



# ***Ethernet-based fieldbus functionality for Neutron scattering experiments with PROFINET IO***

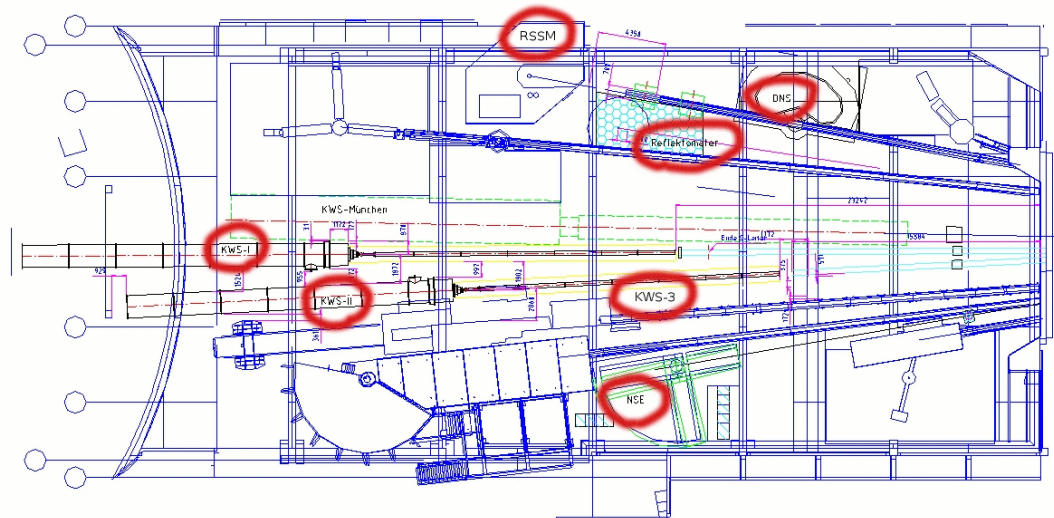
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- Jülich Center for Neutron Science (JCNS)*
- PROFINET CBA*
- PROFINET IO*
- Application to Neutron Scattering*

# Jülich Centre for Neutron Science JCNS

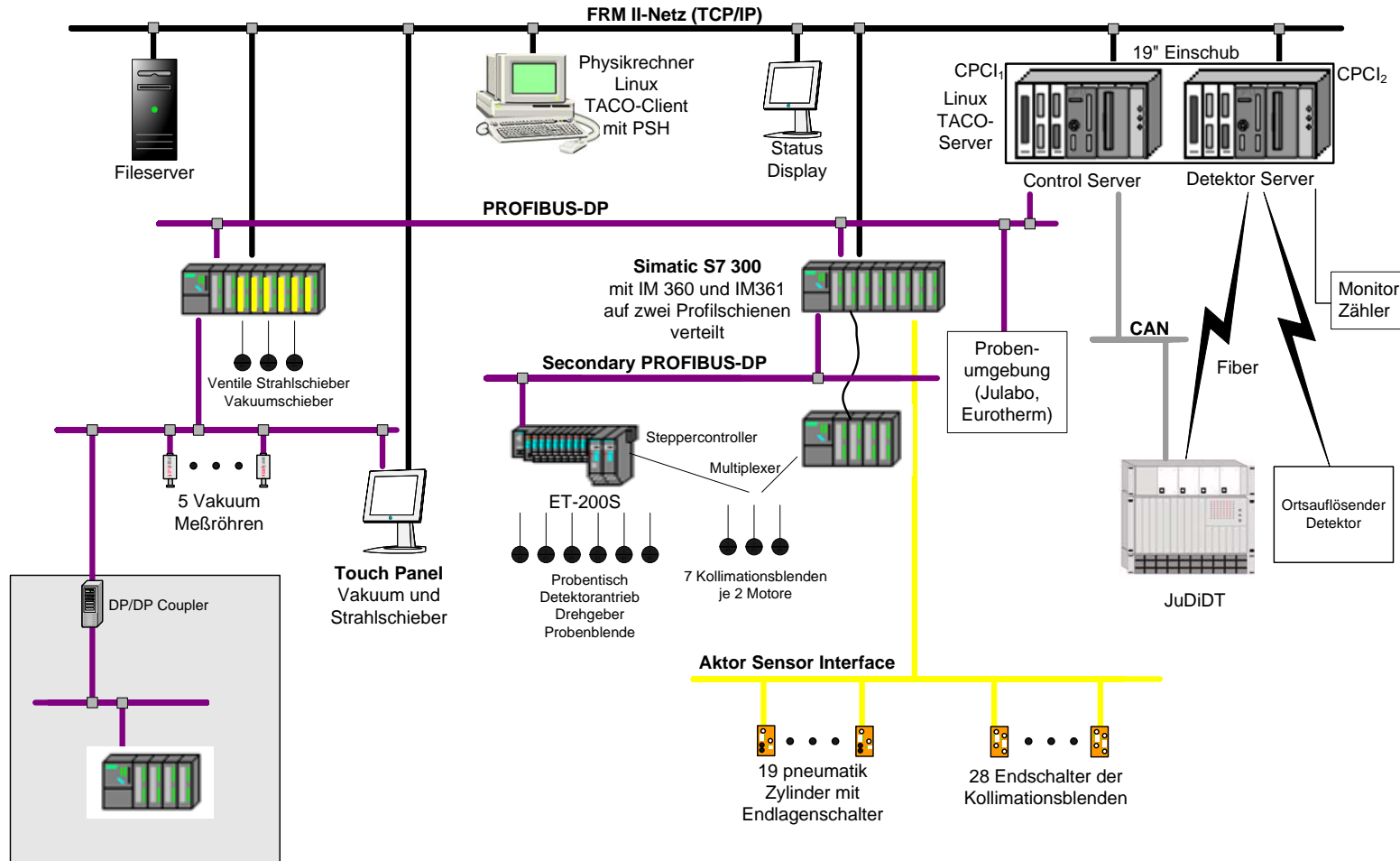
- JCNS founded after shutdown of FRJ-2 in May 2006
- Branchlabs in Garching (FRM-II), Oak Ridge (SNS) and Grenoble (ILL)
- 8 experiments being built at FRM-II (30 new staff members)
- “Jülich-Munich Standard”

- TACO
- Linux
- Python
- S7 PLCs
- PROFIBUS





# Example: Small Angle Scattering KWS2





## Motivation

- *Connection of process equipment to server computer: PROFIBUS DP*
- *Problem:*
  - *Controller availability for cPCI/Linux*
  - *Continuous device driver modifications*
- *Possible solution: Ethernet*
- *Problem:*
  - *Missing Application Layer*
  - *Inappropriate for the factory floor (RT features, noise, etc.)*
- *Several initiatives during the last years*
  - *Ethernet/IP (Allen Bradley)*
  - *Modbus/TCP (Schneider)*
  - *Powerlink (B&R)*
  - *EtherCAT (Beckhoff)*
  - *PROFINET (PNO, Siemens): PROFINET CBA and IO*

## PROFINET CBA Model

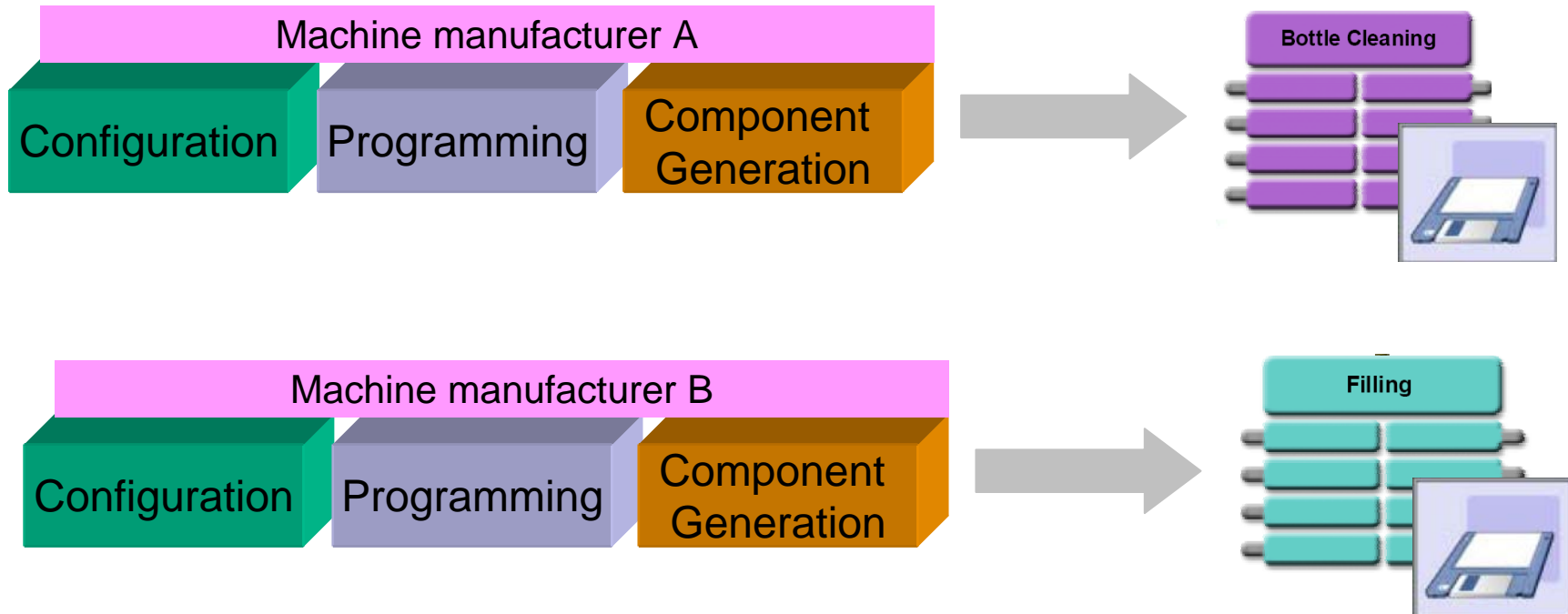
- *Uniform approach to **engineering**, data transfer and diagnosis*
- *Open, vendor-independent communication based on Ethernet + TCP/IP (IEC 61784-1)*
- *Object-oriented component-based model supporting modularization of an automation system*
- *Automation system is subdivided into autonomous components, described by interface variables*



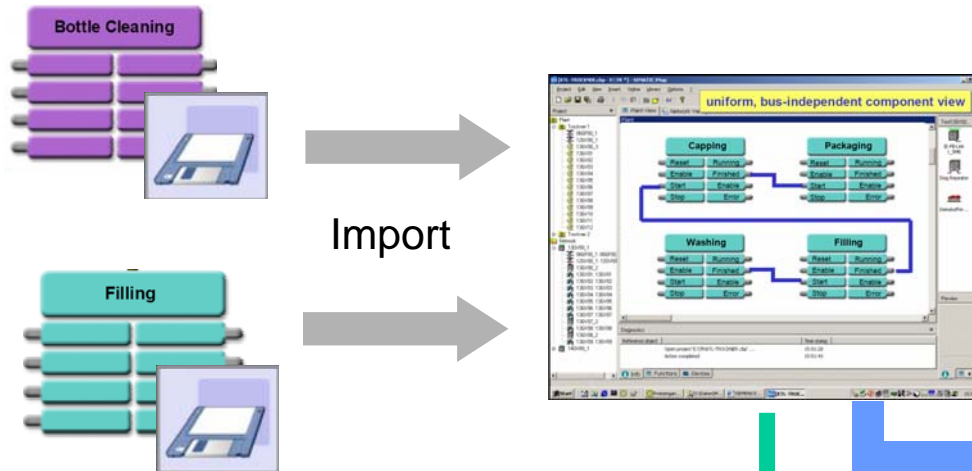
# CBA Engineering

Vendor-specific configuration and programming tools

Vendor-independent XML-file



# CBA Connection Editor

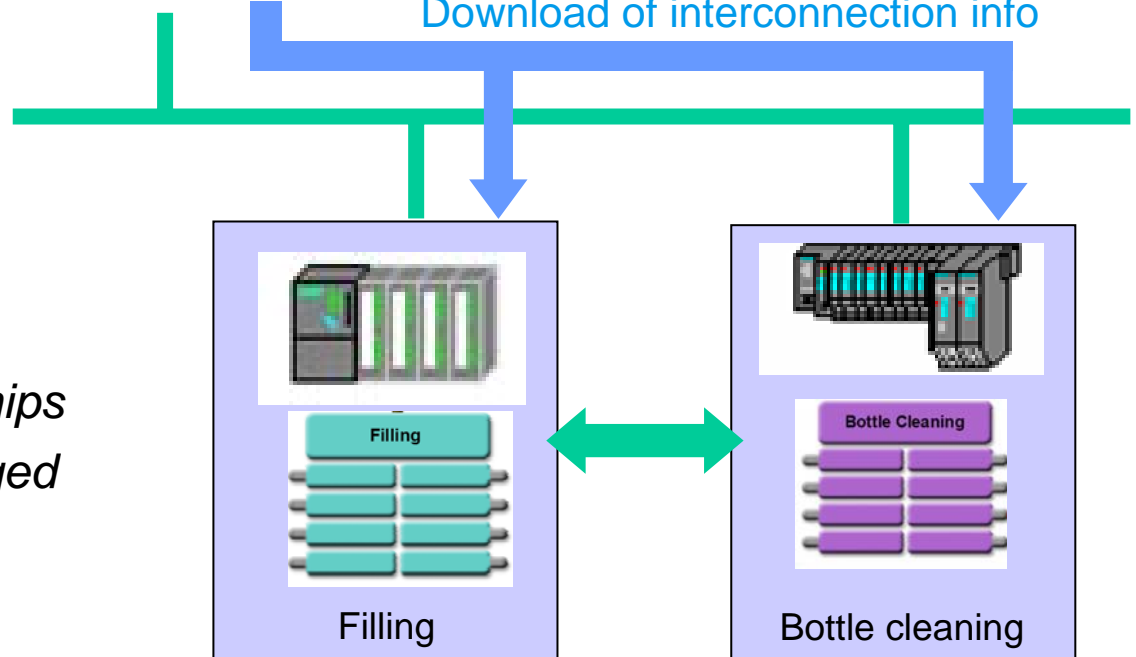


- *Vendor independent tool*
- *Imports XML-files*
- *Definition of Interconnections*
- *Download of Interconnections*
- *Diagnostics*

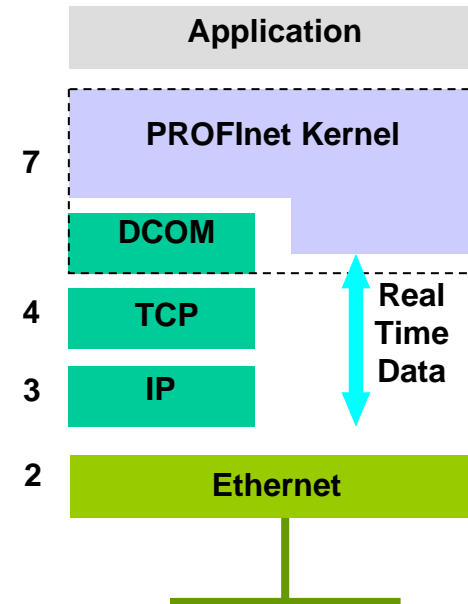
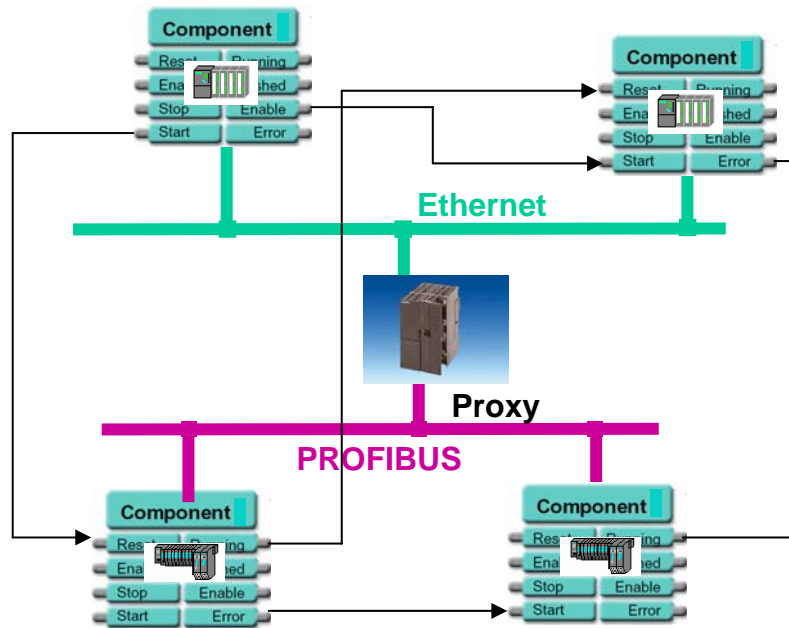
Download of interconnection info

## **Interconnection info:**

- *Communication partners*
- *Communication relationships*
- *Information to be exchanged*
- *Update cycle, etc.*



# PROFINET CBA Communication

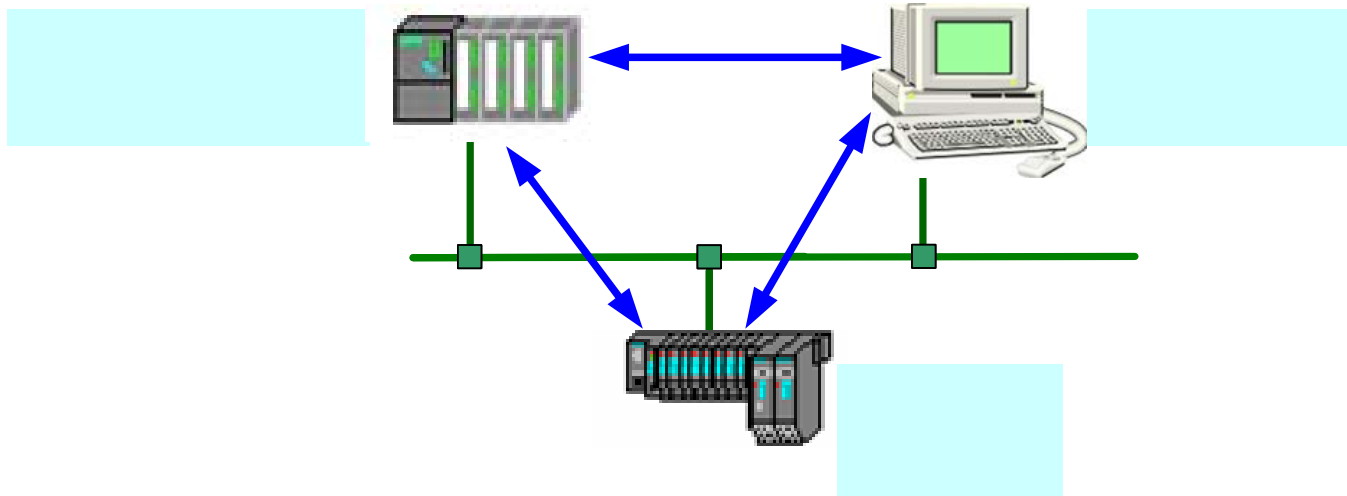


- *Transparent PROFIBUS integration with proxies*
- *Runtime model:*
  - *device = collection of COM objects => DCOM*
  - *automatic data transfer by PROFINet Kernel*
- *DCOM/TCP/IP can be bypassed by Soft Real Time Stack*
- *Free source code available for PNO members*



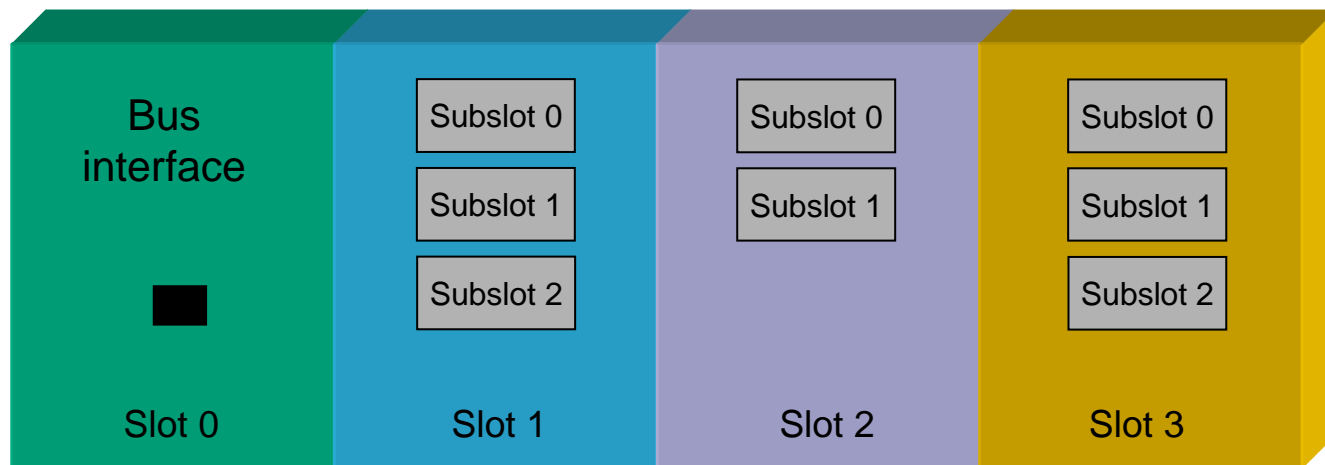
## **PROFINET IO Model**

- *Designed in 2003 by PNO as supplement to PROFINET CBA (hidden in a component) – will be included in IEC61874-2*
- *Aims at decentral periphery scenarios with cyclic data exchange*
- *Closely resembles PROFIBUS model and operation*
- *3 categories of stations (master/slave scenario):*
  - *IO controller: typically a PLC*
  - *IO device: subordinate field device*
  - *IO supervisor: typically an engineering station*



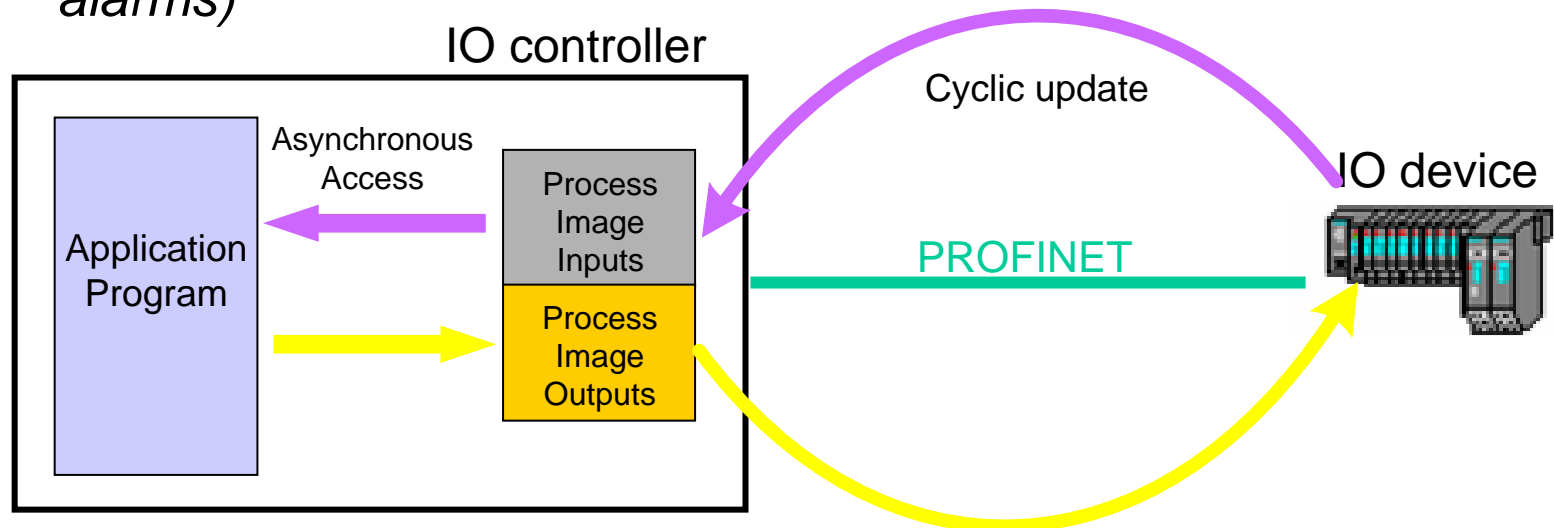
# IO Device Model

- *(Potentially) modular device model*
- *Slot/Subslot: Common addressing scheme for data, alarms and diagnostic information*
- **GSD-File** defines device features (modular structure, parameters)
- *Engineering tool imports GSD files:*
  - *Offline Device configuration and parameterization*
  - *Downloads configuration to IO controllers*



## PROFINET IO Operation

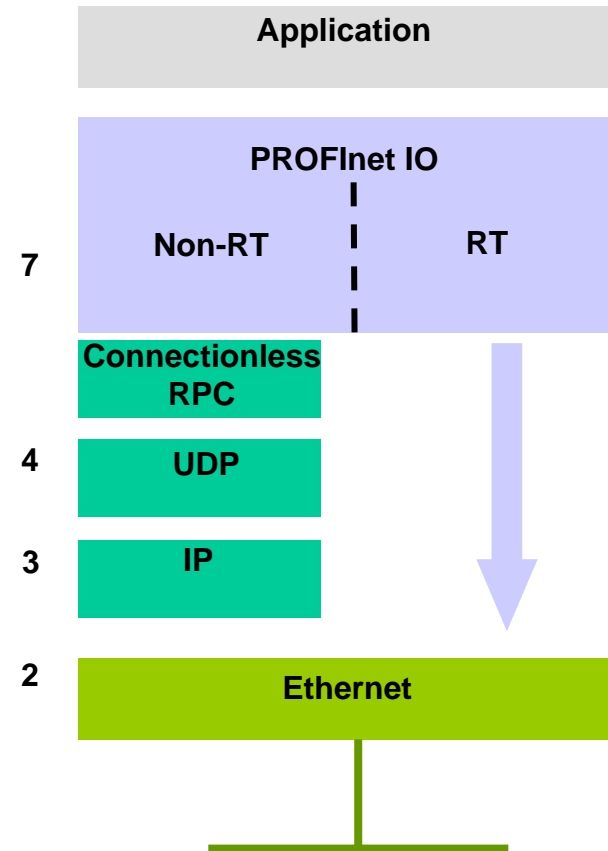
- *Strict sequence of phases:*
  - *IP address assignment via discovery and control protocol (DCP)*
  - *Establishment of application relation and subordinate communication relations via context management services*
  - *Configuration and parameterization of all IO devices via the acyclic record data services*
  - *Entering the **cyclic data exchange mode** (process data + alarms)*





# PROFINET IO communication

- *Non-RT communication (Context Management, acyclic record data)*
- *RT communication*
  - *for cyclic data exchange (and DCP)*
  - *bypasses (optionally) UDP/IP*
  - *ethertype 0x8892*
- *Isochronous RT communication*
  - *Jitter of bus cycle time duration below 1μs*
  - *Employs PTCP (Precision Transparent Clock Protocol) according to IEC61158*
  - *Requires ASIC support*
- *Special connectors for IP20 and IP65 (optionally with power)*
- *ASIC with integrated switch allows bus-like topologies*



## **PROFINET IO at JCNS**

- *PROFINET IO much simpler than CBA*
  - *Similar to PROFIBUS => fits into existing framework*
  - *Well-supported by S7-300 PLCs and ET200S*
  - *PLC programming almost identical to PROFIBUS DP*
- => Decision: Adopt PROFINET IO as an optional replacement for PROFIBUS DP*
- *Problem: Linux-Support*
    - *Avoid communication controllers (also not avail. for cPCI)*
    - *Source Code available for IO device but not for IO controller*
- => Start implementation of PROFINET IO controller subset under Linux*

