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# ETHERNET TECHNOLOGIES: THE PURSUIT OF MULTI-VENDOR INTEROPERABILITY

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ethernet alliance

# Regarding the Views Expressed



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“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 of IEEE.”

# Our Mission and Priorities

We are a global community of system vendors, component suppliers and academia

## ➤ Our Mission

- Promote technologies and products based on existing and emerging IEEE 802 Ethernet standards
- Accelerate industry adoption
- Demonstrate multi-vendor interoperability

## ➤ Strategic Priorities

- Interoperability
- Education



*The Voice of Ethernet*

# What is Ethernet?



- **Ethernet is an innovation brand!**
- **7 Attributes**
  - Native mode internet plumbing
  - High speed
  - Multi-media
  - IEEE 802.3 Standard
  - Implementations not open-sourced
  - Interoperability – Plug-n-play
  - Backwards compatibility

Source: Bob Metcalfe, Inventor of Ethernet

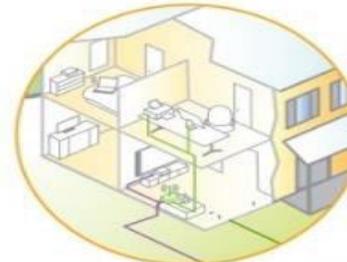
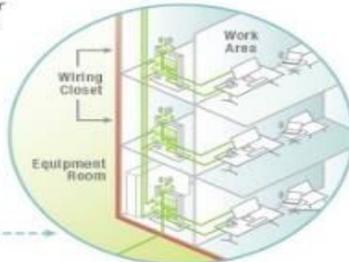
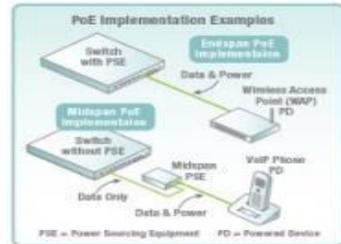
<http://ethernetalliance.org/tef-2013-the-future-of-ethernet-keynote/>

## ENTERPRISE AND CAMPUS

Power over Ethernet is a growing Ethernet application that delivers power and data over Category cabling that has 4 twisted pairs of wires, with Cat 5 or better cabling recommended. 4-Pair PoE is being standardized to deliver over 70W of power over all 4 twisted pairs instead of the two pairs in PoE and PoE+.

PoE Types and Classes	PoE+ - Type 2				4-Pair PoE in Standardization				
	PoE - Type 1				5	6	7	8	
Class	0	1	2	3	4	5	6	7	8
PSE Power (W)	15.4	4	7	15.4	30	45	60	75	90
PD Power (W)	13	3.84	6.40	13	25.5	40	51	62	71

4 - Pair PoE - Type 3  
4 - Pair PoE - Type 4



## RESIDENTIAL AND CONSUMER

Most homes have wireless access points (WAPs) with 4 or more Ethernet ports. Smart TVs, network attached storage (NAS) and other household products come with Ethernet ports that can be used to create the smart home.

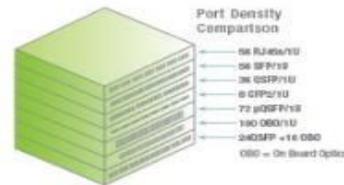
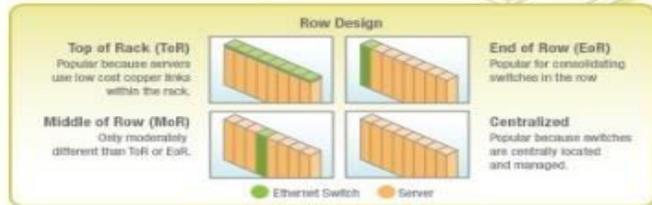
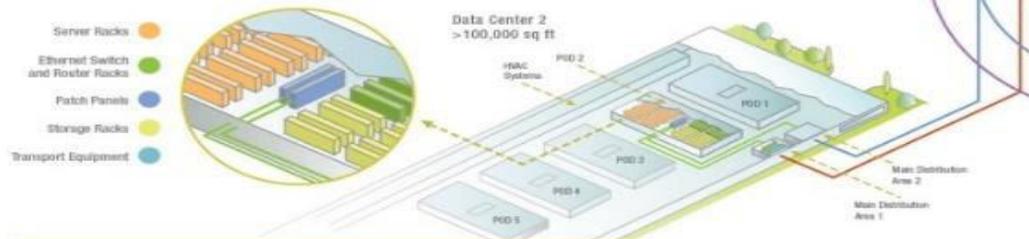
**Automotive Ethernet**  
Ethernet is being deployed in automobiles and will become the de facto standard for automobile networks by 2020. Because of requirements for lightweight autos, Ethernet was developed to deliver data and power over a single pair of wires to distances of 15 meters at 100Mb/s and 1Gb/s.

**Power Over Data Lines (PoDL)**  
PoDL delivers data and power to cameras, lights, entertainment systems, controls and other devices throughout the car.

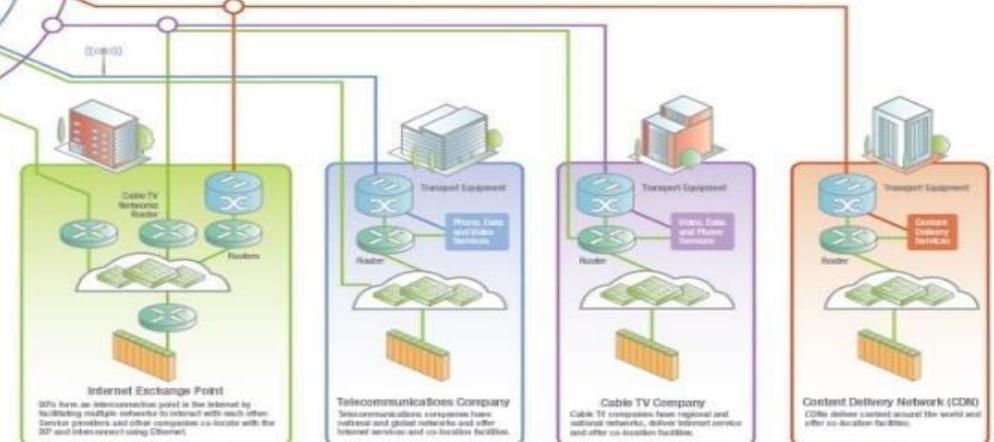
**Wireless Connectivity**  
Connected cars are expected to drive increased traffic to wireless networks that result in more wireless backhaul traffic over Ethernet.

## BACKBONE TO OTHER CITIES

## BACKBONE TO OTHER CITIES



**MANs**  
Metropolitan Area Networks (MANs) come in many varieties and deliver services to a variety of enterprises, organizations and consumers. Some MANs are based on Ethernet, but the largest MANs are based on Optical Transport Networks (OTN) technologies.



Hyperscale data centers drive amazing Ethernet volumes when hundreds of thousands of servers are connected on one site.

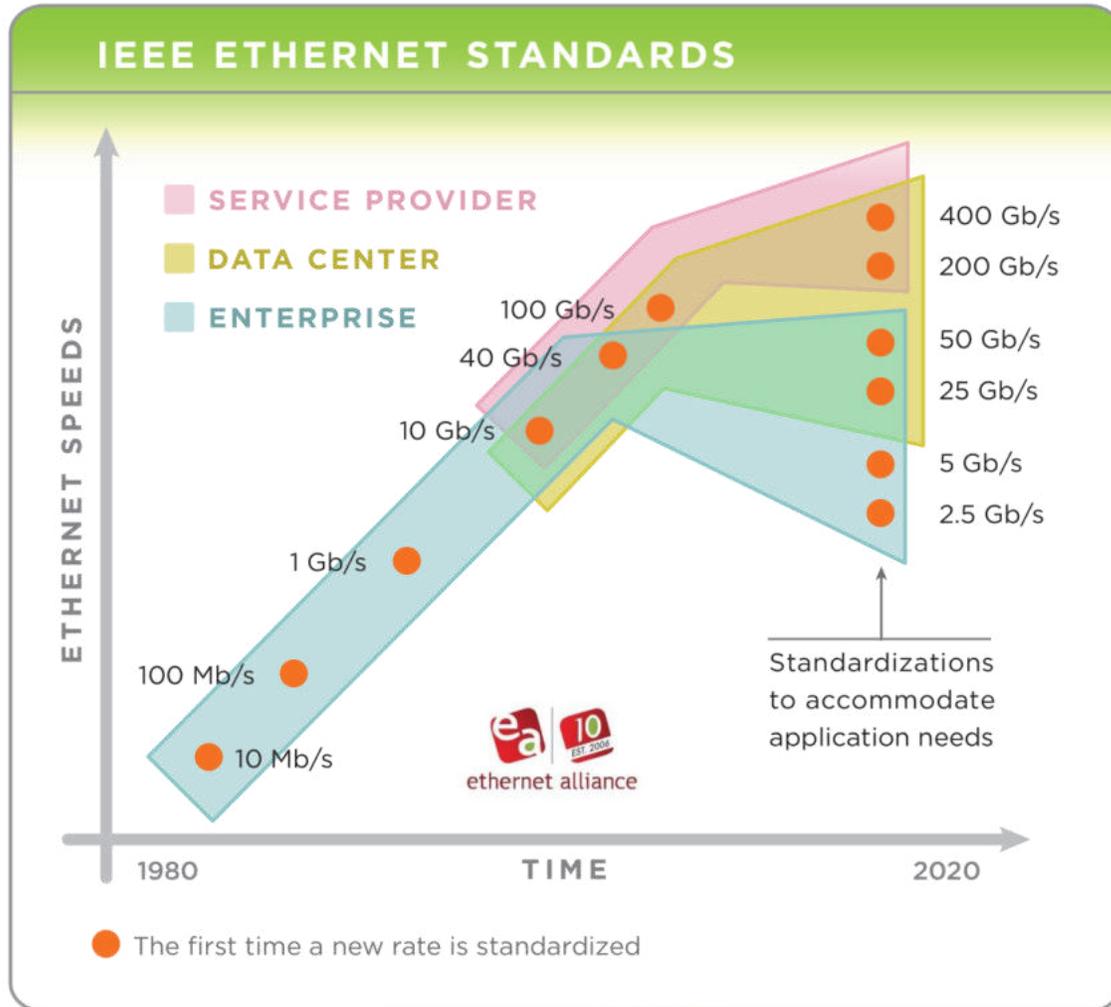
Service Providers deploy MANs and WANs to connect businesses and consumers. Some carriers deploy hyperscale data centers as well.

## HYPERSCALE DATA CENTER

## SERVICE PROVIDERS

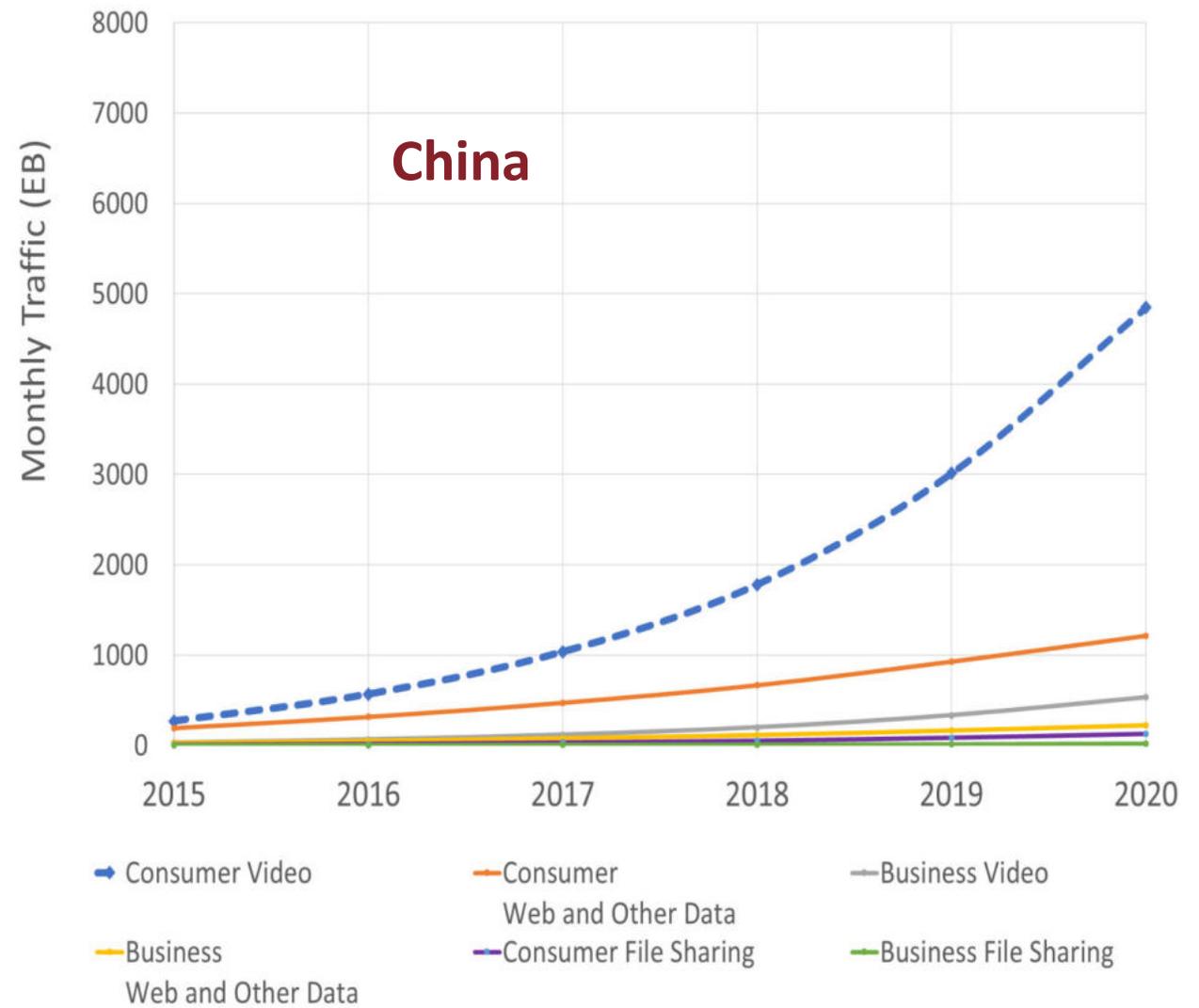
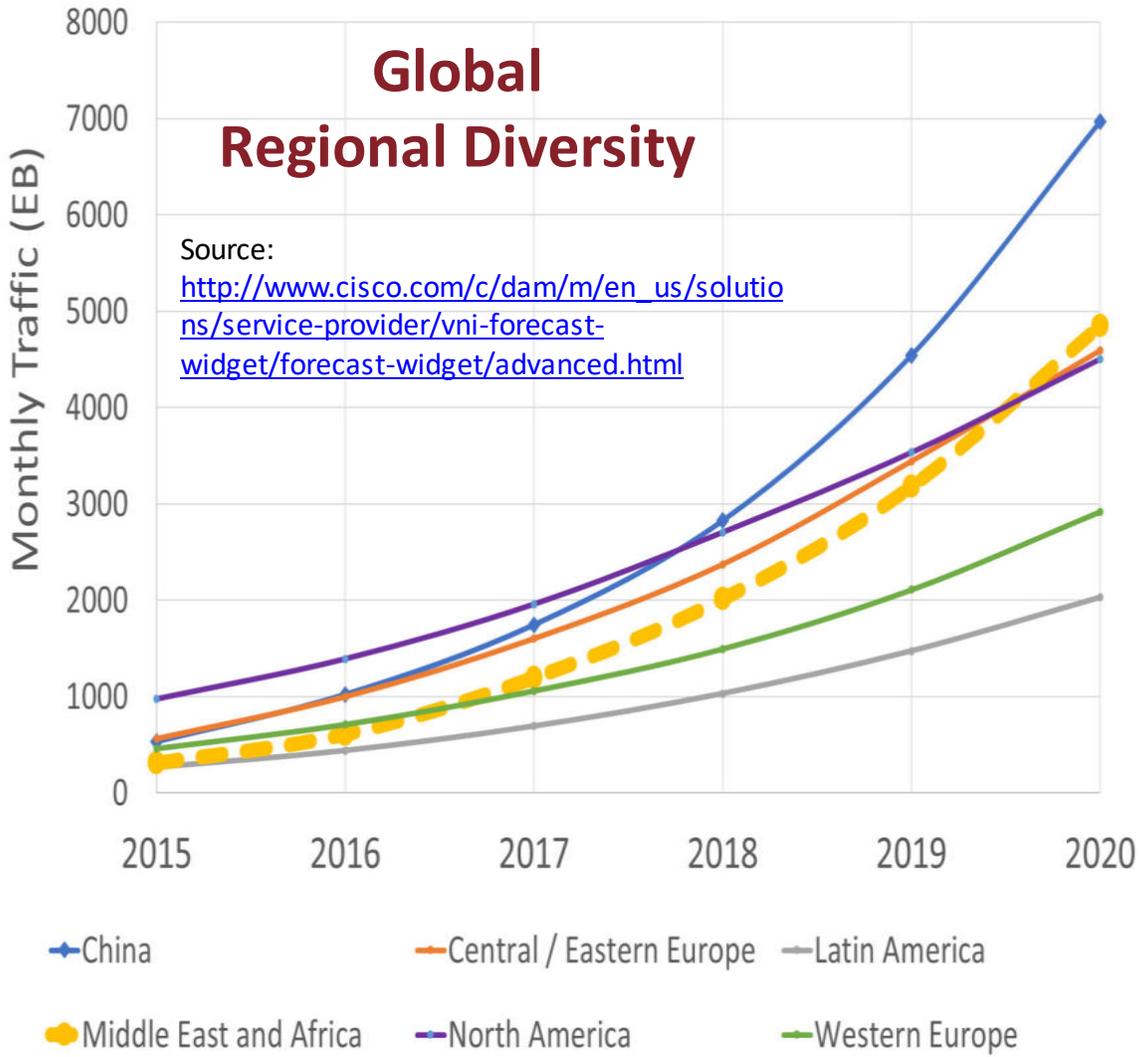


# Multiple Justifications Drive Ethernet



- Higher Speeds relative to application
- Various reasons justify new solutions
  - “Fatter” Pipes
  - Next Generation of Servers
  - Support of Next Gen WiFi / Re-use of existing cabling infrastructure
- The Ethernet community has responded best to customer demand

# Mobile Networks Bandwidth Trends



# Emerging Applications



## IoT

**> 20 Billion  
devices by 2020**

**Across the Web**



## Automotive

**400 Million  
Ethernet ports  
by 2020**

**Strategy Analytics**

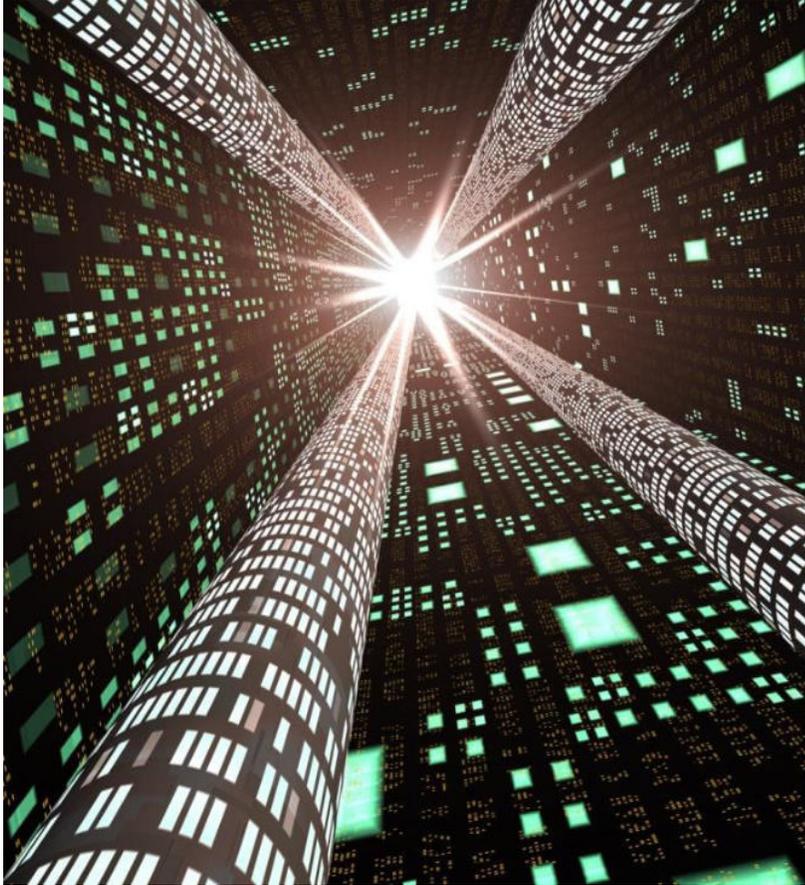


## 5G

**25 million  
subscriptions  
worldwide at  
the end of 2021**

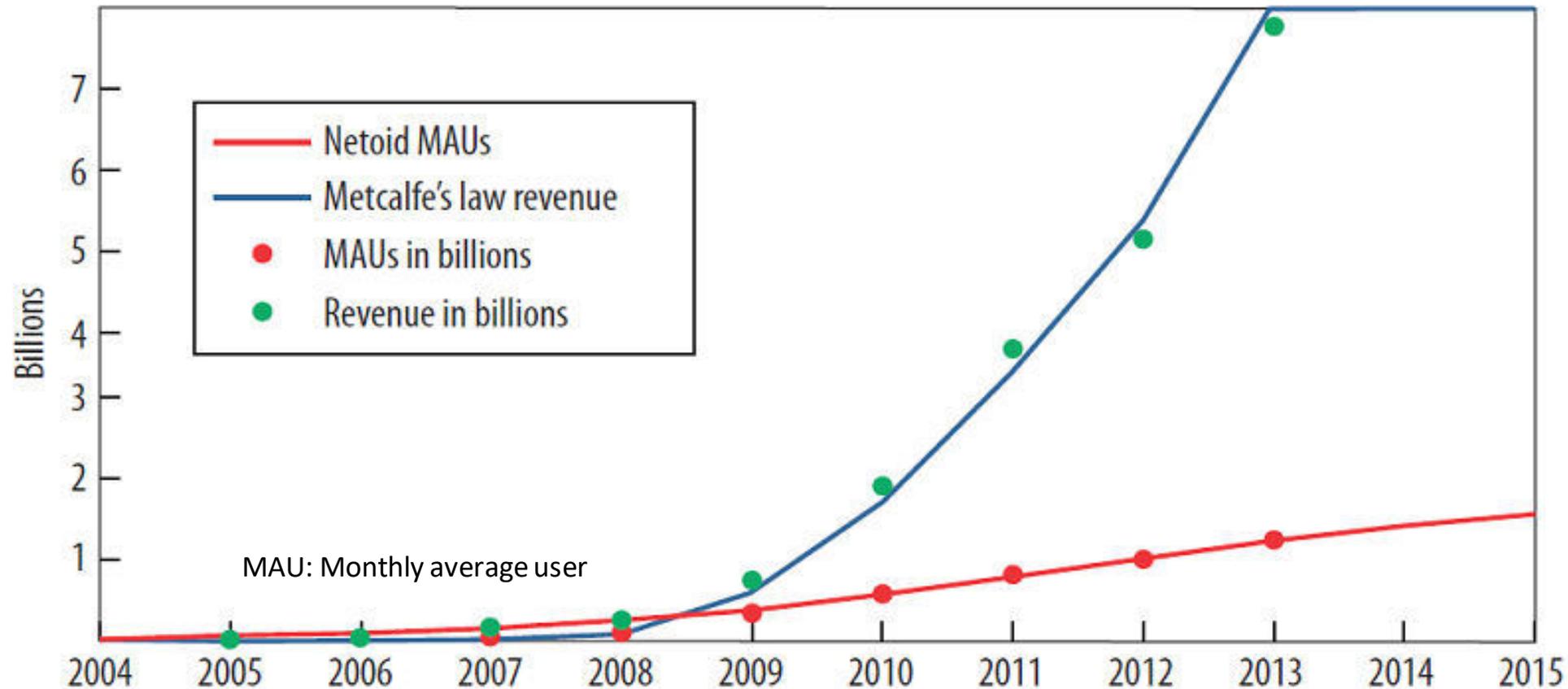
**Ovum**

# Metcalfe's Law



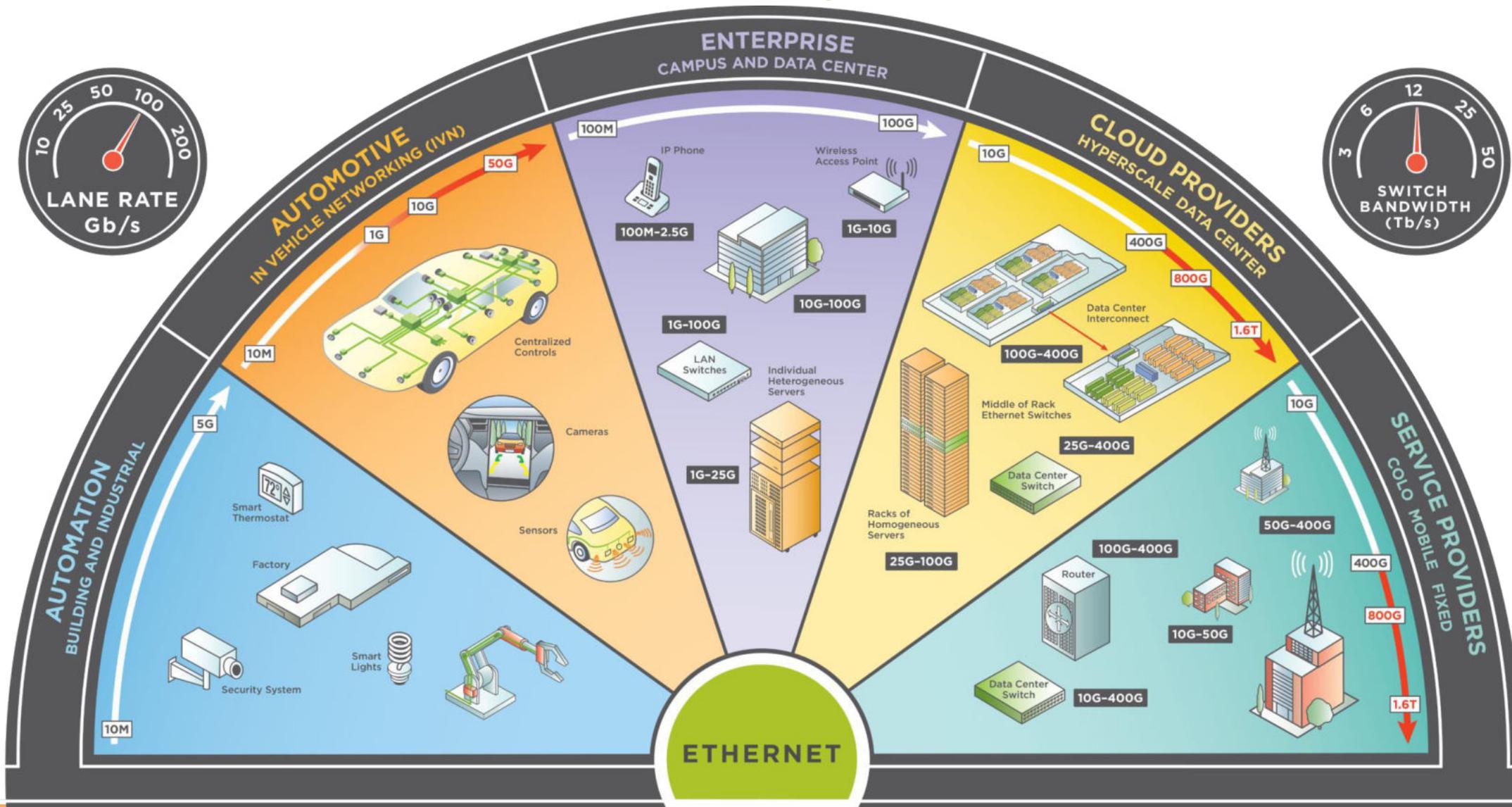
The value of a telecommunications network is proportional to the square of the number of connected users of the system.

# Metcalfe's Law on Facebook Network



Used with permission from Robert Metcalfe. "Metcalfe's Law after 40 Years of Ethernet," IEEE Computer, Dec 2013.

# The 2019 Ethernet Roadmap



# IEEE 802.3 Standards Activity Snapshot

- **Recently Ratified Standards**
  - IEEE 802.3bq 25G/40G BASE-T 2016
  - IEEE 802.3by 25GbE 2016
  - IEEE 802.3bz 2.5G/5GBASE-T 2016
  - IEEE 802.3bs 200GbE & 400 GbE 2017
  - IEEE 802.3cc 25GbE SMF 2017
  - IEEE 802.3bt DTE Power via MDI over 4-Pair (PoE) Sept 2018
  - IEEE 802.3cb 2.5 Gb/s and 5 Gb/s Backplane Sept 2018
  - IEEE 802.3cd 50GbE/100GbE/200GbE Dec 2018
- **Task Forces in Process**
  - IEEE P802.3cg 10 Mb/s Single Twisted Pair Ethernet Sept 2019
  - IEEE P802.3ck 100 Gb/s, 200 Gb/s, and 400 Gb/s Electrical Interfaces March 2021
  - IEEE P802.3cm 400 Gb/s over Multimode Fiber Dec 2019
  - IEEE P802.3cn 50 Gb/s, 200 Gb/s, and 400 Gb/s over Single-Mode Fiber Jun 2020
  - IEEE P802.3cp Bidirectional 10 Gb/s, 25 Gb/s, and 50 Gb/s Optical Access PHYs Per PAR – June 2022
  - IEEE P802.3cs Increased-reach point-to-multipoint Ethernet optical subscriber access (Super-PON) Per PAR - Sept 2022
  - IEEE P802.3ct 100 Gb/s and 400 Gb/s over DWDM Systems Sept 2021
- **Study Groups in Process**
  - 100 Gb/s per lane Optical PHYs

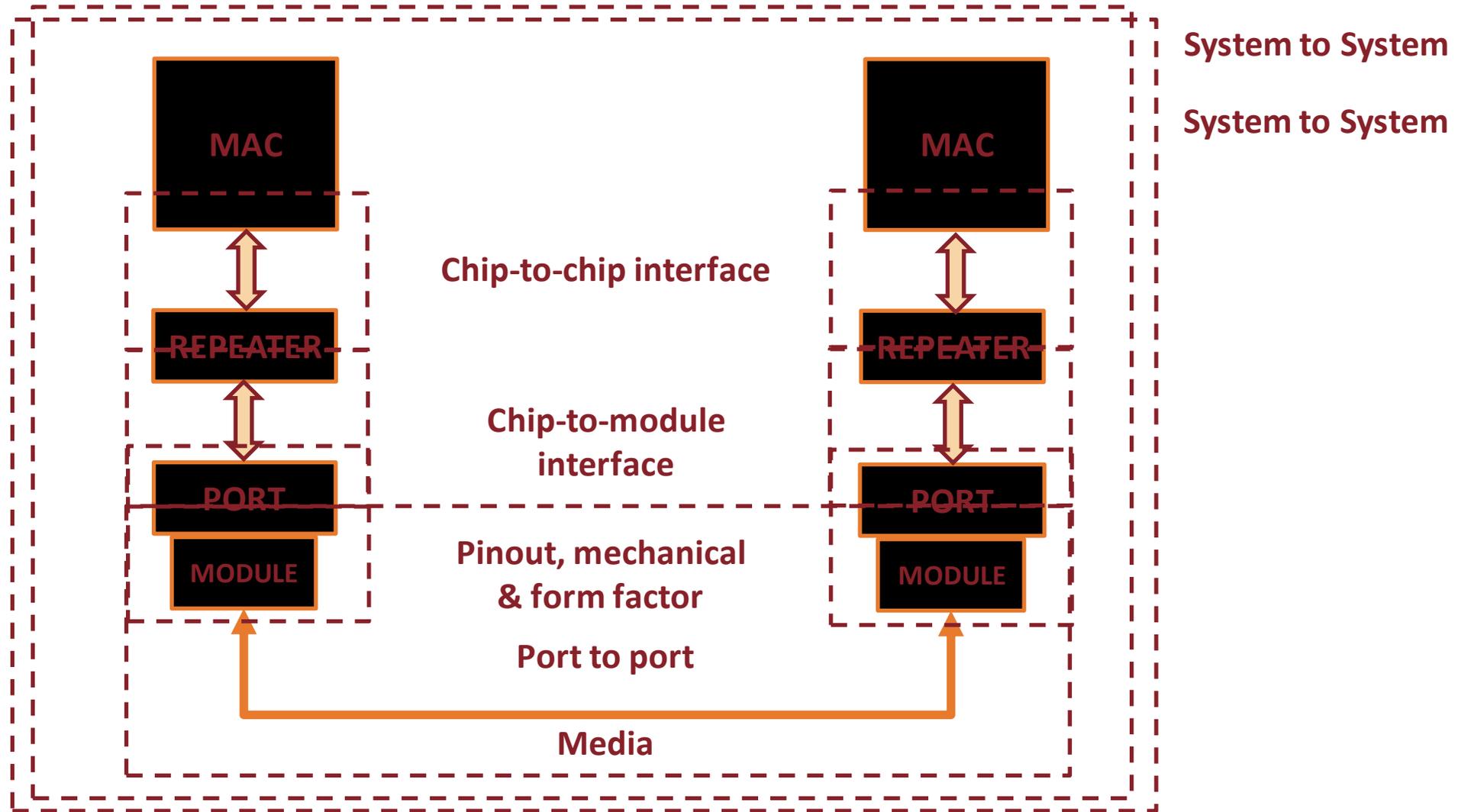
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# OUR MISSION: DEMONSTRATE MULTIVENDOR INTEROPERABILITY

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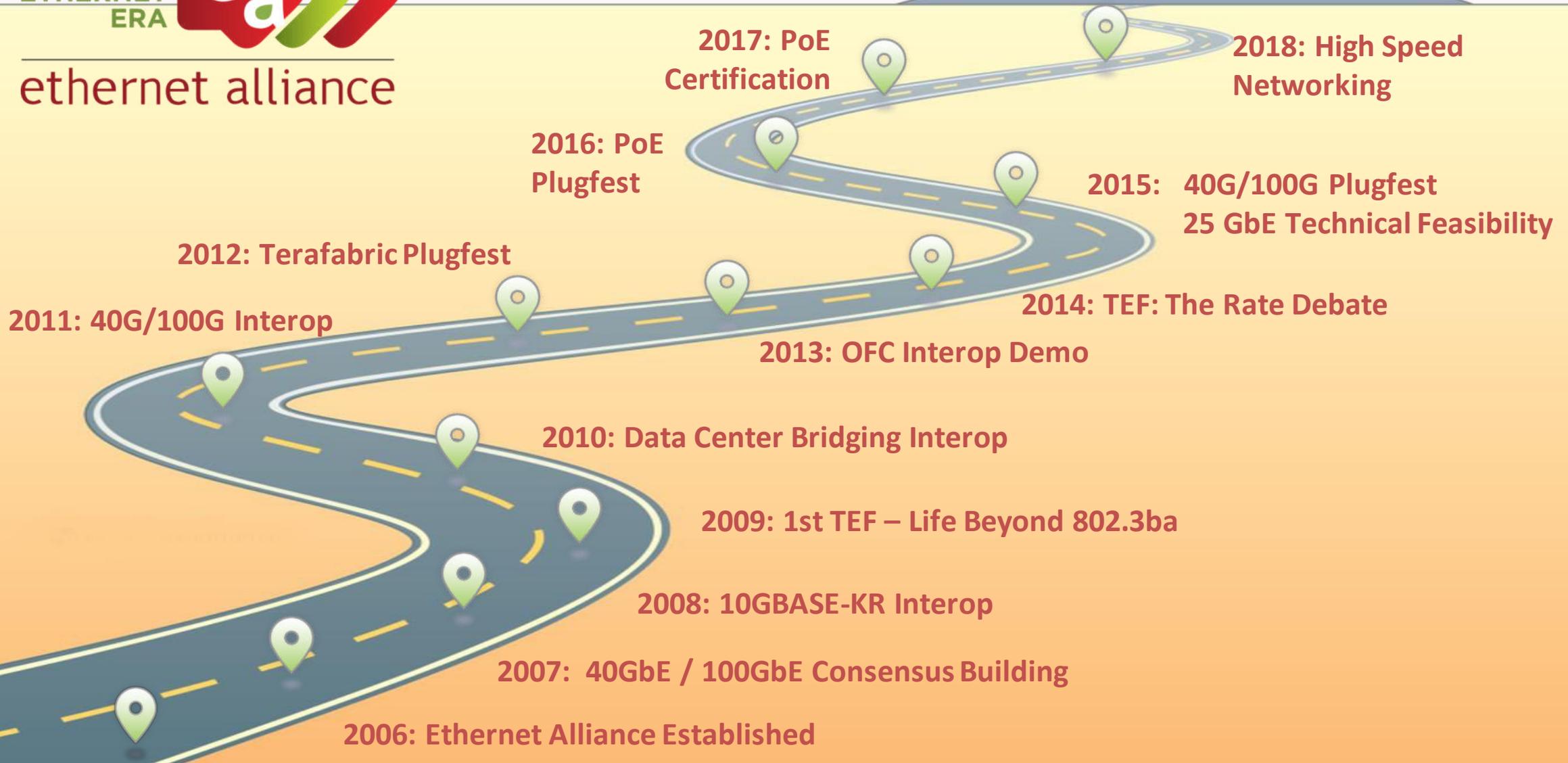


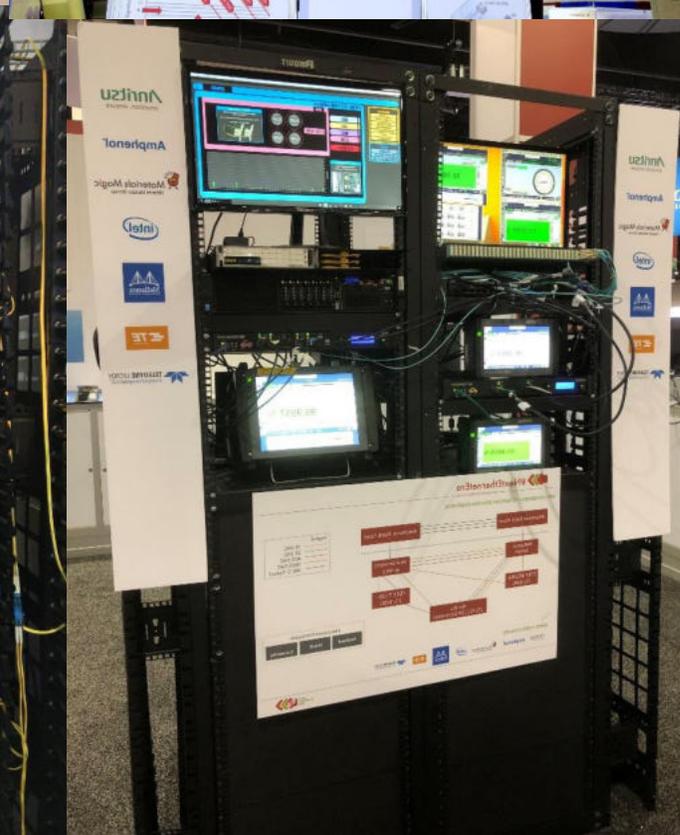
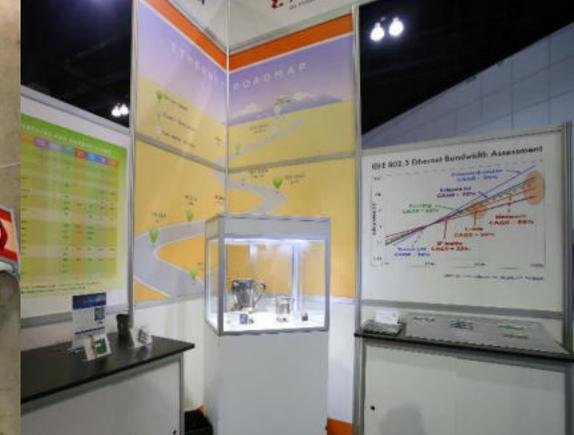
# The Anatomy of Interoperability



# Demonstrating Multi-vendor Interoperability

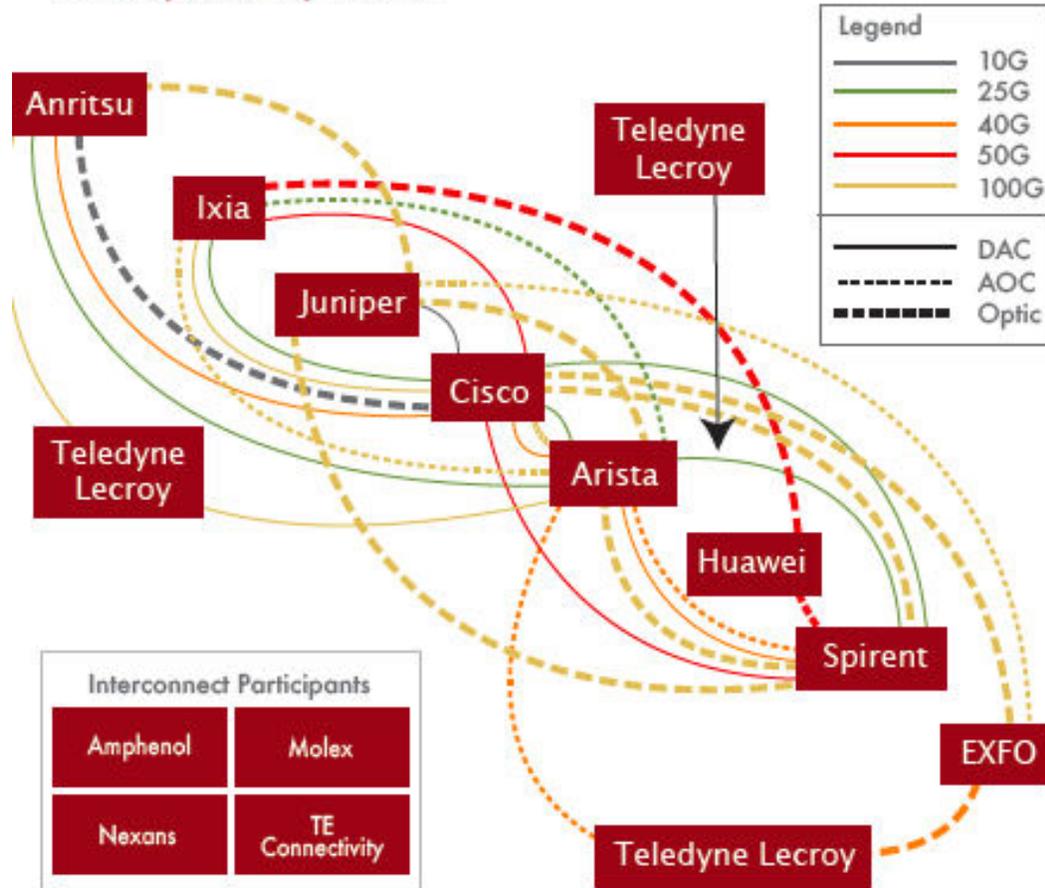
- Interoperability Plugfests
- Tradeshow demonstrations
- Ethernet Alliance PoE Certification Program





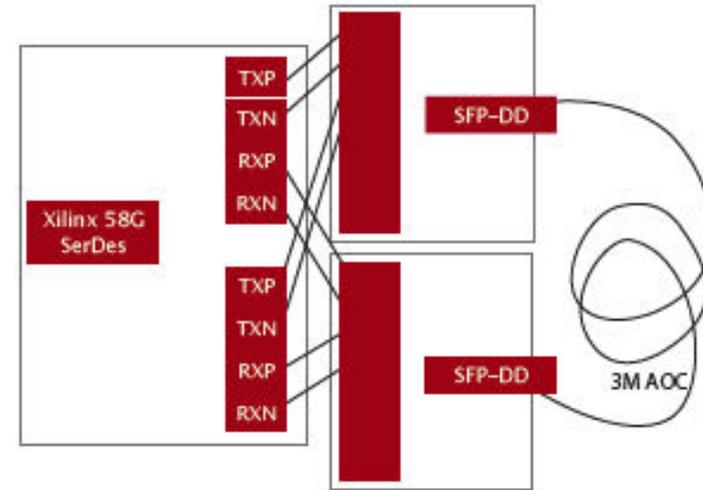
# INTEROPERABILITY DEMONSTRATIONS

## Ethernet Alliance 10GbE to 100GbE Interoperability Demo



## SFP-DD Demonstration

2 lanes of 53 Gb/s PAM4 over 3 meters of Finisar SFP-DD AOC via Molex SFP-DD cage and paddle board



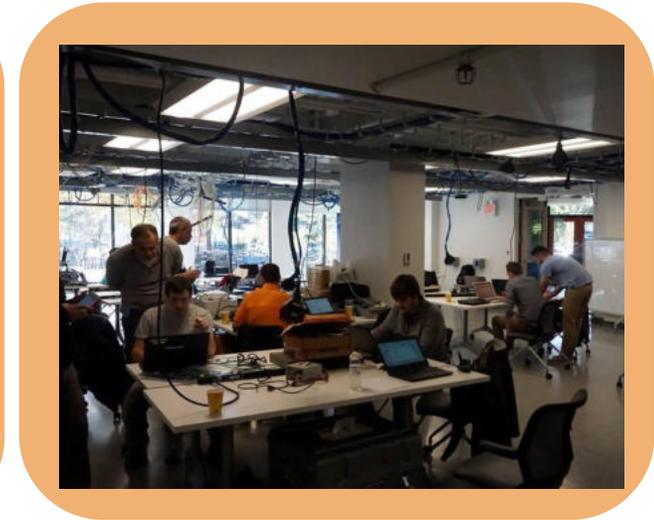
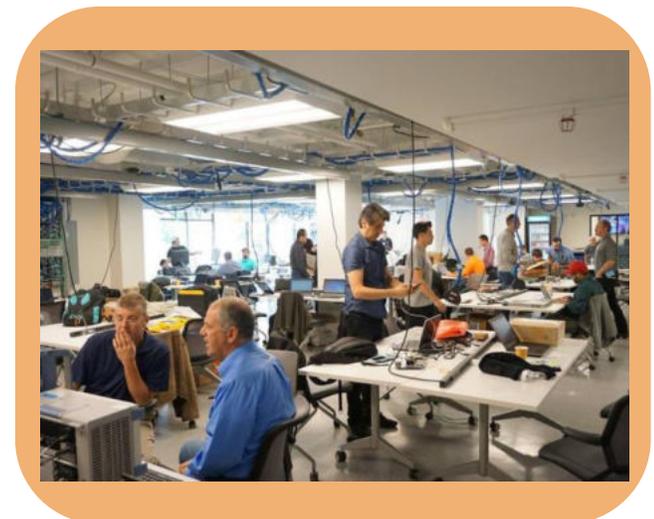
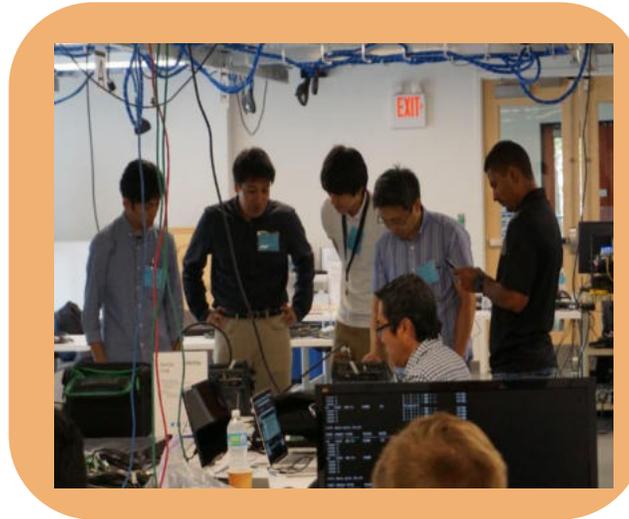
## 50GbE PAM4 Demo

50GbE PAM4 Generation and Analysis Demonstration



# Our Investment in Multi-vendor Plugfests

- **Plugfests**
  - PoE (802.3af / 802.3at)
  - 2.5G / 5G / 10G BASE-T
  - 25GbE / 100 GbE
  - 100GbE
  - 4 Pair PoE
  - High Speed Networking
    - 25 / 100 GbE
    - 50/ 400 GbE



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# Ethernet Alliance PoE Certification Program

- Meets Ethernet Alliance Certification Test Plan
  - Gen 1: Based on IEEE Std 802.3™-2015 PoE
  - Gen 2: Based on IEEE Std 802.3™-2018 4 Pair PoE
- Confidence of interoperability between certified products
- PSE / PD Logo Distinction
- Class Number indicates maximum class supported
- Easy Interoperability: PSE Class must be greater than or equal to PD Class

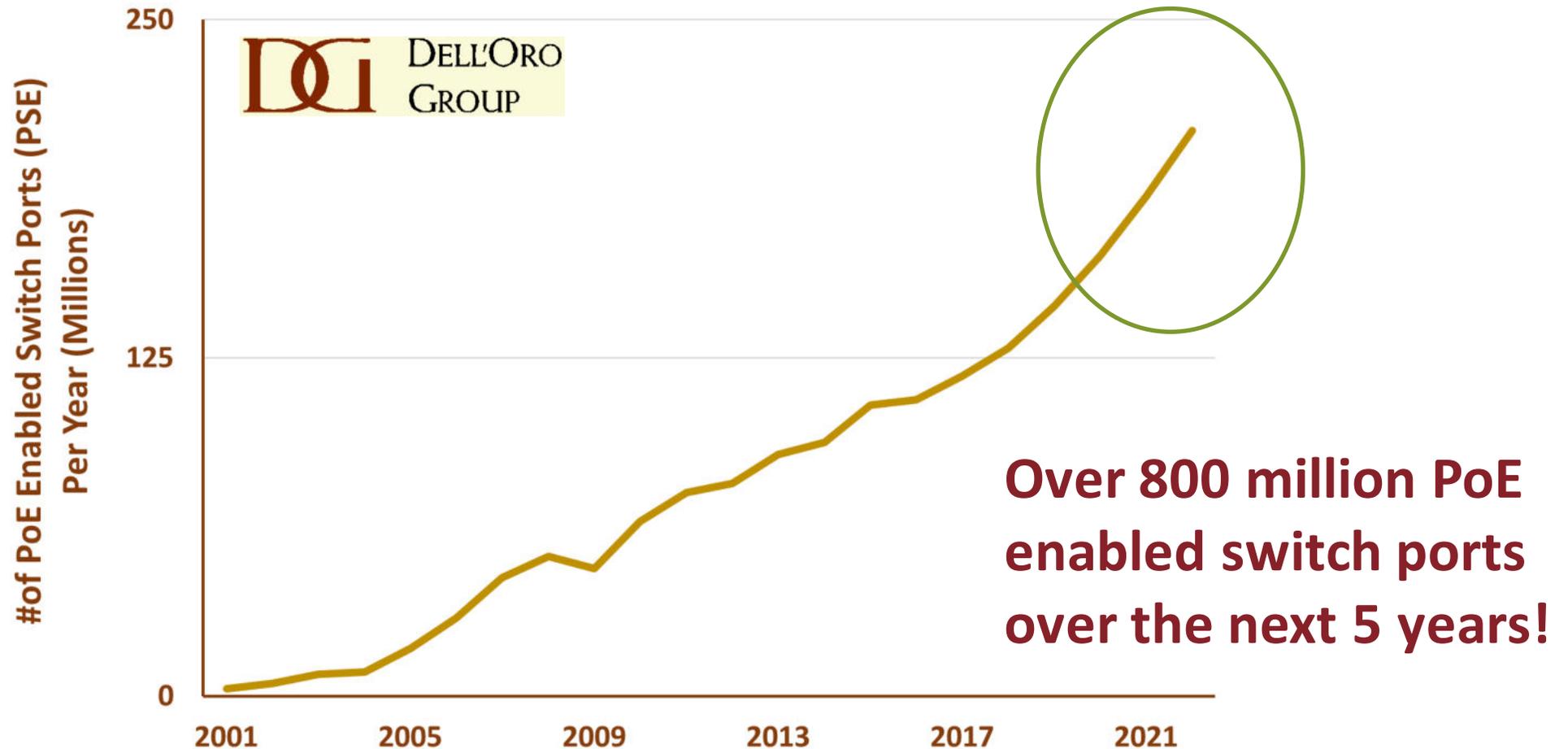


*PSE Class "4" Logo*



*PD Class "1" Logo*

# PoE Enabled Switch Ports Forecast

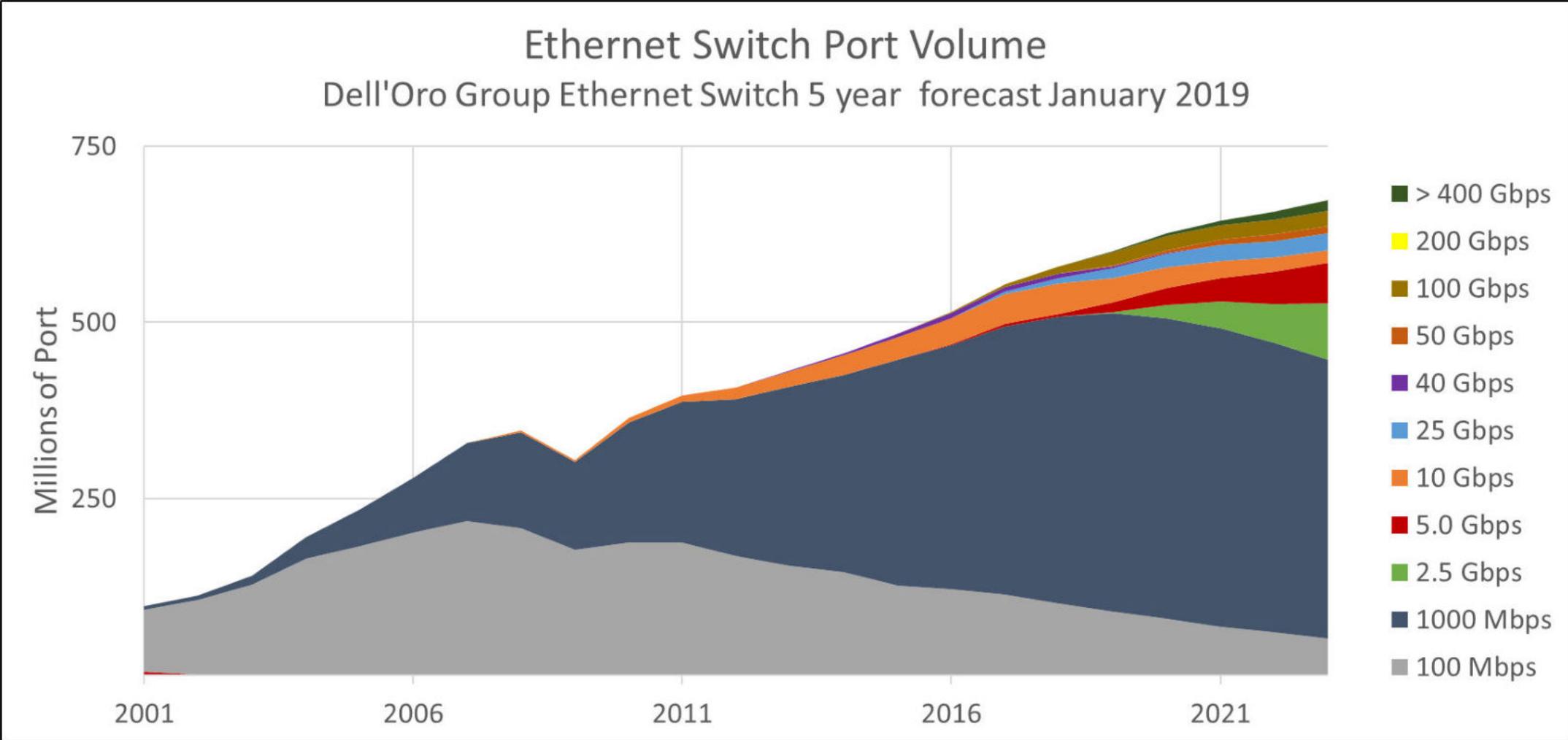


Source: Dell'Oro Group, Feb 2018

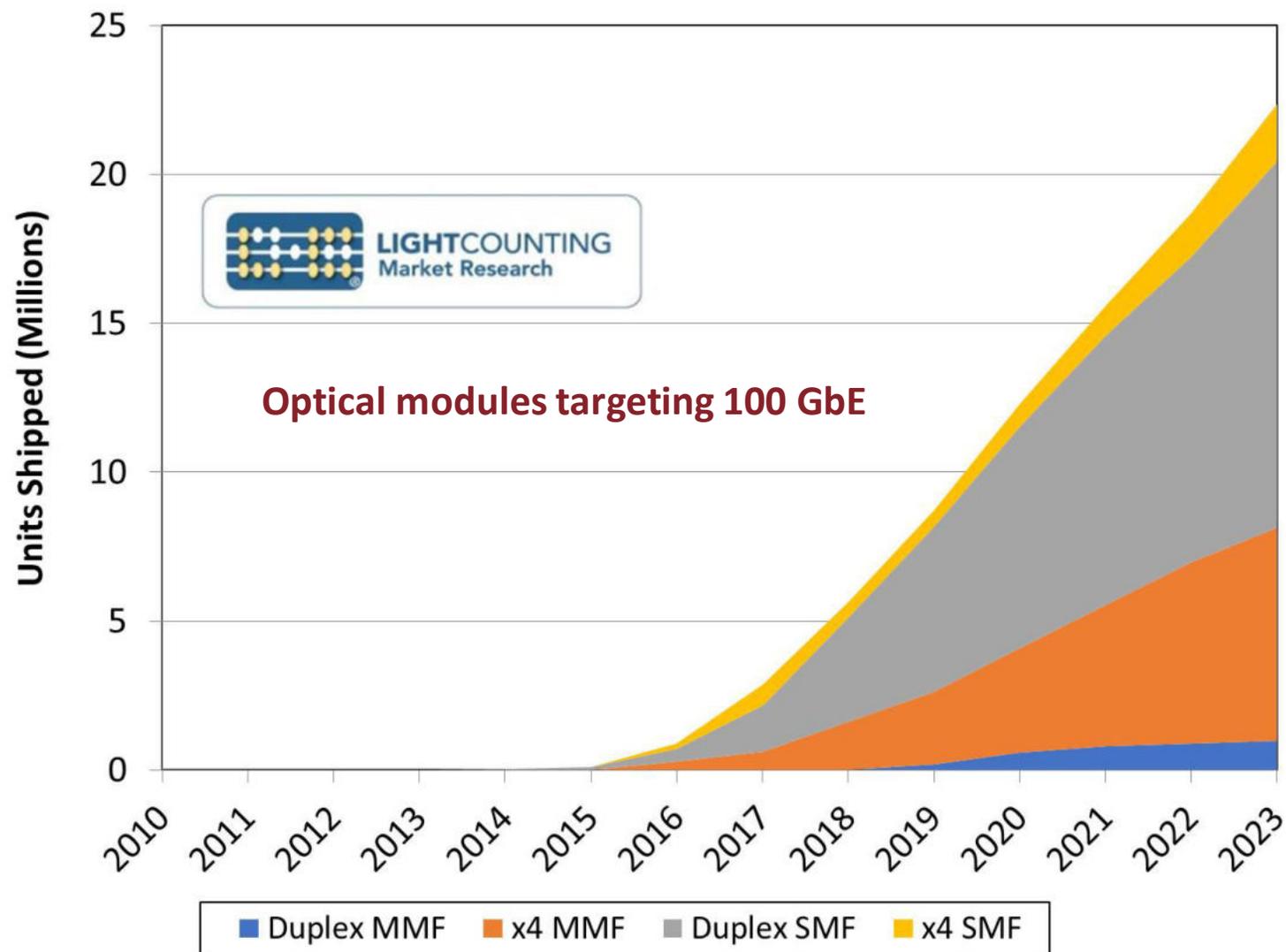
# Moving Forward

- **Multi-vendor Interoperability is an attribute of Ethernet**
- **Ethernet standards are important, but are a step on the path to wide-scale deployment**
- **New technologies are coming at an increasing pace**
- **The Ethernet Alliance leads the Ethernet industry in its investment in demonstrating multi-vendor interoperability**

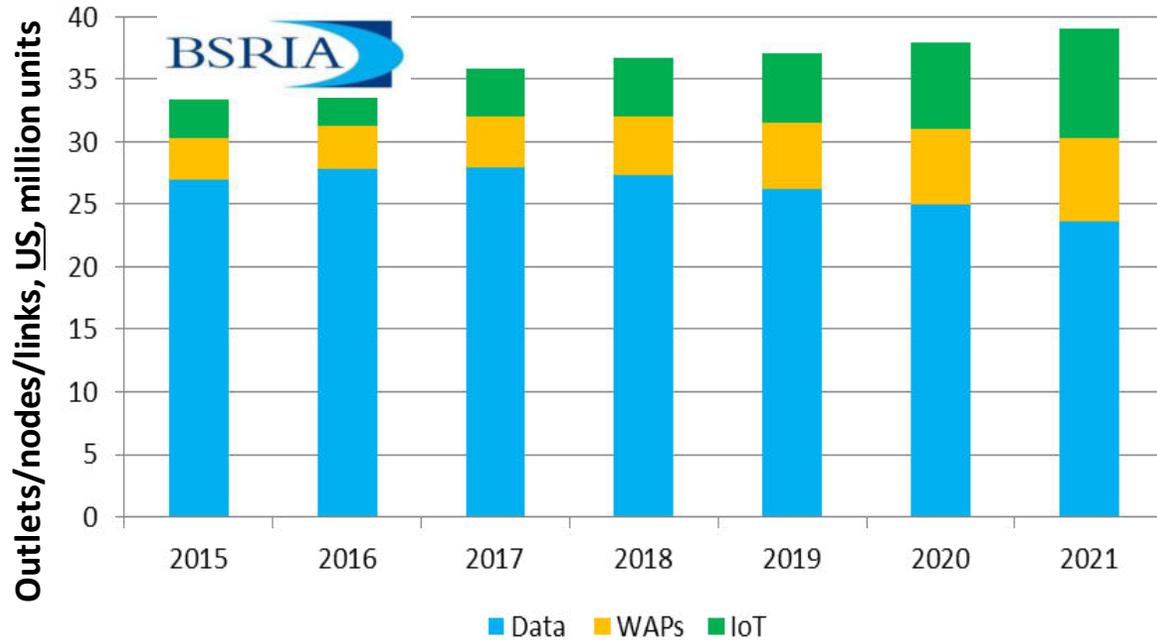
# Ethernet Speed Transitions



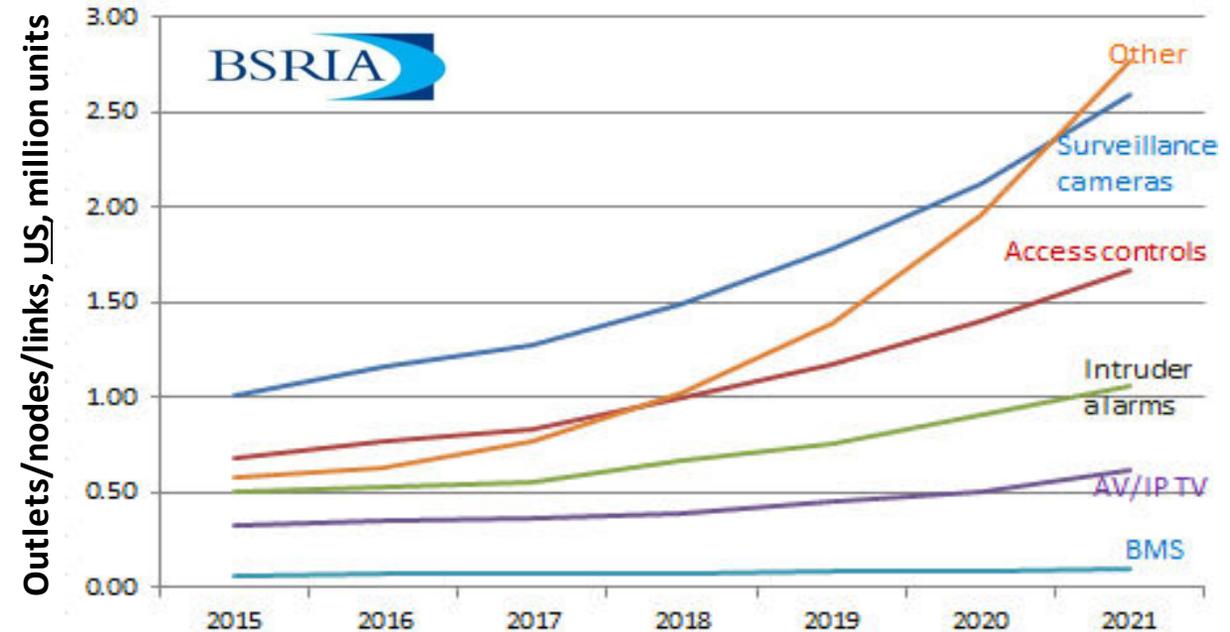
# Interoperability Can Impact Deployment



# Network links/nodes sales and growth, USA



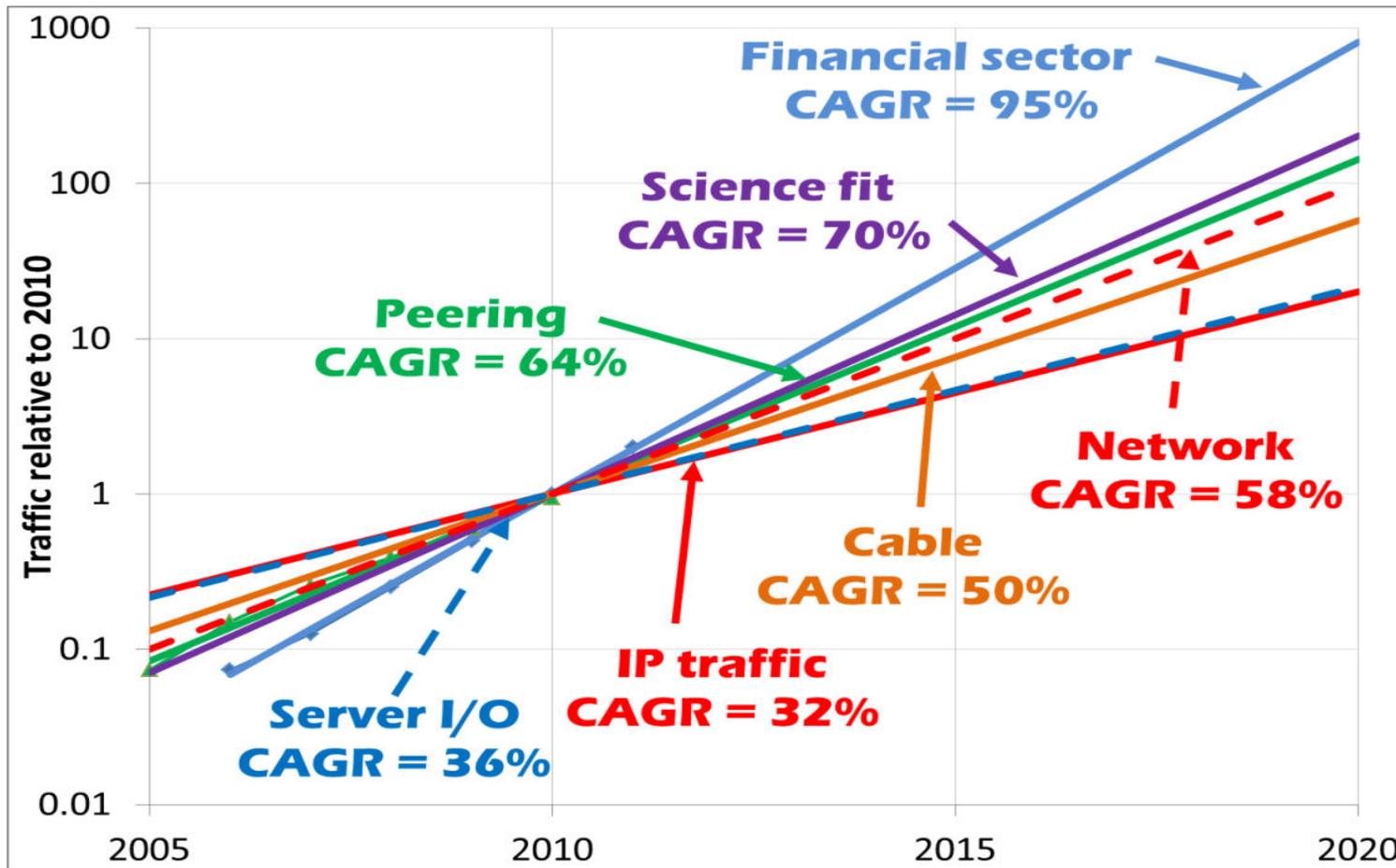
## “IoT” Breakout



Source: BSRIA survey and modelling May 2017

Other: Lighting, digital signage, point of sales/card readers, white boards, smoke detection, room booking

# This Chart Helped Launch 400GbE



- Diverse applications!
- Diverse bandwidth growth rates!
- New Ethernet Bandwidth Assessment underway!

Source: [http://www.ieee802.org/3/ad\\_hoc/bwa/BWA\\_Report.pdf](http://www.ieee802.org/3/ad_hoc/bwa/BWA_Report.pdf)

[http://www.ieee802.org/3/ad\\_hoc/bwa2/index.html](http://www.ieee802.org/3/ad_hoc/bwa2/index.html)

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