25-Gigabit Pluggable Transceiver for Data Center Applications

Upgrading seamlessly from 10G to 25G

With exponential growth in Internet users and applications, data center traffic continues to experience explosive growth. Driven by increases in social networking, IP and video content delivery and demanding business applications are now pushing beyond the speed limits of traditional server and switch infrastructure. To meet these needs, data center (Figure 1) operators are now turning to mature, cost-effective 25G Ethernet technology, including new 25G switches and high-bandwidth servers with 25G Network Interface Cards (NIC).

Features

- IEEE standards-based 25G over MMF or SMF
- Options for operation up to 400 m over MMF or up to 10 km over SMF
- 25G and 10G dual-rate capability
- Backward compatibility with IEEE 10Gb-SR/LR and 25GbE-SR/LR
- SFP28 form factor
- Operates over duplex LC-connectorized MMF and SMF fiber infrastructure
- Enables incremental upgrade to 25G SR from 10G SR

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Cisco’s newest transceivers, including SFP-25G-SR-S, SFP-10/25G-CSR-S, and SFP-10/25G-LR-S (Figure 2) are the bridge to what’s possible by enabling optical 25G transmission in data centers.

Figure 2. Cisco transceiver modules for data center applications

Data center network architectures

Today’s next-generation data center architecture is generally implemented in either a Top-of-Rack (TOR), Middle-of-Row (MOR), or End-of-Row (EOR) configuration, with 25G between the switches and the servers and NICs (see Figure 3). The distance from the switches to a server or NIC generally ranges from half a meter to 100 meters. The 25G links are implemented with Direct-Attached Cables (DAC), Active Optical Cables (AOC) or transceivers, and Single-Mode Fiber (SMF) or Multi-Mode Fiber (MMF).

Figure 3. Data center TOR and EOR network architectures

Many data center operators choose MMF or SMF transceivers and fiber, over DACs and AOCs, because they want to simplify and future-proof the cable infrastructure (see Figure 4). Using the pluggable architect, data center operators can easily replace transceivers or upgrade TOR, MOR and EOR switches, servers, NICs, and transceivers without replacing cabling infrastructure.
The network transformation to 25G

The data center architecture is dramatically transforming. Until recently, data centers consisted largely of 1/10G servers-NICs, and 1/10/40G EOR-MOR-TOR switches such as Cisco Catalyst® switches that interface to the leaf switches to 10/40G uplink interfaces. Today, data centers are built with high-performance 10/25G servers-NICs, and 10/25/40/100G EOR-MOR-TOR switches, such as Cisco’s newest 10/25/40/100G Nexus® 9000 Series and Cisco® Nexus 3000 Series Switches that interface to the leaf using 40/100G interfaces (see Figure 5).

Forward Error Correction (FEC) for 25G transceivers

In order for data transmission to operate nearly error-free*, the IEEE 802.3by (IEEE-25G-SR) specifications and IEEE 802.3cc (IEEE-25G-LR) specifications call for Forward Error Correction (FEC) using RS-FEC (IEEE 802.3 clause 82), which can correct errors down to Bit Error Rate (BER) $5 \times 10^{-5}$. The downside is that RS-FEC adds approximately 250ns of latency, which is equivalent to approximately 50 meters of cable. Links using FC-FEC (IEEE 802.3 clause 108) can correct errors down to BER $10^{-8}$; however FEC adds 82ns of latency, which is equivalent to approximately 16 meters of cable (see Figure 6).

*Note: Higher level protocols can efficiently deal with “nearly error-free” transmission when the BER is less than $10^{-12}$
Cisco Short Reach “CSR” technology enables a low-latency data center

Low-latency may be critical for financial applications.

With advanced Cisco® Short Reach “CSR” technology, SFP-10/25G-CSR-S can be used in data centers to reduce latency by using no FEC, FC-FEC, or RS-FEC at these distances:

- None - Upto 30 m over OM3 (or Upto 50 m over OM4)
- FC-FEC - Upto 70 m over OM3 (or Upto 100 m over OM4)
- RS-FEC - Upto 300 m over OM3 (or Upto 400 m over OM4)

Usage of FC-FEC is also a valuable feature for older-generation switches and NIC cards that don’t have support for RS-FEC but still need to operate at 25 Gigabits over longer distances than available by using a DAC or AOC.

In order to achieve the transmission with FC-FEC or no FEC, an SFP-10/25G-CSR-S must be used on both ends of the link and the host needs to operate at the same FEC.

Future-proofing data centers with dual-rate 10/25G technology

To future-proof the network, the new SFP-10/25G-CSR-S and SFP-10/25G-LR-S transceivers have a dual-rate capability that allows interoperability with 10G-SR MMF transceivers* and 10G-LR SMF transceivers. This allows a data center to be incrementally upgraded at either the end of the fiber (server, NIC, or switch) with a full upgrade to 25G when the time is right (see Figure 7).

The supported distances of the SFP-10/25G-CSR-S, when used with IEEE 25G-SR, is limited to 70m over OM3 (100m over OM4).

*Note: May require a 4 dB attenuator to be fully IEEE compliant

Interoperability with 40G and 100G

In some circumstances, the TOR, MOR or EOR switch may only have Quad Small Form-Factor Pluggable (QSFP) interfaces. With the new SFP-10/25G-CSR-S, a switch can also interoperate with Cisco QSFP-40G-SR4* or Cisco QSFP-40G-SR4-S transceivers at 4x10G or with Cisco QSFP-100G-SR4-S transceivers at 4x25G using third-party MMF breakout cables that would be plugged into that switch. Conversely, the new SFP-10/25G-LR it can also interoperate with a Cisco QSFP-4x10G-LR4-S transceiver at 4x10G or with Cisco QSFP-100G-PSM4-S transceivers at 4x25G using third-party SMF breakout cables that would be plugged into the TOR, MOR, or EOR switch. For 100G interoperability, 25G requires the usage of RS-FEC, which has been standardized for 100G operation.

*Note: May require a 4 dB attenuator to be fully IEEE compliant
Platform support
Cisco 25G transceivers are supported on Cisco switches. For more details, refer to the Transceiver Module Group (TMG) Compatibility Matrix.

For more information, read the Cisco 25GBASE SFP28 Modules Data Sheet.

Figure 8. A Cisco 10/25G transceiver supports 100G and 40G breakout modes

The Cisco family of 25G transceivers for data center applications

Table 1 summarizes the full line of Cisco transceivers and cables for data center applications.

Table 1. Cisco 25G transceivers and cables for data center applications

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*Note: Depends upon fiber quality