Foundation Fieldbus Control System

Fieldbus Foundation
FFIC + ISA Fieldbus Foundation Conference-2010

-Sandeep Redkar
What is Fieldbus?

- Fieldbus is a digital, *two-way* multi-drop communication link connecting intelligent measurement and control devices, automation devices, and display systems.
A network is a complete fieldbus with devices
- Note: Sometimes use the term “link” or “bus” for network.
- Fieldbus Device Types defined by DLL spec:
  - Link Master, with Link Active Scheduler
  - Basic
  - Bridge
  - Host

LAS = Link Active Scheduler
Fieldbus Devices

- **Basic** - not capable of scheduling a network
- **Link Master (LM)** - capable of scheduling (controlling communications) on a network. Each network must have at least one LM.
  - **Link Active Scheduler (LAS)** - the LM that is actually scheduling a network.
  - When Function Blocks are configured, the configurator creates the schedule for a bus, and downloads it to the Link Master.
- **Bridge** - connects two or more networks
- **Host** – server that configures the network and function blocks
Traditional methods had the loop closure in the process controller.

Foundation Fieldbus enables you to distribute the loop closure from the process controller to the field instrumentation.

Foundaion Fieldbus is shifting the process control strategy paradigm.
To shift the control to field devices require interoperable control algorithms from different vendors.

Smart Field Devices not only convert the sensor data but they can also have a rich set of Function Blocks and control algorithms.
Foundation Fieldbus is much more than a Device Network...it can provide DCS type control functionality

Example Applications

- Single Loop Control
- Feedforward Control
- Cascade Control
- Override Control
- Ratio Control
- Manual Loader
- Lead/Lag Compensation
- Signal Characterization
- Timing and Integration
- Advanced Alarming
- Motor Control
- Math
- Supervisory Data Acquisition
- Sensor bus interfacing
- Coordinated Drives
- Batch Control

Basic Function Blocks
- PID Control, Ratio Control
- Manual Loader, PD Control
- Ratio, Control Selector
- Discrete Input/Output
- Analog Input/Output
- Bias/Gain

Advanced Function Blocks
- Analog Alarm, Arithmetic
- Deadtime, Device Control
- Input Selector, Integrator
- Setpoint Ramp Generator
- Splitter Lead/Lag, Timer
- Signal Characterizer

Flexible Function Blocks
- 8 Channel Analog Input/Output
- 8 Channel Discrete Input/Output
- Application Specific (IEC 61131-3)

Standard Function Blocks

H1/HSE

Batch/Discrete/Hybrid/Remote I/O/PLC Applications
FOUNDATION Fieldbus Function Blocks have a defined Structure this makes them interoperable

- Foundation FieldBus Specification provides for
  - standardized function blocks
  - vendor enhanced function block
  - vendor - custom function blocks

- Distribution and execution of functions in field multi vendor devices in an integrated, seamless manner

- Consistent definition of information that will be communicated and functions that will be distributed

PID= Proportional/Integral/Derivative
Multi-Vendor Interoperable Function Blocks

- Mode Control
  - Out of Service
  - Initialization
  - Lock Out
  - Auto/Manual
  - Cascade
  - Remote Cascade
  - Remote Output

- Status
  - Quality of data
  - Causes of degradation
  - Limit Conditions
  - Control Handshaking
  - Fault-State Initiation
  - Alarm Indication

FFB includes the ability to use & configure any vendor devices that comply with the Fieldbus Standard with RSFieldbus
Alarm Detection And Reporting is built into the Function Blocks

- Alarm Detection & Reporting per FB
  - Alarm Summary for each Condition
    - Status
    - Report Ack, Operator Ack
  - Alarm Conditions
    - Hi, Hi-Hi, Lo, Lo-Lo,
    - Dev Hi, Dev Lo, Discrete, etc
  - Alarm Parameters
    - Limit, Priority
  - Local Time Tagging
- Supports SOE Data Logging
  - Buffers alarms
Common FB Configurations

- **Input**: AI, DI
- **Output**: AO, DO

### Manual Control
- AI
- AO

### Feedback Control
- AI
- PID
- AO
- AO

### Override Control
- AI
- PID
- RA
- SS
- AO

### Ratio Control
- AI
- PID
- AO

### Cascade Control
- AI
- PID
- AO
- AO

### Split Range Control
- AI
- PID
- BG
- BG
- AO
- AO

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Foundation Fieldbus Synchronizes the Data flow between the Function Blocks

- Function Block Scheduling
  - Scheduled from fraction of 1 millisecond upwards
    [System Management]
  - Synchronized Scheduling Between Devices
    [Link Active Schedule]
  - Synchronization is Optional
- Trend Support
  - 16 Samples of any Variable
  - Floats, Discrete, Bitstrings
  - Dynamic Assignment
  - Independent Save Period
  - Includes a “status” byte per sample
  - Automatic Publication
Deterministic Scheduling

- Execution of function blocks and communication is scheduled
- Execution is deterministic
- Control is really distributed “on the wire”
- KEY feature of FOUNDATION fieldbus - it is a system, not just a bus
- FF also includes provisions for a back-up schedule. All Link Master capable devices keep a copy of the schedule.
A “macrocycle” is a single iteration of a schedule within a device. The following figure shows the relationships between the absolute link schedule start time, LAS macrocycle, device macrocycles, and the start time offsets.
To manage the data communications Foundation Fieldbus uses a Link Active Scheduler (LAS)

- “Network Administrator”
  - Manages all the H1 communication and syncs devices
  - “Knows” all devices manages adds / deletions
  - Transmits the compel data message
  - Controller, Linking Device or Instrument can be the LAS
Link Active Scheduler (LAS) Devices

- LAS functions:
  - Pass Token
  - Maintain Live List
  - Schedule Compelled Data (CD)
  - Synchronization Data Link Time
  - Insure LAS backup
Multi-Master Redundancy

LAS = Link Active Scheduler

LAS transfer happens automatically

LAS = Link Active Scheduler
PlantPAx

- PlantPAx and FFB provides for a highly distributed process automation control system
  - Regulatory Loop control can be executed in the Fieldbus device, or in the Logix engine
  - Communications between the FFLD and a Logix controller is defined through function Blocks
- Display Data, Alarm and Events from Fieldbus and CLX are presented to FTView as part of the Distributed Database
Benefits

Improved Operations

- Remote Monitoring
- Event Monitoring
- Historical Trending
- Condition Monitoring
- Advanced Diagnostics
- Engineering
- Configuration and Maintenance
- User Management
- Visualization

Asset management and Device Information is available throughout the process facility

Improved Operations
Benefits

It’s all about Improving Operations

• 1. Installed cost Reduction
  – Reduced Engineering Costs
  – Lower Installation Costs
  – Quicker Start-ups

• 2. Operating Benefits
  – Improved Integrity
  • Reduced Off Normal Operation
  • Reduced Down Time
  – Process Control Improvements
  • Operate Closer to Limits

3. Maintenance Benefits
  – Planned Maintenance
  – Plug and Play Devices
  – Improved Diagnostic Tools
  – Less Downtime
& broad asset management capabilities

- Device calibration data management & records retention
  - Integrated calibration management software
  - Hand-held calibrator Support
- Archival, Change Control & Disaster Recovery
  - Centralized, versioned, secure configuration storage
  - Automatically uploads & compares robot, controllers and drive configuration files to the master files
- Logs
  - Audits human activities and system events
- Authentication
  - Access rights for viewing and to initiate action
- Reporting
  - Variety of formats - scheduled or on demand
DD IMPLEMENTATION

Standard DDs plus optional Incremental DDs

Device Description Services Library

Host Application

Descriptions are read from the DD.

Data are read from the device over the fieldbus.

Number of digits of precision.

Engineering Unit

Label

25.50 %

Measured_Value
What is a DD File

The DD provides an extended description of each object in the Virtual Field Device (VFD) as shown in Figure 21. The DD provides information needed for a control system or host to understand the meaning of the data in the VFD including the human interface for functions such as calibration and diagnostics. Thus, the DD can be thought of as a “driver” for the device.
Device Description (DD)/Common File Format (CFF)

– Key to interoperability
– Defines standard and special parameters a device contains.
– Eliminates need to revise host system software to add a new device to the system.
– Eliminates need to develop & support custom interfaces and custom drivers.
– Fosters product innovation and development of new field devices.

Field devices will consist of:
• Actual physical field device
• Device Description (DD)
• Common File Format (CFF)

DDs & CFFs will be provided by device supplier or host supplier.
Device Descriptions

• Benefits of device descriptions include:
  – Operators use only one HMI, and all process data looks and feels the same for operators
  – Describe all the capabilities of a Foundation Fieldbus device in a standard language
  – Maintenance needs only one configurator, not a different handheld for each device
  – Device descriptions are the key to interoperability
Asset Management Software
Typical Automation Project or Installation
FDT (Field Device Tool) Group

- FDT goal is to provide customers with better solutions via open standards.
- FDT uses proven Windows standards.
- FDT is not a new digital bus or protocol.
- FDT has no allegiance to any one specific bus protocol.
- FDT is supported by over 50 users and manufacturers.

For more information please visit booth # 529
“With accelerating user support, FDT will become a leading field device, control valve, sensor, and production equipment information distribution standard for supervisory and business applications”

-ARC Group
Concept of Field Device Technology (FDT): Analogous to the MSWindows / Printer Interface

- The printer driver is used in the same way in different PC software
- The printer driver contains configuration, diagnostics, & other functionalities
- The printer driver is developed & delivered by printer manufacturer
FactoryTalk AssetCentre and FDT-DTMs

**BLUE:** AssetCentre Client

**RED:** DTM
Two parts of the FDT Architecture

The FDT Frame Application

- Common Environment
- Network Configuration
- Navigation
- User Management
- Device Management
- Database Storage

The Device Type Manager (DTM)

- is the device driver
- provided by device manufacturer
- loaded on any Frame Application
- has a standardized interface to the Frame Application
- has the graphical user interface
- includes the complete parameters of the device
Two Types of DTMs

CommDTM
For communication devices
- PC communication cards
- Couplers
- Gateways
- Linking devices

Device DTM
For field devices
- Valves and actuators
- Sensors and transmitters
- Drives and motors
- Pumps
DTM Networks

• Path from the FactoryTalk Client to the device

• Assemble one or more communications DTMs together, 1756-Chassis > 1756-IE8H

• Device is the last DTM in the path i.e. Endress+Hauser iTemp 162
DTM Networks

• Scan Network
  – Automatically scan and add devices to the DTM Network
  – Automatically capture model number, serial, manufacture, etc..

• Mix and match hardware & different protocols
  – HART, Foundation Fieldbus & Profibus
  – Various System vendors
  – Various device manufacturers

• Server-Client Architecture
  – Single repository
  – DTM Network configuration available to any client
DTM View

- Rich set of graphical user feature and functions
  - Edit & view online/offline parameters
  - Upload/download configuration
  - Diagnostics, print, help manuals, etc..

- Additional Functions
  - Trending, simulation, etc.
  - Vendor & device specific

- Server-Client Architecture
  - Single repository
  - DTM configuration available to any FactoryTalk AssetCentre client
Benefits of Process Device Configuration

• View and edit the configuration for a device (online / offline)
• Print the configuration for a device
• Manage multiple instrument types across multiple vendors
• Manage multiple instrument types across multiple protocols (HART, Profibus PA and Foundation Fieldbus)
• Remotely connect to instruments to diagnose and correct problems quickly
• Manage installed drivers via the Catalog
• Easily configure the network(s) from AssetCentre client computer(s) to the physical devices
Asset Management Problem

- It is becoming increasingly difficult to manage change through configuration alterations, including daily operations like troubleshooting, minor adjustments, monitoring and temporary patches.
  - Many devices have complex configurations and sophisticated programs
  - Many devices can be configured remotely
  - While reaping the rewards of these devices, the administration of these same systems is becoming more difficult
  - Meanwhile, there is increasing pressure from regulations, costs, unnecessary downtime, safety, training, etc.
Process Device Support - Device Configuration

- Device configuration
  - Plug in makes AssetCentre an FDT frame application
  - Supports a wide variety of process instruments and buses through plug-in drivers (DTMs) from device manufacturers
  - Fully integrated with FactoryTalk Security, FactoryTalk Audit, etc.
Thank You