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A New Network Paradigm: Cutting Cost, Space and Energy Use

Military agencies, like their civilian counterparts, juggle a number of requirements when deploying local area networks (LANs). First, they must stay up-to-date technologically, in terms of network speed, capacity and functionality. At the same time, they have to control both upfront and long-term LAN costs. Finally, they have to figure out a way to achieve those objectives while also complying with a federal mandate to trim energy consumption 30% by 2015.

That's a tall order. But military agencies can now achieve these goals by deploying an advanced optical LAN solution, based on gigabit passive optical networking (GPON) technology. The solution delivers a "70-80-90" set of benefits: reduce capital costs by up to 70%, trim power consumption by up to 80%, and shrink the required floor, rack and closet space by up to 90%.

In the past, all GPON solutions were created for the residential market. However, the Joint Interoperability Test Command (JITC) has now certified one such solution as government- and enterprise-ready — the Tellabs Optical LAN solution. The only JITC-certified optical LAN solution for the U.S. Federal Government

An optical LAN is a Layer-2 transport medium, built with PON technology and fiber-optic cabling, which provides converged video, data and voice services at gigabit speeds over a single strand of fiber to end-users. Compared with legacy active-Ethernet solutions, an optical LAN dramatically reduces electronics and cabling requirements. The PON cabling infrastructure supports bandwidth of more than 50 terabits per second (Tbps), and the single-mode fiber extends the LAN reach up to 30 kilometers without signal regeneration.

Costs of Active-Ethernet vs. Optical LANs

So how does an optical LAN solution compare with the widely deployed active-Ethernet LAN architecture? Cost is one differential. In one fiber-to-the-desk (FTTD) LAN serving 2,000 users, the capital expenditure (CapEx) cost of building an active-Ethernet solution is in excess of $1 million. By contrast, an Optical LAN would save more than the 70%.

Federal government-specific features for information security.

In terms of power usage, the optical LAN is significantly "greener." In the 2,000-user example, active-Ethernet consumes more than 10 watts per user, where optical LAN consumes less than 2 watts per user.

Based on the Department of Energy's estimated 2009 commercial rate of 10.5 cents per kilowatt hour, the optical LAN solution achieves a power consumption savings of more than 80% over the active-Ethernet LAN. Comparing annual operating expenditures (OpEx) for utility costs, the optical LAN saves $72,000 versus the active-Ethernet LAN.

A typical legacy active-Ethernet LAN serving up to 2,016 end-users requires 90 rack units. And because most active-Ethernet LAN switches occupy one rack for the switch, and two additional racks for running the large bundles of copper cables, a 2,016-user active-Ethernet LAN would occupy 18 equipment racks.

Contrast that with a scenario in which an optical LAN serves up to 2,048 optical network terminals (ONTs) and 7,700 end-users. Thanks to the OLT's 90% greater density, this solution requires only 1 equipment rack and 9 rack units.

Eliminate Distance, Eliminate Costs

Another significant benefit provided by an optical LAN is the fact that it requires fewer communications closets and, in some cases, eliminates them altogether. As a result, an agency not only "recovers" physical space but also cuts expense by eliminating unnecessary communications closets. Further savings are realized by reducing excess network equipment. Given the 100-meter distance limitation on Category 3/5/5e/6 cabling in the active-Ethernet LAN, an agency must install repeaters or switches across the building or campus. The single-mode fiber in the optical LAN, however, can reach up to 30 kilometers. This enables an agency to:

- Reduce or eliminate repeaters, switches and communications closets
- Deploy an OLT in a single, central location
- Run links from that lone OLT to all end-users in the building and/or across the campus.

Keep the Copper, Keep the Savings

A second comparison scenario focuses on a fiber-to-the-communications-closet deployment serving 2,989 LAN users. In this instance, an agency has decided to retain its installed copper cabling, deploy an access device in the communications closet and link that device back to a central switch. The CapEx costs of the active-Ethernet versus optical LAN solutions are again in excess of $1 million, with optical LAN saving approximately 50%.

On the power consumption front, the active-Ethernet LAN still consumes more than 10 watts per user, compared with less than 2 watts per user for the optical LAN—a savings of more than 80%. The rack unit comparison is 210 versus 150, with the optical LAN taking up 29% less physical space. Comparing the annual OpEx for utility costs, the optical LAN saves $54,000 yearly over the active-Ethernet network.

Why Architecture Matters

Examining the configurations of the two LAN architectures helps illustrate more clearly the cost differences between them. Throughout military agencies, Category 3/5 copper cables typically connect 3 layers of routers and switches in an active-Ethernet LAN. A router on the top-most layer links to campus- or building-aggregation switches below. These routers, in turn, connect further down to communications closets. Links then extend from the communications closets to a pool of end-users. This legacy network is shown in Figure 1.

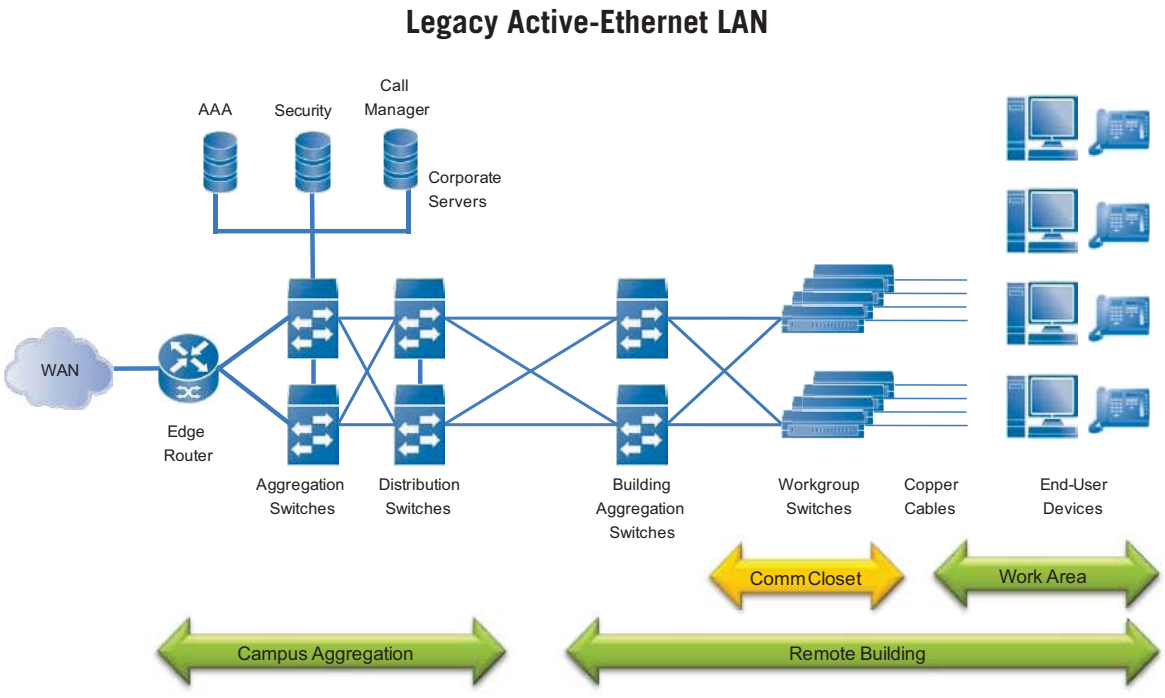

Figure 1. Copper-based LAN systems have a 100-meter limitation that drives a 4-tier network architecture for a typical campus. Workgroup switches are placed on every floor in a building, sometimes in multiple communication closets per floor. Additional switches aggregate the traffic for each building, and in turn, the building aggregation switches connect to campus aggregation and distribution switches which then connect to a router and finally the WAN.

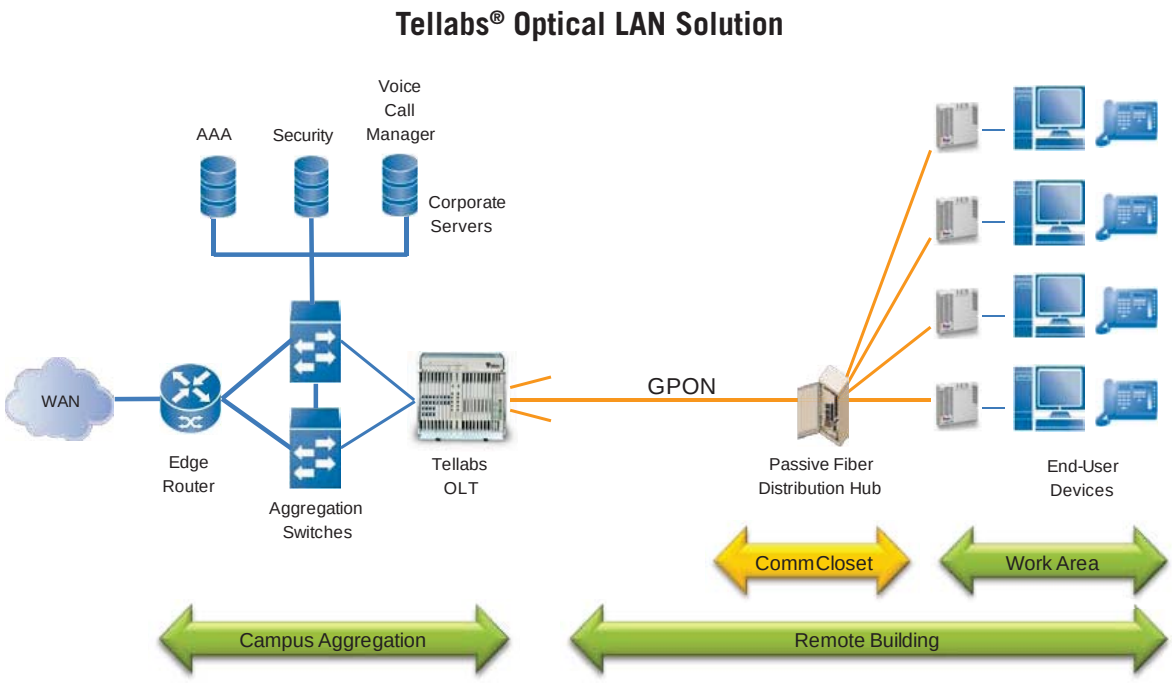

Figure 2. An optical LAN, on the other hand, simplifies the network and eliminates aggregation levels. The optical LAN replaces the active electronics in the communication closet with passive optical splitters. And because an optical LAN has a reach of 30 kilometers without signal regeneration, the building aggregation switches and he campus distribution switches can also be eliminated.

Contrast that with an optical LAN. This solution retains the router at the top-most layer but effectively eliminates the campus- and building-aggregation switches, as well as the communications closets. Instead, a single-mode fiber, typically equipped with a 1x32 splitter, runs between the router and OLT to the ONT(s) serving end-users. The optical LAN network is shown in Figure 2.

Optical LANs Reduce Total Cost of Ownership

In addition to reducing CapEx and OpEx, an optical LAN reduces the total cost of ownership (TCO) relative to active-Ethernet LANs. How? Its carrier-class design eliminates the need to swap out pricey Ethernet LAN switches every 5 to 7 years, as agencies must do with their legacy LAN architectures.

That technology refresh entails multiple tasks, such as:

- Engineering for the new network design
- Site surveys
- Bid generation, review and award
- Contract negotiations
- CapEx investments in significant platform upgrades or change-outs
- Program management
- Time and labor costs incurred by the actual installation.

Further, when agencies replace their switches, they also evaluate their cabling to determine if a change-out is required. Newer switches feature speeds that are faster than the installed cabling is capable of supporting. As all agencies know, replacing the LAN cabling is a recurring, massive and expensive undertaking. Worse, each time the agency replaces its Category N cabling with Category N+1 cabling, it basically trades one kind of bandwidth-limited media for another.

Fiber, on the other hand, can carry virtually unlimited bandwidth. Many optics engineers believe fiber can carry more than 50 Tbps. If an agency is planning to change out its cabling, why continue replacing copper when it can install fiber once and never replace it again? Plus, with OLTs currently capable of a 30-kilometer reach, distance limitations are no longer a constraint. Agencies can, for example, deploy in a single building one OLT that serves an entire campus while delivering 1Gbps per end-user today.

Agencies also have the flexibility to deploy an Optical LAN in an FTTD topology or to run fiber to the communications closet. In the FTTD configuration, an OLT serves an entire building, with speeds of 1G per end-user. A splitter-equipped fiber distribution hub (FDH) on each floor routes the fiber to desktop ONTs throughout the building.

The fiber-to-the-communications-room topology calls for installing the FDH in one location in a building. Fiber is run up the risers to communications closets and then existing copper cables are re-used. In the example of a 3-building campus, the agency can deploy the OLT in several ways: 1 OLT per building to aggregate just that building's traffic; 1 OLT in 1 building to aggregate traffic from all three buildings; or combinations thereof.

An optical LAN thus extends the network lifecycle to 10 years or more. This approach enables:

- Gradual, more predictable costs for bandwidth upgrades over the full 10-year period
- Modest ongoing maintenance costs associated with fiber
- Seamless addition of more technology-based capabilities, such as wave division multiplexing 40- and 100-Gbps transport and terabyte switching.

Migration Path to VoIP

Most military and civilian agencies plan to migrate from plain old telephone service (POTS) to voice over Internet Protocol (VoIP), but the current price of VoIP handsets, which ranges from $400 to $800, makes it difficult to build a viable business case. However, Tellabs offers a unique solution that provides a controlled, cost-effective migration to VoIP. For example, an agency with an FTTD optical LAN can deploy advanced desktop ONTs which feature 2 RJ-11 phone ports. As a result, the agency can achieve multiple objectives with just 1 device:

- Continued support for POTS, including facsimile
- Protection of existing investments in associated "plain old black phones"
- A migration path to VoIP phone service while avoiding the considerable costs of VoIP handsets.

Given that most military locations continue to rely on Class 5 switches with tip-ring pairs going to the desktop, an end-user can plug in a plain old black telephone, as well as a fax machine, to the ONT's RJ-11 ports. Consequently, this type of advanced ONT saves considerable costs on the customer-premises equipment (CPE) side.

The multi-desk unit ONT paves a smooth migration path to VoIP service by supporting both analog voice and Session Initiation Protocol (SIP). As a result, an agency can immediately obtain a VoIP-enabled back-end of its network, as well as continued connection to a Class 5 switch. Then it can gradually move users — 1 at a time, a floor at a time, etc. — to VoIP service, while preserving its CPE investments.

A True Government Solution

An enterprise optical LAN solution needs to include several capabilities before it qualifies as a true, JITC-certified government LAN solution. An optical LAN's advanced ONT has all of the required functionality built-in. It provides integrated Ethernet bridging, VLAN capability needed for network segmentation, and end-user authentication and security filtering. Because it functions much like an Ethernet switch, this advanced ONT makes it possible for an agency to replace an Ethernet-switched LAN seamlessly.

Thus by replacing their legacy LANs with optical solutions based on GPON technology, military and civilian agencies can readily achieve their overriding LAN objectives. This next-generation technology delivers the necessary speeds, capacity and functionalities. It controls both near- and long-term CapEx and OpEx. And it complies with the government's "go-green" mandate. Equally important, by deploying an optical LAN that's certified as a true government LAN, agencies have a network that's designed to satisfy their unique requirements for years to come.

Next Step:

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