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Core to Access Optical Networking Architecture for Defense and Civilian Government Entities

Introduction

Government entities, both defense and civilian, aiming to modernize their core, aggregation, distribution and access network infrastructure within buildings and across campus are best advised to choose a fiber-based solution. These stateof-the-art high-performance optical networks converge services and applications in a more secure, scalable and stable manner. They simplify the network while transporting a wide range of contemporary and legacy voice, data, video and wireless traffic for a smart solution that exceeds DISA Unified Capabilities Requirements. In order to take advantage of the benefits of an end-to-end optical network, Tellabs recommends that Passive Optical LAN using Gigabit Passive Optical Networking (GPON) for serving the distribution and access functions, and optical transport using Dense Wave Division Multiplexing (DWDM) serving core and aggregation purposes be adopted [Figure 1]. This solution is currently successfully deployed by multiple U.S. Department of Defense (DoD) agencies worldwide and is consistent with multiple agency network unification plans.



Figure 1: Tellabs Optical LAN high availability solution with industry-leading network uptime

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Distribution and Access: Passive Optical LAN

Tellabs introduced Optical LAN, based on GPON technology, to the DoD approximately 5 years ago. Since then, it has been added the Unified Capabilities Requirements by DISA, tested and JITC approved for high-availability applications, and deployed and adopted by the U.S. Army, U.S. Air Force, USMC, DHS, DoE, NSA, NRO and other federal entities.

This Optical LAN technology not only provides significant operational and technological advantages but also has proven to lower upfront cost, power and space requirements. Optical LAN allows the convergence of voice, video, data and wireless networks over a future-proofed fiber optic infrastructure. By consolidating voice, video, data and wireless networks and reducing the need for traditional copper infrastructure, the Tellabs Optical LAN Solution reduces up-front capital expense while lowering ongoing operating expenses.

The key features of the Tellabs Optical LAN Solution are:

- Industry-leading GPON per ITU-T 984.x standard
- Full Ethernet Layer 2 support, such as IEEE 802.1D, 802.1P. 802.1Q and RSTP
- Support for analog voice (e.g., POTS), VoIP, all data, RF video, IP video and wireless
- High-density and low-density distribution shelves with 19"- and 23"-mounting options
- Variety of ONT options: communications closet, desktop, in-wall and in-cubicle
- Delivery of Gigabit speeds over 10/100/1000 Ethernet connections
- Power over Ethernet, including both IEEE 802.3af PoE and IEEE 802.3at PoE+ ONT options
- Powered Device (PD) management, monitoring and configuration using Link Layer Discovery Protocol (LLDP)
- Innovative 48 VDC desktop ONTs allowing for remote powering options
- Bandwidth and Quality of Service (QoS) defined in software and dynamically allocated based on real-time needs
- Bulk provisioning Network Access Control (NAC) based for automated profile provisioning
- Advanced encryption with constantly churning 128-bit keys
- Option for armored and alarmed fiber integration solutions
- JITC-certified high availability, including Type-B PON redundancy, which provides fiber route diversity with 2:x passive optical splitters (e.g., 2:16, 2:32) and redundant OLTs positioned in geographically dispersed locations
- All Tellabs Optical LAN hardware and software complete JITC testing and certification

Optical Line Terminal (OLT) — The Tellabs® 1100 Optical Line Terminal (OLT) Series serves as the Ethernet-centric distribution shelf position in the main data center in an Optical LAN architecture. The Tellabs OLTs can serve 100 to 100,000 endpoints with a mix of converged voice, video, data and wireless access from the core transport layer directly to the user over a single fiber. The Tellabs OLTs come in both 19"- and 23"-versions and support integrated L2 switching, VLAN groups, VLAN trunking, Ingress Filter Rate Limiting, Layer 2 through Layer 4 Access Control Lists, strong authentication, Network Access Control, Quality of Service and Class of Service delivery. The Tellabs OLTs deliver voice, video and data services as follows:

- High-speed Data services standard Layer 2 Enterprise Networking via 10/100/1000Base-T Ethernet connections at the ONT as well as multiple combinations of 1 Gbps and 10 Gbps uplink from the OLT into the Core/WAN network.
- Video Radio Frequency (RF) video overlay through RF over Glass (RFoG) supporting a CATV architecture, Internet Protocol Television (IPTV), Video on Demand (VoD), video surveillance/ security and videoconferencing.
- Voice both Session Initiation Protocol (SIP)-based Voice over Internet Protocol (VoIP) and Class 5 (TDM) voice interfaces are supported. AS-SIP interoperability is almost complete and is available in today's available hardware.
- Wireless Tellabs works with industry-leading Wi-Fi manufacturers for subtending wireless access points (WAPs) from the ONTs. Also, the fiber-based infrastructure can be leveraged for cost-effective distributed antenna systems (DASs) deployment.

Optical Network Terminal (ONT) – Tellabs[®] 1100 Optical Network Terminal (ONT) Series has options for secure in-wall, in-cubicle, desktop or at the communications closet and enables the infrastructure to carry high-speed data, video, voice and wireless over a shared fiber infrastructure. The ONTs support Power over Ethernet (PoE), including both low-power IEEE 802.3af PoE and high power IEEE 802.3at PoE+ ONT options. Powered Device (PD) management, monitoring and configuration are supported through Link Layer Discovery Protocol (LLDP). Tellabs[®] ONTs offer a variety of interfaces, including standards-based 10/100/1000Base-T Ethernet, RF interfaces, for RFoG/CATV-type video architectures and traditional analog POTS interfaces. Tellabs offers ONTs for indoor and outdoor applications.

Panorama[™] PON Manager — Tellabs® Panorama PON Manager is an element management system that offers a complete management solution for the Tellabs Optical LAN Solution. The feature-rich Tellabs® Panorama PON Manager is available in both Solaris[™] and Windows® operating environments and offers a full suite of management capabilities — user management, configuration management, performance management and security management. It also supports remote upgrades, service fulfillment, service assurance, remote back-up, remote capacity and inventory reporting, and a variety of additional functions.

The Tellabs® Panorama PON Manager provides an easy-to-use graphical user interface (GUI) and online help utility, enabling users to accomplish complex network element activities through simple point-and-click operations. The Tellabs Panorama PON Manager also features a client-server architecture that supports automatic discovery of the deployed network, offering full fault, configuration, automation, performance and security capabilities. In addition, the Tellabs Panorama PON Manager hosts a suite of Northbound Interfaces (NBIs) that enables one to automate back-end office operations. A mature and full-featured management solution, the Tellabs Panorama PON Manager has been field proven, with deployment in hundreds of network operator environments ranging from United States government installations to the largest North American Tier 1 service provider Passive Optical Networks.

Tellabs Panorama PON Manager supports:

- Security and Element Management System (EMS) administration
- IPv6 for Network Management System (NMS)-to-EMS communication
- Redundant configurations to allow for resilient NMS-to-EMS communications
- IPSec for NMS-to-EMS communication
- IPSec for EMS client to EMS server communication
- Network Element-level (e.g., OLT) security
- Secure downloads
- Role-based administration
- User-defined security privileges and security audits
- Manages over 500 OLTs and supports over 250 simultaneous user sessions

Superior Security — Utilizing fiber optic cable for the transport mechanism effectively removes all TEMPEST concerns. Fiber is not susceptible to electromagnetic interference (EMI), radio frequency interference (RFI) or electromagnetic pulse (EMP). Copper acts like an antenna, broadcasting radio frequencies that can be intercepted without a physical tap or intrusion. It is far more difficult to tap fiber physically, and stateful Optical LAN protocols preclude malicious taps without detection. Optical LAN ensures robust security at the OLT and ONTs, providing protection at the physical, data and user layers. It provides for the management of Network Access Control authentication and authorization via Optical LAN's implementation of IEEE 802.1x and RADIUS recommendations as well as strict user-definable roles for element management. Access control lists and other Denial-of-Service protection functions establish barriers to malicious attacks. Because an ONT is a thin client device, it does not store user and provisioning information; only the OLT stores all user policies. Government IT professionals can install ONTs behind lockable covers or inside walls, with faceplate screws alarmed through the intelligent, centrally located management system. On an ONT, the default state for all Ethernet ports is "disabled," which means that attackers cannot penetrate them. Finally, because there is no access at ONTs, they are unmanaged and have no local user interface, making them very secure.

Option for Armored, Alarmed and 24/7/365 Monitored Fiber —

The All-Secure[™] PON solution offers the highest-possible security connectivity. All-Secure PON uses armored and alarmed fiber, which is monitored on a 24/7/365 basis. Because IT staffers can install and operate it for a fraction of the cost of legacy hardened carrier Protective Distribution Systems (PDSs), Tellabs Optical LAN is deployed in the most secure government and military networks in the United States.

Options for both Analog Voice and Voice over IP – Legacy copper-based non-GPON data offerings provide only Ethernet interfaces. If government entities need to add support for RF video or analog voice (e.g., POTS), then a wasteful overlaid physical infrastructure was purchased, installed and maintained. However, in addition to data, Tellabs Optical LAN has the unique capability to also support POTS voice and RF video over the same fiber-based infrastructure. Specific to voice, Tellabs Optical LAN offers the following voice capabilities:

- 1) POTS over Optical LAN (TDM)
- 2) POTS over Optical LAN with ASSIP Conversion
- 3) VoIP over Optical LAN

The simultaneous support for both analog and VoIP phones enables VoIP environment with connectivity either to legacy TDM voice switch or IP PBX/Call Manager. This provides a significant capital savings associated with the deferral of a VoIP phone purchase.



Figure 2: Tellabs® Optical LAN supporting both analog (e.g., POTS) voice and VoIP

Tellabs Optical LAN Solution, inclusive of the OLTs, ONTs and PON Manager can provide the following benefits:

- Both Capital and Operational Savings The Tellabs Optical LAN Solution lowers network equipment CapEx costs by up to 30–50% and operational costs up to 50–70% compared to traditional copper-based data networks. And where voice and video convergence is required, further enhancements to this business case can be enjoyed.
- Power savings support green initiatives (US EO13423 and EPACT) — The Tellabs Optical LAN Solution offers power savings of up to 30-65% to support green initiatives and reduce the total cost of ownership. Because Optical LAN uses a passive architecture (e.g., GPON), it requires no power within the optical distribution. The Tellabs Optical LAN system's high level of integration reduces equipment requirements by offering multiple services. Not only does less equipment equal less power, but it also has a ripple effect on many other areas, including power distribution and switchgear, power conversion and cooling.
- Reduces Space Requirements The high level of integration and aggregation can reduce floor, rack and closet space by up to 90%. Reduction in floor space lowers operating expenses by reducing necessary overhead costs. In addition, the small footprint associated with Optical LAN technology enables nextgeneration performance and services in smaller communication closets not originally designed for advanced communication equipment.
- Furnishes High Levels of Security The inherent security capabilities of Optical LAN, combined with the Tellabs Optical LAN system's added security capabilities at the physical data layer and the end-user port ensure that agencies can maintain a highly secure communications environment.
- Resiliency and High Availability The Tellabs Optical LAN Solution supports JITC-certified Type-B PON redundancy that adds fiber route diversity in the optical plant and redundant

OLTs positioned in geographically dispersed locations. Furthermore, the Tellabs Optical LAN Solution supports dual -homing capability using Rapid Spanning Tree Protocol (RSTP). This feature enables carrier class protection of the OLT by supporting equipment redundancy and facility redundancy, including path diversity to redundant transport elements (e.g., Tellabs® 7100 Optical Transport System).

Core and Aggregation: Dense Wave Division Multiplexing (DWDM)

An OTS is the ideal extension of the Optical LAN Solution, converging the most advanced optical and services layer technologies into one versatile, feature-rich and ultrareliable system for mission-critical applications. An OTS scales seamlessly from small enterprise applications to very large service providersized applications. An OTS can rapidly allocate bandwidth to meet traffic demands and can efficiently transport a variety of network services: VoIP, video, Carrier Ethernet, SAN, SONET, wavelength, etc., via 10 Gbps, 40 Gbps or 100 Gbps wavelengths.

By utilizing other embedded technologies such as an OTS, one can further simplify network designs and collapse overlay networks, reducing both capital and operational expenses while providing a reliable and resilient network infrastructure. An OTS leverages the use of DWDM in the core and the use of wavelengths as "virtual fibers" to connect router ports together; thus, only a simple 10 G pipe is created, resulting in what is typically very underutilized bandwidth, by as much as 90% (i.e., a 10 G wave is being used for what amounts to 1 G of traffic demand).

In addition to DWDM functions, an OTS expands the service layer to include Layer 2 switching on a pair of cards. Together with a switching fabric, transponder modules perform the function of a Carrier Ethernet switch. This technology can be applied by creating a Layer 2 network at the distribution layer. Rather than

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Figure 3: Optical Transport Solution (OTS) using Dense Wave Division Multiplexing (DWDM)

having underutilized point-to-point 10 G connections from the distribution to core locations, traffic can now be aggregated from the core nodes, placed onto efficiently filled 10 G wavelengths and distributed to the ADN nodes.

The network can be designed such that both core nodes have visibility to all wavelengths, providing each access distribution node (e.g., GPON optical line terminal) connectivity to each main core node and creating a logical mesh without > 2 physical paths at any individual location. This enables the network to be engineered for the actual bandwidth usage at the time of implementation while maintaining no single point of failure. Physical ports and, therefore, cost are saved on the transport equipment and the core routers when compared to the existing solutions. An OTS DWDM architecture is equipped to address mission-critical parameters of the DoD networks.

Summary

Tellabs recommends a connection-oriented Layer 2 transport architecture that will simplify network designs and ongoing operations while collapsing overlay networks — thus reducing both capital and operational expenses. Cost reductions are achieved by removing the cost of Layer 3 at the edge and backhauling to fewer, more prominent Layer 3 core routers. This further simplifies network designs and eliminates the number of systems that need to be deployed, managed and maintained. It also improves the reliability, security and resiliency of the network infrastructure. In summary, based on cost, power space and the operational advantages described and quantified, Tellabs recommends deploying the following end-to-end architecture for the core, aggregation, distribution and access:

- Optical LAN in the Distribution-to-Access networks Optical LAN provides voice, video, data and wireless services to end users. Network resources such as bandwidth and QoS are defined in software and dynamically allocated based on realtime needs.
- OTS in the Core-to-Distribution networks An OTS efficiently backhauls Optical LAN traffic to core locations using connection-oriented Layer 2 Carrier Ethernet (either G.8031/2 or MPLS-TP) and thus reduce the number of Layer 3 core routers required in the network.

These Tellabs solutions are U.S. JITC certified and deployed by the U.S. Army, U.S. Air Force, USMC, NSA, NRO, DoE, INSCOM and MCIA as examples. The military Target Architecture meets the design requirements for modernize the core enterprise information infrastructure at military installations worldwide. Optical LAN and OTS ultimately replace the antiquated, costly, unsupportable and maintenance-intensive legacy systems with a simplified converged Optical Network that is more secure, scalable, stable and smart.



Tellabs Optical LAN Solution for Government

Operations Benefits

- 1 Simple: converges services and applications such as, VoIP, unified communications, POTS, IP video, RF video and all data, smart buildings apps, security, surveillance, environmental and automation, Wi-Fi and DAS across fiber
- 2 Scalability: to keep pace with LAN growth and keep pace with technology
- **3 Smart**: responsible choice for maximizing tight government budgets and tax payer monies in the most cost effective manner
- **4** Security: provided at the highest levels based on years of deployments in US most secure military networks
- 5 Stability: maximum network reliability with industry leading network uptime for real time services and critical services

Network Benefits

- Eliminate telecom rooms, reduce LAN mid-span electronics, purge cabling and associated materials impacting corporations sustainability "green" goals
- 2 Simple: centralized intelligence and management of OLAN reduces WAN/ LAN complexity thus helps balance IT skill-set and resource re-allocations
- **3 Scalable**: Occupies 90% less space yet has 4x greater GbE density and 300 times greater reach
- **4 Smart**: cost effective means of optimizing wireline and wireless (e.g. Wi-Fi and DAS) networks
- 5 Stable: fiber cable has no known bandwidth limits nor obsolescence horizon, thus LAN fiber cabling investment is protected

Take the next step. Contact Tellabs today.



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