

Tellabs® Optical Enterprise

Bringing Cost-Effective, Secure and Reliable, High-Bandwidth and Energy-Efficient Optical Networking to Federal Agencies

Executive Summary

Federal agencies that need to upgrade or replace existing telecommunications networks are looking for solutions that reduce capital and operating expenses, provide high security/reliability, furnish high bandwidth — and improve energy efficiency. Tellabs meets these requirements with Tellabs® Optical Enterprise.

Tellabs Optical Enterprise is the first Joint Interoperability Test Command (JITC)-tested solution to combine Enterprise Gigabit Passive Optical Network (GPON) access with a switched packet optical transport over a Dense Wavelength Division Multiplexing (DWDM) solution that incorporates Reconfigurable Optical Add-Drop Multiplexing (ROADM), Layer 2 Ethernet and SONET technologies. This platform offers a highly flexible and dynamic optical network while enabling video, data and voice/TDM network convergence. With this solution, federal agencies benefit from:

- Savings in capital and operating expenses, power consumption, and space
- High levels of security, reliability, and availability
- Bandwidth efficiency
- Data network and TDM convergence
- Fiber conservation
- Investment protection

This white paper will describe the key capabilities of Tellabs Optical Enterprise, how it delivers these benefits, and how it compares to existing federal agency solutions.

Telecommunications Requirements are Complex and Mission-Critical

As federal agencies — both military and civilian — replace or augment existing telecommunications equipment, they must address increasingly complex and mission-critical requirements. Telecommunications networks for federal agencies must fit constrained budgets while providing greater bandwidth with higher security and reliability — all while complying with energy-efficiency mandates.

Reduced Capital and Operating Expenses

While the Stimulus Act is boosting budgets for telecommunications projects in the near term, these increases are expected to be short-lived. Long term, federal agencies need solutions that lower initial capital expenses and reduce the total cost of ownership for the network, enabling them to address more of their telecommunications requirements while minimizing ongoing operational expenses.

Improved Security and Reliability

Natural disasters, power outages, cable cuts and software problems have always held the potential to cripple the telecommunications services of an entire region. But while those risks were long seen as manageable, the events of 9/11, Hurricane Katrina and increasing cyber-crime have heightened concern over network vulnerabilities.

At the same time, more agencies are operating Voice over Internet Protocol (VoIP) networks and putting voice, data and video on a single network. Network downtime or degraded performance — due to network issues, natural disasters, terrorist or criminal activities — can now paralyze an agency's operations. Thus, agencies are looking for higher service levels, such as 99.999% availability, which equates to about 5 minutes of downtime per year. That compares with previous standards of 99.8%, which allows more than 17 hours of downtime per year — or about 200 times greater downtime.

Higher Bandwidth

Data bandwidth demand in federal agencies continues to increase due to the popularity of new bandwidth-hungry applications, such as multimedia, high bandwidth services and growing data centers that include storage networks, IP-enhanced applications and Virtual Private Networks. With these high bandwidth applications, federal communications decision-makers must ensure that they can provide cost-efficient bandwidth that can easily adjust and grow with the organization.

Support for Green Initiatives

Over the past two years, the Office of Management and Budget, in line with Executive Order 13423 and EPACT 2005 guidance, has mandated that agencies purchase environmental and energy-saving electronic equipment to reduce greenhouse gases. According to Onvia¹, in 2008, "green" initiatives climbed 25% over the previous year. This trend is expected to continue as aging government buildings are retrofitted to meet modern day standards.

Tellabs Optical Enterprise: Meeting Federal Agency Requirements

Tellabs Optical Enterprise meets federal agency requirements by providing a high-bandwidth, field proven, carrier-class solution that delivers reliable, secure voice, video and data services to federal military and civilian agencies in a cost-effective and energy-efficient manner. Tellabs Optical Enterprise is JITC tested. It offers Enterprise GPON access and a switched packet optical transport over DWDM that includes ROADM, Ethernet, and SONET technologies. The result is a single solution that furnishes a highly flexible and dynamic optical network, and offers a clear path for data and voice/TDM network convergence.

¹ <http://www.smartbrief.com/news/aaaa/industryPR-detail.jsp?id=2F65F6EA-F0F7-4736-8556-DE61EB89F4EB>

By consolidating many previously separate networks, Tellabs Optical Enterprise reduces up-front capital expense while lowering ongoing operating expenses. Because federal agencies can purchase the entire solution from a single vendor, they benefit from having a single contract to negotiate and a single vendor to manage for maintenance, service, and support. Tellabs is the first GPON vendor to be JITC tested with defined test cases, and is the leading North American PON vendor with more than 3,000+ OLTs deployed commercially among the largest U.S. service providers.

An Integrated Optical Access and Transport Solution

Most telecommunications vendors offer either the access networking equipment or the optical transport core equipment, only. Tellabs Optical Enterprise provides a complete, integrated solution that incorporates both optical access and optical transport. The Tellabs solution comprises an Enterprise GPON access network, implementing the Tellabs® 1150 Optical Line Terminal (OLT) or the Tellabs® 1134 OLT, and the Tellabs® 1600 Optical Network Terminal Series – Integrated Power Supply Unit (ONT iPSU), and a switched packet optical transport over a DWDM core, through the Tellabs® 7100 Optical Transport System (OTS).

Federal agencies have the option of purchasing either the entire integrated Tellabs Optical Enterprise solution, or the access and transport components separately. The following sections discuss the capabilities and benefits of the Tellabs optical access and optical core network technologies for federal agencies.

Tellabs 1150/1134 OLT and Tellabs 1600 ONTs: Enterprise GPON Optical LAN Solution

Fiber is the ultimate carrier of bandwidth. As federal agencies increasingly employ high-bandwidth applications, such as video conferencing, remote training and large high definition imagery file transfers, they are adopting fiber access networks. Today, GPON — an all-fiber access architecture that links the datacenter to the user premises through a passive Optical Distribution Network (ODN) — is coming to be known as the technology of choice for Fiber to the Premises and the premier PON standard.

Developed for the residential market, GPON standards were finalized in 2003. The first commercial, full-rate GPON deployment in North America launched in June 2006. Today, the GPON market is experiencing strong growth. According to Infonetics² the worldwide market for PON systems, which includes BPON, EPON, GPON, and WDM-PON equipment, jumped 56% to \$1.74 billion in 2008 over 2006. Infonetics expects GPON adoption to eclipse EPON in 2009.

Although most GPON deployments are currently in North America, Light Reading Insider³ estimates that by 2011, GPON will be used in about half of all fiber-connected households in Europe and about one-third of fiber-connected households in Asia/Pacific. This growing market acceptance reflects GPON's ability to support mission-critical carrier and enterprise applications with greater efficiency than EPON.

GPON technology benefits from much greater efficiency and security, as compared to EPON. GPON attains up to 95% bandwidth utilization efficiency, where EPON suffers from as low as 69% efficiency. Couple this with strong encryption support (GPON – AES encryption; EPON – none), GPON delivers the most bandwidth efficient and secure PON technology available.

The Tellabs® 1150 OLT is a high-density optical access platform that takes advantage of GPON capabilities to deliver high bandwidth and a mix of converged voice, video, and data access from the core transport layer directly to the user over a single fiber. The Tellabs® 1134 OLT is a smaller form-factor unit based on the same technology and architecture, offering a lower cost for smaller (lower density) deployments. Key features of the Tellabs offerings include:

- High bandwidth
- A clear migration path and mix of services
- Hybrid voice capabilities
- Security capabilities
- Stringent bandwidth delivery with Quality of Service (QoS) and Class of Service (CoS).
- The only GPON solution with true enterprise features and functionality

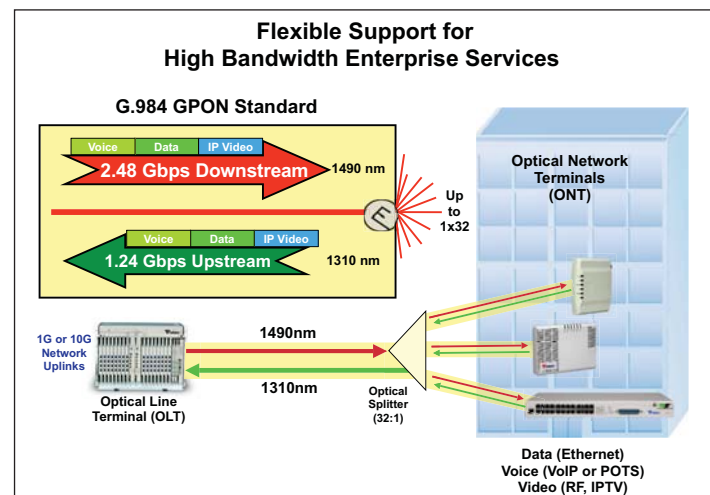


Figure 1.

High Bandwidth

With downstream speeds of 2.48 Gbps and upstream speeds of 1.24 Gbps, GPON provides the necessary bandwidth to deliver voice, data, and video services.

A Mix of Services and Clear Migration Path

The ITU created GPON with the ability to support multiple services. The Tellabs 1150/1134 OLTs take advantage of this capability to provide a smooth upgrade path from existing to next-generation services, in part through their support for legacy traffic in its native

² "Infonetics: GPON prepares to take off in 2008, WDM-PON emerges" March 20, 2008, Lightwave Online <http://www.lightwaveonline.com/business/market-research/infonetics-gpon-prepares-to-take-off-in-2008-wdm-pon-emerges-54885532.html?pc=ENL>

format (i.e., TDM) as well as native IP traffic. The Tellabs 1150/1134 OLTs support the following emerging and legacy voice, video, high-speed data, and business services.

- **Voice** — Both Session Initiation Protocol (SIP)-based Voice over Internet Protocol (VoIP) and POTS telephone services.
- **Video** — Video on Demand (VoD), Internet Protocol Television (IPTV), and Radio Frequency (RF) video overlay with one-way and two-way transmission through RF over Glass (RFoG).
- **High-speed data services** — Standard Layer 2 enterprise networking that furnishes high-speed data access via 100Base-T and 1000Base-T Ethernet connections at the ONT.

As agencies put in place Tellabs Optical Enterprise to carry these services, Tellabs offers them a choice of implementation options. Agencies can install an end-to-end optical network. Using GPON technology in the access layer enables Layer 2 data networking and simultaneous support for VoIP and POTS services over the same fiber all the way from the OLT to the ONT, for a maximum distance of 20 Km. Thus GPON eliminates the need for a copper infrastructure in new implementations, potentially saving millions of dollars due to reduction or elimination of copper infrastructure.

Alternatively, Tellabs enables agencies to replace the copper plant within the campus environment with fiber carrying both high-speed Data and VoIP over a GPON infrastructure, with all services fully integrated into an IP Transport Aggregation Network, while retaining their existing PSTN hand-off. Agencies simply use the Tellabs 1600-729 Multi-Desk Unit (MDU) to provide a POTS interface to each user's desk. An integrated analog terminal adapter within the Tellabs 1600-729 MDU converts the POTS voice to SIP for transport over the data network, where it is switched to a Tellabs® 1000 Multiservice Access Platform (MSAP), functioning as a Voice Gateway (VGW). The VGW then aggregates the VoIP traffic from the access network and provides a standard GR-303/TR-08 interface or TR-57 analog interface to the TDM voice switch.

This approach reduces capital and operating costs, including operating costs for copper, by eliminating the ongoing maintenance associated with a copper infrastructure. At the same time, Tellabs Optical Enterprise eliminates costly items, such as remote switches and separate TDM transport equipment, as well as their associated annual maintenance and software licensing. Yet, agencies can avoid the effort and expense of replacing links to the desktop.

If an agency wishes to migrate this architecture to VoIP, the integrated ATA functionality in the Tellabs ONT iPSUs enables deployment into a IP-enabled PBX environment. Agencies can then use the Tellabs VGW's Element Management System to migrate end-users from the traditional TDM voice network to a VoIP core through simple provisioning. As agencies migrate to VoIP, Tellabs enables them to strictly control costs. Typically, upgrading to VoIP requires not only the installation of a softswitch, but also the upgrade of each user's handset to a VoIP phone, which can cost \$300 to \$700 per unit. Yet it is estimated that only 5% to 20% of users actually require advanced VoIP features. The

Tellabs 1150 OLT GPON solution enables agencies to continue using their existing POTS handsets for all users that do not require advanced VoIP features, eliminating the need for costly handset upgrades.

Security Capabilities

Because it uses optical fiber, GPON is highly secure due to the elimination of EMI radiation associated with traditional copper wired facilities. In addition, the Tellabs 1150/1134 OLTs provide powerful security measures at the physical layer, data layer, and at the end-user port to greatly reduce the potential for Denial of Service (DoS), redirects or other malicious attacks.

Tellabs GPON provides mechanisms such as Access Control Lists (ACLs), Broadcast Datagram Rate Limiting at each end-user device and strong authentication. Flexible authentication mechanisms include 802.1x and DHCP Option 82. Authentication based on 802.1x allows multiple end-devices per end-user port along with advanced intrusion detection — effectively locking down the physical port upon detection of an untrusted device. Access control lists provide flexibility to statically and/or dynamically permit/deny datagrams based on Layer 2 (Ethernet) rules, Layer 3 (IP) rules, and Layer 4 (TCP/UDP) rules.

Additionally, a fiber deployment to the desktop minimizes the copper wiring between end-user devices and reduces TEMPEST emanation concerns.

Stringent Bandwidth Delivery with QoS and CoS

Designed for the most demanding enterprise network, robust, state-of-the-art wire-speed and non-blocking devices are incorporated to ensure stringent bandwidth delivery and Quality of Service (QoS). Bandwidth allocation occurs within the Tellabs 1150/1134 OLT through multiple mechanisms. At the physical layer, all GPON interfaces support the provisioning of bandwidth to each subscriber in the form of Peak Information Rate (PIR) and Committed Information Rate (CIR) in both downstream and upstream directions independently. Management of allocated bandwidth to each subscriber supports both Class of Service (CoS) and QoS mechanisms for effective delivery of multiple services. CoS is supported with priority queuing according to 802.1p and/or Differentiated Services Code Point (DSCP) marking. QoS is supported with traffic scheduling, shaping and policing algorithms specific to the subscriber service profile.

Benefits of Tellabs Enterprise GPON

With high bandwidth, a clear migration path and mix of services, security and QoS/CoS capabilities, the Tellabs 1150/1134 OLTs offer federal agencies benefits that include reduced capital and operating costs, power savings, lower space requirements, high levels of security, and high availability.

Cuts Capital and Operating Expenses

The Tellabs optical access solution reduces capital and operating expenses significantly. GPON technology enables federal agencies to share the cost of running fiber from the data center to the user

³ "GPON Market Forecast: The Horizon Beyond Verizon" by LightReading Insider http://www.lightreading.com/insider/details.asp?sku_id=1663&skuitem_itemid=1019

premises among many users — usually up to 32 locations — rather than requiring agencies to deploy individual fibers to each location, resulting in lower costs. The fiber is run from the data center to a centralized distribution point, from which fiber extends to each user location. Passive optic splitters extend the fiber to the distribution point, guiding the laser light on the fiber to the appropriate locations. Because PONs require no power in the optical distribution network to power the splitters, the resulting overall operational costs and complexity are low.

Fiber is not subject to environmental impacts such as oxidation that raise operating expenses of copper. Optics provide a lower mean time between failure than copper, which cuts maintenance costs. Fiber does not suffer from radiated emissions (EMI) as does copper, providing significant security benefits for federal networks. In addition, in real world conditions, fiber is more durable than copper, lasting 50-100 years compared with 20-30 years for copper.

The Tellabs 1150/1134 OLT's high level of integration further reduces capital and operating expenses. Each business ONT supports multiple densities of POTS, Gigabit Ethernet, Fast Ethernet, and RF. This integrated approach eliminates costly hardware within a network such as remote switches as well as their associated provisioning cost, annual maintenance and software licensing fees.

Power Savings Support Green Initiatives and Reduce Costs

The Tellabs 1150/1134 systems offer power savings of up to 80% to support green initiatives and reduce total cost of ownership. Because GPON is a passive architecture, it requires no power within the optical distribution. The Tellabs 1150/1134 systems' high level of integration reduces equipment requirements for agencies offering multiple services. Not only does less equipment require less power, it has a ripple effect on many other areas, including power distribution and switchgear, power conversion and cooling.

Lowers 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 GPON technology enables next-generation performance and services in smaller communication closets not originally designed for advanced communication equipment.

Furnishes High Levels of Security

The innate capabilities of GPON combined with the Tellabs 1150/1134 systems include security capabilities at the physical, data layer, and the end-user port ensure that federal agencies can maintain a highly secure communications environment.

Resiliency and High Availability

Tellabs® 1100 OLT solutions support Dual Homing capability using Rapid Spanning Tree (RSTP) protocol. This feature enables carrier class

protection of the OLT by supporting equipment redundancy and facility redundancy, including path diversity to redundant transport elements (such as the Tellabs 7100 OTS). The Dual Homing feature allows Tellabs Optical Enterprise to serve high availability end-users such as C2 users, who issue guidance or orders that direct, control or coordinate military forces, and Special C2 users, who require telecommunications service for intelligence, alert and strategic readiness and must communicate with the President and other high-ranking officials.

The Core Network — Switched Packet Optical Transport over DWDM with the Tellabs 7100 Optical Transport System

The Tellabs 7100 OTS solution offers migration to a dynamic optical network that can grow to any capacity, rapidly allocate bandwidth to meet traffic demands, and efficiently carry any type of service (voice, video, Metro Ethernet, SAN, SONET, wavelength, and so on). The Tellabs 7100 OTS integrates multiple technologies into one platform to enable data and TDM convergence, reducing network elements and the capital and operational costs associated with overlay networks. These technologies include:

- Integrated Layer 2 Ethernet switching
- SONET/SDH switching
- DWDM
- Multi-rate add-drop multiplexing
- Optical networking, using Wavelength Selective Switching (WSS) ROADM
- Carrier-class hardware redundancy and circuit availability features.

Integrated Layer 2 Ethernet and SONET/SDH Switching

In the transport layer, the Tellabs 7100 OTS supports SONET/SDH switching side-by-side with Layer 2 switching to enable widespread Carrier Ethernet services and network convergence. Agencies deploy the desired Layer 1, 2, or 3 services across the optical layer by simply plugging in the appropriate interface card. Agencies can thus simultaneously support native packet and SONET based voice, video and data services simultaneously over a single network without the need for overlays. In this way, the Tellabs 7100 OTS:

- Reduces capital costs by maximizing port utilization on costly routers and decreasing fiber requirements in the distribution portion of the network where fiber is most scarce
- Cuts operational costs by lowering the number of network elements to manage
- In conjunction with ROADM, supports efficient, robust and scalable networks for mission-critical bandwidth intensive applications — today and tomorrow.

Agencies can also continue to support the current TDM network as they establish a migration path forward to an all-packet network.

DWDM

DWDM multiplexes multiple wavelengths of light onto a single fiber. DWDM increases the capacity of this fiber by first assigning incoming

optical signals to specific frequencies within a designated frequency band and then multiplexing the resulting signals out onto one fiber. Each wavelength can carry multiple signals at a different rate (OC-3, -12, -48 etc) and in a different format (SONET, ATM, IP data, etc).

Multi-rate Add-Drop Multiplexing

The add/drop multiplexer combines or multiplexes several streams of data into a single beam of light. It manages network bandwidth by switching large numbers of SONET or data circuits in a single piece of networking equipment. The Tellabs 7100 OTS uniquely enables agencies to deploy different lines using software-configurable interface cards, which can support any type of line (e.g. OC-3, OC-12 and Gigabyte Ethernet) on any interface port, while other vendors require a specific card for each type of line. This enables operators to simply deploy a full OC-192 ADM on an interface card pair in the Tellabs 7100 OTS port shelf, as opposed to an entirely separate ADM network element.

Optical Networking with WSS ROADM

Wavelength activation with older DWDM systems was complex, expensive, and slow. Activating a wavelength required complex planning followed by a truck roll to every node in the wavelength's path to add transponders, balance, and tune the network. This resulted in high capital and operating expenses, while the time required to deploy and activate additional bandwidth was measured in weeks. This manual process also increased the potential for error and decreased reliability. ROADM enables wavelengths to be passed through and dropped or added remotely without new hardware and without a truck roll, reducing costs and speeding service activation.

Today's third-generation ROADMs, including the Tellabs 7100 OTS, employ WSS. Now considered the technology of choice for carriers worldwide, WSS ROADM brings more flexibility and lower total cost of ownership to various network scenarios. WSS ROADM allows operators to route any wavelength, or any combination of wavelengths, to any node without the need to predefine traffic demands or install additional devices, thereby reducing the time to deploy new services.

WSS ROADMs enable the operator to select and then re-select the specific wavelength to add/drop at the node, which is particularly beneficial when traffic is difficult to predict or if it is expected to change often. WSS ROADMs can also be deployed not only in rings and chains, as in previous generations, but in multi-ring and mesh topologies common in metro core and regional WDM networks. The Tellabs 7100 OTS adds the ability to provide automatic power balancing, so when agencies insert a new node into an existing network, the network automatically reengineers power levels appropriately.

Redundancy and Circuit Availability Features

The Tellabs 7100 OTS ensures reliability and availability by providing a high level of redundancy as well as circuit availability features.

The Tellabs 7100 OTS includes redundant controller modules and power supplies. Additionally, one node can support up to eight different fiber paths, each carrying up to 88 channels of 40G traffic. Thus, this topology provides highly scalable bandwidth along with numerous protection paths for every circuit on the network compared with the one protection path provided by a ring topology, resulting in significantly fewer service interruptions.

Additionally, the Tellabs 7100 OTS includes a number of capabilities that ensure availability of the circuit. These include Layer 0 Optical Protection Switching Modules, UPSR (SONET), Link Aggregation, Resilient Packet Ring (RPR) and Rapid Spanning Tree Protocol (RSTP). Customers also have the option of enabling the ASON/GMPLS control plane to automatically re-route around failures in the network. With these capabilities, the Tellabs 7100 OTS is able to provide sub-50-ms switchover times to mitigate network failures. In contrast, many router based systems can take seconds to come back online. These redundancy and circuit availability features enable high reliability.

Benefits of Tellabs Optical Transport

With Layer 2 switching, DWDM, multi-rate add-drop multiplexing, optical networking including WSS ROADM, and redundancy and circuit availability features, agencies can benefit from greater bandwidth efficiency, improved reliability, data network/TDM convergence, fiber conservation and investment protection.

Bandwidth Efficiency

Commonly, federal agency networks are designed with partially filled, physical point-to-point connections that result in an inefficient use of network resources and extra port or interface expense. Tellabs Optical Enterprise implements a Layer 2 switched transport network over DWDM wavelengths to distribute traffic from core routers to distribution switches. By utilizing an intelligent Layer 2 network instead of point-to-point pipes, traffic can be aggregated from multiple sites and combined into efficiently filled 10G wavelengths. This approach reduces the quantity of 10G connections required in the core and thus lowers the cost of both the core router and transport equipment. In a DWDM environment, it also conserves wavelengths, and therefore bandwidth, for future expansion.

High Reliability

A February 2007 survey of 388 federal government IT managers found that 93% require 99.999% telecom network uptime and that reliability and outages are among the main issues that keep them up at night.⁴ The Tellabs 7100 OTS — with its redundancy and circuit availability features — is proven on customer networks to have 99.9999% or “six nines” availability. In December 2007, the United States Information Systems Engineering Command's (ISEC) Technology Integration Center (TIC) certified the Tellabs 7100 OTS for use in an environment that's the ultimate in mission-critical applications: broadband connections between Army bases and soldiers in the battlefield. The Tellabs 7100 OTS is also certified by the Joint Interoperability Test Command (JITC) and on the DoD's Transport Approved Products List.

⁴ www.tellabs.com/news/2007/nr022607.shtml

Data network and TDM convergence

The Tellabs 7100 OTS has integrated Carrier Ethernet Layer 2 switching capability and SONET ADM/digital cross connect functionality in one platform, so it can simultaneously carry native Ethernet and TDM traffic on the same network, separated by wavelength. This convergence reduces the total number of elements required to run the network, which means fewer devices to purchase and install and lower overall network costs. Compare Figure 2 with Figure 3.

For example, rather than stacking ADM devices to run SONET traffic over the data network, agencies can simply insert a pair of transponder modules into the same Tellabs OTS 7100 node that carries data traffic. By reducing the number of network elements, convergence also reduces operating expenses by up to 65% through lower costs for provisioning, maintenance, troubleshooting, power consumption, installation and upgrades to these network elements. The Tellabs 7100 OTS also provides the option to support DS1 interfaces where required.

Fiber Conservation

A dynamic optical network that uses the Tellabs 7100 OTS integrated switching with ROADM enables traffic to be steered in any direction from a particular site and ultimately to any fiber path in the network. This enables agencies to use the fiber topology more efficiently without having to rely on physical point-to-point and partial or full mesh connections. In some deployments, Tellabs Optical Enterprise can eliminate physical point-to-point fiber links between sites and routers. Since network construction for creating fiber paths is typically the biggest expense in the network, significant savings can be realized, as network construction can cost up to \$95 per foot in typical terrain.

Investment Protection

Federal agencies continue to introduce new data services and applications, and to construct new buildings. All of these factors have led to higher bandwidth demands, taxing the existing data network and causing agencies to fund and manage a new technology upgrade approximately every three to five years. This represents not only a significant capital expense but a large operational undertaking after implementation.

In contrast, the Tellabs 7100 OTS can dramatically extend the lifecycle of the network. Once in place, the Tellabs 7100 OTS is currently able to expand to up to 88-, 40 Gbps wavelengths, offering virtually infinite bandwidth in a campus or regional environment.

Tellabs continues to develop the Tellabs 7100 OTS with clear paths forward such as Layer 2 scalability, Terabyte switching and 100 Gbps technology, all of which protect the existing Tellabs 7100 OTS investment. It is feasible that today's 3-year to 5-year life cycle of the transport network could extend to 10 to 15 years with Tellabs Optical Enterprise, dramatically reducing capital expense as well as the design, installation, training, provisioning and management expenses associated with platform upgrades.

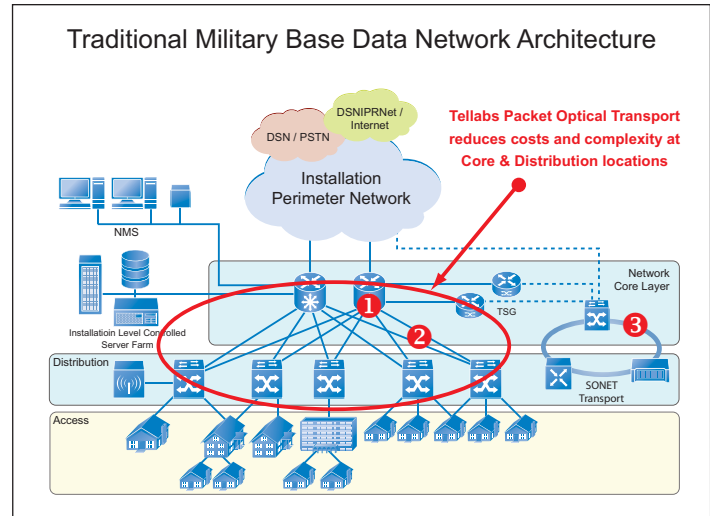


Figure 2.

- 1 High port counts on expensive routers
- 2 Partially filled links result in inefficient bandwidth usage
High construction cost for any fiber links that may not already exist
- 3 Completely separate overlay SONET network

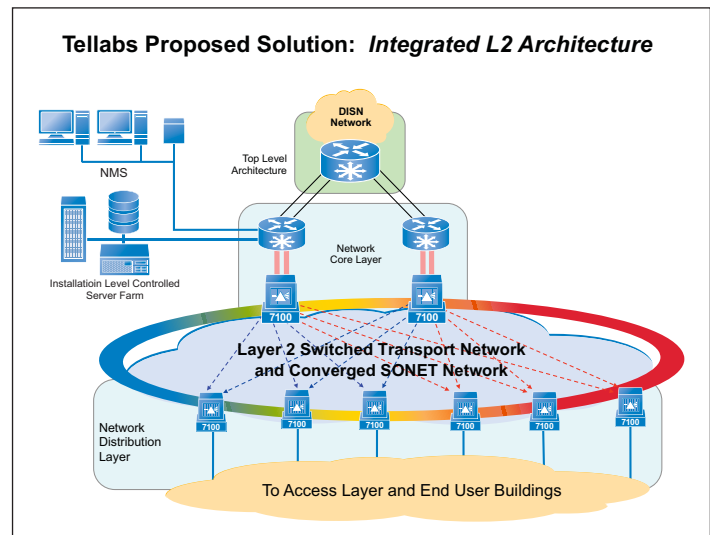


Figure 3.

Tellabs Optical Enterprise Benefits

- Reduce port counts on expensive routers
- Efficiently fill 10G wavelengths with Layer 2 aggregation
- Enable virtually infinite bandwidth DWDM core
- Reduce fiber complexity and construction
- Eliminate overlay SONET networks

Conclusion

With Tellabs Optical Enterprise, federal agencies gain a complete optical networking solution that incorporates both optical access and optical transport. The result is a robust, integrated, multiservice architecture based on Commercial Off-The-Shelf technology that offers a wide range of efficiencies in initial designs as well ongoing operations as the network is maintained. By combining GPON access with switched packet optical transport over DWDM that incorporates ROADM, Ethernet and TDM, Tellabs Optical Enterprise provides benefits that include:

- Significant savings in capital and operating expenses, power consumption and space
- High levels of security
- Bandwidth efficiency
- High reliability
- Data and TDM network convergence
- Smooth transition to VoIP and other advanced technologies
- Fiber conservation and investment protection.

For more information on how your agency can benefit from this solution, please contact us at:

Tellabs® Government Systems
 20360 Seneca Meadows Parkway
 Germantown, MD 20876
 U.S.A.
 +1 240 686 6801
www.tellabs.com/markets/government/
sales-info@tellabs.com

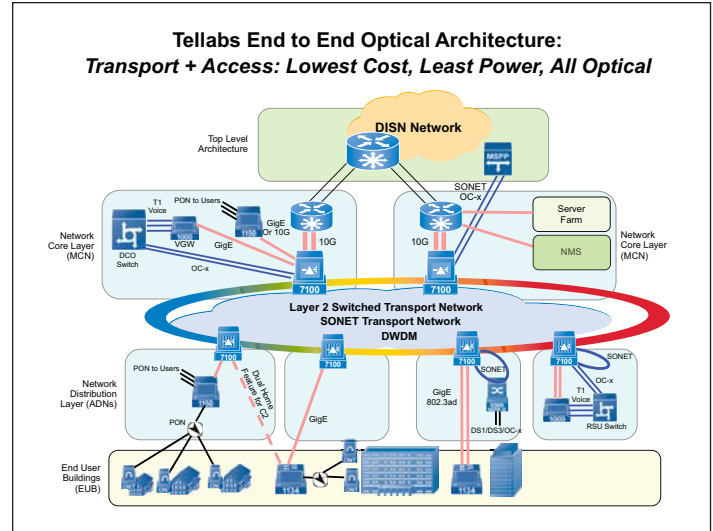


Figure 4.

North America

Tellabs
 One Tellabs Center
 1415 West Diehl Road
 Naperville, IL 60563
 U.S.A.
 +1 630 798 8800
 Fax: +1 630 798 2000

Tellabs® Government Systems

20360 Seneca Meadows Parkway
 Germantown, MD 20876
 U.S.A.
 +1 240 686 6801
www.tellabs.com/partners/government
sales-info@tellabs.com

Statements herein may contain projections or other forward-looking statements regarding future events, products, features, technology and resulting commercial or technological benefits and advantages. These statements are for discussion purposes only, are subject to change and are not to be construed as instructions, product specifications, guarantees or warranties. Actual results may differ materially.

The following trademarks and service marks are owned by Tellabs Operations, Inc., or its affiliates in the United States and/or other countries: TELLABS®, TELLABS and T symbol®, and T symbol®.

Any other company or product names may be trademarks of their respective companies.

© 2009 Tellabs. All rights reserved.
 74.2124E Rev. B 11/09