White Paper
August 2020

Advanced protocols require
Ultra Low Loss Solutions

Nexans

Keeping up with technology and preparing for future demand

In recent years, the role of data centres and the related ecosystem has changed significantly, which is putting increased pressure on network requirements. Digitisation of business processes and the advent of social media, online content and Internet of Things have resulted in exponential data traffic growth. The trend towards virtualisation and cloud will continue to accelerate. Global data growth predictions from leading research firms and institutes point to annual increases.

Hyperscale data centre operators such as Amazon and Google are building out their data centres with delivery speeds of 100G to further accommodate data traffic expectations in coming years. Small tests for 400G are considered based on recently approved IEEE protocols. In general, Hyperscale data centres have been working with 100G for some time and we expect these solutions to become widely adopted in Enterprise data centres as well. Data centre managers from Enterprises need to prepare for the next technology evolution.

Different flavours of protocols for 100G Ethernet are becoming available. These are either based on parallel transmission or on duplex transmission such as SWDM (Short Wavelength Division Multiplexing). What's more, Fibre Channel is moving to the next speed node and 32G transceivers are expected to be installed soon. However, all Ethernet and Fibre channel protocols have one thing in common: the reach is reduced to around 100m and, especially, Designing systems working with very tight optical budget has become more of a challenge than ever before.

Furthermore, the complexity of data centre configurations is increasing. Replication of core switches or fibre channel directors are adding more and more connections to the channel. Also, creation of channels between different data rooms can result in channels with up to 6 connections.
In this white paper, we will take a closer look at the issues that arise from these evolutions, and examine how they can be resolved by the introduction of Ultra Low Loss connectivity solutions.

A closer look at the next generation of high speed protocols

Below we would like to introduce various new protocols for Ethernet and Fibre Channel that have become available recently for the next migration to higher speeds in Enterprise data centres.

100G with parallel optics

In 2015, IEEE published a second generation protocol of 100G on parallel optics (100GBASE-SR4). The protocol was developed in the IEEE task force IEEE802.3bm This new protocol uses 4 fibres to send and 4 fibres to receive information. Connectivity for this protocol is the multi-fibre connector MPO. Only one wavelength is used: 850nm.

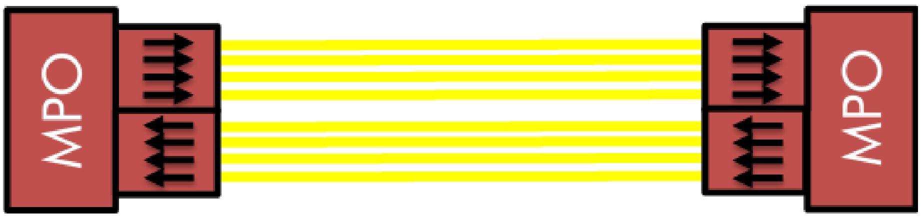
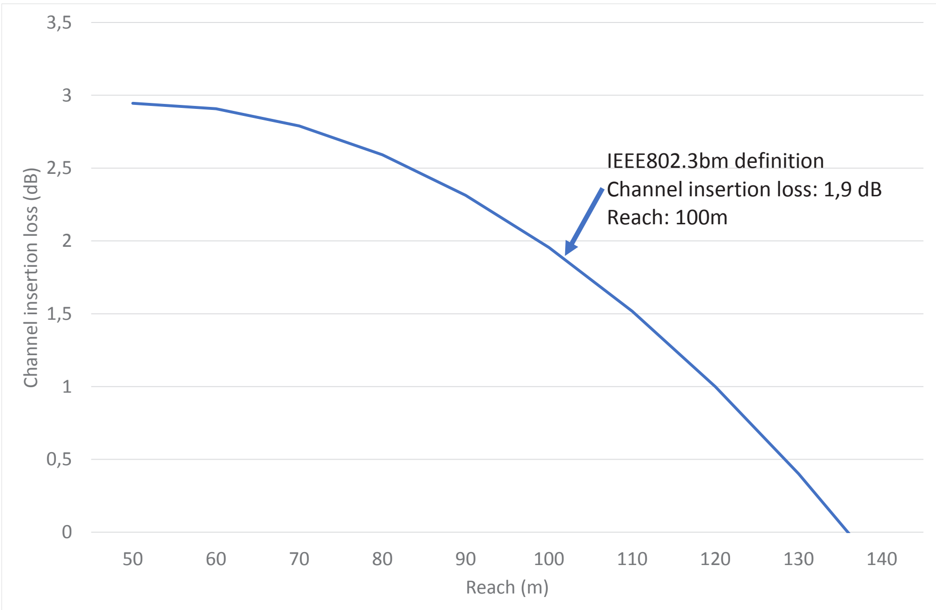


Figure 1: Schematic parallel optics

The IEEE802.3bm task force has developed a curve with the maximum channel insertion loss as a function of reach based on assumptions for transceivers. Based on typical data centre designs the required reach was defined as 100m resulting in a maximum channel loss of 1.9dB. Multimode cables have a maximum cable attenuation of 3.5dB/km at 850nm. This leaves only 1.55dB available for connectivity insertion loss in a channel. This reduced optical budget puts stringent requirements on the components used in a complex data centre channel.



Graph A: Channel insertion loss as function of reach for 100GBASE-SR4. Graph according to presentation of John Petrilla, IEEE Task Force 802.3bm, May 2013.

100G solutions for duplex transmission

Outside IEEE there have been other exciting developments for 100G. These new technologies use multiple wavelength for transmission over multimode fibres around the 850nm window.

SWDM

Short Wavelength Division Multiplexing (SWDM) has been defined by the SWDM Alliance in a Multiple Source Agreement (MSA). Four different wavelengths are used in the 850nm-930nm window. Each wavelength has a capacity of 25G, leading to a total capacity of 100G on one fibre. For SWDM all information is sent in one direction on one fibre. A second fibre is used to receive information. So, as a total of only 2 fibres is required the connectivity side can be handled easily using the well-known LC connector. Multiple suppliers for switches and servers are embracing this protocol. Solutions from switch and server suppliers like Arista, HPE, Dell and others are already available on the market.
According to the SWDM MSA, a maximum distance of 100m is supported on OM4 with a maximum insertion loss for LC connectivity of 1.5dB.

Figure 2: Schematic Short Wavelength Division Multiplexing

BiDi

Cisco has developed a proprietary Bi-Directional 'BiDi' solution for 100G. Recently also other switch suppliers like Arista, Dell, HPE and others have introduced compatible BiDi transceivers. On the same fibre 50G of information is sent on 855nm in one direction while in the opposite direction 908nm is used to receive 50G. Two fibres are required to achieve a total capacity of 100G. Also, this technology uses duplex LC connectivity. The reach with BiDi for 100G on OM4 is 100m with a maximum channel loss of 1.9dB.

Figure 3: Schematic BiDi

Fibre Channel

Fibre Channel protocols are defined by the **InterNational Committee for Information Technology Standards** (INCITS). Fibre channel 32G was defined in the protocol standard Physical Interface 6 (PI-6) by the T11 Technical Committee.
Increasing the speed to 32G has also reduced the reach for Fibre Channel, which has now become comparable to the reach of Ethernet 100G standards. PI-6 provides insertion loss values as function of distance comparable to the graph of the Ethernet standards similar to Graph A. Basically, it means that lower loss connectivity solutions result in longer reach.

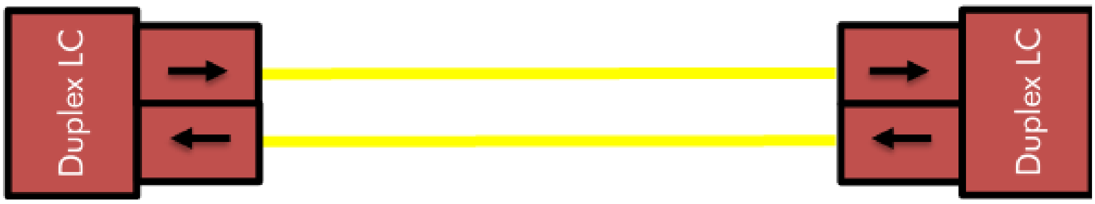


Figure 4: Fibre Channel 32G

Table 1: Fibre Channel for 32G according to PI-6: Connections loss and corresponding reach for OM4 cabling.

Connections loss	3.0 dB	2.4 dB	2.0 dB	1.5 dB	1.0 dB
Reach	20m	65m	80m	100m	110m

Key benefits of Ultra Low Loss in the Core Network

The 3 main benefits of introducing an Ultra Low Loss solution in a 100G core data centre networks are:

Large numbers of connections

With increased complexity in data centres, more and more connections are added to the optical channel. Ultra Low Loss solutions can accommodate this increased complexity without sacrificing the reach of the advanced protocols.

Longer distances

Essential, as data centre rooms can be vast, and often multiple rooms need to be interconnected.

Increased flexibility

Today, data centres and edge infrastructure have to be more flexible than ever. This means they must be easy to scale up, or down, in line with demand and functionality requirements. Also, adding, removing or changing large numbers of connections must be possible in a quick and simple manner. With the larger number of connections possible and the longer reach, Ultra Low Loss connectivity solutions facilitate these things without compromising on optical budget at higher speeds on demanding links between server switches and storage devices.

It is worth pointing out that in the access or leaf network, the benefits offered by Ultra Low Loss connectivity are not especially relevant. Speeds are lower, distances to be crossed are shorter and there are fewer connections.

Barriers to adoption

Let's look at some potential barriers to adopting 100G – and reasons they might not be barriers after all.

Compatibility issues moving forward

Parallel optics for 40G and 100G has already been embraced for some time by hyperscale data centres and very early adopters of large Enterprise data centres.
In the more distant future a move to 400G is expected. IEEE has already approved a new protocol for 400G based on parallel optics that can use the same cable infrastructure as for 40G and 100G. Hyperscale data centres are slowly starting to introduce these new protocols. For Enterprise customers, 400G is still a long way off.

Many Enterprise customers are only now starting to move to 40G and 100G. They can select the well-established parallel transmission protocols or can now benefit from the new protocols based on duplex transmission. Installing cabling infrastructure based on duplex LC will allow them to have a seamless migration from 10G over 40G to 100G.

Non-standard compliant transceivers

Parallel optics users prefer to stay with this technology choice when migrating to 100G, whereas new users are often interested in continuing to use their cable infrastructure based on duplex transmission. However, it is important to point out that transceivers for parallel optics are fully compliant with the relevant IEEE standards. Duplex transmission based on SWDM or BiDi is not defined in IEEE protocols. Solutions are always supplier-specific. Working outside the scope of accepted standards may introduce technical problems and the risk of being tied to a proprietary technology (such as having issues with vendor lock-in). BiDi, for example, has proven its worth in existing 40G applications, but it is not available from all switch suppliers and its performance is not guaranteed by all cabling suppliers.

Unfamiliarity

Customers may not want to start patching with MPO patch cords. With protocols for duplex transmission, they may continue to use familiar duplex LC patch cords.

Cost

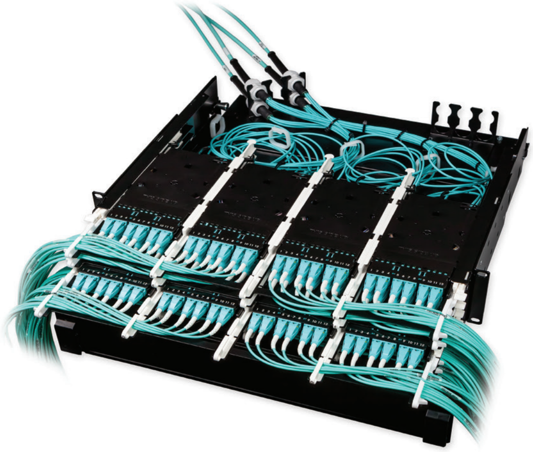
The cost of transceivers for 100G based on parallel optics has decreased significantly over the past few years. As a result, 100G is no longer that much more expensive than 40G, thus reducing the barrier to higher speeds.
Transceivers for BiDi and SWDM for a cable infrastructure based on duplex transmission were till recently proprietary and sold at a premium. Now they become more widespread and prices are expected to decline. A cost/benefit analysis is recommended.

Nexans Ultra Low Loss product offering

Data centres are evolving over time. Extensions with new cabinets in additional rows or new PoDs (Point of Delivery) are common. Also, new applications require additions or changes to the existing cabling infrastructure. A flexible and scalable solution based on Ultra High Density patch panels, together with a variety of high fibre count Pre-Terms, enables the data centre manager to overcome these challenges. Nexans ENSPACE systems combine advanced panel designs with a range of modules and Pre-Terms to tailor the solution to every project need.
The ENSPACE system consists of patch panels, trunks and modules that support both duplex and parallel transmission.
For parallel transmission ENSPACE MPO adaptor modules are used together with ENSPACE Ultra Low Loss MPO trunks. One MPO adaptor module can support up to 6 MPO connections.

For protocols based on duplex transmission like SWDM for 100G and Fibre Channel for 32G, Ultra Low Loss ENSPACE MPO-LC modules together with ENSPACE Ultra Low Loss trunks provide the required cable infrastructure. The MPO-LC modules have 12 LC adaptors with integrated shutters in front of the module and one MPO adaptor in the rear for the connection with the ENSPACE MPO trunk. This approach allows a very fast installation of a high number of ports in a data centre.

In data centres space comes at a premium. For the Ultra High Density (UHD) areas like patching zones, Nexans has developed ENSPACE UHD panels. The patch panel supports 144 LC connections or 72 ports per 'U' without compromising operational efficiency. The panels feature three individual sliding trays per 'U'. Each individual tray can be pulled forward to allow fingertip access to the patch cords and ease day-to-day operations. An innovative rear tray access facilitates the installation of the Pre-Terms with the UHD panels. The panels are available in 1U, 2U and 4U.



Server racks require less ports. The ENSPACE HD panels can have up to 96 LC connections or 48 ports. They were specifically designed for this area of the data centres.
The ENSPACE modules can be installed from the front or the rear. These additional ports can be added as and when needed without interrupting already installed connections. Moves, adds and changes for every project can be accommodated without impact on the operation of a data centre. More information on the ENSPACE range can be found on the website at

www.nexans.co.uk/ENSPACE

Ultra Low Loss achieved by Nexans ENSPACE solutions
Channel insertion loss reduced with ULL

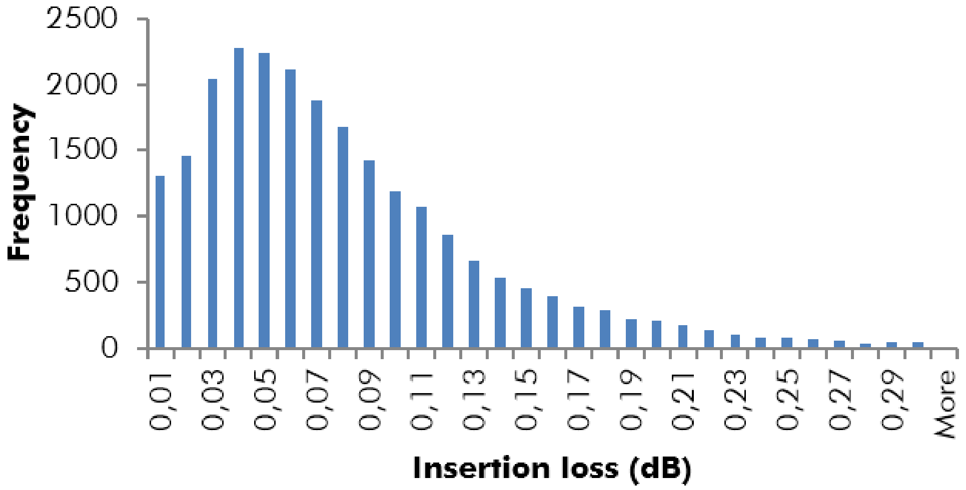
Based on years of production knowhow of MPO connectors the insertion loss for key components of the Nexans' ENSPACE range can be reduced to achieve Ultra Low Loss performance.

Specifically, the insertion loss value for an ENSPACE MPO-LC module has been reduced from 0.5dB to 0.35dB. Also, the insertion loss for MPO-connections required for parallel optics has been reduced from 0.3dB to 0.25dB.

These values are still very conservative as can be seen from the production chart on Graph 2. 80% of all measured values remain well below 0.15dB!

For very conservative calculations of the possible reach the maximum insertion loss values have been used for the 2- or 4-connection channels. The advantage is that there is, in reality, significant overhead in the channel. For a channel with 4 MPO-LC modules, for instance, the average insertion loss value will approach the typical value of 0.2dB. For each module there is 0.15dB overhead or a total of 0.6dB in this specific channel with 4 MPO-LC modules.

For a channel with 6 MPO-LC modules Nexans assumes a very conservative average value of 0.25dB (compared to the maximum of 0.35dB) leading to a connectivity insertion loss of 1.5dB in this channel.



Graph 2: : Insertion loss for multimode MPO at 850nm

Improvements for parallel optics

With the Ultra Low Loss connectivity of the ENSPACE MPO-MPO trunks and the low cable attenuation of 3.0dB/km at 850nm reach can now be define for 2, 4 and 6 connection models. For a 2-connection model, for instance, the IEEE reach of 100m has been extended to 120m using Nexans advanced solutions. 110m in a 6-connection model is also guaranteed by Nexans.

Improvements for SWDM and BiDi

The SWDM MSA gives a maximum distance of 100m supported on OM4 with a maximum insertion loss for LC connectivity of 1.5dB. With the ENSPACE Ultra Low Loss modules the insertion loss for connectivity is always well below 1.5dB up to 6 modules in a channel. Hence the 100m reach of SWDM is well supported, even with significant headroom.

For BiDi the channel insertion loss is defined as 1.9dB. With a low cable attenuation of 3.0dB/km the insertion loss available for connectivity is 1.6dB. As explained above, the connectivity insertion loss with ULL is always well below 1.5dB. Hence BiDi can be supported with a reach of 100m on OM4 with 6 modules in a channel.

Improvements for Fibre Channel

With ENSPACE ULL modules, 32G Fibre Channel in a 2 module can be supported up to 120m. With 6 modules 32G Fibre Channel is guaranteed to 100m.

Parallel optics			
number of MPO connections	2	4	6
100GBASE-SR4	120m	110m	105m
Duplex transmission			
number of MPO-LC modules	2	4	6
100G SWDM	100m	100m	100m
100G BiDi	100m	100m	100m
32G Fibre Channel	120m	105m	100m

Table 2: reach for various advanced protocols

Conclusion

The increased need for more complex configurations and extended reach, combined with the reduction in optical budget for the advanced protocols for the next generation of data centres, result in a marked need for Ultra Low Loss connectivity solutions.

By designing and building cabling networks with Ultra Low Loss components, the Enterprise data centre manager improves their ability to take advantage of a wide variety of future protocols. This allows them the flexibility to move from duplex to parallel transmission schemes, to manage multiple patching locations, and/or to support extended reaches.

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