PROFINET vs Ethernet

Overview, Roles, and Implementation

Introduction

PROFINET is the Industrial Ethernet solution created by PROFIBUS and PROFINET International (PI). Ethernet is the most popular communication medium for creating networks worldwide. The roles and specifications of these two technologies often cause confusion. This White Paper will help clear any doubts by explaining the difference between Ethernet and PROFINET. Also, it will expand on their roles in automation applications.

Background Information: The ISO/OSI Model

Ethernet-based communications can be represented by a seven-layer model: the ISO/OSI Reference Model. The model generically describes the means and methods used to transmit data across a network. Each layer has a specific name and function, as shown in Figure 1. Some protocols use all seven layers for communication, while other protocols use a subset of them.
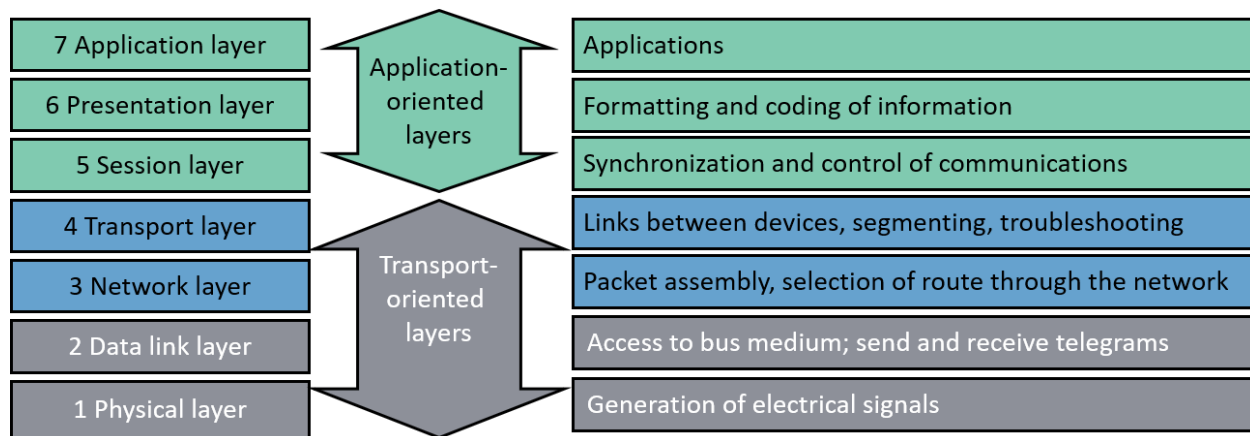
7 Application layer	Application-oriented layers	Applications
6 Presentation layer		Formatting and coding of information
5 Session layer		Synchronization and control of communications
4 Transport layer	Transport-oriented layers	Links between devices, segmenting, troubleshooting
3 Network layer		Packet assembly, selection of route through the network
2 Data link layer		Access to bus medium; send and receive telegrams
1 Physical layer		Generation of electrical signals

Figure 1- ISO-OSI Model

The next sections will refer to the communication layers in the ISO/OSI Model to explain core principles and mechanisms of Ethernet and PROFINET.

The Difference Between Ethernet and PROFINET

What is Ethernet?

IEEE 802.3 specifies the standards that comprise Ethernet. Ethernet sits on Layer 1 (Physical Layer) and Layer 2 (Data Link Layer) of the ISO/OSI Model. Ethernet frames include information such as the MAC addresses of sender and receiver, virtual LAN (VLAN) tagging, and Quality of Service (QoS).

Ethernet is used to connect nodes in a Local Area Network. The physical link between nodes in an Ethernet network can be, for example, a twisted pair cable or a fiber optic cable. Nowadays, Ethernet is the most common communication medium worldwide; used in homes, enterprises, factories, and general infrastructure due to its speed, affordability, and versatility.

The Difference Between Ethernet and Industrial Ethernet

Ethernet and Industrial Ethernet are the exact same thing. The only difference is that Industrial Ethernet includes running Ethernet traffic over more ruggedized hardware. For example, the cabling employed for Ethernet-based communications can vary substantially across applications. Ethernet cables can be classified according to their network characteristics (i.e., Cat 5, Cat6, Cat7). On top of that, they can be classified as either commercial Ethernet (often referred to as just 'Ethernet') or Industrial Ethernet.

On the wire, Ethernet and Industrial Ethernet are identical. Their specifications (i.e., transmission speed and bandwidth) apply across different cable types. However, their target applications vary.

Commercial Ethernet hardware is not designed for usage in industrial applications. It is more suited for standard consumer environments, such as home and office networks. In those locations, cables are not exposed to extreme environmental conditions or excessive stress. On a factory floor however, commercial Ethernet cables can damage and break easily. Employing commercial Ethernet hardware in industrial applications is extremely risky, as hardware failures can interrupt critical and expensive processes.

Industrial Ethernet cables and hardware are designed for industrial applications. Industrial environments are characterized by challenging conditions, such as extreme temperatures, humidity,

vibrations, and electromagnetic interference. Industrial Ethernet hardware is rugged, and its wiring is protected with shielding and jacketing.

What is PROFINET?

PROFINET is an Ethernet-based solution. It is a communication protocol to exchange data between controllers and devices. Controllers can be Programmable Logic Controllers (PLCs), Distributed Control Systems (DCSs), or Programmable Automation Controllers (PACs). Devices can be I/O blocks, vision systems, RFID readers, drives, process instruments, or other sensors and actuators.

PROFINET sits on Layer 7 of the ISO/OSI Model. It defines cyclic and acyclic communication, such as diagnostics, functional safety, and alarms. Again, PROFINET is based on standard Ethernet for its communication medium. Having Ethernet on the factory floor brings many benefits, such as:

- High bandwidth
- Large message size
- Flexible topology options
- Extensive address space

PROFINET vs. Ethernet

PROFINET and Ethernet are complementary technologies that fulfill different roles in automation networks. Ethernet (Layer 1 and 2) defines the signals on the wire, how to access the bus, and how to send and receive frames in a LAN. PROFINET is an application (Layer 7); it allows users to build a network configuration and define the data exchange between components.
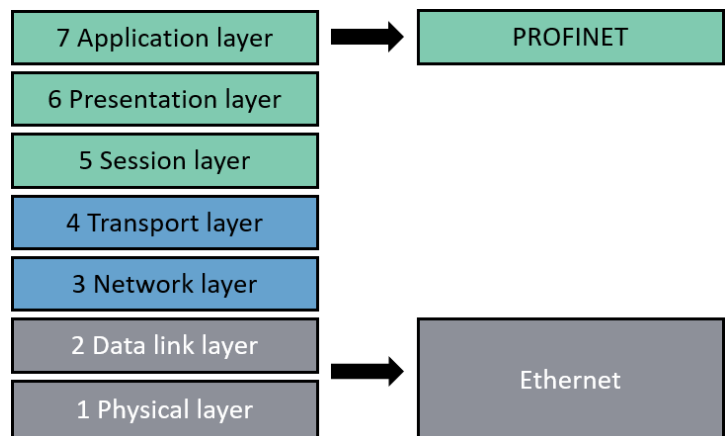
7 Application layer	➤ PROFINET
6 Presentation layer	
5 Session layer	
4 Transport layer	
3 Network layer	
2 Data link layer	➤ Ethernet
1 Physical layer	

Figure 2- PROFINET and Ethernet in the ISO-OSI Model

PROFINET and Ethernet FAQ

"Is PROFINET… Ethernet?"

PROFINET is an application that is based on Ethernet. Comparing PROFINET to Ethernet would be like comparing the language we speak with the telephones we use – both are required to communicate.

"Can PROFINET networks use standard Ethernet hardware?"

Standard Ethernet hardware, such as commercial Ethernet cables, connectors, and switches, can be implemented in a PROFINET network. PROFINET does not require specialized hardware. However, commercial Ethernet hardware is not recommended for industrial environments, as those components are not properly equipped for the task. PI highly recommends employing industrially-graded networking components that are built for the factory floor. These components can survive such a challenging environment and reduce the risk of costly downtime and maintenance due to hardware failure/damage.

"Can PROFINET and Ethernet employ the same switch?"

Since PROFINET is based on standard unmodified Ethernet, the network is not restricted to just PROFINET telegrams. PROFINET can coexist with other Ethernet-based protocols (i.e., MQTT, SNMP, OPC UA, HTTP) in the same network and share network infrastructure, such as switches and cabling. Ethernet switches in a PROFINET application switch all Ethernet traffic, regardless of their application.

Summary

PROFINET and Ethernet are not competing technologies. They are complementary technologies that fulfill crucial roles in automation facilities. PROFINET is the communication protocol at the Application Layer and Ethernet is the communication medium.

A PROFINET network can be implemented on existing and new Ethernet networks without the need for specialized cables, connectors, or switches. PROFINET can coexist in such Ethernet networks with other Ethernet protocols that fulfill complementary tasks, such as managing network diagnostics, sending data to the cloud, and interfacing with web servers.