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EDITORIAL GUIDE

New opportunities for PON

Passive optical network (PON) technology has established a strong foothold in telco networks. Now with the attention given to Google as well as the opening of other application spaces, PON is beginning to be viewed in a new light for a wider variety of applications.

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Cable MSOs ponder PON

by **STEPHEN HARDY**

THE SCTE CABLE-TEC Expo is annually the best place to get a reading on what technologies cable operators in the U.S. plan to deploy in their networks. That was again true October 21–24, when the cable industry gathered for this year's edition in Atlanta. While much of the technology discussion revolved around the imminence of such HFC-specific advancements as DOCSIS 3.1 and the Converged Cable Access Platform (CCAP), passive optical networks (PONs) also received a fair amount of attention. However, it isn't quite clear whether that attention was focused on the right place.

The assumption among most observers with whom I've spoken is that cable operators will deploy EPON if and when they finally get around to mass adoption of optical access technologies. Certainly CableLabs is operating along this line. The U.S. cable industry's primary standards group has finished the first version of its DOCSIS Provisioning of EPON (DPoE) specifications and has its eye on the IEEE's EPON over coax (EPoC) standards work. A CableLabs spokesman described during one session how cable multiple systems operators (MSOs) might employ EPoC alongside EPON and point-to-point Ethernet networks, particularly to supply business services.

All that is fine, except for one detail: If a cable operator has deployed a PON already, it's more likely that the infrastructure is based on GPON, not EPON.

Why is this the case? For one thing, at 2.5 Gbps, GPON offers greater downstream speeds than EPON's 1 Gbps. It's also the preferred PON of the telcos against which these cable operators compete, so it's more likely to create a level broadband access playing field.

That would appear to imply there's a disconnect between CableLabs and its constituency in terms of which PON technology to pursue for standards work.

In fact, representatives of some vendors on the SCTE Cable-Tec show floor who support DPoE have said they've received inquiries from cable MSOs about the feasibility of "DOCSIS Provisioning of GPON."

But that apparent disconnect may not be as significant as one might fear. As mentioned previously, most of the EPON-related efforts are targeted at business applications, while many if not most of the GPON deployments address residential service requirements. And with the advent of DOCSIS 3.1 and its 10-Gbps capacity promise, cable operators won't have to turn to GPON fiber to the home to keep up with Verizon, Google Fiber, and other competitors who leverage optical access technologies. When operators do need fiber access, DPoE offers an option that's more economical for dense applications than RF over glass (RFoG) while maintaining compatibility with DOCSIS, so operators won't have to use separate operating systems for their HFC and PON infrastructure.
So there will be less reason to install GPON rather than EPON. The question then becomes whether the cable operator in question wants a PON-based approach at all. If that answer is yes, EPON will likely become increasingly popular in cable-operator networks. And CableLabs will avoid having to wipe egg off its face.

STEPHEN HARDY is Editorial Director & Associate Publisher of *Lightwave*.

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Technology and business drivers for passive optical LANs

by **LONI LE VAN-ETTER**

PASSIVE OPTICAL LAN (POL) technology platforms optimized for enterprise LAN environments have become available only in the last couple of years from such companies as Tellabs and Motorola (recently acquired by Google). Yet, this technology – which enables a singlemode fiber-to-the-desktop architecture for the LAN – is quickly gaining traction in the market.

POLs are finding their place deeper within the LAN to meet the needs of very large and demanding Layer 2 switched applications. And it's easy to see why[1]:

:: scalability and reliability

:: ease of use and administration

:: energy savings and environmental sustainability

:: high-bandwidth connectivity

:: advanced security

:: disruptively low total cost of ownership (savings in initial capital equipment cost as well as ongoing operational cost).

Decision makers are increasingly choosing to forgo the status quo and take advantage of what POLs have to offer for the long-term benefit of their organizations.

Mature and reliable technology

POL network equipment is compliant to the ITU-T G.984 Gigabit Passive Optical Network (GPON) technology standard. PON technology was developed for and deployed in the U.S. by Verizon (for FiOS triple-play services) and by many other telecom operators around the world. The FTTH Council Europe

estimates that PON architectures currently make up 20% of FTTP/H access networks around the world, and that number is growing.[2] And in the U.S., over 64% of broadband FTTH deployments use PON technologies, 51% of which is GPON.[3]

POL customers benefit from the widespread adoption of ITU G.984-compliant GPON equipment for FTTH in three ways.

1. Equipment prices are being driven down by world demand.
2. POL equipment has been designed to the highest specifications in the harshest outside plant environments and typically achieves the stringent so-called five-9s of reliability (99.999% uptime) to meet telecom operators' standards. (Typically, Ethernet switches are designed to less stringent requirements.)
3. FTTH deployments have scaled to support millions of users and diverse services while enabling very efficient remote management and maintenance for the entire network via software features. POL vendors offer the same robust server and client network element management software (albeit with added enterprise-centric software enhancements) for the enterprise environment, which provides powerful operational, administration, and maintenance (OAM) functionality. In addition, POL vendors typically offer various scalable software licensing packages to optimize their offerings relative to the size of the network.

Environmental sustainability

POL technology's energy savings and environmental sustainability stem not necessarily from what it has, but from what it doesn't have.

A typical large Layer 2 switched Ethernet campus network (as depicted on the left side of Figure 1) requires multiple levels of aggregation at the campus distributor, building distributor, and floor distributor/communications closet. Multiple layers of switches are required to aggregate the traffic back to the core-routed network. The layers are also required because the various cabling media choices used with traditional active Ethernet networks are limited in performance over a specified distance due to signal attenuation and other performance parameters (as per IEEE and TIA standards specifications). Cat 6A copper cabling for the horizontal links, for example, is specified to support 1 or 10 Gigabit Ethernet up to a 100-m

limit (328 ft), while multimode dual fiber connections for the backbone links can support 10 Gigabit Ethernet up to 2 km.

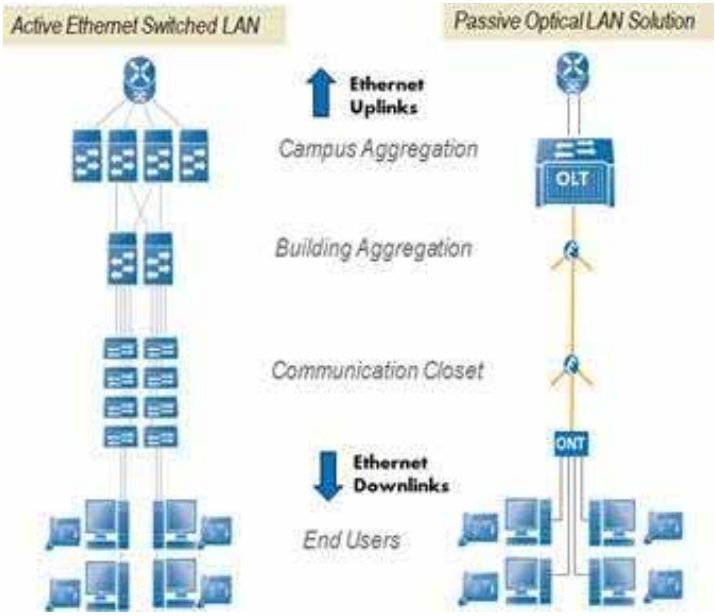

FIGURE 1. *A typical active Ethernet switched LAN approach versus a POL architecture.*

In contrast, a POL network (depicted in on the right) does not require any active components on any floor or even in each building. This is because singlemode fiber communications media can support very high transmission speeds (in the terabits) over much longer distances – up to 20-30 km (over 12 miles) per industry standards specifications. Only a simple passive (non-powered) optical splitter is needed to distribute and branch the communications signals to the optical network terminals (ONTs) located in or near the work areas. The ONTs (also known as the workgroup terminals) come with various port configurations to support all services required, such as VoIP or POTS, IP/Ethernet data, analog or switched digital video, etc. For example, an ONT (shown in Figure 2) has four service ports of 10/100/1000 Base-T with IEEE 802.3at compliant Power over Ethernet (PoE) supported. Local AC power with optional battery and UPS can also be provided.

FIGURE 2. *A typical ONT/work group terminal.*

Instead of installing the typical two to four home-run copper cables from the communications closet to every work area, now only one lightweight, small-diameter single-fiber cable can be installed to the ONT, enabling considerable savings in infrastructure materials and installation labor.

A streamlined POL architecture provides the following quantifiable benefits:

:: reduced HVAC requirements and costs for cooling racks of active electronics

:: reduced amount of UPS backup power required for centralized active electronics

:: significantly reduced material in plastics and copper required for the infrastructure cabling, connectivity, and apparatus

:: reduced time to install, test, commission, and maintain the system.

Overall, the GPON POL platform typically requires lower power consumption on a per-Ethernet-port basis compared to the traditional active switched Ethernet networking approach. (Refer to each networking vendors' specifics on per chassis and per port power consumption details.)

High-bandwidth connectivity and considerations for POL

With regard to bandwidth management, the POL system offers a unique, efficient, and optimized way to provide guaranteed bandwidth for various services while allowing up to 1-Gbps Ethernet connectivity and burst rate for many users. The POL system northbound connections to the core-routed network are provided as multiple 1-Gbps or 10-Gbps Ethernet aggregated links up to 40 Gbps, while the service ports for the endpoint devices are typically standard 10/100/1000 Base-T Ethernet interfaces connecting to devices via regular RJ-45 copper patch cords (no PC fiber NIC cards required).

Due to the inherently variable patterns required for different communications traffic as well as the specific bandwidth requirements based upon service types, Ethernet connections may at times require only low-bandwidth transmission, while at other times may require much more. The POL system enables network managers to specify and ensure a guaranteed bandwidth by the system via the committed information rate (CIR) setting to assure quality communications for real-time services. At the same time, the POL platform allows specified flows to burst up to the peak information rate (PIR) setting, which optimizes the dynamic distribution of bandwidth for each PON port (2.4 Gbps down/1.2 Gbps up) between many users, typically up to 32 or 64. The optical line terminal (OLT) aggregation switch provides for non-blocking wire throughput of all the traffic across the LAN. The aggregated uplink connections to the core-routed network from the OLT

are then chosen and sized to accommodate the guaranteed overall CIR for the system.

Stringent security required for the government

POL technology uses the highly secure Advanced Encryption Standard (AES) 128-bit protocol as well as other advanced identification and authentication features. The POL platforms from some vendors have already passed the extensive information assurance test requirements of the U.S. Department of Defense Joint Interoperability Test Command (JITC). These tests evaluate security features of the network equipment and assess their ability to support critical and highly secure military and government agency networks. Focused government entities were, in fact, the initial requesters of the POL technology and were early adopters of it, beginning in 2009.

Meeting TIA standards

POL is now supported by the Telecommunications Industry Association (TIA) 568-C.0 Generic Cabling Standards. On August 14, 2012, the TIA cabling standards organization approved and published Addendum 2 to the TIA-568-C.0 Generic Telecommunications Cabling for Customer Premise standard. In this officially approved update to the cabling standards document, the GPON approach has been added and categorized as a supported singlemode fiber application for the LAN. The standard's channel definition now includes support for passive optical splitters, which are a key component of the architecture. The Addendum 2 update calls for an optical attenuation budget for the GPON Channel infrastructure of 13 to 28 dB, corresponding to the ITU-T G.984 GPON standard compliance requirements relative to the Class B+ optical transmission characteristics.

In addition, according to the ANSI/TIA 568-C cabling standards, copper cabling requires measured verification of no less than seven technology parameters for confirmation of the installed copper infrastructure performance characteristics. Testing is required for installed copper home-run cables to each and every Ethernet device. On the other hand, POL infrastructure deployment requires only half to one-quarter the amount of horizontal runs and only one measured test parameter (optical attenuation). Therefore, it will be far easier and take far less time to install and test than traditional balanced 100-Ohm copper structured cabling.

Who can benefit from POL?

POL is best suited for larger LAN deployments, where the scalable and immediate cost savings and longer-term operational benefits compound most greatly. Verticals that could most benefit from POL include:

:: Department of Defense military bases/posts

:: federal and municipal government agencies and entities

:: large hospitality facilities/hotels/resorts

:: higher and lower education campus networks

:: healthcare facilities/hospitals

:: large enterprise businesses

:: financial institutions

:: media companies

:: cruise/Naval ship communications

:: industrial/manufacturing plant networks

:: airports and stadiums.

Disruptively low total cost of ownership

Until recently, the high cost of a future-proof, fiber-to-the-desktop LAN architecture kept it out of reach for many organizations. However, today, capital expense related to POL equipment and infrastructure can be 40% less than the traditional active switched Ethernet approach.[4]

In addition, deploying a POL system can result in 50% to 70% savings in system operational expenses compared to a copper system due to less energy consumption, reduced HVAC and UPS cooling requirements, and lower monitoring and maintenance costs.[4] This disruptively low total cost of ownership savings along with the many other benefits of the future-proof fiber infrastructure accounts for why POL is gaining traction in the market.

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What can you learn from Google Fiber?

by **STEPHEN HARDY**

GOOGLE ORIGINALLY PITCHED Google Fiber as a testbed. But that pitch has changed; company Executive Chairman Eric Schmidt revealed in December that Google likely will expand its fiber to the home (FTTH) efforts to other markets. And given the company's early success, why not? Google Fiber attained initial take rates in Kansas City of about 30%, a level most other new service providers would take years to reach.

It's true some of Google Fiber's success can be attributed to the fact that, well, it's Google. But Google's name recognition only gave it a headstart. Other providers of FTTH-based services can learn a lot from the way Google built momentum around its new service.

Because it's Google

Let's acknowledge the advantages Google had that other alternative communications service providers likely do not. Name recognition equal to that of the incumbents comes to mind first. Just about anybody who uses the Internet has at least heard of the company; most use its search engine. And people think of the brand positively. It's likely the delivery of Internet service didn't seem like a stretch for a company synonymous with the Internet. That's why 1,100 communities responded to its request for information (RFI).

The frenzy surrounding that RFI provided a second advantage other alternative carriers would struggle to recreate -- full investment within Kansas City in Google Fiber's success. Emotional investors included local authorities -- who weren't likely to offer too much resistance to the acquisition of the necessary rights of way and permitting, regardless of how much incumbent providers might complain -- as well as Google's prospective customers. Google capitalized on its

customer investment via its "fiberhood" concept, which created a success-based deployment model that minimized stranded investment.

Google or not

Yet it may be that Google's built-in advantages are more a question of degree than truly unique. Certainly few companies could create the nationwide hoopla Google achieved. But Google demonstrated that at least 1,100 communities in the U.S. want a fiber-based alternative to the services their local carriers provide. That's a lot of demand. With the right opportunity analysis, new entrants may uncover a level of customer interest that will put adequate pressure on local authorities to not let the interests of incumbent providers stand in the way of a new alternative.

Meanwhile, media and technology marketing consultancy Ideas & Solutions! Inc. has published a study that describes Google's marketing campaign in Kansas City. The campaign focused strongly on community outreach in a way other service providers could easily emulate. The campaign included social media; local promotional events planned by neighborhood organizers; the Google Fiber store, where many of those promotional events took place; a Google ice cream truck; and yard signs.

Other service providers might not buy an ice cream truck. But they should note that each of these elements created direct engagement with potential customers and enabled Google to publicize what its service would entail and how different it would be from what others currently provided.

Whether Google will become a national force or a regional player remains unknown. But its early success in Kansas City provides plenty of lessons worth emulating.

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