Cover Slide – Read and Delete

EtherCAT is:

- Faster
- Synchronization
- Industrial Ethernet
- Flexible
- Easier to configure
- Cost effective
- Easier to implement
- Well proven
- Open
- Conformance
- Safety
- Redundancy
- Versatile

EtherCAT Introduction: This slide set intends to provide an overview over the most important features of the EtherCAT technology.

Please do not forward the slides in PPT format – only as PDF!

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It is, however, prohibited explicitly to use slides or elements from the slides (e.g. pictures) for any other purpose than to introduce and promote the EtherCAT technology.

The animations have been developed with and for Microsoft PowerPoint 2003. Some elements will not work with earlier versions.

For comments regarding the slides please contact info@ethercat.org

Nuremberg, May 2009,

EtherCAT Technology Group

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EtherCAT®
The Ethernet Fieldbus.

Why Ethernet for Automation?

EtherCAT is:

- Faster
- Synchronization
- Industrial Ethernet
- Flexible
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- Well proven
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- Today at controller level: state-of-the-art
- Advantages for fieldbuses:
  - lower costs because the use of commodity technology
  - Ethernet technology is driven by the office sector
  - access to internet technology (e.g. webserver)
  - reduction of interfaces
- But: Common Ethernet does not achieve fieldbus requirements as…
  - Low cost, performance, deterministic (real time),…

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EtherCAT - The Ethernet Fieldbus.

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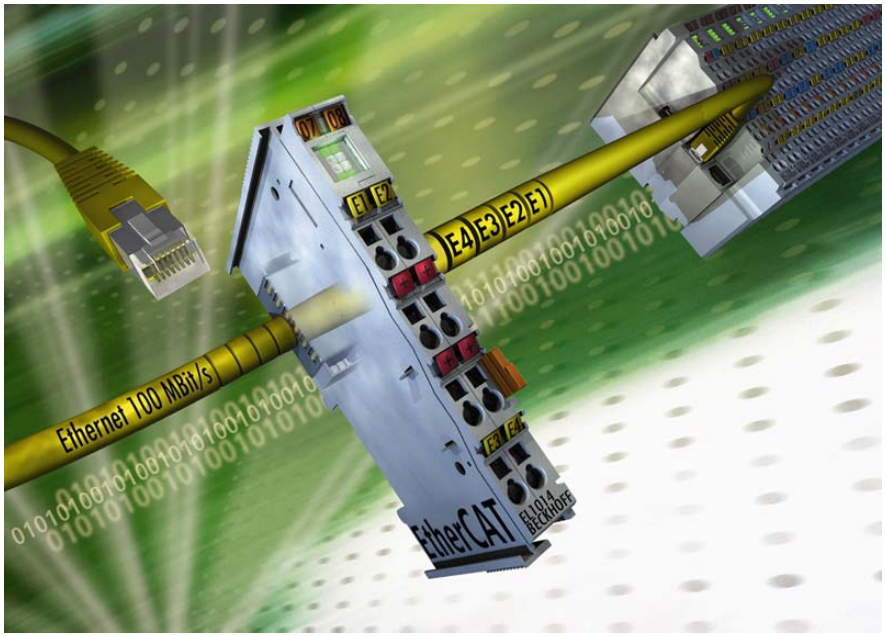
- EtherCAT is real time down to the I/O level
- No underlying sub-systems any more
- No delays in gateways
- In- and outputs, sensors, actuators, drives, displays: **everything in one system!**



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EtherCAT is faster

EtherCAT is:

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- Transmission Rate:
  - 2 x 100 Mbit/s (Fast Ethernet, Full-Duplex)

- Update Times:
  - 256 digital I/O in 11 µs
  - **1000 digital I/O** distributed to 100 nodes in **30 µs** = 0.03 ms
  - 200 analog I/O (16 bit) in 50 µs, 20 kHz Sampling Rate
  - **100 Servo-Axis** (each 8 Byte In + Out) in **100 µs** = 0.1 ms
  - 12000 digital I/O in 350 µs

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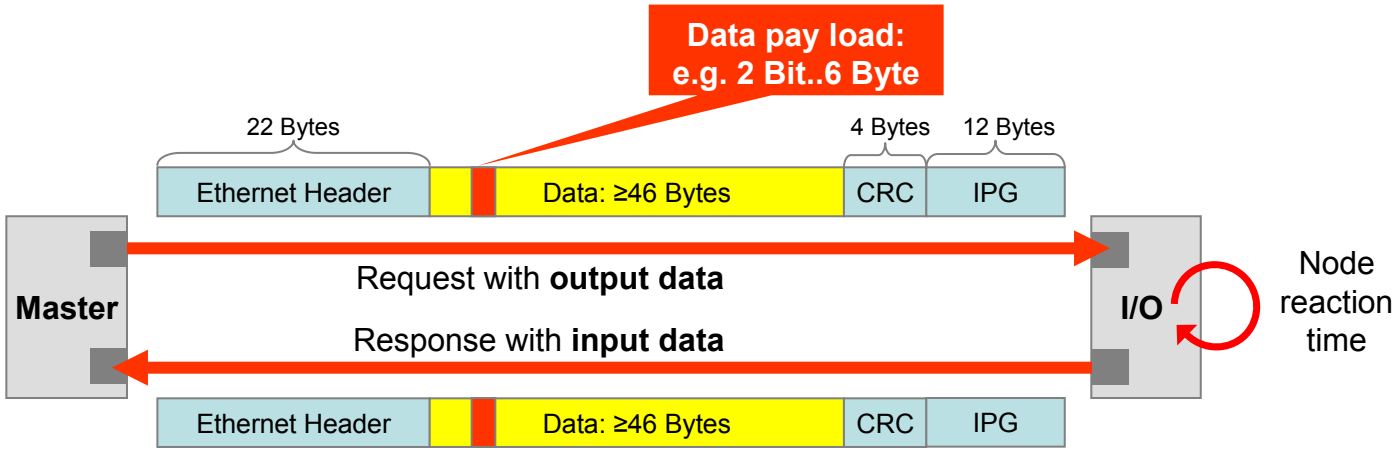
- Bandwidth Usage of Ethernet for I/O and Drives:
  - Ethernet Frame: ≥ 84 Bytes
    incl. Preamble + IPG (interpacket gap)



  - with 4 Byte input + 4 Byte output per node:
    - **4,75%** application data ratio at **0 µs** reaction time/node
    - **1,9%** application data ratio at **10 µs** reaction time/node

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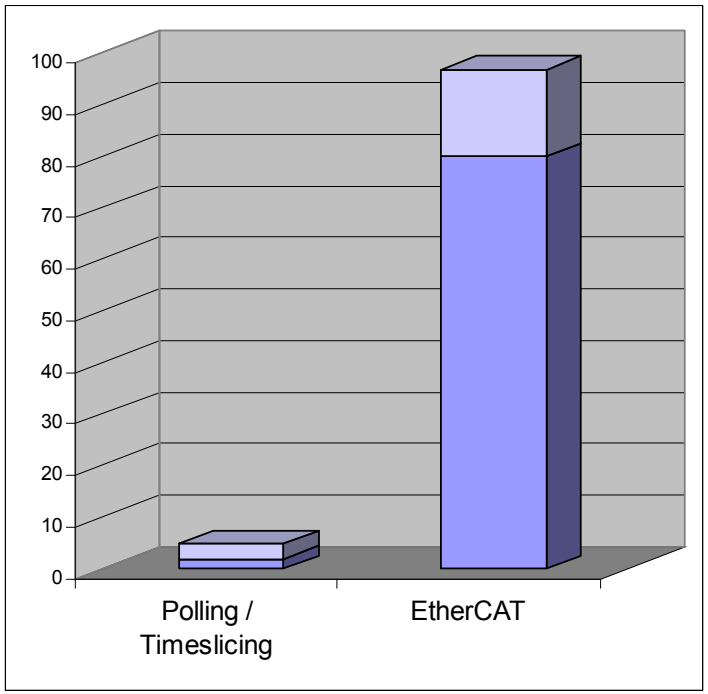
- Bandwidth Usage Comparison:
  - At 4 Byte user data per node:
    - Polling / Timeslicing: ~ 2..5 %
  - From 2 Bit user data per node:
    - **EtherCAT: ~ 80..97 % (Full Duplex, 2 x 100 MBit/s)**



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Functional Principle: Ethernet „on the fly“

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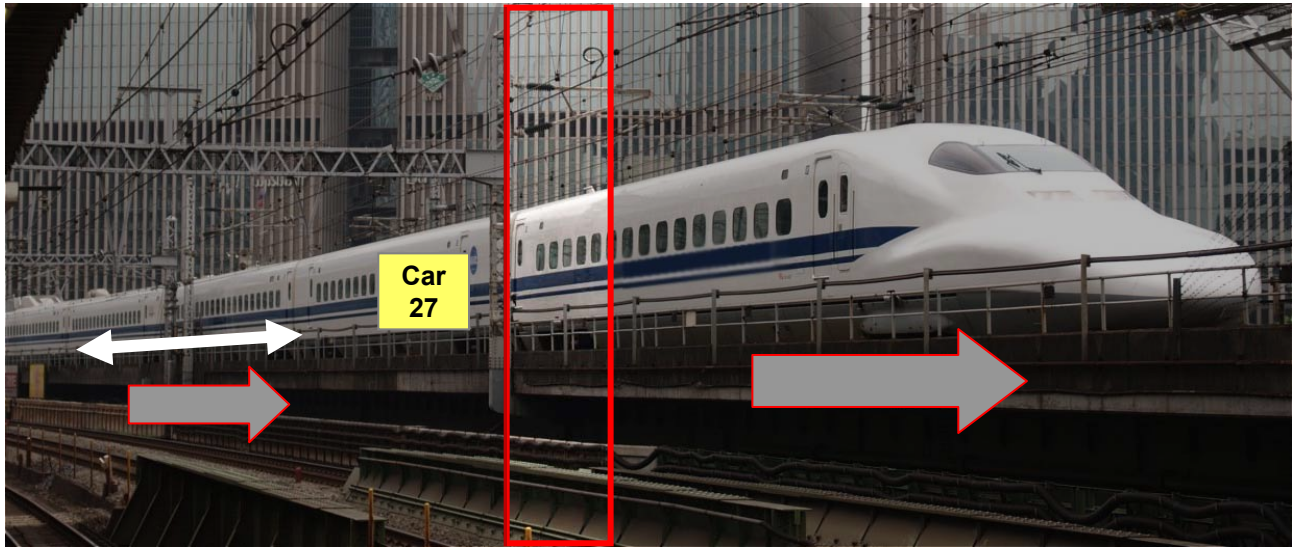

- Analogy Fast Train:
  - “Train” (Ethernet Frame) does not stop
  - Even when watching “Train” through narrow window one sees the entire “Train”
  - “Car” (Sub-Telegram) has variable length
  - One can “extract” or “insert” single “persons” (Bits) or entire “groups” (Bytes) – even multiple groups per train

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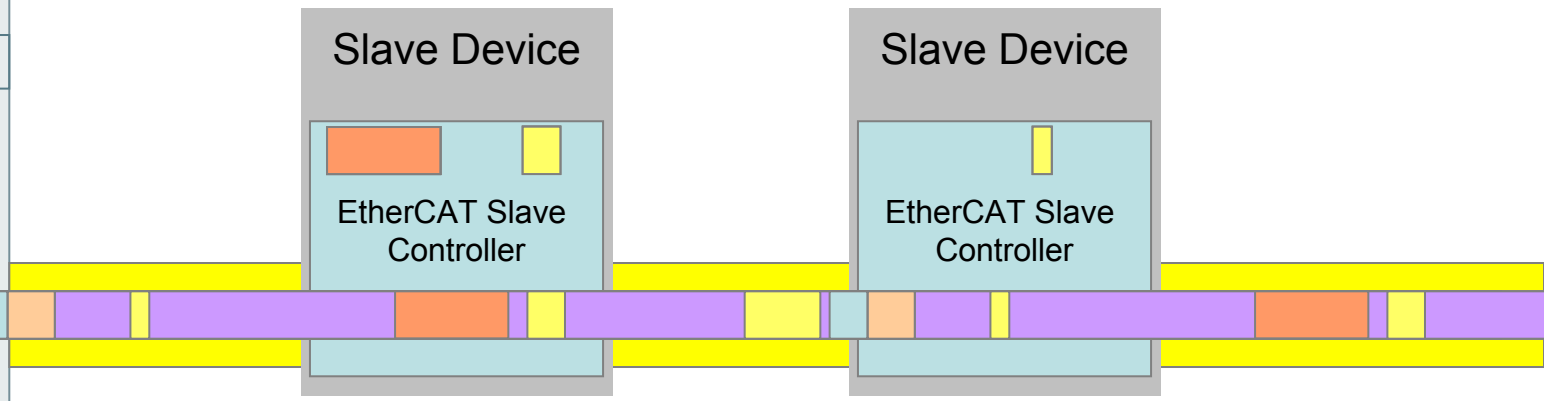

- Process data is extracted and inserted on the fly:
  - Process data size per slave almost unlimited (1 Bit…60 Kbyte, if needed using several frames)
  - Compilation of process data can change in each cycle, e.g. ultra short cycle time for axis, and longer cycles for I/O update possible
  - in addition asynchronous, event triggered communication

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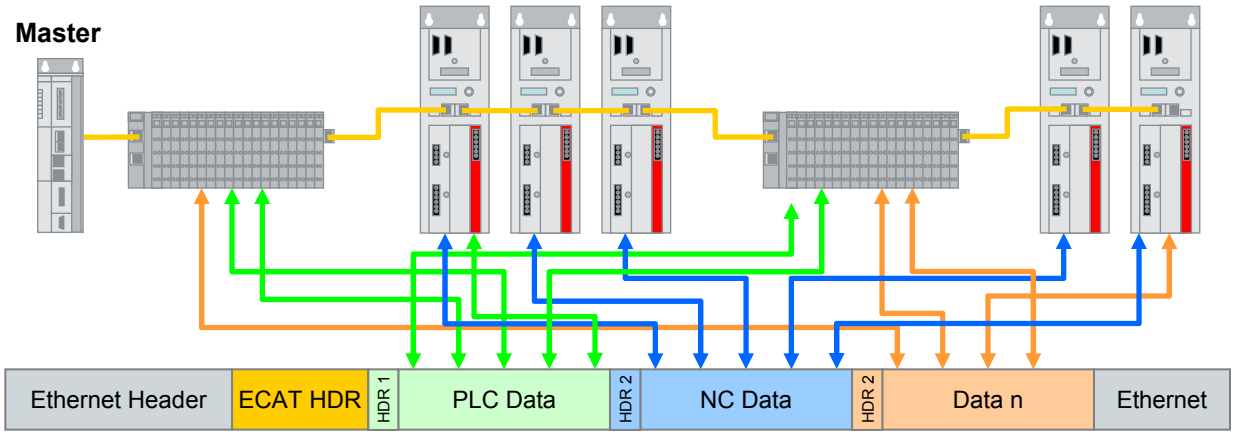

- Minimal protocol overhead via implicit addressing
  - Optimized telegram structure for decentralized I/O
  - Communication completely in hardware: maximum (+ predictable!) performance
  - No switches needed if only EtherCAT devices in the network
  - Outstanding diagnostic features
  - Ethernet-compatibility maintained

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Performance: Application Example

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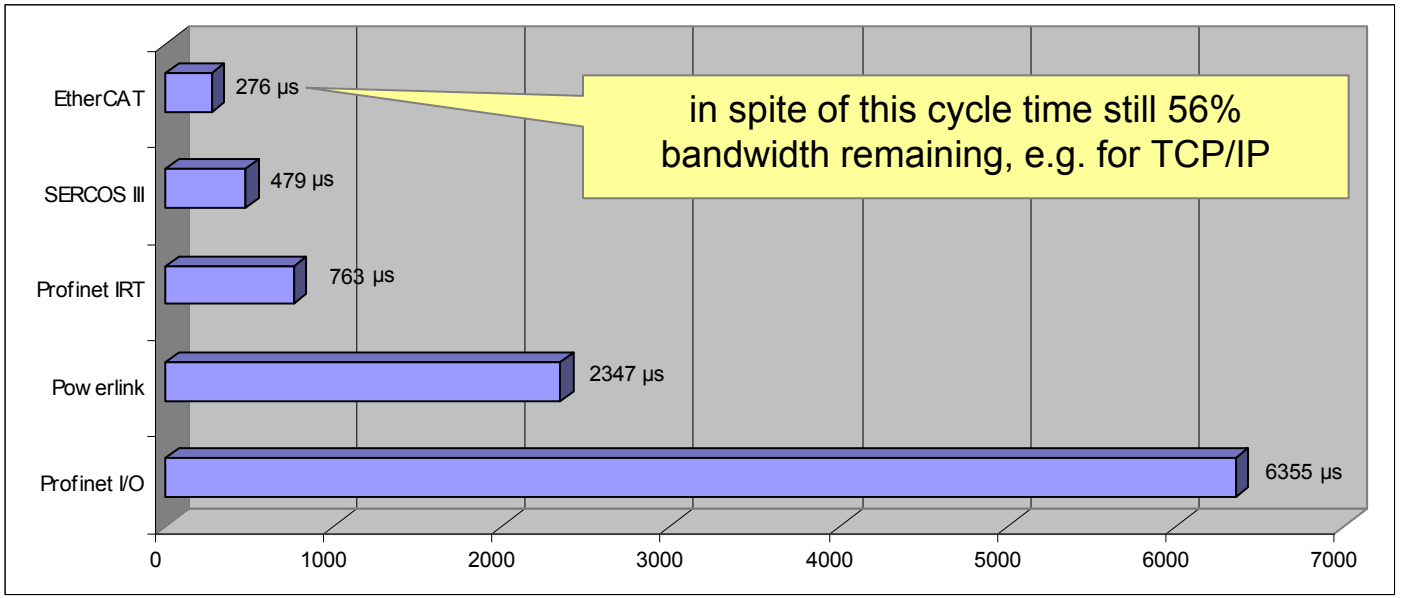
- 40 Axis (each 20 Byte Input- and Output-Data)
- 50 I/O Station with a total of 560 EtherCAT Bus Terminals
- 2000 Digital + 200 Analog I/O, Bus Length 500 m
- Performance EtherCAT: **Cycle Time = 276 µs** at 44 % Bus Load, **Telegram Length = 122 µs**



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‘Slow’ Control Systems benefit, too

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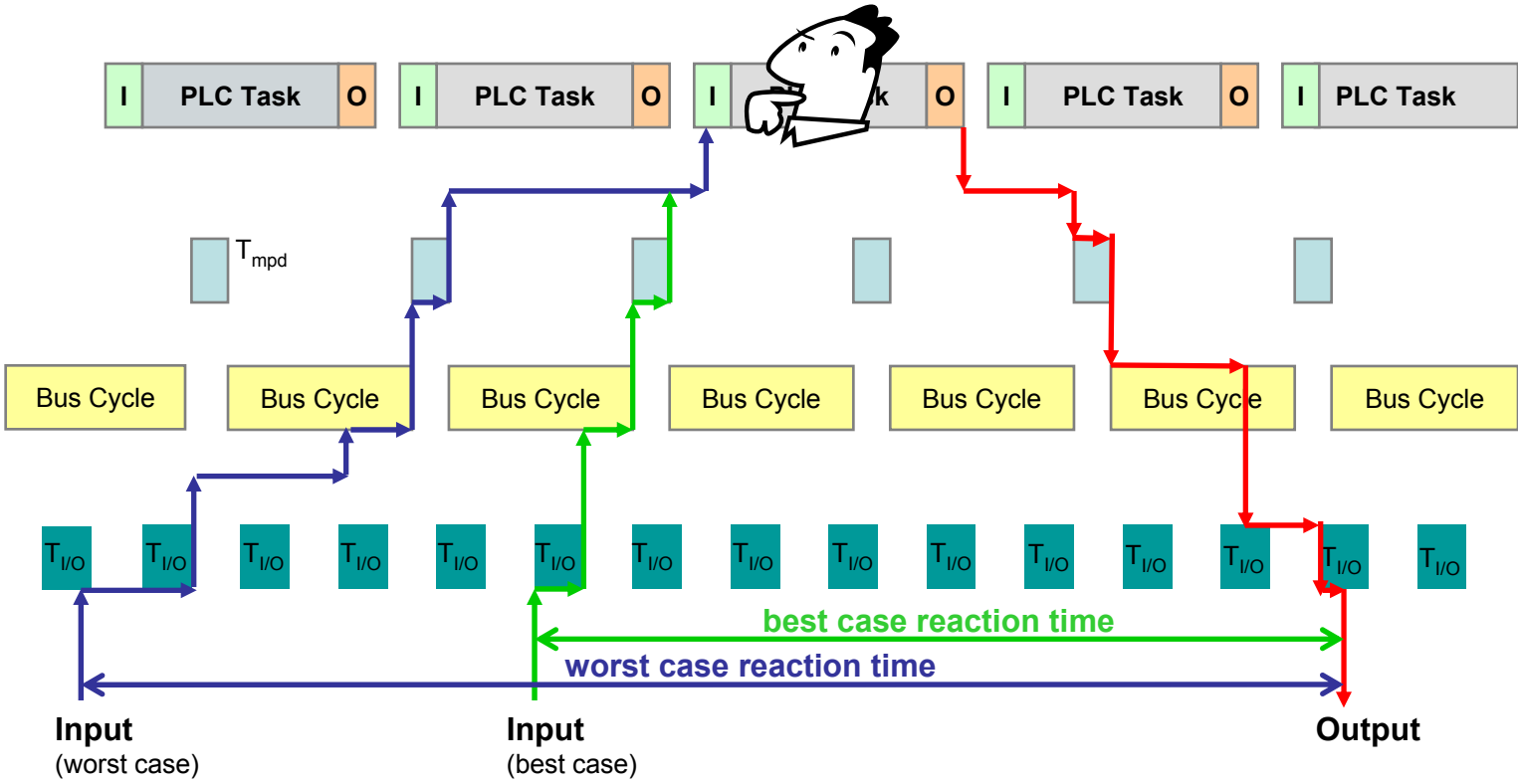
- Reaction time with legacy fieldbus I/O:



T_{mpd}: Master Processing Delay

$T_{I/O}$: Local I/O Update Time
(local Extension Bus + Firmware)

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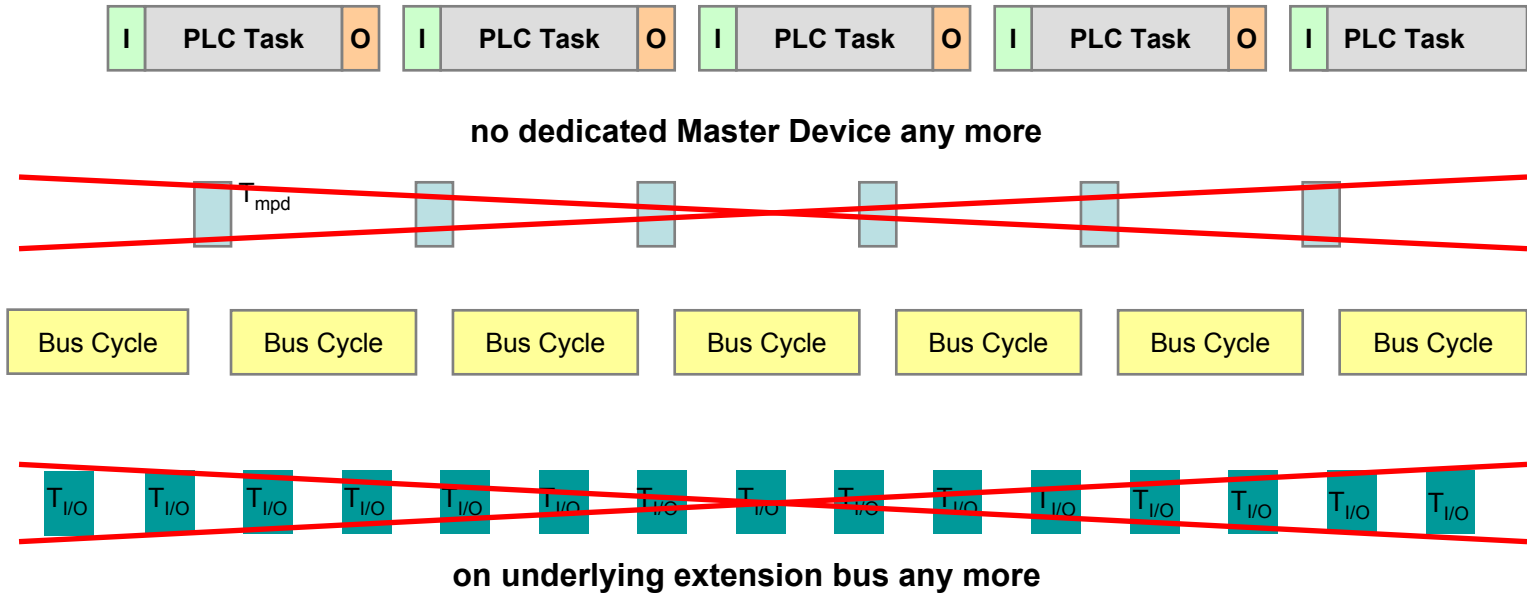
- System Architecture with EtherCAT:



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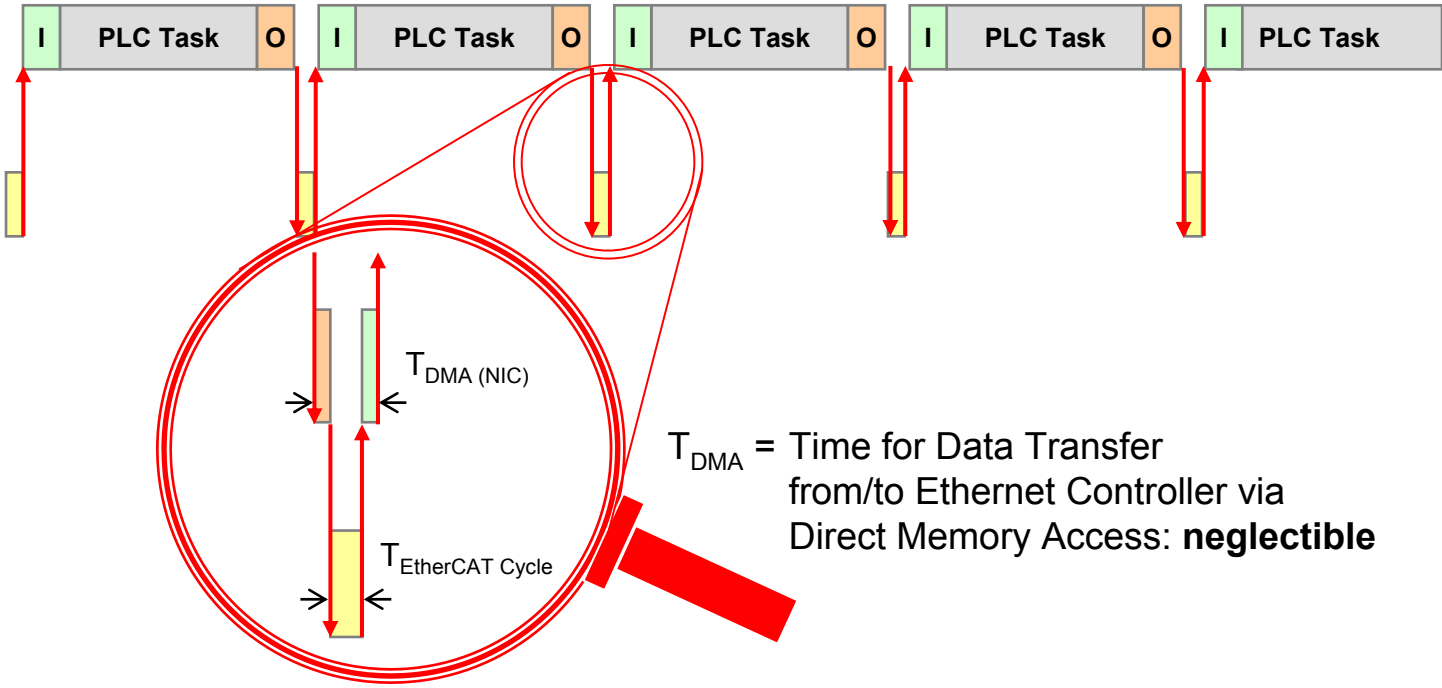

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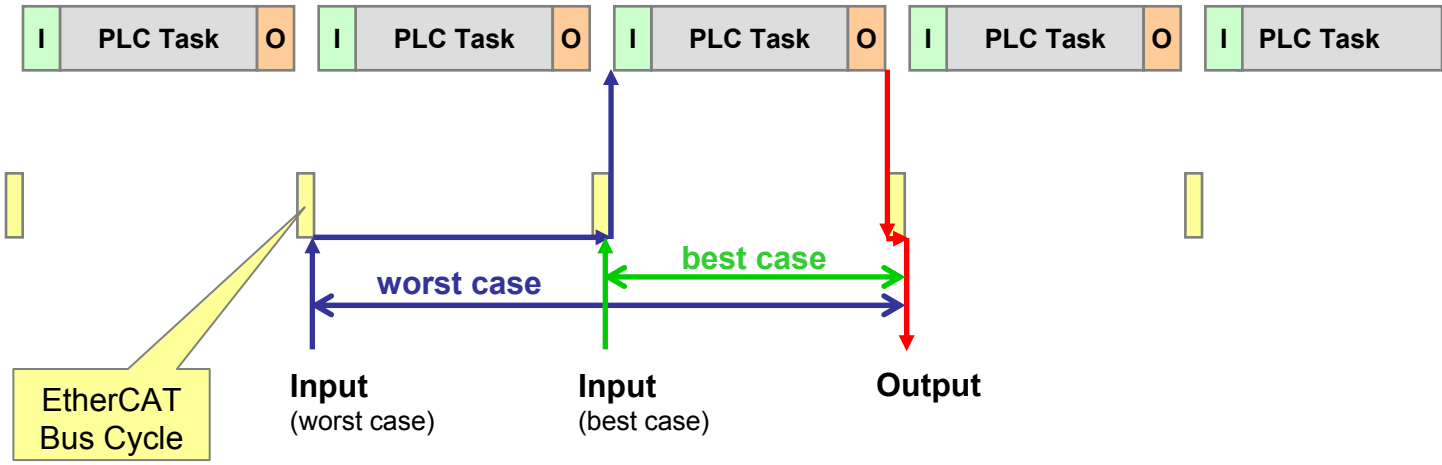
- Reaction Time with EtherCAT:



  - Reaction time reduced significantly with the same controller performance
  - no underlying local I/O cycles and extension bus delays any more
  - Due to the very simple protocol no dedicated master systems (e.g. plug-in cards) required

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Fieldbus: requires Mapping in Control System

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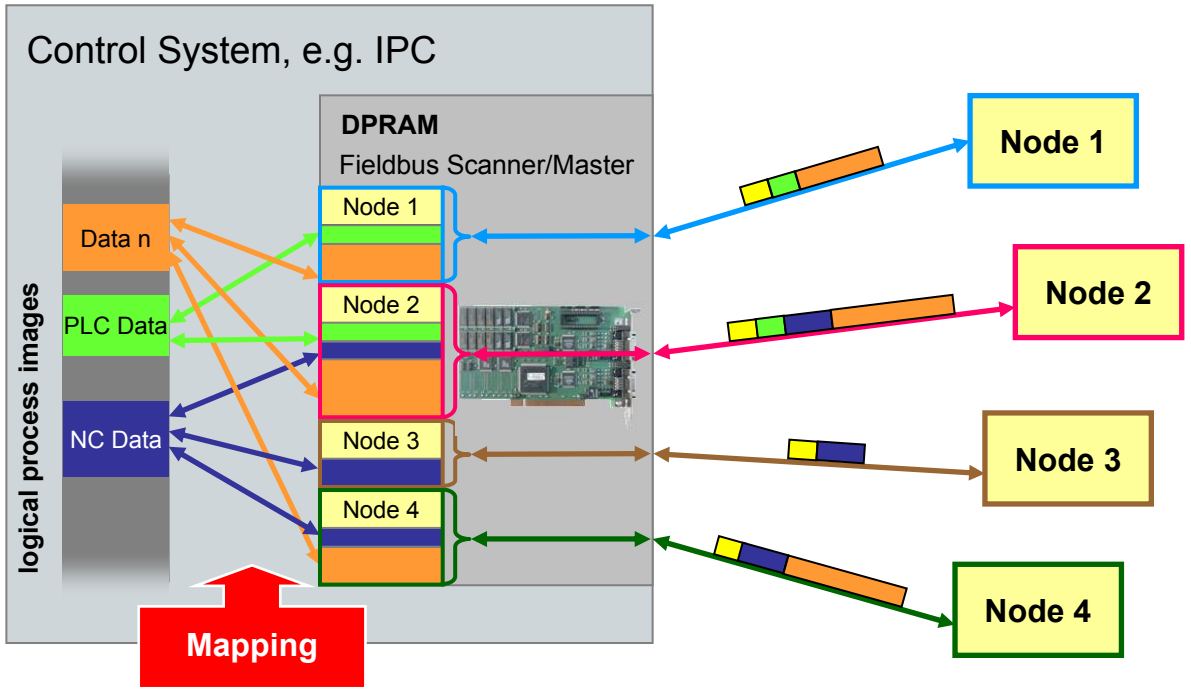
- Traditional fieldbus system generate *physical* process image
- This has to be mapped to *logical* process image(s)



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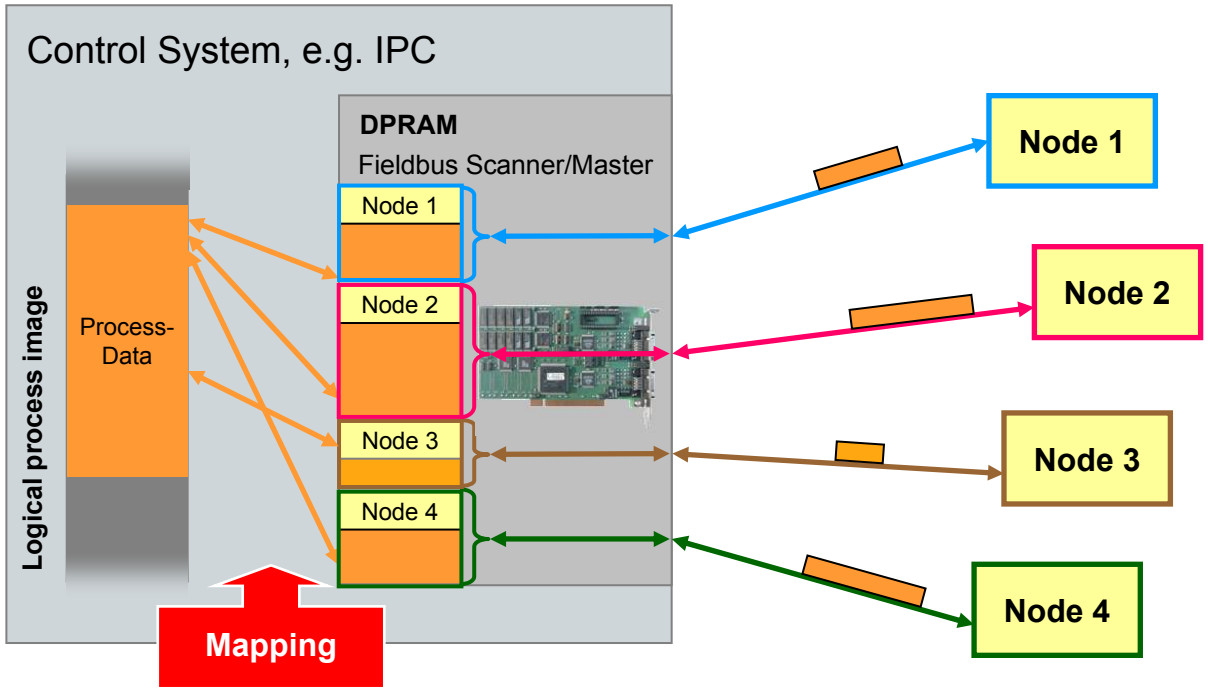
- The same applies to control system with just one process image
- Resorting of process data (“Mapping”) is required, too



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EtherCAT: Mapping moved into Slave Devices

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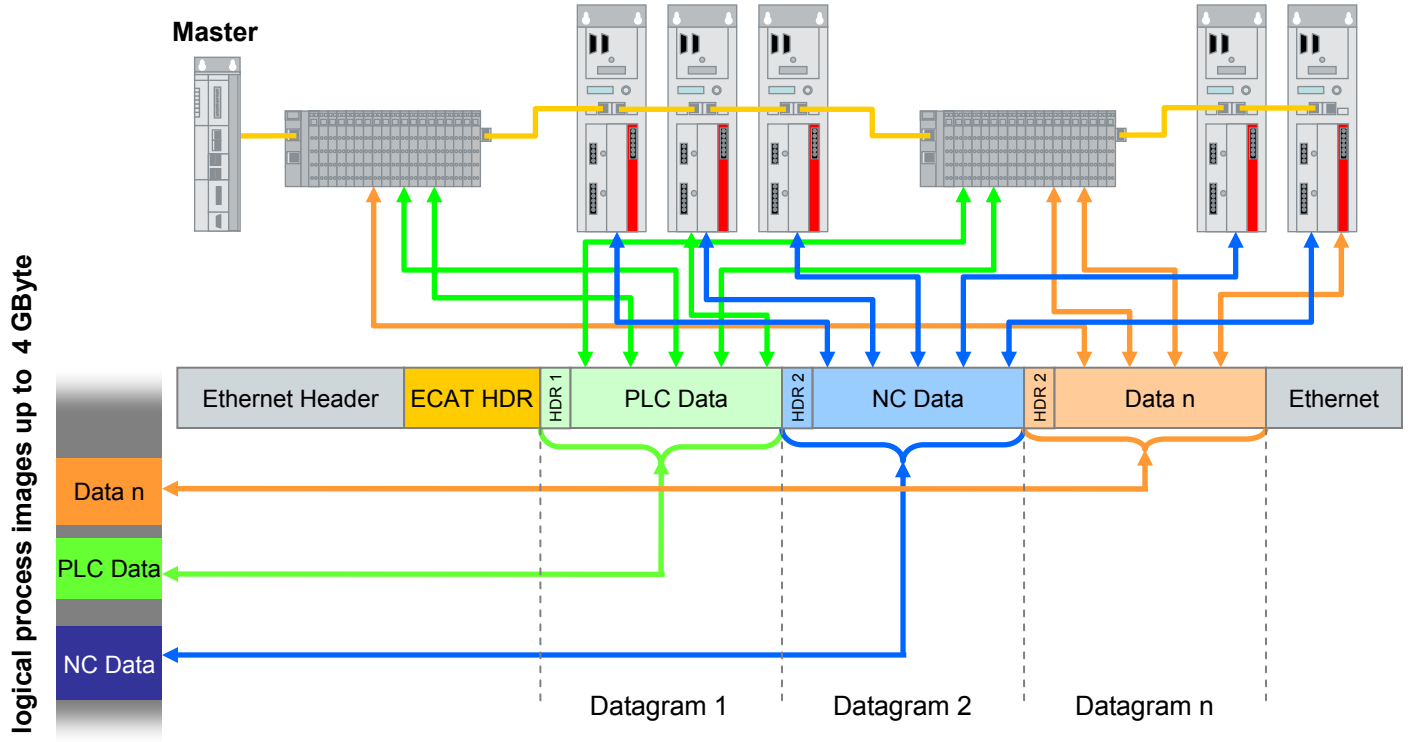

- Control System is unburdened, master becomes very simple
- Data is transmitted according to the application requirements: extremely fast, flexibly and efficiently

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Direct Memory Access saves time

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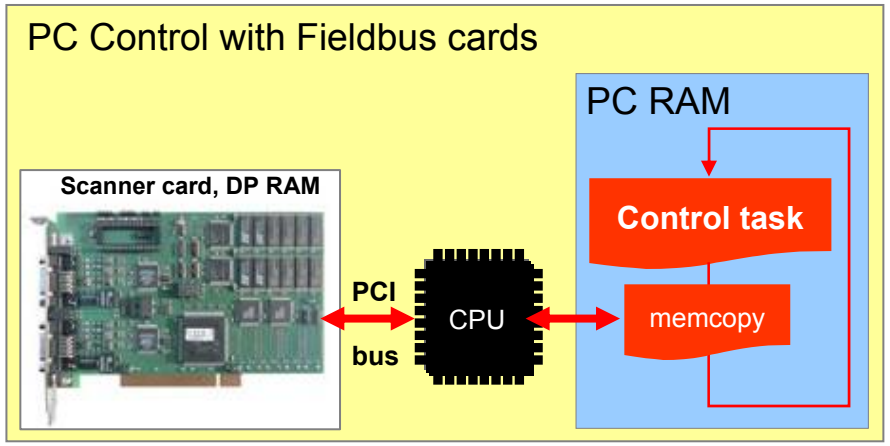
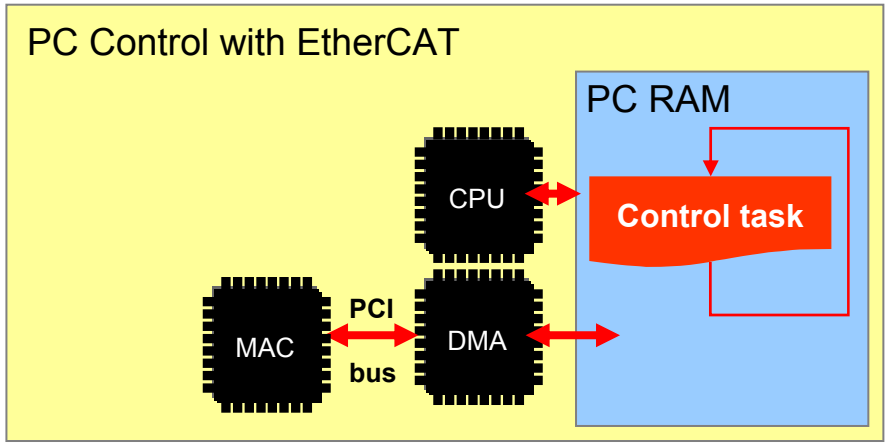
- Fieldbus cards: up to 30% of CPU time for data copying



- EtherCAT: MAC is PCI Bus master, data is provided by DMA directly to PC RAM: CPU relieved more performance



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EtherCAT Propagation Delay Measurement (1)

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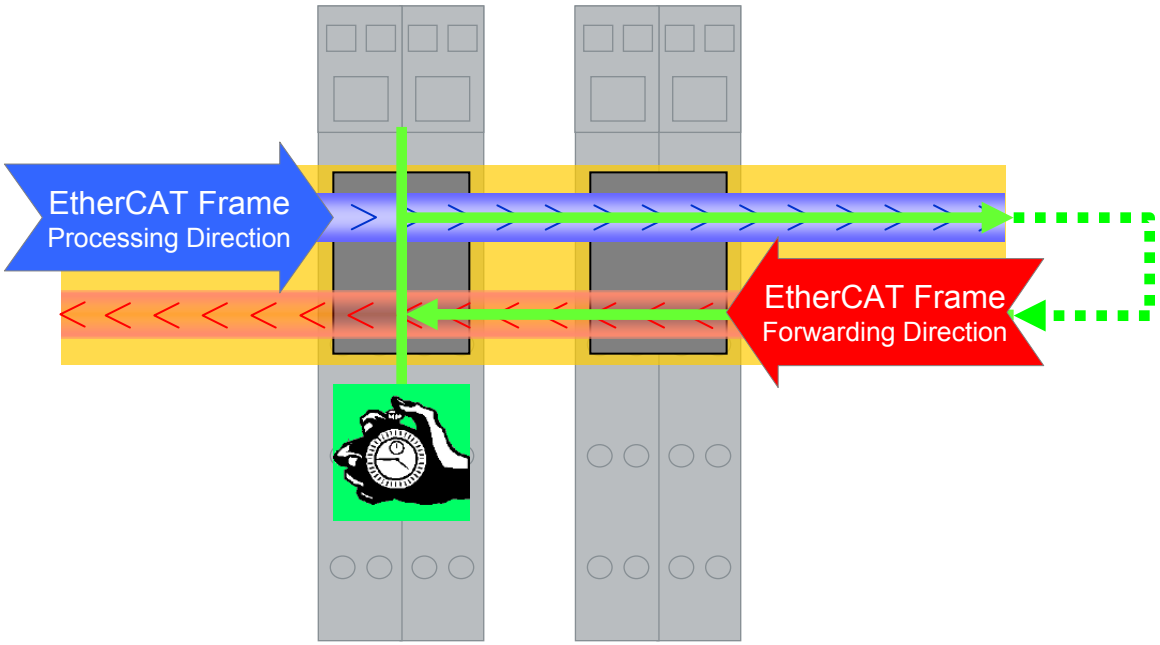
- EtherCAT Node measures time difference between leaving and returning frame



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EtherCAT Propagation Delay Measurement (2)

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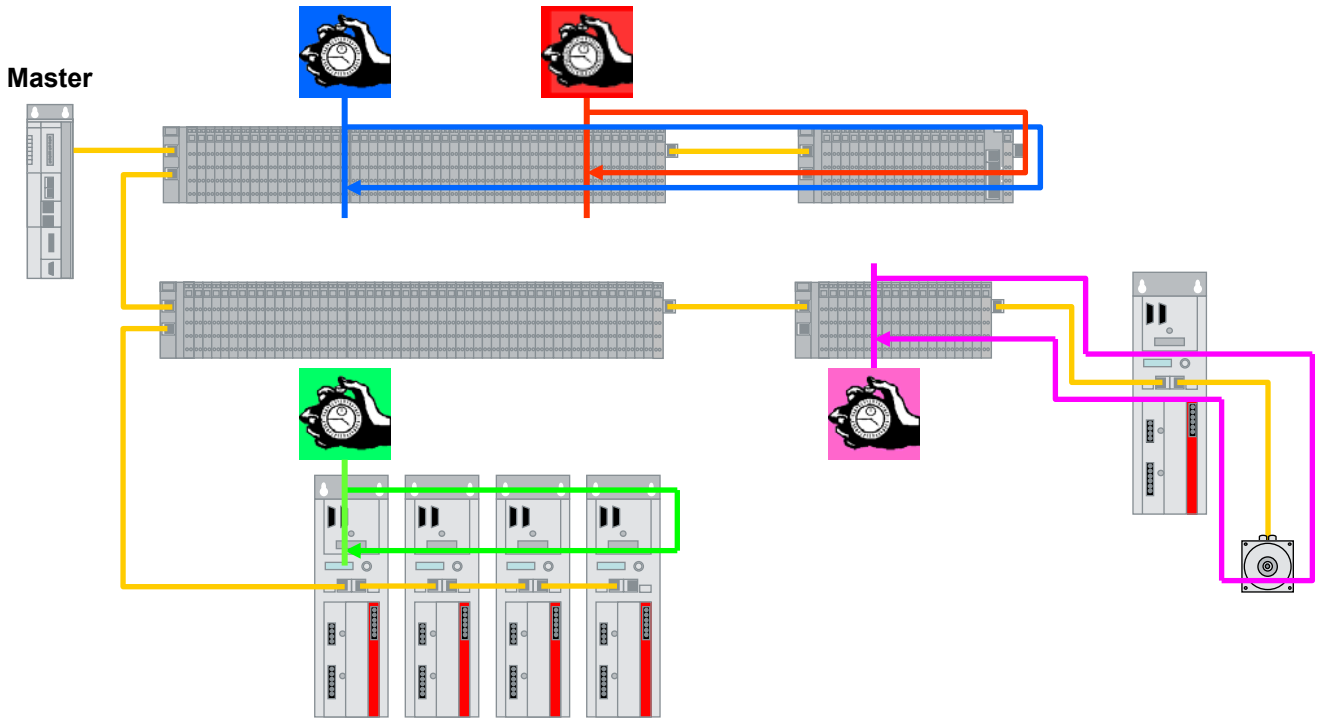

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Distributed Clocks

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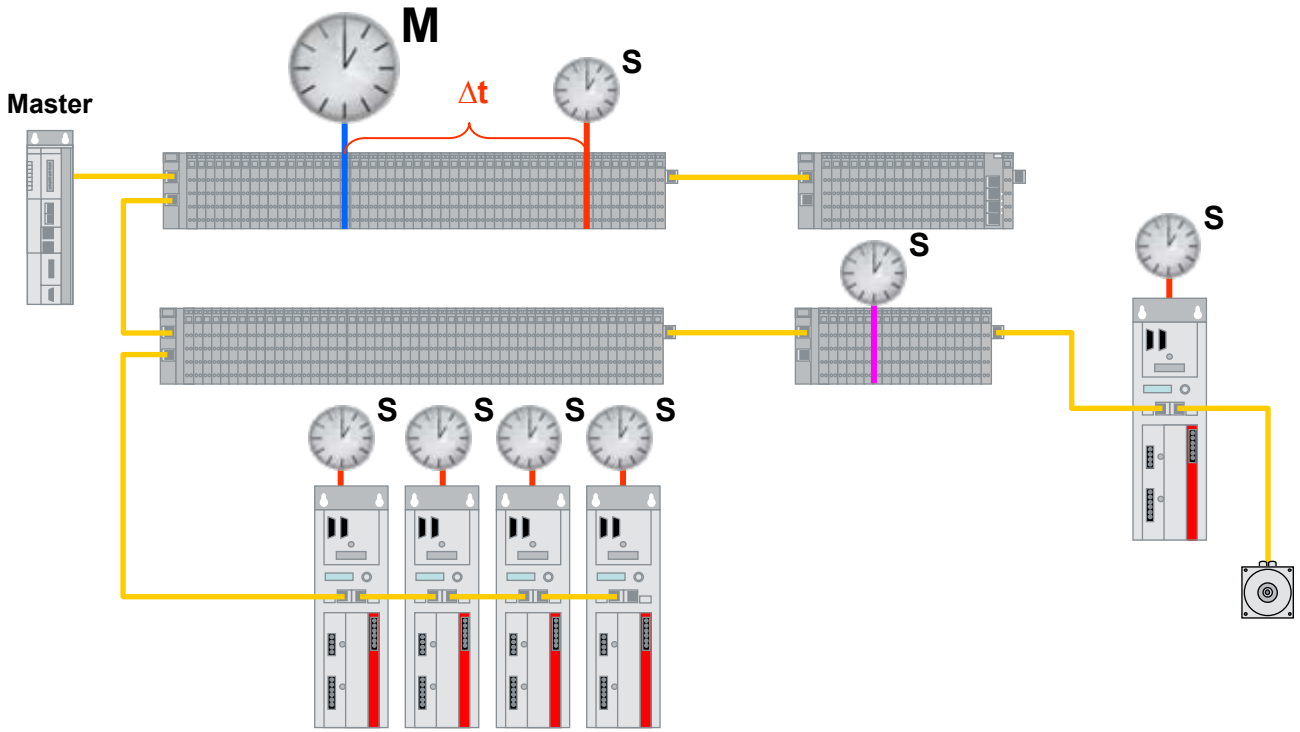
- Precise Synchronization (<< 1 µs!) by exact adjustment of Distributed Clocks



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External Clock Synchronization: IEEE 1588

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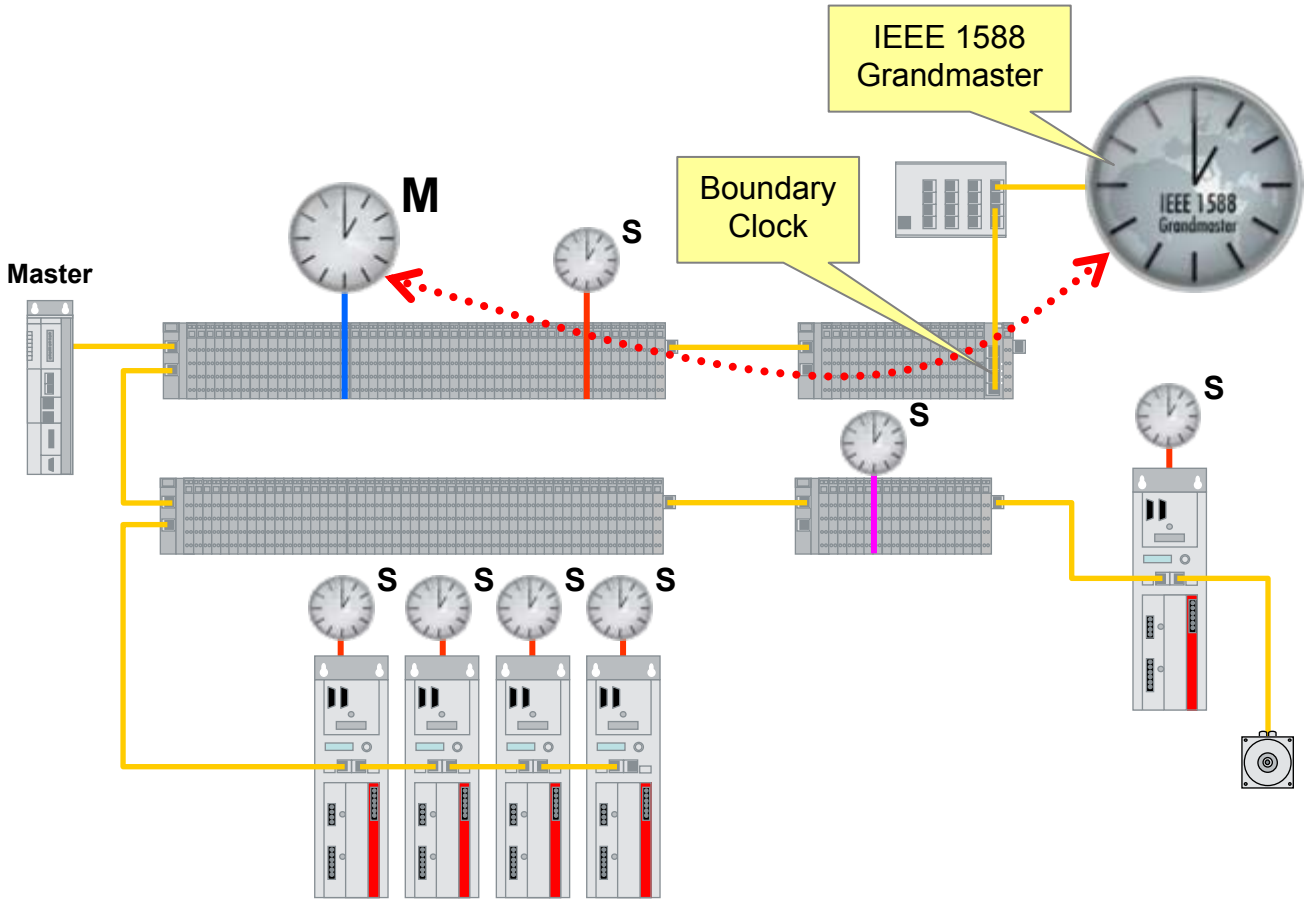
- Switchport with integrated IEEE 1588 Boundary Clock



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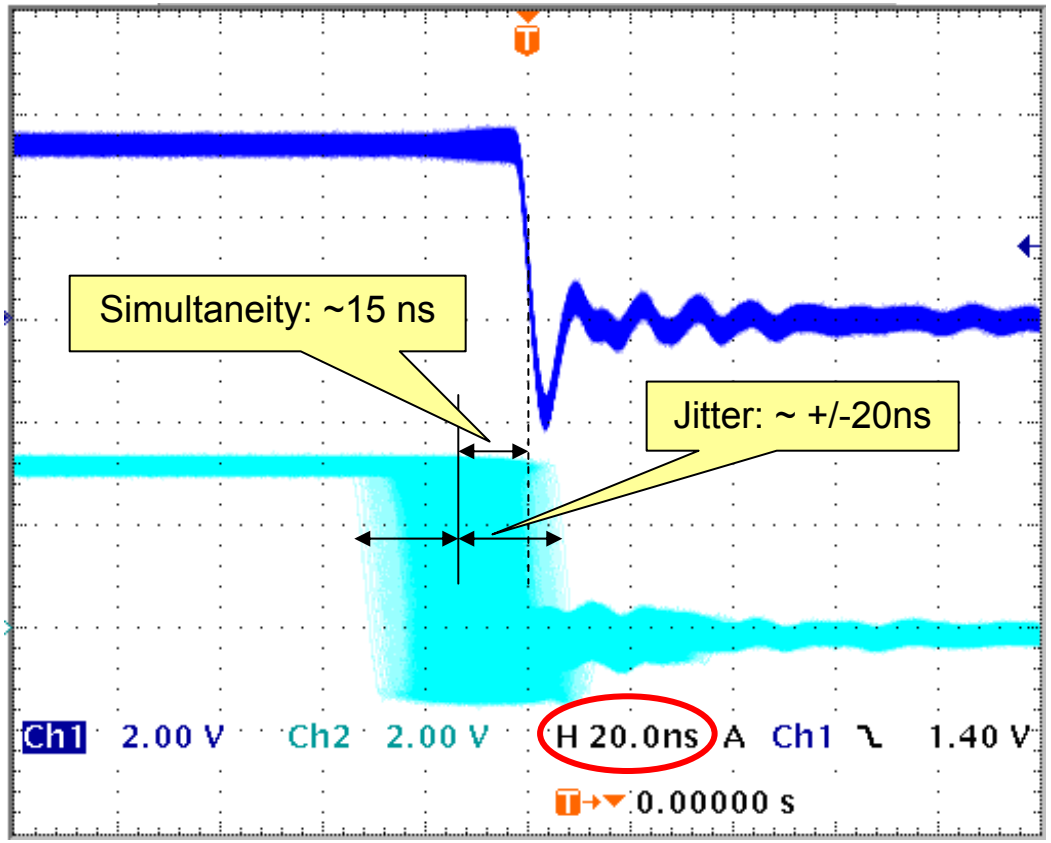
- Long Term Scope View of two separated devices
- 300 Nodes in between, 120m Cable Length



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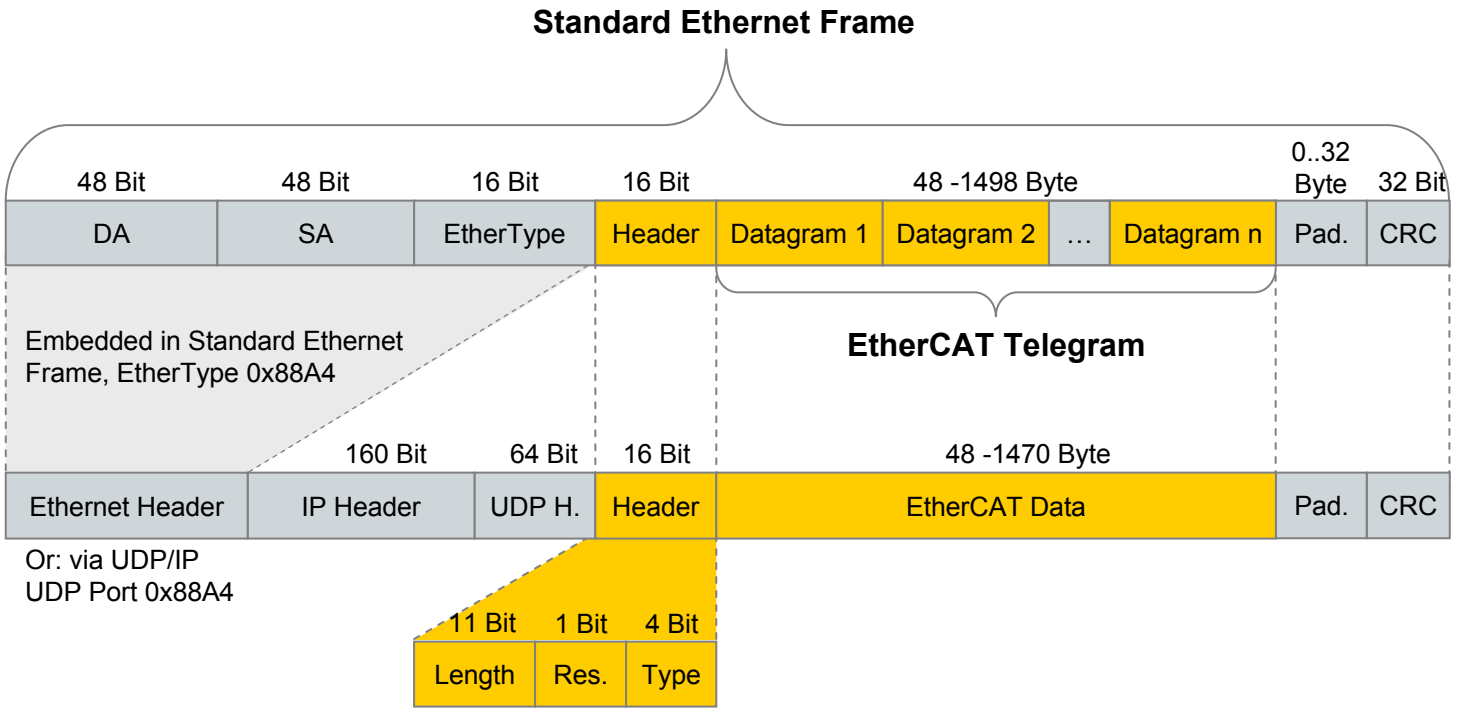
- EtherCAT uses Standard Ethernet Frames: IEEE 802.3
- Alternatively via UDP/IP (if IP Routing is needed)
- no shortened frames



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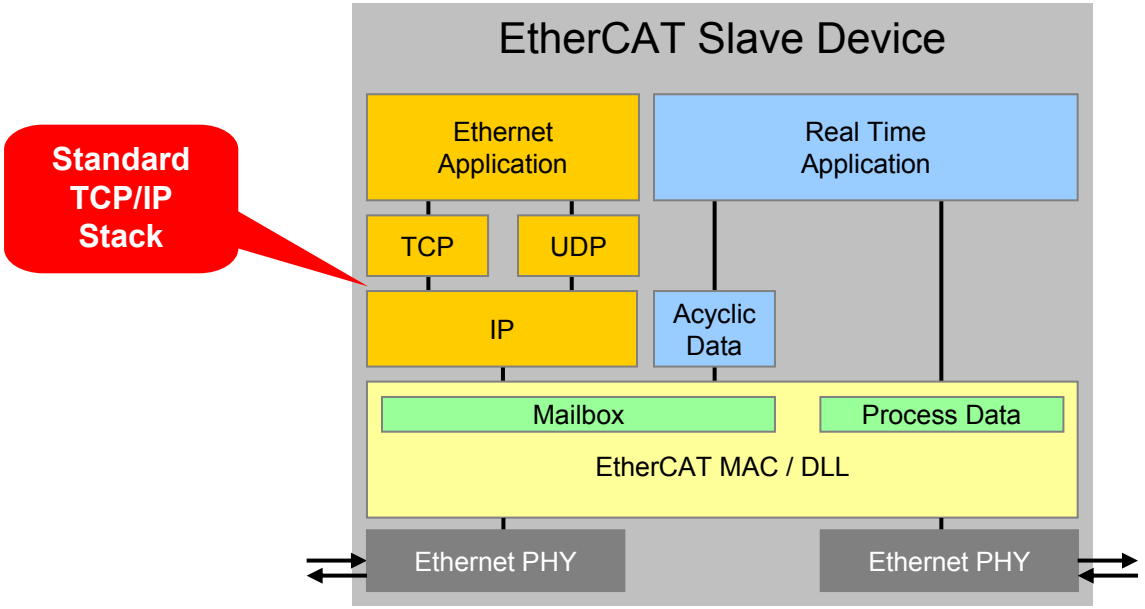
- fully transparent for TCP/IP
- all Internet technologies (HTTP, FTP, Webserver,…) available without restricting the real time capabilites!
- full tool access to devices at real time operation – with and without TCP/IP



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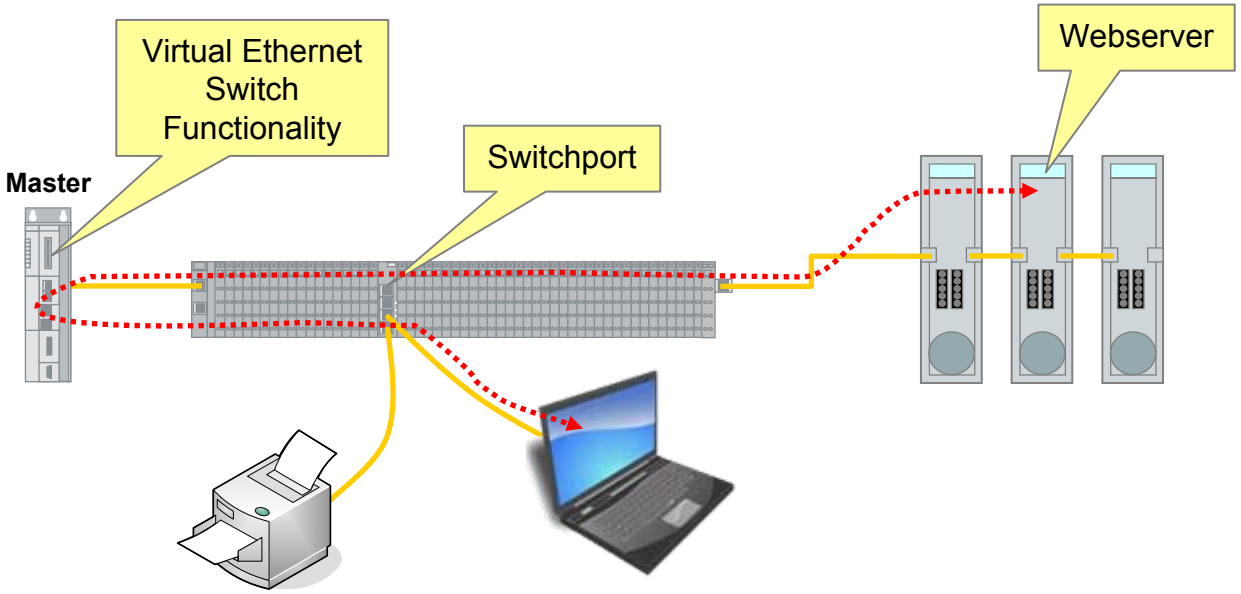
- Any Ethernet Device can be connected to Switchport
- Access to Webserver with Standard Browser



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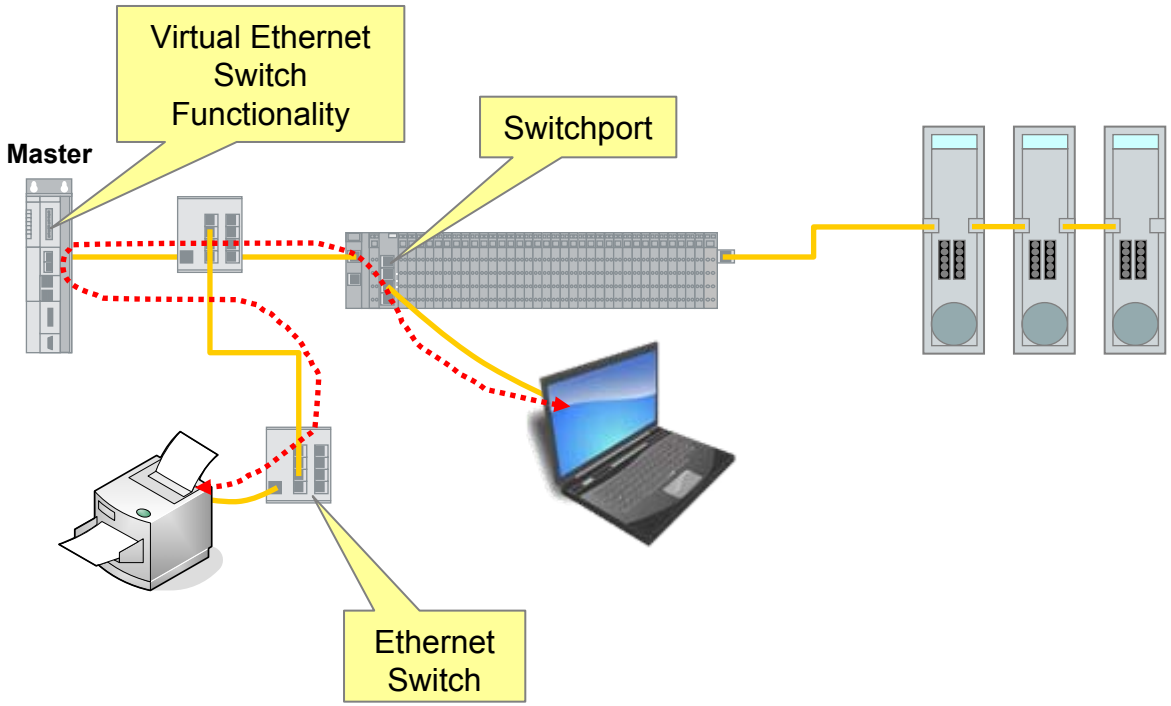
- Virtual Ethernet Switch routes any Ethernet Frame
- From inside as well as from outside the segment



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Switchport: Any Ethernet Protocol

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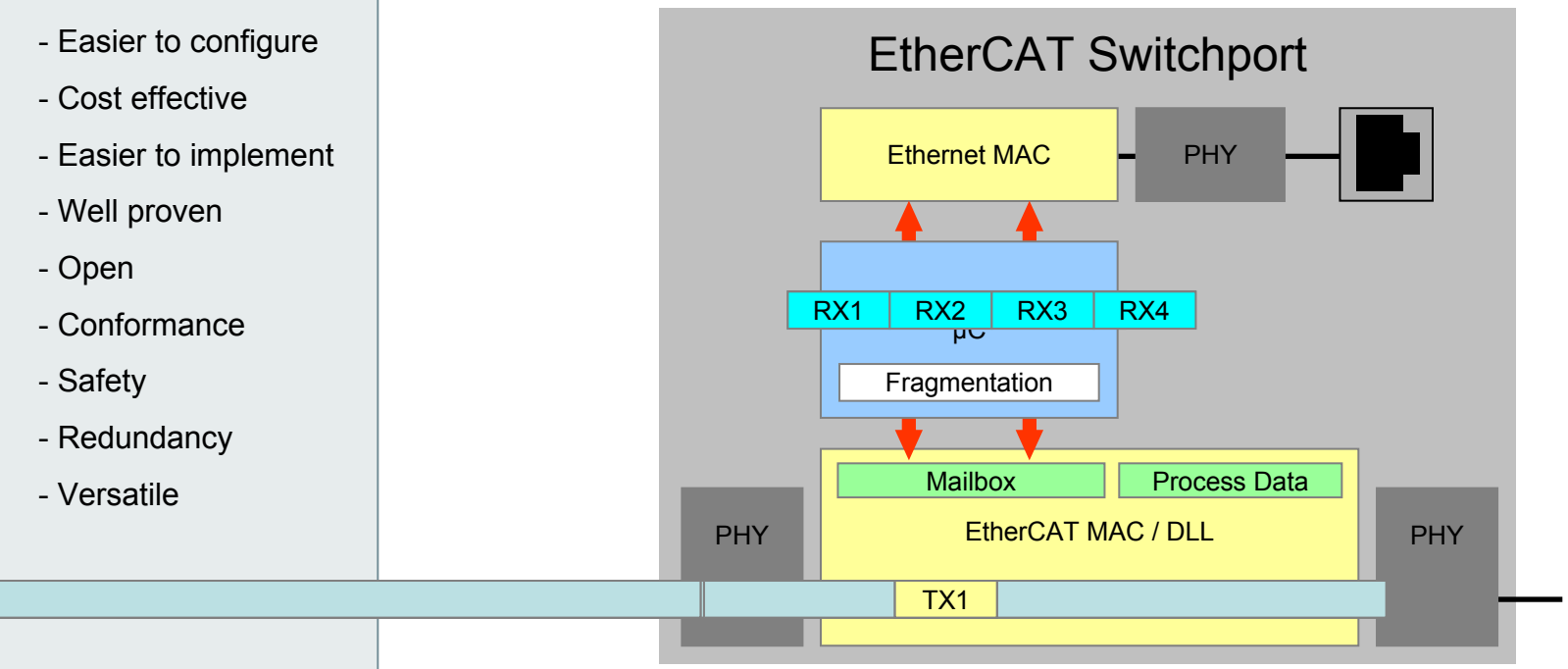
- Interface to any Ethernet Device or Network
- Ethernet Frames are inserted into EtherCAT Protocol:
  - 'Ethernet over EtherCAT'



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Vertical Integration (1)

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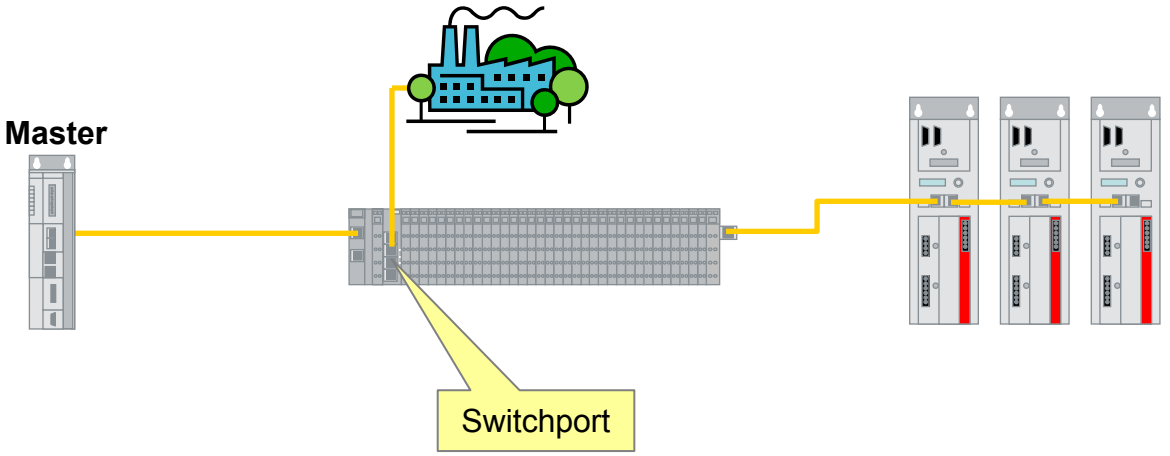
- …via Switchport



- + any Ethernet Protocol can be used
- + requires only one Ethernet Port (at IPC/Controller)
- + EtherCAT performance is not limited

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Vertical Integration (2)

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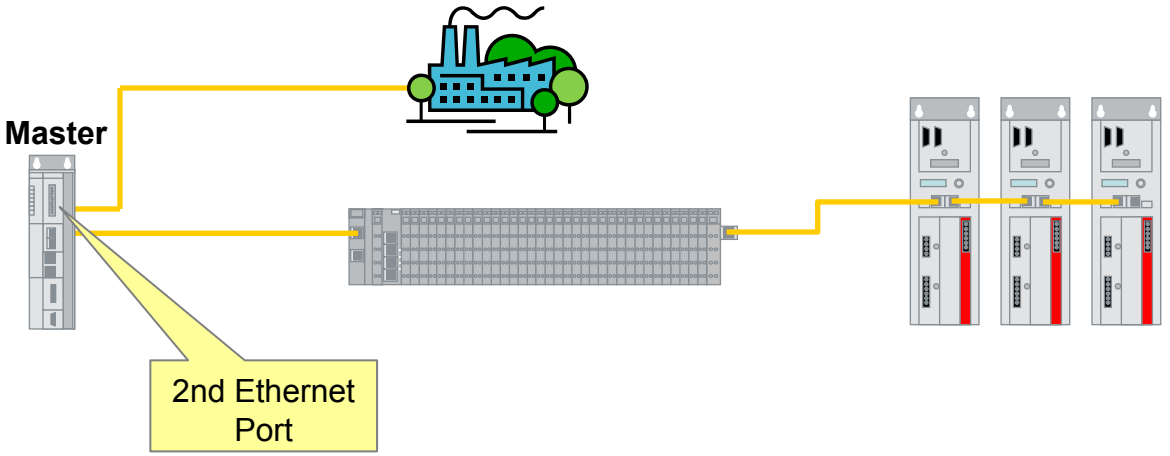
- ...via 2. Ethernet Port



- + any Ethernet Protocol can be used
- + EtherCAT performance is not limited
- but: requires second Ethernet Port (at IPC/Controller)

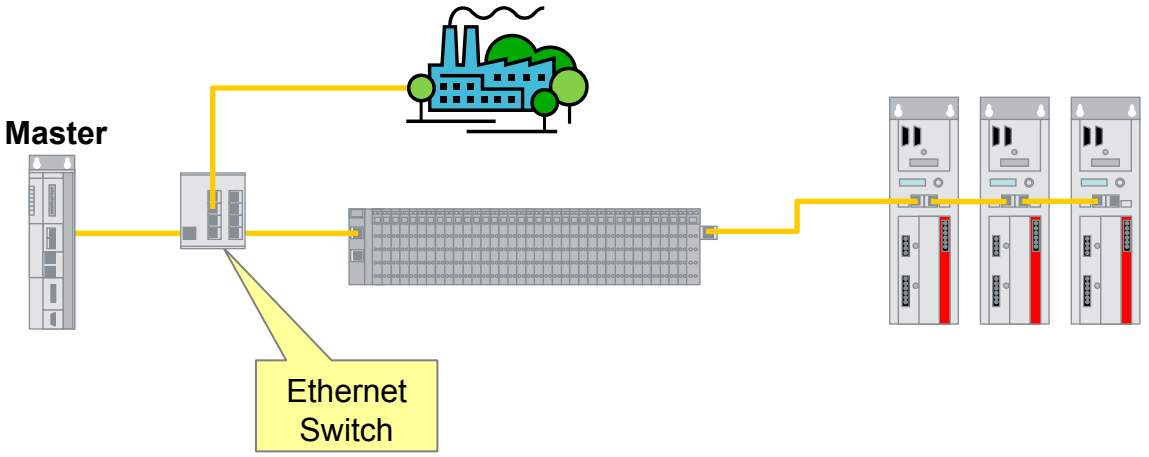
© EtherCAT Technology Group, 2009

Vertical Integration (3)

EtherCAT is:

- Faster ✓
- Synchronization ✓
- Industrial Ethernet
- Flexible
- Easier to configure
- Cost effective
- Easier to implement
- Well proven
- Open
- Conformance
- Safety
- Redundancy
- Versatile

- …via Switch



- + any Ethernet Protocol can be used
- + requires only one Ethernet Port (at IPC/Controller)
- but: performance reduced by switch delay (and generic Ethernet traffic)

© EtherCAT Technology Group, 2009

EtherCAT wiring is more flexible

EtherCAT is:

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- Industrial Ethernet ✓
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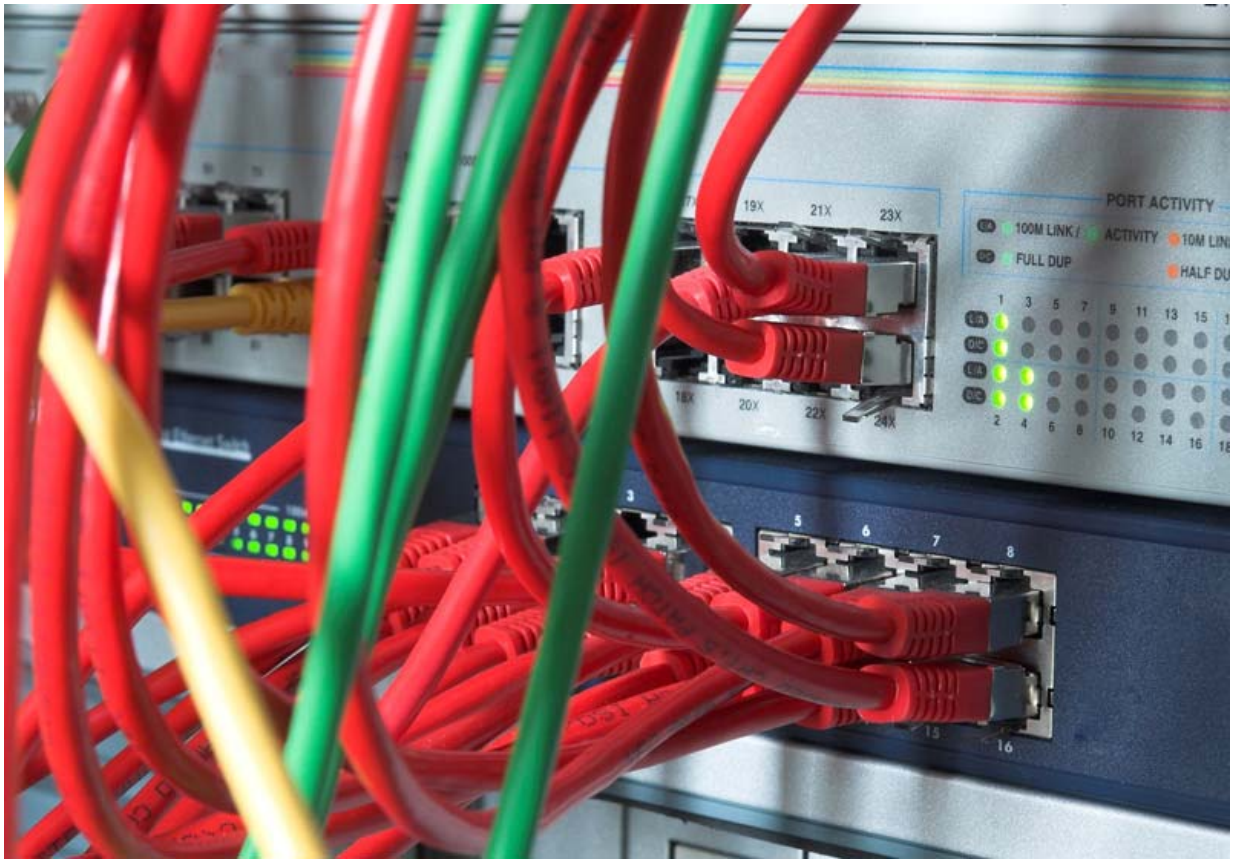
- Standard Ethernet Topology: Star



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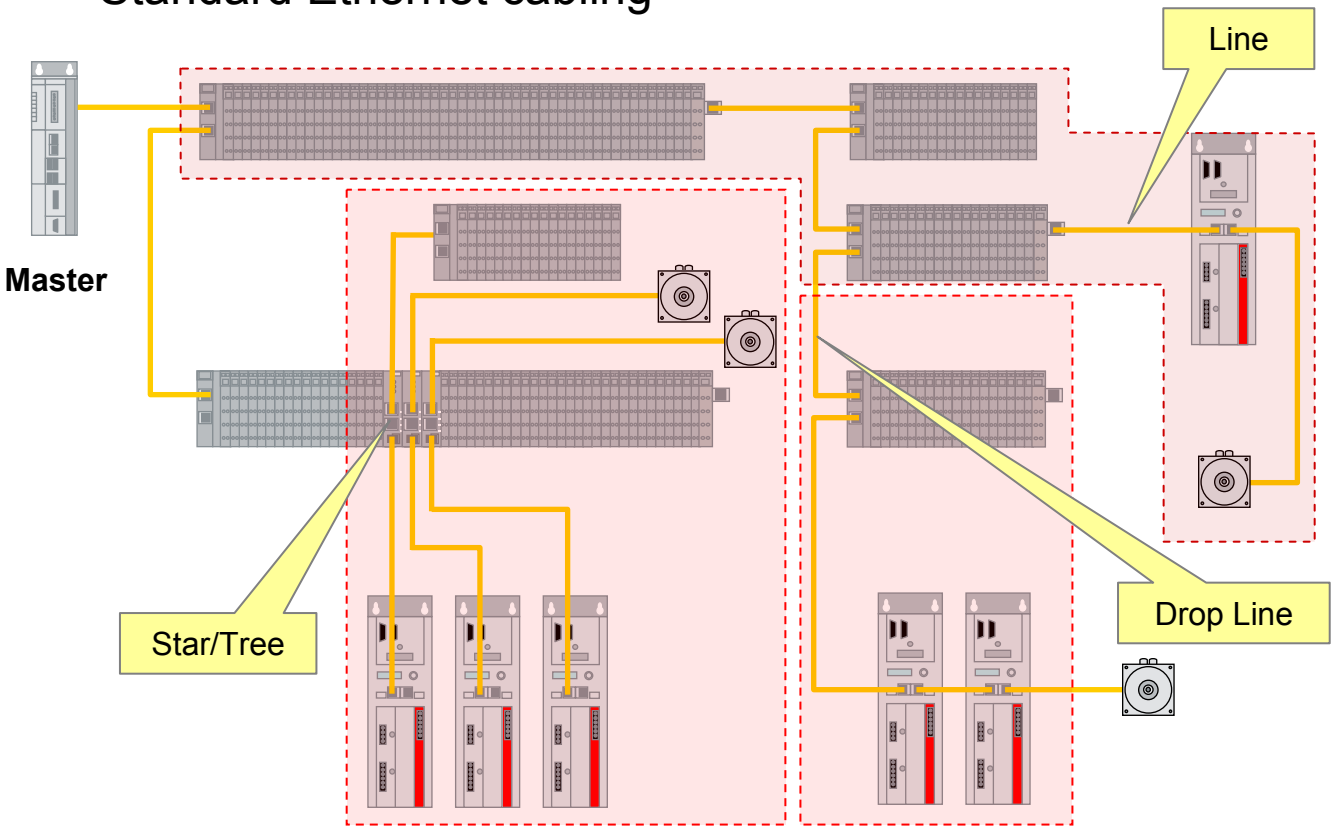
- Flexible tree structures – arbitrarily extendable
  - Topology variants like Line, Star, Tree, Daisy Chain + Drop Lines possible; can be used in any combination!
  - Up to 65.535 nodes for each EtherCAT segment
  - Standard Ethernet cabling



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EtherCAT wiring is more flexible

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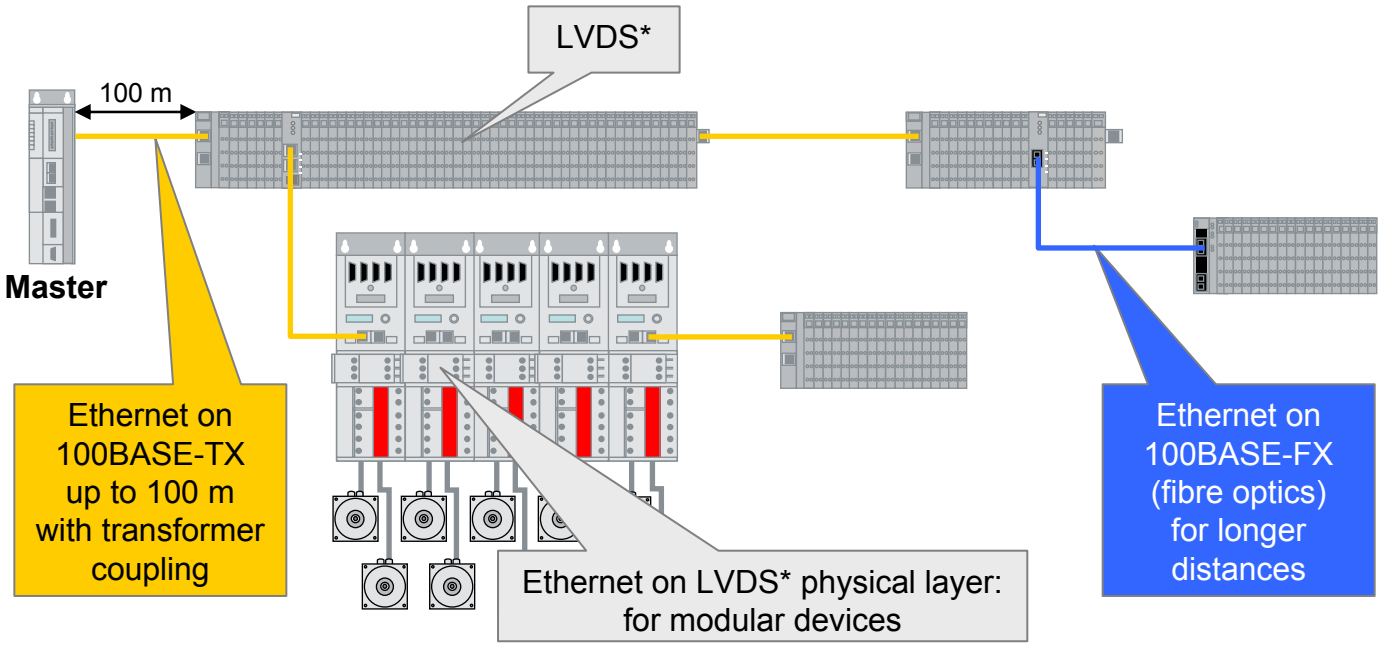
- Ethernet Signal Variants of EtherCAT:
  - 100BASE-TX (up to 100 m between 2 nodes)
  - 100BASE-FX (longer distances between 2 nodes)
  - LVDS (for modular devices)



- Any number of physical layer changes allowed

*LVDS: Low Voltage Differential Signaling according to ANSI/TIA/EIA-644, also used in IEEE 802.3ae (10Gigabit Ethernet)

© EtherCAT Technology Group, 2009

EtherCAT Extra Large System Test

EtherCAT is:

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© EtherCAT Technology Group, 2009

EtherCAT instead of PCI

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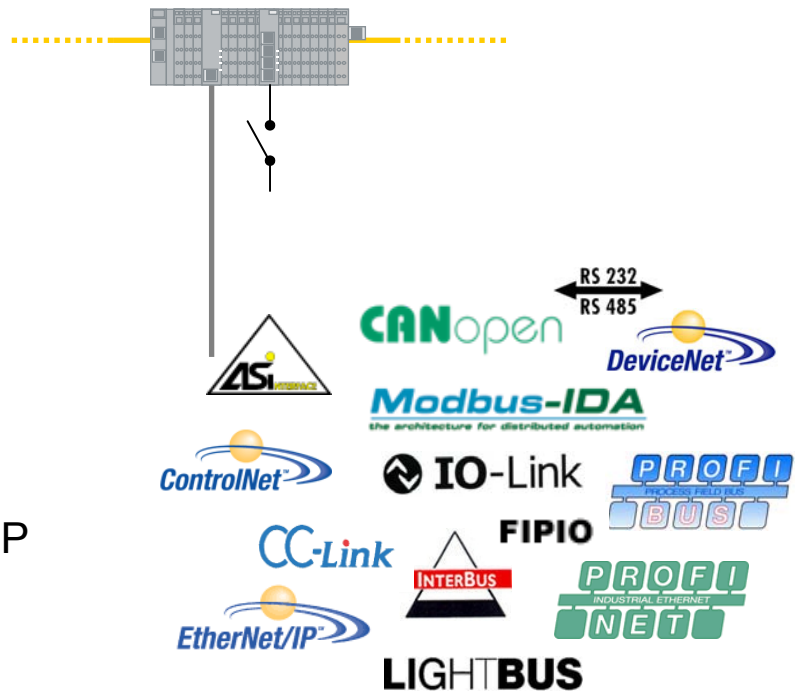
- Protection of your investment
- smooth migration path from legacy fieldbus to EtherCAT
- seamless integration of existing fieldbus devices, e.g.:
  - AS-Interface
  - CAN, CANopen
  - CC-Link
  - ControlNet
  - DeviceNet
  - Ethernet/IP
  - FIPIO
  - Interbus
  - IO-Link
  - Lightbus
  - LONWorks
  - Modbus Plus, RTU, TCP
  - MPI
  - PROFIBUS
  - PROFINET IO
  - …
- maximum system expandability with low cost fieldbus gateways



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EtherCAT instead of PCI

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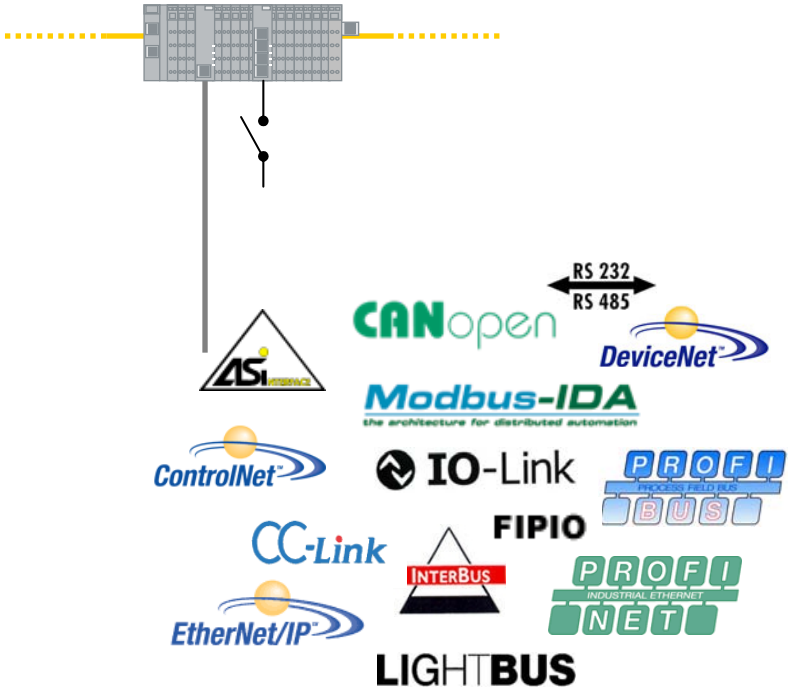
- Update Times (examples):
  - Process image update-time via PCI (**500 Bytes** input and output data each): **400 µs**
  - Process image update-time via EtherCAT (**1.500 Bytes** input and output data): **150 µs**



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EtherCAT instead of PCI

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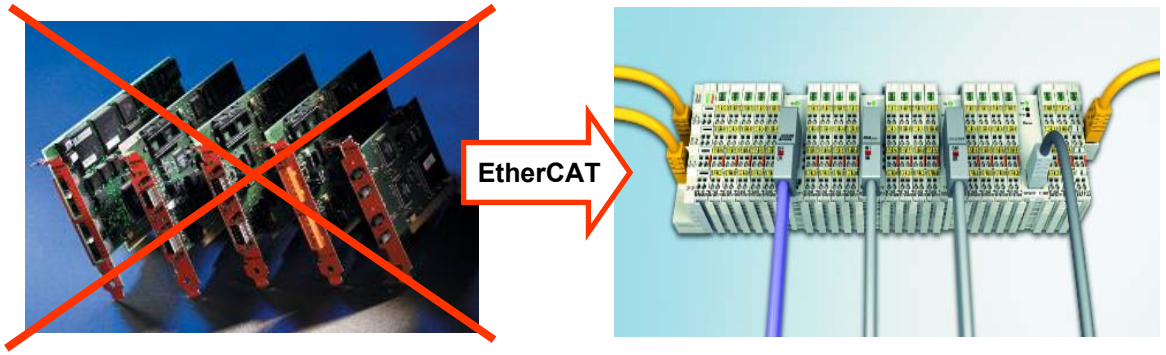
- No Slots in Control System (IPC or PLC) required any more
- Nevertheless maximum expandability



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EtherCAT is easier to configure

EtherCAT is:

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- Industrial Ethernet ✓
- Flexible ✓
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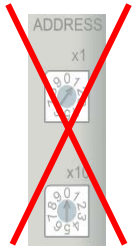
- Addressing
  - No manual address setting required
  - Addresses can be assigned automatically
  - Addresses can be kept
    - no new addressing if nodes are added



© EtherCAT Technology Group, 2009

EtherCAT is easier to configure

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- Topology:
  - Automatic topology target/actual comparison
- Diagnosis:
  - Diagnosis with exact localization
- Network planning:
  - Performance independent of:
    - Slave implementation
    - Topology (no Switches/Hubs)

© EtherCAT Technology Group, 2009

EtherCAT is lower costs (1): Engineering

EtherCAT is:

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- Synchronization ✓
- Industrial Ethernet ✓
- Flexible ✓
- Easier to configure ✓
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- Easier to implement
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- Implementation / Tools:
  - Standard Network Monitor Tools, e.g. MS Network Monitor or Wireshark: free of charge
  - Parser Software: free of charge
- Less effort for Network planning:
  - Simplified configuration
  - Default settings will work, no network tuning
- Improved Diagnosis:
  - Faster error handling leads to less downtime
- Faster Setup:
  - No address setting required

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EtherCAT is lower costs (2): Hardware

EtherCAT is:

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- Industrial Ethernet ✓
- Flexible ✓
- Easier to configure ✓
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- Easier to implement
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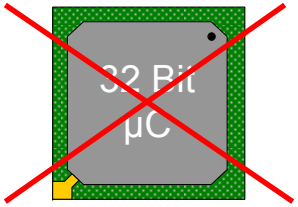
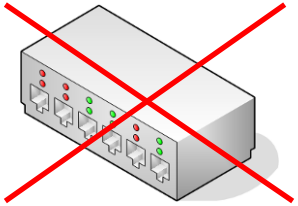
- Versatile

- Master:
  - no dedicated plug in card (co-processor)
  - on-board Ethernet Port is fine

- Slave:
  - low cost Slave Controller
    - FPGA or ASIC
  - for simple devices: no µC needed
  - no powerful µC needed



- Infrastructure:
  - no Switches/Hubs required
  - Standard Ethernet Cabling + Connectors



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EtherCAT is easier to implement: Slave

EtherCAT is:

- Faster ✓
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- Flexible ✓
- Easier to configure ✓
- Cost effective ✓
- Easier to implement
- Well proven
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- Versatile

- Slave Implementation:
  - All time critical functions implemented on ASIC or FPGA
    - ESC handles Real-time Protocol in Hardware
  - Integrated Communication State Machine
  - Network Performance independent of
    - Slave-µC Performance
    - Protocol Stack
  - For usage with or without µC (Host CPU)
    - Integrated DPRAM (1…8kByte)
    - Integrated Distributed Clock Handling
    - Ultra precise interrupts to µC

© EtherCAT Technology Group, 2009

EtherCAT Slave Controller Features: ASIC (1)

EtherCAT is:

- Faster ✓
- Synchronization ✓
- Industrial Ethernet ✓
- Flexible ✓
- Easier to configure ✓
- Cost effective ✓
- Easier to implement
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Name	ET1100 	ET1200 	netX5 
Type	ASIC	ASIC	ASIC
Hardware Supplier	BECKHOFF	BECKHOFF	hilscher COMPETENCE IN COMMUNICATION
Package	BGA128 0,8mm Pitch	QFN48 0,5mm Pitch	BGA201 0,8mm Pitch
Size	10 x 10 mm	7 x 7 mm	13 x 13 mm
µC Interface	serial/parallel (8/16-bit, async)*	serial*	serial (SPI), parallel (8/16/32-bit, async)
Digital I/O	32	8-16*	16
DPRAM	8 kByte	1 kByte	6 kByte
SyncManager	8	4	8
FMMUs	8	3	8
Distributed Clocks	Yes	Yes	Yes
No. Of Ports	2-4 (MII/E-bus)*	2-3 (E-bus/max. 1xMII)*	2 (MII)
Specials	Routable with standard PCB	-	Multi Protocol Support

* configurable

© EtherCAT Technology Group, 2009

EtherCAT Slave Controller Features: ASIC (2)

EtherCAT is:

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- Synchronization ✓
- Industrial Ethernet ✓
- Flexible ✓
- Easier to configure ✓
- Cost effective ✓
- Easier to implement
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- Safety
- Redundancy
- Versatile

Name	netX 100	netX 500	netX50
Type	ASIC	ASIC	ASIC
Hardware Supplier	hilscher	hilscher	hilscher
Package	BGA345 1mm Pitch	BGA345 1mm Pitch	PBGA 1mm Pitch
Size	22x22 mm	22x22 mm	19x19 mm
µC Interface	µC-Bus (internal, 32-bit)	µC-Bus (internal, 32-bit)	µC-Bus (internal, 32-bit)
Digital I/O	16 (GPIO)	16 (GPIO)	32 (GPIO)
DPRAM	256/400 Byte (Mailbox/Process Data)	256/400 Byte (Mailbox/Process Data)	6 kByte
SyncManager	4	4	8
FMMUs	3	3	8
Distributed Clocks	Yes	Yes	Yes
No. Of Ports	2 (100BASE-TX)	2 (100BASE-TX)	2 (100BASE-TX)
Specials	Multi Protocol Support, Integrated: PHYs, ARM-9 µC	Multi Protocol Support, Integrated: PHYs, ARM-9 µC	Multi Protocol Support, Integrated: PHYs, ARM-9 µC

© EtherCAT Technology Group, 2009

EtherCAT Slave Controller Features: FPGA

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Name	ET1810/ET1811/ET1812	ET1815/ET1816/ET1817
Type	FPGA + IP Core	FPGA + IP Core
Hardware Supplier	ALTERA	XILINX
Supported Chips	Cyclone I+II+III, Stratix I+II+III+IV+GX+II GX, Arria GX	Spartan 3+3E+3A+3AN+3ADSP, Virtex II+II Pro+II Pro X+4+5
Package	FPGA dependent	FPGA dependent
Size	FPGA dependent	FPGA dependent
µC Interface	serial/parallel (8/16-bit, async) AVALON®*	serial/parallel (8/16bit, async) OPB®*
Digital I/O	8-32*	8-32*
DPRAM	1...60 kByte*	1...60 kByte*
SyncManager	0…8*	0…8*
FMMUs	0…8*	0…8*
Distributed Clocks	Yes*	Yes*
No. Of Ports	2 (MII)	2 (MII)
Specials	Several IP Core License models available	Several IP Core License models available

* configurable

© EtherCAT Technology Group, 2009

EtherCAT is easier to implement: Master

EtherCAT is:

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- Easier to implement
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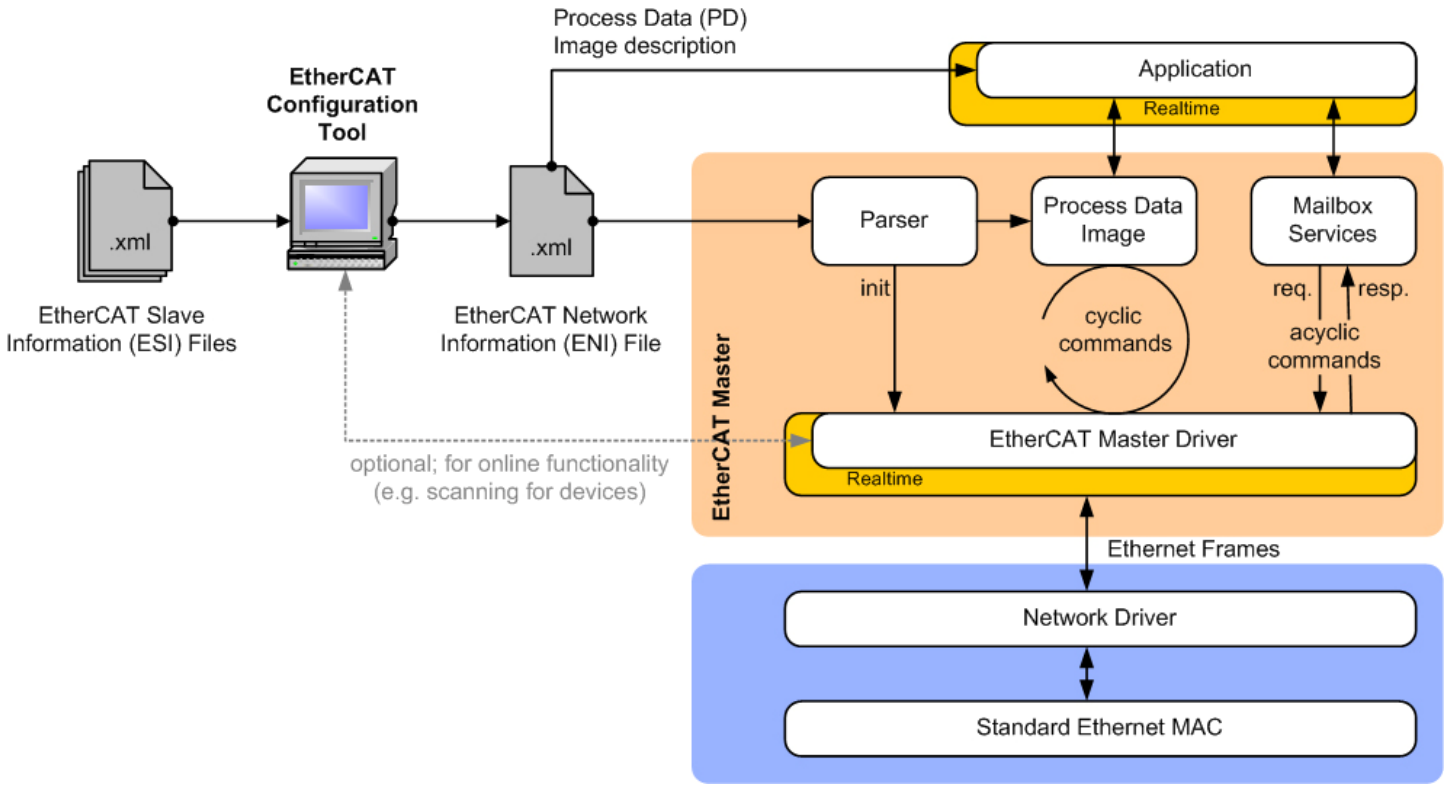
- Master Implementation:
  - e.g. with Master Sample Code (Source)
  - EtherCAT Configuration Tool
  - XML Data format of ESI and ENI



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EtherCAT is easier to implement: Master

EtherCAT is:

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- Cost effective ✓
- Easier to implement ✓
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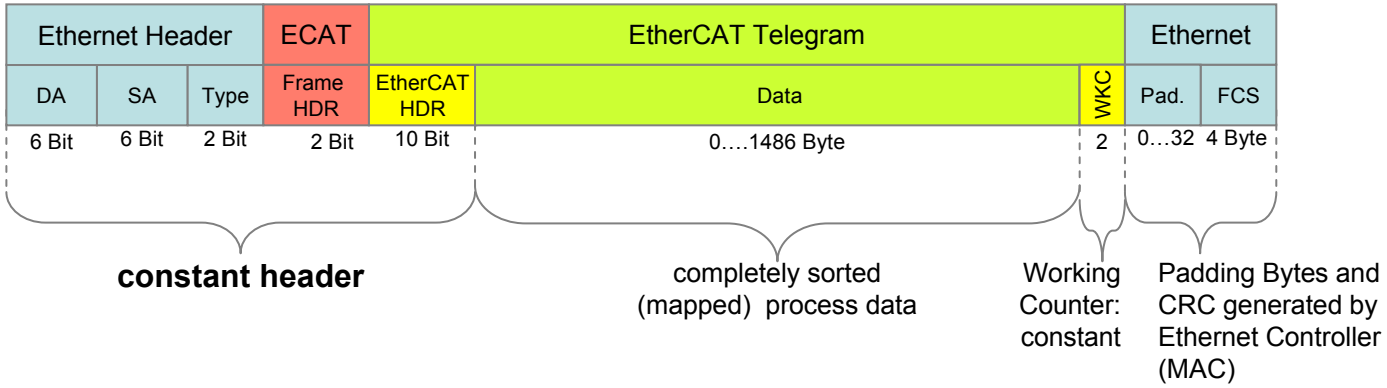
- Example: Master with just one process image
  - typical e.g. for small controllers with one control task
  - up to 1488 Byte Process data size
  - Header for Process Data communication remains constant



  - Master can be implemented with minimal effort
  - No separate communication processor required (e.g. on plug-in card)
  - Much simpler that legacy fieldbus systems
  - Very much simpler than competing Industrial Ethernet approaches…

© EtherCAT Technology Group, 2009

EtherCAT is well proven

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- Versatile

- In series production since 2003
- Numerous applications
- Great product variety of available EtherCAT products

© EtherCAT Technology Group, 2009

EtherCAT Architecture + Device Profiles

EtherCAT is:

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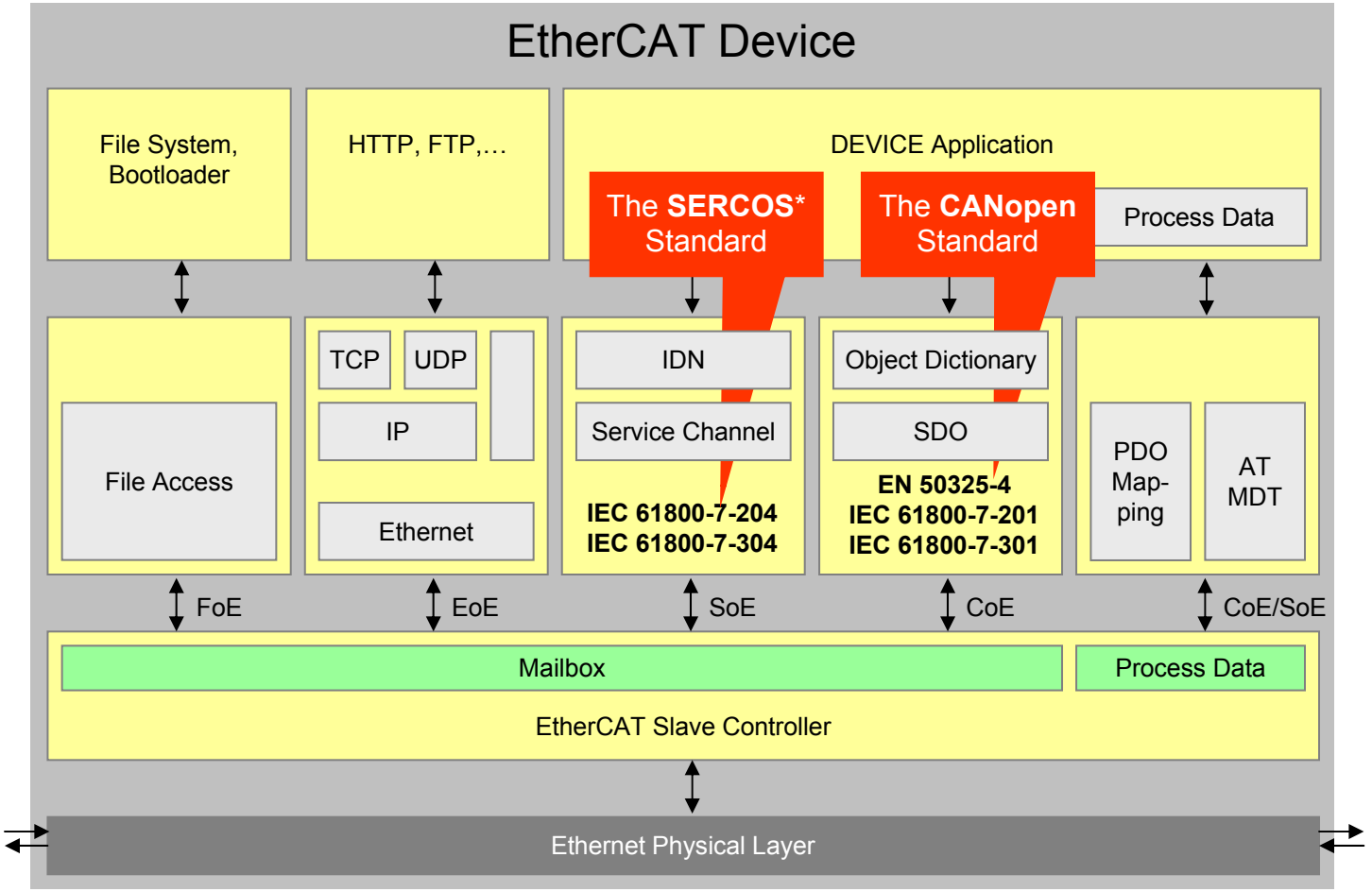

*SERCOS interface™ is a trademark by SI e.V.

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Typical EtherCAT Device Architecture

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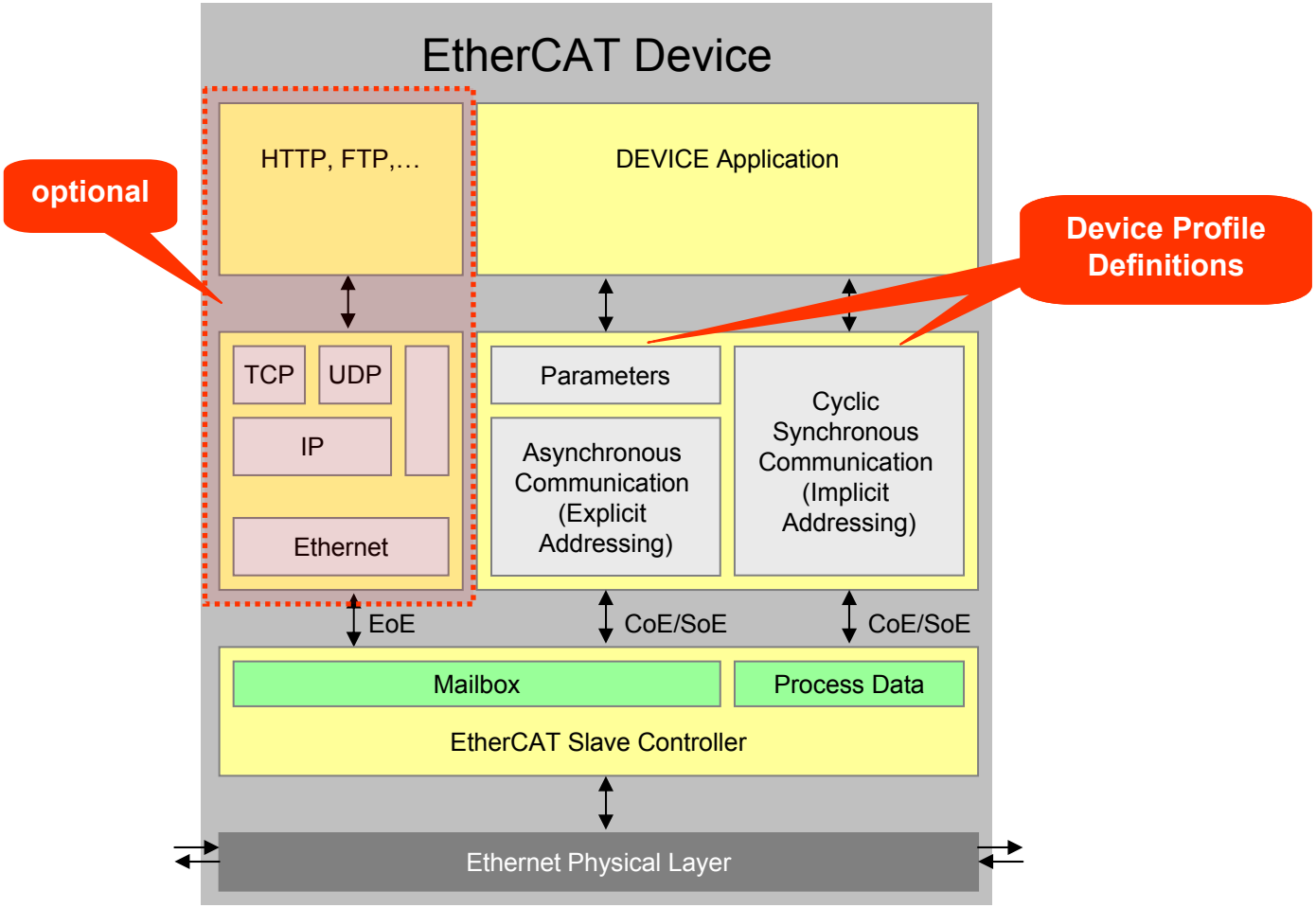

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IEC 61491 EtherCAT Servodrive Architecture

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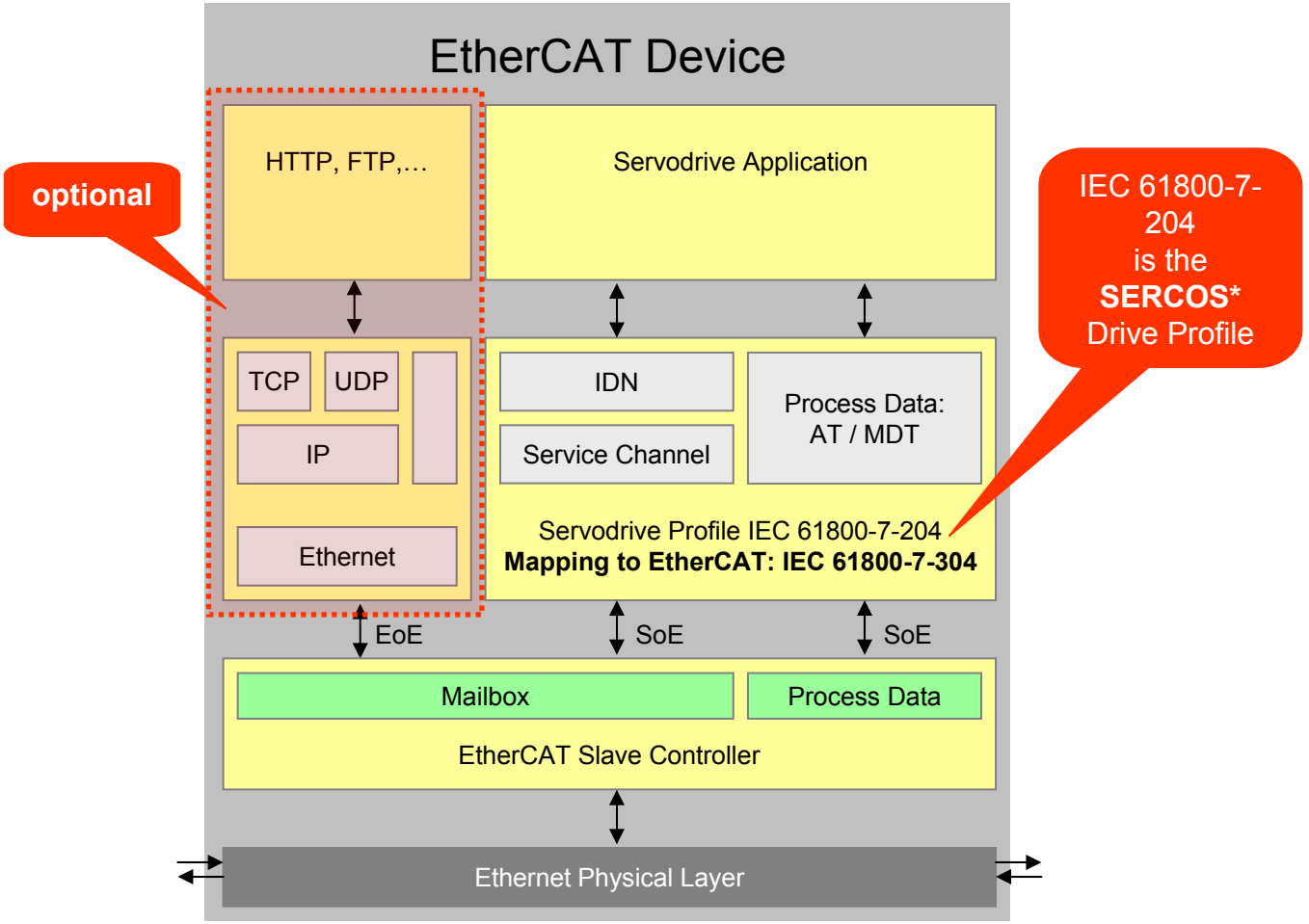

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EtherCAT in IEC 61800-7

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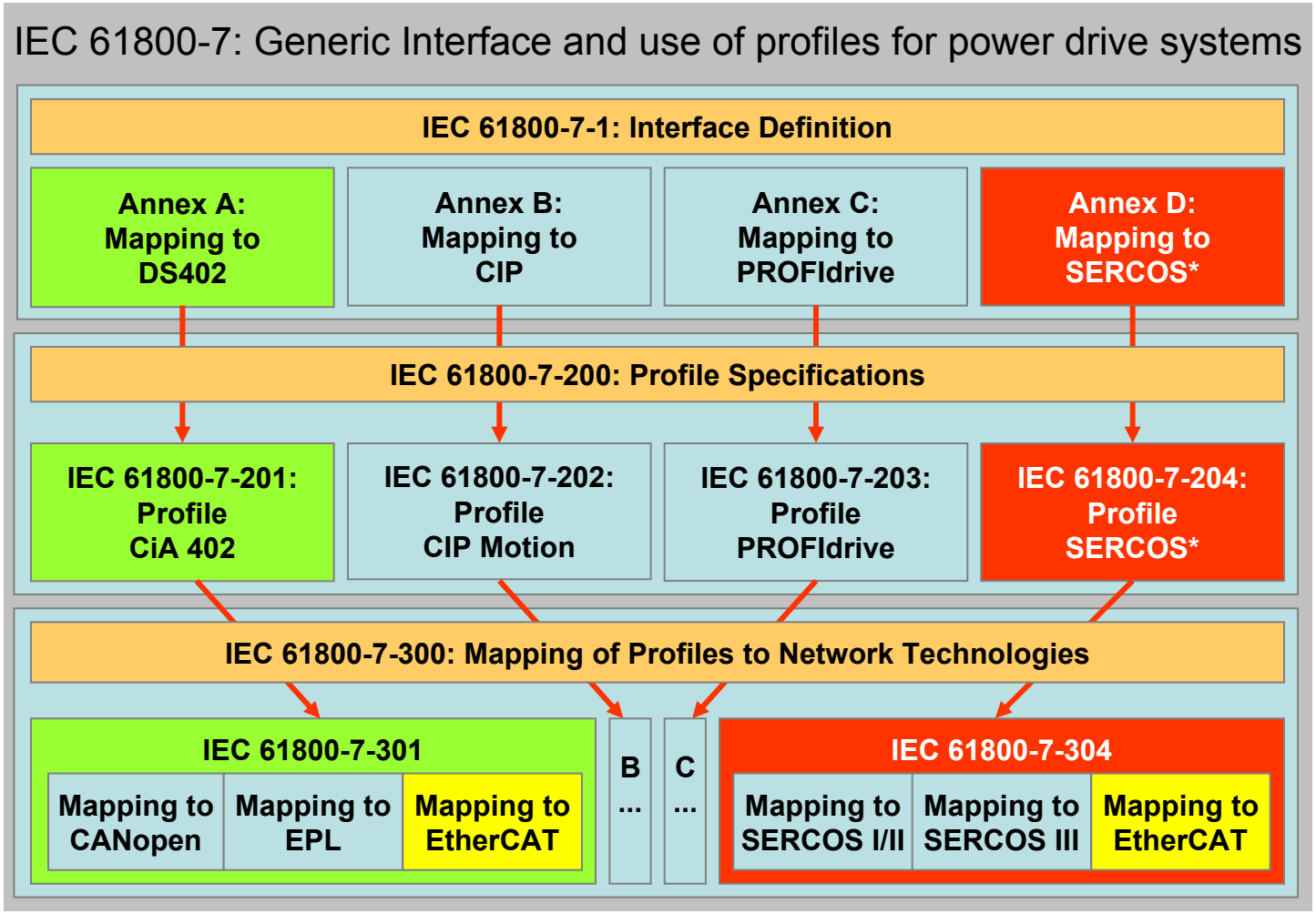

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EtherCAT is an open technology

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- Foundation: November 2003
- Tasks: Support, Advancement and Promotion of EtherCAT
- The worlds largest organization dedicated to Industrial Ethernet
- more than 940* member companies from 45 countries in 6 continents:
  - Device Manufacturers
  - End Users
  - Technology Providers
- Membership is open to everybody

*as of Feb 2009

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- Protocol is disclosed completely:
  - EtherCAT is IEC, ISO and SEMI Standard (IEC 61158, IEC 61784, ISO 15745, SEMI E54.20)

IEC Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

ISO

- Slave Controller from several sources available
- Slave Controller provides interoperability
- ETG organizes Interoperabilitly Testing („Plug Fests“), Workshops and Seminars
- Conformance Testing + Certificates

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- Master Stacks for various RTOS available*, including Open / Shared Source!
  - eCos
  - Intime
  - Linux with RT-Preempt
  - MICROWARE OS-9
  - On Time RTOS-32
  - PikeOS
  - Proconos OS
  - Real-Time Java
  - RMOS
  - RT Kernel
  - RT-Linux
  - RTXC Quadros
  - RTAI Linux
  - QNX
  - VxWin + CeWin
  - VxWorks
  - Windows CE
  - Windows XP/XPE with CoDeSys SP RTE
  - Windows XP/XPE with TwinCAT RT-Extension
  - XENOMAI Linux

*as of May 2009

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EtherCAT Technology Group and IEC

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- Management Board of IEC has approved Liaison of EtherCAT Technology Group with IEC SC65C WG 11/12/13 + JWG10 (SC65C: Digital Communication)

IEC
Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

- Thus ETG is official IEC Standardization Partner

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ETG Team Worldwide

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ETG Membership Development

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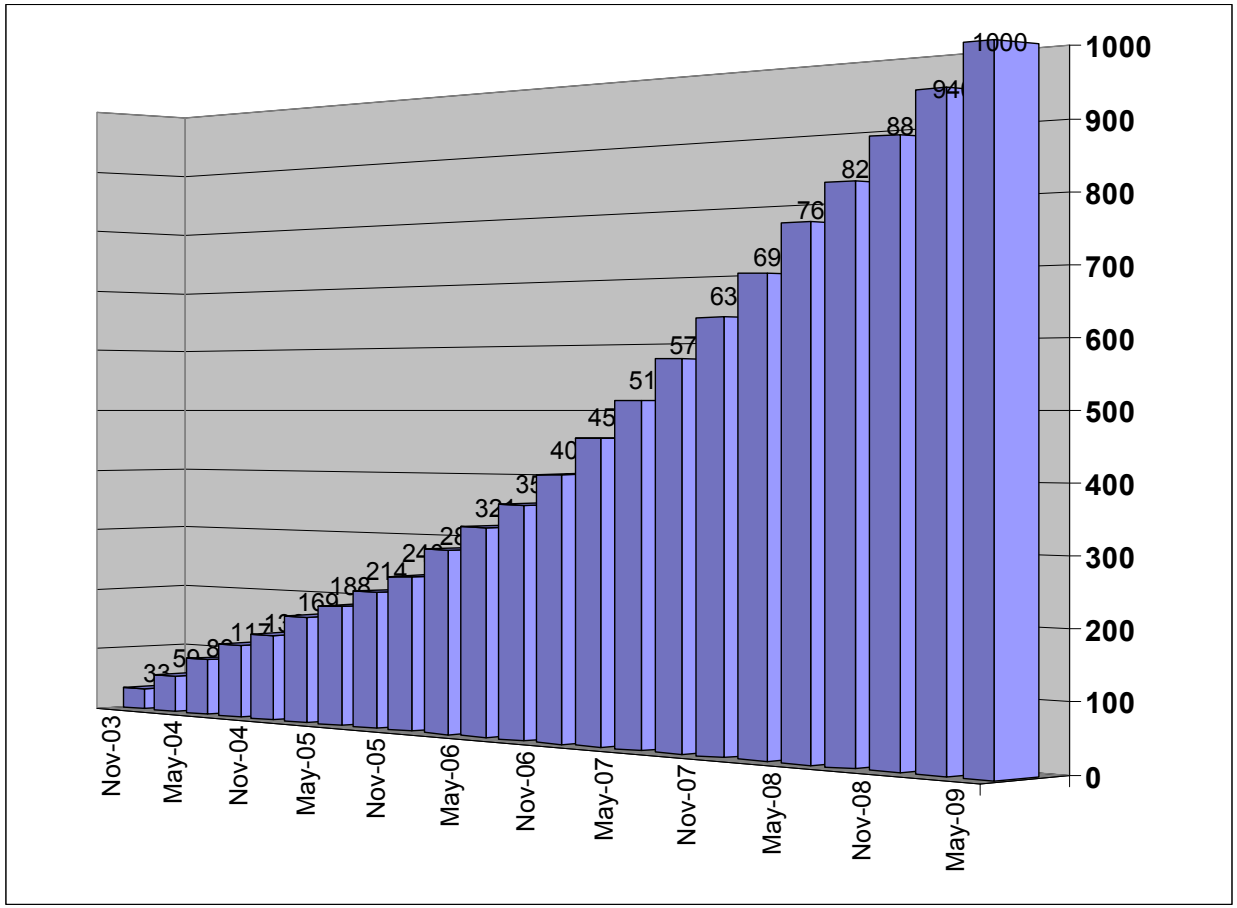
- As of April 2009: 1000 Members



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Members from 45* Countries, 6 Continents

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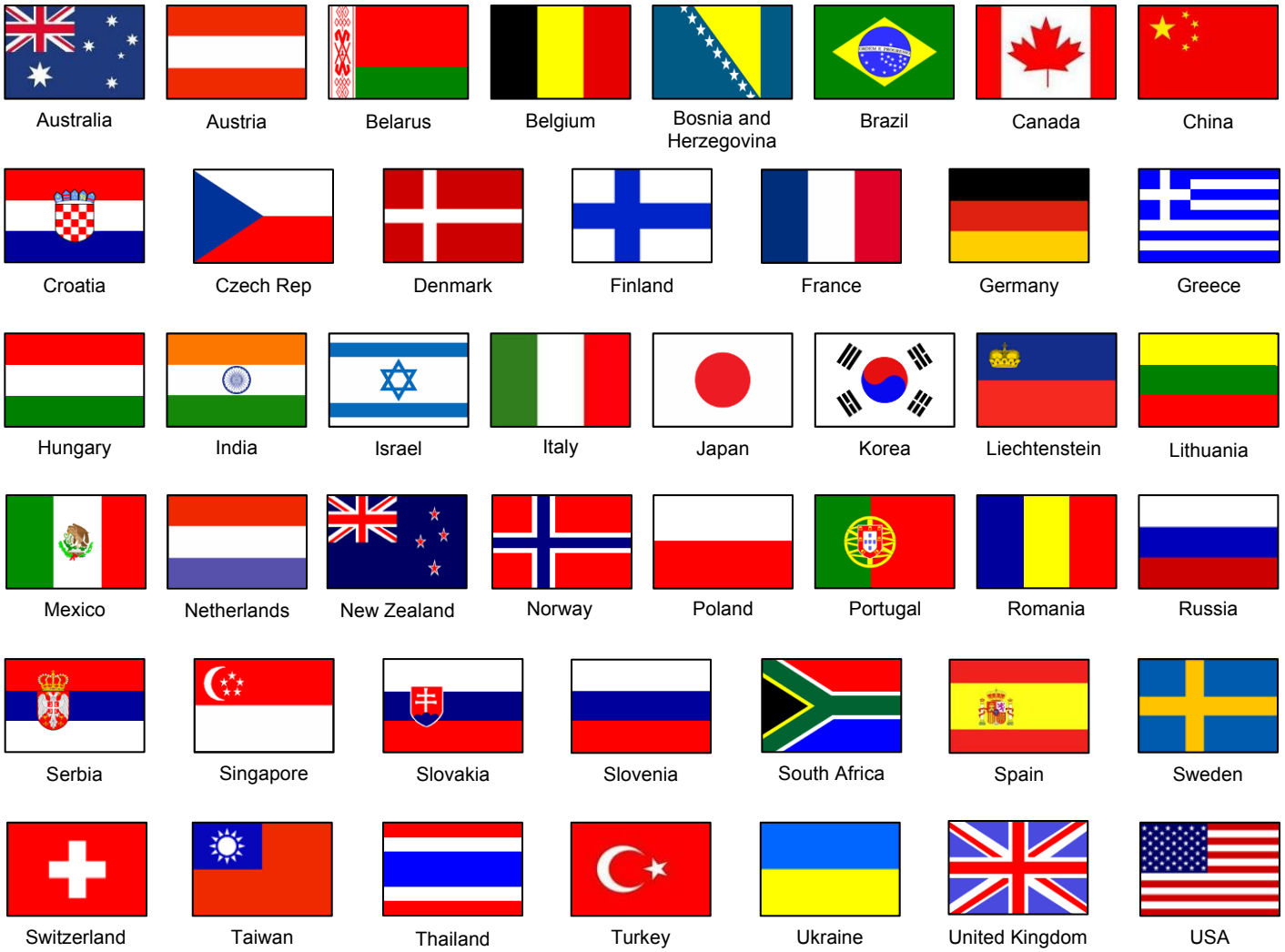

*as of April 2009

© EtherCAT Technology Group, 2009

ETG: Active Members

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- Versatile

- Much more important than membership figures: How many are active, how many implement the technology?
- Dec 2008: More than **690 Implementation Kits** sold to ETG Members (25% Master, 75% Slaves), plus there are Open + Shared Source masters!
- SPS/IPC/Drives 2008: 60 Vendors with over 180 different EtherCAT Devices at ETG booth:
  - 25 different drives from 16 manufacturers jointly operating in one network
  - 15 different functional Masters in one setup, using 10 different operating systems
  - Safety devices (master + slave devices) from 2 manufacturers operating in one system
  - Master to Master and redundancy live demo

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EtherCAT: Large Product Selection

EtherCAT is:

- Faster ✓
- Synchronization ✓
- Industrial Ethernet ✓
- Flexible ✓
- Easier to configure ✓
- Cost effective ✓
- Easier to implement ✓
- Well proven ✓
- Open
- Conformance
- Safety
- Redundancy
- Versatile

I/O, Controller, HMI, Servo Drives, Variable Speed Drives
Sensors, Slave + Master Development Kits
Control Panels, Hydraulic Valves
and Pneumatic Valves,
…

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Conformance and Interoperability

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EtherCAT® Conformance tested

- Conformance and interoperability are very important factors for the success of a communication technology
  - Conformity to the specification is an obligation to all users of the EtherCAT technology
  - Therefore the **EtherCAT Conformance Test Tool** (CTT) is used
  - Test Cases for the CTT are provided by the Working Group „Conformance“ within the ETG community
  - The **EtherCAT Conformance Test** proves conformance officially with issuing a certificate after passing the test at an offical **EtherCAT Test Center** (ETC)

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Safety over EtherCAT: Features (1)

EtherCAT is:

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Safety over EtherCAT®

- Safety over EtherCAT (FSoE) defines a safety communication layer for the transportation of safety process data between Safety over EtherCAT devices.
- FSoE is an open technology within the EtherCAT Technology Group (ETG).
- The protocol is developed according to IEC 61508
  - It meets the Safety Integrity Level (SIL) 3
  - Residual Error Probability R(p) < 10^{-9}
- The protocol is approved by an independent Notified Body (TÜV)

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Safety over EtherCAT: Features (2)

EtherCAT is:

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- Open ✓
- Conformance ✓
- Safety
- Redundancy
- Versatile

Safety over EtherCAT®

- FSoE Frame is mapped in the cyclic PDOs
  - Minimum FSoE Frame-Length: 6 Byte
  - Maximum FSoE Frame-Length: depending on the number of safe process data of the Slave Device
  - Therefore the protocol is suitable for safe I/O as well as for functional safe motion control
- Confirmed transfer from the FSoE Master to the FSoE Slave and vice versa.
- Safe Device Parameter can be downloaded from the Master to the Slave at Boot-Up of a FSoE Connection
- Certified products with Safety over EtherCAT are available since 2005.

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Safety over EtherCAT: Features (3)

EtherCAT is:

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- Well proven ✓
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Safety over EtherCAT®

- The FSoE specification has no restrictions according to:
  - Communication layer and interface
    The communication layer is not part of the safety measures: black channel
    (assumed unsolved bit error rate: $p = 10^{-2}$)
  - Transmission speed
  - Length of safe process data
    (lenght of safe process data is arbitrary)
- Routing via unsafe gateways, fieldbus systems or backbones is possible

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Safety over EtherCAT: Routing

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- Cost effective ✓
- Easier to implement ✓
- Well proven ✓
- Open ✓
- Conformance ✓
- Safety
- Redundancy
- Versatile

Safety over EtherCAT®

- Can be routed via non-safe gateways
- Can be routed via fieldbus systems
- One Safety technology for (almost) all bus systems

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Safety over EtherCAT: Software Architecture

EtherCAT is:

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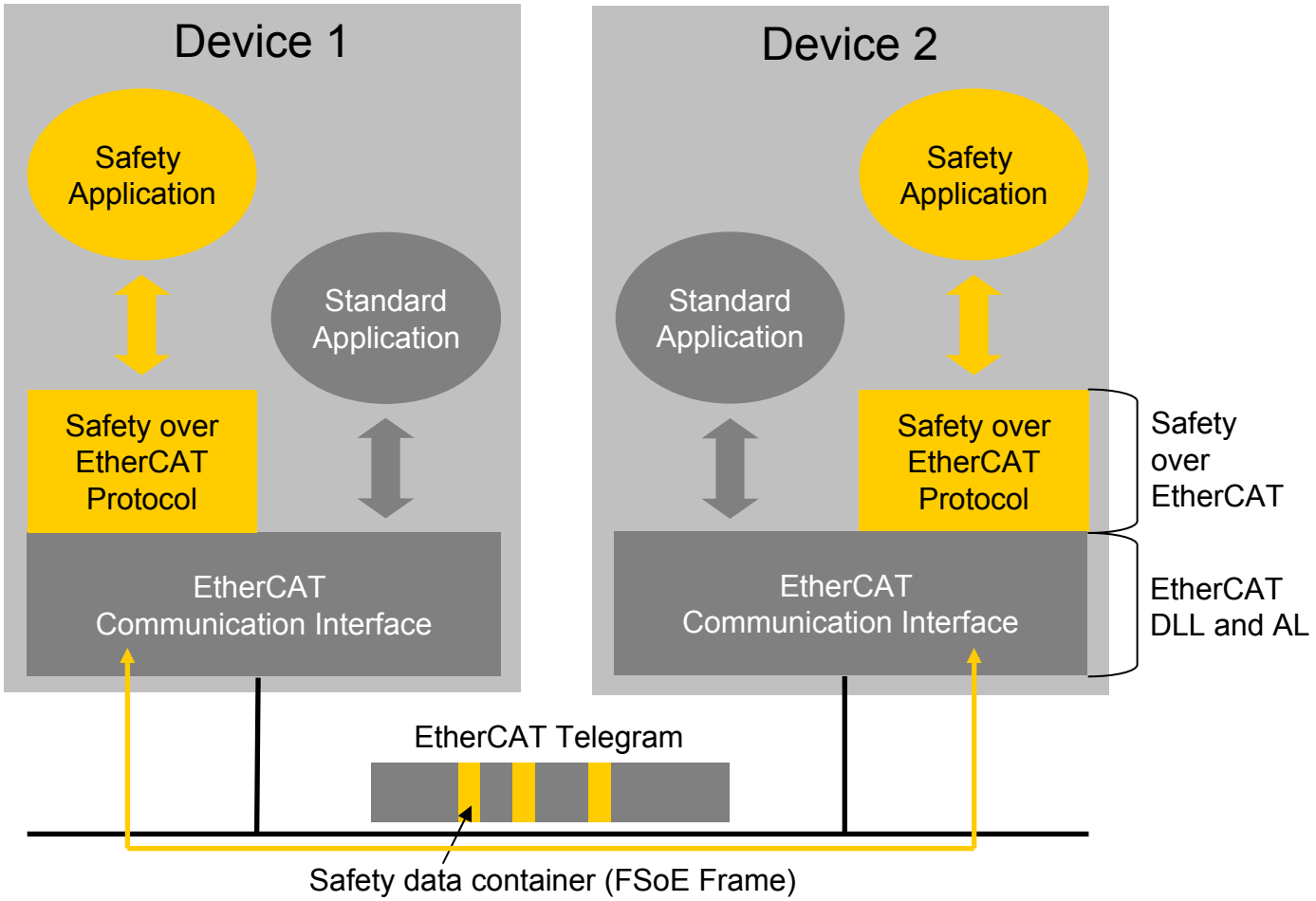
- Black channel approach
  - with safety and non-safety data on the same bus



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Safety over EtherCAT: Hardware Architecture

EtherCAT is:

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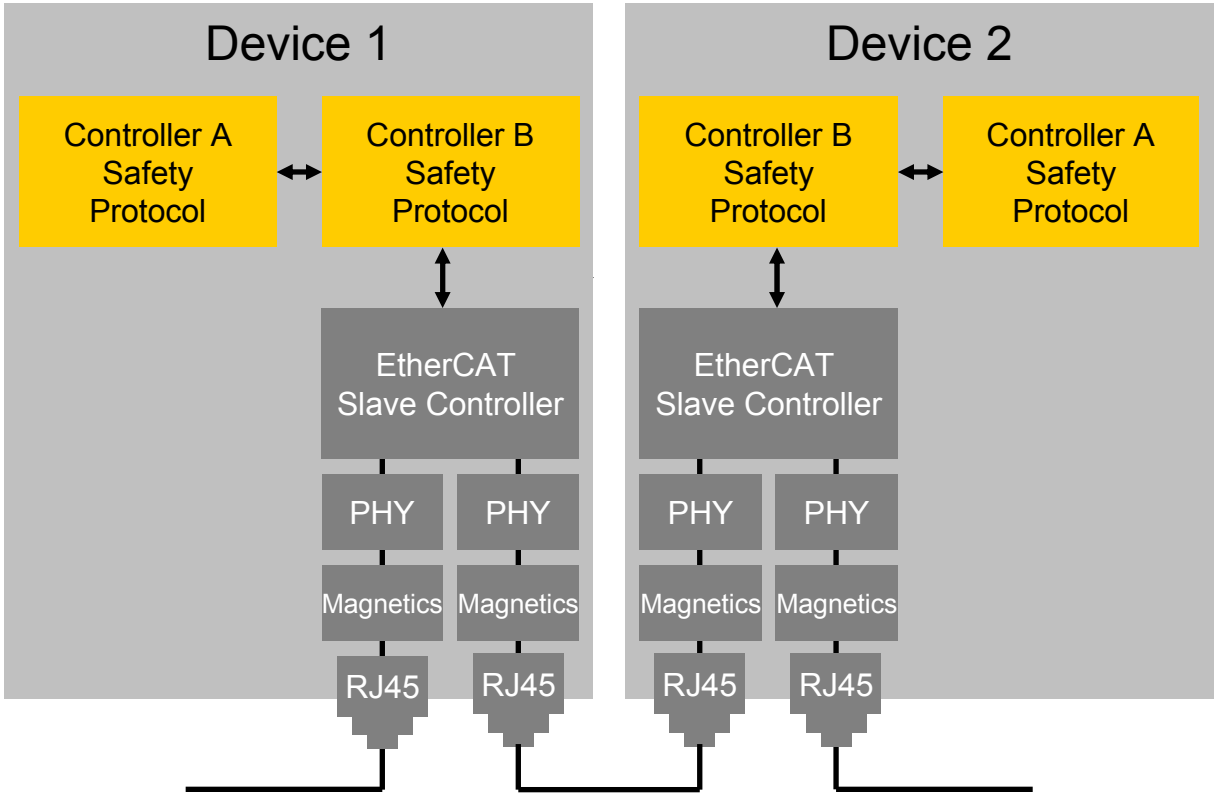
- Versatile

- One channel communication system
  - Model A according to IEC 61784-3 Annex A



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Safety over EtherCAT: Frame Structure

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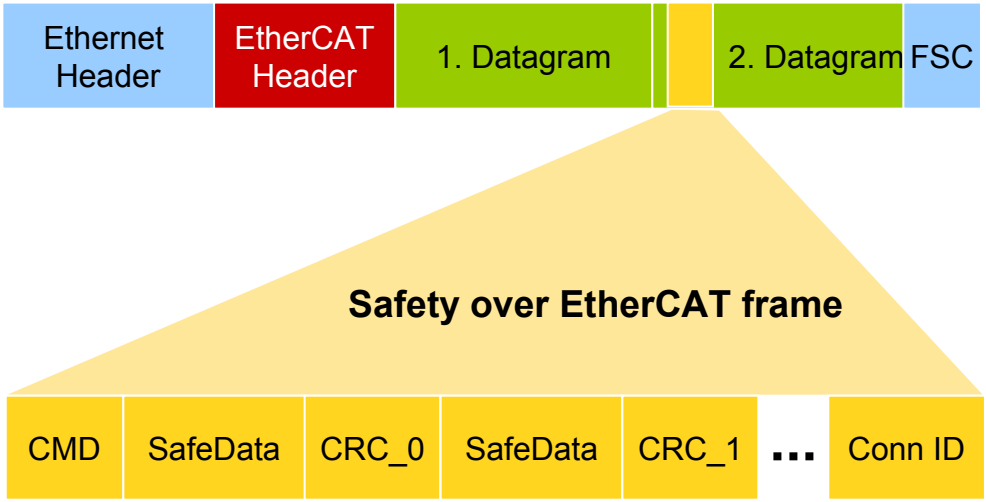
- Ethernet telegram



  - Safety over EtherCAT frame
    - The FSoE Frame is a data container mapped in the process data of the devices
    - A new FSoE Frame is recognized if at least one bit has changed according to the last frame
    - For every 2 Byte SafeData a 2 Byte CRC is calculated
    - Up to n Byte SafeData can be transmitted

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Safety over EtherCAT: Safety Measures

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Error \ Measure	Sequence Number	Watchdog	Connection ID	CRC Calculation
Unintended repetition	☑			☑
Loss	☑	☑		☑
Insertion	☑			☑
Incorrect sequence	☑			☑
Corruption				☑
Unacceptable delay		☑		
Masquerade		☑		☑
Repeating memory errors in Switches	☑			☑
Incorrect forwarding between segments			☑	

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Safety over EtherCAT: Implementation Example

EtherCAT is:

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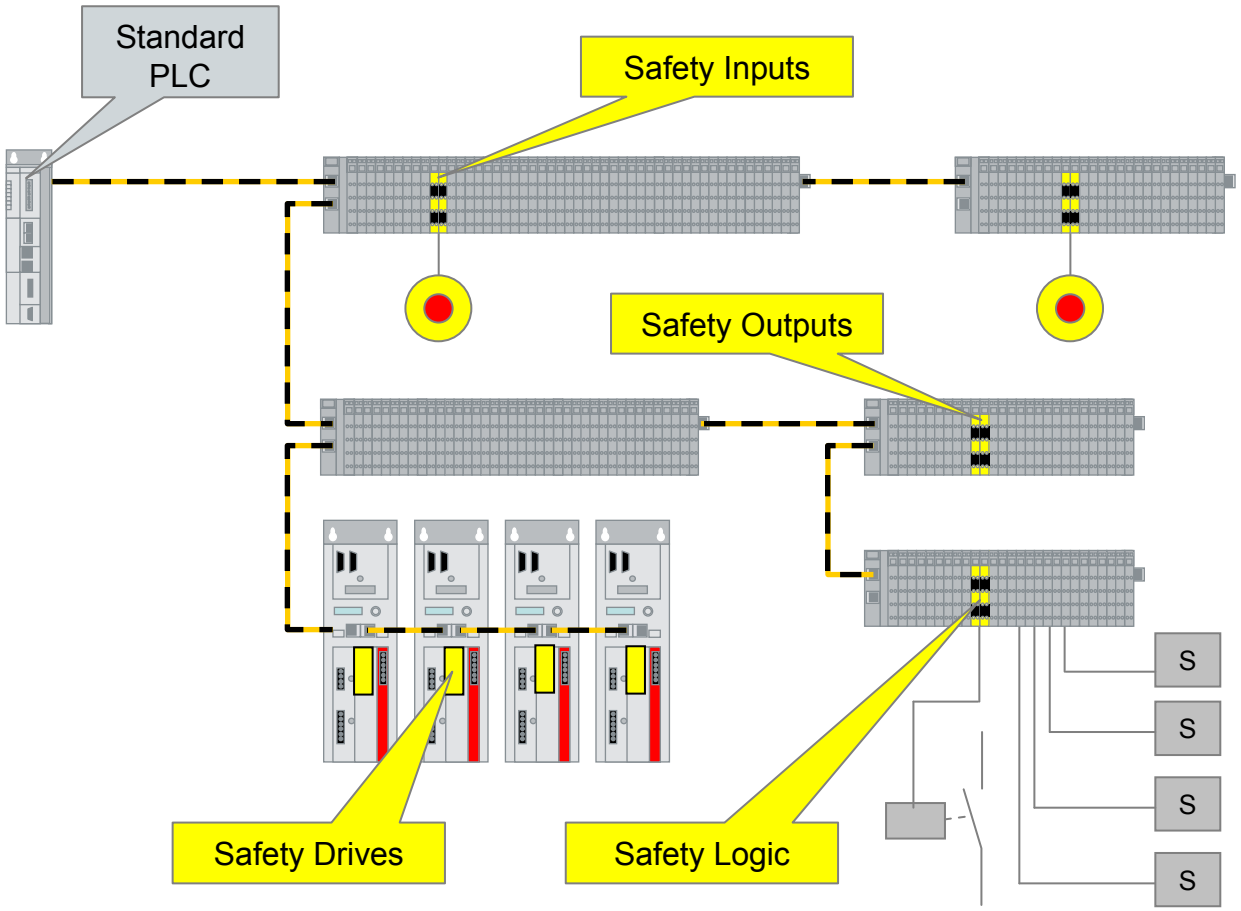
- Decentralized Safety-Logic
- Standard PLC routes the safety messages



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Safety over EtherCAT: Advantages

EtherCAT is:

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- Cost effective ✓
- Easier to implement ✓
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- Safety
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- Versatile

- Fully integrated solution:
  - safe and standard communication in one channel
- Reduction of fieldbuses and interfaces
- Central configuration, diagnosis and maintenance for safe and ‚unsafe' I/O in one tool
- Safety application makes full use of EtherCAT advantages:
  - Short reaction times
  - Almost unlimited number of nodes
  - Large network extensions
  - Cable redundancy options
  - High Flexibility with Hot Connect

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EtherCAT: High availability

EtherCAT is:

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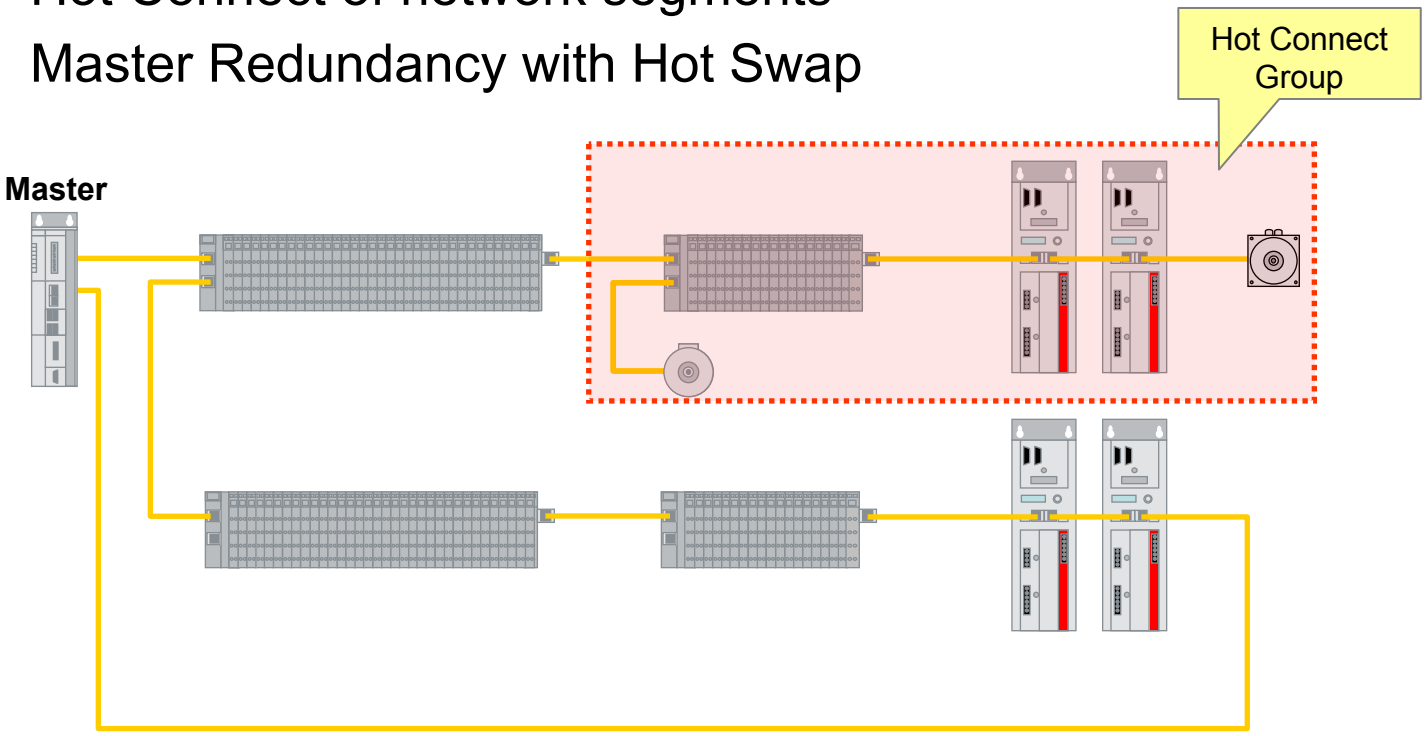
- Redundancy
- Versatile

- Cabling redundancy
  - 2nd Ethernet port needed on master side only
- Hot Swap of devices
- Hot Connect of network segments
- Master Redundancy with Hot Swap



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Without Redundancy: Normal Operation

EtherCAT is:

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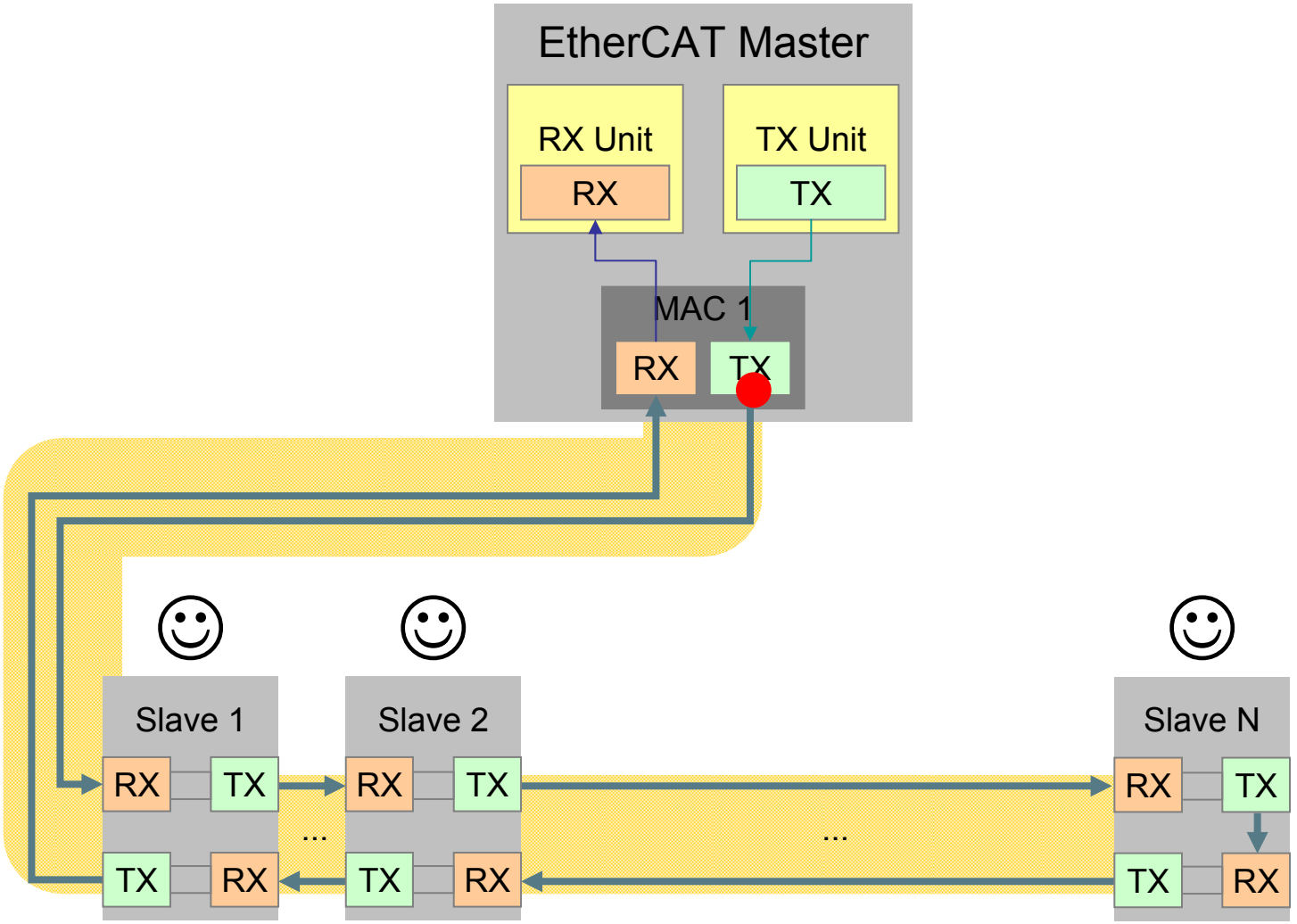

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Without Redundancy: Cable Failure

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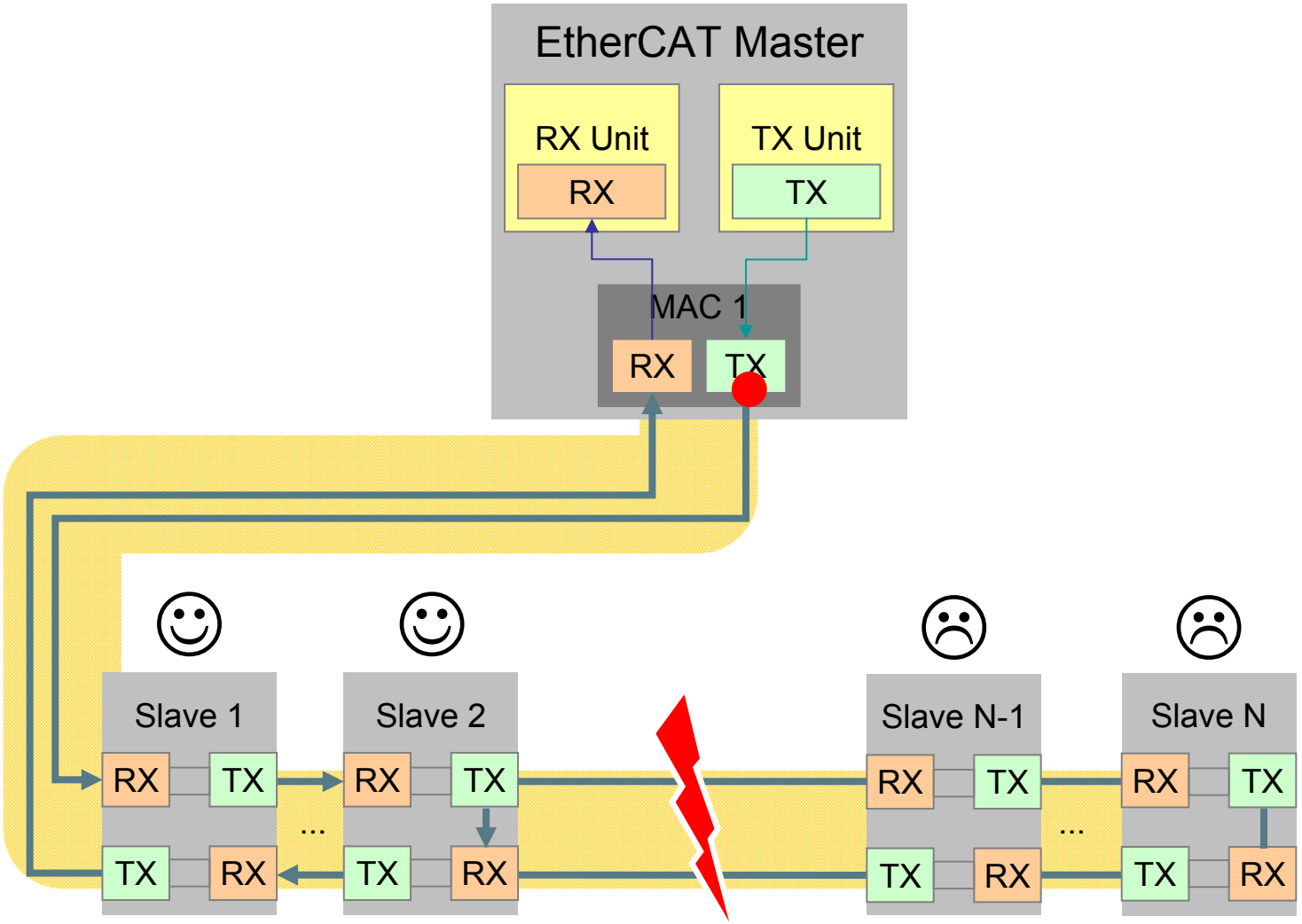

© EtherCAT Technology Group, 2009

Without Redundancy: Node Failure

EtherCAT is:

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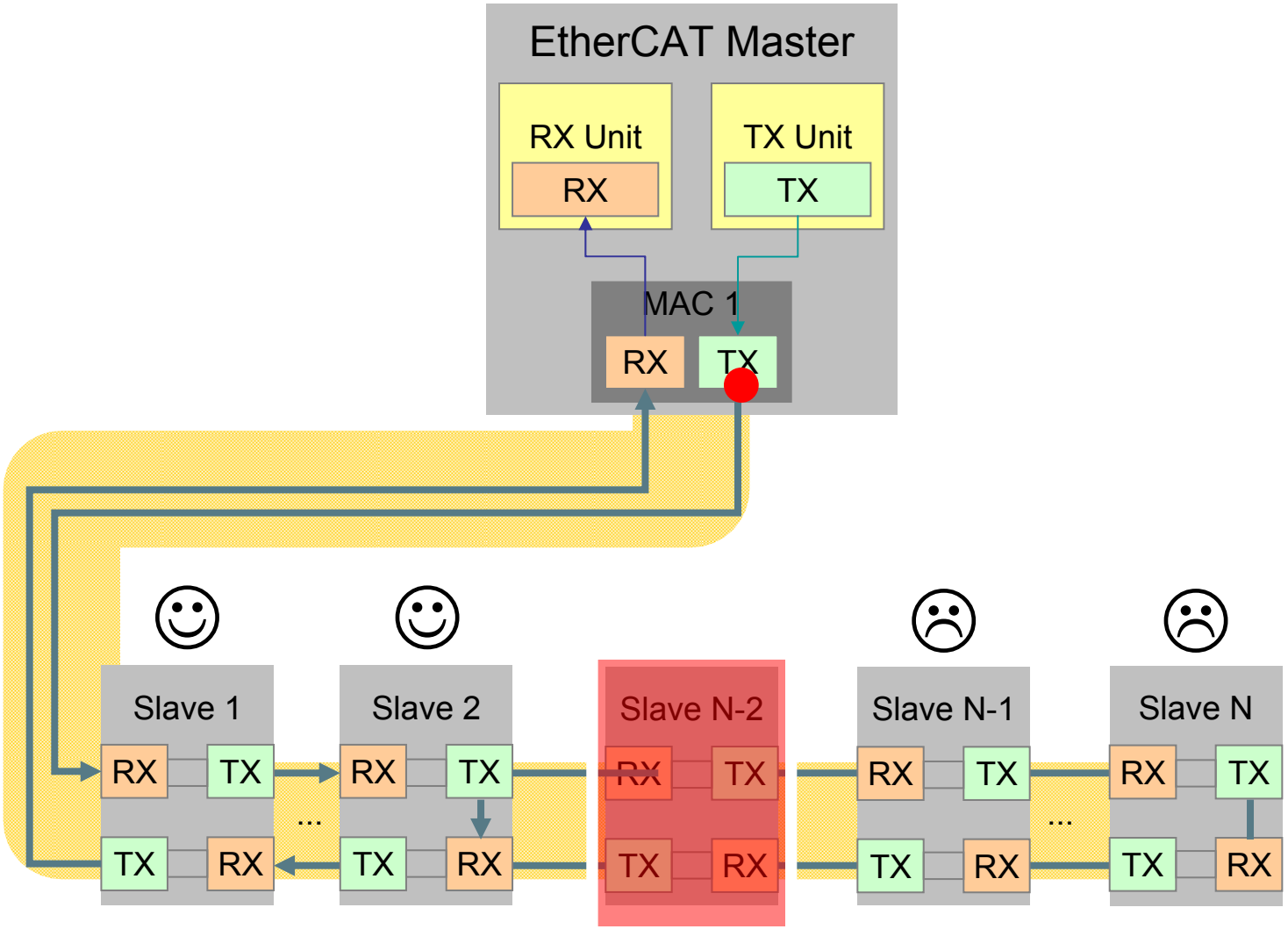

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With Redundancy: Normal Operation

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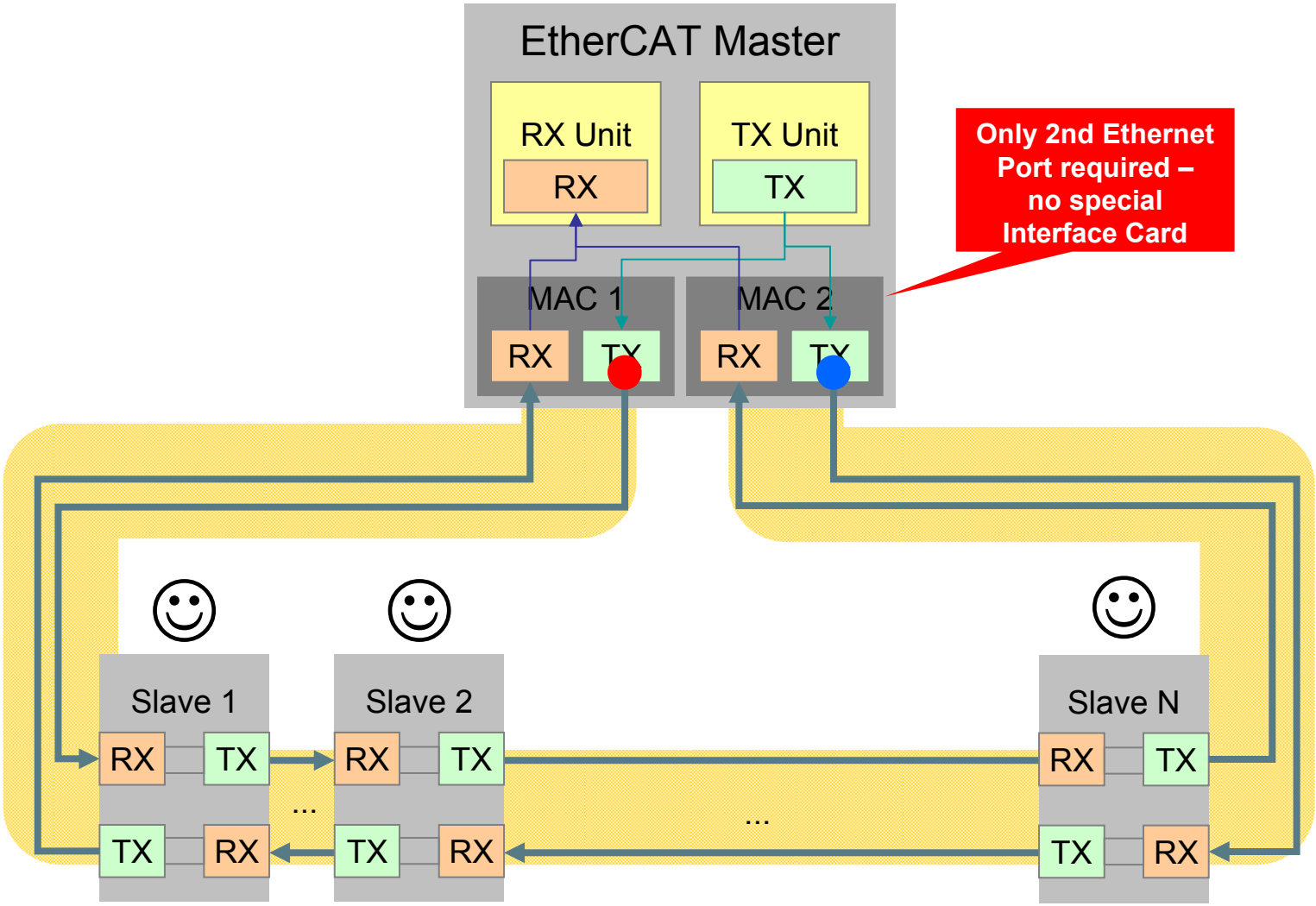

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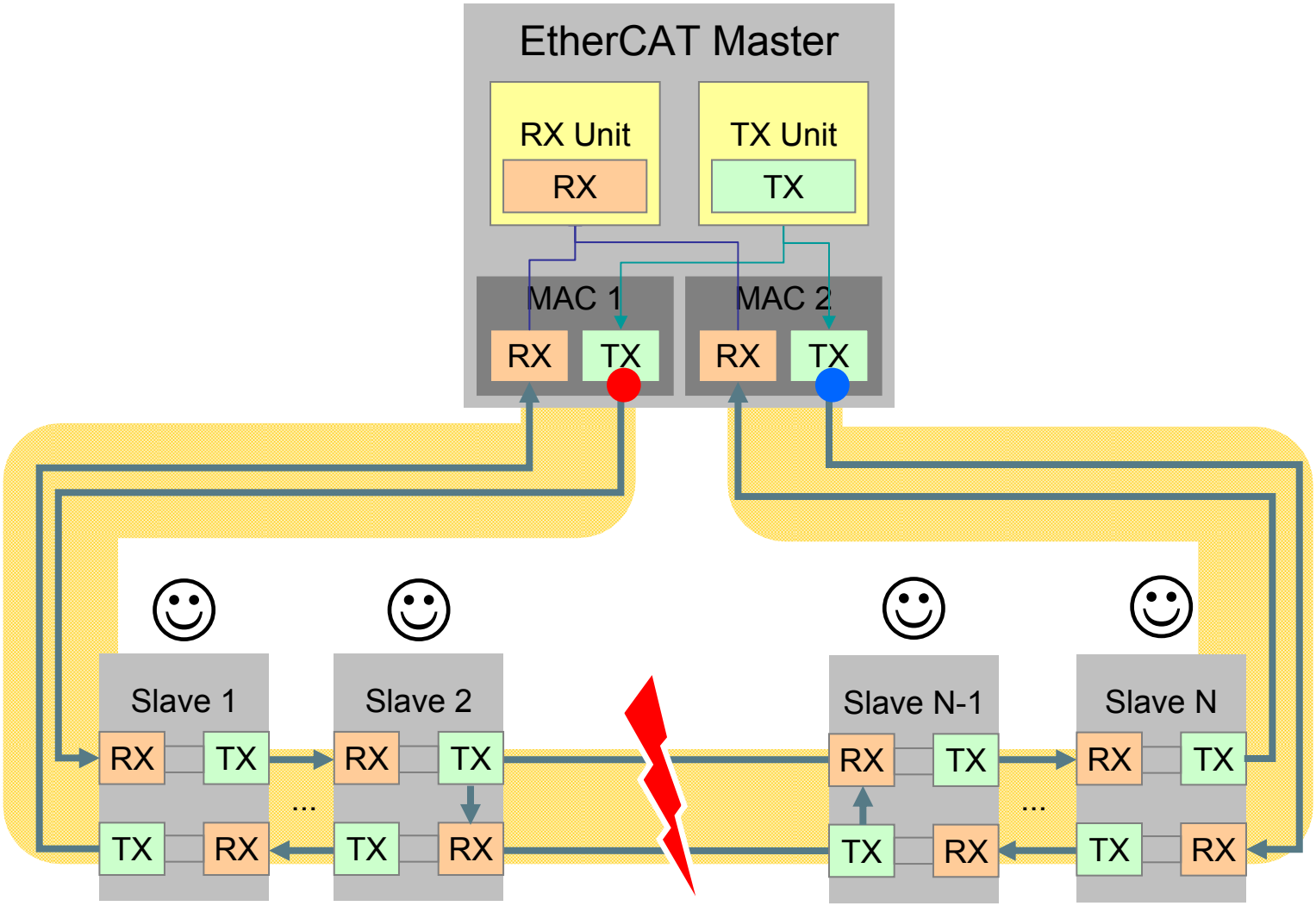

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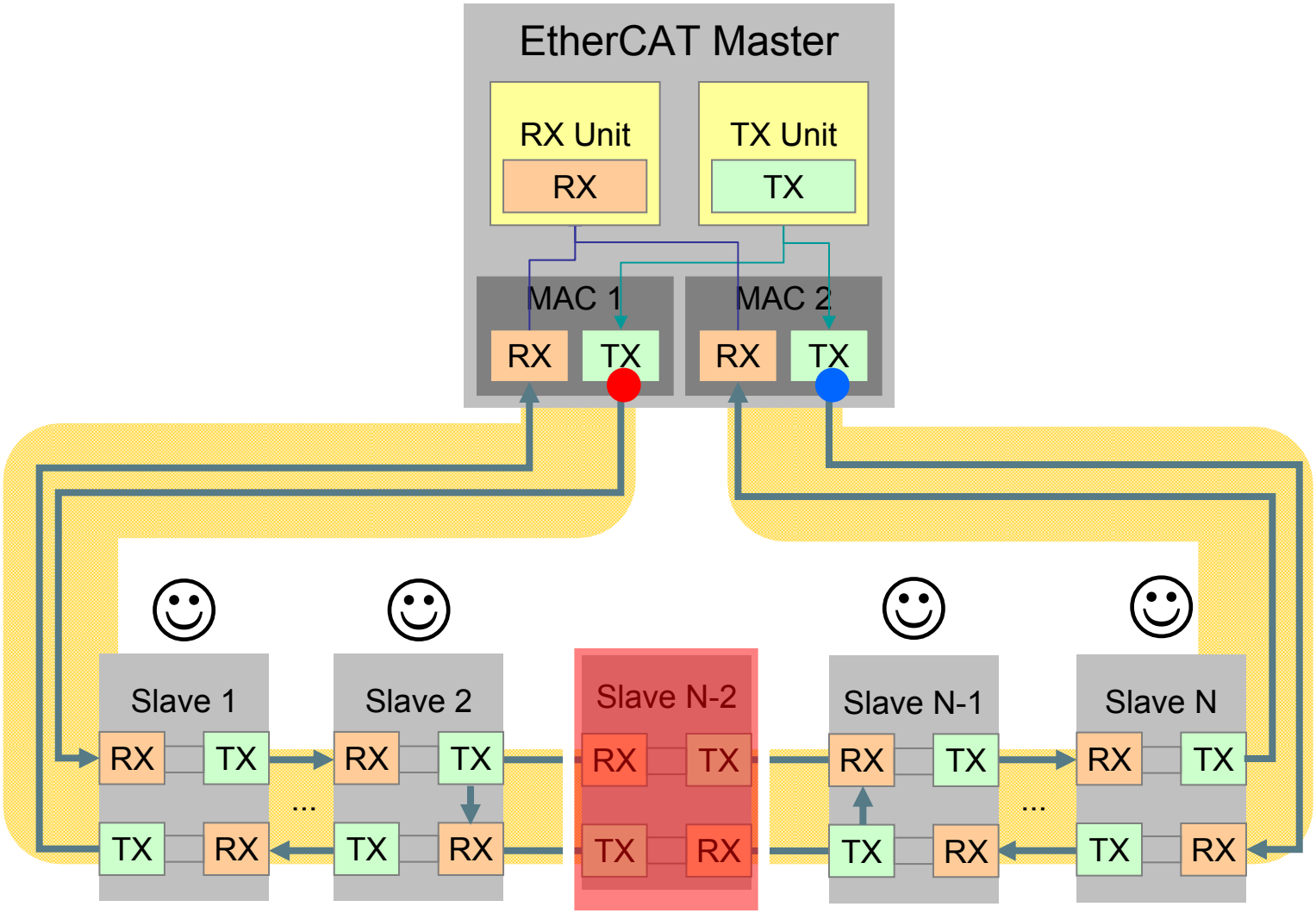

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EtherCAT: various system architecture

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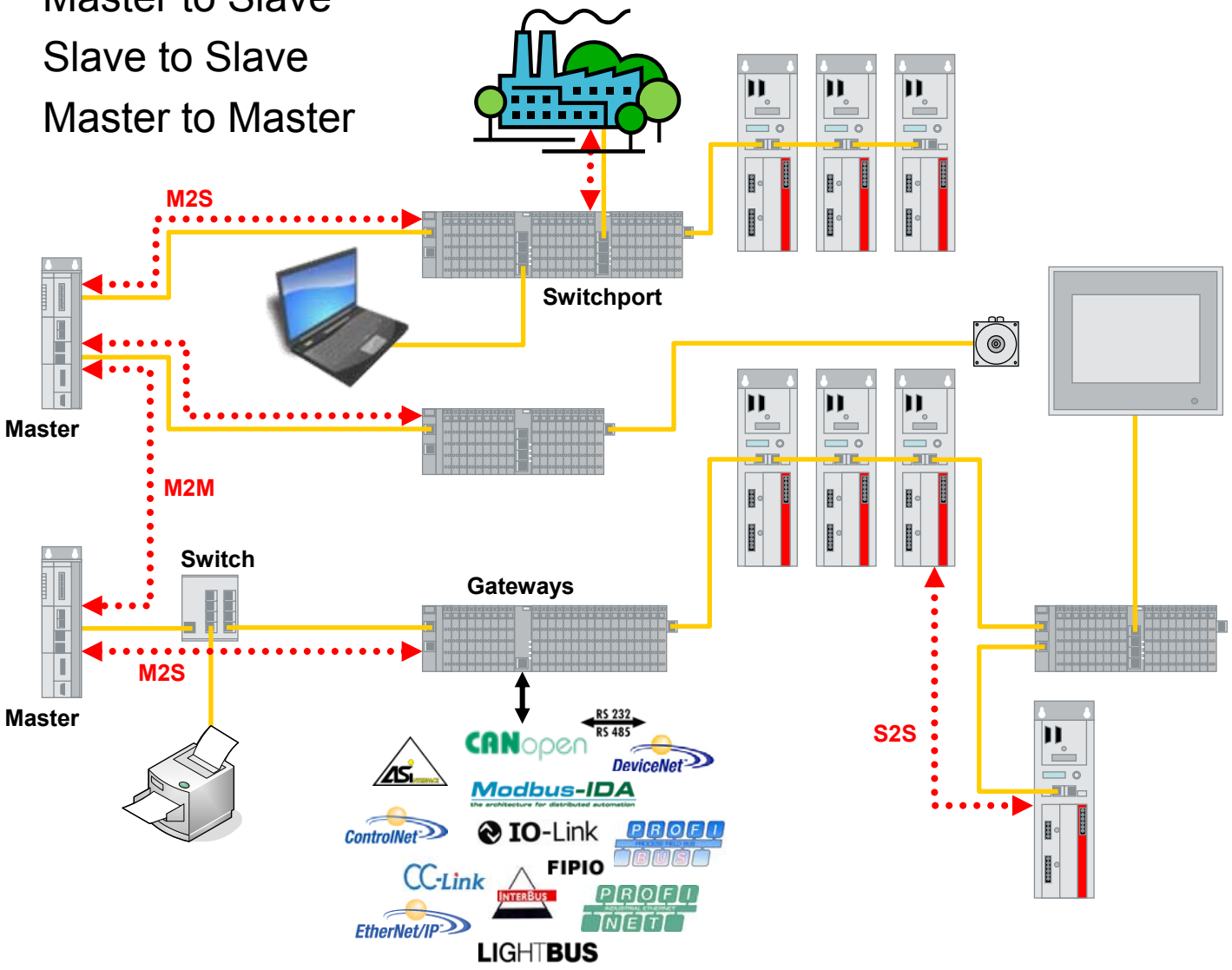
- Master to Slave
- Slave to Slave
- Master to Master



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EtherCAT and Wireless Communication

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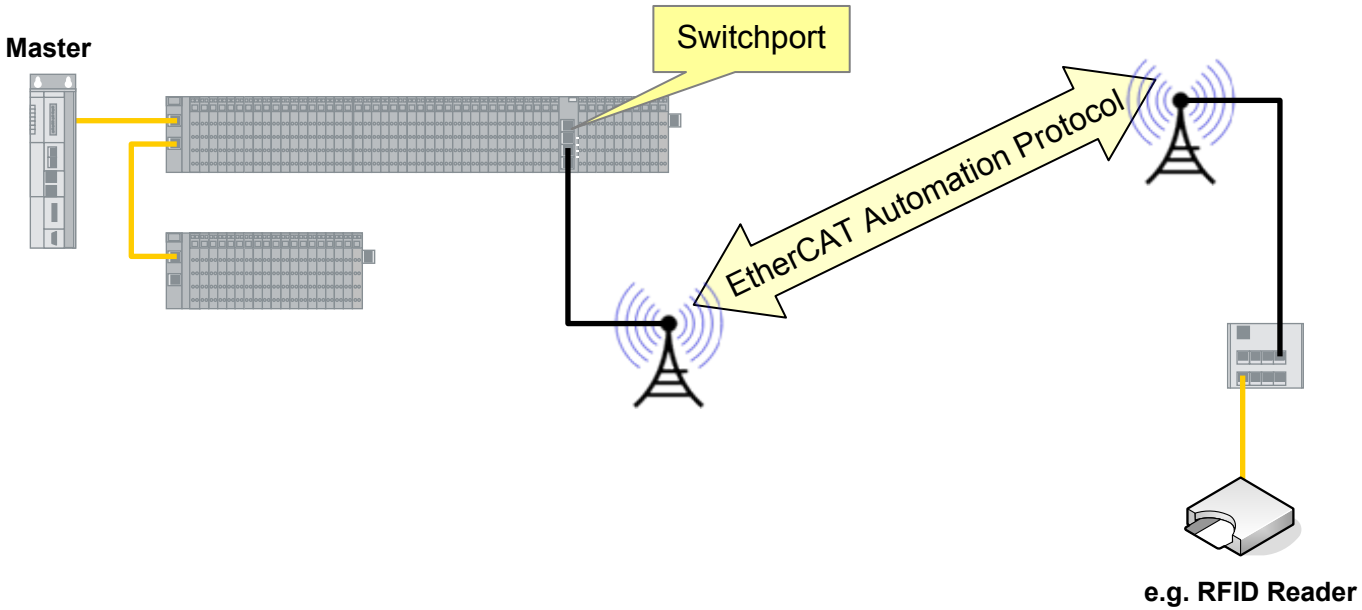
- Safety ✓
- Redundancy ✓
- Versatile

- Wireless Devices can be connected via Switchport
- Wireless segment does not slow down EtherCAT communication
- Protocol: EtherCAT Automation Protocol
  - Pushed and/or Polled Process Data Exchange
- Wireless Segment transparent for Master Device



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Why do Companies choose EtherCAT?

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- Versatile

- High Performance
  - EtherCAT is the fastest Industrial Ethernet technology
- Flexible Topology
  - Benefit not only for widely distributed applications
- Ease of Use
  - Easy configuration and maintenance
- Low Cost
  - Inexpensive implementation & infrastructure
- Functional Safety
  - Safety communication integrated
- Product Variety
  - Great variety of available EtherCAT products

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EtherCAT Application Fields

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- Versatile

- Fast applications, e.g.:
  - packaging machines
  - high speed presses
  - injection molding machines
  - woodworking machines
  - machine tooling (CNC)
  - test beds
  - robotics
  - …
- Widely distributed applications, e.g.:
  - materials handling
  - logistics
  - data acquisition
  - …

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EtherCAT Application Fields

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- Redundancy ✓
- Versatile

- Due to low cost master and simple wiring as well:
  - Small Embedded Controller
  - Small PLCs
  - Any PC based Control Application
    - with or without real time requirements

- EtherCAT allows one to apply fieldbus technology where cost issues require direct wiring today

© EtherCAT Technology Group, 2009

EtherCAT - The Ethernet Fieldbus.

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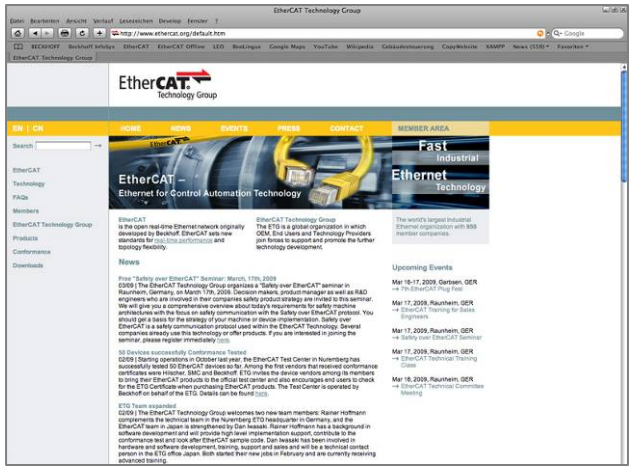
Please visit

www.ethercat.org

for more information



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