore allows the configuration of your Switch to be saved as a file on a remote server, or to be restored onto the Switch from a remote file.

For further information about Configuration Save and Restore, see Chapter 11 "Using Switch Configuration Features".

2 OPTIMIZING BANDWIDTH

There are many ways you can optimize the bandwidth on your network and improve network performance. If you utilize certain Switch features you can provide the following benefits to your network and end users:

- Increased bandwidth
- Quicker connections
- Faster transfer of data
- Minimized data errors
- Reduced network downtime

For detailed descriptions of the web interface operations and the command line interface (CLI) commands that you require to manage the Switch please refer to the Management Interface Reference Guide supplied in HTML format on the CD-ROM that accompanies your Switch.

Port Features

The default state for all the features detailed below provides the best configuration for most users. *In normal operation, you do not need to alter the Switch from its default state.* However, under certain conditions you may wish to alter the default state of these ports, for example, if you want to force a port to operate at 10 Mbps.

Duplex

Full duplex allows packets to be transmitted and received simultaneously and, in effect, doubles the potential throughput of a link. Half duplex only allows packets to be transmitted or received at any one time.

To communicate effectively, both devices at either end of a link *must* use the same duplex mode. If the devices at both ends of a link support auto-negotiation, this is done automatically.

If the devices at both ends of a link do not support auto-negotiation, both ends must be manually set to full duplex or half duplex accordingly.

Ports operating at 1000 Mbps support full duplex mode only.

Flow Control

All Switch ports support flow control, which is a mechanism that minimizes packet loss during periods of congestion on the network. Packet loss is caused by one or more devices sending traffic to an already overloaded port on the Switch. Flow control minimizes packet loss by inhibiting the transmitting port from generating more packets until the period of congestion ends.

Flow control is supported on ports operating in half duplex mode, and is implemented using the IEEE 802.3x standard on ports operating in full duplex mode.

Auto-negotiation

Auto-negotiation allows ports to automatically determine the best port speed, duplex-mode (only at 10 Mbps and 100 Mbps) and flow control. When auto-negotiation is enabled (default), a port “advertises” its maximum capabilities — these capabilities are by default the parameters that provide the highest performance supported by the port.

You can modify the capabilities that a port "advertises" on a per port basis, dependent on the type of port.

You can disable auto-negotiation on all fixed ports on the Switch, or on a per port basis. You can also modify the capabilities that a port “advertises” on a per port basis, dependent on the type of port.

For auto-negotiation to work, ports at both ends of the link must be set to auto-negotiate.

GBIC or SFP ports do not support auto-negotiation of port speed.

If auto-negotiation is disabled, the ports will no longer operate in auto-MDIX mode. Therefore, if you wish to disable auto-negotiation you must ensure you have the correct type of cable, that is cross-over or straight-through, for the type of device you are connecting to. For more information on suitable cable types, please refer to the Getting Started Guide that accompanies your Switch.

Ports operating at 1000 Mbps support full duplex mode only.

Smart Auto-sensing

Smart auto-sensing allows auto-negotiating multi-speed ports, such as 10/100 Mbps or 10/100/1000 Mbps, to monitor and detect a high error rate on a link, or a problem in the “physical” interconnection to another port and react accordingly. In other words, auto-negotiation may “agree” upon a configuration that the cable cannot sustain; smart auto-sensing can detect this and adjust the link accordingly.

For example, smart auto-sensing can detect network problems, such as an unacceptably high error rate or a poor quality cable. If both ends of the link support 100/1000 Mbps auto-negotiation, then auto-sensing tunes the link to 100 Mbps to provide an error-free 100 Mbps connection to the network.

An SNMP Trap is sent every time a port is down-rated to a lower speed.

Conditions that affect smart auto-sensing:

- Smart auto-sensing will not operate on links that do not support auto-negotiation, or on links where one end is at a fixed speed. The link will reset to the higher speed of operation when the link is lost or the unit is power cycled.
- Smart auto-sensing can only be configured for the whole Switch and not on a per port basis.

GBIC or SFP ports do not support smart auto-sensing.

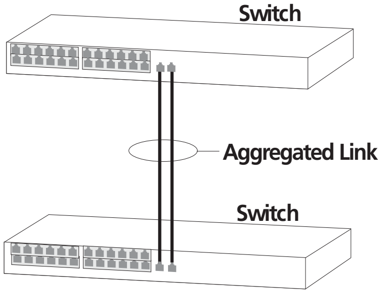
Aggregated Links

Aggregated links are connections that allow devices to communicate using up to four member links in parallel. Aggregated links are supported on the 10/100/1000BASE-T ports and GBIC or SFP ports. These parallel links provide two benefits:

- They can potentially double, triple or quadruple the bandwidth of a connection.
- They can provide redundancy — if one link is broken, the traffic load can be shared amongst the remaining link(s).

Figure 1 shows two Switches connected using an aggregated link containing two member links. If all ports on both Switch units are configured as 1000BASE-T and they are operating in full duplex, the potential maximum bandwidth of the connection is 2 Gbps.

Figure 1 Switch units connected using an aggregated link



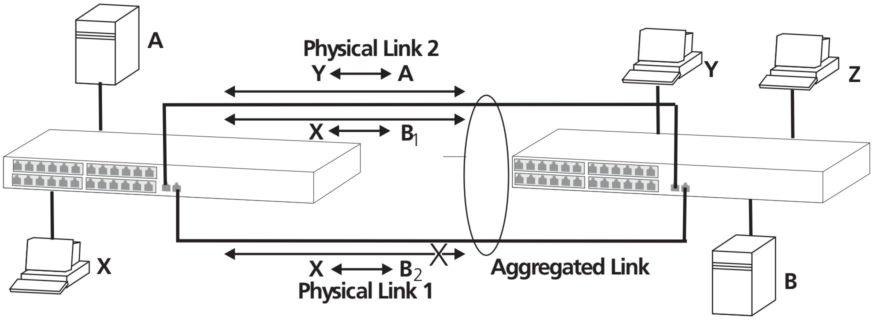
How 802.3ad Link Aggregation Operates

Your Switch supports IEEE 802.3ad standard aggregated links which uses the Link Aggregation Control Protocol (LACP). LACP provides automatic, point-to-point redundancy between two devices (switch-to-switch or switch-to-server) that have full duplex connections operating at the same speed.

By default, LACP is disabled on the 10/100/1000BASE-T and GBIC or SFP ports. If you enable LACP your Switch will detect if there is more than one connection to another device and will automatically create an aggregated link consisting of those links.

If a member link in an aggregated link fails, the traffic using that link is dynamically reassigned to the remaining member links in the aggregated link. Figure 2 shows the simplest case: two member links, that is the physical links, form an aggregated link. In this example, if link 1 fails, the data flow between X and B is remapped to physical link 2. The re-mapping occurs as soon as the Switch detects that a member link has failed — almost instantaneously. As a result, aggregated link configurations are extremely resilient and fault-tolerant.

Figure 2 Dynamic Reassignment of Traffic Flows



The key benefits of 802.3ad link aggregation are:

- Automatic configuration — network management does not need to be used to manually aggregate links.
- Rapid configuration and reconfiguration.
- Compatibility — non-802.3ad devices can interoperate with a 802.3ad enabled devices. However, you will need to manually configure the aggregated links as LACP will not be able to automatically detect and form an aggregation.
- The operation of 802.3ad can be configured and managed via network management.

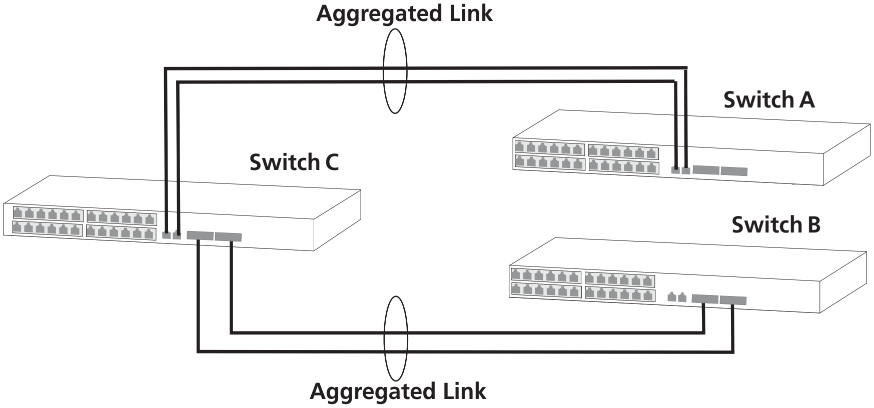
Implementing 802.3ad Aggregated Links

LACP can be enabled or disabled on a per port basis. You can implement 802.3ad aggregated links in three ways:

- Manual Aggregations — You can manually add and remove ports to and from an aggregated link via Web or CLI commands. However, if a port has LACP enabled, if a more appropriate or correct automatic membership is detected by LACP, it will override the manual configuration.

  For example, in Figure 3, if a port on Switch C is physically connected to Switch B, but you manually configure the port on Switch C to be a member of an aggregated link for Switch A in error, LACP (if it is enabled) will detect this and place the port in the aggregated link for Switch B, thus overriding the manual configuration.

Figure 3 Aggregated — Link Example



- LACP Pre-Configured Aggregations — If you need to know which aggregated link is associated with which device in your network you can use a LACP pre-configured aggregation. This allows you to manually configure the MAC address of a particular partner device (called the partner ID) against a specified aggregated link. LACP will then automatically determine the port membership for that aggregated link.

  The aggregated link may be manually configured with appropriate configuration settings, such as VLAN membership, to match the partner device.

- LACP Automatic Aggregations — If LACP detects at least two active ports sharing the same partner device, and if no matching pre-configured aggregated links exist, LACP will automatically assign a free un-configured aggregated link to form an aggregated link with the partner device. The aggregated link will inherit its configuration from the first port originally detected against the partner device.

  If you have an existing single port connection between two devices, this automatic behavior allows quick and easy addition of extra bandwidth by simply adding an extra physical link between the units.

The Spanning Tree costs for a port running LACP is the cost assigned for an aggregated link running at that speed. As required by the IEEE 802.3ad standard, no changes in cost are made according to the number of member links in the aggregated link.

By default LACP is disabled on all 10/100/1000BASE-T and GBIC or SFP Switch ports.

Aggregated Links and Your Switch

When any port is assigned to an aggregated link (either manually or via LACP) it will adopt the configuration settings of the aggregated link. When a port leaves an aggregated link its original configuration settings are restored.

A maximum of four active aggregated links can be created. A maximum of four ports may be added manually to any individual aggregation, but any number may join automatically via LACP. There are however a few points to consider:

- When creating an aggregation between two systems, the ports in the aggregation must not be physically connected together until the aggregation has been correctly configured at both ends of the link. Failure to configure the aggregation at both ends before physically connecting the ports can result in a number of serious network issues such as lost packets and network loops.
- If multiple links are connected between a unit and more than four other devices, only four of the devices will be assigned to aggregated links. The remaining devices will each only have one link made active, that is, passing data. All other links will be made inactive to prevent loops occurring.

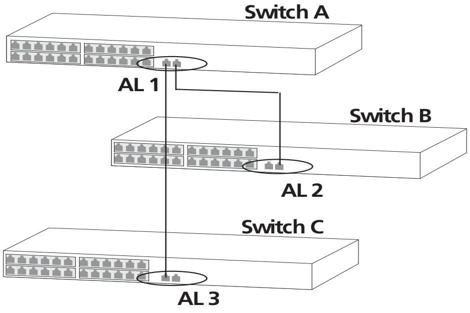
  LACP detects if one of the existing four aggregated links is removed and will then automatically assign one of the remaining devices to the aggregated link that has become free.
- When multiple links of different speed connect two devices only the highest speed links will be aggregated. The other links will be held in a standby state until there is a problem with a higher speed link(s). The lower speed link(s) will then become active.
- Note that the port security must be disabled on any port that is to become part of an aggregated link. It is not possible to configure this feature on a port that is a member of an aggregated link, and vice versa.
- A LinkUp / LinkDown trap will only be sent for individual links. The Traps will not be sent for an aggregation.

When setting up an aggregated link, note that:

- The ports at both ends of a member link must be configured as members of an aggregated link, if you are manually configuring aggregated links.
- A member link port can only belong to one aggregated link.

- The member link ports can have different port configurations within the same aggregated link, that is, auto-negotiation, port speed, and duplex mode. However, please note the following:
  - To be an active participant in an aggregated link the member link ports must operate in full duplex mode. (If a member link port does not operate in full duplex mode it can still be a member of an aggregated link but it will never be activated.)
  - If ports of a different speed are aggregated together, the higher speed links carry the traffic. The lower speed links only carry the traffic if the higher speed links fail.
- Member links must retain the same groupings at both ends of an aggregated link. For example, the configuration in Figure 4 will not work as Switch A has one aggregated link defined whose member links are then split between two aggregated links defined on Switches B and C. Note that this illegal configuration could not occur if LACP is enabled.

Figure 4 An illegal aggregated link configuration



To make this configuration work you need to have two aggregated links defined on Switch A, one containing the member links for Switch B and the other containing those for Switch C.

When using an aggregated link, note that:

- To gather statistics about an aggregated link, you must add together the statistics for each port in the aggregated link.
- If you wish to disable a single member link of an aggregated link, you must first physically remove the connection to ensure that you do not lose any traffic, before you disable both ends of the member link

separately. If you do this, the traffic destined for that link is distributed to the other links in the aggregated link.

If you do not remove the connection and only disable one end of the member link port, traffic is still forwarded to that port by the aggregated link port at the other end. This means that a significant amount of traffic may be lost.

- Before removing all member links from an aggregated link, you must disable all the aggregated link member ports or disconnect all the links, except one — if you do not, a loop may be created.

Traffic Distribution and Link Failure on Aggregated Links

To maximize throughput, all traffic is distributed across the individual links that make up an aggregated link. Therefore, when a packet is made available for transmission down an aggregated link, a hardware-based traffic distribution mechanism determines which particular port in the link should be used; this mechanism uses the MAC address. The traffic is distributed among the member links as efficiently as possible.

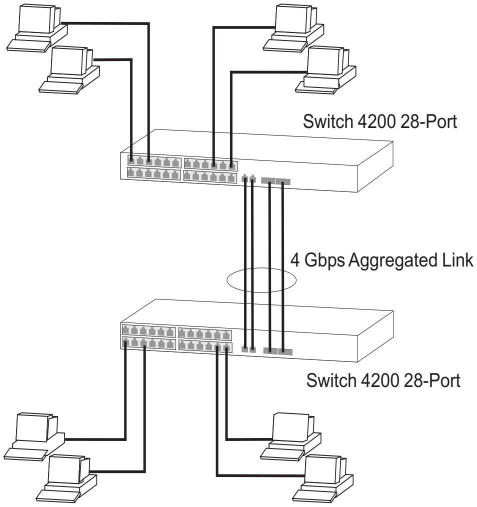
To avoid the potential problem of out-of-sequence packets (or "packet re-ordering"), the Switch ensures that all the conversations between a given pair of endstations will pass through the same port in the aggregated link. Single-to-multiple endstation conversations, on the other hand, may still take place over different ports.

If the link state on any of the ports in an aggregated link becomes inactive due to link failure, then the Switch will automatically redirect the aggregated link traffic to the remaining ports. Aggregated links therefore provide built-in resilience for your network.

Aggregated Link Example

The example shown in Figure 5 illustrates an 4 Gbps aggregated link between two Switch units.

Figure 5 A 4 Gbps aggregated link between two Switch units



To set up this configuration:

1. Add the 1000BASE-T ports on the upper unit to the aggregated link.
2. Add the 1000BASE-T ports on the lower unit to the aggregated link.
3. Add the SFP ports on the upper unit to the aggregated link.
4. Add the SFP ports on the lower unit to the aggregated link.
5. Connect the 1000BASE-T port marked ‘Up’ on the upper Switch to the 1000BASE-T port marked ‘Up’ on the lower Switch.
6. Connect the 1000BASE-T port marked ‘Down’ on the upper Switch to the 1000BASE-T port marked ‘Down’ on the lower Switch.
7. Connect the SFP port marked ‘27’ on the upper Switch to the SFP port marked ‘27’ on the lower Switch.
8. Connect the SFP port marked ‘28’ on the upper Switch to the SFP port marked ‘28’ on the lower Switch.

3 USING MULTICAST FILTERING

Multicast filtering improves the performance of networks that carry multicast traffic.

This chapter explains multicasts, multicast filtering, and how multicast filtering can be implemented on your Switch. It covers the following topics:

- What is an IP Multicast?
- Multicast Filtering
- IGMP Multicast Filtering

For detailed descriptions of the web interface operations and the command line interface (CLI) commands that you require to manage the Switch please refer to the Management Interface Reference Guide supplied in HTML format on the CD-ROM that accompanies your Switch.

What is an IP Multicast?

A *multicast* is a packet that is intended for “one-to-many” and “many-to-many” communication. Users explicitly request to participate in the communication by joining an endstation to a specific multicast group. If the network is set up correctly, a multicast can only be sent to an endstation or a subset of endstations in a LAN, or VLAN, that belong to the relevant multicast group.

Multicast group members can be distributed across multiple subnetworks; thus, multicast transmissions can occur within a campus LAN or over a WAN. In addition, networks that support IP multicast send only *one* copy of the desired information across the network until the delivery path that reaches group members diverges. It is only at these points that multicast packets are replicated and forwarded, which makes efficient use of network bandwidth.

A multicast packet is identified by the presence of a multicast group address in the destination address field of the packet's IP header.

Benefits of Multicast

The benefits of using IP multicast are that it:

- Enables the simultaneous delivery of information to many receivers in the most efficient, logical way.
- Reduces the load on the source (for example, a server) because it does not have to produce multiple copies of the same data.
- Makes efficient use of network bandwidth and scales well as the number of participants or collaborators expands.
- Works with other IP protocols and services, such as Quality of Service (QoS).

There are situations where a multicast approach is more logical and efficient than a unicast approach. Application examples include distance learning, transmitting stock quotes to brokers, and collaborative computing.

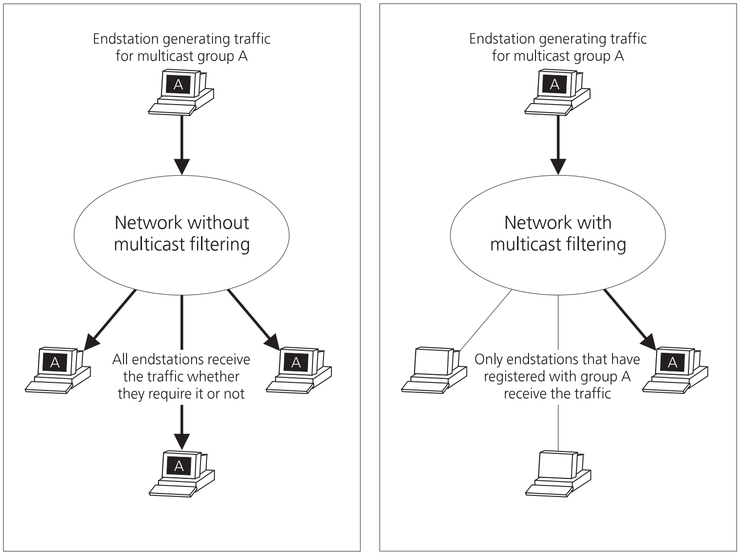
A typical use of multicasts is in video-conferencing, where high volumes of traffic need to be sent to several endstations simultaneously, but where broadcasting that traffic to all endstations would seriously reduce network performance.

Multicast Filtering

Multicast filtering is the process that ensures that endstations only receive multicast traffic if they register to join specific multicast groups. With multicast filtering, network devices only forward multicast traffic to the ports that are connected to registered endstations.

Figure 6 shows how a network behaves without multicast filtering and with multicast filtering.

Figure 6 The effect of multicast filtering


Endstation generating traffic for multicast group A
A
Network without multicast filtering
A
All endstations receive the traffic whether they require it or not
A
A
Endstation generating traffic for multicast group A
A
Network with multicast filtering
Only endstations that have registered with group A receive the traffic
A

Multicast Filtering and Your Switch

Your Switch provides automatic multicast filtering support using IGMP (Internet Group Management Protocol) Snooping. It also supports IGMP query mode.

Snooping Mode

Snooping Mode allows your Switch to forward multicast packets only to the appropriate ports. The Switch “snoops” on exchanges between endstations and an IGMP device, typically a router, to find out the ports that wish to join a multicast group and then sets its filters accordingly

Query Mode

Query mode allows the Switch to function as the Querier if it has the lowest IP address in the subnetwork to which it belongs.

IGMP querying is disabled by default on the Switch 4200 Family. This helps prevent interoperability issues with core products that may not follow the lowest IP address election method.

You can enable or disable IGMP query mode for all Switch units in the stack using the `queryMode` command on the command line interface IGMP menu.

You would enable query mode if you wish to run multicast sessions in a network that does not contain any IGMP routers (or queriers). This command will configure the Switch 4200 Series to automatically negotiate with compatible devices on VLAN 1 to become the querier.

The Switch 4200 Family is compatible with any device that conforms to the IGMP v2 protocol.

IGMP Multicast Filtering

IGMP is the system that all IP-supporting network devices use to register endstations with multicast groups. It can be used on all LANs and VLANs that contain a multicast capable IP router and on other network devices that support IP.

IGMP multicast filtering works as follows:

1. The IP router (or querier) periodically sends *query* packets to all the endstations in the LANs or VLANs that are connected to it.

   If your network has more than one IP router, then the one with the lowest IP address becomes the querier. The Switch can be the IGMP querier and will become so if its own IP address is lower than that of any other IGMP queriers connected to the LAN or VLAN. However, as the Switch only has an IP address on its default VLAN, the Switch will only ever query on the default VLAN (VLAN1). Therefore, if there are no other queriers on other VLANs, the IP multicast traffic will not be forwarded on them.
2. When an IP endstation receives a query packet, it sends a *report* packet back that identifies the multicast group that the endstation would like to join.
3. When the report packet arrives at a port on a Switch with *IGMP multicast learning* enabled, the Switch learns that the port is to forward traffic for the multicast group and then forwards the packet to the router.
4. When the router receives the report packet, it registers that the LAN or VLAN requires traffic for the multicast groups.
5. When the router forwards traffic for the multicast group to the LAN or VLAN, the Switch units only forward the traffic to ports that received a report packet.

Enabling IGMP Multicast Learning

You can enable or disable multicast learning and IGMP querying using the `snoopMode` command on the CLI or the web interface. For more information about enabling IGMP multicast learning, please refer to the

Management Interface Reference Guide supplied on your Switch CD-ROM.

If IGMP multicast learning is not enabled then IP multicast traffic is always forwarded, that is, it floods the network.

For information about configuring IGMP functionality on an endstation, refer to the user documentation supplied with your endstation or the endstation's Network Interface Card (NIC).

4 USING RESILIENCE FEATURES

Setting up resilience on your network helps protect critical links against failure, protects against network loops, and reduces network downtime to a minimum.

This chapter explains the features supported by the Switch that provide resilience for your network. It covers the following topics:

- Spanning Tree Protocol (STP)
- Rapid Spanning Tree Protocol (RSTP) — an enhanced version of the STP feature.

For detailed descriptions of the web interface operations and the command line interface (CLI) commands that you require to manage the Switch please refer to the Management Interface Reference Guide supplied in HTML format on the CD-ROM that accompanies your Switch.

Spanning Tree Protocol (STP)

The Spanning Tree Protocol (STP) makes your network more resilient to link failure and also provides a protection from loops — one of the major causes of broadcast storms. STP is enabled by default on your Switch.

To be fully effective, STP must be enabled on all Switches in your network.

RSTP provides the same functionality as STP. For details on how the two systems differ, see "How RSTP Differs to STP" on page 45.

The following sections explain more about STP and the protocol features supported by your Switch. They cover the following topics:

- What is STP?
- How STP Works
- Using STP on a Network with Multiple VLANs

The protocol is a part of the IEEE 802.1D bridge specification. To explain STP more effectively, your Switch will be referred to as a bridge.

Rapid Spanning Tree Protocol (RSTP)

The Rapid Spanning Tree (RSTP) is an enhanced Spanning Tree feature. RSTP implements the Spanning Tree Algorithm and Protocol, as defined in the IEEE 802.1w standard. RSTP is enabled by default.

3Com recommends that you use the Rapid Spanning Tree Protocol feature (enabled by default) to provide optimum performance for your network and ease of use.

Some of the benefits of RSTP are:

- Faster determination of the Active Spanning Tree topology throughout a bridged network.
- Support for bridges with more than 256 ports.
- Support for Fast-Forwarding configuration of edge ports provided by the 'Fast Start' feature. Fast Start allows a port that is connected to an endstation to begin forwarding traffic after only four seconds; this “Auto” setting is default for front panel ports. During these four seconds RSTP (or STP) will detect any misconfiguration that may cause a temporary loop and react accordingly.

  If you have Fast Start disabled on a port, the Switch will wait for 30 seconds before RSTP (or STP) lets the port forward traffic. If you set Fast Start to “Enable” mode, ports enter the forwarding mode immediately after becoming active. This mode should be used for ports connected to edge devices in an AppleTalk network.
- Easy deployment throughout a legacy network, through backward compatibility:
  - it will default to sending 802.1D style BPDU's on a port if it receives packets of this format.
  - it is possible for some ports on a Switch to operate in RSTP (802.1w) mode, and other ports, for example those connected to a legacy Switch, to operate in STP (802.1D) mode.
  - you have an option to force your Switch to use the legacy 802.1D version of Spanning Tree, if required.

What is STP?

STP is a bridge-based system that allows you to implement parallel paths for network traffic and uses a loop-detection process to:

- Find and disable the less efficient paths (that is, the paths that have a lower bandwidth).
- Enable one of the less efficient paths if the most efficient path fails.

RSTP provides the same functionality as STP. For details on how the two systems differ, see "How RSTP Differs to STP" on page 45.

As an example, Figure 7 shows a network containing three LAN segments separated by three bridges. With this configuration, each segment can communicate with the others using two paths. Without STP enabled, this configuration creates loops that cause the network to overload.

Figure 7 A network configuration that creates loops

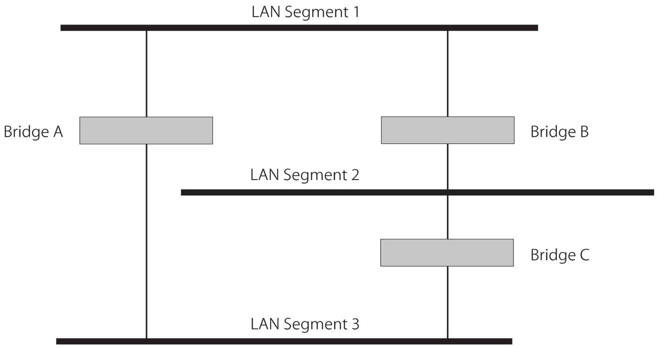
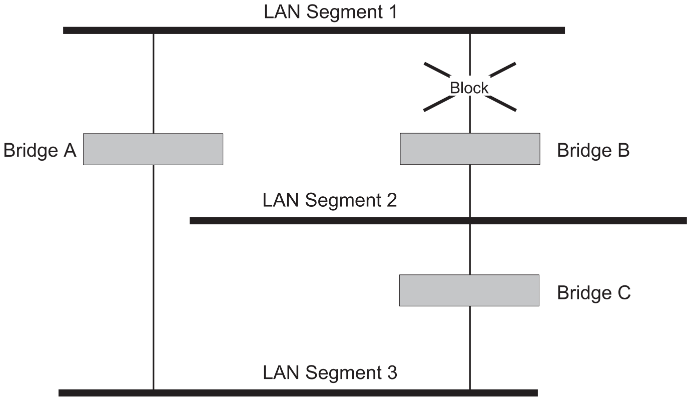


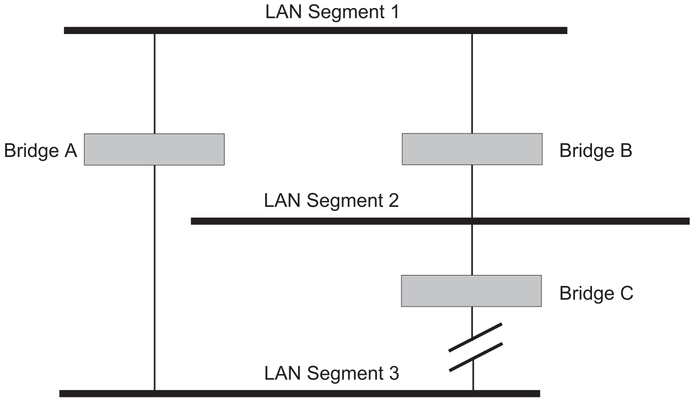
Figure 8 shows the result of enabling STP on the bridges in the configuration. STP detects the duplicate paths and prevents, or *blocks*, one of them from forwarding traffic, so this configuration will work satisfactorily. STP has determined that traffic from LAN segment 2 to LAN segment 1 can only flow through Bridges C and A, because, for example, this path has a greater bandwidth and is therefore more efficient.

Figure 8 Traffic flowing through Bridges C and A



If a link failure is detected, as shown in Figure 9, the STP process reconfigures the network so that traffic from LAN segment 2 flows through Bridge B.

Figure 9 Traffic flowing through Bridge B



STP determines which is the most efficient path between each bridged segment and a specifically assigned reference point on the network. Once the most efficient path has been determined, all other paths are blocked. Therefore, in Figure 7, Figure 8, and Figure 9, STP initially determined that the path through Bridge C was the most efficient, and so blocked the path through Bridge B. After the failure of Bridge C, STP re-evaluated the situation and opened the path through Bridge B.

How STP Works

When enabled, STP determines the most appropriate path for traffic through a network. It does this as outlined in the sections below.

STP Requirements

Before it can configure the network, the STP system requires:

- Communication between all the bridges. This communication is carried out using Bridge Protocol Data Units (BPDUs), which are transmitted in packets with a known multicast address.
- Each bridge to have a Bridge Identifier. This specifies which bridge acts as the central reference point, or Root Bridge, for the STP system — the lower the Bridge Identifier, the more likely the bridge is to become the Root Bridge. The Bridge Identifier is calculated using the MAC address of the bridge and a priority defined for the bridge. The default priority of your Switch is 32768.
- Each port to have a cost. This specifies the efficiency of each link, usually determined by the bandwidth of the link — the higher the cost, the less efficient the link. Table 3 shows the default port costs for a Switch.

Table 3 Default port costs

Port Speed	Link Type	Path Cost 802.1D-1998	Path Cost 802.1w
10 Mbps	Half Duplex	100	2,000,000
	Full Duplex	95	1,999,999
	Aggregated Link	90	1,000,000*
100 Mbps	Half Duplex	19	200,000
	Full Duplex	18	199,999
	Aggregated Link	15	100,000*
1000 Mbps	Full Duplex	4	20,000
	Aggregated Link	3	10,000*

* This path cost is correct where there are two ports in an aggregated link. However, if there are more ports in the aggregated link, the path cost will be proportionately lower. For example, if there are four ports in the aggregated link, the 802.1w path costs will be: 500,000 for 10 Mbps, 50,000 for 100 Mbps, and 5,000 for 1000 Mbps. The 802.1D-1998 path cost values are not affected by the number of ports in an aggregated link.

STP Calculation

The first stage in the STP process is the calculation stage. During this stage, each bridge on the network transmits BPDUs that allow the system to work out:

- The identity of the bridge that is to be the Root Bridge. The Root Bridge is the central reference point from which the network is configured.
- The Root Path Costs for each bridge — that is, the cost of the paths from each bridge to the Root Bridge.
- The identity of the port on each bridge that is to be the Root Port. The Root Port is the one that is connected to the Root Bridge using the most efficient path, that is, the one that has the lowest Root Path Cost. Note that the Root Bridge does not have a Root Port.
- The identity of the bridge that is to be the Designated Bridge of each LAN segment. The Designated Bridge is the one that has the lowest Root Path Cost from that segment. Note that if several bridges have the same Root Path Cost, the one with the lowest Bridge Identifier becomes the Designated Bridge.

  All traffic destined to pass in the direction of the Root Bridge flows through the Designated Bridge. The port on this bridge that connects to the segment is called the Designated Bridge Port.

STP Configuration

After all the bridges on the network have agreed on the identity of the Root Bridge, and have established the other relevant parameters, each bridge is configured to forward traffic only between its Root Port and the Designated Bridge Ports for the respective network segments. All other ports are blocked, which means that they are prevented from receiving or forwarding traffic.

STP Reconfiguration

Once the network topology is stable, all the bridges listen for Hello BPDUs transmitted from the Root Bridge at regular intervals. If a bridge does not receive a Hello BPDU after a certain interval (the Max Age time), the bridge assumes that the Root Bridge, or a link between itself and the Root Bridge, has gone down. The bridge then reconfigures the network to cater for the change. If you have configured an SNMP trap destination, when the topology of your network changes, the first bridge to detect the change sends out an SNMP trap.

⚠ ***CAUTION:*** *Network loops can occur if aggregated links are manually configured incorrectly, that is, the physical connections do not match the assignment of ports to an aggregated link. RSTP and STP may not detect these loops. So that RSTP and STP can detect all network loops you must ensure that all aggregated links are configured correctly.*

How RSTP Differs to STP

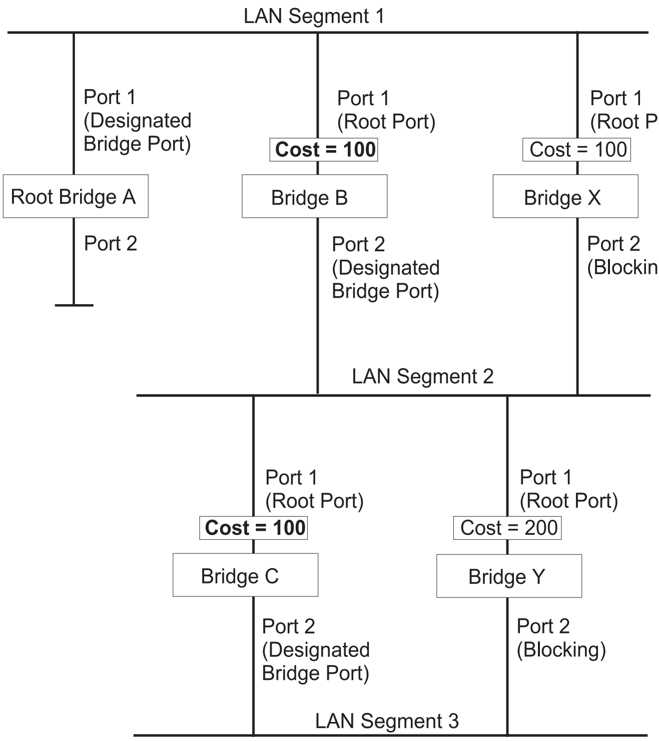
RSTP works in a similar way to STP, but it includes additional information in the BPDUs. This information allows each bridge to confirm that it has taken action to prevent loops from forming when it wants to enable a link to a neighbouring bridge. This allows adjacent bridges connected via point-to-point links to enable a link without having to wait to ensure all other bridges in the network have had time to react to the change.

So the main benefit of RSTP is that the configuration decision is made locally rather than network-wide which is why RSTP can carry out automatic configuration and restore a link faster than STP.

STP Example

Figure 10 shows a LAN that has STP enabled. The LAN has three segments, and each segment is connected using two possible links.

Figure 10 Port costs in a network



- Bridge A has the lowest Bridge Identifier in the network, and has therefore been selected as the Root Bridge.

- Because Bridge A is the Root Bridge, it is also the Designated Bridge for LAN segment 1. Port 1 on Bridge A is therefore selected as the Designated Bridge Port for LAN Segment 1.
- Port 1 of Bridges B, C, X and Y have been defined as Root Ports because they are the nearest to the Root Bridge and therefore have the most efficient path.
- Bridges B and X offer the same Root Path Cost for LAN segment 2, however, Bridge B has been selected as the Designated Bridge for the segment because it has a lower Bridge Identifier. Port 2 on Bridge B is therefore selected as the Designated Bridge Port for LAN Segment 2.
- Bridge C has been selected as the Designated Bridge for LAN segment 3, because it offers the lowest Root Path Cost for LAN Segment 3:
    - the route through Bridges C and B costs 200 (C to B=100, B to A=100)
    - the route through Bridges Y and B costs 300 (Y to B=200, B to A=100).

  Port 2 on Bridge C is therefore selected as the Designated Bridge Port for LAN Segment 3.

STP Configurations

Figure 11 shows three possible STP configurations using SuperStack 3 Switch units.

- **Configuration 1 — Redundancy for Backbone Link**

  In this configuration, the Switches both have STP enabled and are connected by two links. STP discovers a duplicate path and blocks one of the links. If the enabled link breaks, the disabled link becomes re-enabled, therefore maintaining connectivity.

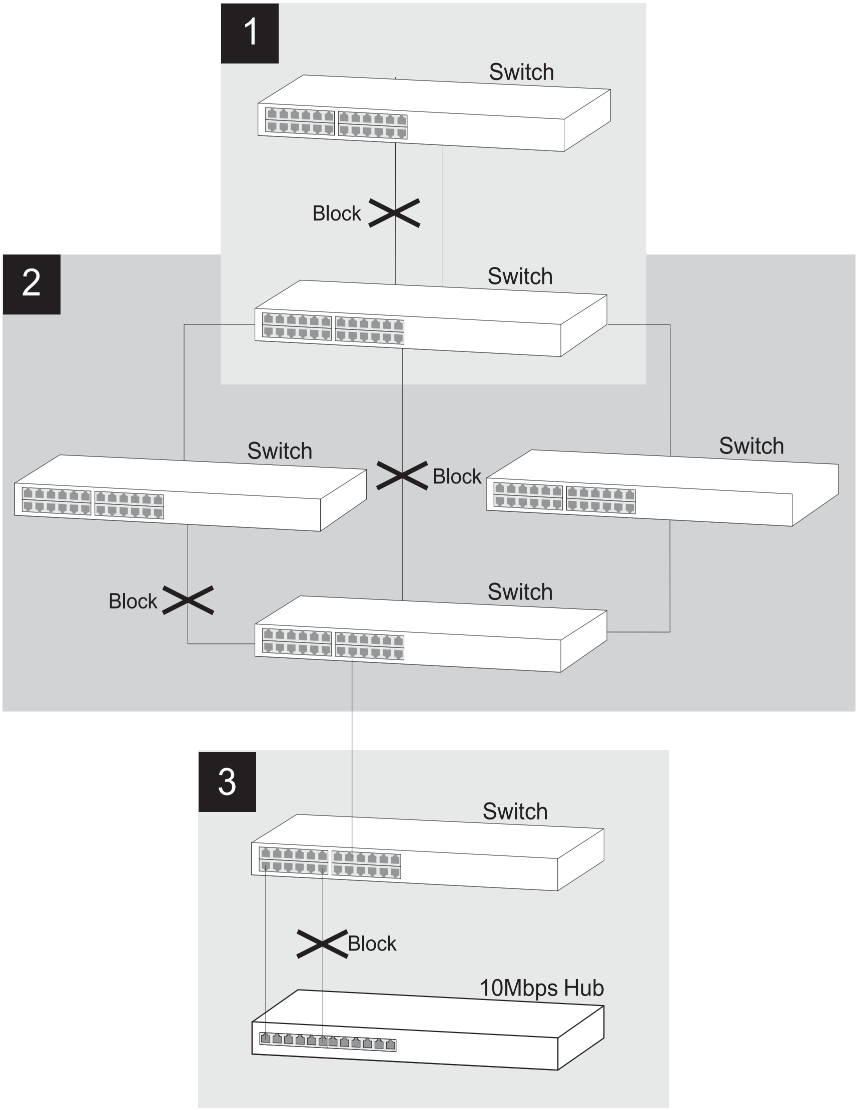
- **Configuration 2 — Redundancy through Meshed Backbone**

  In this configuration, four Switch units are connected in a way that creates multiple paths between each one. STP discovers the duplicate paths and blocks two of the links. If an enabled link breaks, one of the disabled links becomes re-enabled, therefore maintaining connectivity.

- **Configuration 3 — Redundancy for Cabling Error**

  In this configuration, a Switch has STP enabled and is accidentally connected to a hub using two links. STP discovers a duplicate path and blocks one of the links, therefore avoiding a loop.

Figure 11 STP configurations

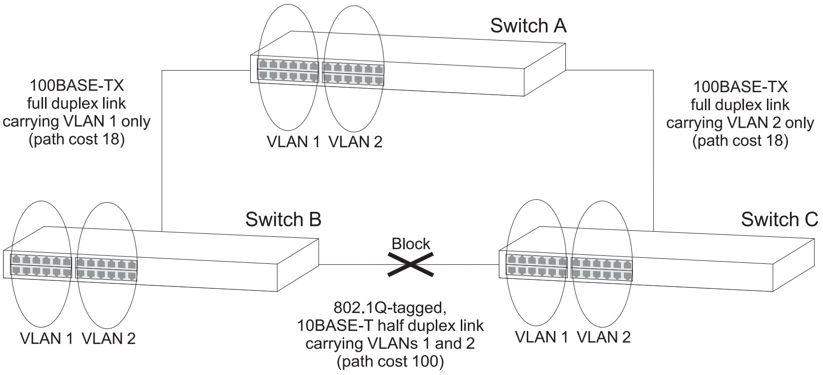


Using STP on a Network with Multiple VLANs

The IEEE 802.1D standard does not take into account VLANs when it calculates STP information — the calculations are only performed on the basis of physical connections. For this reason, some network configurations can result in VLANs being subdivided into a number of isolated sections by the STP system. Therefore, you must ensure that any VLAN configuration on your network takes into account the expected STP topology and alternative topologies that may result from link failures.

For example, Figure 12 shows a network containing VLANs 1 and 2. They are connected using the 802.1Q-tagged link between Switch B and Switch C. By default, this link has a path cost of 100 and is automatically blocked because the other Switch-to-Switch connections have a path cost of 36 (18+18). This means that both VLANs are now subdivided — VLAN 1 on Switch units A and B cannot communicate with VLAN 1 on Switch C, and VLAN 2 on Switch units A and C cannot communicate with VLAN 2 on Switch B.

Figure 12 Configuration that separates VLANs



To avoid any VLAN subdivision, it is recommended that all inter-Switch connections are made members of all available 802.1Q VLANs to ensure connectivity at all times. For example, the connections between Switches A and B, and between Switches A and C should be 802.1Q tagged and carrying VLANs 1 and 2 to ensure connectivity.

For more information about VLAN Tagging, see Chapter 8 “Setting Up Virtual LANs”.

5 USING THE SWITCH DATABASE

What is the Switch Database?

The Switch Database is used by the Switch to determine where a packet should be forwarded to, and which port should transmit the packet if it is to be forwarded.

The database contains a list of entries — each entry contains three items:

- MAC (Ethernet) address information of the endstation that sends packets to the Switch.
- Port identifier, that is the port attached to the endstation that is sending the packet.
- VLAN ID of the VLAN to which the endstation belongs.

For details of the number of addresses supported by your Switch database, please refer to Chapter 1 of the Getting Started Guide that accompanies your Switch.

For detailed descriptions of the web interface operations and the command line interface (CLI) commands that you require to manage the Switch please refer to the Management Interface Reference Guide supplied in HTML format on the CD-ROM that accompanies your Switch.

How Switch Database Entries Get Added

Entries are added to the Switch Database in one of two ways:

- The Switch can learn entries. The Switch updates its database with the source MAC address of the endstation that sent the packet, the VLAN ID, and the port identifier on which the packet is received.
- You can enter and update entries using the **`bridge addressDatabase`** CLI command, the *Bridge > Address Database* Web Interface operation, or an SNMP Network Manager, for example 3Com Network Supervisor.

Switch Database Entry States

Databases entries can have three states:

- *Learned* — The Switch has placed the entry into the Switch Database when a packet was received from an endstation. Note that:
  - Learned entries are removed (aged out) from the Switch Database if the Switch does not receive further packets from that endstation within a certain period of time (the *aging time*). This prevents the Switch Database from becoming full with obsolete entries by ensuring that when an endstation is removed from the network, its entry is also removed from the database.
  - Learned entries are removed from the Switch Database if the Switch is reset or powered-down.
- *Non-aging learned* — If the aging time is set to 0 seconds, all learned entries in the Switch Database become non-aging learned entries. This means that they are not aged out, but they are still removed from the database if the Switch is reset or powered-down.
- *Permanent* — The entry has been placed into the Switch Database using the management interface. Permanent entries are not removed from the Switch Database unless they are removed using the **`bridge addressDatabase remove`** CLI command or the Switch is initialized.

6 USING TRAFFIC PRIORITIZATION

Using the traffic prioritization capabilities of your Switch allows your network traffic to be prioritized to ensure that high priority data is transmitted with minimum delay.

For a list of the features supported by your Switch, please refer to the Management Quick Reference Guide supplied in PDF format on the CD-ROM that accompanies your Switch.

For detailed descriptions of the web interface operations and the command line interface (CLI) commands that you require to manage the Switch please refer to the Management Interface Reference Guide supplied in HTML format on the CD-ROM that accompanies your Switch.

The SuperStack 3 Switch 4200 Family has two traffic queues per port giving it a basic capability to prioritize traffic. For more granular prioritization and an enhanced Quality of Service support, other products are available in the 3Com range of stackable Switches.

What is Traffic Prioritization?

Traffic prioritization allows high priority data, such as time-sensitive and system-critical data to be transferred smoothly and with minimal delay over a network.

Traffic prioritization is most useful for critical applications that require a high level of service from the network. These could include:

- **Converged network applications** — Used by organizations with a converged network, that is, a network that uses the same infrastructure for voice and video data and traditional data. Organizations that require high quality voice and video data transmission at all times can ensure this by maximising bandwidth and providing low latency.

- **Resource planning applications** — Used by organizations that require predictable and reliable access to enterprise resource planning applications such as SAP.
- **Financial applications** — Used by Accounts departments that need immediate access to large files and spreadsheets.
- **CAD/CAM design applications** — Used by design departments that need priority connections to server farms and other devices for transferring large files.

How Traffic Prioritization Works

Traffic prioritization ensures that high priority data is forwarded through the Switch without being delayed by lower priority data. Traffic prioritization uses the two traffic queues that are present in the hardware of the Switch to ensure that high priority traffic is forwarded on a different queue from lower priority traffic. High priority traffic is given preference over low priority traffic to ensure that the most critical traffic gets the highest level of service.

The Switch employs two methods of classifying traffic for prioritization. Traffic classification is the means of identifying which application generated the traffic, so that a service level can be applied to it.

The two supported methods for classifying traffic are:

- 802.1D (classification is done at layer 2 of the OSI model).
- DiffServ code point (classification is done at layer 3 of the OSI model).

802.1D traffic classification

At layer 2, a traffic service class is defined in 802.1Q frame, which is able to carry VLAN identification and user priority information. The information is carried in a header field immediately following the destination MAC address, and Source MAC address.

802.1D Priority Levels

The traffic prioritization feature supported by the Switch at layer 2 is compatible with the relevant sections of the IEEE 802.1D/D17 standard (incorporating IEEE 802.1p). Once a packet has been classified, the level of service relevant to that type of packet is applied to it.

The 802.1D standard specifies eight distinct levels of priority (0 to 7), each of which relates to a particular type of traffic. The priority levels and their traffic types are shown in Figure 13 in order of increasing priority.

You cannot alter the mapping of priority levels 0 - 7 to the traffic queues. These priority levels are fixed to the traffic queues as shown in Figure 13.

Figure 13 IEEE 802.1D traffic types

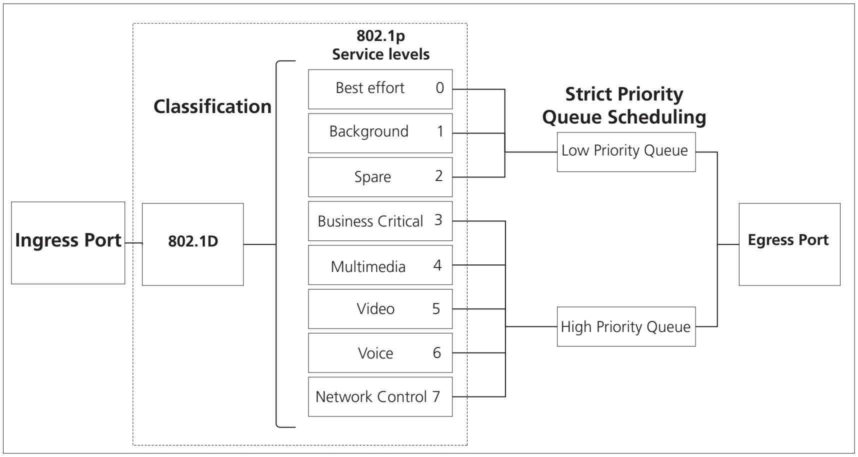


Figure 13 illustrates IEEE 802.1D traffic types as well as associated priority levels and how they are mapped to the two supported traffic queues.

The 802.1D service level of the packet is not altered by the Switch 4200 Series.

DiffServ traffic classification

DiffServ is an alternative method of classifying traffic so that different levels of service can be applied to it on a network. DiffServ is a layer 3 function; and the service to be applied is contained within the DSCP field, which is in the IP header of a packet.

Figure 14 DSCP Service Level Mapping

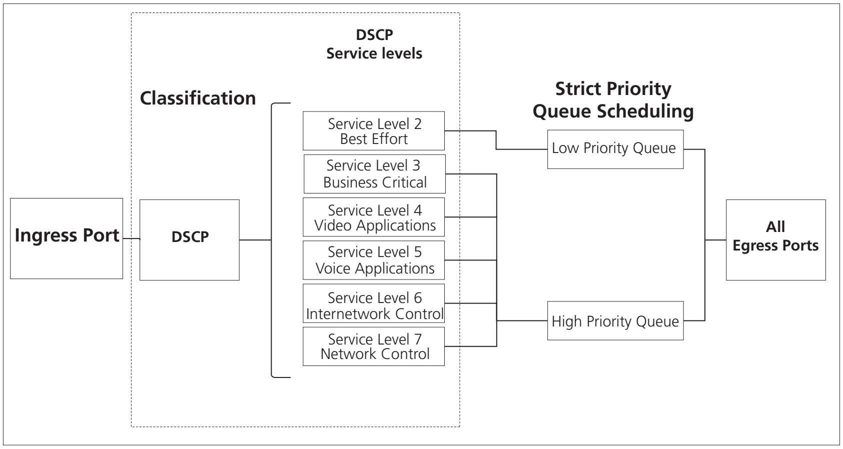


Figure 14 illustrates how DiffServ code point (DSCP) service levels are mapped to the two Traffic Queues.

The DSCP service level of the packet is not altered by the Switch 4200 Family.

Traffic Prioritization and your Switch

The traffic should be marked as it enters the network; the marking can be achieved in two ways:

- The original device can apply the DSCP or 802.1p markings to the packet before transmission.
- The edge port on the Switch connecting the originating device can classify and mark or re-mark the packets before sending them to the network. This is not done by the Switch 4200 Family, an intermediate device in the network is required to do this.

Received packets in the Switch 4200 Family are checked for DSCP classification and IEEE 802.1D priority. The Switch 4200 Family does not set or modify priority levels within the packet.

The transmitting endstation sets the priority of each packet. When the packet is received, the Switch places the packet into the appropriate queue, depending on its priority level, for onward transmission across the network. The Switch determines which queue to service next through its Strict Priority queuing mechanism. This method services both traffic queues, giving priority to the high priority queue.

How traffic is processed to provide Quality of Service

A received packet at the ingress port is checked for its DSCP and IEEE 802.1D attributes to determine the level of service that the packet should receive.

802.1D packets are categorized into the 8 traffic classes defined by IEEE 802.1D; the higher the class the higher the priority given the packet on transmission.

DSCP packets are categorized into the six service levels as shown in Figure 14 and mapped to the appropriate queue.

The priority defined in the service level directs the packet to the appropriate egress queue. When a packet comes in with both 802.1D and DSCP priority markings, the higher of the priorities will be used.

Received packets in the Switch 4200 Family are only checked for DSCP and 802.1D attributes. No other attributes are supported.

Traffic queues are preset on a per-unit basis on the Switch 4200 Family.

Configuring traffic prioritization for QoS on a 4200 Family

QoS can be configured on your Switch using the 3Com Network Supervisor or via the Command Line Interface (CLI).

You can also configure QoS via the command line interface (CLI). For a detailed description of the commands that you require, refer to the Management Interface Reference Guide supplied in HTML format on the CD-ROM that accompanies your Switch.

Configure Quality of service in the Switch 4200 Family in the following way:

1. **Apply Traffic classification** First identify the types of traffic requiring special treatment. These types are defined in the QoS feature through the creation of classifiers. The Switch 4200 Family supports two types of packet attributes on which to classify incoming traffic, Differentiated Services Code Point (DSCP) and IEEE 802.1D.
2. **Identify Service Levels** You must then identify the level of service each classifier should receive. Note that DSCP service levels will be set somewhere else in the network and not in the Switch 4200 Family. Note also that 802.1D service levels are fixed and cannot be altered.

3. **Create Profiles** The next step is to create a profile, which associates classifiers with service levels.
4. **Apply QoS profile** After a QoS profile has been created, it can be assigned to the Port(s). When the profile is assigned to the port(s), the QoS configuration defined in the profile will immediately become active.

Head of Line Blocking (HOL)

You can adjust the Head of Line Blocking settings for Fast Ethernet ports to one of the following:

- *QoS* — This is the default setting. Using this setting, the Switch uses a maximum of 12 packets of egress buffering per port (potentially 18 kilobytes) for normal priority traffic. This gives the flexibility to ensure that high priority traffic can be provided with sufficient extra buffering. Ingress flow control is not normally required with this setting. Data protocols operating window sizes greater that 18 kilobytes will not work efficiently with this setting.
- *Data* — This setting increases the maximum egress buffer per port to 32 kilobytes or 27 packets. This setting is suitable if data applications require a window size of up to 32 kilobytes. Under these circumstances, high priority traffic may not always be able to access sufficient Switch buffers to guarantee the expected QoS.
- *Advanced* — You should only use this setting if you are an experienced network administrator. It allows you to set HOL to suit certain specialist applications. It has two modes:
  - *Disable* — This mode disables HOL completely. All egress and ingress buffers will be used on demand and QoS settings will be largely ineffective in buffer-overload situations. When ingress buffers are exhausted, flow control will operate.
  - *Enable HOL with specific HOL values* — This allows you to set a value between 10 and 50 kilobytes of egress buffering.

7 STATUS MONITORING AND STATISTICS

This chapter contains details of the features that assist you with status monitoring and statistics.

For detailed descriptions of the web interface operations and the command line interface (CLI) commands that you require to manage the Switch please refer to the Management Interface Reference Guide supplied in HTML format on the CD-ROM that accompanies your Switch.

RMON

Using the RMON capabilities of a Switch allows you to improve your network efficiency and reduce the load on your network.

This section explains more about RMON. It covers the following topics:

- What is RMON?
- Benefits of RMON
- RMON and the Switch

What is RMON?

RMON is a system defined by the IETF (Internet Engineering Task Force) that allows you to monitor the traffic of LANs or VLANs.

RMON is an integrated part of the Switch software agent and continually collects statistics about a LAN segment or VLAN, and transfers the information to a management workstation on request or when a pre-defined threshold is crossed. The workstation does not have to be on the same network as the Switch and can manage the Switch by in-band or out-of-band connections.

The RMON Groups

The IETF define groups of Ethernet RMON statistics. This section describes the four groups supported by the Switch 4200 Family, and details how you can use them.

Statistics

The Statistics group provides traffic and error statistics showing packets, bytes, broadcasts, multicasts and errors on a LAN segment.

Information from the Statistics group is used to detect changes in traffic and error patterns in critical areas of your network.

History

The History group provides historical views of network performance by taking periodic samples of the counters supplied by the Statistics group.

The group is useful for analyzing the traffic patterns and trends on a LAN segment, and for establishing the normal operating parameters of your network.

Alarms

The Alarms group provides a mechanism for setting thresholds and sampling intervals to generate events on any RMON variable.

Alarms are used to inform you of network performance problems and they can trigger automated responses through the Events group.

Events

The Events group provides you with the ability to create entries in an event log and send SNMP traps to the management workstation. Events are the action that can result from an RMON alarm. In addition to the standard five traps required by SNMP (link up, link down, warm start, cold start, and authentication failure), RMON adds two more: rising threshold and falling threshold.

Effective use of the Events group saves you time; rather than having to watch real-time graphs for important occurrences, you can depend on the Event group for notification. Through the SNMP traps, events can trigger other actions, therefore providing a way to automatically respond to certain occurrences.

Certain Events can also generate automatic emails. See “Email Notification of Events” on page 62.

Benefits of RMON

Using the RMON features of your Switch has three main advantages:

- **It improves your efficiency**

  Using RMON allows you to remain at one workstation and collect information from widely dispersed LAN segments or VLANs. This means that the time taken to reach a problem site, set up equipment, and begin collecting information is largely eliminated.

- **It allows you to manage your network in a more proactive manner**

  If configured correctly, RMON can deliver information before problems occur. This means that you can take action before they affect users. In addition, probes record the behavior of your network, so that you can analyze the causes of problems.

- **It reduces the load on the network and the management workstation**

  Traditional network management involves a management workstation polling network devices at regular intervals to gather statistics and identify problems or trends. As network sizes and traffic levels grow, this approach places a strain on the management workstation and also generates large amounts of traffic.

  RMON, however, autonomously looks at the network on behalf of the management workstation without affecting the characteristics and performance of the network. RMON reports by exception, which means that it only informs the management workstation when the network has entered an abnormal state.

RMON and the Switch

The RMON support provided by your Switch is detailed in Table 4.

Table 4 RMON support supplied by the Switch

RMON group	Support supplied by the Switch
Statistics	A new or initialized Switch has one Statistics session per port.
History	A new or initialized Switch has two History sessions per port. These sessions provide the data for the Web interface history displays: ■ 30 second intervals, 120 historical samples stored ■ 2 hour intervals, 96 historical samples stored
Alarms	A new or initialized Switch has the following alarm(s) defined for each port: ■ Broadcast bandwidth used ■ Percentage of errors over one minute You can modify these alarms using an RMON management application, but you cannot create or delete them. You can define up to 200 alarms for the Switch. For more information about the alarms setup on the Switch, see "Alarm Events" on page 60 and "The Default Alarm Settings" on page 61.
Events	A new or initialized Switch has Events defined for use with the default alarm system. See "The Default Alarm Settings" on page 61 for more information.

When using the RMON features of the Switch, note the following:

- After the default sessions are created, they have no special status. You can delete or change them as required.
- The greater the number of RMON sessions, the greater the burden on the management resources of the Switch. If you have many RMON sessions, the forwarding performance of the Switch is not affected but you may experience slow response times from the web interface.

Alarm Events

You can define up to 200 alarms for the Switch. The events that you can define for each alarm and their resulting actions are listed in Table 5.

Table 5 Alarm Events

Event	Action
No action	
Notify only	Send Trap.

Table 5 Alarm Events

Event	Action
Notify and filter port	Send Trap. Block broadcast and multicast traffic on the port. Recovers with the *unfilter port* event.
Notify and disable port	Send Trap. Turn port off.
Notify and enable port	Send Trap. Turn port on.
Disable port	Turn port off.
Enable port	Turn port on.
Notify and unfilter port	Send Trap. Stop blocking broadcast and multicast traffic on the port.
System started	
Software Upgrade report	

The Default Alarm Settings

A new or initialized Switch has the following alarm(s) defined for each port:

- Broadcast bandwidth used
- Percentage of errors over one minute

The default values and actions for each of these alarms are given in Table 6.

Table 6 Values for the default alarm(s)

Statistic	High Threshold	Low Threshold Recovery	Period
Broadcast bandwidth used	Value: 20% Action: Notify and filter	Value: 10% Action: Notify and unfilter	30 secs
Number of errors over 10 seconds	Value: 8 errors per 10 seconds Action: Smart auto-sensing will reduce port speed	Value: 8 errors per 10 seconds Action: None. (Speed can only be increased upon link loss, for example by removing and replacing the cable, or by triggering the port to perform another auto-negotiation on that link.)	10 secs

The Audit Log

The Switch keeps an audit log of all management user sessions, providing a record of a variety of changes, including ones relating to RMON. The log can only be read by users at the *security* access level using an SNMP Network Management application.

Each entry in the log contains information in the following order:

- Entry number
- Timestamp
- User ID
- Item ID (including qualifier)
- New value of item

The last 16 operations are stored in the audit log. The oldest records are overwritten first.

Email Notification of Events

Your Switch allows you to receive email notification when certain RMON events occur. You can receive notification via email, SMS (Short Message Service), or pager, of the event that has occurred.

This feature uses an SMTP (Simple Mail Transfer Protocol) email client to send the notification email. The Short Message Service (SMS) and pager messages are constrained on message size so they are sent to a different email address which creates the message to be displayed and then forwards it on to the SMS or pager gateway.

You can configure the email address to which you wish the notifications to be sent. However, you cannot change the factory default notification messages for event emails.

RMON traps continue to be sent, in addition to any email notifications you may receive.

The events that can generate email notification are:

- Unit powers up.
- Unit in the stack fails.
- Fan in the unit fails.

- A link fails or returns to service — you can select specific links that you wish to receive messages for, for example, a mission-critical link to a server.
- A security violation occurs.
- A resilient link activates
- System Started
- Smart Autosensing Activated
- Temperature Critical
- Secure address learned
- Execution of intrusion action
- Authentication failure
- POST Failed ports
- Port access authentication failure
- Port access logon
- Port access logoff

8 SETTING UP VIRTUAL LANS

Setting up Virtual LANs (VLANs) on your Switch reduces the time and effort required by many network administration tasks, and increases the efficiency of your network.

This chapter explains more about the concept of VLANs and explains how they can be implemented on your Switch. It covers the following topics:

- What are VLANs?
- Benefits of VLANs
- VLANs and Your Switch
- VLAN Configuration Examples

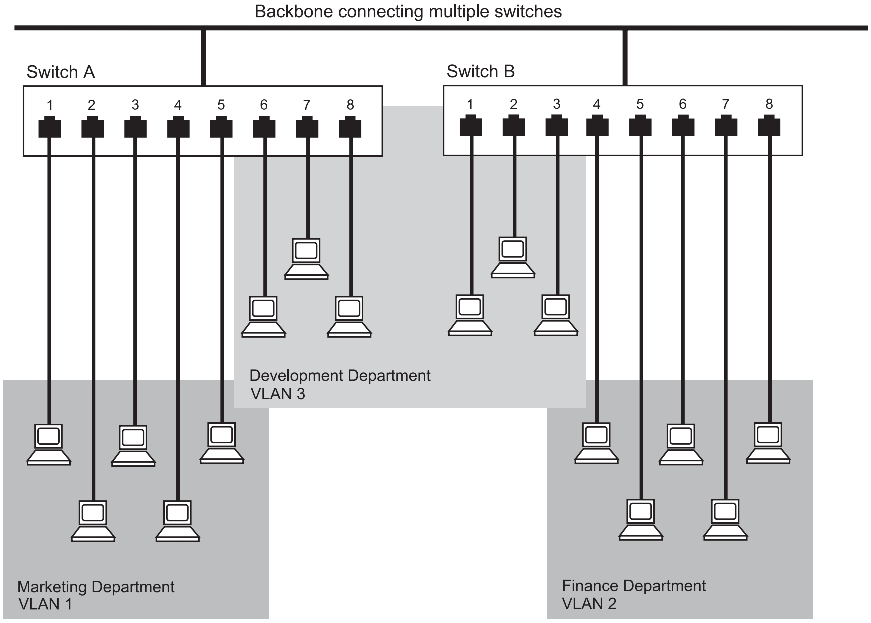
For detailed descriptions of the web interface operations and the command line interface (CLI) commands that you require to manage the Switch please refer to the Management Interface Reference Guide supplied in HTML format on the CD-ROM that accompanies your Switch.

What are VLANs?

A VLAN is a flexible group of devices that can be located anywhere in a network, but which communicate as if they are on the same physical segment. With VLANs, you can segment your network without being restricted by physical connections — a limitation of traditional network design. As an example, with VLANs you can segment your network according to:

- **Departmental groups** — For example, you can have one VLAN for the Marketing department, another for the Finance department, and another for the Development department.
- **Hierarchical groups** — For example, you can have one VLAN for directors, another for managers, and another for general staff.
- **Usage groups** — For example, you can have one VLAN for users of e-mail, and another for users of multimedia.

Figure 15 A network setup showing three VLANs



Benefits of VLANs

The main benefit of VLANs is that they provide a network segmentation system that is far more flexible than any traditional network. Using VLANs also provides you with three other benefits:

- **VLANs ease the movement of devices on networks**

  With traditional networks, network administrators spend much of their time dealing with moves and changes. If users move to a different subnetwork, the addresses of each endstation must be updated manually.

  With a VLAN setup, if an endstation in VLAN *Marketing* for example is moved to a port in another part of the network, and retains its original subnet membership, you only need to specify that the new port is in VLAN *Marketing*. You do not need to carry out any re-cabling.

- **VLANs provide extra security**

  Devices within each VLAN can only communicate with other devices in the same VLAN. If a device in VLAN *Marketing* needs to communicate with devices in VLAN *Finance*, the traffic must pass through a routing device or Layer 3 switch.

- **VLANs help to control traffic**

  With traditional networks, congestion can be caused by broadcast traffic that is directed to all network devices whether they require it or not. VLANs increase the efficiency of your network because each VLAN can be set up to contain only those devices that need to communicate with each other.

VLANs and Your Switch

Your Switch provides support for VLANs using the IEEE 802.1Q standard. This standard allows traffic from multiple VLANs to be carried across one physical link.

The IEEE 802.1Q standard allows each port on your Switch to be placed in:

- Any one VLAN defined on the Switch.
- Several VLANs at the same time using 802.1Q tagging.

The standard requires that you define the following information about each VLAN on your Switch before the Switch can use it to forward traffic:

- *VLAN Name* — This is a descriptive name for the VLAN (for example, Marketing or Management).
- *802.1Q VLAN ID* — This is used to identify the VLAN if you use 802.1Q tagging across your network.

The Default VLAN

A new or initialized Switch contains a single VLAN, the Default VLAN. This VLAN has the following definition:

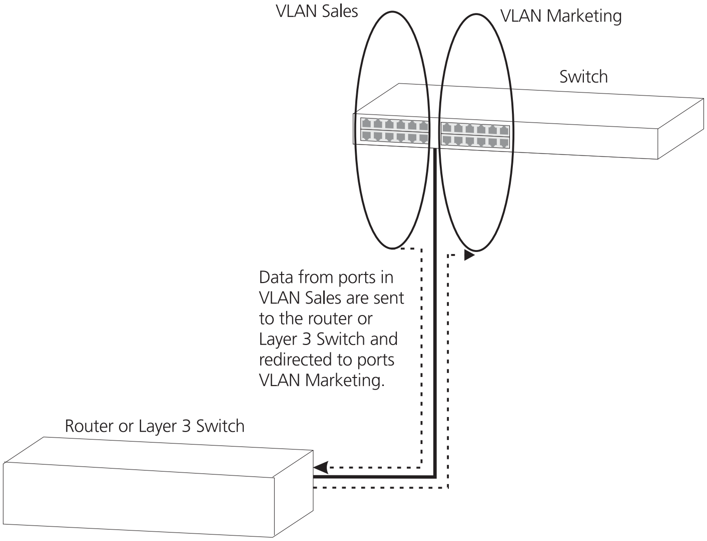
- *VLAN Name* — Default VLAN
- *802.1Q VLAN ID* — 1 (if tagging is required)

All the ports are initially placed in this VLAN, and it is the only VLAN that allows you to access the management software of the Switch over the network.

Communication Between VLANs

If the devices placed in a VLAN need to communicate to devices in a different LAN, each VLAN requires a connection to a router or Layer 3 switching device. Communication between VLANs can only take place if they are all connected to a routing or Layer 3 switching device.

Figure 16 Two VLANS connected via a router


VLAN Sales
VLAN Marketing
Switch
Data from ports in VLAN Sales are sent to the router or Layer 3 Switch and redirected to ports VLAN Marketing.
Router or Layer 3 Switch

Creating New VLANs

If you want to move a port from the Default VLAN to another VLAN, you must first define information about the new VLAN on your Switch.

VLANs: Tagged and Untagged Membership

Your Switch supports 802.1Q VLAN tagging, a system that allows traffic for multiple VLANs to be carried on a single physical (backbone) link.

When setting up VLANs you need to understand when to use untagged and tagged membership of VLANs. Quite simply, if a port is in a single VLAN it can be an untagged member but if the port needs to be a member of multiple VLANs tagged membership must be defined. Typically endstations (for example, clients or servers) will be untagged members of one VLAN, while inter-Switch connections will be tagged members of all VLANs.

The IEEE 802.1Q standard defines how VLANs operate within an open packet-switched network. An 802.1Q compliant packet carries additional information that allows a switch to determine to which VLAN the port belongs. If a frame is carrying the additional information, it is known as *tagged*.

To carry multiple VLANs across a single physical (backbone) link, each packet must be tagged with a VLAN identifier so that the Switches can identify which packets belong in which VLANs. To communicate between VLANs a router must be used.

Placing a Port in a Single VLAN

Once the information for a new VLAN has been defined, you can place a port in that VLAN.

Creating an IEEE 802.1Q Tagged Link

This method of tagging is defined in the IEEE 802.1Q standard, and allows a link to carry traffic for any of the VLANs defined on your Switch. 802.1Q tagging can only be used if the devices at both ends of a link support IEEE 802.1Q.

To create an 802.1Q tagged link:

1. Ensure that the device at the other end of the link uses the same 802.1Q tags as your Switch, that is, the same VLAN IDs are configured (note that VLAN IDs are global across the network).
2. Place the Switch ports in the required VLANs as tagged members.
3. Place the port at the other end of the link as a tagged member of the same VLANs as the port on your Switch.

VLAN Configuration Examples

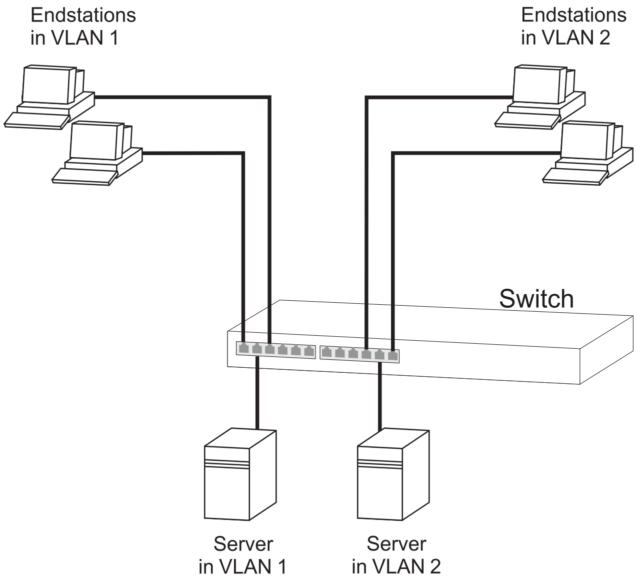
This section contains examples of simple VLAN configurations. It describes how to set up your switch to support simple untagged and tagged connections.

Using Untagged Connections

The simplest VLAN operates in a small network using a single switch. In this network there is no requirement to pass traffic for multiple VLANs across a link. All traffic is handled by the single Switch and therefore untagged connections can be used.

The example shown in Figure 17 illustrates a single Switch connected to endstations and servers using untagged connections. Ports 1, 2 and 3 of the Switch belong to VLAN 1, ports 10, 11 and 12 belong to VLAN 2. VLANs 1 and 2 are completely separate and cannot communicate with each other. This provides additional security for your network.

Figure 17 VLAN configuration example: Using untagged connections



To set up the configuration shown in Figure 17:

1 **Configure the VLANs**
Create VLAN 2 on the Switch. VLAN 1 is the default VLAN and already exists.

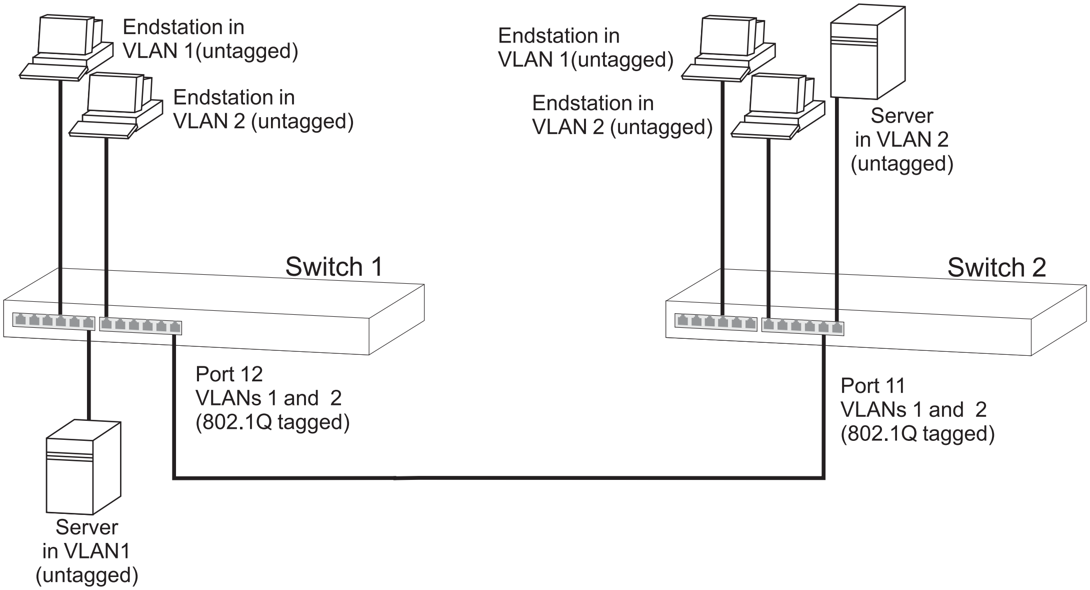
2 Add ports to the VLANs
Add ports 10, 11 and 12 of the Switch as untagged members to VLAN 2.

Using 802.1Q Tagged Connections

In a network where the VLANs are distributed amongst more than one Switch, you must use 802.1Q tagged connections so that all VLAN traffic can be passed along the links between the Switches. 802.1Q tagging can only be used if the devices at both ends of a link support IEEE 802.1Q.

The example shown in Figure 18 illustrates two Switch units. Each switch has endstations and a server in VLAN 1 and VLAN 2. All endstations in VLAN 1 need to be able to connect to the server in VLAN1 which is attached to Switch 1 and all endstations in VLAN 2 need to connect to the server in VLAN2 which is attached to Switch 2.

Figure 18 VLAN configuration example: 802.1Q tagged connections



Endstation in VLAN 1(untagged)
Endstation in VLAN 2 (untagged)
Endstation in VLAN 1(untagged)
Endstation in VLAN 2 (untagged)
Server in VLAN 2 (untagged)
Switch 1
Switch 2
Port 12 VLANs 1 and 2 (802.1Q tagged)
Port 11 VLANs 1 and 2 (802.1Q tagged)
Server in VLAN1 (untagged)

To set up the configuration shown in Figure 18:

1 Configure the VLANs on Switch 1
Define VLAN 2. VLAN 1 is the default VLAN and already exists.

2 Add endstation ports on Switch 1 to the VLANs
Place the endstation ports in the appropriate VLANs as untagged members.

3 **Add port 12 on Switch 1 to the VLANs**
Add port 12 on Switch 1 as a tagged member of both VLANs 1 and 2 so that all VLAN traffic is passed over the link to Switch 2.

4 **Configure the VLANs on Switch 2**
Define VLAN 2. VLAN 1 is the default VLAN and already exists.

5 **Add endstation ports on Switch 2 to the VLANs**
Place the endstation ports in the appropriate VLANs as untagged members.

6 **Add port 11 on Switch 2 to the VLANs**
Add port 11 on Switch 2 as a tagged member of both VLANs 1 and 2 so that all VLAN traffic is passed over the link to Switch 1.

7 **Check the VLAN membership for both switches**
The relevant ports should be listed in the VLAN members summary.

8 **Connect the switches**
Connect port 12 on Switch 1 to port 11 on Switch 2.

The VLANs are now configured and operational and the endstations in both VLANs can communicate with their relevant servers.

9 USING AUTOMATIC IP CONFIGURATION

This chapter explains more about IP addresses and how the automatic configuration option works. It covers the following topics:

- How Your Switch Obtains IP Information
- How Automatic IP Configuration Works
- Important Considerations

ⓘ *For detailed information on setting up your Switch for management, see the Getting Started Guide that accompanies your Switch.*

ⓘ *For detailed descriptions of the web interface operations and the command line interface (CLI) commands that you require to manage the Switch please refer to the Management Interface Reference Guide supplied in HTML format on the CD-ROM that accompanies your Switch.*

ⓘ *For background information on IP addressing, see* Appendix C "IP Addressing".

How Your Switch Obtains IP Information

You can use one of the following methods to allocate IP information to your Switch (essential if you wish to manage your Switch across the network):

- **Automatic IP Configuration** (default) — the Switch tries to configure itself with IP information. It uses the following industry standard methods to automatically allocate the Switch IP information:
  - Dynamic Host Configuration Protocol (DHCP)
  - Auto-IP — the Switch will configure itself with its default IP address 169.254.100.100 if it is operating in a standalone mode, and/or no other Switches on the network have this IP address. If this default IP address is already in use on the network then the Switch detects this and configures itself with an IP address in the range 169.254.1.0 to 169.254.254.255.
  - Bootstrap Protocol (BOOTP)

  For ease of use, you do not have to choose between these three automatic configuration methods. The Switch tries each method in a specified order as described in "Automatic Process" on page 75.
- **Manual IP Configuration** — you can manually input the IP information (IP address, subnet mask, and default gateway).

If you select an option for no IP configuration the Switch will not be accessible from a remote management workstation on the LAN. In addition, the Switch will not be able to respond to SNMP requests.

How Automatic IP Configuration Works

When your Switch is powered up for the first time the IP configuration setting is set to `automatic` — this is the default setting.

If your Switch has been powered up before, whichever of the three options for IP configuration (`manual, automatic, none`) was last configured is activated when the Switch powers up again.

You can switch to manual IP configuration at any time using a serial port connection to set up the IP information. For more information see the Getting Started Guide that accompanies your Switch.

Automatic Process

To detect its IP information using the automatic configuration process, the Switch goes through the following sequence of steps:

1 The DHCP client that resides in the Switch makes up to four attempts to contact a DHCP server on the network requesting IP information from the server. The attempts are at 0, 4, 12, 28 second intervals.

- If a DHCP server is on the network and working correctly it responds to the clients request with an IP address (allocated from a pool of available addresses) and other parameters such as a subnet mask, default gateway, lease time, and any other options configured in the DHCP server.

The way a DCHP server responds is dependant on the DHCP server settings. Therefore the way your DHCP server responds may be different to the process outlined.

- If the DHCP process fails after 30 seconds on all four attempts, then the Switch activates its Auto-IP configuration feature.

2 The Auto-IP feature starts with an IP address of 169.254.100.100. It uses the Address Resolution Protocol (ARP) to check to make sure this address is not already in use on the network. If not, it will allocate this default address to the Switch.

If this IP address is already in use, Auto-IP will check once every second for three seconds for an IP address on the 169.254.x.y subnet (where x = 1-254 and y = 0-255) (Auto-IP only uses addresses in the range 169.254.1.0 through to 169.254.254.255 as valid addresses.) Once Auto-IP has ensured that an IP address is not already in use on the network, it assigns it to the Switch with a subnet mask of 255.255.0.0 and a default gateway of 0.0.0.0.

3 While the Auto-IP assigned address is in use:

- The Auto-IP client continues to check every 30 seconds (using ARP) to ensure that any other Auto-IP hosts have not mistakenly configured themselves using the same Auto-IP address.
- DHCP and BOOTP requests also continue in the background. The requests begin 3 minutes after either the Auto-IP address is assigned, or 125 attempts to establish a valid Auto-IP address, whichever occurs first. The requests proceed with DHCP requests for 1 minute; a 3 minute pause; DHCP requests for another minute; a 3 minute pause; BOOTP requests for one minute; a 3 minute pause; then the process repeats until a DHCP or BOOTP server answers the requests.

Important Considerations

This section contains some important points to note when using the automatic IP configuration feature.

The dynamic nature of automatically configured IP information means that a Switch may change its IP address whilst in use.

Event Log Entries and Traps

An event log will be generated and an SNMP trap will be sent if any of the following changes occur in the IP configuration:

- IP address configuration is changed manually
- IP address changes from Auto-IP to DHCP IP configuration
- DHCP negotiates a change in the IP configuration from Auto-IP
- BOOTP negotiates a change in the IP configuration

10 MAKING YOUR NETWORK SECURE

This chapter explains the security features of the Switch and gives examples of how and why you would use them in your network. It covers the following topics:

- Port Security
- What is Network Login?
- What is Rada?
- Auto VLAN Assignment
- What is Disconnect Unauthorized Device (DUD)?
- What is RADIUS?

For detailed descriptions of the Web interface operations and the Command Line Interface (CLI) commands that you require to manage the Switch please refer to the Management Interface Reference Guide supplied in HTML format on the CD-ROM that accompanies your Switch.

Port Security

The Switch supports the following port security modes, which you can set for an individual port or a range of ports:

- **No Security**

  Port security is disabled and all network traffic is forwarded through the port without any restrictions.

- **Continuous Learning**

  MAC addresses are learned continuously by the port until the number of authorized addresses specified is reached. When this number is exceeded the first address that was learned by the port is deleted, allowing a new address to be learned.

- **Automatic Learning**

  MAC addresses are learned continuously by the port until the number of authorized addresses specified is reached. When this number is exceeded the port automatically stops learning addresses and Disconnect Unauthorized Device (DUD) is enabled on the port. For further information see "What is Disconnect Unauthorized Device (DUD)?" on page 85.

- **Learning Off**

  Only traffic received from an authorized address (either configured by management or learned while the port was prevously operating in the "Automatic Learning" mode) is forwarded. While in this mode the DUD operation is enabled. When a port in this mode has learned the maximum number of authorized addresses configured for the port then it will transition to the "Learning Off" mode.

- **Network Login**

  When a 802.1X client has been successfully authorized, all network traffic is forwarded through the port without any restrictions. For further information see "What is Network Login?" on page 80.

- **Network Login (Secure)**

  When a 802.1X client has been successfully authorized, only network traffic that is received from the authorized client device is forwarded through the port. The source MAC address in received packets is used to determine this; all traffic from other network devices is filtered. Disconnect Unauthorized Device (DUD) is enabled on the port.

- **Rada (Radius Authenticated Device Access)**

  Rada (Radius Authenticated Device Access) provides a means of disabling access and where necessary the VLAN assignment based purely on central authentication of an End Station's MAC address. In practice this can be used to provide RADIUS-based security for network administrators who do not have 802.1X clients installed. Another application would be to isolate individual PCs that have been identified to contain viruses.

This mode should not be considered a totally secure mode, as it can be bypassed by MAC-address spoofing.

Rada can authenticate multiple MAC addresses on a single port, Network Login authentication is limited to a single device on each port.

- **Rada Else Network Login (Secure Network Login with Rada Override)**

  This mode provides the secure login capability of 802.1X, and also offers an override capability based on MAC address. This mode is intended for use where 802.1X Network Login is the normal access mechanism, but a means of isolating hosts is still required – for example client virus isolation.

  This mode is intended to complement 802.1X network login, and can be used to authorise host access to any network resource. It can only be considered secure if the MAC-based authentication is configured to deny access to all secure network resources. It is intended to prevent access to secure network resources if a particular edge device is authorized by Rada (for example, if a PC is known to be infected by a virus) and placed on a seperate ‘safe’ VLAN.

- **Rada Or Network Login (Mixed Secure Network Login and Rada-based Network Access)**

  This mode provides for both 802.1X and Rada authentication to be operated in parallel. It provides a migration path where a single port may be used by a number of devices at different times, only some of which support 802.1X. It also allows a single port configuration to be used throughout a switch, regardless of the type of device that is to be connected. For example this mode could be used in education, where a large and varied range of “student” PCs and devices can use Rada authentication, but permanent staff require a secure log-in to enhanced services.

This mode can only be considered totally secure if the Rada based authentication is configured to deny access to secure network resources, and where 802.1X Network Login does not share a port (that is not via a hub).

What is Network Login?

Network Login controls user access at the network edge by blocking or unblocking access on a per-port basis.

When a client device attempts to connect to a Switch port, the user is challenged to provide their identity and authentication credentials in the form of a user name and password. The user information is then sent to a remote RADIUS server in the network for authentication. This information must be successfully authenticated and authorized before the client device is granted access to the network.

For further information about RADIUS, see "What is RADIUS?" on page 85.

The client device must be directly connected to the Switch port (no intervening switch or hub) as the Switch uses the link status to determine if an authorized client device is connected. Network Login will not operate correctly if there is a "bridge" device between the client device and the Switch port, or if there are multiple client devices attached via a hub to the Switch port.

In addition to providing protection against unauthorized network access, Network Login also allows the user of a port to be identified. This user identification information can be used for service accounting or billing, or to help network administrators resolve problems.

Network Login is a feature that is particularly relevant in publicly accessible networks, such as education campuses or conference facilities, which often have limited control over physical access to areas with live network connections.

Network Login is based on the IEEE Std 802.1X-2001, which defines a mechanism for user authentication for port-based network access control.

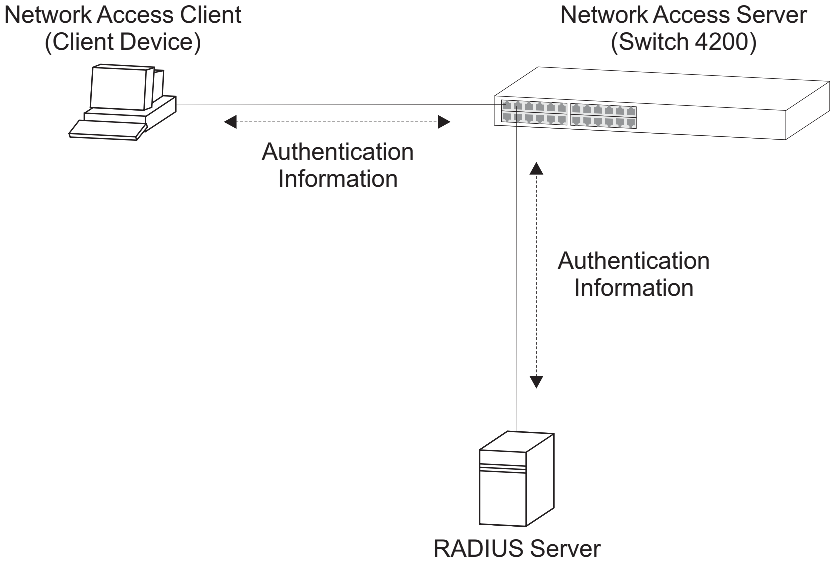
For further information about Network Login, see "Auto VLAN Assignment" on page 83.

How Network Login Works

When Network Login is enabled the Switch acts as a relay agent between the client device that is requesting access to the network and the RADIUS server. The authentication information that is exchanged between the client device and the RADIUS server is received and transmitted by the Switch, as shown in Figure 19. The Switch does not interpret or store this information.

If the RADIUS server is unavailable, the switch may be configured to provide default access on each port that has switch-configured VLAN and QoS parameters. If default access has not been configured the switch will maintain port security settings.

Figure 19 Network Login Operation



When the client device and RADIUS server have exchanged authentication information, the Switch receives either an authentication succeeded or failed message from the server, and then configures the port to forward or filter traffic as appropriate. If access is granted, the Spanning Tree Protocol places the port into the forwarding state and the client device can obtain an IP address.

If possible, when a port is configured for Network Login, it should also be configured to 'Auto' or 'Enable' Spanning Tree Protocol (STP) FastStart. STP Faststart minimizes the delay before STP places the port into the forwarding state.

For Network Login, the Switch uses EAP (Extensible Authentication Protocol).

For further information about RADIUS, see "What is RADIUS?" on page 85.

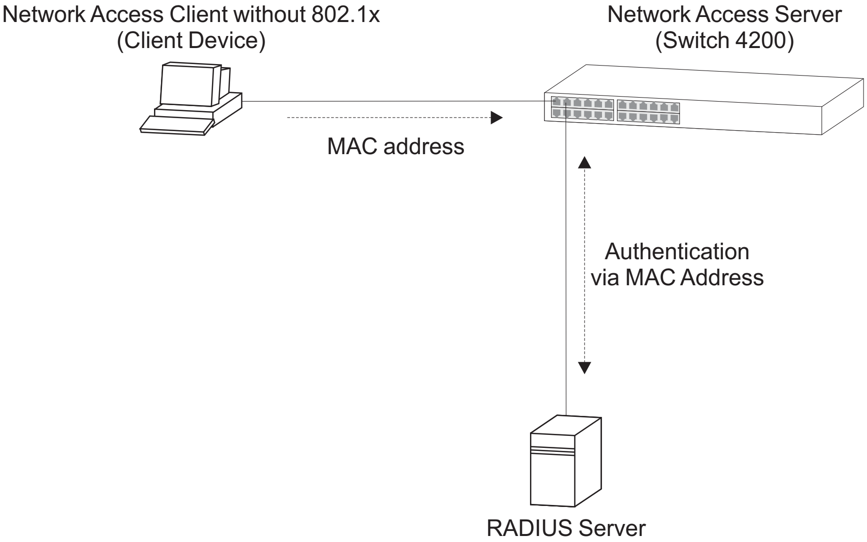
What is Rada?

The Radius Authenticated Device Access feature complements the existing 802.1X support of the Switch. Instead of needing an 802.1X client on every end station, the switch can use the MAC address of the end station to query the RADIUS server.

How Rada Works

The Rada feature controls the network access of a host based on authenticating its MAC address. A host is allowed access to the entire network, to a restricted network or no access at all. The switch obtains the network access authorisation from a centrally located RADIUS server by supplying the MAC address of the host as shown in Figure 20

Figure 20 Network Login Operation via MAC Address



For Rada, the Switch uses PAP (Password Authentication Protocol).

Rada has an 'Unauthorized Device action' of allowDefaultAccess or blockMacAddress, which control the action on authentication refusal.

- allowDefaultAccess grants a device access based on the port's configured VLAN and QoS parameters.
- blockMacAddress blocks (filters) any traffic to or from the device.

Rada is similar to DUD (Disconnect Unauthorized Device), only Rada affects a single device where as DUD affects the whole port.

Rada can also be used in conjunction with the existing 802.1X Secure Network Login to provide the capability to support a variety of host and network configurations.

RADIUS Server settings for Rada

When setting up Rada on a RADIUS server the following attributes should be taken into consideration.

- Users must be set up on the RADIUS Server for each device that is to be authenticated, using the MAC address for username and the same MAC address for the password.
- The username should be set as the MAC address of the device. This must be of the form of Hex digits separated by hyphens, for example '08-05-54-AB-CD-EF'.

Table 7 Setting Rada attributes

Attribute	Value
Framed-Protocol	PPP
Service-Type	Framed

Auto VLAN Assignment

Auto VLAN assignment complements the basic Network Login and Rada features. It allows an appropriate VLAN configuration to be obtained from a RADIUS server when a user or device authenticates on a port. The configuration obtained will be specific to the user or device authenticated on the port.

The RADIUS Server may be configured with VLAN parameters for each user or device. One or more VLANs may be configured for each user, to allow multiple VLANs to be communicated to the device requesting the user authentication.

Important Considerations

This section contains some important considerations when using Network Login or Rada on the Switch .

- Before you enable Network Login or Rada you must ensure that:
  - RADIUS has been configured on the Switch.
  - The RADIUS server in your network is operational.
- If the RADIUS server fails or is unavailable, client devices will be unable to access the network or be restricted to the default access.
- Network Login and Rada are not supported on ports configured to operate as members of an aggregated link.
- Some client devices that are connected to the Switch port may not support network login, for example printers. You should configure the Switch port to operate in Automatic Learning mode, so that network traffic that does not match the MAC address for the client device is filtered, or use the basic Rada mode.
- You should enable Network Login or Rada on all relevant Switch ports. Failure to enable authentication on a single port could compromise the security of the entire network.

RADIUS Server settings for Auto VLAN

When setting up Auto VLAN on a RADIUS server the following attributes must be set to supply VLAN data to the Switch:

Table 8 Setting Auto VLAN attributes

Attribute	Value
Tunnel-Type	VLAN
Tunnel-Medium-Type	802
Tunnel-Private-Group-ID	<VLAN ID to be assigned>

The Tunnel-Private-Group-ID attribute specifies the VLAN to be assigned. This can take various forms to indicate if the port is untagged or tagged member, for example ‘2u 3t' means that the port is an untagged member of VLAN 2 and a tagged member of VLAN 3.

The switch will assign the first VLAN number with no suffix, or with a ‘U’ or ‘u’ suffix, as an untagged VLAN for the port. Any further VLAN numbers with no suffix, or with the ‘U’ or ‘u’ suffix, will be assigned as a tagged VLAN on the same port. For example; all the following strings are identical after processing: “23 7T 88T”, “7T 88t 23u”, “88T 23 7t “, ”23 7 88”, “7T 23u 88u”.

What is Disconnect Unauthorized Device (DUD)?

The port security feature Disconnect Unauthorized Device (DUD), disables a port if an unauthorized client device transmits data on it.

DUD may be automatically enabled when a port is set to one of the following port security modes:

- Automatic Learning
- Network Login (Secure)
- Learning off

How DUD Works

Disconnect Unauthorized Device (DUD) protects the network by checking the source MAC address of each packet received on a port against the authorized addresses for that port.

You can configure DUD to perform one of the following actions if an unauthorized client device transmits data on the port:

- *Permanently disable the port* — The port is disabled and data from the unauthorized client device is not transmitted.
- Temporarily disable the port — The port is disabled for 20 seconds. When the time period has expired the port is re-enabled; if the port is set to one of the Network Login security modes, the client device is authenticated again.
- *Do not disable the port* — The port is not disabled and data from authorized client devices will continue to be transmitted, whilst data from unauthorized client devices will be filtered.

What is RADIUS?

Remote Authentication Dial-In User Service (RADIUS) is an industry standard protocol for carrying authentication, authorization and configuration information between a network device and a shared authentication server. Transactions between each network device and the server are authenticated by the use of a shared secret. Additional security is provided by encryption of passwords to prevent interception by a network snooper.

RADIUS is defined in the RFCs 2865 and 2866, “Remote Authentication Dial-in User Service (RADIUS)” and “RADIUS Accounting”.

Network Login and Rada both utilize the RADIUS protocol.

11 USING SWITCH CONFIGURATION FEATURES

This chapter explains the configuration features supported by the Switch that aid ease of use and configuration of your network. It covers the following topics:

- Configuration Save and Restore
- Upgrading Management Software

For detailed descriptions of the web interface operations and the command line interface (CLI) commands that you require to manage the Switch please refer to the Management Interface Reference Guide supplied in HTML format on the CD-ROM supplied with your Switch or on the 3Com Web site.

Configuration Save and Restore

The Configuration Save and Restore feature allows the configuration of your Switch to be saved as a file on a remote server, or to be restored onto the Switch from a remote file. The configuration information is stored in an editable ASCII text file as a set of Command Line Interface (CLI) commands.

All configuration information that can be set using the Switch's Command Line Interface is saved and restored. Sensitive information such as user passwords and the IP address configuration is not saved. You can edit the text file and add this information if you wish before restoring the configuration.

If the Switch is part of a stack, it is the configuration of the stack that is saved and restored. You cannot restore the configuration of a single unit in the stack from the saved file; you must restore the configuration of the entire stack.

You must have either the *manager* or *security* management access level to be able to save and restore the Switch configuration. If a manager level user attempts to restore a configuration that was saved by a security level user, the restore operation will fail because the security level commands are not available to the manager. A manager level user can only save a configuration that contains the commands that are available to that user level.

Important Considerations

- The Switch unit must be reset to its factory default settings before you can restore a configuration onto it. You can reset the Switch using the **`system control initialize`** CLI command or the *System* > *Control* > *Initialize* Web interface operation.
- The configuration can only be restored onto a device or stack which has the same physical connections and configuration, including expansion modules, as when the configuration was initially saved. The restore operation will be unsuccessful if the physical configuration of the device or stack is different.
- The configuration of the Switch must only be restored or saved by a single user at a time. The **`system summary`** CLI command displays the progress of restore and save operations to all other users.
- When using the Configuration Save and Restore feature, 3Com recommends that aggregated links are configured as either:
  - Manual aggregations with Link Aggregation Configuration Protocol (LACP) disabled on the ports that are to be manually placed in the aggregated link.

  or

  - LACP automatic aggregations — that is, LACP enabled on all ports and the aggregated links created automatically. The aggregated link should be enabled and Spanning Tree Protocol enabled.

  Parameters such as VLANs and Fast Start may be set up as required.

  Other combinations of port settings, however, are not recommended as Configuration Restore will only perform a “best effort” restore of the configuration. For example, LACP automatic aggregations with manually defined ports are restored as manual aggregations with manual ports. LACP automatic aggregations with automatic ports where the aggregated link is disabled and Spanning Tree Protocol is disabled are restored as manual aggregations with the aggregated link disabled.

For further information about LACP, see Chapter 2 "Optimizing Bandwidth".

- When restoring a configuration onto a unit over an aggregated link, communication with that unit may be lost because the restore operation disables the aggregated link ports. Communication over the aggregated links is re-established when the restore operation has been completed.
- When RADIUS is set as the authentication system mode for the Switch and the configuration is saved, the shared secret (password) is not saved and the system mode is saved as local. You must either edit the saved configuration text file prior to restoring it, or reconfigure the values using the CLI or Web interface after the Configuration Restore has been completed.

For detailed descriptions of the Configuration Save and Restore Web interface operations and Command Line Interface (CLI) commands, please refer to the Management Interface Reference Guide supplied in HTML format on the CD-ROM that accompanies your Switch.

Upgrading Management Software

Your Switch has an image of the Switching software residing in Flash memory. During the software upgrade process the loading software image will always over-write the existing software image. In the event of a software upgrade failing you must completely reinstall the image to avoid potential complications. You will not be able to run a corrupted or missing software image.

The CD-ROM supplied with your Switch includes a Software Update Utility that can be used to update the management software of the Switch. The Utility should only be used if a previous upgrade has failed, and you are unable to communicate with the Switch using the web interface or command line interface. You can find the Utility in the *Utility* directory on the CD-ROM.

For a detailed description of how to upgrade the software on your Switch please refer to the Management Interface Reference Guide supplied in HTML format on the CD-ROM supplied with your Switch or on the 3Com Web site.

CAUTION: *3Com strongly recommends that you use the TFTP Server as the primary means of upgrading your Switch. The Software Update Utility should only be used if a TFTP software upgrade has failed and the Switch* *has subsequently failed to power up correctly. The symptoms of a failed TFTP software upgrade are: the PowerOn Self Test (POST) has failed, the Power/Self Test LED is yellow, all of the Port Status LEDs are Off, you cannot access the Switch via Telnet.*

II APPENDICES AND INDEX

A CONFIGURATION RULES

Configuration Rules for Gigabit Ethernet

Gigabit Ethernet is designed to run over several media:

- Single-mode fiber optic cable, with connections up to 5 km (3.1 miles). Support for distances over 5 km is supported depending on the module specification.
- Multimode fiber optic cable, with connections up to 550 m (1804 ft).
- Category 5 cabling, with connections up to 100 m (328 ft).

The different types of Gigabit Ethernet media and their specifications are detailed in Table 9.

Table 9 Gigabit Ethernet cabling

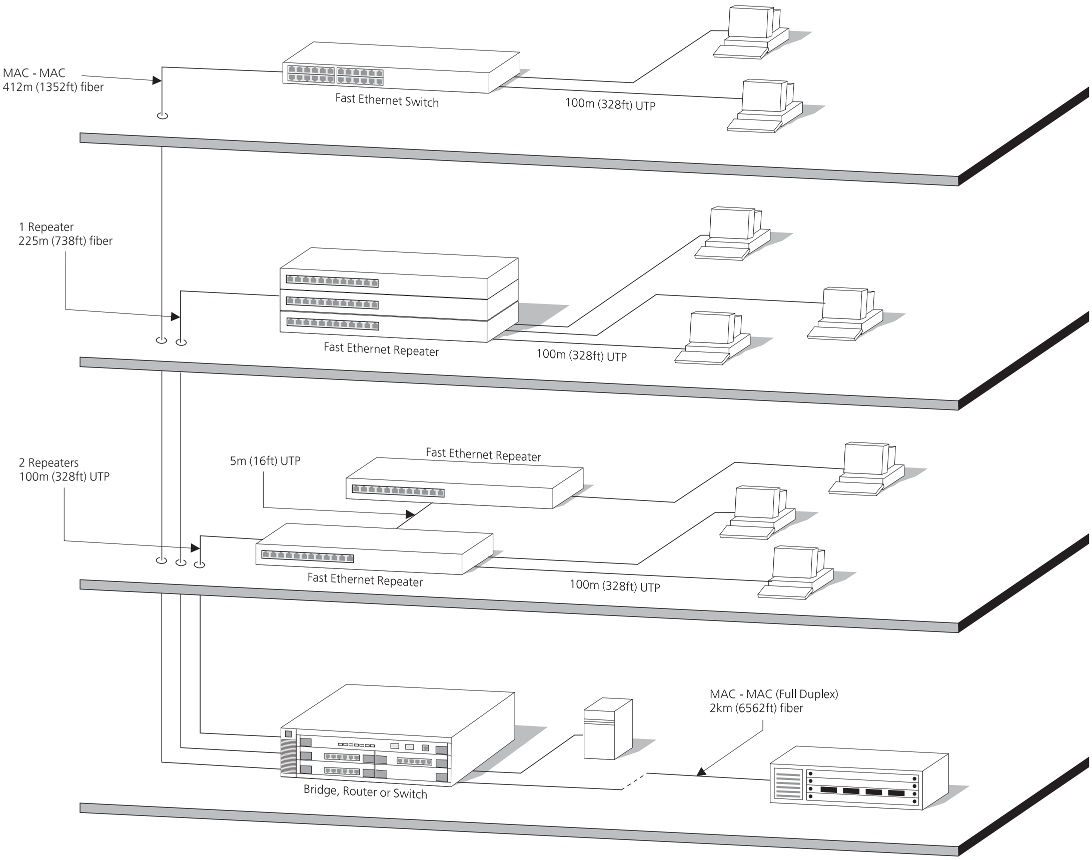
Gigabit Ethernet Transceivers	Fiber Type	Modal Bandwidth (MHz/km)	Lengths Supported Specified by IEEE (meters)
1000BASE-LX	62.5 µm MM	500	2–550
	50 µm MM	400	2–550
	50 µm MM	500	2–550
	10 µm SM	N/A	2–5000
1000BASE-SX	62.5 µm MM	160	2–220
	62.5 µm MM	120	2–275
	50 µm MM	400	2–500
	50 µm MM	500	2–550
1000BASE-T	N/A	N/A	100

MM = Multimode *SM = Single-mode*

Configuration Rules for Fast Ethernet

The topology rules for 100 Mbps Fast Ethernet are slightly different to those for 10 Mbps Ethernet. Figure 21 illustrates the key topology rules and provides examples of how they allow for large-scale Fast Ethernet networks.

Figure 21 Fast Ethernet configuration rules



The key topology rules are:

- Maximum UTP cable length is 100 m (328 ft) over Category 5 cable.
- A 412 m (1352 ft) fiber link is allowed for connecting switch-to-switch, or endstation-to-switch, using half-duplex 100BASE-FX.
- A total network span of 325 m (1066 ft) is allowed in single-repeater topologies (one hub stack per wiring closet with a fiber link to the

collapsed backbone). For example, a 225 m (738 ft) fiber link from a repeater to a router or switch, plus a 100 m (328 ft) UTP link from a repeater out to the endstations.

Configuration Rules with Full Duplex

The Switch provides full duplex support for all its ports, including Expansion Module ports. Full duplex allows packets to be transmitted and received simultaneously and, in effect, doubles the potential throughput of a link.

With full duplex, the Ethernet topology rules are the same, but the Fast Ethernet rules are:

- Maximum UTP cable length is 100 m (328 ft) over Category 5 cable.
- A 2 km (6562 ft) fiber link is allowed for connecting switch-to-switch, or endstation-to-switch.

B NETWORK CONFIGURATION EXAMPLES

This chapter contains the following sections:

- Simple Network Configuration Examples
  - Desktop Switch Example
- Advanced Network Configuration Examples
  - Improving the Performance and Resilience of Your Network

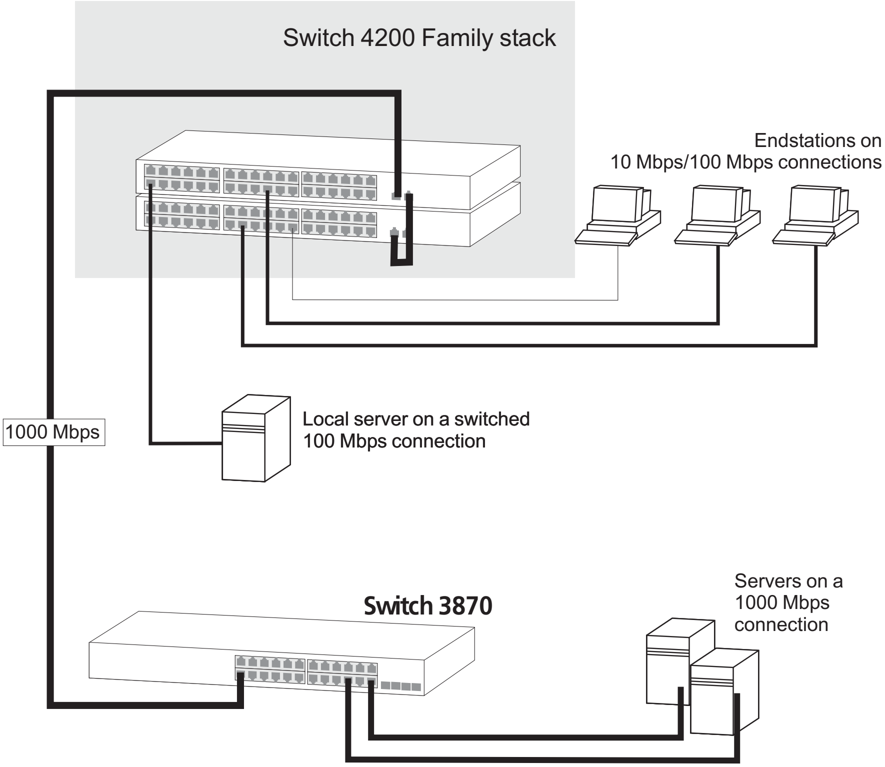
Simple Network Configuration Examples

The following illustrations show some simple examples of how the Switch 4200 Family can be used in your network.

Desktop Switch Example

The example in Figure 22 shows how the Switch 4200 Family can be used for a group of users that require dedicated 10 Mbps or 100 Mbps connections to the desktop. The Switch 4200 Family stack uses one of its built-in 1000BASE-T ports to provide a Gigabit Ethernet link to a Switch 3870 in the basement.

Figure 22 Using the Switch 4200 Family in a desktop environment



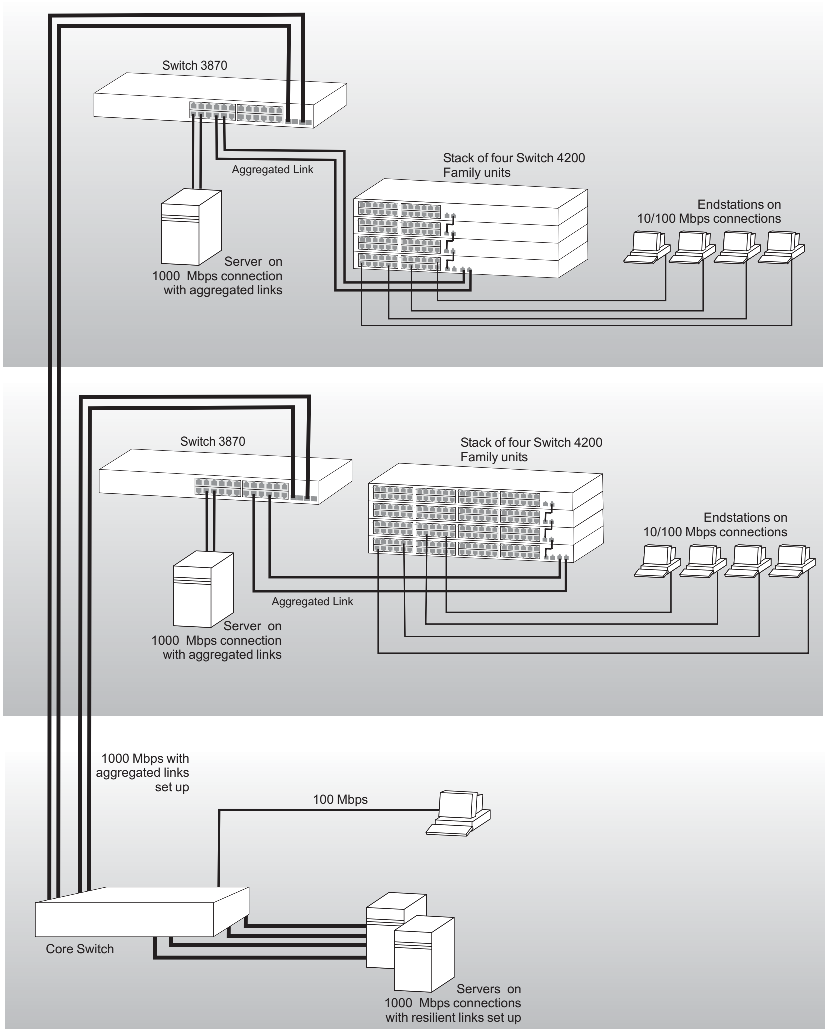
Advanced Network Configuration Examples

This section shows some network examples that illustrate how you can set up your network for optimum performance using some of the features supported by your Switch.

Improving the Performance and Resilience of Your Network

Figure 23 shows how you can set up your network to improve its resilience by using aggregated links; this increases the bandwidth available for the backbone connection and also provides extra resilience.

Figure 23 Network set up to provide resilience


Switch 3870
Aggregated Link
Stack of four Switch 4200 Family units
Endstations on 10/100 Mbps connections
Server on 1000 Mbps connection with aggregated links
Switch 3870
Stack of four Switch 4200 Family units
Endstations on 10/100 Mbps connections
Aggregated Link
Server on 1000 Mbps connection with aggregated links
1000 Mbps with aggregated links set up
100 Mbps
Core Switch
Servers on 1000 Mbps connections with resilient links set up

C IP ADDRESSING

This chapter provides some background detail on the IP information that needs to be assigned to your Switch to enable you to manage it across a network. The topics covered are:

- IP Addresses
- Subnets and Subnet Masks
- Default Gateways

IP addressing is a vast topic and there are white papers on the World Wide Web and publications available if you wish to learn more about IP addressing.

IP Addresses

This IP address section is divided into two parts:

- Simple Overview — Gives a brief overview of what an IP address is.
- Advanced Overview — Gives a more in depth explanation of IP addresses and the way they are structured.

Simple Overview

To operate correctly, each device on your network must have a unique IP address. IP addresses have the format *n.n.n.n* where *n* is a decimal number between 0 and 255. An example IP address is '192.168.100.8'.

The IP address can be split into two parts:

- The first part, called the network part, ('192.168' in the example) identifies the network on which the device resides.
- The second part, called the host part, ('100.8' in the example) identifies the device within the network.

If your network is internal to your organization only, you may use any arbitrary IP address. 3Com suggests you use addresses in the series

192.168.100.*X* (where *X* is a number between 1 and 254) with a subnet mask 255.255.255.0. If you are using SLIP, use the default SLIP address of 192.168.101.1 with a subnet mask of 255.255.255.0.

These suggested IP addresses are part of a group of IP addresses that have been set aside specially for use "in house" only.

***CAUTION:** If your network has a connection to the external IP network, you must apply for a registered IP address. This registration system ensures that every IP address used is unique; if you do not have a registered IP address, you may be using an identical address to someone else and your network will not operate correctly.*

Obtaining a Registered IP Address

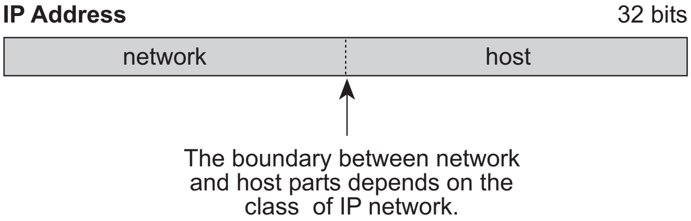
InterNIC Registration Services is the organization responsible for supplying registered IP addresses. The following contact information is correct at time of publication:

World Wide Web site: **`http://www.internic.net`**

Advanced Overview

IP addresses are 32-bit addresses that consist of a *network part* (the address of the network where the host is located) and a *host part* (the address of the host on that network).

Figure 24 IP Address: Network Part and Host Part


IP Address
32 bits
network
host
The boundary between network and host parts depends on the class of IP network.

IP addresses differ from Ethernet MAC addresses, which are unique hardware-configured 48-bit addresses. A central agency, such as the InterNIC Registration Services mentioned above, assigns the network part of the IP address, and you assign the host part. All devices that are connected to the same network share the same network part (also called the *prefix*).

Dotted Decimal Notation

The actual IP address is a 32-bit number that is stored in binary format. These 32 bits are segmented into 4 groups of 8 bits — each group is referred to as a *field* or an *octet*. Decimal notation converts the value of each field into a decimal number, and the fields are separated by dots.

Figure 25 Dotted Decimal Notation for IP Addresses

```
10011110.01100101.00001010.00100000     = Binary notation

                      158.101.10.32     = Decimal notation
```

The decimal value of an octet whose bits are all 1s is 255.

Network Portion

The location of the boundary between the network part and the host part depends on the class that the central agency assigns to your network. The three primary classes of IP addresses are as follows:

- **Class A address** — Uses 8 bits for the network part and 24 bits for the host part. Although only a few Class A networks can be created, each can contain a very large number of hosts.
- **Class B address** — Uses 16 bits for the network part and 16 bits for the host part.
- **Class C address** — Uses 24 bits for the network part and 8 bits for the host part. Each Class C network can contain only 254 hosts, but many such networks can be created.

The high-order bits of the network part of the address designate the IP network class. See Table 10.

Table 10 How Address Class Corresponds to the Address Number

Address Class	High-order Bits	Address Number (Decimal)
A	0nnnnnnn	0-127
B	10nnnnnn	128-191
C	11nnnnnn	192-254

Subnets and Subnet Masks

You can divide your IP network into sub-networks also known as subnets. Support for subnets is important because the number of bits assigned to the device part of an IP address limits the number of devices that may be addressed on any given network. For example, a Class C address is restricted to 254 devices.

The IP address can also contain a *subnetwork part* at the beginning of the host part of the IP address. Thus, you can divide a single Class A, B, or C network internally, allowing the network to appear as a single network to other external networks. The subnetwork part of the IP address is visible only to hosts and gateways on the subnetwork.

When an IP address contains a subnetwork part, a *subnet mask* identifies the bits that constitute the subnetwork address and the bits that constitute the host address. A subnet mask is a 32-bit number in the IP address format. The *1* bits in the subnet mask indicate the network and subnetwork part of the address. The *0* bits in the subnet mask indicate the host part of the IP address, as shown in Figure 26.

Figure 26 Subnet Masking

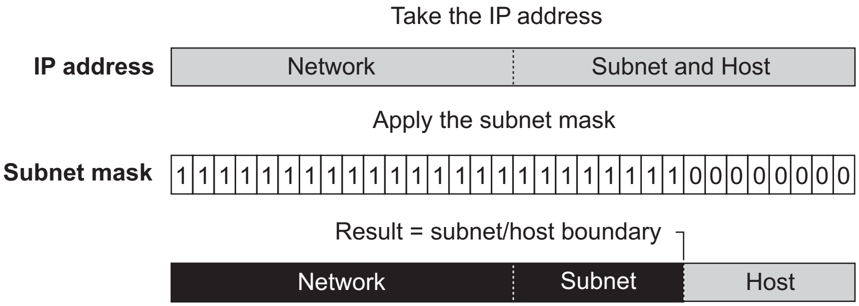


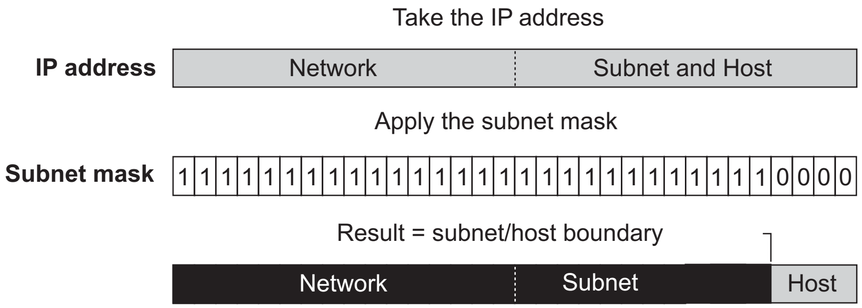
Figure 27 shows an example of an IP address that includes network, subnetwork, and host parts. Suppose the IP address is *158.101.230.52* with a subnet mask of *255.255.255.0*. Since this is a Class B address, this address is divided as follows:

- *158.101* is the network part
- *230* is the subnetwork part
- *52* is the host part

As shown in this example, the 32 bits of an IP address and subnet mask are usually written using an integer shorthand. This notation translates four consecutive 8-bit groups (octets) into four integers that range from 0 through 255. The subnet mask in the example is written as 255.255.255.0.

Traditionally, subnet masks were applied to octets in their entirety. However, one octet in the subnet mask can be further subdivided so that part of the octet indicates an *extension* of the network number, and the rest of the same octet indicates the host number, as shown in Figure 27.

Figure 27 Extending the Network Prefix



Using the Class B IP address from Figure 26 (158.101.230.52), the subnet mask is 255.255.255.240.

The number that includes both the Class B natural network mask (255.255) and the subnet mask (255.240) is sometimes called the *extended network prefix*.

Continuing with the previous example, the subnetwork part of the mask uses 12 bits, and the host part uses the remaining 4 bits. Because the octets are actually binary numbers, the number of subnetworks that are possible with this mask is 4,096 (2^{12}), and the number of hosts that are possible in each subnetwork is 16 (2^{4}).

Subnet Mask Numbering

An alternate method to represent the subnet mask numbers is based on the number of bits that signify the network portion of the mask. Many Internet Service Providers (ISPs) now use this notation to denote the subnet mask. See Table 11.

Table 11 Subnet Mask Notation

Standard Mask Notation	Network Prefix Notation
100.100.100.100 (255.0.0.0)	100.100.100.100/8
100.100.100.100 (255.255.0.0)	100.100.100.100/16
100.100.100.100 (255.255.255.0)	100.100.100.100/24

The subnet mask 255.255.255.255 is reserved as the default broadcast address.

Default Gateways

A gateway is a device on your network which is used to forward IP packets to a remote destination. An alternative name for a gateway is a Router. “Remote” refers to a destination device that is not directly attached to the same network segment as the source device.

The source device cannot send IP packets directly to the destination device because it is in a different network segment. Instead you configure it to send the packets to a gateway which is attached to multiple segments.

When it receives the IP packets, the gateway determines the next network hop on the path to the remote destination, and sends the packets to that hop. This could either be the remote destination or another gateway closer towards the destination.

This hop-by-hop process continues until the IP packets reach the remote destination.

If manually configuring IP information for the Switch, enter the IP address of the default gateway on the local subnet in which the Switch is located. If no default gateway exists on your network, enter the IP address `0.0.0.0` or leave the field blank.

D STANDARDS SUPPORTED

This Appendix lists the industry standards supported by this version of Gigabit Multilayer Switching Software

Table 12 Standards Supported.

SNMP:

SNMP Protocol (RFC 1157)

MIB-II (RFC 1213)

Bridge MIB (RFC 1493)

RMON MIB II (RFC2021)

Remote Monitoring MIB (RFC 1757)

MAU MIB (RFC 2239)

Administration:

UDP (RFC 768)

IP (RFC 791)

ICMP (RFC 792)

TCP (RFC 793)

ARP (RFC 826)

TFTP (RFC 783)

DHCP (RFC 2131, RFC 2132, RFC 1534)

BOOTP (RFC 951, RFC 1497)

Terminal Emulation:

TELNET (RFC 854)

Network Login:

Network Login (IEEE 802.1X)

RADIUS (RFC 2618, 2620)

GLOSSARY

3Com Network Supervisor The 3Com network management application used to manage 3Com's networking solutions.

10BASE-T The IEEE specification for 10 Mbps Ethernet over Category 3, 4 or 5 twisted pair cable.

100BASE-FX The IEEE specification for 100 Mbps Fast Ethernet over multimode fiber-optic cable.

100BASE-TX The IEEE specification for 100 Mbps Fast Ethernet over Category 5 twisted-pair cable.

1000BASE-T The IEEE specification for 1000 Mbps Gigabit Ethernet over four-pair Category 5 twisted-pair cable.

1000BASE-SX The IEEE specification for 1000 Mbps Gigabit Ethernet over fiber-optic cable.

aging The automatic removal of dynamic entries from the Switch Database which have timed-out and are no longer valid.

Aggregated Links Aggregated links allow a user to increase the bandwidth and resilience between switches by using a group of ports to carry traffic between the switches.

auto-negotiation A feature on twisted pair ports that allows them to advertise their capabilities for speed, duplex and flow control. When connected to a port that also supports auto-negotiation, the link can automatically configure itself to the optimum setup.

backbone The part of a network used as a primary path for transporting traffic between network segments.

bandwidth The information capacity, measured in bits per second, that a channel can transmit. The bandwidth of Ethernet is 10 Mbps, the bandwidth of

Fast Ethernet is 100 Mbps, and the bandwidth of Gigabit Ethernet is 1000 Mbps.

baud The signalling rate of a line, that is, the number of transitions (voltage or frequency changes) made per second. Also known as *line speed*.

BOOTP The BOOTP protocol allows you to automatically map an IP address to a given MAC address each time a device is started. In addition, the protocol can assign the subnet mask and default gateway to a device.

bridge A device that interconnects two LANs of a different type to form a single logical network that comprises of two network segments.

Bridges learn which endstations are on which network segment by examining the source addresses of packets. They then use this information to forward packets based on their destination address. This process is known as filtering.

broadcast A packet sent to all devices on a network.

broadcast storm Multiple simultaneous broadcasts that typically absorb all the available network bandwidth and can cause a network to fail. Broadcast storms can be due to faulty network devices.

cache Stores copies of frequently accessed objects locally to users and serves them to users when requested.

Classifier Classifies the traffic on the network. Traffic classifications are determined by protocol, application, source, destination, and so on. You can create and modify classifications. The Switch then groups classified traffic in order to schedule them with the appropriate service level.

collision A term used to describe two colliding packets in an Ethernet network. Collisions are a part of normal Ethernet operation, but a sudden prolonged increase in the number of collisions can indicate a problem with a device, particularly if it is not accompanied by a general increase in traffic.

CSMA/CD Carrier-sense Multiple Access with Collision Detection. The protocol defined in Ethernet and IEEE 802.3 standards in which devices transmit only after finding a data channel clear for a period of time. When two devices transmit simultaneously, a collision occurs and the colliding devices delay their retransmissions for a random length of time.

DHCP Dynamic Host Control Protocol. A protocol that lets you centrally manage and automate the assignment of Internet Protocol (IP) addresses in an organization's network.

DNS Domain Name System. This system maps a numerical Internet Protocol (IP) address to a more meaningful and easy-to-remember name. When you need to access another device on your network, you enter the name of the device, instead of its IP address.

DSCP DiffServ Code Point (DSCP) — is the traffic prioritization bits within an IP header that are encoded by certain applications and/or devices to indicate the level of service required by the packet across a network.

DUD Disconnect Unauthorized Device. A port security feature that disables a port if an unauthorized client device transmits data on it.

endstation A computer, printer or server that is connected to a network.

Ethernet A LAN specification developed jointly by Xerox, Intel and Digital Equipment Corporation. Ethernet networks use CSMA/CD to transmit packets at a rate of 10 Mbps over a variety of cables.

Ethernet address See *MAC address*.

Fast Ethernet An Ethernet system that is designed to operate at 100Mbps.

forwarding The process of sending a packet toward its destination using a networking device.

Forwarding Database See *Switch Database*.

filtering The process of screening a packet for certain characteristics, such as source address, destination address, or protocol. Filtering is used to determine whether traffic is to be forwarded, and can also prevent unauthorized access to a network or network devices.

flow control A mechanism that prevents packet loss during periods of congestion on the network. Packet loss is caused when devices send traffic to an already overloaded port on a Switch. Flow control prevents packet loss by inhibiting devices from generating more traffic until the period of congestion ends.

FTP File Transfer Protocol. A protocol based on TCP/IP for reliable file transfer.

full duplex A system that allows packets to be transmitted and received at the same time and, in effect, doubles the potential throughput of a link.

gateway See *router*.

GBIC Gigabit Interface Converter.

Gigabit Ethernet IEEE standard 802.3z for 1000 Mbps Ethernet; it is compatible with existing 10/100 Mbps Ethernet standards.

half duplex A system that allows packets to transmitted and received, but not at the same time. Contrast with *full duplex*.

hub A device that regenerates LAN traffic so that the transmission distance of that signal can be extended. Hubs are similar to repeaters, in that they connect LANs of the same type; however they connect more LANs than a repeater and are generally more sophisticated.

HTTP Hypertext Transfer Protocol. This is a set of rules for exchanging files (text, graphic images, sound, video, and other multimedia files) on the World Wide Web.

IEEE Institute of Electrical and Electronics Engineers. This American organization was founded in 1963 and sets standards for computers and communications.

IEEE 802.1D A standard that defines the behavior of bridges in an Ethernet network.

IEEE 802.1p A standard that defines traffic prioritization. 802.1p is now incorporated into the relevant sections of the IEEE 802.1D/D17 standard.

IEEE 802.1Q A standard that defines VLAN tagging.

IEEE 802.3x A standard that defines a system of flow control for ports that operate in full duplex.

IEEE 802.1w A standard that defines Rapid Spanning Tree Protocol (RSTP) behavior.

IETF Internet Engineering Task Force. An organization responsible for providing engineering solutions for TCP/IP networks. In the network management area, this group is responsible for the development of the SNMP protocol.

IGMP snooping A mechanism performed by an intermediate device, such as a Layer 2 Switch, that optimizes the flow of multicast traffic. The device listens for IGMP messages and build mapping tables and associated forwarding filters, in addition to reducing the IGMP protocol traffic.

Internet Group Management Protocol Internet Group Management Protocol (IGMP) is a protocol that runs between hosts and their immediate neighboring multicast routers. The protocol allows a host to inform its local router that it wishes to receive transmissions addressed to a specific multicast group. Based on group membership information learned from the IGMP, a router is able to determine which if any multicast traffic needs to be forwarded to each of its subnetworks.

Intranet An Intranet is an organisation wide network using Internet protocols such as web services, TCP/IP, HTTP and HTML. An Intranet is normally used for internal communication and information, and is not accessible to computers on the wider Internet.

IP Internet Protocol. IP is a layer 3 network protocol that is the standard for sending data through a network. IP is part of the TCP/IP set of protocols that describe the routing of packets to addressed devices.

IPX Internetwork Packet Exchange. IPX is a layer 3 and 4 network protocol designed for networks that use Novell® Netware®.

IP address Internet Protocol address. A unique identifier for a device attached to a network using TCP/IP. The address is written as four octets separated with periods (full-stops), and is made up of a network section, an optional subnet section and a host section.

Jitter An expression often used to describe the end-to-end delay variations during the course of a transmission. See also *latency*.

LAN Local Area Network. A network of endstations (such as PCs, printers, servers) and network devices (hubs and switches) that cover a relatively small geographic area (usually not larger than a floor or building). LANs are characterized by high transmission speeds over short distances (up to 1000 m).

LLC Logical Link Control. A sublayer of the IEEE data link layer that is located above the MAC sublayer. The LLC sublayer is responsible for MAC sublayer addressing, flow control, error control, and framing.

latency The delay between the time a device receives a packet and the time the packet is forwarded out of the destination port.

line speed See *baud*.

loop An event that occurs when two network devices are connected by more than one path, thereby causing packets to repeatedly cycle around the network and not reach their destination.

MAC Media Access Control. A protocol specified by the IEEE for determining which devices have access to a network at any one time.

MAC address Media Access Control address; also called hardware or physical address. A layer 2 address associated with a particular network device. Most devices that connect to a LAN have a MAC address assigned to them as they are used to identify other devices in a network. MAC addresses are 6 bytes long.

main port The port in a resilient link that carries data traffic in normal operating conditions.

MDI Medium Dependent Interface. An Ethernet port connection where the transmitter of one device is connected to the receiver of another device.

MDI-X Medium Dependent Interface Cross-over. An Ethernet port connection where the internal transmit and receive lines are crossed.

MIB Management Information Base. A collection of information about the management characteristics and parameters of a networking device. MIBs are used by the Simple Network Management Protocol (SNMP) to gather information about the devices on a network. The Switch contains its own internal MIB.

multicast A packet sent to a specific group of endstations on a network.

multicast filtering A system that allows a network device to only forward multicast traffic to an endstation if it has registered that it would like to receive that traffic.

Network Login A port security feature that controls user access at the network edge by blocking or unblocking access on a per-port basis.

NIC Network Interface Card. A circuit board installed in an endstation that allows it to be connected to a network.

Policy Comprises a set of “rules” that are applied to a network so that a network meets the needs of the business. That is, traffic can be prioritised across a network according to its importance to that particular business type.

POST Power On Self Test. An internal test that a Switch carries out when it is powered-up.

QoS Profile Consists of multiple sets of rules (classifier plus service level combinations). The QoS profile is assigned to a port(s).

protocol A set of rules for communication between devices on a network. The rules dictate format, timing, sequencing and error control.

Rada Radius Authenticated Device Access. This feature uses a device MAC address for authentication against a RADIUS server.

RADIUS Remote Authentication Dial-In User Service. An industry standard protocol for carrying authentication, authorization and configuration information between a network device and a shared authentication server.

Rapid Spanning Tree Protocol An enhanced version of the Spanning Tree Protocol that allows faster determination of Spanning Tree topology throughout the bridged network.

repeater A simple device that regenerates LAN traffic so that the transmission distance of that signal can be extended. Repeaters are used to connect two LANs of the same network type.

resilient link A pair of ports that can be configured so that one takes over data transmission should the other fail. See also *main port* and *standby port*.

RMON IETF Remote Monitoring MIB. A MIB that allows you to remotely monitor LANs by addressing up to nine different groups of information.

router A router is a device on your network which is used to forward IP packets to a remote destination. An alternative name for a router is a gateway.

RPS Redundant Power System. A device that provides a backup source of power when connected to a Switch.

RSTP See *Rapid Spanning Tree Protocol.*

SAP Service Access Point. A well-defined location that identifies the user of services of a protocol entity.

segment A section of a LAN that is connected to the rest of the network using a switch or bridge.

server A computer in a network that is shared by multiple endstations. Servers provide endstations with access to shared network services such as computer files and printer queues.

Service Levels Once traffic is classified, service levels can be applied to determine how the Switch treats classified packets. The Switch offers some predefined standard service levels, for example, best effort, business critical, network control, and so on.

SLIP Serial Line Internet Protocol. A protocol that allows IP to run over a serial line (console port) connection.

SMTP Simple Mail Transfer Protocol. An IETF standard protocol used for transferring mail across a network reliably and efficiently (as defined in RFC 821).

SNMP Simple Network Management Protocol. The current IETF standard protocol for managing devices on an TCP/IP network.

Spanning Tree Protocol (STP) A bridge-based system for providing fault tolerance on networks. STP works by allowing you to implement parallel paths for network traffic, and ensure that redundant paths are disabled when the main paths are operational and enabled if the main paths fail.

stack A group of network devices that are integrated to form a single logical device.

standby port The port in a resilient link that takes over data transmission if the main port in the link fails.

STP See *Spanning Tree Protocol (STP)*.

subnet mask A subnet mask is used to divide the device part of the IP address into two further parts. The first part identifies the subnet number. The second part identifies the device on that subnet.

switch A device that interconnects several LANs to form a single logical LAN that comprises of several LAN segments. Switches are similar to bridges, in that they connect LANs of a different type; however they connect more LANs than a bridge and are generally more sophisticated.

Switch Database A database that is stored by a switch to determine if a packet should be forwarded, and which port should forward the packet if it is to be forwarded. Also known as Forwarding Database.

TCP/IP Transmission Control Protocol/Internet Protocol. This is the name for two of the most well-known protocols developed for the interconnection of networks. Originally a UNIX standard, TCP/IP is now supported on almost all platforms, and is the protocol of the Internet.

TCP relates to the content of the data travelling through a network — ensuring that the information sent arrives in one piece when it reaches its destination. IP relates to the address of the endstation to which data is being sent, as well as the address of the destination network.

Telnet A TCP/IP application protocol that provides a virtual terminal service, letting a user log into another computer system and access a device as if the user were connected directly to the device.

TFTP Trivial File Transfer Protocol. Allows you to transfer files (such as software upgrades) from a remote device using the local management capabilities of the Switch.

traffic classification Traffic can be classified using one or more of types of traffic classifiers. A classifier detects the packet attributes and classifies the traffic accordingly.

traffic prioritization A system which allows data that has been assigned a high priority to be forwarded through a switch without being obstructed by other data.

unicast A packet sent to a single endstation on a network.

VLAN Virtual LAN. A group of location- and topology-independent devices that communicate as if they are on the same physical LAN.

VLAN tagging A system that allows traffic for multiple VLANs to be carried on a single link.

WAN Wide Area Network. A communications network that covers a wide area. A WAN can cover a large geographic area, and may contain several LANs within it.

Webcache A device that is installed on the network to cache frequently accessed Web pages from which they can be retrieved, thus reducing network traffic over the WAN.

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