HMS Industrial Networks

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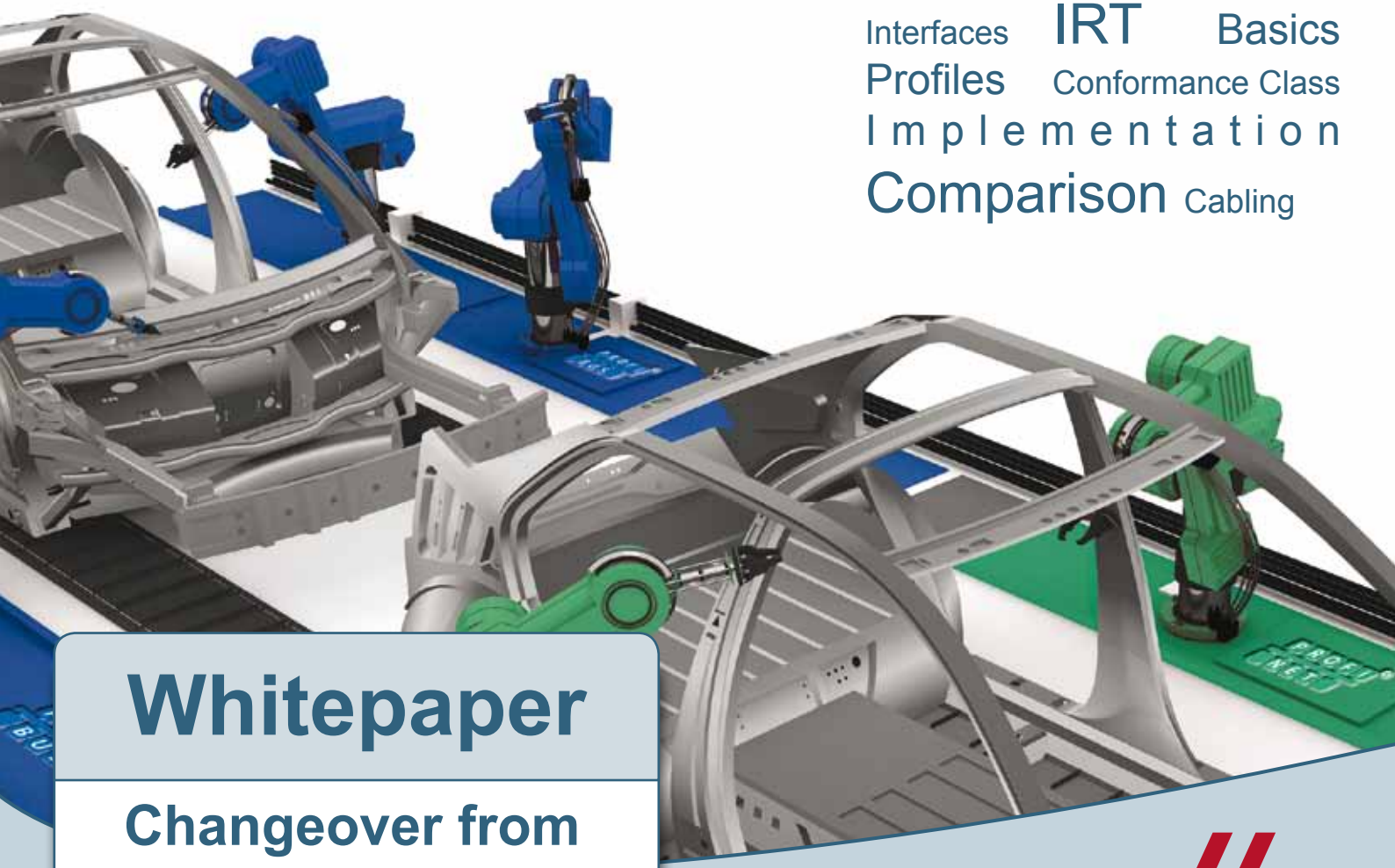
Guide to efficient changeover from

Profibus to Profinet

Why change? Certifcation
AIDA GSD file Profibus
Interfaces IRT Basics
Profiles Conformance Class
Implementation
Comparison Cabling



Whitepaper

Changeover from Profibus to Profinet

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Guide to efficient changeover from Profibus to Profinet

Executive Summary

In many fields of automation technology Profibus has established itself as a reliable communication system. 2009 saw a total installation of 3.1 million new Profibus devices corresponding to a growth rate of 11%. If you can believe in the sayings of media and marketing departments of various interest groups, then Profibus has already passed its peak, and in the future only the new industrial Ethernet systems like Profinet, EtherNet/IP, and EtherCAT will be installed.

Current market studies however show, that the transition from standard fieldbusses to industrial Ethernet systems advances much slower than initially expected. In consequence: Profibus and Profinet will be used in parallel depending on the application requirements.

It is important that device manufacturers, plant operators and system integrators should right now make themselves familiar with the new technology because early adopters such as the German car manufacturers Audi, BMW, Daimler and VW already force their suppliers to equip devices and systems with a Profinet interface.

Plant operators and system integrators should develop a sound understanding of the benefits, which the new Profinet technology could offer for their machines and plants. Likewise, they should become aware of the risks which come along with the new technology.

This white paper is a brief introductory guide for your efficient change over. It shows the main differences between Profibus and Profinet and points out the common ground. It also gives a basic overview of the key functions and features of the Profinet technology without getting lost in bits and bytes.

Best practice tips will help you to avoid common errors of implementation and usage of the new technology. This white paper is based on many years of experience of HMS Industrial Networks, a leading supplier of industrial communication technology and accredited Profinet Competence Center. HMS would be glad, to assist you in your first steps into the new Profinet technology.

Have a successful and efficient change over

Michael Volz

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1 Motivation for the change over and some constraints, when to stick

Profinet, as well as EtherNet/IP, Modbus-TCP, and EtherCAT rank among the leading industrial Ethernet systems. Stimulated by intense marketing efforts of the respective user organizations, users have developed high levels of expectation, awaiting that the new technology will solve a huge variety of different communications tasks. The German automotive industry took a pioneering role. Audi, Daimler, BMW, and VW have joined together and established the AIDA organization (automation initiative of German car manufacturers) which favors Profinet as new common communication standard for body shop applications. The car maker's main reasons to select the new technology are:

- Profinet is based on industrial Ethernet and transmits real time data (I/O signals) and IT data (quality and statistics data) over the same cable. While up to now two different bus systems were necessary to perform these tasks, Profinet can transmit data for both applications over a single network which cuts installation and maintenance costs.
- Profinet is capable to transmit even larger amounts of I/O data with high speed in real time. If required, data transmission can be performed clock-synchronized using the Profinet IRT protocol, thus enabling communications between motion control applications and control systems.
- Using ProfiSafe, safe I/O signals can be transmitted via Profinet without the need for a separate cabling for safe data. This further saves installation and maintenance costs. A separate safety network is completely unnecessary.

Users of Profinet will take advantage in complex applications where the above mentioned features play a substantial role. For standard applications where I/O signals and acyclic data of a machine or system must be transmitted in a simple, secure, and reliable manner, Profinet offers only minor functional or economic benefits. In these cases, fieldbus systems like Profibus, DeviceNet, and CANopen obviously are the systems of choice.

Before being able to manage the change over, you will have to make yourself familiar with the basics of Profinet technology. The following chapters will provide you with a quick and easy readable introduction.

2 Profinet basics at a glance

Profinet technology was jointly developed by Siemens and the Profibus Nutzerorganisation (PNO). The initial version Profinet-CBA (Component Based Automation) targeted the requirements of distributed automation. It never gained remarkable market share however. More interesting is the Profinet IO version which aims at fast transmission of I/O data for decentralized peripheral devices. Profinet IO picks up well known mechanisms from Profibus-DP. It shows an almost identical plant view and has many similarities concerning engineering. This paper only discusses Profinet IO, simply called Profinet herein.

To cover the widest range of applications, Profinet IO defines three real-time classes. The wide range of possible functionalities is split up into three conformance classes.

2.1 Transmission technology

Profinet uses 100 Mbit/s Fast-Ethernet for physical data transmission. The use of switches to set-up the Profinet network is mandatory. This way, collisions (which are possible for standard Ethernet implementations) are totally prevented. The network provides real-time data transmission with predictable transfer time. 4-wire Ethernet cable or fiber optic cable are used as transmission media. Wireless transmission based on WSAN technology is in preparation.

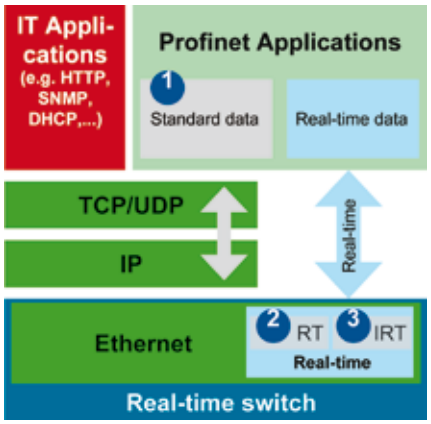
2.2 Protocol architecture

Profinet uses the international standardized Ethernet protocol IEEE 802.3 for the lower layers of the data transmission. On top of this, Profinet uses specific protocols for real-time data transmission. TCP/IP based communication is used at network start-up as well as for the transmission of diagnosis and alarm messages. Network management and redundancy functions are also using TCP/IP based protocols. Profinet provides the possibility to transmit real-time data and IT data virtually in parallel over the same physical network. IT data like production statistics, quality data or web pages are transmitted via standard http and ftp protocols.

1 Standard channel:
- Device parameterization and configuration
- Reading of diagnostics data

2 Real-time channel RT:
- High-performance cyclic transfer of user data
- Event-controlled signals

3 Real-time channel IRT:
- Isochronous transfer of user data
- Jitter < 1 µsec



2.3 Mode of operation of Profinet IO

Profinet IO builds on the proven functional model of Profibus-DP. The system is designed for fast transmission of I/O data and simultaneously provides possibilities for the transmission of acyclic data, parameters, alarms, and diagnosis data. Transmission of IT data like web sites, files, and emails complements the transfer of real-time data. Existing expert knowledge on Profibus-DP remains useful, but is in no way sufficient to securely run the Profinet system. As in the case of Profibus-DP, Profinet IO devices are classified in accordance with their typical tasks.

IO Controller

The Profinet IO Controller performs the master functionality for the I/O data communication of decentralized field devices. Typically, the I/O Controller is the communication interface of a PLC. Its functionality is comparable to a Profibus-DP master, class 1.

IO Device

Decentralized field devices like I/Os, drives, operator terminals, and valve blocks are called IO Devices. The functionality is comparable to a Profibus slave.

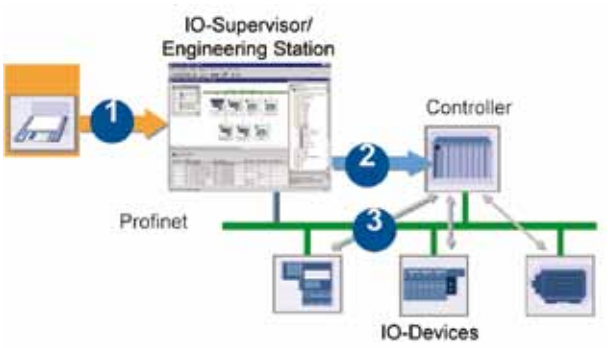
IO Supervisor

This is the designation for the engineering and diagnosis tool. Its functionality is similar to that of a class 2 master of Profibus-DP. The IO Supervisor has access to process and parameter data and can process alarm and diagnosis messages.

PROFINET	Comparison of device functionalities	PROFIBUS
Profinet IO Controller: Device that initiates the I/O data traffic; access on I/O signals via process image		Master: Device that initiates the I/O data traffic; access on I/O signals via process image
Profinet IO Device: Decentrally located field device assigned to an IO-Controller.		Slave: Decentrally located field device assigned to a Master.
Profinet IO Supervisor: HMI and diagnostics station		Master Class 2: HMI and diagnostics station

2.4 Engineering based on GSD files

As already known from Profibus-DP, a Profinet system must first be configured before it can be used for data transmission. An engineering tool like Siemens Step7 is used to configure the system. Profinet field devices (→ IO Devices) are included in the network configuration via their General Station Description file (→ GSD file). The engineering tool will upload configuration data into the Profinet Master (→ IO Controller). The IO Controller runs its initialization sequence, and after successful completion the actual data transmission is started.



1. GSD import and configuration in engineering tool
2. Download of the configuration data into controller
3. Cyclic data exchange between controller and field devices

The device manufacturer provides the functional description of a field device (Profinet IO Device) in its GSD file. This GSD file is used to integrate field devices into the engineering tool.

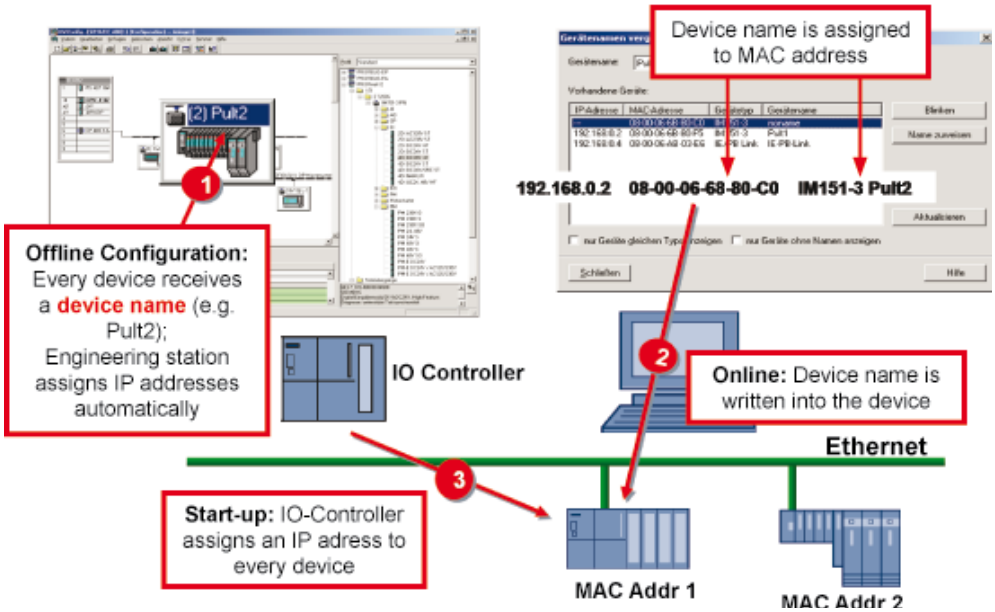
The file contains all necessary parameter details about the field device like device information, communication parameters, module organization, and diagnosis and alarm messages. The Profinet GSD file is written in the description language GSDML which is similar to XML.

Best practice

The Siemens engineering tool Step7 already has the Profinet GSD files of Siemens devices in its built-in GSD catalogue (like for Profibus). Profinet GSD files for third party devices must first be imported, before they can be utilized in the configuration.

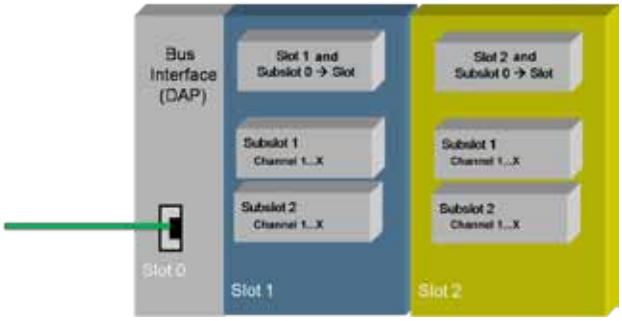
2.5 Device addressing through name assignment

In the engineering tool, a logical name is assigned to every field device which should be related to its functionality in the plant. It will be transformed into an IP address during address resolution. The address can be automatically assigned by the engineering tool or manually by the user. The worldwide unique Ethernet-MAC address of a device however is unchangeably “burnt” in by the manufacturer during production of the Profinet device.



2.6 Profinet IO device data modeling

The General Station Description files (GSD) of the IO Devices get imported into the configuration tool. Subsequently, symbolic peripheral addresses (e.g. IW100 or O16.2) are assigned to every I/O channel of the decentralized field devices. Addressing of I/O data uses the following parameters:



Slot:
Addressing of a physical slot in a modular device

Subslot:
Addressing of data

Channel:
Addressing of a single I/O signal

Best practice

Many modular I/O devices can be utilized for Profinet by simply changing the bus coupler module. Existing I/O modules can be used without any changes. Even PLC programs can be used to a great extent without changes.

2.7 System power-up

From the user's point of view, the IO Controller autonomously initiates the system power-up after startup/ restart according to the configuration data. During power-up, the IO Controller builds up communication relations with individual IO Devices. It configures devices and assigns parameter values to the I/O modules of the respective device. During system startup several interactions are run between IO Controller and IO Device. A typical normal start up (NSU) can take up to 10 seconds or more. This long period of time may be OK for the initial startup. For a restart or during dynamic addition or removal of devices during operations, this time interval is unacceptable. Under the urging of AIDA, Fast Start Up (FSU) has been introduced to Profinet, cutting down the startup time of an individual IO Device to a maximum of 500 ms.

Best practice

Though the Fast Start Up (FSU) functionality for a quick system startup is quite useful, it doesn't belong to mandatory functions. When selecting automation devices, it's always good practice to check, whether FSU is supported.

2.8 Data transmission

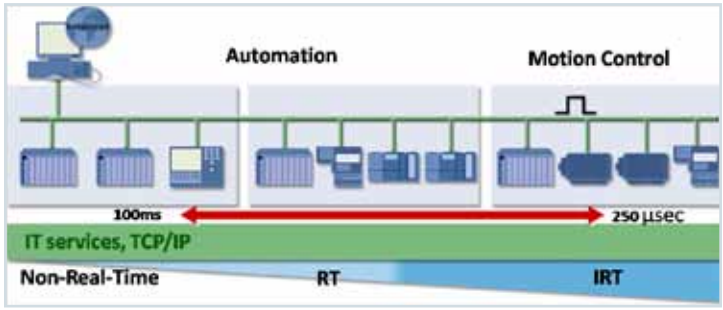
After a successful startup, I/O signals of peripheral field devices are cyclically transmitted to the PLC. The PLC is processing the data and transmits output data cyclically back to the field devices. Using the engineering tool, the frequency of transmission can be configured in multiples of the bus clock for each individual field device and each transmission direction.

Instead of the Master/Slave model of Profibus, Profinet IO follows a Provider/Consumer model of data exchange. This way, IO Devices (Slaves) can send their data autonomously to the IO Controller (Master) without explicit request.

2.9 Real-time behavior

Profinet uses three graded classes for its real time data transmission:

- Non-Real-Time: Communication over Ethernet TCP/IP without any claim to real-time performance
- RT: Real-time-communication for I/O data traffic
- IRT: Clock-synchronized real-time-communication for motion control applications



Best practice

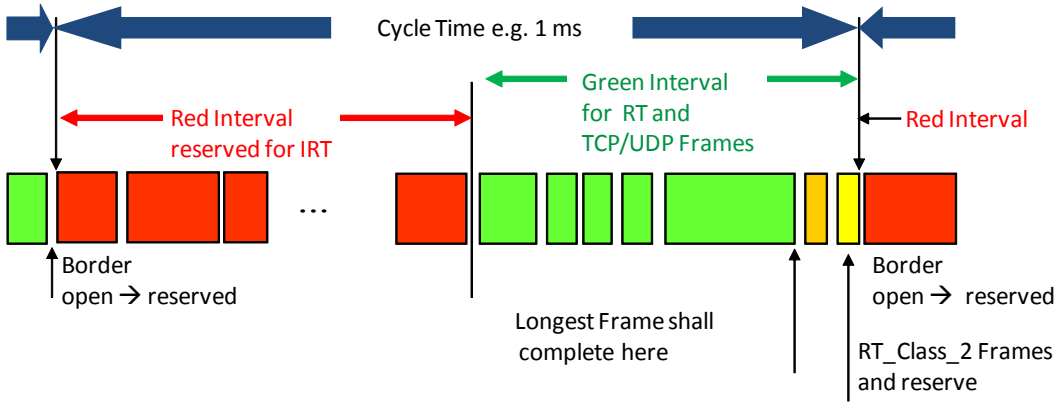
The real-time behavior of Profinet IO real-time communication (RT) is quite comparable to the timing behavior of Profibus-DP.

For best scalability of communication options and determinism, Profinet IO defines real-time classes. From the user's point of view it's a matter of unsynchronized (RT) or clock synchronized (IRT) communication. They don't differ in performance but in synchronism of data transmission (determinism).

RT_CLASS_1 = unsynchronized RT communication
Unsynchronized RT communication is the standard mode of data transmission for Profinet IO. It's real-time behavior is comparable to Profibus-DP. For this RT class, standard switches, suited for industrial use, can be used. The field devices don't need to provide special Profinet hardware support.

RT_CLASS_2 = IRT with high flexibility
In synchronized IRT communication mode according to RT_Class_2 (IRT Flex) the start of a bus cycle is defined for all nodes (→ clock synchronization). This specifies exactly the allowable time slots for field device transmission activity. For all field devices participating in RT_CLASS_2 communication, this is always the start of the bus cycle. Only Profinet-suitable real-time switches and Profinet field devices with special Profinet hardware support can be used inside the IRT domain. Mixed operation with Profinet RT devices is possible when RT devices are arranged at the end of the IRT line.

RT_CLASS_3 = IRT with high performance
During synchronized RT_CLASS_3 communication, process data is transmitted with maximum precision and in exact order, specified during system configuration in the engineering tool (maximum allowable deviation from start of bus cycle of 1 µs). In RT_CLASS_3 communication, there are no wait times for IRT frames, and highest performance and clock synchronism are achieved. On the other hand, there is a remarkable engineering effort and only little flexibility for modifications or extensions of the network. Only Profinet-suitable real-time switches and Profinet field devices with special Profinet hardware support can be used inside the IRT domain.



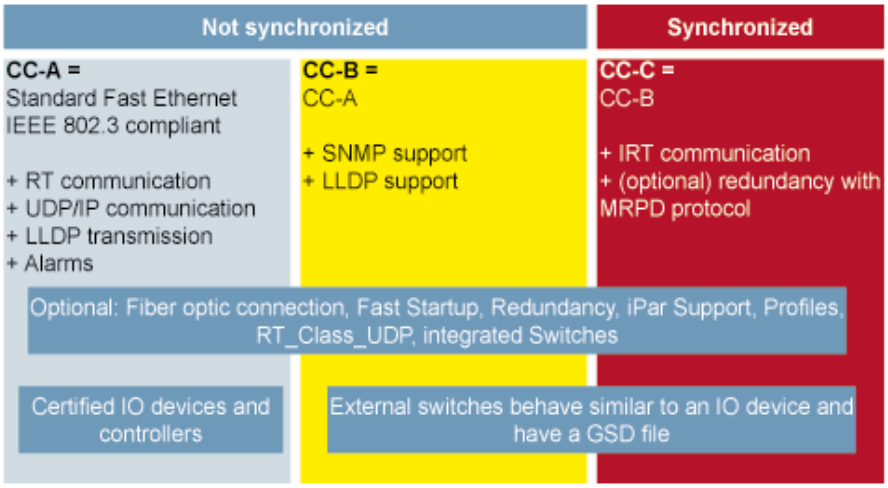
Best practice

Mixed operation of Profinet RT devices with IRT devices is possible when RT devices are arranged at the end of the IRT line.

3 Conformance Classes

Profinet is designed for comprehensive usability in automation engineering: To meet various requirements, three Profinet conformance classes have been defined. They are building up on one another, each providing the functionality typical for the respective application.

Conformance Class A (CC-A):
Use of the infrastructure of an existing Ethernet network including integration of basic Profinet functionality. All IT services can be used without restrictions. Examples of typical applications are e.g. building automation and process automation.



Conformance Class B (CC-B):
In addition to the functions of CC-A, the scope of functions of CC-B supports easy and user-friendly device replacement without the need for an engineering tool. In addition, CC-B devices support advanced device diagnosis as e.g. port status messages. To improve data security, an optional, performance-matched media redundancy protocol is used. All IT services can be run without restrictions. Examples of typical applications are found in automation systems with a super-imposed machine controller, running a deterministic, but not clock synchronized data cycle. The real-time behavior of a Profinet CC-B installation is comparable to the timing behavior of Profibus-DP or other popular field busses like DeviceNet, CANopen, and CC-Link.

Conformance Class C (CC-C):
In addition to the functions of CC-B, the scope of functions of CC-C supports high-precision and deterministic data transmission including clock synchronous applications. The optional media redundancy enables smooth switchover of the I/O data traffic, if a fault should occur. Considering the total available transmission bandwidth, all IT services can be used without restrictions. Typical applications can be found in motion control applications for printing, milling, and textile processing machines. The real-time behavior of a Profinet installation in CC-C can't be met with Profibus. Comparable results concerning performance and clock synchronism are achievable with EtherCAT, Powerlink, and Sercos III.

3.1 Who really needs IRT?

Clock synchronous communication using Profinet IRT functionality according to conformance class C is only needed for applications, where fast control loops are closed via the network. Typical applications are gear or crankshaft grinding machines, high speed milling, wood working machines, packaging and printing machines.

From today's point of view, the majority of Profinet applications can be well served with systems of conformance class B featuring integrated two-port-switch, redundancy and Fast Start Up. Today, applications in need of conformance class C are mainly found in motion control applications.

Best practice

With IRT, Profinet can be used in Motion Control applications with cycle times < 1 ms and Jitter < 1 µs. However, currently (Q2-2010) only a few devices support the full IRT functionality.

3.2 Are there any differences between application profiles?

Application profiles are specifications of features and behavior for Profinet field devices which have been jointly developed by manufacturers and users. The use of application profiles for standardization aims at the interchangeability of functional equivalent devices from different manufacturers. Profibus has a great number of different application profiles which are currently ported to Profinet by working groups of the Profibus Nutzerorganisation e.V. (PNO). The goal is, to make devices behave equal from a user's point of view, irrespective of whether they are controlled by Profibus or Profinet. Major application profiles include:

PROFIsafe:

- Specifications for the transmission of safety related data (Safety), available for Profibus and Profinet.
- Identical behavior from the user's point of view

PROFIdrive:

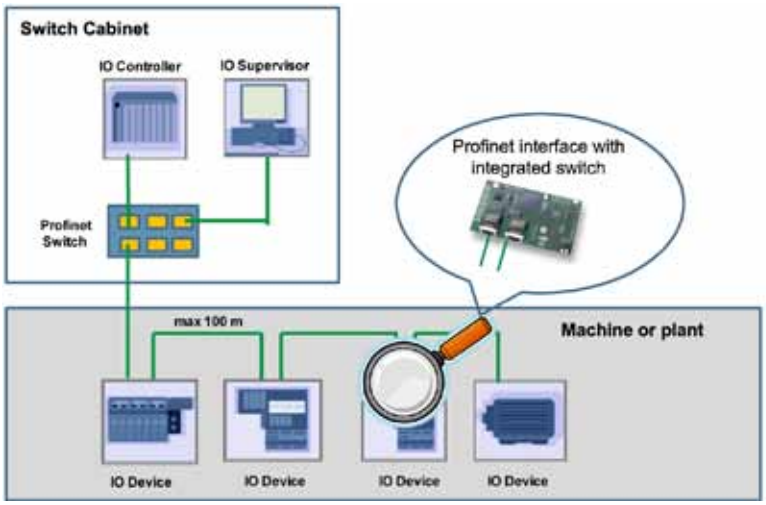
- Specifications for the control of electrical drives, available for Profibus and Profinet
- Identical behavior from the user's point of view

PROFIenergy

- Specifications for control and optimization of energy consumption of field devices developed on request of the automotive industry, available for Profinet

4 How is a typical Profinet installation organized?

Profinet uses 100 Mbit/s Fast-Ethernet for physical data transmission. All bus devices are solely connected via switches. The use of hubs is not allowed. The consistent use of switches provides high flexibility in terms of network topology and enables an almost unlimited network extension. In principle, Profinet can be installed in star, line, or ring topology. In practice however, installation in star or line topology is preferred. Normally, a line topology is chosen when the Profinet devices are equipped with an internal two-port switch. In the automotive industry, devices with integrated switches became standard. Expensive external switches are avoidable to a large extent. The installation of the Profinet network follows the production line - equal to the well-known Profibus line topology.



4.1 Are there special Profinet cables?

Profinet cables are similar to shielded standard four-wire 1:1 Ethernet category 5 cables. The use of these cables in the field is not recommended due to their EMC properties and the costly assembly process. The Profinet specification defines a special Profinet cable, which is aimed at the requirements of automation technology in terms of handling, ruggedness, EMC properties and color coding.

- Type A: Four-wire shielded copper cable for fixed installation
- Type B: Four-wire shielded copper cable for flexible installation
- Type C: Four-wire shielded copper cable for continuous movement

Best practice

For a quick laboratory set-up shielded standard 1:1 Ethernet cables can be used.

4.2 What about fiber optic cables?

When extreme EMC or strong potential differences are to be expected in certain plant areas, Profinet should be implemented using fiber optic cables. Fiber optic cables are mandatory for Profinet installations in the Volkswagen Group.

For bidirectional transmission of signals two optical lines are combined in a fiber optic connection. A fiber optic access port consists of a sender and a receiver. A fiber optic cable consists of two fibers.

Four different types of fiber are used for Profinet. Type selection shall consider the requirements of the respective automation project.

- Glass fiber, single-mode or multi-mode, for very long distances
- Hard clad fiber (HCS) for medium distances
- Plastic fiber (POF) for short distances

4.3 What types of plug connectors are used for Profinet?

Inside a control cabinet RJ 45 connectors with IP 20 protection rating are used.
If service is needed, a notebook can easily be attached. Profinet RJ 45 plugs are only compatible to commercial available RJ 45 plugs in terms of contact arrangement. In contrast to commercial plugs, Profinet plugs are specially designed for Profinet cables and facilitate cable assembly in the field. To cut down assembly time, special stripping tools (→ Profinet Stripping Tool) are available. Cable, plug and stripping tool from the same manufacturer are perfectly matched. The handling is comparable to the well-known Profibus Fast Connect System.

Best practice

Not every plug type suits every device. For instance, Phoenix Profinet RJ 45 plugs don't fit every Profinet connection port of Siemens devices.

Outside of control cabinets the harsh environment must be taken into consideration. Here, a push-pull plug connector with protection class IP 65 or IP 67 is used.

The used Profinet device or switch must have the exact mating connection port.

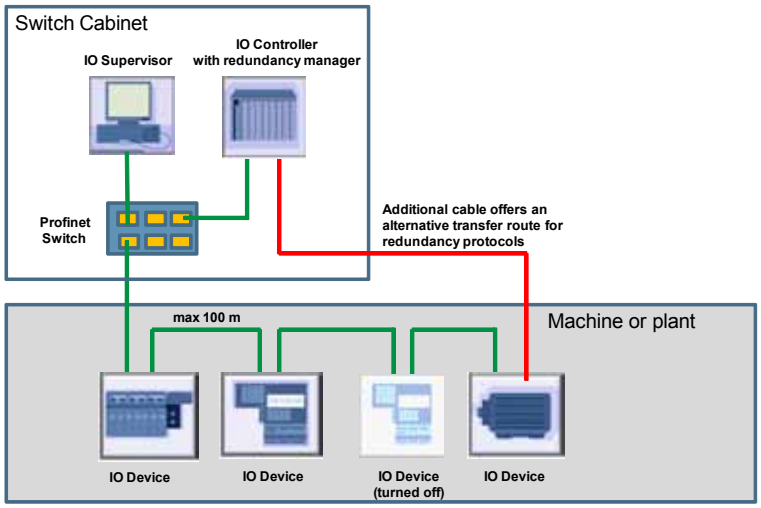
For fiber optic cables SCRJ plugs are used. The basic version of this plug is designed for inside-use in control cabinets (IP 20). For harsh environments, or IP 65 / IP 67 requirements, the SCRJ push-pull version is used.

4.4 What's the use of the redundancy feature?

Profinet's redundancy functions shall guarantee a trouble-free data transmission even when there is an interruption along the transmission line. The redundancy function is of great importance as it shall not only compensate for a physical interruption of the line. The much higher risk is given, when a system is layed out in line topology and one device in the line is switched off or fails. Without the redundancy function, simple

switching-off of a device may severely disturb the network. The redundancy functions solve that problem and re-direct data traffic to alternate paths. Depending on the real-time requirements three different redundancy protocols can be used:

- **Class 1 MRP:** Profinet Media Redundancy Protocol
  Scope of application: Non-real-time, typical switchover time < 200 ms
- **Class 2 MRRT:** Profinet Media Redundancy Protocol for Realtime
  Scope of application: Real-time applications, smooth switchover
- **Class 3 MRPD:** Profinet Media Redundancy Protocol for IRT-Frames
  Scope of application: Motion control applications, clock-synchronous switchover



Best practice

Today (Q2-2010) most devices support redundancy with MRP protocol.

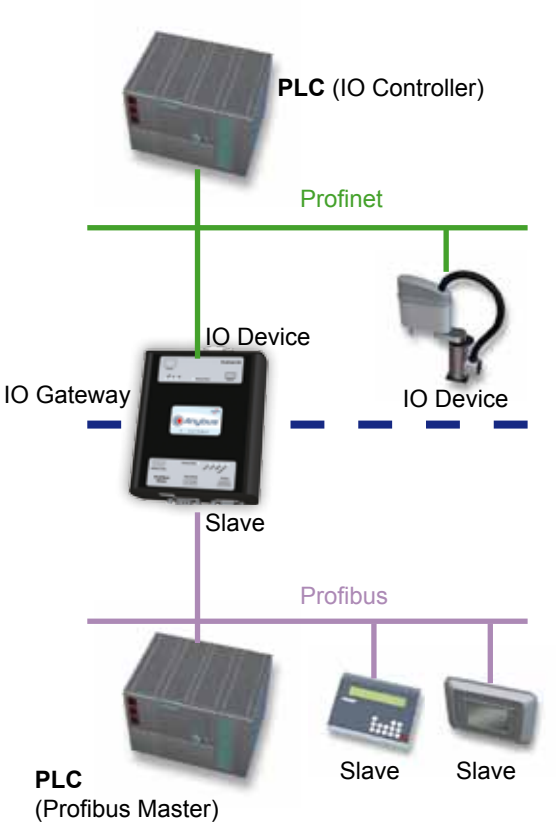
5 How can Profibus-based sections of a plant be integrated into Profinet?

The currently demanding economic situation supports the coexistence of Profibus and Profinet: New plants are no longer designed from scratch. Existing machines and plant parts are often integrated into new structures without change. Depending on the actual application, Profibus and Profinet are coupled via proxies or IO gateways.

Proxies come in handy when all parts of the plant are controlled by a superimposed PLC and the subordinate parts don't have local PLCs. IO gateways should be used when the PLC remains in the subordinate Profibus-based part and only selected control and synchronization information is exchanged between both parts of the plant.

5.1 How to interconnect two plant parts which each have their own PLC?

Very often, a large proportion of production know how is concentrated in the code of the PLC programs. So it makes sense to integrate existing parts of a plant into the new Profinet-based system including their respective PLC.



It's important, that both parts of the plant can be synchronized to each other and can exchange control and status information. This is achieved via I/O signals like start and stop signals or ready and error messages.

The interconnection of the two parts can simply and reliably be organized using an IO gateway like the Anybus X-gateways from HMS. From the network's point of view, the IO gateway behaves like a slave on the Profibus side, and like an IO device on the Profinet side of the combined network.

Data transmission in a gateway is cross-wise. Profibus input data become Profinet output data and vice versa. Data flow is controlled through cyclic IO data exchange from both PLCs.

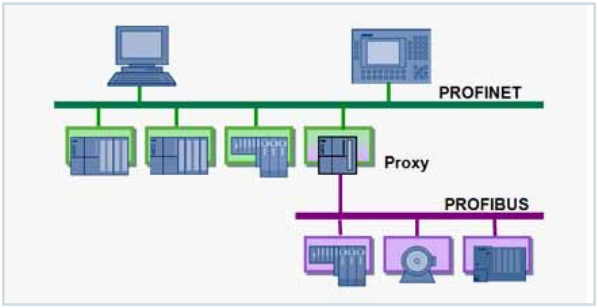
Best practice

Best practice: In machine building industry, IO gateways are often used as well-defined interfaces between two different parts of a plant. The involved networks are not necessarily of a different type. Gateways can connect identical types of network as well. Profibus-Profibus or Profinet-Profinet couplers are typical applications. The Anybus X-gateway family from HMS again provides suitable solutions.

5.2 How are proxies performing?

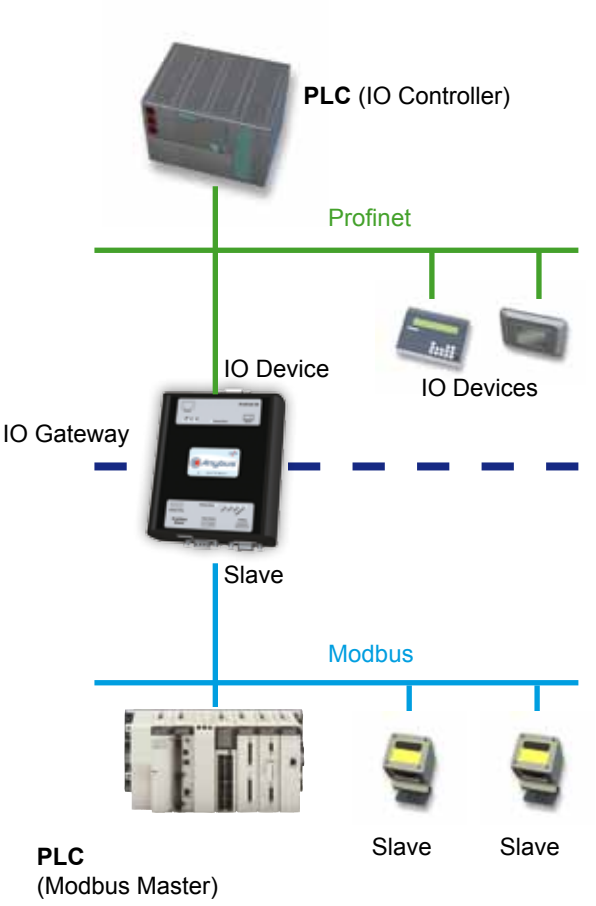
If all of the plant's intelligence is concentrated in the superimposed PLC of the Profinet, Profibus automation devices can be integrated into Profinet by means of a proxy.

A proxy is regarded as a master on the Profibus side and as an IO device on the Profinet side. It represents the Profibus participants for the Profinet side. From the Profinet PLC's point of view, Profibus devices behave as if they were directly connected to Profinet. The complete engineering is organized in the configuration tool of the Profinet PLC. Profibus-Profinet proxies are offered e.g. by Siemens, Profinet-Interbus proxies are offered by Phoenix Contact.



5.3 How can other fieldbus types be integrated into Profinet?

To interconnect with other plant parts which are based on field busses like DeviceNet, CA-Nopen, Interbus or CC-Link, IO gateways can be used. IO gateways combine both worlds. They transmit selected control and status signals as I/O signals between both nets. Computation and evaluation of the signals is performed by the respective PLCs of both nets. The PLC programs can be utilized unchanged to a large extent. Gateways are regarded as slaves on both sides.

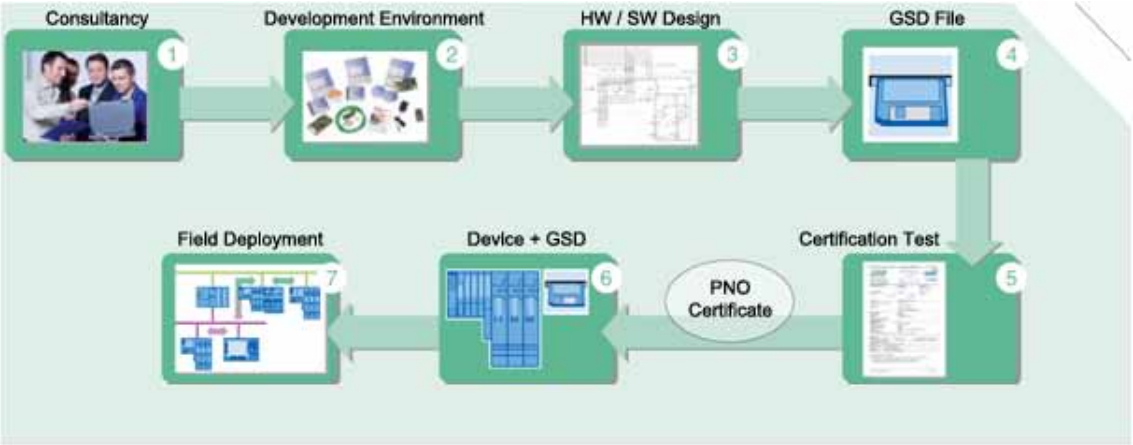


Best practice

The Anybus X-gateway family from HMS includes more than 180 different variants of IO gateways, enabling the linking of all popular fieldbus and PLC worlds.

6 How to develop a Profinet device interface

Every design process for a new device consists of several distinct steps. A typical process flow for a Profinet design is shown in the following illustration.



At the very beginning of the integration of a Profinet communication interface into a field device, information shall be gathered on how Profinet operates and which method of implementation to choose. A good introduction into the topic can be derived from accredited Profinet competence centers offering consulting services and seminars.

Every new development will reach its goal faster, when “the wheel doesn’t need to be re-invented”. At Profinet, device manufacturers can draw on an extensive range of pre-certified basic technology components as well as on the sound expertise of proven technology partners.

	Internal Profinet know-how required	Time-to-Market	Internal development resources required
In-house development	Profound	Long	Many
Cooperation with development partner	Internal gaps in Profinet knowledge are closed by the partner	Medium	Medium
Development by technology partner	Only little knowledge required	Depending on the partner‘s experience	Little

Depending on the required functionality (Conformance Class) developers have to choose the implementation method that best suits the individual case. Engineering capacity, in-house Profinet know how, expected production costs for the interface and time-to-market are among the key items which should be considered. Moreover, it should be carefully decided, whether a pure Profinet interface is to be designed or a more general interface, which is also suitable for communications via Profibus and other industrial networks

6.1 Hardware and software design

Design approach as well as time and effort for hard- and software design highly depend on the chosen implementation method. Development work can be done completely in-house or in cooperation with a development/ technology partner. In-house development requires sound Profinet know how and free resources for hard- and software development. To unburden in-house development resources, developer-packages, ready-to-install communication modules and a large variety of development services are offered to suitably support device manufacturers - ranging from an early concept stage over hardware/software development to certification.

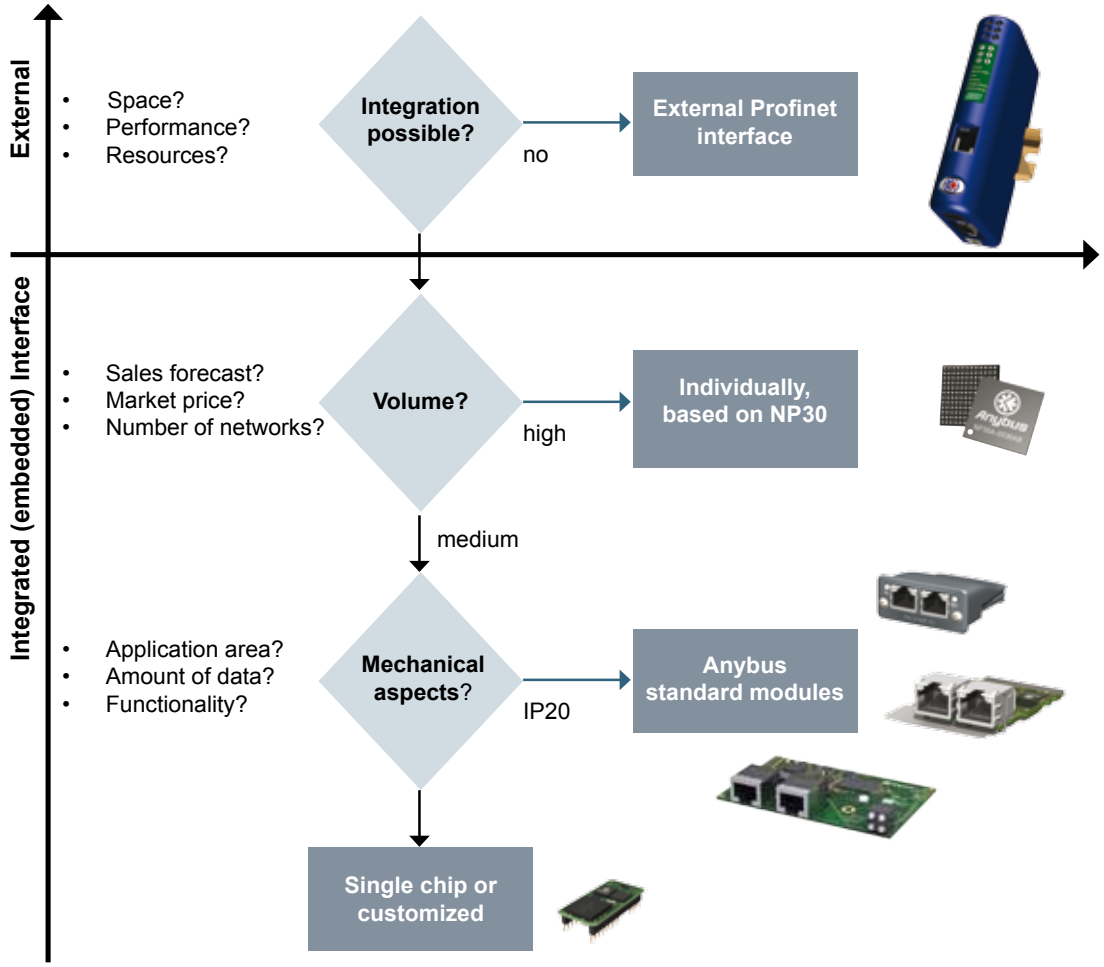
	Development cost	Manufacturing cost per item	Time-to-Market
Individual design	High	Optimal	Long
Communication module	Low	Depending on quantity	Short
External coupler	None	High	Very short

Best practice

Before starting to develop a Profinet device interface, device manufacturers should consider the targeted conformance class, as the implementation method has great influence on the achievable conformance class.

6.2 What can HMS offer to support the development of a Profinet interface?

To assist the development of a Profinet device interface, HMS offers a broad spectrum of certified basis technology and development-supporting services. All solutions have in common, that the device manufacturer doesn't need to dive into details of Profinet protocols and stacks. The communication interface will be designed based on proven Anybus technology components. Thanks to the modular concept, a universal communication interface will be developed, which provides possibilities to access many industrial networks within a single step of development.



6.3 External couplers → Anybus Communicator


Communicator

The use of an external protocol converter (Anybus Communicator) is appropriate when the field device has a serial interface and the Profinet connection can't be integrated. The Communicator is connected to the serial interface of the field device and converts the device's protocol into Profinet protocol. Neither hardware, nor software of the field device needs to be altered.

6.4 Ready-to-install communication modules → Anybus-S and Anybus-CC


Anybus-CC

For a device-internal implementation of a Profinet interface HMS offers ready-to-install communication modules. They manage the complete protocol autonomously without loading the device's processor. The module comprises all hardware components of the Profinet interface including the internal two-port switch. The required development is limited to connecting the module to the device's circuitry via a serial or parallel dual-port RAM interface. The remarkable features of this solution are low development expenses and short design time. Typical design time: two weeks. Further benefit of this approach is the large variety of available functional compatible modules. Not only Profinet and Profibus are supported, but also field busses like DeviceNet, ControlNet, CANopen, CC-Link, Interbus, and Modbus as well as industrial Ethernet systems like EtherNet/IP, EtherCAT, Modbus-TCP, and Sercos III.


Anybus-S

Best practice

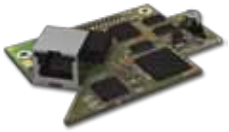
All modules of a module family feature a unified hard- and software interface. To a large extent, the device's software can be designed irrespective of the chosen bus system.

6.5 Single chip interface → Anybus-IC


Anybus-IC

Small-sized field devices can benefit from HMS' Anybus-IC, an all-in Profinet solution with the footprint of a 32 pin DIL socket. Barely 8 cm² are needed by the IC to present a full featured Profinet interface. A serial UART interface connects to the device's electronics. The IC is also suitable for processorless field devices, as up to 128 I/O signals can be directly controlled.

6.6 Customer specific solutions


Customized

In addition to standard modules, HMS offers customer specific solutions based on the Anybus NP30 processor. These individual solutions build up on the proven Anybus technology and come into play, whenever special requirements must be considered which can't be met by standard modules, e.g. high protection class (IP 65), individual footprint, special terminals, or a specific power supply. Customer specific modules feature the same software interface as standard modules. Relying on proven technology, customers benefit from short development times, low risk and fixed costs, which include HMS' continuous software updates.

Overview of Profinet interface solutions from HMS

Product family	Achievable conformance class	Package	Recommended for volume (pcs.)/ year	Integrated two-port switch	IRT hardware support
Communicator	A	External coupler, DIN rail mounting	Small, up to 100	No	No
Anybus-S	A, B, C	Standard module, Credit card sized	Medium, up to 1k	Yes	Yes
Anybus-IC	A	Standard module, DIL-32 socket	Medium, up to 2k	No	No
Anybus-CC	A, B, (C planned)	Standard module, CompactFlash sized	High, up to 5k	Yes	Planned
Customer specific	A, B, C	Individual solution, Sized to meet customer requirements	Very high, up to 20k	Yes	Yes

7 Do Profinet devices have to be certified?

The certification serves quality assurance and helps to reduce inter-operability problems between Profinet devices from different manufacturers. Most plant operators only accept certified Profinet devices. At Profinet, device certification by an accredited test laboratory is mandatory. Globally, six Profinet test laboratories are available.

The fully developed Profinet device gets tested by an accredited test laboratory. In case of positive test results, the device manufacturer can use the test report to apply for a certificate to the Profibus User Organization (PNO). Among the performed tests are:

- Hardware tests
- Run-in tests
- Tests of the state machines
- Responses on errors
- Behavior in the network
- Alarm tests
- Check of the GSD file

Best practice

Due to the huge functionality of Profinet technology, the failure rate of the initial testing is very high - especially for in-house developments. If the device manufacturer however uses ready-to-install communication modules, he can benefit from HMS' know-how and the opportunity to run a pre-certification test based on the official test software at HMS.

8 What's the purpose of Profinet Competence Centers?

Compared to Profibus, Profinet is a very innovative and multifaceted technology. Accredited Profinet competence centers provide valuable assistance for a quick access to Profinet technology, offering a broad range of trainings and services.

HMS runs an accredited competence center for Profibus and Profinet in Germany. The range of trainings and services is consequently targeted towards the needs of device manufacturers. It's the company's goal to guide device manufacturers through all phases of the development cycle on a partnership basis. The range of services covers trainings on Profinet fundamentals and services which are aimed at the aspects of Profinet interfacing using Anybus technology. They include implementation consultancy, developer trainings, development support, adaptations of the GSD file and preparatory tests for a successful certification.

9 Comparison between Profibus and Profinet

To find out, whether the changeover to Profinet pays off in a specific case, it's advisable to set up a comparison under technical and commercial criteria.

From the technical point of view, Profinet impresses with its comprehensive communications options, the graded real-time concept, the coexistence of real-time communication and IT functions and a virtually unlimited number of participants in a virtually unlimited extension of the network. On the other hand, Profinet brings more complexity, the need for a careful planning of the network, and some more pitfalls for newcomers must be taken into account.

Technical criteria

	Profibus	Profinet
Number of stations	Max. 127	Nearly unlimited
Max. transmission speed	12 Mbit/s	100 Mbit/s, 1 Gbit/s planned
Reach of the network at max. speed	Approx. 1 km (depending on repeater type)	Several km, depending on the performance desired
Amount of data per telegram	Max. 244 Byte	Max. 1.440 Byte
Performance (Best Case)	1 k I/O data and 32 Stations in > 1 ms mit Jitter > 10 µs	1 k I/O data and 32 Stations in < 1 ms mit Jitter < 1 µs
Combination of real-time and IT communication	Not possible	Possible
Bus powering, intrinsic safety	Possible	Planned
Concept of communication	Master-Slave	Provider-Consumer

Under a commercial point of view it is noticeable, that the installed basis of both systems shows double-digit growth rates - even in 2009, the year of the financial crisis. Growth-rates of Profinet are (on a significant smaller number of installed devices) much higher than those of Profibus. But a rapid changeover can't be derived from these figures. In addition, it is obvious that the number of Profinet-capable field devices is manageable, whereas a Profibus interface today is standard functionality for almost every field device.

Commercial criteria

	Profibus	Profinet
Main field of application (today)	Production, process, and building automation	Production, especially automotive industry (AIDA)
Available PLC master interfaces	All leading PLC and IPC manufacturers	Siemens, Phoenix Contact, further under development
Complexity	Manageable, Profibus know-how sufficient	High, additional IT knowledge incl. security necessary
Motion Control	Only Profibus DPV2	Only Profinet IRT
Market penetration (Q2-2010)	International, largest market in Europe	International, largest market in Germany
Maintenance and set-up tools	Wide range of tools available	Only a few tools available, very expensive
Device certification	Optional	Mandatory
Diversity of devices	> 2000 devices	> 200 devices
Installed base (Q4/2009)	Approx. 31 million nodes, growth 2009: 11 %	Approx. 2 million nodes, growth 2009: 31 %

The use of Profinet will pay back, when the application really benefits from the new features: the coexistence of IT and real-time communication, the higher amount of data and the much larger possible extent of the network. For standard applications where cyclic I/O data traffic between PLC and peripheral devices is in the focus, field busses like Profibus, DeviceNet, CANopen, and CC-Link are still the systems of choice.

10 Further information

Subject	Internet address
Official Profinet website	www.profinet.com
Profinet connectivity solutions	www.anybus.com/products/profinet.shtml

11 Disclaimer

HMS has taken the utmost care in compiling the information contained in this white paper, we cannot guarantee that the content is completely error-free, and HMS can assume no liability, regardless of the legal basis for any potential claims. The information in this Whitepaper is reviewed on a regular basis. Any necessary corrections will be made in subsequent editions. We would be grateful for any suggestions as to how the content could be improved. Any designations that appear in this brochure could potentially constitute trademarks. Any use of such trademarks by third parties for their own ends risks infringing the rights of the proprietors concerned. This Whitepaper is not intended as a substitute for IEC 61158 or IEC 61784 or for the Profinet guidelines and profiles; in case of doubt, reference must always be made to these official sources of information.

HMS Industrial Networks is the leading independent supplier of embedded network technology for automation devices. HMS develops and manufactures solutions for interfacing automation devices and systems to industrial networks. Development and manufacturing takes place at the headquarters in Halmstad, Sweden. Local sales and support is handled by the branch offices in China, USA, Germany, Italy, France, UK and Japan. HMS employs over 160 people and reported sales of €23 million in 2009. HMS is listed on the NASDAQ OMX Nordic Exchange in Stockholm in the category small Cap, Information Technology: ISIN SE0002136242.

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