

100G to 800G: Building the future high-speed network

Switching speeds are changing, with serializer/deserializer (SERDES) speeds stepping quickly from 10G through 25G, 50G to 100G and perhaps 200G in the future. Higher switching speeds drive higher network speeds, which naturally favor fiber-optic network links. In turn, the SERDES speeds of network switches tend to determine the speed that servers are attached to the network. Matching speeds end-to-end provides the most cost-effective solution.

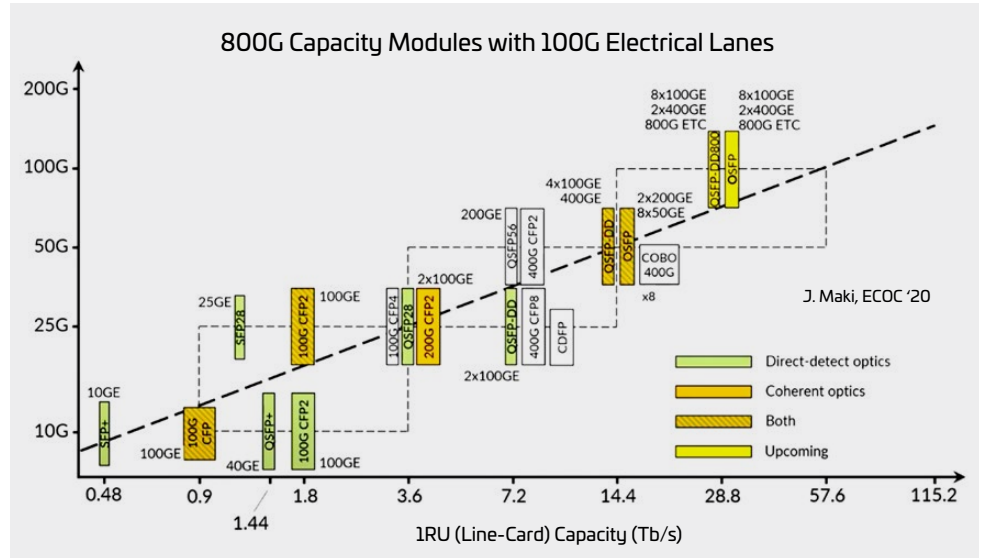


Figure 1: Optics and SERDES speeds increase in lock step
Source: Juniper Networks

To support faster speeds and boost efficiency, switches are increasing in port density (a.k.a. radix) and moving from a top-of-rack (ToR) topology to either middle-of-row (MoR) or end-of-row (EoR) configuration. As a result, the ability to manage the large number of server attachments with greater efficiency is becoming critical.

Accommodating this need in the server row requires new optic modules and structured cabling, such as those defined in the IEEE802.3cm standard. Among other things, IEEE802.3cm describes the benefits of pluggable transceivers for use with high-speed server network applications in large data centers.

Another response to the changes in server row configurations is the evolution of switch radix and switch capacity. Driven by the need for greater efficiency, networks are deploying higher radix application-specific integrated circuits (ASICs). Increasing the ASIC input/output capability supports more network device connections and reduces the number of switches needed for a cloud network. Figure 2 shows how, as the ASIC switch radix increases, EoR or MoR topologies improve management of the large number of server attachments. This structured cabling design provides for rack and stack server deployments.

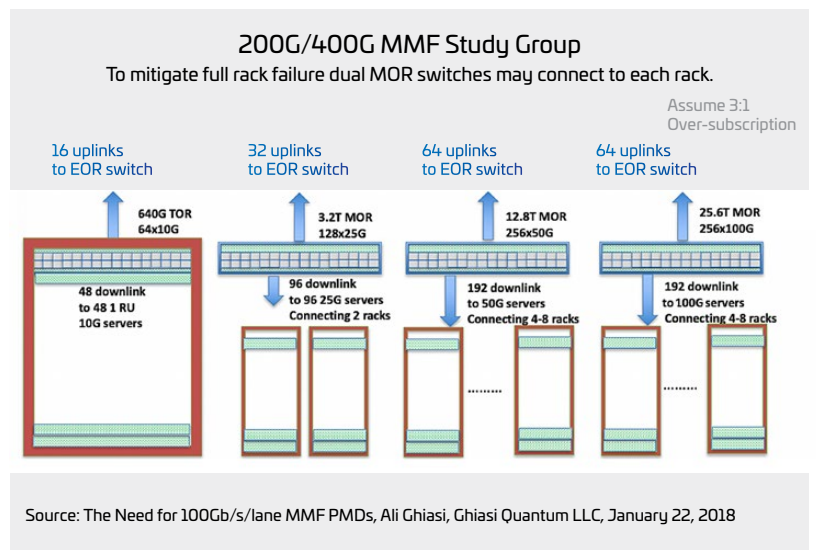


Figure 2

Switch radix equals the number of ports the switch offers at a given speed. The higher the radix, the less number of switches required in the network for a given number of servers.

At the same time, reductions in both the number of network switches and switching latency are increasing the efficiency of switch capacity, as seen in Figure 3. Improvements in radix ASIC and switching capacity are both continuing to evolve at a rapid pace.

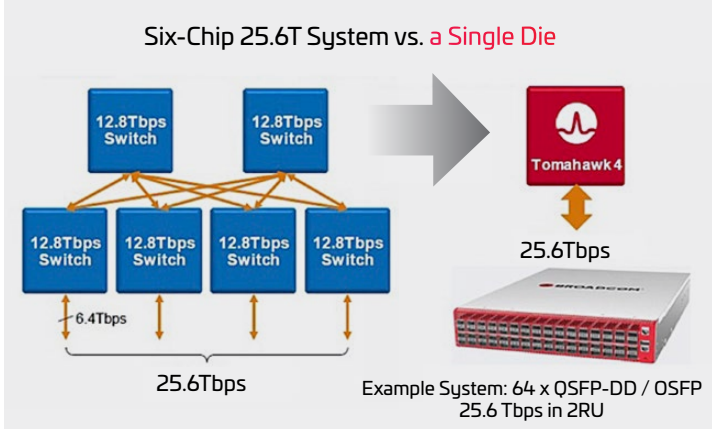


Figure 3 : Streamlining the switch layer increases switch capacity efficiency

Source: Broadcom

How cloud networks impact design

Cloud networks contain a large number of edge devices, which require a high number of optic connections—preferably at a low cost. Low-cost pluggable modules help reduce overall cost and power usage while mitigating issues associated with the deployment of active optical cables (AOCs) and direct attach cables (DACs) at new higher speeds.

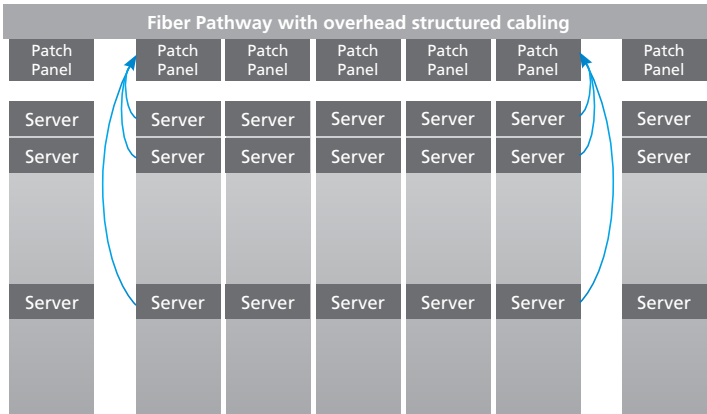


Figure 4 Source: IEEE CFI Consensus Presentation Draft

The need for low-cost optics and the reduced length between server connections—generally less than 100 meters and often less than 50 meters—are driving the development of a multimode fiber (MMF) transceiver with optic applications that can support both switch-to-

switch and switch-to-server configurations. **Multimode continues to provide the most cost-effective system costs when link lengths are short.**

Figure 5 shows the benefits of selecting a high-bandwidth MMF. As speeds increase, options for shortwave division multiplexing (SWDM) enable more efficient use of fibers with a greater variety of wavelengths. OM4 and OM5 cabling also help network managers address issues regarding higher bandwidth complexity and extended link distances. The latter is especially important as the 150 m reach of OM4/OM5 supports longer switch-to-switch connections.

The IEEE 802.3cm standard also introduces two MMF server connection types—each with 16 fibers (eight fiber pairs), as shown in Figure 6. As discussed above, this allows for individual server connections that can vary based on the number of 50G lanes assigned to the link (e.g., 50G, 100G, 200G). Structured cabling solutions are supporting this in-row topology—providing the flexibility to support flexible breakout mapping (N*lane-rate). The basic design is now based on octal modules instead of the previous QSFP modules. This change includes logical mapping of existing 12-fiber and 24-fiber cabling commonly deployed with previous QSFP generations.

400 G	Standard	# fibers	Maximum Distance
	400GBase	32	OM3 70m
	400GBase-SR8	16	OM4 100m
	400GBase-SR4.2	8	OM4 100m
			WBMMF (OM5) 150m

Figure 5: 400G improves fiber-use efficiency and link distances

Source: CommScope

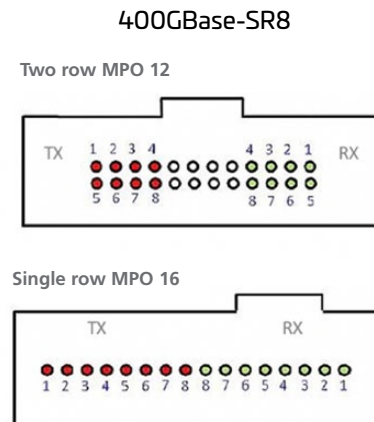


Figure 6 : MPO 12/MPO16 connector interfaces for 400GBASE-SR8

Source: IEEE Standards Association, 802.3cm

On to 800G?

The introduction of 100G I/Os will double switch port speeds. The same 400G cabling strategies and higher bandwidth MMF can support this transition to 800G modules. The IEEE 802.3db task force is now working on a new transceiver standard to support the 100G transmission on a single wavelength over 100 m of OM4 fiber. For shorter links, less than 50 m, the task force is also exploring the potential for a very low-cost option.

Capitalizing on the octal module and the introduction of 100G electrical lanes, a new MSA has been formed to develop 800G optic applications. The MSA participants began by assuming 100G would require SMF to the servers. While it is still early, many believe that short links will again favor low-cost MMF VCSELs vs. SiP and SM lasers. However, an 800G module does not introduce a new 800G MAC rate. The IEEE has launched a [study group](#) to help transition to the next plateau of higher Ethernet rates. 800G is certainly on the map, and a path to 1.6T and beyond is also being explored. As 800G development begins, new optic modules will be introduced. Table 1 lists some of the popular optic modules that customers are planning to deploy.

8x100GbE, 2x400GbE

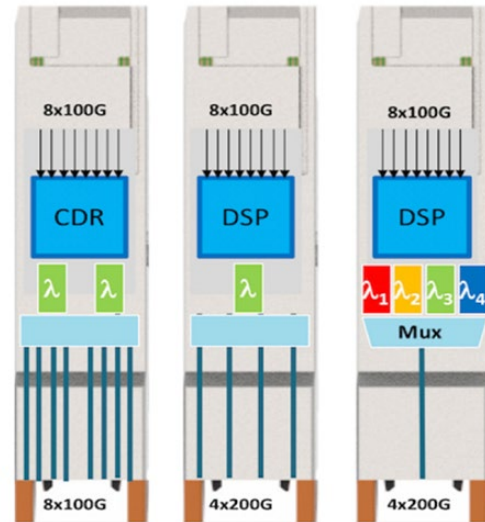


Figure 7: 800G pluggable objectives

800G Capacity with 100G Electrical Lanes

Reach	Application			
	8x100 Ethernet	4x200 Ethernet	2x400 Ethernet	800G Ethernet
SR (50m)	8x100GBASE-SR1	4x200GBASE-SR2	2x400GBASE-SR4	
DR (500m)	8x100GBASE-DR		2x400GBASE-DR4	
FR (2km)	8x100GBASE-FR1		2x400GBASE-FR4	800G-FR4/FR8
LR (6km)			2x400GBASE-LR4-6	
LR (10km)	8x100GBASE-LR1		2x400G-LR4-10	
LR (High Loss)				OIF 800G Coherent
ER (30-40km)				
ZR (80-120km)				OIF 800G Coherent

Table 1: Potential optical modules for 800G applications

Customer demand?

Source: J. Maki, Juniper OIF presentation

Key takeaways for the journey to 800G and beyond

As data centers, service providers and enterprise network managers navigate the inevitable changes in their physical layer infrastructure, their strategies will be impacted by the following trends:

- **The nature of switches is changing:** Driven by the need for greater efficiency, networks are deploying larger radix ASICs and switching.
- **Speeds will increase quickly:** Server refresh cycles should be aligned with the expected introduction of faster switching speeds as 50G and 100G SERDES are incorporated into server NICs.
- **Server-row topologies are changing:** Network managers should plan a path to 16-fiber deployments—matching the octal QSFP-DD and OSFP transceiver modules.
- **Benefits of structured cabling in server rows:** Compared to AOCs and DACs, structured cabling is migration proof and well suited to the increased densities high radix switches offer.
- **Continued need for high-quality optics:** As network speeds increase, so does the demand for higher bandwidth (think OM5 MMF) and lower losses.
- **MMF has a long future in the data center:** Prompted by the growth of hyperscale environments, the industry continues to develop new transceivers for short reach applications. As always, VCSEL technology continues to shine for these short reach applications.

Using these trends as guide rails, network managers will be better able to keep their infrastructures future-ready yet fully capable of satisfying the current demand for speed, efficiency and performance.



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