Fieldbus Foundation
Mumbai, India
22 September 2010

Automation Infrastructure
Fieldbus Foundation Market Data

- Today >340 Global Members & Corporate Affiliates,
- >600 Registered Devices, 13 Hosts
- 7,000+ fieldbus control systems installed or on order around the world
- 1,000,000+ FOUNDATION™ fieldbus devices in service worldwide

The adoption of FOUNDATION Fieldbus has skyrocketed over the past several years. ARC estimates that the total market for fieldbus products and services is rapidly approaching a billion dollars.
Why Foundation Fieldbus?
Why Foundation Fieldbus?

- Extensive Block Model
- Common Data
- Common Time
- Deterministic Control
- Publish and Subscribe
- High availability
- Standards Based Control Network
- Network Management

FOUNDATION technology incorporates key aspects of what ARC calls the Collaborative Process Automation System.
Process Industry Challenges

Benchmark Results Indicate Room for Improvement

- 20-40% of control loops in manual control
- 80% of control loops demonstrate excessive process variability
- Many potential Advanced Process Control (APC) benefits are being missed
- Unplanned downtime is the largest single source of lost revenue
- 86% of maintenance is reactive (too late) or preventive (unnecessary)
- Best practice is 40% with predictive/proactive
- Most Petrochemical companies are not making returns greater than their cost of capital
Why Foundation Fieldbus

Opportunities

✓ Better measurements
✓ Accurate & stable control
✓ More capability at more levels
✓ More cost effective control system
✓ Higher availability
✓ Common interface for:
  ✓ Sequence control
  ✓ Continuous control
  ✓ Engineering
  ✓ Maintenance
  ✓ Reporting
Why Foundation Fieldbus?

Open Scalable Integration

• Foundation fieldbus was designed from the beginning for the process industry

• It is more than a Protocol, it is an **Automation Infrastructure**

• Standards Based

• Globally Accepted

• Tightly Integrated

• Easily Scalable
Why Foundation Fieldbus?

Process Integrity

• Robust design
• Redundant beyond any other technology
• Control in the Field (CIF)
• Safety Protocol FOUNDATION™ for SIF
Control in the Field:

Analysis of Performance Benefits

Dr Andy Clegg, ISC Ltd
Objectives

- Many Foundation Fieldbus installations worldwide
- Control in the Field (CIF) technology exists within FF, where control functions execute in Field devices
- CIF can provide many potential benefits over control in the DCS
- Here potential improvements in control performance are reported
  - Compared to Control in DCS within FF scheme
  - Understand what kind of processes would benefit
  - Identify potential industrial applications
There are many reviews of what benefits CIF can provide:

- Improved Control Loop Performance
- Increased reliability and availability
- Improved loop integrity
- Reduced loading on DCS / PLC and network
- Lower capital and installation costs
- Reduced Operating costs
CIF Control Performance

Benefits

- Improvements in control loop performance for CIF arise from:
  - Faster sample times
  - Shorter latency (delays) in the read-execute-write cycle
  - Guaranteed determinism

- For control in the DCS, sample time and latency are typically longer
  - Also, DCS and FF segment updates can be asynchronous leading to significantly longer and potentially variable latencies

- Delays in a control loop limit the performance
Observations

- For typical fast process loops (e.g. flow, pressure), CIF will provide up to a 40-60% faster settling time, and up to 30-50% better rejection of disturbances
  - The faster the process, the larger are the benefits
  - Assuming baseline case of asynchronous Control in the DCS – which is typical
- For slower processes (e.g. > than 40 secs settling time) and processes with any significant deadtime (e.g. > than 5 secs) the benefits become small

- The performance benefits will be reduced if:
  - Slew rate and saturation of the actuators limit the available performance
  - If it is desired to use a de-tuned controller
  - FF devices with slower block execution times, if the FF segment is heavily loaded, if the control functionality is complex or if the design of the CIF is not good
Potential Industrial Applications

- The findings show that CIF will provide significant performance benefits for loops with certain dynamics
  - Typically flow and pressure and some temperature loops

- Applications where such improved performance may be beneficial include:
  - Paper Manufacturing, Power Generation, Combustion Control, Continuous Food Manufacturing and Compressor Control
  - CIF could be important for controllers that respond to spurious events
    - i.e. that try to maintain operations, before safety protection systems are engaged
    - e.g. pressure control of fuel gas for a gas turbines in a power generating plant
    - when one GT trips the controller has to act quickly to stop the other GT tripping on a high fuel gas pressure
Summary

- It has been shown that CIF can provide significantly better control for fast process loops
  - In terms of speed and ability to reject disturbances

- For some process loops (e.g. slow dynamics and where there is significant deadtime) no improvement in control will be realisable
  - Or if there are constraints within the CIF implementation
Summary

- Control in the Field has higher Availability
- Control in the Field has lower Variability
- Devices with more function blocks offer more flexibility for Control in the Field
- Most of the regulatory control can be done in the field
  - Devices involved in a control strategy should be in the same segment or bridging is required

- Advanced Control, Optimization should be done in the DCS. This type of control can always send setpoints for the regulatory control

- Customers are realizing the benefit of Foundation Technology
Shell Global Solutions International (SGSI) has performed extensive evaluation of control in the field. A statement by the company indicated, “Control in the field using FOUNDATION fieldbus technology is recommended by SGSI for simple and cascading loops, not for complex loops. Major benefits identified by SGSI are reduced process controller loading, reduced network traffic enabling more loops per segment, as well as very fast loop response.”
"Foundation Fieldbus CIF with inherent backup capability prevented 2 incorrect plant shutdowns, which would have resulted from communication interruptions"  

Shin-Etsu
Why Foundation Fieldbus?

Business Intelligence

Extensive, Structured, Usable Diagnostics!!
Why Foundation Fieldbus

The global process industry loses $20 billion, or five percent of annual production, due to unscheduled downtime and poor quality.

ARC estimates that almost 80 percent of these losses are preventable, with 40 percent largely due to operator error.

- Source ARC Insight June 10 2010
“Unneeded” Trips To The Field - Avoided Through Remote Diagnostics

Source: Dow Chemical Company
The Opportunity

- Improved plant stability and reliability
- Improved asset utilization
- Reduced operating and maintenance fixed cost
- Improved Variable Cost
Diagnostics and EDDL
Using the power of FOUNDATION Fieldbus, and considering NAMUR requirements, the new standard diagnostic profile aim to:

- Standardize the integration of diagnostic information
- Guarantee valuable information to the user
Role Based Diagnostics

Process Control Engineering Station

Asset Management Maintenance Station

HSE Control Network

H1 Process Network

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Diagnostic Categories

- Failure
- Out of Specification
- Function Check
- Maintenance Required
<table>
<thead>
<tr>
<th>Alarm Type</th>
<th>Relation</th>
<th>Failure Type</th>
<th>Block Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process Alarm</td>
<td>Process / Environment</td>
<td>Process failures</td>
<td>Function</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Faults in the process</td>
<td></td>
</tr>
<tr>
<td>Device Alarm</td>
<td>Instrument</td>
<td>Sensor/Actuator element failures</td>
<td>Transducer &amp; Resource</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Faults in the sensor or actuator element</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Process / Environment</td>
<td>Electronic failures</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Faults in the electronics</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Configuration/servicing failures</td>
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<td></td>
<td></td>
<td>Installation faults, fault during start-up</td>
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<td></td>
<td></td>
<td>Process induced failures</td>
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<td></td>
<td></td>
<td>Faults due to process influence</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Faults due to non-compliance with specified</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>operating conditions</td>
<td></td>
</tr>
</tbody>
</table>
# New Field Diagnostic Alarms

<table>
<thead>
<tr>
<th>Parameter Name (*)</th>
<th>NE107 Status Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD_FAIL_ALM</td>
<td>Failure</td>
</tr>
<tr>
<td>SD_OFFSPEC_ALM</td>
<td>Out of Specification</td>
</tr>
<tr>
<td>SD_MAINT_ALM</td>
<td>Maintenance Required</td>
</tr>
<tr>
<td>SD_CHECK_ALM</td>
<td>Function Check</td>
</tr>
</tbody>
</table>

## Additional supporting parameters
- Enable/Disable of diagnostic detection
- Enable/Disable Simulation
- Configure Priority
- Configure Alert Suppression (Detect, but not alert)
- Recommended Actions

* Parameter names will have localized text labels. e.g. “Failure Alarm”
EDDL and Field Diagnostics

EDDL visualizes device diagnostics to assist in maintenance troubleshooting.
Field Diagnostics device registration is available today with ITK 5.1

Field Diagnostics are required for new device registrations starting with ITK 6.0 (Released this past week)

Field Diagnostics support are required for new host registrations.
2. Host Interoperability Support Test Profiles

2.1 Profile Groups and Classes
A host application will consist of one or more hardware and software components specified by the host manufacturer. For example, a Class 61 integrated host may consist of a controller, engineering station, operation station and asset management station. Individually, these components may not conform to a profile class, but collectively these components function as a single host profile class. The host manufacturer must specify all components that collectively meet the profile class.

It is possible that a host may meet multiple profiles. For example, a host may meet both Class 63 and Class 64. In this case, some features in class 63 are specified as mandatory and specified as prohibited in class 64. The manufacturer must document how those host features are enabled in Class 63 while disabled in Class 64. (e.g. menu configuration)

<table>
<thead>
<tr>
<th>Group 6 Host Profile Classes</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 61 Integrated Host</td>
<td>Primary, on process host that manages the communication and configuration of all devices on a network.</td>
<td></td>
</tr>
<tr>
<td>Class 62 Visitor Host</td>
<td>Temporary, on process host with limited access to device parameterization.</td>
<td></td>
</tr>
<tr>
<td>Class 63 Bench Host</td>
<td>Primary, off process host for configuration and setup of a non-commissioned device</td>
<td></td>
</tr>
<tr>
<td>Class 64 Bench host</td>
<td>Primary, off process host with limited access to device parameterization of an off-line, commissioned device</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
In addition to the profiles listed above, the hosts may be suffixed by a compliance level "a" or "b" as specified in table 2.2.1. Each compliance level will become mandatory for new campaigns as defined by the FF-525 Host Profile Test and Registration Process.

2.1.1 Class 61 - Integrated Host
The class 61 integrated host is the primary on-process host.

2.1.1.1 Characteristics
- Fixed H1 address, on process
- Sets and manages Physical Device TAGs for all devices.
- Sets and manages the network configuration (device address, link parameters, application time)
FOUNDATION™ for Safety Instrumented Functions (SIF)
Development History

SIF Application Concept
Development History

H1 Communication System (Black Channel) is unchanged. SIF protocol above the Black Channel detects network faults and appropriate action is taken without human intervention.

Design to IEC 61508

Black Channel

Design to IEC 61508

FF-SIF Communication Diagnostics
New SIF Function Blocks

Function Block diagnostics detect application faults and appropriate action is taken without human intervention.

Design to IEC 61508

Black Channel

Design to IEC 61508

New SIF Function Blocks & Function Block Diagnostics
Non-safety related information from the SIS devices is available to the BPCS and operator.

Potential quantity of control peer to peer - across high level network.
Every thing becomes safety
Preparedness to freeze a valve and rely on twin during repair time.
The need for a valve with i/p and sov type functionality sat on a H1 FF + H1 SIS bus. Single cable.

Detailed SIF Application Example
Column Overpressure

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Shell Project & Technology has decided that FF-SIF will be specified for use on a Nederlandse Aardolie Maatschappij (NAM) project in the Netherlands. This is the first of a number of identical projects expected to utilize the technology.

Shell is in discussions with several leading automation suppliers for commitments on the logic solver. When the instrument scope is complete, Shell is expecting the various device vendors to provide safety-approved products for the initial installations.

The Shell Project & Technology Group Process Automation Control and Optimization (PACO) will monitor the development together with our NAM project organization.

Shell Project & Technology is anxious to see industry progress in the area of FF-SIF implementation.
Saudi Aramco successfully launched two FF-SIF pilot projects and plans have been initiated to install working FF-SIF systems within operating oil and gas facilities.

A project is planned for the Juaymah gas plant in Saudi Arabia in late 2010. Saudi Aramco expects FF-SIF installation at the Juaymah gas plant to show how the use of fieldbus communications results in lower costs due to reduced hardwired I/O to the safety logic solver, as well as enhanced local testing and diagnostic capabilities.

A second FF-SIF installation is planned with emergency isolation valves with automated functional testing and diagnostics. This configuration will replace existing emergency isolation valves with new valve bodies and pneumatic valve actuators fitted with FF-SIF smart valve controllers.

After these smaller pilot projects are complete, Saudi Aramco plans expanded deployment of FF-SIF technology in order to exploit its benefits on larger, mega scale projects.
SIF Summary

Demanded by End Users to gain benefits of H1 in Safety Instrumented Functions

Technical Specification Development Project Approved by BOD in October 2002

TÜV Protocol Type Approval including SIL 3 in December 2005

Marketing Demonstration Approved by BOD in October 2005

Marketing Demonstration Press Day completed May 2008

SIF_AI and Interoperability Test System released in 2008

SIF_DO and Interoperability Test System released in Q1 2010

Pilot projects underway at Shell and Saudi Aramco 2009 - 2011

SIF Registered Products Expected 2012
SIF Summary

**CAPEX Savings**
- Faster Commissioning
  - Engineering tools provide faster commissioning
- Less Hardware
  - Eliminate HART multiplexers
  - No solenoids or limit switches needed with digital positioners
  - Reduced wiring and terminations
  - Fewer marshalling cabinets

**OPEX Savings**
- Advanced Diagnostics
  - Easier detection of random and systematic failures
  - Increase operating reliability and safety by reducing spurious trips
- Increased Test Interval
  - Integrated system provides partial stroke testing
  - Flattening Slope and Drift of PFD average curve – Chevron Research
  - Diagnostics enable upset and trip data to be used in the interval calculation
- Improved Asset Management
  - Integration of device diagnostics data
  - Easier maintenance of devices
  - **Support for Field Diagnostics per NAMUR NE107 mandatory (role-based diagnostics)**
Field Device Integration (FDI) Project

Single solution for integration of field devices into host systems

Combines strengths of EDDL and Device Type Manager (DTM)

Open specification that will be an international Standard

Technology direction agreed by major suppliers

Use cases agreed by major end users
FDI Project Architecture

- Advanced Client Applications – Configuration, Diagnostics, Maintenance
- Based on OPC Unified Architecture (OPC UA) Standard

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FDI Device Package Technologies

- **Device Definition** (Mandatory)
- **Business Logic** (Optional)
- **User Interface Description** (Optional)
- **User Interface Plug-in** (Optional)

**IEC 61804-3 EDDL International Standard**

TBD
High Speed Ethernet
(HSE)

Wireless and Remote I/O
(WIO)
WIO Charter

✓ Develop use cases and requirements for HSE remote I/O and wireless communication in monitoring and control that are interoperable using function blocks and EDDL.

✓ Develop a project plan which includes:
  ➢ Solutions using FOUNDATION™ and wireless technologies
  ✓ Solutions for device interoperability and network configuration
  ➢ Validation of technical specifications
  ➢ Interoperability test and registration procedures

✓ Obtain Technical Steering Committee (TSC) approval of the Project Plan

✓ Develop the Technical Specifications

✓ Obtain lab prototypes and validate technical specifications

✓ Demonstrate interoperability of WIO devices at end user sites
WIO Development Phases

**WIO Phase 1**
HSE Remote I/O

**WIO Phase 2**
HSE Backhaul & WirelessHART I/F

**WIO Phase 3**
Flexible Function Blocks & I/F to other Networks

**WIO Phase 4**
ISA100 I/F

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WIO Development Teams

Fieldbus Foundation - ISA100 Cooperation
HSE Backhaul Team

HSE RIO Team

WIO Gateway

Conventional I/O
H1
Wired HART

Wireless HART
ISA100.11a

Wireless Sensor Team

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90% perceive FOUNDATION fieldbus as leading technology
84% believe CAPEX costs are equal to or lower than conventional I/O
91% believe FOUNDATION technology delivers OPEX savings

- Easier maintenance 67%
- Increased availability 63%
- Increased efficiency 28%
- Improved product quality 20%
- Situation prevention 20%
- MES connectivity 15%

54 respondents
Savings- End User Survey

Did FOUNDATION deliver CAPEX savings?  Yes
Savings in engineering & design…………….50%
No additional cost in documentation……….85%
Savings due to reduced footprint……………77%
Achieved return on investment in less than two years…………………………………………………75%

Did FOUNDATION deliver OPEX savings?  Yes
Enhanced device diagnostics………………….90%
Tight control of the process………………….60%
Enhanced effectiveness of system…………61%
Increased system availability……………….59%
Enhanced operator effectiveness……………85%
Ease of device replacement…………………85%
Business justification: Brunner Mond

- Fieldbus delivered payback in < 24 months
  - process efficiency gains
  - Increase in throughput without added raw material
- Fieldbus installed on 23 Solvay towers
- All project objectives met
- Enables personnel to maintain ideal conditions
  - Advanced sequencing of Solvay towers
  - Operators have more understanding of process

SOURCE: – Phil Stoor
Technical Paper – Feb 07
Business justification: Shell Deer Park

- 20% cost reduction in engineering
- 1% increase in production availability

“FOUNDATION technology has prevented shutdowns, saving an estimated $10 million on our plant” Rick Heiberg Shell

- Extra 700 barrels/day
- Fieldbus enabled DP controller to close emergency slide valve 4 seconds before shutdown
  - Saving estimated $275k

SOURCE: – Roger Erfurdt
Presentation EUC Oct 04
Thank You