OPTOMIND: New AOC Solution in the Rack

The data center industry is growing rapidly. Data center traffic is forecasted to exceed 25% compounded growth through 2019, according to the Cisco Global Cloud Index. The primary drivers to this growth are the continued trends toward cloud computing, migration of private data centers to third party-managed cloud servers, customer demand for more content-driven capacity on their devices, and business demand for significant big data analytics. Applications for high quality video streaming service, artificial intelligence (AI), internet of things (IoT), smart city, autonomous driving with a connected car, and higher data traffic with 5G mobile networking in coming years are drivers as well.

According to the Cisco Global Cloud Index, hyperscale data centers will grow from 338 in number at the end of 2016 to 628 by 2021 which will represent 53 percent of all installed data center servers by 2021. Traffic within hyperscale data centers will quadruple by 2021. Hyperscale data centers already account for 39 percent of total traffic within all data centers and will account for 55 percent by 2021.

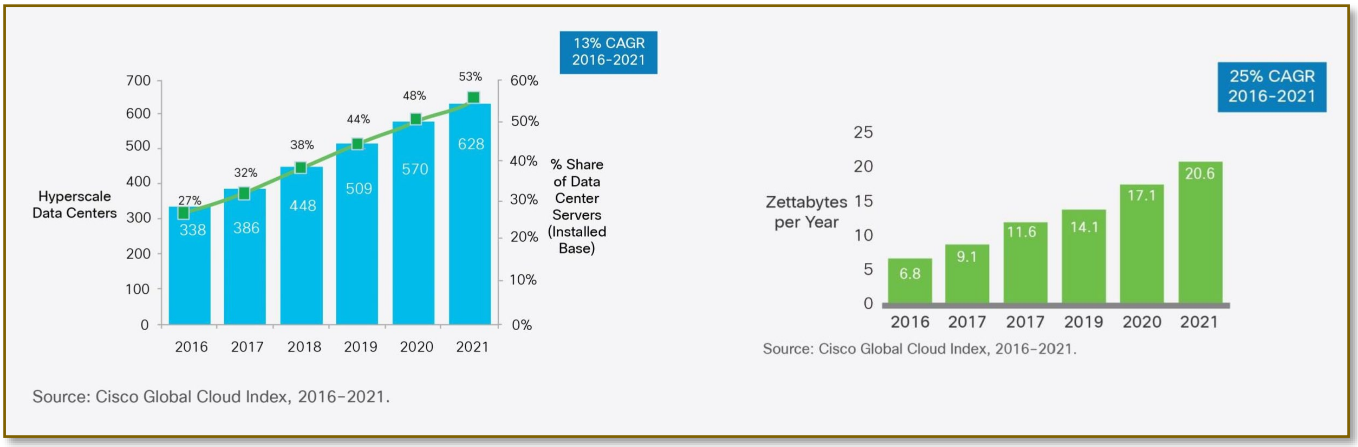

Figure 1 Global hyperscale data center growth & global data center IP traffic growth

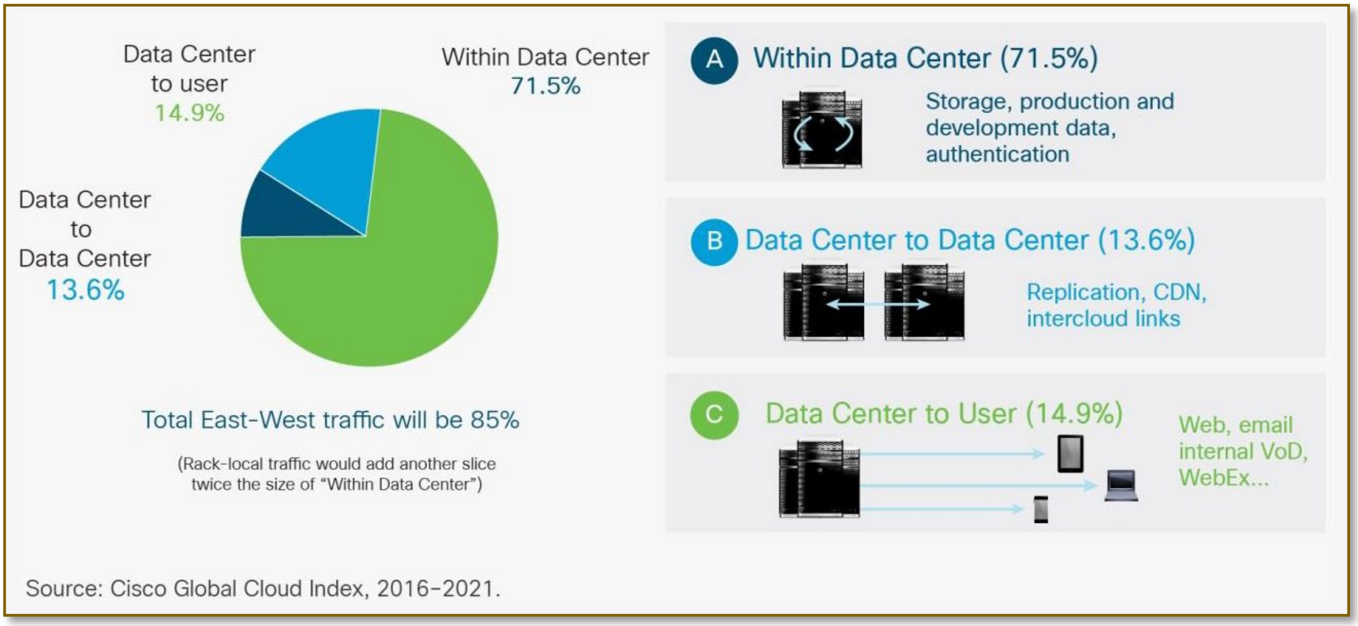

Figure 2 Global data center traffic by destination

As shown in Figure 2, the traffic within data centers will remain as a majority over the forecast period, accounting for 75.4 percent of data center traffic in 2016 and 71.5 percent by 2021. The totals for "within data center" do not include rack-local traffic (traffic that remains within a given server rack). Rack-local traffic is approximately twice the volume of "within data center" traffic indicated in the forecast. The inclusion of rack-local traffic would attribute more than 90 percent of overall traffic to "within data center".

Direct Attach Cable (DAC)

A DAC is the most popular data cable – the most cost-effective solution with high volume available to connect within the rack-local traffic. It uses just two wires and a shield to transmit high speed data per direction. At higher signal rates, the wire needs to be thicker and includes more EMI shielding to travel longer distances which makes the DAC shorter and difficult to bend.

At high signal rates e.g. 25 Gbps (the typical data rate in switch and server networks), the wires cannot perform as a transmission medium beyond 3 m. DAC requires equalization to transmit 25 Gbps signals without error for a short reach, and may need to use forward error correction (FEC) circuits to handle significant amounts of errors. However, the use of FEC adds about 100 ns delays, and these delays are critical for server traffics requiring the most frequent data transmissions — high performance computing (HPC) and hyper scale Ethernet data center networks. To operate data center effectively, the latency delay should be minimized to avoid congestion.

High speed data signals can be measured by eye diagrams to visualize signal quality and jitter.

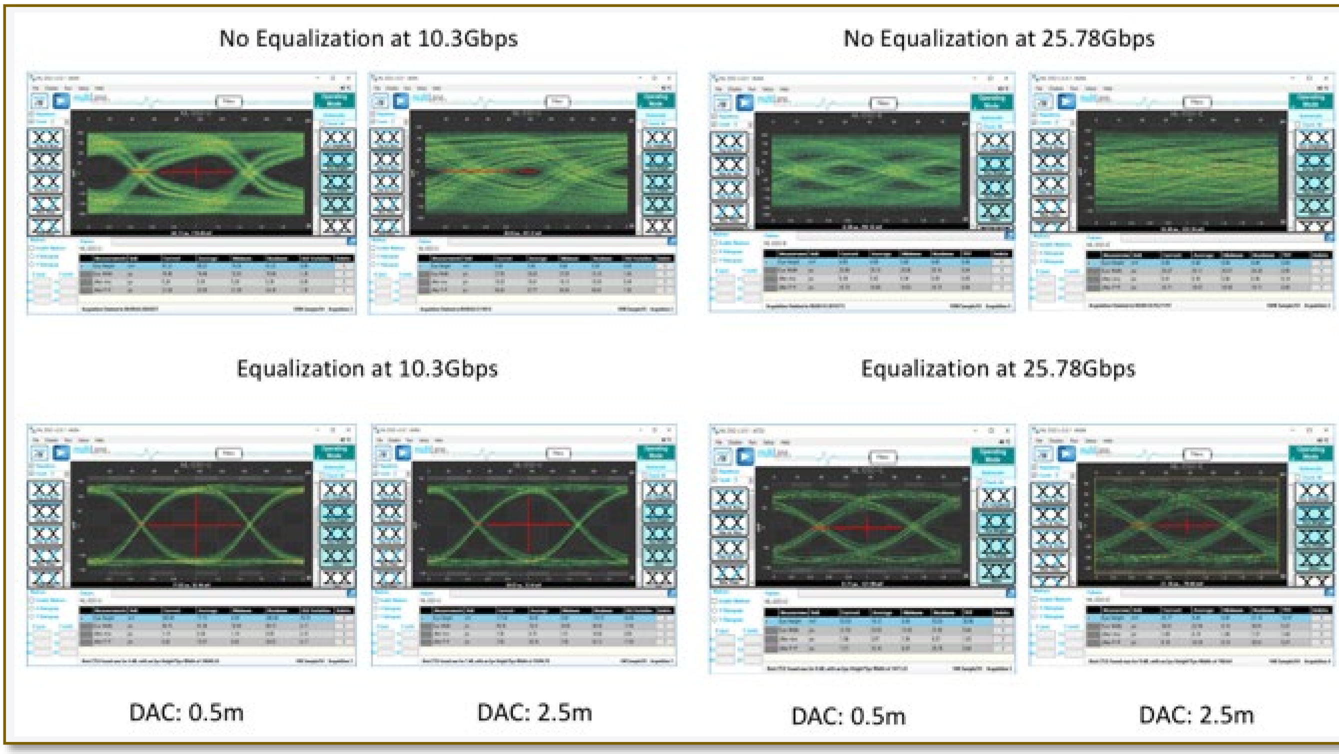

Figure 3 DAC eye diagrams at 10.3 Gbps and 25.78 Gbps for 0.5m and 2.5m with and without equalization

A tier 1 grade 25 Gbps DAC was used to measure eye diagrams at 10.3 Gbps and 25.78 Gbps for 0.5 m and 2.5 m with and without equalization to analyze the signal quality, respectively. Equalization may be necessary to get a good eye shape at 10.3 Gbps. The amplitude of the signal for 2.5 m DAC reduced to 50% and 20% of 0.5 m DAC at 10.3 Gbps and 25.78 Gbps, respectively. The signal integrity of 2.5 m DAC at 25.78 Gbps was much weaker than that of 0.5 m DAC. 2.5 m DAC showed a significant bit error ratio (BER) at 25.78 Gbps and required the use of forward error correction (FEC) to correct its transmission.

Active Optical Cable (AOC) in Hyperscale Data Center

Traditional telecom optical transceivers are fixed to network ports to secure electrical connection firmly, but this has a drawback in the case of repair or replacement. Small form factor pluggable (SFP) optical transceivers, which are connectorized in electrical connection as well as optical connection, are becoming more pervasive in data center network. SFP makes data center maintenance easy and convenient. DAC is a copper wire cable with SFP interface at both ends, and it is the most popular choice for efficient operations of data centers owing to its easy installation and maintenance for short ranges e.g., top of rack (TOR) applications.

AOC is a solution which combines both the DAC and SFP optical transceiver by embedding the optical fiber within itself, minimizing the optical link overhead and avoiding handling of the optical connector, – the main source of optical transceiver failure during its installation and replacement.

In the past, manufacture of conventional AOC was not cost-effective due to its vestigial origins as an optical transceiver. One example is an optical ferrule which is required to mate the optical fiber to the module. The optical ferrule is a key component connecting the optical module and the optical fiber. Most AOC designs have evolved from the optical transceiver coupled to the optical connector and positioned the optical connector within SFP body to have it fixated firmly during the assembly. Such designs cannot achieve ultra high-volume manufacturing at low cost in hyper scale data center application for short reach, and thus they cannot deliver AOC as a viable alternative to DAC. Directly attaching optical fiber during the assembly may overcome this shortcoming, but it requires a new optical engine design.

Optomind's optical engine design is intended for high-volume manufacturing to support hyperscale data centers at acceptable costs. Optomind's optical engine attaches optical fiber to the module directly instead of using any type of optical ferrule. This design can adopt optical fibers with glass and plastic without any complications. Its optical module is alignment-free and does not require any high precision equipment or skilled operators.

This revolutionary optical module design provides high misalignment tolerance to the positioning of optical devices, multiple lenses and prism optics through a single sophisticated plastic injection mold. Furthermore, this mold delivers a fiber guide without the optical ferrule, and encapsulation packaging which protects both the chipset and the optical devices.

Advantages of AOCs Compared to DACs or Optical Transceivers

AOC provides several advantages in HPC and hyper scale data center network applications.

Compared to DACs, AOCs offer:

- Superior reach, up to 100 m with OM3 multimode glass optical fiber at 25.78 Gbps
- Thinner diameter and lighter cables with a high port density, allowing easier system maintenance, increased airflow and flexible cable management
- Galvanic isolation that insulates the ground loops between the ports, thereby providing a better system reliability than DAC

AOC differs from conventional optical transceivers in various aspects and provides multiple benefits including cost advantages, while maintaining the same signal quality of the optical transceiver.

- Lower pricing than optical transceivers by omitting expensive optical testing and optimizing optical link performance by embedding the optical fiber within the optical module during the assembly.
- Lower power consumption than an optical transceiver with lower optical link margin overhead.
- Plug and play convenience in deployment – the same as a DAC in user operation.
- Eliminates an optical connector – reducing operating expense and increasing system reliability

Traditional AOCs use two optical transceivers with integrated fibers that require the same optical connector and ferrule inside the casing. Optomind's optical engine with its new optics design does not employ any other component to achieve optical coupling in assembly.

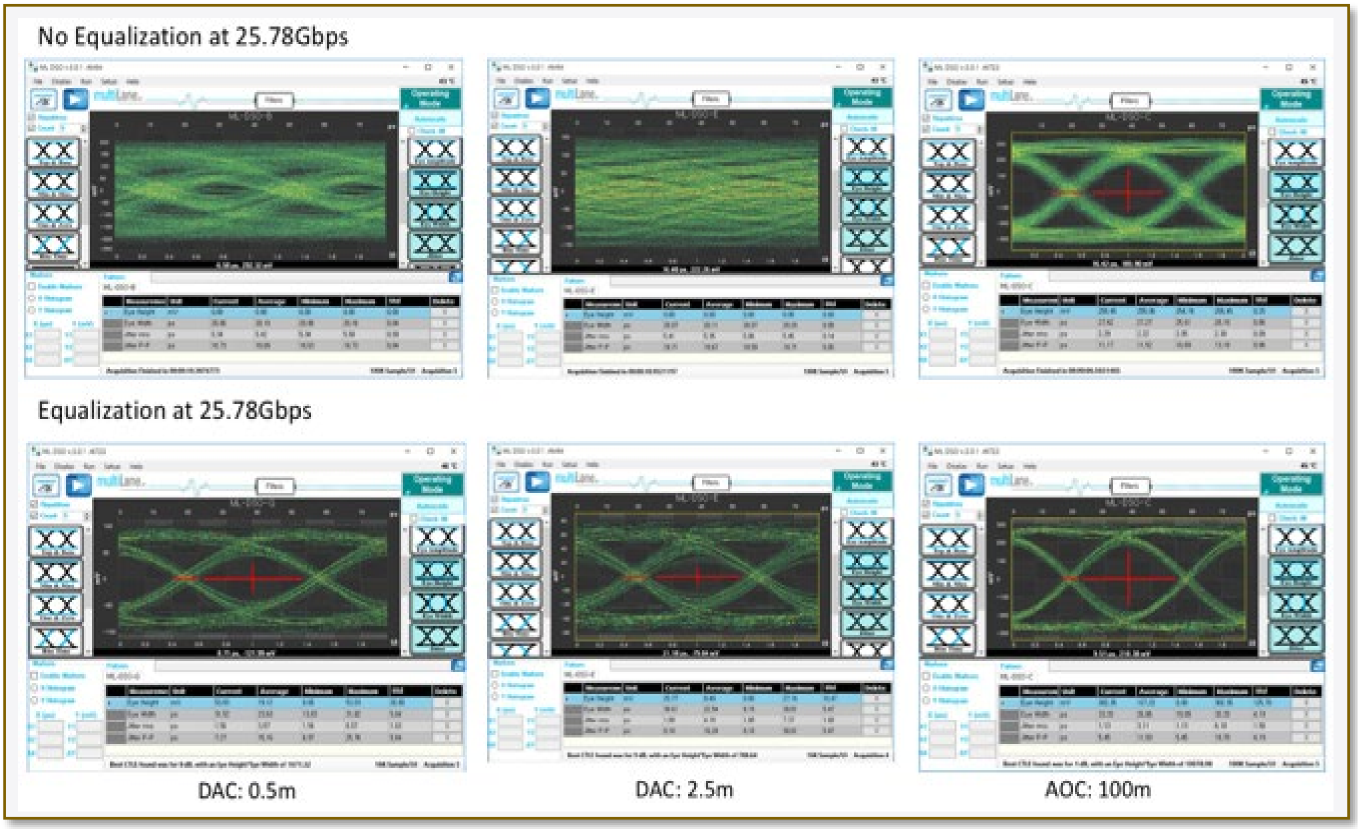

Figure 4 Eye diagram comparison at 25.78 Gbps for 0.5 m and 2.5 m DAC and 100 m AOC with and without equalization, respectively

Electrical eye diagrams at receiving end were measured for 0.5 m and 2.5 m DAC and 100 m AOC with and without equalization at 25.78 Gbps to evaluate signal quality performance. As shown in Figure 4, the AOC does not require equalization for 100m link length. This implies that the system does not require equalizer when only AOC is used. In addition, the amplitude of AOC signal is significantly higher than that of DAC, hence AOC does not require any amplification of the signal received from the system.

Optomind's AOC Solution

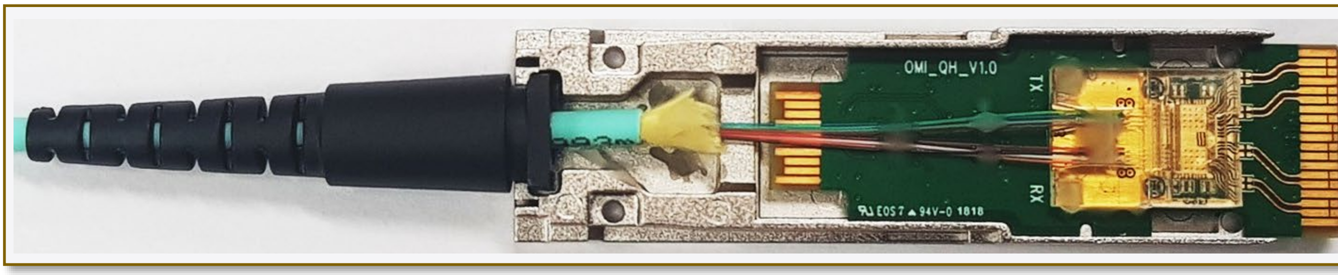

Figure 5 Optomind's optical engine inside Optomind QSFP28 AOC

Figure 5 illustrates the Optomind's optical engine used for Optomind QSFP28 AOC. There is only one unit of transparent optical sub-assembly attached to optical fibers without any additional component or structure on the printed circuit board. The beauty of the simple design reduces the material cost and simplifies the assembly process for ultra high-volume manufacturing.

Optomind

Optomind Inc. is a forerunner in development of advanced optical engines and their cost-effective high-volume manufacture, delivering finest optical interconnect solutions to both data center and non-data center applications as an active optical cable (AOC) or embedded optics.
For more information, please visit optomindinc.com.

OPTOMIND
16 Deogyeoungdaero #1556, Suite B-301
Yeongtong-gu, Suwon, 16690, Republic of Korea
Tel.: +82 31 232 1318
optomindinc.com