Application Note

Tellabs Optical LAN Solution

Cost effective high performance green building ICT infrastructure and LEED certification impact

Introduction

The information and communication technology (ICT) industry is in an excellent position to produce drastic environmental efficiencies and business cost savings. As enterprise corporations investigate means to improve profit, planet and people – the ICT electronics and cabling infrastructure is prime corporate asset to fulfill these improvements.

Optical LAN (OLAN) utilizing Passive optical network (PON) technology is well positioned to deliver cost effective, low energy, small form-factor ICT infrastructure that directly impact architects, engineers, CIOs, IT managers, building tenants and building owners eco-friendly high performance building initiatives. Optical LAN can directly impacts high performance buildings, such as:

- LAN Design
- Cost Savings
- Energy Savings
- Space /Material Reduction
- LEED Certification
- Building Value

LAN Design

Traditional copper based active Ethernet LAN design was a fully meshed hierarchy of energized electronics providing Ethernet switching functions at the core, aggregation and access positions of a building LAN (Figure 1). Often there were multiple cable infrastructure serving overlay networks for data, voice and video. These copper-based infrastructures used CAT, twisted pair or COAX for cabling, and if fiber was used, the optical services were deployed using Multi Mode Fiber (MMF).

Fiber based OLAN leveraged the inherent benefits of PON with a centrally located Optical Line Terminal (OLT) at the core, and passive optical distribution splitters at the aggregation and Optical Network terminations (ONT) position at the access (Figure 2). OLAN uses a Single Mode Fiber (SMF) for in building and across campus cabling that converges all building ICT services over single infrastructure such as voice, video, data, wireless access, security, surveillance and building automation.

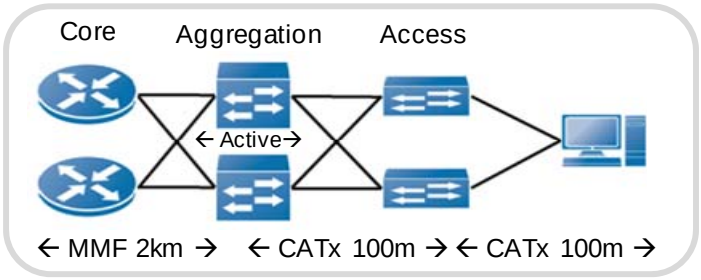


Figure 1: copper based active Ethernet LAN

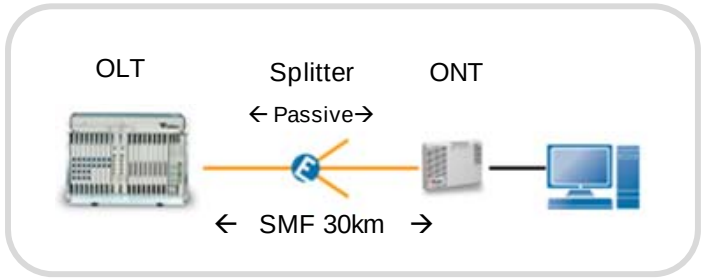


Figure 2: Fiber based Optical LAN

Studies have shown that fiber access for telecommunications service providers are proven less resource depletion, greenhouse gas emissions, carbon footprint and toxins into the environment compared to the status quo[1]. OLAN seeks to exploit these same factors, and apply them to high performance buildings.

Cost Savings

In a direct comparison, OLAN has achieved positive separation beyond traditional copper based active Ethernet LAN design relative to equipment CapEx, OpEx and fiber based cable infrastructure.

Equipment CapEx savings – OLAN has enjoyed up to 70% CapEx savings when compared to the copper based alternative. Not all configurations result it such a large division, but at the simplest level it is intuitive that with less electronics in the network, customers have less equipment to purchase. Other factors that expand on the benefits of OLAN are the fact that a single OLT, single ONT and single SMF ODN infrastructure achieves 99.999% reliability. For active Ethernet LAN to achieve 99.999% availability then the network design would dictate fully meshed, fully redundant electronics at core, aggregation, access and even redundant optical NICs at workstations[2].

Another factor that drives separation in cost is OLAN's efficient support for both VoIP phones and analog POTS phones, and IP video and RF video. OLAN can provide cost effective hybrid network architectures that serve analog POTS phones and RF video over the same SMF cable infrastructure with concurrent service delivery (i.e. both VoIP & POTS phones, and IP & RF video simultaneously).

Equipment OpEx savings – Once again, less equipment to purchase means less electronics to maintain, but it also means less reoccurring annual right-to-use and service support agreements to purchase. Often these yearly support fees can be as much as 80% higher the comparable fee associated with Tellabs OLAN solution.

Centralized control through Element Management System, instead of accessing network elements locally through the craft user interfaces is major contributor to lower OpEx. Instead of many IT support personnel fanning out to manage nodes spread-out across the facility, OLAN emphasizes centralized management through an intuitive graphical user interface. IT personnel with limited human resources and juggling constant time constraints will benefit from this efficient means of provisioning, adds, moves, changes and administering software upgrade. Unfortunately large organization lose ~3.6% annual revenue due to network downtime and there is a direct correlation with human factor being the largest contributor responsible for 50% to 80% outages[3]. Thus, there are benefits to prioritizing machine-to-machine and centralized management as much as possible.

OLAN also offers the lower first training costs and no cost of annual training refresh certifications. OLAN training is typically completed after one week of classroom time. At the end of this 5-day OLAN training, student gain the knowledge they need to operate the OLAN OLT, ONT and EMS. Competitive active Ethernet training programs (e.g. CCNx certification) require weeks of commitment and annual refresh work. The biggest expense of these active Ethernet certification courses is not the cost of the class, but the travel expense and lost hours away from their expected daily work duties.

---

[1] Developing a generic approach for measuring FTTH solutions using Life Cycle Analysis methodology - http://www.ftthcouncil.eu/documents/Reports/SUDEFIB_LifeCycleAnalysis_Report0308.pdf
[2] Enterprise Campus 3.0 Architecture: Overview and Framework (Figure 17) http://www.cisco.com/en/US/docs/solutions/Enterprise/Campus/campover.html#wp709052
[3] Juniper Networks - What's Behind Network Downtime? Infonetics Research study 2008 http://www-05.ibm.com/uk/juniper/pdf/200249.pdf

Cabling CapEx savings – OLAN and SMF gain CapEx saving relative to traditional copper based active Ethernet LAN based on lower material and installation costs.

Relative to material cost savings, a TE Connectivity study compared SMF ($0.089 per lineal foot) and CAT6 ($0.35 per lineal foot) and MMF ($0.45 per lineal foot) showed a substantial savings for OLAN SMF[4].

With today's bend resistant fiber solutions trending toward ever-easier installations and pre-terminated solutions provide rapid and cost effective installations, Corning concluded that in many cases fiber solutions are less costly than copper for inside building LAN infrastructure[5]. By combining on-site SC/APC connector system provides fast installation with no fusion splicing, bend resistant fiber, ornamental wall molding with adhesive backing solution, 3M was able to cut installation costs in half for existing facilities LAN cable infrastructure upgrades[6].

Furthermore, SMF resistance to electromagnetic interference (EMI), radio frequency interference (RFI) and crosstalk, significantly reduces the design and installation rules around power cables. Lighter and stronger SMF uses J-hook installation instead of cable trays and conduit. All of the above-mentioned results in lower cable infrastructure installation costs.

Energy Savings

Customer generated business case have shown that OLAN can save up to 80% less power consumption by OLT and ONTs when compared to traditional copper based active Ethernet LAN[7]. With a fully meshed hierarchy of active Ethernet switches, energy is consumed every time an Optical-to-Electrical conversions or Electrical-to-Optical conversion occurs. Obviously a passive optical network has fewer Optical-to-Electrical conversions or Electrical-to-Optical conversions and therefore it will consume less energy[8].

When the energy savings of OLAN is reviewed one quickly realizes the rippling effect that the savings causes relative to electrical (plug load) and thermal (HVAC) load design of the total building. For example, 1-watt of electricity consumption saved in a data center results in 2.4x savings throughout the entire building. This is a direct result from less DC-DC, AC-DC, power distribution, transformer, generator and battery back-up needed. From a thermal stand-point, lower energy consumption of OLAN most importantly results in less HVAC capacity required. Forward looking building design could even use temperature hardened OLT in data center/telecom closet and thus eliminate the need for forced air conditioning and only use fresh air ventilation.

With all the great energy savings directly resulting from OLAN, it is easy to extrapolate the corresponding reductions in carbon emissions. For example, a 2,000 end-point Optical LAN building saves 28 KWH, thus converting KWH to CO2, that building saves 165 tons carbon emissions per year[9].

---

[4] TE "Optical LAN Solutions Capabilities Overview and Fast Facts" http://www.adc.com/Attachment/1270741792520/109364AE.pdf
[5] Corning - "Understanding Fiber Optics and Local Area Networks"
http://catalog2.corning.com/CorningCableSystems/media/Resource_Documents/additional_information_rl/LAN-737-EN.pdf
[6] 3M -
http://solutions.3m.com/wps/portal/3M/en_US/Telecom/Home/Products/Fiber/OnePass/?WT.mc_id=PA_CMD_BBP_May_OnePassCS
"Total Package from 3M Cuts Fiber Installation Costs in half"
http://multimedia.3m.com/mws/mediawebserver?mwsId=SSSSSufSevTsZxtUoY_xmYtZevUqevTSevTSevTSeSSSSSS--&fn=Elauwit%20case%20study.pdf
[7] per A New Network Paradigm: Cutting Cost, Space and Energy Use (June 2010) -
http://www.tellabs.com/resources/papers/tlab_olan-paradigm_wp.pdf
[8] "Vision and Roadmap Workshop on Routing Telecom and Data Centers Toward Efficient Energy Use" (October 2008)
http://www1.eere.energy.gov/manufacturing/datacenters/pdfs/vision_and_roadmap.pdf
[9] per Tellabs "Optical LAN network architecture helps operators meet tangible green goals" April 2012
http://www.tellabs.com/blog/index.cfm/2012/4/4/Optical-LAN-network-architecture-helps-operators-meets-tangible-green-goals

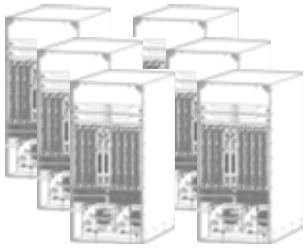
Space/Material Reduction

For OLAN space and material savings have direct impact on the equipment, cabling and the building itself.

Equipment impact – OLAN provide superior density with 8,192 IP/Ethernet end-points being served by one OLAN OLT occupying 9 rack units or 15 ¾ inches (Figure 3). In comparison, an active Ethernet node that serves 2,016 IP/Ethernet end-points occupies 90 rack units or 157 ½ inches (Figure 4). Furthermore, ODN splitters eliminate the need for active electronics used in the aggregation sector of this LAN, there for telecom closets/IDF are eliminated. This directly results in less space, power and thermals demands in the main data center/MDF. It also means less space, power, thermals and FEWER telecom closets/IDF required through-out the building.

OLAN
8,192 users
9 rack units

Figure 3: Data center OLAN OLT size & density



Traditional LAN
2,016 users
90 rack units
3 telco racks used

Figure 4: Data center active Ethernet size & density

Another aspect of OLAN equipment (and SMF cable) space and material reduction is its' ability to converge services. This single network infrastructure can support voice (IP or POTS), data, video (IP or RF), wireless access points, building security, surveillance and automation.

This translates into OLAN being an excellent choice for buildings that have restricted space. For example, OLAN is ideal for building with challenging cable access, especially retro-fits projects and even historic buildings preservation.

Cabling impact – SMF provides best future proof all-fiber LAN infrastructure choice. In contrast to MMF and CATx cabling, SMF has enjoyed stable industry standard over recent years and holds the best promise for supporting future technologies (e.g. 10GbE GPON, WDM PON, 40GbE, 100GbE). For example, in March of 2010 NTT demonstrated the ability to transport 69Tbps of data over a single 240 km long SMF.

CATx cabling standard has not been stable with over five variations defined in the past 10 years (i.e. 3, 5, 5e, 6, 6a, 7, etc…). At all key attributes SMF is smaller, lighter, stronger, tighter bend radius, higher bandwidth, longer reach, better EMI/RFI, faster connectors, longer life and less expensive than CATx. Relative to OLAN, a single SMF strand can carry services to 128 IP/Ethernet end-points, while CATx often only one. Taking into consideration environmentally factors, copper based products consumes 100x to 200x more natural resources than glass based products[10].

Similar to CATx industry standards, MMF standard continues to evolve and struggles to keep pace with today's technologies and bandwidth capacity requirements (i.e. OM1 to OM4). Though MM optics promise lower costs and lower energy use, but when calculating cost/power across an end-to-end network, OLAN once again proves better cost/power. MMF main weakness is lower bandwidth capacity and short reach when compared directly to SMF. For example, MMF does not support DWDM and 100GbE demos have been over four fibers.

[10] (6) Institute f. Climate, Environment and Energy, GmbH, Wuppertal
http://www.wupperinst.org/en/publications/wuppertal_spezial/index.html

Building impact – All of the above referenced benefits for OLAN and SMF have direct impacts on design of high performance building. Less active electronics and smaller form-factor equipment means lower power at data center/MDF and telecom closets/IDF reduces building overall power load. Less thermals at data center/MDF and telecom closets/IDF lowers HVAC load. Finally, smaller data center/MDF and fewer telecom closets/IDF lowers HVAC/power load as well. Fewer cables and smaller cable means less plastics thus less smoke load on building. Less floor and wall penetrations, results in less fire hazard (e.g. fire stopping).

In general, the gains in building floor space from OLAN allow real estate square footage to be re-purposed for revenue generating, building amenities and building aesthetics. Dematerialize building infrastructure improves sustainability goals, since less material being used in a building leads to the best possible cradle-to-grave life cycle analysis. With this near future proof LAN infrastructure, the number of technology refresh is greatly reduced resulting in significantly less waste (e.g. money, time, natural resources) over the long run.

LEED Certification

The best success in driving the creation of high performance buildings have been developed and managed by U.S. Green Building Council (USGBC)[11]. Their program is called Leadership in Energy and Environment Design (LEED). It covers new construction (e.g. new construction, major renovations, core and shell of building) and existing buildings (e.g. quantify and compare building operations, improvements and maintenance). LEED's goal is to maximize building operational efficiencies while minimizing environmental impact. LEED works on a point system that awards points based on sustainability, water efficiency, energy & atmosphere, material & resources, indoor environmental quality, innovation in operations and regional priority (Figure 5).

Figure 5: LEED certification placards displayed at building premises

LEED certified buildings are designed to lower operating costs and increase asset value, reduce waste sent to landfills, conserve energy and water, be healthier and safer for occupants and reduce harmful greenhouse gas emissions. Often LEED certified buildings qualify for tax rebates, zoning allowances and other incentives.

OLAN and SMF can impact on LEED certification by direct contributing to energy savings, indirect lowering thermal loads for HVAC, reduce harmful greenhouse gas emissions, lowers operating costs, increases asset value and reduces waste sent to landfills. Engineering and designing a building with OLAN and SMF can also result in additional innovation bonus points!

[11] U.S. Green Building Council - http://www.usgbc.org/

Building Value

The ultimate goal of OLAN is to contribute to a high performance build, improve building value and quality of user experience. Studies have shown that buildings with fiber connections sell for 5 to 10% premium and OLAN seeks to achieve that same value gain inside buildings[12]. An OLAN design can differentiate a building in order to attract and retain tenants/employees.

Once LEED certification is achieved, building owners, IT manager, and tenants can reap the reward of the measurable high performance building. For example, there Federal, State and Local tax incentives and rebate/reimbursement/grant programs. There are even rebate to be gained through local utility power companies. On average LEED certified new construction building achieve 30% better energy performance when compared to similar non-certified buildings[13].

OLAN building are well positioned to hold their value since technology upgrades are independent of fiber infrastructure, thus as stated earlier, OLAN and SMF represent the best possible choice for future-proof LAN. For example, when/if the transition from 2.4GbE GPON to 10GbE GPON is executed, there is no wavelength conflicts between from 2.4GbE GPON and 10GbE GPON. This will allow OLAN owners to utilize the same SMF and ODN splitter. With no wavelength conflict both 2.4GbE GPON and 10GbE GPON will be support simultaneously within the same network and over the existing LAN infrastructure. Looking further into the future, the SMF well suited to support future DWDM PON implementation, such as SARDANA[14].

Summary

Optical LAN can directly impacts high performance buildings. With positive contributions to LAN design, equipment and cabling cost savings, total building energy savings, space and material reduction, LEED Certification and ultimately improves building value.

For more information, please contact your local Tellabs sales representative, local Tellabs sales office, at the phone numbers provided below or visit www.tellabs.com.

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

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

Europe, Middle East & Africa
Tellabs
Abbey Place
24–28 Easton Street
High Wycombe, Bucks
HP11 1NT
United Kingdom

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

[12] 5th Edition Spring 2011 Fiber Primer from Broadband Properties Magazine http://www.ftthcouncil.org/en/knowledge-center/ftth-best-practices-clearing-house/2011-fiber-primer
[13] Per "Energy Performance of LEED for New Construction Buildings " http://www.usgbc.org/ShowFile.aspx?DocumentID=3930
[14] Per Tellabs "Pushing the limits of PON: the SARDANA project Pushing the limits of PON: the SARDANA project" http://www.tellabs.com/resources/multimedia/index.cfm/id/5BF4C6C0-0CA1-399D-7F9B3B4909432670.cfm