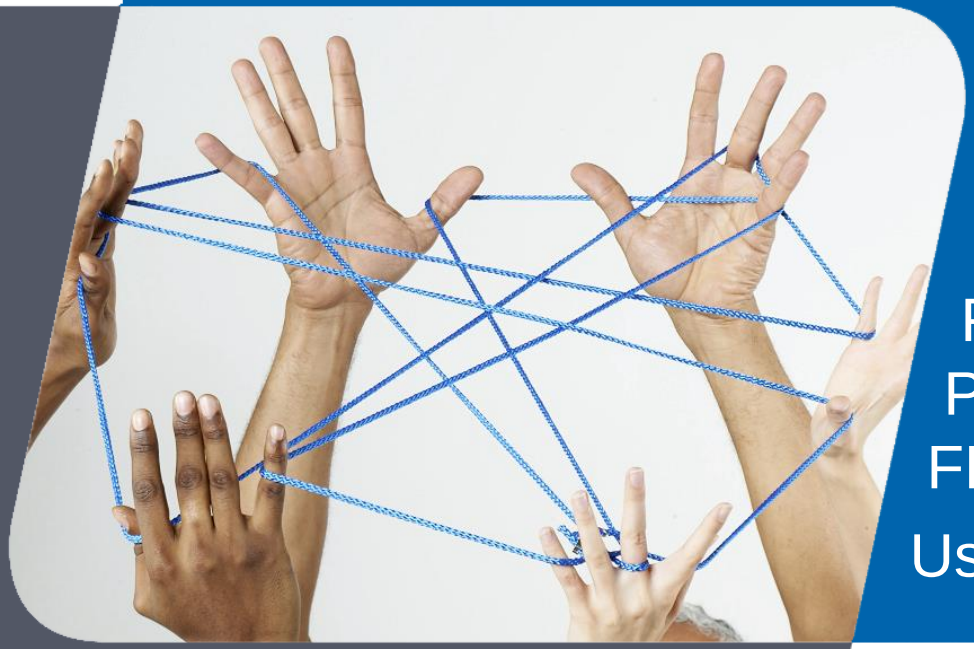
PI Technologies for Process Automation



PROFIBUS
PROFINET
Field devices
Profiles
FDI
User benefits

Preface

- Until now this slide set has been titled **PROFIBUS Basic Slide Set** from historical reasons. While presenting PROFIBUS *technology* as a whole it concentrated on its version PROFIBUS PA as far as its *application* has been concerned.

- Over time PROFIBUS technologies have been and will be further complemented and replaced with the even more powerful, Ethernet-based PROFINET technology. This will also happen in the process automation application field.

  Therefore this new version of the Basic Slide Set (2017)
  - includes technologies of PROFIBUS and PROFINET including new accompanying technologies such as FDI
    and
  - is titled **PI Technologies for Process Automation.**

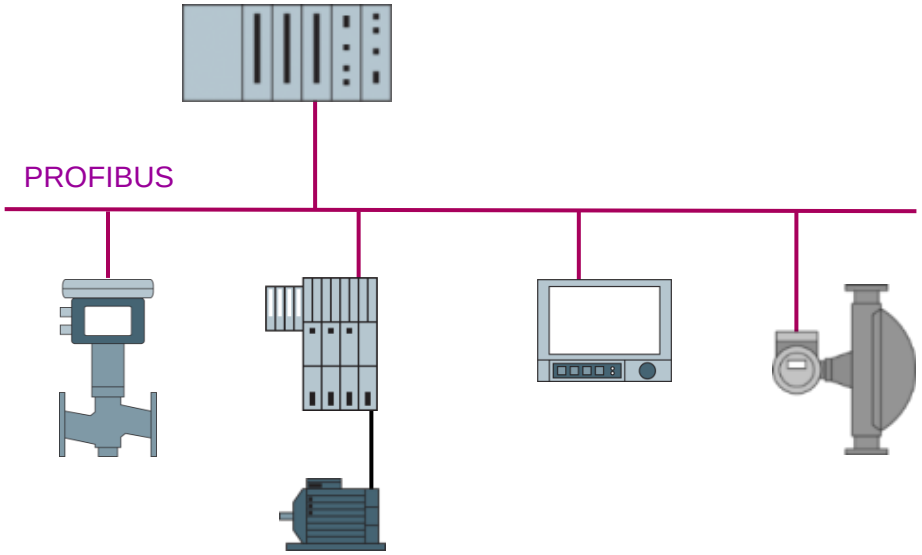
What is PROFIBUS?

A short introduction

What is PROFIBUS?

Fieldbus-based automation standard

- PROFIBUS is the fieldbus-based automation standard of PROFIBUS & PROFINET International (PI), the largest automation community in the world.
- PROFIBUS links controllers or control systems to several decentralized field devices (sensors and actuators) via a single cable.

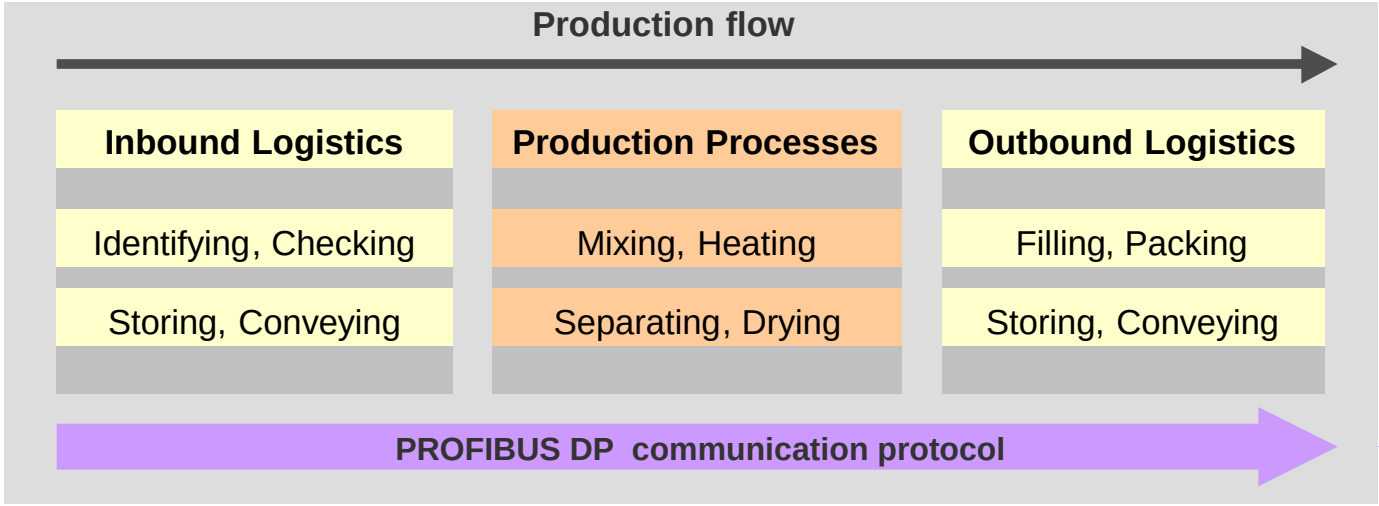


Controller or Control system

Field devices PROFIBUS DP

What is PROFIBUS?

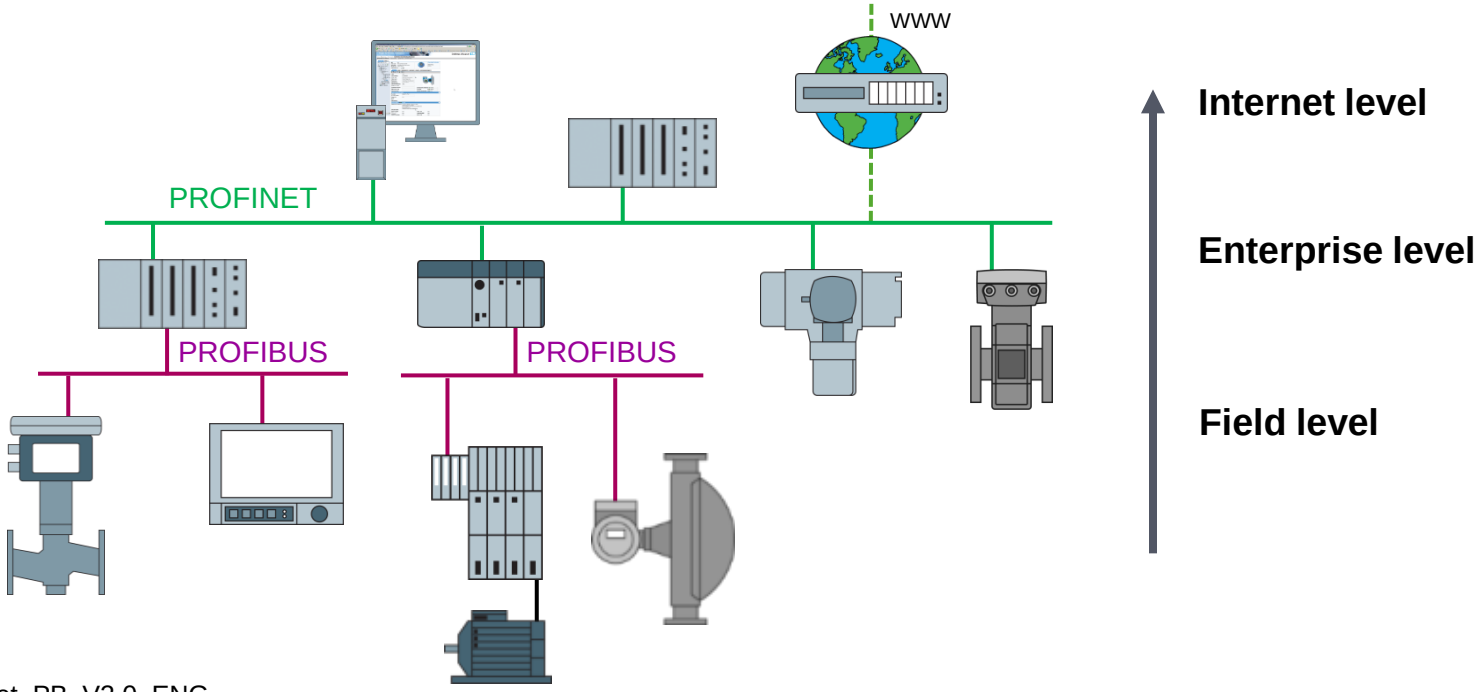
- **Only one single protocol**
  - PROFIBUS supports factory and process automation as well as drive applications with the same consistent communication protocol named PROFIBUS DP.
  - This enables mixed (hybrid) applications, where continuously running processes, e.g. mixing or drying, are combined with discrete functions such as identifying, conveying or packing.



What is PROFIBUS?

Part of a multi-level network

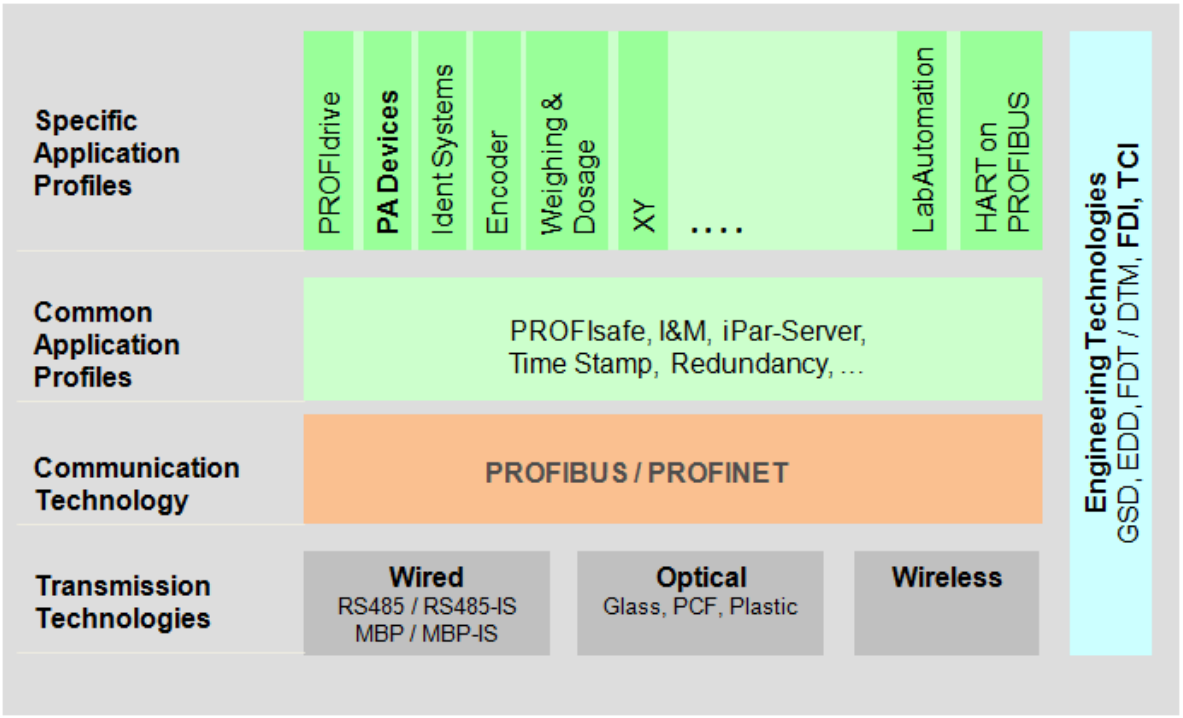
- PROFIBUS enables consistent data exchange with higher-ranking communication systems.
- PROFIBUS is part of the communication network between field level and enterprise level, or even going up to the internet.



What is PROFIBUS?

PROFIBUS is a modular structured system

- PROFIBUS modules are arranged according to their functionalities: (Transmission, Communication, Application, Integration).
- A PROFIBUS application for a certain industry sector (solution) is implemented by combining suitable modules: >> *next slide*.



What is PROFIBUS?

PROFIBUS solutions for various industry sectors

Market Segment	Process Automation Ex / non-Ex areas	Factory Automation	Motion Control	Safety Application
PROFIBUS Solution (Common term)	PROFIBUS PA	PROFIBUS DP	PROFIdrive	Safety
Application Profile	PA (and others)	e. g. Ident Systems	PROFIdrive	PROFIsafe
Communication Technology	PROFIBUS DP			
Tansmission Technology	MBP / MBP-IS RS 485 / 485-IS	RS 485	RS 485	RS 485 MBP-IS

PROFIBUS Key Applications

Factory automation

- Vehicle manufacture
- Bottling plants
- Warehousing systems
- Switchgear
- Hollow glass production

Process automation

- Chemical industry
- Petrochemical industry
- Paper and textile industry
- Foodstuffs
- Power stations
- Sewage plants

Drive technology

- Machine tools
- Packaging machines
- Pressing plants
- Paper production

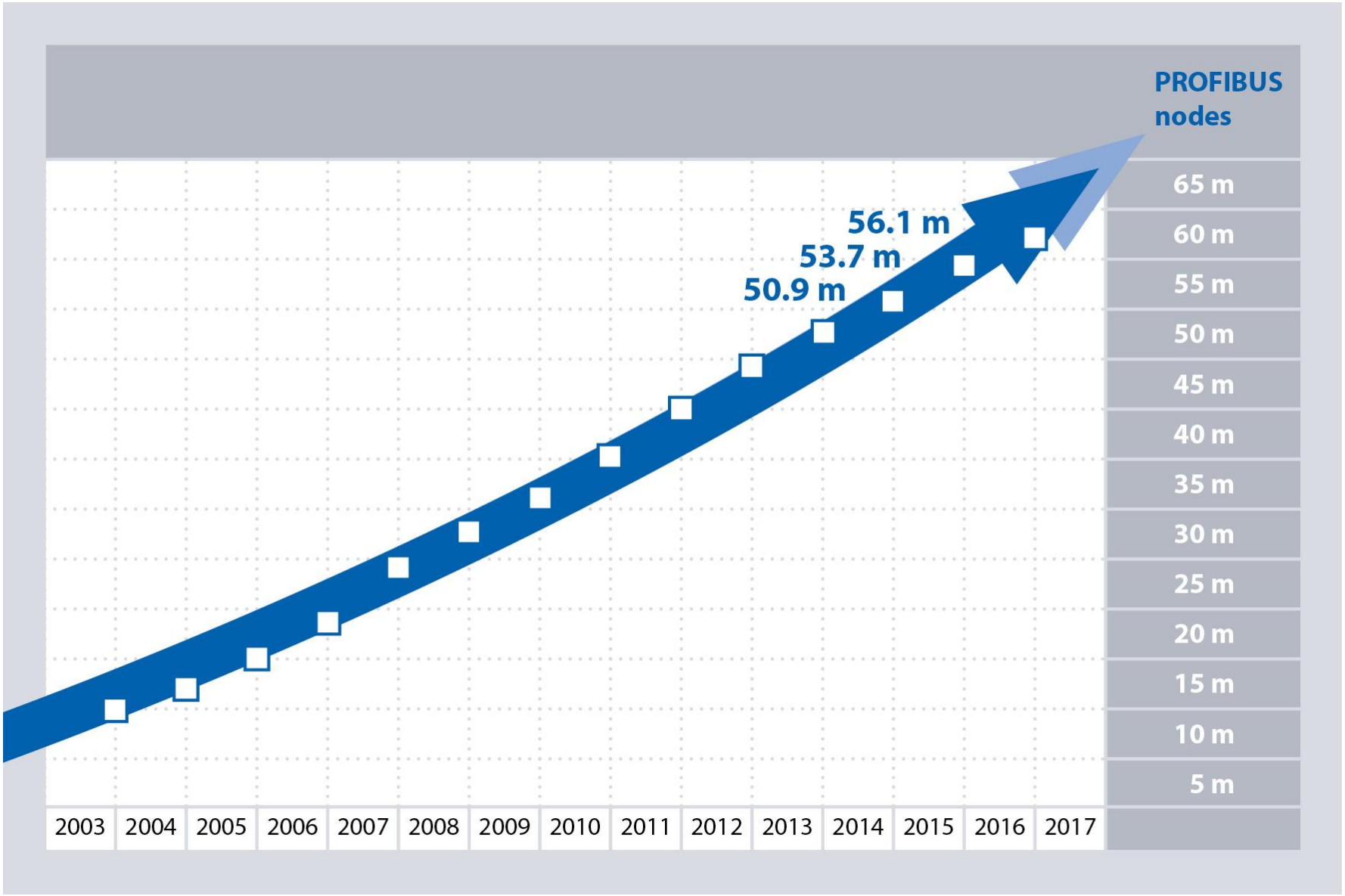
Safety applications

- Vehicle assembly
- Machine tool building

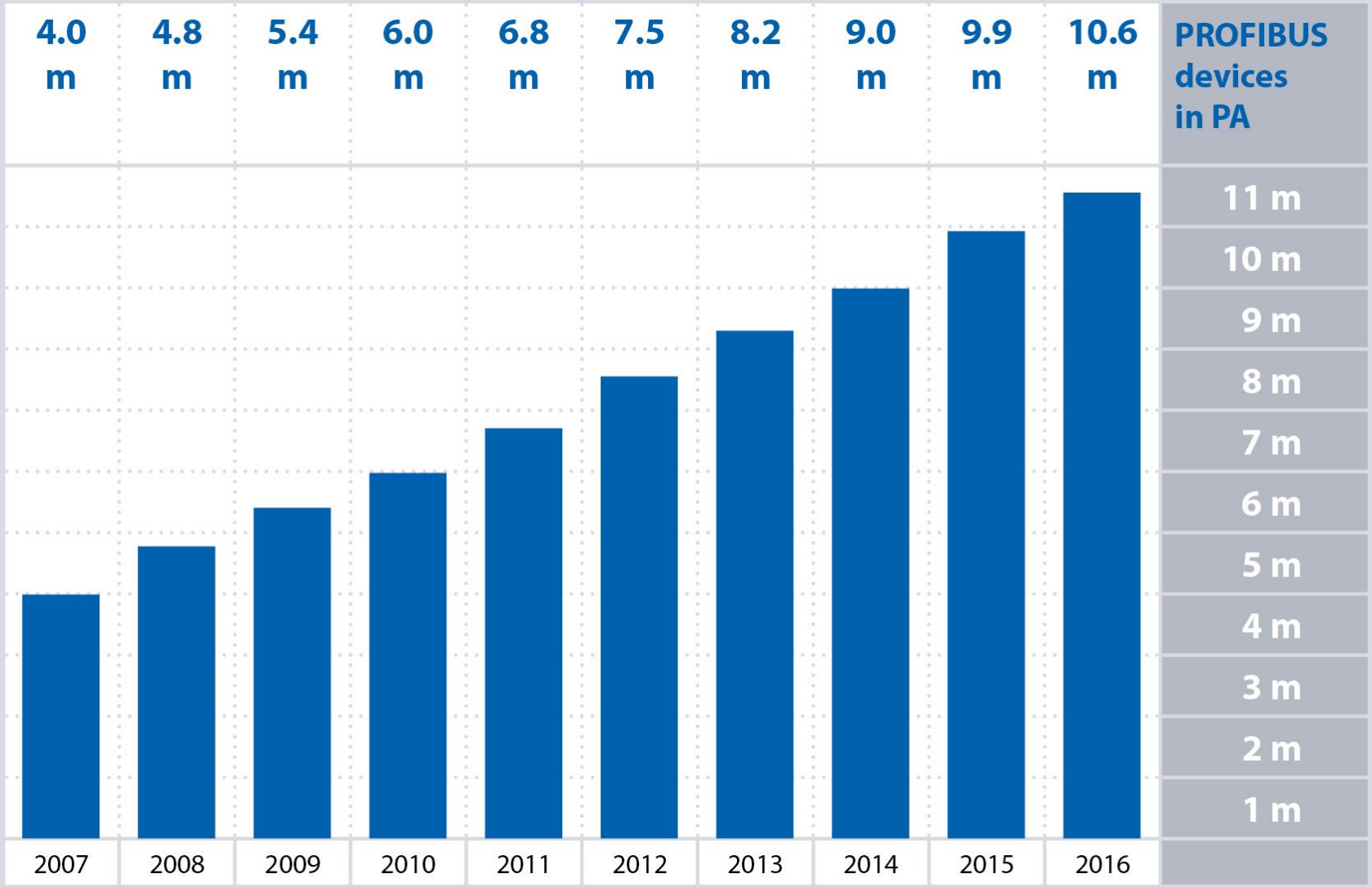
What is PROFIBUS?

- **PROFIBUS DP and PROFIBUS PA**
  - **PROFIBUS DP** (**D**ecentraliced **P**eriphery) is mainly used for high speed input/output devices and to link intelligent devices such as drives. It can use different physical layers such as RS-485, wireless or fiber optics. RS-485 is the most common one.
  - **PROFIBUS PA** (**P**rocess **A**utomation) refers to the following additional features:
    - Bus powered by using the Manchester encoded Bus Powered (MBP) physical layer according to IEC 61158-2
    - Intrinsically safe design
    - Configuration over the bus
    - Device profile

PROFIBUS Nodes



PROFIBUS Devices for PA



Online product guide

- **More than 2,500 „PROFIBUS Devices“ are available in the PROFIBUS product guide**

How to use the slide set

- In the following, the slide set provides compact information about technology, operation, application and benefits of PROFIBUS and PROFINET in Process Automation..
- For easy handling, the slide set is structured in „tasks“. Click  to find the list of tasks.
- Additional information is available to many pages under  (top left)
- For in-depth information see „Literature List“ under 

Task overview (Click a button to open)

Technology

- Fieldbus talks digital
- Diagnosis & Asset Manag.
- PROFIsafe
- Communication Protocol
- Device integration, FDI
- PROFINET in PA
- Transmission technologies
- Components and topology
- Application Profiles
- Explosion protection

Life Cycle Management

- How to design PB?
- How to install PB?
- How to manage field devices?
- How to use diagnostics?
- How to benefit from PROFIBUS?

Organisation / Support

- PROFIBUS & PROFINET International (PI)
- Implementation and certification
- Standardization
- Literature

Success Stories

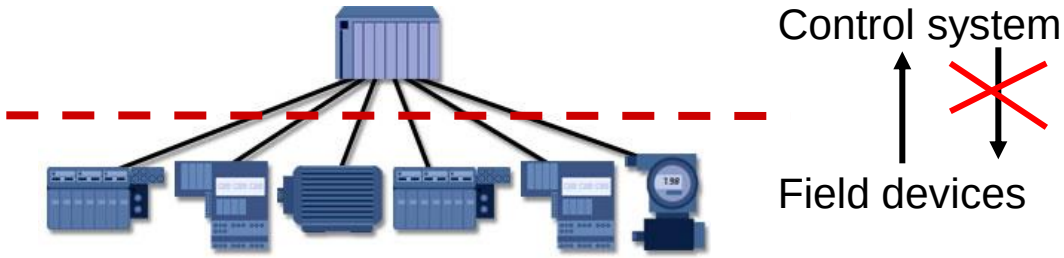
- Process and manufacturing industries

Fieldbus talks digital

Stepping from analog to digital communication means a major paradigm shift

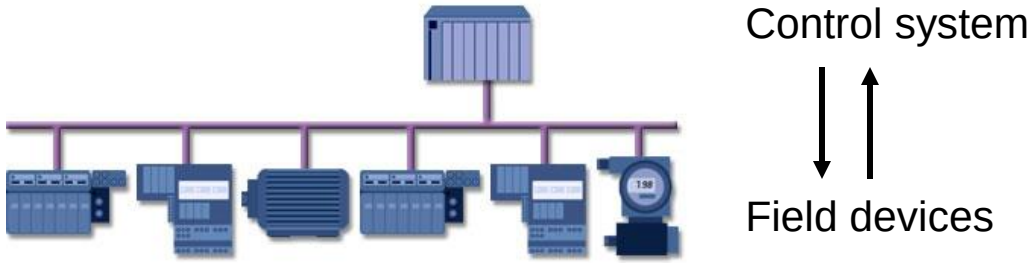
Fieldbus talks digital

- **Non-fieldbus system: One way communications**
  - Tasks of field devices and control system are clearly separated
  - Only analog values (measured data) are transferred
  - Only a one-way communication exists



Fieldbus talks digital

- **Fieldbus system: Digital and two-way communications**
  - Field devices are an integral part of a control system
  - Digital values are transferred by a two-way communication link
  - A digital dialogue exists between controller and field devices
  - Field devices adapt a new role in the automation system; this is a major paradigm shift



Fieldbus talks digital - Benefits

Benefits of using a digital fieldbus (PROFIBUS)

- **Plant Asset Management is enabled**
  Information from process and devices are available in the controller.

- **Construction and installation is optimized**
  100s of separate wires are reduced down to just one cable.

- **Commissioning is fastened**
  The end user can scale the devices from one central location.

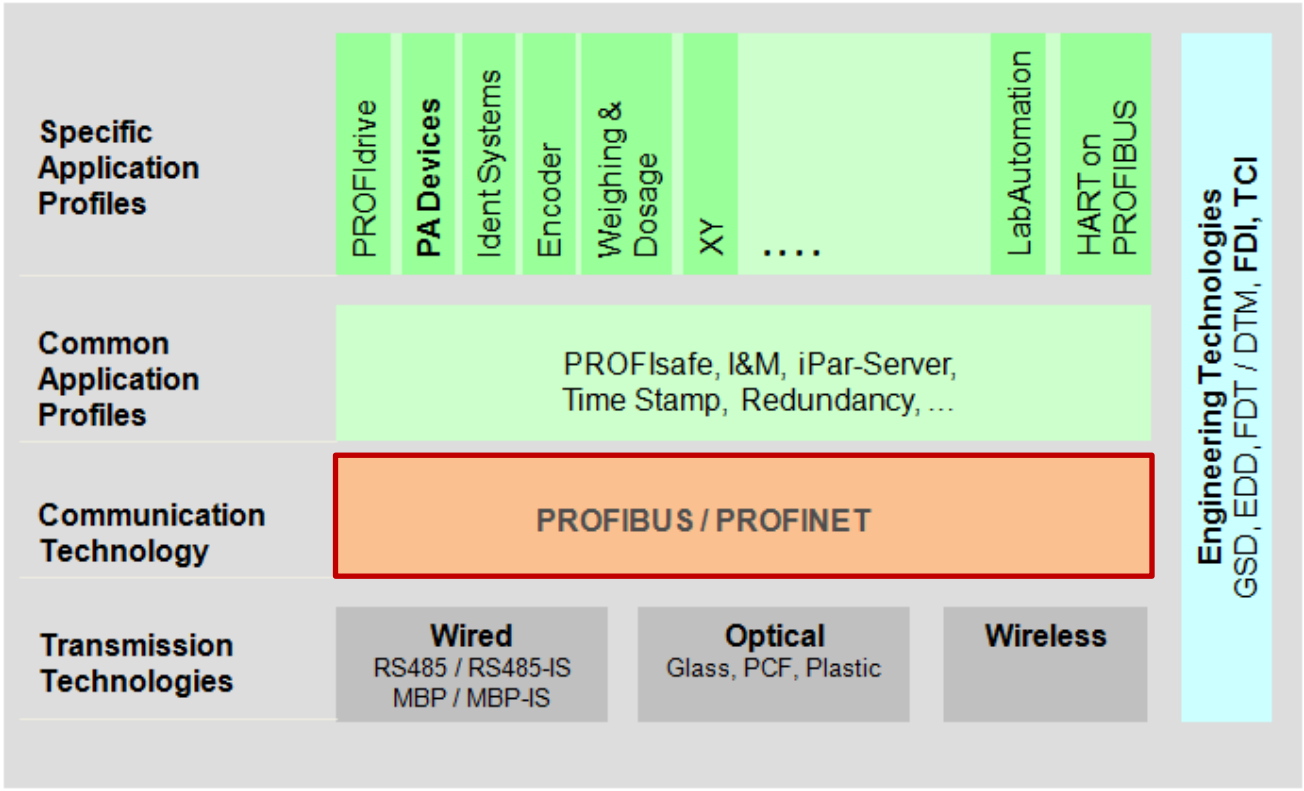
- **Accuracy is increased**
  No need for digital/analogue conversion (in the device) and analogue/digital conversion (in the controller). >> higher accuracy

- **Process variables can be trusted**
  The diagnostic information and status bytes tell the user if they can trust the process variable or not.

Communication Protocol PROFIBUS DP

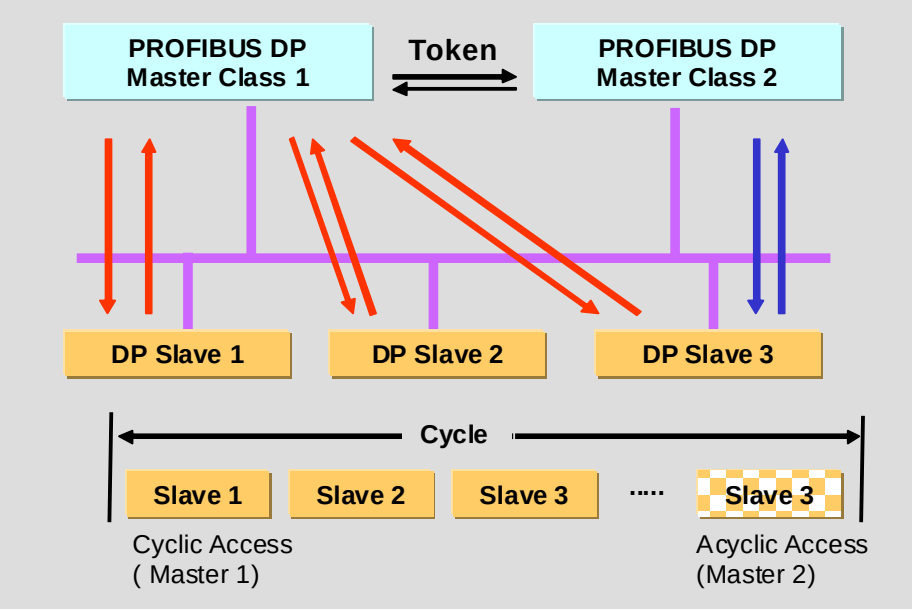
One single, consistent protocol for all applications in factory and process automation

PROFIBUS DP communication protocol



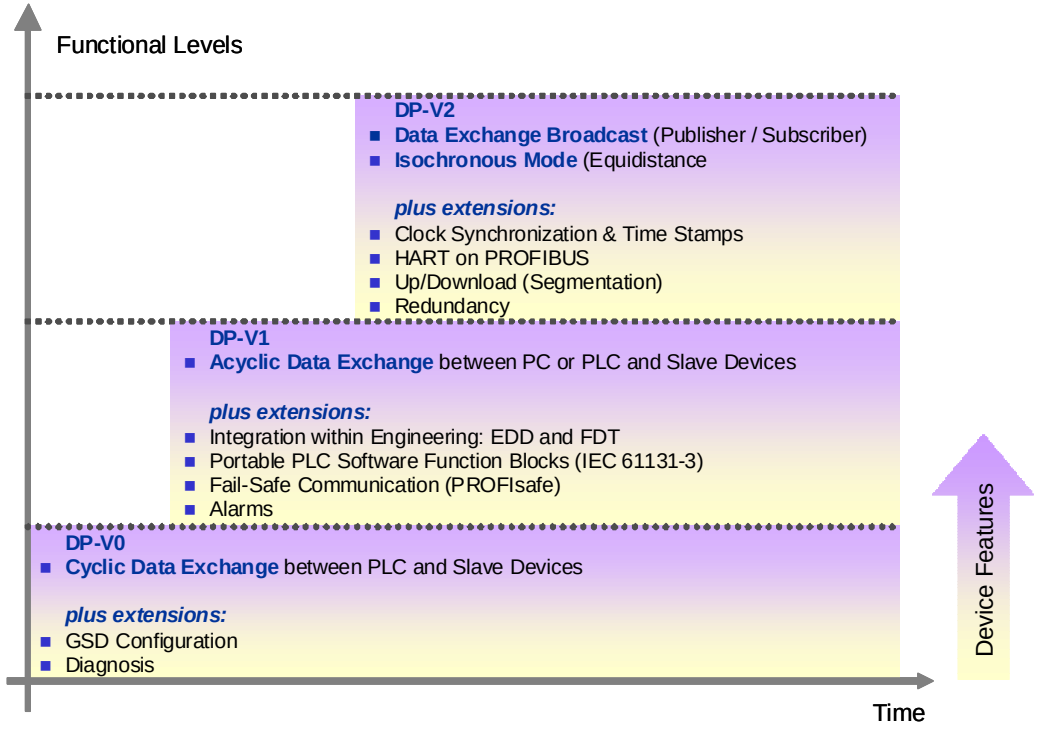
Communication Protocol DP

- PROFIBUS uses a single, open communication protocol (PROFIBUS DP, **D**ecentralized **P**eriphery) for all applications
  - The protocol uses the “Master-Slave“ model: One device (master) controls one or more other devices (slaves).
  - The protocol uses the “Token Passing“ model: The “token“ is transmitted across the network; the station which holds the token controls the access to the network.



Communication Protocol DP

- PROFIBUS DP exists in three versions:
  - **DP-V0:** Overall command structure, cyclic data exchange
  - **DP-V1:** Extension by acyclic data exchange et al.
  - **DP-V2:** Further extension by time stamp, clock synchronization et al.



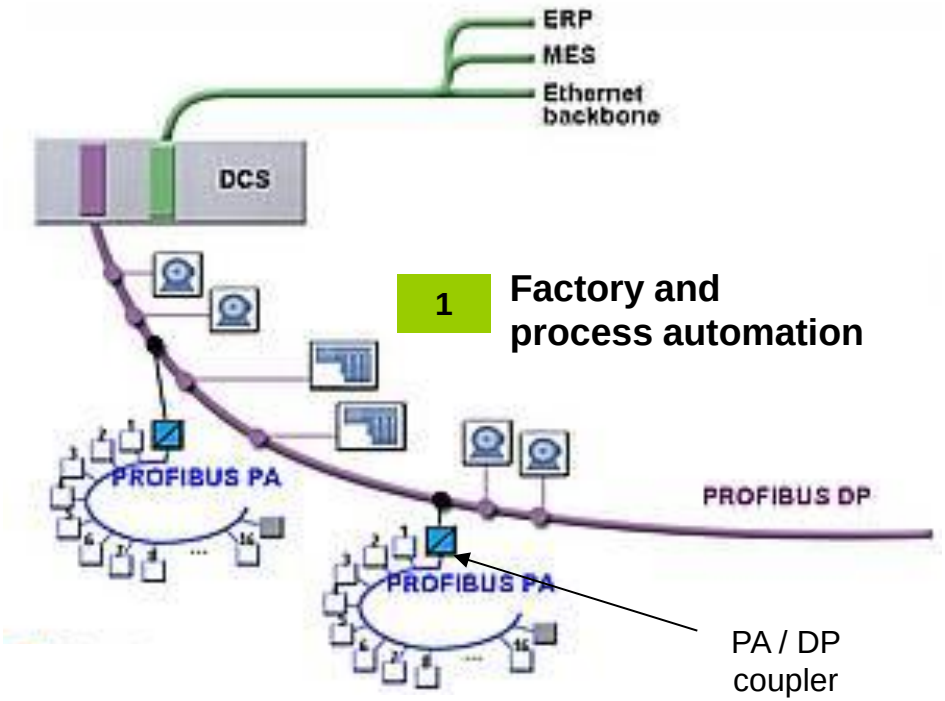
Communication Protocol DP

One single protocol for all applications

- PROFIBUS DP carries all communications between a DCS or controller and individual field devices.
- Factory devices and certain process devices are *directly* connected to PROFIBUS DP.

  1
- Process automation (PA) devices, grouped in “PA segments”, are connected to PROFIBUS DP via coupler or links.

  2



1 **Factory and process automation**

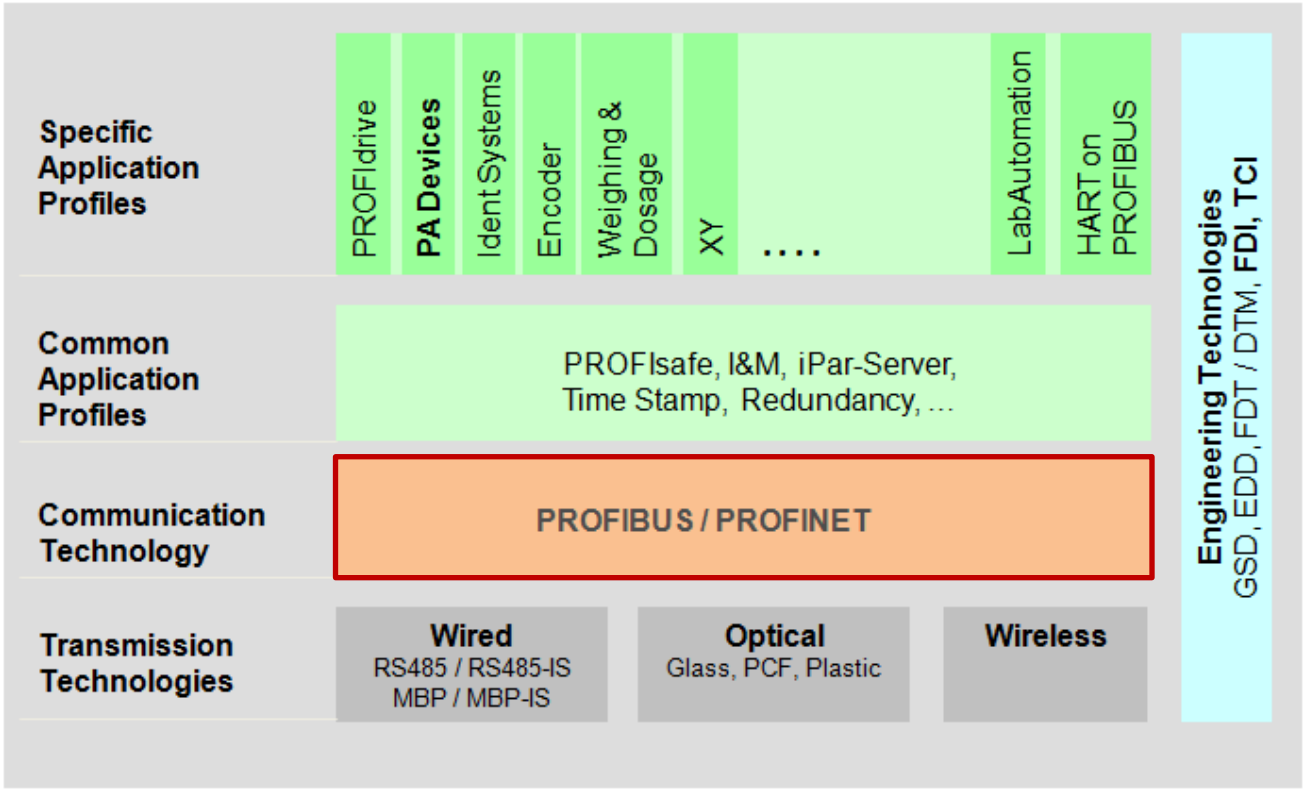
2 **Process automation**

Transmission Technologies

RS 485
MBP
Optical
Wireless

Transmission Technologies

- **PROFIBUS supports different transmission technologies**



Transmission Technologies

Wired transmission (1)
RS 485 and RS 485-IS for high transmission rates

	RS 485 PROFIBUS DP	RS 485 - IS PROFIBUS DP
Data transfer rate	9,6 … 12.000 Kbit/s	9,6 … 1.500 Kbit/s
Power supply	---	---
Devices/Segment (max.)	31	31
Devices/Segment (typical)	10	10
Trunk length (max,)	100-1200 m deoendin on data rate	100-1200 m depending on data rate
Spur length (max.)	---	---
IS: Intrinsical Safe		

Transmission Technologies

Wired transmission (2)
MBP and MBP-IS for power and communication over one cable

	MBP PROFIBUS PA	**MBP - IS** PROFIBUS PA [1)]
Data transfer rate	31.25 Kbit/s	
Power supply	typ. 24 … 30 V	typ. 13.2 V
	typ. 0.5 … 1 A	typ. 100 mA
Power and signal transfer	Twisted two wire cable	
Devices per segment (max.)	31	
Devices per segment (typical)	14 … 20	4 … 6
Connection of field devices	Via spurs to the trunk	
Trunk length (max,)	1900 m	1000 m
Spur length (max.)	120 m	60 m

1) For installation according to FISCO

Transmission Technologies

Optical transmission

- Various types of fiberoptic cables are supported.
- Typical topology structures are star and ring, linear structures are also possible.
- The implementation of a fiberoptic cable network involves the use of electrooptical converters.

Fiber type	Core diameter [µm]	Transmission range
Multi-mode glass fiber	62,5 / 125	2 - 3 km
Single-mode glass fiber	9 / 125	> 15 km
Plastic fiber	980 / 1000	Up to 100 m
HCS® fiber	200 / 230	Approx. 500 m

Wireless transmission

- PROFIBUS & PROFINET International supports various solutions which are available on the market for wireless transmission. Realization is done by gateways.

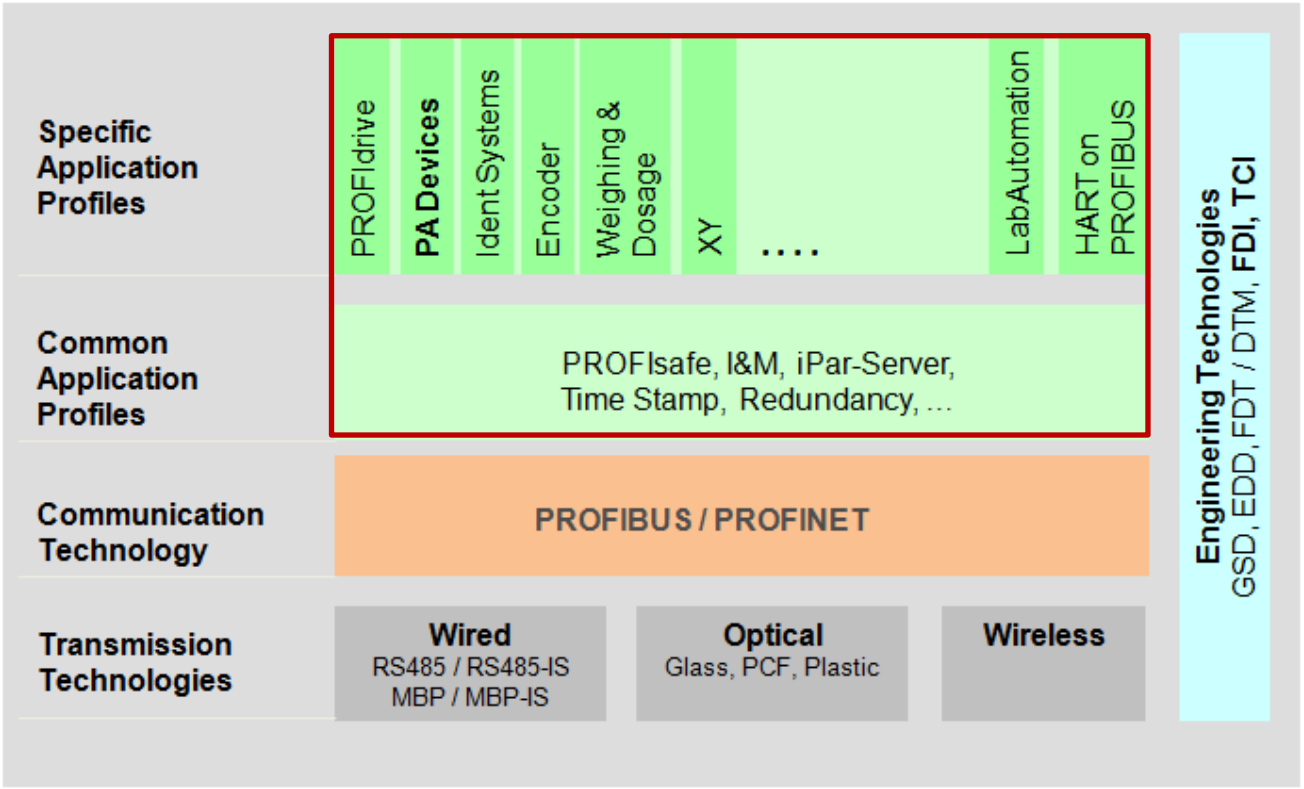
PROFIBUS Application Profiles

Application profiles greatly improve feasibility of PROFIBUS

Application Profiles

Application Profiles

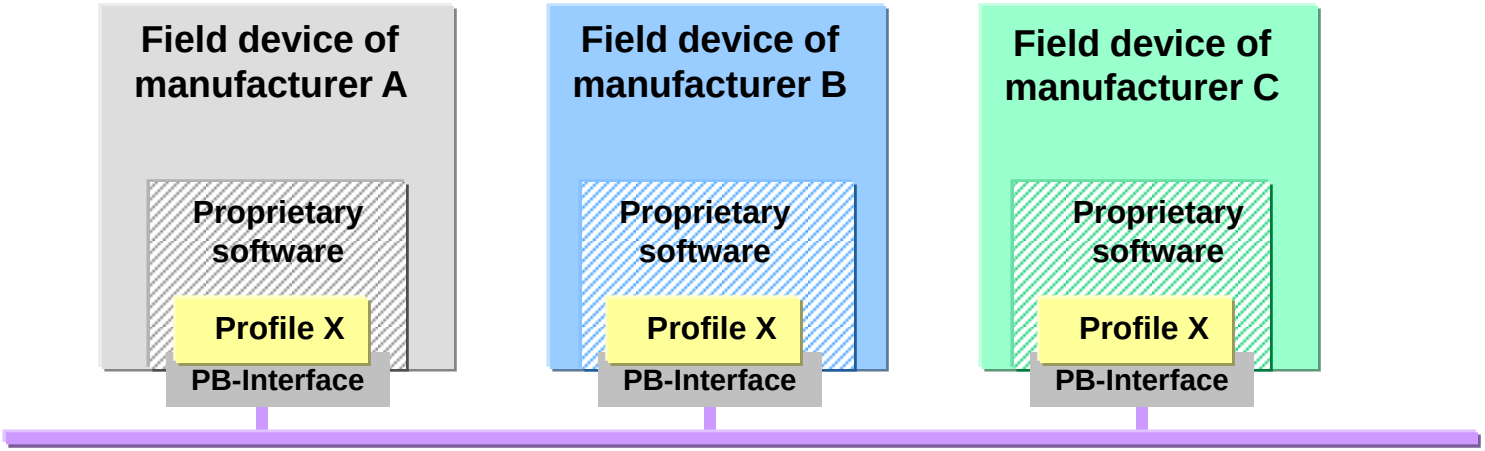
To ensure correct interaction between the bus nodes of an automation system, the basic functions and services of the nodes must match. This uniformity is achieved through the use of “Application profiles”.



Application Profiles

- PROFIBUS Application Profiles (APs) are vendor-independent specifications implemented into PROFIBUS devices to enable uniform behaviour of devices from different manufacturers.
  - **General** cross-device-class behavior
    (e.g. in safety or redundancy applications; identification data)
  - **Specific** device-class-specific behavior
    (e.g. process devices, drives, identification devices)
  - **Specific** Industry-specific behavior
    (e.g. rail vehicles, laboratory devices)
- Application profiles are specified by PI working groups and are available from PI, actually 22).

Application Profiles



Implementation of an identical profile (X) in all devices allows consistent behavior and interoperability of the devices at the bus.

Application Profiles

- **PROFIBUS profiles (selection out of a total of 22):**
  - **PROFIdrive**
    specifies the device behavior and access behavior to data for variable speed electric drives.
  - **Ident Systems**
    specifies the communication between identification devices such as barcode reader or transponder.

Continued next page…




Application Profiles

- **PROFIBUS profiles continued:**
  - **PA Devices (“PA”)**
    specifies the properties and behavior of process automation devices (transmitter, pumps, analyzer, …).
    Read more: Two slides further
  - **I&M (Identification & Maintenance)**
    specifies a concept for identification of PROFIBUS devices and internet access to device-specific information.
  - **HART on PROFIBUS**
    specifies the integration of HART devices in PROFIBUS systems.
  - **PROFIsafe**
    defines safe communication of safety-related devices with safety controllers via PROFIBUS.

Application Profiles

- **PROFIBUS profiles continued:**
  - **Encoder**
    defines the connection of rotary, angular, and linear encoders with single-turn and multi-turn resolution.
  - **Remote IO**
    defines the interchangeability of remote IO devices in process automation.

Application Profile PA 3.02

- **PA profile V 3.02 provides mechanisms and functions for easy management of field devices and diagnostics**

When a field device has to be replaced, the new device (with possibly advanced technology) automatically determines and assumes the tasks of the predecessor model without any interruption of the process.

Read details under “How to manage field devices?”.

Additional profile 3.02 specifications include mandatory mapping of specific diagnostic information of field devices onto standardised categories and faster transfer of field device data.

Read more details under “How to use diagnostics?” and “Diagnosis & Asset Management”.

Diagnosis & Asset Management

PROFIBUS provides excellent support to Asset Management

Assets and Plant Asset Management

- **Assets**
  Any item of economic value such as cash, inventory, buildings, machines, office or plant equipment, patents, know how etc.

- **Plant Assets**
  Virtual and physical assets applicable to manufacturing activities (controllers, field devices, drives etc.).

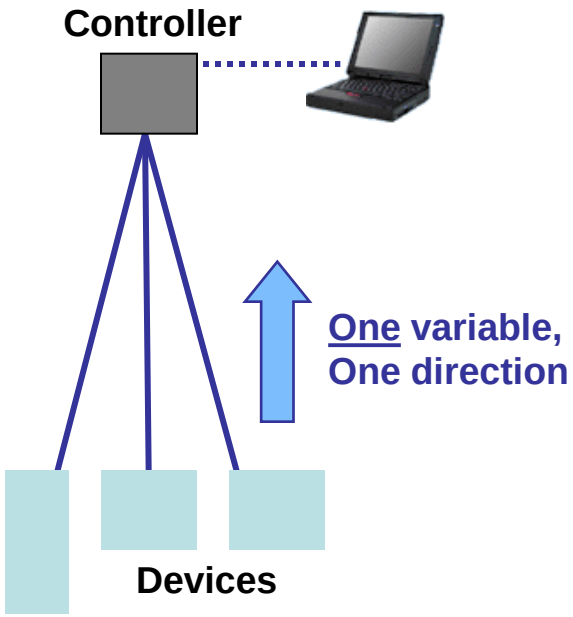
- **Plant Asset Management**
  All measures to monitor critical plant assets for optimal use, reducing the risk of failures while ensuring functionality and availability.

- **PROFIBUS diagnosis capabilities**
  Support plant asset management extensively.

The diagnosis features of PROFIBUS offer intensive support for plant asset management

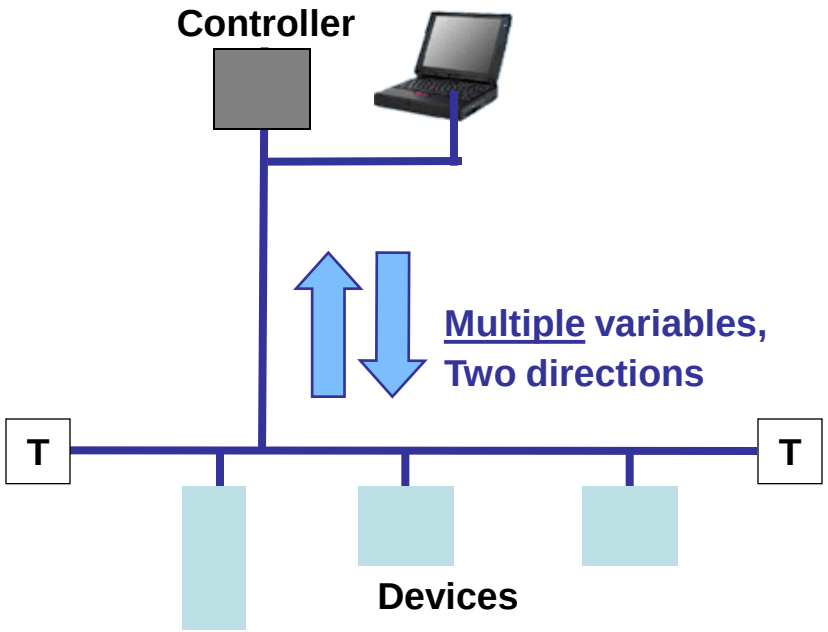
Assets and Plant Asset Management

- Unlike conventional communication systems, PROFIBUS allows a detailed “view into field devices”.



Conventional system

Very limited system view, device details are „invisible“.

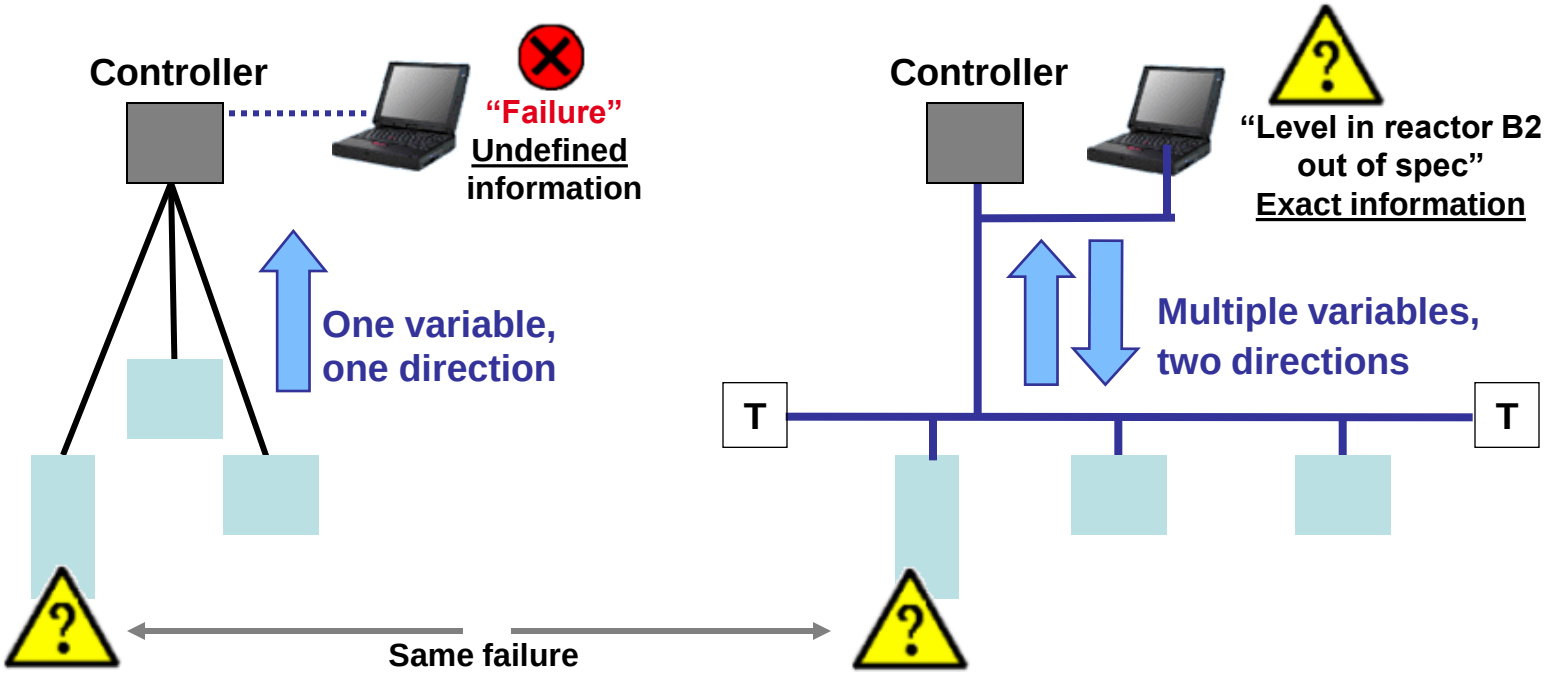


PROFIBUS

Expanded system view, device details are „visible“.

Assets and Plant Asset Management

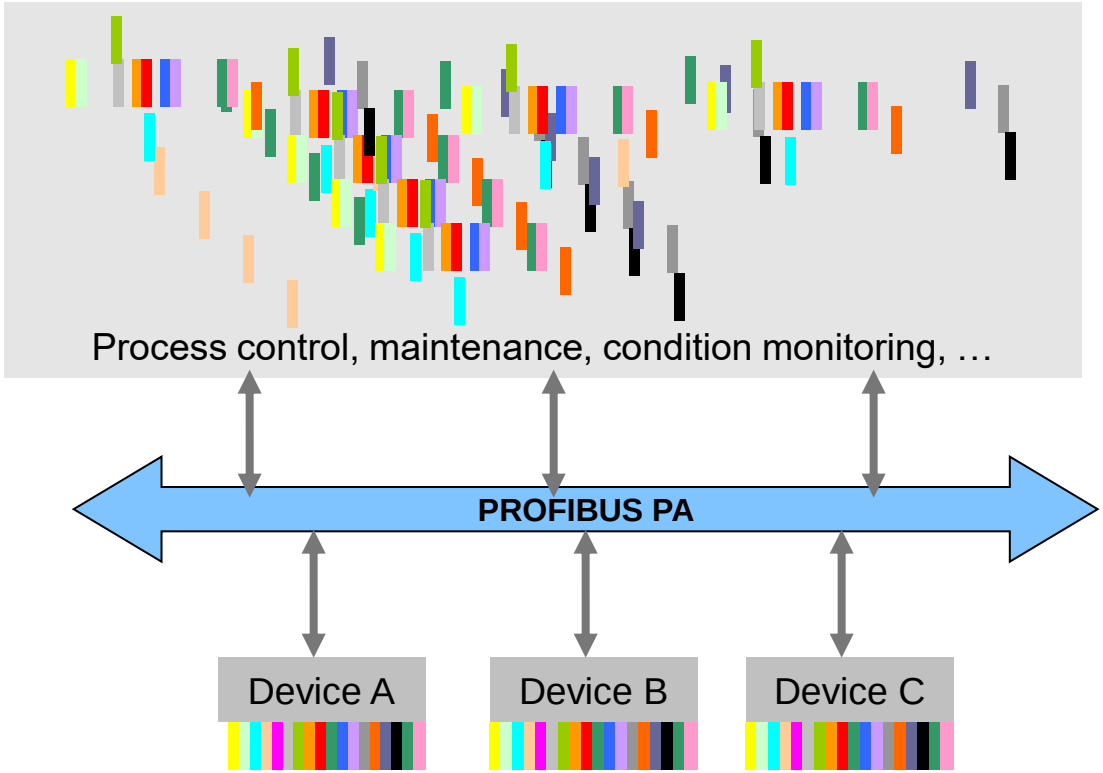
- Example from a chemical plant:
  "Level in reactor 2B gets out of spec"
  - Conventional system (left) reports just undefined "Failure".
  - PROFIBUS (right) reports exact diagnosis information.



Device Diagnostic with PA Profile

- **Before profile 3.02 was introduced**

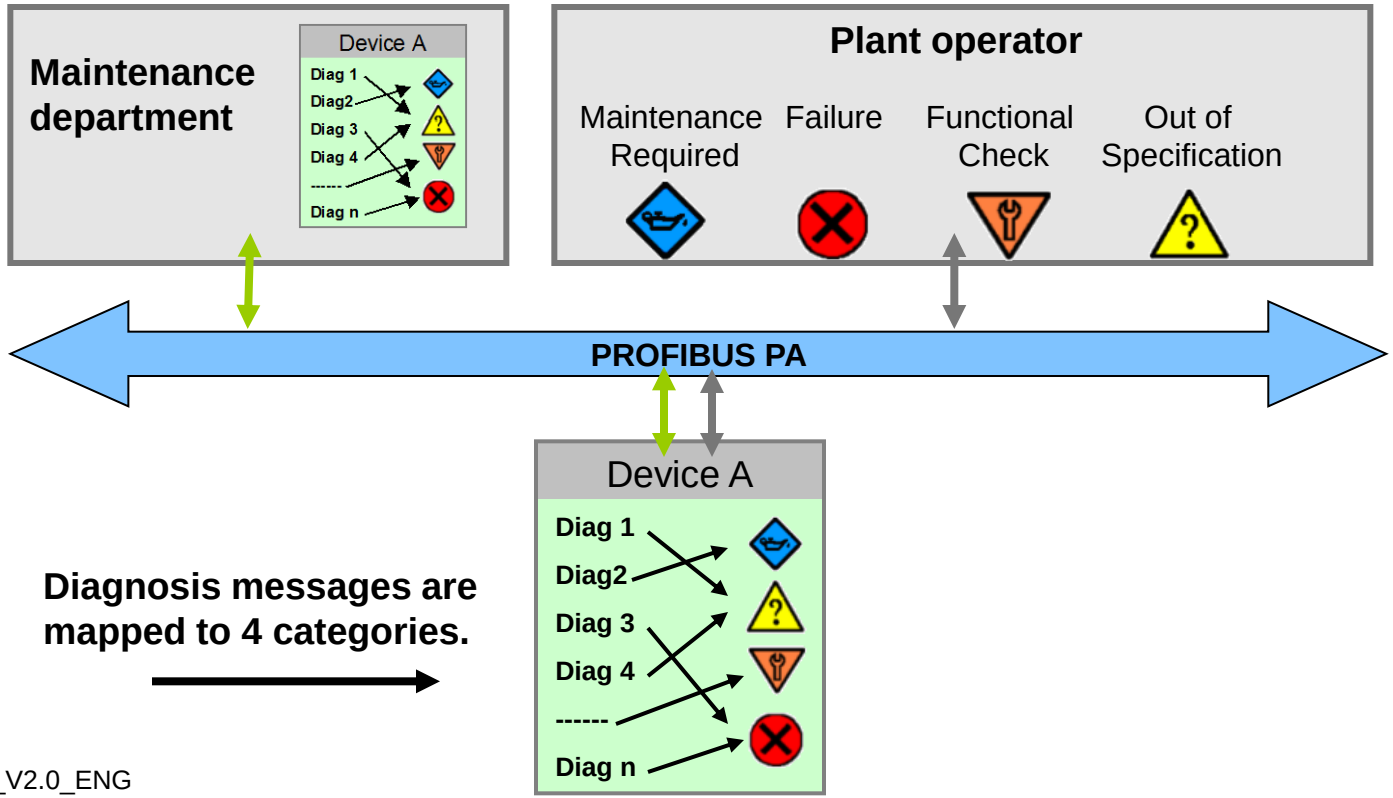
all diagnosis messages have been provided to all users.
>> Difficult to manage by the operators



Device Diagnostic with PA Profile

With Profile 3.02

- Diagnosis messages are mapped to categories already by the manufacturer, categories comply with NAMUR NE 107.
- Plant operator gets categorized information.
- Maintenance department gets full information.



Field Device Integration

GSD

EDD

FDT

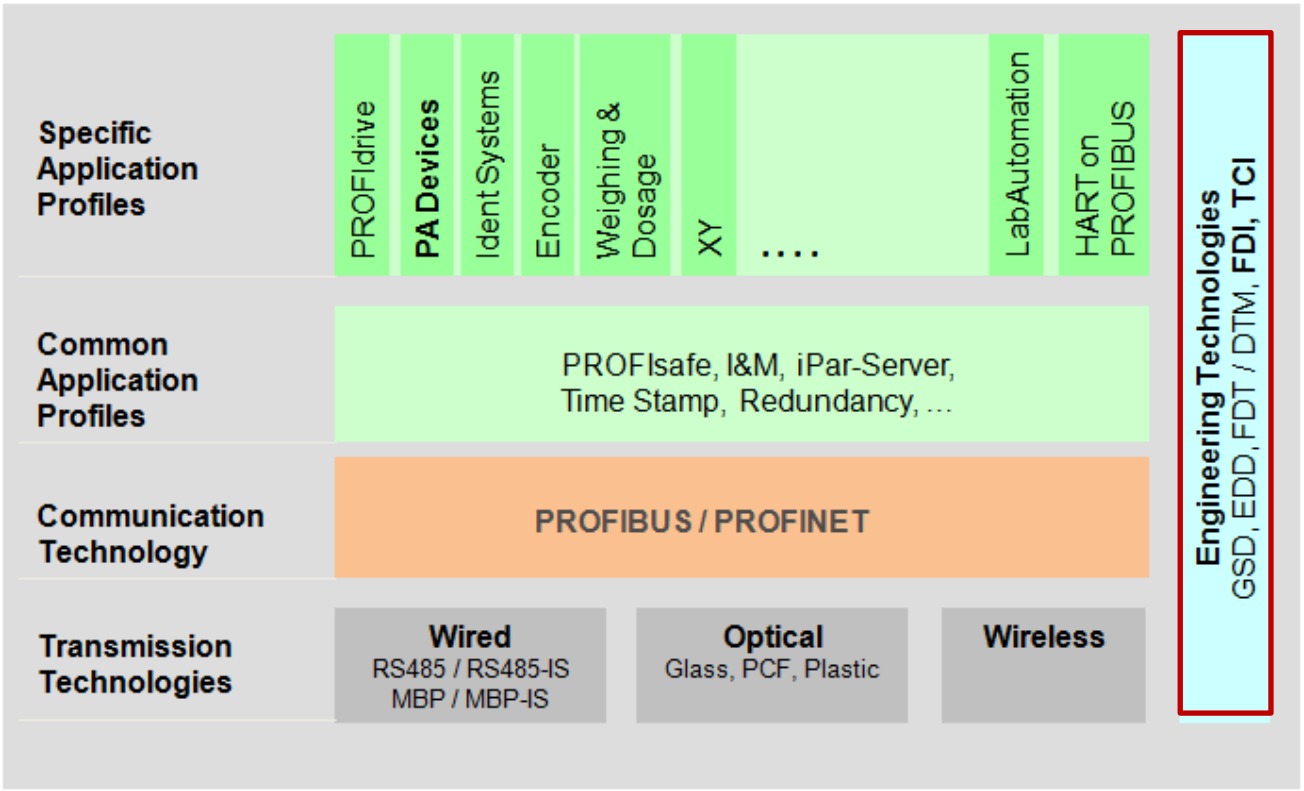
FDI

Field Device integration. Introduction

- The openess of PROFIBUS allows to operate field devices and control system from different manufactures in one plant which causes different types of user interfaces.
- For the operators this requires a standardized procedures during configuration, installation, and operation of the devices. For this purpose, standards have been developed.
- Such a device integration is performed by mapping the device functionality to an operating software together with consistent data retention and identical data structures for all devices.
- Various device integration technologies has been developed and are used on the market: GSD, EDD, FDT/DTM and FDI; see the following slides.

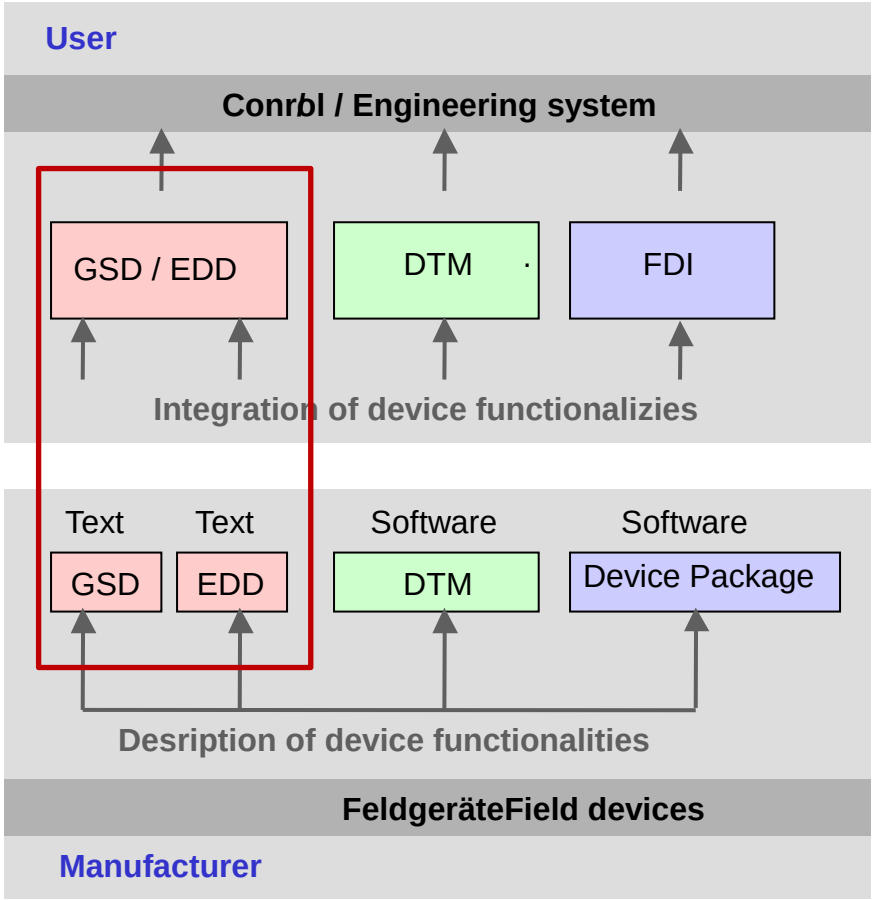
Field Device integration

- PROFIBUS supports different technologies for field device intergration: GSD, EDD, FDT/DTM, FDI, and TCI.
  (TCI is used in factory automation only!)



Field Device integration - GSD

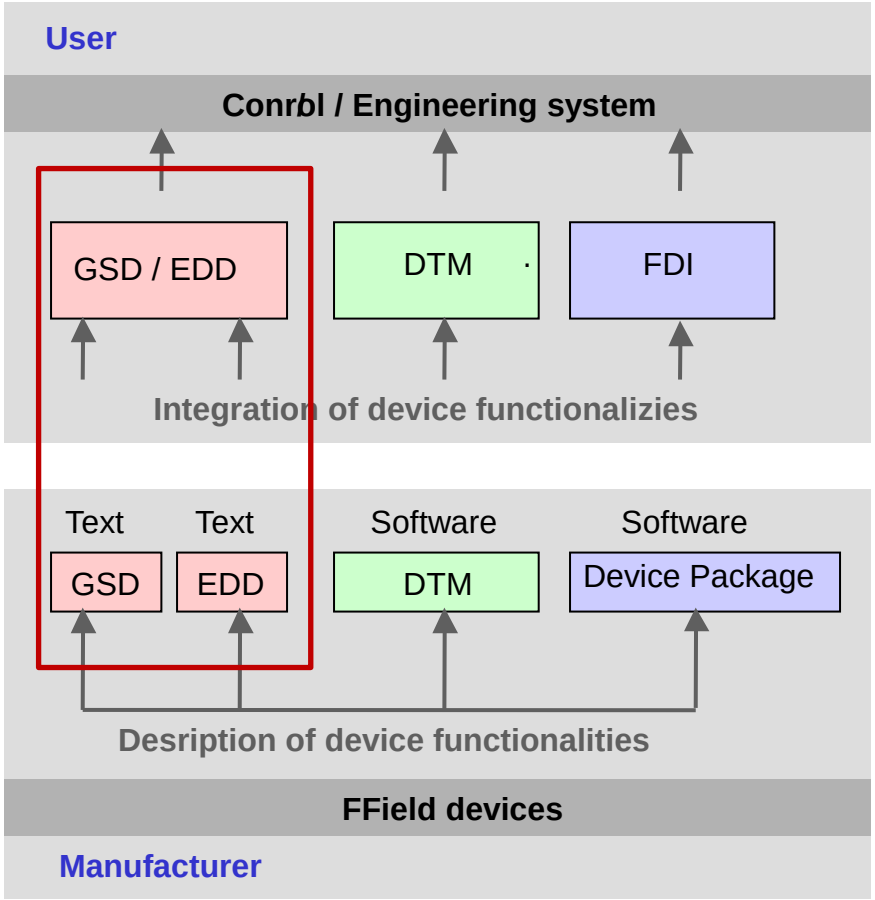
- **GSD (General Station Description) is used for**
  - mandatory textual description of any PROFIBUS field device,
  - field device integration into the master and
  - for cyclic data exchange of data.



Field Device integration - EDD

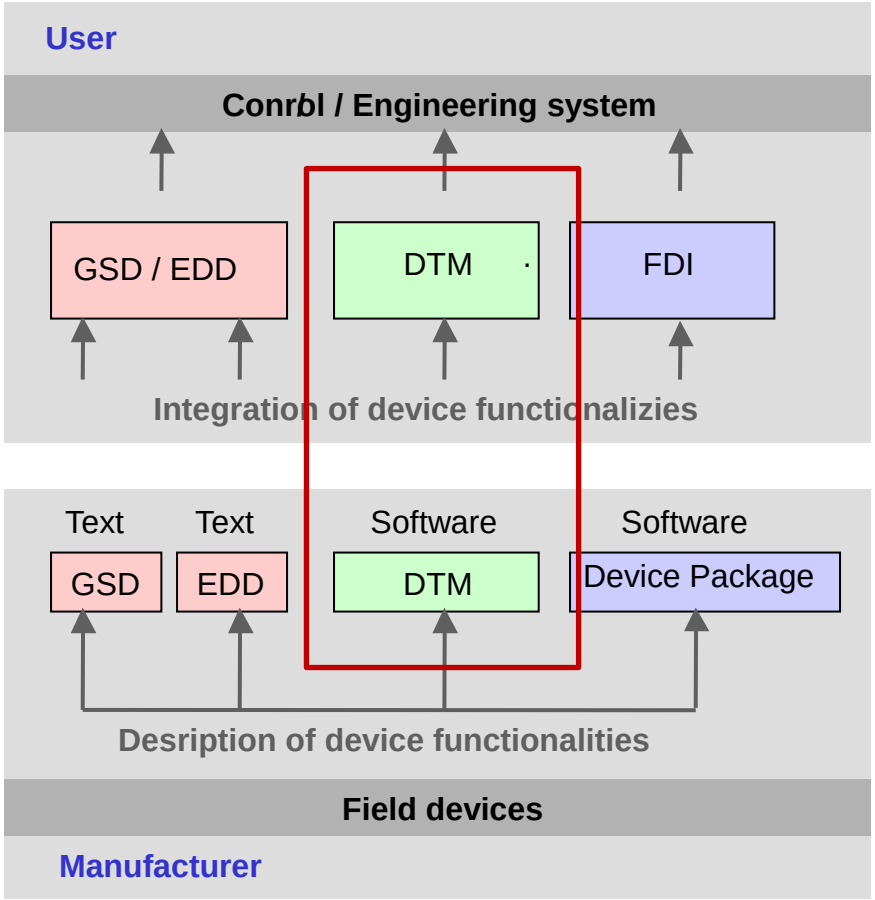
EDD (Electronic Device Description

- Is used in addition to a GSD
- to textually describe application related functionalities and parameter of complex field devices and
- to allow exchange of additional information with the master for e.g. diagnosis or asset management.



Field Device integration – FDT/DTM

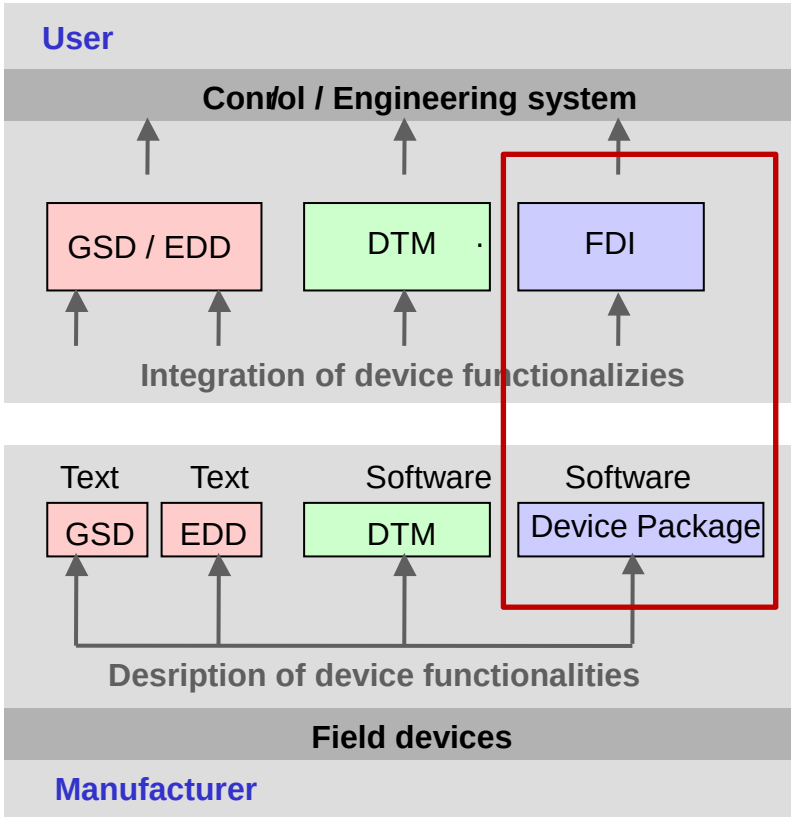
- **FDT/DTM (Field Device Technology / Device Type Manager)**
  - Is a software-based method of device integration
  - A DTM is a field device related software component
  - A DTM communicates with the engineering system in a “Frame application” via the FDT-interface.



Field Device integration – FDI (1)

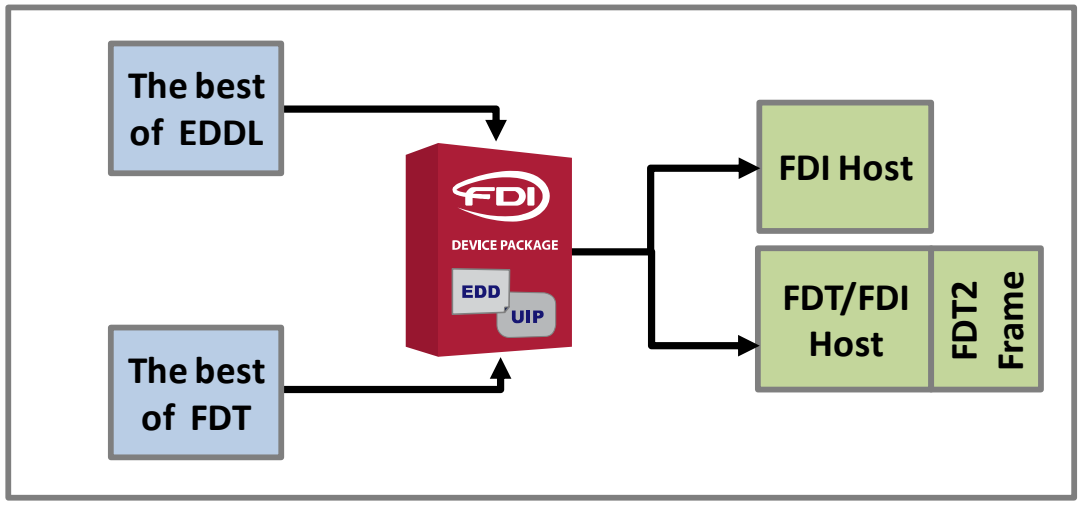
FDI (Field Device Integration)

- FDI is a new field device integration technology which combines best elements of both EDD and FDT/DTM.
- FDI has been developed by FDI Coorporation LLC (FDT Group, Fieldcomm Group, Profibus & Profinet International, and OPC Foundation)
- FDI is standardized since 2015 in IEC 62769



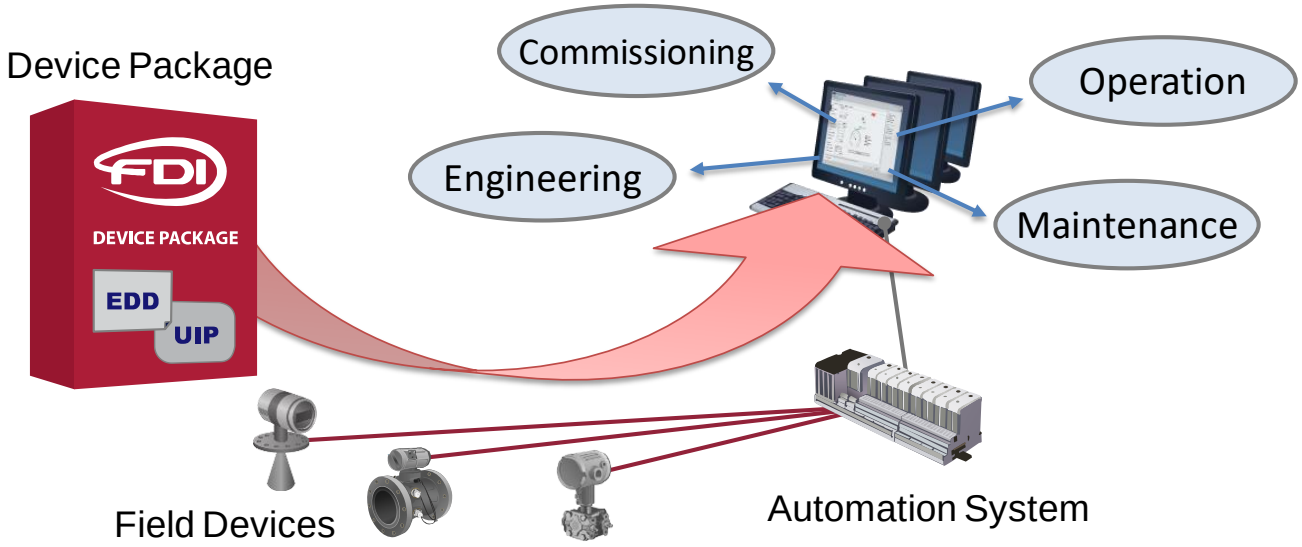
FDI - Field Device Integration (2)

- **FDI is based on present technologies**
  - FDI uses the best components of the previous technologies (EDDL and FDT) and combines them in the „Device Package“
  - The „Device Package“ and thus the corresponding field device can be integrated into an FDI-Host as well as into a FDT(FDI-Host



FDI - Field Device Integration (3)

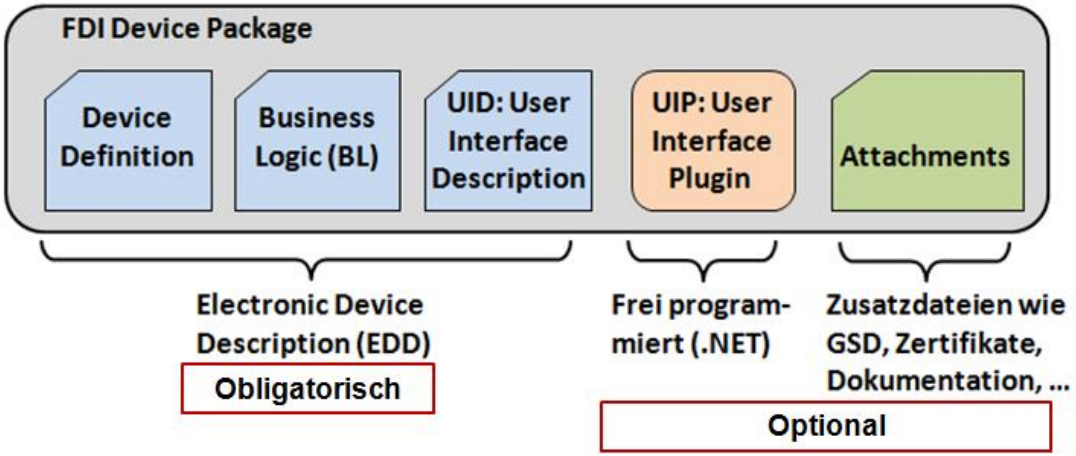
- **Device Package represents the field device**
  - The „Device Package“ describes the field device with all functionalities according to IEC 29500 (Container Format).
  - The „Device Package“ remains unchanged over the entire service life of the field device and is used in tools and control systems during engineering, commissioning, operation, and maintenance.



FDI - Field Device Integration (5)

FDI Device Package: Content

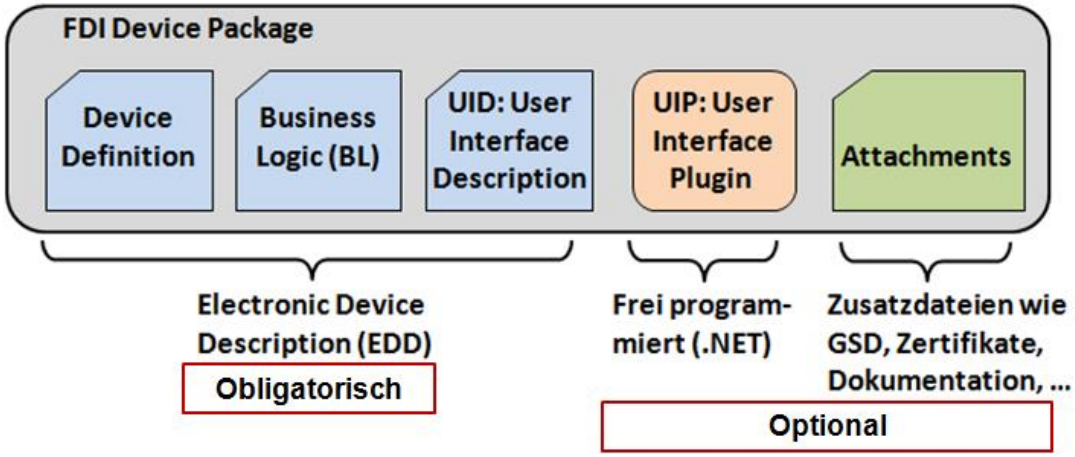
- The “FDI Device Package” is a scalable software component and represents the core of the FDI technology. It contains mandatory and optional files which are required for configuration, commissioning, diagnosis and calibration of the device over its entire service life.



FDI - Field Device Integration (5)

FDI Device Package: Device description

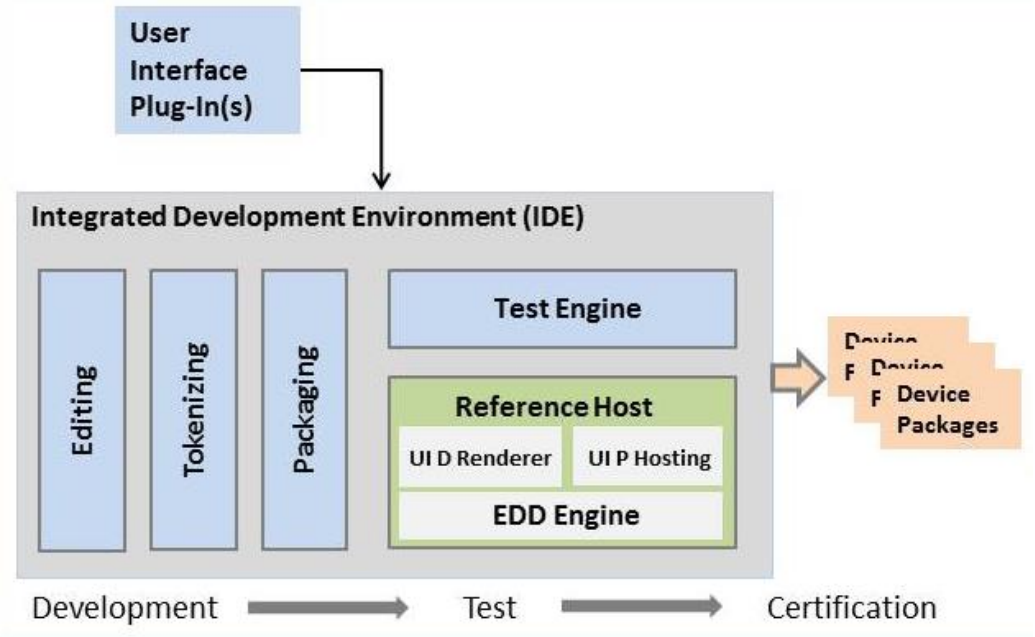
- Description is based on the harmonized EDD description language EDDL according to IEC 61804
  - **Device Definition:** Device details (internal structure, …)
  - **Business Logic:** Preliminary data consistency
  - **User Interface Description:** Consistent device operation
  - **User Interface Plugin:** Free programmable user interface
  - **Attachments:** Product information, certificates, service advise, …



FDI - Field Device Integration (2)

Integrated Development Environment (IDE)

- The Integrated Development Environment IDE enables the device manufacturer to develop Device Packages at low effort.
- IDE supports PROFIBUS, PROFINET, Foundation Fieldbus and HART. It enables to convert EDD-files into FDI-Packages and can also be also used as test environment.



FDI - Field Device Integration (2)

- **FDI Hosts**

- FDI hosts are powerful interfaces to field devices and can act as
  - a device management software as part of a Process Control System
  - a Plant Asset Management System
  - a device configuration tool on a laptop
    or handheld field communicator

- For a defined field device, device manufacturers have to develop just one device package instead of, until now, two separate components DD and DTM.

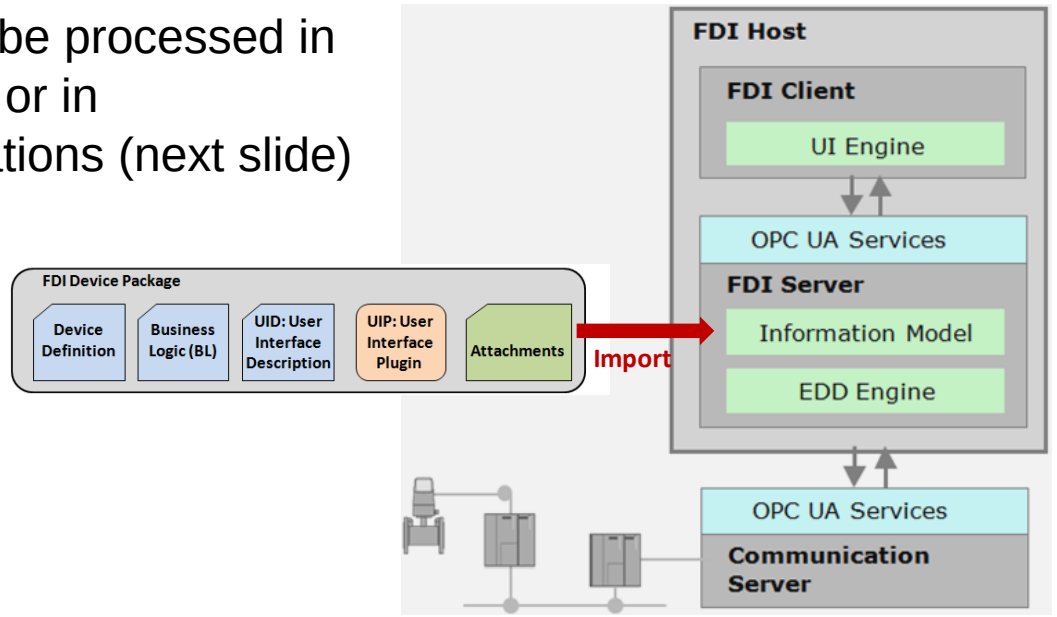
- Device Packages can be used in two different host environments: FDI-Host and FDT/FDI-Host.

FDI - Field Device Integration (2)

FDI Device Packages in Hosts

- Device Packages are imported into hosts and not, like programs, installed. Therefore, after importing a device package, the user can immediately start operating the device. No rebooting is required and no interoperability problems with components and Windows version will happen.

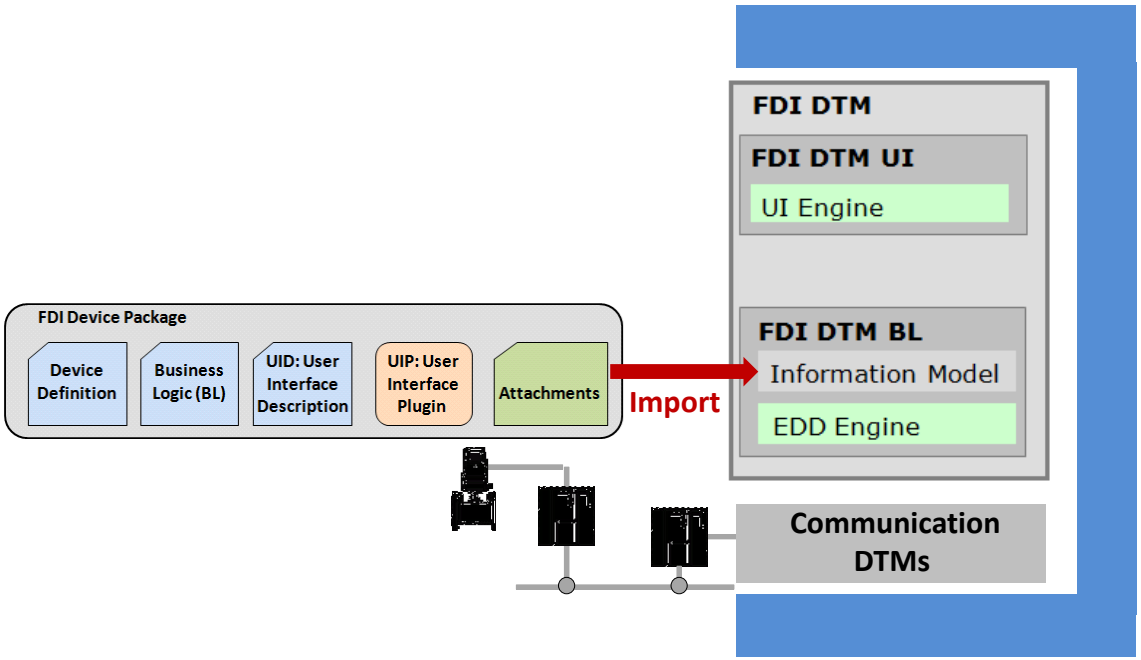
- Device Packages can be processed in FDI Hosts (see figure) or in FDT2™ frame applications (next slide)



FDI - Field Device Integration (4)

FDI Package

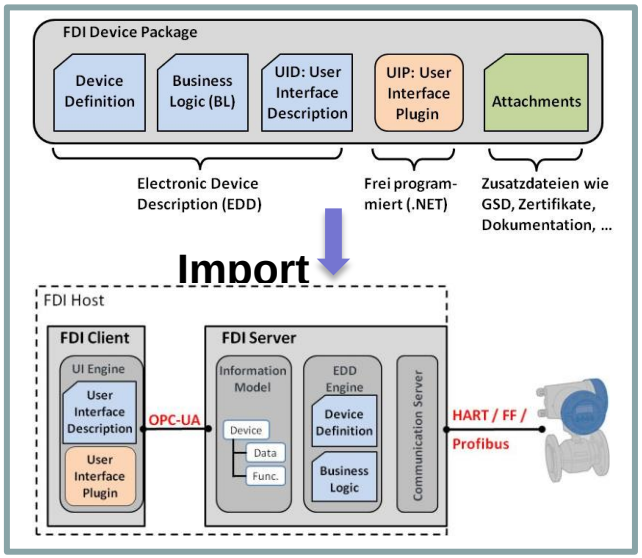
- “FDI Device Packages” in a FDT2™ frame application

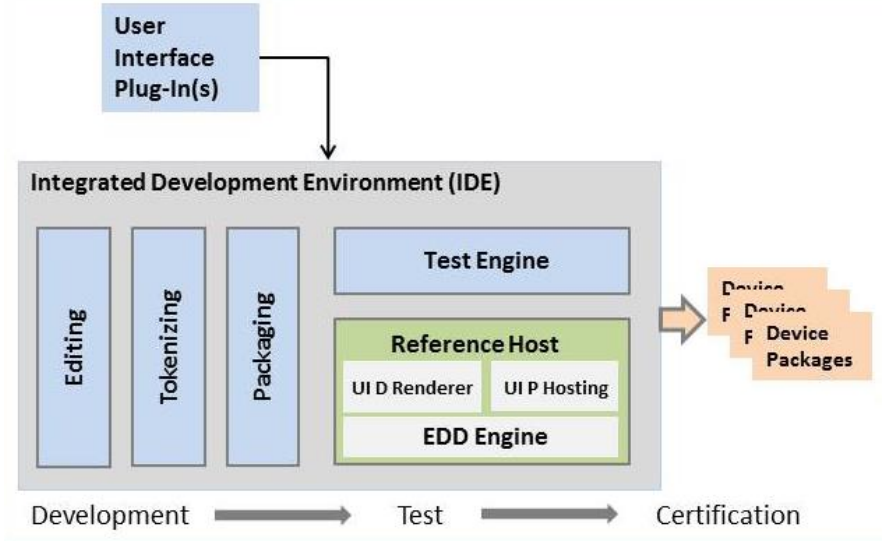


FDI - Field Device Integration (4)

Common Host Components

To ensure same behavior of FDI Device Packages in various Host systems, uniform and multi-protocol host components have been developed: UI Engine and EDD-Engine.

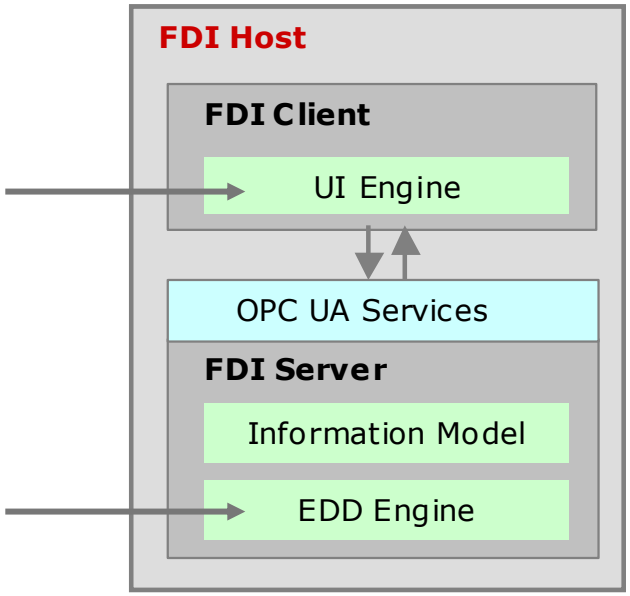




FDI - Field Device Integration (5)

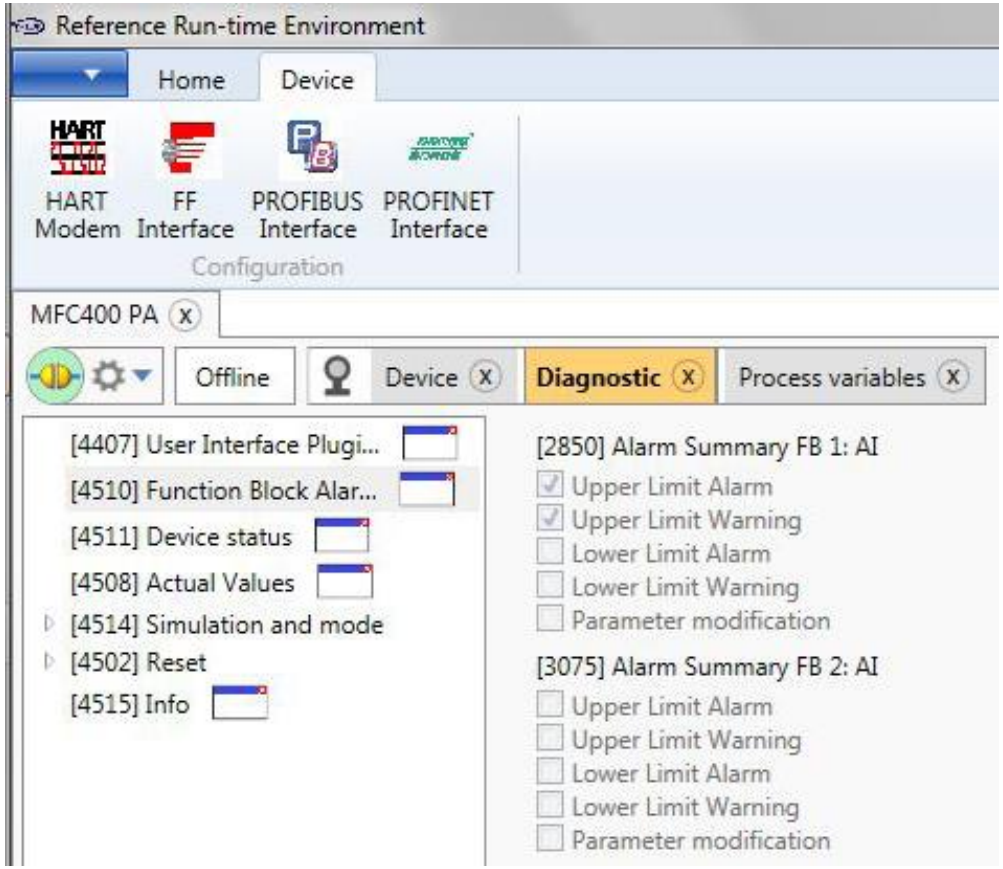
Common Host Components

- **The UI Engine** ensures that user interface elements (UID and UIP) are executed in the same way in different host systems.
- **The EDD Engine** supports the entire scope of EDDL versions in accordance with IEC 61804 in a multiprotocol manner including backward compatibility.



FDI - Field Device Integration (4)

- **Example 1**
  EDD based part of a Device Package in the FDI Reference Host



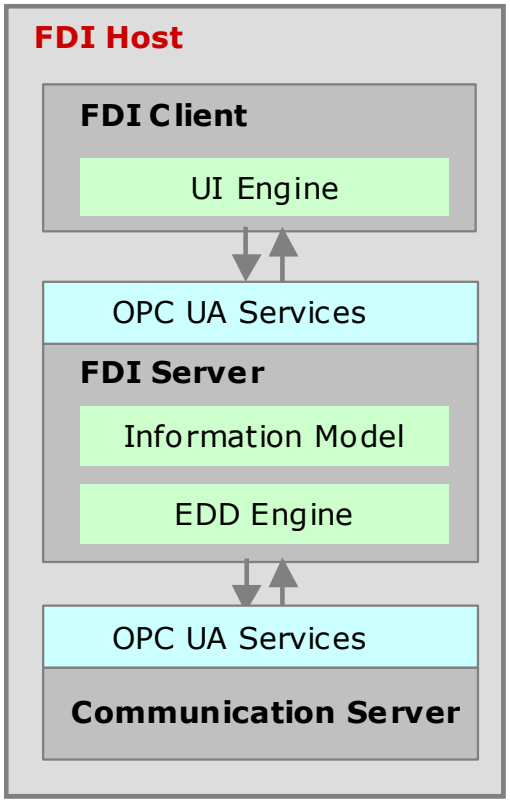
FDI - Field Device Integration (5)

Example 2
Free programmed graphical elements

FDI - Field Device Integration (6)

FDI – Scalable architecture (1)

- The FDI standard allows the implementation of different software architectures for a host starting from a tool for a single user up to a distributed multi-user application with client/server architecture.
- FDI Clients are used by operators to work with automation instruments.
- The FDI Server manages device packages, involves communication to connected devicesusing standard protocols, maps the communication topology to the automation system etc.



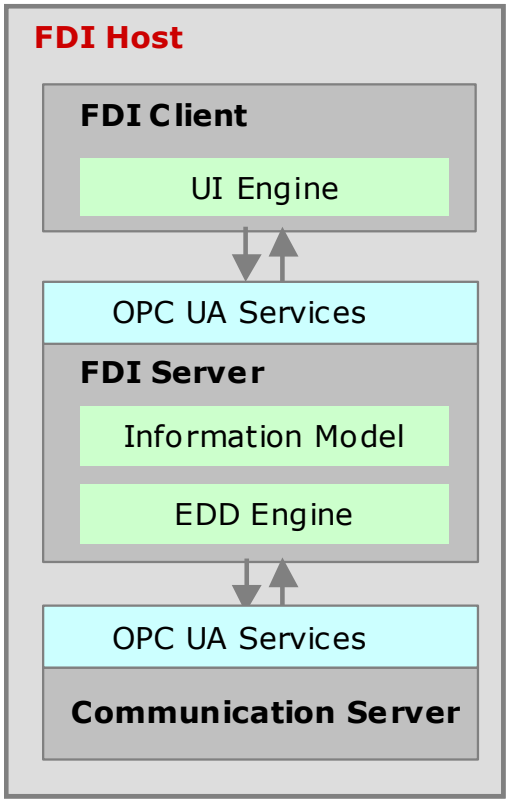
FDI - Field Device Integration (7)

FDI – Scalable architecture

- **Standard protocols** like HART, PROFIBUS, PROFINET, or Foundation Fieldbus are supported by the FDI server.
  Other protocols are supported by the FDI communication server(s).

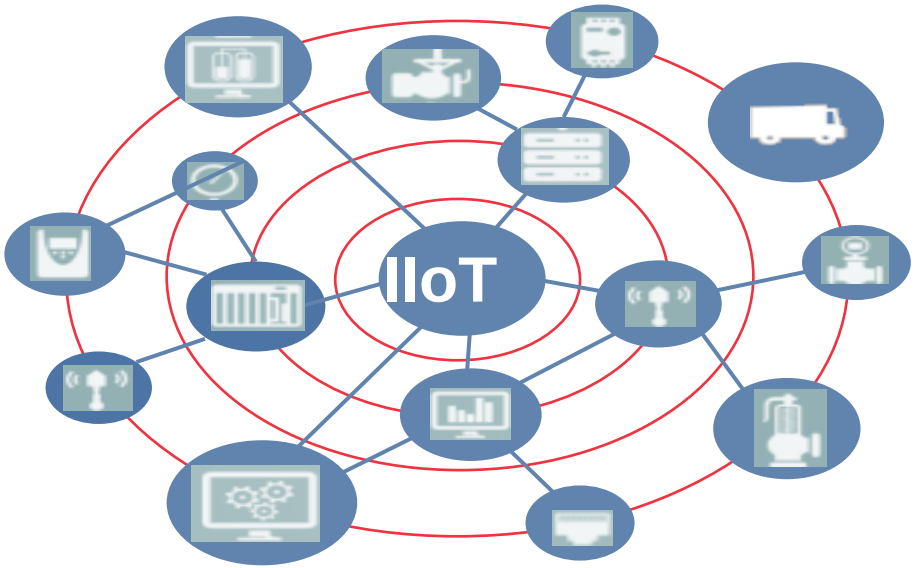
- **OPC-UA** is used as interface in FDI hosts.
  The OPC UA services allow secure access to the devices and allows easy access from and to other applications.

- **The information model** represents the device instances and the entire communication infrastructure.



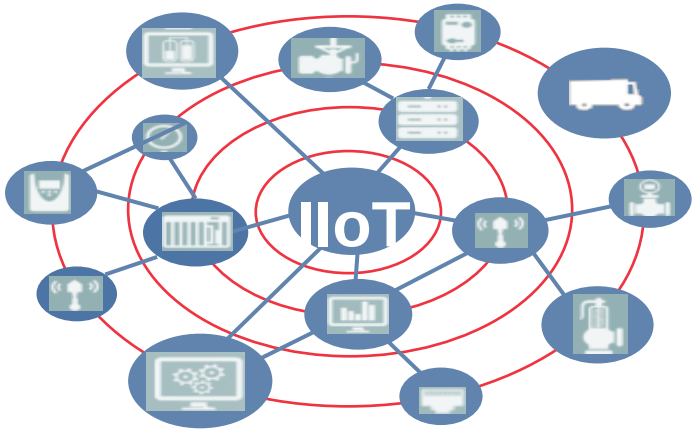
FDT - Field Device Integration (8)

- **FDI – Door opener for Industry 4.0**
  - FDI connects field devices to the IOT. Within this context, any physical object with a microcontroller is a “thing” with a virtual presence in the internet.
  - Virtual object are able to exchange information and to interact with software applications (Services) or persons.



FDT - Field Device Integration (9)

- **FDI and the Industry 4.0 Administration Shell**
  - PROFIBUS and PROFINET devices are delivered with descriptions (GSD, EDD) which contain information about the device and its features.
  - This corresponds to the concept of the Administration Shell in the RAMI-model of Industry 4.0
  - Using FDI, the information of the Device Package is available and could get part of the administration shell.
  - Thus, field devices become Industry 4.0 components.



FDT - Field Device Integration (10)

- **User Benefits of FDI technology**
  - FDI simplifies working processes
    - Direct access to all information in the Device Package
    - Device Package contains complete device documentation
  - FDI reduces integration effort
    - Only one , unified integration technology
  - FDI protects existing investments
    - Upgrade of existing DDs to FDI packages
    - FDI Hosts support installed base
  - FDI brings field devices to the Internet of Things

Network Components

Repeater
Coupler/Links
Junction boxes
Fieldbus barriers

Network components

Repeaters

- Repeaters are devices that repeat an electrical signal thereby returning it to its full strength but introducing a delay in the signal.
- Repeaters extend the total length of a network and the number of devices on the network.
- Repeaters are mainly used in DP-networks with their daisy chain topology to allow more devices connected to the network.
- In PA-networks, a coupler with a new PA-segment can be added in case of an overloaded segment and to add more devices.

Couplers and Links

- PROFIBUS PA segments are attached to the PROFIBUS DP backbone through some sort of coupler or link.
- A number of companies supply such kind of equipment with different technical features and designations:
  - „PROFIBUS DP/PA Segment coupler“
  - „PROFIBUS DP/PA Link“
  - „PROFIBUS DP/PA Linking device“

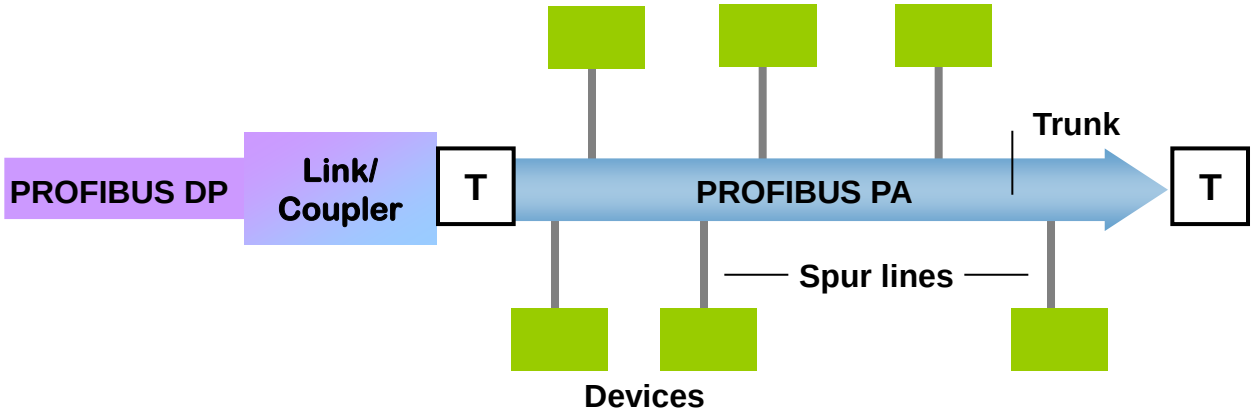
Junction boxes (for PROFIBUS PA)

- Junction boxes (also fieldbus coupler, field barrier, multibarrier, ...) are used to connect spur lines to the trunk and offer numerous special features that vary between models and manufacturers.

For details see chapter „How to install PROFIBUS?“.

PROFIBUS PA - Trunk topology

- Junction boxes and field barriers are used in networks to connect trunks (main line) to spurs.
- Features and device names depend on the manufacturer



PROFIBUS in hazardous environments

MBP-IS
FISCO
High-Power
Trunk

PROFIBUS in hazardous environments

- In hazardous environments, fieldbus systems must comply with two IEC standards:
  - IEC 60079: Explosive atmospheres
  - IEC 61158-2: Fieldbus/Physical layer specification

- Hazardous zones and PROFIBUS solution
  - Zone 0, 1 and 2 define areas of a plant, where explosive substances may exist in the air and an electrical spark could trigger an explosion.
  - The respective PROFIBUS solution limits the energy going to the bus and the devices to eliminate the danger of generating a sparc.

- The „Intrinsically Safe (IS)“ version of the MBP physical layer (MBP-IS) complies with this approach.

See also chapter “transmission technology“ .

Data of MBP and MBP-IS physical layers

	MBP PROFIBUS PA	MBP- IS PROFIBUS PA
Baud rate	31.25 kBit/sec	31.25 kBit/sec
Voltage	24 ... 30 V	13,2 V
Current	1000 mA	110 mA
Devices/segment (max.)	32	
Devices/segment (typic.)	14 ... 20	4 ... 6
Cable length max.	1900 m	1000 m
Spur line length max.	120 m	60 m

Note:
RS485 is also available in an intrinsically safe (IS) version, which runs at lower power levels with a special coupler and a special wiring.
This is a cost effective solution for remote I/O in IS environment.

Fieldbus Intrinsically Safe Concept (FISCO)

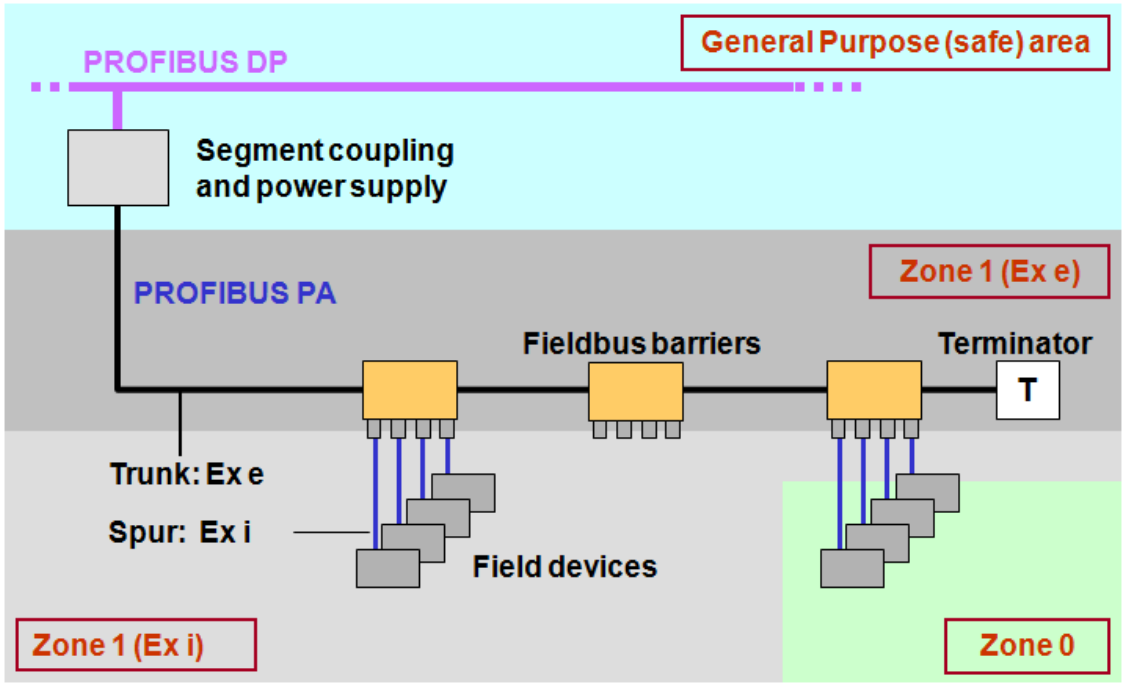
- The FISCO (Fieldbus Intrinsically Safe Concept) provides easy and fast design of PROFIBUS PA networks in hazardous areas.
- FISCO enables to get IS approval without individual calculations.
- FISCO requirements:
  - Only one power source permitted.
  - All other components are drains.
  - Maximum overall cable length 1000 m
  - Maximum spur line length 60 m
  - Power supply, coupler and field devices must be FISCO certified.

From Intrinsic Safety to the High-Power-Trunk

- Intrinsic safety (I.S.) is the method of choice for instrument connections in hazardous areas.
- I.S. does not satisfy completely the needs regarding to cable length and number of devices compared to applications outside of hazardous areas.
- The High-Power Trunk Concept solves this limitation and makes PROFIBUS PA best suited for use in hazardous areas.

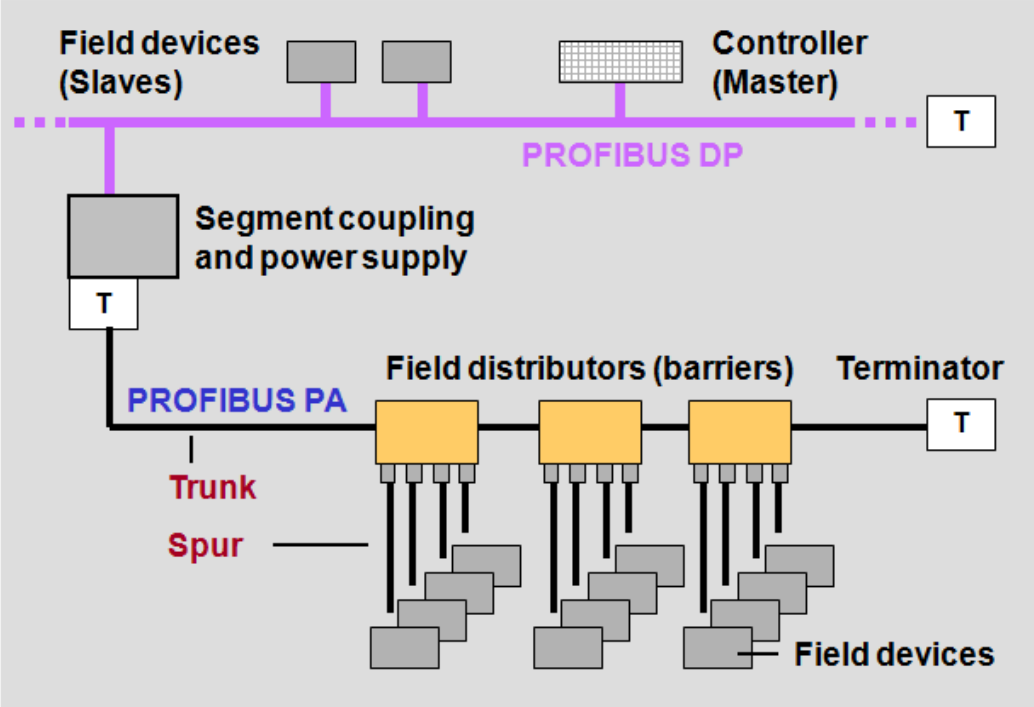
PROFIBUS PA in hazardous areas

- **High-Power-Trunk to supply Zone 1**
  - The trunk is installed with increased protection in zone 1 to allow increased supply current for more field devices.
  - The field devices are connected using Ex i ignition protection.



PROFIBUS PA in hazardous areas

- **High-Power-Trunk to supply zone 2**
  - The trunk is installed using ignition protection none-sparkling
  - The connection of field devices uses “energy limited”



PROFIBUS in Safety Applications (PROFIsafe)

PROFIsafe enables all kinds of Safety Applications

Safety Applications (PROFIsafe)

- **Objective of “Safety” is to avoid accidents and damages in case of failures and to ensure maximum safety for …**

… People

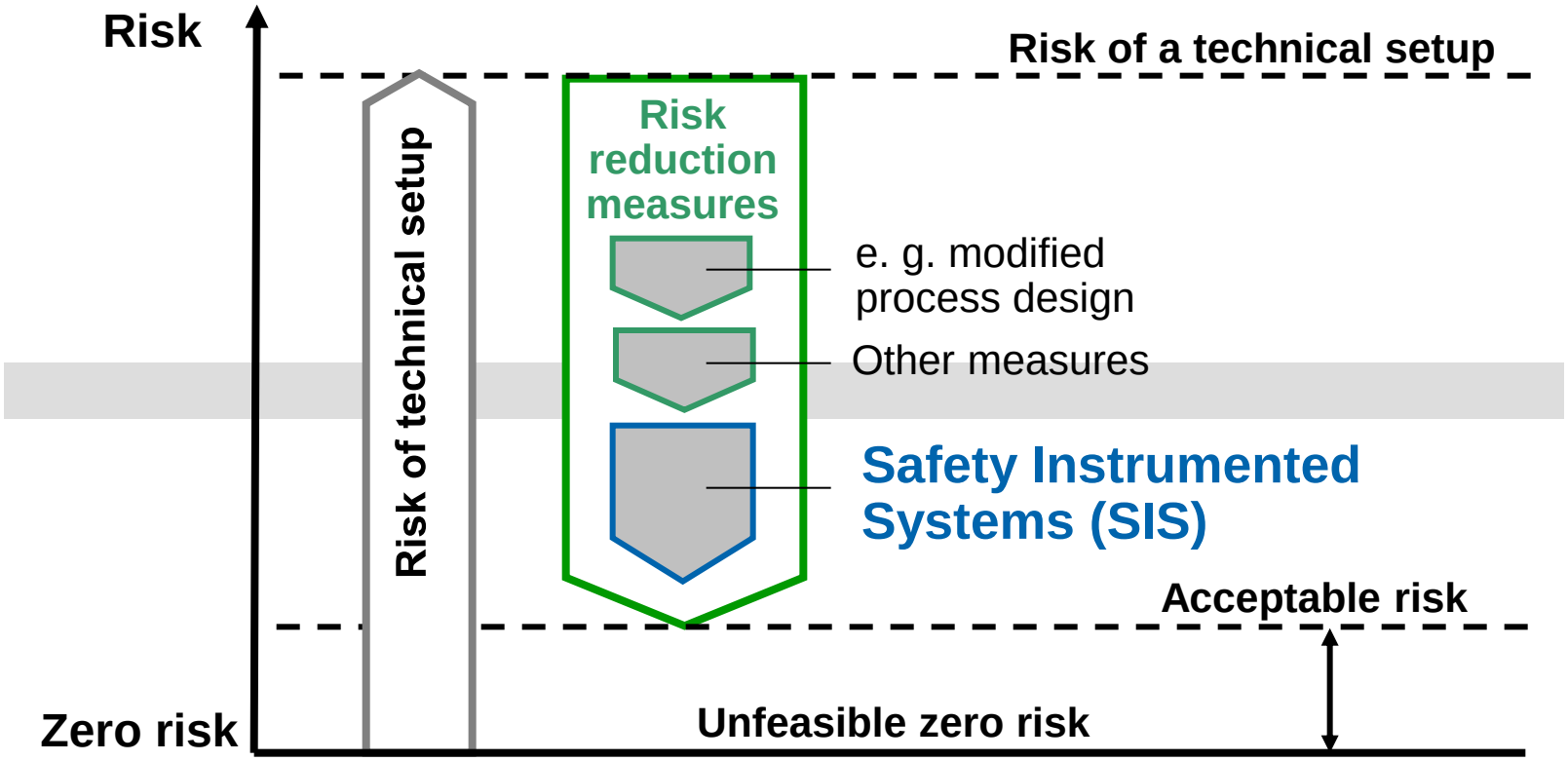
… Process

… Environment and nature

- Safety applications are essential in all sectors of automation.

Safety Applications (PROFIsafe)

- Objective: Reduce the risk to an acceptable level.
- Solution: Install risk reduction measures including safety systems.



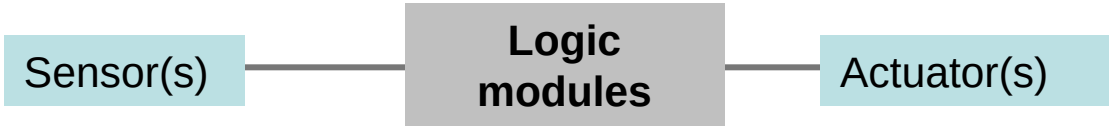
SIL and Risk Reduction

- SIL is a A performance criteria of a Safety Instrumented System (SIS) which describes, among other things, the Probability of Failure on Demand (PFD). SIL covers four levels SIL 1 to SIL 4.
- PFD is a value that indicates the probability of a system failing to respond to an actual demand. PFD is also referred to as “safety unavailability”.

Safety Integrity Level (SIL)	Probability of failure on demand (PFD) per year	Risk Reduction Factor (1 / PFD)
SIL 1	>= 10^{-2} to <10^{-1}	100 to 10
SIL 2	>= 10^{-3} to <10^{-2}	1000 to 100
SIL 3	>= 10^{-4} to <10^{-3}	10 000 to 1000
SIL 4	>= 10^{-5} to <10^{-4}	100 000 to 10 000

Safety Instrumented System (SIS)

A combination of sensors, logic modules (e.g. controls) and actuators which detects abnormal operating conditions and returns the plant automatically to a safe state again.



Safety Applications (PROFIsafe)

- **Safety technology**
  progressed from conventional relay controls to safety control systems.
- **Safety communication**
  uses standard and proprietary bus systems.

- **With PROFIsafe, PROFIBUS has a leading position:**

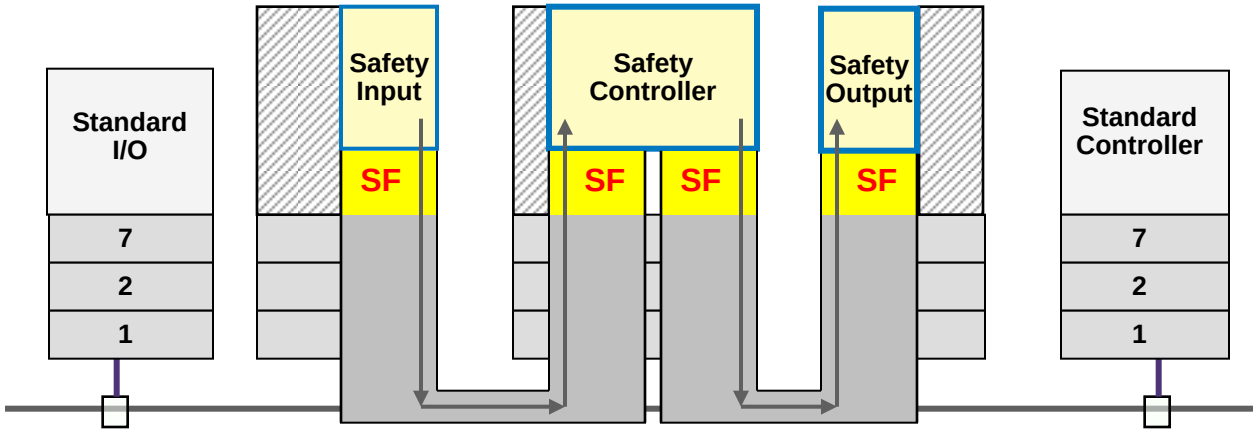
  - PROFIsafe is an additional communication layer above layer 7.
    It completely covers factory and process automation applications.
    It covers the entire transmission path from sensor/IO to the controller.

  - PROFIsafe is standardized in IEC 61784-3-3 and complies with SIL 3 according to IEC 61508.

  - With PROFIsafe, safety communication is combined with the benefits of standard communication, both using the same bus and cable.

Safety Applications (PROFIsafe)

Standard and safety communication on the same bus



Black Channel:
Not safety-related components such as ASICs, links, cables etc.

SF

PROFIsafe (Safety Function, Safety Layer)
Part of the safety-related communication system, located above layer 7
Safety Layers checks addressing, signature, fault tolerance time etc.

Safety-related components (I/Os, controller, control systems)
These are not part of PROFIsafe!

Not safety-related functions, e.g. diagnosis

PROFINET in Process Automation

Overview

Ethernet, Industrial Ethernet and PROFINET

- **Ethernet** is a communication technology (hard- und software) for use in cable networks, standardized in in IEEE 802.3 since 1982 and with an actual data rate of up to 10 Gbit/s.

- **Industrial Ethernet** is a further development of Ethernet for use in industrial environments (Automation technology) using robust, industry-suited components and functionalities, which meet typical requirements pf process industries such as real time behavior.

- **PROFINET** is the open, Industrial Ethernet-based and standardized (IEC 61158 and 61784) solution of PROFIBUS & PROFINET International (PI) for universal use in all segments of Automation technology.
  PROFINET is to-day
  - In factory automation widely used in all sectors and
  - In process automation widespread used as system bus and in the status of stepwise introduction in the field.

Requirements of Process Industry on Fieldbus technology

- The requirements of Process Industries (Chemical, Petrochemical, Oil&Gas, etc.) differ from those of Manufacturing Industry:
  - Wide-spread plants with a service life up to 40 years
  - Highest availability without any interruption (24/365)
  - Operation in explosion-hazardous areas
  - Flexible plant topology and robust connection technology
  - Redundancy concepts for critical functions
  - Trouble-free configuration in run
  - Investment protection for existing plants
  - Suited for structures with more than 10 000 components/devices
  - Installation and operation by skilled workers
- Other industries such as food, environmental, pharma, water/waste water or biotechnology show minor requirements regarding e.g. plant size or explosion protection.

PROFIBUS PA meets the specific requirements of the Process Industry to-day and in future (Investment protection)

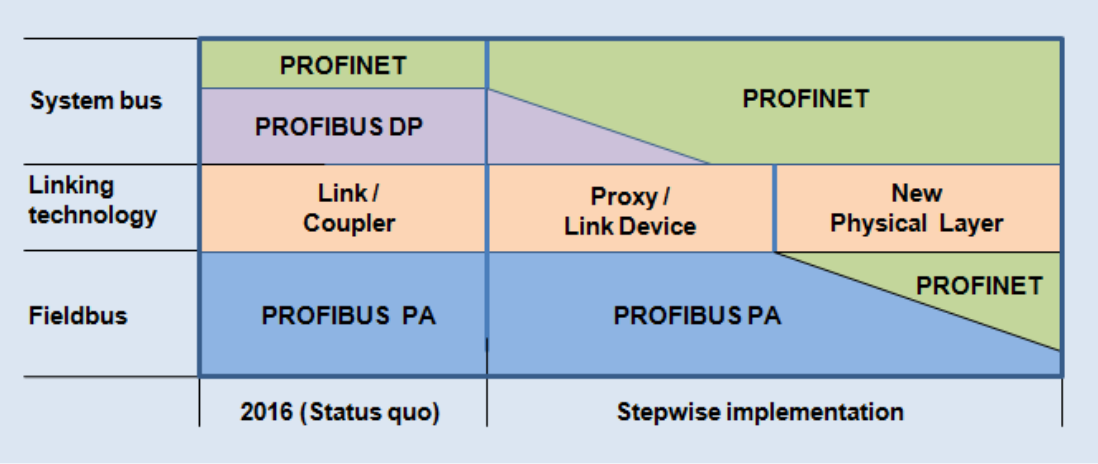
- **PROFIBUS PA** is the proved fieldbus of PI for the process industries. PROFIBUS PA enables wide-spread networks, explosion protection, and digital integration of the field instrumentation in conaol and asset management systems.

- **PROFIBUS PA** is also the designation for a segment of networked PA field devices (devices with the PA Profile implemented) which is linked to a PROFIBUS DP or PROFINET network via a coupling element ((Link, coupler, proxy).

- **PROFIBUS PA** is and will remain the future-prove, sustainable key technology of PI for the Process Industry with ensures investment protection. Connective components to to future fieldbus system will ensure this.

Transition from PROFIBUS to PROFINET

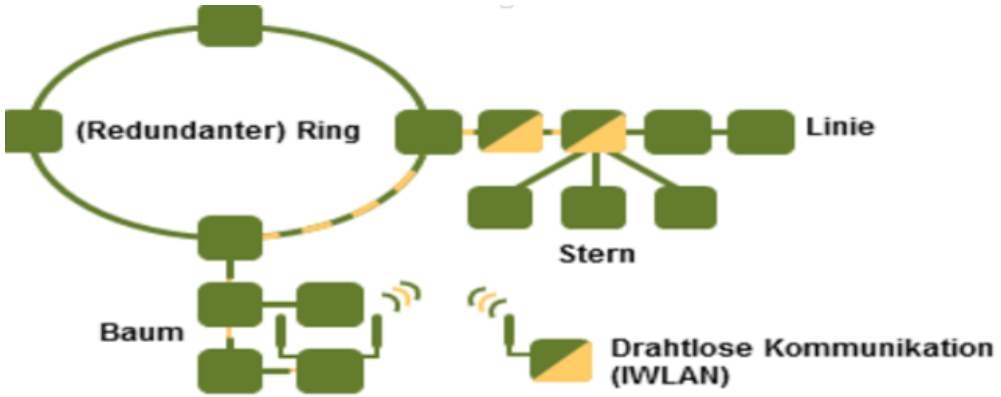
- Premises of PI for implementation of the transition:
  - Smooth, stepwise procedure
  - Coordination of manufacturers and users
  - Highest priority for investment protection
  - PROFIBUS PA remains key technology
- Result
  Solution platform with timely shifted established and new technologies and solutions



PROFINET has been and will be expanded stepwise by process industry relevant functions

Already in PROFINET implemented functions (1):

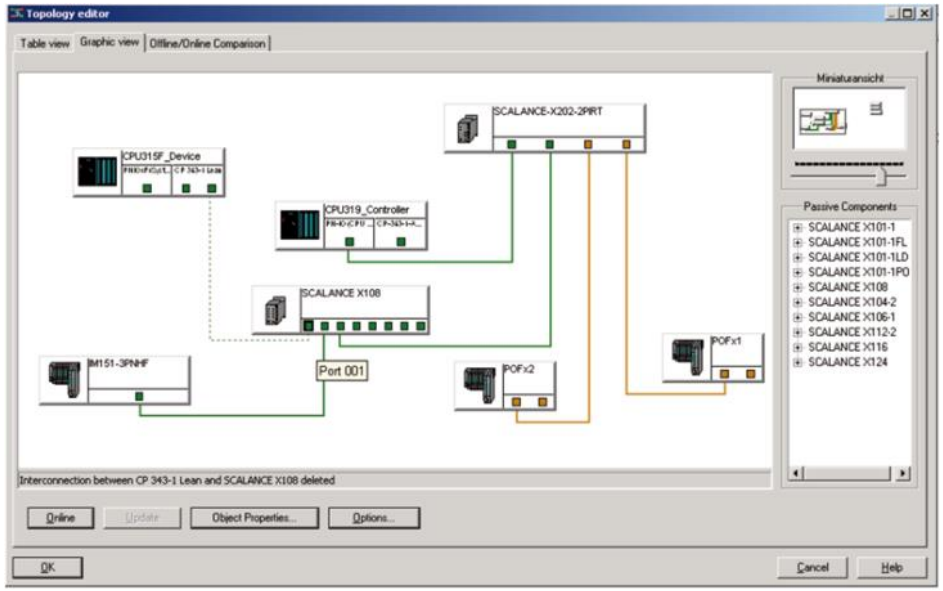
- **Network installation (topology)**
  - Line topology (for e.g. end devices)
  - Star topology (for e.g. control rack solutions)
  - Ring topology (for e.g. redundancy solutions) and
  - Tree topology (for e.g. mixed solutions)



PROFINET has been and will be expanded stepwise by process industry relevant functions

Already in PROFINET implemented functions (2):

- **Network diagnosis using LLDP** (Link Layer Discovery Protokoll) for
- Neigborhood detection and
- Graphic display of plant topology



- **Network management**
  using the Simple Network Management Protocoll (SNMP) for maintenance and network component control.

PROFINET has been and will be expanded stepwise by process industry relevant functions

Already in PROFINET implemented functions (3):

- **Easy device exchange**
  through cyclic exchange of neigbor hood information between the devices and integration of the new device in the known neigborhood of the former device.
- **Security**
  through a staged security concept with multible, configurable security zones.
- **Safety (SIL)**
  through the protocol (as defined in EC 61784-3-3) for functional safety in the case of transmission of elements of a fail-safe controller with those of the process controller on the same network

PROFINET has been and will be expanded stepwise by process industry relevant functions

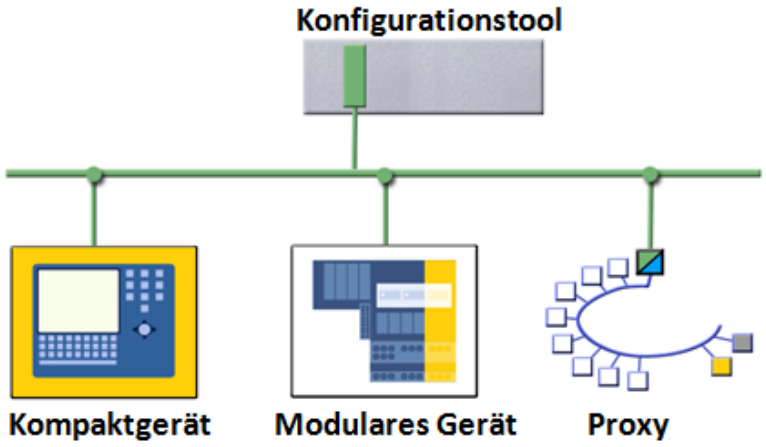
Already in PROFINET implemented functions (4):

- **User benefits**
  - Automatic design and checking of plant topology
  - Accelerated commissioning and easy device exchange
  - Easy configuration even without engineering tool
  - Prevention of interest conflicts
  - Handling easier as with 4-20 mA technology
  - Diagnosis handling according to NAMUR NE 107 remains unchanged

PROFINET has been and will be expanded stepwise by process industry relevant functions

PROFINET functions in realization (1):

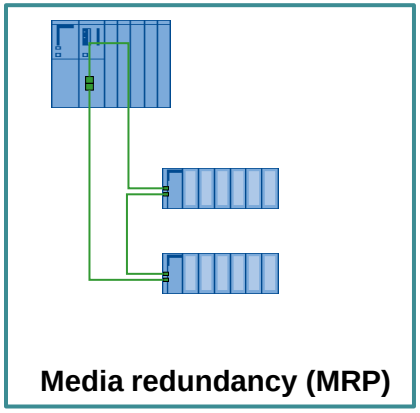
- **Changes in run**
  Intervention into a running plant (e.g. for device exchange) is shock-free and without any reaction on the communication on the network. This works for various types of devices.



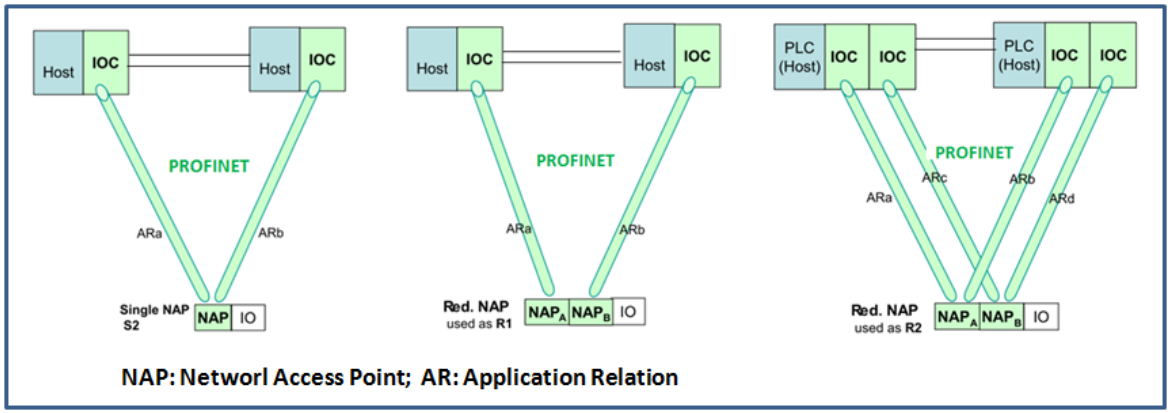
PROFINET has been and will be expanded stepwise by process industry relevant functions

PROFINET functions in realization (2):

- **Redundancy solutions**
  - Media redundancy (left) with more than one communication path between device and controller
  - System redundancy (right) with more than one communication relation between device and redundant controllers



Media redundancy (MRP)



NAP: Networl Access Point; AR: Application Relation

PROFINET has been and will be expanded stepwise by process industry relevant functions

PROFINET functions in realization (3):

- **User benefits from redundancy**
  - Formation of an electrical ring
  - No additional hardware required
  - Combination of media- and system redundancy
  - Free scalable availability
  - Highest availability by means of 4-path redundancy

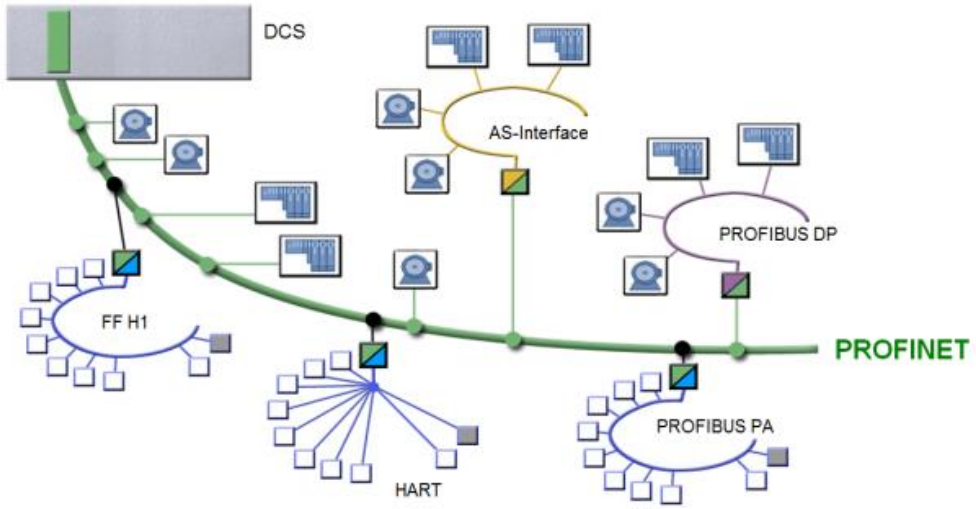
PROFINET has been and will be expanded stepwise by process industry relevant functions

PROFINET functions in realization (4):

- **Time stamping**
  according to IEEE 1588 including filing and precise cause analysis

- **Proxy technology**
  to integrate existing plant sections into PROFINET.

- Proxy: A gateway which represents structured devices in a PROFINET network .
  See also next slide.



PROFINET has been and will be expanded stepwise by process industry relevant functions

PROFINET functions in realization (5):

- **User benefits from proxy technology**
  - Openess through integration of existing fieldbus systems and installed base
  - 100% investment protection
  - Stepwise transition from PROFIBUS to PROFINET
  - Standardized engineering
  - Suitability for use in explosion-hazardous areas

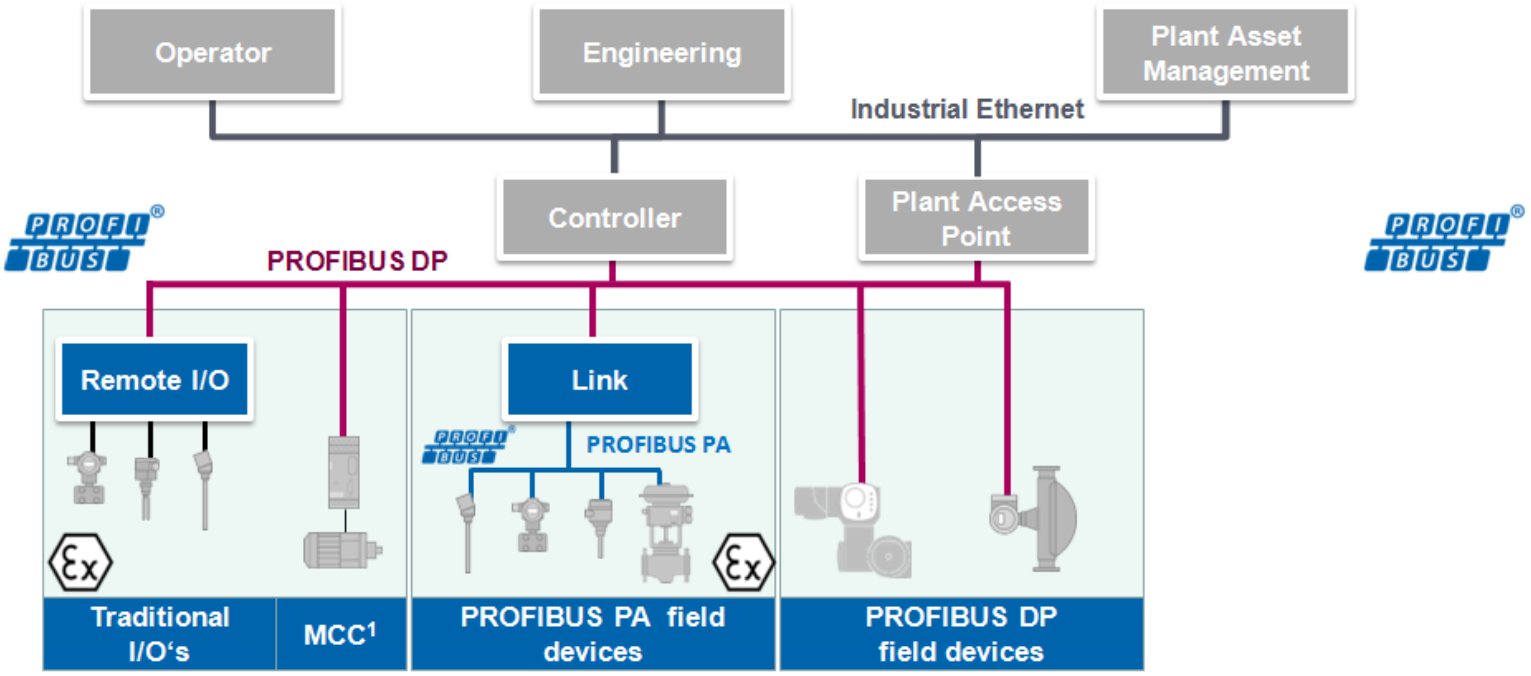
PROFINET has been and will be expanded stepwise by process industry relevant functions

PROFINET functions in definition:

- **Upgraded PA device profile**
  - Independent from physical layer and protocol
  - Input of user experiences and requirements
  - Consideration of “Core Parameter”
- **Resulting user benefits**
  - Consistent and simple processes
  - Manufacturer-independent project planning by Profile-GSD
  - Continued existence of diagnosis model acc. to NE 107
  - Data exchange turns into information exchange because of transmission of higher data rate
  - Synchronization of measured value unit between field device and control system

Topology to day: PROFIBUS DP in the field

Devices and PROFIBUS PA segments are connected to PROFIBUS DP via Remote I/O, Links or direct.

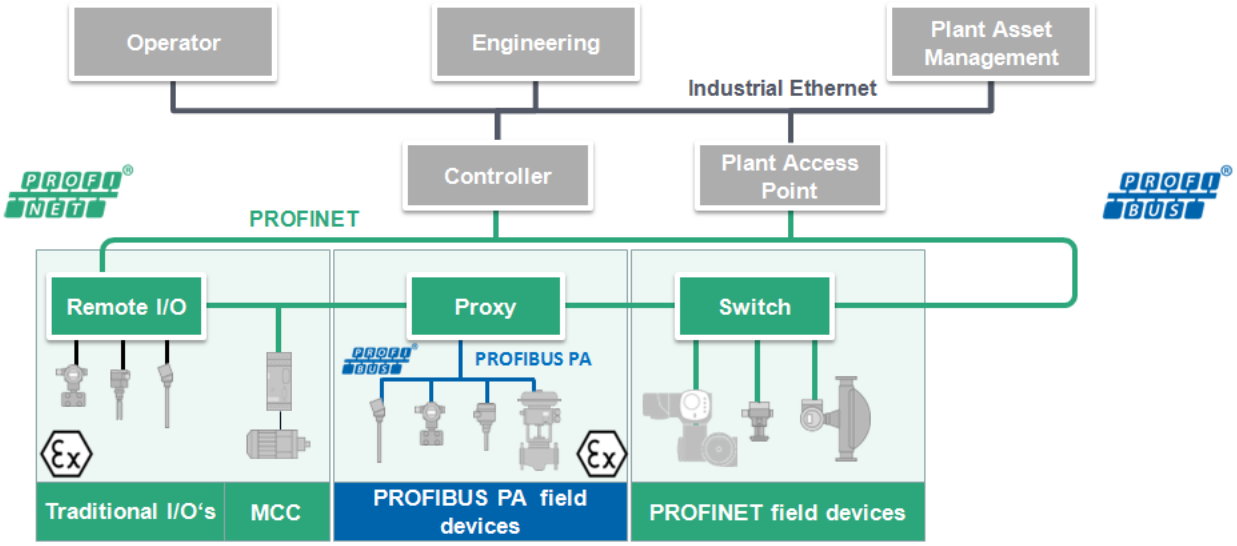


[1] MCC: Motor Control Center

Topology to day and in the near future: PROFINET in the field for certain applications

Device integration to PROFINET:

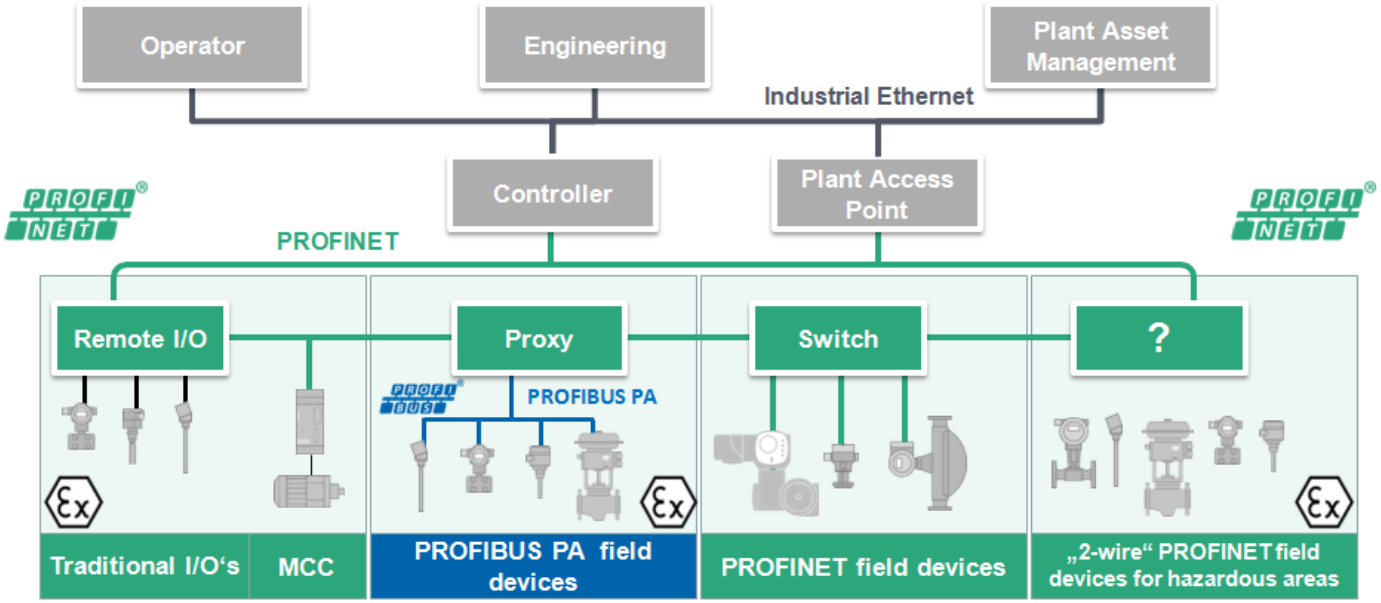
- **Direct :** Devices such as Remote I/O or or Motor Management Systems (left)
- **Via switches: P**ROFINET- devices without need for Ex-protection and optionally with energy supply via PoE (right) and
- **Via a proxy:** unchanged PROFIBUS PA segments.(center))



Topology in the future:
PROFINET in the field, even under ex-hazardous conditions

Integration to PROFINET:

- **Devices:** via Remote IO, Switches and a future Ethernet Physical Layer with Ex-suitability
- **PROFIBUS PA-Segments:** via Proxy



Topology in the future:
PROFINET in the field, even under ex-hazardous conditions (2)

Consistent Physical Layer for Ethernet-based communication
Required features:

- Power and communication via a single medium
- Communication line length up to 1000 m
- Easy to handle installation technology
- Ignition protection for explosion-hazardous areas
- Development independent of PI;
  PI however will support the solution.

How to design PROFIBUS?

PROFIBUS provides clear design and topology concepts

How to design PROFIBUS?

- **PROFIBUS uses two physical layers: RS-485 and MBP**
  - In “PROFIBUS DP”, the “DP Protocol” runs on RS-485.
  - In “PROFIBUS PA”, the “DP Protocol” runs on MBP*).

	RS - 485 PROFIBUS DP	MBP PROFIBUS PA	MBP- IS PROFIBUS PA
Baud rate	9.6 ... 12.000 kBit/s	31.25 kBit/sec	31.25 kBit/sec
Devices/segment (max.)	32	32	32
Devices/segment (typic.)		14 ... 20	4 ... 6
Cable length max.	1200	1900 m	1000 m
Spur line length max.		120 m	60 m

*) **MBP**: **M**anchester Coded **B**us **P**owered

How to design PROFIBUS?

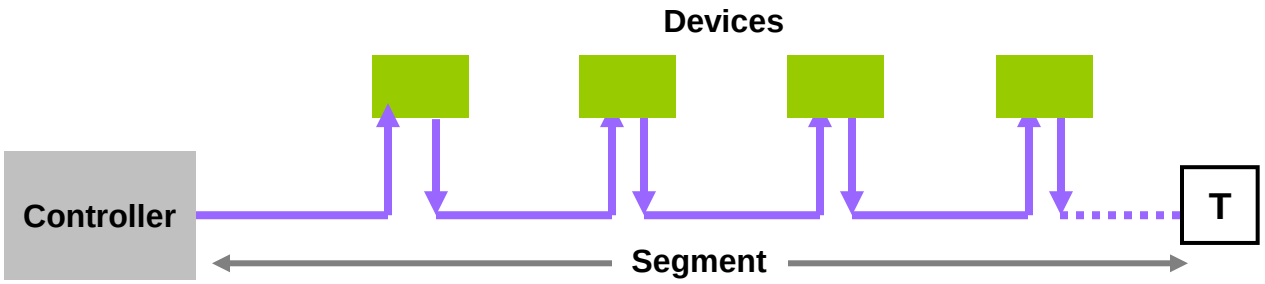
- **PROFIBUS DP and PA feature different network layouts**
  - PROFIBUS DP running on RS-485 allows only daisy chained nodes in the network layout and no spur lines.
  - PROFIBUS PA running on MBP allows much more flexibility in network layout including a variety of topologies such as trunk, star, or tree.
  - Both must be terminated at the extreme ends; termination characteristics are different for DP and PA networks.

*) **MBP**: **M**anchester Coded **B**us **P**owered

How to design PROFIBUS DP?

PROFIBUS DP via RS-485

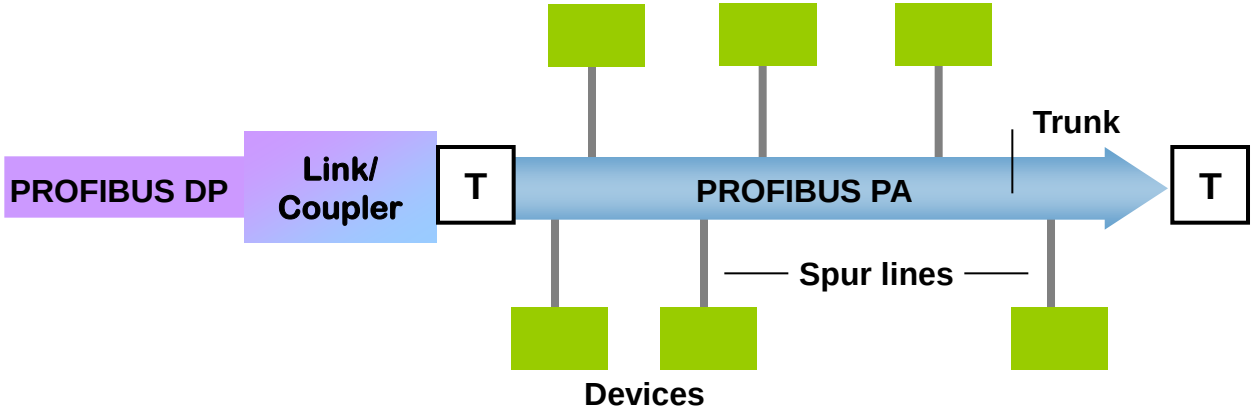
- 32 devices max. (incl. controller) on one segment.
- Devices must be daisy chained; no spur lines.
- Segment must be terminated (T).
- Baud rate depends on segment length.
- Repeater are possible, 9 max. per segment.
- Use of “recommended grounding methods”.



How to design PROFIBUS PA?

PROFIBUS PA - Trunk topology

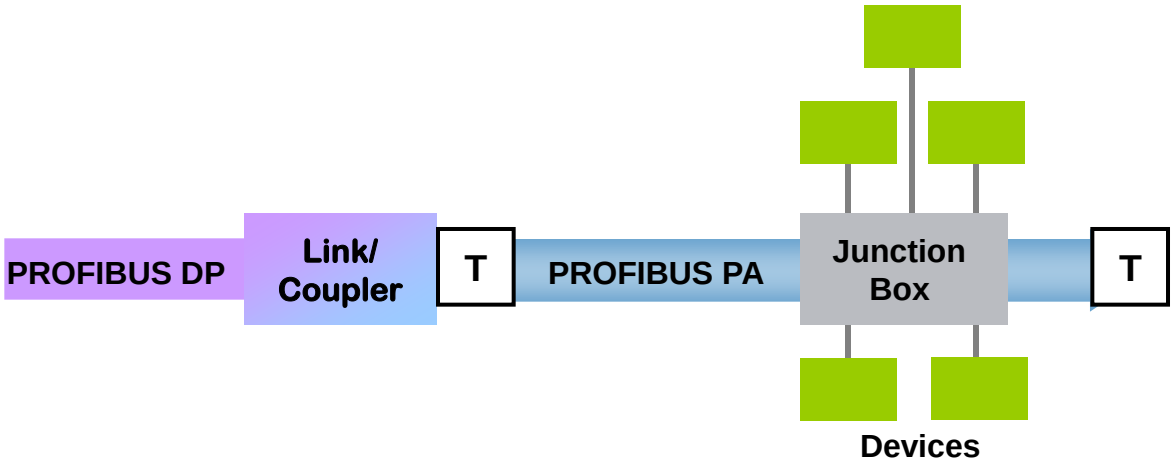
- One main cable (trunk) and spur lines
- Maximum length of spurs depends on number of spurs
- T-connectors with or without short-circuit protection
- With optional overvoltage protection
- Convenient and easy solution



How to design PROFIBUS PA?

PROFIBUS PA - Star topology

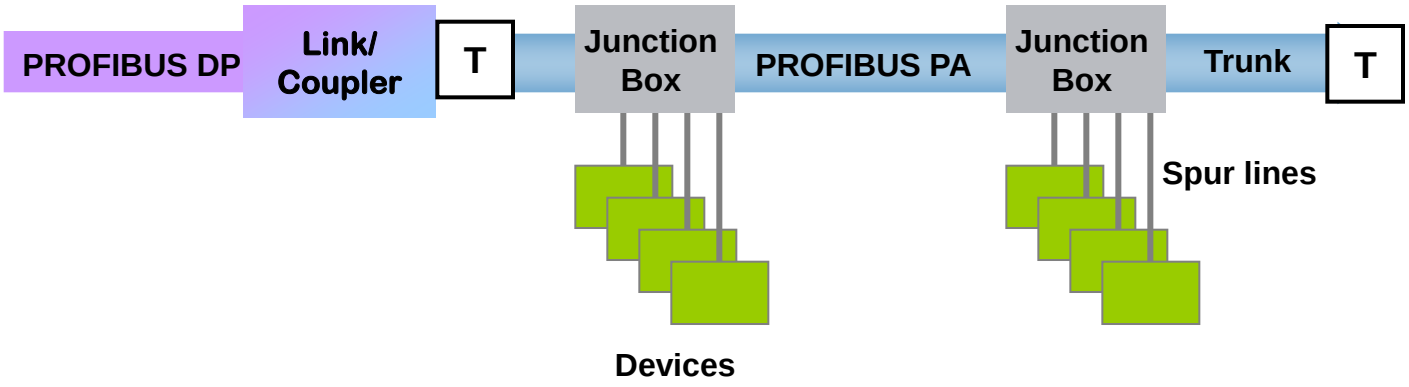
- Junction Box with or without short-circuit protection
- All spur lines come from the junction box:
- Convenient and easy solution



How to design PROFIBUS PA?

PROFIBUS PA - Trunk-and-spur topology

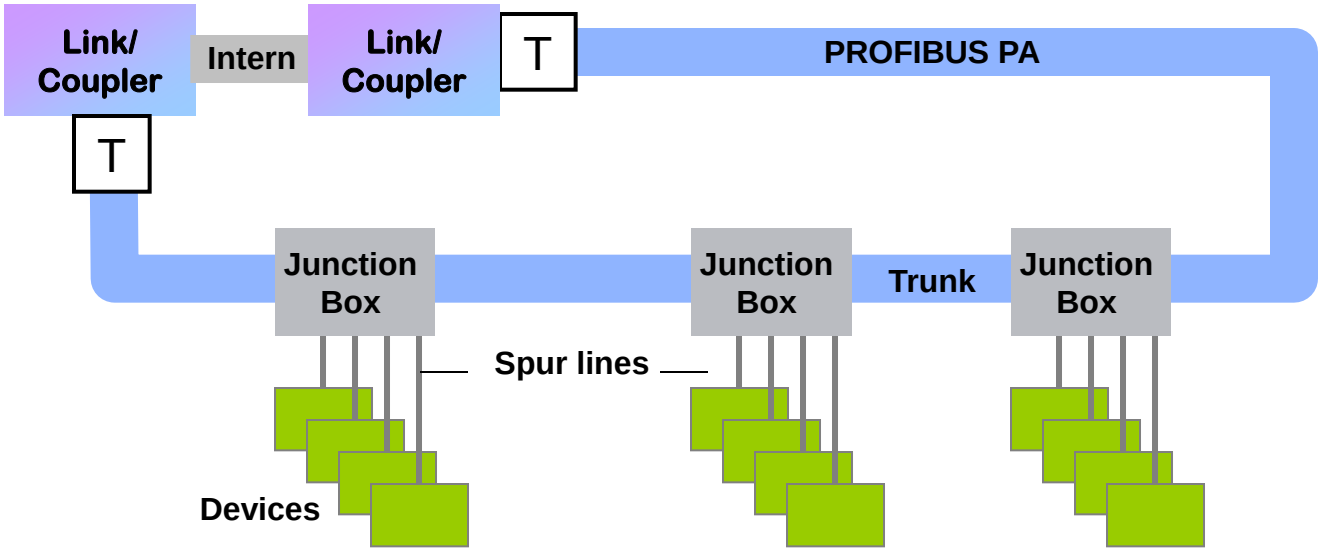
- Short-circuit protection at the spur lines
- Clearly arranged and easy to document



How to design PROFIBUS PA?

PROFIBUS PA - Ring topology

- Two redundant links/couplers
- High availability of the trunk
- Short-circuit protection at the spur



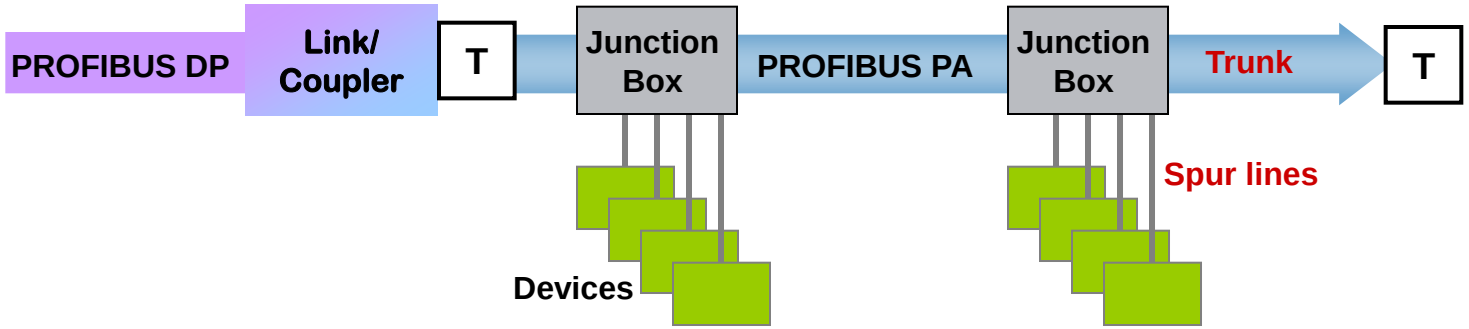
How to install PROFIBUS?

"Trunk and Spur"

The most common installation concept

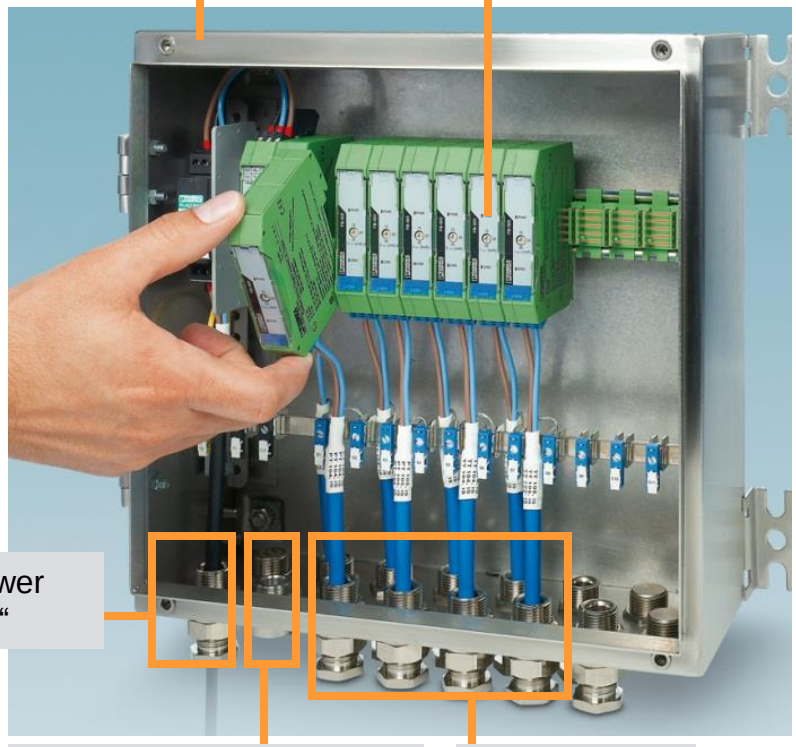
Installation: Trunk and Spur concept

- **“Trunk and Spur“ is the most common installation concept.**
  - Very clearly arranged and easily to document
  - Short-circuit protection at the spur
  - Junction boxes are easy accessible.



Installation: Junction Boxes

- **Junction boxes connect spur lines to the trunk.**

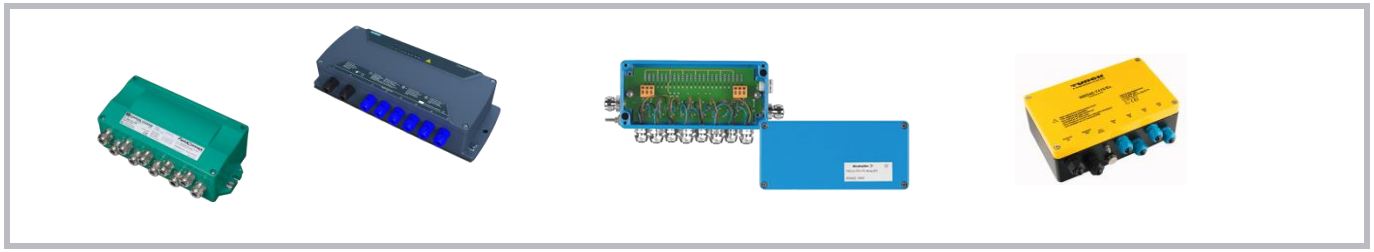


Installation: Junction Boxes

Fieldbus Junction Boxes

- Installed on an easy accessible location of the plant
- Mounted in a cabinet to protect against humidity and dust
- Coupled to the trunk which either terminates or continues to the next junction box
- Spurs to the field devices are applied in the box
- Electronic provides functional protection (e.g. short-cut at the spur) and explosion protection (e.g. intrinsically safe)

- Junction Boxes are available from various vendors in different design.



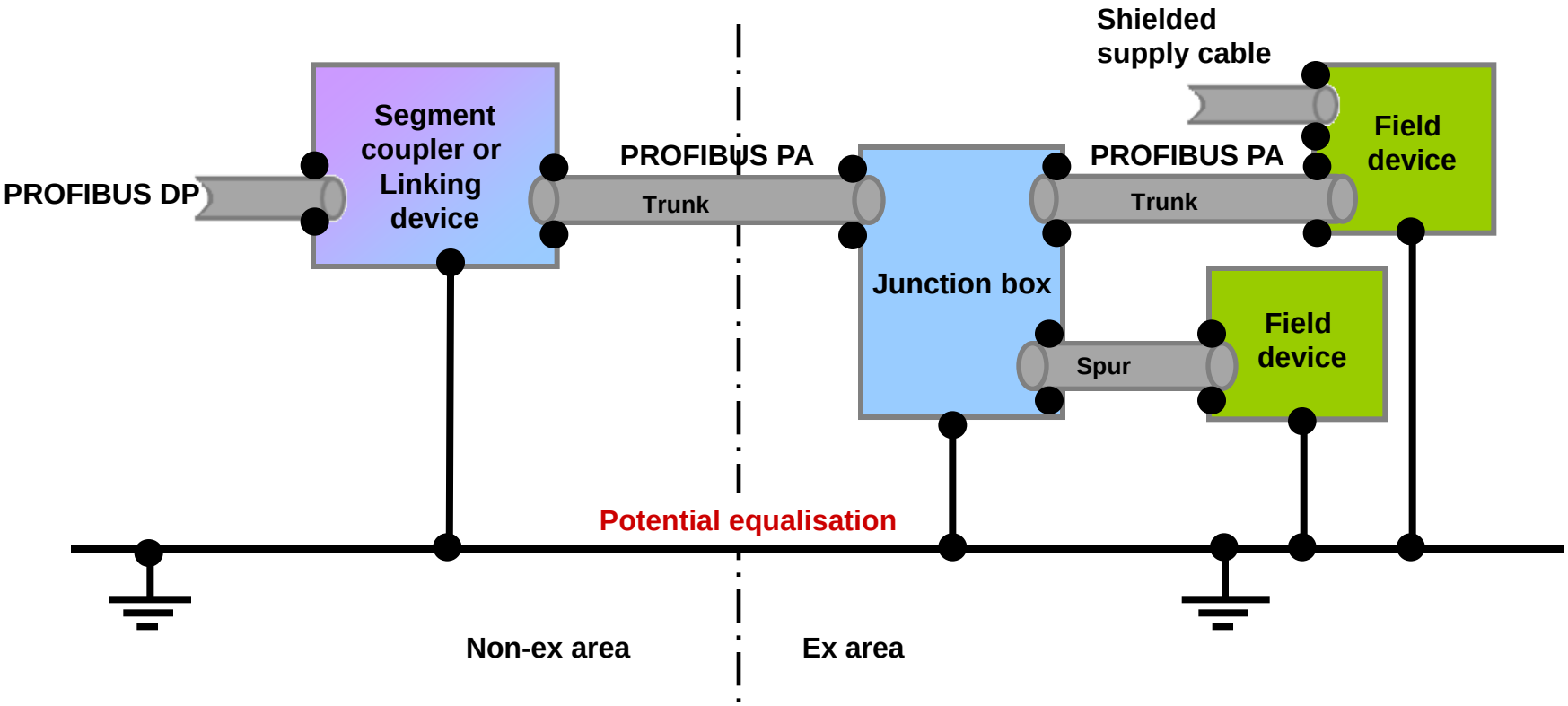
Installation: Shielding and Grounding

- **Shielding and Grounding**
  - The recommended grounding practices:
    - Connect all cable shields to ground.
    - Use a grounding cable to go from cabinet to cabinet in the same segment.
  - Types of grounding:
    - Direct grounding (at any connecting point)
    - Capacitive grounding

Installation: Shielding and Grounding

Direct Grounding

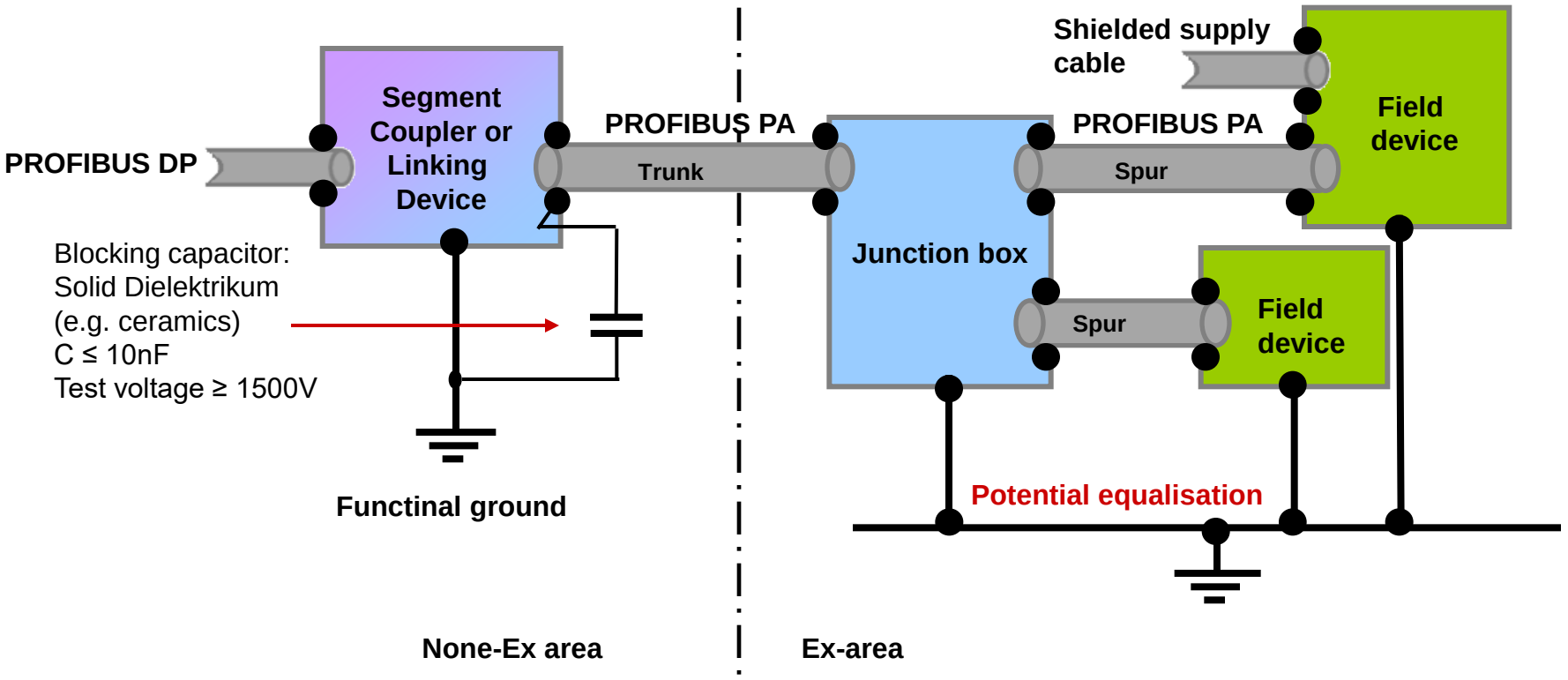
- Requires potential equalisation between Ex- und non-ex areas.



Installation: Shielding and Grounding

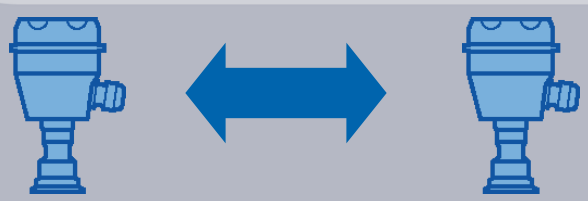
Capacitive Grounding

- To be used as soon as potential equalisation is not secured.



How to manage PA Field Devices?

PROFIBUS PA device management is easy

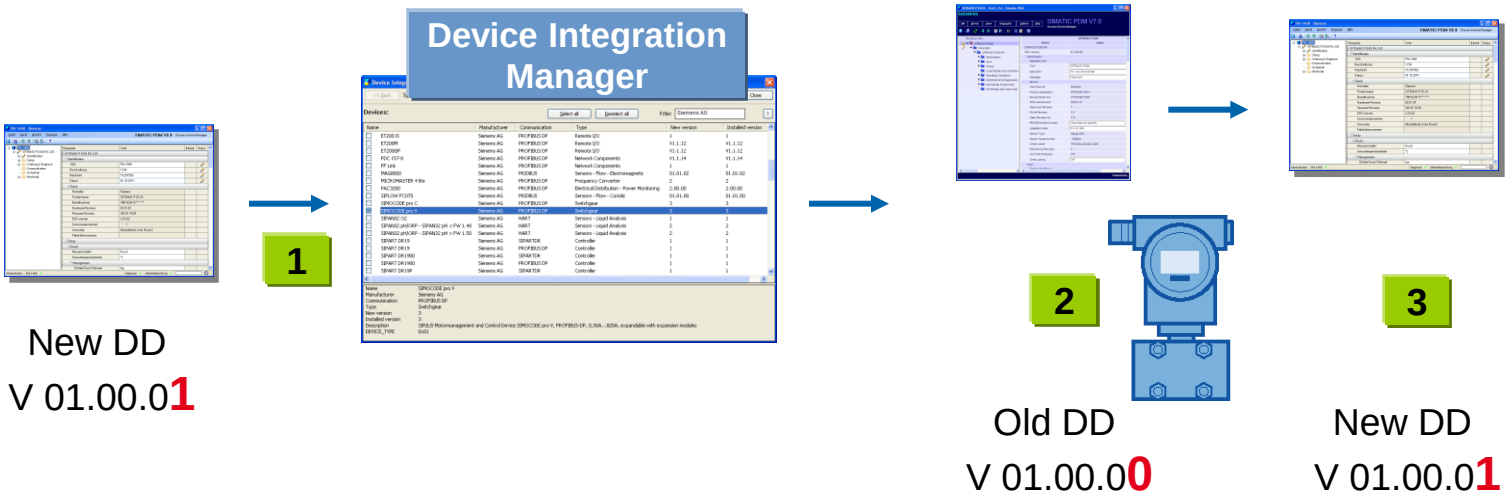


Field Device Management (6 Use Cases)

1. Device Update with a new (compatible) Device Description
2. Device Upgrade with a new DD with extended functionality
3. Device Exchange with same device type and same version
4. Device Exchange with same device type but different version
5. Device Exchange with device of different type or from different supplier using the profile GSD
6. Device Exchange with device of different type or from different supplier using PA Profile 3.02
7. Device-neutral Configuration

Device Update

Use of a new compatible Device Description (DD)



Step 1: Import the new DD

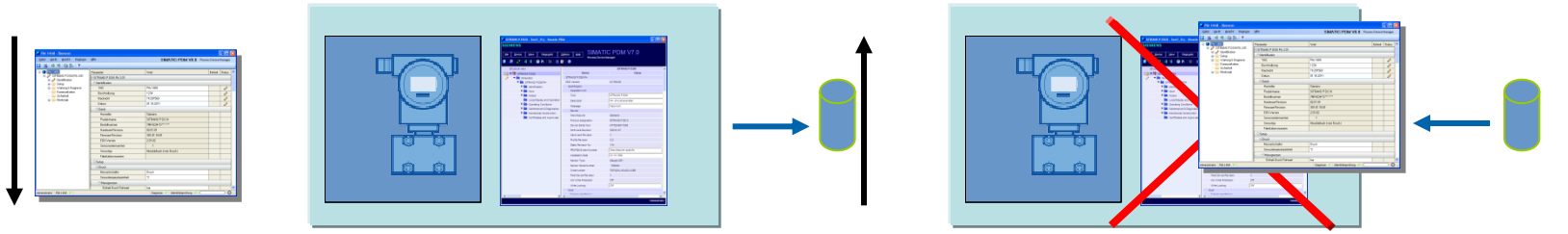
Step 2: Replace the old DD content by the new one

Step 3: Old DD is overwritten

PA Field Device Management – Use case 2

Device Update

Use of a new DD with extended functionality



1 New DD V 01.01.00

2 Old DD V 01.00.00

3

4

Step 1: Import the new DD

Step 2: Export the old parameter data

Step 3: Exchange the DD

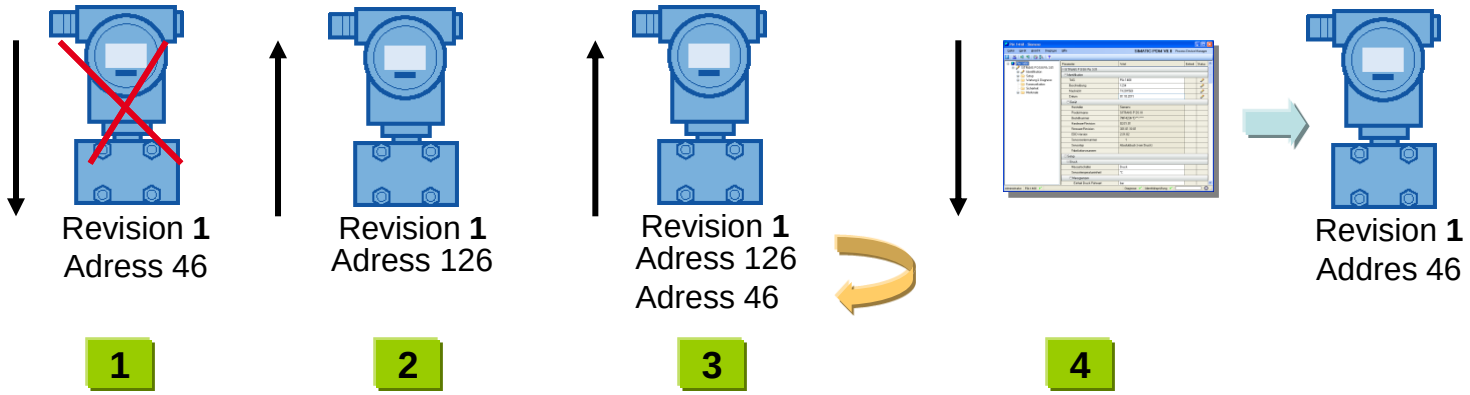
Step 4: Import the new parameter data

Step 5: Compare with field device to complete parameter (not shown)

PA Field Device Management – Use case 3

Device Exchange

Same device type and same version



Step 1: Remove old/defect device (tagged with address 46)

Step 2: Install new device (tagged preliminary with address 126)

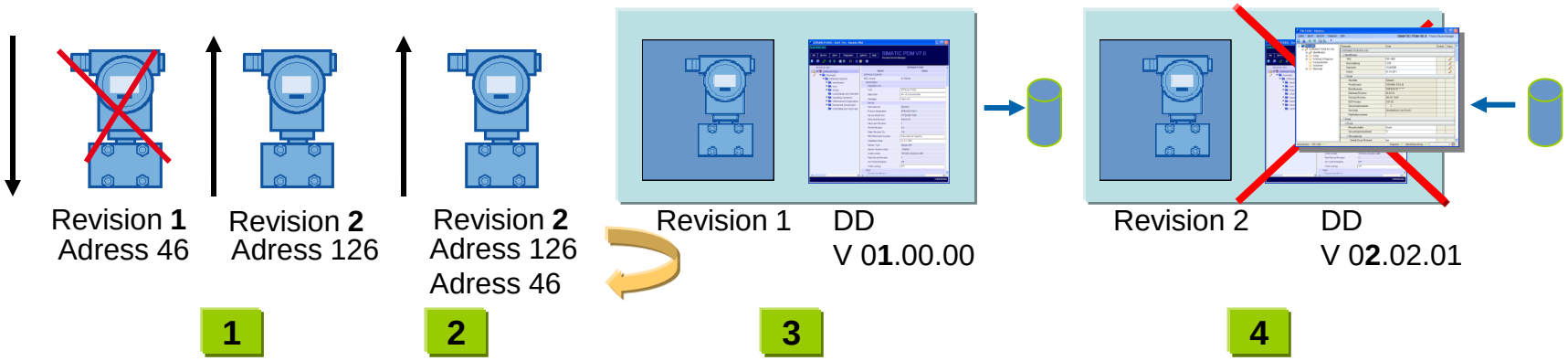
Step 3: Change address of new device to 46

Step 4: Upload parameter data

PA Field Device Management – Use case 4

Device Exchange

Same device type but different versions



Step 1: Remove old/defect device (tagged with address 46)

Step 2: Install new device (Rev. 2, with address 126) and change address to 46

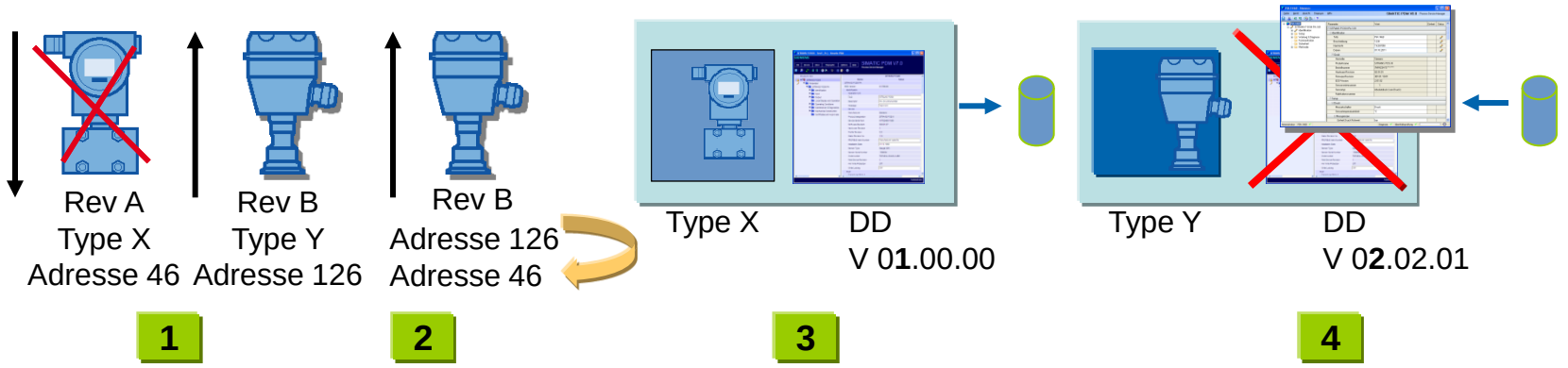
Step 3: Exchange DD and export parameter data

Step 4: Import parameter data

Step 5: Complete parameterization and upload parameters into the device (not shown)

Device Exchange

Device of different type or from different supplier - Use of profile GSD



Step 1: Remove old or defect device (Rev A, Type X, tagged with address 46)

Step 2: Install new device (Rev B, Type Y, with address 126) and change to 46

Step 3: Export parameter data

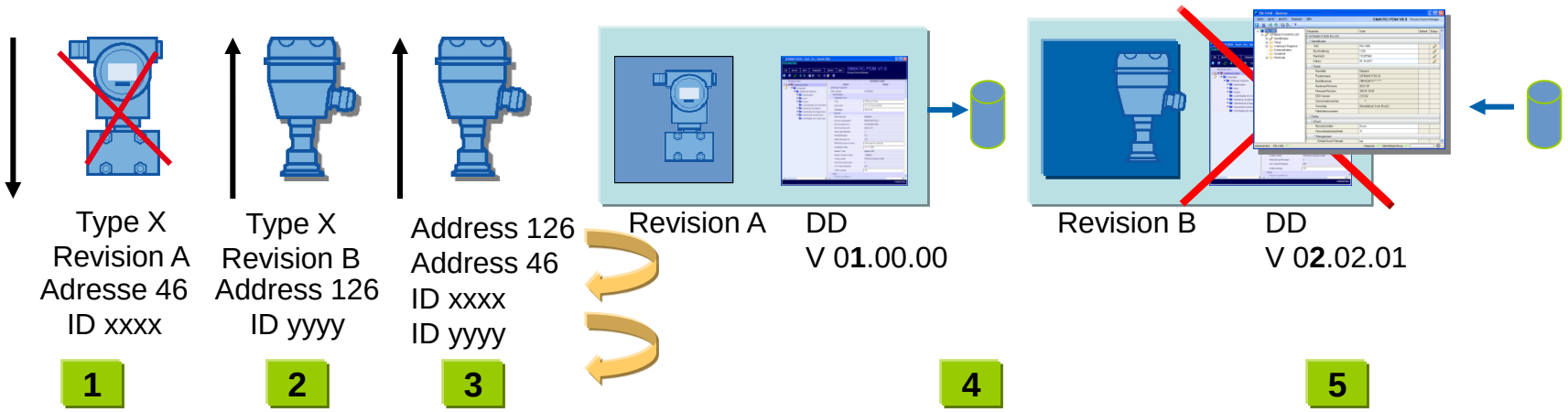
Step 4: Exchange DD and import parameter data

Step 5: Complete parameterization and upload parameters into the device (not shown)

PA Field Device Management – Use case 6

Device Exchange

Device of same type and same supplier/dufferent GSD –
Use of PA Profile 3.02



Step 1: Remove old/defect device (Type X, Rev A, address 46, ID XXXX)

Step 2: Install new device (Type X, Rev B, address 126, ID YYYY)

Step 3: Change adress to 46; ID is automatically changed to YYYY

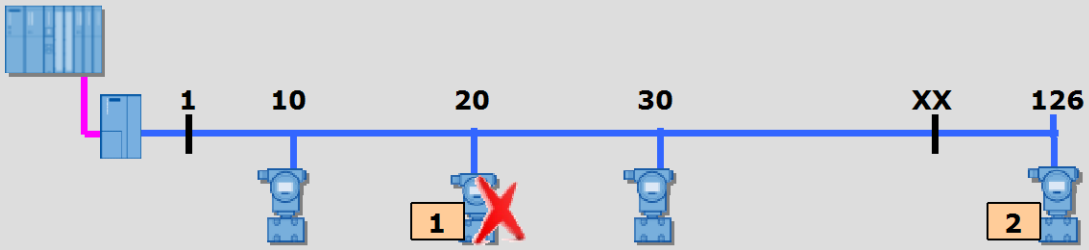
Step 4: Export parameter data

Step 5: Exchange DD and import parameter data

Step 6: Complete parameterization and upload parameters into the device (not shown)

Use of PA field devices in practice

Easy field device exchange

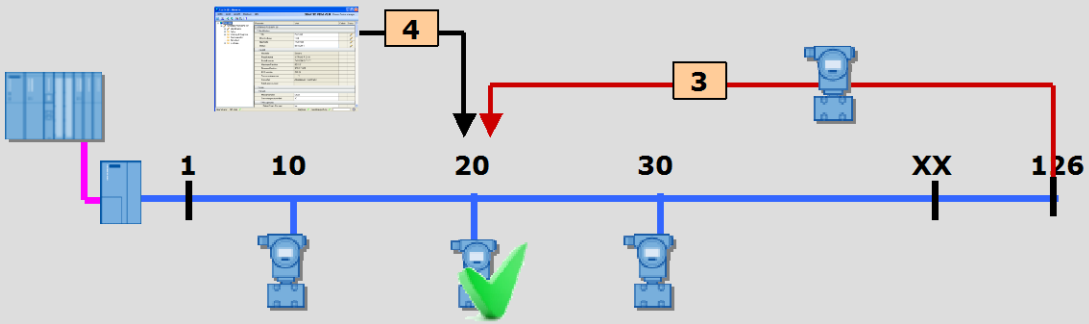


1 Device at location (adress) 20 must be replaced

2 New device (from storage) is implemented on adress 126

3 New device is shifted to adress 20

4 Parameter set of former device is loaded into the new device
New device is operational



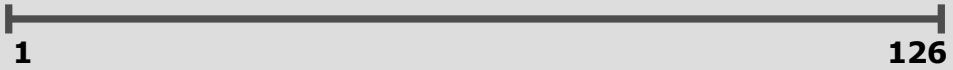
Service range in the adress space

- A „service range“ can be used for device-storing: keeping them live on the network but without imple-menting them in the PLC/DCS, for example to paramterize them via the bus.

- Also, this devices can be kept as a backup for critical positions. As soon as an operational device fails, the backup device can be set to the corresponding adress via the bus and build in at the correct position.

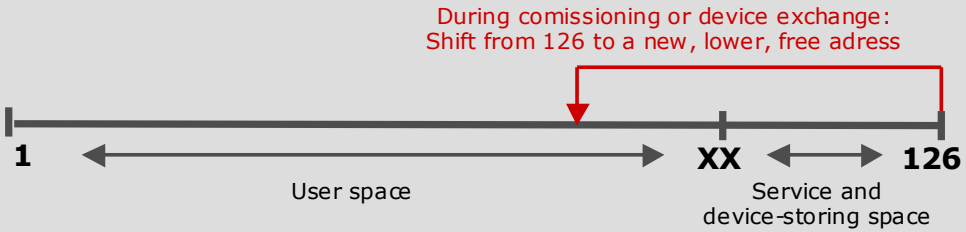
Default according to specification

Segment extent	32 devices
Adress space	1 – 126
Typical adresses	1 for service-Tools, 126 for device exchange



Re-setting for practical use (Installation of a service range)

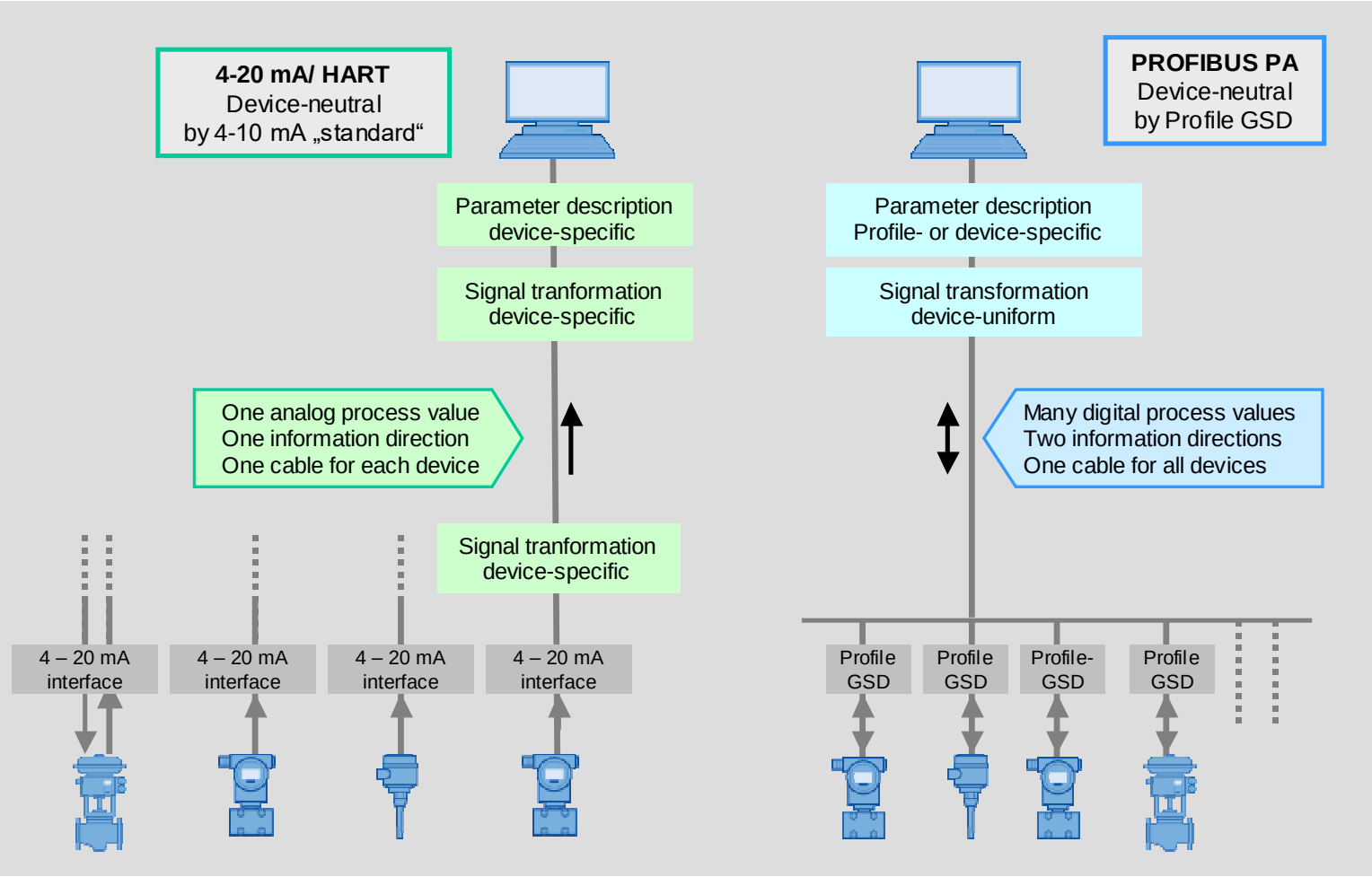
Segment extent	32 devices
Adress space	1 – 126
User space	1 – XX (XX freely selectable)
Space for service and device-storing	XX – 126 (Adresses for several devices)



Use of PA field devices in practice

- Device-neutral Configuration
  - During plant installation and commissioning, the final field device assembly is often not yet known in detail A “device-neutral” configuration is helpful in this case.
  - Conventional field devices are principally „device neutral“; because all feature the 4-20 mA “interface” and transmit one process value in one direction on one separate cable each.
  - Modern PROFIBUS PA field devices allow “device-neutral interfacing” by using the *Profile GSD.*
  - The *Profile GSD* acts as an identic interface for all PA devices with regard to transmission of defined vendor-neutral process values.

Device-neutral communication configuration



Use of PA field devices in practice

- GSD means **G**eneral **S**tation **D**escription

- A GSD is a text file defining all protocol information and cyclic data of a field device. It is used by the network configuration software
  - to identify the slave and
  - To set up the data exchange between the master and the slave during cyclic data exchange.

- A Profile-GSD comprises all field device information which correspond to the content of a PROFIBUS profile, e.g. the “PA profile”.

- Therefore, all PROFIBUS PA devices dispose of an uniform Profile-GSD which is, in some aspects, comparable to the 4-20mA concept of conventional devices.

How to use PROFIBUS PA Diagnostics?

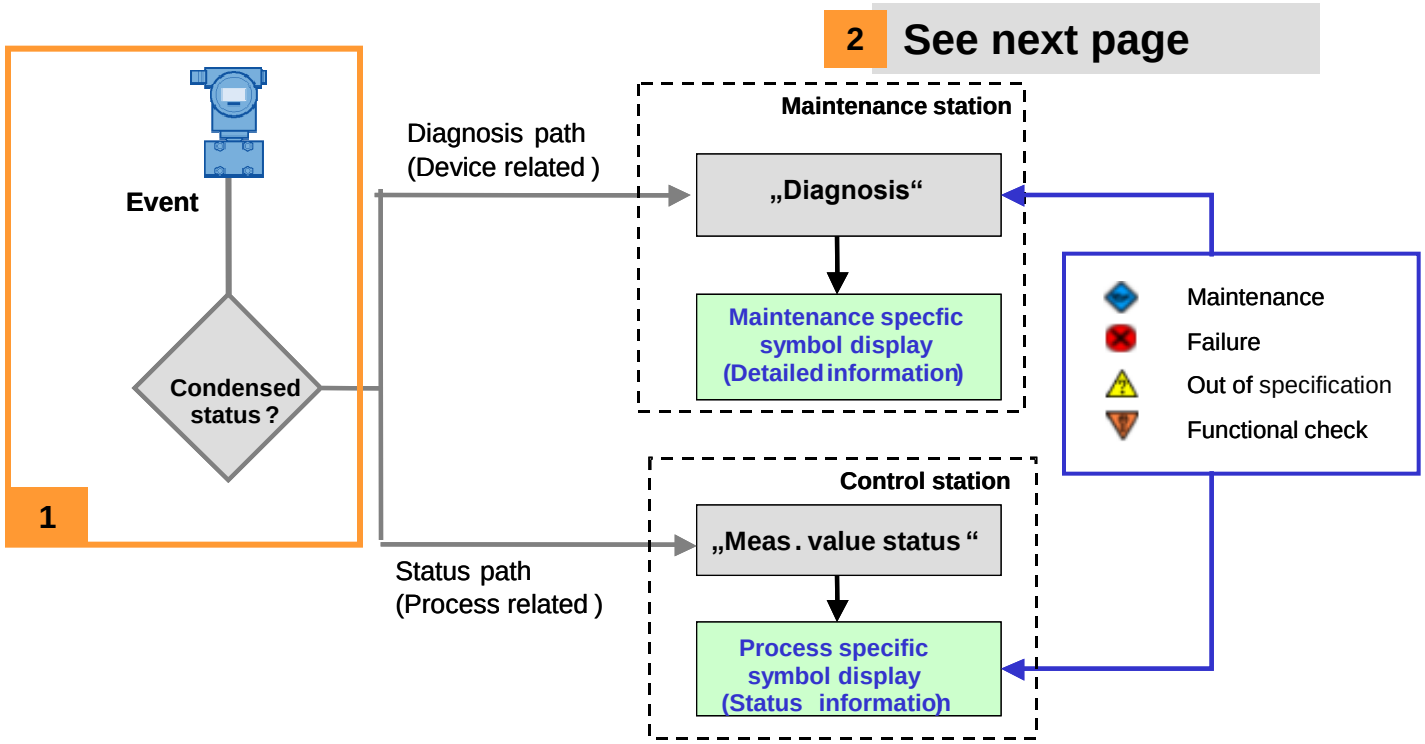
PROFIBUS PA provides an intelligent Diagnosis Concept

PROFIBUS PA Diagnosis Concept

- **Different tasks for plant operators and maintenance personnel**
  - **Process plant operators** have to control mainly availability and validity of process values, to ensure the process is running well.
  - **Maintenance and service personnel** have to control the correct functioning of the devices and, if necessary, to locate and replace defect equipment.
  - PROFIBUS PA (profile 3.02) diagnosis technology offers an efficient solution to select the right information for any of these groups and thus to avoid an overflow with information and alarms.
  - The solution is based on the NAMUR NE 107 recommendation regarding the use of 6 different classes of alarms.

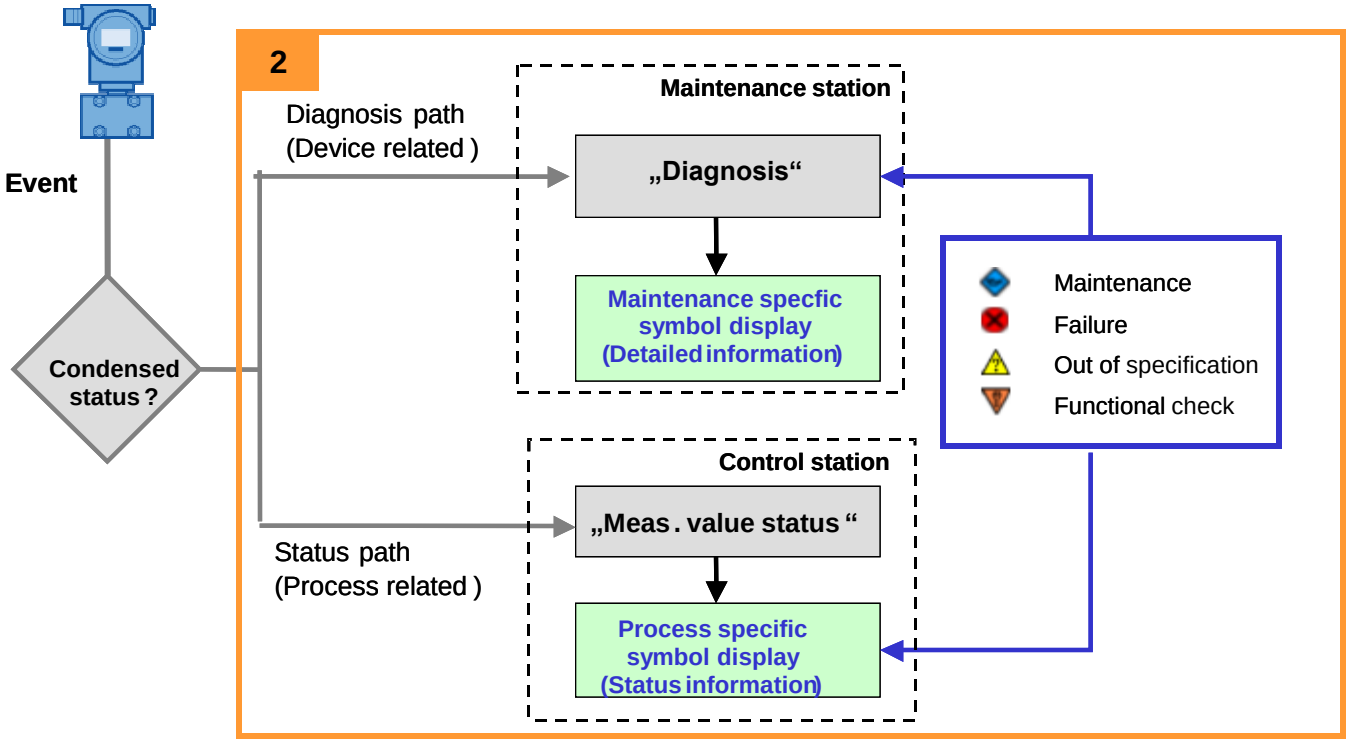
PROFIBUS PA Diagnosis Concept

- PROFIBUS PA devices 1 transfer cyclically, along with the process value, a “value status” (condensed status) which carries easy-to-interpret information. The value status is categorized in one the 6 classes as specified in the NAMUR recommendation NE 107.



PROFIBUS PA Diagnosis Concept

- The condensed status signal **2** is transmitted to the maintenance station (via “Diagnosis path”) and to the operator station (via “Status path”) where the signal is interpreted. Visualization is done by displaying symbols from NE 107: Typically just one symbol (ok or not ok) at the operator station, but more symbols at the maintenance station providing more details.



PROFIBUS PA Diagnosis Concept

- More information: see “Diagnosis & Asset Management”.

PROFIBUS Benefits

PROFIBUS generates multiple benefits

Multiple benefits from PROFIBUS (1)

- PROFIBUS is based on modularity and standards
  - **The benefit: Flexibility and Ease of use**
- The single communication protocol enables continuous, discrete, and safety-related processes to run on the same bus
  - **The benefit: No need for separate bus systems**
- Device profiles ensure compatible device behaviour at the bus
  - **The benefit: User can select the best suited device**

Multiple benefits from PROFIBUS (2)

- Diagnostic data display sorted according to NAMUR NE 107
  - **The benefit: Operator can reliably detect the device status**
- The integrated redundancy ensures uninterrupted operation
  - **The benefit: High plant availability and efficiency**

Multiple benefits from PROFIBUS (3)

- **Benefits for management and engineering staff**

  - **Plant Manager**
    - Lower overall plant costs
    - Faster and more flexible production
    - Better and constant product quality
    - Safer plant operation
    - Increased ROI
    - More flexible production

  - **Engineering staff**
    - Less wiring and less hardware needs
    - Faster engineering
    - Huge vendor choice
    - Easier commissioning
    - Simpler documentation
    - Modular and flexible solutions

Multiple benefits from PROFIBUS (4)

Benefits for operators and plant

Operators staff

- Transparency down to the sensor
- Improved maintenance conditions
- Improved Asset Management
- More flexible production
- Shorter downtimes

Plant

- Advanced technology
- Easy migration
- Easier revamps
- Less expensive upgrades
- Longer useful life

PROFIBUS & PROFINET International (PI)

Organisation
Technologies
Support
Website

Two Technologies – One Organisation

PI (PROFIBUS & PROFINET International)

- Regional PI Associations
- PI Competence Centers
- PI Test Laboratories
- PI Training Centers

Development and support of two technologies

Fieldbus-based Automation Technology

Ethernet-based Automation Technology

PI - Worldwide Presence and Support

Over 1,400 member companies worldwide

26
Regional PI Associations
Your local contacts!

55
Competence Centers
Your support for technical questions!

31
Trainig Centers
Learn from the best!

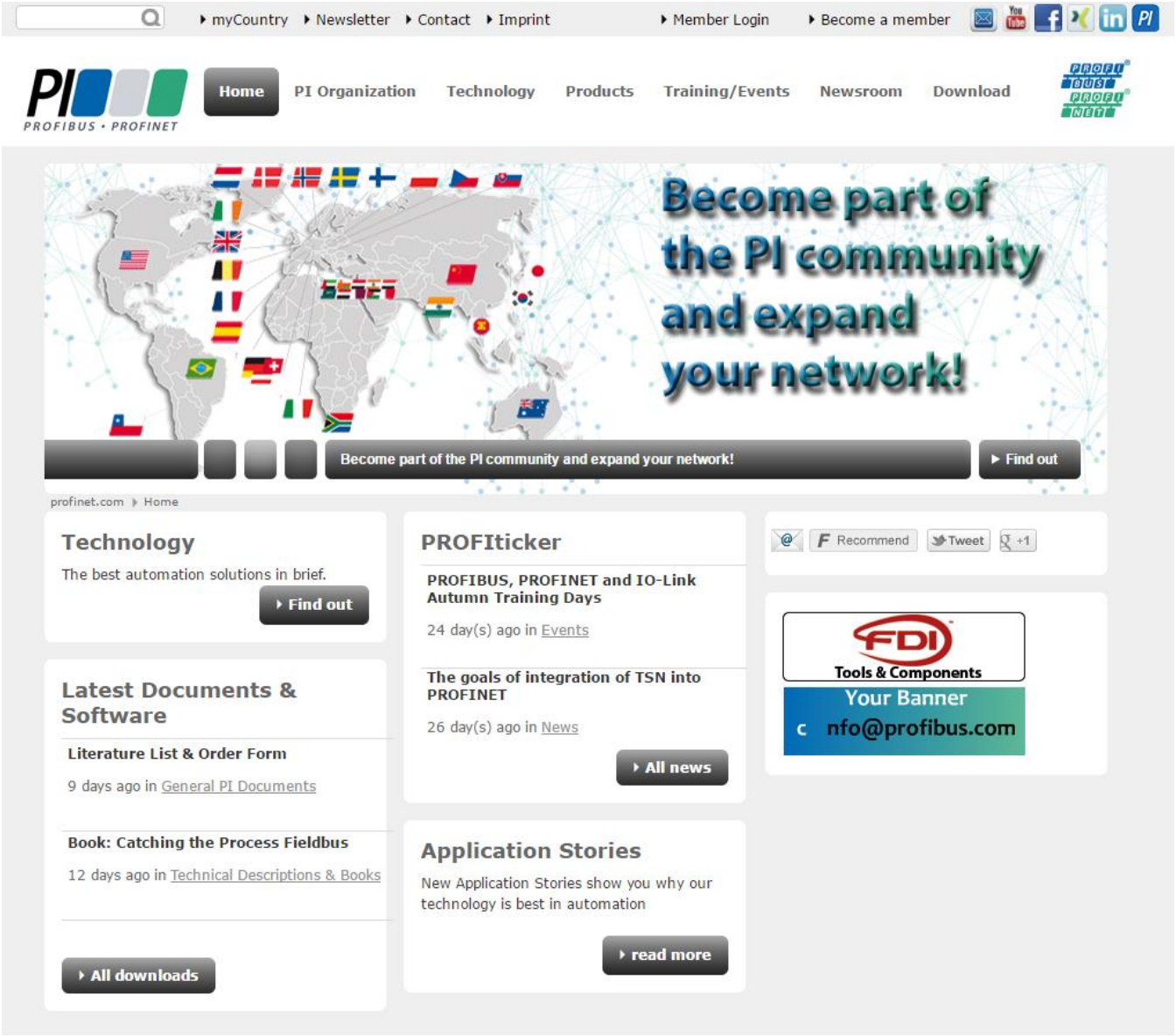
10
Test Laboratories
Your partners for certification!

PI - Benefits of Membership

- With its background of more than 25years and over 1,400 member companies PROFIBUS & PROFINET International (PI) is the most influential interest group in industrial communication.
- The unique intenational network and experience of PI provide the member companies with a significant competitive edge.
- PI members benefit from the professional marketing of PROFIBUS and PROFINET at national and international levels.
- PI members have access to all technical documentation and can participate in further developments of technologies.
- The regional representatives provide worldwide support for realizing developments, training users and certifying products.

PI - Reasons for worldwide success

PI - Website: http://www.profibus.com/



PROFIBUS Standardization

PROFIBUS is standardized worldwide

Standardization

- **PROFIBUS is an open fieldbus, based on IEC standards**

  - **IEC 61158**
    „Digital data communication for measurement and control – Fieldbus for use in industrial control systems“

    IEC 61158 deals with the technologies. The individual fieldbuses are differentiated by the definition of “fieldbus protocol types”.

  - **IEC 61784**
    „Profile sets for continuous and discrete manufacturing relative to fieldbus use in industrial control systems“

    IEC 61784 specifies in „Communication Profile Families“ which subsets of services and protocols of IEC 61158 (and other standards) are used by a given fieldbus system.

PROFIBUS and PROFINET in IEC 61158 and IEC 61784

Communication Profiles (CPF) in **IEC 61784**		"**IEC 61158** protocol types" corresponding to CPFs		
CPF	Technology	Type Number	CP number	Technology
1	FF			
2	CIP			
3	PROFIBUS	3	CP 3/1	PB DP
		3	CP 3/2	PB PA
		10	CP 3/4	PN IO CC A
		10	CP 3/5	PN IO CC B
		10	CP 3/6	PN IO CC C
9	HART	20	CP 9/1	HART
18		22		

For PROFIBUS and PROFINET the communication subsets are summarized in CPF 3.

PROFIBUS is type 3 and PROFINET type 10 of IEC 61158 protocol types.
Actually, more than 20 protocol types exist.

PROFIBUS Implementation and Certification

Interfaces

Protocol

Application Profiles

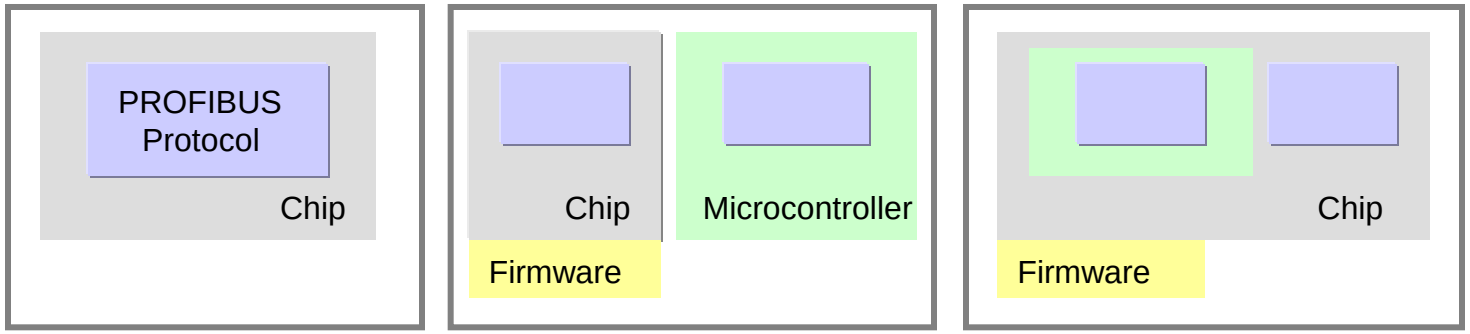
Implementation: Transmission interfaces

- **Without power supply from the bus cable**
  - Standard copper-based RS485 (RS485-IS) interface
  - Data rates from 9.6 KBit/s to 12 MBit/s
  - Modules are available from various manufactures
- **With power supply from the bus cable**
  - MBP (Manchester Coded Bus Powered) technology supplies current of 10-15 mA on the bus cable.
  - Special chips draw the required operating energy from the MBP bus connection as supply voltage to the electronic components of the device.
  - Chips also convert the digital signals of the protocol chip to the bus signal that is modulated to the energy supply.

Implementation: Communication protocol

- **For small quantities of devices: Interface modules**
  - PROFIBUS interface modules which implement the full bus protocol are available on the market.

- **For larger quantities of devices: Protocol chips**
  - Single chip solution with all functions integrated on the chip without a separate microcontroller (below, left)
  - Chips combined with a microcontroller and firmware to provide the full implementation of the PROFIBUS protocol (mid)
  - Protocol chips which already include a micro-controller inside the communication module (right)



Implementation: Application profiles

- Interpretation of data in a field device is generally handled by the user.
- User profiles (application profiles) represent the links between the PROFIBUS protocol and the actual application in a field device.
- Data formats, data access methods, parameterization and cyclical and acyclic communication diagnostics defined in the profile descriptions are implemented in software.
- Implementation is handled by the device manufacturers or by technology suppliers.

PROFIBUS Certification

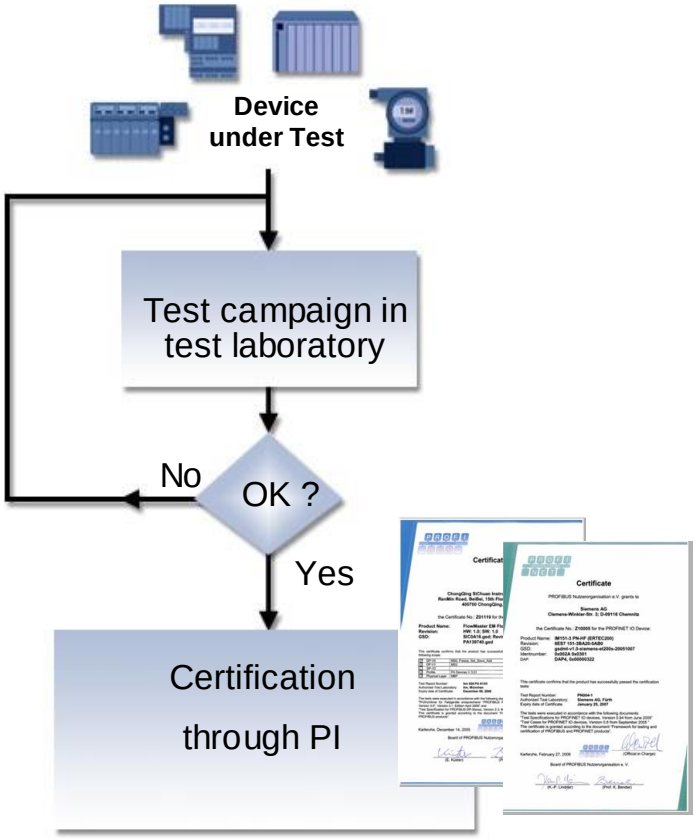
Device “Testing and Certification” procedure

Certification rules

- Uniform test measures and test process
- Comprehensible and documented results

Advantages

- Accreditation according to overall guidelines of PI ensures quality standard.
- Certification ensures interoperability and plant availability.



PROFIBUS

Literature

Literature

- PROFIBUS System Description (PI)
- PROFINET System Description (PI)
- PI White Paper: PROFINET – The Solution Platform for Process Automation (PI)
- Introductory book: J Powell, H Vandelinde,
  “On the road with the process fieldbus –
  An introduction to PROFIBUS for process automation” (PI)
- Specialist book M. Popp: “The New Rapid Way to PROFIBUS“ (PI)
- Specialist book: Ch.Diedrich / Th. Bangemann: “Profibus PA”
  Oldenbourg Industrieverlag (in German)

PROFIBUS

Success stories

Manufacturing and process industries

Success Stories

- Numerous „Case Studies“ are available on the PI Website, describing PROFIBUS applications in process and manufacturing industries:
  - Car manufacturing
  - Cross industry applications
  - Energy, Pulp & Paper
  - Food & Beverage
  - Metal, Mining, Glass, Cement
  - Oil & Gas
  - Packing & Filling
  - Paints, Chemical, Pharma
  - Traffic, Infrastructure
  - Water & Wastewater

http://www.profibus.com/index.php?id=5013&pxdprofibusfilter_technology[0]=2&pxdprofibusfilter_technology[1]=3