Date : 6th February, 2010 (Saturday)
Time : from 09:00 am to 05:30 pm.
Venue : IIT Convention Centre
         Gajendra Circle, IIT Campus,
         Adayar, Chennai.

K.Ibrahim Raja  B.Sc, B.Tech(MIT)
@ Present : Principal Engineer ,
            Technip
            Chennai

Previous : Manager, Engineers India
           Ltd, New Delhi
Fieldbus Engineering in Green Field Plants
An EPC's Perspective

- Basic Engineering
- Detailed Engineering
- Installation
- Commissioning
Fieldbus Engineering in Green Field Plants
An EPC's Perspective – Basic Engineering

- Basic Engineering

- Decision on Technology: Conventional or Foundation Fieldbus/Profibus/As-i Bus
- Concept: FISCO, FNICO, High Power Trunk, Exd
- Complying to International Standards IEC, AG standards, etc
- Process Design (Identifying loops, symbol)
- Identify Registered Instruments
- Control assignment
- Cable routing, Control room location

Based on above, Design basis / Std Spec for FF shall be prepared for the project
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Conventional Technology

- Topology - One to One
- Transmission method - 4 - 20 mA DC analog
- Transmission direction - One way
- Signal type - Single signal
- Protocol standardisation - Internationally standardised
- Remote setup of field devices - Not possible
- Self diagnostics - Information cannot be obtained from field devices
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**Foundation Fieldbus Technology**

- Topology
  - Multidrop
- Transmission method
  - Only Digital
- Transmission direction
  - Bi-directional
- Signal type
  - Multiplex signal
- Protocol standardisation
  - Internationally standardised.
- Remote setup of field devices
  - Possible
- Self diagnostics
  - Information can be obtained through HHT or separate maintenance systems.
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- **As-i Bus**
  - bit level (push buttons, limit switches, etc.)

- **ProfiBus**
  - Support analog signals and Master-Slave comm through RS485

- **Fieldbus**
  - Digital replacement of 4-20 mA Conventional signals
  - A Digital, 2 way, Multi-Drop communication
  - As per IEC 61158 and ISA S50
  - H1 LAN (31.25 kbps), HSE (100 Mbps-Backbone), Peer-to-Peer communication Supports Intrinsic Safety
  - In India, MRPL, HPCL, Reliance, Essar – Proved
Foundation Fieldbus is a digital, two-way, multidrop communication link among intelligent measurement and control devices.

Conventional DCS: 2-wire, loop powered, one-way communication, single data, multi-cabling till control room

Fieldbus Network Concept: 2-way, loop powered, IS, diagnostic, signature, plugging detection, single cabling, Inter operable, Plug & Play

Diagrams courtesy of the Fieldbus Foundation, www.fieldbus.org
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- Concept

Based on Area classification, Concept to be decided

- **FISCO**: As per IEC 60079-27,
  1 km/ 4 device/ 12.4V@120 mA (Zone 1, IIC), 1.9 km/ 9 device/ 13.1@250 mA (Zone 2, IIB), Spur length 60 m

- **FNICO**: As per IEC 60079-27,
  500 m/ 6 device/ 12.4@180 mA (Zone 2, IIC), 500 m/ 8 device/ 13.1@320 mA (Zone 2, IIB), Spur length 60 m

- **High Power Trunk**: As per ISA S 50.02
  1700 m/ 12 Devices/ 24 V DC@ 500 mA (Zone 1 / 2), IS Device, IS Barrier, Exd Terminator, Exe Junction box, etc.

  - See the comparison Curve
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No of Devices in High power Trunk concept is High. Hence in Hazardous area based Refinery, this concept is selected.
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Typical Fieldbus Segment Configuration (Topology)

A. Bus with Spurs
- requires layout design
- requires taps
- difficult to change

B. Daisy Chain
- requires layout design
- difficult to change
- difficult to maintain

C. Tree
- conforms to present practices
- wiring savings are realized only in "home-run" cable
**Fieldbus Engineering in Green Field Plants**  
*An EPC's Perspective – Basic Engineering*

**International Standards for Foundation Fieldbus**

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISA 50.02 Part 2</td>
<td>Fieldbus Standard for use in Industrial Control system, Part 2: Physical Layer Specification and Service Definition</td>
</tr>
<tr>
<td>AG-181</td>
<td>System Engineering Guidelines</td>
</tr>
<tr>
<td>AG-140</td>
<td>Application Guidelines for 31.25 kbps &amp; wiring system</td>
</tr>
<tr>
<td>IEC 61158-2</td>
<td>Digital data communication for measurement and control fieldbus for use in Industrial Control system Part 2 to Part 6</td>
</tr>
<tr>
<td>IEC 600079-27</td>
<td>Electrical apparatus for explosive gas atmosphere - FISCO and FNICO</td>
</tr>
</tbody>
</table>
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- Process Design

- FF implemented for Complete refinery except Complex loops, Special loops (say Anti-Surge, BMS), Interlock & Shutdown loops
- Identify the above loops
- Segregation of Critical/ Semi-Critical/ Non-Critical loops
- Deciding the package philosophy
- Representing in PID
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- **Instrument Design**: Identify the FF Registered Instruments & Non-FF Devices (such as Process Analysers, F&G detectors)

- **Layout Design**: Location of control room, Cable routing

- **Control Design**:
  - No of control loop in one segment
  - Macrocycle time based on Scan time
  - Field control or DCS control if so for which loop
  - Redundancy requirement of H1 card, FFPS, etc
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- Importance Basic Engineering

Basic engineering is Must. If not, it will end up as follows,
- Revise the Process design due to philosophy change
- Revise Instrument & JB Location drawing
- Affect on Cable schedule, MTO, JB MTO,
- Revise Instrument Specification, Re-order
- Revise FF segment Table, Revalidation, Rework on DCS engineering
- Rework, Additional Manhour, Schedule affect
Fieldbus Engineering in Green Field Plants
An EPC's Perspective – Detailed Engineering

- Detailed Engineering
  - Finalising FF Segment Philosophy
  - Tag mark-up in Layout & Junction Box Location Drawing
  - FF Segment design
  - Optimizing the segment & Revise Layout
  - FF Segment Validation – Preliminary
  - Preparation of Instrument specification
  - FF Segment Validation – Final
  - System Specification
  - Wiring
Finalising FF Segment Philosophy

- Concept: High Power Trunk
- Basis (As per ISA S 50.02):
  - Spur length – 100 m, Trunk length – 1700m, Min Oper Device Voltage – 9.5 V, Min Oper Field Barrier Voltage – 17 V, Max Device Current – 20 mA,
  - Macro Cycle time – 1000 msec, Schedule – 70%, Un Sch-30%, Execution time – 32 msec,
  - Scan time – P, F, DP - 500 msec, T, L, Analyser – 1000 msec
- Max Open loop per segment – 12 device
- For Close loop,
  - 1 Close loop (500 msec scan) – 1 Close loop+ 6 Open loops
  - 1 Close loop (1000 msec scan) – 1 Close loop+ 10 Open loops
## FF Segment Philosophy Table – Distance based

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Segment Description</th>
<th>No. of Closed Loops in 500msec</th>
<th>No. of Closed Loops in 1000msec</th>
<th>Open Loops</th>
<th>Temp. Mux</th>
<th>Total Devices</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 Closed Loop (500msec)</td>
<td>1</td>
<td>0</td>
<td>6</td>
<td>4+2</td>
<td>8</td>
<td>Worst case</td>
</tr>
<tr>
<td>2</td>
<td>2 Closed Loops (500msec)</td>
<td>2</td>
<td>0</td>
<td>4</td>
<td>2+2</td>
<td>8</td>
<td>Worst case</td>
</tr>
<tr>
<td>3</td>
<td>1 Closed Loop (1000msec)</td>
<td>0</td>
<td>1</td>
<td>10</td>
<td>7+3</td>
<td>12</td>
<td>Worst case</td>
</tr>
<tr>
<td>4</td>
<td>2 Closed Loops (1000msec)</td>
<td>0</td>
<td>2</td>
<td>8</td>
<td>5+3</td>
<td>12</td>
<td>Worst case</td>
</tr>
<tr>
<td>5</td>
<td>3 Closed Loops (1000msec)</td>
<td>0</td>
<td>3</td>
<td>6</td>
<td>3+3</td>
<td>12</td>
<td>Worst case</td>
</tr>
<tr>
<td>6</td>
<td>2 Closed Loops (1-500msec &amp; 1-1000msec)</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>2+2</td>
<td>8</td>
<td>Worst case</td>
</tr>
<tr>
<td>7</td>
<td>3 Closed Loops (1-500msec &amp; 2-1000msec)</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>8</td>
<td>Worst case</td>
</tr>
<tr>
<td>8</td>
<td>4 Closed Loops (1-500msec &amp; 3-1000msec)</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>Worst case</td>
</tr>
<tr>
<td>9</td>
<td>Open Loops Only</td>
<td>0</td>
<td>0</td>
<td>12</td>
<td>9+3</td>
<td>12</td>
<td>Worst case</td>
</tr>
<tr>
<td>10</td>
<td>Open loops with Mux</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>4+2</td>
<td>8</td>
<td>Worst case</td>
</tr>
<tr>
<td>11</td>
<td>Mux Only</td>
<td>0</td>
<td>0</td>
<td>3+2</td>
<td>5</td>
<td>8</td>
<td>Worst case</td>
</tr>
</tbody>
</table>
Tag mark-up in Layout & Junction Box Location Drawing

INPUT
1) PLOT PLAN
2) 3D MODEL

TAG MARKUP IN LAYOUT

IDENTIFY FF TAGS

INPUT: FF PHILOSOPHY TABLE

GROUPING TAGS IN ONE SEGMENT

SELECT SUITABLE TAG

CHECK MEETING PHILOSOPHY

NO

YES

IDENTIFY LOCATION FOR JUNCTION BOX

PREPARE FF SEGMENT TABLE
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An EPC's Perspective – Detailed Engineering
Fieldbus Engineering in Green Field Plants
An EPC's Perspective – Detailed Engineering

- **FF Segment design**
  - Based on Philosophy Table & Layout, Segment to be designed
  - Preparing FF Segment Table
  - Validating segment in term of Voltage loading using reputed validation software segment checker,
  - Validating segment based on cycle time loading
  - Optimizing the segment & Revise Layout
### Table for Segment Loading - VGO Unit

| TAG NO  | TRUNK BLDG (L) LENGTH (M) | TRUNK BLDG (R) LENGTH (M) | TRUNK BLDG (L) TYPE A, FF in (M) | TRUNK BLDG (R) TYPE A, FF in (M) | SEGMENT NO | SPUR JS NO | SPUR JS TO INT. JS LENGTH (M) | INTERMEDIATE JS (L/R/NO) | TRUNK BLDG IN AGE (R) (INCHES) | INSTRUMENT MANUFACTURERS NAME | EXECUTION TIME (TENTATIVE) IN (MS) | RESPONSE TIME AS PER EPC | REMARKS |
|---------|--------------------------|--------------------------|----------------------------------|----------------------------------|------------|-----------|-------------------------------|---------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-----------------------------|--------|
| 127-FV002 | 30 | 30 | 30 | 30 | SEGMENT 1 | 30 | | | | Emerson / Honeywell | 32 | 0.5 | | |
| 127-FV003 | 30 | 30 | 30 | 30 | | | | | | Emerson / Honeywell | 32 | 0.5 | | |
| 127-FV004 | 30 | 30 | 30 | 30 | | | | | | Emerson / Honeywell | 32 | 0.5 | | |
| 127-FV005 | 30 | 30 | 30 | 30 | | | | | | Emerson / Honeywell | 32 | 0.5 | | |
| 127-PT0095 | 30 | 30 | 30 | 30 | | | | | | Emerson / Honeywell | 32 | 0.5 | | |
| 127-PT0096 | 30 | 30 | 30 | 30 | | | | | | Emerson / Honeywell | 32 | 0.5 | | |
| 127-PT0097 | 30 | 30 | 30 | 30 | | | | | | Emerson / Honeywell | 32 | 0.5 | | |
| 127-PT0098 | 30 | 30 | 30 | 30 | | | | | | Emerson / Honeywell | 32 | 0.5 | | |

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- Preparation of Instrument specification
  - Which function blocks are required?
  - Timing for block execution
  - LAS Backup Designation
  - DD Files, CFF Files – Revision
  - Firmware Revisions ITK 4.61
  - Details in http://www.fieldbus.org
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An EPC's Perspective – Detailed Engineering

## Fieldbus Device Data Sheet

### Fieldbus Tag Name:
XX-LT-003

<table>
<thead>
<tr>
<th>Basic Fieldbus Function Blocks</th>
<th>Segment Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog Input Block (AI) 2</td>
<td>Device: 3051CD2F02A1AS6M5K5</td>
</tr>
<tr>
<td>30 Number Execution Time</td>
<td>Segment #: XX-4-2</td>
</tr>
<tr>
<td>Discrete Input Block (DI) 0</td>
<td>LAS Capable: Yes No</td>
</tr>
<tr>
<td>0 Number Execution Time</td>
<td>Device current draw (mA): 19</td>
</tr>
<tr>
<td>Bias/Gain Station (BG) 0</td>
<td>Device minimum voltage (V): 9</td>
</tr>
<tr>
<td>0 Execution Time</td>
<td>Device capacitance: .00</td>
</tr>
<tr>
<td>Manual Loader (ML) 0</td>
<td>Polarity Sensitive: Yes No</td>
</tr>
<tr>
<td>0 Number Execution Time</td>
<td>Segment terminator location:</td>
</tr>
<tr>
<td>Analog Output Block (AO) 0</td>
<td>DD Revision: 7.2</td>
</tr>
<tr>
<td>0 Number Execution Time</td>
<td>CFF Revision: 7.2</td>
</tr>
<tr>
<td>Discrete Output Block (DO) 0</td>
<td></td>
</tr>
<tr>
<td>0 Number Execution Time</td>
<td></td>
</tr>
<tr>
<td>Control Selector (CS)</td>
<td></td>
</tr>
<tr>
<td>PID,PI, I Controller (PID) 0</td>
<td></td>
</tr>
<tr>
<td>0 Execution Time</td>
<td></td>
</tr>
<tr>
<td>Ratio Station (RA)</td>
<td></td>
</tr>
<tr>
<td>P, PD Controller (PD) 0</td>
<td></td>
</tr>
<tr>
<td>0 Number Execution Time</td>
<td></td>
</tr>
</tbody>
</table>

* Execution Time in msec.
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Minimum Specification for FF Devices

Following are the minimum requirements for Fieldbus Devices.

The device shall satisfy the requirements of the Fieldbus Foundation specifications and shall have FF CHECKMARK. The Devices shall be certified for intrinsic safety EEx ia (ATEX or equivalent certification).

Foundation Fieldbus Device shall be certified as passing the ITK 4.61 or later and shall include Device Description (DD) and Common File Format (CFF) files.

The FF device and all function blocks shall be tested and certified by the vendor of the control system Host.

The Devices shall be provided with Flash memory for downloading the revised firmware in future.

Function block shall be downloadable into the devices by the end user.

Capable of performing continuous diagnostics, including self test functions, to provide specific diagnostic information at the Man Machine Interface (MMI).

All Fieldbus instruments shall include menus and method’s (wizards) to allow easy setup and calibration from the MMI.

FF Device shall have three support files .FFO, SYM and CCF which contain information necessary to configure the Host systems. The support files shall include two Device Description Files and one Capability File, as defined in Fieldbus Foundation specification FF-040. The capabilities file and DD files shall be provided by the device vendor and shall not be downloaded from the Foundation Fieldbus website.

Device vendors shall provide DTM (Device Type Manager) files for all devices and shall develop these files where they are not available. The DTM files shall be compatible with the host DCS system using FDT/DTM technology.

Standard programmatic interface shall follow FDT Group 1.2 standards. Any revision to host Operating System or device DD shall not require changes to the DTM for EDD.
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Final Documents after Award of Contract

1. Awarded Vendor for Instruments
2. IFC Plan
3. IFC Layout
4. Box 3D Model

Correction of FF Loading in Layout

Final FF Segment Table (by D&C)

Validation of FF Segment Table based on
- Voltage Dropping
- Macro Cycle Time

Validated FF Segment Table

Preparation of Final Wiring Document
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Wiring Document
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- System Specification
  - Configuration
  - Redundancy
  - Communication Protocol
    FDT/DTM, EDDL
  - Macro cycle schedule
  - OSI Reference Model
  - Diagnostics
  - Host Test Kit 4.2

Figure: OSI Reference Model
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Cyclic Functions
- Control Functions
  - Function Block Execution (3244)
  - PID- / AO- Function Block Execution (DVC5000)
  - Cyclic Communication between Devices and / or Controller

Acyclic Functions
- Alarms and Events
- Maintenance and Diagnostic Information
- Program Invocation
- Permissive
- “View Data” Communication
- Trend Information
- Configuration & Downloads

Host Interface incl. LAS

Communication across the bus

period(Macrocycle)
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An EPC's Perspective - Installation

Tradition Installation Arrangement

**Significant Costs:**
- wiring
- I/O cards
- cables
- terminations
- IS barriers
- marshaling

![Diagram of Tradition Installation Arrangement]

- Controller
- I/O Interface
- I/O Terminations
- Marshaling
- IS (Exi) Barriers
- other Junction Boxes
- 4-20 mA or Analog

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An EPC's Perspective - Installation
Foundation Fieldbus Installation

Cost savings:
• wiring
• I/O cards & cables
• terminations
• IS barriers
• marshaling

Similar I/O Cards
Reduced Wiring
H1 I/O Interface
H1 I/O Terminations
Junction Box
Fewer Terminations
H1 Fieldbus all-digital
Marshaling
IS (Ex i) Barriers
Fewer IS barriers
Control room

- Less I/O, Less Space Required
- Uses one I/O module for up to 32 devices
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An EPC's Perspective – Commissioning

Fieldbus is practical, today!

- Instead of two person for one device. In FF commissioning one person for multiple device. Interoperability
- Networking capability of FF allows user to commission an Device in minutes
- Possible of source of error is less for FF device. Hence calibration is not required or very less
- Due to less no of cabling in marshalling, verification during commissioning is very less

Fieldbus will lead to cost & Time savings

- Enhanced device capability advantages
- Slashed installation time & cable costs i.e 6-8 hours reduction for particular installation
- Automatic documentation & schedule prints
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An EPC's Perspective – Project Control
Affect on Conventional Project Schedule due to FF

Managing a Fieldbus Project

- Work Scope
- Stage 1 Approval
- P&ID Development
- Cost Estimate Scope
- HAZOP
- Credibility
- Funding Approval
- Vendor Selection
- Procurement
- Engineered Design
- Control Narrative
- Plant Layout
- Risk Assessment
- Construction Bid
- Bid Review
- F.A.T.
- Construction
- S.A.T.
- Training
- Commissioning
- “Make it Right”

Work Scope
Stage 1 Approval
P&ID Development
Cost Estimate Scope
HAZOP
Cost Estimate
Funding Approval
Vendor Selection
Procurement
Engineered Design
Control Narrative
Plant Layout
Risk Assessment
Construction Bid
Bid Review
F.A.T.
Construction
S.A.T.
Training
Commissioning
“Make it Right”

Fig 1. Traditional Automation Project GANTT Chart
Fig 2. Fieldbus Automation Project GANTT Chart

The most obvious changes from the Gantt chart other than the previously discussed issue of training is the shift forward in preparation of the control narrative and plant layout.

06-Feb-2010

2010 FFIC-Chennai Conference
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**Advantages in FF Technology**

- Wiring savings
- Hardware savings-fewer devices (instruments barriers and I/O)
- Documentation savings-Simpler layout and drawings
- Reduced Engineering costs
- Footprint savings
- Multi-variable field devices
- Interoperability and freedom of choice
- Reduced Commissioning and startup costs
- Reduced downtime
- Integrity improved
- DCS future capacity savings
- Control in the field
- Device Plug and Play
- On line configuration
- Time Stamping and Synchronisation
- Obsolescence Robustness
- Status Information
- Tag Search Capability
- Interface to High Speed Ethernet
- Trend storage in the field device
- Predictive Maintenance
- DCS future capacity savings
- Automated data collection for asset management
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Step towards FF Technology:
Status of FF Implementation in India

- 5 Years Back -
  for Non Critical Open Loops
- 3 Years Back -
  for all Open Loops
- 2 Years Back -
  for all Open loops & Non Critical Close Loops
- Today - For all loops
- except Complex & Shutdown loops
- Soon, All Existing will revamped to FF
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Conclusion

Foundation Fieldbus Technology, despite being a step change, requires Team work, Training in FF and mind set to take the challenge for successful project execution.