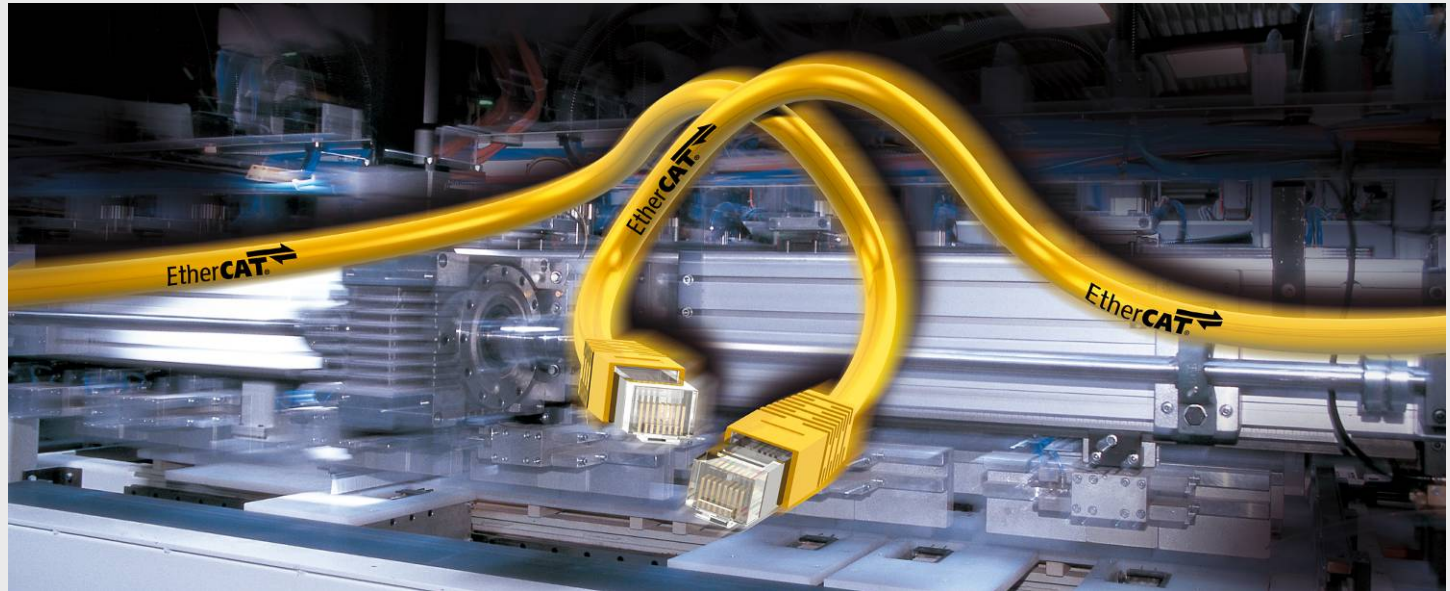


EtherCAT is:

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

## EtherCAT Introduction

Robert Bühlmann, Profimatics GmbH

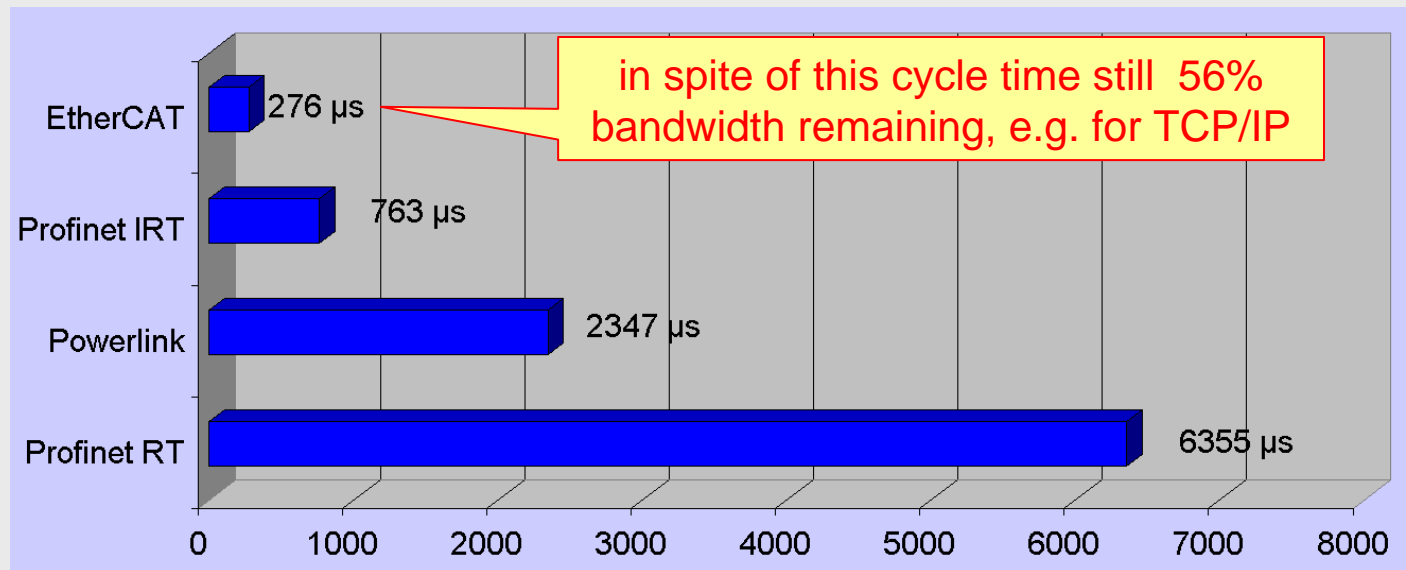


# EtherCAT Performance Example

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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 276µs** at 44% Bus Load, Telegram Length 122µs
- For comparison: Profinet IRT **763 µs**, Powerlink V2 **2347µs\***, Profinet RT **6355 µs**

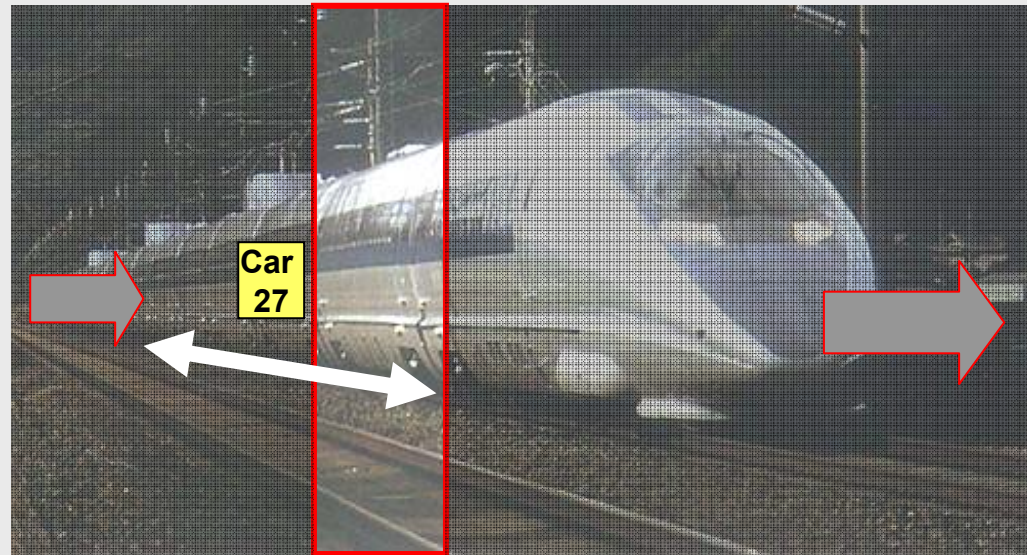


\* Quelle: Ethernet Powerlink Spec V 2.0, App.3

# Functional Principle: Ethernet „on the Fly“

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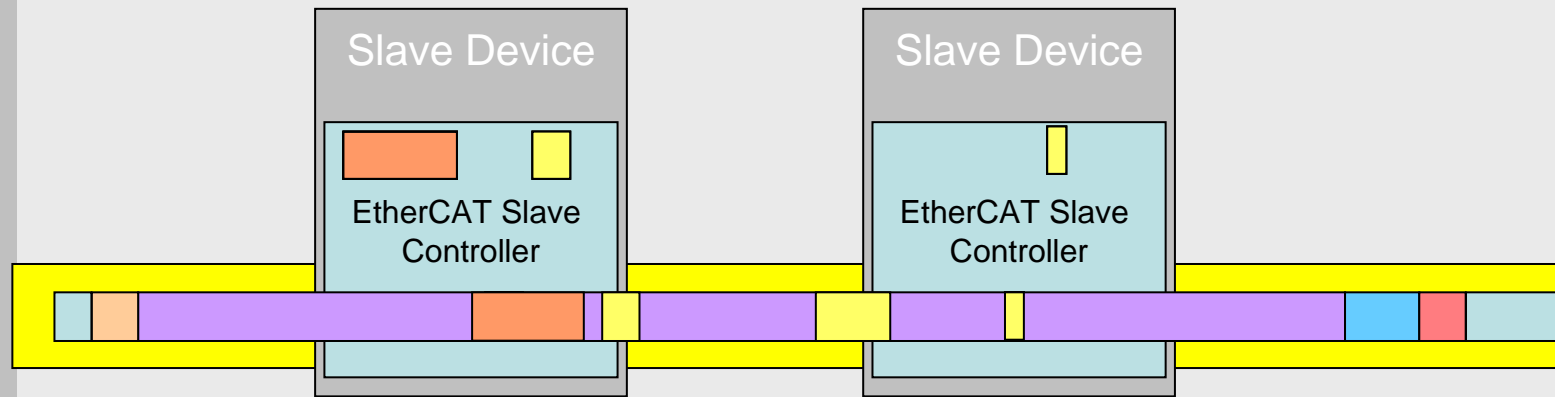
Analogy Fast Train:

- „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

# Functional Principle: Ethernet „on the Fly“

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Process data is extracted and inserted on the fly

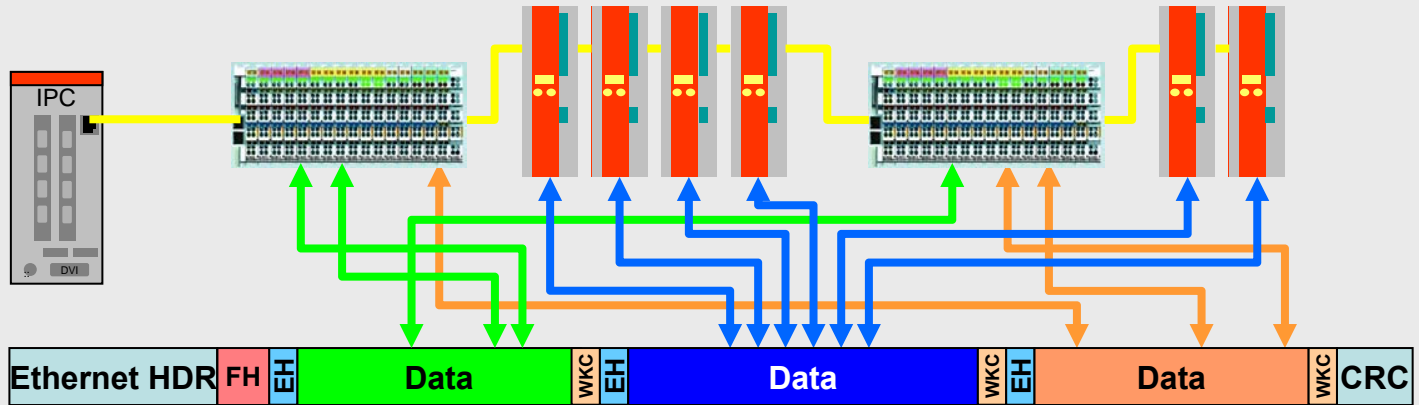
- Process data size per slave almost unlimited (1 Bit...60 Kbyte, if needed using several frames)
- Compilation of process data can change in each cycle, e.g. ultra short cycle time for axis, and longer cycles for I/O update possible
- In addition asynchronous, event triggered communication

# Functional Principle: Ethernet „on the Fly“

EtherCAT is:

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## Minimal protocol overhead via implicit addressing



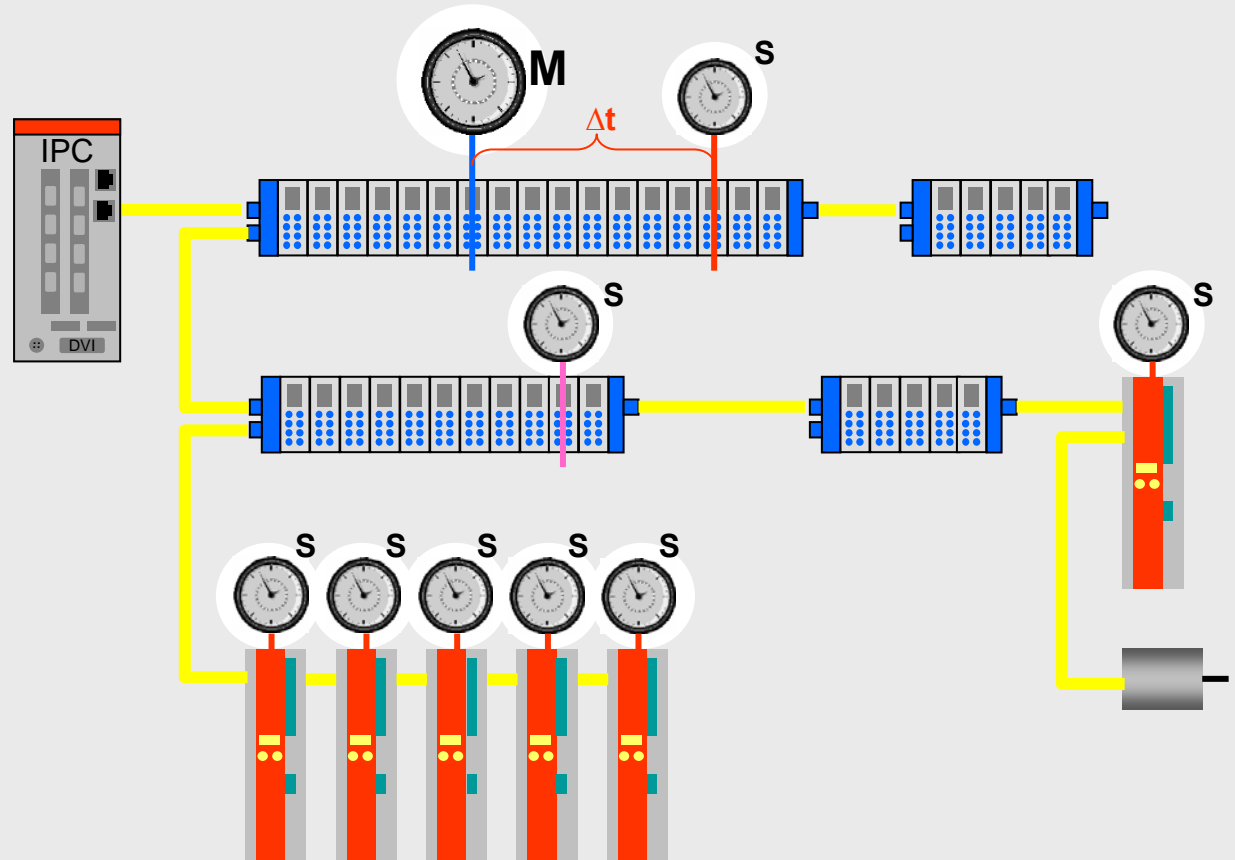
- Optimized telegram structure for decentralized I/O
- Communication completely in hardware: maximum performance
- no switches needed if only EtherCAT devices in the network
- Outstanding diagnostic features
- Ethernet-compatibility maintained

# EtherCAT Distributed Clocks

EtherCAT is:

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

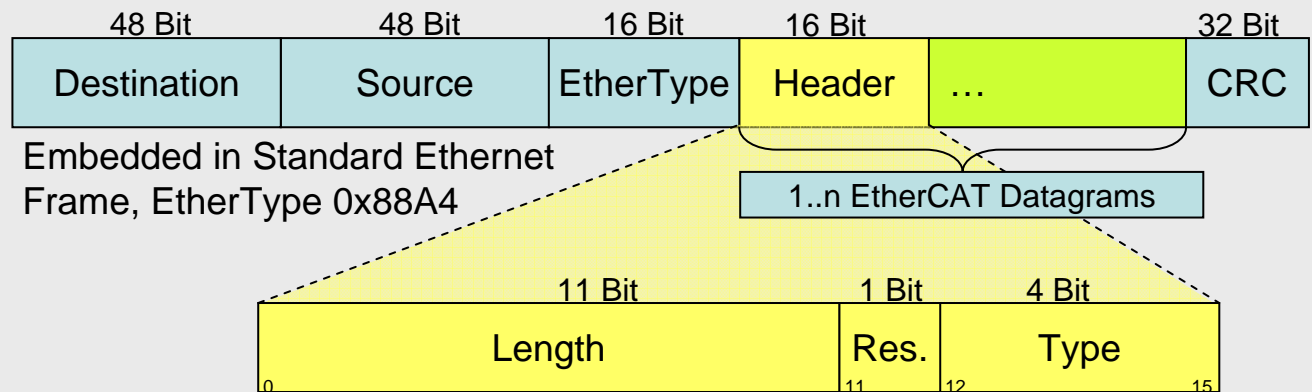


# EtherCAT is Industrial Ethernet!

EtherCAT is:

- faster
- Industrial Ethernet
- most flexible to wire
- Master
- redundancy
- simpler to configure
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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

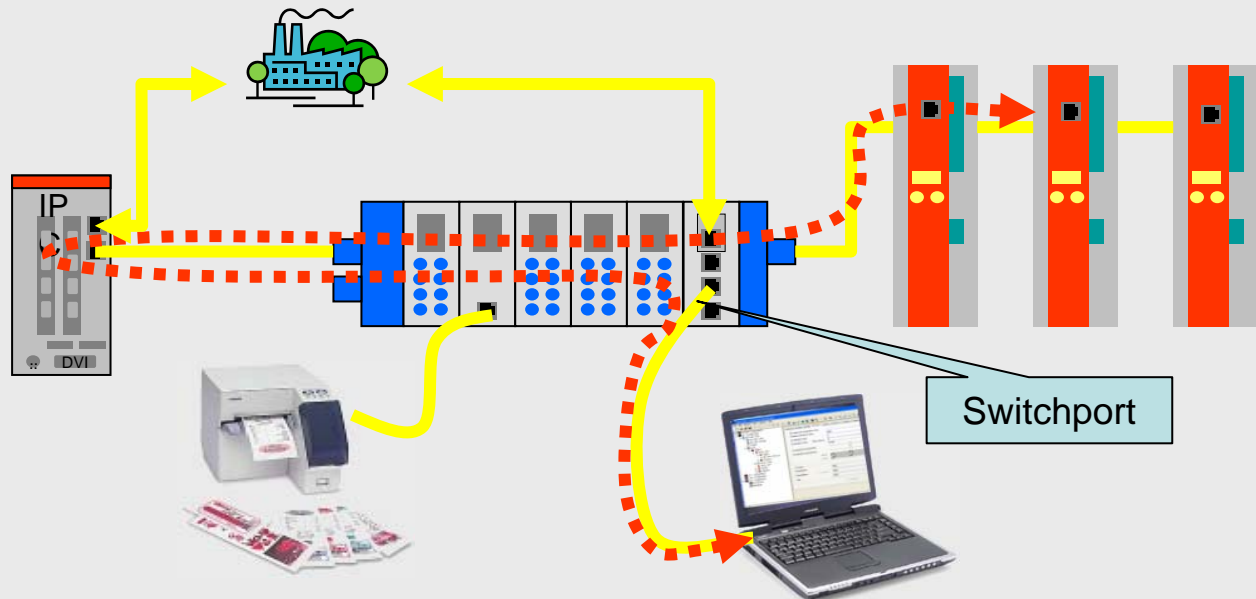


# EtherCAT is Industrial Ethernet!

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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

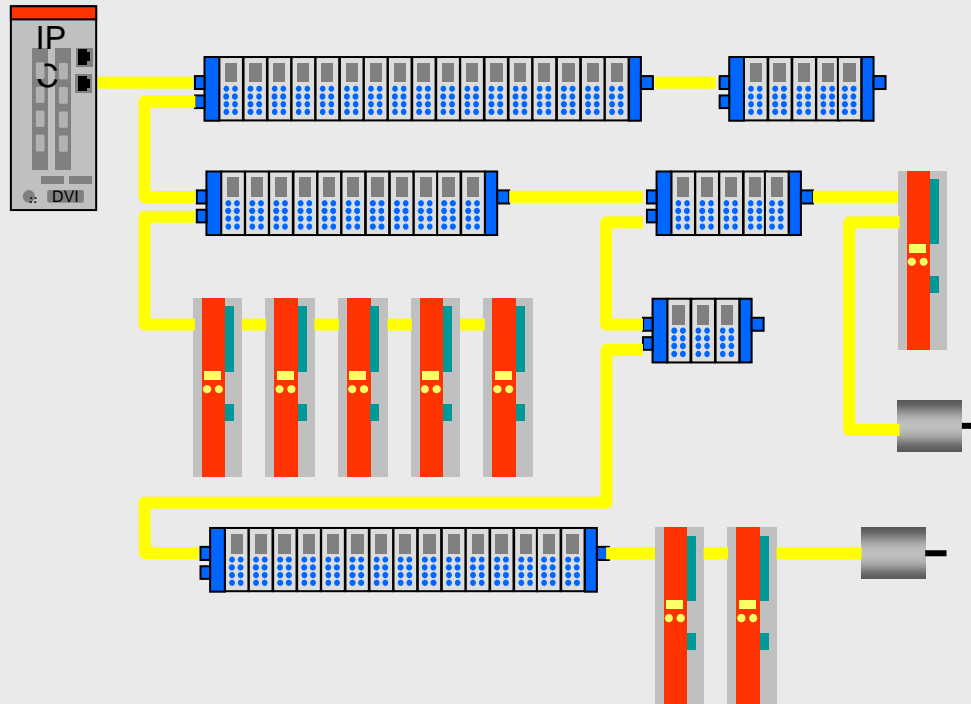


# EtherCAT is most flexible to wire

EtherCAT is:

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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



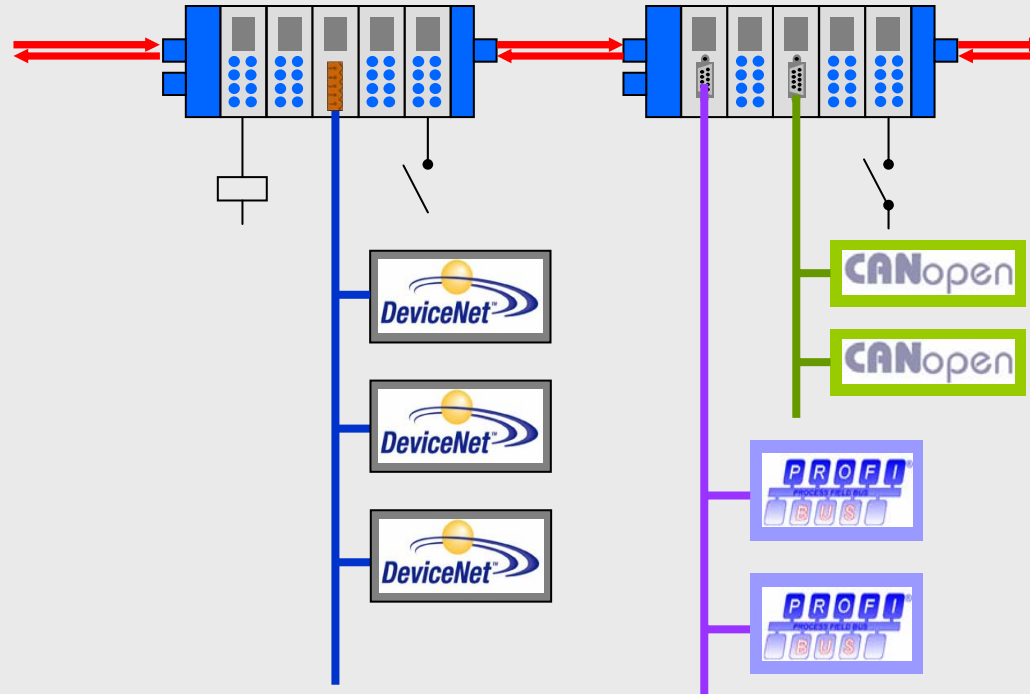
# Fieldbus Gateways

EtherCAT is:

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- Industrial Ethernet ✓
- most flexible to wire

- Master
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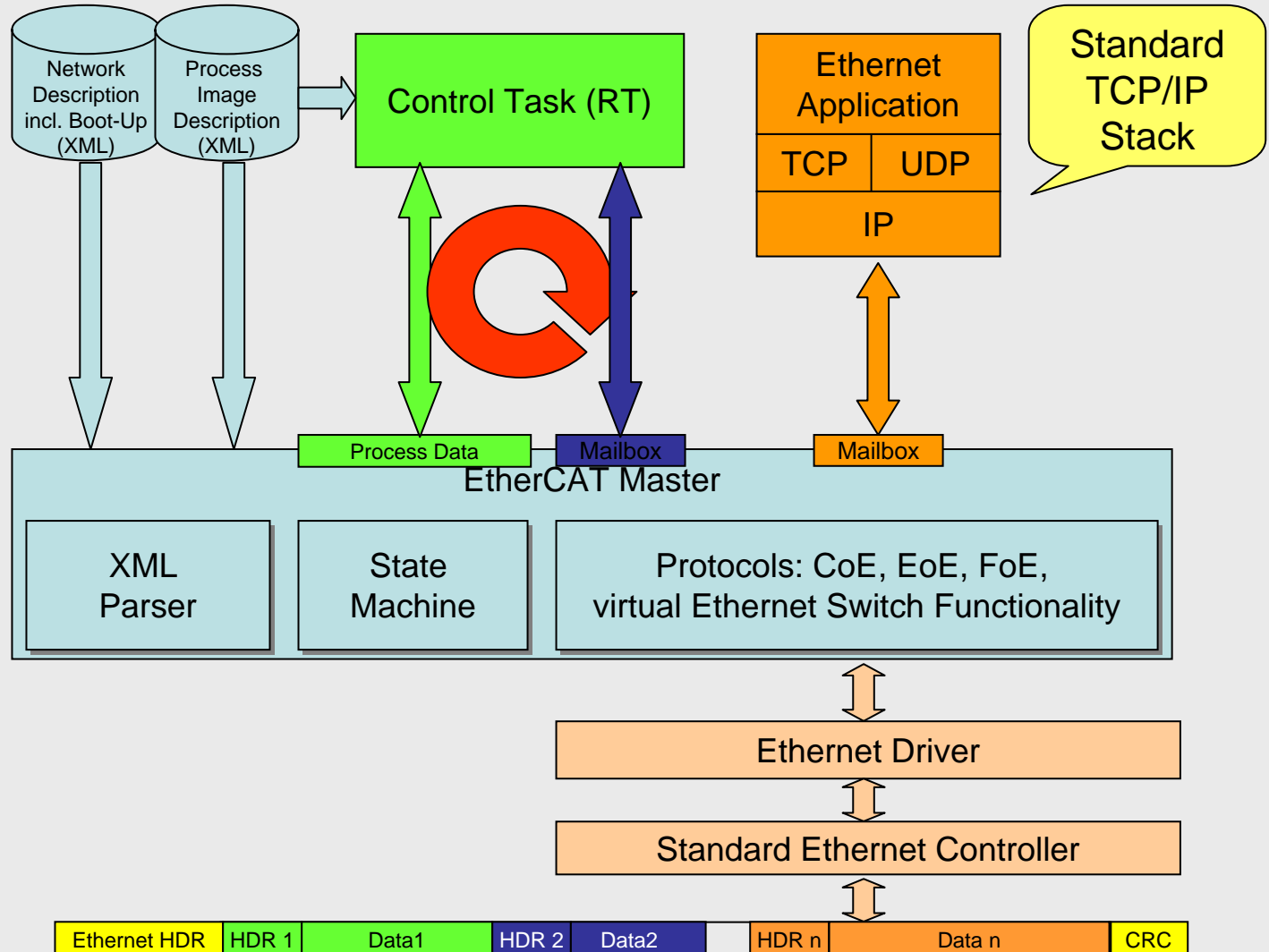
- EtherCAT Performance allows for: EtherCAT instead of PCI
- no card slots required any more
- maximum system expandability with low cost fieldbus gateways
- seamless integration of fieldbus devices protects your investment
- smooth migration path from fieldbus to EtherCAT



# Master Implementation

EtherCAT is:

- faster ✓
- Industrial Ethernet ✓
- most flexible to wire ✓
- Master
- redundancy
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# Master Implementation

EtherCAT is:

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Hard Realtime OS, 50us Cycletime, approx. 2-3 us Jitter, Pentium-D  
 Fast real-time O/S  
 Integrated Embedded WebServer  
 Broad range of ethernet cards  
 Scalable architecture  
 Simple Application Development  
 Visual Studio environment  
 Win32 API  
 Build in XML Parser  
 Windows DLL for Driver Interface, Process Interface and API  
 All interfaces accessible from Windows and real time applications  
 Multiple Master on one system  
 Minimal System runs off a floppy disk

# Master Implementation

EtherCAT is:

- faster ✓
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- most flexible to wire ✓
- Master
- redundancy
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Applications:

[CoDeSys \(Realtime\)](#)

[LabView](#) (Windows Version, non Realtime)

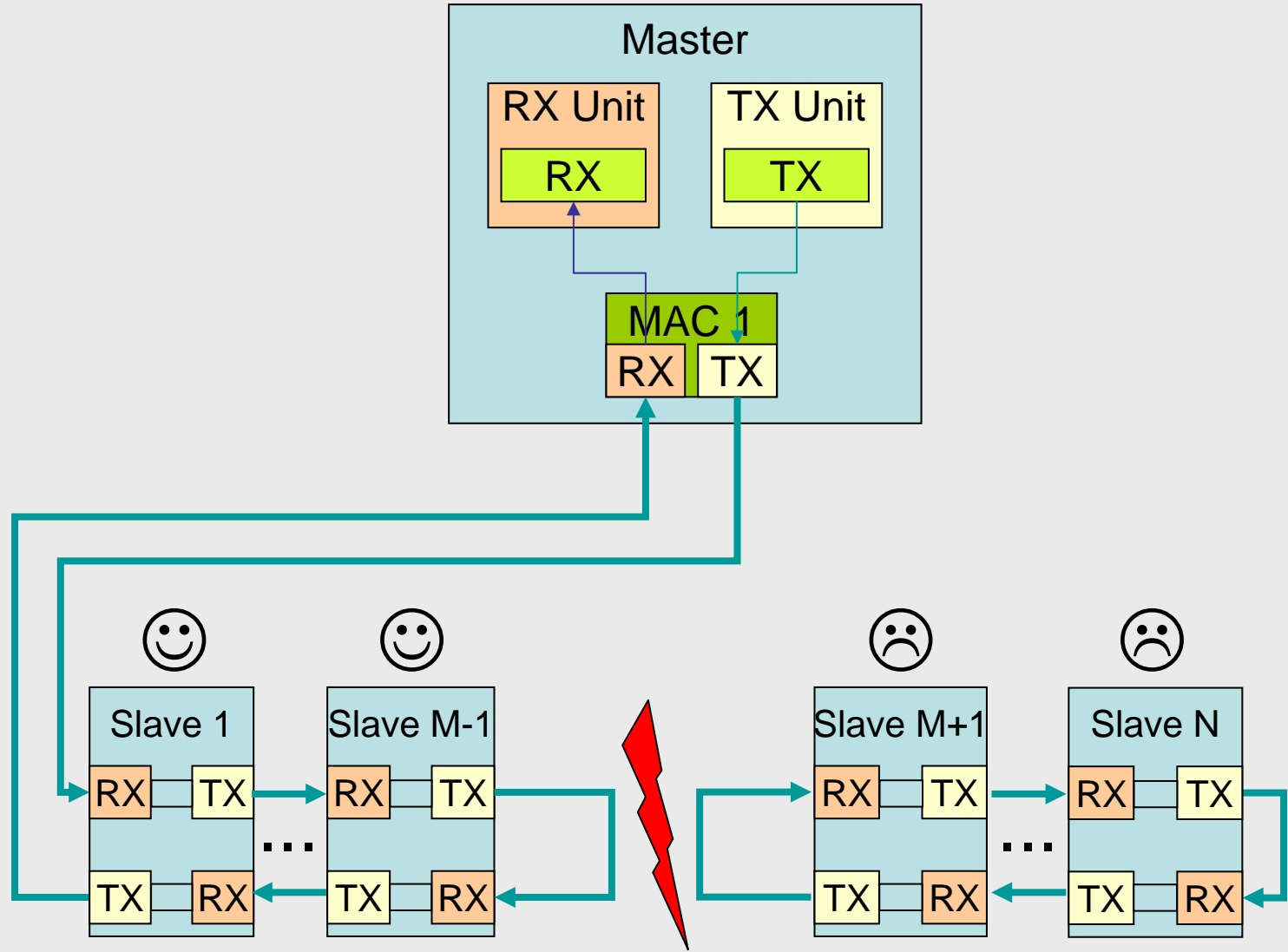
[C, C++](#) with Visual Studio, Realtime

[Excel](#) (non Realtime)

[Realtime WebServer](#)

# Without Redundancy: Cable Failure

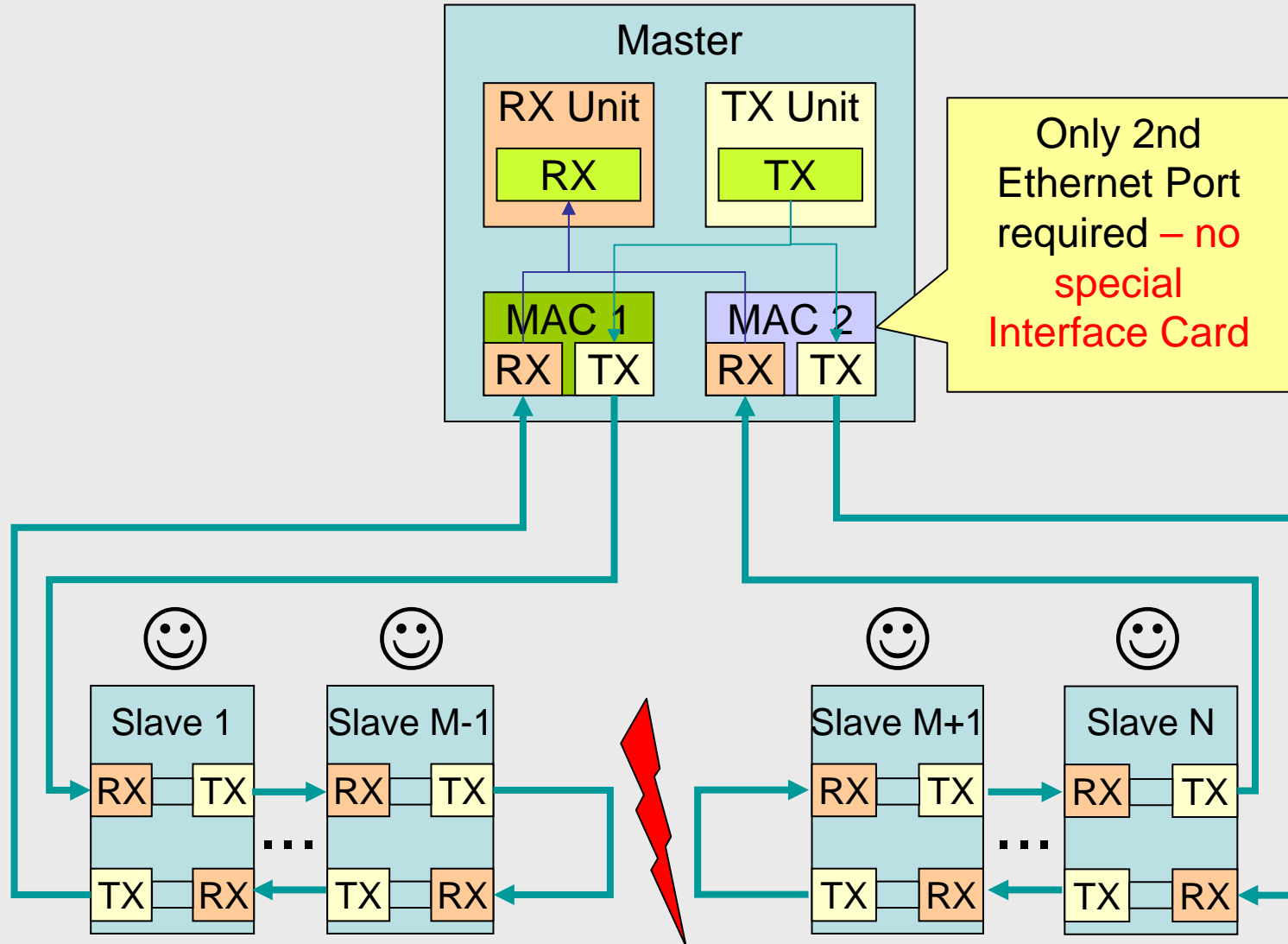
- EtherCAT is:
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  - Industrial Ethernet ✓
  - most flexible to wire ✓
  - Master ✓
  - redundancy
  - simpler to configure
  - low cost
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# With Redundancy: Cable Failure

EtherCAT is:

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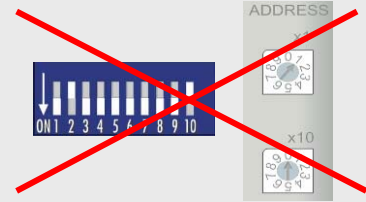
# EtherCAT is simpler to configure

EtherCAT is:

- faster ✓
- Industrial Ethernet ✓
- most flexible to wire ✓
- Master ✓
- redundancy ✓
- simpler to configure
- low cost
- well proven
- open
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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,  $\mu$ C 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



EtherCAT is:

- faster ✓
- Industrial Ethernet ✓
- most flexible to wire ✓
- Master ✓
- redundancy ✓
- simpler to configure ✓
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## Master:

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



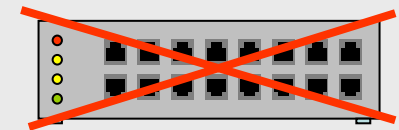
## Slave:

- low cost Slave Controller
- FPGA or ASIC
- no powerful  $\mu$ C needed



## Infrastructure:

- no Switches/Hubs required
- Standard Ethernet Cabling



# EtherCAT is well proven

EtherCAT is:

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

- 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

EtherCAT is:

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

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



- EtherCAT is part of ISO 15745-4
- Integration in IEC 61158, IEC 61784 and IEC 61800-7 on the way
- Slave Controller from several suppliers
- Slave Controller provide interoperability
- ETG organized „Plug-Fests“, and prepares conformity tests

# EtherCAT is an open technology



- Foundation: November 2003
- Tasks: Support, Advancement and Promotion of EtherCAT
- Already more than 300\* member companies from 25 countries in Europe, America and Asia/Pacific:
  - Device Manufacturers
  - End Users
  - Technology-Provider
- Membership is open to everybody

\* as of April 2006

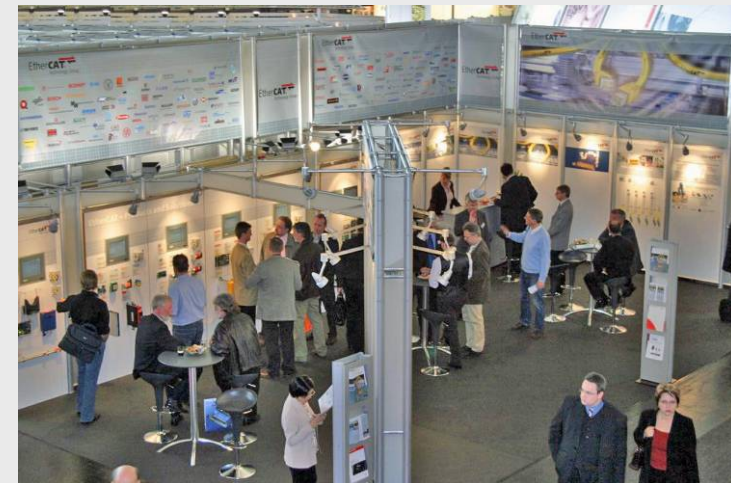
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# ETG: Active Members

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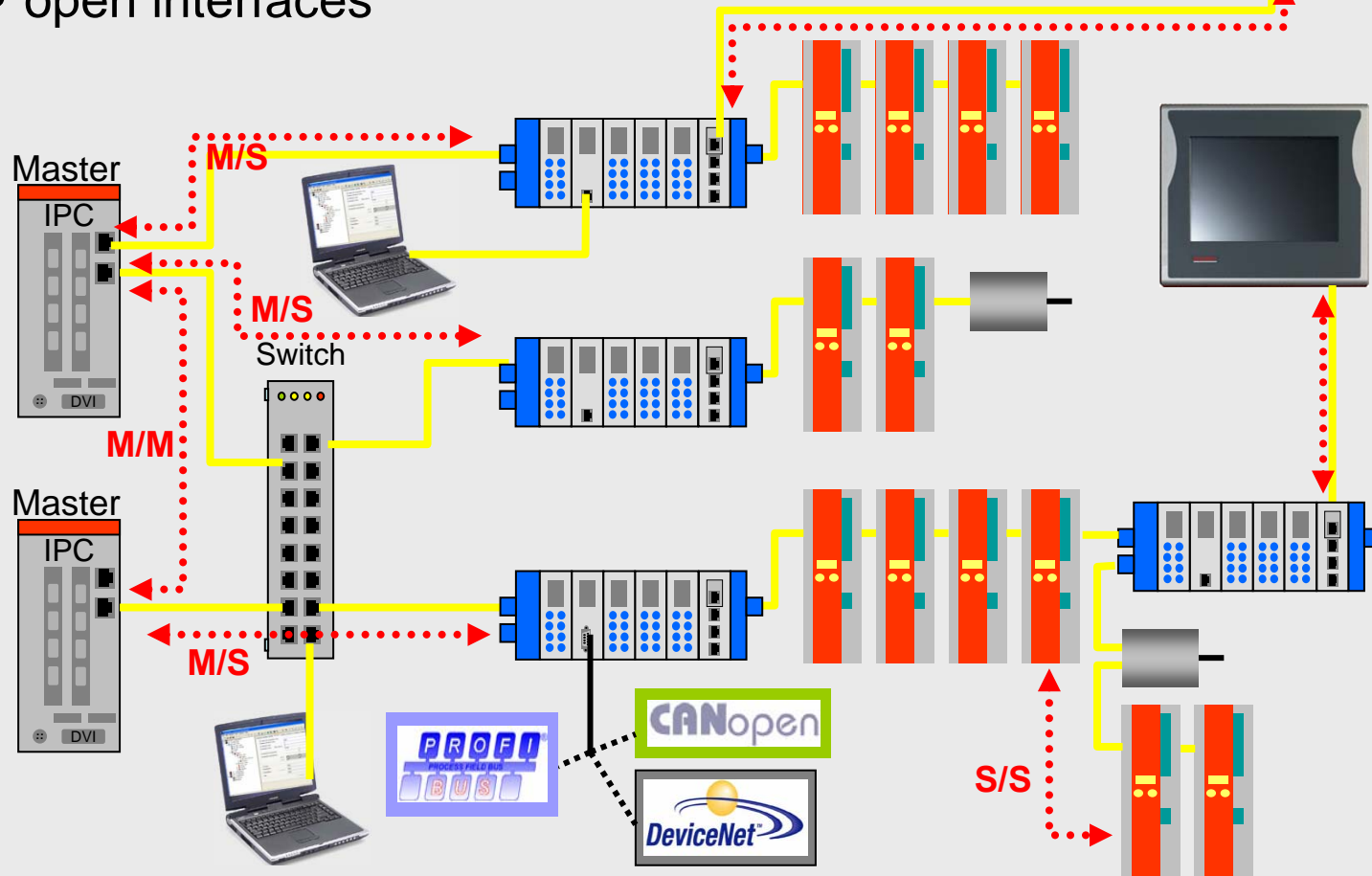
- More important than membership figures: how many are active, how many implement the technology?
- April 2006: more that 200 implementation kits sold to ETG members (26% Master, 74% Slaves)
- Hannover Fair 2006: 41 Exhibitors, more than 80 different EtherCAT devices at EtherCAT joint booth
  - among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



# EtherCAT: versatile System Architecture

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

- 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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- faster ✓
- Industrial Ethernet ✓
- most flexible to wire ✓
- Master ✓
- redundancy ✓
- simpler to configure ✓
- low cost ✓
- well proven ✓
- open ✓
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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
- ...



## Typical EtherCAT application fields

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And:

Due to low cost master and simple wiring as well:

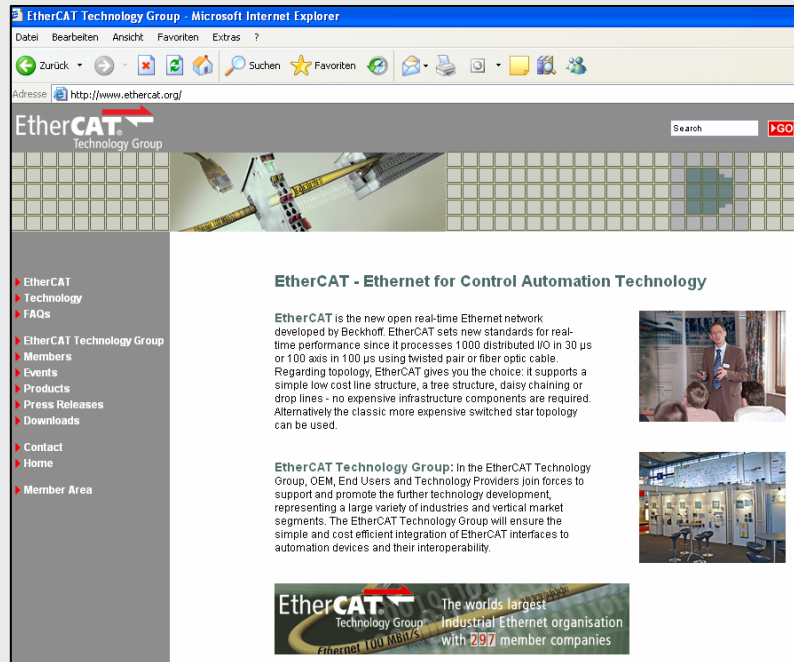
- Small embedded Controller
- Small PLCs
- Any PC based control application
  - with or without real time requirements

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

EtherCAT is:

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

## EtherCAT is the right choice - also for your application?!



[www.ethercat.org](http://www.ethercat.org)