Real-Time Ethernet Standards

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Real-Time Ethernet Standards

Want something exiting?

ETHERNET POWERLINK STANDARDIZATION GROUP

PROFINET INDUSTRIAL ETHERNET

EtherNet/IP

EtherCAT Technology Group

Contents

- Introduction to Real-Time Ethernet
- Presentation of Different Standards
- Comparision of Standards
- Expected Market Shares
- Expected Geographical Importance

Why Realtime Ethernet?

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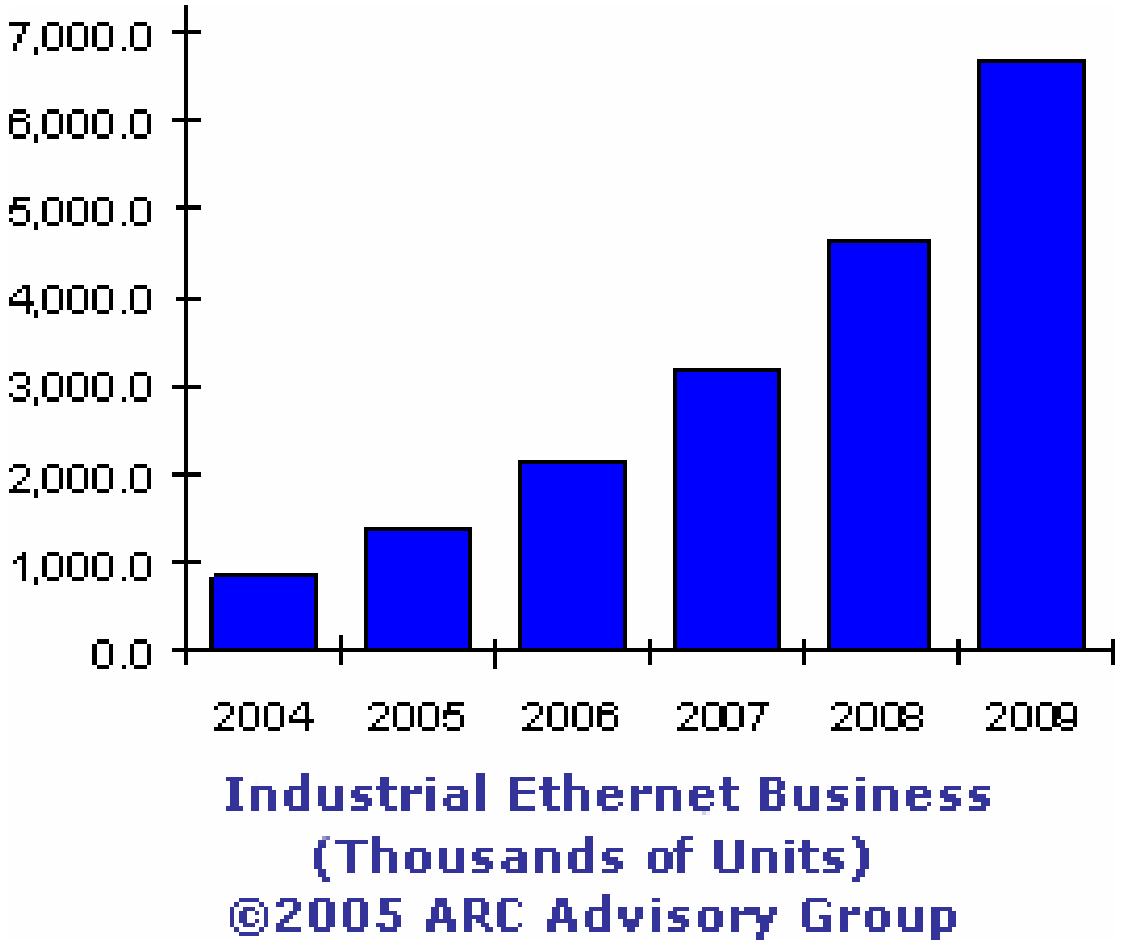
- Ethernet - The common physical media to replace different fieldbus systems in industrial automation.
- Reasons: High Speed (100 Mbit/s), high synchronization accuracy (< 1 us), reasonable cost, compatibility to office networks & the internet.
- Prerequisite: Ethernet stations must behave in a deterministic way by eliminating packet collisions.
- Different methods: Clock synchronization (IEEE 1588) master/slave architectures, synchronous protocols.
- Different competing standards: Ethernet Powerlink, Ethernet/IP, ProfiNet V3, EtherCAT, Sercos III...

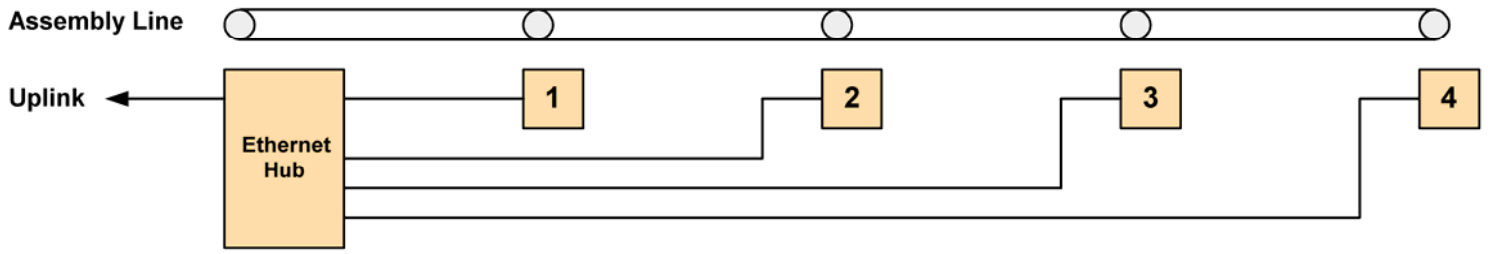
Why Industrial Automation?



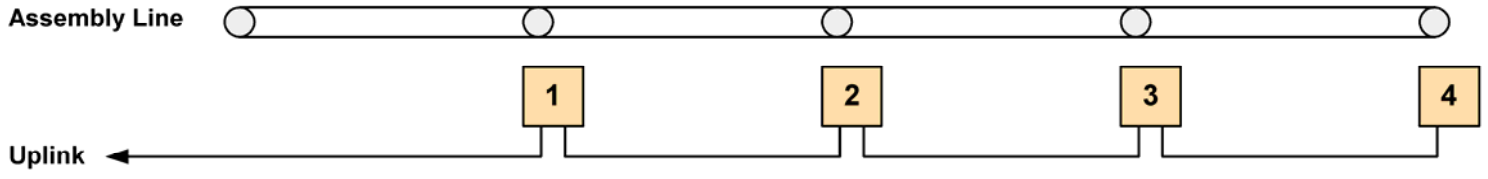
The worldwide market for Industrial Ethernet is expected to grow at a Compounded Annual Growth Rate (CAGR) of 51.4 percent over the next five years. The market totalled 840 thousand units in 2004 and is forecasted to total just over 6.7 million units in 2009, according to a new ARC Advisory Group study. This market study includes revenue for Industrial Ethernet Switches which had worldwide sales of $124.4 million in 2004 and is expected to grow to $939.8 million in 2009 for a CAGR of 49.9%

Network Topology (1)

- Industrial Automation prefers Line or Ring Topology (Bus System) over a Star Topology.
- Every Node should have an integrated Hub or Switch.



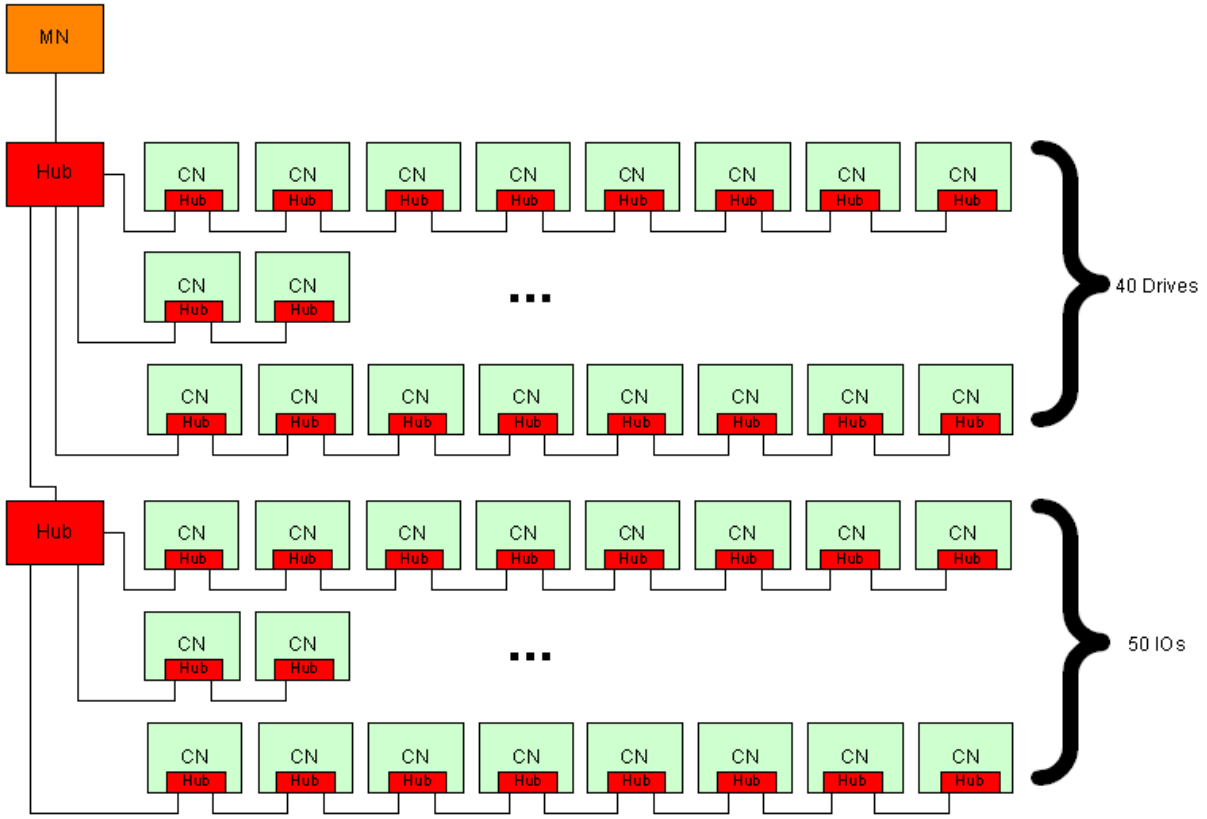
Star Topology: Expensive Cabling



Line Topology: Cost Efficient Cabling

Network Topology (2)

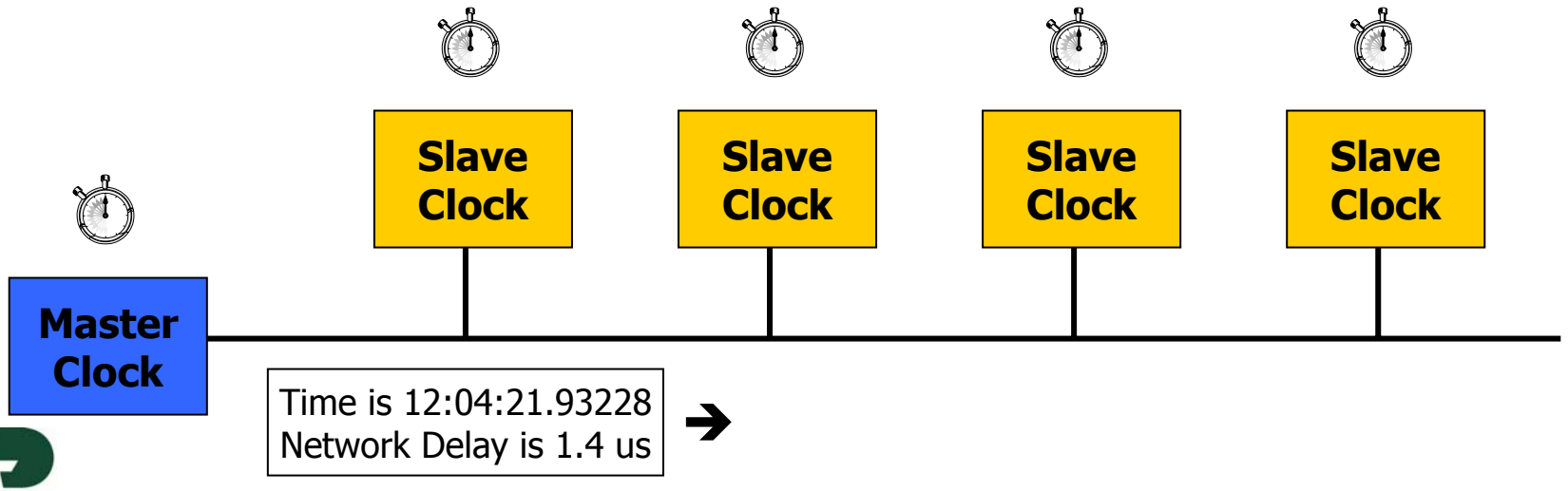
- A combined Star/Line topology is welcome.



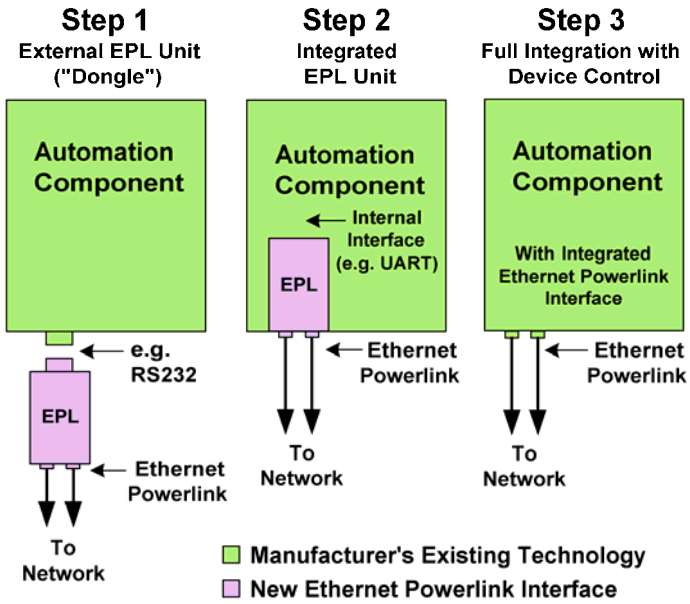
What is Clock Synchronization?

- If in a network every node has exactly the same local time and a schedule for actions is known, then synchronization can happen independently (without even sending synchronization frames).

- The most common standard for synchronising network stations is defined in IEEE1588.



Smooth Migration from Module to full Integration



Device Manufacturer used to have an existing Controller System.

Should be adoptable to the newest Real-time Ethernet Technology with the smallest possible effort.

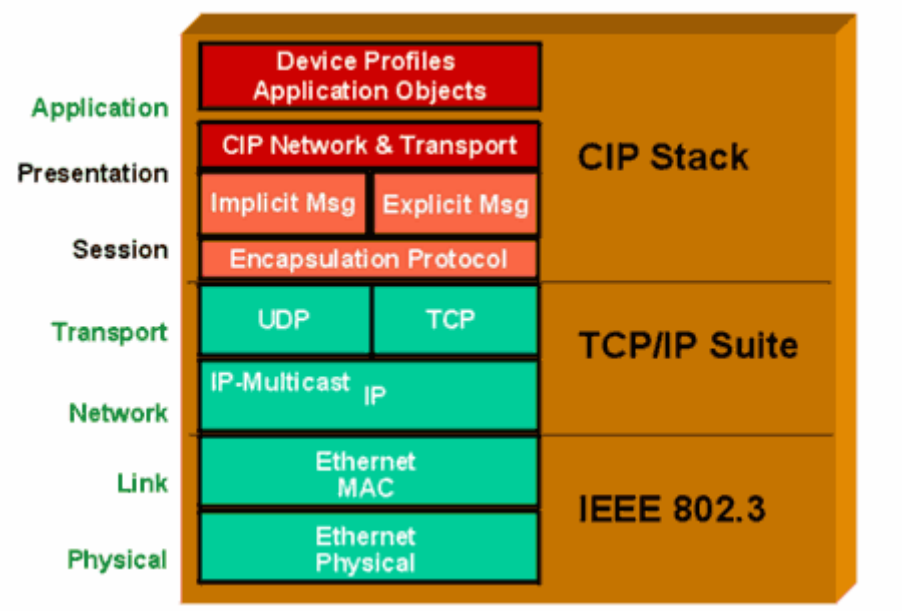
Device Manufacturer may not want to take care about details of protocol implementation.

EtherNet/IP - Facts

- The „Rockwell Automation“ Standard
  - Dominated by one company
  - Standard ethernet chips
  - Time Stamping Unit for Clock Synchronization (IEEE1588)
  - Successor of DeviceNet (CAN) and ControlNet
- Features
  - Soft Real-Time (w/o HW assistance): Jitter of 5-10 us
  - Hard Real-Time (with HW assistance): Jitter < 1 us
  - Flexible network topology (line and star)
  - Complex configuration (Network priority settings etc.)
- Organisation
  - Open DeviceNet Vendor Association (ODVA)
  - www.odva.org

EtherNet/IP - Operating Principle

- Clock Synchronization through IEEE1588
- Uses standard IP Frames for communication

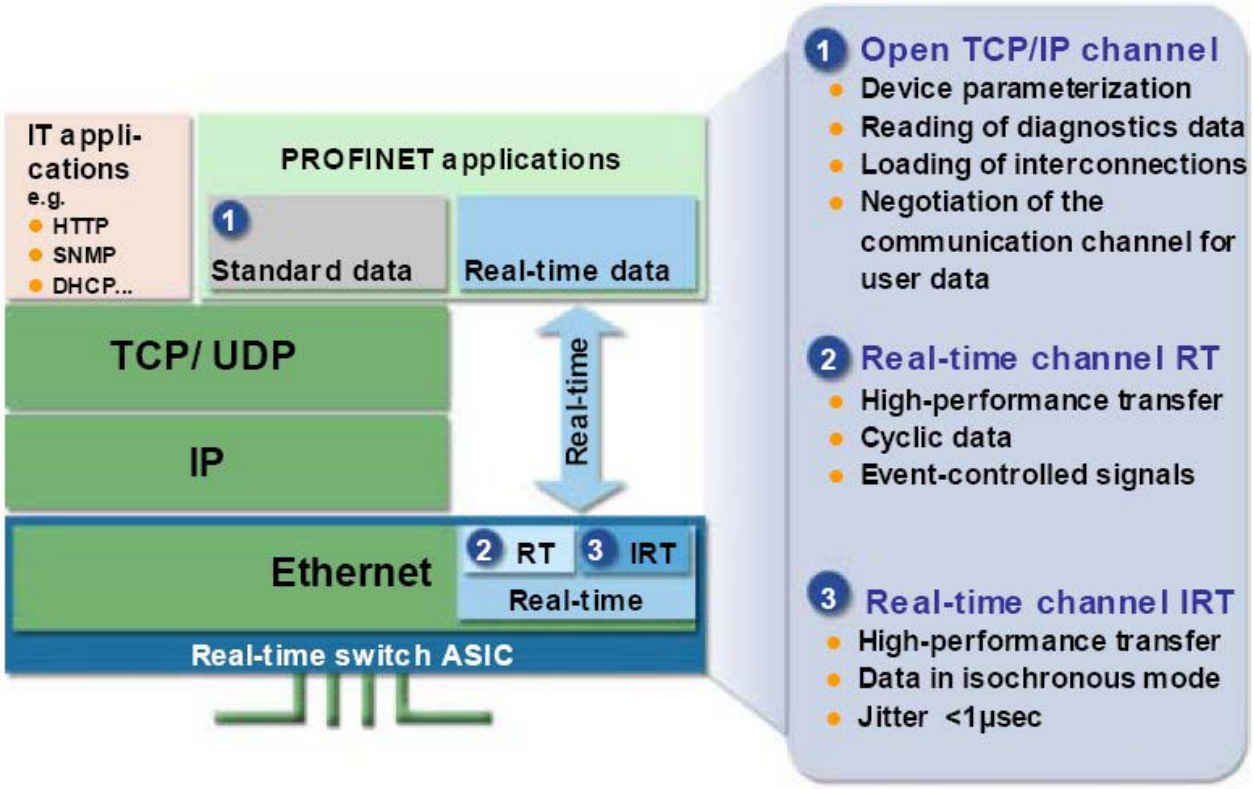


PROFInet - Facts

- The „SIEMENS“ Standard
  - Dominated by one company
  - Special interface ASICs needed (as of today)
  - No standard ethernet framing
  - Time Stamping Unit for Clock Synchronization (IEEE1588)
  - Successor of PROFIbus
- Features
  - Soft Real-Time: Jitter > 10 us
  - Hard Real-Time (with HW Assistance): Jitter < 1 us
  - Restricted network topology (Line and Star)
  - Complex configuration (Network priority settings etc.)
- Organisation
  - Profibus Nutzer Organisation (PNO)
  - www.profibus.com

PROFInet - Operating Principle

- Priority Driven Ethernet Transfer (special Switches)
- Clock Synchronization through IEEE1588

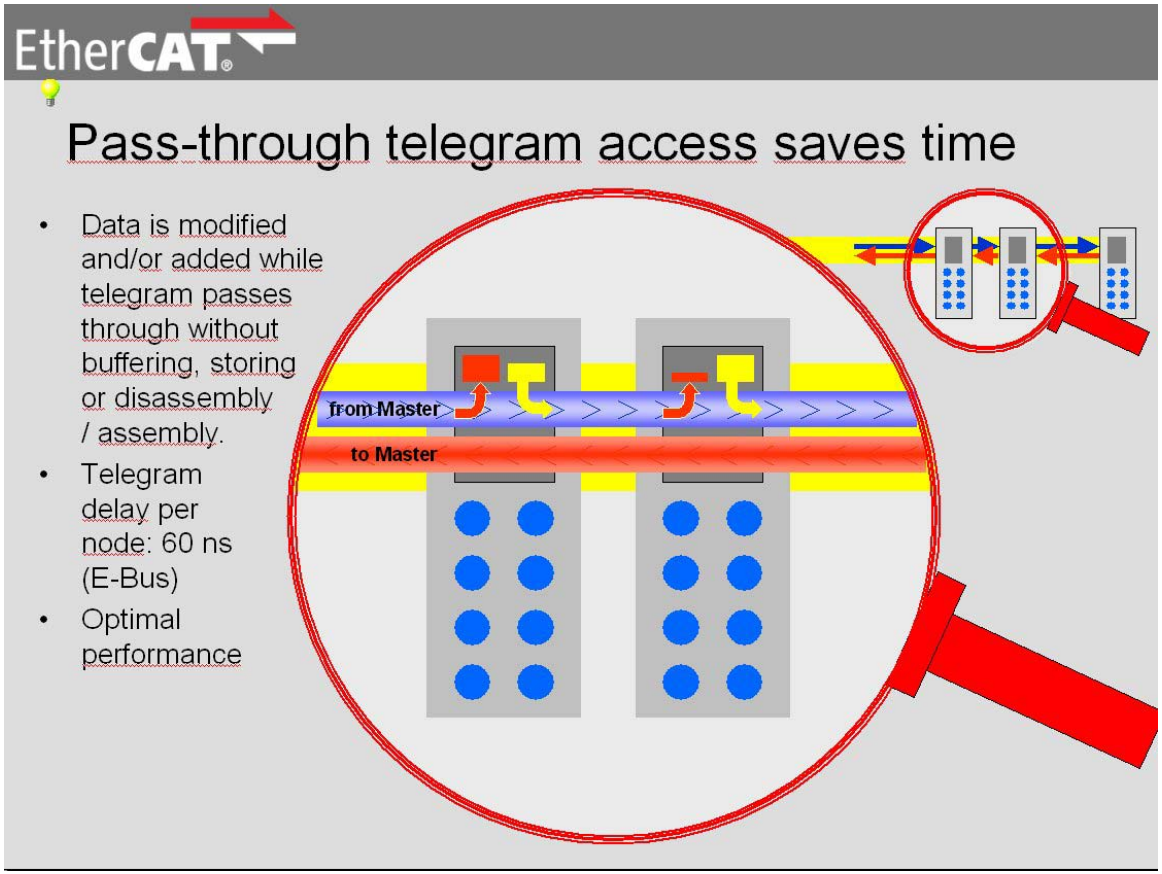


EtherCAT - Facts

- The „Beckhoff“ Standard
  - Dominated by one company
  - Special Interface ASICs needed
  - No standard ethernet framing
  - Elements of Interbus-S and CANopen
- Features
  - Synchronization Jitter > 1 us
  - Restricted network topology (only Ring)
  - Plug-and-Play configuration
  - Standard IP-Traffic only tunneled
- Organisation
  - EtherCAT Technology Group (ETG)
  - www.ethercat.org

EtherCAT - Operating Principle

- Ring Topology, large ethernet frames circulating
- Data read/write on-the-fly, each node at specific offset



Other Industrial Ethernet Standards

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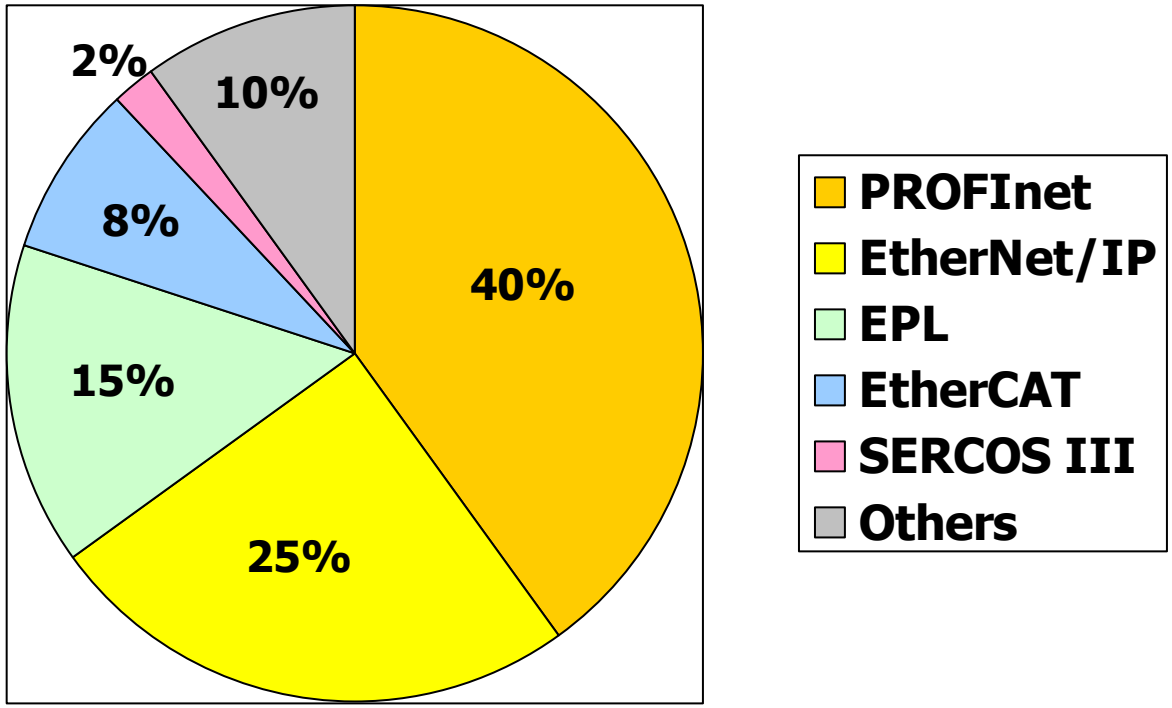
- SERCOS III (Bosch Rexroth)
  - Paper ware, no specification ready yet
- JetSync (Jetter)
  - Lonesome combatant, German island solution
- IDA, Modbus TCP (Schneider Electric and others)
  - Not capable of real-time synchronization
- Synqnet
  - Ethernet physics, nothing more
  - Restrictive license policy
- PowerDNA
  - Proprietary solution without market importance

Comparison of Standards

	Ethernet Powerlink	EtherNet/IP (Rockwell)	PROFInet (SIEMENS)	EtherCAT (Beckhoff)
Type of Standard	Open	Proprietary	Proprietary	Proprietary
Installed Nodes (as of May 05)	> 80.000	Pilot Installations only	Pilot Installations only	Pilot Installations only
Required Hardware	Standard Ethernet Controller	Standard Ethernet Controller	Special ASIC	Special ASIC
Synchronization through	Sync Frames	Clock Synchronization (IEEE1588)	Clock Synchronization (IEEE1588)	Sync Frames
Network Topology	Any, needs hubs	Any, needs Switches with boundary Clock	Restricted, needs Switches with boundary Clock	Restricted (Ring)
Network Configuration	Easy	Complex	Complex	Easy
Origin Technology	CANopen	DeviceNet, ControlNet	PROFIbus	Interbus-S, CANopen

Expected Market Shares

World Market Shares in 2010

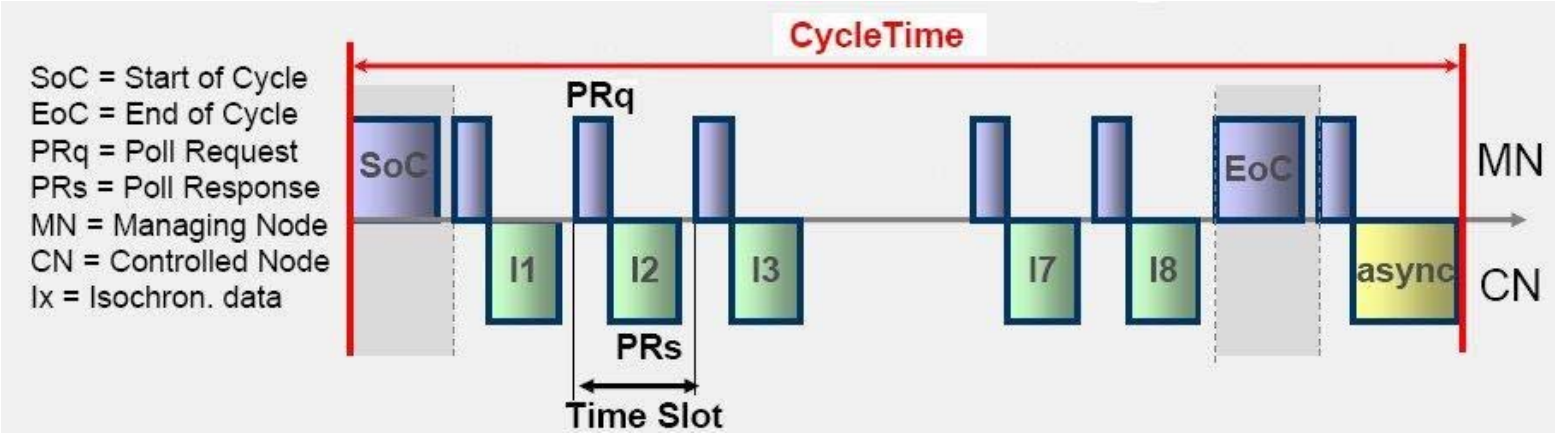


Ethernet Powerlink - Facts

- Open to Everyone
  - Open standard, license free
  - Standard ethernet chips (no special ASICs)
  - IP-based protocols supported
  - Device and communication profiles known from CANopen
- Features
  - Synchronization Jitter < 1 μs
  - Up to 240 nodes on a network
  - Flexible network topology (Line and star)
  - Plug-and-Play installation
- Organisation
  - Ethernet Powerlink Standardization Group (EPSG)
  - www.ethernet-powerlink.com

thernet Powerlink - Operating Principle

- Managing Node (MN) generates time schedule
  - Configurable number and duration of time slots
  - SoC frame syncs all nodes, PRq frame polls every node
- Controlled Nodes (CN) broadcast data on request
  - Isochronous data exchange with MN
  - Asynchronous IP traffic (CN-to-CN) in remaining time slot



Expected Geographical Importance

- SIEMENS PROFINet
  - Worldwide importance as expected market leader
- Rockwell EtherNet/IP
  - Most important in the US and in Japan
  - Minor importance in other regions
- Ethernet Powerlink
  - Most important in Europe
  - Some importance in the US
  - Minor importance in Asia
- Other Standards
  - Only minor regional importance

Concept of Micro WebTarget3/RTE

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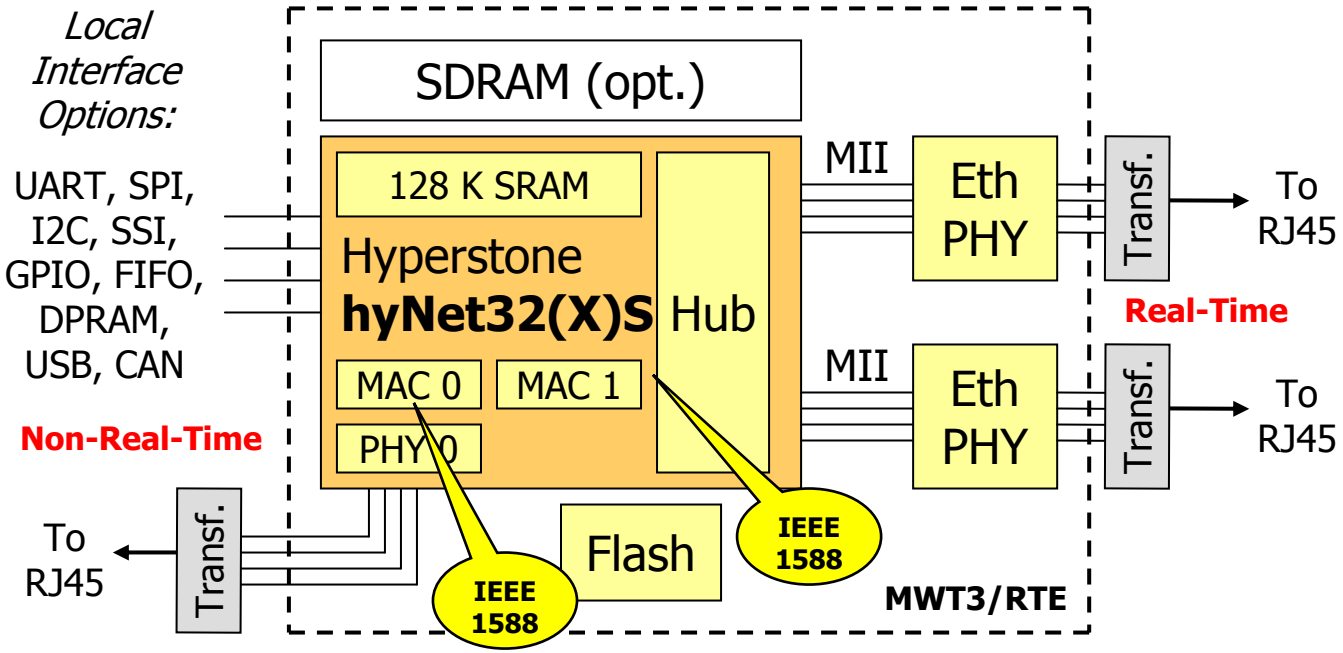
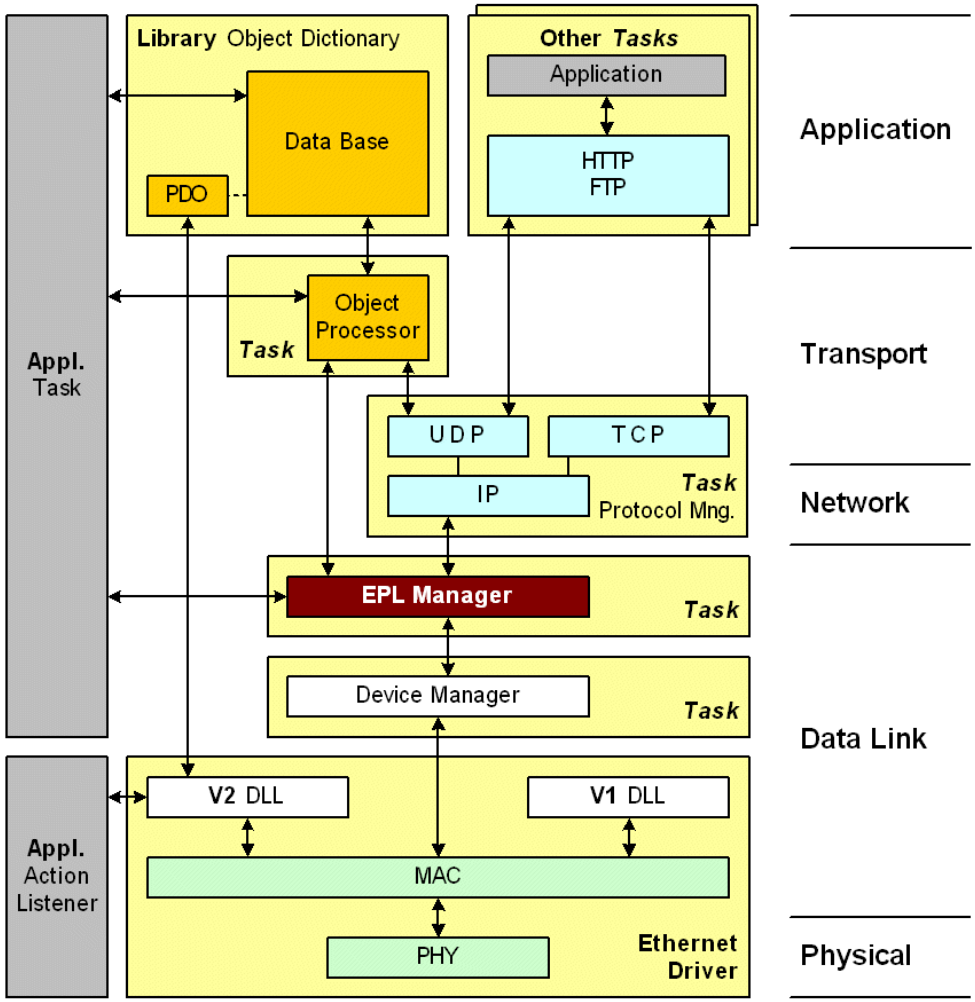
MWT3/RTE: A highly integrated Real-Time Ethernet board



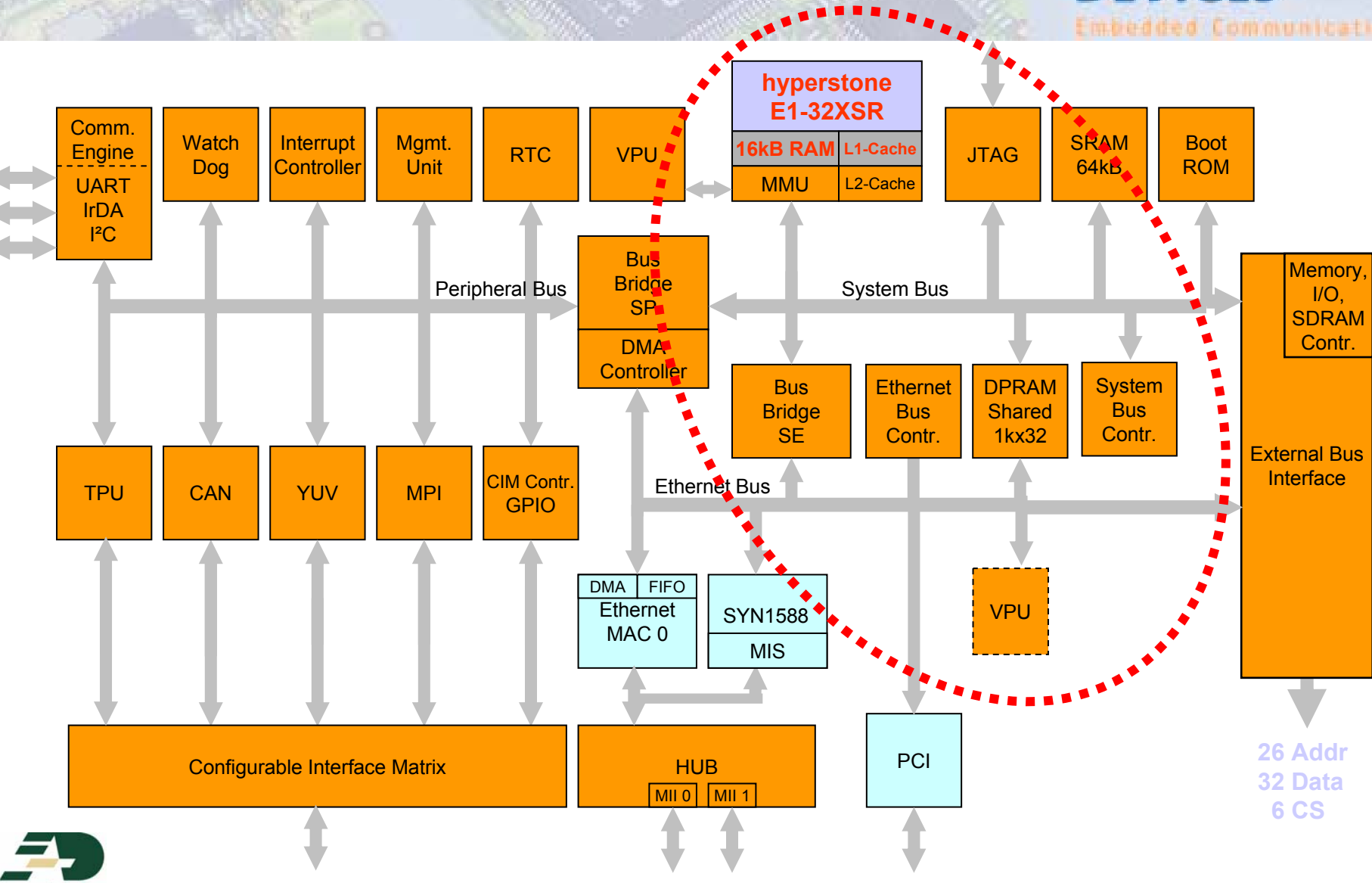
Ready for: ETHERNET POWERLINK STANDARDIZATION GROUP, EtherNet/IP, (PROFINET)

EPL Stack embedded in an RTOS

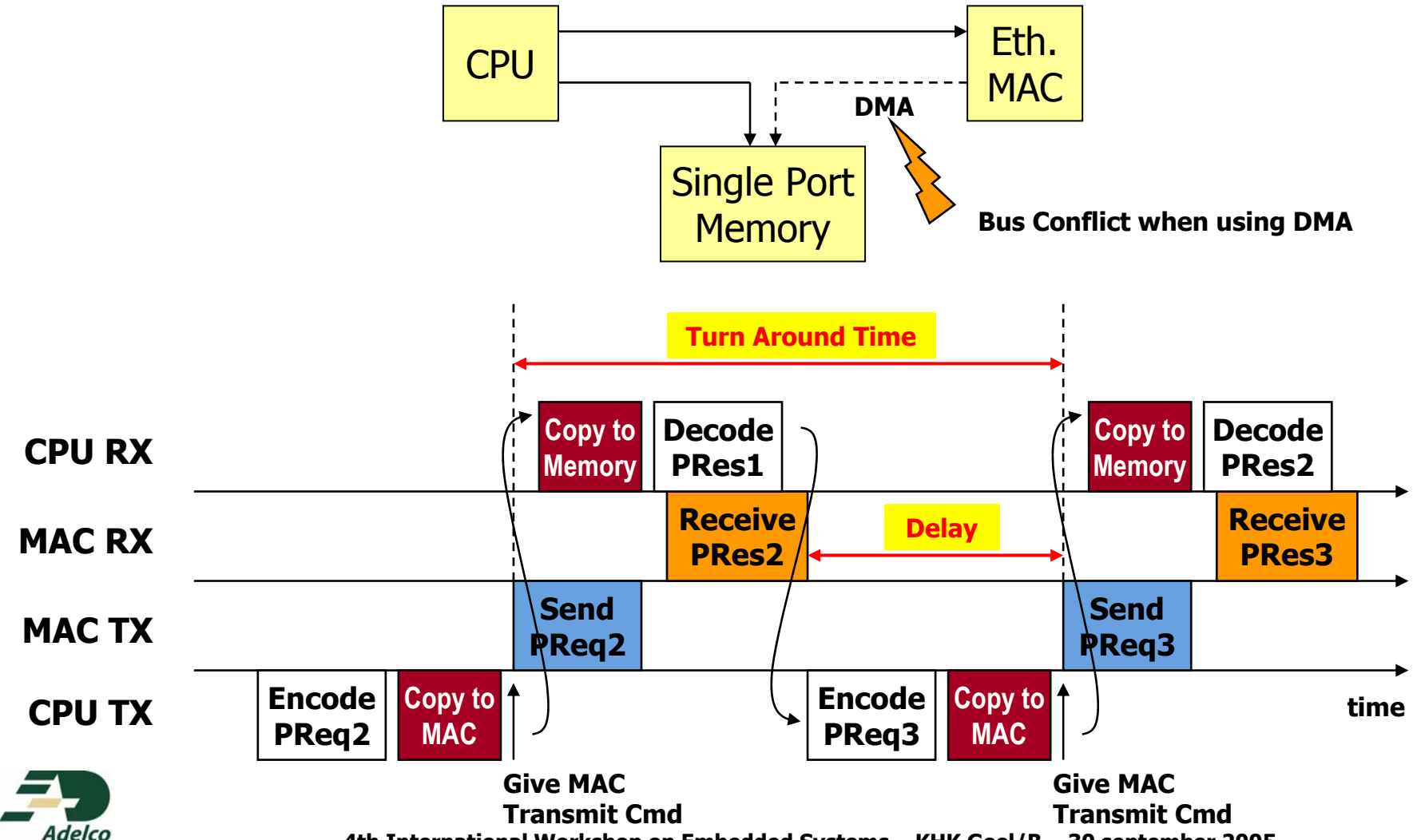
- Benefits for EPL from HyNetOS
  - Proven Real-Time Kernel
  - Sophisticated Priority Concept
  - Hardware-based Timer Task
  - Deterministic Memory Manager
  - Flexible File System
  - Message System for internal communication



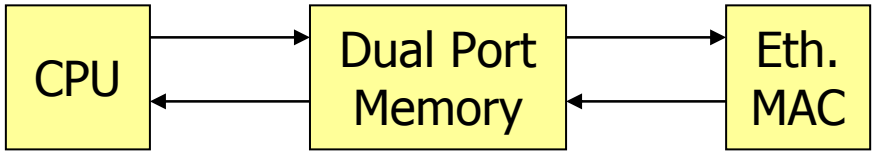
HyNet32S


hyperstone
E1-32XSR
16kB RAM
L1-Cache
MMU
L2-Cache
Comm. Engine
UART
IrDA
I²C
Watch Dog
Interrupt Controller
Mgmt. Unit
RTC
VPU
JTAG
SRAM 64kB
Boot ROM
Peripheral Bus
Bus Bridge SP
DMA Controller
System Bus
Memory, I/O, SDRAM Contr.
Bus Bridge SE
Ethernet Bus Contr.
DPRAM Shared 1kx32
System Bus Contr.
External Bus Interface
TPU
CAN
YUV
MPI
CIM Contr. GPIO
Ethernet Bus
DMA
FIFO
Ethernet MAC 0
SYN1588
MIS
VPU
Configurable Interface Matrix
HUB
MII 0
MII 1
PCI
26 Addr
32 Data
6 CS

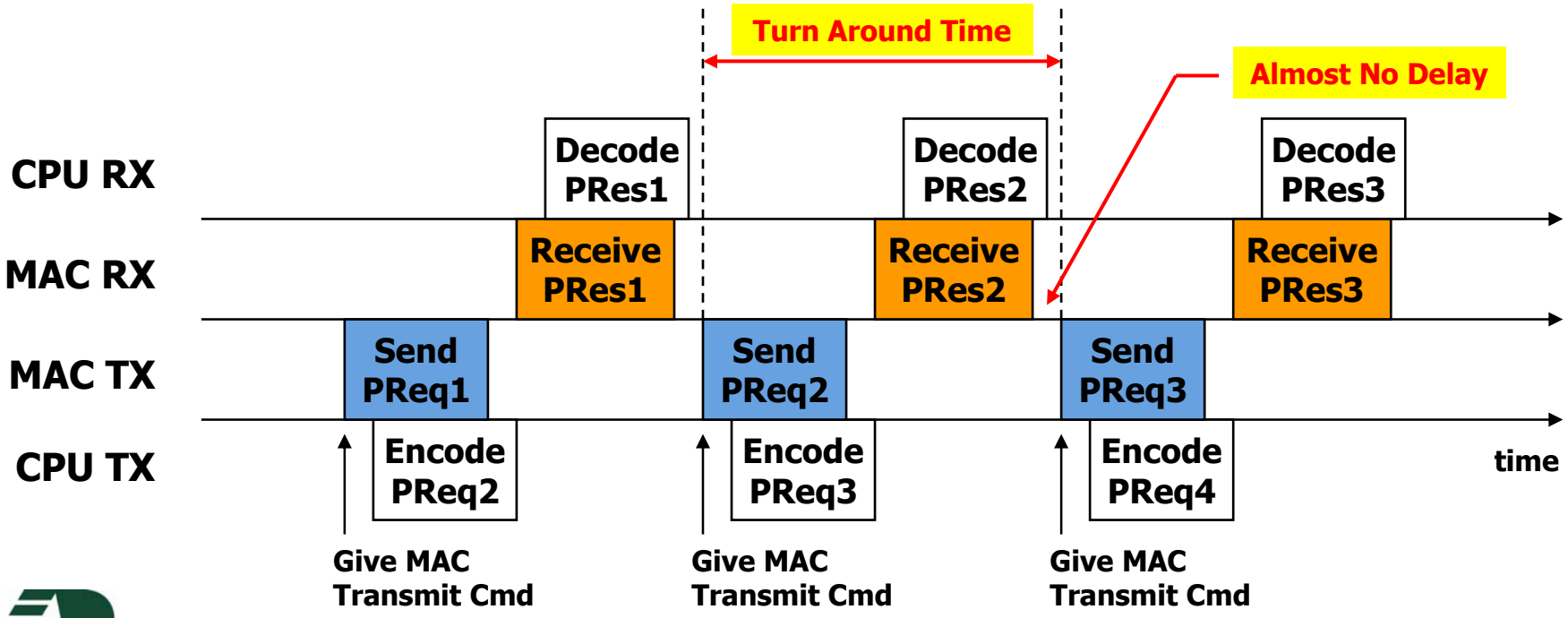
Classic MN Frame Processing



Optimized MN Frame Processing



Internal hyNet32 Architecture



Guaranteed Performance

- SND's EPL stack has been optimized for the Hyperstone CPU architecture.
- We guarantee response times (CN) & Preq/Pres turnaround times (MN).
- We guarantee that legacy ethernet and TCP/IP traffic nor other drivers or sources of interrupts will have influence on performance.
- Other EPL stacks, having more the focus on portability, will never have this level of optimization.

Added Value for Competitive Products

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- Apart from an EPL Stack, HyNetOS offers you a lot more:
  - Application level: e.g. HTTP, FTP, PPP, SMTP, SNMP.
  - System level: e.g. file system (FAT16), routing capabilities, multi-protocol environments, PTP (IEEE1588), Java VM.
  - Device driver level: e.g. UART, I^2C, SSI, CAN, USB, LCD, keypad, WLAN, Bluetooth, Memory Card.

- HyNetOS Tools
  - Remote loading over ethernet (HYLOAD).
  - Remote tracing over ethernet (HYTRACE).
  - Remote configuration over ethernet (HYMON).
  - Remote flash adminstration over ethernet (HYFLASH).

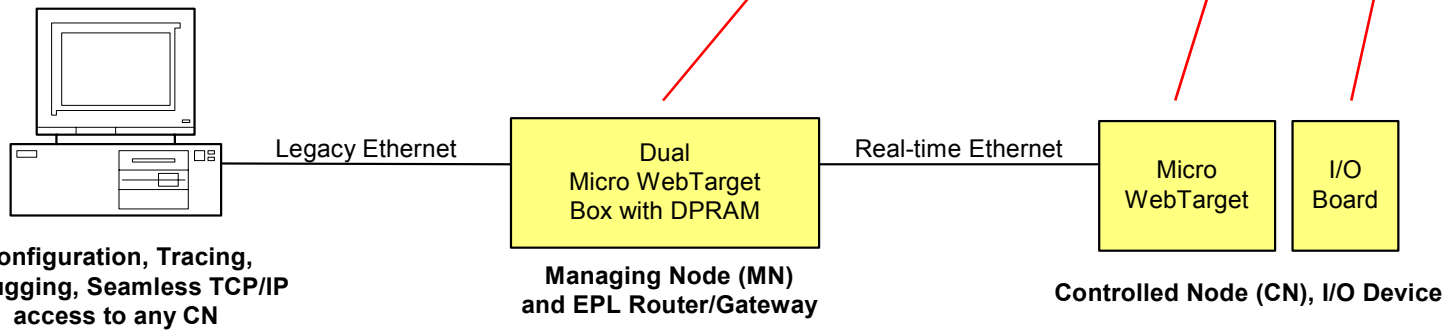
Special EPL Tools (3rd party „*Port*")

- EPL Design Tool
  - Graphical application for offline object dictionary creation.
  - Supports communication profiles: DS301, DS302.
  - Supports device profiles: DS401, DS402, DS403, DS404.
  - Various output formats: HyNetOS configuration file, generated C header file, EDS file (XML).

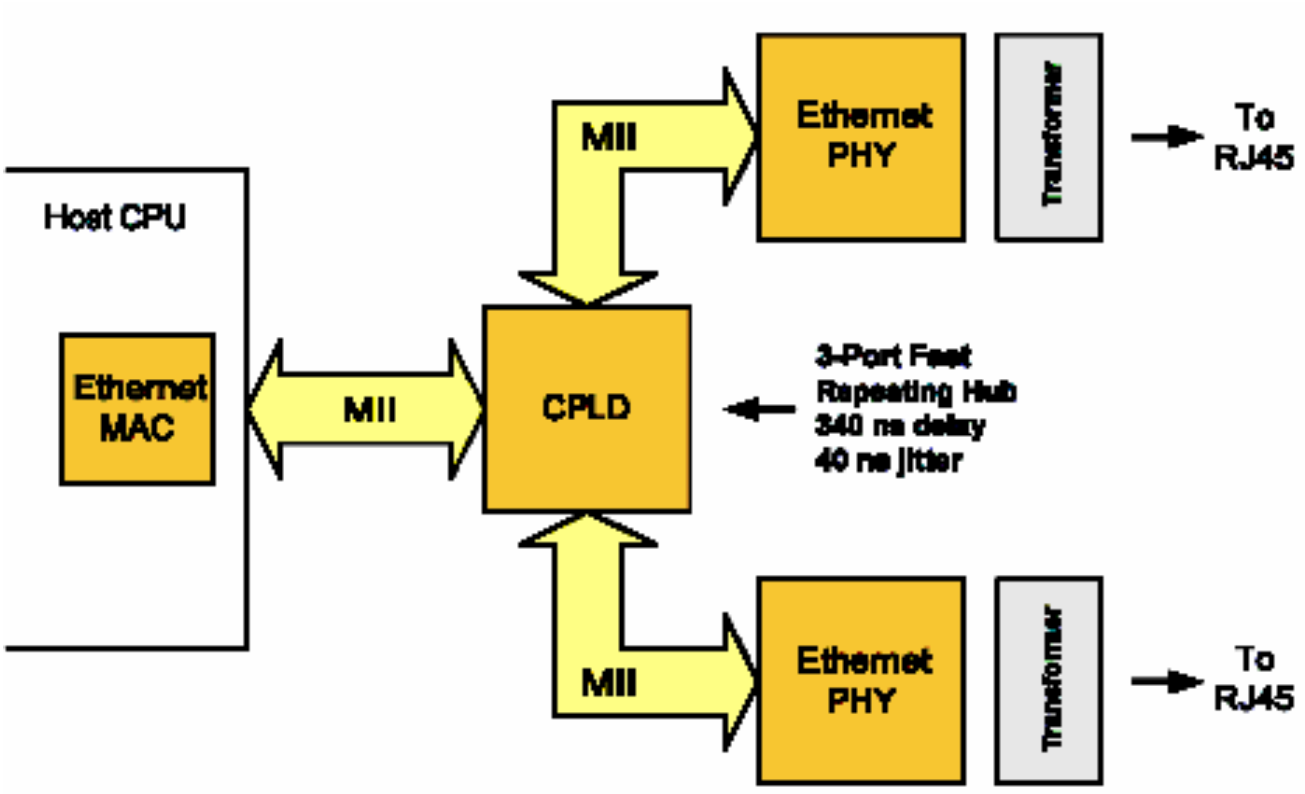
- EPL Device Monitor
  - Graphical online inspection and online configuration (SDO) of EPL devices (Object Dictionary Contents).
  - Execution of NMT services and commands (for testing purposes).
  - Requires EPL gateway box from SND.

EPL Evaluation Kit

- 1 EPL Gateway Box (MN)
- 1 Micro WebTarget I/O Board (CN)
- All Power Supplies and Cables
- HyNetOS Evaluation Version incl. all Extensions and EPL Stack
- Complete Set of Development Tools (C-Compiler, Linker, Debugger)
- SND's Ethernet-based Administration Tools
- Evaluation Version of 3rd Party *EPL Design Tool* and *EPL Device Monitor* („Port")
- 1 Year Updates and Support



Ethernet Hub Design



- Available as binary code for selected CPLDs
- Available as VHDL source code for on-chip integration

Roadmap for RTE-Standards

- ETHERNET Powerlink
  - 99% Ready, release and cerfication expected early 2006
- EtherNet/IP
  - Begin implementation in November 2005
  - First beta (soft Real-time) in Spring 2006
  - Full beta (incl. CIPSync hard Real-time) in 2Q 2006
  - Release in Summer 2006
- PROFInet
  - Evaluation of prerequisites starting in Q4/2005
  - Begin implementation in Summer 2006
  - Release in 2007

Thank You