PROFIBUS • PROFINET

PROFINET System Description

Technology and Application

PROFINET®

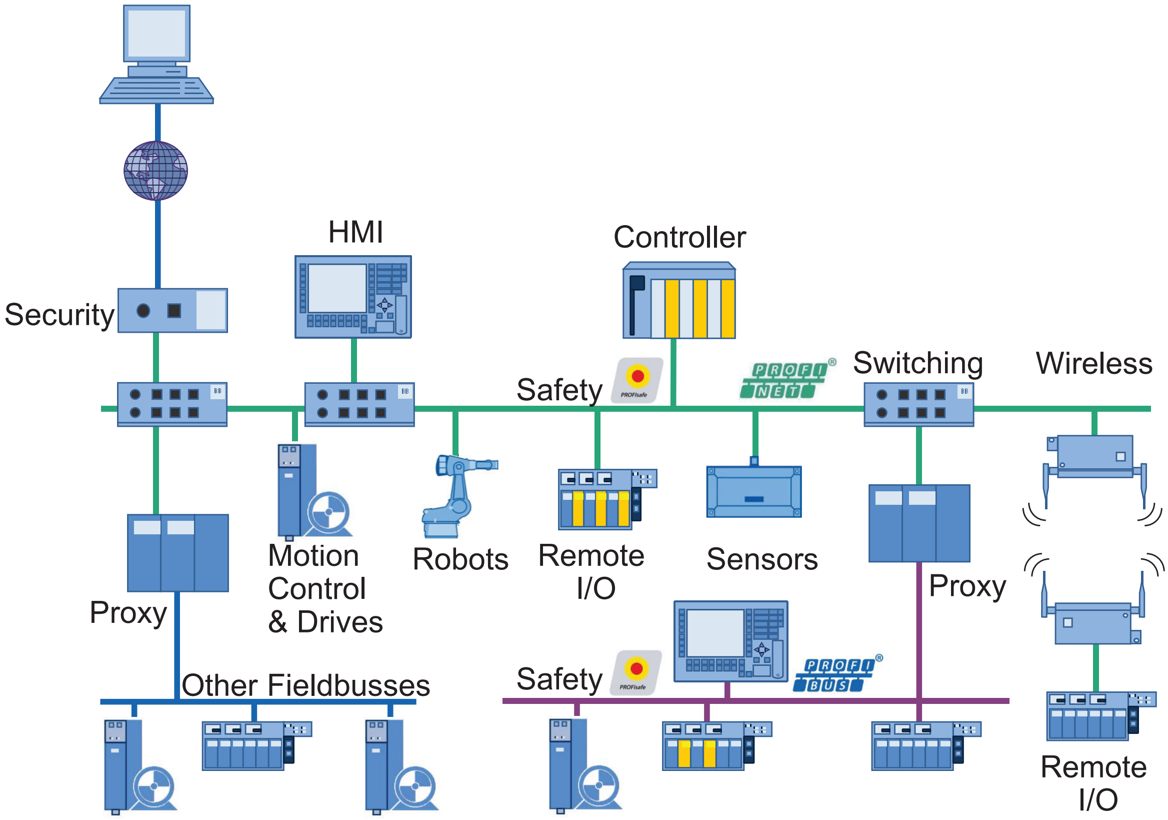


Figure 1: PROFINET satisfies all requirements of automation technology

Introduction

The ever-shorter innovation cycles for new products makes the continuous evolution of automation technology necessary. The use of fieldbus technology has been a significant development in the past few years. It has made it possible to migrate from centralized automation systems to decentralized ones. PROFIBUS, as the global market leader, has set the benchmark here for 25 years.

In today's automation technology, Ethernet and information technology (IT) are increasingly calling the shots with established standards like TCP/IP and XML. Integrating information technology into automation opens up significantly better communication options between automation systems, extensive configuration and diagnostic possibilities, and network-wide service functionality. These functions have been integral components of PROFINET from the outset.

PROFINET is the innovative open standard for Industrial Ethernet. PROFINET satisfies all requirements of automation technology (Figure 1). Whether the application involves production automation, process automation, or drives (with or without functional safety), PROFINET is the first choice across the board. As a technology that is standard in the automotive industry, widely disseminated in machine building, and well-proven in the food and packaging and logistics industries, PROFINET has found its way into all application areas. New application areas are constantly emerging, such as marine and rail applications or even day-to-day operations, for example, in a beverage shop. And now: the new PROFIenergy technology profile will improve the energy balance in production processes.

PROFINET is standardized in IEC 61158 and IEC 61784. The ongoing further development of PROFINET offers users a long-term view for the implementation of their automation tasks.

For plant and machine manufacturers, the use of PROFINET minimizes the costs for installation, engineering, and commissioning. For plant owners, PROFINET offers ease of plant expansion and high plant availability due to autonomously running plant units and low maintenance requirements.

The mandatory certification for PROFINET devices also ensures a high quality standard.

Contents

Notes on content

This document describes all essential aspects of the PROFINET technology.

Chapter 1 introduces PROFINET and provides an overview of the market position and modular design.

Chapter 2 describes the underlying models and the engineering of a PROFINET system.

Chapters 3 to 5 cover the basic functions of PROFINET communication from the perspective of conformance classes.

Chapter 6 contains a brief description of optional functions that are used in different applications.

Chapters 7 to 9 are dedicated to the integration of fieldbuses and other technologies, profiles, and specific process automation topics in PROFINET and describe the additional benefits for PROFINET systems.

Chapter 10 describes relevant aspects of PROFINET networks such as topologies, cables, connectors, web integration, and security.

Chapter 11 is directed at product managers and provides information on product implementation and certification.

Chapter 12 provides information on PROFIBUS & PROFINET International, the world's largest interest group for industrial automation.

1 PROFINET at a glance

PROFINET is the communication standard for automation of PROFIBUS & PROFINET International (PI).

The modular range of functions makes PROFINET a flexible solution for all applications and markets. With PROFINET, applications can be implemented for production and process automation, safety applications, and the entire range of drive technology up to and including isochronous motion control applications. Application profiles allow optimal use of PROFINET in all areas of automation engineering.

The following 10 reasons argue for the use of PROFINET:

1) Ease of use

For plant and machine manufacturers, the use of PROFINET minimizes the costs for installation, engineering, and commissioning.

The plant owner profits from ease of plant expansion, high plant availability, and fast and efficient automation.

2) Flexible network topology

PROFINET is 100% Ethernet compatible according to IEEE standards and adapts to circumstances in the existing plant thanks to its flexible line, ring, and star structures and copper and fiber-optic cable solutions. PROFINET saves on expensive custom solutions and enables wireless communication with WLAN and Bluetooth.

3) Integrated diagnostics

PROFINET includes intelligent diagnostic concepts for field devices and networks. Acyclic diagnostic data transmission provides important information regarding the status of devices and network, including a display of the network topology.

4) Integrated safety

The proven PROFIsafe safety technology of PROFIBUS is also available for PROFINET. The ability to use the same cable for standard and safety-related communication yields savings for devices, engineering, and setup.

5) High availability

PROFINET integrates automatically reacting redundancy solutions. The defined concepts for media and system redundancy increase the plant availability significantly.

6) Scalable real time

Communication takes place over the same cable in all applications, ranging from simple control tasks to highly demanding motion control applications. For high-precision closed-loop control tasks, deterministic and isochronous transmission of time-critical process data with a jitter of less than 1 µs is possible.

7) Expanded system structures

Besides the conventional automation structure consisting of a controller and its field devices, hierarchical structures with intelligent field devices and the shared use of field devices and input modules by multiple controllers can also be realized.

8) Everything on one cable

With its integrated, Ethernet-based communication, PROFINET satisfies a wide range of requirements, from data-intensive parameter assignment to extremely fast I/O data transmission. PROFINET thus enables automation in real-time. In addition, PROFINET provides a direct interface to the IT level.

9) Support for energy optimization

With the PROFIenergy profile integrated in PROFINET devices, the energy use in an automation system can be measured using a standardized method and controlled by selectively switching functions on and off without additional hardware.

10) Global support

Specifications and documentation are prepared within the global PROFIBUS & PROFINET International (PI) organization. Training and consulting are provided by a global network of Competence Centers. Establishment of the proven certification process ensures a high standard of quality for PROFINET products and their interoperability in plants.

1.1 Conformance classes

The scope of functions supported by PROFINET IO is clearly divided into conformance classes ("CC"). These provide a practical summary of the various minimum properties.

There are three conformance classes that build upon one another and are oriented to typical applications (Figure 2).

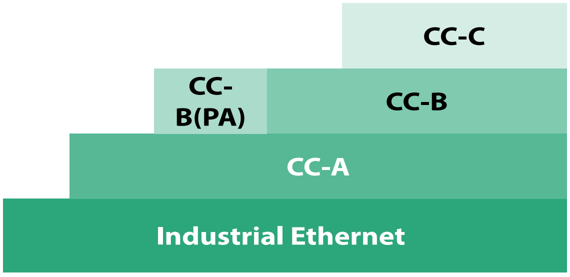


Figure 2: Structure of conformance classes

CC-A provides basic functions for PROFINET IO with RT communication. All IT services can be used without restriction. Typical applications are found, for example, in business automation. Wireless communication is specified for this class.

CC-B extends the concept to include network diagnostics via IT mechanisms as well as topology information. The system redundancy function important for process automation is contained in an extended version of CC-B named CC-B(PA).

CC-C describes the basic functions for devices with hardware-supported bandwidth reservation and synchronization (IRT communication) and is thus the basis for isochronous applications.

The conformance classes also serve as the basis for the certification and the cabling guidelines.

A detailed description of the CCs can be found in the document "The PROFINET IO Conformance Classes" [7.042].

1.2 Standardization

The PROFINET concept was defined in close collaboration with end users based on standard Ethernet according to IEEE 802 in IEC 61158 and IEC 61784. Figure 3 lists additional specifications of the functionalities in the form of different joint profiles. These form the basis for device- or application-specific profiles. Instructions are created for the necessary planning, engineering, and commissioning steps. The basics for this form the guidelines for engineering PROFINET systems.

2 Modeling and engineering

This section presents the models of a PROFINET IO system and uses an example planning process to describe the addressing options.

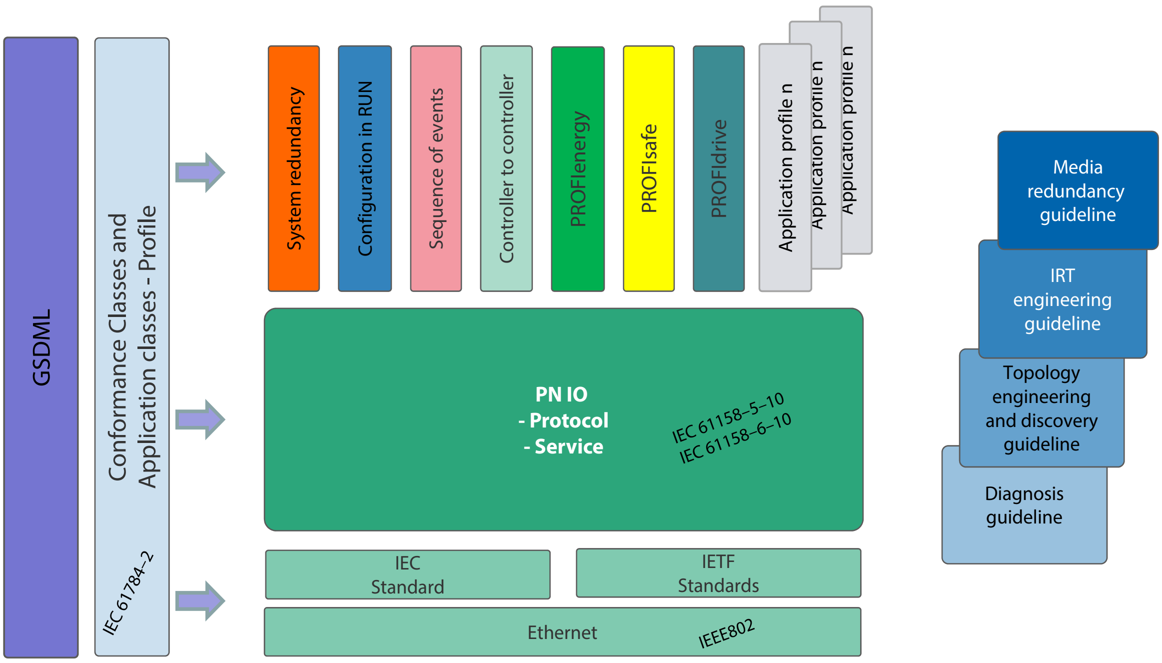


Figure 3: Structure of standards

2.1 System model of a PROFINET IO system

PROFINET IO follows the Provider/Consumer model for data exchange. Configuring a PROFINET IO system has the same look and feel as in PROFIBUS. The following device classes are defined for PROFINET IO (Figure 4):

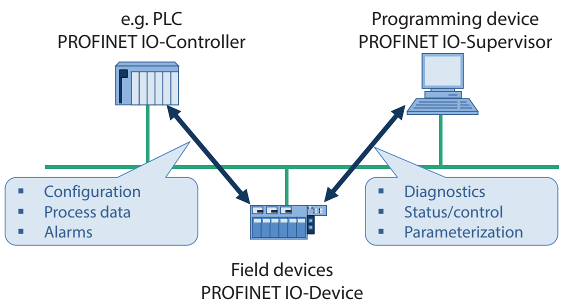


Figure 4: Communication paths for PROFINET IO

IO controller: This is typically the programmable logic controller (PLC) on which the automation program runs. This is comparable to a class 1 master in PROFIBUS. The IO controller provides output data to the configured IO devices in its role as provider and is the consumer of input data of IO devices.

IO device: An IO device is a distributed I/O field device that is connected to one or more IO controllers via PROFINET IO. It is comparable to the function of a slave in PROFIBUS. The IO device is the provider of input data and the consumer of output data.

IO Supervisor: This can be a Programming Device (PD), personal computer (PC), or human machine interface (HMI) device for commissioning or diagnostic purposes and corresponds to a class 2 master in PROFIBUS.

A plant unit contains at least one IO controller and one or more IO devices. IO supervisors are usually integrated only temporarily for commissioning or troubleshooting purposes.

2.2 Device model of an IO device

The device model describes all field devices in terms of their possible technical and functional features. It is specified by the DAP (**D**evice **A**ccess **P**oint) and the defined modules for a particular device family. A DAP is the access point for communication with the Ethernet interface and the processing program. A variety of I/O modules can be assigned to it in order to manage the actual process data traffic.

The following structures are standardized for an IO device:

- The **slot** designates the place where an I/O module is inserted in a modular I/O field device. The configured modules containing one or more subslots for data exchange are addressed on the basis of the different slots.
- Within a slot, the **subslots** form the actual interface to the process (inputs/outputs). The granularity of a subslot (bitwise, bytewise, or wordwise division of I/O data) is determined by the manufacturer. The data content of a subslot is always accompanied by status information, from which the validity of the data can be derived.

The **index** specifies the data within a slot/subslot that can be read or written acyclically via read/write services. For example, parameters can be written to a module or manufacturer-specific module data can be read out on the basis of an index. Certain indices are defined in the standard, and other indices can be freely defined by the manufacturer.

Cyclic I/O data are addressed by specifying the slot/subslot combination. These can be freely defined by the manufacturer. For acyclic data communication via read/write services, an application can specify the data to be addressed using **slot**, **subslot**, and **index** (Figure 5).

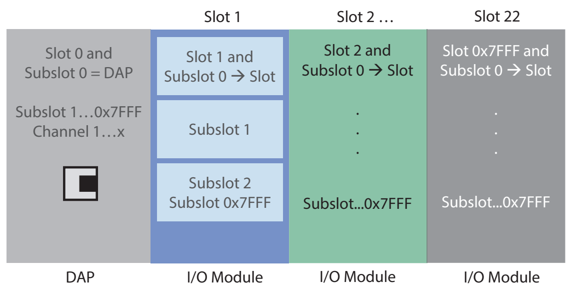


Figure 5: Addressing of I/O data in PROFINET on the basis of slots and subslots

To avoid competing accesses in the definition of user profiles (e.g., for PROFIdrive, weighing and dosing, etc.), the **API** (**A**pplication **P**rocess **I**dentifier/Instance) is defined as an additional addressing level.

PROFINET differentiates between **compact field devices**, in which the degree of expansion is already specified in the as-delivered condition and cannot be changed by the user, and **modular field devices**, in which the degree of expansion can be customized for a specific application when the system is configured.

2.3 Device descriptions

To enable system engineering, the GSD files (General Station Description) of the field devices to be configured are required. This XML-based GSDML describes the properties and functions of the PROFINET IO field devices. It contains all data relevant for engineering as well as for data exchange with the field device. The field device manufacturer must supply the XML-based GSD in accordance with the GSDML specification.

2.4 Communication relations

To establish communication between the higher-level controller and an IO device, the communication paths must be established. These are set up by the IO controller during system startup based on the configuration data received from the engineering system. This specifies the data exchange explicitly.

Every data exchange is embedded into an AR (**A**pplication **R**elation) (Figure 6). Within the AR, CRs (**C**ommunication **R**elations) specify the data explicitly. As a result, all data for the device modeling, including the general communication parameters, are downloaded to the IO device. An IO device can have multiple ARs established from different IO controllers, for example, for shared devices.

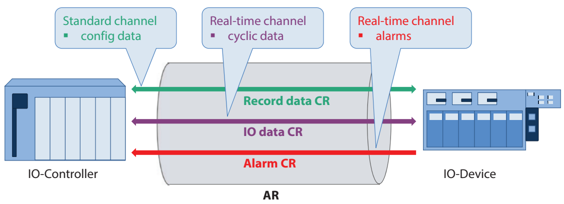


Figure 6: Application relations and communication relations

The communication channels for cyclic data exchange (IO data CR), acyclic data exchange (record data CR), and alarms (alarm CR) are set up simultaneously.

Multiple IO controllers can be used in a PROFINET system (Figure 7). If these IO controllers are to be able to access the same data in the IO devices, this must be specified when configuring (shared devices, shared inputs).

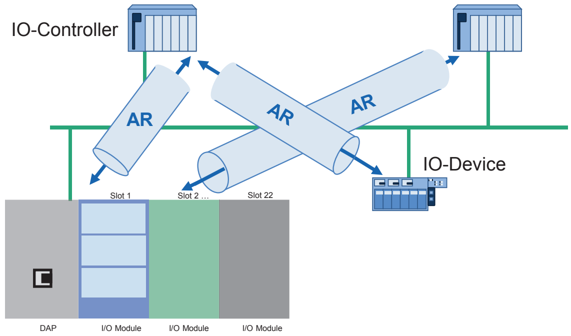


Figure 7: A field device can be accessed by multiple application relations

An IO controller can establish one AR each with multiple IO devices. Within an AR, several IOCRs on different APIs can be used for data exchange. This can be useful, for example, if more than one user profile (PROFIdrive, Encoder, etc.) is involved in the communication and different subslots are required. The specified APIs serve to differentiate the data communication for an IOCR.

2.5 Addressing

Ethernet devices always communicate using their unique MAC address (see box).

In a PROFINET IO system, each field device receives a symbolic name that uniquely identifies the field device within this IO system. This name is used for relating the IP address to the MAC address of the field device. The DCP (Discovery and basic Configuration Protocol) is used for this.

MAC address and OUI (organizationally unique identifier)

Each PROFINET device is addressed using its globally unique MAC address. This MAC address consists of a company code (bits 24 ... 47) as an OUI (Organizationally Unique Identifier) and a consecutive number (bits 0 … 23). With an OUI, up to 16,777,214 products of a single manufacturer can be identified.

Bit value 47 ... 24			Bit value 23 ... 0		
00	0E	CF	XX	XX	XX
Company code -> OUI			Consecutive number		

The OUI is available free of change from the IEEE Standards Department.

PI provides all device manufacturers that do not want to apply for their own OUI 4 K-areas of the PI OUI. This service allows companies to acquire MAC addresses directly from the PI Support Center. The OUI of PI is 00-0E-CF.

This name is assigned to the individual devices and thus to the IO device's MAC address by an engineering tool using the DCP protocol during commissioning (device initialization). Optionally, the name can also be automatically assigned by the IO controller to the IO device by means of a specified topology based on neighborhood detection.

The IP address is assigned based on the device name using the DCP protocol. Because DHCP (Dynamic Host Configuration Protocol) is in widespread use internationally, PROFINET has provided for optional address setting via DHCP or via manufacturer-specific mechanisms.

The addressing options supported by a field device are defined in the GSDML file for the respective field device.

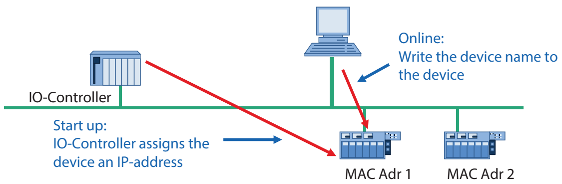


Figure 8: Name assignment

2.6 Engineering of an IO system

Each IO controller manufacturer also provides an engineering tool for configuring a PROFINET system.

During configuring, the IO controller(s) in a PROFINET IO system and the IO devices to be controlled are defined. The desired properties of the cyclic data exchange within the communication relations are specified for this.

Likewise, the assignment of modules and submodules for the slots and subslots of the IO device must be specified for each IO device based on the modules and submodules defined in the GSDML file. At the same time, more precise behavior and properties of the devices and modules can be specified using parameters. The configuring engineer configures the real system, so to speak, symbolically in the engineering tool. Figure 9 shows the relationship between GSDML definitions, the configuration, and the real plant view.

During commissioning, the configuration of the PROFINET IO system is downloaded to the IO controller. As a result, an IO controller has all the information needed for addressing the IO devices and the data exchange.

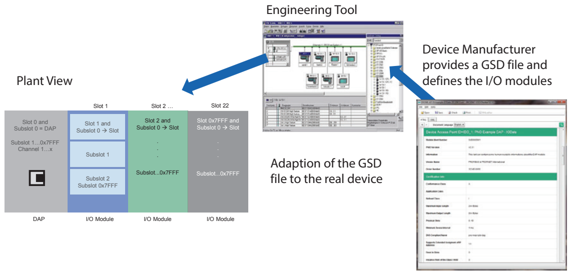


Figure 9: Assignment of definitions in the GSD file to IO devices when configuring the system

Either the devices of the PROFINET IO are initialized with the engineering tool now, or the IO controller receives the planned topology and can assign this name itself during system power-up on the basis of this information. With the assigned name, the IO controller can assign all planned IO devices their IP addresses during system power-up. An IO controller always initiates system power-up after a startup/restart based on the configuration data without any intervention by the user. During system power-up, each IO controller establishes an explicitly specified application relation (AR) with the associated communication relations (CR) for each configured IO device. This specifies the cyclic I/O data, the alarms, the exchange of acyclic read/write services, and the expected modules/submodules. After successful system power-up, the exchange of cyclic process data, alarms, and acyclic data communication can occur.

2.7 Web integration

PROFINET is based on Ethernet and supports TCP/IP. This also enables, among other things, the use of web technologies such as access to an integrated web server on the field devices. Depending on the specific device implementation, diagnostics and other information can be easily called up using a standard web browser, even across network boundaries. PROFINET itself does not define any specific content or formats. Rather, it allows an open and free implementation.

3 Basic functions

The basic functions of Conformance Class A include cyclic exchange of I/O data with real-time properties, acyclic data communication for reading and writing of demand-oriented data (parameters, diagnostics), including the identification & maintenance function (I&M) for reading out device information and a flexible alarm model for signaling device and network errors with three alarm levels (maintenance required, urgent maintenance required, and diagnostics) -> see Table 1.

Requirement	Technical function/ solution
Cyclic data exchange	PROFINET with RT communication
Acyclic parameter data/ Device identification (HW/ FW)	Read Record/ Write Record I&M0
Device/ network diagnos-tics (alarms)	Diagnostics and maintenance

Table 1: List of basic functions

3.1 Cyclic data exchange

Cyclic I/O data are transmitted via the "IO Data CR" unacknowledged as real-time data between provider and consumer in an assignable time base. The cycle time can be specified individually for connections to the individual devices and are thus adapted to the requirements of the application. Likewise, different cycle times can be selected for the input and output data, within the range of from 250 µs to 512 ms.

The connection is monitored using a time monitoring setting that is derived from a multiple of the cycle time. During data transmission in the frame, the data of a subslot are followed by a provider status. This status information is evaluated by the respective consumer of the I/O data. It can use this information to evaluate the validity of the data from the cyclic data exchange alone. In addition, the consumer statuses for the counter direction are transmitted.

The data in the message frames are followed by accompanying information that provides information about the data's validity, the redundancy, and the diagnostic status (data status, transfer status). The cycle information (cycle counter) of the provider is also specified so that its update rate can be determined easily. Failure of cyclic data to arrive is monitored by the respective consumer in the communication relation. If the configured data fail to arrive within the monitoring time, the consumer sends an error message to the application (Figure 10).

The cyclic data exchange can be realized with standard Ethernet controllers and takes place without any TCP/IP information directly on Layer 2 with Ethertype 0x8892.

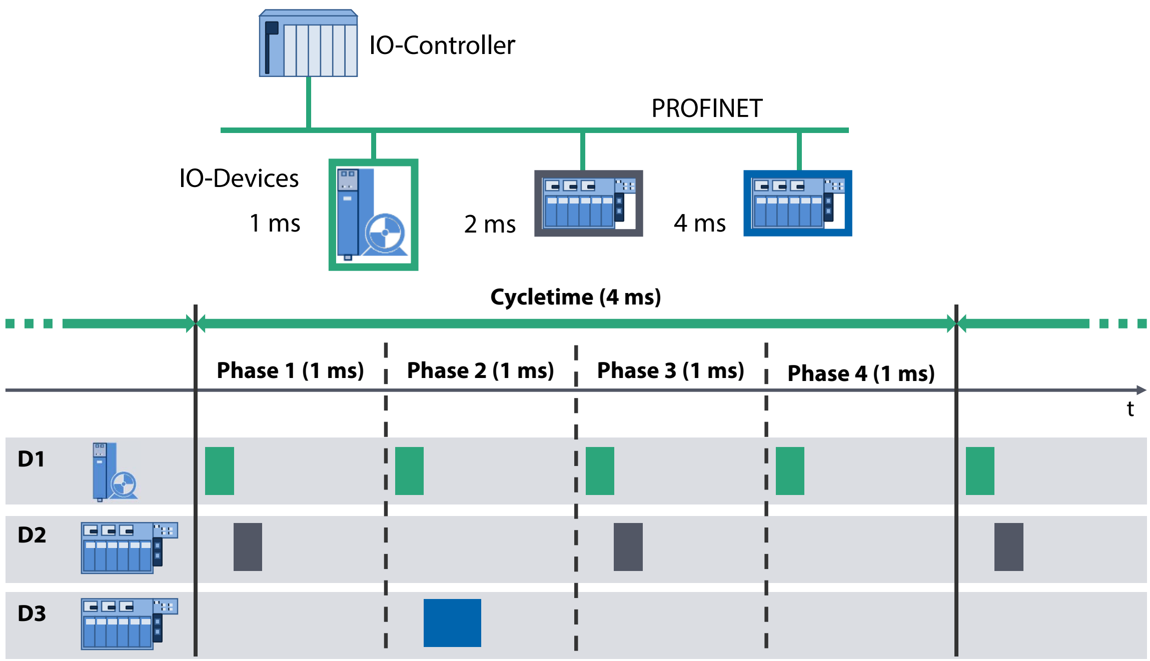


Figure 10: Real-time communication with cycle time monitoring

For the network infrastructure in the case of CC-A, commercially available switches that meet at least the following requirements can be used:

- Support of 100 Mbps full duplex with auto crossover and auto negotiation according to IEEE 802.1D.
- Prioritization of cyclic data with VLAN tag priority 6 according to IEEE 802.1Q.
- Support of neighborhood detection with Link Layer Discovery Protocol (LLDP) according to IEEE 802.1AB, i.e., these messages with the special Ethertype must not be forwarded by the switch.

3.2 Acyclic data exchange

Acyclic data exchange using the "Record Data CR" can be used for parameter assignment or configuration of IO devices or reading out status information. This is accomplished with the read/write frames using standard IT services via TCP/IP[1], in which the different data records are distinguished by their index. In addition to the data records that are freely definable by device manufacturers, the following system data records are also specially defined:

Diagnostic information about the network and the devices can be read out by the user from any device at any time.

Identification and maintenance information (I&M) for explicit identification of the devices and modules and their versions.

The ability to read out identification information from a field device is very helpful for maintenance purposes. For example, this allows inferences to be drawn regarding incorrect behavior or unsupported functionality in a field device. This information is specified in the I&M data structures.

The I&M functions are subdivided into 5 different blocks (IM0 ... IM4) and can be addressed separately using their index. Every IO device must support the IM0 function with information about hardware and firmware versions.

The I&M Specification "Identification & Maintenance Functions" [3.502] provides additional information regarding this concept.

1 In this brochure, TCP/IP is used as the term for the internet services. UDP is always used as the protocol for PROFINET IO.

3.3 Device/network diagnostics

A status-based maintenance approach is currently gaining relevance for operation and maintenance. It is based on the capability of devices and components to determine their states and to communicate them over agreed mechanisms. A system for reliable signaling of alarms and status messages by the IO devices to the IO controller was defined for PROFINET IO for this purpose.

This alarm concept covers both system-defined events (such as removal and insertion of modules) as well as signaling of faults that were detected in the utilized controller technology (e.g., defective load voltage or wire break). This is based on a state model that defines "good" and "defective" status as well as the "maintenance required" and "maintenance demanded" prewarning levels. A typical example of "maintenance required" is the loss of media redundancy. When a redundant connection is lost, "maintenance required" is signaled, but all devices can still be reached.

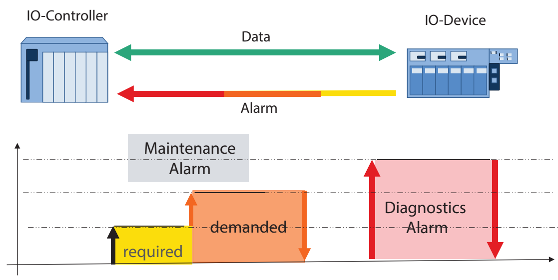


Figure 11: Diagnostic model for signaling faults with different priority

Diagnostic alarms must be used if the error or event occurs within an IO device or in conjunction with the connected components. You can signal an incoming or outgoing fault status (Figure 11).

In addition, the user can define corresponding **process alarms** for messages from the process, e.g., limit temperature exceeded. In this case, the IO device may still be operable. These process alarms can be prioritized differently from the diagnostic alarms.

The documentation "Diagnosis for PROFINET IO" [7.142] provides additional information about these concepts.

4 Network diagnostics and management

In Conformance Class B, the network diagnostics of all PROFINET devices is expanded and topology detection is introduced. This information is compiled in the Management Information Base (MIB) and the extensions to the Link Layer Discovery Protocol (LLDP-EXT MIB) and can be read out from each PROFINET device using the Simple Network Management Protocol (SNMP) or the acyclic PROFINET services for the Physical Device Object (PDEV).

4.1 Network management protocol

In existing networks, SNMP has established itself as the de facto standard for maintenance and monitoring of network components and their functions. For diagnostic purposes, SNMP can read-access network components, in order to read out statistical data pertaining to the network as well as port-specific data and information for neighborhood detection. In order to monitor PROFINET devices even with established management systems, implementation of SNMP is mandatory for devices of Conformance Class B and C.

4.2 Neighborhood detection

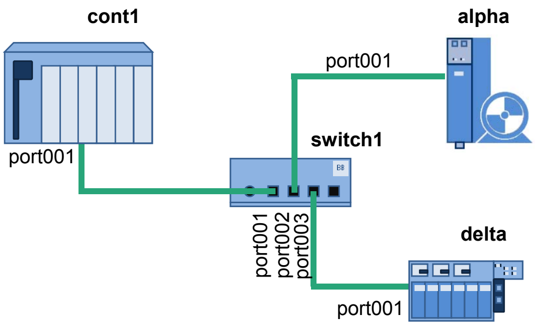


Figure 12: PROFINET field devices know their neighbors

Automation systems can be configured flexibly in a star- or tree-shaped line structure.

PROFINET field devices use the LLDP according to IEEE 802.1AB to exchange the available addressing information via each port. This allows the respective port neighbor to be explicitly identified and the physical structure of the network to be determined. In Figure 12 – as an example – the "delta" device is connected to "port003" of "switch1" via "port001".

With this neighborhood detection, a preset/actual comparison of the topology is possible and changes of the topology during operation can be recognized immediately. This is also the basis for the the automatic naming during device replacement.

4.3 Representation of the topology

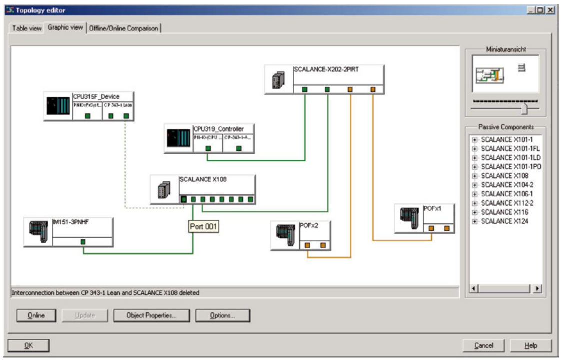
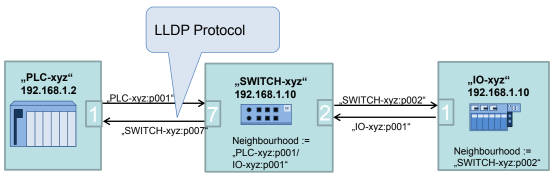


Figure 13: Plant topology

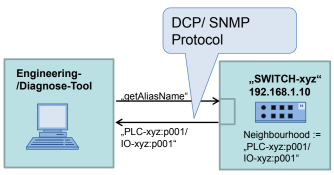
A plant owner can use a suitable tool to graphically display a plant topology and port-granular diagnostics (Figure 13). The information found during neighborhood detection is collected using the SNMP. This provides the plant owner a quick overview of the plant status.

4.4 Device replacement

If a field device fails in a known topology, it is possible to check whether the replacement device has been reconnected in the proper position. It is even possible to replace devices without the use of an engineering tool: When replaced, a device at a given position in the topology receives the same name and parameters as its predecessor (Figure 14).



Cyclic data exchange of the neighborhood port-based to the duration



Reading out the neighborhood from the engineering system

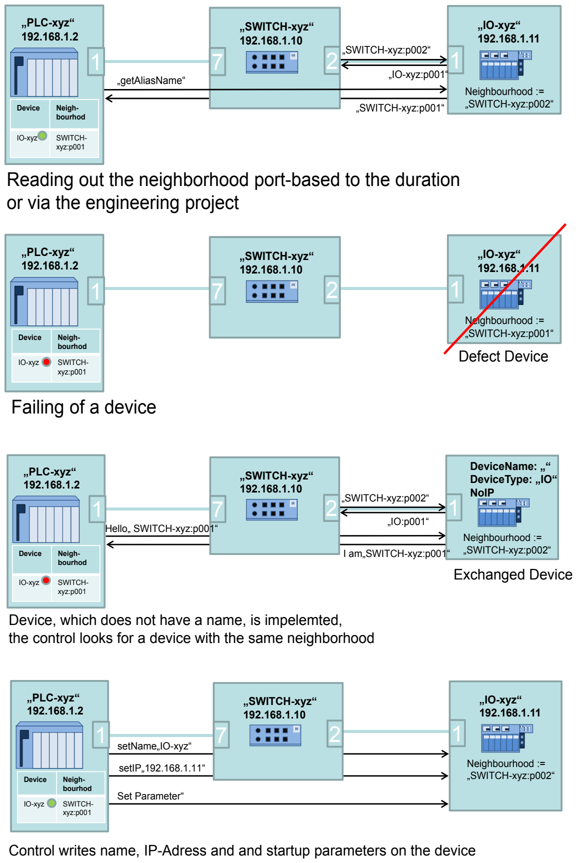


Figure 14: PROFINET IO supports convenient device replacement and displaying of plant topology

4.5 Integration of network diagnostics into the IO system diagnostics

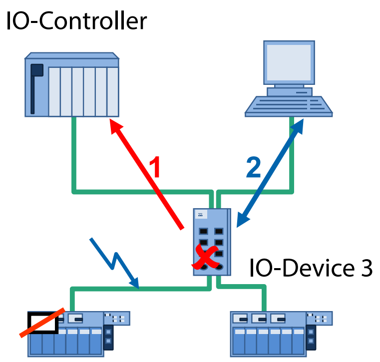


Figure 15: Integration of network diagnostics into the IO system diagnostics

For integration of the network diagnostics into the IO system diagnostics, a switch must also be used as a PROFINET IO device. Acting as an IO device, this type of switch can signal identified network errors of a lower-level Ethernet line and specific operating states to its IO controller by transmitting acyclic alarms using the "alarm CR" (number 1 in Figure 15). In this way, the network diagnostics can be integrated into the IO system diagnostics. Access from a network manager (number 2 in Figure 15) is always still possible.

5 Synchronous real-time

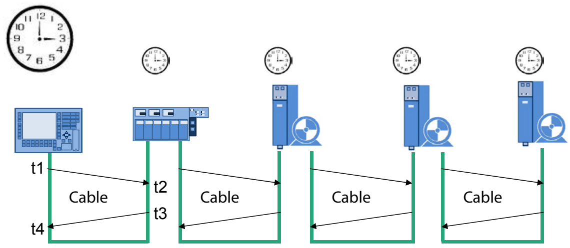


Figure 16: Synchronization of clock pulse generators within an IRT domain by the clock master

Conformance Class C includes all necessary network-wide synchronization functions for applications with the most stringent requirements for deterministic behavior. Networks based on Conformance Class C enable applications having a jitter of less than 1 microsecond. The cyclic data packets are transferred as synchronized packets on a reserved bandwidth. All other packets, such as packets for diagnostics or TCP/IP, share the rest of the Ethernet bandwidth.

By default, the minimum update rate is defined at 250 µs in Conformance Class C. For maximum control performance, this can be reduced to as low as 31.25 µs, depending on the hardware used. In order to expand data volumes when cycle times are set at less than 250 µs, a message frame optimization method (dynamic frame packing, DFP) is incorporated. With this method, nodes that are wired together in a line structure are addressed with one frame. In addition, for cycle times less than 250 µs, the TCP/IP communication is fragmented and transmitted in smaller packets.

These concepts and the planning procedure are explained in detail in the document "PROFINET IRT Engineering" [7.172]. The most important elements are summarized in the following.

5.1 Synchronized communication

In order for the bus cycles to run synchronously (at the same time) with a maximum deviation of 1 µs, all devices involved in the synchronous communication must have a common clock. A clock

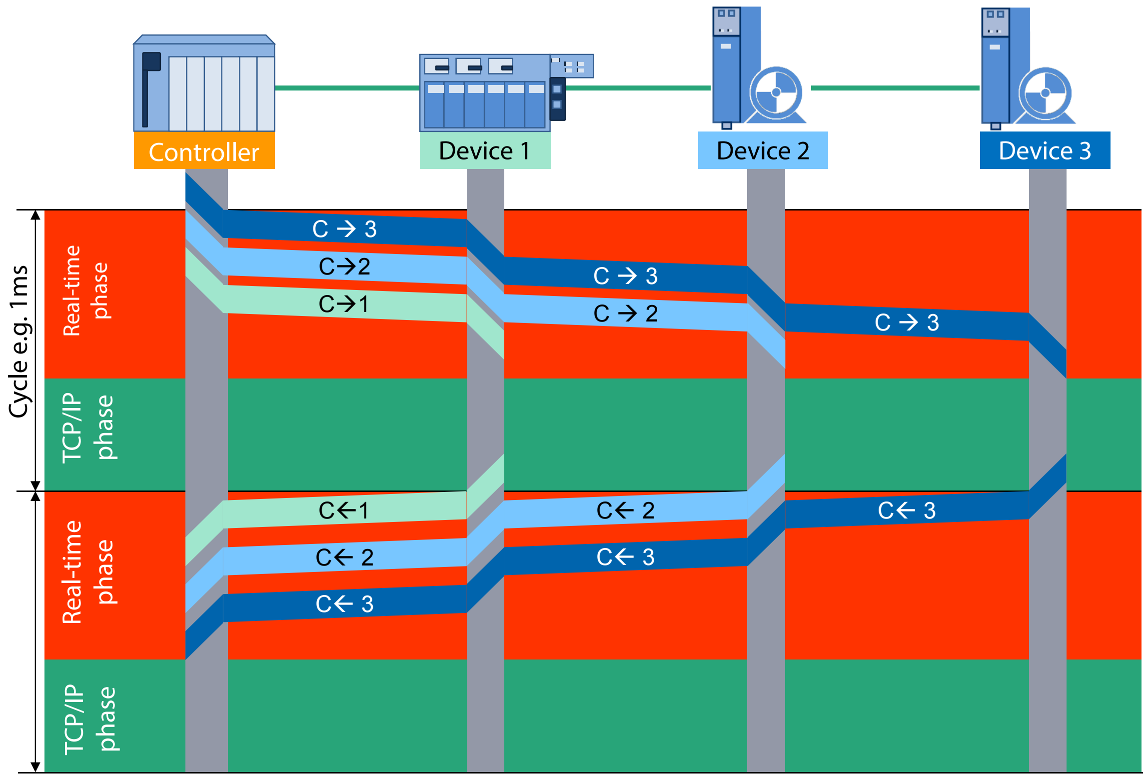


Figure 17: IRT communication divides the bus cycle into a reserved interval (red) and an open interval (green)

master uses synchronization frames to synchronize all local clock pulse generators of devices within a clock system (IRT domain) to the same clock (Figure 16). For this purpose, all of the devices involved in this type of clock system must be connected directly to one another, without crossing through any non-synchronized devices. Multiple independent clock systems can be defined in one network.

To achieve the desired accuracy for the synchronization and synchronous operation, the runtime on each connecting cable must be measured with defined Ethernet frames and figured into the synchronization. Special hardware precautions must be taken for implementing this clock synchronization.

The bus cycle is divided into different intervals for synchronized communication (Figure 17). First, the synchronous data are transmitted in the red interval. This red interval is protected from delays caused by other data and allows a high level of determinism. In the subsequent open green interval, all other data are transmitted according to IEEE 802 and the specified priorities. The division of the individual intervals can vary. If forwarding of the data before the start of the next reserved interval is not assured, these frames are stored temporarily and sent in the next green interval.

5.2 Mixed operation

A combination of synchronous and asynchronous communication within an automation system is possible, if certain preconditions are met. Figure 18 shows a mixed operation. In this example, a synchronizable switch has been integrated in the field device for devices 1 to 3. The other two devices are connected via a standard Ethernet port and thus communicate asynchronously. The switch ensures that this communication occurs only during the green interval.

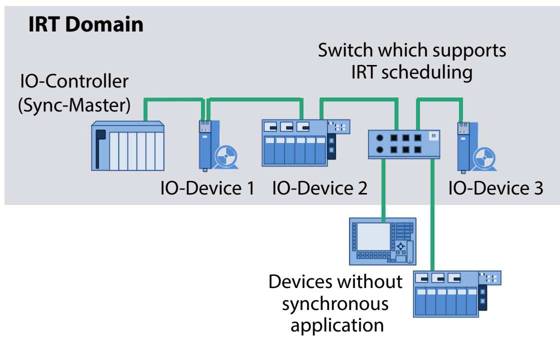


Figure 18: Mixed operation of synchronized and unsynchronized applications

5.3 Optimized IRT mode

When the time ratios are subject to stringent requirements, the efficiency of the topology-oriented synchronized communication can be optimized using dynamic frame packing (DFP) (Figure 19).

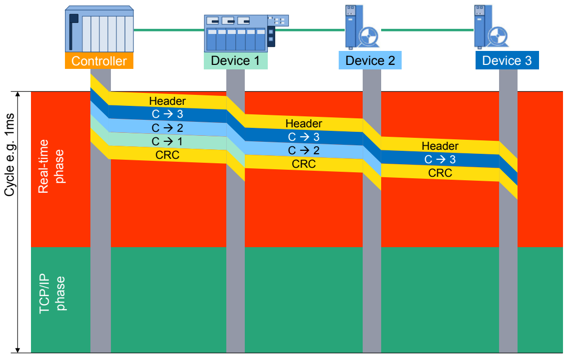


Figure 19: Packing of individual frames into a group frame

For a line structure, the synchronous data of several devices are optionally combined into one Ethernet frame. The individual cyclic real-time data can be dynamically extracted for each node. Because the data from the field devices to the controller are also strictly synchronized, these data can be assembled by the switch in a single Ethernet frame. Ideally, only one frame is then transmitted for all operated field devices in the red interval. This frame is disassembled or assembled in the corresponding switch, if required. The sum of these frames is shorter because the header only has to be transferred once.

DFP is optional for systems with stringent requirements. The functionalities of the other intervals are retained, i.e., a mixed operation is also possible here. To achieve short bus cycles of up to 31.25 µs, however, the green interval must also be sharply reduced. To accomplish this, the standard Ethernet frames for the application are disassembled transparently into smaller fragments, transmitted in small pieces, and reassembled.

6 Optional functions

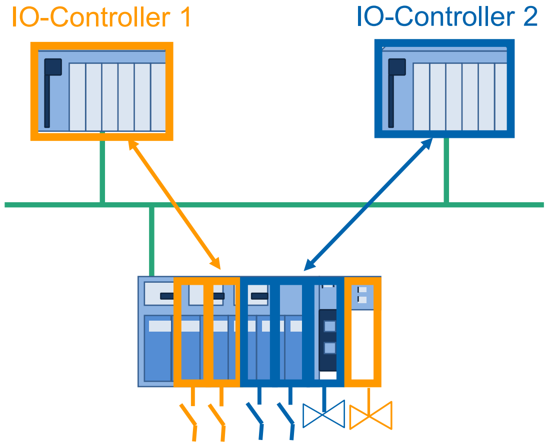


Figure 20: Shared device: Access by multiple controllers to different modules in a device

PROFINET also offers a variety of optional functions that are not included in devices by default by way of conformance classes (Table 2). If additional functions are to be used, this must be checked on a case-by-case basis using the device properties (data sheet, manuals, GSDML file).

Requirement	**Technical function/ solution**
Multiple access to inputs by various controllers	Shared Input
Distribution of device functions to various controllers	Shared device
Extended device identification	Identification & Maintenance IM1-4
Automatic parameter assignment of devices using parameter sets	Individual param-eter server
Configuration changes during operation	Configuration in Run (CiR)
Time stamping of I/O data	Time sync
Fast restart after voltage re-covery	Fast start up (FSU)
Higher availability through ring redundancy	MRP/MRPD
Call of a device-specific engineering tool	Tool Calling Inter-face (TCI)

Table 2: List of possible optional functions

6.1 Multiple access to field devices

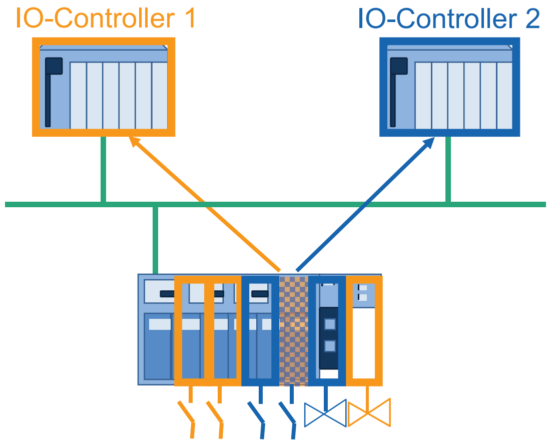


Figure 21: Shared input: Multiple controllers read the same inputs on a device

The innovative starting point for **shared devices** is the parallel and independent access of two different controllers to the same device (Figure 20). In the case of a shared device, the user configures a fixed assignment of the various I/O modules used in a device to a selected controller. One possible application of a shared device is in fail-safe applications in which a fail-safe CPU controls the safe portion of the device and a standard controller controls the standard I/O within the same station. In the safety scenario, the F-CPU uses the fail-safe portion to safely switch off the supply voltage of the outputs.

In the case of a shared input, there is parallel access to the same input by two different controllers (Figure 21). Thus, an input signal that must be processed in two different controllers of a system does not have to be wired twice or transferred via CPU-CPU communication.

6.2 Extended device identification

Further information for standardized and simplified identification and maintenance is defined in additional I&M data records. The I&M1-4 data contain plant-specific information, such as installation location and date, and are created during configuring and written to the device (Table 3).

IM1	TAG_FUNCTION TAG_LOCATION	Plant designation Location designation
IM2	INSTALLATION_ DATE	Installation date
IM3	DESCRIPTOR	Comments
IM4	SIGNATURE	Signature

Table 3: Extended device identification

6.3 Individual parameter server

The individual parameter server functionality is available for backing up and reloading of other optional individual parameters of a field device (Figure 22).

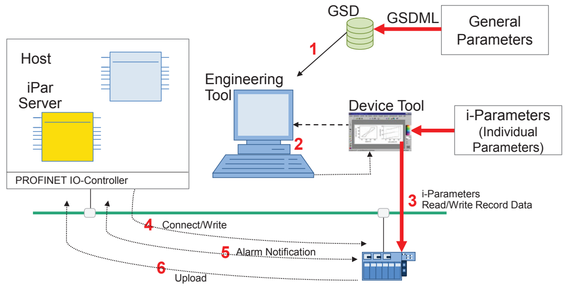


Figure 22: A parameter server can be used to automatically reload backed-up data during device replacement

The basic parameter assignment of a field device is carried out using the parameters defined in the GSDML file for the field device. A GSDML file contains module parameters for I/O modules, among other things. These are stored as static parameters and can be loaded from the IO controller to an IO device during system power-up. For many field devices it is either impossible or inappropriate to initialize parameters using the GSDML approach due to the quantities, the user guidance, or the security requirements involved. Such data for specific devices and technologies are referred to as individual parameters (iPar). Often, they can be specified only during commissioning. If such a field device fails or is replaced, these parameters must also be reloaded to the new field device. An additional tool is not needed for this. The individual parameter server provides plant owners a convenient and uniform solution for this.

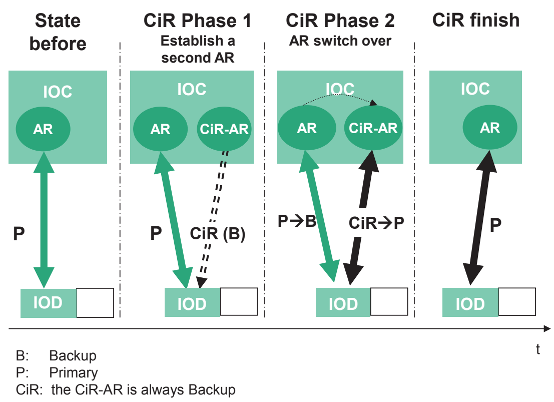


Figure 23: Configuration changes without plant interruption thanks to redundant connection

6.4 Configuration in Run

Like in the case of redundancy, uninterrupted plant operation also plays a critical role in process automation in the case of configuration changes to devices and the network or insertion, removal or replacement of devices or individual modules (Figure 23).

All of these "Configuration in Run" measures (CiR) are carried out in PROFINET without any interruption and without adversely affecting network communication. This ensures that plant repairs, modifications, or expansions can be performed without a plant shutdown in continuous production processes, as well.

This concept is described in detail in the document "Configure in Run" [7.112].

6.5 Time stamping

In large plants, the ability to assign alarms and status messages to a sequence of events is often required. For this purpose, an optional time stamping of these messages is possible in PROFINET IO. In order to time stamp data and alarms, the relevant field devices must have the same time of day. To accomplish this, a master clock and the time synchronization protocol are used to set the clocks to the same time.

6.6 Fast start up

Fast **S**tart **U**p (FSU) defines an optimized system power-up in which data exchange begins much faster starting with the second power-up since many parameters are already stored in the field devices. This optional path can be used in parallel with standard power-up (which is still used after "Power On" in the case of the first power-up or "Reset"). It must be possible to store communication parameters retentively for this.

6.7 Higher availability

Chaining of multiport switches allowed the star topology widely used in Ethernet to be effectively combined with a line structure. This combination is especially well-suited for control cabinet connections, i.e., line connection between control cabinets and star connection to process-level field devices. If the connection between two field devices in a line is interrupted, the field devices situated after the interruption are no longer accessible. If increased availability is required, provision must be made for redundant communication paths when planning the system, and field devices/switches that support the redundancy concept of PROFINET must be used.

A redundant communication path can be formed efficiently by closing a line to form a ring. In the event of an error, the connection to all nodes is ensured via the alternative connection. This achieves a tolerance for one fault. Organizational measures must be taken to ensure that this fault is eliminated before a second once occurs.

PROFINET has two mechanisms for setting up ring-shaped media redundancy, depending on the requirements:

Media Redundancy Protocol (MRP)

The MRP protocol according to IEC 62439 describes PROFINET redundancy with a typical reconfiguration time of < 200 ms for communication paths with TCP/IP and RT frames after a fault. Error-free operation of an automation system involves

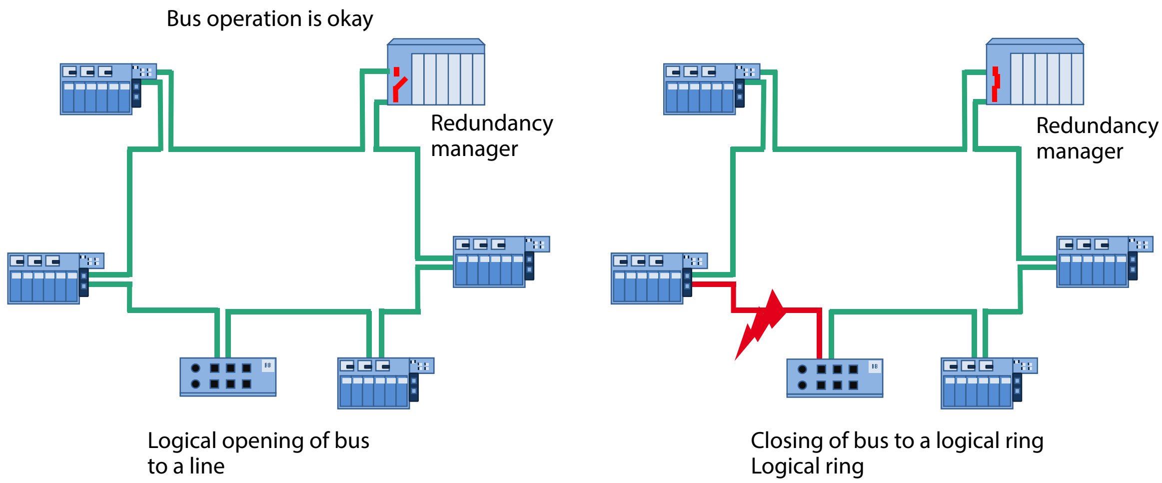


Figure 24: Preventing circulation of frames by logical separation of the bus

a media redundancy manager (MRM) and several media redundancy clients (MRC) arranged in a ring, as shown in Figure 24.

The task of a media redundancy manager (MRM) is to check the functional capability of the configured ring structure. This is done by sending out cyclic test frames. As long as it receives all of its test frames again, the ring structure is intact. Through this behavior, a MRM converts a ring structure into a line structure and thus prevents the circulating of frames.

A media redundancy client is a switch that acts only as a "passer" of frames and generally does not assume an active role. In order for it to be integrated in a ring, it must have at least two switch ports.

Media redundancy for planned duplication (MRPD)

IEC 61158 describes the redundancy concept MRPD (**M**edia **R**edundancy for **P**lanned **D**uplication) for topology-optimized IRT communication, which enables smooth switchover from one communication path to another in the event of a fault. During system power-up, the IO controller loads the data of the communication paths for both communication channels (directions) in a communication ring to the individual nodes. Thus, it is immaterial which node fails because the loaded "schedule" for both paths is available in the field devices and is monitored and adhered to without exception. Loading of the "schedule" alone is sufficient to exclude frames from circulating in this variant: the recipient rejects the second frame.

6.8 Call of an engineering tool

Complex devices, such as drives, laser scanners, etc., often have their own tools (engineering software, tools) for making settings for these IO devices. With the tool calling interface (TCI) these device tools can now be called directly from the plant engineering system for parameter assignment and diagnostics. In this case, the communication of PROFINET is used directly for the settings in the field device. In addition to the directly integrated device tools, other technologies such as EDDL and FDT can also be used with appropriate adaption software. TCI consists of the following main components:

Call interface: The user can call up various field device user interfaces (Device Tools = DT) from the engineering system (ES). Functions are primarily initiated in the device tools through user interaction.

Communication interface: The TCI communication server allows the field device user interface (DT) to communicate with the field device.

7 Integration of fieldbus systems

PROFINET specifies a model for integrating existing PROFIBUS systems and other fieldbus systems such as INTERBUS and DeviceNet. This means that any combination of fieldbus and PROFINET-based subsystems can be configured. Thus a smooth technology transition is possible from fieldbus-based systems to PROFINET. The following requirements are taken into consideration here:

- The plant owner would like to be able to integrate existing installations into a newly installed PROFINET system easily.
- Plant and machine manufacturers would like the ability to use their proven and familiar devices without any modifications for PROFINET automation projects, as well.
- Device manufacturers would like the ability to integrate their existing field devices into PROFINET systems without the need for costly modifications.

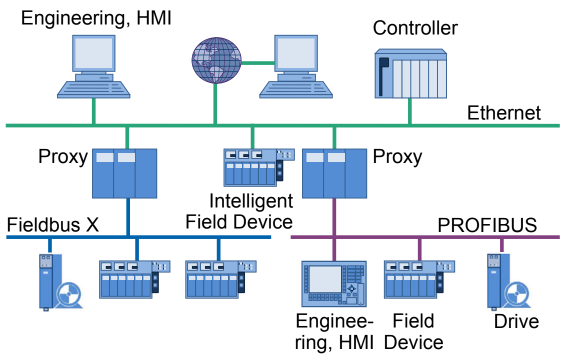


Figure 25: Integration of fieldbus systems is easy with PROFINET

Fieldbus solutions can be easily and seamlessly integrated into a PROFINET system using proxies and gateways. The proxy acts as a representative of the fieldbus devices on the Ethernet. It integrates the nodes connected to a lower-level fieldbus system into the higher-level PROFINET system. As a result, the advantages of fieldbuses, such as high dynamic response, pinpoint diagnostics, and automatic system configuration without settings on devices, can be utilized in the PROFINET world, as well. These advantages simplify planning through the use of known sequences. Likewise, commissioning and operation are made easier through the comprehensive diagnostics properties of the fieldbus system. The devices and software tools are also supported in the usual manner and integrated into the handling of the PROFINET system.

8 Application Profiles

By default, PROFINET transfers the specified data transparently. It is up to the user to interpret the sent or received data in the user program of a PC-based solution or programmable logic controller.

Application profiles are joint specifications concerning certain properties, performance characteristics, and behavior of devices and systems that are developed by manufacturers and users. The term "profile" can apply to a few specifications for a particular device class or a comprehensive set of specifications for applications in a particular industry sector.

In general, two groups of application profiles are distinguished:

General application profiles that can be used for different applications (examples of these include the PROFIsafe and PROFIenergy profiles).

Specific application profiles that were developed in each case only for a specific type of application, such as PROFIdrive or devices for process automation.

These application profiles are specified by PI based on market demand and are available on the PI website.

8.1 PROFIsafe

The PROFIsafe designation refers to a protocol defined in IEC 61784-3-3 for the implementation of functional safety (fail-safe) and recognized by IFA and TÜV. PROFIsafe can be used with PROFIBUS and PROFINET alike.

The use of PROFIsafe enables elements of a fail-safe controller to be transferred directly to the process control on the same network. The need for additional wiring is eliminated.

An introduction to PROFIsafe can be found in "PROFIsafe System Description" [4.352], and the specification is available under [3.192].

8.2 PROFIdrive

The PROFIdrive designation refers to the specification of a standardized drive interface for PROFIBUS and PROFINET. This application-oriented profile, which has been standardized in IEC 61800-7, contains standard definitions (syntax and semantics) for communication between drives and automation systems, thus assuring vendor neutrality, interoperability, and investment protection.

The PROFIdrive application profile provides the foundation for almost every drive task in the field of industrial automation engineering. It defines the device behavior and the procedure for accessing drive data of electric drives and also optimally integrates the additional PROFIsafe and PROFIenergy profiles.

An introduction to PROFIdrive can be found in "PROFIdrive System Description" [4.322], and the specification is available under [3.172].

8.3 PROFIenergy

The high cost of energy and compliance with legal obligations are compelling industry to engage in energy conservation. The recent trends toward the use of efficient drives and optimized production processes have been accompanied by significant energy savings. However, in today's plants and production units, it is common for numerous energy consuming loads to continue running during pauses. PROFIenergy addresses this situation.

PROFIenergy enables an active and effective energy management. By purposefully switching off unneeded consumers, energy demand and, thus, energy costs can be significantly reduced. In doing so, the power consumption of automation components such as robots and laser cutting machines or other subsystems used in production industries is controlled using PROFIenergy commands. PROFINET nodes in which PROFIenergy functionality is implemented can use the commands to react flexibly to idle times. In this way, individual devices or unneeded portions of a machine can be shut down during short pauses, while a whole plant can be shut down in an orderly manner during long pauses. In addition, using PROFIenergy the plant production can be sized to the energy consumption (readback of energy values) and optimized.

The specification of PROFIenergy is available under [3.802] .

9 PROFINET for Process Automation

Compared with production automation, process automation has a few special characteristics that contribute to defining the use of automation to a large extent. For one thing, plants can have a service life of many decades. This gives rise to a requirement, on the part of plant owners, for older and newer technologies to coexist in such a way that they are functionally compatible. For another thing, requirements for reliability of process systems, particularly in continuous processes, are often considerably greater. As a result of these two factors, investment decisions regarding new technologies are significantly more conservative in process automation than in production automation.

For the optimal use of PROFINET in all sectors of process automation, PI has created a requirements catalog in collaboration with users. In this manner, it is ensured that owners of plants having an existing future-proof system based on PROFIBUS can change to PROFINET at any time. The goal is to be able to replace the current use of PROFIBUS DP with PROFINET.

The requirements mainly include the functions for cyclic and acyclic data exchange, integration of fieldbuses (PROFIBUS PA, HART, and FF), integration and parameter assignment of devices including Configuration in Run, diagnostics and maintenance, redundancy, and time stamping. These requirements are summarized in the CC-B (PA).

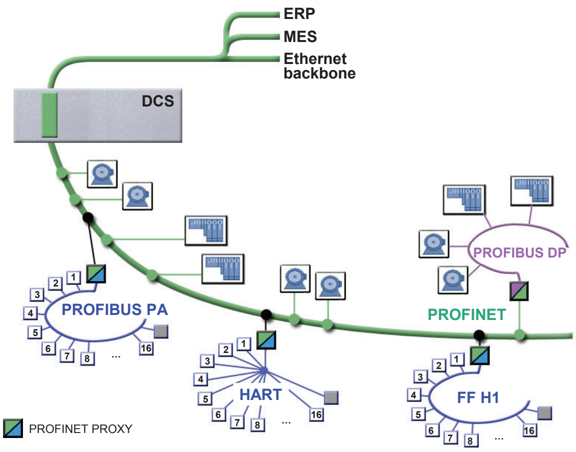


Figure 26: Example architecture for use of PROFINET in process automation

The energy-limited bus feed of devices in hazardous areas on Ethernet has not been formulated as a requirement, since PROFIBUS PA already provides an ideal, proven solution for this. In addition, proven, field-tested Ethernet solutions currently do not exist for this.

10 Network installation

PROFINET is based on a 100 Mbps, full-duplex Ethernet network. Faster communication is also possible on all transmission sections (e.g., between switches, PC systems, or camera systems).

PROFINET defines not only the functionality but also the passive infrastructure components (cabling, connectors). Communication may take place via copper or fiber-optic cables. In a Conformance Class A (CC-A) network, communication is also allowed over wireless transmission systems (Bluetooth, WLAN) (Table 4). The cabling guideline defines 2-pair cabling according to IEC 61784-5-3 for all conformance classes. For transmission systems with Gigabit cabling requirements, 4-pair cabling may also be used.

For a CC-A network, complete networking with active and passive components according to ISO/IEC-24702 is allowed, taking into consideration the CC-A cabling guide. Likewise, active infrastructure components (e.g., switches) according to IEEE 801.x can be used if they support the VLAN tag with prioritization.

Easy-to-understand and systematically structured instructions have been prepared to enable problem-free planning, installation, and commissioning of PROFINET IO [8.062], [8.072], [8.082]. These are available to all interested parties on the PI website. These manuals should be consulted for further information.

Network cabling and infrastructure components	Solution	Conformance class
Passive network components (connectors, cables)	RJ45, M12	A, B, C
Copper and fiber-optic transmission systems	TX, FX, LX,	A, B, C
Wireless connections	WLAN, Bluetooth	A
IT switch	With VLAN tag according to IEEE 802.x	A
Switch with device function	PROFINET with RT	B
Switch with device function and bandwidth reservation	PROFINET with IRT	C

Table 4: Network installation for different conformance classes

10.1 Network configuration

PROFINET IO field devices are always connected as network components via switches. Switches integrated in the field device are typically used for this (with 2 ports assigned). PROFINET-suitable switches must support "autonegotiation" (negotiating of transmission parameters) and "autocrossover" (autonomous crossing of send and receive lines). As a result, communication can be established autonomously, and fabrication of the transmission cable is uniform: only 1:1 wired cables can be used.

PROFINET supports the following topologies for Ethernet communication:

Line topology, which primarily connects terminals with integrated switches in the field (Figure 27).

Star topology, which requires a central switch located preferably in the control cabinet.

Ring topology, in which a line is closed to form a ring in order to achieve media redundancy.

Tree topology, in which the topologies indicated above are combined.

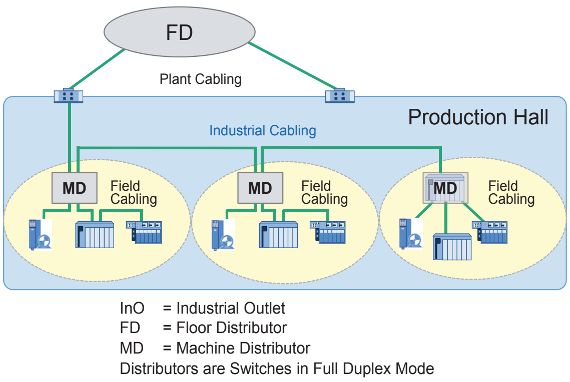


Figure 27: Ethernet networks in industrial environments usually have line topology

10.2 Cables for PROFINET

The maximum segment length for **electrical data transmission** with copper cables between two nodes (field devices or switches) is 100 m. The copper cables are designed uniformly in AWG 22. The Installation Guide defines different cable types that have been optimally adapted to the respective industrial boundary conditions. Sufficient system reserves allow an industrial-strength installation with no limitation on transmission distance.

The PROFINET cables conform to the cable types used in industry:

- **PROFINET Type A:** Standard permanently-routed cable, no movement after installation
- **PROFINET Type B:** Standard flexible cable, occasional movement or vibration
- **PROFINET Type C:** Special applications: for example, highly-flexible, constant movement (tow chain or torsion)

Fiber-optic data transmission with fiber-optic cable has several advantages over copper:

- Electrical isolation when equipotential bonding is difficult to achieve
- Immunity against extreme EMC requirements
- Transmission over distances up to several kilometers without repeater.

For short distances, the use of 1-mm polymer optic fibers (POF) is supported, whose handling conforms optimally to industrial applications.

10.3 Plug connectors

PROFINET has divided the environmental conditions into just two classes. This eliminates unnecessary complexity and meets the specific requirements of automation. The PROFINET environmental classes for the automation application have been subdivided into one class inside protected environments, such as in a control cabinet, and one class outside of control cabinets for applications located directly in the field (Figure 28).

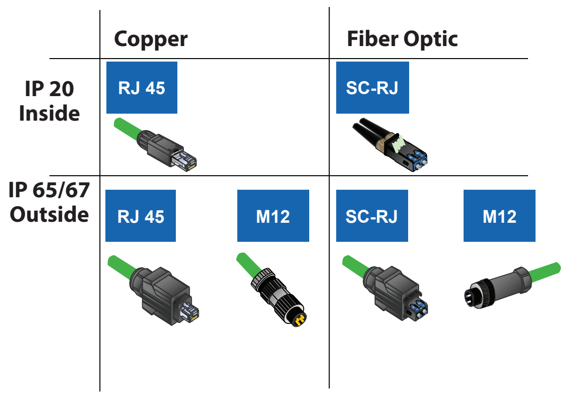


Figure 28: PROFINET offers a range of industrial plug connectors

The selection of suitable PROFINET plug connectors conforms to the application. If the emphasis is on a universal network that is to be office-compatible, electrical data transmission is via RJ 45, which is prescribed universally for inside environmental conditions. For the outside environment, a push-pull plug connector has been developed that is also fitted with the RJ 45 connector for electrical data transmission. The M12 connector is also specified for PROFINET.

For **optical data transmission** with polymer optic fibers, the SCRJ plug connector, which is based on the SC plug connector, is specified. The SCRJ is used both in the inside environment as well as in connection with the push-pull housing in the outside environment. An optical plug connector is available for the M12 family and can be used for PROFINET and the 1-mm polymer optic fiber transmission (POF).

At the same time, the plug connectors are also specified for the **power supply**, depending on the topology and the supply voltage. Besides the push-pull plug connector, a 7/8" plug connector, a hybrid plug connector, or an M12 plug connector can also be used. The difference between these connectors lies in their connectible cross sections and thus their maximum amperages.

10.4 Security

For networking within a larger production facility or over the Internet, PROFINET relies on a phased security concept. It recommends a security concept optimized for the specific application case, with one or more upstream security zones. On the one hand, this unburdens the PROFINET devices, and on the other hand, it allows the security concept to be optimized to changing security requirements in a consistent automation engineering solution.

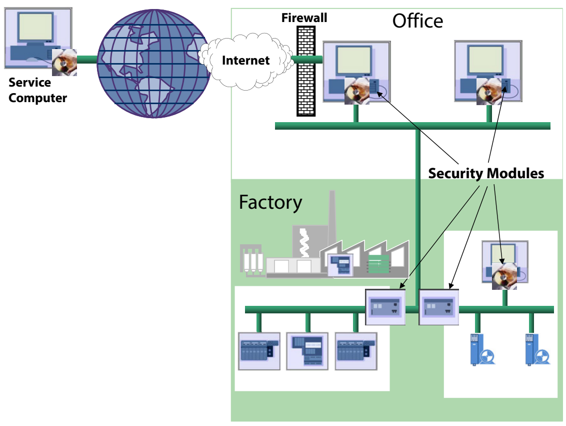


Figure 29: Access to machines and systems using secure connections

The security concept provides for protection of both individual devices as well as whole networks from unauthorized access. In addition, there are security modules that will allow networks to be segmented and, thus, also separated and protected from the safety standpoint. Only explicitly identified and authorized messages reach the devices located inside such segments from the outside (Figure 29). Additional information regarding security can be found in the "PROFINET Security Guideline" [7.002].

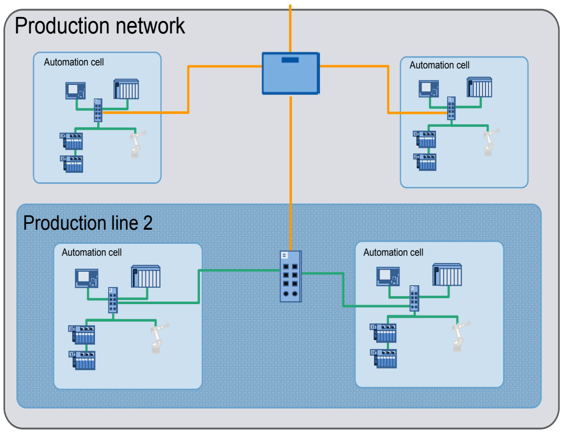


Figure 30: Segmentation of automation network

11 PROFINET Technology and Certification

PROFINET is standardized in IEC 61158. It is on this basis that devices in industrial plants can be networked together and exchange data without errors. Appropriate quality assurance measures are required to ensure interoperability in automation systems. For this reason, PI has established a certification process for PROFINET devices in which certificates are issued based on test reports of accredited test labs. While PI certification of a field device is not yet required for PROFIBUS, the guidelines for PROFINET have changed such that any field device bearing the name PROFINET must be certified. Experience with PROFIBUS over the last 20 years has shown that a very high quality standard is needed to protect automation systems as well as plant owners and field device manufacturers.

11.1 Technology support

Device manufacturers that want to develop an interface for PROFINET IO have the choice of developing field devices based on existing Ethernet controllers. Alternatively, member companies of PI offer many options for efficient implementation of a PROFINET IO interface.

To make development of a PROFINET IO interface easier for device manufacturers, the PI Competence Centers and member companies offer PROFINET IO basic technology (enabling technology). Consulting services and special developer training programs are also available. Before starting a PROFINET IO development project, device manufacturers should always perform an analysis to determine whether internal development of a PROFINET IO device is cost-effective or whether the use of a ready-made communication module will satisfy their requirements.

More detailed information on this topic can be found in the brochure, "PROFINET Technology – The Easy Way to PROFINET" [4.272], which can be downloaded from the PI website.

11.2 Tools for product development

Free software tools are made available to device manufacturers for development and checking their products. A GSDML editor assists the manufacturer when creating the GSDML file for its product. With the GSDML editor, these files can be created correctly and checked.

Likewise, a PROFINET tester software is available for testing PROFINET functionalities. The current version supports testing of all conformance classes as well as IRT functions. The additional security tester allows testing for reliable function of a field device, including under load conditions. This tester is used by the test labs for certification testing as well.

11.3 Certification test

A certification test is a standardized test procedure that is performed by specialists whose knowledge is kept up to date at all times and who are able to interpret the relevant standards unequivocally. The test scope is described in binding terms in a test specification for each laboratory. The tests are implemented as so-called black box tests in which the tester is the first real user.

The defined test cases developed for use during a certification test are exclusively real world-oriented and are based on industrial automation. This affords all users the maximum possible assurance for use of the field device in a system. In very many cases, the dynamic behavior of a system can be simulated in the test lab.

PI awards the certificate to the manufacturer based on the test report from an accredited test lab. A product must have this certificate in order to use the PROFINET designation. For the plant manufacturer/owner, the use of certified products means time savings during commissioning and stable behavior during the entire service life. They therefore require certificates for the field devices used, in accordance with the utilized conformance class.

12 PROFIBUS & PROFINET International (PI)

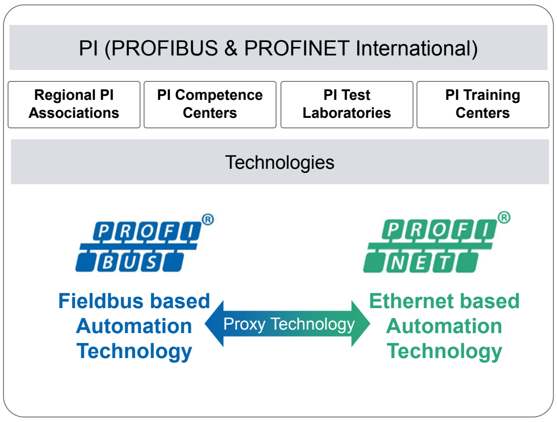


Figure 31: PROFIBUS & PROFINET International (PI)

Open technologies require a company-independent institution as a working platform for activities related to support, further development, and marketing. This was achieved for the PROFIBUS and PROFINET technologies by the founding of the PROFIBUS Nutzerorganisation e.V. (PNO) in 1989 as a non-profit interest group of manufacturers, users, and institutions. The PNO is a member of PI (PROFIBUS & PROFINET International), an umbrella group which was founded in 1995. With its 27 regional associations (RPA) and approximately 1,400 members, PI is represented on every continent and is the world's largest interest group for the industrial communications field (Figure 31).

12.1 Responsibilities of PI

The key tasks performed by PI are:

- Maintenance and ongoing development of PROFIBUS and PROFINET.
- Promoting the worldwide use of PROFIBUS and PROFINET
- Protection of investment for users and manufacturers by influencing the development of standards
- Representation of the interests of members to standards bodies and unions

- Worldwide technical support of companies through PI Competence Centers (PICC).
- Quality assurance through product certification based on conformity tests at PI test labs (PITL).
- Establishment of a worldwide training standard through PI Training Centers (PITC).

Technology development

PI has handed responsibility for technology development over to PNO Germany. The Advisory Board of PNO Germany oversees the development activities. Technology development takes place in the context of more than 40 working groups with input from approximately 1,000 experts mostly from engineering departments of member companies.

Technical support

PI supports more than 50 accredited PICCs worldwide. These facilities provide users and manufacturers with all manner of advice and support. As institutions of PI, they are independent service providers and adhere to the mutually agreed rules. The PICCs are regularly checked for their suitability as part of an individually tailored accreditation process. A list of the current Competence Center locations can be found on the web site.

Certification

PI supports 10 accredited PITLs worldwide for the certification of products with a PROFIBUS/ PROFINET interface. As institutions of the PI, they are independent service providers and adhere to the mutually agreed rules. The testing services provided by the PITLs are regularly audited in accordance with a strict accreditation process to ensure that they meet the necessary quality requirements. A list of the current Test Lab locations can be found on the web site.

Training

Approximately 30 PI Training Centers have been set up with the aim of establishing a global training standard for engineers and technicians. The accreditation of the Training Centers and the experts that are based there ensures the quality of the training and, thus, the quality of the engineering and installation services for PROFIBUS and PROFINET. A list of the current Training Center locations can be found on the web site.

Internet

Current information on PI and the PROFIBUS and PROFINET technologies is available on the PI website www.profibus.com and www.profinet.com. This includes, for example, an online product guide, a glossary, a variety of web-based training content, and the download area containing specifications, profiles, installation guidelines, and other documents.

12.2 Literature from PI

PI makes additional documents and specifications available on its website www.profinet.com. To quickly find these documents, simply enter the order number in the Search box at the top left.

For plant planners and owners, the following manuals are available:

[8.062] PROFINET Design Guideline

[8.072] PROFINET Installation Guideline

[8.082] PROFINET Commissioning Guideline

Additional system descriptions and guidelines have been published by PI:

[4.322] PROFIdrive System Description, Technology and Application

[4.352] PROFIsafe System Description, Technology and Application

[4.272] PROFINET Technology – The Easy Way to PROFINET

[7.002] PROFINET Security Guideline

[7.042] The PROFINET IO Conformance Classes, Guideline for PROFINET IO

[7.112] Configure in Run, Common Profile for PROFINET IO

[7.122] System Redundancy – Common Profile for PROFINET IO

[7.142] Diagnosis for PROFINET IO, Guideline for PROFINET

[7.162] Fiber Optic Diagnosis, Guideline for PROFINET

[7.172] PROFINET IRT Engineering, Guideline for PROFINET

[7.182] Topology Engineering and Discovery, Guideline for PROFINET IO

These specifications of profiles have a direct relationship with PROFINET:

[3.172] PROFIBUS and PROFINET, Profile Drive Technology, PROFIdrive Profile

[3.192] PROFIsafe Specification – Profile for Safety Technology on PROFIBUS DP and PROFINET IO

[3.502] Profile Guidelines Part 1: Identification and Maintenance Functions

[3.802] Common Application Profile PROFIenergy, Technical Specification for PROFINET

Place for notes

PROFINET System Description
Technology and Application

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Worldwide support with PI!

For additional information and contact information, go to: www.profibus.com/pi-organization/

Regional PI Association (RPA)	Regional PI Associations (RPAs) represent PI around the world and are your personal local contacts. They are responsible for local marketing activities for purposes of spreading PROFIBUS, PROFINET, and IO-Link, which include among others trade fair appearances, seminars, workshops, and press conferences, as well as public relations activities.
PI Competence Center (PICC)	The PI Competence Centers (PICCs) collaborate closely with the RPAs and are your first point of contact when you have technical questions. The PICCs are available to assist you in the development of PROFIBUS or PROFINET devices and the commissioning of systems, and they provide user support and training.
PI Training Center (PITC)	PI Training Centers (PITCs) support users and developers in gaining experience with the PROFIBUS and PROFINET technologies and their possible uses. Individuals who successfully complete the final exam of the Certified Installer or Engineer course receive a certificate from PI.
PI Test Lab (PITL)	PI Test Labs (PITLs) are authorized by PI to conduct certification tests for PROFIBUS and PROFINET. You receive a certificate from PI for your product once it passes the test. The certification program plays a major role in the sustainable quality assurance of products and thus assures that the systems in use exhibit a high level of trouble-free operation and availability.

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