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TWDM PON Is on the Horizon

Facilitating fast FTTx network monetization

Summary

Catalyst

With the completion of lab trials this year, commercial trials expected in 2015, and initial deployments forecast for 2016, TWDM PON (time wavelength division multiplexing passive optical networking) is on the horizon. While today's PON meets the requirements of residential subscribers, small-to-medium-sized businesses (SMBs), and some MBH (mobile backhaul) applications, CSPs (communications service providers) want an access solution with higher bandwidth and enough flexibility to also support large enterprises and fronthaul. TWDM PON fulfills this role and provides pay-as-you-grow options, allowing realistic adoption of FMC (fixed–mobile convergence) throughout the access network. In addition TWDM PON enables efficient sharing of the FTTx network, whether mandated by regulatory authorities or chosen by CSPs through co-investment partnerships. The TWDM PON architecture facilitates FTTx network monetization with its support of high-revenue services over the same ODN (optical distribution network) as residential subscribers.

Ovum view

- **TWDM PON supports fast FTTx network monetization.** Today's PON supports residential and non-residential customers and applications including FTTH, SMBs, and MBH. TWDM PON allows support for higher-ARPU subscribers such as enterprises, leading to faster ROI (return on investment) while enabling pay-as-you-grow network deployment options.
- **TWDM PON will surpass XG-PON1 as the next-gen GPON architecture of choice.** The bandwidth upgrade enabled by XG-PON1 compared to GPON is not sufficiently attractive to many CSPs. CSPs are seeking significantly more downstream/upstream bandwidth to enable the support of high-ARPU business services.
- **TWDM PON will be adopted both by CSPs new to FTTx and those with existing GPON networks.** TWDM PON uses the same ODN as existing GPON networks, enabling reuse of expensive network assets. For CSPs evaluating FTTx network architectures, TWDM PON is attractive given its ability to support multiple types of subscribers and applications simultaneously.
- **The TWDM PON ecosystem is robust.** PON component and equipment vendors are ready. Standards are well under way with completion expected in early 2015. In addition, vendors are developing technologies to lower the cost of TWDM PON gear, particularly for optical network terminals (ONTs), the customer premises equipment.
- **CSPs should evaluate TWDM PON, focusing on network deployment and monetization scenarios.** Now is the time CSPs should begin evaluating TWDM PON, analyzing deployment scenarios in terms of operational and monetary benefits. This analysis encourages equipment vendors to develop case studies and models.
- **TWDM PON's architecture and flexibility position it to become the FMC access platform.** It can support wireline and wireless-related services (MBH and fronthaul) along with respective subscriber, application, and bandwidth growth.

The case for next-gen PON

PON is the leading FTTx architecture

FTTH networks are supporting more than 130 million households around the world today. PON is the dominant FTTx technology due to the cost advantages of its point-to-multipoint architecture when compared to point-to-point fiber. PON's dominance will continue: Ovum forecasts that more than 90% of the expected 300 million FTTH subscribers in 2019 will be on PON networks.

Today's PON networks are reaching beyond residential subscribers; they are supporting SMBs and MBH (mobile data backhaul) traffic. These non-FTTH applications provide additional revenue streams, usually at higher ARPUs (average revenues per user) than residential subscribers, while using the same network. Support for MBH service requirements became possible when timing and synchronization functions were added at the component and equipment levels.

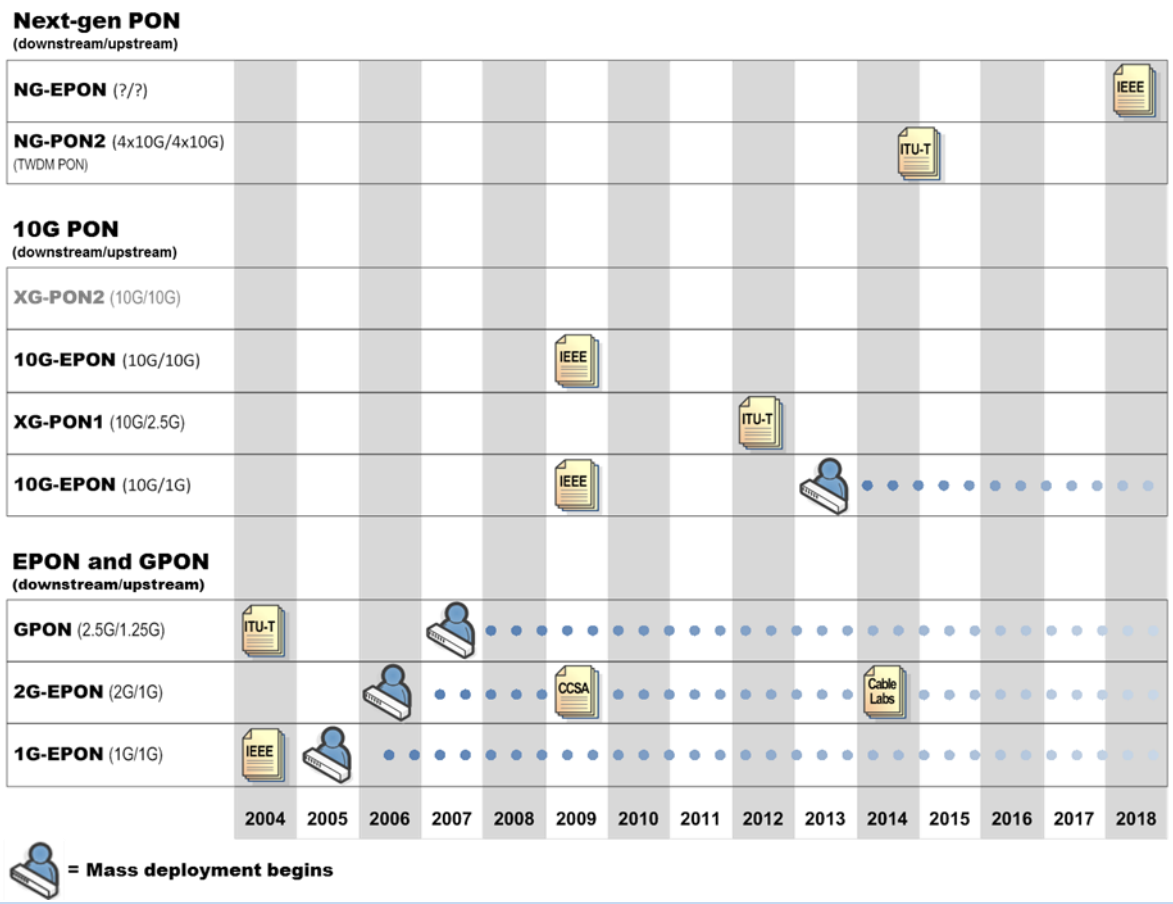
CSPs are interested in evolving their networks to meet the application and service requirements of different types of users while lowering the costs of network builds and operations. Next-gen PON supports the delivery of ever-increasing video-intensive applications – video now represents the majority of Internet traffic, with continuous growth in both video downloads and uploads. PON's use for MBH is expanding, providing a growing revenue source for FTTx operators choosing to lease their FTTx networks for this service. Several wireless operators have acquired wireline networks to support internal MBH needs, thereby reducing opex associated with the leasing of MBH services.

Next-gen PON solutions

Overview

Next-gen PON solutions have focused on higher bandwidths for both downstream and upstream transmission. There are two major development efforts, one focused on EPON and one focused on GPON, following their respective standards groups, IEEE and ITU-T/FSAN. PON development and standardization activities are summarized in Figure 1.

Figure 1: Next-gen PON development and standardization efforts



Source: Ovum

Applications driving demand for next-gen PON

Four major application areas are driving next-gen PON development and standardization.

- FTTBuilding for multi-dwelling units (MDUs) – In these deployments, next-gen PON would provide more bandwidth to be shared among the units in the building.
- Enterprises – Next-gen PON would provide enterprises with more upstream bandwidth, supporting video conferencing and cloud-based file backup, for example.
- MBH – Next-gen PON supports the growth in mobile traffic that needs to be backhauled along with backhaul support for VDSL2 vectoring and g.fast micronodes.
- Fronthaul – The use of PON for fronthaul becomes an option with TWDM PON supported by a point-to-point fiber overlay on a dedicated wavelength. In the future, PON equipment vendors believe that fronthaul could be supported as a dedicated wavelength within a TWDM PON optical line terminal (OLT). Fronthaul refers to the connection between disparate radios to the centralized controllers via CPRI (common public radio interface) thereby supporting cloud-based radio access networks (C-RANs), for example.

Currently, the major drivers of next-gen PON are to serve enterprise subscribers and MBH. FTTH is becoming the norm in the majority of FTTx deployments due to improvements in the flexibility and size of fiber cabling along with operational issues and costs associated with FTTBuilding. The use of PON for fronthaul is still a new application.

Next-gen EPON – status, standard, ecosystem, and deployments

The IEEE ratified 10G EPON (802.3av) in September 2009 with two variations:

- 10G EPON symmetrical – supporting 10G downstream and upstream
- 10G EPON asymmetrical – supporting 10G downstream and 1G upstream.

10G EPON was designed to coexist with 1G EPON and to provide backward compatibility with 1G EPON. For example, 10G EPON and 1G EPON can operate on the same ODN, enabling CSPs to upgrade specific subscribers to 10G while maintaining other subscribers at 1G.

The 10G EPON ecosystem is robust and includes laser vendors, optical interface chip vendors, bidirectional optical subassembly (BOSA) and transceiver vendors, media access control (MAC) chip vendors, and equipment vendors. China Telecom has tested and shown interoperability at both the component and equipment levels.

10G EPON equipment is shipping, although volumes are well below original forecasts. Deployments include FTTBuilding MDUs and non-FTTH applications, such as enterprises and MBH. Enterprise services and MBH are the leading applications for 10G symmetrical EPON. CSPs deploying 10G EPON include traditional telcos, such as China Telecom, and cable operators, such as Bright House Networks in the US.

EPON component and equipment vendors along with CSPs have begun to discuss NG-EPON options beyond 10G via the IEEE 802.3 NG-EPON Ethernet Working Group.

Next-gen GPON – status, standard, ecosystem, and deployments

The ITU, through the FSAN (Full Service Access Network) Next-Generation PON (NG-PON) Task Group, has established standards for next-gen GPON.

- XG-PON1 (part of NG-PON1) – Provides asymmetrical speeds of 10G downstream and 2.5G upstream as outlined in the ITU standard G.987, which was ratified in 2010.
- TWDM PON (part of NG-PON2) – Combines the dedicated wavelength approach of WDM PON with GPON's support for multiple subscribers on each wavelength. The standard for TWDM PON is expected to be completed in the first half of 2015. TWDM PON provides four or more wavelengths per fiber, each of which is capable of delivering symmetrical or asymmetrical bit rates of 10G or 2.5G.

XG-PON1 was designed to coexist with GPON on the same ODN, allowing subscribers to be upgraded incrementally. Solutions using the XG-PON1 standard have been developed by leading PON component and equipment vendors. Several CSPs have trialed XG-PON1 equipment, but there have been very few commercial deployments to date. Lack of significant demand for XG-PON1 will likely continue, as GPON provides sufficient bandwidth for initial MBH and SMB applications.

FSAN's participants analyzed a number of approaches to NG-PON2 including WDM PON. After significant cost and operational analysis, they chose TWDM PON. With WDM PON, each customer is assigned a dedicated wavelength, offering bandwidth and performance advantages, but equipment and operational costs are high when compared to the point-to-multipoint architecture of TWDM PON.

TWDM PON is likely to be chosen by CSPs as the next-gen GPON solution due to its overall bandwidth capacity, ability to separate traffic types by wavelength, and pay-as-you-grow wavelength and bandwidth flexibility. In addition, TWDM PON, unlike GPON and XG-PON1, can easily support the equivalent of regulation-mandated LLU (local loop unbundling) in FTTx networks.

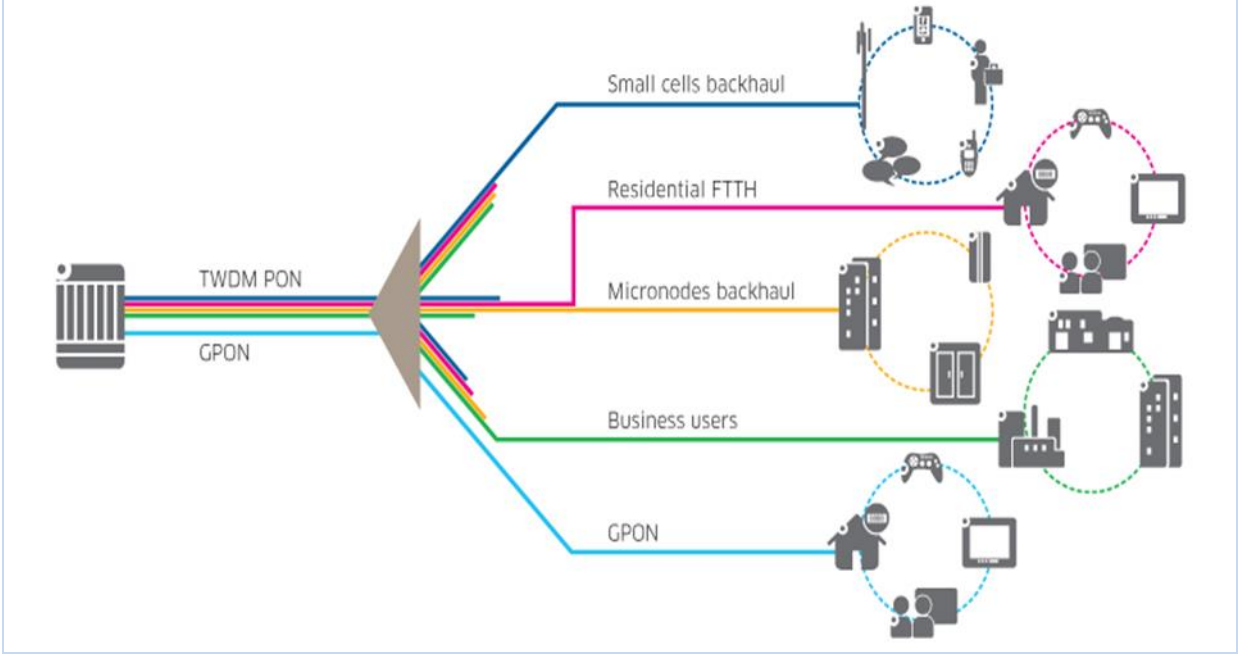
TWDM PON – analysis, ecosystem, and status

Overview of TWDM PON

The TWDM PON network architecture combines the cost advantages of GPON, which can support multiple subscribers on a single wavelength, with the wavelength flexibility of WDM PON, which allows wavelengths to be dedicated to particular subscribers or applications. TWDM PON can provide 80G of capacity with eight wavelengths of 10G each. However initial equipment solutions are focusing on 40G with support for four wavelengths.

Figure 2 depicts the TWDM PON architecture. It coexists with GPON and XG-PON1 without requiring changes to the underlying ODN.

Figure 2: TWDM PON network architecture



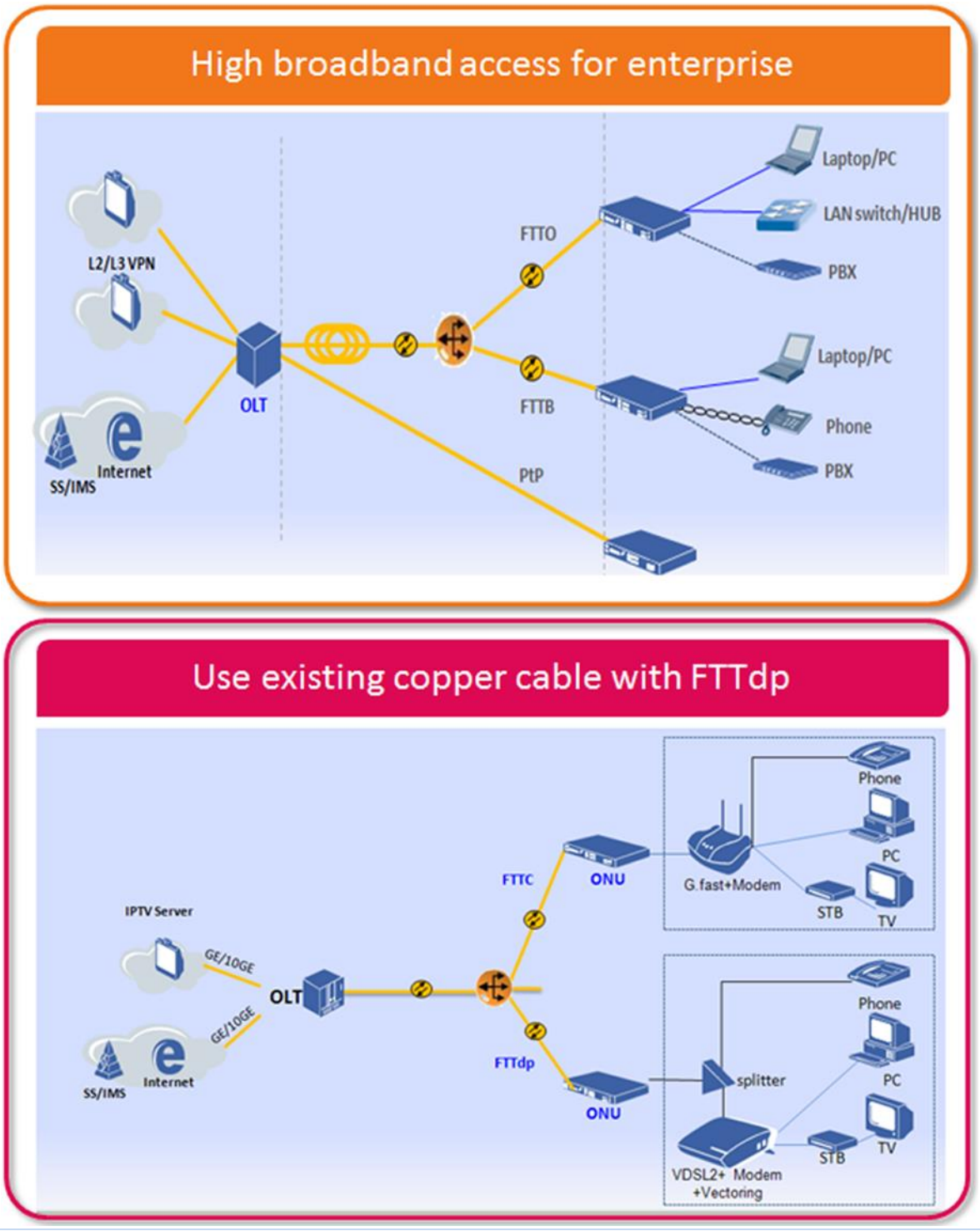
Source: Alcatel-Lucent

TWDM PON's major advantages

Enabling faster network monetization

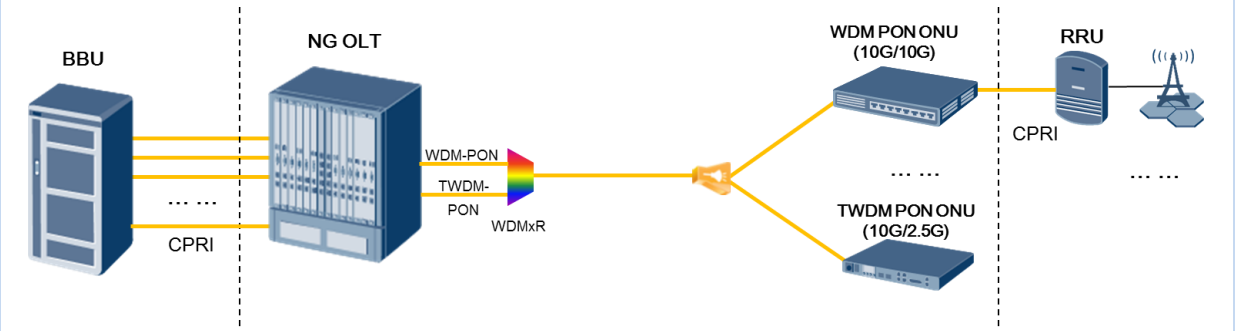
A significant advantage of TWDM PON is its ability to support different types of subscribers or applications by using different wavelengths and different bit rates on those wavelengths. A CSP can assign a single wavelength to a particular customer, such as an enterprise, or to a particular application, such as mobile backhaul, as shown in Figures 3 and 4. The ability to simultaneously support more subscribers, more applications, and even network sharing leads to faster network monetization, which is important given the costs associated with building an FTTx network.

Figure 3: TWDM PON – supporting multiple service types



Source: ZTE

Figure 4: TWDM PON – supporting fronthaul with WDM PON



Source: Huawei

Dedicated wavelength flexibility supports open access FTTx networks. Often government regulatory authorities require CSPs, particularly incumbents, to share their fiber infrastructure for a fee, similar to LLU (local loop unbundling) in copper-based networks. Other CSPs may choose to lease a portion of the fiber-based access infrastructure to another CSP, such as an over-the-top (OTT) player, or several CSPs may choose to co-invest in building the FTTx network. In these scenarios, TWDM PON supports sharing of the FTTx network since dedicated wavelengths can be assigned for LLU or to different CSPs. Fiber sharing is more difficult on today's PON networks. For example, in the case of bitstream sharing, there is inherent bandwidth competition between the multiple CSPs as they try to maximize QoS (quality of service) for their respective customers.

In addition, point-to-point connections can be established over the TWDM PON network for specific applications such as fronthaul, which has strict performance requirements including latency.

Coexistence and selected upgrades – supporting rational investment

TWDM PON coexists with GPON and XG-PON1. First, no changes are required to the ODN itself, including fibers, splitters, distribution frames, and cabinets, to name a few elements within the FTTx network. Bottom line: GPON network investment is preserved.

Second, TWDM PON can be added on top of an existing GPON or XG-PON1 network; an existing GPON network can be upgraded piecemeal and over time as determined by a CSP. This provides a CSP with tremendous network planning and expansion flexibility. A CSP could deploy TWDM PON where it has identified new market opportunities, such as enterprise subscribers or the leasing of MBH services. It could use TWDM PON for internal support of 4G LTE fronthaul and backhaul needs. The CSP could also opt to upgrade existing high-end residential customers to TWDM PON where it faces significant competition from other CSPs promoting 1G and beyond.

Pay-as-you-grow flexibility by adding wavelengths

In addition to choosing when to deploy TWDM PON, CSPs can choose how to deploy TWDM PON. The FSAN Task Group developed TWDM PON to support pay-as-you-grow wavelength additions. Wavelengths can be added one by one as needed to support customer growth and high-bandwidth applications.

Positioned to become the FMC access platform

Over the past several years, a number of wireless operators have acquired wireline telcos. Strategic reasons for these acquisitions include the offering of bundled wireline/wireless services, use of the wireline network for internal MBH and fronthaul needs, and expansion into the fast-growing data center market. Converged CSPs are seeking a unifying access platform that supports both wireline

and wireless-related services while lowering capex and opex as the subscriber base and application offerings grow. TWDM PON fits the requirements of a FMC access platform, with the necessary architecture and flexibility to support wireline and wireless-related services while meeting their respective subscriber and bandwidth growth needs.

TWDM PON – challenges and potential solutions

A significant challenge for TWDM PON revolves around the cost of the ONT optics for CPE (customer premises equipment). TWDM PON requires tunable optics, and accurate tuning must be possible in the field to support efficient installation and operations. Non-tunable GPON ONT BOSAs (bidirectional optical subassemblies) cost under $9 today, and the price continues to decline year over year. The future cost of a tunable ONT BOSA or transceiver laser for TWDM PON should decline to around $100 with volume shipments. While the cost of expensive OLT optics can be spread over many subscribers, especially with the bandwidth supported by TWDM PON, ONT costs become substantial as more subscribers are brought onto the network. While there is less price sensitivity for high-ARPU customers and applications, such as enterprises and MBH, CSPs are highly concerned regarding residential equipment costs. However, residential customers on a TWDM PON network can remain on existing GPON connections, thereby mitigating the expense of CPE upgrades.

Our discussions with vendors, including Alcatel-Lucent, Huawei, and Adtran, indicate that they are exploring solutions for lowering the costs of tuning – for example, by using cooling and heating technologies to perform in-field transmitter tuning. Further research is expected to lead to further cost reductions and improved tuning accuracy.

Status – standards, availability, and testing

We expect the FSAN Task Group to complete the standards for TWDM PON this year or next, with ratification by the ITU in 2015. Since the standards are nearly complete, PON equipment vendors have developed first-generation TWDM PON solutions. Product availability has been announced by major tier-1 and tier-2 vendors including Alcatel-Lucent, Huawei, ZTE, and Adtran. In addition, PON component vendors, such as laser vendors, optical interface chip vendors, and optical transceiver/BOSA vendors, are developing TWDM PON–compliant products. Currently TWDM PON solutions are based on field-programmable gate arrays (FPGAs). We do expect PON MAC chip vendors to begin application-specific integrated chip (ASIC) development following standardization.

Initial testing of TWDM PON has been carried out by several CSPs in Europe and the US. Several of the early tests focused on the ability of TWDM PON to support FMC as these CSPs are seeking a next-generation FMC access platform given their wireline and wireless businesses.

Initial commercial deployments of TWDM PON may begin in late 2015, although 2016 is more likely. We expect widespread deployments in 2017 or 2018.

TWDM PON deployment scenarios and economics

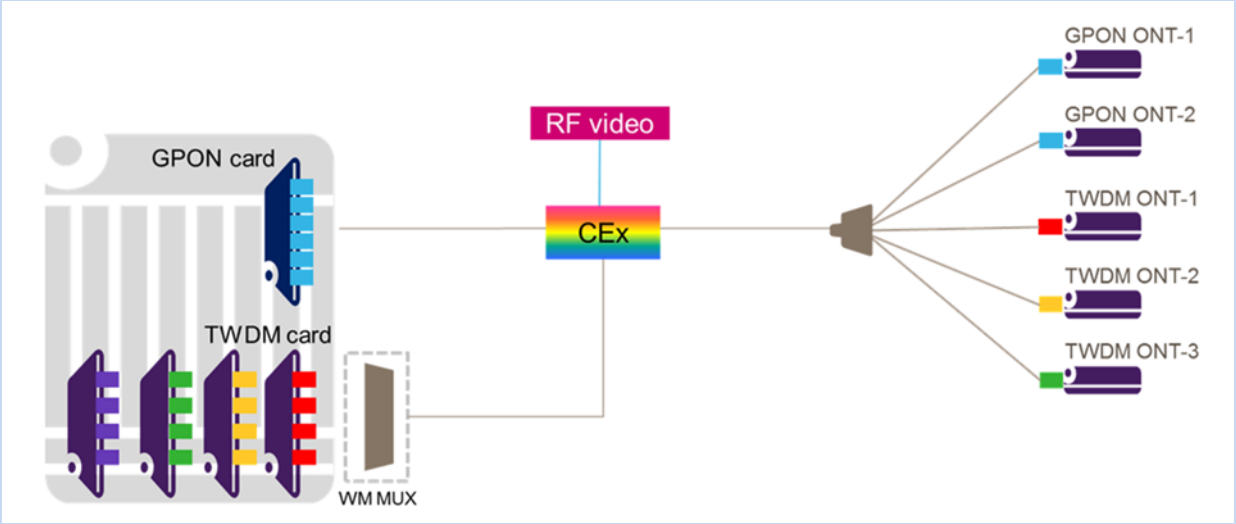
Moving from GPON to TWDM PON – upgrade scenario

CSPs with existing GPON FTTx networks and those in the planning stage need to evaluate the advantages of TWDM PON along with potential deployment scenarios. In TWDM PON, the

wavelengths need to be multiplexed, and there are several ways to implement multiplexed wavelengths into a GPON network.

In the case of an existing GPON network, the most likely upgrade approach is to insert a TWDM card into the OLT platform as shown in Figure 5. The TWDM PON line card could have one wavelength on each port or different wavelengths on each port depending on subscriber, application, and bandwidth projections. The wavelengths are routed to a wavelength demux device, which directs the upstream signal into the corresponding port on the line card. Several implementations of demux devices are possible, and they can be external to the TWDM card or integrated on the card.

Figure 5: Upgrading an existing GPON network – modular TWDM line card approach



Source: Alcatel-Lucent

The nonintegrated, modular approach provides several operational and economic advantages, such as

- straightforward support for pay-as-you-grow wavelength adds
- easy bit rate configuration for each wavelength. This enables CSPs to customize the amount of bandwidth allocated (any combination of 10G and 2.5G in both upstream and downstream) for each customer type or application (residential, SMB, MBH, enterprise)
- simple facilitation of wavelength unbundling per operator, which supports governmental requirements for fiber sharing or co-investment partnership business models.

From an operational perspective, existing GPON subscribers that will remain on GPON must be briefly taken offline (out of service) during installation of the coexisting element (CEx in Figure 5), after which service is restored. For example, residential subscribers that will be remaining on GPON and not upgraded to TWDM PON will experience a brief service outage (which can be planned during low-usage hours), but only when the CEx is introduced. Thereafter, wavelength additions or changes will not impact existing subscribers except those being upgraded or migrated to new wavelengths.

It should be noted that the same scenario described here would also apply in the case of XG-PON1 upgrades, since a CEx would also have to be introduced to enable the combination of GPON and XG-PON1 wavelengths.

Once the TWDM PON card is installed, the CSP can support TWDM PON–based services. New ONTs would need to be installed at current subscribers that are upgrading to TWDM PON. This ONT replacement process can be planned to minimize outage time. New subscribers can be brought onto the TWDM PON network over time, meeting operational efficiencies and sales objectives.

GPON and TWDM PON – new network scenario

In the case of new GPON FTTx network builds, a CSP could choose to install TWDM PON from the beginning or to use a hybrid GPON and TWDM PON approach. The CSP could also choose to install integrated GPON/TWDM PON line cards. However, the modular approach provides flexibility in terms of pay-as-you-grow economics.

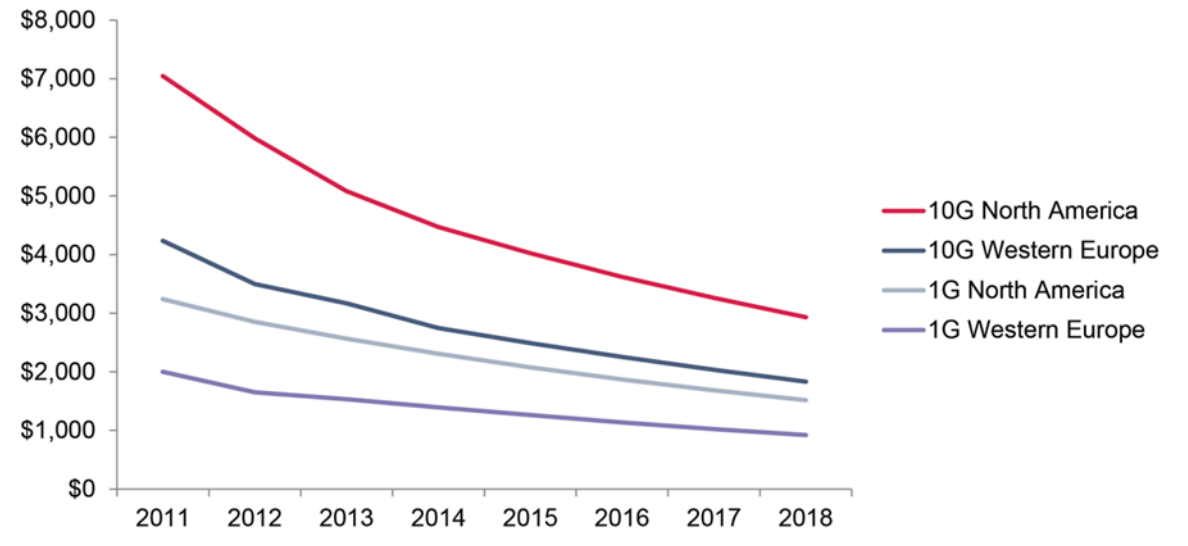
Economics of TWDM PON versus the alternatives

It is important to evaluate the economics of TWDM PON versus XG-PON1 versus GPON. Today's GPON is supporting the bandwidth requirements of residential subscribers and is capable of supporting future bandwidth requirements of, for example, 4K and 8K TV. In addition, today's GPON is supporting MBH. So are there economic and operational reasons to move to TWDM PON?

Ovum believes that non-FTTH applications are the main drivers for TWDM PON. These applications include MBH and fronthaul along with FTTx for enterprises.

We start with a focus on revenues and use carrier Ethernet service revenues as a proxy for MBH services. As shown in Figure 6, for 2014 monthly revenues for 1G capacity are around $2,300 in North America compared to $1,400 in Western Europe, while 10G capacity revenues are around $4,500 for North America compared to $2,700 for Western Europe.

Figure 6: Carrier Ethernet services – average monthly revenues by capacity, 2011–18



Source: Ovum

FTTH residential service ARPU is approximately $170 for Verizon FiOS subscribers and around $50 for residential customers of Sweden's TeliaSonera. Table 1 shows the ratios of carrier Ethernet service revenues to residential revenues using the assumption that residential ARPUs decline 5% per year. The revenue difference between carrier Ethernet services and residential services is significant.

Consequently, TWDM PON's ability to support more MBH services plays an important role in network monetization.

Table 1: Comparison of carrier Ethernet services to residential services – monthly ARPU, 2014 vs. 2018

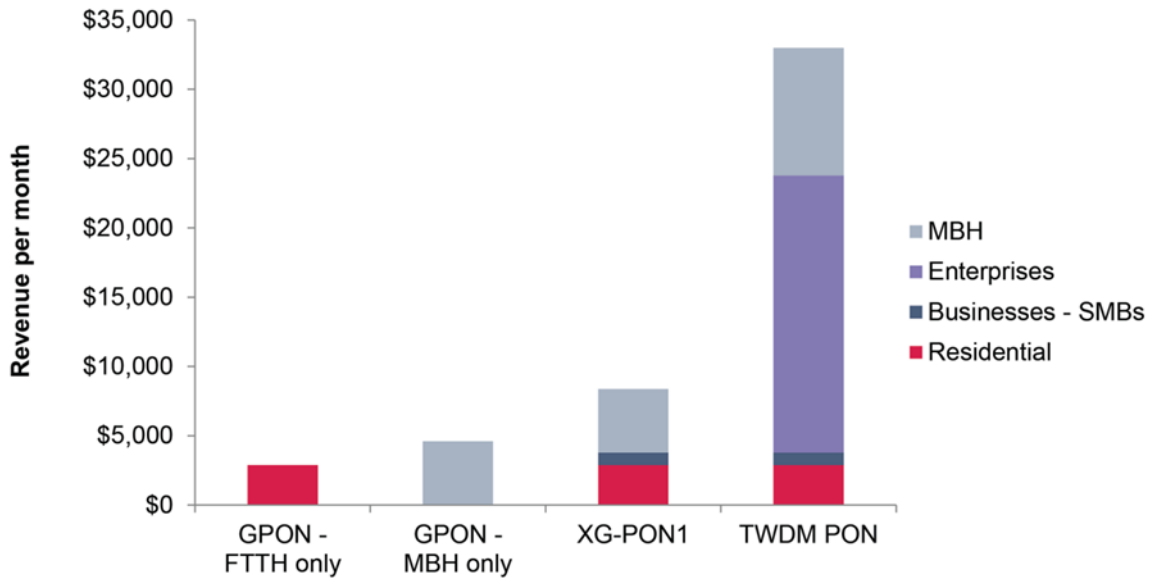
	2014	2018
North America – 1G Ethernet services capacity to residential	14x	11x
North America – 10G Ethernet services capacity to residential	26x	21x
Western Europe – 1G Ethernet services capacity to residential	28x	23x
Western Europe – 10G Ethernet services capacity to residential	55x	45x

Source: Ovum

Next, we built revenue scenarios per OLT for GPON, XG-PON1, and TWDM PON networks based on number of subscribers, types of subscribers, and respective ARPUs. There are many ways to build revenue scenarios; we have based this analysis on discussions with PON equipment vendors and CSPs. For example, CSPs supporting PON for MBH typically dedicate PON OLT ports for MBH – they do not mix and match MBH traffic with any other type of traffic – so we offer two revenue models for GPON, one focused on FTTH subscribers and one dedicated to MBH.

Figure 7 displays a set of revenue scenarios for GPON for FTTH, GPON for MBH, XG-PON1, and TWDM PON using ARPUs for residential, MBH, and enterprise customers in North America. The large revenue differential between TWDM PON and other types of GPON is due primarily to the support of enterprises. While TWDM PON can support more MBH, there is a limit to the amount of MBH needed in any one particular geographical area, even when a CSP supports mulitple wireless operators.

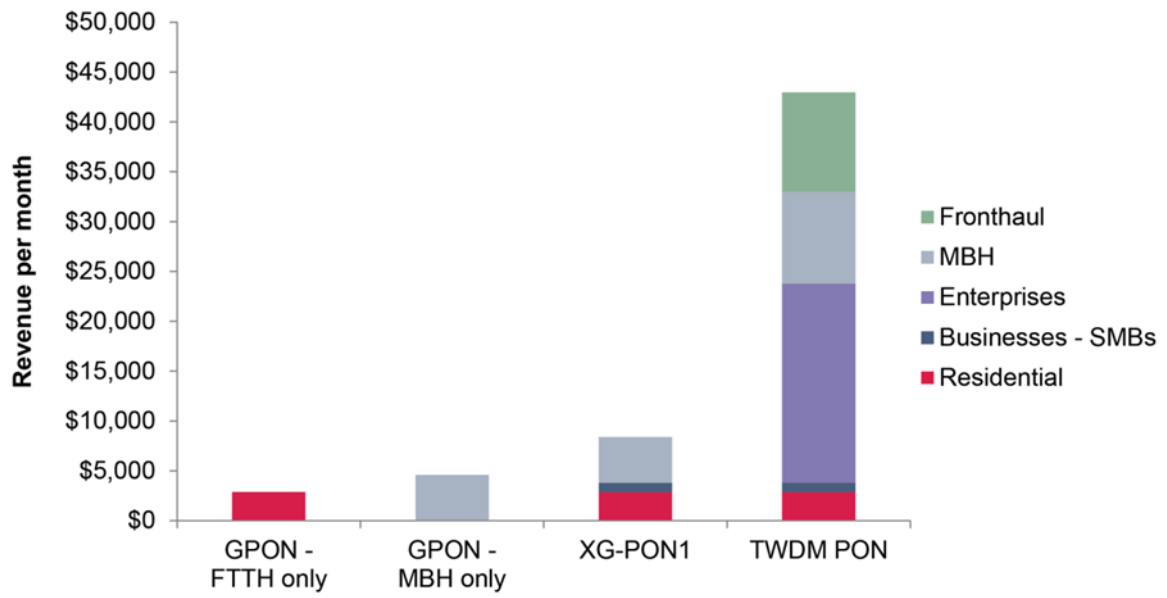
Figure 7: Revenue scenarios for GPON, XG-PON1, and TWDM PON – North America



Source: Ovum

TWDM PON will also be able to support fronthaul, either directly with a dedicated wavelength or on a point-to-point overlay. Figure 8 displays a revenue model that encompasses a point-to-point fronthaul service on top of TWDM PON, which is likely to be the initial approach to support fronthaul.

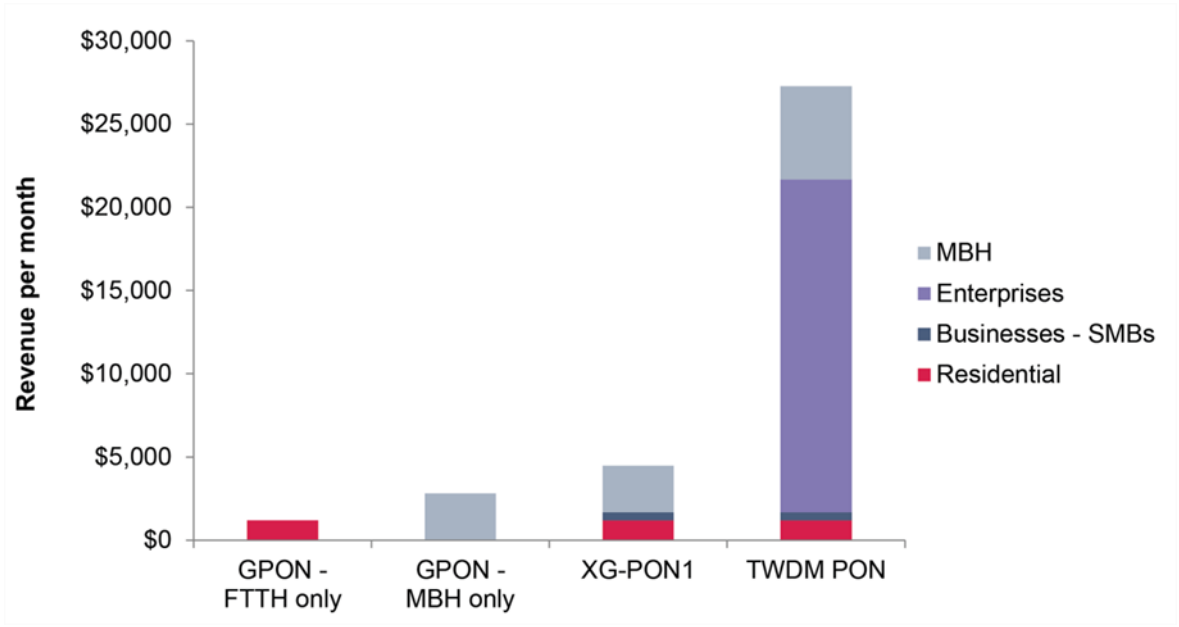
Figure 8: Revenue scenarios for GPON, XG-PON1, and TWDM PON with fronthaul – North America



Source: Ovum

The revenue scenarios for Western Europe reflect the even larger differential between residential and carrier Ethernet services compared to North America, as shown in Figure 9.

Figure 9: Revenue scenarios for GPON, XG-PON1, and TWDM PON – Western Europe



Source: Ovum

Table 2 provides a summary of the revenue scenarios for North America and Western Europe, with and without fronthaul, comparing the different scenarios to GPON FTTH. Clearly, TWDM PON, with its support for enterprises and MBH, offers a significant revenue advantage in Western Europe and even in North America where resdiential ARPU is significantly greater. These large revenue differentials likely explain why several CSPs plan to bypass XG-PON1 as an upgrade option.

Table 2: Revenue scenarios – comparisons to GPON FTTH for North America and Western Europe

	GPON – MBH	XG-PON1	TWDM PON	TWDM PON with fronthaul overlay
North America	1.6x	2.9x	11.5x	14.9x
Western Europe	2.3x	3.7x	22.7x	31.1x

Source: Ovum

Next, we need to examine the cost differentials of TWDM PON versus GPON and XG-PON1, focusing on the costs that are the same regardless of the underlying GPON-based architecture and those that are different.

Major cost categories include:

- civil works – the cost of building the ODN. Civil work costs will be the same across all three network architectures
- network electronics – GPON FTTPremises has the lowest costs, followed by XG-PON1. TWDM PON with four wavelengths would have the highest costs. We assumed that XG-PON1 electronics are 4x those of GPON while TWDM PON electronics are 10x those of GPON
- premise installations – in a FTTPresmise scenario, the costs of drop fiber and premise installations are the same across all three GPON architectures
- fiber cabinets and outside plant cabinets – the costs are the same across all three network archiectures
- OLT equipment – the cost of optics increases as one moves from GPON to XG-PON1 to TWDM PON. We assumed that XG-PON1 OLT port costs are 4x those of GPON while TWDM PON OLT ports are almost 50x those of GPON, reflecting the expense of tunable optics, multiple wavelengths, a wavelength demux device, and a coexisting element.
- CPE (customer premise equipment) – in general, CPE costs rise from GPON to XG-PON1 to TWDM PON. We made the assumption that residential subscribers would remain on GPON throughout the models with a CPE cost of $100. CPE costs for MBH were increased significantly across the next-gen GPON architectures, rising from $200 for GPON to $600 for XG-PON1 and $1,800 for TWDM PON.

The cost differences between GPON, XG-PON1, and TWDM PON are significantly lower than the revenue differentials, which means the ROI horizon for TWDM PON is significantly shorter than it is for GPON or XG-PON1, as shown in Table 3. In particular the ROI horizon for GPON FTTH in Western Europe is very long given the relatively low ARPU from residential customers.

Table 3: ROI time horizons – North America and Western Europe

	GPON – FTTH	GPON – MBH	XG-PON1	TWDM PON
North America	8.9 years	5.6 years	3.3 years	Slightly over 1 year
Western Europe	21.4 years	9.1 years	6.1 years	1.2 years

Source: Ovum

Bottom line: enterprise and MBH services have a major impact on the ROI scenarios even though TWDM PON elements, such as tunable ONTs, OLT ports, and network electronics, are more expensive.

The ROI analysis assumes that subscribers are brought onto the FTTx networks as soon as they are completed. In addition, the analysis does not take into account the amount of time to build the FTTx network and install central office equipment. However, these assumptions impact all of the PON scenarios equally; consequently, even if two years are allocated for network build and bringing clients onto the network, TWDM PON would still have a significant advantage of 3 years (1 year plus 2 years) until ROI compared to GPON-FTTH with 23 years (21 years plus 2 years).

The ROI time horizons did not change meaningfully when a point-to-point overlay for fronthaul was added to the model. The costs of the overlay and accompanying equipment would be offset by the revenue stream.

Summary

TWDM PON has the opportunity to become the access technology for supporting a wide range of subscribers and applications, leading to faster network monetization. Table 4 provides a summary of the advantages and disadvantages of TWDM PON versus GPON and XG-PON1.

TWDM PON's architecture is fundamentally different than that of GPON and XG-PON1. Its design enables the assignment of wavelengths to specific customers or applications. This design also provides an easy solution for sharing the fiber network either to meet LLU regulations or to support co-investment. The wavelength design also enables CSPs to add wavelengths as needed, providing a pay-as-you-grow platform. While GPON and XG-PON1 can support MBH, TWDM PON can provide more bandwidth, thereby supporting more MBH traffic. The assignment of wavelengths enables the support of enterprise services. In addition TWDM PON was designed to allow point-to-point overlays for the support of fronthaul.

Table 4: TWDM PON versus the alternatives – summary analysis

	GPON	XG-PON1	TWDM PON
Simple support for fiber unbundling	+	+	+++
Flexible growth – pay as you grow	+	+	+++
Ability to support MBH	+	++	+++
Ability to support mobile fronthaul	-	-	+++
Ability to support enterprise services	-	+	+++
Overall FMC support	-	-	+++
Ecosystem – status	+++	+	+
Commodity-priced equipment	+++	+	-

Source: Ovum

The major drawback to TWDM PON is its cost, and costs will decline once deployments begin.

Next step for TWDM PON

Market education

Equipment vendors need to focus on market education covering network design, deployment and upgrade scenarios, and the types of subscribers/services that can be supported. The ecosystem needs to have a single, concise message regarding the definition, capabilities, and costs of TWDM PON.

Appendix

Sponsor

This research was sponsored by Alcatel-Lucent.

Methodology

Data for this report was collected via interviews with service providers and equipment vendors along with participation in industry conferences and seminars. Data was supplemented through review of publicly available product information and press releases. In addition, data and forecasts from Ovum's WBIS (World Broadband Information Service) were used.

Further reading

Market Share Report: 2Q14 FTTx, DSL, and CMTS, TE0006-000932 (September 2014)

Market Share Spreadsheet: 2Q14 FTTx, DSL, and CMTS (Revenues), TE0006-000926 (August 2014)

Market Share Spreadsheet: 2Q14 FTTx, DSL, and CMTS (Units), TE0006-000925 (August 2014)

Update on PON for Mobile Backhaul – Focus on North American Market Opportunity, TE0006-000919 (August 2014)

OC FTTx Forecast Spreadsheet: 2013–19, TE0017-000011 (July 2014)

"Equipment vendors gain as MSOs respond to Google Fiber," TE0006-000894 (July 2014)

"PON optical component outlook rosier than expected," TE0017-000001 (May 2014)

FTTx Announcement Database – 2H13, TE008-001412 (January 2014)

"Alcatel-Lucent wins over Bright House Networks with 10G EPON," TE003-00058 (October 2013)

"CommScope's S-1 filing signals that infrastructure is hot," TE003-000571 (August 2013)

PON for Mobile Backhaul, TE003-000569 (August 2013)

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We hope that this analysis will help you make informed and imaginative business decisions. If you have further requirements, Ovum's consulting team may be able to help you. For more information about Ovum's consulting capabilities, please contact us directly at consulting@ovum.com.

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