White Paper
The future is bright!
The future is Singlemode Fibre.

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without compromise.

Background

There has been much debate in the media over the last few years about whether Singlemode or Multimode is the sensible approach to be adopted within Data Centre environments going forward. This discussion has been made even more complex with the introduction of OM5 fibre over the last 18 months.

If we take a step back to look at the basic recommendation of any standard being that you should design your infrastructure to be able to support two iterations of technology or hardware upgrades, it sets the foundation for some interesting arguments.

For a number of years IEEE 802.3 taskforce have been working on higher and higher Ethernet speeds, not only going from 10G to 40G and 100G, but they have also been exploring 25G, 50G, 200G and 400G primarily for use within the Data Centre environment. In December 2017 they published 802.3bs for 200 and 400G over fibre.

Currently; there are a couple of basic premises to this White Paper, Firstly Single-Mode systems are recognised to be more expensive than Multimode, purely due to the current cost of the Electro-optics. However the greater transmission distance, higher bandwidth, upgrade capability and future developments based on singlemode should outweigh the cost argument in time.

Whilst it is possible to use multimode fibre, for IEC 802.3bs and these higher speeds it would take 16 parallel fibres to support 400G transmission with a limited distance of 100m. This development starts to become a watershed moment when you consider that the same performance can be achieved up to 500m using 4 singlemode fibres.

In a very similar vein we also need to consider the Fibre Channel used in Storage Area Networks (SANs) which is estimated to use approximately 25-30% of the fibre installed in Data Centres. The Fibre Channel Industry Association (FCIA) has based their roadmap for the future on effectively doubling transmission speeds every few years.

In 2016, FCIA introduced "Gen6 Fibre Channel", which consists of two key speeds — 32GFC in the SFP28 form factor and 128GFC in the QSFP28. With Multimode they both have the same distance limitation of 100m, whilst with singlemode it is capable of 10km distances. Currently 32GFC uses duplex fibres while 128GFC is based on quad lanes using MPO/MTP connectivity for both Multimode (100m) and Singlemode (10km) fibre.

Arguments

Cost

The key argument is cost and it is agreed that multimode electro-optics are currently cheaper by a significant factor; however the landscape is changing and potentially very quickly. At the same time, it is not always clear cut. Some will highlight the development of OM5 as being the next 'shining light' in this reasoning but they will be missing some very key points:

"OM5 offers longer lengths than OM4."

If you look at the reality, the advantages are minimal. In some case it will only offer an additional 50m over what can be delivered by OM4.

"OM5 will reduce costs."

Again, this is a fallacy. At this present moment in time, OM5 fibre and connectivity (Patch Leads and Pigtails etc.) are approximately 10 times more expensive than the equivalent singlemode products. As for the transceivers, they are currently on par with singlemode costs at best due to volume and demand.

Also bear in mind a later argument regarding the Open Compute Project.

"OM5 will create higher density."

How? Whilst it may be the case in relation to OM3, this argument does not stand up against OM4, which can support the same density but over shorter distances. When you consider singlemode it has already been demonstrated that a quarter of the fibres are required to provide a greater distance.

Furthermore, it is common practice to 'break out' higher bandwidth ports to increase port density; this is not possible using SWDM and OM5 fibre.

The final arguments on cost are very simple:

SWDM electro-optics that take advantage of OM5 are currently on par with singlemode devices due to market demands and volume of shipments. This factor will change when the Open Compute Project pushes forward with their 'short-reach, low-cost' project.

This could potentially bring the singlemode cost below that of OM4 devices, never mind OM5.

Due to low demand, the current cost of OM5 glass is between 5 & 10 times higher than OS2 despite the reported shortages in the latter. This means a 100m link of OM5 could cost €450 and one using OS2 costing €45. This more than negates the cost difference in singlemode and multimode SFPs.

Agreed over time costs will reduce as demand increases but the same can be said over singlemode SFPs.

continued overleaf

Future Performance

The 802.3bs Standard supports:

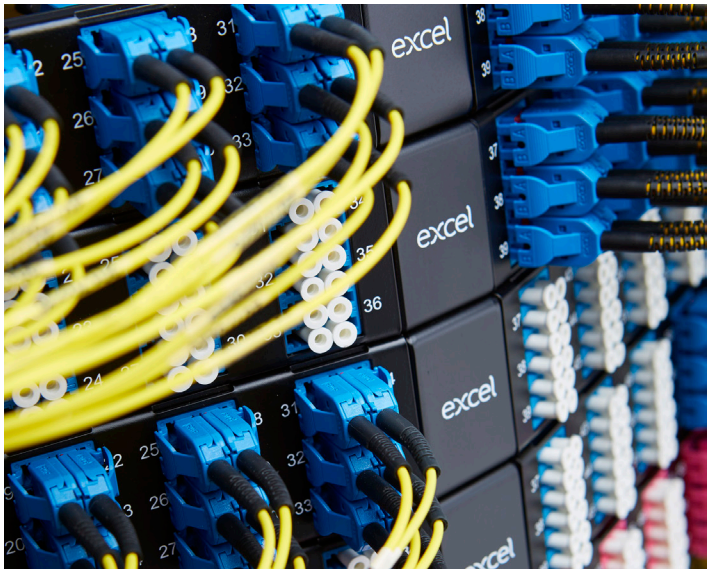
- **200GBASE-DR4**: 200 Gb/s using 200GBASE-R Encoding and 4-level pulse amplitude modulation over four lanes of SM fibre, with reach up to at least 500 m.
- **200GBASE-FR4**: 200 Gb/s using 200GBASE-R encoding and 4-level pulse amplitude modulation over four WDM lanes on SM fibre, with reach up to at least 2 km.
- **200GBASE-LR4**: 200 Gb/s using 200GBASE-R encoding and 4-level pulse amplitude modulation over four WDM lanes on SM fibre, with reach up to at least 10 km.
- **400GBASE-DR4**: 400 Gb/s using 400GBASE-R encoding and 4-level pulse amplitude modulation over four lanes of SM fibre, with reach up to at least 500 m.
- **400GBASE-FR8**: 400 Gb/s using 400GBASE-R encoding and 4-level pulse amplitude modulation over eight WDM lanes on SM fibre, with reach up to at least 2 km.
- **400GBASE-LR8**: 400 Gb/s using 400GBASE-R encoding and 4-level pulse amplitude modulation over eight WDWDM lanes on SM fibre, with reach up to at least 10 km.
- **400GBASE-SR16**: 400 Gb/s using 400GBASE-R encoding over sixteen lanes of MM fibre, with reach up to at least 100 m.

These are the options available within the new standard; it should be noted that the only option using multimode fibre is the last one, which requires a 16 fibre MPO/MTP with a distance supported up to 100m. These are also notoriously very difficult to terminate and if any damage happens in the field to a single fibre core then the whole connector and assembly needs to be replaced, making them quite expensive, especially compared to 2 x LC duplex connections using singlemode fibre.

Conclusion

All the standards recommend that you should design your infrastructure to be able to support two iterations of technology or hardware upgrades. With the pace of progress in the development of new technology, it makes total sense to base any new installations on the flexibility and future-proofing provided by singlemode. Not only the longer distances and fewer channels, it will also come down to the economies of scale. Bodies such as the Open Compute Project, which includes all the major equipment vendors, are pushing to introduce new low-cost, short reach SFP and QSFPs that have previously provided a cost barrier for the wider adoption of singlemode.

From experience with some of the leading Data Centre and Cloud Services operators, it is an argument that has been clearly accepted as they are all moving to a singlemode model to give themselves the edge in the future. This approach will soon filter down to the rest of the market.



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