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Our exhaustive intelligence and deep technology expertise enable us to uncover actionable insights that help our customers connect the dots in today's constantly evolving technology environment and empower them to improve their businesses – today and tomorrow.

* The majority of IHS Markit technology research products and solutions were acquired by Informa in August 2019 and are now part of Omdia.

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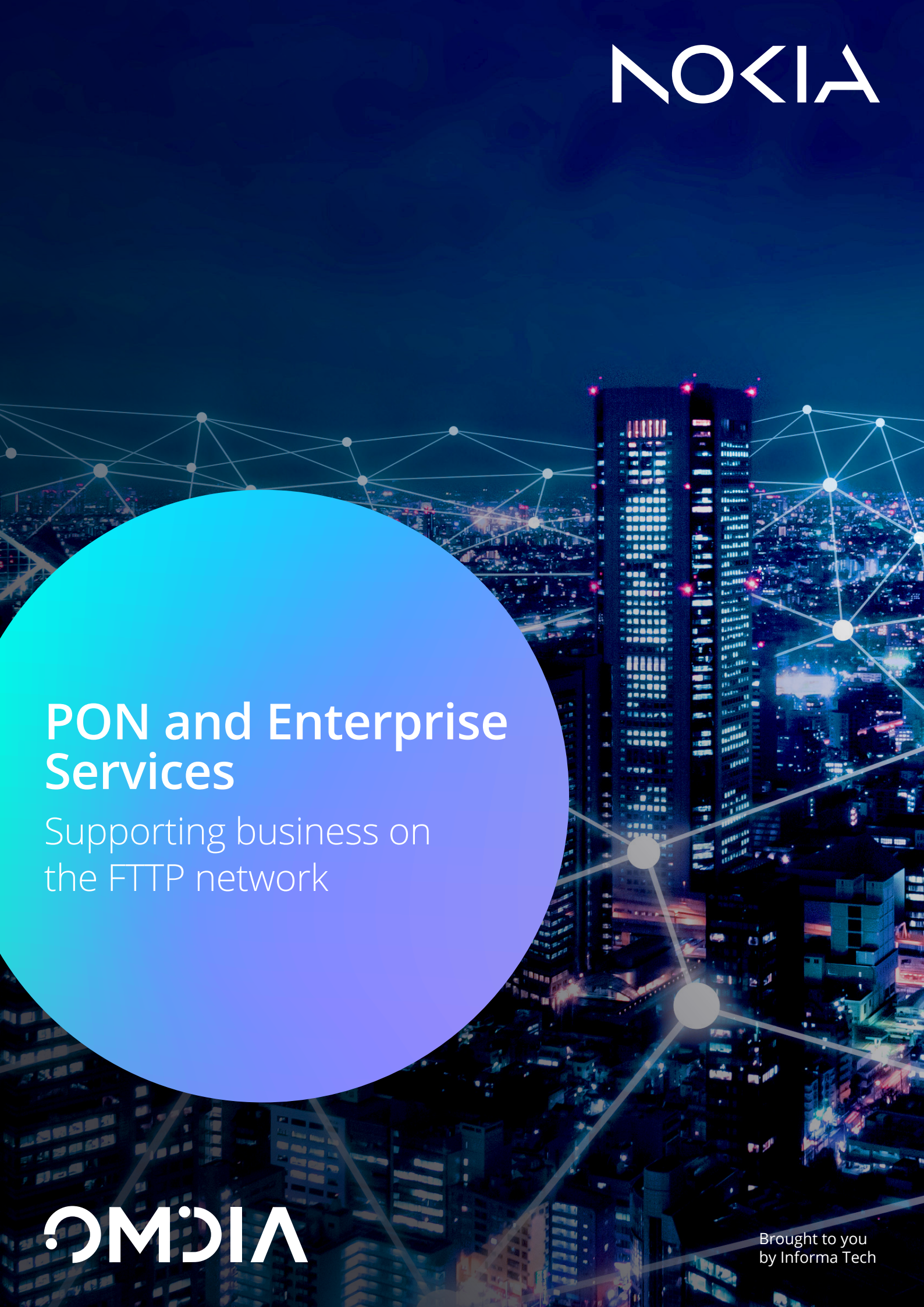

PON and Enterprise Services

Supporting business on the FTTP network

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Methodology

Omdia conducted in-depth interviews with operators from all regions in the world. The operators were diverse in terms of size, use of PON for enterprise services, and next-generation PON deployment plans. In addition, Omdia used existing market share trackers and forecasts from its Broadband Access Intelligence Service (BAIS).

Summary

Operators around the world are deploying fiber access network infrastructure using Passive Optical Networking (PON) solutions, benefitting from PON's advantages—such as the efficiency of its point-to-multipoint (P2MP) topology and energy savings. PON technologies are also easy to upgrade at both the network and the customer's premise sides, without requiring changes to the underlying optical distribution network (ODN).

This advantage helps explain why many operators are upgrading their fiber access networks to symmetrical 10G PON, which includes both XGS-PON and 10G EPON. Moreover, there is an exciting roadmap for PON technology upgrades beyond 10G PON—25G PON is in early deployment stages, 50G PON solutions will become available, and research efforts for 100G PON are underway, making PON very much the mainstream technology of choice for fiber access networking.

Many operators are now extending PON's usage to support enterprises, both large and small. For some operators, the goal is to use the same ODN for both residential and enterprise customers. This strategy is sometimes referred to as converged access networking, or universal access. These operators are keen to extend the benefits of PON-based fiber access networks to business subscribers.

However, based on extensive interviews with operators in all regions, Omdia finds that not all operators have adopted a multi-use or convergence strategy. Some operators express concerns regarding PON's technical abilities to support service guarantees or service level agreements (SLAs) to enterprise subscribers.

In addition, many operators have different engineering divisions based on subscriber type, and there is little incentive to share access networks between the divisions. Other operators are concerned that they will not be able to charge higher tariffs to enterprise subscribers if the same network is also used for residential subscribers. Consequently, these operators promote the use of point-to-point (P2P) Active Ethernet for enterprise customers.

There are good reasons why this situation is set to change. Operators are under pressure, given the growing bandwidth demand and the increased use of edge- and cloud-based applications by residential and enterprise customers. Such demands can be met with today's 10G PON technologies. PON also supports enterprise SLAs, encompassing bandwidth availability, latency and jitter requirements, security, and redundancy.

At the same time, many operators are striving to lower operating costs and improve ROI in FTTP infrastructure; the multi-usability of the PON infrastructure helps meet these objectives. In addition, many C-level executives are pressuring for a converged access network, and operators are facing increased competition from a wide range of fiber-focused operators.

Based on interviews, Omdia finds that enterprise customers are already beginning to churn from traditional operators offering high-priced P2P Active Ethernet services to operators offering a less-expensive FTTP PON-based network.

This white paper delves into the use of PON for enterprise services, based on in-depth interviews with different types of operators around the globe. It also explores the challenges and solutions, along with the advantages of adopting a convergence strategy.

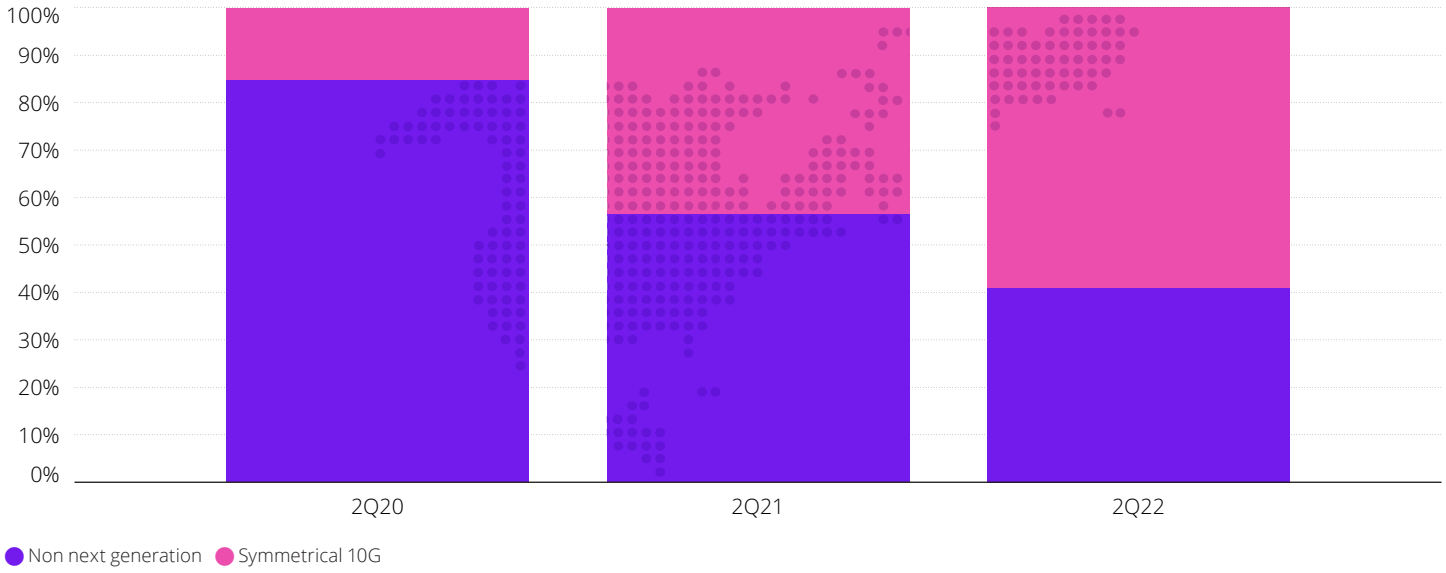
PON's technical capabilities

The use of PON infrastructure to support enterprises is not new, and PON technology has evolved to meet enterprise access networking requirements. This section presents PON's technical capabilities that allow it to support business services.

Bandwidth upgrades while preserving investment

PON technologies are designed to preserve investments in the underlying capital-intensive ODN while enabling bandwidth upgrades for subscribers. This capability is a good fit for enterprises that require scalable, symmetrical bandwidth to support cloud- and edge-based services and applications. PON technologies are well positioned to meet this requirement because they are designed to support easy upgrades on the network side, such as moving from GPON to XGS-PON, or from EPON to 10G EPON, with minimal service downtime.

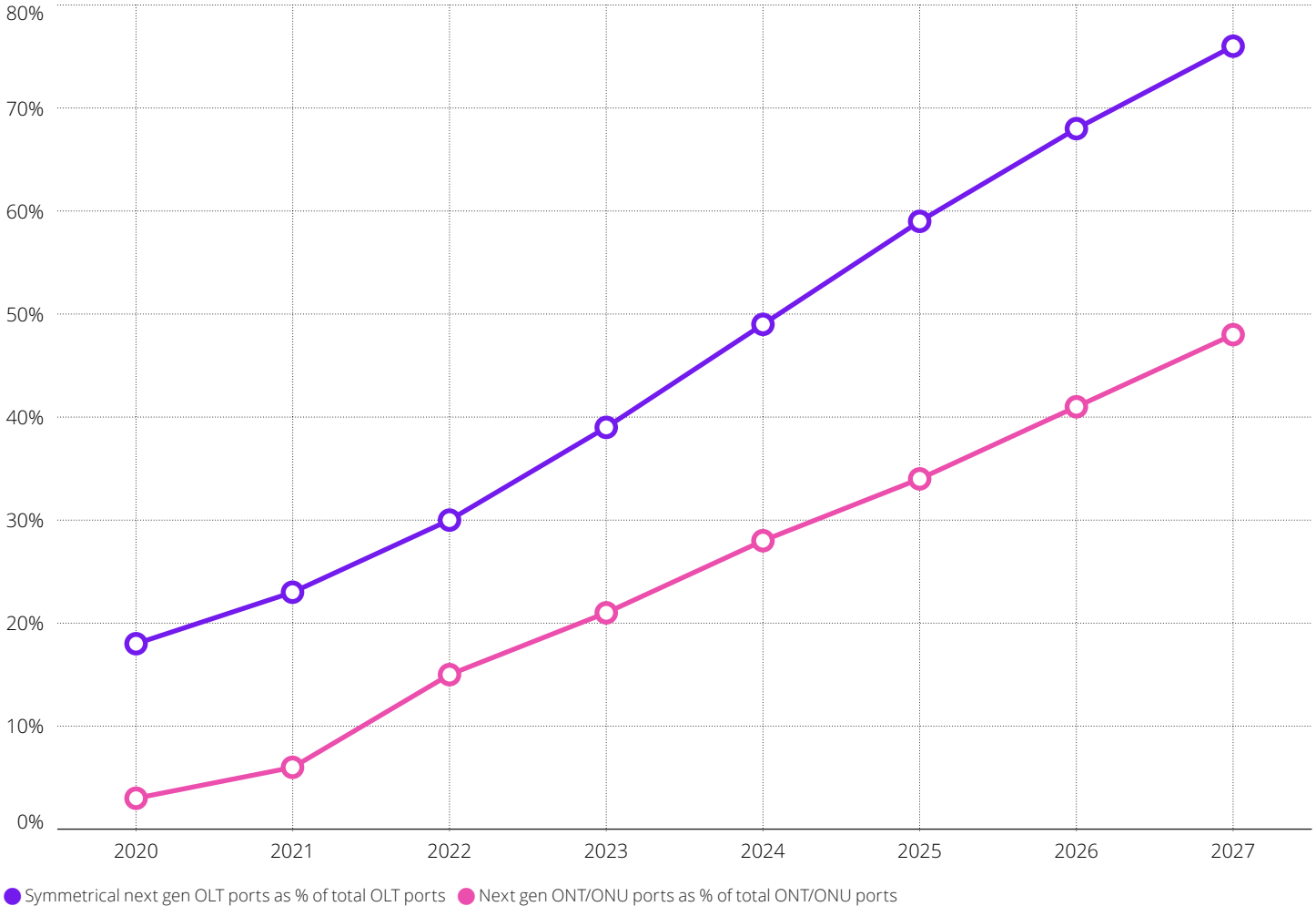
Figure 1: Symmetrical 10G PON OLT port shipments compared with non-next-generation – North America



Source: Omdia

This advantage explains why 10G PON OLT solutions, including XGS-PON and 10G EPON, are deployed in commercial volume by hundreds of operators around the world. The pace of uptake is rapid, and symmetrical 10G PON OLT port shipments are now dominating total OLT port shipments in North America, as shown in Figure 1. Symmetrical 10G PON OLT port shipments are also growing rapidly in EMEA (Europe, Middle East, Africa), rest of Asia & Oceania, and Latin America & the Caribbean.

Figure 2: Symmetrical next-generation OLTs and next-generation ONT/ONU ports, global – Actual and forecast

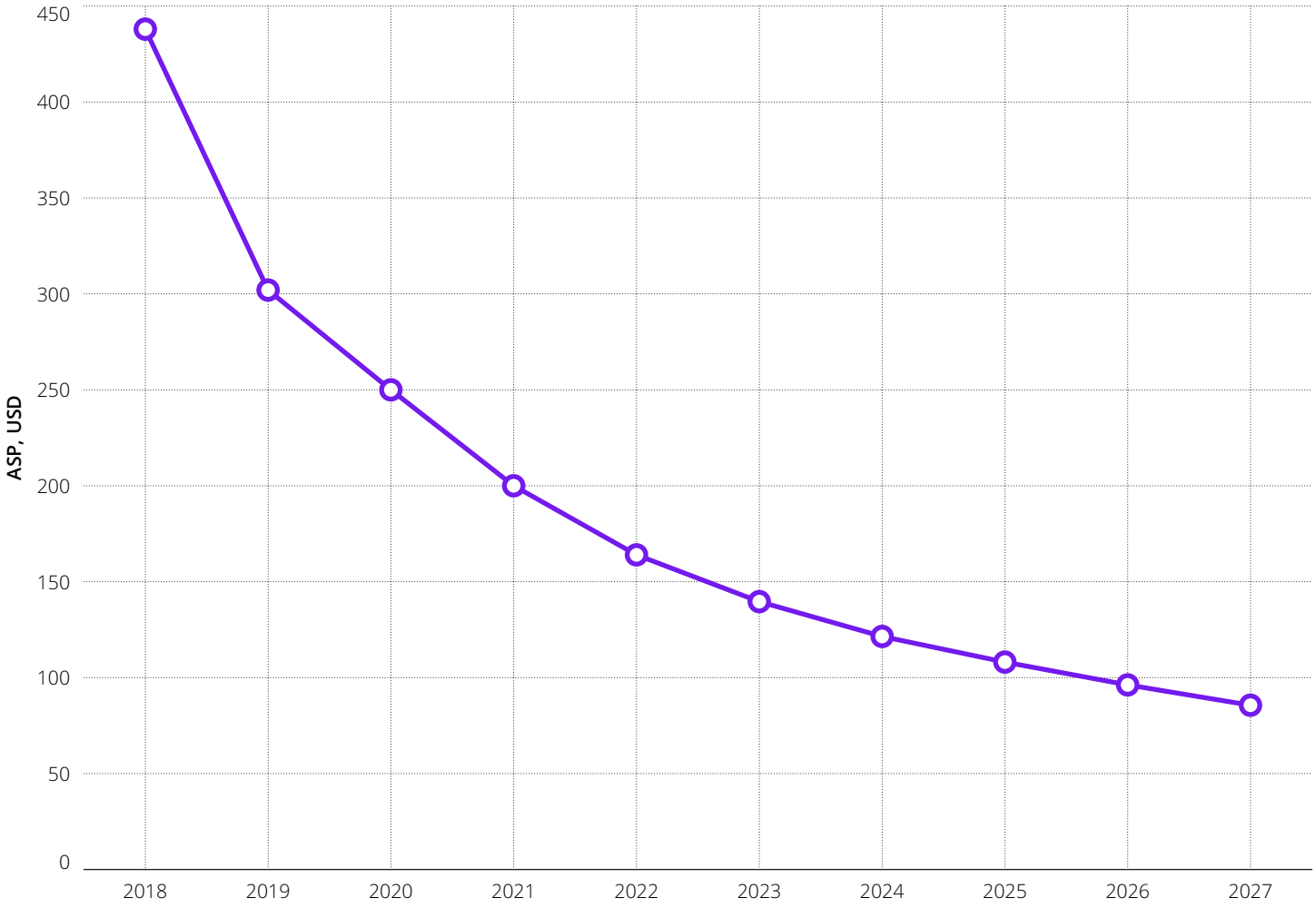


Source: Omdia

PON networks are well positioned to meet enterprises' continuing bandwidth requirements. Symmetrical 25G PON solutions are available today and commercial deployments have begun, while 50G PON is standardized, with initial pilots expected in 2023. In addition, 100G PON research and development efforts are underway.

Initial growth in next-generation PON OLT shipments can also generate economies of scale and help reduce prices for such OLT ports. Next-generation PON can also be cost effective because it supports higher capacities, which means it has the potential to support more customers with the same speeds compared with GPON, or alternatively, the same number of customers as GPON but with higher speeds. These factors mean that by 2027, symmetrical next-generation PON (e.g., XGS-PON, 10G EPON, and 25G PON) will dominate OLT port shipments, as shown in Figure 2.

Figure 3: ASPs for XGS-PON ONT/ONU ports – North America



Source: Omdia

Figure 2 also shows that next-generation PON ONT/ONU shipments are growing rapidly, reflecting the fact that operators have begun to deploy 10G-capable ONTs/ONUs on the subscriber side, thereby seamlessly supporting higher bandwidths when the subscriber wants them. Operators are also keen to deploy XGS-PON ONTs/ONUs because the costs of such equipment are continuing to decline rapidly, as shown in Figure 3. Residential XGS-PON ONTs/ONUs have dropped in price, from over $1300 in 2016 to around $160 in 2022, averaging the costs of bridge and gateway solutions. Average selling prices (ASPs) will fall further over time as shipments continue.

In summary, PON offers operators the potential to provide multi-gigabit bandwidths to enterprises. Operators can easily and cost-effectively upgrade their networks to next-generation PON on both the network and subscriber sides, and this helps explain why next-generation PON technologies are already being deployed in significant volumes.

SLAs

Operators are supporting SLAs on PON as they would on P2P fiber. The underlying fiberbased topology does not impact an operator's ability to provide data throughput, latency, jitter, packet loss, and redundancy SLAs. SLAs also encompass time-to-repair

metrics, and these are important reasons why enterprises are prepared to pay higher prices than non-enterprise customers. Importantly, the time-to-repair metric is likely to be unaffected by the underlying P2P or PON fiber topology.

Operators have adopted various strategies regarding SLAs for enterprises on PON networks, which highlights the flexibility of PON network topologies. Several examples from Omdia's in-depth interviews regarding SLAs are noted below:

- One operator offered a committed-rate service, meaning that they could dedicate 1G, 2G, 4G, and 8G to a particular customer—usually an enterprise, but sometimes a high-end residential user.
- Another operator noted that it offers three levels of services—committed rate, guaranteed rate, and best effort. This operator's sales team strives to sell the committed-rate service because the tariffs are significantly higher. The operator wants higher revenues, although competition is now impacting this strategy.
- A further approach offered by another operator is not to offer different classes of services for enterprise customers on the PON infrastructure. This operator noted that its business customers are satisfied with the service levels they receive.

Security and redundancy

PON technology and equipment solutions contain features that separate, encrypt, and secure data. According to several operators that support enterprise services on their PON infrastructure, PON's features are more secure than P2P Active Ethernet.

PON's security features include:

- **User isolation.** PON technology uses the gigabit encapsulation method (GEM), which is a label in the traffic header to isolate traffic for each user.
- **Traffic encryption.** In addition to data being separated for each user, the data itself is protected by encryption such as Advanced Encryption Standard (AES). Encryption keys are generated by each ONT/ONU and sent upstream to the OLT.
- **User activation.** PON has a user activation procedure that prevents unauthorized devices from being connected. Each ONT/ONU has a unique serial number and registration ID, which are programmed by the operator, so the OLT distinguishes ahead of time which ONTs/ONUs are to receive service, and therefore traffic.
- **Message integrity.** Message integrity checks (MICs) are used by OLTs and ONTs/ONUs to verify that the upstream and downstream control messages came from a legitimate source and have not been tampered with. MIC keys are independently calculated by the OLT and ONT/ONU and are executed in the control layer as a protection against malicious users.

Redundancy is a topic often raised by enterprise customers. While few enterprises are willing to pay for redundancy, they want to know that redundancy is an available option.

PON networks can provide a wealth of redundancy solutions, including:

- **Path protection**, such as the availability of a back-up fiber or the ability to switch to a different fiber in the case of fiber cuts.
- **OLT equipment redundancy**, where an enterprise can be transferred to a different OLT port in case of failure.
- **ONT equipment redundancy**, supplying a business with multiple ONTs in case of failure.
- **Combinations of the above**, thereby providing different types of redundancy in parallel.

“We are using PON to support business services. XGS PON meets our customer requirements and 25G PON will support even larger enterprises.”

“Our CEO pushed for convergence, the use of the PON infrastructure for enterprise services. PON gives more capacity at less power than P2P and we care about power.”

“We want to use the same infrastructure as much as possible. You can support SLA requirements on PON, it is the same as supporting them on P2P, just watch utilization.”

TIER 1 OPERATORS ACROSS THE GLOBE

Network resources – Monitoring, control, and management

Network operations require traffic monitoring, control, and management—regardless of the underlying access technology.

Several well-established methods exist for adjusting PON network resources to meet traffic requirements with minimal impact on existing subscribers and applications. Operators cited the following methods during the interviews:

- Adding XGS-PON support to the existing ODN. XGS-PON can provide 10G symmetrical capacities, thereby increasing downstream bandwidth by 4x and upstream bandwidth by 8x compared with GPON. XGS-PON and GPON can also be supported from the same combo PON OLT port, which provides even greater deployment flexibility.
- Deploying 25G GPON, which can coexist on the same ODN and OLT port as XGS-PON and GPON; 25G GPON can provide 2.5x downstream and upstream bandwidth versus XGS-PON.
- Changing the mix of subscribers on an OLT port. For example, if multiple businesses are on the same OLT port, traffic from each business may be high during the same hours. Combining residential and business subscribers on the same port may smooth out traffic peaks. This can be done during a very short maintenance window.
- Assigning a specific subscriber, such as a "power user," to a different OLT port. This lowers traffic utilization and potential congestion on that specific port. Again, this can be executed during a very short maintenance window.
- Reducing the number of splitters in the ODN. Many operators have placed the first set of splitters, such as a 1x2 or 1x4, inside the central office. Splitters can be removed, thereby reducing the number of subscribers per OLT port. This approach increases the number of OLT ports used.

Operators have different strategies for mixing residential and enterprise traffic on an OLT port. PON technology and traffic management tools support this wide range of strategies, as indicated by the answers in our interviews:

- One operator stated it built its network with 1x16 splits and mixed residential and enterprise traffic on the same PON OLTs. The operator notes this can work well because the timing of the different users' respective network usage, especially downstream versus upstream, can offset each other nicely. Nonetheless, the operator monitors usage closely and has had to move subscribers onto different ports to maintain QoS.
- Another operator noted it also monitors customers' traffic and that if peak traffic approaches 80% of OLT port throughput, the operator adds ports and reassigns customers.
- Another approach highlighted by one operator is to separate subscriber traffic by type. The operator does not mix residential and business traffic on the same OLT port. While the operator can have up to around 30 residential subscribers per OLT port, it limits business subscribers per port to a much lower number.

In summary, PON and the underlying P2MP ODN can support the technical requirements for enterprise services, including bandwidth, redundancy, and security. PON is already enabling operators to choose different strategies regarding business service SLAs. Some operators are focused on charging higher tariffs for SLAs, while others are choosing not to do so. However, the choice is a strategic business decision rather than a technical decision. Consequently, it is important to analyze the financial benefits of using PON infrastructure for enterprise subscribers.

Achieving the financial benefits

In addition to PON's technological suitability for supporting enterprise customers, there are compelling financial reasons for using PON infrastructure to support residential and enterprise subscribers. This approach is often referred to as converged access or universal access.

PON's cost advantages

There are operational and capital expense advantages to PON versus P2P optical networking solutions. Figure 4 summarizes PON's key advantages.

A P2P optical networking solution, such as Active Ethernet, requires a dedicated optical link per subscriber. This approach is expensive in terms of optics and fiber cabling, but it also poses space and power challenges—especially in dense areas, such as cities and towns.

A P2P network for a city with 1 million premises would require 1 million fiber terminations in an operator's central office, leading to high power consumption and extensive space requirements just to support fiber terminations. In contrast, the use of PON technology for access is a key component of the sustainability goals—including energy reduction plans—adopted by many operators. This is because of PON networks' passive connection between the OLT and ONT/ONU.

There was consensus throughout the interviews regarding the cost advantages of PON:

- PON offers huge cost savings compared with P2P. PON gives more capacity with less power. PON requires only a single transceiver at the central office for the number of subscribers served per OLT port. PON OLT optics, especially XGS-PON, can support multiple customers, so the optics savings are huge.
- PON ONTs/ONUs are significantly less expensive than P2P. One operator noted it is paying around $650 for high-end enterprise-grade XGS-PON ONTs, compared with more than $3,500 for a P2P solution.
- PON ODN construction costs continue to decline. The operator stated that the cost of connecting each home is much lower today, and there are solutions to cover multiple dwelling units (MDUs).

Figure 4: PON's advantages and business impact

- Fiber efficient
- Space savings for fiber terminations
- Energy savings –significant energy savings across the network
- Reuse expensive fiber cable plant for different customers and applications
- Supports wholesalers, retailers, mobile-only, and mixed/integrated

- Flexibility - upgrade network equipment and then upgrade subscribers as needed
- Built-in security across network stack
- Strong ecosystem
- Add access to well-established metro hardware and software solutions
- Support time-sensitive applications at the edge

Source: Omdia

It is also costly to maintain, upgrade, and manage multiple access networks for different subscriber types. For example, PON and P2P networks are managed in quite different ways, so catering to both residential and enterprise customers on the PON network offers reduced cost and complexity in terms of OSS and BSS integration.

In addition, using a single PON network for both residential and enterprise subscribers has the potential to deliver higher revenue and improve payback on investments in the network. XGS-PON can support more customers and meet many business services' bandwidth requirements. In a typical multi-use XGS-PON deployment, cumulative revenues can quickly exceed costs—potentially by the third year—while for residential-only XGS-PON deployments, this period will be considerably longer, potentially seven years or more. Furthermore, over time, the multi-use XGS-PON infrastructure continues to support more revenue than if the XGS-PON infrastructure is used only for residential services.

Addressing organizational challenges

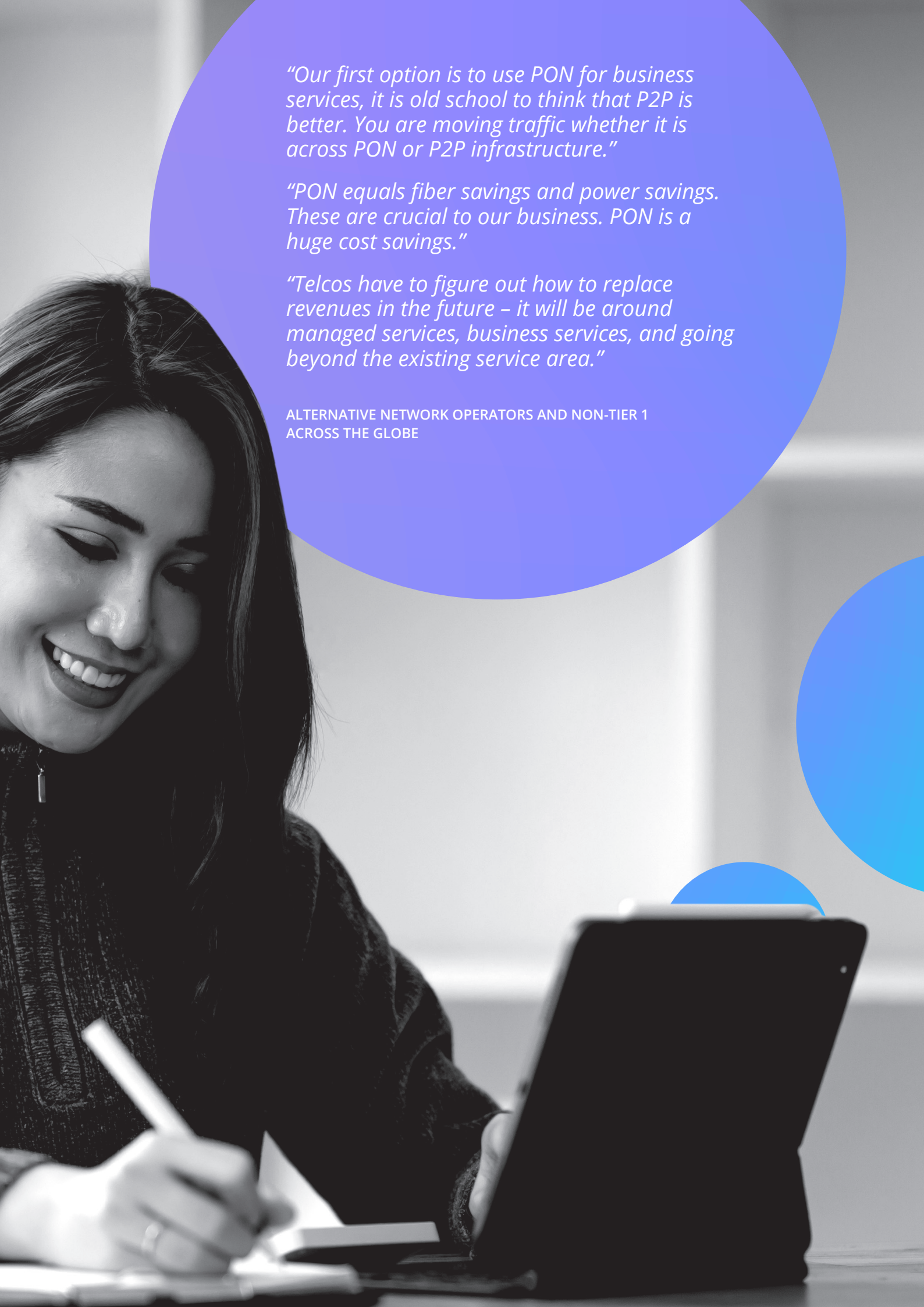
C-level executives set the goal for multi-use

PON is clearly technically capable of supporting enterprise customers, and doing so on a converged network alongside residential customers has important financial benefits. However, extending PON's use to enterprise subscribers also has some additional challenges. In this section, Omdia considers the need to overcome organizational silos.

The involvement of C-level executives is often crucial for setting the goal of PON multi-use. The executives can bring together and align engineering, operations, marketing, and sales teams. C-level executives set the stage for cooperation across organizational divisions and traditional silos. Executives can develop key performance indicators (KPIs) that reflect fiber access network reuse.

The importance of C-level involvement to establish cross-team KPIs was highlighted by many executives and managers during the interviews. The lack of collaboration was cited as a key challenge for the multi-use of the FTTP network.

- One operator highlighted that business services are handled by a different organization with different engineers and a different CEO than residential services. However, the operator noted it is going through a massive transformation to become more agile, more digital, and faster-to-market with new services. This transformation is driven from the top of the organization. The operator noted the transformation would enable it to support business services more efficiently and effectively, leading it toward a modern converged access network.
- Another operator stated it does not want to run multiple networks (one for residential and one for business services). This operator is working hard to support businesses on its GPON network, with the mandate to do so from the CEO.
- In another case, the different business units of the operator provide the engineering team with their forecasts. The engineering team then designs the network according to those forecasts, striving to put as much traffic from different types of subscribers onto the PON infrastructure as possible.



“Our first option is to use PON for business services, it is old school to think that P2P is better. You are moving traffic whether it is across PON or P2P infrastructure.”

“PON equals fiber savings and power savings. These are crucial to our business. PON is a huge cost savings.”

“Telcos have to figure out how to replace revenues in the future – it will be around managed services, business services, and going beyond the existing service area.”

ALTERNATIVE NETWORK OPERATORS AND NON-TIER 1
ACROSS THE GLOBE

Managing internal and external churn

Operators must also consider the impact of launching enterprise services over PON networks on any existing P2P Active Ethernet customers that they have. Operators considering using PON networks for enterprise connectivity must also assess the likely success of such a strategy by analyzing the competitive environment in their respective markets.

Assessing the impact of PON on existing P2P customers

Several operators have expressed concern that moving enterprises onto the PON infrastructure would reduce revenues. These operators believe they will be unable to charge the same tariff for a PON-based service versus a P2P service and are concerned about internal churn and losing P2P enterprise customers to their own PON infrastructure.

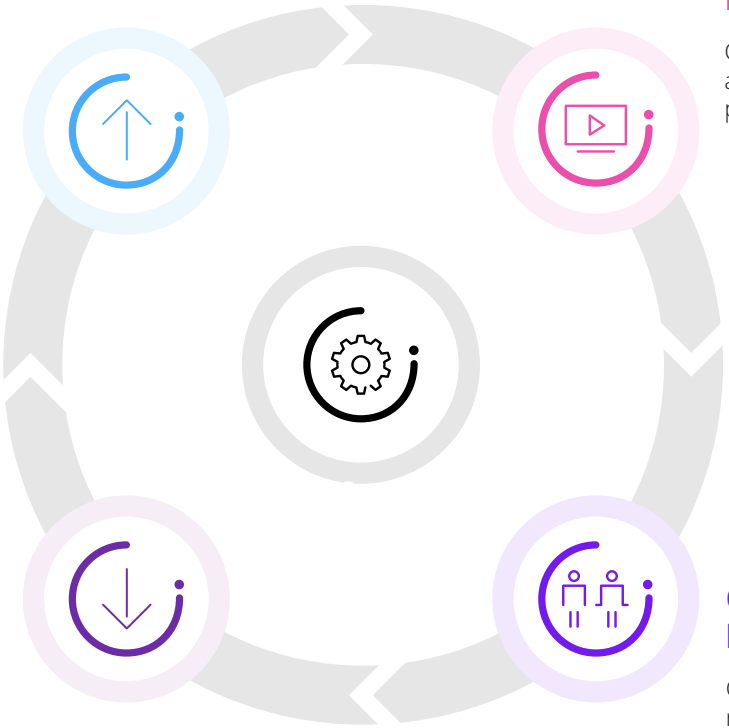
- One operator noted it has good results on P2P and that the pricing is much higher compared to PON. As a result, this operator is still pushing P2P because it is a higher-margin business. The operator acknowledges that there is space on the PON-based infrastructure for enterprise services; however, the operator prefers the higher revenues that P2P achieves, and its enterprise sales team pushes the older P2P approach because of this.

Concerns around internal churn are understandable. However, many operators face increased competition because different types of alternative network operators (altnets) deploy FTTP networks. Consequently, operators are facing both internal and external churn.

- In one interview, an operator expressed concerns about internal churn to lower-priced PON services and that, as a result, it markets P2P to enterprises. At the same time, the operator also stated it worries about external churn because its business customers could go to the competitor that offers lower tariffs on PON infrastructure.

Protecting revenues on a P2P network may work in the short term, until a competitor offers business services at a lower price on a PON-based fiber network, as summarized in Figure 5.

Figure 5: Churn owing to external competition



Source: Omdia

Mitigating internal and external churn

Omdia's interviews highlighted that most operators have developed a range of strategies for managing churn and the threat of lower revenues. Some operators focus on the volume of subscribers rather than the ARPU, while others focus on value-added services.

- One operator noted that its strategy is to focus on volume. The operator uses PON for 99% of the market opportunity. It offers 10x the bandwidth for less than $100 per month. The operator says this is very appealing to SMEs because these customers were paying much more—sometimes 10x more—to its competitors for P2P. The operator notes that it is going full steam ahead with XGS-PON and will only consider building separate networks for different types of subscribers as a last resort.
- Another operator stated that business subscribers will go to the least expensive bandwidth offering if it meets their requirements. As a result, the operator noted that traditional telcos will not be able to keep most of their high-tariff P2P customers and that PON, and particularly XGS-PON, can supply the necessary bandwidth. The operator's conclusion was that operators must offer managed services, such as managed Wi-Fi, to make up for the loss of revenues from P2P offerings.
- Another operator highlighted the competition from aggressive fiber access network builders. The operator stated that business subscribers are moving to the competition that uses PON. As a result, the operator is focusing on value-added services and quad-play offerings.

To converge or not

Convergence strategy analysis

After operators have assessed potential obstacles to a converged network strategy that uses PON for enterprise connectivity, they must decide on their strategy.

Some operators have used PON infrastructure to support business customers for over 15 years. Often, the early adopters were smaller operators with single engineering teams supporting network design and equipment choices for different types of subscribers. These smaller operators were not siloed by different engineering or operational teams for each type of subscriber.

More recently, new operators, such as altnets, have been using PON infrastructure for multiple types of subscribers. Some new operators want to support as much traffic as possible, leading to faster financial payback and a higher ROI.

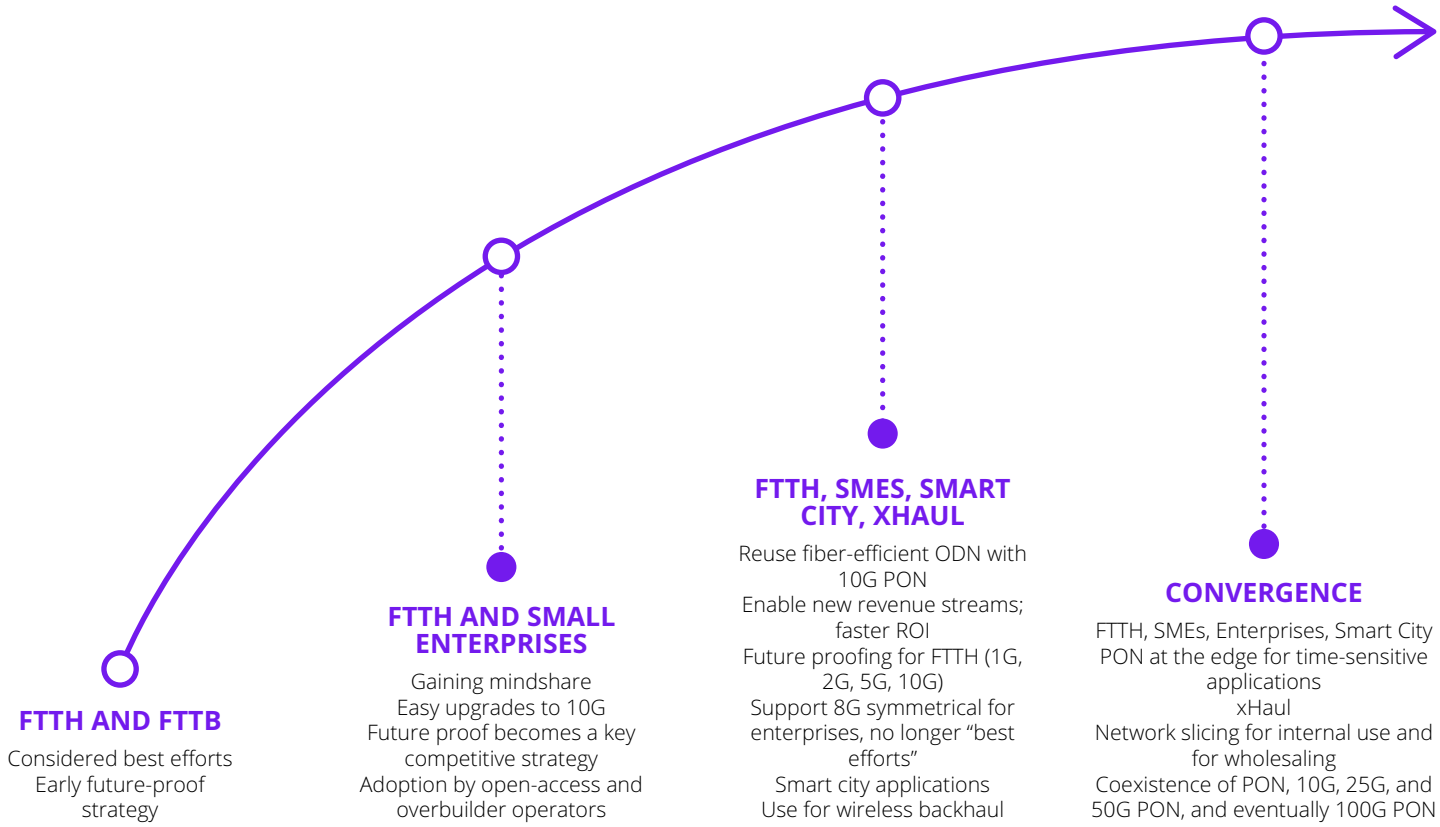
However, PON's heritage is its "best-effort" services for residential customers. This helps explain that while PON's usage is evolving quickly, many operators remain at the first stage regarding their use of PON, as shown in Figure 6.

In many cases, the larger and older operators are facing a difficult challenge regarding the use of PON infrastructure for "beyond-residential." They have separate divisions designing, building, and upgrading networks for different types of subscribers. In parallel, enterprise marketing and sales teams understand P2P-based services and have been marketing and selling these services for many years.

Operators, whether larger or smaller or older or newer, should evaluate the convergence of the access network, using PON infrastructure to support both residential and enterprise customers, when feasible. Figure 7 summarizes the recommended considerations for adopting a converged access network strategy.

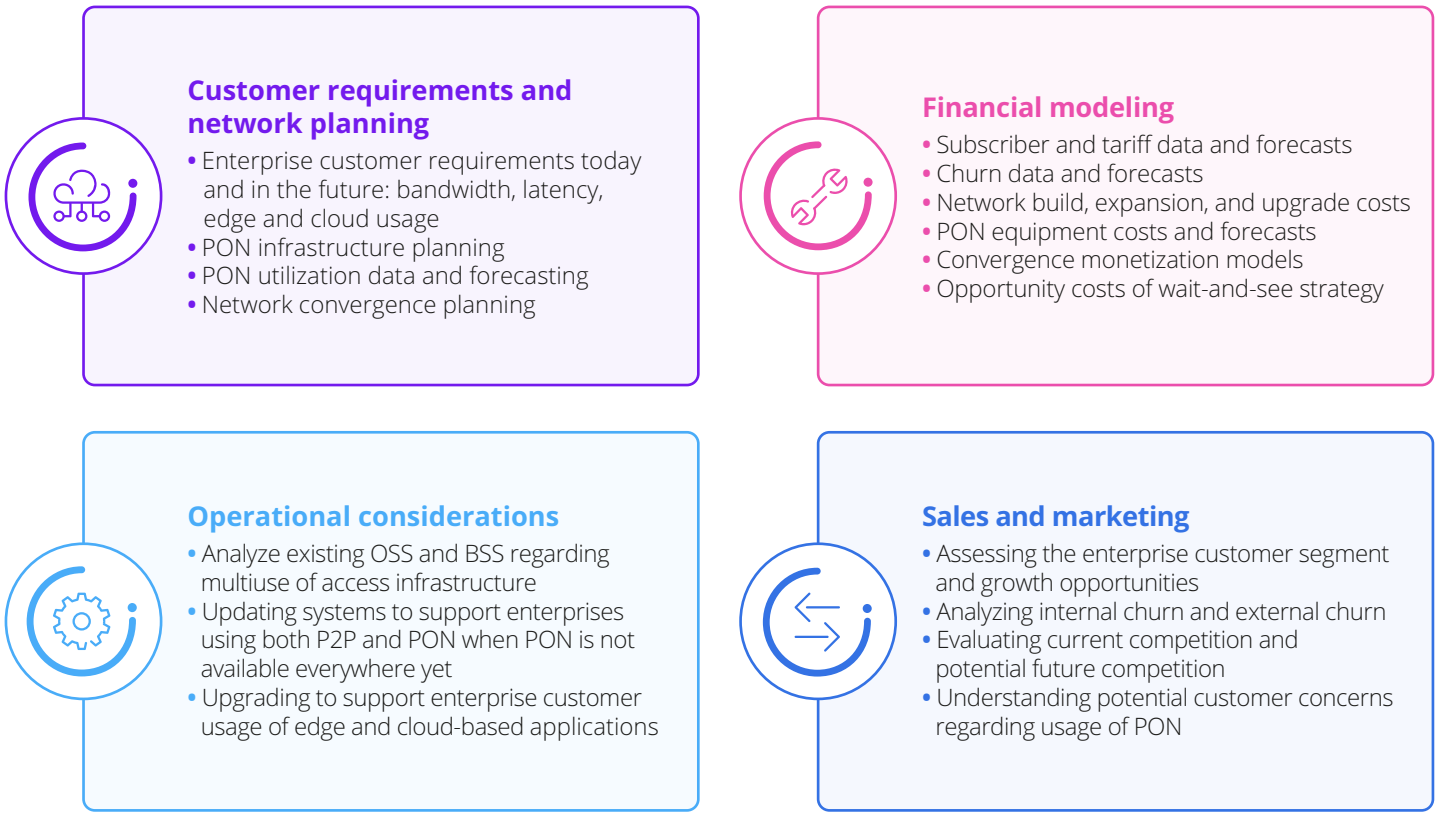
There are many factors to evaluate, which are interrelated. For example, financial modeling is based on many inputs, ranging from the estimated costs of network upgrades and customer premise equipment (CPE) to the impact of competition on churn and tariff strategies. Convergence strategy analysis needs to be holistic and led by an executive with the resources and authority to pull together the different divisions.

Figure 6: PON's expanding and evolving role



Source: Omdia

Figure 7: Convergence considerations



Source: Omdia

Wait-and-see strategy

After evaluating the value of moving to a converged network, some operators may decide to continue supporting multiple access networks for residential and enterprise customers. However, the analysis—whether to move to a converged network or otherwise—must be revisited every year or two to assess if market conditions have changed.

The relevant factors that operators must consider include:

- Bandwidth demand among enterprise customers
- Demand for cloud-based and edge-based applications by enterprise customers
- Internal plans regarding PON infrastructure upgrades, such as GPON to XGS-PON and to 25G PON and beyond
- Vendor solutions, such as the pricing of next-generation PON equipment, including OLT ports and ONTs/ONUs
- Internal churn rates (the churning of enterprise customers to available PON-based offerings)
- Competitors' PON deployment plans, such as expansions and upgrades
- Competitors' offerings and pricing strategies
- External churn rates (the churning of enterprise customers to PON-based networks offered by competitors)

Conclusions

Operators have the opportunity to move toward a converged or universal access network, using PON infrastructure to support enterprise customers. PON networks have the technological capabilities to support enterprise customers. Next-generation PON will be valuable for enterprises because the usage of edge- and cloud-based applications continues to grow, requiring the high and symmetrical bandwidths that XGS-PON and 10G EPON provide.

PON technology also offers well-established upgrade paths from 10G to 25G PON to 50G PON and beyond to cater for enterprises' future connectivity needs. The technological capabilities of PON are also shown by the fact that it already supports a range of customers, from those requiring strict SLAs and committed rates to those seeking best-effort services. Furthermore, PON technology supports secure communications.

The multi-use of PON infrastructure extends PON's capital and operational efficiencies, as well as energy savings to the support of enterprise customers, enabling operators to achieve a faster financial return on the underlying PON ODN roll-out. The price differences between older generations of PON equipment (e.g., GPON) and newer generations of PON equipment (e.g., XGS-PON) are declining rapidly, leading to even faster monetization of the PON infrastructure, especially in a multi-use scenario.

Operators must also consider some of the barriers to the adoption of a multi-use strategy for their PON infrastructure. Operators must involve different divisions across the organization and overcome organizational silos to move to a multi-use strategy. The evaluation process should be led by C-level executives, involving senior management in the evaluation and decision process.

Operators must also consider some of the potential financial challenges of moving to a multi-use strategy for their PON network. The decision to move to convergence should encompass the impact of potential internal churn, external churn to competitors, and increasing bandwidth demand by residential and enterprise customers. Even if the decision is to wait and see, the decision should be re-evaluated as updated information becomes available.

In summary, PON infrastructure multi-use is gaining traction, supporting residential and business services. Operators that move toward such a converged network architecture stand to benefit.

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