



EtherCAT

Industrial Ethernet
Symposium 2006

EtherCAT is:

- faster
- Industrial Ethernet
- most flexible to wire
- safety
- redundancy
- simpler to configure
- low cost
- well proven
- open
- versatile
- the right solution for your application!

Martin Rostan,
Executive Director, EtherCAT Technology Group



www.siemens.com/ies2006



3rd International
**Industrial
Ethernet
Symposium**

October 3-4, 2006, Chicago, IL



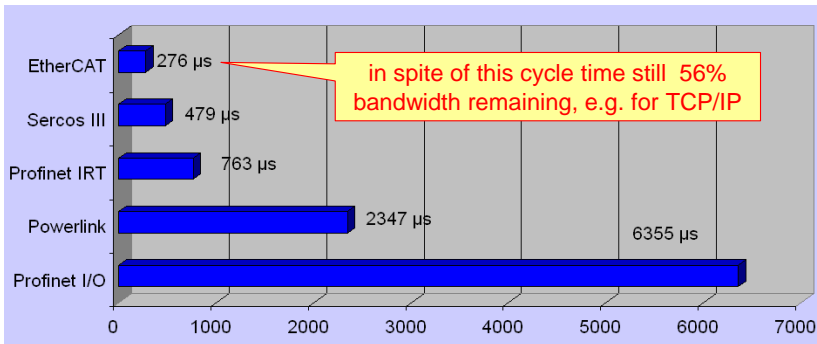
EtherCAT Performance Example

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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 μ s**
at 44% Bus Load, Telegram Length 122 μ s
- For comparison:
Profinet IRT **763 μ s**, Powerlink V2 **2347 μ s***, Profinet RT **6355 μ s**



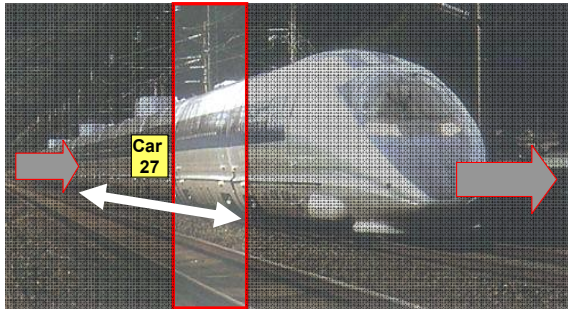
* Source: Ethernet Powerlink Spec V 2.0, App.3
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Functional Principle: Ethernet „on the Fly“

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Analogy Fast Train:

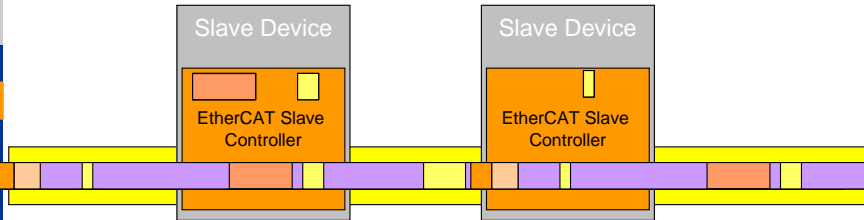
- „Train“ (Ethernet Frame) does not stop
- Even when watching „train“ through narrow window one sees the entire train
- „Car“ (Sub-Telegram) has variable length
- One can „extract“ or „insert“ single „persons“ (Bits) or entire „groups“ – even multiple groups per train

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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

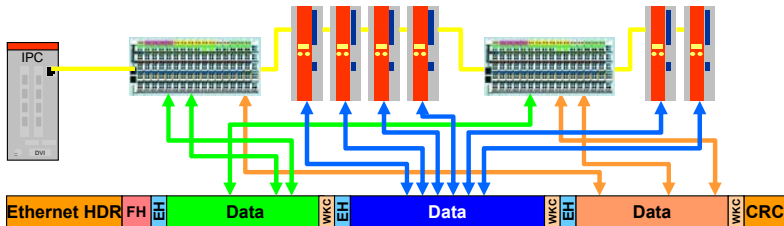
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Minimal protocol overhead via implicit addressing



- Optimized telegram structure for decentralized I/O
- Communication completely in hardware: maximum performance
- no switches needed if only EtherCAT devices in the network
- Outstanding diagnostic features
- Ethernet-compatibility maintained

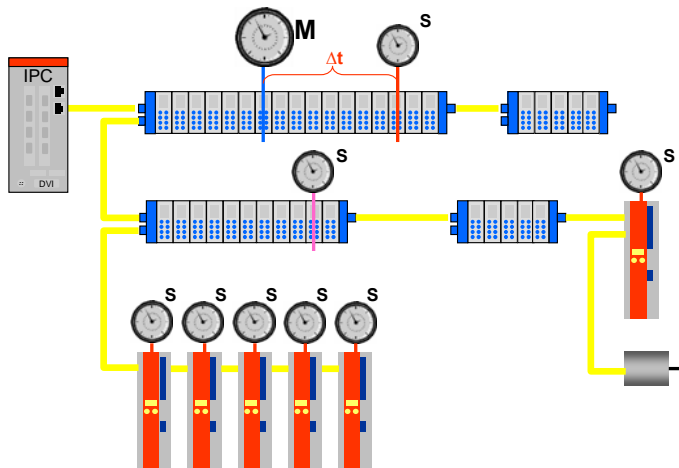
EtherCAT Distributed Clocks

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Precise Synchronization ($\ll 1 \mu\text{s}$!) by exact adjustment of distributed clocks



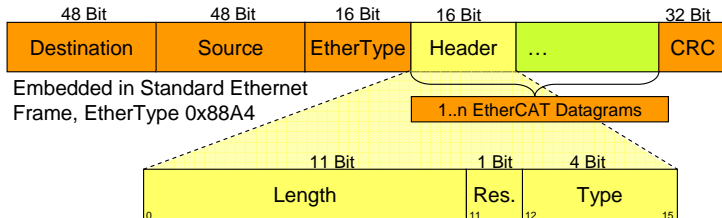
EtherCAT is Industrial Ethernet!

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- EtherCAT: only Standard Ethernet Frames (IEEE 802.3)
- Master: Ethernet MAC without co-processor or special HW
- Fully transparent for other Ethernet protocols
- Internet Technologies (TCP/IP, FTP, Web server etc.) without restricting the real time capabilities, even with 100µs cycle time – no large time gaps for rare traffic needed
- Full Tool-Access to devices at real time operation – with and without TCP/IP



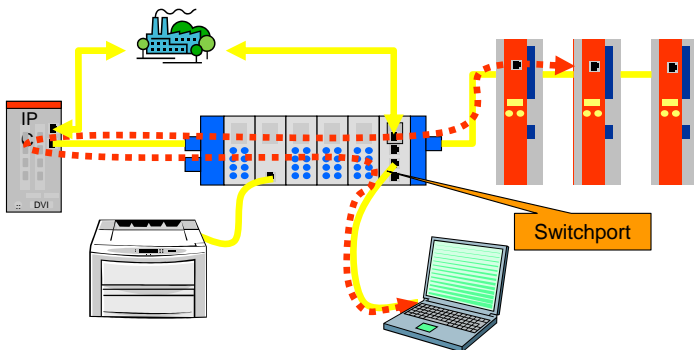
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- Connection to any Ethernet device via Switchport
- Access to web server with standard browser
- Switchport can be implemented as device feature, separate device or software functionality in master
- Switchport allows for hard real time capability with parallel Ethernet communication of any kind



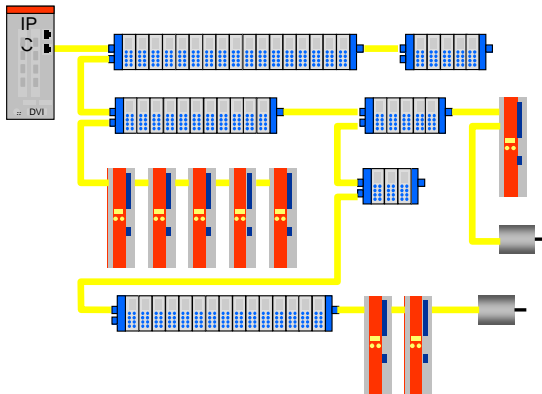
EtherCAT is most flexible to wire

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- Flexible tree structures – arbitrarily extendable
- Line without limitations through cascaded switches or hubs
- 100 m between two nodes, up to 65535 nodes in one segment
- branches can be connected/removed at run time („Hot Connect“)
- Straight or crossed cables – automatic detection



Fieldbus Gateways: EtherCAT instead of PCI

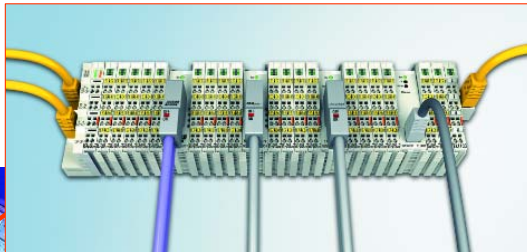
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- No Slots in Control System (IPC or SPS) required any more
- Nevertheless maximum expandability
- seamless integration of fieldbus devices protects your investment
- smooth migration path from fieldbus to EtherCAT

EtherCAT



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Safety over EtherCAT: Features

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- TÜV certified technology
- Developed according to IEC 61508
- Protocol meets Safety Integrated Level (SIL) 4
- Device implementations typically SIL 3
- Suitable for functional safe I/O as well as for functional safe motion control
- Variable CRC size for minimal overhead
- Safe Parameter Download at boot-up: most simple device exchange possible
- Safety devices already available

Certified Functional Safety

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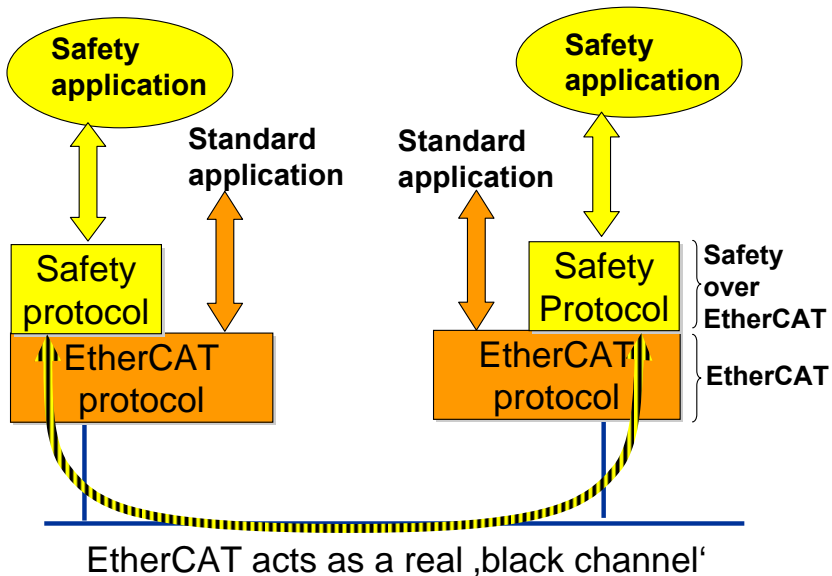


Safety over EtherCAT: Technology Approach

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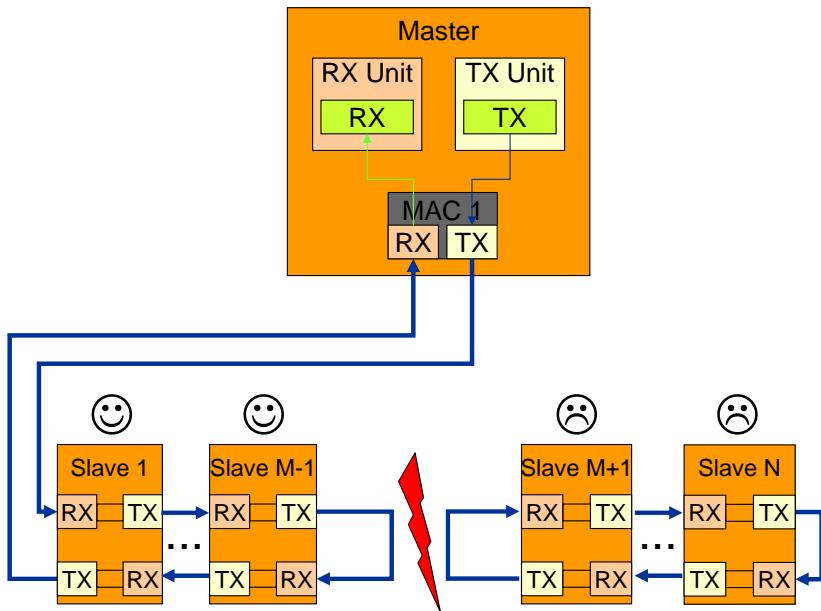


Without Redundancy: Cable Failure

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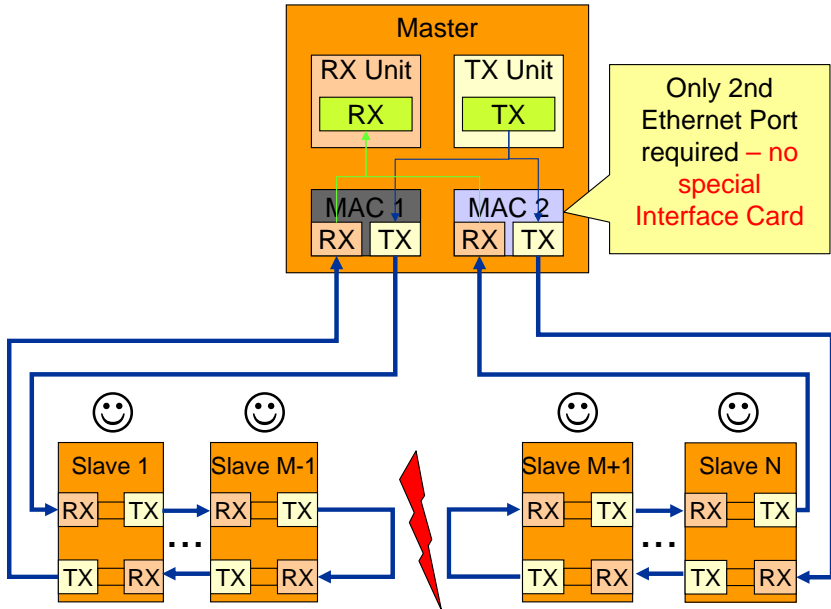


With Redundancy: Cable Failure

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EtherCAT is simpler to configure



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Addressing:

- No manual address setting required
- Addresses can be kept – no new addressing if nodes are added

Topology:

- Automatic topology target/actual comparison possible

Diagnosis:

- Diagnosis information with exact localization

Network planning:

- Performance independent of slave implementation (e.g. stack features, μC performance)
- Performance widely independent from topology (no switches/hubs)
- Performance more than sufficient - therefore no „tuning“ required any more, default settings do the job

EtherCAT is lower costs



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Master:

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

Slave:

- low cost Slave Controller
- FPGA or ASIC
- no powerful μC needed

Infrastructure:

- no Switches/Hubs required
- Standard Ethernet Cabling

EtherCAT is well proven

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- in series applications since end of 2003
- more nodes in the field than PROFINET IRT, Powerlink Version 2 and SERCOS III altogether...



EtherCAT is an open technology

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- Protocol is published completely:
- EtherCAT is IEC Specification (IEC/PAS 62407)



Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия



- EtherCAT is part of ISO 15745-4
- EtherCAT is part of IEC 61158 (CDV), IEC 61784-2(CDV) and IEC 61800-7(CDV)
- Slave Controller from several suppliers
- Slave Controller provide interoperability
- ETG organizes „Plug-Fests“, and prepares conformity tests

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- Foundation: November 2003
- Tasks: Support, Advancement and Promotion of EtherCAT
- Already more than 350* member companies from 27 countries in Europe, America and Asia/Pacific:
 - Device Manufacturers
 - End Users
 - Technology-Provider
- Membership is open to everybody

* as of Sept 2006

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EtherCAT Technology Group Members (9/2006)

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ETG: Active Members

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- More important than membership figures: how many are active, how many implement the technology?
- April 2006: more that 200 implementation kits sold to ETG members (26% Master, 74% Slaves)
- Hannover Fair 2006: 41 Exhibitors, more than 80 different EtherCAT devices at EtherCAT joint booth
 - among those: 20 drives and 10 different master shown in function



EtherCAT: versatile System Architecture

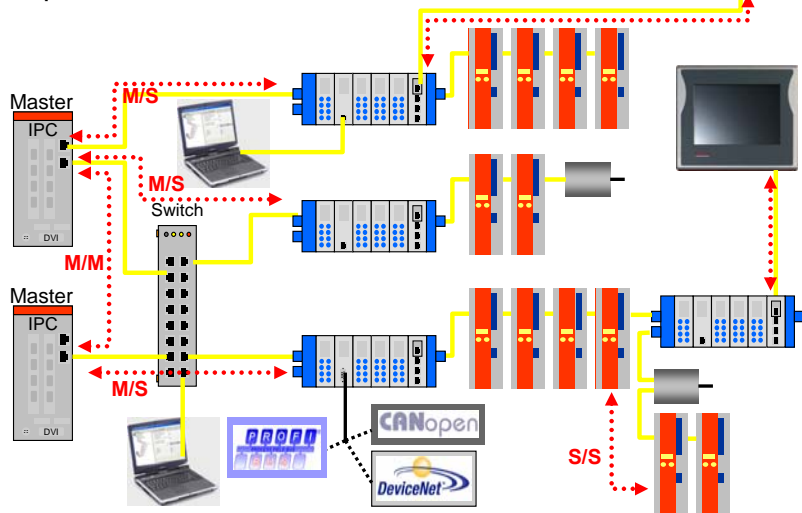


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- Master to Slave, Slave to Slave, Master to Master
- Transparent tool access to all nodes
- open interfaces



Typical EtherCAT application fields

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- All **fast** applications, e.g.:
- packaging machines
 - high speed presses
 - injection molding machines
 - woodworking machines
 - machine tooling (CNC)
 - robotics
 - ...

- All **widely distributed** applications, e.g.:
- materials handling,
 - logistics
 - data acquisition
 - ...





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And:

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.

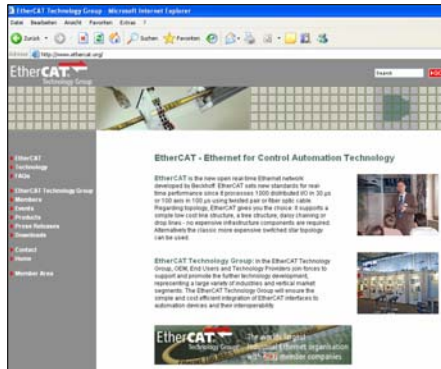
Summary

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EtherCAT – don't settle for less!



www.ethercat.org