PROFINET

Jie Cao
Outline

- At a glance
- Communication details
- Integration of Fieldbus Systems
- Application Profiles
- Installation Technology
PROFINET, Industrial Ethernet for advanced manufacturing
PROFINET is the standard for industrial networking in automation.

- It connects devices, systems, and cells, facilitating faster, safer, less costly and higher quality manufacturing.

- It easily integrates existing systems and equipment while bringing the richness of Ethernet down to the factory floor.
Standardization

- PROFINET is 100% Ethernet-compatible according to IEEE standards.

PROFINET is fully compatible with - and leverages all the features of - office Ethernet with real time performance required of industrial automation and ability to withstand harsh industrial environments.

- PROFINET is standardized in IEC 61158 and IEC 61784
Communications Services

- Standard TCP/IP
- Real Time (PROFINET RT)
- Isochronous Real Time (PROFINET IRT)
Conformance Classes

- Industrial Ethernet
  - CC-A
    - CC-B (PA)
      - CC-B
        - CC-C
          - Basic functions for devices
          - Isochronous Real Time
          - Network diagnostics
          - Topology information
          - RT communication
          - Wireless communication
          - System redundancy
PROFINET I/O device classes

I/O-Supervisor

I/O-Controller

I/O-Device
Communication paths for PROFINET I/O
PROFINET I/O based on slots and subslots
Device Descriptions

GSD: General Station Description

GSDML: GSD files written in XML format

- Properties of the I/O-Device (e.g., communication parameters)
- Insertable modules (number of type)
- Configuration data for individual modules (e.g., 4–20 mA analog input)
- Parameters of modules
- Error texts for diagnostics (e.g., wire break, short circuit)
Communication Relations

1. Every data exchange is embedded into an application relation (AR)
2. Within the AR, communication relations (CRs) specify the data explicitly
3. An I/O-Controller can establish one AR each with multiple I/O-Devices
4. An I/O-Device can have multiple ARs established from different I/O-Controllers
5. Within an AR, several 10 Communication Relations (10 CR) and APIs can be used for data exchange, and they are set up simultaneously
Addressing

DCP: Dynamic Configuration Protocol
Usage of switches

Industrial multiport switches

MAC address:
08-06-00-12-13-44
08-06-00-12-13-44

Ethernet controller with integrated switch ports
- Autonegotiation
- Autocrossover
- Full duplex
Diagnostics

Diagnostic information

- Slot number (module)
- Channel number
- Channel type (input/output)
- Coded fault cause (e.g., wire break, short circuit)
- Additional manufacturer-specific information
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PROFINET Communication

Standard Communication with UDP (100ms)

Real-Time Communication (5-10ms)
Isochronous Real Time (PROFINET IRT)

Every device knows exactly in which time slot it is allowed to send data over the bus.

The communication cycle is split into a deterministic part and an open part.

IRT(250~31.25us)  RT and UDP/IP
Conformance Classes

Class C
High-performance, Deterministic Data Transmission

Class B
Convenient Diagnostics (SNMP) Topology Determination

Class A
Standard Ethernet Network Components
Conformance Class A

- Cyclic Data Exchange
- Acyclic Parameter Data
- **Device/Network Diagnostics**
Conformance Class B

- Network Management Protocol
  - Simple Network Management Protocol (SNMP)
- Neighborhood Detection
- Representation of the Topology
- **Device Replacement**
  - DCP: discovery and configuration protocol
- Integration of Network Diagnostics into the I/O System Diagnostics
- CCB-PA (process automation)
Neighborhood Detection:
LLDP – link layer discovery protocol
Representation of the Topology
Conformance Class C

- Synchronized Communication
- Mixed Operation
- Optimized IRT Mode
Synchronized Communication

The bus cycles to run synchronously (at the same time) with a maximum deviation of 1 µs
Synchronized Communication
Mixed Operation

IRT domain

Switch which supports IRT scheduling

I/O-Controller (Sync-Master)

I/O-Device 1  I/O-Device 2  I/O-Device 3

Devices without synchronous application

E.g. 1 ms position control cycle

Synchronization

Isochronous communication

Standard

IRT-data

TCP/IP-data

Cycle 1

Cycle 2

Cycle n

= time domain
Optimized IRT Mode

From 250 us to 31.25 us
## Conformance Classes

<table>
<thead>
<tr>
<th>Basic function</th>
<th>CC-A</th>
<th>CC-B</th>
<th>CC-C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic function</td>
<td>PROFINET IO with RT communication</td>
<td>PROFINET IO with RT communication</td>
<td>PROFINET IO with IRT communication</td>
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<tr>
<td></td>
<td>• Cyclic I/O</td>
<td>• Cyclic I/O</td>
<td>• Cyclic I/O</td>
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<td>• Parameters</td>
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<td>• Alarms</td>
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<tr>
<td></td>
<td>• Topology information (LLDP)</td>
<td>• Topology information (LLDP) with LLDP-MIB</td>
<td>• Topology information (LLDP) with LLDP-MIB</td>
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<tr>
<td></td>
<td></td>
<td>• System redundancy (only for CC-B( PA))</td>
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<tr>
<td>Certification</td>
<td>Controller/devices with certificate</td>
<td>Controller/devices with certificate</td>
<td>Controller/devices with certificate</td>
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<tr>
<td></td>
<td>Infrastructure via manufacturer declaration</td>
<td>Infrastructure via manufacturer declaration</td>
<td>Infrastructure via manufacturer declaration</td>
</tr>
<tr>
<td>Cabling</td>
<td>IEC 61784-5-3 and ISO/IEC 24702 (CC-A Cabling Guide)</td>
<td>IEC 61784-5-3</td>
<td>IEC 61784-5-3</td>
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<tr>
<td></td>
<td>• Copper, fiber-optic</td>
<td>• Copper, fiber-optic</td>
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<td></td>
<td>• Wireless</td>
<td></td>
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<tr>
<td>Typical application</td>
<td>Infrastructure</td>
<td>Factory Automation</td>
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<tr>
<td></td>
<td>Building Automation</td>
<td>Process Automation</td>
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</table>

*Figure 2: Contents of Conformance Classes*
Conformance Classes

<table>
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<tr>
<th>Interface</th>
<th>Single Port</th>
<th>Multi Port</th>
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<tr>
<td>Conformance Class A</td>
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</tr>
<tr>
<td>Conformance Class B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conformance Class C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Standard MCU with Ethernet Support
- FPGA
- Module
- ASIC with PROFINET Support *

*) CC-C only if synchronization is available
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Integration of Fieldbus Systems
PROFINET VS. PROFIBUS

• Unlimited scalability
• Unlimited address space
• Larger message size (1440 bytes vs. 244)
• The possibility to coordinates more drive axes – with IRT updates in 1 ms range, with less than 1uSec jitter
• It’s faster too, which means more application potential and fewer interfaces
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Application Profiles

Application profiles are specifications for particular properties, performance characteristics, and behavior of devices and systems that are developed jointly by manufacturers and users.

- **PROFI safe**
- **PROFI drive**
- **PROFI energy**
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Installation Technology for PROFINET

Cables for PROFINET

- PROFINET Type A: Standard permanently routed cable, no movement after installation
- PROFINET Type B: Standard flexible cable, occasional movement or vibration
- PROFINET Type C: Special applications: for example, highly flexible, constant movement (trailing cable or torsion)
## Plug Connectors

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<thead>
<tr>
<th></th>
<th>Copper</th>
<th>Fiber optic</th>
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<tbody>
<tr>
<td><strong>IP 20 inside</strong></td>
<td><img src="image1" alt="Image of RJ 45" /></td>
<td><img src="image2" alt="Image of SC-RJ" /></td>
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<tr>
<td></td>
<td>RJ 45</td>
<td>SC-RJ</td>
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<tr>
<td><strong>IP 67 outside</strong></td>
<td><img src="image3" alt="Image of RJ 45" /></td>
<td><img src="image4" alt="Image of M12" /></td>
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<tr>
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<td>RJ 45</td>
<td>M12</td>
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<td>Variant 14</td>
<td>Variant 5</td>
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<td>Pas 61076-3-117</td>
<td>IEC 61076-3-106</td>
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<td>AIDA</td>
<td>Hybrid 24 V</td>
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Security