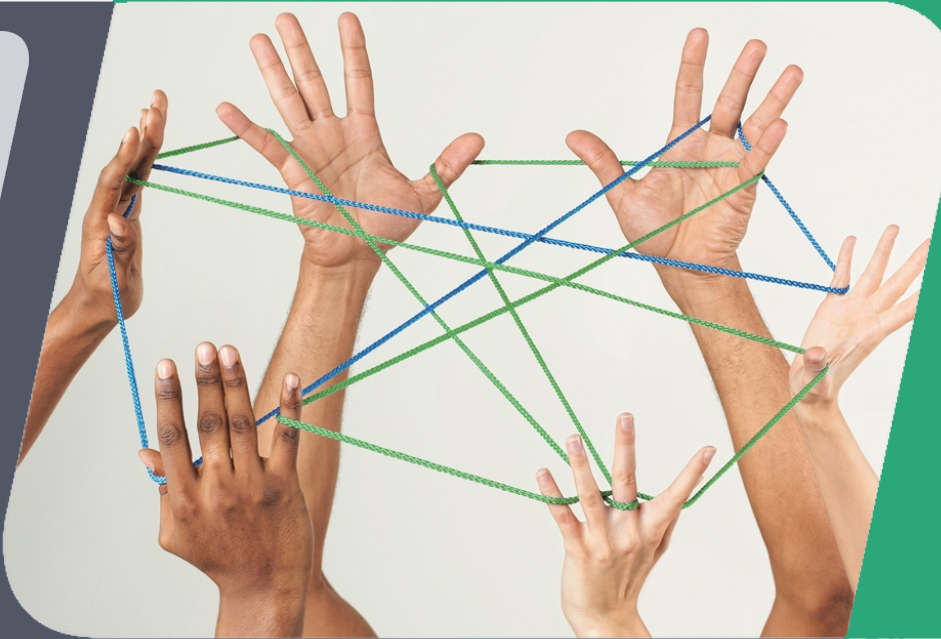**PROFIdrive**

Basic

Slide Set

PROFIdrive

(Drive Technology)

Technology

PROFIdrive
on PROFIBUS

PROFIdrive
on PROFINET

Implementation

- The **PROFIdrive Basisc Slide Set**
  provides compact information on technology, operation, application and benefits of drive technology and PROFIdrive

- The presentation mode (F5) should be used

- For some slides additional information is avalable which can be found by clicking on 💬 (top left on the slide)

- For easy handling, the slide set is structured in sections
  Click to find the list of content

Continue

Back to Start

PROFIdrive at a glance

- PROFIdrive is the leading vendor-neutral, IEC-standardized Motion Control technology, developed and supported by PROFIBUS & PROFINET International.

- PROFIdrive interfaces different drives from different vendors with the plants or machines communication system

- PROFIdrive, by its own outstanding features and by using other PI technologies such as PROFIBUS, PROFINET, PROFIsafe and PROFIenergy, provides best possible solutions to the demanding requirements of to days automation.

- The SlideSet PROFIdrive provides an overview of drive technology using PI technologies

Continue

Back to Start

Drive technology

| Introduction | Generals | Technical Progress |

Device profiles PROFIdrive und Encoder

| Device Profiles | Profile PROFIdrive | Profile Encoder |

PROFIBUS (Fieldbus) as drive bus

| PROFIBUS Basics | PROFIdrive on PROFIBUS |

PROFINET (Industrial Ethernet) as drive bus

| PROFINET Basics | PROFIdrive on PROFINET |

Special applications and solutions

| Drives and Safety | Drives and Energy Efficiency |

Implementation

| PROFIdrive implementation Community project |

Organisation and Support

| PROFIBUS & PROFINET International (PI) | Certification |

Case Studies

Drive technology

with PROFIdrive (1)

Generals

Applications

Drive Technology

- Drive technology is a fundamental requirement in both manufacturing and process automation

- Use cases range
  - from drives with fixed and variable speed such as for pumps, fans or compressors etc.,
  - to single-axis positioning controllers for applications such as for moving, setting and positioning,
  - to multi-axis interpolation for packaging, printing, or milling.

- Drives are extremely significant in terms of industrial energy saving tasks, because electrical drives account for almost 2/3 of industrial power demand.

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Back to Start

Important facts

- Electric drive technology has passed through a significant innovation phase contributed to various progress in manufacturing and process industries.

- Electric drives are respnsible für up to 70 % of total industrial power consumption. Therefore, progess in drive technology includes remarkable savings in power consumption.

- Drives technology innovation is strongly related to innovation in communication technology such as Fieldbus and Ethernet.

- Innovation was also driven by the development of internationally-standardized, vendor-neutral „device profiles" for drive devices.

Back to content

Application „Pumps"

▮ Flexible process control due to fast, precise flow rate adjustment

▮ Safety-related shutdown in case of faults or maintenance

▮ Energy savings through higly efficient motors and speed-controlled drives

▮ High plant availability and service life

Back to content

Application „Compressors and fans"

- Centralized control in distributed systems using fieldbus interfaces

- Easy maintenance through networking with centralized control units

- Energy saving potential through flexible motor speed presetting and control

Back to content

Application „Conveying"

- Minimized downtimes through easy extensibilitxy and fast device replacement

- Increased productivity during commissioning due to integrated safety functions

- Excellent availability due to high quality and comprehensive diagnostics for preventive maintenance

Back to content

Application „Motion Control"
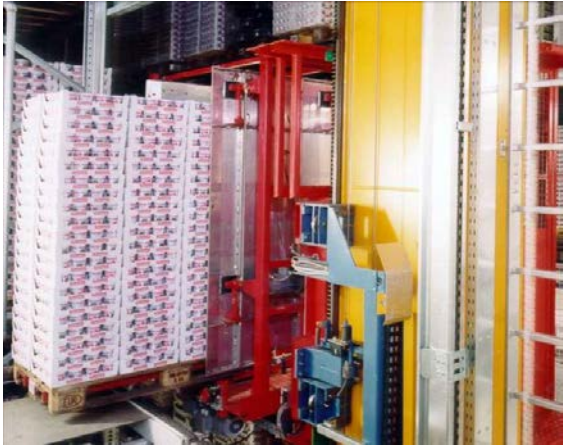
- Support of flexible machine concepts for fast realization of user-specific requirements

- Good scalability and flexibility of systems and plants

- Synchronized motion through clock-synchroneous communication

- Fulfillment of increasing requirements for axis-number and short cycle times through PROFINET

Back to content

„Wireless" Applications

- As other field devices drives can be operated in wireless applications using industrial WLAN gateways.

- Applications include e.g.
  - Suspension tracks
  - Driverless transport systems
  - etc.

Back to content

Drive technology (2)

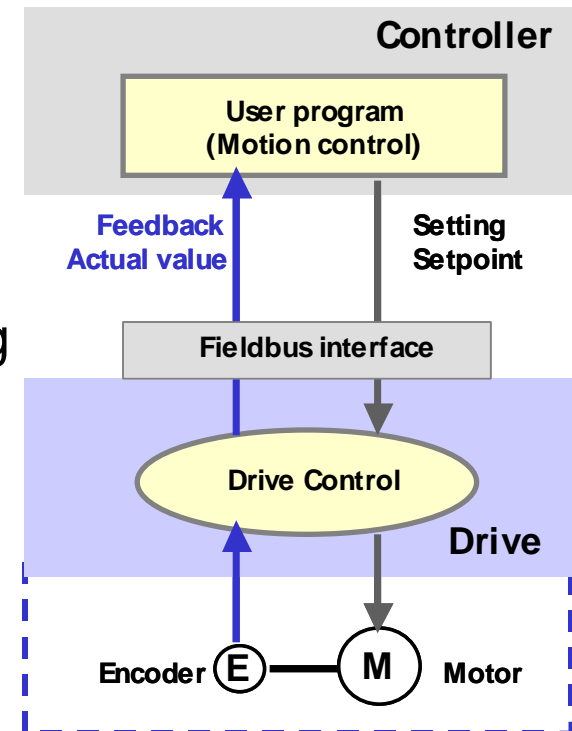**Technical progress**

Back to content

Drive technology <u>before</u> the fieldbus era

- Drive technology was generally understood to mean a frequency converter or servo amplifier that controlled a motor according to a preset speed setpoint.

- The earliest drive systems used discrete analog interfaces with I/O terminals to transfer commands and signals.

- In the 1980s, serial interfaces such as RS422 and RS232 were introduced to connect a PC for parameter assigment or commissioning purposes.

- A <u>second</u> interface was used to connect the drive to a control system and a <u>third</u> interface was used to forward process variables to a downstream drive.
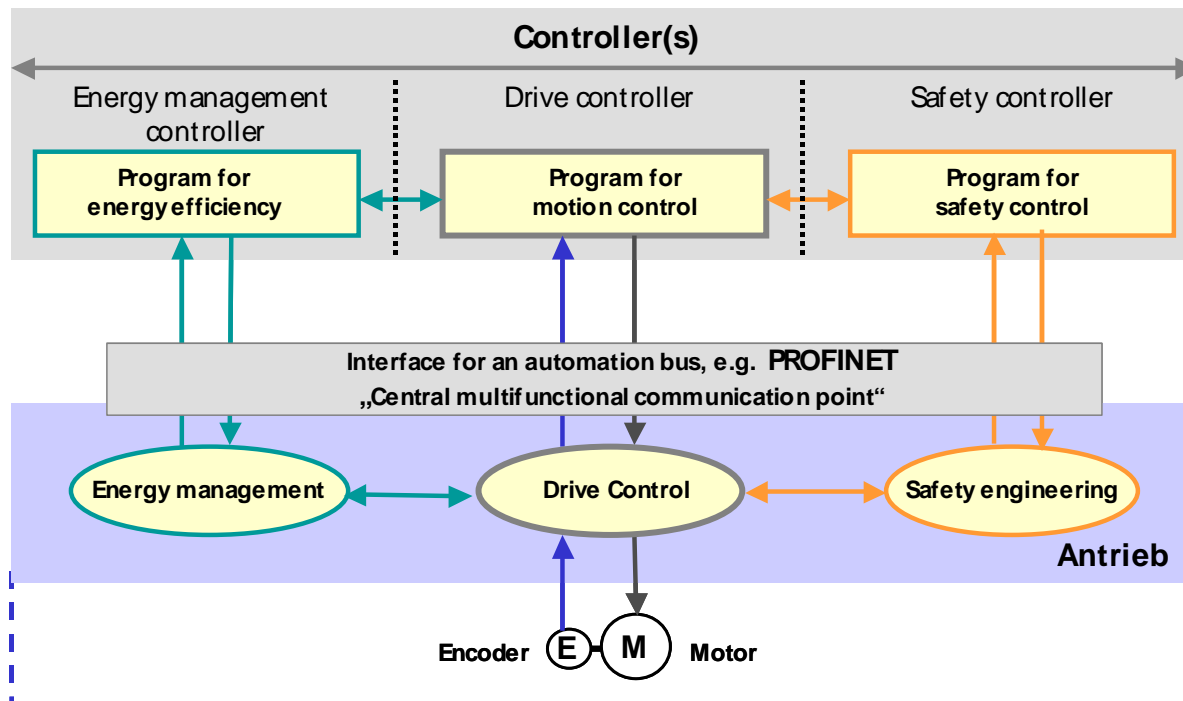
Back to content

Drive technology <u>during</u> the fieldbus era

- The upcoming fieldbus technology was first seen on the interface with I/O signals to be read into the control system and output from there using cyclic communication.

- Later, cyclic communication has been added for parameter assignment and commissioning to replace the „second" interface.

- With introduction of direct data exchange in PROFIBUS also the „third" interface between drives was replaced with a single interface on the drive.

- Later on the transmission rate was increased from 1.5 to 12 Mbps and isochroneous communication and clock synchronization was added for motion control applications.

Controller

User program
(Motion control)

Feedback
Actual value

Setting
Setpoint

Fieldbus interface

Drive Control

Drive

Encoder (E)———(M) Motor

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Drive technology in the Ethernet era

🔹 In the Ethernet era, drive technology started to use industrial ethernet networks (such as PROFINET) and to combine with additional applications such as safety engineering and energy management.

🔹 The drive is evolving into a platform for various drive-related functions.

PROFIBUS

Basics
Application
PROFIBUS DP

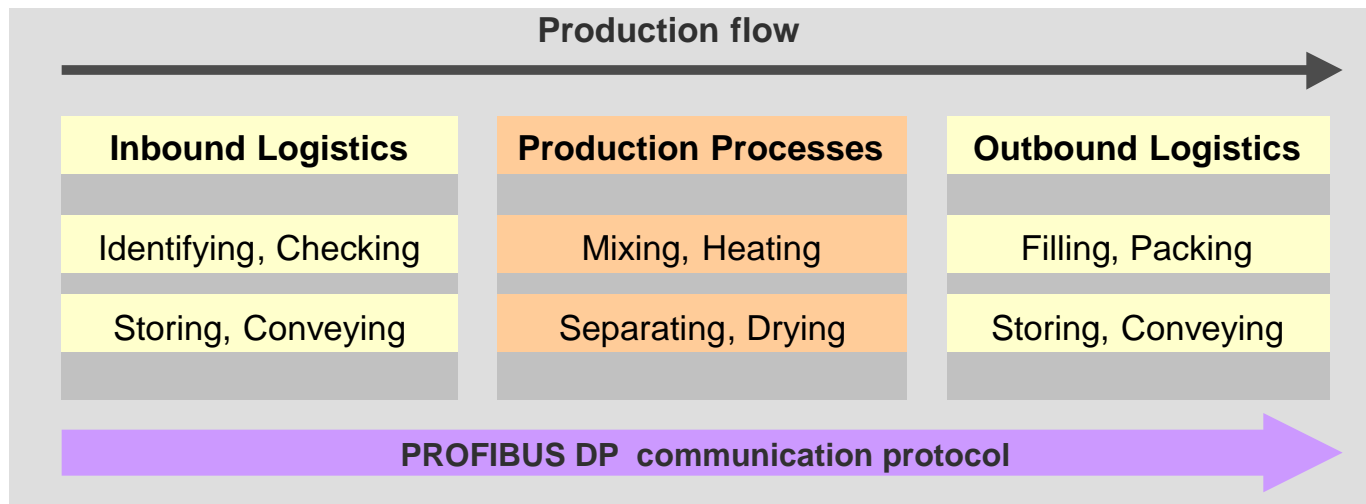## Fieldbus-based automation standard

� PROFIBUS is the fieldbus-based automation standard of PROFIBUS & PROFINET International (PI).

▓ PROFIBUS Iis a communication system that inks controllers or control systems to decentralized field devices such as sensors, actuators or drives via a single cable.

PROFIBUS

**Controller or
Control system**

Field devices

**Back to
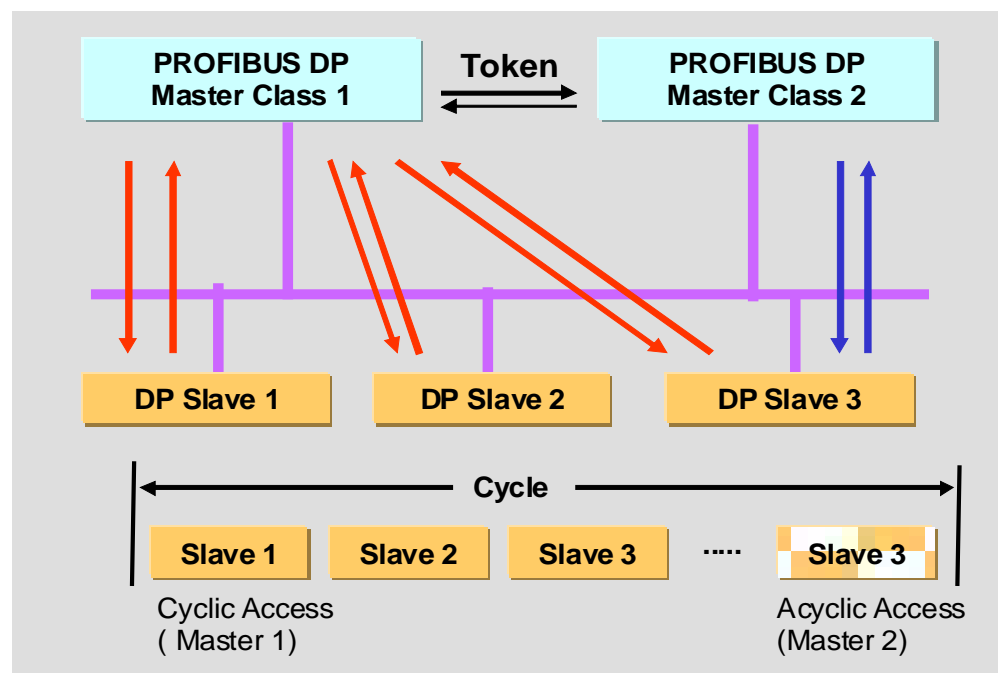content**
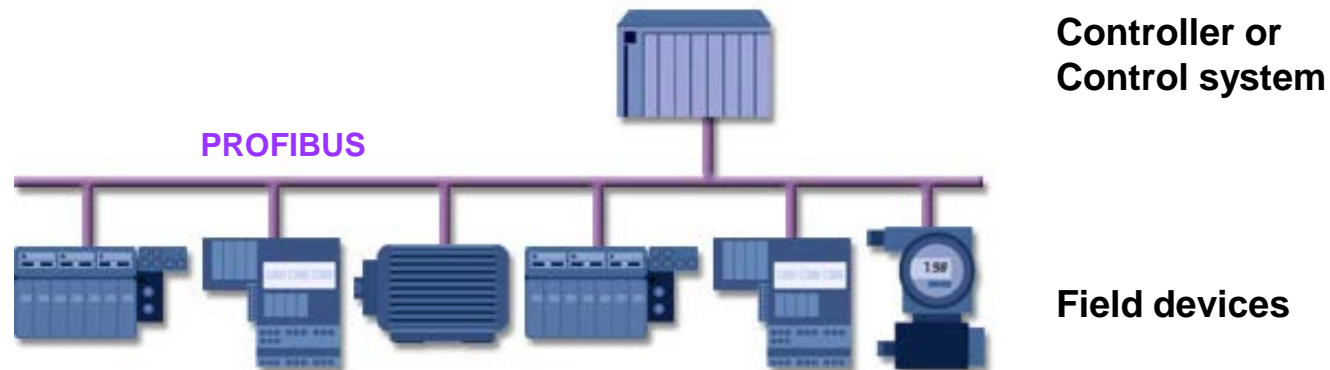
PROFIBUS (2)

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.

Production flow

Inbound Logistics	Production Processes	Outbound Logistics
Identifying, Checking	Mixing, Heating	Filling, Packing
Storing, Conveying	Separating, Drying	Storing, Conveying

PROFIBUS DP communication protocol

Back to content

PROFIBUS DP (**D**ecentralized **P**eriphery)

- PROFIBUS uses a single, open communication protocol (PROFIBUS DP, **D**ecentralized **P**eriphery) for all applications.

  - PROFIBUS DP uses the "Master-Slave" model: One device (master) controls one or more other devices (slaves).

  - PROFIBUS DP uses the "Token Passing" model: The "token" is transmitted across the network; the station in possession of the token controls the access to the network.

PROFIBUS DP Master Class 1 — Token — PROFIBUS DP Master Class 2

DP Slave 1 | DP Slave 2 | DP Slave 3

Cycle

Slave 1 | Slave 2 | Slave 3 | ..... | Slave 3

Cyclic Access (Master 1)

Acyclic Access (Master 2)

Back to content

PROFIBUS DP provides three versions

▪ **DP-V0**
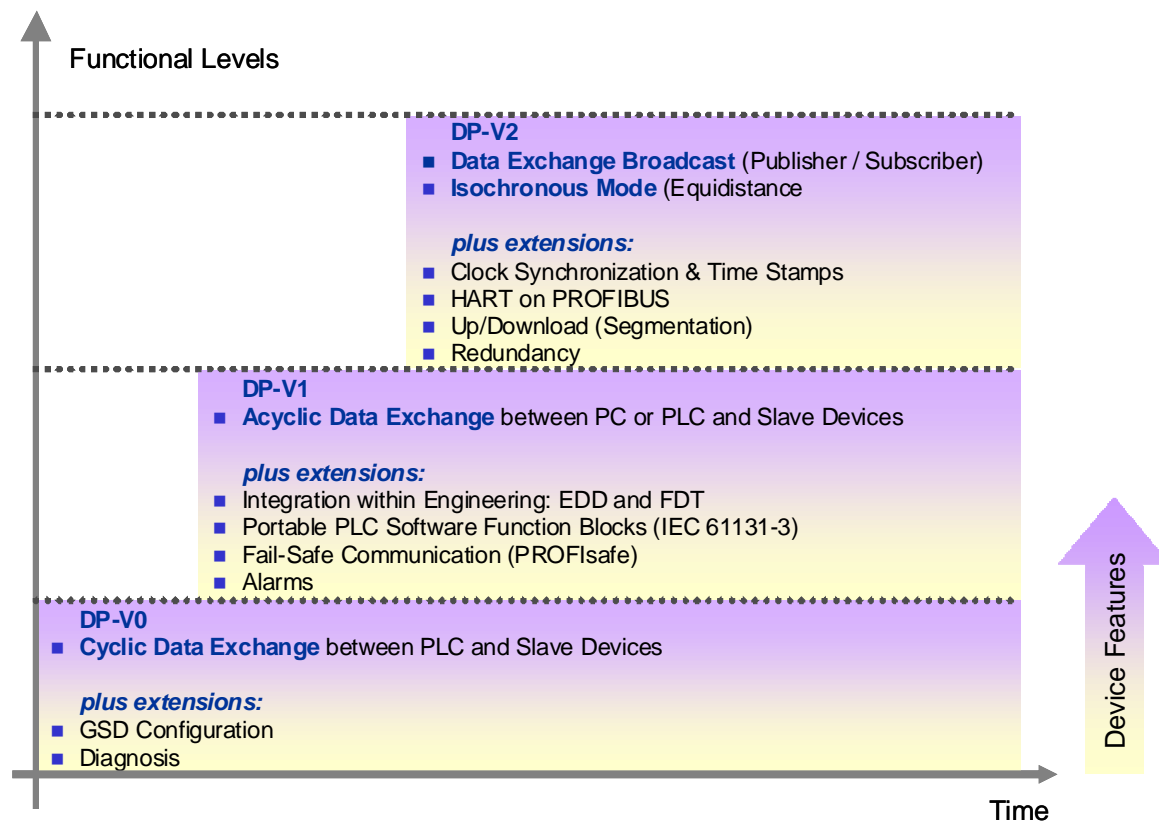Overall command structure, cyclic data exchange

▪ **DP-V1**
Extension by acyclic data exchange et al.

▪ **DP-V2**
Further extension by time stamp, clock synchronization et al.
Typically used in drive and motion control

Functional Levels

DP-V2
- **Data Exchange Broadcast** (Publisher / Subscriber)
- **Isochronous Mode** (Equidistance

plus extensions:
- Clock Synchronization & Time Stamps
- HART on PROFIBUS
- Up/Download (Segmentation)
- Redundancy

DP-V1
- **Acyclic Data Exchange** between PC or PLC and Slave Devices

plus extensions:
- Integration within Engineering: EDD and FDT
- Portable PLC Software Function Blocks (IEC 61131-3)
- Fail-Safe Communication (PROFIsafe)
- Alarms

DP-V0
- **Cyclic Data Exchange** between PLC and Slave Devices

plus extensions:
- GSD Configuration
- Diagnosis

Device Features
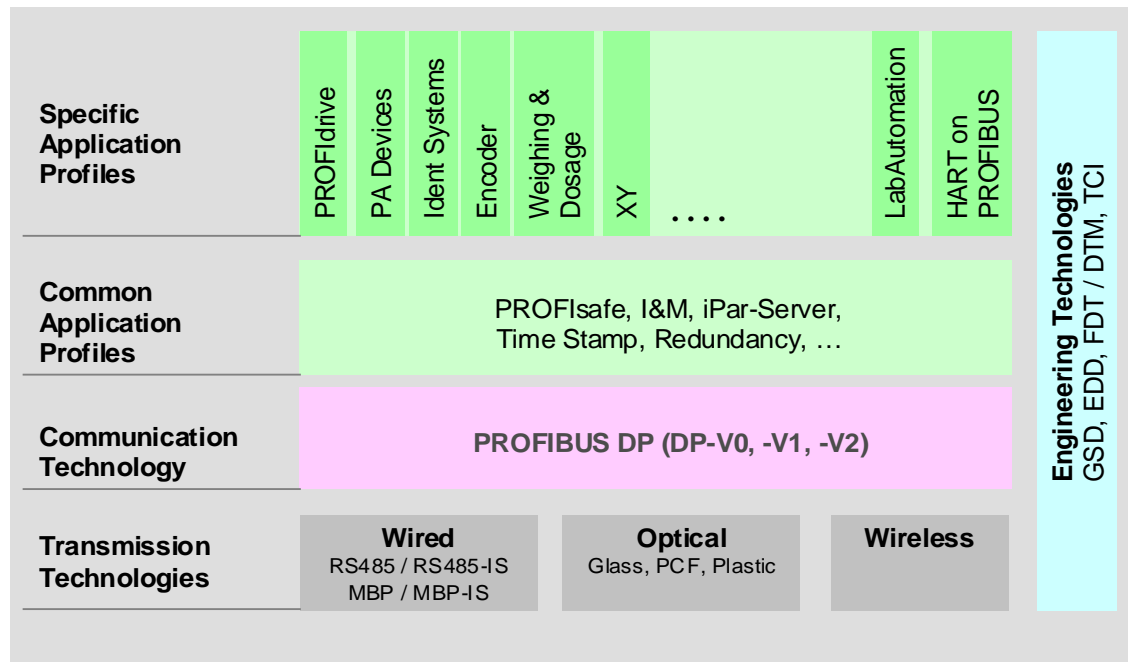
Time

Back to content

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.

Internet

PROFINET

PROFIBUS   **PROFIBUS**

Internet level

Enterprise level

Field level
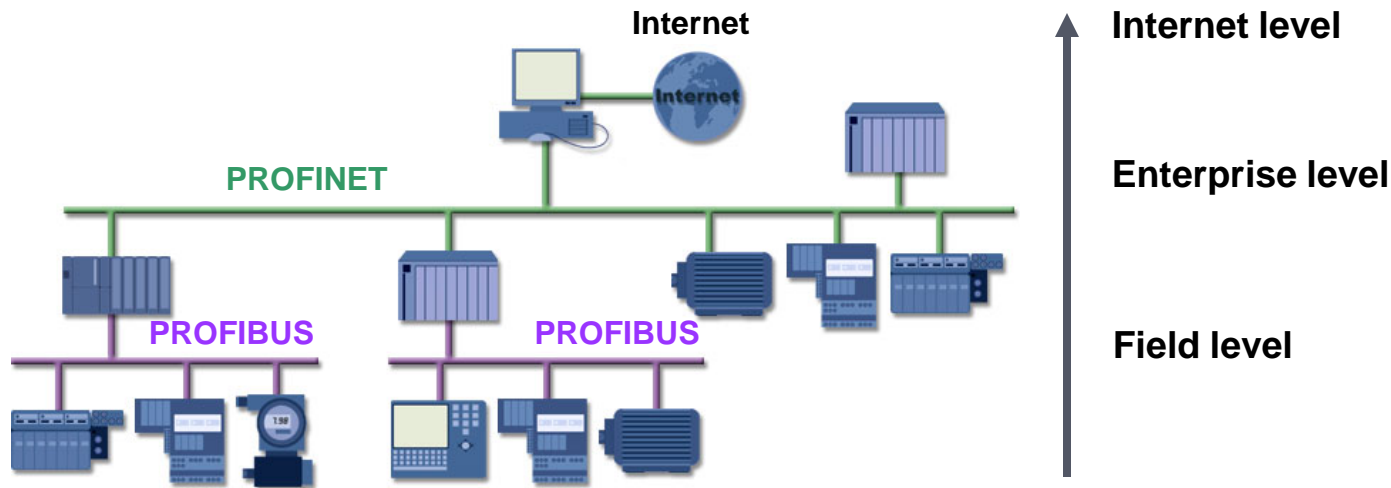
PROFIBUS (4)

A modular structured system

- PROFIBUS consists of different functional modules which are arranged according to their functionalities:Transmission, Communication, Application and Engineering/Integration.

Specific Application Profiles	PROFIdrive	PA Devices	Ident Systems	Encoder	Weighing & Dosage	XY	. . . .		LabAutomation	HART on PROFIBUS	Engineering Technologies GSD, EDD, FDT / DTM, TCI
Common Application Profiles	PROFIsafe, I&M, iPar-Server, Time Stamp, Redundancy, …										
Communication Technology	**PROFIBUS DP (DP-V0, -V1, -V2)**										
Transmission Technologies	**Wired** RS485 / RS485-IS MBP / MBP-IS			**Optical** Glass, PCF, Plastic			**Wireless**				

Back to content

Dedicated solutions for various industry sectors

▪ A PROFIBUS solution for a certain industry sector is implemented by combining suitable modules

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 Devices (and others)	e.g. Ident Systems	PROFIdrive	PROFIsafe
Communication Technology	PROFIBUS DP	PROFIBUS DP	PROFIBUS DP	PROFIBUS DP
Transmission Technology	MBP / MBP-IS RS 485 / 485-IS	RS 485	RS 485	RS 485 MBP-IS

Back to content

Key applications in different industries

Factory automation	Process automation	Drive technology	Safety applications
• Vehicle manufacture • Bottling plants • Warehousing systems • Switchgear • Hollow glass production	• Chemical industry • Petrochemical industry • Paper and textile industry • Foodstuffs • Power stations • Sewage plants	• Machine tools • Packaging machines • Pressing plants • Paper production	• Vehicle assembly • Machine tool building

Back to content

PROFIdrive

on PROFIBUS

Basics

PROFIdrive at a glance

- PROFIdrive is the modular device profile for drive devices developed by PROFIBUS & PROFINET International (PI).

- PROFIdrive has already enabled fieldbus-based drive solutions from the 1990s on using PROFIBUS DP as communication system.

- To meet the increasing user requirements, PROFIdrive has been continuously developed further by a PI working group with participants from different device manufacturers.

- Since 2005 PROFIdrive can also be used on Ethernet-based PROFINET communication (see special section).

PROFIdrive Milestones

▰	1991	Start of profile work
▰	1997	Profile version 2.0
▰	2002	Profile version 3.1 for use on PROFIBUS DP-V2
▰	2005	Use also possible on PROFINET
▰	2005	Use also possible in safety applications
▰	2007	International standardization in IEC 61800-7

Further development steps please see
in section "PROFIdrive on PROFINET"

Solution for Motion Control

- PROFIdrive together with RS 485 transmission and PROFIBUS DP communication technology forms the PROFIBUS-Solution "Motion Control".

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 Devices (and others)	e.g. Ident Systems	PROFIdrive	PROFIsafe
Communication Technology	PROFIBUS DP	PROFIBUS DP	PROFIBUS DP	PROFIBUS DP
Transmission Technology	MBP / MBP-IS RS 485 / 485-IS	RS 485	RS 485	RS 485 MBP-IS

Back to content

Device Profiles

Generals

Digital Interface

Uniform properties and behavior

- Device Profiles desrcibe specific device properties that have been jointly specified by device manufactureres for uniform implementation into their devices.

- Devices with the same device profile will – irrespective of the manufacturer – exhibit the same behavior on a bus system

- Users benefit result from a larger device selection and greater ease of device replacement, commissioning and diagnostics

- Device profiles not only define data-exchange but also specify the meaning of drive-specific data and parameters. Therefore, progam sections of a PLC can remain unchanged when used with different devices that feature the same profile

Back to content

A different view to device profiles

- Viewed in a different way, a device profile establishes a „cross-vendor digital interface" for communication between the automation system and the devices.

- This is performed by explicit specifications regarding functionality and parameters of the respective devices or device classes.

- The importance of such interfaces is increasing with respect to the enormous data quantities that are beeing exchanged as the degree of automation advances.

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Device Profiles

„PROFIdrive" and

„Encoder"

Profile PROFIdrive

Application Classes Interface functions

Profile Encoder

PROFIdrive at a glance

- PROFIdrive is the modular device profile of PROFIBUS & PROFINET International (PI) for drive devices

- PROFIdrive has already enabled fieldbus-based drive solutions from the 1990s on using PROFIBUS DP as communication system

- To meet the increasing user requirements, PROFIdrive has been continuously developed further by a PI working group with participants from different device manufacturers

- PROFIdrive can be used with Fieldbus-based PROFIBUS as well as with Ethernet-based PROFINET communication

Back to content

Milestones

- 1991   Start of profile work
- 1997   Profile version 2.0

- 2002   Profile version 3.1 for use with PROFIBUS DP-V2
- 2005   Use also possible with PROFINET
- 2005   Use also possible in safety applications
- 2007   International standardization in IEC 61800-7
- 2009   Option for energy management through joint
              use of PROFIenergy application profile
- 2011   **Community Project** for joint further development
              and free of charge PROFIdrive source code

Further steps see PROFIdrive on PROFINET

PROFIdrive structure

- The basic specifications of the PROFIdrive standard include
  - Base model definition
  - Parameter model definition
  - Application model definition
  - Mapping to PROFIBUS
  - Mapping to PROFINET

- The major part of the profile (yellow box) describes functions that are independent of the communication system.
  This part remains unchanged when PROFIdrive is used on PROFIBUS or PROFINET.

PROFIdrive
- PROFIdrive Base Model
- PROFIdrive Parameter Model
- PROFIdrive Application Model

PROFIBUS
PROFIdrive mapping to PROFIBUS DP

PROFINET
PROFIdrive mapping to PROFINET IO

Back to content
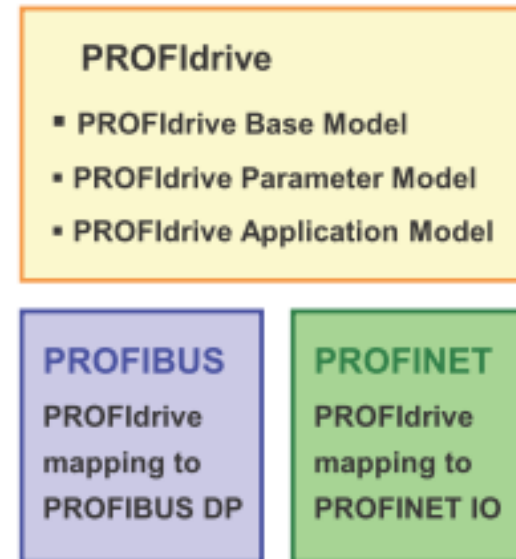
Application Classes (AK1 - AK 6)

- PROFIdrive spans all of the extremely diverse applications of drive technology.
- To avoid unneeded load in case of simple applications, PROFIdrive is structured into six application classes (AK 1 to 6).
- A drive device can span one or more device classes depending on market segment and implementation.
- In all application classes, except class 1, the technology functions are distributed between the controller and drives.

- **The Application Classes** are assigned to (see next slide)
  - Non-isochronous or isochronous operation (second line from above)
  - Converters or drives (third line from above)
  - Proportion of automation functions within the drive (vertical position)

Application classes

- Application classes allow flexible and cost efficient design of drive devices

Performance features of PROFIdrive application classes (AK1 - AK6)			
Non-isochronous operation			**Isochronous operation**
Converters without servo motor	**Drives with servo motor**		
		Closed-loop drive control with open-loop single-axis positioning control — **AK 3**	Same as AK 4/5, except for decentralized automation, e.g., for clocked processes and electronic shaft — **AK 6**
Same as AK 1, but with distribution of automation among several drives — **AK 2**			
Standard drive with closed-loop speed control — **AK 1**			**Servo drive** with isochronous closed-loop speed and position control with central motion control — **AK 4/5**

Automation proportion in the drive: High → Low

| **Applications**	Pumps, fans, compressors Conveyor belts, elevators, etc.	Single-axis positioning Simple handling of caps Paper machines	Machine tools, robots Paper machines Packaging machines

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Back to content

Application classes

- **Application class 1**
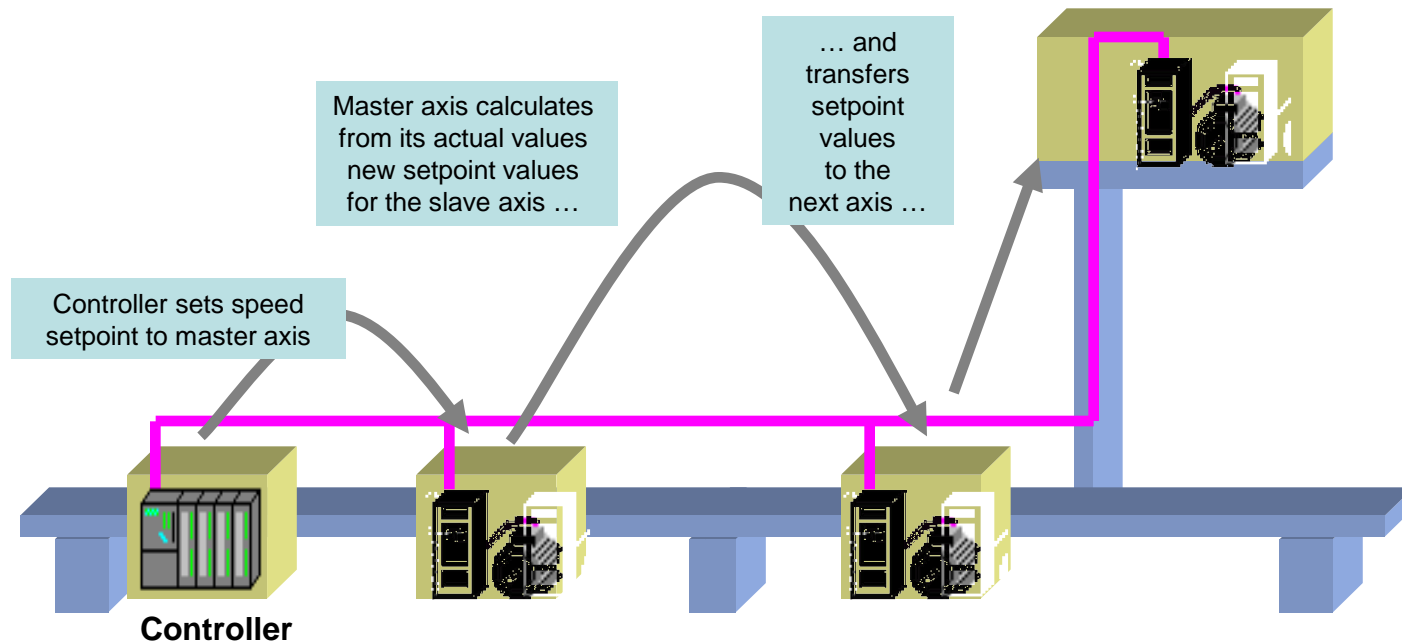 Standard drives with open/closed-loop speed ctr. (pumps, compress. ..)
- **Application class 2**
  As class 1, but with technology functions in the drives for e.g. closed-loop pressure or flow control and for distribution of functions among controller and multiple drives.

Back to content
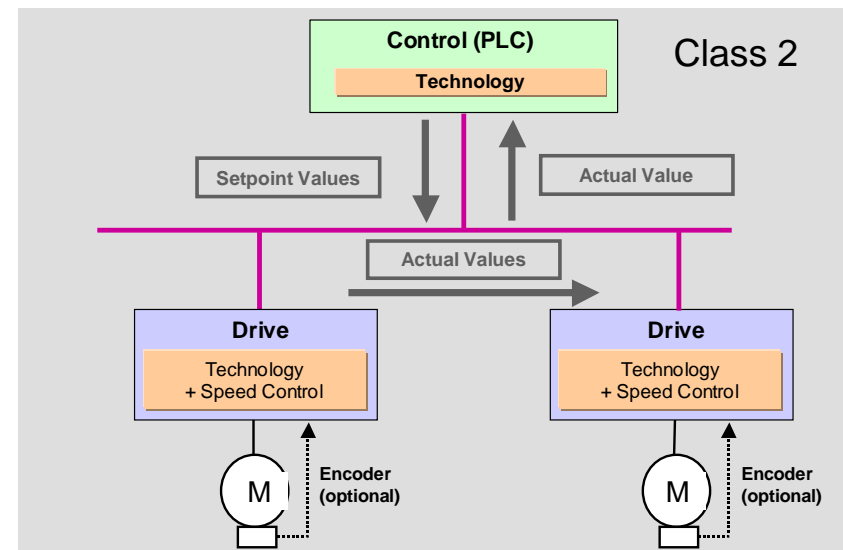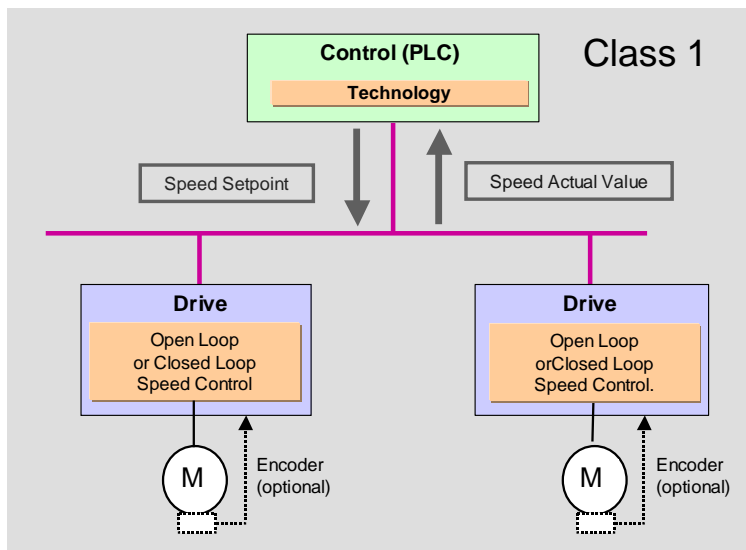
Application class 2 (example)

▮ **Drive-to-drive communication for e.g. generating a setpoint cascade**

Master axis calculates from its actual values new setpoint values for the slave axis …

… and transfers setpoint values to the next axis …

Controller sets speed setpoint to master axis

Controller

Back to content

Application class 2 (example)

- **A single bus system for**
  - **Operating and monitoring**
  - **Process data for visualization and diagnostics**
  - **Set point cascade for numerous drives**

Unwinder   Wire Drawing Cylinders   Delivery   Annealer   Take-up Stand
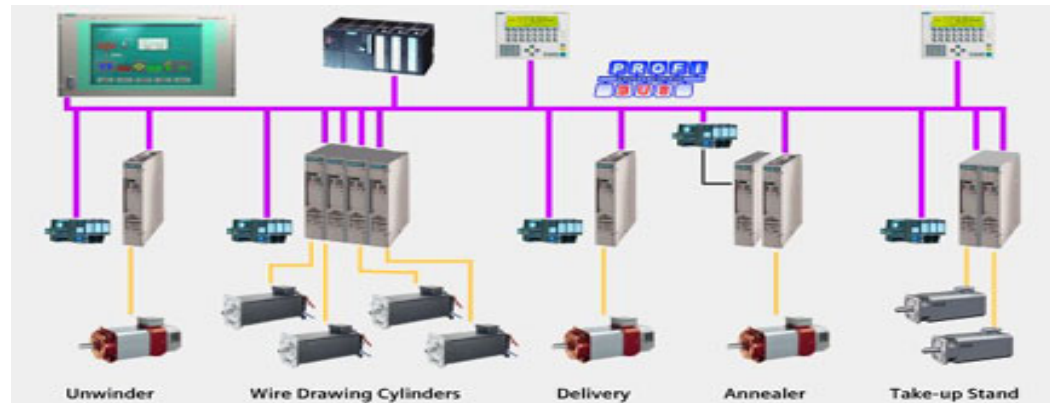
Application classes

- ## Application class 3
  Drives with closed-loop drive and position control e.g. for twisting bottle caps on and off. The drive acts as autonomuous single axis positioning drive.
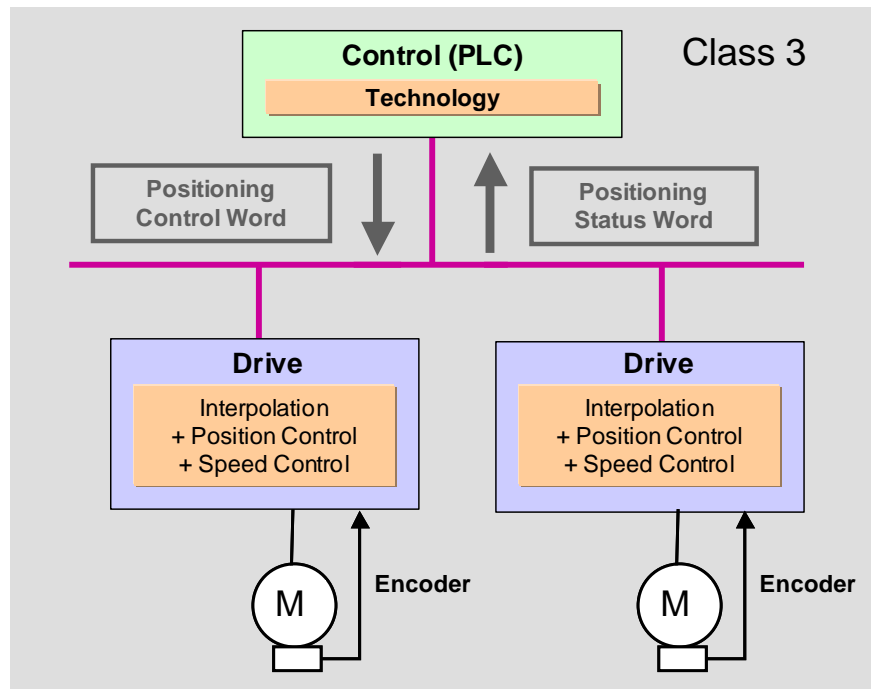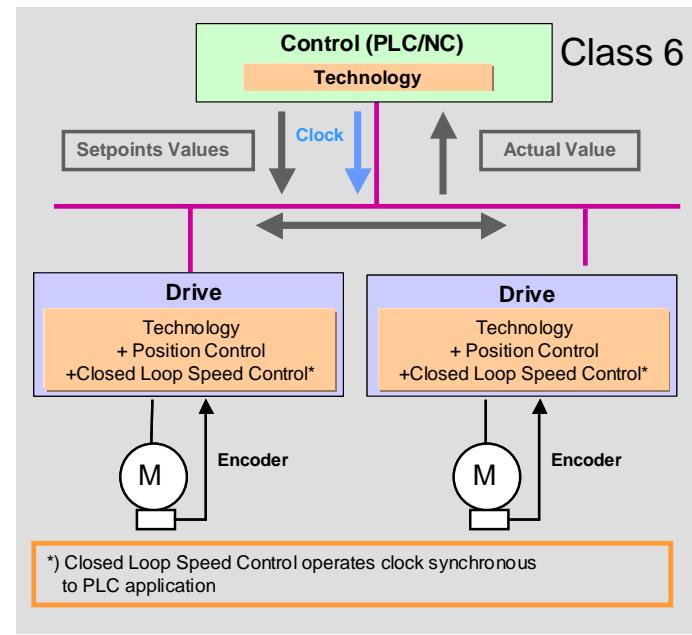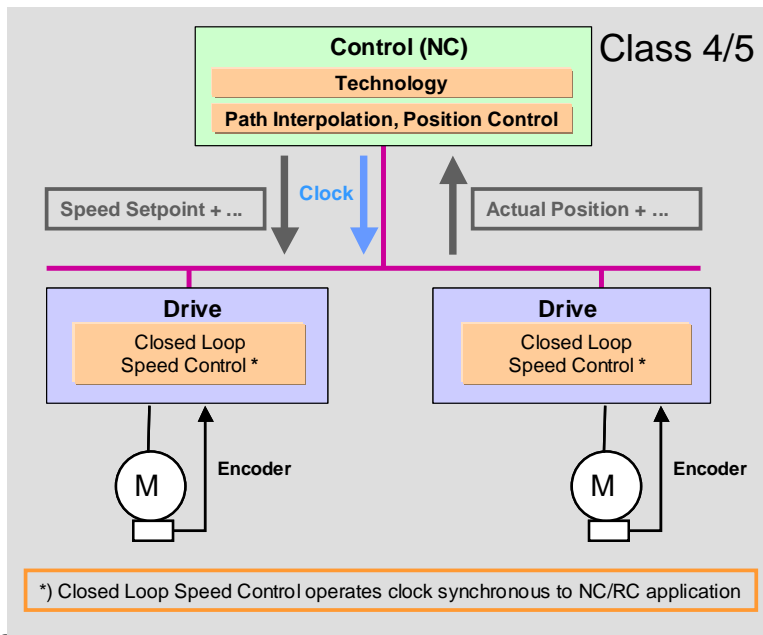
Application classes

- **Application class 4/5**
  Servo drives with central motion control in multiple axes, e.g. for machine tools or robots with closed-loop speed control in the drive and closed-loop motion control in the controller with clock-synchrinization
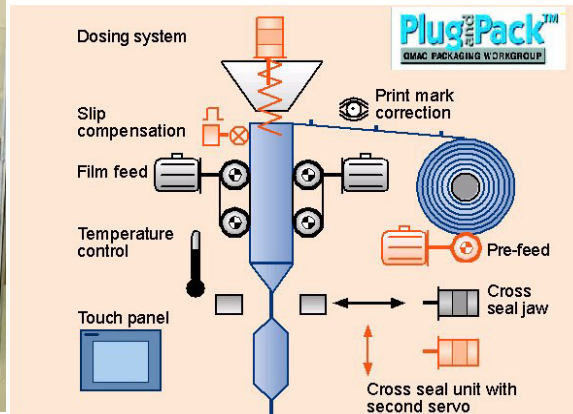- **Application class 6**
  Servo drives for decentralized automation, e.g. for electronic shafts or clocked machines with synchronized master and slave drives

Back to content

Application class 4 (example)

- Central motion control system with decentralized servo drives

Machine with isochronous drives

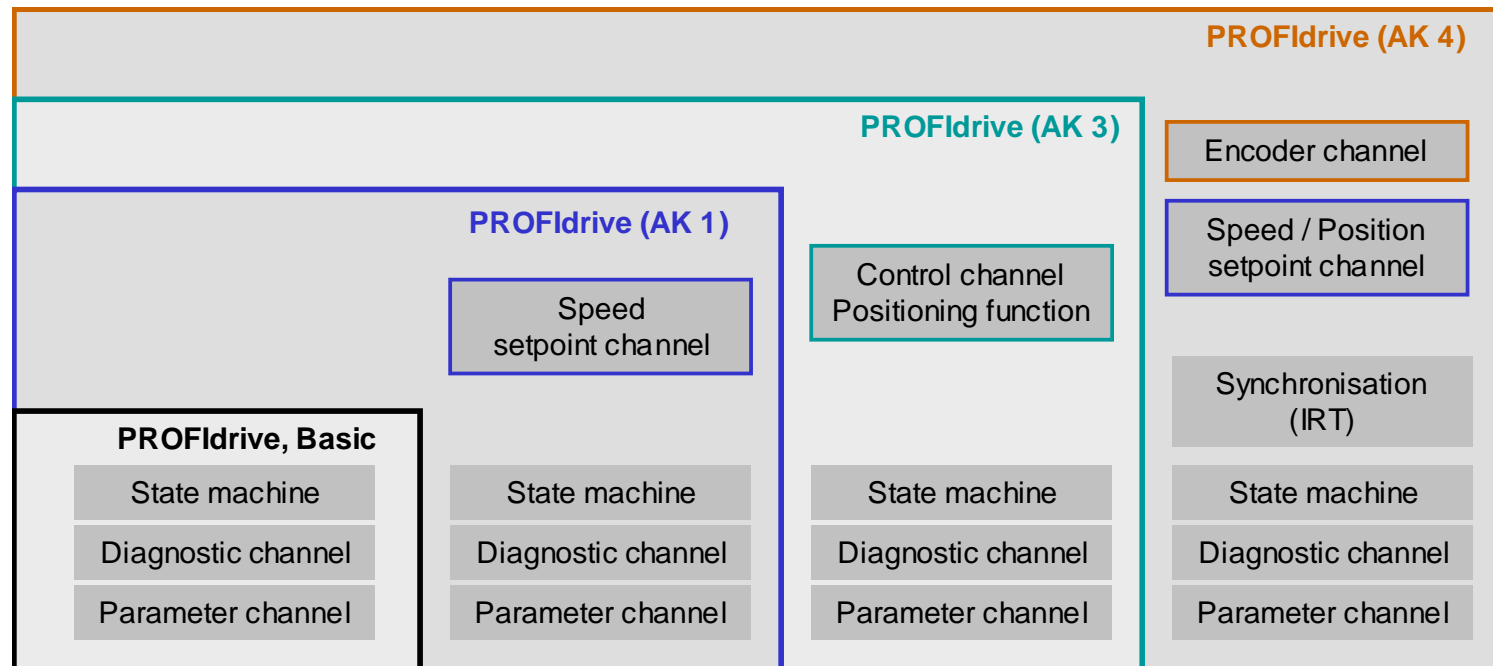**Electronic gear**

Back to content

Application class 6 (example)

- Decentral automation with eletronically controlled drives which move synchronously to a master drive with high velocity

DP Master

Back to content
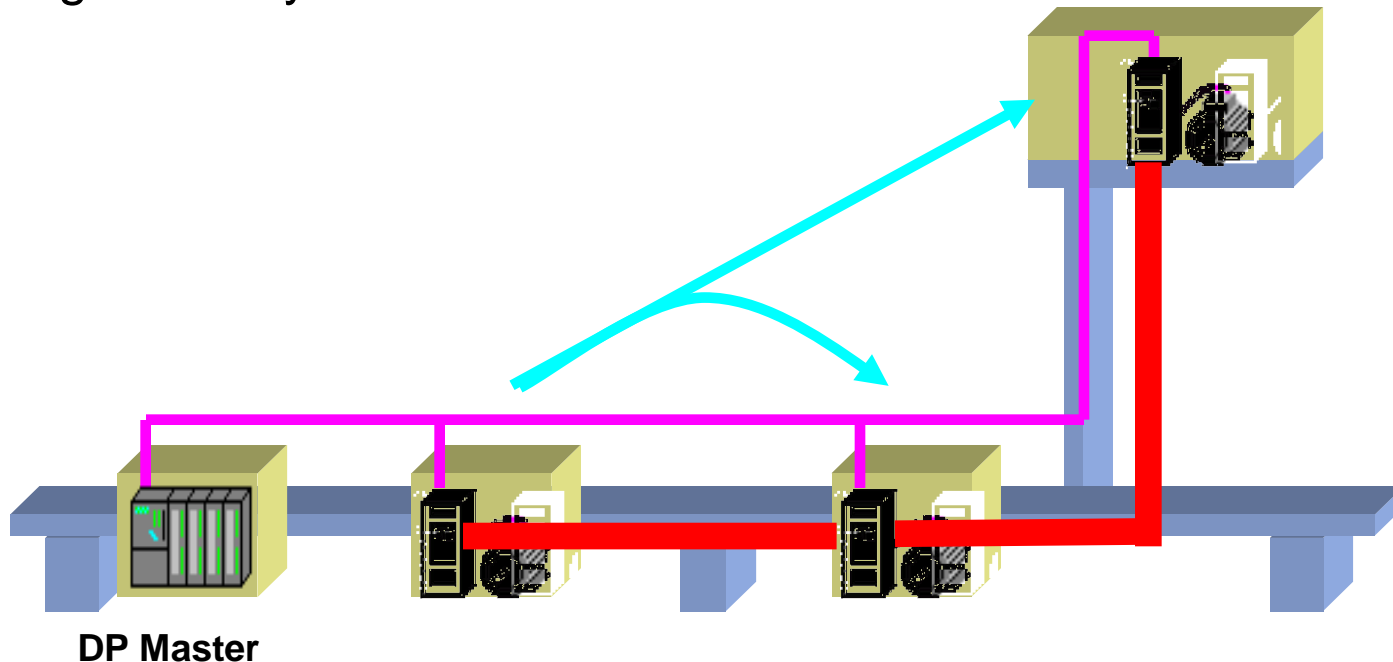
Modular interface functions

▫ The realization of particular application classes requires implementation of the corresponding interface functions
▫ The interface functions have a modular structure

PROFIdrive (AK 4)

PROFIdrive (AK 3)

Encoder channel

PROFIdrive (AK 1)

Speed / Position setpoint channel

Control channel Positioning function

Speed setpoint channel

Synchronisation (IRT)

PROFIdrive, Basic

State machine	State machine	State machine	State machine
Diagnostic channel	Diagnostic channel	Diagnostic channel	Diagnostic channel
Parameter channel	Parameter channel	Parameter channel	Parameter channel

Back to content

Harmonization

- **PROFIdrive** ensures vendor-neutral and interoperable drive devices by using a consistent drive interface
    - State machine
    - Application classes
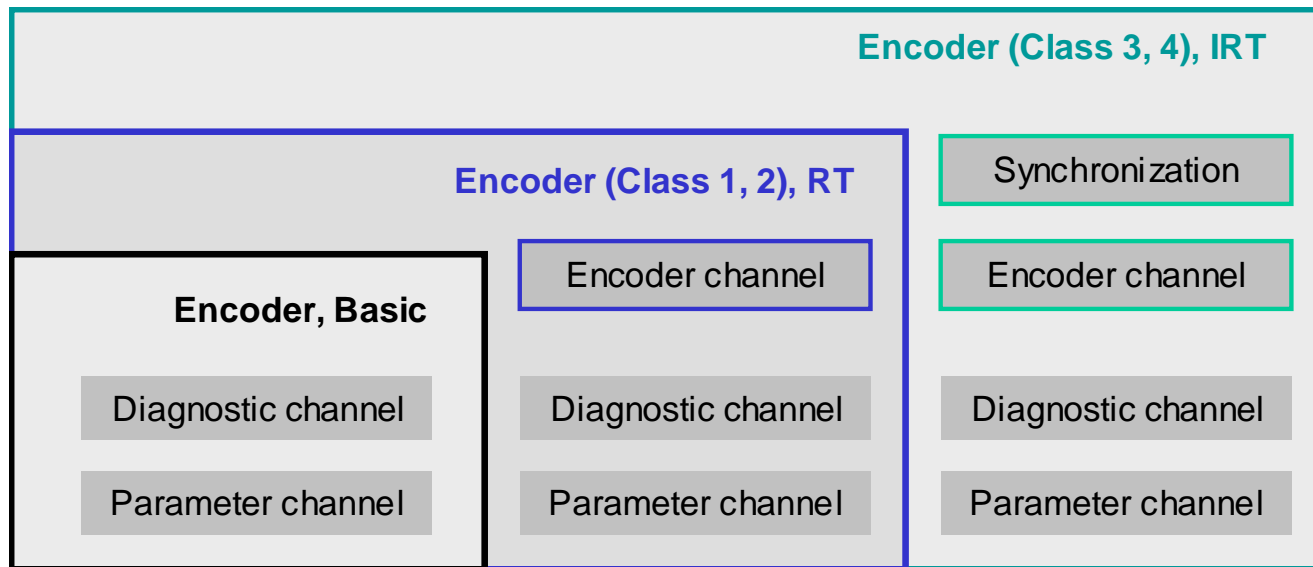   - Telegrams for data transfer
    - Diagnostic routines

- **PROFIdrive** ensures protection of investment through
    - Identical interface (from application view) to PROFIBUS and PROFINET
    - Vendor-neutral device functionality
    - Internationally standardized specification

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Definition

- The **Encoder** device profile defines a uniform interface comprizing application-specific classes
  - Classes 1 and 2 include simpler encoders without isochronous position or speed signals to the controller
  - Classes 3 and 4 include isochronous encoders that provide a PROFIdrive encoder channel and can also be used with standard motion controllers or fast digital control loops

Encoder (Class 3, 4), IRT

Encoder (Class 1, 2), RT

Synchronization

Encoder, Basic

Encoder channel	Encoder channel

Diagnostic channel	Diagnostic channel	Diagnostic channel
Parameter channel	Parameter channel	Parameter channel

BSS_Drives_201401_E_V1.0

PROFINET

Industrial Ethernet
(Basics)

Ethernet

- Ethernet technology specifies protocols and hardware for wired data networks to exchange data packets between devices

- Transmission rates range from 10 Mbps, 100 Mbps (Fast Ethernet) to 1000 Mbps (Gigabit Ethernet) and 10 Gbps.

- Specification comprizes definitions for cable types, connectors, packet formats and other transmission formats.

- Ethernet conforms to IEEE 802.3 and comprizes layer 1 and part of layer 2 in the OSI model.

- Ethernet often serves as base for network protocols like TCP/IP that operate in higher layers.

Back to content

Industrial Ethernet

- Industrial Ethernet is a term for all efforts to strengthen the Ethernet standard for use in industrial environments
    - Switches for industrial application; mounting rail systems
    - EMC interference immunity
    - protection against dust and splashing water
    - Increased availability

- Highly important are
    - Short and extremely short cycle times, simulaneously with high level of determinism and synchroneous behavior
    - Powerful diagnostic mechanism

IEEE 802.3

Standards for Ethernet were developed in the responsibility of Working Group 802.3 of IEEE and are based on IEEE 802.1 (Internet Working) and IEEE 802.2 (Logical Link Control, LLC)..

Since that time, **Ethernet** became the synonym for all specifications by it.

Back to content

Internet communication in the ISO/OSI model

- The ISO/OSI model divides the overall communication function into 7 logical layers; each layer takes a portion of this function
- Each layer uses its internal processes to generate a layer-specific output which serves as input fpr the next higher layer
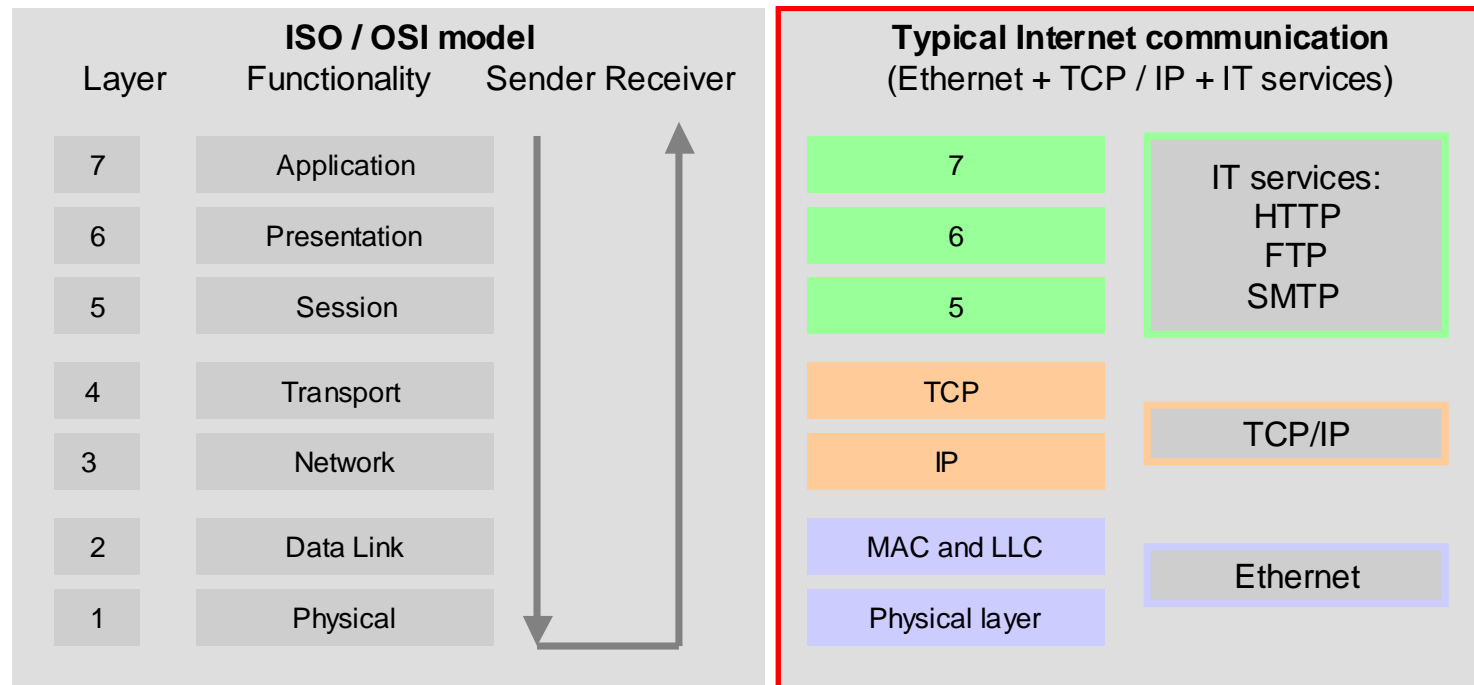
Back to content

PROFIdrive

on PROFINET

PROFINET

**PROFINET
as „Drive Bus"**

PROFINET Basics

▰ PROFINET has become the leading Industrial Ethernet Standard in the market. It is supported by many product vendors, thus ensuring long-term availability and investment protection.

▰ PROFINET uses the same Ethernet technology as offices and IT departments but with enhanced capabilities to meet the far tougher conditions encountered in industrial applications.

▰ As standard technology that in the automotive industry, widely spread in machine building, and well-proven in the food and packaging and logistics industries, PROFINET has found its way into all application areas including drives and motion.

PROFINET Basics ctd.

- PROFINET is the Industrial Ethernet solution of PROFIBUS & PROFINET International (PI).

- PROFINET builds on the wide experience of PI gained over decades with PROFIBUS in the industrial fieldbus environment

- PROFINET realizes fast vertical and horizontal data exchange at all levels and thus is the basis for efficient machine and plant automation including integration into the corporate level

- PROFINET is standardized in IEC 61158

- PROFINET is a high-performance "Drive bus" when operated together with drive devices using the PROFIdrive device orofile

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Back to content

PROFINET is suited for all industrial applications

- PROFINET integrates all automation functions and levels of a plant **including drives** in one single approach

Back to content
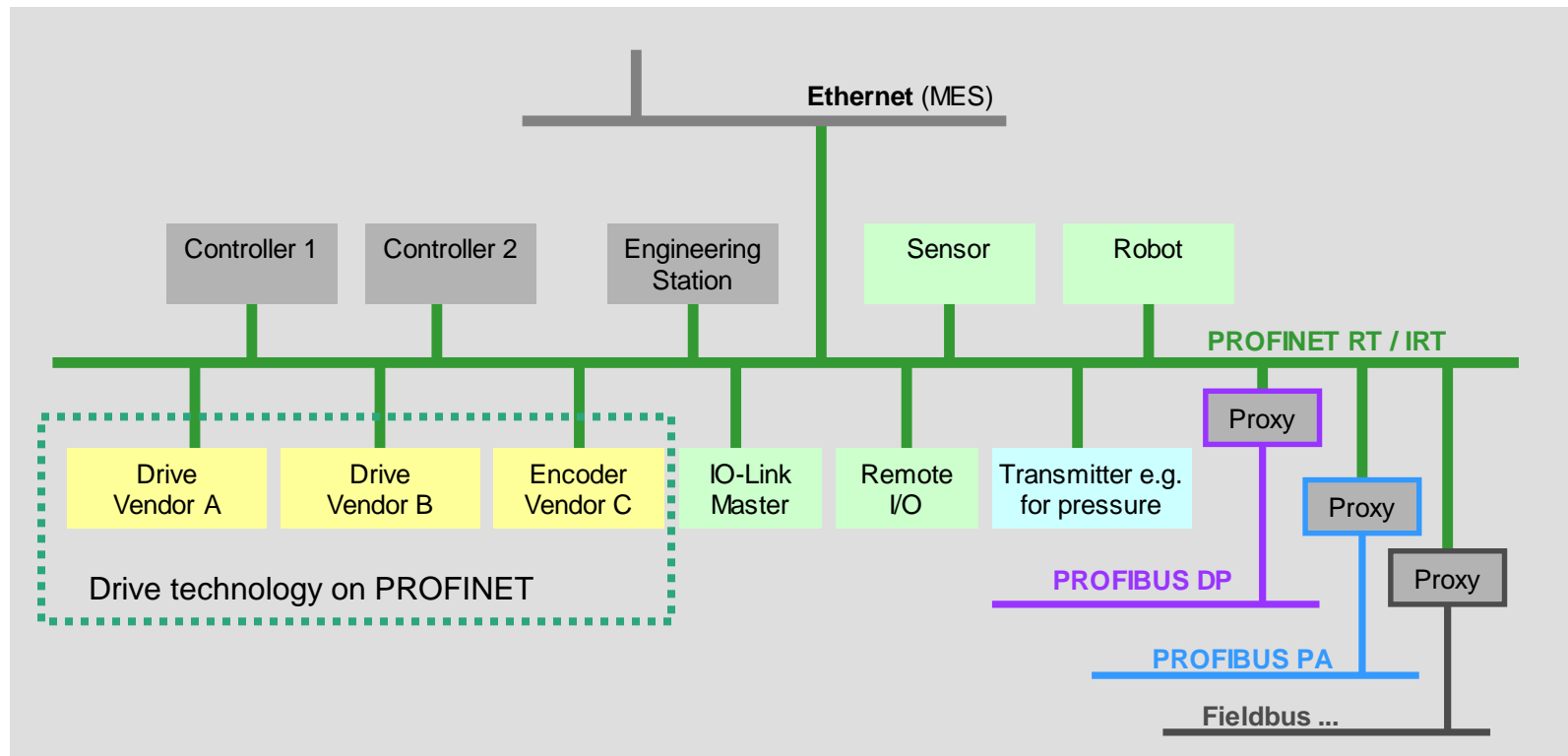
PROFINET cycle times are scalable

PROFINET supports
- fast communication of I/O data with a high level of determinism (Real Time RT and Isochroneous Real Time IRT
- and - at the same time and on the same cable - standard TCP/IP communication for use of all IT services and Web tools

Back to content
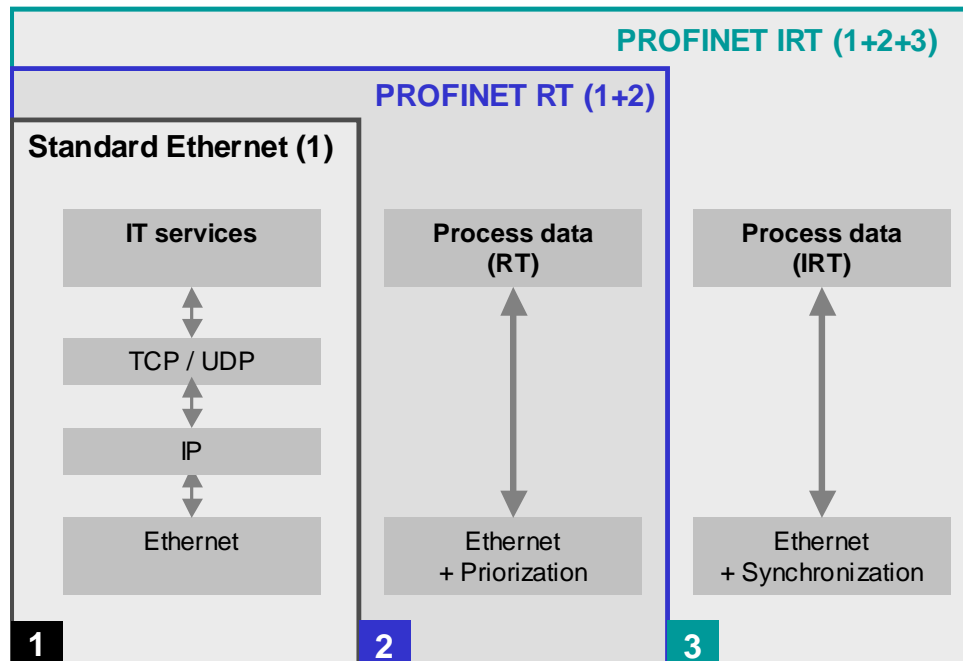
PROFINET cycle time range ans drive use cases

■ The cycle time of PROFINET ranges from TCP/IP to IRT down to 31,25 µs. It covers all drive applications including motion control and aditionally provides a performance reserve

Back to content
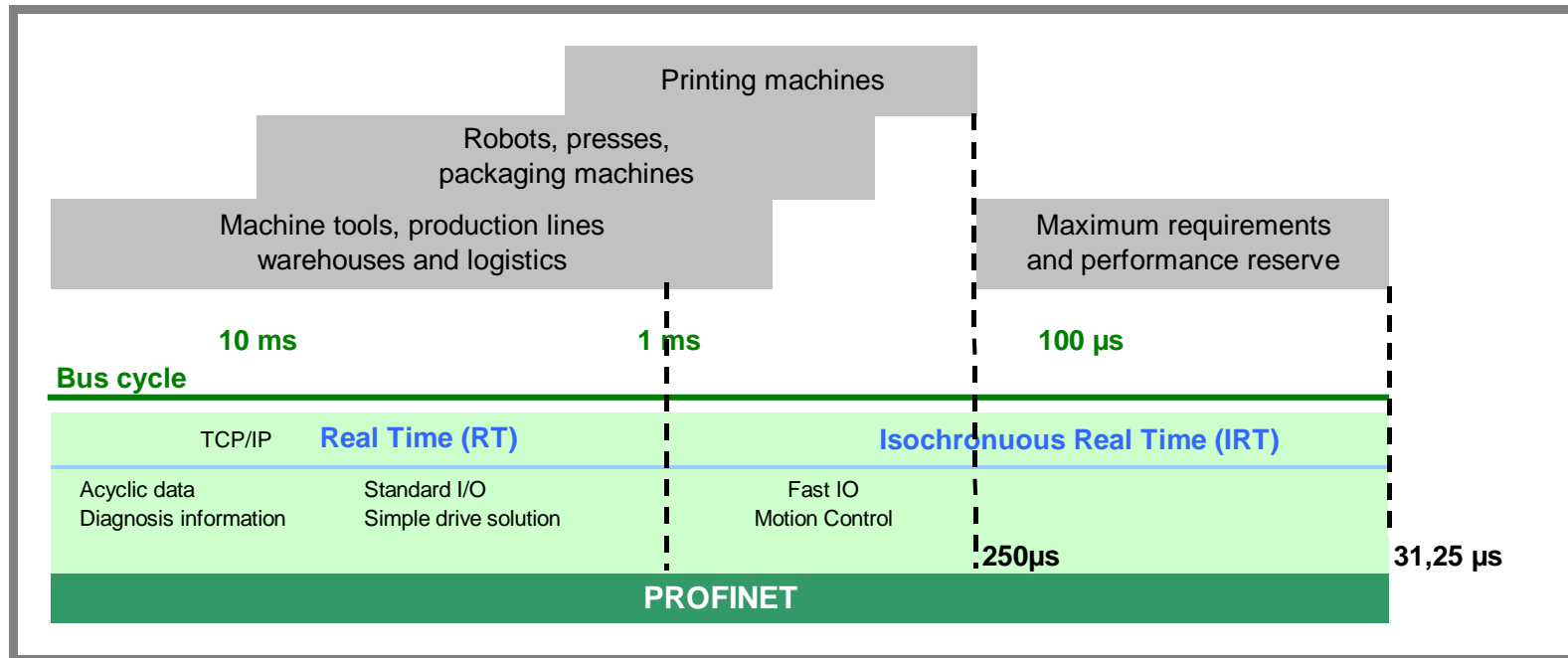
PROFINET scalable performance classes

- PROFINET performance is scalable by subdividing its functions into three Conformance Classes (CC) and a number of options

	Conformance classes			Options (for all CCs)
	CC-A	CC-B	CC-C	
Cyclic data exchange, Real-Time (RT)	■	■	■	
Acyclic data exchange, Non-Real-Time via standard TCP/UDP	■	■	■	
Access to IT services via standard TCP/UDP	■	■	■	
Reading out of identification information of devices (I&M function)	■	■	■	
Diagnosis of device states (tiered alarm model)	■	■	■	
Same device model as for PROFIBUS DP facilitates technology switch	■	■	■	
Model for integrating PROFIBUS and other fieldbuses	■	■	■	
Diagnostics for monitoring and maintenance of network components		■	■	
Topology detection for simple device replacement, etc.		■	■	
Topology display for easy plant documentation		■	■	
Isochronous real-time communication (IRT)			■	
Further optimized IRT communication for the most stringent requirements			■	
Use of PROFIdrive profile for drive technology and motion control				■
Use of PROFIsafe profile for safety-related communication				■
Use of PROFIenergy profile for energy efficiency optimization				■
Access by multiple controllers to one device input (shared input)				■
Distribution of device functions to various controllers (shared devices)				■
Access to devices without plant shutdown (Configuration in Run)				■
Time stamping for alarms and status messages				■
Redundancy mechanisms for high plant availability				■
Extended I&M functions (see item 4)				■
Industrial Wireless communication via WLAN and Bluetooth				■
Call-up of a specific engineering tool (of a device)				■

| Application areas of conformance classes of PROFINET			
Building automation, process automation	■		
Drive technology, machine control		■	
Isochronous applications, motion control			■

Back to content

PROFINET expands to drive application

- Ethernet, in its „Industrial Ethernet" version, has been long accepted in industry for
  - networking of controllers and visualization stations and
  - integrating instrumentation and controls into higher corporate levels

- In the field level of drives and transmitters, however, fieldbus-based technology is still used.

- But times are changing:
  Industrial Ethernet-based solutions get increasingly attention in the drive world with PROFINET in the leading position.
  Main benefits are much higher performance and the integrated approach of the plant-wide communication infrastructure.
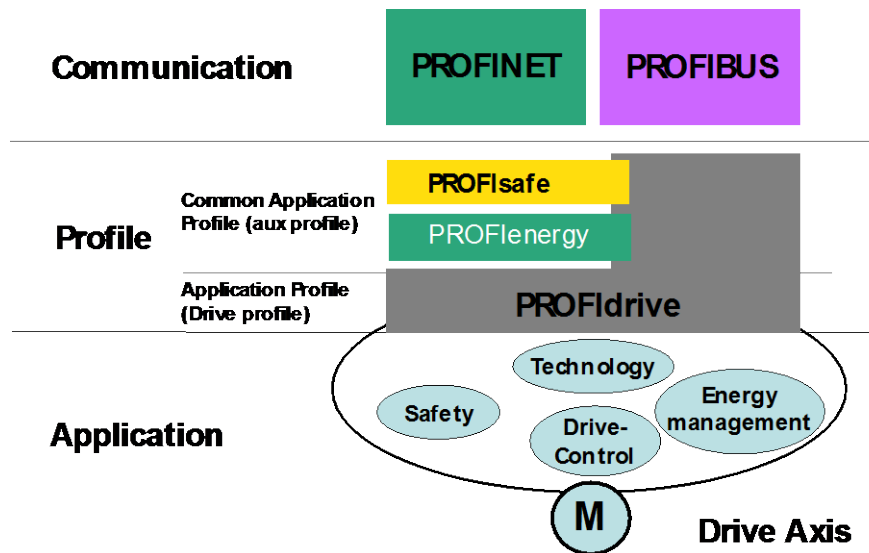
PROFIdrive on PROFINET

- In combination with PROFINET, PROFIdrive becomes a high-performance, ethernet-based technology for comprehensive drive solutions

- Conversely, in combination with PROFIdrive, PROFINET becomes a drive bus for the most stringent requirements that is without any limitation suitable for all other automation tasks.

PROFINET for all automation tasks including drives

Back to content
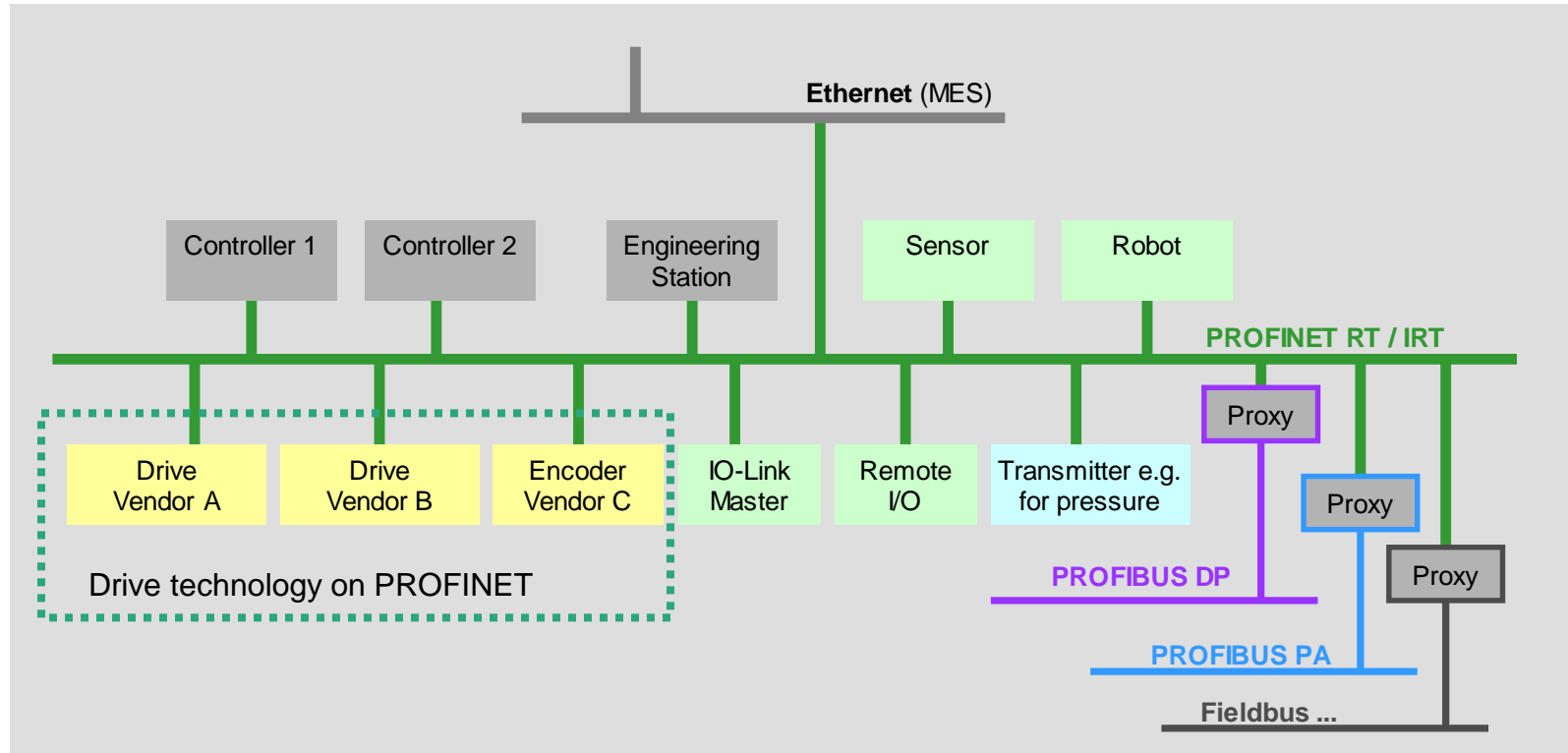
PROFIdrive profile on both PROFIBUS and PROFINET

- The PROFIdrive device profile (beginning from version 4.0 of 2005) can be used with PROFINET without any reprogramming of the application.
- This meets the machine building industry´s demand for an easy and low-cost way of operating devices on both communication systems

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Back to content

PROFIdrive profile on both PROFIBUS and PROFINET

- The dual use of PROFIdrive is possible because the architecture of PROFIdrive strictly separates between
  - communication system and
  - communication-independent functions (primarily the application)

- The figure shows the correspondences
  - P-Device and Supervisors are terms from the object model of PROFIdrive

PROFIdrive	PROFIBUS	PROFINET
PROFIdrive Controller	PROFIBUS DP Master Class 1	PROFINET Controller
PROFIdrive P-Device	PROFIBUS DP Slave	PROFINET Device
PROFIdrive Supervisor	PROFIBUS DP Master Class 2	PROFINET Supervisor

Benefit 1 - More flexibility

- The openness of PROFINET provides an integrated and uniform automation network in machines and plants and allows to connect standard Ethernet devices

- The topology options (line, star, tree, ring) offer complete freeedom for new plants or adapting to existing structures

- PROFINET is 100% Ethernet and supports TCP/IP and thus the use of all Web technologies

- In addition to drives with PROFIdrive, other devices with PROFINET interfaces (e.g. transmitters) can be operated on the same network

Back to content

Benefit 2 - More Performance

▮ The scalable cycle times of PROFINET open the way to all drive and motion control applications thereby increasing the productivity of plants and machines

▮ With version 2.3 PROFINET provides cycle times down to 31,35 µs with exact detreministic behavior and without any limitation to the TCP/IP communication

▮ PROFINET communication is deterministic with a jitter < 1 µs and thus ensures maximum precision of the executed functions

▮ PROFINET provides best possible availability through its media redundancy via integrated interfaces or external switches

Back to content

Benefit 3 - More efficiency

- PROFINET requires only one cable for transmission of both machine data and simultaneous IT communication

- PROFINET does not require time-consuming entry of IP adresses -   Adressing is automatically done.

- High machine availability is achieved by powerful device and network diagnostics and the use of switches in field devices

- A replaced device is automatically assigned the name of its predecessor; no engineering tool is required for that

- With PROFIenergy individual loads or whole production units can be selectivity switches off during idle times

Drives and Safety

PROFIdrive on PROFIsafe

Safety channel

Multi-profile Drive

Safety communi-
cation model

Safety channel

- Today, drives will be increasingly equipped with autonomous functional safety (Drive-based safety)

- Drive-based functions must be handled by safety control systems (Safety PLC) as part of the automation

- For these application requirements PROFIdrive has specified a safety channel „PROFIdrive on PROFIsafe"

- **„PROFIdrive on PROFIsafe"** describes the interaction of autonomous safety functions with a safety control system and defines possible safety functions and its general behaviour.
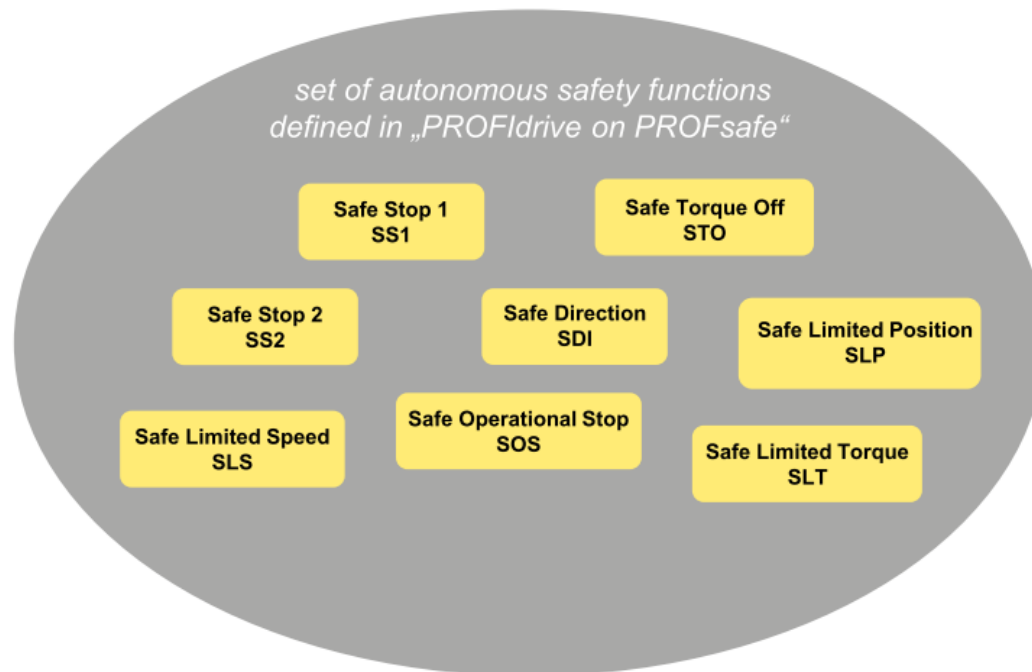
Back to content

Multi-profile Drive

- A "Multi-profile drive" device is equipped with, besides PROFIdrive, additional profiles such as PROFIsafe and/or PROFIenergy.
- In case of using e.g. PROFIsafe it provides a safety and a non-safety communication channel.

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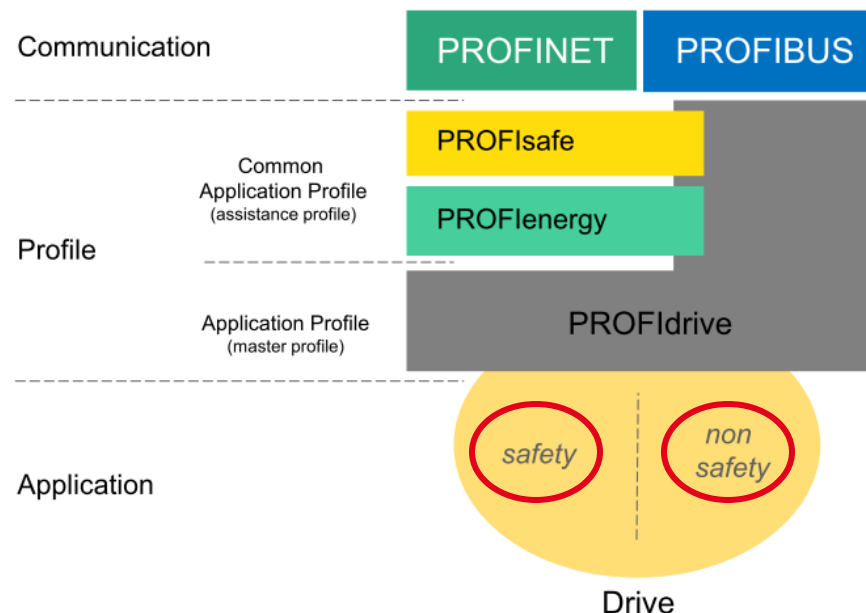
Autonomous Safety functions of Drives

- „PROFIdrive on PROFIsafe" defines a non-exhaustive list of possible drive-based safety functions (IEC 81800-5-2)
- The list can be expanded with vendor-specific functions
- The implementation of the drive based safety functions is in the responsibility of the drive manufacturers


set of autonomous safety functions defined in „PROFIdrive on PROFsafe"

Safe Stop 1 SS1 · Safe Torque Off STO · Safe Stop 2 SS2 · Safe Direction SDI · Safe Limited Position SLP · Safe Limited Speed SLS · Safe Operational Stop SOS · Safe Limited Torque SLT

Back to content

PROFIdrive Safety Communication Model

▰ PROFIdrive Safety Channel

- ▰ Standard communication format according to PROFIsafe spec.
- ▰ F-Host/F-Device layer according to PROFIsafe specification

▰ PROFIdrive Safety Telegram

- ▰ PROFIdrive telegrams for drive-based safety specified as F-Input/Output data
- ▰ Telegrams are linked to a subslot within the drive object analogue to PROFIdrive standard telegrams
- ▰ The drive safety process is controlled via "Safety Control Word" and "Safety Status Word".
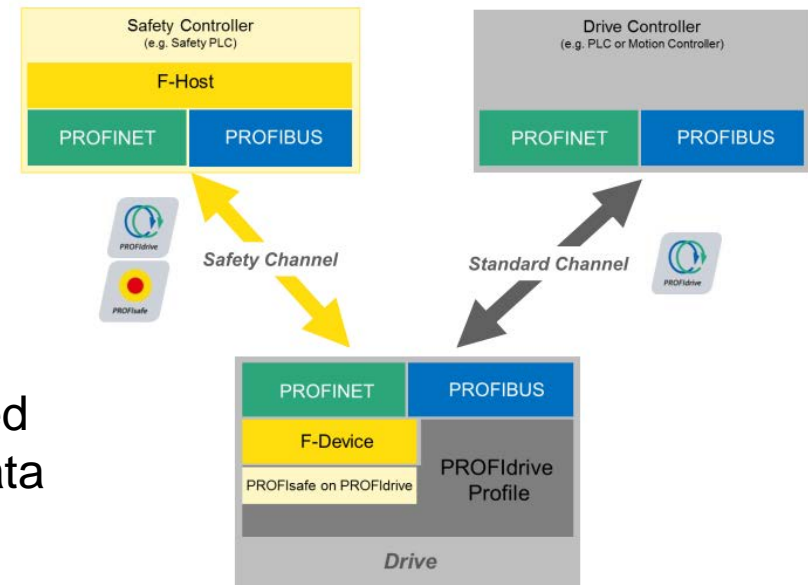
Back to content

Drives and

Energy efficiency

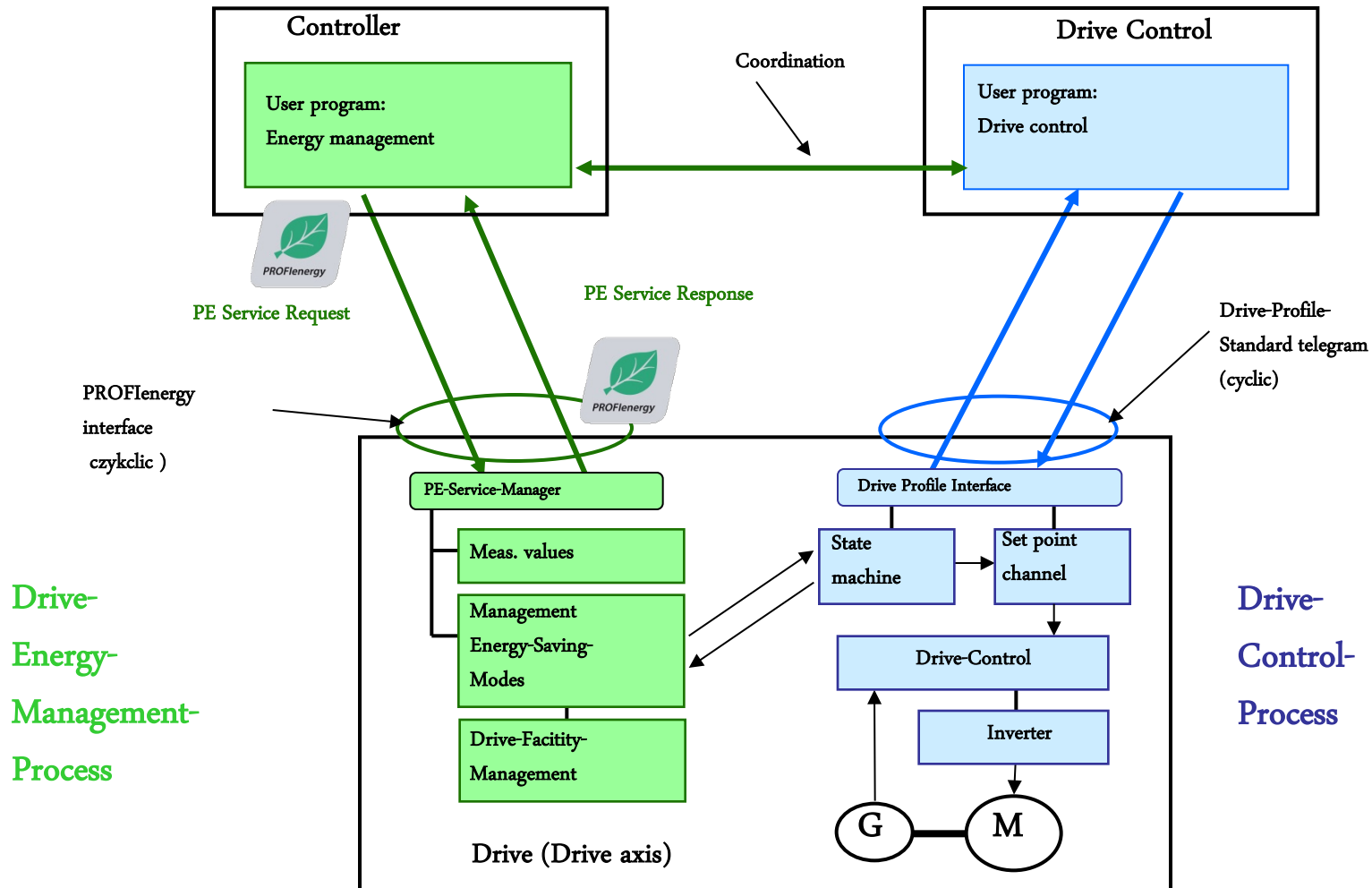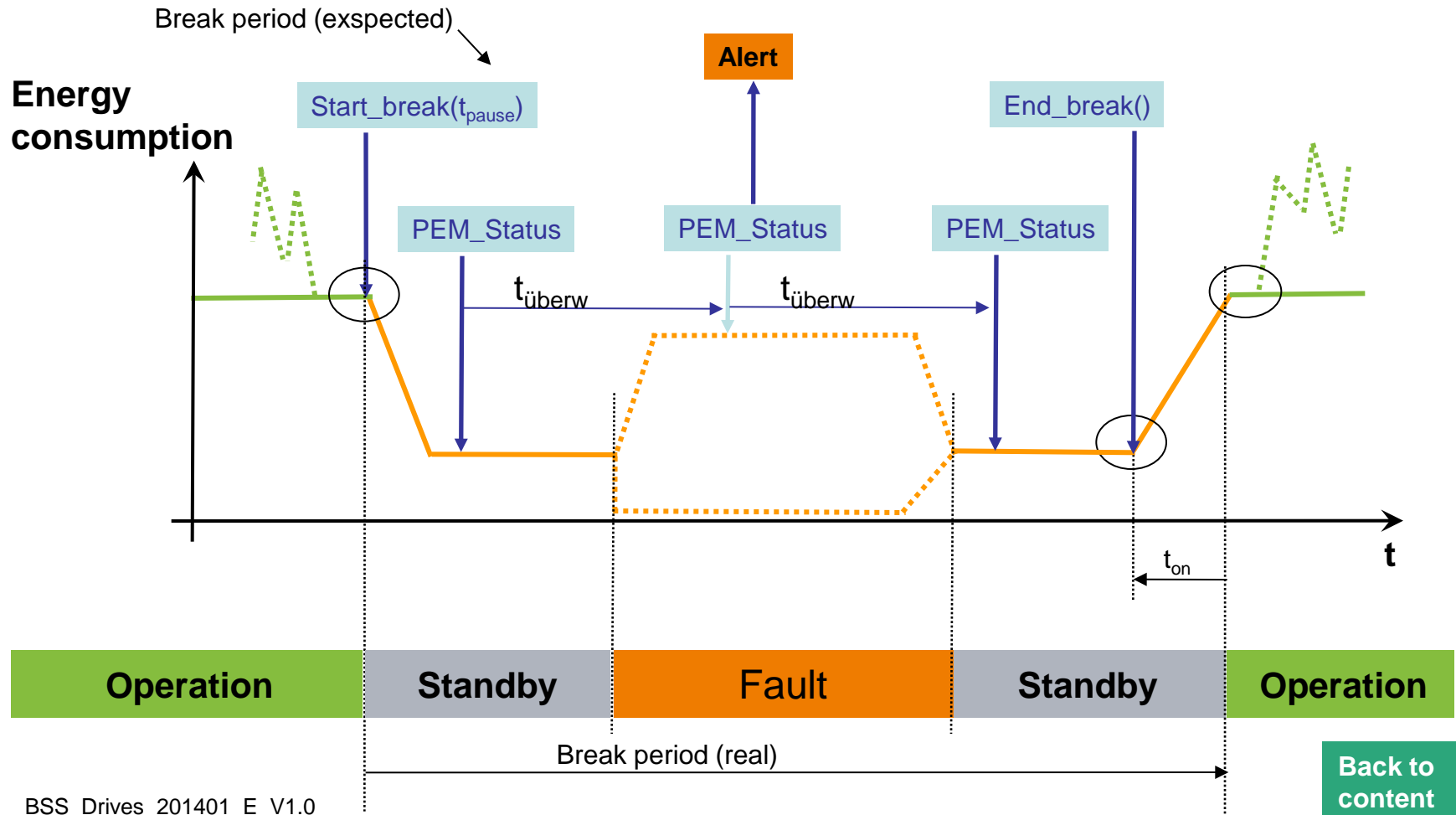**PROFIenergy**

PROFIenergy application profile

- PROFIenergy is a profile of the Real Time PROFINET protocol and an enabler for intelligent energy management

- PROFIenergy implements energy saving concepts by placing energy consuming devices (robots, conveyors, ...) into „sleep" mode during equipment idle times

- The profile requires firmware in vendor supplied devices to enable responding to PROFIenergy commands and status requests

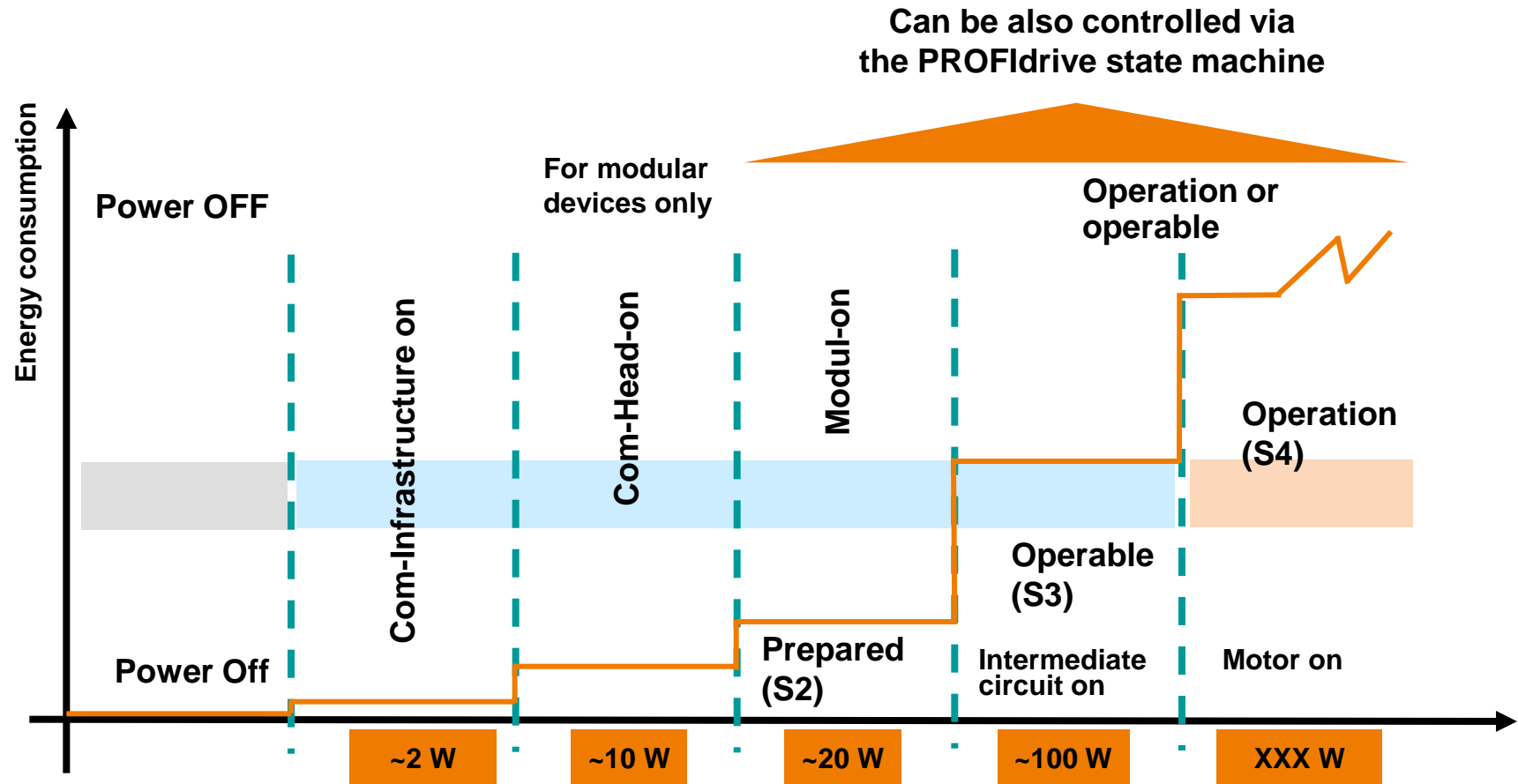- Energy savings up to 30% have been calculated in typical cases

Back to content

Realization of PROFIenergy in a drive

Back to content

PROFIenergy cycle

Break period (exspected)

Alert

Energy consumption

Start_break(t_{pause})

End_break()

PEM_Status

PEM_Status

PEM_Status

$t_{überw}$ $t_{überw}$

t_{on}

t

| Operation | Standby | Fault | Standby | Operation |

Break period (real)

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Back to content

Energy steps of drive devices

Can be also controlled via
the PROFIdrive state machine

Energy consumption

Power OFF

For modular
devices only

Operation or
operable

Com-Infrastructure on

Com-Head-on

Modul-on

Operation
(S4)

Operable
(S3)

Prepared
(S2)

Power Off

Intermediate
circuit on

Motor on

| ~2 W | ~10 W | ~20 W | ~100 W | XXX W |

Back to
content

Conclusion

- PROFIenergy supports enegy saving concepts in drive technology
  - Raise of additional potentials by optimized stand-by management
  - Existing stand-by solutions can be simplified

- PROFIenergy provides an easy to handle interface
  - Device and vendor independent
  - Process dependencies are solved on-site
  - Hierarchical structures are supported

- PROFIenergy is sustainable
  - Easy to expand for additional use cases and requirements
  - „Advanced" communication features already integrated

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Implementation and Community project

Concepts

Alternatives

Reference implementation

Different implementation concepts

- Implementation method depends on
  - Design and performance scope of the device
  - Exspected production quantities
  - Business model (Time to market etc.)

- Implementation alternatives
  - Development in-house or by a service provider
  - Use of ready-made modules or a customized design
  - Fixed design (Asic) or recobfigurable (FPGA)

- Member companies of PI offer a comprehensive range of hard- and software and services to support device manufacturers.

- The Community project „Reference implementation of PROFIdrive profile" provides a very cost- and time-effective and solution.

Choice of technologies

▪ **E**x**ternal protocol converter**
via a serial interface of the device in case of the implementation
into the device is either infeasible or undesirable.

▪ **Ready-to-install communication modules**
provide implementation in the device with minimum in-house work.
The entire protocol runs on the modul; the in-house work is
reduced to connecting the module to the device electronics.

▪ **Single-chip interface with standard Ethernet controller**
for compact devices and large production numbers exspected:
   ▪ ASICSs (ERTEC, TPS 1., ...)
   ▪ FPGA-technology (Field Programmable Gate Array)

Community project (www.industrialnetworx.com/profidrive-profile)

⬛ The Community project „Reference Implementation of PROFIdrive profile" provides an extremely cost- and time-efficient solution.
⬛ The community supports drive device manufacturers by providing the source code of a standard implementation of PROFIdrive free of charge. The community further supports source code implementation up to device certification.

⬛ This development represents a de facto standard reference implementation in drive technology

PROFIdrive Profile Implementation
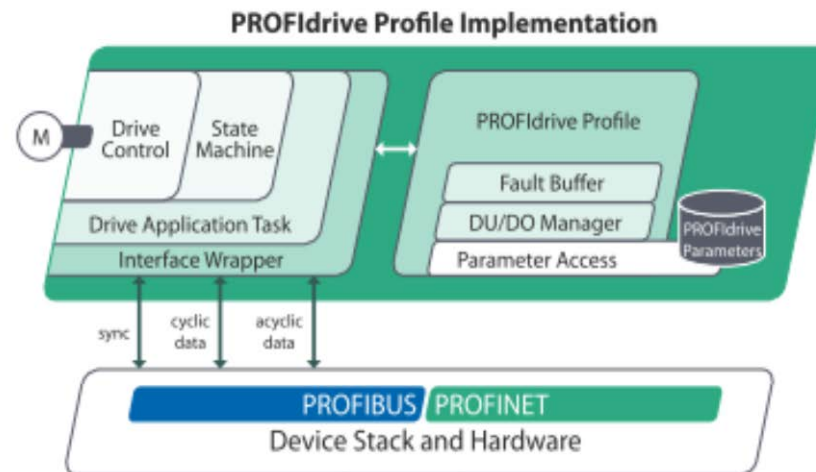
⬛ For details see:

www.industrialnetworx.com/profidrive-profile

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Back to content

Contribution of the community project to the drive interface
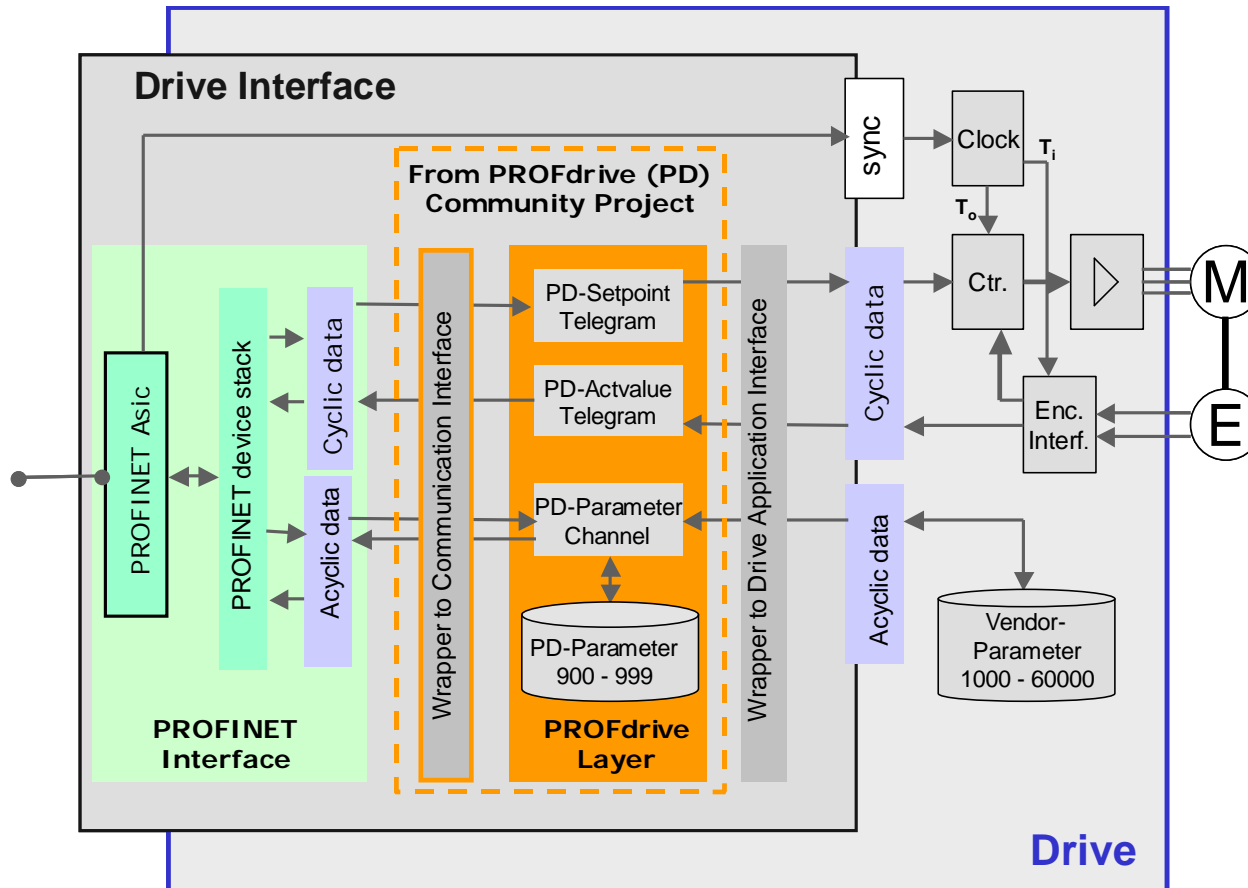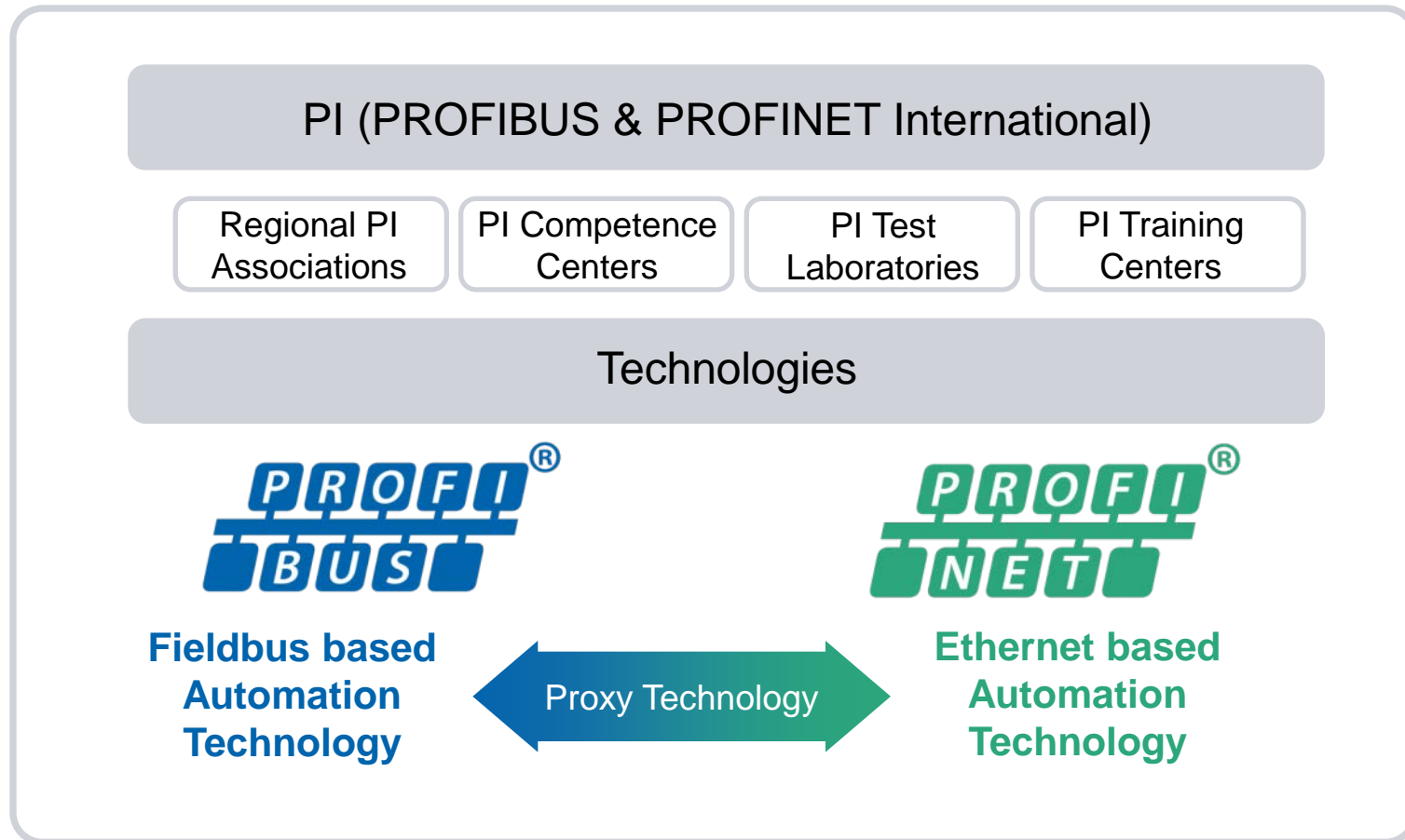
PROFIBUS & PROFINET

International (PI)

- Two technologies
- Global support
- Benefits from membership

Leader in industrial communication

- PROFIBUS & PROFINET International (PI) is the most influential interest group in the field of industrial communication.

- PI´s industrial networking solutions are based on two technologies: Fieldbus-based PROFIBUS and Ethernet-based PROFINET.

- PI hosts a large number of active Working Groups which are responsible for developing, standardizing and maintaining PROFIBUS and PROFINET.

- PI heads a global network of vendors, end users, developers, and System Integrators having a common interest in promoting , supporting and using PROFIBUS and PROFINET.

Back to content

Two technologies in one organisation

PI (PROFIBUS & PROFINET International)

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

Technologies

Fieldbus based Automation Technology

Proxy Technology

Ethernet based Automation Technology

Global engagement and support

- **Regional representatives (27)**
  for contact

- **Competence centers (50)**
  for support in all
  technical issues.

- **Training centers (27)**
  for intensive technical
  training and exchange of
  practicalexperiences

- **Test Labs (11)**
  are experienced partners for device certification

All figures as of year 2013.

Back to content

Benefits from membership

- The international network and the experience of PI provide significant competitive advantages to the members

- Members will benefit from the professional national and international marketing of PROFIBUS an PROFINET

- Members have access to all technical documents and can participate in the development of new technologies

- The regional representatives offer worldwide support for development projects, training and certification

Back to content

PROFIdrive

Certification

Device conformance with the PROFIdrive profile specification

- Devices differ depending on manufacturer and performance class
- Device conformance with profile specification is ensured by a certification test in a test lab
- This test is part of PI`s quality control program

- The „PROFIdrive profile tester" is used to perform the test which allows a more or less automatic test procedure
- The test also includes the interaction with devices which have been already certified before
- Based on a successful test report, PI will edit a certificate to the manufacturer/device

- The "Profile tester" is also available for member companies for use during their own development work

- The drive (test sample) is connected to the tester

- The test runs more or less automatically based on script files

- Results of the single test steps are automatically documented

- Finally a test report is prepared