PROFIBUS vs PROFINET

Comparison and Migration Strategies

Introduction

PROFIBUS and PROFINET are two different widely deployed automation protocols created by the same organization. PROFIBUS is a classical serial fieldbus and PROFINET is an industrial Ethernet standard. They share similarities due to their common source, but PROFINET has additional capabilities that allow faster and more flexible communication. This white paper will explore the differences between them and explain migration strategies from PROFIBUS to PROFINET.

PROFIBUS vs PROFINET

The following table summarizes the main similarities and differences between PROFIBUS and PROFINET:

	PROFIBUS	PROFINET
Organization	PROFIBUS & PROFINET International	
Hardware definition	GSD files	
Application profiles	Same	
Physical layer	RS-485	Ethernet
Speed	12 Mbit/s	1 Gbit/s or 100 Mbit/s
Telegram	244 bytes	1440 bytes (cyclic)[1]
Address space	126	unlimited
Technology	master/slave	provider/consumer
Wireless	Possible[2]	IEEE 802.11, 15.1
Motion	32 axes	>150 axes
Machine-to-machine	No	Yes
Vertical integration	No	Yes
Connectivity	PA + others[2]	many buses

Both protocols were created and are supported by the same organization: PROFIBUS & PROFINET International (PI). General Station Description(GSD) files define PROFIBUS and PROFINET hardware, which are ASCII files and XML files, respectively. PROFIBUS and PROFINET also share the same application profiles. Application profiles are agreements within families of devices on how to use PROFIBUS or PROFINET data to ensure interoperability and interchangeability. These application

[1] with multiple telegrams: up to 232-65 (acyclic)
[2] not in specification, but solutions available

profiles guarantee fast and smooth planning, commissioning, and operation of modern automation devices and systems from various manufacturers. Some of the most popular profiles are:

- PROFIsafe: Functional safety
- PROFIenergy: Energy management
- PROFIdrive: Drives and motors
- Process Automation: Continuous process

PROFIBUS was created in 1989; it was one of the main drivers for the industry-wide transition from 4-20 mA analog signals to digital fieldbuses (RS-485). The later transition from RS-485 to Ethernet was also similarly a shift to a more modern technology. Ethernet is ubiquitous. Because PROFINET uses standard Ethernet, it is future-proof. As commercial Ethernet advances, PROFINET takes advantage. For example, PROFINET started running on 100 Mbit/s Ethernet, today PROFINET can run on Gigabit Ethernet (and higher). The conversion to an Ethernet-based communication provides higher bandwidth, larger message size, and unlimited[3] address space. Unlimited address space may be limited by individual controllers based on their processor and memory.

PROFINET speed improved thanks to its provider/consumer model and by leveraging the full-duplex nature of Ethernet. In a provider/consumer model any node communicates whenever needed and since Ethernet networks are switched networks, there are no collisions on the network. Full duplex means devices can send and receive on separate lines, without needing to wait for either. PROFIBUS avoided collisions by using a master/slave approach; master/slave communication is efficient, but slower. The master oversees the network and the nodes talk only when spoken to by the master.

PROFIBUS can transmit messages wirelessly, but often requires proprietary radios from the same manufacturer at both ends. PROFINET, being standard Ethernet, uses Wi-Fi and Bluetooth. Again, as Wi-Fi or Bluetooth evolve, PROFINET evolves by taking advantage of the latest specifications.

[3] address space limited only by controller's processor and memory, not by PROFINET specification

Individual companies have created gateways to do the translations from other networks to PROFIBUS. PROFINET has gone one step further by defining proxies in its own specification. Proxies are like gateways in that they translate one protocol to another, but unlike gateways, they are defined in an open standard. PROFINET has available proxies for PROFIBUS DP, PROFIBUS PA, AS-i, IO-Link, DeviceNet, Foundation Fieldbus, CANopen, Modbus, HART, etc. For example, IO-Link and AS-i proxies allow communication with smart devices without an Ethernet port.

Current Adoption

PI conducts a yearly audit to count new PROFIBUS and PROFINET nodes. According to the 2016 audit, PROFIBUS and PROFINET added 2.4M and 3.6M devices respectively. 2016 was the first year PROFINET sold more nodes than PROFIBUS, but there are still over 56.1M PROFIBUS nodes installed worldwide.

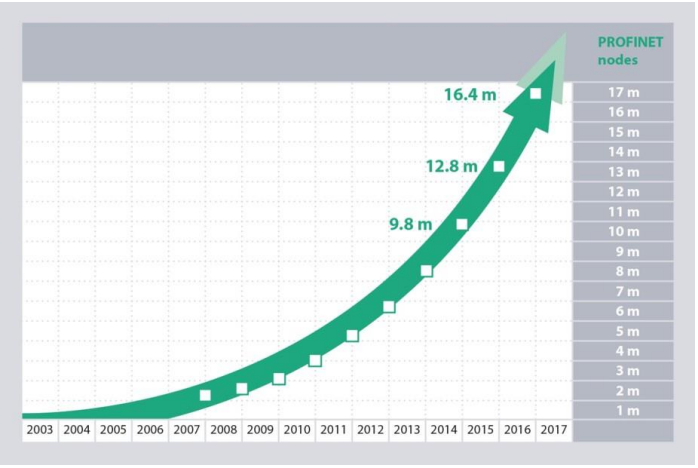

Figure 1 Number of installed PROFINET nodes

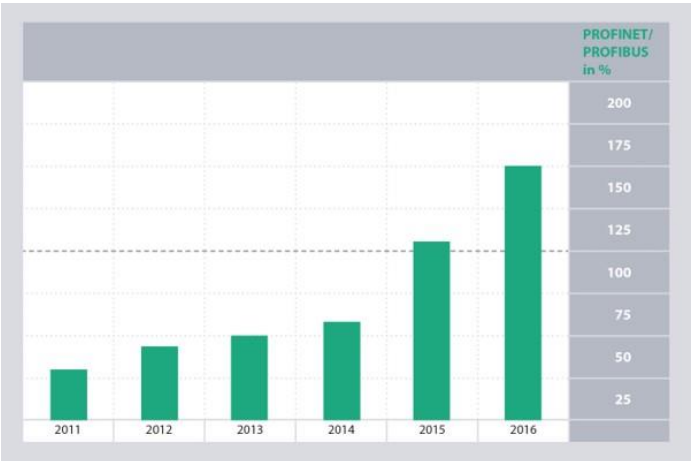

Figure 2 PROFINET and PROFIBUS node relationship

Migration from PROFIBUS to PROFINET

PROFINET leverages PROFIBUS technologies to ensure a smooth and cost-effective migration between them. Depending on the factory state and current network technology there are two migration approaches: greenfield and brownfield installation

- **Greenfield installation:** In networking, a greenfield installation occurs when a network is nonexistent in the first place. The new network is designed according to all specifications and necessities of the future factory.

- **Brownfield installation:** With a brownfield installation, there is an installed network of some nature already. In a brownfield installation there are two approaches:

  - **Step-wise migration:** Legacy fieldbuses can be preserved by upgrading specific areas in the factory floor to industrial Ethernet. Plant operators can schedule the upgrades during down seasons, slack times, downtimes, mandatory maintenance, etc. This avoids potentially expensive disruptions to plant production, and project management is much easier.

  - **Rip-and-replace:** In case of highly outdated hardware, or fieldbus investments that met their desire lifecycle, the equipment is removed and replaced. It is a disruptive process and a management challenge but brings all the benefits of industrial Ethernet immediately. Rip-and-replace installations can also be scheduled strategically to avoid expensive disruptions to plant production.

In many cases, it will be required to establish communication between the fieldbus and Ethernet networks. PROFIBUS to PROFINET proxies allow seamless communication; Figure 3 shows a proxy diagram between a PROFINET backbone and PROFIBUS devices. The Proxy is a

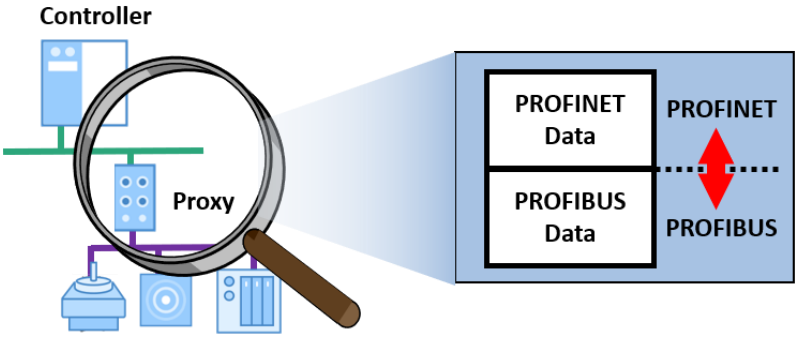

Figure 3 PROFINET to PROFIBUS proxy

PROFINET device on the network and represents all the PROFIBUS Components. The PROFIBUS slave data is “translated” within the proxy to the PROFINET protocol. The Proxy is also the Master within the PROFIBUS master/slave communication protocol. Proxies are also used in PROFINET networks when encountering hazardous environments where Ethernet cannot be installed. PROFIBUS PA or other fieldbuses must be installed in those areas.

Summary

There are many substantial differences between PROFIBUS and PROFINET, especially in performance. Even though PROFINET has now outpaced PROFIBUS in 2016, PROFIBUS is not disappearing but slowly migrating to newer technologies like PROFINET. PROFIBUS networks are widely used in process automation and required in hazardous environments. There are different migration strategies, but PI technologies ensure a smooth and cost-effective migration overall. PROFINET is a newer and more flexible technology that is also future-proof, since it uses standard Ethernet. PROFINET is also ready to preserve legacy investments by integrating serial fieldbuses via proxies where needed.

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