The Findings of the IEEE 802.3 Industry Connections Ethernet Bandwidth Assessment Ad Hoc

(Plus Updated Data)

Joint ITU/IEEE Workshop
Ethernet – Emerging Applications and Technologies

Geneva, Switzerland
22 September 2012

Regarding the Expressed Views

- 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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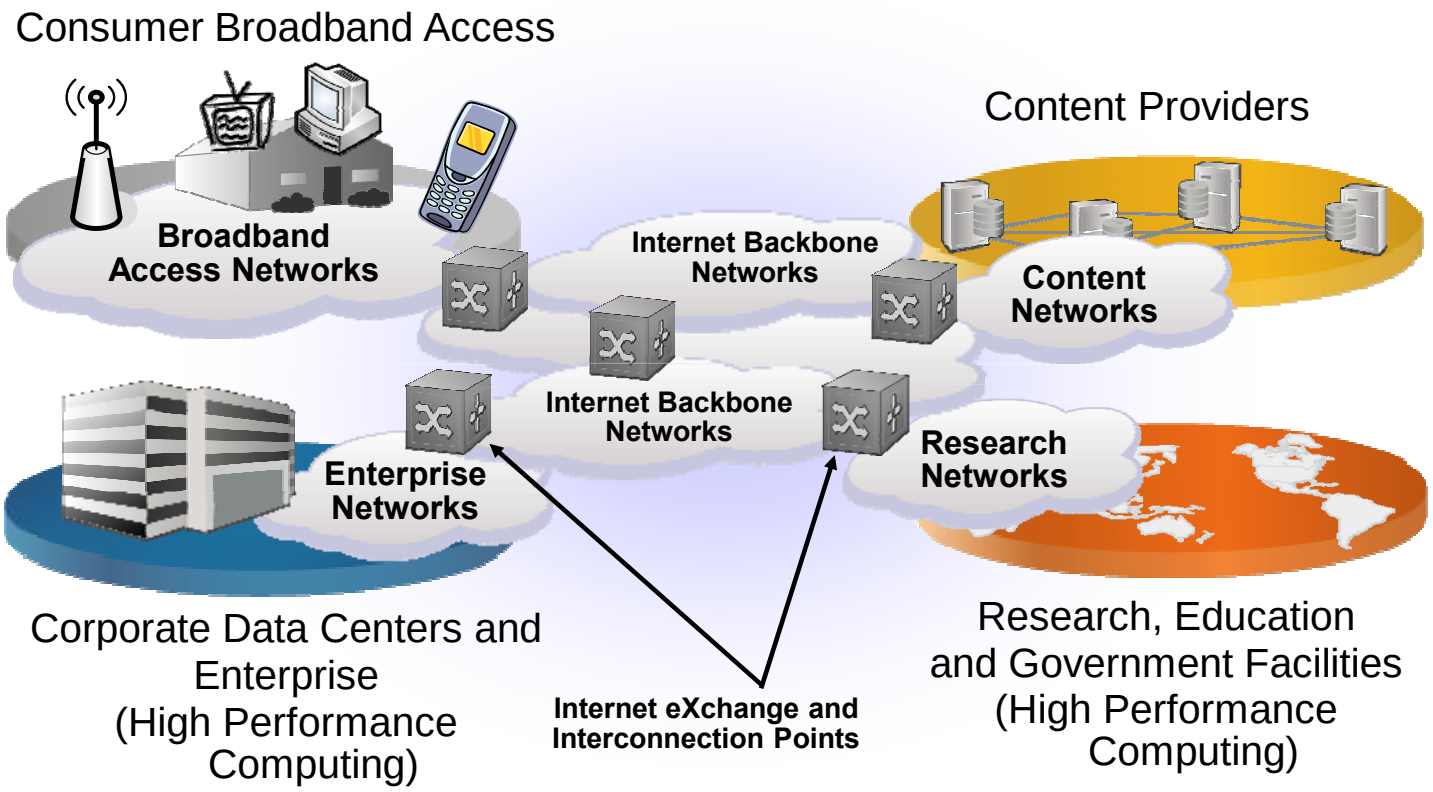
Disclaimers

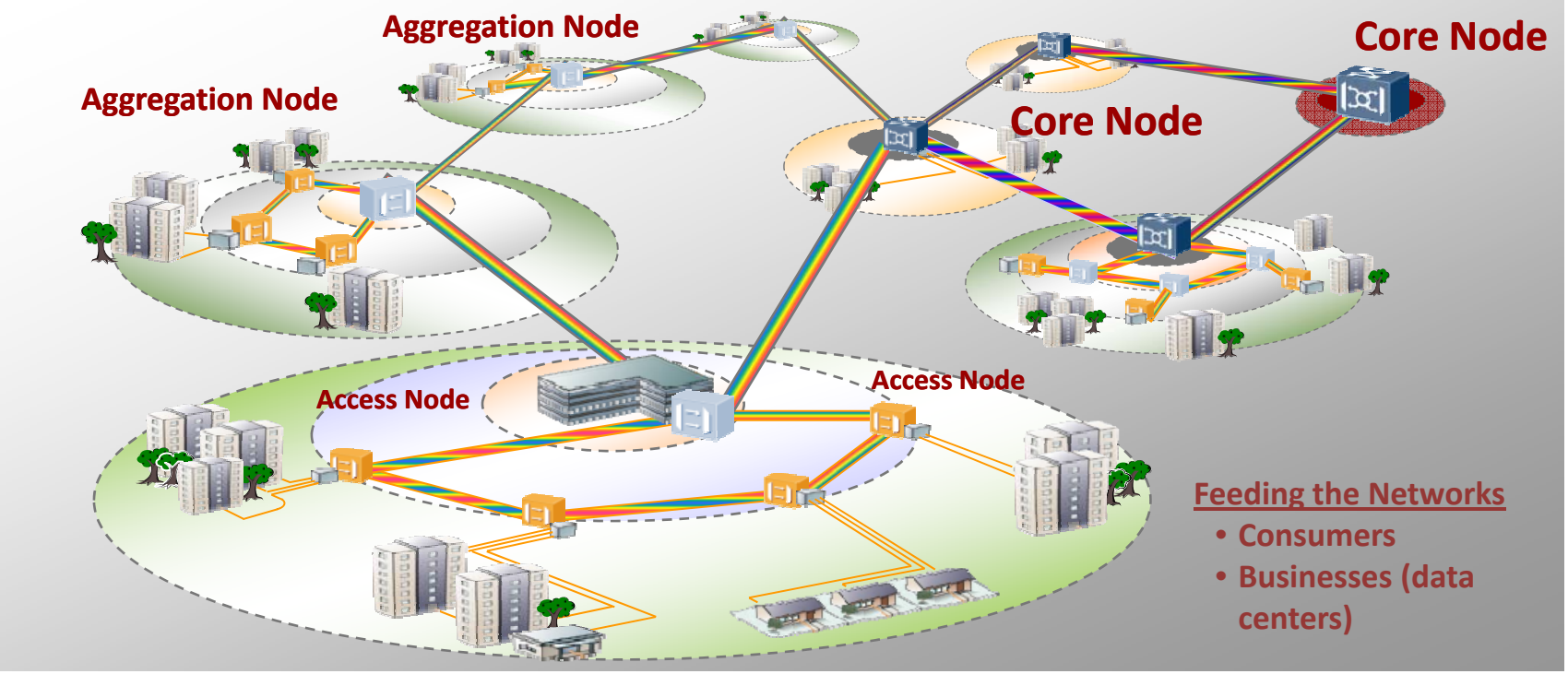
- All contributed information is solely the perspective of the respective contributors.
- The views expressed in the Assessment solely represent the views of the IEEE 802.3 Working Group, and do not necessarily represent a position of the IEEE, the IEEE Standards Association, or IEEE 802.

The 2006 HSSG Call-For-Interest

The Ethernet Ecosystem



Transport Network Classifications



Note: "Aggregation Nodes" in single carrier networks are equivalent to "IXPs" in multi carrier networks

Source: http://www.ieee802.org/3/ad_hoc/bwa/public/nov11/huang_01_1111.pdf

The 2007 HSSG Tutorial

Why Higher Speed Ethernet?

Fundamental bottlenecks are happening everywhere

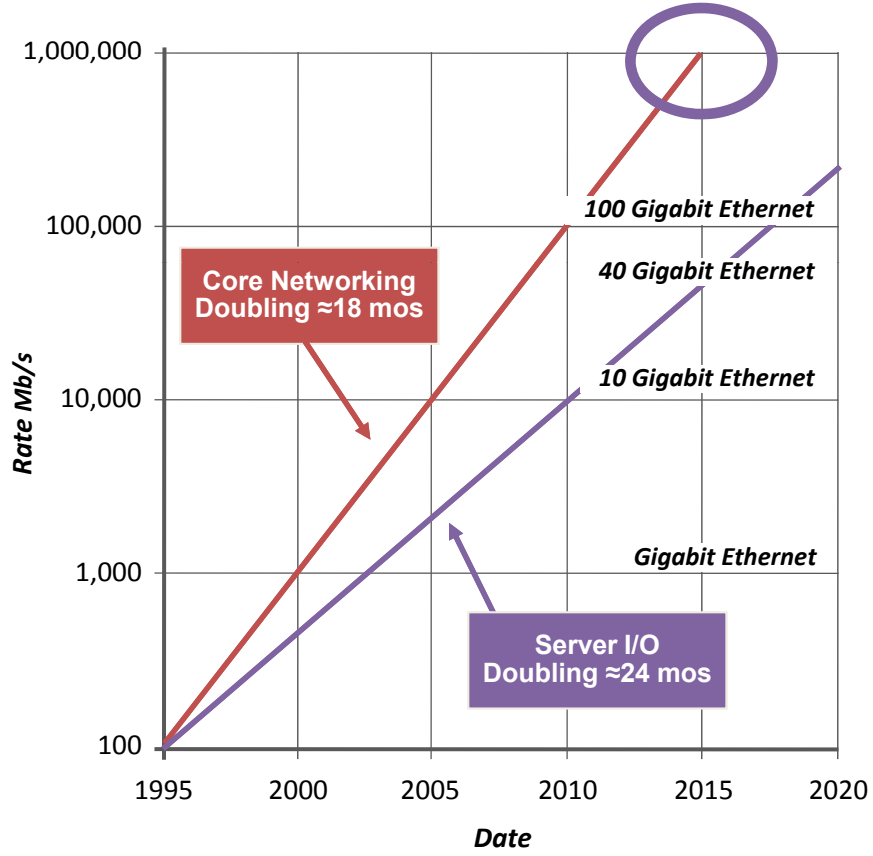
Increased # of users	+	Increased access rates and methods	+	Increased services	=	**Bandwidth explosion everywhere**
As demonstrated by the number of ISPs: Comcast, AOL, YahooBB, NTT, Cox, EasyNet, Rogers, BT, ...		EFM, xDSL, WiMax, xPON, Cable, WiFi, 3G/4G...		YouTube, BitTorrent, VOD, Facebook, Kazaa, Netflix, iTunes, 2nd life, Gaming...		

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 Industry Connections Ethernet Bandwidth Assessment Ad Hoc

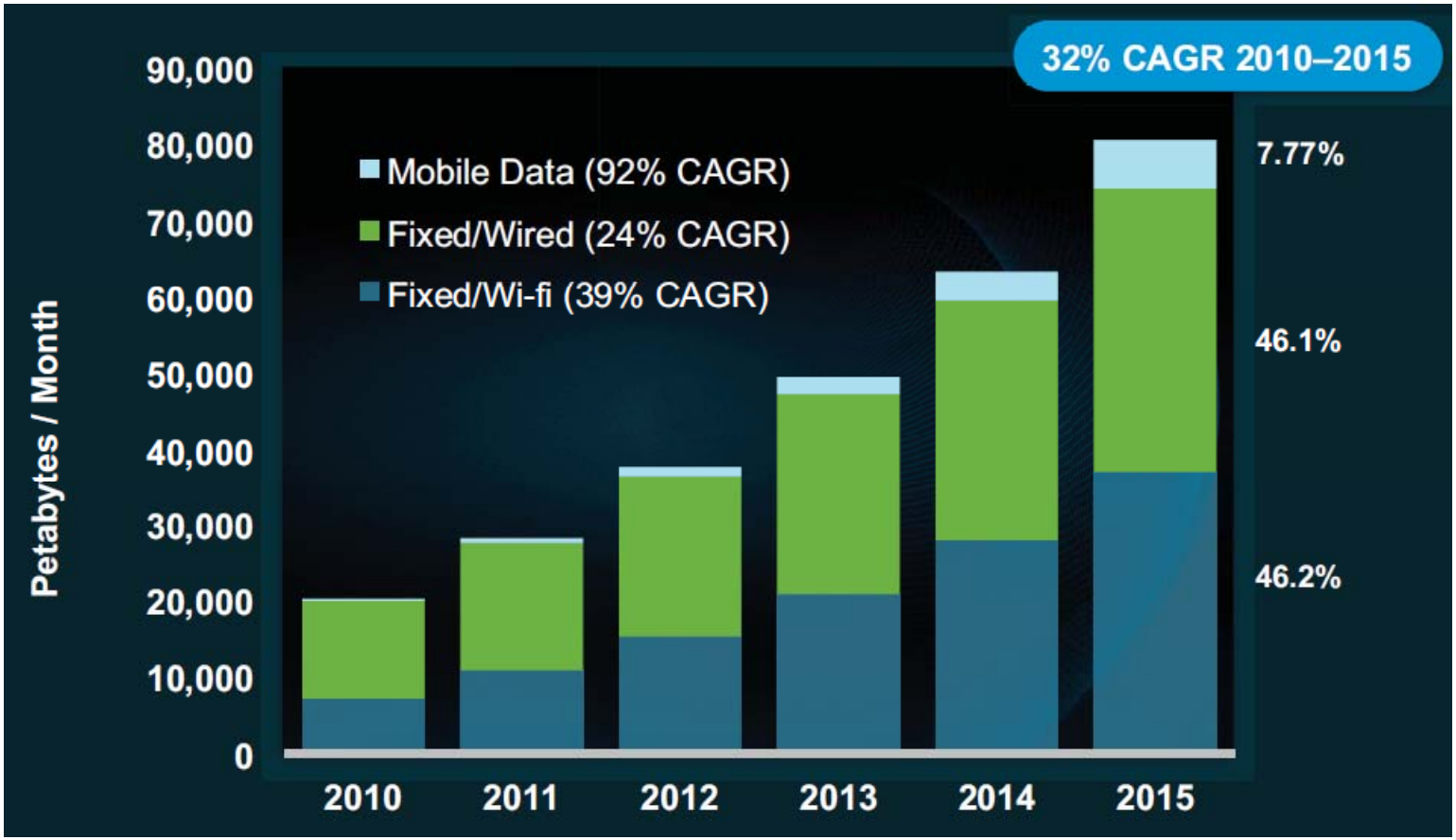


IEEE 802.3 BWA
Web & Reflector Information

- Assessment - http://www.ieee802.org/3/ad_hoc/bwa/BWA_Report.pdf
- Tutorial - http://www.ieee802.org/802_tutorials/2012-07/BWATutorial_D1_12_0716.pdf
- Webpage - http://www.ieee802.org/3/ad_hoc/bwa/index.html
- Reflector - http://www.ieee802.org/3/ad_hoc/bwa/reflector.html

- 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

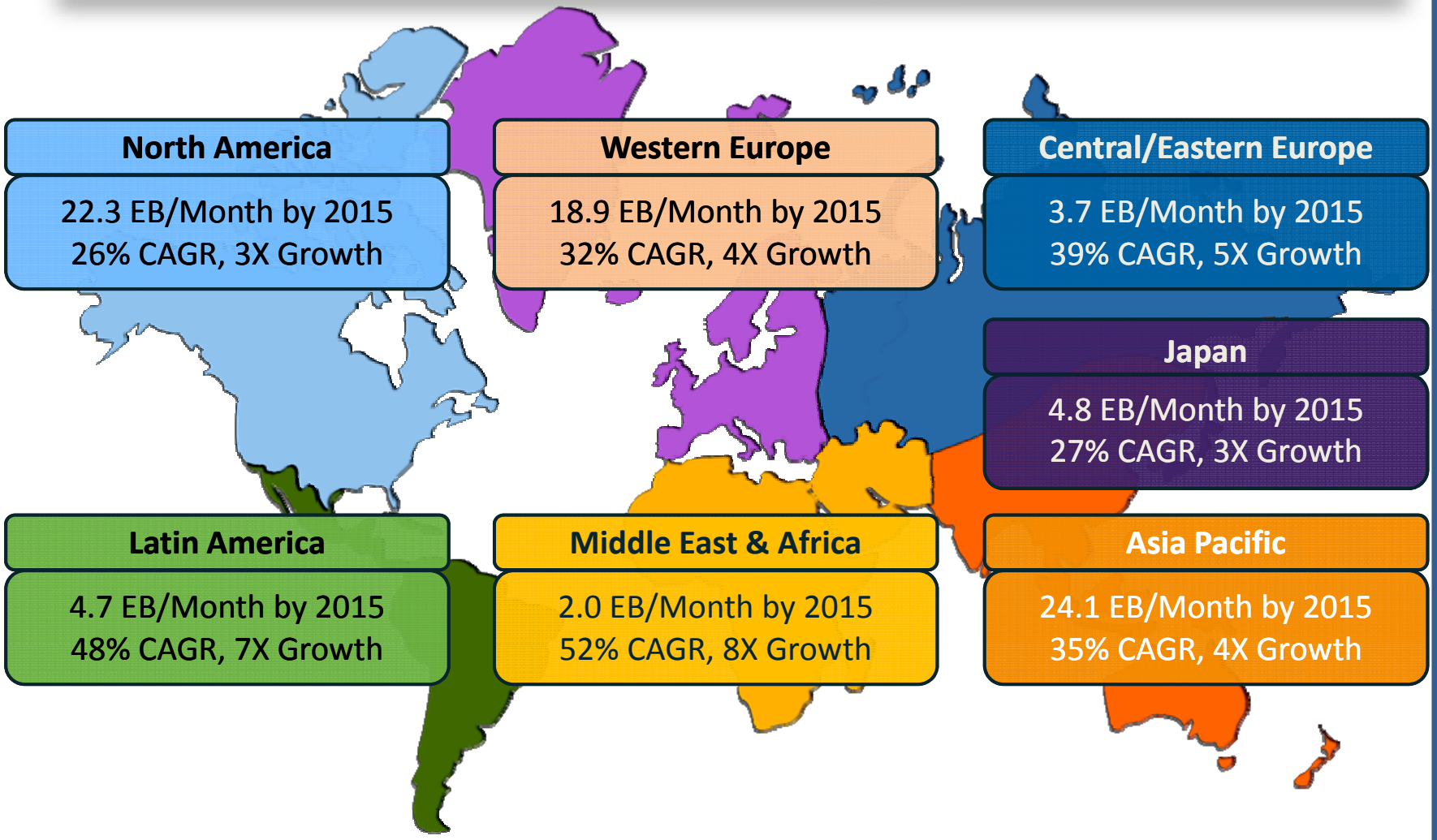
Global IP Traffic by Local Access Technology



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

Global IP Traffic Growth, 2010–2015

Regional contributions to the Zettabyte journey



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

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

Networking

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

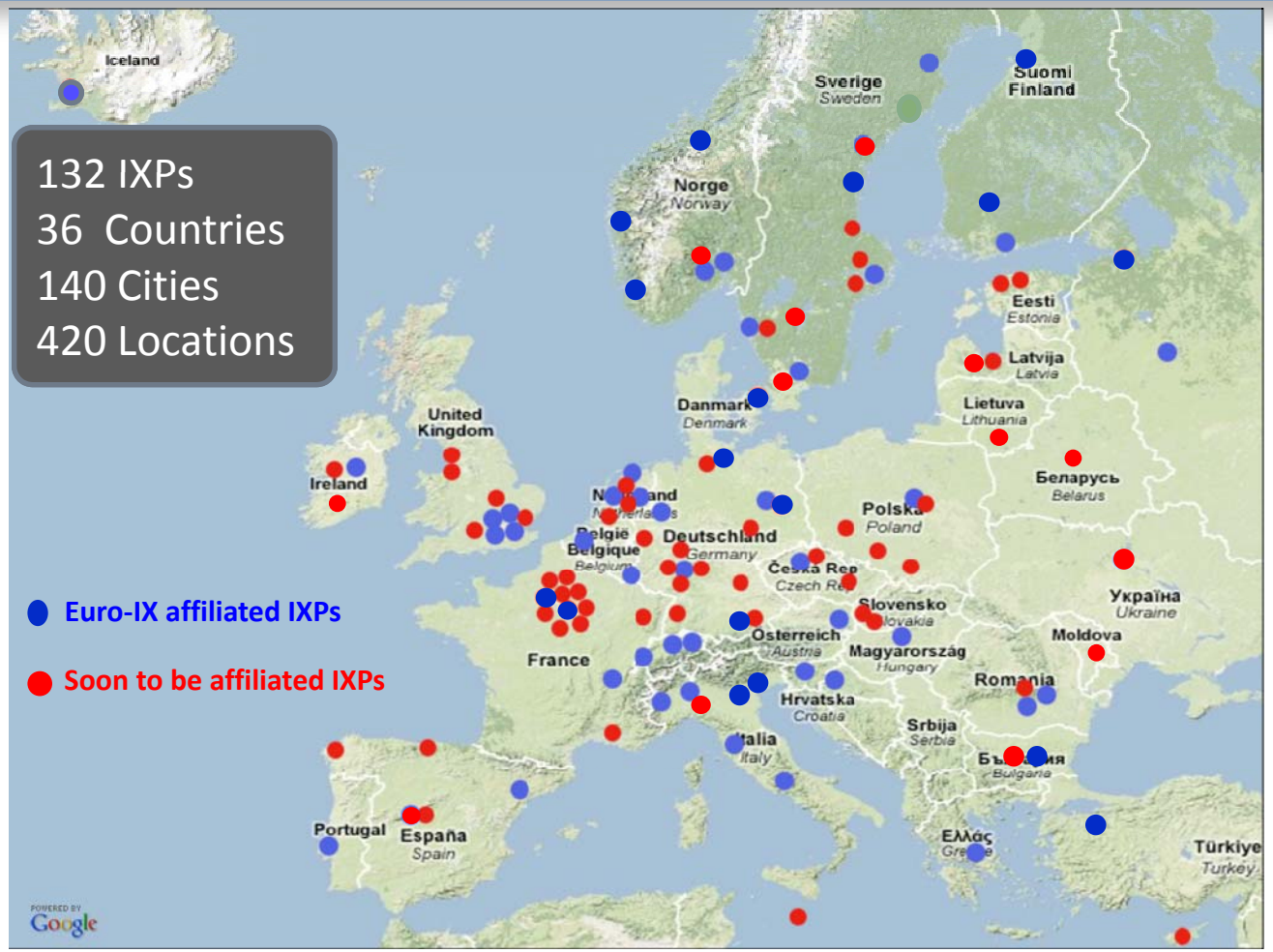
Compute

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

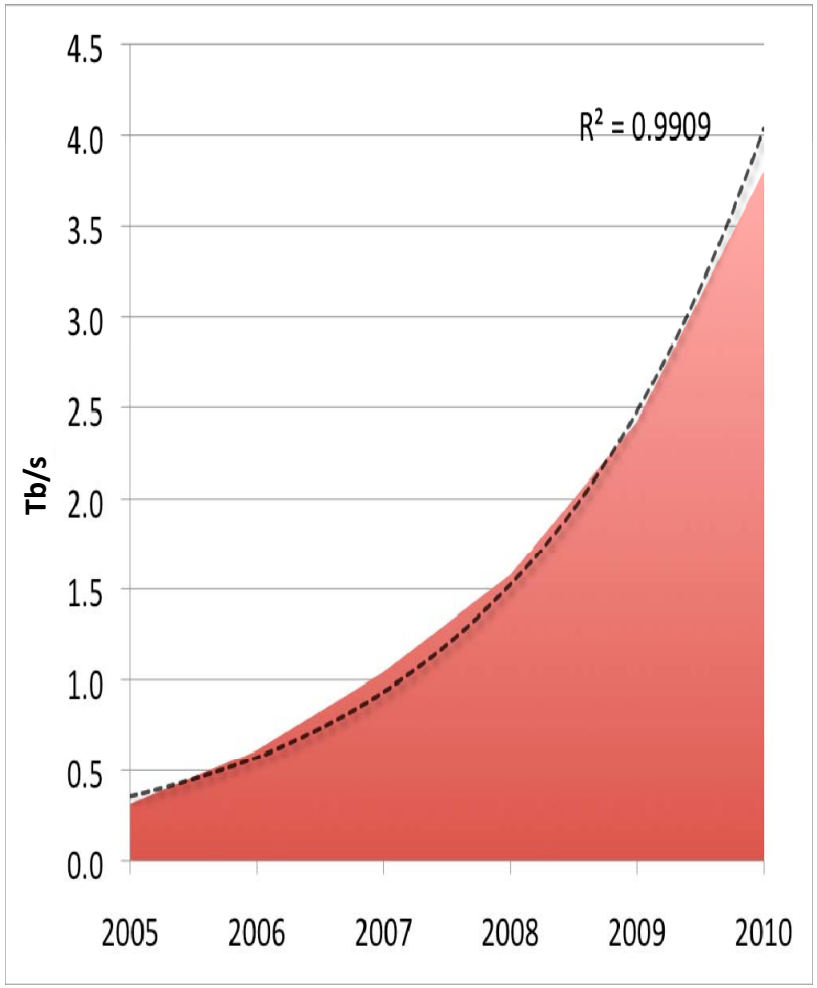
Euro-IX IXP Locations

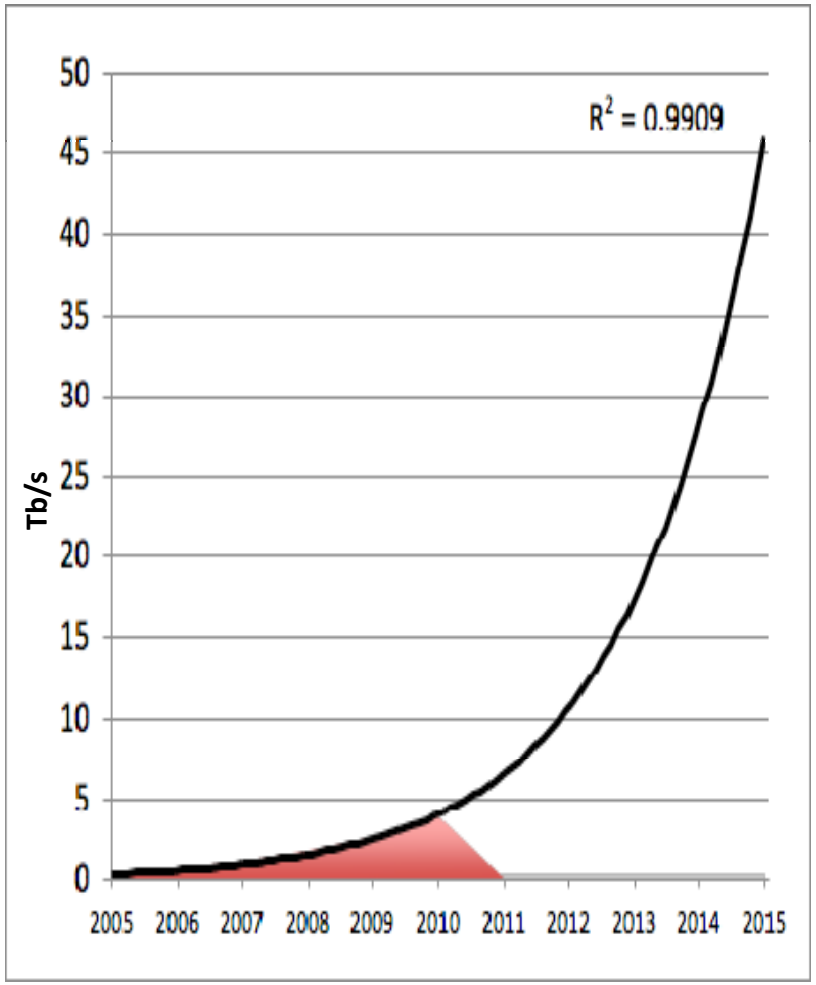


Note: Global 321 IXP's (100%), EU 41%, America's 33%, Asia-Pacific 19%, Africa 7%

Source: http://www.ieee802.org/3/ad_hoc/bwa/public/nov11/steenman_01_1111.pdf

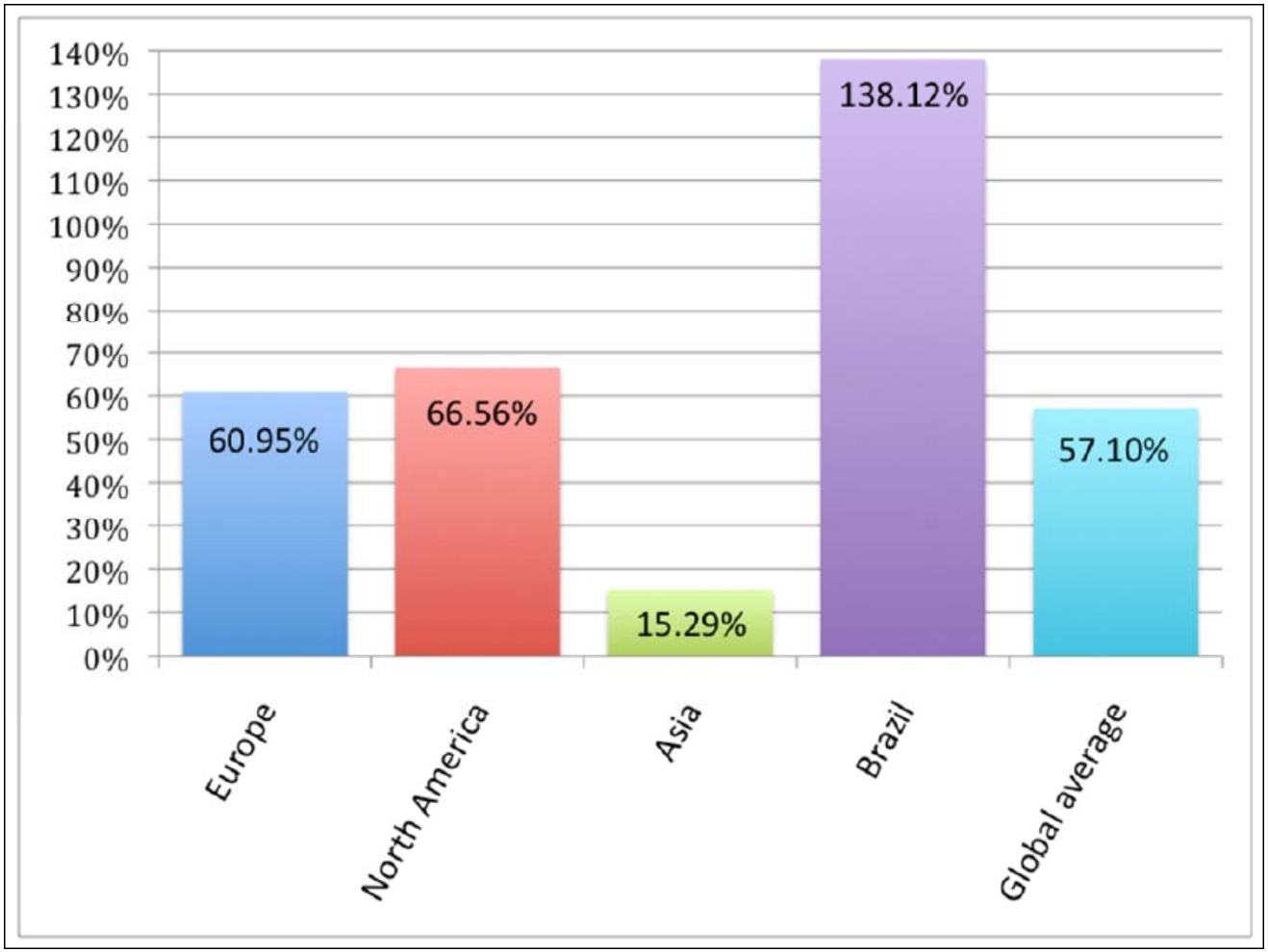
Five Year Peak European IXP Traffic Projections





Source: http://www.ieee802.org/3/ad_hoc/bwa/public/nov11/steenman_01_1111.pdf

Global Annual IXP Peak Traffic Growth Rates: By Region (for 2010)



Source: http://www.ieee802.org/3/ad_hoc/bwa/public/nov11/steenman_01_1111.pdf

Science: Big Data Sources

CERN is "the tip of the iceberg"

Today

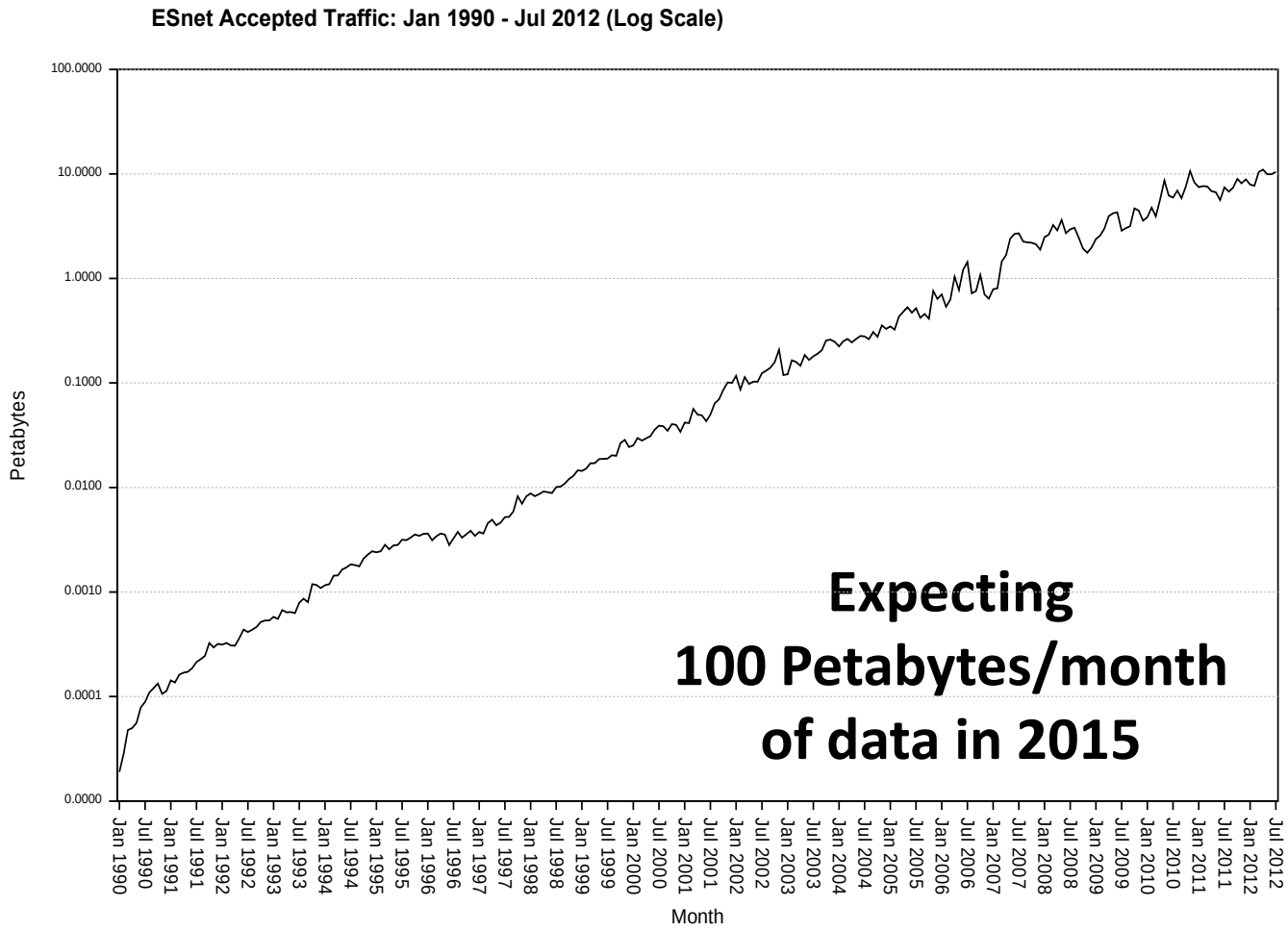
- **CERN**
  - Atlas detector in LHC (Large Hadron Collider) generates ~1 petabyte/sec
  - Trigger farm reduces to 450MB/sec
    - Tens of Gb/s of outbound traffic to analysis centers
- **Genome sequencing**
  - Per-instrument data rate strongly ↗ (~10x over 5 years)
  - Data costs plummeting → vastly increased data volume
  - http://www.genome.gov/sequencingcosts/

Future

- **Belle-II**
  - 250PB of experimental data in first 5 years of operation
- **Square Kilometer Array (SKA)**
  - ~2800 receivers in telescope array
  - 2 petabytes/sec to central correlator
    - sending @ ~100 Gb/s to analysis centers

Source: http://www.ieee802.org/3/ad_hoc/bwa/public/dec11/dart_01_1211.pdf (updated: interview Eli Dart, August 29, 2012)

ESnet Accepted Traffic (Petabytes/month)



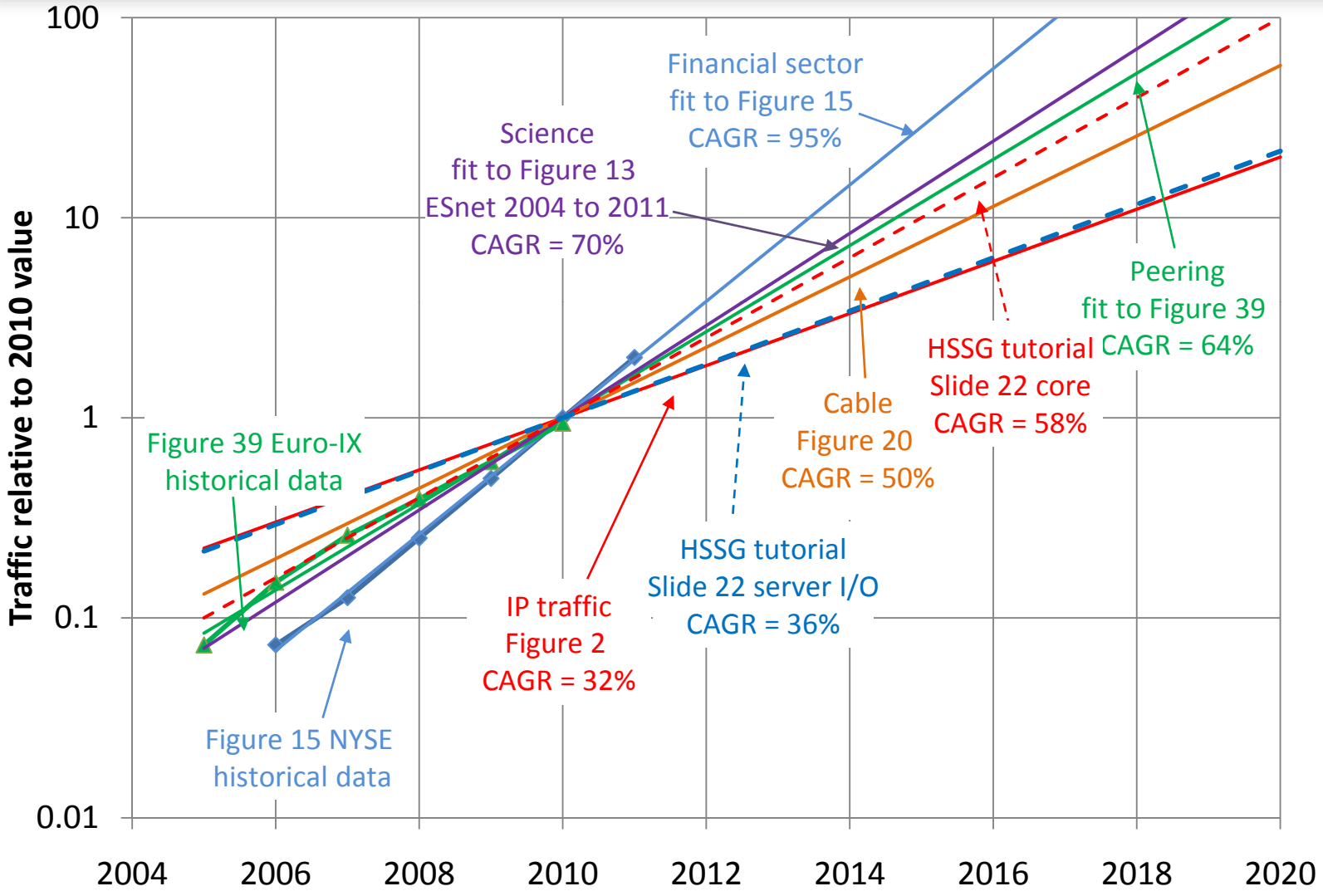
Source: http://www.ieee802.org/3/ad_hoc/bwa/public/dec11/dart_01_1211.pdf (updated 29 August, 2012)

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

JD4

Growth Rate Trends



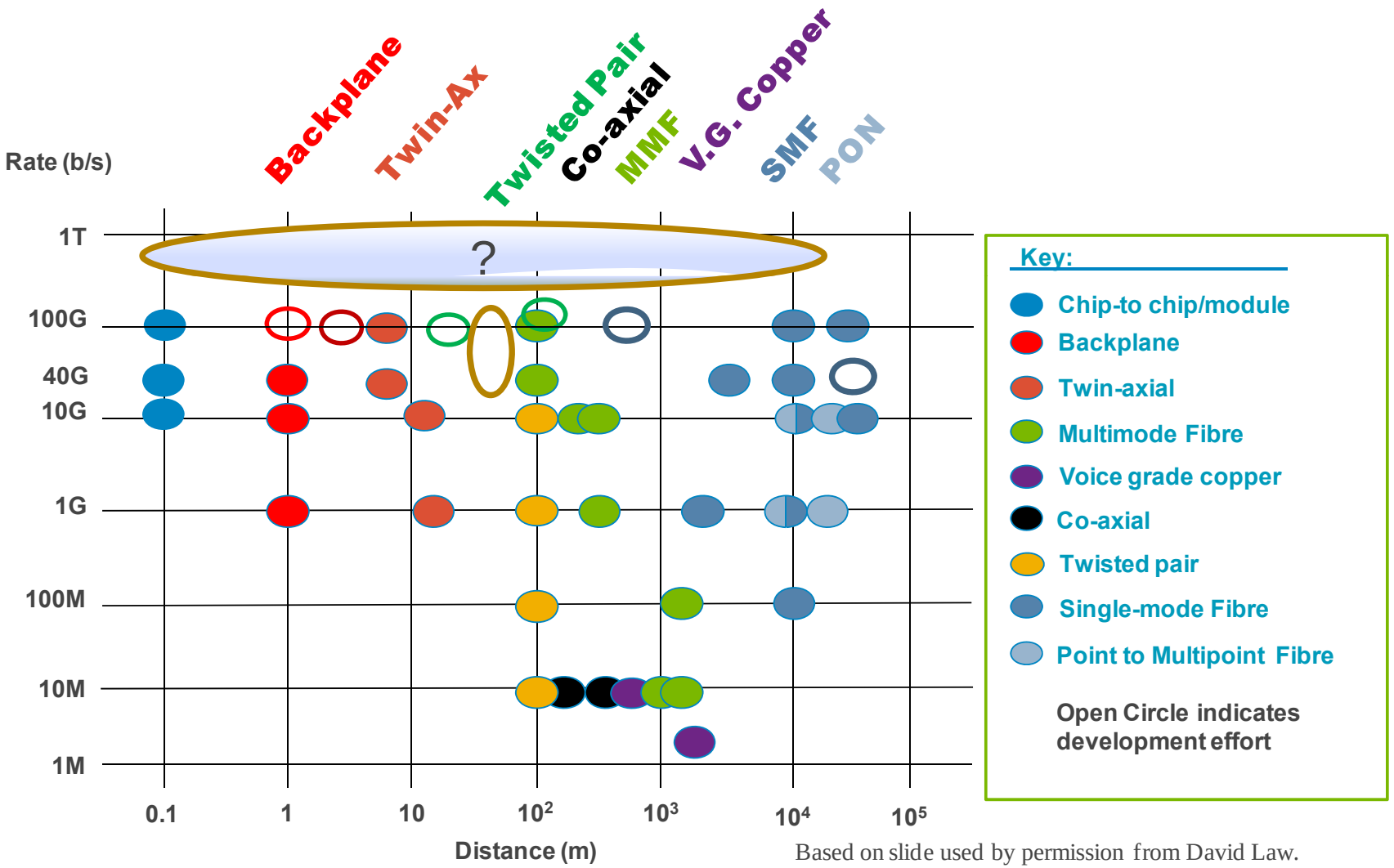
Slide 19

JD4 pete - somewhere in here we need to work the word "average"
JDAMBROSIA, 8/28/2012

IEEE 802.3 Higher Speed Ethernet Consensus Ad Hoc

- 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 (jdambrosia@ieee.org)

The Ethernet Eco-System



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THANK YOU!
QUESTIONS?