The Need for Network Speed

Your ticket for today and tomorrow's journey

Author: Stephen J. Morris

Senior Product Manager, Panduit EMEA

Despite consistent forecasts in the growth of data, there often exists uncertainty surrounding the optimal specification for a fibre network to meet this rapidly developing trend. Multiple factors come into consideration when deciding which grade of Single Mode Fibre or Multi Mode Fibre represents the best 'path' forward.

Introduction

We are poised for gigantic growth in data traffic transacting within the data centre. Commonly known as 'machine to machine' (M2M) or 'East to West' communications, M2M is predicted to grow by 44% CAGR between 2015-2020 (source: Cisco). Partly meeting this development, 100G is forecast to represent over 50% of data centre optical transceiver transmission capacity by 2019 (source: Infonetics). Additionally, 400G is expected to appear between 2018-2020. As the industry readies itself to migrate toward the next generation of Ethernet speed, are you prepared for the next leap?

In the past, decision-making between single mode fibre (SMF) and multimode fibre (MMF) solutions were relatively clear cut – the former provided highest bandwidth at a price, the latter a cost-efficient alternative in less speed and reach sensitive use cases. However, today critical factors in decision making include determining whether current bandwidth requirement can be economically met; reach/distance requirements including foreseen network architecture specific goals achieved; and whether future Ethernet and/or Fibre Channel speed can be supported or easily migrated to over the ROI period. These four inter-dependent criteria and must be considered to reach the optimal choice.

Single Mode Fibre or Multi Mode Fibre?

With seemingly infinite bandwidth (information carrying capacity), SMF has often been considered the best insurance policy by network designers and data centre to ensure a future without bandwidth bottlenecks. Traditionally there have been high costs associated with SMF optical systems, this cost addition is attributed to the price of the optical transceiver modules and overall cost is less influenced by the price of the passive optical cabling

At the same time, it is acknowledged that despite the cost penalty, SMF technology does indeed hold advantages over MMF in terms of longer reach and bandwidth capability. But as companies embark on a transition towards high-speed data transport journey, do alternative fibre cabling systems offer capabilities that that previously only SMF could satisfy?

At this point, it is important to acknowledge that the paradigm has recently shifted in terms of decision making when determining which grade of fibre provides the best return on investment, in your particular environment. Technological advance now places MMF at the top of list in terms of making an informed choice for both present and future network needs.

Is the MMF pipe large enough to support future generations of traffic?

Multimode fibre supports a large proportion of today's applications and reaches in the data centre at significantly lower cost. Additionally, it has the capacity to meet future data capabilities of data centres with a roadmap that can feasibly support up to 800G Ethernet.

The bandwidth capabilities of MMF has grown exponentially with advances in optical transmission technology. More recent MMF transmission developments have seen the introduction of faster vertical cavity surface emitting laser (VCSEL) moving from 10G to 25G, doubling of the line rate (PAM4) and short wave division multiplexing (SWDM).

Using a combination of these advances in MMF technology, new 100G transceiver modules are anticipated being released to market during 2017. These will comply to the SWDM Alliance multisource agreement (MSA) and enable 100G over two MMF's (duplex transmission/fibre pair). Second and third generation MMF SWDM developments present a clear roadmap to 200G (two fibres) and when combined in 'parallel optic' form this roadmap easily extends all the way 800G.

In support of this development, IEEE 802.3 high speed study groups are currently reviewing the SWDM MMF roadmap, with the latest 'call for interest' reflecting proposed new SWDM nomenclature e.g., 800GBASESR4.4 for 800G (i.e. 4 pairs of MMF's – operating at 4 wavelengths to achieve 800G).

Do you need OM5 for SWDM?

There are multiple MMF fibre grades that support SDWM including OM3, OM4, OM4+ and OM5. First generation 40/100G Multimode SWDM transceivers are expected to operate with varying levels of performance over multiple grades of MMF.

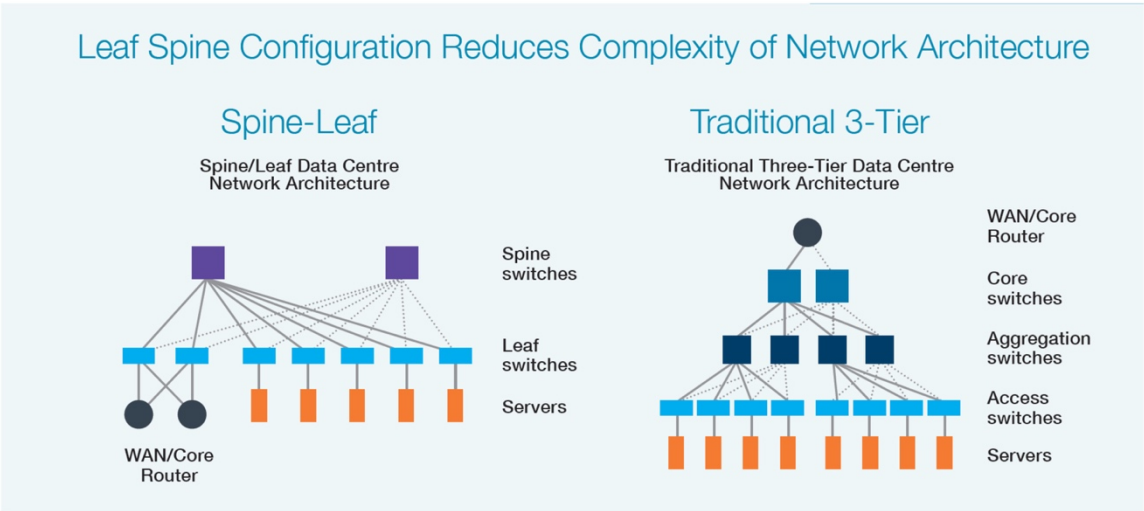
100G SWDM MSA (from the SWDM Alliance), states the following reach for MMF duplex transmission of 100G:

- 75m on OM3, maximum channel insertion loss 1.8dB IL
- 100m OM4. maximum channel insertion loss 1.9dB IL
- 150m OM5 maximum channel insertion loss 2.0dB IL

OM5 and OM4+ such as Panduit SignatureCore are able to provide additional reach and performance headroom for SWDM MMF applications. Most manufacturers are able to offer OM4 and OM4+ solutions at a lower cost to OM5. In many instances OM4+ can match the same reach/IL parameter of OM5 for SWDM applications, and may even be able to provide reach advantages over OM5 for single wavelength applications (850nm).

Application driven decision making

The rise of software-defined networking (SDN) has caused data centre designers to realign from traditional three layer topologies (Figure 1) to 'spine and leaf' architecture (figure 2).



Panduit Diagram: Leaf Spine Configuration

Article DCW – Future of Fibre

Collapsing the 3 three-layer architecture, to spine-leaf, drives higher port/connector density at the spine as every leaf is connected to every spine switch. A popular practice to resolve higher density connectivity challenges and increase efficiencies at the spine is to use cable assemblies and equipment that can operate 'break-out' configuration (see figure 3).

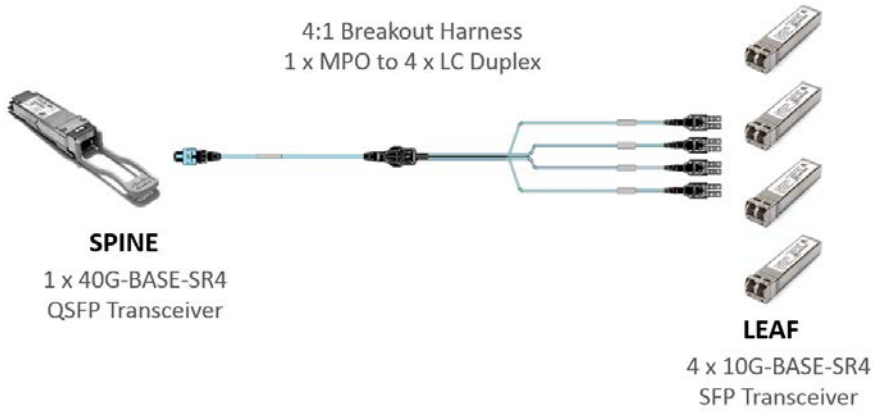


fig 3.0

Breakout application drives early adoption of high speeds in the data centre.

Taking 40G MMF data centre deployments as an example, over 50% of market adoption is believed to be related to 'breakout' configurations i.e. 40G to 4x10G. However, the key driver was not for 40G end-to-end but to deliver efficiencies in distribution of 10G including (estimates only):

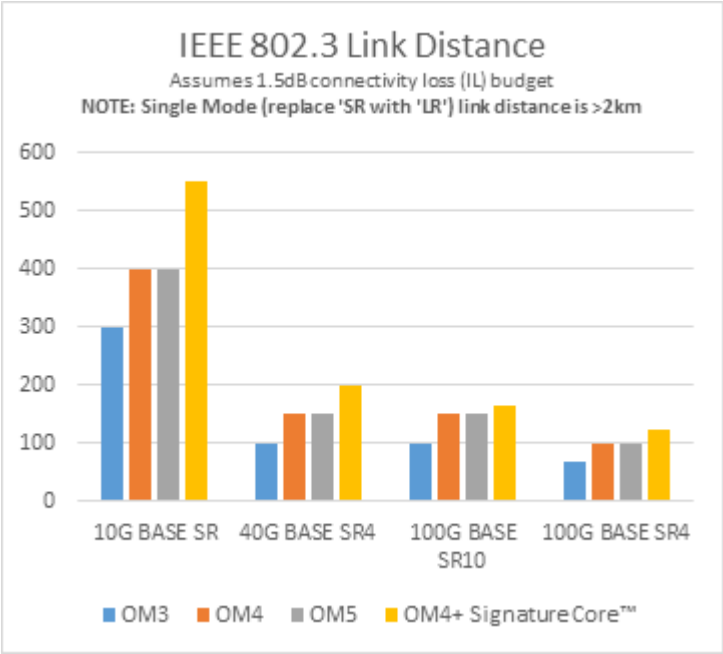
- 20-30% cost saving per port
- 30-50% less power per port
- 50% rack-unit space saving at Spine
  - More space for revenue generating equipment
  - Adds value where space is a premium/limited

The same concept of continuous incremental efficiencies will drive 100G (100G to 4x25G) and 400G (100G to 4 x100G) in the near future. However, it should be noted that the first generation of SWDM over MMF is unlikely to support 'break-out' mode/ configuration. This should be a considered when evaluating the benefit of 'duplex' vs 'parallel' high speed transmission and network architecture design(s).

Cable Reach

Hyperscale data centres are typically very large facilities that house >50,000 server ports. The reach (distance between server/switches) in such facilities often exceeds 150m. With such long reaches it is not unusual to see a mix of 80:20 in favour of SMF. The opposite can be said for Enterprise data centres, where typically 95% of reaches are <100m and the mix is more likely to represent 80:20 in favour of MMF.

There are advanced grades of optical fibre that offer extended reach MMF far beyond the standards, likewise enhanced transceiver specification to achieve the same end. The chart xx gives examples of link distances based on a standard (non-extended reach) transceivers.



Cost

MM transceivers are manufactured with lower cost VSCEL compared to the higher cost lasers typically seen in SM transceiver optics. These VCSEL take advantage of the larger MMF core/ cladding diameter (50/125 micron - OM3, OM4, OM4+ & OM5) making the overall solution a lower premium.

The structured cabling element (which includes fibre cabling) of a network installation typically represents <5% of an IT managers budget. Whilst the cost of the fibre grade itself (SMF or MMF) represents a very small percentage of the cable system make-up when considering each fibre channel/ link. Taking the example of a 10G MMF channel and adding the cost of the transceivers to the passive fibre cable infrastructure, the cost of the transceivers would represent circa 80% of the total cost.

The IEEE high speed study group have multiple objectives for both MMF and SMF for data rate up to and beyond 400G. There is desire to simplify and reduce the cost of single mode transceiver optical modules, this may come with compromises, an example is IEEE 400GBASE-DR4, which has a reach objective of 500m – this is shorter than the >Km typically seen for SM solutions today.

The gap between MMF and SMF is expected to narrow in future as faster optoelectronic technology matures and volumes increase, however, as a solution today, the price premium for SMF is typically 1.5 to 4 times that of a MMF solution depending on data rates/transceiver module type used. There are exceptions – for example, advances in silicon photonics based SMF transceivers such as 100GBASE-PSM4 which is expected to closely align MMF and SMF price levels.

Conclusion

Single mode fibre continues to play an important role where reaches extend beyond 400m (up to 10G) and typically beyond 150m (40G data rates and beyond) which can include applications across aisles and across site (campus).

The introduction of 100G-BASE-PSM4 (parallel single mode) brings with it a new breed of SMF transceiver, incorporating low cost silicon photonics. This is expected to drive closer price alignment between MMF and SMF solutions, thus, increase popularity of SMF – particularly for greenfield 100G deployments.

However, there is a significant pre-existing installed base of MMF (OM3, OM4, OM4+) in data centres and legacy network expansion represents circa 50% of market requirement. Both equipment manufacturers and customers have a vested interest in supporting and maximising the ROI of this legacy infrastructure investment. Therefore, a mass migration towards SMF in brownfield sites is not expected anytime soon.

In any event, the bandwidth of today's multi mode fibre solutions far exceed their perceived limitations. This being the case, bandwidth should no longer be the barrier for consideration of MMF to meet current or future needs. In addition, MMF is the most cost effective choice for the majority of data centre uses where reach is typically <150m.

The businesses case for MMF continues to strengthen as the applications, bandwidth and roadmap it supports extends.