IEC61158 Technology Comparison

State of the Bus

Fieldbus Inc.

- Provides vendor-neutral fieldbus solutions to End Users, Device Vendors, and Others needing additional fieldbus expertise
- For Device Vendors FI can provide:
  - ▸ Development tools such as stacks and function blocks
  - ▸ Starter Kits
  - ▸ Training
  - ▸ Customized software and hardware
  - ▸ Complete drop-in solutions
- For End Users FI can provide:
  - ▸ Training
  - ▸ System Preparation (RFQ, scope, choosing host system and devices)
  - ▸ System Design
  - ▸ Installation Assistance
  - ▸ System Configuration Assistance
  - ▸ Commissioning Assistance
  - ▸ Long Term Support (Improve diagnostics, make use of fieldbus data, trouble-shooting, process refinement)

Fieldbus Inc. Contact Information

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Purpose

- Motivation for fieldbus projects

- Technical analysis of IEC 61158/61184

- Criteria for fieldbus standard technologies

- Comparison of process fieldbus technologies
  - Technical merits
  - Global significance

- Market for fieldbus

Fieldbus defined

- fieldbus - an industrial network system for real-time distributed control.

- fieldbus - any open, digital, multi-drop communications network for intelligent field devices

Viable Standardized Technology

- International recognition

- Market significance

- Global availability (global install base)

- Suppliers

- Support organizations (local and international)
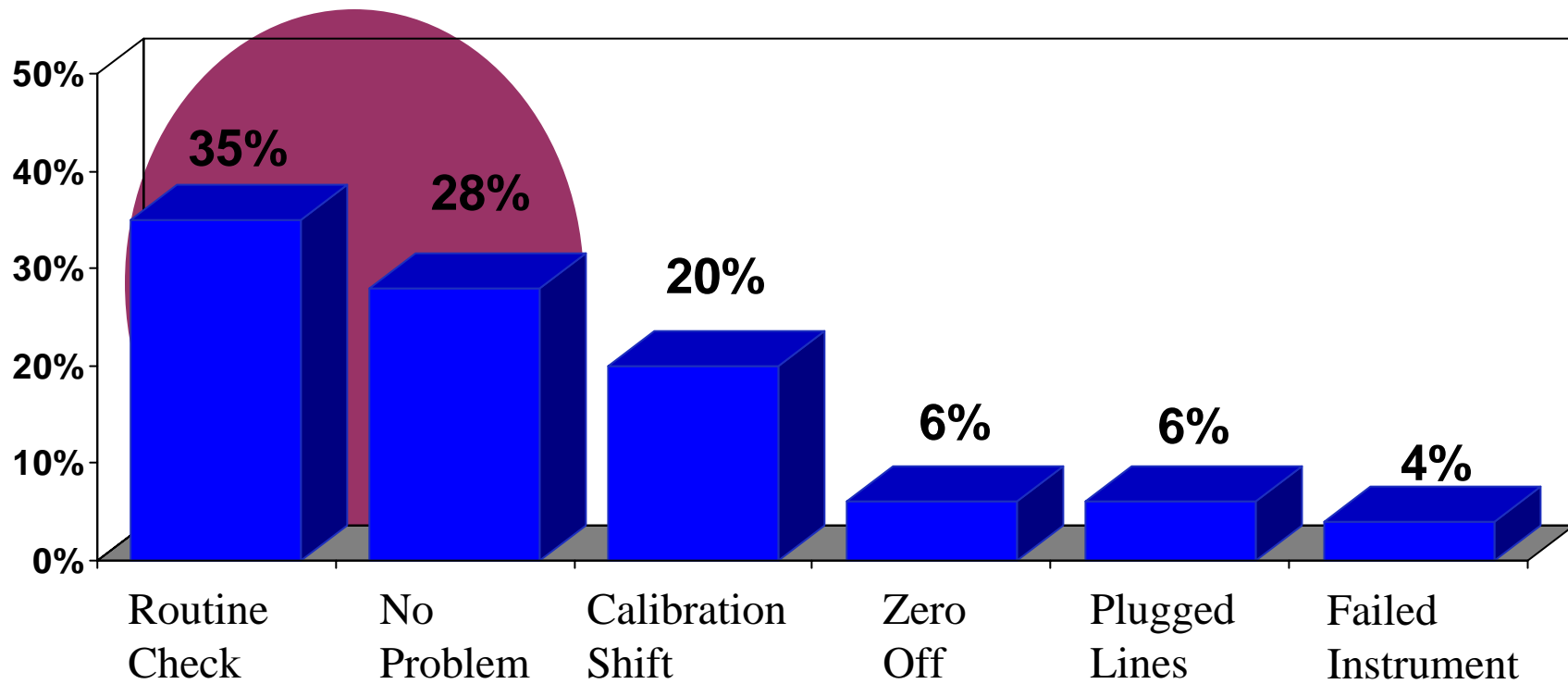
FIELDBUS MOTIVATION

The Justification For Fieldbus
Well Established

- Lower Project cost – helps with justification
  - Start-up and commissioning
  - Engineering and design
  - Control panels and real-estate
  - Cable and wiring
- Increase process availability
  - Realtime diagnostics
  - Remote Calibration
  - Process aware devices
  - Reduce unplanned shutdowns
- Asset Management benefits
  - Lower operating and maintenance cost
  - Aid in regulatory compliance
  - Improve plant operations and efficiency

"Unneeded" Trips To The Field Avoided Through Remote Diagnostics

Bar chart:
- Routine Check: 35%
- No Problem: 28%
- Calibration Shift: 20%
- Zero Off: 6%
- Plugged Lines: 6%
- Failed Instrument: 4%

Source: Dow Chemical Company

FIELDBUSES

fieldbuses listings online

- A-bus
- Arcnet
- Arinc 625
- ASI
- Batibus
- Bitbus
- CAN
- ControlNet
- DeviceNet
- DIN V 43322
- DIN 66348
- FAIS
- EIB
- Ethernet
- Factor
- FOUNDATION fieldbus
- FIP
- Hart

- IEEE 1118
- Instabus
- Interbus-S
- ISA SP50
- IsiBus
- IHS
- ISP
- J-1708
- J-1850
- LAC
- LON
- MAP
- Master FB
- MB90
- MIL 1553
- MODBUS
- MVB
- P13/42

- Partnerbus
- P-net
- Profibus-FMS
- Profibus-PA
- Profibus-DP
- PDV
- SERCOS
- SDS
- Sigma-i
- Sinec H1
- Sinec L1
- Spabus
- Suconet
- VAN
- WorldFIP
- ZB10

International Electrotechnical Commission

IEC

IEC

- International Electrotechnical Commission
  - Founded 1906

- National Committees of member countries
  - P – participant members
  - O – observer members

- One Country = One Vote

- 2/3 of National Committees must agree

- 5 National Committees must serve as editor

- Negative votes require justification

Participant Countries
IEC 61158 – 29 participants

Austria
Belgium
Canada
China
Czech Republic
Denmark
Finland
France
Germany
Hungary
Italy

Japan
Korea, Republic of
Luxembourg
Mexico
Netherlands
New Zealand
Norway
Poland
Portugal
Romania
Russian Federation

Slovakia
South Africa
Spain
Sweden
Switzerland
United Kingdom
United States of
America

Observer Countries
IEC 61158 – 11 observers

Australia
Bulgaria
Greece
India
Ireland
Malaysia
Serbia
Singapore
Slovenia
Turkey
Ukraine

Examining IEC 61158

FIELDBUS SPECIFICATIONS

Specifications
IEC 61158

- Digital data communications for measurement and control - Fieldbus for use in industrial control systems

- 1999 - first release

- 2003 - revised

- 2007 – revised
  - additional technologies
  - technology removal

IEC 61158
Structure

- IEC 61158-1: Fieldbus for use in industrial control systems - Part 1: Introductory guide

- IEC 61158-2: Fieldbus for use in industrial control systems - Part 2: Physical Layer specification

- IEC 61158-3: Fieldbus for use in industrial control systems - Part 3: Data link layer service definition

- IEC 61158-4: Fieldbus for use in industrial control systems - Part 4: Data link layer protocol specification

- IEC 61158-5: Fieldbus for use in industrial control systems - Part 5: Application layer service definition

- IEC 61158-6: Fieldbus for use in industrial control systems - Part 6: Application layer protocol specification

IEC 61158 ("Original" 1999- 2008)
Types of fieldbus

- Foundation fieldbus H1 & H2 from SP50 (Type 1)

- ControlNet (Type 2)

- Profibus- DP, PA (Type 3)

- P-Net (Type 4)

- Foundation fieldbus HSE (Type 5)

- Swiftnet (Type 6)

- WorldFIP (Type 7)

- Interbus-S (Type 8)

IEC 61158 (Updated 2008)

- Added many additional fieldbus types

- Dropped at least one (SwiftNet)

- Re-organized types into Communication Profile Familes (CPF)

IEC 61158 - 2008

- 79 communication technologies

- 15 Communication Profile Families

- IEC 61158 - Industrial communication networks - Fieldbus specifications

- IEC 61784 - Industrial communication networks - Profiles

IEC 61158 – 2008

- CPF Number 1 – FOUNDATION Fieldbus
  - ▸ H1, H2, HSE

- CPF Number 2 – CIP
  - ▸ ControlNet, EtherNet/IP, DeviceNet

- CPF Number 3 – Profibus
  - ▸ DP, PA, Profinet (4 types)

- CPF Number 4 – P-NET
  - ▸ P-NET RS-485, P-NET RS-232, P-NET on IP

- CPF Number 5 – WorldFIP
  - ▸ 3 types

- CPF Number 6 – InterBus
  - ▸ Several types

IEC 61158 (Updated 2008 continued)

- CPF Number 8 – CC-Link
  - ▸ 3 types

- CPF Number 9 – HART

- CPF Number 10 – Vnet/IP

- CPF Number 11 - TCnet
  - ▸ 2 types

- CPF Number 12 – EtherCat

- CPF Number 13 – Ethernet Powerlink

IEC 61158 (Updated 2008 continued)

- CPF Number 14 – EPA

- CPF Number 15 – MODBUS-RTPS
  - ▸ MODBUS-RTPS
  - ▸ MODBUS TCP

- CPF Number 16 – SERCOS
  - ▸ Types I, II, and III

FIELDBUS MARKET

Worldwide Installed Devices
Continuous Process Control

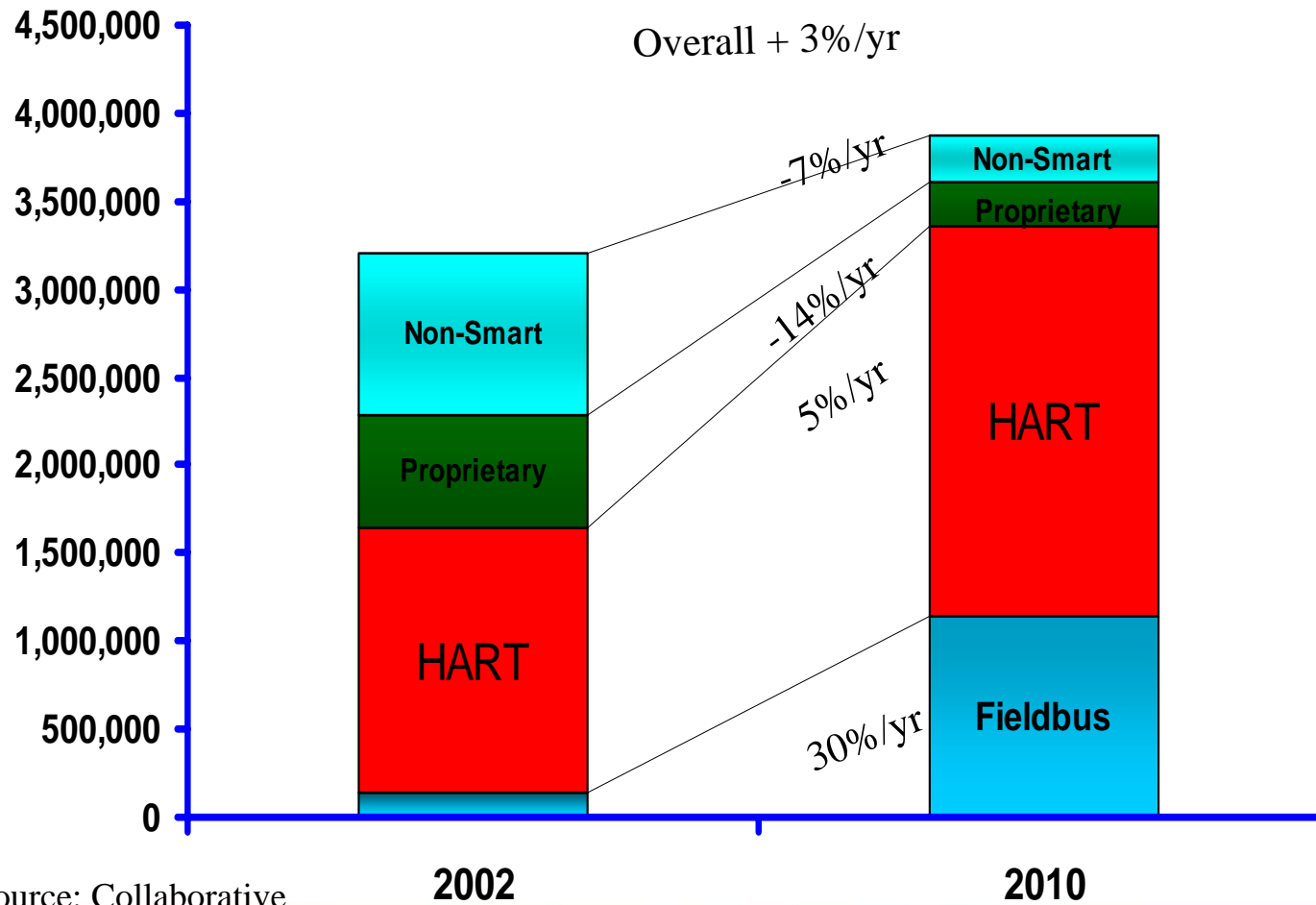56 Million Installed Devices in 2006

33%

12%

10%

3%

42%

■ HART ■ Fieldbus ■ Proprietary ■ 4-20mA + ■ Pneumatic

Smart

Non - Smart
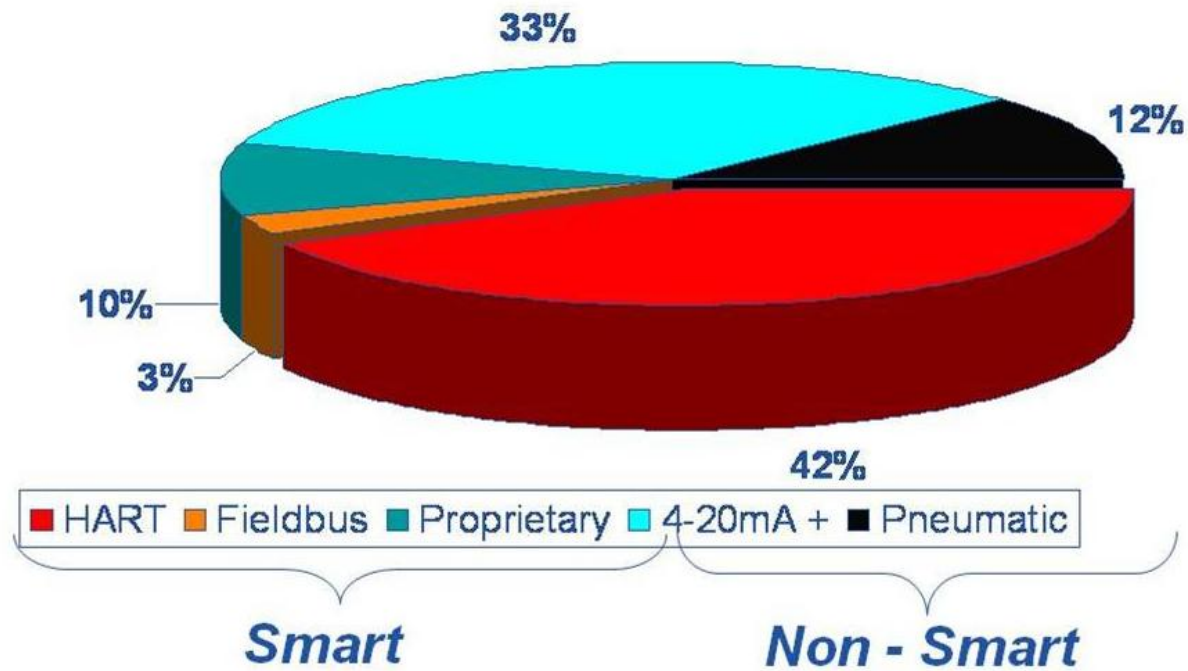
Source: ARC Advisory Group

45% of the installed base must be upgraded.

Market Outlook - Intelligent Devices

Overall + 3%/yr

4,500,000
4,000,000
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0

Non-Smart

Proprietary

HART

-7%/yr
-14%/yr
5%/yr
30%/yr

Non-Smart

Proprietary

HART

Fieldbus

Source: Collaborative

2002

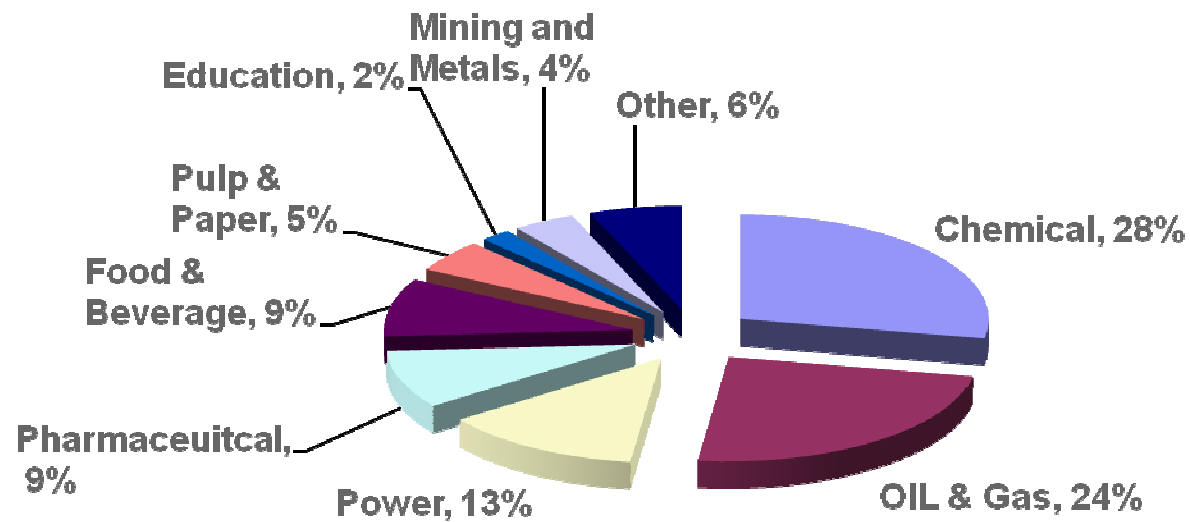**2010**

Your Fieldbus Solution Source

Market Drivers

- End User situation
  - ▶ Fewer people to manage assets
  - ▶ Greater need to continuously reduce maintenance cost
  - ▶ Understand the benefit of using available devices & to use process information to better manage operations
  - ▶ Need to extract the highest possible value from existing and future investments

- Technology enhancements
  - ▶ Integrated data - possible with control system enhancements
  - ▶ Digital integration – combinations of networks & technologies
  - ▶ Fieldbus has come of age
    - Participation from most major suppliers
    - Many device types – and growing
    - Field proven, tested and documented
    - Being installed globally by all major industries

Global Industry Distribution
FOUNDATION fieldbus

Education, 2% | Mining and Metals, 4%
Pulp & Paper, 5%
Food & Beverage, 9%
Pharmaceuitcal, 9%
Power, 13%
Other, 6%
Chemical, 28%
OIL & Gas, 24%

Source FF EPC Seminar in Japan 2006

Your Fieldbus Solution Source

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Market Leaders Install Fieldbus

- Chemical & Petrochemical
  - Witco Specialty Chemicals
  - Shell Chemical
  - Lyondell
  - BASF
  - Deten Chemicals
  - Degussa
  - Akzo Nobel
  - Castrol
  - Carbowil Spolkz
  - Shin-Etsu
  - Yanshan Ethylene Complex
  - Juhua Chemical

- Oil & Gas
  - Pemex
  - Calcasieu
  - Athabasca Oil
  - Syncrude Canada
  - Shell Oil
  - Shell Petroleum Development
  - PDVSA
  - Comestible
  - Snam Rete
  - Gaz De France
  - Kvaerner
  - Sakhalin
  - Murphy Oil

Market Leaders Install Fieldbus

- Power
  - ‣ Aurora Energy
  - ‣ Montana-Dakotas Utilities
  - ‣ Austin Utilities
  - ‣ Pietrafitta Nuova
  - ‣ Duke Energy
- Food & Beverage
  - ‣ Canandaiqua Winery
  - ‣ Quest Food
  - ‣ Allied Domecq
  - ‣ Guinness Anchor
- Water & Wastewater
  - ‣ Orange County
  - ‣ City of Scottsdale
  - ‣ Dekalb County
  - ‣ Changi Water Reclamation
  - ‣ Tennessee Valley Authority

- Metals & Mining
  - ‣ American Soda Mine
  - ‣ Lurgi
  - ‣ BHP Billiton
- Pulp & Paper
  - ‣ Bowater
  - ‣ Abitibi Newsprint
  - ‣ Avenor
  - ‣ Forchem Greenfield CTO
- Pharmaceuticals & Biotech
  - ‣ Novo Nordisk
  - ‣ AstraZeneca
  - ‣ Pfizer
  - ‣ Amersham
  - ‣ GlaxoSmithKline

Examining IEC 61158

FIELDBUS COMPARISON

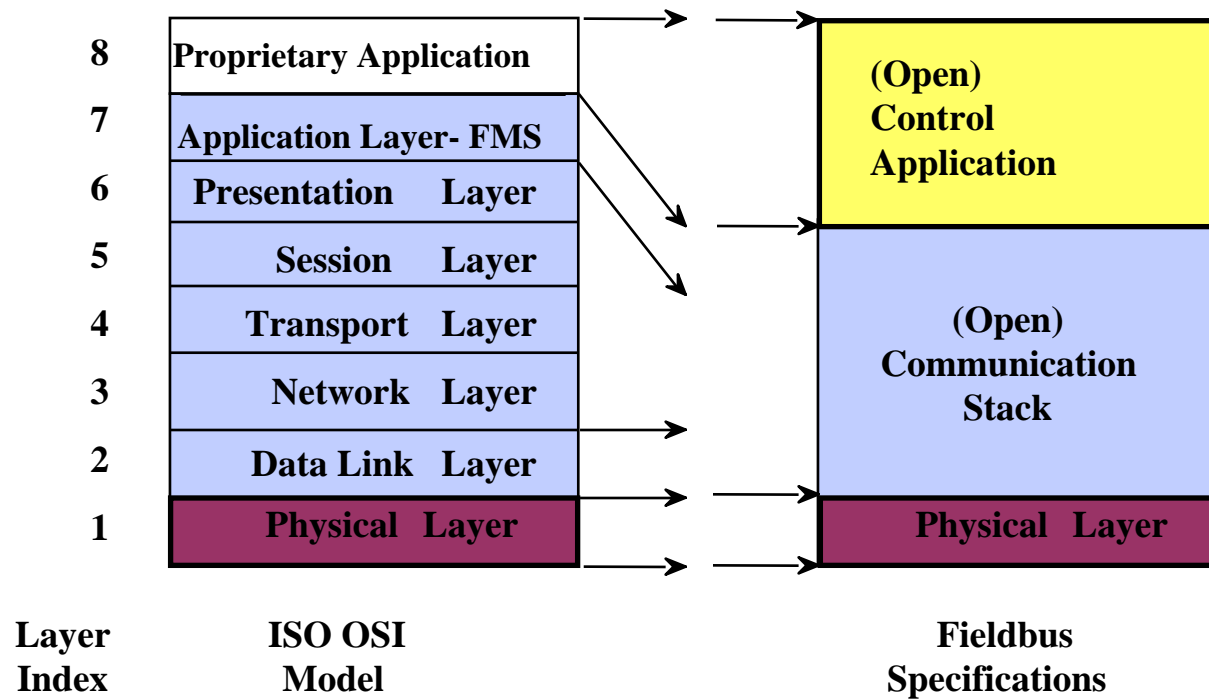# Many Buses in the Process and Manufacturing Industries

- ## IEC Standard buses
    - ▸ ControlNet, FF H1, FF HSE, Profibus,
    - ▸ Interbus-S, P-net, CAN

- ## Defacto Standard buses
    - ▸ HART, MODBUS (now IEC too)

- ## Others
    - ▸ AS-i, LON

Focus on Broad Application Process Technologies In Use and Growing

- FF H1

- FF HSE

- Profibus PA (Process Automation)

- ProfiNet

- Profibus DP (Decentralized Peripherals)

- MODBUS

- HART

Fieldbus OSI Layered View

Layer Index	ISO OSI Model	Fieldbus Specifications
8	Proprietary Application	(Open) Control Application
7	Application Layer- FMS	
6	Presentation Layer	
5	Session Layer	(Open) Communication Stack
4	Transport Layer	
3	Network Layer	
2	Data Link Layer	
1	Physical Layer	Physical Layer

Physical Layer Comparison

Bus Technology	Standards	Pwr w/Comm	Comm Type	Comm Speed	IS Possible	Max Distance	# devices
FF H1	IEC 61158, ISA SP50	Yes	All Digital	31.25 Kbs	Yes	1.9km, 9.5 km	32 per seg
Profibus PA	IEC 61158	Yes	All Digital	31.25 Kbs	Yes	1.9km, 9.5 km	32 per seg
FF HSE	IEC 8802, IEEE 802.3	No	All Digital	100 Mbs, 1 Gbs	No	100 m	Unlimited
ProfiNet	IEC 8802, IEEE 802.3	No	All Digital	100 Mbs, 1 Gbs	No	100 m	Unlimited
MODBUS	IEEE 1451.2, TIA-485	No	All Digital	9.6 Kbs – 12 Mbs	No	1512 m	247 per seg
Profibus DP	IEEE 1451.2, TIA-485	No	All Digital	9.6 Kbs – 12 Mbs	No	1512 m	247 per seg
HART	Bell 202, 4-20mA	Yes	Digital over analog	1.2 Kps – 9.6 Kps	Yes	3.0 km	1 w/Analog, 64

Data Link Layer Comparison

Bus Technology	Standards	Data Link Type	Error Detection	Deterministic	Comm Relationships	Time Features
FF H1	IEC 61158, ISA SP50	Token Passing	16-bit CRC	Yes	Client/server, pub/sub, sink/source	TM distributes time
Profibus PA	IEC 61158	Token Passing	16-bit CRC	Yes	Master/slave	None
FF HSE	IEC 8802	Token Passing	16-bit CRC	No	Client/server, pub/sub, sink/source	TM distributes time
ProfiNet	IEC 8802	Token Passing	16-bit CRC	No	Master/slave	None
MODBUS	None	master/slave address scheme	1-bit	No	Master/slave	None
Profibus DP	IEC 61158	master/slave address scheme	1-bit	No	Master/slave, pub/sub	None
HART	None	Flat addressing	CRC	No	Master/slave	None

Application Layer Comparison

Bus Technology	Standards	Data Transfer	Supports Control in the Field	Peer to Peer Comm	Alerts and Trends in Devices	Time Features
FF H1	IEC 61158, ISA SP50, Function block application based on IEC 61804 (Draft)	AI, AO, DI, DO, PID, PD, CS, MIO, many more	Yes	Yes	Yes	Single sense of time
Profibus PA	IEC 61158	AI, AO, DI, DO	No	No	Yes	None
FF HSE	IEC 61158	Same as H1	Yes	Yes	Yes	Single sense of time
ProfiNet	IEC 61158	Same as DP	No	No	Yes	None
MODBUS	IEC 61158	Registers	No	No	No	None
Profibus DP	IEC 61158	AI, AO, DI, DO	No	No	No	None
HART	IEC 61158	Commands	Yes	No	No	None

HISTORY

HART History

- ## Rosemount (Emerson) - 1986
  - ▸ Developed

- ## Open Protocol -1990

- ## HART User Group - 1990

- ## HART Communication Foundation – 1993

- ## IEC 61158/IEC 61784 – 2007
  - ▸ International Electrotechnical Commission

Modbus History

- Modicon (Schneider Electric) - 1979
  - Developed
  - Open protocol

- Modbus IDA – 2004

- IEC 61158/IEC 61784 – 2007
  - International Electrotechnical Commission

PROFIBUS History

- field bus – 1987
  - ▶ 21 German companies and institutes
- PNO – 1989
  - ▶ Profibus Nutzerorganisation
- DIN 19245 - 1991/1993
  - ▶ German Institute for Standardization
- EN 50170 – 1996
  - ▶ European Committee for Standardization
- IEC 61158/IEC 61784 – 1999
  - ▶ International Electrotechnical Commission

FOUNDATION fieldbus History

- ISA SP50 – 1988

- ANSI/ISA – S50.02 – 1994
  - American National Standard

- ISP Foundation – 1993
  - Merged with WorldFIP North America 1996

- Fieldbus Foundation – 1996

- IEC 61158/IEC 61784 – 1999
  - International Electrotechnical Commission

MARKET DATA

HART Market Data

- Installations all over the world
- Over 200 HART member companies
- 26 million HART devices currently in service
- 8+ different suppliers have registered devices
- Over 10 registered HART devices

- Focus is on drop-in replacement of 4-20mA devices.

Source: HART Communication Foundation website, August 2008

Your Fieldbus Solution Source

Modbus Market Data

- Installations all over the world
- Over 58 Modbus member companies
- Large number of Modbus devices currently in service
- 19+ different suppliers have registered products
- Over 50 registered Modbus products
- 39 tested and registered host systems

- Focus is on PLC/IPC systems (SCADA).

PROFIBUS Market Data

- Installations all over the world
- Over 1400 PROFIBUS member companies
- 25 million PROFIBUS (DP,PA, etc) devices currently in service
- 750,000 PROFIBUS PA devices installed
- 1.14 million PROFINET nodes
- 52+ different suppliers have registered devices
- Over 113 total registered PROFIBUS devices
- Over 34 registered PROFIBUS PA devices

- Focus is on discrete and manufacturing process.

Source: Profibus International website, September 2008

Your Fieldbus Solution Source

FOUNDATION fieldbus Market Data

- Installations all over the world
- Over 350 FF member companies
- 950,000 fieldbus devices currently in service
- 11,000 fieldbus systems installed or on order
- 65+ different suppliers have registered devices
- Over 250 registered FF devices
- 20 FF Host Systems from 11 companies have passed Host Interoperability Support Test(HIST)

- Focus is on continuous process.

Source: Fieldbus Foundation website, August 2008

ORGANIZATIONS

Organizations - 2008

- FOUDATION fieldbus
  - ▶ Fieldbus Foundation (FF)
  - ▶ www.fieldbus.org

- HART
  - ▶ HART Communication Foundation (HCF)
  - ▶ www.hartcomm.org

- PROFIBUS
  - ▶ PROFIBUS International (PI)
  - ▶ www.profibus.com

- Modbus
  - ▶ Modbus IDA (Modbus)
  - ▶ www.modbus.org

SUMMARY

Summary - HART

- Defacto standard for smart devices (~20 years)
- Benefits of 4-20 signal and digital info
- Can be used in IS areas
- Slow digital communications
- Limited multi-drop capabilities
- Mediocre host support (improving)
- Continues to grow
- Wireless HART

Summary - MODBUS

- Defacto standard for PLC and IPC (~30 years)
- Large installed base
- Mostly for simple and PLC interfaces
- Cannot be used in IS areas
- Fast digital communications
- Tested proven technology
- Custom host interfaces

Summary - Profibus DP

- Large installed base
- Mostly for manufacturing automation
- Cannot be used in IS areas
- Fast digital communications
- Tested proven technology
- Custom host interfaces

Summary - Profibus PA, ProfiNet

- PA is mostly found in Germanic Countries
- Can be used in IS areas
- Digital communications fast enough
- No control in the field
- ProfiNet is the backbone solution

Summary - FF H1, FF HSE

- Digital replacement of 4-20
- Can be used in IS areas
- Digital communications fast enough
- Control in the field
- HSE is the backbone solution (not well received)

Fieldbus Technology Challenges

Users see the following as some of the challenges

- Selecting the best combination of bus technologies for the application
- Integration options and solutions
- The "costs" of the technology
- Technology training & development at all levels of the organization
- Testing and interoperability issues
- Next generation of products must simplify the entire process and reduce the "pain"
- Simplify licensing

Common Mistakes

- Wait for the market to decide which technology will win

- Building a plan that positions fieldbus as "the" solution

- Think that fieldbus implementation is fast and easy

- The competition is going to wait to see how this all shakes out

- Think that you need to do fieldbus by yourself

Recommendations

- Contact your key suppliers to discuss their fieldbus plans and activities

- Create or update your device communication strategies

- Review your current installations

  ▸ Update to current standards

  ▸ Identify new market expectations

- Get key staff trained on target technologies

- Budget appropriate resources and funding to match communication strategies & implementations

- Prepare an integration position to include technology on key projects

- Use fieldbus technology to improve overall plant efficiency

Summary – IEC 61158

- Specification provides a single document for comparison of technologies.

- Specification does not provide the end user with a single best option.

Summary – IEC 61158

- Value to the user
  - Single format
  - Summary of technologies

- Value to the developer
  - Single format
  - Summary of technologies

- Value to the organizations
  - International approval
  - Recognition

Conclusion

- Commonly accepted that plants must implement intelligent devices and common communication technology.

- All technologies discussed meet the criteria for viable technology.

- Application of technology is your guide.

The Future

- Market decision further refines choices

- More collaboration
  - EDDL and FDT/DTM
  - FF, HART, and PROFIBUS

Thank You

- Questions

- Discussion

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Your Fieldbus Solution Source