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, troubleshooting, process refinement)
Fieldbus Inc. Contact Information

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9390 Research Blvd., Suite I-350
Austin, Texas USA 78759
+1.512.794.1011
www.fieldbusinc.com
fi-info@fieldbusinc.com
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

Source: Dow Chemical Company
### 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**

<table>
<thead>
<tr>
<th>Austria</th>
<th>Japan</th>
<th>Slovakia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>Korea, Republic of</td>
<td>South Africa</td>
</tr>
<tr>
<td>Canada</td>
<td>Luxembourg</td>
<td>Spain</td>
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<td>New Zealand</td>
<td>United Kingdom</td>
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<td>Finland</td>
<td>Norway</td>
<td>United States of America</td>
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<tr>
<td>France</td>
<td>Poland</td>
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<td>Germany</td>
<td>Portugal</td>
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<td>Hungary</td>
<td>Romania</td>
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<tr>
<td>Italy</td>
<td>Russian Federation</td>
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</tbody>
</table>
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 61158-3: 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 Families (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

- **Smart** (42%)
- **Non-Smart** (58%)

- 45% of the installed base must be upgraded.

Source: ARC Advisory Group
Market Outlook - Intelligent Devices

Overall + 3%/yr

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

Source: Collaborative

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

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

Source FF EPC Seminar in Japan 2006
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
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  ▸ Integrated data - possible with control system enhancements
  ▸ Digital integration – combinations of networks & technologies
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    • Many device types – and growing
    • Field proven, tested and documented
    • Being installed globally by all major industries
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 |  
7 | Application Layer - FMS | (Open) Control Application
6 | Presentation Layer | (Open) Communication Stack
5 | Session Layer | Physical Layer
4 | Transport Layer | Physical Layer
3 | Network Layer |  
2 | Data Link Layer |  
1 | Physical Layer |  

Fieldbus Specifications

Your Fieldbus Solution Source
## Physical Layer Comparison

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

Your Fieldbus Solution Source
## Data Link Layer Comparison

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

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

Source: Modbus IDA website, September 2008
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
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

Contact:
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fi-info@fieldbusinc.com