
AN ETHERNET FORECAST

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TEF, 2016

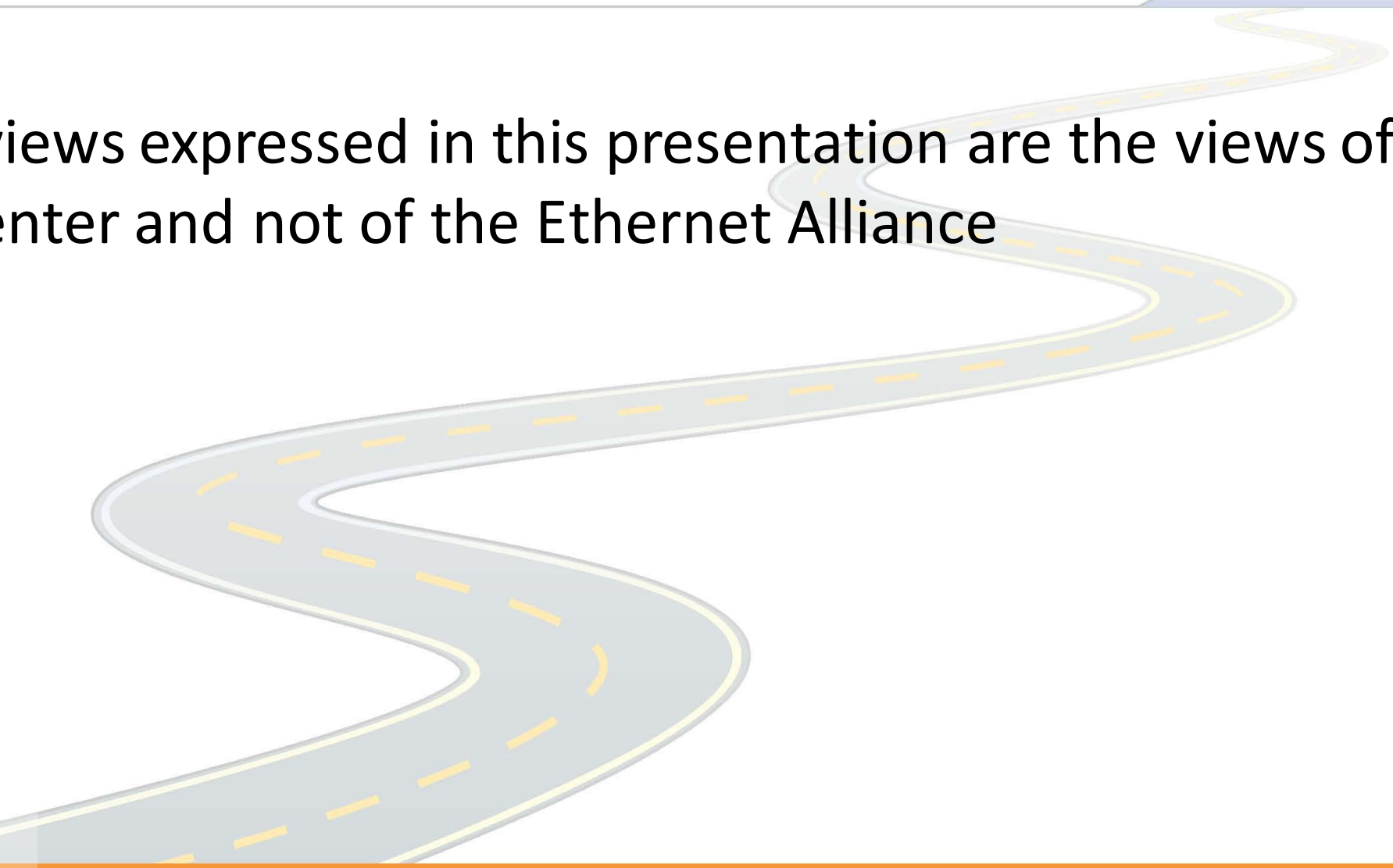
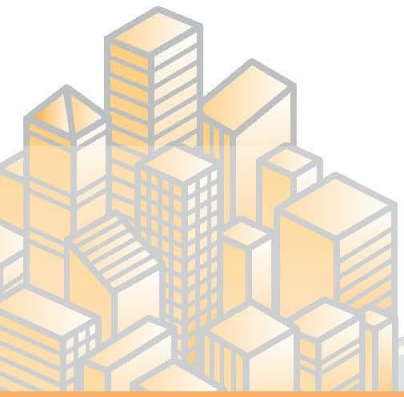
September 9, 2016



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

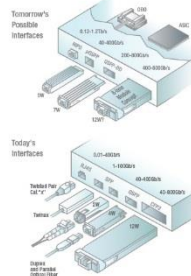


The 2016 Ethernet Roadmap - Front

MEDIA AND MODULES

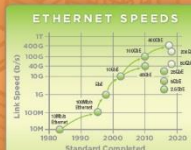
Ethernet is wired technology and supports a variety of media including backplanes, twisted pair, coax, multimode fiber and singlemode fiber. Most people know Ethernet by the twisted pair or Cat "x" cabling with RJ45 connectors because close to a billion ports a year are sold.

The graphic below shows multiple types of modules that may be used for copper or optical links. The upper modules are being developed to support ultra-high density port counts. The QSFP shrinks the GSPF down to an SFP size while the QSFP-DD doubles the lane count to 8. On Board Optics (OBO) enable the highest port counts on switches.



2016 ETHERNET ROADMAP

THE PAST, PRESENT AND FUTURE OF ETHERNET



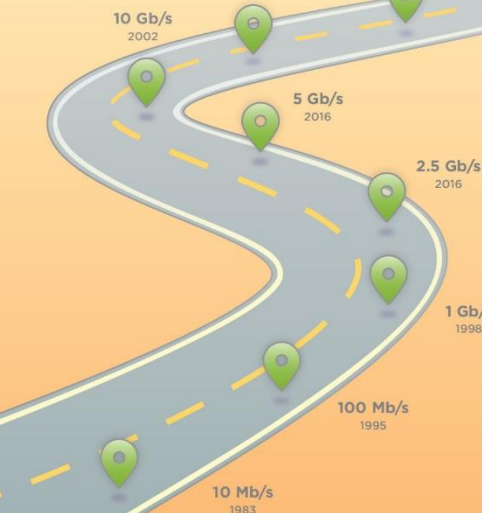
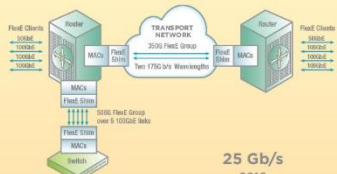
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\$9.95

2016 ETHERNET ROADMAP

FLEX ETHERNET (FLEXE)

Defined by the Optical Interworking Forum (OIF), FlexE is often called a new generation of Link Aggregation (LAG) and may provide a path to speeds higher than 400G without an IEEE standard. Proponents of FlexE claim that higher speeds like 800G are not necessary since these speeds just aggregate many lanes that run at lower speeds. FlexE can aggregate individual Ethernet links and creates a FlexE Mac that connects to another FlexE MAC. The illustration below shows a 500G FlexE group that bonds five 100G links together.



TO TERABIT SPEEDS



ETHERNET INTERFACES AND NOMENCLATURE

	Electrical Interface	Backplane	Twisted Pair	Twisted Pair	MSFP	Parallel SFP	21m SFP	10m SFP	40m SFP
10BASE-				T					
100BASE-			TX	FX				LX	
1000BASE-		KX	CX	T	SX				LX
2.5GBASE-		KX		T					
5GBASE-		KR		T					
10GBASE-	SFI, XFI	KX4, KR	CR	T	SR			LR	ER
25GBASE-	25GAUI	KR	CR	T	SR			LR	ER
40GBASE-	XLAI	KR4	CR4	T	SR4		FR	LR4	ER4
50GBASE-	50GAUI (-27)	KR	CR		SR		FR	LR	
100GBASE-	CAUI10	KR4, KR2	CR10,		SR10	PSM4	10X10	LR4	ER4
	CAUI4		CR4,		SR4		CWDM4	10X10	10X10
	CAUI-2		CR2		SR2		CLR4		
200GBASE-	200GAUI-4	KR4	SR4		SR4		FR4	LR4	
400GBASE-	CDALU-16				SR16	DR4	FR8	LR8	
	CDALU-8								

Gray Text = IEEE Standard Red Text = In Standardization Green Text = Under consideration in IEEE
Blue Text = Non-IEEE standard but complies to IEEE electrical interfaces






To get a PDF version of the roadmap and to find out more about the roadmap, please go to: www.ethernetalliance.org/roadmap/

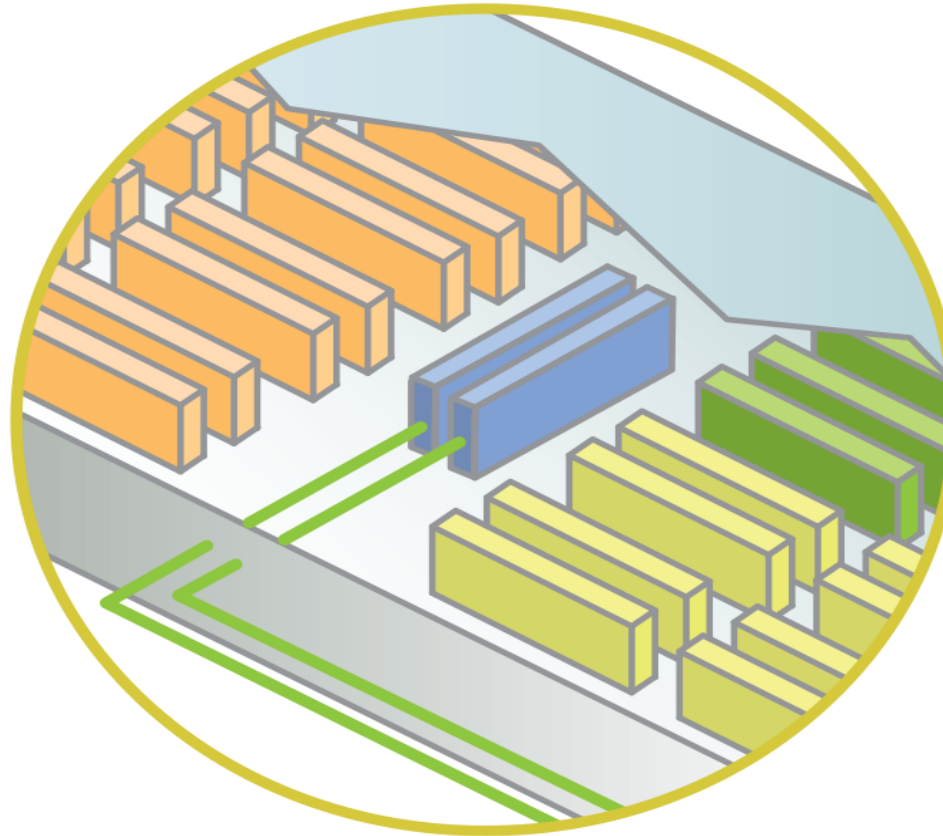


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Panel #1 – The Future Ethernet Data Center

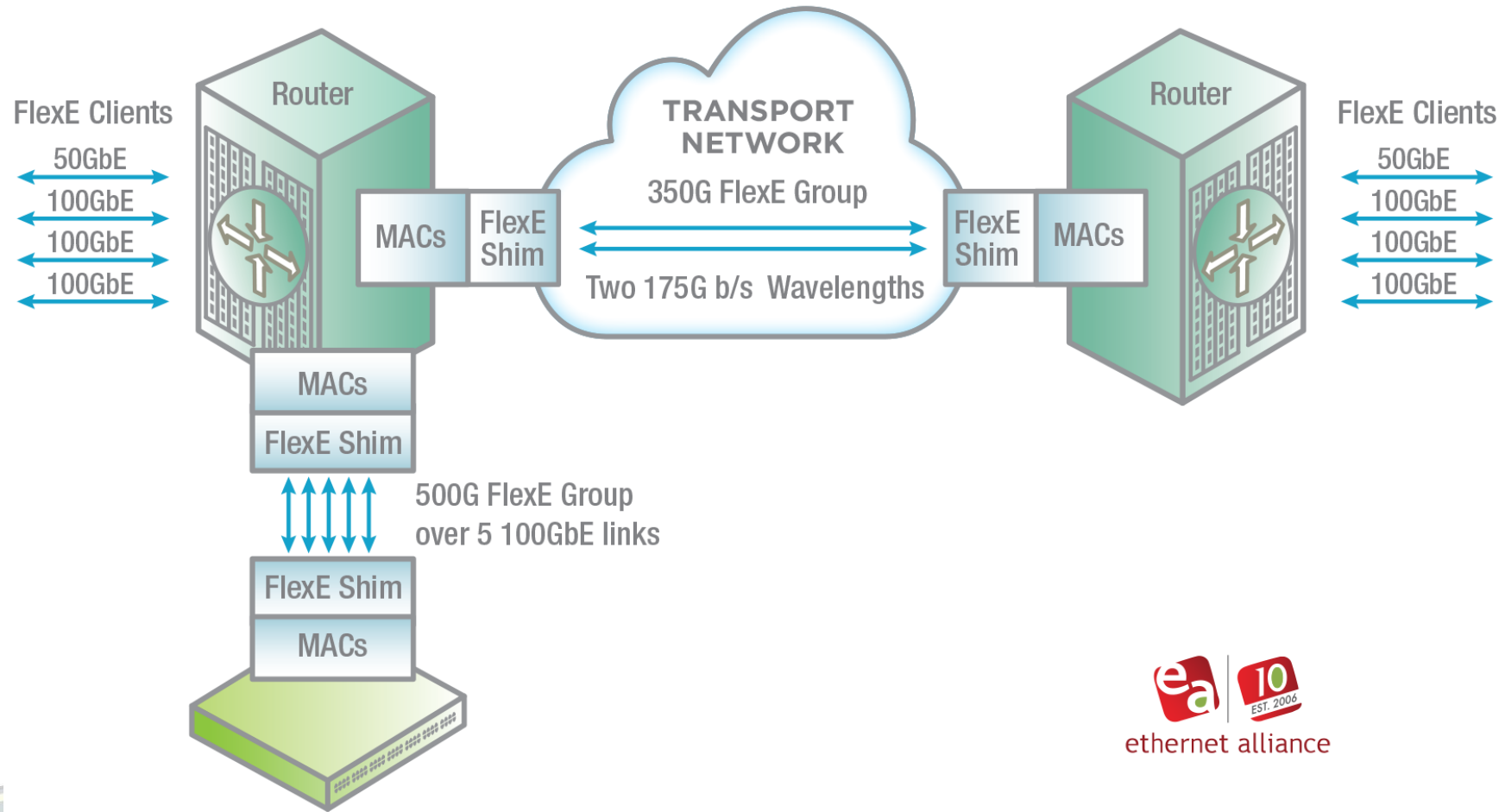
- Server Racks 
- Ethernet Switch and Router Racks 
- Patch Panels 
- Storage Racks 
- Transport Equipment 



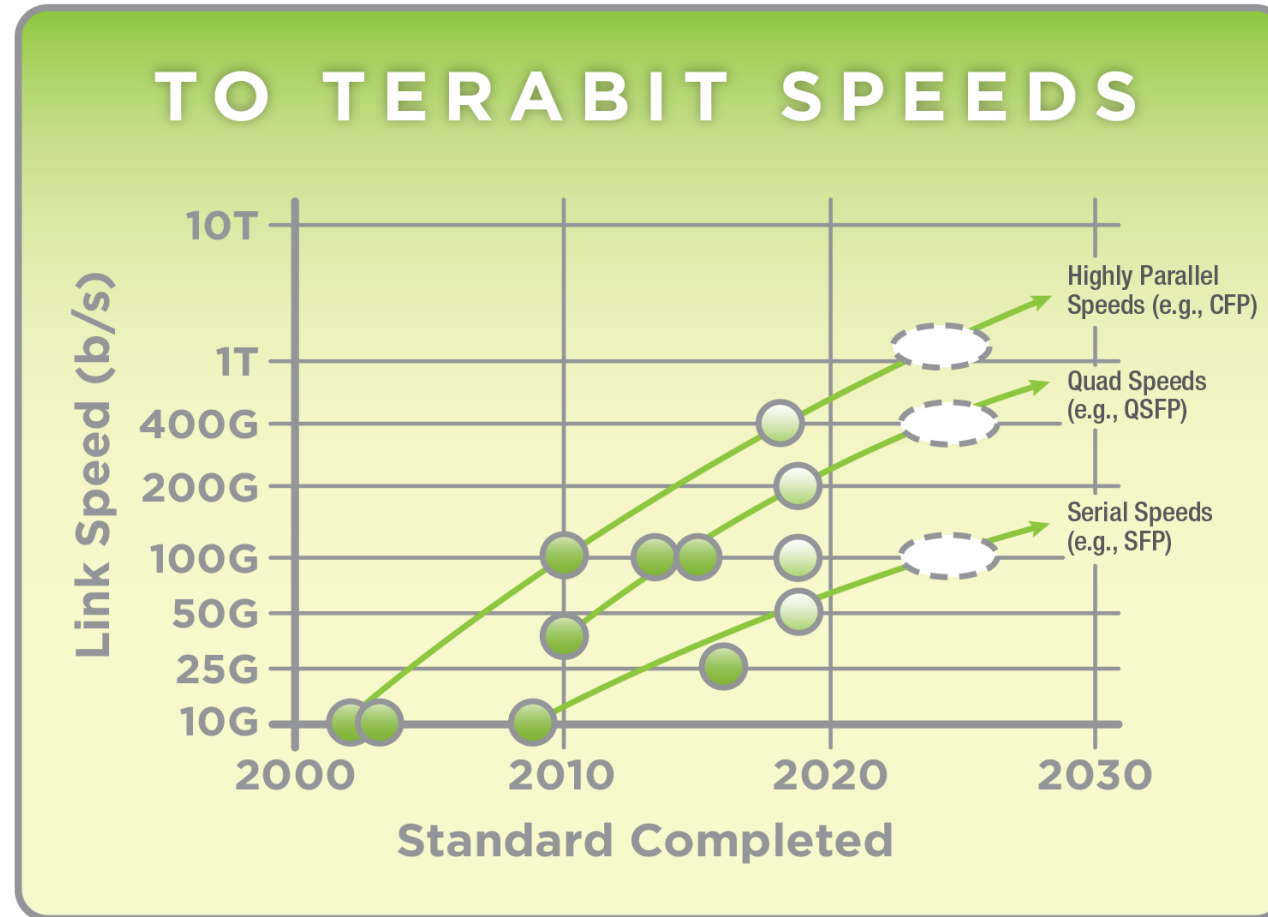
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Panel #2 – Ethernet Flexes its Ports



Panel #3 – Interconnect Beyond 50Gb/s



● Ethernet Speed ● Speed in Development ○ Possible Future Speed



Panel #4 – Are Standardized Ethernet Optics Obsolete?

ETHERNET INTERFACES AND NOMENCLATURE

	Electrical Interface	Backplane	Twinax Cable	Twisted Pairs	MMF	Parallel SMF	2km SMF	10km SMF	40km SMF	
10BASE-				T						1
100BASE-				TX	FX			LX		3
1000BASE-		KX	CX	T	SX			LX		5
2.5GBASE-		KX		T						2
5GBASE-		KR		T						2
10GBASE-	SFI, XFI XSBI, XAUI	KX4, KR	CX4 SFP+DAC	T	SR			LR	ER	12
25GBASE-	25GAUI	KR	CR	T	SR			LR	ER	7
40GBASE-	XLAUI	KR4	CR4	T	SR4		FR	LR4	ER4	8
50GBASE-	50GAUI 50GAUI-2	KR, KR2	CR, CR2		SR		FR	LR		9
100GBASE-	CAUI10 CAUI4 100GAUI-2	KR4, KR2	CR10, CR4, CR2		SR10 SR4 SR2	PSM4 DR	10X10 CWDM4 CLR4	LR4 10X10	ER4 10X10	20 +3
200GBASE-	200GAUI-4 200GAUI-8	KR4	CR4		SR4	DR4	FR4	LR4		8
400GBASE-	400GAUI-16 400GAUI-8				SR16	DR4	FR8	LR8		6

Gray Text = IEEE Standard Red Text = In Standardization
Blue Text = Non-IEEE standard but complies to IEEE electrical interfaces



IEEE Standards = 43

In IEEE Standards = 30

MSAs = 10

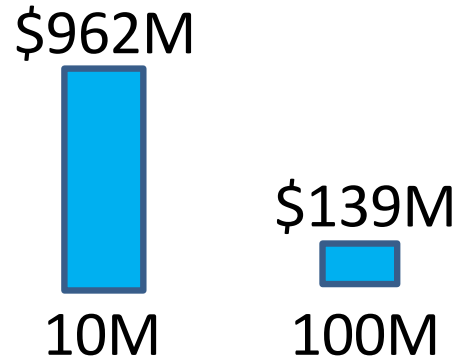
4WDM MSAs = 3

In early 2016, more
IEEE Standards were
in development than
were standard!
37-36

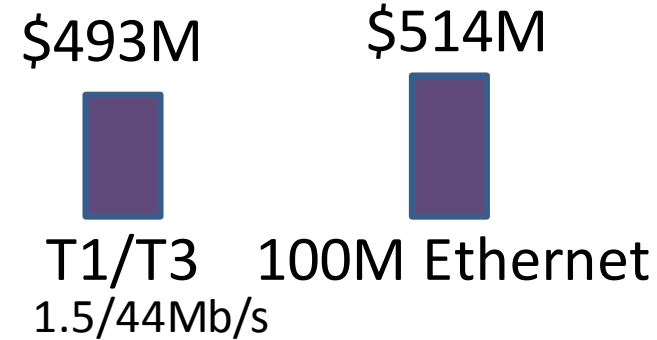
1995 – Pre-Gigabit Era

Switch Market
\$1B
2M Ports
ASP = \$545

Switch Revenue



Router Revenue



High End
Ethernet
Router Market
\$514M
171k Ports
ASP = \$3,000

Module Types

1X9



TO Optics



Pre-Pluggable Modules

Cabling

RG8



CAT5



RJ45

2000 – Gigabit Era Begins

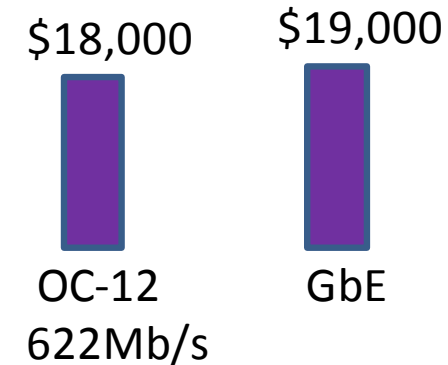
Switch Market
\$12B
101M Ports
ASP = \$118

50X port
count in 5
years

Switch Port ASP



Router Port ASP



High End
Ethernet
Router Market
\$1.4B
334k Ports

Port Count
Up 2X

Module Types

GBIC



1st Gen Pluggable Modules

Fiber Optic Cabling

SC
Connector
OM1
(FDDI Grade)

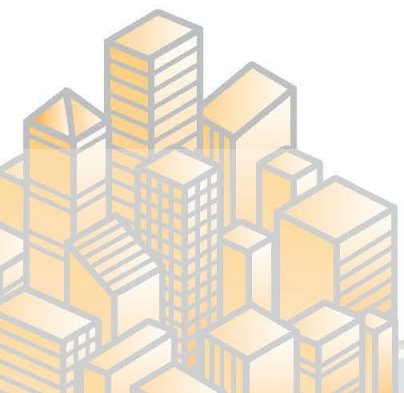


1000BASE-T
standardized
but not yet
common

2005 – Gigabit Era Matures

Switch Market
\$14B
234M Ports
ASP = \$60

Doubled Port
Count again



Switch Port Shipments

182M



100M

52M



GbE

141k

10GbE

Router Port Shipments

Different Scale

95k

100M

120k

GbE

8k

10GbE

High End
Ethernet
Router Market
\$2.6B
345k Ports

Module Types

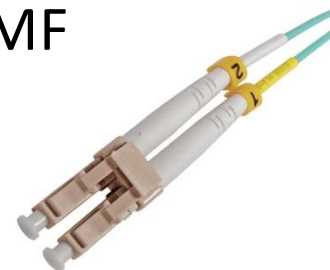
SFP
<5Gb/s



2nd Gen Pluggable Modules

Cabling

LC with OM2/3
MMF



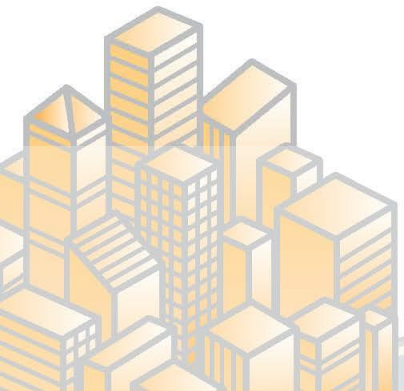
RJ45 with
CAT 5/5E



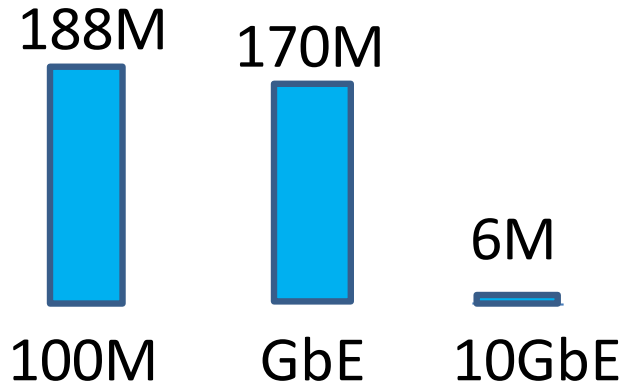
2010 – nX10 Gigabit Era Begins

Switch Market
\$20B
395M Ports
ASP = \$51

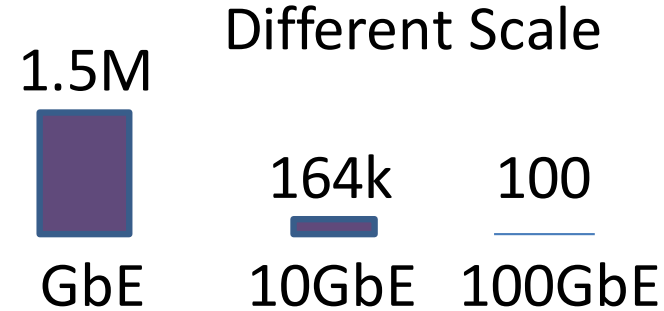
Almost
Doubled Port
Count again



Switch Port Shipments



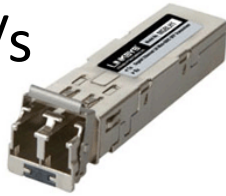
Router Port Shipments



High End
Ethernet
Router
Market
\$6.4B
2M Ports

Module Types

SFP+
10Gb/s



QSFP+
4X10G



nX10G Pluggable Modules

Cabling

12-fiber MPO
with OM2/3



RJ45 with
CAT 6/6A



Port Count
Up ~6X

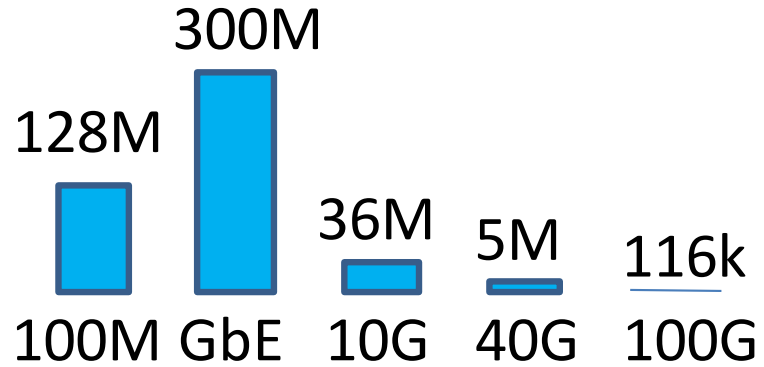
2015 – nX25 Gigabit Era Begins

Switch Market
\$24B
484M Ports
ASP = \$49

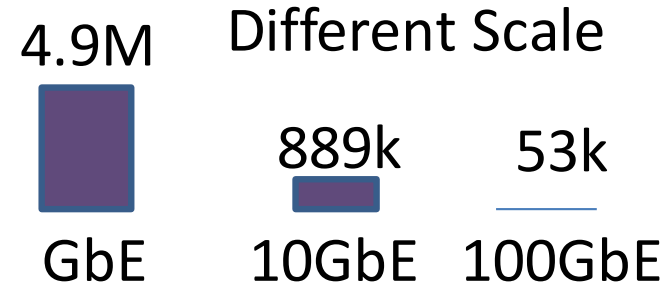
Port Count
Growing about
4% CAGR



Switch Port Shipments



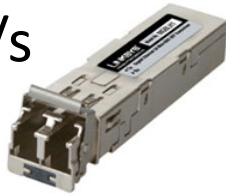
Router Port Shipments



High End
Ethernet
Router
Market
\$9.6B
5.9M Ports

Module Types

SFP28
26Gb/s



QSFP28
4X26G



nX25G Pluggable Modules

Cabling

QSFP-SFP
Breakout



RJ45 with
CAT 6/6A



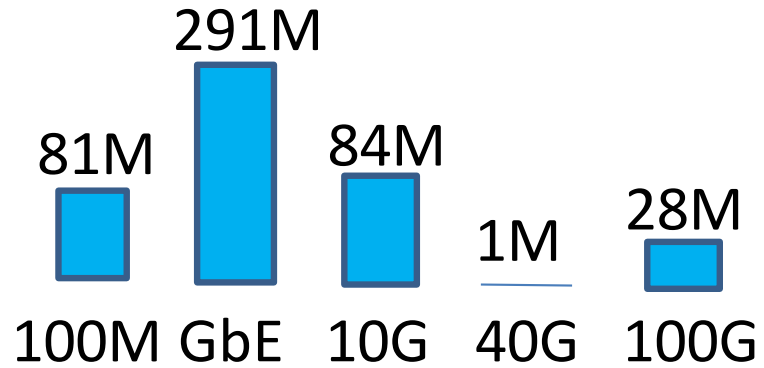
Port Count
Up ~3X

2020 – nX50 Gigabit Era Begins

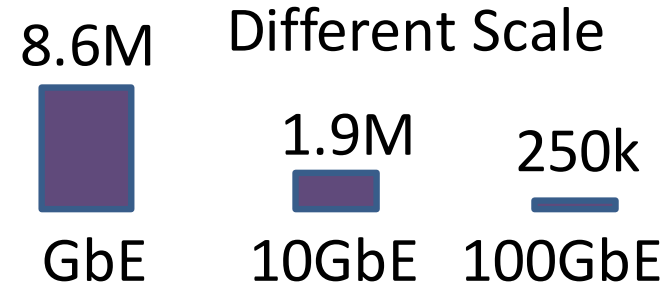
Switch Market
\$26B
485M Ports

Port Count
Flat

Switch Port Shipments

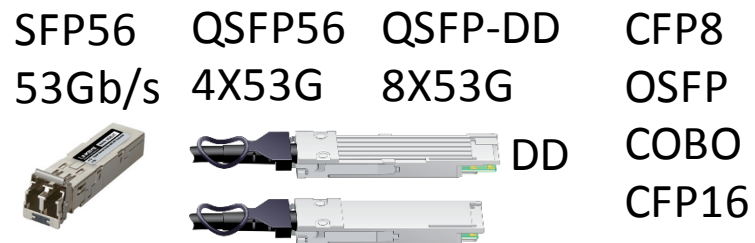


Router Port Shipments



High End
Ethernet
Router
Market
\$11B
11M Ports

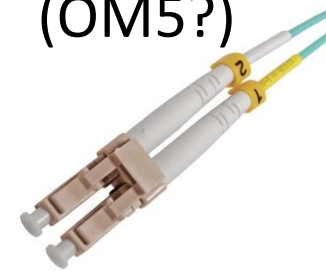
Module Types



nX50G Pluggable Modules

Cabling

WB-MMF
(OM5?)



RJ45 with
CAT 7/8



Port Count
Up ~2X



2025 – nX100 Gigabit Era Begins

Switch Market
Fairly Flat and
>\$20B?
Port Counts
Up from HDD
and Auto?
ASP Flat?

Switch Predictions




100M to 400G
256-512 Port ASICs?
Embedded Optics?
SMF and Silicon Photonics?

Router Forecast

GbE to 800GbE
Flex Ethernet
For Terabit Ethernet?

High End
Ethernet
Router
Market
>\$15B? with
added
services?
15M? Ports

Module Types

SFP112	QSFP112	QSFP-DD	COBO
106Gb/s	4X106G	8X106G	CFP16
		DD	CFP32
		QSFP	xFP

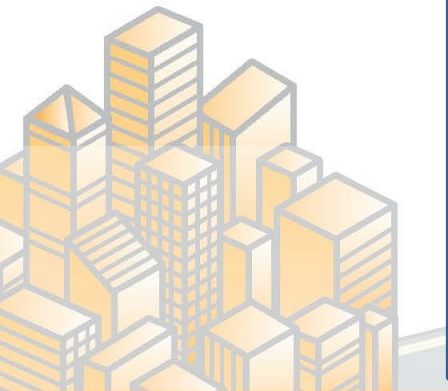
nX100G Pluggable Modules

Cabling

OM6?



RJ45 with
CAT 9?



Will Ethernet Be More of the Same?

- Will Ethernet in 2026 look pretty much the same as today with everything running much faster?
- Will 100G lanes be affordable?
- Will innovation overcome legacy?

