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**

Technological module (Mechanics + Electronics + Software)
CBA Engineering

Vendor-specific configuration and programming tools

Vendor-independent XML-file

Machine manufacturer A
Configuration Programming Component Generation

Machine manufacturer B
Configuration Programming Component Generation

Bottle Cleaning

Filling
**CBA Connection Editor**

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

**Import**

**Download of interconnection info**

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

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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