Evaluating and Enhancing Green Practices with Cisco Catalyst Switching (was: Catalyst 6500 Energy Sustainability)

Introduction

National security, environmental, and resource supply issues will encourage governments to implement green initiatives and incentives. There will be business ramifications as a result of policies implemented by local, state, and federal governments around the world. As traditional energy supplies decrease and newer, but more costly, renewable supplies are brought online, organizations will be forced to look for more efficient ways to deploy their data networks to meet stricter government regulations and prevent overall negative effects.

Cisco has recognized this impending effect on the IT community for some time and has been building products and developing new technologies to assist organizations in this transition. This document describes the energy sustainability characteristics of the Cisco® Catalyst® 6500 Series Switch. The Cisco Catalyst 6500 Series Switch offers the latest technologies to enable organizations to meet the green requirements of today while providing a flexible architecture to address the necessities of tomorrow. This paper covers the following topics:

- Energy savings
- Operational efficiency
- Innovative business practices

Energy Savings

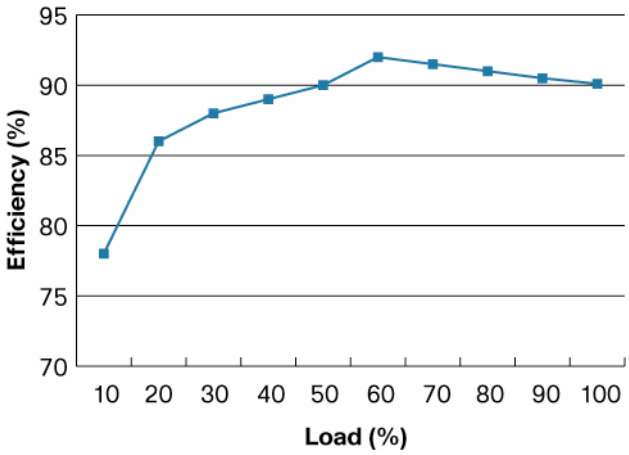
One of the most direct ways that organizations can achieve their goals to become greener is to deploy solutions that offer improved energy efficiency. Even though power related to network equipment is just a fraction of an enterprise's overall power usage, the Cisco Catalyst 6500 Series Switch has made advancements in power management and infrastructure consolidation that allow IT groups to deploy more energy-efficient architectures. Some of these enhancements include higher efficiency power supplies, EnergyWise, intelligent power management, virtualization, and others.

Power Management: Power Supply Efficiency

There have been several hardware enhancements in the area of energy efficiency for the Cisco Catalyst 6500 Series Switch. The most pronounced change has been in the efficiency of the power supplies. When this switch was first

introduced, the efficiency of the power supplies was in the range of 80 percent. With the ratification of IEEE 802.3af Power over Ethernet in 2003, the demand for power delivery in the data network increased dramatically as customers began to converge their data and voice networks. Recognizing this, Cisco developed higher capacity power supplies for the Cisco Catalyst 6500 Series Switch to meet this new demand and at the same time took advantage of new technology to provide power supplies with efficiency in the 91 percent range. Figure 1 shows an actual AC power supply efficiency curve of the 6000W power supply.

Figure 1. AC Power Supply Efficiency



Going from 80 percent to 90 percent might not sound like a lot, but consider the environmental and financial effect that such a change entails:

Example 1: Power Supply Efficiency Savings

Switch with 384 IEEE Class 3 devices (15.4W each) = ~5913.6W from the system power supplies

A power supply with 80 percent efficiency draws ~7392W from the power source (19.25W per device)

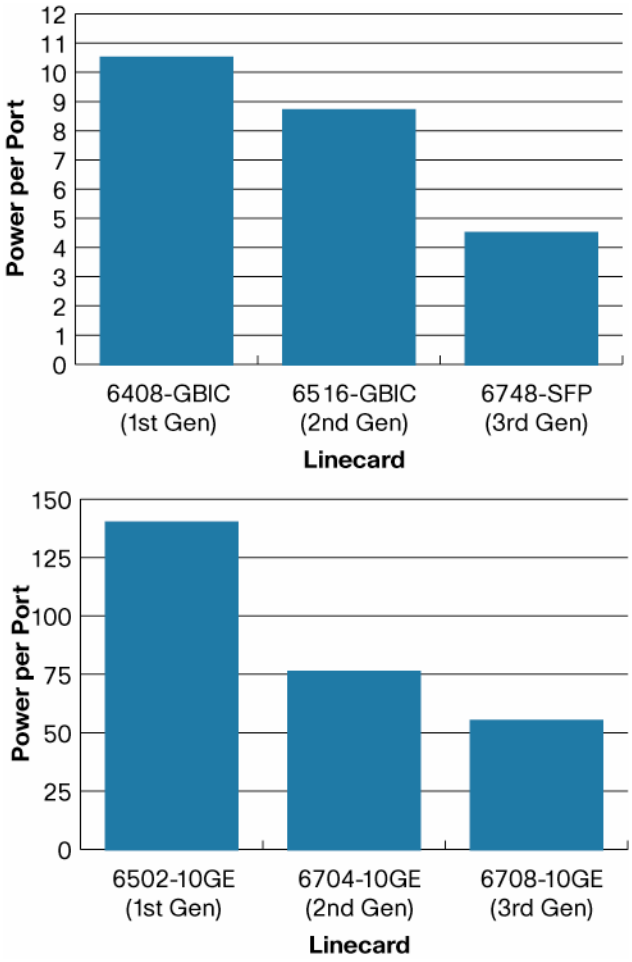
A power supply with 90 percent efficiency draws ~6571W from the power source (17.11W per device)

As you can see, that is a difference of ~821W for this one access switch. If these devices are powered on 12 hours a day for 365 days, that is a savings of ~3596 kilowatt-hours per year per switch. Some organizations might run these devices 24 hours a day, which would double the savings. The financial savings from a power perspective are pretty obvious, but the environmental savings might not be so apparent. When considering all power sources, a kilowatt-hour of electricity generation creates ~1.25lb of CO2. By moving to more efficient power supplies, this would represent a savings of ~4500lb of CO2 per access switch. Since governments around the world are looking at carbon taxes, usually based on tons of CO2 generated, the improvement of power supply efficiency will further add to the bottom line by resulting in lower tax burdens.

Power Management: Performance-to-Power Gain

While increases in power supply efficiency might seem to have the largest effect on an organization's drive to reduce their carbon footprint, other hardware enhancements on the Cisco Catalyst 6500 Series Switch will also further the goal to become greener. The ability to move more data with fewer components allows organizations to deploy more efficient architectures. Figure 2 shows how improvements in technology have resulted in the ability to transmit more information while increasing power efficiency.

Figure 2. GE and 10GE Power Efficiency Improvements on Cisco Catalyst 6500 Line Cards



Further enhancements, such as the ability to dynamically apply power to only certain portions of the hardware based on traffic utilization, are being investigated. These hardware enhancements will allow organizations to deploy architectures to solve their information requirements while moving toward a greener infrastructure to meet the needs of an environmentally changing world.

Power Management: Cisco Discovery Protocol, LLDP, and Power Policing

Ever since Cisco began deploying prestandard PoE, the Cisco Catalyst 6500 Series Switch has been able to interact with devices enabled by Cisco Discovery Protocol to dynamically assign power. This interaction allows the system to more efficiently distribute power to powered devices (PDs) by using Cisco Discovery Protocol to determine exactly how much power a PD requires. For example, if an IEEE Class 3 Cisco Phone comes online, the system will first allocate 15.4W from the power budget to meet the IEEE Class 3 requirement. Once the phone is online, the system and phone will communicate using Cisco Discovery Protocol, and part of that communication will include the phone's actual power requirement. The system will compare the actual power requirement with what was originally allocated. If the actual requirement is lower, then the system will change the allocation to match actual requirement. Now that IEEE 802.1ab Link-Layer Discovery Protocol (LLDP) is available, this capability might be able to be extended to devices not capable of using Cisco Discovery Protocol in the future.

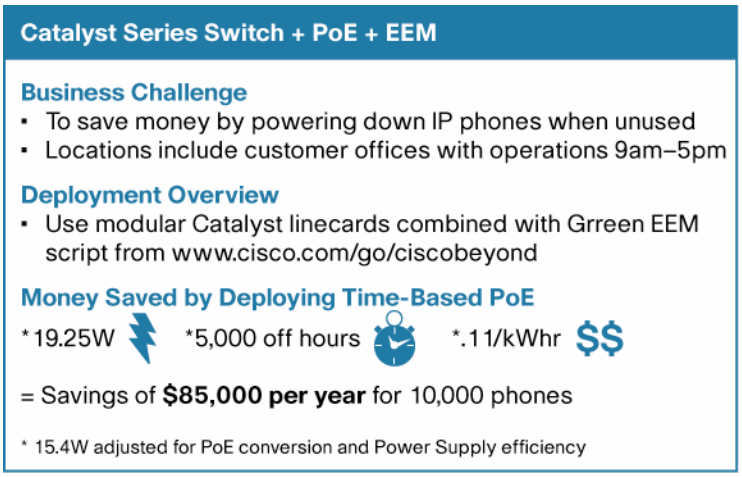
In addition to Cisco Discovery Protocol and LLDP, the Cisco Catalyst 6500 Series Switch supports the ability to manually configure the amount of power allocated to a port supporting a PD. This support began with Cisco IOS® Software Release 12.2(33)SXH and requires the WS-F6K-48-AF PoE daughter card. For example, consider a PD that is IEEE 802.3af Class 3, does not support Cisco Discovery Protocol and only requires 10W to operate. By

default the system will allocate 15.4W for this PD to comply with the IEEE 802.3af standard, thereby wasting 5.4W from the power budget. By manually setting the power allocation to the 10W the device actually requires, power resources will be more efficiently utilized. This would prevent the organization from buying more equipment and running more electrical circuits than were necessary.

Power Management: Embedded Event Manager (EEM)

Beginning with Cisco IOS Software Release 12.2(18)SXF5 for the Cisco Catalyst 6500, the Embedded Event Manager (EEM) feature has allowed for the creation of custom scripts to implement commands based on system events. One of the more useful events is the Timer Event, which is essentially similar to a CRON operation in other environments. This timer event allows the engineer to instruct the system to implement a script at a specific time based on the switch's internal clock. This can be very advantageous when it comes to power management, especially in an environment that is not 24x7. Figure 3 shows an example of how EEM has been used to provide a customer with a more energy-efficient infrastructure, resulting in financial savings and a lower environmental effect.

Figure 3. Time-Based PoE Using Embedded Event Manager (EEM)



This example shows just the financial benefit, but we can also calculate the environmental benefit of deploying this intelligent power management capability with EEM. As we saw previously, every 1 kilowatt-hour of electricity averages ~1.25lb of CO2 release. That means that this organization is saving:

Example 2: CO2 Savings from Intelligent Power Management

19.23W[1] / phone * 10,000 phones = 192,300W

192,300W / 1000 = 192.3 kilowatts

192.3 kilowatts * 5000 hours = 961,500 kilowatt-hours

961,500 kilowatt-hours * 1.25 lb CO2 / kilowatt-hour = 1,201,875 lb CO2 SAVED !!

By simply utilizing a script to shut of their phones when not needed, this organization is saving $85,000 and reducing their carbon footprint by over 600 tons. Additional savings could be realized by a minor modification of this script to turn off not only the phones but also the line cards to which the phones are attached. EEM gives an engineer the ability to implement any system command once the required event has been detected by the system.

[1] This number will vary based on power supply and PoE conversion efficiency

Power Management: EnergyWise Phase I

Starting with Cisco IOS Software Release 12.2(33)SXI4, the Cisco Catalyst 6500 Series Switch supports EnergyWise Phase I and Phase II. EnergyWise Phase I delivers the same intelligent power management as we saw in the EEM example, except it can be extended across the entire infrastructure of a facility. EnergyWise is an industrywide initiative being undertaken by Cisco and several other vendors to address the areas shown in Figure 4.

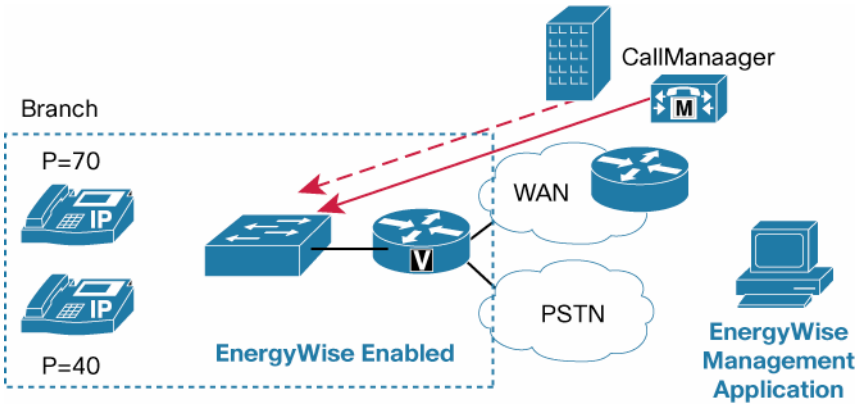
Figure 4. EnergyWise Functions

EnergyWise provides an organization with an in-depth overview of its power consumption and will allow for the consumption to be altered based on policies that can react real-time to changing environmental conditions. EnergyWise policies can be centrally maintained and distributed to all EnergyWise entities (that is, any device that communicate with an EnergyWise Network). Each EnergyWise entity can have a priority assigned so that a policy can be written to affect a subset of EnergyWise Entities instead of all of them.

Consider the EEM example in Figure 3. What if the customer wanted one phone to be on at all times for emergency purposes? That could certainly be accomplished with the EEM script by having a corporate policy to have all emergency phones in a certain port in a chassis (for example, port 48 or slot 1). That way the script could be written to shut down all ports but that one.

What happens, though, if somebody moves that phone to a different port and leaves the emergency port with no phone connected because they are not aware of the corporate policy? The phone will go offline and there will be no emergency services in that location until the problem is remedied. EnergyWise can solve this problem by utilizing separate priorities for EnergyWise entities, no matter where they are in the network. Figure 5 shows how EnergyWise can enable the same Time-Based PoE policy that is possible with EEM.

Figure 5. Time-Based PoE Using EnergyWise

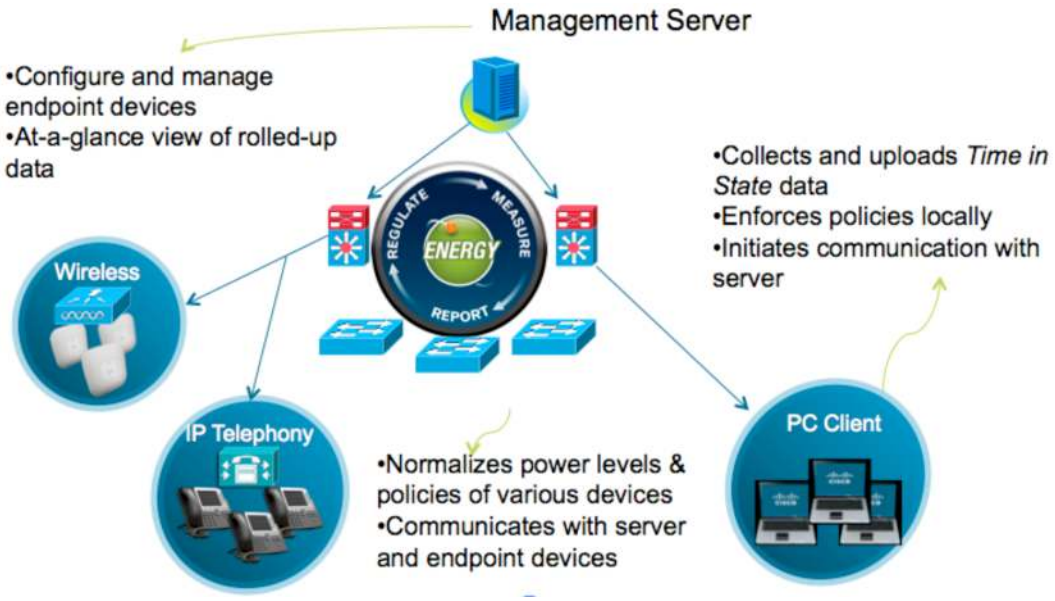


In this example, the EnergyWise Management Application would send out a policy to all of the registered EnergyWise neighbors telling them to shut down all devices with Priority < 50. This means that the phone on the top, which might be the emergency phone, would not be affected since its priority is greater than 50. All other devices whose priorities are less than 50, whether they be phones, access points, or anything else that is EnergyWise aware, will get shut down. If someone were to move the phone with priority 70 to another spot within the network, it would not matter since the priority will not change.

Power Management: EnergyWise Phase II

EnergyWise Phase II extends the ability to monitor devices and enforce policies beyond PoE devices to laptops, desktops, and servers. As part of the EnergyWise Phase II infrastructure, Cisco is partnering with a company called Verdiem, which has created a client that can run under a Windows OS (other OSs to follow). This client, called Surveyor, communicates with an EnergyWise management system to report power information and to enforce policies configured on the management system. Figure 6 shows how the Surveyor client operates within an EnergyWise infrastructure.

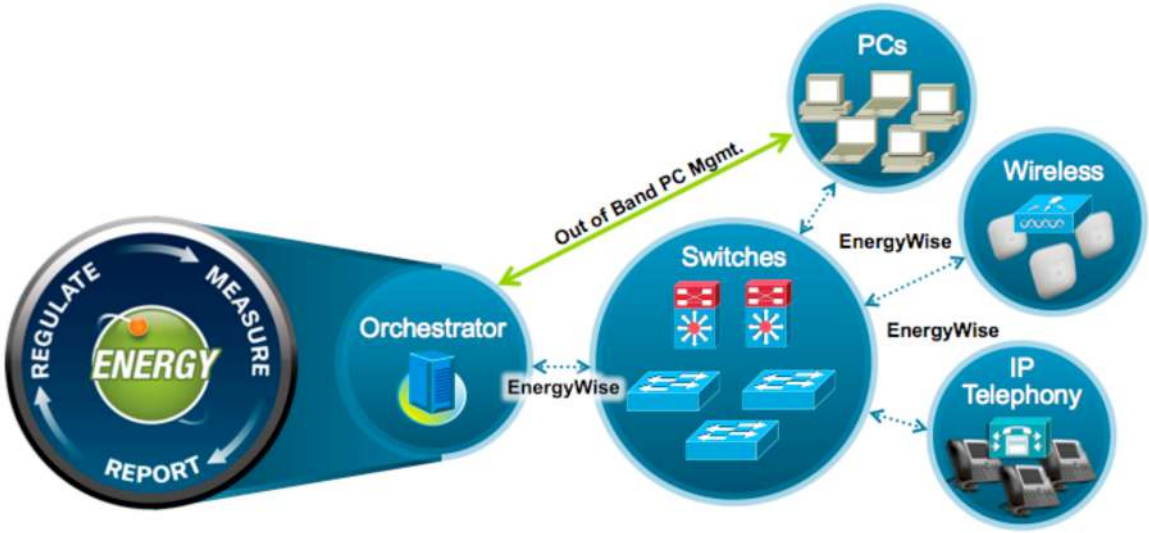
Figure 6. Surveyor Client in EnergyWise Infrastructure



EnergyWise Phase II also introduces the Cisco EnergyWise Orchestrator management infrastructure for EnergyWise deployments. The Cisco EnergyWise Orchestrator provides customizable management-level reports to communicate energy savings and can be used to measure, report and regulate energy consumption of a broad array

of IT devices. The Cisco EnergyWise Orchestrator controls power states of all IT devices using EnergyWise and provides comprehensive power management for PCs using an additional out-of-band protocol. The Cisco EnergyWise Orchestrator can be on a single server or can be scaled up and out by being installing the multiple services on individual physical servers. Figure 7 shows how orchestrator fits into an EnergyWise infrastructure.

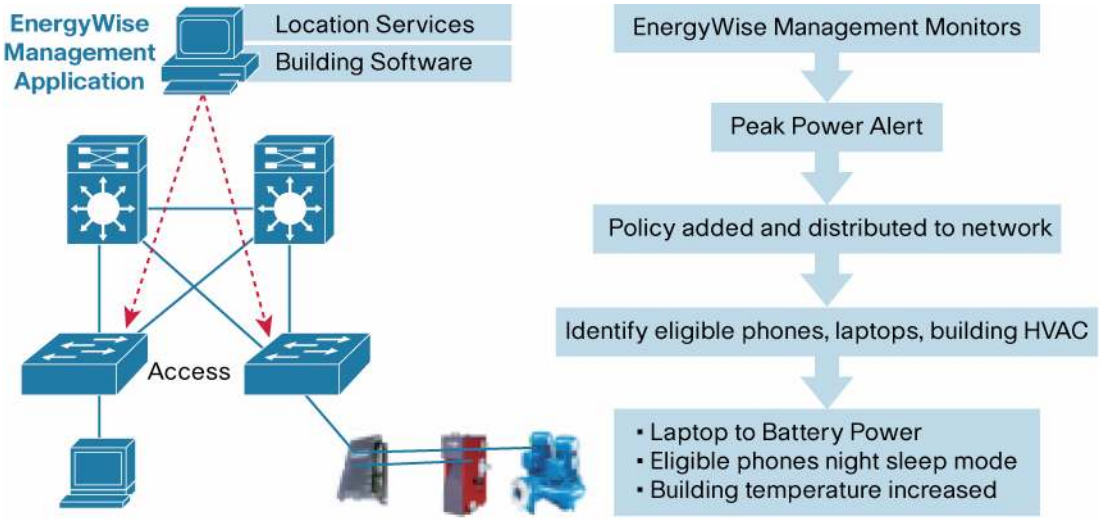
Figure 7. Surveyor Client in EnergyWise Infrastructure



Power Management: EnergyWise Future

The future plans for EnergyWise to interact with multiple different systems attached to the network make it a much more powerful tool than a standalone script. Once the proper applications and APIs are available, EnergyWise will be able to manage not only PoE devices and PCs but also HVAC systems and other building control systems. Consider the example in Figure 8.

Figure 8. Peak Power Monitoring with EnergyWise



In this example, the EnergyWise Management Application is monitoring the entire building's total power draw and comparing that to the available power from the utility. If the power level begins to get to within a predetermined range of the maximum power available, or if the area starts to suffer a temporary drop in power due to a rolling brown-out, then the EnergyWise Management Application can detect this and take action. Based upon predefined response policies, EnergyWise might be able to:

- Notify the HVAC control system to change temperature by a certain amount.
- Notify laptops to begin running on battery until they are drawn down to a certain remaining percentage.
- Send eligible phones into sleep mode, or change operating mode from color to black-and-white.
- Turn off eligible light fixtures.

These capabilities will not be available in the first two phases of EnergyWise implementation, but they are the types of initiatives that Cisco is driving with other vendors across the networking, PC and building control systems industries. The Cisco Catalyst 6500 Series Switch is an integral part of these types of networks, and EnergyWise support is a primary initiative that will allow the platform to maintain its leadership role in the area of green IT.

Infrastructure Consolidation: Virtualization

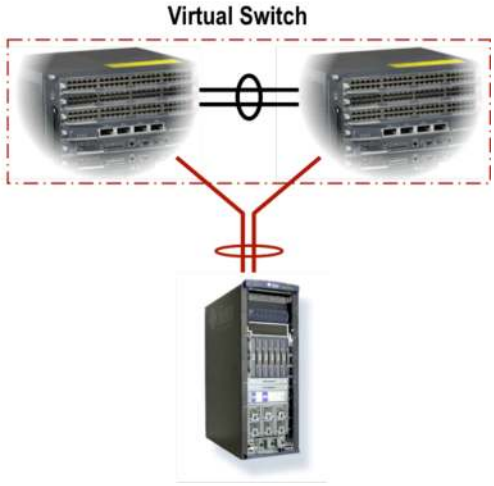
The Cisco Catalyst 6500 Series Switch offers a variety of virtualization technologies that enable organizations to achieve a greener infrastructure. Virtualization might offer the biggest benefit in this area, but most customers still view virtualization as primarily an enabler of separation for security purposes. Part of this reasoning is due to the relative newness of green initiatives, but the flipside of it is also because virtualization has been pretty much taken for granted to date.

When discussions about virtualization are held, most people will talk about MPLS, VRFs, server virtualization or perhaps some new technology on the virtualization horizon. What most people never seem to talk about is a technology that has been around for more than a decade: Virtual Local Area Networks (VLANs). If your organization is using VLANs, then you are using virtualization. While perhaps not as exciting or cutting edge as some of these newer virtualization technologies, from an energy sustainability perspective the VLAN is just as effective as any of these others.

The green benefit of virtualization is realized by allowing an organization to deploy one common infrastructure to meet the diverse needs of its customer base. Whether it is a service provider using virtualization (maybe MPLS) to segment customers, a hospital system using virtualization (maybe VLANs) to meet regulatory requirements for patient data or an enterprise customer using virtualization (maybe VRF-lite) to segment areas of the business, all are deploying one single architecture instead of multiple independent architectures to meet their requirements.

The Cisco Catalyst 6500 supports MPLS, VRF-lite and VLANs. A new virtualization technology called the Virtual Switching System (VSS) was introduced on the Cisco Catalyst 6500 in 2008. This new virtualization technology allows two Cisco Catalyst 6500 switches to be bundled together to appear as one device. As a result, devices connecting to a VSS see a single device to which they can form a Multi-chassis EtherChannel® (MEC) by connecting one uplink to each switch in the VSS. This has some definite advantages from a network management and support perspective (for example, no need to support HSRP/VRRP and no need to rely on STP for loop management), but it also has a positive effect on an organization’s drive to become more energy efficient. This deployment is shown in Figure 9.

Figure 9. Virtual Switching System in the Data Center



As organizations continue to virtualize their server infrastructure with technologies such as those offered by VMware, link utilization will be driven higher and higher as a single server begins to act as multiple servers. If each uplink from the server in Figure 9 is 10/100/1000, then as overall bandwidth driven by the server approaches 1-Gbps, the network administrator will have two choices. One choice is to add another server to the infrastructure, but this would require an entire new server's worth of power, cooling and rack space to be provisioned. The second choice is to simply add an additional pair of uplinks to the server and add those to the existing MEC that is formed with the VSS. While this will also incur additional power and cooling, it will not be nearly as much for a pair of NICs (or a single dual-interface NIC) as it would be for an entire server.

The evolution of 10 Gigabit Ethernet allows organizations to further virtualize their server infrastructure and become more energy sustainable. Without having to worry about the limitations of a 1Gbps link, network engineers can maximize the number of virtual machines on a single server, thereby preventing the need to deploy more physical hardware and incur costs associated with increased power and cooling. While the Cisco Catalyst 6500 Series Switch has supported 10 Gigabit Ethernet fiber interfaces for many years, a new 10GBaseT line card (WS-X6716-10G-3C/3CXL) has been released that well positions the Cisco Catalyst 6500 to catch the transition to 10G LAN-on-Motherboard (LOM) when the industry moves in that direction. This will allow Cisco customers to more easily and cost effectively deploy a virtualized server infrastructure.

Whether an organization is deploying VMware, MPLS, VLANs, VRF-lite or VSS, virtualization technologies provide energy sustainability by allowing for a common architecture to support the organization's needs. The virtualization capabilities of the Cisco Catalyst 6500 Series Switch have continued to evolve with the needs of our customers, and now the additional green benefit of these technologies is being realized.

Infrastructure Consolidation: Virtualized Services

In addition to L2 / L3 virtualization, the Cisco Catalyst 6500 supports services modules offering virtual contexts that allow organizations to deploy L4-7 services in a way that will assist them in meeting their green initiatives. The Firewall Services Module (FWSM), Application Control Engine (ACE) and Virtual Private Networking Services SPA Interface Processor (VPN Services SIP) can each be divided into as many as 250 individual contexts allowing any port in the chassis to become services enabled. This becomes an especially compelling advantage from an energy sustainability perspective since only a single blade needs to be deployed to take the place of potentially 250 individual devices that would all require their own power, cooling and rack space.

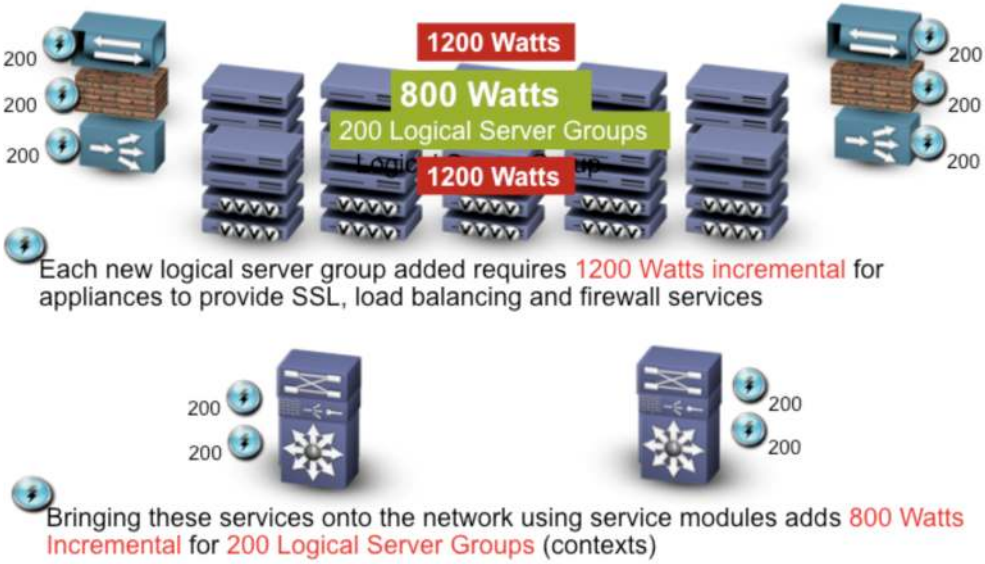
To assist in the deployment of virtualized services, the Cisco Catalyst 6500 business unit has developed two reference architectures: Borderless Services Node (BSN) and Datacenter Services Node (DSN). The Cisco Catalyst

6500 Borderless Services Node (BSN) allows customers to order a Cisco Catalyst 6500 Series system that includes a VSS capable Supervisor Engine VS-S720-10G-3C, two Firewall Services Module (FWSM) and one Wireless Service Module (WiSM) to deliver 8Gbps combined services throughput to service this emerging need and meet customer demand for integrated mobility and security. The BSN solution will demonstrate how primary products and technologies such as FWSM, WiSM, VSS and Identity come together to deliver an integrated services solution.

The DSN is a dedicated Cisco Catalyst 6500 Services Chassis housing 3 Firewall Service Modules (FWSM) and 1 Application Control Engine (ACE), providing up to 15 Gbps of secure load balancing system throughput. The DSN enables cloud services by integrating firewall security and application delivery along with the integration of third party solutions and monitoring.

Figure 10 shows an example of how virtualized services can benefit an organization's effort to become more efficient

Figure 10. Virtualized Services Modules vs Appliances



In Figure 10 we see that for every new logical server group that is added, a pair of load balancers, firewalls and SSL termination devices must be added if the appliance model is being followed. If each of these were to draw 200W, then that means that for every additional logical server group an additional 1200W of power is required. By using virtualized service modules to achieve this same result, a total of 4 modules would be required to achieve the same level of support with a total power requirement of 800W.

An organization might decide that it does not need 200 logical server groups but rather 5. The results are the following:

Appliance Model

5 Logical Server Groups

10 Firewalls @ 200W each = 2000W

10 Load Balancers @ 200W each = 2000W

10 SSL Terminators @ 200W each = 2000W

Total Power Consumption = 6000W (6kw)

6 kw * 24 hours/day * 365 days/year = **52,560 kilowatt hours/year**

1.25 lb CO2 / kilowatt hour * 52,560 kilowatt hours/year = **65,700 lb CO2 / year**

$.12 / kilowatt hour * 52,560 kilowatt hours / year = **$6307.20 / year**

Virtualized Service Model

5 Logical Server Groups

2 Firewalls @ 200W each = 400W

2 Application Control Engines (load balancing + SSL termination) @ 200W each = 400W

Total Power Consumption = 800W (.8kw)

.8kw * 24 hours/day * 365 days/year = **7008 kilowatt hours/year**

1.25 lb CO2 / kilowatt hour * 7008 kilowatt hours/year = **8,760 lb CO2 / year**

$.12 / kilowatt hour * 7008 kilowatt hours / year = **$840.96 / year**

By deploying a virtualized services model, even for a small deployment such as shown in the 5 logical server group example, an organization will realize immediate gains in their efforts to become greener and more profitable. One must also consider the amount of dollars saved by the reduced amount of cooling as well as the lower environmental effect by not requiring the production of 30 devices when just 4 will meet the service requirements. Service virtualization is another difference-making technology that makes the Cisco Catalyst 6500 a smart choice for organizations looking to increase the bottom line and decrease their carbon footprint.

Operational Efficiency

Unlike energy savings which can offer a directly measured green benefit, operational efficiency is a little more difficult to quantify. The Cisco Catalyst 6500 Series Switch has long had a philosophy of sustainable operations as demonstrated by the extensibility and longer lifecycles of the two platforms.

Platform Extensibility

Due to the flexible modular architectures of the Cisco Catalyst 6500, the capabilities of the platform can be extended without the need to undergo a complete network overhaul. The addition of new Supervisors can deliver new services to legacy line cards, eliminating the need to upgrade an entire chassis to take advantage of new features. This means that as industry trends changed from 100-Mbps to 1-Gbps to 10-Gbps, the platform has been able to adapt simply by developing new interface modules to adjust to the evolving needs of the network. The Cisco Catalyst 6500 allows for interface modules of different generations to co-exist in a single chassis, providing organizations with a smoother transition from one architecture to the next. From a financial perspective, this allows IT groups to implement new technologies at a lower cost by supporting a “pay-as-you grow” philosophy of technology migration. From a energy sustainability perspective, this means that the amount of e-waste is significantly reduced. Consider the example below.

Example 3: E-Waste Reduction through Platform Extensibility

2001

Company XYZ purchases a Cisco Catalyst 6500 to act as a Data Center server aggregation device, providing 10/100 connectivity to the servers and multi-Gbps port channels (using the Supervisor 2 GBIC interfaces) for uplink. The list price (based on $US) of such a configuration would have been:

1 x 6509 Chassis @ $9,500 each = $9,500

2 x 2500W Power Supplies @ $3,000 each = $6,000

2 x Supervisor 2 @ $28,000 each = $56,000

6 x 48-port 10/100 @ $18000 each = $108,000

Total = $179,500

2004

Due to increased business and two acquisitions since 2001, Company XYZ needs to upgrade half of their Data Center servers to 10/100/1000 to meet expanded data demands. They also need to provide 10-Gbps uplinks to handle the traffic demands on the network.

2008

Company XYZ has been implementing server virtualization using VMware, causing their link utilization to climb but their physical server count to be cut in half. They currently have a standard L2 infrastructure with spanning tree and HSRP, but need something more robust and easy to manage due to increased video traffic in the network.

In 2004, Company XYZ purchases the following to meet their new demands (list prices in $US, not including potential trade-in credits):

1 x Fan Tray 2 @ $500 each = $500

2 x Supervisor 720-3B @ $28,000 each = $56,000

1 x 4-port 10GE @ $20,000 = $20,000

3 x 48-port 10/100/1000 @ $15,000 each = $45,000

Total = $121,500

Since the Cisco Catalyst 6500 allows different generations of modules to operate in the same chassis, Company XYZ can keep all of their 10/100 line cards in the chassis and still deliver the higher data requirements. In addition, new features of the Supervisor 720 such as IPv6, MPLS, GRE and Enhanced uRPF can be applied to the legacy 10/100 ports without upgrading those modules in any way. If the Cisco Catalyst 6500 did not have this capability, Company XYZ would have had to buy a new chassis, new power supplies and 3 additional line cards to replace their legacy line cards. This would have added over $50,000 to the cost of the project (per switch) and would have increased the e-waste for Company XYZ as they would have had to rid themselves of this redundant equipment instead of carrying it forward. It would have also increased the overall environmental effect of the project as the new chassis, power supplies and line cards would have had to have been manufactured and shipped to Company XYZ.

In 2008, Company XYZ decides that they will upgrade their Cisco Catalyst 6500s to support VSS to make their architecture more robust to meet their evolving video needs. To achieve this they purchase (list prices in $US, not including potential trade-in credits):

1 x Supervisor 720-10G @ $38,000 each = $38,000

Total = $38,000

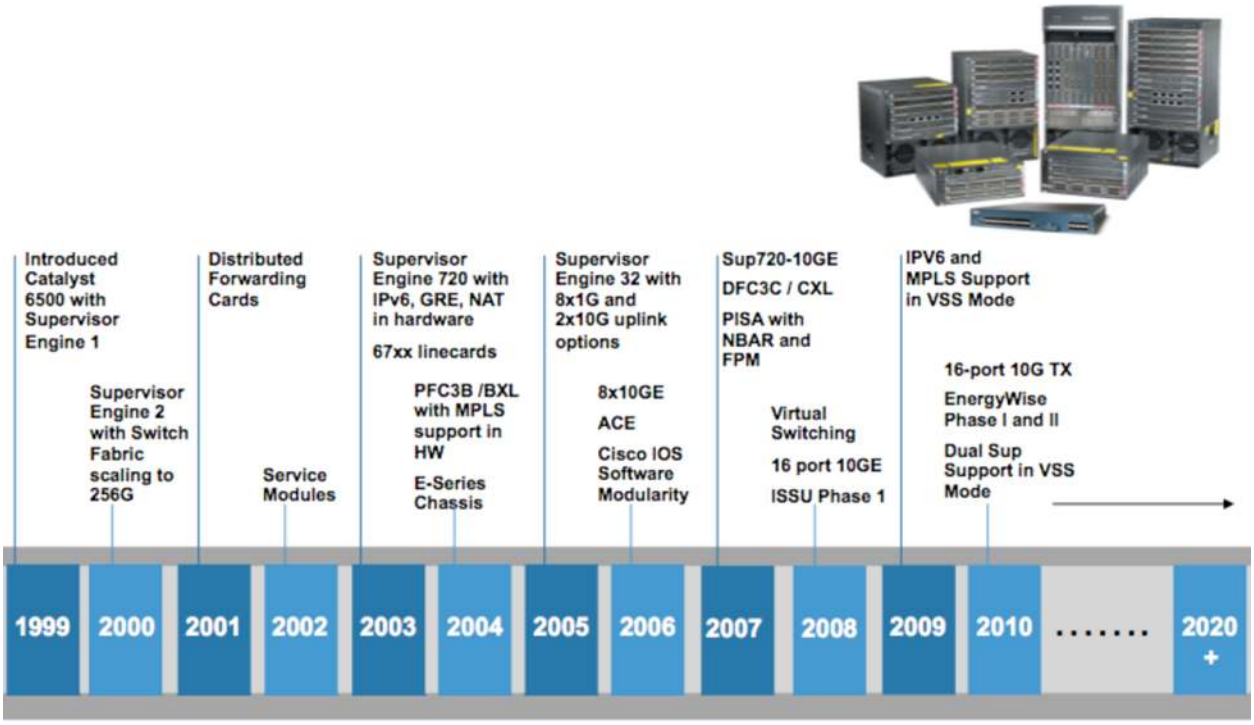
Since Company XYZ's server count has been cut in half due to virtualization, they can trade in their remaining 48-port 10/100 modules. VSS mode supports the following system components of the system as configured before the purchase of the Supervisor 720-10G: the 4-port 10GE and 48-port 10/100/1000 line cards purchased in 2004, the Fan Tray 2 purchased in 2004 and the 6509 chassis purchased in 2001. One of the Supervisor 720-3Bs can be traded in or redeployed since in 2008 VSS mode supported only a single Supervisor in a each chassis of the VSS. The Cisco Catalyst 6500's architecture is saving Company XYZ in excess of $75,000 (per switch) since the existing chassis, line cards and power supplies do not have to be replaced, and the amount of e-waste is drastically reduced for the same reason.

Extended Lifecycles

The Cisco Catalyst 6500 Series Switch is engineered to provide industry-leading investment protection to make sure that the architecture you deploy today can be incrementally changed as the needs of your organization evolve. This allows for a pay-as-you-grow implementation that allows IT groups to more quickly deploy new technology while

reducing costs (see Example 3) and moving toward meeting green initiatives. Figure 11 shows the platform longevity for the Cisco Catalyst 6500 and Cisco Catalyst 4500

Figure 11. Cisco Catalyst 6500 Investment Protection



Innovative Business Practices

The desire to meet energy sustainability initiatives and improve the bottom line will drive organizations to begin changing their business behavior. Remote Collaboration technologies such as Cisco WebEx® conferencing, Cisco TelePresence™ conferencing, and Unified Communications are enabling organizations to make more efficient use of workspaces as well as allowing them to implement work models that reduce travel and make telecommuting more feasible. The Cisco Catalyst 6500 Series Switch is an integral part of the architectures supporting these initiatives due to its robust architecture and QoS portfolio.

Remote Collaboration Technology Support

The Cisco Catalyst 6500 Series Switch is well positioned to support the collaboration technologies that can enable organizations to transition to a greener footprint. Most of these technologies revolve around high-bandwidth, high-priority traffic that must be guaranteed from end-to-end to maintain a high quality interaction. From a raw bandwidth perspective, the Cisco Catalyst 6500 Series Switch meets the needs of these evolving technologies. The Cisco Catalyst 6500 can support up to 720-Gbps per individual system or 1.44-Tbps when utilizing the Virtual Switching System (VSS). This is achieved by providing a dedicated 80-Gbps per slot (bi-directional) with distributed forwarding technology that can drive over 700 Mpps in a VSS.

Raw bandwidth is not the only factor to consider when determining if a platform can adequately support collaboration technologies which demand guaranteed transmission throughout a network. Quality of Service (QoS) capabilities of the infrastructure are just as important. The Cisco Catalyst 6500 Series Switch has hardware-based QoS mechanisms that guarantee high-priority traffic will be transmitted through the network should congestion conditions arise. This is achieved by implementing per-port strict priority queues into which this high-priority collaboration traffic

can be placed. Traffic in these strict priority queues will always be transmitted before traffic in the lower priority queues, guaranteeing full link bandwidth for the high-priority traffic if needed.

The final major consideration for support of high-priority collaboration traffic is the availability of the network. Collaboration traffic is sensitive to delays, requiring a network architecture that can recover quickly from an outage and that can support upgrades with little to no traffic effect. The Cisco Catalyst 6500 supports hardware availability features such as redundant Supervisors, redundant power supplies and online insertion and removal of line cards. It also supports link redundancy using EtherChannel, Equal Cost Multi-Path (ECMP) and Multi-chassis EtherChannel (MEC … for VSS only) that can redirect traffic subsecond in case of a link failure.

For software availability, the Cisco Catalyst 6500 supports Non-Stop Forwarding with Stateful Switchover (NSF/SSO) for subsecond, stateful failover between redundant Supervisors. The Cisco Catalyst 6500 with 12.2(33)SXI and newer code has support for Enhanced Fast Software Upgrades (EFSU) to enable lower impacting software upgrades in dual-Supervisors systems. When using EFSU in a VSS, at least 50 percent of the VSS will be available at all times during the upgrade process.

Green Impact of Remote Collaboration

The Cisco Catalyst 6500 Series Switch has the necessary features and architectural robustness to support collaboration technologies and help achieve an organization's green initiatives. Below is an example of how Cisco is using these technologies to transition to a greener organization.

Cisco has been utilizing new collaboration technologies very aggressively on a switching infrastructure largely based on the Cisco Catalyst 6500 Series Switch. Figures 12 through 14 show the green effect that Cisco has experienced as a result of deploying these technologies and enabling the Cisco Virtual Offices.

Figure 12. Cisco TelePresence Effect Within Cisco

Figure 13. Cisco Unified MeetingPlace and Cisco WebEx Effect Within Cisco

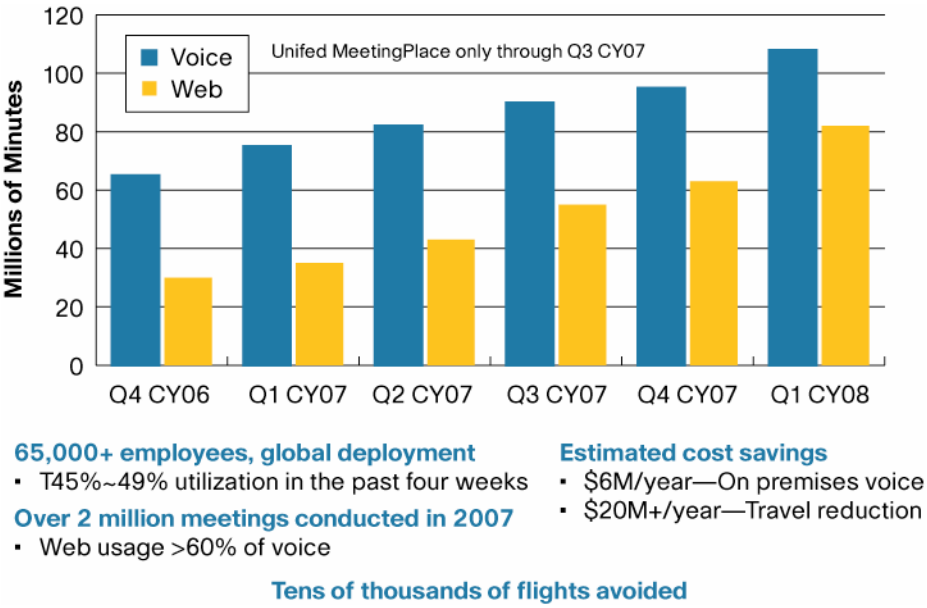
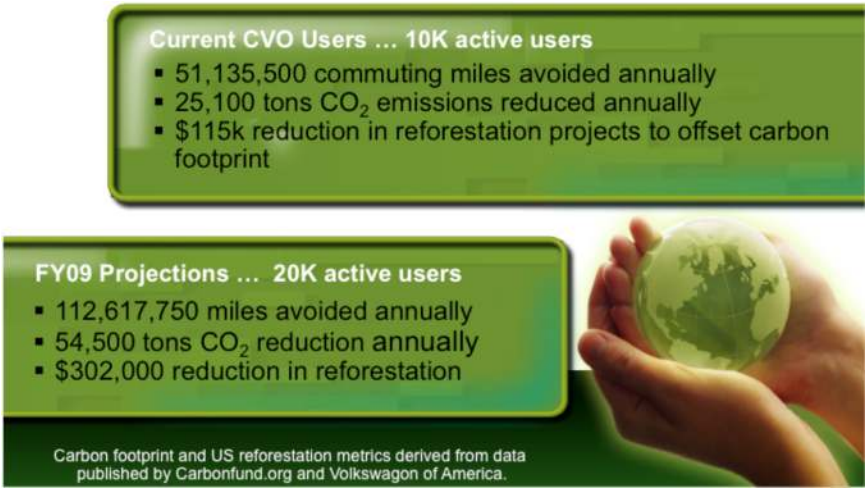


Figure 14. Cisco Virtual Offices at Cisco



The numbers in Figures 12 through 14 indicate that new collaboration technologies can have a dramatic effect on the bottom line and can contribute significantly to meet green initiatives. The Cisco Catalyst 6500 Series Switch has the necessary architecture and features to enable an organization to realize these gains, and new features and architectures are being developed that will allow the platform to continue this support as new technologies emerge.

Conclusion

As we move forward into the 21st century, organizations will face added pressure to become more environmentally friendly as a result of changing public perception about our effect upon our environment. Responding to these changing perceptions, governments around the globe have already begun to enact tougher environmental policies to address national security, environmental and resource supply concerns. To comply with these policies and prevent a bottom-line effect, organizations are looking at ways to transition to data networks with a higher level of energy sustainability.

The Cisco Catalyst 6500 Series Switch offers a number of solutions to enable organizations to make this transition, and Cisco will continue to invest in new energy-efficient technologies as new challenges arise. Increased energy savings through enhanced power management and infrastructure consolidation, operational efficiency using platform extensibility and longer lifecycles and innovative business practices resulting from new collaboration technologies make the Cisco Catalyst 6500 Series Switch a sensible choice for organizations needing to meet the green initiatives of the 21st century.

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