40GBASE-T / Category 8 Update

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Athens, 11 November 2013

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NGBase-T Update

Market Need for NGBASE-T

Lessons learned from 10GBASE-T

Progress To-date

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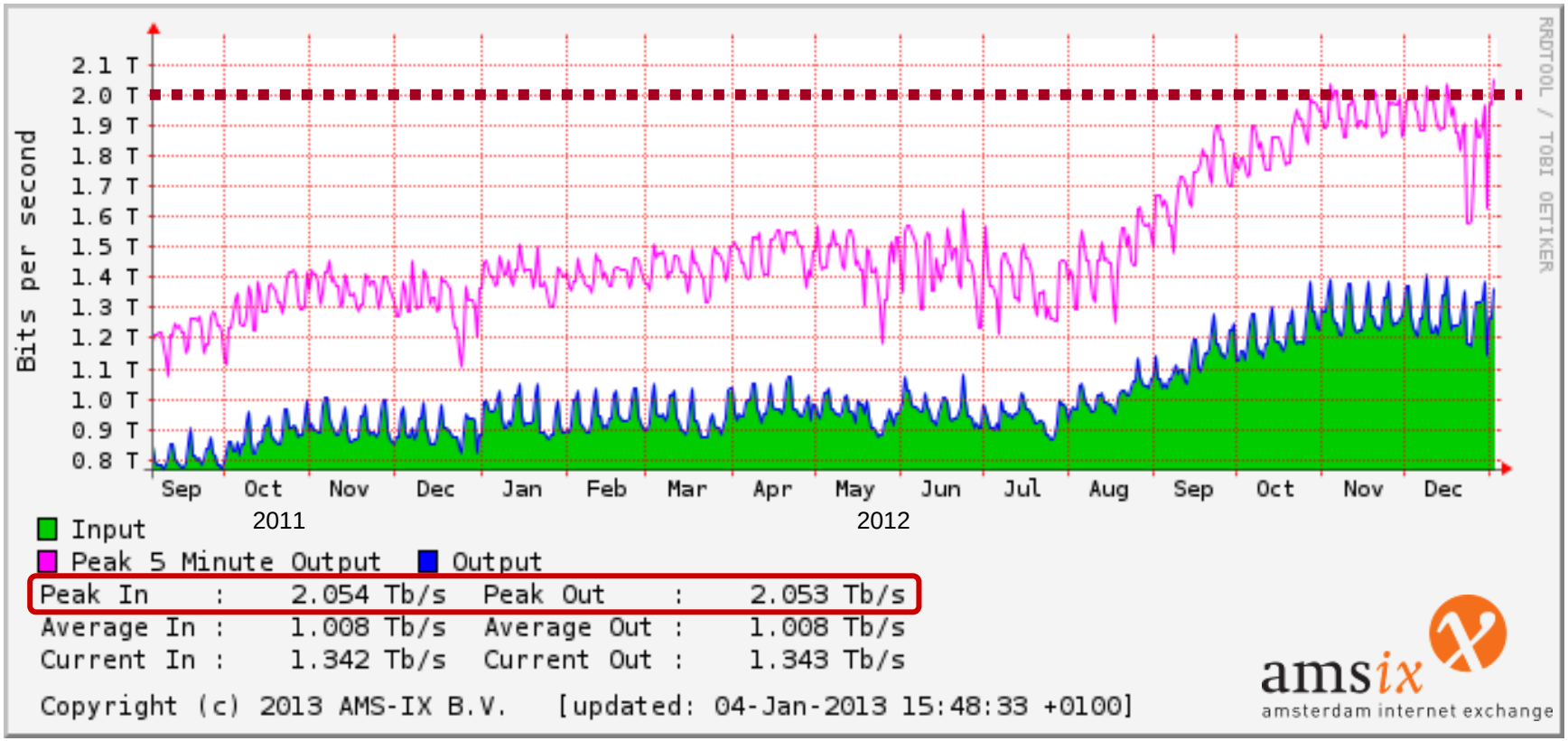
EU Example:
AMS-IX Traffic Exceeding 2 Tb/s



High speed interfaces needed to efficiently transport data

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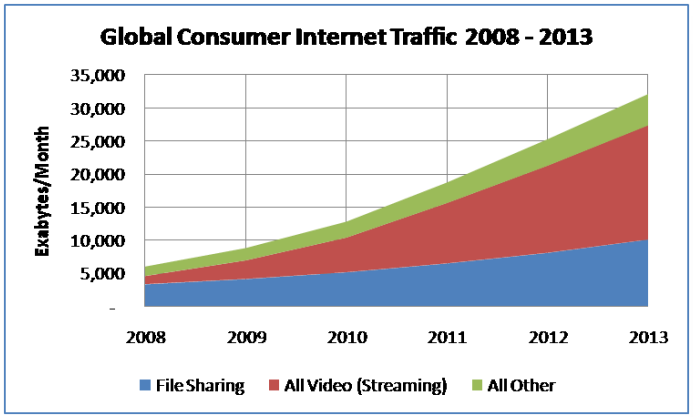
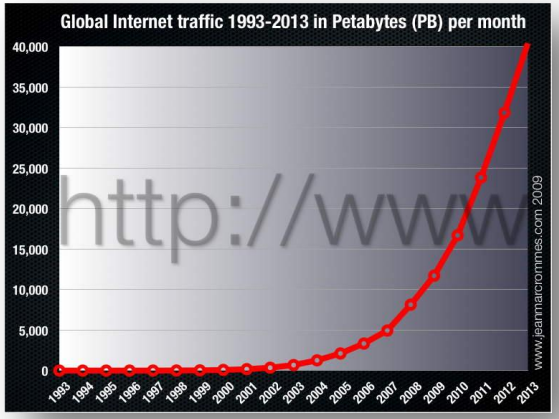
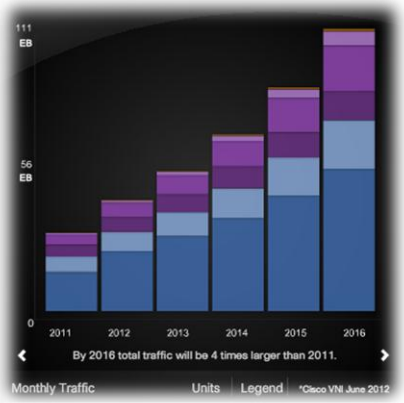
The curve!







Source: Cisco Visual Networking Index: Forecast and Methodology, 2008 - 2013

- In 2016, the gigabyte equivalent of all movies ever made will cross Global IP networks every 3 minutes.
- Globally, IP traffic will reach 15 Gigabytes per capita in 2016, up from 4 Gigabytes per capita in 2011.
- 50 Billion IP devices on Internet by 2010.

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The New World - The Internet World

- Society has become addicted to the Internet
- We "need" to be connected in the office, (wired and wireless), on the move, (wireless), at home, (broadband)

- Facebook -5 M photos uploaded per hour
- Youtube -3,000 hrs uploaded per hour

Average Western person today consumes as much data by 9.00 AM each day as a person in the 1700's did in his lifetime!!

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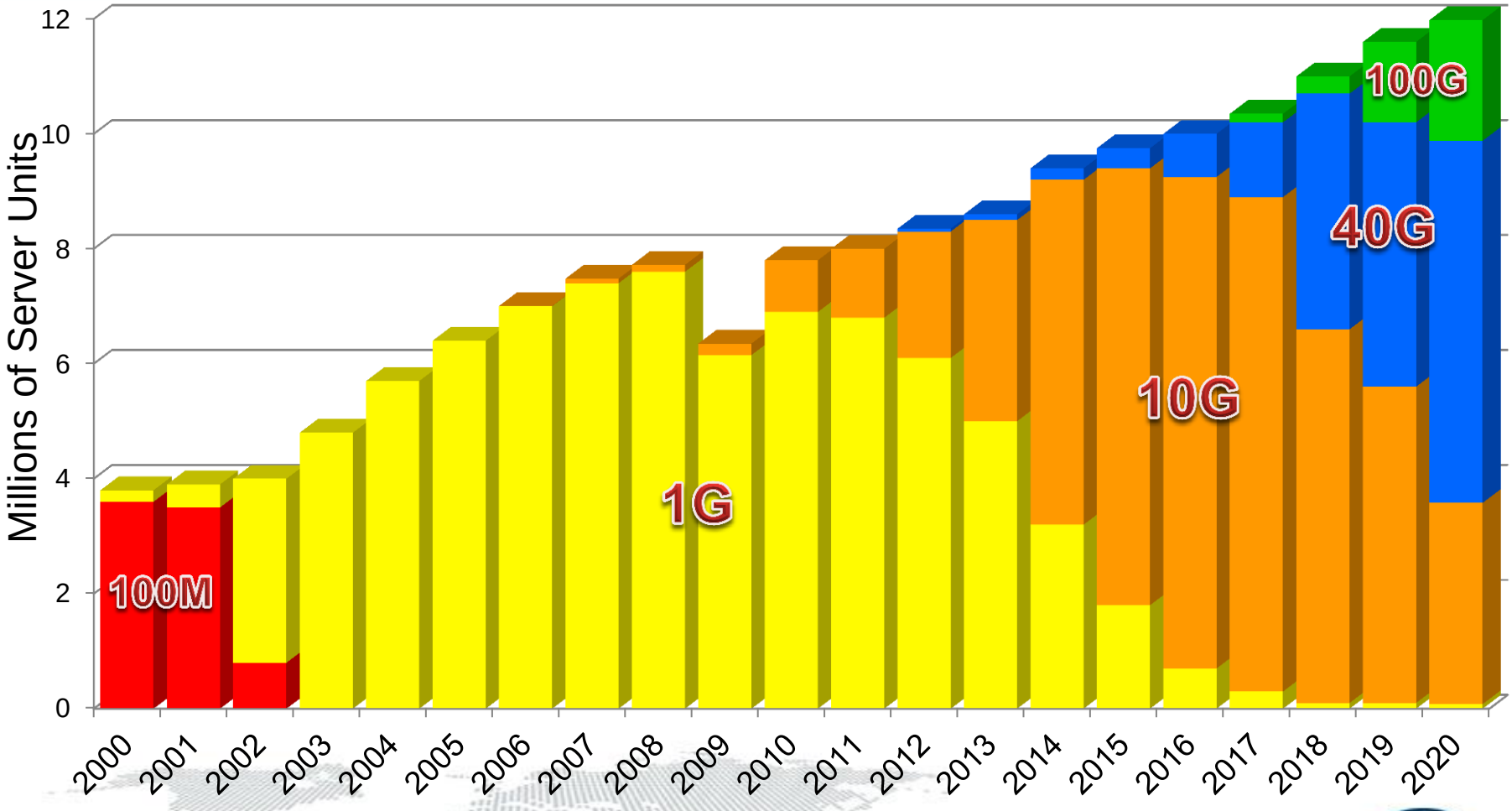
Market Data and Forecast for Server Port Speeds through 2020



Source: IEEE 802.3 NGBASE-T CFI Meeting – July 2012

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Addressing the Need for 40GbE: Current PMDs and their Applications

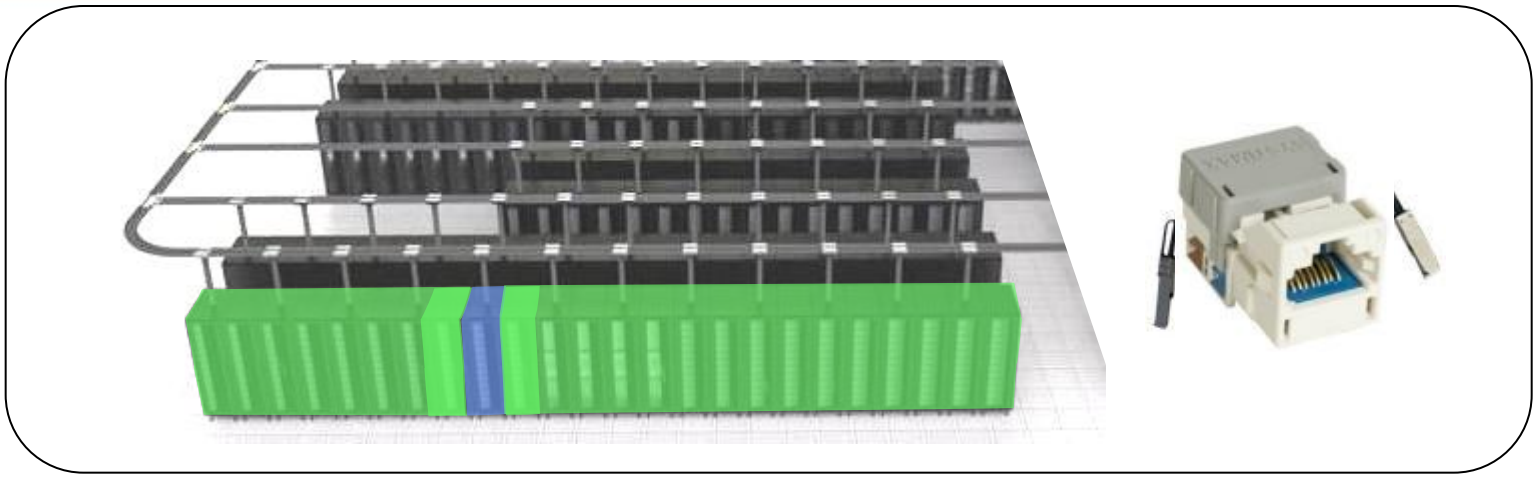
Copper

	PHY	Support	Application
	40GBASE-KR4	4 Lanes over Backplane ≤ 1 m	Backplane
	40GBASE-CR4	4 Lanes over Twinax ≤ 7 m	Top of Rack

Fibre

	40GBASE-SR4	4 Lanes @ 850 nm ≤ 100 m with OM3 ≤ 150 m with OM4	Switch Uplink
	40GBASE-LR4	4λ CWDM @ ~1310 nm ≤ 10 km with OS1/OS2	Backbone/ Carrier
	40GBASE-FR	40G @ ~1550 nm ≤ 2 km with OS1/OS2	Backbone/ Carrier

40GBASE-T Link Segment Objective



- 40GBASE-CR4 “Direct Attach” reach is limited to adjacent cabinets
- Cost effective solution needed for End-of-Row (EOR) / Middle-of-Row (MOR) topologies
- 40GBASE-T solution proposed for this application

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NGBase-T Update

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Lessons learned from 10GBASE-T

Progress To-date

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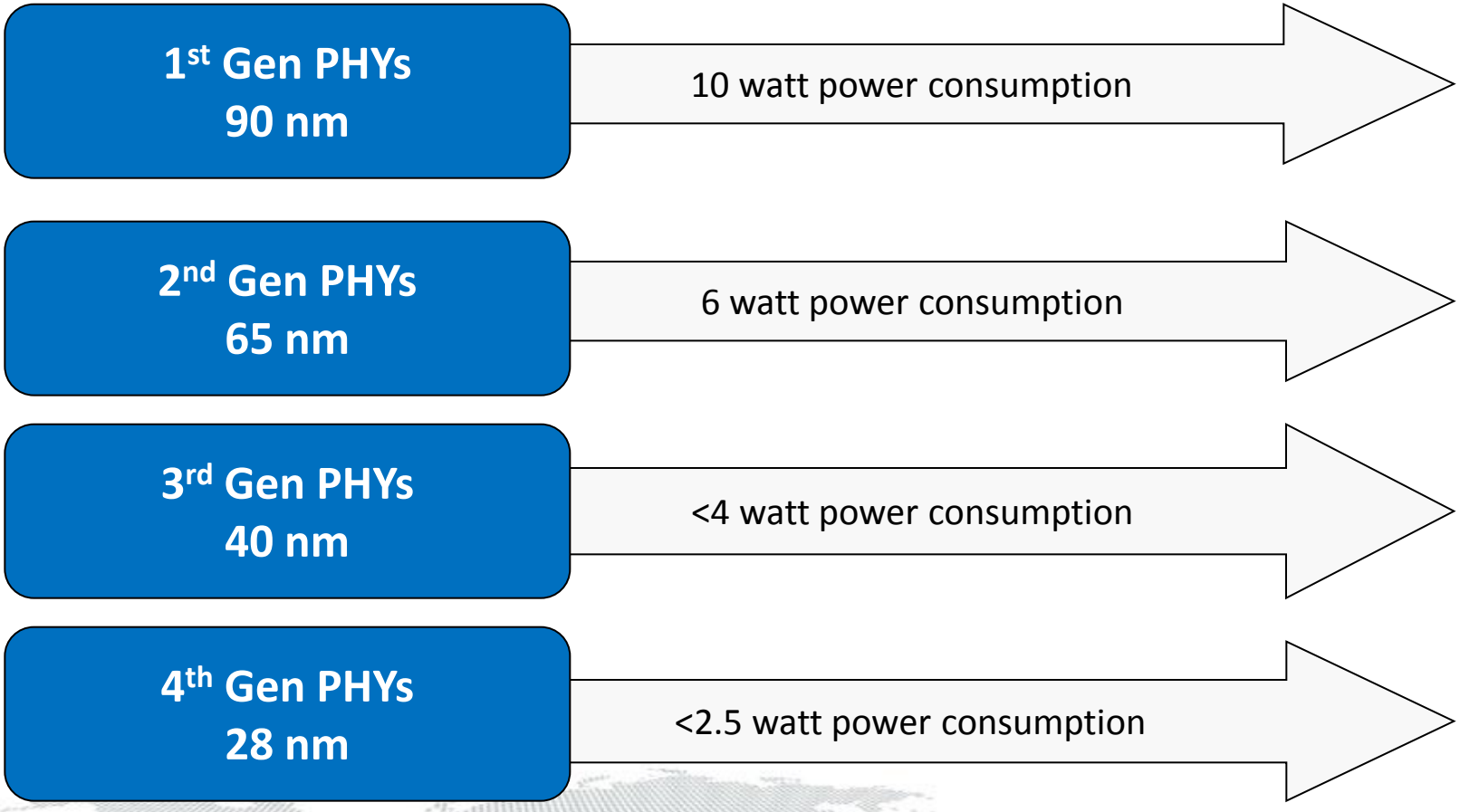
Mass Adoption of 10GBASE-T
Why so long?



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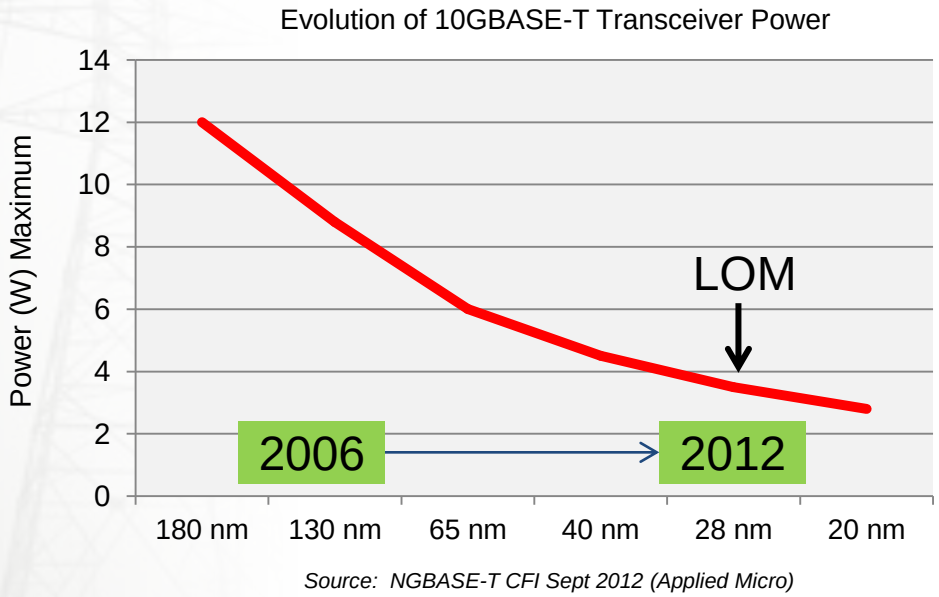
10GBASE-T and Power

- Power became *the* key design issue while 10GBASE-T was in development
- Several generations of silicon were developed before the power levels were acceptable



Source: NGBASE-T CFI Sept 2012 (Applied Micro)

- To simplify development of NGBASE-T, power concerns should be addressed up front

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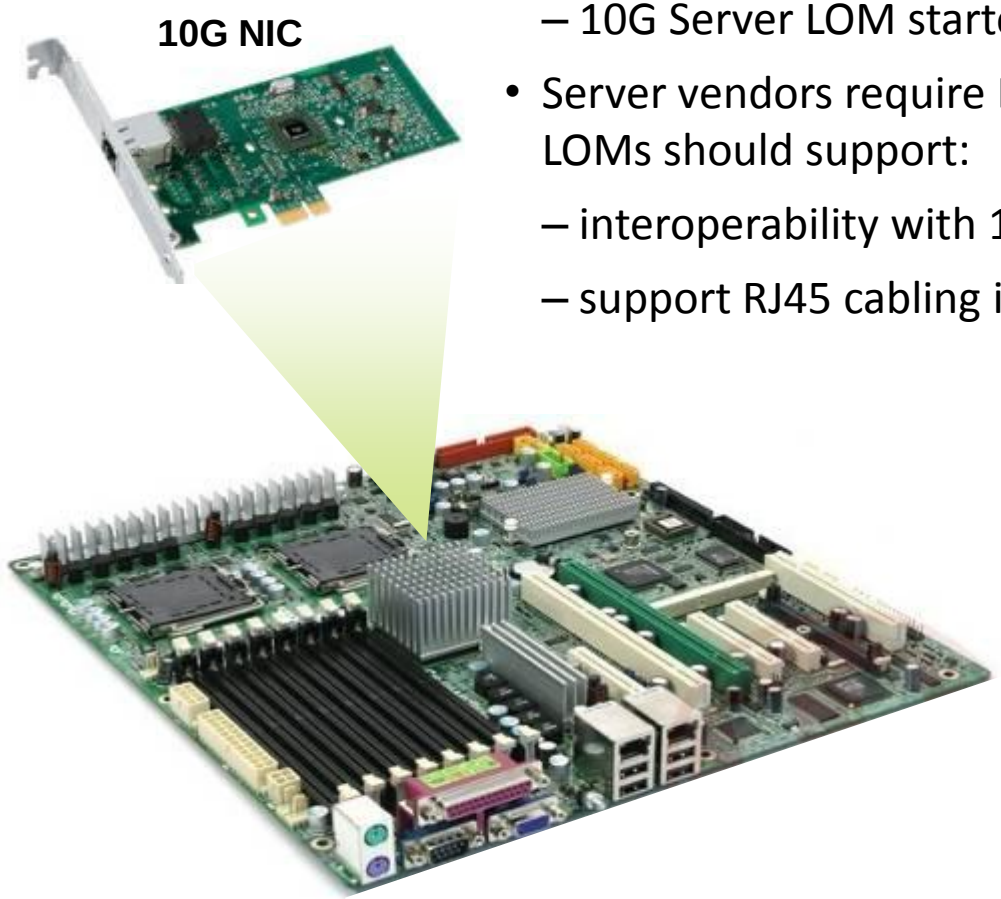
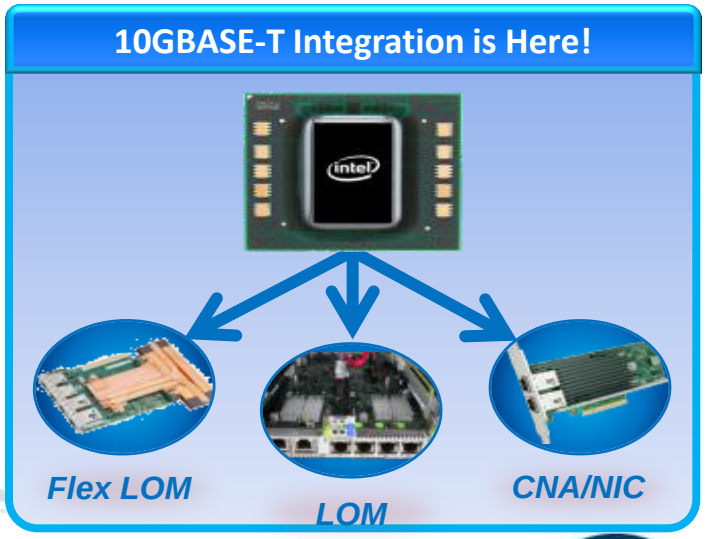
LAN on Motherboard 10GBASE-T Server Ports



- LOM removes the cost barrier to adopt 10G on servers
  - 10G Server LOM started volume shipments in 2012
- Server vendors require LOM to be backward compatible, hence LOMs should support:
  - interoperability with 100M/1G/10G switches
  - support RJ45 cabling infrastructure



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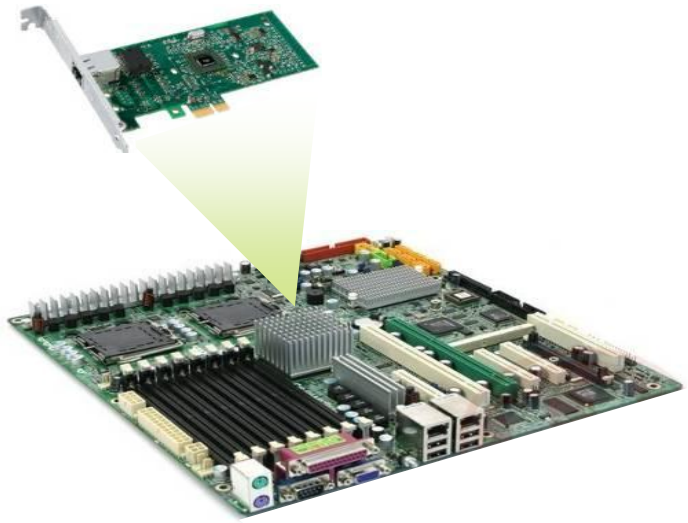
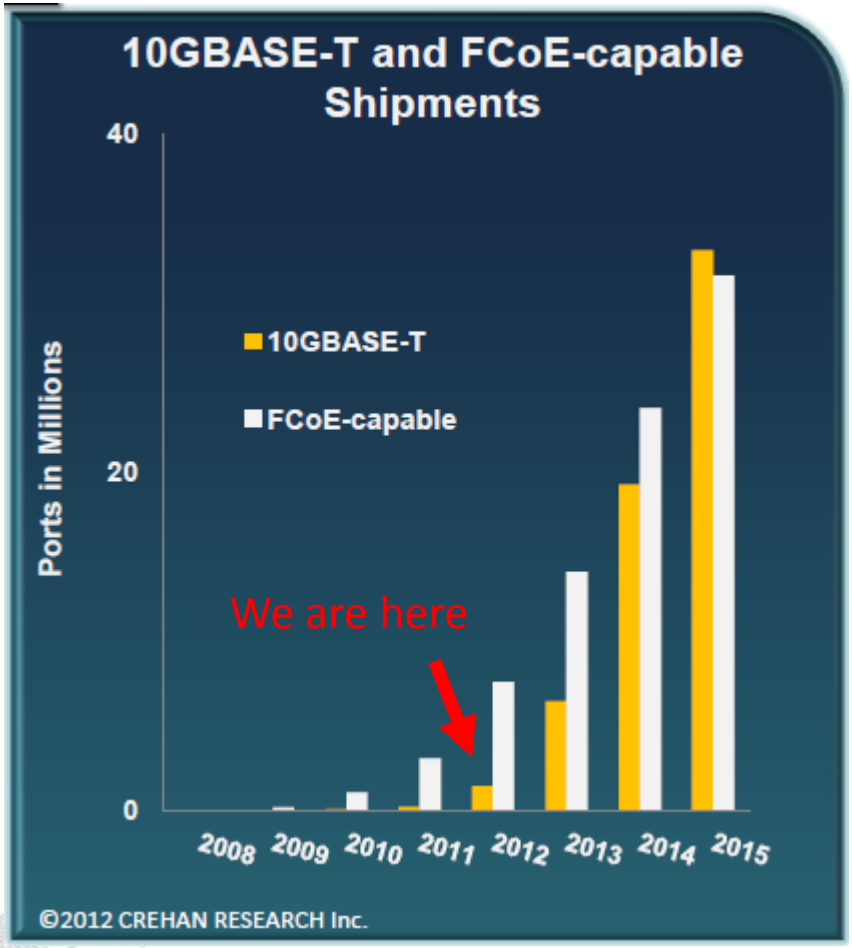
Mass Adoption of 10GBASE-T

A number of drivers:

- Costs
- Customer needs
- Key technologies
- Applications
- User scenarios and values





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NGBASE-T Transceiver Design Considerations

- Moving through several generations of silicon delayed deployment of 10GBASE-T
- Keeping the NGBASE-T complexity at the same level as 10GBASE-T will speed development
- Mass market need for 40G in the DC forecasted for 2016-17
- Higher bandwidth cabling system can facilitate this:

$$IL_{\text{10GBASE-T@100 m \& 400 MHz}} \approx IL_{\text{40GBASE-T@50 m \& 1600 MHz}}$$

- Adding 25% overhead brings frequency to 2 GHz

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NGBase-T Update

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40GbE and 100GbE Options

Interfaces	IEEE Standards	Supported Media	Distance Supported
40GBASE-KR4	802.3ba	Backplane, 4-Lane	≤ 1 m
40GBASE-CR4	802.3ba	Twinax, 4-Lane	≤ 7 m
40GBASE-SR4	802.3ba	Multimode @ 850 nm, 4-Lane	OM3 ≤ 100 m OM4 ≤ 150 m
40GBASE-LR4	802.3ba	Singlemode @ 1310 nm, CWDM	OS1/OS2 ≤ 10 km
40GBASE-FR	802.3bg	Singlemode @ 1550 nm, Serial	OS1/OS2 ≤ 2 km
100GBASE-CR10	802.3ba	Twinax, 10-Lane	≤ 7 m
100GBASE-SR10	802.3ba	Multimode @ 850 nm, 10-Lane	OM3 ≤ 100 m OM4 ≤ 150 m
100GBASE-LR4	802.3ba	Singlemode @ 1310 nm, CWDM	OS1/OS2 ≤ 10 km
100GBASE-ER4	802.3ba	Singlemode @ 1310 nm, CWDM	OS1/OS2 ≤ 40 km

CWDM: Coarse Wavelength Division Multiplexing

Extended Reach 40GbE-SR

- Emerging de-facto standard: Extended Reach 40GbE-SR QSFP+ transceivers now available
  - Avago: 40GBASE-eSR4
  - Cisco: QSFP-40G-CSR4
  - Dell Force10: GP-QSFP-40GE-ESR4
- Supports 40GbE
  - 300 m on OM3
  - 400 m on OM4
- Must be used at both ends of link

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40GbE and 100GbE Technologies in Development

Interfaces	IEEE Standards	Supported Media	Distance Supported
40GBASE-ER4	802.3bm	Singlemode @ 1310 nm, CWDM	OS1/OS2 ≤ 40 km
100GBASE-SR4	802.3bm	Multimode @ 850 nm, 4-Lane	OM3 ≤ 70 m OM4 ≤ 100 m
100GBASE-xxxx	802.3bm	Singlemode	OS1/OS2 ≤ 500 m
100GBASE-CR4	802.3bj	Twinax, 4-Lane	≤ 5 m
100GBASE-KR4	802.3bj	Backplane, 4-Lane	IL ≤ 35 dB @ 12.9 GHz IL ≤ 33 dB @ 7 GHz
100GBASE-KP4	802.3bj	Legacy Backplane, 4-Lane	

802.3bm: Q1 2015
802.3bj: Q2 2014

CWDM: Coarse Wavelength Division Multiplexing
xxxx: Not defined yet. Depends on choice of technology

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Link Aggregation: 802.3ad/802.1ax Temporary Solution

Pros

- Addresses bandwidth requirements between releases of faster links

Cons

- Non-deterministic performance
- Fastest flow limited to individual link speed
- Exponential bandwidth growth implies:
  - Exponential growth in number of links
  - Growth in operational & management issues
- Doesn't scale forever

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40GBASE-T Link Segment Objective

- Transceiver and LOM technologies require reasonable power consumption
- Committing to develop new LOM technology requires
  - Reasonable power
  - High adoption rate (economy of scale)
    - Compatibility with legacy speeds
  - Low cost
- Support Auto-Negotiation
- Define a link segment based upon copper media specified by ISO/IEC SC25 WG3 and TIA TR42.7 meeting the following characteristics:
  - 4-pair, balanced twisted pair copper cabling
  - Up to 2 connectors
  - Up to at least 30 m

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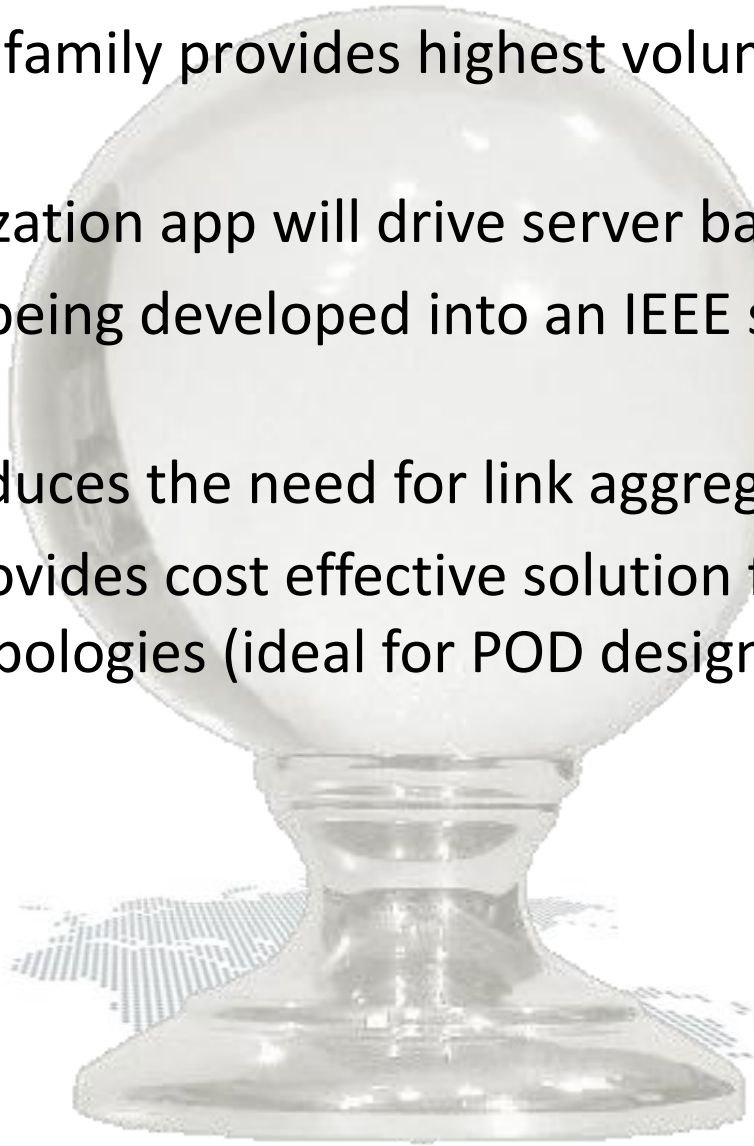
Summary

- Server BASE-T family provides highest volume Ethernet port shipment
- Server virtualization app will drive server bandwidth
- 40GBASE-T is being developed into an IEEE standard (802.3bq)
- 40GBASE-T reduces the need for link aggregation
- 40GBASE-T provides cost effective solution for EOR/MOR data center topologies (ideal for POD design)



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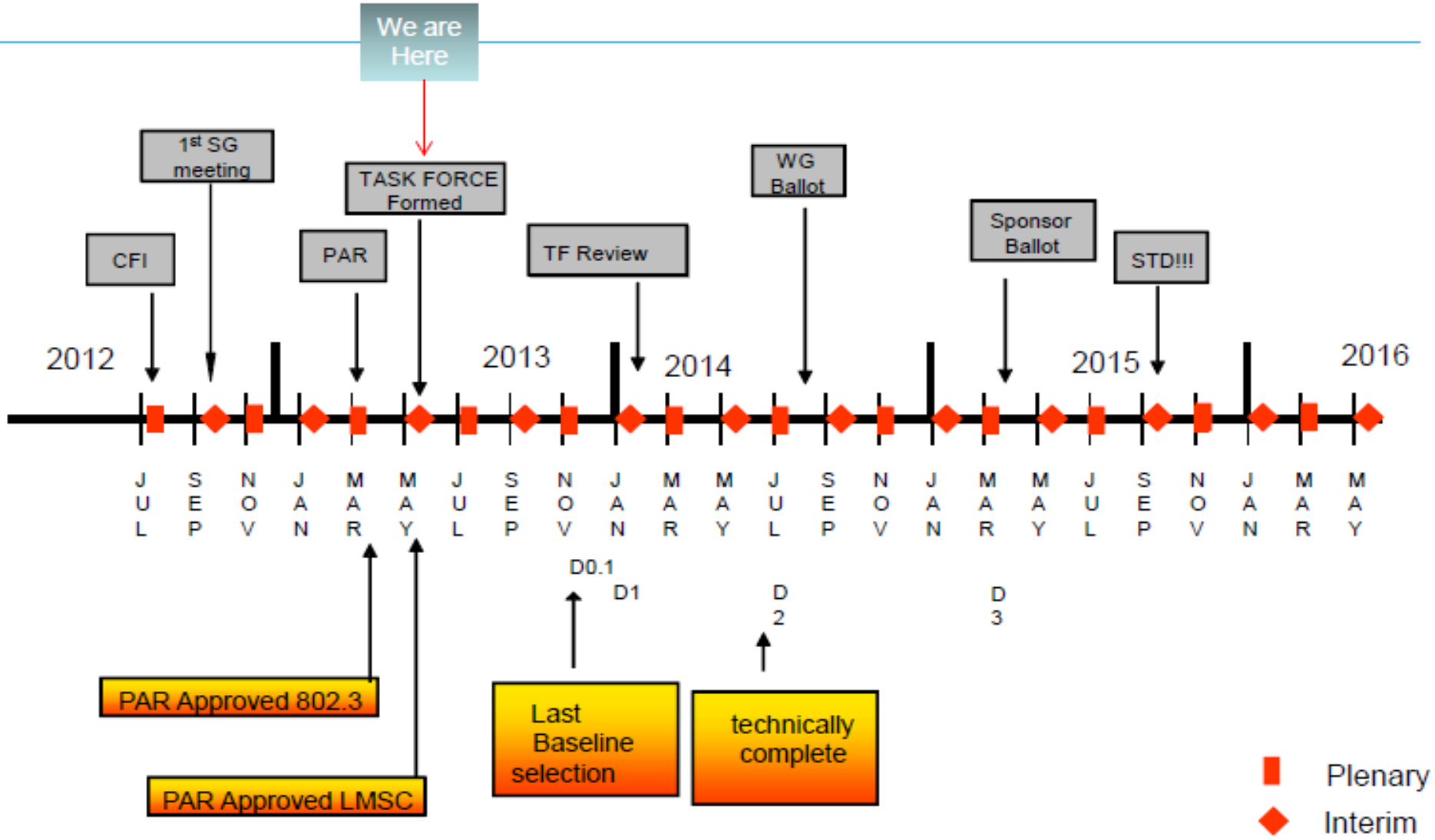
40GBASE-T Proposed Timeline



Source: IEEE 802.3 802.3bq 40GBASE-T TF May 2013

40GBASE-T Update
Activities Since January 2013

JANUARY 22	IEEE	CommScope's Category 8 channel demonstration to IEEE
February 13	TIA	TIA TR42 Meeting (02/13) Propose CAT 8 as name
MARCH 13	ISO IEC	ISO/IEC agreement on Category 8 naming convention
MARCH 20	IEEE	40GBASE-T Task Force (802.3bq) announced.

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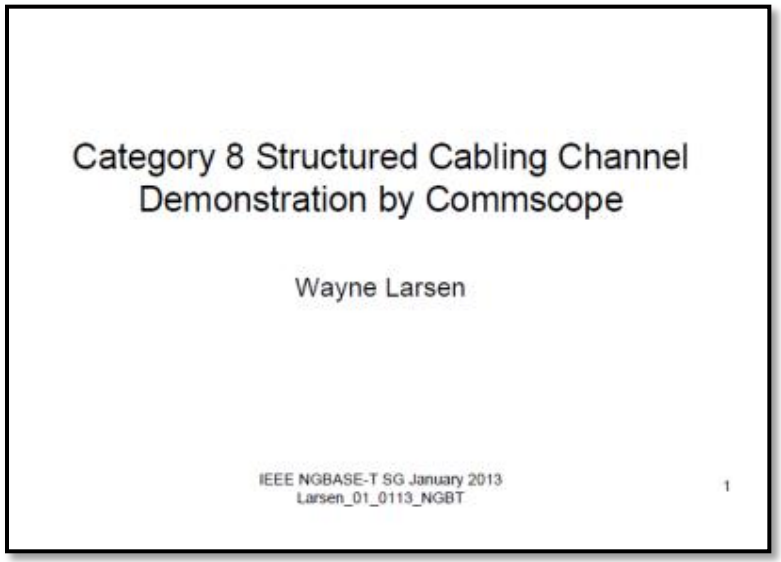
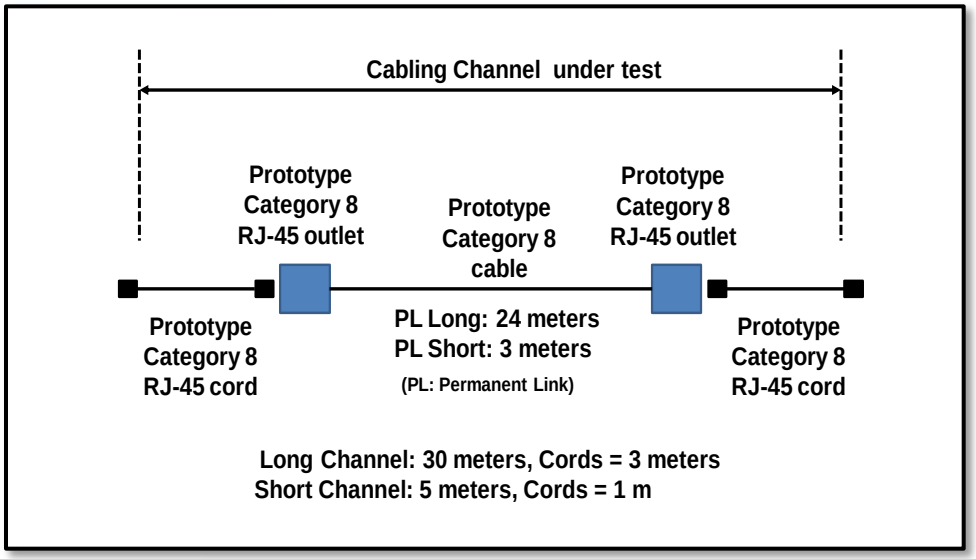
CAT 8 Demonstration to IEEE January 2013

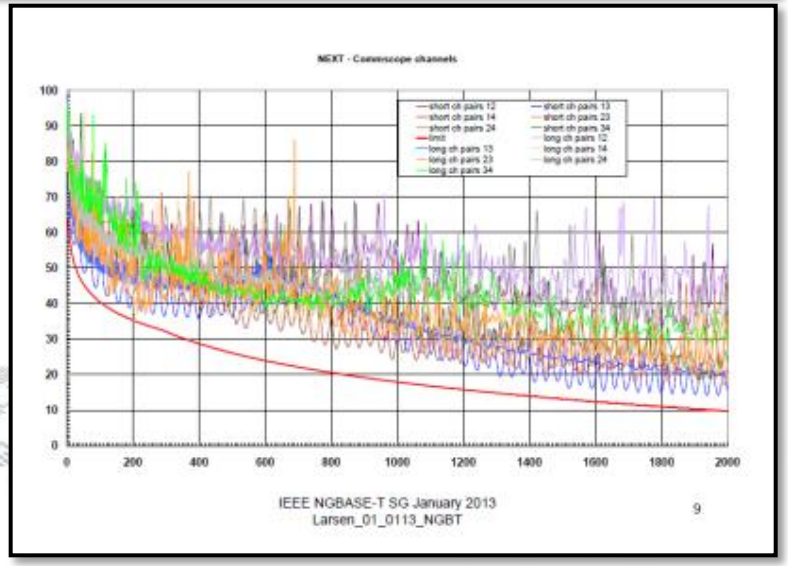




As a follow up to the joint contribution made to IEEE in November with Belden, CommScope presented an end to end proof of concept Category 8 channel with our components: cable, connectors and cords.

- Focused our commitment on the ubiquitous RJ-45 connector
- Press Release issued 14 February, broadly reported on in trade press

http://www.ieee802.org/3/NGBASET/public/jan13/Larsen_01a_0113_NGBT.pdf



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Category 8 Press Release Tremendous Media Coverage

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CommScope demos technical feasibility of Category 8 copp

February 15, 2013

CommScope Showcases Technical Feasibility of Category 8 Copper

Datacenter Dynamics

COMMSCOPE DEMOS CATEGORY 8 CABLING

40gbps on copper twisted pair cables

14 February 2013 by DatacenterDynamics FOCUS

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CommScope demos Cat 8 feasibility enterprise

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CommScope demos technical feasibility of Category 8 copper cabling system

February 14, 2013

CommScope announced that it has successfully demonstrated the technical feasibility of Category 8 cab enterprise networks. The company calls the demonstration "a step along the path towards a viable 40GB

Topic: Networking

Follow via:

40Gbps 'copper cabling' Ethernet one step closer to becoming reality

Summary: Prototype Category 8 RJ-45 connectors and copper twisted pair cables were used in a proof-of-concept demonstration of the technology to an IEEE study group.

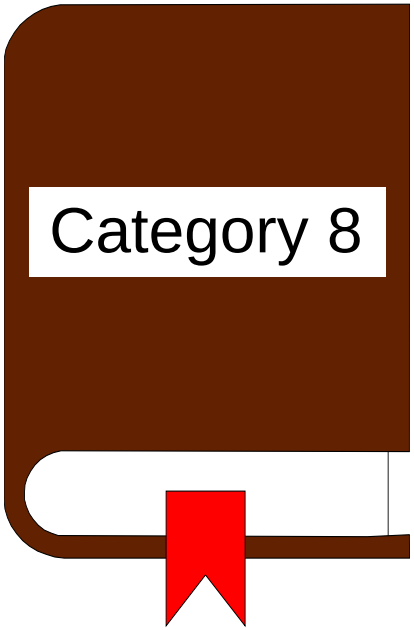
By Adrian Kingsley-Hughes for Hardware 2.0 | February 14, 2013 -- 15:06 GMT (07:06 PST)

40Gbps Ethernet breakthrough

Posted by admin on Mar 4, 2013 in Datacentre, Structured ca

More on the news we Tweeted last week, that Commscope has succ towards a viable 40GBASE-T system for datacentre applications.

TIA TR-42.7: Category 8



First Draft Proposal from CommScope
Feb 2012

TIA selected Category 8 nomenclature
Oct 2012

TIA Liaison (Draft Spec) to IEEE
Nov 2012

CommScope Category 8 POC to IEEE
Jan 2013

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TIA TR-42.7: Category 8

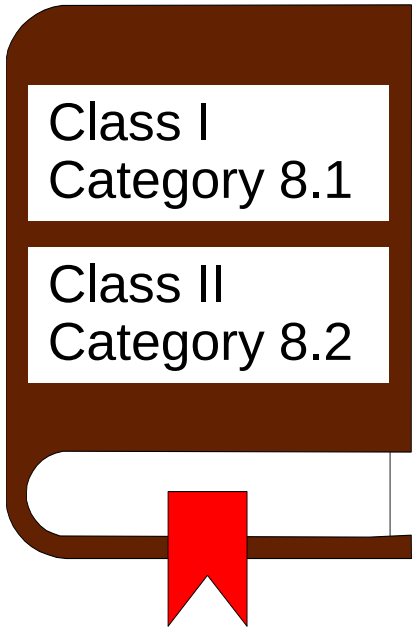
- Specified to 2 GHz
- Minimum cable design: F/UTP
- Align configuration with IEEE objective: 2-connection, 30 meters channel
- Adopted ISO Class II channel RL spec
  - Improved connector RL required
  - Cable RL unchanged
- New task group formed to study “the concept of ISO Class II limits” for Category 8 cabling

TIA Category 8: Backward-Compatibility Matrix

		Category of Modular Connecting Hardware Performance				
		Cat 3	Cat 5e	Cat 6	Cat 6A	Cat 8
Category of Modular Plug and Cord Performance	Cat 3	Cat 3	Cat 3	Cat 3	Cat 3	Cat 3
	Cat 5e	Cat 3	Cat 5e	Cat 5e	Cat 5e	Cat 5e
	Cat 6	Cat 3	Cat 5e	Cat 6	Cat 6	Cat 6
	Cat 6A	Cat 3	Cat 5e	Cat 6	Cat 6A	Cat 6A
	Cat 8	Cat 3	Cat 5e	Cat 6	Cat 6A	Cat 8

Matrix of backward-compatible mated component performance

ISO/IEC JTC1 SC25 WG3: Category 8.1 and Category 8.2



Draft Technical Report (PDTR 11801-99-1) Nov 2012

Class I
Class II

ISO Liaison to IEEE Nov 2012

ISO selected Category 8.1 and Category 8.2 nomenclatures Mar 2013

Class I: Cat 8.1
Class II: Cat 8.2

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ISO/IEC JTC1 SC25 WG3: Category 8.1 and Category 8.2

- Class I: Uses Category 8.1 components

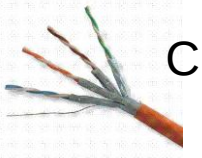
  Class II: Uses Category 8.2 components
- Cat 8.1: Minimum cable design: F/UTP

  Cat 8.2: Minimum cable design: x/FTP
- Specified to 1.6 GHz with 2 GHz under consideration
- Configuration: 2-connection, 30 meters channel

Channel I achieved by using **Category 8.1** components (F/UTP)

- ISO/IEC Category 8.1 components are backwards compatible and interoperable with Category 6A

RJ-45



Channel II achieved using **Category 8.2** components (S/FTP)

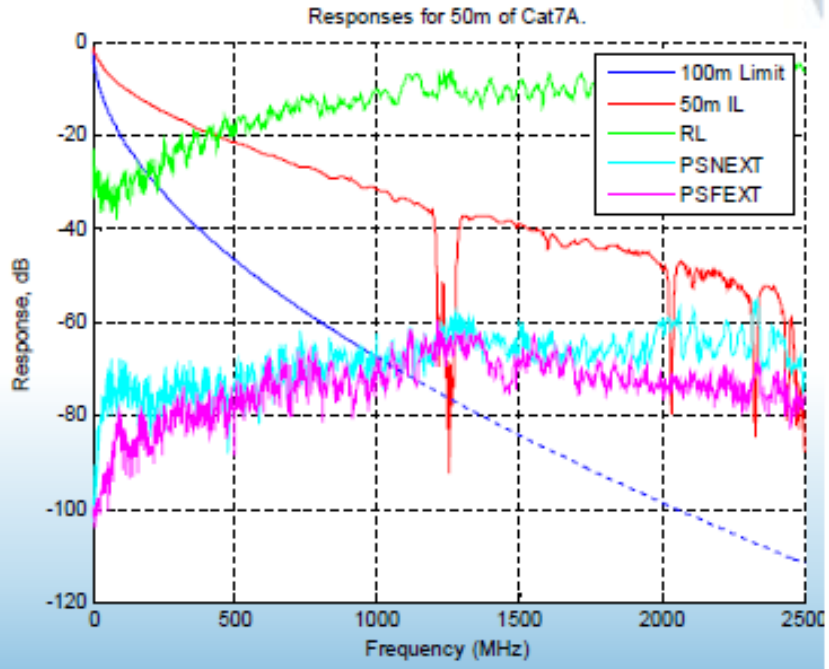
- *Implied* that ISO/IEC Category 8.2 components are backwards compatible and interoperable with Category 7A

RJ-45 or Non-RJ-45

Existing Cat 7A Cables IL

THE 50M DATA

- The suck out at ~1200MHz means we should avoid putting Nyquist here. Note it violates the 100m IL extrapolated limit line.
- Outer shielding means Alien XT is not a concern.
- Very good PSNEXT and PSFEXT levels (still >20dB down on signal even at 1GHz).
- RL crosses IL at less than 500MHz.
- Implies echo will dominate impairments at receiver.

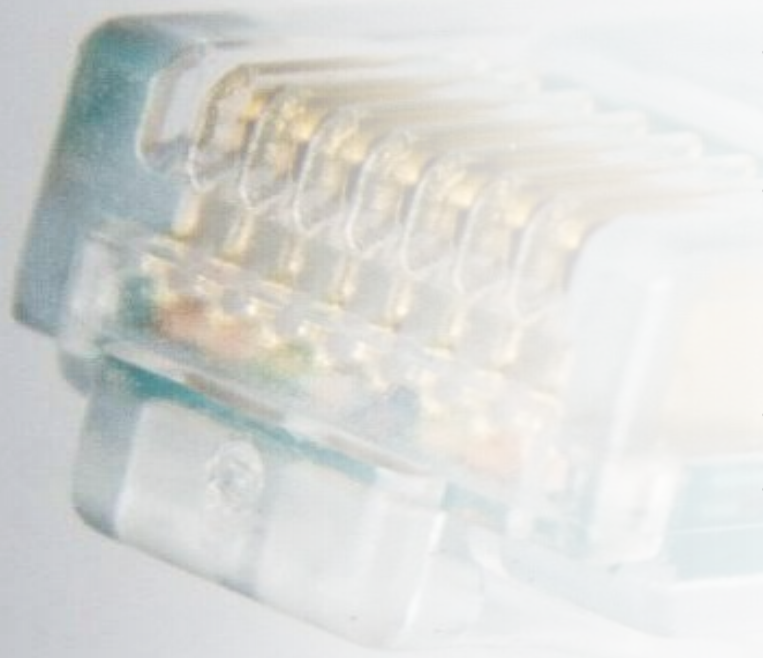


ISO/IEC SC25 WG3 Cat 8: Backward-Compatibility Matrix

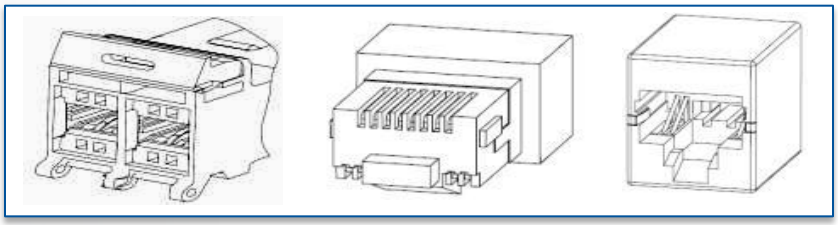
		Category of Modular Connecting Hardware Performance						
		Cat 5e	Cat 6	Cat 6_A	Cat 7	Cat 7_A	Cat 8.1	Cat 8.2
Category of Modular Plug and Cord Performance	Cat 5e	Cat 5e	Cat 5e	Cat 5e	Cat 5e	Cat 5e	Cat 5e	Cat 5e
	Cat 6	Cat 5e	Cat 6	Cat 6	Cat 6	Cat 6	Cat 6	Cat 6
	Cat 6_A	Cat 5e	Cat 6	Cat 6_A	Cat 6_A	Cat 6_A	Cat 6_A	Cat 6_A
	Cat 7	Cat 5e	Cat 6	Cat 6_A	Cat 7	Cat 7	Cat 6_A	Cat 7
	Cat 7_A	Cat 5e	Cat 6	Cat 6_A	Cat 7	Cat 7_A	Cat 6_A	Cat 7_A
	Cat 8.1	Cat 5e	Cat 6	Cat 6_A	Cat 6_A	Cat 6_A	Cat 8.1	Cat 8.1
	Cat 8.2	Cat 5e	Cat 6	Cat 6_A	Cat 7	Cat 7_A	Cat 8.1	Cat 8.2

Matrix of backward-compatible mated component performance

Category 8 and the RJ-45



- RJ-45 Proves itself again
- World's only ubiquitous connector
- Long the industry favourite for data cabling
- Prevalent in other industries
  - Facilities
  - Consumer electronics
- Where Ethernet goes, so goes the RJ-45
- Alternate design connectors have met with very limited success to date



- **Category 8 objective is to use the RJ-45**

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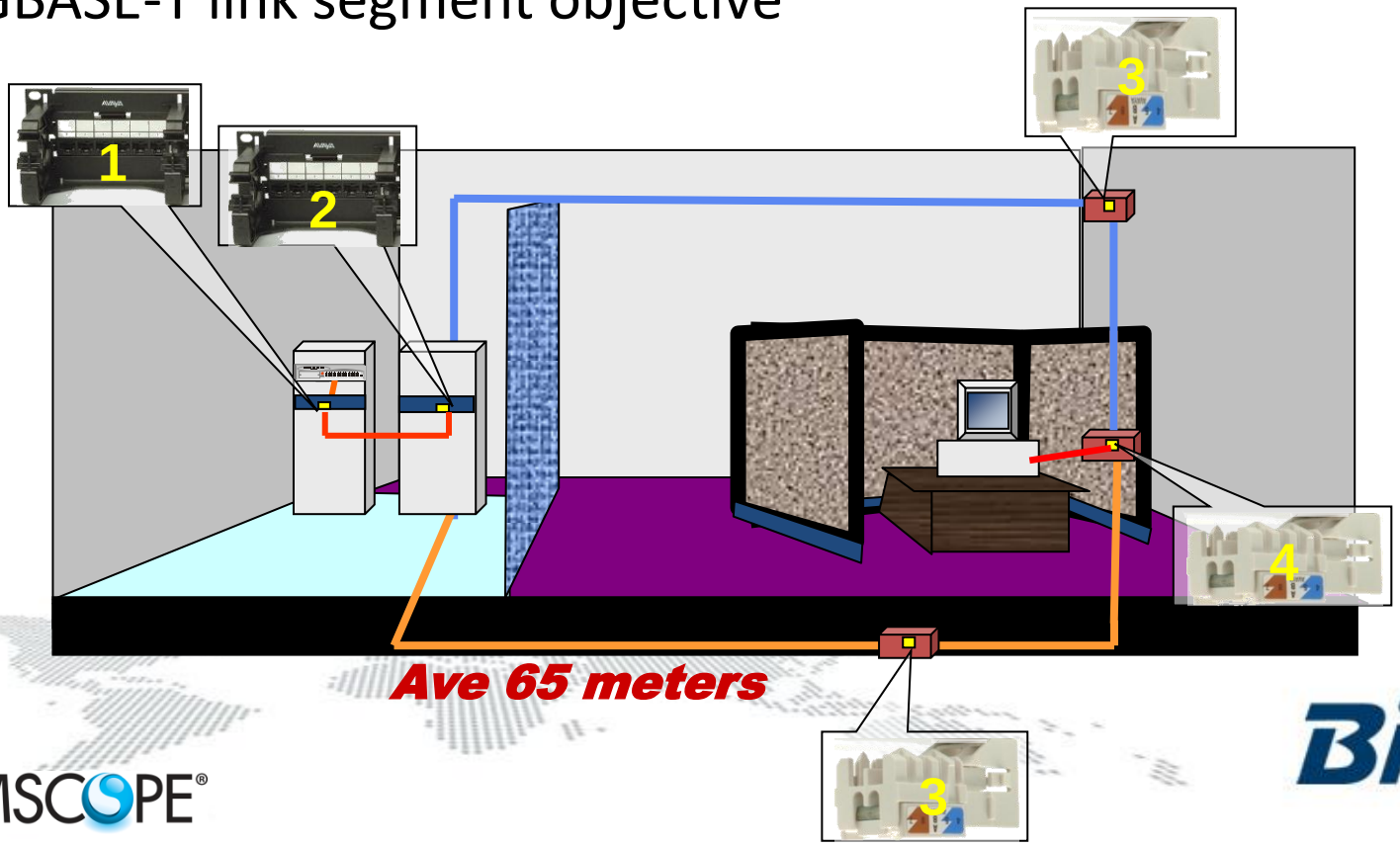
Impact on Enterprise Architecture Design

- IEEE 802.3bq 40GBASE-T link segment objective is 2-connection, 30 meters
- Majority of installed Enterprise cabling links exceed the 40GBASE-T link segment objective



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Summary and Key Points

- **The cabling industry has come together and is building a clear path for supporting 40G applications over copper , and that path is Category 8**
- Rapid Progress to-date:
  - Use of industry favourite RJ45 connector
  - Demonstrated working 40GBase-T Channel out to 2 GHz
  - Current draft Category 8 specifications specified to at least 1.6 GHz
    - ISO/IEC TR 11801-99-1 Class I (Category 8.1) and Class II (Category 8.2) specified to 1.6 GHz
    - TIA Category 8 specified to 2 GHz
    - The choice of code to use for 40GBASE-T will determine the ultimate critical frequency for the app and therefore the maximum frequency for the cabling specifications. This decision will be determined by the IEEE 802.3bq task force (primarily the equipment/transceiver vendors)
  - Two connectors channel configuration, at least up to 30 meters

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Summary and Key Points

- Future of Category 7/7A is questionable
  - It has not been completely ruled out for 40G
  - Establishment of Category 8 specs in ISO/IEC out to 1600 MHz does raise serious questions about its viability
  - Raises serious question of any value add for CAT7/7A over Cat6A
  - Category 7A is specified to only 1 GHz
  - Current installed base of ‘Category 7A‘ cabling IL doesn’t meet the proposed draft Category 8 IL specifications
  - In addition, majority of the installed base of ‘Category 7A‘ cabling consists of Category 7A cables terminated on Cat 6 or Cat 6A connectors and connecting hardware
  - Also, majority of installed Enterprise cabling links exceed the 40GBASE-T link segment objective

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