

Basics of PROFIBUS PROFIBUS in Practice

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Endress+Hauser

Two Technologies, One Organization



PROFIBUS

More than 40 million installed devices.
About 5.4 million in the process industry.



PROFIBUS Nutzer Organisation (PNO) is an
Regional PI Association (RPA) and a permanent
PI Support Center (PISC)
(Karlsruhe, Germany):
administers global activities



PROFINET

4.3 million installed devices, end of 2012

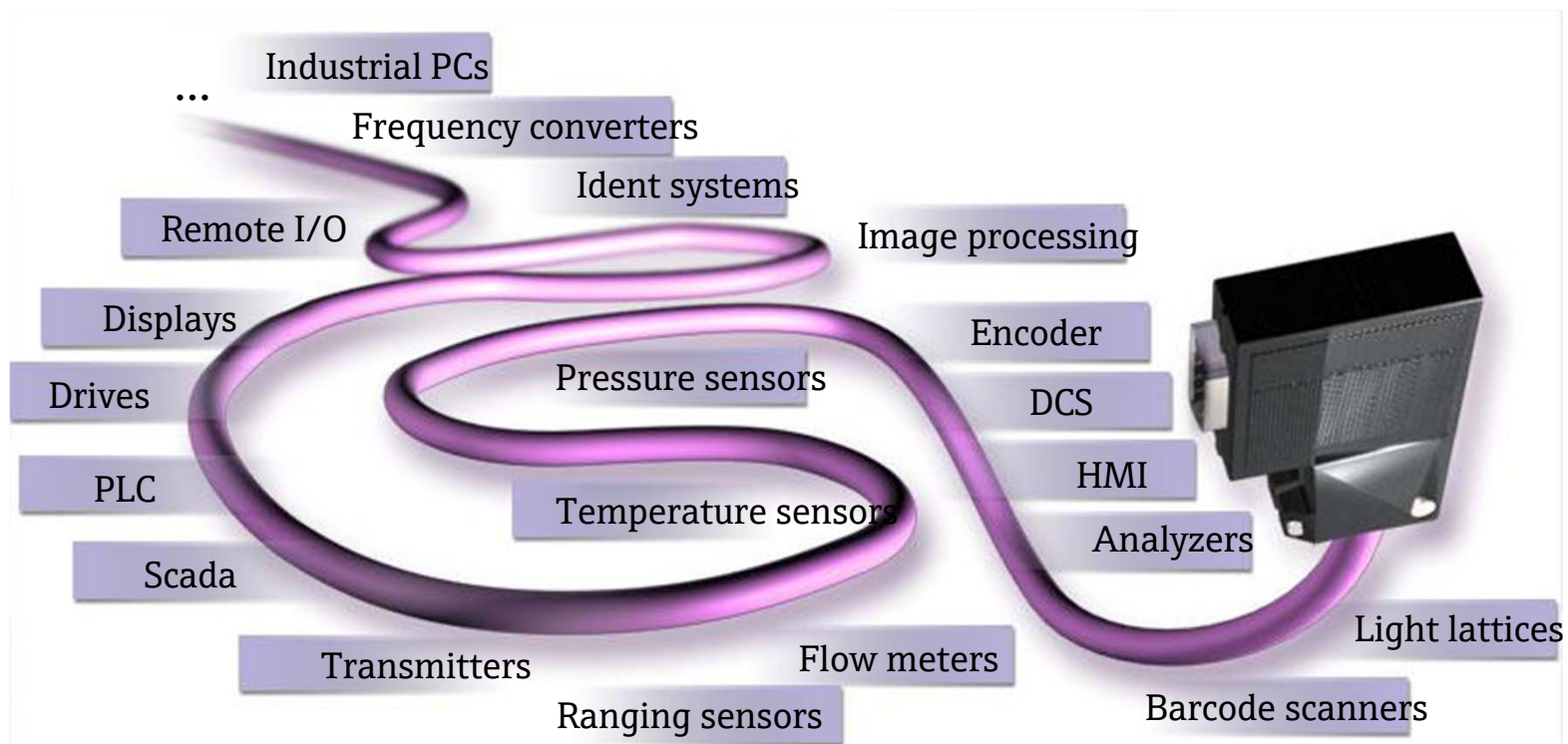
- 49 PI Competence Centers (PICC) in 22 countries
- 27 Regional PI Associations (RPA) worldwide
- 11 PI Test laboratories (PITL) worldwide for certification
- 26 PI Training Center (PITC) worldwide



Technical Milestones

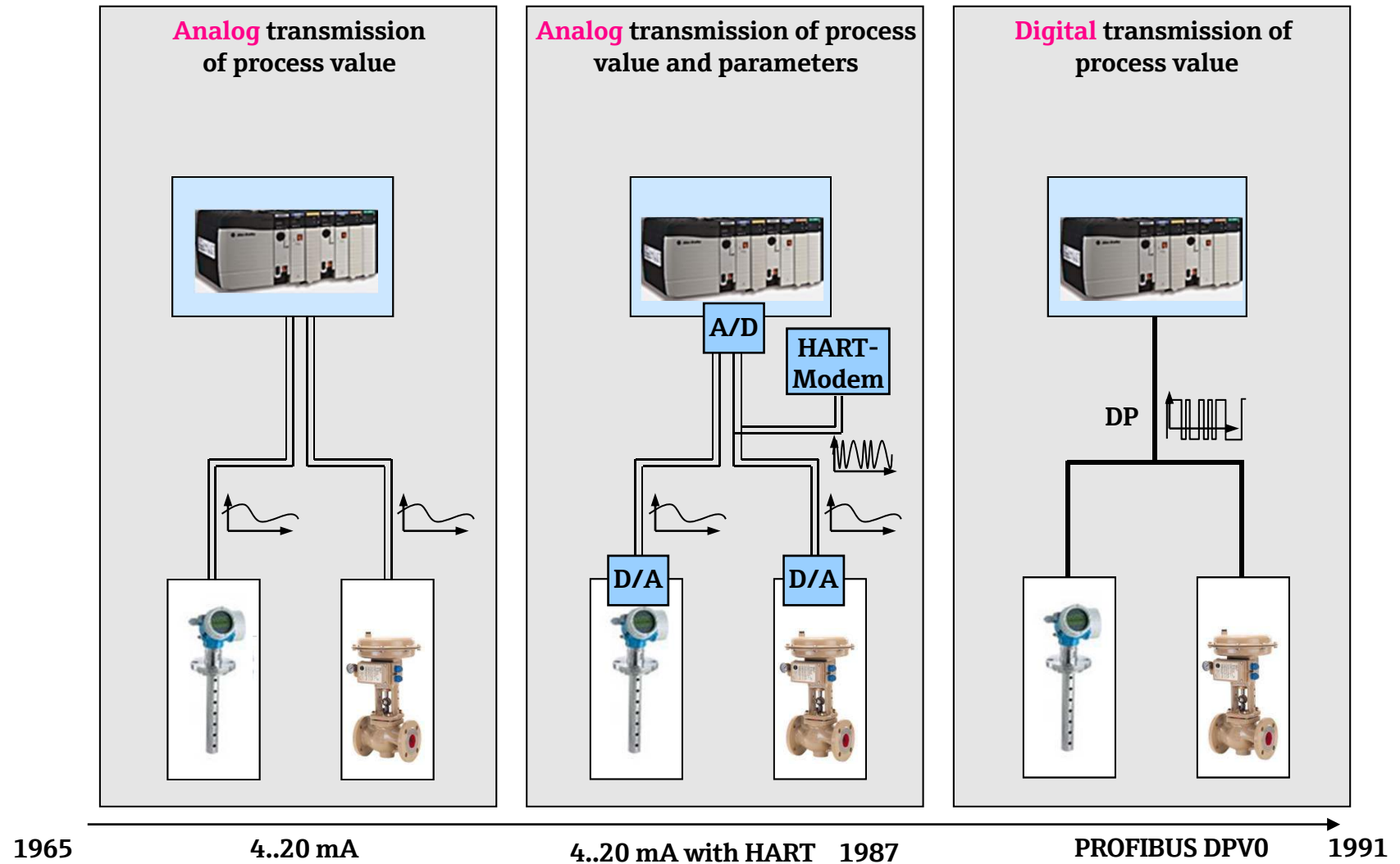
- **2010 First certified PA Profile 3.02 device**
- 2008 Specification PROFIBUS PA Profile 3.02
- 2007 First PROFIBUS Coupler with embedded physical layer diagnostics
- 2005 I+M Function implemented for PROFIBUS PA
- 2004 PROFINET IO based on Real-Time & synchronized real-time
- 2002 PROFIBUS DP-V2 and PROFINET part of IEC 61158/IEC 61784; 10 profiles available
- 2001 Presentation of the Ethernet-based PROFINET (CBA)
- 2000 100,000 PROFIBUS devices in process automation
- 1999 PROFIsafe – Profile for safety technology, PROFIdrive – Profile for variable-speed drives
- **1998 PROFIBUS PA – Profile for process automation**
- 1996 PROFIBUS becomes European Standard EN 50170
- 1995 1st application in process automation (PA)
- 1993 PROFIBUS DP becomes DIN 19245 (Part 3)
- **1991 PROFIBUS becomes DIN 19245 (Part 1 and 2)**

PROFIBUS Product Spectrum



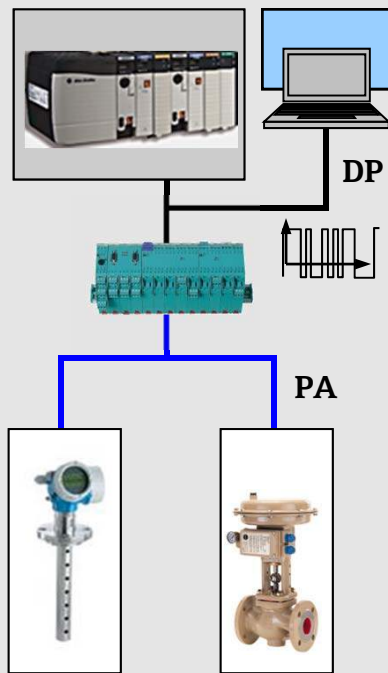
More than 5,000 products overall from more than 250 manufacturers

Development of Digital Communication



Development of Digital Communication

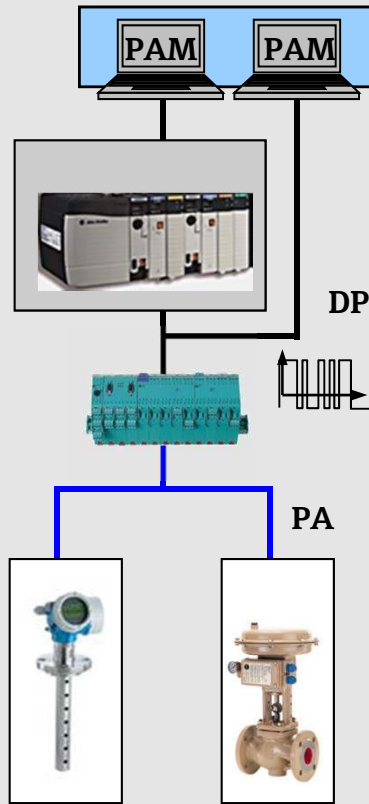
Digital transmission of process value and parameters



PROFIBUS DPV1 extension
PROFIBUS PA, Profile 2.0

1997

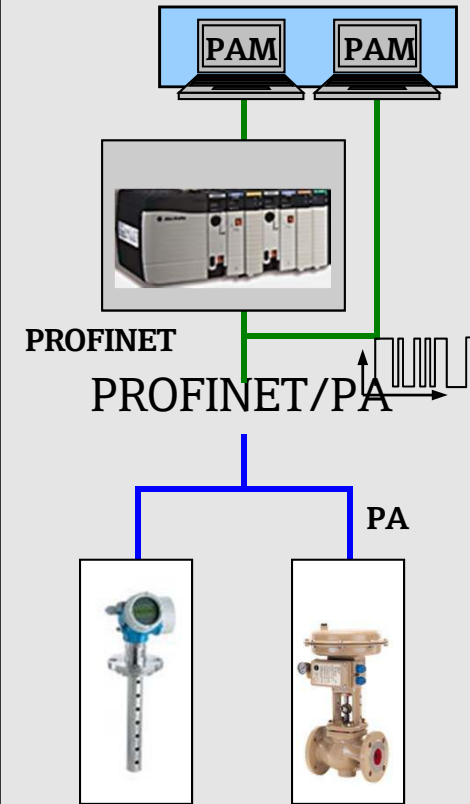
Integration of fieldbus devices into Plant Asset Management



International Standardization
Profile 3.0X

2000

Integration of Industrial Ethernet into automation environment



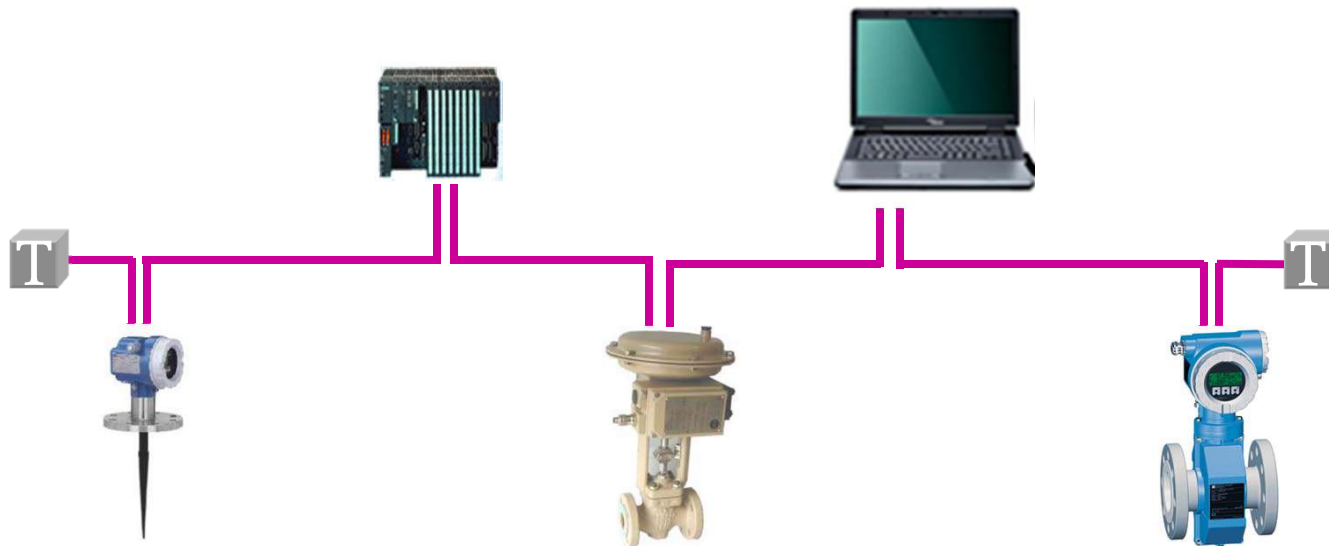
PROFINET / PROFINET IO

2004...

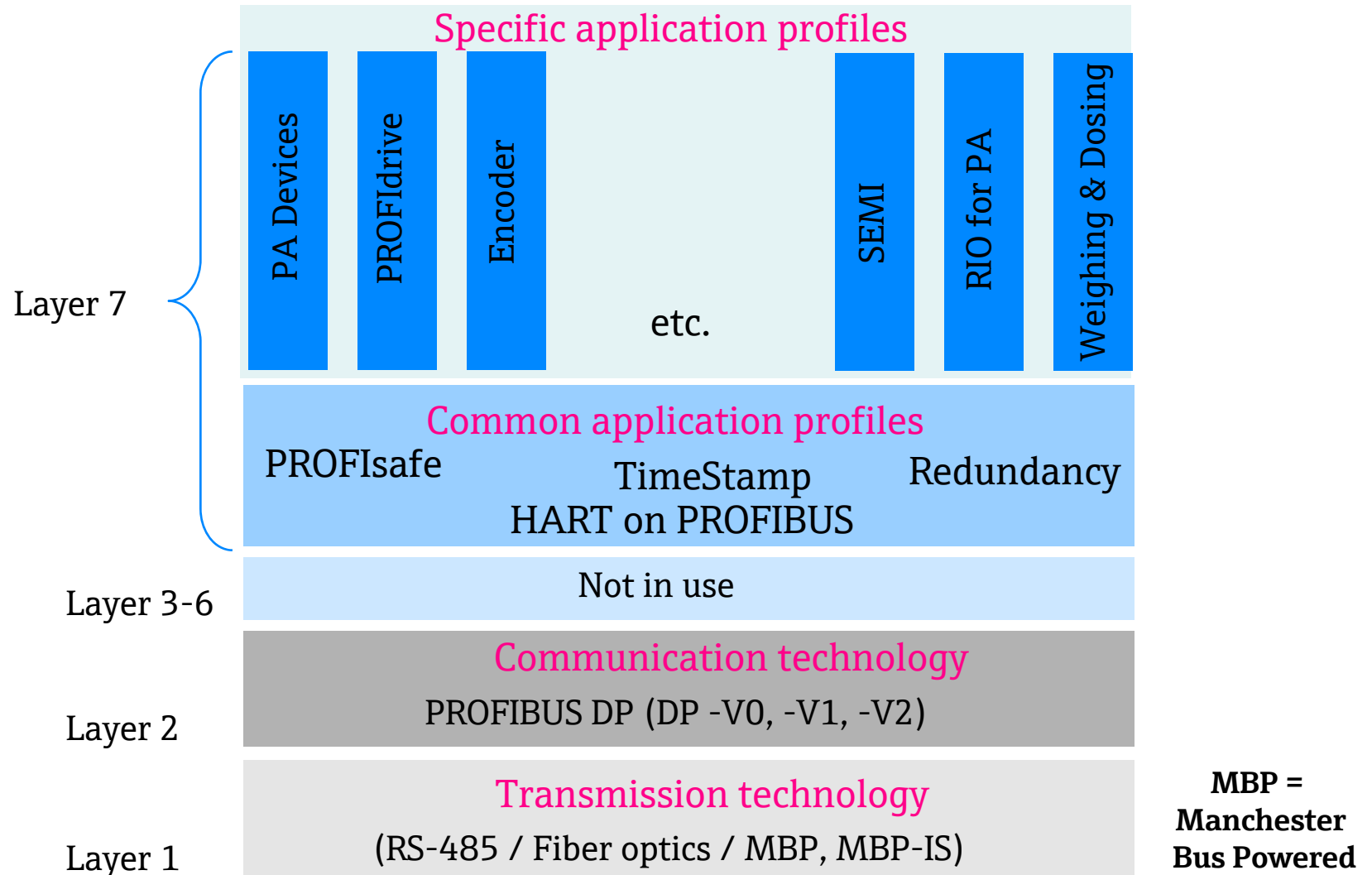
What is a fieldbus?

The fundamental task of a fieldbus is to exchange information:

- In digital form
- With less wiring (unlike point-to-point connections)
- with a group of participants (hence “bus”)
- In a reliable way
- In real time



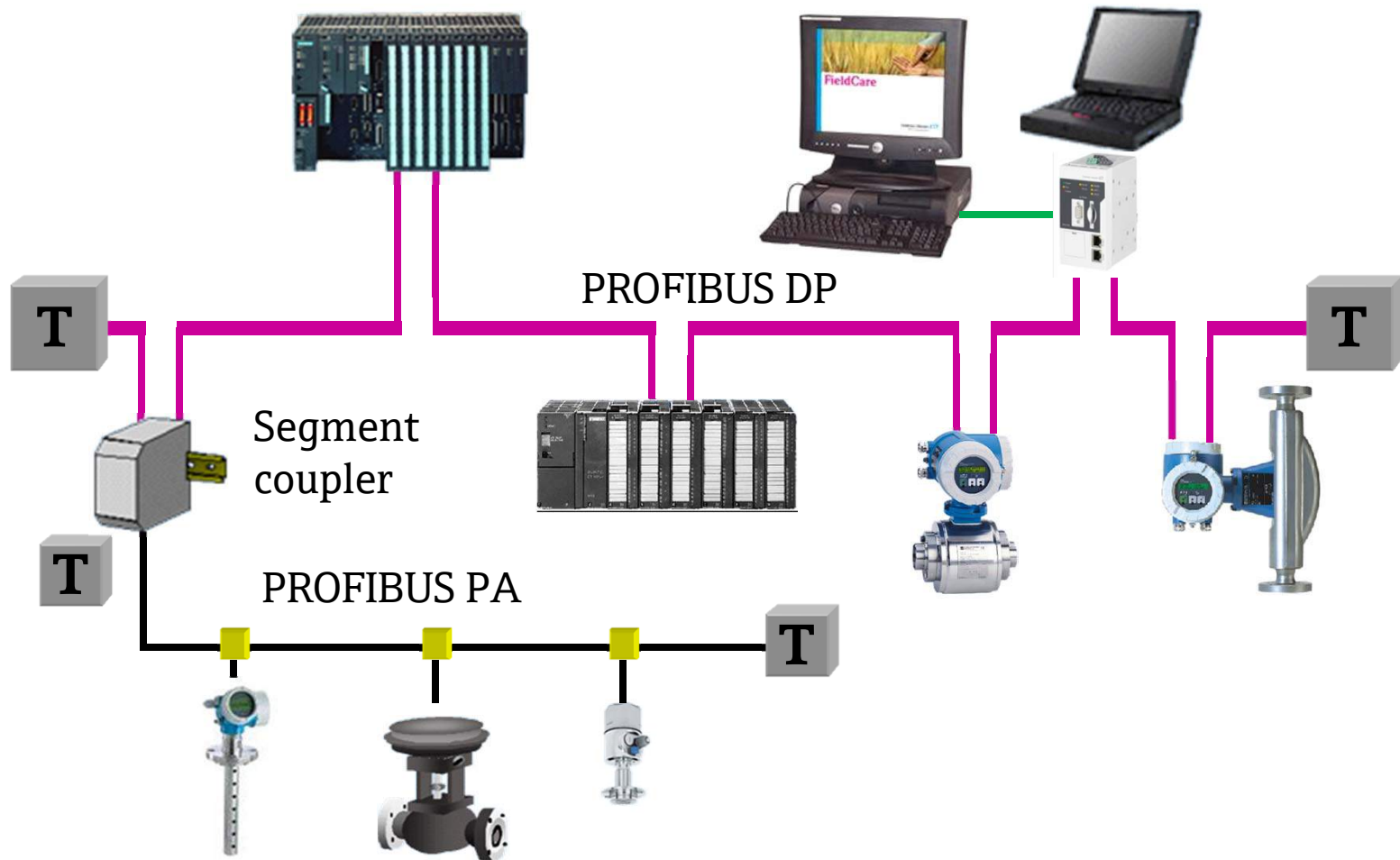
Communication layers (OSI model)



Architecture PROFIBUS DP/PA

Process Automation System

Plant Asset Management System



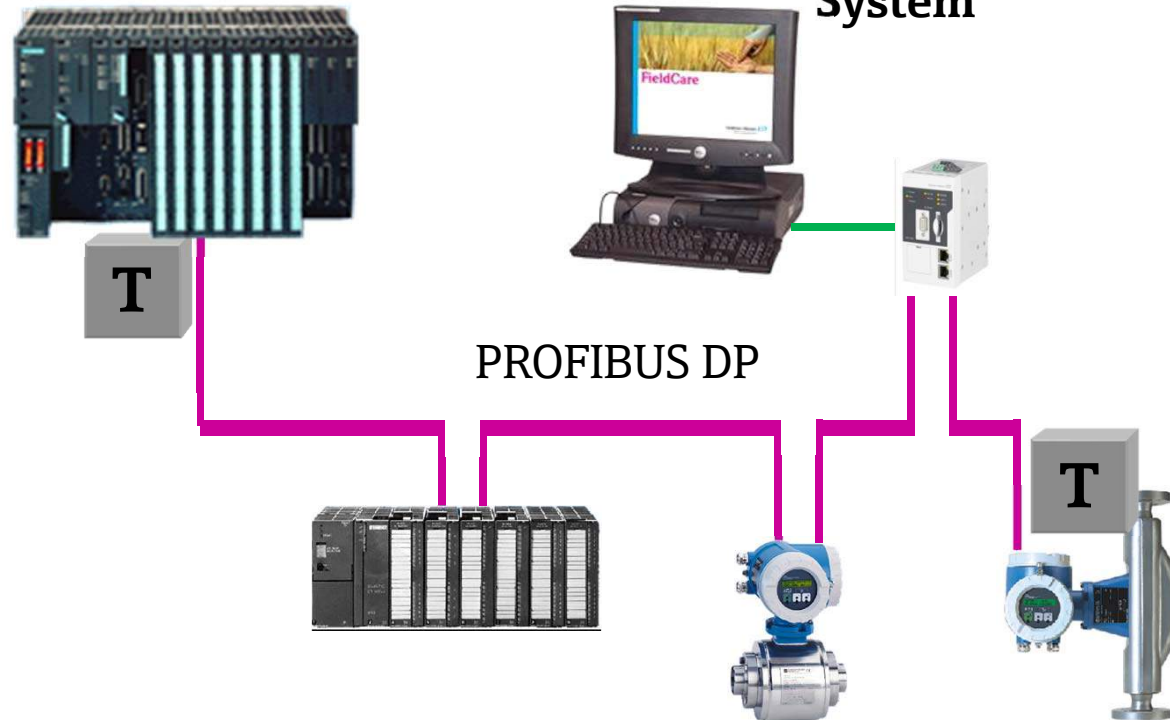
Application	PROFIBUS DP <u>D</u> ecentralized <u>P</u> eripheral	PROFIBUS PA <u>P</u> rocess <u>A</u> utomation
Protocol	Common DP protocol: • fast cyclic process data transmission • acyclic services to access device parameters • two defined master classes	
Physics	RS 485 9.6 ... 12000 kBit/s	MBP 31.25 kBit/s

MBP = Manchester encoding, Bus powered

PROFIBUS DP

Process Automation System

**Plant Asset Management
System**

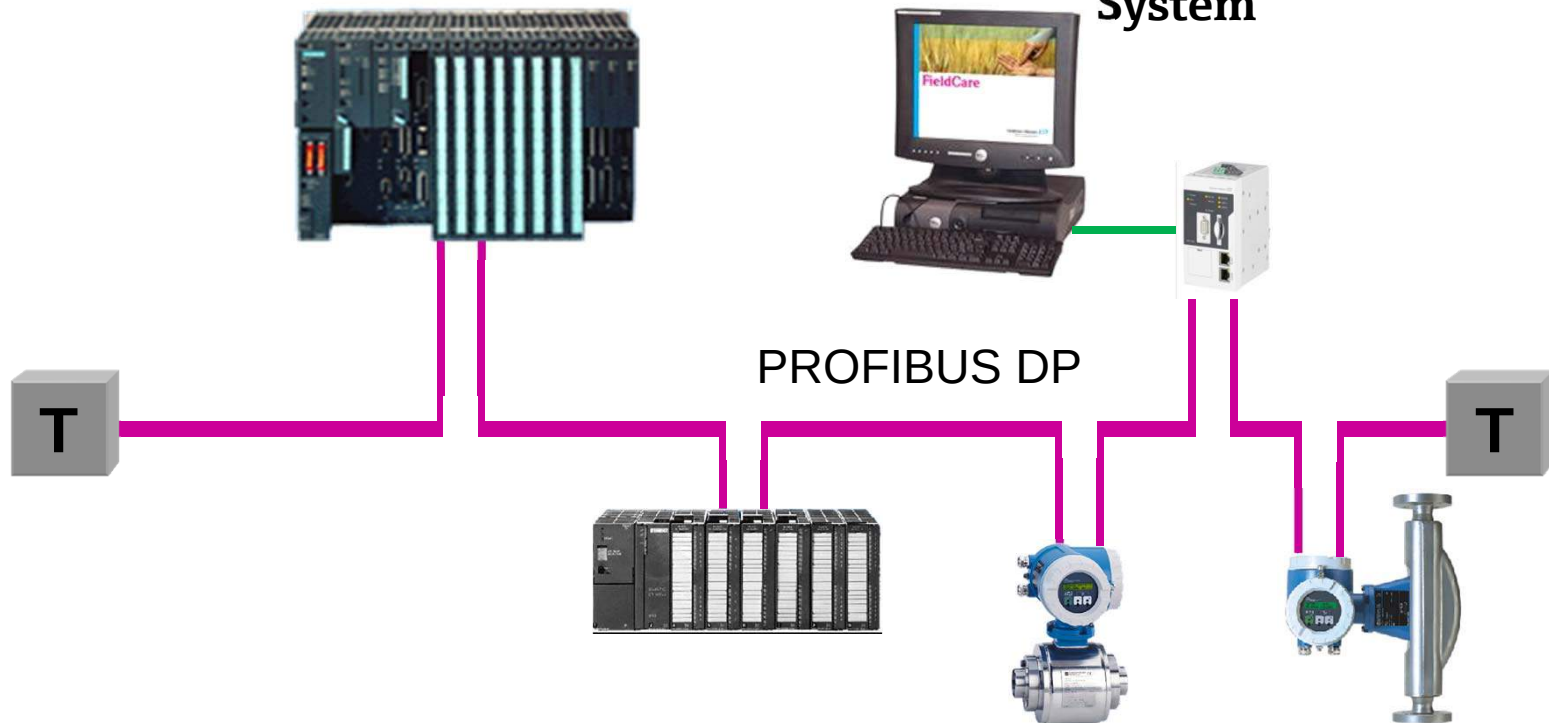


PROFIBUS DP based on line topology

PROFIBUS DP

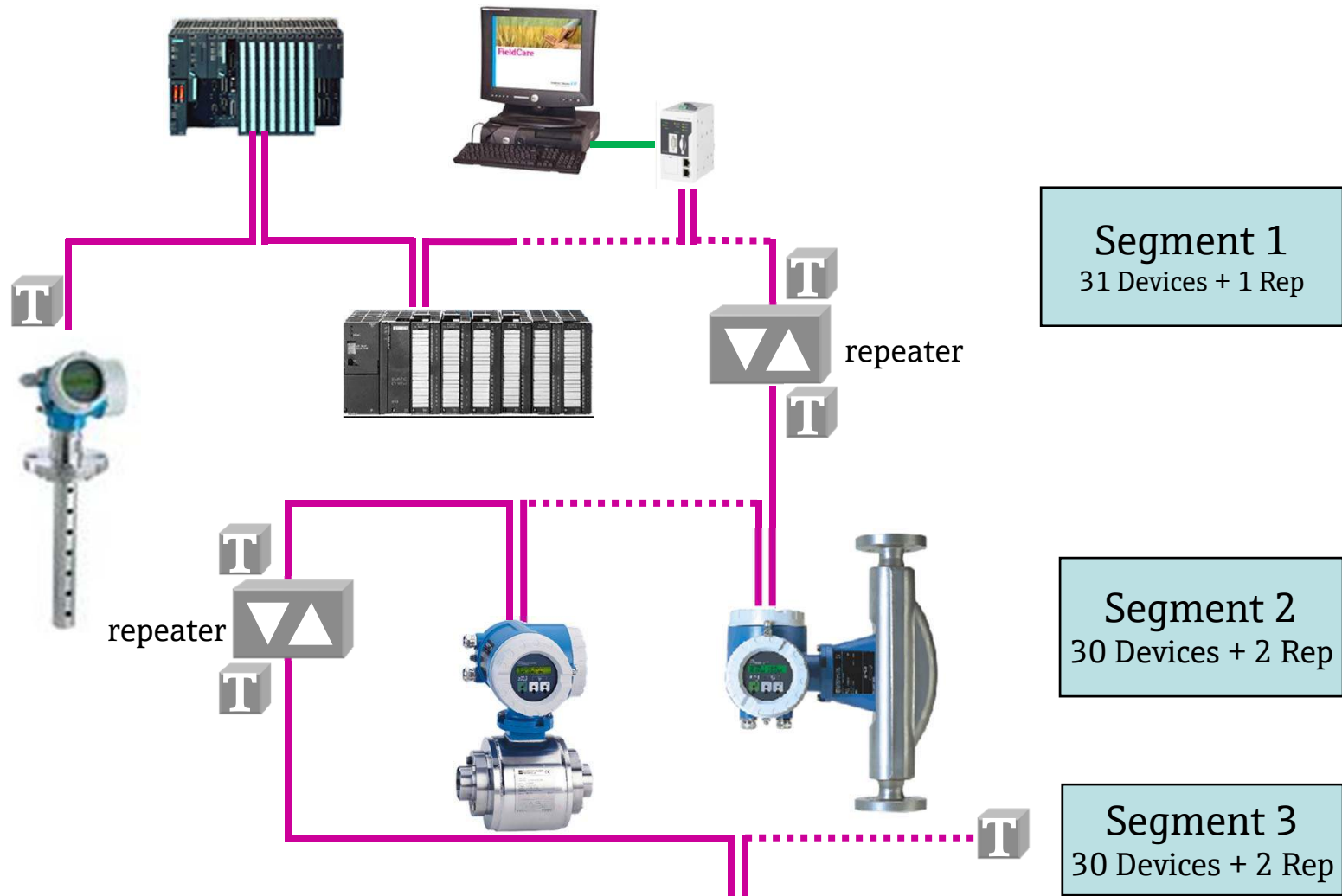
Process Automation System

Plant Asset Management System



PROFIBUS DP based on line topology

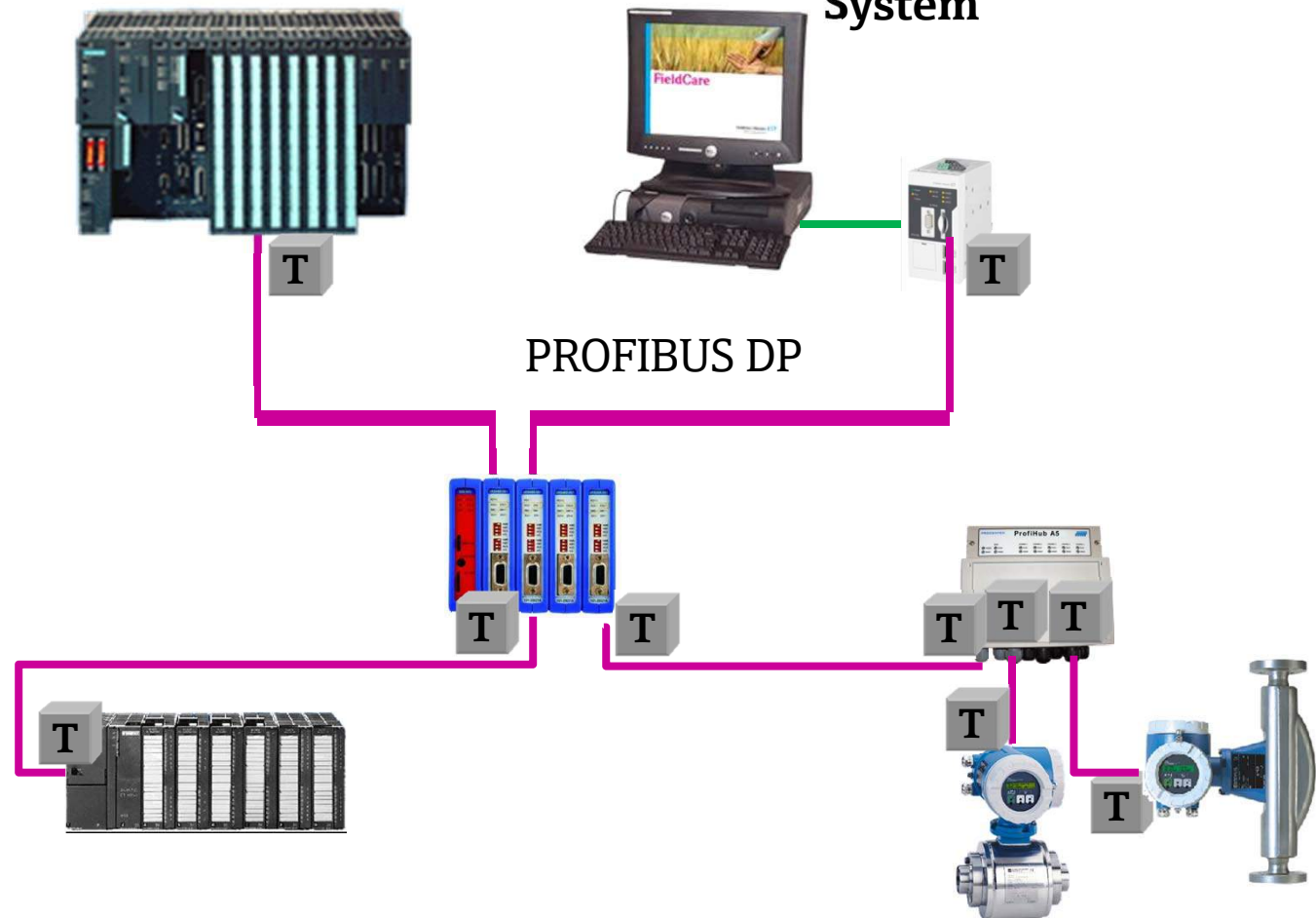
PROFIBUS DP / Extension



PROFIBUS DP

Process Automation System

Plant Asset Management
System



PROFIBUS DP based on star topology

Facts: physical transmission via RS-485

- 2-wire cable, shielded
- 5V differential voltage signal
- Max. 1200 m line length per segment (depending on transmission rate)
- Max. 5 segments connected via repeater (depending on product type)
- Max. 126 addresses possible
- Max. 32 nodes per segment
- Alternatively fiber optic cable
- No reverse-connect protection
- A separate power supply is necessary for each device!

PROFIBUS DP maximum line length

Transmission Rate (kBit/s)	Max Segment Length (m)
9.6	1200
19.2	1200
45.45	1200
93.75	1200
187.5	1000
500	400
1500	200
3000, 6000, 12000	100

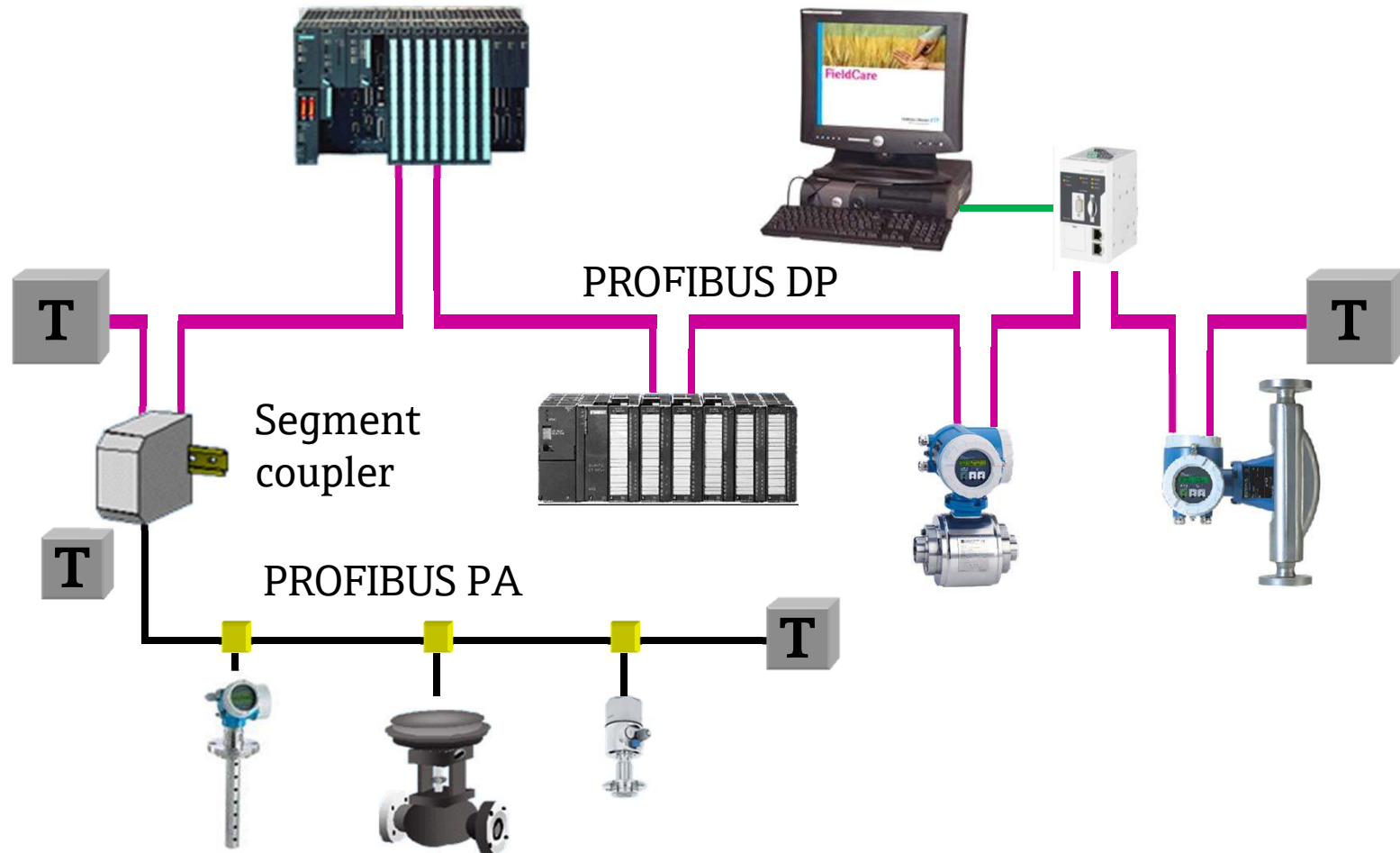
The values refer to Cable Type A
with the following properties:

Impedance	135...165 Ω
Capacity	< 30 pf/m
Loop resistance	110 Ω /km
Wire diameter	0.64 mm
Core cross-section	> 0.34 mm ²

PROFIBUS PA

Process Automation System

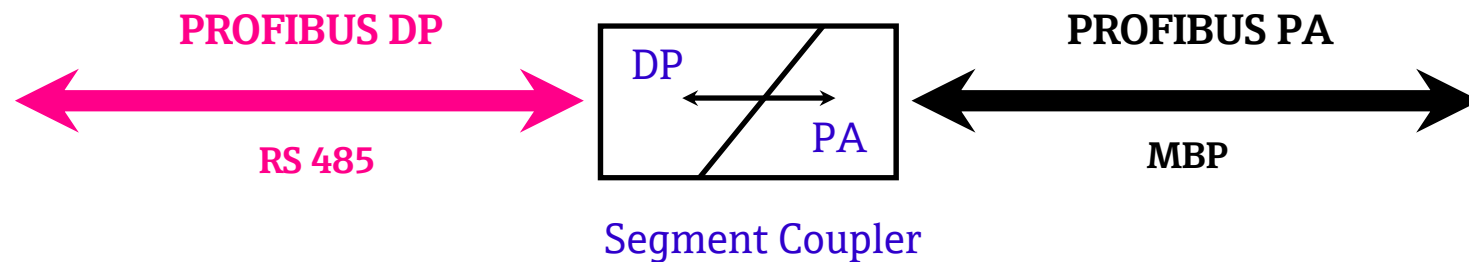
Plant Asset Management System



Facts: PROFIBUS PA

- Remote power supply and communication in 2-wire technology (optional intrinsically safe)
- Integrated reverse-connect protection possible (e.g. E+H)
- Fixed transmission rate of 31.25 kBit/s
- Up to 32 participants per segment (up to 10 for Ex-ia IIC applications)
- Line length up to 1900 m (Ex-ia IIC up to 1000 m)

Segment Couplers



- Asynchronous format
- NRZ coding
- 1 Byte > 11 Bit
(1 start + 8 Bit + 1 Stop + 1 Parity)
- Bitrate variable 9.6 Kbit/s to 12 Mbit/s

- Synchronous format
- Manchester Coding
- 1 Byte = 8 Bit
- Fixed bitrate = 31.25 Kbit/s

SIEMENS DP/PA Link

IM 153-2
(IM 157 old version)

1..5 DP/PA Coupler(s)



Pepperl+Fuchs SK3 PROFIBUS Power Hub

- Coupling of PROFIBUS DP with PA
- PROFIBUS DP:
 - 45.45 kbps ... 12 Mbps
 - Automatic transmission rate detection
- Cyclical data interchange over buffer
- Transparent
- PROFIBUS PA:
 - Independent cycle
 - One bus master per segment, very fast
 - No configuration required
 - Advanced Diagnostics (More information in the chapter diagnostics)

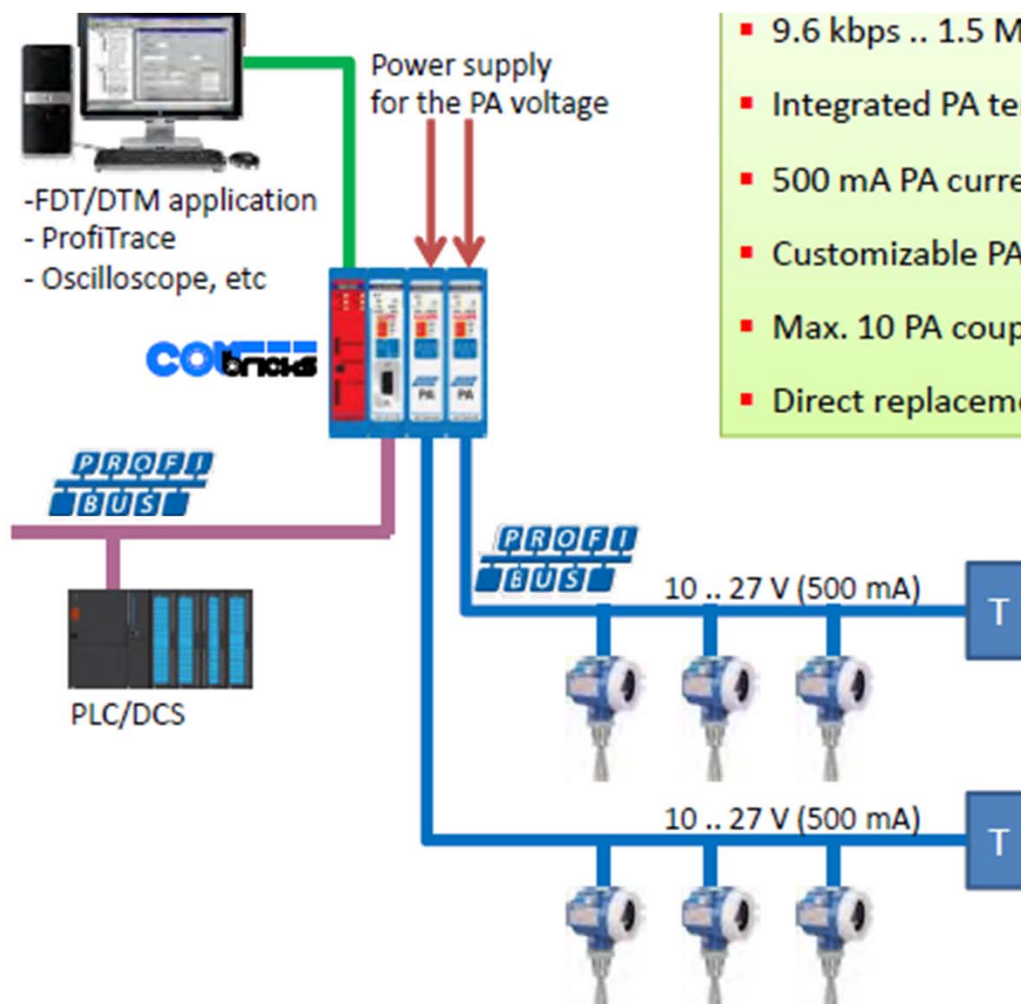


Pepperl+Fuchs Compact PROFIBUS Power Hub

- Gateway for PROFIBUS DP/PA
 - 45.45 kbps ... 12 Mbps
- Transparent – Needs no configuration
- Two independent fieldbus segments
- Motherboard design

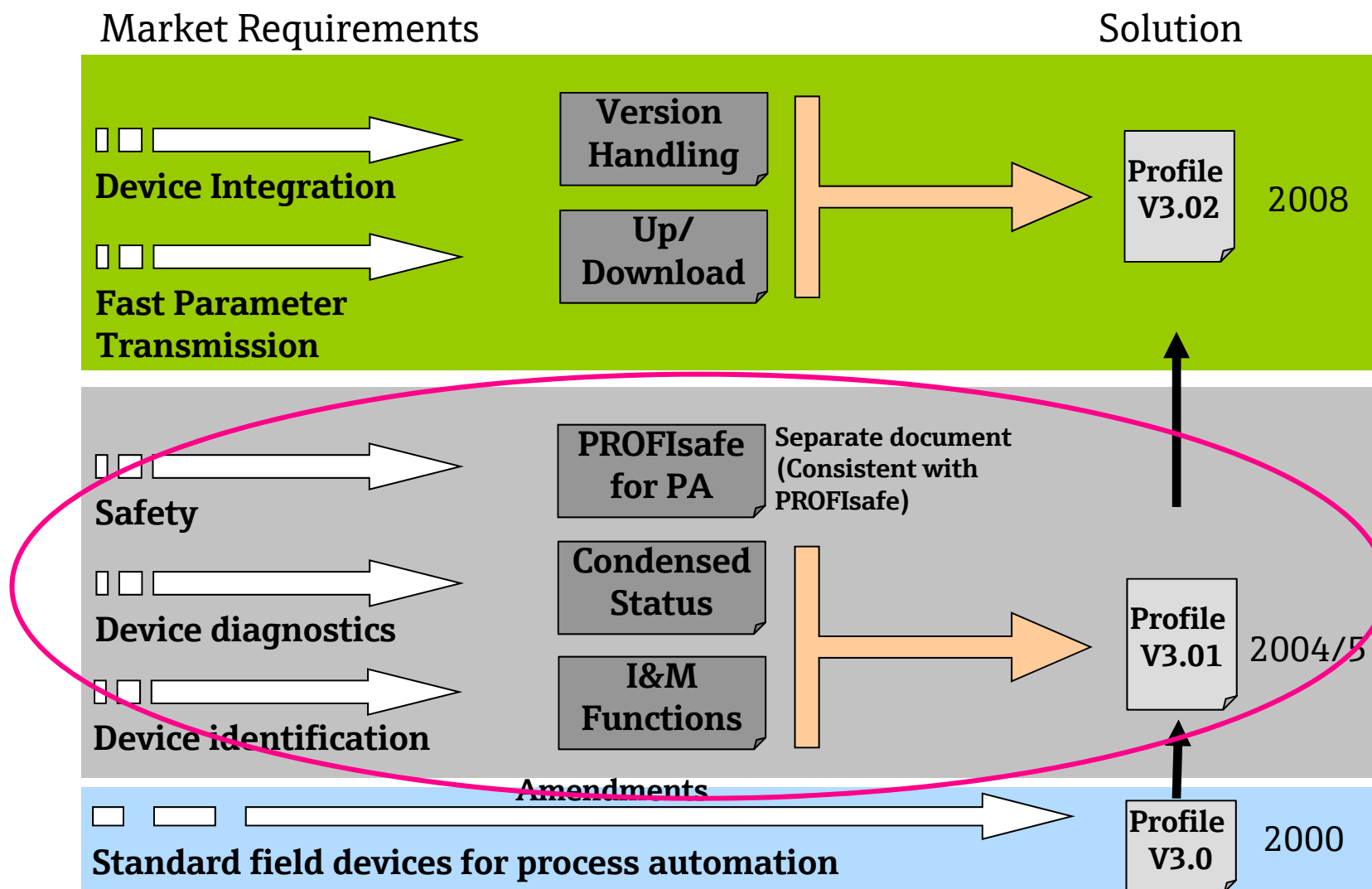


PROCENTEC Combricks



- 9.6 kbps .. 1.5 Mbps on PROFIBUS DP side
- Integrated PA termination in coupler mode
- 500 mA PA current
- Customizable PA voltage
- Max. 10 PA coupler modules
- Direct replacement for 3rd party couplers

PROFIBUS PA – Profile 3.01

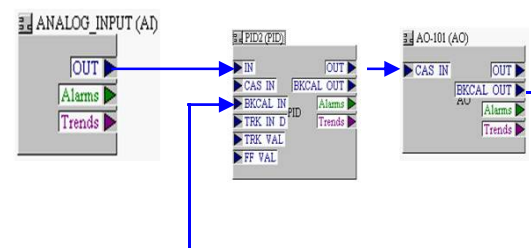


Different Views of Diagnostics

Asset
Management



Process
Control



Diagnostic

Status

Different Views of Diagnostics

Status signals according to NE107

Asset
Management



Failure



Maintenance
request



Check



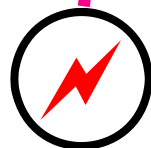
Out of
Specification

Process
Control



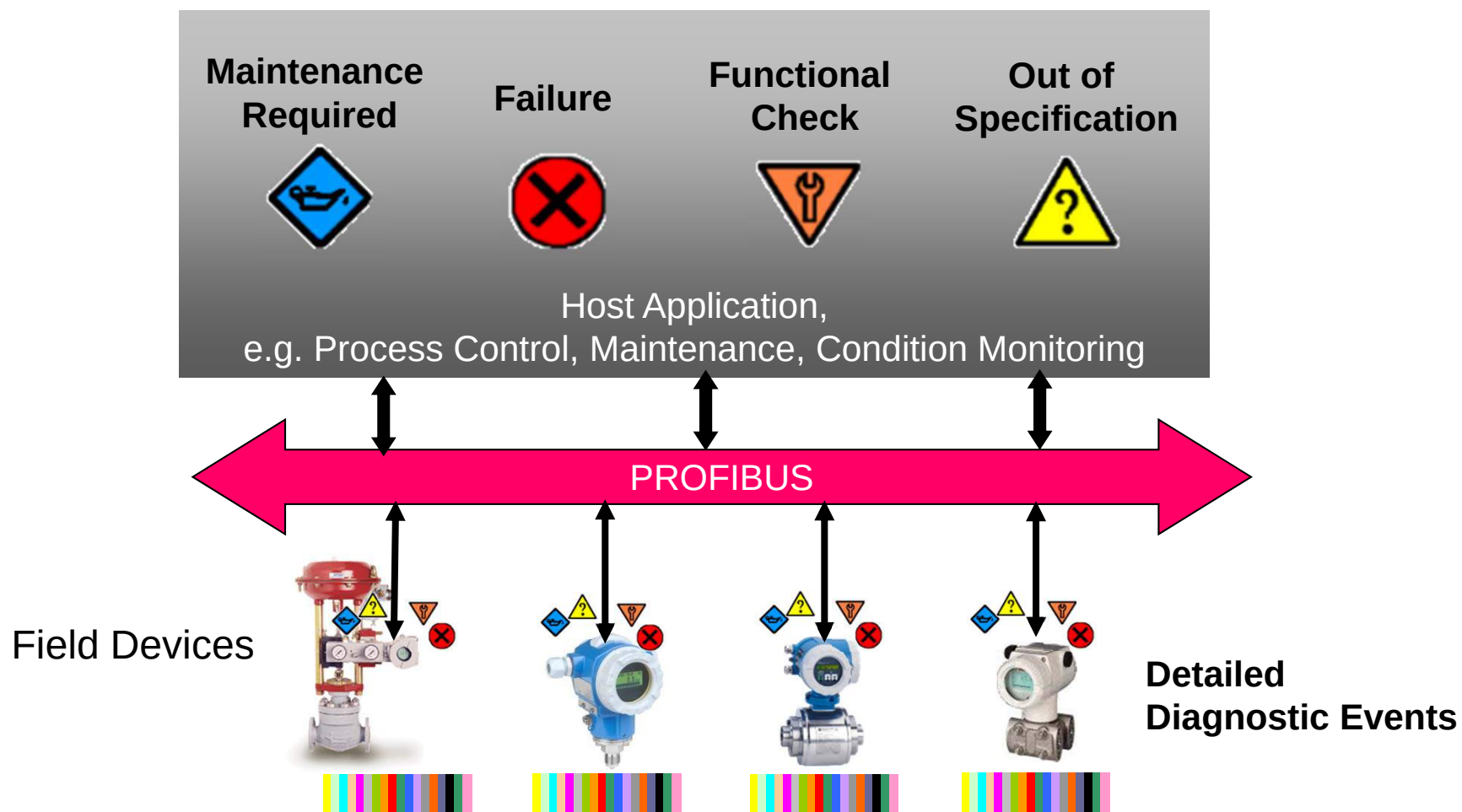
PLC Interface

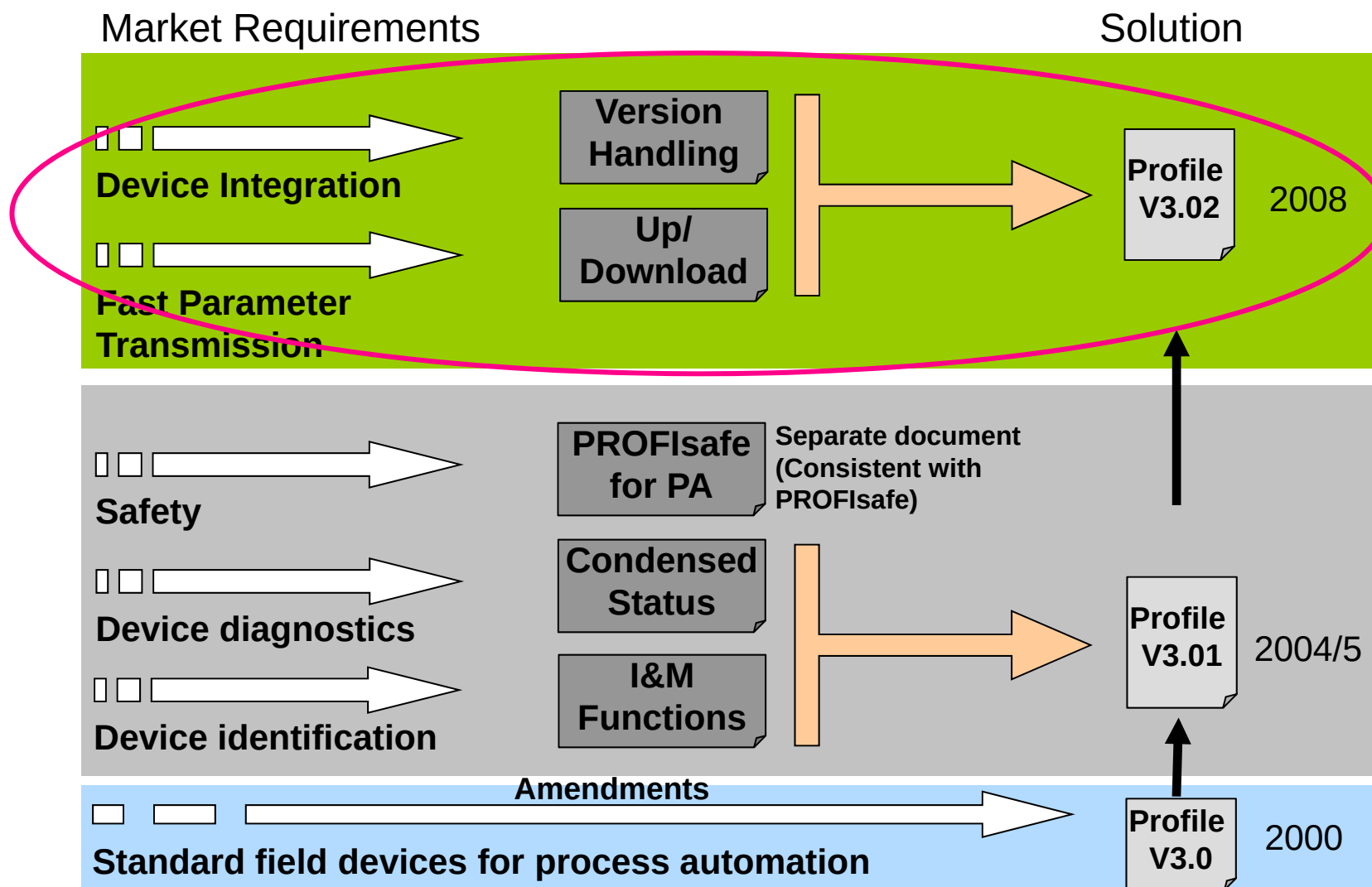
- BAD
- UNCERTAIN
- GOOD



Diagnostic Event

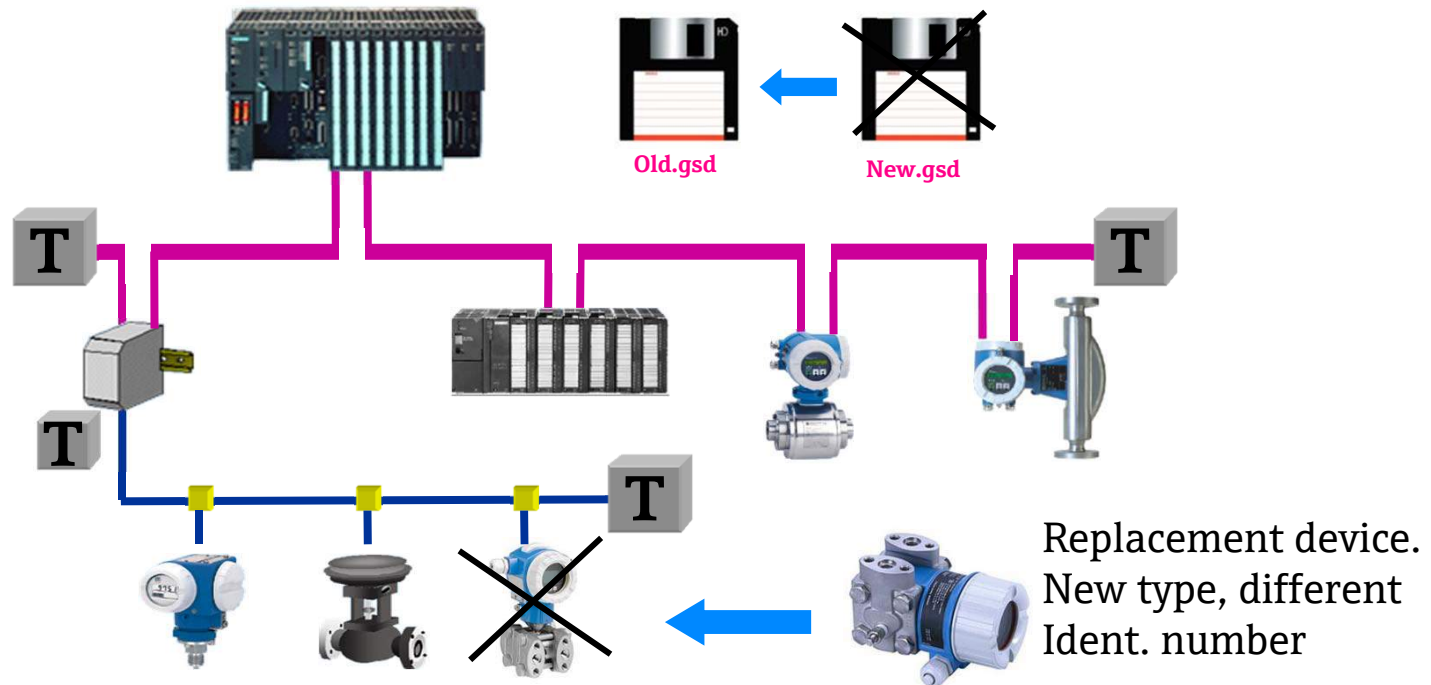
Condensed Status & Diagnostic Messages





Most important improvement by PA Profile 3.02

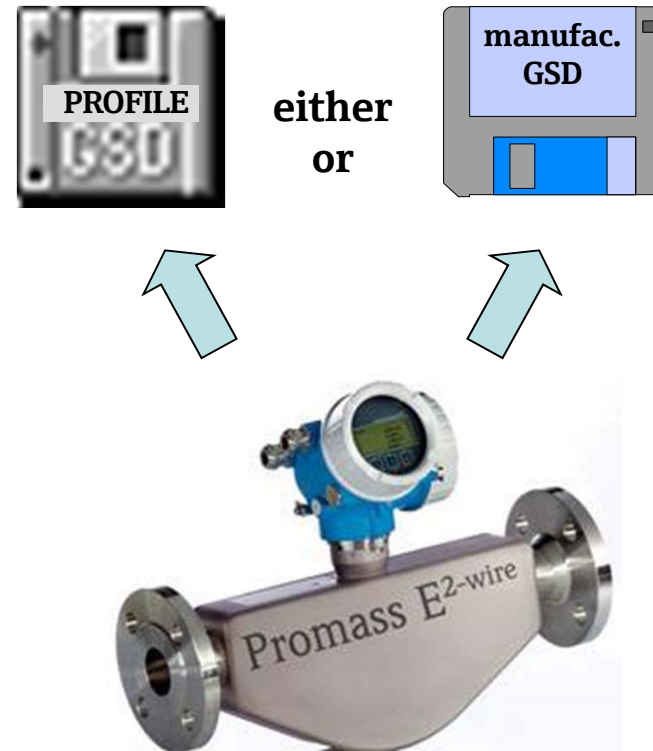
- Automatic Ident Number Adaptation
(used by cyclic communication)
- Easy handling of device exchange during plant runtime
 - No GSD file exchange necessary
 - No plant shutdown because of required PLC download



PA Profile GSD vs. manufacturer-specific GSD

**PA Profile 3.x devices are compatible with the:
Manufacturer-specific GSD and the PROFILE GSD!**

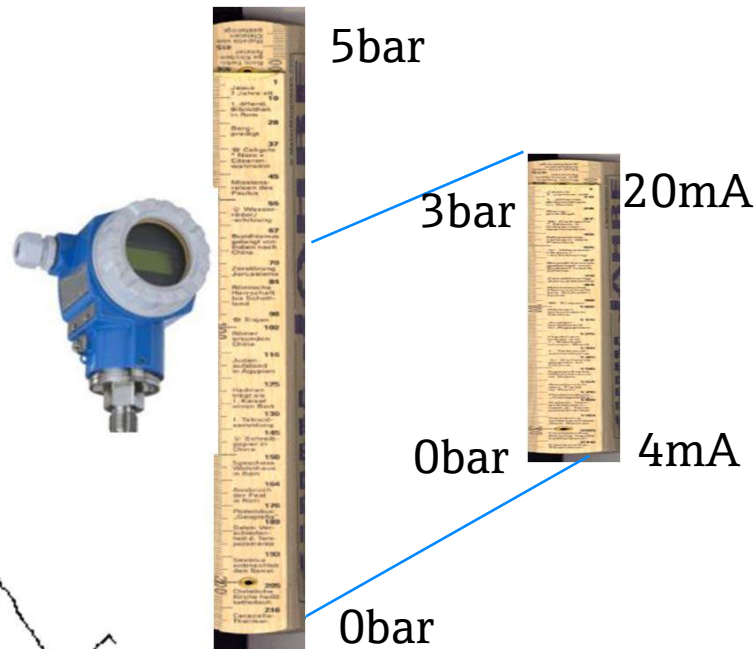
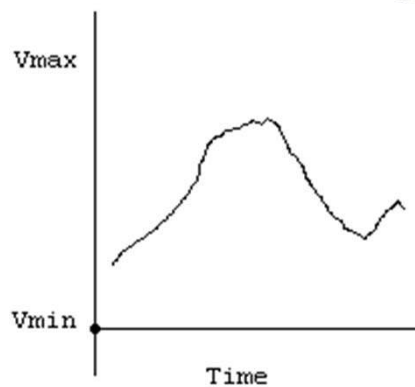
- The device can either operate with the manufacturer specific GSD or with the PROFILE GSD.
- Using the PROFILE GSD, functionalities may remain unused!



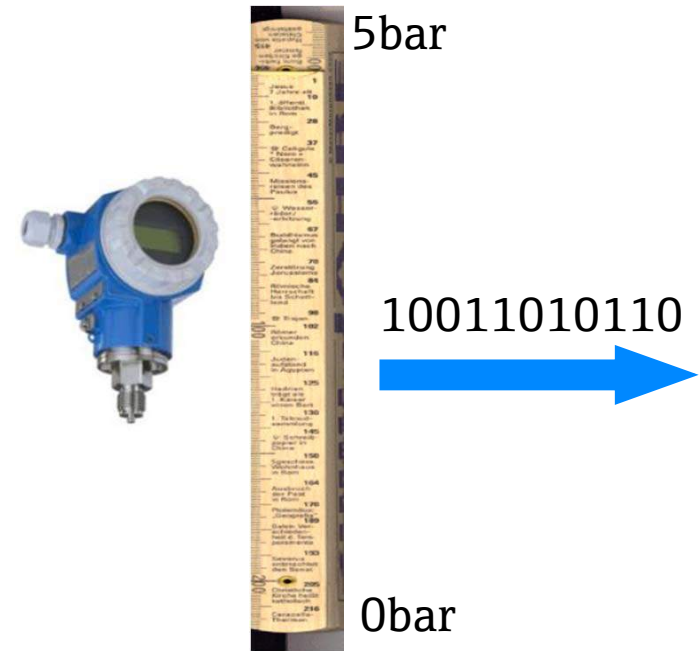
User benefits

- No scaling necessary

Conventional



Fieldbus



Full resolution of process value over the entire physical measuring range
e.g. Pressure membrane 0-5 bar

User benefits

- Higher precision of process value

Conventional



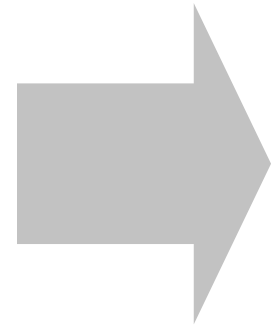
11.53mA (= 5.5 meter)



Fieldbus



Process Value



5.532 meter

- Multivariable devices

Conventional



One PV per outlet or cable
e.g.
■ Density

Fieldbus



Several PVs over the bus
■ Density
■ Temp.
■ Flow
■ Counter...

User benefits

- Parameterization of field devices via PROFIBUS from operator station

Conventional



Parameterization
in the field on the device

Fieldbus



Parameterization
from the control room



■ Diagnostic data

- Bidirectional communication (device – PLC/DCS)
- Predictive maintenance
- Customized diagnostic
- Devices offer substitute process value if device fails



Failure



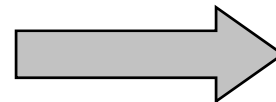
**Maintenance
request**



Check



**Out of
Specification**

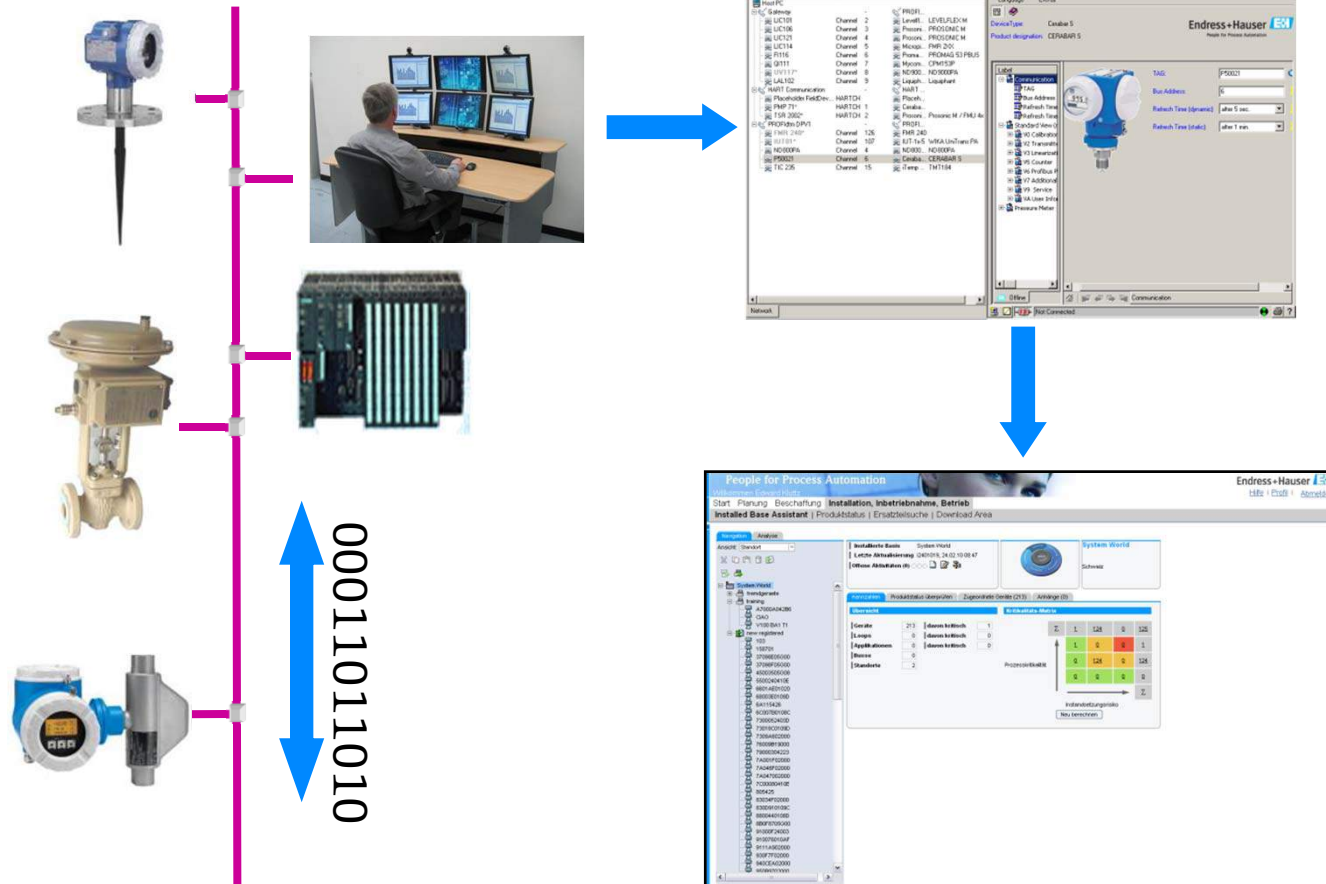


- Empty pipe detection
- Sensor drift
- Dirty pipe, please clean
- Maintenance needed
-



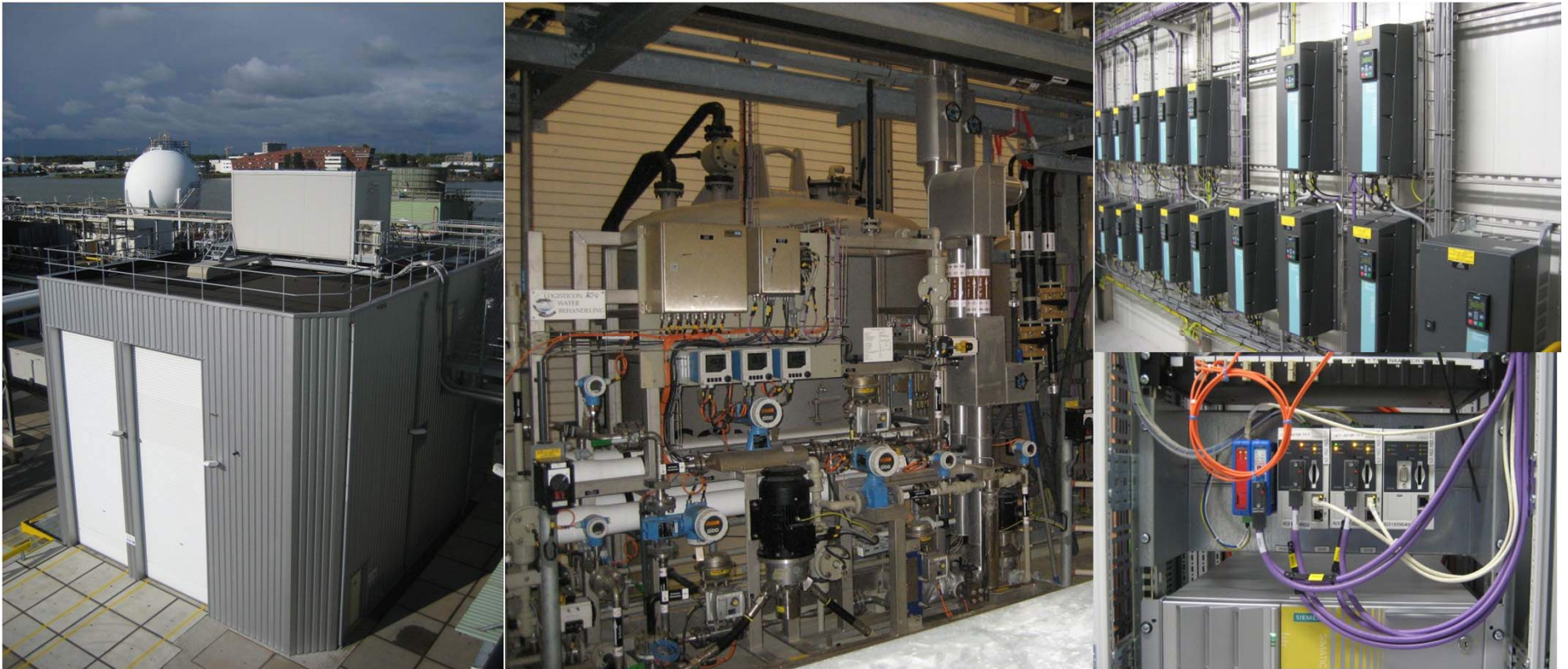
Cost savings: Maintenance Costs

■ Plant and Life Cycle Management



Gen-X Project at DuPont, Dordrecht

Cost reductions and process optimization by digitalization



- DuPont has committed to eliminate the use of a polymer processing aid in the Fluoropolymers production facilities before 2015.

(Planned investment 9 million EURO)

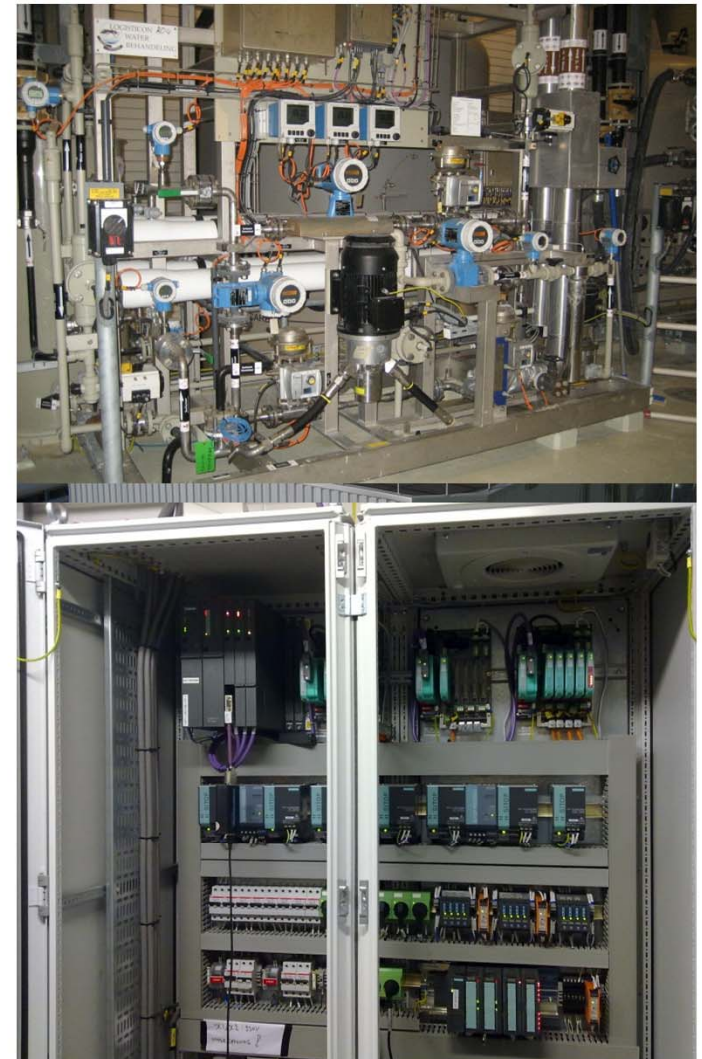
- To realize this, new facilities for chemical dosing, waste water - and air abatement should be installed.

(3 separate projects fully operational before September 1, 2012)

- Technology selection based on pilot tests.

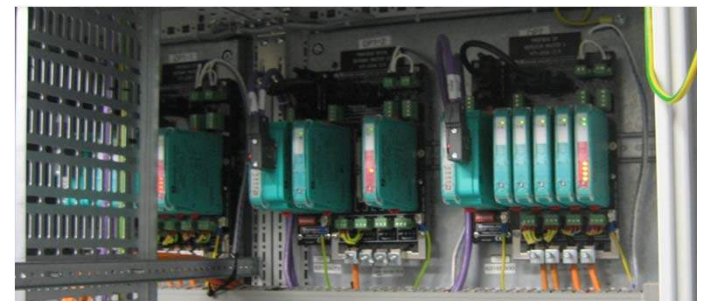
(Pilot project executed in 2009)

- Automation technology selection to provide a fully automated plant with high availability.

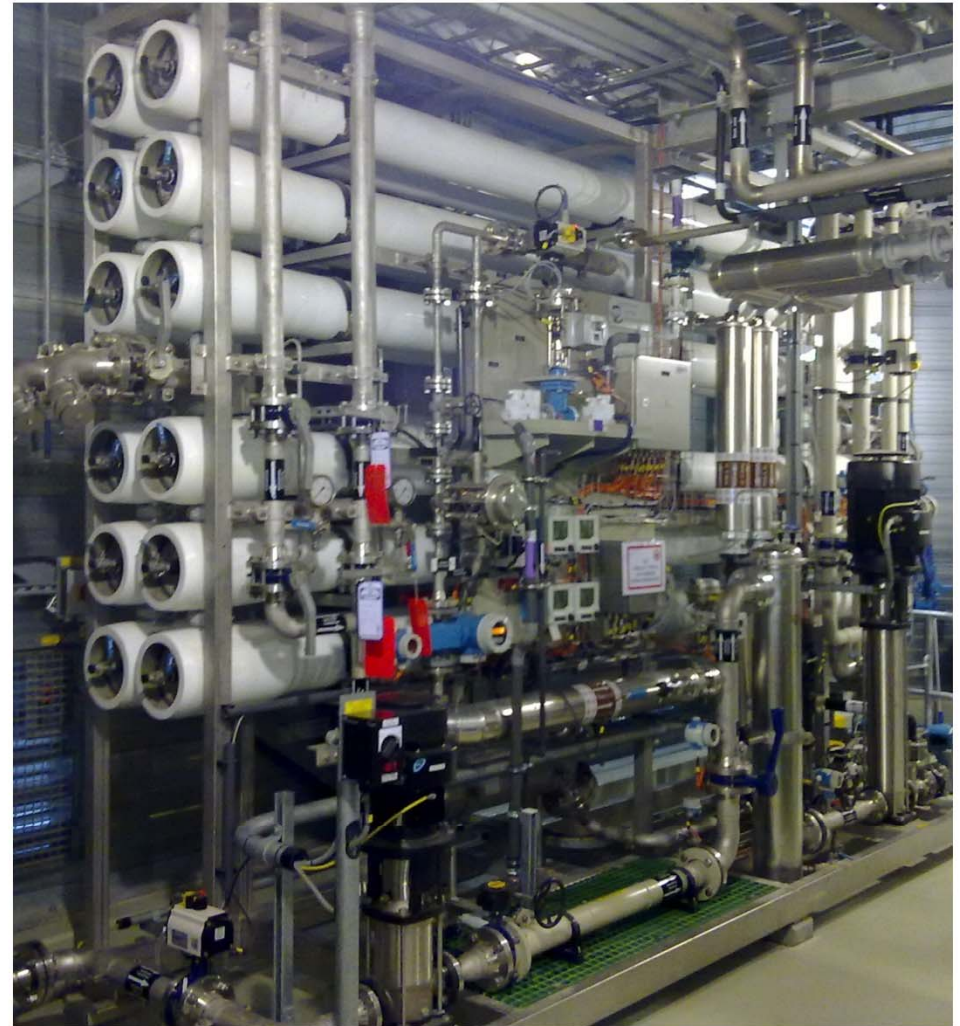


Gen-X Project

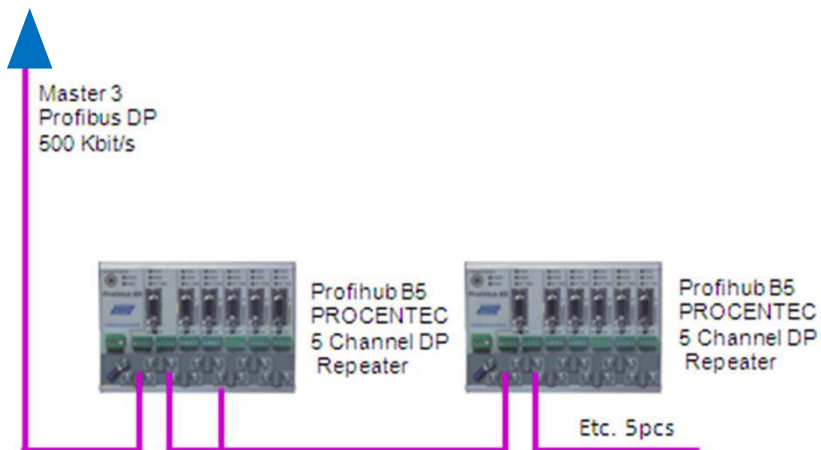
- DuPont at Dordrecht, chemical industry.
- Full continuous operation 24/7/365.
- High availability technical installation.
- Siemens PCS7 process automation system.
- Endress+Hauser FieldCare Plant Asset Management system with Fieldgate SFG500 PROFIBUS intelligent access points.
(>> **PROFIBUS Device Health Status**)
- PROCENTEC COMBricks modular repeaters.
(>> **PROFIBUS network diagnostics**)
- Pepperl+Fuchs PROFIBUS DP/PA Gateway with advanced diagnostics.
(>> **PROFIBUS PA network diagnostics**)

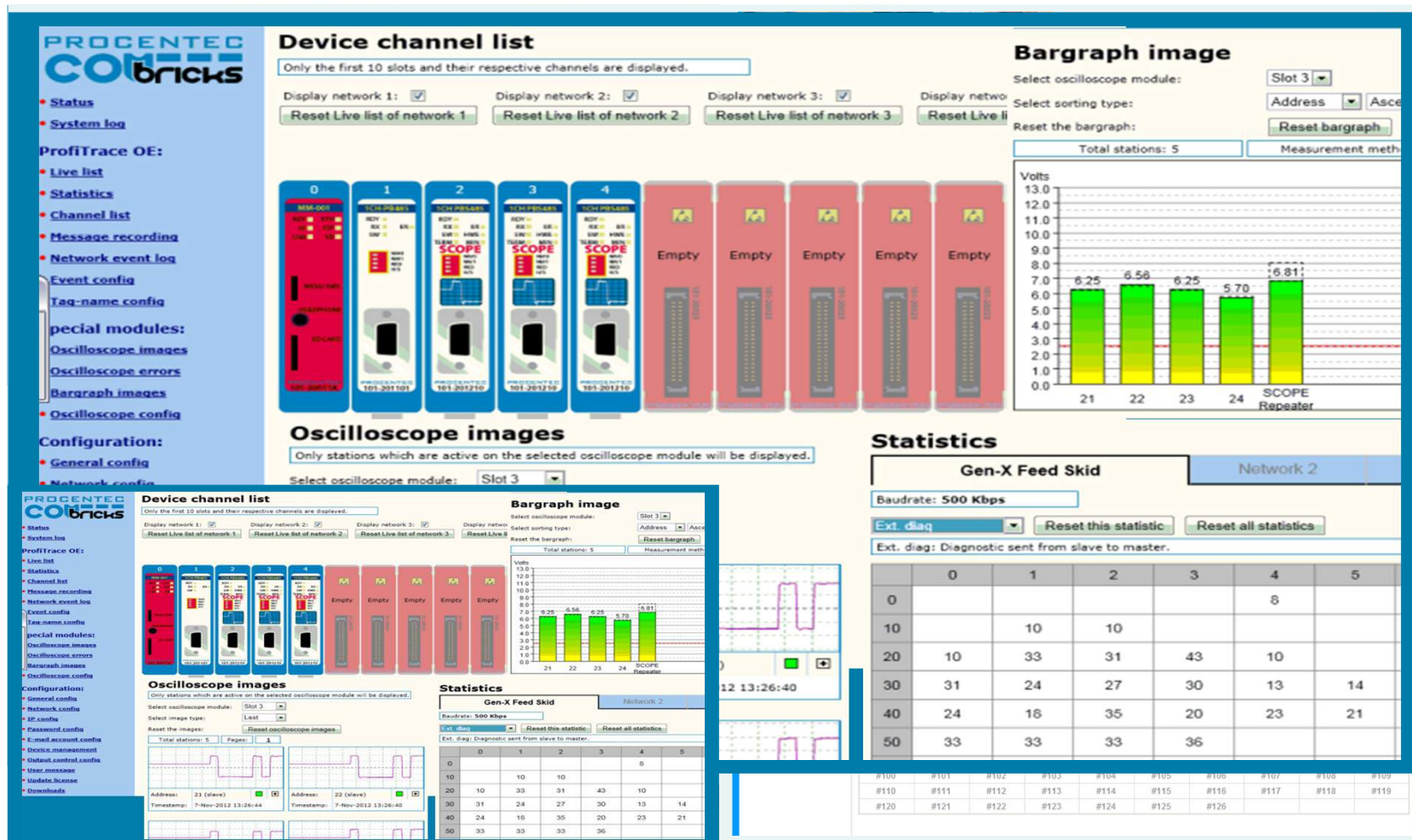


- PROFIBUS DP (80 slaves)
 - Siemens remote IO
 - Siemens variable speed drives
 - Festo valve islands
 - E+H plant access points (MC2)
 - PROCENTEC modular repeater
- PROFIBUS DP/PA
 - P+F DP/PA Gateway
- PROFIBUS PA (200 slaves)
 - E+H flow
 - E+H level
 - E+H pressure
 - E+H temperature
 - E+H analyse
 - Metso valve positioners



Gen-X Project DuPont at Dordrecht





Project results



Customer Benefits:

- Remote maintenance
- Assurance of settings
- Easy troubleshooting
- Automatic Notification
- Online network monitoring
- Maintenance workflow optimization

Applying Field Network Engineering and Plant asset management functions have made the project successful.

Marcel Middeldorp adds: “Far-reaching digitalization in particular has helped us reach the project targets. We have seen good results with the commissioning and start-up. The installation is robust and solid. **An unwanted malfunction can now be quickly and efficiently detected.** Much more information becomes available via the installed software than when using a conventional 4...20mA environment. Getting used to this new software takes some time and practice, but fortunately this was only minimal. In a relatively short time, we have fully commissioned our installation in Dordrecht and have started production.”