Graceful migration to future generations of Passive Optical LAN

Tellabs is a pioneer in Passive Optical Network (PON) technologies. In 2003, Tellabs led the industry in the high-volume commercial deployment of broadband PON. In 2005, Tellabs was one of the first companies to bring to market Gigabit PON solutions. And in 2009, Tellabs was praised for the groundbreaking adaptation of PON for specific use for Enterprise Local Area Networks (LANs) applications. Today, Tellabs is credited with providing the equipment for the largest FTTH PON in North America as well as the largest Optical LAN (OLAN) in the world.

Now is the time to consider the impact of future generations of PON. Back in 2010, Tellabs delivered 10 GbE PON OLT and ONTs for an international next-generation PON initiative called scalable advanced ring-based passive dense access network architecture (SARDANA). Tellabs won the Global Telecoms Business Innovations Award in 2011 for this SARDANA work, which proved the technical viability of 10 GbE PON and DWDM PON. Tellabs continues to leverage the success of the SARDANA deliverables relative to considerations for future high-volume commercially viable future generation PON solutions that will deliver 10 Gbps speed services.

Introduction

Tellabs' goals for next-generation 10 GbE PON are to make sure that the customer's investment in Optical LAN is protected by eliminating the rip-and-replace of electronics and cabling. The intent is to ensure that customers have a future-proof graceful migration path as their network needs evolve with new services and application, which may require greater bandwidth. Tellabs wishes to make certain that customers have cost-effective next-generation LAN choices; that is, Tellabs' intent that the timing of 10 GbE solutions aligns with market demand, thus ensuring that the latest technology, smallest sized, lowest power and best cost value are obtained. To that end, Tellabs is assessing the following macro topics in preparation for delivering commercially viable next-generation PON:

- Modern LAN traffic patterns
- Managing modern LAN bandwidth
- Future generation PON choices
- Tellabs' space/material, power and cost innovations
- Tellabs' Path to 10 GbE PON

Highlights

- Next-generation 10 GbE PON will provide symmetrical transmission speeds
- Tellabs' Optical LAN OLTs and ONTs equipment are designed taking into account future generation impacts
- Current single-mode fiber cabling and passive optical splitters support next-generation 10 GbE PON
- Tellabs' powering solutions take into account the expected higher demands of 10 GbE
- Today's 2.4 GbE (ITU 984) ONTs will be supported alongside the new 10 GbE ONTs
- The upgrade to next-generation 10 GbE PON can be done on a per ONT (per super-user) basis

Modern LAN traffic patterns

10 years ago, 80% of LAN traffic travelled peer to peer and thus stayed local. This was due to the fact that LAN infrastructure basically connected telephones and computer workstations. With today's modern high-performance LAN traffic, 90% of LAN traffic flows directly thru the core router to the wide area network (WAN). This is because modern high-performance LAN transportation is a means for browser-based applications, virtual desktop, hosted/managed, cloud-based and wireless services.

In the past, legacy copper-based LANs were designed with racks and stacks of Ethernet switches connected by a tangled mess of meshed point-to-point cabling. This created the wasteful

one-to-one relationship of electronics, dedicated corporate resources and cabling for each peer-to-peer end user. The design was wasteful because the potential bandwidth capacity at the last 100 m point-to-point cable connectivity was never fully realized across the LAN nor was the highly probable bottleneck across the WAN.

Optical LAN's architecture better serves modern LAN traffic patterns. Its fundamental architecture is optimized for the most efficient path to the WAN. Optical LAN's point-to-multipoint configuration minimizes the number of managed devices in the aggregation, distribution and access portion of the LAN. Optical LAN defines LAN resources in software and then dynamically allocates those resources based on real-time needs. The first benefit of this architecture is that fewer moving parts mean fewer things to buy, rack, stack, power, air condition, ventilate, provision, manage and break. It also means fewer electrical-to-electrical and optical-to-electrical conversions as the LAN traffic travels to the WAN. With fewer electrical-to-electrical and optical-to-electrical conversions, the LAN's experience improved energy consumption, and they also gain the benefit of reduced latency.

Optical LAN has the same value proposition as cloud-based services, application, computing and networking. Cloud-architecture shifts expense, complexity, energy and space to a centralized shared location without compromising security. Optical LAN replicates those same cloud benefits and successes. If CIOs and IT pros embrace cloud technologies, then OLAN will be accepted for all the same reasons.

Managing modern LAN bandwidth

In a 2013 study, Gartner Research looked at the future impact of high-performance modern LAN video, wireless and cloud computing and forecast a projected peak bandwidth per user. The outcome of the research stated that heavy video, wireless and cloud computing would require bandwidth per user in the 1 Mbps to 7 Mbps range. This is far below the 1 Gbps and 10 Gbps fear mongering from the legacy copper-based LANs equipment manufacturers, which continue to promote the purchase of more racks and more stacks of Ethernet switches.

What the Gartner Research study exposed was that an average corporate worker rarely needs more than 1 Mbps for emailing, Web browsing, VoIP service, data center access, enterprise software, collaboration applications and other cloud-based services. Even high-definition 1080p IP video telepresence systems ask for 15 Mbps connectivity. Wireless access points supporting IEEE 802.11n theoretical air interface maximum are 54 M, but design and planning guides call for 24 M Ethernet backhaul throughput. And then IEEE 802.11 ac, ad, dual radio WAPs state that their theoretical air interface maximum is 600 Mbps and that their expected backhaul throughput will be 50% in most practical deployments. Once again, these bandwidth requirements are well below 1 Gbps and 10 Gbps.

Optical LAN is better suited to handle modern LAN traffic patterns and bandwidth. Instead of legacy copper-based LANs dedicated resources, Optical LAN defines resources in software and dynamically allocates those resources based on real-time needs.

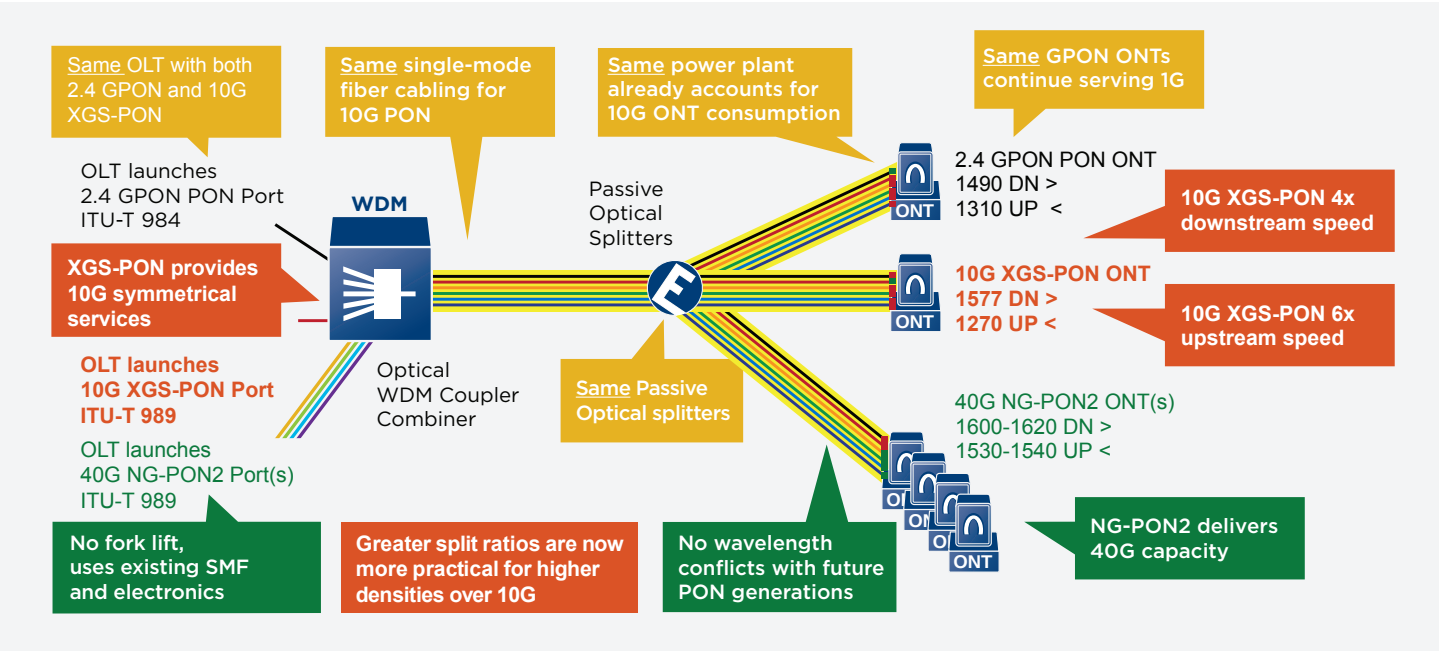


Figure 1: Graceful Migration to Future Generations of Passive Optical LAN

Future generation PON choices

Contemporary Gigabit PON provides the capacity of 2.4 Gbps in the downstream direction and 1.2 in the upstream direction. It follows Full Service Access Network (FSAN) recommendations that are ratified and published within ITU-T G.984 standards. It is widely deployed supporting millions of end users around the world. XG-PON1 and XG-PON2 are defined in ITU-T G.987 standards. XGS-PON is defined in ITU-T G.989 and provides the framework for both asymmetrical (e.g., 10 Gbps ds and 2.4 Gbps us) and symmetrical (e.g., 10 Gbps ds and 10 Gbps us) transmission versions. Though there have been many demonstrations of XG-PON, including Tellabs' SARDANA, the technology has not experienced commercial adoption. Next up is the industry work being focused on a collection of architectures under consideration for NG-PON2. NG-PON2 is inclusive of 40 Gbps PON and WDM PON versions and is progressing through the standards adoption process within the ITU-T G.989 framework.

All of these next-generation PON options will deliver 10 Gbps transmission speeds. The FSAN and ITU have been very smart in identifying and preparing for all the future wavelengths required for XG-PON, XGS-PON and NG-PON support. This ensures that there will be no wavelength conflict between today's Gigabit PON and future generations of PON. It also ensures that the different generations of PON will be able to coexist over the same fiber plant infrastructure simultaneously. This provides protection for those who invest in fiber-based LANs today against the need to rip and replace the electronics and/or cabling in order to support future generations of PON [Figure 1].

Tellabs' space/material, power and cost innovations

Future generations of PON will have many choices, all of which will have the ability to deliver 10 Gbps capacity. However, these higher-speed 10 GbE PON solutions will come with a premium attached to space/material, power/thermals and costs. To balance the total 10 GbE PON value proposition, Tellabs is working toward innovations relative to lowering space/material, power/thermals and cost impact.

Space/Material Innovations — There are 4 areas where Tellabs innovations can help lower the space and material impact of next-generation 10 GbE PON. First, Tellabs will look to support 10 GbE into our existing line of small form-factor in-wall and in-cubical mini ONTs. Next, it is a Tellabs' goal to support both 2.4 GbE PON (ITU-984) and 10 GbE PON service from the same OLT distribution shelf, thus providing cost savings. Third, Tellabs is reviewing the commercial viability of a one rack unit small form-factor OLT.

Finally, once 10 GbE PON is deployed it will make sense to use passive optical splitters with an even greater split ratio than x:32. For example, higher density systems with x:64 and x:128 passive optical splitters will be more appropriate for many services/applications and lead to lower per port costs for the overall system.

Cost Innovations — The greatest cost innovation provided by future generations of PON is the fact that today's single-mode fiber, fiber management and passive optical splitters will still work. Not having another rip-and-replace event for either equipment or cabling will save huge amounts of money. A major piece of this graceful migration will be enabled by the simultaneous support of 2.4 GbE PON (ITU-984) and 10 GbE PON service cards in today's OLT distribution shelves. With both 2.4 GbE PON (ITU-984) and 10 GbE PON service cards in a common OLT distribution shelf, 10 GbE upgrades will be managed at the ONT end-points. Next, cost savings will come from being able to support higher-density systems with optical plant split ratios of x:64 and x:128 that will substantially bring down per port costs. Last, one rack unit small form-factor OLT will be targeted at a low cost point to make

Tellabs' Path to 10 GbE PON

Tellabs is developing a next-generation 10 GbE PON solution, based on G.989 XGS-PON. It will provide symmetrical capacity of 10 Gbps in both upstream and downstream directions. The first iteration of the next-generation solution will include a new OLT distribution shelf (OLT6, OLT16), new 10 GbE PON service card (OIU8) and new 10 GbE ONT (ONT205). Tellabs will follow that release with a new high-capacity Ethernet Service Unit (ESU).

Next-Generation High-Capacity ESU — This next-generation ESU will be equipped with "either" one 40 GbE uplink or four 10 GbE network uplinks "and" four 1 GbE network uplinks. With the new ESU deployed in combination with the next-generation 10 GbE PON service card (OIU8), customers will tap into redundant 40 Gbps capacity traces (e.g., 80 Gbps total capacity per slot) for intershelf and card-to-card transmissions. Its first introduction will be in a form factor suitable for OLT6 distribution shelf deployments. Later versions will be supported in the OLT16, ONT1134 and OLT1150.

Next-Generation 10 GbE PON service card — This next-generation XGS-PON 10 GbE PON service card will be equipped with eight 10 GbE PON ports capable of 10 Gbps symmetrical service delivery. The new 10GbE PON service card, in combination with new high-capacity ESU, will tap into 80 Gbps capacity traces (e.g., 80Gbps total capacity per slot) for intershelf and card-to-card transmissions. There will be no wavelength conflict between today's 2.4 GbE PON (ITU-984) card and the 10 GbE PON card (G.989); thus, both can be commingled in the same OLT distribution shelf. Its first introduction will be in a form factor suitable for both 1150E OLT and 1134 OLT deployments. (Note: for 1134 OLT, the next-generation 1134 OLT ESU will be required.)

Summary

Ultimately, Tellabs' goal is to design Optical LAN solutions taking into account next-generation impacts (e.g., wavelengths, powering, size, etc.). We will work to prove current single-mode fiber cabling and passive optical splitters will support next-generation 10 GbE PON solutions. And that today's 2.4 GbE (ITU 984) ONTs will be supported alongside the new 10 GbE ONTs (ITUG.989), thus providing a graceful migration to next-generation 10 GbE PON that can be done on a per ONT (per super-user) basis. By delivering on these goals, Tellabs will add one more chapter to its pioneering achievements, thus including successful implementation of commercially viable next-generation 10 GbE PON solutions.

Next-Generation 10 GbE PON ONTs — There are two configurations of XGS-PON 10 GbE PON ONTs in planning:

The size of these ONTs is on track to be similar to the 140C ONT and 709GP ONT. Tellabs is assuming that these 10 GbE PON ONTs will come with an estimated 5-watt increase in power consumption. This 5-watt assumption is most likely high, but ensures that Tellabs designs infrastructure deployed today, including powering systems that will support future 10 GbE ONTs.

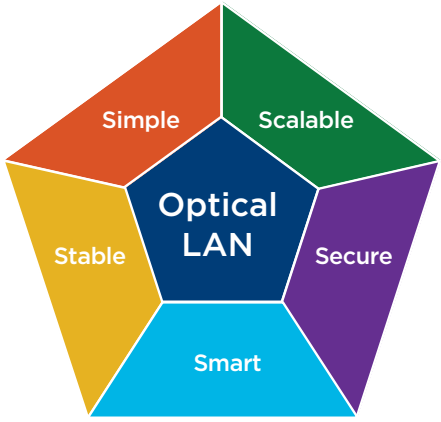
Tellabs' current development plan of record targets the new high-capacity ESU, the new 10 GbE PON service card and the new 10 GbE ONT for availability in 2017. The development, release and timing of features or functionality described for Tellabs' products remains at Tellabs' sole discretion. The information that is provided within this paper is neither a commitment nor a legal obligation to deliver any material, code or functionality.

The correct platform.

The right features and capabilities.

At the right time.

At the right price point.



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