The Future of 400G AOCs in the Data Center

This year was supposed to be the big one for 400G. Switches based on12.8T ASICs with a capacity of 32 x 400G ports were released in 2019, potentially enabling significant deployments of 400G in the data center in 2020. Service providers have been experimenting with 200G, 400G and 600G modules for about seven years, but these earlier implementations were often proprietary and deployment was measured in small numbers of modules/boards. Last year was the first time that 400G really hit the mainstream.

400G in the post-Covid era: In fact the 400G market in 2020 seems to have been mixed. Covid-19 quickly resulted in bandwidth hunger from locked-down populations trying to work at home and entertain themselves at home. This put considerable pressure on networks worldwide. CIR's contacts at transceiver suppliers tell us that they are having a hard time keeping up with the transceiver demand from hyperscale data centers and carriers including.

This presumably includes a demand for 400G transceivers, which, during 2020, will go mostly to the likes of Alibaba Cloud, IBM Cloud, Microsoft Azure, Amazon Web Services, Google Cloud, Oracle, Salesforce and SAP. Nonetheless, we strongly suspect that many of the plans for 400G outside of largest data centers have been delayed as engineers and installers at many facilities find themselves in lock down.

If there is going to be a 400G boom we think it will now occur in the 2021/2022. There will be a big pent-up demand for 400G transceivers once the pandemic crisis is sufficiently mitigated. So in 2021 we anticipate enterprise data centers, sized below the hyperscale, to take off in terms of their 400G purchases.

The role of AOCs in 400G deployment: According to CIR's latest report, "Active Optical Cables: Market Forecasts -- 2020 to 2024," about 90,000 x 400G Active Optical Cables (AOCs) will be shipped in 2020 (See Exhibit below). If this sounds like a large number consider that the number of 100G AOCs shipped worldwide in 2020 is about 10 times this number.

Worldwide Shipments of 400G Active Optical Cables

	2020	2021	2022	2023	2024
Number of AOCs shipped (000)	90	240	380	570	850
Price per AOC ($)	4,841.0	2,347.0	1,748.4	1,428.6	1,138.2
Market value ($ Millions)	434.4	555.7	660.0	816.6	970

Source: CIR

The 400G AOC market is made more significant by the fact that compared with AOCs at other data rates 400G AOCs are extraordinarily expensive. So the relatively small number of 400G AOCs shipped generate $434 million in 2020. By 2021, we think that 400G AOCs will be shipped in volumes that are an order of magnitude greater than they are this year. By 2022 we foresee the price of 400G AOCs dropping to a level that might be considered by data center managers to be "normal" for high-end AOCs.

It is clear though that much of the design activity in the AOC space is already focused on 400G transceivers. AOCs operating at 400G are now available from several firms,

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many of them Chinese. Firms currently offering 400G AOCs include Gigalight, InnoLight, Hisense, 10Gtek, Tarluz, Skylane Optics, Arista, and ProLabs. 400G AOCs mostly seem to use the QSFP-DD module, although some use OSFP.

QSFP-DD transceivers feature an eight-lane electrical interface, with each lane capable of achieving up to 50G data rate. These transceivers also enable up to 20W power with the use of heat sinks to dissipate the heat from the DSP. QSFP-DD is likely to be the market leader for 400G applications for the data center applications in general QSFP-DD supports both 200G (8x25G) and 400G (8x50G).

AOC's purpose: Meanwhile, from the end user side of things, the primary reason for using a 400G AOC is cost, which is about half that of using a transceiver pair with an optical cable. In terms of 32-port switch, this could translate to a $100,000 cost saving at current prices. The downside of the AOC is that as a practical matter, range is an issue. Thus, 400G AOCs are generally rated for 70 meters using OM3 fiber and 100 meters using OM4 fiber. As shown in the Exhibit below, AOCs at any data rate compete not just with transceiver pairs but also with copper DACs (digital active cable).

AOCs and their Competitors

Product	Technology	Appropriate distance (meters)	Advantages/Disadvantages
DAC	Copper	3-7 meters	Low cost, but copper cables can get heavy and have higher power consumption
AOC	Transceivers bonded to optical cable	3-100 meters on MMF, 100-200 meter on SMF	Fiber optics at low cost, but tendency to break when extended over long distances. More flexible (more bend) than copper. Power consumption is about 2.2W. Lower maintenance.
Fiber optic transceiver pair	Transceivers with detachable optical connector	Potentially any distance. Always used for longer hauls	"Rolls Royce" solution. Power consumption is 2.6 to 4.5 W

Source: CIR

A surprising number of firms are selling 400G DACs today. Surprising, because just three years ago, we were told – and by insiders -- that 400G-over-copper --could never happen. DACs represent a lower constraint on the 400G AOC market, because for distances up to 3 meters.

In data com, there appears to be an unwritten law, copper never dies.

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