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Innovation Frontier

Photonics: Enabling Digital Revolution

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Photonics and optical communications: the unsung heroes of the digital revolution

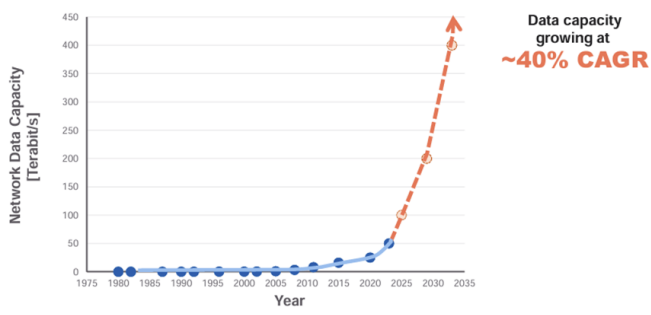
The photonics and optical communications industries are the unsung heroes of the digital revolution. Their innovation is enabling the bandwidth and data transfer speeds that we take for granted today and will be making possible the exciting advances in communications and artificial intelligence (AI) going forward. It is a significant proportion of our Global Innovation Fund portfolio, and in this article we'll look at some of the reasons why we see potential in this area.

We are experiencing rapid growth of data everywhere. IDC, a respected market forecaster, estimates that the "datasphere" (amount of data created, captured and consumed) has been growing at 20% CAGR over the past couple of decades (2010 to 2025E), and is forecast to double again over the next 4 years, so this pace of growth is not slowing.

We are experiencing this in our daily lives and in the more specialist industrial settings: our photos increase in resolution and are becoming videos, jet engines generate gigabytes of data with every flight, industrial equipment collects vibration data to enable predictive maintenance.

Data communication sits at the core of this and benefits from this growth. We have continually grown into the capacity that the industry built and consistently required more. In fact, the pace of network capacity is forecast to grow even faster than the datasphere – as we create and collect data, we need to transfer it more often and at faster speed. The network capacity growth required to service, transmit and receive this expanding datasphere is forecast to be substantially higher, 40% CAGR to 2035, than the "datasphere" growth itself.

UNRELENTING NETWORK DATA CAPACITY GROWTH



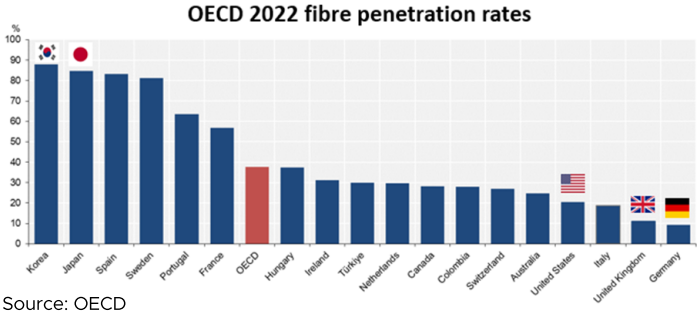
Source: LightCounting, Lumentum

Why does it benefit the optical communications industry specifically? It is to do with a concept of "attenuation" - signal loss over distance. In copper, which up until recently was the main conduit of data and signal, attenuation grows with higher frequency, and frequency is correlated with bits per second data transfer speed. So as broadband speeds increase, copper is increasingly failing to cope. As a result, it is technologically inevitable that we need to shift data transfer more and more from copper to fiber optics, which does not suffer from the same issue.

We have seen it in the consumer broadband offering. Whereas once fiber only reached telephone exchanges, it has rolled out to cabinets on street corners, and now to consumers' homes. This "fiberisation" has further to run. As the chart shows we're not yet done with household fiber broadband penetration. Whereas highly fiberized countries like South Korea and Japan are near 90% penetrated, major economies like US, UK and Germany are lagging a long way behind.

This fiberisation is repeated across enterprise networks as well, driving demand for optical communications components and equipment.

OECD 2022 fibre penetration rates



Source: OECD

Another aspect favouring photonics is energy consumption. Optical communications consume a lot less power than copper to transmit data (70% less by some estimates). Data centres already account for 4% of global electricity consumption, and in some areas you can't build a new data centre as there is simply no electric power available. In other cases, for example in high performance AI datacentres, energy consumption is so high that the servers need to be water-cooled. So energy efficiency plays to photonics advantage, too.

Two recognised technological developments on everyone's mind, 5G and AI, also help photonics market grow.

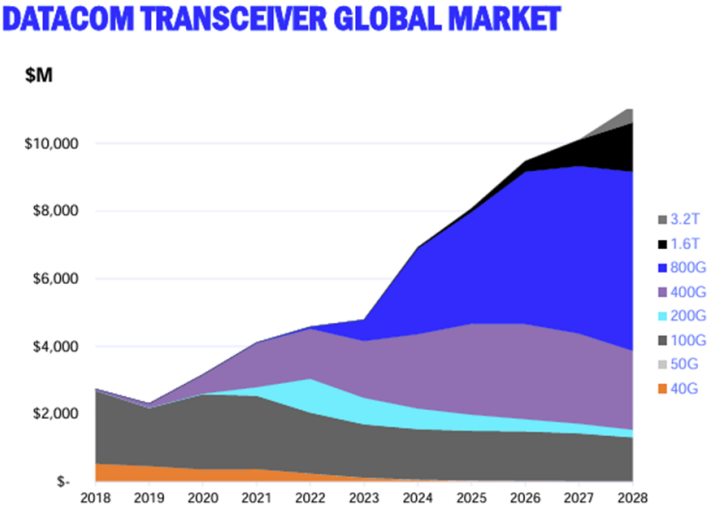
Telecom companies had rolled out their initial 5G networks, and will continue to "densify" these, making the base stations (both large cell towers and small cells in busier urban environments) more dense than the 3G or 4G networks were in their time. As those cells fill up with wireless data traffic, landing that data back into the network core will require optical links - so called backhaul and fronthaul. Effectively, 5G network architecture will require more fiber everywhere.

AI is also proving to be an accelerant for optical communications. AI "clusters", super-computer installations that run the likes of ChatGPT and other LLM AI models, require a lot of data to be transmitted around the data centre. According to Arista, the networking spend per dollar of capex in such environments could be over 2x the "traditional" data centre and a lot more optics will need to be used.

The photo is the latest Google AI supercomputer, powered by its proprietary TPU chips. While chips got most of the attention, what is equally interesting is the optical connections between the elements of this structure. Google and other hyperscalers need to connect individual servers with optical communications to ensure that "interconnect" does not slow down the overall system performance and that power consumption is sustainable.

Source: Google

As a result, the industry expects structural growth in demand for optical components for both telecom networks and data centres of 12-13% CAGR between 2023 - 2028, (according to LightCounting and Dell'Oro, leading industry forecasters). These two market segments are already multi-billion dollars in market size each and are growing fast.



Source: LightCounting, Coherent

AI related optical markets are growing even faster and forecast to grow between 30% and 40% CAGR between 2023 and 2028 (according to Lumentum and Coherent, leading vendors in that segment).

Optical communications and AI capture the headlines, but the same or similar photonics components enable other game-changing functionality in areas as varied as industrial cutting and welding applications, industrial and auto sensors, 3D printing, semiconductor manufacturing and aerospace and defence. For example, anti-missile measures increasingly see flares being replaced by directed laser beams, and the nuclear industry is talking about using lasers to enrich uranium. In sensors, the same technology that transmits signals in long distance optical cables is used to authenticate user's facial features in Apple's FaceID application.

The photonics industry is a set of oligopolies, concentrated small groups of companies that excel in a particular segment. Technology transitions between generations of products had winnowed out the field to a few successful, profitable leaders. The speed race in photonics (from 50 Gigabit per second to 100, 200, 400 and now 800) is similar to semiconductor industry "Moore's Law".

Western component players Coherent and Lumentum lead across several applications and are particularly strong in telecom and datacom photonics. IPG Photonics and NLight lead in industrial applications. MKS Instruments leads in specialist semiconductor and electronics photonics tools. Chinese players have been disruptive at the low end of industrial use cases, and some like Innolight achieved strong market shares in data com, but may struggle to grow from here given geopolitical issues. US listed Fabrinet is a leading contract manufacturer in the photonics space.

As a result of this concentrated competitive set, deep technology moats and attractive long term growth most of these companies are profitable and cash generative through the cycle – an essential feature we're looking for in our investments.

Some of these markets are also cyclical, so this compelling structural growth is never a straight line upwards. In certain segments we're experiencing these cyclical headwinds right now. Telecom capex has temporarily slowed, as the industry digests its first wave of spending on 5G networks. 3D sensing in smartphones and photonics for industrial applications are both subject to product cycles and general macroeconomic uncertainty. As a result, there are opportunities to buy into these multi-year growth runways at an attractive, temporarily depressed valuation. We are confident that these issues will prove transitory and therefore photonics is a material part of our Global Innovation Fund portfolio.

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