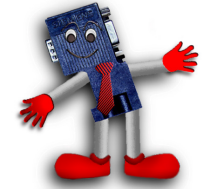




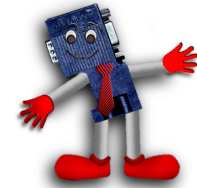
PROFIBUS



⇒ **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**

⇒ **standardization**



EN 50170 Volume 2

**General Purpose
Automation**

PROFIBUS-FMS
RS 485 / FO

Universal

- Large variety of applications
- Multi-master communication

Factory Automation

PROFIBUS-DP
RS 485 / FO

Fast

- Plug and play
- Efficient and cost effective

Process Automation

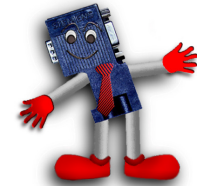
PROFIBUS-PA
IEC 1158-2

Application Oriented

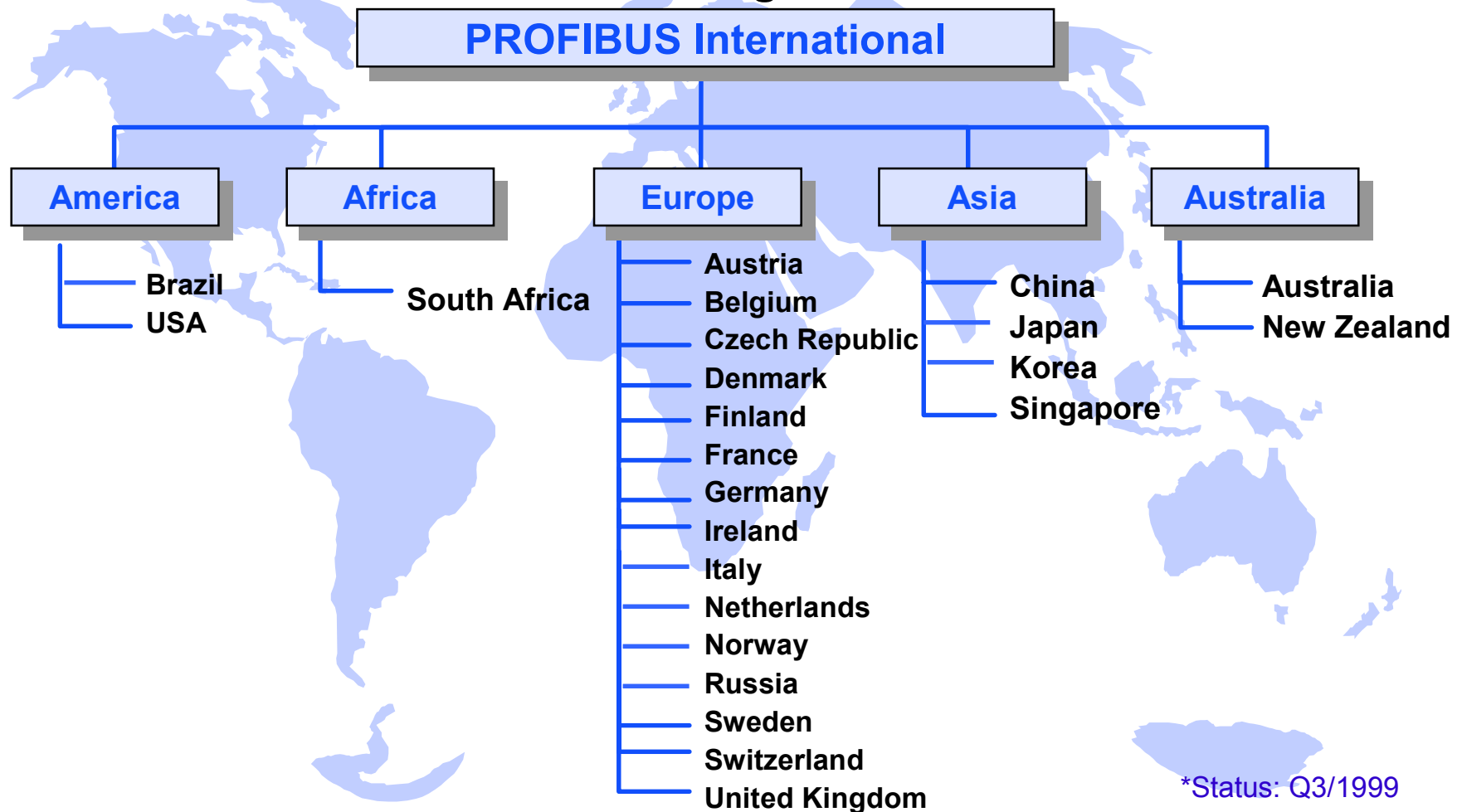
- Powering over the bus
- Intrinsic safety



INTERNATIONAL

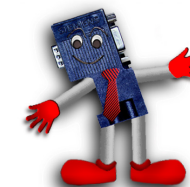


⇒ More than 900 members - 23 regional user associations





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

Valves

Pneumatic Valves
Magnetic Valves

MMI

Operator Panels
Text Displays

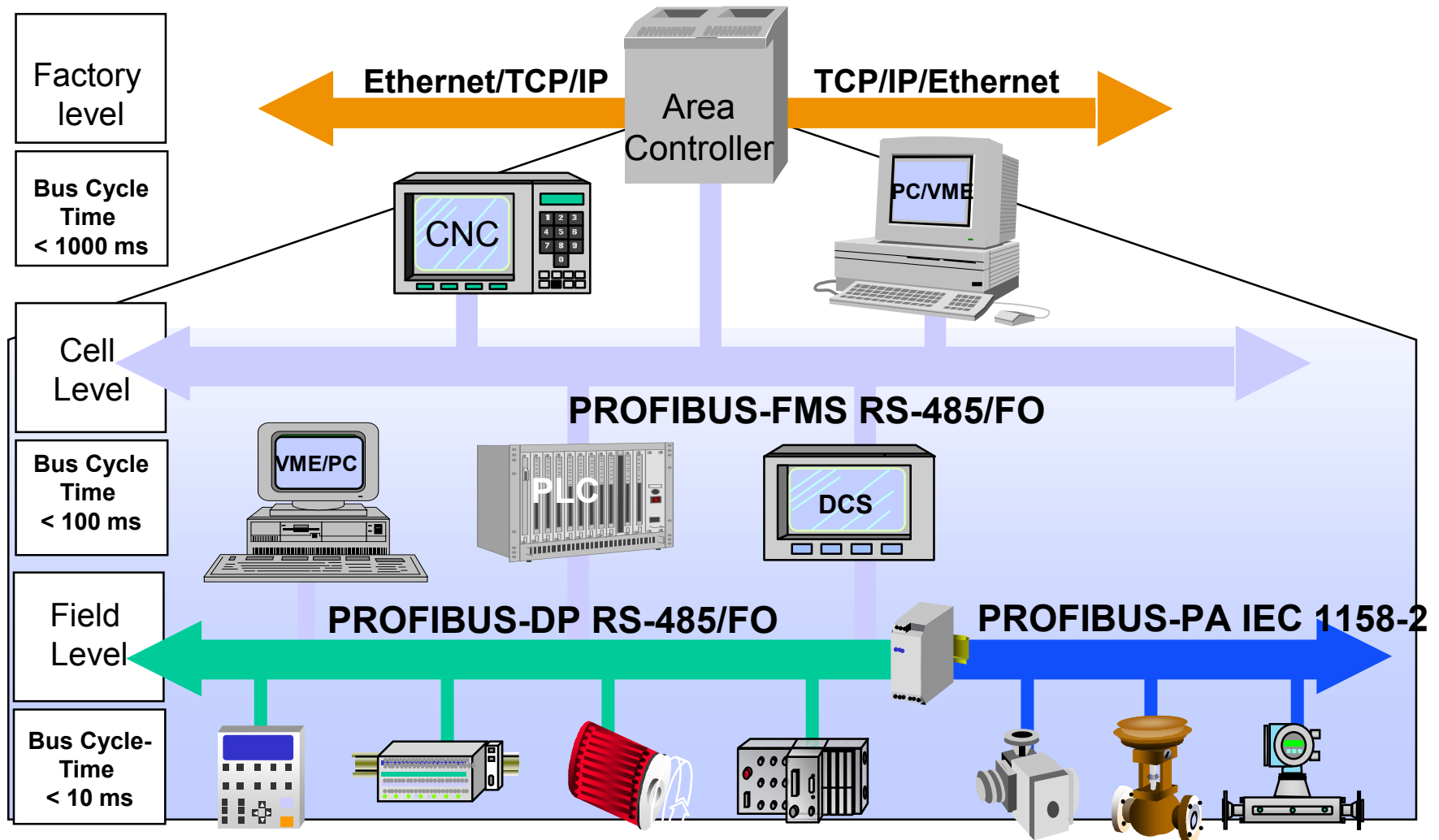
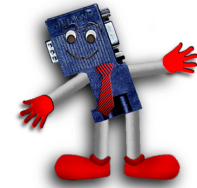
Instruments

Level
Flow
Pressure
Temperature

Gateways

AS-Interface
Proprietary networks

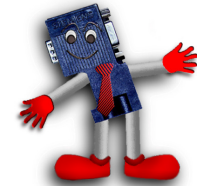
SIEMENS



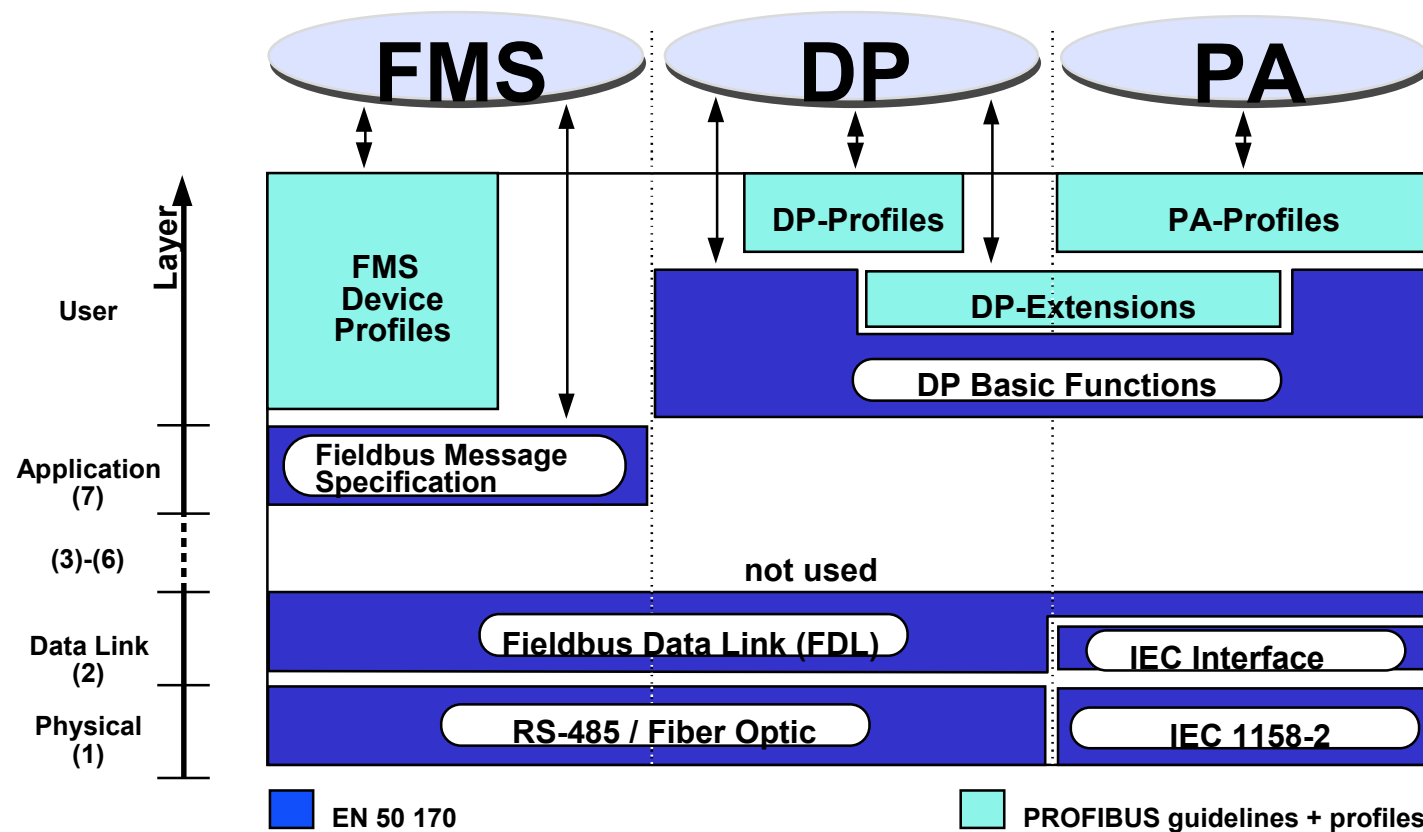
SIEMENS



EN 50170 - 2

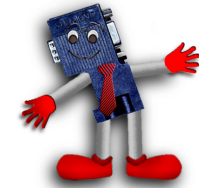


⇒ The PROFIBUS Protocol is in Accordance with the ISO/OSI Reference Model for Open Systems

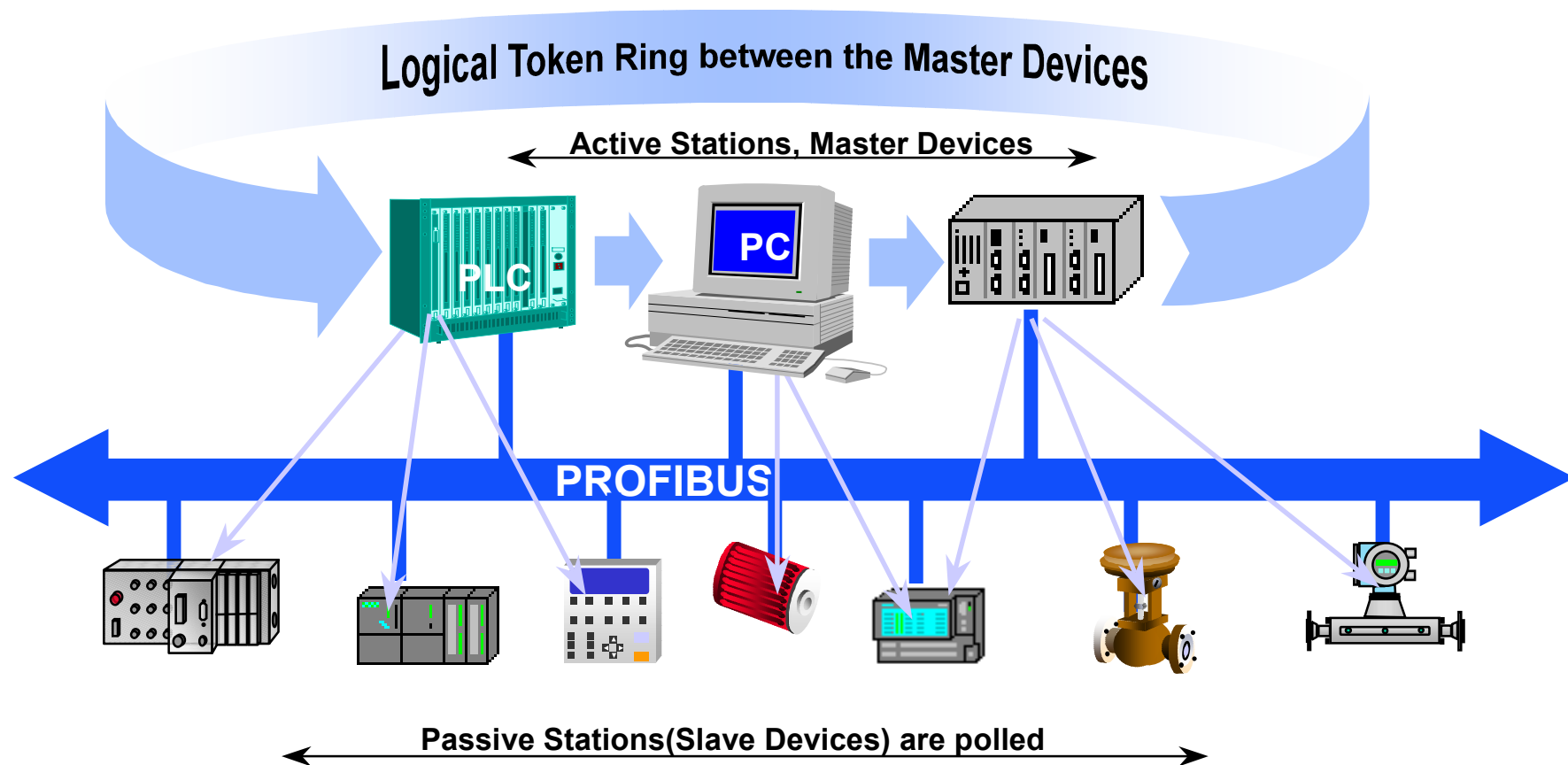




Bus Access

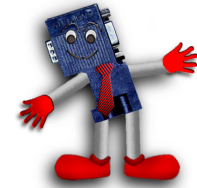


⇒ The PROFIBUS Bus Access Method combines Multi-Master and Master-Slave communications





Bus Access

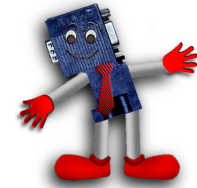


- ⇒ the PROFIBUS Bus Access Protocol (Layer 2) is identical for all three PROFIBUS variations
- ⇒ this enables transparent communication and easy combinations of FMS/DP/PA Network sections
- ⇒ Because FMS/DP use the same Physical Media (RS-485/FO), they can be combined on the same cable





Bus Access



⇒ Hybrid Bus Access Protocol

- ✓ Token-Passing between Masters
Master - Slave Protocol between Master and Slaves

⇒ Master

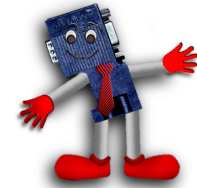
- ✓ active stations with the right to control the bus for a limited amount of time (Token - Hold - Time)

⇒ 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

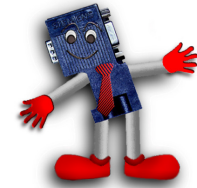
T_{TR} = Target Token Rotation Time

T_{RR} = Real Token Rotation Time

$$T_{TH} = T_{TR} - T_{RR}$$



FMS, DP, PA



⇒ **FMS stands for Fieldbus Messaging System**

✓ peer to peer communication

⇒ **DP stands for Decentralized Periphery**

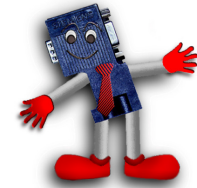
✓ fast data exchange

⇒ **PA stands for Process Automation**

✓ intrinsically safe environment



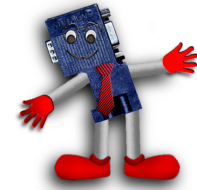
FMS/DP In Common



- ⇒ **DP and FMS are based on same 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**



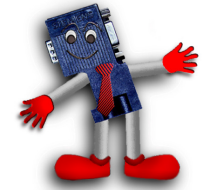
FMS/DP In Common



- ⇒ **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**



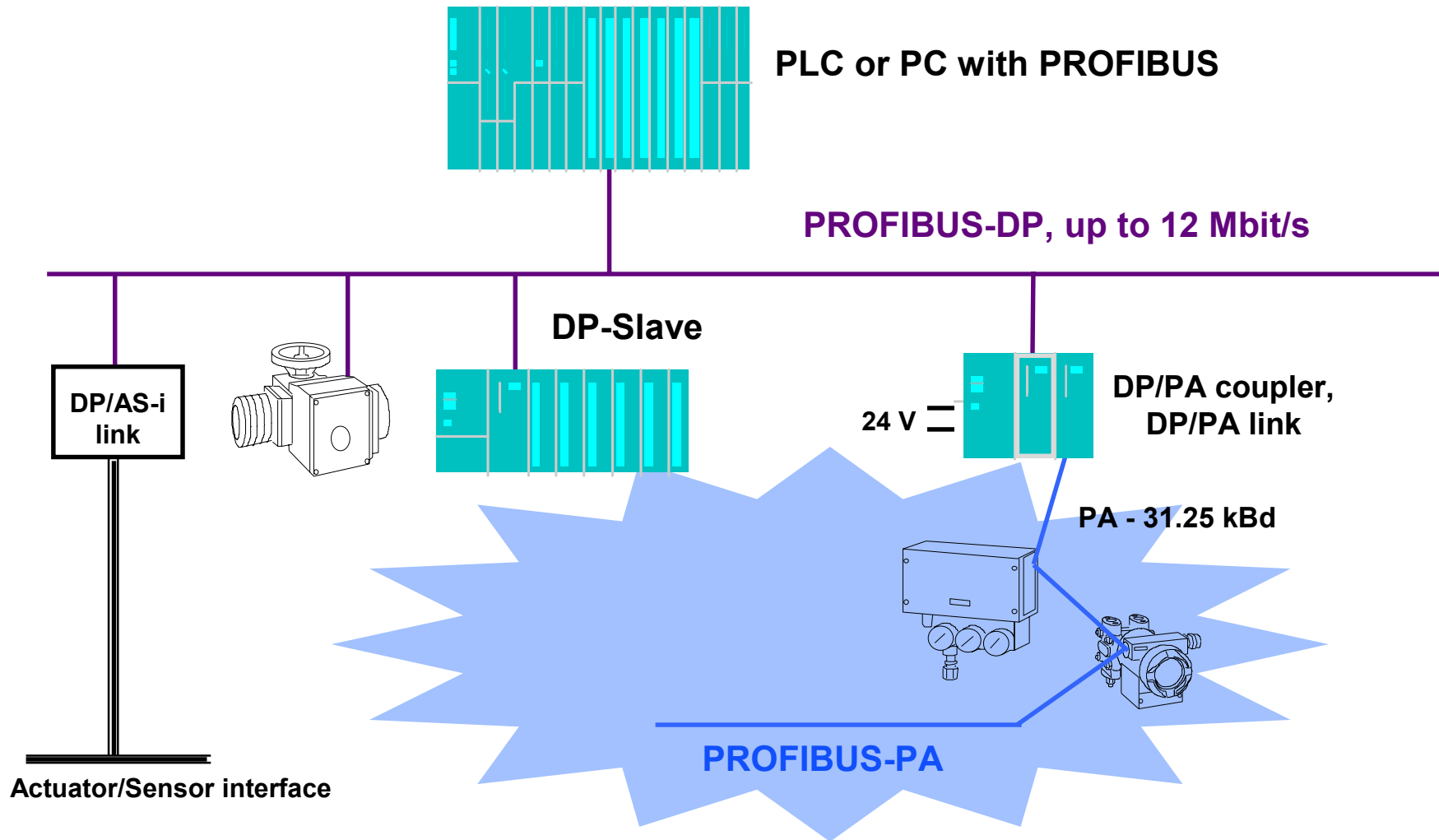
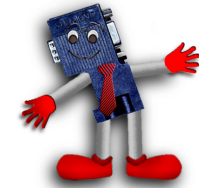
PA/DP In Common



- ⇒ **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**

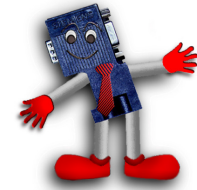


PA/DP In Common





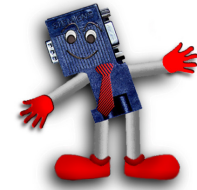
FMS Features



- ⇒ **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 Services

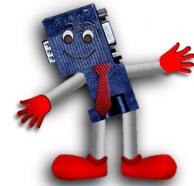


- ⇒ **The FMS application layer (7) consists of the following parts:**
 - ✓ **The Fieldbus Message Specification (FMS) and**
 - ✓ **the Lower Layer Interface (LLI)**

- ⇒ **FMS services are a subset of the MMS services (MMS=Manufacturing Message Specification, ISO 9506)**
 - ✓ **have been optimized for field bus applications and have been expanded by functions for communication object administration and network management**

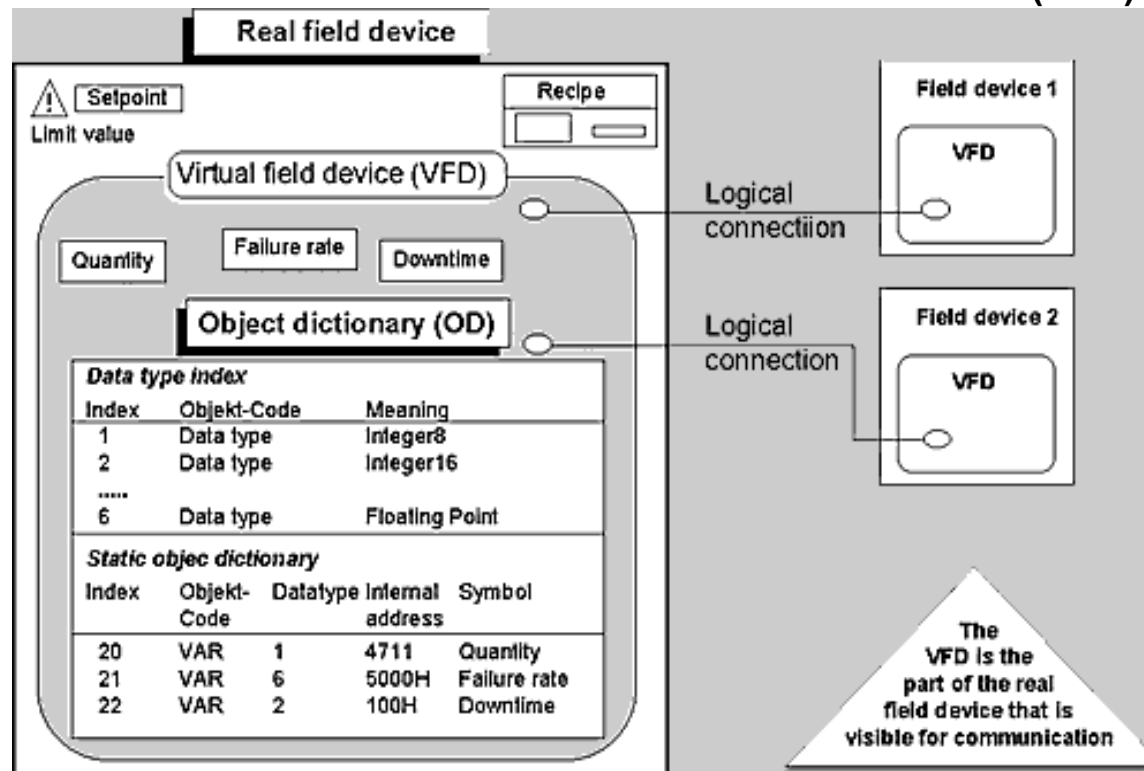


FMS Services



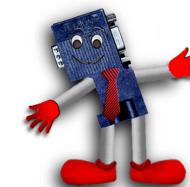
virtual field device (VFD).

- ⇒ The PROFIBUS-FMS communication model permits distributed application processes to be unified into a common process by using communication relationships.
- ✓ The portion of an application process in a field device which can be reached via communication is called a virtual field device (VFD)

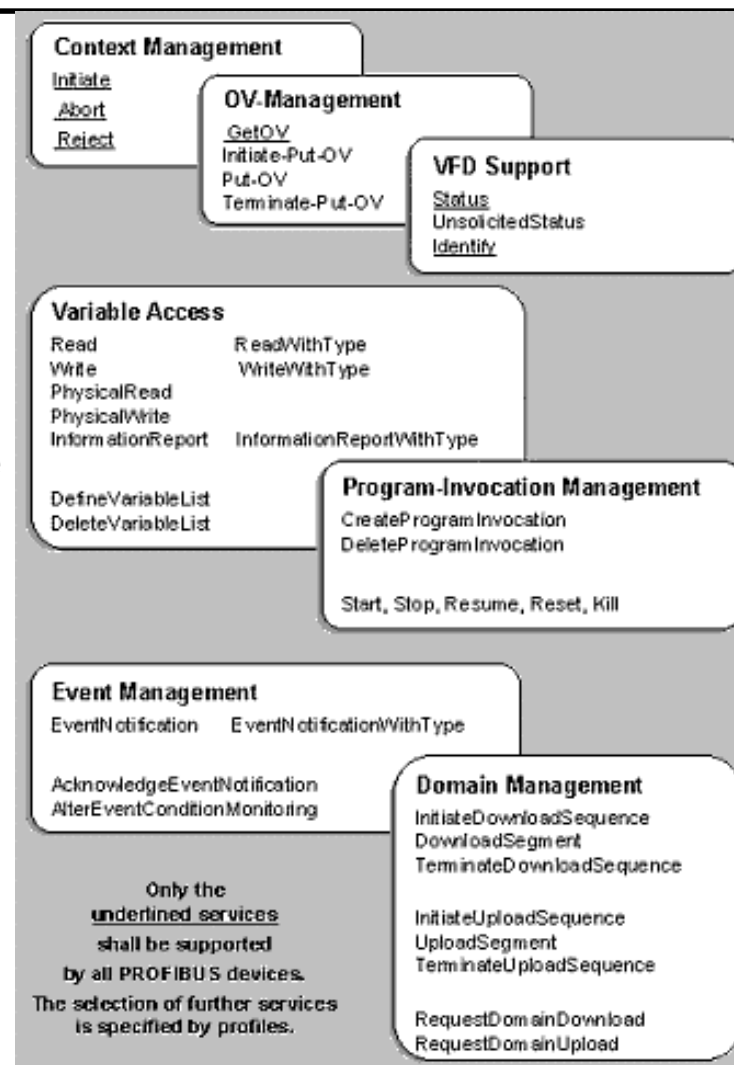




FMS Services

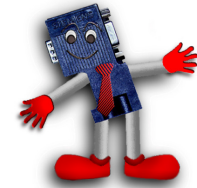


- ⇒ **Context Management** services are for establishing and terminating logical connections.
- ⇒ **Variable Access** services are used to access variables, records, arrays or variable lists.
- ⇒ **Domain Management** services are used to transmit large memory areas. The data must be divided into segments by the user.
- ⇒ **Program Invocation Management** services are used for program control.
- ⇒ **Event Management** services are used to transmit alarm messages. These messages can also be sent as broadcast or multicast transmissions.
- ⇒ **VFD Support** services are used for identification and status polling. They can also be sent spontaneously at the request of a device as multicast or broadcast transmissions.
- ⇒ **OD Management** services are used for read and write access to the object dictionary.



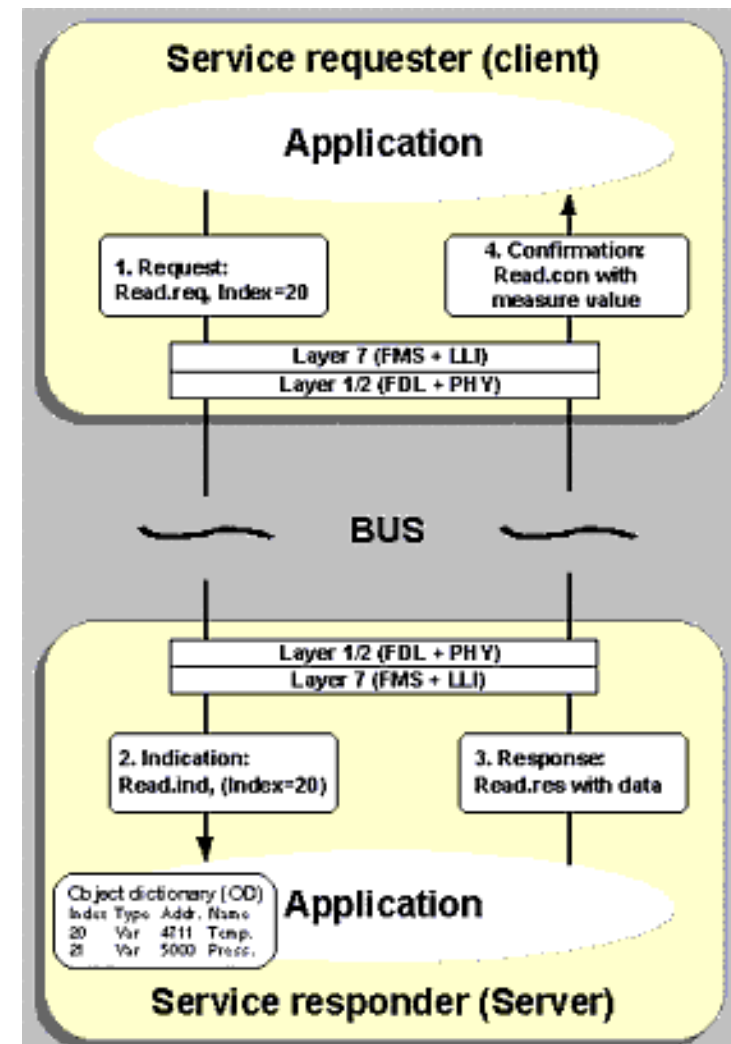


FMS Services



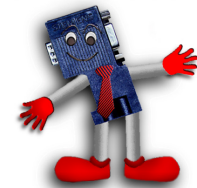
⇒ **Confirmed services** can only be used for connection-oriented communication relationships. The execution of a service is shown in Figure

⇒ **Unconfirmed services** can also be used on connectionless communication relationships (broadcast and multicast). They can be transmitted with high or low priority.

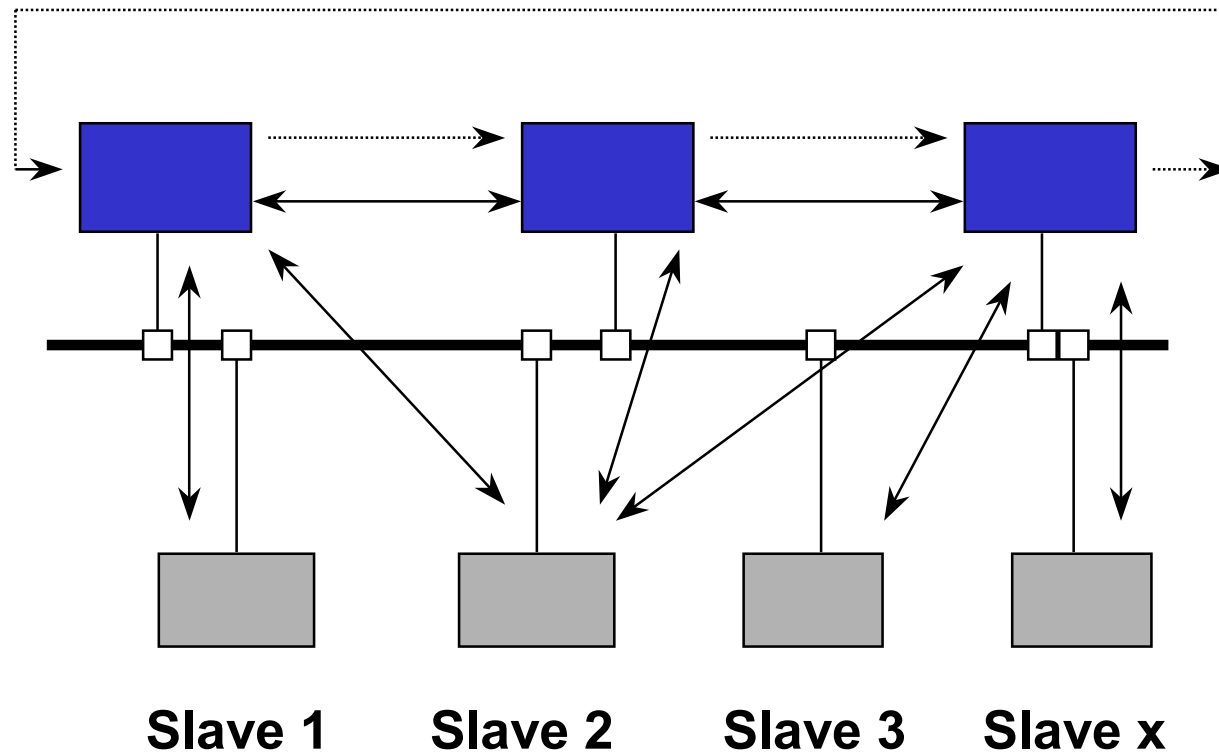




FMS Features

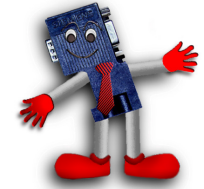


⇒ **FMS access procedure**





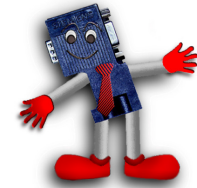
PA Features



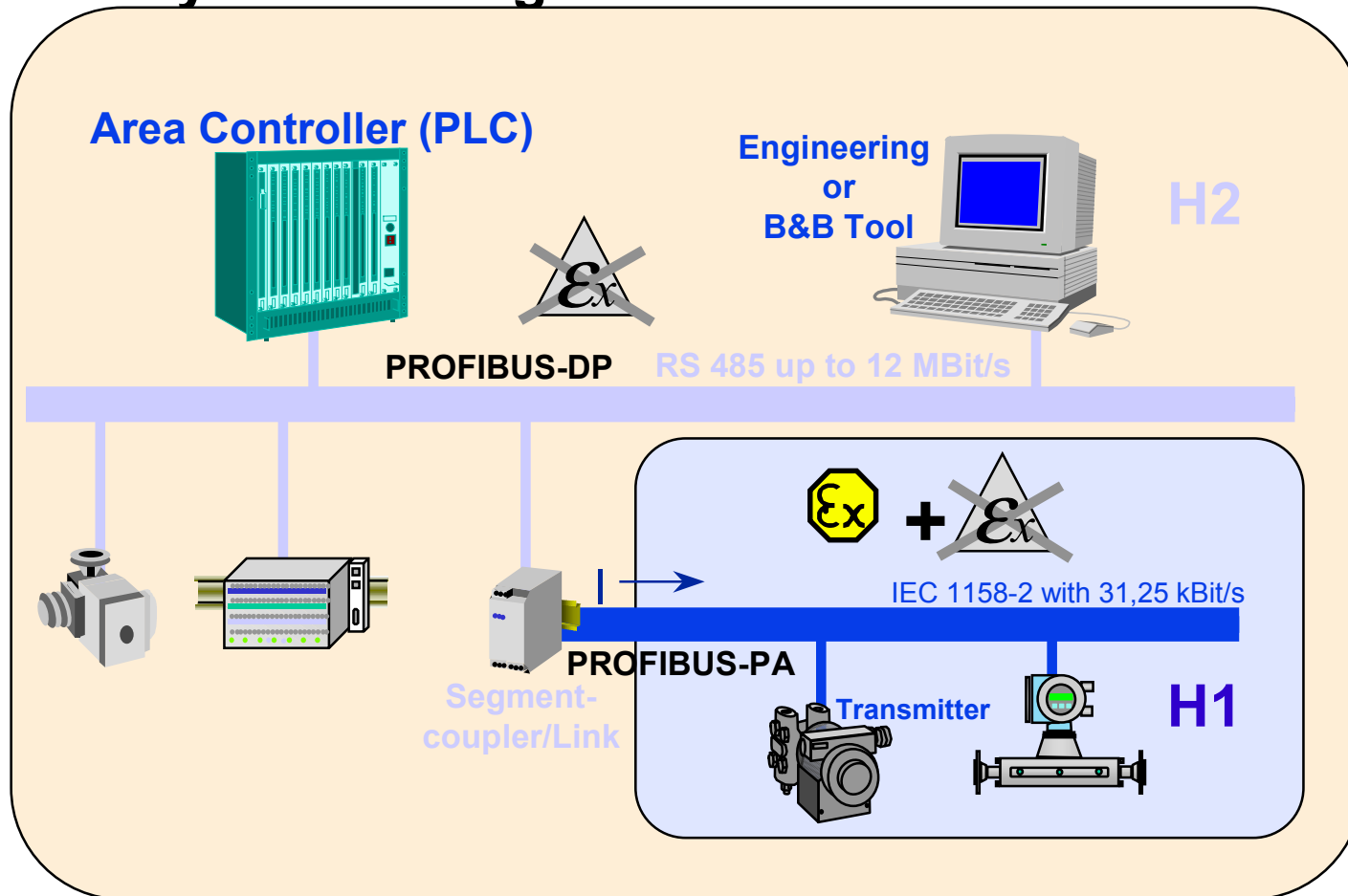
- ⇒ **Based on the extended PROFIBUS-DP Protocol and IEC 1158-2 Transmission**
- ✓ **Suitable to replace today's 4...20 mA Technology**
 - ✓ **Only two wires for data and power**
 - ✓ **Connects Instruments to the control system via a serial bus**
 - ✓ **Functional improvements plus reliable serial digital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



PA Features

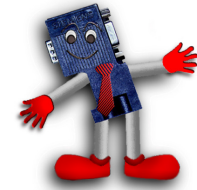


Typical System Configuration with PROFIBUS-PA

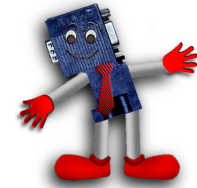




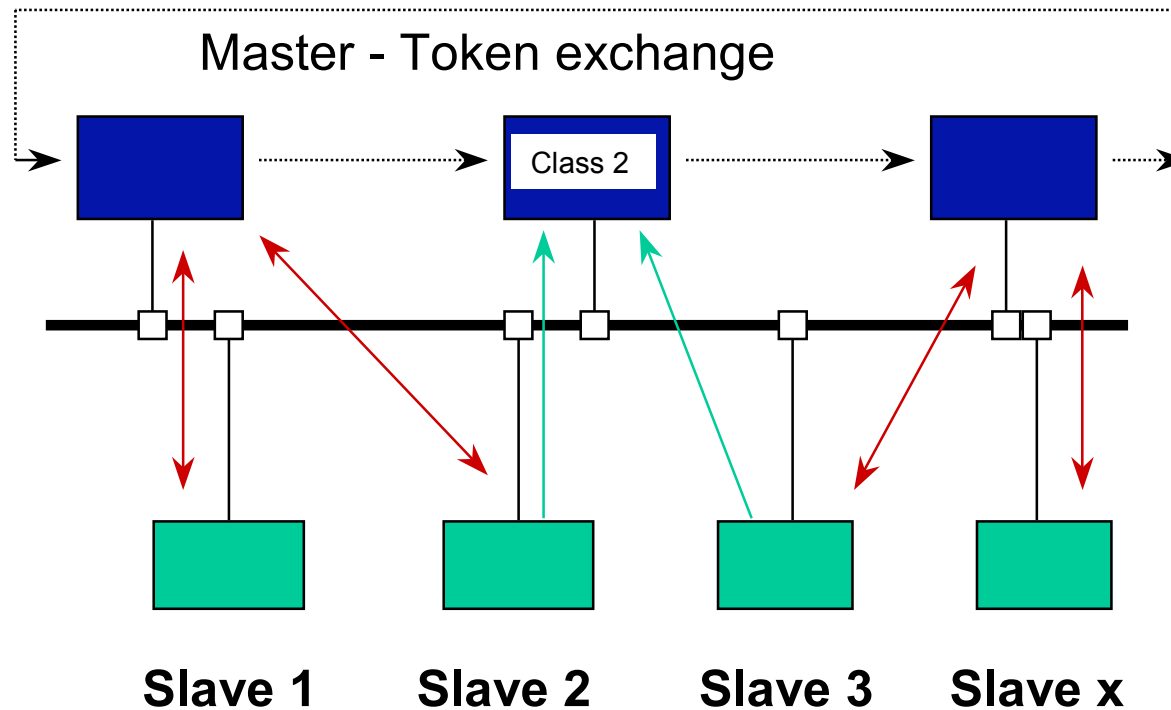
DP Features



- ⇒ **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**

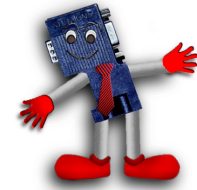


⇒ DP- Access Procedure





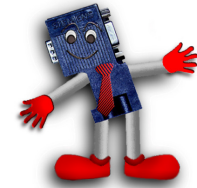
Reliability-DP/FMS



- ⇒ **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



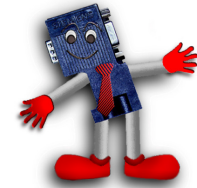
PROFIBUS Wiring



- ⇒ **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**

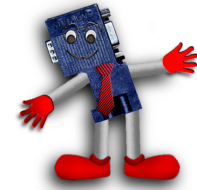
- ✓ line parameters are defined in EN 50170
- ✓ standard cable available from Belden and Siemens
- ✓ standard connectors available

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



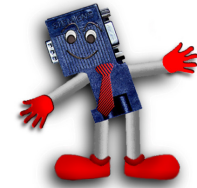
⇒ fiber optic components

- ✓ 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

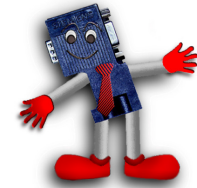


⇒ infrared components

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

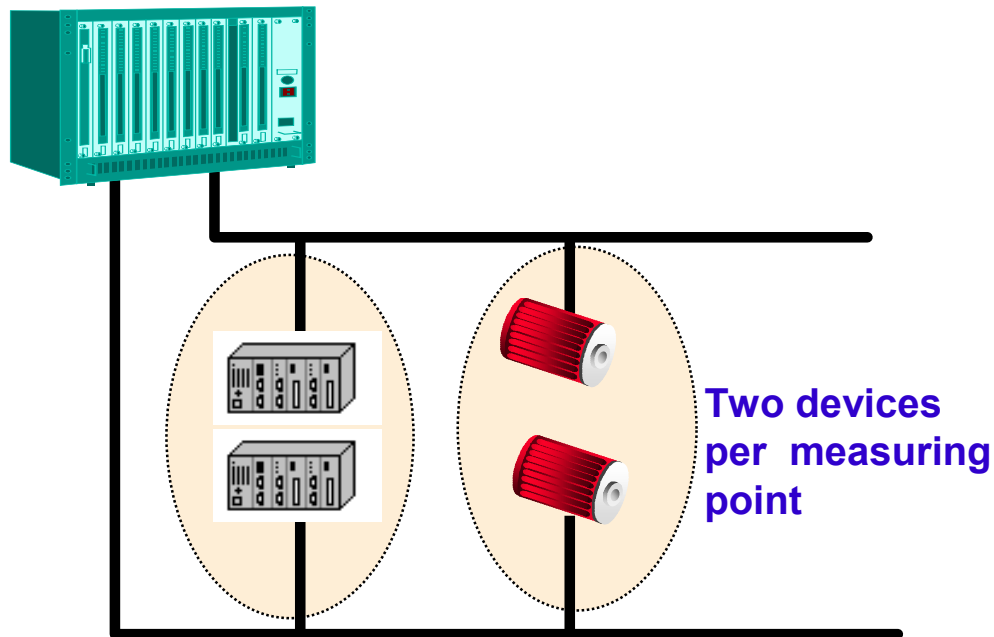


PROFIBUS Wiring



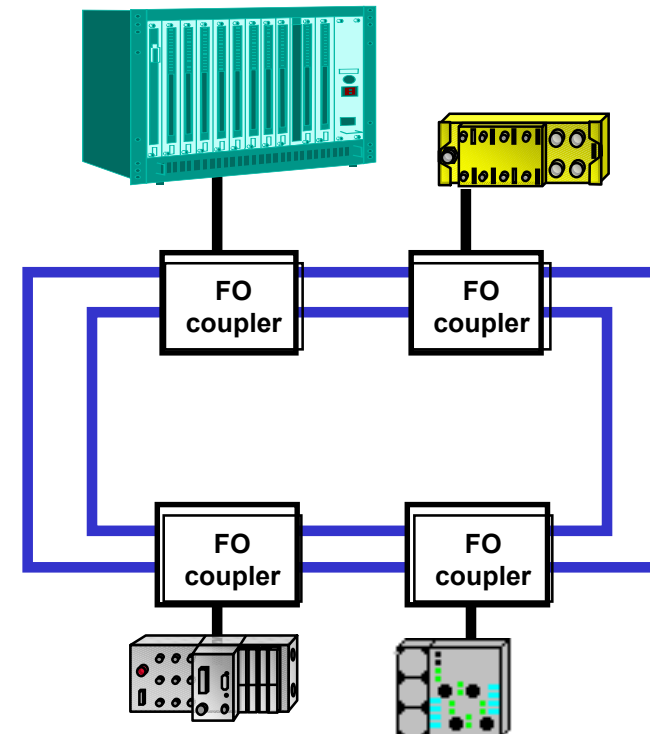
⇒ Redundancy Improves System Reliability

System redundancy



Several interfaces enable redundant systems

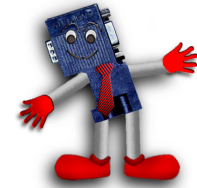
Media redundancy



Fiber optic segments enable redundant wiring



DP Details



⇒ class 1 master -

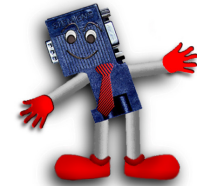
- ✓ central controller which exchanges data with the connected I/O devices (slaves)
- ✓ determines the baudrate
- ✓ handles the Token
- ✓ several class1 masters are permitted, typical devices are PLC, PC

⇒ class 2 master -

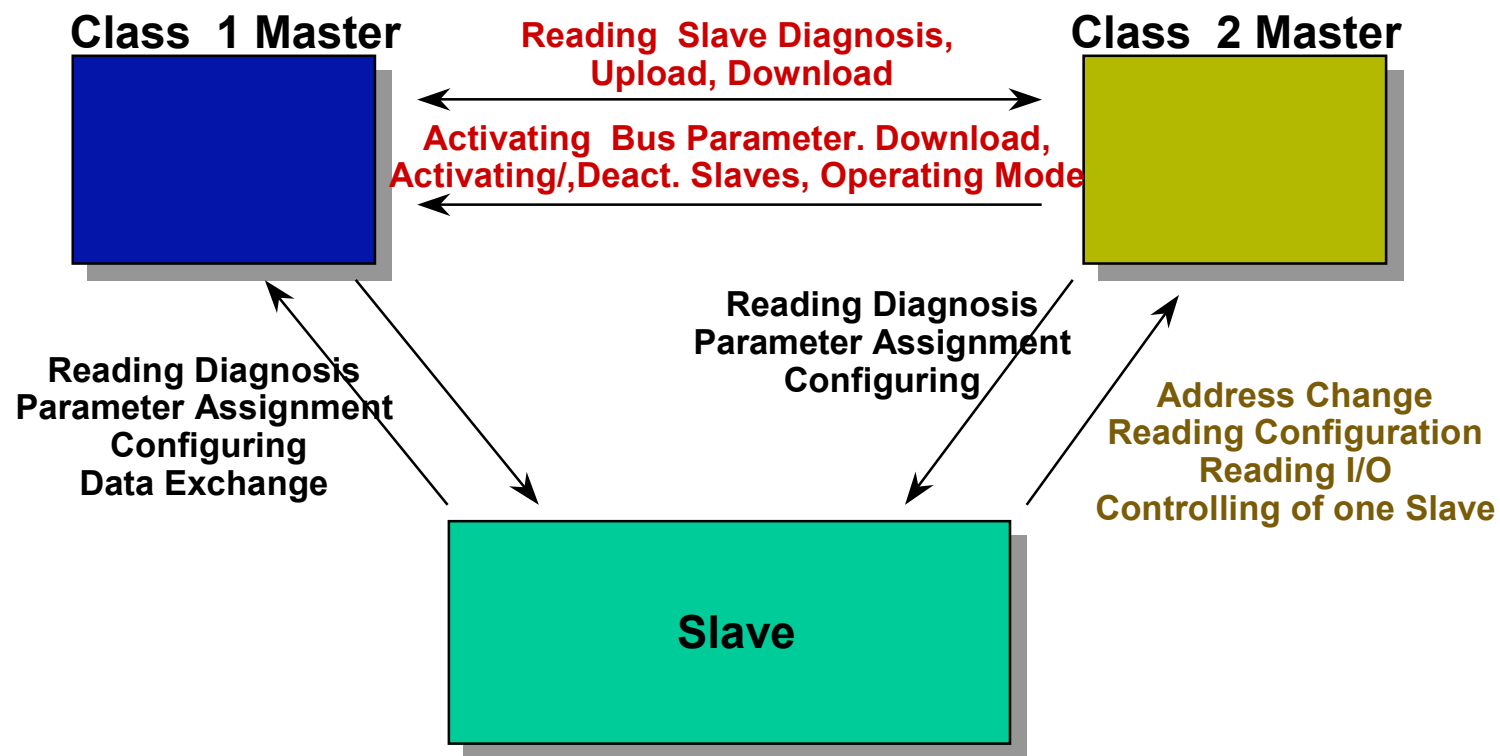
- ✓ diagnostic and startup tool, typically a configuration tool
- ✓ can control one slave at a time

⇒ slave station -

- ✓ passive station which acknowledges messages or answers per request



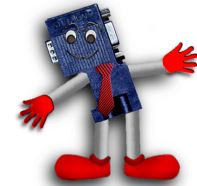
⇒ master- master, master- slave communication



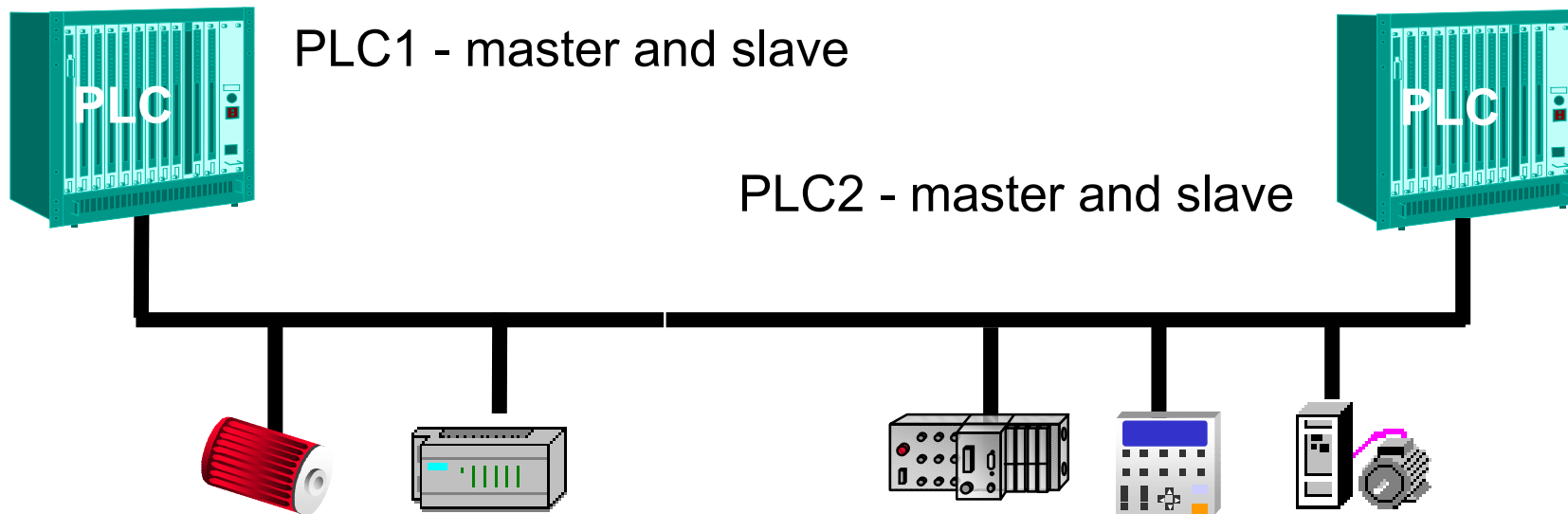
a device can consist of multiple functions, e.g.... class1 and class2, class1 and slave



DP Details

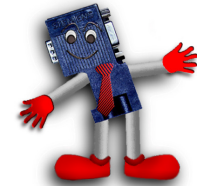


- ⇒ A device can consist of multiple functions, e.g... class1 and class2, class1 and slave, which allows:
- ✓ a simple master master communication via the master - slave combination
 - ✓ whenever one master has the token the other PLC can be a slave to this master

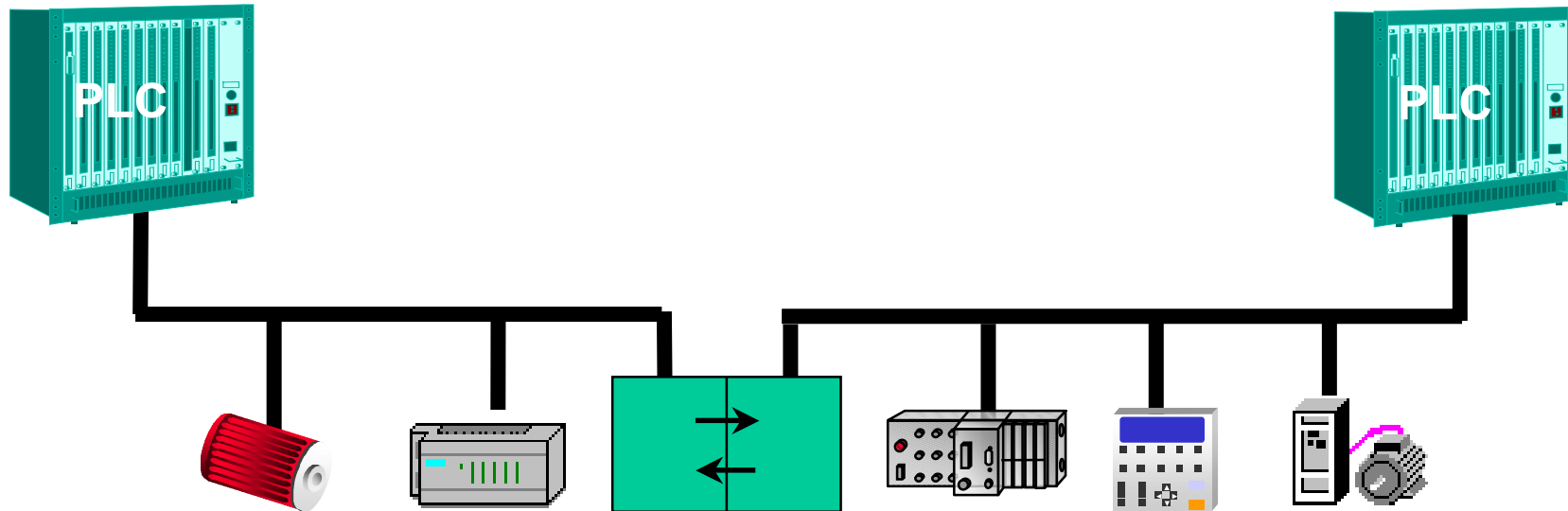




DP Details

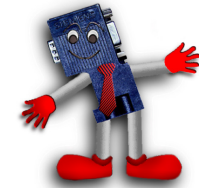


- ⇒ **Master - Master communication by using a DP-DP gateway**
- ✓ **combination of two mono master systems**
 - ✓ **simple data exchange between the two masters up to 244 byte**

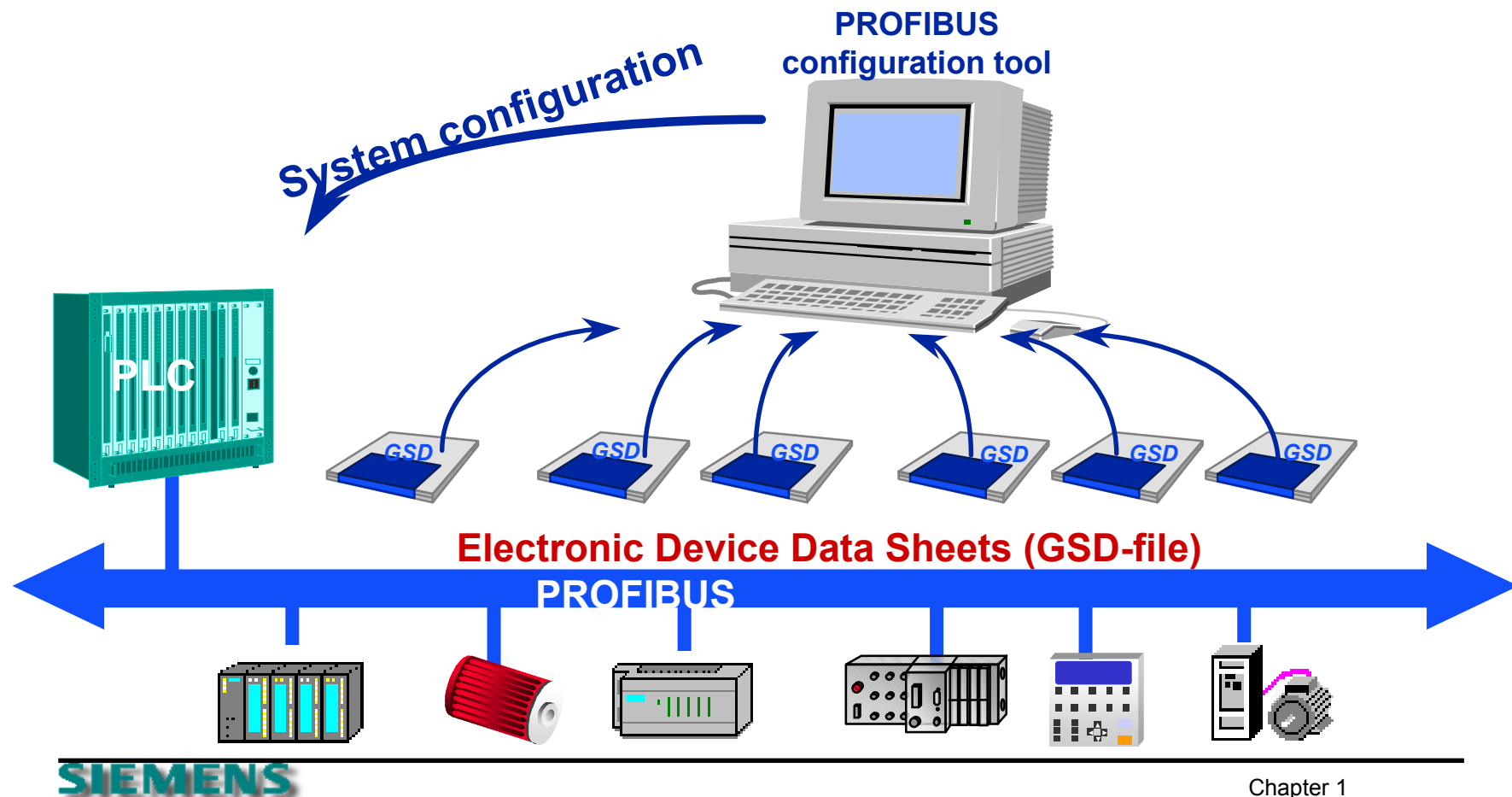




Interoperability

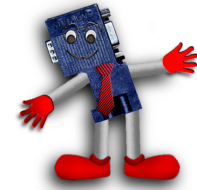


⇒ Open Configuration permits Plug and Play





Device Description

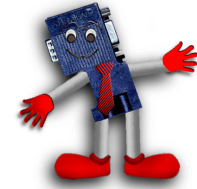


⇒ GSD file

- ✓ each slave or master class 1 device on PROFIBUS DP needs to have a device description file, the characteristic of each PROFIBUS-DP device is described in the GSD-File
- ✓ the GSD-file contains all device specific parameters e.g.:
 - × Supported Baudrate
 - × Supported Message Length
 - × Number of input / output data
 - × Meaning of diagnostic messages
 - × Options for modular devices e.g. which are available
- ✓ text file (ASCII-format)
- ✓ each configuration tool relates to the GSD information



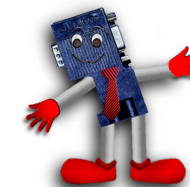
Device Description



- ✓ **GSD-Files are created by the device vendors**
- ✓ **the PROFIBUS Trade Organization provides an GSD-Editor which makes it very easy to create GSD-Files**
- ✓ **the GSD-Editor contains a GSD-Checker which guarantees the conformance of the GSD-Files to the PROFIBUS standard**
- ✓ **a library of GSD-Files is provided at the PROFIBUS web page: <http://www.profibus.com>**



Device Description



# P r o f i b u s _ D P	(M)
: < P R M - T e x t _ D e f _ L i s t >	(O)
P r m T e x t =	
... ..	
E n d P r m T E x t	
; < E x t - U s e r _ P r m _ D a t a _ D e f _ L i s t >	(O)
E x t U s e r P r m D a t a =	
... ..	
E n d E x t U s e r P r m D a t a	
; < U n i t _ D e f i n i t i o n _ L i s t >	(M)
G S D _ R e v i s i o n = 1	
V e n d o r _ N a m e =	
... ..	
... ..	
; S l a v e s p e c i f i c d a t a	(M)
F r e e z e _ m o d e _ s u p p o r t e d =	
... ..	
... ..	
; U s e r _ P r m _ d a t a	
... ..	
; U n i t _ d i a g n o s t i c	
... ..	
; < M o d u l e _ D e f i n i t i o n _ L i s t	(M)
M o d u l e =	
... ..	
E n d M o d u l e	

← Parameter text (O)

← ext. user parameter data (O)

← mandatory general data (M)

← generic slave data (M)

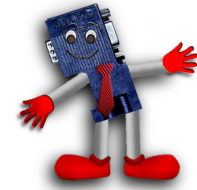
← device related slave data (O)

← I/O definition (M)



DP Interactions

DP Extended

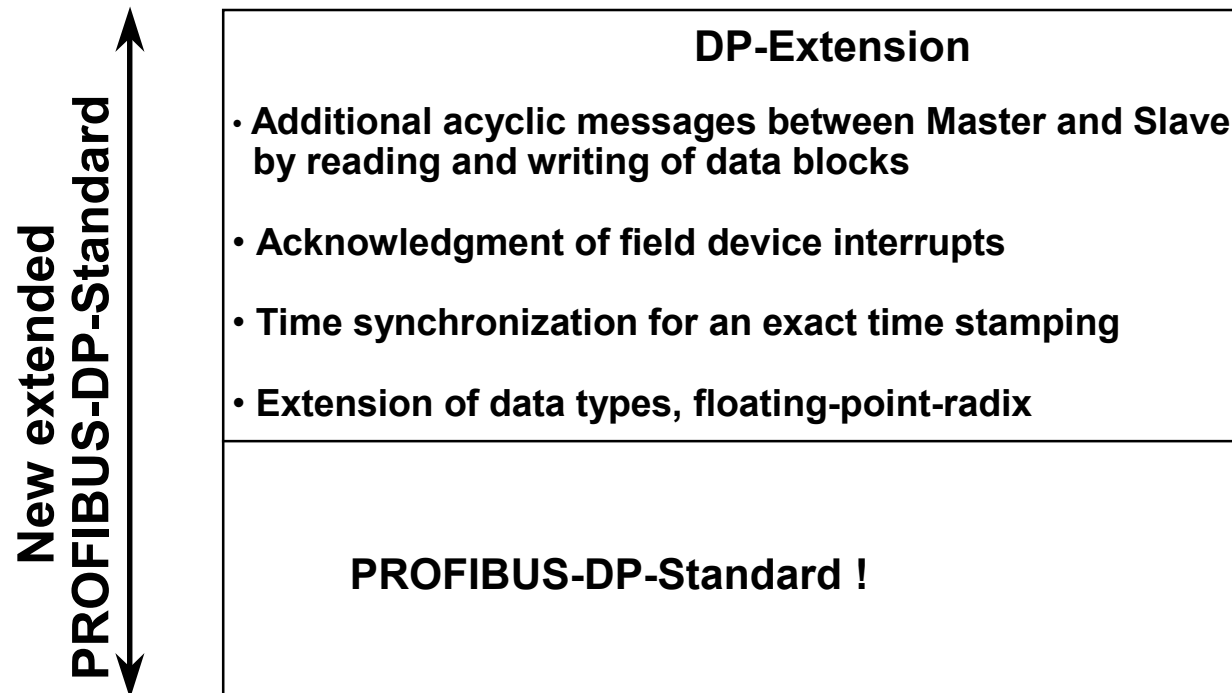
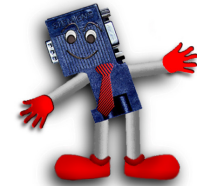


⇒ Why DP extended?

- ✓ the requirements of the process industry are included
- ✓ selecting and changing parameters of a field device from several DP-Masters, e.g.. CPU, PG or HMI Devices
 - × provides for higher flexibility in operation
- ✓ Interrupts from Field Devices, e.g.. for diagnostics, have to be accepted by the DP-Master
 - × allows for greater security
- ✓ time stamping of events, e.g.. for interrupts, accurate history of special events
- ✓ additional data formats are necessary for transmitting data, e.g.. floating-point-radix



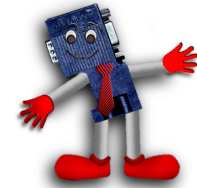
DP Extended



→ every station that handles the DP-extensions must meet the previous PROFIBUS-DP-Standard-Functions!



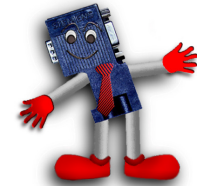
DP Extended



- ⇒ **Acyclic communication connections between Class 1 Master and Slave via Slave SAP 51**
- ✓ **Read data set (DDL_M_Read)**
 - ✓ **Write data set (DDL_M_Write)**
 - ✓ **Acknowledge alarms (DDL_M_Alarm_Ack)**
 - ✓ **Only the master that parameterized and configured the slave can utilize the SAP 51 for these services also**
 - ✓ **Alarm can only be acknowledged by the Class 1 Master via SAP 51 (access protection)**



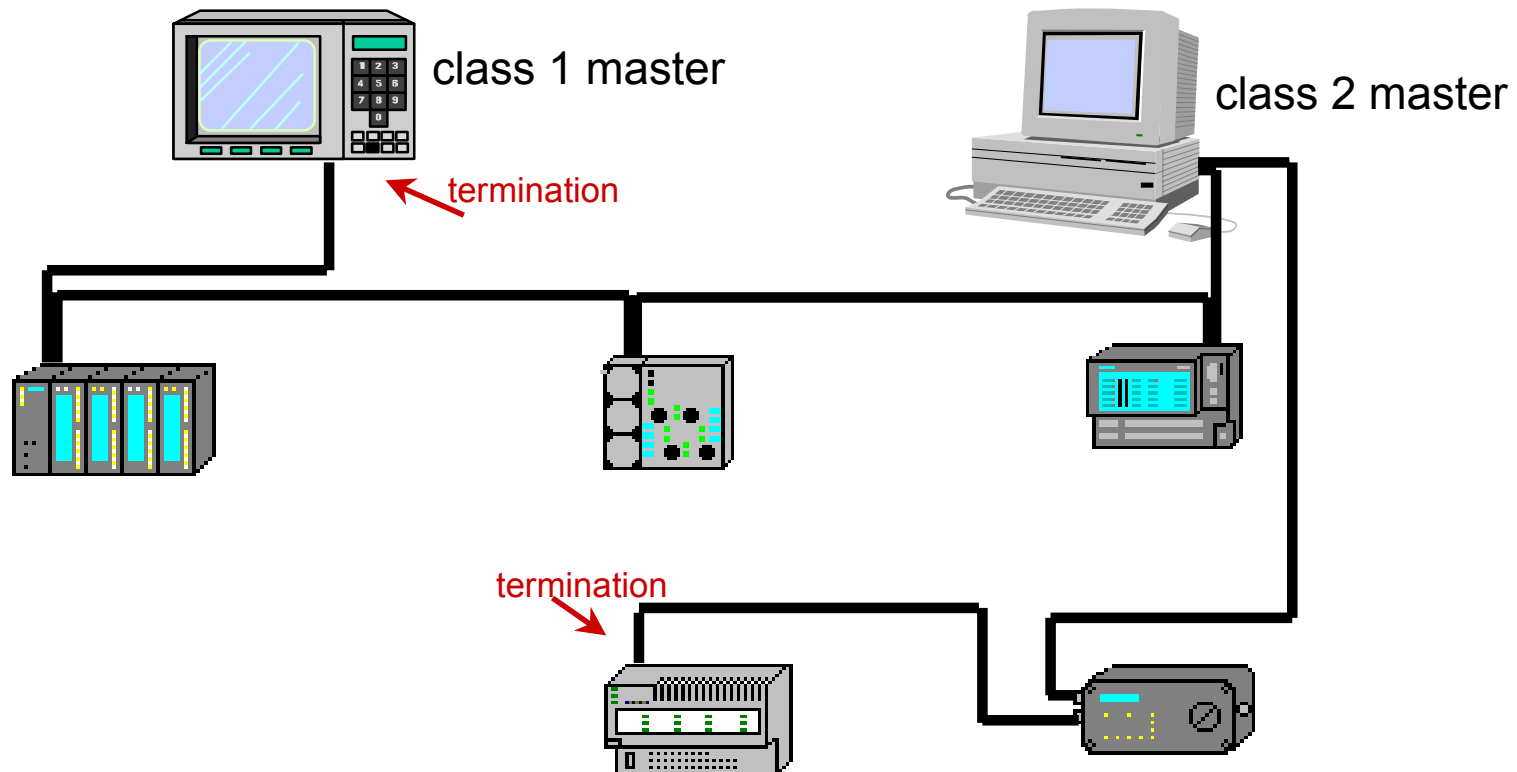
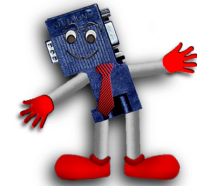
DP Extended



- ⇒ **Acyclic communication relations between Class 2 Master and Slave via SAP 0...49**
- ✓ **Initiate (MSAC2_Initiate) - SAP 49**
 - ✓ **Abort (MSAC2_Abort)**
 - ✓ **Read Data Set (MSAC2_Read)**
 - ✓ **Write Data Set (MSAC2_Write)**
 - ✓ **Data Transport (MSAC2_Data_Transport)**

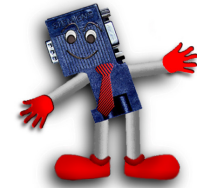


Network Setup





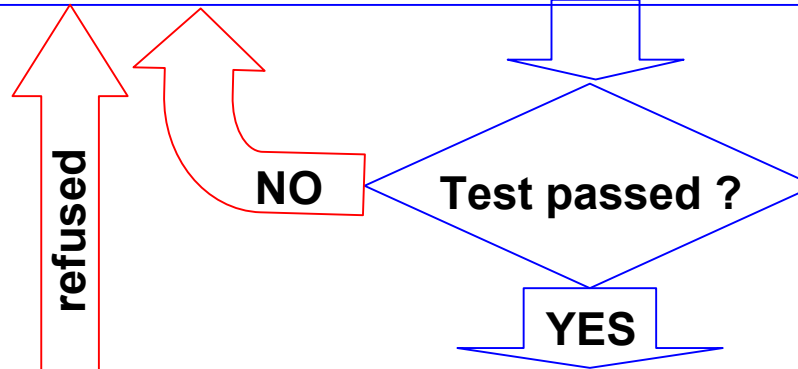
PIC certification



⇒ How to certify a device!

- Vendor applies for an ID number from PROFIBUS International (PI) for his device
- Vendor develops the PROFIBUS device and writes a GSD file

Applies for Certification test at any PROFIBUS Test Lab



Vendor receives two test reports and can apply for a certificate via PI

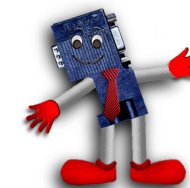


CERTIFICATE

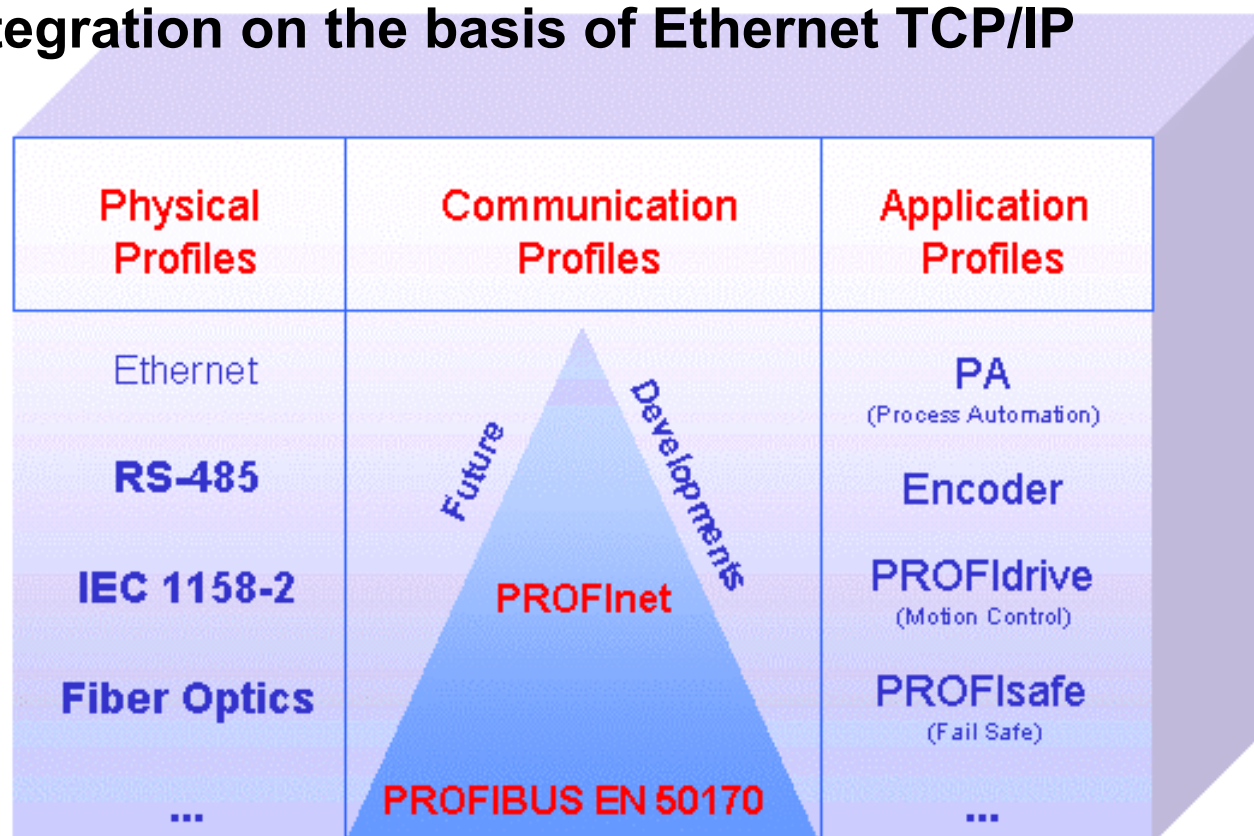




Profibus & Ethernet

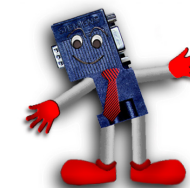


⇒ The PROFIBUS User Organization is currently working on the implementation of universal concepts for vertical integration on the basis of Ethernet TCP/IP





PROFINet



- ⇒ Automation object model according to the Microsoft COM/DCOM standard
- ⇒ Communication: TCP(UDP)/IP and DCOM wire protocol devices
- ⇒ Object handling in engineering and HMI: Microsoft OLE, ActiveX
- ⇒ Integration of existing unchanged PROFIBUS bus segments and PROFIBUS based devices

