



Wiring Closet Switches Become Smarter & Greener

Power Management Is Added To Edge Switches

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Abstract

Wiring closet switches are undergoing a renaissance as the number and type of end-point devices accessing applications through multiple networks soar. Once the device for connecting desktops, wiring closet switches now connect wireless access points, laptops, kiosks, netbooks, IP phones, printers, video desktop systems, electrical power systems and more. As networks go borderless so too are wiring closet switches. Wiring closet switches are pervasive as they connect all end-points into an enterprise network distributing network services, applications and now power throughout a corporation. Network intelligence and services have shifted toward network access, enabling power management, unified communications, integrated security, wireless LAN access, application delivery, and high availability to support real time applications and much more. This white paper documents the dynamics forcing a change in wiring closet switching with recommendations and guidelines for IT business leaders to assist them in fixed switch vendor selection. The new Cisco edge switching products, Cisco Catalyst 3750-X, 3560-X, and 2960-S Series Switches are profiled as they represent progressive thinking in this space.



1.0 Introduction: Existing wiring closet deployments

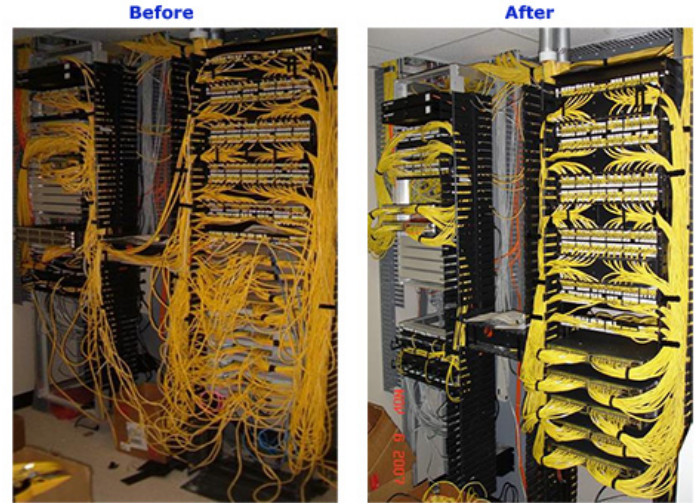
The edge or access of a network connects all end-points into an enterprise network infrastructure. The network edge is made up of wiring closet switches, which are usually fixed ethernet switching devices. The market for wiring closet switches is fundamentally changing.

In the previous decade IT organizations had traditionally pursued an edge network that utilized shared hubs and switches to provide connectivity to end-points. The primary buying criteria was price per port with low price being paramount. These switching devices possessed few network services such as layer 2 forwarding, Virtual Local Area Networking (VLAN), Routing Information Protocol (RIP) and a configuration tool as their primary network management capabilities. In short, the old network access model provided best effort connectivity services with little to no operational control.

As a result of these past decisions, edge/access security was limited, with layer 2 security measures often implemented haphazardly. Multiple VLANs were relied upon to maintain separation of user traffic and provided limited access control. Most switches relied on RIP as an interior gateway routing protocol but limitations in its algorithm could lead to sporadic outages that would render the network unusable. Wiring of switches is often disorganized after years of physical troubleshooting; additionally, adds, moves and changes without good network management systems contribute to a lack of availability, reliability and extended time to resolve faults (see Before and After photos).

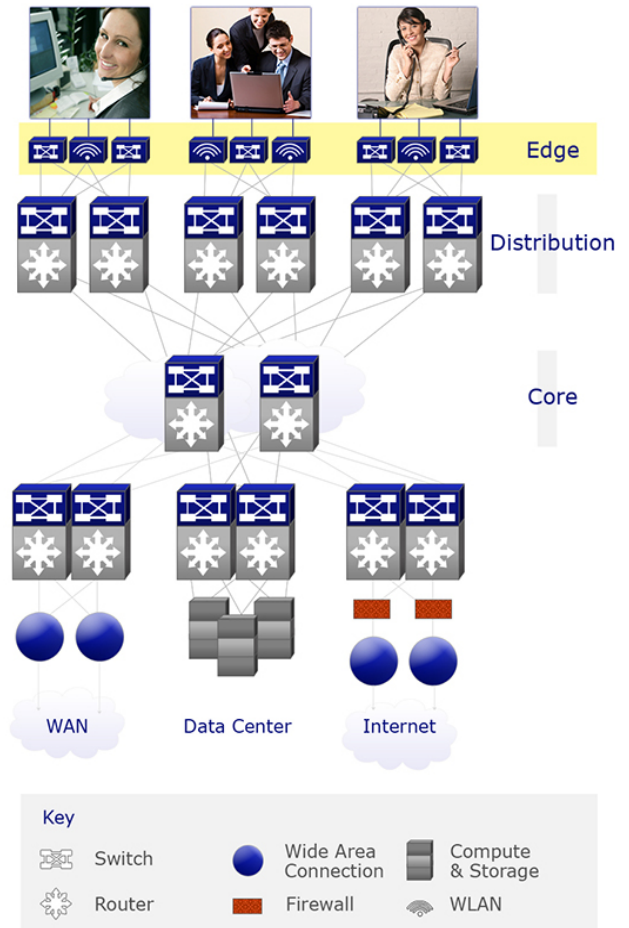
IT departments viewed wiring closet switches as commoditized networking equipment, with little differentiation between vendors. As a result, purchasing decisions were typically made solely on the basis of upfront acquisition cost with little regard for the increased lifecycle costs these purchases incurred on operations. Large organizations that focused their decisions on acquisition costs had soon assembled an enterprise network made up of equipment from different vendors throughout their wiring closets, which may have been different than distribution and core switch suppliers. Equipment from multiple vendors made effective management difficult and the multiple management systems necessitated that these organizations keep a large staff with diverse skills to maintain network functionality.

Wiring closet switch manufacturers have been driven to deliver increased network services in their products due to changing enterprise network demands, discussed below. As a result wiring closet switches and the network edge in particular have transitioned from being a commodity connectivity service to a strategic enabler of new IT applications and services while being the first level of defense to mitigate against internal network threats and attacks. This is a fundamental change in enterprise network design upon which business and IT leaders need to take action; see recommendations section.



Before and after photos of a wiring closet, courtesy of Sanford Health Network after their upgrade to next generation Cisco wiring closet switches. Notice the wiring closet vendor consistency and organization which hastens troubleshooting in the after photo.

Typical Dual Backbone Network



A new category of wiring closet switches has recently begun to appear on the market. These switches offer a host of new features that allow vendors to compete on different multiple fronts beyond traditional price per port metrics. It is important for executives responsible for purchasing decisions to understand this new basis of competition and to take into account not just their organization's current needs but also heretofore unconsidered future needs before selecting wiring closet switches and designing the next generation edge network.

1.1 Enterprise Trends

A new set of enterprise trends is forcing IT executives to review projects, programs and priorities as they seek to drive down Total Cost of Ownership (TCO) while extracting additional value from their enterprise network. Business executives expect their IT departments to meet continually growing demands for increased number of networked applications and associated performance without significant year over year network expenditures. To manage this requirement, IT leaders seek to purchase network switches that possess more forward-looking designs and significant upgradeability than what was provided by the previous generation of equipment.

IT Application Infrastructure Changes

There are fundamental changes taking place with IT applications and communications, which are forcing new network edge requirements into the market. From an IT application perspective many IT leaders are deploying Web 2.0 technologies which enable social networking and local content creation such as blogs, podcasts, vidcast, etc., that are consumed throughout an organization and between partners, suppliers and at times customers. Data center consolidation, virtualization and cloud computing projects are growing in popularity across all market segments, changing traffic patterns and increasing bandwidth requirements. Virtualized desktop deployments are on the rise, which downloads a user's profile after log in and creates their unique application environment. Video on-demand is mainstream while video conferencing use consumes greater than 60%, in some cases, of corporate bandwidth. In addition high-def end-point camera pricing has plummeted or is packaged within new computing systems while unified communication providers integrate click-to-conference capabilities into their unified communications soft end-points, increasing use and the need for private/secure communications. All of the above plus unforeseen developments point to a new dynamic in mixed secure traffic patterns with increased desktop bandwidth and service requirements, as applications, mobile devices, data and now networks go borderless.

A New Era in Communications Has Emerged

IP telephony and now unified communications (UC) offer strong economic advantages, prompting business and IT leaders to adopt this technology. To support UC, wiring closet switches need to distribute power over Ethernet and provide unique configuration profiles for these end-points. In addition to UC, mobility, in particular Wireless LANs (WLANs) adoption has become mainstream as IT leaders start to implement the latest high speed WLAN option in 802.11n. As WLAN technology continues on its high adoption trajectory, wiring closet switches must be able to support mobility through the ever-increasing value offered by WLANs with power and management capabilities. The rise of laptop and WiFi-enabled mobile device adoption in the enterprise has provided the ability for employees to be nomadic, allowing them to take their computing platform anywhere in the enterprise. This has introduced a need for the network to deploy policy for the user based on its current point of attachment, as this is no longer static or wired. Wiring closet switches need the intelligence to: 1) negotiate PoE levels as opposed to using the non-granular IEEE 802.3af classes; 2) negotiate end-point policies based on identity and/or equipment type; and 3) provide for automatic VLAN assignment for UC and other applications.

Power Management

The demands on the network continue to grow as additional devices are deployed throughout the enterprise. WLAN access points, video surveillance, IP phones, specialty devices such as health care instrumentation, point of sale devices and soon even laptops will require power distribution from the edge of the network. Power over Ethernet (PoE) is not only an efficient and Green Power distribution mechanism which facilitates Uninterruptible Power Supply (UPS) deployments but a low cost alternative to supplying power to devices which are located away from existing power outlets and infrastructure. PoE also provides central control of power distribution, which simplifies rebooting

and powering down a device when necessary, thus reducing the threat of brownouts. In addition to PoE, the network has the ability to monitor and control power consumption of both IT and non-IT devices such as environmental and lighting through approaches such as Cisco EnergyWise.

The Network Edge Is The First Level of Defense

As executive management has become aware of the real and brand tarnishing cost associated with an insecure network, network security initiatives have increased in their priority and Board of Director visibility. All prior generations of wiring closet switches are less secure than today's devices. Network security approaches to the mitigation of internal threats and attacks are table stakes in the building of a secure and intelligent network edge. Previous wiring closet switches or current switches without advanced features relied upon layer 2-based VLANs as their main defense. This level of security is wholly inadequate as a defense strategy and even worse, many organizations did not implement VLAN-based security consistently across the entire organization. With the myriad of threats facing IT organizations, including an ever-growing population of spy-ware, espionage, mal-ware and unauthorized network access, Network Access Control (NAC), end-to-end encryption and application policing has increased in importance for organizations committed to protecting the integrity of their network, the privacy of their data and providing compliance to various government and industry regulations. This new generation of wiring closet switches is powerful enough to deliver security features without compromising network performance or employee productivity.

Total Cost of Ownership

The network edge and wiring closet switches in particular have a total cost of ownership break down of 20 percent capital and 80 percent operational spend respectively, according to Gartner Group. The heavily weighted operational cost is a direct consequence of IT leaders purchasing wiring closet switches based upon lowest acquisition cost without attention to its operational impact. Purchasing wiring closet switches from multiple vendors based primarily on a low acquisition cost cause an IT organization to incur significant costs going forward for the following reasons:

1. Additional personnel are required to support multiple vendor systems
2. Additional purchases are usually needed to add capability and sparing
3. The lack of upgradeability necessitates a faster replacement cycle
4. Lost opportunity to take advantage of synergies provided by an end-to-end integrated solution
5. Missed or delayed business opportunities due to network downtime
6. Lack of service and connectivity consistency across employees and devices due to a mixed vendor network edge

What is alarming about the TCO characteristics of the old network edge is that IT organizations are paying much more than they need to as operational cost, which includes salaries and fringe benefits, are a larger burden upon a corporation's expense while capital expenditure is amortized over some number of years. While new wiring closet switches may be more expensive from a capital acquisition point of view, their operational cost will be lower and the total dollar spend over a three-year period will also be lower while delivering increased value to the enterprise.

Remember that 80% of the cost of wiring closet switching is incurred over the course of its operational lifecycle as troubleshooting, maintenance, skilled technical staff, facilities and lost productivity. Astute IT business leaders will always trade off an increase in capital cost for lower operational cost. In the next section we present a new class of wiring closet switches and discuss how new designs are addressing both the above changes in enterprise IT and reducing TCO.

2.0 A New Class of Wiring Closet Switches Emerges

Wiring closet switch suppliers have recognized the above enterprise trends and responded to the growing needs of their customers with a new type of smart green wiring closet switch that adds significant functionality over and above previous switch generations. These suppliers are succeeding at delivering increased value to IT organizations and

in the process transforming the commoditized network edge into a strategic IT asset. These new switches build upon the capabilities of the previous generation and enable a host of new applications such as UC, Telepresence, enterprise-wide mobility, increased LAN bandwidth options and enhanced security features that provide a new degree of protection against internal security threats.

Intelligence and network services are being distributed to the network edge or access, allowing wiring closet switches to support enterprise transitions in IT application infrastructure and communications adding business value in the process. This new class of wiring closet switches includes the following characteristics:

1. **Power Management & Redundancy:** Power is now distributed to multiple devices within a stack offering both improved power management and distribution conserving energy use and increasing reliability. In addition some edge devices are able to monitor and control power of PoE, non-PoE as well as non-IT devices, which offers significant advantages to overall corporate power conservation, energy cost reduction and management.
2. **Network Modules:** Easier upgrades from 1 to 10 Gbs Ethernet through field replaceable uplinks without service disruption.
3. **Network Services Options:** Multiple software images that offer differing network services such as layer 2, layer 3 support, etc. Full layer 3 forwarding enabling all the value associating with routing including high availability, segmentation and simpler troubleshooting are now included in some wiring closet switches.
4. **Quality of Service:** New wiring closet switches tag applications at access to guarantee priority throughout an internal network and active monitoring.
5. **Power over Ethernet (PoE)/PoE +:** Power is efficiently distributed over ethernet cables, enabling new classes of devices to emerge and operate in environments that lack electrical infrastructure.
6. **Integrated Security:** Integrated security features such as Cisco TrustSec provide policy-based access control, identity-aware networking and switch level encryption to bolster internal threat defense.
7. **Wireless Local Area Networking:** WLAN integration, which includes access point PoE and controller support, increases WLAN coverage. Further common network management interfaces streamline operational support for both wired and wireless networks.
8. **Unified Communication (UC):** UC support via PoE to power IP phones and UC end-points plus unique UC configuration profiles to ensure reliable and stable UC operation.
9. **Application Intelligence:** Application intelligence or the categorizing of applications as they enter the wiring closet and either mark them with QoS or discard the application, affording application policing at the network edge.

In addition to the above network services, wiring closet switches have become more powerful from a performance point of view, while engineers have increased switch reliability, availability and manageability designs. Power supplies are more efficient and serviceable, reducing power consumption and service outage. Bandwidth and packet processing performance have increased to support higher densities of 1 and 10 Gbps Ethernet while offering clever approaches to ease the transition to higher LAN speeds.

2.1 The New Basis of Competition Emerges

This new category of smart green edge switches has redefined the basis of competition among switch vendors. These advanced features allow for a degree of differentiation that was not possible for the previous generation. Organizations must assess their needs and begin making decisions based on a host of new factors besides initial acquisition cost. The following nine items are the new basis of competition among smart green wiring closet switch suppliers.

Power Management

In IT power management has been focused on data center energy efficiency. While this activity delivers real results in both power consumption reduction and savings on spend, there is a broader networked-based approach to address the remaining 98% power consumed which can deliver far greater gains in power efficiency and cost reduction. The networked approach to power management is based upon the simple fact that all devices are

connected into a network. Today these devices are IT-based, including computers, storage, printers, access points, cameras, phones, special network appliances such as firewalls, mobile devices, and increasingly TVs and other non-IT electronics. The network is in a unique position to monitor, distribute commands and most importantly control the power consumption of the devices it connects. This concept is straightforward for devices that obtain their power from network switches via Power over Ethernet (PoE) such as wireless LAN access points (AP), IP phones, ethernet/IP-based video surveillance cameras, etc. But the networked approach to the power management concept is being extended to non-PoE IT devices such as computers, digital signage, printers, storage, fax machines, etc. The concept can be extended further still to non-IT systems such as building controls, lighting, elevators, 24/7 monitoring systems, HVAC-sensors, fire/smoke sensors, et al. Some smart green edge switches are now able to deliver power management to IT and increasingly non-IT devices. For example, Cisco's 3750-X and 3560-X smart green switches offer a new approach to power management and distribution called StackPower, discussed below.

Power over Ethernet (PoE)

PoE is a standard wiring closet requirement as it enables a wide range of devices to exist in areas that are not wired for electrical power, in addition to being convenient and an efficient power distribution method. The IEEE 802.3af standard provides only 15.4W over ethernet cables. The current PoE standard 802.3at provides 30W per port. Flexibility in this area is highly desirable when selecting a wiring closet switch. Indeed, the new WiFi standard, 802.11n, access points require higher power than 15.4W, which is the maximum power supported with IEEE 802.3af. Cisco introduced 802.3at PoE support across the Catalyst portfolio for such requirements along with color IP Phones, cameras, remote ethernet switches, etc. Wiring closet switches should support 802.3af and 802.3at to provision 802.11n access points, IP Phones, etc., with intelligent power monitoring to actively manage PoE ports by enabling alarms and shut down of PoE ports when faulty. Wiring closet switches should support full class 3 802.3af and 802.3at PoE as a requirement. Note that most products only support a fixed power budget of 370 watts for 24- or 48-port fixed configured switches, which will limit the availability of power to all ports.

Future Proofing

Future proofing is found in backward and forward migration strategies to utilize past investment as part of upgrades. Another aspect of future proofing is acquiring wiring closet switches with more than enough packet processing and low latency performance to meet existing requirements and unforeseen demands. In short future proofing means having enough headroom for growth in terms of raw performance such as 10 Gb Ethernet upgrades and future applications deployable in similar network module form plus network service intelligence. For example, Cisco's "source specific multicast" feature which improves the reliability of video multicast is an example of products which anticipate future customer requirements and include them within its wiring closet switches.

Transitioning From 1Gb Ethernet to 10Gbps Ethernet

10Gbps Ethernet is the future of networking, with more than 1 million 10Gbps-capable ports shipped in 2007 and double that number in 2008. If the past is a guide to the future, then over time more and more 1Gb Ethernet ports will upgrade to 10 Gbps, placing strain on wiring closet packet processing performance while driving up 10Gbps port density requirements plus upstream distribution and core switch capabilities. This increased bandwidth will enable organizations to collaborate in new and dynamic ways, e.g., enterprise-wide video conferencing, social networking, etc.

High Reliability and Availability

High availability switch features ensure that the network edge does not suffer downtime. Some wiring closet switches implement a stacking feature to increase port density when needed, avoiding larger than needed capital acquisitions. This is an effective approach to scale and in some cases availability; however care must be applied when researching the stacking mechanism. Seek out those stacking approaches that utilize dual rotating rings as this provides redundancy with fast convergence time during auto-healing in the case of failure, thus ensuring uptime.

Power supply systems can either add or subtract from high availability. Many suppliers have equipped their wiring closet switches with redundant power supply modules which are hot swappable or with field replaceable power supply and fans that do not disrupt power flowing to the switch. Cisco's Catalyst 6500, 4500, 3750-E/X, 3560-E/X and Juniper's new EX series of switches are examples of advantaged power supply systems. The Cisco Catalyst 3560-X and 3750-X switches offer field replaceable and hot swap network modules, power supply units and fans, which is unique in the industry today for edge switches.

Most if not all network managers seek to eliminate spanning tree from their networks as it is a source of troubleshooting difficulties, link downtime and inefficiency. To meet this end some wiring closet switch suppliers such as Cisco's FlexLinks, Avaya's Multi-Link Trunking, Juniper's Redundant Trunk Group (RTG), and ProCurve's switch meshing have implemented technology to decrease convergence time of link failure to the 100 to 50 millisecond range. Some approaches such as Cisco's FlexLinks and Etherchannel support provide load balancing between links too.

High Performance

As an ever-increasing amount of traffic is placed upon the network, performance remains an important differentiator between switches. The ability of this latest generation of switches to handle load imposed by voice and video traffic in addition to the standard application demands is critical. The best switches can determine the nature of the packets being sent to them and dynamically adapt to ensure that additional latency is not added to real time communication. Smart green wiring closet switches equipped with 24 or 48 10/100/1000 port densities plus dual 10 Gigabit Ethernet uplinks connected via a non-blocking packet switching capacity across all ports and traffic types (including unicast and multicast flows) define high performance devices.

Reduced / Contained Operational Costs

To reduce the largest and most expensive component of the network edge's TCO, switch features that minimize operational impact should be exploited. Most features which reduce or maintain operational spend are found in network management. Proactive automated management features such as run-time checking the health of switch hardware components and verifying proper operation of systems data and control are built into some switches and reduce operational time spent troubleshooting. Self-provisioning capabilities such as image upgrades and auto configuration install reduce operational spend on switch deployment time; they also enable reduction of switch replacement which increases overall up time. Other bases of competition will contribute to lower operational cost as well, such as high availability, unified communications support, security, power management and mobility integration as well as troubleshooting tools and overall network monitoring.

Another example of operational cost efficiency is Cisco's Smart Operations feature set available in the Catalyst switches. Cisco Catalyst Smart Operations is a set of capabilities that simplify LAN deployment, configuration, and troubleshooting by enabling zero touch installation and replacement of switches plus fast software upgrades. Cisco Smart Operations include Cisco Smart Install, a transparent plug and play technology to configure the Cisco IOS image and switch configuration without user intervention. Cisco Auto Smart ports provide automatic configuration as devices connect to a switch port, allowing auto detection plus plug and play as a device connects to the network. Cisco Smart Configuration creates a single point of management for a group of switches and in addition adds the ability to archive and backup configuration files to a file server or switch allowing zero touch switch replacement.

Consistent Network Management

Consistent network management means leveraging the same supplier for the network edge, distribution and core. By standardizing on a supplier a consistent network management environment will be realized with the benefits of either lower operational cost or the ability to increase the level of services to employees with the same operational head count. In addition to switch configuration, troubleshooting and network monitoring, there are vendor specific features, which add value to operational efficiency. Some of these features include the ability to stack wiring closet switches with auto-configuration and auto-upgrade tools such as with Cisco's Catalyst 3750-E/X series and remote traffic mirroring which sends traffic to operational staff's physical locations even if they are in different subnets.

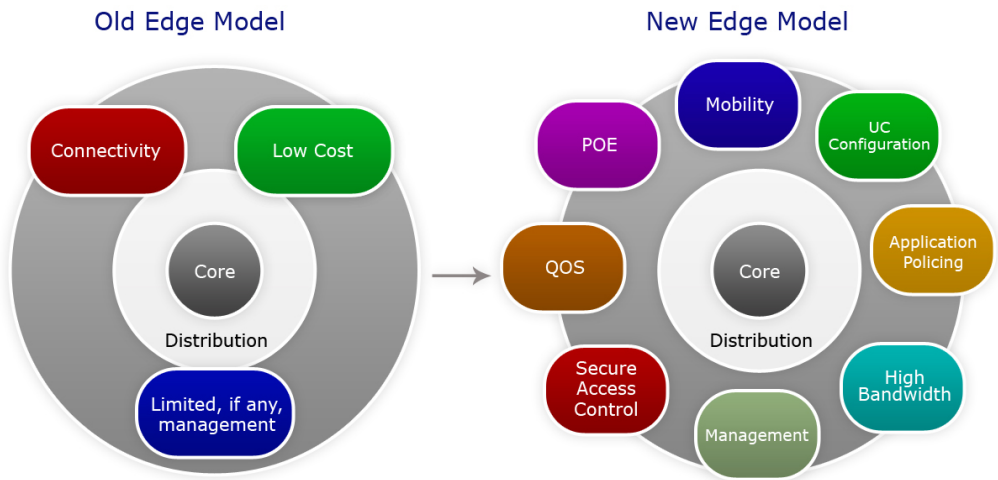
Wiring closet switches that deliver real-time diagnostics, which communicate the health of their internal operations are both rare and highly valuable to lowering time spent troubleshooting network and application faults. All of the above are currently unique features of Cisco Catalyst switches. While most suppliers adhere to standardized MIBs and an IT organization can deploy a vendor-independent management layer, it has been our experience that this approach does not deliver the economic and operational efficiency most IT leaders seek. MIBs reflect the most common features/functions supported on switches. As switches have increased in functionality, and deliver more services at the access layer, standards bodies have not reacted quickly enough to adapt the MIB. Therefore, using the MIB as the basis for network management in a multi-vendor network requires IT to utilize the least common denominator of features across vendors.

True Layer 3 Support

To support all the above-mentioned trends and yet unforeseen applications, wiring closet switches are required to support full layer 3 forwarding. This generation of wiring closet switches will support both layer 2 services such as VLANs while replacing RIP with more advanced routing protocols such as EIRGP. Note that static routing is not full layer 3 support and will not deliver the advantages mentioned above. Full layer 3 support contributes to improved network reliability, availability and manageability. Cisco’s Catalyst switches and Juniper’s new EX series of switches offer full layer 3 and 2 support.

Support of UC, Mobility and Security

This basis of competition is one of the most important attributes to the new network edge. Wiring closet switches need to both support standard interfaces and services for UC, mobility and security so that mixed vendor solutions may occur. There is value and large operational efficiency gained when a single supplier provides UC, mobility and security solutions along with the network infrastructure. The level of integration of these important services into the wiring closet switch is a choice every IT department will make depending upon their constraints, vendor relationships and risk tolerance..



Many studies have identified that network managers spend significant time troubleshooting client issues/problems. Rapid problem resolution positively impacts a company’s profitability and performance. Client/end-point troubleshooting is greatly simplified with a unified solution that helps track assets, devices and users independent of their network access type i.e., wired or wireless. For example, Cisco Catalyst switches and Mobility Services Engine (MSE) work together to provide centralized visibility and control for mobile and fixed assets which accelerates client troubleshooting, thus improving user productivity and corporate profitability.

For network security, wiring closet switches required hardware-based encryption preferably based upon IEEE 802.1ae and to enforce post-NAC decisions; that is after an end-point’s posture has been assessed. Other key attributes are the support of 802.1x for AAA (authentication, authorization, and accounting) services and identity-based networking. To mitigate man-in-the-middle and Denial of Service (DoS) attacks, DHCP snooping, dynamic ARP inspection, IP source guard and port security are important feature sets. To mitigate disruption of service due to broadcast, multicast and unicast storms, some switches offer storm control.



For mobility, some switch suppliers offer an integrated WLAN controller module, but the most important aspect of unified networking is common network management and PoE/PoE+ to support 802.11a, b, g and n access points. For unified communications VLANs are important, while PoE 802.3at is paramount. Some switch suppliers go further by easing IP phone configuration with templates while making the configuration file portable across the network, so that users may plug in their IP phones to different network ports which prompts the wiring closet switch to download its unique configuration file.

The new basis of competition among wiring closet switch suppliers is based upon switch attributes, scale, and features which reduce operational requirements and spend plus possess the ability to not only support but add value to UC, mobility and security. In the next section we review Cisco's new 3750-X and 3560-X feature set versus the above requirements and compare it against a few suppliers.

Cisco Systems

Cisco Systems is the world leader in enterprise networking with over 60% market share in ethernet switching and 92% percent of the enterprise router market according to data from the NPD Group/Distributor Track for the six-month period ending June 2007. Its Catalyst Ethernet switch product line is the broadest and most widely deployed in the industry. Cisco recently introduced a new platform of its wiring closet fixed switch family called the "X" series of switches, which adds power management, improves 1 and 10Gb Ethernet port density and transition, encryption security, software packages and increased PoE/PoE+ support. The Cisco Catalyst 3560-X and 3750-X switches offer field replaceable and hot swap network modules, power supply units and fans, which is unique in the industry today for edge switches. The 3750-X series inherits the basic architecture of the 3750-E series including its stacking technology known as StackWise Plus. We review Cisco's Catalyst 3750-X, 3560-X and 2960-S series of wiring closet switches.



Cisco Launches New X & S Series Edge Switches

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Cisco Catalyst 3750-X Series

The Catalyst 3750-X series of switches stand out as the best-in-class fixed wiring closet 24- and 48-port 10/100/1000 switches that are 10Gb Ethernet ready and offer hot swappable 1-to-10Gbe Network Modules. Its significant innovations come in the form of power management via StackPower, encryption, a new hot swappable network module to ease the transition from 1 to 10 Gb Ethernet uplinks and increased redundancy. It supports 802.3at PoE + at 30 Watts per port on all ports simultaneously. These switches are built with field replaceable dual power supplies that are more efficient than the E series and redundant cooling fans. This family of switches is available with a choice of software packages, LAN base, IP base and IP Services. The LAN Base offers integrated security, including Network Admission Control (NAC), quality of service (QoS), and resiliency to deliver intelligent services for the network edge. The IP Base package includes all of the LAN base features plus advanced QoS, rate-limiting, ACLs, RIP, IPv4, IPv6 and Cisco EnergyWise. The IP Services package includes all of the IP base features plus advanced hardware-based unicast and multicast routing built on advanced routing protocols, including EIGRP, OSPF, BGP.

Cisco Catalyst 3560-X Series

The Catalyst 3560-X series offers all of the same innovations of the 3750-X but without stacking, meaning that StackWise Plus and StackPower are only available in the 3750-X series. The 3560-X boasts enterprise level performance and a robust feature set, including 10Gbps Ethernet, hot swappable 1 and 10 GbE components plus

redundant and hot swappable power supplies and fans, as well as high performance optical SFP and SFP+ connectors.

Cisco Catalyst 2960-S Series

The Catalyst 2960-S series in Cisco's entry level wiring closet switches. These switches are stackable with the FlexStack system. The 2960-S enjoys new power supplies that are 50% more efficient and PoE+ support.

Key Cisco Catalyst 3750-X/3560-X Series Switches Features vs New Basis of Competition

Power Management: These switches offer Cisco's EnergyWise energy management system that controls not only PoE devices but some non-PoE and non-IT devices. Cisco EnergyWise is a capability that is not matched by any other switch supplier and allows IT to monitor, manage and control power consumption of devices connected into Cisco switches. In addition to Cisco EnergyWise, Cisco is introducing a new power management approach to stacking 3750-X switches called StackPower. Just like Cisco extended the data and control bus to span over multiple motherboards between switches in a stack with StackWise Plus, StackPower unifies the power plane so all power capacity is shared among all switches in the stack.

The X series redefines power supplies in fixed switching. The X series supports dual power supplies that can be configured in one of four combinations of AC/AC, AC/DC, AC only or DC only. These power supplies share in providing power to all switches in the stack versus what is common in the industry today of one supply being active while the second is in standby or in back up mode. Cisco's StackPower innovation is that all power supplies combine and create a pool of power such that all power allocations are distributed from the power pool. A power supply's physical location is independent from where its power is being used. StackPower has a redundant mode where a reserve amount of power is partitioned for redundancy (backup) and that amount is equal to the largest power supply in the stack. This is very important especially when all 48 ports are supplying full 802.3at PoE + power drawing 1440 W plus switch power requiring about 200W. Therefore, a 48-port switch with all ports providing 30W of PoE + requires a power budget of 1,640 Watts and two power supplies.

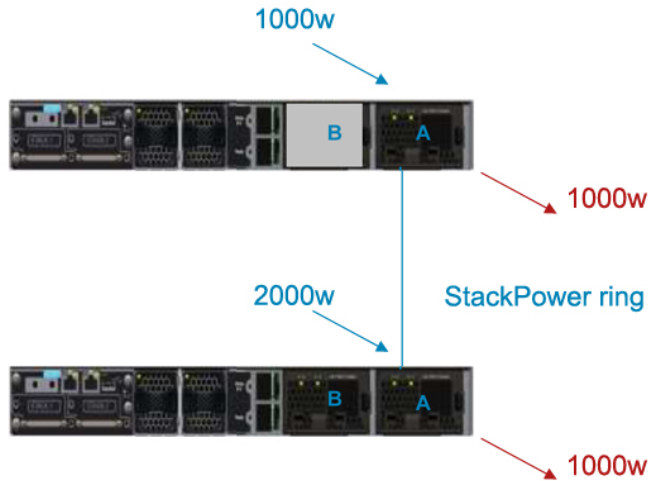
The North America electrical systems are based upon 120-volts with 15 amp circuits being most common, providing a maximum power delivery of 1.8 kiloWatts (kW) per circuit. When more than 1.8 kW are required a second power supply and circuit can be administrated. To manage a stack of switches distributing PoE + power efficiently and with new flexibility Cisco introduced StackPower. StackPower manages all the power supplies, two per switch in a stack, as a pool of power delivering power where it's needed. StackPower allows IT to only be concerned with the total available power to the stack, independent of the power supply and type of power, that is AC or DC.

As an example of StackPower, consider a simple case of two switches in a stack where one switch is equipped with power supplies and the other is not. The switch with power supplies provides power to the switch without thanks to StackPower. StackPower allows cost reduction with less heat and cooling costs allowing the power supplies to operate more efficiently. Another example is illustrated in the figure below. To the left are two switches in a stack where the switch on top is supplied 1 kW of power. The second switch on the bottom is supplied with two 1-kW power supplies. The total power available to the stack is 3 kW. Assume PoE + devices are consuming 1 kW of power on each switch totaling 2 kW of power. Traditionally the 1-kW switch would have no extra power available while the 2 kW switch would have 1kW of a backup power supply. In traditional power supply designs, no additional PoE + ports could be administrated on the 1kW switch as its power has been allocated. But with StackPower, IT could administer PoE + ports on the 1kW top switch as StackPower views a total of 3kWs available to the stack. StackPower distributes the extra power available on the bottom 2kW switch to support the power draw on the top 1kW switch automatically, without requiring the network administrator to calculate a power budget for each switch in the stack. This allows the network administrator to connect PoE/PoE + devices on any switch port in the stack as long as the total power available to the stack is not exceeded. This is a great design feature for those network administrators who are powering phones, access points, etc., across their network. Also, reserve power can be defined too so that some power is not pooled but used to power the stack in case of failure.

Yet another example on the right in the figure below illustrates how StackPower reallocates power to the top switch during a single power supply failure.

StackPower

Extra Power Supply

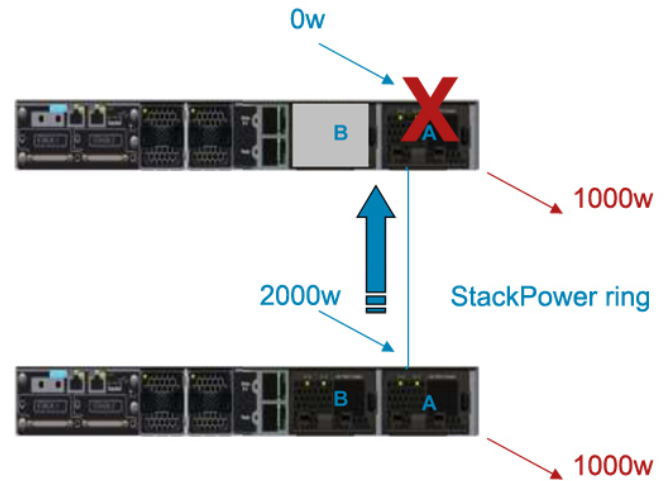


Available Pwr	Allocated Pwr	Unused Pwr
3000w	2000w	1000w

- StackPower can set aside power for possible failures



Single Failure with Extra Power Supply



Available Pwr	Allocated Pwr	Unused Pwr
2000w	2000w	0w

- StackPower provides power to switch 1
- Zero-Footprint RPS

Power over Ethernet (PoE)/PoE+: The 3750-X/3560-X Series are both available in PoE/PoE + configurations. In addition to standard 802.3af PoE these switches support the latest IEEE 802.3at standard which delivers PoE at 30W per port as well as an intelligent dynamic power allocation which distributes the right amount of power required to various end-points rather than deliver 15.4W or 30W to every end-point independent of power requirement. These switches support full class 3 802.af PoE on all 48-port configurations without the need for an additional power shelf or injector as is common for most other competitors. In addition they support 30W per port on all 24 or 48 ports simultaneously in a single RU switch.

Future Proofing: The 3750-X/3560-X Series switches are backward compatible with the 3750 and 3560 switches, which also allows integration with ISR 2800 and 3800 for branch office solutions. Catalyst 3750-X StackWise Plus technology provides inter-switch bandwidth of up to 64 Gbps and is common to 3750-E and 3750-X. The Catalyst 3750-G and 3750v2 utilize the original StackWise interconnect that operates at 32G. StackWise Plus is backward compatible with Stackwise.

Transitioning From 1Gb Ethernet to 10Gbps Ethernet: The X series of switches support a new network module that delivers two uplink configurations: 1) four 1Gb Ethernet (4-1Gbe) via SFP connector and 2) two 10Gb Ethernet ports via SFP+ connector plus two 1Gb Ethernet ports via SFP (2-10Gbe + 2-1Gbe). With SFP+ there is no need for



TwinGig converter technology and the network module is hot swappable. The new network module makes the transition from 1 to 10 Gb Ethernet much less costly and easier to deploy.

High Reliability and Availability: The 3750-X series of switches support Cisco's latest innovation called StackPower. StackPower aggregates and shares available input power capacity to all switches in the stack as explained above. The 3750-X and 3560-X platforms support dual redundant power supplies and fans that are hot swappable and field replaceable plus offer a redundant external power option.

As fans are the only moving part in a switch, they are susceptible to mechanical failure. The X series provides two fan modules offering redundancy with a total of four fans per switch. The X series can survive a fan failure as fans work together so that if one fan fails, three are enough to provide cooling. The fan modules are hot swappable. This is an improvement to the E series, which supported one hot swappable fan module.

The 3750-X-Series supports StackWise Plus, which is the same fault tolerant stacking mechanism as the E series. StackWise Plus utilizes a dual rotating ring, which provides redundancy with auto-healing in the case of failure, ensuring uptime. The X series supports Cisco's Flex Link, which provides an alternative to Spanning Tree link redundancy between switches. Flex Link sports a convergence time, in the case of link failure, within 100 to 50 ms ensuring that real time voice connections are not interrupted or fail.

High Performance: The 3750-X/3560-X Series Switches incorporate a switching fabric that delivers full line rate packet processing.

Reduced/Contained Operational Costs: There are a wide range of features built into the 3750-X/3560-X, E and G series of switches which reduce or maintain operational cost. These include its StackWise/StackWise plus technology, which provides auto-configuration, auto-upgrade and failed unit replacement capabilities, all of which lower operational expenses. Also Cisco's General On-line Diagnostics (GOLD) is unique in that it provides run-time checking of hardware components health and verifying proper operation of systems data and control, minimizing troubleshooting time.

Adding a new switch to the stack has been fully automated in the X series. For example, a network administrator will first connect the switch to the stack then add power. The stack detects a new switch is being added to the stack and checks its software version. If the new switch is not running the same software version, then the master switch in the stack will upgrade the switch to the same software version running in the stack. This avoids the time and need to pre-stage the switch. The stack then looks to configure the switch with the global configuration including port specific configuration details and ACLs. This information is dynamically learned by every switch that joins the stack after being upgraded/downgraded to the same IOS version. During this process the new switch is loaded with configuration detail and receives a copy of the TCAM or (Ternary Content Addressable Memory) image that includes the FIB (forwarding information base). The FIB is built and synchronized by the stack master and distributed among stack members. This process is exactly analogous to adding a line card to a chassis. The more switches that are added to the stack the greater redundancy as a master switch failure will be resumed by any "slave switches" within a one to two seconds.

Consistent Network Management: The 3750-X/3560-X series switches are equipped with a host of management features; in particular for experts CLI is available for quick and detailed configuration. These switches can also be managed via CiscoWorks LAN Management Solution (LMS) providing a consistent management experience between edge, distribution and core switching.

True Layer 3 Support: There are three software licenses available: LAN Base, IP Base, and IP Services. LAN Base offers integrated security, including Network Admission Control (NAC), advanced quality of service (QoS), and resiliency to deliver intelligent services for the network edge. IP Base enables layer 2 forwarding, IPv6 management, and basic layer 3 routing, including Enhanced Interior Gateway Routing Protocol (EIGRP) stub and Protocol Independent Multicast (PIM) stub mode. IP Services includes IP Base and enables advanced layer 3 routing such as EIGRP, Open Shortest Path First (OSPF), multicast routing and IPv6 forwarding in hardware routing functionality. With the 3750-X/3560-X and 2960-S switches able to run a similar LAN Base IOS version customers can more easily

upgrade to 3750-X/3560-X switches. Further, LAN Base offers tighter software integration between the X and S platforms, which is ideal for customers that may need more functionality than the 2960-S in parts of their network but not all the software features afforded in IP Base and IP Services IOS versions on the 3750-X/3560-X switches.

Support of UC, Mobility and Security: Line rate encryption is available on all user ports of the 3750-X/3560-X series switches thanks to a dedicated ASIC (application-specific integrated circuit) that performs MACsec; IEEE 802.1ae standard encryption and key management. To take advantage of encryption either the IP-based or IP Services software package is required. While most of the software features are common to the LAN and IP-based image, encryption and StackPower are disabled in the LAN-based software image. The IP-based software image is by far the most widely deployed; therefore, most Cisco customers will receive encryption capability.

Cisco has partnered with Intel to develop IEEE 802.1AE (MACsec) encryption on Network Interface Cards (NIC) and LAN on Motherboard (LOM) chipset form factors. The result is that PC vendors have desktop computers in the market today with the Intel MACsec LOM. To secure communications in an enterprise the last or first 100 meters is the most important link to protect as it's the most vulnerable to eavesdropping or tapping. To secure the last 100 meters, end-points need to support MACsec and its key management standard MACsec Key Agreement (MKA) as defined in IEEE 802.1X-REV. The next generation of motherboards will support MACsec, and for those PCs, IP phones and videophones that don't support an MACsec encryption in hardware, supplicant software will be available.

The 3750-X/3560-X and E series switches support UC, Video and wireless LAN services via QoS, security, PoE/PoE+, intelligent power management, Smartports technology which stores IP phone, WLAN AP, video camera etc configurations via LLDP-MED and/or CDP plus field replaceable power supply and fans. Cisco's Auto Smartports automatically provisions the switch with required QoS and other settings, reducing operational cost. Therefore, when an IP phone, wireless AP or Video camera is connected to the network, the right configuration is applied by learning via CDP and LLDP. The switches also support Source Specific Multicast (SSM) for one-to-many video communications. There is a wide range of standard and advanced security options including 802.1x for identity-based networking, NAC enforcement, hardware ACL, DHCP snooping, dynamic ARP inspection (DAI), IP Source Guard (IPSG) and port security to mitigate against man-in-the-middle plus DoS attacks. Storm control is also unique which prevents LAN traffic from being disrupted by broadcast, multicast and unicast storms.

A Word On The Cisco Catalyst 2960-S Series Switch

Ease of operation differentiates the 2960-S from other entry level edge switches. Cisco is bringing features to the 2960-S that were once only available on the 3750 and 3560 platforms including 10 Gb Ethernet, stacking, 802.3at PoE+ and improved power efficiency. The 2960-S platform includes approximately 12 new switches and FlexStack, a new stacking option. FlexStack delivers 20 Gbs of inter-switch packet processing performance. Its connectors are different, but its management interface is similar to StackWise Plus, pursuing network administrators' experience of managing both switching platforms. Thus, the 2960-S enjoys the same capabilities as StackWise including lower total cost of ownership through simplified management. The Cisco FlexStack provides a unified data plane, unified configuration, and single IP address management to manage a group of switches as one.

There are significant differences between FlexStack and StackWise in terms of redundancy and availability. StackWise Plus's intelligence is embedded in hardware offering fast convergence times during reconfiguration in the unlikely event of switch failure, for example. In StackWise Plus there are two rings, which are load balanced resulting in a quick and seamless reconfiguration of communications between switches in the stack. FlexStack is a point-to-point physical ring topology without blocking any port and achieving a 20G channel over the 2 stacking ports. For example, assume Switch 1 needs to communicate to Switch 3. This communication is predetermined/configured before the stack is operational. Therefore, when Switch 1 needs to communicate to Switch 3, their path of communications is predetermined and does not vary. During a failure, the system re-converges in software, which is slower than StackWise's hardware implementation. As an example, if a failure occurs on a StackWise Plus system a phone call traversing the stack would not be interrupted meaning the user would have no knowledge of the failure event. On a FlexStack system that same call might be dropped. In short, StackWise Plus is a bi-directional load-balancing system while FlexStack is a ring that re-converges in software. The table below highlights the differences between FlexStack and StackWise Plus.

	2960-S Stacking Ease of Use	3750-X StackWise+ Ease of Use and High Availability
Device Limit	4 units	9 units
Stack Bandwidth	20G / 40G	32G / 64G
Dynamic Ring Load Balancing	No	Yes
Stack Convergence	1-2 seconds	Few milliseconds
Stack QoS	Applied hop by hop	Applied on ingress
StackPower	No	Yes
Management	Single IP address, SNMP, SYSLOG	Single IP address, SNMP, SYSLOG
Configuration	Single config and CLI, auto image and config update	Single config and CLI, auto image & config update
Show and Debug Commands	Unified	Unified
Single Forwarding & Control Plane	Synchronize ARP, MAC Address, IGMP, VLAN tables	Synchronize ARP, MAC Address, IGMP, VLAN, Routing tables
Cross-Stack Features	Yes	Yes
Single Bridge-ID	Yes	Yes
Redundancy	Stack master 1:N redundancy	Stack master 1:N redundancy

SFP+ is the preferred connector on the 3560-X, 3750-X and 2960-S series switches for 1 and 10 Gb Ethernet. The 2960-S series does support PoE +, but without the same power capability as the 3560-X and 3750-X platforms; meaning that the PoE power budget will be between 740-to-370-watts depending upon power supply capacity. The 2960-S is more efficient and consumes less power than the 2960-G. The 2960-S switches are all stackable when equipped with a stacking module and 1 or 10Gb Ethernet uplinks are decided at time of acquisition, as a network module is not available.

Conclusion

Cisco has built two very scalable platforms that start at an entry level with the Cisco Catalyst 2960-S Series Switch, which services the SMB market scaling up to the mid-enterprise with the Cisco Catalyst 3750-X/3560-X Series Switches. The platforms are built for fault tolerance/non-stop operation thanks to redundancy in power and fans. The XSeries is the greenest switching platform in the industry with less energy consumption of previous generations, efficient power distribution to PoE/PoE+ devices and most importantly the ability to monitor and control the power consumption of the devices it connects through Cisco EnergyWise. Line rate encryption at the edge of the network with both fixed and stackable switching is an industry first.

The closest competitor to the Cisco Catalyst 2960-S is HP ProCurve's 2910 and 5400. The 2910 series has been available since April 2009 and consists of two 24-port and two 48-port fully managed Layer 2 10/100/1000 switches. The switches support two optional two-port 10Gb Ethernet (CX4 and SFP+) modules and redundant/external power. Two of the four switches support PoE +; however they are rated at 490W, enough power to support only 14 of the 24 ports. The switches feature variable-speed fans that adjust to accommodate cooling needs. As the ProCurve 2910 does not stack it cannot compete with the Cisco 2960-S on port density, performance and ability to scale. To compare the Cisco 2960-S port density, performance and feature set against the proCurve product line, one is forced to look toward its modular line and its ProCurve 5400zl series. But the 5400zl is a core, distribution and advanced access layer modular switch being much more expensive and having more overkill than Cisco's entry level 2960-S.

In essence Cisco has redefined the entry level edge switch market by packing it with features, performance and scale only available in much higher end competitive products.

The closest competitor to the Cisco Catalyst 3750-X/3560-X switches is HP ProCurve's modular 5400zl and Juniper's stackable EX4200. Juniper's EX4200 is the closest competitive product to the 3750-X/3560-X in terms of port density, performance and power/fan redundancy. However the EX4200 does not enjoy the PoE+, hardware-based per port encryption, high availability features such as online insertion and removal of uplinks and power management advantages found in the Cisco Catalyst 3750-X/3560-X switches. The EX 4200 offers integration with Juniper's Unified Access Control solution through 802.1X. As for the proCurve 5400zl again it's a module switch which carries a larger upfront capital spend than the stackable 3750-X. It's PoE+ capabilities are limited to two modules in the 5400zl chassis; its HP ProCurve 5406zl-48G-PoE+ Switch J9447A and HP ProCurve 5412zl-96G-PoE+ Switch J9448A which are supplied with a 1.5kW power supply, which will power 50 ports out of 48 and 96 respectively and does not support hardware-based per port encryption. Where Cisco's 3750-X/3560-X switches excel is in price, performance, power management and port density.

4.0 Industry Recommendations

The choice of wiring closet switches depends upon the current and projected needs of the organization, incumbent suppliers and budget availability. It is important to consider TCO during vendor and switch selection. Items which tend to increase operational cost, the largest TCO cost component in the network edge, are: hardware diversity, configuration and support complexity, security and regulatory demands, conflicting performance criteria, higher costs for incremental services, higher recurring expenses, minimal opportunities for automation, multiple maintenance contracts, minimal synergies between applications, lack of business agility and high upgrade costs.

When selecting suppliers it's important to verify the exact meaning of feature attributes when comparing switching solutions. For example, "stackability" is a desirable feature in many switches at this level and each vendor may define this feature differently. Some will use terms such as stackability when their switches are pileable which reduces performance, reliability and availability. Further care should be applied to PoE/PoE+, in particular to terms such as "all ports support PoE". IT buyers should look at the total power available to be distributed to ensure that all ports can be powered with 15.4W for class 3 devices or 30W for PoE+ devices. Layer 3 support is another attribute which suppliers claim but all offer different levels of support. For example, Cisco offers a deeper level of layer 3 support than all others.

When choosing between the many options for smart green wiring closet switches available on the market today, a number of factors should be considered. These factors can be grouped into four broad categories, each of which can then be further broken down into sub-factors presented in the framework below:

Factors to Consider When Selecting a Wiring Closet Switch

Power Management and Organizational Costs: Remember that initial acquisition cost is typically 20% of TCO while operational spend consumes approximately 80% of cost over a 3 year period. If TCO reduction is important to your organization look to standardize on suppliers and place a large weight on operational cost reduction attributes identified above. Some switches can monitor and control the power consumed by IT and non-IT devices connected to the network, offer efficiency power suppliers and internal power distribution. These power management features are highly desirable especially as energy cost is projected to exceed server acquisition cost in the next few years.

Current Organization Requirements: Monitor and when possible model network edge performance, traffic flows and bandwidth requirements. In short, IT leaders need to make a judgment on how important network uptime, applications and workflow are to their organization for the network edge. Are real-time applications such as UC, click-to-conference, Web 2.0, and Telepresence supported in the IT application infrastructure, on top of existing office productivity and workflow applications, etc? If so then attributes of power management, redundant power supplies, hot swappable components, layer 3 support, high reliability and availability are important in the vendor selection process. If security and vulnerability reduction are important due to regularity conformance and/or executive

mandate then strong integrated management, encryption and security tools are required, such as network access control and threat mitigation options as outlined in Section 2.1.

Future Organizational Needs: It's always easier to gather current organizational requirements than to anticipate future demands. Here industry initiatives are usually helpful in charting future and unexpected requirements. For example, the IT industry has shifting toward Web 2.0-based application delivery which includes locally generated real-time media such as podcast, blogs, vidcast, etc. Real-time communication such as UC, Telepresence, click-to-conference and IP video are entering a business cycle where massive consumption and deployment will occur due to strong industry and cultural trends. Some of the network edge suppliers profiled above have anticipated these demands and build attributes into their fixed switches to enable their deployment without the need for new equipment. Some of these attributes include upgradability via new software versions instead of new hardware, easy and low cost transitions from 1Gb to 10Gbps, PoE/PoE+ with flexibility to support 802.11n and efficient power distribution, WLAN integration, unified communications and video distribution support.

Incumbents: Another important factor when selecting a wiring closet switch is the status of existing network suppliers which the organization already supports. In short, many network operations personnel will need compelling reasons to switch away from incumbent vendors. Not supporting the above outlined new basis of competition is a strong compelling reason. Most IT organizations will seek to leverage skill sets and experience currently present within the organization. Another factor, often not discussed but very much prevalent in the vendor selection process is maintaining the largest career opportunities available which is usually equated to gaining experience with the vendor who possesses the largest market share, affording these executives a wide range of future employment options. Incumbent inertia is gained by IT management's resistance to an increase in operational and training cost if additional personnel must be hired to support new wiring closet switch suppliers. Organizations must determine the proper value to place on each of these factors when making a purchasing decision regarding a wiring closet switch. Obviously, different organizations will have different needs both now and going forward and not every factor should bear equal weight for each organization. In fact, we recommend that weights be placed on the basis of comparison attributes that reflect organization needs. In addition to the above, and to assist organizations in making their decisions, below we offer Lippis Consulting's top five recommendations for these types of purchasing decisions:

1. Think of Wiring Closet Switches As Strategic IT Assets

Wiring closet switches are strategic IT assets, which enable power management and a host of new applications and communication options. No longer do these devices simply offer a connectivity service, but rather a wide range of network services that enable mobility, unified communications and provide internal threat defense.

2. Consolidate Wiring Closet Devices To A Single Supplier Who Meets The Basis Of Competition

Wiring closet switches are no longer commodity items purchased based upon lowest cost. It is recommended that IT organizations consolidate their wiring closet switch purchases to a single supplier to increase operational expense efficiency by providing consistency in the network edge.

3. Only Procure PoE/PoE+ Wiring Closet Switches as Most Networking Devices Will Require Network-Based Power

It is inevitable that WLANs, IP phones, surveillance cameras, video conferencing devices, etc., will increasingly require PoE and PoE+, as they are on their way to being pervasively deployed. Also there is a plethora of new devices which derive their power from PoE, such as security surveillance, point of sale devices, health care instrumentation, in the near future laptops and many other devices. IT organizations should consider replacing their wiring closet switches with PoE/PoE+ supported wiring closet switches pervasively throughout their organization. Cisco customers are recommended to experiment and use its Cisco EnergyWise power management as it's a free feature set that can contribute to green initiative by monitoring and controlling energy from IT and non- IT devices connected to the network.

4. Consider Supplier Consistencies Between Wiring Closet, Aggregation And Core To Streamline Operational Expense

Significant synergies can be achieved by selecting a single vendor to provide switching capabilities across wiring closet, distribution and the network core. Operational expense can be contained and minimized, as fewer personnel are required to support a single vendor solution versus multiple platforms. Expertise in a single vendor's products can then be developed reducing troubleshoot time, increasing availability and network reliability all at a lower TCO. Every switch supplier has a broad portfolio of products that span edge, distribution and core, be it Cisco, Avaya, Juniper, HP/3Com, or Extreme and Foundry who are not covered in this report.

5. Consider the Basis Of Competition As Required Features To Support Both Existing & Unforeseen Future Applications

The basis of competition described above provides a useful guide to the new features available in wiring closet switches. For most organizations looking to purchase new switching hardware, it makes sense to consider these features as required since buying hardware that lacks these attributes has the potential to severely limit the organization's capabilities going forward. The needs of business are constantly changing with unforeseen new applications; IT organizations need to have a network to support the future. As a result, selecting a switch that does not support advanced features like power management, PoE + or 10Gbps Ethernet will significantly increase total ownership cost as these switches will more than likely have to be replaced in the near term.

About Nick Lippis



Nicholas J. Lippis III is a world-renowned authority on advanced IP networks, communications and their benefits to business objectives. He is the publisher of the Lippis Report, a resource for network and IT business decision leaders to which over 30,000 business and IT executive leaders subscribe. Its Lippis Report podcasts have been downloaded over 80,000 times; i-Tunes reports that listeners also download the Wall Street Journal's Money Matters, Business Week's Climbing the Ladder, The Economist and The Harvard Business Review's IdeaCast. Mr. Lippis is currently working with clients to transform their converged networks into a business platform.

He has advised numerous Global 2000 firms on network architecture, design, implementation, vendor selection and budgeting, with clients including Barclays Bank, Microsoft, Kaiser Permanente, Sprint, Worldcom, Cigital, Cisco Systems, Nortel Networks, Lucent Technologies, 3Com, Avaya, Eastman Kodak Company, Federal Deposit Insurance Corporation (FDIC), Hughes Aerospace, Liberty Mutual, Schering-Plough, Camp Dresser McKee and many others. He works exclusively with CIOs and their direct reports. Mr. Lippis possesses a unique perspective of market forces and trends occurring within the computer networking industry derived from his experience with both supply and demand side clients.