AUTOMOTIVE CONNECTIVITY:
IMPACT ON THE GLOBAL NETWORK OF TOMORROW

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November 1, 2017

ethernet alliance

Regarding the Views Expressed

Steve's Industry Involvement

- Consultant, High Speed Design, Inc.
- Consulting Member, Ethernet Alliance
- Chair, IEEE P802.3ch Multi-Gigabit Automotive Ethernet PHY Task Force
- Executive Secretary, IEEE 802.3 Working Group

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

Per IEEE-SA Standards Board Bylaws, Dec 2016

"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. "

The “Exponential Factor”

“The greatest shortcoming of the human race is our inability to understand the exponential function.”

Albert Bartlett – American Scholar

Introduction

- Bandwidth growth is driven by
  - Number of users
  - Access rates
  - Services / Applications offered
- Connected Cars represent a new “user” or “end station”
- As automotive applications (e.g. cloud services, mapping, telemetry, and data analytics) increase, what will be the impact on the traffic of tomorrow’s networks?
- Annual global IP traffic surpassed the zettabyte (ZB; 1000 exabytes [EB]) threshold in 2016, and will reach 2.3 ZB by 2020.
  - Global IP traffic will reach 1.1 ZB per year or 88.7 EB (one billion gigabytes [GB])per month in 2016
  - By 2020, global IP traffic will reach 2.3 ZB per year, or 194 EB per month

WHAT IS THE “GLOBAL NETWORK?”

November 1, 2017

NEXT ETHERNET ERA

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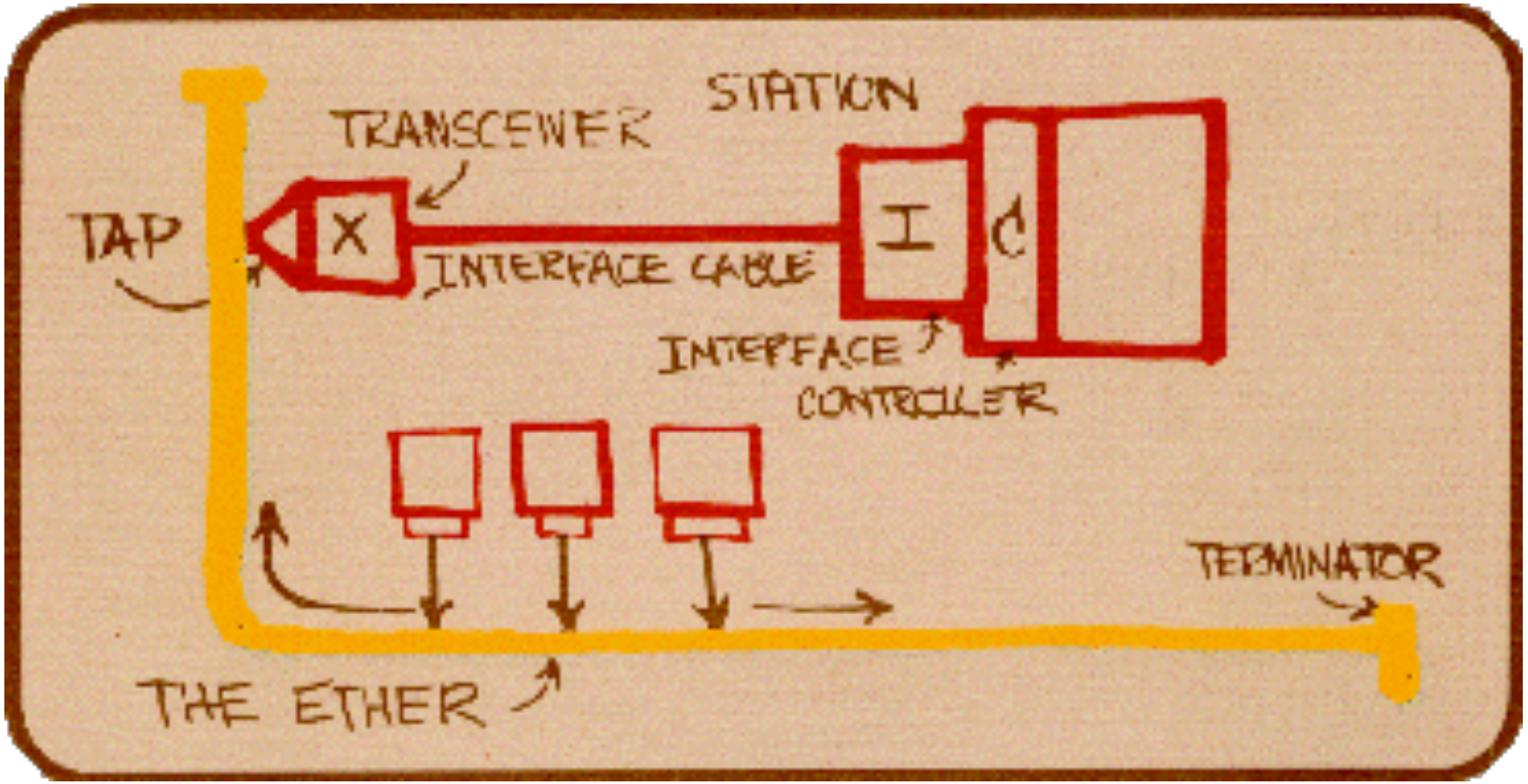
The Start of Ethernet

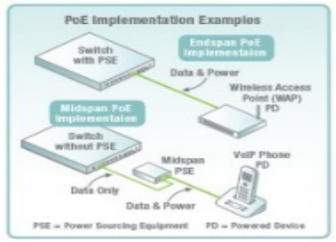


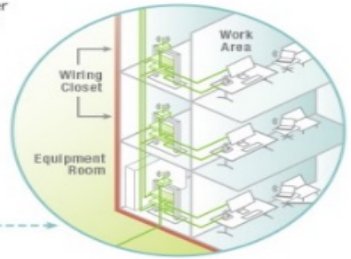
Source: http://www.ieee802.org/3/ethernet_diag.html

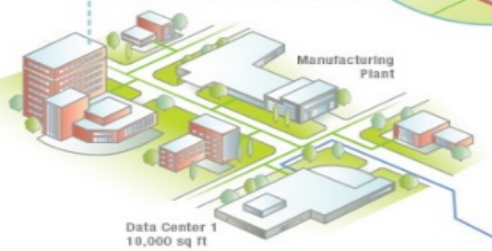
ENTERPRISE AND CAMPUS

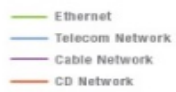
Power over Ethernet is a growing Ethernet application that delivers power and data over Category cabling that has 4 twisted pairs of wires, with Cat 5 or better cabling recommended. 4-Pair PoE is being standardized to deliver over 70W of power over all 4 twisted pairs instead of the two pairs in PoE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

PoE Types and Classes	PoE – Type 1			PoE+ – Type 2	4-Pair PoE in Standardization				
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	6.49	13	25.5	40	51	62	71
4 – Pair PoE–Type 3									
4 – Pair PoE–Type 4									



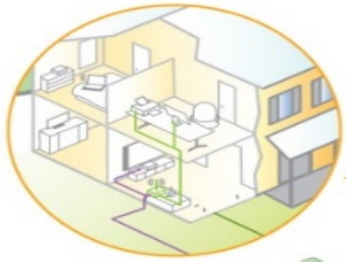






RESIDENTIAL AND CONSUMER

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 defacto 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)

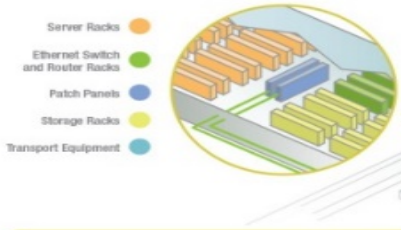
PoDL delivers data and power to cameras, lights, entertainment systems, controls and other devices throughout the car.

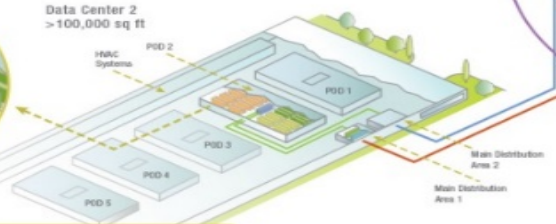
Wireless Connectivity

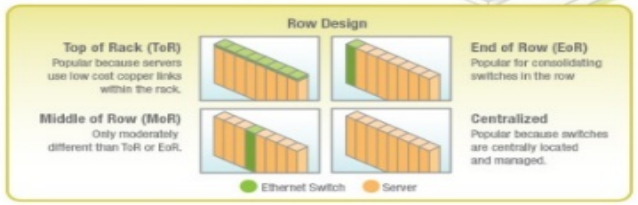
Connected cars are expected to drive increased traffic to wireless networks that result in more wireless backhaul traffic over Ethernet.

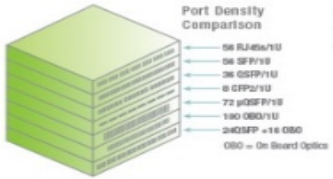
BACKBONE TO OTHER CITIES

BACKBONE TO OTHER CITIES



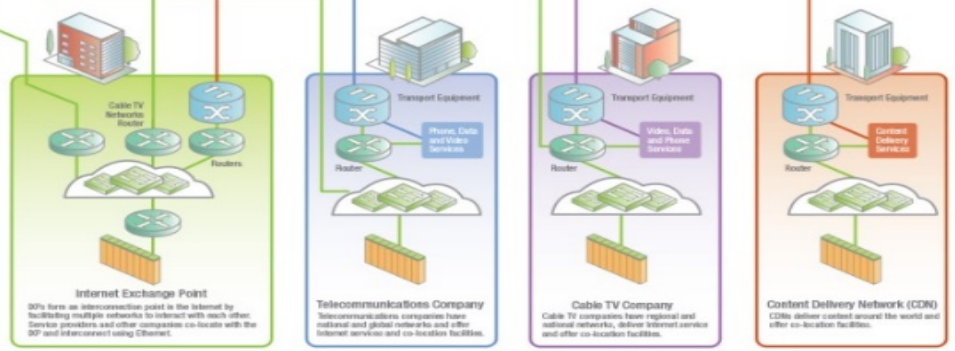






MANs

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.

HYPERSCALE DATA CENTER

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

SERVICE PROVIDERS

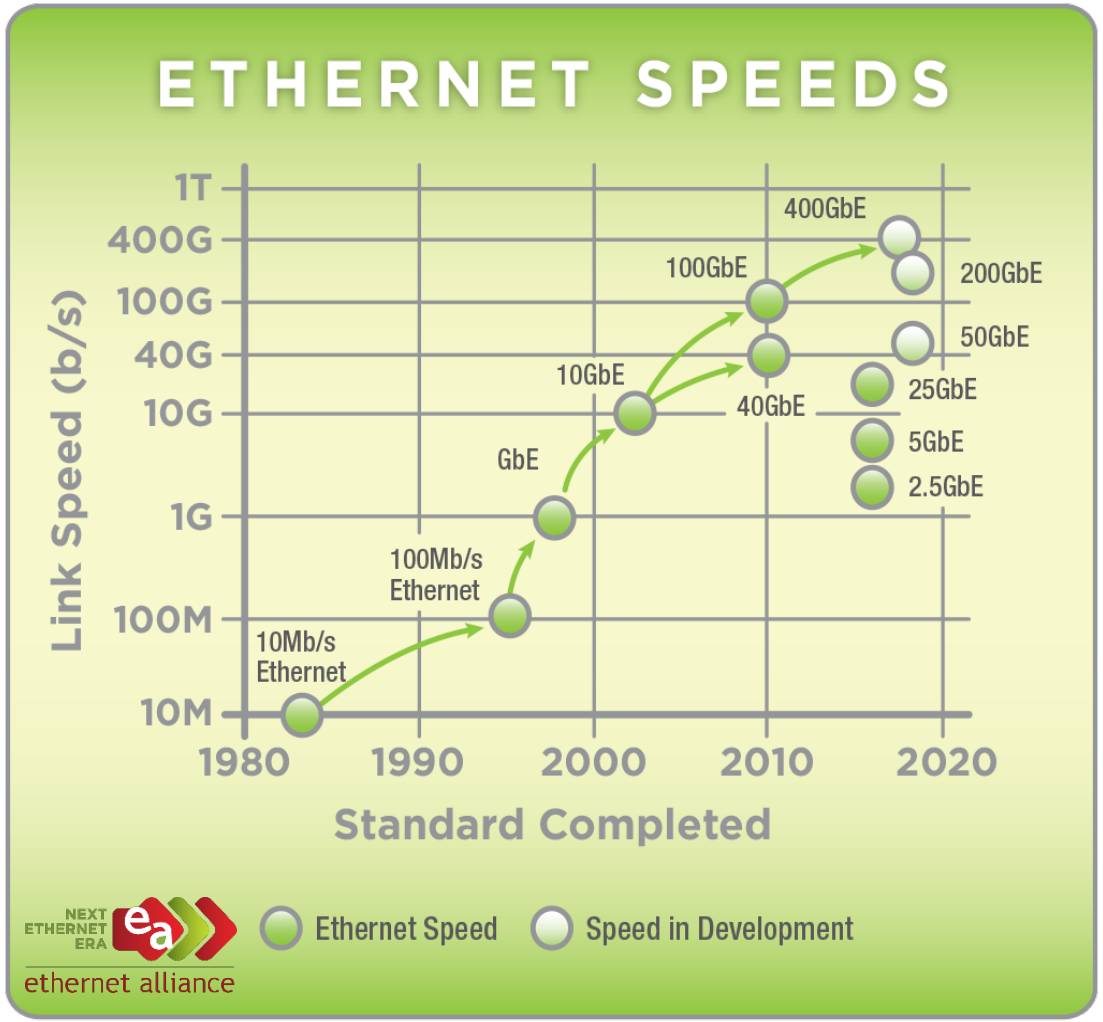
NEXT ETHERNET ERA ethernet alliance

Source: https://ethernetalliance.org/roadmap/

"Those who don't know history are destined to repeat it."

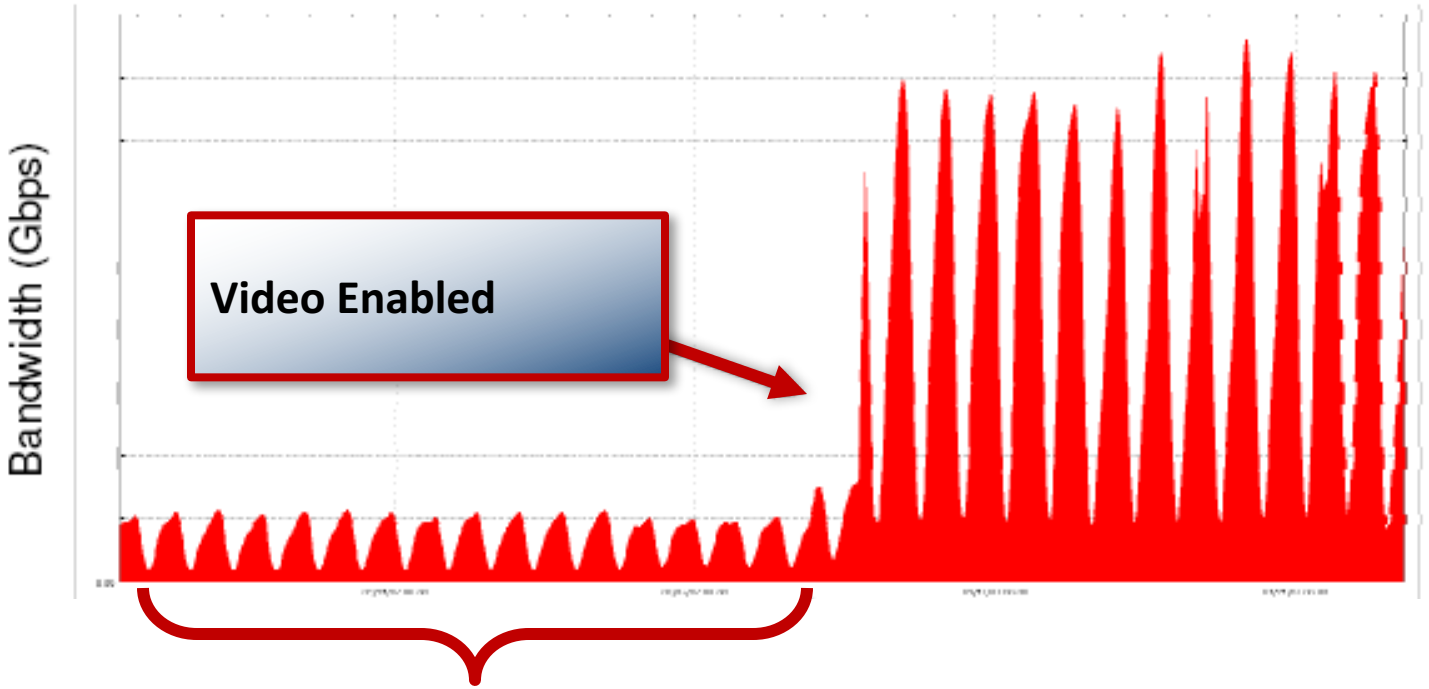
Edmund Burke (1729-1797)

Ethernet's History of Rates



OFC / NFOEC 2008: Facebook Living in the Video World

TOOTHBRUSH GRAPH

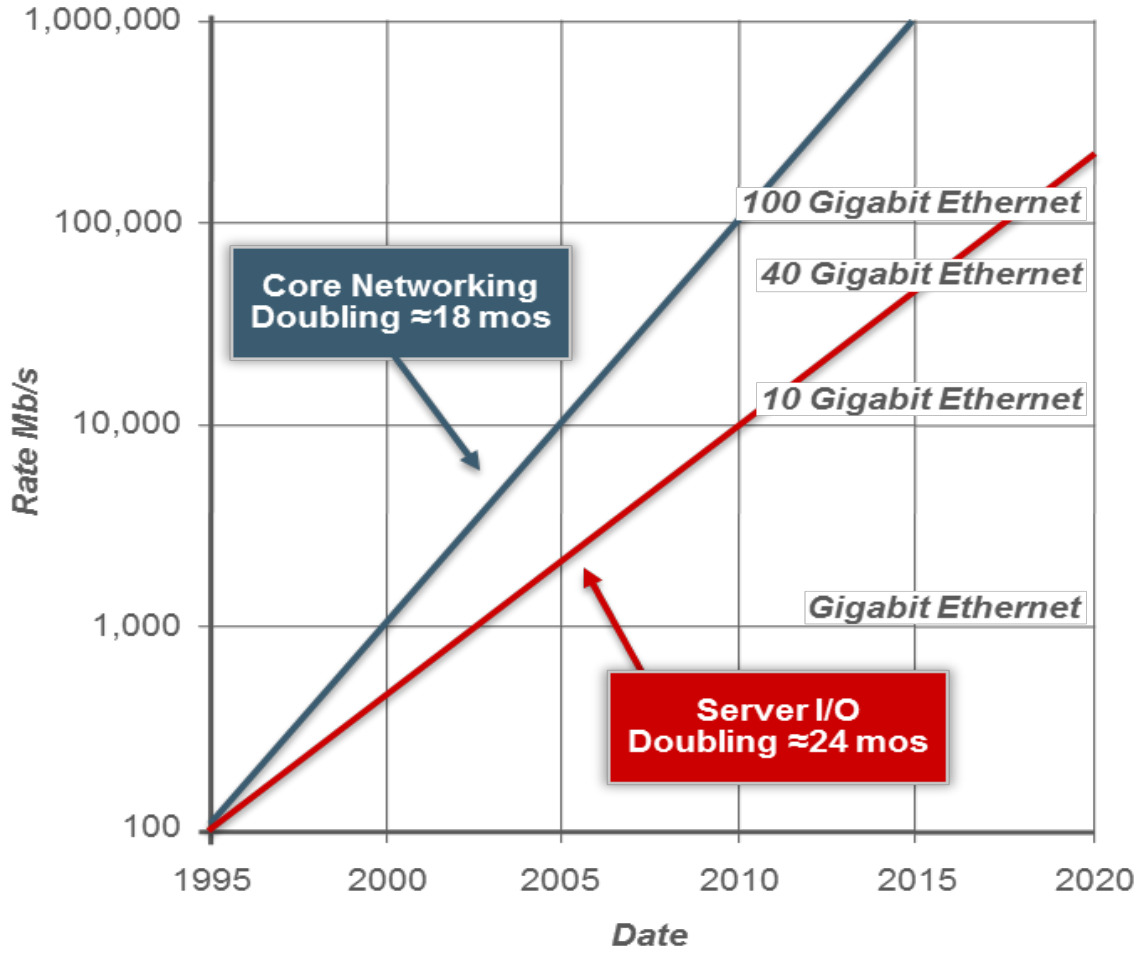


This was a huge amount of traffic (multiple web services, millions of users)

Source: Donn Lee Presentation OFC 2008

10

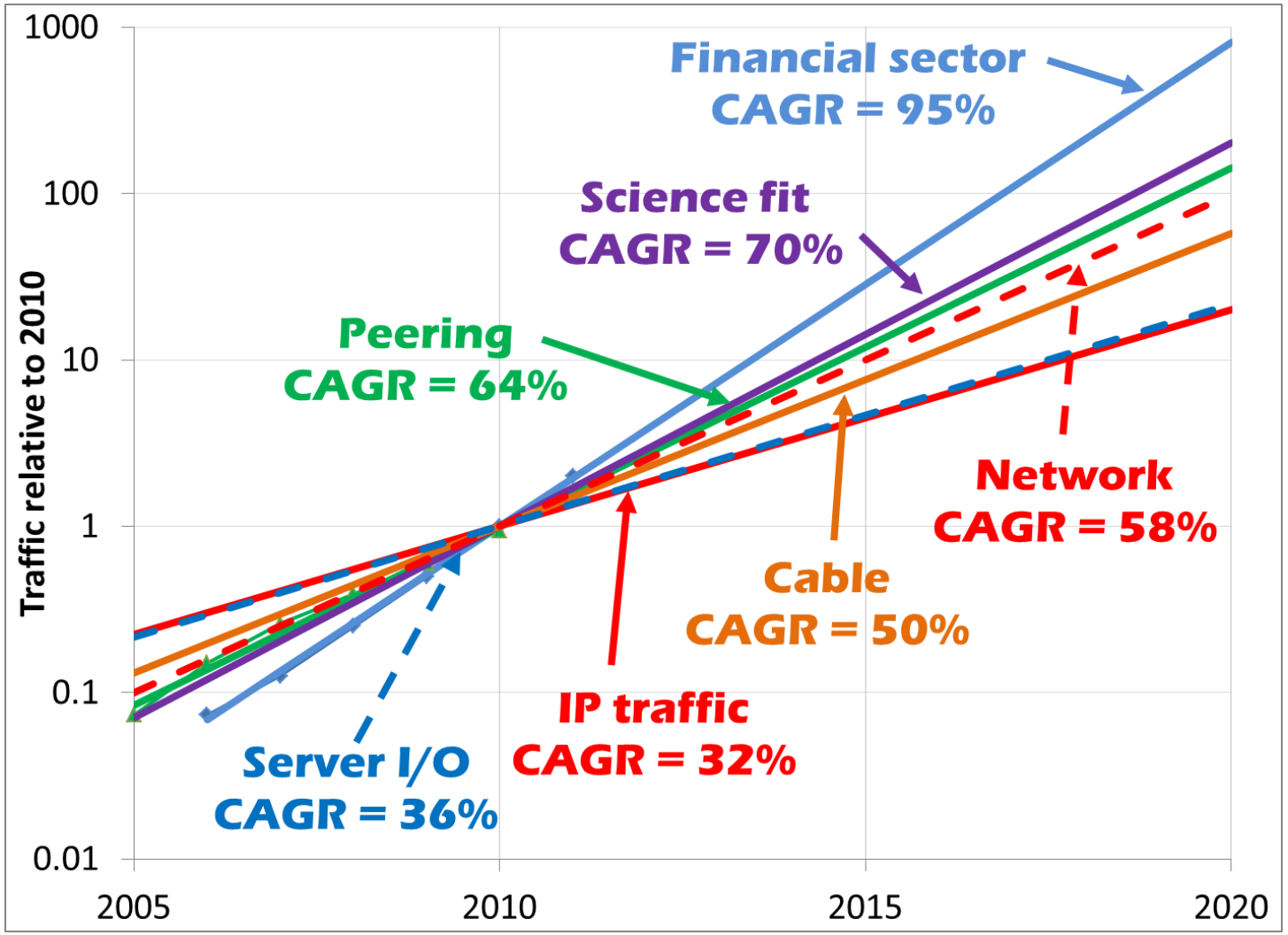
Some perspective:
The View After 10 Gigabit Ethernet



The beginning....

Source: http://www.ieee802.org/3/hssg/public/nov07/HSSG_Tutorial_1107.zip

The IEEE 802.3 Ethernet Bandwidth Assessment



Trend #1

Bandwidth Growth

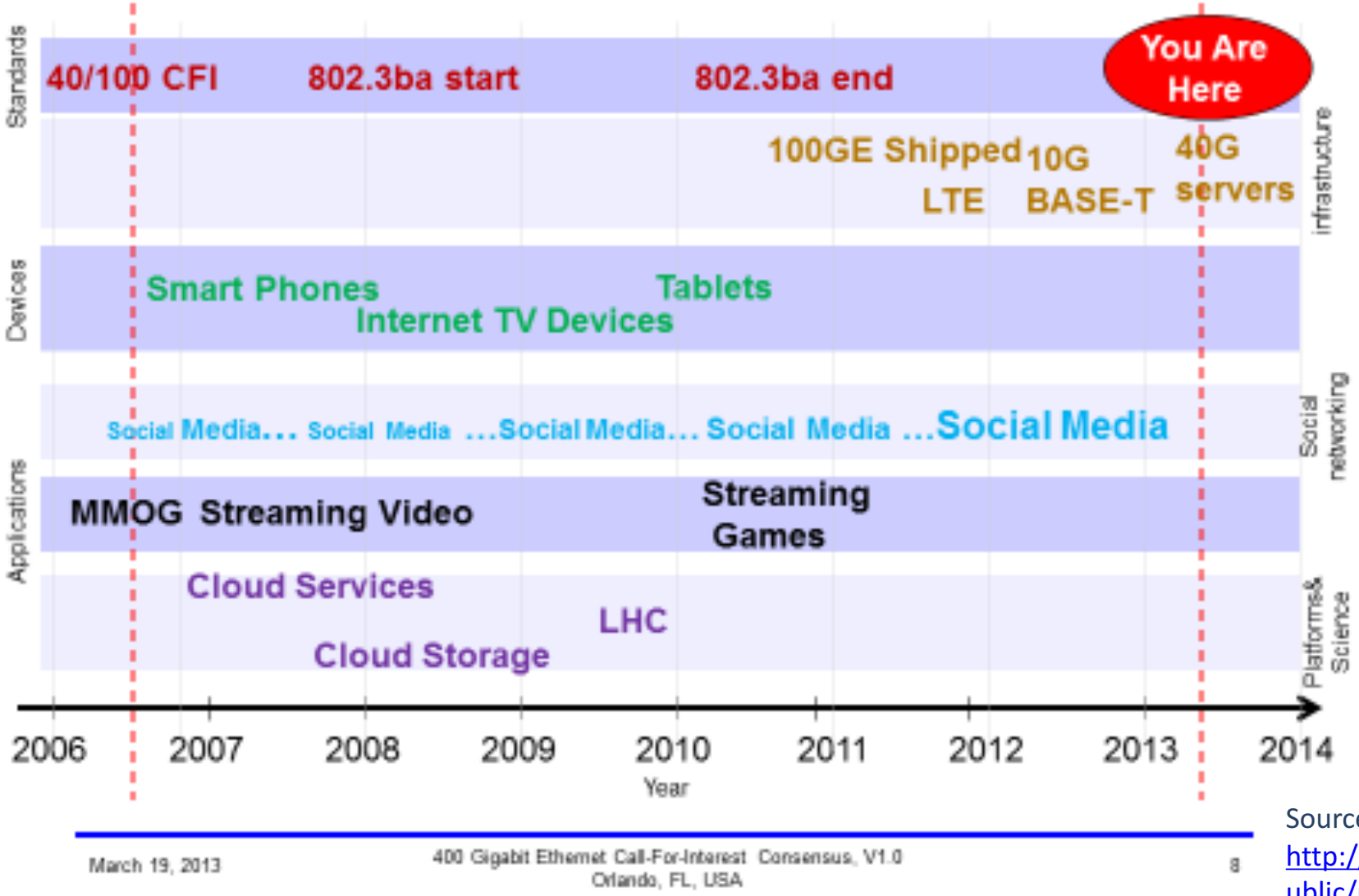
Trend #2

Diversity Growth

Note: autos were not in this forecast!

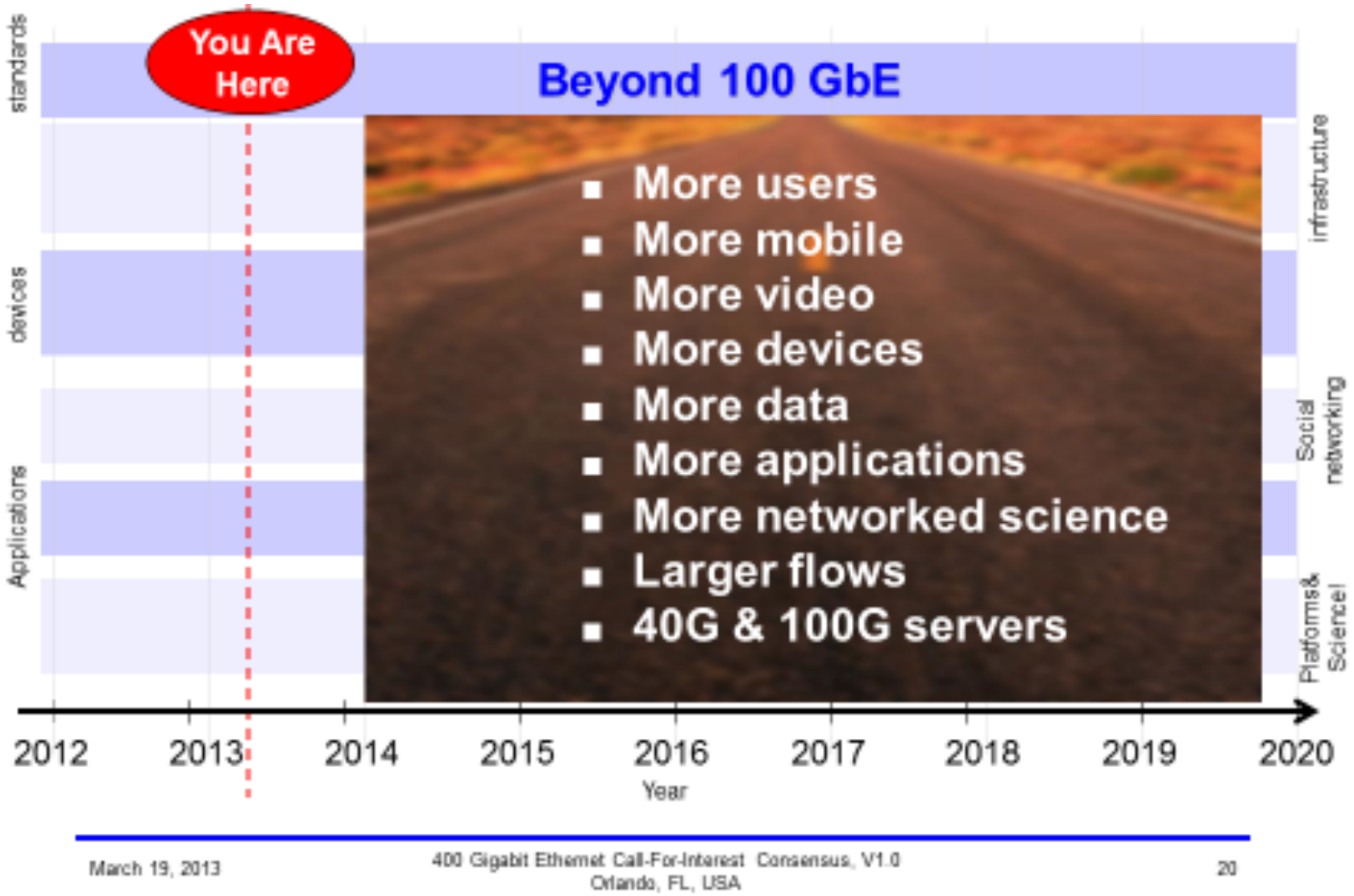
Source: www.ieee802.org/3/ad_hoc/bwa/BWA_Report.pdf

“Disruptions” 2007 - 2014



Source: http://www.ieee802.org/3/400GSG/public/mar13/CFI_01_0313.pdf

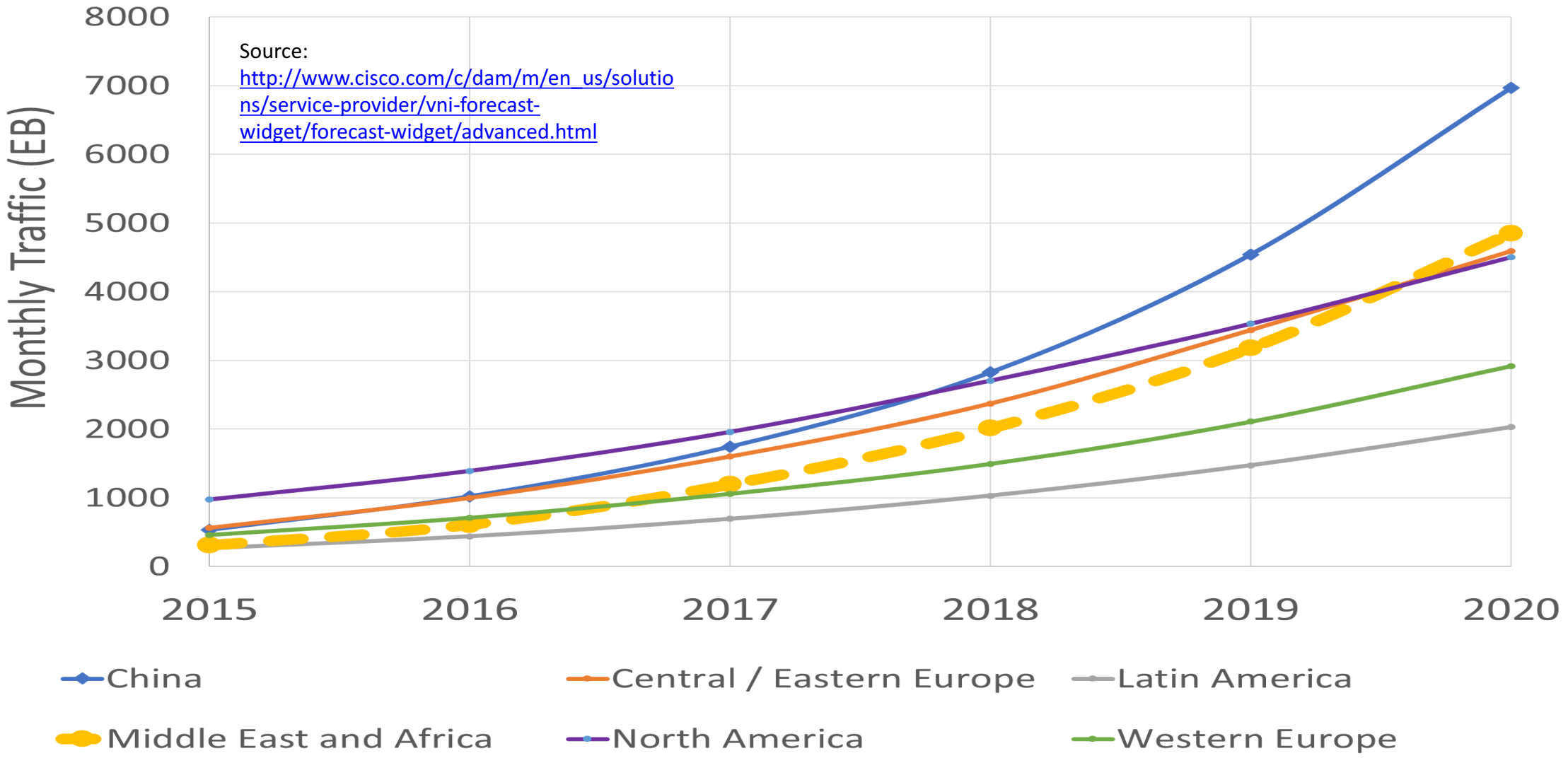
The World During the Development of 400GbE



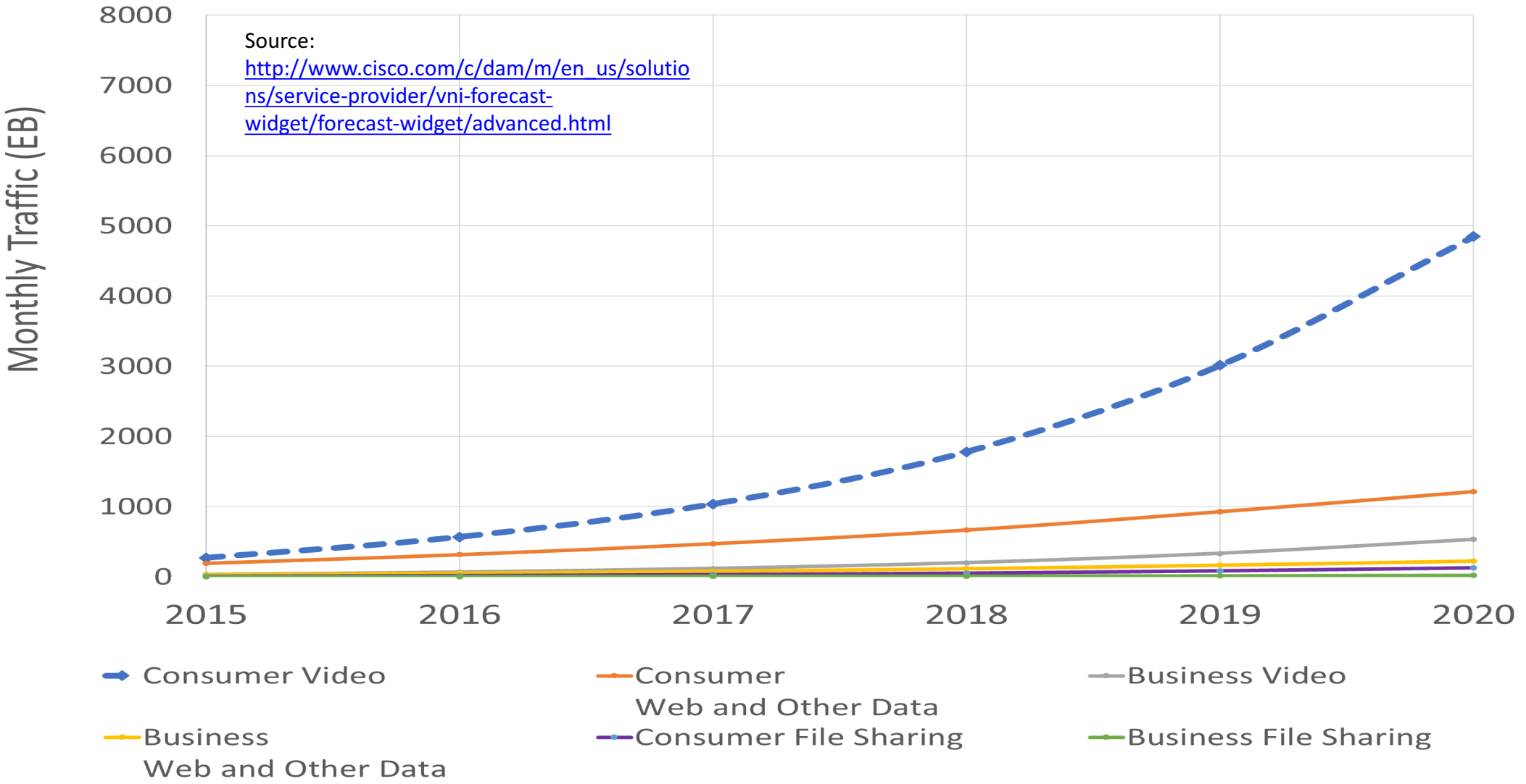
- Many of these same trends will be experienced by the Connected Car
- History will repeat itself

Source: http://www.ieee802.org/3/400GSG/public/mar13/CFI_01_0313.pdf

Mobile Networks Bandwidth Trends - Global



Mobile Networks Bandwidth Trends - China

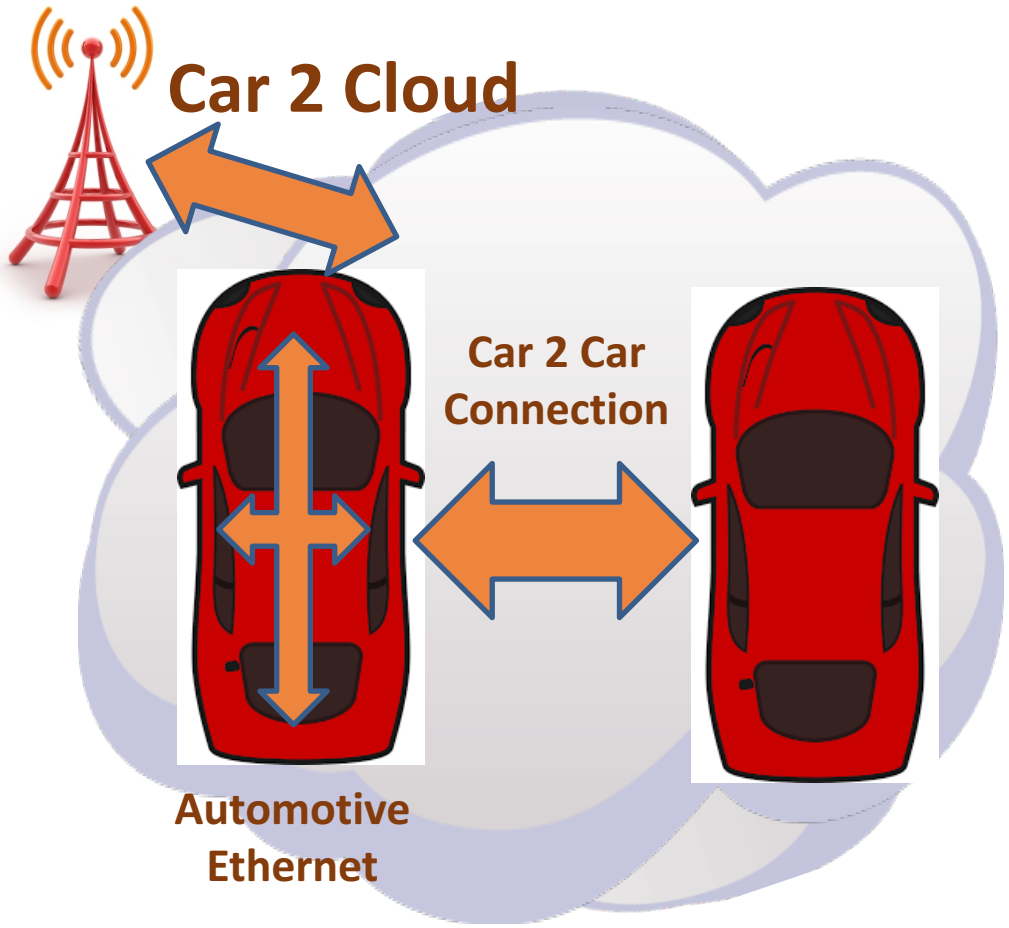


The Automobile – the Next End Station

Metcalfe's Law: The value of a telecommunications network is proportional to the square of the number of connected users of the system

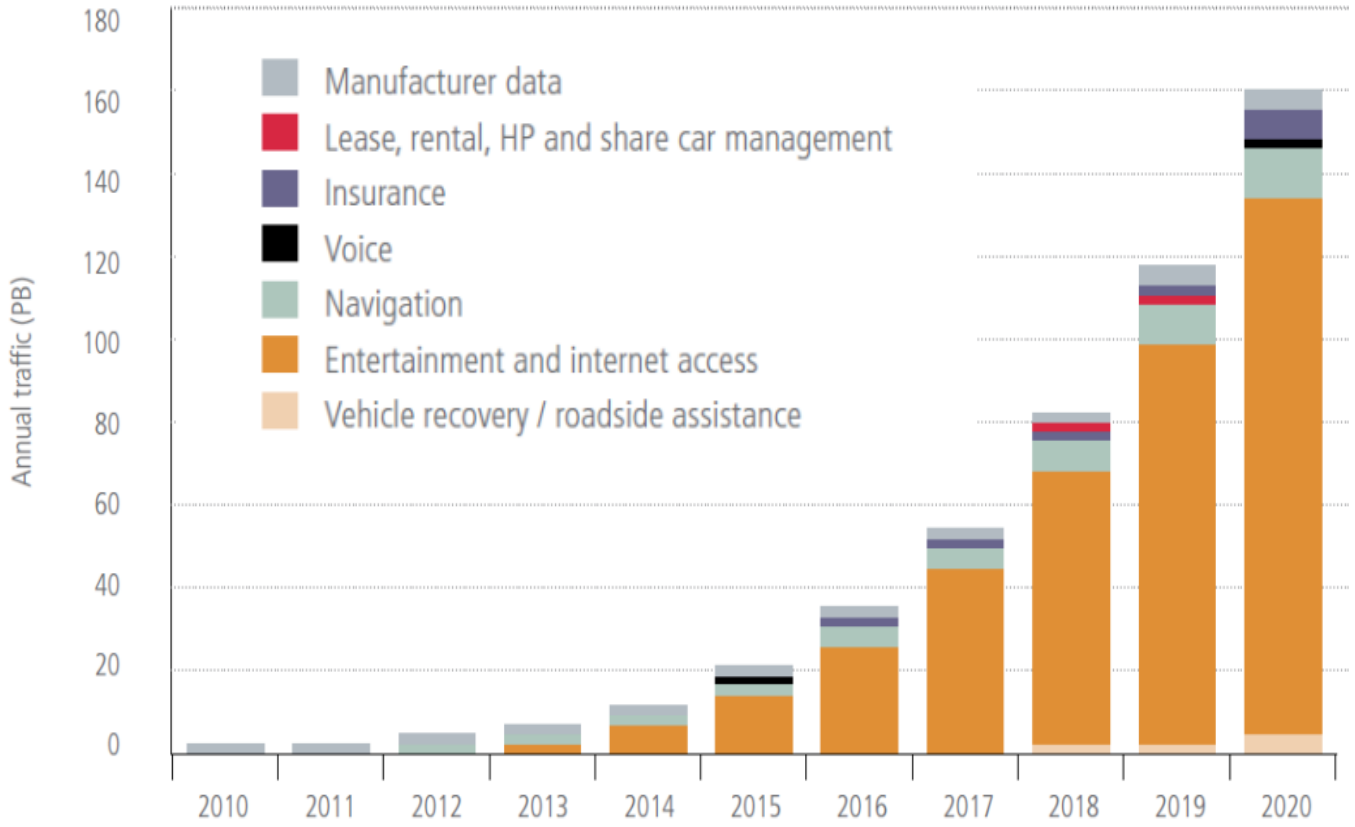
-Dr. Robert Metcalfe, inventor of Ethernet

Connected Cars – Driving Bandwidth on Mobile Networks



2019- 117 Million Vehicles to be produced *

* CFI Multi-Gig Automotive Ethernet PHY, http://www.ieee802.org/3/cfi/1116_1/CFI_01_1116.pdf.



2011 Forecast for Global Wireless Traffic Generated by Embedded Mobility by Application

Source - GSMA, Connecting Cars: The Technology Roadmap, February 2013, https://www.gsma.com/iot/wp-content/uploads/2013/02/GSMA_mAutomotive_TechnologyRoadmap_v2.pdf

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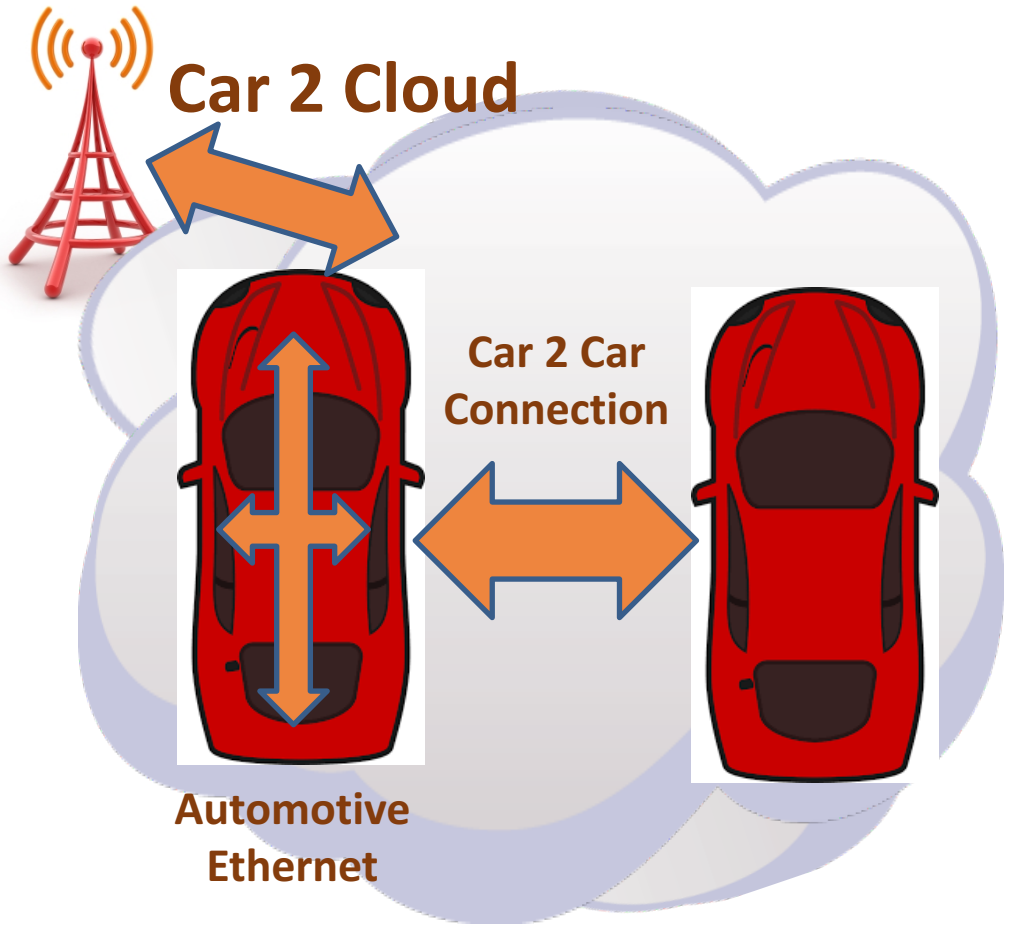

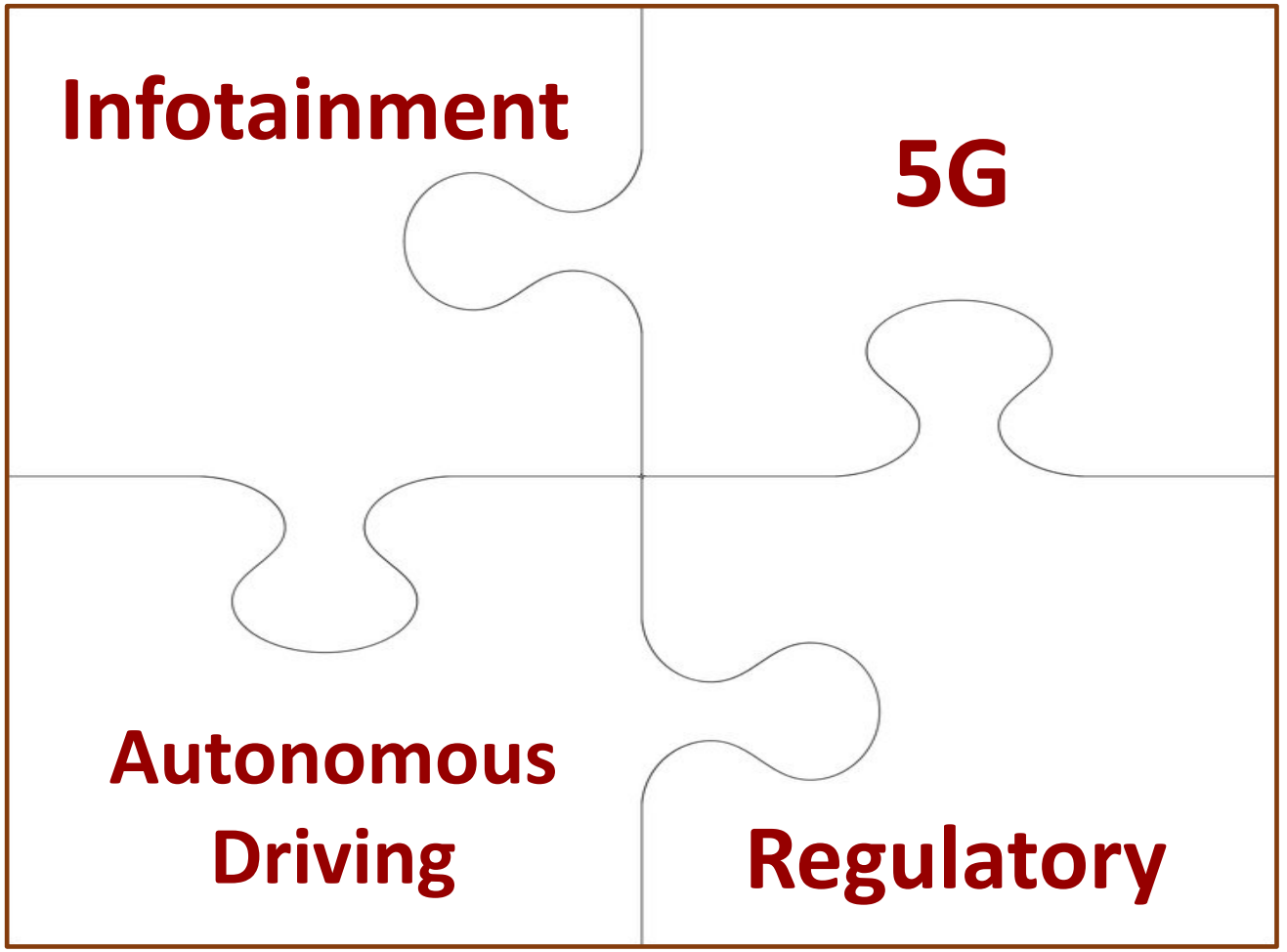

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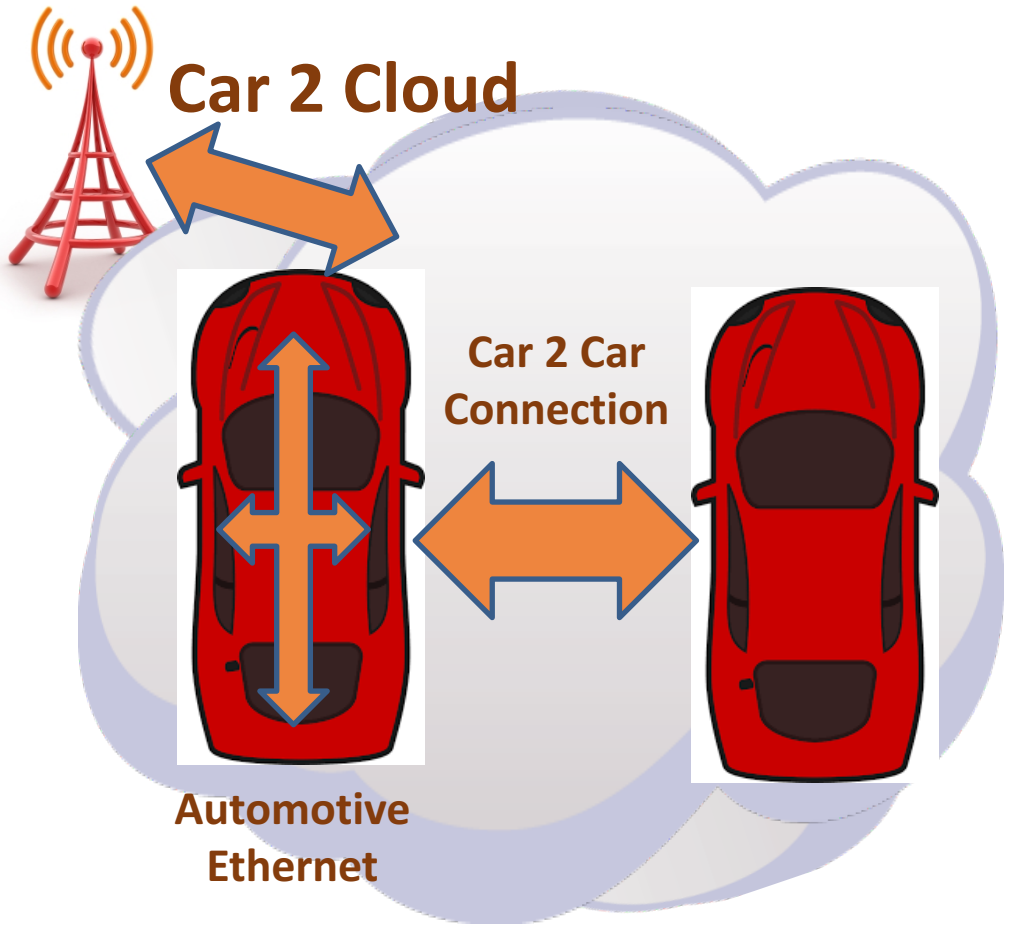


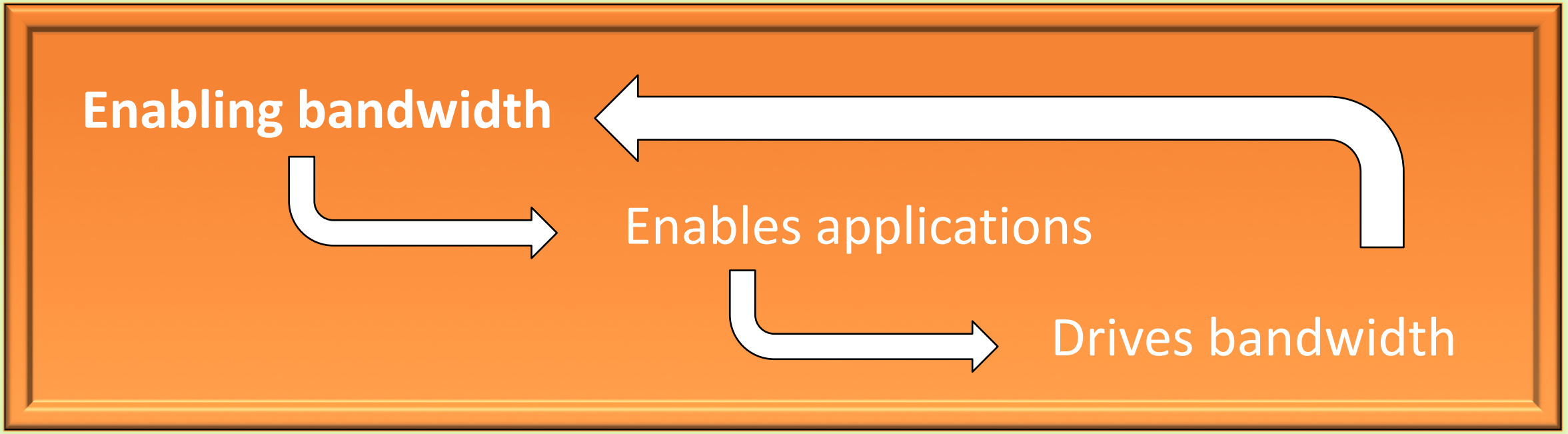
What Else?

Will there be enough bandwidth in the global network?

2019- 117 Million Vehicles to be produced *

* CFI Multi-Gig Automotive Ethernet PHY, http://www.ieee802.org/3/cfi/1116_1/CFI_01_1116.pdf.

The Story Remains the Same….



The Connected Car is the Next Chapter

A Simple Equation to Remember

# of Users **X** **Increased access rates & types of connections** **X** **Applications**

= Bandwidth Explosion

Summary

- Global bandwidth usage – growing exponentially
- Social media, smartphones, and video all disrupted the global network
- Continuous new drivers to bandwidth growth
- We need to understand how automobiles will add to this bandwidth usage to insure that the global network will support the needs
- We need the automotive industry to help us understand how to support the bandwidth needs---help us help you!

Thank you!

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