

# Cisco Catalyst 2950

## Long-Reach Ethernet Switches

**Cisco's Long Reach Ethernet switches meet the demands of high bandwidth applications while leveraging existing copper wiring infrastructures. Catalyst® 2950 Long-Reach Ethernet (LRE) Series switches enable enterprise and service provider customers to extend intelligent Ethernet services over existing phone and legacy wiring, at distances of up to 5000 feet. Cisco is the only company with the breadth of technologies that allow customers to deliver intelligent network services across any combination of wired and wireless infrastructures.**

The Cisco Catalyst 2950 LRE solution delivers cost-effective, high-performance broadband access to enterprise campus environments and multi-tenant buildings (such as, hotels, apartment buildings, and office buildings). The Cisco LRE technology dramatically extends the reach of Ethernet up to 5,000 feet over existing Category 1/2/3 wiring at speeds from 2 to 15 Mbps symmetric. LRE co-exists on the same medium as Plain Old Telephone Service (POTS), digital telephone, and ISDN traffic, and co-exists with asymmetric digital subscriber line (ADSL) in the same wire bundle, allowing service providers to provision LRE to buildings where broadband services already exist.

### Enterprise

The Catalyst 2950 LRE enables enterprises to deploy productivity enhancing applications across their entire network while avoiding the costs of rewiring. Based on Cisco's market leading Catalyst 2950 Series, the 2950 LRE is a familiar product for existing Cisco customers and allows networks to reach areas previously not feasible due to wiring or distance limitations.

### Metro Access

Ideal for metro Ethernet access in residential and small-office, home-office (SOHO) markets, the Catalyst 2950 LRE switches extend intelligence to the metro access edge, enabling service breadth, availability, security, and manageability while leveraging the existing in-building wiring. Featuring advanced rate limiting, voice virtual LAN (VLAN) support, and multicast management, these switches enable a variety of residential metro services such as Internet access, voice over IP (VoIP), and broadcast video.

### Hospitality

The Catalyst 2950 LRE broadband networking solution enables hoteliers to deliver secure high-speed Internet access to guest and conference rooms to attract and retain business travelers. By deploying the Cisco LRE solution, hotel owners can future proof their buildings for a wide range of applications that will ensure operational efficiency and customer loyalty for years to come while avoiding the costs of rewiring.



## Product Overview

The Cisco Catalyst® 2950 LRE switches are fixed-configuration, stackable models that provide wire-speed LRE and Gigabit Ethernet connectivity for small and midsized networks. The Catalyst 2950 Series is an affordable product line that brings intelligent services, such as enhanced security, high availability and advanced quality of service (QoS), to the network edge—while maintaining the simplicity of traditional LAN switching. When a Catalyst 2950 LRE switch is combined with a Catalyst 3550 Series switch, the solution can enable IP routing from the edge to the core of the network. Embedded in Catalyst 2950 Series switches is the Cisco Cluster Management Suite (CMS) Software, which allows users to simultaneously configure and troubleshoot multiple Catalyst desktop switches using a standard Web browser. In addition to CMS, Cisco Catalyst 2950 LRE switches provide extensive management tools using Simple Network Management Protocol (SNMP) network management platforms such as CiscoWorks for Switched Internetworks.

The Cisco 2950 LRE solution includes the Cisco Catalyst® 2950 LRE switches, the Cisco 575 and 585 LRE Customer Premise Equipment (CPE) devices, and the Cisco LRE POTS Splitter. Each LRE link is terminated with either the Cisco 575 or 585 LRE CPEs, and a POTS splitter is required when POTS traffic coexists with the LRE link over the same line.

The Cisco Catalyst 2950 LRE switches consist of the following devices—which are based upon the Enhanced Image (EI) Software for the Catalyst 2950 Series.

- *Catalyst 2950ST-24-LRE*—24 LRE ports + 2 10/100/1000BASE-T ports + 2 Small Form-Factor Pluggable (SFP) ports (two of the four uplinks active at one time)
- *Catalyst 2950ST-8-LRE*—8 LRE ports + 2 10/100/1000BASE-T ports + 2 SFP ports (two of the four uplinks active at one time)

The two built-in Gigabit Ethernet SFP ports support 1000BASE-SX and 1000BASE-LX modules. The dual SFP-based and copper Gigabit Ethernet implementation provides customers with tremendous deployment flexibility—allowing customers increased availability with the redundant uplinks. High levels of stack resiliency can also be implemented by deploying dual redundant Gigabit Ethernet uplinks and UplinkFast technologies for high-speed uplink and stack interconnection failover, and Per VLAN Spanning Tree Plus (PVST+) for uplink load balancing.

## Long-Reach Ethernet Technology

The LRE technology employs Quadrature Amplitude Modulation (QAM). QAM modulation uses both signal amplitude and phase to define each symbol. LRE uses the most sophisticated QAM technology with various QAM modulations (QAM-256, QAM-128, QAM-64, QAM-32, QAM-16, QAM-8, and QAM-4). The system administrator may choose profiles that use different modulations and frequency plans according to the line specification and rate definition. LRE is designed to support multiQAM in order to achieve performance as close to the physical limit as possible, while maintaining low cost and low power.

Cisco LRE facilitates the transport of symmetrical, bi-directional data over unshielded, copper twisted-pair telephone wires originally intended for the frequency band between 300 Hz and 3.4 KHz. The system employs Frequency Division Duplexing (FDD) to separate the downstream channel, the upstream channel, and POTS, ISDN, or PBX signaling services in the frequency domain. This enables service providers to overlay LRE on existing POTS, ISDN, or analog PBX signaling services without disruption. Both LRE and POTS/ISDN/analog PBX services may be transmitted over the same line without interfering with each other.



## **Intelligence in the Network**

Networks of today are evolving to address four new developments at the network edge:

- Increase in desktop computing power
- Introduction of bandwidth-intensive applications
- Expansion of highly sensitive data on the network
- Presence of multiple device types, such as IP phones and wireless LAN access points

These new demands are contending for resources with many existing mission-critical applications. As a result, IT professionals must view the edge of the network as critical to effectively manage the delivery of information and applications.

As companies increasingly rely on networks as the strategic business infrastructure, it is more important than ever to ensure their high availability, security, scalability and control. By adding Cisco intelligent functionality to the wiring closet, customers can now deploy network-wide intelligent services that address these requirements in a consistent way from the desktop to the core and through the WAN.

With Cisco Catalyst Intelligent Ethernet switches, Cisco enables companies to realize the full benefits of adding intelligent services into their networks. Deploying capabilities that make the network infrastructure highly available to accommodate time-critical needs, scalable to accommodate growth, secure enough to protect confidential information, and capable of differentiating and controlling traffic flows are key to further optimizing network operations.

## **Network Security through Advanced Security Features**

The Cisco Catalyst 2950 LRE Series switches offer enhanced data security through a wide range of security features. These features allow customers to enhance LAN security with capabilities to secure network management traffic through the protection of passwords and configuration information; to provide options for network security based on users, ports and MAC addresses; and to enable more immediate reactions to intruder and hacker detection. The security enhancements are available free-of-charge by downloading the latest software release for the Catalyst 3550 and 2950 switches.

Secure Shell (SSH) and Simple Network Management Protocol version 3 (SNMPv3) with encryption protect information from being tampered with or eavesdropped by encrypting information being passed along the network, thereby guarding administrative information. To use these features, the crypto (encrypted) Catalyst 2950 LRE software image must be installed on your switch.

Private VLAN Edge isolates ports on a switch, ensuring that traffic travels directly from the entry point to the aggregation device through a virtual path and cannot be directed to another port. Local Proxy Address Resolution Protocol (ARP) works in conjunction with private VLAN edge to minimize broadcasts and maximize available bandwidth.

Port-based Access Control Parameters (ACPs) restrict sensitive portions of the network by denying packets based on source and destination MAC addresses, IP addresses, or TCP/UDP ports. ACP lookups are done in hardware; therefore, forwarding performance is not compromised when implementing this type of security in the network. In addition, Time-based ACLs allow configuration of differentiated services based on time periods. ACLs can also be applied to filter traffic based on DSCP values. Port security provides another means to ensure the appropriate user is on the network by limiting access based on MAC addresses. For authentication of users with a Terminal Access



Controller Access Control System (TACACS+) or RADIUS server, 802.1x provides port-level security. SNMPv3 (non-crypto) monitors and controls network devices as well as manages configurations, performance, collection of statistics and security.

With the multi-layer Cisco Catalyst 2950 LRE switches, network managers can implement high levels of console security. Multilevel access security on the switch console and the web-based management interface prevents unauthorized users from accessing or altering switch configuration. TACACS+ or RADIUS authentication enables centralized access control of the switch and restricts unauthorized users from altering the configuration. Deploying security can be done through Cisco CMS Software Security Wizards, which ease the deployment of security features that restrict user access to a server, a portion of the network, or access to the network.

### **Network Control through Advanced Quality of Service and Rate Limiting**

The Catalyst 2950 LRE Series switches offer superior and highly granular QoS based on Layer 2-4 information, to ensure that network traffic is classified, prioritized, and congestion is avoided in the best possible manner. The Catalyst 2950 LRE Series switches can classify, reclassify, police (determine if the packet is in or out of predetermined profiles and affect actions on the packet), and mark or drop the incoming packets before the packet is placed in the shared buffer. Packet classification allows the network elements to discriminate between various traffic flows and enforce policies based on Layer 2 and Layer 3 QoS fields.

To implement QoS, these switches first identify traffic flows, or packet groups, and classify or reclassify these groups using the DiffServ Code Point field (DSCP) in the IP packet and/or the 802.1p class of service (CoS) field in the Ethernet packet. Classification and reclassification can also be based on criteria as specific as the source/destination IP address, source/destination MAC address or the Layer 4 Transmission Control Protocol (TCP)/User Datagram Protocol (UDP) ports. At the ingress (incoming port) level, the Catalyst switches will also perform policing and marking of the packet.

After the packet goes through classification, policing, and marking, it is then assigned to the appropriate queue before exiting the switch. The Catalyst 2950 LRE Series switches support four egress (outgoing port) queues per port, which allows the network administrator to be more discriminating and specific in assigning priorities for the various applications on the LAN. At the egress level, the switch performs scheduling, which is an algorithm/process that determines the order in which the queues are processed. The switches support Weighted Round Robin (WRR) scheduling or strict priority scheduling. The WRR scheduling algorithm ensures that the lower priority packets are not entirely starved for bandwidth and are serviced without compromising the priority settings administered by the network manager. Strict priority scheduling ensures that the highest priority packets will always get serviced first, ahead of all other traffic, and that the other three queues will be serviced using WRR best effort.

These features allow network administrators to prioritize mission-critical and/or bandwidth-intensive traffic, such as ERP (Oracle, SAP, and so on), voice (IP telephony traffic) and CAD/CAM over less time-sensitive applications such as FTP or e-mail (SMTP). For example, it would be highly undesirable to have a large file download destined to one port on a wiring closet switch and have quality implications such as increased latency in voice traffic, destined to another port on this switch. This condition is avoided by ensuring that voice traffic is properly classified and prioritized throughout the network. Other applications, such as web browsing, can be treated as low priority and handled on a best-efforts basis.



The Catalyst 2950 LRE Series switches are capable of allocating bandwidth based on several criteria including MAC source address, MAC destination address, IP source address, IP destination address, and TCP/UDP port number. Bandwidth allocation is essential in network environments requiring service-level agreements or when it is necessary for the network manager to control the bandwidth given to certain users. The Catalyst 2950 LRE Series switches support up to 6 policers per LRE port and up to 60 policers on a Gigabit Ethernet port. This gives the network administrator very granular control of LAN bandwidth.

### **Network Availability**

To provide efficient use of resources for bandwidth-hungry applications like multicasts, the Cisco Catalyst 2950 LRE Series Intelligent switches support Internet Group Management Protocol (IGMP) snooping in hardware. Through the support and configuration of IGMP snooping via the Cisco CMS Software, Catalyst 2950 LRE Series switches deliver outstanding performance and ease of use in administering and managing multicast applications on the LAN.

The IGMP snooping feature allows the switch to “listen in” on the IGMP conversation between hosts and routers. When a switch hears an IGMP join request from a host for a given multicast group, the switch adds the host’s port number to the Group Destination Address (GDA) list for that group. And, when the switch hears an IGMP leave request, it removes the host’s port from the Content Addressable Memory (CAM) table entry.

PVST+ allows users to implement redundant uplinks while also distributing traffic loads across multiple links. This is not possible with standard Spanning-Tree Protocol implementations. Cisco UplinkFast technology ensures immediate transfer to the secondary uplink, much better than the traditional 30 to 60 second convergence time. This is yet another enhancement of the Spanning-Tree Protocol implementation. An additional feature that enhances performance is Voice VLAN. This feature allows network administrators to assign voice traffic to a VLAN dedicated to IP telephony—simplifying phone installations and providing easier network traffic administration and troubleshooting.

Multicast VLAN Registration (MVR) is designed for applications using wide-scale deployment of multicast traffic across an Ethernet ring-based service provider network (for example, the broadcast of multiple television channels over a service-provider network). MVR allows a subscriber on a port to subscribe and unsubscribe to a multicast stream on the network-wide multicast VLAN.

### **Network Management**

The Cisco Cluster Management Suite (CMS) is Web-based software that is embedded in Catalyst 3550, 2950, 2950 LRE, 3500 XL, 2900 XL, and 2900 LRE XL switches. Through Cisco Switch Clustering technology, users access Cisco CMS with any standard Web browser to manage up to 16 of these switches at once, regardless of their geographic proximity—with the option of using a single IP address for the entire cluster if desired. With the addition of the Catalyst 3550 switches, Cisco CMS Software can now extend beyond routed boundaries for even more flexibility in managing a Cisco cluster.

Cisco CMS provides an integrated management interface for delivering intelligent services, such as multi-layer switching, QoS, multicast and security access control lists (ACLs). Thus, CMS allows administrators to take advantage of benefits formerly reserved for only the most advance networks without having to learn the command-line interface (CLI) or even the details of the technology.

The new Guide Mode in Cisco CMS leads the user step-by-step through the configuration of advanced features and provides enhanced online help for context-sensitive assistance. In addition, Cisco AVVID (Architecture for Voice, Video, and Integrated Data) Wizards provide automated configuration of the switch to optimally support video



streaming or video conferencing, voice over IP (VoIP) and mission-critical applications. These Wizards can save hours of time for network administrators, eliminate human errors, and ensure that the configuration of the switch is optimized for these applications.

Cisco CMS Software supports standards-based connectivity options such as Ethernet, Fast Ethernet, Fast EtherChannel, Gigabit Ethernet, and Gigabit EtherChannel connectivity. Because Cisco Switch Clustering technology is not limited to a single stack of switches, Cisco CMS Software expands the traditional cluster domain beyond a single wiring closet and saves time and effort for network administrators.

Catalyst 2950 LRE switches can be configured either as “command” or “member” switches in a Cisco switch cluster. Cisco CMS also allows the network administrator to designate a standby or redundant command switch, which takes the commander duties should the primary command switch fail. Other key features include the ability to configure multiple ports and switches simultaneously, as well as perform software updates across the entire cluster at once, and clone configurations to other clustered switches for rapid network deployments. Bandwidth graphs and link reports provide useful diagnostic information and the topology map gives network administrators a quick view of the network status.

In addition to CMS, Cisco Catalyst 2950 LRE switches provide extensive management tools using Simple Network Management Protocol (SNMP) network management platforms such as CiscoWorks for Switched Internetworks.

The Cisco Catalyst 2950 LRE switches deliver a comprehensive set of management tools to provide the required visibility and control in the network. Managed with CiscoWorks2000, Catalyst family switches can be configured and managed to deliver end-to-end device, VLAN, traffic, and policy management. Coupled with CiscoWorks2000, Cisco Resource Manager Essentials, a Web-based management tool, offers automated inventory collection, software deployment, easy tracking of network changes, views into device availability, and quick isolation of error conditions.

**Figure 1** Cisco Catalyst 2950 LRE Switches



**Figure 2** Cisco Catalyst 2950ST 8 LRE Switch





**Figure 3** Cisco Catalyst 2950 Long-Reach Ethernet Solution



The Catalyst 2950 Series switches fully support the CISCO575-LRE and CISCO585-LRE CPEs and the Cisco LRE POTS splitter. Please refer to the Cisco LRE CPE and Cisco LRE POTS Splitter data sheets for more information.



## Product Features and Benefits

Feature	Benefit																																																																
Performance																																																																	
Robust Performance Over Existing Telephone Wiring	<ul style="list-style-type: none"><li>• 2-15 Mbps bandwidth over category 1/2/3/5 single-pair copper wiring over distances up to 5,000 feet.</li><li>• Profiles available for optimizing upstream and downstream bandwidth requirements: (Actual achievable data rates depend on cable quality, noise and cross talk environment.)</li></ul>																																																																
	<table><tr><th>Profile Name</th><th>Downstream</th><th>Upstream</th><th>Notes</th></tr><tr><td>LRE-15</td><td>15</td><td>15</td><td>LRE-15LL for low latency</td></tr><tr><td>LRE-15_5</td><td>15</td><td>5</td><td></td></tr><tr><td>LRE-15_3</td><td>15</td><td>3</td><td></td></tr><tr><td>LRE-15_1</td><td>15</td><td>1</td><td></td></tr><tr><td>LRE-10</td><td>10</td><td>10</td><td>LRE-10LL for low latency</td></tr><tr><td>LRE-10_5</td><td>10</td><td>5</td><td></td></tr><tr><td>LRE-10_3</td><td>10</td><td>3</td><td></td></tr><tr><td>LRE-10_1</td><td>10</td><td>1</td><td></td></tr><tr><td>LRE-8</td><td>8</td><td>8</td><td></td></tr><tr><td>LRE-7</td><td>7</td><td>7</td><td></td></tr><tr><td>LRE-5</td><td>5</td><td>5</td><td>LRE-5LL for low latency</td></tr><tr><td>LRE-4</td><td>4</td><td>4</td><td></td></tr><tr><td>LRE-4_1</td><td>4</td><td>1</td><td>LRE-4_1LL for low latency</td></tr><tr><td>LRE-3</td><td>3</td><td>3</td><td></td></tr><tr><td>LRE-2</td><td>2</td><td>2</td><td></td></tr></table>	Profile Name	Downstream	Upstream	Notes	LRE-15	15	15	LRE-15LL for low latency	LRE-15_5	15	5		LRE-15_3	15	3		LRE-15_1	15	1		LRE-10	10	10	LRE-10LL for low latency	LRE-10_5	10	5		LRE-10_3	10	3		LRE-10_1	10	1		LRE-8	8	8		LRE-7	7	7		LRE-5	5	5	LRE-5LL for low latency	LRE-4	4	4		LRE-4_1	4	1	LRE-4_1LL for low latency	LRE-3	3	3		LRE-2	2	2	
	Profile Name	Downstream	Upstream	Notes																																																													
	LRE-15	15	15	LRE-15LL for low latency																																																													
	LRE-15_5	15	5																																																														
	LRE-15_3	15	3																																																														
	LRE-15_1	15	1																																																														
	LRE-10	10	10	LRE-10LL for low latency																																																													
	LRE-10_5	10	5																																																														
	LRE-10_3	10	3																																																														
	LRE-10_1	10	1																																																														
	LRE-8	8	8																																																														
	LRE-7	7	7																																																														
	LRE-5	5	5	LRE-5LL for low latency																																																													
	LRE-4	4	4																																																														
	LRE-4_1	4	1	LRE-4_1LL for low latency																																																													
	LRE-3	3	3																																																														
LRE-2	2	2																																																															
	<ul style="list-style-type: none"><li>• Rate selection automates the process of selecting a profile that is optimal on a given interface thereby greatly improving the ease of installation and optimizing the bandwidth for a given environment. Profiles are grouped into sequences that can be configured by the customer.</li><li>• Flexibility to use either 10BaseT/100BaseTX/1000BaseT autosensing ports, or SFPs for fiber connectivity to support LRE switch daisy-chaining, aggregation or server/router connectivity.</li><li>• Full-duplex operation on all ports, delivering up to 15 Mbps symmetric on LRE ports and up to 1000 Mbps symmetric on 10/100/1000 and SFP ports.</li></ul>																																																																





Feature	Benefit
<b>Robust Performance Over Existing Telephone Wiring</b> <i>continued</i>	<ul style="list-style-type: none"> <li>• Reed-Solomon Forward Error Correction and high interleaver protect data payload and header information in noisy environments.</li> <li>• LRE Link Persistence allows configuration of delay duration before dynamic MAC addresses are removed from the MAC address table due to LRE link drops. Enabled by default.</li> <li>• Diagnostic Link Monitoring allows customers to track conditions on the LRE link and take system-defined actions after certain thresholds are reached.</li> </ul>
<b>Availability</b>	
<b>Superior Redundancy for Fault Backup</b>	<ul style="list-style-type: none"> <li>• IEEE 802.1D Spanning-Tree Protocol support for redundant backbone connections and loop-free networks simplifies network configuration and improves fault tolerance.</li> <li>• Support for Cisco Spanning-Tree Protocol enhancements such as UplinkFast, BackboneFast and PortFast technologies ensure quick fail-over recovery enhancing overall network stability and availability.</li> <li>• IEEE 802.1w Rapid Spanning-Tree Protocol (RSTP) provides rapid convergence of the spanning tree independent of spanning-tree timers.</li> <li>• Support for Cisco's optional, 300-watt redundant AC power system provides a backup power source for up to four units for improved fault tolerance and network uptime.</li> <li>• Command switch redundancy enabled in the Cisco Cluster Management Suite (CMS) Software allows customers to designate a backup command switch that takes over cluster management functions if the primary command switch fails.</li> <li>• Provides unidirectional link detection (UDLD) and Aggressive UDLD for detecting and disabling unidirectional links on fiber-optic interfaces caused by incorrect fiber-optic wiring or port faults.</li> </ul>
<b>Integrated Cisco IOS® Features for Bandwidth Optimization</b>	<ul style="list-style-type: none"> <li>• Bandwidth aggregation up to 4 Gbps (2 ports full duplex) through Gigabit EtherChannel® technology and up to 240 Mbps (8 ports full duplex) through Port Aggregation Protocol (PagP) technology on LRE ports enhances fault tolerance and offers higher-speed aggregated bandwidth between switches, to routers and individual servers.</li> <li>• Per-port broadcast, multicast, and unicast storm control prevents faulty end stations from degrading overall systems performance.</li> <li>• Per virtual LAN (VLAN) SpanningTree Plus (PVST+) allows for Layer 2 load sharing on redundant links to efficiently utilize the extra capacity inherent in a redundant design.</li> <li>• IEEE 802.1s Multiple Spanning-Tree Protocol (MSTP) allows a spanning tree instance per VLAN enabling Layer 2 load sharing on redundant links.</li> <li>• VLANTrunking Protocol (VTP) pruning limits bandwidth consumption on VTP trunks by flooding broadcast traffic only on trunk links required to reach the destination devices. DynamicTrunking Protocol (DTP) enables dynamic trunk configuration across all ports in the switch.</li> <li>• Internet Group Management Protocol (IGMP) snooping provides for fast client joins and leaves of multicast streams and limits bandwidth-intensive video traffic to only the requestors. MulticastVLAN Registration (MVR), IGMP filtering and fast-join and immediate leave are available as enhancements.</li> <li>• Multicast VLAN registration (MVR) continuously sends multicast streams in a multicast VLAN while isolating the streams from subscriber VLANs for bandwidth and security reasons.</li> <li>• Supports additional frame formats: Ethernet II (tagged and untagged), 802.3 (SNAP encapsulated tagged and untagged frames)</li> </ul>



Feature	Benefit
<b>Security</b>	
<b>Network-Wide Security Features</b>	<ul style="list-style-type: none"> <li>• Filtering of incoming traffic flows based on Layer 2, Layer 3 or Layer 4 access control parameters (ACPs) prevents unauthorized data flows.             <ul style="list-style-type: none"> <li>– The following Layer 2 ACPs or a combination can be used for security classification of incoming packets: source Media Access Control (MAC) address, destination MAC address, and 16-bit Ethertype.</li> <li>– The following Layer 3 and Layer 4 fields or a combination can be used for security classification of incoming packets: source IP address, destination IP address, TCP source or destination port number, User Datagram Protocol (UDP) source, or destination port number. ACLs can also be applied to filter based on DSCP-values.</li> <li>– Time-based ACLs allow configuration of differentiated services based on time-periods.</li> </ul> </li> <li>• Secure Shell Protocol (SSH) provides secure login sessions and other communications between two untrusted hosts over an insecure network by encrypting the entire session. SSH features strong cryptographic authentication, strong encryption, and integrity protection. To use this feature, the crypto (encrypted) Catalyst 2950 LRE software image must be installed on your switch.</li> <li>• SNMPv3 with encryption provides secure access to devices by authenticating and encrypting all SNMP packets over the network. The encryption portion of SNMPv3 requires the crypto Catalyst 2950 LRE software image to be installed on your switch.</li> <li>• Password recovery feature allows the administrator to protect access to the switch configuration files by forcing a user with physical access to the switch to interrupt the switch start process only by agreeing to set the system back to default configuration.</li> <li>• SNMPv3 (non-crypto) monitors and controls network devices, manages configurations, statistics collection, performance, and security</li> <li>• Private VLAN edge (protected port) provides security and isolation between ports on a switch, ensuring that voice traffic travels directly from its entry point to the aggregation device through a virtual path and cannot be directed to a different port.</li> <li>• Support for the 802.1x standard allows users to be authenticated regardless of which LAN port they are accessing, and provides unique benefits to customers who have a large base of mobile (wireless) users accessing the network.</li> <li>• Port Security secures the access to a port based on the MAC address of a users device. The aging feature removes the MAC address from the switch after a specific timeframe to allow another device to connect to the same port.</li> <li>• MAC Address Notification allows administrators to be notified of new users added or removed from the network.</li> <li>• Spanning-tree root guard (STRG) prevents edge devices not in the network administrator's control from becoming Spanning-Tree Protocol root nodes.</li> <li>• The Spanning-Tree Protocol PortFast/bridge protocol data unit (BPDU) guard feature disables access ports with Spanning-Tree Protocol PortFast-enabled upon reception of a BPDU, and increases network reliability, manageability, and security.</li> <li>• Multilevel security on console access prevents unauthorized users from altering the switch configuration.</li> <li>• TACACS+ and RADIUS authentication to enable centralized control of the switch and restrict unauthorized users from altering the configuration.</li> <li>• The user-selectable address-learning mode simplifies configuration and enhances security.</li> <li>• Trusted Boundary provides the ability to trust the QoS priority settings if an IP phone is present and disable the trust setting in the event that the IP phone is removed, thereby preventing a rogue user from overriding prioritization policies in the network.</li> </ul>



Feature	Benefit
<b>Network-Wide Security Features</b> <i>continued</i>	<ul style="list-style-type: none"> <li>• IGMP Filtering provides multicast authentication by filtering out non-subscribers and limits the number of concurrent multicast streams available per port.</li> <li>• Support for dynamic VLAN assignment through implementation of VLAN Membership Policy Server (VMPS) client functionality provides flexibility in assigning ports to VLANs. Dynamic VLAN enables fast assignment of IP address.</li> <li>• Cisco CMS Software Security Wizards ease the deployment of security features for restricting user access to a server, a portion of the network or access to the network.</li> </ul>
<b>Quality of Service (QoS)</b>	
	<p><i>Overview</i></p> <ul style="list-style-type: none"> <li>• The switches support the aggregate QoS model by enabling classification, policing/ metering, and marking functions on a per-port basis at ingress and queuing/ scheduling function at egress.</li> <li>• The switches support configuring QoS ACPs on all ports to ensure proper policing and marking on a per-packet basis using ACPs. Up to four ACPs per switch are supported in configuring either QoS ACPs or security filters.</li> </ul> <p><i>QoS Classification Support at Ingress</i></p> <ul style="list-style-type: none"> <li>• The switches support QoS classification of incoming packets for QoS flows based on Layer 2, Layer 3, and Layer 4 fields.</li> <li>• The following Layer 2 fields or a combination can be used for classifying incoming packets to define QoS flows: source MAC address, destination MAC address, 16-bit Ethertype.</li> </ul> <p><i>The switches support identification of traffic based on Layer 3 ToS field – DSCP values.</i></p> <ul style="list-style-type: none"> <li>• The following Layer 3 and 4 fields or a combination can be used to classify incoming packets to define QoS flows: source IP address, destination IP address, TCP source or destination port number, UDP source or destination port number.</li> </ul> <p><i>QoS Metering/Policing at Ingress</i></p> <ul style="list-style-type: none"> <li>• Support for metering/policing of incoming packets restricts incoming traffic flows to a certain rate.</li> <li>• The switches support up to 6 policers per LRE port, and 60 policers on a Gigabit Ethernet port.</li> <li>• The switches offer granularity of traffic flows at 1 Mbps on LRE ports, and 8 Mbps on Gigabit Ethernet ports.</li> </ul> <p><i>QoS Marking at Ingress</i></p> <ul style="list-style-type: none"> <li>• The switches support marking/re-marking packets based on state of policers/meters.</li> <li>• The switches support marking/re-marking based on the following mappings: from DiffServ Code Point (DSCP) to 802.1p, and 802.1p to DSCP.</li> <li>• The switches support 14 well-known and widely used DSCP values.</li> <li>• The switches support classifying or reclassifying packets based on default DSCP per port. Also support classification based on DSCP-values in ACL.</li> <li>• The switches support classifying or reclassifying frames based on default 802.1p value per port.</li> <li>• The switches support 802.1p override at ingress.</li> </ul> <p><i>QoS Scheduling Support at Egress</i></p> <ul style="list-style-type: none"> <li>• Four queues per egress port are supported in hardware.</li> <li>• The Weighted Round Robin (WRR) queuing algorithm ensures that low-priority queues are not starved.</li> <li>• Strict-priority queue configuration via Strict Priority Scheduling ensures that time-sensitive applications such as voice always follow an expedited path through the switch fabric.</li> </ul>



Feature	Benefit
<b>Sophisticated Traffic Management</b>	
	<ul style="list-style-type: none"><li>• The switch supports up to 6 policers per LRE port and up to 60 policers on a Gigabit Ethernet port.</li><li>• The switches offer granularity of traffic flows at 1 Mbps on LRE ports, and 8 Mbps on Gigabit Ethernet ports.</li><li>• The switch offers the ability to limit data flows based on MAC source/destination address, IP source/destination address, TCP/UDP port numbers, or any combination of these fields.</li><li>• The switch offers the ability to manage data flows asynchronously upstream and downstream from the end station or on the uplink.</li></ul>
<b>Management</b>	
<b>Superior Manageability</b>	<ul style="list-style-type: none"><li>• An embedded Remote Monitoring (RMON) software agent supports four RMON groups (history, statistics, alarms, and events) for enhanced traffic management, monitoring, and analysis.</li><li>• The switch supports all nine RMON groups through the use of a Cisco SwitchProbe<sup>®</sup> Analyzer (Switched Port Analyzer [SPAN]) port, permitting traffic monitoring of a single port, a group of ports, or the entire switch from a single network analyzer or RMON probe.</li><li>• A SPAN port monitors traffic of a single port from a single network analyzer or RMON probe.</li><li>• Remote Switch Port Analyzer (RSPAN) allows network administrators to locally monitor ports in a Layer 2 switch network from any other switch in the same network.</li><li>• The Domain Name System (DNS) provides IP address resolution with user-defined device names.</li><li>• Network Time Protocol (NTP) provides an accurate and consistent timestamp to all switches within the intranet.</li><li>• Trivial File Transfer Protocol (TFTP) reduces the cost of administering software upgrades by downloading from a centralized location.</li><li>• Crash Information support enables switch to generate a crash file for improved troubleshooting.</li><li>• RTTMON-MIB allows users to monitor network performance between a Catalyst switch and a remote device.</li><li>• Multifunction LEDs per port for port status, 10BASE-T/100BASE-TX/1000BASE-T indication, as well as switch-level status LEDs for system and redundant power supply provide a comprehensive and convenient visual management system.</li><li>• Read-only MIB support for LRE profiles and FastEthernet ports on LRE CPEs</li></ul>



Feature	Benefit
<b>Cisco Cluster Management Suite (CMS)</b>	<ul style="list-style-type: none"><li>• Cisco Cluster Management Suite (CMS) Software allows the user to manage up to 16 inter-connected Cisco Catalyst 3550, 2950, 2950 LRE, 3500 XL, 2900 XL, and 2900 LRE XL switches without the limitation of being physically located in the same wiring closet, and with the option of using a single IP address for the entire cluster if desired. Full backward compatibility of the Cisco CMS Software ensures that any Cisco Catalyst 3550, 2950, 2950 LRE, 3500 XL, 2900 XL, and 2900 LRE XL switch can be managed with a Cisco Catalyst 2950 LRE Switch.</li><li>• Easy to use interface for managing LRE rate selection process.</li><li>• Cisco Architecture for Voice, Video, and Integrated Data (AVVID) Wizards use just a few user inputs to automatically configure the switch to optimally handle different types of traffic: voice, video, multicast, and/or high-priority data.</li><li>• A security wizard is provided to restrict unauthorized access to servers and networks, and restrict certain applications on the network.</li><li>• One-click software upgrades can be performed across the entire cluster simultaneously, and configuration cloning enables rapid deployment of networks.</li><li>• Cisco Cluster Management Suite Software has been extended to include multilayer feature configurations such as access control parameters (ACPs) and QoS parameters.</li><li>• Cisco Cluster Management Suite Guide Mode assists users in the configuration of powerful advanced features by providing step-by-step instructions.</li><li>• Cisco Cluster Management Suite provides enhanced online help for context-sensitive assistance.</li><li>• Easy-to-use graphical interface provides both a topology map and front panel view of the cluster.</li><li>• Multi-device and multi-port configuration capabilities allow network administrators to save time by configuring features across multiple switches and ports simultaneously.</li><li>• Ability to launch the web-based management for a Cisco Aironet Wireless Access Point by simply clicking on its icon in the topology map.</li><li>• User-personalized interface allows users to modify polling intervals, table views, and other settings within CMS and retain these settings the next time they use CMS.</li><li>• Alarm notification provides automated email notification of network errors and alarm thresholds</li></ul>
<b>Support for CiscoWorks</b>	<ul style="list-style-type: none"><li>• Manageable through CiscoWorks network management software on a per-port and per-switch basis providing a common management interface for Cisco routers, switches and hubs.</li><li>• Simple Network Management Protocol (SNMP) v1, v2, and v3 and Telnet interface support delivers comprehensive in-band management, and a command-line interface (CLI)-based management console provides detailed out-of-band management</li><li>• Cisco Discovery Protocol (CDP) Versions 1 and 2 enable a CiscoWorks network management station to automatically discover the switch in a network topology.</li><li>• Supported by the CiscoWorks 2000 LAN Management Solution</li></ul>



Feature	Benefit
Ease of Use and Ease of Deployment	<ul style="list-style-type: none"><li>• Archive download is a convenient tool to upgrade (or downgrade) the set of binaries on the switch. It performs memory availability checks and automatically configures the switch to use the new binaries. Archive upload can be used to archive the existing set of binaries on the switch to a storage (such as a TFTP server).</li><li>• Auto-configuration eases deployment of switches in the network by automatically configuring multiple switches across a network via a boot server.</li><li>• Auto-negotiating on all ports automatically selects half- or full-duplex transmission mode to optimize bandwidth.</li><li>• Cisco VTP supports dynamic VLANs and dynamic trunk configuration across all switches.</li><li>• Voice VLAN simplifies telephony installations by keeping voice traffic on a separate VLAN for easier network administration and troubleshooting.</li><li>• Dynamic Trunking Protocol (DTP) enables dynamic trunk configuration across all ports in the switch.</li><li>• Port Aggregation Protocol (PAgP) automates the creation of Cisco Fast EtherChannel® or Gigabit EtherChannel groups, enabling linking to another switch, router, or server.</li><li>• IEEE 802.3z-compliant 1000BASE-SX and 1000BASE-LX physical interface support through a field-replaceable SFP module provides customers unprecedented flexibility in switch deployment.</li><li>• The default configuration stored in Flash ensures that the switch can be quickly connected to the network and can pass traffic with minimal user intervention.</li><li>• The switches support non-standard Ethernet frame sizes up to 1,536 bytes.</li></ul>

## Product Specifications

(See separate Cisco LRE CPE and Cisco LRE POTS Splitter data sheets for Cisco 575 CPE, Cisco 585 CPE, and Cisco LRE POTS Splitter product specifications.)

Feature	Description
Performance	<ul style="list-style-type: none"><li>• 8.8-Gbps switching fabric</li><li>• Catalyst 2950ST-24-LRE: 4.7-Gbps maximum forwarding bandwidth</li><li>• Catalyst 2950ST-8-LRE: 4.2-Gbps maximum forwarding bandwidth (Forwarding rates based on 64-byte packets)</li><li>• Catalyst 2950ST-24-LRE: 3.5-Mpps wire-speed forwarding rate</li><li>• Catalyst 2950ST-8-LRE: 3.2-Mpps wire-speed forwarding rate</li><li>• 8-MB memory architecture shared by all ports</li><li>• Up to 32-MB SDRAM and 8-MB Flash memory</li><li>• Configurable up to 8000 MAC addresses</li><li>• Configurable maximum transmission unit (MTU) of up to 1,536 bytes</li></ul>



Feature	Description
Management	<p><i>Catalyst 2950 LRE specific:</i></p> <ul style="list-style-type: none"><li>• ETHER-LIKE-MIB</li><li>• CISCO-VDSL-LINE-MIB</li><li>• IF-MIB (RFC 1573) support for CPE Ethernet ports</li><li>• RMON-MIB (RFC 1757) support for CPE Ethernet ports</li></ul> <p><i>Catalyst 2950 Series:</i></p> <ul style="list-style-type: none"><li>• BRIDGE-MIB</li><li>• CISCO-2900-MIB</li><li>• CISCO-CDP-MIB</li><li>• CISCO-CLUSTER-MIB</li><li>• CISCO-CONFIG-MAN-MIB</li><li>• CISCO-FLASH-MIB</li><li>• CISCO-IMAGE-MIB</li><li>• CISCO-MAC-NOTIFICATION-MIB</li><li>• CISCO-MEMORY-POOL-MIB</li><li>• CISCO-PAGP-MIB</li><li>• CISCO-PING-MIB</li><li>• CISCO-PROCESS-MIB</li><li>• CISCO-PRODUCTS-MIB</li><li>• CISCO-RTTMON-MIB</li><li>• CISCO-SMI</li><li>• CISCO-STACKMAKER-MIB</li><li>• CISCO-STP-EXTENSIONS-MIB</li><li>• CISCO-SYSLOG-MIB</li><li>• CISCO-TC</li><li>• CISCO-TCP-MIB</li><li>• CISCO-VLAN-MEMBERSHIP-MIB</li><li>• CISCO-VTP-MIB</li><li>• ENTITY-MIB</li><li>• IANAifType-MIB</li><li>• IF-MIB (RFC 1573)</li><li>• OLD-CISCO-CHASSIS-MIB</li><li>• OLD-CISCO-CPU-MIB</li><li>• OLD-CISCO-INTERFACES-MIB</li><li>• OLD-CISCO-IP-MIB</li><li>• OLD-CISCO-MEMORY-MIB</li><li>• OLD-CISCO-SYSTEM-MIB</li><li>• OLD-CISCO-TCP-MIB</li><li>• OLD-CISCO-TS-MIB</li><li>• RFC1213-MIB (MIB-II)</li><li>• RFC1398-MIB (ETHERNET-MIB)</li><li>• RMON-MIB (RFC 1757)</li><li>• RS-232-MIB</li><li>• SNMPv2-MIB</li><li>• SNMPv2-SMI</li><li>• SNMPv2-TC</li><li>• TCP-MIB</li><li>• UDP-MIB</li></ul>



Feature	Description
Standards	<ul style="list-style-type: none"><li>• IEEE 802.1x</li><li>• IEEE 802.1w</li><li>• IEEE 802.1s</li><li>• IEEE 802.3x full duplex on 10BASE-T, 100BASE-TX, and 1000BASE-T ports</li><li>• IEEE 802.1D Spanning-Tree Protocol</li><li>• IEEE 802.1p class-of-service (CoS) prioritization</li><li>• IEEE 802.1Q VLAN</li><li>• IEEE 802.3 10BASE-T specification</li><li>• IEEE 802.3u 100BASE-TX specification</li><li>• IEEE 802.3ab 1000BASE-T specification</li><li>• IEEE 802.3z 1000BASE-X specification</li><li>• 1000BASE-SX (SFP)</li><li>• 1000BASE-LX (SFP)</li><li>• RMON I and II standards</li><li>• SNMPv1, SNMPv2c, SNMPv3</li></ul>
Y2K	<ul style="list-style-type: none"><li>• Y2K compliant</li></ul>
Connectors and Cabling	<ul style="list-style-type: none"><li>• LRE ports: RJ-21 connector; one-pair Category 1, 2, or 3 unshielded twisted-pair (UTP) cabling</li><li>• 10BASE-T ports: RJ-45 connectors; two-pair Category 3, 4, or 5 unshielded twisted-pair (UTP) cabling</li><li>• 100BASE-TX ports: RJ-45 connectors; two-pair Category 5 UTP cabling</li><li>• 1000BASE-T ports: RJ-45 connectors; two-pair Category 5 UTP cabling</li><li>• 1000BASE-SX and -LX SFP-based ports: SC fiber connectors, single-mode or multimode fiber</li><li>• Management console port: 8-pin RJ-45 connector, RJ-45-to-RJ-45 rollover cable with RJ-45-to-DB9 adapter for PC connections; for terminal connections, use RJ-45-to-DB25 female data-terminal-equipment (DTE) adapter (can be ordered separately from Cisco, part number ACS-DSBUASYN=)</li></ul>
Power Connectors	<p>Customers can provide power to a switch by using either the internal power supply or the Cisco Redundant Power System (RPS) 300. The internal power supply connector is located in the front of the switch and the RPS connector is located at the back of the switch.</p> <p><i>Internal Power Supply Connector</i></p> <ul style="list-style-type: none"><li>• The internal power supply is an auto-ranging unit.</li><li>• The internal power supply supports input voltages between 100 and 240 VAC.</li><li>• Use the supplied AC power cord to connect the AC power connector to an AC power outlet.</li></ul> <p><i>Cisco RPS Connector</i></p> <ul style="list-style-type: none"><li>• The connector offers connection for an optional Cisco RPS 300 that uses AC input and supplies DC output to the switch.</li><li>• The connector offers a 300-watt redundant power system that can support six external network devices and provides power to one failed device at a time.</li><li>• The connector automatically senses when the internal power supply of a connected device fails and provides power to the failed device, preventing loss of network traffic.</li><li>• Attach only the Cisco RPS 300 (model PWR300-AC-RPS-N1) to the redundant-power-supply receptacle.</li></ul>
Indicators	<ul style="list-style-type: none"><li>• Per-port status LEDs: link integrity, disabled, activity, and speed (uplinks only) indications.</li><li>• System status LEDs: system and RPS indications.</li></ul>





Feature	Description
<b>Dimensions and Weight (H x W x D)</b>	<ul style="list-style-type: none"><li>• 1.72 x 17.5 x 9.7 in. (4.36 x 44.5 x 24.6 cm) (Catalyst 2950ST-24-LRE, 2950ST-8-LRE)</li><li>• 1.0 rack-unit high</li><li>• 8.5 lb (3.9 kg) (Catalyst 2950ST-24-LRE, 2950ST-8-LRE)</li></ul>
<b>Environmental Ranges</b>	<ul style="list-style-type: none"><li>• Operating temperature: 32° to 113°F (0° to 45°C)</li><li>• Storage temperature: –13° to 158°F (–25° to 70°C)</li><li>• Operating relative humidity: 10 to 85% (non-condensing)</li><li>• Operating altitude: Up to 10,000 ft (3,000 m)</li><li>• Storage altitude: Up to 15,000 ft (4,570 m)</li><li>• Not intended for use on top of desktops or in open office environments</li></ul>
<b>Power Requirements</b>	<ul style="list-style-type: none"><li>• Catalyst 2950ST-24-LRE: Power consumption: 45W maximum, 154 BTUs per hour</li><li>• Catalyst 2950ST-8-LRE: Power consumption: 30W maximum, 102 BTUs per hour</li><li>• AC input voltage/frequency: 100 to 127/200 to 240 VAC (auto-ranging), 50 to 60 Hz</li></ul>
<b>Mean Time Between Failure (MTBF)–Predicted</b>	<ul style="list-style-type: none"><li>• Catalyst 2950ST-24-LRE: 324,854 hours</li><li>• Catalyst 2950ST-8-LRE: 420,254 hours</li></ul>
<b>Regulatory Agency Approvals</b>	
<b>Safety Certifications</b>	<ul style="list-style-type: none"><li>• UL mark to UL60950</li><li>• CUL mark to CAN/CSA C22.2 No. 60950-00</li><li>• TUV GS mark to EN60950</li><li>• Evaluated to AS/NZ 3260 and TS001</li><li>• CE mark</li></ul>
<b>Electromagnetic Compatibility Certifications</b>	<ul style="list-style-type: none"><li>• FCC Part 15 Class A</li><li>• EN 55022: 1998 Class A (CISPR22 Class A)</li><li>• EN 55024: 1998 (CISPR24)</li><li>• VCCI Class A</li><li>• AS/NZS 3548 Class A</li><li>• CE Marking</li><li>• CNS 13438</li><li>• BSMI Class A</li><li>• MIC</li><li>• BCIQ</li></ul>
<b>Warranty</b>	<ul style="list-style-type: none"><li>• Limited lifetime warranty</li></ul>



## Service and Support

The services and support programs described in the table below are available as part of the Cisco Desktop Switching Service and Support solution, and are available directly from Cisco and through resellers.

Service and Support	Features	Benefits
<b>Advanced Services</b>		
<i><b>Total Implementation Solutions (TIS)</b> available direct from Cisco</i> <i><b>Packaged Total Implementation Solutions (PackagedTIS)</b> available through resellers</i>	<ul style="list-style-type: none"><li>• Project management</li><li>• Site survey, configuration deployment</li><li>• Installation, text, and cutover</li><li>• Training</li><li>• Major Moves, Adds, Changes (MAC)</li><li>• Design review and product staging</li></ul>	<ul style="list-style-type: none"><li>• Supplements existing staff</li><li>• Ensures functionality meets needs</li><li>• Mitigates risk</li></ul>
<b>Technical Support Services</b>		
<i><b>SMARTnet and SMARTnet Onsite (OS)</b> available direct from Cisco</i> <i><b>Packaged SMARTnet</b> available through resellers</i>	<ul style="list-style-type: none"><li>• 24x7 access to software updates</li><li>• Web access to technical repositories</li><li>• Telephone support through the Technical Assistance Center</li><li>• Advance replacement of hardware parts</li></ul>	<ul style="list-style-type: none"><li>• Enables proactive or expedited issue resolution</li><li>• Lowers cost of ownership by utilizing Cisco expertise and knowledge</li><li>• Minimize network downtime</li></ul>

## Ordering Information

Model Numbers	Configuration
<b>WS-C2950ST-24-LRE</b>	<ul style="list-style-type: none"><li>• 24 LRE ports + 2 10/100/1000BASE-T ports + 2 SFP ports (two of the four uplinks active at one time)</li><li>• Based upon the 2950 Enhanced Software Image (EI)</li></ul>
<b>WS-C2950ST-8-LRE</b>	<ul style="list-style-type: none"><li>• 8 LRE ports + 2 10/100/1000BASE-T ports + 2 SFP ports (two of the four uplinks active at one time)</li><li>• Based upon the 2950 Enhanced Software Image (EI)</li></ul>
<b>GLC-SX-MM(=)</b>	<ul style="list-style-type: none"><li>• GE SFP, LC connector SX transceiver</li></ul>
<b>GLC-LH-SM(=)</b>	<ul style="list-style-type: none"><li>• GE SFP, LC connector LX transceiver</li></ul>

### For More Information on Cisco Products, Contact:

- US and Canada: 800 553-NETS (6387)
- Europe: 32 2 778 4242
- Australia: 612 9935 4107
- Other: 408 526-7209
- World Wide Web URL: <http://www.cisco.com>

**Corporate Headquarters**

Cisco Systems, Inc.  
170 West Tasman Drive  
San Jose, CA 95134-1706  
USA  
[www.cisco.com](http://www.cisco.com)  
Tel: 408 526-4000  
800 553-NETS (6387)  
Fax: 408 526-4100

**European Headquarters**

Cisco Systems International BV  
Haarlerbergpark  
Haarlerbergweg 13-19  
1101 CH Amsterdam  
The Netherlands  
[www-europe.cisco.com](http://www-europe.cisco.com)  
Tel: 31 0 20 357 1000  
Fax: 31 0 20 357 1100

**Americas Headquarters**

Cisco Systems, Inc.  
170 West Tasman Drive  
San Jose, CA 95134-1706  
USA  
[www.cisco.com](http://www.cisco.com)  
Tel: 408 526-7660  
Fax: 408 527-0883

**Asia Pacific Headquarters**

Cisco Systems, Inc.  
Capital Tower  
168 Robinson Road  
#22-01 to #29-01  
Singapore 068912  
[www.cisco.com](http://www.cisco.com)  
Tel: +65 6317 7777  
Fax: +65 6317 7799

Cisco Systems has more than 200 offices in the following countries and regions. Addresses, phone numbers, and fax numbers are listed on the  
**Cisco Web site at [www.cisco.com/go/offices](http://www.cisco.com/go/offices)**

Argentina • Australia • Austria • Belgium • Brazil • Bulgaria • Canada • Chile • China PRC • Colombia • Costa Rica • Croatia  
Czech Republic • Denmark • Dubai, UAE • Finland • France • Germany • Greece • Hong Kong SAR • Hungary • India • Indonesia • Ireland  
Israel • Italy • Japan • Korea • Luxembourg • Malaysia • Mexico • The Netherlands • New Zealand • Norway • Peru • Philippines • Poland  
Portugal • Puerto Rico • Romania • Russia • Saudi Arabia • Scotland • Singapore • Slovakia • Slovenia • South Africa • Spain • Sweden  
Switzerland • Taiwan • Thailand • Turkey • Ukraine • United Kingdom • United States • Venezuela • Vietnam • Zimbabwe

All contents are Copyright © 1992–2002, Cisco Systems, Inc. All rights reserved. Catalyst, Cisco, Cisco IOS, Cisco Systems, the Cisco Systems logo, EtherChannel, EtherSwitch, and GigaStack are registered trademarks of Cisco Systems, Inc. and/or its affiliates in the U.S. and certain other countries.

All other trademarks mentioned in this document or Web site are the property of their respective owners. The use of the word partner does not imply a partnership relationship between Cisco and any other company. (0208R)