IEEE 1588 Workshop Tutorial
Industrial and Motion Control Applications

- Introduction to industrial automation
- Communication networks
- Applications
- PROFINET

SIEMENS
Automation hierarchy

Enterprise Resource Planning System

ERP

MES

Control Level
- Factory Automation
- Process Automation

Field Level

PROFINET devices support MES

Introduction

Network

Applications

PROFINET

IEEE 1588
Industrial and Motion Control Applications

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Example from the food & beverage industry:

- Wash bottles
- Fill bottles
- Close bottles
- Pack bottles

Horizontal integration along the production line

Data exchange between intelligent devices within the machine
Communication network Standards

IEC/PAS 62411 and IEC 61784-2

The Open
Industrial Ethernet Standard
For Automation

PROFINET

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Real-Time Ethernet (RTE) with PROFINET

PROFINET

Real-Time Communication
PROFINET CBA: Real-Time between Components

- The user chooses the QoS „Real-Time Data Transmission“ in the configuration tool.

- The Communication relationships between the devices is established over TCP/IP.

- Subsequently, process data are transmitted cyclically between devices via the Real-Time channel.
Demands on Motion Control applications

- Wood-, glass- and ceramic-processing machines
- Plastics injection molding machines
- Packaging machines
- Printing presses
Trends

- Time stamping from sensor level to HMI

- Precise clock synchronization
  - With bridges (e.g. IE → PB) actually 10 ms plant wide
  - Industrial Ethernet (IE) actually 1 ms plant wide
  - Both are to enhance

- Enhanced diagnosis required with precise time stamping

- A plant wide reliable synchronization source

- Robots synchronized using clock synchronization

- Clock synchronization protocols:
  - NTP in cell level (HMI, EMS, ERP)
  - PTP (IEEE 1588) in field level (actor/sensor + control)
Application Requirements

- Chronological association of diagnosis and process alarms
- Time dependent process synchronization
  - Net diagnosis on switch port with time stamp
- log files with time stamp
  - Security log files (IP-ACL)
  - Configuration log files
  - Device log files
- Clock synchronization precision plant wide below 1ms
  - IP-sub-net included
- Standby-Clock master
- Alerts for clock master failures
- Summer/Winter-time adjust independent of clock synchronization protocol
PROFINET distinguishes between two real-time classes with differences regarding the performance:

- **Real-Time:**
  - Using standard components
  - Performance characteristics like fieldbuses today (e.g. PROFIBUS)
  - Typical application area: Factory Automation

- **Isochronous Real-Time:**
  - Clock synchronized communication
  - Hardware support via Switch-ASIC
  - Typical application area: drive control in Motion Control applications
Motion Control with PROFINET

Advantages at a glance

- Isochronous communication for Motion Control Applications
- Short and deterministic reaction times of < 1ms, Jitter < 1µs
- Integration of decentralized field devices
- TCP/IP for engineering, diagnostics and HMI connection
Isochronous Real-Time Communication (IRT)

Requirements on Ethernet for Motion Control
- Highest performance
- Time synchronization inclusive determinism
- Openness for unrestricted access to the IT world, which means no restrictions for TCP/IP
PROFINET and IRT

What are the pre-conditions?

- Segmentation of the communication
- Use of time based communication
- Clock-Synchronization
IRT Scheduling

Scheduling of communication systems
- High accurate cycle synchronization
- Separate time areas for real-time and TCP/UDP

E.g. 1 ms position control cycle

Isochronous Communication
IRT data

Standard Communication
e.g. TCP/IP data