Panduit Article – Future of Fibre in the Data Centre

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Digital disruption across most market sectors is continuing to drive the need for higher performance infrastructure within the burgeoning data centre market. Enterprises in financial services, media, e-health and retail, especially online, are at the forefront of phenomenal growth in data traffic. A consequence is a future where a high percentage of that traffic will be within the data centre environment across machine-to-machine applications, utilising technologies such as AI (Artificial Intelligence) and ML (Machine Learning) to communicate petabytes of data daily. Physical infrastructure architects are now scrutinising the latest and next generation products and platforms to ensure data centres have the capability to scale exponentially to satisfy this data traffic requirement.

The challenges for the network are ever growing demand for faster speed, 40GE (Gigabit Ethernet), 100GE today and 200GE and 400GE within three years, and the physical distances to be coverage. The connectivity to the server stack is changing, with 25GB servers already deployed in web platform data centres. As a result, cable and switching fabric must have the capability to service the roll out of 50GB server technology, which is already underway.

By their nature, AI and ML solutions rely on large data sets, preferably multiple terabytes and soon to be petabytes, to analyse and learn. This quantity of data already requires 50GE and the demand curve is forecast to rise sharply to 100GE.

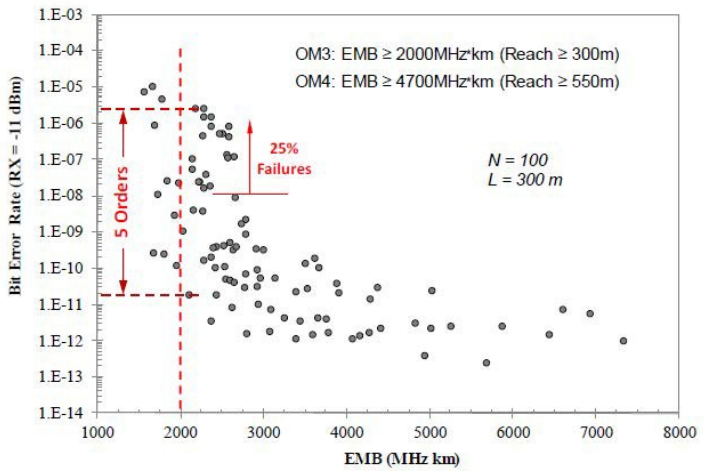
Expectations are that Ethernet based networking will continue to provide near-linear scalability, however, the volume of data traffic generated can be significant. Therefore, intelligent handling is required to ensure the network Is not overwhelmed resulting in latency and even outages. Already 50GE and 100GE ASICs (Application Specific Integrated Circuits) are deployed by hyperscale datacentres. This creates another pressure point for network architects to dynamically meet this growing diversity of communications patterns across the network, with different traffic classes having separate networking requirements for throughput flows, deadline flows and interactive flows.

A clear demonstration of this move towards increased performance is the growth in higher speed port shipments, with 25GE and 100GE port speeds combined at 46% share, will match the shipments of 10GE ports by 2021. The direction of travel for speed and capacity is only going one way and the networking technology that organisations trust to scale linearly is Ethernet whether on single-mode or multimode fibre optic cable.

With 40/100GE already being deployed and the standards for 200/400GE under approval and published by the IEEE, Ethernet is the preferred networking platform. It can deliver data centre architecture and design to meet future applications needs whilst providing low operating costs today. Multimode fibre will continue to be the predominant fibre optic cable used in the market as it continues to offer key benefits to most data centre builders and operators. Multimode fibre provides lower cost solution over single-mode as it utilises cheaper laser transceivers, its installation allows wider alignment tolerances, and it consumes less power. Single-mode fibre is a less robust connectivity solution, whilst multimode is more tolerant to dirt and dust, it does not require high return loss, is resilient to multipath interference and is more forgiving to long-term connector degradation. Although infrastructure within the data centre accounts for around 2% of the build cost of the site, once operational the percentage of outages where infrastructure is the cause is much higher.

As the monetary cost of outages increases and reputational damage can be even more financially severe, the advantages for installing the highest quality infrastructure solutions become obvious. As the market for fibre optic cable technology has advanced it has become clear that the variation in the quality and capability of the various manufacturers' cabling solutions has diverged. Recent market testing of cable illustrates the importance of understanding the specification and identifying the capabilities of the manufacturers of the fibre optics being supplied.

Figure 1. *Channel Performance vs Fibre Bandwidth (EMB – Effective Modal Bandwidth)*



The Future of Multimode Fibre

For short reach applications less than 100 m, such as switch to server and server to server (machine to machine) interconnections is where Multimode Fibre adds real benefit inside the data centre. Industry standard fibre which is laser optimised now provides a scale of fibre capabilities to assist data centre operators to plan successful infrastructure installs and upgrades dependent of operational requirements up to at least 400 Gb/s.

Table 1. *Laser Optimized Multimode Fibre Types*

Fibre Type	EMB at 850 nm (MHz·km)	EMB at 953 nm (MHz·km)
OM3	2000	NA
OM4	4700	NA
OM5	4700	2470
Dispersion compensating OM4+	5500	2000

▪OM3 and OM4 are designed for 850nm transmission
▪MMF is sorted as OM3 & OM4 based on Effective Modal Bandwidth (EMB)
•EMB is calculated from DMD measurement
▪OM5 includes a specified EMB at a longer wavelength (953nm)
•Only provides a benefit for SWDM-4 applications where the required reachexceeds the standards specified maximum channel reach (non-standard)
▪Signature Core OM4+ is a high-performance dispersion compensating OM4 fibre

OM3 and OM4 are designed for high bandwidth at 850nm, whilst OM5 is specified for longer wavelengths (953nm), SWDM-4 applications. The dispersion compensating OM4+ is an essential element for single wavelength and BiDi systems applications.

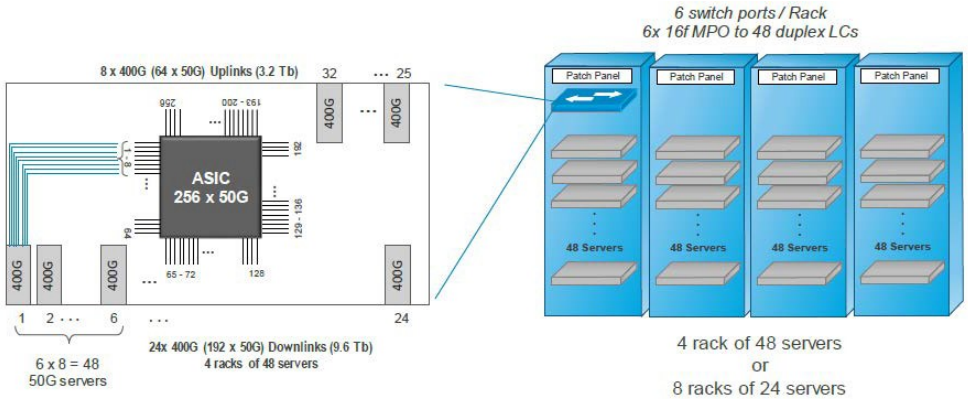
In technology development terms, the move to 40Gbps saw the emergence of parallel optics. This was because the VCSELS (Vertical Cavity Surface Emitting Laser) used in fibre optics transmits at 10Gbps. To achieve higher data rate transmission, aggregated lanes are used. To reach 40Gbps four parallel fibres aggregate 10Gbps per fibre.

The addition of lanes had an unforeseen benefit. It allowed switch manufacturers to increase port density. This was possible because each lane in Ethernet is independent. So, instead of building switches with 96x 10GB ports, this was condensed to 32x 40GB high density ports. This is known as breakout and is important because everything that has been worked on to develop standards to get to 40Gbps, 100Gbps, 200Gbps and 400Gbps is breakout compatible.

This year 50GE, 100GE and 200GE multimode fibre standards will be ratified. Over the next three years 100Gbps breakout at 4x 25G lanes and 200Gbps breakout at 4x 50G lanes will be widely deployed.

Currently a new IEEE 802.3 task force has been established (802.3cm), in which Panduit is a key contributor to define and propose standards. One objective is to define 400Gbps across eight separate 50Gbps lanes to be used for connecting servers and switches, figure 1. There is also a specification for 400Gbps over four lanes at 100Gbps per lane, each lane carrying two wavelengths – which Panduit supports, but will not support breakout solutions defined in IEEE.

Figure 2. *Multimode fibre switch to server breakout application*



- High density 32x400G port switch
- 50G servers to be supported by
  - 400GBASE-SR8 to 50GBASE-SR breakout

The Path to 800GE

Forward towards 800Gbps and beyond will also likely be breakout compatible. This is a sensible path that will reduce 800Gbps switches down to 32 ports. This can be achieved by specifying 100Gbps serial transmission per lane. Feasibility of this solution was demonstrated recently at the 2018 Optical Fiber Conference (OFC) by Panduit researchers. Breakout at 800Gbps will be far more efficient in terms of heat dissipation, eye safety, and space and power densities. It will also bring down the cost of manufacture.

Conclusion

Multimode Fibre is essential for high speed data traffic in data centres. The next step up is already in discussion by the Ethernet Alliance and an IEEE ad hoc group which are mapping a journey to 800GE and 1.6TE networks. There are however questions on the suitability of Multimode Fibre beyond 800GE for server to server connectivity due to its relatively short reach. At that point, Panduit is proposing multiple lanes 100Gbps serial data transmission, as it believes that utilising 100Gbps serial and bi- directional SWDM2 a data rate of 1.6Tbps can be achieved. Until then, Multimode Fibre's position as the choice for most data centre infrastructure is confirmed.