Fieldbus Technology Overview

- I/O-Fieldbus
- Advanced Fieldbus
- Industrial Ethernet
- Process Automation
IO bus (and related) system technologies

[Logos: ASi INTERFACE, CompoNet, CC-Link/LT]
Positioning and potential of individual bus systems at the field level

Complexity of application [sensors & actuators]

- Communication
- Motion Control
- > 20% closed loop
- Pre-processing
- > 20% analogue
- > 90% Digital

Compact
manually
operating
workspaces

Automation
Cell

Linked,
station-oriented
machines

Automation
plants

Plant/machine
design [dimensions & structure]
Network topology with I/O bus (AS-Interface)

1. PC connection
2. Multipin Wiring
3. PLC cards for device control
Network topology with I/O bus (AS-Interface)

[1] PC connection
[2] I/O Bus
[3] PLC cards for device control

Usually small slaves, longer distances, limited functionality. Focus on easy installation system.
Network topology with I/O bus (AS-Interface)

[1] PC connection
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Usually small slaves, longer distances, limited functionality. Focus on easy installation system.
Development of bus systems in the last decade

- I/O-Bus in the past was synonym to AS-Interface

AS-interface as the market leader world-wide. Late market entrance of the others.
All about AS-Interface

Relevance
- AS-interface dominates the I/O market with a worldwide connectivity of over 80%
- Compared to field bus systems, AS-interface hold position 3 after Profibus and DeviceNet reg. number of nodes installed

Fieldbus organisation
- The Fieldbus club is ASI Association
  http://www.as-interface.net/

Major suppliers
- There are roughly 300 suppliers of AS-Interface network and control devices. Leaders in Europe are Siemens, ifm, Pepperl&Fuchs, Schneider, B&W. Also many PLC and I/O suppliers integrate platforms from Bihl&Wiedemann, KSK, Murr and others.

Distribution AS-interface Regions

Asia/Japan: strong growth expected
All about CompoNet

Relevance
- Not recognised by any studies (until 2010)
- No products available on odva homepage

Fieldbus organisation
- The ODVA (Open DeviceNet Vendor Association)
  - focuses the development and extension of DeviceNet, ControlNet and Ethernet/IP technology.
  - CIP (Common Industrial Protocol) is the consolidated application layer
  - Other topics: CIPMotion, CIP Safety, DeviceNet, Ethernet/IP, details: www.odva.org

Major suppliers
- Omron developed the technology and will focus on networks in the Asian region
- Rockwell Automation (Allen-Bradley) is expected to be the major supplier for PLC and field devices
All about CC-Link LT

Relevance
- Cc-Link/LT Not recognised by any studies
- Only very few products in Mitsubishi catalogue

Fieldbus organisation
- Die CC-Link Partner Association (CLPA) besteht aus derzeit rund 500 Mitgliedsfirmen, die inzwischen mehr als zwei Millionen Netze installiert haben. CC-Link +LT organisation http://www.cc-link.org/

Major suppliers
- Spec. 2005 finished and published
- Mitsubishi

Regional CC-Link/LT distribution not yet visible

Major vendors Rockwell Automation and Omron
Just to remember: the Festo CP/CPI system

**Festo CP and CPI system**
- First decentral I/O system IP65 for valve terminals
- Started 1996 for CPV and CPA terminals
- Redesigned after 10 years – doubled performance

**USPs:**
- 3 master platforms (CPX, CPI and FB Direct terminals)
- 3 I/O module platforms (robust, compact and ecoline)
- 3 pneumatic platforms (CPV, CPV-SC and MPA) [CPA phase-out planned]

Competes against many field bus I/O systems from manufactures like Phoenix, Beckhoff, B&R, Murr, ... SMC, Norgren: **but they all have multipin VT only!**
Just to remember: the Festo CPI system

Festo CPI system for decentralized I/O

- I/O bus comparable system, based on CAN field bus
- Up to 128 resp. 512 I/O
- Radius 10 m around field bus node
- Digital I/O and valve terminals only
- Module oriented diagnostics
- Granularity:
  - 8IN, 16IN, 32IN modules
  - 4OUT, 8OUT modules
  - CPV: 4/8 16 OUT/valves per CPI slave
  - MPA: 2…32 OUT/valves per CPI slave
- Cycle time 2 ms (CPI slaves only), 4 ms CP slave(s)
All about IO-Link

IO-Link Brings Intelligence to Simple Devices

- IO-Link is not an industrial network, but rather a simple protocol that adds communication capabilities to devices connected to existing industrial networks.
- Former named by Siemens: IQ sense
- IO-Link uses the existing 24 VDC point-to-point wiring between field devices and I/O channels to transmit additional data via a UART-based pulse modulation over distances of up to 15 meters.
- Driven mainly by sensor companies. Own “field bus” organisation:

http://www.io-link.com/

Distribution not yet visible
Advanced Fieldbus technologies

DeviceNet

CC-Link

CANopen

INTERBUS

PROFiBUS
Positioning and potential of individual bus systems at the field level

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[sensors & actuators]

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I/O Bus

- Compact manually operating workspaces
- Automation Cell
- Linked, station-oriented machines
- Automation plants

Plant/machine design
[dimensions & structure]

EtherNet TCP/IP

Drive-Bus

Fieldbus
What is new with advanced fieldbus systems

- **Modular hardware configuration**
  Optimal and easy hardware configurations of complex and modular products may help to map I/O data to the plc projects and to locate easily parameters and diagnostic data

- **Device and module parameterization**
  Need of setting up diagnostics and configuration of decentral field devices

- **Integrated diagnostics**
  Helps to identify failures very fast and to visualize them transparently. Reduction of down-time

- **Bandwidth for process data and devices**
  Control of mixed signals like analogue and digital signals

- **Acyclic data access**
  Change of parameters and validation of advanced diagnostics during the run-time of the PLC program
Network topology with I/O Fieldbus

[1] PC connection
[2] I/O Bus
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Network topology with Fieldbus

[1] Corporate network / Intranet
[2] I/O Bus
[3] Field device network / Fieldbus
[4] Fieldbus to I/O bus gateway
Network topology with Fieldbus

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Development of bus systems in the last decade

Clear consolidation to open communication fieldbus systems
All about Profibus

Relevance

- Profibus dominates the market with a worldwide connectivity of over 40%
- Profibus is the number 1 and major fieldbus technology and will keep dominance

Fieldbus organisation

- The Fieldbus club is PNO (Profibus User Organization) which administrates Profibus and ProfiNet technologies for 1400 member companies.
  - More details: www.profibus.com

Major suppliers

- The major supplier of Profibus network and control devices is Siemens.
- Some other PLC suppliers integrate Profibus platforms like Hilscher Sycon (e.g. Schneider Electric).
All about DeviceNet

Relevance
- Number 2 network in the world market
- Expected to keep place 2 in 2010

Fieldbus organisation
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Major suppliers
- Rockwell Automation (Allen-Bradley) is the major supplier for PLC and field devices
- Omron focuses DeviceNet networks in the Asian region

Regional DeviceNet distribution
Major vendors Rockwell Automation and Omron
All about Interbus

Relevance
- Interbus is a common fieldbus in the European automotive industry. The protocol was released in 1987 but it will just survive as niche application in some branches.

Fieldbus organisation
- The “Interbus Club” focuses actually to the adaptation and integration of Interbus systems into Profinet host systems
  - More details: www.interbusclub.com

Major suppliers
- The major supplier of Interbus network and control devices is Phoenix Contact.
All about CANopen

Relevance
- CANopen was designed for motion-oriented machine control networks, such as handling systems. Often used with PC based control systems. The main market is in Europe.

Fieldbus organisation
- The CiA (CAN in Automation)
  - focuses the development and extension of CANopen and CAN technology.
  - Integration of branch specific adaptations and generic device profiles
  - Other topics: General CAN, DeviceNet
  - More details: www.can-cia.org

Major suppliers
- CANopen is driven by a group of small- and middle-sized companies in central Europe
All about CC-LINK

Relevance
- CC-Link focuses regionally in Asia and especially Japan.
- Forecasts show that CC-Link looses market share.
- An Industrial Ethernet adaptation is not available.

Fieldbus organisation
- The CC-Link Partner Association (CLPA) supports CC-Link vendors from the head-office in Japan.
  - More details: www.cc-link.org

Major suppliers
- The major supplier of CC-Link network and control devices is Mitsubishi Electric.
All about ControlNet

**Relevance**
- Number 3 network in the North American market
- ControlNet actually loses relevance, many customers switch to Ethernet/IP
- With redundancy and determinism ControlNet is established as a niche fieldbus

**Fieldbus organisation**
- ControlNet International
  - Sub-organization of the ODVA
  - More details: www.controlnet.org

**Major suppliers**
- Rockwell Automation (Allen-Bradley) is the major supplier for PLC and field devices
Industrial Ethernet Fieldbus systems
What is Industrial Ethernet?

Industrial Ethernet describes:

- The adaptation of ethernet components into the rough industrial environment
- Fieldbus based communication protocols for use with or inside the TCP/IP stack
- The possibility of information access and engineering advantages through the local network and IT-technology
**Industrial Ethernet hardware components**

Typical components in ethernet networks are hubs and switches with RJ45 connectors

- The industrial environment defines higher conditions in the field:
  - High protection rates, e.g. IP65/67
  - Temperature
  - Vibration
  - Reliability, ...

- Typical office components cannot fulfill such conditions

- New definitions for special business orientations define special components

- The prices of industrial ethernet components are much more expensive
Industrial Ethernet Fieldbus concepts

To adopt the conditions of industrial networks, like real-time and availability, to ethernet based installations, new communication protocols have been created:

- Ethernet/IP
- Profinet
- MODBUS/TCP
- EtherCAT
- Ethernet Powerlink
Positioning and potential of individual bus systems at the field level

**Complexity of application**
- [sensors & actuators]
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**I/O Bus**
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- Automation plants

**Fieldbus**

**Drive-Bus**

**Industrial EtherNet**

**EtherNet TCP/IP**

**Plant/machine design**
- [dimensions & structure]
What is new with advanced fieldbus systems

- **Modular hardware configuration**
  Optimal and easy hardware configurations of complex and modular products may help to map I/O data to the plc projects and to locate easily parameters and diagnostic data.

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- **Integrated diagnostics**
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- **Bandwidth for process data and devices**
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- **Acyclic data access**
  Change of parameters and validation of advanced diagnostics during the run-time of the PLC program.
What is new with industrial ethernet fieldbus system

- **Higher bandwidth**
  Enables communication between controllers.
  Integration of more complex products with large I/O size

- **Expansion of network technology**
  More devices may be integrated into the fieldbus networks due to IP addressing technology with sub-networks.
  Network peripheries like WLAN routers, switches, proxy and gateway servers may be included.

- **Integration of IT-Technology**
  More diagnostic tools which are able to communicate to the field devices via ethernet from any point inside the control architecture.
Network topology with Fieldbus and Ethernet

[1] Corporate network / Intranet
[3] Field device network / Fieldbus
[4] Ethernet gateway server
Network topology with Industrial Ethernet

[1] Corporate network / Intranet
[3] Field device network / Fieldbus
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Network topology with Industrial Ethernet

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Network topology with Industrial Ethernet

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3. Field device network / Fieldbus
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Network topology with Industrial Ethernet

1. Corporate network / Intranet
2. Automation network / Ind. Ethernet
3. Field device network / Fieldbus
4. Ethernet gateway server
5. Fieldbus gateway devices
6. Industrial network peripherals
Trend review 2006-2002: Industrial Ethernet

2006: industrial Ethernet will co-exist with fieldbus – driven by complex applications
All about Ethernet/IP

Relevance
- Ethernet/IP (Ethernet Industrial Protocol)
- Part of Rockwell Automation network architecture
- Expected to win market share in the next years

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Major suppliers
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Regional Ethernet/IP distribution
All about ProfiNet

Relevance

- ProfiNet is supposed to dominate the market of industrial ethernet within the next years.

Fieldbus organisation

- The Fieldbus club is PNO (Profibus User Organization) which administrates Profibus and ProfiNet technologies.
  - More details: www.profibus.com

Major suppliers

- The major supplier of ProfiNet network and control devices is Siemens.
- Also Phoenix Contact provides a broad portfolio of ProfiNet controllers and field devices as well as active network devices.

Expected regional ProfiNet distribution
All about Modbus/TCP

Relevance
- Modbus TCP is actually strong in Schneider Electric host environments but also often integrated in PC based control
- Expected to win market share in the next years

Fieldbus organisation
- The Modbus-IDA
  - focuses the development and extension of the Modbus protocols for serial and ethernet communication
  - More details: www.modbus.org

Major suppliers
- Schneider Electric is the major supplier for PLC and field devices
All about EtherCAT

Relevance
- EtherCAT is a solution optimized for closed control chains in machines. With the fast cycle-time it is ideal for motion control
- Expected to win market share especially in Germany in the next years

Fieldbus organisation
- The EtherCAT technology group focuses the development and extension of the EtherCAT
  - More details: www.ethercat.org

Major suppliers
- Beckhoff is the core supplier for EtherCAT control and I/O systems
Fieldbus in process automation
### Complexity of Application

[Sensors and Actuators]

- **Enterprise Communication**
- **Plant Communication**
- **Drives and Remote I/O**
- **> 40% Analog**
- **> 90% Digitale Signale**

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**Installation Type**

[Dimension & Structure]

- **Package Units**
- **Utilities/Batch Plants**
- **Continuous/Large Plants**

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**Custom Numbers**

- **EtherNet TCP/IP**
- **Industrial EtherNet**
- **Plant-Fieldbus (z.B. Profibus DP, DP-IS, DeviceNet)**
- **Process-Fieldbus (z.B. Profibus PA, FF-H1)**
- **I/O Bus (AS-i)**
Process Fieldbus – Network Topology – Modern Concept
Control Architecture of large process plant

OS:
Operator Station – Monitoring and Operation of the plant

ES:
Engineering Station – Comparable to “Programming Device“

AS:
Automation System – the control element
All about Profibus PA

**Relevance**
- Profibus PA is dominant in Europe, worldwide it plays a smaller role

**Fieldbus organisation**
- The Fieldbus organisation is PNO (Profibus User Organization) which administers Profibus and Profinet technologies for 1400 member companies.
  - More details: www.profibus.com

**Major suppliers**
- As with Profibus DP, the major supplier of host systems is Siemens.
- Special Profibus PA Network Components are supplied by Pepperl&Fuchs, MTL-Relcom, Stahl.
All about Foundation Fieldbus H1

Relevance
- Foundation Fieldbus is the worldwide dominant Fieldbus for Process Automation

Fieldbus organisation

Major suppliers
- Host Systems: Emerson Process, Yokogawa, Honeywell, ABB
- Field Devices: Emerson Process, Yokogawa, Honeywell, ABB, Endress+Hauser, Siemens
- Network Components: Pepperl&Fuchs, MTL-Relcom, Stahl, Siemens.

Regional FF H1 distribution
2.1 Profibus PA and Foundation Fieldbus H1 – where is the difference?

**Profibus PA**

- Distribution mainly in Europe
- Technically close to Profibus DP – transparent coupling
- Supported by Siemens, ABB and any other manufacturer who supports Profibus
- DCS integration is GSD-Based (like Profibus DP)

**Foundation Fieldbus H1**

- Distribution mainly in NA and Asia
- Developed purposely for PA
- Offers additional functions: Control in the Field
- Supported by Emerson, Yokogawa, Honeywell, ABB
- DCS integration is EDD based
Process IO connection - HART

HART-Signal is modulated on an analog signal – like a modem!

Point-to-Point connection

**Analog**: Main Process Value

**HART**: Parameters, Secondary Process Values and Diagnostics