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Powering Innovations Untether Optical LANs

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When connecting Smart Buildings and the Internet of Things (IoT), hard restrictions exist related to network power, bandwidth, density, and reach. An electrical signal, whether delivering electricity or data, is bound by physical limitations that in the past were only overcome by making transport media larger, more rigid, harder to work with, shorter, and more expensive. These factors have harsh negative impacts on businesses trying to embrace digital transformation and corporate sustainability goals.

On the bright side, the past decade has ushered in enterprise network progress by prioritizing fiber cabling and taking advantage of Passive Optical Network (PON) design to optimize the underlying architecture for Smart Buildings, IoT, and sustainability initiatives [Figure 1 below]. Fiber cabling has no known bandwidth capacity or connectivity density limitations. Enterprise-based Passive Optical Local Area Networks (LAN) have proven to offer better scalability, security, stability, and sustainability when compared to traditional inbuilding networks. Relative to reach, these passive networks can deliver Ethernet connectivity across 12-mile distances over a reliable infrastructure with no powering and limited human touch.

Up until now, the powering challenges have proven more difficult to overcome, especially as related to Smart Buildings and IoT connectivity demands. With ongoing innovations improving powering methods for enterprise connectivity, however, Optical LAN benefits can now be fully optimized [Figure 2 on next page]. These new forward-thinking means of powering can be leveraged for scalability, such as Power over Ethernet, Class 2 Remote Power, Class 4 Pulse Power, and Direct Current (DC)

Microgrids, thus untethering Passive Optical LANs.

Figure 1: An Optical LAN design with a remote powered Optical Network Terminal

Power over Ethernet – Power over Ethernet (PoE) allows network cables to carry electricity, enabling devices such as Smart Building and IoT devices to be energized and connected over the same Ethernet cable. This eliminates separate power cables, simplifies installation, and reduces costs.

First came the PoE standard (IEEE 802.3af), which allowed for 15.4 watts, followed by the PoE+ standard (IEEE 802.3at), offering up to 30 watts of power to the Powered Devices (PD). The latest PoE standard (IEEE 802.3bt) can deliver up to 60 watts of power (Type 3) or 90 watts of power (Type 4) to PDs. PoE is an efficient way to power and connect PDs, however, its reach is limited by the distance an Ethernet signal can travel, which is 300 feet. Optical LAN architecture helps extend that PoE reach, as it is common for the Ethernet ports on the optical-to-electrical media converters, called Optical Network Terminals (ONTs), to support all versions of PoE. PoE-enabled ONTs, connected via up to 12-mile passive networks, can deliver these different levels of power (e.g., 15W, 30W, 60W, 90W) to sub-tended PDs more efficiently. By reducing the distance that PoE travels, with shorter CATx patch cords between ONTs and PDs, PoE over Optical LAN improves power delivery by 13%.

Class 2 Power Systems – Class 2 powering systems are low voltage systems that provide remote Direct Current (DC) electricity to connected PDs. Class 2 systems are designed to meet strict safety standards defined by the National Electric Code (NEC), which specifies the maximum power output and voltage levels for Class 2 circuits.

These Class 2 systems start with an Alternating Current (AC) to DC rectifier from a centralized source. From there it goes to a current-limiting DC-DC converter that transforms 48Vdc into an NEC Class 2-compatible source to ensure safety and fire prevention. The current limiting panels include circuitry to limit the total power per circuit to 100VA and -57Vdc. This system can be installed using conventional surface-mounted cable (no conduit, MC, or armored cable) and it does not require a certified electrician. Copper wires then carry power directly to the end devices, like the Optical LAN end device called an Optical Network Terminal (ONT). The existing copper wires can be repurposed as CATx cabling, or new hybrid fiber cabling that includes two copper wire conductors can be used.

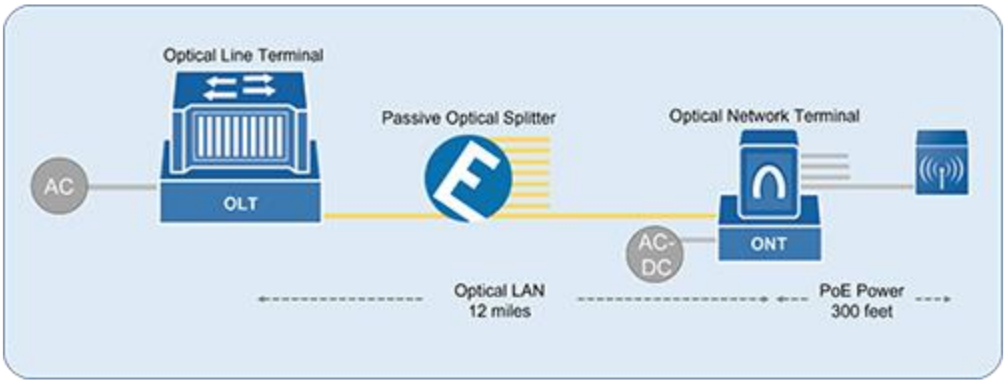

Figure 2: A Passive Optical LAN connecting Ethernet endpoints 12 miles away

Remote powering systems can be either distributed or centralized in design. Distributed remote power is typically in an IDF or zone distribution box and can be energized from a DC power plant from the main data room. Centralized remote power is consolidated in the main data room where the localized power distribution units feed the PDs. Their DC voltage range is from 48vdc to 54vdc. Depending on the gauge of copper wires used and the amount of wattage needed, these systems can extend the reach of Optical LAN ONTs from 300 to 2000 feet [Figure 3 on next page].

Class 4 Power Systems – Class 4, also known as Fault-Managed Power (FMP), is the newest powering technology defined by standards set forth by NEC. It can safely deliver higher voltages better than other class-rated circuits since they have added safeguards for monitoring and fault management. Furthermore, Class 4 has greater reach as it can safely and reliably power devices such as sensors, cameras, wireless access points, Optical LAN ONTs, and other IoT devices over longer distances. What makes Class 4 FMP innovative is its safe-to-touch and intelligent pulse power that transmits energy in short beats. This is accomplished by using a specialized power supply that delivers energy in short bursts, which are typically less than one millisecond in duration. These pulses of energy work in concert with voltage limitations (450 Volts DC line-to-line or 225 Volts DC line-to-ground) and power shut-off (within 5 seconds of a fault occurring) based on the detection of fault conditions, like contact with human skin. Class 4 FMP powering is an important technology for modern connectivity, as it provides a safe and reliable way to power energy-hungry devices over greater distances. Additionally, these systems can help to minimize the copper cabling and overall power consumption of IoT networks, making them an important technology for sustainable and energy-efficient buildings. Even better, these Class 4 powering systems deliver up to 600W per copper pair over a 6,500 feet distance, such as an Optical LAN ONT that can be located one mile away over a passive network infrastructure [Figure 4 on next page].

DC microgrids - are an effective way to power Smart Buildings and IoT networks, offering advantages such as energy efficiency, scalability, and flexibility in integrating with renewable energy sources that align well with Optical LAN attributes.

One advantage of DC microgrids is that they eliminate the need for power conversion from AC to DC, which is required by many IoT devices such as sensors, cameras, and other low-power devices. This eliminates the inefficiencies and losses associated with conversion, which can be significant when dealing with large numbers of devices.

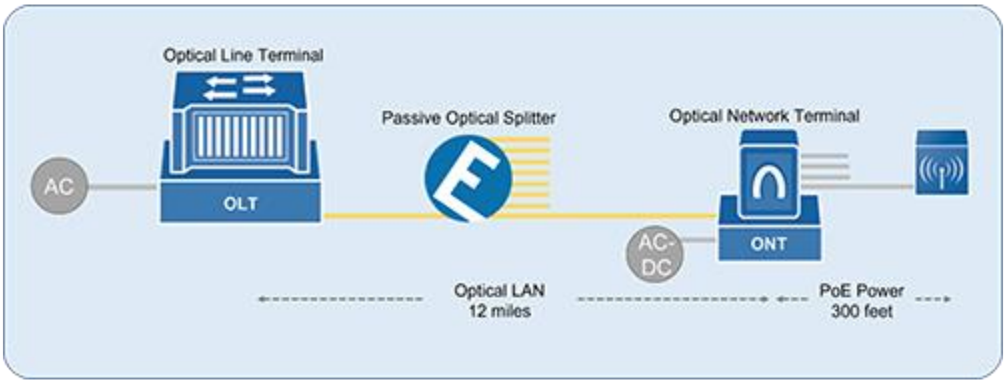

Figure 3: An Optical LAN using Class 2 power to connect an ONT out 2,000 feet

Another advantage of DC microgrids is that they can be easily integrated with renewable energy sources such as solar panels and wind turbines, which generate DC power. This makes them an ideal choice for modern buildings that are designed to be sustainable and energy efficient.

DC microgrids can be built in different configurations, such as centralized, decentralized, or hybrid. In a centralized configuration, a single DC power source supplies energy to all devices in the network. In a decentralized configuration, each device is equipped with its own DC power source, such as a battery or a solar panel. Hybrid configurations combine both centralized and decentralized systems to realize the benefits of both. DC microgrids are an effective way to power Smart Buildings and IoT networks, offering advantages such as energy efficiency, scalability, and flexibility in integrating with renewable energy sources that align well with Optical LAN attributes.

Passive Optical LAN – With all these powering innovations unleashing Passive Optical LAN architecture to its full potential, and connecting Ethernet end-points miles away, enterprise businesses are now able to make huge advancements in scalability, security, stability, and sustainability.

Optical LAN provides better scalability by using passive optical splitters to distribute the signal from a single optical fiber cable to multiple devices, without requiring any power. This makes it a cost-effective and efficient way to distribute the signal, with minimal signal loss, allowing Optical LANs to support a profusion of Ethernet connectivity over long distances. Additionally, Optical LANs allow in-building networks to be designed with either a reduced number or total elimination of telecommunications rooms. Fiber-based LANs offer enterprise networks greater security by promoting the use of optical cabling, which is inherently more secure than copper cabling. Unlike copper cables, fiber cables are immune to electromagnetic interference and cannot be easily tapped, making them more difficult to intercept or disrupt. Furthermore, Optical LAN reduces the network attack surface by significantly reducing the number of full-function switches, user management access ports, IP Addresses, IT staff touches, doors to lock, and telecom rooms to secure.

Optical LAN experiences greater network uptime. This is because Optical LAN utilizes passive optical splitters instead of active components, which reduces the risk of network downtime. Another advantage of Optical LAN is that it requires less human touch to operate. Since human error is the most common cause of network outages, Optical LAN provides a more reliable network with fewer IT and networking staff required.

The move toward fiber, and limitation of copper, is more environmentally friendly compared to legacy networks. Optical LAN requires fewer power-consuming components than traditional copper-based networks, resulting in significantly lower energy consumption and a smaller carbon footprint. Moreover, fiber optic cables are more durable and have a longer lifespan than copper cables, which reduces the need for replacement and results in less waste. All of this helps enterprises hit net-zero goals more readily.

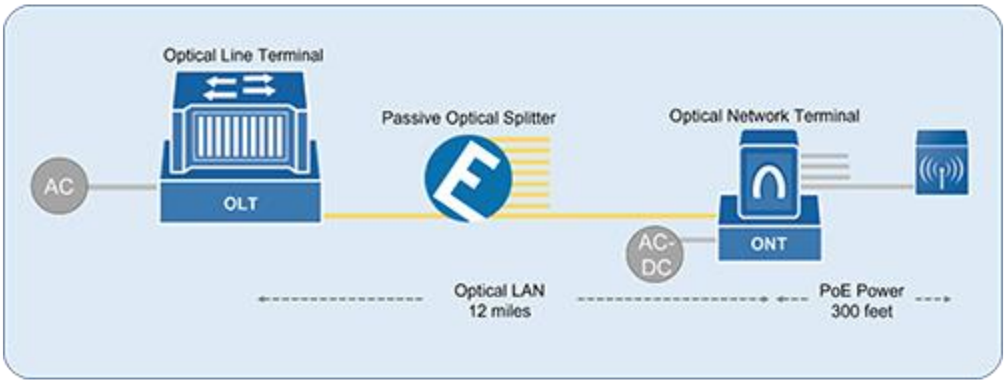

Figure 4: An Optical LAN with Class 4 reaching 6,500 feet to energize an ONT

In summary, Optical LANs provide several advantages over traditional copper-based LANs for connecting Smart Buildings and IoT devices using fiber cabling. Optical LANs are more secure due to the inherent security features of fiber optic cables, and the use of passive components minimizes the risk of unauthorized access or network downtime. Optical LANs are scalable for connectivity density, bandwidth capacity, and extended distances. Finally, Optical LANs are more sustainable and environmentally friendly, requiring fewer power-consuming components and promoting efficient use of resources.

As the demand for energy-efficient and sustainable buildings continues to grow, PoE, Class 2 Power, Micro Grids, Class 4 power, and Passive Optical LANs are likely to become an increasingly important technology for modern connectivity. In fact, in-building and campus-wide networks that leverage these technologies together will gain the greatest advantages towards energy savings and sustainability contributions. The perfect alignment of these innovations in fiber cabling, Optical LANs, and powering systems will enable untethered future digital transformation, Smart Buildings, and IoT scalability.