Tellabs Access Solutions

Optical LAN's Superior Traffic Management

Introduction

The days of building local area networks (LAN) to support telephones, desktop workstation and locally switched traffic have passed. Ten years ago LANs were designed to support peer-to-peer traffic flows because 80% of the traffic stayed local, but today it is expected that 90% of the LAN traffic flows directly to the wide area network (WAN)[1]. LAN traffic has made 180 degree change in direction because of browser-based applications, wireless (3G/4G/Wi-Fi convergence), employee personal traffic, hosted/managed and cloud-based services. The modern high performance corporate LANs need to support new SMART building systems, a wide range of mobile devices (e.g. BYOD), cloud-computing, and a constant influx of new software applications. IT professionals also find themselves balancing corporate data alongside of employee personal data and external malicious attacks versus internal security vulnerabilities.

With changes in the workplace come changes in LAN traffic management which triggers a corresponding change in the LAN infrastructure architecture. Copper-based LANs were once adequate for telephones and desktop workstation, but their architecture is cumbersome, un-secure, inefficient and expensive with the advent of SMART buildings, wireless and cloud-computing evolution.

The purpose of this application note is to provide IT professionals with success based guidance related to:

- Common LAN traffic restrictions
- Converged services and networks through traffic segmentation with hard Quality of Service
- Cost effectively manage LAN traffic bandwidth requirements and new traffic flow
- Optical LAN is the Simple and Secure solution for modern corporate LAN

Common LAN traffic restrictions

It is an undisputable fact that fiber provides greater bandwidth than copper cabling. For example, single mode fiber has proven capacity measured in terabytes [Figure 1]. It is prudent for IT professionals to investigate common traffic restrictions for both Optical LAN and legacy copper-based LANs that exist at the connection to Wide Area Network (WAN) or Internet Service Provider (ISP), core router, shared resources, split ratios and over-subscription/concentration .

Figure 1: CAT3 cable Kbps capacity, CAT5e cable Mbps capacity and single mode fiber with Tbps capacity

[1] February 2011 – Gartner Research – Rethinking LAN Switching Architectures - http://www.gartner.com/id=1562816

WAN/ISP Connectivity – Today the majority of the LAN traffic is destined for the WAN. The question becomes, what size WAN/ISP connection has a company purchased? More than likely the WAN/ISP connection capacity is measured in Kbps or Mbps and shared across all users and IP/Ethernet end-points within an enterprise facility. Even if a large corporation has purchased outside connectivity measured in Gbps, it is highly un-likely that internal math would prove that all users and IP/Ethernet end-points are receiving gigabit rate data speeds. For a 1,000 user/end-point enterprise corporation example, a 48-port gigabit Ethernet workgroup switch would need to be only equipped with 40 user/end-point connection and be uplinked with four 10 Gbps interfaces. The core router would then need the density to aggregate one hundred 10 Gbps interfaces travelling back from 25 48-port gigabit Ethernet workgroup switch. Ultimately the core router would need to have terabyte connection to WAN/ISP, or ten 100 Gbps, or twenty-five 40 Gbps or one hundred 10 Gbps interfaces – all of those scenarios would be VERY expensive, at best 99.9% availability (~5.5 hours of down time annually) with ZERO redundancy resiliency and thus highly un-likely to exist in the real world [Figure 2].

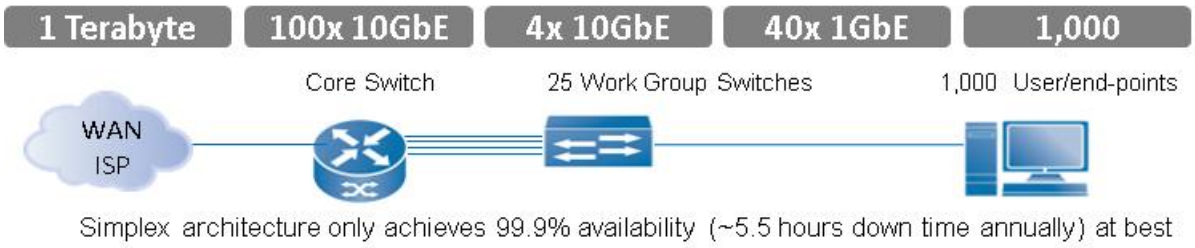

Figure 2: Terabyte WAN/ISP connection required for non-blocking 1Gbps service to 1,000 users/end-points

Core Router – The core router in the building's main data center is the focal point of all the LANs traffic. It provides connectivity to WAN, ISP, external VPNs, all content, and all corporate resources. This location in the network requires the highest degree of attention to assure no traffic bottlenecks exist and no security breaches occur. The core router is a sophisticated piece of equipment and an expensive one. Since Optical LAN has superior aggregation and distribution, by deploying Optical LAN you can save ports on the core router, thus saving money on the core router and saving money on the total LAN infrastructure.

Shared Resources – Ethernet by nature is a shared resource [Figure 3]. Passive optical distribution networks are negatively described as a shared resource across their 1:x passive optical network splitters. However, it is also a fact that everything on a legacy copper-based active Ethernet network is shared beyond the first 100m/300ft point-to-point CATx cabling drop. Furthermore, ever-popular cloud-based computing technologies are shared resource as well, and there are good business reasons why shared resources are acceptable. Just like with cloud-based computing, Optical LAN takes advantage of this architecture to simplify the LAN, lower costs, reduce energy consumption and save space without sacrificing any security.

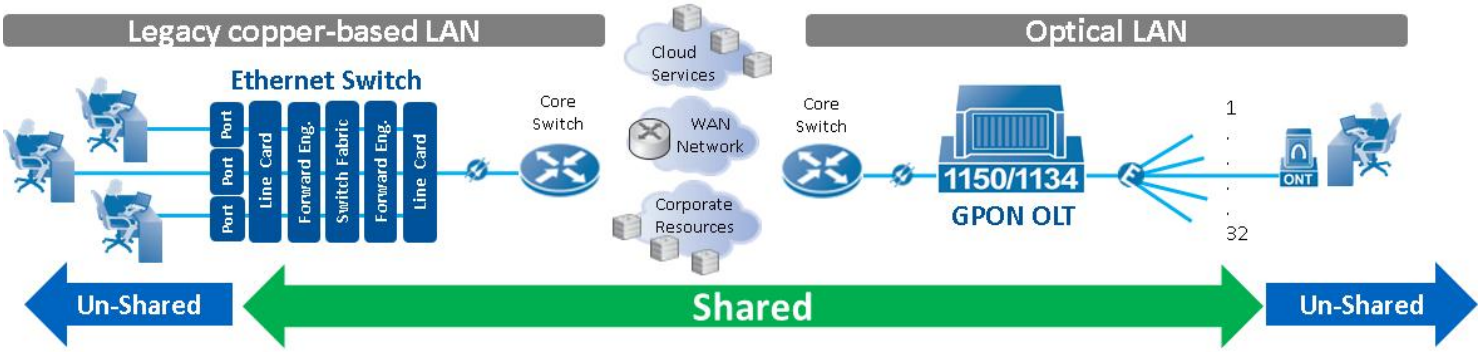

Figure 3: Shared network, shared resources and shared services

Split Ratios – With Optical LAN, passive optical distribution splitters are used through-out the distribution, aggregation and access networks. These splitters commonly are deployed in 1:2, 1:4, 1:8, 1:16 and 1:32 increments. Similarly a legacy copper-based Active Ethernet workgroup switch provides a 1:24 or 1:48 split ratio [Figure 4]. That is, these workgroup switches share a common uplink across either 24 or 48 ports. At an even greater granular level, one would find 24 or 48 ports workgroup switches or 24 or 48 ports service modules sub-components are comprised of 1:4, 1:6 and 1:8 Ethernet chips that have 1 Gbps or 4 Gbps traces back to a supervisor engine. All of these embedded splits of legacy copper-based active Ethernet are NOT exposed to network architects and engineers. Therefore, the benefit of Optical LAN optical distribution splitters is that they provide network architects and engineers the flexibility to match low bandwidth high density end-points with high split ratios and high bandwidth low density end-points with smaller split ratios.

Figure 4: Copper-based LAN workgroup switch akin to a "2x24 splitter and 2x48 splitter"

Over-Subscription/Concentration – Whether we are examining WAN/ISP connectivity, core router, shared resources and/or split ratios, over-subscription (or concentration) exists at all these points in the network [Figure 5]. And in fact, copper-based LAN design guidelines call for 20:1 over-subscription/concentration, because "*Typical campus networks are engineered with oversubscription. It is not generally practical to provide line rate for every port upstream from the access-to-distribution switch, the distribution-to-core switch, or even for core-to-core links* ."[2] The highest levels over-subscription/concentration will occur near the WAN/ISP connectivity and core router. What is important to IT professionals is providing traffic management for the best possible network performance by taking advantage of Optical LAN's superior security, segmentation and QoS capabilities.

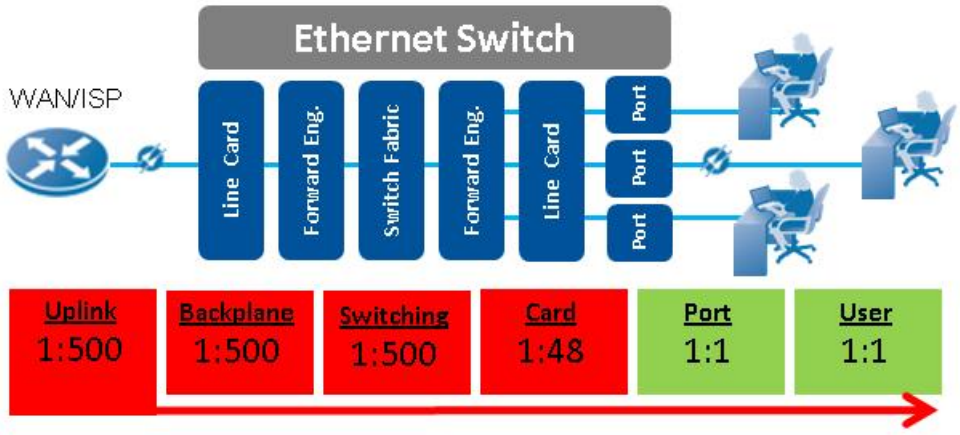

Figure 5: Over-subscription/concentration levels across a legacy copper-based LAN switch architecture"

[2] http://www.cisco.com/en/US/docs/solutions/Enterprise/Campus/HA_campus_DG/hacampusdg.html#wp1108620

Converges services and networks through segmentation with hard QoS

To assure the highest degree of LAN performance, traffic management needs to balance bursty traffic, interactive traffic, real-time latency sensitive traffic, and non-real time traffic. Optical LAN can accomplish the highest LAN performance through traffic segmentation, low latency, and QoS mechanisms while drastically improving network security compared to the legacy copper-based LAN alternative.

Segmentation - Legacy copper-based LANs that place all traffic in a single broadcast domain can easily overload the network. The better design is to create traffic (service) segmentation through advance VLAN capabilities. Optical LAN allows service-level VLANs that segregates and secures data flows to Optical Network Terminal (ONT) Ethernet ports. VLAN trunking, termination and translation, allow for rate shaping on a per service type. Traffic classification is accomplished per IEEE 802.1p, IEEE 802.1q and even DSCP to guarantees voice quality. With VLAN trunking, you can support multiple services and multiple end devices per ONT Ethernet port.

Latency – Network performance is affected by a large number of factors in addition to bandwidth. Increasing bandwidth capacity does not directly equate to better network performance. Service performance is also directly dictated by latency (the effect of physical distance and physical communications media), jitter, packet loss, and congestion[3]. Optical LAN has proven 1ms latency measured during formal multi-vender end-to-end interoperability testing at US Department of Defense certification through Joint Interoperability Test Command (JITC). In 2008, the U.S. Department of Energy (DoE) brought together more than 60 experts from the energy, telecommunications, and IT industries. The DoE wanted them to brainstorm ways to improve efficiency of, among other things, data centers and telecommunications equipment[4]. One of their findings states that reducing the number of optical-to-electrical and electrical-to-optical conversions results in better network performance and lower energy consumption - Optical LAN does just that. In fact, Optical LAN can eliminate all of the O-E-O conversions over a 30km/18mi reach.

Quality of Service - Strict QoS is delivered through Optical LAN via traffic segmentation/classification, rate limiting, policing, queue management, scheduling and shaping mechanisms [Figure 6].

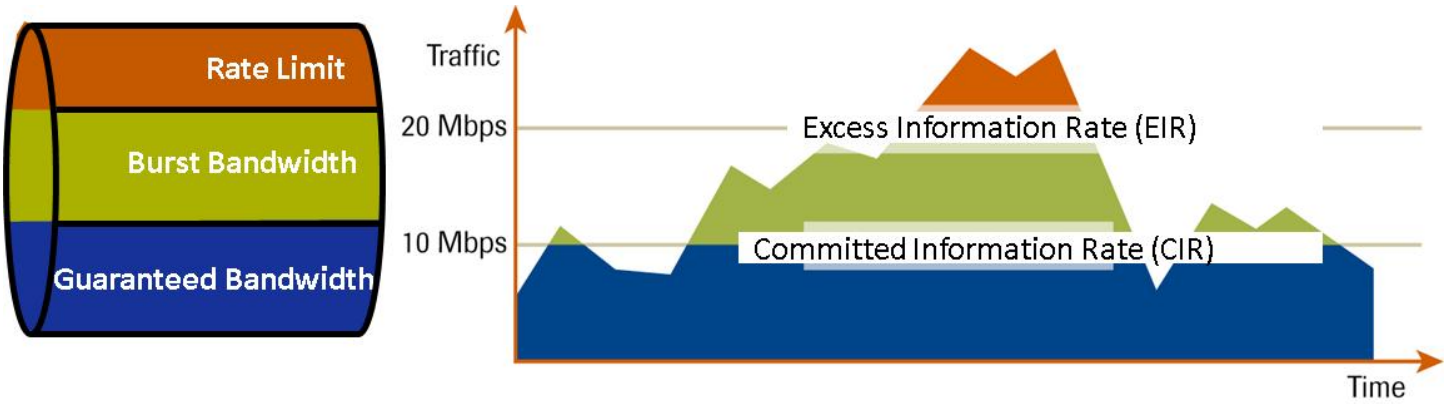

Figure 6: Optical LAN independently set QoS per port and per service, and per up-stream and per downstream

[3] http://www.f5.com/pdf/white-papers/bandwidth-myth-wp.pdf
[4] http://www1.eere.energy.gov/manufacturing/datacenters/pdfs/vision_and_roadmap.pdf

As stated, the above traffic classification is done on all ingress traffic (e.g. Data, VoIP, POTS, IP Video) based on traffic type defined by VLAN during provisioning (per Dest MAC, VLAN, 802.1p marking, DSCP marking). Rate limiting and policing is defined in Service Level Agreement by setting Committed Information Rate (CIR), Excess Information Rate (EIR) and Access Control List (ACL) filters. This sets the guaranteed bandwidth per user, per service or per end-device, while smoothing bursty traffic and establishing ultimate rate limits. Based on traffic management criteria, the system then employs Tail Drop or Weighted Random Early Discard (WRED) modes against throttled traffic. At that point, queue management kicks in. Optical LAN supports eight (8) class queues available within the network and four (4) class queues available at each end port. This ensures strict traffic delivery based on hard QoS parameters by providing IT professionals with granular traffic shaping capabilities.

It should be noted that Tellabs Optical LAN allows network managers to create global profiles related to particular services, segmentation, QoS and security that can then be aligned with specific users and IP/Ethernet end-points. If an individual user moves to a new location, those profiles automatically follow the individual user. This helps speed the process of Moves, Adds and Changes within a LAN and simplifies day-to-day network management.

Cost effectively manage LAN traffic bandwidth requirements and new traffic flow

Back in the days when IT professionals did not have the ability to enforce traffic management policies, LANs required relatively big pipes operating at 50% capacity to assure no collisions. When IT professionals take advantage of traffic management policies of strict service segmentation and hard QoS, you would be surprised at the true real-world bandwidth requirements of the most common LAN services [Figure 7].

Common LAN Service Per User	Bandwidth
Email and Web Browsing	500Kbps
Voice over IP	110Kbps
Cloud-based Services (data storage, enterprise s/w, collaboration, etc...) Low	50Kbps
Cloud-based Services (data storage, enterprise s/w, collaboration, etc…) High	100Kbps
Wireless Access Point Capacity (IEEE 802.11 a/b/g/n)	24Mbps[5]
Wireless Access Point High Capacity (IEEE 802.11 ac/ad, dual radio)	300Mbps[6]
IP Video Surveillance Standard Definition (MPEG4/H.264)	2Mbps
IP Video Surveillance High Definition (MPEG4/H.264)	6Mbps
IP Video Conferencing / Telepresence (720p-Good, includes primary/auxiliary)	2Mbps
IP Video Conferencing / Telepresence (1080p-Best, includes primary/auxiliary)	15Mbps

Figure 7: Bandwidth goals for common LAN services per industry accepted Planning and Design Guidelines

[5] IEEE 802.11n theoretical air interface maximum is 54M, design and planning guides call for 24M Ethernet backhaul through-put
[6] IEEE 802.11 ac, ad, dual radio state theoretical air interface maximum is 600Mbps, expected backhaul through-put will be 50%

In 2013 Gartner Research did a study of estimated peak bandwidth per user in a commercial enterprise LAN and found that 200Kbps was more than sufficient [Figure 8][7]. This study took into consideration the impact of video, wireless and cloud computing on the LAN.

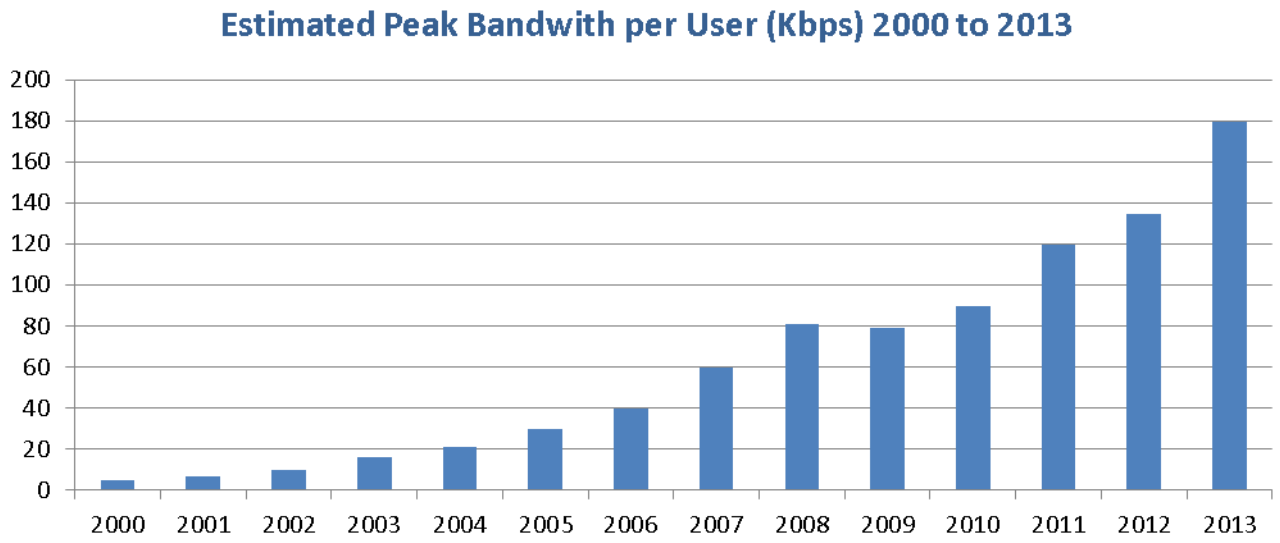

Figure 8: Gartner Research estimate bandwidth per user in average enterprise (March 2013)

The Gartner Research went on to estimate the future expansion of video, wireless and cloud computing and offered forecast of 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 1Mbps to 7Mbps range [Figure 9].

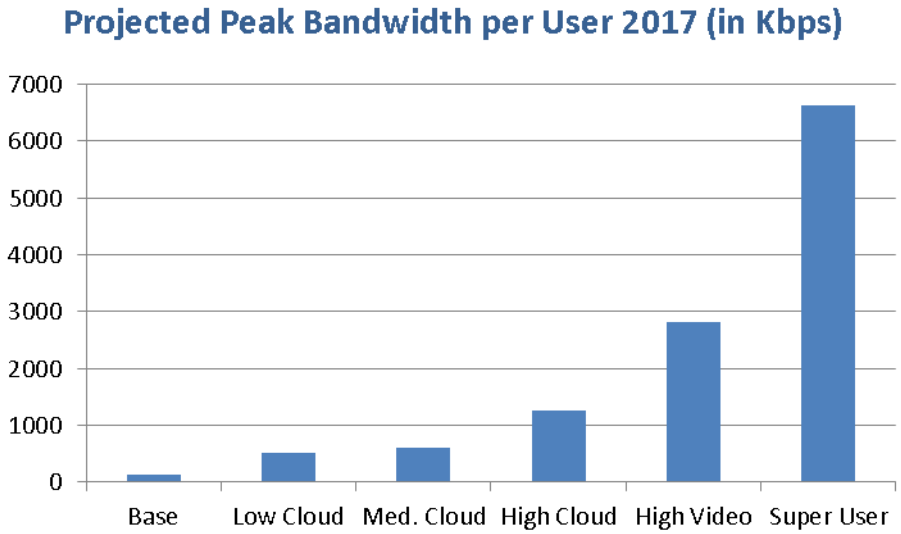

Figure 9: Gartner Research projected peak bandwidth per user by 2017 (March 2013)

7 http://my.gartner.com/portal/server.pt?open=512&objID=202&&PageID=5553&mode=2&in_hi_userid=2&cached=true&resId=2383515&ref=AnalystProfile

Optical LAN can deliver symmetrical gigabit rate service at an ONT 10/100/1000 RJ-45 Ethernet port. When, and where, to allocate gigabit rate service is at the discretion of the network architects and engineers. Based on the bandwidth chart above, one can see that guaranteeing 10 Mbps or 100 Mbps service rates is more than sufficient for most LAN services including video, wireless and cloud computing [Figure 10]. In fact, while network managers can create global traffic profiles at 10Mbps or 100Mbps rates, and align them with users, ports and services, the Optical LAN transport can ALWAYS accelerate to gigabit rate speeds as network congestion allows.

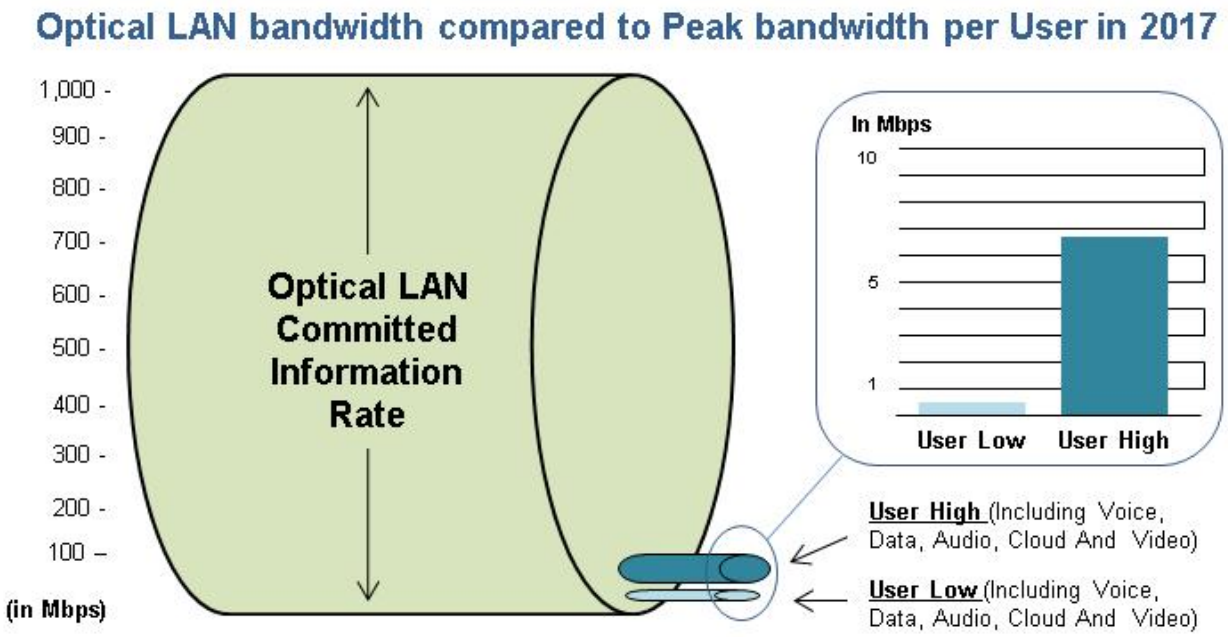

Figure 10: Gigabit Ethernet committed data rate across Optical LAN architecture

The above facts beg the question - why invest in a copper-based LAN whose dedicated one gigabit point-to-point access cannot support one gigabit bandwidth through-out the LAN? Furthermore, the copper-based LAN architectures of a hierarchy of stacked switches and meshed CATx cabling do not reflect the needs of modern LAN traffic flows derived from video, wireless and cloud-computing growth. Perhaps the best advice for CIOs and IT professionals is to simplify the LAN infrastructure and focus more resources towards WAN, ISP, core switching, building automation, wireless and cloud-computing technologies that are demanding the most attention these days.

In short, Optical LAN is better than copper-based LANs. Optical LAN is proven -

- Simple
- Secure
- Stable
- Scalable
- And, it cost less

Optical LAN is the Simple and Secure solution for modern corporate LAN

With the complexity of the traffic traveling across the LAN, there comes the need to simplify the underlying LAN infrastructure. At the same time, network security needs to increase due to internal and external threats.

Simplify – Optical LAN is simple because it significantly reduces the number of managed devices within a LAN. Less moving parts means less things to buy, rack, stack, power, A/C, ventilate, provision, manage and less things to break. IT staff will have comfort knowing that Optical LAN does not change the end-points. It continues to leverage existing core switches, PBX, VoIP, unified communications, POTS, data, wireless access, surveillance, security and building automation. By simplifying the LAN the IT staff workload is greatly reduced. Furthermore, Optical LAN converges whole networks, and their services, to one fiber infrastructure. In the past, disparate networks were built and maintained for separate voice, video and a multitude of data traffic across wasteful redundant cable plant – this convergence can help IT staff with legacy network modernization regardless of IP voice or analog voice, IP video or RF video, wireless access and all smart building services.

Security - Traffic is more secure on Optical LANs than copper-based LANs. Fiber is not subjected to Electro-Magnetic Interference, Radio-Frequency Interference, nor Electro-Magnetic Pulse. Copper acts like an antenna and broadcasts radio frequencies that can be intercepted without a physical tap. Fiber is more difficult to physically tap, and stateful Optical LAN protocols preclude malicious tap without detection. Optical LAN uses robust security at Optical Line Terminals (OLT) and ONTs with protection at physical, data and at user layer. Network Access Control authentication and authorization is managed through IEEE 802.1x, RADIUS and strict user definable roles for the element management. Malicious attack barriers are established with Access Control Lists and other Denial of Service protection functions.

Private sector entities such as Healthcare, Education, Finance, Banking, Utility, Transportation and Gaming can have total confidence with Optical LAN's superior security considering how the US government relies on it.

Optical LAN is a trusted infrastructure for high security networks in the US Department of Defense, Energy, Homeland Security, and National Security Agency. Tellabs Optical LAN is certified JITC approved for high availability networks, and Certified TEMPEST Technical Authority (CTTA). For Top Secret networks, Tellabs Optical LAN has also been tested, certified and deployed in highly classified US government facilities using alarmed armored fiber in hardened carrier Protective Distribution System (PDS) architecture [Figure 11]. This All-Secure™ PON solution can save up to 66% in installation and 75% in operational costs[8].

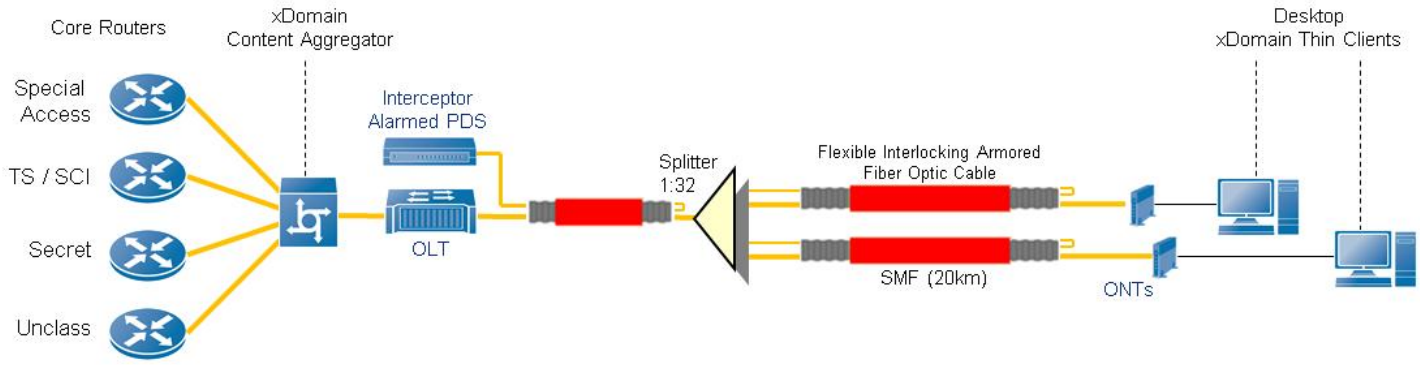

Figure 11: Optical LAN, plus alarmed armored fiber equals All-Secure PON

[8] Tellabs All-Secure PON - http://www.tellabs.com/solutions/opticallan/tlab-secure-pon.pdf

LAN built for today's High Performance Buildings, Mobile, Cloud & Collaboration

Copper-based LANs have been design and deployed in the same architecture for decades based on serving telephones and desktop computers. We witnessed CATx cabling struggle to keep pace moving from CAT3 to CAT6, and now CAT8 is being defined by the standards bodies. We have seen fork-lift equipment upgrades from Fast Ethernet to gigabit Ethernet and now again with 10 gigabit Ethernet. Technology has progressed and now IT professionals are challenged by SMART building, mobile wireless including BYOD, cloud computing, business analytics, business intelligence, big data and constant influx of new applications. Yet, the meshed, stacked, hierarchy of copper-based active Ethernet LANs has maintained the same telephones and desktop computers footprint?

Optical LAN can provide a simple and more secure LAN than what is possible with copper-based LANs. IT professionals have the means to accurately manage common LAN traffic restrictions, converge services and networks through traffic segmentation with hard QoS to assure highest LAN performance. In the end, Optical LAN is the best solution possible to cost effectively manage traffic bandwidth requirements relative to new traffic flow patterns of the modern LAN.

For more information about Optical LAN being simple, secure, stable, scalable and costing less, please contact your local Tellabs sales representative at the phone numbers provided below or visit www.tellabs.com.

Tellabs – North America
One Tellabs Center
1415 West Diehl Road
Naperville, IL 60563 USA
+1 630 798 8800
Fax: +1 630 798 2000

Tellabs - Asia Pacific
3 Anson Road
14–01 Springleaf Tower
Singapore 079909
Republic of Singapore
+65 6215 6411
Fax: +65 6215 6422

Tellabs - Europe, Middle East & Africa
Abbey Place
24–28 Easton Street
High Wycombe, Bucks - HP11 1NT
United Kingdom
+44 870 238 4700
Fax: +44 870 238 4851

Tellabs - Latin America & Caribbean
1401 N.W. 136th Avenue
Suite 202
Sunrise, FL 33323 USA
+1 954 839 2800
Fax: +1 954 839 2828