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Bandwidth Growth and the Next Speed of Ethernet

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Regarding the Views Expressed

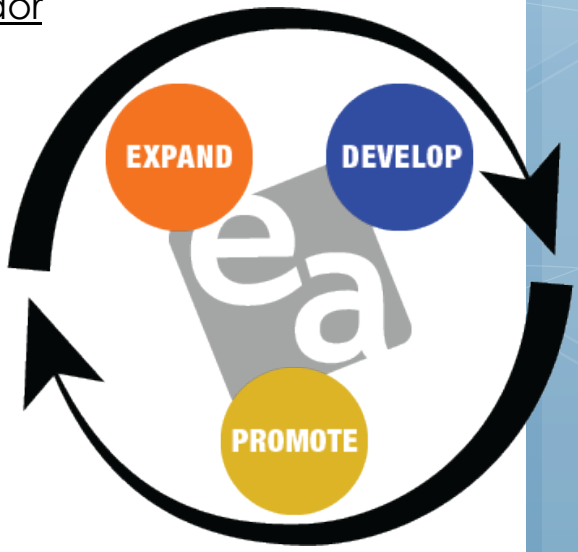
- The views expressed on IEEE standards and related products should NOT be considered the position, explanation, or interpretation of the Ethernet Alliance.

- 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."

THE ETHERNET ALLIANCE

- A global community of end users, system vendors, component suppliers and academia
- **Its Mission**
  - To promote industry awareness, acceptance and advancement of technology and products based on, or dependent upon, both existing and emerging IEEE 802 Ethernet standards and their management.
  - To accelerate industry adoption and remove barriers to market entry by providing a cohesive, market responsive, industry voice.
  - Provide resources to establish and demonstrate multi-vendor interoperability.
- **Activities**
  - Promote marketing and education awareness
  - Interoperability testing and demonstration
  - Industry consensus building
  - Technology and standards incubation
- For more information – see www.ethernetalliance.org



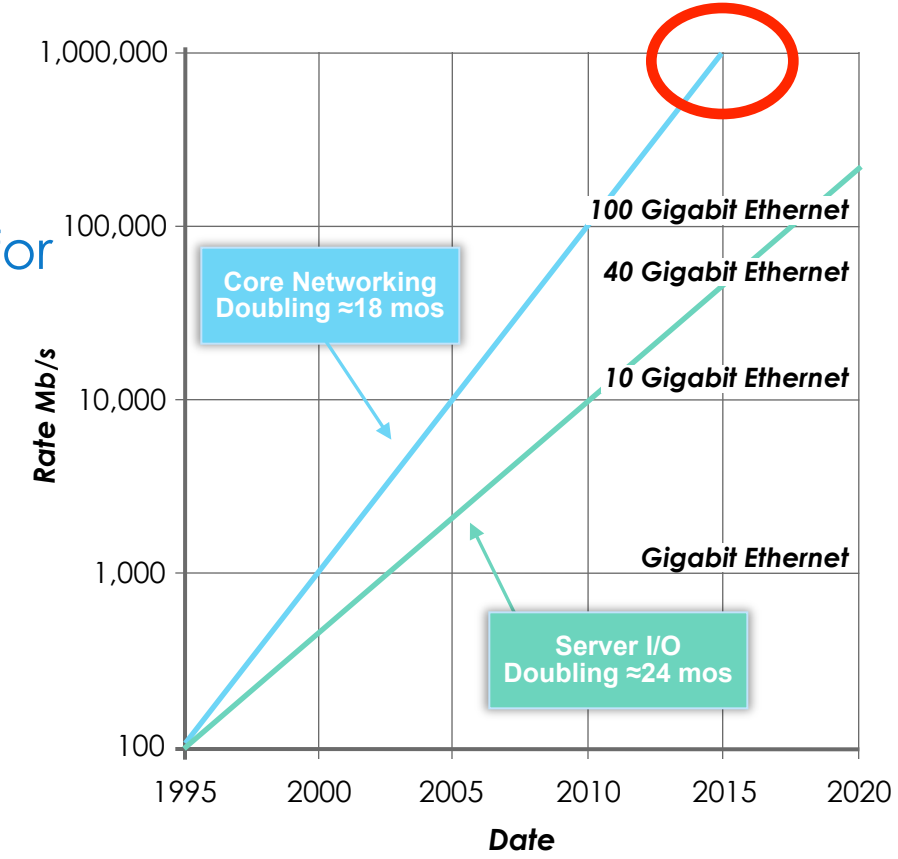
Findings of the IEEE 802.3 Ethernet Bandwidth Assessment Ad Hoc

Life after IEEE P802.3ba

- End-users through the prior HSSG: The next speed of Ethernet must begin when 100GbE done!
- HSSG Bandwidth Forecast for "Core Networking"
  - 2013: 400 Gb/s
  - 2015: 1 Tb/s
- Other bandwidth trends?

- 2011 Formation of:

  IEEE 802.3 Ethernet Bandwidth Assessment Ad Hoc

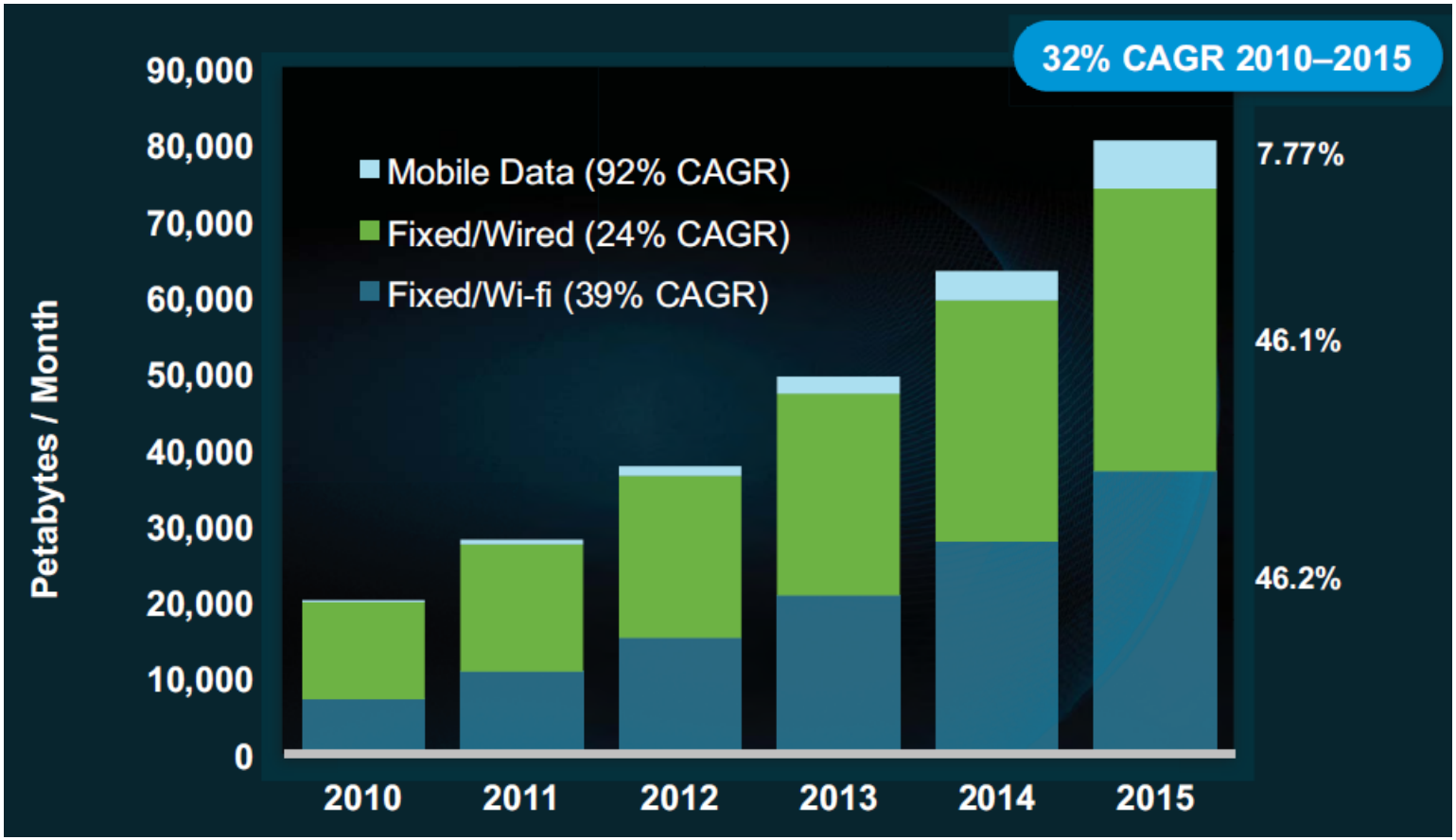


Source: 2007 HSSG Tutorial,
http://www.ieee802.org/3/hssg/public/nov07/HSSG_Tutorial_1107.zip

IEEE 802.3 BWA Ad Hoc Information

- Charter and Scope
  - Evaluate Ethernet wireline bandwidth needs of the industry
  - Reference material for a future activity
  - The role of this ad hoc is to gather information, not make recommendations or create a CFI
- Webpage - http://www.ieee802.org/3/ad_hoc/bwa/index.html
- Reflector - http://www.ieee802.org/3/ad_hoc/bwa/reflector.html
- Final report - http://www.ieee802.org/3/ad_hoc/bwa/BWA_Report.pdf
- The report summarizes inputs from a variety of sources on:
  - Server architectures and bandwidth requirements
  - Network architectures and bandwidth requirements
  - End user requirements and bandwidth usage
  - Forecasts for Internet, storage and transport network bandwidth

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

Data Center Growth

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Increased Storage + **Increased Processing** + **Increased Bandwidth** = **Bandwidth Explosion**

Networking

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

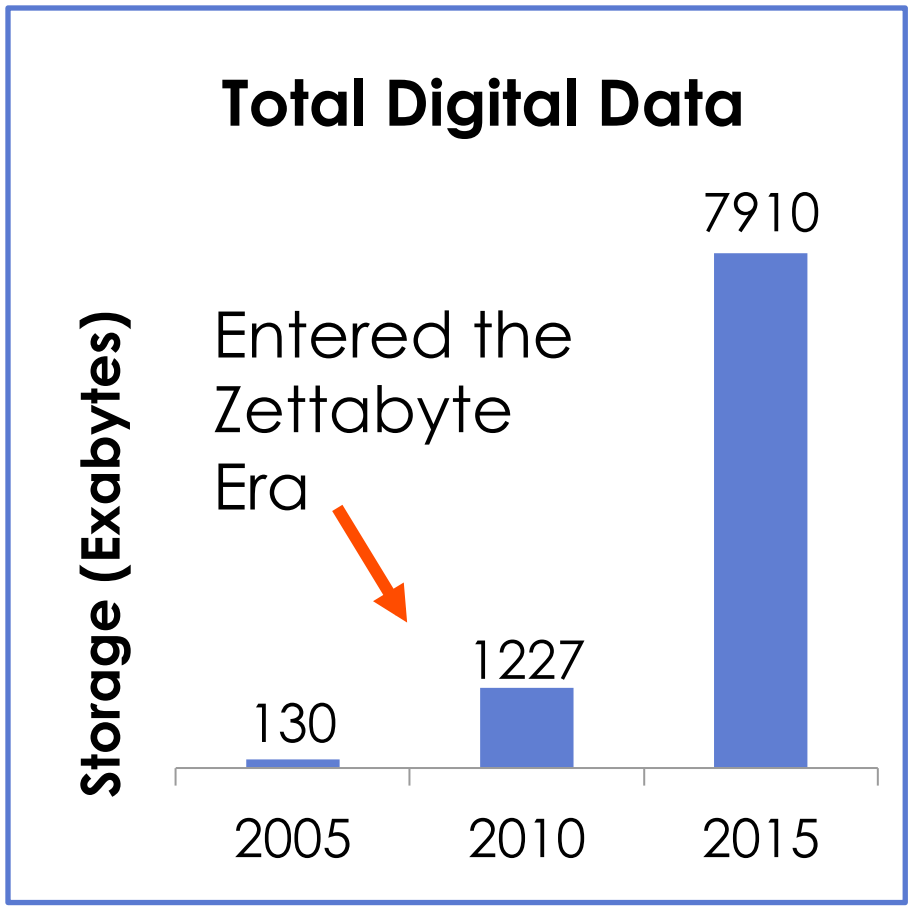
Compute

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

External Storage Shipments

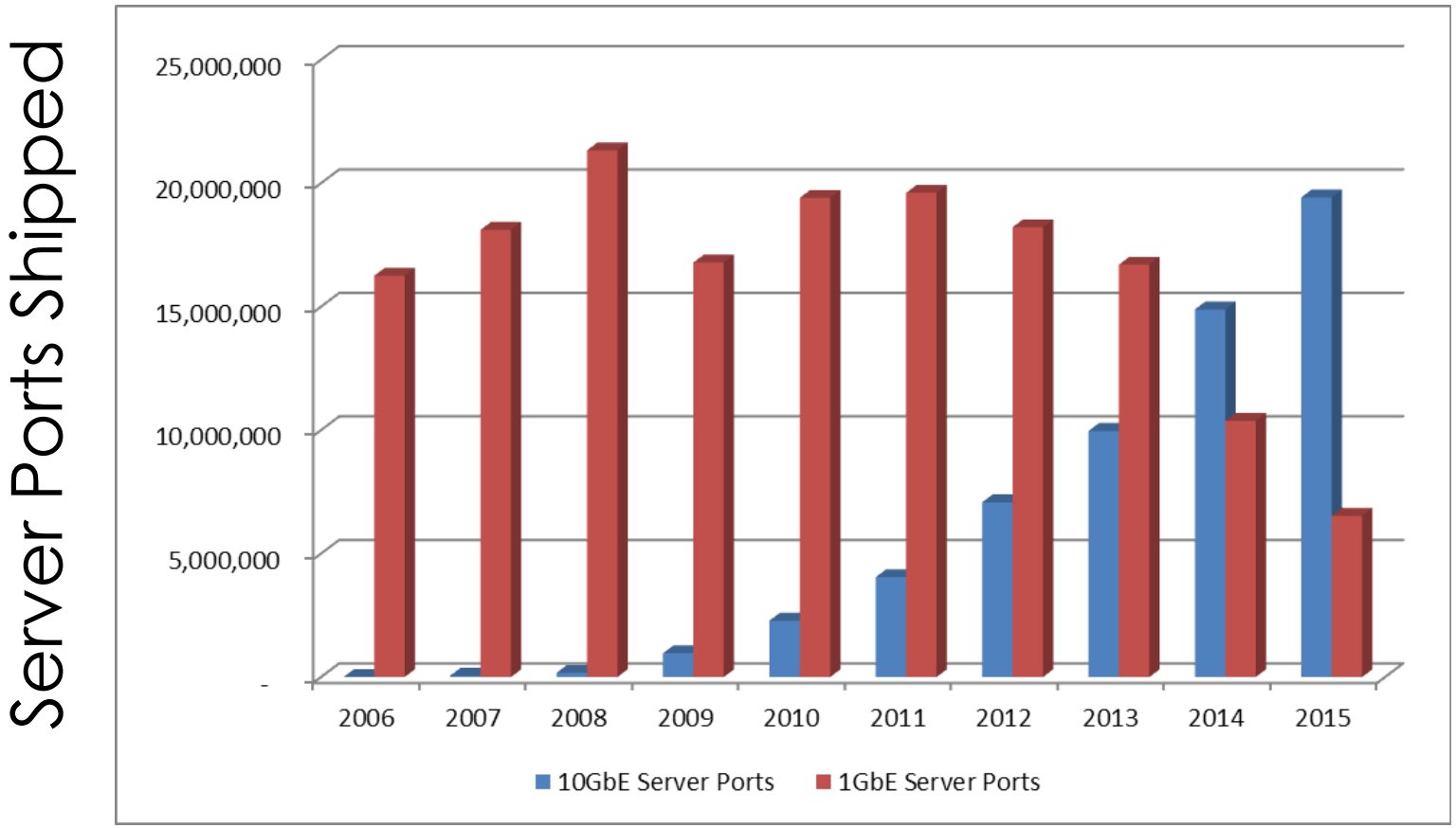


Growth over Next Decade	
# of Servers	x10
Storage	x50
# of Files	x75

Consider the implications!

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

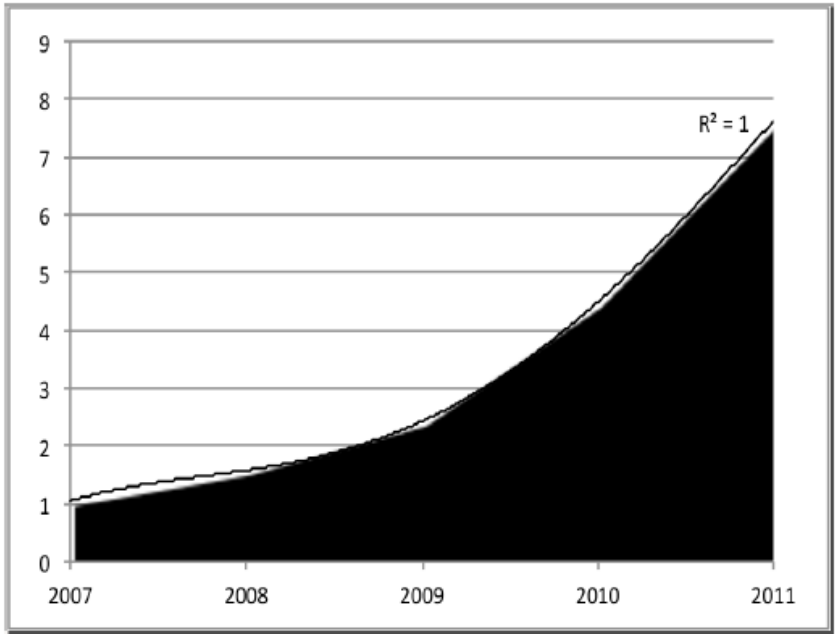
Server Port Speed

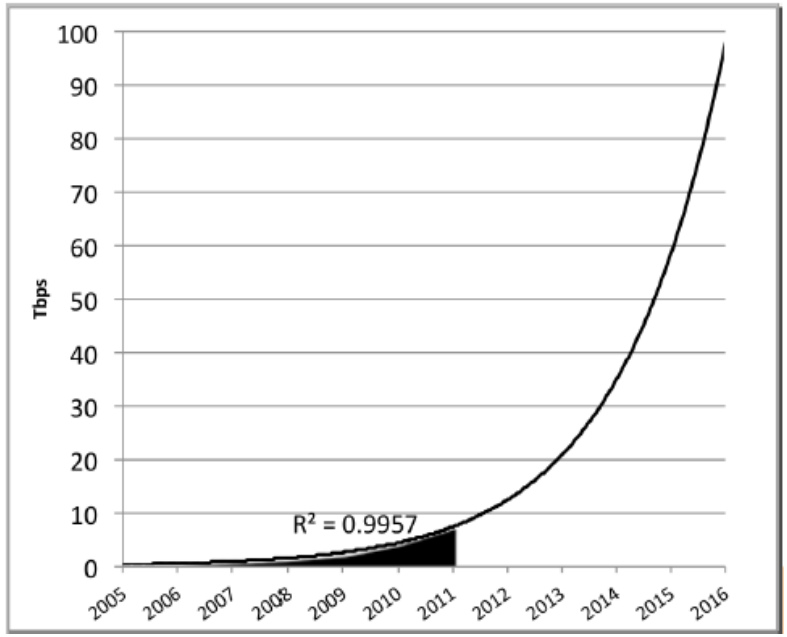


Source: http://www.ieee802.org/3/ad_hoc/bwa/public/jul11/brown_01a_0711.pdf

Five Year Peak European IXP Traffic Projections

EURO-IXP peak traffic surpassed 7 Tbps in 2011 and projected to reach over 90 Tbps in 2016





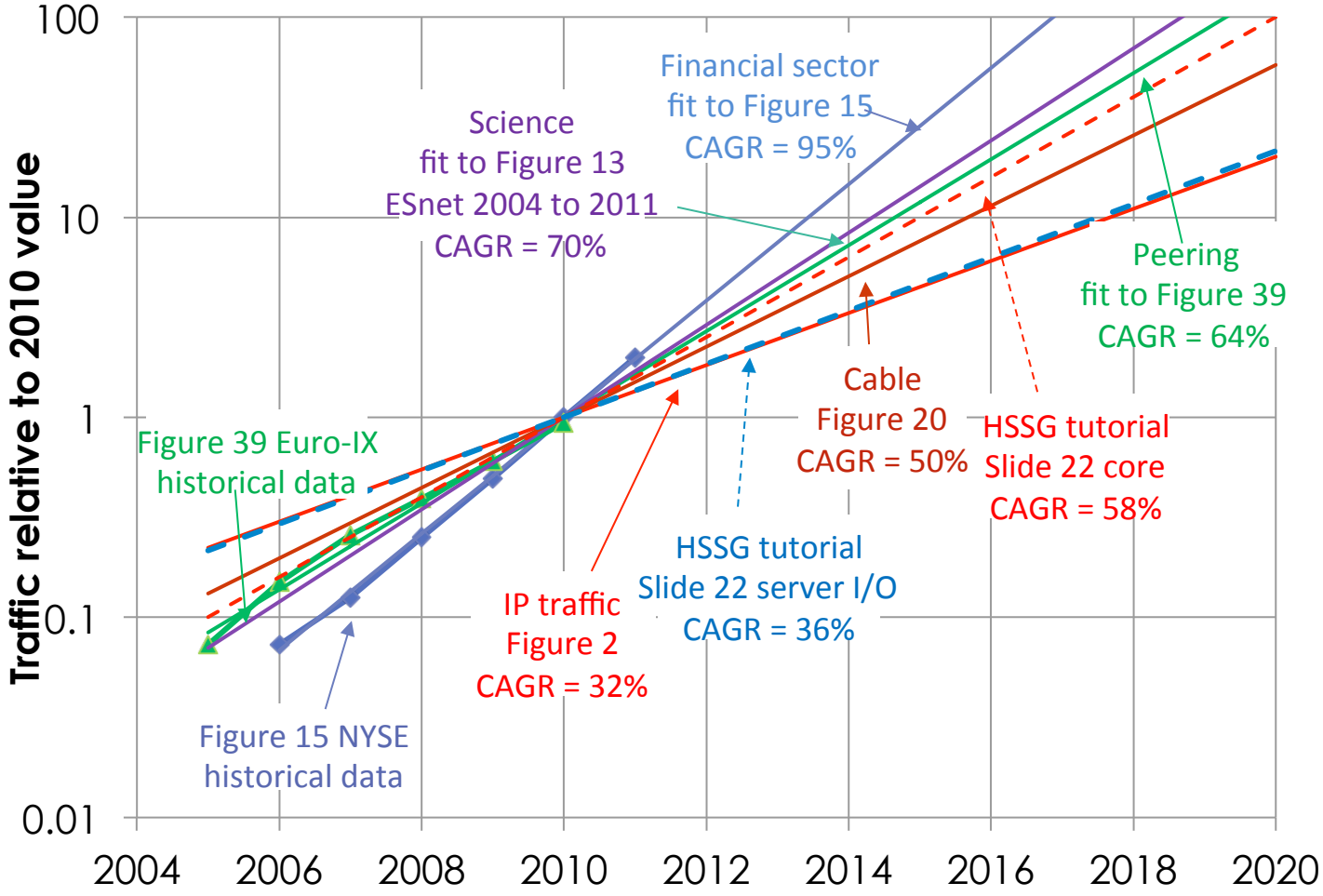
Note: These charts are updated from the data in the BWA report

Source: http://www.ethernetalliance.org/wp-content/uploads/2012/04/Ethernetnet-Alliance-ECOC-2012-Panel-2.pdf

Summary method

- Relative growth of the various sectors plotted on a single chart
  - The growth of each sector was normalized to 2010 (the year IEEE Std 802.3ba was approved)
- This growth is a predictor of the future only if downward cost per bit trend is continued
  - Ethernet cost per bit has to fall with time or the predicted exponential rise in traffic will result in unsupportable costs
- Servicing demand with existing rates or new ones > 100 Gb/s will depend on the cost effectiveness of the solution

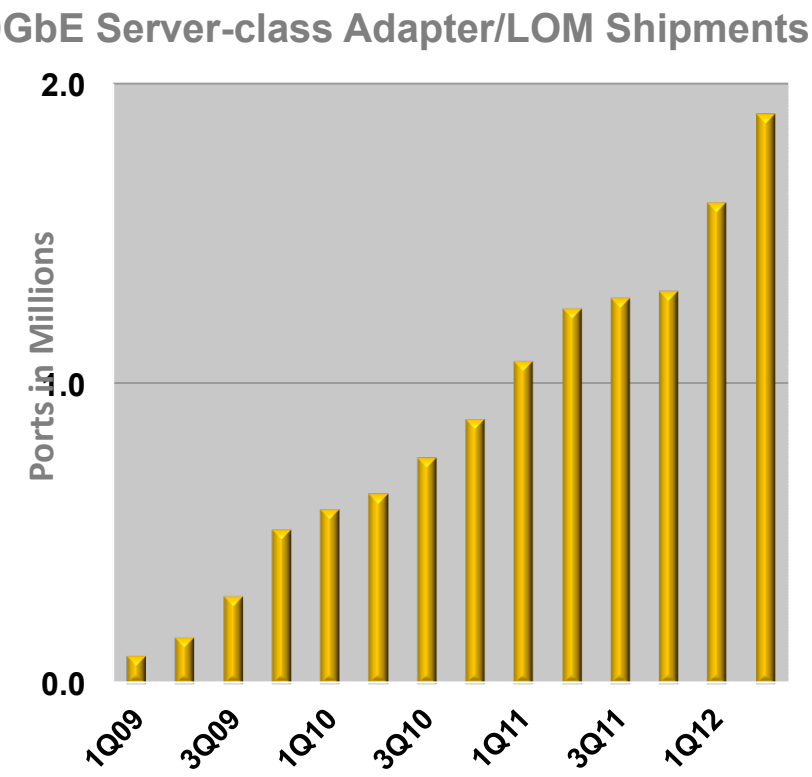
Forecast: 2015: Terabit! 2020:10 Terabit!

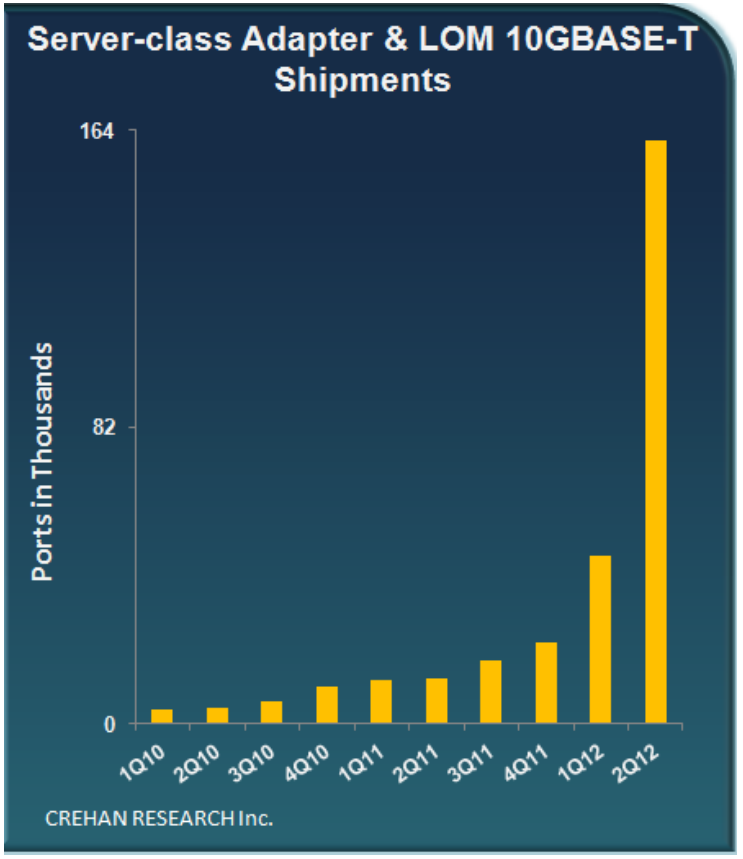


Source: IEEE 802.3 Ethernet Bandwidth Assessment, http://www.ieee802.org/3/ad_hoc/bwa/BWA_Report.pdf.

The Next Speed Of Ethernet

The 10GbE Server Market Looks Bright!





All data used with permission Seamus Crehan, Crehan Research.

The Future is Here

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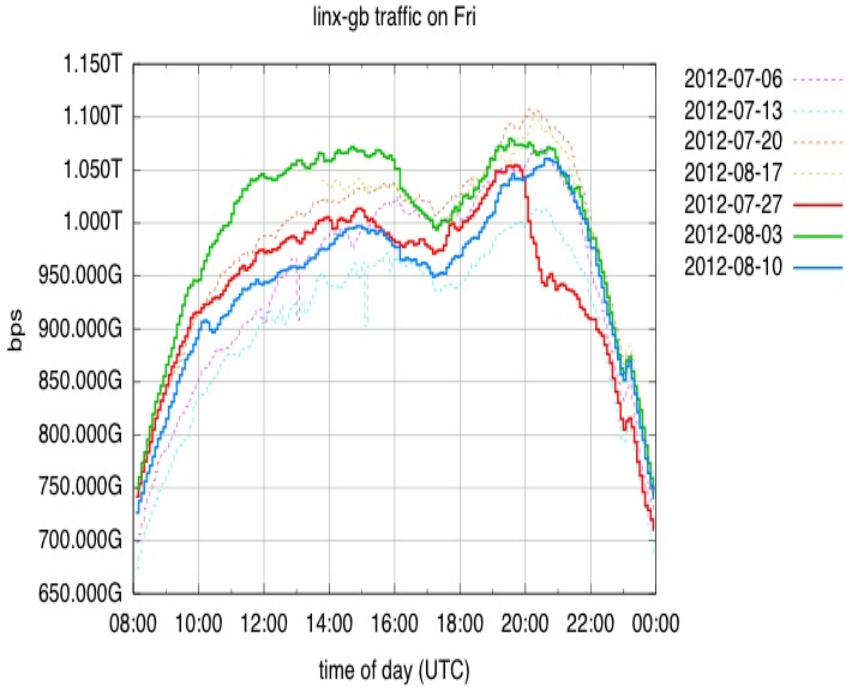
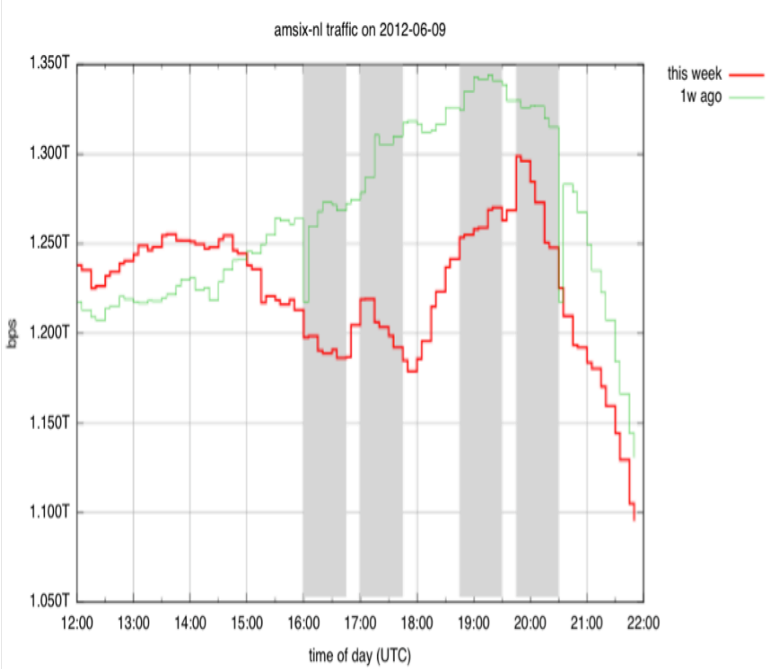
2012 Summer Olympics



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.

IEEE 802.3 HSE Consensus Ad Hoc

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- Charter and Scope
  - Focus on building consensus related to the next speed of Ethernet for wireline applications, which will be used for the evaluation and possible development of an IEEE 802.3 Call-For-Interest for the next Higher Speed Study Group. The requested duration for this Industry Connections activity is 12 months.
- Webpage – http://www.ieee802.org/3/ad_hoc/hse/index.html
- Reflector - http://www.ieee802.org/3/ad_hoc/bwa/reflector.html
- Participation is open and all are invited.
- Chair – John D'Ambrosia, Dell

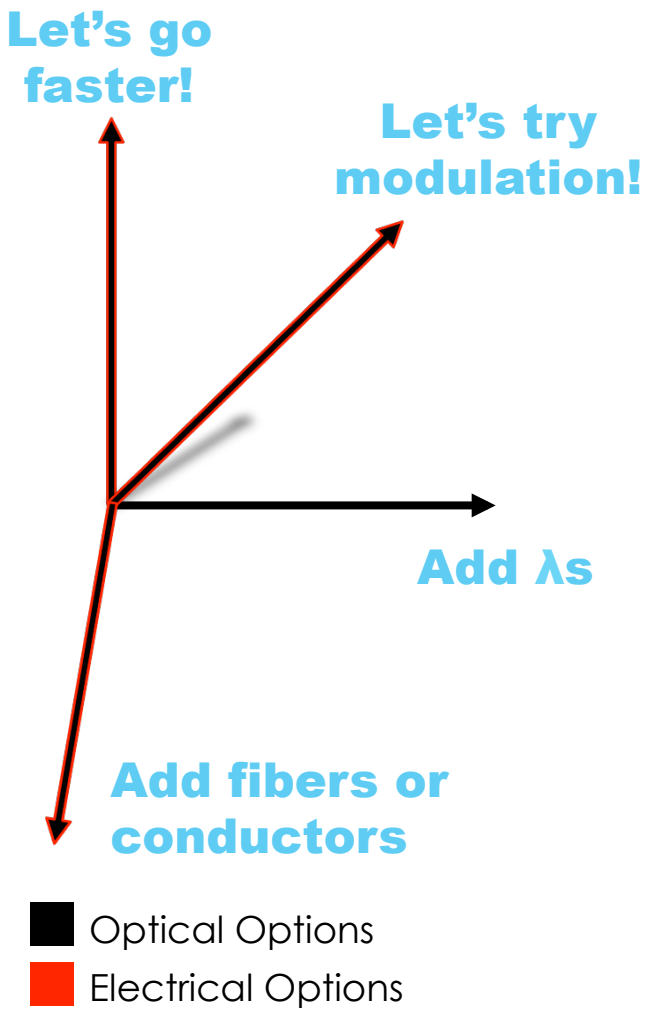
Sept 12 Highlights

- Webpage - http://www.ieee802.org/3/ad_hoc/hse/public/12_09/index.shtml
- Strawpoll - I support the following data rate as the basis for near term CFI:
  - 1. 400 Gb/s 61
  - 2. 1 Tb/s 0
  - 3. 400 Gb/s and 1 Tb/s 0
  - 4. Rate TBD in SG 1
  - 5. No CFI 0
- Agreement – CFI to be requested for March 2013, pending progress of group.

Considering the Options

- **Time Division Multiplexing**
  - Let's go faster
- **Modulation**
  - Let's add more symbols per second
- **Wavelength Division Multiplexing**
  - Let's add wavelengths
- **Space Division Multiplexing**
  - Let's add fibers or conductors

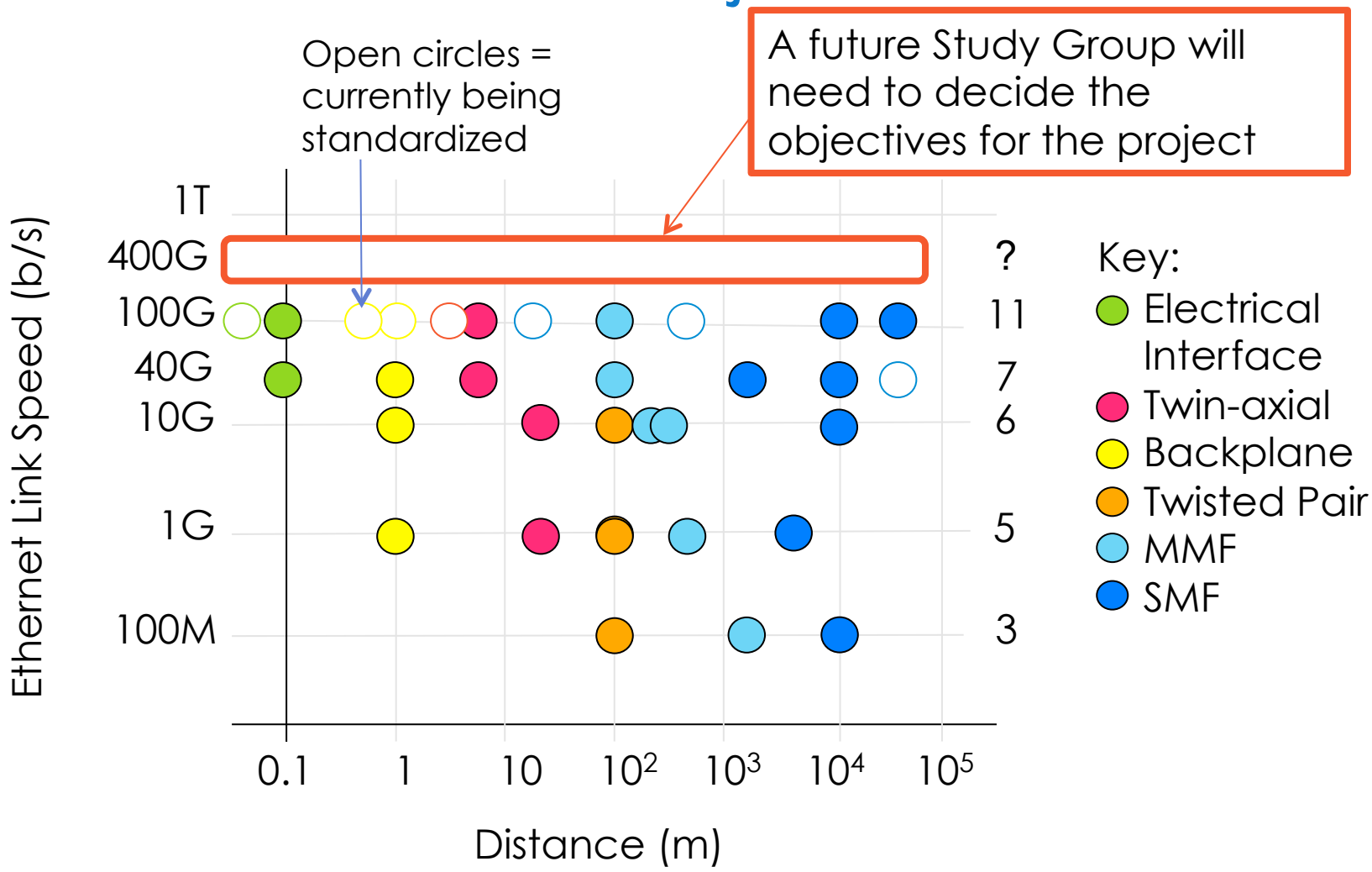
Bit rate, Gb/s	Gb/s per Lane	Number of lanes
100	10	10
	25	4
400	25	16
	40	10
	50	8
1000	25	40
	50	20



400 GbE versus TbE

- Terabit capacities forecasted for 2015
- Cost target approximately at or below 100G cost/bit/s
- 400 GbE
  - Time is of the essence
  - Technical feasibility – leverage developed and emerging technologies
    - MAC
    - 25 Gb/s signaling
- Terabit Ethernet
  - Time for economic / technical feasibility solutions not know

Possible 400GbE Objectives



Based on slide used with permission by David Law

Ethernet Alliance

- 400 GbE SubCommittee formed
  - Build consensus on requirements and standardization of 400 GbE
  - Gather and exchanging data relative for observed deployment models, applications, reaches
  - Build industry awareness
- We need your support on answering questions regarding
  - Broad market potential
  - Reach
  - Media

Summary

- Bandwidth capacity growing at an average of 58% CAGR
  - In 2015 the average demand will be 10x the demand in 2010
  - In 2020 the average demand will be 100x the demand in 2010
- IEEE 802.3 Higher Speed Ethernet Consensus Ad hoc formed
- Developing consensus on the next speed of Ethernet
  - When? CFI planned in March
  - Rate? 400GbE is the growing consensus
  - Physical Layer Specifications? (reach, media)
- The Ethernet Alliance is collecting input from multiple groups regarding these issues to provide input into the IEEE

Discussion and Q&A

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Thank you