PROFIBUS Workshop

PROFIBUS

- Overview — chapter 1
  - PROFIBUS EN 50170
  - PTO
- Protocols FMS, DP, PA
  - reliability
  - wiring
- DP-details — chapter 2
  - GSD - file
  - functions
- ASICs — chapter 3
- PIC and certification — chapter 4

PROFIBUS

- **Why select a fieldbus system**
  - **independent of proprietary solution**
  - **vendor independent**
  - **cost savings**
  - **increase of productivity in terms of**
    - **faster**
    - **more flexible**
    - **easy expandable**
    - **customized**

PROFIBUS

- **What a fieldbus system needs to offer**
  - **deterministic (since parallel wiring will be replaced)**
  - **flexible**
  - **interoperable (multi-vendor use)**
  - **cost effective (installation, startup, service)**
  - **reliable and safe**
  - **easy to use**
  - **solution for all your automation needs**
- **standardization**

EN 50170 Volume 2

General Purpose Automation	Factory Automation	Process Automation
PROFIBUS-FMS	**PROFIBUS-DP**	**PROFIBUS-PA**
RS 485 / FO	**RS 485 / FO**	**IEC 1158-2**
Universal	**Fast**	**Application Oriented**
- Large variety of applications - Multi-master communication	- Plug and play - Efficient and cost effective	- Powering over the bus - Intrinsic safety

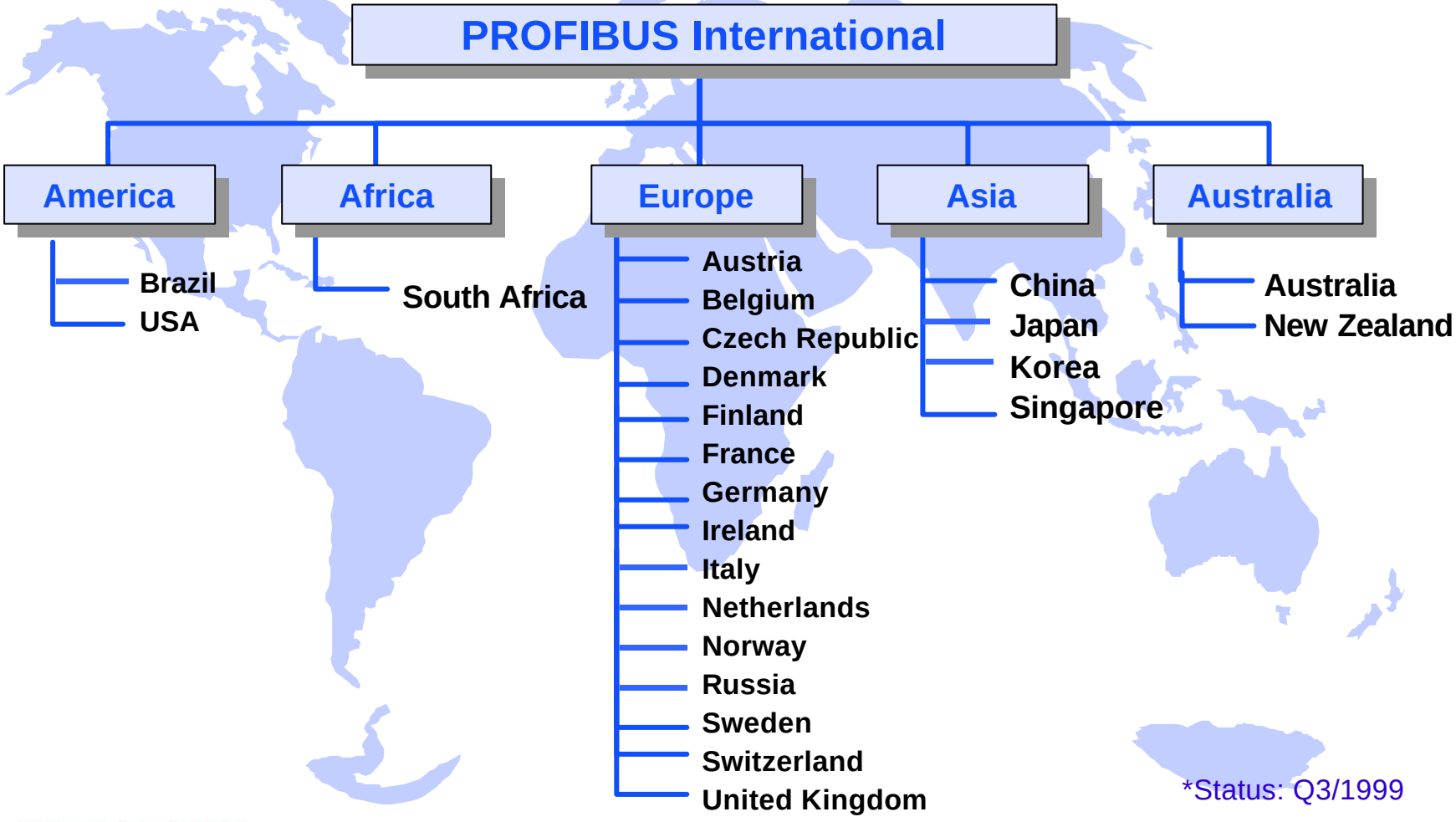
EN 50170

- The PROFIBUS Standard EN 50170 is complete, open, vendor- independent and validated
- The PROFIBUS Technology is in accordance with existing parts of the IEC Fieldbus Standard IEC 1158
- PROFIBUS is proven and has an installed base of > 3,000,000* devices that are in use all over the world
- The stable PROFIBUS Standard protects the investments of users and vendors world-wide

*Status: Q3/1999

INTERNATIONAL

- More than 900 members - 23 regional user associations



*Status: Q3/1999

PRODUCT Variety

- **Today there are more than 1,900* products from more than 280* different vendors available**

Get your free copy of the latest PROFIBUS product guide:

on CD available from every user group world-wide

or visit the Web - Site: http://www.profibus.com

*Status: Q3/1999

PRODUCT Variety

Drives
- AC Drives
- DC Drives

Controllers
- PLC/NC/RC
- VME, PC
- Workstation

Software Drivers
- DOS/Windows/NT/95
- RT-OS/OS9/VRTX
- VxWorks/PSOS+
- OS2, QNX
- UNIX/VMS

Tools
- Configuration
- Bus Monitor
- Engineering

Decentralized I/O
- Binary I/O
- Analog I/O
- Regulators
- Timer
- Counter
- Ident-Systems

Network components
- Repeaters
- Fiber optics
- Cables

Services
- Development Support
- Implementation Support
- Training

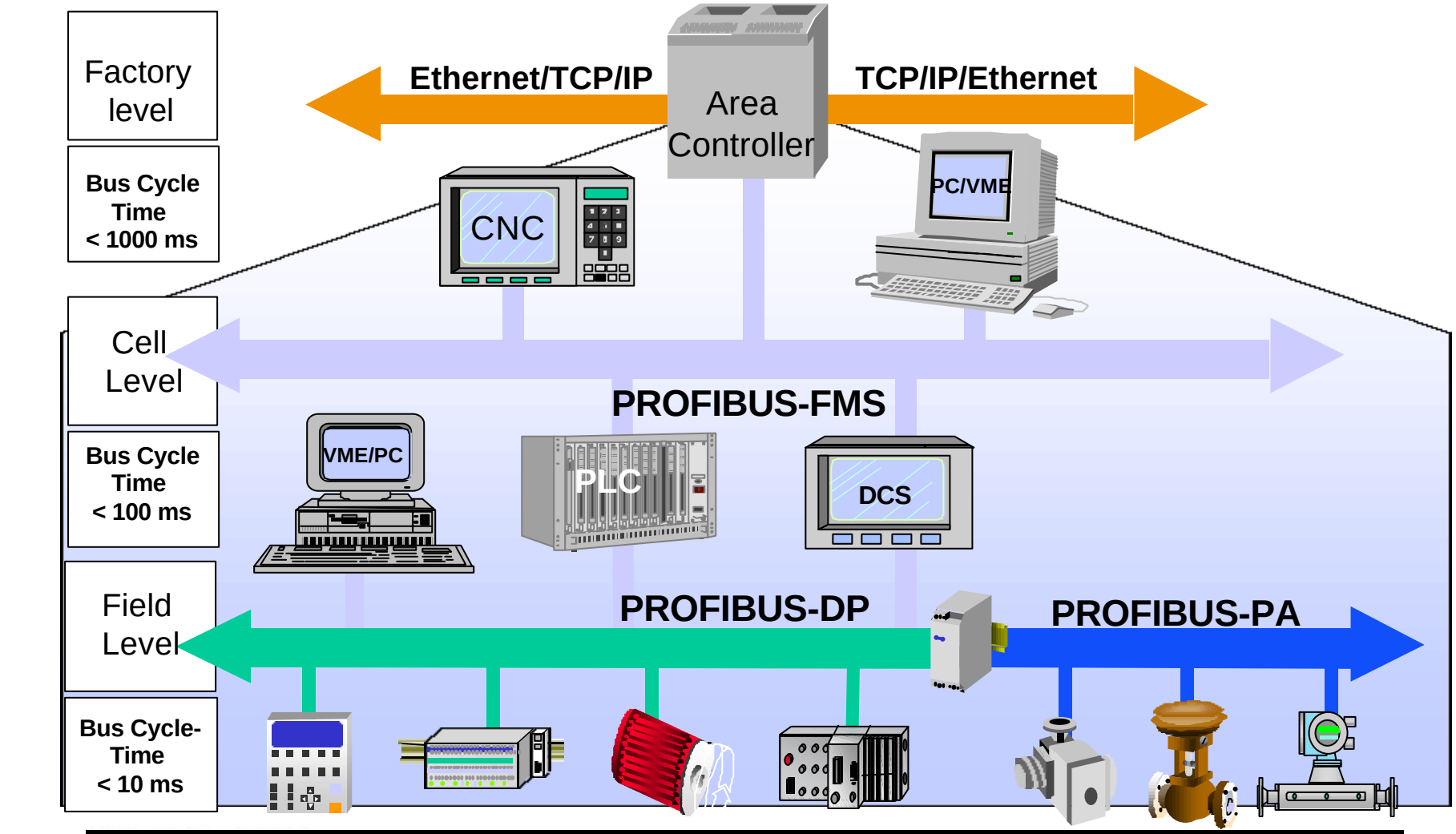
Host Interfaces
- VAX computers
- VME computers

MMI
- Operator Panels
- Text Displays

Instruments
- Level
- Flow
- Pressure
- Temperature

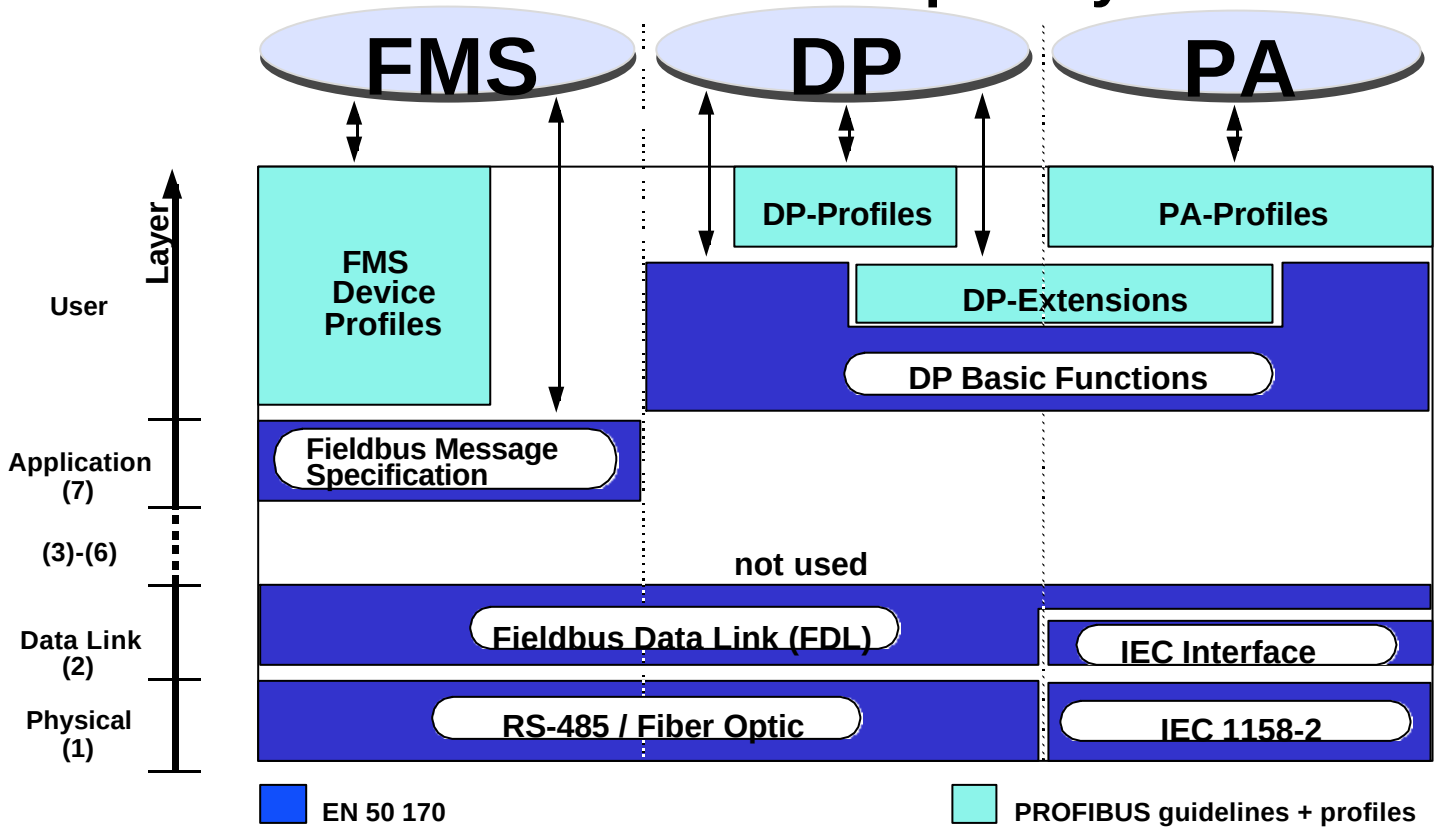
Valves
- Pneumatic Valves
- Magnetic Valves

Gateways
- AS-Interface
- Proprietary networks


Factory level
Bus Cycle Time < 1000 ms
Cell Level
Bus Cycle Time < 100 ms
Field Level
Bus Cycle-Time < 10 ms
Ethernet/TCP/IP
Area Controller
TCP/IP/Ethernet
CNC
PC/VME
PROFIBUS-FMS
VME/PC
PLC
DCS
PROFIBUS-DP
PROFIBUS-PA

EN 50170 - 2

- The PROFIBUS Protocol is in Accordance with the ISO/OSI Reference Model for Open Systems

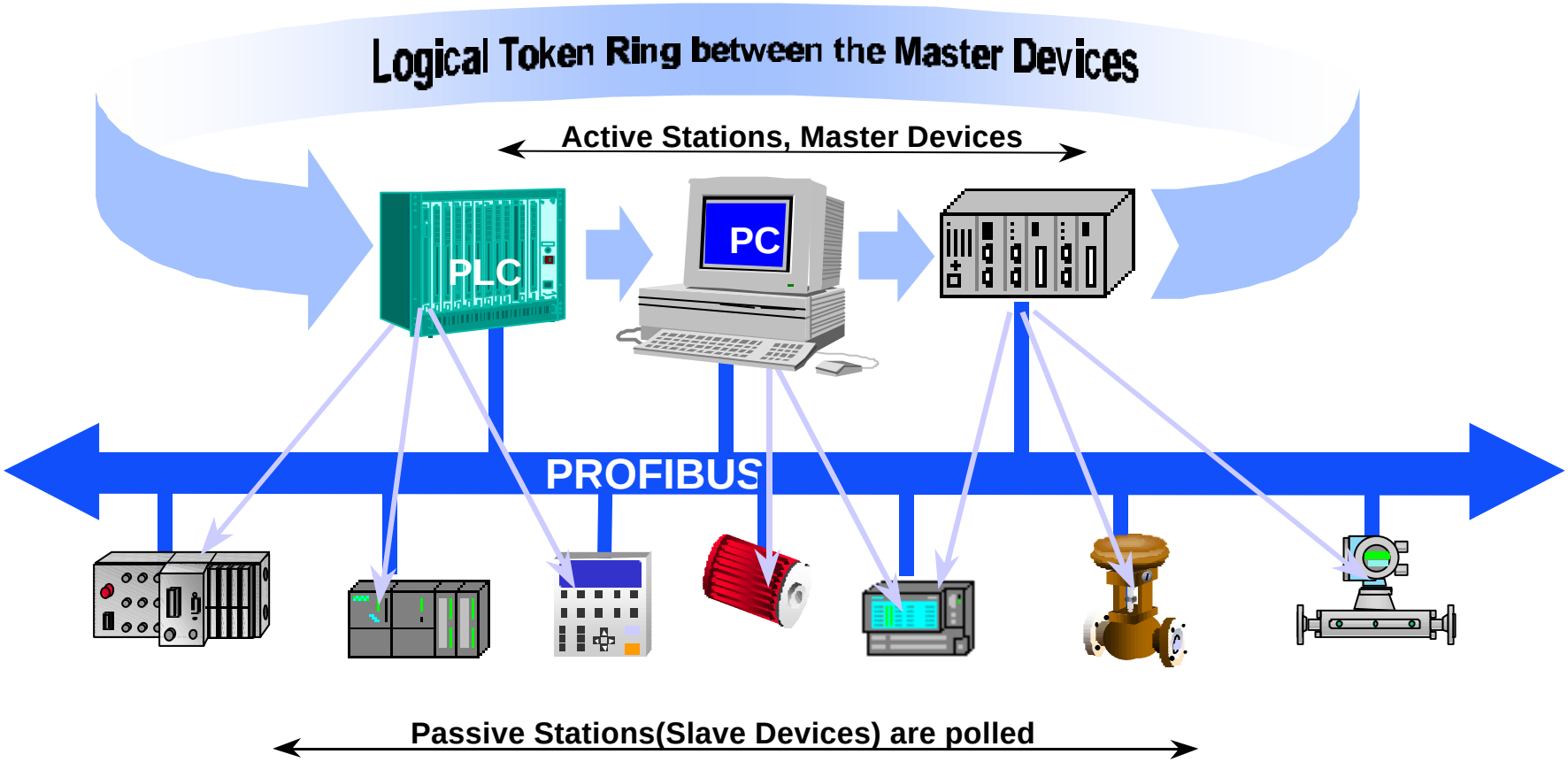


Product Profiles

- PROFIBUS has defined profiles for the easy interconnectivity of certain product ranges
  - NC/RC Profile (3.052)
  - Encoder Profile (3.062)
  - Variable-Speed Drive Profile (3.071)
  - Operator Control and Process Monitoring Profile (HMI)
  - PA Profile

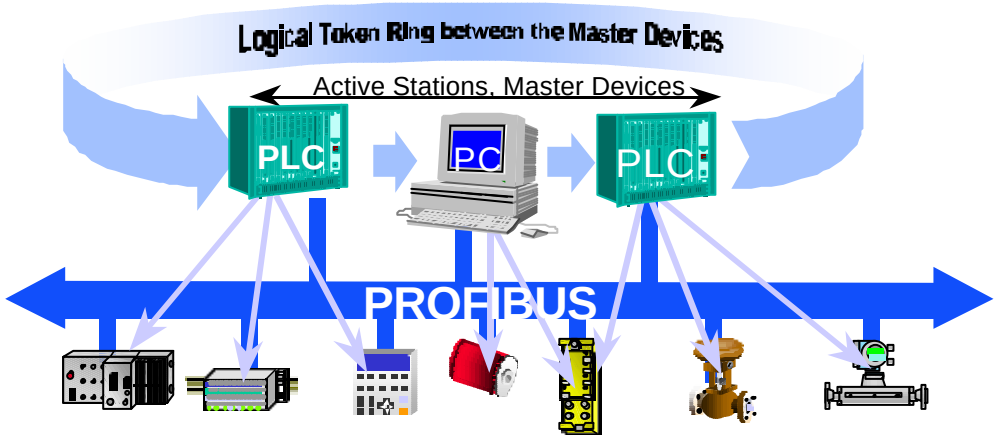
Bus Access

- The PROFIBUS Bus Access Method combines Multi-Master and Master-Slave communications



Bus Access

- the PROFIBUS Bus Access Protocol (Layer 2) is identical for all three PROFIBUS variations
- this enables transparent communication and easy combinations of FMS/DP/PA Network sections
- Because FMS/DP use the same Physical Media (RS-485/FO), they can be combined on the same cable



Bus Access

- **Hybrid Bus Access Protocol**
  - Token-Passing between Masters
    Master - Slave Protocol between Master and Slaves
- **Master**
  - active stations with the right to control the bus for a limited amount of time (Token - Hold - Time)
- **Slave**
  - Slaves only respond on request of a Master - they have no rights to control the bus

Bus Access

- **in Multi-Master Networks, the Token Passing procedure must ensure that each master has enough time to fulfill its communication tasks**
- **the user therefore configures the overall Target Token Rotation Time (TTR) taking into account the communication tasks of all masters**
- **each Master calculates the available amount of time for its communication tasks at token receipt according to the following rule:**

T_{TH} = Token Hold Time

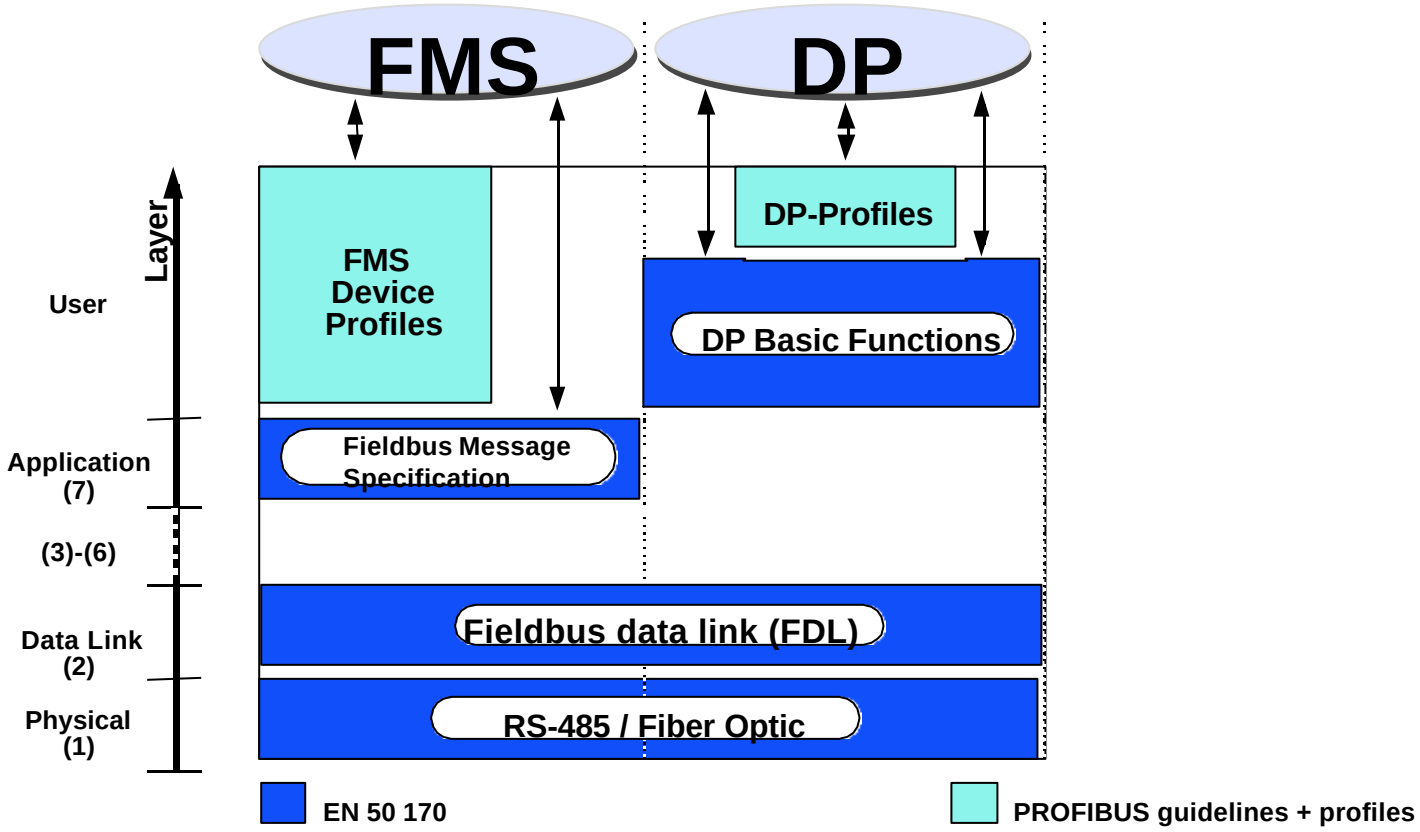
T_{TR} = Target Token Rotation Time

T_{RR} = Real Token Rotation Time

FMS, DP, PA

- **FMS stands for Fieldbus Messaging System**
  - **peer to peer communication**
- **DP stands for Decentralized Periphery**
  - **fast data exchange**
- **PA stands for Process Automation**
  - **intrinsically safe environment**

FMS/DP In Common



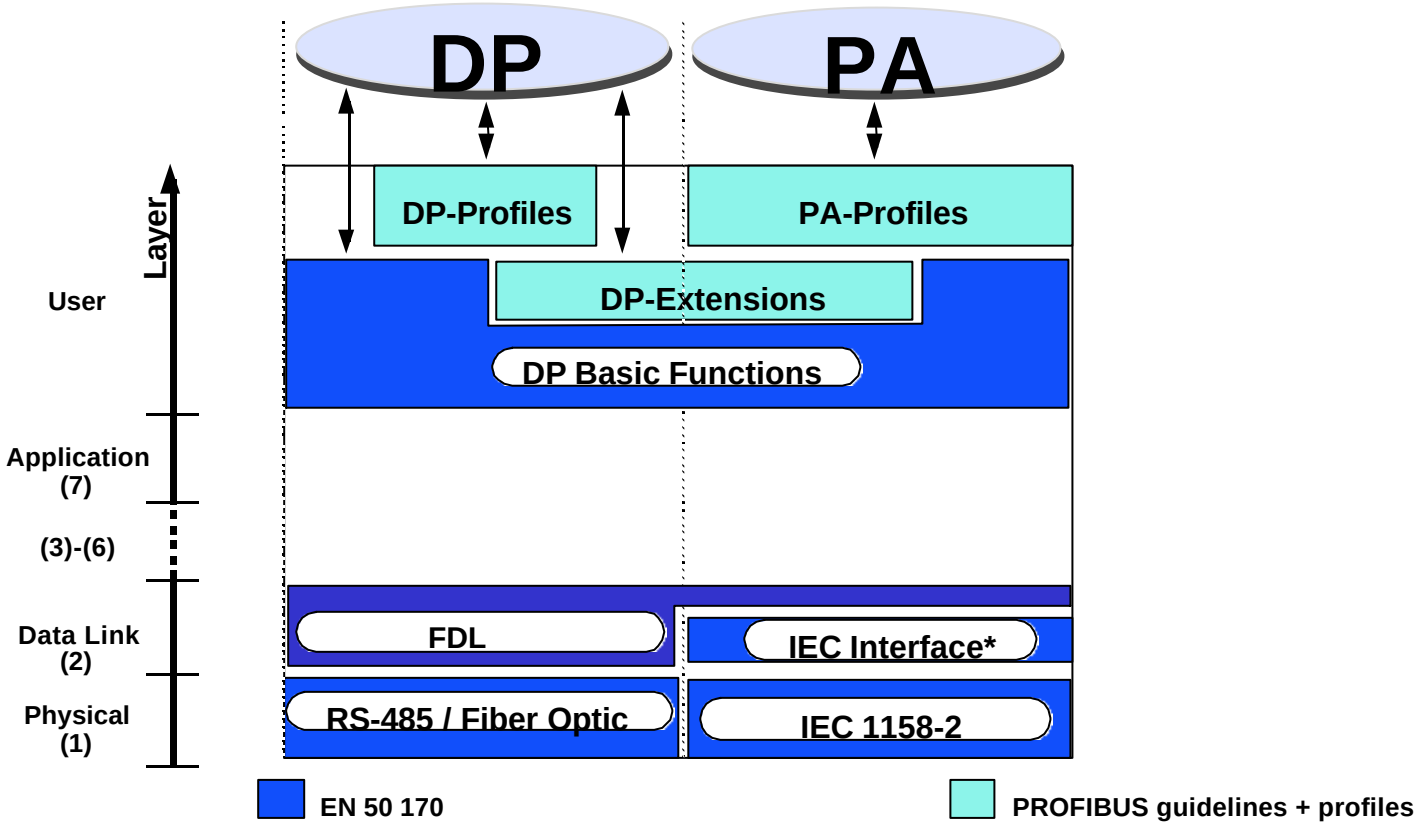
FMS/DP In Common

- DP and FMS are based on Layer 1 and 2:
  - DP and FMS can be operated on the same bus
  - Message header and data length are identical
  - The bus physics are identical
- One master can service several slaves
- Several masters can participate on the bus
- Baudrates from 9.6 kBd up to 12 MBd are possible

FMS/DP In Common

- Data transmission can be between 1 and 244 bytes
- 126 stations can be connected
- System can consist of several segments
- 32 stations (RS 485 drivers) per segment
- Common components
  - Cabling, connectors, repeater, fibre optic
- Savings in maintenance and spare parts inventory

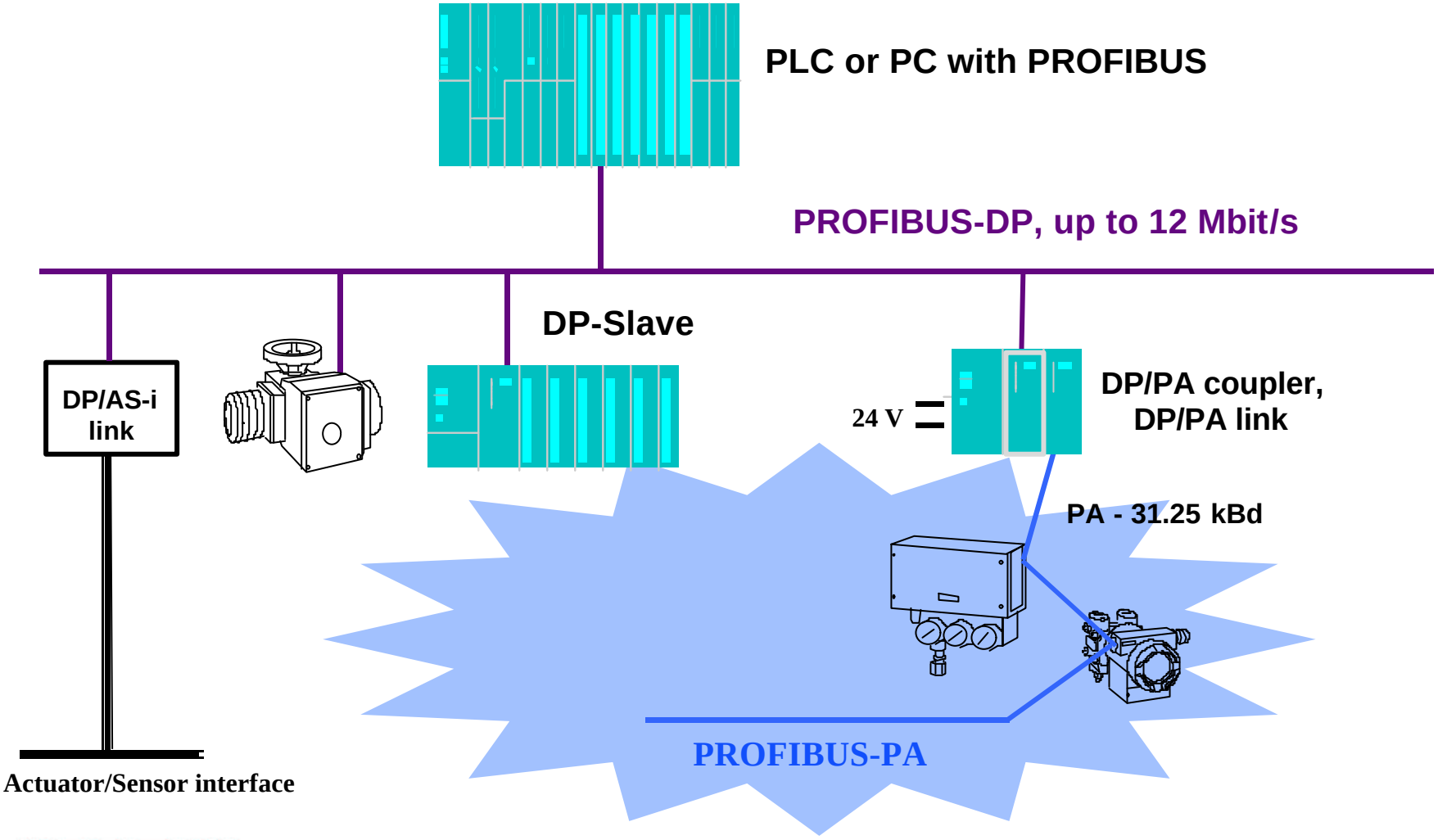
PA/DP In Common



PA/DP In Common

- DP and PA are based on the same protocol definition - DP/V1 (extended DP)
  - DP and PA can use the same master systems
  - Message header and data length are identical
  - Configuration tools are the same
  - Data transmission can be between 1 and 244 bytes

PA/DP In Common



FMS Features

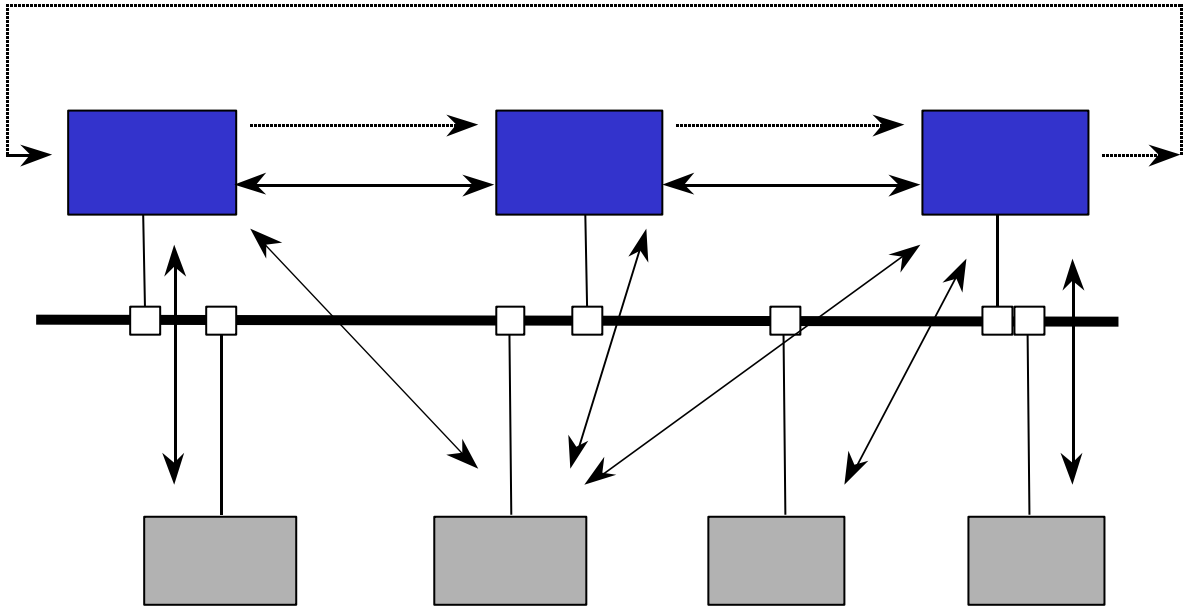
- FMS is optimized for universal, object oriented communication of intelligent master devices at the cell level
- FMS permits a subset of the MMS-Functions (Manufacturing Message Specification, ISO 9506)
- A slave can be assigned to several masters
  - Several masters can write to the same slave
- Communication connections can be temporary or permanent
- Communication is defined in a communication relation list

FMS Features

- **Main application areas are:**
  - **Transmission of large amounts of data e.g.. programs, data blocks....**
  - **Integration of several decentralized process parts to one common process**
  - **Communication between intelligent stations**

FMS Features

- FMS access procedure



PA Features

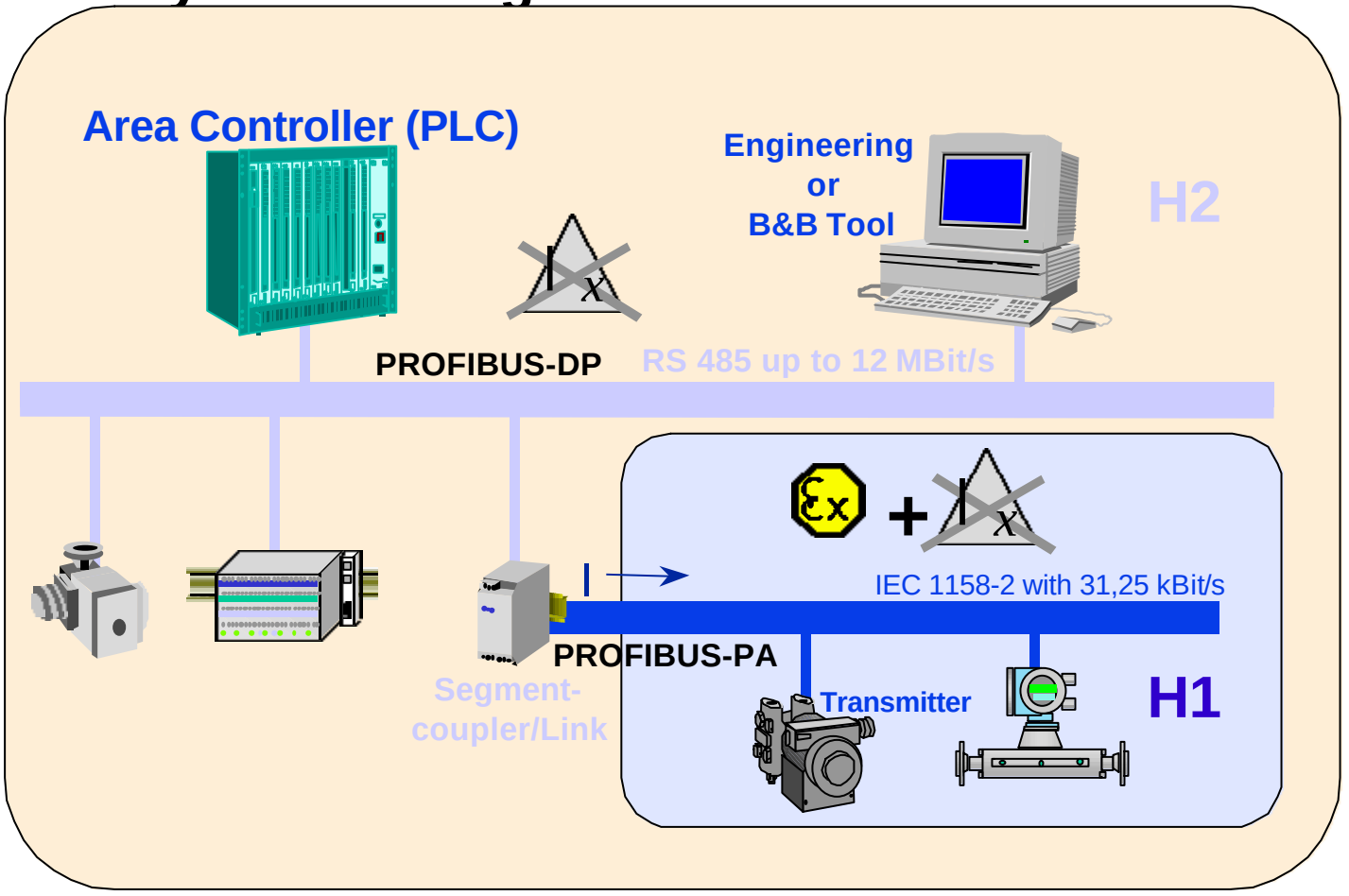
- **Based on the extended PROFIBUS-DP Protocol and IEC 1158-2 Transmission**
  - **Suitable to replace today's 4...20 mA Technology**
  - **Only two wires for data and power**
  - **Connects Instruments to the control system via a serial bus**
  - **Functional improvements plus reliable serial digital transmission**
  - **Control, regulation and monitoring via a simple twisted pair cable**
  - **A single engineering tool for all devices**

PA Features

- **Based on the extended PROFIBUS-DP Protocol and IEC 1158-2 Transmission**
  - **Interoperability and interchangeability due to the PROFIBUS-PA Profile**
  - **Maintenance and diagnostic information from the instruments available**
  - **low power management and therefore suitable for EEx-Applications with Intrinsic Safety**
  - **Distance up to 1900m per segment**

PA Features

Typical System Configuration with PROFIBUS-PA

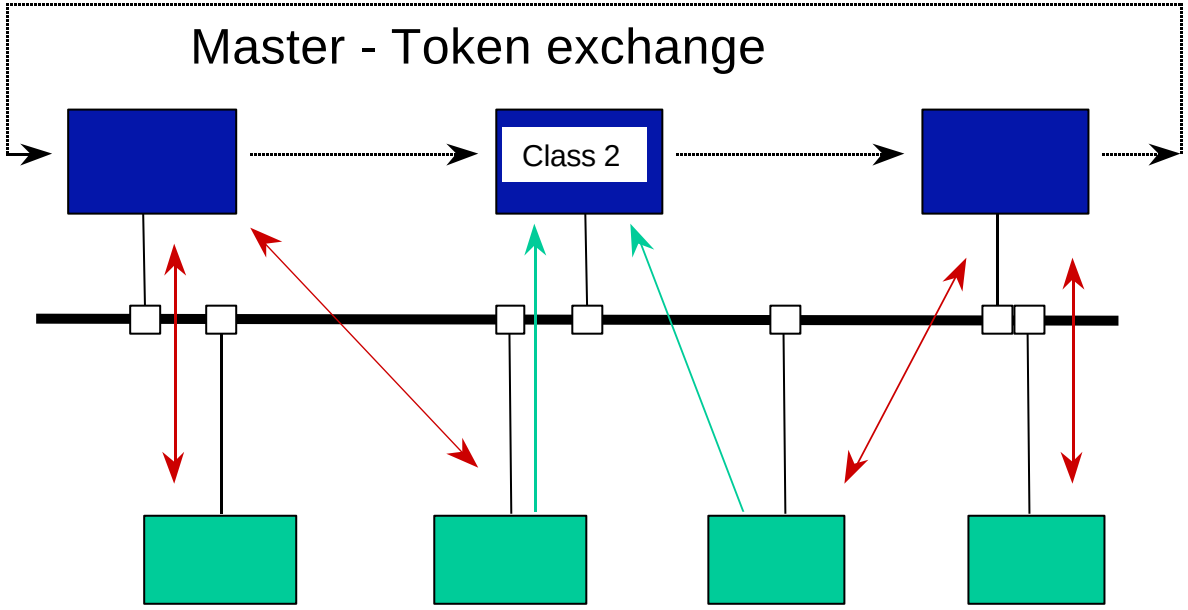


DP Features

- DP communication is permanent and cyclic
- the transmitted data is specified during the configuration (optimized data exchange)
- only one master can write outputs (safety aspect)
- data can be read by controlling and Class 2 master
- acyclic data via DPV1 functions
- alarm acknowledgment
- fastest fieldbus system (up to 12 MBaud)
- up to 244 byte input AND 244 byte output data per station

DP Features

- **DP- Access Procedure**



Reliability - DP/FMS

- Hamming Distance HD = 4
- HD 4 means, that up to 3 transmission failures at a time can be detected (done by the ASICs)
  - By detecting a faulty telegram, it will be resent automatically without affecting other existing stations
- HD 4 is a term used to describe the reliability of the data transmission on the Profibus network.
  - Special Start and End Sentinels
  - Parity Bit for Each Byte
  - Slip Free
  - According to IEC 870-5-1
  - Delimiter Synchronization

Reliability - DP/FMS

- HD 4 enables the detection of the following errors:
  - Line Protocol Errors
    - Framing Errors
    - Overrun Errors
    - Parity Errors
  - Transmission Protocol Errors
    - Faulty Start Delimiter
    - Frame Check Bytes
    - End Delimiters
    - Invalid Frame Length
    - Invalid Response Times

PROFIBUS Wiring

- **PROFIBUS DP/FMS wiring can be done with:**
  - **twisted shielded pair copper cable**
  - **fiber optic components**
  - **infrared components**
- **detailed installation guideline is available**
  PTO order no. 2.112

PROFIBUS Wiring

- twisted shielded pair cable
  - line parameters are defined in EN 50170
  - standard cable available from Belden and Siemens
  - standard connectors available

Baudrate	Max. Segment length	Max. Expansion
9.6	1000m / 3278feet	10,000m / 32786feet
19.2	1000m / 3278feet	10,000m / 32786feet
93.75	1000m / 3278feet	10,000m / 32786feet
187.5	1000m / 3278feet	10,000m / 32786feet
500.0	400m / 1311feet	4,000m / 13114feet
1,500.0	200m / 655feet	2,000m / 6557feet
3,000.0	100m / 327feet	1,000m / 3270feet
6,000.0	100m / 327feet	1,000m / 3270feet
12,000.0	100m / 327feet	1,000m / 3270feet

max. expansion is done with 9 repeaters in a row

PROFIBUS Wiring

- **Special requirements for baudrates >1.5 MBaud**
  - **use of Baudrates greater than 1.5 MBaud requires special connectors. The connector or the device has to have built in Inductors in order to run with higher baudrates (as stated in the PROFIBUS guidelines)**
  - **spur lines are not allowed when using baud rates greater than 1.5 MBaud**
  - **in some applications, several bus connectors are used at electrically short distances; 12 MBaud installations require a minimum cable length between two stations of 1m/ 3feet**

PROFIBUS Wiring

- **Cable Shielding**
  - **use only cables with braided shields.**
  - **the shield density should be more than 80 %**
  - **always connect the cable shields at both ends**
  - **if a potential difference occurs between the grounding points, an equalization current can flow through a shield connected at both ends. In this case, install an additional potential equalization line**

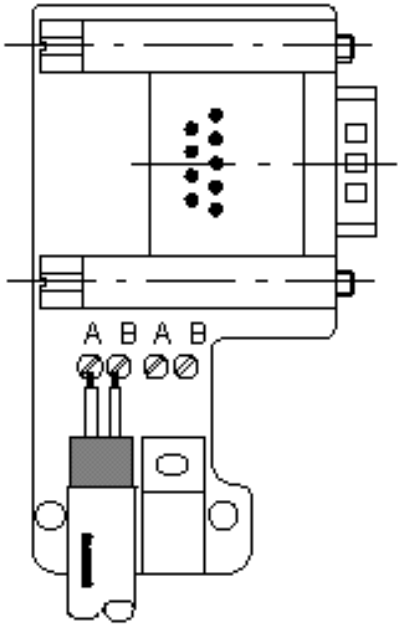
PROFIBUS Wiring

- one preferred connector type - 9 pin Sub-D
  - connectors with integrated termination available
  - for use of higher baudrates, inductivity built in
  - easy plug and unplug without interrupting the communication to other devices
  - other connector types are possible; mandatory signals (A,B, GND, 5V) must be provided as well as a possibility for termination

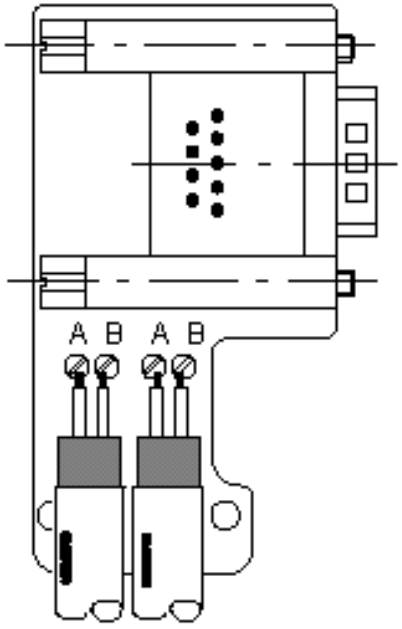
PROFIBUS Wiring

- **9 pin sub D**

Bus cable connection for **first and last stations** on the bus[1]



Bus cable connection for **all other stations** on the bus



[1]: The bus cable can be connected to either the left or right set of terminals!

PROFIBUS Wiring

- fiber optic components
  - plastic and glass fiber optic is available
  - optical plugs and modules are available

- noise immune
- potential difference independent
- longer distances (up to 20 miles)
- redundant operating is possible
- line, ring and star configuration

PROFIBUS Wiring

- infrared components
  - wireless linking of devices in close-up ranges
  - communication with moving devices
  - communication with changing devices
  - noise immune
  - ground independent

PROFIBUS Wiring

- **PROFIBUS FMS / DP both based on RS 485**
  - **Termination is necessary**
  - **Expansion of network through segments**
  - **the two wire cable is usually color coded**

  !! recommendation:

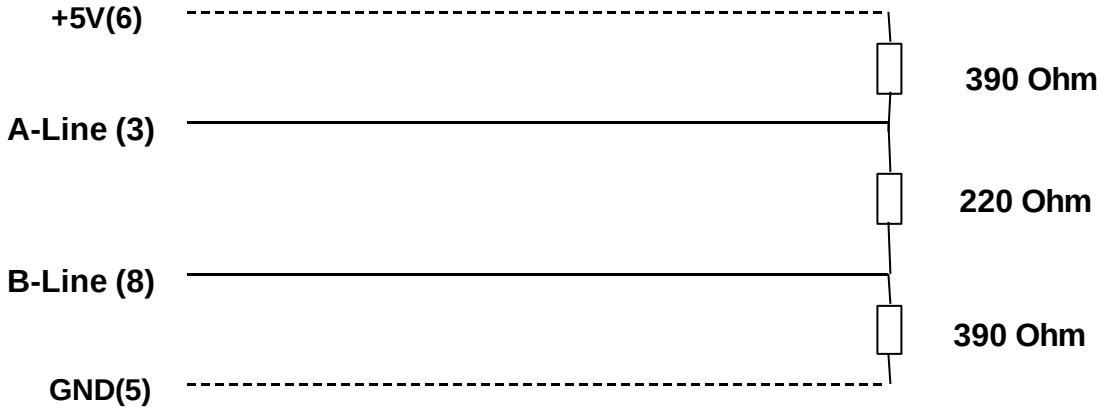
  use always the red wire for signal B (pin3 - TXD/RXD-positive)

  and the green wire for signal A (pin 8 - TXD/RXD-negative)
  - **the shield is connected to housing**

PROFIBUS Wiring

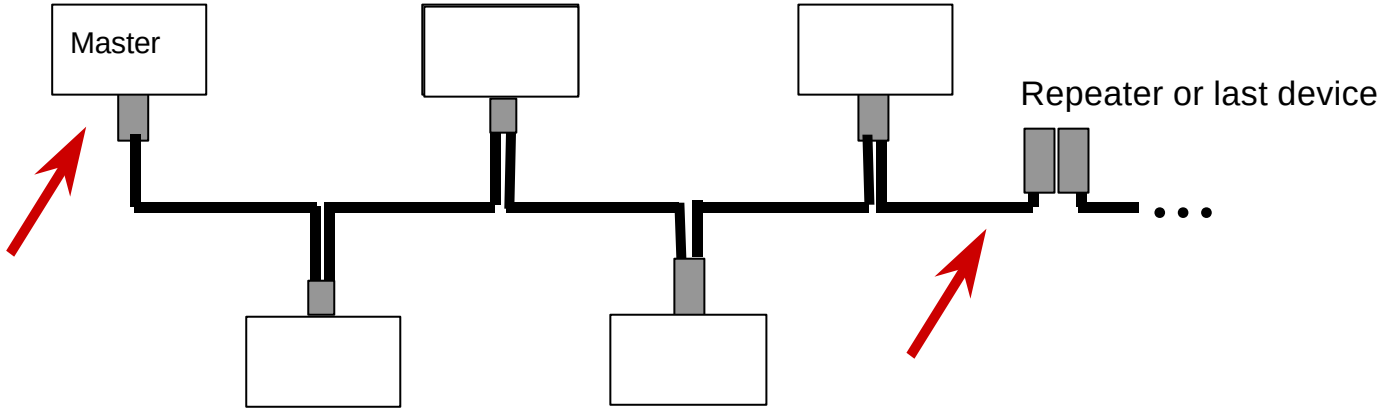
Termination (RS485 feature)

- each segment needs to be terminated at both ends
- termination needs to be powered at all time
- if possible use one termination at the master
- power for termination or the termination itself needs to be provided by the device



PROFIBUS Wiring

- **Segment structure with termination**



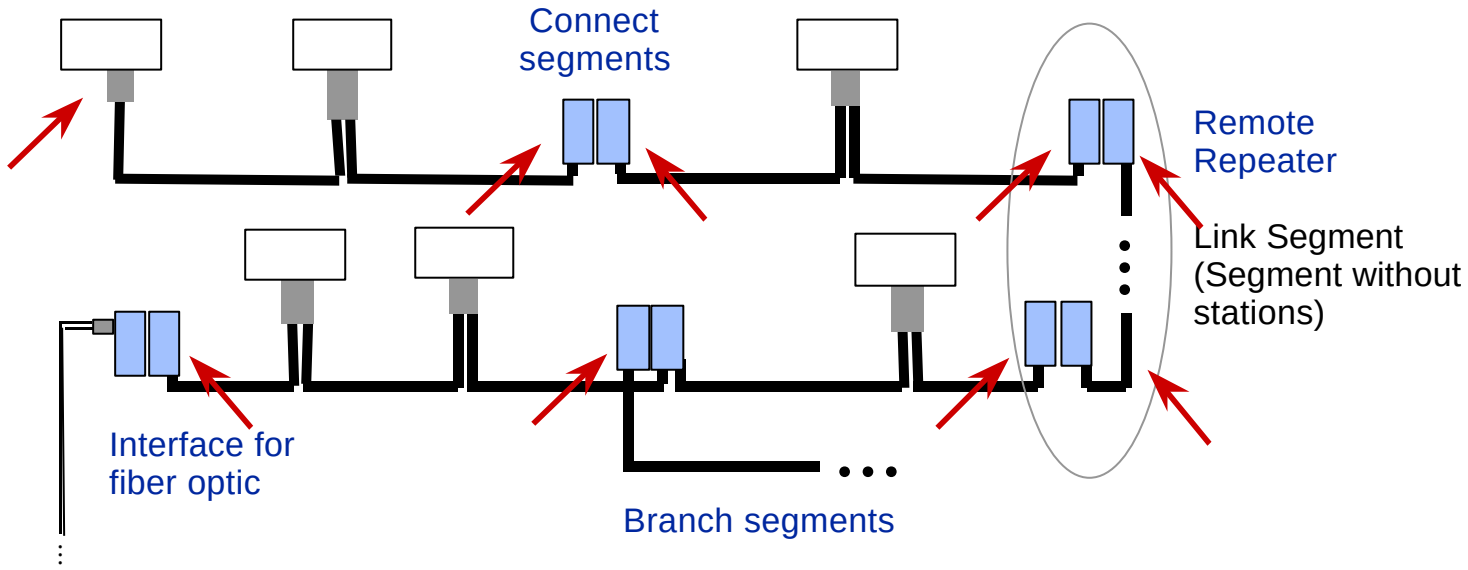
Termination “on” (usually whenever only one cable is connected to a device the termination needs to be “on”)

PROFIBUS Wiring

- **Segments are needed for**
  - exceeding the length
  - exceeding 32 devices (incl. Repeater/OLM)
- **Segments can be used for**
  - building branch segments
  - connecting up to 126 stations (no addr. for Repeater/ OLM)
- **Rules**
  - segment has a max. of 32 devices (incl. Repeater/OLM)
  - the first and the last segment can have 31 stations
  - segments between have 30 stations as a maximum

PROFIBUS Wiring

- segment structure with termination

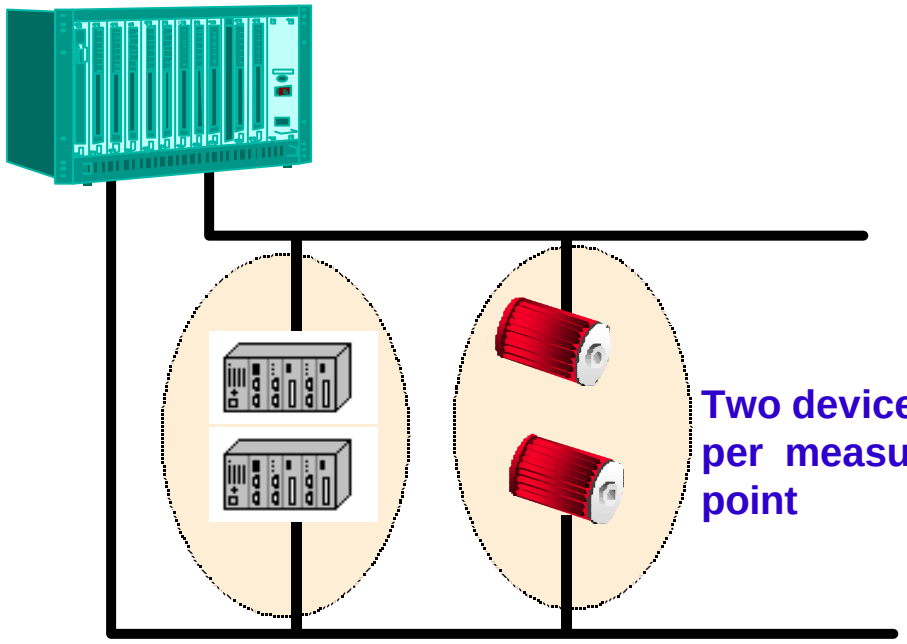


Max. Number Repeater Cascading: 9

PROFIBUS Wiring

Redundancy Improves System Reliability

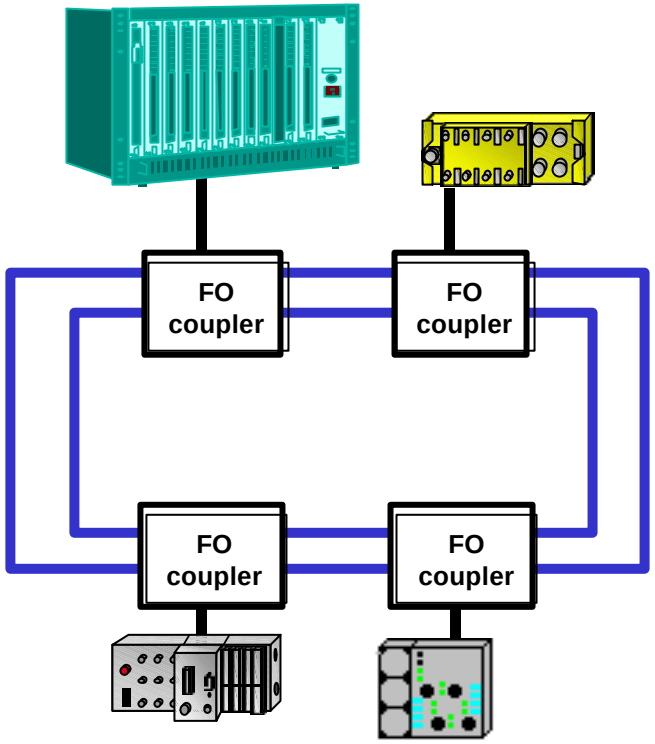
System redundancy



Two devices per measuring point

Several interfaces enable redundant systems

Media redundancy



Fiber optic segments enable redundant wiring

COST Savings

- **Cost Savings in Hardware and Assembly**
  - Less hardware components (I/O, terminal blocks, barriers)
    Easier, quicker and less expensive installation
- **Cost Savings in Engineering**
  - Easier configuration (only one tool for all devices)
    Easier preventive maintenance
    Easier and much faster system start-up
- **Greater Manufacturing Flexibility**
  - Improved functionality increases plant productivity
    Improved availability and reduced down time
    Accurate and reliable diagnostic data
    Reliable digital transmission technology

COST Savings