



ETHERNET ROADMAP UPDATE

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DISCLAIMER

The views expressed in this presentation are the views of the presenter and not of the Ethernet Alliance.

Ethernet Roadmap Updates

- Since the August meeting, several standards are being worked on in IEEE 802.3
 - 25GbE Study Group met for the first time
 - 25GBASE-T Call for Interest (CFI) was announced
 - Next Generation Enterprise Access BASE-T PHY CFI announced
- If these pass, we could have 5 new speeds being developed simultaneously:
 1. 2.5GbE
 2. 5GbE
 3. 25GbE
 4. 50GbE
 5. 400GbE



>1B Ports Shipped in 2014!

Over 7 Billion Ethernet ports shipped in last decade!

	Ethernet Switch Ports ¹	Router Ports ²	Controllers and Adapters ³	PoE Devices ⁴	Access Ports ⁵	Total
2004	195M	1.2M	110M*	8.9M	62M	377M
2014	452M	1.8M	294M	98M	129M	974M

Probably another 100M ports on widgets, TVs, video games and other equipment in 2014.

With Internet of things and vehicular applications expected to ship 100s of Millions of ports by the end of the decade, Ethernet will surpass **1.5B Ports/year** by 2020.

1. Dell'Oro Ethernet Switch Layer 2+3 Report, July 2014

2. Dell'Oro Routers Report, July 2014

3. Dell'Oro Controller and Adapter Report, January 2012

4. Based on PoE switch ports from Dell'Oro Ethernet Switch Layer 2+3 Report, July 2014

5. Dell'Oro Access Five Year Forecast, July 2014

* 2006 values since 2004 values weren't available



Ethernet Alliance Roadmap

Find more at:

www.ethernetalliance.org/subcommittees/roadmapping-subcommittee/

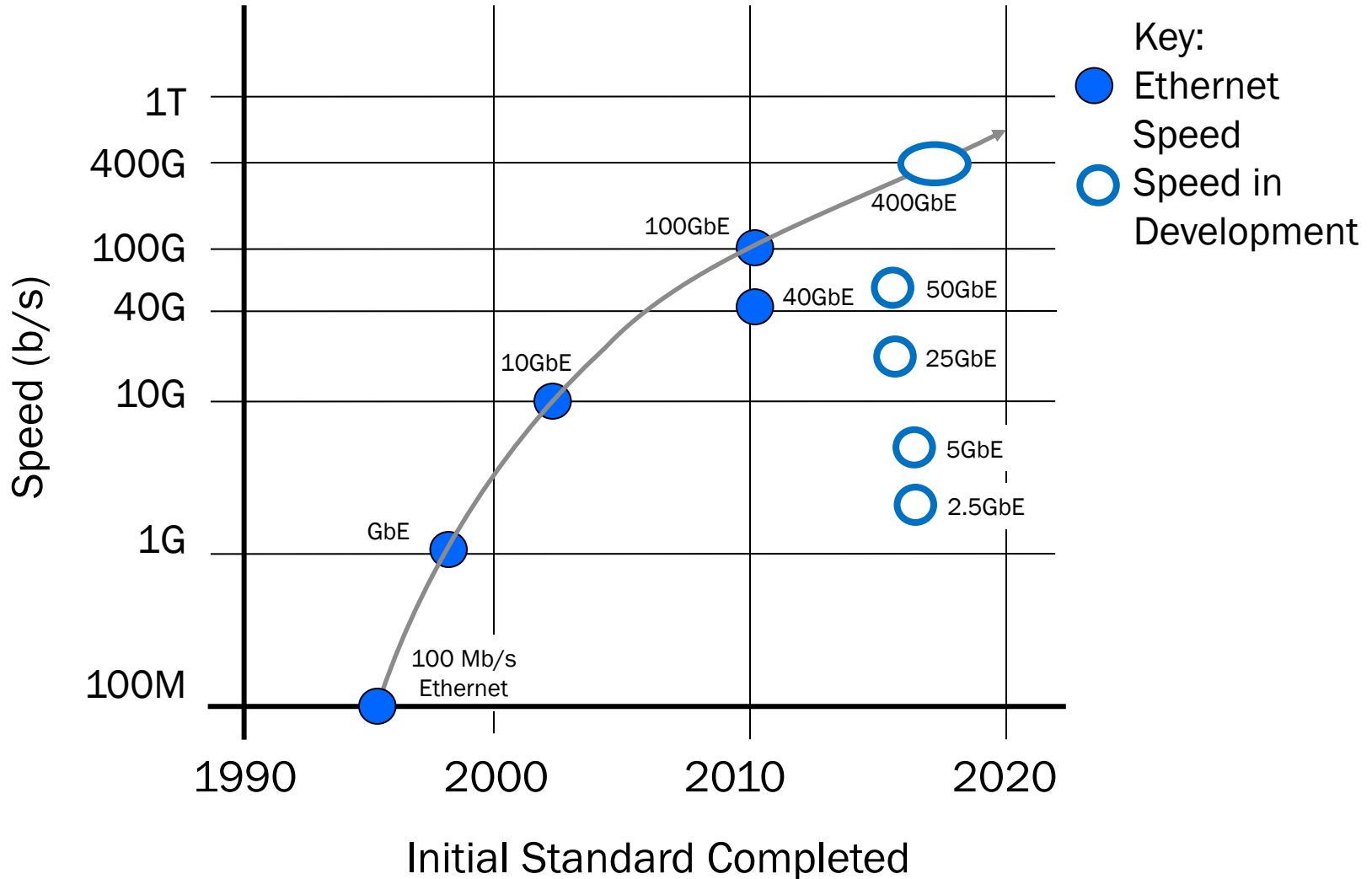
Name	Speed	Date Initial Standard Ratified
10Mb/s Ethernet	10 Mb/s	1983
100Mb/s Ethernet	100Mb/s	1995
Gigabit Ethernet	1 Gb/s	1998
10 Gigabit Ethernet	10 Gb/s	2002
25 Gigabit Ethernet	25Gb/s	2016 (est)*
40 Gigabit Ethernet	40 Gb/s	2010
100 Gigabit Ethernet	100 Gb/s	2010
400 Gigabit Ethernet	400 Gb/s	2017 (est)**

*Estimated on a 2-year standardization process that started with the CFI in July 2014

**Estimated on a 4-year standardization process that started with the CFI in March 2013



Ethernet Speeds - Log



Why 2.5G to 50G?

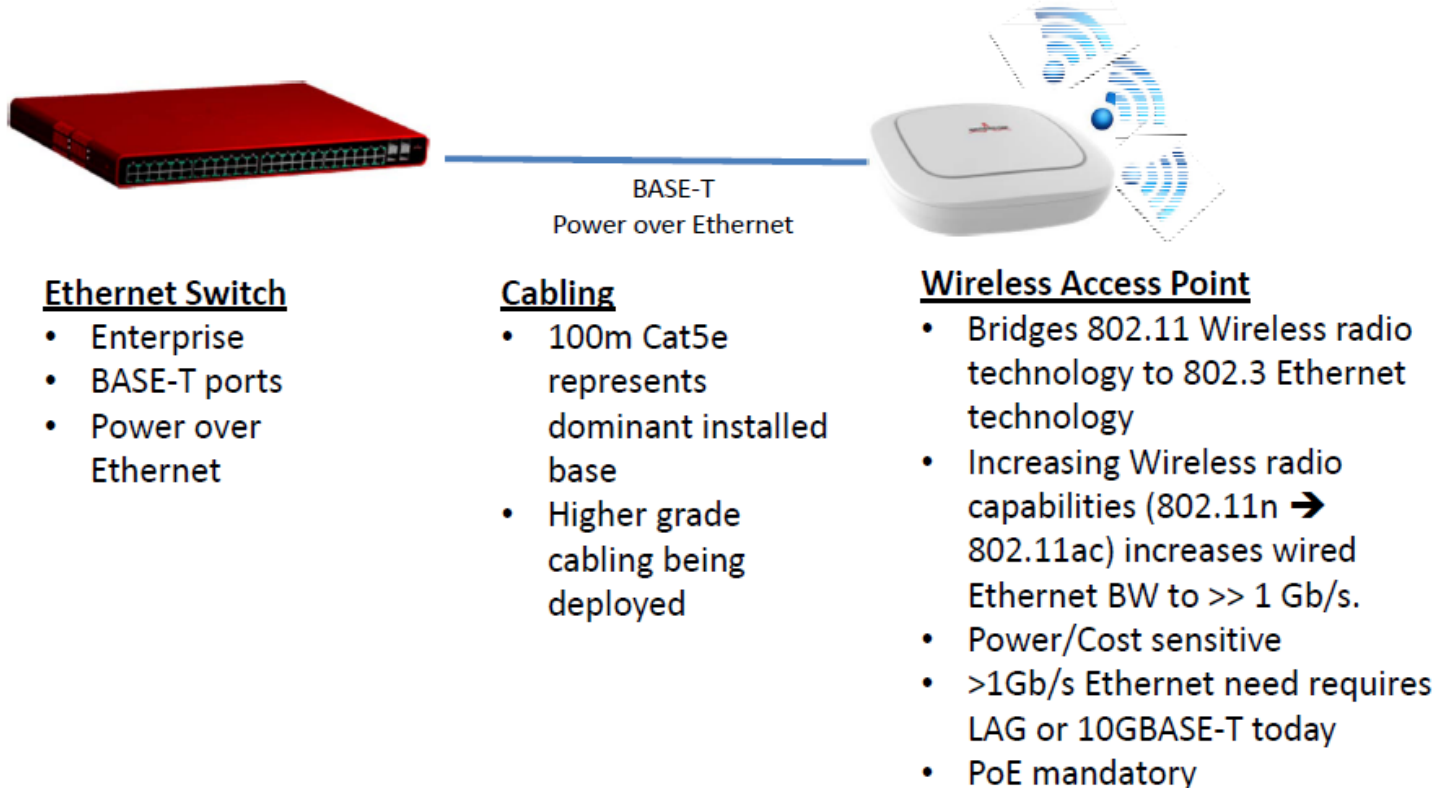
- Installed base of CAT5E cabling driving 2.5GBASE-T
 - 10GBASE-T doesn't support 100m of CAT5E
- Installed base, new technology and low cost of SFP+ driving 25GbE
 - Serial lanes lower cost than parallel lanes of 40GbE
- 40GBASE-T looks very challenging, but 25GBASE-T looks easier
- 100GbE still prohibitively expensive for many users
- 1X40GbE SFP+ should deliver good bandwidth/\$ compared with 40GbE QSFP+ (4X10G)
- Can 50GbE SFP+ be deliver better bandwidth/\$ too?



Figure from Upcoming 2.5G CFI

Next Generation Enterprise Access BASE-T PHY

802.3 Ethernet and 802.11 Wireless LAN



Why 25G Now?

- Best cost/Gbps soon
- Technology is ready
 - ASICs are port limited, so need more Gb/s/port

640Gb/s

64 Ports
of 10G



64 10GbE port ASIC enables
48 SFP+ and 4 QSFP+
640Gb/s of Throughput

5X

More

3.2 Tb/s

128 Ports
of 25G



128 25GbE port ASIC enables
32 QSFP+
3.2 Tb/s of Throughput



5X The Calories

McDonald's
Hamburger
-250 calories



Burger King's
Triple Whopper with
Cheese
-1250 calories



1000X The Storage

2003
512MB



2014
512GB!



How Long are Bits and Frames?

A 1GFC Frame is about 4km long and a 1GFC bit is 7.41” long

A 32GFC Frame is about 125 m and a 32GFC bit is about ¼” long

	Data Rate	Bit time	speed of light in glass	bit length	bit length	frame length
	bits/second	picoS/bit	m/s	m/bit	inches/bit	m/frame
1GFC	1,062,500,000	941	200,000,000	0.188	7.41	3975.53
2GFC	2,125,000,000	471	200,000,000	0.094	3.71	1987.76
4GFC	4,250,000,000	235	200,000,000	0.047	1.85	993.88
8GFC	8,500,000,000	118	200,000,000	0.024	0.93	496.94
16GFC	14,025,000,000	71	200,000,000	0.014	0.56	248.47
32GFC	28,050,000,000	36	200,000,000	0.007	0.28	124.24
100fs	My Master's Thesis at LLNL	0.1	300,000,000	0.000030	0.001181	

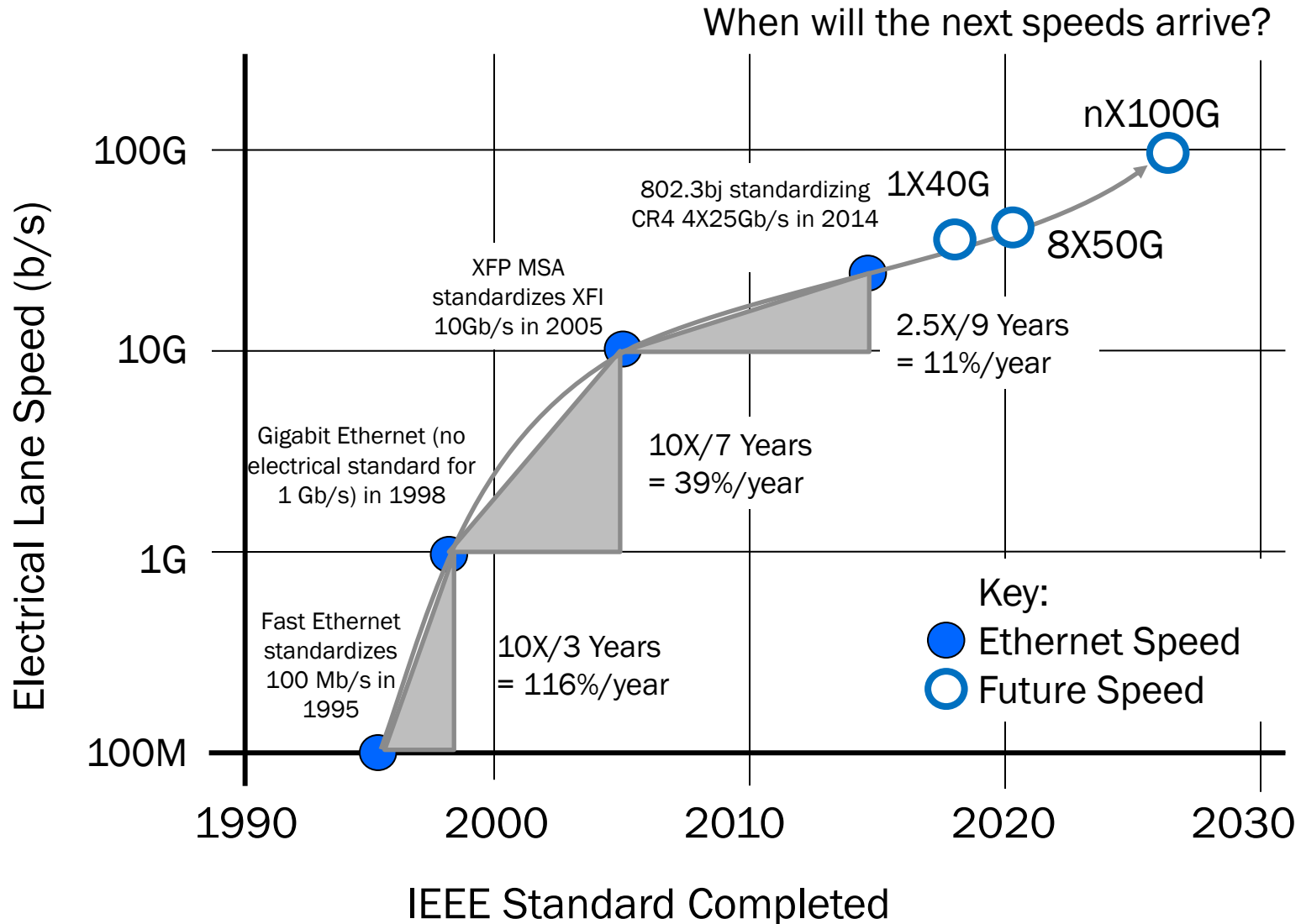


25GbE Standards

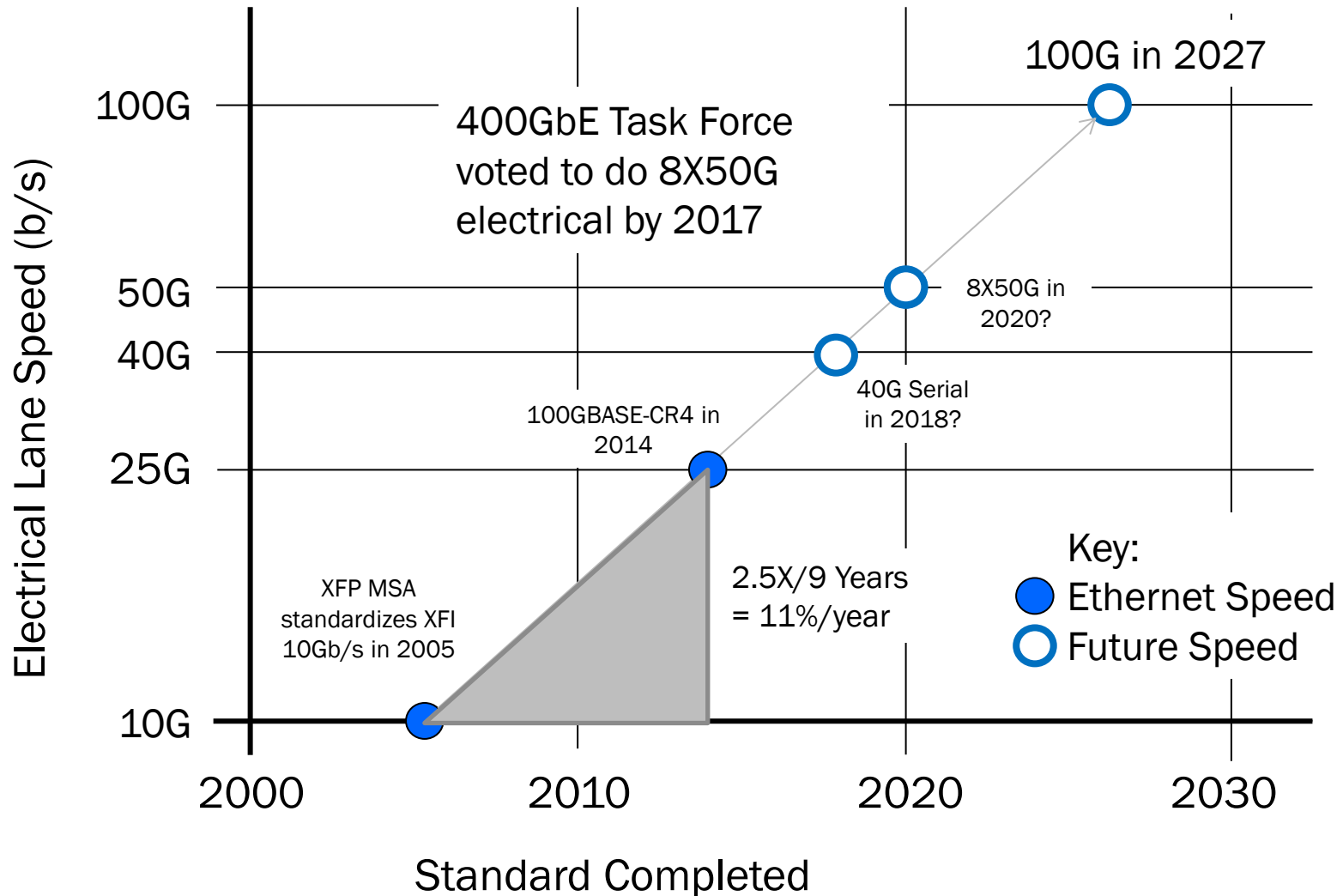
- Current 25GbE Study Group has following objectives:
 - Backplanes like 802.3bj
 - 3m of Twinax
 - 5m of Twinax
 - 100m like 100GBASE-SR4
- 25GBASE-T CFI coming next month
 - Don't know what distance or cabling yet?
 - 40GBASE-T defined for 30m over CAT8 – in letter ballot



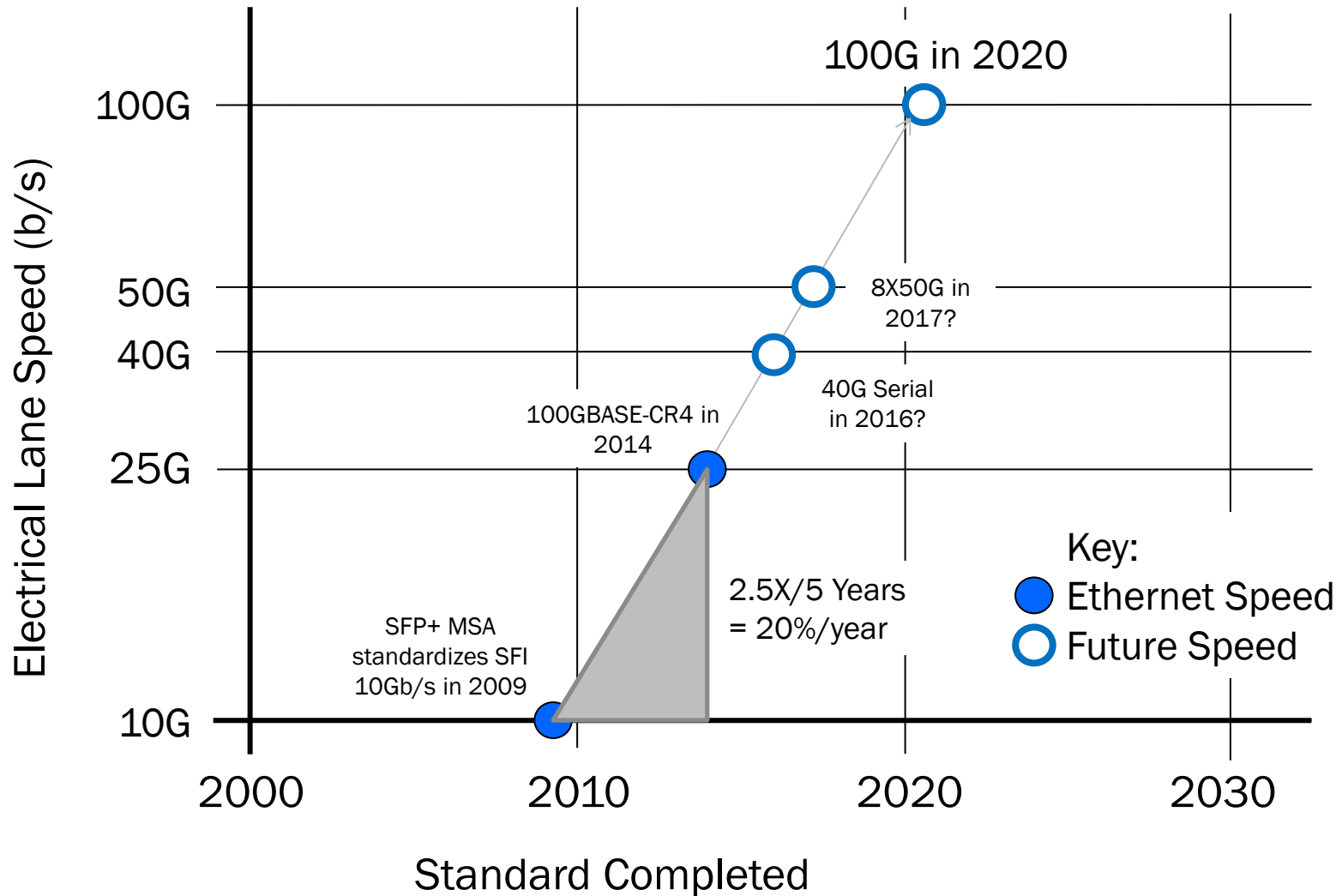
Electrical Interface Speeds



11% CAGR is Fairly Slow



20% CAGR is Great!

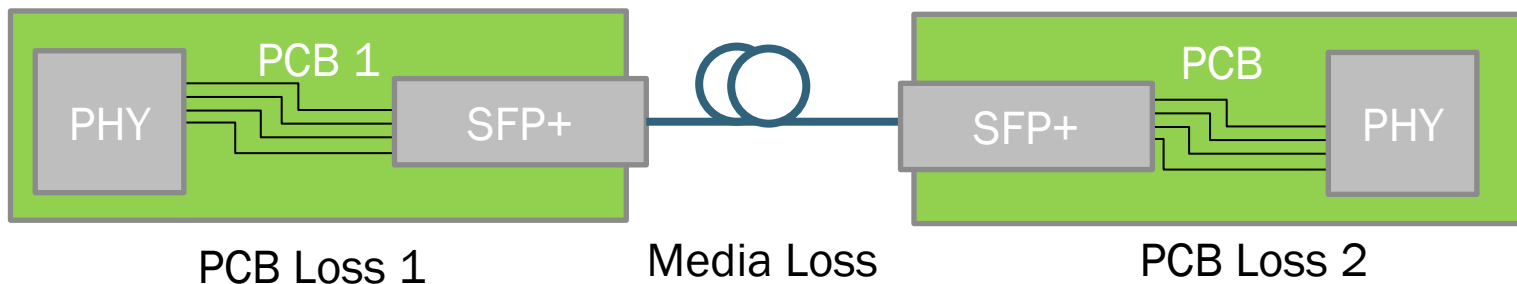


How far will 40G Serial go?

- Bandwidth Length Product depends on Media

Speed	Reach with PCB Loss =10dB	MMF Reach (OM3)	BASE-T Cable Distance
1G	20-36"	550m	100m on CAT5
10G	10-15"	300m	100m on CAT6A
25G	4-6"	100m	??
40G	??	70m?	30m on CAT8
50G	???	50m?	??

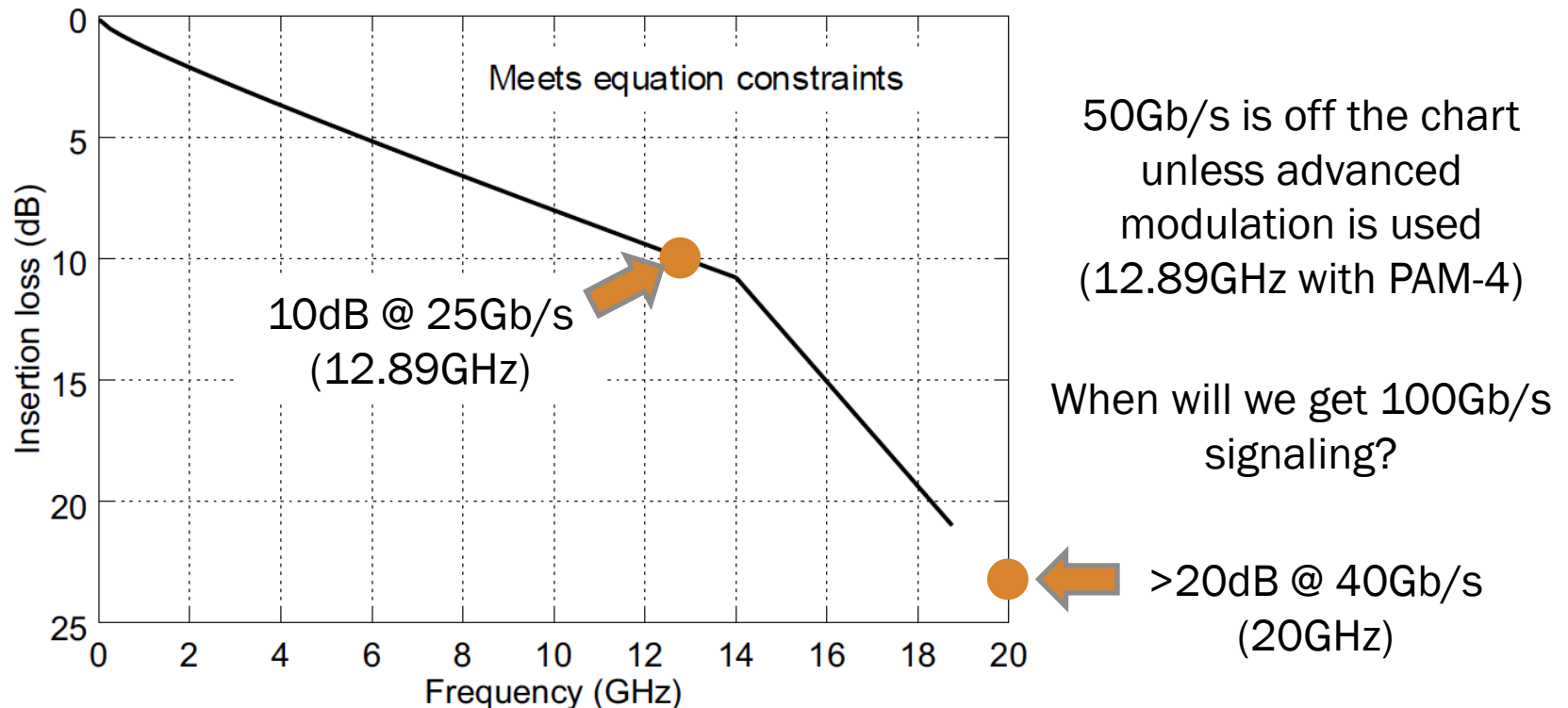
One example of an Ethernet Link



It's Only Getting Harder

- Higher speeds equal higher loss and power or shorter distances

CAUI-4 (4X25G) Chip to Module Insertion Loss



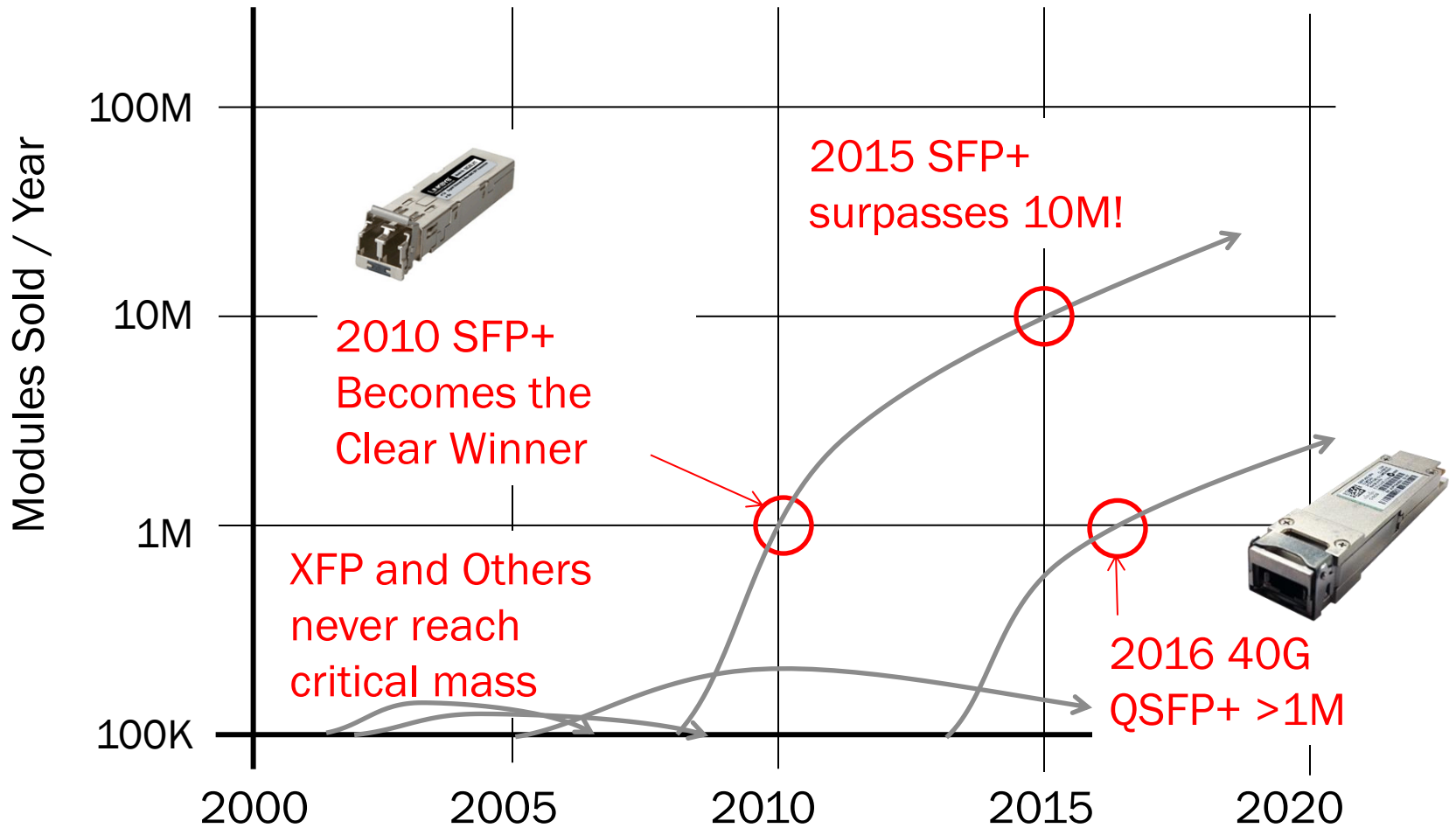
Where's the Debate?

- Should we standardize 40GbE Serial in SFP+?
- Should we standardize 50GbE Serial in SFP+?
- Should we standardize 100GbE Serial in SFP+?
 - 4X100GbE QSFP112 should combine to 400GbE
- 400GbE has many options:
 - Should 8X50G Electrical Interface be NRZ or PAM-4
 - Should optics be 8X50G or 4X100G λ and what encoding (NRZ, PAM-4, DMT, CAP, QAM)?
- Many BASE-T questions to be discussed later...



10G Recap - SFP+ and QSFP+ Win!

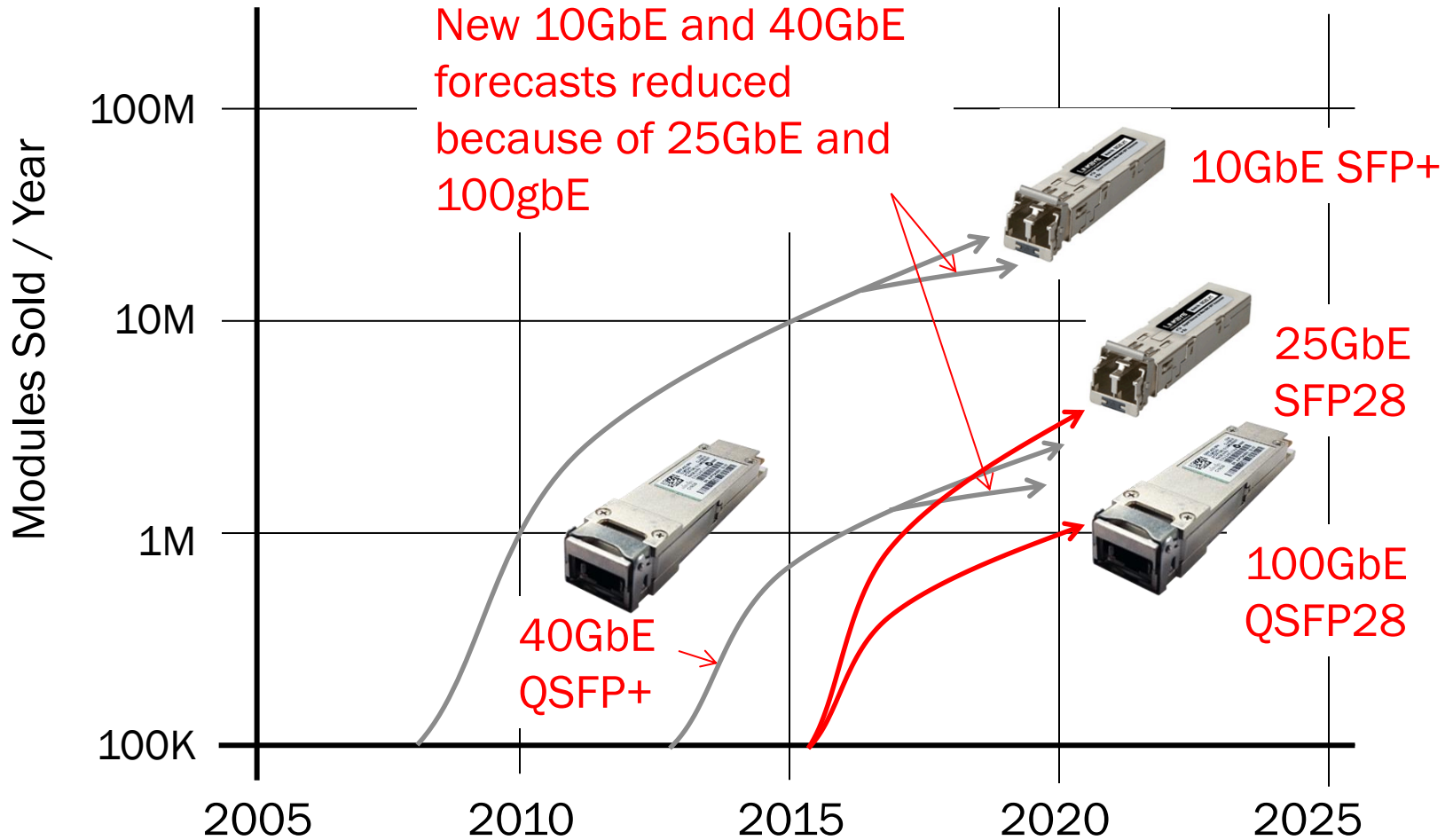
Before 25GbE and 50GbE Came Along



Based on LightCounting Forecasts



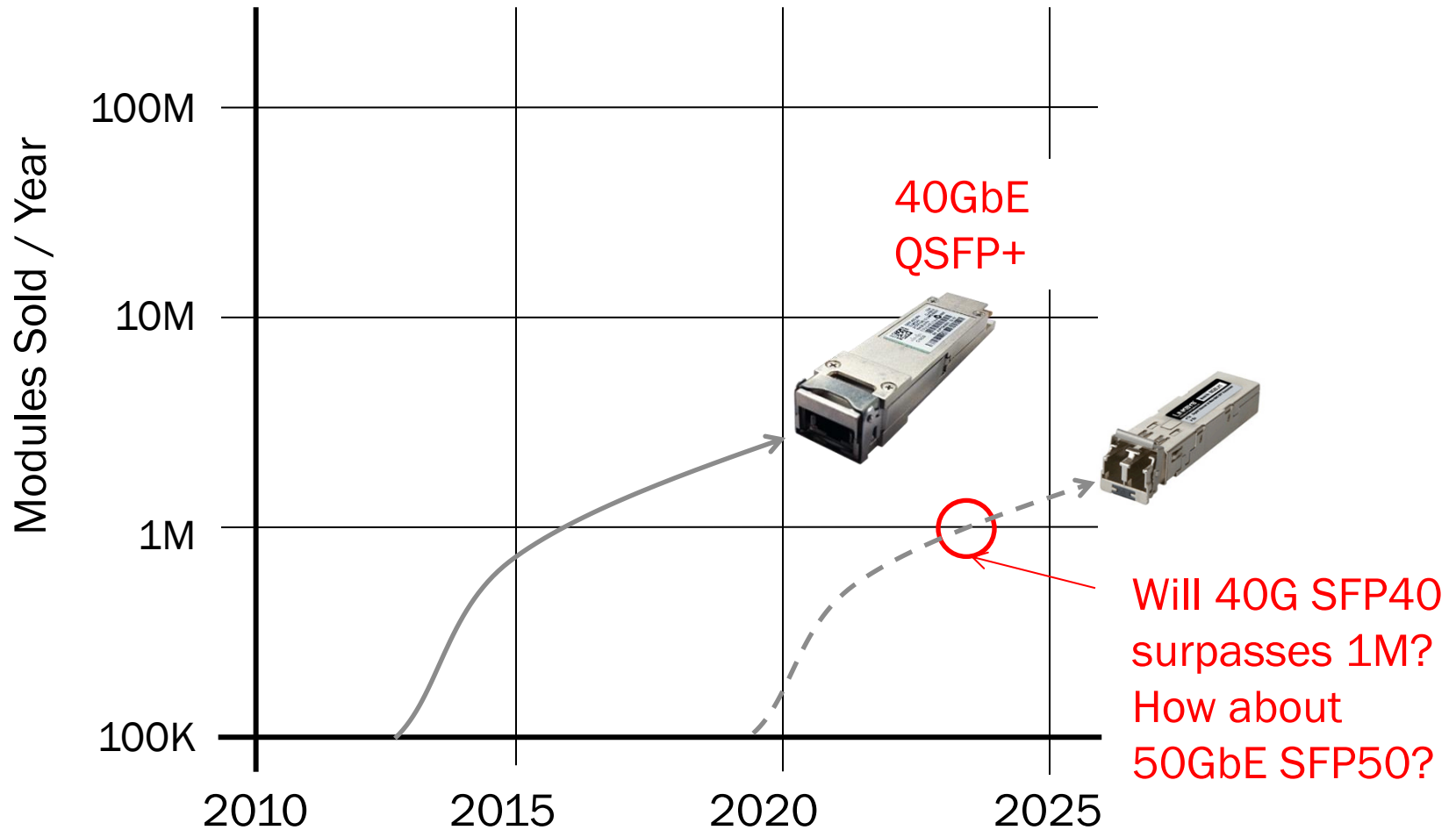
How does 25GbE Affect this?



Based on LightCounting Forecasts until 2016



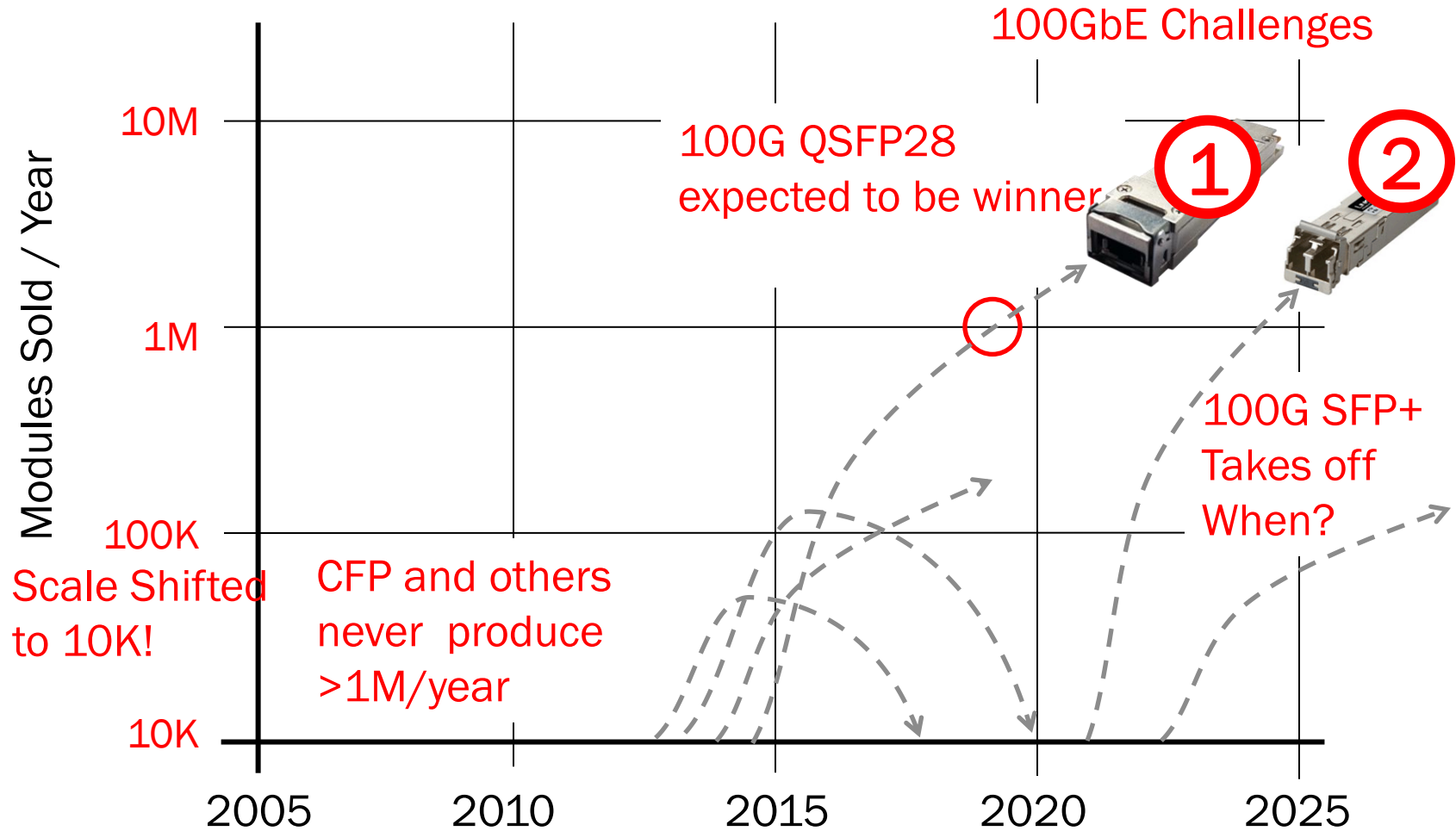
40G - Will SFP+ win?



QSFP+ Up to 2016 Based on LightCounting Forecasts



100G - QSFP28 then SFP+?



Based on General Trends



Challenging the Industry

- The Ethernet Alliance has created two challenges related to 100GbE:

1. The Holy Cup of 100GbE Lambda

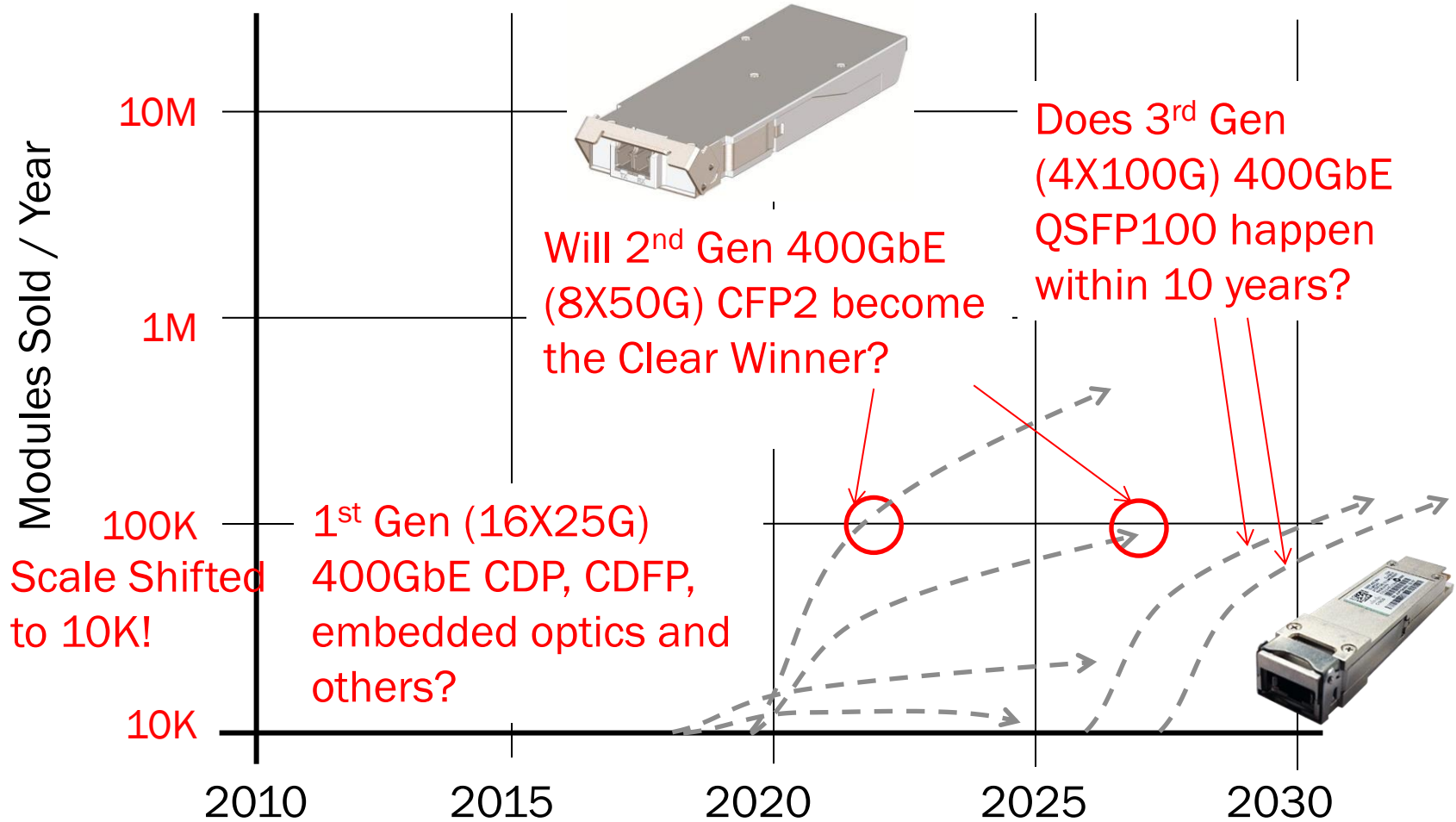


See Details at:
<http://www.ethernetalliance.org/subcommittees/roadmap-subcommittee/>

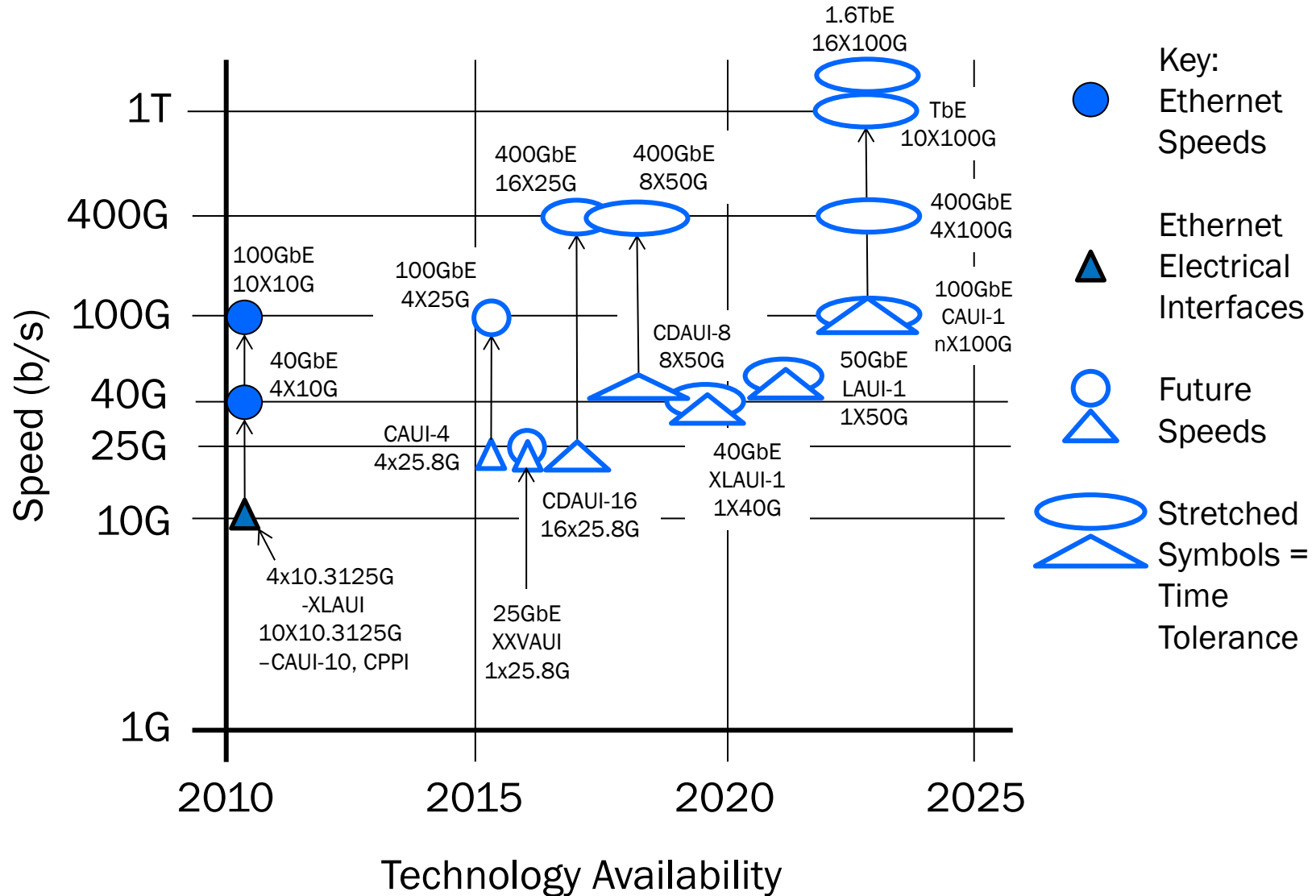
2. The Holy Grail of 100GbE SFP+



400G - Still Developing



Ethernet Speeds 2010-2025



Where's the Debate?

- What modulation should be used for 50Gb/s?
 - NRZ and PAM-4 both could work, but which will dominate?
- Where should the 50G Electrical be used?
 - 2nd Gen 400GbE (8X50G) is a given
 - Should we do 3rd Gen 100GbE (2X50G)?
 - Should we have 2nd Gen 50GbE (1X50G)?
 - 1st Gen 50GbE (2X25GbE) is in 25G Ethernet Consortium
- When will 100G Optics be used?
 - 4X100GbE being debated in 400GbE (802.3bs) now
 - 100GbE QSFP28 Single Lambda not far away
 - 100GbE SFP+ is out a ways



The Rate Debate is Next Week!

- Where: Santa Clara Convention Center
- When: Next Thursday, October 16th
- <http://www.ethernetalliance.org/the-rate-debate/>



Morning Agenda

Time	Topic	Speaker(s)	
9:10am	<i>Ethernet Alliance Roadmap Intro</i>	Scott Kipp, Ethernet Alliance President (Brocade)	
9:30am	<i>Networking Data Rates inside the Data Centers</i>	Alan Weckel, Dell'Oro Group	
9:50am	<i>Server Diversity: Why One Speed Is No Longer Enough</i>	Dave Chalupsky, Intel	
10:10am	<i>Implications of the Next Signaling Rate on Ethernet Speeds</i>	Kapil Shrikhande, Dell	
10:30am	<i>Lane Rates</i>	Rob Stone, Broadcom	
10:50am	<i>Break</i>		
11:05am	<i>Discussion on Sessions</i>	Scott Kipp, Ethernet Alliance President (Brocade)	
11:35am	<i>Guest Speaker</i>	Gavin Cato, Dell	



Afternoon Agenda

Time	Topic	Speaker(s)	
1:00pm	<i>Data Center Fabrics</i>	Thomas Scheibe, Cisco	
1:25pm	<i>Introduction of Session</i>	Scott Kipp, Ethernet Alliance President (Brocade)	
1:30pm	<i>Faster – 56Gb/s Standardization Efforts at the OIF</i>	David Stauffer, Kandou Bus Nathan Tracy, TE Connectivity	
1:50pm	<i>The Impact of Ethernet Rates on Optics</i>	Mitch Fields, Avago	
2:10pm	<i>50Gb/s: The Next Unifying Per Lane Rate</i>	Chris Cole, Finisar	
2:30pm	<i>Discussion on Session</i>	Scott Kipp, Ethernet Alliance President (Brocade)	
2:55pm	<i>Break</i>		
3:15pm	<i>BASE-T Panel: 2.5 to 25G</i>	Dave Chalupsky, Intel	
4:00pm	<i>Flexible Ethernet Rates for Router to Transport</i>	Stephen Trowbridge, Alcatel Lucent	
5:00pm	<i>Wrap-up</i>	John D'Ambrosia, Dell	
5:30pm	<i>Networking Reception</i>	All	



BROCADE 

THANK YOU

