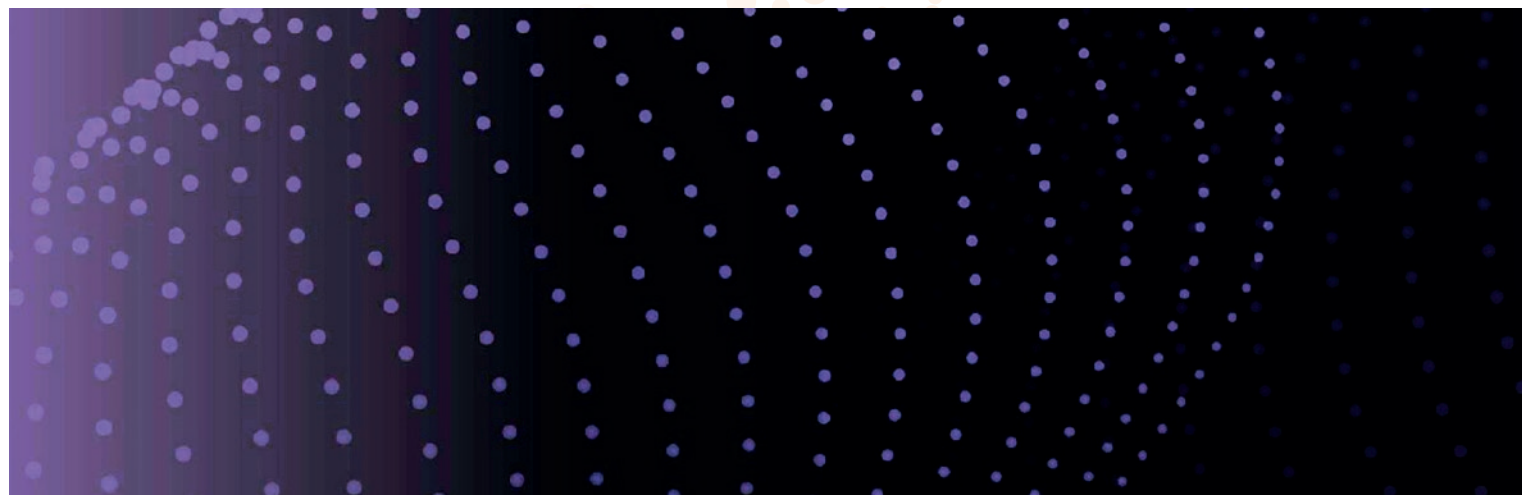




Why XGS-PON?

AN OVERVIEW OF THE BUSINESS OPPORTUNITIES

BY NOKIA

THE IMPORTANCE OF XGS-PON FOR UNLOCKING BUSINESS OPPORTUNITIES

The adoption of 10Gbps Symmetrical Passive Optical Network (XGS-PON) solutions is accelerating, and the technology has already been widely deployed. For example, Omdia estimates that 67% of PON optical line terminal (OLT) shipments in North America will be XGS-PON in 2023. For operators, XGS-PON is an enabler of improved competitive positioning, increased revenue, and network efficiency.

The strategic advantages of XGS-PON apply to all types of operators, whether they are telco or cable operators, incumbent or alternative, retail or wholesale focused, in a developed country or a developing country, or with a residential-only focus or multi-use focus. This white paper provides a concise overview for decision makers of the strategic rationale for XGS-PON deployments.

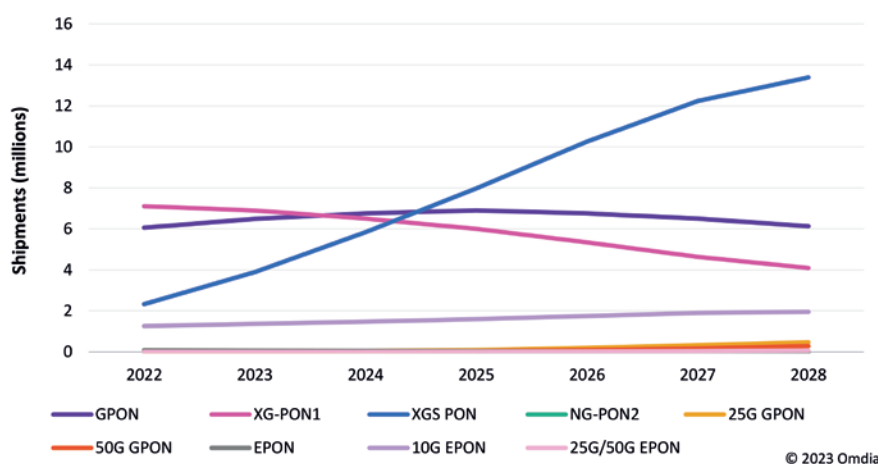


Figure 1: Global PON OLT port shipments by technology, 2022–28

THE MOMENTUM BEHIND XGS-PON DEPLOYMENTS IS GROWING

There is considerable momentum behind 10G symmetrical PON (XGS-PON) deployments across the globe, and Omdia forecasts that XGS-PON OLT port deployments will increase from 2.3 million in 2022 to 13.4 million in 2028.

The growth in XGS-PON volumes reflects the fact that the technology is being deployed by a wide range of operators, each with its own specific motivations. For established fibre-to-the-premises (FTTP)

operators, XGS-PON delivers competitive differentiation and opportunities for upsell. For greenfield fibre operators, XGS-PON makes sense because of the small cost differential in comparison with Gigabit Passive Optical Network (GPON) as well as the fact that the active equipment cost is a modest percentage of the cost of the outside plant rollout. In addition, new-entrant greenfield fibre players need to establish and differentiate themselves in the market with the best and latest technology. Governments investing in broadband are also taking a long-term view of the value of FTTP infrastructure, so XGS-PON rollouts, which avoid

the need for a new investment cycle anytime soon, fit well within this overall idea. Wholesale-only operators are also attracted to XGS-PON since it provides them with the best opportunity to attract retail internet service providers (ISPs) to their network. Finally, cable operators are seeing the benefits of XGS-PON, for instance, as a cost-effective and high-performance upgrade to existing DOCSIS networks.

There are broadly three reasons for operators to deploy XGS-PON:

- In the first instance, competition is an important driver. In areas of fibre

overbuild, XGS-PON could be an important differentiator and could drive home the performance advantage of FTTP over cable and fixed wireless access (FWA). XGS-PON allows operators to easily provide symmetrical gigabit and multigigabit access, which will become increasingly important as more and more subscribers take such speeds. As Figure 2 demonstrates, by 2027 32% of global consumer broadband subscriptions will be for speeds of 1Gbps and above.

- XGS-PON also provides operators with notable opportunities to increase revenue. This could be from the premium consumer segment or from the wholesale segment. Furthermore, XGS-PON could increase revenue from the enterprise and mobile transport segments.

- Finally, XGS-PON provides operators with the benefits of network efficiency. It provides huge headroom for operators to keep upgrading user services without having to change network and home equipment while also providing improved energy efficiency over earlier PON technologies. The fact the same XGS-PON network can be used for multiple applications also provides efficiency benefits.

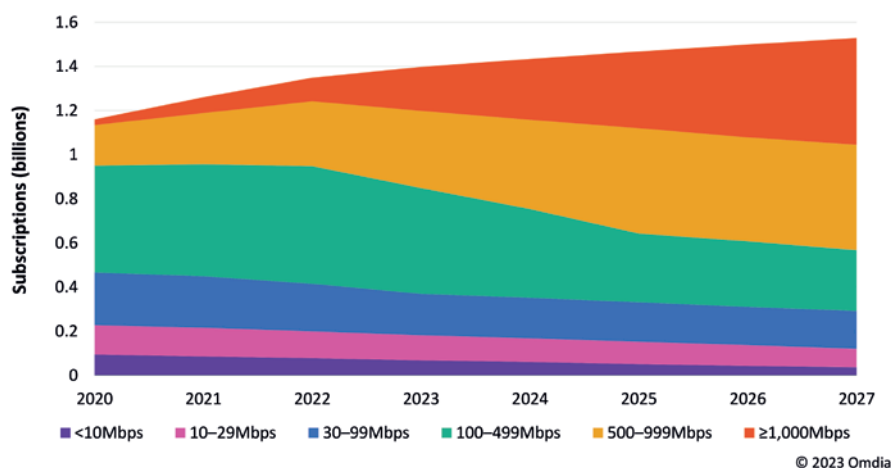


Figure 2: Global consumer fixed broadband subscriptions by speed, 2020–27

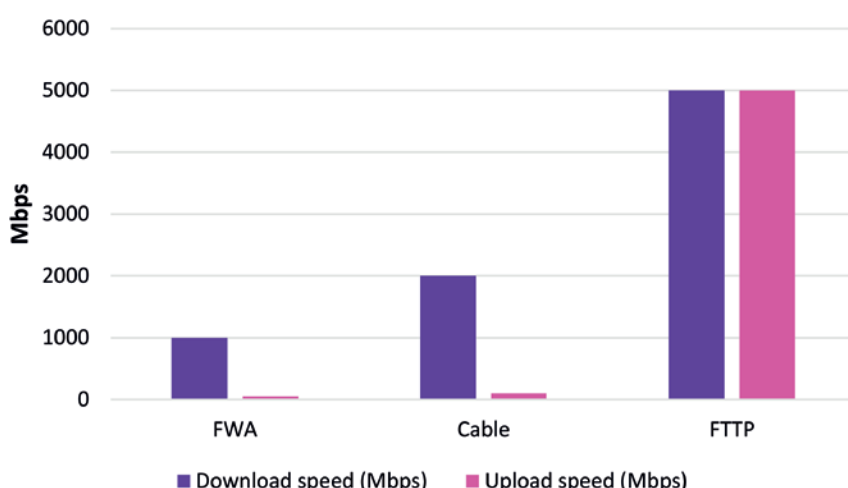


Figure 3: Maximum download and upload speed by technology, US Tier 1 operator consumer broadband tariffs, June 2023

DIFFERENTIATING AGAINST COMPETITORS WITH XGS-PON

In many markets, both developed and developing, FTTP overbuild is increasing. In this context it will be important for operators to offer the highest speeds over FTTP and invest in XGS-PON rollouts in order to maintain premium market positioning. It makes little sense for an operator to invest in an FTTP rollout with the rationale of providing the best-quality network and then be usurped by an FTTP competitor that is offering higher speeds.

Multigigabit access delivered via XGS-PON FTTP is also a significant differentiator against alternative broadband infrastructures such as cable and FWA. For example, DOCSIS 3.1 cannot compete against XGS-PON in terms of the ability to support symmetrical multigigabit speeds. DOCSIS 4.0 can support symmetrical multigigabit speeds, but both Extended Spectrum DOCSIS 4.0 and Full Duplex DOCSIS 4.0 require extensive network modifications and investment.

Extended Spectrum DOCSIS 4.0 requires changes to passive components and amplifiers, and Full Duplex DOCSIS 4.0 requires a new breed of amplifiers. By way of contrast, XGS-PON can reuse the same fibre outside plant and, in most cases, the same access nodes, which helps to explain why many cable operators are now upgrading to 10G PON technologies. In addition, XGS-PON offers very large download and upload speed advantages over FWA. Not only can XGS-PON offer higher maximum speeds, there is also much less variability in speeds in comparison with FWA, which is more affected by capacity constraints and by factors such as the local environment, which could affect in-building performance.

Figure 3 shows the scale of the speed advantage XGS-PON has over rival technologies. It shows the maximum download and upload speeds offered by Tier 1 US operators over different technologies and demonstrates that operators launching XGS-PON are well placed to position themselves as the operator with the best-quality network. The central idea of investing in FTTP is to provide subscribers with a superior network experience, so upgrading to XGS-PON and putting clear water between FTTP and alternative infrastructures fits very clearly into the overall investment rationale.

XGS-PON ENABLES MORE REVENUE

DELIVERING PREMIUM VALUE TO END USERS

XGS-PON enables operators to enhance their residential services with gigabit and multigigabit offerings. Of the operators analysed by Omdia in 2020, 323 offered gigabit access, but by 2022 this number had increased to 451. The number of operators offering 10Gbps speeds also increased strongly, from 36 in 2020 to 55 in 2022. Such offers are becoming increasingly important for several reasons.

Video is the biggest driver of bandwidth, and a clear trend of “everything becoming video” is apparent. This means video is not merely restricted to entertainment, home working, or education but has become a most preferred format for sending/receiving information (e.g., as user guides or instructions on how to perform activities such as cooking a recipe).

New video-based applications such as virtual reality and cloud gaming are also significant, because they need a higher bit rate per stream, which also increases bandwidth needs. Online gaming, which can incorporate game-playing online via both consoles and PCs, is already hugely important, and one indication of this is that in Omdia’s consumer survey from April 2023, 34% of Australian adult respondents said they were console gamers and 31% that they were PC gamers. The figures were similar for other markets. Moreover, online gaming is likely to grow in importance over time: 49% of Australian adult survey respondents aged 18–24 were console gamers, and 46% were PC gamers.

A further driver of increasing bandwidth requirements is the growing number of simultaneous video streams in households. For example, in Omdia’s

consumer survey from April 2023, 45% of US survey respondents either strongly agreed or tended to agree with the statement that they watched video clips on a device while watching TV. In addition, there is a growing likelihood of different family members viewing different video streams at the same time, which will also increase bandwidth requirements.

Another important point to consider is home working, for which XGS-PON is particularly well suited. For example, almost all office tools are in the cloud, and users would like to access files at the same speed as if a file were on the local hard drive. XGS-PON’s 10Gbps uplink capacity can help fulfill this requirement and delivers an eightfold improvement over GPON. Operators should also look to target home workers since this is a potentially lucrative segment. For example, of the UK respondents to Omdia’s 2022 Digital Consumer Insights survey, 54% stated they would be willing to pay more for a working-from-home service where all work applications were prioritised to offer the best quality.

In addition, at the simplest level the gigabit and multigigabit speeds that XGS-PON enables can be valuable to end users that are downloading and uploading large files. It is worth noting along these lines that the average size of a webpage has grown much bigger over time; for example, data from the HTTP Archive shows the average desktop webpage size has increased by 412% since November 2010, so such downloads can potentially take longer than before without faster speeds.

Further evidence of the need for XGS-PON comes from growing traffic volumes coupled with operators moving to offer gigabit service tiers. If operators offer a gigabit service tier, then 1Gbps on the PON must be reserved for an end user performing a broadband speed test. As

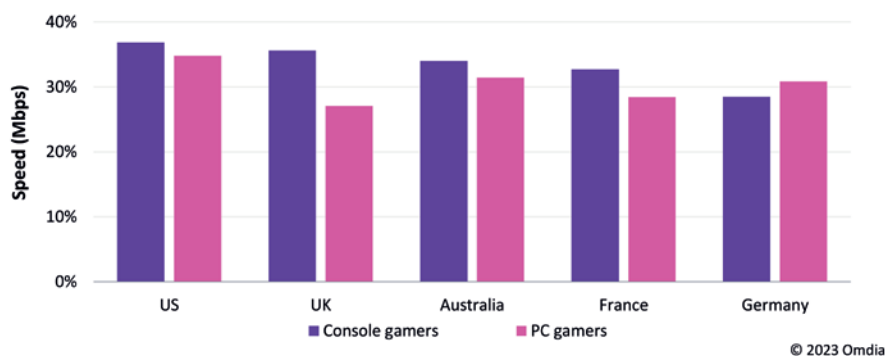


Figure 4: Selected countries, share of console and PC gamers among total respondents, April 2023



Figure 5: AT&T, retail tariff pricing for FTTP, June 2023

broadband traffic levels continue to grow this means the remaining bandwidth on a GPON FTTP network will be quickly saturated, which drives the need for an XGS-PON upgrade.

XGS-PON ALLOWS OPERATORS TO OFFER A WIDE RANGE OF TARIFFS TO BOOST REVENUE

The launch of XGS-PON and gigabit and multigigabit access provides operators with more flexibility in their tariff-tiering strategies. There are two strategies depending on business priorities, competitive landscape, and so on:

- Operators could choose to make gigabit and multigigabit access a mass-market offering or even an entry-level tier. In this way they can maximise the attraction of the fastest speeds to a wide base of customers and thereby increase the subscription acquisition benefits. Example of this approach include Salt in Switzerland and some UK altnets. Many of these same arguments also apply to wholesale-focused operators. For wholesale players having a high-capacity network is key in order to attract more retail service providers to their networks. More retail service providers increases the likelihood of greater overall subscription take-up on the network, which improves the rollout business case for the wholesale-focused operator.
- Alternatively, operators—whether retail or wholesale focused—could choose to price gigabit and multigigabit access at a premium. In this way they can increase ARPU by capitalising on the demand among the subset of customers willing to pay more for the

fastest speeds. In addition, pricing gigabit and multigigabit access at a premium places operators in a strong position to capitalise on the halo effect whereby even if the subscriber does not take the highest speed offer, they are more likely to choose a faster speed than they would have done if gigabit or multigigabit access was not available. AT&T is a good example of an operator that focuses on charging a premium for gigabit and multigigabit access (see Figure 5). An indication of the success of this strategy is that in its 1Q23 earnings call, the operator noted that the ARPU of new FTTP customers was about \$70. By way of comparison the retail price of the operator's 300Mbps plan is \$55 per month, and its 500Mbps plan costs \$65 per month.

XGS-PON also provides operators with more room for upselling over time because it offers a long runway for further speed increases without the need to change anything in the OLT or optical network terminal (ONT). Gradually increasing the maximum speeds with XGS-PON provides operators with greater opportunities to continue to sell such speeds for a premium price or use them to retain customers, with practically no additional investment. Moreover, some subscribers that take FTTP speeds of, say, 100Mbps today may be considered unlikely to instantly upgrade to multigigabit access in one jump. However, over time end users are likely to move to multigigabit access in several incremental steps, and moving to XGS-PON can help support this process. It can therefore be seen that investing in XGS-PON today can keep delivering revenue benefits in the long run.

XGS-PON MULTI-USE STRATEGIES TO BOOST REVENUE

The vast majority of operators, more than 90% according to a recent Omdia survey, stated that they want to use their PON infrastructure to support more than just residential customers, such as enterprise services and transport. This multi-use strategy for the PON infrastructure enables operators to make more versatile use of their network, thereby increasing revenue. The adoption of next-generation PON technologies, such as XGS-PON, is fundamental to this multi-use strategy: 10Gbps symmetrical bandwidth supports many enterprise requirements. In addition, XGS-PON can support transport applications, such as public Wi-Fi traffic aggregation, and in some cases, wireless backhaul. The additional revenue opportunity could be sizable given the high ARPU associated with segments such as enterprise connectivity.

XGS-PON DELIVERS NETWORK EFFICIENCY BENEFITS

LONG-TERM VALUE WITH LOW INCREMENTAL INVESTMENT

The fact that XGS-PON provides a long runway for continued speed increases is also significant from a cost perspective. Operators that invest in XGS-PON ONTs today will be able to continue using them as subscribers migrate over time to higher speeds. This approach was successfully used by operators on GPON networks, but such networks are now reaching their maximum capacity, which necessitates the investment in XGS-PON.

XGS-PON is also an efficient investment from a network perspective because it does not require any modification to the outside plant. Moreover, the technology can coexist on the same optical distribution network with GPON, which means existing GPON subscriptions can easily be upgraded to XGS-PON. XGS-PON also provides investment efficiency because operators have the potential option to upgrade their networks to support 25G PON in the future without altering their OLT hardware.

A further indication of the network efficiency benefits that XGS-PON can provide is that, as discussed, it can support a multi-use strategy with the same optical distribution network being used for residential, enterprise, and

mobile transport applications. This is important because it can deliver operational expenditure savings.

WHOLESALE STRATEGIES AND NETWORK EFFICIENCY

Several national governments have implemented wholesale FTTP network builds. This wholesale network approach promotes fibre deployment efficiencies since a premise is passed just once by fibre, and multiple fibre passings are eliminated. These national wholesalers then partner with multiple retailers, enabling a range of offerings to end users. Such government-backed rollouts are often targeted in more rural areas where commercial FTTP rollout is not viable.

XGS-PON rollouts in these areas can serve policy objectives of providing world-class broadband for all and can ensure that there are no in-country disparities in the quality of broadband access between rural and urban areas.

XGS-PON AND SUSTAINABILITY

Energy consumption has become one of the important considerations for operators as they support sustainable connectivity and bandwidth growth. Adopting energy-efficient PON technologies is crucial for operators as they seek to lower operational expenses, reduce their carbon footprint, and meet any regulatory guidelines and requirements.

An XGS-PON OLT provides 4× faster downstream speeds than a GPON OLT, while its power consumption is only 2.2× greater than GPON for those with fewer than 32 PON ports and 1.7× greater for those with more than 32 PON ports, based on the European Commission's "Broadband Communication Equipment Codes of Conduct." The bottom line is that XGS-PON supports more bandwidth without the same growth rate in energy consumption.

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BRIEF CASE STUDIES

RESIDENTIAL

Frontier

In January 2023, Frontier, a large US operator, announced its networkwide 5Gb fibre internet service, highlighting the 125× faster upload speeds, 5× faster download speeds, and 2.5× lower latency than cable. Frontier has promoted itself as the "un-cable" operator that ranks as the operator with the fastest upload speeds in the US. Frontier's consumer strategy is based on delivering customer experiences unmatched by competitors such as cable operators. A measure of the growing momentum behind Frontier's strategy is that the operator added a record 87,000 fibre subscriptions in 1Q23. Moreover, Frontier noted in May 2023 that 55% of its fibre subscription acquisitions were for gigabit and multigigabit speeds.

AT&T

AT&T announced expansion of its "hyper-gig" fibre offering in March 2022. AT&T increased its highest-speed service tier to 5Gbps across parts of its footprint. According to the operator, multigigabit speeds meet the growing bandwidth demands from the home, "similar to freeways with several high-speed lanes, multigig speeds open those lanes for various connected devices to run at their fastest possible speed." The success of AT&T's strategy is demonstrated by the fact that it is consistently growing its FTTP subscription base by more than 200,000 subscriptions every quarter. Moreover, the operator had achieved an FTTP subscription take-up rate of 38% at end-1Q23.

KPN

KPN, the incumbent in the Netherlands, launched XGS-PON in September 2021. KPN offers maximum download and upload speeds of 1Gbps. These symmetrical speeds can be an important differentiator against cable operator VodafoneZiggo, which offers maximum upload speeds of only 75Mbps. KPN was able to seamlessly upgrade its existing GPON FTTP network to XGS-PON without requiring any modifications to the fibre outside plant. An indication of the success of KPN's deployment is that it achieved year-on-year growth in fibre broadband service revenue of 10% in 1Q23.

WHOLESALE AND MULTI-USE

Chorus

Chorus is a wholesale-only operator of fibre broadband infrastructure in New Zealand. XGS-PON has enabled Chorus to support differentiated services, such as HyperFibre 2000, HyperFibre 4000, and HyperFibre 8000, to its retail service provider customers. Chorus's wholesale offers are used by retailers to supply residential and enterprise subscribers. Its 1Gbps, 2Gbps, 4Gbps, and 8Gbps offers accounted for 33% of residential fibre adds in 2H22.

NBI

NBI is delivering high-speed broadband services to homes, businesses, farms, and schools in rural areas in Ireland as part of the government's National Broadband Plan. NBI is a wholesale-only provider and has onboarded 51 retail service providers that are selling services as of June 2023. Some retailers offer multigigabit services. NBI's initial deployment of XGS-PON has helped it to rapidly increase the entry-level speeds included in its wholesale offers to 500Mbps.

Frontier

Frontier has adopted a multi-use strategy using XGS-PON, enabling multigigabit service offerings to residential and business customers throughout 25 states. Frontier cited 19% fibre revenue growth in the small and medium-sized enterprise (SME) sector in 1Q23, following 15% growth in 4Q22.

Frontier has been able to grow its SME subscription base and revenue through its XGS-PON deployment strategy.