Practical comparison between:

PROFIBUS

and

PROFINET

Annual Meeting PICC/PITC/PITL Genova, Italy June 2016

SIMLOGIC. PICC POLAND
Mariusz Jablonski

LITERATURE

1. PI PROFIBUS/PROFINET MATERIALS
2. Industrial communiction with PROFINET Manfred Popp
3. PROFIBUS Manual MAX FENSTER
4. SIEMENS - From PROFIBUS DP to PROFINET IO Programming Manual, 10/2006
5. SIEMENS MATERIALS FOR PROFINET AND PROFIBUS

The differences between PROFIBUS and PROFINET

Overview
USS RS485
ETHERNET
FACTORY
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PROFIDRIVE
PROFIENERGY
VLAN
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IMPLEMENT
SIEMENS PLC
PRESENT

	PROFIBUS	PROFINET
organization	PI	
application profiles	same	
concepts	Engineering, GSDs	
physical layer	RS-485	Ethernet
speed	12Mbit/s	1Gbit/s or 100Mbit/s
telegram	244 bytes	1440 bytes (cyclic)^
address space	126	unlimited
technology	master/slave	provider/consumer
connectivity	PA + others*	many buses
wireless	possible*	IEEE 802.11, 15.1
motion	32 axes	>150 axes
machine-to-machine	No	Yes
vertical integration	No	Yes
^with multiple telegrams: up to 2^{32}-65 (acyclic)		
*not in spec, but solutions available		

Source: PI USA Articel

PROFIBUS/PROFINET - Communication Services

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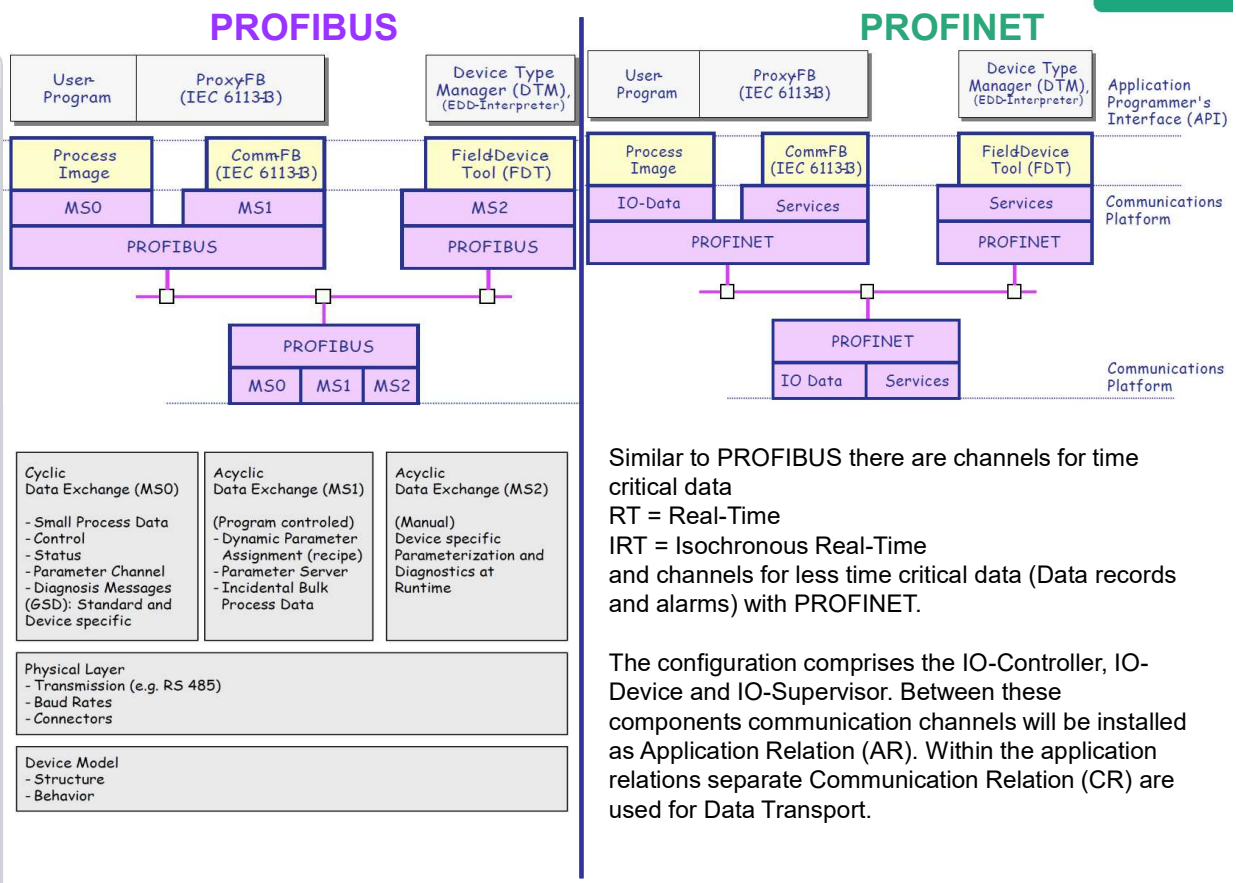

Similar to PROFIBUS there are channels for time critical data
RT = Real-Time
IRT = Isochronous Real-Time
and channels for less time critical data (Data records and alarms) with PROFINET.

The configuration comprises the IO-Controller, IO-Device and IO-Supervisor. Between these components communication channels will be installed as Application Relation (AR). Within the application relations separate Communication Relation (CR) are used for Data Transport.

Application Profiles

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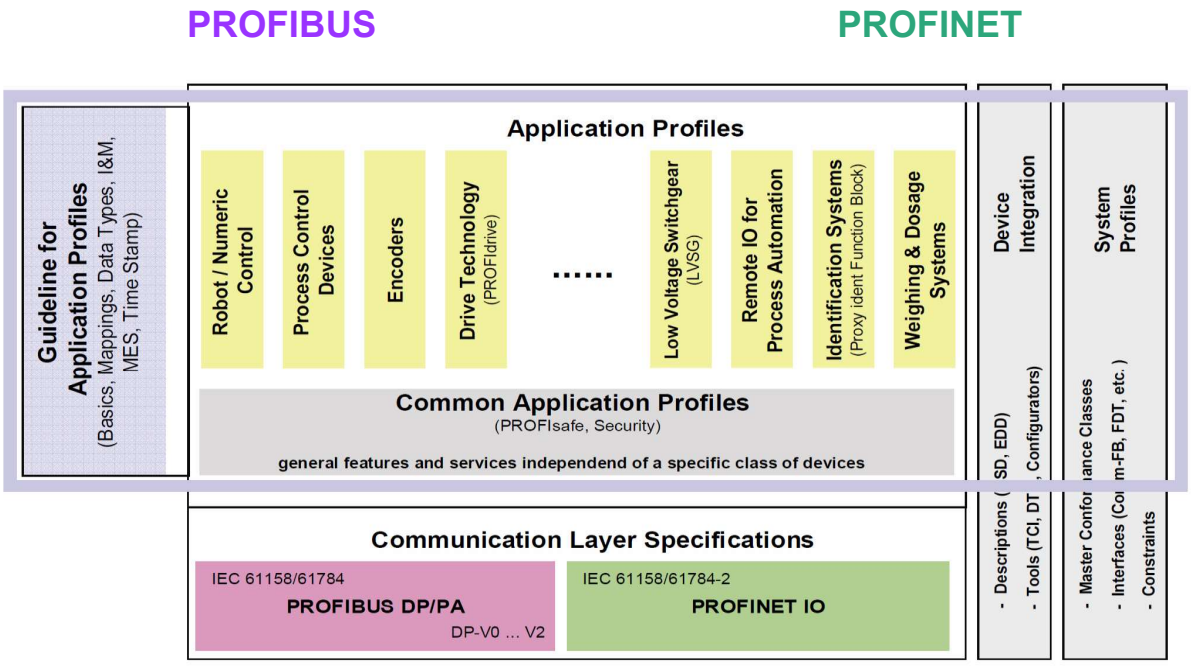

Application Profiles an Common Application Profiles are based on Communication Layer Specifications.

RS 485 USS - > PROFIBUS

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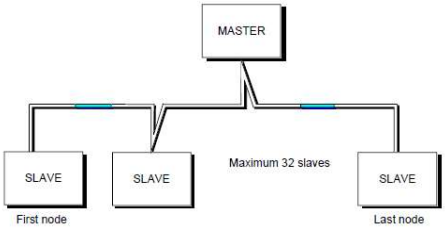
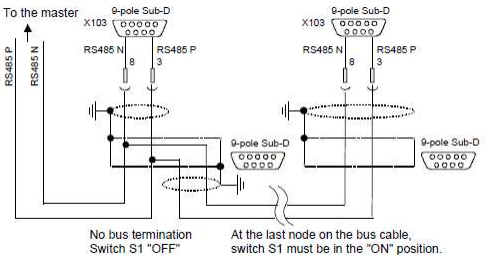
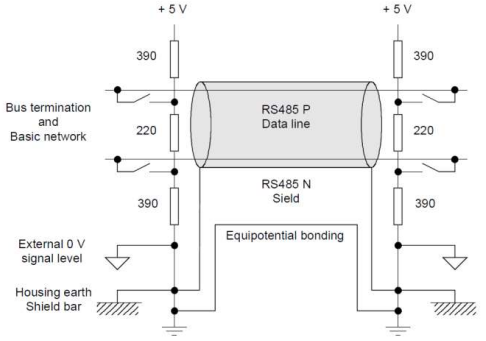
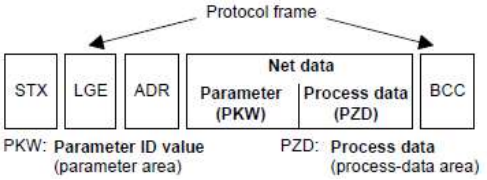


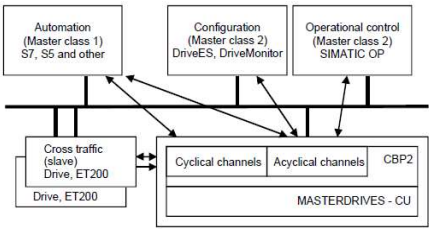


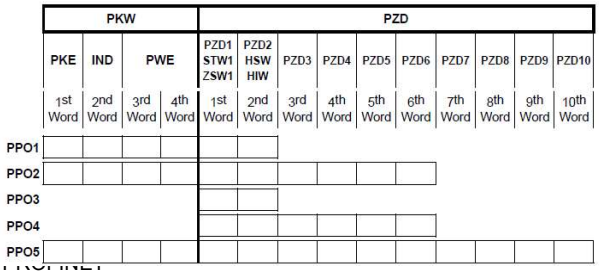


Data transfer rate	Max. number of nodes	Max. cable length
9.6 kbit/s	32	1200 m
19.2 kbit/s	32	1200 m
93.75 kbit/s	32	1200 m
187.5 kbit/s	30	1000 m

Cable resistance (20°C)	≤ 40 Ω/km
Insulation resistance (20°C)	≥ 200 MΩ/km
Operating voltage (20°C)	≥ 300 V
Test voltage (20°C)	≥ 1500 V
Temperature range	-40 °C ≤ T ≥ 80 °C
Load capability	≥ 5 A
Capacitance	≤ 120 pF/m







ETHERNET – INDUSTRIAL - PROFINET

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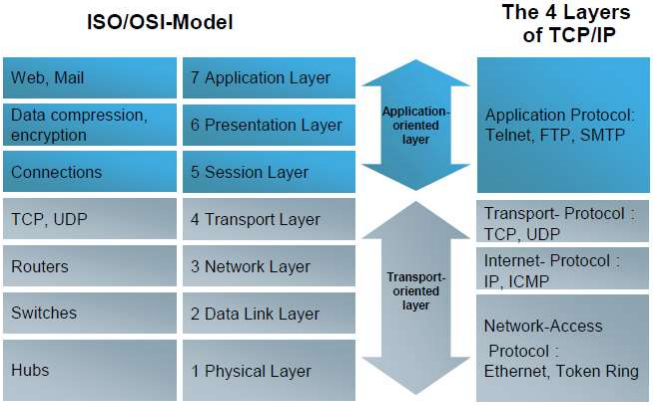

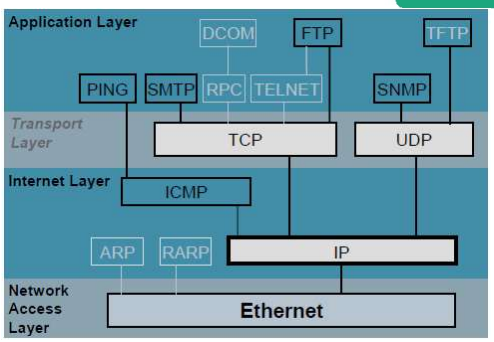

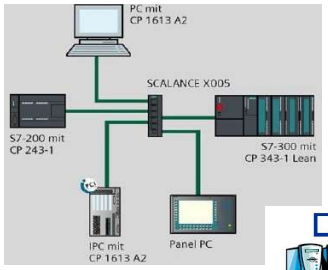

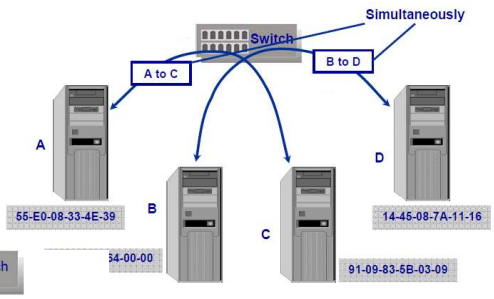

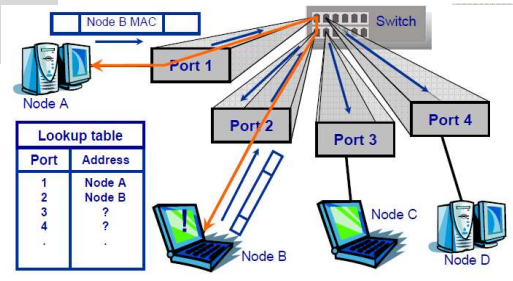

ETHERNET VS INDUSTRIAL ETHERNET

SIEMENS

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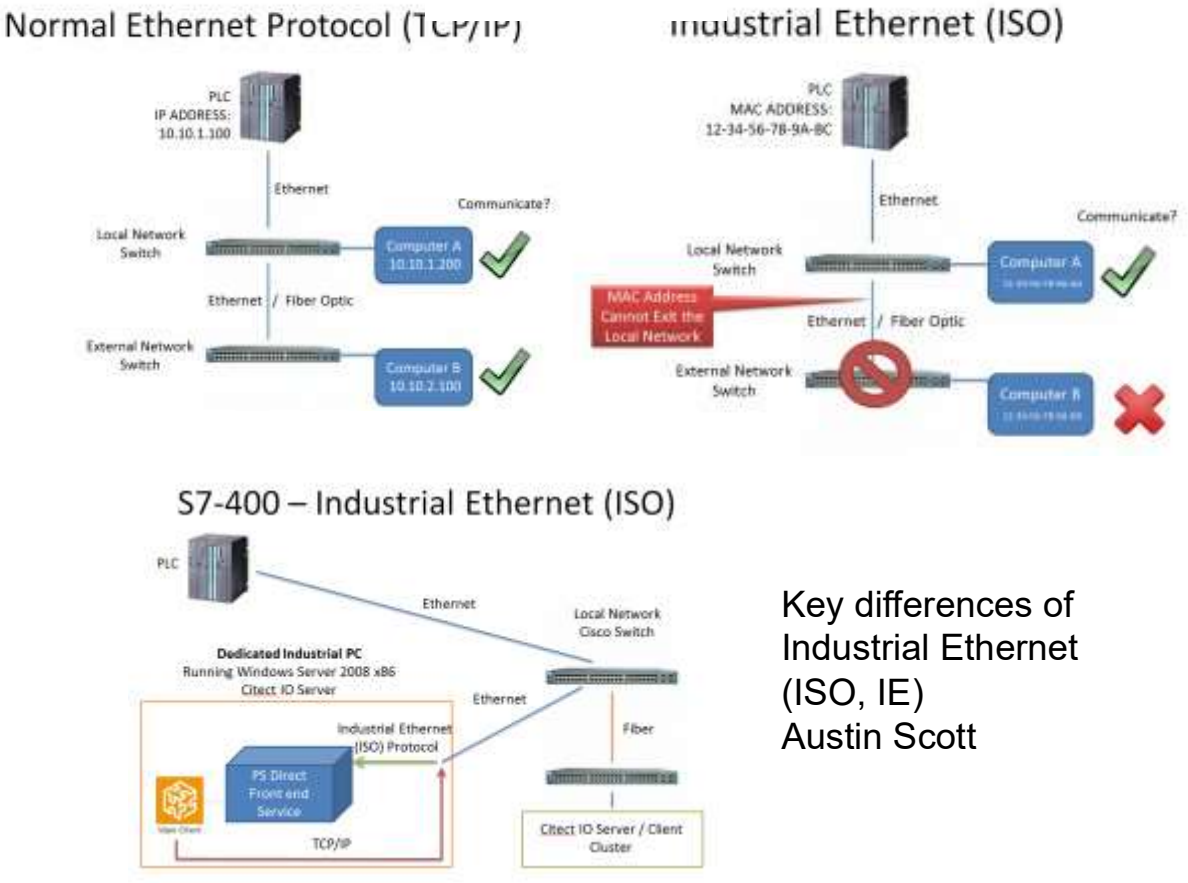

Key differences of Industrial Ethernet (ISO, IE)
Austin Scott

Annual Meeting PICC/PITC/PITL Genova, Italy June 2016

PROFINET – PROFIBUS FACTORY INTEGRATION

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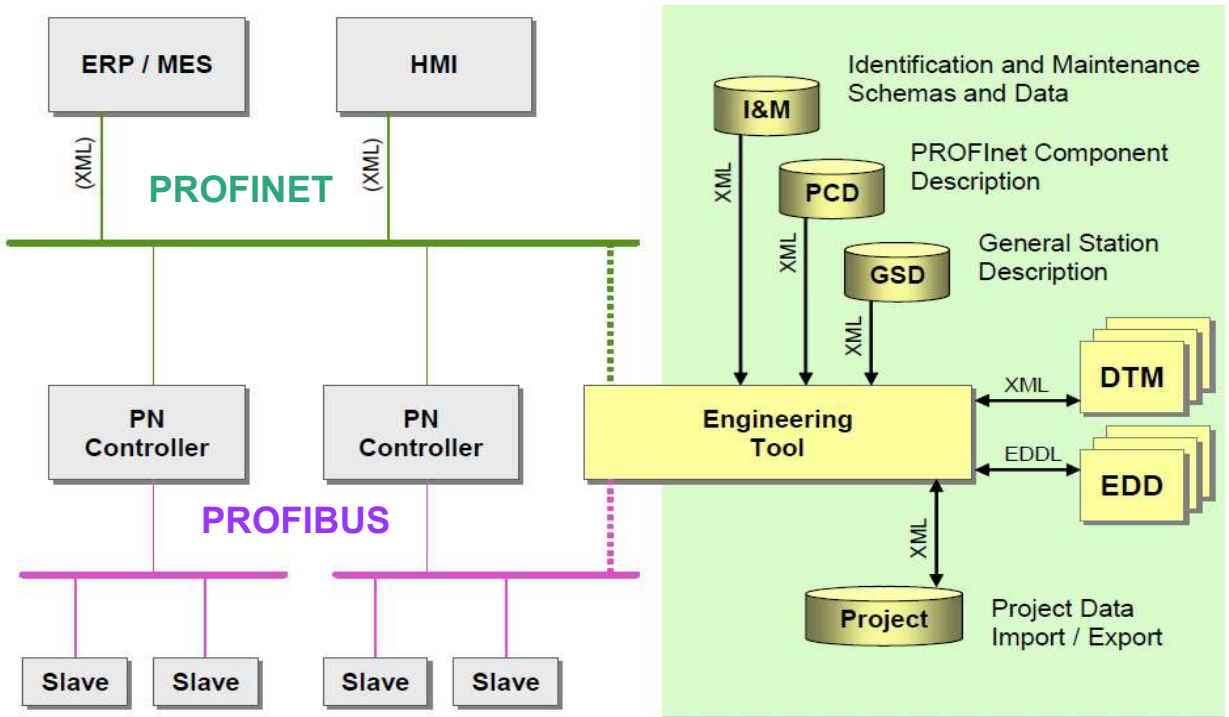

Mariusz Jablonski / Practical comparison between PROFIBUS and PROFINET

ISO/OSI 7-layer model expand to 4 layers in Ethernet

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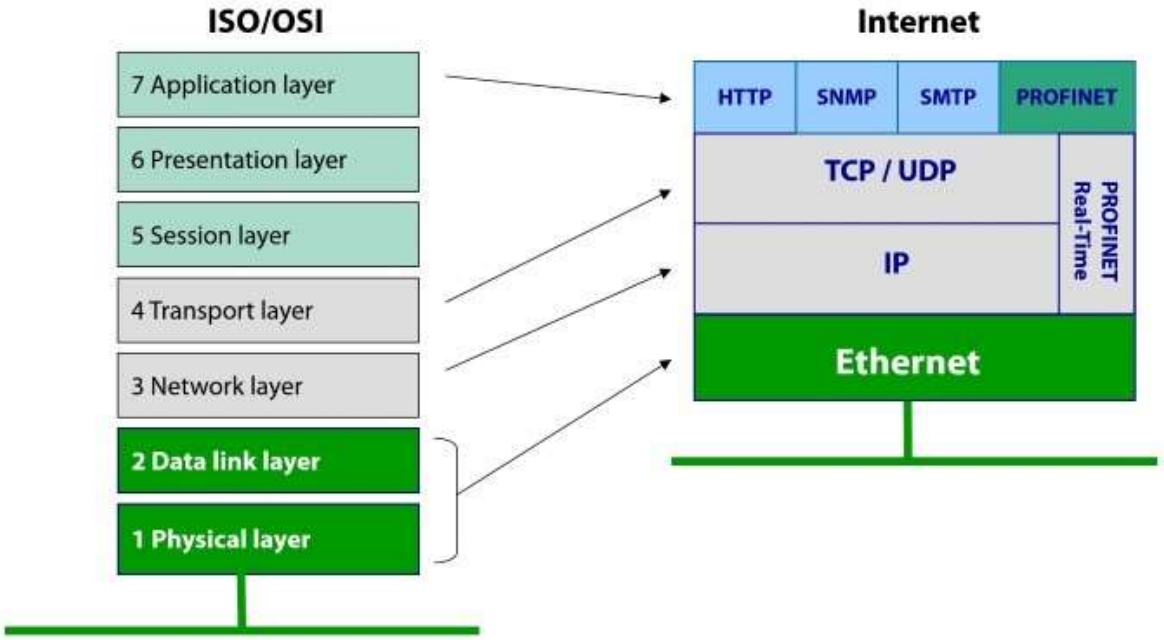

The ISO/OSI 7-layer communications network model with connections to 4 layers in Ethernet usage. The common requirement is that an application layer protocol is required, be it email (SMTP), web browser (HTTP), or PROFINET.

ISO / OSI MODEL

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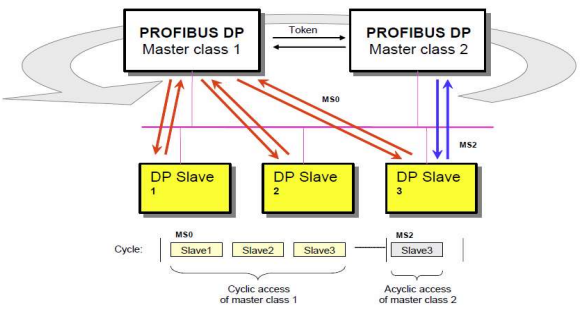
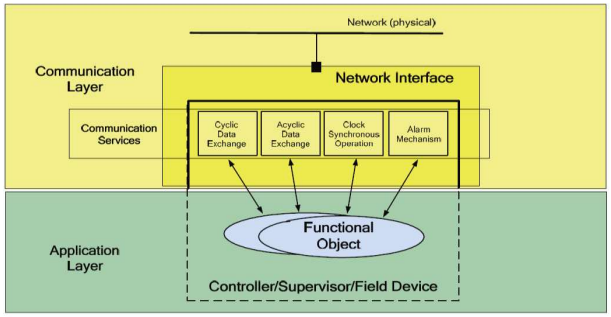
PROFIBUS

Layer	Name	Content
(Layer 8)	User Layer	Profiles
Layer 7	Application Layer	DP / FMS protocol
Layer 2	Data Link Layer	FDL protocol
Layer 1	Physical Layer	Transmission technology



PROFINET

IEC 61158 document	IEC document content	OSI layer
IEC 61158-1	Introduction (not relevant here)	
IEC 61158-2	Physical Layer Specification and Service Definition (not relevant here)	1
IEC 61158-3	Data Link Service Definition (not relevant here)	2
IEC 61158-4	Data Link Protocol Specification (not relevant here)	2
IEC 61158-5	Application Layer Service Definition	7
IEC 61158-6	Application Layer Protocol Specification	7



PROFIBUS - Data types, Programming Languages and Platforms

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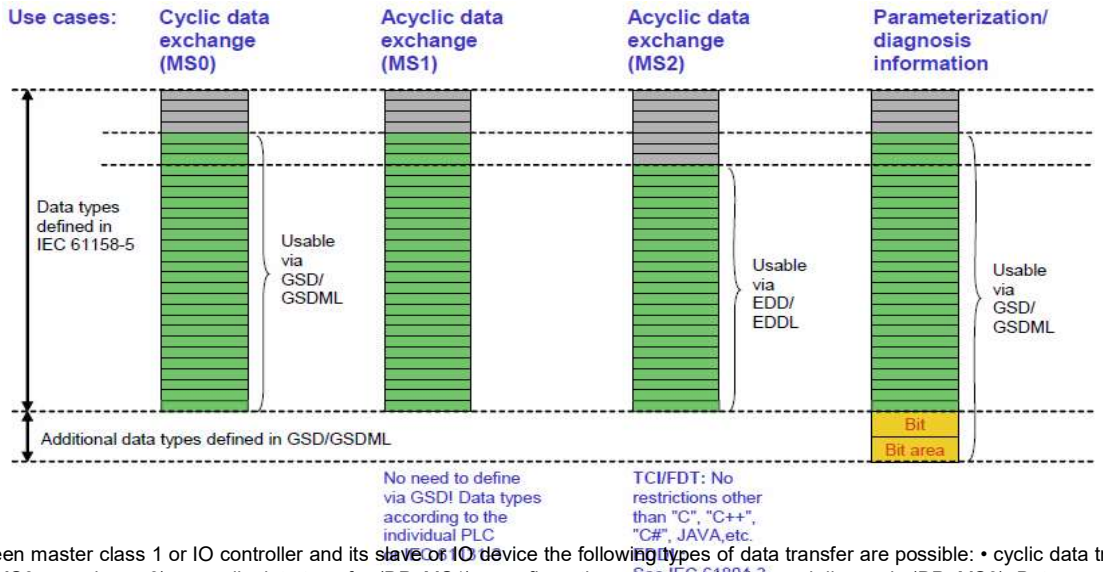

Between master class 1 or IO controller and its slave or IO device the following types of data transfer are possible: • cyclic data transfer (DP: MS0, see clause 3), • acyclic data transfer (DP: MS1), • configuration, parameterization and diagnosis (DP: MS0). Between master class 2 and slaves only acyclic data transfer (DP: MS2, see clause 3) is possible. The valid set of data types is different for the different transfer possibilities. The **cyclic** data transfer is configured using GSD/GSDML, which therefore only allows data types defined in GSD/GSDML. The **MS1** data transfer provides acyclic transmission of the application data (e.g. from a proxy function block) between a master class 1 and slave application. This means the selection of data types primarily depends on the programming languages of the master class 1 application (e.g. IEC 61131-3. The **MS2** data transfer provides acyclic transmission of the application data (e.g. commissioning or diagnosis tool) between a master class 2 and slave application. This means the selection of data types primarily depends on the programming languages of the master class 2 and slave application. This is either a PC software environment (C++, C#, Java) or an EDD driven application. The PC software offers free data type definitions, the EDD provides a subset of the IEC 61158 data types. **Parameterization and diagnosis** as provided through means of GSD/GSDML using a data type set defined in GSD/GSDML. Additionally for this data transfer "Bit" and "Bit area" data types are available. The usable data type sets for EDDL are defined in IEC 61804-3 and for GSD/GSDML the related PROFIBUS Guideline and for GSDML within the corresponding PROFINET Specification. Figure is qualitatively illustrating the ranges of available data types within the different use cases.

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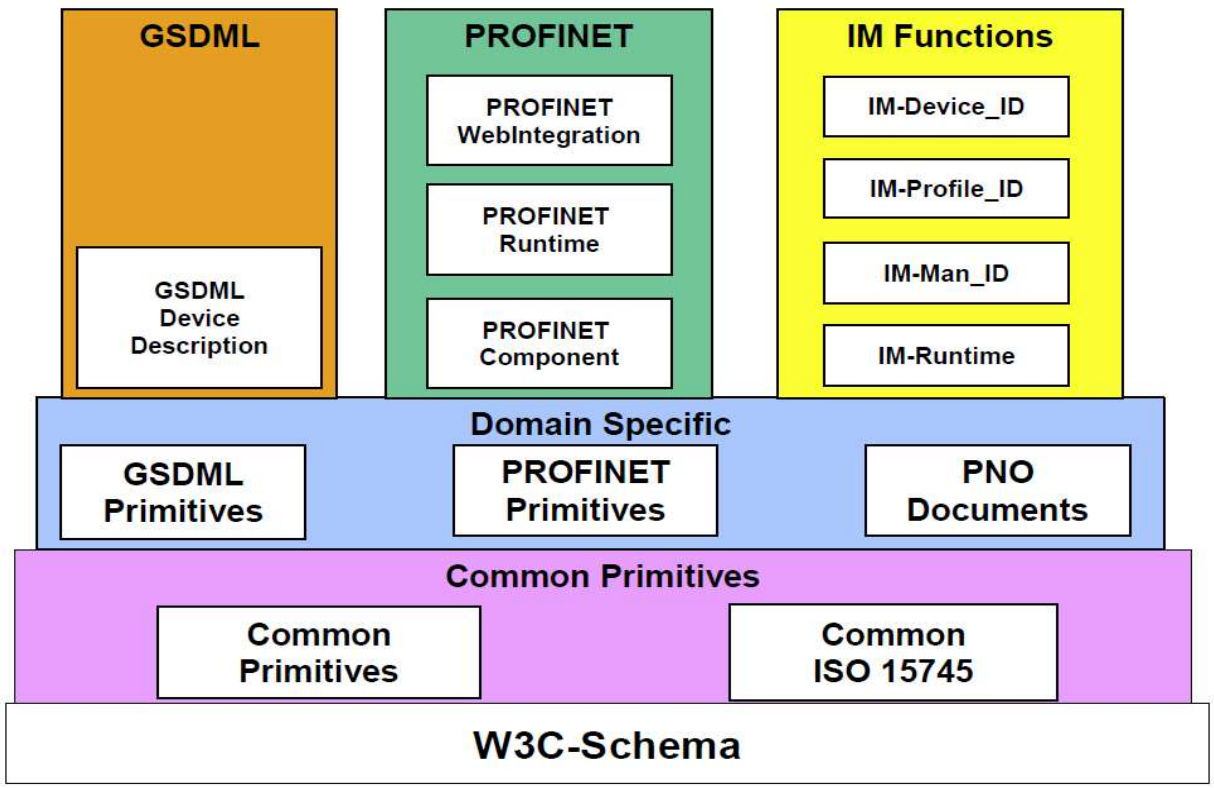

PROFINET protocols

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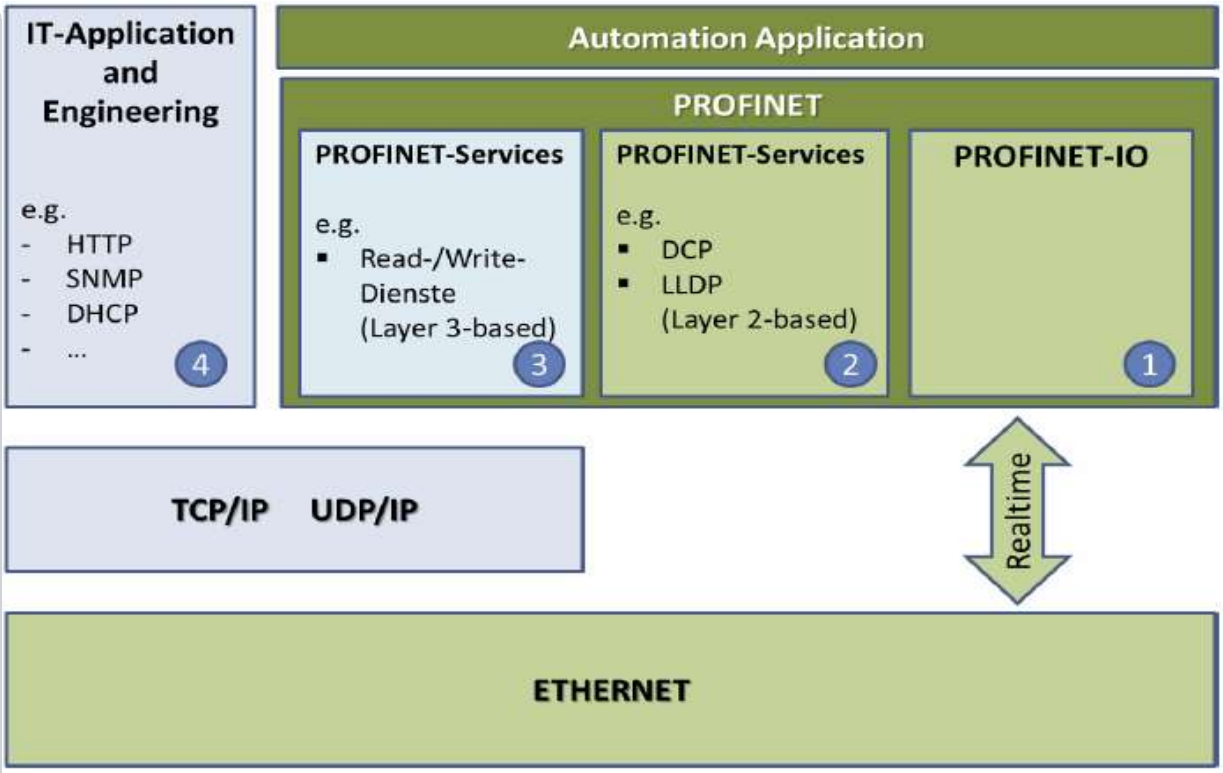

PROFIBUS and PROFINET
Installation Guideline for Cabling and Assembly – Part 1

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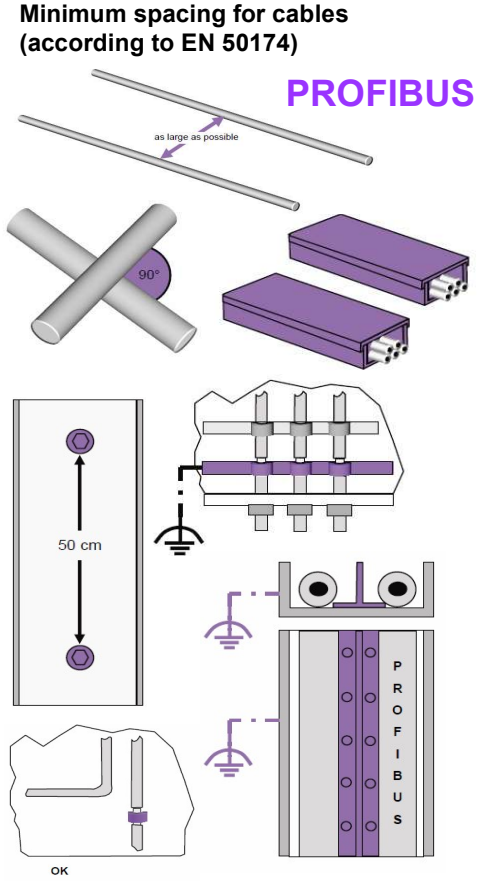
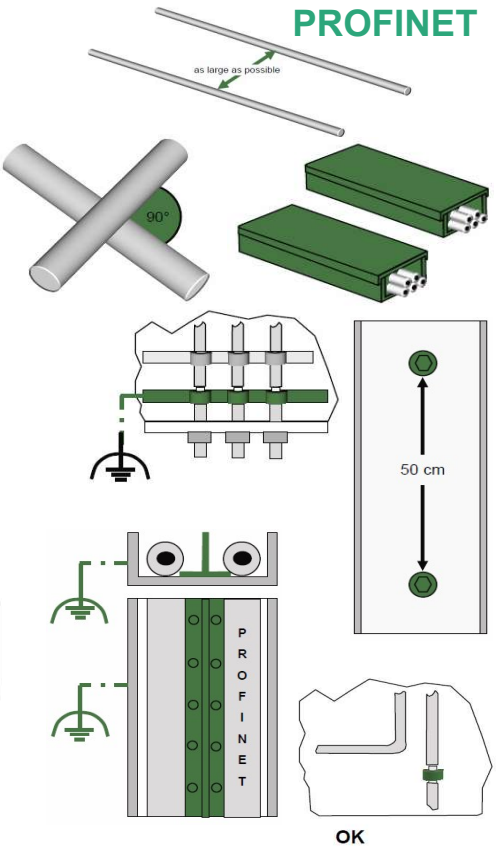
Minimum spacing for cables (according to EN 50174)



Minimum cable spacing according to IEC 61918



PROFIBUS and PROFINET
Installation Guideline for Cabling and Assembly – Part 2

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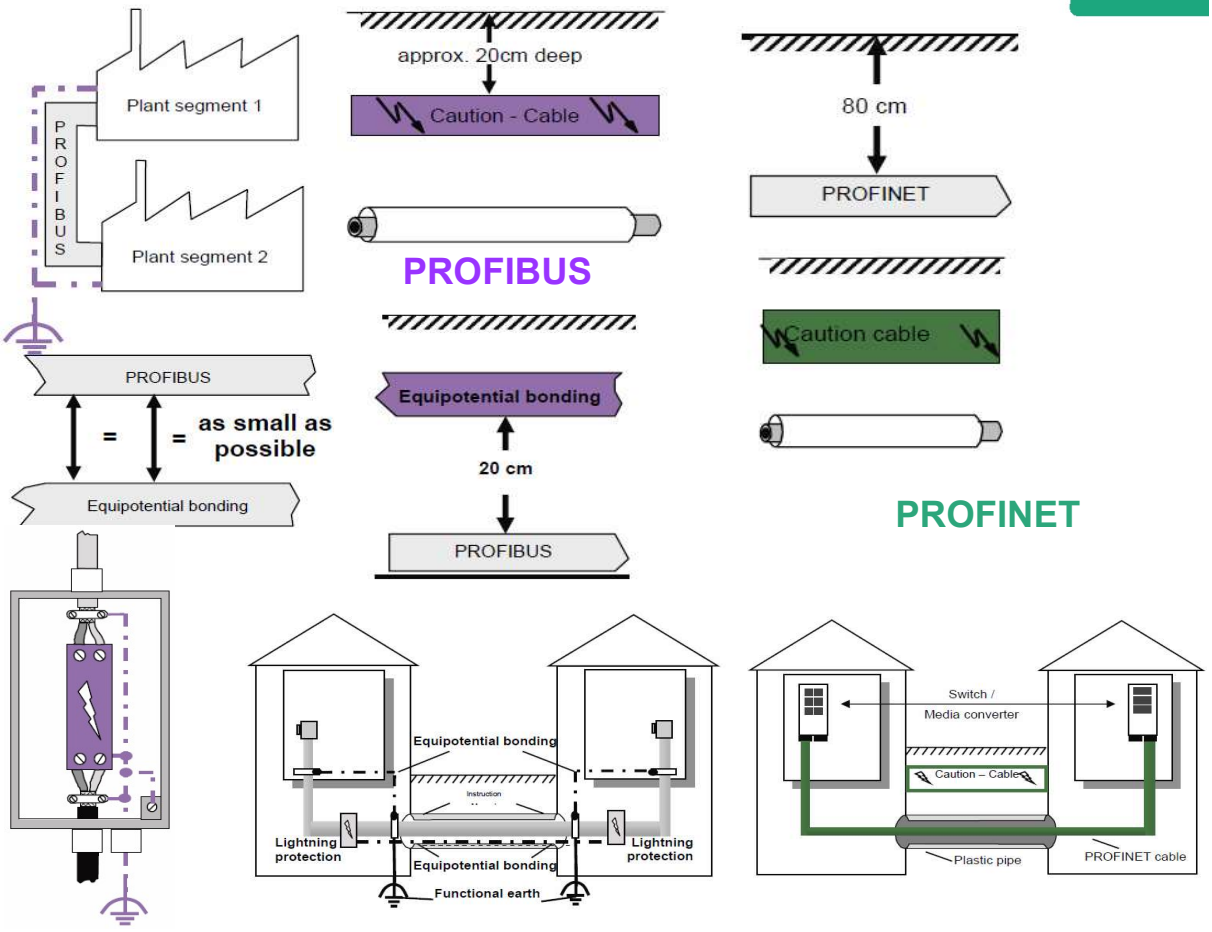

PROFIBUS and PROFINET
Installation Guideline for Cabling and Assembly – Part 3

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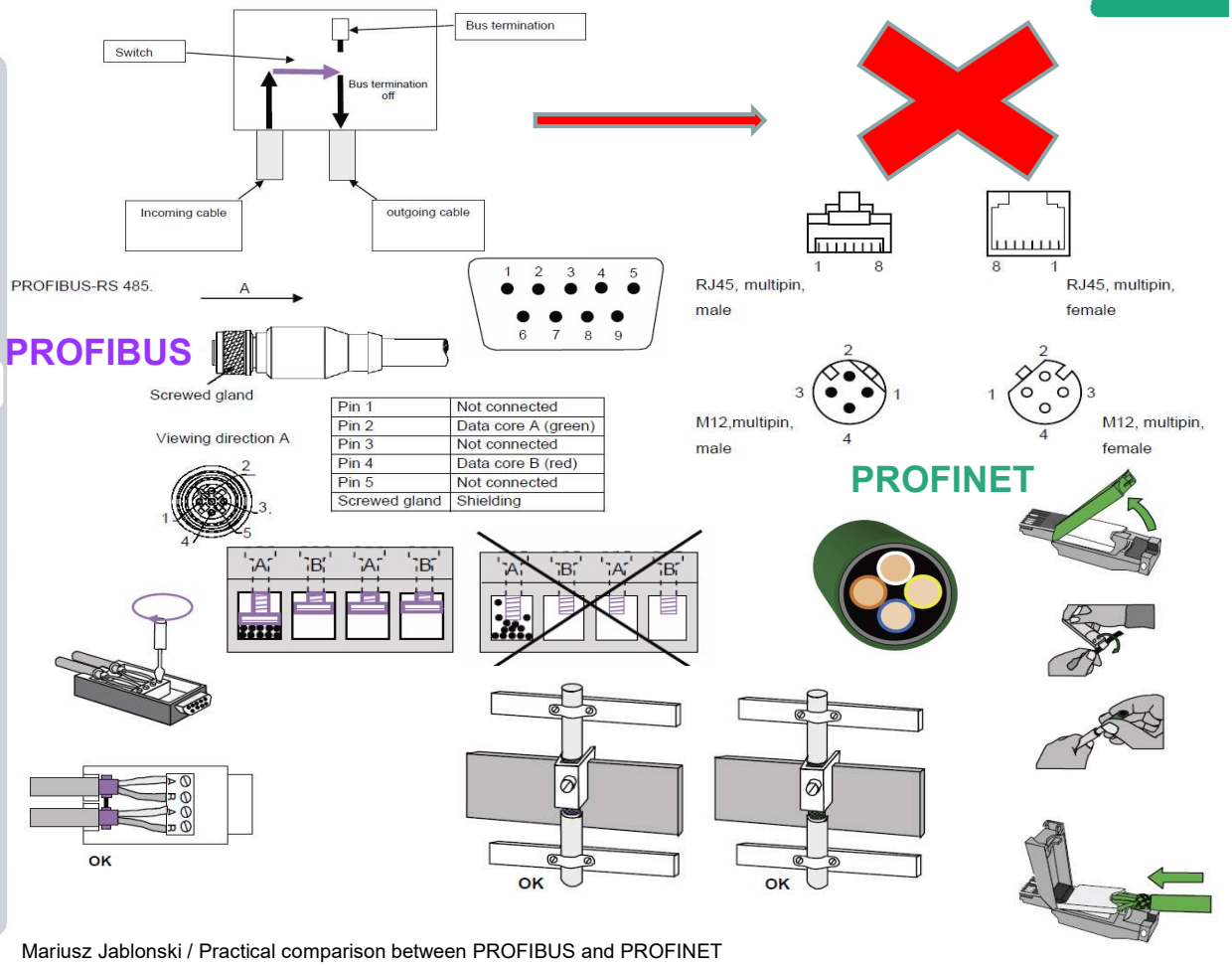

Pin 1	Not connected
Pin 2	Data core A (green)
Pin 3	Not connected
Pin 4	Data core B (red)
Pin 5	Not connected
Screwed gland	Shielding

Steps of commissioning PROFIBUS/PROFINET

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PROFIBUS

PROFINET

Step 1: Visual inspection

Step 2: Acceptance measurements

Step 3: System configuration

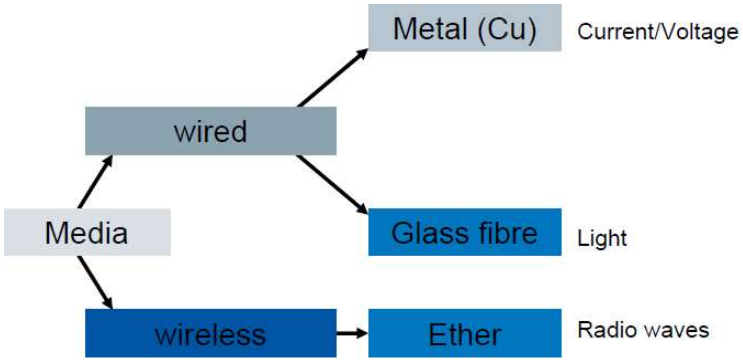
Step 4: Verify the address setting of PROFIBUS/PROFINET stations.

Step 5: Commission Masters/Slaves and IO Controllers / IO Devices

Step 6: Test signal inputs

Step 7: Test signal outputs

Step 8: Create acceptance checklist



Steps 1 and 2 are part of the assembly acceptance and should already be completed. Steps 3 to 8 are now explained in more detail.

System configuration (step 3)

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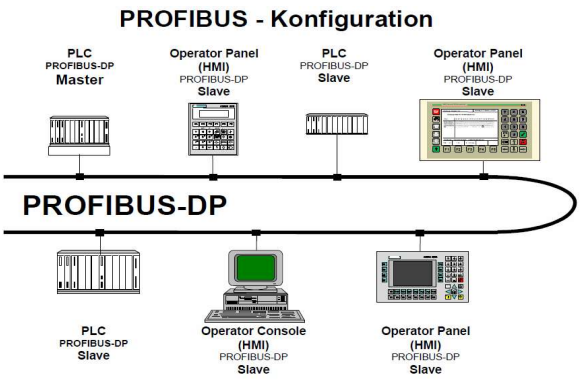
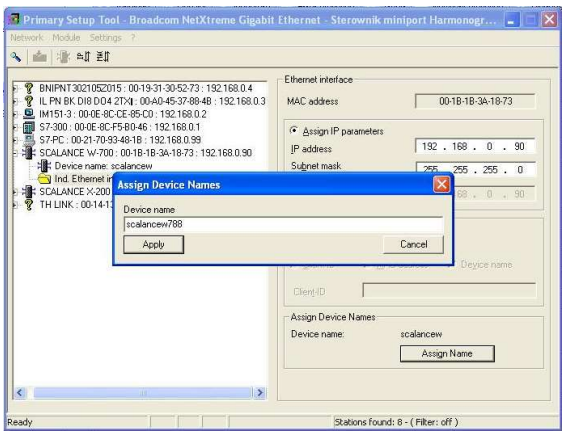
PROFIBUS

Configuration of the PROFIBUS devices generally involves using a software configuration tool to describe your PROFIBUS system. Because the programming device and software varies from manufacturer to manufacturer, we cannot give detailed instructions on how this stage is carried out. Before you start with system configuration you should be familiar with the operation of the programming device and the associated software. Here we list a few points that you should be aware of.



PROFINET

A configuration tool is required for the configuration of PROFINET devices. The system configuration will not be described in more detail here because operation of the configuration software varies from manufacturer to manufacturer. Prior to starting to configure the system, you should familiarize yourself with the system configuration software. Only a few basic points to be observed will be explained here.



GSD,GSDML - Device description files

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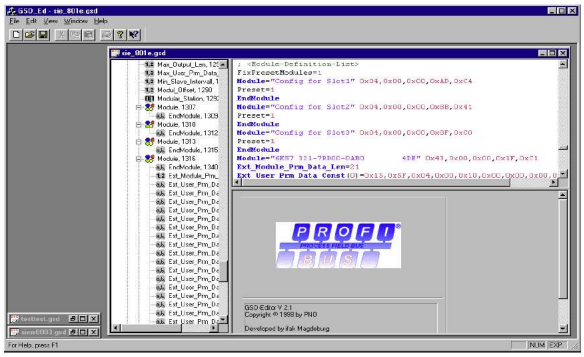
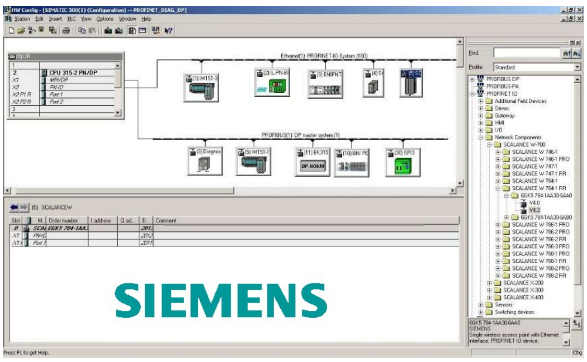


PROFIBUS stations are integrated in a project via device description files. This involves a standardized file type in which PROFIBUS station characteristics are described. The device description file is generally abbreviated as "GSD file". GSD stands for "General Station Description". The GSD file for a device contains standardized information on the characteristics and options available for that device. GSD files often incorporate text which appears on the PC screen in the configuration tool.

"SIEM8027.GSD" – A GSD file for Siemens device with ID 8027
"WAGOB760.GSE" – An English language file, for WAGO device ID B760

PROFINET



PROFINET nodes are integrated into projects using device description files. This is a standardized type of file which describes the properties of the PROFINET nodes. The device description file for PROFINET is usually abbreviated “GSD file”. GSD stands for “General Station Description” while the extension ML indicates the use of XML). A GSD file for a device contains standardized information on its properties.

“GSD–V2.2–Siemens–ET200S–20040720.xml”

Address settings

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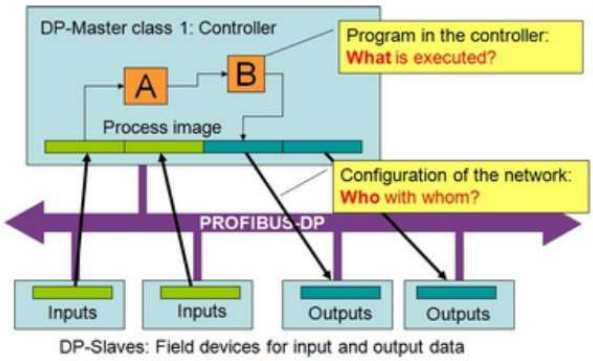
SIEMENS PLC
PRESENT

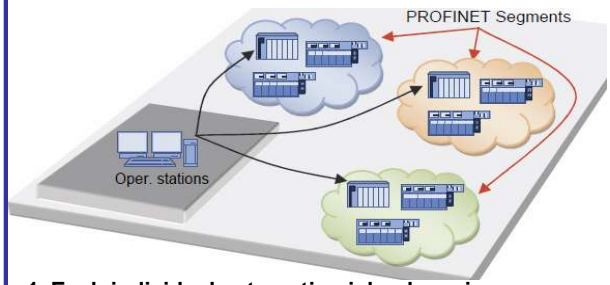
PROFIBUS

Addressing - It is essential that the address of every PROFIBUS station is correctly set in the configuration tool. We should ensure that the addresses used in the configuration tool agree with the planned addresses of the PROFIBUS stations. In addition, you should check that the addresses set on the physical PROFIBUS stations matches with the addresses in the project plan.
Bus parameters - Bus parameters are used to set the details of the timing within a PROFIBUS cycle.

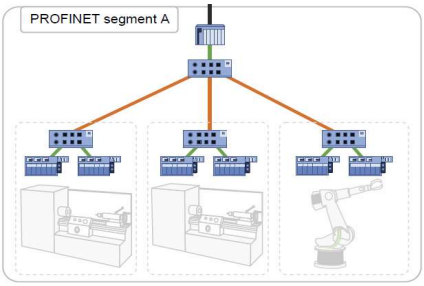


DP-Slaves: Field devices for input and output data

PROFINET



1. Each individual automation island receives an address range
Operator station: 192.168.1.xxx
PROFINET segment A: 192.168.2.xxx
PROFINET segment B: 192.168.3.xxx etc.
2. The individual device types of a PROFINET segment are assigned to different address ranges:
PN IO controller / “segment A”:192.168.2.1 to 192.168.2.19
Switches: 192.168.2.20 to 192.168.2.49
PN IO devices: 192.168.2.50 to 192.168.2.199
Diagnosis: 192.168.2.200 to 192.168.2.254



Commissioning PROFIBUS/PROFINET stations (step 5)

Overview
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PROFIDRIVE
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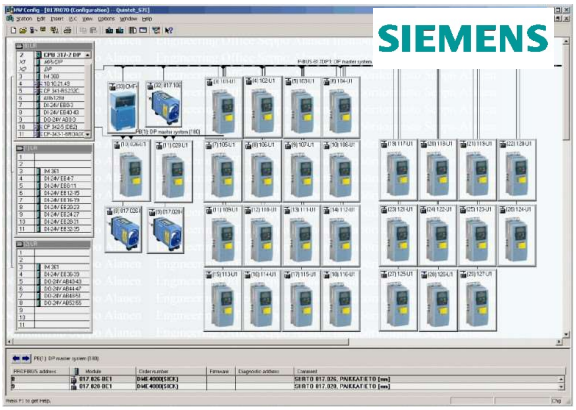
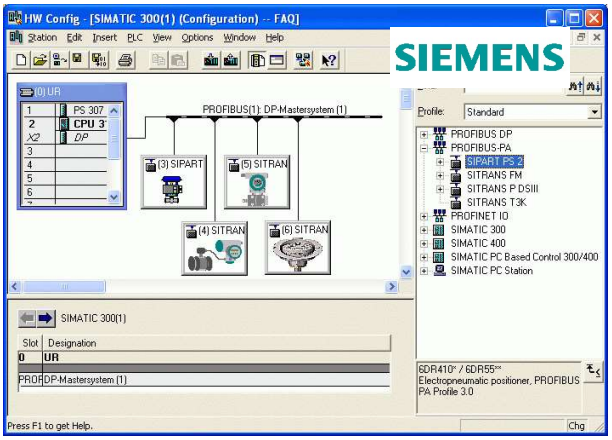
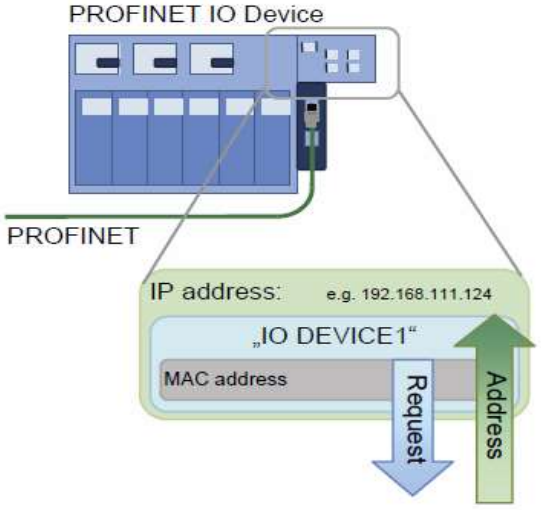
PROFIBUS





PROFINET

Addressing of a PROFINET IO DEVICE therefore in total includes:
– **MAC address,** which is pre-defined in the device and can usually not be modified.
– **Device names** which can be freely selected, but which should reflect the relevant plant part for convenience reasons.
– **IP address,** which can also be freely selected, but which follows a firm scheme and which should be selected, similar to the device name, according to the assigned plant.



ADDRESS AND NAMES

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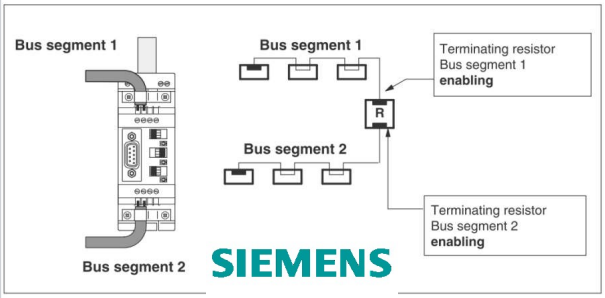
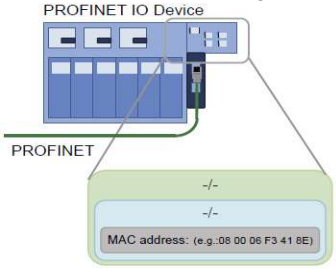
PROFIBUS

The address of a PROFIBUS station can be set in one of three ways:
• A local switch on the device (binary dip switch or rotary switch).
• Software setting of device address over the PROFIBUS network using a configuration tool (called a Class-II master).
• Some devices may use special software and a serial link or hand-held tool to set the device address (e.g. some masters, drives or HMI devices).



PROFINET

For PROFINET, this procedure has been selected because names are easier to handle than more complex IP addresses. In their original delivery status, PROFINET IO devices do not have a device name, but only a MAC address. This address is persistently stored in the device; it is globally unique and can usually not be changed. Some manufacturers have proprietary tools which allow for a MAC address to be changed in case a device has to be replaced. Many PROFINET devices have the MAC address printed on the housing or on the rating plate.



A PROFINET IO device can only be addressed by a PROFINET IO controller after having been allocated a device name, usually for the acyclic transfer of planning data (among others the IP address) or when starting the PROFINET IO device. Cyclical exchange of data is realized using the MAC address, if the PROFINET IOController and the PROFINET IO-Device are placed in the same subnet.

Operation state

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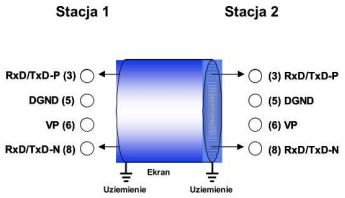
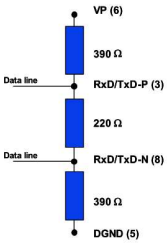
PROFIBUS

PROFIBUS telegrams can be corrupted by pickup or reflections. PROFIBUS has many mechanisms to ensure reliable communications even in the presence of such corruption. For example, any corrupted request or response will cause the controlling master to repeat the request.



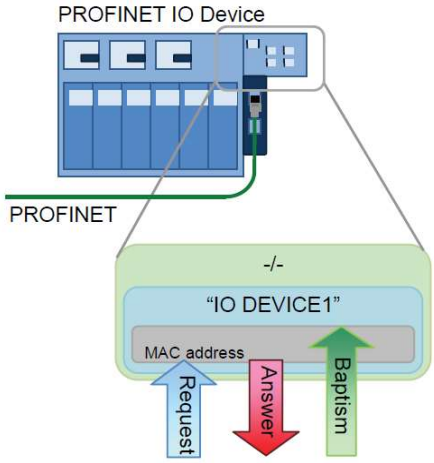
Okablowanie



Terminator

PROFIBUS systems can operate for long periods without visible error, even though a number of telegrams are being corrupted. Ideally, the commissioning engineer would like to know the extent of telegram corruption occurring on a network so that corrective measures can be taken.

PROFINET



The device name must persistently stored in the device. When a defective device is replaced, you have to repeat the "device baptism" with the new device. To avoid this step, some manufacturers offer devices with a removable medium. Here the device parameters are stored on a replaceable storage medium. In case a component fails, the storage medium is inserted in the replacement component, thus being immediately operational.

Testing the Signal Inputs (step 6) and Outputs (step 7) - PROFIBUS

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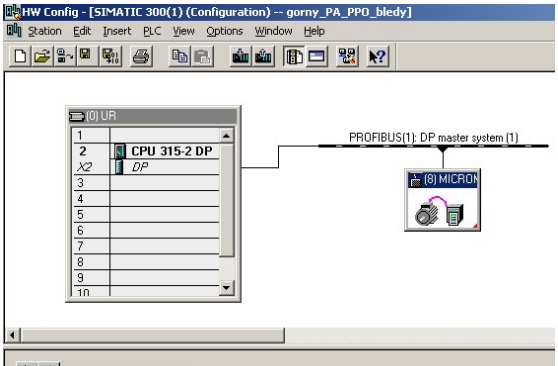
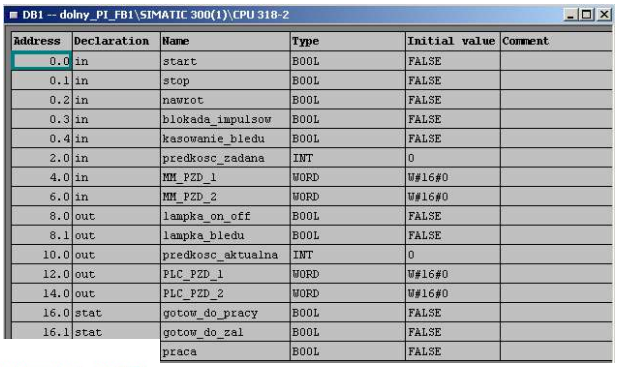
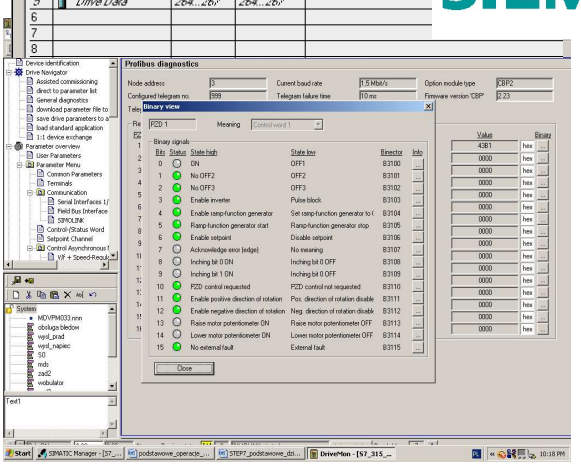
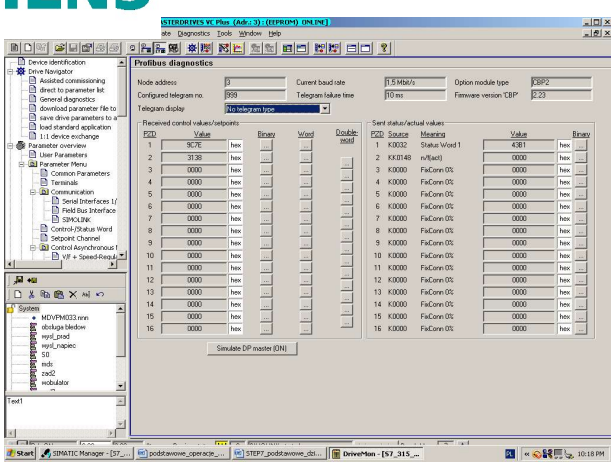




Address	Declaration	Name	Type	Initial value	Comment
0.0	in	start	BOOL	FALSE	
0.1	in	stop	BOOL	FALSE	
0.2	in	nawrot	BOOL	FALSE	
0.3	in	blokada_impulsow	BOOL	FALSE	
0.4	in	kasowanie_bledu	BOOL	FALSE	
2.0	in	predkosc_zadana	INT	0	
4.0	in	MM_PZD_1	WORD	W#16#0	
6.0	in	MM_PZD_2	WORD	W#16#0	
8.0	out	lampka_on_off	BOOL	FALSE	
8.1	out	lampka_bledu	BOOL	FALSE	
10.0	out	predkosc_aktualna	INT	0	
12.0	out	PLC_PZD_1	WORD	W#16#0	
14.0	out	PLC_PZD_2	WORD	W#16#0	
16.0	stat	gotow_do_pracy	BOOL	FALSE	
16.1	stat	gotow_do_zal	BOOL	FALSE	
		praca	BOOL	FALSE	

SIEMENS





NetworkTime data type for "time stamping"

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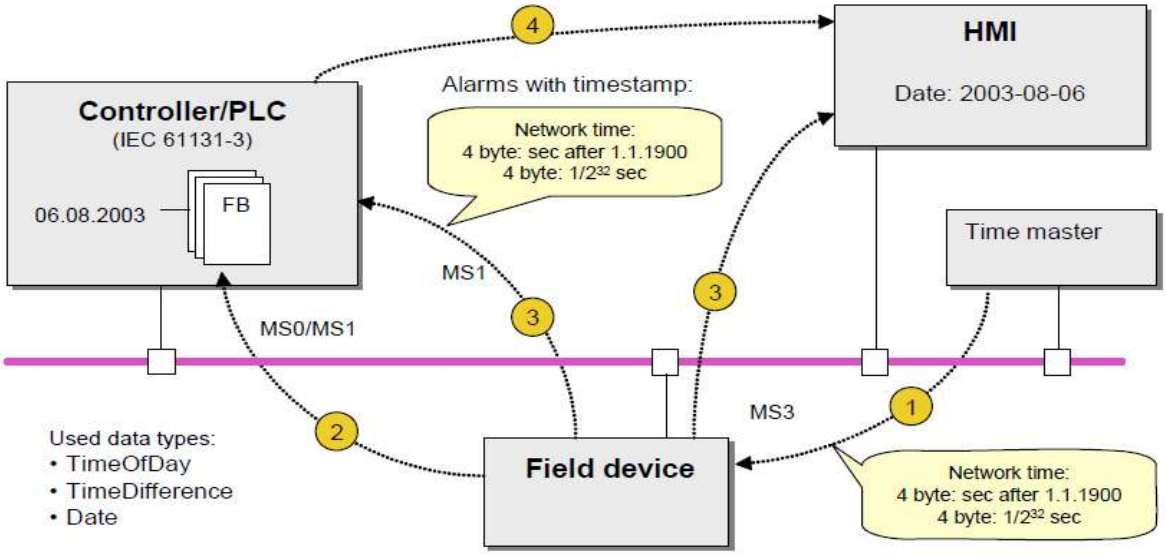
PROFIBUS **PROFINET**



Real Token Rotation Time tRR

PROFIBUS **SIEMENS** **PROFINET**

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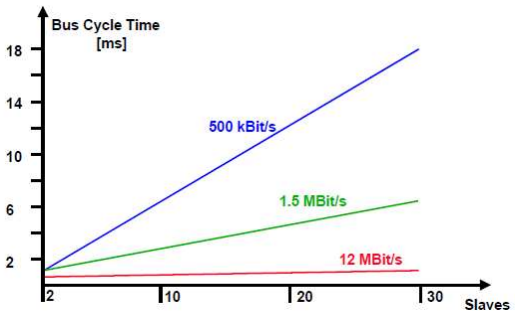

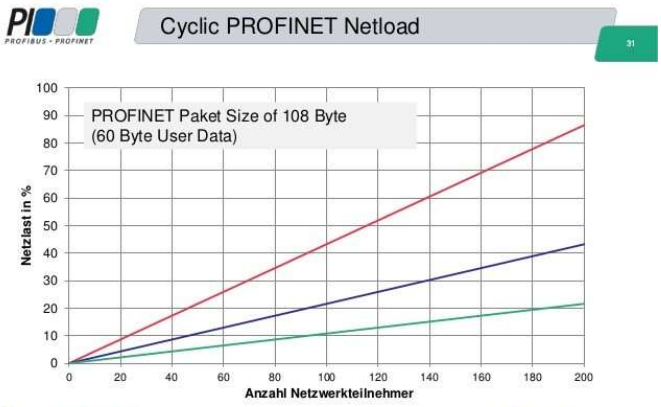

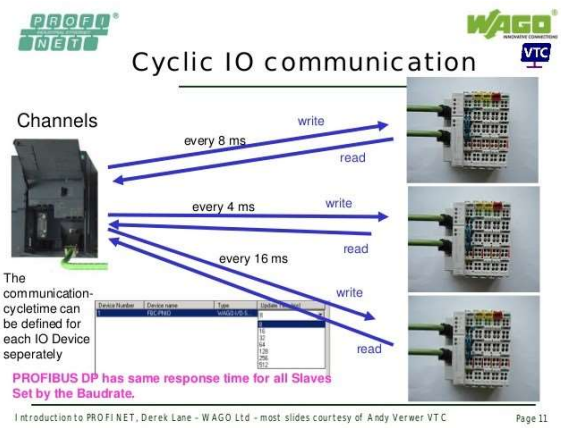

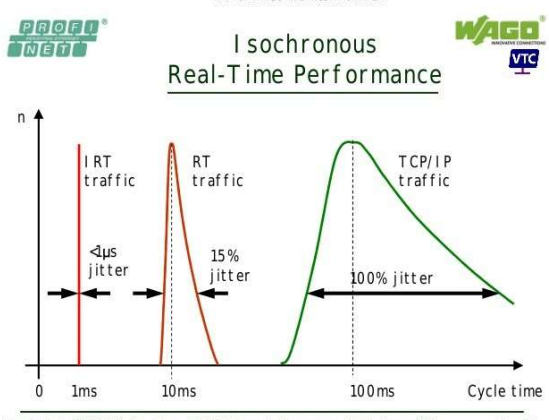

Network Load and diagnostics

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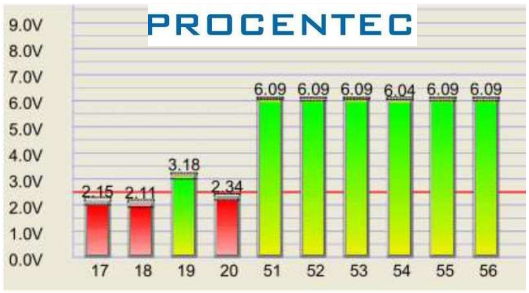
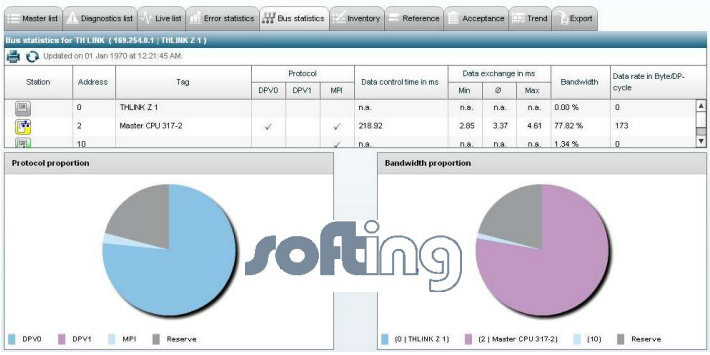
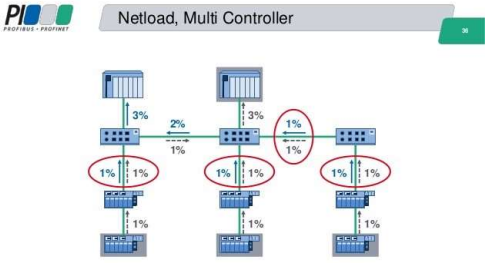
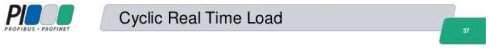




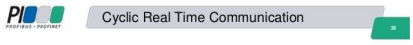
PROFINET





Generated cyclic real time netload (typ. PROFINET Packet Size 60 Byte PROFINET User data, 100 Mbit/s)

Update time	Generated cyclic real time netload per PROFINET Device
1 ms	0,86 %
2 ms	0,43 %
4 ms	0,22 %
8 ms	0,11 %



Recommended threshold values for netload of cyclic real time communication

Netload	Recommendation
< 20%:	No action neccessary
20…50%:	It is recommended to check the designed netload
> 50%:	There is a necessity to take measures to reduce the netload

PROFINET RULES FOR COMMUNICATION

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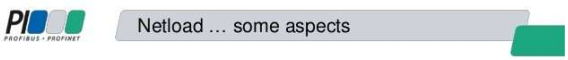
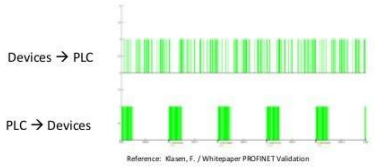
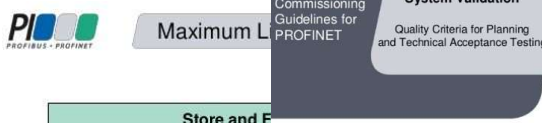
… some figures based on 100 Mbit/s

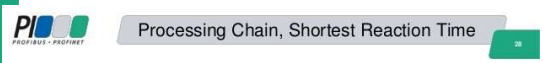
- 64 Byte= 512 Bit = approx. 5 microseconds
  → approx. 150 PROFINET packets/ms
  → approx. 0,5% netload per device at an IO cycle of 2 ms
- 1500 Byte: approx. 125 microseconds
  → approx. 8 IP packets/m



- no uniform load
- Different in each cable segment
- Full Duplex
- Load distribution to/from controller (up-/downstream)
- …

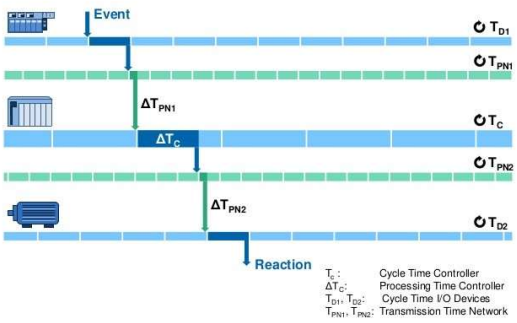






Store and F… Maximum Line De…			
1 ms	2 ms	4 ms	8 ms
7	14	28	58

Cut through Switches Maximum Line Depths with Update Time of			
1 ms	2 ms	4 ms	8 ms
64	100	100	100



Overview on PROFIBUS DP diagnosis structures

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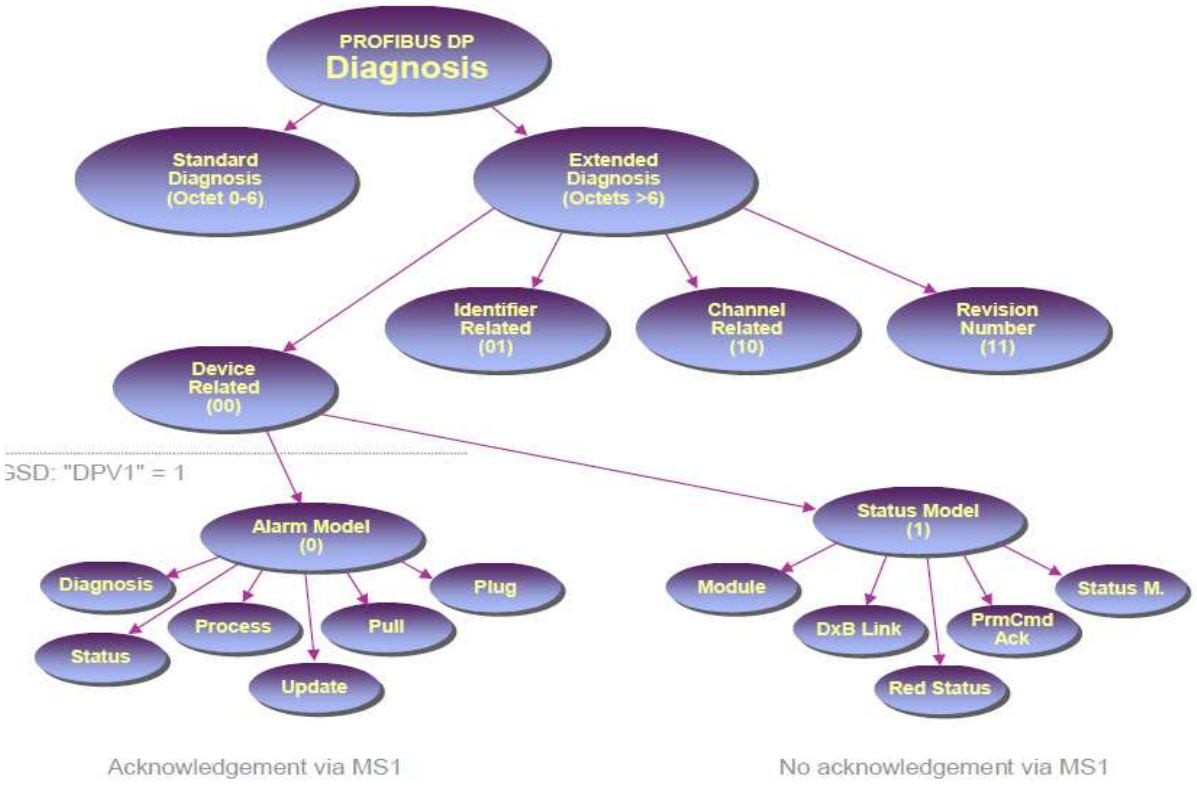
PROFIBUS



Data flow for diagnosis, status, and alarms PROFIBUS

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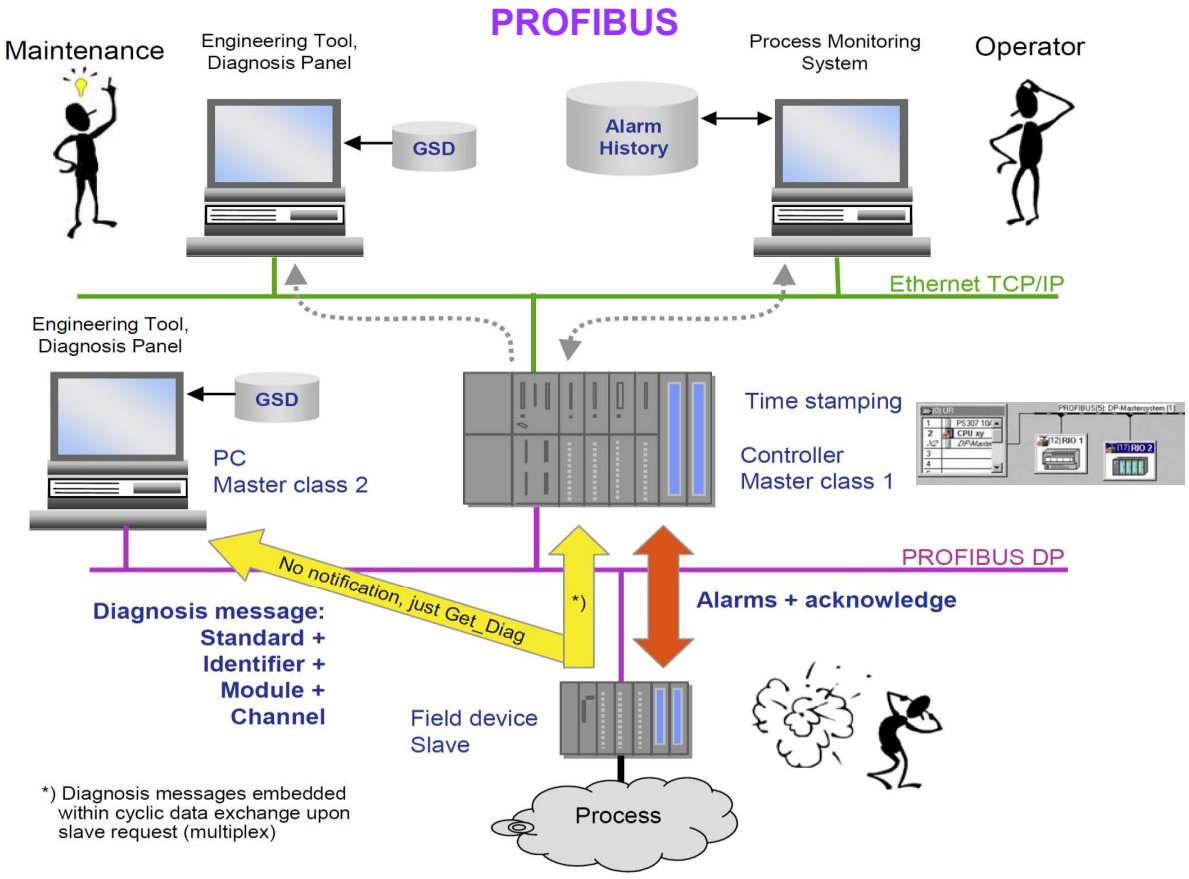

Diagnostics - PROFIBUS

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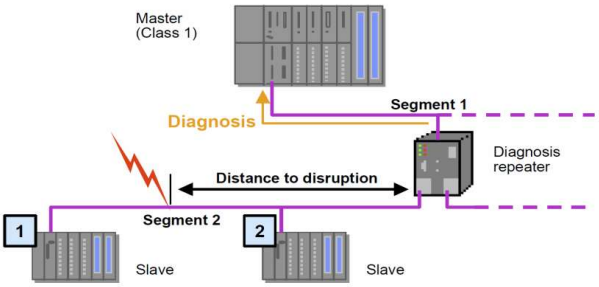
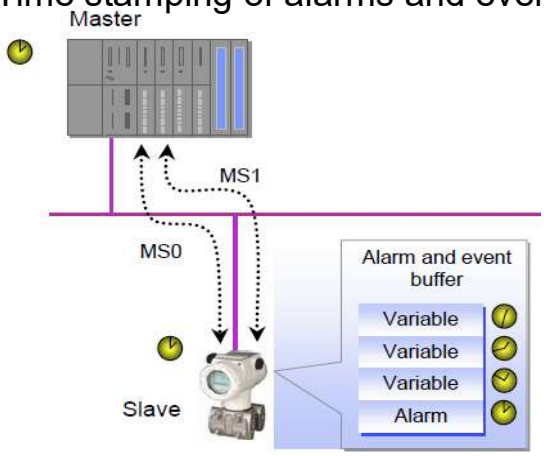
Diagnosis repeater to detect network problems



Time stamping of alarms and events



PROFINET

Layer	Description / potential sources of error
7 Application Layer	Frontend application
6 Presentation Layer	This layer determines the presentation of data to be transferred. Errors may be found in the range of ASCII, JPEG or CSV.
5 Session Layer	DNS Typical error in this layer: Incorrect assessment of available bandwidth.
4 Transport Layer	Typical error in this layer: TCP window size too small
3 Network Layer	IP and routing Typical errors in this layer: incorrect or dual IP addresses incorrect netmasks
2 Data Link Layer	MAC addresses Typical errors in this layer: incorrect or dual MAC addresses Incompatible frame types
1 Physical Layer	This layer combines connectors, cabling and signal level. Line testers can be used for troubleshooting (chapter 2.1) Typical errors in this layer: incorrect or defective cables Incompatible cable types

Starting from the bottom layer, the following procedure should be used:

- Check the cabling structure (line tester)
- Measure the optical fiber
- Check the WLAN signal strength
- Start Read Record Diagnose at IO controller / live list
- Connection test using ICMP telegrams
- Check diagnostics telegram
- Record the data traffic using an analyzer (e.g. Wireshark)

Diagnostics - PROFIBUS

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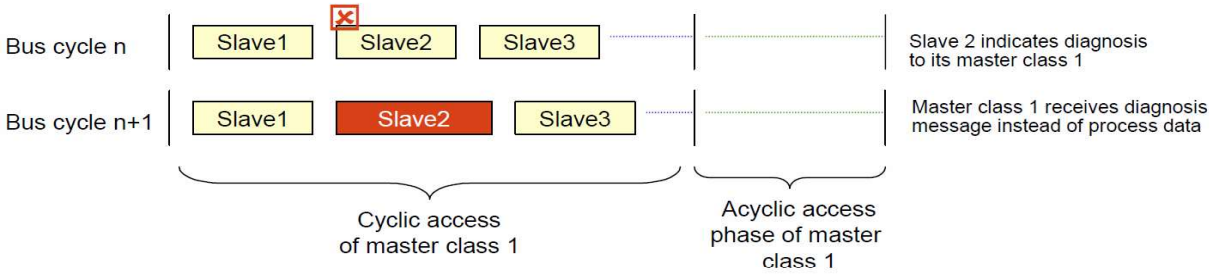
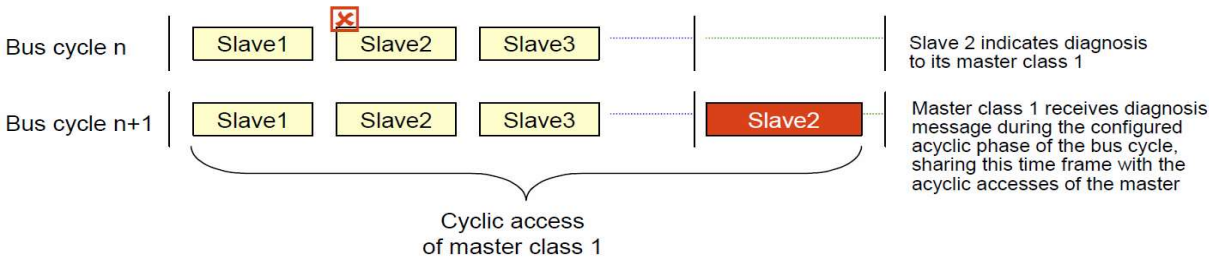
PROFIBUS

Delayed diagnosis mode for time critical applications

Normal diagnosis:



Delayed diagnosis mode:



Diagnostics levels in PROFINET IO

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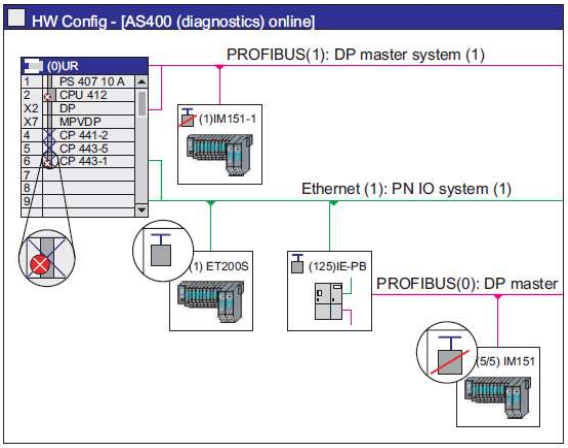

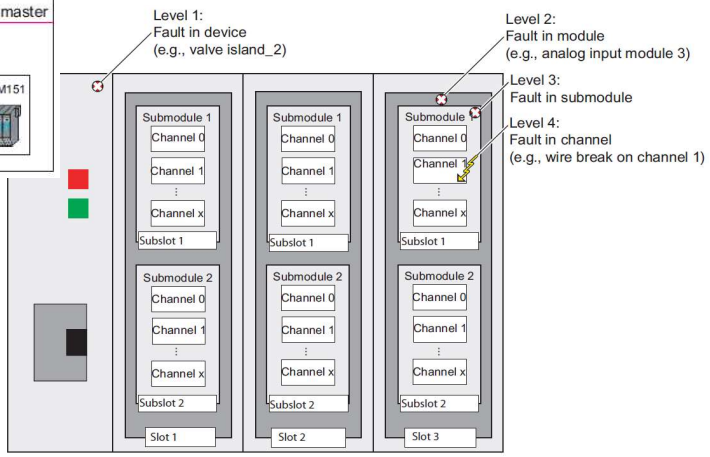

Diagnostics records in PROFINET IO There are two different types of diagnostics record:
1. Channel diagnostics records Channel diagnostics records are generated if a channel is in an error state and / or has triggered an interrupt. A diagnostics record of length 0 is returned if there is no fault.
2. Vendor-specific diagnostics records
The structure and size of vendor-specific diagnostics records depend on the vendor's settings. For information about vendor-specific diagnostics records, refer to the appropriate device manual.

PROFINET DIAGNOSTICS

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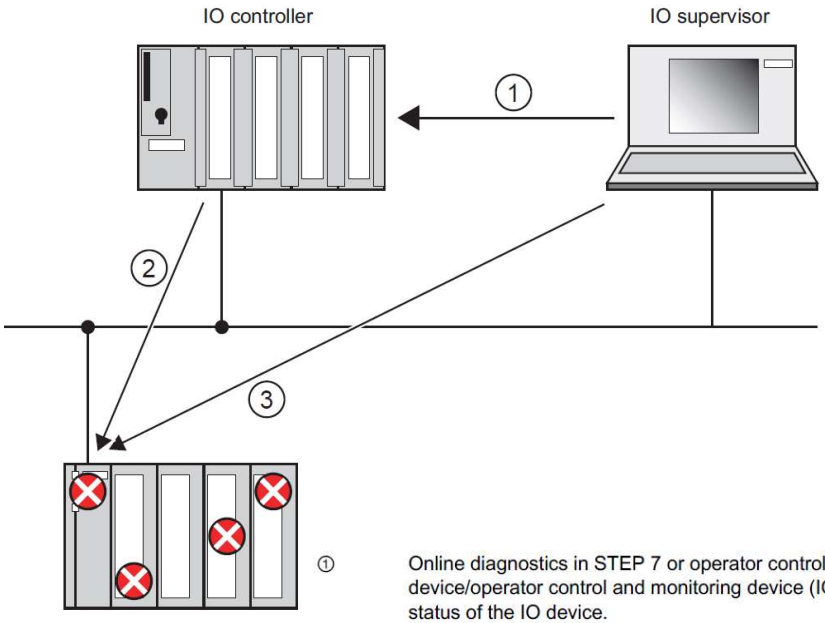

① Online diagnostics in STEP 7 or operator control and monitoring device: The programming device/operator control and monitoring device (IO supervisor/HMI) requests the station status of the IO device.

② Following the request from the IO supervisor/HMI, the IO controller automatically reads the entire station status asynchronously directly from the IO device and stores the read diagnostic information in system status lists on the IO controller. The IO supervisor/HMI then accesses these system status lists.

③ Online diagnostics in STEP 7 or operator control and monitoring device: The IO supervisor/HMI can also read the station status directly from the IO device without the IO controller being involved. This is only possible if the IO supervisor/HMI is connected directly to Industrial Ethernet.

This means that you can access diagnostic information during the commissioning phase or during service even if the IO controller is not operational.

EXPANDED DIAGNOSTICS FOR SWITCHES

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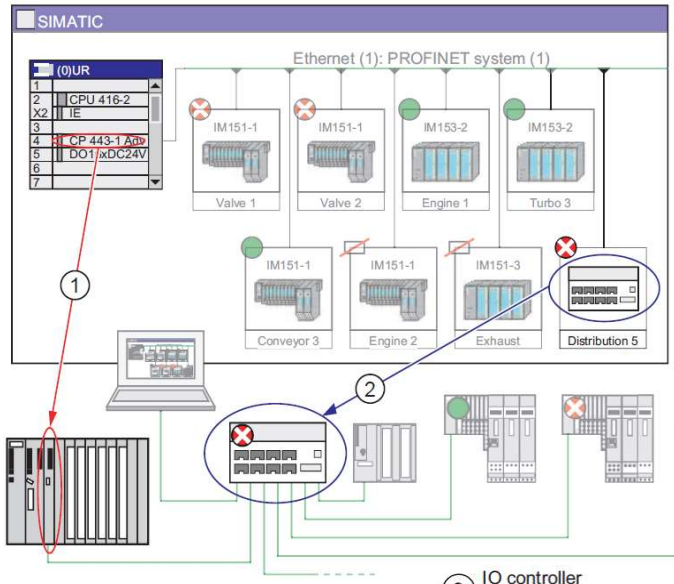
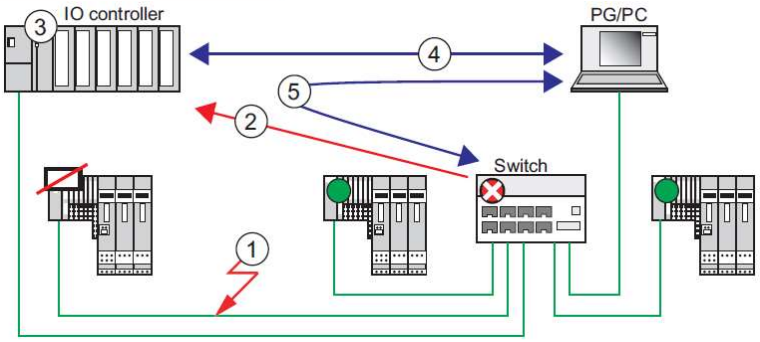


Sequence with a Wire Break



Physical overview of fieldbus integration

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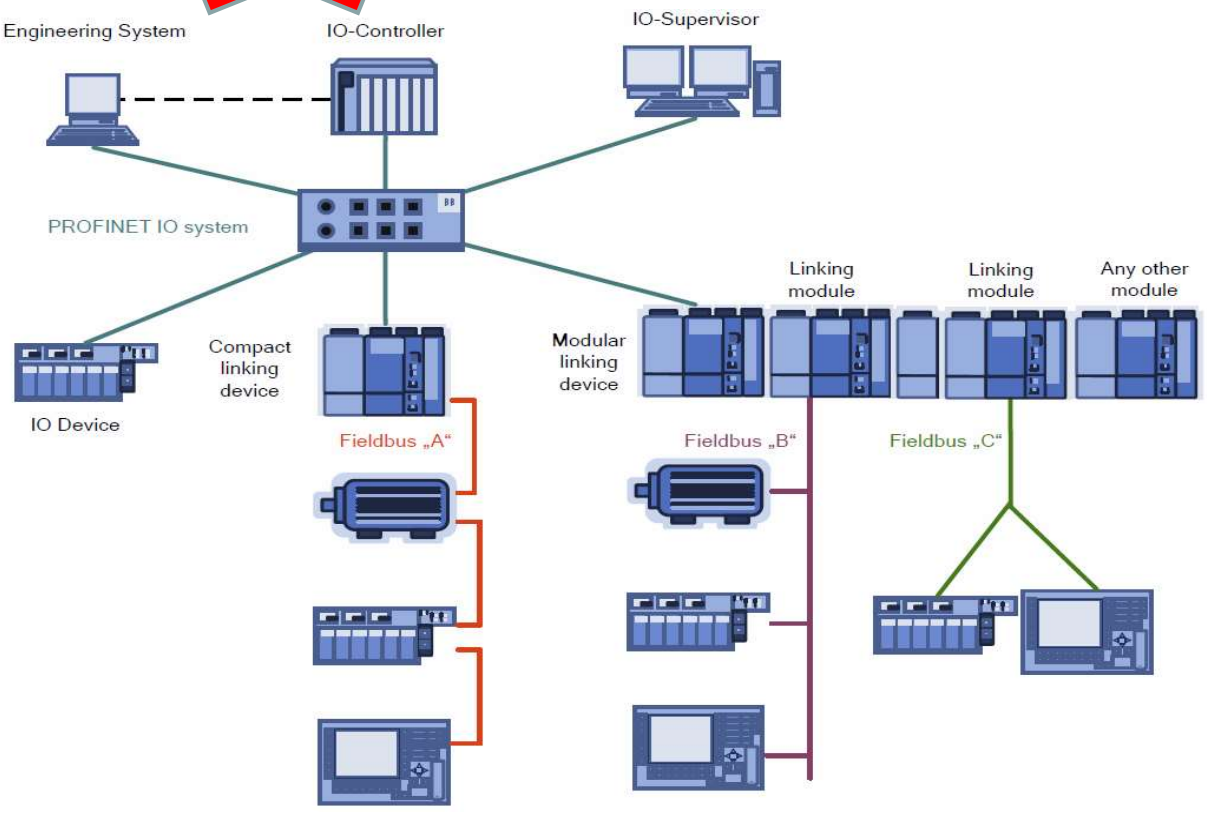

Workflow of fieldbus integration

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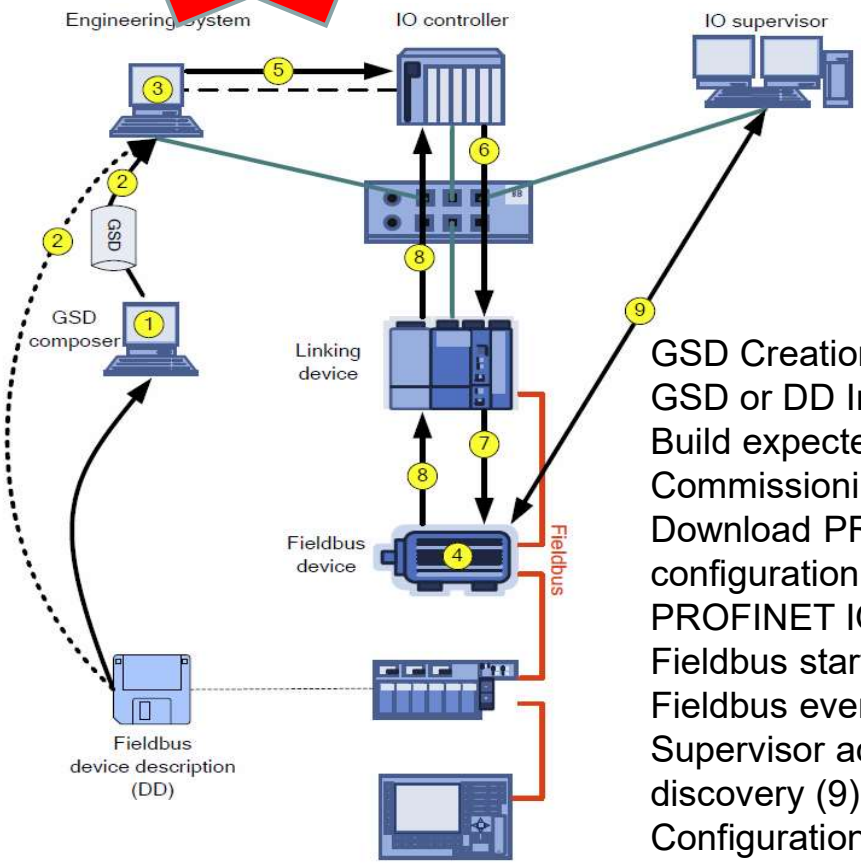

GSD Creation (1):
GSD or DD Import (2):
Build expected configuration (3):
Commissioning (4):
Download PROFINET IO configuration (5):
PROFINET IO Start-up (6):
Fieldbus startup (7):
Fieldbus events (8):
Supervisor access and fieldbus discovery (9):
Configuration changes (10):

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Slot cluster concept with modular linking devices

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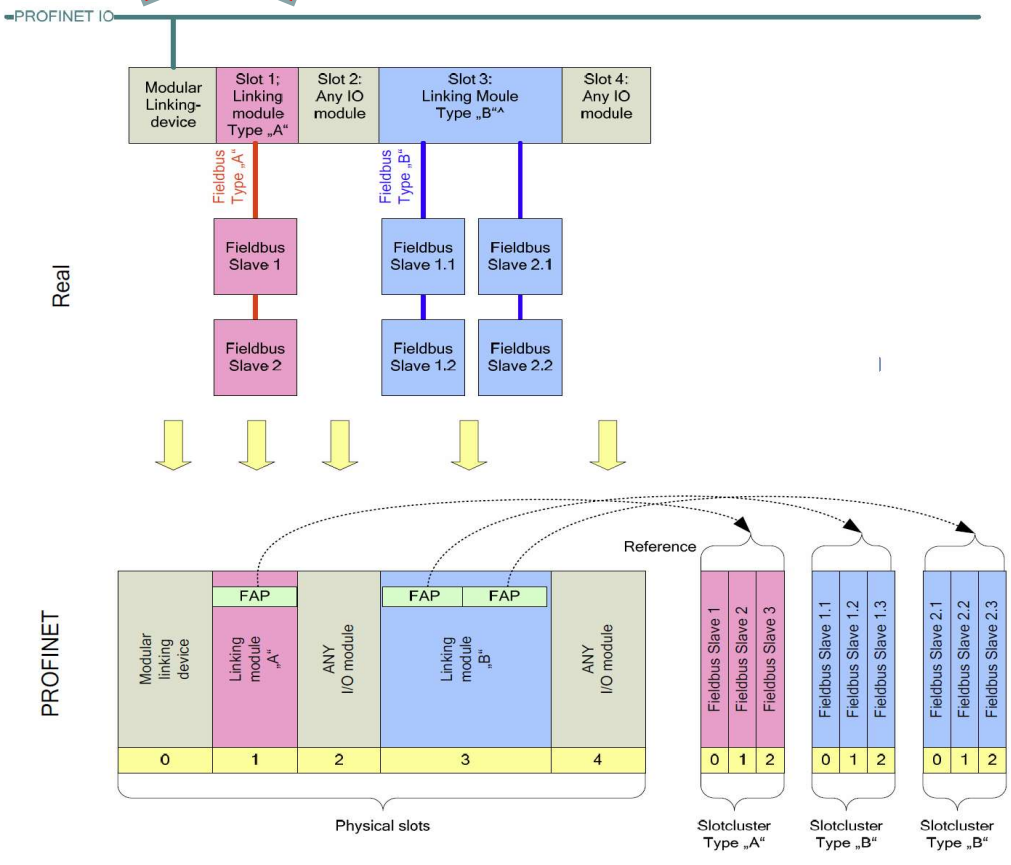

Mariusz Jablonski / Practical comparison between PROFIBUS and PROFINET

Bus interface diagnostics DAP

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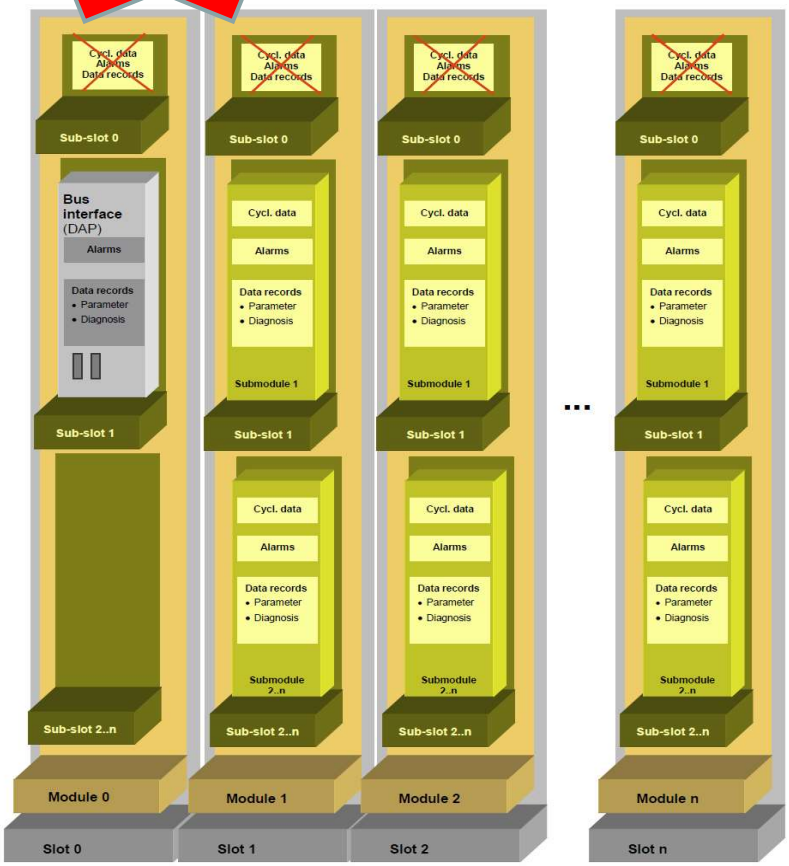

PROFINET DIAGNOSTICS

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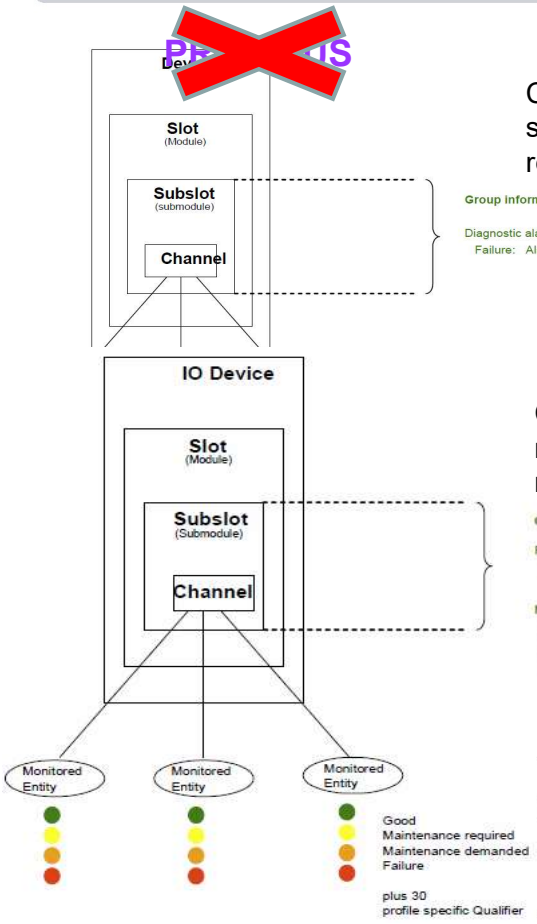

Classification of the channel, the diagnostic statuses and the group information with regard to the diagnostic alarm

Group information

Diagnostic alarm
Failure: AlarmSpecifier.SubmodulDiagnosisState

Classification of the channel, the diagnostic / maintenance states and the group information with regard to the diagnostic alarm

Group information within Diagnostic alarm

Failure Status
Failure: AlarmSpecifier.SubmodulDiagnosisState

Maintenance Status
Maintenance required: Add USI 0x8100, MaintenanceRequired to alarm header
Maintenance demanded: Add USI 0x8100, MaintenanceDemanded to alarm header
Profile specific Qualifier_2 - 31: Add USI 0x8100, Qualifier_2 ... 31 to alarm header

Individual status within Diagnostic alarm

ChannelErrorType

within ChannelProperties

Good/Failure:	Specifier
Maintenance required:	MaintenanceRequired
Maintenance demanded:	MaintenanceDemanded
Profile specific Qualifier_2 - 31:	QualifiedDiagnosis

Utilization options of the diagnosis / maintenance with regard to the diagnostic alarm

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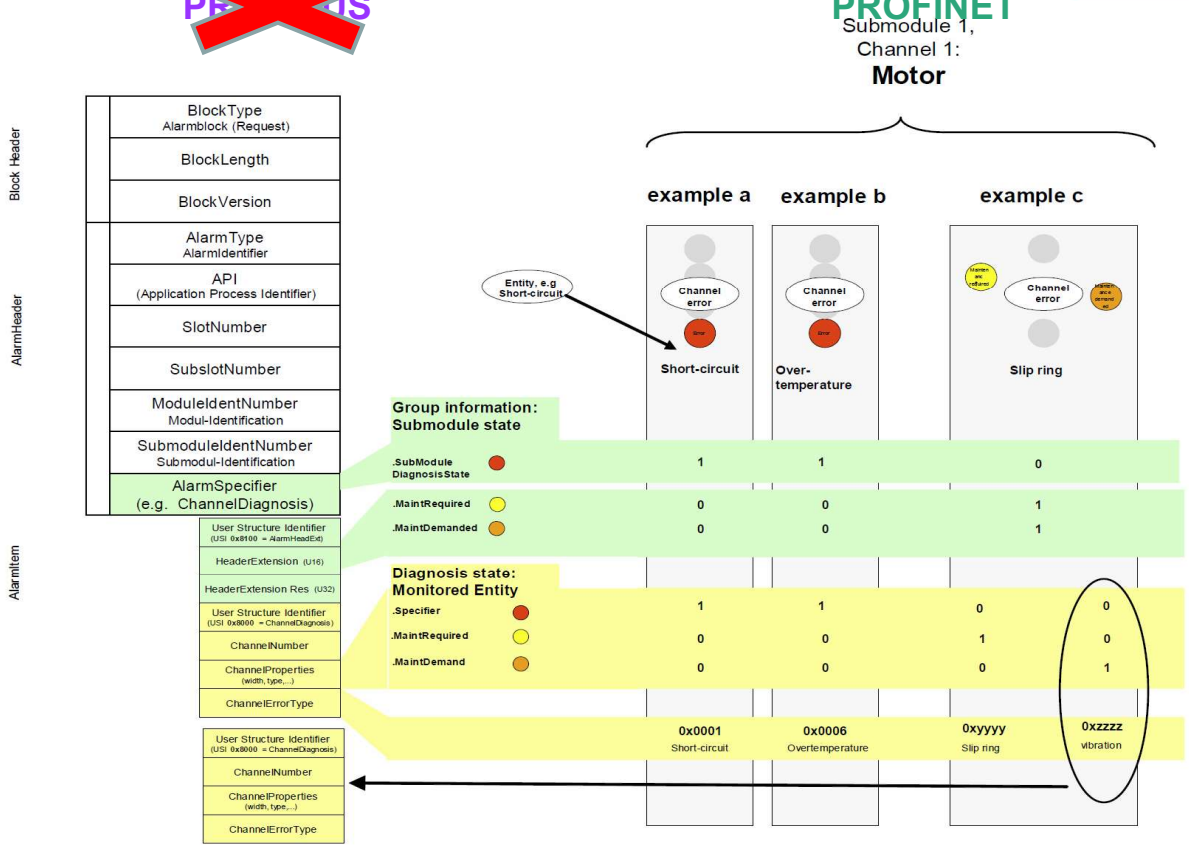

IEC 61499 Distributed Automation

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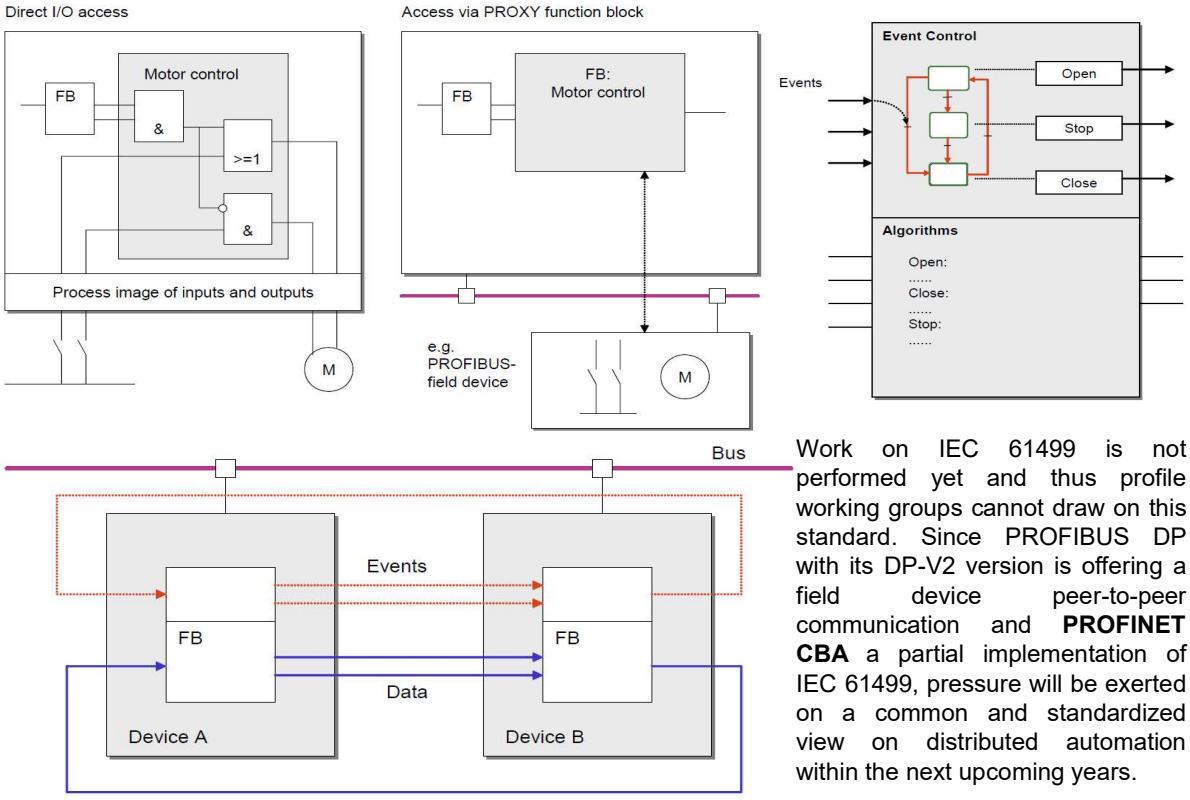
PROFIBUS **PROFINET**

Principle of centralized control acc. IEC 61131-3 (Proxy FB)



Work on IEC 61499 is not performed yet and thus profile working groups cannot draw on this standard. Since PROFIBUS DP with its DP-V2 version is offering a field device peer-to-peer communication and **PROFINET CBA** a partial implementation of IEC 61499, pressure will be exerted on a common and standardized view on distributed automation within the next upcoming years.

Field device platforms implementing PROFIBUS profiles

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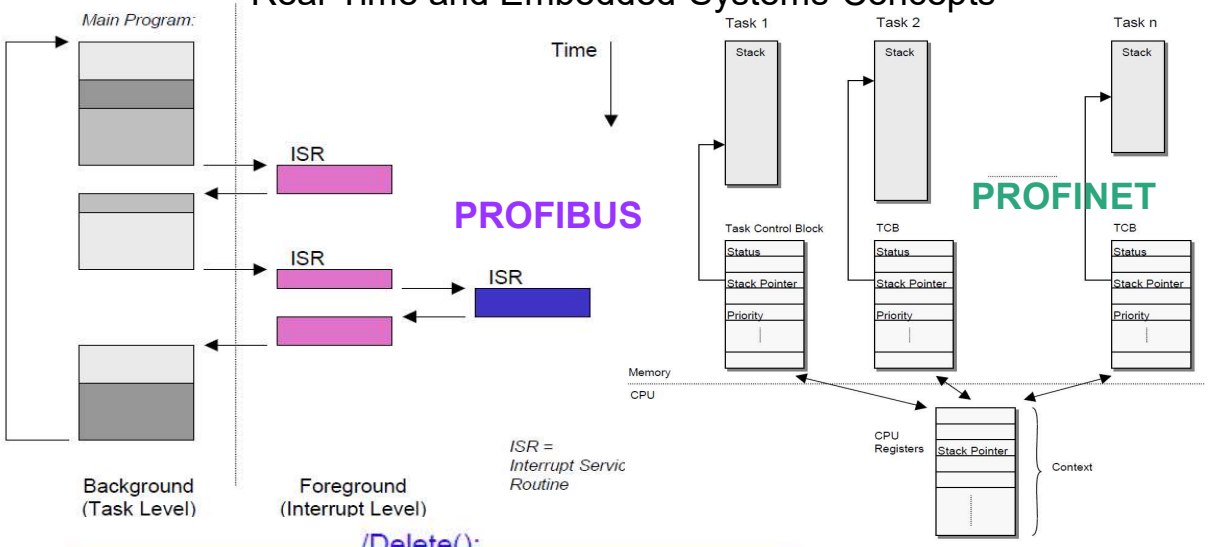
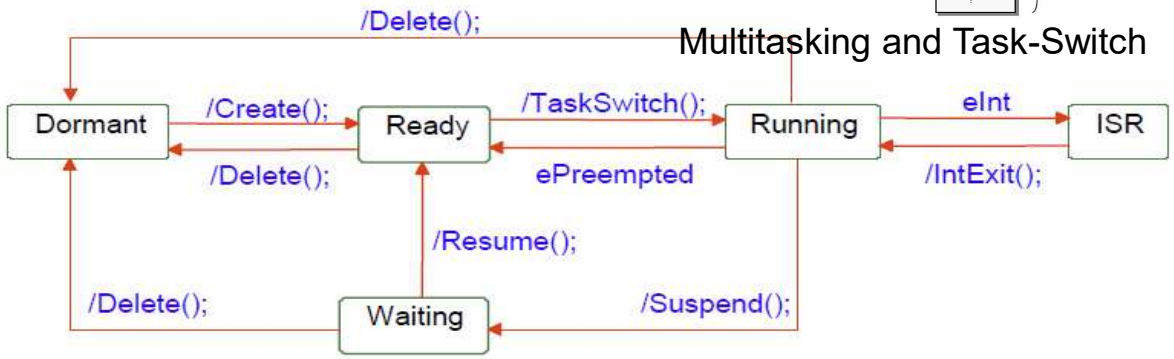
Real-Time and Embedded-Systems-Concepts



Multitasking and Task-Switch



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Profile for Identification Systems, Proxy Ident Function Block - RFID

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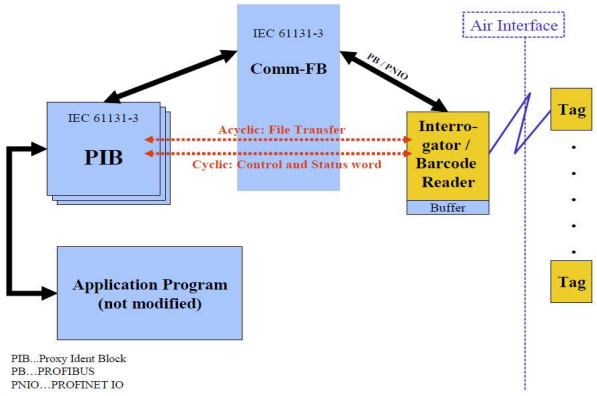
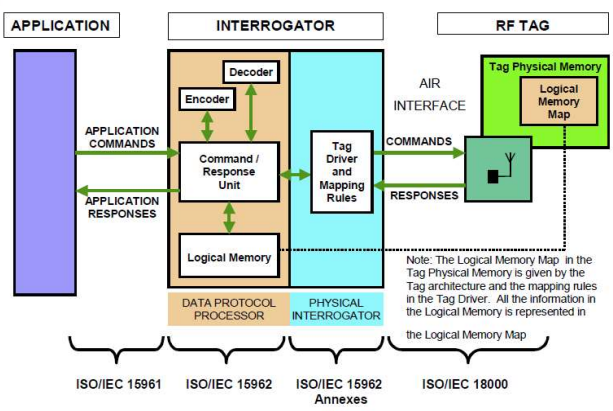
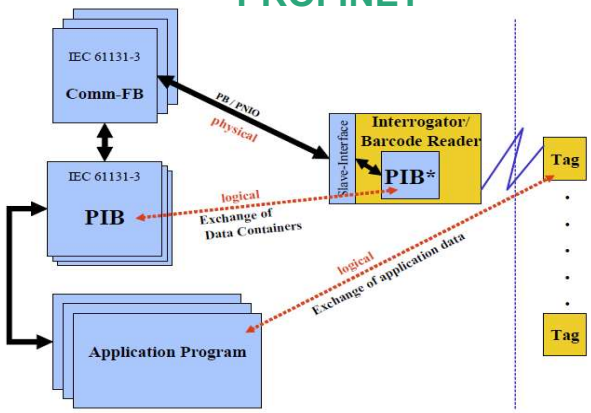
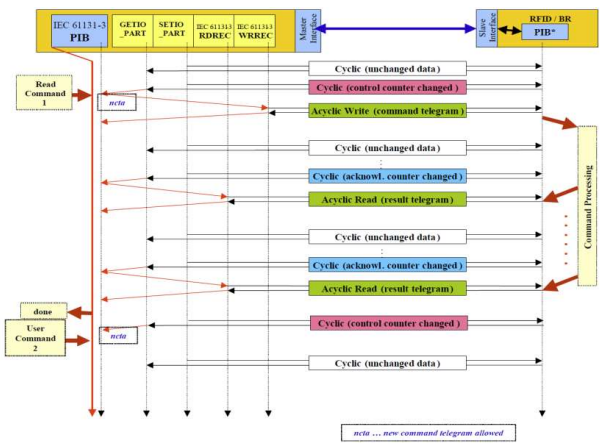




PROFINET





Host / Engineering Functions for PROFIBUS

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	robots & numerical control	PA Devices	Encoder	PROFIsafe	PROFIdrive (see next table)	Fluid Power / Hydraulics	SEMI	Identification Systems	weighing & dosage systems	Intelligent pumps	low voltage switch gears	remote IO for process control	IO-Link Integration	lab devices	train applications	PROFIenergy
PROFIBUS DP - Master																
cyclic data (DP V0)	m	m	m	m		m	m	m	m	m	m	n.a.	m	m	n.a.	n.a.
use cyclic data in PLC program (ST and Communication Function Blocks): GETIO_PART, SETIO_PART								m	m			n.a.			n.a.	n.a.
diagnosis status message		m	m					o	o	m		n.a.	m		n.a.	n.a.
alarms (DP V1)			o					o	o			n.a.			n.a.	n.a.
data records – Host (DP V1: MS1)		o	m	m				m	m	o		n.a.	m		n.a.	n.a.
data records – PC (DP V1: MS2)		m	m	m				o	o	o		n.a.	m		n.a.	n.a.
use data records within PLC program (ST and Communication Function Blocks): RDREC, WRREC								m	m			n.a.			n.a.	n.a.
Parameter Server Status Message Type 7				m								n.a.	o		n.a.	n.a.
SIL claim		o	o	m								n.a.			n.a.	n.a.
GSD Version	1.0	5.0	2.0	5.04		1.0	5.0	5.0	5.0	5.0	1.0	n.a.	5.0	5.0	n.a.	n.a.
TCI Support				m								n.a.	m		n.a.	n.a.
PROFIdrive: Isochronous Mode (DP V2)												n.a.			n.a.	n.a.
PROFIdrive: data-exchange broadcast												n.a.			n.a.	n.a.

The following legend applies:
m = shall (mandatory)
o = may (optional), according to the specific application profile
blank = may (optional), can be used but not addressed in the specific application profile
n.a. = not applicable

Host / Engineering Functions for PROFIBUS and PROFIdrive

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	PROFIdrive	PROFIdrive application class 1	PROFIdrive application class 2	PROFIdrive application class 3	PROFIdrive application class 4	PROFIdrive application class 5	PROFIdrive application class 6
PROFIBUS DP - Master							
cyclic data (DP V0)		m	m	m	m	n.a.	m
use cyclic data in PLC program (ST and Communication Function Blocks): GETIO_PART, SETIO_PART						n.a.	
diagnosis status message						n.a.	
alarms (DP V1)						n.a.	
data records – Host (DP V1: MS1)					m	n.a.	
data records – PC (DP V1: MS2)		m	m	m	m	n.a.	m
use data records within PLC program (ST and Communication Function Blocks): RDREC, WRREC						n.a.	
Parameter Server Status Message Type 7						n.a.	
SIL claim		o	o	o	o	n.a.	o
GSD Version		3.0	4.0	3.0	4.0	n.a.	4.0
TCI Support						n.a.	
PROFIdrive: Isochronous Mode (DP V2)		o		o	m	n.a.	m
PROFIdrive: data-exchange broadcast			m			n.a.	m

The following legend applies:
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Host / Engineering Functions for PROFINET

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	robots & numerical control	PA Devices	Encoder	PROFIsafe	PROFIdrive (see next table)	Fluid Power / Hydraulics	SEMI	Identification Systems	weighing & dosage systems	Intelligent pumps	low voltage switch gears	remote IO for process control	IO-Link Integration	lab devices	train applications	PROFIenergy
PROFINET IO - Controller																
RT	n.a.	n.a.	m	m		n.a.	m	m	n.a.	m	m	m	m	n.a.	m	m
IRT	n.a.	n.a.	o			n.a.			n.a.		o			n.a.		
use cyclic data in PLC program (ST and Communication Function Blocks): GETIO_PART, SETIO_PART	n.a.	n.a.				n.a.		m	n.a.					n.a.		
use data records within PLC program (ST and Communication Function Blocks): RDREC, WRREC	n.a.	n.a.				n.a.		m	n.a.				m	n.a.		
Parameter Server Update Alarm	n.a.	n.a.		m		n.a.			n.a.				o	n.a.		
SIL claim	n.a.	n.a.	o	m		n.a.			n.a.					n.a.		
GSDML Version	n.a.	n.a.	2.1	2.2		n.a.		2.0	n.a.	2.0	1.0	2.0	2.2	n.a.	2.2	2.25
TCI Support	n.a.	n.a.		m		n.a.			n.a.				m	n.a.		
PROFIdrive: M CR (Broadcast)	n.a.	n.a.	o			n.a.			n.a.					n.a.		

The following legend applies:
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Host / Engineering Functions for PROFINET and PROFIdrive

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	PROFIdrive	PROFIdrive application class 1	PROFIdrive application class 2	PROFIdrive application class 3	PROFIdrive application class 4	PROFIdrive application class 5	PROFIdrive application class 6
PROFINET IO - Controller							
RT		m	m	m	o	n.a.	m
IRT					m	n.a.	m
use cyclic data in PLC program (ST and Communication Function Blocks): GETIO_PART, SETIO_PART						n.a.	
use data records within PLC program (Communication Function Blocks): RDREC, WRREC						n.a.	
Parameter Server Update Alarm						n.a.	
SIL claim		o	o	o	o	n.a.	o
GSDML Version		2.0	2.0	2.0	2.0	n.a.	2.0
TCI Support						n.a.	
PROFIdrive: M CR (Broadcast)			m			n.a.	m

The following legend applies:
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Amendment PROFIdrive on PROFIsafe

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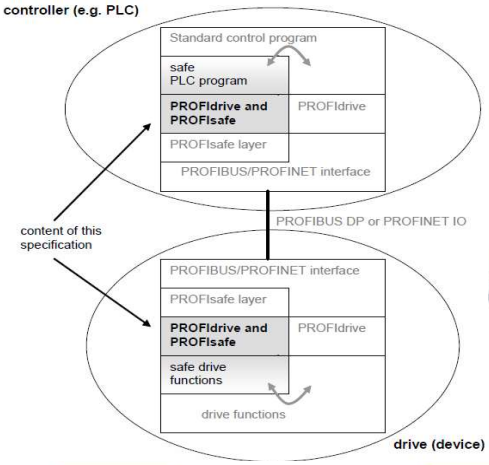
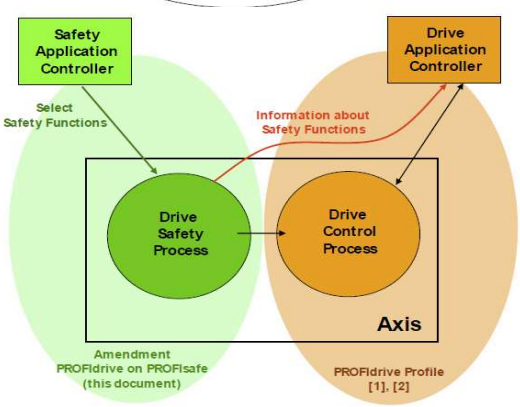
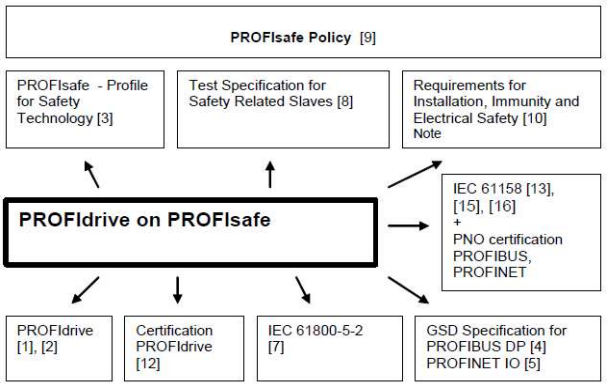
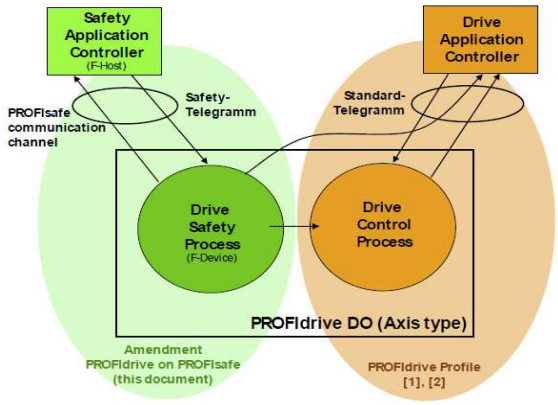




PROFINET





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PROFISAFE WITH PROFIDRIVE

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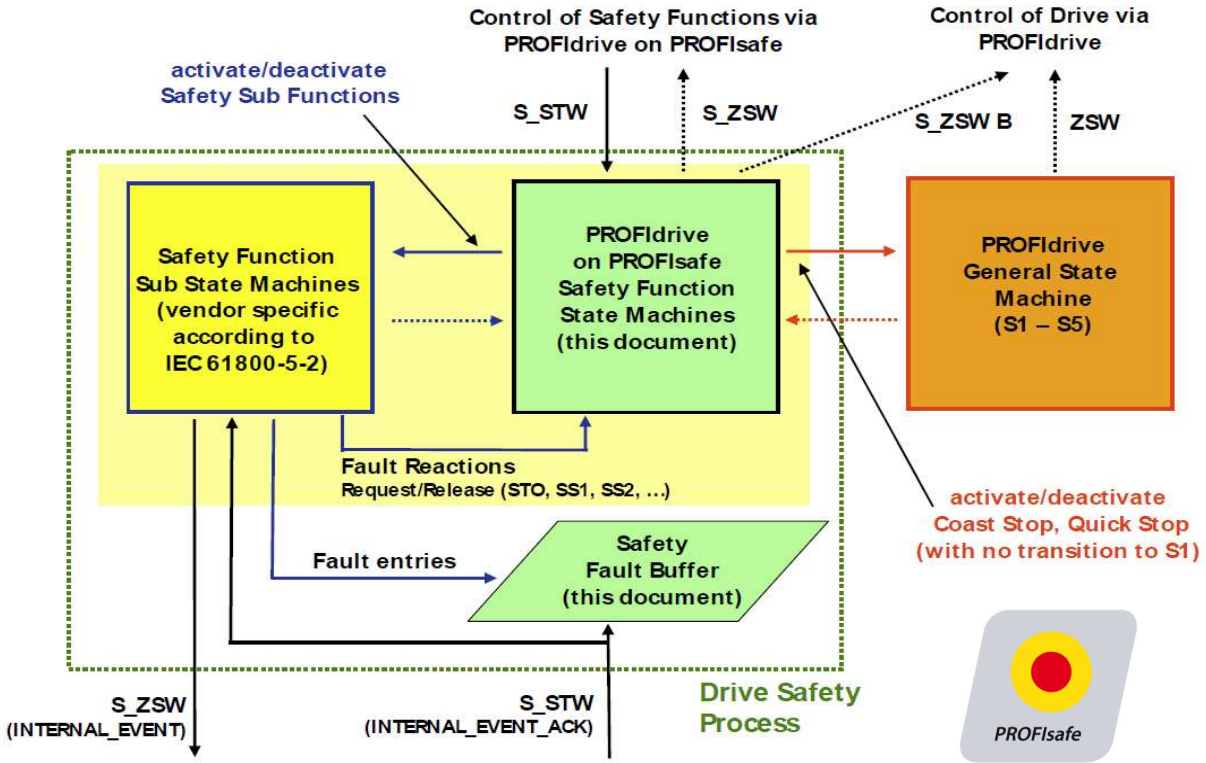

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General Sequence of activation of STO

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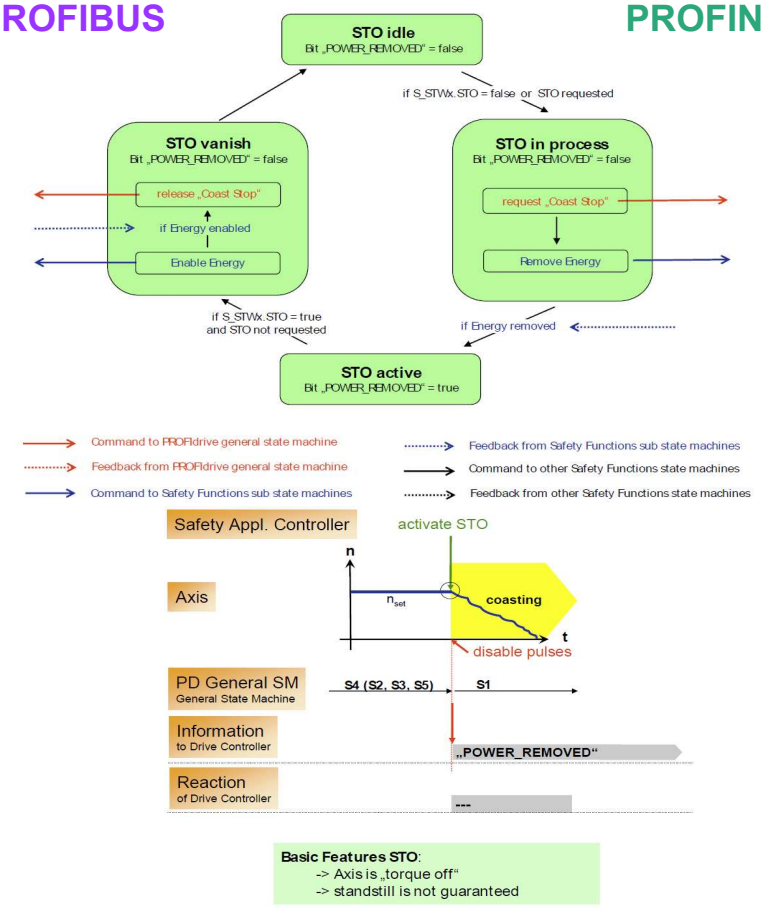
SIEMENS PLC
PRESENT

PROFIBUS **PROFINET**



Basic Features STO:
-> Axis is „torque off"
-> standstill is not guaranteed

PROFIBUS AND PROFINET WITH PROFIDRIVE

Overview
USS RS485
ETHERNET
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ISO/OSI
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PROFIDRIVE
PROFIENERGY
VLAN
VPN
PROFINET CBA
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SIEMENS PLC
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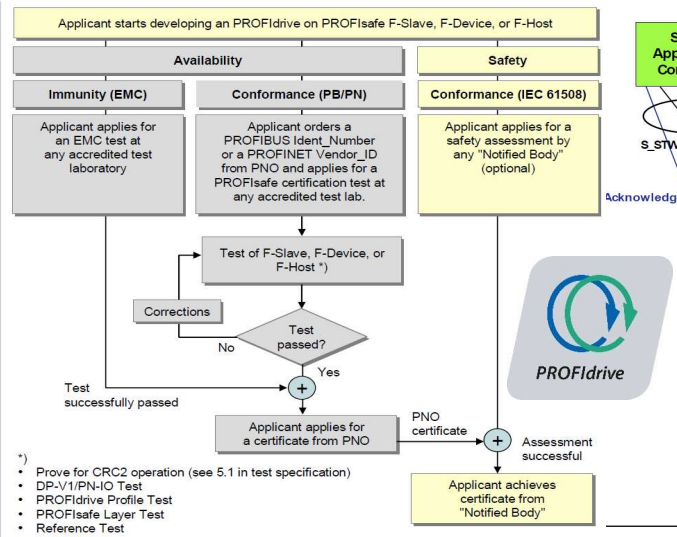
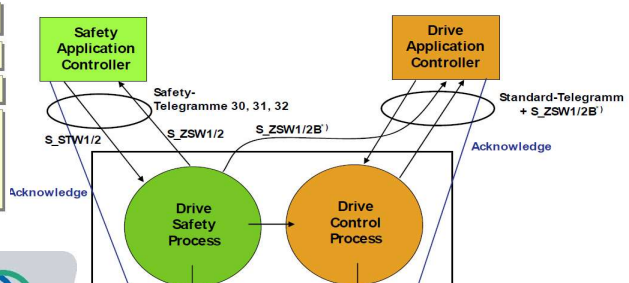
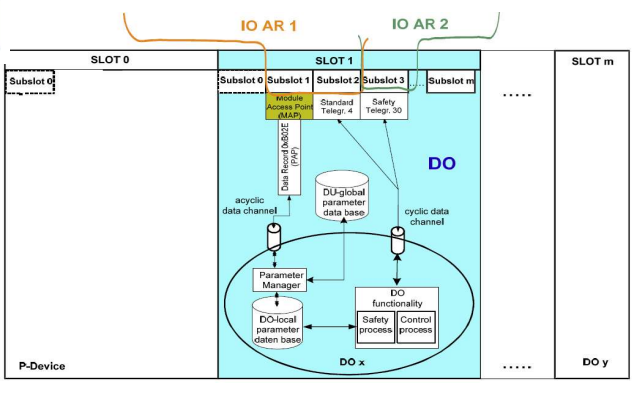
PROFIBUS **PROFINET**





PROFIBUS header	PROFIsafe user data	PROFIsafe trailer	PROFIdrive user data	...	PROFIBUS trailer
	F Process Data	Status/Control Byte CRC2		...	
	F-Data (=PROFIdrive PROFIsafe Telegram)			...	
	Slot x		Slot x+1	...	



RT AND IRT COMMUNICATION

Overview
USS RS485
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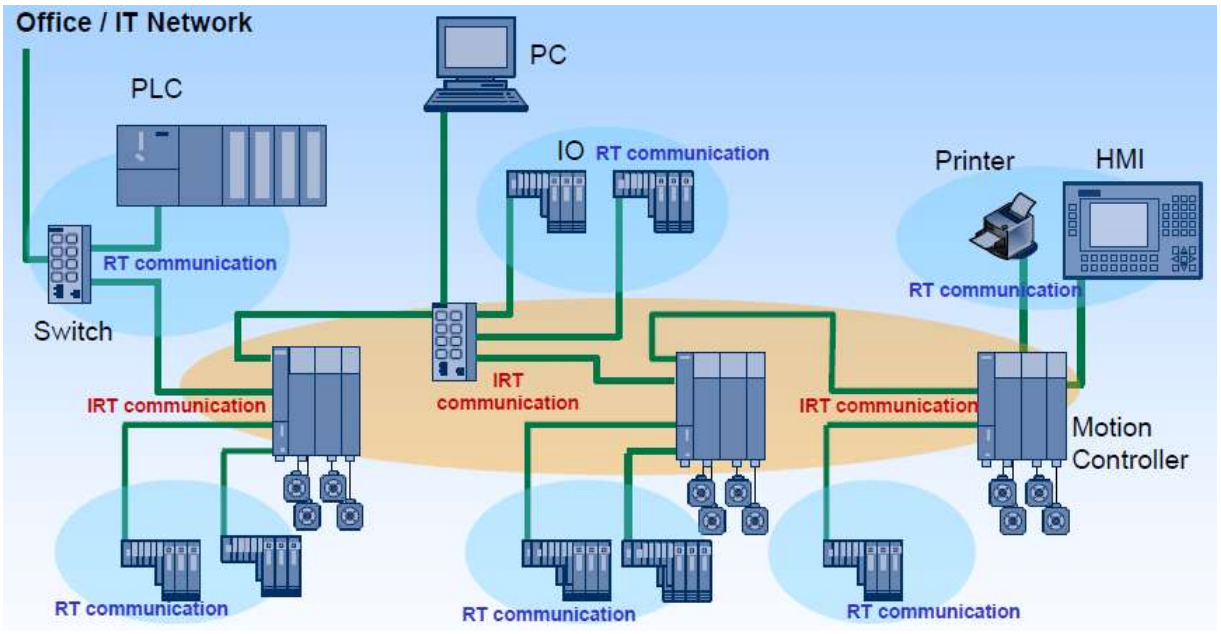
PROFIBUS **PROFINET**



PROFIdrive

MOTION CONTROL

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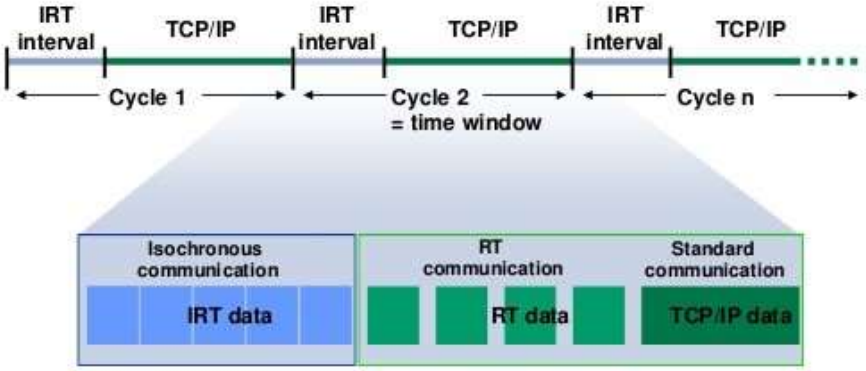
Agenda
Uniform structures
Performance
Integration
Innovations
Enhancement

PROFINET is Real-time Ethernet



- Bandwidth reservation for isochronous communication
- IRT permits high-precision synchronization

PROFIdrive

Hardest Real-time by means of Isochronous Real-time (IRT)

PROFINET Marketing - Benefits

Function diagram of the basic controller for all operating modes

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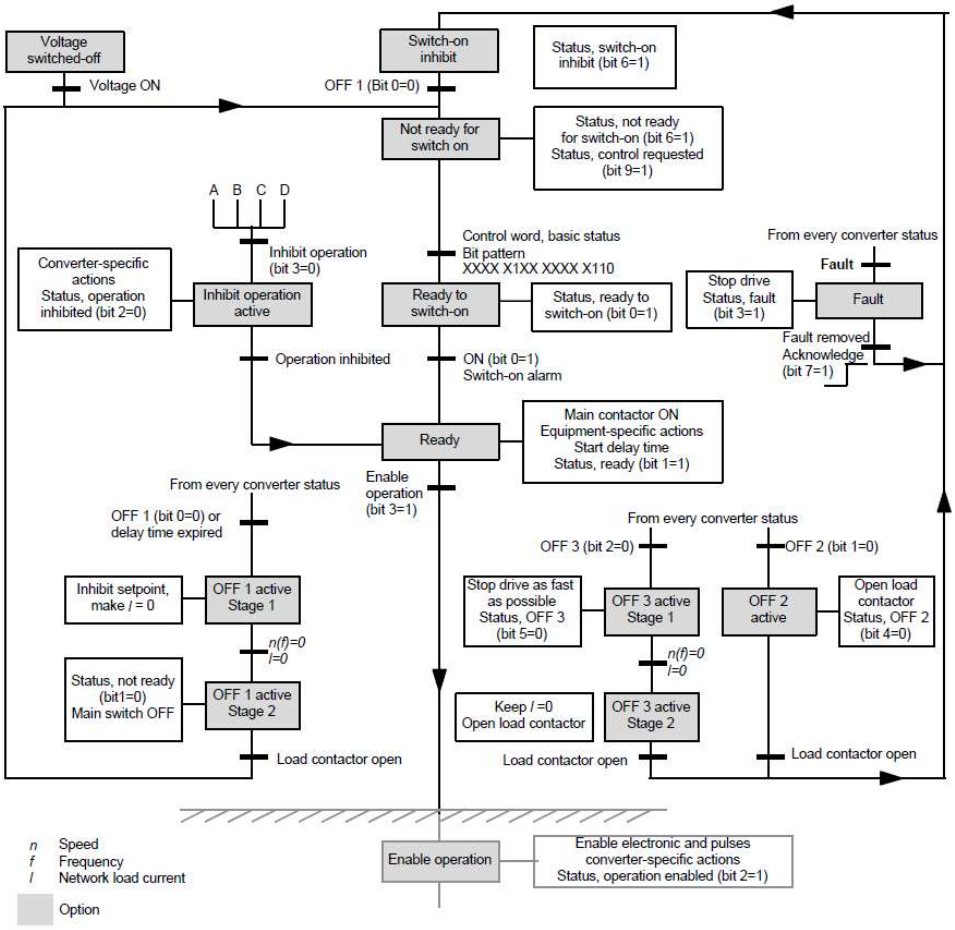

Function diagram of the speed control mode, control and status word

Overview
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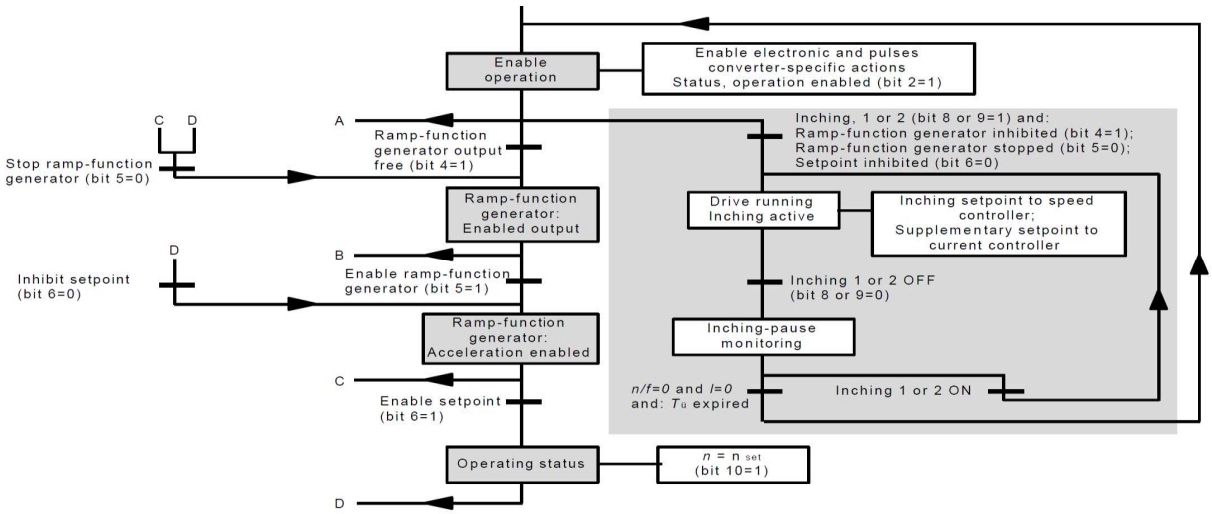

CONTROL AND STATUS WORDS

Overview
USS RS485
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Control word 1 r550

Bit No.	Meaning
Bit 0	**0=OFF1, Shutdown via ramp-function generator, followed by pulse disable,** 1=ON, operating condition (edge-controlled)
Bit 1	**0=OFF2, pulse disable, motor coasts down** 1=Operating condition
Bit 2	**0=OFF3, quick stop** 1=Operating condition
Bit 3	**1=Inverter enable, pulse enable** 0=Pulse disable
Bit 4	**1=Ramp-function generator enable** 0=Set ramp-function generator to 0
Bit 5	**1=Start ramp-function generator** 0=Stop ramp-function generator
Bit 6	**1=Setpoint enable** 0=Setpoint disable
Bit 7	**0 =>1 Edge fault acknowledgement**
Bit 8	**1=Inching bit0**
Bit 9	**1=Inching bit1**
Bit 10	**1=Control requested** 0=No control requested
Bit 11	**1=Clockwise phase sequence enable** 0=Clockwise phase sequence disable
Bit 12	**1=Counter-clockwise phase sequence** enable 0=Counter-clockwise phase sequence disable
Bit 13	**1=Raise mot. potentiometer**
Bit 14	**1=Lower mot. potentiometer**
Bit 15	**0=External fault 1** 1=No external fault

Status word 1 r552

Bit No.	Meaning
Bit 0	**1=Ready to switch on** 0=Not ready to switch on
Bit 1	**1=Ready for operation (DC link loaded, pulses disabled)** 0=Not ready for operation
Bit 2	**1=Run (voltage at output terminals)** 2) 0=Pulses disabled
Bit 3	**1=Fault active (pulses disabled)** 0=No fault
Bit 4	**0=OFF2 active** 1=No OFF2
Bit 5	**0=OFF3 active** 1=No OFF3
Bit 6	**1=Switch-on inhibit** 0=No switch-on inhibit (possible to switch on)
Bit 7	**1=Warning active** 0=No warning
Bit 8	**1=No setpoint/actual value deviation detected** 0=Setpoint/actual value deviation
Bit 9	**1=PZD control requested (always 1)**
Bit 10	**1=Comparison value reached** 0=Comparison value not reached
Bit 11	**1=Message low voltage** 0=Message no low voltge
Bit 12	**1=Request to energize main contactor** 0=No request to energize main contactor
Bit 13	**1=Ramp-function generator active** 0=Ramp-function generator not active
Bit 14	**1=Positive speed setpoint** 0=Negative speed setpoint
Bit 15	**1=Kinetic buffering/flexible response active** 0=Kinetic buffering/flexible response inactive

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Function diagram of the positioning mode, control and status word

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PROFIENERGY
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PROFINET CBA
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SIEMENS PLC
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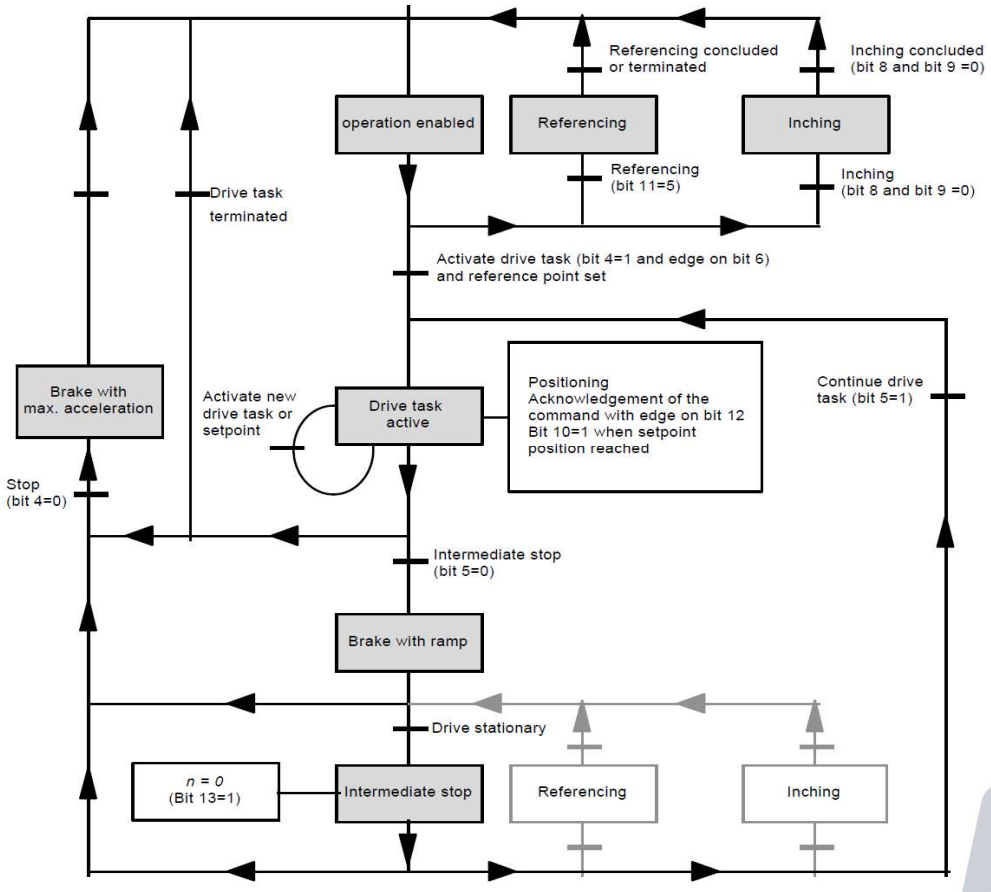

PROFIdrive

Parameter process data object (PPO)

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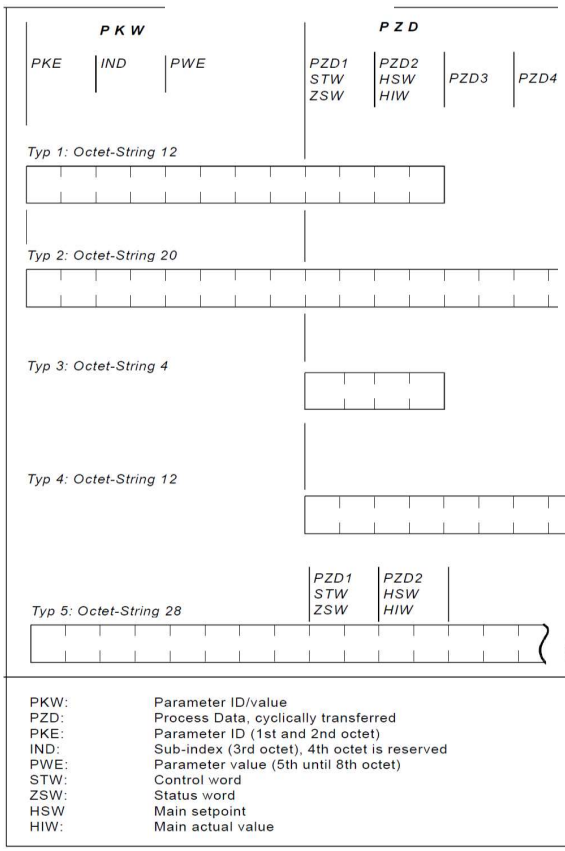
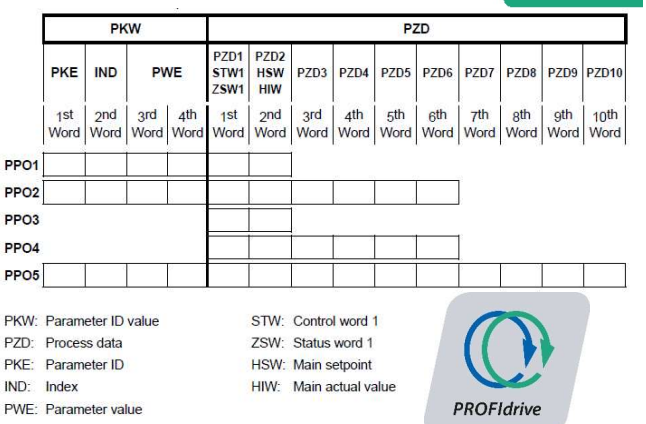
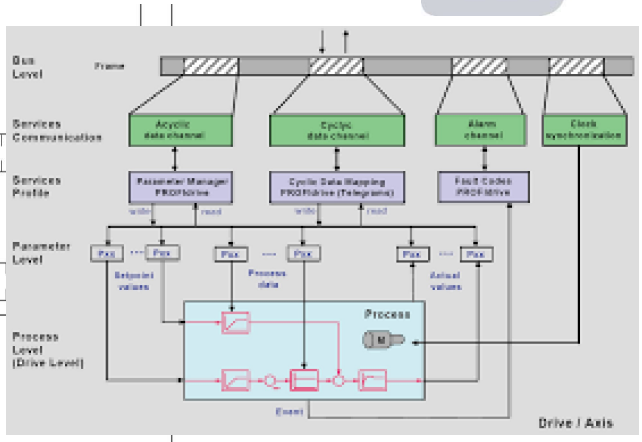




PROFIdrive



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Profile Drive Technology Encoder Profile – Part 1

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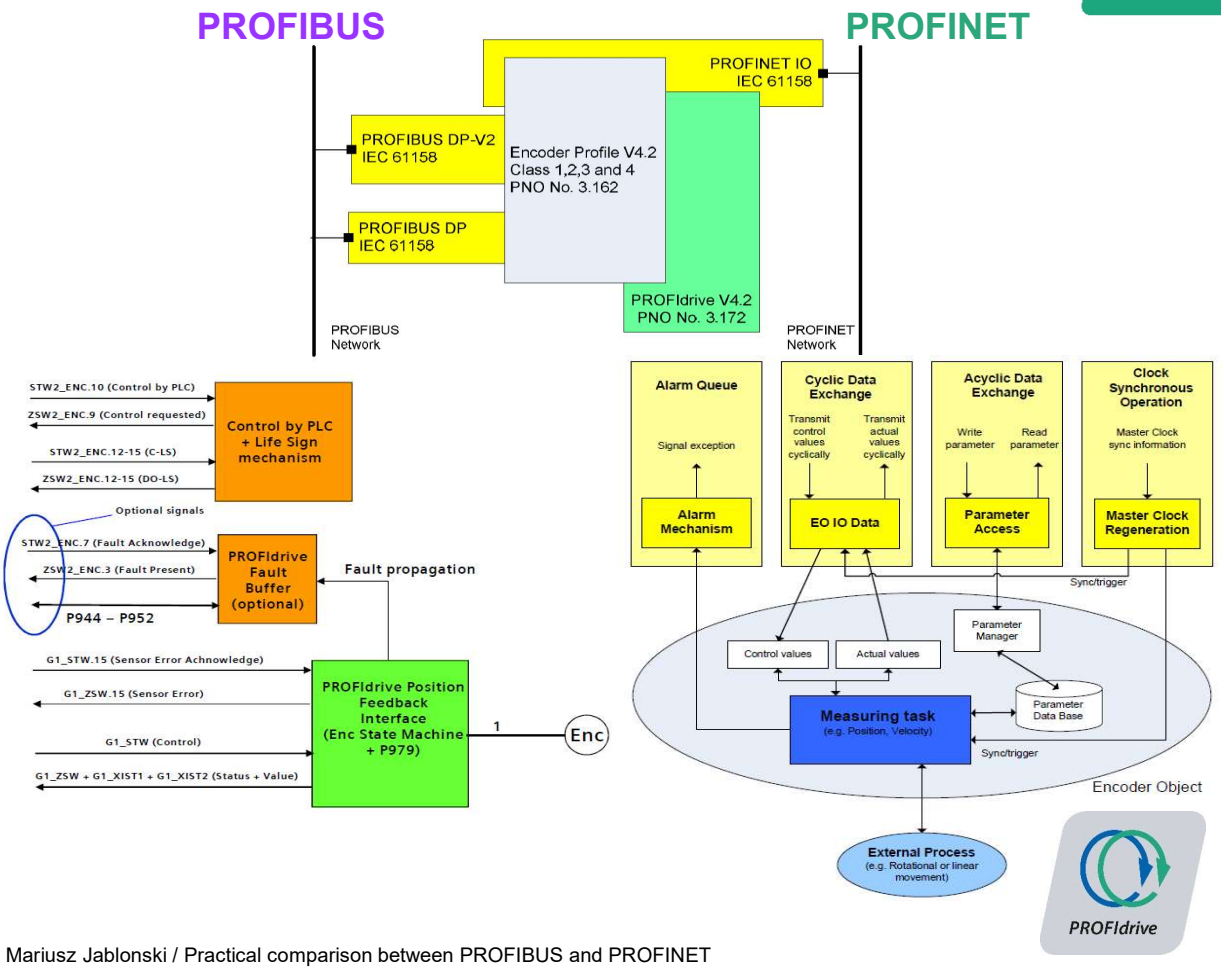

PROFIdrive

Mariusz Jablonski / Practical comparison between PROFIBUS and PROFINET

Profile Drive Technology Encoder Profile – Part 2

Overview
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PROFIDRIVE
PROFIENERGY
VLAN
VPN
PROFINET CBA
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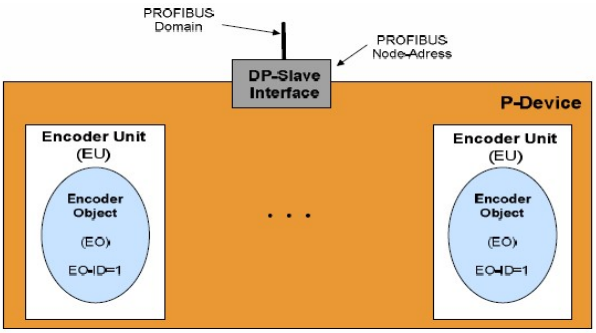
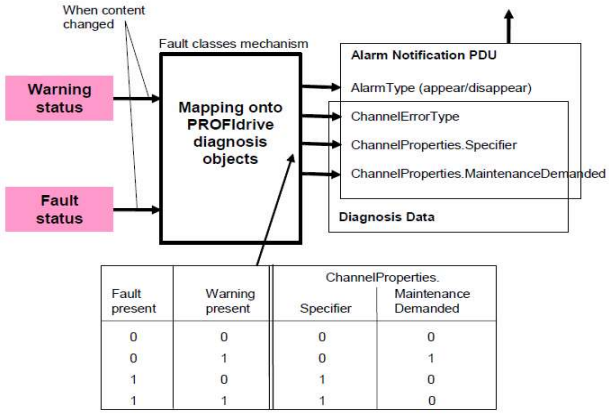
SIEMENS PLC
PRESENT

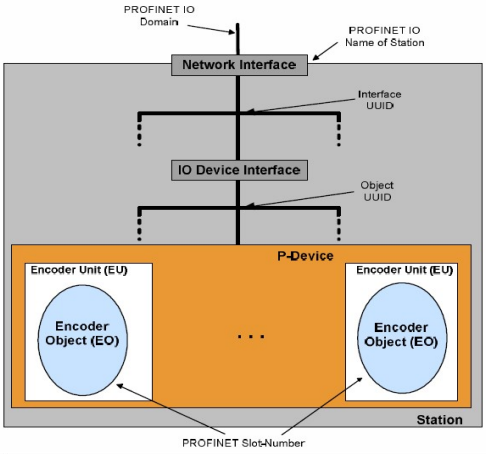
PROFIBUS

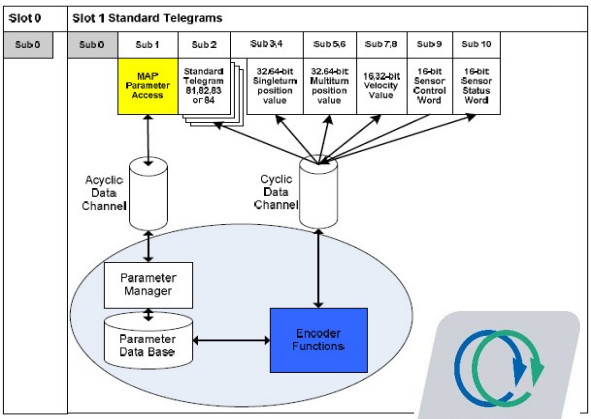




Fault present	Warning present	ChannelProperties. Specifier	ChannelProperties. Maintenance Demanded
0	0	0	0
0	1	0	1
1	0	1	0
1	1	1	0

PROFINET





PROFIdrive

Common Application Profile PROFIenergy

Overview
USS RS485
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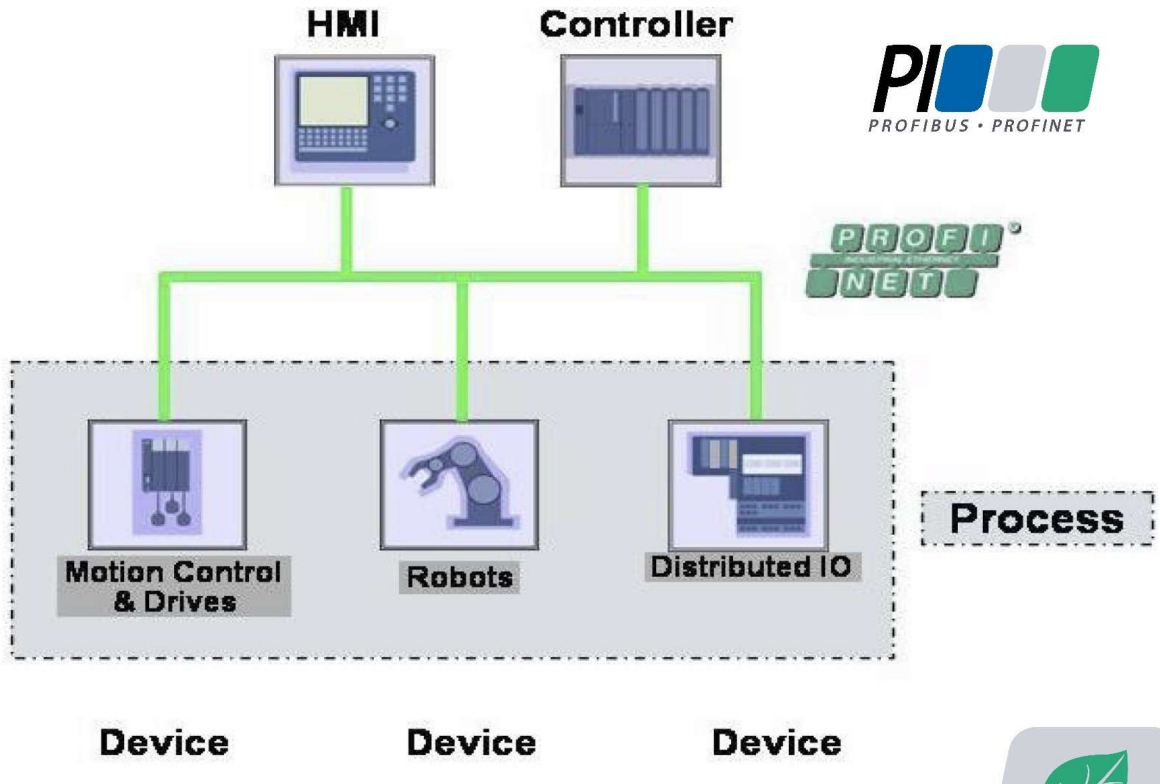
SIEMENS PLC
PRESENT



PROFIenergy

PROFIENERGY

Overview
USS RS485
ETHERNET
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DIAGNOSTICS
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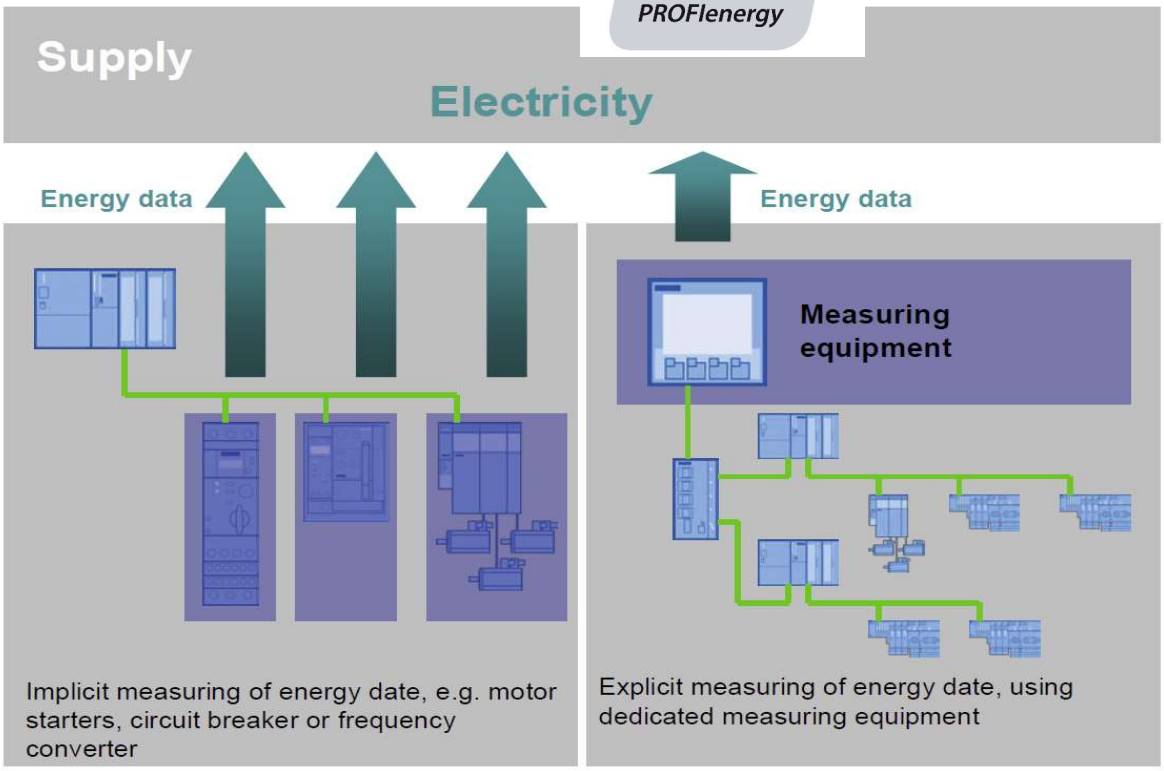

Overview of PROFIenergy states

Overview
USS RS485
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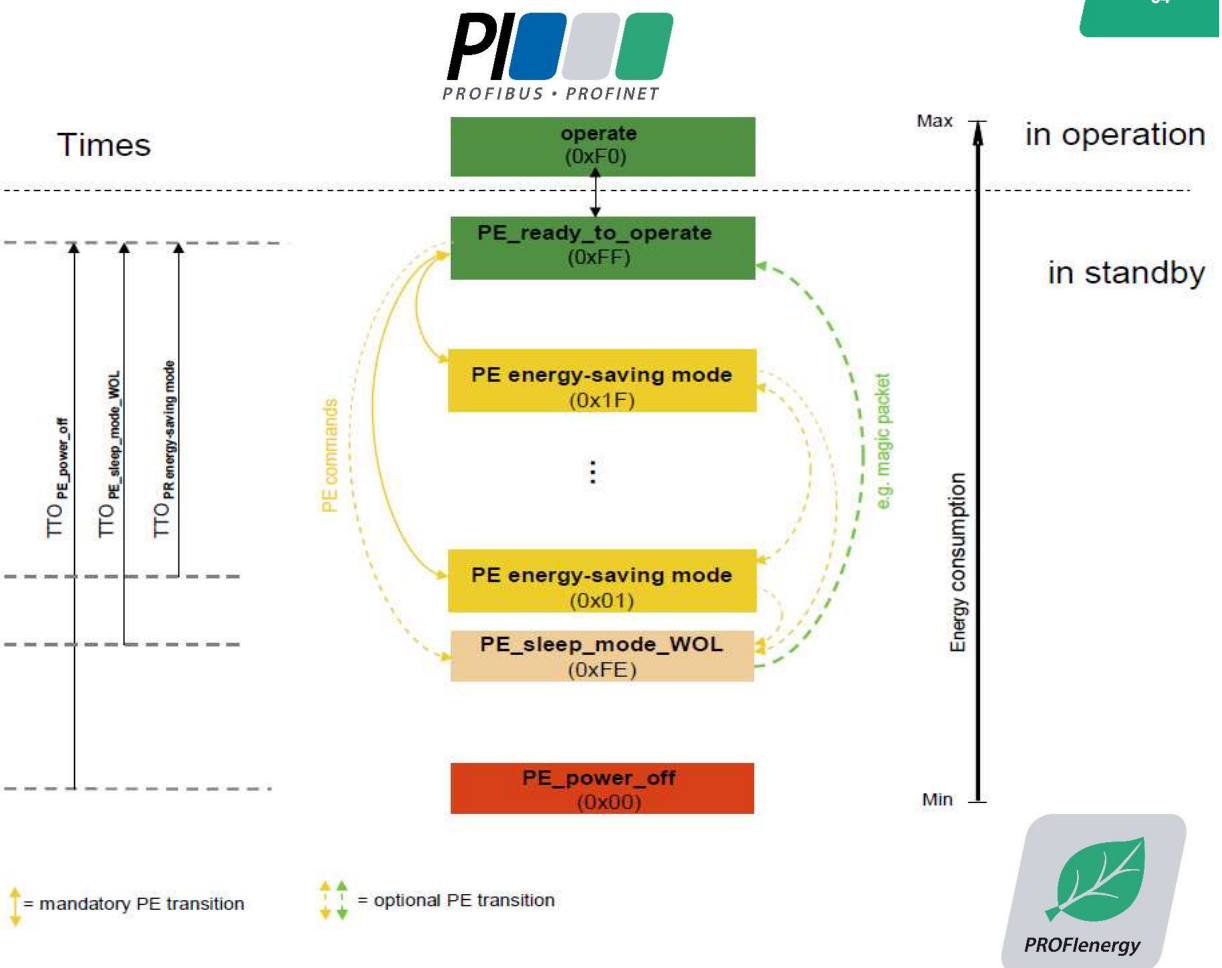
PRESENT



Device with PE Entity located in a Function Module

Overview
USS RS485
ETHERNET
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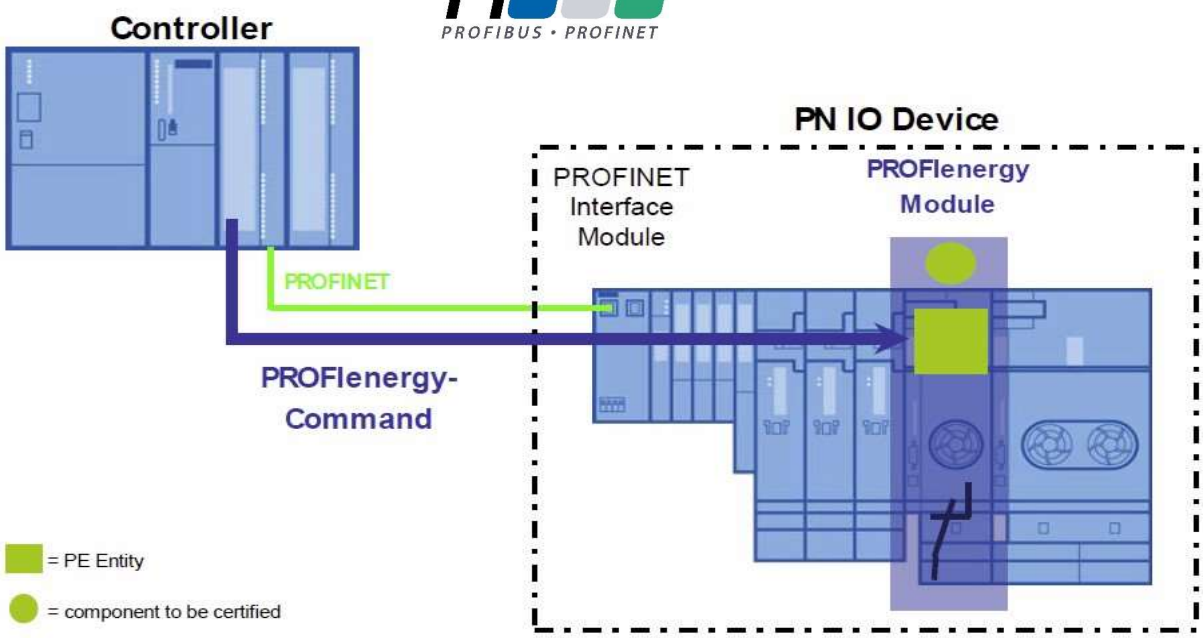

The controller communicates directly with the PROFIenergymodule.
The PROFINET InterfaceModuleis not affected by this communication.

Device with PE Entity located in the PROFINET Interface Module

Overview
USS RS485
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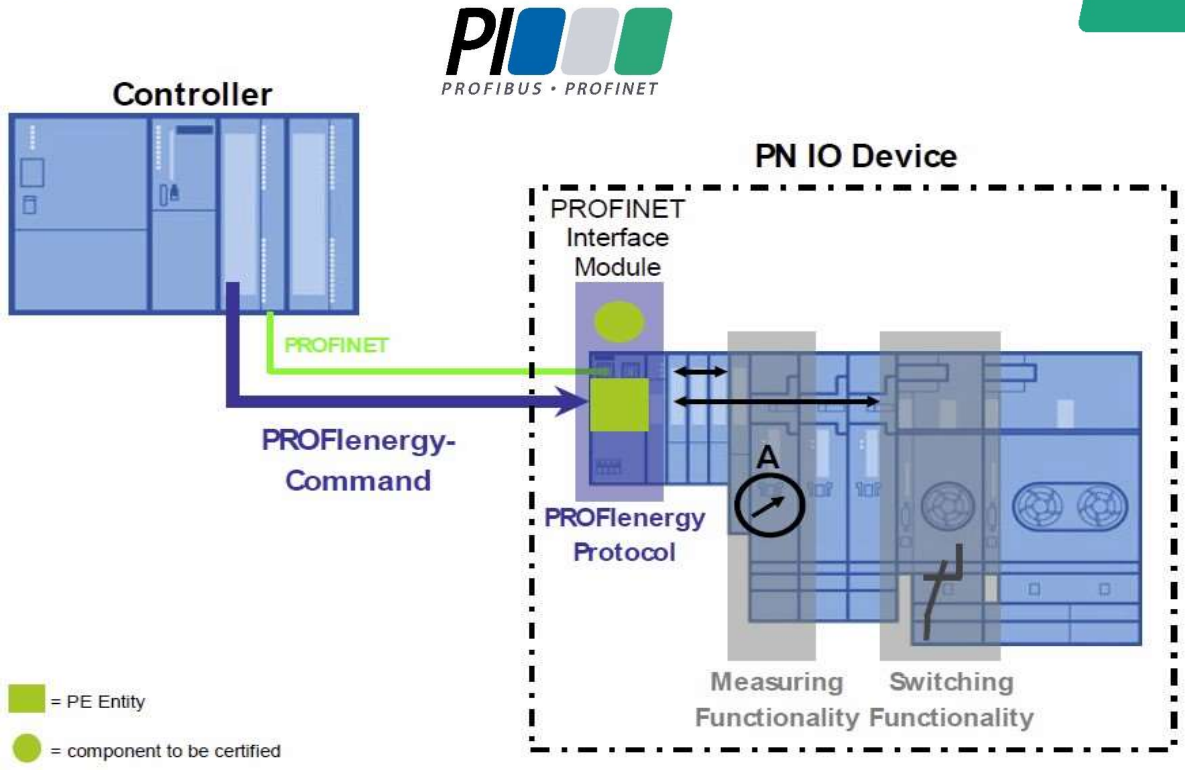

The controller communicates to the PROFINET interface module, which is a representative for the whole PN IO device.

Possible VLAN

Overview
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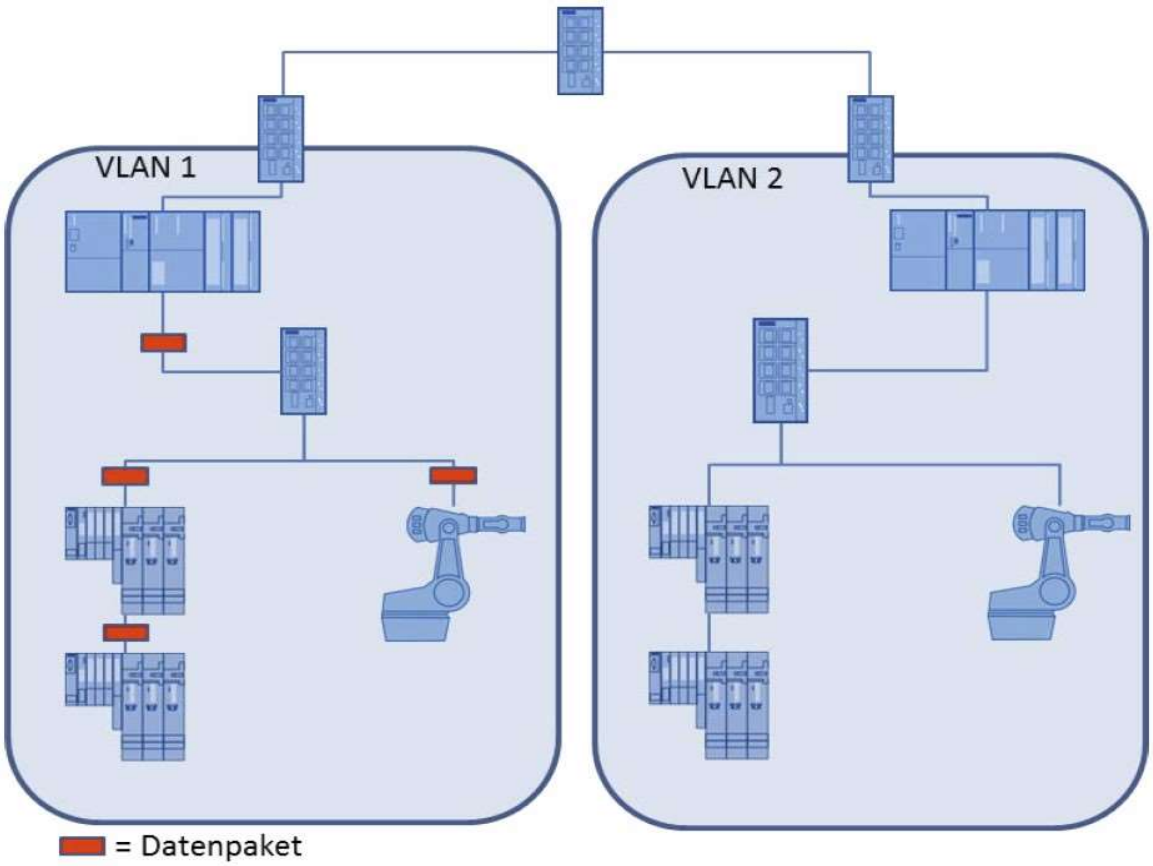

Measurement of VLAN signal strength

Overview
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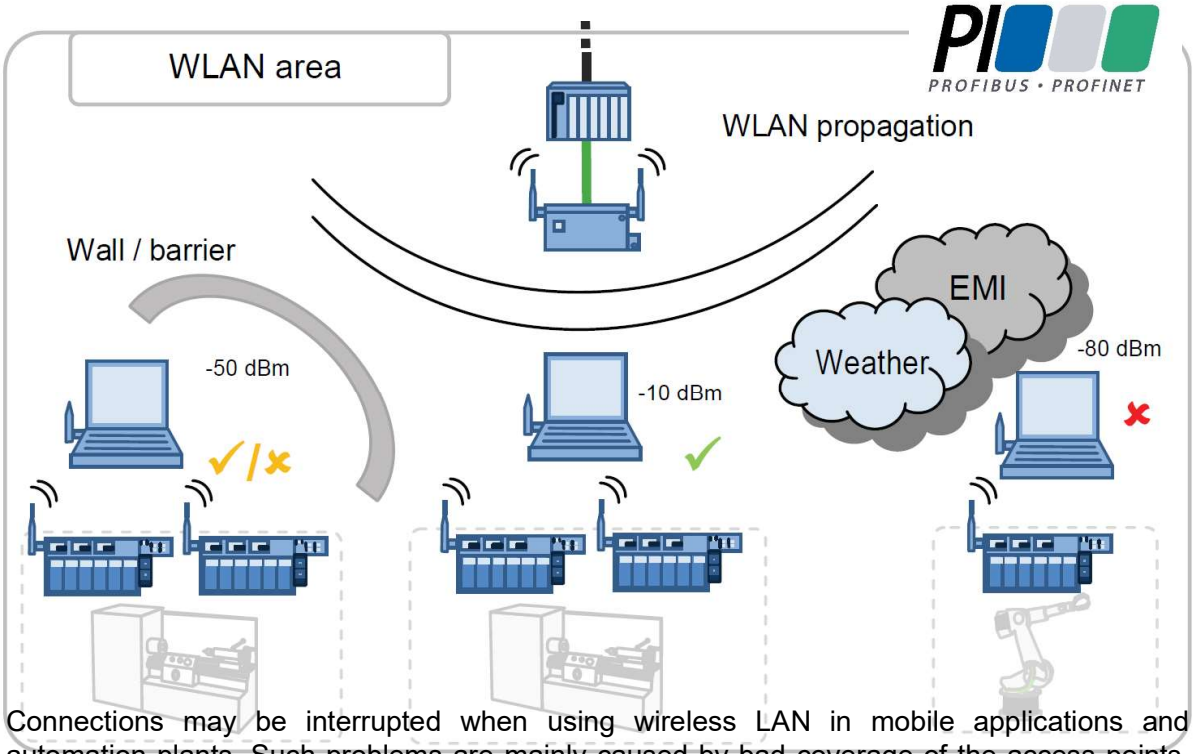

Connections may be interrupted when using wireless LAN in mobile applications and automation plants. Such problems are mainly caused by bad coverage of the access points. Disconnections may occur e.g. in the vicinity of power lines or due to imperfectly aligned antennae. The transmit power and transmit direction of the WLAN access point in practice usually differs from the theoretical values. The signal may be attenuated by walls, metal constructions or EMI. If WLAN is used outside of buildings, e.g. for point-to-point radio systems, the signal strength may also be affected by the weather.

Principle of a VPN

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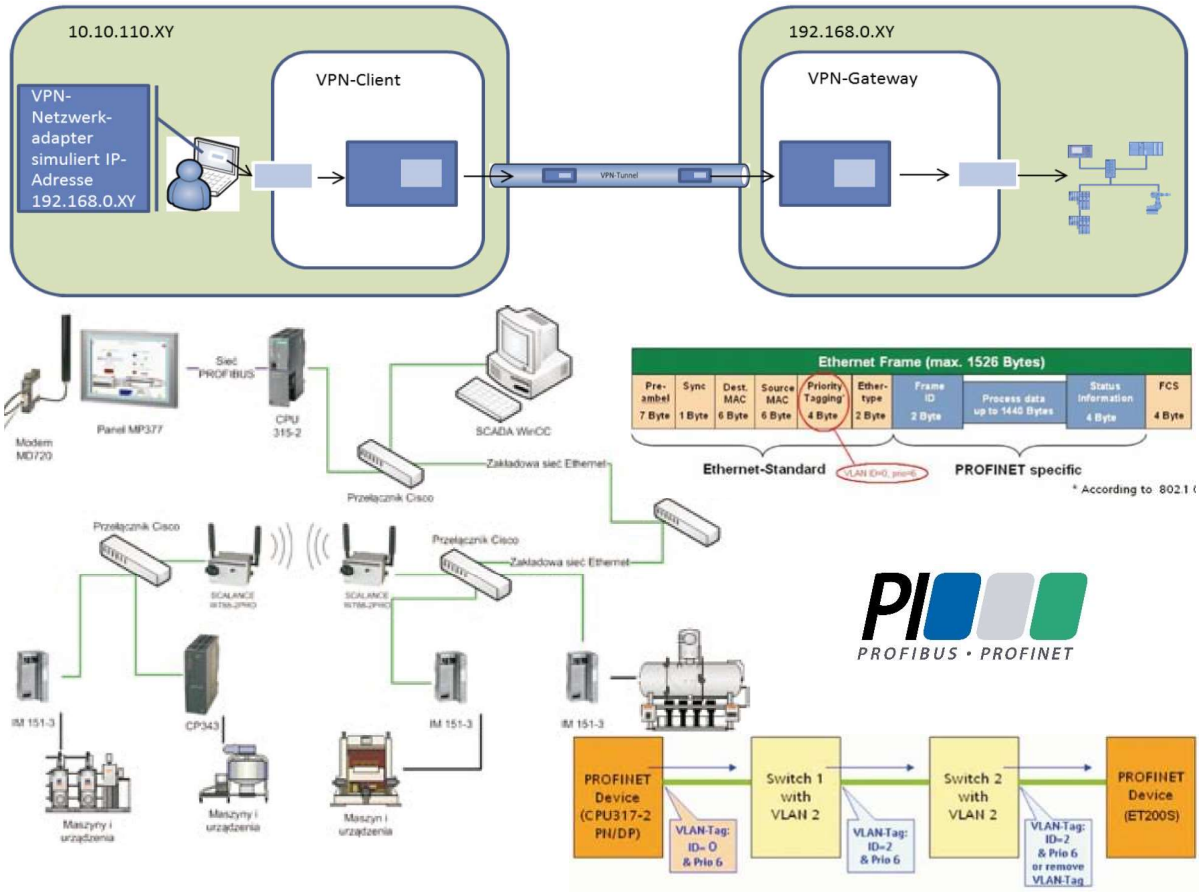

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SAFETY COMMUNICATIONS?

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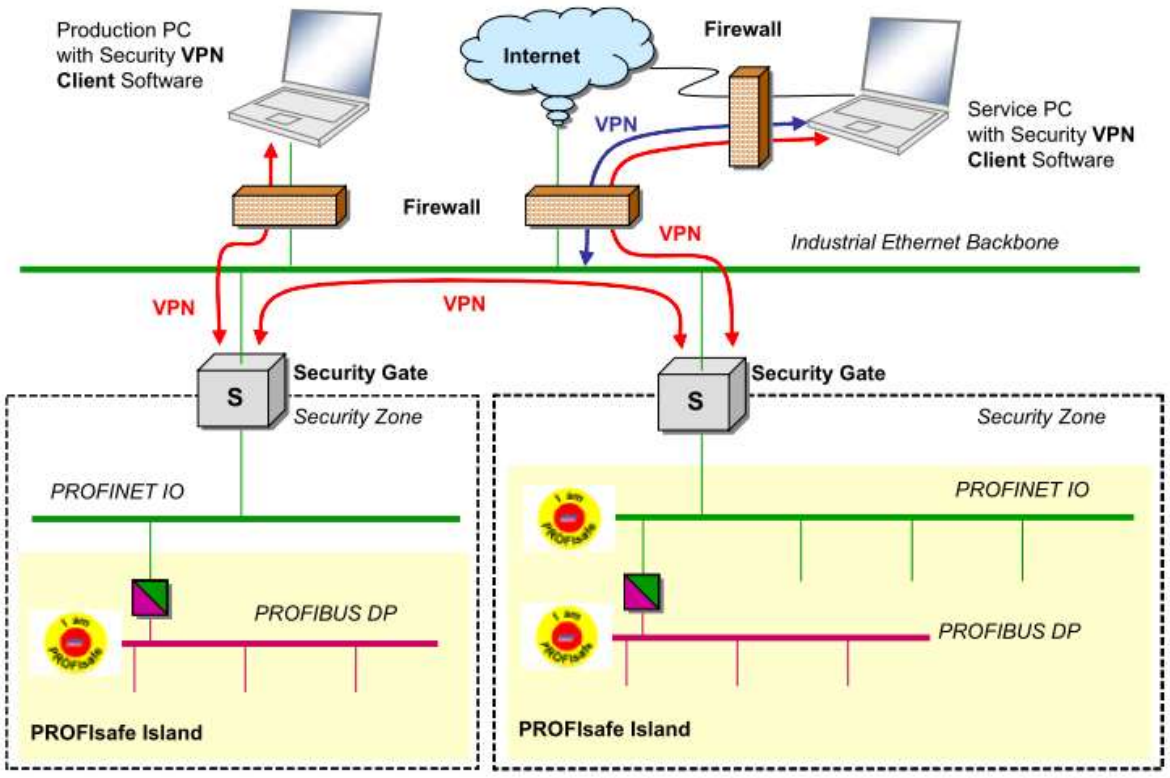

Maintenance state for CBA components

PROFINET

Overview
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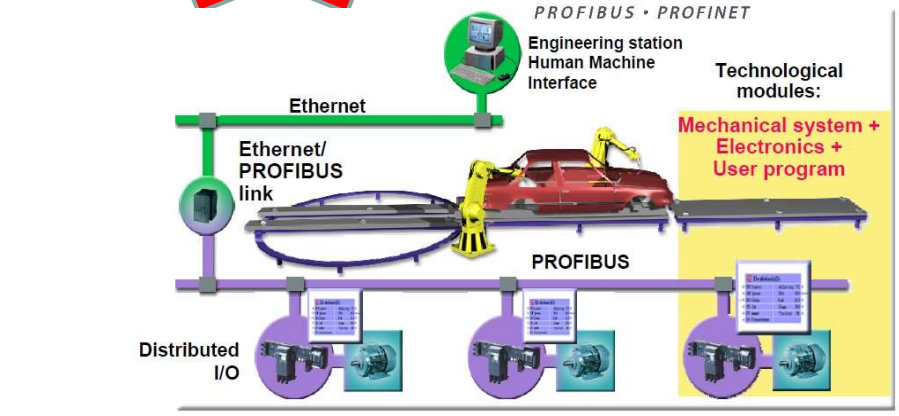

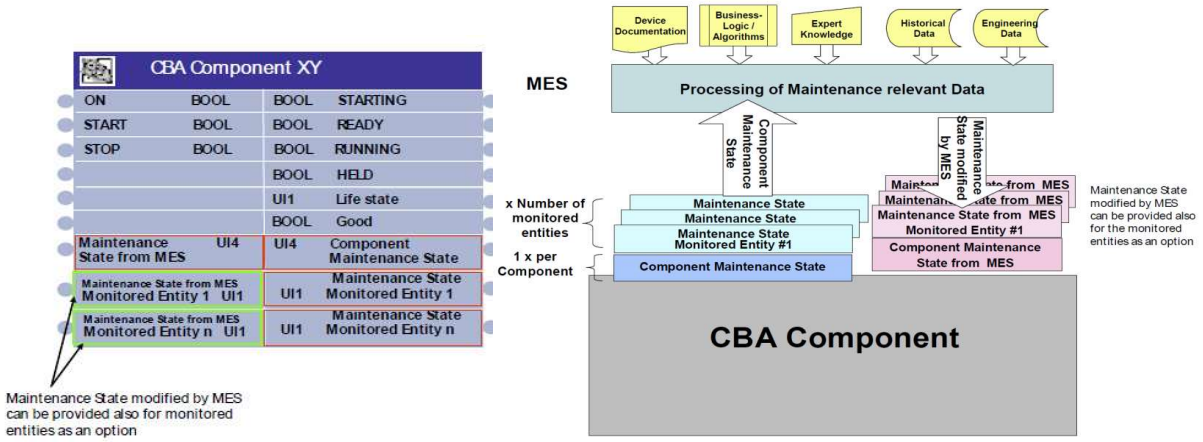

Comparison the technology of PROFINET IO and PROFIBUS

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Comparison of the transmission technology of PROFINET IO and PROFIBUS DP

Feature	PROFINET IO	PROFIBUS DP
Cable transmission technology	Industrial Ethernet over copper or fiber-optic cable.	PROFIBUS over copper or fiber-optic cable.
Wireless transmission technology	Industrial WLAN supports wireless transmission.	Infrared transmission is supported.

Comparison of PROFINET IO and PROFIBUS DP topology

Feature	PROFINET IO	PROFIBUS DP
Topology	Standard: Star and tree topology Line and ring topologies are supported	Standard: Line Tree and ring topologies are supported
Implementation in star topology	Only one network node per switch port	PROFIBUS DP is normally looped through from one node to the next. For information about tree and ring topologies, refer to the *PROFIBUS Networks* manual.
Implementation in tree topology	The switches are interconnected.	
Implementation in line topology	PROFINET devices are interconnected using integrated switches.	
Implementation in ring topology	Both ends in a line are joined by a redundancy manager to form a ring topology.	

Addressing PROFIBUS

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Addressing I/O devices/DP slaves

Feature	PROFINET IO	PROFIBUS DP
Addressing	Assigning IP addresses and device names to IO devices in STEP 7. Transferring the device name to Micro Memory Card by means of STEP 7. Assignment of IP addresses to IO devices by the IO controller. Assignment of IP addresses to switches or CPs by means of Primary Setup Tool (PST). Certain switches feature an integrated web-based management tool which can be accessed with standard browsers. This tool can also be used to assign IP addresses.	PROFIBUS address coding by means of DIL switch or configuration in STEP 7.

GSD - Import of device data in STEP 7

Feature	PROFINET IO	PROFIBUS DP
Import of device data in STEP 7	GSD file in XML format	GSD file in ASCII format

The GSD file for PROFINET IO is imported as in PROFIBUS DP

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Representation in STEP 7/NCM PC

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Comparison of the representation of PROFINET IO and PROFIBUS DP in STEP 7 and NCM PC

Feature	PROFINET IO	PROFIBUS DP
Subnet name	Ethernet	PROFIBUS
Subsystem name	IO system	DP master system
Name of the master device	IO controller	DP master
Name of the slave device	IO device	DP slave
Hardware catalog	PROFINET IO	PROFIBUS DP
Numbering	Device number	PROFIBUS address (corresponds with the station number)
Operating parameters, diagnostics address	Listed in the object properties of the interface module in slot 0	Listed in the object properties of the station System parameters which are not available at a module/submodule are inactive.

Blocks in PROFINET IO and PROFIBUS DP

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Blocks	PROFINET IO	PROFIBUS DP
SFC12 (deactivation and activation of DP slaves/IO devices)	Yes CPU S7-300: firmware V2.4.0 or later S7-400: firmware V5.0 or later	Yes
SFC13 (reading diagnostics data from a DP slave)	No Replaced by: • Event-driven: SFB54 • Status-driven: SFB52	Yes
SFC 58/59 (write/read record in I/O)	No Replaced by: SFB53/52	Yes Should already have been replaced by SFB53/52 in DPV1
SFB52/53 (read/write record)	Yes	Yes
SFB54 (evaluate interrupt)	Yes	Yes
SFC102 (read predefined parameters - S7-300 CPU only)	No Replaced by: SFB81	Yes for S7-300 SFC54 for S7-400

Comparison of the organization blocks of PROFINET IO and PROFIBUS DP

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Blocks	PROFINET IO	PROFIBUS DP
OB83 (hot swapping of modules/submodules)	Also supported on S7-300, new error information	S7-300 does **not** support this function Slaves integrated via the GSD file report the removal/insertion of modules/submodules during operation in the form of a diagnostics interrupt and thus via OB82. S7 slaves report a station failure and call OB86 when an insertion/removal interrupt is generated.
OB86 (rack failure)	New error information	Unchanged

PROFINET FUNCTIONALITY IN PLC

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Which IO controller support the function IRT, prioritized startup, MRP, MRPD, PROFIenergy, Shared device, I device and Isochronous mode in TIA Portal?

Entry-ID: 102325771

Module	Order number	IRT	prioritized startup	MRP	MRPD	PROFIenergy	Shared device[6]	I device	Isochronous mode	Link to Product information
PC CPs										
CP1616	6GK1161-6AA01	from V2.0	from V2.2.0	from V2.2.0	–	from V2.5.2	–	from V2.5.2	yes	http://support.automation.siemens.com/WW/view/en/50755157
CP1616	6GK1161-6AA02	from V2.0	from V2.2.0	from V2.2.0	–	from V2.5.2	–	from V2.5.2	yes	
CP1604	6GK1160-4AA00	from V2.0	from V2.2.0	from V2.2.0	–	from V2.5.2	–	from V2.5.2	yes	http://support.automation.siemens.com/WW/view/en/58346178
CP1604	6GK1160-4AA01	from V2.0	from V2.2.0	from V2.2.0	–	from V2.5.2	–	from V2.5.2	yes	
SIMATIC NET PC software										
SOFTNET PROFINET IO	6GK1704-1HWxx-3AA0	–	–	–	–	from V8.2	–	from V8.1	–	–
S7-1500 CPUs										
CPU 1518-4 PN/DP	6ES7518-4AP00-0AB0	from V1.5	from V1.5	from V1.5	–	from V1.5	from V1.5	from V1.5	from V1.5	http://support.automation.siemens.com/WW/view/en/86549996
CPU 1518F-4 PN/DP	6ES7518-4FP00-0AB0	from V1.5	from V1.5	from V1.5	–	from V1.5	from V1.5	from V1.5	from V1.5	http://support.automation.siemens.com/WW/view/en/87596995
CPU 1517-3 PN/DP	6ES7517-3AP00-0AB0	from V1.6	from V1.6	from V1.6		from V1.6	from V1.6	from V1.6	from V1.6	http://support.automation.siemens.com/WW/view/en/95292442
CPU 1517F-3 PN/DP	6ES7517-3FP00-0AB0	from V1.6	from V1.6	from V1.6		from V1.6	from V1.6	from V1.6	from V1.6	http://support.automation.siemens.com/WW/view/en/93483034
CPU 1516-3 PN/DP	6ES7516-3AN00-0AB0	from V1.0	from V1.0	from V1.0	–	from V1.0	from V1.1	from V1.0	from V1.0	http://support.automation.siemens.com/WW/view/en/66470496
CPU 1516F-3 PN/DP	6ES7516-3FN00-0AB0	from V1.0	from V1.0	from V1.0	–	from V1.0	from V1.5	ab V1.0	from V1.0	http://support.automation.siemens.com/WW/view/en/75204015
CPU 1515-2 PN	6ES7515-2AM00-0AB0	from V1.5	from V1.5	from V1.5	–	from V1.5	from V1.5	from V1.5	from V1.5	http://support.automation.siemens.com/WW/view/en/86549991
CPU 1515F-2 PN	6ES7515-2FM00-0AB0	from V1.6	from V1.6	from V1.6	–	from V1.6	from V1.6	from V1.6	from V1.6	http://support.automation.siemens.com/WW/view/en/93483029
CPU 1513-1 PN	6ES7513-1AL00-0AB0	from V1.0	from V1.0	from V1.0	–	from V1.0	from V1.1	from V1.0	from V1.0	http://support.automation.siemens.com/WW/view/en/66470491
CPU 1511-1 PN	6ES7511-1AK00-0AB0	from V1.0	from V1.0	from V1.0	–	from V1.0	from V1.1	from V1.0	from V1.0	http://support.automation.siemens.com/WW/view/en/66470541
S7-1200 CPUs										
CPU 1211C	6ES7211-1AE40-0XB0	–	–	–	–	–	–	from V4.0	–	http://support.automation.siemens.com/WW/view/en/89899865
	6ES7211-1BE40-0XB0	–	–	–	–	–	–	from V4.0	–	http://support.automation.siemens.com/WW/view/en/89899883
	6ES7211-1HE40-0XB0	–	–	–	–	–	–	from V4.0	–	http://support.automation.siemens.com/WW/view/en/89899901
CPU 1212C	6ES7212-1AE40-0XB0	–	–	–	–	–	–	from V4.0	–	http://support.automation.siemens.com/WW/view/en/89899919
	6ES7212-1BE40-0XB0	–	–	–	–	–	–	from V4.0	–	http://support.automation.siemens.com/WW/view/en/89899937
	6ES7212-1HE40-0XB0	–	–	–	–	–	–	from V4.0	–	http://support.automation.siemens.com/WW/view/en/89899955
CPU 1214C	6ES7214-1AG40-0XB0	–	–	–	–	–	–	from V4.0	–	http://support.automation.siemens.com/WW/view/en/90018057
	6ES7214-1BG40-0XB0	–	–	–	–	–	–	from V4.0	–	http://support.automation.siemens.com/WW/view/en/90018063
	6ES7214-1HG40-0XB0	–	–	–	–	–	–	from V4.0	–	http://support.automation.siemens.com/WW/view/en/90018069
CPU 1215C	6ES7215-1AG40-0XB0	–	–	–	–	–	–	from V4.0	–	http://support.automation.siemens.com/WW/view/en/90018075
	6ES7215-1BG40-0XB0	–	–	–	–	–	–	from V4.0	–	http://support.automation.siemens.com/WW/view/en/90018081
	6ES7215-1HG40-0XB0	–	–	–	–	–	–	from V4.0	–	http://support.automation.siemens.com/WW/view/en/90018087
CPU 1217C	6ES7217-1AG40-0XB0	–	–	–	–	–	–	from V4.0	–	http://support.automation.siemens.com/WW/view/en/67813297
S7-400 CPUs										
CPU 412-2PN	6ES7412-2EK06-0AB0	from V6.0	from V6.0	from V6.0	–	from V6.0	–	from V6.0	from V6.0[2]	http://support.automation.siemens.com/WW/view/en/43411825
CPU 414-3PN/DP	6ES7414-3EM05-0AB0	from V5.2	from V5.2	–	–	from V5.0	–	–	–	http://support.automation.siemens.com/WW/view/en/23235944
CPU 414-3PN/DP	6ES7414-3EM06-0AB0	from V6.0	from V6.0	from V6.0	–	from V6.0	–	from V6.0	from V6.0[2]	http://support.automation.siemens.com/WW/view/en/43411729
CPU 414F-3PN/DP	6ES7414-3FM06-0AB0	from V6.0	from V6.0	from V6.0	–	from V6.0	–	from V6.0	from V6.0[1(2)]	http://support.automation.siemens.com/WW/view/en/43941570
CPU 416-3PN/DP	6ES7416-3ER05-0AB0	from V5.2	from V5.2	–	–	from V5.0	–	–	–	http://support.automation.siemens.com/WW/view/en/23227870
CPU 416-3PN/DP	6ES7416-3ES06-0AB0	from V6.0	from V6.0	from V6.0	–	from V6.0	–	from V6.0	from V6.0[2]	http://support.automation.siemens.com/WW/view/en/43411965[6]
CPU 416F-3PN/DP	6ES7416-3FR05-0AB0	from V5.2	from V5.2	–	–	from V5.0	–	–	–	http://support.automation.siemens.com/WW/view/en/23875857
CPU 416F-3PN/DP	6ES7416-3FS06-0AB0	from V6.0	from V6.0	from V6.0	–	from V6.0	–	from V6.0	from V6.0[1(2)]	http://support.automation.siemens.com/WW/view/en/43941575

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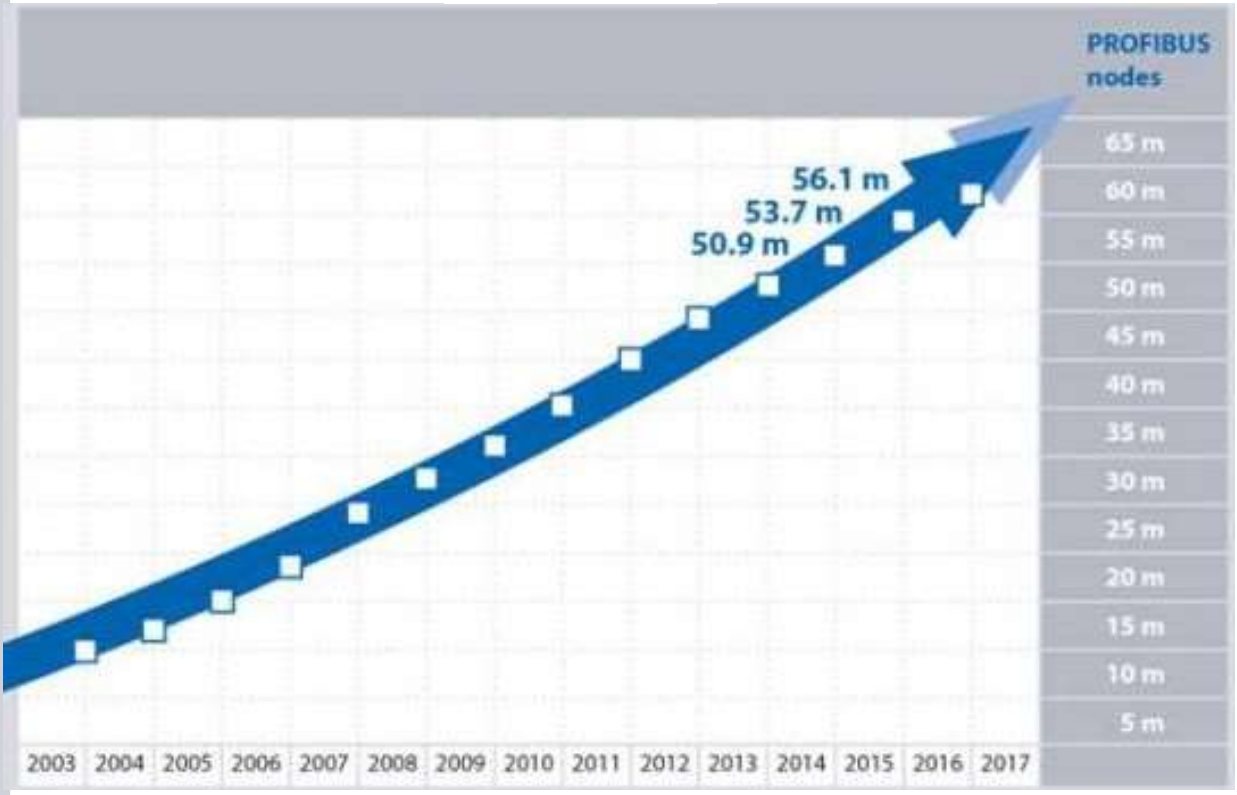

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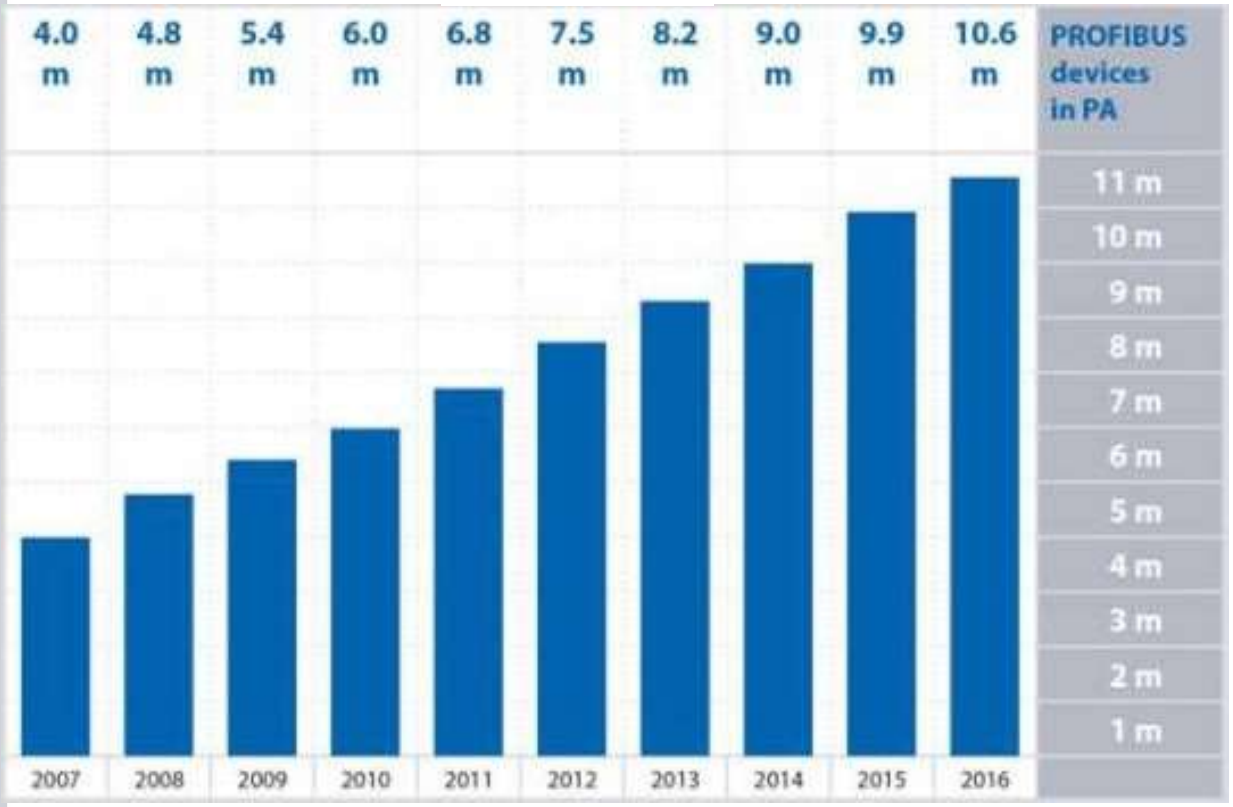

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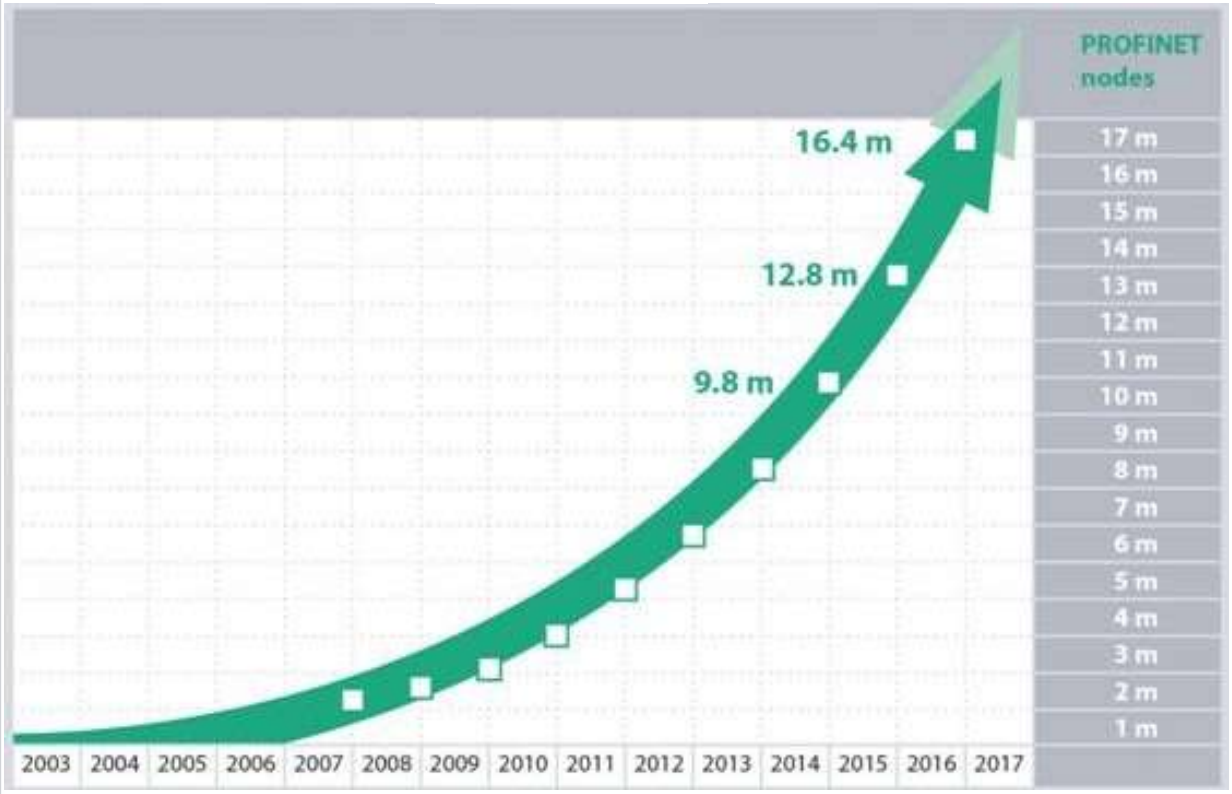

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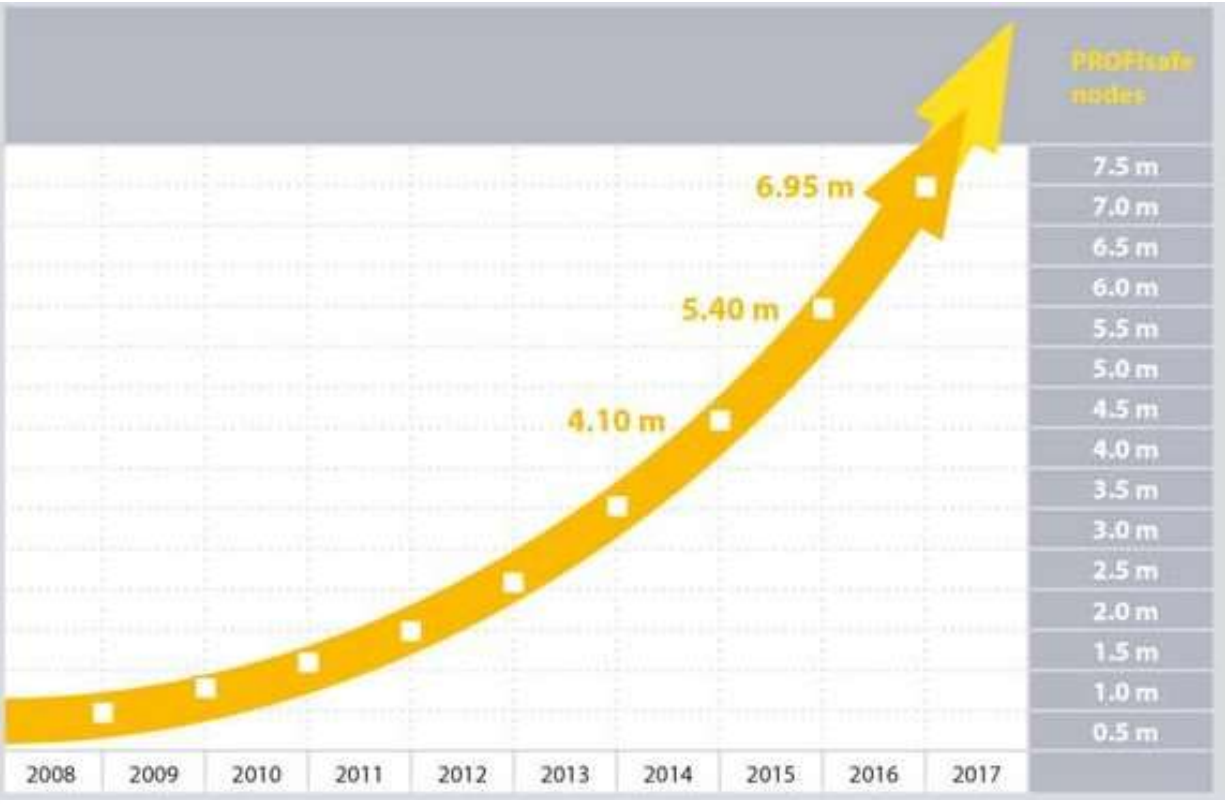

IO-LINK NODES PRESENT STATE

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