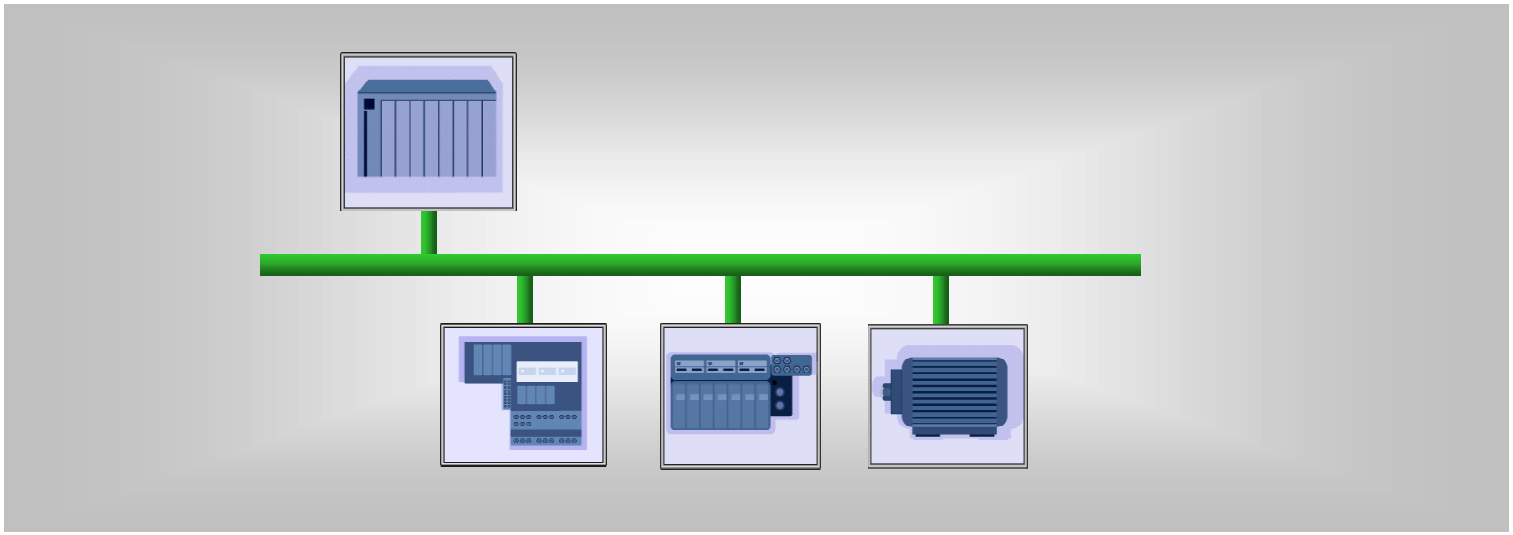
- Functional Scope
- Software-Stack
- Device Model
- Objects & Services
- Engineering
- Device Description
- IO-Controller
- Address Assignment
- Start up procedure
- ARs and CRs
- Data Exchange
- Diagnosis/Alarms
- Proxy

PROFINET IO



Decentral Periphery

PROFINET as Modular Technology

PROFINET IO – Decentral Periphery

- Functional Scope
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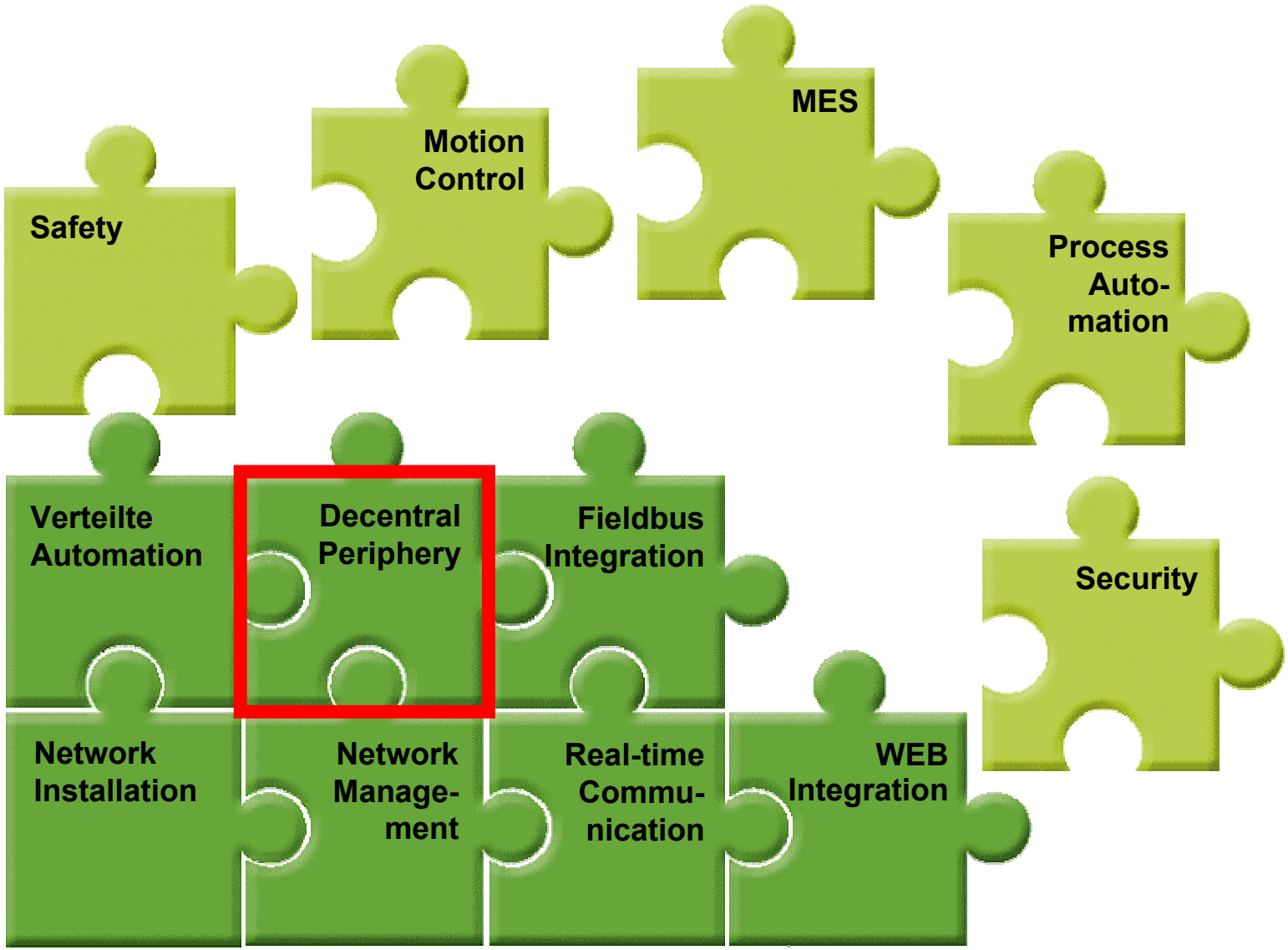

Why Ethernet for Decentral Periphery?

Arguments and Advantages:

- Ethernet is a well proven standard in the Office-World
- Ethernet is used since long time for communication between Controllers in the Automation industry
- Ethernet should also be used to communicate between Controllers and devices
- IT- Functionality can also be used in the field level
- Vertical integration of the field-communication with Manufacturing Execution Systems (MES)

Functional Scope of PROFINET IO

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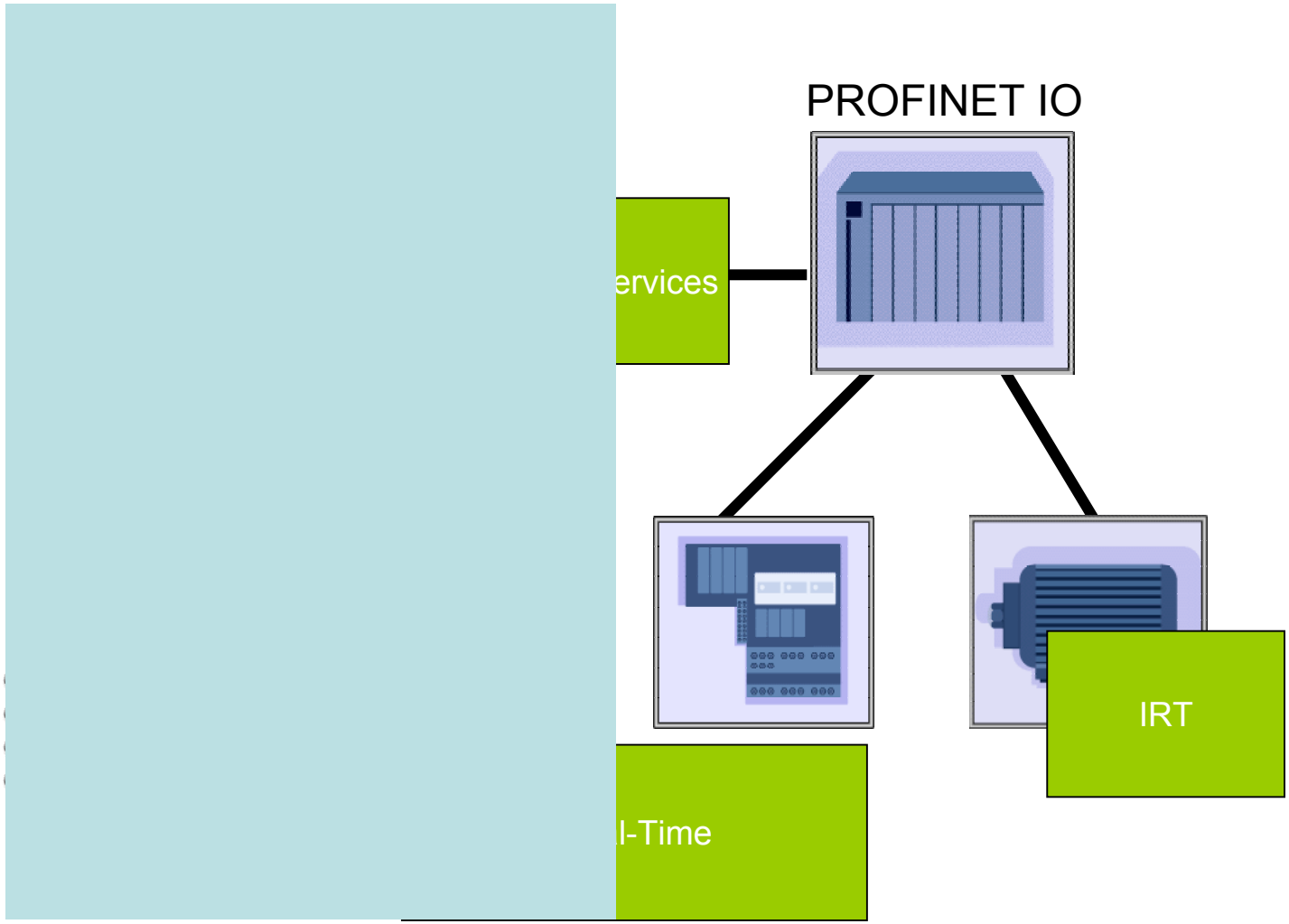
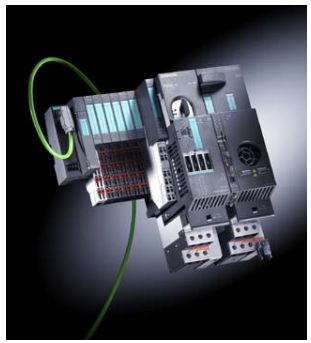


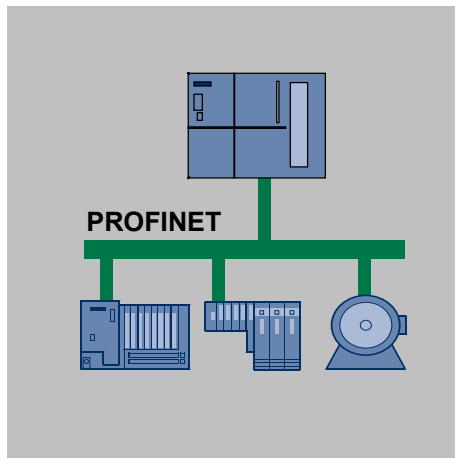
What is PROFINET IO ?



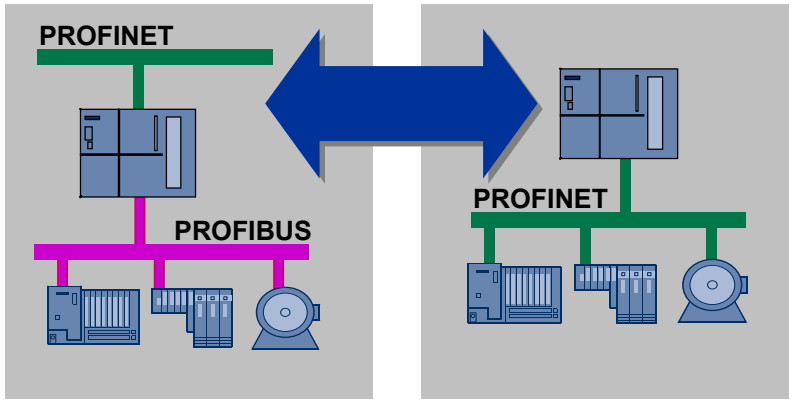
PROFINET IO is Decentral Periphery with Ethernet connection and PROFINET communication.

PROFINET IO uses

- **Communication via Real-Time and Non Real-Time**
- **Device description based on XML-standard**

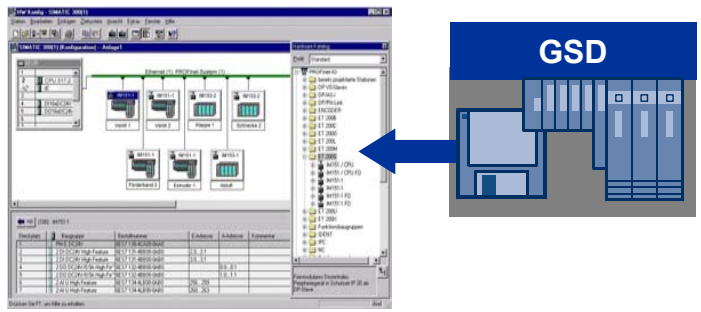


How is PROFINET IO implemented?



- **Decentral Periphery: only the bus interface changes**
- **Periphery boards can be used universally**

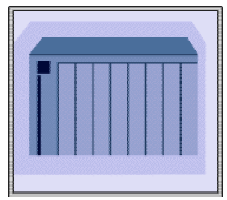
- **Device Configuration**
  ➡ **in well known way**
- **PLC-User program**
  ➡ **in well known way**



Flexible integration of decentral field devices on PROFIBUS and PROFINET possible → Investment Protection

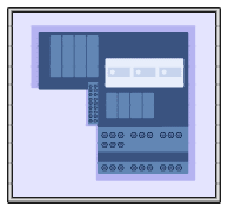
Device Designation and their Roles

- **PROFINET IO-Controller:**



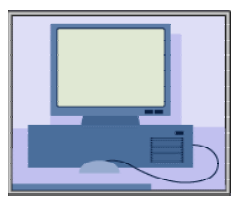
  - Data exchange of IO signals to assigned field devices
  - Device containing the control program Austausch der

- **PROFINET IO-Device:**



  - Field Device attached to the PROFINETIO-Controller

- **PROFINET IO-Supervisor:**



  - HMI and Diagnosis Station

Device Designation and their Roles

PROFINET IO – Decentral Periphery

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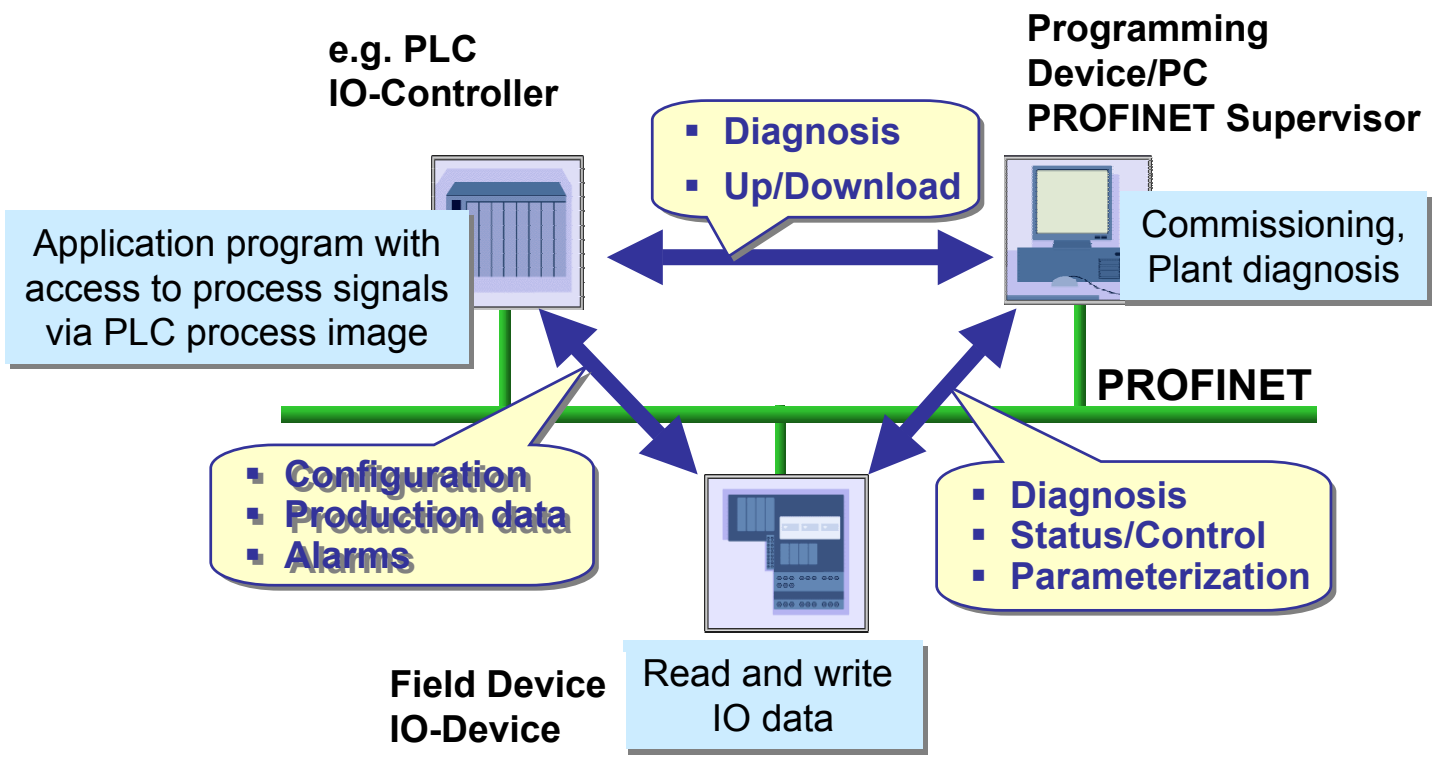
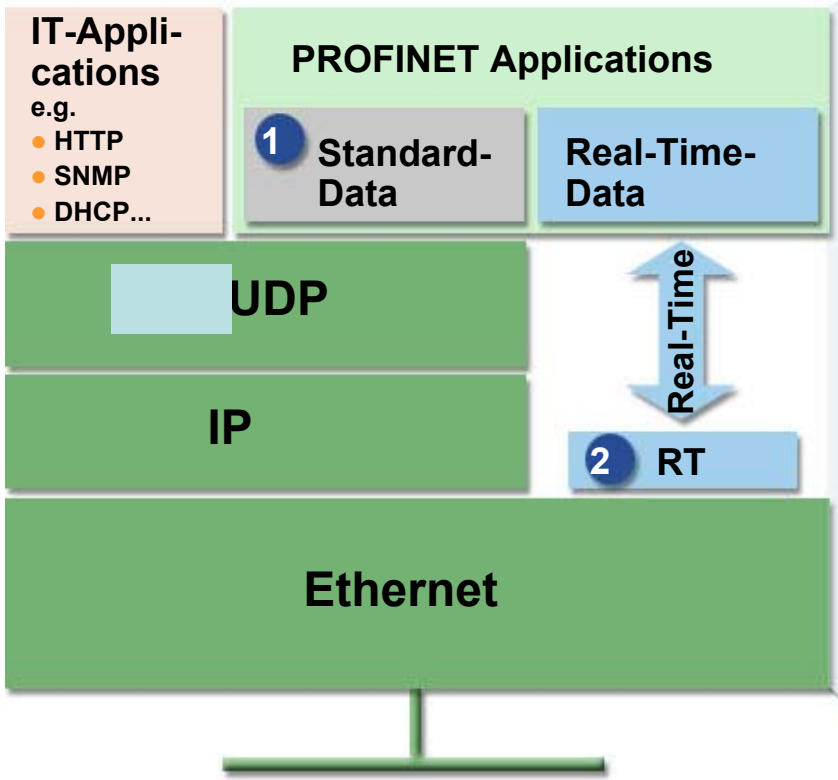


Communication Stack



1 Open channel for UDP/IP

- Device parameterization and configuration
- Reading of diagnosis data
- Negotiation of the communication channel for the user data

2 Real-Time channel RT

- Performant cyclic user data
- Event controlled messages/alarms

Communication Paths

Non Real Time

- Start up
- Set up of an application relation
- Set up of a communication relation
- Exchange of non time critical informations (read diagnosis,..)
- Exchange of general device informations.
- Read and modify device parameters.
- Read and write process related informations

Real-Time

- Cyclic data exchange
- Consumer-Provider-Model
- Monitoring of the communication
- Alarms

Further relevant Protocols for PROFINET IO

DHCP (Dynamic Host Configuration Protocol) for assignment of IP-addresses.

DNS (Domain Name Service) to manage logical names

SNMP (Simple Network Management Protocol) to read status and statistic informations.

ARP (Address Resolution Protocol) to convert IP-Addresses into Ethernet Addresses

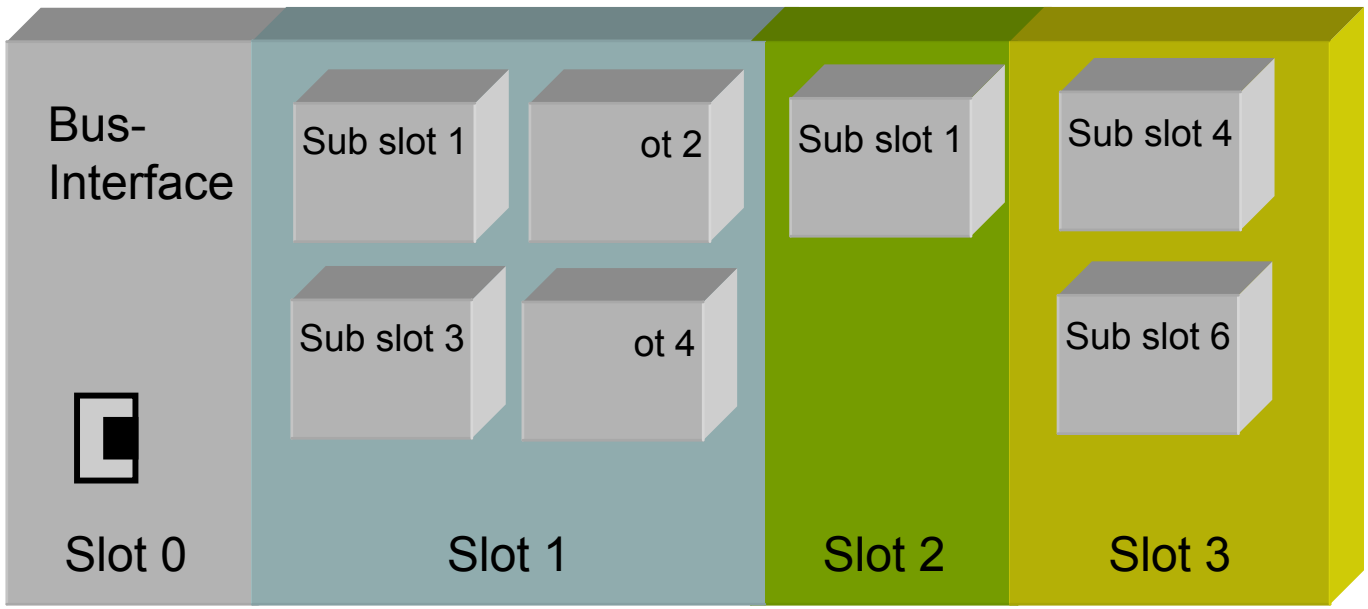
ICMP (Internet Control Message Protocol) used to transmit error informations.

The PROFINET IO Device Model

- **The PROFINET device model is comparable with PROFIBUS**
  - Compact devices
  - Modular devices
- **The reusability of existing IO-Modules from PROFIBUS guarantees investment protection for manufacturers and plant owners.**

The PROFINET IO Device Model

- **Existing IO-Periphery and PROFINET-Bus-Interface → PROFINET-Device**



- **IO-Data is always assigned to a sub slot.**
- **Every sub slot may have IO-Daten as well as alarms**

Objects and Services

Real Time Data

- Exchange of the cyclic process-data
- Update time is configurable

Characteristics

- cyclic
- Consumer-Provider-Model
- unconfirmed
- configurable update time
- buffer to buffer
- The user data is accompanied by status informationen
- Data exchange is time controlled

Objects and Services

Non Real Time Data

- Acyclic data exchange
- Parameterization of IO-Devices
- Configuration of IO-Devices
- Read status informationen

Characteristics

- Acyclic data exchange
- Bidirectional
- One to one
- Connection oriented
- Queued
- Confirmed
- Monitoring of Repetition with „SequenceCounter“

Record Data (Read and Write Services)

- **Diagnosis information** can be read from the user from every device at any time
- **Logbook entries** for alarms and error messages
- **Identification informations** acc. to PNO-Guideline „I&M Functions“
- **Information functions** about real and logical module structures.
- **IO-Data Objects** (to read back the IO-data).

Objects and Services

Alarms are Real Time data

- Report of operating states
- system defined events (e.g. pull and plug of boards)
- user defined events

Characteristics

- acyclic
- queued
- confirmed
- directed and
- secured

Alarms → “All Inclusive”

- **Process-Alarme** shall be used if the event is process related
- **Diagnosis-Alarms** shall be used if the error or event is coming up device internal
- **Pull and Plug-Alarm**
- **Return-Alarm**
- **Redundancy alarm**
- **Control by Supervisor**
- **Release by Supervisor**

The alarms can be prioritised differently

Engineering

PROFINET IO – Decentral Periphery

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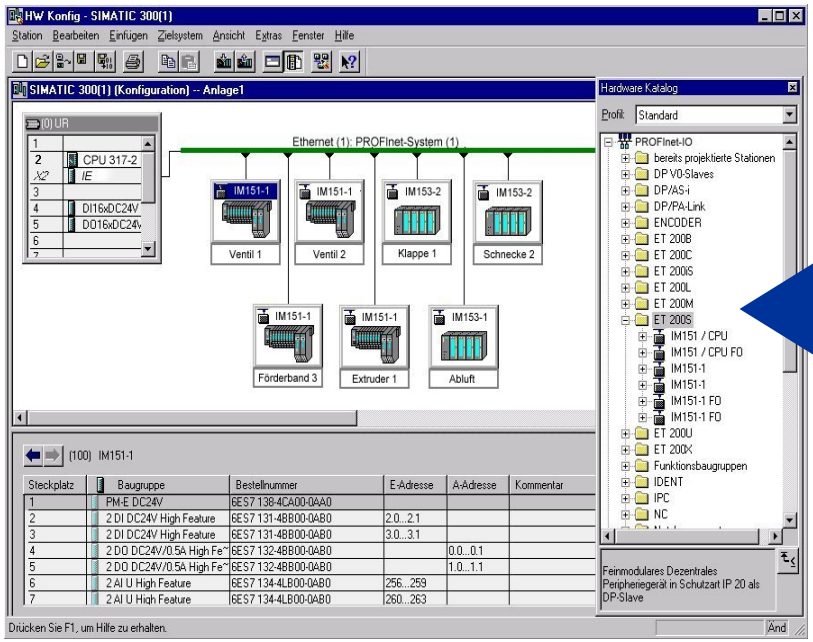
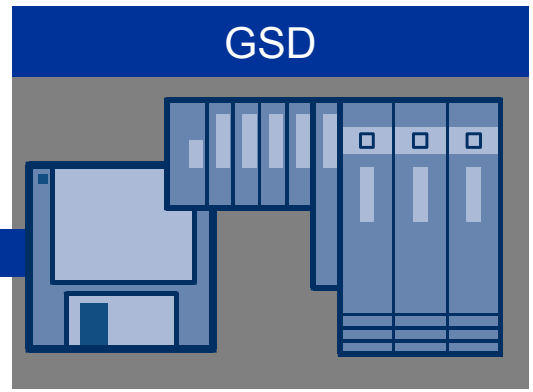
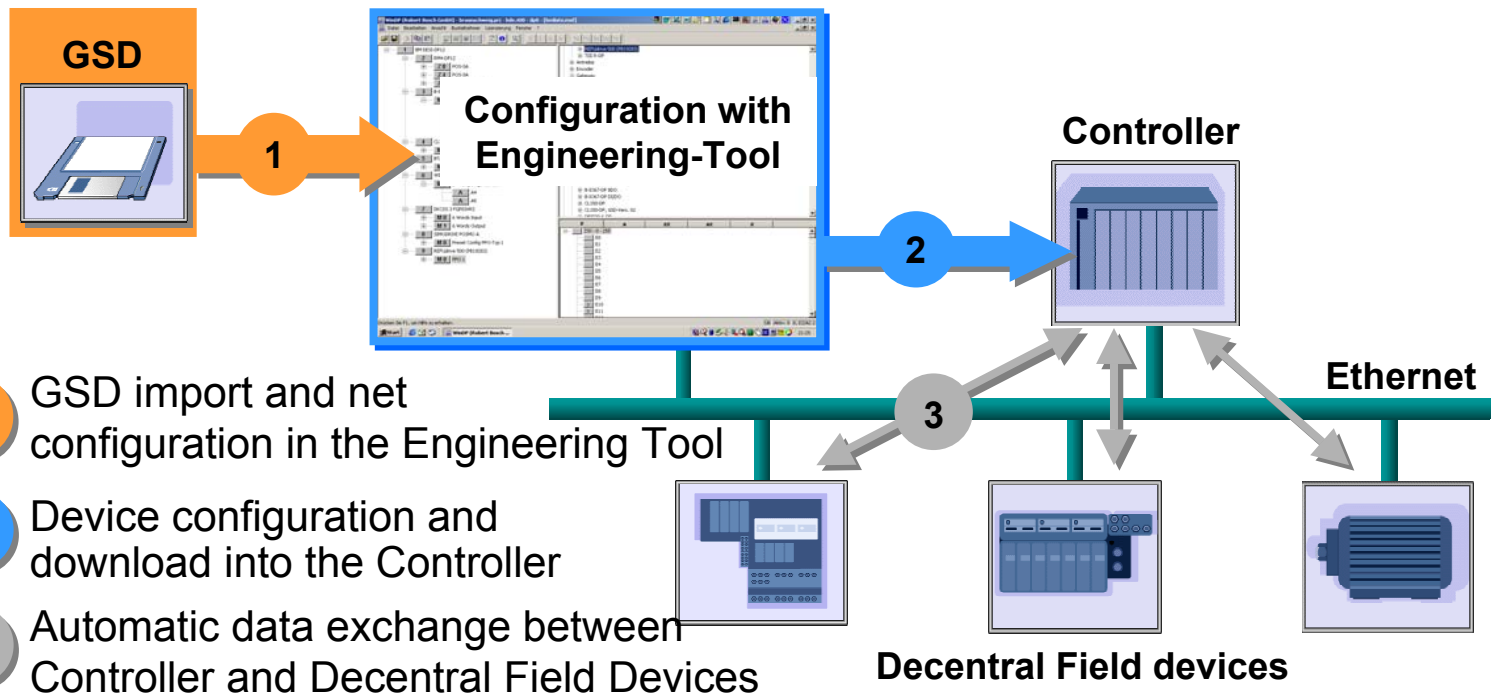




Identical engineering view for PROFIBUS and PROFINET

From Engineering to Data Exchange

- Every Ethernet device has the same priority in the network
- Decentral field devices will be assigned to a controller during network configuration
- The device description of the field devices is defined in a GSD-file



1. GSD import and net configuration in the Engineering Tool
2. Device configuration and download into the Controller
3. Automatic data exchange between Controller and Decentral Field Devices

The Device Description (GSD)

Structure of a GSD File

- **Profile Body** → DeviceIdentity-Block (VendorID, DeviceID, InfoText, VendorName)
- **DeviceFunction-Block** → (Family, MainFamily and ProductFamily)
- **ApplicationProcess-Block**
  - DeviceAccessPointList
  - ModuleList
  - ValueList
  - ChannelDiagList
  - GraphicsList
  - CategoryList
  - ExternalTextList

GSD Example

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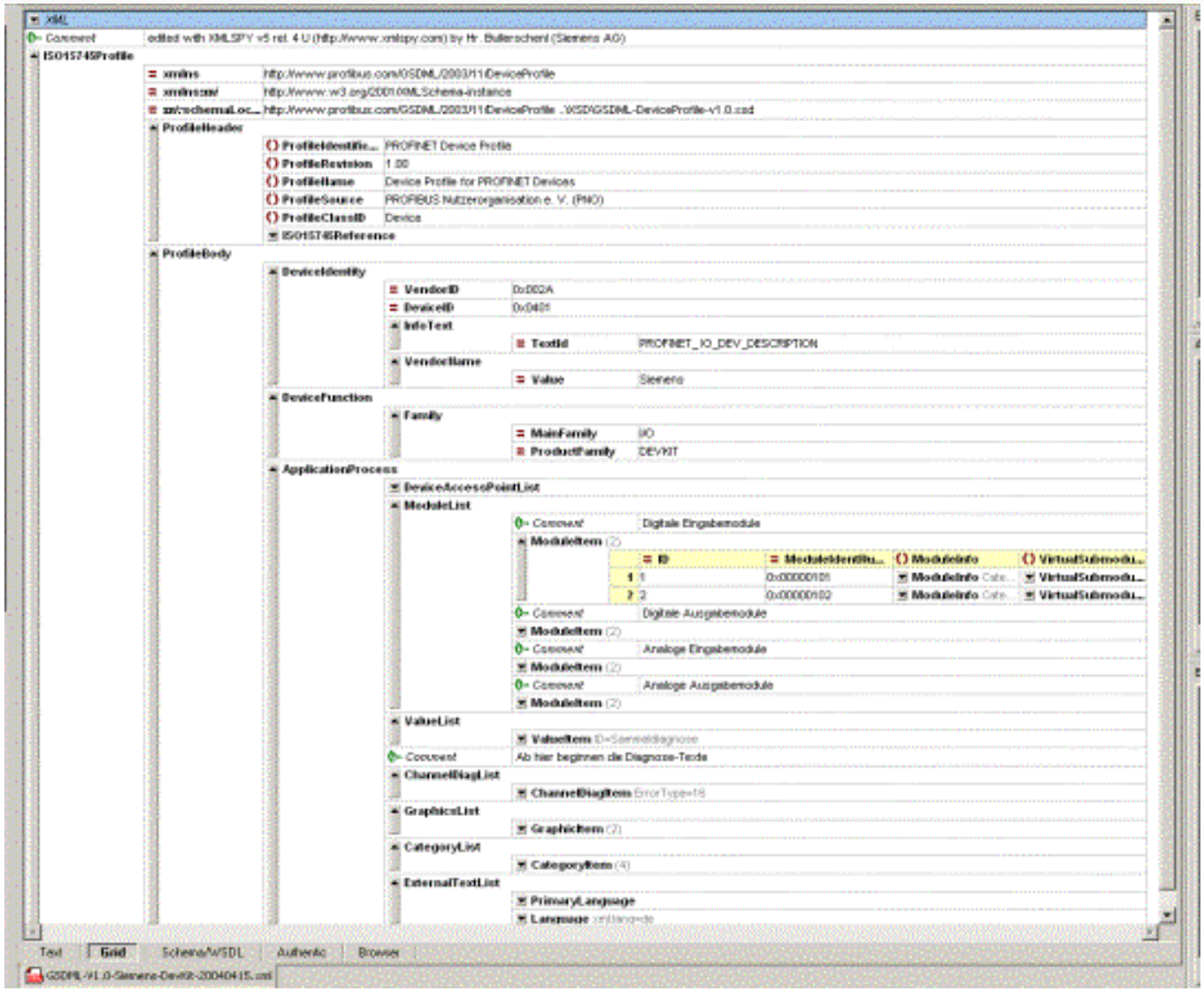
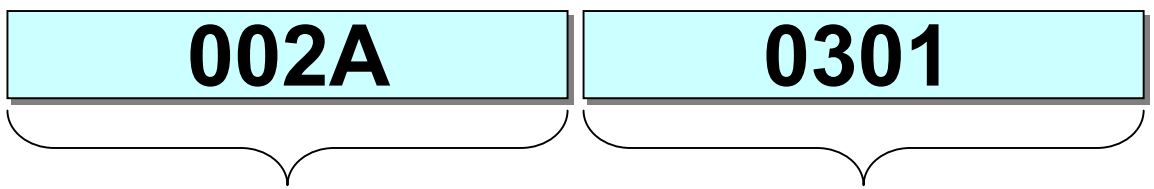
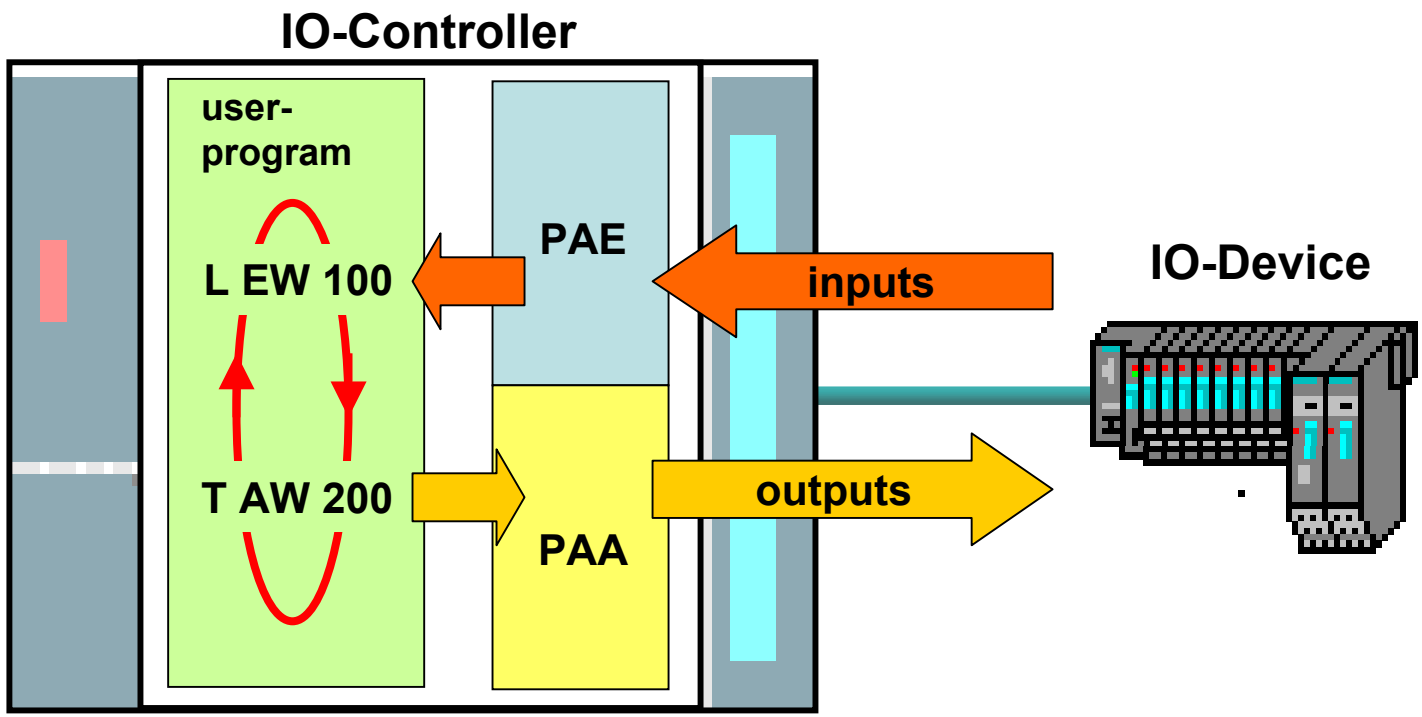


Unique Device Identification

- **A world wide unique Device-Ident-Number is attached to each PROFINET IO-Device**
- **The 32-bit Device-Ident-Number is split in:**
  - 16-bit Manufacturer Identification (e.g. 002A → Siemens)
  - 16-bit Device Identification (e.g. 0301 → ET200S)
- **The Manufacturer Identification is assigned by the PNO**
- **The device identification can be assigned by the manufacturer**

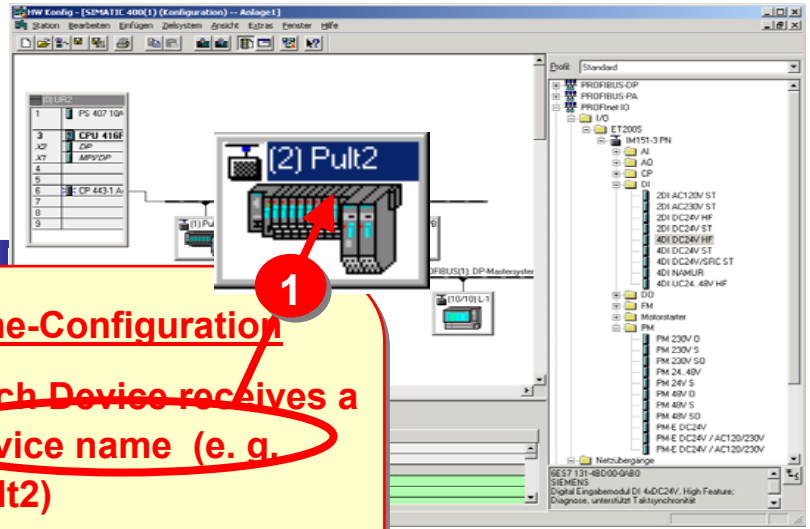


IO Data Exchange



- The IO-data is stored in the process image

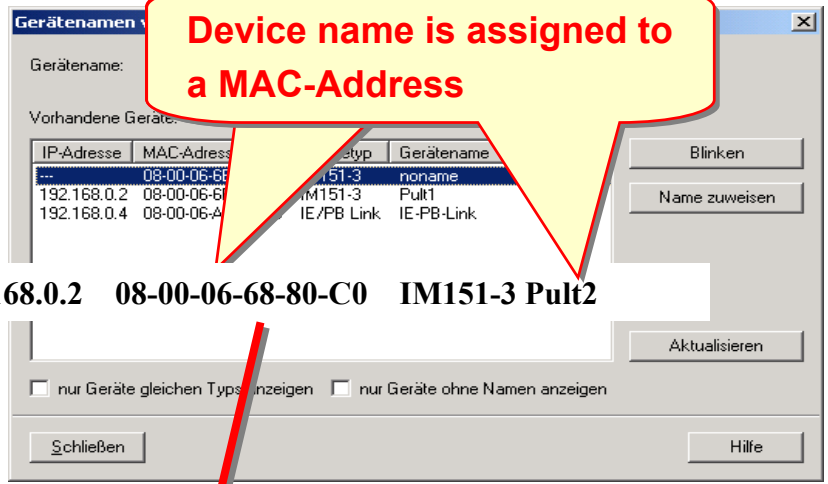
Example of Address Assignment: PROFINET with DCP (Discovery Configuration Protocol)



Offline-Configuration

- Each Device receives a device name (e. g. Pult2)
- Configuration tool automatically assigns the IP-Address

1



Device name is assigned to a MAC-Address

192.168.0.2 08-00-06-68-80-C0 IM151-3 Pult2

IO-Controller

2

Online:
Write device name into the device

PROFINET

MAC Addr 1

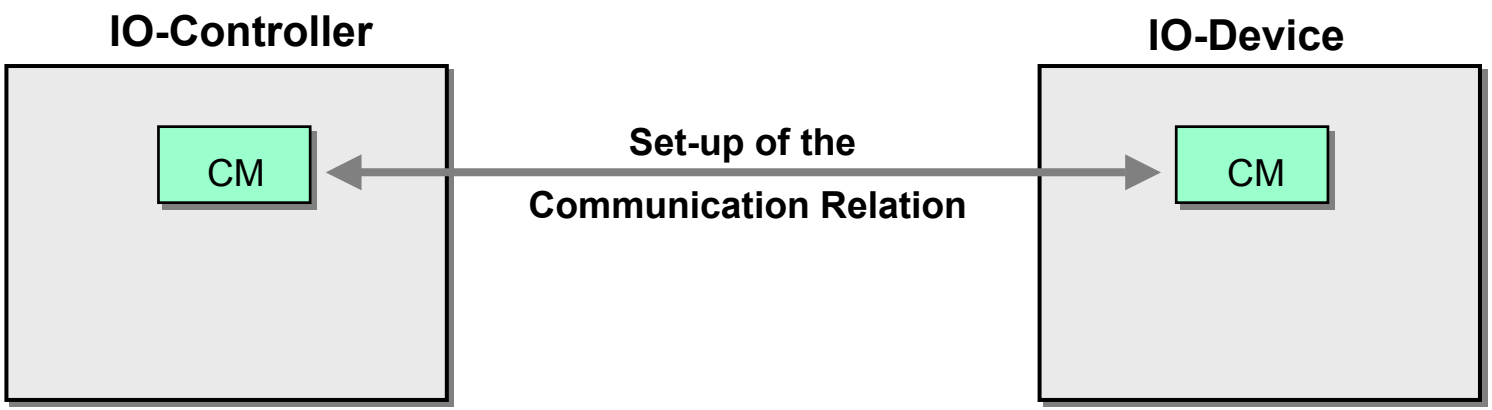
MAC Addr 2

3

Start up:
IO-Controller assigns IP-Address to the device

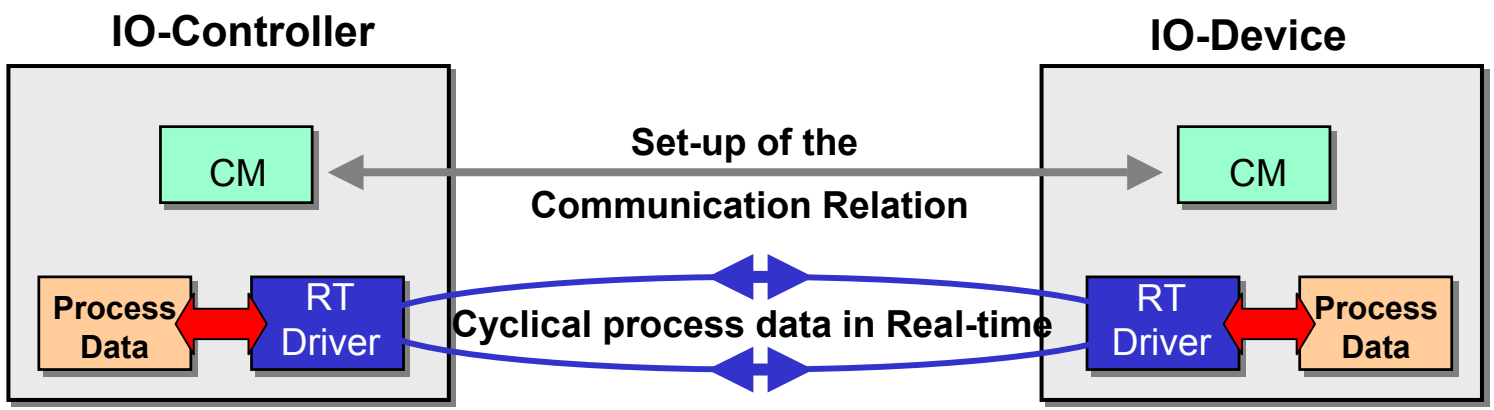
The Start-up Phase

- **The Application Relation (IO-AR) between the devices is set-up by the so called Context Management (CM) via UDP/IP and RPC (Remote Procedure Call).**
- **This step establishes the communication relation for the process data (IO data CR) automatically.**
  - IO-data and update rate is specified here



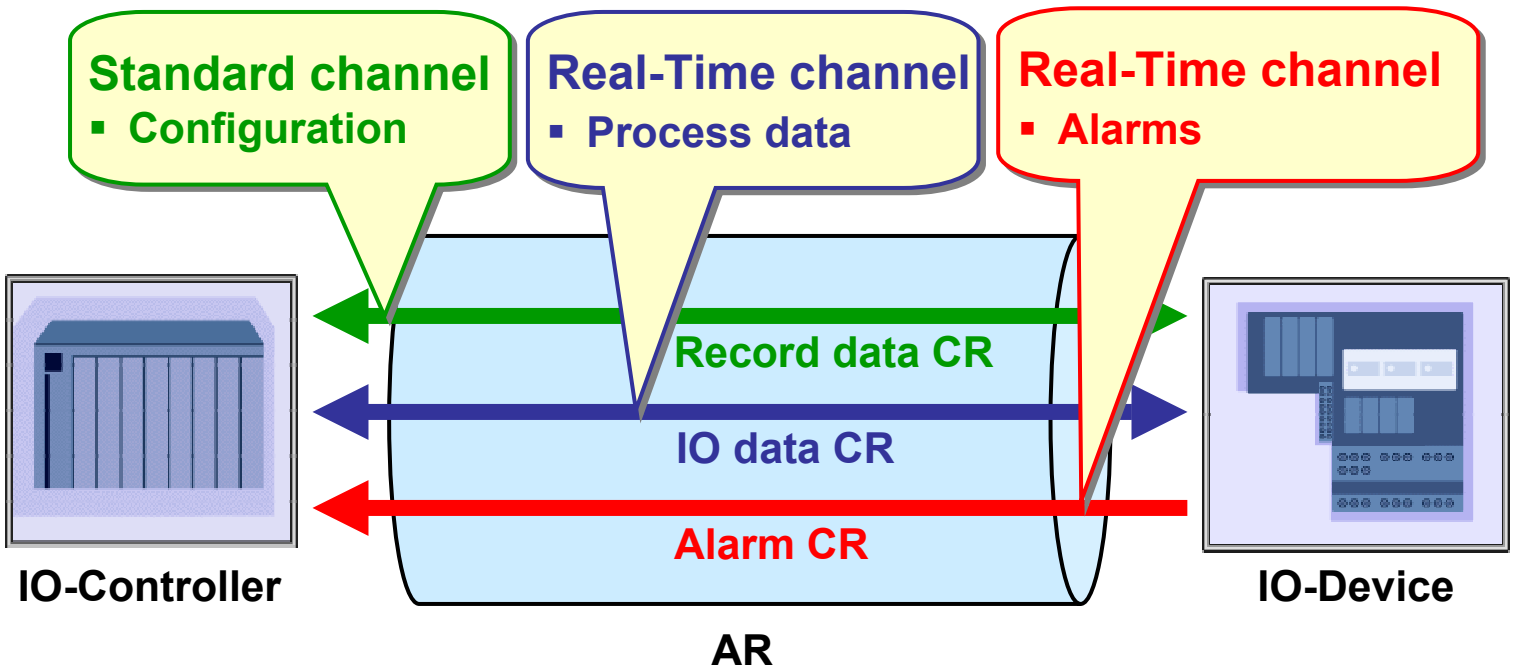
The Start-up Phase

- **Subsequently, the process data is transmitted cyclically between the devices via the real-time channel**
- **The cyclic date exchange is done via the real-time channel**
- **Diagnosis data and alarms are transferred in the acyclic real-time channel**

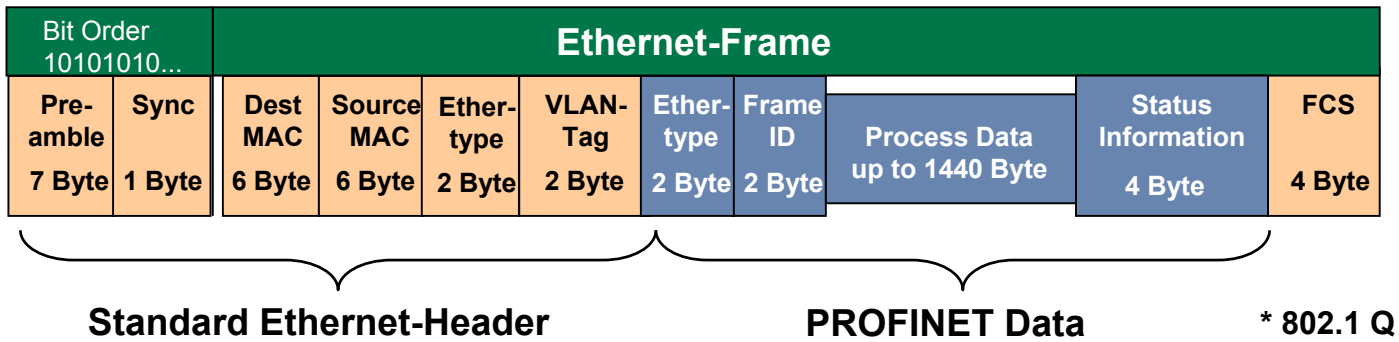


Data Exchange between Devices

- There is an Application Relation (AR) defined between IO-Controller and IO-Device
- An AR may contain several Communication Relations (CR´s) for configuration, process data and alarms

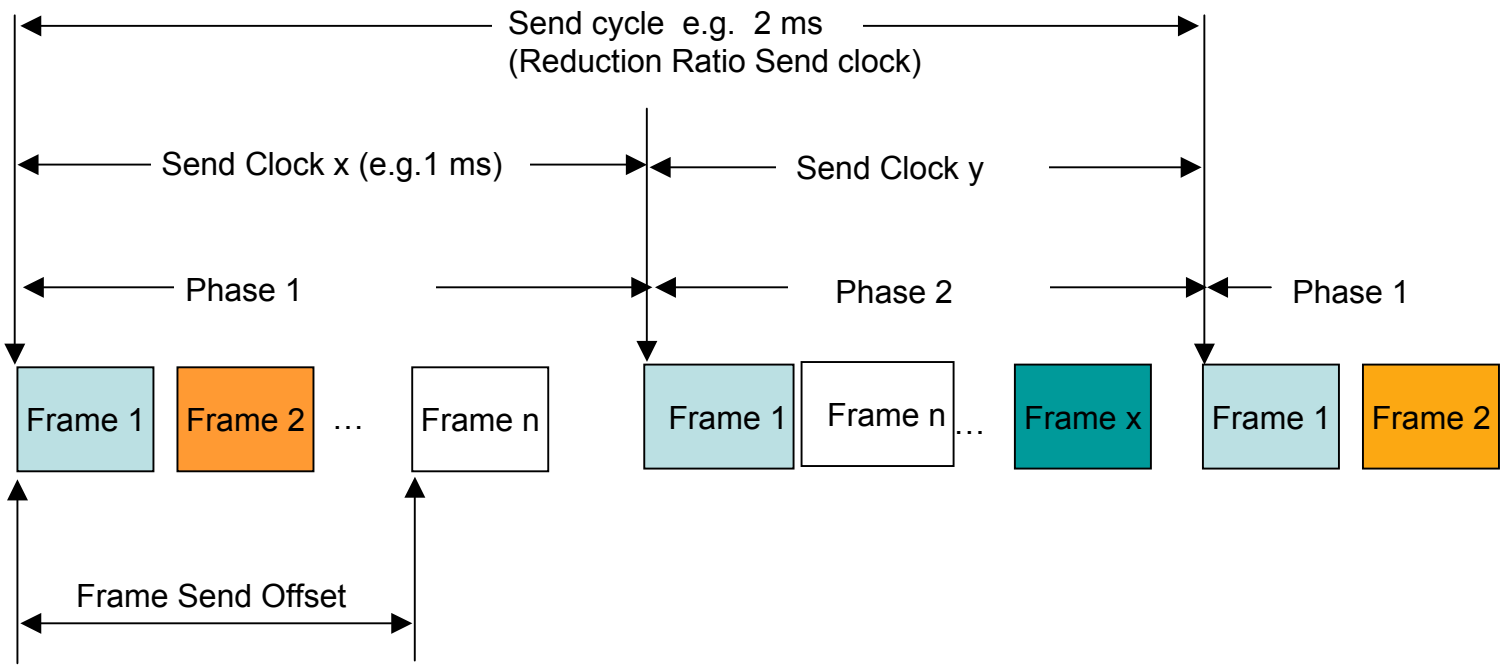


Standard-Ethernet-Frame with PROFINET-Extension



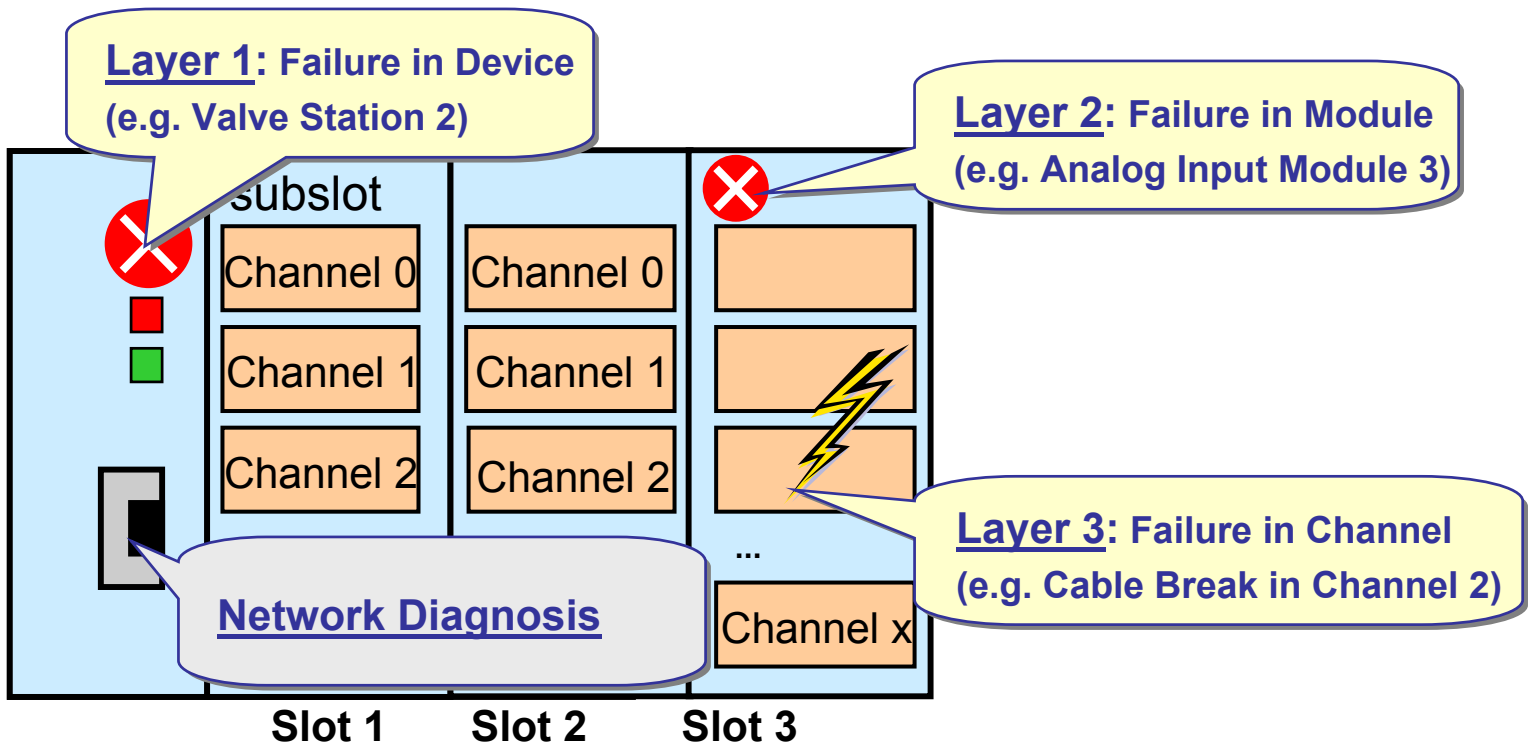
- VLAN-Tag: Definition of the priority
- The minimum Ethernet frame is 64 bytes

Reduction Ratio

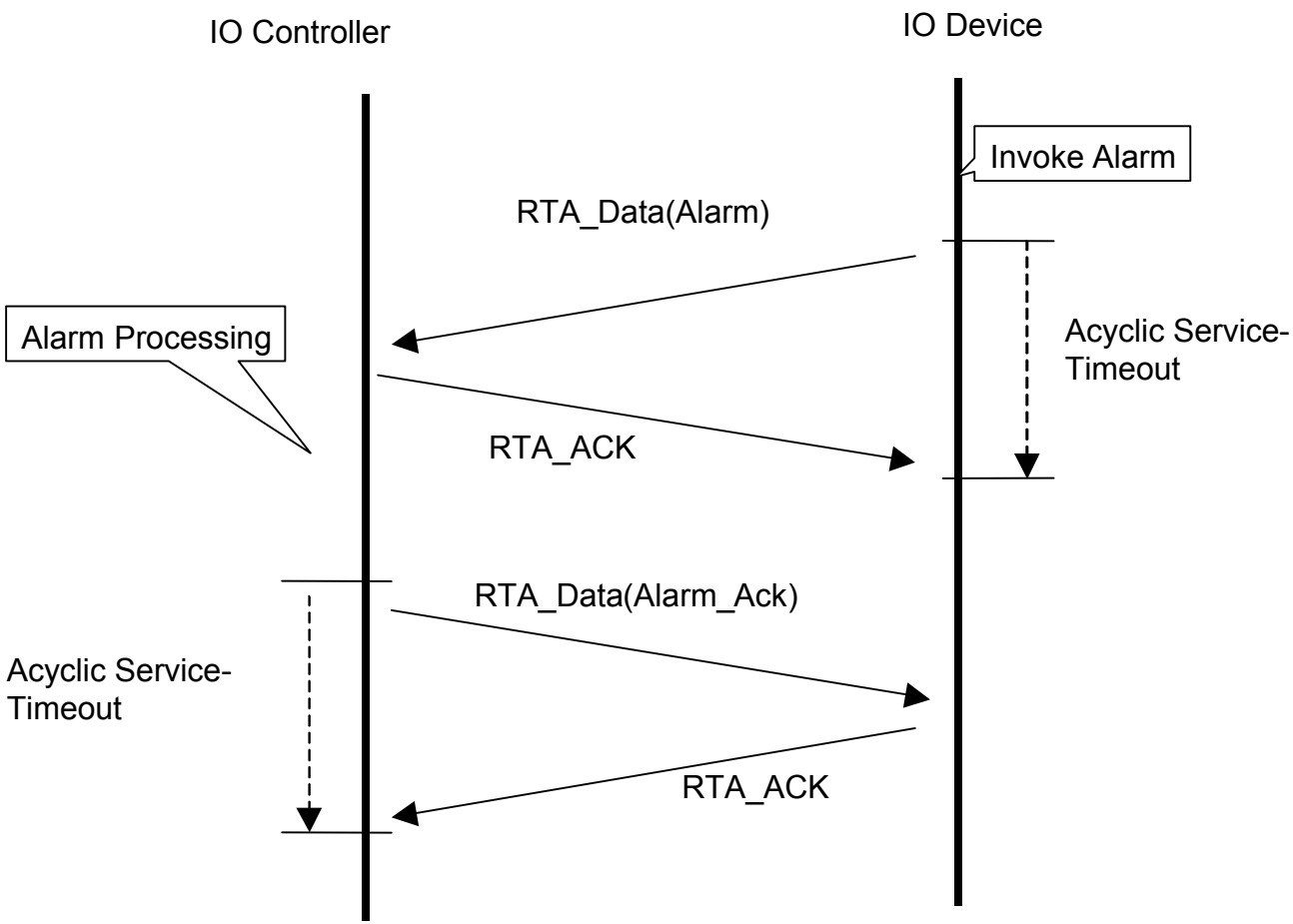


Quick Error Localization through Structured Error Information

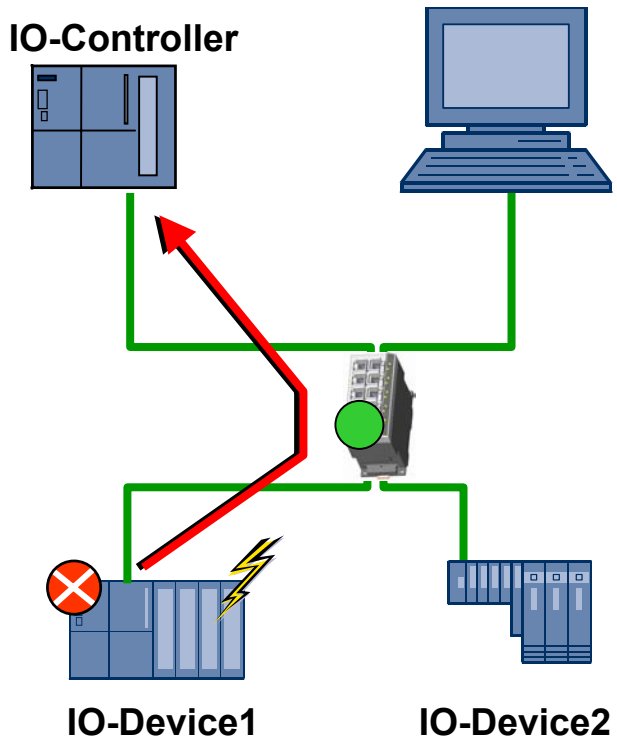
- **The diagnostic information is structured hierarchically**
  - Station name, slot, subslot,channel, channel type, error information
- **SNMP completes the diagnosis with network information**

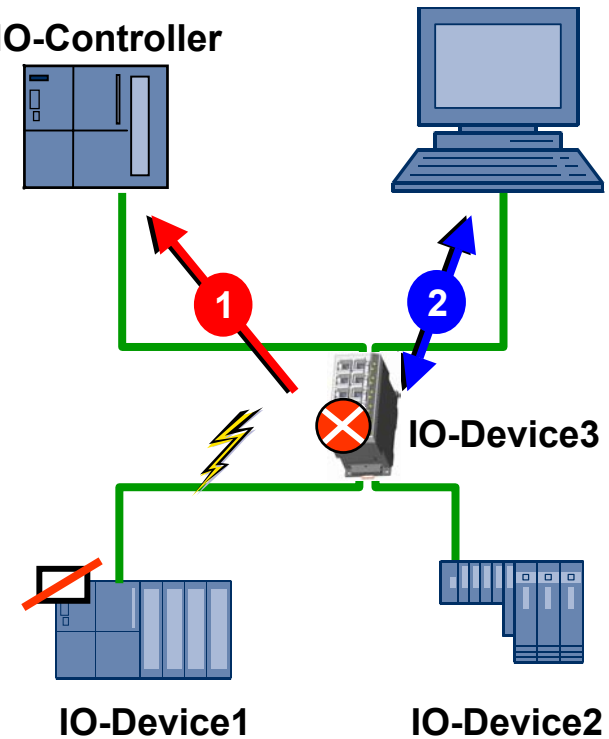


Report of Alarms



Network Diagnosis



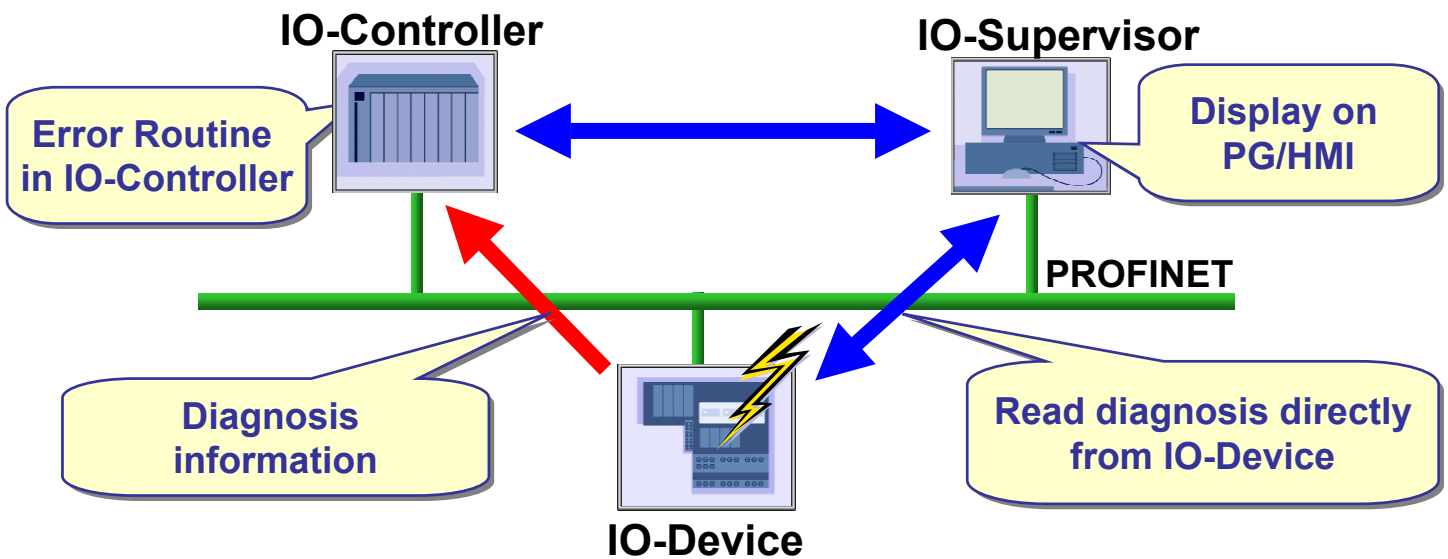


- The switch passes the PROFINET-Diagnosis from the IO-Devices to the Controller

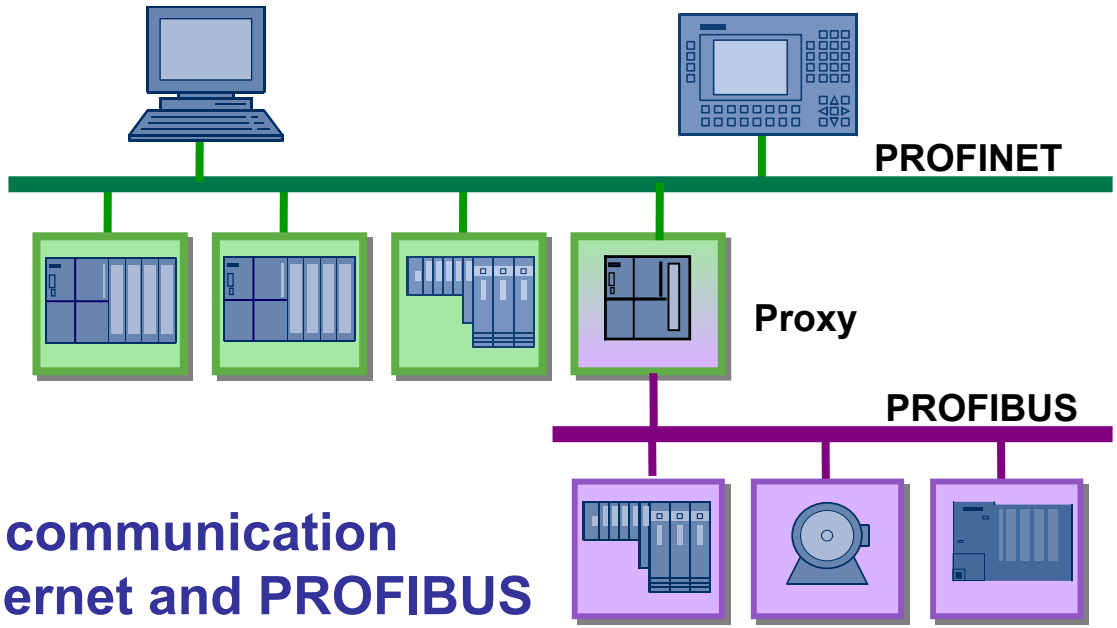
- Switch is configured as IO-Device (GSDML)
- Switch reports Network-failure as PROFINET-Diagnosis to the IO-Controller(1)
- Additional SNMP-channel for Standard-Information (2)

Diagnosis there, where it is needed

- **Diagnosis information is transmitted as alarm from the IO-Device to the IO-Controller**
  - The alarm triggers a reaction in the PLC program
- **IO-Supervisor gets the diagnosis information directly from the IO-Device**
  - Display diagnosis information on service PG or HMI station



Integration of PROFIBUS in PROFINET



Transparent communication between Ethernet and PROFIBUS

- Parts or even the complete PROFIBUS is represented by a Proxy
- The Proxy is a PROFINET participant on Ethernet and DP-Master for PROFIBUS

Openness through integration of existing field buses is Investment protection for device manufacturers and users

PROFINET IO / PROFIBUS - System

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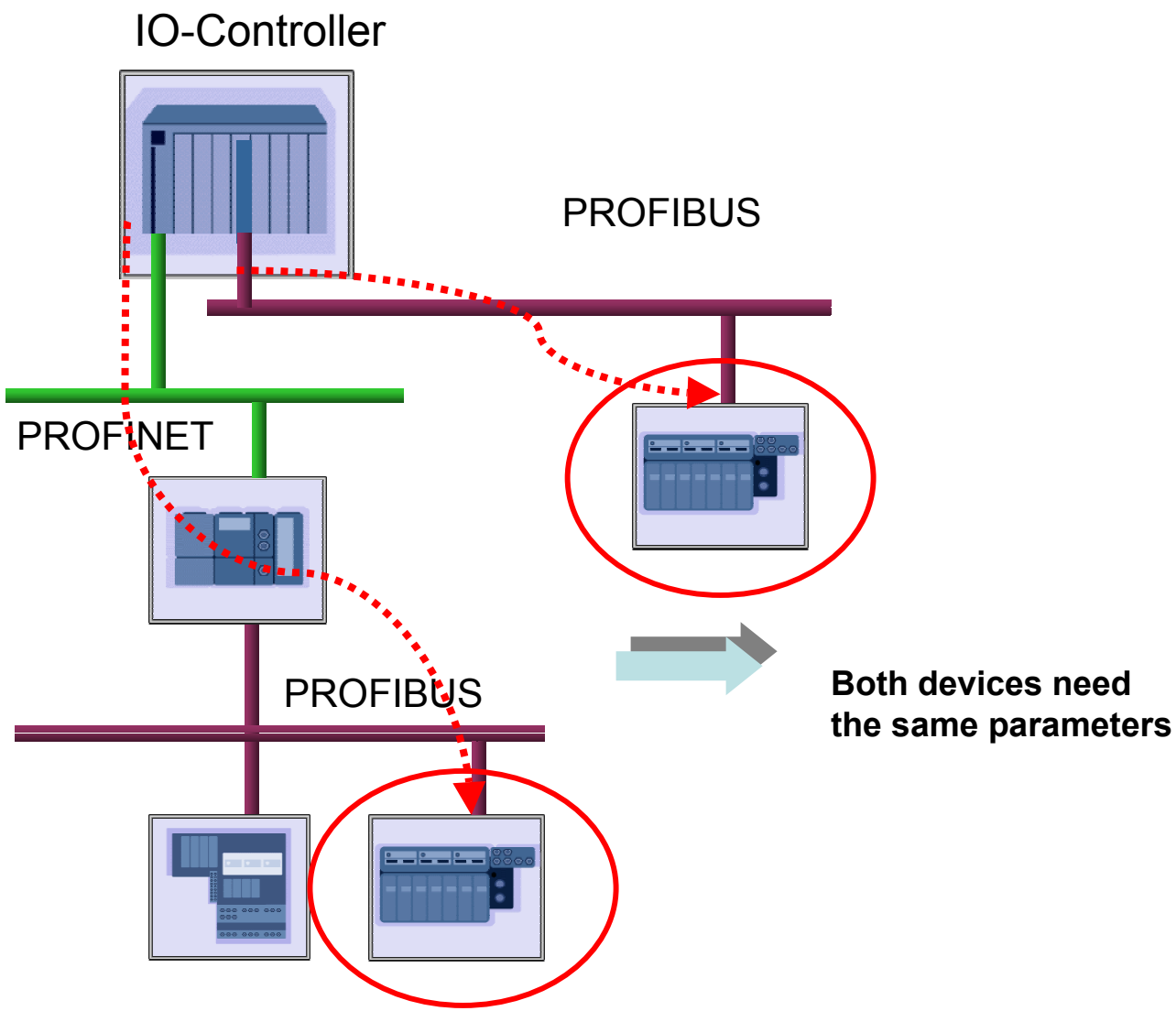

PROFINET IO – Proxy