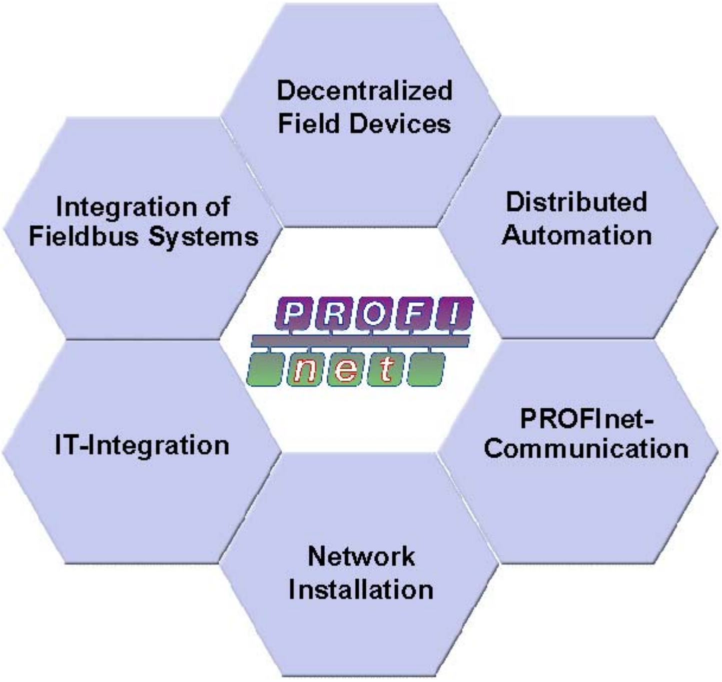
PROFInet

Technology and Application

System Description

Open Solutions for the World of Automation



Introduction

Due to ever shorter innovation cycles for new products, the field of automation is in a constant state of change. In this context, the implementation of fieldbus technology in recent years represents a major innovation. It enables the change-over from central to distributed automation systems. As the world market leader in this field, PROFIBUS has now been setting standards for 15 years.

Events in modern automation are increasingly determined by information technology (IT) with established standards, such as TCP/IP and XML. The integration of information technology into modern automation has produced a considerable improvement in communication options between automation systems, as well as extensive configuration and diagnostic options and remote service functions. From the outset, these functions have been an integral part of PROFInet.

PROFInet is the innovative and open standard for industrial automation based on Industrial Ethernet. PROFInet supports easy implementation of solutions in factory automation and Motion Control.

As well as utilization of IT technology, investment protection also plays a key role in the PROFInet concept. PROFInet enables integration of existing fieldbus systems, such as PROFIBUS, without the need to modify existing devices. This protects existing investments of plant operators/ owners, machine/plant manufacturers and device manufacturers alike.

PROFInet meets all automation demands. PROFInet also incorporates years of know-how from the PROFIBUS and Industrial Ethernet world. The use of open standards, the simple handling and the integration of existing devices determined the definition of PROFInet from the outset. PROFInet is now integrated in the IEC 61158.

The continuous further development of PROFInet offers users a long-term perspective for realization of their automation projects.

For plant/mechanical engineers, the use of PROFInet minimizes the cost of installation, engineering and commissioning. For plant operators/owners, PROFInet enables simple expansion of plants and offers high plant availability due to autonomous subsections.

Furthermore, the method of certification established by PROFIBUS International ensures a high quality standard of PROFInet products.

The document gives you a detailed explanation of how the tried and tested PROFIBUS technology and the established IT standards have been implemented in PROFInet.

Contents

1. An overview of PROFInet

PROFInet is the innovative automation standard of PROFIBUS International for the implementation of an integrated and consistent automation solution based on Industrial Ethernet. PROFInet supports the integration of simple distributed field devices and time-critical applications in Ethernet communication, as well as the integration of component-based distributed automation systems.

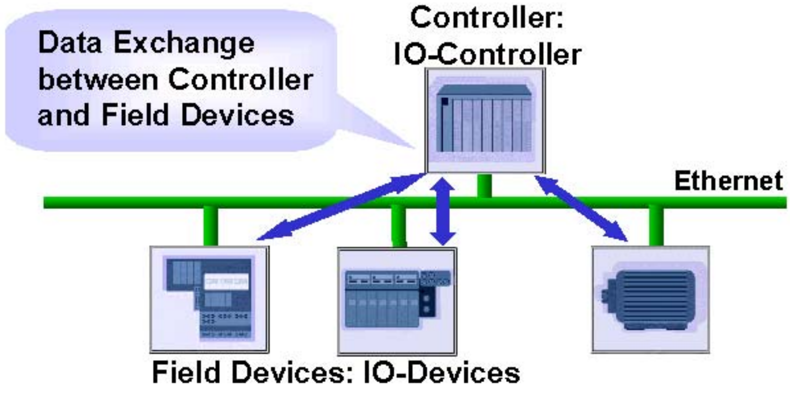


Figure 1: The architecture of PROFInet IO is similar to that of PROFIBUS DP

1.1 Distributed field devices (PROFInet IO)

Distributed field devices are integrated through PROFInet IO. This uses the usual IO view of PROFIBUS DP, whereby the IO data of field devices are cyclically transmitted to the process image of the PLC.

PROFInet IO describes a device model that is based on the key features of PROFIBUS DP and comprises slots and channels. The characteristics of the field devices are described via a GSD (General Station Description) on an XML basis.

The engineering of PROFInet IO will be familiar to all system integrators of PROFIBUS DP, whereby the distributed field devices are assigned a controller during configuration.

PROFInet on the basis of a component model is described via a PCD (PROFInet Component Description). It is XML-based and can be created using either the Component Generator of a manufacturer-specific configuration tool or the PROFInet Component Editor.

The engineering of distributed automation plants differentiates between the programming of the control logic of the individual technological modules (manufacturer-specific configuring tools) and the technological configuration of the overall plant, which determines the communication relationships between the technological modules.

1.3 Communication

PROFInet uses different performance levels for communication purposes:

- PROFInet transfers non-time-critical data, such as parameters, configuration data and connection information over the standard channel via TCP/UDP and IP. This meets the requirements for the connection of automation levels to other networks (MES, ERP).
- For transmission of time-critical process data within the production plant, it uses the real-time channel Soft Real Time (SRT). It is implemented as software based on available controllers.

1.2 Distributed automation (components model)

The PROFInet component model is effective in distributed automation plants. It is ideal for intelligent field and automation devices with programmable functionality.

The component model describes the autonomous modules of machines or plants as technological modules. A distributed automation system developed on the basis of technological modules simplifies the modular design of plants and machines, thus considerably simplifying the re-use of plant and machine parts. This significantly reduces engineering costs.

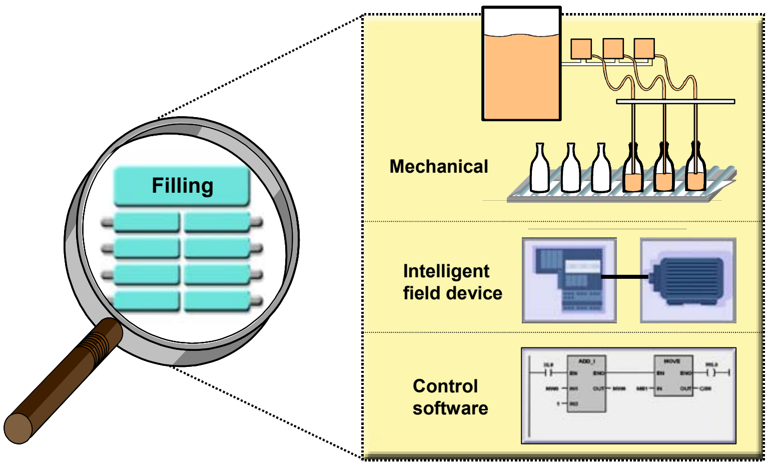


Figure 2: Mechanics, electrics/electronics and software are combined to create technological modules

- For time synchronized applications, Isochronous Real Time (IRT) communication is available which allows jitter accuracy of 1 µs at a clock rate of 1 ms.

1.4 Network installation

PROFInet network installations are based on the specific requirements for Ethernet networks in an industrial environment. They provide the device manufacturer with clear specifications for device interfaces and the cabling required. The "PROFInet Installation Guideline" provides plant manufacturers/ operators with simple rules for the installation of Ethernet networks.

1.5 IT integration

Network management covers all functions for the administration of PROFInet devices in Ethernet networks. This includes device and network configurations and network diagnostics.

For Web Integration, PROFInet uses Ethernet-based technologies and enables access to PROFInet components by means of standard technologies from the Internet.

To obtain an open link to other system worlds, PROFInet uses OPC DA and DX.

1.6 Fieldbus integration

A key aspect for PROFInet is the seamless transition from existing fieldbus solutions, such as PROFIBUS DP, to Ethernet-based PROFInet. As far as the device/plant/ machine manufacturer and the end user are concerned, this is an important protection of existing investments.

PROFInet offers two methods of integrating fieldbus systems:

- *Integration of fieldbus devices via so-called proxies:* In this case the proxy represents the lower-level field devices on the Ethernet. Using the proxy concept, PROFInet offers a fully transparent transition from existing to newly installed devices.
- *Integration of complete fieldbus applications:* A fieldbus segment represents a self-contained component. The representative of this component is the PROFInet device, which at a lower level operates a fieldbus such as PROFIBUS DP. As such, the complete functionality of a lower-level fieldbus is stored in the proxy in the form of a component. This is then available on the Ethernet.

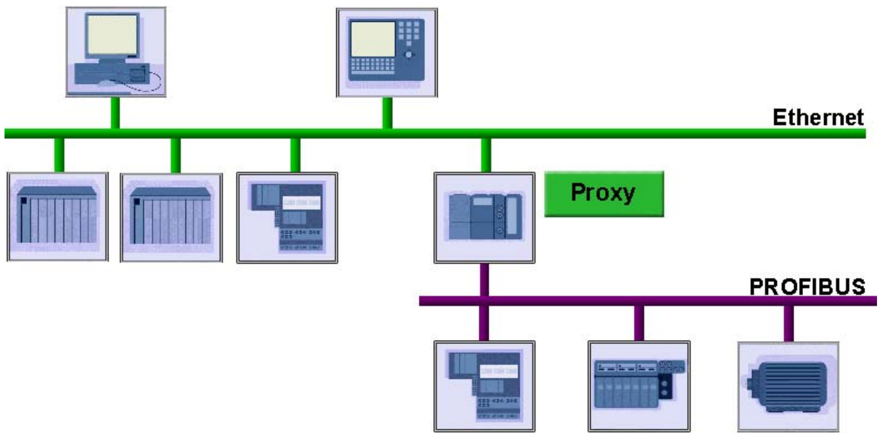


Figure 3: PROFIBUS systems can be integrated in PROFInet using a proxy

2. Decentralized field devices

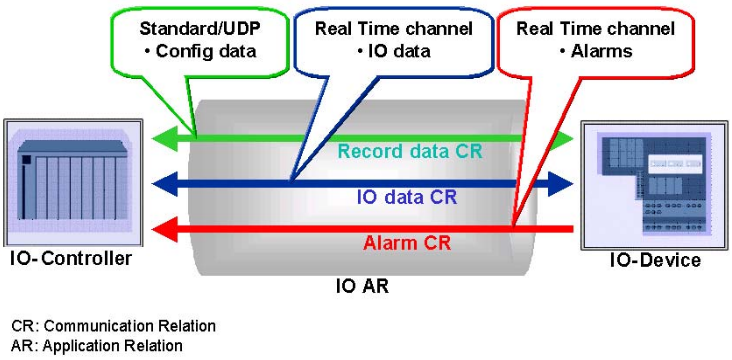


Figure 4: The consumer/provider model is used for communication relationships in PROFInet IO

With PROFInet IO, integration of the decentralized field devices is implemented directly on the Ethernet. For this purpose, the master-slave access method, familiar from PROFIBUS DP, is converted to a provider-consumer model. From a communication point of view, all devices on the Ethernet are treated democratically. However, the configuration process is used to determine assignment of the field devices to a central controller, whereby the familiar PROFIBUS user interface is transferred to the PROFInet peripherals: the distributed peripheral reads in the peripheral signals and transfers them to the controller. The controller then processes the signals and transfers the outputs on to the distributed peripheral.

2.1 Scope of functions

PROFInet IO distinguishes between three device types: IO-Controller, IO-Device and IO-Supervisor:

- IO-Controller: Controller on which the automation program is run
- IO-Device: remotely assigned field device, which is assigned to an IO-Controller
- IO-Supervisor: programming device/PC with commissioning and diagnostics functions

Data can be transferred between IO-Controller and IO-Devices over the following channels:

- cyclic IO data over the real-time channel
- event-controlled alarms over the real-time channel
- parameter assignment, configuration and reading of diagnostic information over standard channel on the basis of UDP/IP.

To start, application relations (IO-AR) are established between the IO-Controller and the IO-Device on the UDP/IP channel. It contains several communication relationships (CRs) through which the configuration and IO data as well as interrupts are transferred. The IO-Controller transfers the parameterization and configuration data of the assigned IO-Devices over the "Record Data CR". Cyclic transmission of the IO data is implemented over the "IO CR"; the acyclic events are transmitted over the "alarm CR" to the IO controller and acknowledged. PROFInet alarm types are unplug, plug in, diagnostics, status, and update alarm. Manufacturer-specific alarms are also possible. High or low priority can be assigned to alarms.

2.2 Device models

A uniform device model is specified for the PROFInet IO-Device, which enables the configuration of modular and compact field devices. This is orientated to the characteristics of PROFIBUS DP and, for a modular field device, comprises slots for the insertion of modules. These modules are fitted with IO channels which serve the input and output of process signals.

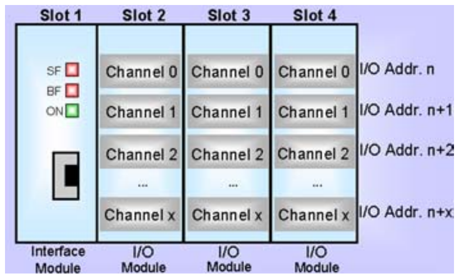


Figure 6: The PROFInet IO device model is similar to the PROFIBUS DP device model

This modular design ensures that the existing PROFIBUS DP range of IO modules can also be incorporated in PROFInet without requiring any modification. This ensures investment protection for device manufacturers and operators/ owners (e.g., spare parts inventory).

Each IO-Device is assigned a globally unique device ID within the framework of PROFInet IO. This 32-bit Device-Ident-Number is broken down into a 16-bit manufacturer ID and a 16-bit device ID.

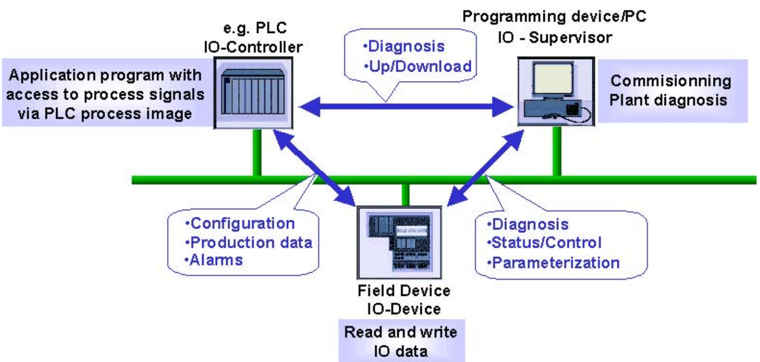


Figure 5: Functional scope of PROFInet IO

The manufacturer identification is assigned by PI. The device ID can be individually assigned by manufacturers to suit their own product development.

2.3 Device description

A PROFInet IO-Device is integrated in the configuration tool in the same manner as a PROFIBUS DP device, i.e. via a device description. The characteristics of an IO device are described in a GSD (General Station Description), which contains all the information that the field device requires:

- Properties of the IO-Device (e.g., communication parameters)
- Plug-in modules (quantity and type)
- Configuration data of the individual modules (e.g., analog input modules)
- Parameters of the modules (e.g., 4...20mA)
- Error texts for diagnostics (e.g., wire break, short-circuit)

The GSD is XML-based. The fact that XML is an open, widespread and accepted standard for describing data means availability of powerful tools and derived properties:

- Creation and validation through implementation of standard tools
- Integration of foreign languages
- Hierarchical structuring

The structure of the GSD corresponds to ISO 15745, comprising a device-specific part with the configuration data and parameters of the modules as well as a communication-specific part with transmission speed and connection system.

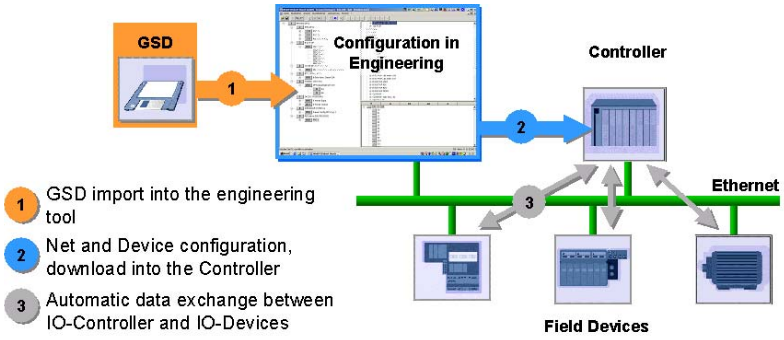


Figure 7: From configuration to data exchange

2.4 Configuration and data exchange

The description files of the IO-Devices are imported to the configuration tool. The individual IO channels of the field devices are assigned peripheral addresses. The peripheral input addresses contain the received process values. The application program evaluates these and processes them. The application program creates the peripheral output values and transmits them to the process. In addition, the parameterization of the individual IO modules or channels is implemented in the configuration tool, e.g., 4...20mA current range of an analog channel.

On completion of configuration, the configuration data are downloaded to the IO-Controller. The IO-Devices are automatically parameterized and configured by the IO-Controller and then enter the cyclic data exchange.

2.5 Diagnostics

PROFInet IO supports a multi-layer diagnostics concept that enables efficient error location and elimination.

When an error occurs, the defective IO-Device generates a diagnostics alarm at the IO-Controller. This alarm calls up a corresponding program routine in the PLC program that enables a reaction to the fault. If a device or module fault means that it needs to be completely replaced, the IO-Controller automatically carries out the parameterization and configuration of the new device or module.

The diagnostic information is hierarchically structured:

- Slot number (module)
- Channel number
- Channel type (input/output)
- Coded cause of failure (e.g., wire break, short-circuit)
- Additional manufacturer-specific information

When an error occurs at a channel, the defective IO device generates a diagnostics alarm at the IO controller. This alarm invokes the call-up of a corresponding error routine in the control program. Once the error routine has been implemented, the IO-Controller acknowledges the error at the IO-Device. This acknowledgement mechanism ensures the sequential processing of the error in the IO-Controller.

3. Distributed automation

Developments in the field of automation have seen the creation of modular plant or machines. This structuring gave impetus to the further development of automation to distributed automation systems. PROFInet also has a solution for this purpose, which is to break devices down into technological modules.

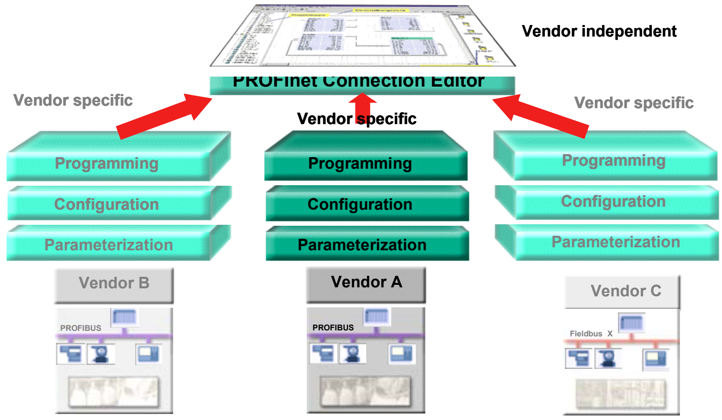


Figure 8: PROFInet is based on a multi-vendor engineering concept

3.1 Technological modules

In the goods manufacturing process, the function of an automatic plant or machine is performed through the defined interaction of mechanical, electrical/electronics and control logic/software. Working on this principle, PROFInet defines the mechanical, electrical/electronics and control logic/software parts in functional terms to form a *technological module (*see Figure 2).

3.2 PROFInet components

The representative of a technological module in the plant engineering is the so-called PROFInet component. Each PROFInet component has an interface, which contains the technological variables that are exchanged with other components.

The PROFInet components are modeled with standardized COM technology. COM is a further development of the object orientation concept and enables the development of applications based on prefabricated components. A feature of the components is that they form autonomous units and can form relations with other components.

The components can be flexibly combined like building blocks and are easy to re-use, regardless of their internal implementation. The mechanisms for accessing the component interfaces are uniformly defined in PROFInet.

Granularity of the technological modules

When specifying the granularity of modules it is important to consider their re-usability in various systems in the light of costs and availability. The objective is to combine individual components as flexibly as possible using the modular principle in order to create a complete system. On the one hand, too fine a granularity produces a technological view of the installation that is more complex. This results in higher engineering costs. On the other hand, an all-too coarse of granularity reduces the degree of re-usability. This results in higher costs for implementation.

The software components are created by the manufacturer of the machine or plant. The *component design* has had a major impact on the lowering of engineering and hardware costs and on the time-related characteristics of the automation system. During definition of a component, the granularity may stretch from an individual device through to a complete machine with a multitude of devices.

3.3 PROFInet Engineering

A vendor-independent *engineering concept* was created for the user-friendly configuration of a PROFInet system. On the one hand the engineering concept can be used to develop configuration tools able to use multi-vendor components, on the other hand it permits the vendor- or user-specific expansion of functions.

The engineering model distinguishes between programming the control logic of the individual technological modules and the technological configuration of the complete system. A system-wide application is created in three stages.

Creating the components

The components are created as an image of the technological modules by the builder of the plant or installation. Programming and configuration of the devices is implemented as before with the respective manufacturer-specific tools. This

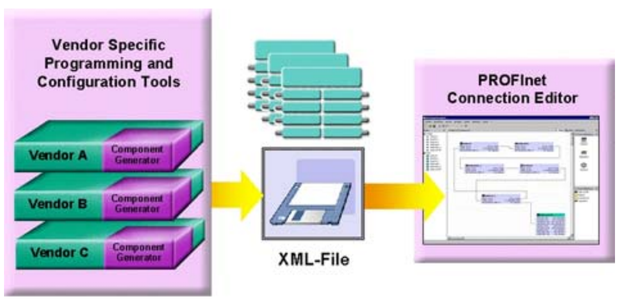


Figure 9: Component generation is standardized with PROFInet

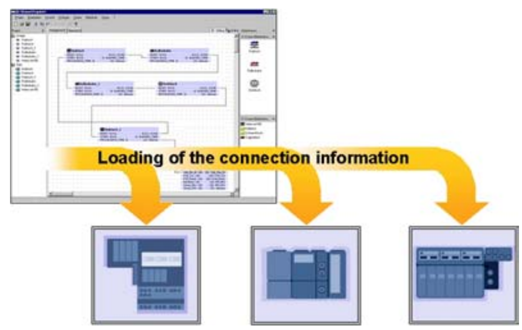


Figure 10: The connection information is downloaded to the field devices after configuration

allows continued use of existing application programs and utilization of programmer and service personnel expertise.

Finally, the application software is encapsulated in the form of a PROFInet component, whereby a component description PCD (PROFInet Component Description) is created and imported to the library of the Connection Editor.

Connecting the components

Using the PROFInet *Connection Editor,* the created PROFInet components are taken from a library and connected to form an application with simple clicks of the mouse.

This connection with simple graphical configuration replaces the previous, labor-intensive programming of communication relationships. Programming requires detailed knowledge of the integration and sequencing of communication functions in the device. When programming, it must already be clear which devices will communicate with each other, when communication will take place and over which bus system. However, no knowledge of the communication functions is necessary during configuration as these are run automatically in the devices.

The connection editor draws together the individual applications that are distributed throughout the system. It works independently of manufacturer, i.e. it configures PROFInet components from different vendors.

Download

After connection of the components, the connection information and the code and configuration data of the components are

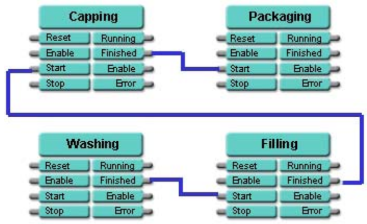


Figure 11: Communication is configured using the Connection Editor

downloaded to the PROFInet devices with a simple mouse-click. Thus, each device knows all its communication partners, communication relationships and exchangeable information. The distributed application can be implemented.

3.4 Component description (PCD)

The PROFInet Component Description (PCD) is an XML file. It is created using vendor-specific tools assuming that these have a Component Generator. Alternatively, you can create the PCD file using a multi-vendor PROFInet Component Editor, which can be downloaded from the PROFIBUS website www.profibus.com

The PCD file contains information about the function and objects of the PROFInet components. These include the following:

- *description of components as library elements:* component ID, component name
- *description of hardware:* IP address, access to diagnostic data, download of connections
- *description of software functionality:* assignment of software to hardware, component interface, properties of variables, such as their technological name, data type, and direction (input or output)
- *buffer for component project*

Component libraries are formed to support re-usability.

3.5 Connection Editor

A Connection Editor usually offers two views: the system and the network view.

In the *system view*, the necessary components are imported from the library and placed on the screen, and the various connections are established. This creates the *technological* structure and its logical relations within the system.

The *topological* structure of the automation system is created in the *network view*. In this case, the field devices and programmable controllers are assigned to a bus system and the device addresses are fixed in accordance with the rules of the underlying bus system.

3.6 PROFInet Runtime

The PROFInet runtime model defines functions and utilities that require cooperating automation components to fulfill an automation task. It establishes and monitors the connections between the PROFInet components configured by the engineering tool. It sets up a provider-consumer model in which the provider generates and sends data that the consumer receives and processes.

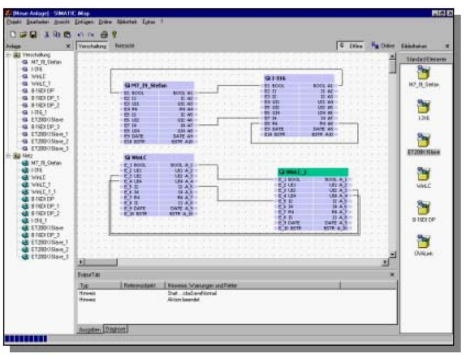


Figure 12: The system view in the Connection Editor displays the connected components

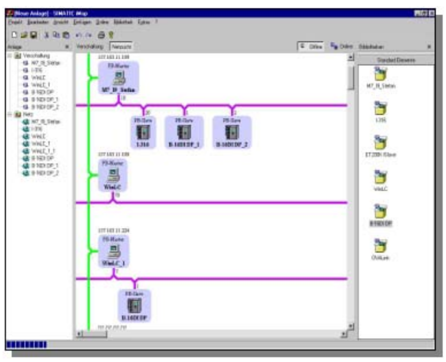


Figure 13: The network view in the Connection Editor shows the connected field devices

4. PROFInet communication

The Ethernet-based communication at PROFInet can be scaled. It has three performance levels:

1. TCP, UDP and IP for non-time-critical data, such as parameter assignment and configuration,

2. Soft Real Time (SRT) for time-critical process data used in the field of factory automation and

3. Isochronous Real Time (IRT) for particularly sophisticated demands, as for Motion Control applications.

These three performance levels of PROFInet communication cover the entire spectrum of automation applications. Key features of the PROFInet communication standard include the following:

- Coexistent use of real-time and TCP-based IT communication on a single line
- Standardized real-time protocol for all applications, for communication between components in distributed systems as well as between the controller and the decentralized field devices
- Scaleable real-time communication from performant to high-performant and time synchronized

The characteristics of the scaleable and standardized communication basis are one of the key strengths of PROFInet. They ensure consistency right through to corporate management level and fast response times in the automation process.

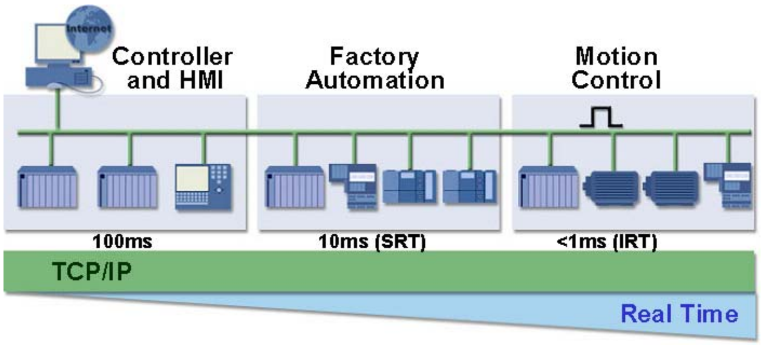


Figure 14: The Ethernet-based communication for PROFInet can be scaled.

4.1 Standard communication with TCP/UDP

PROFInet uses Ethernet and TCP/IP as its basis for communication. As far as communication protocols are concerned, TCP/IP is a de-facto standard in the IT landscape. However, with regard to the interoperability of different applications, it is not enough to establish a common TCP or UDP based communication channel (Layer 4) on the field devices. The fact is, that TCP/IP only provides the basis for enabling Ethernet devices to exchange data through a transport channel in local and distributed networks. Additional specifications and protocols, so-called *application protocols,* are therefore required at a higher level than TCP or UDP. Interoperability is only ensured if the same application protocol is used for all devices. Typical application protocols are, for example, SMTP (used for e-mail), FTP (used for file transfer) and HTTP (used on the Internet).

4.2 Real Time communication

In the field of factory automation, real-time applications require update/response times within a range of 5-10ms. The update time is the time which passes when a variable is created in a device application, then sent to a partner device through the communication systems, and is subsequently made available to the application again at this partner device.

Implementation of real-time communication should result in only minimal loading of the processor for the devices in order to ensure that the processing of the application program continues to have priority.

Experience has shown that the transmission time along the line with Fast Ethernet (100 Mbps Ethernet) or higher is negligible in comparison to the execution time in the devices. The time taken to make the data available in the provider's application is not affected by the communication. This also applies to the processing of the received data in the consumer. This means that any notable improvements in the update time, and hence in the real-time response, are to be achieved primarily through suitable optimization of the communication stack in the provider and the consumer.

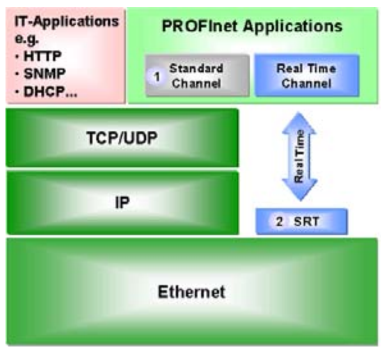


Figure 15: Communication channels with PROFInet

Ethernet
Ethernet is standardized in IEEE 802.3. Specifications include access technology, transmission procedures and transmission media for Ethernet (10 Mbps), for Fast Ethernet (100 Mbps) and for Gigabit Ethernet (1Gbps). PROFInet uses Fast Ethernet and Gigabit Ethernet.

Fast Ethernet for 100 Mbps is a compatible expansion of the 10 Mbps Ethernet. Full duplex mode and switching are integrated and standardized in Fast Ethernet.

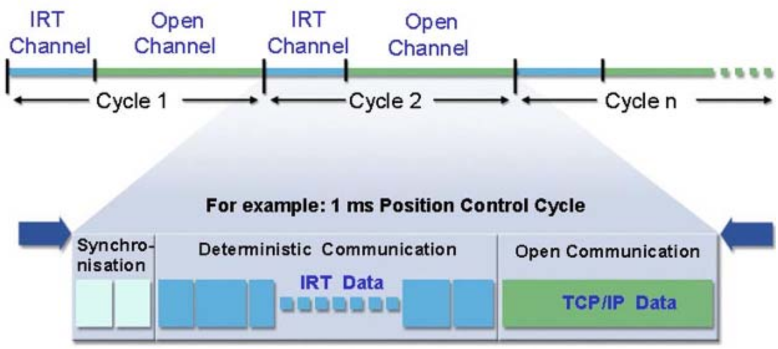


Figure 16: Scheduling of communication system for IRT

Soft Real Time (SRT)

In order to satisfy real-time requirements in automation, PROFInet has an optimized real-time communication channel – the Soft Real Time channel.

This channel is Ethernet-based (Layer 2). This solution minimizes run times in the communication stack appreciably and increases performance with regard to the update rate of process data. Firstly, the elimination of several protocol levels reduces the message length, and secondly, it takes less time before the transmission data are ready for sending i.e. are ready for processing by the application. At the same time the processor power needed in the device for communication is greatly reduced.

Optimized data transmission through prioritization

In PROFInet there is not only a minimized communication stack in the programmable controllers; the transmission of data in the network is also optimized. In order to optimize results in these cases too, the packets are prioritized in PROFInet in accordance with IEEE 802.1Q. Data flow between the devices is then controlled by the network components on the basis of this prioritization. Priority 6 is the standard priority for real-time data. This ensures priority handling over other applications, such as Internet telephony with Priority 5.

Isochronous Real Time (IRT)

However, the aforementioned solutions are not sufficient for Motion Control applications. These require update rates of around 1 ms with a jitter accuracy for the consecutive cycles of 1µs for up to 100 nodes. To meet these demands, PROFInet has defined the time-slot-controlled transmission method IRT on the Layer 2 Protocol for Fast Ethernet.

Through the time synchronization of participating devices (network components and PROFInet devices) with the aforementioned accuracy, a time slot can be specified in the network during which the key data needed for the automation task are transmitted. The communication cycle is broken down into a deterministic part and an open part. The cyclic real-time telegrams are transported in the deterministic channel, while the TCP/IP telegrams are transported in the open channel. The process is comparable with the traffic on a freeway, of which the left lane is reserved for time-critical traffic (real-time traffic) and prevents the other road users (TCP/IP traffic) from switching to this lane. Even congestion in the right lane does not affect the time-critical traffic.

IP

Data transmission with the Internet Protocol (IP) represents a non-secure package transmission (datagrams) between an IP source and an IP destination. Datagrams may be lost due to interference on the transmission channel or overloading of the network, and they may arrive several times or in a different order than the one in which they were sent. It can be assumed, however, that any datagram received is correct. Due to the 32-bit checksum of the Ethernet packet, it is highly unlikely for errors in the packet to go undetected.

TCP

TCP ensures that data transmission from sender to receiver is error-free, in the correct sequence and complete. TCP is connection-orientated, i.e. a connection is established between two stations prior to transmission of the data blocks and is disconnected again after transmission. TCP has mechanisms for continuous monitoring of the established connection.

UDP

Like TCP, UDP ensures that data transmission from sender to receiver is error-free, in the correct sequence and complete. However, in contrast to TCP, UDP is connectionless, i.e. each data packet is treated as a single message and there is no transport acknowledgement. Because there is no timeout monitoring or connection buildup/cleardown, UDP is better suited to time-critical applications than TCP. With UDP, the data blocking and communication monitoring, which is implicit with TCP, can be carried out at the application level e.g. over RPC (Remote Procedure Call).

Implementation of the isochronous data transmission is hardware-based. An ASIC with this functionality covers the cycle synchronization and time slot reservation function for real-time data. The hardware-based implementation enables the required accuracy in the required order of magnitude and also relieves the processor in the PROFInet device of communication tasks. This frees up computing time that can be made available for automation task solutions.

4.3 Communication with PROFInet IO

With PROFInet IO the UDP/IP-based RPC is used at startup for the initiation of data exchange between the devices, parameter assignment of the distributed field devices and diagnostics. Due to the open and standardized RPC protocol, HMI stations and engineering systems (IO-Supervisors) can also access PROFInet IO-Ddevices. The PROFInet real-time channel is then used for the transmission of IO and alarms.

In a typical IO configuration, an IO-Controller exchanges cyclic IO with several decentralized field devices (IO-Devices) via communication relationships. In each scan cycle, the input data are sent from the assigned field devices to the IO-Controller and, in reaction to this, the output data are sent back to the corresponding field devices. The communication relationships are monitored through the monitoring of received cyclic messages. For example, if the input frames fail to arrive for 3 cycles, the IO-Controller detects that the respective IO-Device has failed.

The data transmission layer of PROFInet is defined in IEEE 802.3, which describes the configuration of the protocols and fault monitoring. A user data telegram comprises a minimum of 64 bytes and a maximum of 1500 bytes. The overall protocol overhead for real-time data is 28 bytes.

4.4 Communication between components

In the PROFInet component view, DCOM (Distributed COM) is specified as the shared TCP/IP-based application protocol between PROFInet components. DCOM is the expansion of COM (Component Object Model) for the distribution of objects and their interoperability in a network. DCOM is based on the standardized protocol RPC. As well as accessing the engineering system, e.g. loading connections, reading diagnostic data, device parameterization and configuration, PROFInet also uses DCOM to establish connections and exchange user data.

However, it is not necessary to use DCOM for user data exchange between PROFInet components. The user configures whether user data is exchanged over DCOM or the real-time channel in the engineering system. While devices are setting up a communication they can then agree if necessary to use a real-time-capable protocol, because communication between such plant/machine modules may require real-time conditions which cannot be satisfied by TCP/IP and UDP.

TCP/IP and DCOM form the common "language" that can definitely be used to start communication between the devices. The PROFInet real-time channel is then used for real-time communication between the individual nodes in time-critical applications. In the configuring tool, the user can decide the quality of service by setting the change rate, i.e. whether the values are transmitted between the components cyclically during runtime or only in the case of change. Cyclic transmission is better in the case of high change rates because the checks for change and acknowledgment result in a higher processor load than sending in cyclic mode.

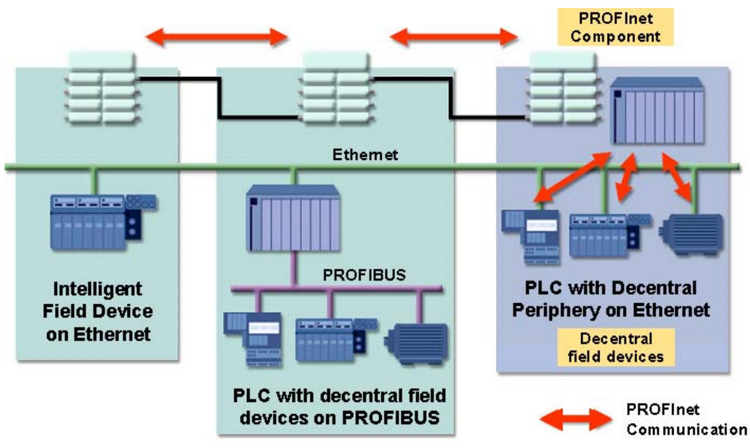


Figure 17: PROFInet communication between PROFInet components and PROFInet IO-Devices

5. Network installation

The international standard ISO/IEC 11801 and its European equivalent EN 50173 define an application-neutral, standard IT network for a building complex. The two standards are largely identical in content. Both assume that the buildings are put to office-like use and claim to be application-neutral.

Neither standard takes account of the specific requirements that need to be met by Ethernet networks in an industrial environment, e.g.,

- Installation-specific cable routing
- An individual level of networking for each machine/plant
- Line network topologies
- Rugged, industry-compatible cables and connectors designed to meet special requirements with regard to EMC, temperature, moisture, dust and vibration

For this reason, the "PROFInet Installation Guideline" defines industry-standard cabling for Fast Ethernet based on the specifications of IEC 11801.

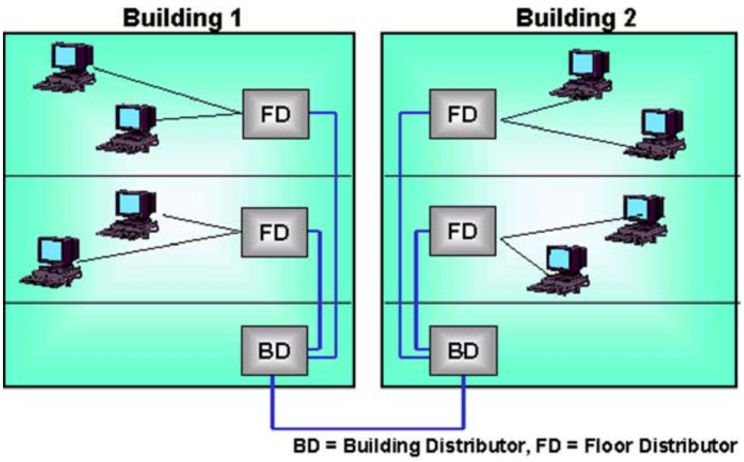


Figure 18: Ethernet networks in the office world usually use a tree topology

5.1 Network topologies

Network topologies are orientated to the requirements of the units to be networked. The most frequently used network topologies are star, line, tree and ring structures. In practice, a system tends to consist of a mixture of these structures, which are described below in greater detail. These structures can be implemented with either copper or fiber-optic cables and can also be used with PROFInet.

Star

The star structure is characterized by a central signal distributor (switch) with individual connections to all the network's terminals. Applications for star-shaped network structures are areas of high device density and short radius of expansion, e.g., small manufacturing cells or a single production machine.

Tree

The tree topology results from joining together several stars to form a network; a mixture of fiber-optic and twisted pair cabling is possible where necessary. It is used for dividing complex installations into sub-installations.

Line

The line structure is implemented by means of a switch near the connecting terminal or a switch integrated in the terminal.

It is primarily used in systems with extensive structures, e.g., conveyor systems, and for joining together manufacturing cells.

Ring (redundancy)

Closing the ends of a line with an additional connection produces a ring structure.

Ring topologies are used in systems with high availability requirements in order to protect against broken lines or faulty network components.

Office sector	Production and fieldsector
fixed basic installation in the building	cabling extremely dependent on plant
Cable laid in false floors	plant-specific cable routing
variable device connection at the workplace	connection points are rarely changed
Pre-assembled device connection cables	device connections are assembled locally
Networks use tree topology	networks usually use line topologies and (redundant) ring topologies
large data packages (e.g. images)	small data packages (measured values)
medium network availability	extremely high network availability
moderate temperatures	extreme temperatures
no moisture	possible moisture (IP65)
virtually no vibration	vibrating machines
low EMC load	high EMC load
low mechanical risk	risk of mechanical damage
virtually no chemical hazards	chemical load due to oily or aggressive atmospheres

Table 1: Differences between office and automation technology

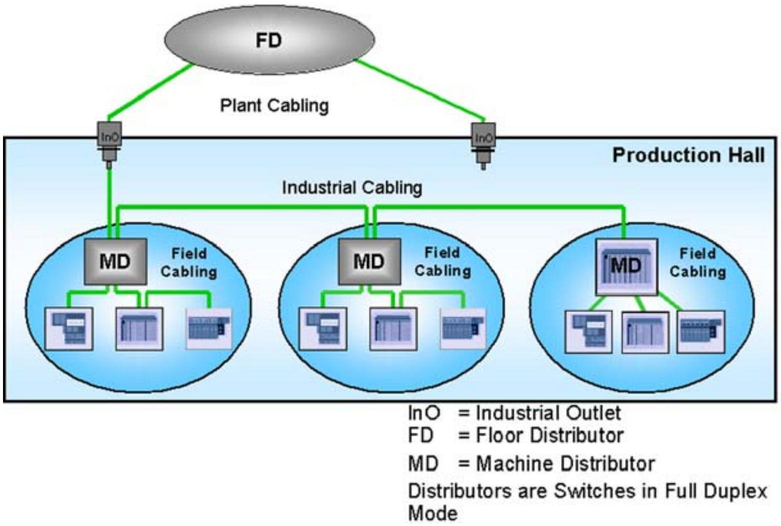


Figure 19: Ethernet networks in an industrial environment usually use a line topology

5.2 PROFInet cabling

Industry-standard cables can be subject to extreme mechanical stress and are specially manufactured to meet these demands. PI has defined a range of different cable types that are optimally designed to suit the respective industrial boundary conditions. Thanks to sufficient system reserves, the transmission length of an industry-standard installation can be created without restrictions.

Connectors and cables form a perfectly coordinated system. Only components whose compatibility has been tried and tested receive the designation PROFInet component.

The requirements to be met by cabling at field level are similar to those in PROFIBUS. Because stations are supplied not only with data but also with 24 V, a hybrid cabling structure is ideal. Hybrid cables contain conductors for the transmission of both signals and power. Hybrid cables are available as: Cu/FOC cable (2 optical fibers for data transmission / 4 wires for power transmission) as well as Cu/Cu cable (4 wires for data transmission / 4 wires for power transmission).

Fiber-optic conductors are insensitive to electromagnetic interference and usually permit more extensive networks than symmetric copper cables.

PROFInet cabling with symmetrical copper cables

Signal transmission over symmetrical copper cables (twisted pairs) is performed in accordance with 100BASE-TX at a transmission speed of 100 Mbps (Fast-Ethernet). Two shielded copper cables twisted in pairs (STP= Shielded Twisted Pair) are defined as the transmission medium.

Only shielded cables and connecting elements are allowed. The individual components have to satisfy the requirements of Category 5 in accordance with IEC 11801. The entire transmission path has to meet the requirements of Class D in accordance with IEC 11801. Furthermore, PROFInet cables have a cable cross-section of AWG 22 in order to enable even complex cabling structures through minimum damping. For this reason, the specification of the PROFInet cables supports a modular setup, which ensures an IEC 11801-compliant structure on adherence to simple installation rules.

Detachable connections are made using an RJ45 or M12 connector system. Device connections take the form of jacks. The connecting cables (device connection cables, terminal cables) are equipped accordingly with connectors at both ends, which can be pre-assembled with the specified AWG 22 cable.

All the devices are connected through an active network component. PROFInet uses switched network components. The specification of the network components ensures simple installation. Transmission cables are equipped with the same connectors at both ends and are pre-assembled with the same assignments. The maximum segment length is 100m.

PROFInet cabling with fiber-optic conductors

PROFInet can be operated using multimode or single mode fiber-optic conductor lines. Signal transmission is performed over 2 fiber-optic conductors in accordance with 100BASE-FX at a transmission rate of 100 Mbps. The optical interfaces are compliant with the specifications ISO/IEC 9314-3 (multimode) and ISO/IEC 9314-4 (single mode).

For applications outside the switchgear cabinet, the outer sheath has to meet the requirements (mechanical, chemical, thermal) imposed at the specific point of use.

For multimode lines the maximum segment length is 2 km, for single mode lines it is 14 km.

5.3 Connectors

A major criterion for use in industry is the handling of local connection systems. Connectors for M12 as well as RJ 45 are available for this purpose. Local assembly of these connectors is easy using standard tools.

With PROFInet, the RJ45 with IP20 is used in switchgear cabinets. It is compatible with the office connector. Connectors outside the switchgear cabinet need to take special account of industrial requirements. Types RJ45 with IP65 or IP67 or type M12 are used in these cases.

Figure 20: Example of a RJ45 connector for IP20

The RJ45 with IP65 / IP67 is enclosed in a rugged case with a push-pull lock. Special models also offer up to IP68 protection rating.

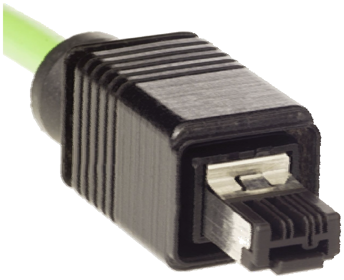


Figure 21: Example of a RJ45 connector for IP 67

The RJ 45 connectors for PROFInet are versions 4 and 5 specified in the draft of IEC 61076-3-106.

The M12 connector used for PROFInet is the shielded D-coded version specified in the draft IEC 61076-2-101.

The duplex DC connector system in accordance with ISO/IEC 11801 is primarily used in the field of fiber-optics. The latter is described in IEC 60874-14. Devices are equipped with the socket and the connection cable with the plug. It is also possible to use BFOC/2.5 fiber-optic connectors in accordance with IEC 60874-10.

The hybrid connector is used where distributed field modules are connected through a combined connector with data and supply voltage. The RJ45 with IP67 has a 2-pair, shielded data line for communication and 4 copper conductors for the voltage supply. A fully shock-hazard-protected connector enables the use of identical connectors at both ends as the pin-socket changeover is no longer necessary due to the integrated protection.

Figure 22: Example of a RJ45 hybrid connector for IP 67

5.4 Switches

PROFInet always uses switches as network components. Switches are devices positioned along the transmission path between the terminals to regenerate and selectively relay incoming signals. They serve the structuring of networks. They are based on the specifications of the ISO/IEC 15802-3.

Switches suitable for PROFInet are designed for Fast-Ethernet (100 Mbps, IEEE 802.3u) and full duplex transmission. A switch working in full duplex mode receives and sends data simultaneously at the same port. The use of switches prevents collisions during transmission. Hence there is no loss of bandwidth due to the Ethernet collision procedure. Network configuration is greatly simplified because there is no checking of section lengths within a collision domain.

10BASE-TX (10 Mbps, CSMA/CD) is also supported in order to ensure compatibility with old systems or single, old terminals or hubs. Switches suitable for PROFInet also support prioritized telegrams according to IEEE 802.1Q, standardized diagnostic paths as well as Auto Polarity Exchange, Auto-negotiation Mode and Auto-Cross-Over-Function. Port mirroring for diagnostic purposes is optional.

Even if they comply with the aforementioned functionality, it is usually not possible to use switches from the office sector. Special switches are used for applications in industrial environments. This is firstly due to the fact that their design, both mechanical (IP degree of protection, …) and electrical (24 Volt power supply, …), has been specially developed for rugged industrial use. And secondly, they need to meet the EMC demands of machines in an industrial environment in order to ensure safe operation.

6. IT integration

By using Ethernet as the communication medium, IT functions can also be integrated in PROFInet as well as the automation functionalities described.

In conjunction with TCP/UDP and IP, with Ethernet and Switching technology comes an increased demand for network management than is the case in the fieldbus world. A concept was therefore specified for network management in PROFInet in order to regulate all technical aspects of the integration of PROFInet devices in such networks. This concept covers the following main subject fields: network infrastructure, IP management, network diagnosis and time synchronization. The network management simplifies the administration and management of Ethernet by using standard protocols from the IT sector.

A further aspect is the use of Internet technologies in automation technology. Within the framework of Web Integration, PROFInet specifies a concept that enables access to PROFInet components. This is implemented via web services based on standard Internet technologies, such as HTTP, XML and HTML.

6.1 Network management

Network management covers all the functions required for the administration of a network, such as configuration (assignment of IP addresses), error monitoring (diagnostics) or performance optimization.

IP management

PROFInet's use of TCP/UDP and IP means it is necessary to assign an IP address to network users, i.e., PROFInet devices.

- *Address assignment with manufacturer-specific configuration systems:* This alternative is required in case there is no network management system available. The DCP protocol (Discovery and Basic Configuration) is specified for PROFInet. It enables assignment of IP parameters with manufacturer-specific configuration/programming tools or in cross-system engineering, e.g., in the PROFInet Connection Editor. DCP is mandatory for PROFInet devices, thus ensuring the uniform behavior of all PROFInet devices.

- *Automatic address assignment with DHCP:* the Dynamic Host Configuration Protocol (DHCP) is today the de-facto standard for the assignment and management of IP addresses in networks with network management systems in an office environment. PROFInet has elected to use these standards and describes optimum use of DHCP in a PROFInet environment. The implementation of DHCP in PROFInet devices is optional.

Diagnostics management

The reliability of network operations takes very high priority in the network management. In existing networks, the *Simple Network Management Protocol (SNMP)* is now the de-facto standard for the maintenance and monitoring of network components and their functions. SNMP is also ideal for monitoring PROFInet devices with established management systems. SNMP provides for both reading access (monitoring, diagnostics) and writing access (administration) to a device.

Initially, only reading access of device parameters was specified in PROFInet. As with the IP management functions, SNMP is optional. When SNMP is implemented in components, only standard SNMP data is accessed (MIB 2).

Specific diagnosis of PROFInet components is possible through the mechanisms described in the PROFInet specification. SNMP is not intended to open up any further diagnostic route in this connection but should enable integration in network management systems which normally do not process PROFInet-specific data.

6.2 Web services

PROFInet does not just support the use of modern Ethernet-based technologies. PROFInet components can also be accessed by web clients based on standard Internet technologies, such as HTTP, XML, HTML or scripting.

In this case, data are transmitted in a standardized form (HTML, XML) and visualized using standardized front ends (browsers such as Netscape, MS Internet Explorer, Opera, etc.). This enables integration of data from PROFInet components in modern, multimedia-supported information systems, thus allowing PROFInet components to reap the benefits of Web Integration in an IT landscape, e.g., the use of browsers as a uniform user interface, flexible access to information from any number of clients, platform-independence of clients and reduced outlay for the installation and maintenance of client software.

Functional properties

The design of PROFInet Web Integration focuses on commissioning and diagnostics. Web-based concepts can be used particularly effectively within these fields of application:

- No special tools are necessary to access the components; established standard tools can be used.

- Global access makes it easy for component manufacturers to support users during commissioning.

- The self-description of components enables access using standard tools; no need for configuration information.

Possible scenarios for Web Integration in the commissioning and maintenance sector include: testing and commissioning, overview of device master data, device diagnostics, and system and device documentation.

Information should be made available in both man-readable form (e.g. with a browser) and machine-readable form (e.g. as an XML file). With PROFInet Web Integration, both options are consistently available. PROFInet Web Integration also makes standardized XML schemes available for certain information.

Technical properties

The basic component of Web Integration is the web server. It forms the interface between the PROFInet object model and the basic technologies for Web Integration.

Using PROFInet, Web Integration can be scaled through the performance level and properties of the web server. This means that even simple PROFInet devices, with only an "embedded web server", can participate in the Web Integration alongside a PROFInet device via an "MS Internet Information Server" or "Apache Web Server".

Web integration for PROFInet is designed so that it can be made optionally available on each device. Certain functions are optional and can be added depending on the performance level of the device. It is thus possible to implement scaleable solutions that are optimized for the particular application. The PROFInet-specific elements can be seamlessly integrated in a component's web implementation.

Using uniform interfaces and access mechanisms, creators of technological components make their technological data available over the web. The namespace and addressing concept specified in PROFInet Web Integration enables the addressing of PROFInet component model elements over the web server. This supports creation of dynamic web pages using current data from the component.

Scope

Web Integration is optional with PROFInet, as it is arranged as an independent element alongside the PROFInet object model and neither interferes with the other.

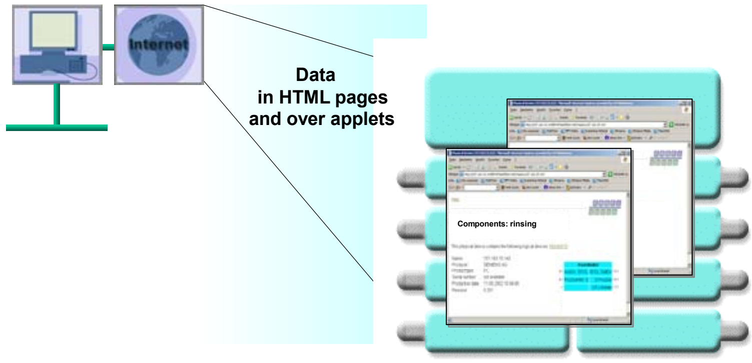


Figure 23: Web integration enables web access to PROFInet components

As far as the system architecture of an automation system with PROFInet is concerned, it supports all architectural forms, particularly the use of proxies for linking to any fieldbuses. The specification includes corresponding models that describe the relationships between the PROFInet components, existing web components and the elements of PROFInet Web Integration.

Security

The specification of PROFInet Web Integration is designed so that access to the PROFInet devices is identical from the Intranet or Internet. This enables utilization of all the advantages of Web Integration, even if the device itself is not networked to the Internet. With this type of local access, the risk of unauthorized access is extremely small and comparable with modern HMI systems.

For networking within larger factory premises or over the Internet, PROFInet Web Integration relies on a graded security concept. It recommends a security concept optimized for concrete applications with one or more upstream security zones. This means that no structural restrictions are made to the Web Integration concept, as the security measures are always located externally to the PROFInet devices. This not only relieves the PROFInet devices, but also allows the security concept to be optimally modified to meet changing safety demands while offering a constant automation solution.

The best practice suggestions of PROFInet Web Integration contain scenarios and examples showing how demand-dependent security mechanisms can be implemented for all PROFInet devices.

For example, it is possible to implement security mechanisms in the transport protocols (TCP/UDP and HTTP). The encoding, authentication and access management of the web servers used are also scalable. Further-reaching security elements such as application gateways can be added for web services if required.

6.3 OPC

The PROFInet component model and OPC have the same technological basis in DCOM. This offers user-friendly options for data communication between various parts of the system.

OPC is a widely used interface for exchanging data between applications in automation technology. OPC supports the flexible selection of multi-vendor devices and data exchange between devices without the need for programming.

OPC DX is not object-oriented like PROFInet but tag-oriented, i.e. the automation objects are not COM objects but names (tags).

OPC DA (Data Access)

OPC DA (Data Access) is an industrial standard that defines a set of application interfaces. This standardizes access to the data of measuring and control devices, the locating of OPC servers and simple browsing in the name spaces of the OPC server.

OPC DX (Data Exchange)

OPC DX defines a communication standard for the higher-level exchange of non-time-critical user data at system levels between different makes and types of control systems, e.g., between PROFInet and Ethernet/IP. However, OPC DX does not permit direct access to the field level of a different system.

OPC DX is an extension of the OPC DA specification and defines a set of standard interfaces for the interoperable exchange of data and server-to-server communication in Ethernet networks.

OPC DX is extremely useful for:

- *Users and system integrators* who want to integrate manufacturer-independent devices, control systems and software and implement access to shared data in multi-vendor systems, and
- *Manufacturers* who want to offer products that build on an open industry standard for interoperability and data exchange.

PROFInet

is an open system which specifies the runtime communication and engineering worlds within a PROFInet system and to lower-level PROFIBUS systems and other fieldbus systems. PROFInet offers the necessary real-time capability for automation applications through to high-performance and time synchronized Motion Control applications.

OPC DX

enables an additional, open data transfer between PROFInet and other Ethernet-based communication systems, whereby OPC DX places low demands on real-time communication.

OPC DX and PROFInet

OPC DX was developed with the aim of enabling at least a minimum of interoperability between different fieldbus systems and Ethernet-based communication protocols without compromising the integrity of the various technologies.

OPC DX was integrated in PROFInet in order to obtain an open link to other system worlds. Integration is achieved as follows:

- Each PROFInet node can be addressed as an OPC server because the basic capabilities already exist in the form of the PROFInet Runtime implementation.
- Each OPC server can be operated as a PROFInet node through a standard adapter. This is achieved through the OPC Objectizer, a software component that implements a PROFInet device on the basis of an OPC server in a PC. This software component need only be implemented once and can then be used for all OPC servers.

The functionality and performance of PROFInet is far greater than that of OPC. In addition, PROFInet offers the required real-time capability for automation solutions. On the other hand, OPC provides a higher degree of interoperability.

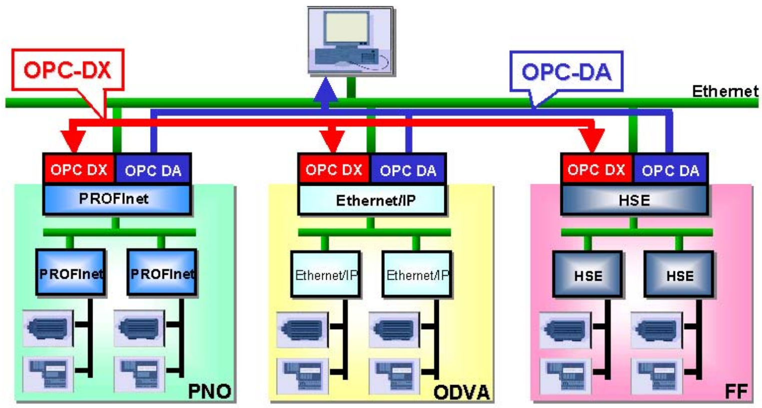


Figure 24: Cross-system data exchange with OPC DA and OPC DX

7. Integration of fieldbus systems

PROFInet offers a model for incorporating existing PROFIBUS and other fieldbus systems in PROFInet. This means you can build up a system consisting of a random mixture of fieldbus and Ethernet-based subsystems. This enables the continuous transfer of technology from fieldbus-based systems to PROFInet.

7.1 Migration strategies

The high number of existing PROFIBUS systems means that for reasons of investment protection it is essential to support simple integration of these systems in PROFInet (migration), whereby the following distinctions can be made:

- *User-owners* want simple integration of their existing installations in a new PROFInet system.
- *Plant and machine manufacturers* want to be able to use their field-tested and documented device range in PROFInet automation projects without the need for modification.
- *Device manufacturers* want to be able to integrate their field devices in PROFInet systems without any further outlay for modifications.

PROFInet offers two methods for connecting fieldbus systems:

- Integration of fieldbus devices through proxies
- Integration of fieldbus applications

7.2 Integration with proxies

The PROFInet proxy concept supports integration of existing fieldbus systems that is simple and offers a high degree of transparency.

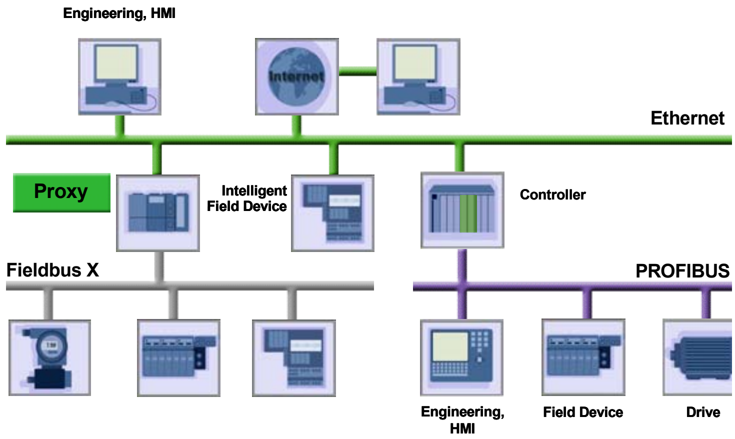


Figure 25: PROFIBUS and other fieldbus systems can be integrated in an automation device via a proxy or as a fieldbus application

On Ethernet, the proxy is the representative for one or more fieldbus devices (e.g., on PROFIBUS). This representative ensures transparent communication between networks (no tunneling of protocols). For example, it ensures transparent forwarding of cyclic data to the fieldbus devices.

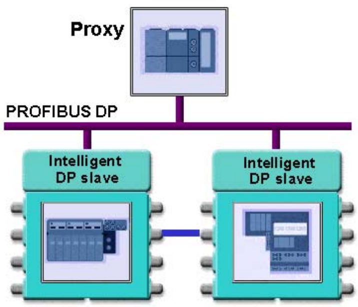


Figure 26: The principle of integrating individual fieldbus devices using a proxy

In the case of PROFIBUS DP, the proxy on the one side is the PROFIBUS master, which coordinates the data exchange of the PROFIBUS nodes and is the Ethernet device with PROFInet communication on the other. Proxies can be implemented, e.g., as PLC, as PC-based control or as a simple gateway.

Within the framework of PROFInet IO, the DP slaves on PROFIBUS are treated as IO devices. In the component view, the intelligent DP slaves are used as autonomous PROFInet components. Within the PROFInet connection editor, such components cannot be distinguished from components directly on Ethernet. The proxies support transparent communication between devices on different bus systems.

7.3 Integration of fieldbus applications

An entire fieldbus application can be mapped as a PROFInet component within the framework of the component model. This is important if an existing running plant is to be expanded with PROFInet, whereby it does not matter which fieldbus is used to automate the plant section.

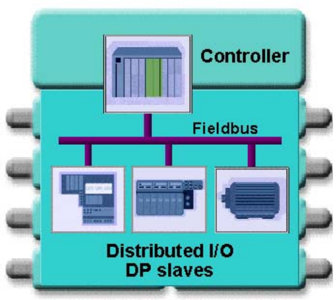


Figure 27: The principle of integration of fieldbus applications

In order for the existing plant to be able to communicate with PROFInet, it is necessary for the fieldbus master in the PROFInet component to be PROFInet-capable. This means that existing fieldbus mechanisms (e.g., PROFIBUS DP) are used within the component and PROFInet mechanisms are used outside the component.

This migration option protects any user investment in existing systems and wiring (this may be the plant operator/owner or plant manufacturer). It also safeguards any expertise already in user programs. Thus PROFInet enables a smooth transition to new system sections.

7.4 PROFInet and other fieldbus systems

Using the aforementioned integration methods, PROFInet therefore supports integration of not only PROFIBUS, but also of other fieldbus systems such as Foundation Fieldbus, DeviceNet, Interbus, CC-Link, etc. This is done by defining a bus-specific image of the component interfaces for the data transmission options of the respective bus and by saving it in the proxy. This allows connection of any fieldbus to PROFInet in one fell swoop.

7.5 Example of a modular machine

Figure 28 shows an example of a modular machine from the food industry. The bottle-filling machine consists of four modules. All essential steps of the overall application, i.e., rinsing, filling, capping and packaging are accommodated by these four modules. On the one hand this example demonstrates the independent coexistence of PROFIBUS and PROFInet in the overall system. On the other hand it highlights the simple integration of existing machine sections.

In this example it is assumed that the PROFIBUS system (rinsing and filling) continues to be used, whereas the capping and packaging units are to be renewed and extended on the basis of PROFInet.

The independence of communication procedures and the use of proxy technology enable the existing PROFIBUS system to remain in use fully unchanged. It is only necessary to connect the communication relationships between the components in the engineering of the new machine configuration. The controller responsible for the PROFIBUS system only needs to be extended by an Ethernet module (hardware and software) and the proxy functionality (software).

The proxy function ensures that the PROFInet-specific view remains encapsulated in the control system as a technological module. All operations upstream from PROFIBUS continue to run as before.

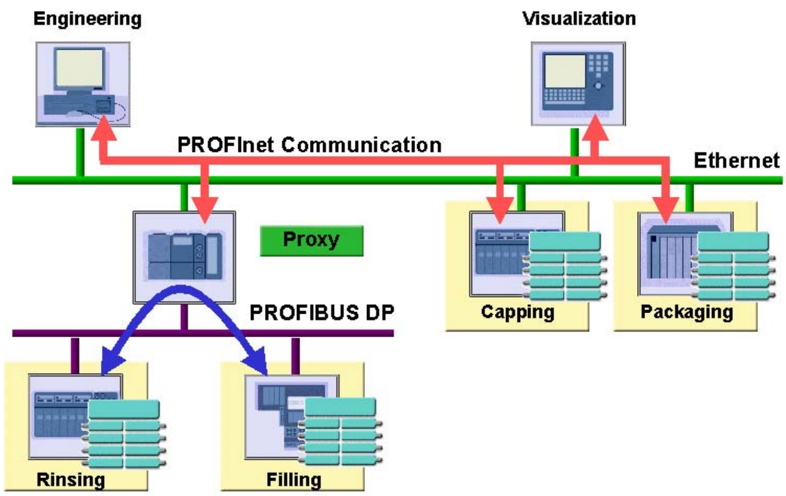


Figure 28: PROFIBUS DP can be integrated in PROFInet using proxy technology.

8. Services offered by PI

Optimum support from PROFIBUS International is important if PROFInet is to become established on the market as quickly as possible. A powerful package of services and products has been established to achieve this goal.

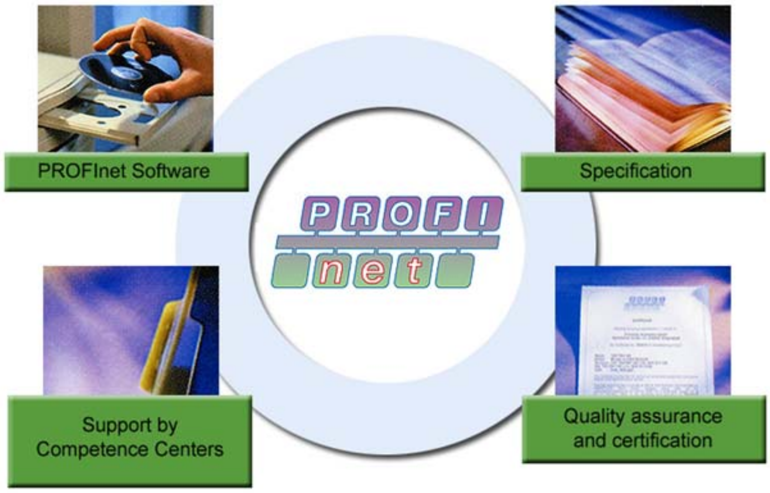


Figure 29: The PROFIBUS International range of services

8.1 Technology development

PROFInet IO

A specification is available for PROFInet IO. This specification contains a detailed description of the device model and the behavior of a field device in the form of protocols and communication operations (so-called state machines). This type of description has already proven effective with PROFIBUS DP. The degree of detail in the PROFInet IO specification enables the software creation of a standard stack of different stack suppliers.

It must be assumed that different implementations will be offered by a number of firms. For example, Siemens offers an implementation in the form of a development package.

Component model

As with PROFInet IO, the PROFInet component technology is available as a detailed specification. The specification covers the aspects communication, device model, engineering, network management, Web Integration and fieldbus connection.

In addition to the specification, PROFIBUS International also offers PROFInet software for the component technology in the form of source code.

The PROFInet software covers all runtime communications. This combination of specification and operating system-independent software as source code enables the simple and low-cost integration of PROFInet in the broadest range of device operating system environments.

The PROFInet Runtime software is configured so that it supports the simple integration of existing application software in the runtime object model.

PROFInet already offers sample portings for Win32, Linux, and VxWorks.

The PROFInet Runtime software is of modular design and consists of various layers, each of which has to be adapted to the system environment. The adaptations are limited to the porting interfaces leading to the various functional parts of the environment, to the operating system (e.g., Win32) and to the device application (e.g. PLC). A porting manual is available to support porting operations. It is then easier for the device developer to understand the various steps required for porting.

8.2 Quality measures

In the development of PROFInet, PROFIBUS International has ensured from the outset that the entire life cycle – from the specification of PROFInet to the systems engineering stage – is supported by measures which guarantee a high level of quality in the various phases.

QM of the specification and implementation process

The PROFInet specification and software are developed in a cross-company working group, the "PROFInet Core Team". The entire development process from the first registering of demands through to the release of the PROFInet Runtime software is covered by a quality management system (QM).

The quality measures are set out in a Quality Manual which is adapted to the boundary conditions of the cross-company development team. This ensures that the source code complies with the currently valid rules of Quality Management.

The Quality Manual describes the process model to be used and defines the terms, methods and tools to be employed in the quality measures. It also specifies the assigned areas of responsibility throughout the quality process. An important element in this respect is Error Management. It includes an unequivocal classification of errors and a traceable error information system.

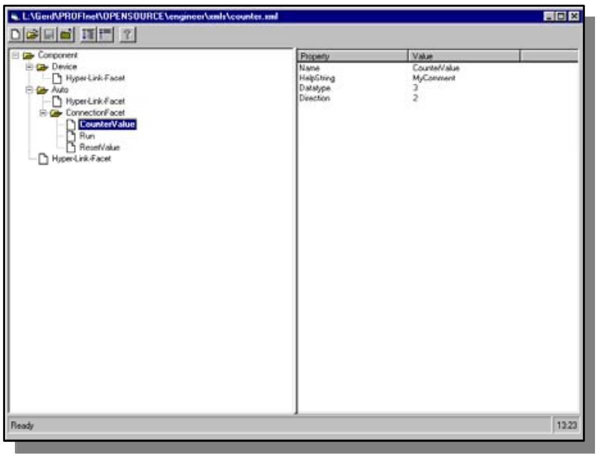


Figure 30: PROFInet Component Editor

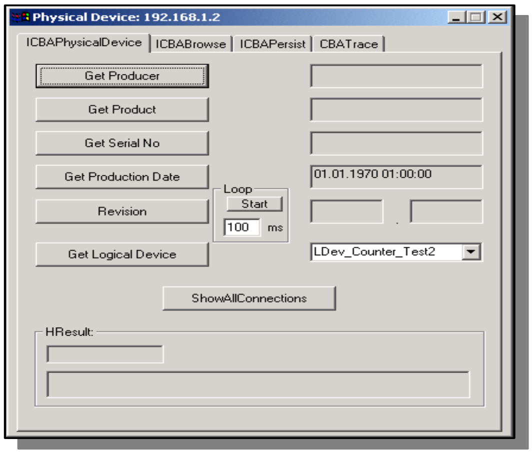


Figure 31: The PROFInet Test Tool

Testing and certification

In order to ensure the correct interaction of all PROFInet devices and a high product-quality, a certification system has been set up along the lines of the proven system for PROFIBUS products from the outset. At the heart of this process are certification tests carried out by test laboratories authorized by PROFIBUS International. The test for obtaining a certificate from one of these test laboratories ensures that the products comply with specifications and are error-free.

Error information book

An error information book has been set up at PROFIBUS International so that errors and requests from end-users and device manufacturers are systematically treated in the runtime software. An error database for recording all errors and their status has been made available for this purpose. The data base entries are made in accordance with the rules of the quality process.

8.3 Technical support

For PROFInet to be successful, it is important to ensure rapid market availability of a sufficient number of PROFInet products from various manufacturers.

Competence Centers

PROFInet Competence Centers were established to support the product development process. This ensures optimum implementation of the porting to the different operating systems and adaptation to product-specific boundary conditions. The Competence Centers help all interested companies to build up know-how so that further product developments can be expertly tackled in their own development departments without additional support.

Other services offered by the PROFInet Competence Centers include a telephone hotline and the organization of target-group-orientated workshops.

Tools

Device manufacturers need a tool for creating a component description of Ethernet devices in the form of an XML file. PROFIBUS International offers the PROFInet Component Editor – similar to the GSD Editor for PROFIBUS DP – on its website www.profibus.com ready to download.

To prepare newly developed products for certification, PROFIBUS International also offers a PROFInet Test Tool that can be downloaded from its website. The device manufacturer can use the PROFInet Test Tool to carry out static tests prior to certification.

9. Glossary

Client/Server	Principle of establishing connections	The network user that establishes a connection is called the client. The user to which the connection is established is called the server.
COM/DCOM	Component Object Model/ Distributed Component Object Model	COM is a basic object model. It allows objects to make their functionality available to other components. DCOM is an extension of COM for communicating through a network.
Component Generator		Functional extension of a vendor-specific configuration tool to generate an XML based PROFInet Component Description (PCD).
Connection Editor		Vendor-independent enginnering tool to configure plant wide applications. The connection editor draws together the individual applications that are distributed throughout the system.
CSMA/CD	Carrier Sense Multiple Access/Collision Detection	A procedure for controlling access to the bus by various users
DCP	Discovery and Basic Configuration	Defines the assignment of IP parameters using vendor-specific configuration/programming tools or a by means of plant-wide Engineering, e.g. of a PROFInet Connection Editor.
DHCP	Dynamic Host Configuration Protocol	De-facto standard for the dynamic issuing and management of IP addresses from a pre-defined area
ERP	Enterprise Resource Planning	
Ethernet	Protected trade mark of the Xerox company (introduced in 1975)	Ethernet is standardized and serves to describe the physical and Data Link level of a network.
FTP	File Transfer Protocol	Protocol for the transmission of files; based on TCP/IP
Gateway		Interconnects two or more networks with even different physical layers. Provides the necessary translation, both in terms of hardware and software.
GSD	General Station Description	A GSD (General Station Description) contains an XML-based description of IO-Device' properties like communication parameter as well as number, type, configurations data, parameter and diagnostic information of modules.
HMI	Human Machine Interface	The visible face of a system on the control and monitoring platform
HTML	Hypertext Markup Language	Document description language
HTTP	Hypertext Transfer Protocol	Application protocol that is used in Internet.
IO-Controller		Controller at PROFInet IO on which the automation program is run.
IO-Device		Remotely assigned field device, which is assigned to an IO-Controller.
IO-Supervisor		Programming device/PC with commissioning and diagnostics functions at PROFInet IO
IP	Internet Protocol	Connectionless protocol for the transmission of data messages; IP is often used in conjunction with TCP in order to ensure safe data transmission.
IRT	Isochronous Real Time	Isochronous Real Time channel for particularly sophisticated demands, as for Motion Control applications (time synchronized applications). The realization as hardware allows clock rates of 1 ms and lower at a jitter accuracy of 1 µs.
MES	Manufacturing Execution System	
Object		A data carrier that has a time-variable status and whose responses to incoming messages are defined
OLE	Object Linking and Embedding	A mechanism for the creation and editing of documents containing objects which were created by various applications.
OPC	OLE for Process Control	Introduced in 1996; the generally recognized interface for exchanging data between Windows-based applications in automation technology.
OPC DA	OPS Data Access	Industrial standard that defines access to the data of measuring and control devices, the locating of OPC servers and simple browsing in the name spaces of OPC servers based on client/server communication.

OPC-DX	OPC Data Exchange	Standard for the Ethernet-based exchange of non-time-critical user data between multi-vendor automation systems based on server-to-server communication
PCD	PROFInet Component Description	XML-based file containing information about functions and objects of PROFInet components.
PROFInet Component Editor		Stand alone tool to generate XML-based PROFInet Component Description (PCD) files; available for download from the website www.profibus.com.
Proxy		Representative of an object in the object model; it makes the PROFInet view available on a field device or field device group. On Ethernet, the proxy is the representative for one or more PROFIBUS devices.
RPC	Remote Procedure Call	Defined call interface for calling up programs in remote devices.
Runtime	Runtime	Designation for the status of a system "operation mode" as opposed to the system status "in the engineering phase"
SNMP	Simple Network Management Protocol	A TCP/IP based communications protocol for the maintenance and monitoring of networking components
SRT	Soft Real Time	Real-time channel for time-critical process data used in the field of factory automation. It is implemented as software based on available controllers.
Switch Technology		Technology for dividing an Ethernet network into different sub-networks; serves to prevent collisions and improve utilization of the bandwidth.
TCP	Transmission Control Protocol/Internet Protocol	Communications protocols for transferring data between local networks. TCP is connection-orientated and is used for communication on the Internet. TCP is usually used in conjunction with IP (TCP/IP)
UDP	User Datagram Protocol	Transport protocol with broadcast properties. Ideal for the transmission of time-critical I/O data
XML	Extensible Markup Language	Definition of a structured *data* description

More information as well as PROFIBUS and PROFInet guidelines, profiles and the PROFInet Runtime Software are available on www.profibus.com

PROFInet

System Description
Version November 2003

Order number 4.132

Publisher

PROFIBUS Nutzerorganisation e. V.
Haid-und-Neu-Str. 7
D-76313 Karlsruhe
Germany
Tel. : +49 (0) 721 / 96 58 590
Fax : +49 (0) 721 / 96 58 589
germany@profibus.com

PROFIBUS Trade Organization PTO
16101 N. 82nd Street, Suite 3B
AZ 85260 Scottsdale
USA
Tel. : ++1 480 483 2456
Fax : ++1 480 483 7202
usa@profibus.com

Liability exclusion

PNO / PTO has elaborated the contents of this brochure carefully. Nevertheless, errors can not be excluded. Liability of PNO / PTO is excluded, regardless of its reason. The data in this brochure is checked periodically, however. Necessary corrections will be contained in subsequent versions. We gratefully accept suggestions for improvement.

Terms used in this brochure may be trademarks, their use by third parties for any purposes may violate the rights of the owner.

This brochure is not a substitute for standards IEC 61158 and IEC 61784 and the PROFIBUS and PROFInet guidelines, profiles as well as the PROFInet Runtime Software. In case of doubt, please refer to these publications which take precedence.

Australia and New Zealand PROFIBUS User Group
(ANZPA), c/o OSItech Pty. Ltd.
P.O. Box 315
Kilsyth, Vic. 3137
Phone: ++61 3 9761 5599
Fax: ++61 3 9761 5525
Email: australia@profibus.com

PROFIBUS Belgium
August Reyerslaan 80
1030 Brussels
Phone: ++32 2 706 80 00
Fax: ++32 2 706 80 09
Email: belgium@profibus.com

Associacao PROFIBUS Brazil
c/o Siemens Ltda IND1 AS
R. Col. Bento Bicudo, 111
05069-900 Sao Paolo, SP
Phone: ++55 11 3833 4958
Fax: ++555 11 3833 4183
Email: brazil@profibus.com

Chinese PROFIBUS User Organisation
c/o China Ass. for Mechatronics Technology
and Applications
1Jiaochangkou Street Deshengmenwai
100011 Bejing
Phone: ++86 10 62 02 92 18
Fax: ++86 10 62 01 78 73
Email: china@profibus.com

PROFIBUS Association Czech Republic
Karlovo nam. 13
12135 Prague 2
Phone: ++420 2 2435 7610
Fax: ++420 2 2435 7610
Email: czechrepublic@profibus.com

PROFIBUS Denmark
Masloev Byvej 19 - 23
2760 Masloev
Phone: ++45 40 78 96 36
Fax: ++45 44 97 77 36
Email: denmark@profibus.com

PROFIBUS Finland
c/o AEL Automaatio
Kaamatie 4
00410 Helsinki
Phone: ++35 8 9 5307259
Fax: ++35 8 9 5307360
Email: finland@profibus.com

France PROFIBUS
4, rue des Colonels Renard
75017 Paris
Phone: ++33 1 45 74 63 22
Fax: ++33 1 45 74 03 33
Email: france@profibus.com

PROFIBUS Nutzerorganisation
Haid-und-Neu-Str. 7
76131 Karlsruhe, Germany
Phone: ++49 721 96 58 590
Fax: ++49 721 96 58 589
Email: germany@profibus.com

Irish PROFIBUS User Group
c/o Flomeaco Endress + Hauser
Clane Business Park, Kilcock Road
Clane, Co. Kildare
Phone: ++353 45 868615
Fax: ++353 45 868182
Email: ireland@profibus.com

PROFIBUS Network Italia
Via Branze, 38
25123 Brescia
Phone: ++39 030 338 4030
Fax: ++39 030 396 999
pni@profibus.com

Japanese PROFIBUS Organisation
TFT building West 9F
3-1 Ariake Koto-ku
Tokyo 135-8072
Phone: ++81 3 3570 3034
Fax: ++81 3 3570 3064
Email: japan@profibus.com

Korea PROFIBUS Association
#306, Sungduk Bldg
1606-3,Seocho-dong, Seocho-gu
Seoul 137-070, Korea
Phone: ++82 2 523 5143
Fax: ++82 2 523 5149
Email: korea@profibus.com

PROFIBUS Nederland
P.O. Box 2099
3800 CB Amersfoort
Phone: ++31 33 469 0507
Fax: ++31 33 461 6638
Email: netherlands@profibus.com

PROFIBUS User Organisation Norway
c/o AD Elektronikk AS
Haugenveien 2
1401 Ski
Phone: ++47 909 98640
Fax: ++47 904 05509
Email: norway@profibus.com

PROFIBUS User Organisation Russia
c/o Vera + Association
Nikitinskaya str, 3
105037 Moscow, Russia
Phone: ++7 095 742 68 28
Fax: ++7 095 742 68 29
Email: russia@profibus.com

PROFIBUS Slovakia
c/o Dept. of Automation KAR FEI STU
Slovak Technical University
Ilkovičova 3
812 19 Bratislava
Phone: ++ 421 2 6029 1411
Fax: ++ 421 2 6542 9051
Email: slovakia@profibus.com

PROFIBUS Association South East Asia
2 Kallang Sector
349277 Singapore
Phone: ++65 6740 7607
Fax: ++65 6740 7141
Email: southeastasia@profibus.com

PROFIBUS User Organisation Southern Africa
5 Commerce Crescent West,
Eastgate Ext. 13
Sandton 2148
Phone: ++27 11 262 6000
Fax: ++27 11 262 6052
Email: southernafrica@profibus.com

PROFIBUS i Sverige
Kommandörsgatan 3
28135 Hässleholm
Phone: ++46 4 51 49 460
Fax: ++46 4 51 89 833
Email: sweden@profibus.com

PROFIBUS Schweiz
Kreuzfeldweg 9
4562 Biberist
Phone: ++41 32 672 03 25
Fax: ++41 32 672 03 26
Email: switzerland@profibus.com

PROFIBUS Thai Association
Charn Issara Tower II, 31st Floor
2922/283 New Petchburi Road
10310 Bangkapi, Huaykwang, Bangkok
Phone: ++662 715-4570
Fax: ++662 715-4841
Email: thailand@profibus.com

The PROFIBUS Group
Unit 6 Oleander Close, Locks Heath,
Southampton, Hants, SO31 6WG
Phone: ++44 1489 589 574
Fax: ++44 1489 589 574
Email: uk@profibus.com

PROFIBUS Trade Organization, PTO
16101 N. 82nd Street, Suite 3B
Scottsdale, AZ 85260 USA
Phone: ++1 480 483 2456
Fax: ++1 480 483 7202
Email: usa@profibus.com

PROFIBUS International Support Center
Haid-und Neu-Straße 7
D-76131 Karlsruhe
Phone ++49 721 96 58 590
Fax ++49 721 96 58 589
Email: info@profibus.com
www.profibus.com