LISA '12: The Evolution of Ethernet



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Regarding the Views Expressed

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- Per IEEE-SA Standards Board Operations Manual, January 2005:

  "At lectures, symposia, seminars, or educational courses, an individual presenting information on IEEE standards shall make it clear that his or her views should be considered the personal views of that individual rather than the formal position, explanation, or interpretation of the IEEE."

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AGENDA

- Introduction
- Building Your Network
- The Growth of Ethernet
- Ethernet and the Data Center
- The Road to Success
- Wrap-up
- Q&A

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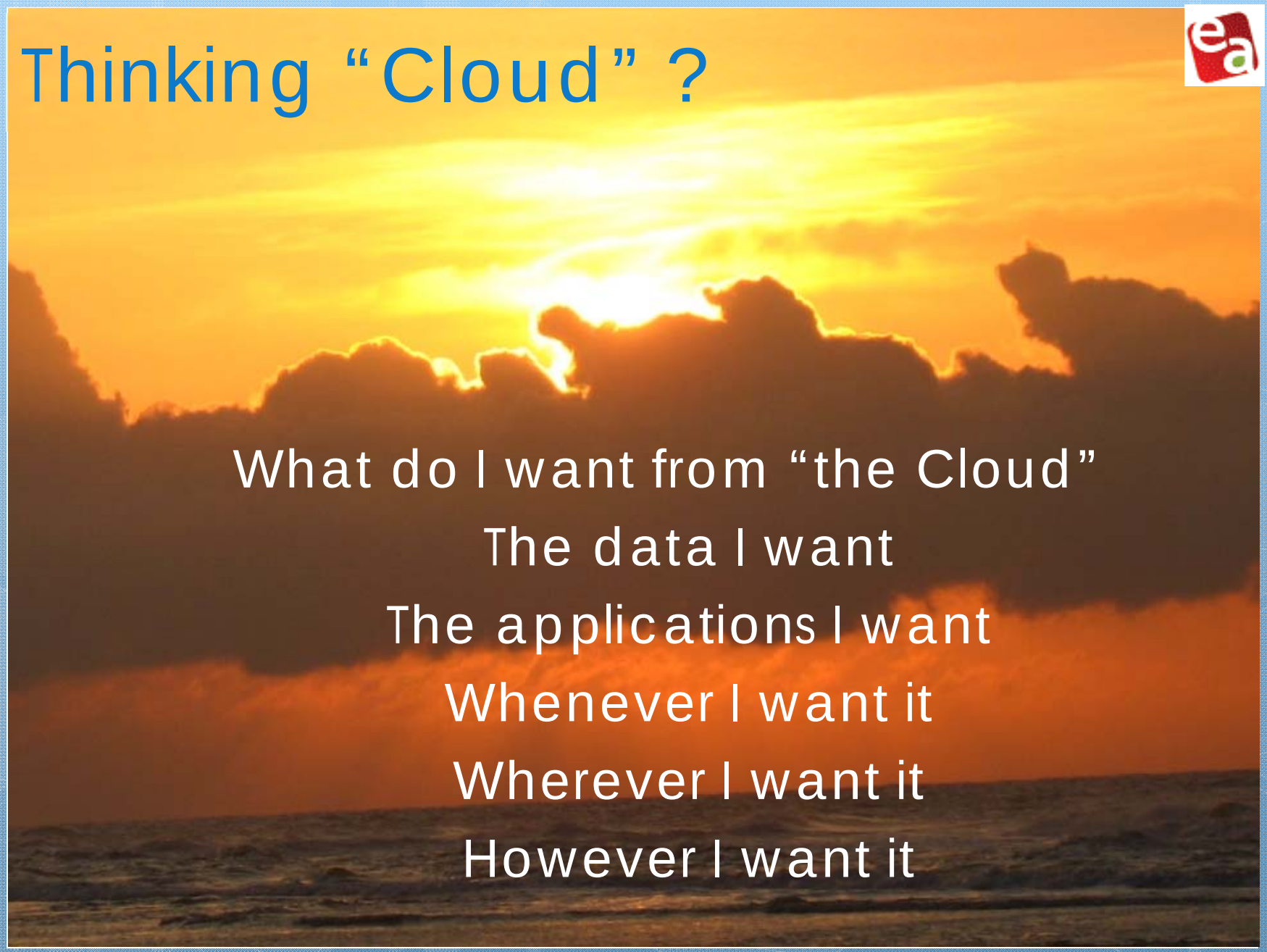
How do we tell the story??

- Speed ?
- Media ?
- Deployment ?
- Function ?
- Application ?
- What's Next ?



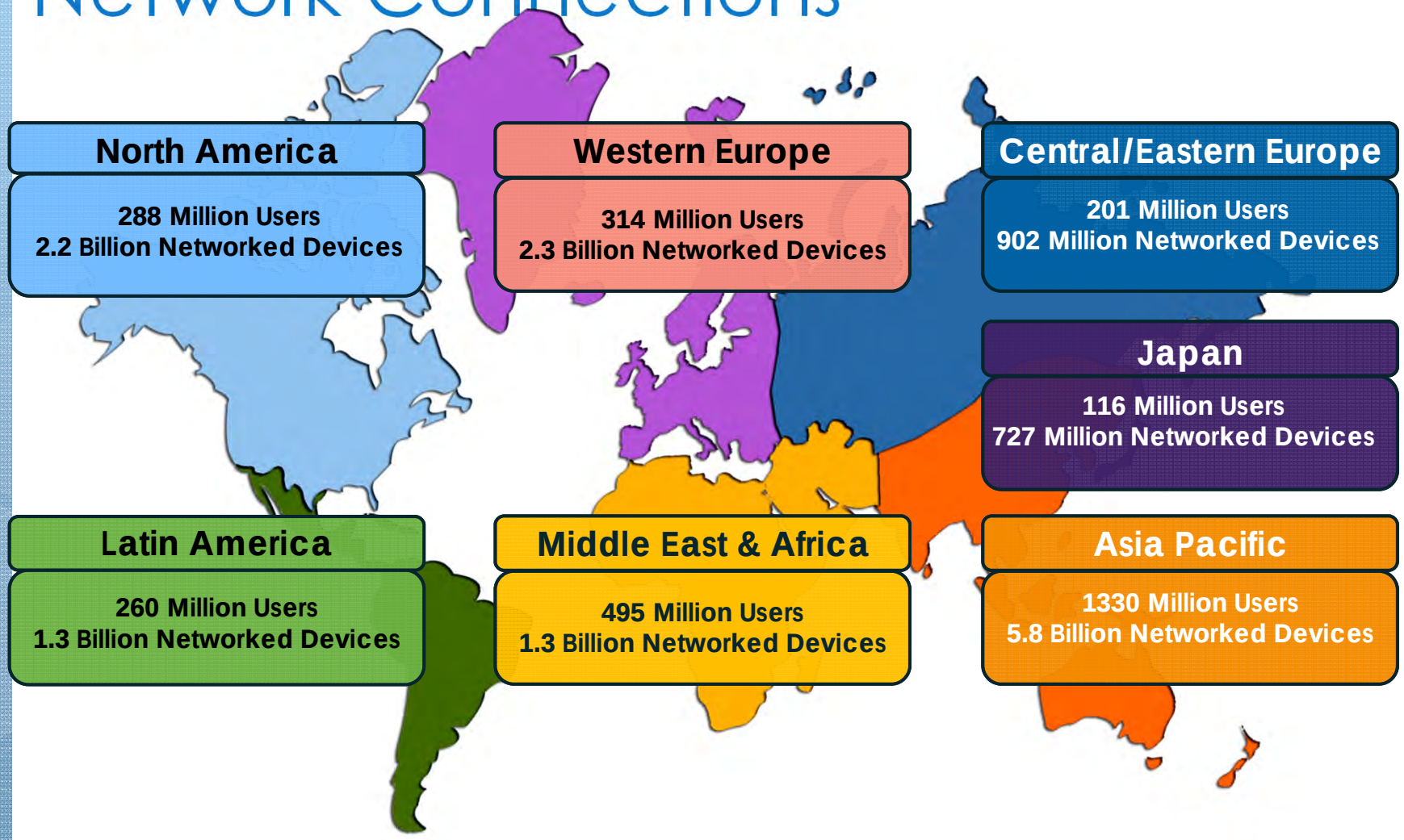
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Thinking "Cloud" ?



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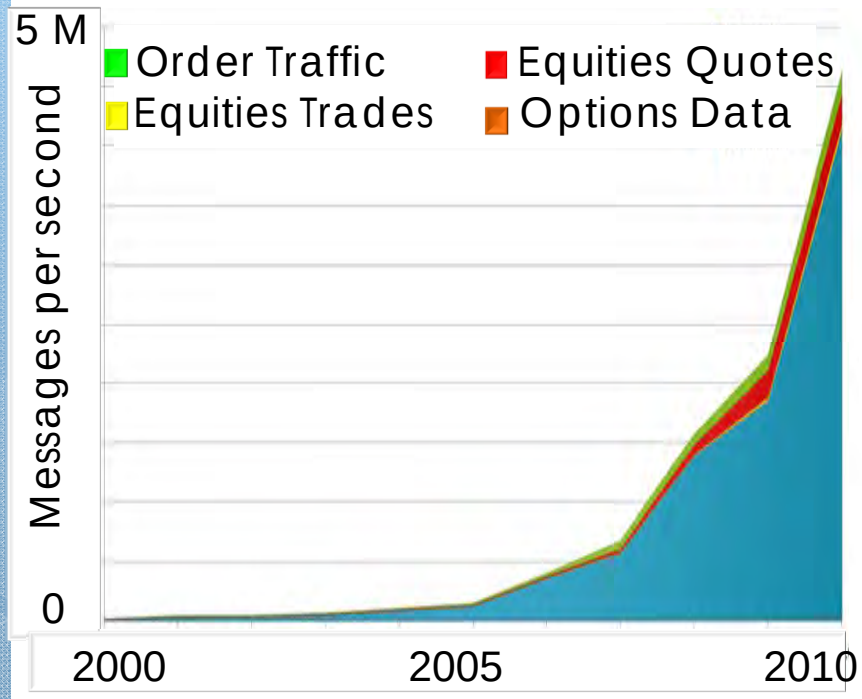
2015 Global Users and Network Connections



Source: nowell_01_0911.pdf citing Cisco Visual Networking Index (VNI) Global IP Traffic Forecast, 2010–2015, http://www.ieee802.org/3/ad_hoc/bwa/public/sep11/nowell_01_0911.pdf

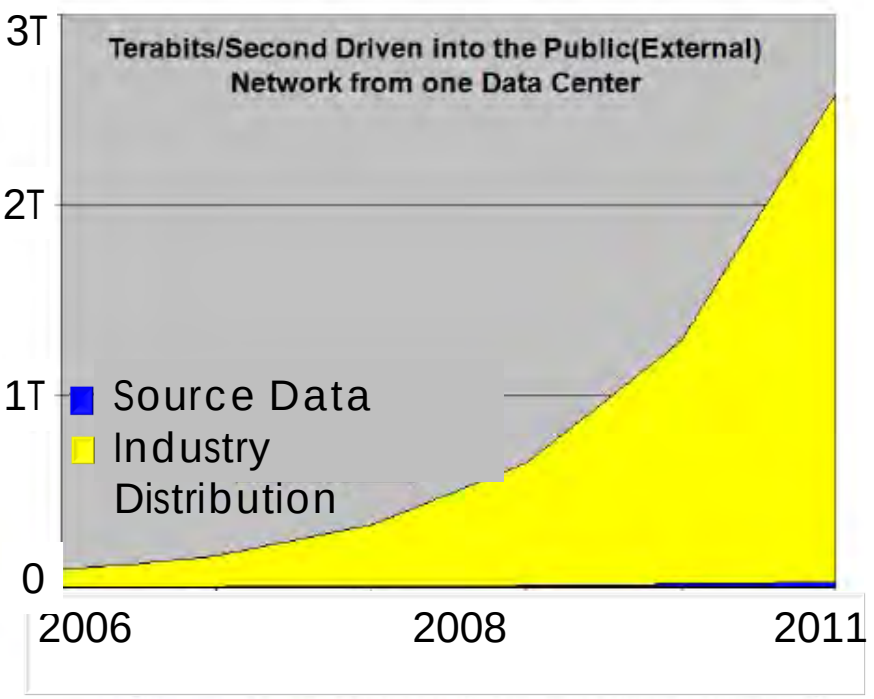
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Example: Financial Sector



Usage growth

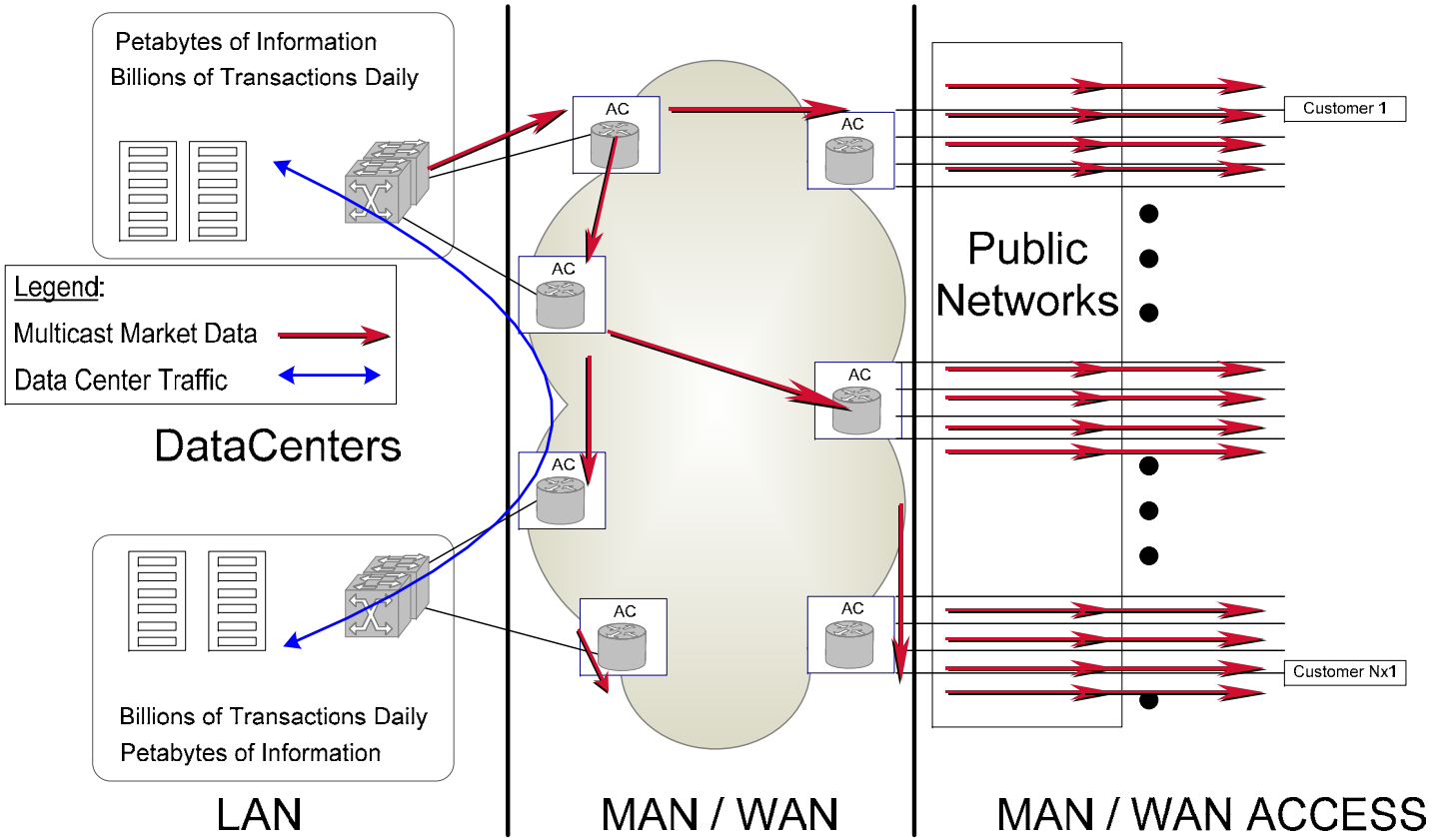
Bandwidth Growth



Source: http://www.ieee802.org/3/ad_hoc/bwa/public/jun11/bach_01a_0611.pdf

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Growth is throughout the Eco-system

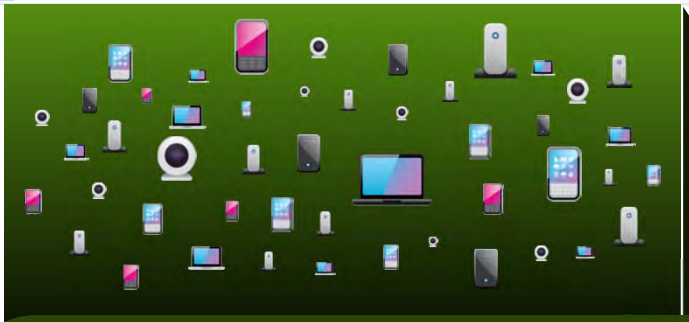


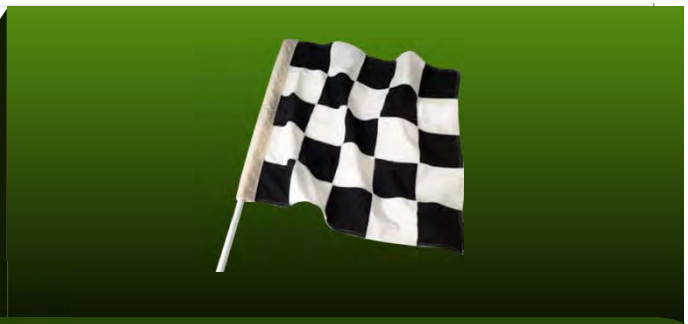
Networking equipment, compute (servers) equipment and storage equipment all required to scale to match application requirements

Source: http://www.ieee802.org/3/ad_hoc/bwa/public/jun11/bach_01a_0611.pdf

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The Equation Remains the





More Devices

Speed Increasing

YOU

More Internet Users

More Rich Media Content





Source: nowell_01_0911.pdf citing Cisco Visual Networking Index (VNI) Global IP Traffic Forecast, 2010–2015, http://www.ieee802.org/3/ad_hoc/bwa/public/sep11/nowell_01_0911.pdf

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Metcalfe's Law

The value of a telecommunications network is proportional to the square of the number of connected users of the system

Ethernet

Benefits	Challenges
Any where	Developing it
Any time	Deploying it
Any way	Managing it

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BUILDING YOUR NETWORK

Ethernet's
Building Blocks



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What's Your Network Concern?

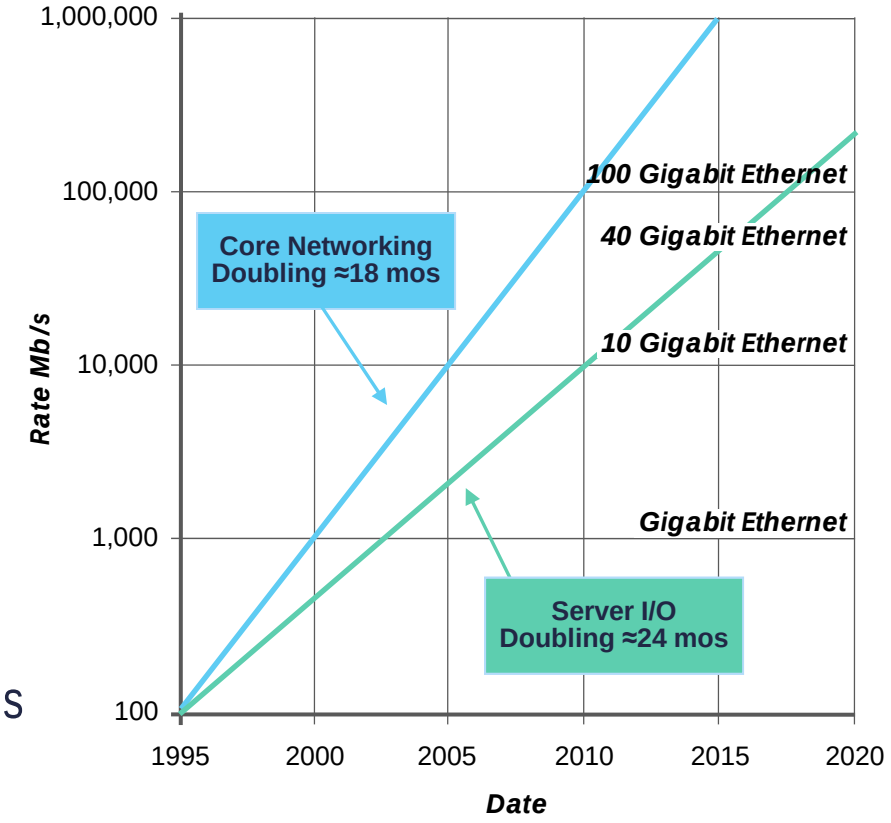
- Network Concerns?
  - Enterprise?
  - Data Center?
  - Metro?
  - Carrier?
  - Wireless?
  - Wi-Fi?
  - Automotive?
- Ethernet is everywhere!



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One Size Doesn't Fit All Anymore

- Industry challenges
  - Market Need
  - Increasing Bandwidth
  - Technical Feasibility
  - Lowering Cost per bit!
- Think "Big"
  - Scaling
  - Economics of applications will dictate solutions!
  - Connecting everyone, everywhere, all the time!



Why was 40GbE and 100GbE developed?

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IEEE 40Gb/s and 100Gb/s: Currently Defined Physical Layer Specifications

Media	PHY name	Description	40G	100G
Backplane	40GBASE-KR4	At least 1m backplane	4x10G Parallel	
Cu Cable	40GBASE-CR4 100GBASE-CR10	At least 7m cu (twin-ax) cable	4x10G Parallel	10x10G Parallel
Multimode Fiber	40GBASE-SR4 100GBASE-SR10	At least 100m OM3 MMF (150m OM4 MMF)	4x10G Parallel	10x10G Parallel
Single Mode Fiber	40GBASE-FR	At least 2km SMF	40G Serial	
	40GBASE-LR4 100GBASE-LR4	At least 10km SMF	4x10G WDM	4x25G WDM
	100GBASE-ER4	At least 40km SMF		4x25G WDM

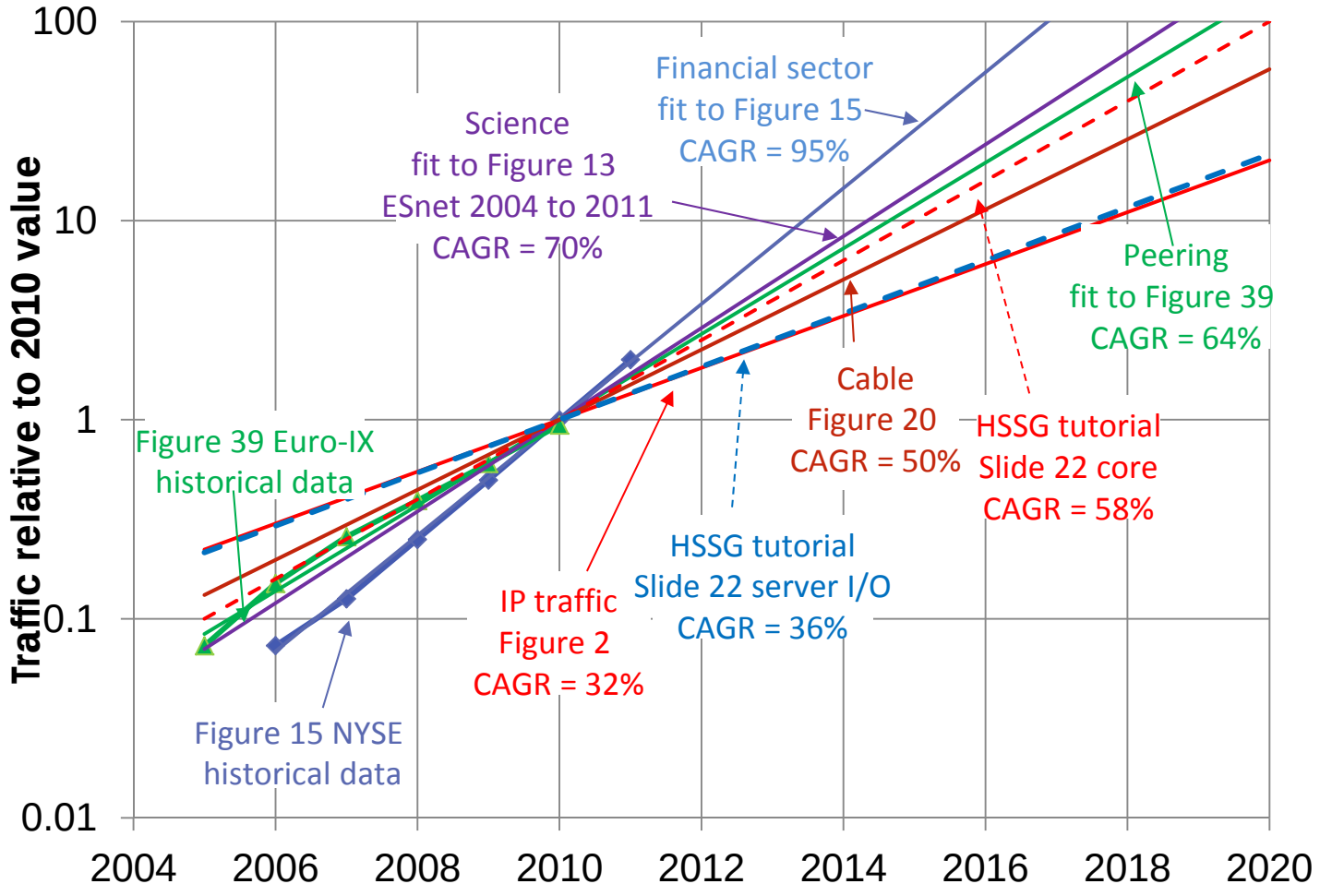
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Growing the 100GbE Family

Media	PHY name	Description	40G	100G
PCB Traces	CAUI	Chip-to-chip and chip-to-module interfaces		4x25G Parallel
Backplane	100GBASE-KR4 100GBASE-KP4	NRZ-based PHY PAM-4 based PHY		4x25G Parallel
Cu Cable	100GBASE-CR4	At least 5m cu (twin-ax) cable (NRZ)		4x25G Parallel
Twisted Pair	To be determined	To be determined	√	
MMF	100GBASE-nRx	At least 20m MMF At least 100m MMF		4x25G Parallel
SMF	40GBASE-nRx	At least 40km SMF	4x10G WDM	
	100GBASE-nRx	At least 500m SMF		?

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Forecast: 2015: Terabit! 2020:10 Terabit!

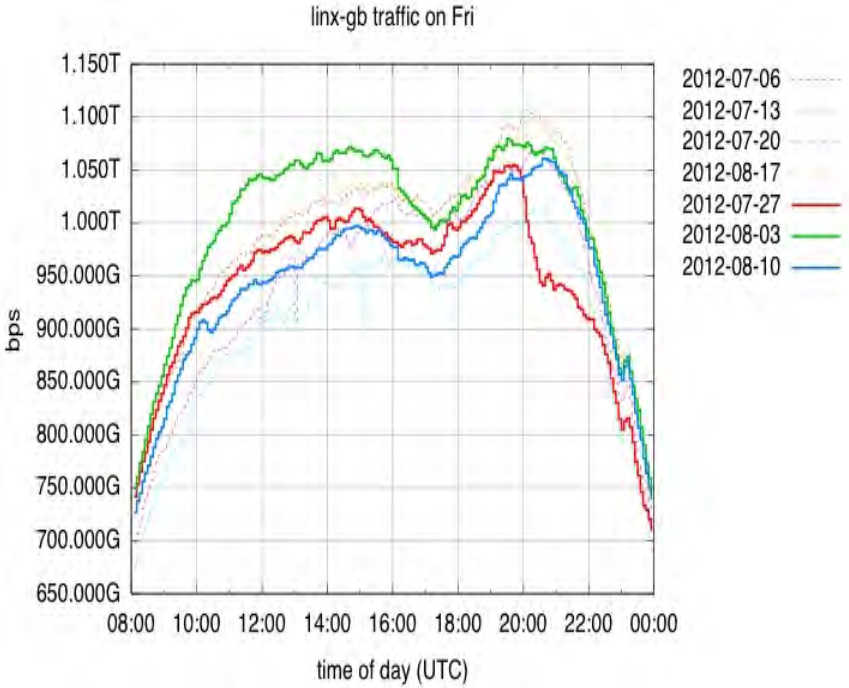


Source: IEEE 802.3 Ethernet Bandwidth Assessment, http://www.ieee802.org/3/ad_hoc/bwa/BWA_Report.pdf.

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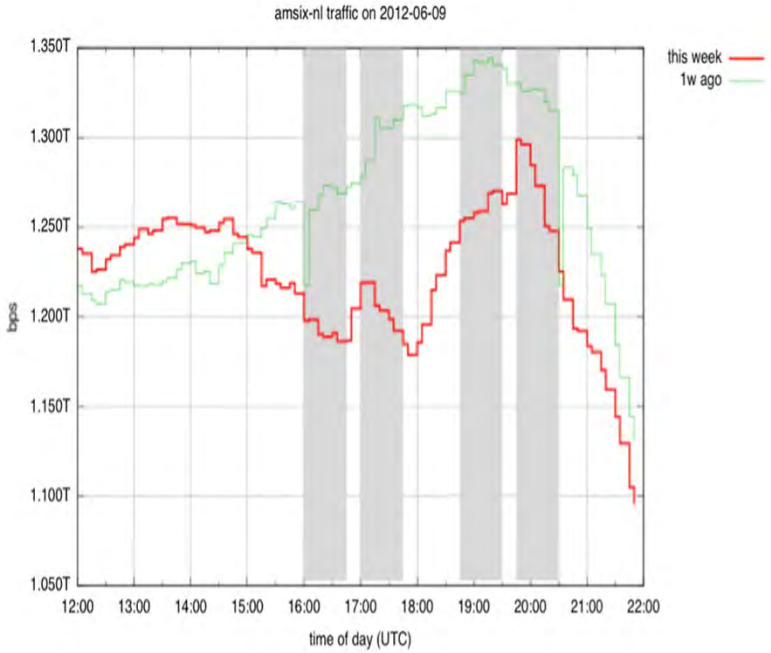
The Future is Here

2012 Summer Olympics



Source: https://labs.ripe.net/Members/fergalc/internet-traffic-during-olympics-2012

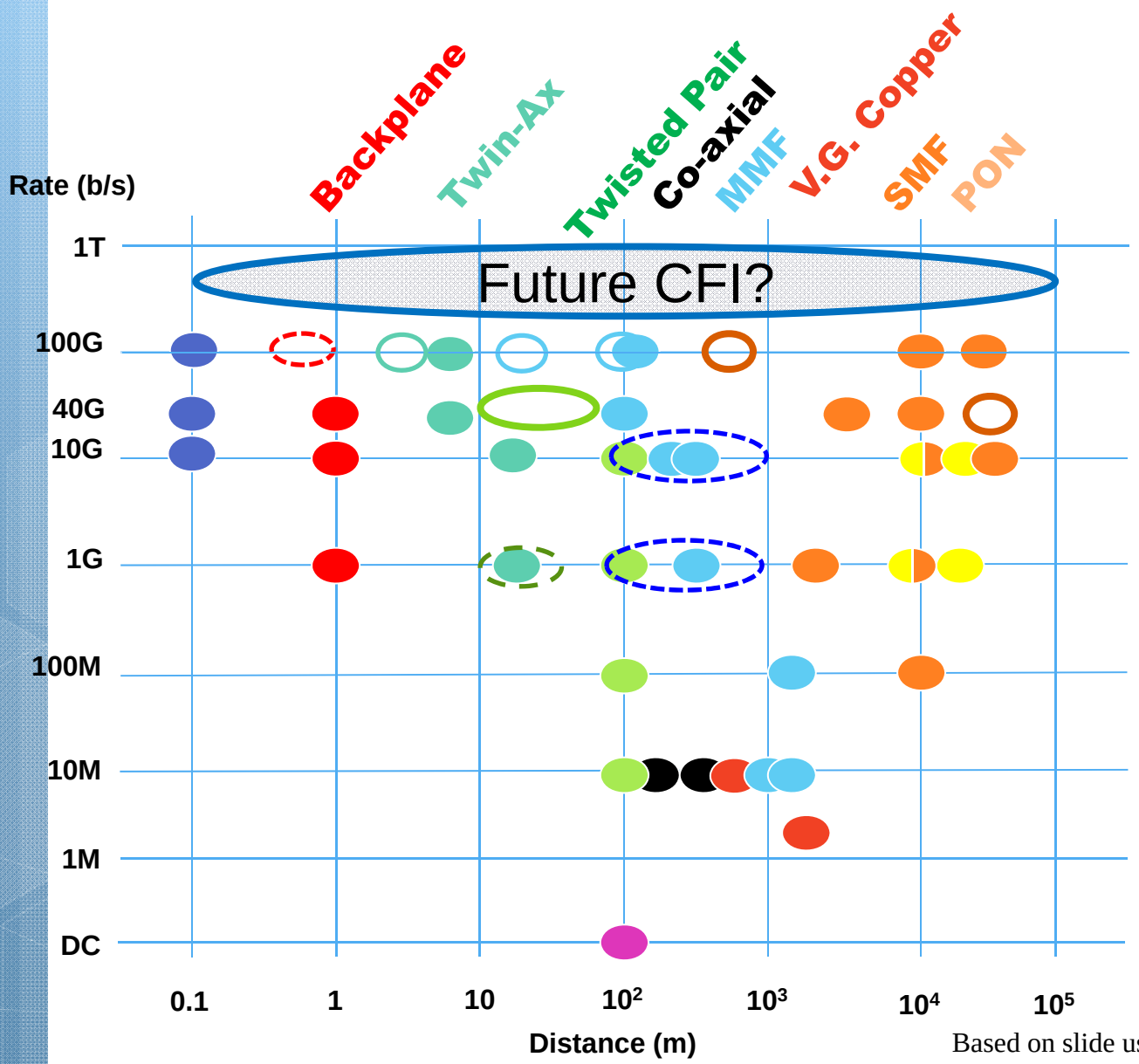
After First Round of Euro 2012 Matches



Source: https://labs.ripe.net/Members/fergalc/internet-traffic-after-first-round-of-euro-2012-matches/AMSIXNL.png

Thanks to Bijal Sanghani, Euro-IX.

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Key:

- Chip-to chip/module
- Backplane
- Twin-axial
- Multimode Fibre
- Voice grade copper
- Co-axial
- Twisted pair
- Reduced Twisted pair
- Single-mode Fibre
- Point to Multipoint Fibre
- Power Over Ethernet
- Co-axial Network
- Open Circle indicates development effort
- Distance channel model dependent

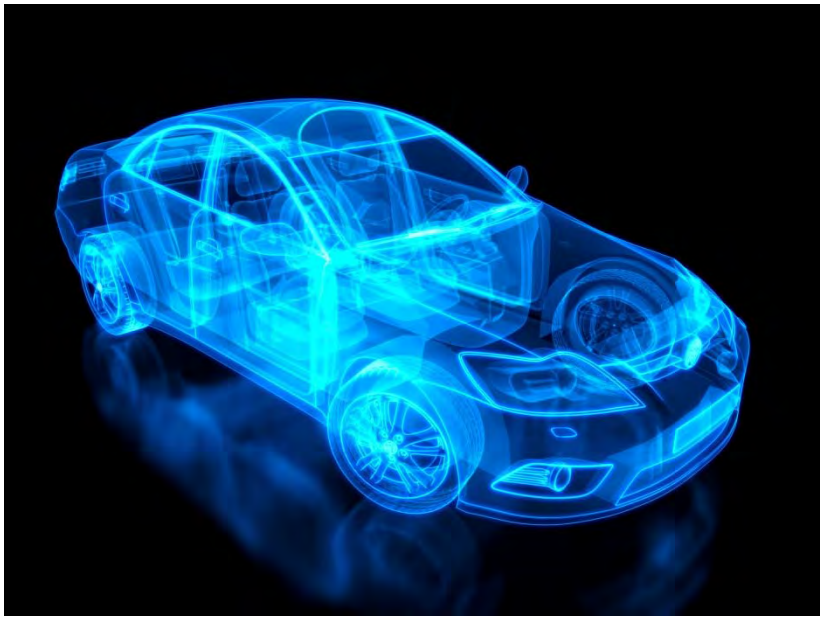
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Ethernet's Expanding Eco-system

- Formation of IEEE P802.3bp RTPGE Task Force
- GbE for Automotive!
- By 2019 – nominal estimate: 300 M ports per year





- What new services will be introduced?
- What will this mean to you?

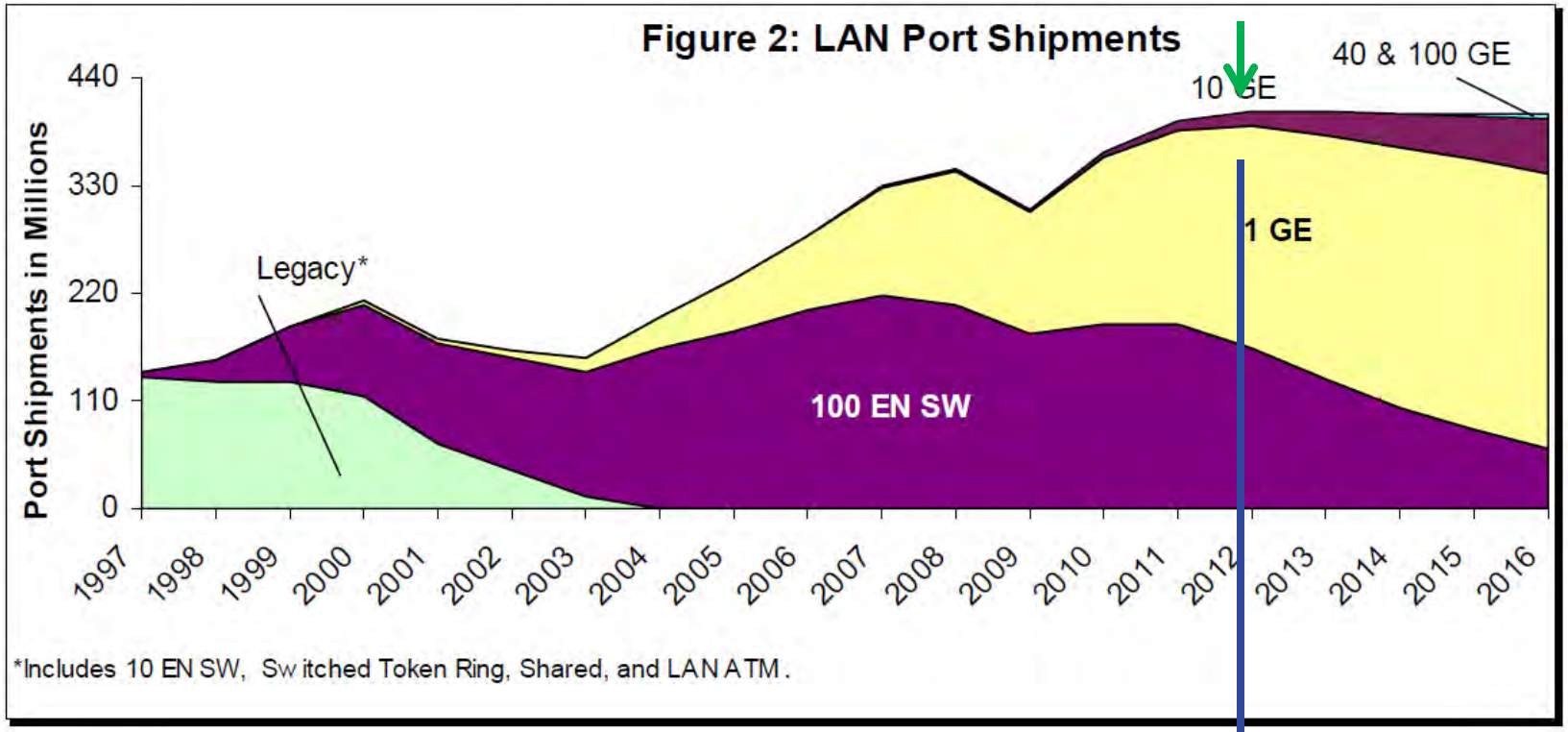
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The Growth of Ethernet

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Ethernet Port Shipments

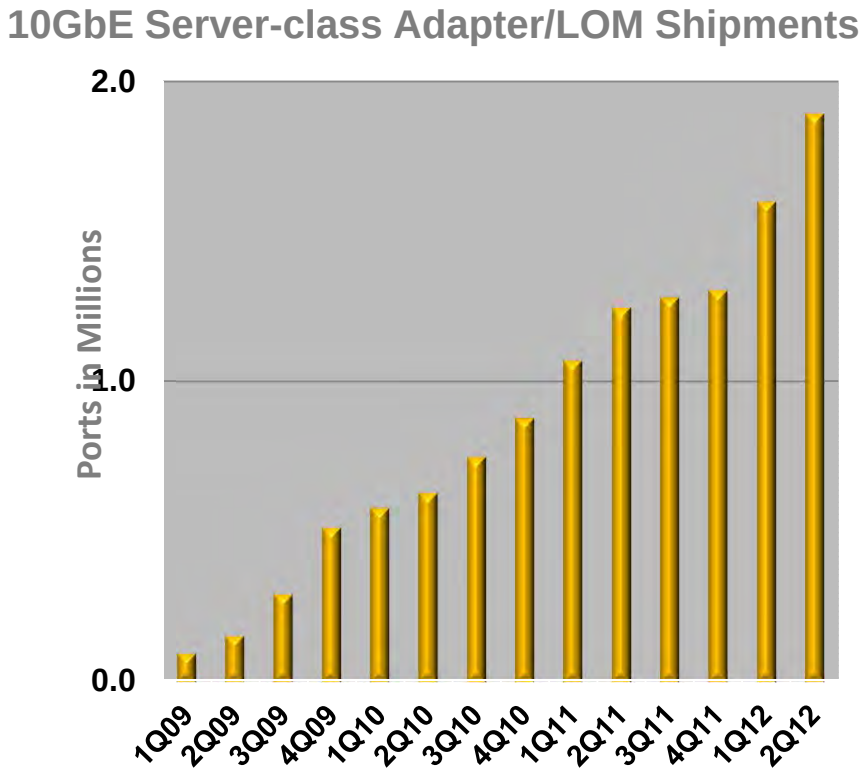
Over 400 Million Ports shipped in 2012 for the first time!

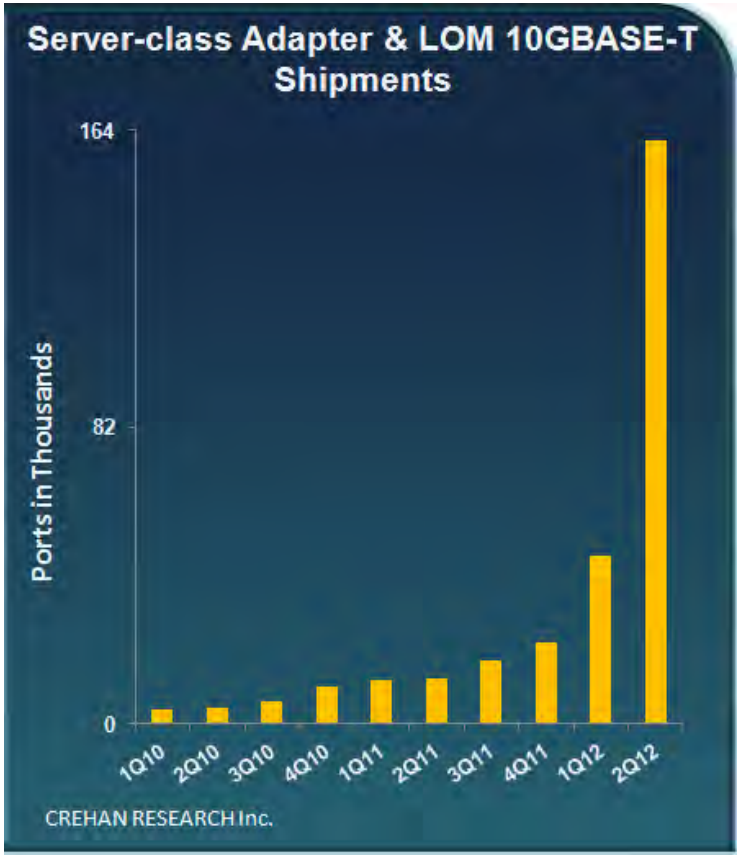


Source: Dell'Oro Ethernet Switch Forecast Report, July 2012

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The 10GbE Server Market Looks Bright!

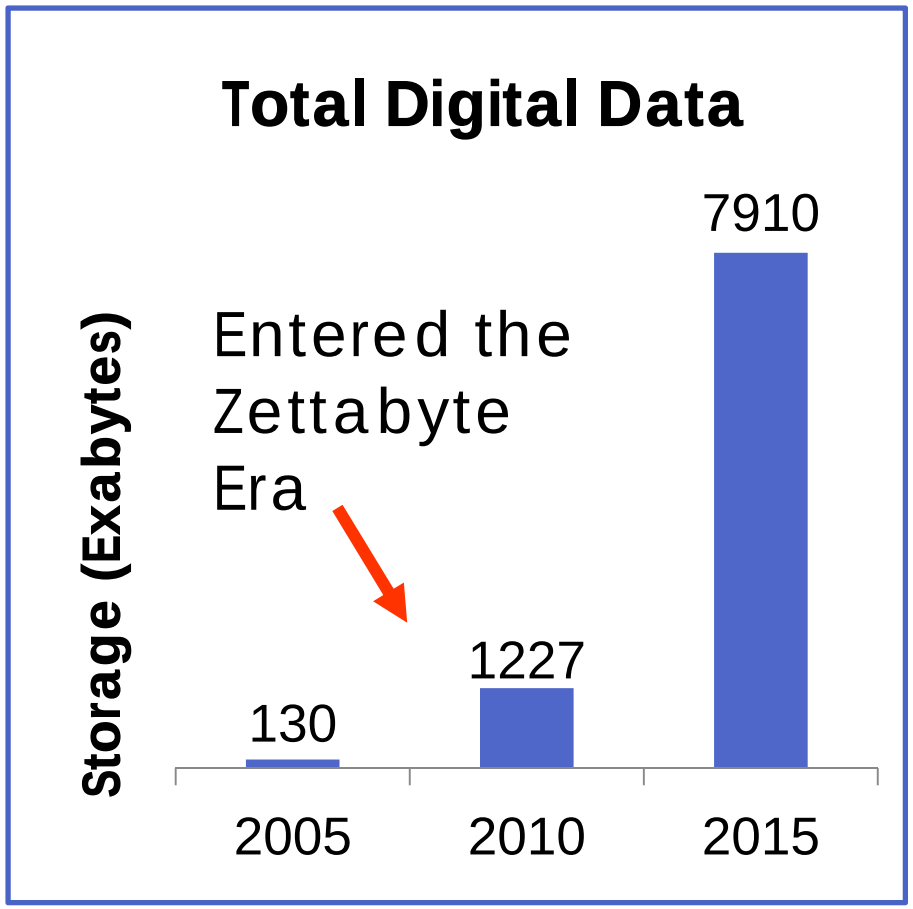




All data used with permission Seamus Crehan, Crehan Research.

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External Storage Shipments



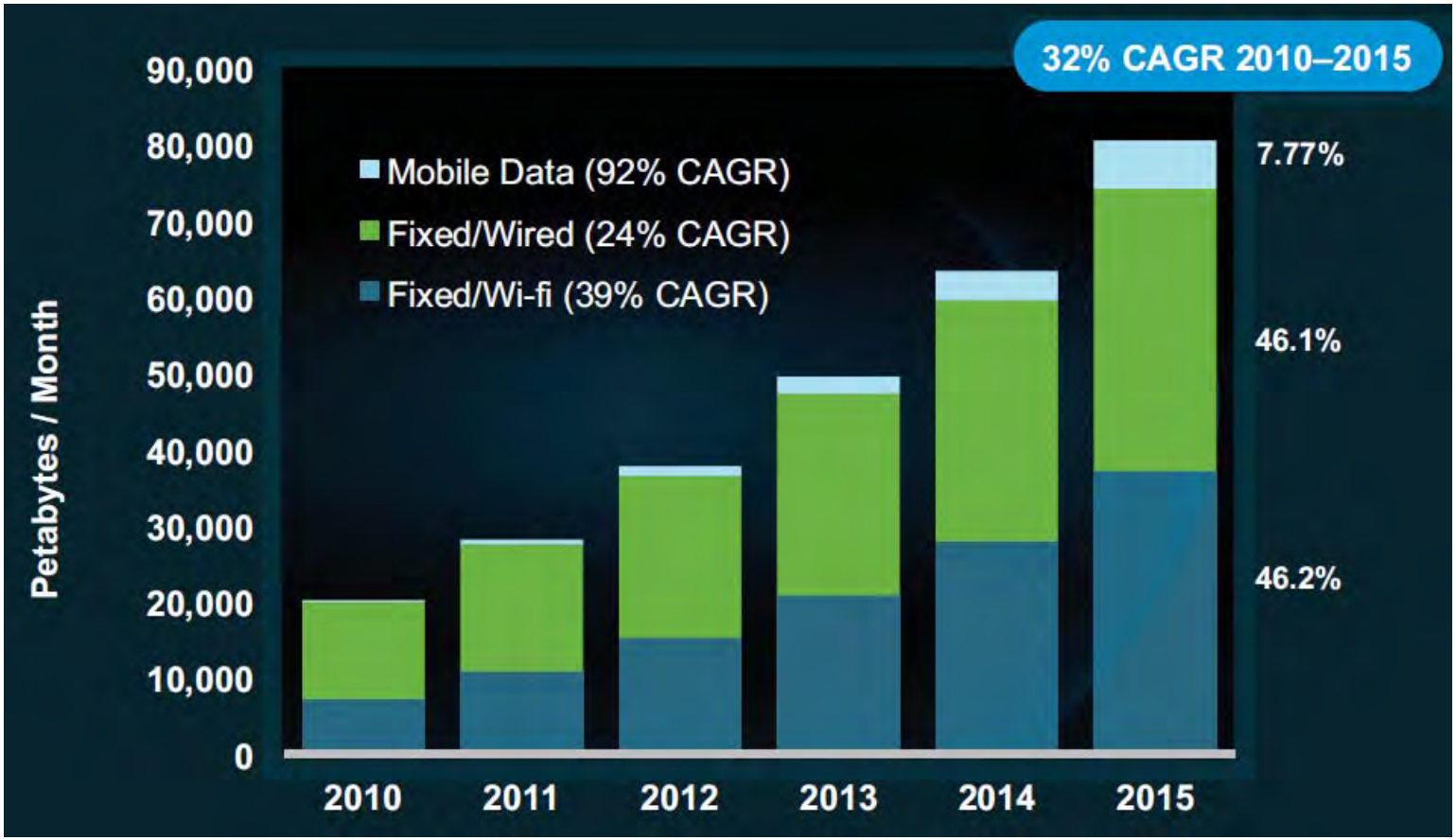
Growth over Next Decade	
# of Servers	x10
Storage	x50
# of Files	x75

Consider the implications!

Source: http://www.ieee802.org/3/ad_hoc/bwa/public/sep11/kipp_01a_0911.pdf

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Global IP Traffic by Local Access Technology



Source: nowell_01_0911.pdf citing Cisco Visual Networking Index (VNI) Global IP Traffic Forecast, 2010–2015, http://www.ieee802.org/3/ad_hoc/bwa/public/sep11/nowell_01_0911.pdf

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Data Center Growth

Networking

Entered the 100GbE era in 2010
Individual switches have Tb/s of bandwidth

Compute

First petaflop supercomputers in 2011
Individual servers delivering 10s of Gb/s of I/O
PCIe 3.0 supports 2 x 40GbE NICs now

Storage

Entered the zettabyte (1 billion terabytes) era in 2010
Individual disk drives over 1 terabyte
1000 disk drive storage subsystem equals 1 Petabyte

ETHERNET: The Progression of Plug-n-Play

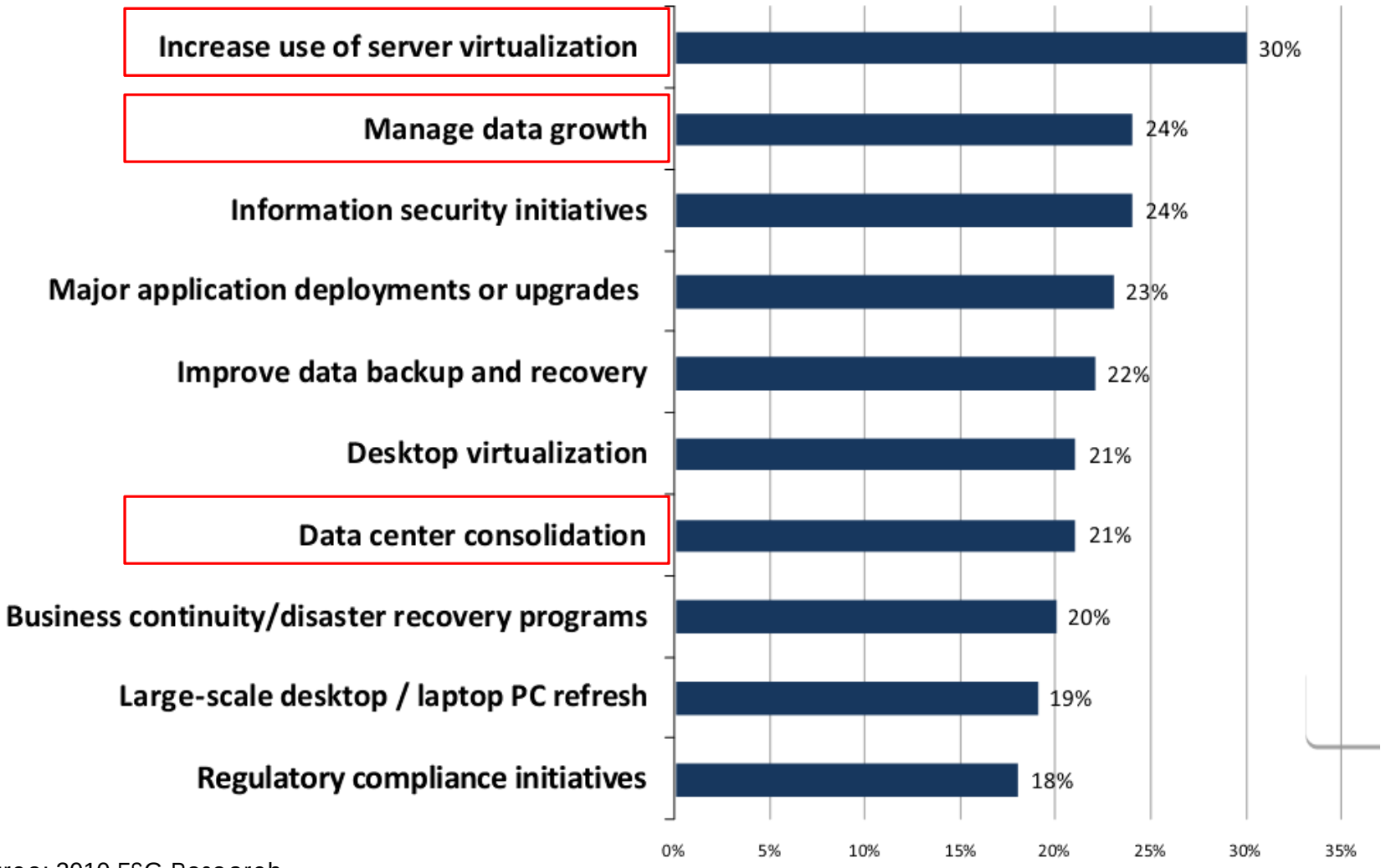
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ETHERNET AND THE DATA CENTER

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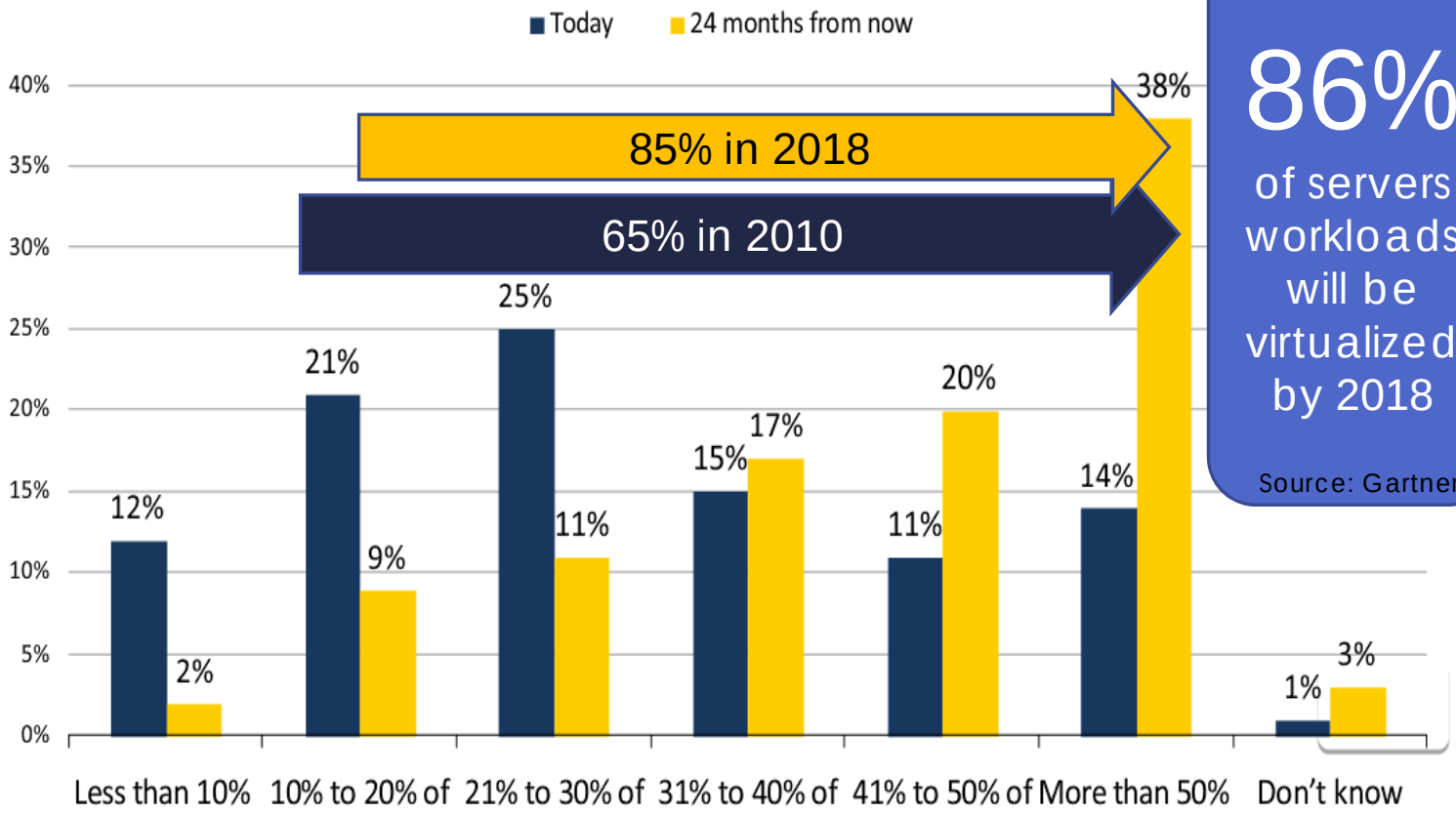
Top IT Initiatives



Source: 2010 ESG Research

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Server Virtualization – Driving the data center evolution



86%

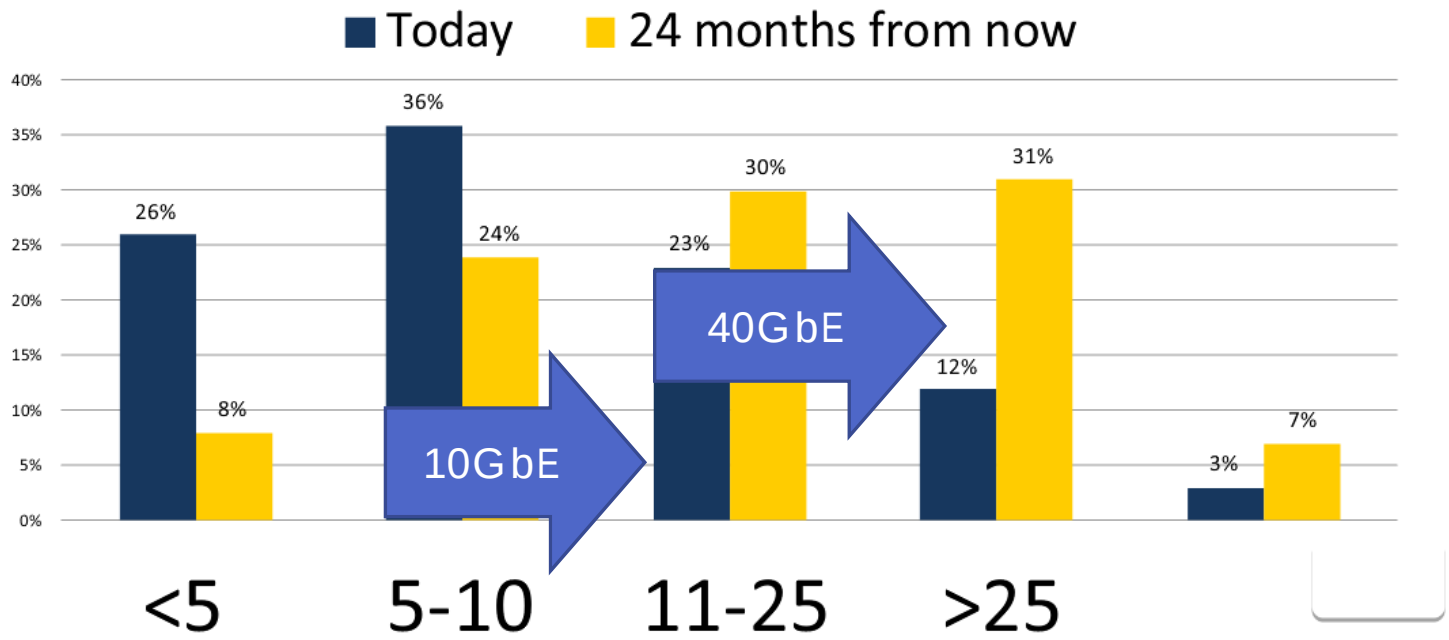
of servers workloads will be virtualized by 2018

Source: Gartner

Source: ESG Research

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VM density drives I/O demand which drives Network Innovation



Virtual Machine density: Number of VMs deployed per physical server

Source: ESG Research

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10Gb Ethernet Solutions in the Data Center

Consolidation
Optimizing data center resources



Virtualization
Increasing resource utilization, availability and agility



Convergence
Unified data center fabric



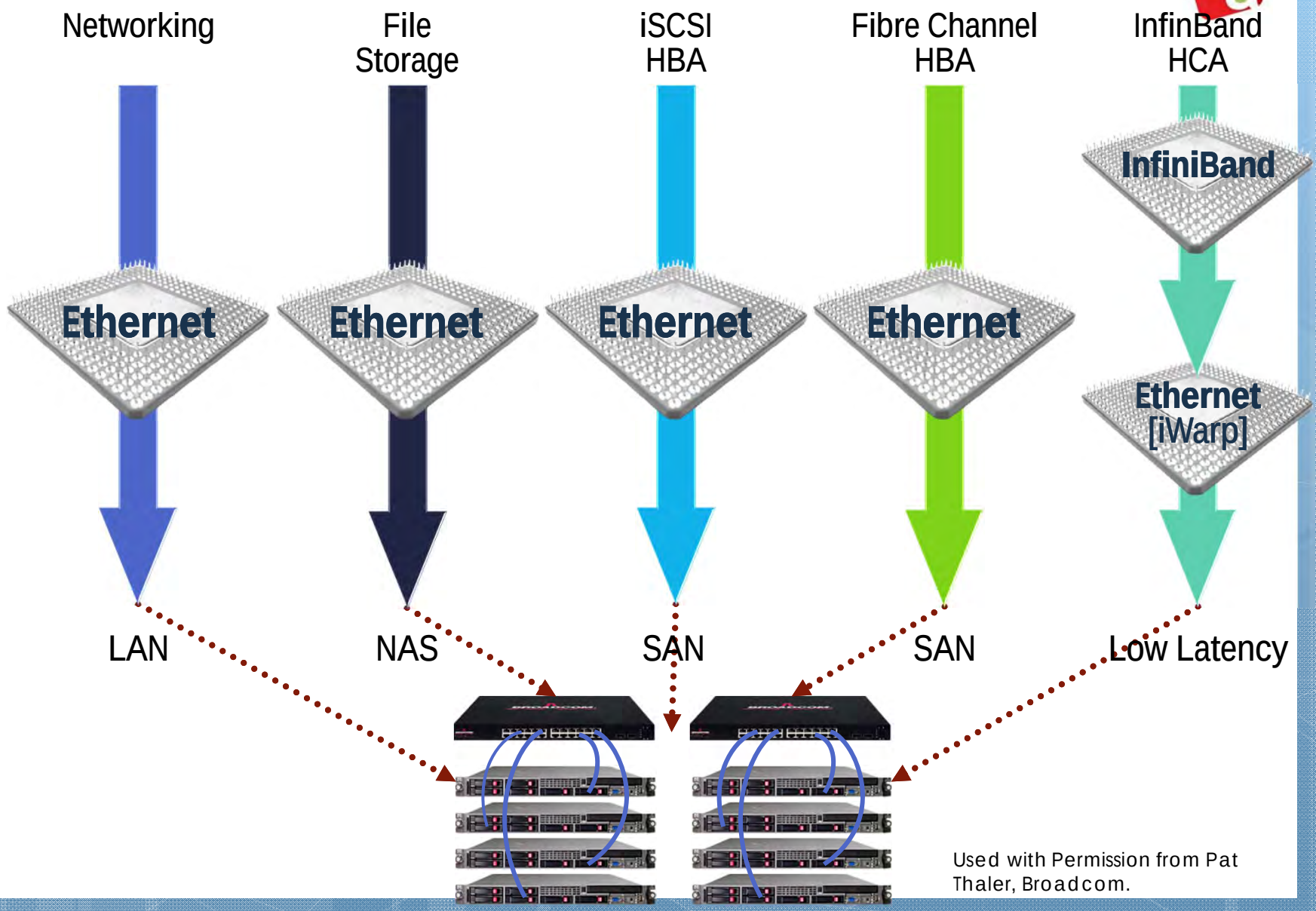
Cloud
Completing the journey



Data Center Evolution

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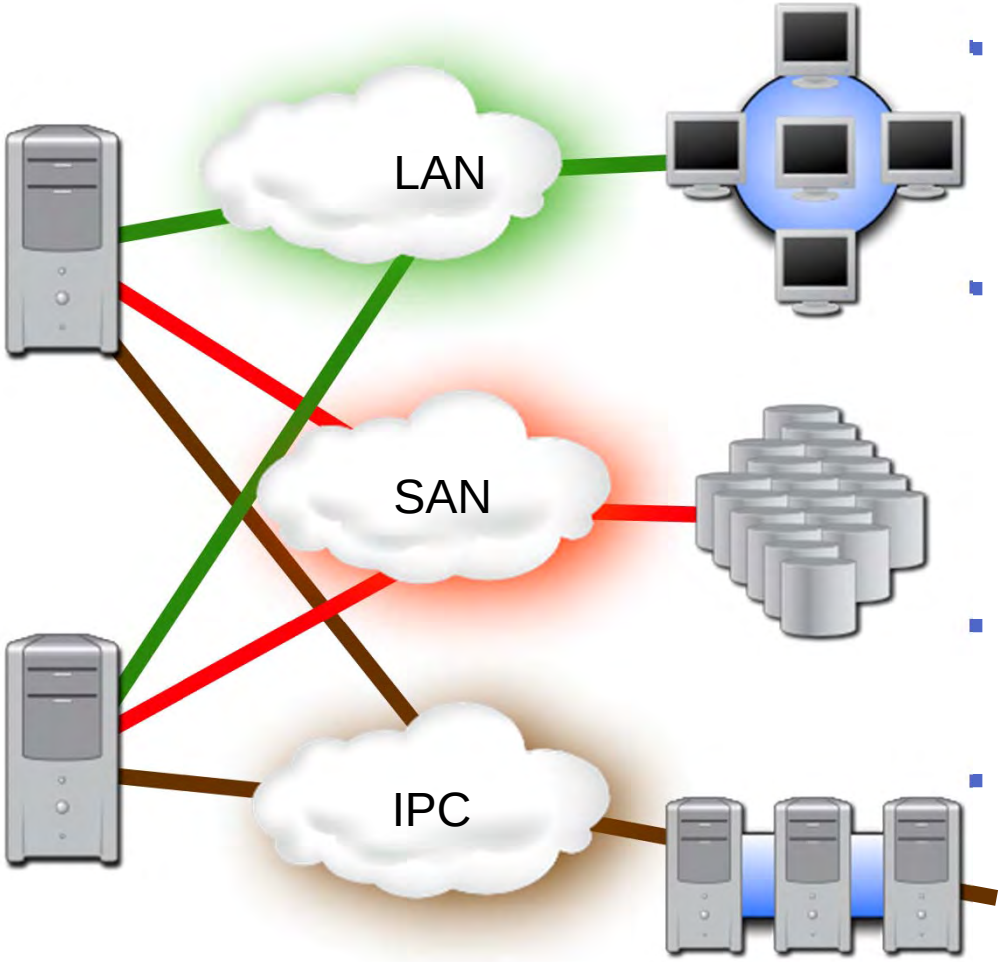
All Roads Lead to Ethernet for Data Center I/O



Used with Permission from Pat Thaler, Broadcom.

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Today's Environment



- Separate networks for each traffic type
  - LAN, SAN, IPC
- Unique infrastructure
  - Server adapters
  - Fabric switches
  - Cables
- Separate management schemes
- Inherently costly and complicated

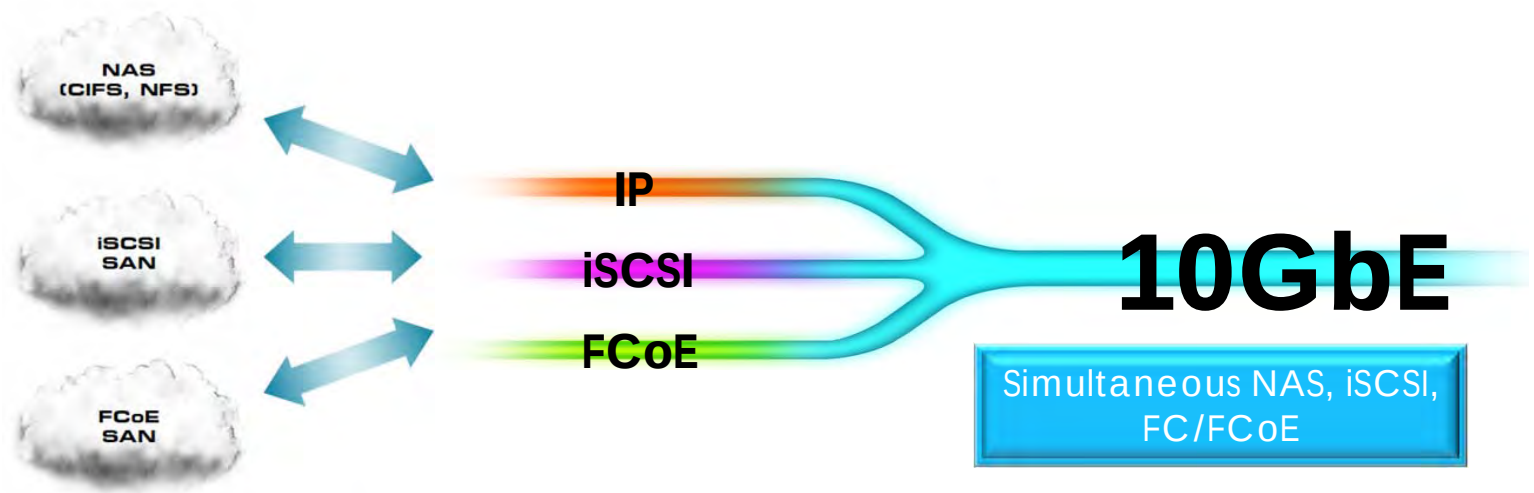
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What is Data Center Bridging?

- Terminology
  - Enhanced Ethernet
  - Datacenter Ethernet
  - Converged Enhanced Ethernet
- Lossless vs. lossy
  - Ethernet = Lossy (expected to “drop” packets when busy)
  - Fibre Channel = Lossless (expected to not lose information)
  - SCSI does not recover quickly from lost packets
- Enhanced Ethernet is lossless
  - New features have been added to prevent dropped packets
  - Better suited for transporting SCSI traffic

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Data Center Bridging (DCB) enables converged networks



- Standards Done!
- IEEE 802.1Qaz: Enhanced Transmission Selection (ETS)
- IEEE 802.1Qbb: Priority-based Flow Control (PFC)
- IEEE 802.1Qau: Congestion Notification

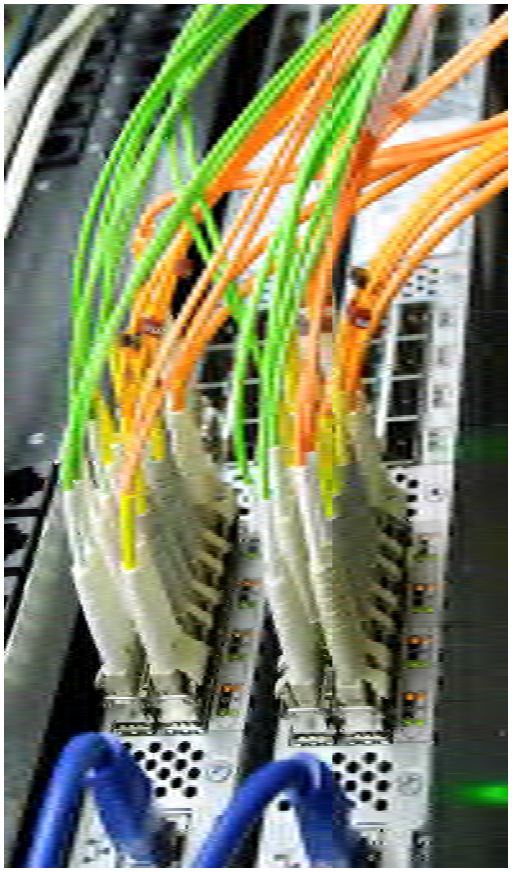
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Data Center Bridging Standards

- **Pause IEEE 802.3X – defines link level flow control and specifies protocols, procedures and managed objects that enable flow control full-duplex Ethernet links to prevent lost packets**
- **Priority Flow Control (PFC) IEEE 802.1Qbb – enhances pause mechanism to achieve flow control of 8 traffic classes by adding priority information in the flow control packets** (http://www.ieee802.org/1/files/public/docs2008/bb-pelissier-pfc-proposal-0508.pdf)
- **Enhanced Transmission Selection (ETS) IEEE 802.1Qaz – assigns traffic classes into priority groups and manages bandwidth allocation and sharing across priority groups** (http://www.ieee802.org/1/files/public/docs2008/az-wadekar-ets-proposal-0608-v1.01.pdf)
- **Data Center Bridging Exchange Protocol (DCBX) IEEE 802.1Qaz – "Advertisement/configuration" to allow devices to automatically exchange DCB link capabilities** (http://www.ieee802.org/1/files/public/docs2008/az-wadekar-dcbx-capability-exchange-discoveryprotocol-1108-v1.01.pdf)
- **Congestion Notification (CN) IEEE 802.1Qau – allows bridges to send congestion signals to end-systems to regulate the amount of network traffic**

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Quick reminder on Data Center Bridging



- Unifying I/Os and networks over Ethernet
- Enhanced switches to support lossless Ethernet
- Essentially, improved Ethernet that is suitable for data center applications
- Use cases support multiple storage protocols and LAN, and high performance computing

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Deployment Process

- Today: Not Converged
  - Separate NIC & HBA
- Step 1: Converged edge
  - DCB adapters
  - DCB “top of rack” switch
- Step 2: Converged core
  - Expanded converged network
  - Native attach storage
- Goal: Converged network
  - Multiple storage technologies over Ethernet



- Process **Benefit**: Provides the building blocks to upgrade
  a portion of or all data center network assets into a converged infrastructure

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Enhanced Transmission Selection (ETS)

Standards

- IEEE 802.1Qaz
  - Approved as IEEE standards in June 2011

Industry

- Many switch, adapter and chipset vendors
  - Switch vendor support
- Interoperability
  - Not applicable
    - See DCBX interoperability
  - Local forwarding decision
  - Works well end-to-end across different vendors

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Data Center Bridging eXchange (DCBX)

Standards

- Pre-standard
  - Convergence Enhanced Ethernet (CEE)
- IEEE P802.1Qaz
  - Approved as IEEE standards in June 2011

Industry

- Many switch, adapter and chipset vendors
- Interoperability
  - Most venders support CEE 1.01
    - Highly interoperable
  - Few venders support IEEE 802.1Qaz today
    - Most have roadmap to support this in near future

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Congestion Notification

Standards

- IEEE 802.1Qau
  - Approved as IEEE standards in 2010

Industry

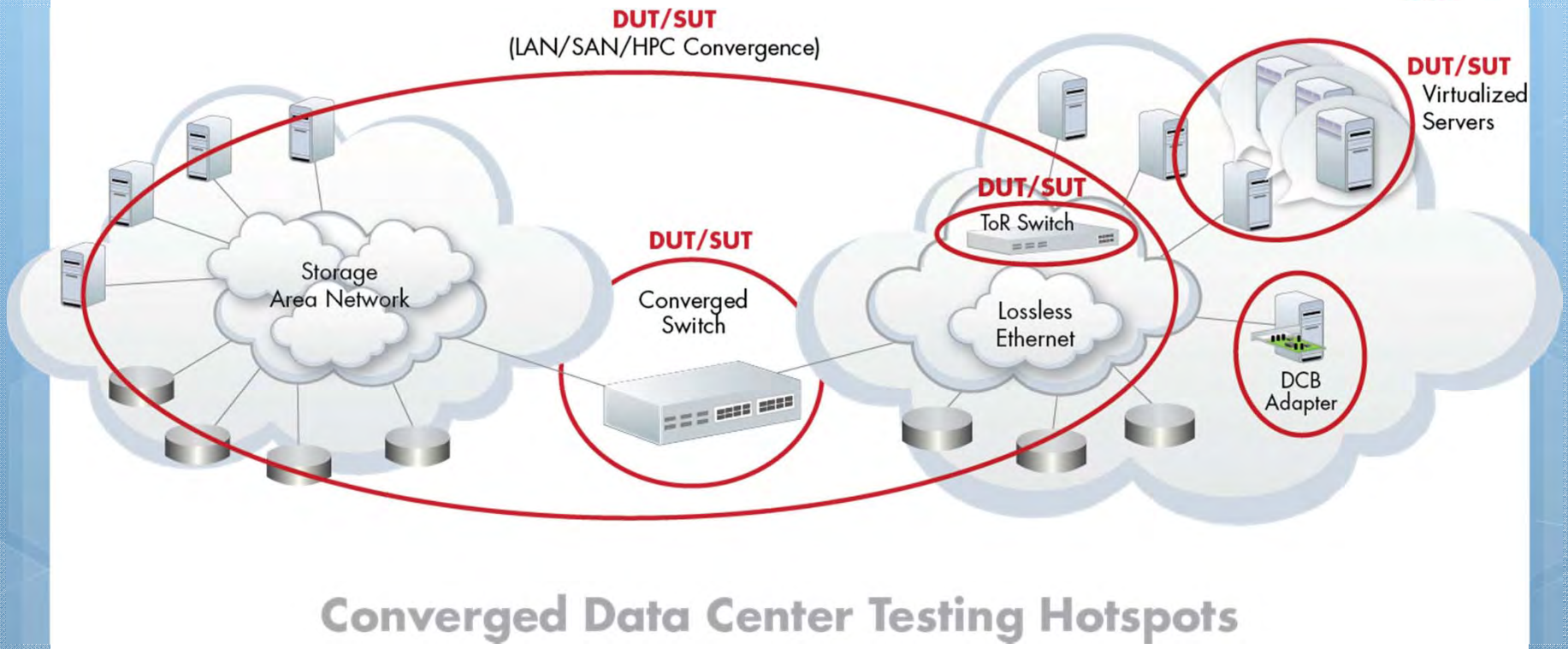
- Very few support
- Few have roadmap in the near future
- Interoperability
  - Limited early interoperability testing fall 2010
  - More testing planned

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A lot to test in the Converged Data Center

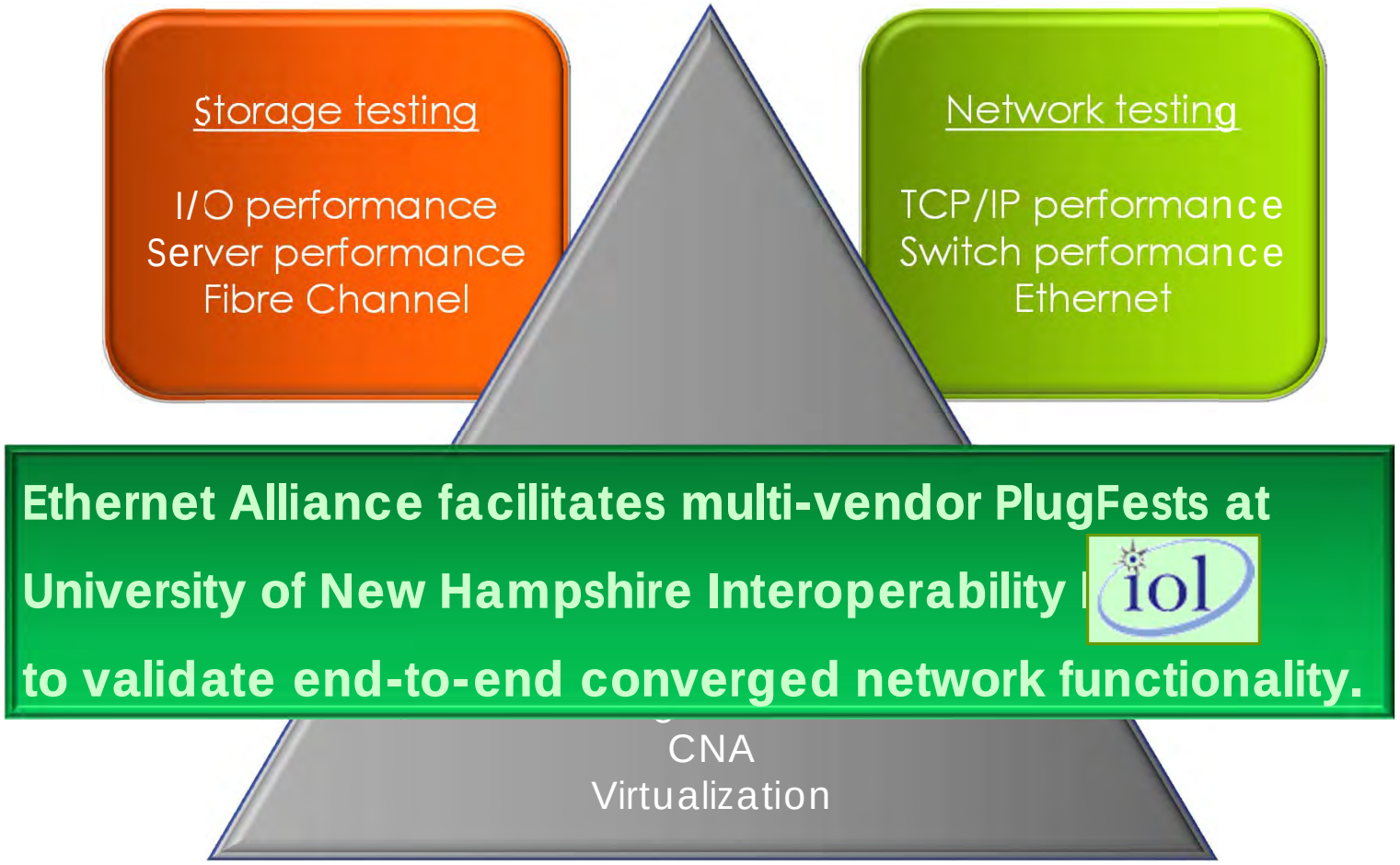


Converged Data Center Testing Hotspots

DCB protocols, FCoE/iSCSI/RoCE /iWARP applications, converged switches, DCB adapters, Bridging protocols, Routing protocols, 40/100GbE uplinks, virtualization performance

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Ethernet Alliance Testing end-to-end



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Interoperability Demonstrations



- OFC 2012: From the Cloud to the Data Center
  - Optical Technologies Featured
    - 100 GbE over OTN
    - 100 GbE (100GBASE-LR4)
    - 40 GbE
    - 40 GbE to 4 x 10 GbE Breakout
    - 10 GbE

http://www.ethernetalliance.org/wp-content/uploads/2012/02/EA_OFC12_press-release.pdf

- Interop Las Vegas 2012
  - Ethernet's data center support
    - Cloud computing
    - Convergence
    - Virtualization
  - Featured
    - 40 GbE
    - 10 GbE

http://www.ethernetalliance.org/wp-content/uploads/2012/05/EA_PressRelease_Interop_FINAL-050112-2.pdf

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TeraFabric Plugfest 2012

- When: Oct 22 – 26, 2012
- Where: Univ. of New Hampshire, Interoperability Laboratory
- 18 companies participated
- Testing Included
  - Data Center Bridging
    - 10GBASE–T
    - 10G/40G Ethernet DCB network
    - Terabit capable fabric with 18 vendors interoperating

http://www.ethernetalliance.org/wp-content/uploads/2012/10/EA_Terafabric_media-alert_FINAL_101712.pdf



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THE ETHERNET ALLIANCE

A global community of end users, system vendors, component suppliers and academia

- ***Mission***
  - Promote existing and emerging IEEE 802 Ethernet standards
  - Accelerate industry adoption
  - Demonstrate multi-vendor interoperability
- ***2012 Strategic Priorities***
  - Demonstrating Interoperability
  - Industry Consensus Building
  - Global Expansion
  - Marketing & Education



The Voice of Ethernet

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Reaching Consensus

- Myth: The IEEE makes the decisions
- Reality: The IEEE is a forum for the industry to make the decisions
- Any standards development effort might include these (and others):
  - End users
  - Equipment Vendors
  - Chip Vendors
  - Optics Vendors
  - Cable Suppliers
  - Connector Vendors
  - Test Equipment Vendors
  - PCB Materials Vendors
  - PCB Mfg. and Assembly Vendors
  - Consultants
- In the IEEE technical decisions require ≥ 75% consensus
- What is the industry consensus?

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The Ethernet Alliance

The Voice of Ethernet

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  Join the Ethernet Alliance LinkedIn group

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- Questions? Contact:
  - Morgan Fricke – Director of Operations
    - morgan@ethernetalliance.org
  - John D'Ambrosia – Chairman of the Board
    - Chair@ethernetalliance.org

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Discussion and Q&A



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