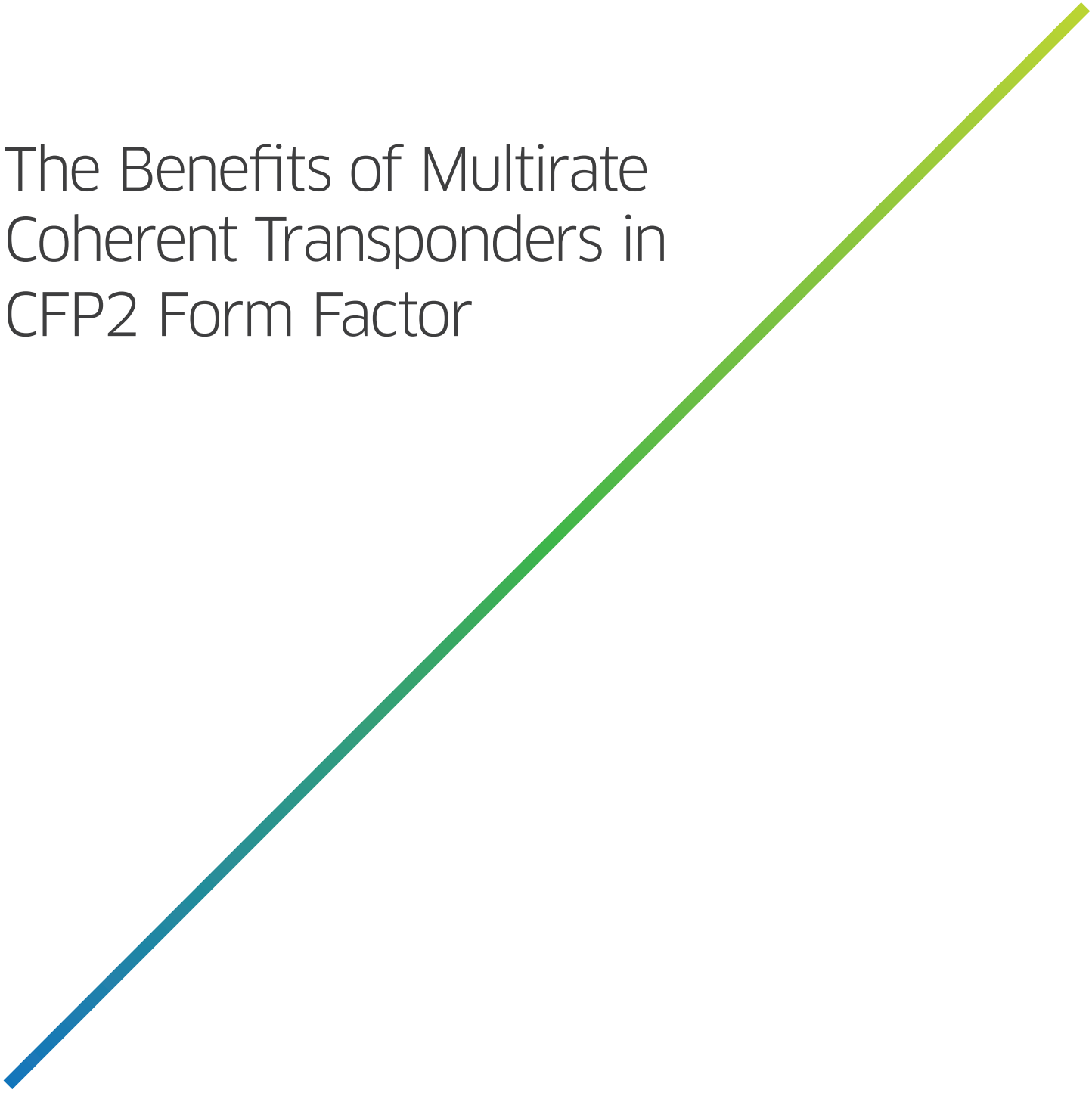
LUMENTUM

The Benefits of Multirate Coherent Transponders in CFP2 Form Factor



The exponential growth of content delivery and enterprise cloud service delivery, combined with the promise of future 5G wireless-based services for consumers, the IOT, and connected vehicles worldwide, will create unprecedented increases in network traffic across all access, edge, and core networks.

To meet the imperative need for higher capacity and providing the best user experience, the operator and product development communities must accelerate roll-out of the networks of the future. On top of providing the best performance at the lowest operating cost per bit, they also have to enable attributes such as on-demand and scalable capacity, high efficiency, and intelligence through simple, fully-configurable, and automated network elements.

On Lowest Cost per Bit, Performance, and Scalability
The last five years have seen an evolution toward optimized network topologies and link specifications for distinct uses cases. These can be grouped into two main categories:

a. **Edge Aggregation,** which includes service provider wireless backhauling, residential, and enterprise/data center aggregation applications.

Links are defined as point-to-point single span or –ZR (for short) reaches between 40 km unamplified (loss limited case) and 80 km both unamplified and amplified (OSNR limited case).

Edge aggregation platforms are predominantly edge routers and L2/L3 switch-based mux-ponder nodes requiring low complexity and scalable 100/200G coherent uplink interfaces. The new digital coherent optics (DCO) in a CFP2 form factor (CFP2-DCO) perfectly suits such applications, adding true plug-and-play and pay-as-you-grow flexibility and enabling deployments to use integrated platforms (nowadays referred to as IP over DWDM or packet and optical layers in a single platform).

It should be noted that for the unamplified case (Figure 1), the user has possibility to tradeoff between single wavelength (i.e. without the AWG multiplexers) and multiple DWDM channel transmission. For the former, the AWG loss is "reallocated" to the fiber to enable much longer reach.

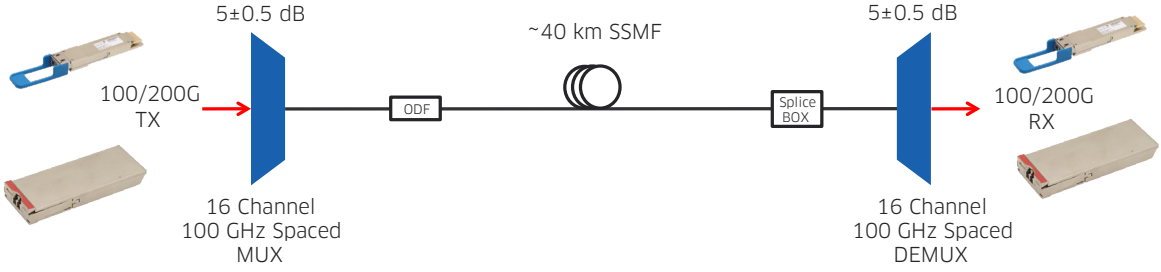


Figure 1. Example of unamplified 40 km link in an edge aggregation application (downstream direction only).

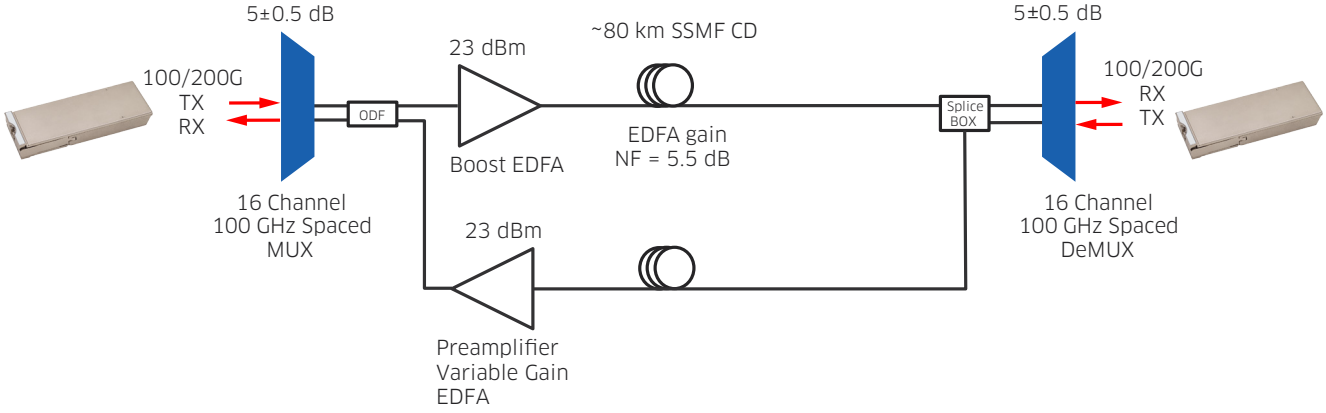


Figure 2. Amplified link described in CableLabs® Point-to-Point Coherent Optics Specifications (downstream and upstream directions)

b. **Metro and Long-Haul Transport,** which includes service provider optical transport, private cloud hyperscale data center interconnect (DCI), and the burgeoning education/research and colocation DCI applications.

In this category, transport DWDM links are amplified and can be point-to-point single span over 80 km (see Figure 3) or feature multiple spans for reaches over thousands of kilometers (both point-to-point and ring-based with ROADMs).

DCI applications include both metro and long-haul transport links, which require the highest density combined with low power and maximum performance to achieve the lowest cost per bit. Similar to edge aggregation, using pluggable modules such as the current 100/200 CFP2-DCO or 400G pluggable modules in the near future, permits the integration of the optical layer in the edge router platform instead of the more traditional segmentation where routing and DWDM/optical functions are segregated.

It should be noted that some operators have indicated their continued preference for segmentation or splitting both functions to maintain the benefits of maximizing faceplate densities, fault domain isolation, and decoupling technology roadmaps.

Service provider packet optical transport is the traditional market for coherent deployments. These predominantly use more versatile packet optical transport systems where advanced OTN/Optical layer features (switching and cross connect), high density, and carrier-grade performance are required. Even here, CFP2-DCO provides full transponder functionality in a CFP2 form and doubles front plate densities compared to the CFP-DCO (and quadruples the line card capacity when 200G transmission is enabled).

Based on the requirements of the use cases discussed, CFP2-DCO offers the most compelling mix of flexibility, performance, and low power (see Table 1).

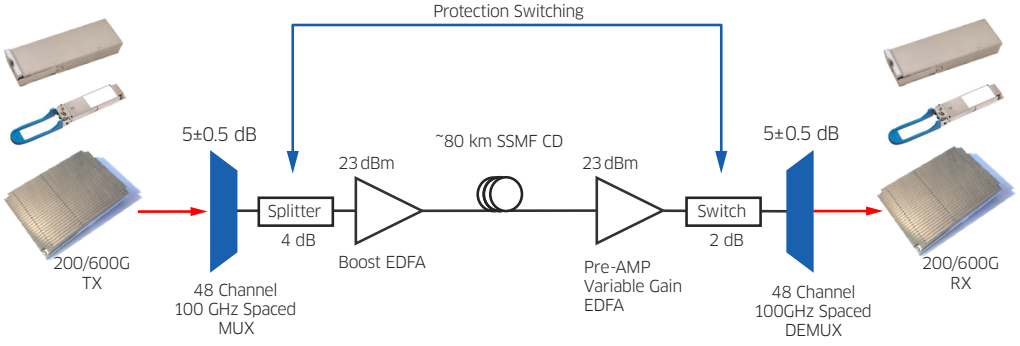


Figure 3. Example of an 80 km amplified link for metro data center interconnect (200G to 600G coherent transmission, downstream direction only).

Table 1. CFP2-DCO provides a compelling mix of flexibility, performance, and low power over many use cases. This table shows typical values for illustration purposes. Please contact Lumentum for detailed specifications and conditions.

	Condition	100G DP-QPSK Edge Aggregation	100G DP-QPSK Long Haul Transport	200G DP-8QAM Long Haul Transport	200G DP-16QAM Metro Transport
Baud rate	BER at 10^{-15} post FEC	~28 Gbaud	~31 Gbaud	~43 Gbaud	~31 Gbaud
Typical OSNR		14 dB	12 dB	18 dB	20 dB
Minimum Rx sensitivity	>35dB OSNR	-29 dBm	-30 dBm	-24 dBm	-22 dBM
FEC (Net Coding Gain/Threshold)	7% overhead	SC-FEC (9.4 dB/4.5E^{-3})	-	-	-
	15% overhead	-	SD-FEC (10.3 dB/1.45E^{-2})	SD-FEC (10.3 dB/1.45E^{-2})	SD-FEC (10.3 dB/1.45E^{-2})

The Lumentum 100/200G CFP2-DCO Transceiver
The 100/200G CFP2-DCO pluggable transceiver module is designed to enable fast integration, operational ease, low maintenance, and vendor/platform diversity. Key features include:

- State-of-the-art indium phosphide-based transmit receive optical subassembly (TROSA)
- Flex-grid support over C-band wavelengths
- The industry's lowest power and most interoperable DSP ASIC solution
- Fully compatible and interoperable with Acacia® Communications AC200

CFP2-DCO is the ideal form factor to meet the real-world requirements of many of today's edge aggregation, metro and long haul transport applications.

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North America
Toll Free: 844 810 LITE (5483)

Outside North America
Toll Free: 800 000 LITE (5483)

China
Toll Free: 400 120 LITE (5483)

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