WHITE PAPER

The Journey Forward: Passive Optical LAN for the Corporate-Wide Enterprise

How Passive Optical LAN Solutions Enable the Journey to Enterprise IT Resource Optimization

Introduction

These days, virtually everyone who works in an office environment is struggling with the enterprise-wide mandate to do more work with less money and resources.

For corporate information technology managers, the do-more-with-less dilemma manifests itself in the challenge to meet the networking needs of the enterprise with extremely limited and decreasing budgets, personnel, and building space – all while ensuring that a decrease in resources does not equal a decrease in the enterprise's network performance.

In order to optimize limited resources, it's very important, now more than ever, to consider alternatives to a traditional Ethernet LAN – alternatives that address the current limited resources of the enterprise IT organization while at the same time deliver enhanced capability and ready the network for future growth.

And to that end, many enterprises are looking to solutions that eschew traditional copper-only Ethernet LANs in favor of passive optical fiber LAN solutions, which provide an all-fiber LAN throughout the enterprise to interconnect stationary Ethernet-based systems, such as end-user devices, access points and wireless controllers, application servers and printers.

The idea of using an all-fiber network to lower a network's cost of ownership may come as a surprise to veteran IT professionals. Although fiber technology has been proving itself as a superior networking solution for years, it has also gained a reputation as a technology that is too expensive for the enterprise.

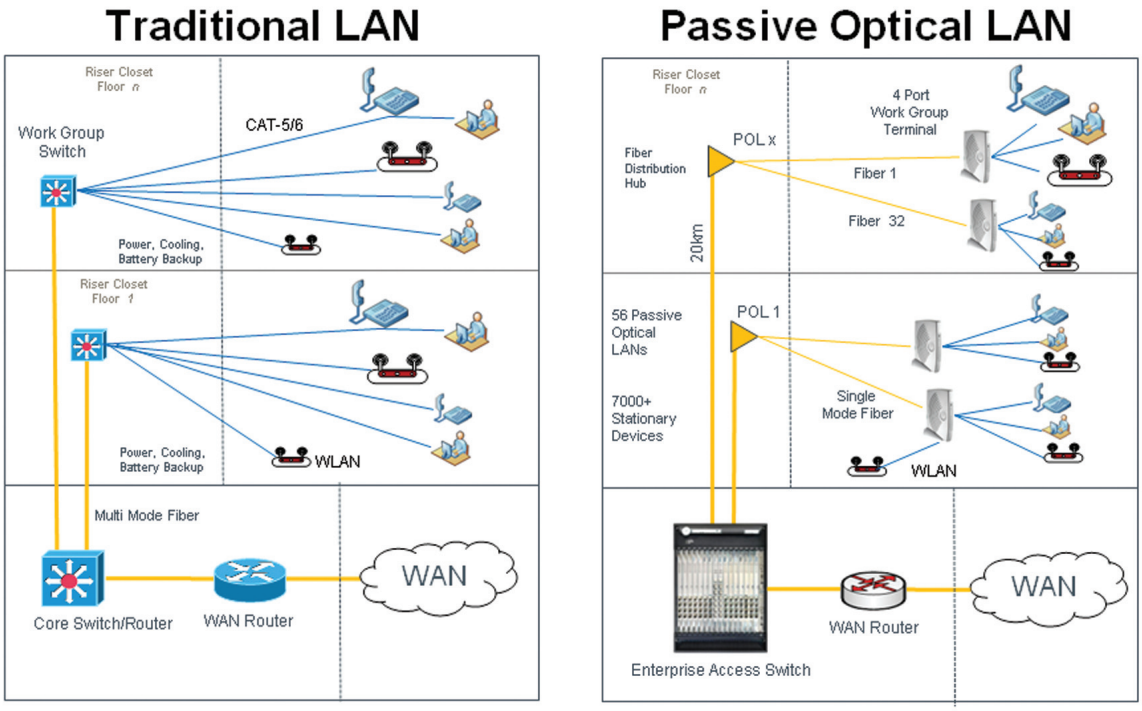
Furthermore, carrier adoption of fiber-optic technology for its consumer customers leads to the natural assumption that this "carrier-class" technology might be too complicated for adoption by a staff-strapped enterprise. However, fiber has evolved over the years. Actually, while fiber was cost-prohibitive in its nascence and limited to point-to-point applications within the floor of the enterprise, the fact is that today's fiber solutions are actually far less expensive to implement, operate and manage than the Ethernet LANs found in most corporate environments today. That's why it makes sense to consider a Passive Optical LAN – a network that employs a Gigabit passive optical networking (GPON) solution – that fundamentally changes the enterprise LAN dynamic and sets enterprises on the path towards using a more simple, more secure and much more cost effective way to deploy and manage any Ethernet-based service requirement found throughout the corporate-wide enterprise.

What is a Passive Optical LAN?

Based on the same proven and standards based technology as Verizon's successful FiOS service, a Passive Optical LAN (POL) is a point-to-multipoint network in which a single aggregation switch provides more than 7,000 IP voice, data, and video network connections to any Ethernet-based device or system. Enterprise communications travel over an optical fiber for a distance of up to 20km. The connections are well equipped for high-bandwidth multimedia applications – supporting aggregate downstream data throughput of 2.5 Gigabits per second, and an aggregate upstream rate of 1.25 Gigabits per second.

The enterprise aggregation switch (EAS) sits in the datacenter and via a POL carries IP voice, data and video to predetermined termination points where optical splitters take in the POL connection and passively redistribute the secondary connection to up to 64 optical workgroup terminals (WGT), each of which supports four Ethernet end-devices or systems and comes in power-over-Ethernet (PoE) and non-PoE versions.

Simple Comparison of Traditional and Passive Optical LAN Architectures



Basically, the POL uses passive optical splitters in lieu of Ethernet copper cables. By essentially splitting up wavelengths of light in order to provide network connections to each of an enterprise's floors, a POL accommodates a tremendous amount of IP traffic over a very lightweight all-fiber passive infrastructure. The "passive" descriptor refers to the fact there are no active electronics between the EAS and the WGTs. In short, implementing a POL means eliminating the many distribution and workgroup switches, cables and wiring closets found in a traditional LAN scenario.

And while it is a carrier-class solution -- making it more reliable than copper -- a Passive Optical LAN is not only more cost effective but also much more cost effective and simpler to deploy and manage and infinitely more environmentally friendly than the Ethernet copper counterparts that most enterprises use today.

The Real Measure: A Passive Optical LAN Offers Both a Tremendous Return on Investment and Lowest Total Cost of Ownership

Implementing a Passive Optical LAN in lieu of a traditional copper Ethernet LAN provides dramatic savings in total cost of ownership, both in terms of capital and operating expenditures, according to a recent study by the consultancy Network Strategy Partners, LLC.

The study discusses two likely scenarios: a single four-floor building that provides 1,044 Fast Ethernet connections to its employees, and a six-building office park that provides 18,936 Fast Ethernet connections for the entire enterprise campus.

If the single-building office were to replace its network with a POL, that office would end up cutting its capital expenses by 39 percent and its operating expenses by 52 percent – a total cost of ownership savings of 45 percent. If the multi-building campus were to employ a POL, the savings would amount to 41 percent for capital expenses and 71 percent for operating expenses – a TCO of 54 percent.

Passive Optical LAN Scenario	CapEx	OpEx	TCO
Single Building	39%	52%	45%
Multiple Buildings	41%	71%	54%

Source: Networks Strategy Partners, Transformation of the Enterprise Network Using Passive Optical LAN, March 2009

The reasons for such dramatic savings are pretty straightforward. Basically, POL incorporates a highly scalable centralized distribution approach with the passive nature of GPON. Adding to this is POL's inherent reach and ability to serve the same Ethernet-based devices or systems while using a greatly simplified architecture consisting of an EAS and WGT. There is simply less resource, capital and operational expenses required to support a POL deployment compared with the myriad copper Ethernet cables and multiple distribution and workgroup switches of a traditional Ethernet LAN.

Equipment-packed intermittent distribution frames (IDF) or wiring closets can create a tremendous amount of heat. Eliminating workgroup switches means eliminating the expenses associated with power, cooling and battery backup where deployed.

- Assuming that most enterprises currently use a Category 5V cabling system that provides a single Ethernet port per user, the comparative power savings that comes with installing a POL amounts to using 10.2 percent fewer kilowatt hours per square foot in an environment with some 250 users, and 31.3 percent fewer kilowatt hours per square foot in a campus with 10,000 users.

As for cabling connection costs, it is true that while fiber costs have decreased over time, installing a single fiber connection can still be more expensive than installing a single Category 5 or new Category 6 cable connection. However, the POL is still more cost effective in terms of cabling because a traditional Ethernet LAN requires a cable connection to every single user port. A POL, on the other hand, uses a single fiber between the aggregation switch and the passive fiber distribution hub (FDH) located in the IDF. From the FDH the single POL is split via fiber distribution terminals (FTD) and connected to up to 32 or 64 WGTs with each WGT supporting up to four Ethernet devices or systems. The net result, then, is a much lower cost for lateral cable runs – a savings of up to 85 percent as outlined in the Network Strategy Partner's scenarios – when a POL is employed.

For those business' that are leasing their office spaces, installing a POL can potentially cut a company's network-related floor space costs in half by eliminating the traditional distribution, workgroup switches and cables. A traditional Ethernet LAN requires at least one IDF or wiring closet housing at least one workgroup switch per floor. Often the traditional LAN requires multiple wiring closets per floor, due to inherent reach issues that limit copper Ethernet cables to a length of a 325 feet. But with a POL, no traditional distribution or workgroup switches are required on any floor in the building, because a single fiber supports miles and miles of connectivity. In other words, POL eliminates the need for costly-to-install and costly-to-operate distribution and workgroup switching elements of the traditional LAN.

The cost of vendor service contracts is also dramatically lower with a POL compared with a traditional Ethernet LAN. According to Network Strategy Partners, the cost of POL service contracts in the scenarios analyzed can be as much as 55 percent less than that of a traditional Ethernet LAN.

The source of this cost advantage is simply that POL has only five Ethernet switching systems (**four AXS 1800s and one core switch/router**) that require network care and consume electric power, while the PMO has 80 such systems.

This is due largely to POL having a fraction of the equipment elements to support as compared to the architecturally and operationally complex traditional Ethernet LAN. A POL eliminates all the annual licensing fees and service fees attached to traditional distribution and workgroup switches. But a POL also diminishes service-associated costs as it is based on GPON technology which was designed from the ground up as a carrier-grade solution that meets the stringent requirements of an always on, always available carrier-class IP network services architecture.

Keeping it Simple: A Passive Optical LAN Greatly Simplifies Network Operations

Again, GPON, the technology on which Passive Optical LANs are based, was initially designed for carriers. And while the idea of a carrier-based technology might conjure images of complicated switching system, the truth is that GPON is deliberately uncomplicated. It really makes a lot of sense that a carrier-class technology would prioritize simplicity. For carriers, providing service to tens of millions of residential users necessitates ease of use for both the end user – who wants to avoid calling for help, and the carriers, which can't afford to employ highly trained engineers to make house calls.

For the enterprise, this translates to ease of implementation, ease of management, and ease of scalability and upgrades. In every respect, a POL is simpler to run than a traditional Ethernet LAN.

A side-by-side comparison of a traditional Ethernet LAN and a POL clearly explains why it's so much easier to design, install and run a POL – especially in corporate campuses with multiple buildings:

*An **Ethernet LAN** requires a WAN router, a core switch/router, and then a distribution switch in each building, and then a workgroup switch on each floor of each building, and loads of copper, including a Category 5 or 6 cable for every single user connected to each of the workgroup switches. This can be a major headache from a design standpoint, especially in older buildings that weren't designed to support mazes of wires.*

From a learning curve standpoint, IT managers are forced to deal with the fact that the multiple boxes on the Ethernet LAN are often managed by multiple applications and software platforms. Often this requires a team of network engineers who are fluent in multiple coding languages – and willing to learn more as the network grows and standards change. Expanding the network can mean employing whole new routing protocols.

And from a maintenance standpoint, suffice it to say that the more boxes there are on a network, the more points of failure there are.

Furthermore, growing the network always necessitates physically installing new boxes and extending the complexity of the LAN.

*A **Passive Optical LAN**, on the other hand, requires only a WAN router, a core switch/router, an EAS, the fiber, passive optical splitters and a WGT. POL lends itself naturally to central management and because of its inherent reach capabilities there's never a need to deal with multiple wiring closets in multiple buildings. While an Ethernet LAN requires a cable for each user connection, POL is designed such that through passive splitters POL supports up to 32/64 WGTs per LAN. There are simply fewer active devices and connections to support.*

Furthermore, every aspect of the POL is centrally controlled and managed at the EAS. The learning curve for running a POL is low because it requires only one software management platform and eliminates the excessive routing and management protocols needed to control traditional Ethernet networks such as Spanning Tree Protocol. And IT directors can use the centralized POL management platform to remotely and directly manage every WGT and Ethernet port on the network.

Expanding a POL is simply a matter of adding new EAS POL connectivity via quick connect FDH and FDT locations and a WGT – a welcome alternative to engineering and building new wiring closets and laying miles of copper cable. Making upgrades to the POL means upgrading a single aggregation switch rather than going from building to building to upgrade multiple switches and all WGTs are remotely addressable and upgradeable.

Playing it Safe: A Highly Secure Passive Optical LAN Thwarts Attack and Theft of IPR

A Passive Optical LAN is inherently more secure than an Ethernet LAN for the simple reason that optical fiber does not conduct electricity as copper does. Electrically based services, unfortunately, are known points of security risk.

The problem is that copper emits electromagnetic radiation (EMR) signals. Those signals – which contain all the information that the copper is carrying at the time – can be intercepted and reconstructed on a nearby device. In theory, EMR is a hacker's paradise. The U.S. military has been aware of the problem for decades, having launched a study – code-named "Tempest" – in the 1960s to study the phenomenon. The problem has been enough of a concern over the years that "Tempest radiation" has become part of the common technology industry lexicon.

Optical fiber, on the other hand, is a dielectric material, meaning it doesn't conduct electricity or radiate electromagnetic signals. With a POL, Tempest radiation is a non issue.

Furthermore, POL technology supports security mechanisms such as AES (advanced encryption standard) 128-bit encryption and 802.1x authentication between the EAS and every deployed WGT. And as a technology initially designed for carriers to provide service to millions of customers in and throughout the public domain, it also includes built-in identity management (DHCP option 82).

It should be noted that while POL in the enterprise is a fairly new idea, there are many early adopters. The majority of these are government agencies, and suffice it to say that in this day and age, a government agency wouldn't deploy a POL without being absolutely sure that the technology is absolutely secure.

Guaranteeing Reliability: A Passive Optical LAN Ensures Uptime

In the technology industry, the term "carrier-class" has become synonymous with "extremely reliable." To that end, IT managers are well aware that equipment vendors tend to overuse the term in their marketing materials, even if their products are not truly carrier class.

However, IT professionals can rest assured that POL technology is truly carrier class because it was initially deployed in carrier networks as GPON. Promoting this fact is that using significantly fewer network elements than an Ethernet LAN will logically lead to fewer points of failure. Finally, the ease of implementation inherent in a POL will mitigate any downtime related to set-up errors. To that end, a POL is very reliable, promising 99.999 percent uptime.

Delivering Green: Passive Optical LAN is an Environmentally Responsible Investment

In addition to the pressure to be prudent with both financial and personnel resources, enterprises are also under pressure to be prudent with the planet. Most companies have adopted various environmental awareness initiatives, whether those initiatives are self-mandated, or mandated by their customers, or even mandated by governmental law.

A POL is inherently greener than a copper-based Ethernet LAN for many of the same reasons that it is more cost-effective. Eliminating the need for distribution and workgroup switches means eliminating the current energy needs and corresponding carbon footprint associated with the many thousands of kilowatt hours of power and cooling systems usage on each floor of every building on campus in operation 24 hours a day, 365 days per year.

Unlike a traditional distribution or workgroup switch, a passive optical splitter requires no special environmental considerations and requires 0 kilowatt hours of annual energy usage and produces 0 carbon footprint during operation. In a building that employs 3200 network users, the use of a POL rather than a traditional Ethernet LAN results in a percentage power savings of about 32.8 kilowatt hours per square foot.

And a general reduction in necessary floor space needed for the networking of traditional distribution or work group switches and cables will lead to a reduction in general electricity costs – not just in terms of powering the equipment but in terms of providing electricity and climate control to the office space.

The Next Generation LAN Today: Adding Passive Optical LAN to Motorola's Enterprise Solutions Portfolio

Motorola's Passive Optical LAN solution provides a simple, reliable, secure and low-cost means to interconnect stationary Ethernet-based systems, such as end-user devices, access points and wireless controllers, application servers and printers.

This five-nines-reliable system provides a gigabit distribution network that either augments or replaces legacy Ethernet or copper network infrastructure for hundreds to thousands of endpoints. The solution is easy to design, implement and operates at a fraction of the cost of legacy Ethernet copper networks. Motorola's Passive Optical LAN solutions deliver rapid ROI and revolutionize how complex, inefficient, and costly enterprise networks can be deployed. Highly secure, the Passive Optical LAN simplifies the enterprise network while greatly reducing associated capital and operational expenses that drain precious resource from today's IT environments.

Passive Optical LAN is uniquely positioned to enhance Motorola's Wireless Enterprise, a mobile network solution comprised of wireless LAN (WLAN), broadband and Voice Over WLAN (VoWLAN) products. By networking traffic between APs, controllers and business systems, customers will gain improved mobility and throughput in addition to unmatched reliability, gap-free security with the best ROI and lowest TCO.

Motorola, a veteran in the design and deployment of both carrier and enterprise networking technologies, now offers all the tools necessary to deploy a superior Passive Optical LAN in the enterprise. Motorola's Passive Optical LAN elements include:

The Motorola Enterprise Aggregation Switch: Enabling the delivery of secure IP voice, video, and data services over a single fiber to any stationary Ethernet device or system in the enterprise. The Motorola EAS is an aggregation switch that supports up to 7168 Gigabit Ethernet ports per chassis, via 56 passive optical LANs, which each support up to 64 Ethernet end points. The EAS employs a high level of security with both 128-bit AES encryption and 802.1x authentication for access controls.

The Motorola AXSvision Advanced Element Management System: AXSvision is a graphically rich element management application designed to support of all elements of the POL environment. Robust and reliable, AXSvision software is designed for scalability and supports a broad range of deployment options, offering enterprises the ability to support simplification of their network's operation by reducing the complexity of system monitoring and management.

The Motorola Passive Optical LAN Workgroup Terminal: The Motorola WGT connects stationary Ethernet devices and systems to the POL, providing line-rate gigabit services at distances of up to 16 miles (about 20km) from the data center. Each WGT provides four 10/100/1000bT Ethernet ports and can be remotely monitored, addressed and upgraded via AXSvision.

The Fiber Distribution Hub: A passive element that does not require any power (or electronics), the hub houses the optical splitters, essentially taking the place of workgroup switches.

The Fiber Distribution Terminal: Another passive element that requires no power, the Fiber Distribution Terminal distributes the single POL connection from the FDH to area WGTs.

Motorola's AXS1800 Enterprise Aggregation Switch, ONT1120GE Work Group Terminal and AXSvision, System Graphical User Interface

Conclusion

While the all-fiber enterprise approach was once cost-prohibitive and technically cumbersome, deploying the all-fiber enterprise with Passive Optical LAN today is viable and undoubtedly more cost-effective – in terms of ROI and lifecycle TCO – than a traditional Ethernet LAN. Motorola's Passive Optical LAN solution offers Enterprise IT professionals access to a new and simple approach to connecting LAN services to any stationary Ethernet device or system. Providing superior performance, security, and carrier-class reliability, Motorola's proven Passive Optical LAN solution incorporates years of expertise in both carrier and enterprise networking technology into every element of its architecture.

Please contact your Motorola enterprise sales representative to discuss and model how Motorola's Passive Optical LAN Solution can provide more secure, reliable and cost effective IP voice and data communications across your enterprise.

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