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OIF 800ZR Interoperability White Paper
OFC 2025 Plugfest

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ABSTRACT: This paper presents the methodology and results of an interoperability study of 800ZR transceivers conducted during an OFC 2025 plugfest. Eight different transceivers were cross-connected in a matrix of transmitter-to-receiver combinations using a noise-loaded link to characterize the penalties associated with interoperability between suppliers. Individual transceiver performance was tested using 1x800GE, 2x 400GE and 8x100GE traffic over a shortened optical line system link with a DWDM 150 GHz fixed channel grid.

1   Introduction

The Optical Internetworking Forum (OIF) is serving the industry by driving the electrical, optical, and management interfaces that enable efficient and reliable optical networks. The OIF continues to play a key role in the standardization of coherent optics at the physical layer. The 800ZR implementation agreement (IA), OIF-800ZR IA, is one of the latest achievements that helps the industry to build 800 Gbps optical network ecosystems. For this industry exhibition, we focused on the 800ZR application. The specification aim to enable interoperable 800 Gbps solutions using dual-polarization (DP) 16-QAM coherent optical modulation and 118 Gbaud with a forward error correction (FEC) solution based on oFEC which improves OSNR sensitivity. The OIF-800ZR IA defines the structure of the Open FEC (O-FEC) and the 800ZR uses the structure of the open source system for higher performance. Previous OIF 400ZR interoperability white papers demonstrate a healthy 400ZR ecosystem with multiple vendors. This white paper follows the same approach for the 800ZR application.

To continue supporting the industry needs, the OIF conducts these plugfests to provide quantified measurements on the quality of the links between different coherent pluggable modules. We use the required optical signal to noise ratio (rOSNR) of the receiver as a performance metric.

In this white paper, we document results from multiple 800ZR QSFP-DD and OSFP modules using different Ethernet traffic. The goal of the event was to provide network operators insight into the 800ZR application following the same test methods previously applied to the OIF-400ZR application.

2   Test Setup

The test setups utilized a combination of optical network equipment from different vendors. The test setups cover one configuration: the noise loaded short link, was configured into a host router interface measuring the interoperability performance using an optical switch.

The noise loaded short link test setup is displayed in Figure 1 (module interop). The test configuration utilizes a reduced set of OLS equipment similar to the previous OIF interoperability tests, noted in the OIF ECOC 2023 White paper. The OLS elements, provided by Cisco, ensured a 75 GHz channel was received by the module. The test equipment was provided by EXFO noted below.

The Figure 1 use the EXFO LTB-8 mainframe and the EXFO DCO BERT application to generate and evaluated 800 Gbps traffic. During the interoperability tests, an EXFO 8x8 low-loss optical switch was introduced to speed up the testing process. The optical switch was located between the EXFO host LTB-8 mainframe, and the noise loaded short link as labeled in Figure 1. Additionally, EXFO provided fiber inspection probes and cleaning equipment to ensure clean fiber connections between the module and optical links.

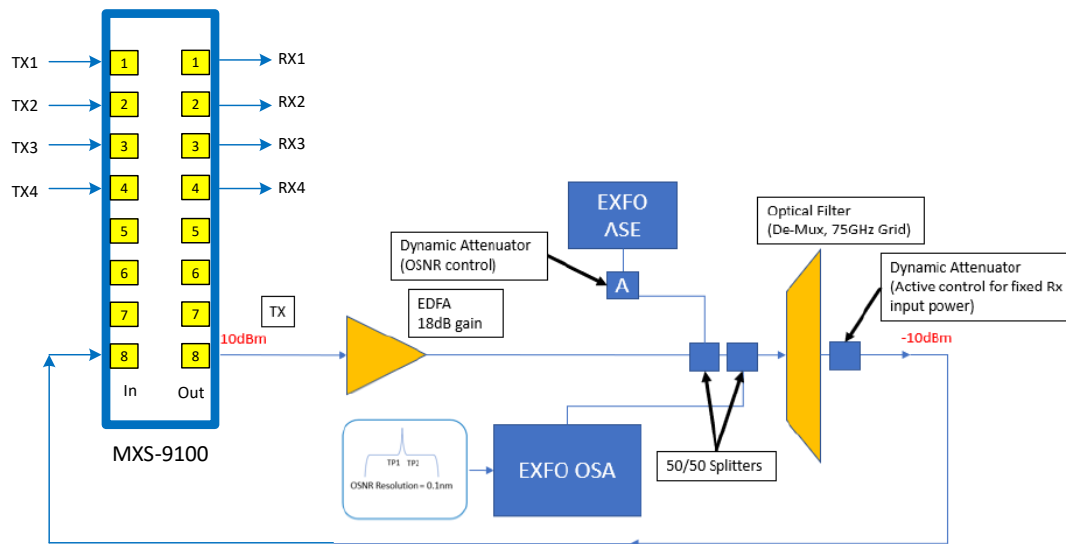These test investigations were conducted during an OIF plugfest hosted by Keysight, Santa Clara CA.

Figure 1 800ZR plugfest test setup for the noise loaded short link for the rOSNR interop test.

3   Test Procedure

The OIF plugfest compared the performance of different 800ZR modules. In all test setups the modules were configured to the same setting by the tester or router using the CMIS registers. All modules were configured into an 800ZR Application with the 800GE client interface or 800G breakout interfaces, tuned to optical channel 27 (193.775 THz), and set Tx output power to -2 dBm.

EXFO's end-to-end automation transceiver validation test tool was used to optimize the testing using a test matrix designed for multi transceiver testing.
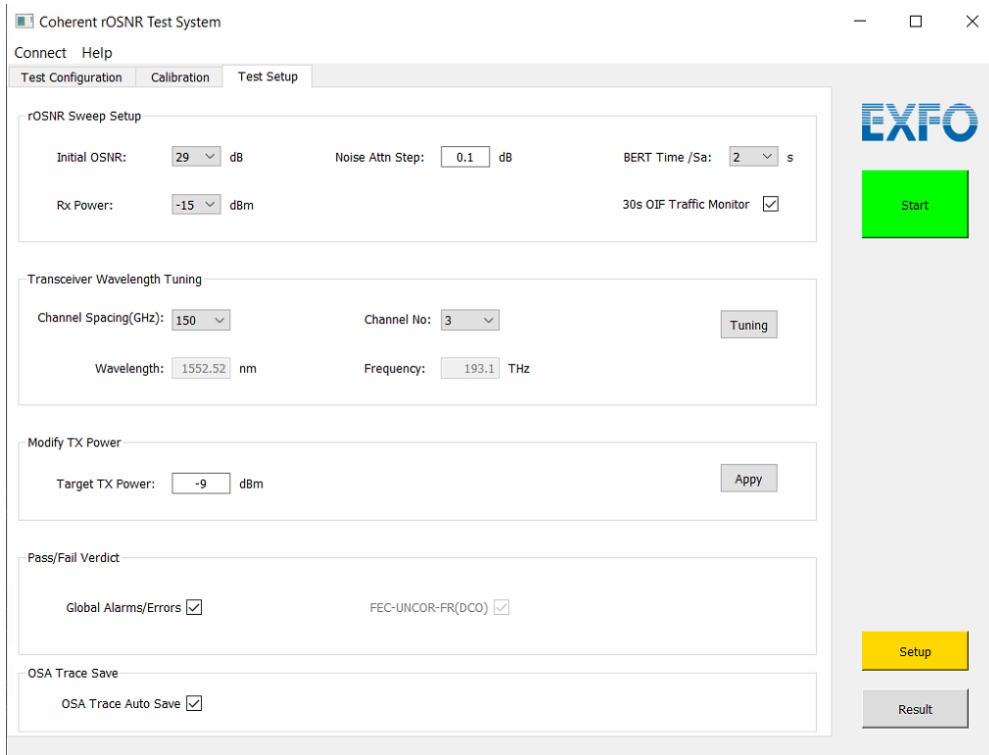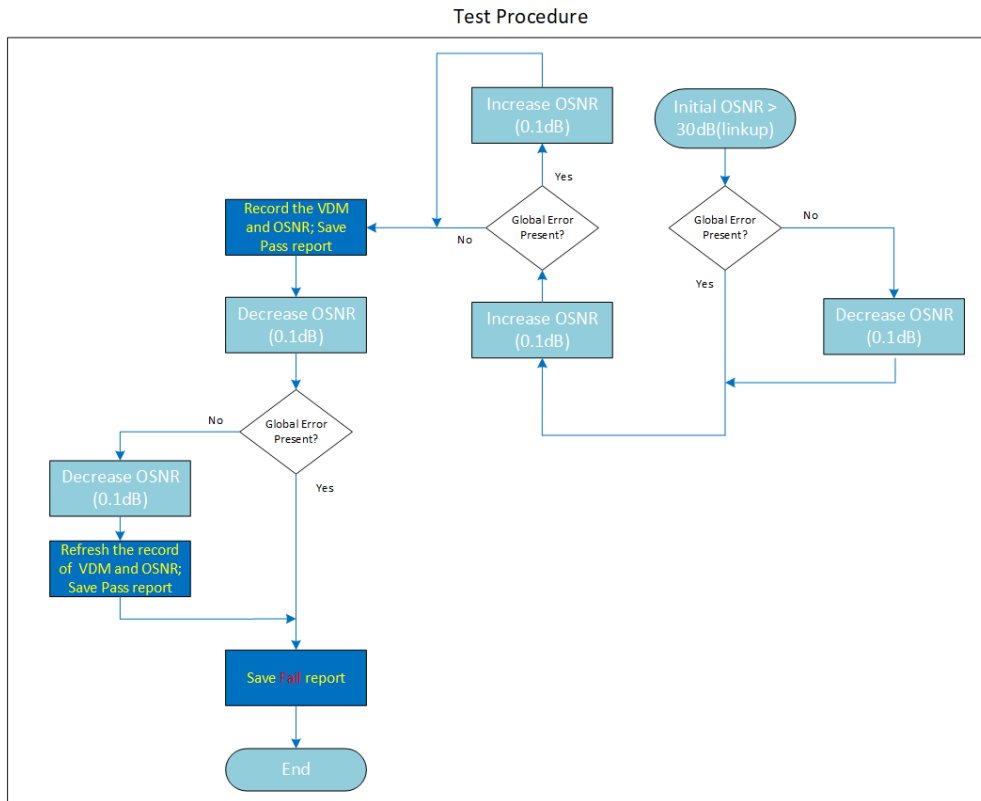
Figure 2 800ZR Test Procedure and Configuration.

One of the first tests is the loopback performance. This test is used to establish that each transceiver can operate adequately and set a performance reference level based on the shortest link. All the 800ZR modules were tested one at a time. First, all of the fibers connecting to the modules and the test setup were inspected with an EXFO fiber inspection probe (EXFO's FIP-500) and cleaned if the FIP test failed. The Tx of the DUT module was connected to the input of the short link (input of the EDFA). The Rx of the DUT module was connected to the output of the short linked (the dynamic controlled attenuator). Next the link was configured to have a high OSNR (>30 dB) to ensure the 800ZR loopback link was established. At this point the *rOSNR test process* began, which is defined in previous OIF 400ZR Interoperability papers. The traffic soak period for each measurement was 30 seconds and the noise steps were incremented by 0.1dB. After the *rOSNR test process* a *validation step* was taken to ensure "error free" traffic at a certain OSNR level. The *validation step* is the same process that was defined in previous OIF 400ZR Interoperability white papers.
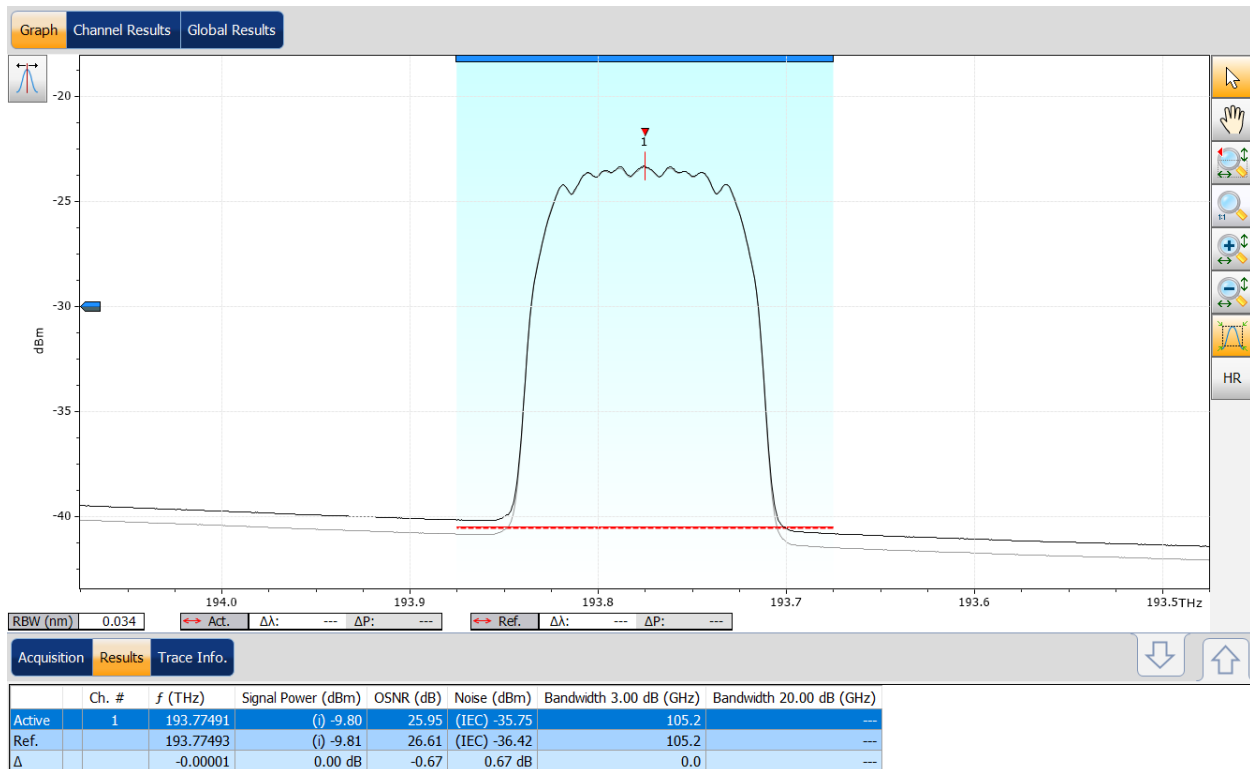
Figure 3 Representative 800ZR Spectrum.

The rOSNR was measured with a FTBx-5255 spectrum analyzer; The noise floor was measured at 100GHz on both sides of the central wavelength and the noise normalized at 0.1nm, the analysis of the OSA automatically integrated the signal on the channel width and subtract the noise from the measurement.

On the spectrum measurement example you will notice 2 traces, the rOSNR measured with uncorrected bit errors and the one in light gray showing the rOSNR measurement without uncorrectable bit errors.

A mix of eight QSFP-DD and OSFP 800ZR modules were tested at one time, the EXFO tester was capable of hosting seven modules, the remainder were tested in the second rotation phase. Again, all fiber connecting to the seven modules were cleaned and inspected following the same steps as the first test. With the introduction of the optical switch (EXFO's MXS-9100), all seven modules remained in the same configuration throughout the rOSNR interop test. First the loopback performance was tested by configuring the optical switch to allow one input/output (I/O) port from the Tx/Rx of one module to maintain a link with the noise loaded short link setup. Note, the return signal (to complete the 800ZR link) was routed through the optical switch I/O ports from the receiving DUT module to the transmitting DUT module, bypassing the noise loaded short link. Next the short link was configured to have a high OSNR (>30 dB) to ensure the 800ZR link was established. At this point the same exact *rOSNR test process* and *validation steps* were performed. At the end of the data collection, the optical switch was reconfigured to allow a new I/O port (and a new DUT module) to establish a link with the noise loaded short link setup. This process was repeated until all eight DUT modules loopback performance was tested.

Next the rOSNR interop performance was measured between each Tx and Rx combination. The DUT modules would continue to remain in the same configuration. The optical switch was configured to pair Tx and Rx from different DUT modules. The optical switch enabled the Tx from one DUT module to connect into the input of noise loaded short link through the I/O ports. The output signal from the noise loaded short link was configured into the Rx of another DUT module through the I/O ports. Again, the return signal (to complete the 800ZR link) was routed through the optical switch I/O ports from the receiving DUT module to the transmitting DUT module, bypassing the noise loaded short link. Next the noise loaded short link was configured to have a high OSNR (>30 dB) to ensure the 800ZR short link was established. At this point the same exact *rOSNR test process* and *validation steps* were performed as the first test and loopback test. At the end of the data collection, the optical switch was reconfigured to connect a new pair of DUT modules until all Tx-to-Rx combinations were tested.

After the loopback, all interop combinations were tested, completing and capturing all data points.

4   Test Data

We are presenting two parameters of our test data: rOSNR interop threshold, rOSNR self-loopback threshold. The letter code assignment for each vendor remains the same in both data sets.

Table 1 displays the self-loopback rOSNR threshold results tested over the link. The data set includes the CMIS reported OSNR value from the transceiver and the OSA measured OSNR value after the 30 second period of error-free traffic. The delta is the difference between the two values. Almost all loopback rOSNR threshold measurements met the 800ZR Rx OSNR tolerance requirement of ≤27 dB/0.1 nm., with the exception of two transceivers. The delta between the reported value and the OSA measured value shows little variation. Table 1 indicates that the variations in self-loopback rOSNR threshold are insignificant suggesting the router is a viable host platform network uses to simulate real applications.

Table 1 800ZR self-loopback rOSNR comparison between the transceiver VDM OSNR and OSA. Not Reported (NR).

Vendor	Transceiver VDM loopback	EXFO OSA (dB)	Delta (dB)
K	25.7	25.1	-0.6
L	26.0	25.5	-0.5
M	26.1	25.9	-0.2
N	26.0	26.1	0.1
O	26.6	26.3	-0.4
P	NR	26.7	N/A
Q	27.6	27.2	-0.4
R	NR	27.7	N/A

Table 2 displays the interop rOSNR threshold for each Tx paired with each Rx from the test. The data in Table 2 was measured by the OSA after the 30 second period of error-free traffic. The highlighted cells are the self-loopback test results from each vendor. The data shows variation in the loopback performance and interop performance. Just like the first test, all loopback rOSNR threshold measurements meet the 800ZR Rx OSNR tolerance requirement of ≤27 dB/0.1 nm following the OIF reference 6.1.330 conditions and comments. However, two Tx-to-Rx pairs exceeded the rOSNR tolerance limit with values ranging from 27.21 dB to 27.72 dB. Two test points were incomplete during the OIF plugfest because the Tx-to-Rx combination failed to establish an 800ZR link.

Table 2 800ZR Interop rOSNR

EXFO OSA 193.775 THz		Tx							
		Vendor K	Vendor L	Vendor M	Vendor N	Vendor O	Vendor P	Vendor Q	Vendor R
	K	25.08	26.13	25.47	26.54	25.51	25.45	27.18	27.51
	L	26.01	25.51	28.79	30.40	27.85		26.14	26.40
	M	25.51	26.25	25.92	26.77	25.63	25.75	27.29	27.70
Rx	N	25.95	26.59	26.48	26.05	26.07	26.21	25.83	26.61
	O	25.70	26.09	26.09	25.84	26.25	26.15	27.45	27.99
	P	26.03		26.56	27.18	26.20	26.74	27.91	28.21
	Q	25.40	25.69	26.05	25.52	25.51	25.62	27.21	25.99
	R	25.76	26.76	26.05	25.75	26.04	26.15	27.89	27.72

5   Summary

The OIF 800ZR OSFP and QSFP-DD plugfest quantitatively demonstrates that all eight vendors can operate 800 Gbps traffic over a DWDM optical line system as defined in the 800ZR implementation agreement.

The tests were once again limited in the time (traffic soak periods), but the results provide network operators guidance to perform their own in-depth evaluation. There was an observable difference in rOSNR performance between different combinations of 800ZR modules and three Tx-to-Rx combinations required further debugging for a successful link, suggesting additional testing is needed. Similar to the 400ZR Application, the OSNR value reported by the module can be used for basic guidance, but it is still recommended to use a high resolution OSA when measuring rOSNR. The addition of automation test tool and the 8x8 optical switch into the test setup provided an option to speed-up testing of multiple modules by allowing modules to stay in a pre-configured ready state, reducing the re-configuration commands, and removing the module initialization time. Test groups must be pre-planned to take advantage of the optical switch.

This plugfest and subsequent demonstration further explores the coherent pluggable ecosystem that includes the 400ZR and the 800ZR applications. However, during this interop investigation there were significant complications during the tests, including interop links that required additional debugging and two missing transmitter measurements. While the OIF community strives to test and demonstrate pluggable interoperability, these tests suggest more work is needed.

6   References:

OIF, "OIF-800ZR-01.0 – Implementation Agreement 800ZR", created and approved October 8, 2024

 OIF, "400ZR+ Interoperability Demo ECOC 2023"

OIF, "400ZR Interoperability White Paper OFC 2023 Plugfest"

OIF, "OIF Update! Defining 800ZR, 800LR, and Random 400ZR Information"

OIF, "400ZR Interoperability White Paper ECOC 2022 Plugfest"

OIF, "400ZR Interoperability Demo", presented at ECOC 2022 September 19-21 Basel, Switzerland

EXFO, "Defective or functional? Why transceiver validation is important for sustainable data centers"

SNIA, "SFF-8024 Module Management Reference Code Tables"

7   Appendix A: List of Contributors

Accelink - Hang Xie and Xiao Li - 800ZR OSFP

Ciena - Gary Wang - WaveLogic 5 Nano 100G-400G Universal QSFP-DD

Cisco - Tuan Tran and Doug Cattarusa - 400G 800ZR QSFP-DD, NCS 1001 DWDM Line System, NCS 1001 Mux/Demux Patch Panel

Coherent - Abdi Zolfaghari and Vera Koleva- 400G 800ZR QSFP-DD-DCO

EXFO - Jean-Marie Vilain, Gwenn Amice - Transmission & Optical Test Bench:
- 2x LTB-8 Mainframe
- 4x FTBx-88801 hosting QSFP-DD/OSFP 800G dual port with DCO BERT Application
- MXS-9100, 8x8 optical matrix switch
- FTBx-5255 optical spectrum analyzer
- 2x FTBx-3500-BI variable attenuator with embedded power monitoring
- 1x FTBx-9600-01-02-50E-EI utility module with integrated optical couplers and splitters
- 1x FTBx-9600-01-02-10S utility module with integrated optical couplers and splitters
- AEDFA-NS2380 ASE source
- FTBx-1750-031-4, high performance power meter
- FIP-430P/FIP-500 Fiber inspection probe

HG Genuine - Bing Xu or Sophie Feng – 800ZR QSFP-DD

Hisense - Oliver Huang - QSFP-DD 800ZR

Infinera Zulfikar Morbi - 800ZR OSFP
Juniper Networks - Jose Aris Dimabuyu (JAD) – QSFP-DD 800ZR

Marvell - Chris Wong- 800ZR QSFP-DD

Precision Optical Technologies - Pol Torres Compta – 800ZR QSFP-DD

8   Appendix B: Glossary

800ZR - Digital Coherent Optical physical interface defined in the OIF-800ZR implementation agreement

800GE – 800 Gigabit Ethernet defined by IEEE 802.3

ASE - Amplified spontaneous emission

BERT - Bit Error Rate Tester

C-FEC - Concatenated Forward Error Correction

O-FEC - Open Source Forward Error Correction

CMIS - Common Management Interface Specification

DP-16QAM – Dual Polarization 16 state Quadrature Amplitude Modulation

DUT – Device under test

DWDM - Dense Wavelength-Division Multiplexing

EDFA - Erbium-Doped Fiber Amplifier

EVM - Error Vector Magnitude

FEC (post-FEC) - Forward Error Correction (after the Forward Error Correction process)

Gbps - Gigabit per second

IA - Implementation Agreement

OSA - Optical Spectrum Analyzer

OSNR - Optical Signal to Noise Ratio

QSFP-DD - Quad Small Form Factor Pluggable Double Density

rOSNR - required OSNR

Rx – Receiver

Tx – Transmitter

VDM - Versatile Diagnostic Monitoring

9   Authors (both from EXFO)

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About the OIF:

For more than 25 years, OIF has accelerated progressive transformation in optical networking by serving as the only global industry forum driving the electrical, optical and control interoperability that enables a more efficient and reliable network. Its active member ecosystem collaborates through a transparent and fast-paced process to develop, validate and publish Implementation Agreements (IAs) and technical white papers that are critical to accelerating market adoption of optical networking technologies.

Based on established methodologies including the documentation of industry requirements, bringing forward member-driven technical solutions, validation testing and free publishing, OIF's interoperability solutions are vital to the global network.

With more than 160 member companies spanning component suppliers to network operators, OIF members strive to identify the industry's needs and requirements and rapidly develop solutions that directly impact and facilitate global connectivity in the open network world.

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