

# Product Overview

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This chapter provides an overview of Catalyst 4500 series switches and includes the following major sections:

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- [Layer 3 Software Features, page 1-6](#)
- [Management Features, page 1-12](#)
- [Security Features, page 1-16](#)
- [Metro Feature, page 1-21](#)

**Note**

For more information about the chassis, modules, and software features supported by the Catalyst 4500 series switch, refer to the *Release Notes for the Catalyst 4500 Series Switch* at this location:

[http://www.cisco.com/en/US/docs/switches/lan/catalyst4500/release/note/OL\\_5184.html](http://www.cisco.com/en/US/docs/switches/lan/catalyst4500/release/note/OL_5184.html)

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## Layer 2 Software Features

The following subsections describe the key Layer 2 switching software features on the Catalyst 4500 series switch:

- [802.1Q and Layer 2 Protocol Tunneling, page 1-2](#)
- [CDP, page 1-2](#)
- [EtherChannel Bundles, page 1-2](#)
- [Jumbo Frames, page 1-2](#)
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## 802.1Q and Layer 2 Protocol Tunneling

802.1Q tunneling is a Q-in-Q technique that expands the VLAN space by retagging the tagged packets that enter the service provider infrastructure. 802.1Q tunneling allows service providers to assign a VLAN to each customer without losing the original customer VLAN IDs inside the tunnel. All data traffic that enters the tunnel is encapsulated with the tunnel VLAN ID. Layer 2 Protocol Tunneling is a similar technique for all Layer 2 control traffic. 802.1Q tunneling and Layer 2 Protocol Tunneling are supported on supervisor engines V , V-10GE, and 6-E.

For information on configuring 802.1Q tunneling, see [Chapter 23, “Configuring 802.1Q and Layer 2 Protocol Tunneling.”](#)

## CDP

The Cisco Discovery Protocol (CDP) is a device-discovery protocol that is both media- and protocol-independent. CDP is available on all Cisco products, including routers, switches, bridges, and access servers. Using CDP, a device can advertise its existence to other devices and receive information about other devices on the same LAN. CDP enables Cisco switches and routers to exchange information, such as their MAC addresses, IP addresses, and outgoing interfaces. CDP runs over the data-link layer only, allowing two systems that support different network-layer protocols to learn about each other. Each device configured for CDP sends periodic messages to a multicast address. Each device advertises at least one address at which it can receive Simple Network Management Protocol (SNMP) messages.

For information on configuring CDP, see [Chapter 24, “Configuring CDP.”](#)

## EtherChannel Bundles

EtherChannel port bundles allow you to create high-bandwidth connections between two switches by grouping multiple ports into a single logical transmission path.

For information on configuring EtherChannel, see [Chapter 20, “Configuring EtherChannel.”](#)

## Jumbo Frames

The jumbo frames feature allows the switch to forward packets as large as 9216 bytes (larger than the IEEE Ethernet MTU), rather than declare those frames “oversize” and discard them. This feature is typically used for large data transfers. The jumbo feature can be configured on a per-port basis on Layer 2 and Layer 3 interfaces and is supported only on WS-X4306-GB: all ports, WS-X4232-GB-RJ: ports 1-2, WS-X4418-GB: ports 1-2, WS-X4412-2GB-TX: ports 13-14, 4648-GB-RJ45V, WS-X4648-GB+RJ45V, WS-X4706-10GE linecards, and on Supervisor uplink ports.

For information on Jumbo Frames, see [Chapter 6, “Configuring Interfaces.”](#)

## Link Layer Discovery Protocol

To support non-Cisco devices and to allow for interoperability between other devices, the switch supports the IEEE 802.1AB LLDP. Link Layer Discovery Protocol (LLDP) is a neighbor discovery protocol that is used for network devices to advertise information about themselves to other devices on the network. This protocol runs over the data-link layer, which allows two systems running different network layer protocols to learn about each other.

LLDP supports a set of attributes that it uses to discover neighbor devices. These attributes contain type, length, and value descriptions and are referred to as *TLVs*. LLDP supported devices can use TLVs to receive and send information to their neighbors. Details such as configuration information, device capabilities, and device identity can be advertised using this protocol.

For information on configuring LLDP, see [Chapter 25, “Configuring LLDP and LLDP-MED.”](#)

## Multiple Spanning Tree

IEEE 802.1s Multiple Spanning Tree (MST) allows for multiple spanning tree instances within a single 802.1Q or Inter-Switch Link (ISL) VLAN trunk. MST extends the IEEE 802.1w Rapid Spanning Tree (RST) algorithm to multiple spanning trees. This extension provides both rapid convergence and load balancing within a VLAN environment.

MST allows you to build multiple spanning trees over trunks. You can group and associate VLANs to spanning tree instances. Each instance can have a topology independent of other spanning tree instances. This new architecture provides multiple forwarding paths for data traffic and enables load balancing. Network fault tolerance is improved because a failure in one instance (forwarding path) does not affect other instances (forwarding paths).

For information on configuring MST, see [Chapter 17, “Configuring STP and MST.”](#)

## Per-VLAN Rapid Spanning Tree

Per-VLAN Rapid Spanning Tree (PVRST+) is the implementation of 802.1w on a per-VLAN basis. It is the same as PVST+ with respect to STP mode and runs RSTP protocol based on 802.1w.

For information on configuring PVRST+, see [Chapter 17, “Configuring STP and MST.”](#)

## QoS

The quality of service (QoS) feature prevents congestion by selecting network traffic and prioritizing it according to its relative importance. Implementing QoS in your network makes network performance more predictable and bandwidth use more effective.

The Catalyst 4500 series switch supports the following QoS features:

- Classification and marking
- Ingress and egress policing, including per-Port per-VLAN policing
- Sharing and shaping

Catalyst 4500 series switch supports trusted boundary, which uses the Cisco Discovery Protocol (CDP) to detect the presence of a Cisco IP phone (such as the Cisco IP Phone 7910, 7935, 7940, and 7960) on a switch port. If the telephone is not detected, the trusted boundary feature disables the trusted setting on the switch port and prevents misuse of a high-priority queue.

The Catalyst 4500 series switch also supports QoS Automation (Auto QoS), which simplifies the deployment of existing QoS features through automatic configuration.

### Cisco Modular QoS Command-Line-Interface (Supervisor Engine 6-E)

Cisco Modular QoS CLI (MQC) is the framework used to implement Cisco IOS Software QoS. MQC allows the user to define a traffic class, create a traffic policy (containing the QoS feature to be applied to the traffic class), and attach the traffic policy to an interface. MQC is a cross-Cisco baseline that provides a consistent syntax and behavior of QoS features across multiple product families. Cisco IOS Software Release 12.2(40)SG complies to MQC for configuration of QoS features on the Supervisor Engine 6-E. MQC enables rapid deployment of new features and technology innovations and facilitates the management of network performance with respect to bandwidth, delay, jitter, and packet loss, enhancing the performance of mission-critical business applications. The rich and advanced QoS features that are supported as part of the Supervisor Engine 6-E are enabled using Cisco MQC.

### Two-Rate Three-Color Policing (Supervisor Engine 6-E)

The Two-Rate Three-Color Policing feature (also termed *Hierarchical QoS*) limits the input or output transmission rate of a class of traffic based on user-defined criteria and marks or colors packets by setting the applicable differentiated services code point (DSCP) values. This feature is often configured on the interfaces at the edge of a network to limit the rate of traffic entering or leaving the network. Using this feature, traffic that conforms to user-defined criteria can be sent through the interfaces, while traffic that exceeds or violates these criteria is sent out with a decreased priority setting or even dropped.

For information on QoS and Auto QoS, see [Chapter 34, “Configuring Quality of Service.”](#)

## Resilient Ethernet Protocol

Resilient Ethernet Protocol (REP) is a Cisco proprietary protocol that provides an alternative to Spanning Tree Protocol (STP) to control network loops, handle link failures, and improve convergence time. REP controls a group of ports connected in a segment, ensures that the segment does not create any bridging loops, and responds to link failures within the segment. REP provides a basis for constructing more complex networks and supports VLAN load balancing.

For information on QoS and Auto QoS, see [Chapter 18, “Configuring Resilient Ethernet Protocol.”](#)

## Spanning Tree Protocol

The Spanning Tree Protocol (STP) allows you to create fault-tolerant internetworks that ensure an active, loop-free data path between all nodes in the network. STP uses an algorithm to calculate the best loop-free path throughout a switched network.

For information on configuring STP, see [Chapter 17, “Configuring STP and MST.”](#)

The Catalyst 4500 series switch supports the following STP enhancements:

- Spanning tree PortFast—PortFast allows a port with a directly attached host to transition to the forwarding state directly, bypassing the listening and learning states.
- Spanning tree UplinkFast—UplinkFast provides fast convergence after a spanning-tree topology change and achieves load balancing between redundant links using uplink groups. Uplink groups provide an alternate path in case the currently forwarding link fails. UplinkFast is designed to decrease spanning-tree convergence time for switches that experience a direct link failure.
- Spanning tree BackboneFast—BackboneFast reduces the time needed for the spanning tree to converge after a topology change caused by an indirect link failure. BackboneFast decreases spanning-tree convergence time for any switch that experiences an indirect link failure.

- Spanning tree root guard—Root guard forces a port to become a designated port so that no switch on the other end of the link can become a root switch.

For information on the STP enhancements, see [Chapter 19, “Configuring Optional STP Features.”](#)

## Stateful Switchover

Stateful switchover (SSO) enables you to propagate configuration and state information from the active to the redundant supervisor engine so that sub-second interruptions in Layer 2 traffic occur when the active supervisor engine switches over to the redundant supervisor engine.

- Stateful IGMP Snooping

This feature propagates the IGMP data learned by the active supervisor engine to the redundant supervisor engine so that when a switchover occurs, the newly active supervisor engine is aware of the multicast group membership, which alleviates a disruption to multicast traffic during a switchover.

- Stateful DHCP Snooping

This feature propagates the DHCP-snooped data from the active supervisor engine to the redundant supervisor engine so that when a switchover occurs, the newly active supervisor engine is aware of the DHCP data that was already snooped, and the security benefits continue uninterrupted.

For information about SSO, see [Chapter 9, “Configuring Cisco NSF with SSO Supervisor Engine Redundancy.”](#)

## SVI Autostate

When a SVI has multiple ports on a VLAN, normally the SVI will go down when all the ports in the VLAN go down. You might design your network so that some ports should not be counted in the calculation of SVI “going up or down.” SVI Autostate provides a knob to mark a port so that it is not counted in the SVI “going up and down” calculation and applies to all VLANs that are enabled on that port.

## UBRL

User Based Rate Limiting (UBRL) enables you to adopt microflow policing to dynamically learn traffic flows and rate limit each unique flow to an individual rate. UBRL is available only on the Supervisor Engine V-10GE with the built-in NetFlow support.

For information about UBRL, see [Configuring User Based Rate Limiting, page 34-42.](#)

## UDLD

The UniDirectional Link Detection (UDLD) protocol allows devices connected through fiber-optic or copper Ethernet cables to monitor the physical configuration of the cables and detect a unidirectional link.

For information about UDLD, see [Chapter 26, “Configuring UDLD.”](#)

## Unidirectional Ethernet

Unidirectional Ethernet uses only one strand of fiber for either transmitting or receiving one-way traffic for the Gigaport, instead of two strands of fiber for a full-duplex Gigaport Ethernet.

For information about Unidirectional Ethernet, see [Chapter 30, “Configuring Unidirectional Ethernet.”](#)

## VLANs

A VLAN configures switches and routers according to logical, rather than physical, topologies. Using VLANs, a network administrator can combine any collection of LAN segments within an internetwork into an autonomous user group, such that the segments appear as a single LAN in the network. VLANs logically segment the network into different broadcast domains so that packets are switched only between ports within the VLAN. Typically, a VLAN corresponds to a particular subnet, although not necessarily.

For more information about VLANs, VTP, and Dynamic VLAN Membership, see [Chapter 13, “Configuring VLANs, VTP, and VMPS.”](#)

The following VLAN-related features are also supported.

- **VLAN Trunking Protocol (VTP)**—VTP maintains VLAN naming consistency and connectivity between all devices in the VTP management domain. You can have redundancy in a domain by using multiple VTP servers, through which you can maintain and modify the global VLAN information. Only a few VTP servers are required in a large network.
- **Private VLANs**—Private VLANs are sets of ports that have the features of normal VLANs and also provide some Layer 2 isolation from other ports on the switch.  
For information about private VLANs, see [Chapter 36, “Configuring Private VLANs.”](#)
- **Private VLAN Trunk Ports**—Private VLAN trunk ports allow a secondary port on a private VLAN to carry multiple secondary VLANs.
- **Private VLAN Promiscuous Trunk Ports**—Private VLAN promiscuous trunk extends the promiscuous port to a 802.1Q trunk port, carrying multiple primary VLANs (hence multiple subnets). Private VLAN promiscuous trunk is typically used to offer different services or content on different primary VLANs to isolated subscribers. Secondary VLANs can not be carried over the private VLAN promiscuous trunk.
- **Dynamic VLAN Membership**—Dynamic VLAN Membership allows you to assign switch ports to VLANs dynamically, based on the source Media Access Control (MAC) address of the device connected to the port. When you move a host from a port on one switch in the network to a port on another switch in the network, that switch dynamically assigns the new port to the proper VLAN for that host. With the VMPS Client feature, you can convert a dynamic access port to a VMPS client. VMPS clients can use VQP queries to communicate with the VMPS server to obtain a VLAN assignment for the port based on the MAC address of the host attached to that port.

## Layer 3 Software Features

A Layer 3 switch is a high-performance switch that has been optimized for a campus LAN or an intranet, and it provides both wirespeed Ethernet routing and switching services. Layer 3 switching improves network performance with two software functions—route processing and intelligent network services.

Compared to conventional software-based switches, Layer 3 switches process more packets faster; they do so by using application-specific integrated circuit (ASIC) hardware instead of microprocessor-based engines.

The following subsections describe the key Layer 3 switching software features on the Catalyst 4500 series switch:

- [CEF, page 1-7](#)
- [HSRP, page 1-7](#)
- [IP Routing Protocols, page 1-8](#)
- [Multicast Services, page 1-10](#)
- [NSF with SSO, page 1-11](#)
- [Policy-Based Routing, page 1-12](#)
- [Unidirectional Link Routing, page 1-12](#)
- [VRF-lite, page 1-12](#)

## CEF

Cisco Express Forwarding (CEF) is an advanced Layer 3 IP-switching technology. CEF optimizes network performance and scalability in networks with large and dynamic traffic patterns, such as the Internet, and on networks that use intensive web-based applications or interactive sessions. Although you can use CEF in any part of a network, it is designed for high-performance, highly resilient Layer 3 IP-backbone switching.

For information on configuring CEF, see [Chapter 28, “Configuring Cisco Express Forwarding.”](#)

## HSRP

The Hot Standby Router Protocol (HSRP) provides high network availability by routing IP traffic from hosts on Ethernet networks without relying on the availability of any single Layer 3 switch. This feature is particularly useful for hosts that do not support a router discovery protocol and do not have the functionality to switch to a new router when their selected router reloads or loses power.

For information on configuring HSRP, refer to the following URL:

[http://www.cisco.com/en/US/docs/ios/ipapp/configuration/guide/ipapp\\_hsrp\\_ps6350\\_TSD\\_Products\\_Configuration\\_Guide\\_Chapter.html](http://www.cisco.com/en/US/docs/ios/ipapp/configuration/guide/ipapp_hsrp_ps6350_TSD_Products_Configuration_Guide_Chapter.html)

## SSO Aware HSRP

SSO Aware HSRP offers continuous data packet forwarding during a supervisor engine switchover without a path change to the standby HSRP router. During supervisor engine switchover, NSF with SSO continues forwarding data packets along known routes using the HSRP virtual IP address. When both supervisor engines fail on the active HSRP router, the standby HSRP router takes over as the active HSRP router. It further extends reliability and availability offered by the Catalyst 4500's NSF with SSO to the Layer 3 aggregation with redundant chassis. SSO aware HSRP is available for Supervisor Engine IV, V and V-10GE on Catalyst 4507R and 4510R chassis with supervisor redundancy.

## IP Routing Protocols

The following routing protocols are supported on the Catalyst 4500 series switch:

- [BGP, page 1-8](#)
- [EIGRP, page 1-8](#)
- [GLBP, page 1-9](#)
- [IGRP, page 1-9](#)
- [IS-IS, page 1-9](#)
- [OSPF, page 1-10](#)
- [RIP, page 1-10](#)
- [VRRP, page 1-10](#)

### BGP

The Border Gateway Protocol (BGP) is an exterior gateway protocol that allows you to set up an interdomain routing system to automatically guarantee the loop-free exchange of routing information between autonomous systems. In BGP, each route consists of a network number, a list of autonomous systems that information has passed through (called the autonomous system path), and a list of other path attributes.

The Catalyst 4500 series switch supports BGP version 4, including classless interdomain routing (CIDR). CIDR lets you reduce the size of your routing tables by creating aggregate routes, resulting in supernets. CIDR eliminates the concept of network classes within BGP and supports the advertising of IP prefixes. CIDR routes can be carried by OSPF, EIGRP, and RIP.

### BGP Route-Map Continue

The BGP Route-Map Continue feature introduces the continue clause to the BGP route-map configuration. The continue clause provides more programmable policy configuration and route filtering. It introduces the capability to execute additional entries in a route map after an entry is executed with successful match and set clauses. Continue clauses allow configuring and organizing more modular policy definitions to reduce the number of policy configurations that are repeated within the same route map.

### EIGRP

The Enhanced Interior Gateway Routing Protocol (EIGRP) is a version of IGRP that combines the advantages of link-state protocols with distance-vector protocols. EIGRP incorporates the Diffusing Update Algorithm (DUAL). EIGRP includes fast convergence, variable-length subnet masks, partially bounded updates, and multiple network-layer support. When a network topology change occurs, EIGRP checks its topology table for a suitable new route to the destination. If such a route exists in the table, EIGRP updates the routing table instantly. You can use the fast convergence and partial updates that EIGRP provides to route Internetwork Packet Exchange (IPX) packets.

EIGRP saves bandwidth by sending routing updates only when routing information changes. The updates contain information only about the link that changed, not the entire routing table. EIGRP also takes into consideration the available bandwidth when determining the rate at which it transmits updates.

**Note**

Layer 3 switching does not support the Next Hop Resolution Protocol (NHRP).

**Note**

Customers can configure Enhanced Interior Gateway Routing Protocol (EIGRP) to route IPv6 prefixes. EIGRP configuration and protocol behavior for both IPv4 and IPv6 prefixes are similar, providing operational familiarity and continuity. EIGRP support for IPv6 will enable customers to use their existing EIGRP knowledge and processes, allowing them to deploy an IPv6 network at a low cost.

## GLBP

The Gateway Load Balancing Protocol (GLBP) feature provides automatic router backup for IP hosts configured with a single default gateway on a LAN. Multiple first hop routers on the LAN combine to offer a single virtual first hop IP router while sharing the IP packet forwarding load. GLBP devices share packet-forwarding responsibilities, optimizing resource usage, thereby reducing costs. Other routers on the LAN may act as redundant GLBP routers that will become active if any of the existing forwarding routers fail. This improves the resiliency of the network and reduces administrative burden. GLBP is a feature that is applicable for the Supervisor Engine 6-E and the classic supervisor engines.

For details on GLBP, refer to this URL:

[http://www.cisco.com/en/US/docs/ios/ipapp/configuration/guide/ipapp\\_glbp\\_ps6350\\_TSD\\_Products\\_Configuration\\_Guide\\_Chapter.html](http://www.cisco.com/en/US/docs/ios/ipapp/configuration/guide/ipapp_glbp_ps6350_TSD_Products_Configuration_Guide_Chapter.html)

## IGRP

The Interior Gateway Routing Protocol (IGRP) is a robust distance-vector Interior Gateway Protocol (IGP) developed by Cisco to provide for routing within an autonomous system (AS). Distance vector routing protocols request that a switch send all or a portion of its routing table data in a routing update message at regular intervals to each of its neighboring routers. As routing information proliferates through the network, routers can calculate distances to all nodes within the internetwork. IGRP uses a combination of metrics: internetwork delay, bandwidth, reliability, and load are all factored into the routing decision.

## IS-IS

The Intermediate System-to-Intermediate System Protocol (IS-IS Protocol) uses a link-state routing algorithm. It closely follows the Open Shortest Path First (OSPF) routing protocol used within the TCP/IP environment. The operation of ISO IS-IS Protocol requires each router to maintain a full topology map of the network (that is, which intermediate systems and end systems are connected to which other intermediate systems and end systems). Periodically, the router runs an algorithm over its map to calculate the shortest path to all possible destinations.

The IS-IS Protocol uses a two-level hierarchy. Intermediate Systems (or routers) are classified as Level 1 and Level 2. Level 1 intermediate systems deal with a single routing area. Traffic is relayed only within that area. Any other internetwork traffic is sent to the nearest Level 2 intermediate systems, which also acts as a Level 1 intermediate systems. Level 2 intermediate systems move traffic between different routing areas within the same domain.

An IS-IS with multi-area support allows multiple Level 1 areas within a single intermediate system, thus allowing an intermediate system to be in multiple areas. A single Level 2 area is used as backbone for inter-area traffic.

Only Ethernet frames are supported. The IS-IS Protocol does not support IPX.

## OSPF

The Open Shortest Path First (OSPF) protocol is a standards-based IP routing protocol designed to overcome the limitations of RIP. Because OSPF is a link-state routing protocol, it sends link-state advertisements (LSAs) to all other routers within the same hierarchical area. Information on the attached interfaces and their metrics is used in OSPF LSAs. As routers accumulate link-state information, they use the shortest path first (SPF) algorithm to calculate the shortest path to each node. Additional OSPF features include equal-cost multipath routing and routing based on the upper-layer type of service (ToS) requests.

OSPF employs the concept of an area, which is a group of contiguous OSPF networks and hosts. OSPF areas are logical subdivisions of OSPF autonomous systems in which the internal topology is hidden from routers outside the area. Areas allow an additional level of hierarchy different from that provided by IP network classes, and they can be used to aggregate routing information and mask the details of a network. These features make OSPF particularly scalable for large networks.

## RIP

The Routing Information Protocol (RIP) is a distance-vector, intradomain routing protocol. RIP works well in small, homogeneous networks. In large, complex internetworks, it has many limitations, such as a maximum hop count of 15, lack of support for variable-length subnet masks (VLSMs), inefficient use of bandwidth, and slow convergence. RIP II does support VLSMs.

## VRRP

Virtual Router Redundancy Protocol (VRRP) is a standard based first-hop redundancy protocol. With VRRP, a group of routers function as one virtual router by sharing one virtual IP address and one virtual MAC address. The master router performs packet forwarding, while the backup routers stay idle. VRRP is typically used in the multi vendor first-hop gateway redundancy deployment.

## Multicast Services

Multicast services save bandwidth by forcing the network to replicate packets only when necessary and by allowing hosts to join and leave groups dynamically. The following multicast services are supported:

- Cisco Group Management Protocol (CGMP) server—CGMP server manages multicast traffic. Multicast traffic is forwarded only to ports with attached hosts that request the multicast traffic.
- Internet Group Management Protocol (IGMP) snooping—IGMP snooping manages multicast traffic. The switch software examines IP multicast packets and forwards packets based on their content. Multicast traffic is forwarded only to ports with attached hosts that request multicast traffic.

Support for IGMPv3 provides constrained flooding of multicast traffic in the presence of IGMPv3 hosts or routers. IGMPv3 snooping listens to IGMPv3 query and membership report messages to maintain host-to-multicast group associations. It enables a switch to propagate multicast data only to ports that need it. IGMPv3 snooping is fully interoperable with IGMPv1 and IGMPv2.

Explicit Host Tracking (EHT) is an extension to IGMPv3 snooping. EHT enables immediate leave operations on a per-port basis. EHT can be used to track per host membership information or to gather statistics about all IGMPv3 group members.

For information on configuring IGMP snooping, see [Chapter 21, “Configuring IGMP Snooping and Filtering.”](#)

- IPv6 Multicast Listen Discovery (MLD) and Multicast Listen Discovery snooping—(MLD is a protocol used by IPv6 multicast devices to discover the presence of multicast listeners (nodes wishing to receive IPv6 multicast packets) on its directly attached links and to discover which multicast packets are of interest to neighboring nodes. MLD snooping is supported in two different versions: MLD v1 and MLD v2. Network switches use MLD snooping to limit the flood of multicast traffic, causing IPv6 multicast data to be selectively forwarded to a list of ports that want to receive the data, instead of being flooded to all ports in a VLAN. This lessens the load on devices in the network, minimizing unnecessary bandwidth on links, enabling efficient distribution of IPv6 multicast data.

For information on configuring multicast services, see [Chapter 22, “Configuring IPv6 MLD Snooping.”](#)

- Protocol Independent Multicast (PIM)—PIM is protocol-independent because it can leverage whichever unicast routing protocol is used to populate the unicast routing table, including EIGRP, OSPF, BGP, or static route. PIM also uses a unicast routing table to perform the Reverse Path Forwarding (RPF) check function instead of building a completely independent multicast routing table.

For information on configuring multicast services, see [Chapter 31, “Configuring IP Multicast.”](#)

## NSF with SSO

Non-Stop Forwarding with Stateful Switchover (NSF/SSO) offers continuous data packet forwarding in a Layer 3 routing environment during supervisor engine switchover. It further extends reliability and availability offered by the Catalyst 4500’s SSO and NSF-aware to the Layer 3 networks. During supervisor engine switchover, NSF/SSO continues forwarding data packets along known routes while the routing protocol information is recovered and validated, avoiding unnecessary route flaps and network instability. With NSF/SSO, IP phone calls do not drop. NSF/SSO is supported for OSPF, BGP, EIGRP, IS-IS, and Cisco Express Forwarding (CEF). NSF/SSO is typically deployed in the most critical parts of an enterprise or service provider network, such as Layer 3 aggregation/core or a resilient Layer 3 wiring closet design. It is an essential component of single chassis deployment for critical applications. NSF/SSO is available for all shipping supervisor engines on Catalyst 4507R and 4510R chassis with supervisor redundancy.

For information on NSF with SSO, see [Chapter 9, “Configuring Cisco NSF with SSO Supervisor Engine Redundancy.”](#)

## ISSU

SSO requires the same version of IOS on both the active and standby supervisor engines. Because of version mismatch during an upgrade or downgrade of the Cisco IOS software, a Catalyst 4500 series switch is forced into operating in RPR mode. In this mode, after the switchover, you can observe link-flaps and a disruption in service. This issue is solved by the In Service Software Upgrade (ISSU) feature that enables you to operate in SSO/NSF mode while performing software upgrade or downgrade.

ISSU allows an upgrade or downgrade of the Catalyst IOS images at different release levels on the both the active and standby supervisor engines by utilizing the Version Transformation Framework between the stateful components running on each supervisor engine.

## Policy-Based Routing

Traditional IP forwarding decisions are based purely on the destination IP address of the packet being forwarded. Policy Based Routing (PBR) enables forwarding based upon other information associated with a packet, such as the source interface, IP source address, Layer 4 ports, and so on. This feature allows network managers more flexibility in how they configure and design their networks.

For more information on policy-based routing, see [Chapter 32, “Configuring Policy-Based Routing.”](#)

## Unidirectional Link Routing

Unidirectional link routing (UDLR) provides a way to forward multicast packets over a physical unidirectional interface (such as a satellite link of high bandwidth) to stub networks that have a back channel.

For information on configuring unidirectional link routing, refer to the chapter “Configuring Unidirectional Link Routing” in the *Cisco IP and IP Routing Configuration Guide*.

## VRF-lite

VPN routing and forwarding (VRF-lite) is an extension of IP routing that provides multiple routing instances. Along with BGP, it enables the creation of a Layer 3 VPN service by keeping separate IP routing and forwarding tables for each VPN customer. VRF-lite uses input interfaces to distinguish routes for different VPNs. It forms virtual packet-forwarding tables by associating one or more Layer 3 interfaces with each VRF, allowing the creation of multiple Layer 3 VPNs on a single switch. Interfaces in a VRF could be either physical, such as an Ethernet port, or logical, such as a VLAN switch virtual interface (SVI). However, interfaces cannot belong to more than one VRF at any time.

For information on VRF-lite, see [Chapter 33, “Configuring VRF-lite.”](#)

## Management Features

The Catalyst 4500 series switch offers network management and control through the CLI or through alternative access methods, such as SNMP. The switch software supports these network management features:

- [Cisco Network Assistant and Embedded CiscoView, page 1-13](#)
- [Dynamic Host Control Protocol, page 1-13](#)
- [FAT File Management System \(Supervisor Engine 6-E only\), page 1-13](#)
- [Forced 10/100 Autonegotiation, page 1-13](#)
- [Intelligent Power Management, page 1-14](#)
- [IP SLA, page 1-14](#)
- [MAC Address Notification, page 1-14](#)
- [MAC Notify MIB, page 1-14](#)
- [NetFlow Statistics, page 1-14](#)
- [Secure Shell, page 1-15](#)

- [Simple Network Management Protocol, page 1-15](#)
- [SPAN and RSPAN, page 1-15](#)
- [Virtual Router Redundancy Protocol, page 1-15](#)
- [Web Content Coordination Protocol, page 1-16](#)

## Cisco Network Assistant and Embedded CiscoView

Web-based tools to configure the Catalyst 4500 series switch. Cisco Network Assistant manages standalone devices, clusters of devices, or federations of devices from anywhere in your intranet. Using its graphical user interface, you can perform multiple configuration tasks without having to remember command-line interface commands. Embedded CiscoView is a device management application that can be embedded on the switch flash and provides dynamic status, monitoring, and configuration information for your switch.

Visual port status information—The switch LEDs provide visual management of port- and switch-level status.

For more information on Cisco Network Assistant and Embedded CiscoView, see [Chapter 12, “Configuring the Catalyst 4500 Series Switch with Cisco Network Assistant.”](#)

## Dynamic Host Control Protocol

The Catalyst 4500 series switch uses DHCP in the following ways:

- **Dynamic Host Control Protocol server**—The Cisco IOS DHCP server feature is a full DHCP server implementation that assigns and manages IP addresses from specified address pools within the router to DHCP clients. If the Cisco IOS DHCP server cannot satisfy a DHCP request from its own database, it can forward the request to one or more secondary DHCP servers defined by the network administrator.
- **Dynamic Host Control Protocol autoconfiguration**—With this feature your switch (the DHCP client) is automatically configured at startup with IP address information and a configuration file.

For DHCP server configuration information, refer to the chapter, “Configuring DHCP,” in the *Cisco IOS IP and IP Routing Configuration Guide* at the following URL:

[http://www.cisco.com/en/US/docs/ios/ipaddr/configuration/guide/iad\\_dhcp\\_rdmf\\_ps6350\\_TSD\\_Products\\_Configuration\\_Guide\\_Chapter.html](http://www.cisco.com/en/US/docs/ios/ipaddr/configuration/guide/iad_dhcp_rdmf_ps6350_TSD_Products_Configuration_Guide_Chapter.html)

## FAT File Management System (Supervisor Engine 6-E only)

The FAT file system is widely used to manage files on device disks and flash. The support of the FAT file system allows one to easily remove, add, and/or transfer images to and from the flash.

## Forced 10/100 Autonegotiation

This feature allows you to configure a port to limit the speed at which it will autonegotiate to a speed lower than the physically maximum speed. This method of reducing the throughput incurs much less overhead than using an ACL.

## Intelligent Power Management

Working with powered devices (PDs) from Cisco, this feature uses power negotiation to refine the power consumption of an 802.3af-compliant PD beyond the granularity of power consumption provided by the 802.3af class. Power negotiation also enables the backward compatibility of newer PDs with older modules that do not support either 802.3af or high-power levels as required by IEEE standard.

For more information on Intelligent Power Management, see the “Intelligent Power Management” section in [Chapter 11, “Configuring Power over Ethernet.”](#)

## IP SLA

Cisco IOS IP Service Level Agreements (SLAs) allows Cisco customers to analyze IP service levels for IP applications and services by using active traffic monitoring—the generation of traffic in a continuous, reliable, and predictable manner—for measuring network performance. With Cisco IOS IP SLAs, service provider customers can measure and provide service level agreements, and enterprise customers can verify service levels, verify outsourced service level agreements, and understand network performance. Cisco IOS IP SLAs can perform network assessments, verify quality of service (QoS), ease the deployment of new services, and assist with network troubleshooting.

For more information on IP SLA, see [Chapter 49, “Configuring Cisco IOS IP SLAs Operations”](#).

## MAC Address Notification

MAC address notification monitors the MAC addresses that are learned by, aged out or removed from the Catalyst 4500 series switch. Notifications are sent out or retrieved via the CISCO-MAC-NOTIFICATION MIB. It is typically used by a central network management application to collect such MAC address notification events for host moves. User configurable MAC table utilization thresholds can be defined to notify any potential DoS or man-in-the-middle attack.

For information on MAC Address Notification, see [Chapter 4, “Administering the Switch.”](#)

## MAC Notify MIB

The MAC Notify MIB feature monitors network performance, utilization, and security conditions enabling a network administrator to track the MAC addresses that are learned or removed on the switch forwarding the Ethernet frames.

## NetFlow Statistics

NetFlow Statistics is a global traffic monitoring feature that allows flow-level monitoring of all IPv4-routed traffic through the switch. Both routed and switched IP flows are supported.

For more information on NetFlow statistics, see [Chapter 48, “Configuring NetFlow.”](#)

## Secure Shell

Secure Shell (SSH) is a program that enables you to log into another computer over a network, to execute commands remotely, and to move files from one machine to another. The switch may not initiate SSH connections: SSH will be limited to providing a remote login session to the switch and will only function as a server.

## Simple Network Management Protocol

Simple Network Management Protocol (SNMP) facilitates the exchange of management information between network devices. The Catalyst 4500 series switch supports these SNMP types and enhancements:

- SNMP—A full Internet standard
- SNMP v2—Community-based administrative framework for version 2 of SNMP
- SNMP v3—Security framework with three levels: noAuthNoPriv, authNoPriv, and authPriv (available only on a crypto image, like cat4000-i5k91s-mz)
- SNMP trap message enhancements—Additional information with certain SNMP trap messages, including spanning-tree topology change notifications and configuration change notifications

For more information on SNMP, see [Chapter 47, “Configuring SNMP.”](#)

## SPAN and RSPAN

Switched Port Analyzer (SPAN) allows you to monitor traffic on any port for analysis by a network analyzer or Remote Monitoring (RMON) probe. You also can do the following:

- Configure ACLs on SPAN sessions.
- Allow incoming traffic on SPAN destination ports to be switched normally.
- Explicitly configure the encapsulation type of packets that are spanned out of a destination port.
- Restrict ingress sniffing depending on whether the packet is unicast, multicast, or broadcast, and depending on whether the packet is valid.
- Mirror packets sent to or from the CPU out of a SPAN destination port for troubleshooting purposes.

For information on SPAN, see [Chapter 45, “Configuring SPAN and RSPAN.”](#)

Remote SPAN (RSPAN) is an extension of SPAN, where source ports and destination ports are distributed across multiple switches, allowing remote monitoring of multiple switches across the network. The traffic for each RSPAN session is carried over a user-specified RSPAN VLAN that is dedicated for that RSPAN session on all participating switches.

For information on RSPAN, see [Chapter 45, “Configuring SPAN and RSPAN.”](#)

## Virtual Router Redundancy Protocol

The Virtual Router Redundancy Protocol (VRRP) operates between routers attached to a common LAN and enables them to provide first-hop resiliency to LAN clients.

For information on VRRP, see the URL:

[http://www.cisco.com/en/US/docs/ios/ipapp/configuration/guide/ipapp\\_vrrp\\_ps6350\\_TSD\\_Products\\_Configuration\\_Guide\\_Chapter.html](http://www.cisco.com/en/US/docs/ios/ipapp/configuration/guide/ipapp_vrrp_ps6350_TSD_Products_Configuration_Guide_Chapter.html)

## Web Content Coordination Protocol

Web Content Communication Protocol (WCCP) Version 2 Layer 2 (L2) redirection enables Catalyst 4500 series switches to transparently redirect content requests to the directly connected content engines via a Layer 2/MAC address rewrite. The WCCPv2 L2 redirection is accelerated in the switching hardware, and is therefore more efficient than Layer 3 (L3) redirection using Generic Routing Encapsulation (GRE). The content engines in a cache cluster transparently store frequently accessed content and then fulfill successive requests for the same content, eliminating repetitive transmissions of identical content from the original content servers. It supports the transparent redirection of HTTP and non-HTTP traffic with ports or dynamic services, such as Web caching, HTTPS caching, File Transfer Protocol (FTP) caching, proxy caching, media caching, and streaming services. WCCPv2 L2 redirection is typically deployed for transparent caching at network edge, such as regional or branch sites. WCCPv2 L2 redirection can not be enabled on the same input interface with PBR or VRF-lite. ACL based classification for L2 redirection is not supported.

For information on WCCP, see [Chapter 52, “Configuring WCCP Version 2 Services.”](#)

## Security Features

The Catalyst 4500 series switch offers network management and control through the CLI or through alternative access methods, such as SNMP. The switch software supports these security features:

- [802.1X Identity-Based Network Security, page 1-17](#)
- [Dynamic ARP Inspection, page 1-17](#)
- [Dynamic Host Configuration Protocol Snooping, page 1-18](#)
- [Flood Blocking, page 1-18](#)
- [Hardware-Based Control Plane Policing, page 1-18](#)
- [IP Source Guard for Static Hosts, page 1-18](#)
- [IP Source Guard, page 1-19](#)
- [Local Authentication, RADIUS, and TACACS+ Authentication, page 1-19](#)
- [Network Admission Control \(NAC\), page 1-19](#)
- [Network Security with ACLs, page 1-20](#)
- [Port Security, page 1-20](#)
- [Storm Control, page 1-20](#)
- [uRPF Strict Mode \(Supervisor Engine 6-E only\), page 1-20](#)
- [Utilities, page 1-21](#)

## 802.1X Identity-Based Network Security

This security feature consists of the following:

- 802.1X protocol—This feature provides a means for a host that is connected to a switch port to be authenticated before it is given access to the switch services.
- 802.1X with VLAN assignment—This feature enables you to enable non-802.1X-capable hosts to access networks that use 802.1X authentication.
- 802.1X RADIUS accounting—This feature enables you to track the usage of network devices.
- 802.1X authentication for Guest VLANs—This feature enables you to use VLAN assignment to limit network access for certain users.
- 802.1X with MAC Authentication Bypass—This feature provides network access to agentless devices without 802.1X supplicant capabilities, such as printers. Upon detecting a new MAC address on a switch port, the Catalyst 4500 series switch will proxy an 802.1X authentication request based on the device's MAC address.
- 802.1X with Inaccessible Authentication Bypass—This feature applies when the AAA servers are unreachable or non-responsive. In this situation, 802.1X user authentication typically fails with the port closed, and the user is denied access. Inaccessible Authentication Bypass provides a configurable alternative on the Catalyst 4500 series switch to grant a critical port network access in a locally-specified VLAN.
- 802.1X with Unidirectional Controlled Port—This feature allows the Wake-on-LAN (WoL) magic packets to reach a workstation attached to an unauthorized 802.1X switch port. Unidirectional Controlled Port is typically used to push out Operating Systems or software updates from a central server to workstations at night.
- 802.1X Authentication Failed Open Assignment—This feature enables you to configure a switch to handle the case when a device fails to authenticate itself correctly through 802.1X (for example, not providing the correct password).
- 802.1X with Voice VLAN—This feature enables you to use 802.1X security on a port while enabling it to be used by both Cisco IP phones and devices with 802.1X supplicant support.
- 802.1X Convergence—This feature provides consistency between the switching business units in 802.1X configuration and implementation.
- Multi-Domain Authentication—allows both a data device and a voice device, such as an IP phone (Cisco or non-Cisco), to authenticate on the same switch port, which is divided into a data domain and a voice domain.

For more information on 802.1X identity-based network security, see [Chapter 37, “Configuring 802.1X Port-Based Authentication.”](#)

## Dynamic ARP Inspection

Dynamic ARP Inspection (DAI) intercepts all ARP requests, replies on untrusted ports, and verifies each intercepted packet for valid IP to MAC bindings. Dynamic ARP Inspection helps to prevent attacks on a network by not relaying invalid ARP replies out to other ports in the same VLAN. Denied ARP packets are logged by the switch for auditing.

For more information on dynamic ARP inspection, see [Chapter 41, “Configuring Dynamic ARP Inspection.”](#)

## Dynamic Host Configuration Protocol Snooping

Dynamic Host Configuration Protocol (DHCP) Snooping is a security feature that is a component of a DHCP server. DHCP snooping provides security by intercepting untrusted DHCP messages and by building and maintaining a DHCP snooping binding table. An untrusted message is a message that is received from outside the network or firewall that can cause traffic attacks within your network.

DHCP snooping acts like a firewall between untrusted hosts and DHCP servers. It also provides a way to differentiate between untrusted interfaces connected to the end-user and trusted interfaces connected to the DHCP server or another switch.

For DHCP server configuration information, refer to the chapter, “Configuring DHCP,” in the *Cisco IOS IP and IP Routing Configuration Guide* at the following URL:

[http://www.cisco.com/en/US/docs/ios/ipaddr/configuration/guide/iad\\_dhcp\\_rdmf\\_ps6350\\_TSD\\_Products\\_Configuration\\_Guide\\_Chapter.html](http://www.cisco.com/en/US/docs/ios/ipaddr/configuration/guide/iad_dhcp_rdmf_ps6350_TSD_Products_Configuration_Guide_Chapter.html)

For information on configuring DHCP snooping, see [Chapter 40, “Configuring DHCP Snooping, IP Source Guard, and IPSG for Static Hosts.”](#)

## Flood Blocking

Flood blocking enables users to disable the flooding of unicast and multicast packets on a per-port basis. Occasionally, unknown unicast or multicast traffic from an unprotected port is flooded to a protected port because a MAC address has timed out or has not been learned by the switch.

For information on flood blocking, see [Chapter 43, “Port Unicast and Multicast Flood Blocking.”](#)

## Hardware-Based Control Plane Policing

Control Plane Policing provides a unified solution to limit the rate of CPU bound control plane traffic in hardware. It enables users to install system wide control plane ACLs to protect the CPU by limiting rates or filtering out malicious DoS attacks. Control plane policing ensures the network stability, availability and packet forwarding, and prevents network outages such as loss of protocol updates despite an attack or heavy load on the switch. Hardware based control plane policing is available for all shipping Catalyst 4500 supervisor engines. It supports various Layer 2 and Layer 3 control protocols, such as CDP, EAPOL, STP, DTP, VTP, ICMP, CGMP, IGMP, DHCP, RIPv2, OSPF, PIM, TELNET, SNMP, HTTP and packets destined to 224.0.0.\* multicast link local addresses. Pre-defined system policies or user-configurable policies can be applied to those control protocols.

For information on control plane policing, see [Chapter 39, “Configuring Control Plane Policing.”](#)

## IP Source Guard for Static Hosts

This feature allows you to secure the IP address learned from static hosts via ARP packets and then bind that IP address to a given MAC address using the device tracking database, allowing entries to survive through link down events.

IP Source Guard (IPSG) for static hosts allows multiple bindings per port per mac address for both dhcp and static hosts i.e. in both device tracking database as well as dhcp snooping binding data base. Moreover, it enable you to take action when a limit is exceeded.

For information on configuring IPSG for static hosts, see [Chapter 40, “Configuring DHCP Snooping, IP Source Guard, and IPSG for Static Hosts.”](#)

## IP Source Guard

Similar to DHCP snooping, this feature is enabled on an untrusted 12 port that is configured for DHCP snooping. Initially all IP traffic on the port is blocked except for the DHCP packets, which are captured by the DHCP snooping process. When a client receives a valid IP address from the DHCP server, a PVACL is installed on the port, which restricts the client IP traffic only to clients with assigned IP addresses, so any IP traffic with source IP addresses other than those assigned by the DHCP server will be filtered out. This filtering prevents a malicious host from attacking a network by hijacking neighbor host's IP address.

For information on configuring IP Source Guard, see [Chapter 40, “Configuring DHCP Snooping, IP Source Guard, and IPSG for Static Hosts.”](#)

## Local Authentication, RADIUS, and TACACS+ Authentication

Local Authentication, Remote Authentication Dial-In User Service (RADIUS), and Terminal Access Controller Access Control System Plus (TACACS+) authentication—These authentication methods control access to the switch. For additional information, refer to the following URL:  
[http://www.cisco.com/en/US/docs/ios/sec\\_user\\_services/configuration/guide/sec\\_cfg\\_authentifcn\\_ps6350\\_TSD\\_Products\\_Configuration\\_Guide\\_Chapter.html](http://www.cisco.com/en/US/docs/ios/sec_user_services/configuration/guide/sec_cfg_authentifcn_ps6350_TSD_Products_Configuration_Guide_Chapter.html)

## Network Admission Control (NAC)

NAC supports consists of two features:

- NAC Layer 2 IP Validation

NAC L2 IP is an integral part of Cisco Network Admission Control. It offers the first line of defense for infected hosts (PCs and other devices attached to a LAN port) attempting to connect to the corporate network. NAC L2 IP on the Cisco Catalyst 4500 series switch performs posture validation at the Layer 2 edge of the network for non-802.1x-enabled host devices. Host device posture validation includes anti-virus state and OS patch levels. Depending on the corporate access policy and host device posture, a host may be unconditionally admitted, admitted with restricted access, or quarantined to prevent the spread of viruses across the network.

For more information on Layer 2 IP validation, see the URL:

[http://www.cisco.com/en/US/products/hw/switches/ps4324/prod\\_configuration\\_guide09186a00805764fd.html](http://www.cisco.com/en/US/products/hw/switches/ps4324/prod_configuration_guide09186a00805764fd.html)

- NAC Layer 2 802.1X Authentication

The Cisco Catalyst 4500 series switch extends NAC support to 802.1x-enabled devices. Like NAC L2 IP, the NAC L2 802.1x feature determines the level of network access based on endpoint information.

For more information on 802.1X identity-based network security, see [Chapter 37, “Configuring 802.1X Port-Based Authentication.”](#)

## Network Security with ACLs

An access control list (ACL) filters network traffic by controlling whether routed packets are forwarded or blocked at the router interfaces. The Catalyst 4500 series switch examines each packet to determine whether to forward or drop the packet based on the criteria you specified within the access lists.

MAC access control lists (MACLs) and VLAN access control lists (VACLs) are supported. VACLs are also known as VLAN maps in Cisco IOS.

The following security features are supported:

- MAC address filtering, which enables you to block unicast traffic for a MAC address on a VLAN interface.
- Port ACLs, which enable you to apply ACLs to Layer 2 interfaces on a switch for inbound traffic.

For information on ACLs, MACLs, VLAN maps, MAC address filtering, and Port ACLs, see [Chapter 42, “Configuring Network Security with ACLs.”](#)

## Port Security

Port Security restricts traffic on a port based upon the MAC address of the workstation that accesses the port. Trunk port security extends this feature to trunks, including private VLAN isolated trunks, on a per-VLAN basis.

Sticky port security extends port security by saving the dynamically learned MAC addresses in the running configuration to survive port link down and switch reset. It enables a network administrator to restrict the MAC addresses allowed or the maximum number of MAC addresses on each port.

Voice VLAN sticky port security further extends the sticky port security to the Voice-over-IP deployment. Voice VLAN sticky port security locks a port and blocks access from a station with a MAC address different from the IP phone and the workstation behind the IP phone.

For information on port security, see [Chapter 38, “Configuring Port Security.”](#)

## Storm Control

Broadcast suppression is used to prevent LANs from being disrupted by a broadcast storm on one or more switch ports. A LAN broadcast storm occurs when broadcast packets flood the LAN, creating excessive traffic and degrading network performance. Errors in the protocol-stack implementation or in the network configuration can cause a broadcast storm. Multicast and broadcast suppression measures how much broadcast traffic is passing through a port and compares the broadcast traffic with some configurable threshold value within a specific time interval. If the amount of broadcast traffic reaches the threshold during this interval, broadcast frames are dropped, and optionally the port is shut down.

Cisco IOS Software Release 12.2(40)SG allows suppression of broadcast and multicast traffic on a per-port basis. (Supervisor Engine 6-E only)

For information on configuring broadcast suppression, see [Chapter 44, “Configuring Storm Control.”](#)

## uRPF Strict Mode (Supervisor Engine 6-E only)

The uRPF feature mitigates problems caused by the introduction of malformed or forged (spoofed) IP source addresses into a network by discarding IP packets that lack a verifiable IP source address. uRPF deflects denial-of-service (DoS) and distributed denial-of-service (DDoS) attacks by forwarding only

packets that have source addresses that are valid and consistent with the IP routing table. This helps to protect the network of the customer, the ISP, and the rest of the Internet. When using uRPF in strict mode, the packet must be received on the interface that the router would use to forward the return packet. uRPF strict mode is supported for both IPv4 and IPv6 prefixes. IPv6 Forwarding in Hardware IPv6 is the next-generation IP protocol, designed to solve numerous problems that the original

For information on configuring broadcast suppression, see [Chapter 29, “Configuring Unicast Reverse Path Forwarding”](#)

## Utilities

### Layer 2 Traceroute

Layer 2 Traceroute allows the switch to identify the physical path that a packet takes from a source device to a destination device. Layer 2 traceroute supports only unicast source and destination MAC addresses.

For information about Layer 2 Traceroute, see [Chapter 7, “Checking Port Status and Connectivity.”](#)

### Time Domain Reflectometry

Time Domain Reflectometry (TDR) is a technology used for diagnosing the state and reliability of cables. TDR can detect open, shorted, or terminated cable states. The calculation of the distance to the failure point is also supported.

For information about TDR, see [Chapter 7, “Checking Port Status and Connectivity.”](#)

### Debugging Features

The Catalyst 4500 series switch has several commands to help you debug your initial setup. These commands are included in the following groups:

- **platform**
- **debug platform**

For more information, refer to the *Catalyst 4500 Series Switch Cisco IOS Command Reference*.

## Metro Feature

### Resilient Ethernet Protocol

Resilient Ethernet Protocol (REP) is a Cisco proprietary protocol that provides an alternative to Spanning Tree Protocol (STP) to control network loops, handle link failures, and improve convergence time. REP controls a group of ports connected in a segment, ensures that the segment does not create any bridging loops, and responds to link failures within the segment. REP provides a basis for constructing more complex networks and supports VLAN load balancing.

For more information on REP, refer to this location:

[http://www.cisco.com/en/US/docs/switches/metro/catalyst3750m/software/release/12.2\\_40\\_se/configuration/guide/swrep.html](http://www.cisco.com/en/US/docs/switches/metro/catalyst3750m/software/release/12.2_40_se/configuration/guide/swrep.html)