White paper

800G OpenZR+

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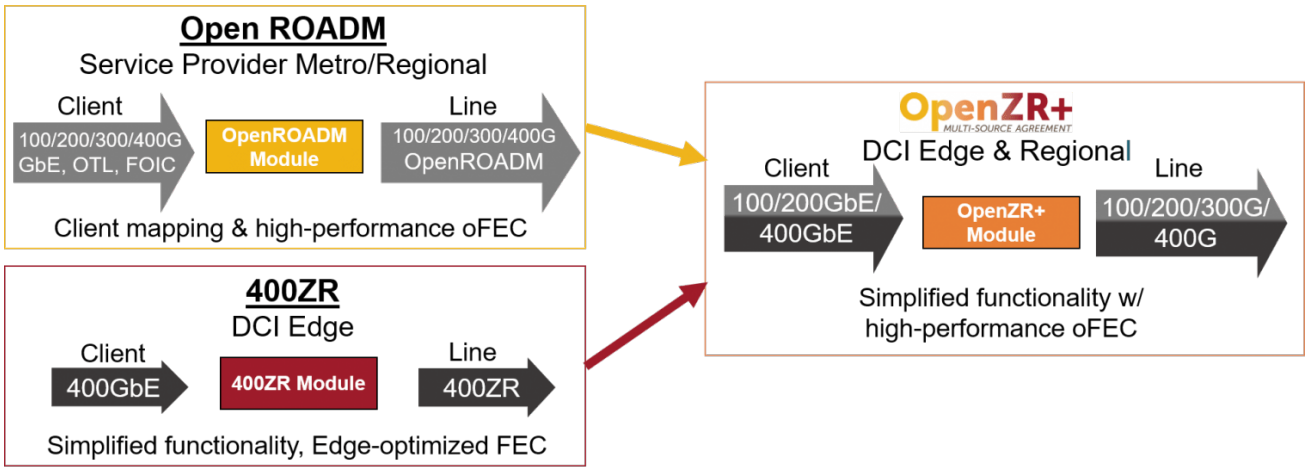
1. Introduction

Several years ago, hyperscale network operators saw an opportunity for coherent Dense Wavelength Division Multiplexing (DWDM) transport optics to plug directly into routers for 400 Gbps Data Center Interconnections (DCIs) with reaches up to 120km. This point-to-point, IP-over-DWDM architecture would eliminate the need for external optical transmission systems thus saving capital and operating expenses.

The Optical Internetworking Forum (OIF) started the 400ZR project in 2016 to standardize interoperable coherent interfaces with power consumption/dissipation to support small form-factors, such as QSFP-DD and OSFP, to plug into routers. Targeting a module power consumption/dissipation of 15 Watts, OIF standardized on the minimum features and performance to achieve the specific DCI use-case. The 400ZR standard was completed in 2020, vendors demonstrated interoperability to this standard, and the 400ZR solution was deployed in hyperscale DCI networks.

In parallel, system vendors demonstrated that improved thermal performance could be achieved for these small form-factors, which allowed digital signal processors (DSP) and module vendors to support additional functionality and higher performance. Building on the success of OIF, other standards bodies, such as Open ROADM, defined standards for applications beyond DCI that included additional features and higher performance. Open ROADM was defined for OTN-based networks that require support for additional protocols that can increase the ratio of overhead bits.

The OpenZR+ Multi-Source Agreement (MSA) defined interoperability specifications that expanded the applications for 400G coherent optical transceivers in small form-factor pluggable modules for longer-reach IP-over-DWDM links. 400G OpenZR+ was a combination of the OIF 400ZR and Open ROADM 400G industry standardization efforts:



Specifically, 400G OpenZR+ combined the focus on ethernet traffic, higher performance, and multi-vendor interoperability to provide network operators with an operationally efficient solution for DCI and service provider applications with support for regional and long-haul reaches. Now the industry is looking to the OpenZR+ MSA group for guidance addressing similar applications with 800G coherent optical transceivers in small form-factor pluggable modules.

2. Other 800G Standardization Efforts

OIF released OIF-800ZR-01.0, Implementation Agreement for 800ZR Coherent Interfaces, in October 2024 which defined a single-wavelength 800G coherent line interface and frame format for single-span, amplified, 80-120km, point-to-point, DWDM noise-limited links (e.g. DCI applications). The agreement specified client interfaces of 100GE, 200GE, 400GE and 800GE, and that the coherent line interface used OFEC for forward error correction and dual-polarization 16QAM (DP-16QAM) modulation.

The Open ROADM MSA group released version 6.0 of the W-Port Digital Specification and the optical specification in December 2023 which extended OIF 800ZR specifications for use in metro and optical switched network applications. Eight FlexO-x(e)-D[P]O information structures are defined where x = [4, 6, 8] represents 400G, 600G, and 800G respectively, (e) stands for ethernet optimized payloads, and [P] defines interoperable Probabilistic Constellation Shaped (PCS) modulations. The shaped modulations are defined over 16QAM constellation points. Ethernet payloads are GMP mapped directly into 100G FlexO slices then 128-bit interleaved to a FlexO-xe.

In April 2024, Open ROADM optical specification version 7.00 was released which added specifications for out-of-band control of remote transponders. In March 2025, version 8.00 of the optical specification was released which added specifications for Transceiver Direct Attach (TDA) application.

3. 800G OpenZR+

As previously stated, the purpose of the OpenZR+ MSA group is to drive interoperability specifications that expand the applications for coherent optical transceivers in small form-factor pluggable modules for longer-reach IP-over-DWDM links. The group reviewed both the OIF 800ZR implementation agreement, the Open ROADM 800G W-Port Digital Specification, and the Open ROADM 800G optical interface specification, and found a subset of these specifications address the purpose of OpenZR+. Instead of creating a new specification for 800G OpenZR+ which duplicates these specifications, this white paper points to parts of these specifications that apply for 800G OpenZR+.

The following industry specifications address 800G OpenZR+ applications:

- From the Open ROADM optical interface specification, the following operational modes and associated optical specifications:

Open ROADM Operational Mode	PCS	Line Side Framing	Frame to Lane Adaptation	SM Media Interface (SFF-8024)		
				Spec Reference	ID	ID (Hex)
OR-W-800G-oFEC-118Gbd	No	FlexO-8e-DO	FOIC8.8 [DP-16QAM]	FLEXO-8e-DO-16QAM/FOIC8e.8-DO	102	66
OR-W-400G-oFEC-118Gbd	No	FlexO-4e-DO	FOIC4.8 [DP-QPSK]	FLEXO-4e-DO-QPSK/FOIC4e.4-DO	100	64
OR-W-600G-oFEC-118Gbd	Yes	FlexO-6e-DPO		FLEXO-6e-DPO-16QAM/FOIC6e-DPO	106	6A
OR-W-800G-oFEC-131GbdE	Yes	FlexO-8e-DPO		FLEXO-8e-DPO-16QAM/FOIC8e.8-DPO	104	68
OR-W-800G-oFEC-118Gbd_type3	No	FlexO-8e-DO	FOIC8.8 [DP-16QAM]	FLEXO-8e-DO-16QAM/FOIC8e.8-DO	102	66
OR-W-400G-oFEC-118Gbd_type3	No	FlexO-4e-DO	FOIC4.8 [DP-QPSK]	FLEXO-4e-DO-QPSK/FOIC4e.4-DO	100	64
OR-W-600G-oFEC-118Gbd_type3	Yes	FlexO-6e-DPO		FLEXO-6e-DPO-16QAM/FOIC6e-DPO	106	6A
OR-W-800G-oFEC-131GbdE_type3	Yes	FlexO-8e-DPO		FLEXO-8e-DPO-16QAM/FOIC8e.8-DPO	104	68

- From OIF 800ZR, the following host/client electrical interfaces:

		Instances by Operational Mode Data Rate		
Client Type	Chip-to-Module interface	800G	600G	400G
100GBASE-R	100GAUI-1	8x	6x	4x
200GBASE-R	200GAUI-2	4x	3x	2x
400GBASE-R	400GAUI-4	2x	N/A	1x
800GBASE-R	800GAUI-8	1x	N/A	N/A

4. Mapping of Open ROADM Types to Network Add/Drop Structure

OpenZR+ coherent optical transceivers can be used in network architectures with either “colored” add/drop structure or “colorless” add/drop structure.

Add/drop structure “colored” refers to network architectures that use optical band-pass filters to add and drop one specific DWDM optical signal from the common fiber. With this structure, optical signals outside the targeted optical signal (out-of-band signals) are filtered from the drop path to the coherent receiver so there are no impairments due to these out-of-band signals. Add/drop structure “colorless” refers to network architectures that use optical combiners/splitters to add and drop DWDM optical signals from the common fiber. With this structure, optical signals outside the targeted optical signal (out-of-band signals) are not filtered from the drop path to the coherent receiver so impairments from these out-of-band signals can impact performance. For “colorless”, more stringent specifications are required to minimize penalties due to impairments from these out-of-band signals.

For 400G, OpenZR+ MSA revision 3.0 defined an “A” configuration for “colored” and “B” configuration for “colorless” with different specifications for the following:

- Transmitter optical output power with transmit disabled
- Transmitter total output power during wavelength switching
- Transmitter in-band (IB) OSNR
- Transmitter out-of-band (OOB) OSNR
- Receiver colorless drop OSNR penalty
- Receiver colorless drop adjacent channel crosstalk penalty at OSNR limit

The relaxed specifications for “A” configuration may enable lower-cost 400G transceiver solutions.

Open ROADM optical specification version 8.00 specifies three different types: original (blank or Type 1), Type 2 and Type 3. These types map to OpenZR+ add/drop structure as follows:

Open ROADM Type	OpenZR+ Add/Drop Structure
Original (blank or Type 1)	Colorless
Type 2	Does not map
Type 3	Colored

5. Conclusion

The advancements in 800G standardization efforts by OIF and the Open ROADM MSA group have laid a robust foundation for the development and deployment of high-capacity, coherent optical interfaces. The OIF-800ZR Implementation Agreement and the Open ROADM version 7.0 specifications provide comprehensive guidelines for 800G coherent line interfaces, ensuring compatibility and performance across various network scenarios.

The OpenZR+ MSA group's initiative to identify interoperability specifications for 800G OpenZR+ further extends the applicability of coherent optical transceivers, particularly for longer-reach IP-over-DWDM links. By leveraging existing specifications from OIF-800ZR and Open ROADM, OpenZR+ aims to streamline the development process and promote widespread adoption of 800G technology.

Additionally, the consideration of relaxed specifications for colored network architectures highlights the flexibility and adaptability of OpenZR+ coherent optical transceivers. This approach not only addresses the diverse needs of modern network infrastructures but also paves the way for cost-effective solutions in both colored and colorless add/drop structures.

In summary, the collaborative efforts in standardizing 800G technology underscore the industry's commitment to advancing optical networking capabilities, ensuring higher data rates, improved performance, and greater interoperability for future network deployments.

6. References

These were the current revisions of the referenced documents as of the publication date of this white paper:

- OIF-800ZR-01.0 (October 8, 2024)
- Open ROADM Optical Specification, Rev 8.0.1 (April 22, 2025)
- Open ROADM MSA 6.0 W B400G Port Digital Specification (400G-800G), Rev 1.0.1 (December 7, 2023)
- SFF-8024, SFF Module Management Reference Code Tables, Rev 4.13 (June x, 2025)