

# Cisco Catalyst 3650 Series Switches

## Product Overview

The Cisco® Catalyst® 3650 Series is the next generation of enterprise-class standalone and stackable access-layer switches that provide the foundation for full convergence between wired and wireless on a single platform. The Cisco Catalyst 3650 is built on the advanced Cisco StackWise®-160, and takes advantage of the new Cisco® Unified Access Data Plane (UADP) application-specific integrated circuit (ASIC). This switch can enable uniform wired-wireless policy enforcement, application visibility, flexibility, application optimization, and superior resiliency. The Cisco Catalyst 3650 Series Switches support full IEEE 802.3at Power over Ethernet Plus (PoE+), and offer modular and field-replaceable redundant fans and power supplies. They can help you increase wireless productivity and reduce your TCO.

- Integrated wireless controller capability with:
  - Up to 40G of wireless capacity per switch (48-port models)
  - Support for up to 25 access points and 1000 wireless clients on each switching entity (switch or stack)
- 24 and 48 10/100/1000 data and PoE+ models with energy-efficient Ethernet (EEE) supported ports
- Three fixed-uplink models with 4 x Gigabit Ethernet, 2 x 10 Gigabit Ethernet, or 4 x 10 Gigabit Ethernet ports
- Optional Cisco StackWise-160 technology that provides scalability and resiliency with 160 Gbps of stack throughput
  - Dual redundant, modular power supplies and three modular fans providing redundancy
  - Full IEEE 802.3at (PoE+) with 30 W power on all ports in 1 rack unit (RU) form factor
- Software support for IPv4 and IPv6 routing, multicast routing, modular quality of service (QoS), Flexible NetFlow (FNF) Version 9, and enhanced security features
- Single universal Cisco IOS® Software image across all license levels, providing an easy upgrade path for software features
- Enhanced limited lifetime warranty (E-LLW) with next business day (NBD) advance hardware replacement and 90-day access to Cisco Technical Assistance Center (TAC) support

## Switch Models and Configurations

All Cisco Catalyst 3650 Series Switches have fixed, built-in uplink ports and ship with one power supply. Tables 1 through 5 provide further details. Figure 1 is an image of the Cisco Catalyst 3650 Series Switches.

**Figure 1.** Cisco Catalyst 3650 Series Switches



Table 1 shows the Cisco Catalyst 3650 Series configurations.

**Table 1.** Cisco Catalyst 3650 Series Configurations

Models	Fixed Uplinks	Total 10/100/1000 Ethernet Ports	Default AC Power Supply	Available PoE Power
WS-C3650-24TS	4 x Gigabit Ethernet with Small Form-Factor Pluggable (SFP)	24	250 WAC	-
WS-C3650-48TS		48		
WS-C3650-24PS		24 PoE+	640 WAC	390 W
WS-C3650-48PS		48 PoE+		
WS-C3650-48FS		48 PoE+	1025 WAC	775 W
WS-C3650-24TD	2 x 10 Gigabit Ethernet with SFP+ or 4 x Gigabit Ethernet with SFP	24	250 WAC	
WS-C3650-48TD		48		
WS-C3650-24PD		24 PoE+	640 WAC	390 W
WS-C3650-48PD		48 PoE+		
WS-C3650-48FD		48 PoE+	1025 WAC	775 W
WS-C3650-48TQ	4 x 10 Gigabit Ethernet with SFP+ or 4 x Gigabit Ethernet with SFP	48	250 WAC	
WS-C3650-48PQ		48 PoE+	640 WAC	390 W
WS-C3650-48FQ		48 PoE+	1025 WAC	775 W

### Fixed Uplinks

All Cisco Catalyst 3650 Series Switches have fixed, built-in uplink ports. Customers can choose from three types of uplink ports at the time of the switch purchase:

- 4 x Gigabit Ethernet with Small Form-Factor Pluggable (SFP)
- 2 x 10 Gigabit Ethernet with SFP+ or 4 x Gigabit Ethernet with SFP
- 4 x 10 Gigabit Ethernet with SFP+ or 4 x Gigabit Ethernet with SFP

The SFP+ interface supports both 10 Gigabit Ethernet and Gigabit Ethernet ports. Refer to Table 1 for a description of the basic switch models and the corresponding uplink ports. Refer to Table 2 for a description of the various uplink port interface options.

**Table 2.** Network Module Configurations

Network Module	Interface Options	
	10 Gigabit Ethernet SFP+ Ports	Gigabit Ethernet SFP Ports
4 x Gigabit Ethernet	0	4
4 x Gigabit Ethernet/2 x10 Gigabit Ethernet Network Modules	2	0
	0	4
	2	2
4 x Gigabit Ethernet/4 x10 Gigabit Ethernet Network Modules	4	0
	0	4
	2	2
	3	1
	1	3

### Dual Redundant Modular Power Supplies

The Cisco Catalyst 3650 Series Switches support dual redundant power supplies (See Figure 2). The switch ships with one power supply by default, and the second power supply can be purchased at the time of ordering the switch or at a later time. If only one power supply is installed, it should always be in power supply bay 1. The switch also ships with three field-replaceable fans.

**Figure 2.** Redundant Power Supplies



Table 3 shows the different power supplies available in these switches and available PoE power.

**Table 3.** Switch Models and Corresponding Default Power Supplies

Models	Default Power Supply	Available PoE Power
24-port data switch	PWR-C2-250WAC	-
48-port data switch		
24-port PoE switch	PWR-C2-640WAC	390 W
48-port PoE switch		
48-port full PoE switch	PWR-C2-1025WAC	775 W

In addition to the power supplies listed in Table 3, a 640 WDC power supply is available at the time of order or as a spare on all switch models. The DC power supply also delivers PoE capabilities for maximum flexibility (refer to Table 5 for available PoE budget with DC power supplies). Customers can mix and match the AC and DC power supplies in the two available power supply slots. Any of these power supplies can be installed in any of the switches.<sup>1</sup>

<sup>1</sup> The 250 WAC power supply will be supported on the PoE-capable switches in a future release.

**Table 4.** Available PoE with DC Power Supply

Model	Number of 440WDC Power Supplies	Total Available PoE Budget
24-port or 48-port PoE Switch	1	390 W
	2	780 W

## Power over Ethernet Plus (PoE+)

The Cisco Catalyst 3650 Series Switches support both PoE (IEEE 802.3af) and PoE+ (IEEE 802.3at standard), which provide up to 30 W of power per port. 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 WLAN deployments. The Cisco Catalyst 3650 Series Switches can provide a lower TCO for deployments that incorporate Cisco IP phones, Cisco Aironet<sup>®</sup> wireless LAN (WLAN) access points, or any IEEE 802.3at-compliant end device. Table 5 shows the power supply combinations required for different PoE needs.

**Table 5.** Minimum Power Supply Requirements for Full PoE and PoE+

	24-Port PoE Switch	48-Port PoE Switch
PoE on All Ports (15.4 W per port)	One PWR-C2-640 WAC	One PWR-C2-1025WAC or Two PWR-C2-640 WAC
PoE+ on All Ports (30 W per port)	One PWR-C2-1025WAC or Two PWR-C2-640 WAC	Two PWR-C2-1025 WAC

## Benefits

### Converged Wired plus Wireless Access

The Cisco Catalyst 3650 is a standalone and stackable access switching platform that enables wired plus wireless services on a single Cisco IOS XE Software-based platform. With this, Cisco has pioneered a host of rich capabilities such as high availability based on stateful switchover (SSO) on stacking, granular QoS, security, and Flexible NetFlow (FNF) across wired and wireless in a seamless fashion. Also, the wired plus wireless features are bundled into a single Cisco IOS Software image, which reduces the number of software images that users have to qualify/certify before enabling them in their network. The single console port for command-line interface (CLI) management reduces the number of touch points to manage for wired plus wireless services, thereby reducing network complexity, simplifying network operations, and lowering the TCO to manage the infrastructure.

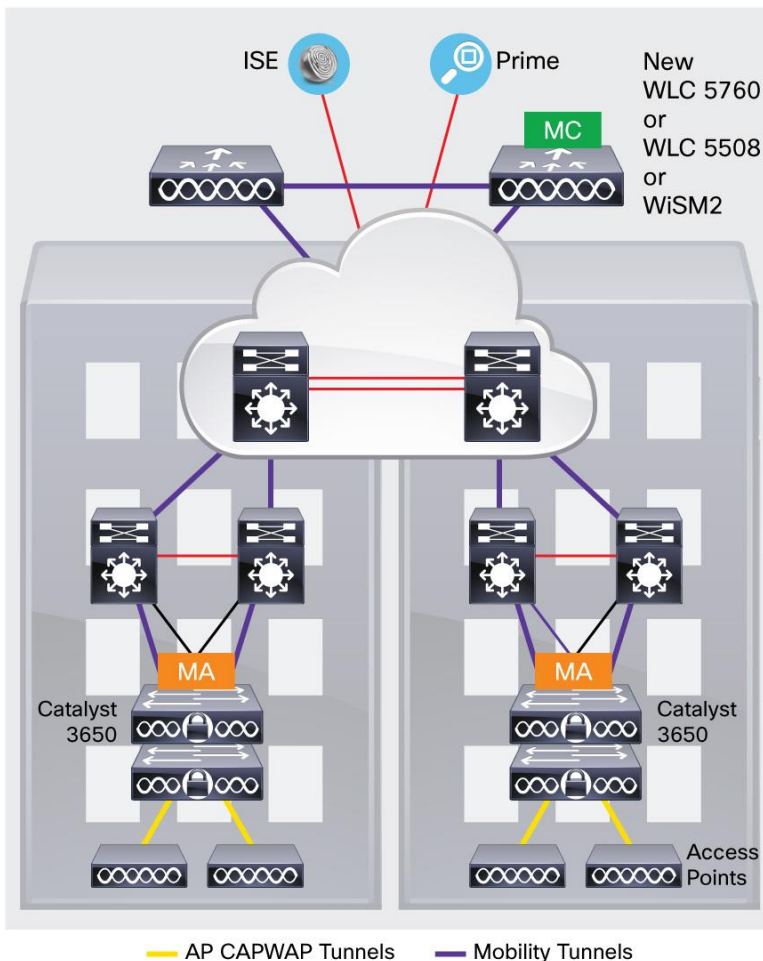
Converged wired plus wireless not only improves wireless bandwidth across the network but also the scale of wireless deployment. Each 48-port Cisco Catalyst 3650 provides 40 Gbps of wireless throughput (20 Gbps on the 24-port model). This wireless capacity increases with the number of members in the stack. This makes sure that the network can scale with current wireless bandwidth requirements, as dictated by IEEE 802.11n-based access points and with future wireless standards such as IEEE 802.11ac. Additionally, the Cisco Catalyst 3650 distributes the wireless controller functions to achieve better scalability. Each Cisco Catalyst 3650 switch/stack can operate as the wireless controller in two modes:

- **Mobility agent (MA):** This is the default mode in which the Cisco Catalyst 3650 switch ships. In this mode the switch is capable of terminating the CAPWAP tunnels from the access points and providing wireless connectivity to wireless clients. Maintaining wireless client databases and configuring and enforcing security and QoS policies for wireless clients and access points can be enforced in this mode. No additional license on top of IP Base is required to operate in the mobility agent mode.

- Mobility controller (MC):** In this mode, the Cisco Catalyst 3650 switch can perform all the mobility agent tasks in addition to mobility coordination, radio resource management (RRM), and Cisco CleanAir<sup>®</sup> coordination within a mobility subdomain. The mobility controller mode can be enabled on the switch CLI. IP Base license level is required when the Cisco Catalyst 3650 switch is acting as the mobility controller. A centrally located Cisco 5508 Wireless LAN Controller (WLC 5508), Cisco Wireless Services Module 2 (WiSM2) (when running AireOS Version 7.3), and Wireless LAN Controller 5760 can also perform this role for larger deployments.

With mobility agents located in the wiring closets providing 40 Gbps of wireless per switch ( $n \times 40$  Gbps for a stack of  $n$  switches) and mobility controllers managing some of the central wireless functions, the converged access-based wireless deployment provides best-in-class scalability for wireless and significantly improved wireless throughput.

**Figure 3.** Mobility Controller (MC) and Mobility Agent (MA)



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## Distributed Intelligent Services

### Flexible NetFlow (FNF)

Full visibility into the wired plus wireless traffic is achieved because of the access point Control and Provisioning of Wireless Access Points (CAPWAP) tunnel termination on the switch. This helps identify users and user traffic flows in order to identify potential attackers and take corrective action at the access layer before the attack penetrates further into the network. This is achieved using FNF, which monitors every single flow entering and exiting the switch stack for wired and wireless users. It also helps identify the top wired/wireless talkers and enforce appropriate bandwidth provisioning policies.

### QoS

The 3650 switch has advanced wired plus wireless QoS capabilities. It uses the Cisco modular QoS command line interface (MQC). The switch manages wireless bandwidth using unprecedented hierarchical bandwidth management starting at the per-access-point level and drilling further down to per-radio, per-service set identification (SSID), and per-user levels. This helps manage and prioritize available bandwidth between various radios and various SSIDs (enterprise, guest, and so on) within each radio on a percentage basis. The switch is also capable of automatically allocating equal bandwidth among the connected users within a given SSID. This makes sure that all users within a given SSID get a fair share of the available bandwidth while being connected to the network. The UADP ASIC enables the hierarchical bandwidth management and fair sharing of bandwidth, thereby providing hardware-based QoS for optimized performance at line-rate traffic.

In addition to these capabilities, the switch is able to do class of service (CoS) or differentiated services code point (DSCP) based queuing, policing, shaping, and marking of wired plus wireless traffic. This enables users to create common policies that can be used across wired plus wireless traffic. The 3650 also supports downloadable policy names from the Cisco Identity Services Engine (ISE) when a user successfully authenticates to the network using the ISE.

### Security

The Cisco Catalyst 3650 provides a rich set of security features for wired plus wireless users. Features such as IEEE 802.1x, Dynamic Host Configuration Protocol (DHCP) snooping, IP Source Guard and control plane protection, wireless intrusion prevention systems (WIPSs), and so on enable protection against unauthorized users and attackers. With a variety of wired plus wireless users connecting to the network, the switch supports session-aware networking, in which each device connected to the network is identified as one session, and unique access control lists (ACLs) and/or QoS policies can be defined and applied using the ISE for each of these sessions, providing better control on the devices connecting to the network.

### Resiliency

#### **Cisco StackWise-160 Technology**

The Catalyst 3650 supports an optional stacking module that is based on the Cisco StackWise-160 technology. Cisco StackWise-160 technology is built on the highly successful industry-leading StackWise® technology, which is a premium stacking architecture. StackWise-160 has a stack bandwidth of 160 Gbps. StackWise-160 uses Cisco IOS Software SSO for providing resiliency within the stack. The stack behaves as a single switching unit that is managed by an “active” switch elected by the member switches. The active switch automatically elects a standby switch within the stack. The active switch creates and updates all the switching/routing/wireless information and constantly synchronizes that information with the standby switch. If the active switch fails, the standby switch assumes the role of the active switch and continues to keep the stack operational. Access points continue to

remain connected during an active-to-standby switchover. A working stack can accept new members or delete old ones without service interruption. StackWise-160 creates a highly resilient single unified system of up to nine switches, providing simplified management using a single IP address, single Telnet session, single CLI, auto-version checking, auto-upgrading, auto-configuration, and more. StackWise-160 also enables local switching in Cisco Catalyst 3650 Series Switches. (See Figure 4)

**Figure 4.** StackWise-160 Kit with Stack Adapters and Cables



### **Foundation for Open Network Environment**

The heart of the Cisco Catalyst 3650 is the UADP ASIC with programmability for future features and intelligence with investment protection. The new ASIC provides the foundation for converged APIs across wired and wireless, Cisco Open Network Environment, software-defined networking (SDN) readiness and OnePK SDK through software updates over the product lifetime.

### **Software Features and Services on Cisco Catalyst 3650 Series Switches**

Software services supported on the Cisco Catalyst 3650 Series Switches can be classified into five broad categories:

- Ease of operations
- Advanced security features
- Resiliency
- Application visibility and control

### **Ease of Operations**

The Cisco Catalyst 3650 helps reduce the operating costs through:

- Cisco Catalyst Smart Operations
- Easy-to-use deployment and control features
- Efficient switch operations
- Network management tools

### **Cisco Catalyst Smart Operations**

Cisco Catalyst Smart Operations are a comprehensive set of capabilities that simplify LAN deployment, configuration, and troubleshooting. In addition to adaptive, always-on technologies such as StackWise-160, Cisco Catalyst Smart Operations enable zero-touch installation and replacement of switches, fast upgrade, and ease of troubleshooting with reduced operational cost. Cisco Catalyst Smart Operations are a set of features that includes Smart Install, Auto Smartports, Smart Configuration and Smart Troubleshooting to enhance operational excellence:

- Cisco Smart Install is a transparent plug-and-play technology to configure the Cisco IOS Software image and switch configuration without user intervention. Smart Install utilizes dynamic IP address allocation and the assistance of other switches to facilitate installation, providing transparent network plug and play.
- Cisco Auto Smartports provide automatic configuration as devices connect to the switch port, allowing auto-detection and plug and play of the device onto the network.
- Cisco Smart Troubleshooting is an extensive array of debug diagnostic commands and system health checks within the switch, including Generic Online Diagnostics (GOLD) and Onboard Failure Logging (OBFL).
- Embedded Event Manager (EEM) is a powerful and flexible feature that provides real-time network event detection and onboard automation. Using EEM, customers can adapt the behavior of their network devices to align with their business needs. This feature requires the IP Base feature set.

### **Easy-to-Use Deployment and Control Features**

- User experience:
  - IP service-level agreements (SLAs) enable customers to assure new business-critical IP applications, as well as IP services that utilize data, voice, and video, in an IP network. This feature requires the IP Services feature set.
  - DHCP autoconfiguration of multiple switches through a boot server eases switch deployment.
  - Automatic QoS (AutoQoS) simplifies QoS configuration in voice over IP (VoIP) networks by issuing interface and global switch commands to detect Cisco IP phones, classify traffic, and help enable egress queue configuration.
  - Autonegotiation on all ports automatically selects half- or full-duplex transmission mode to optimize bandwidth.
  - Automatic media-dependent interface crossover (MDIX) automatically adjusts transmit and receive pairs if an incorrect cable type (crossover or straight through) is installed.
- Simplified configuration and connectivity:
  - Dynamic Trunking Protocol (DTP) facilitates dynamic trunk configuration across all switch ports.
  - Port Aggregation Protocol (PAgP) automates the creation of Cisco Fast EtherChannel groups or Gigabit EtherChannel groups to link to another switch, router, or server.
  - Link Aggregation Control Protocol (LACP) allows the creation of Ethernet channeling with devices that conform to IEEE 802.3ad. This feature is similar to Cisco EtherChannel technology and PAgP.
  - Unidirectional Link Detection Protocol (UDLD) and aggressive UDLD allow unidirectional links caused by incorrect fiber-optic wiring or port faults to be detected and disabled on fiber-optic interfaces.
  - Cisco VLAN Trunking Protocol (VTP) Version 3 supports dynamic VLANs and dynamic trunk configuration across all switches.
- Efficient switch operation:
  - Switching database manager (SDM) templates, VLAN template (specific to LAN Base license level), and advanced template allow the administrator to automatically optimize the ternary content-addressable memory (TCAM) allocation to the desired features based on deployment-specific requirements.
  - Local proxy Address Resolution Protocol (ARP) works in conjunction with private VLAN edge to minimize broadcasts and maximize available bandwidth.



- Stacking master configuration management with Cisco StackWise-160 technology helps make sure that all switches are automatically upgraded when the master switch receives a new software version. Automatic software version checking and updating help ensure that all stack members have the same software version.
- Trivial File Transfer Protocol (TFTP) reduces the cost of administering software upgrades by downloading from a centralized location.
- Network Timing Protocol (NTP) provides an accurate and consistent timestamp to all intranet switches.
- Multicast:
  - Optimized multicast for wired plus wireless: Cisco Catalyst 3650 offers greater multicast efficiency by receiving only one multicast stream and replicating it for all connected wired plus wireless devices connected to that switch.
  - Internet Group Management Protocol (IGMP) v1, v2, v3 snooping for IPv4: multicast listener discovery (MLD) v1 and v2 snooping provides fast client joins and leaves of multicast streams and limits bandwidth-intensive video traffic to only the requestors.
- Monitoring:
  - Remote Switch Port Analyzer (RSPAN) allows administrators to remotely monitor ports in a Layer 2 switch network from any other switch in the same network.
  - For enhanced traffic management, monitoring, and analysis, the Embedded Remote Monitoring (RMON) software agent supports four RMON groups (history, statistics, alarms, and events).
  - Layer 2 traceroute eases troubleshooting by identifying the physical path that a packet takes from source to destination.
  - Wireless RF management provides both real-time and historical information about RF interference affecting network performance across controllers using systemwide Cisco CleanAir technology integration.

### **Efficient Switch Operation**

Cisco Catalyst 3650 Series Switches, designed and engineered by Cisco, provide optimum power-saving, EEE, low-power operations for industry best-in-class power management and power consumption capabilities. The Cisco Catalyst 3650 ports are capable of reduced power modes so that ports not in use can move into a lower power utilization state. Other efficient switch operation features are:

- Cisco Discovery Protocol Version 2 allows the Cisco Catalyst 3650 Series Switches to negotiate a more granular power setting when connecting to a Cisco powered device such as IP phones or access points than what is provided by IEEE classification.
- Per-port power consumption command allows customers to specify a maximum power setting on an individual port. Per-port PoE power sensing measures actual power being drawn, enabling more intelligent control of powered devices.
- The PoE MIB provides proactive visibility into power usage and allows customers to set different power-level thresholds.

### **Environmentally Responsible**

Organizations may choose to turn off access point radios to reduce power consumption during off-peak hours. The integrated wireless LAN controller avoids the deployment of additional devices in the network.

## Network Management Tools

The Cisco Catalyst 3650 Series Switches offer both a superior CLI for detailed configuration and Cisco Prime™ infrastructure for unified wired plus wireless management. Prime infrastructure provides day 0 and ongoing provisioning, ongoing monitoring and maintenance, configuration templates, and device and user 360-degree views and serves as the FNF collector for user traffic views using the Prime Assurance Manager module.

For detailed information about Cisco Prime infrastructure, go to <http://www.cisco.com/en/US/products/ps12239/index.html>.

## Advanced Security Features

Cisco Catalyst 3650 Series Switches support advanced security features including but not limited to:

- Protection against attackers:
  - Port security secures the access to an access or trunk port based on MAC address. It limits the number of learned MAC addresses to deny MAC address flooding.
  - DHCP snooping prevents malicious users from spoofing a DHCP server and sending out bogus addresses. This feature is used by other primary security features to prevent a number of other attacks such as ARP poisoning.
  - Dynamic ARP inspection (DAI) helps ensure user integrity by preventing malicious users from exploiting the insecure nature of ARP.
  - 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.
  - The Unicast Reverse Path Forwarding (RPF) 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.
  - Bidirectional data support on the SPAN port allows the Cisco intrusion detection system (IDS) to take action when an intruder is detected.
- User authentication:
  - Flexible authentication that supports multiple authentication mechanisms, including 802.1X, MAC authentication bypass, and web authentication using a single, consistent configuration.
  - RADIUS change of authorization and downloadable calls for comprehensive policy management capabilities.
  - 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, which helps ensure that users cannot snoop on other users' traffic.
  - Multidomain authentication allows an IP phone and a PC to authenticate on the same switch port while placing them on appropriate voice and data VLAN.
  - MAC address notification allows administrators to be notified of users added to or removed from the network.
  - Mobility and security for secure, reliable wireless connectivity and consistent end-user experience. Increased network availability through proactive blocking of known threats.

- IGMP filtering provides multicast authentication by filtering out nonsubscribers and limits the number of concurrent multicast streams available per port.
- ACLs:
  - Cisco security VLAN ACLs on all VLANs prevent unauthorized data flows from being bridged within VLANs.
  - Cisco standard and extended IP security router ACLs define security policies on routed interfaces for control-plane and data-plane traffic. IPv6 ACLs can be applied to filter IPv6 traffic.
  - Port-based ACLs for Layer 2 interfaces allow security policies to be applied on individual switch ports.
- Device access:
  - 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 Protocol, Kerberos, and the cryptographic version of SNMPv3 require a special cryptographic software image because of U.S. export restrictions.
  - TACACS+ and RADIUS authentication facilitates centralized control of the switch and restricts unauthorized users from altering the configuration.
  - Multilevel security on console access prevents unauthorized users from altering the switch configuration.
- Bridge protocol data unit (BPDU) Guard shuts down Spanning Tree PortFast-enabled interfaces when BPDUs are received to avoid accidental topology loops.
- Spanning Tree Root Guard (STRG) prevents edge devices not in the network administrator's control from becoming Spanning Tree Protocol root nodes.
- Wireless end-to-end security offers CAPWAP-compliant DTLS encryption to make sure of encryption between access points and controllers across remote WAN/LAN links.

## Resiliency

Borderless networks enable enterprise mobility and business-grade video services. Industry's first unified network (wired plus wireless) location services enable tracking of mobile assets and the users of those assets for both wired plus wireless devices. The true borderless experience is enabled by the following feature sets in the Cisco Catalyst 3650 Series Switches:

- High availability
- High-performance IP routing
- Superior QoS

## High Availability

In addition to StackWise-160, the Cisco Catalyst 3650 Series supports high-availability features including but not limited to the following:

- Cross-Stack EtherChannel provides the ability to configure Cisco EtherChannel technology across different members of the stack for high resiliency.
- Flexlink provides link redundancy with convergence time less than 100ms.
- IEEE 802.1s/w Rapid Spanning Tree Protocol (RSTP) and Multiple Spanning Tree Protocol (MSTP) provide rapid spanning-tree convergence independent of spanning-tree timers and also offer the benefit of Layer 2 load balancing and distributed processing. Stacked units behave as a single spanning-tree node.

- Per-VLAN Rapid Spanning Tree (PVRST+) allows rapid spanning-tree reconvergence on a per-VLAN spanning-tree basis, without requiring the implementation of spanning-tree instances.
- Switch-port autorecovery (Err-disable) automatically attempts to reactivate a link that is disabled because of a network error.

## High-Performance IP Routing

The Cisco Express Forwarding hardware routing architecture delivers extremely high-performance IP routing in the Cisco Catalyst 3650 Series Switches:

- IP unicast routing protocols (static, Routing Information Protocol Version 1 [RIPv1], and RIPv2, RIPv2, RIPv2, Enhanced Interior Gateway Routing Protocol [EIGRP] stub) are supported for small-network routing applications with the IP Base feature set. Limited static routing with the LAN Base feature set. Equal-cost routing facilitates Layer 3 load balancing and redundancy across the stack.
- Advanced IP unicast routing protocols (Open Shortest Path First [OSPF], EIGRP, Border Gateway Protocol Version 4 [BGPv4], and Intermediate System-to-Intermediate System Version 4 [IS-ISv4]) are supported for load balancing and constructing scalable LANs. IPv6 routing (OSPFv3, EIGRPv6) is supported in hardware for maximum performance. OSPF for routed access is included in the IP Base image. The IP Services feature set is required for full OSPF, EIGRP, BGPv4, and IS-ISv4.
- Policy-based routing (PBR) allows superior control by facilitating flow redirection regardless of the routing protocol configured. Virtual routing and forwarding (VRF)-Lite enables a service provider to support two or more VPNs, with overlapping IP addresses. The IP Services feature set is required.
- Protocol-independent multicast (PIM) for IP multicast routing is supported, including PIM sparse mode (PIM-SM), PIM dense mode (PIM-DM), PIM sparse-dense mode, and source-specific multicast (SSM). The IP Services feature set is required.
- IPv6 addressing is supported on interfaces with appropriate show commands for monitoring and troubleshooting.

## Superior QoS

The Cisco Catalyst 3650 Series offers Gigabit Ethernet speed with intelligent services that keep traffic flowing smoothly, even at 10 times the normal network speed. Industry-leading mechanisms for cross-stack marking, classification, and scheduling deliver superior performance for data, voice, and video traffic, all at wire speed.

The following are some of the QoS features supported in the Cisco Catalyst 3650 Series Switches:

- Granular wireless bandwidth management and fair sharing use Cisco's proven Cisco IOS Software and UADP ASIC technology to provide hierarchical bandwidth management at line rate (per access point, per radio, per SSID, per client-based policies). Fair sharing across the users within an SSID makes sure that no single user is starved because of other heavy-hitting users. Fair sharing is automatically enabled for wireless at user level as well as SSID level.
- 802.1p CoS and DSCP field classification is provided, using marking and reclassification on a per-packet basis by source and destination IP address, MAC address, or Layer 4 Transmission Control Protocol/User Datagram Protocol (TCP/UDP) port number.

- Shaped round robin (SRR) scheduling helps ensure differential prioritization of packet flows by intelligently servicing the ingress queues and egress queues. Weighted tail drop (WTD) provides congestion avoidance at the ingress and egress queues before a disruption occurs. Strict priority queuing helps ensure that the highest priority packets are serviced ahead of all other traffic.
- The Cisco committed information rate (CIR) function provides bandwidth in increments as low as 8 Kbps.
- Rate limiting is provided based on source and destination IP address, source and destination MAC address, Layer 4 TCP/UDP information, or any combination of these fields, using QoS ACLs (IP ACLs or MAC ACLs), class maps, and policy maps.
- Eight egress queues per port for wired traffic and four egress queues for wireless help enable differentiated management of different traffic types across the stack for wired traffic. Up to 2000 aggregate policers are available per switch.

### Application Visibility and Control Using Flexible NetFlow (FNF)

Cisco IOS Software FNF is the next generation in flow visibility technology, allowing optimization of the network infrastructure, reducing operation costs, and improving capacity planning and security incident detection with increased flexibility and scalability. The Cisco Catalyst 3650 provides optimized application visibility with FNF across wired plus wireless. The switch is capable of 48,000 flow entries on 48-port models and 24,000 flow entries on 24-port models across wired and wireless. With UADP ASIC, Cisco Catalyst 3650 delivers next-generation flow technology with unprecedented flexibility and comprehensive visibility extending from Layer 2 (MAC and VLAN) to Layer 4 (TCP/UDP) flags and so on across wired plus wireless traffic. The Cisco Catalyst 3650 switch is Medianet capable to provide visibility and troubleshooting capabilities across wired plus wireless video traffic. Specific Medianet features will be enabled in future software updates.

The flow data collected by FNF can be exported to an external collector for analysis and reporting or tracked by the EEM. The Cisco Catalyst 3650 enables powerful on-box and customizable event correlation and policy actions with EEM, allowing the switches to trigger customized event alarms or policy actions when the predefined condition is met. With no external appliance required, customers are able to use existing infrastructure to perform traffic monitoring, making traffic analysis economical even on a large IP network.

Details about Cisco FNF are available at

[http://www.cisco.com/en/US/prod/collateral/iosswrel/ps6537/ps6555/ps6601/ps6965/product\\_data\\_sheet0900aecd804b590b.html](http://www.cisco.com/en/US/prod/collateral/iosswrel/ps6537/ps6555/ps6601/ps6965/product_data_sheet0900aecd804b590b.html).

The Cisco Catalyst 3650 supports Wireshark, the world's foremost network protocol analyzer, and is ideal for proactive debugging, troubleshooting, and network performance monitoring. Using Wireshark, a user can capture control and data wired and wireless packets, easily displaying and analyzing them on a screen or a Wireshark GUI. Using Flexible NetFlow and Embedded Event Manager, a Wireshark packet capture can be initiated in events such as SYN flood attacks or abnormal bandwidth usage by specific users.

High-performance video over wireless integrates Cisco VideoStream technology to optimize the delivery of video applications across the WLAN.

Wired plus wireless IP telephony supports [unified communications](#) for improved collaboration through messaging, presence, and conferencing and supports all Cisco Unified Communications wireless IP phones for cost-effective, real-time voice service.

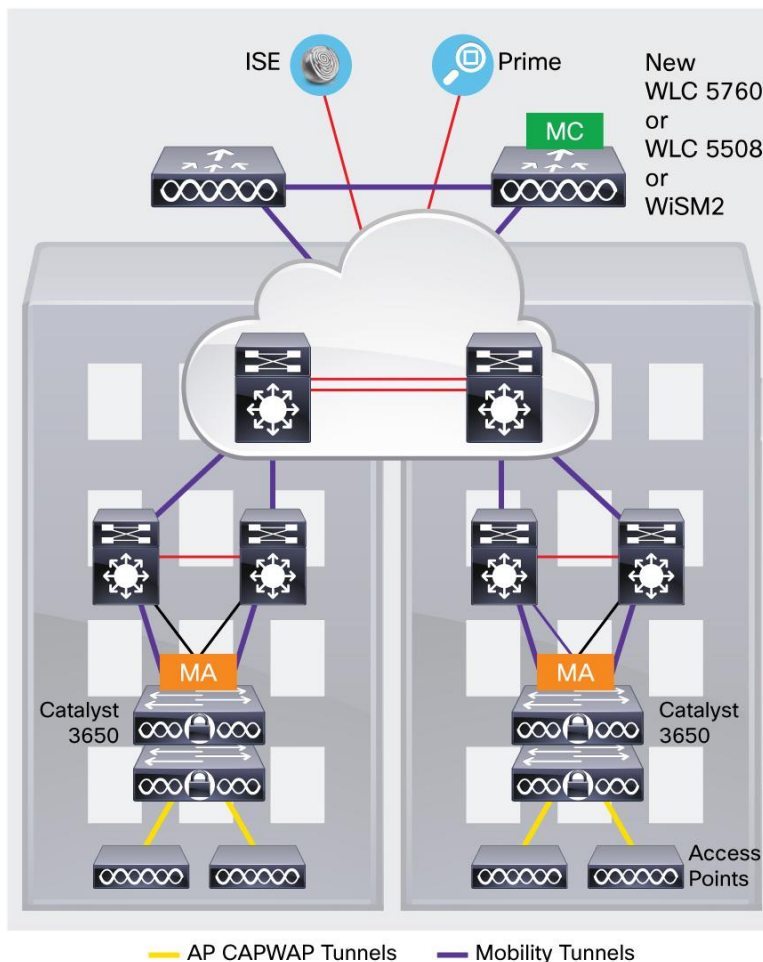
## Deployment Options

### Campus

In a campus-type deployment, operating the Cisco Catalyst 3650 in the mobility agent mode and centralizing the mobility controller functionality in a WLC 5760, WLC 5508, or WiSM2 helps achieve better scalability and performance. The Cisco Catalyst 3650 provides CAPWAP termination for access points, uniform policy enforcement for wireless clients, better wireless bandwidth, and uniform Cisco IOS Software-based configuration and monitoring for wired plus wireless features. The mobility controller provides central mobility, RRM, and CleanAir coordination.

Backward compatibility with traditional centralized wireless deployment mode on the WLC 5508, WiSM2, and WLC 5760 helps ensure that customers can migrate to the Cisco Catalyst 3650-based converged access approach in phases, providing a continued controller for existing access points. This migration also provides investment protection on the existing wireless controller infrastructure. A phased adoption of the new Cisco Catalyst 3650 helps ensure that migration to the converged access mode of wireless is seamless. Figure 5 shows the Cisco Catalyst 3650 in a campus deployment.

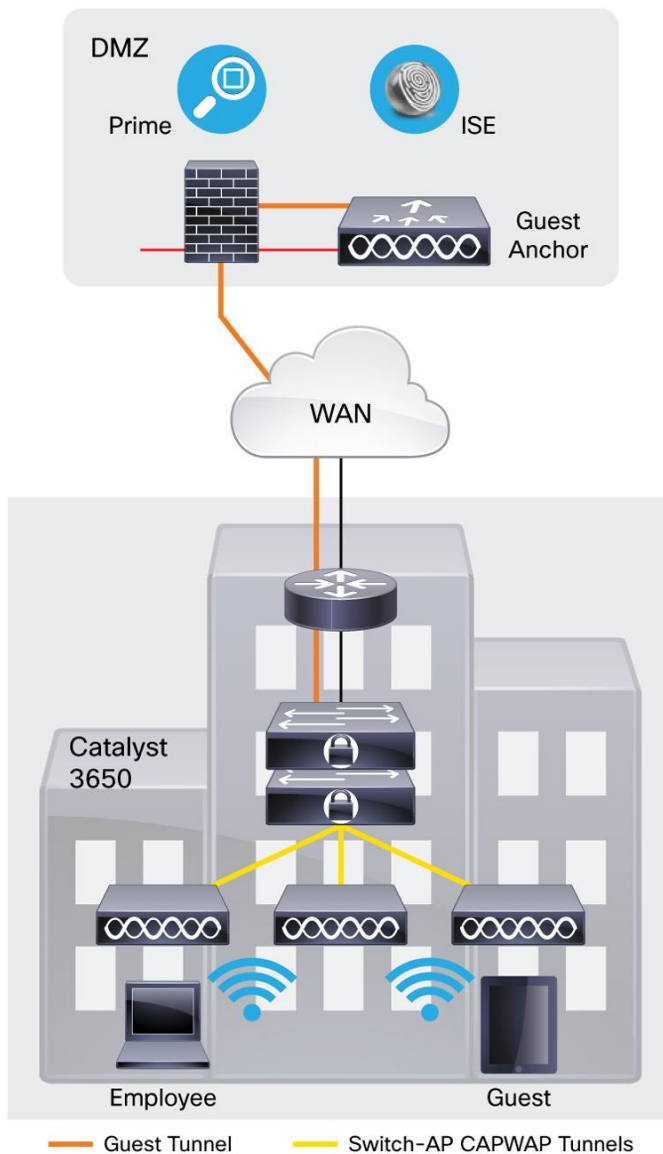
**Figure 5.** Deploying Cisco Catalyst 3650 in a Branch Environment



## Branch

3650 is optimized for branch deployments when it operates in mobility controller mode. In this mode, not only can the switch terminate CAPWAP tunnels from the access points and provide client connectivity, it can also manage mobility within the branch. This eliminates the need for a local controller in every branch in addition to the access-layer switches. Also, complete visibility into the wired plus wireless traffic means that the WAN router can prioritize the right wired plus wireless traffic in and out of the branch. Figure 6 shows the Cisco Catalyst 3650 in a branch deployment.

**Figure 6.** Deploying Cisco Catalyst 3650 in a Branch Location



## Cisco Catalyst 3650 Series Specifications

### Switch Performance

Table 6 shows Cisco Catalyst 3650 Series Switches performance specifications.

**Table 6.** Cisco Catalyst 3650 Performance Specifications

Performance Numbers for All Switch Models	
Switching capacity	176 Gbps on 48-port models 88 Gbps on 24-port models
Stacking bandwidth	160 Gbps
Total number of MAC addresses	32,000
Total number of IPv4 routes (ARP plus learned routes)	24,000
FNF entries	48,000 flow on 48-port models 24,000 flows on 24-port models
DRAM	4 Gb
Flash	2 Gb
VLAN IDs	4,094
Total switched virtual interfaces (SVIs)	1,000
Jumbo frame	9198 bytes
Total routed ports per 3650 stack	208
Wireless	
Number of access points per switch/stack	25
Number of wireless clients per switch/stack	1000
Total number of WLANs per switch	64
Wireless bandwidth per switch	Up to 40 Gbps on 48-port models Up to 20 Gbps on 24-port models
Supported Aironet access point series	3700, 3600, 3500, 2600, 1600, 1260, 1140, 1040
Forwarding Rate of Switch Models (with the 2 x 10 Gigabit Ethernet Uplink-Models for 24-Port Models and the 4 x 10 Gigabit Ethernet Uplink-Models for 48-Port Models)	
Model	Forwarding Rate
3650-24TD 3650-24PD	65.47 Mpps
3650-48TQ 3650-48PQ 3650-48FQ	130.95 Mpps

### Dimensions, Weight, Acoustic, Mean Time Between Failure, and Environmental Range Specifications for Cisco Catalyst 3650 Series Switches

Table 7 shows dimensions, weight, acoustic, mean time between failure (MTBF), and environmental range. Weight includes the chassis assembly as it is shipped: three fans, two Stackwise adapters, and one power supply blank. The weight also includes the default power supply that is shipped with the unit.

**Table 7.** Dimensions, Weight, Acoustic, MTBF, and Environmental Range

Dimensions (H x W x D)	Inches	Centimeters
WS-C3650-24T WS-C3650-24P WS-C3650-48T WS-C3650-48P	1.73 x 17.5 x 17.625	4.4 x 44.5 x 44.8
WS-C3650-48F	1.73 x 17.5 x 19.125	4.4 x 44.5 x 48.6



Weight	Pounds	Kilograms
WS-C3650-24T	15.15	6.87
WS-C3650-24P	16.00	7.26
WS-C3650-48T	15.90	7.21
WS-C3650-48P	16.75	7.60
WS-C3650-48F	17.20	7.80
STACK-T2-BLANK	0.1	0.05
C3650-STACK-KIT	0.25	0.11
MTBF Hours		
WS-C3650-24T	661,800	
WS-C3650-24P	528,280	
WS-C3650-48T	527,580	
WS-C3650-48P	383,760	
WS-C3650-48F	383,760	
PWR-C2-250WAC	751,642	
PWR-C2-640WAC	693,692	
PWR-C2-1025WAC	570,259	
PWR-C2-640WDC	706,759	
FAN-T1	16,661,470	
Environmental Ranges		
<b>With AC Power Supply Operating Environment and Altitude</b>	<p>Normal operating temperature* and altitudes:            -5°C to +45°C, up to 5000 feet (1500m)            -5°C to +40°C, up to 10,000 feet (3000m)            -5°C to +35°C, up to 13,000 feet (4000m)            -5°C to +30°C, up to 16,400 feet (5000m)            * Minimum ambient temperature for cold start is 32°F (0°C).</p> <p>Short-term<sup>†</sup> exceptional conditions:            -5°C to +50°C, up to 5000 feet (1500m)            -5°C to +45°C, up to 10,000 feet (3000m)            -5°C to +40°C, up to 13,000 feet (4000m)            -5°C to +35°C, up to 16,400 feet (5000m)            -5°C to +45°C, at sea level with single fan failure</p> <p><sup>†</sup> Not more than following in one-year period: 96 consecutive hours, or 360 hours total, or 15 occurrences.</p>	
<b>With DC Power Supply Operating Environment and Altitude (NEBS)</b>	<p>Normal operating temperature and altitudes:            -5°C to +45°C, up to 6000 feet (1800m)            -5°C to +40°C, up to 10,000 feet (3000m)            -5°C to +35°C, up to 13,000 feet (4000m)            -5°C to +30°C, up to 16,400 feet (5000m)</p> <p>Short-term<sup>†</sup> exceptional conditions:            -5°C to +55°C, up to 6000 feet (1800m)            -5°C to +50°C, up to 10,000 feet (3000m)            -5°C to +45°C, up to 13,000 feet (4000m)            -5°C to +40°C, up to 16,400 feet (5000m)            -5°C to +45°C, at sealevel with single fan failure</p> <p><sup>†</sup> Not more than following in one-year period: 96 consecutive hours, or 360 hours total, or 15 occurrences.</p>	

<b>Relative Humidity</b>	5% to 96%, noncondensing
<b>Acoustic Noise</b> <b>Measured Per ISO 7779 and Declared Per ISO 9296</b> <b>Bystander Positions Operating to an Ambient Temperature of 25°C</b>	With AC or DC power supply (with 16 PoE+ ports loaded): LpA: 45dB typical, 48dB maximum LwA: 5.5B typical, 5.8B maximum Typical: Noise emission for a typical configuration Maximum: Statistical maximum to account for variation in production
<b>Storage Environment</b>	Temperature: -40 to 158° F (-40 to 70° C) Altitude: 16,400 ft (5,000 m)
<b>Vibration</b>	Operating: 0.41Grms from 3 to 500Hz with spectral break points of 0.0005 G2/Hz at 10Hz and 200Hz 5dB/octave roll off at each end.  Non-operating: 1.12Grms from 3 to 500Hz with spectral break points of 0.0065 G2/Hz at 10Hz and 100Hz 5dB/octave roll off at each end.
<b>Shock</b>	Operating: 30G, 2ms half sine  Non-operating: 55G, 10ms trapezoid

## Connectors for Cisco Catalyst 3650 Series

Table 8 shows connectors.

**Table 8.** Connectors

<b>Connectors and cabling</b>	<ul style="list-style-type: none"> <li>• 1000BASE-T ports: RJ-45 connectors, 4-pair Cat-5E UTP cabling</li> <li>• 1000BASE-T SFP-based ports: RJ-45 connectors, 4-pair Cat-5E UTP cabling</li> <li>• 100BASE-FX, 1000BASE-SX, -LX/LH, -ZX, -BX10, DWDM and CWDM SFP transceivers: LC fiber connectors (single-mode or multimode fiber)</li> <li>• 10GBASE-SR, LR, LRM, CX1 (v02 or higher) SFP+ transceivers: LC fiber connectors (single-mode or multimode fiber)</li> <li>• Cisco StackWise-160 stacking ports: copper-based Cisco StackWise cabling</li> <li>• Ethernet management port: RJ-45 connectors, 4-pair Cat-5 UTP cabling</li> <li>• Management console port: RJ-45-to-DB9 cable for PC connections</li> </ul>
<b>Power connectors</b>	<ul style="list-style-type: none"> <li>• Customers can provide power to a switch by using the internal power. The connectors are located at the back of the switch.</li> <li>• Internal power supply connector: The internal power supply is an auto-ranging unit. The internal power supply supports input voltages between 100 and 240VAC. Use the supplied AC power cord to connect the AC power connector to an AC power outlet.</li> </ul>

## Management and Standards Support for Cisco Catalyst 3650 Series Switches

Table 9 shows management and standards support for the Cisco Catalyst 3650 Series.

**Table 9.** Management and Standards Support for the Cisco Catalyst 3650 Series

Description	Specification	
<b>Management</b>	BRIDGE-MIB	CISCO-SNMP-TARGET-EXT-MIB
	CISCO-AUTH-FRAMEWORK-MIB	CISCO-STACKMAKER-MIB
	CISCO-BGP4-MIB, BGP4-MIB	CISCO-MEMORY-POOL-MIB
	CISCO-BRIDGE-EXT-MIB	CISCO-STP-EXTENSIONS-MIB
	CISCO-BULK-FILE-MIB	CISCO-SYSLOG-MIB
	CISCO-CABLE-DIAG-MIB	CISCO-TCP-MIB
	CISCO-CALLHOME-MIB	CISCO-UDLDP-MIB
	CISCO-CEF-MIB	CISCO-VLAN-IFTABLE-RELATIONSHIP-MIB
	CISCO-CIRCUIT-INTERFACE-MIB	CISCO-VLAN-MEMBERSHIP-MIB
	CISCO-ENTITY-VENDORTYPE-OID-MIB	CISCO-VTP-MIB
	CISCO-CONTEXT-MAPPING-MIB	EtherLike-MIB
	CISCO-DEVICE-LOCATION-MIB	HC-RMON-MIB
	CISCO-DHCP-SNOOPING-MIB	IEEE8021-PAE-MIB
	CISCO-EIGRP-MIB	IEEE8023-LAG-MIB
		IF-MIB

Description	Specification	
	CISCO-EMBEDDED-EVENT-MGR-MIB CISCO-ENTITY-FRU-CONTROL-MIB CISCO-ENTITY-SENSOR-MIB ENTITY-MIB CISCO-ERR-DISABLE-MIB CISCO-CONFIG-COPY-MIB CISCO-FLOW-MONITOR-MIB CISCO-FTP-CLIENT-MIB CISCO-HSRP-EXT-MIB CISCO-HSRP-MIB CISCO-IETF-ISIS-MIB CISCO-IF-EXTENSION-MIB CISCO-IGMP-FILTER-MIB CISCO-CONFIG-MAN-MIB CISCO-IP-CBR-METRICS-MIB CISCO-IPMROUTE-MIB CISCO-IP-STAT-MIB CISCO-IP-URPF-MIB CISCO-L2L3-INTERFACE-CONFIG-MIB CISCO-LAG-MIB CISCO-LICENSE-MGMT-MIB CISCO-MAC-AUTH-BYPASS-MIB CISCO-MAC-NOTIFICATION-MIB CISCO-MDI-METRICS-MIB CISCO-FLASH-MIB CISCO-OSPF-MIB CISCO-OSPF-TRAP-MIB CISCO-PAE-MIB CISCO-PAGP-MIB CISCO-PIM-MIB CISCO-PING-MIB CISCO-PORT-QOS-MIB CISCO-PORT-SECURITY-MIB CISCO-PORT-STORM-CONTROL-MIB CISCO-POWER-ETHERNET-EXT-MIB CISCO-PRIVATE-VLAN-MIB CISCO-PROCESS-MIB CISCO-PRODUCTS-MIB CISCO-RF-MIB CISCO-RTP-METRICS-MIB CISCO-RTTMON-MIB CISCO-SMART-INSTALL-MIB	IGMP-MIB IGMP-STD-MIB IP-FORWARD-MIB IP-MIB IPMROUTE-STD-MIB LLDP-EXT-MED-MIB LLDP-MIB NOTIFICATION-LOG-MIB OLD-CISCO-MEMORY-MIB CISCO-CDP-MIB POWER-ETHERNET-MIB RMON2-MIB RMON-MIB SNMP-COMMUNITY-MIB SNMP-FRAMEWORK-MIB SNMP-MPD-MIB SNMP-NOTIFICATION-MIB SNMP-PROXY-MIB SNMP-TARGET-MIB SNMP-USM-MIB SNMPv2-MIB SNMP-VIEW-BASED-ACM-MIB TCP-MIB UDP-MIB CISCO-IMAGE-MIB CISCO-STACKWISE-MIB AIRESPMACE-WIRELESS-MIB CISCO-LWAPP-IDS-MIB CISCO-LWAPP-AP-MIB CISCO-LWAPP-CCX-RM-MIB CISCO-LWAPP-CLIENT-ROAMING-MIB CISCO-LWAPP-DOT11-CCX-CLIENT-DIAG-MIB CISCO-LWAPP-DOT11-CCX-CLIENT-MIB CISCO-LWAPP-DOT11-CLIENT-CCX-REPORTS-MIB CISCO-LWAPP-DOT11-CLIENT-MIB CISCO-LWAPP-DOT11-MIB CISCO-LWAPP-DOWNLOAD-MIB CISCO-LWAPP-LINKTEST-MIB CISCO-LWAPP-MFP-MIB CISCO-LWAPP-MOBILITY-EXT-MIB CISCO-LWAPP-QOS-MIB CISCO-LWAPP-REAP-MIB CISCO-LWAPP-ROGUE-MIB CISCO-LWAPP-RRM-MIB CISCO-LWAPP-SI-MIB CISCO-LWAPP-TSM-MIB CISCO-LWAPP-WLAN-MIB CISCO-LWAPP-WLAN-SECURITY-MIB
<b>Standards</b>	IEEE 802.1s IEEE 802.1w IEEE 802.11 IEEE 802.1x IEEE 802.1x-Rev IEEE 802.3ad IEEE 802.3af IEEE 802.3at IEEE 802.3x full duplex on 10BASE-T, 100BASE-TX, and 1000BASE-T ports	RMON I and II standards SNMPv1, SNMPv2c, and SNMPv3

Description	Specification
	IEEE 802.1D Spanning Tree Protocol IEEE 802.1p CoS prioritization IEEE 802.1Q VLAN IEEE 802.3 10BASE-T specification IEEE 802.3u 100BASE-TX specification IEEE 802.3ab 1000BASE-T specification IEEE 802.3z 1000BASE-X specification

## Power Supply Specifications

Table 10 lists the power specifications for the Cisco Catalyst 3650 Series based on the kind of power supply used.

**Table 10.** Power Specifications for Cisco Catalyst 3650 Series

Description	Specification			
	PWR-C2-1025 WAC	PWR-C2-640 WAC	PWR-C2-250 WAC	PWR-C2-640 WDC
<b>Power Supply Rated Maximum</b>	1025W	640W	250W	640W
<b>Total Output BTU (Note: 1000 BTU per hr = 293 W)</b>	3497 BTU/hr, 1025W	2183 BTU/hr, 640W	853 BTU/hr, 250W	2188 BTU/hr, 640W
<b>Input-Voltage Range and Frequency (Note: ±10% of "Input-Voltage Range")</b>	115-240VAC, 50-60 Hz	100-240VAC, 50-60 Hz	100-240VAC, 50-60 Hz	-36VDC to -72VDC
<b>Input Current</b>	12-6A	8-4A	4-2A	21 - 10.5 A
<b>Output Ratings</b>	12V @ 20.83A -54V @ 14.6A	12V @ 20.83A -54V @ 7.36A	12V @ 20.83A	12V @ 20.83A -54V @ 7.36A
<b>Output Holdup Time</b>	10 ms minimum @ 102.5VAC	16.7 ms minimum @ 100VAC	16.7 ms minimum @ 100VAC	> 2ms@-48VDC
<b>Power-Supply Input Receptacles</b>	IEC 320-C16 (IEC60320-C16)	IEC 320-C16 (IEC60320-C16)	IEC 320-C13 (IEC60320-C13)	Terminal strip
<b>Power Cord Rating</b>	13A	13A	10A	20A @ 100VDC
<b>Physical Specifications</b>	(H x W x D): 1.58 X 3.75 X 13.25 in (4.0 x 9.5 x 33.7 cm) Weight: 3.55 lb (1.61 kg)	(H x W x D): 1.58 X 3.75 X 11.75 in (4.0 x 9.5 x 29.8 cm) Weight: 3.1 lb (1.41 kg)	(H x W x D): 1.58 X 3.75 X 11.75 in (4.0 x 9.5 x 29.8 cm) Weight: 2.55 lb (1.16 kg)	(H x W x D): 1.58 X 3.75 X 11.75 in (4.0 x 9.5 x 29.8 cm) Weight: 2.75 lb (1.25 kg)
<b>Operating Temperature</b>	For the operating temperature ranges at various altitudes of AC and DC power supply module powered switches, see Table 1.			
<b>Storage Temperature</b>	-40 to 158°F (-40 to 70°C)			
<b>Relative Humidity Operating and Non-Operating Noncondensing</b>	5 to 96% noncondensing			
<b>Altitude</b>	16,400 ft. (5,000 meters)			
<b>MTBF</b>	Calculated MTBF must be greater than 300,000 using Telcordia SR-332, Method 1, Issue 3. Demonstrated MTBF is 500,000 hr (with 90% confidence level).			
<b>EMI and EMC Compliance</b>	"AC OK": Input power to the power supply is OK "PS OK": Output power from the power supply is OK			
<b>Safety Compliance</b>	For the operating temperature ranges at various altitudes of AC and DC power supply module powered switches, see Table 1.			
<b>LED Indicators</b>	-40 to 158°F (-40 to 70°C)			

## Power Consumption of Standalone Cisco Catalyst 3650 Series Switches

Table 11 shows power consumption of standalone Cisco Catalyst 3650 Series Switches based on Alliance for Telecommunications Industry Solutions (ATIS) testing using IMIX distribution stream traffic, with input voltage of 115VAC @ 60 Hz, Energy Efficient Ethernet (EEE) enabled, and no PoE loading. The values given are the maximum possible power consumption numbers under the respective test scenarios.

**Table 11.** Power Consumptions (in Watts) of Standalone Cisco Catalyst 3650 Series

Model	Fixed Uplink	Power Consumption (Watts) - (No more than)			
		0% Traffic	10% Traffic	100% Traffic	Weighted Average
WS-C3650-24TS	4 x Gigabit Ethernet with Small Form-Factor Pluggable (SFP)	43.9	56.4	57.1	55.21
WS-C3650-48TS		61.1	85.1	86.4	82.85
WS-C3650-24PS		53.8	65.3	65.9	64.18
WS-C3650-48PS		81.4	98.7	99.5	97.09
WS-C3650-48FS		90.8	108.7	109.4	106.98
WS-C3650-24TD	2 x 10 Gigabit Ethernet with SFP+ & 2 x Gigabit Ethernet with SFP or 4 x Gigabit Ethernet with SFP	54.0	60.8	63.0	60.35
WS-C3650-48TD		73.3	90.9	93.9	89.40
WS-C3650-24PD		61.1	68.3	70.1	67.75
WS-C3650-48PD		80.3	99.1	101.5	97.45
WS-C3650-48FD		88.8	106.5	109.4	105.03
WS-C3650-48TQ	4 x 10 Gigabit Ethernet with SFP+ or 4 x Gigabit Ethernet with SFP	73.0	91.9	96.7	90.47
WS-C3650-48PQ		86.4	103.4	107.4	102.10
WS-C3650-48FQ		96.6	116.2	120.5	114.69

## Safety and Compliance

Table 12 lists the safety and compliance information for the Cisco Catalyst 3650 Series.

**Table 12.** Safety and Compliance Information for Cisco Catalyst 3650 Series

Description	Specification
<b>Safety Certifications</b>	UL 60950-1 Second Edition CAN/CSA-C22.2 No. 60950-1 Second Edition EN 60950-1 Second Edition IEC 60950-1 Second Edition GOST NOM (obtained by partners and distributors)
<b>Electromagnetic Emissions Certifications</b>	47CFR Part 15 (CFR 47) Class A (FCC Part 15 Class A) AS/NZS CISPR22 Class A CISPR22 Class A EN55022 Class A ICES003 Class A VCCI Class A EN61000-3-2 EN61000-3-3 KN22 Class A KCC CNS13438 Class A EN55024 CISPR24 KN24

Description	Specification
<b>Environmental</b>	Reduction of Hazardous Substances (ROHS) 5
<b>Noise Specifications</b>	Office Product Spec: 48dBA at 25°C (refer to ISO 7779)
<b>Telco</b>	Common Language Equipment Identifier (CLEI) Code

## Cisco Enhanced Limited Lifetime Hardware Warranty

The Cisco Catalyst 3650 Series Switches come with an E-LLW that includes NBD delivery of replacement hardware where available and 90 days of 8x5 Cisco TAC support.

Your formal warranty statement, including the warranty applicable to Cisco software, appears in the Cisco information packet that accompanies your Cisco product. We encourage you to review carefully the warranty statement shipped with your specific product before use.

Cisco reserves the right to refund the purchase price as its exclusive warranty remedy.

For further information on warranty terms, visit <http://www.cisco.com/go/warranty>. Table 13 provides information about the E-LLW.

**Table 13.** E-LLW Details

	Cisco E-LLW
<b>Device Covered</b>	Applies to Cisco Catalyst 3650 Series Switches.
<b>Warranty Duration</b>	As long as the original customer owns the product.
<b>EoL Policy</b>	In the event of discontinuance of product manufacture, Cisco warranty support is limited to 5 years from the announcement of discontinuance.
<b>Hardware Replacement</b>	Cisco or its service center will use commercially reasonable efforts to ship a replacement for NBD delivery, where available. Otherwise, a replacement will be shipped within 10 working days after receipt of the RMA request. Actual delivery times might vary depending on customer location.
<b>Effective Date</b>	Hardware warranty commences from the date of shipment to customer (and in case of resale by a Cisco reseller, not more than 90 days after original shipment by Cisco).
<b>TAC Support</b>	Cisco will provide during business hours, 8 hours per day, 5 days per week basic configuration, diagnosis, and troubleshooting of device-level problems for up to a 90-day period from the date of shipment of the originally purchased Cisco Catalyst 3650 product. This support does not include solution or network-level support beyond the specific device under consideration.
<b>Cisco.com Access</b>	Warranty allows guest access only to Cisco.com.

## Licensing for Cisco Catalyst 3650 Series Switches

The three feature sets available with all Cisco Catalyst 3650 Series Switches are:

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

The LAN Base feature set offers enhanced intelligent services that include comprehensive Layer 2 features, with up to 255 VLANs. The IP Base feature set provides entry-level enterprise services in addition to all LAN Base features, with 4094 VLANs. IP Base also includes the support for wireless controller functionality (mobility agent and mobility controller role; additional access point license required for mobility controller role), routed access, smart operations, FNF, and so on. The IP Services feature set provides full enterprise services that include advanced Layer 3 features such as EIGRP, OSPF, BGP, PIM, and IPv6 routing such as OSPFv3 and EIGRPv6. All software feature sets support advanced security and MQC-based QoS.

The Cisco Catalyst 3650 Series Switches with LAN Base feature set can only stack with other Cisco Catalyst 3650 Series LAN Base switches. The same applies to IP Base and IP Services as well. A mixed stack of LAN Base switch with IP Base or IP Services feature set is not supported.

Customers can transparently upgrade the software feature set in the Cisco Catalyst 3650 Series Switches through Cisco IOS Software CLI using the right to use (RTU)-based software upgrade process. Software activation enables the Cisco IOS Software feature sets. Based on the license's type, Cisco IOS Software activates the appropriate feature set. License types can be changed, or upgraded, to activate a different feature set.

### Access Point License for Cisco Catalyst 3650

An access point license is required for Cisco Catalyst 3650 operating in mobility controller mode. No access point license is required for 3650 operating in mobility agent mode. This functionality is included in the IP Base feature set. Other devices that can act as mobility controller are the WLC 5760, WLC 5508, and WiSM2 wireless controllers. Access point licenses can be transferred only between two 3650 switches or between 3650 and 5760 controller and vice versa.

### Software Policy for Cisco Catalyst 3650 Series Switches

Customers with Cisco Catalyst LAN Base and IP Base software feature sets will be provided with maintenance updates and bug fixes designed to maintain the compliance of the software with published specifications, release notes, and industry standards compliance as long as the original end user continues to own or use the product or up to one year from the end-of-sale date for this product, whichever occurs earlier. Customers with licenses for our IP Services software images require a service support contract such as Cisco SMARTnet<sup>®</sup> Service to download updates. This policy supersedes any previous warranty or software statement and is subject to change without notice.

### Cisco and Partner Services for Next-Generation Cisco Catalyst Fixed Switches

Enable the innovative, secure, intelligent edge in the Borderless Network Architecture using personalized services from Cisco and our partners. Through a discovery process that begins with understanding your business objectives, we help you integrate the next-generation Cisco Catalyst fixed switches into your architecture and incorporate network services onto that platform. Sharing knowledge and leading practices, we support your success every step of the way as you deploy, absorb, manage, and scale new technology. Choose from a flexible suite of support services designed to meet your business needs and help you maintain high-quality network performance while controlling operational costs. (See Table 14)

**Table 14.** Technical Services Available for Cisco Catalyst 3650 Switches

Technical Services
<p><b>Cisco SMARTnet Service</b></p> <ul style="list-style-type: none"> <li>• Around-the-clock, global access to the Cisco TAC</li> <li>• Unrestricted access to the extensive Cisco.com knowledge base and tools</li> <li>• Next-business-day, 8x5x4, 24x7x4, and 24x7x2 advance hardware replacement and onsite parts replacement and installation available</li> <li>• Ongoing operating system software updates within the licensed feature set</li> <li>• Proactive diagnostics and real-time alerts on Smart Call Home-enabled devices</li> </ul>
<p><b>Cisco Smart Foundation Service</b></p> <ul style="list-style-type: none"> <li>• NBD advance hardware replacement as available</li> <li>• Business hours access to SMB TAC (access levels vary by region)</li> <li>• Access to Cisco.com SMB knowledge base</li> <li>• Online technical resources through Smart Foundation Portal</li> <li>• Operating system software bug fixes and patches</li> </ul>

Technical Services
<p><b>Cisco SP Base Service</b></p> <ul style="list-style-type: none"> <li>• Around-the-clock, global access to the Cisco TAC</li> <li>• Registered access to Cisco.com</li> <li>• NBD, 8x5x4, 24x7x4, and 24x7x2 advance hardware replacement; return to factory option available<sup>2</sup></li> <li>• Ongoing operating system software updates<sup>1</sup></li> </ul>
<p><b>Cisco Focused Technical Support Services</b></p> <ul style="list-style-type: none"> <li>• Three levels of premium, high-touch services are available: <ul style="list-style-type: none"> <li>◦ Cisco High-Touch Operations Management Service</li> <li>◦ Cisco High-Touch Technical Support Service</li> <li>◦ Cisco High-Touch Engineering Service</li> </ul> </li> <li>• Valid Cisco SMARTnet or SP Base contracts on all network equipment are required</li> </ul>

**Notes:**

<sup>1</sup> Cisco operating system updates include the following: maintenance releases, minor updates, and major updates within the licensed feature set.

<sup>2</sup> Advance hardware replacement is available in various service-level combinations. For example, 8x5xNBD indicates that shipment will be initiated during the standard 8-hour business day, 5 days a week (the generally accepted business days within the relevant region), with NBD delivery. Where NBD is not available, same day ship is provided. Restrictions apply; for details, review the appropriate service descriptions.

**Ordering Information**

Table 15 lists ordering information for the Cisco Catalyst 3650 Series. To place an order, visit the Cisco Ordering homepage at [http://www.cisco.com/en/US/ordering/or13/or8/order\\_customer\\_help\\_how\\_to\\_order\\_listing.html](http://www.cisco.com/en/US/ordering/or13/or8/order_customer_help_how_to_order_listing.html).

**Table 15.** Cisco Catalyst 3650 Series Ordering Information

Product Number	Product Description
<b>Cisco Catalyst 3650 4x1G Uplink Series</b>	
<b>WS-C3650-24TS-L</b>	Standalone with Optional Stacking 24 10/100/1000 Ethernet and 4x1G Uplink ports, with 250WAC power supply, 1 RU, LAN Base feature set
<b>WS-C3650-48TS-L</b>	Standalone with Optional Stacking 48 10/100/1000 Ethernet and 4x1G Uplink ports, with 250WAC power supply, 1 RU, LAN Base feature set
<b>WS-C3650-24PS-L</b>	Standalone with Optional Stacking 24 10/100/1000 Ethernet PoE+ and 4x1G Uplink ports, with 640WAC power supply, 1 RU, LAN Base feature set
<b>WS-C3650-48PS-L</b>	Standalone with Optional Stacking 48 10/100/1000 Ethernet PoE+ and 4x1G Uplink ports, with 640WAC power supply, 1 RU, LAN Base feature set
<b>WS-C3650-48FS-L</b>	Standalone with Optional Stacking 48 10/100/1000 Ethernet PoE+ and 4x1G Uplink ports, with 1025WAC power supply, 1 RU, LAN Base feature set
<b>WS-C3650-24TS-S</b>	Standalone with Optional Stacking 24 10/100/1000 Ethernet and 4x1G Uplink ports, with 250WAC power supply, 1 RU, IP Base feature set
<b>WS-C3650-48TS-S</b>	Standalone with Optional Stacking 48 10/100/1000 Ethernet and 4x1G Uplink ports, with 250WAC power supply, 1 RU, IP Base feature set
<b>WS-C3650-24PS-S</b>	Standalone with Optional Stacking 24 10/100/1000 Ethernet PoE+ and 4x1G Uplink ports, with 640WAC power supply, 1 RU, IP Base feature set
<b>WS-C3650-48PS-S</b>	Standalone with Optional Stacking 48 10/100/1000 Ethernet PoE+ and 4x1G Uplink ports, with 640WAC power supply, 1 RU, IP Base feature set
<b>WS-C3650-48FS-S</b>	Standalone with Optional Stacking 48 10/100/1000 Ethernet PoE+ and 4x1G Uplink ports, with 1025WAC power supply, 1 RU, IP Base feature set
<b>WS-C3650-24TS-E</b>	Standalone with Optional Stacking 24 10/100/1000 Ethernet and 4x1G Uplink ports, with 250WAC power supply, 1 RU, IP Services feature set
<b>WS-C3650-48TS-E</b>	Standalone with Optional Stacking 48 10/100/1000 Ethernet and 4x1G Uplink ports, with 250WAC power supply, 1 RU, IP Services feature set



Product Number	Product Description
WS-C3650-24PS-E	Standalone with Optional Stacking 24 10/100/1000 Ethernet PoE+ and 4x1G Uplink ports, with 640WAC power supply, 1 RU, IP Services feature set
WS-C3650-48PS-E	Standalone with Optional Stacking 48 10/100/1000 Ethernet PoE+ and 4x1G Uplink ports, with 640WAC power supply, 1 RU, IP Services feature set
WS-C3650-48FS-E	Standalone with Optional Stacking 48 10/100/1000 Ethernet PoE+ and 4x1G Uplink ports, with 1025WAC power supply, 1 RU, IP Services feature set
<b>Cisco Catalyst 3650 2x10G Uplink Series</b>	
WS-C3650-24TD-L	Standalone with Optional Stacking 24 10/100/1000 Ethernet and 2x10G Uplink ports, with 250WAC power supply, 1 RU, LAN Base feature set
WS-C3650-48TD-L	Standalone with Optional Stacking 48 10/100/1000 Ethernet and 2x10G Uplink ports, with 250WAC power supply, 1 RU, LAN Base feature set
WS-C3650-24PD-L	Standalone with Optional Stacking 24 10/100/1000 Ethernet PoE+ and 2x10G Uplink ports, with 640WAC power supply, 1 RU, LAN Base feature set
WS-C3650-48PD-L	Standalone with Optional Stacking 48 10/100/1000 Ethernet PoE+ and 2x10G Uplink ports, with 640WAC power supply, 1 RU, LAN Base feature set
WS-C3650-48FD-L	Standalone with Optional Stacking 48 10/100/1000 Ethernet PoE+ and 2x10G Uplink ports, with 1025WAC power supply, 1 RU, LAN Base feature set
WS-C3650-24TD-S	Standalone with Optional Stacking 24 10/100/1000 Ethernet and 2x10G Uplink ports, with 250WAC power supply, 1 RU, IP Base feature set
WS-C3650-48TD-S	Standalone with Optional Stacking 48 10/100/1000 Ethernet and 2x10G Uplink ports, with 250WAC power supply, 1 RU, IP Base feature set
WS-C3650-24PD-S	Standalone with Optional Stacking 24 10/100/1000 Ethernet PoE+ and 2x10G Uplink ports, with 640WAC power supply, 1 RU, IP Base feature set
WS-C3650-48PD-S	Standalone with Optional Stacking 48 10/100/1000 Ethernet PoE+ and 2x10G Uplink ports, with 640WAC power supply, 1 RU, IP Base feature set
WS-C3650-48FD-S	Standalone with Optional Stacking 48 10/100/1000 Ethernet PoE+ and 2x10G Uplink ports, with 1025WAC power supply, 1 RU, IP Base feature set
WS-C3650-24TD-E	Standalone with Optional Stacking 24 10/100/1000 Ethernet and 2x10G Uplink ports, with 250WAC power supply, 1 RU, IP Services feature set
WS-C3650-48TD-E	Standalone with Optional Stacking 48 10/100/1000 Ethernet and 2x10G Uplink ports, with 250WAC power supply, 1 RU, IP Services feature set
WS-C3650-24PD-E	Standalone with Optional Stacking 24 10/100/1000 Ethernet PoE+ and 2x10G Uplink ports, with 640WAC power supply, 1 RU, IP Services feature set
WS-C3650-48PD-E	Standalone with Optional Stacking 48 10/100/1000 Ethernet PoE+ and 2x10G Uplink ports, with 640WAC power supply, 1 RU, IP Services feature set
WS-C3650-48FD-E	Standalone with Optional Stacking 48 10/100/1000 Ethernet PoE+ and 2x10G Uplink ports, with 1025WAC power supply, 1 RU, IP Services feature set
<b>Cisco Catalyst 3650 4x10G Uplink Series</b>	
WS-C3650-48TQ-L	Standalone with Optional Stacking 48 10/100/1000 Ethernet and 4x10G Uplink ports, with 250WAC power supply, 1 RU, LAN Base feature set
WS-C3650-48PQ-L	Standalone with Optional Stacking 48 10/100/1000 Ethernet PoE+ and 4x10G Uplink ports, with 640WAC power supply, 1 RU, LAN Base feature set
WS-C3650-48FQ-L	Standalone with Optional Stacking 48 10/100/1000 Ethernet PoE+ and 4x10G Uplink ports, with 1025WAC power supply, 1 RU, LAN Base feature set
WS-C3650-48TQ-S	Standalone with Optional Stacking 48 10/100/1000 Ethernet and 4x10G Uplink ports, with 250WAC power supply, 1 RU, IP Base feature set
WS-C3650-48PQ-S	Standalone with Optional Stacking 48 10/100/1000 Ethernet PoE+ and 4x10G Uplink ports, with 640WAC power supply, 1 RU, IP Base feature set
WS-C3650-48FQ-S	Standalone with Optional Stacking 48 10/100/1000 Ethernet PoE+ and 4x10G Uplink ports, with 1025WAC power supply, 1 RU, IP Base feature set

Product Number	Product Description
WS-C3650-48TQ-E	Standalone with Optional Stacking 48 10/100/1000 Ethernet and 4x10G Uplink ports, with 250WAC power supply, 1 RU, IP Services feature set
WS-C3650-48PQ-E	Standalone with Optional Stacking 48 10/100/1000 Ethernet PoE+ and 4x10G Uplink ports, with 640WAC power supply, 1 RU, IP Services feature set
WS-C3650-48FQ-E	Standalone with Optional Stacking 48 10/100/1000 Ethernet PoE+ and 4x10G Uplink ports, with 1025WAC power supply, 1 RU, IP Services feature set
<b>Cisco Catalyst 3650 Bundles</b>	
WS-C3650-24PWS-S	Catalyst 3650 24 Port PoE 4x1G Uplink w/5 AP licenses IPB
WS-C3650-24PWD-S	Catalyst 3650 24 Port PoE 2x10G Uplink w/5 AP licenses IPB
WS-C3650-48FWS-S	Catalyst 3650 48 Port FPoE 4x1G Uplink w/5 AP licenses IPB
WS-C3650-48FWD-S	Catalyst 3650 48 Port FPoE 2x10G Uplink w/5 AP licenses IPB
WS-C3650-48FWQ-S	Catalyst 3650 48 Port FPoE 4x10G Uplink w/5 AP licenses IPB
<b>Cisco Catalyst 3650 Series Spare StackWise-160 Module, Cables and Blank</b>	
C3650-STACK-KIT=	Cisco Catalyst 3650 Stack Module spare
STACK-T2-50CM=	Cisco StackWise-160 50CM Stacking Cable Spare
STACK-T2-1M=	Cisco StackWise-160 1M Stacking Cable Spare
STACK-T2-3M=	Cisco StackWise-160 3M Stacking Cable Spare
STACK-T2-BLANK=	Cisco Catalyst 3650 Stacking Blank Spare
<b>Cisco Catalyst 3650 Series RTU Feature License and Software Options</b>	
C3650-RTU=	Paper SW License for Cisco Catalyst 3650 Switches
C3650-48-L-E	Cisco Catalyst 3650 48-port LAN Base to IP Services Paper RTU License
C3650-24-S-E	Cisco Catalyst 3650 24-port IP Base to IP Services Paper RTU License
C3650-24-L-S	Cisco Catalyst 3650 24-port LAN Base to IP Base Paper RTU License
C3650-48-L-S	Cisco Catalyst 3650 48-port LAN Base to IP Base Paper RTU License
C3650-24-L-E	Cisco Catalyst 3650 24-port LAN Base to IP Services Paper RTU License
C3650-48-S-E	Cisco Catalyst 3650 48-port IP Base to IP Services Paper RTU License
L-C3650-RTU=	Electronic SW License for Cisco Catalyst 3650 Switches
L-C3650-48-S-E	Cisco Catalyst 3650 48-port Switch IP Base to IP Services Electronic RTU License
L-C3650-48-L-S	Cisco Catalyst 3650 48-port Switch LAN Base to IP Base Electronic RTU License
L-C3650-48-L-E	Cisco Catalyst 3650 48-port Switch LAN Base to IP Services Electronic RTU License
L-C3650-24-L-S	Cisco Catalyst 3650 24-port Switch LAN Base to IP Base Electronic RTU License
L-C3650-24-S-E	Cisco Catalyst 3650 24-port Switch IP Base to IP Services Electronic RTU License
L-C3650-24-L-E	Cisco Catalyst 3650 24-port Switch LAN Base to IP Services Electronic RTU License
<b>Access Point Licenses</b>	
L-LIC-CT3650-UPG	Primary upgrade license SKU for Cisco 3650 wireless controller (e-delivery)
L-LIC-CTIOS-1A	1 access point adder license for Cisco IOS Software based wireless controller (e-delivery)
LIC-CT3650-UPG	Primary upgrade license SKU for Cisco 3650 wireless controller (paper license)
LIC-CTIOS-1A	1 access point adder license for the Cisco IOS Software based wireless controller (paper license)
<b>Cisco Catalyst 3650 Series Spare Power Supplies and Fan</b>	
PWR-C2-250WAC=	250 WAC power supply spare
PWR-C2-640WAC=	640 WAC power supply spare
PWR-C2-1025WAC=	1025 WAC power supply spare
PWR-C2-640WDC=	640 WDC power supply spare
PWR-C2-BLANK=	Power supply blank spare
FAN-T1=	Fan module spare

Product Number	Product Description
<b>Cisco Catalyst 3650 Series Spare Power Cords</b>	
<b>CAB-TA-NA=</b>	AC power cord for Cisco Catalyst 3650 (North America)
<b>CAB-TA-AP=</b>	AC power cord for Cisco Catalyst 3650 (Australia)
<b>CAB-TA-AR=</b>	AC power cord for Cisco Catalyst 3650 (Argentina)
<b>CAB-TA-SW=</b>	AC power cord for Cisco Catalyst 3650 (Switzerland)
<b>CAB-TA-UK=</b>	AC power cord for Cisco Catalyst 3650 (United Kingdom)
<b>CAB-TA-JP=</b>	AC power cord for Cisco Catalyst 3650 (Japan)
<b>CAB-TA-250V-JP=</b>	Japan 250VAC power cord for Cisco Catalyst 3650 (Japan)
<b>CAB-TA-EU=</b>	AC power cord for Cisco Catalyst 3650 (Europe)
<b>CAB-TA-IT=</b>	AC power cord for Cisco Catalyst 3650 (Italy)
<b>CAB-TA-IN=</b>	AC power cord for Cisco Catalyst 3650 (India)
<b>CAB-TA-CN=</b>	AC power cord for Cisco Catalyst 3650 (China)
<b>CAB-TA-DN=</b>	AC power cord for Cisco Catalyst 3650 (Denmark)
<b>CAB-TA-IS=</b>	AC power cord for Cisco Catalyst 3650 (Israel)
<b>CAB-C15-CBN=</b>	Cabinet jumper power cord, 250 VAC 13A, C14-C15 connectors
<b>CAB-C15-CBN-JP=</b>	Japan Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15
<b>CAB-TA-JP-RA=</b>	Japan AC Right Angled Power Cord for Cisco Catalyst 3650
<b>CAB-TA-NA-RA=</b>	North America AC Right Angled Power Cord for Cisco Catalyst 3650
<b>Catalyst 3650 Series Spare Accessory and Rack Mount Kits</b>	
<b>ACC-KIT-T1=</b>	Accessory kit for Cisco Catalyst 3650 Series
<b>RACK-KIT-T1=</b>	Rack mount kit for Cisco Catalyst 3650 Series
<b>4PT-KIT-T1=</b>	Extension rails and brackets for four-point mounting for Cisco Catalyst 3650 Series

## Optics Compatibility Information

The Cisco Catalyst 3650 Series supports a wide range of optics. Because the list of supported optics is updated on a regular basis, consult the tables available here for the latest SFP compatibility information:

[http://www.cisco.com/en/US/products/hw/modules/ps5455/products\\_device\\_support\\_tables\\_list.html](http://www.cisco.com/en/US/products/hw/modules/ps5455/products_device_support_tables_list.html).



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