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Pioneering 3D photonic integrated circuits

THE JOURNEY FROM 100G TO 400G AND BEYOND

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Ethernet speed increases from 10G, 40G, 100G and now to 400G have been designed to satisfy the ever-increasing demand for higher bandwidth from consumer markets as traffic volumes explode with more and more cloud computing applications and services. The need to deliver content to a myriad of devices efficiently has the full attention of data center operators and drives the journey to 400G and beyond.

In response, three pluggable packaging agreements for 400G transceivers have been made between leading players in the industry: CFP8, QSFP-DD and OSFP. These agreements all aim to increase data rates and port density without the need for additional racks of equipment.

After deciding which of the transceiver form factors to back, companies need to solve issues with packaging, manufacturing processes, thermal management and power consumption before they can make 400G a reality.

Form and function

Dismissing CFP8 as too bulky for their requirements, Amazon, Facebook and Cisco are backing QSFP-DD. QSFP-DD maintains the popular QSFP form factor by stacking connectors, meaning it has the advantage that it is backward compatible with existing QSFP and QSFP28 pluggable modules. This keeps the panel footprint small, but simultaneously restricts future increases in data density due to challenges with thermal management and power efficiency in such a small volume.

In contrast, OSFP – whose proponents include Google and Arista – is a fresh start. With a larger volume and surface area, OSFP takes up more precious front-panel space (up to 32 ports on a one-rack unit, as opposed to 36 for QSFP-DD) and is not backward compatible with legacy equipment, meaning initial investment is higher. However, OSFP has a higher power envelope than QSFP-DD and tackles one of the biggest challenges in moving to 400G – thermal management. Integrating heat sinking directly into the form factor will help cool the module when running eight electrical lanes at 50 Gb/s. Combined, these factors offer more flexibility, future proofing OSFP for 800G.

Each individual 400G QSFP-DD and OSFP module will consume around 10–16 W, meaning a 32-port faceplate could have up to 512 W power density that requires dissipation. With so much power coursing through racks, even with OSFP's heat sink, a major challenge remains in how to manage heat and ensure reliability.

As data rates increase, thermal management within data center racks is a major challenge. An alternative option to the pluggable modules, particularly for 400G and beyond is being investigated by experts at Microsoft and other leading companies. They have formed the Consortium of On-board Optics (COBO).

Unlike pluggable modules, COBO is defining an interchangeable and interoperable optical module installed internally to line-card equipment. This should facilitate higher module port density, increased signal integrity, improved thermal management and better power efficiency. Yet upfront costs will be high, and while faulty pluggable modules can easily be swapped for new ones, when a board-mounted module goes down the whole line card will have to be replaced.

With advantages and disadvantages to each of QSFP-DD, OSFP and COBO's optic module, which of these wins out in the battle to dominate 400G signalling remains to be seen.

The meat of the transceiver

Regardless of whether a transceiver is OSPF, QSFP-DD or COBO's optic module, the packaging specification simply details plugs and connectors, and defines the size of the package. The meat of the transceiver – the optical and electronic components – is left to each manufacturer to make. Hence, to realize any of these modules requires some innovative thinking from the transceiver industry too.

Packing additional fibers and electronics for increased bandwidth into a similar footprint to previous generations of transceivers, companies will have to industrialize and automate their manufacturing processes for accurate, repeatable results. For example, automated alignment and assembly of the optical module is a must. Meanwhile, transceiver blueprints will need to incorporate novel solutions to provide good thermal management and low power consumption. And for those looking beyond 400G, adaptable designs – capable of incorporating arrays of multicore fibers, for example – are key.

About Optoscribe

Formed in 2010, Optoscribe uses its innovative laser direct write technology to manufacture 3D glass-based integrated photonic circuits for the telecommunications and data communications markets. These monolithic optical products are primarily used by high volume optical transceiver manufacturers. Optoscribe photonic integrated circuits are helping transceiver manufacturers cost reduce and automate their existing transceiver products

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