

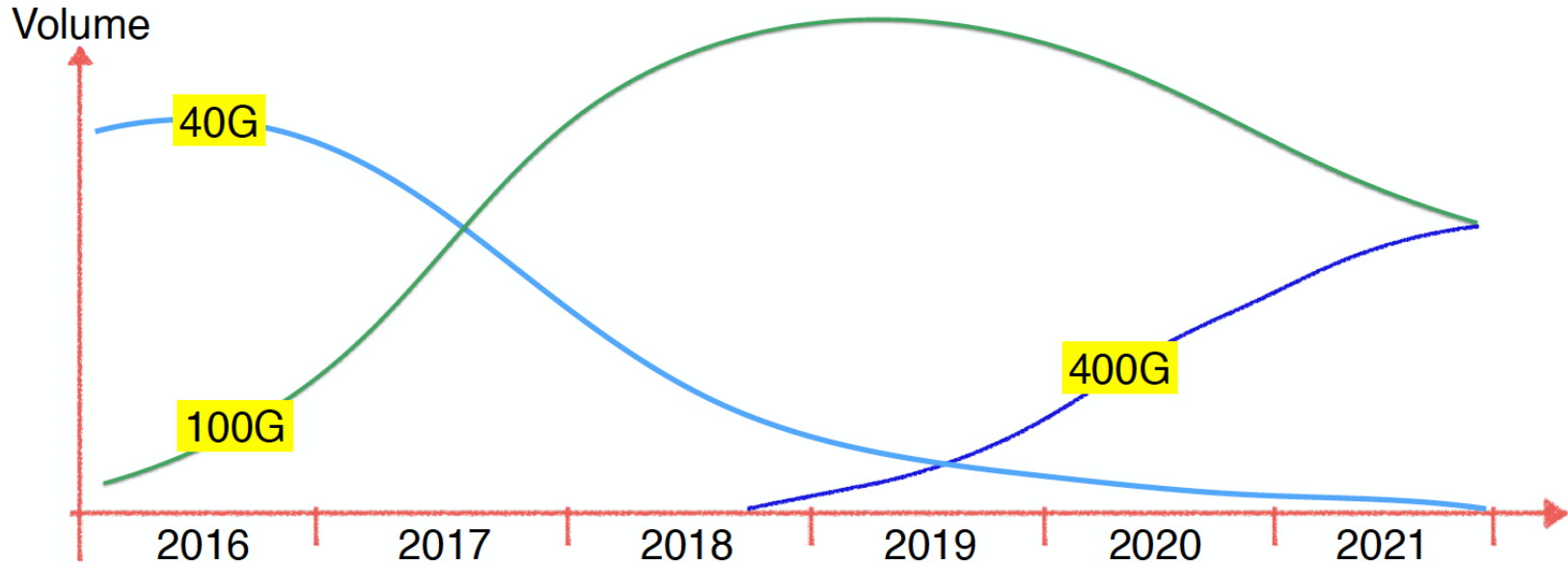


400G Architectures and Optics Overview

NOG.FI – May 17th, 2019

Markku Rantanen <markku@arista.com>

Switch Port Transition from 40G to 400G



How Do Switching Systems Support Higher Speeds?

Switch Chip
limited by
number of I/O
Pins



Single lanes
maximize usable
connectivity

40G and 100G
Use 4 Lanes
Today

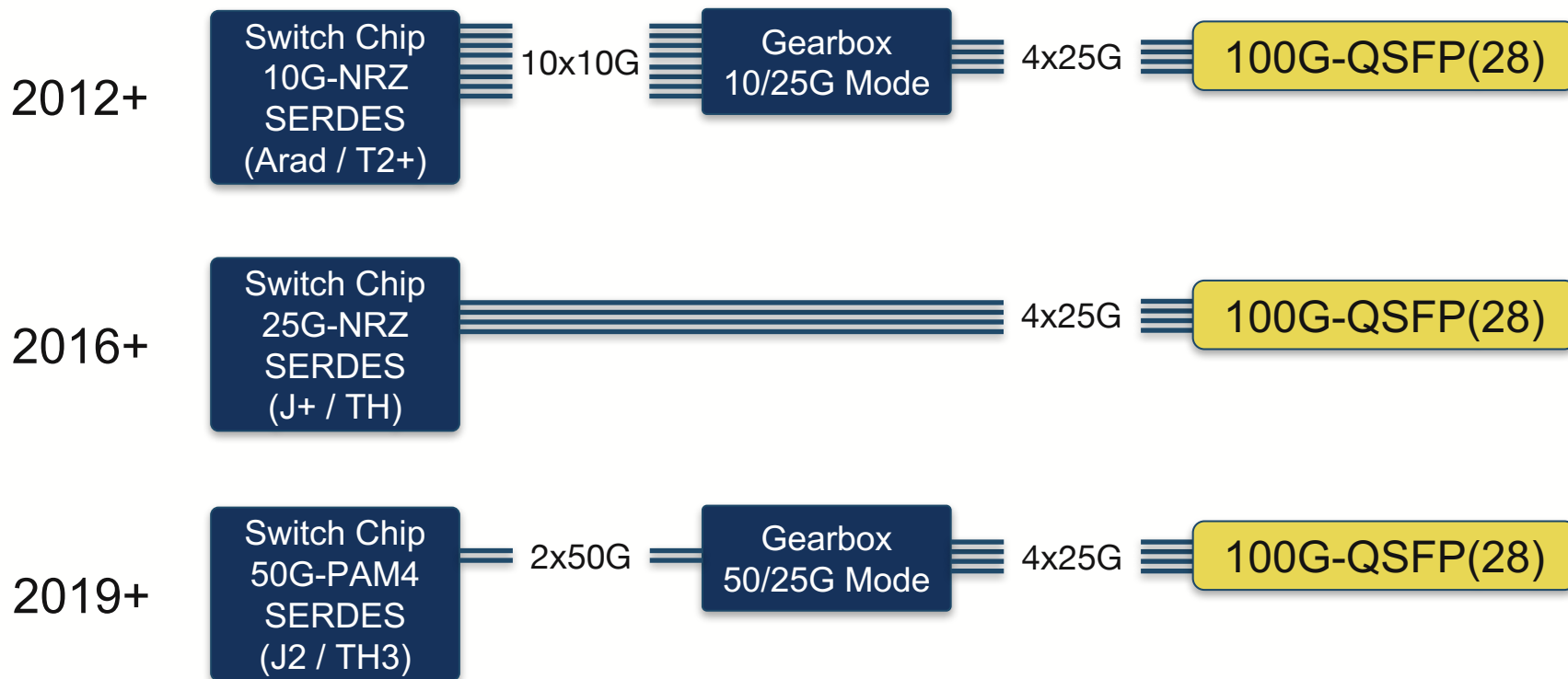
Lane Speed	10Gbps	25Gbps → 50Gbps	100Gbps	
1X	10G	25G	50G	Server Interface
2X	20G	50G	100G	
4X	40G	100G	200G	Spine Interface
8X	-	200G	400G	
Availability	2011	2015	2018	2020

← 4 Years

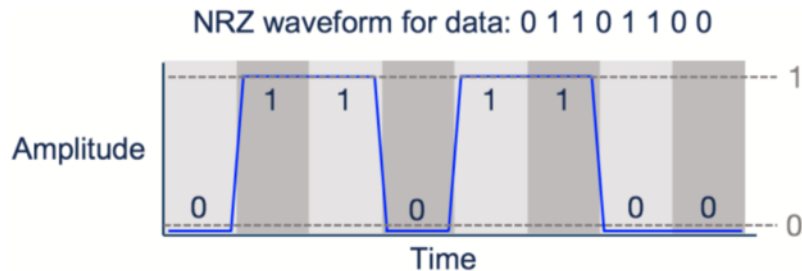
← 3 Years

← 2 Years →

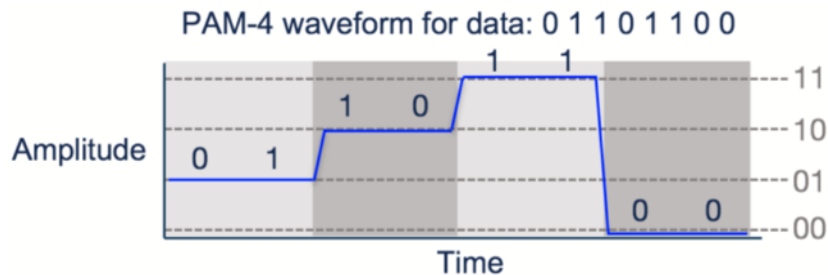
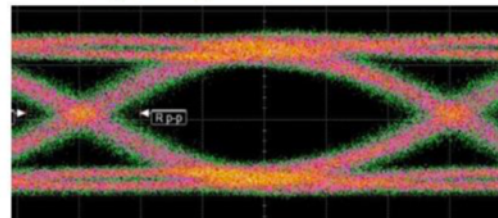
Adapting SERDES Speeds to 100G Interfaces



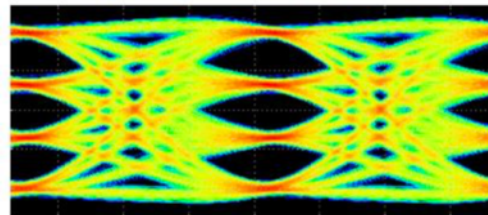
An eye diagram of NRZ and PAM-4 Modulation



Eye diagram for NRZ data

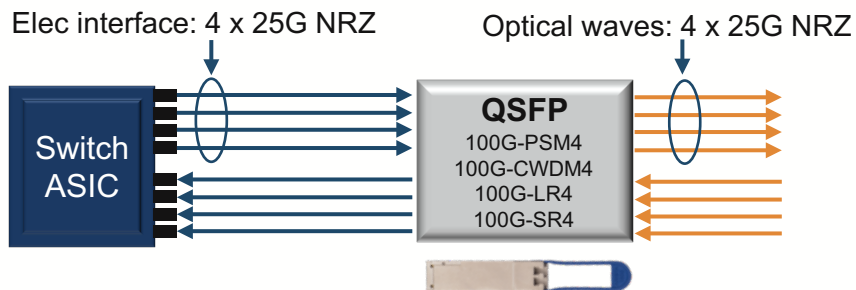


Eye diagram for PAM-4 data

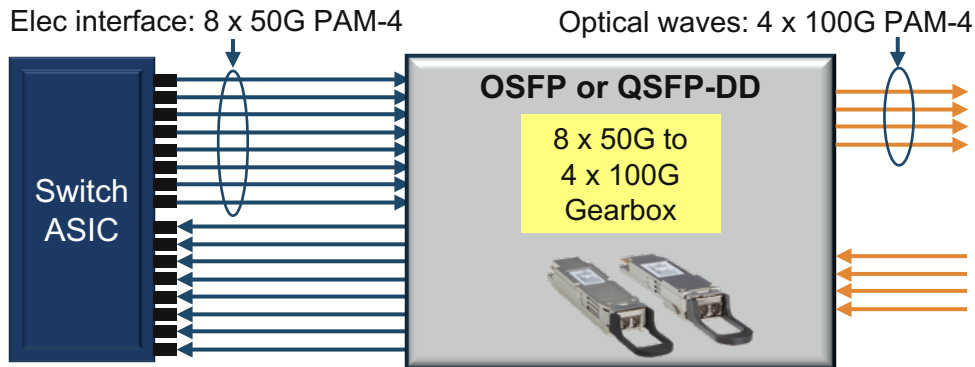


Serdes Speed Transitions → Optics

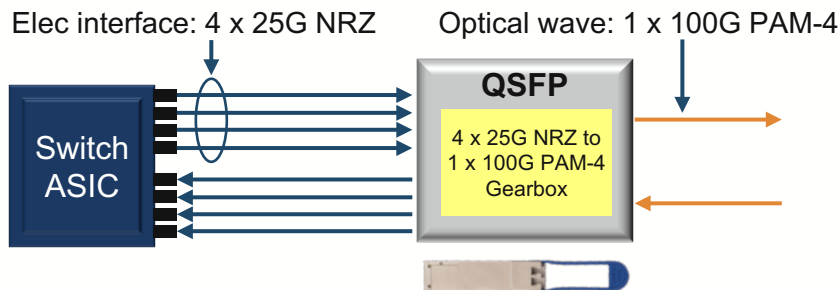
Legacy 100G Optics



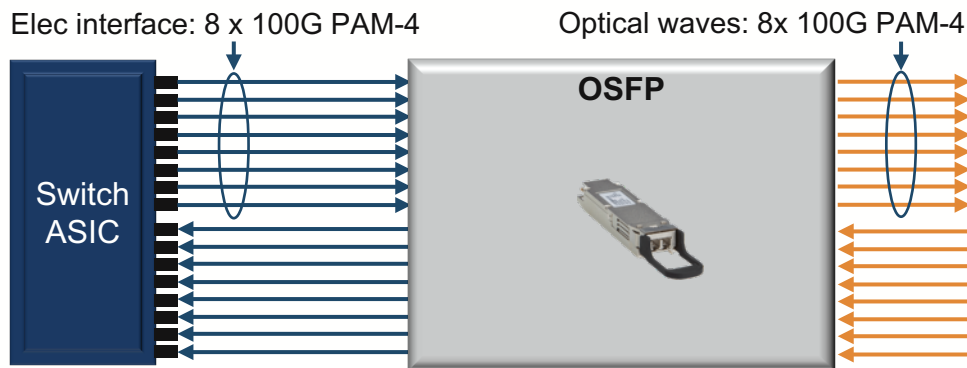
400G Optics



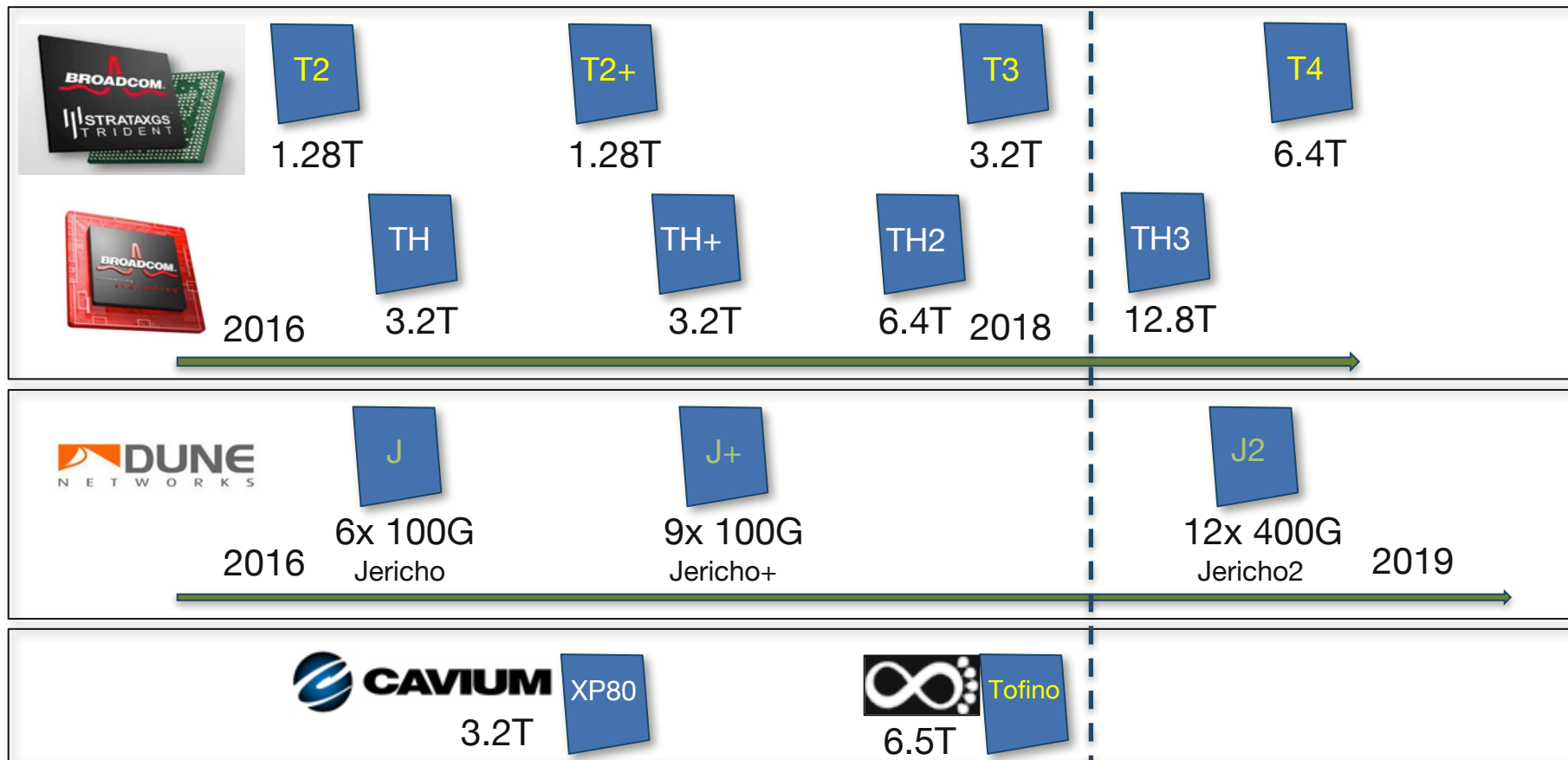
100G-DR and 100G-FR Optical Modules



800G Optics



Partial Silicon Landscape: 2016-2019





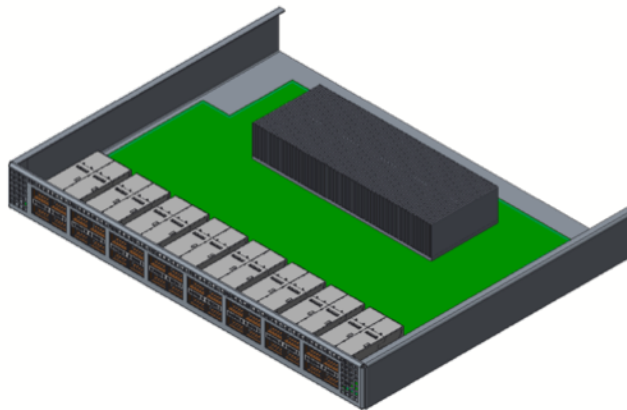
Transceiver form factors

400G Form Factors

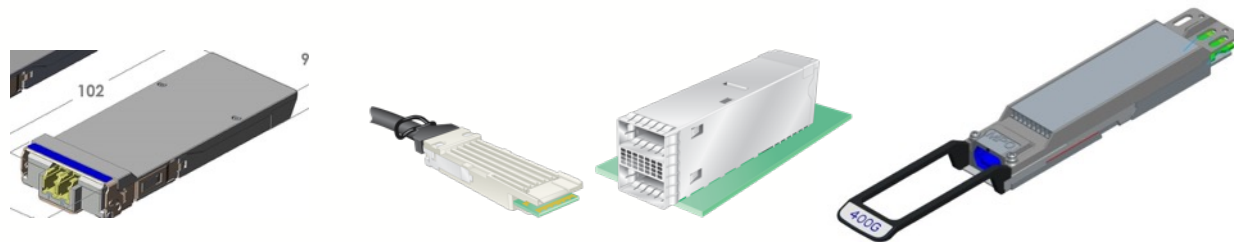
CFP8

 **QSFP**

QSFP-DD 



Candidate 400G Form Factors: CFP8 v QSFP-DD v OSFP



	CFP8	QSFP-DD	OSFP
Size mm (HxLxT)	41.5x107.5x9.5	18.35x89.4x8.5	22.58x107.8x13.0
Thermal Capacity	12-18W	7-12W	12-15W
Organization	http://www.cfp-msa.org/	http://www.qsfp-dd.com/	http://osfpmsa.org/

CFP8 Lacks Density. Really we need to consider QSFP-DD and OSFP

CFP8 400G Optics

- CFP8

- Higher power budget, easier to cool
- 28G SERDES (16x28G) on the electrical side
- More options for high-power optics in the future
- Optical facing LR8 (8x56G) available as of today

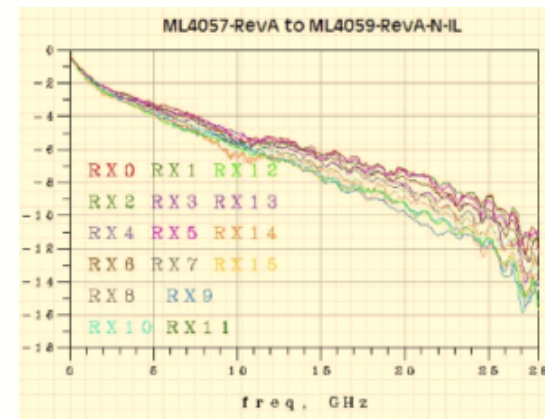
- Outlook to the future

- As AUI is 28G SERDES, optics might need to be replaced to support 800G
- Only optics released are 8 lane on the optical side so far (no LR4/DR4+)
- Low port density due to size of optic

CFP8



CFP8 Form Factor



<https://multilaneinc.com/s-parameter-data-cfp8/>

QSFP-DD 400G Optics

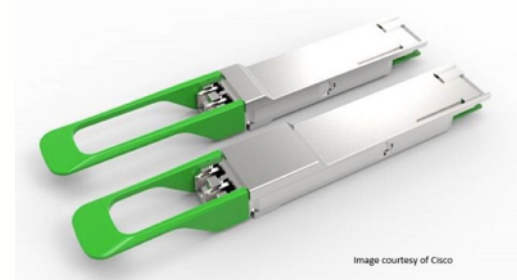
- QSFP-DD

- Reduced power budget as harder to cool
 - » Options with 'extended optics' has been presented, but that means optic will stick further out of the port
- Electrical AUI can be either 8x56G SERDES or 4x112G SERDES
- QSFP-DD is backwards-compatible with QSFP28
- High Port Density – 24 to 36x400G per 1U (depending on the ASIC)
 - » Up to 28.8Tbps with Nx112G Serdes

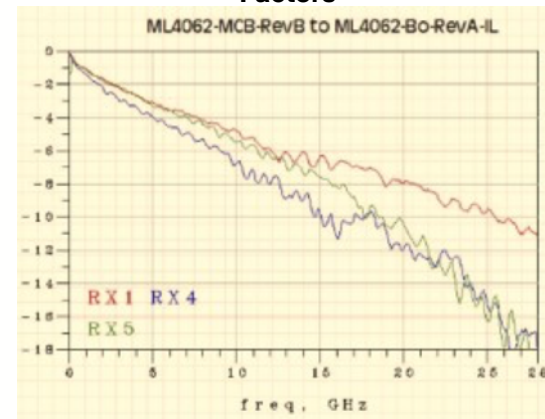
- Outlook to the future

- Challenges for 800G on QSFP-DD
 - » Some constraints due to power/cooling
- 76 pin AUI connector faces challenges around signal synchronicity at 112G-PAM4
- Availability of 8 Lane and 4 Lane optical side (example LR4/LR8)

QSFP-DD ■■■



QSFP-DD Type 1 and Type 2 Form Factors



<https://multilaneinc.com/s-parameter-data-qsfp-dd/>

OSFP 400G Optics



- OSFP

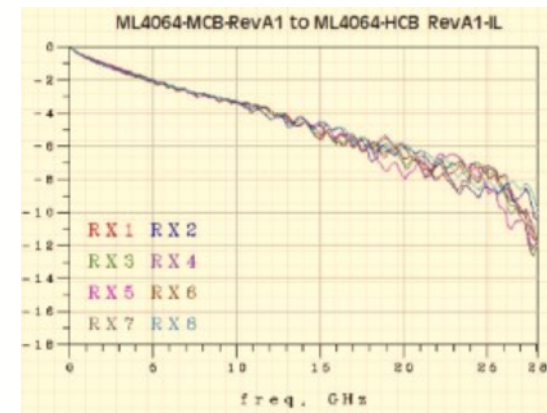
- Higher power budget, easier to cool
 - » Demonstrated 20W power envelope
- More options for high-power optics (like ZR 120km 400g)
- Eight Lanes at 56 or 112Gbps
 - » Supports 400G and 800G (2x400G)
 - » 60 pin AUI connector optimized for high bandwidth SERDES
- High Port Density – 24 to 36x400G per 1U (depending on the ASIC)
 - » Up to 28.8Tbps with Nx112G Serdes

- Outlook to the future

- Roadmap to 800G (2x400G)
 - » Outlook to 2020/2021
- Availability of 8 Lane and 4 Lane optical side (example LR4/LR8)



OSFP Form Factor



<https://multilaneinc.com/s-parameter-data-osfp/>

OSFP 400G Optics

- OSFP-to-QSFP Adapter for 100G compatibility
 - Inserts into an OSFP slot
 - Lets you deploy a 400G switch and run it at plain 100G!
 - Mechanical adaptor - purely passive



400G Pluggable Form Factors

Comparing OSFP and QSFP-DD

36 ports per 1RU

20W Thermal Capacity
for 400G-ZR+ & 800 G

Forward compatible with
800G systems

Backwards compatible
with QSFP28

Max Copper DAC length

 **OSFP**

Yes

Yes

Yes

Yes, with
adapter

3m

QSFP-DD 

Yes

No

No

Yes

2.5m

OSFP



QSFP-DD

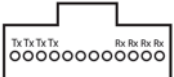
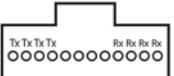
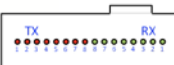


OSFP-QSFP



Optic types

Optical Transceiver Basics

Electrical interface	Form factor & data rate	Optical conn.	Fiber type	Wavelength	Max reach
1G & 10G	 SFP: 1G & 10G	Dual LC 	Duplex SMF Duplex MMF	1310/1550nm 850nm	80km 400m
4 x 10G (40G) or 4 x 25G (100G)	 QSFP: 40G & 100G	Dual LC  MPO-12 	Duplex SMF Duplex MMF Parallel SMF Parallel MMF	4x ~1310/1550nm 4x or 2x ~850nm 1310nm 850nm	40km 40G: 150m, 100G: 100m 40G: 10km, 100G: 500m 40G: 400m, 100G: 300m
8 X 50G	 OSFP: 400G	Dual LC  MPO-12 	Duplex SMF Parallel SMF	4x ~1310nm 1310nm	2km, 10km 2km
8 X 50G	 QSFP-DD: 400G	MPO-16  Dual CS 	Parallel MMF 2 x Duplex SMF	850nm 4x ~1310nm	100m 2km

400G Optics



- Switch Silicon SERDES Transitions drives Optics Transitions
 - 50G-PAM4 ramp starts in 2019, passes 25G-NRZ in 2020
 - 100G-PAM4 ramp starts in 2021, passes 50G-PAM4 in 2022
- 100G-DR1, 400G-DR4 and 400G-FR4 are forwards compatible
 - Will work with Nx50G lanes (2019) and Nx100G lanes (2021)
 - 400G-FR8/LR8 not forwards compatible with 100G electrical lanes

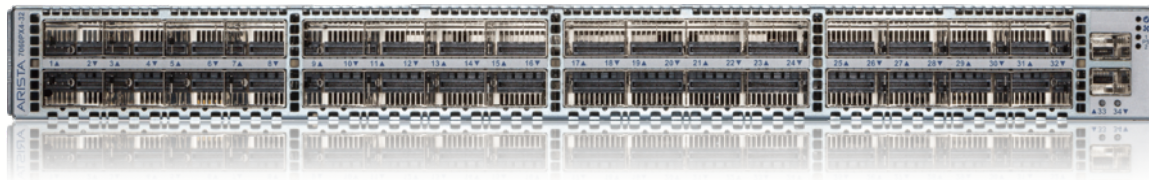
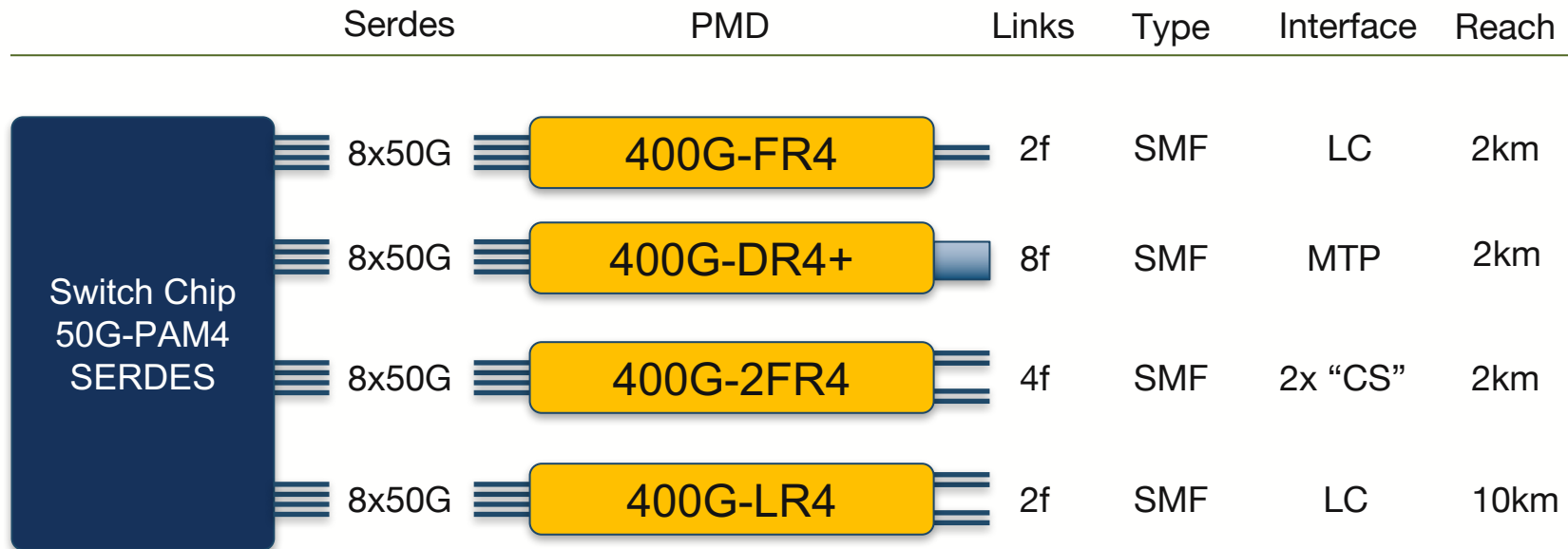
SMF 400G Standards

Standard	Reach	# Fiber	Fiber Type	Power
400G-ZR/ZR+	100km+	2	SMF	15 W+
400G-FR8/LR8	2/10km	2	SMF	12 W
400G-FR4/LR4	2/10km	2	SMF	10 W
400G-DR4+	2km	8	SMF	10 W

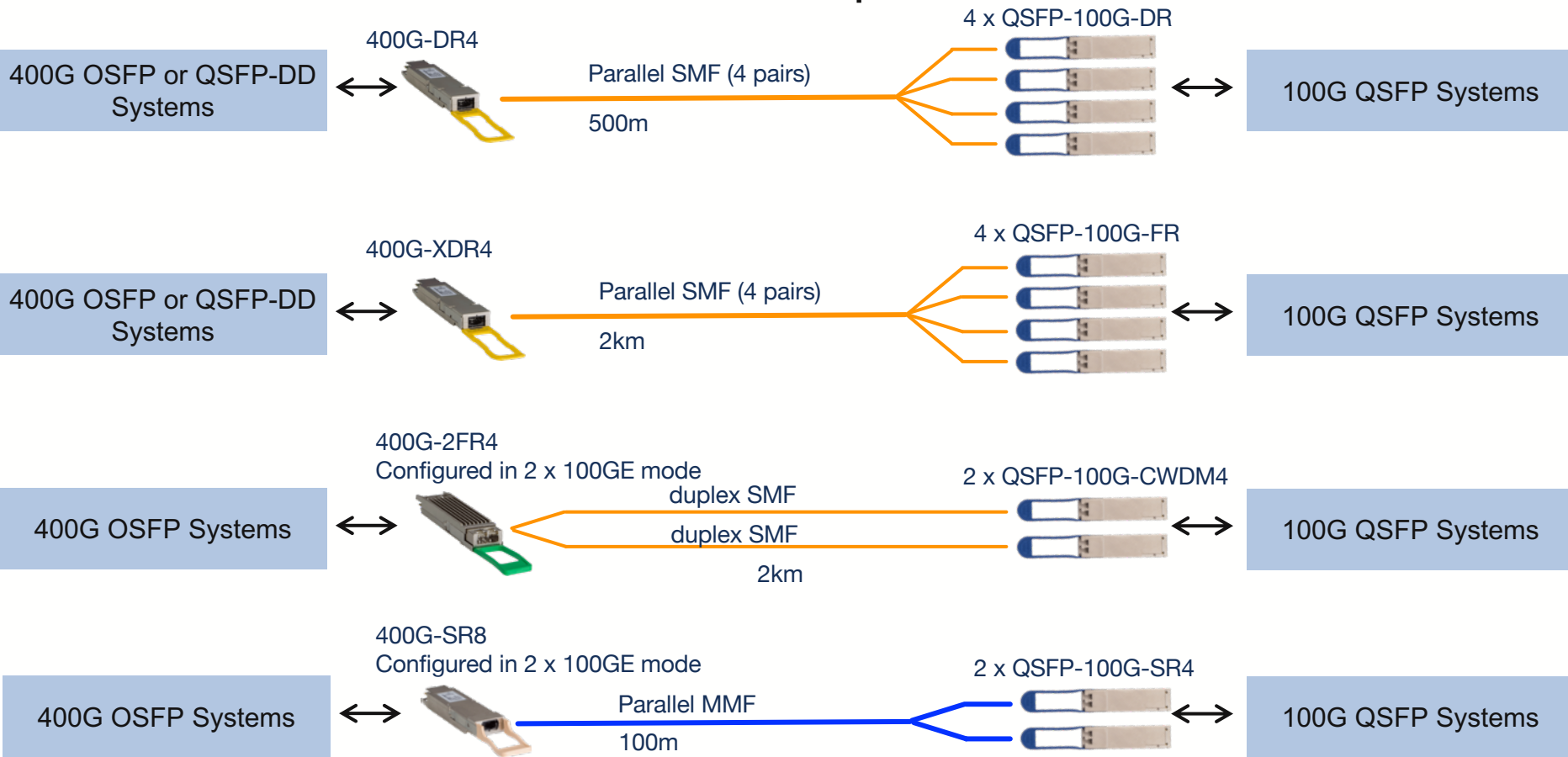
Forward Compatible with 100G SERDES

Not Compatible with 100G SERDES

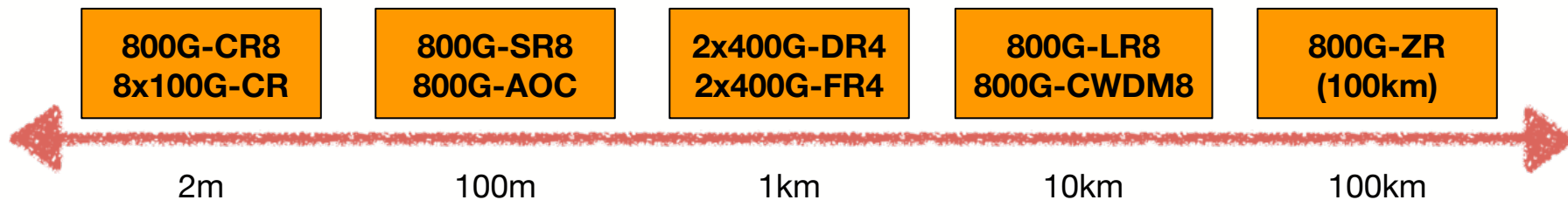
400G Optics



400G to 100G QSFP28 Breakout Options

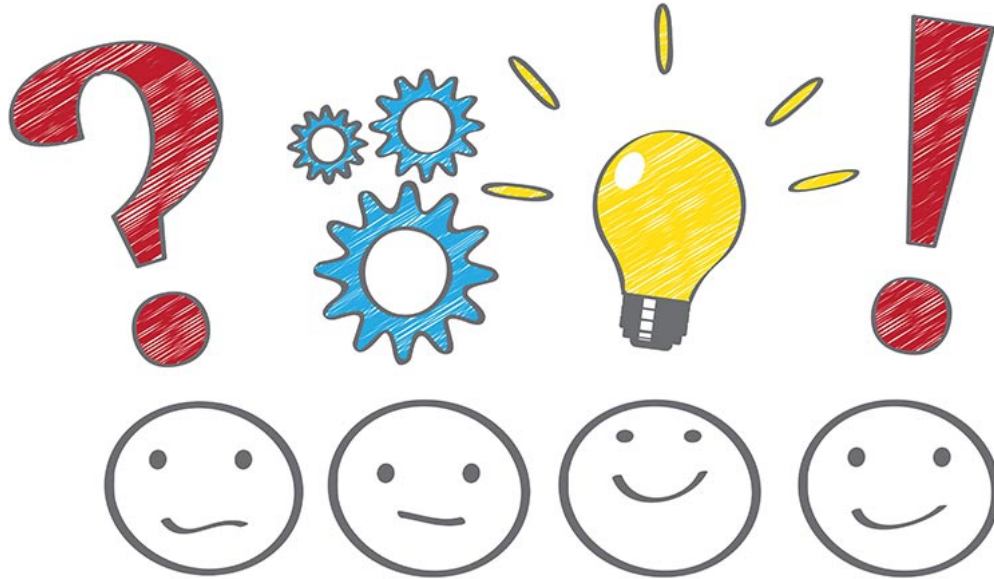


Looking forward ...



- 112G Electrical Performance needed
- Thermal Performance should be kept an eye on
 - Required for 800G and Dual 400G Optics (20W)
- Optical Interoperability with 100G Lambda Optics
 - Interoperability for 400G-DR4/FR4/LR4/etc

Questions?



Thank You For Your Attention

Markku Rantanen
Systems Engineer
Arista Networks, Inc.

markku@arista.com
+358 40 866 8583
<http://www.arista.com>