tellabs™

Is your LAN ready for tomorrow's challenges?

How enterprises are solving evolving network challenges with Optical LAN

Optical LANs versus copper LANs — CIOs and IT professionals are finding solutions to the many network challenges created by the emergence of big data, big data analytics, the virtual desktop, hosted/managed services, software-defined networks, cloud-based computing, wireless (3G/4G, DAS, Wi-Fi, BYOD) communications, the Internet of Things and smart-building technologies. Yet oddly enough, many CIOs and IT professionals have not changed their local area network (LAN) infrastructure, which still consists of copper cabling and racks of Ethernet switches.

Enterprises implemented the copper-based LAN architecture decades ago to support peer-to-peer desktop computer traffic flows; at the time, 80% of the traffic stayed local. Today, because of the new technologies mentioned above, 90% of LAN traffic flows directly to the wide area network (WAN).

Responding to this new environment, the Tellabs™ Optical LAN solution enhances cloud architectures, lays the foundation for software-defined networks and complements wireless technologies. Passive Optical LAN, a simple, secure, stable, scalable, sustainable, and smart alternative to legacy copper-based LANs, saves energy, space and money.

Legacy copper-based LAN — Legacy copper-based LAN typically offers fixed point-to-point connectivity via a hierarchy of racked and stacked Ethernet switches in the main data center and telecommunications closets. To deliver some degree of reliability, that hierarchy creates tangles of meshed copper cabling.

The legacy LAN's service delivery reach is limited to 100 meters for copper and to 550 meters for multimode fiber (MMF) cabling. Regeneration of the signal to travel longer distances consequently creates the need for additional aggregation, distribution and telecom closets to rack and stack additional Ethernet switches. These telecom closets are stuffed not only with the Ethernet switches but also with UPS, A/C, ventilation and fire-suppression equipment, all of which make the closets expensive to build and operate [Figure 1].

Traditionally lacking Quality-of-Service (QoS) mechanisms, the copper-based LAN uses only a few levels of prioritization and relies instead on retransmission when congestion occurs. When retrans-mission fails, the copper-based LAN simply drops packets. Obviously, this architecture came into being before the LAN had to transmit real-time services such as voice and video. The copper-based LAN was — and still is — a poor choice for transmitting real-time services.

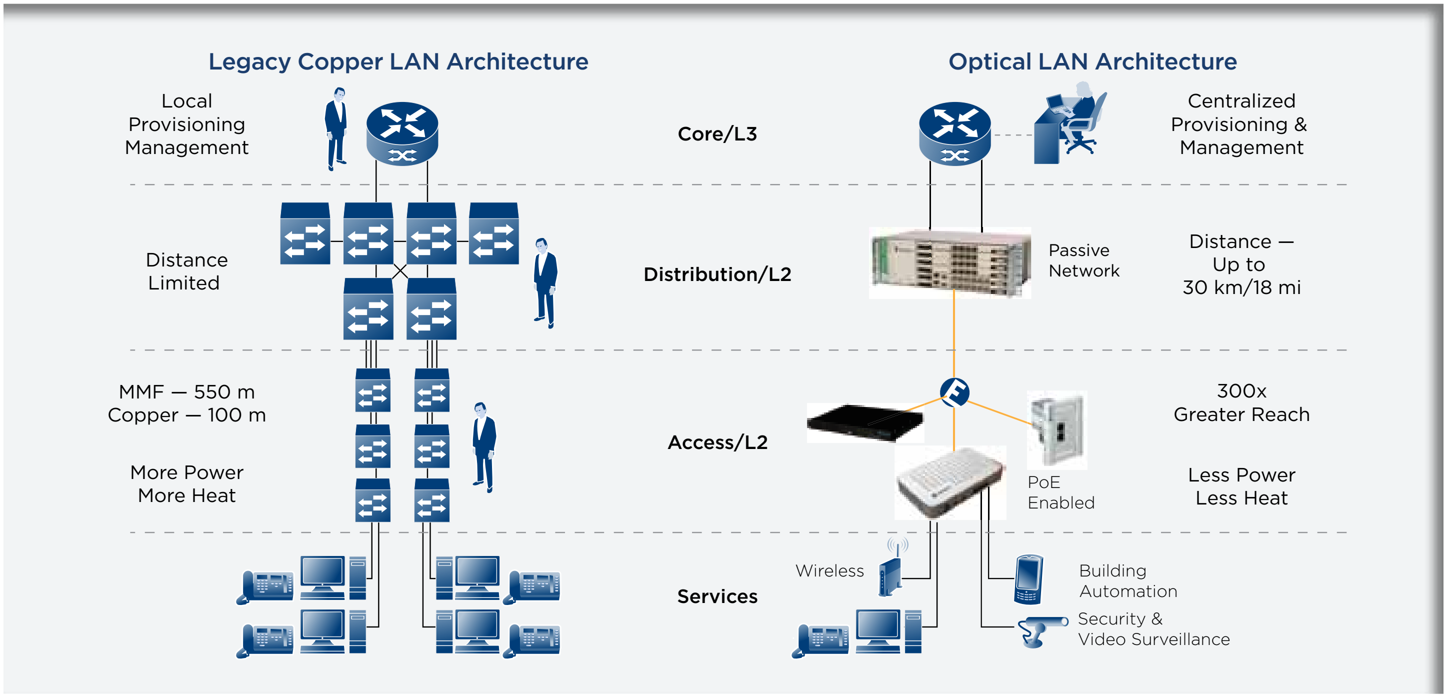

Figure 1: Comparing the architecture of a legacy copper LAN and Passive Optical LAN architecture

To avoid hitting capacity limits, network architects design and physically engineer copper-based LAN installations to deliver 100% x 2 of the anticipated utilization, with bandwidth to be allocated in fixed increments. This expensive, inefficient approach to network design inevitably mandates 2x the equipment and 2x the cabling actually required, resulting in idle capacity and idle equipment CapEx.

To make matters worse, the design often calls for the use of disparate network equipment and cabling to support different services. For example, voice traffic might travel over a copper UTP infrastructure; data traffic might travel over separate, newer CATx cables; and video traffic might travel over a third set of cabling, such as coaxial. This design again is excessive, this time in terms of energy, space, material, cost and operational expenses.

Another operational inefficiency of these legacy copper-based networks is their local management at each Ethernet switch. Skilled IT pros are forced to execute moves/adds/changes (MACs) by interfacing directly with all these switches spread across multiple physical locations, a process that increases the chances of human error and adds to the expense of everyday LAN operations.

Passive Optical LANs — Optical LAN is characterized by a shared point-to-multipoint architecture, a passive optical distribution infrastructure and near-future-proof single-mode fiber connectivity. Similar to cloud-based networks, the OLAN architecture shifts network intelligence to the core and centralizes the management of all far-reaching endpoints. Just as cloud-based computing centrally locates resources for sharing by many users to save energy, space, capital costs and operational costs, OLAN does precisely the same [Figure 2].

Passive Optical LAN architecture centrally locates the Optical Line Terminal (OLT) in the enterprise data center. From this central location, the OLT can serve up to 8,000 Gigabit Ethernet endpoints over single-mode fibers reaching across a Passive Optical Distribution Network (ODN) of 30 km/18 mi [Figure 1].

The OLT has the intelligence to converge multiple network services: voice (analog POTS and VoIP w/PoE); video (IP and RF video); videoconferencing; and wireless and monitoring services (building automation system security cameras and sensors) across the Optical LAN.

The OLT can support multiple 1 Gbps and/or 10 Gbps connections to the WAN, the Internet and other corporate resources in the main data center. Unpowered, unmanaged, highly reliable optical distribution splitters across the Passive ODN handle the LAN's aggregation and distribution functions. Engineers have few restrictions on where they position the ODN splitters. Similarly, they can position the Optical Network Terminals (ONTs), which transition the optical signal back to an electrical signal, in a variety of locations to provide gigabit-speed connectivity to the end-user's device.

The centrally located OLT's intelligence allocates bandwidth dynamically, on a per user or per device basis, as driven by rules using committed information rate (CIR) and excessive information rate (EIR) settings and defined within the software. The software also defines traffic management via advanced VLAN functionality and priorities established by IEEE 802.1p, IEEE 802.1q and DSCP.

Strict rules-based QoS, defined through software, applies dynamically in real-time on a per service or per user basis via mechanisms for traffic segmentation/classification, rate limiting (shaping), queue management (buffering) and scheduling (policing).

The same software-defined, rules-based global provisioning functions operate with authentication and authorization to provide security in the Optical LAN, specifically by implementing the standard IEEE 802.1x, Access Control (e.g., PAC, NAC) and RADIUS protocols, and dynamically allocates in real-time based on a per service and/or per user basis.

	Architechure	Intelligence	Resources	Bandwidth	User Experience	Distance	Management
Legacy Copper LAN	Dedicated Point-to-point (Fixed)	Distributed Intelligence (thick client endpoints)	Dedicated Resources (Fixed)	Dedicated Bandwidth (Fixed)	Limited Class of Service (CoS)	100 m Copper CATx	Local Management
Passive Optical LAN	Shared Point-to-multipoint	Centralized Intelligence (thin client endpoints)	Software Defined Shared Resources Dynamically Allocated	Software Defined Shared Resources Dynamically Allocated	Software Defined Quality of Service (QoS) Dynamically Allocated	30 km Single-Mode Fiber	Centralized Management

Figure 2: Comparing the functionality of a legacy copper LAN and Passive Optical LAN architecture

Simple = Converged Networks & Services — The ability to converge all network services, thereby eliminating the need for multiple platforms and cabling infrastructure while providing highly scalable high-speed data services to all users, is the foremost feature of the Optical LAN. In addition, it supports voice (POTS and VoIP w/PoE), video (RF and IP), wireless and building automation services.

Voice — End-users can connect VoIP phones directly to ONTs via RJ-45 connectors to obtain pure VoIP service. With IP phones directly connected to the PBX/Softswitch, Optical LAN equipment transports the SIP flows transparently over the IP/Ethernet data path. To deliver analog voice (POTS) service, the Optical LAN OLTs and ONTs become SIP-based VoIP endpoints, with a SIP analog telephone adapter positioned at the ONT's RJ-11 interface. A voice gateway (VGW) residing in the main data center provides graceful SIP-to-TDM migration. Situated between the OLT and the voice switch, the VGW translates SIP back into analog POTS format to support legacy circuit-switched PSTN and analog PBXs. Various CLASS services, such as Caller ID, CMWI, call waiting, call forwarding and call transfer, continue to function.

Typically, upgrading to VoIP requires IT staffers not only to install a softswitch but also to upgrade each user's handset to a VoIP phone, which can cost $300–$500 per handset. In most offices, only 5%–20% of users actually require advanced VoIP features. The Tellabs Optical LAN enables those users who do not need advanced VoIP features to continue using their existing analog handsets, thereby eliminating the need for costly handset upgrades.

Video — Video has many purposes within Enterprise LAN, such as entertainment, security and telepresence conferencing. Video content can be delivered in MPEG-encoded IP video on demand and other interactive services. The Optical LAN system carries video flows as IP, leveraging the integrated Internet Group Management Protocol (IGMP) multicast and unicast delivery mechanisms. The Optical LAN also supports Enterprise IP video services, including videoconferencing, telepresence conferencing, telepresence robots and video surveillance.

With an overlay architecture that complies with the ITU-T G.984 recommendation, the Optical LAN can deliver RF video. A third 1550 nm wavelength carries the video on the PON and delivers the video signal to the customer in a format defined by Society of Cable Television Engineers (SCTE) standards. The ITU-T G.984 recommendation governs management of the ONT interface, while a standard "F" coaxial interface supports 54 MHz–900 MHz CATV channel content from the ONTs. Because of the overlay network, the Optical LAN's presence is transparent to the CATV network equipment.

Wireless — Optical LAN is an excellent choice for backhauling wireless traffic and can do so in either of two architectures. Using stand-alone static Wi-Fi architecture, which has no robust controller functionality, Optical LAN reduces cost as well as energy and space requirements. Optical LAN element management also allows the integration of WAP features and functionality, and Optical LAN's greater density and reach improve both the performance and coverage of Wi-Fi services. Further, because Optical LAN interoperates with established Wi-Fi vendors' equipment, enterprises and service providers can select best-of-breed manufacturers to supply advanced Wi-Fi controller functionality. As demonstrated in Optical LAN deployments with industry leaders like Cisco, Aruba, Ruckus and Meru, the controller functionality adds dynamic provisioning, interference correction, load balancing and coverage optimization.

Optical LAN and Distributed Antenna Systems (DAS) also complement one another. Although DAS traffic does not traverse the Optical LAN equipment, it can leverage the same fiber infrastructure that the Optical LAN uses. In and of itself, DAS offers a limited return on investment; it is relatively expensive, does only one thing and few (if any) customers believe that they should pay for it. By contrast, Optical LAN offers an excellent ROI, which can cost-justify deploying DAS over existing spare fiber. In the near term, DAS and Optical LAN can complement each other even more by sharing powering, power backup and fiber management.

Building Automation — Building Management Systems (BMSs) and Building Automation Systems (BASs) are extremely important in any new building and essential for reducing operating costs. Building monitoring devices and system reporting-and-analysis tools require IP/Ethernet connectivity, and Optical LAN recently has assumed responsibility for integrating these functions. Because the majority of BMS/BAS monitoring devices today are IP/Ethernet based, connectivity with the existing and new Optical LAN is seamless. Optical LAN ensures adequate bandwidth, security, authentication and quality of service specific to each monitoring and management device.

Simple = Centralized Management — Optical LAN, with its central management, lays the foundation for software-defined networking (SDN), thereby allowing the global automation of:

- Fault (alarms, diagnostics and troubleshooting)
- Configuration (provisioning and upgrades)
- Automation (OSS, backups and restorations)
- Performance (reporting)
- Security (user roles and access controls)
- Inventory Management

The intelligence required to manage all endpoints and services resides in the central management system and OLT, an approach which accelerates moves/adds/changes while reducing human error. The combination of more machine-to-machine communications and fewer human touches improves network availability. Large businesses lose about 4% of annual revenue because of network downtime, and the human factor is responsible for 50%–80% of all network outages.

Simple = Space and Material Reductions — Reducing cabling, floor, rack and telecom closet space is a high priority for CIOs and IT professionals who want to convert LAN floor space into revenue-generating space. In addition, reducing LAN space, which reduces UPS, fire suppression and HVAC requirements, also cuts overhead costs.

A typical copper-based LAN serving up to 2,000 users requires 90 rack units of space. Active Ethernet LAN switches require one full rack for the switches and two additional racks for terminating the large bundles of copper cables associated with the switches — for a total of 18 seven-foot-tall equipment racks. In contrast, an Optical LAN serves up to 8,000 users and, because of the OLT’s 90% greater density, requires only one equipment rack and a total of 11 rack units within the equipment rack [Figure 3].

Adopting the private cloud concept, Optical LAN, with its 30-km /18-mi reach, enables enterprises to build private LANs across a large campus and extended geographical areas. Enterprises have to replicate legacy copper-based LANs in each building served, but Optical LAN’s single centrally located OLT can deliver gigabit speed to users in multiple buildings that are miles apart.

Sustainable — Optical LAN, which offers energy savings of up to 30%–65% over legacy copper-based LANs, strengthens green initiatives and reduces total cost of ownership. Optical LAN’s passive architecture requires no power within the ODN, thereby eliminating all power requirements from the building-aggregation portion of the network. In addition to requiring less power, the lower amount of required equipment has a ripple effect on many other areas, including power distribution and switch gear, power conversion, power backup, fire suppression and cooling. One in five companies now dedicates a portion of its budget to green IT initiatives.

Tellabs Optical LAN also helps enterprises achieve specific environmental goals, such as LEED certification and ENERGY STAR qualification. Corporations seeking LEED certification (i.e., the internationally recognized green building certification), for new construction or existing buildings achieve maximum operational efficiency with the Tellabs Optical LAN. Its lower power and A/C requirements reduce the environmental impacts of new and upgraded LAN systems. ENERGY STAR, which originated in the United States, is an international standard for energy-efficient consumer products. By establishing criteria for PON equipment, Tellabs became a major contributor to the ENERGY STAR initiative, and ENERGY STAR certification is pending for the Tellabs Optical LAN solution.

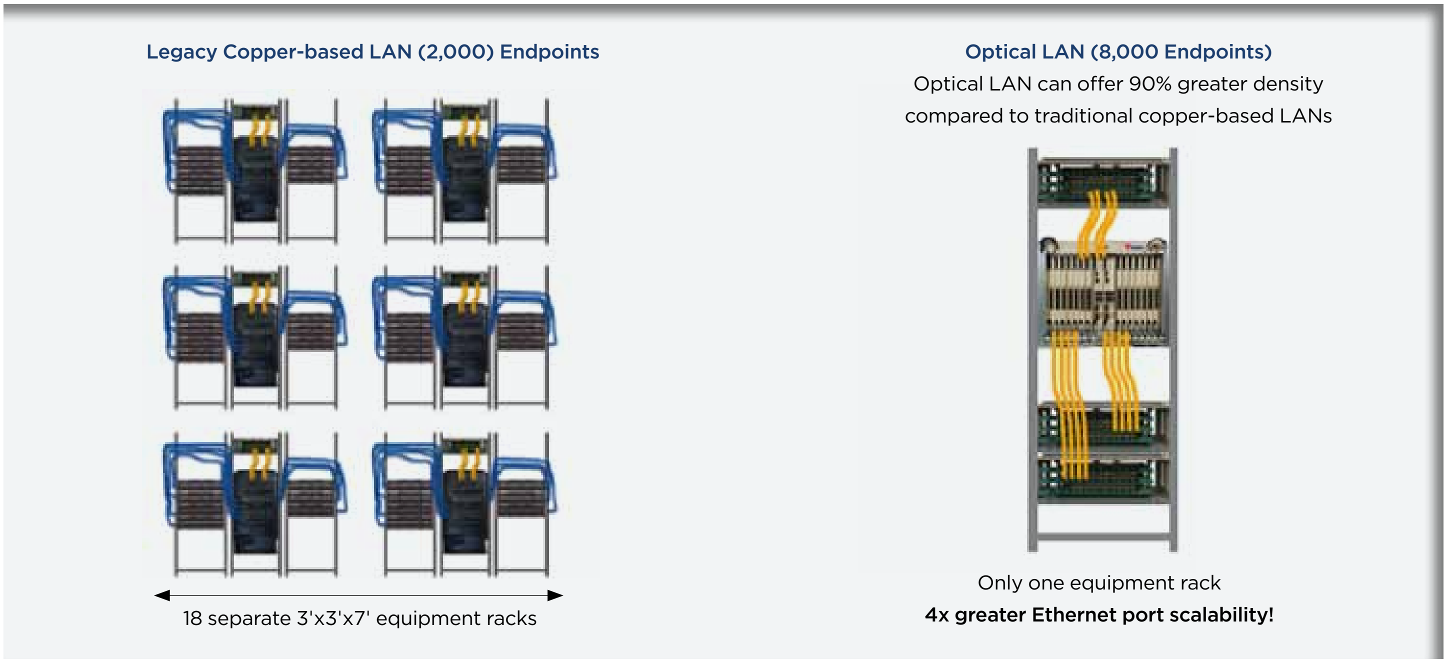

Figure 3: Converge Networks and Converge Services over Passive Optical LAN.

Scalable — Using single-mode fiber (SMF) today is the best way for enterprises to protect their infrastructure investments. Because SMF has demonstrated its ability to carry 101 Tbps of full-duplex bandwidth, the next-generation cable upgrade will not affect the ODN; enterprises only need to upgrade the individual super-user electronics. In addition, SMF extends the Optical LAN's reach to 18 miles (30 km) without signal regeneration.

Because the cable plant typically is the most expensive part of a technology upgrade, installing SMF eliminates the need for additional upgrades to the cable plant in the foreseeable future. Further, recent advances in fiber-connector technology have significantly reduced the cost of installing fiber and, in most cases, fiber installation is now less labor-intensive than copper cable installation.

Finally, compared to a CATx copper cable plant, SMF is smaller, lighter and stronger; has a tighter bend radius, higher bandwidth capacity and longer reach; is less susceptible to EMI interference; has faster connector solutions and longer life; and entails lower material cost than CATx.

Stable — LAN stability can be measured in the percentage of time that the network is up and running throughout a year. A legacy copper-based LAN typically offers 99.9% availability per year, which means 8.7 hours of downtime. On average, a business loses $7,900 per minute in an LAN outage. Compare the legacy LAN numbers with those of a typical Optical LAN, which has a tested availability of 99.999% per year, or only 5 minutes of downtime annually. In other words, one OLT, one SMF, one ODN splitter and one ONT together deliver five 9s of reliability. For a legacy copper-based LAN to achieve five 9s, racking and stacking of more switches would be required as well as multiple meshed connections between/among all those switches, which would add cost, power and space burdens to the network [Figure 4].

An Optical LAN provides equipment redundancy, including redundant common control, Ethernet switch units, network connectivity, power sources and equipment fans.

It also can provide network redundancy via dual homing network connectivity to core routers. Further, Optical LAN can provide fiber route diversity and geographically dispersed OLTs through ITU.T FSAN-defined "Type-B" PON redundancy. By combining equipment and network redundancy, Optical LAN can achieve 99.9999% uptime or six 9s of availability, which translates into only 30 seconds of network downtime annually.

LAN stability also can be measured in terms of the ability to pave a graceful migration path to future technology with fewer "rip and replace" requirements. Historically, copper-based cabling has not kept pace; over the past decade alone, enterprises have had to replace CAT3 cabling, CAT5 cabling, and soon will have to replace their CAT6 copper cabling with CAT8 cabling. SMF infrastructure is the best choice today to future-proof Enterprise LAN equipment; 2.4 GbE OLT/ONTs can migrate to 10 GbE PON on a per endpoint basis while protecting the existing ODN infrastructure investment.

Secure — Traffic is more secure on Optical LAN than on copper-based LANs. 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

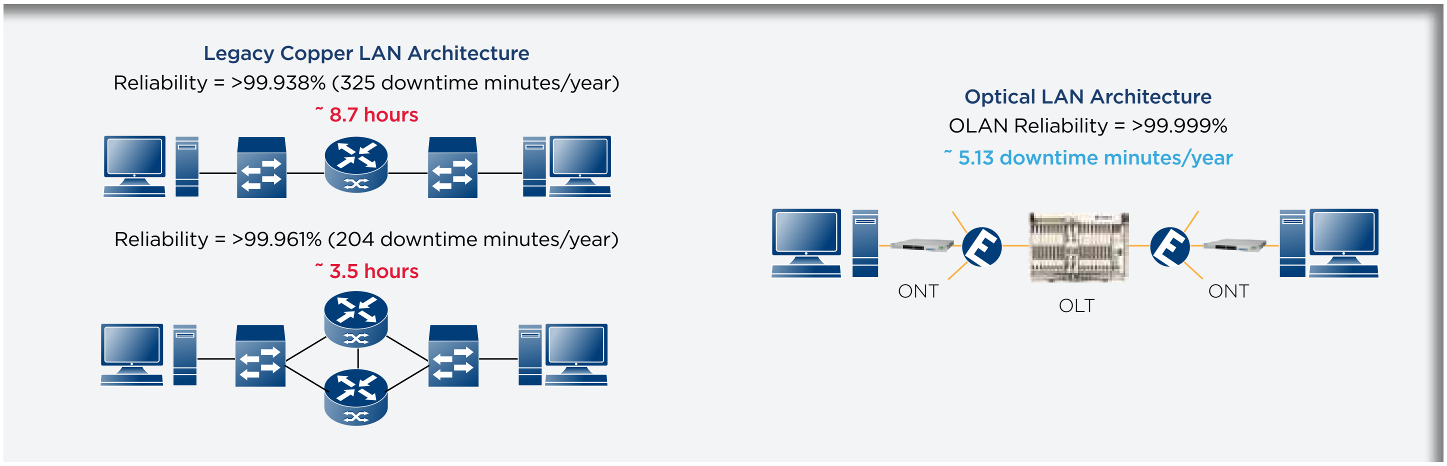

Figure 4: Converge Networks and Converge Services over Passive Optical LAN.

and RADIUS recommendations as well as strict user-definable roles for the 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. 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.

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.

Smart — When upgrading the network infrastructure, smart CIOs and IT professionals look at both the near-term and long-term expenses. Today's enterprise requires solutions that not only lower initial capital expenses but also reduce the network's total cost of ownership (TCO). Forward-looking managers insist that new systems address more of their telecommunications requirements while also minimizing ongoing operational expenses. Optical LAN is the smart choice.

By significantly reducing the number of cable runs, Optical LAN enables the enterprise to significantly reduce the cabling infrastructure costs from the data center to the user. As a result, Optical LAN reduces overall operational costs and network complexity.

Up to 50% to 70% cost savings — Compared to copper-based LANs, Optical LAN provides lower Day-One capital expenses by requiring fewer equipment purchases, greater density and lower installation costs. Similarly, its fiber cable costs less, has better density and lower installation costs. Today, SMF provides faster field connectors as well as options for pre-connectorized solutions. Optical LAN also requires less acceptance testing than copper cabling, and its more economical support agreements, combined with the fact that it requires less ongoing IT staff training certification, translate into lower year-over-year operating expenses. The efficiencies inherent with centralized element management also produce significant operational savings. Taken together, all of these savings compound year-over-year, providing Optical LAN with an outstanding 7–10 year TCO analysis.

Up to 30% to 65% energy savings — End-to-end analysis typically shows Optical LAN power consumption to be less than 5 watts per user — and often below 2 watts per user. That contrasts with copper-based active Ethernet LANs in which power consumption ranges from 5 to 12 watts per user. Optical LAN savings ripple and compound across a building through reduced power plant, power backup and HVAC requirements. One study calculated that for every watt saved in ICT equipment, the enterprise savings increased by a factor of 2 across the entire building.

Up to 90% space savings — Optical LAN's ability to save space, in terms of equipment, is readily apparent in the form of fewer data center requirements and the elimination of telecom closets/IDFs. It also saves space in terms of fiber cabling because SMF is smaller, lighter, has a better bend radius and is easier to install. As a result, Optical LAN saves a significant amount of real estate square footage, which the enterprise can repurpose for usage that generates revenues. For example, a school can free up more desk space for students and teachers; a hotel can offer more rooms and beds; and a hospital can expand resources required by staff and patients.

Summary — CIOs and IT professionals are grappling with the challenges presented by complex, evolving LAN services, including big data, the virtual desktop, hosted/managed services, software-defined networks, cloud-based computing, the Internet of Things, smart-building technologies and wireless (3G/4G, DAS, Wi-Fi, BYOD) communications. Tellabs Optical LAN solution enhances cloud architectures, lays the foundation for software-defined networks and complements wireless technologies. Optical LAN, as the simple, secure, stable, scalable, sustainable and smart alternative to legacy copper-based LANs, allows CIOs and IT professionals to overcome these challenges and, in the process, save their organizations energy, space and money.

Take the next step. Contact Tellabs today.

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