STRUCTURED CABLING
DATACENTER INFRASTRUCTURE OPTIONS

THE LIMITATION OF MULTIMODE FIBER:

In a typical network design, the horizontal is copper, and the vertical is fiber. The architecture of our networks, with switches aggregating multiple copper links for communication through only 1 or 2 links in the backbone means that we always need far greater data rate in the fiber links than in the copper links. However, by using multimode it might seem as if this is becoming a difficult task

Below is a table showing the typical applications for horizontal versus vertical, with usual type of cabling used.

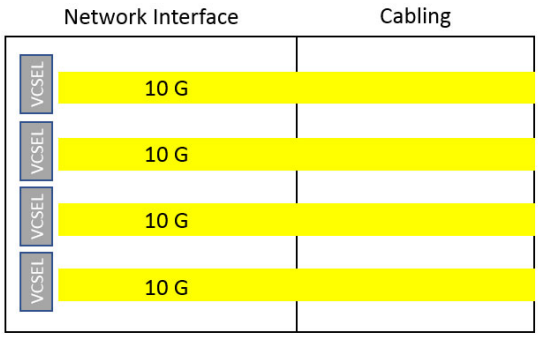
Horizontal, Copper (4pair cables)		Backbone, Multimode fiber (2-core channels)	
Data Rate	Typical Cabling	Data Rate	Typical Cabling
10Mbps	Category 3	100Mbps	OM1
100Mbps	Category 5	1 000Mbps	OM2
1 000Mbps	Category 6	10 000Mbps	OM3
10 000Mbps	Category 6A	50 000Mbps	OM4

Note: Table is not a list of applications per Category, but only typical cases with evolution of cabling technologies.

This shows that backbone has generally had a capacity of 10 times more than associated horizontal. But with the latest Cat.6 A cabling, there is a lack of 100Gbps application on duplex fiber for the backbone.

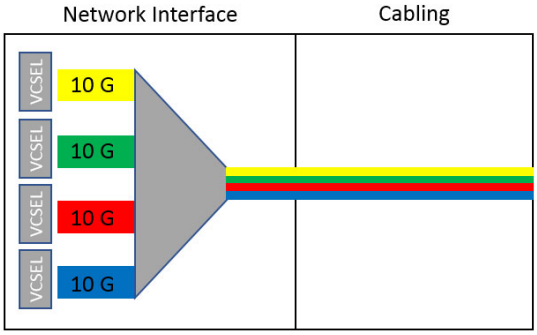
The main limitation comes from the electronics of the light emitters (the VCSELs). They can only "blink" so fast to send the zero's and the ones. So, to increase the amount of information, the only option is to add multiple signals together. Two technical options exist:

1- Send multiple signals on multiple fibers. This is called parallel optics, and generally uses the MPO connector that allows typically 12 fibers in a single connector. Below is a diagram a network interface sending 4 signals of 10Gbps in parallel into a single connector with 4 fibers, and the MPO connector used.



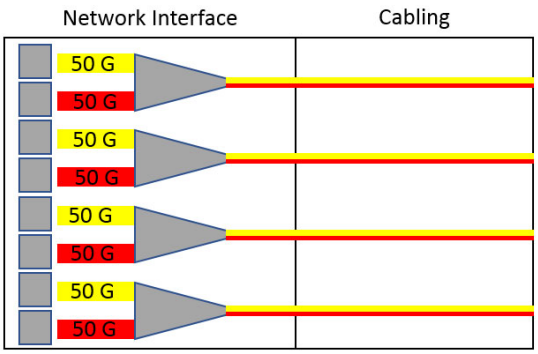
Example: This is used for the 40Gbase-SR application, sending on 4 fibers and receiving on 4 fibers, using 8 fiber of the MPO connector.

2- Send multiple signals of different wavelengths, or "colors" into the same fiber. This is called wavelength division multiplexing (WDM) and can use the traditional 2-core channels using the LC connector. Below is a diagram of a network interface sending 4 signals into a single fiber, and the LC connector used.



Example: This is used for the 40G-SWDM4 application, sending on one fiber and receiving on the other fiber therefore using a duplex LC channel.

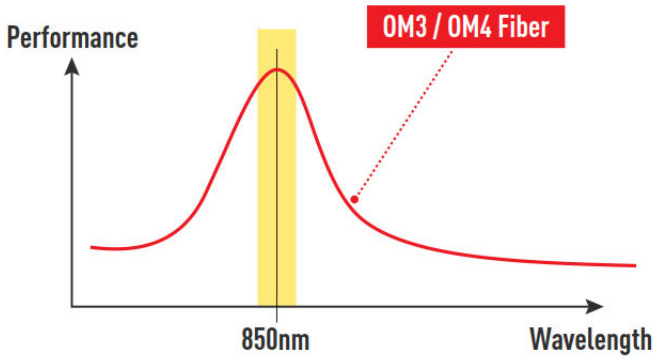
3- A more recent development is to combine both technologies together and provide both parallel optics and WDM in the same cabling to further increase the data rate.

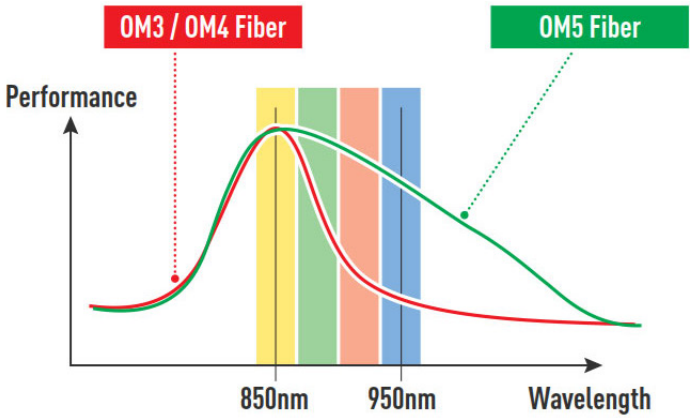


Example: This is used for the 400Gbase-SR4.2, sending on 4 fibers and receiving on 4, each having 2 wavelengths.

THE CASE FOR OM5

The problem is that our current OM3 and OM4 fibers are optimized according to the wavelength traditionally used: 850nm. To accept the 4 signals used in multimode WDM, OM5 has been redesigned to accept wavelengths from 850nm to 950nm. The diagrams below provide a graphical representation.





APPLICATION UPGRADES

By considering all the current applications, either standardized or recognized through multi-source agreements, as well as draft applications to be standardized soon, we can establish the following evolutions of the applications optimized per type of multimode cabling:

1- Duplex channel for single wavelength (typically duplex LC connector with OM3 or OM4 fiber):

10GBASE-SR → 25GBASE-SR → 50GBASE-SR*

2- Duplex channel for multiple wavelength (typically duplex LC connector with OM5 fiber):

10GBASE-SR → 25GBASE-SR → 40G-SWDM4 → 50GBASE-SR → 100G-BiDi or 100G-SWDM4*

3- Multiple fiber solution for parallel optics (typically MPO connector with OM3 or OM4 fiber):

40GBASE-SR4 → 100GBASE-SR4 → 200GBASE-SR4*

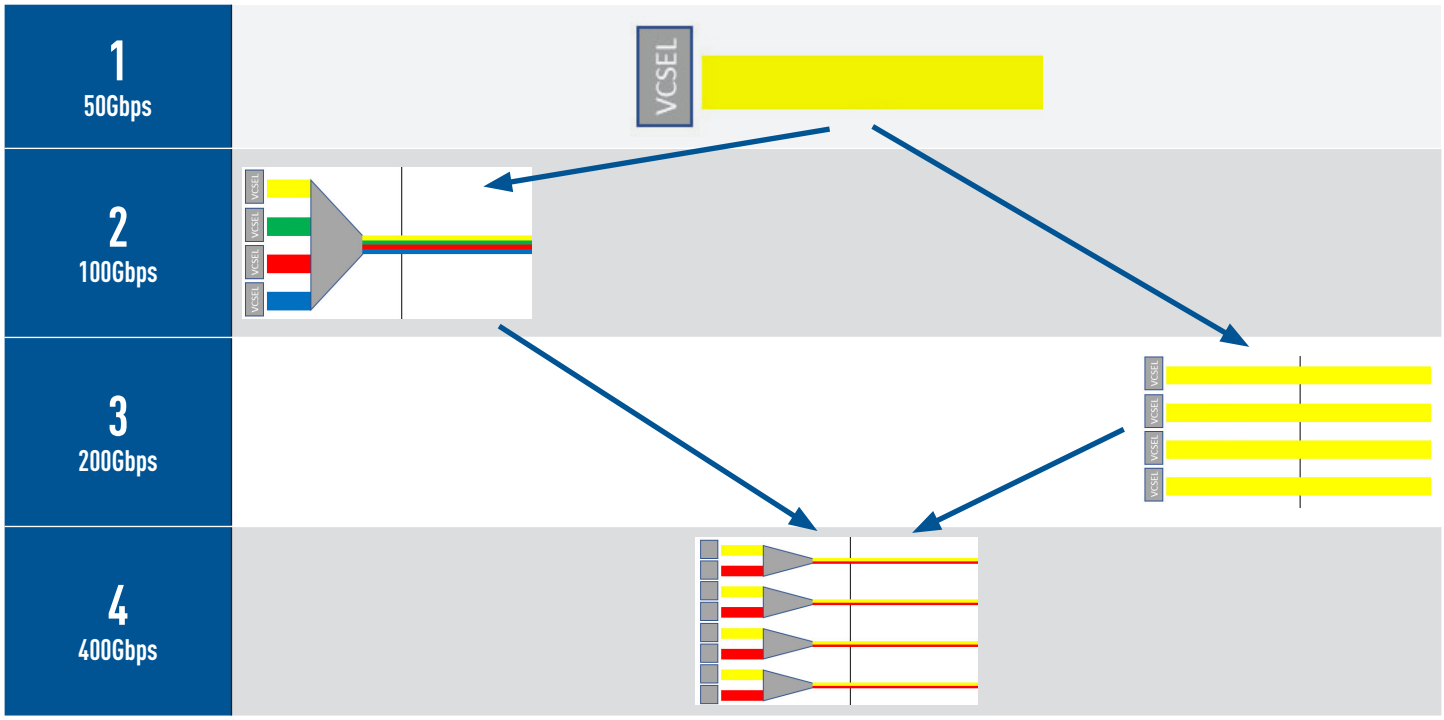
4- Multiple fiber solution for parallel optics and multiple wavelengths (typically MPO connector with OM5 fiber):

40GBASE-SR4 → 100GBASE-SR4 → 200GBASE-SR4 → 400GBASE-SR4.2 or 400G-BD4.2*

**See TR ISO/IEC 11801-9908: "Guidance for the support of higher speed applications over optical fibre channels" for further information. Note that some multiple wavelength applications can function on OM3 and OM4, but to limited distance.*

THE BEST OF BOTH WORLDS

To ensure the maximum lifespan of the fiber cabling it is important to select the right cabling. Today, a duplex OM4 channel can only expect to reach 50Gbps to the maximum distance. To reach 200Gbps, two options are available: duplex channel for multiple wavelength or multiple fiber solution for parallel optics. But to reach 400Gbps the best solutions is the combination of all technologies together.



In conclusion, OM3 and OM4 are perfectly adapted to the application up to today. But with the new technologies appearing in the network interfaces, these will rapidly show their limits in terms of application compatibility.

To allow the multimode fiber infrastructure to reach 400Gbps and ensure the highest life expectancy of the cabling, the best option today is to provide for the full range of technologies. This currently means using OM5 cables with MPO connectors.

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