



Gigabit to the Desktop

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Session Number
Presentation_ID

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Agenda

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- **Gigabit to the Desktop**
- **Power over Ethernet**
- **10 Gigabit in the Core**

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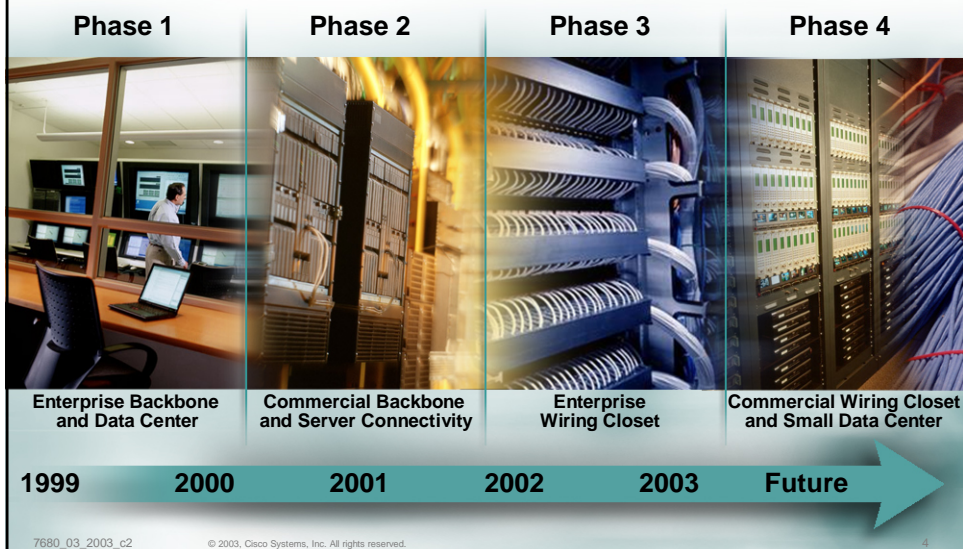
- Gigabit to the Desktop
- Why Gigabit to the Desktop
- Oversubscription, QoS
- TCP performance issues
- Products

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Phases of Gigabit Ethernet Adoption

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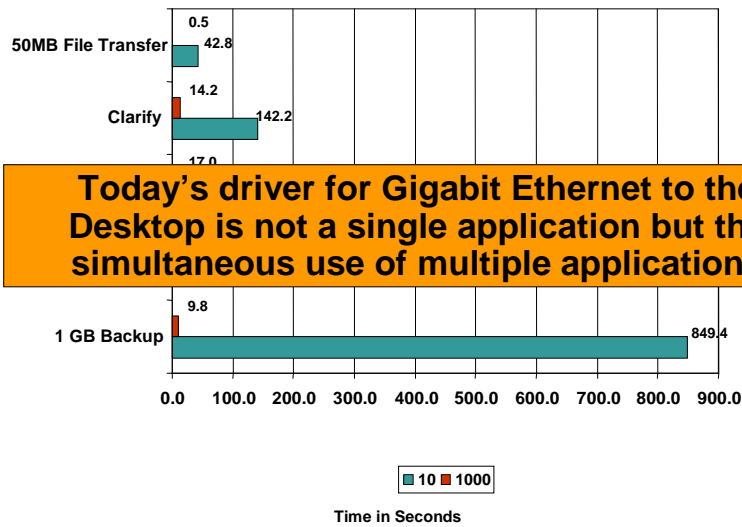
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Network Response Improvements 10mbps v. 1000mbps

Cisco.com



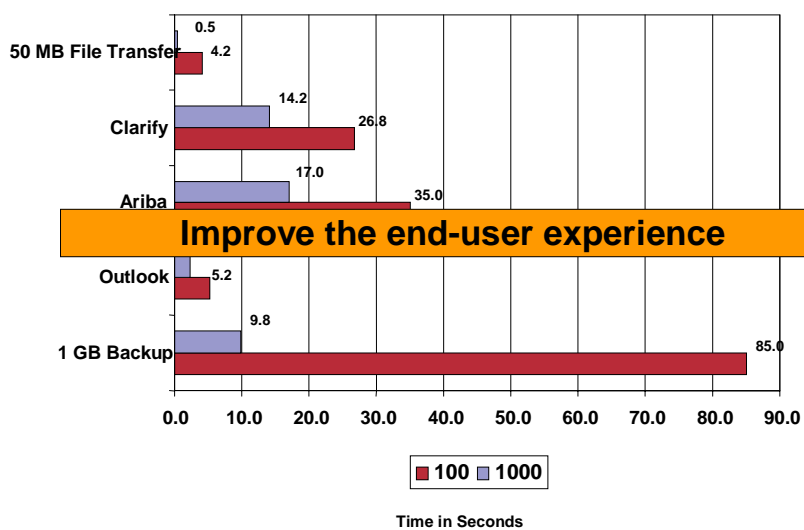
Today's driver for Gigabit Ethernet to the Desktop is not a single application but the simultaneous use of multiple applications

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Network Response Improvements 100mbps v. 1000mbps

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Improve the end-user experience

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Improving Server Efficiency

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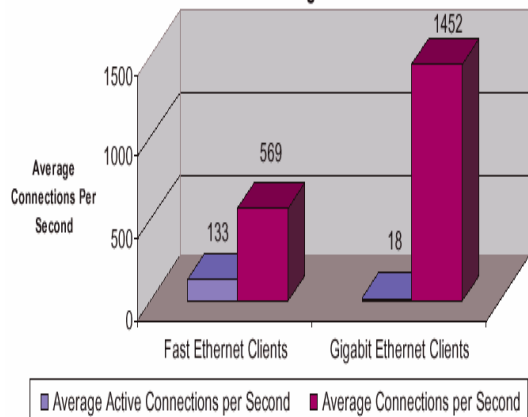
- Matching Client and Server Attach Rates at GbE Speed Significantly Improves Server efficiency.

- This Reduces the costs associated with Adding extra Servers and Infrastructure

- Many Customers are Paying per CPU license fees for Software, improved efficiency can have a significant impact on ROI for GTTD.

VeriTest

WebBench Server Resources Comparison:
Fast Ethernet Clients vs. Gigabit Ethernet Clients

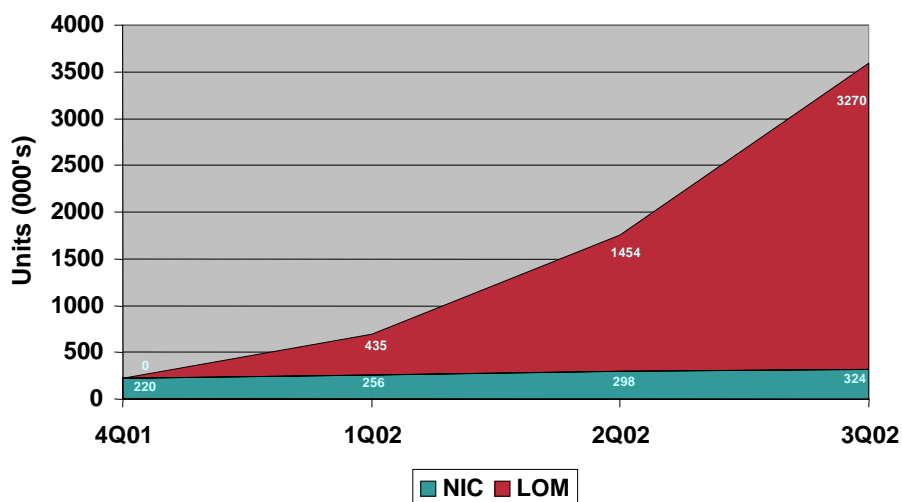


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Gigabit Adapter Sales

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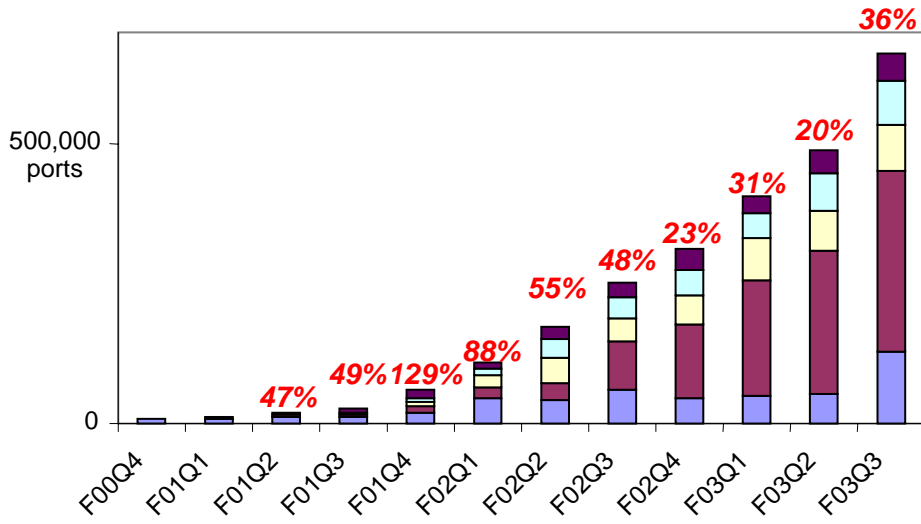
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Growth within Switching:

- Copper GbE ports – All Catalyst Switches

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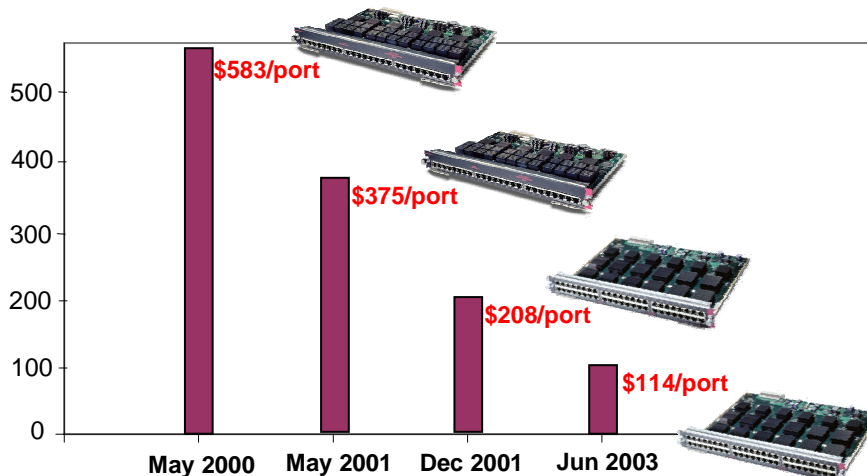


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10/100/1000 \$/port

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WS-X4548-GB-RJ45
\$5,495

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Why Gigabit Ethernet to the Desktop

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- Improve the enduser experience = productivity gains
- Today's driver for Gigabit Ethernet to the Desktop is not a single application but the simultaneous use of **multiple applications**
- Future enhanced **Storage solutions** will leverage higher bandwidths to drive down costs
- Average **PC upgrade cycle is 24 month, Network upgrade cycle typically 3-5 years**
- **Improved Server Efficiency (x 3)** when Desktop and Server match
- Leverage existing copper cabling plant for 10/100/1000
- Use of **inbuild TDR** to manage/Locate Cabling Faults
- Manufacturing cost of 10/100/1000 **dropping to and below** that of 10/100 for both NICs and switch ports
- Gigabit Ethernet NICs as low as \$50, Switchport as low as \$114*
- 10 Gigabit in the core is available for adequate pricing

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- **Gigabit to the Desktop**
 - Why Gigabit to the Desktop # A Game
 - **Oversubscription, QoS**
 - TCP performance issues
 - **Products**

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Over Subscription

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- 1:1 v. 4:1 v. 8:1 designs
- True traffic patterns are random and bursty in nature
- Large data transfers happen much faster minimizing traffic overlap and congestion – eg. 9 seconds vs 85 seconds for 1 GB
- Most mission-critical business applications and most Web transactions use TCP
- TCP is adaptive, rate based, and connection-oriented; it is a well behaved protocol especially when oversubscribed.
- TCP applications run as fast as they can, but back down when faced with congestion.

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Over Subscription

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- Multimedia and IP Telephony traffic use the UDP/RTP protocol
- UDP applications don't have feedback mechanisms so when faced with congestion, these protocols don't back off – frames are just dropped, degrading the quality of what is received.
- QoS is designed to deal with the problems caused by network oversubscription
- To further tame TCP for the benefit of UDP/RTP, WRED can be used

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How we tested

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- Look at day to day functions – compute profile reflects 2.6 GB of data transferred from single user
- Multiple applications running simultaneously
- Transactional and streaming applications within the compute profile
- Same hosts and same scripts used in tests

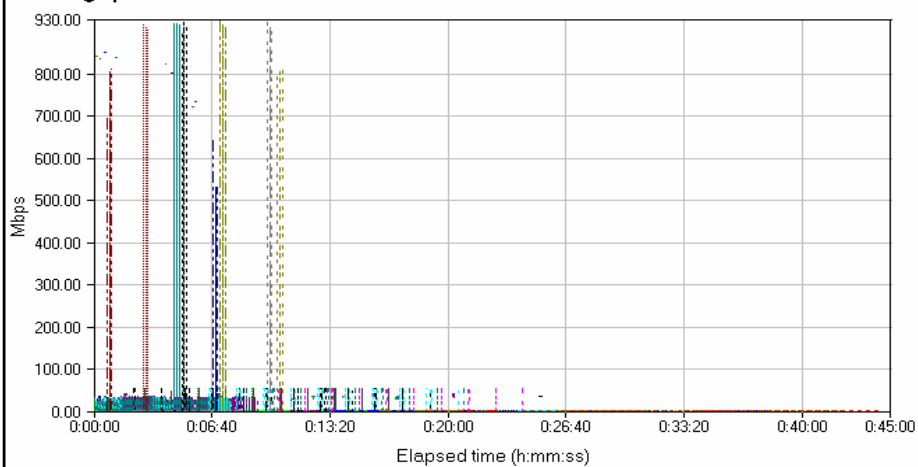
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8:1 Test Results

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Throughput



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- **Gigabit to the Desktop**

- Why Gigabit to the Desktop # A Game

- Oversubscription, QoS

- **TCP performance issues**

- **Products**

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What is the TCP Window size ?

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- Technically, the TCP window size is the maximum amount of data that can be in the network at any time for a single connection. (It is the upper limit of the TCP congestion window.)

- Most OSes and hosts have **upper limits on the TCP window size** (RFC793). These may be as low as 64 KB, or as high as several MB. To enable TCP window sizes larger than 64 KB, TCP large window extensions (RFC 1323) must be enabled

- Enabling High Performance Data Transfers on Hosts

http://www.psc.edu/networking/perf_tune.html

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TCP Window Size and Throughput

Cisco.com

- In our tests we initially ran a 32k windows size, then increased it to 64K, 128K, 256K, 300K and finally 1M. The performance we saw is as follows:

32K	720mbps average
64K	886mbps average
128K	903mbps average
300K	936mbps average
1M	941mbps average

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Calculating Optimal Window Size

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- Network characteristics – bandwidth delay product
- Protocol characteristics - maximum segment size (MSS)
- You compute the optimal TCP window size using the following formula:

$$\text{window size in bytes} = (\text{bandwidth} * \text{RTT})/8$$

- Keep the window size as a mutiple of MSS
e.g. If 375K window is needed, set the window size to 376680 or $258 * 1460$ (MSS)
- Set you receive buffer at least $2 * \text{MSS}$ larger than window size

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- **Gigabit to the Desktop**
 - Why Gigabit to the Desktop # A Game
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Gigabit in the Cisco Catalyst Series line of Switches

Cisco Catalyst Series	1 GE Uplinks	10/100/1000 Ports	10 GE Ports	1GE fiber (GBIC & SFP)
2950	2 ✓	2/module ✓	✗	2/module (GBIC) ✓
3550	2 ✓	10/module 50/stack ✓	✗	10/module (GBIC) 50/stack ✓
3750	4 ✓	24/module 216/stack ✓	1/module ✓	4 SFP uplinks ✓
4500	2/sup ✓	48/blade *384/chasis ✓	✗	48/blade (SFP) 18/blade (GBIC) *384/chasis ✓
6500	2/sup ✓	48/blade 576/chasis ✓	4/blade (Xenpak) 32/chasis ✓	48/blade (SFP) 16/blade (GBIC) 384/chasis ✓

Catalyst 2948G-GE-TX

Cisco.com

- **48 10/100/1000 ports and 4 SFPs in one RU**
 - **L2 features functionality**
 - 2K VLAN/ 4K VLAN ID
 - 16K MAC addresses
 - LACP, 802.1s/.1w, Private VLAN
 - SSH, SNMP V3, 802.1x
 - **Cat OS 8.2(1) GLX**
 - **Supports for redundant power supply (RPS 675)**
 - **Availability: November**
- WS-C2948G-GE-TX**



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Catalyst 2970

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Product Number	Product Description
WS-C2970G-24TS-E	<ul style="list-style-type: none"> • 24 10/100/1000 ports and 4 SFP-based Gigabit Ethernet ports • Wire-speed gigabit switch • 1.5 rack unit (RU) standalone multilayer switch • Enhanced Image (EI) IOS® software installed delivers intelligent L2+ services
WS-C2970G-24T-E	<ul style="list-style-type: none"> • 24 10/100/1000 ports • Wire-speed gigabit switch • 1 rack unit (RU) standalone multilayer switch • Enhanced Image (EI) IOS® software installed delivers intelligent L2+ services

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Cisco Catalyst 3750 Series

Cisco.com

Catalyst 3750G-24T



- 24 10/100/1000 Ports

Catalyst 3750G-24TS



- 24 10/100/1000 Ports
- 4 SFP ports

Catalyst 3750G-12S



- 12 SFP Ports

Catalyst 3750-24



- 24 10/100 Ports
- 2 SFP ports

Catalyst 3750-48



- 48 10/100 Ports
- 4 SFP ports

Two Software Versions

Standard Multilayer Software Image (SMI)

- Enterprise-class intelligent services: Advanced QoS, Enhanced Security, High Availability, RIP and Static IP routing, Routed ACLs, HSRP

Enhanced Multilayer Software Image (EMI)

- SMI feature set plus: Dynamic IP Unicast routing, Smart Multicast routing,

Catalyst 3750-24/48 are orderable with either software image preinstalled

Catalyst 3750-24/48 can be upgraded from SMI to EMI

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Catalyst 4500

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Catalyst 4500 Enhanced 48-Port 10/100/1000 Base-T (RJ-45)



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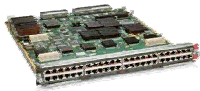
Catalyst 6500



Cisco.com

WS-X6148-GE-TX

- Designed for the Desktop
- 32Gb/s Shared Bus Interconnect
- Upgradeable to Cisco Inline Power or 802.3af Power via a daughter card
- Integrated TDR for Superior Infrastructure Management
- 8:1 oversubscription



WS-X6548-GE-TX

- Designed for the Desktop
- 8Gb/s Switch Fabric Connect
- 32Gb/s Shared Bus Interconnect
- Upgradeable to Cisco Inline Power or 802.3af Power via a daughter card
- Integrated TDR for Superior Infrastructure Management
- 8:1 oversubscription



WS-X6748-GE-TX

- Designed for the Datacenter
- 40Gb/s Switch Fabric Interconnect
- Upgradeable with DFC3 for dCEF Switching
- Integrated TDR for Superior Infrastructure Management



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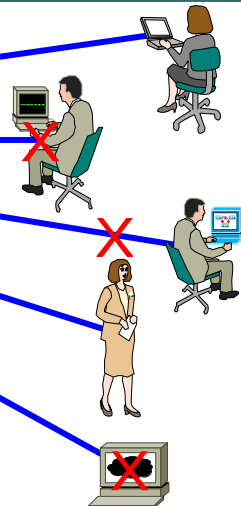
Integrated Time Domain Reflectometer Simplifies Network Management and Operational Control

Cisco.com



Catalyst 6500 Integrated TDR Shows:

- Cable Unplugged from Catalyst 6500
- Cable Unplugged from End Station
- Cable Unplugged from Patch Panel
- Cable Broken at 55 Meters from Catalyst 6500
- Server Down



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Supported with the new 48 port 10/100/1000 modules using any supervisor

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- Gigabit to the Desktop
- Power over Ethernet
- 10 Gigabit in the Core

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- Power over Ethernet
 - Why Power over Ethernet
- IEEE 802.3af explained
- Products

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Why Power over Ethernet

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- **Simplicity** – A single connection provides network and power to end devices enabling simplified, low voltage installation
- **AC-Free Deployments** – No AC power required to support end devices such as IP telephones, wireless access points and Video cameras
- **Mobility** – Low voltage, Ethernet Powered Devices can be easily moved without need for AC power wiring power, reducing cost and minimizing business disruption
- **Safety** – 48V DC low voltage integrated into the Ethernet connection reduce user exposure to local AV power circuits
- **Operational Resiliency** – Centralized power solution simplifies power distribution and allows for a centralized UPS deployment
- **Simplified Manageability** – LAN system Integrated provides for unified management of Ethernet connection and device power
- **Remote Management** – PD devices can be controlled centrally, power can be shut down or reset remotely

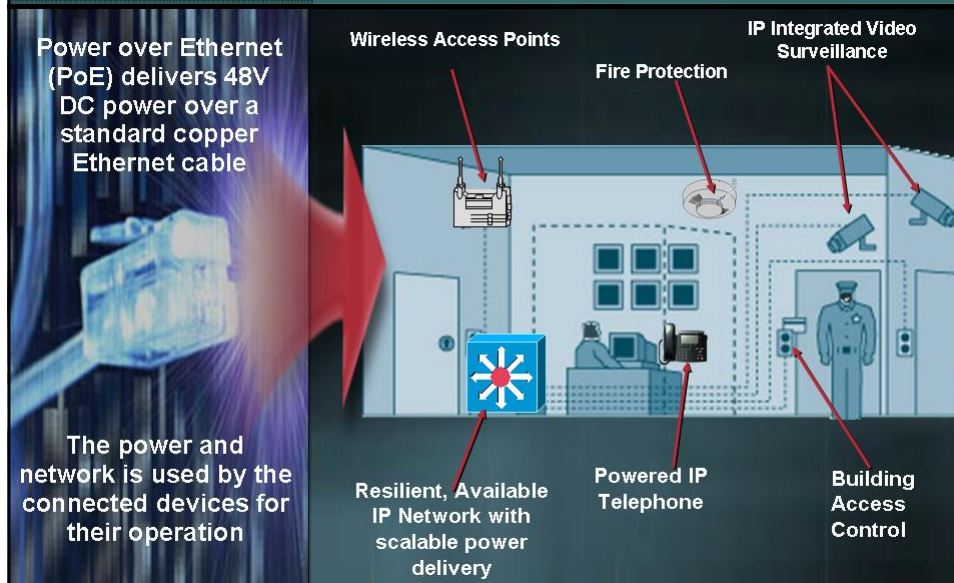
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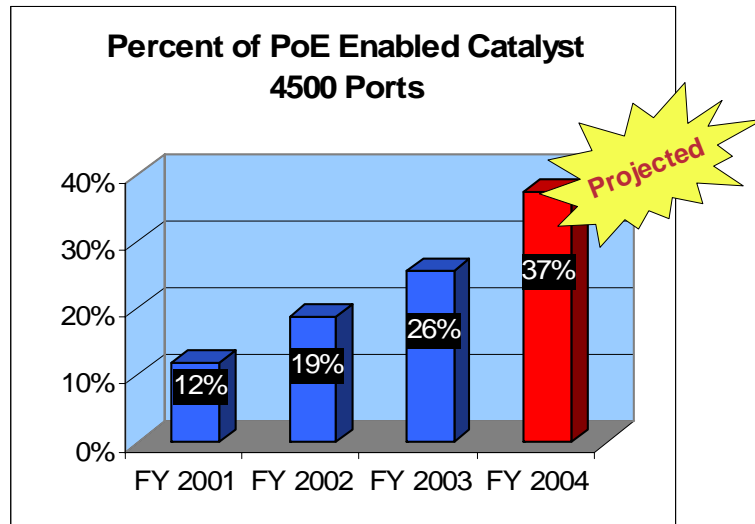
The Ethernet Connected and Powered Organization

Cisco.com



Cat4500 Power over Ethernet (PoE) Booking Trends

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- Power over Ethernet
- Why Power over Ethernet
- IEEE 802.3af explained
- Products

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Cisco Pre Standard & IEEE 802.3af Comparison

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- Differential Mode "Tone" Discovery
Fast Link Pulse on TX – back to RX
- Then PWR on...
- Classification AFTER using CDP
- Up to 6.3 Watts
- Pwr Off on Link down

- Common Mode "Resistor" Discovery :
Apply Voltage to measure ohm signature
- Optional Classification using measured current method (4-, 7-, 15.4- Watts)
- Power on...
- Up to 15.4 Watts
- Pwr Off on Disconnect (DC/AC)
DC : current <5 mAmps
AC: impedance > 1980 Kohms

16M Ports Shipped

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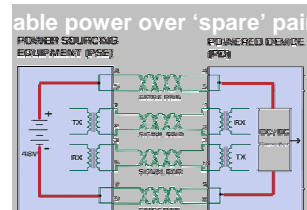
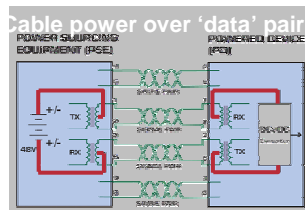
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Power over Ethernet delivery



Cisco.com

- Switch-based PSEs **Power Sourcing Equipment** can use the spare pairs for 10/100 or signal pairs for 10/100 or 10/100/1000
- Mid-span PSEs (patch panels) only support spare pairs for 10/100
- PD must support power over both pair sets – either-or, but not simultaneously



Note: GbE Connections will use power over Data pairs in all cases since there are no spare pairs available.

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Power classification

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- Maximum power is 15.4W per PSE port (12.95W at the PD due to power efficiency issues)
- System does not need to support maximum power per port on all ports simultaneously
- Power classification is optional for PSE and PD (Cisco will implement this feature)

Class Number	Max Power at output of PSE per port
0 (Default)	15.4 watts reserved (actual device requirement can be much less)
1	4 watts
2	7 watts
3	15.4 watts
4	Future Expansion

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New Product Announcements

- **Power over Ethernet**
 - Why Power over Ethernet
 - IEEE 802.3af explained
- **Products**

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Complete Family of 802.3af Power Over Ethernet Solutions

Cisco.com

Cisco's New Power over Ethernet Line-up Delivering Support Across the Portfolio



Catalyst 6500 Series

48-port 10/100 (RJ45 / RJ21)
96-port 10/100
48-port 10/100/1000

AC or DC Source Power



Catalyst 4500 Series

48-port 10/100 (RJ45 / RJ21)
48-port 10/100/1000

AC or DC Source Power



Catalyst 3750 Series

24-port 10/100
48-port 10/100



Catalyst 3560

24-port 10/100
48-port 10/100

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Catalyst 6500 Series 802.3af Power over Ethernet Support

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48 port 10/100/1000
Value Wiring Closet
Classic Series

WS-X6148-GE-45AF



48 port 10/100/1000
Premier Wiring Closet
CEF256 Series

WS-X6548-GE-45AF



96 port 10/100
Classic Series

WS-X6148X2-RJ-45
WS-X6148X2-45AF



48 port 10/100
Value Wiring Closet
Classic Series

WS-X6148-45AF
WS-X6148-21AF



802.3af PoE
Daughter Cards

WS-F6K-GE48-AF
WS-F6K-FE48X2-AF

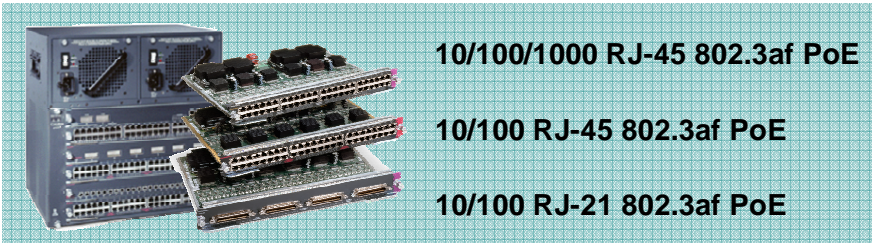


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Catalyst 4500 Series 802.3af Power over Ethernet Support

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10/100/1000 RJ-45 802.3af PoE

10/100 RJ-45 802.3af PoE

10/100 RJ-21 802.3af PoE



Part Number	Description
WS-X4548-GB-RJ45V	Catalyst 4500 PoE 802.3af 10/100/1000, 48-ports(RJ45)
WS-X4248-RJ45V	Catalyst 4500 PoE 802.3af 10/100, 48-ports(RJ45)
WS-X4248-RJ21V	Catalyst 4500 PoE 802.3af 10/100, 48-ports(RJ21)

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Cisco Catalyst 3750 Series 802.3af Power over Ethernet Support

Cisco.com

Catalyst 3750-24PS	Catalyst 3750-48PS
 <ul style="list-style-type: none"> • 24 10/100 PoE ports • 2 SFP ports • 802.3af PoE Support 	 <ul style="list-style-type: none"> • 48 10/100 PoE ports • 4 SFP ports • 802.3af PoE Support



Part Number	Description
WS-C3750-24PS-S	Catalyst 3750 24 10/100 + 2 SFP 802.3af Standard Multilayer Image
WS-C3750-24PS-E	Catalyst 3750 24 10/100 + 2 SFP 802.3af Enhanced Multilayer Image
WS-C3750-48PS-S	Catalyst 3750 48 10/100 + 4 SFP 802.3af Standard Multilayer Image
WS-C3750-48PS-E	Catalyst 3750 48 10/100 + 4 SFP 802.3af Enhanced Multilayer Image

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Cisco Catalyst 3560 Series 802.3af Power over Ethernet Support

Cisco.com

Catalyst 3560-24PS	Catalyst 3560-48PS
 <ul style="list-style-type: none"> • 24 10/100 PoE ports • 2 SFP ports • 802.3af PoE Support 	 <ul style="list-style-type: none"> • 48 10/100 PoE ports • 4 SFP ports • 802.3af PoE Support

Part Number	Description
WS-C3560-24PS-S	Catalyst 3560 24 10/100 PoE + 2 SFP Standard Multilayer Image
WS-C3560-24PS-E	Catalyst 3560 24 10/100 PoE + 2 SFP Enhanced Multilayer Image
WS-C3560-48PS-S	Catalyst 3560 48 10/100 PoE + 4 SFP Standard Multilayer Image
WS-C3560-48PS-E	Catalyst 3560 48 10/100 PoE + 4 SFP Enhanced Multilayer Image

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Cisco On-Line PoE Power Calculator

Cisco.com

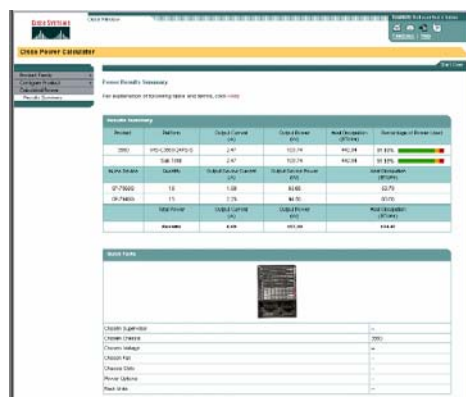
Simplifying PoE configuration and deployment

- New on-line power calculator for all Cisco Catalyst PoE products
- Configuration-driven power requirements for all Cisco PoE products

Identify PD power requirements

Modules deployed

Power supplies required and UPS support requirements



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- Gigabit to the Desktop
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- **10 Gigabit in the Core**

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- **10 Gigabit in the Core**
- Performance Tests
- Products

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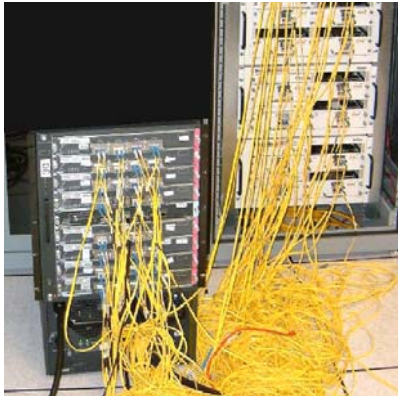
Third Party Performance Verification EANTC Tests



Cisco.com

In July 2003, Cisco Systems commissioned the European Advanced Networking Test Center (EANTC) to verify Catalyst 6500 performance numbers

- European Advanced Networking Test Center—spin-off from Technical University of Berlin
- <http://www.eantc.com>



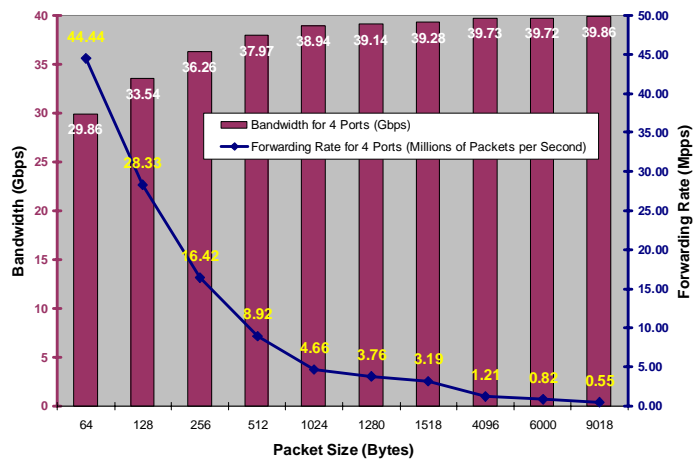
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6704/6748 Performance IOS w/DFC3— 4 x 10G Ports Across Fabric

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Third Party Performance Verification— Network World Tests

Cisco.com

Cisco's Catalyst 6500 raises the stakes

- Four test categories:
 - 10 Gigabit throughput, jitter, and delay
 - 10 Gigabit backbone throughput, jitter, and delay
 - 10 Gigabit failover (ECMP and EtherChannel)
 - 10 Gigabit QoS marking with 1.2 : 1 oversubscription



Network World, 10/20/03

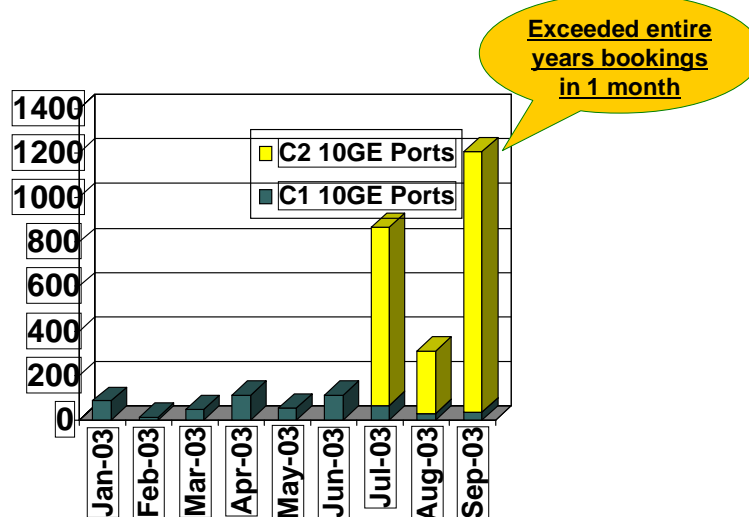
<http://www.nwfusion.com/reviews/2003/1020cisco10gbe.html>

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10 Gigabit port sales

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- **10 Gigabit in the Core**

- **Performance Tests**

- **Products**

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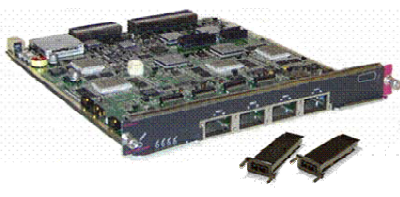
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High Performance 4 port 10GbE Changes 10GbE Economics, Industry Leading Density

NEW!

Cisco.com

4port 10Gb Ethernet aCEF720 Series



Market Leadership – 32 x 10GbE ports/Chassis, Compelling \$ per port broadens deployment

Application – Gigabit Etherchannel Upgrade, Core to Distribution and Datacenter Interconnections

Performance – 40 Gbps/slot for Enterprise Applications

Investment Protection – Industry Standard Modular Optics

Intelligent Services

- Enterprise class 10ms Buffers for Campus Deployments
- 8 Queues, Multiple Thresholds

Evolutionary Infrastructure

- Supported in any Catalyst 6500 with Sup720
- Interoperable with all modules

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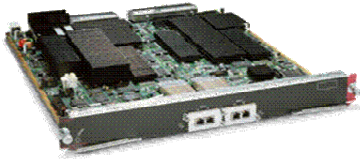
High Performance 2 port 10GbE

Non-Blocking, Deep Buffers – Ideal for Long Haul 10GbE Transport

NEW!

Cisco.com

2 port 10Gb Ethernet dCEF720 Series



Services – Wire-Rate Locally Forwarded IPv6, MPLS, and more

Performance – Non-Blocking 40Gb/s per Slot

Application – Aggregation, SONET Replacement

Investment Protection – Flexible Modular Optics

Intelligent Services

- Deep 150ms buffers / interface for DWDM interconnection and more
- 16 Queues, Multiple Thresholds

Evolutionary Infrastructure

- Increases 10GbE Port Density
- Supported in any Catalyst 6500 with Sup720
- Interoperable with all modules

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Different optics

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10GBASE-LR serial 1310nm Long Haul XENPAK (SMF)

- Provides up to 10 km

10GBASE-ER Serial 1550 nm Extended Reach XENPAK (SMF)

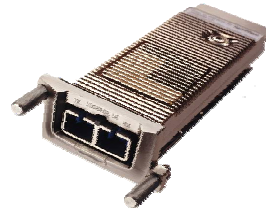
- Provides up to 40 km

10GBASE-LX4 serial 1310nm Multi-Mode XENPAK (MMF)

- Station to Station distances of at least 300m over MMF

10GBASE-SR Serial 850 nm Multimode XENPAK (MMF)

- Station to Station distances of 26m over 62.5um 160MHz*km FDDI grade multi-mode fiber, 300m over 50um 2000MHz*km multi-mode fiber



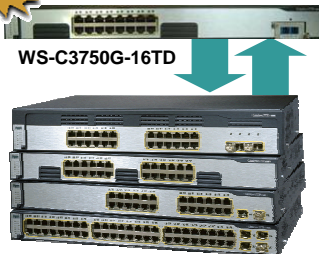
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Catalyst 3750G-16TD 10/100/1000 with 10GbE Stackable

Cisco.com

- 16-port 10/100/1000 with one 10GbE uplink
- Uses existing fiber plant for XENPAK 10GbE interfaces
 - 10GBase-SR, 10GBase-LR, 10GBase-ER, 10GBase-CX4 & 10GBase-LX4
- Integrated Cisco StackWise™ technology for 32Gbps stacking
- Cross-stack Etherchannel of up to two 10GbE uplinks for redundancy and increased throughput
- 1.25:1 over subscribed 10GbE interface
- Same functionality and software options as Catalyst 3750 Series
- Targeted for Enterprise wiring closet and cluster GRID environments



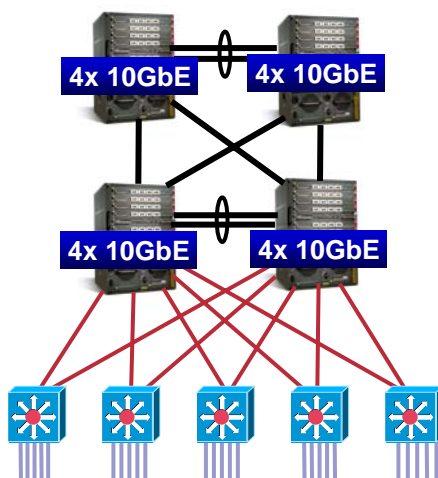
Module Type	Distance
ER SMF	40km
LR SMF	10km
SR MMF	65m
LX4 MMF	300m
CX4 Cu IB	15m

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10GbE from the Distribution to Core

Cisco.com



Driving 10GbE density to 4-ports optimizes each distribution chassis with 1 10GbE uplink slot.

Core can aggregate up to 15 Distribution tiers

10GbE EtherChannel supports link-level resiliency

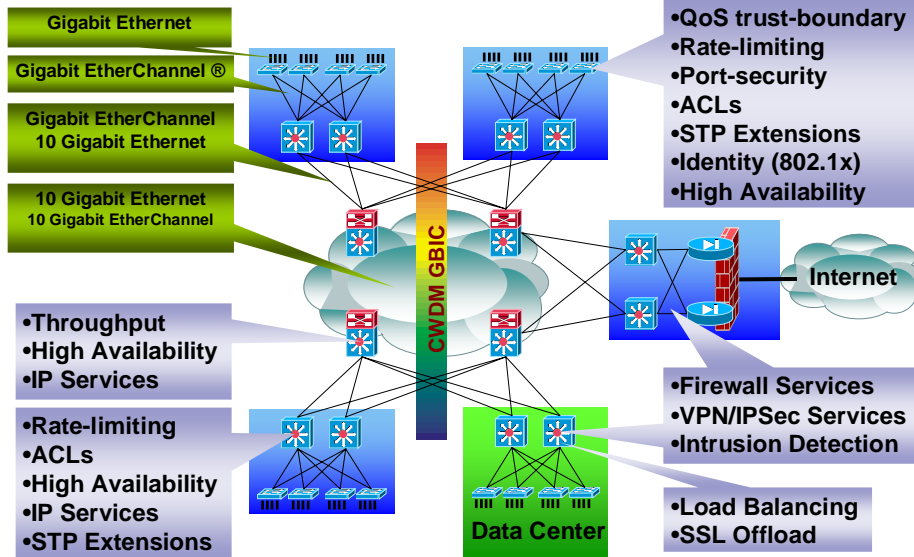
Two redundant core switches can hierarchically support over 300,000 10/100/1000 Ethernet user ports

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Gigabit Intelligent Campus Network Design

Cisco.com



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Summary Q&A

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- Gigabit to the Desktop
- Power over Ethernet
- 10 Gigabit in the Core

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