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Unlocking Innovation in Fiber: The Future is 25G PON

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In today's increasingly digital world, fiber broadband is more important than ever. It delivered the high-speed connectivity that was required for our pandemic shift to home offices, remote learning and keeping in touch with our loved ones. Yet as we emerge from this period, the need for increased speeds and capacity continues to grow unabated, fueled by new immersive consumer applications for the spatial web as well as new network functions and architectures such as edge computing and mobile densification.

Built upon the successes of GPON and now XGS-PON, operators are focusing on ways to further leverage their existing fiber deployments and to drive new investment. This article explores three aspects of how 25GPON is fueling innovation—technology, operations, and services—and how it is changing service providers' business models with a unified fiber infrastructure.

Technology innovations

Fiber to the Home (FTTH) has been an incredible success in delivering a seemingly infinite amount of capacity for customers' existing services and for the next "killer" application. What has made the fiber access market successful is that the technology has delivered a scalable high-performing means of communications at the right price point. During this journey, we have relied on many enabling technology innovations such as the burst mode receiver and the various forms of amplification to bring consumer fiber access into the mainstream. However, what has been just as important is that during this time there have been many small and even imperceptible advances in disparate industries that, when brought together, drive new innovations that have enabled the market to achieve scale and mass adoption.

Generally, optics are the largest percentage of the cost for access equipment, especially at the customer premise. Over the past several decades of boom and bust in the optical component business, a healthy ecosystem developed, which has shipped hundreds of millions if not billions of optical components. From the earliest days of GPON we have refined the performance of those subcomponents to be able to achieve higher and higher line rates. It is this simple tweaking of the fundamental recipes and the imperceptible innovations in manufacturability and testability that have brought us the most gain.

As we look to address the next frontiers of fiber access, we are tempted to leverage technology beyond the access domain that drives additional levels of complexity into the modules. In the recent past, we have learned the hard lesson of adding too much complexity to these optical modules to meet the perceived needs of the industry. These technologies required all-new ecosystems of components and tighter operational parameters that in the end drove up the costs of the solution and prevented widespread adoption. We see the same scenario potentially occurring with other next-generation PON technologies, as they require additional complexity and thereby higher cost by introducing digital signal processors (DSPs) as well as coherent components in the access space.

During the past few decades, the success of TDM-PON depended on the pre-existence of mature optical and electronic technologies deployed in transport systems. Volumes of these technologies drove price erosion, enabling their adoption and widespread fiber-to-the-home development. Therefore, the pragmatic way forward is to continue to implement incremental innovation for the existing optical modules as demonstrated by the simple low-cost and low-risk progression from the GPON optical modules of today to XGS-PON. However, 25G PON is using an innovative approach, leveraging another industry that nowadays is driving significant optical volumes: data centers. The data center business is now driving the volume worldwide, and 25 Gbps channels have been massively deployed for intra-data center connectivity. 25G PON is leveraging this mature ecosystem and the huge volumes of these existing optical technologies deployed in data centers to achieve cost efficiency. All this is being brought to the market with coexistence so there are no changes required to the network to deploy these multi-generational technologies simultaneously.

Operational innovations

When operators first envisioned optical networks in the early 1990s, the killer application was not the Internet but video transport to the home. Slowly, as the creation and eventual control of services moved from the telecommunications operator to the over-the-top providers, the siloed operational models remained largely intact. During this time, much of the service providers' networks were built in a highly cascaded fashion with numerous lower-speed endpoints that are increasingly aggregated further into the network and finally terminating in the core of the network.

As services moved to the edges of the network, service providers augmented their networks with various forms of compute to provide caching and analytics to ensure that the demand did not exceed the capabilities of the network. Going forward, as more of those endpoints are connected

with fiber, the ubiquitous amount of seemingly “infinite” capacity with lower latency is fundamentally changing the way operators view and value their network.

One of the most significant operational transformations operators are exploiting is the combination of residential, commercial, enterprise and mobile services with compute resources over the existing architecture. This is nothing new as many of the operators have used the legacy twisted-pair and coaxial copper-based residential network to capture small- and medium-sized businesses. As we look toward next-generation applications such as the spatial Internet and Web 3.0 applications for both consumers and enterprise, those staid siloed architectures that have served their purpose for the past several decades to provide a fully vertical service offering are rotating 90 degrees and creating functional layers of network operations and capabilities. This operational transformation will allow operators to drive OPEX out of the network by collapsing services and organizational units. It also allows operators to easily introduce multi-technology access solutions such as Fixed Wireless Access and 5G densification transported by the existing access network and to bring software agility into the network by driving both network and customer workloads closer to where they are needed.

Service innovations

From a service innovation perspective, there are several new use cases and services that can take advantage of 25G PON’s massive capacity. Industry 4.0 requires connectivity solutions that deliver high performance and ultra-low latency to support real-time communications and automation that improve efficiency and worker safety, while also helping to reduce costs. 25G PON’s bandwidth, low latency and high reliability can support industrial communications infrastructure for utilities, transportation, mining, manufacturing and more. With its ability to deliver symmetrical data rates of 20 Gbps, 25G PON is also ideal for enterprises as it can support premium business services for multiple users at the same time. Service providers can deploy 25G over their existing PON network so that business network demands can be met on the same fiber initially deployed to support residential applications. The transition from fiber-to-the-home (FTTH) to fiber-to-everything (FTTx) allows service providers to generate new revenues while delivering a unified infrastructure that can connect consumers, enterprises, and industries.

One of the significant advantages of 25G PON is its support for both fixed and mobile networks. A Nokia Bell Labs study quantified the cost benefits of FTTH technology for 5G transport. 25G PON meets the high-performance demands of 5G networks, and FTTH networks are already laid down in dense urban areas where 5G small cells are most likely to be deployed. The study showed that by leveraging these existing fiber networks, service providers can decrease their 5G transport costs by more than 50 percent when compared to traditional transport solutions. For 5G fronthaul networks, which require even greater capacity, 25G PON technology can meet the demand.

For fixed, mobile, and converged service providers, 25G PON delivers clear operational advantages. For fixed and converged service providers, 25G PON deployed as an “anyhaul” service can help them monetize their networks and generate new revenues by deploying new services to enterprises. For mobile-only providersthat lease an FTTH network, 25G PON eliminates the need to deploy their own transport network with significant CAPEX costs while

gaining immediate access to a network that can meet their capacity demands today and in the future.

Ultimately, to achieve lower costs any technology requires volume—and volume is driven by residential broadband. By leveraging the current ecosystems of data center components and 10G components, 25G PON has a clear path to recognizing the right cost and performance profile for the next fiber access upgrade cycle beyond 10G XGS-PON. To date, cumulatively over 60 million GPON OLT ports have been shipped around the world as shown below in Figure 1.

XGS-PON remains the first choice today for newly built future-proof fiber networks. However, in the coming years as service providers look to refresh their service offering with higher capacity, the industry will see 25G as the preferred upgrade path from GPON. This upgrade path can be done by simply upgrading individual devices at specific endpoints that require the increased capacity. It may not necessarily be driven by one killer application that requires 25Gb connectivity, but instead from the need to support a higher aggregate amount of bandwidth on the access network. As an example, an operator utilizing 25G PON and statistical multiplexing can offer multiple 10Gb services without having to re-architect the existing network or disturb the existing outside plant to introduce additional splitters or filters into the network.

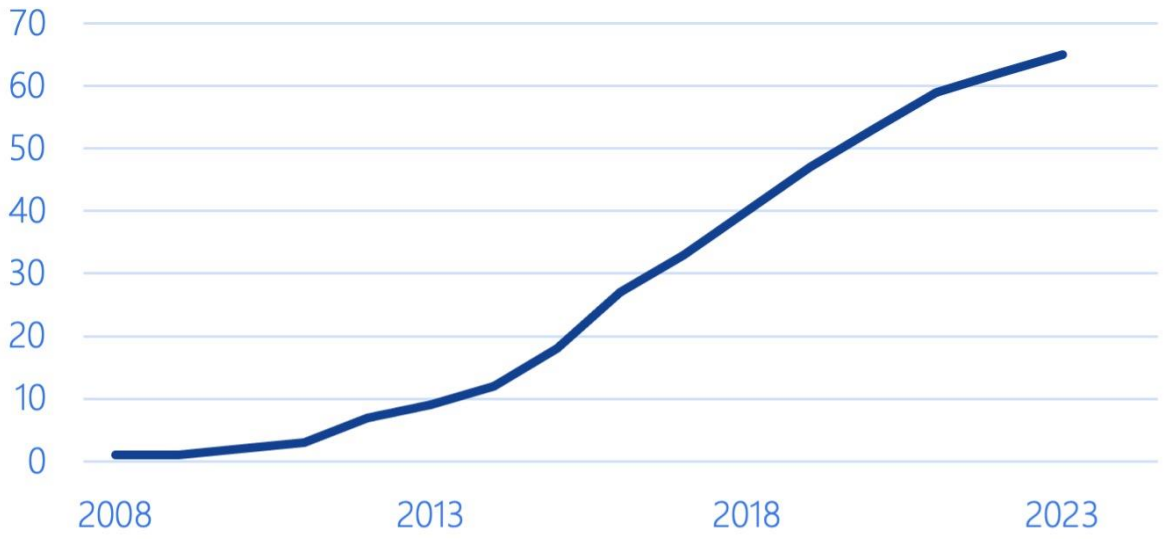

Figure 1: Cumulative GPON OLT Port Shipments. Source: Omdia

Summary

Fiber will continue to hold a predominant role in communications technology moving forward. The deliberately iterative and backwards-compatible nature of PON technology is key to its success. Each generation of PON—from GPON to XGS-PON and now to 25G PON—builds upon the previous generation, allowing broadband service providers to easily and iteratively upgrade their network capacity using their existing fiber infrastructure, while keeping their broadband access costs down. This PON coexistence is critical to service providers, allowing them to leverage the billion or so ONTs already deployed and to upgrade when these new services and bandwidth demands justify the investment.

Broadband service providers will benefit from the technological, operational, and service innovations that come with 25G PON. They have a proven technology solution that builds upon their existing infrastructure. They can take advantage of operational efficiencies that allow them to use the same fiber network for their residential and commercial customers. And they have a fixed network with massive capacity and low latency that can support the latest applications in Industry 4.0, business-class applications, 5G transport and 5G mobile densification.

25G PON offers service providers a cost-efficient, low-risk, high-confidence progression for their network. It delivers the right innovations at the right time—for years to come.