Foundation Fieldbus - Working Today, Preparing for tomorrow

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Director, Industrial Networks
MTL Instrument Group
Today’s Agenda

• Fieldbus Global Projects
  – Global Projects
  – Middle East

• Fieldbus Solutions Today
  – EDDL
  – H1 and HSE

• Digital Control System Trends
  – EDDL Improvements
  – Fieldbus Safety
  – HSE
Fieldbus Implementation
Distribution of Device Types

255 unique and 378 total devices registered
Fieldbus Today

Markets Served

600,000 devices

9000 Systems
Market Distribution

Global

- NA: 43%
- EUR: 25%
- AP: 13%
- MEA: 7%
- LA: 12%

Industry

- Oil & Gas: 29%
- Chemical: 22%
- Other: 8%
- Power: 13%
- Pharmaceutical: 9%
- Food & Beverage: 9%
- Pulp and Paper: 4%
- Education: 3%
- Mining and Metals: 3%

Chemical Industry
Installed Devices

Fieldbus Devices

Global
Middle East

2001 2002 2003 2004 2005 2006
Today’s Fieldbus Solutions
Fieldbus devices are connected in parallel on the bus, which carries digital data from/to all the devices on the bus.

Fieldbus devices provide information to all other devices on the network.
High Speed Ethernet

11 New FF Specifications

FUNCTION BLOCKS

New Protocol Specifications for HSE

HSE APPLICATION PROTOCOL

STANDARD ETHERNET “STACK”

Ethernet Physical Layer

New Function Block Specifications for HSE

Flexible Function Block (MIO)
Flexible Function Block (61131)
FFB Application Guide
Multi - Variable Optimization

Commercial, Off The Shelf (COTS)
Ethernet Equipment

System Architecture Addendum
System Management Addendum
Network Management Addendum
Data Link Addendum - Bridging
Ethernet Presence
Field Device Access Agent
Redundancy
FF Bridges Between FF Networks

Linking Device

FIELDBUS H1

DEVICEs ON DIFFERENT NETWORKS
Live Demo – Modified Logic

Filter B Sequence Logic Runs in HSE FFBs

Filter A
Filter B
Filter C

Run in DeltaV
Run in HSE FFBs
Run in DeltaV

Smar FFB
Softing FFB

DeltaV Commands Smar FFB to run
Softing FFB operates 5 valves and then passes control back to DeltaV

Permissives

Nitrogen Pressure Invensys
∆Pressure across Filters Yamatake
Nitrogen Temperature Yokogawa

Westlock Positioners Driving 8’ Butterfly Valves
HSE Not The End of H1

<table>
<thead>
<tr>
<th></th>
<th>H1</th>
<th>HSE</th>
</tr>
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<tbody>
<tr>
<td>Speed</td>
<td>31.25 kbit/s</td>
<td>10 Mbit/s or 100 Mbit/s</td>
</tr>
<tr>
<td>Distance (per segment)</td>
<td>1,900 m (1.2 miles)</td>
<td>100 m (300 ft)</td>
</tr>
<tr>
<td>Two-wire</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Multidrop</td>
<td>Yes</td>
<td>No (UTP)</td>
</tr>
<tr>
<td>Bus-power</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Intrinsically safe</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Redundancy</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Deterministic</td>
<td>Yes</td>
<td>Yes (with switches)</td>
</tr>
</tbody>
</table>

- H1 used for field instruments
- HSE used at the host-level
- H1 and HSE complement each other
Operations & Maintenance

- Higher sustained production with minimize costs
- Safer operation
- Fewer unscheduled outages
- Shorter scheduled outage
- Longer duration to scheduled outage
- Faster time-to profit

Cash Flow
Expanded System View

**DCS:** Limited system view. Does not include diagnostics and other information from field devices.

**FCS:** Expanded view. Field devices are part of the system.

```
15.3 mA

Tag = LIC-012
Value = 70.34
Units = m³
Status = GOOD
Alarm = Y/N
```
Increased Information

- Information is available for decision making
- Conventional analog system
  - 4 - 20 mA has very limited information content (PV only)
- Fieldbus system
  - instrument identification, location
  - status of PV
  - ambient conditions
  - diagnostics
  - configuration
  - instrument characteristics
  - calibration information: date, method, location, etc.
Areas of failures

- Sensors: 48%
- Actuators: 30%
- I/O: 15%
- Wiring: 5%
- CPU: 2%
Device Maintenance Effort

63% of time is spent investigating “problems” that do not exist. Fieldbus will tell you this so it will no longer be necessary to check these reports.
Asset Management Drivers

- Maintenance Cost Reduction Drives End Users
- 40% of Mfg. Cost is Maintenance
- 50% of Maintenance Is Corrective
  - 10 times More Costly Than Preventative Maintenance
- Preventative Maintenance is Done 25% of Time
  - 5 Times More costly Than Predictive Maintenance
- 60% of Preventative Maintenance is Unnecessary

From ARC Independent Research
Maintenance Savings

- Estimated 10-20% saving in maintenance
  - Assignment of maintenance tasks to operators / right people to do the task
  - Better field diagnostics
  - Better preventative maintenance data
  - Less false alarms
  - Faster troubleshooting
Operations & Maintenance

• Operational efficiency improved by up to 2%
• Predictive maintenance
  – schedule maintenance based on device diagnostics
  – increase plant availability
Characterizing Change

Mean

Standard Deviation: $\sigma$

3$\sigma$ 2$\sigma$ 1$\sigma$ 1$\sigma$ 2$\sigma$ 3$\sigma$

68% 95% >99%

>99%
Impact of Tighter Loop Control

- Digital
- Analogue
- Pneumatic
- Manual

Control Limit
Maintenance

- Expandability and long term maintainability
  - sensors are field-upgradeable
  - open, interoperable technology
    - buy spares from third parties to keep price down
    - buy spares from those who stock, i.e. user need not keep stock
    - “best of its kind” device may be used independent of manufacturer
Periodic diagnostic monitoring

Host control system

Instrument Management Software (including fieldbus diagnostics)

power supply system

Controller I/O

Fieldbus

Hand-held Diagnostic Module

wiring components
Commissioning procedure

- Connect fieldbus tester at each field device and at rack room
  - record readings in each location
- Upload readings to PC
On-line diagnostic monitoring

Host control system

Instrument Management Software
(including fieldbus diagnostics)

Controller I/O

F800 Series fieldbus
power supply system

H1 Fieldbus

Basic failure alarms

F809F on-line
Diagnostic Monitor

Field junction box

Segment 1 of 8
MTL F809F on-line monitoring

- Continuously monitors segment parameters
- Monitors 8 fieldbus segments
- Reports parameters over FOUNDATION fieldbus™ H1
  - Module is a Fieldbus device
- Diagnostic software
  - Integrated in Asset Manager system instrument management software
MTL F809F on-line monitoring

- Open solution
  - FOUNDATION fieldbus™ H1 device easily integrates with Honeywell Experian PKS system
  - Full device description support
- Future proof architecture
  - Fieldbus DTM support planned
  - Enhanced eDDL support planned
- Minimises total cost of ownership by integrating into fieldbus H1 system
  - No additional hardware costs
  - No additional costs in installing, commissioning and maintenance of separate network
  - Instrumentation team use same software for physical layer and fieldbus device diagnostics
MTL F809F prototype results

- Discrete input block
- Resource block
- Segment transducer blocks
- F809FS device
Fieldbus’ Future
EDDL Cooperation Team
Phase 1 Enhancements

- Graphing – Use EDDL for graphical display of static Y-t and XY data
- Charting – Use EDDL for graphical display of real-time data from device
- Enhanced User Interface – Use EDDL to describe screen layout
- Enhanced Data Storage - Use EDD to securely store data on the host

✓ Phase 1 Specification in IEC 61804-3 Edition 1 CDV
✓ Phase 1 Approved Change Requests in IEC 61804-3 Edition 1 CDV
✓ Phase 1 Interoperability Guideline is IEC 61804-4 Edition 1 DTR
Visualization Extensions for Sensor/Actuator Configuration, Motor Control, Radar Level Configuration, Valve Signatures and Other Complex Configuration and Diagnostic Applications

- Parameter organization
- Windows, dialogs, group boxes
- Integration of images
- Support for charts and graphs
- Multiple plots
- Interactive zooming
- Direct editing of graphs
- Emphasis, key points, notes
Extensions for Improved Control of Data Storage on the Host System by the Field Device for Complex Valve Diagnostics, Sensor Drift, Sensor/Actuator Diagnostics and Archived Valve Signatures Applications

- Independent of host operating system
- Independent of host file system
Enhanced User Interface Example

Parameter Organization

Group Boxes

Dialogs

Window

DD Cooperation Project
DD Cooperation Project

Radar Gauge Example

Configuration of thresholds and false echo areas

Radar Gauge Threshold Calibration

Data from Device

Graph

Axis

Waveform
(Data from Device)

Menus & Methods
(Enhanced UI)

Array(s)
(Device Data)

File/List
(Persistent Data)
DD Cooperation Project
Valve Step Example

Real-time Step Response of a valve.

VALVE STEP RESPONSE DIAGNOSTICS

CHART

SOURCEs
(Stored Data and Data from Device)

AXIS

MENUS & METHODS
(Enhanced UI)

ARRAY(s)
(Device Data)

FILE
(Persistent Data)

Travel (From device)

Setpoint (Stored)
Valve Signature (Hysteresis) as a measure of the air pressure to stroke the valve open and close.

**Graph**

**Waveform**
(Data from Device)

**Axis**

**Menus & Methods**
(Enhanced UI)

**Array(s)**
(Device Data)

**File/List**
(Persistent Data)
Best Fit Example

“Best Fit” line can be drawn using new features in DD Methods.

*GRAPH*
*WAVEFORM* (Data from Device)
*AXIS*
*MENUS & METHODS* (Enhanced GUI)
*ARRAY(s)* (Device Data)
*FILE* (Persistent Data)
Motor Control Example

Display motor starts, operating hours, number of overload trips, etc.

Image
EDDL Phase 2 – Scaleable Device Integration

- Simple and complex device integration requires only EDDs
- Advanced requirements utilize OPC UA client applications driven by OPC UA server resident EDDs for online and offline data access
Phase 2 Application Architecture

Client Applications

- OPC UA Client(s)
- Operator HMI
- Configuration/Maintenance
- Trend/Historian
- Plant/Enterprise (e.g. MRP, ERP, Optimization)

Enhanced Procedural Support for Complex Devices

- Off-Line Configuration
- HSE Remote I/O
- HSE Field Device
- H1 Remote I/O
- H1 Linking Device
- HSE OPC UA Server(s)
- HSE EDDL

Blue line is a reference retrieved via FILE and ARRAY EDDL Cooperation Project

Operational Support for Complex Devices

- Enhanced Procedural Support
- Off-Line Configuration
- HSE Remote I/O
- HSE Field Device
- H1 Remote I/O
- H1 Linking Device
- HSE OPC UA Server(s)
- HSE EDDL

Blue line is a reference retrieved via FILE and ARRAY EDDL Cooperation Project
Fieldbus Safety

Design to IEC 61508

Black Channel

Design to IEC 61508

FF-SIS Communication Diagnostics

New SIS Function Blocks & Function Block Diagnostics
Example SIS Application Analog 2 out of 3 Voter
New Fieldbus Initiatives
Fieldbus Wireless

• Communications of Diagnostic Data for Maintenance
  – Integrate with Asset Management solutions
  – Accessible by Technicians in the field

• Build on work of HART Wireless and ISA-100 Committees
HSE Remote I/O

• Requirements for High Speed Ethernet Remote I/O (HSE-RIO)
  – discrete I/O
  – gateways to other lower level networks
    – HART
    – Profibus
    – Modbus
    – AS-I
    – DeviceNet, etc.

• Preliminary Schedule
  – Started January 2007
  – Completion Q4 2008
Foundation Fieldbus
Today’s Solution
The platform for Tomorrow
Questions

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Economic Life Cycle

Engineering, Construction, & Commissioning/Start-up  Operations & Maintenance  Replace

Cash Flow  Time

- Analog
- Fieldbus
Fieldbus Project Costs

• Estimated Project Savings
  – Materials/Field Devices: Increased by 25%
  – Installation Labor: Reduced by 50%
  – Commissioning: Reduced by 75%
  – Engineering: Reduced by 50%

• Overall Capital Savings of 25 – 30%
  – However savings will only be realized if the project is planned as a fieldbus project.
Fieldbus as a Cable Multiplier

Three existing 4-20 mA Pairs

Three existing pairs, one used for fieldbus
Termination count

Field

Marshalling done in Junction Box with Fieldbus so Marsh Cab is optional

Totals: 75 Analog
34 Fieldbus

Conventional analog termination

Fieldbus termination (also included in conventional termination count)
Multivariable Measurements

Conventional:
- 1 measurement / device
- Penetration / signal

Fieldbus:
- Multiple measurement / device

Fieldbus:
- Multiple measurements
  - Pressure
  - Temperature
  - Mass Flow
  - Volumetric Flow

Conventional:
- 1 measurement
Reduced Space Requirements

- Wiring & Rack
- Cable cost
- Junction box
- Cable Conduit
- Processing of cable
- Marshalling
- Barrier

Conventional System

Fieldbus System

Case of 350 I/O points

Courtesy of Emerson Process Management
I/O Reduction

Courtesy of Shell Deer Park

Courtesy of Shell Deer Park

Courtesy of Cargill

Courtesy of Shell Deer Park

Courtesy of Cargill
Project Cost Benefits

- Commissioning Costs Without fieldbus:

  2 hours / device for 2 technicians

- Individually ring out wiring
- Attach device
- Verify communications
- Verify link to control strategy
Project Cost Benefits

- Commissioning Costs With fieldbus:

  25 minutes / device for 1 technician

- Check segment wiring
- Attach device
- Drag-and-drop commissioning