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Passive Optical LANs Supporting Smart and Secure Manufacturing Facilities

Publication date:
Apr 2023
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Overview

Manufacturing facilities are facing challenges including supply chain issues, rising energy costs, and ever-changing customer demand. Many manufacturing facilities are planning to upgrade their internal communications networks, according to Omdia's IT Spend Predictor survey. A Passive Optical LAN (POL) enables a manufacturing facility to support numerous bandwidth-heavy and latency-sensitive applications across 20km, enabling secure connections and interconnections with production lines, machines, warehouses, maintenance yards, and operations in a secure environment. The adoption of POL leads to smarter, safer, and more profitable manufacturing. A POL saves space and power, directly affecting operating margins. In addition, a POL facilitates Industry 4.0 applications, minimizing downtime by supporting predictive maintenance applications. A POL's fiber cabling remains in place for many years, further minimizing downtime compared with periodic replacement of traditional CAT cabling. POLs operate in harsh environments with no electromagnetic interference issues. Furthermore, POLs support secure communications because they can be designed to support different authorization levels throughout the facility.

The need for POL in manufacturing facilities

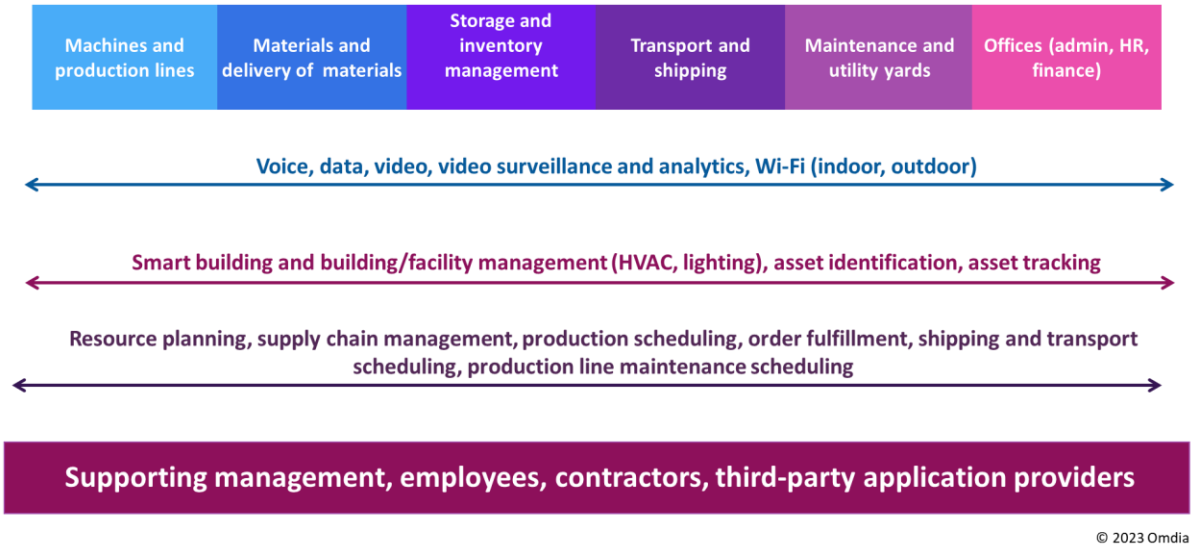
A manufacturing facility requires time-sensitive communications for secure and efficient operations. There are numerous layers of communications, between machines, production lines, operators, raw materials, warehousing, shipping, order fulfillment, maintenance personnel, and accounting. In addition,

efficient manufacturing requires supply chain management for accurate inventory control and communications with suppliers. Plant security requires asset identification and tracking along with perimeter monitoring. Efficient manufacturing requires smart resource planning and scheduling to reduce waste. Smart facility management requires energy-efficient lighting and heating, ventilation, and air conditioning (HVAC) controls. The manufacturing facility is a complex grouping of multiple functions, all requiring networking applications.

A POL can support multiple applications simultaneously across large and diverse plant facilities, encompassing more than just production lines. This enables a facility to use a POL to support traditional communications services such as voice and data, high-resolution video, and wireless (including Wi-Fi, 4G, and 5G) in addition to smart building management, manufacturing resource planning, and office support functions. A POL leads to convergence of communications and applications onto a single, passive, upgradable, scalable, and secure network. Furthermore, a POL is based on optical fiber with passive splitters, making it immune from electromagnetic interference and various environmental factors such as grease, oil, and heat.

Figure 1 provides a simplified overview of the major application groups that require networking within a manufacturing facility.

Figure 1: Manufacturing facility scenario – types of facilities, types of applications, types of users



Source: Omdia

These different types of applications and users have varying requirements regarding bandwidth, latency, and jitter. POL infrastructure meets these varying requirements with bandwidth ranging from 2.5G to 10G, 25G, and even 50G. Upgrades are possible without touching the underlying fiber cabling, known as the optical distribution network (ODN). Dynamic bandwidth algorithms can assign different traffic priorities to applications and user types accordingly.

POLs are managed through a single management platform from a single communications closet or room. The POL can reach 20km without the need for active, field-based components at every 100m. The POL management system assigns access authorization permissions by type/level of employee or machine.

POL infrastructure is considered highly secure, on par with dedicated point-to-point fiber. POL networks encompass end-to-end traffic encryption along with message and user integrity checks. In addition, there are options for redundancy, such as path protection, optical line terminal (OLT) equipment redundancy, optical network terminal (ONT) equipment redundancy, and combinations of these options. A POL network meets the “five 9s” (99.999%) reliability associated with communications service provider (CSP) networks.

With POL, OLTs and ONTs can be upgraded without touching the ODN. This is a major advantage over traditional LANs. Traditional LANs use CAT cabling, which needs to be completely removed and replaced with next-generation cabling to improve network performance. POL upgrades are achieved by replacing the OLTs and ONTs, for example, moving from 2.5G to 10G or 25G equipment and beyond.

In addition, not all ONTs need to be upgraded at the same time. An IT administrator or facility director can upgrade ONTs when and where needed to meet bandwidth requirements. POL fiber cabling has a long life, which means that the ODN can be left in place for years. In addition to their scalability and longevity, POLs are flexible. Additional ONTs can be added as a manufacturing facility expands or as internal space is changed. For example, the redesign of a production line can be accommodated easily within POL infrastructure.

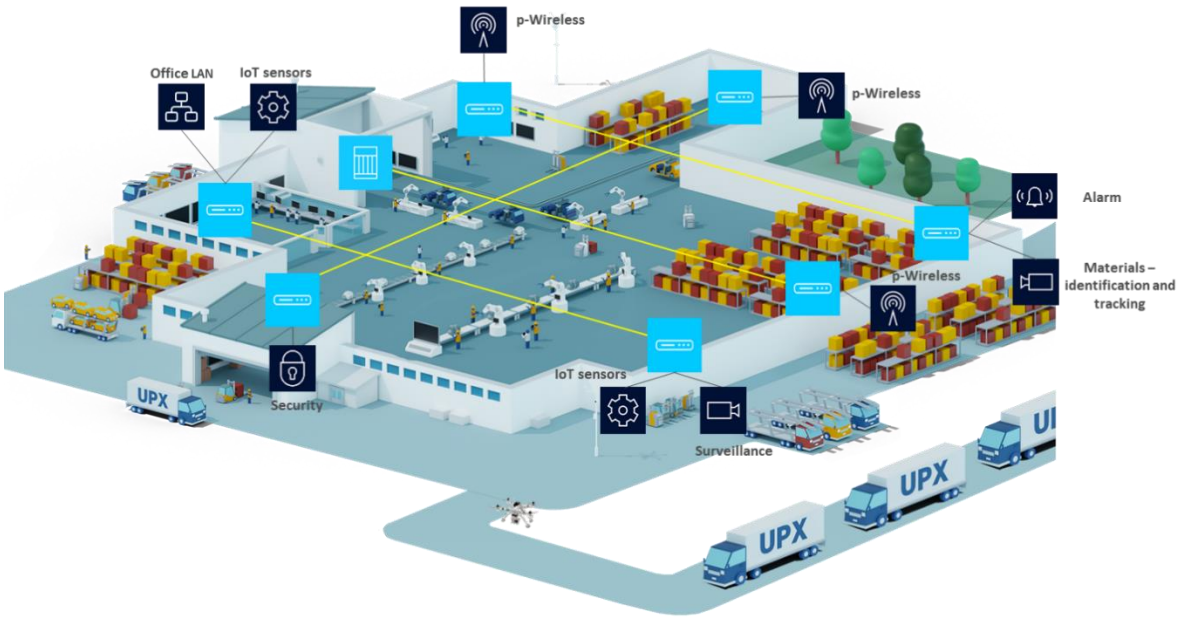
POL within the manufacturing sector

In the manufacturing facility, an OLT is installed at a central communication point in the facility. POL uses fiber cabling and splitters, enabling support to multiple points, often 64 locations from a single Passive Optical Networking (PON) port. An ONT is installed at each communications endpoint—such as a machine, production line, inventory control point, maintenance office, maintenance yard, entry gate, meeting room, office, or CCTV—throughout the facility.

Single-mode fiber supports two-way communications (downstream, upstream) with PON’s built-in wavelength management system.

Figure 2 provides a diagram of POL infrastructure within a manufacturing setting.

Figure 2: POL within the manufacturing facility



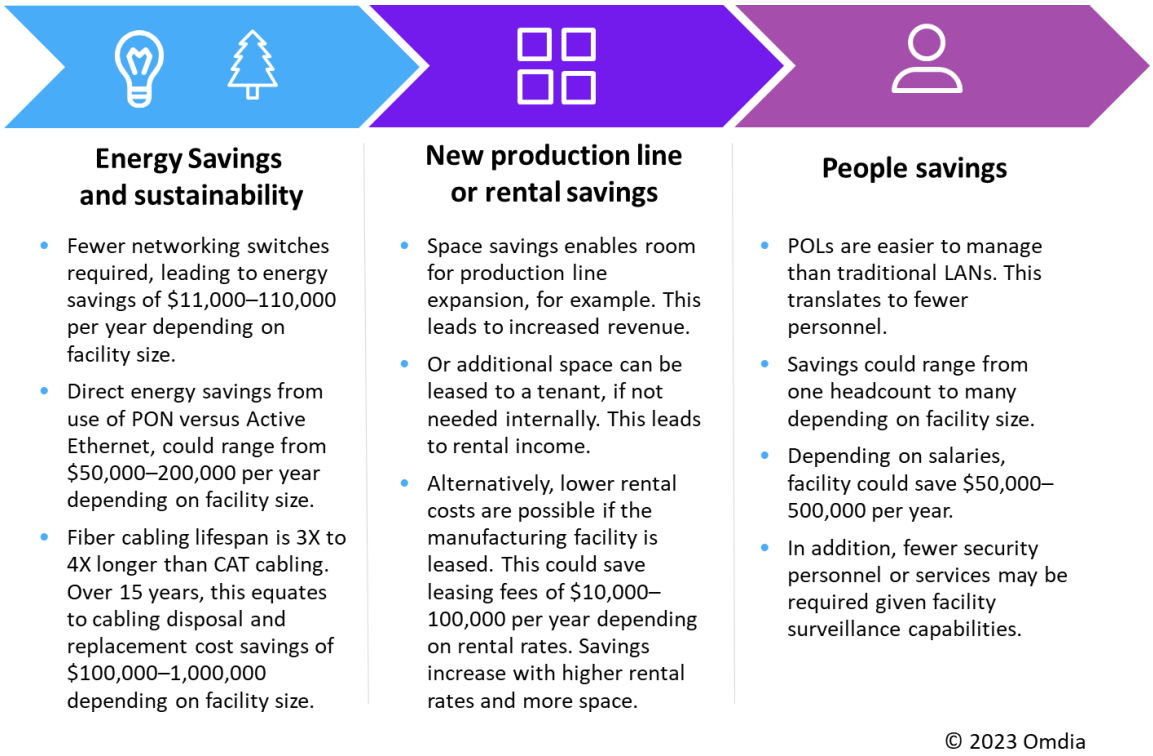
Source: Nokia and Omdia

POL's advantages in the manufacturing facility

There are numerous advantages to POL infrastructure over a traditional LAN. First, a POL uses fewer racks and switches than a traditional LAN. In turn, fewer pieces of networking equipment means savings on space and power. The space saved could be used for another production line or more offices. In addition, there is less equipment to manage, which saves headcount and associated salaries and benefits. Also, optical cabling is smaller than Cat 5 or Cat 6 cabling, thereby reducing the amount of physical space needed for cabling. Consequently, POLs lead to savings in both capital expenditure (capex) and operational expenditure (opex).

Several of the major financial advantages are summarized in **Figure 3**.

Figure 3: POL's major financial advantages – manufacturing facility setting



Source: Omdia

There are numerous other cost advantages as well:

- Minimized production line downtime through timely machine and manufacturing diagnostic data
- Reduced facility downtime when machine and production line changes are made
- Improved security, for example, less theft
- Improved inventory control through asset tracking
- Lower energy costs through smart production and facility management

POL manufacturing facility managers have cited savings in total cost of ownership (TCO) of between 30% to 50% compared with a traditional LAN, depending on facility size, production line requirements, network requirements, energy costs, labor costs, and office/facility rental rates. In addition, these facility managers have commented on the importance of improved security and asset management throughout the facility. Furthermore, POL is a key part of Industry 4.0 digitization of manufacturing facilities, leading to improved production and margins.

Recommendations and next steps

The manufacturing sector is benefiting from investment in POLs, which provide clear TCO advantages over traditional LANs. A POL enables a manufacturing facility to support multiple applications for diverse users, both machines and people, with varying networking requirements, onto a single, secure, and upgradable fiber-based optical network. POLs are environmentally sustainable, using passive components while reducing energy-consuming network elements. They are easy to upgrade without touching the underlying ODN. Furthermore, POLs are adaptable, a key requirement in manufacturing facilities. A POL will provide a future-proof LAN solution for years to come, enabling the digitization of the manufacturing facility.

Appendix

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Omdia commissioned research

This piece of research was commissioned by Nokia.

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