Cisco SM-X Layer 2/3 EtherSwitch Service Module for Cisco 4451-X and Cisco 2900 and 3900 Series Integrated Services Routers

The Cisco® SM-X Layer2/3 EtherSwitch® Service Module can reduce your company's total cost of ownership (TCO) by integrating Gigabit Ethernet (GE) ports within the Cisco 4451-X and Cisco 3900 and 2900 Series Integrated Services Routers (ISRs). This integration allows network administrators to manage a single device using Cisco management tools or the router command-line interface (CLI) for LAN and WAN management needs. This approach reduces network complexity, lowers maintenance contract costs, lessens staff training needs, simplifies software qualification efforts, increases availability, and delivers a consistent user experience at branch offices and headquarters.

Product Overview

The Cisco SM-X Layer2/3 EtherSwitch Modules are an enterprise class line of switches in Cisco ISR extended service module form factor for the Cisco 2900 and 3900 Series and Cisco 4451-X ISRs. These Cisco EtherSwitch Service Modules (Figure 1) greatly expand the capabilities of the router by integrating industry-leading Layer 2 and Layer 3 switching with feature sets identical to those found in the Cisco Catalyst® 3560-X Series.

The new Cisco SM-X Layer2/3 EtherSwitch Service Modules take advantage of the increased capabilities on the Cisco Catalyst 3560-X Series Switches and provide scalability, security, energy efficiency, and ease of operation with innovative features such as Cisco TrustSec® and Media Access Control Security (MACsec) features. Additionally, these service modules enable Cisco's industry-leading power initiatives with IEEE 802.3at Power over Ethernet Plus (PoE+) configurations and per-port PoE power monitoring - all of which enhance the ability of the branch office to scale to next-generation requirements and still meet important initiatives for IT teams to operate a power efficient network. Furthermore, the Cisco Enhanced EtherSwitch Service Modules not only perform local line-rate switching and routing but also support direct service module-to-service module communication through the Integrated Services Routers Generation 2 (ISR G2) Multigigabit Fabric (MGF), which separates LAN traffic from WAN resources.

Because the Cisco SM-X Layer2/3 EtherSwitch Service Modules support the same feature sets as the Cisco Catalyst 3560-X Switches, you can provide a ubiquitous configuration at headquarters and at the branch office to create a consistent experience throughout your network.

Figure 1. Cisco SM-X EtherSwitch Service Modules

Cisco SM-X Layer2/3 EtherSwitch Service Module Software

In addition to IP Base and IP Services feature sets, the Cisco SM-X Layer2/3 EtherSwitch Modules come with a new LAN Base feature set. The three feature sets available with all Cisco SM-X EtherSwitch Modules follow:

- LAN Base: Enterprise access Layer 2 switching features
- IP Base: Baseline enterprise access Layer 3 switching features
- IP Services: Advanced Layer 3 switching (IPv4 and IPv6) features

The LAN Base feature set includes comprehensive Layer 2 features, with up to 255 VLANs. The IP Base feature set provides baseline enterprise services in addition to all LAN Base features, with 1000 VLANs. IP Base also includes support for routed access and MACsec. The IP Services feature set provides full enterprise services that include advanced Layer 3 features such as Enhanced Interior Gateway Routing Protocol (EIGRP), Open Shortest Path First (OSPF), Border Gateway Protocol (BGP), Protocol Independent Multicast (PIM), and IPv6 routing such as OSPFv3 and EIGRPv6. All software feature sets support advanced security, quality of service (QoS), and management features.

Cisco SM-X Layer2/3 EtherSwitch Service Modules support a “Right to Use” license to upgrade the license. For more details, please visit: http://www.cisco.com/en/US/docs/switches/lan/catalyst3750x_3560x/software/release/12.2_53_se/configuration/notes/ol19813.html#wp44153.

Features and Benefits

Architecture Features and Benefits

The Cisco SM-X Layer2/3 EtherSwitch Service Module helps ensure maximum availability, high performance, ease of upgrade, and expandability. The modules have their own processors, switching engines, and flash memory that run independently of host router resources, helping ensure maximum concurrent switching and routing performance as well as providing integrated PoE+, security, and increased ease of management. Additionally, Cisco SM-X EtherSwitch Service Modules run their own Cisco IOS® Software, independent of the router Cisco IOS Software image, allowing for easy upgrades and ongoing software and feature commonality with Cisco Catalyst 3560-X Series Switches. Table 1 lists some of the features and benefits of this architecture.

When inserted within a Cisco 2900 or 3900 Series or Cisco 4451-X Integrated Services Router, the Cisco SM-X EtherSwitch Service Modules provide a fully integrated, secure networking and converged IP communications solution. From a single platform with an integrated switch, you can connect IP phones, wireless access points, and IP-based video cameras to your network and power them using the IEEE 802.3af or IEEE 802.3at PoE+. With the optional integration of Cisco Unified Communications Manager Express, the router can also provide call processing for the phones.

As users attempt network access through the Cisco Enhanced EtherSwitch Service Module, the module can use IEEE 802.1x and a large number of Cisco 802.1x extensions to validate the credentials of the end device and place the user in the appropriate VLAN or Cisco TrustSec group. As the end-user data traverses between the switch module and other network entities or between buildings, this traffic can be encrypted at Layer 2 using MACsec.

Table 1. How Cisco SM-X EtherSwitch Service Module Addresses Customer Needs

Customer Needs	How Addressed by Cisco Enhanced EtherSwitch Service Module
Green IT	
• Cisco EnergyWise® technology • Single power supply for Cisco EtherSwitch device and router	• Cisco EnergyWise technology enables Cisco EtherSwitch devices to automatically reduce off-peak use of PoE. • The modules offer two to eight times lower power consumption than standalone switches. • Because no additional rack space or power supply is needed, there is less to rack, stack, and cool.
Total TCO	
• Scaling network infrastructure across multiple sites • Increasing costs of operating multiple devices at the branch office • Maximizing IT resources	• An integrated switch solution lowers operating costs, simplifies troubleshooting, and enables businesses to scale. • Cisco Catalyst 3560-X software parity enables IT to certify and deploy the same services at the main office and branch office. • The modules offer lower mean time to repair (MTTR). One vendor means one support center to decrease troubleshooting time and eliminate finger pointing among vendors. • Cisco SMARTnet® support covers both integrated services routers and Cisco EtherSwitch devices.
Investment Protection	
• Ensuring compatibility of your network with future networks to deliver leading technology	• The Cisco SM-X EtherSwitch Service Module and Cisco Catalyst 3560-X features, schedule, and roadmap are aligned to provide a consistent user experience and to help ensure no new hardware is required to support the latest innovations.
High Availability	
• Minimizing downtime that affects business operations	• Cisco SM-X EtherSwitch Service Modules run their own Cisco IOS Software images and can be upgraded independent of the host router image. • A single-box solution simplifies remote management and improves services interoperability to help ensure the highest reliability for all users. • End-to-end testing for standards-based and innovative Cisco proprietary features provides superior services interoperability and excellent value. • The modules will use the optional redundant power supplies in Cisco ISRs, including an integrated redundant power system (RPS) on the Cisco 4451-X and Cisco 3900 Series and external Cisco Redundant Power System 2300 (RPS 2300) support on the Cisco 2911 through Cisco 2951 ISRs. • Fewer components (for example, power supplies and fans) results in fewer failures and less downtime. • Mean Time Between Failure (MTBF) is at least twice as high as that for a standalone switch.
Scalability with High-Performance IP Routing for the LAN (IP Base and IP Services)	
• Isolation of LAN traffic and route between VLANs on the Cisco SM-X EtherSwitch Service Module	• Cisco Express Forwarding hardware routing architecture delivers extremely high-performance IP routing and promotes scalability. • The modules offer inter-VLAN IP routing with full local Layer 3 switching between two or more VLANs. • Traffic can be forwarded between service modules over the MGF without affecting the router CPU.

Advanced PoE Support

PoE removes the need for wall power to each PoE-enabled device and eliminates the cost for additional electrical cabling and circuits that would otherwise be necessary in IP phone and wireless LAN (WLAN) deployments.

Although PoE has been employed for more than a decade, it is still an evolving technology. New and innovative applications continue to raise expectations for power requirements.

IEEE 802.3at Power over Ethernet

In addition to 802.3af PoE, the Cisco Enhanced EtherSwitch Service Modules support PoE+ (IEEE 802.3at standard), which provides up to 30W of power per port. The Cisco SM-X EtherSwitch Service Modules can thereby provide a lower TCO for deployments that incorporate Cisco IP Phones, Cisco Aironet® wireless LAN access points, or any IEEE 802.3af-compliant end device.

PoE+ enabled ports can, in addition to PoE+ 30W, also be used to deliver power for current PoE and enhanced ePoE solutions.

Table 2 gives information about total PoE power output. Depending on the Cisco 2900, 3900, or 4451-X router model, the available PoE power ranges from 200 to 1014 watts. Additional PoE features include the following:

- Per-port power consumption control allows you to specify a maximum power setting on an individual port.
- Per-port PoE power sensing measures the actual power being drawn, enabling more intelligent control of powered devices.
- The Cisco PoE MIBs provide proactive visibility into power usage and allow you to set different power-level thresholds.
- Cisco Discovery Protocol Version 2 allows the Cisco SM-X EtherSwitch Service Modules to negotiate a more granular power setting than IEEE classification provides when connecting to a Cisco powered device such as IP phones or access points.
- The Link Layer Discovery Protocol Media Endpoint Discovery (LLDP-MED) link layer discovery protocol and MIB enable interoperability in multivendor networks. Switches exchange speed, duplex, and power settings with end devices such as IP phones.

Power over Ethernet requires the PoE versions of the router power supplies (See Table 3.). The Cisco 2900, 3900, and 4451-X routers support multiple PoE powering modes:

- Normal: One PoE power supply.
- Redundant: Two PoE internal power supplies (Cisco 4451-X and Cisco 3900 Series) or one PoE power supply plus an external Cisco RPS 2300 Redundant Power Supply Unit (Cisco 2911, 2921, and 2951), where one is active and one is standby.
- Boost: Two PoE internal power supplies (Cisco 4451-X and Cisco 3900 Series) or one PoE power supply plus an external Cisco RPS 2300 (Cisco 2900), where both are actively supplying PoE power; redundancy will not be supported in this mode because both power supplies are in active use simultaneously.

Table 2. Power Output

Router	Normal PoE with Single PoE Power Supply (Watts)	Maximum Number of Ports Running at 15.4W in Normal Mode	Maximum Number of Ports Running at 30W in Normal Mode	Maximum Power with Dual PoE Supplies in Boost Mode (Watts)	Maximum Number of Ports Running at 15.4W in Boost Mode	Maximum Number of Ports Running at 30W in Boost Mode
Cisco 4451-X	500	32	16	1000	64	33
Cisco 3900 Series	520	33	16	1040	65	34
Cisco 2951	370	24	12	750	48	25
Cisco 2921	280	18	9	750	48	25
Cisco 2911	200	12	6	750	48	24

Table 3. Power Supply Models

16-, 24-, and 48-Port Cisco EtherSwitch Module	No PoE	PoE (No Redundancy Required)	PoE (Redundancy Required)	PoE Boost Mode (No Redundancy Required)
Cisco 4451-X	PWR-4450-AC	PWR-4450-POE	2 x PWR-4450-POE	2 x PWR-4450-POE
Cisco 3900 Series	PWR-3900-AC/DC	PWR-3900-POE	2 x PWR-3900-AC/DC	2 x PWR-3900-AC/DC
Cisco 2921 and 2951	PWR-2921-51-AC/DC	PWR-2921-51-POE	PWR-2921-51-AC/DC + PWR-RPS2300	PWR-2921-51-AC/DC + PWR-RPS2300
Cisco 2911	PWR-2911-AC/DC	PWR-2911-POE	PWR-2911-AC/DC+ PWR-RPS2300	PWR-2911-AC/DC+ PWR-RPS2300

Secure Networking

Because security needs to be embedded throughout the network, routers and Cisco EtherSwitch devices play a critical role in any network defense strategy. Cisco SM-X EtherSwitch Service Modules provide a rich set of security features and can be a crucial component of your secure network strategy. The modules support a comprehensive set of security features for connectivity and access control, including ACLs, authentication, and port-level security, identity-based network services with 802.1x and Cisco TrustSec security, and switch-to-switch encryption with MACsec.

This set of comprehensive features not only helps prevent external attacks, but also defends the network against "man-in-the-middle" attacks, a primary concern in today's business environment. Table 4 highlights the benefits of the Cisco SM-X EtherSwitch Service Module security features.

Table 4. Security Features of Cisco SM-X EtherSwitch Service Module

Feature	Benefit
Dynamic ARP Inspection (DAI)	• DAI helps ensure user integrity by preventing malicious users from exploiting the insecure nature of the Address Resolution Protocol (ARP).
DHCP Snooping	• This feature prevents malicious users from spoofing a Dynamic Host Configuration Protocol (DHCP) server and sending out bogus addresses. Other primary security features use DHCP Snooping to prevent numerous other attacks such as ARP poisoning.
IP Source Guard	• IP Source Guard prevents a malicious user from spoofing or taking over another user's IP address by creating a binding table between the client's IP and MAC address, port, and VLAN.
Private VLANs	• Private VLANs restrict traffic between hosts in a common segment by segregating traffic at Layer 2, turning a broadcast segment into a nonbroadcast multiaccess-like segment. • Private VLAN Edge provides security and isolation between switch ports, helping ensure that users cannot snoop on other users' traffic. • These features are available in the IP Base and IP Services license levels.
Unicast Reverse Path Forwarding (URPF)	• This feature helps mitigate 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. • This feature is available in the IP Base and IP Services license levels only.
IEEE 802.1x	• IEEE 802.1x allows dynamic, port-based security, providing user authentication. • IEEE 802.1x with VLAN assignment allows a dynamic VLAN assignment for a specific user regardless of where the user is connected. • IEEE 802.1x with voice VLAN permits an IP phone to access the voice VLAN irrespective of the authorized or unauthorized state of the port. • IEEE 802.1x and port security are provided to authenticate the port and manage network access for all MAC addresses, including that of the client. • IEEE 802.1x with an ACL assignment allows for specific identity-based security policies regardless of where the user is connected. • IEEE 802.1x with guest VLAN allows guests without 802.1x clients to have limited network access on the guest VLAN. • Web authentication for non-802.1x clients allows non-802.1x clients to use an SSL-based browser for authentication.

Feature	Benefit
Cisco TrustSec security	• Cisco TrustSec classification and policy enforcement functions are embedded in the Cisco Enhanced EtherSwitch Service Modules. • Cisco TrustSec security simplifies the provisioning and management of secure access to network services and applications by classifying traffic based on the contextual identity of the endpoint versus its IP address. It enables more flexible access controls for dynamic networking environments. • Cisco TrustSec security defines policies using logical policy groupings, so secure access is consistently maintained even as resources are moved in mobile and virtualized networks. De-coupling access entitlements from IP addresses allows common access policies to be applied to wired, wireless, and VPN access consistently.
MACsec	• Exceptional security with integrated hardware support for MACsec is defined in IEEE 802.1AE. MACsec provides MAC layer encryption over wired networks using out-of-band methods for encryption keying. • The MACsec Key Agreement (MKA) Protocol provides the required session keys and manages the keys required for encryption when configured. MKA and MACsec are implemented following successful authentication using the 802.1x Extensible Authentication Protocol (EAP) framework. • In Cisco Enhanced EtherSwitch Service Modules, both the user and down-link ports (links between the switch and endpoint devices such as a PC or IP phone) as well as the network and up-link ports can be secured using MACsec. • With MACsec you can encrypt switch-to-switch links such as access to distribution, or encrypt dark fiber links within a building or between buildings.
Multidomain authentication	• Multidomain authentication allows an IP phone and a PC to authenticate on the same switch port while placing them on the appropriate voice and data VLAN.
MAC Authentication Bypass (MAB)	• MAB for voice allows third-party IP phones without an 802.1x supplicant to get authenticated using the MAC address. • This feature is available in the IP Base and IP Services license levels only.
Advanced ACLs	• Cisco security VLAN ACLs on all VLANs prevent unauthorized data flows from being bridged within VLANs. • This feature is available in the IP Base and IP Services license levels only. • Cisco standard and extended IP Security router ACLs define security policies on routed interfaces for control- and data-plane traffic. IPv6 ACLs can be applied to filter IPv6 traffic. • This feature is available in the IP Base and IP Services license levels only. • Port-based ACLs for Layer 2 interfaces allow security policies to be applied on individual switch ports.
Administrative traffic protection	• Secure Shell (SSH) Protocol, Kerberos, and Simple Network Management Protocol Version 3 (SNMPv3) provide network security by encrypting administrator traffic during Telnet and SNMP sessions. SSH, Kerberos, and the cryptographic version of SNMPv3 require a special cryptographic software image because of U.S. export restrictions. • Some of these features are available in the IP Base and IP Services license levels only.
Switched Port Analyzer (SPAN)	• Bidirectional data support on the SPAN port allows the Cisco Intrusion Detection System (IDS) to take action when an intruder is detected.
Centralized authentication	• TACACS+ and RADIUS authentication facilitates centralized control of the switch and restricts unauthorized users from altering the configuration.
MAC address authentication	• MAC address notification allows administrators to be notified of users added to or removed from the network.
Port security	• Port security secures the access to an access or trunk port based on MAC address.
Console security	• Multilevel security on console access prevents unauthorized users from altering the switch configuration.
Bridge Protocol Data Unit (BPDU) Guard	• BPDU guard shuts down Spanning Tree PortFast-enabled interfaces when BPDUs are received to avoid accidental topology loops.
Spanning-Tree Root Guard	• This feature prevents edge devices not in the network administrator's control from becoming Spanning Tree Protocol root nodes.
Internet Group Management Protocol (IGMP) Filtering	• IGMP filtering provides multicast authentication by filtering out nonsubscribers and limits the number of concurrent multicast streams available per port.
Dynamic VLAN Assignment	• Dynamic VLAN assignment is supported through implementation of VLAN Membership Policy Server client capability to provide flexibility in assigning ports to VLANs. Dynamic VLAN facilitates the fast assignment of IP addresses.

Summary

Cisco SM-X Layer2/3 EtherSwitch Service Modules enable a higher level of control and security with the introduction of Cisco TrustSec security and MACsec. Cisco TrustSec security provides more scalable and advanced authentication of users, whereas MACsec introduces automatic encryption of switch-to-switch traffic. Cisco SM-X EtherSwitch Service Modules also offer enhanced PoE power levels with the introduction of IEEE 802.3at PoE+, broadening the span of network equipment powered from the switch.

By minimizing operating expenses (OpEx) without sacrificing any advanced switching features, Cisco SM-X EtherSwitch Service Modules can help you maximize your return on investment (ROI) for the network infrastructure and accelerate the deployment of productivity-enhancing services to your enterprise branch offices or small to midsize business offices.

Product Specifications

Table 5 gives specifications of the Cisco SM-X EtherSwitch Service Modules. Please note that all Gigabit Ethernet ports support 10/100/1000 Mbps.

Table 5. Product Specifications

Model	Gigabit Ethernet Ports	Layer 2 Switching	Layer 2/3 Switching	PoE/PoE+	Service Module Width
SM-X-ES3-24-P	24	LAN Base	IP Base	X	Single
SM-X-ES3-16-P	16	LAN Base	IP Base	X	Single

Table 6 outlines the number of Cisco SM-X EtherSwitch Service Modules supported per platform. Traffic between modules is switched by the router MGF switch. Each module has a 1-Gbps-per-second link to the MGF.

You can mix and match modules. The numbers in the following tables do not include onboard Ethernet ports or Ethernet ports available on eventual high-speed WAN interface card (HWIC), enhanced HWIC (EHWIC), or network interface module (NIM) modules.

Table 6. Module Support

Model	Maximum No. of Ports Using Service Modules	One Single	One Double	Two Single	One Single + One Double	Two Single + One Double	Three Single	Four Single
Cisco 4451-X	50	X	X	X				
Cisco 3945	98	X	X	X	X	X	X	X
Cisco 3925	74	X	X	X	X			
Cisco 2951	50	X	X	X				
Cisco 2921	50	X	X					
Cisco 2911	24	X						

Software Support

Table 7 details the minimum software needed for Cisco SM-X EtherSwitch support, as well as the default software license. Cisco SM-X EtherSwitch Service Modules are supported in all technology packages.

Table 7. Cisco IOS Software Release Module Support

Model	Default Software	Minimum Cisco EtherSwitch Release	Minimum Cisco IOS M&T Software Release	Minimum Router Cisco IOS XE Software Release
SM-X-ES3-24-P	LAN Base	15.0(2)EJ	15.3(3)M	3.10
SM-X-ES3-16-P	LAN Base	15.0(2)EJ	15.3(3)M	3.10

Physical and Environmental Specifications

Table 8 gives product specifications.

Table 8. Module Specifications

Model	Dimensions: Wide x Deep x High (cm)	Weight (kg)	Operational Temperature	Nonoperational Temperature	Operational Humidity	Nonoperational Humidity
SM-X-ES3-24-P	20.6 x 20.7 x 4.0	0.9	0 to 40℃	-20 to 65℃	5 to 85%	5 to 95%
SM-X-ES3-16-P	20.6 x 20.7 x 4.0	0.9	0 to 40℃	-20 to 65℃	5 to 85%	5 to 95%

Regulatory Compliance, Safety, EMC, Telecommunications, and Network Homologation

When installed in a Cisco 2900 or 3900 Series or Cisco 4451-X ISR, the Cisco EtherSwitch Service Module does not change the standards (regulatory compliance, safety, EMC, telecom, or network homologation) of the router itself. For more information about these routers, please visit:

- http://www.cisco.com/en/US/products/ps10537/index.html
- http://www.cisco.com/en/US/products/ps10536/index.html
- http://www.cisco.com/en/US/products/ps12522/index.html

Ordering Information

Table 9 provides ordering information for Cisco EtherSwitch Service Modules. To place an order, visit the Cisco Ordering Home Page.

Table 9. Ordering Information

Part Number	Description
SM-X-ES3-24-P	SM-X EtherSwitch SM, Layer 2/3 switching, 24 ports Gigabit GE, POE+ capable
SM-X-ES3-16-P	SM-X EtherSwitch SM, Layer 2/3 switching, 16 ports GE, POE+ capable

Step One: License Product ID	Step 2: Choose Upgrade License Product ID	
Product Number and Description	**Product Number**	**Product Description**
C3560X-LIC= **(License Product ID for SM-X EtherSwitch Modules)**	**SM-X EtherSwitch LAN Base to IP Base**	
	C3560X-16-L-S	SM-X-ES3-16-P LAN Base to IP Base Paper License
	C3560X-24-L-S	SM-X-ES3-24-P LAN Base to IP Base Paper License

Step One: License Product ID	Step 2: Choose Upgrade License Product ID	
Product Number and Description	**Product Number**	**Product Description**
	SM-X EtherSwitch LAN Base to IP Service	
	C3560X-16-L-E	SM-X-ES3-16-P LAN Base to IP Service Paper License
	C3560X-24-L-E	SM-X-ES3-24-P LAN Base to IP Service Paper License
	SM-X EtherSwitch IP Base to IP Service	
	C3560X-16-S-E	SM-X-ES3-16-P IP Base to IP Service Paper License
	C3560X-24-S-E	SM-X-ES3-24-P IP Base to IP Service Paper License

Cisco and Partner Services for the Branch Office

Services from Cisco and our certified partners can help you transform the branch-office experience and accelerate business innovation and growth in the Borderless Network. We have the depth and breadth of expertise to create a clear, replicable, optimized branch-office footprint across technologies. Planning and design services align technology with business goals and can increase the accuracy, speed, and efficiency of deployment. Technical services help improve operational efficiency, save money, and mitigate risk. Optimization services are designed to continuously improve performance and help your team succeed with new technologies.

For More Information

This document describes information about Cisco EtherSwitch Service Modules only. For more information about these modules, contact your local Cisco account representative.

For more information regarding software features, please consult the Cisco Catalyst 3560-X webpages at: http://www.cisco.com/en/US/products/ps10744/index.html.

For more information about Cisco 2900 and 3900 Series and Cisco 4451-X Integrated Services Routers, please visit: http://www.cisco.com/en/US/products/ps10906/Products_Sub_Category_Home.html.

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