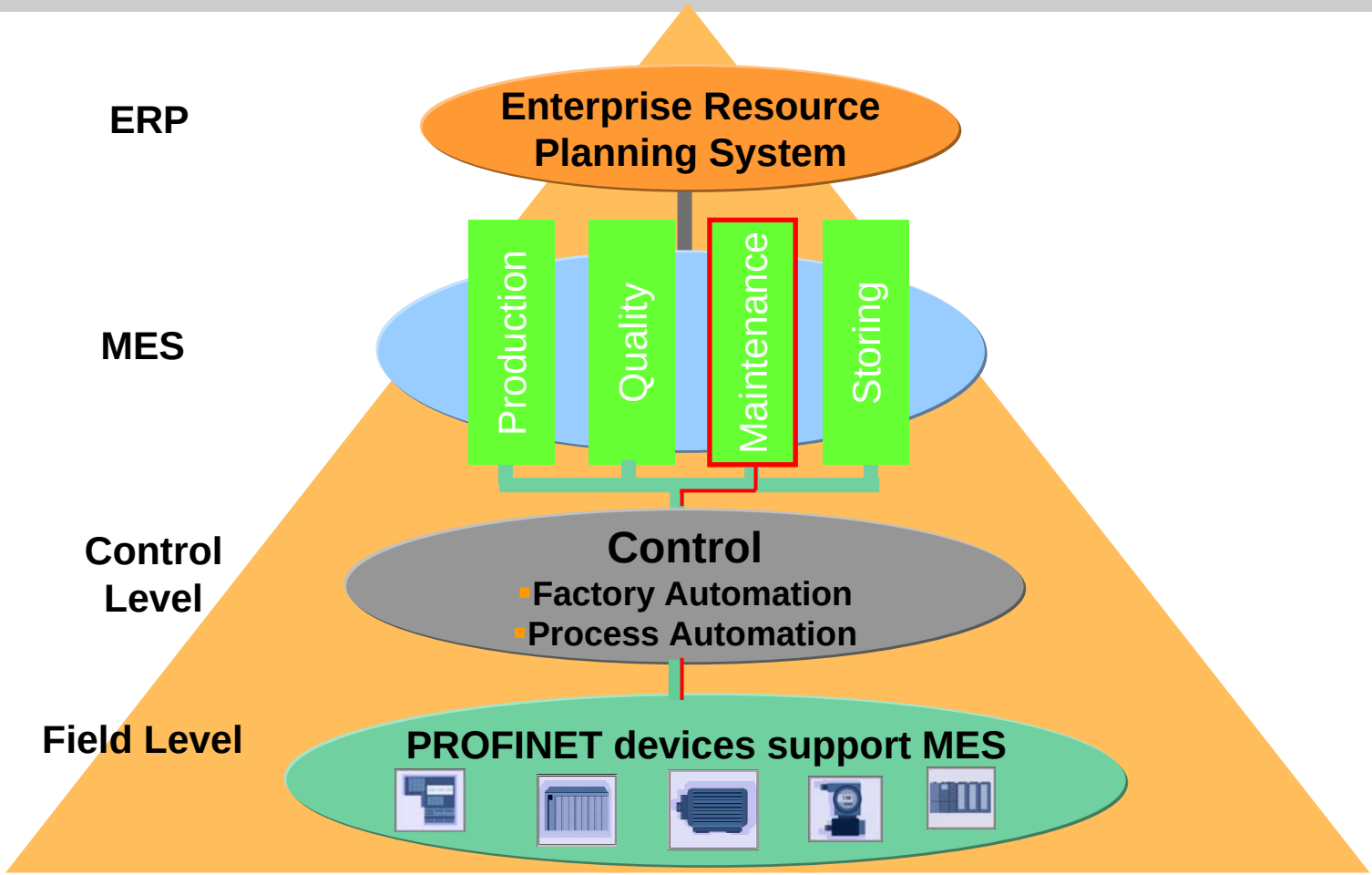
IEEE 1588 Workshop Tutorial

Industrial and Motion Control Applications

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

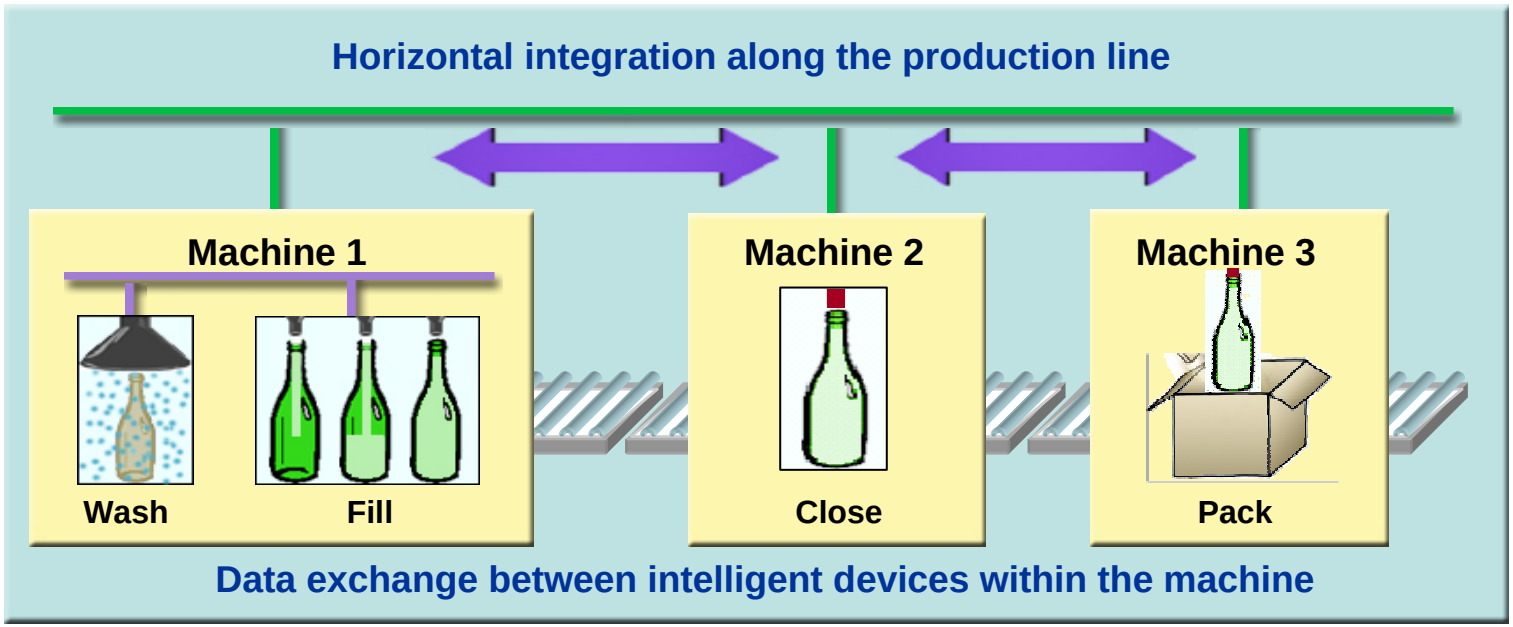
SIEMENS

Automation hierarchy



Distributed Automation – Plant View Modular Plant and Machine Construction

- **Example from the food & beverage industry:**
  - **Wash bottles**
  - **Fill bottles**
  - **Close bottles**
  - **Pack bottles**



Communication network Standards

IEEE 1588
Industrial and Motion Control Applications

- Introduction
- Network
- Applications
- PROFINET

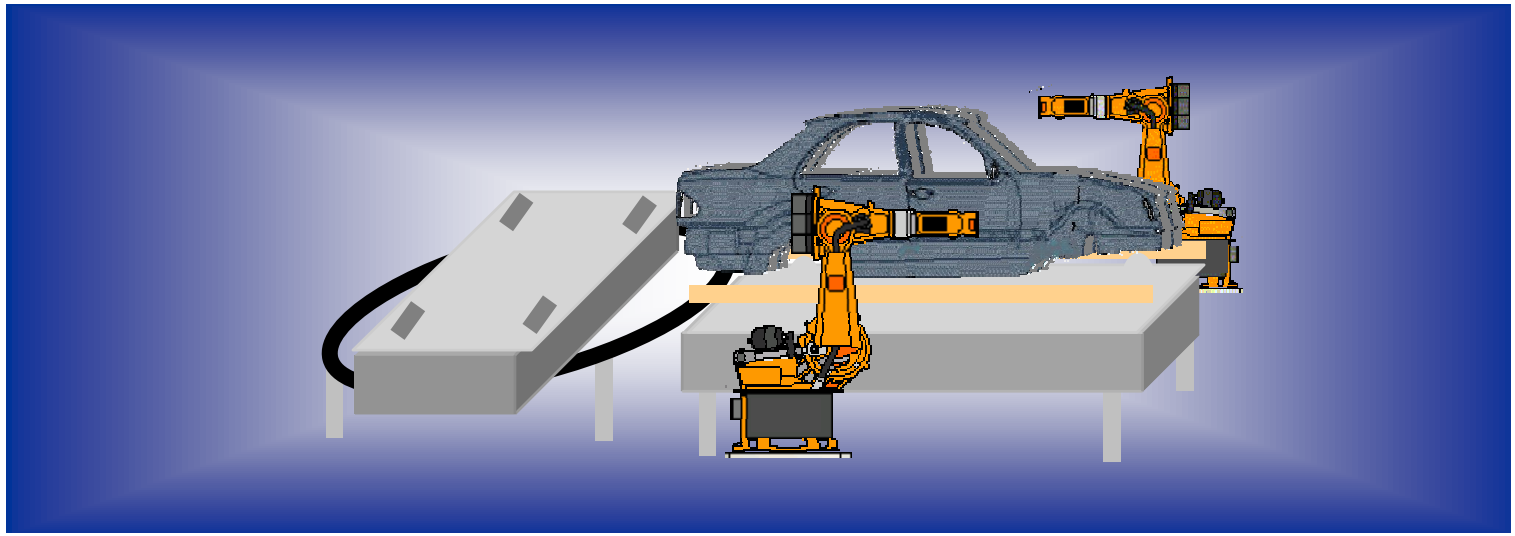
IEC/PAS 62411 and IEC 61784-2

The Open Industrial Ethernet Standard For Automation

Real-Time Ethernet (RTE) with PROFINET

IEEE 1588
Industrial and Motion Control Applications

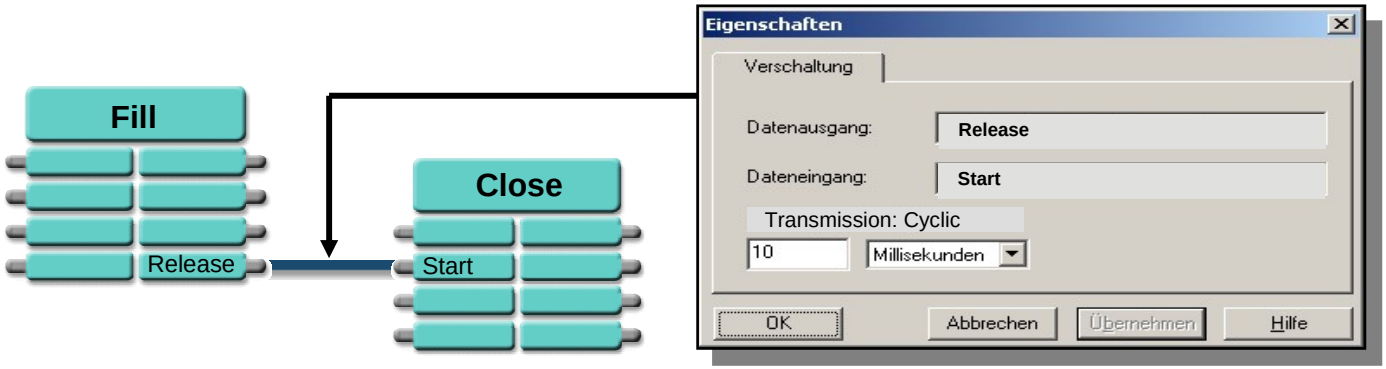
PROFINET



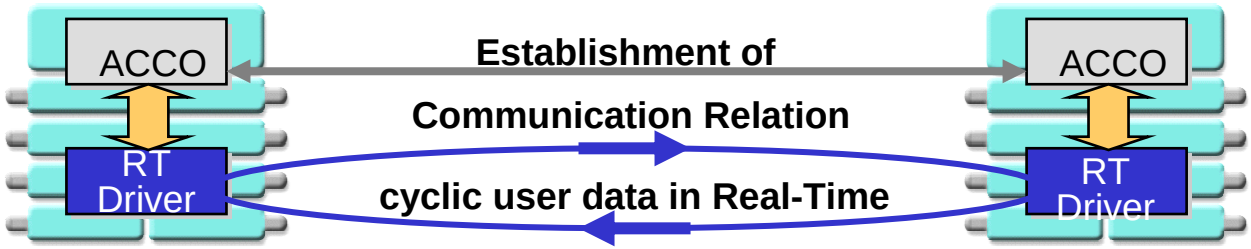
Real-Time Communication

PROFINET CBA: Real-Time between Components

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

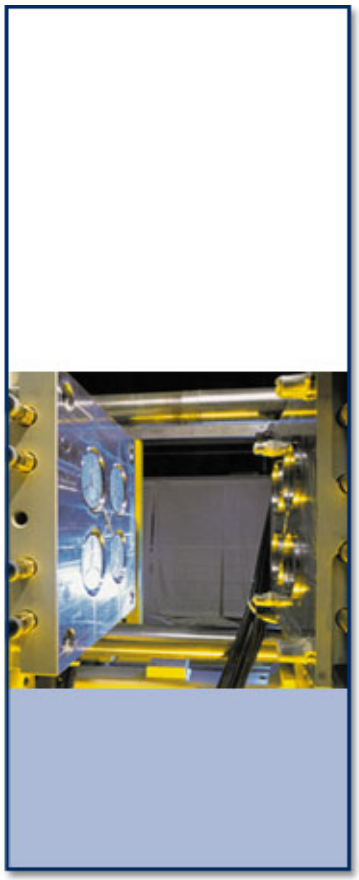


- **The Communication relationships between the devices is established over TCP/IP**
- **Subsequently, process data are transmitted cyclically between devices via the Real-Time channel**

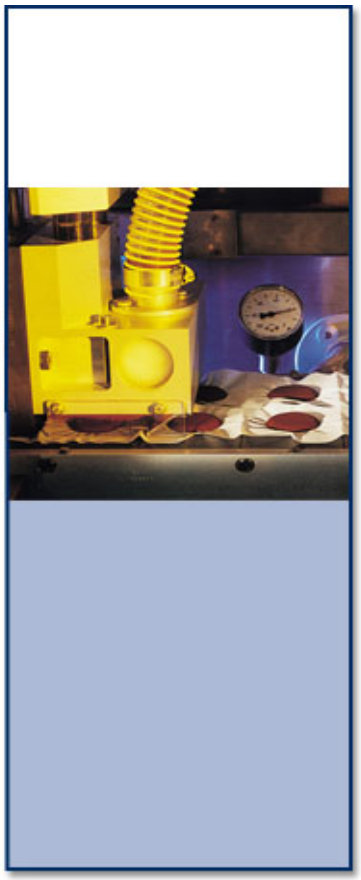


Demands on Motion Control applications

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**

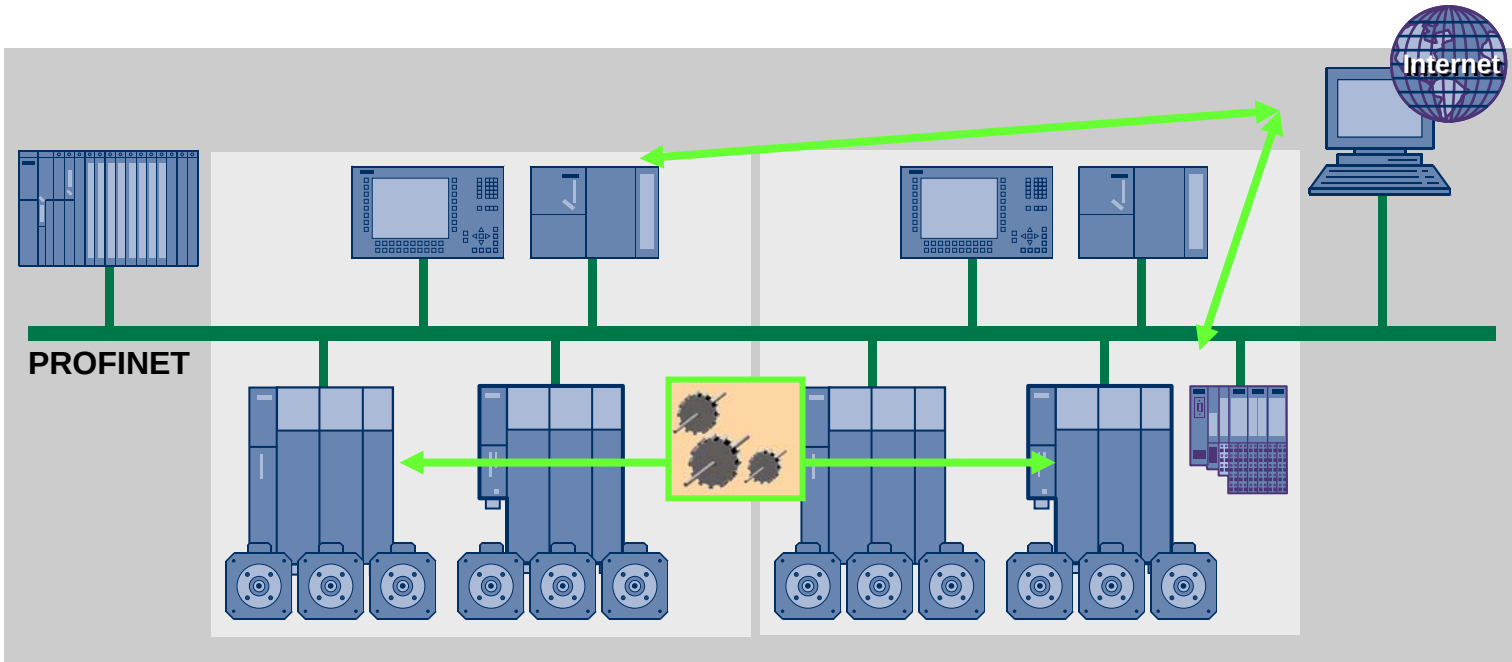
Real-Time Communication Classes

- **PROFINET distinguishes between two real-time classes with differences regarding the performance:**
- **Real-Time:**
  - **Using standard components**
  - **Performance characteristics like fieldlbuses 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**

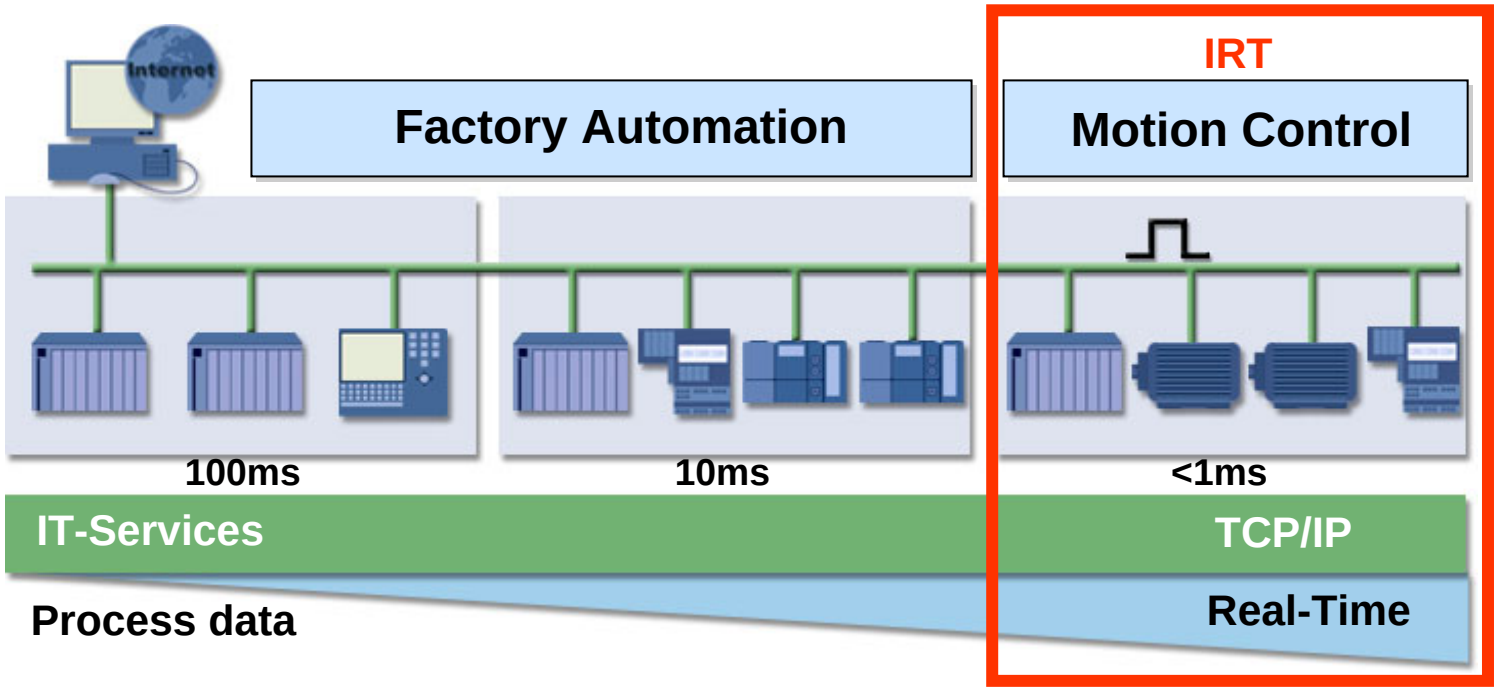
Motion Control with PROFINET

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**