

# Profinet - the open Industrial Ethernet standard for automation

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*Profinet - the open Industrial Ethernet standard for automation*

*Due to the rising demand in factory automation for integrated communication over a single network with comprehensive diagnostics and service functions throughout the network, Industrial Ethernet is now starting to penetrating more and more into the field area. This utilizes the advantages of rugged field buses together with the standardized IT functionalities of Ethernet. The answer to those requirements is PROFINET, the open Industrial Ethernet standard for automation. It supports all communication standards according to IEEE 802.3 but also technology and solutions needed for the use of Ethernet at all levels and in all applications in automation.*

## 1 Introduction

Automation technology has been characterized in the last few years by the increase in the use of distributed networks based on field bus technology. This in conjunction with the upcoming trend for a single network from the management level to the field level has brought Industrial Ethernet into the focus of industrial communication standards and technologies.

The Profinet standard developed by Profibus & Profinet International, the largest field bus organization worldwide, takes the experiences gained with field bus systems and applies them to Industrial Ethernet. The aim is not only to define a new protocol for Industrial Ethernet but to create a system that is 100 % compliant with all communication standards according to IEEE 802.3 and can be easily integrated into existing

field bus systems. Profinet is an open, cross-vendor standard and takes into consideration the requirements for the use of Ethernet at all levels and in all applications in automation technology:

- Real-time capability
- Integration of distributed field devices
- Isochronous motion control applications
- Cross-vendor engineering for distributed automation structures
- Industry-suited installation and network technology
- Simple network administration and diagnostics with IT services,
- Security for protection against unauthorized access and data manipulation
- Failsafe communication.

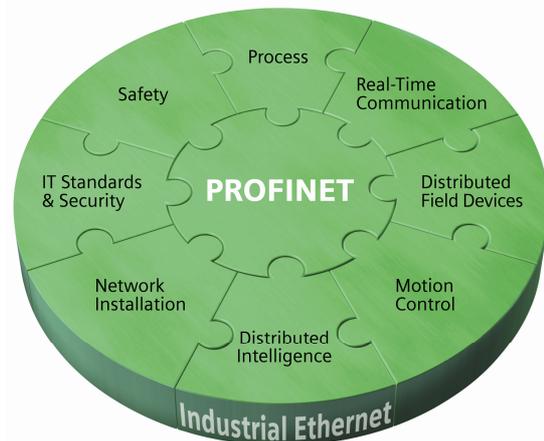


Figure 1 - System overview Profinet

In the following the Profinet highlights like real-time communication & isochronous applications, use of standardized technologies & IT mechanisms and failsafe communication will be explained in more detail.

## **2 Real-time communication and isochronous applications**

One of the preconditions for the use of Ethernet in automation technology is reliable real-time behavior. A system solution is demanded which meets real-time requirements into the high end and at the same time enables unrestricted, parallel use of IT functions. Profinet is the only Ethernet solution which consistently covers all the requirements of real-time communication without restricting the openness.

Although Ethernet with its high transmission rate of 100 Mbit/s is highly suitable for engineering tasks and IT services (such as Web integration or network diagnostics), new requirements exist when using it for cyclic transfer of user data in the field. Since short response times with real-time transmission are of essential importance to the transfer of user data, Profinet makes use of a so-called real-time channel (RT). The performance which can be achieved with this is comparable with that of standard field bus systems, and enables response times below 10 ms. RT is based on standard Ethernet hardware in the data terminals and it assigns priorities to the telegrams according to IEEE-based priority tagging in the switches.

In order to also realize isochronous applications, such as those encountered in drive controls, a jitter accuracy of 1  $\mu$ s and a cycle time of 1 ms can be achieved with guaranteed real-time response. To provide this high performance, Ethernet has been extended by an isochronous communications cycle which is monitored by the hardware. The hardware support is provided by an ERTEC (Enhanced Real-Time Ethernet Controller) ASIC which must be integrated in data terminals and network components. The real-time telegrams are transmitted in a reserved time window in a cyclic sequence. The remaining time of a cycle is used for standard communication. In this manner, both data transmission functions exist next to one another but are not mutually interfering. For example, a user can connect his notebook to any position in the plant in order to

access the device data – without influencing the isochronous communication.

With this isochronous real-time communication Profinet clearly exceeds the already high capacities of existing field busses and offers for high performance applications just as motion control an increased performance by up to factor 100.

The following example underlines this: at a cycle time of 500  $\mu$ s, 70 drives can be operated synchronously with a 50 % reserve of the bandwidth for open communication with IT standards as for diagnostics.

## **3 Use of standardized technologies and IT mechanisms**

As part of the IEC 61158, Profinet is based consistently on the IEEE Ethernet standards with 100 Mbit/s fast Ethernet switching technology. In addition to the star topology commonly used in Ethernet, it also supports line and ring network topologies which are widely used in automation and known from established field busses. This allows a minimized cabling overhead and ensures a maximum availability as all cables, plugs and devices offered for Profinet by Siemens are very rugged and made for industry use.

### **3.1 Distributed field devices**

With this flexibility in setting up network topologies and through the integration of switch functionalities into the devices, Profinet offers the user all possibilities for the in automation technology preferred concept of distributed field devices. They can be directly interfaced to Industrial Ethernet via Profinet. This enables cyclically high-speed data exchange between the I/O devices and I/O controllers. For example: Profinet supports 1440 bytes/cycle per field device in this process and exceeds the data volumes transmittable via a common field bus.

### **3.2 Integrated diagnostics**

Furthermore Profinet permits considerably improved diagnostics functions required for

configuration and integrated diagnostics. By using the same device principle as for Profibus, Profinet offers as basis the same diagnostics information, but goes a step ahead. It offers a uniform diagnostics concept for efficient localization and trouble-shooting of possible faults. If a fault occurs, the IO-Device automatically sends a diagnostic interrupt to the IO-Controller from where a reaction in the user program is initiated. Alternatively the diagnostics information can be read directly from the field device. This is also possible by using web services as many field devices, controllers and switches have an integrated web server accessible worldwide via the Web. Those integrated web services allow new concepts and bring advantages for engineering, commissioning, operation and specially maintenance by worldwide and remote accessibility.

### **3.3 Wireless communication**

Communication in the automation sector was previously associated with hardwired solutions. Profinet, consistent with IEEE standards, provides the possibility to use the established Standard Wireless LAN (WLAN) also on the plant floor. This opens up new possibilities with Profinet in the scope of mobility, flexibility and failsafe communication, which were not possible with conventional field bus systems so far.

However, standard products do not satisfy the high requirements of complex industrial applications, especially if a strictly real-time response is important. The cyclic processing of the control programs must not be prevented or interrupted by long and unpredictable data transfers. It is therefore extremely important that all data transmissions relevant to the process can be planned. Such a real-time response is usually the case for automation applications with the proven field buses (e.g. Profibus), guaranteeing plannable and fast data transfer. This quality is also expected of a wireless channel if it is to be used for automation applications. For this reason, an expansion to the standard has been implemented

with Scalance access points from Siemens which provide the priority stations in the wireless field with a special network quality. Tests and running applications have demonstrated a significant increase in reliability and as a consequence thereof increase in productivity.

### **3.4 Industrial Security**

Profinet allows data in the field level to be accessed from the management level. Thus enables a vertical integration with all its advantages, but however the security of the network and the data must be ensured. Viruses, Trojan horses, etc., are not the only risks; faulty addresses within the company must also be ruled out.

Simple and efficient solutions are required: With Scalance S, Siemens provides network components for industrial data and network security which support Profinet. It can be implemented without deep IT or security knowledge. The "Profinet Security Guideline" from PI International explains principles and concepts on the topic of "Data security in the industrial-environment" like access control & authorization, access levels and data security & security standards such as firewalls.

All those standardized technologies and IT mechanisms describe above make Profinet a complete and comprehensive system solution for industrial automation.

## **4 Failsafe communication with Profisafe**

The same Profisafe profile which has been tried and tested for many years with Profibus is also used with Profinet. This bus-independent, TÜV-certified Profisafe profile supports the standard and failsafe communication via a common physical bus and meets the safety requirements in production automation with IEC 61508 up to Safety Integrity Level 3 (SIL 3) or EN 954-1 up to category 4.

Thanks to this, existing Industrial Ethernet structures can be extended to failsafe communication or subordinate Profibus-based

safety solutions can be integrated easily in Profinet. The use of standard components reduces the type variety. Network transitions between the bus systems can be implemented either by PLC, PC or links. In the latter case, the data is then passed through directly without additional processing. This enables a transparent, economical and simple migration of Profibus systems to Profinet. The same applies for the engineering effort which is reduced in terms of time and costs: Existing safety programs according to the Profisafe profile can be adopted for Profinet.

All this is possible because the communication profile uses the "black channel" technology in which the safety telegram is embedded with its own safety mechanisms in a standard or transport telegram of the subordinate bus system. In this way, standard and failsafe communication can be held on one and the same bus cable whilst the safety and field bus profiles remain clearly separate.

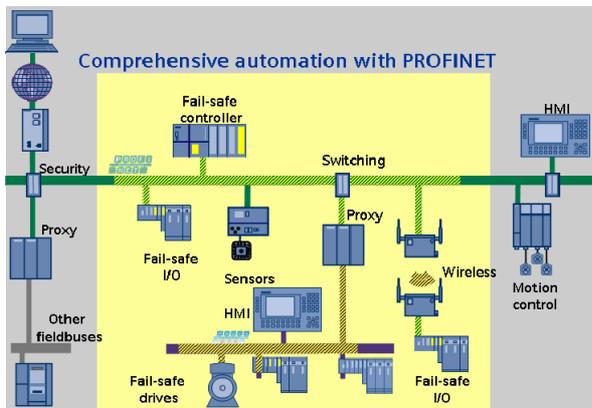


Figure 2 - Failsafe communication with Profisafe

Profinet also opens up new possibilities for the protection of man and machine users even allowing safety-relevant data traffic to be transferred wirelessly. This is made possible by using Scalance W wireless access points and client modules from Siemens which enable the cyclical and reliable wireless transmission of Profinet IO data. This is not possible with conventional field bus systems.

## 5 Applications using Profinet

Many PROFINET applications in different industries and processes are presently in operation. The following three typical applications are examples what is possible by utilizing the advantages PROFINET offers.

### 5.1 Profinet with IRT for printing machines

MAN Roland, the world's second-largest manufacturer of printing machines and international leader for offset roller machines, relies on Profinet with IRT (Isochronous Real Time) in connection with the innovative Motion Control System Simotion and the high-performance Sinamics S120 drive systems. The data exchange between the individual machines unit and the drives takes place deterministically and synchronously via IRT.

Currently, printing machines with up to 80 synchronized axes are in use, distributed to 15 modular stations Simotion D and Sinamics S120. An expansion to more than 100 axes for even larger offset roller machines is possible at any time. An accuracy of 5  $\mu\text{m}$  over a printing length of 1000 mm is not a problem, even if the paper web shoots through the printing device at 900 m/min. The main benefits were:

- Profinet with IRT enables printing machines to achieve substantially improved flexibility and a higher level of precision. This in turn leads to a significant increase of productivity.
- The simultaneously open TCP/IP communication allows the business management level to directly access the controllers and drives, thus establishing transparency in production.

### 5.2 Profinet and wireless LAN in a logistic application

Schmolz & Bickenbach is a leading player in the German steel trade for high-quality steel foundries and steel processing. It recently upgraded its warehouse and replaced the existing festoon cabling to the mobile crane units with wireless communication. This involved the Simatic ET200S being mounted together with an IWLAN/PB PN IO link on the

movable part of the machine in order to control the position and movement of the crane.

The benefits for the customer were numerous:

- Reliable and high performance communication between the fixed Simatic S7 and the movable crane wagons with distributed peripheries ET200S with I/O and SSI transmitters.
- Thanks to wireless communication there are no cable breaks and thus less maintenance and better reliability.
- Future-oriented solution thanks to the simple extension possibilities.
- Remote access to all components via the customer's system network.

### ***5.3 Profinet and Safety Integrated in a fully automated production line***

Volkswagen AG, Europe's largest automobile manufacturer, planned the complete modernization of an existing, conventionally cabled production line for radiators. The aim was a fully-automatic, distributed plant with integrated safety – a solution that uses an Industrial Ethernet network and is characterized by the highest levels of production quality and process safety.

Therefore the new production line has a distributed configuration. Communication with the distributed I/O is handled over Profinet with integrated safety technology. The individual fail-safe modules of the ET 200S distributed I/O for block diagrams, lamella machine and control cabinet communicate with the CPU 416F-2DP central plant controller over Profinet IO using the Profisafe profile. The fail-safe PLC from the Simatic S7-400F family is connected to Profinet with a CP 433-1 Advanced communications processor. A Simatic Panel PC 670 is also connected to the PLC over Profinet for human machine interface functionality.

The achieved benefits were:

- The new production line fulfils all expectations regarding production quality and process safety.
- It is convincing in every other respect too and is characterized by significantly increased transmission performance.
- The integrated connection to the automation components used allows highly effective data archiving.
- Volkswagen expects significant cost savings from the new plant.

## **6 Summary**

Profinet offers today the advantages of rugged field buses together with the standardized IT functionalities of Ethernet according to IEEE standards and in addition a numerous expansions that are essential for the use of Ethernet technology on the plant floor.

The benefits for users are:

- Real-time communication in parallel with IT communication with high performance
- Use of innovative standardized IT mechanisms for automation like security, wireless communication, web services and integrated diagnostics
- Standard and failsafe communication on a single bus and also wirelessly
- Vertical and horizontal integration by using one network from the management to the field level

For Profinet applications more than 120 Profinet products from 30 different vendors are available in the market and the number is strongly increasing. Not least because Profinet is standardized and driven forth by the largest field bus organization Profibus & Profinet International with more than 1400 members.

To sum it up, Profinet offers the necessary solutions and technologies to become the open Industrial Ethernet standard for automation and has already proven itself in many applications.