Fieldbus Foundation™
Fieldbus Basics

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On behalf of
Fieldbus Foundation ™ Marketing Society (Singapore)

Fieldbus Basics Agenda

H1 Basic Review.

- What is Fieldbus?
- Integrated Architecture.

H1 Benefits.

- More data is available.
- Expanded view of Process and Instruments.
- Reduction in System Hardware.
- Wiring Saving.
- Summary.
- 4-20mA versus Fieldbus.

FOUNDATION Fieldbus Technology.

- H1 network review technology.
- Intrinsic Safety.
- DD and CFF Files.
- Typical Fieldbus installation.
- Fieldbus Components.
- H1 Fieldbus Model.

Fieldbus Basics Agenda

FOUNDATION Fieldbus Technology, (cont'd).

- User Application – Resource, Transducer and Function Blocks.
- Standard Function Blocks.
- Example of a Control Loop.
- H1 Link Master Redundancy.
- H1 Link Active Scheduler.
- H1 Link Schedule Optimization.

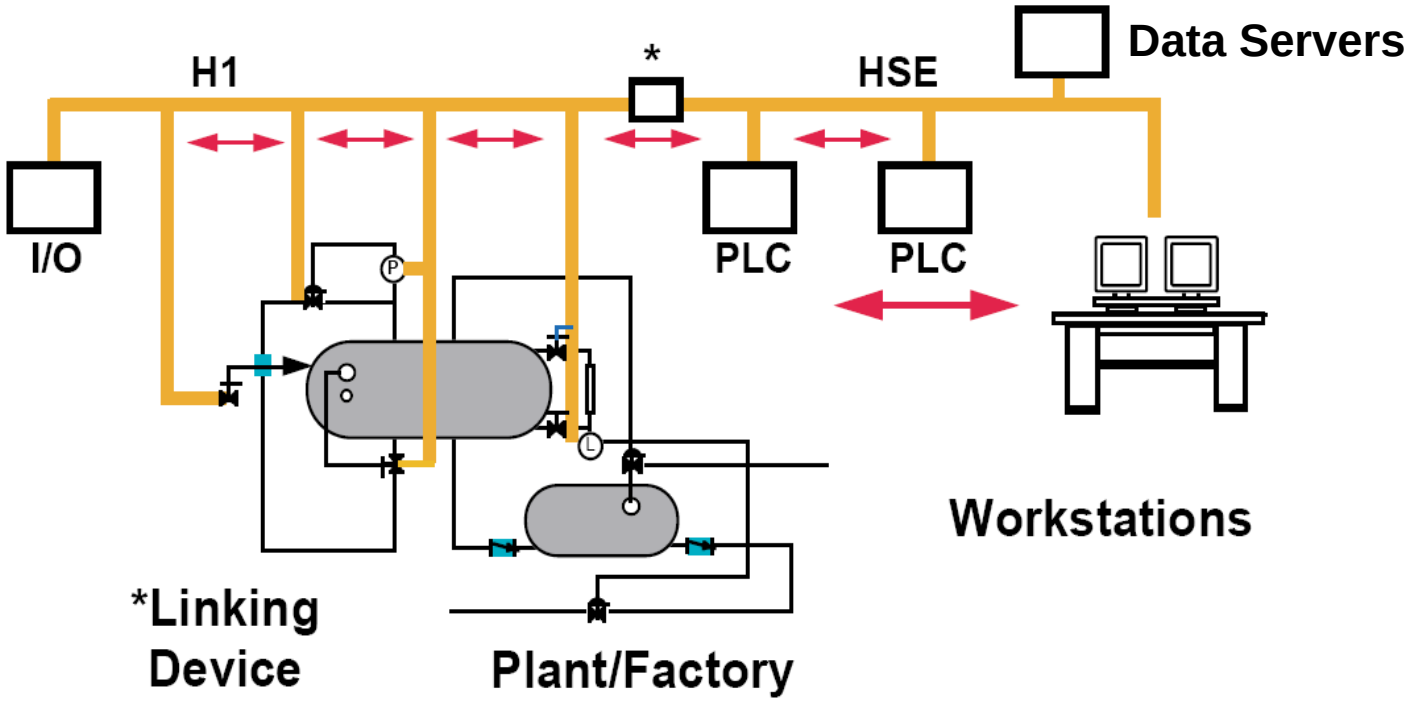
Demonstration (5 to 10 minutes)

- Example of a H1 Fieldbus Link.
- Vendor Devices on a H1 Fieldbus Link.
- Types of Control on the H1 Fieldbus Link.
- Link Optimization on the H1 Fieldbus Link.

H1 Basic Review

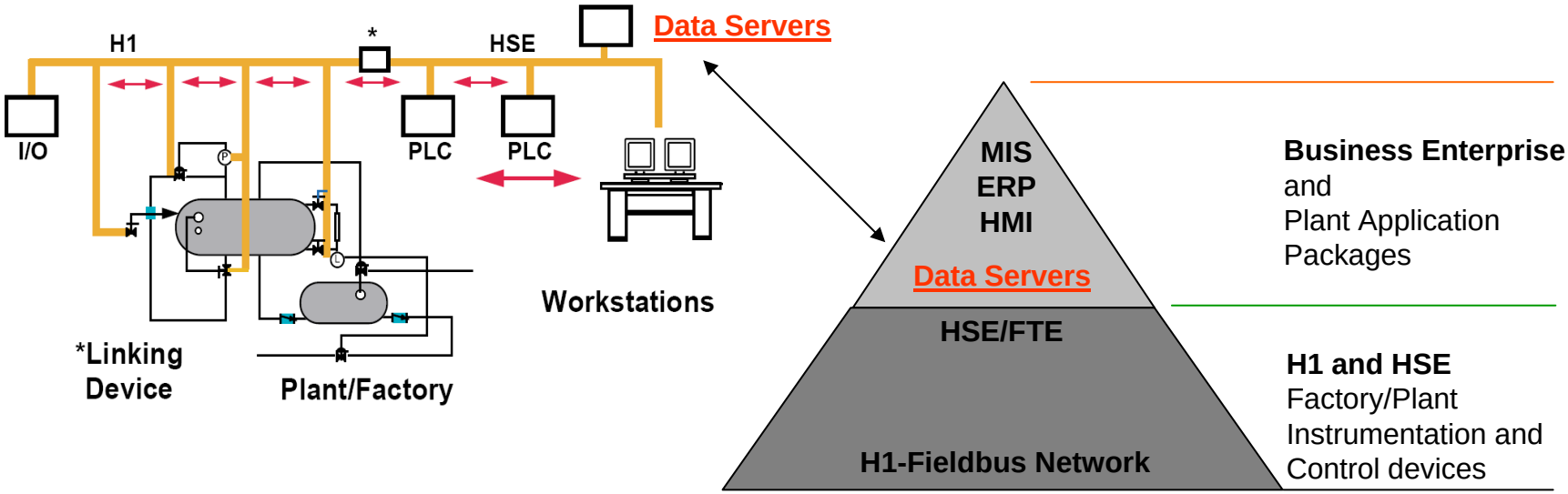
What is Fieldbus?

1. A fieldbus is an all-digital, serial two-way, multi-drop communication System.
2. H1 link (31.25kbps) interconnects field equipment (Sensors, Actuators & I/O).
3. HSE (High Speed Ethernet, 100mbps) provides integration of high speed controllers, subsystems (via Linking Device) and data servers and workstation.



Integrated Architecture

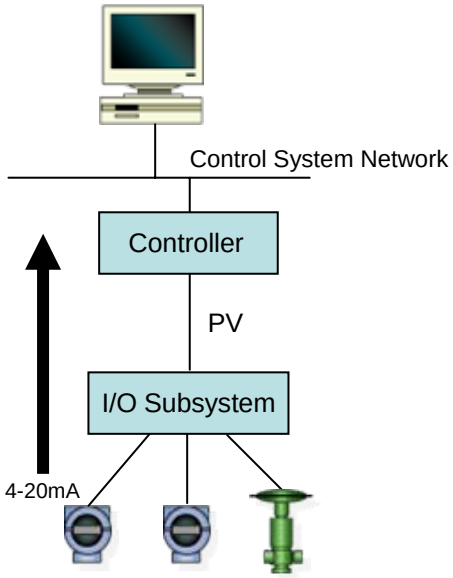
1. Management Information Systems (MIS), Enterprise Resource Planning (ERP), and Human Machine Interface (HMI) access the H1 Fieldbus information via the Data Servers.



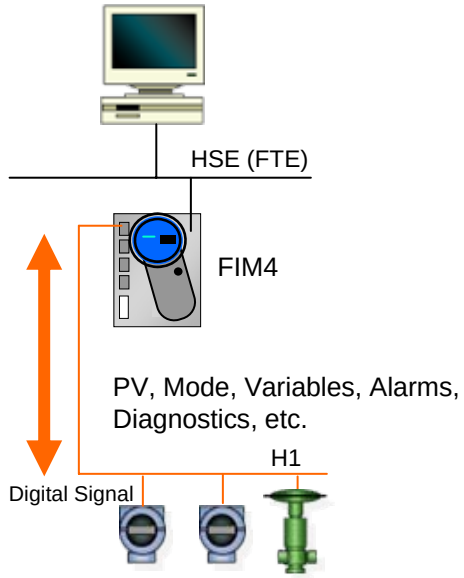
H1 Benefits

More Data is available

1. Fieldbus allows “multiple variables” from each device to be brought into the control system for archiving, trend analysis, process optimization, reporting, predictive maintenance and for asset management.
2. Fieldbus distortion-free characteristics digital communication enables improved control capability which can improve product yields.



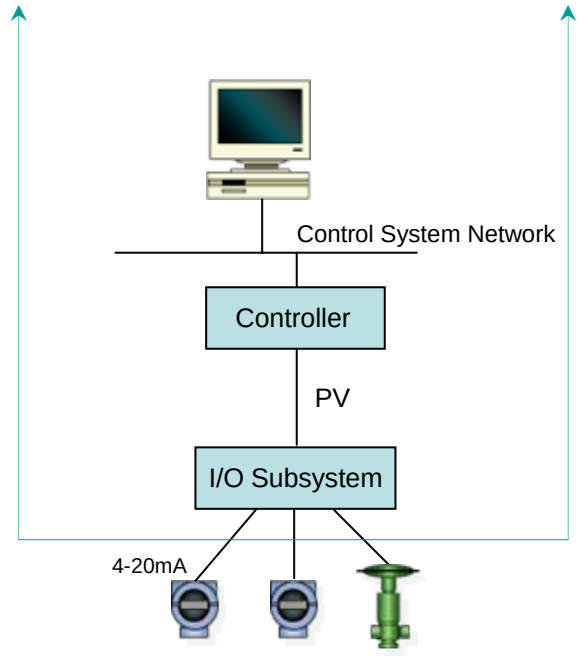
Traditional 4-20mA One Variable (One Direction)



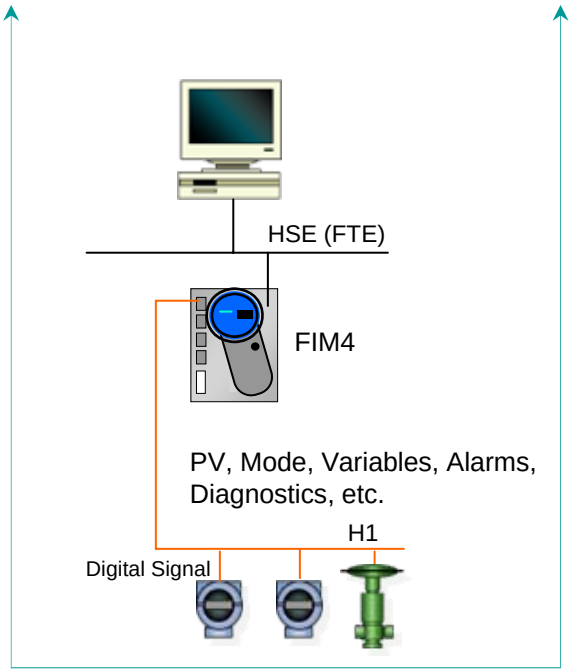
Fieldbus Multiple Variables (Both Directions)

Expanded View of Process & Instrument

1. Self Diagnostics and communication capabilities of microprocessor based fieldbus devices helps reduce downtime and improve plant safety.
2. Plant operation and Maintenance personnel can be notified and corrective actions taken quickly and safely.



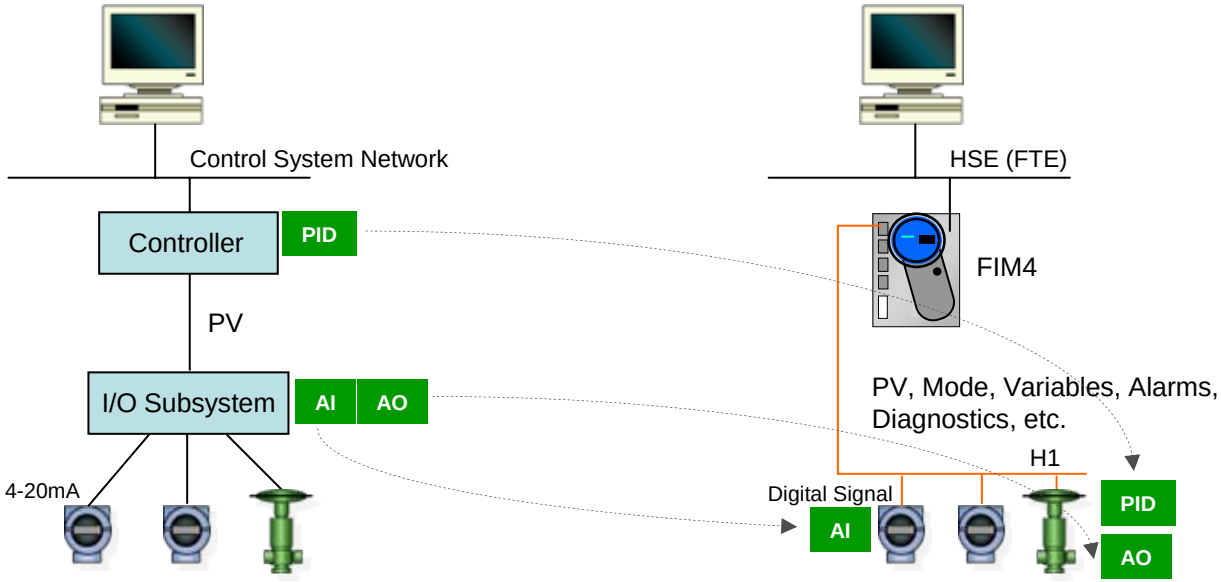
Traditional 4-20mA View stops at I/O Subsystem



Fieldbus Extends View to Field Instrument

Reduction in System Hardware

1. Standard Function Blocks is used to implement the Control Strategy.
2. Many control system functions such as AI, PID and AO can be performed by the field device through the use of these Standard Function Blocks.
3. Distribution of control into field devices can reduced the amount of hardware needed.

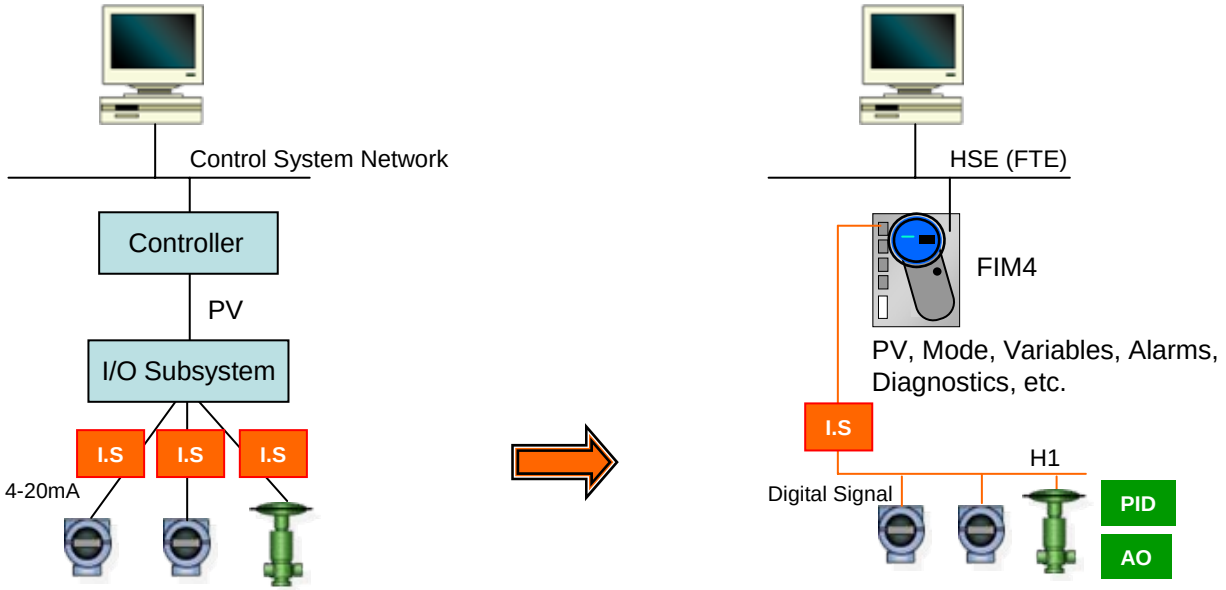


Traditional Control and I/O requires extra hardware

Fieldbus Extends Control and I/O to Field Instrument

Wiring Savings

1. The H1 fieldbus allows many devices to be connected to a single wire pair.
2. This results in less wire, fewer intrinsic safety barriers and fewer marshaling cabinets.



Traditional 4-20mA wiring, One I.S Barrier, One wiring for each Device

One I.S Barrier, One Wire for Many Devices

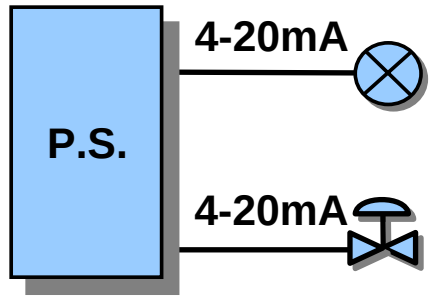
Summary

1. Reduced number of wires and marshaling panels.
2. Reduced number of intrinsic safety barriers.
3. Reduced number of Input/Output Converters.
4. Reduced number of Power Supplies and Cabinets.
5. Reduced size of equipment Rooms.
6. Remote configuration of devices.
7. More information available for Operations.
8. Increased accuracy of measurements.
9. Easier evolution due to standardized function blocks.
10. Increased sophistication and flexibility of instrumentation.
11. Increased uptime due to less equipment, better self diagnostics and remote diagnostics.

4-20mA versus Fieldbus

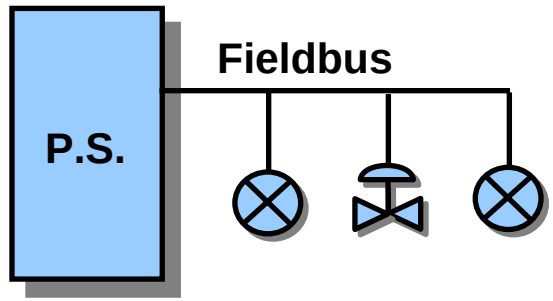
1. A H1 fieldbus retains and optimizes the desired features of the 4-20mA analog system:

   - single Loop integrity.
   - a standardized physical interface to the wire.
   - a bus-powered devices on a single wire pair.
   - intrinsic safety options.



2. In addition, FOUNDATION Fieldbus enables:

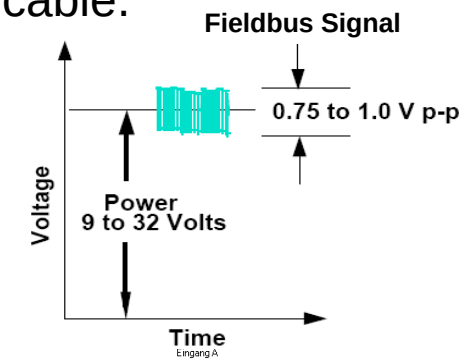
   - increased capabilities (due to full digital communication).
   - reduced wiring and terminations (multiple device on one wire).
   - increased selection of suppliers (due to interoperability).
   - reduced control room loading (control on wire).
   - connection to HSE backbone.

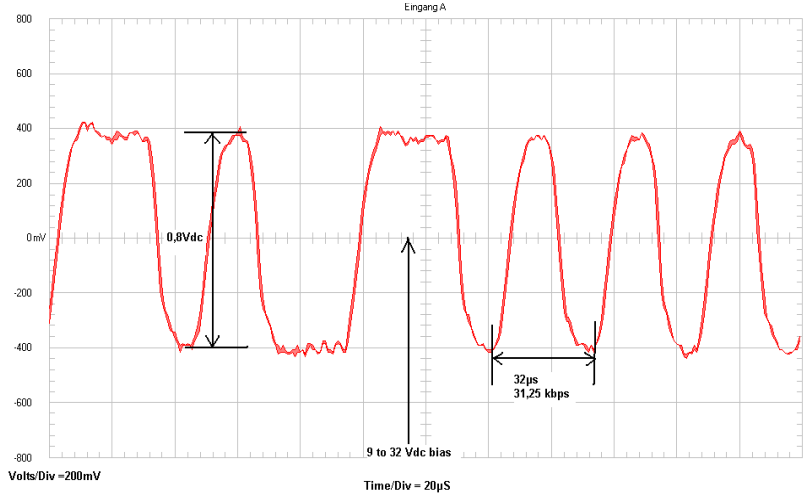


FOUNDATION fieldbus Technology

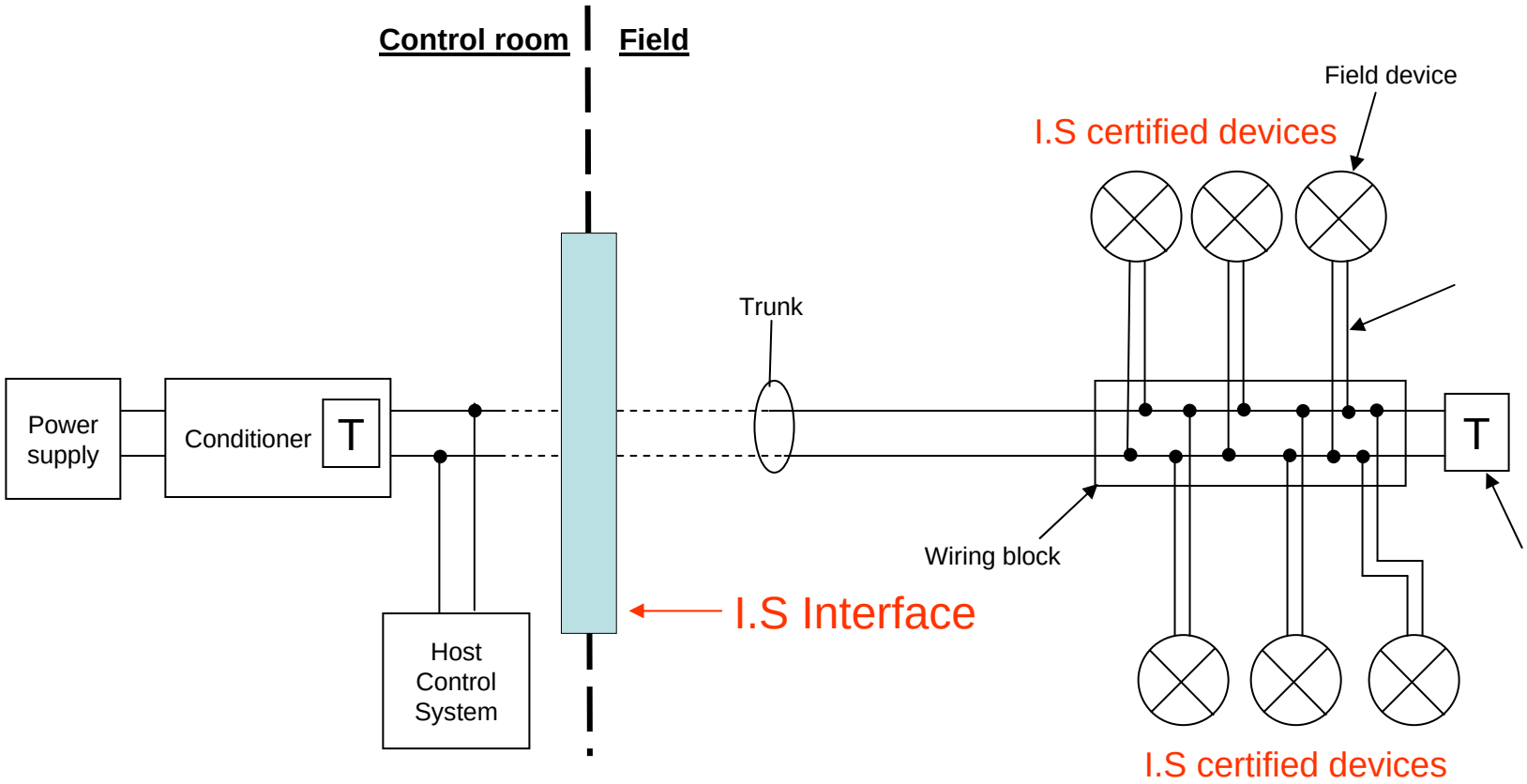
H1 Network Review

1. Multi-Drop wire pair with Power and Signal on same cable.
2. Support Intrinsic Safety.
3. Fault Tolerant, can have multiple Link Masters.
4. Function Blocks built into Field Devices.
5. Control on the Wire – single loop integrity
6. Distance up to 1900 meters.
7. Can add Repeaters to extend > 1900 meters.
8. Max. of 4 repeaters can be used to a maximum distance of 9500 meters.



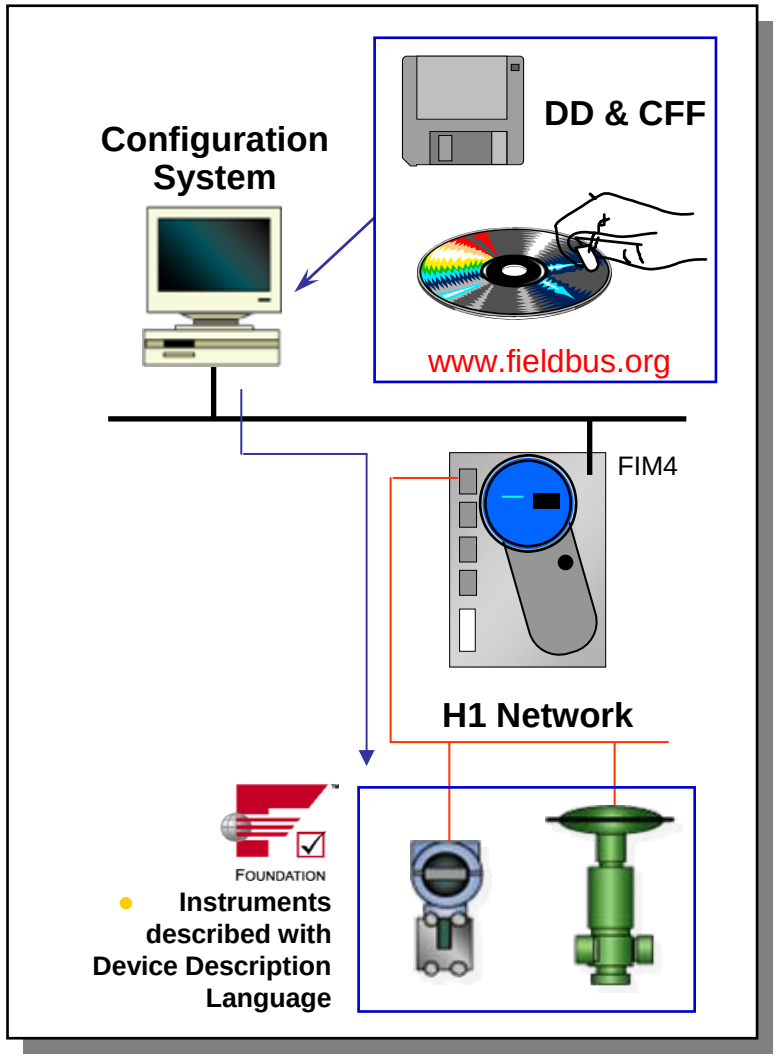


Intrinsic Safety



DD and CFF Files

1. Field Devices will consists of:
   - Actual Physical Device.
   - Device Description (DD).
   - Common File Format (CFF).
2. DDs and CFFs will be provided by the Device Supplier or Host Supplier.
3. Standard parameters present in devices. Option to include specific manufacturer parameters.
4. Parameters and Capabilities are defined in device files – DD and CFF.
5. Device files are key to off-line configuration.

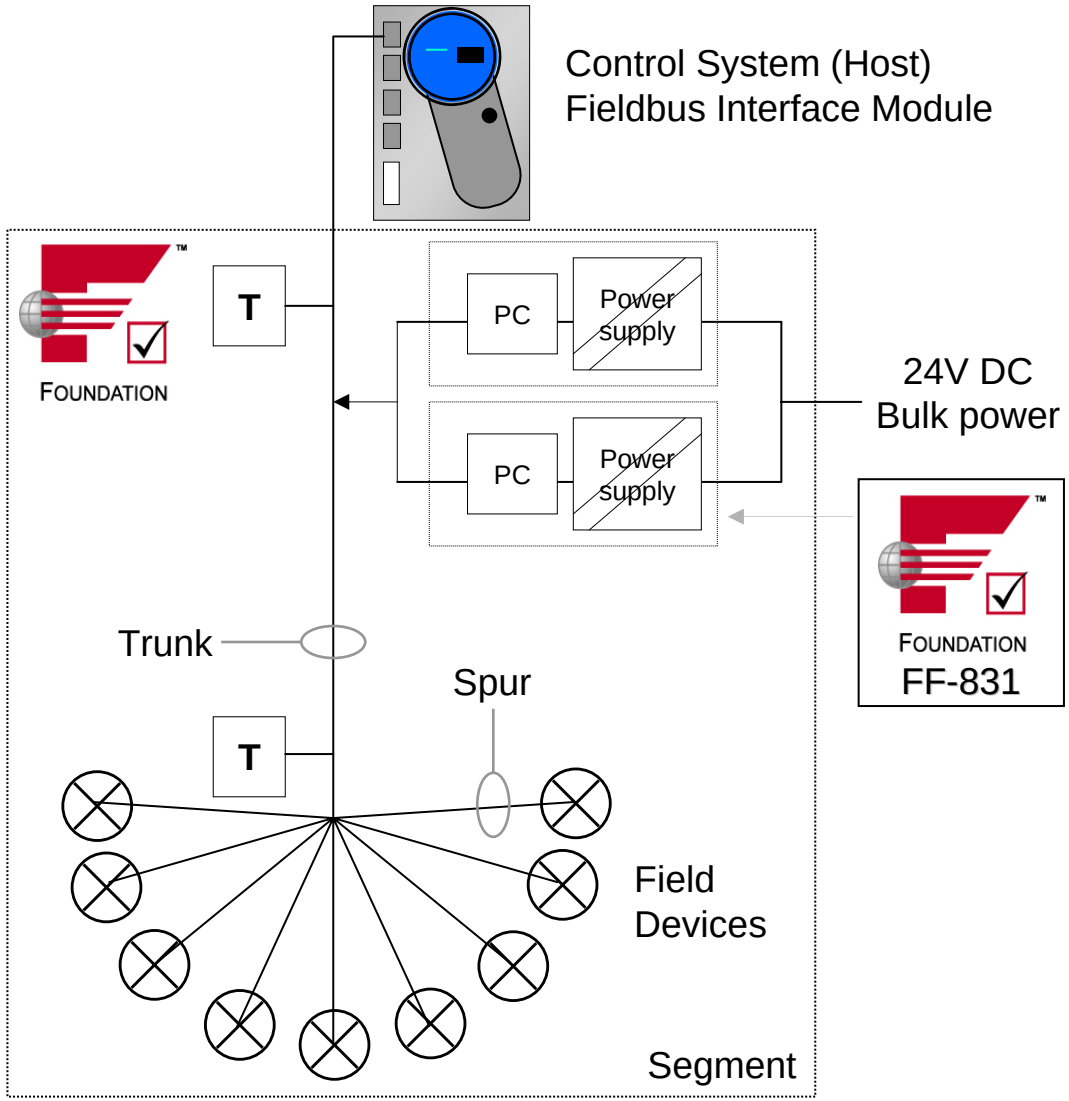


DD and CFF Files

1. Device Descriptor (DD) File allow operation of devices from different suppliers on the same fieldbus with single host system.
2. Common File Format (CFF) is a file which describes the functions and capabilities of a field device. The CFF file is used in conjunction with the Device Descriptor file to enable a host system to configure the system off-line.
3. CFF files are standard ASCII text file.

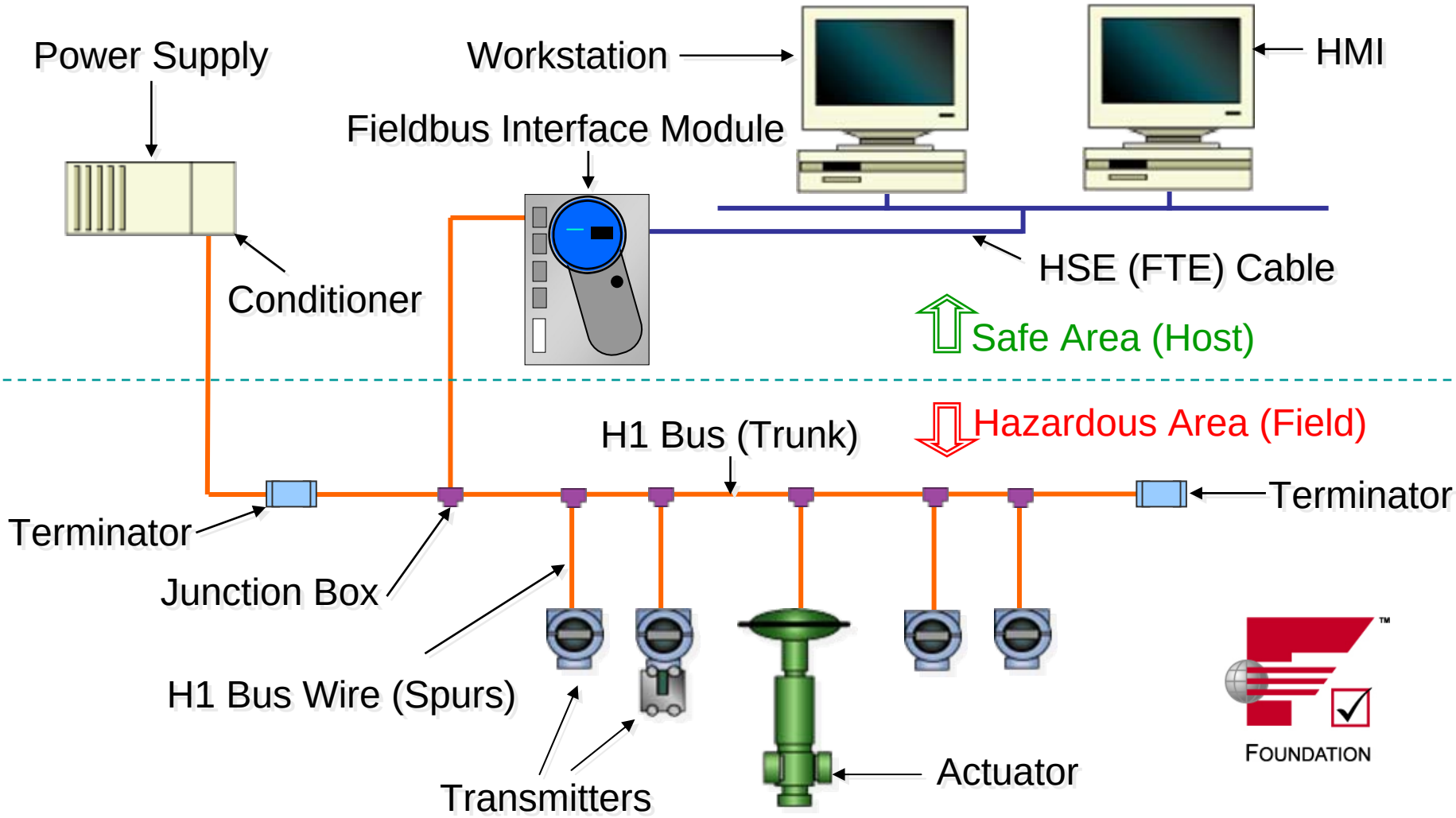
Typical Fieldbus Installation

- An example of the Chicken foot (tree) topology.
- Redundant, isolated power conditioning defined by FF-831, Fieldbus PST Specs.
- Typically 10-12 bus-powered fieldbus devices per segment.
- Spur short-circuit protection.
- Up to 1900 meters.
- Maximum of 9500 meters via repeaters.



Fieldbus Component

FOUNDATION™ Fieldbus System



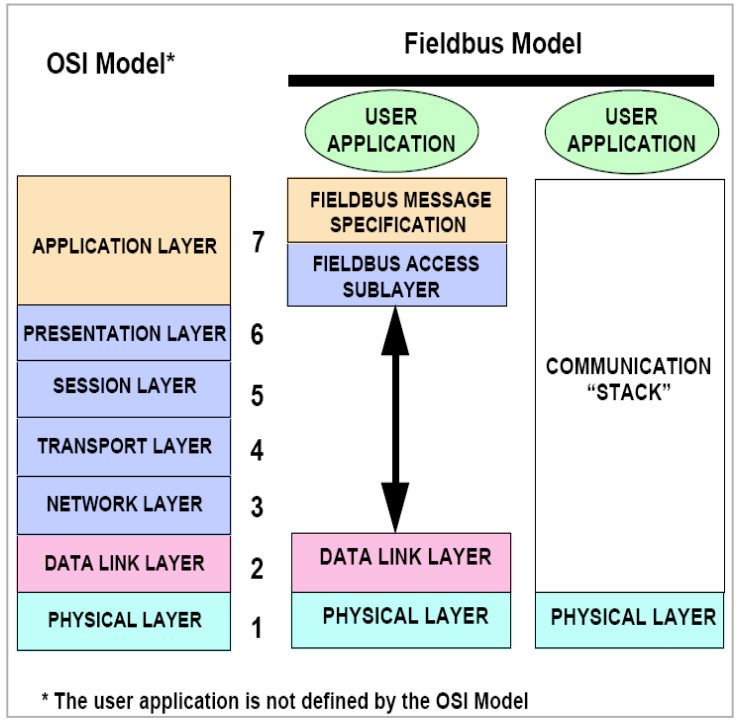
H1 Fieldbus Model

FOUNDATION fieldbus H1 technology consists of:

- The Physical Layer.
- The Communication Stack.
- The User Application Layer.

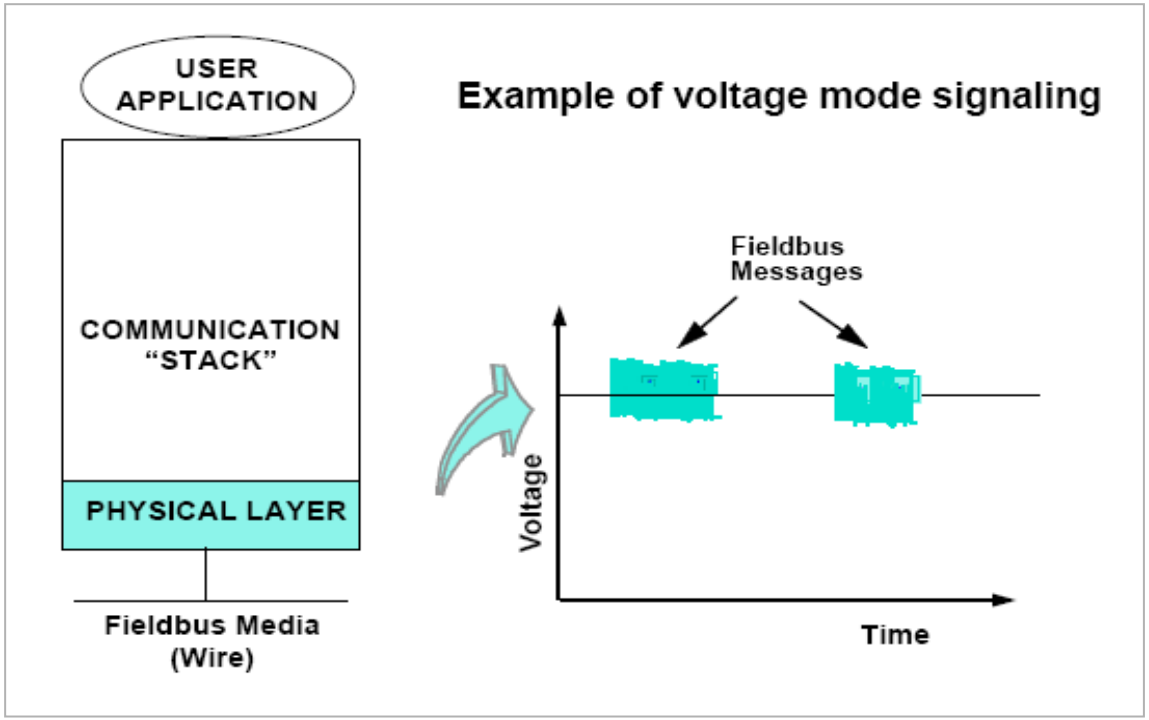
The Open Systems Interconnect (OSI) layered communication model is used to model these components.

- Physical Layer is OSI layer 1.
- Data Link Layer is OSI layer 2.
- FMS is OSI layer 7.
- Communication stack is comprised of layer 2 and layer 7.
- Fieldbus does not use OSI layer 3, 4, 5 and 6.
- FAS maps the FMS into DLL.



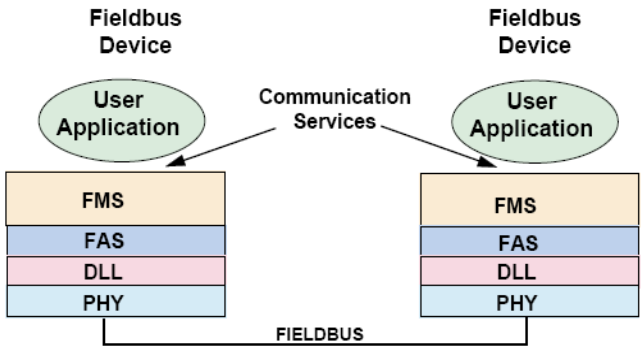
H1 Fieldbus Model

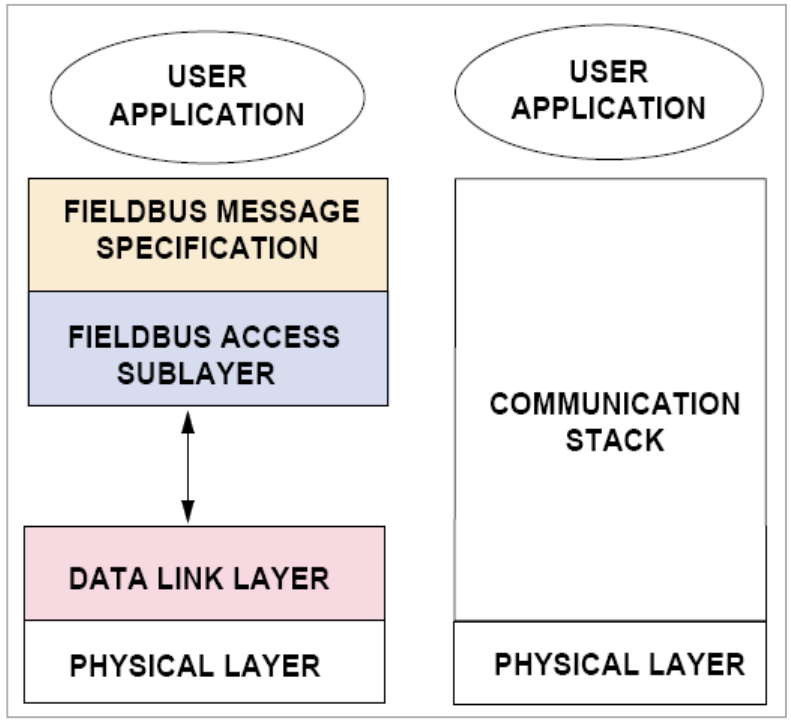
1. The Physical Layer receives messages from the communication stack and converts the messages into physical signals on the fieldbus transmission medium and vice versa.
2. Conversion includes adding and removing preambles, start delimiters and end delimiters.



H1 Fieldbus Model

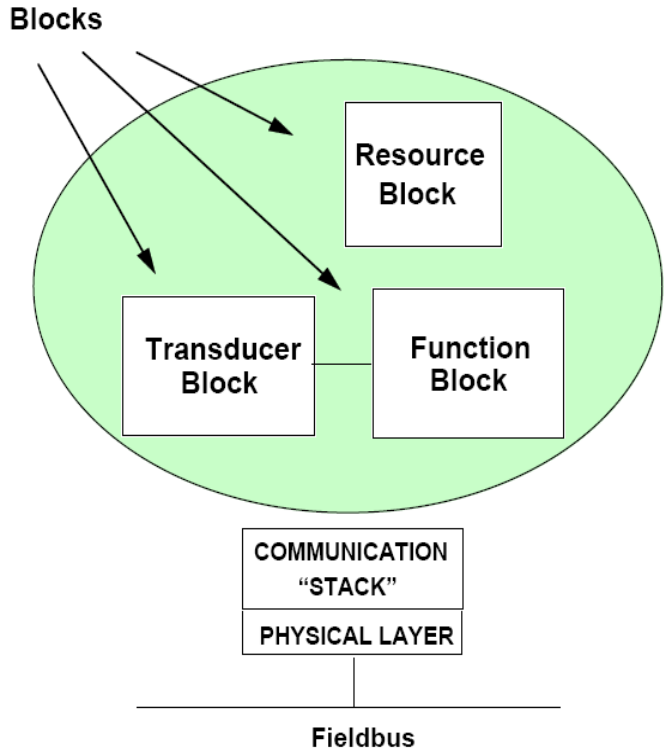
1. The Communication Stack comprises of Layer 2 and 7.
2. Layer 2, the Data Link Layer (DLL) controls transmission of messages onto the fieldbus, through a deterministic centralized bus scheduler call the Link Active Scheduler (LAS).
3. FAS uses the scheduled and unscheduled features of the DLL to provide a service for the FMS.
3. FMS services allow user applications to send messages to each other across the fieldbus using a standard set of messages.





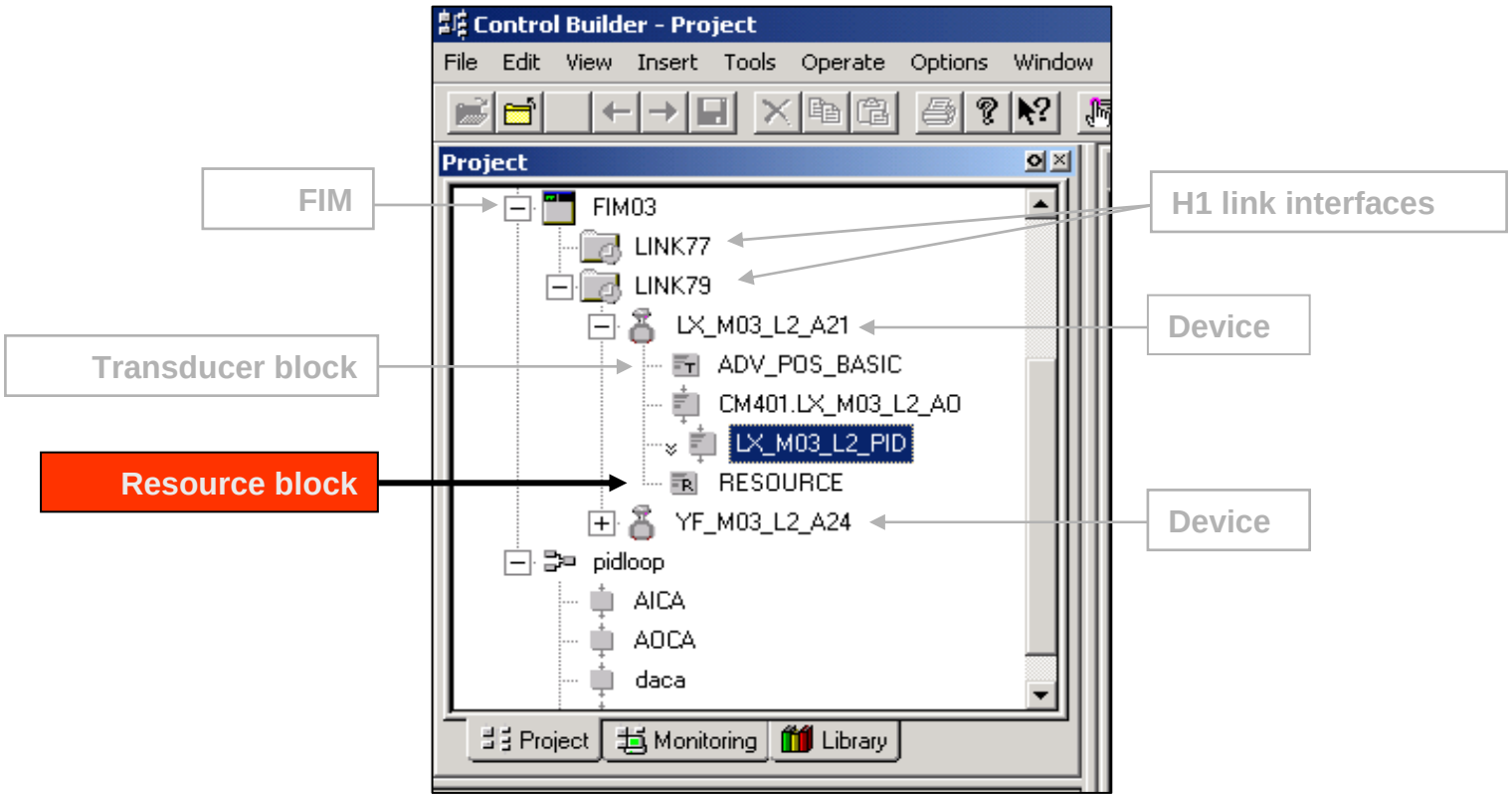
User Application - Blocks

1. The Fieldbus Foundation has defined a standard User Application Layer based on “Blocks”.
2. Blocks are representations of different types of application functions.
3. The types of blocks used in a User Application are described as:
   - Resource Block,
   - Transducer Block,
   - Function Blocks.
4. Devices are configured using Resource Block and Transducer Block.
5. The Control Strategy is built using Function Blocks.



Resource Block

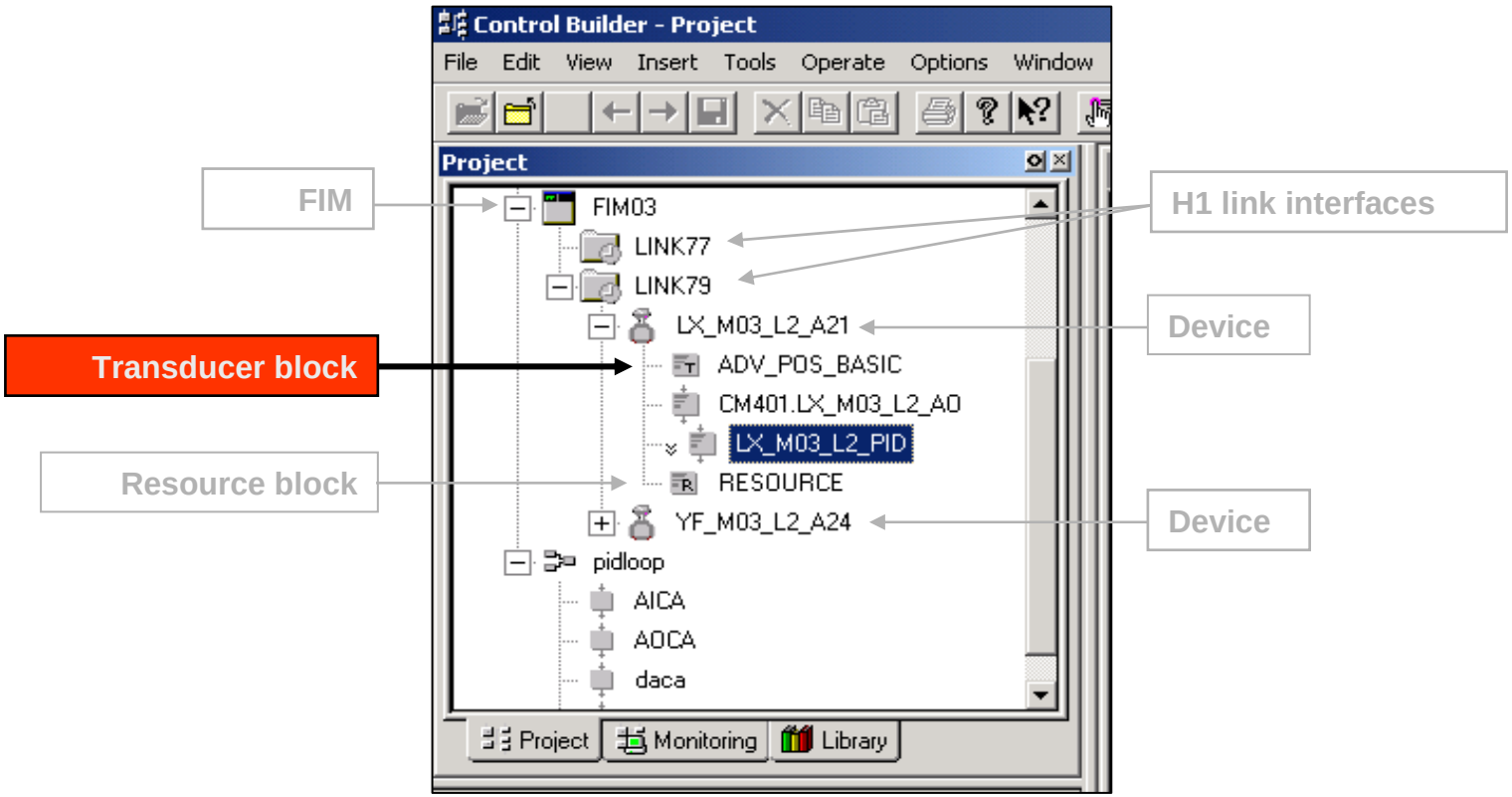
1. The Resource Block describes characteristics of the fieldbus device such as device name, manufacturer and serial number, etc.
2. There is only one Resource Block in a device.



Control Builder Project tab

Transducer Block

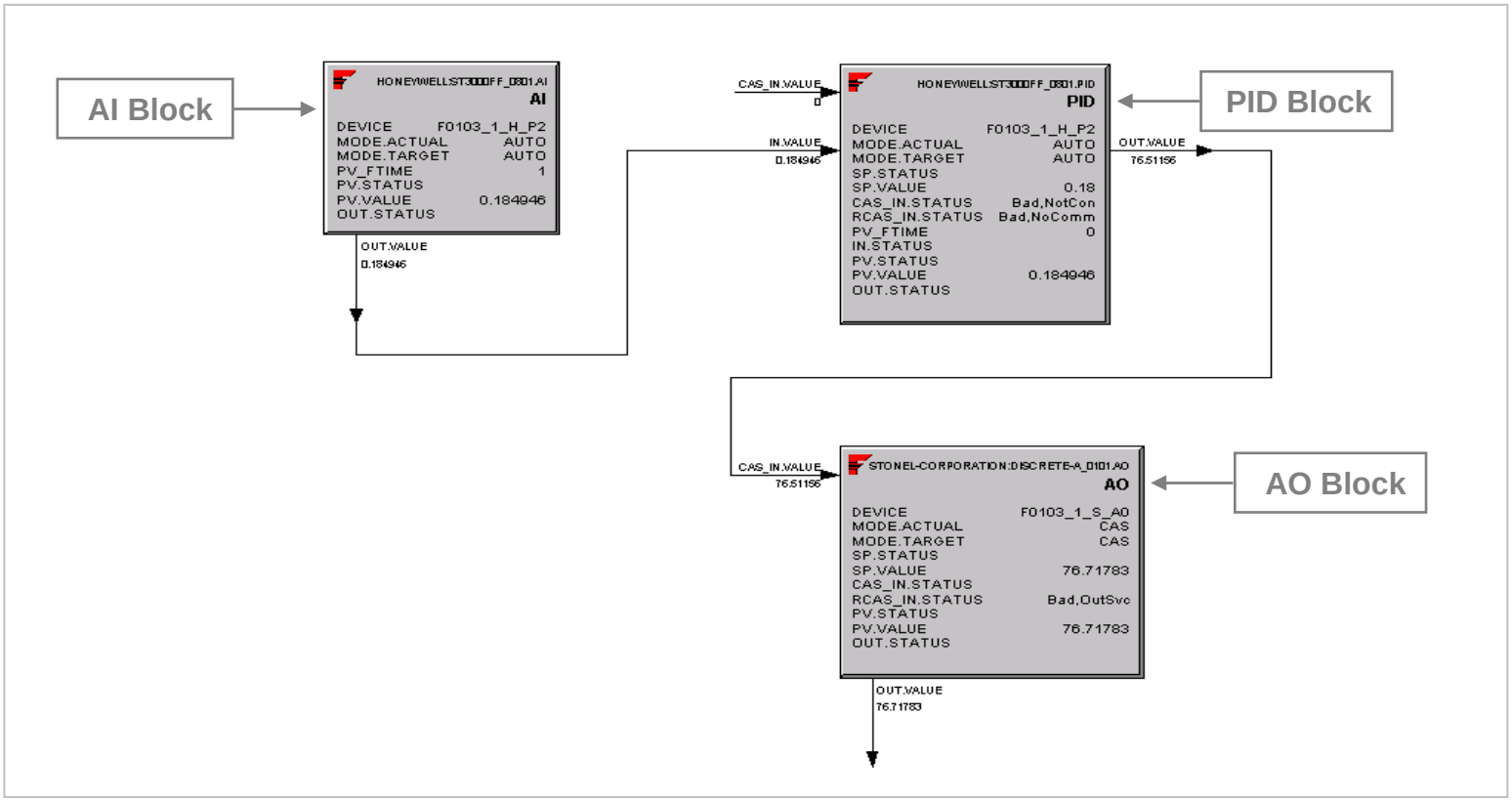
1. Transducer Blocks are used to configure devices.
2. Transducer Blocks are required to Read sensors value and command output value.



Control Builder Project tab

Function Blocks

1. The Control System Strategy is built using Function Blocks. Input and output parameters of Function Blocks can be linked over the fieldbus.
2. The execution of each Function Blocks is precisely scheduled and there can be many function blocks in a single user application.



Standard Function Blocks

1. The Fieldbus Foundation has defined 10 Standard Function Blocks for Basic Control.

Function Blocks	Abbreviation	Class Type
Analog Input	AI	Input
Analog Output	AO	Output
Bias/Gain	BG	Control
Control Selector	CS	Control
Discrete Input	DI	Input
Discrete Output	DO	Output
Manual Loader	ML	Control
Proportional/Derivative	PD	Control
Proportional/Integral/Derivative	PID	Control
Ratio	RA	Control

Standard Function Blocks

2. Eleven other Standard Function Blocks are also defined for Control.

Function Blocks	Abbreviation	Class Type
Device Control	DC	Control
Output Splitter	OS	Control
Signal Characterizer	SC	Control
Lead Lag	LL	Control
Deadtime	DT	Control
Integrator (Totalizer)	IT	Control
Setpoint Ramp Generator	SPG	Control
Input Selector	IS	Control
Arithmetic	AR	Control
Timer	TMR	Control
Analog Alarm	AAL	Control

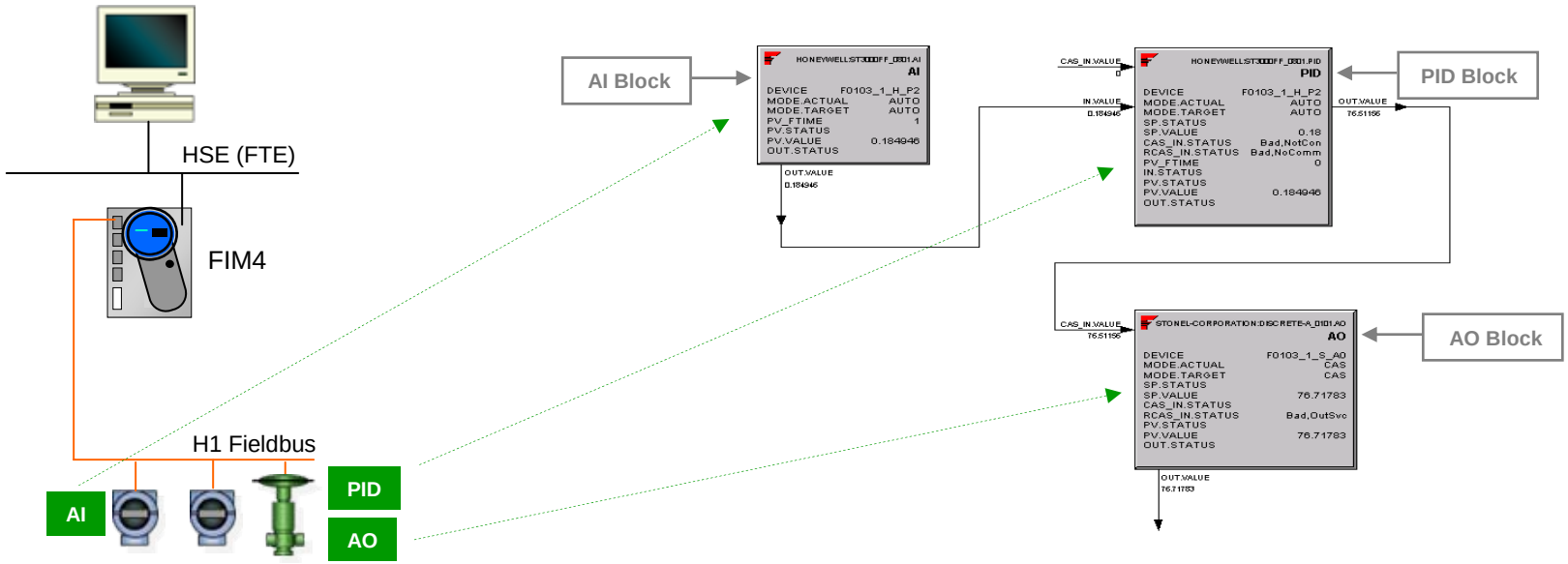
Standard Function Blocks

3. Four other Standard Function Blocks are also defined for Control.

Function Blocks	Abbreviation	Class Type
Multiple Analog Input	MAI	Input
Multiple Analog Output	MAO	Output
Multiple Discrete Input	MDI	Input
Multiple Discrete Output	MDO	Output

Example of a Control Loop

1. Control Strategy can be built using Function Blocks built into field devices.
2. A simple temperature transmitter may contain an AI function block. A Control Valve might contain a PID function block as well as the expected AO Block.
3. Thus, a complete control loop can be built using a simple transmitter and a control valve. Control in the Field does need a Controller.

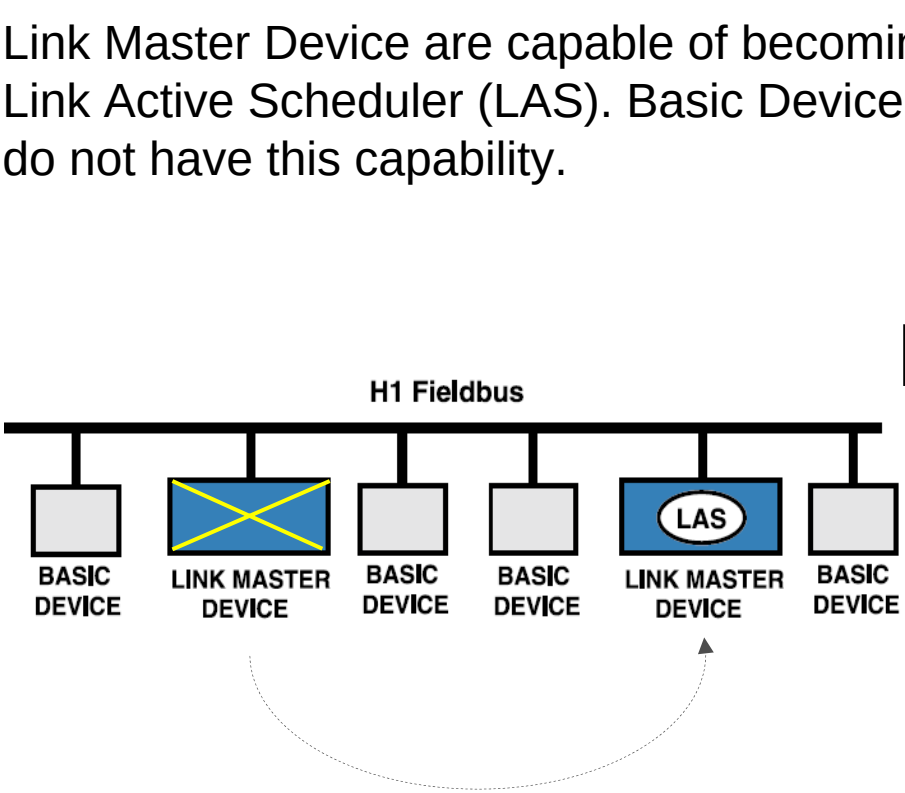


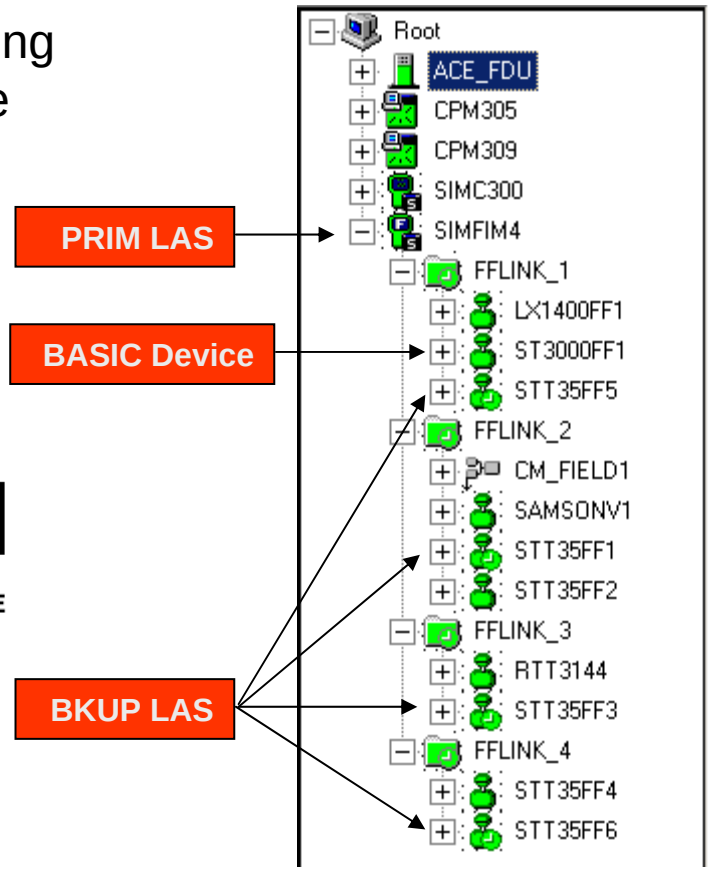
Example of a complete control loop
using Function Blocks located in fieldbus Devices.

Example of a complete control module strategy
Control on the Wire.

H1 Link Master Redundancy

1. Two types of devices are defined in the Data Link Layer (DLL). Link Master and Basic Device.
2. Link Master Device are capable of becoming Link Active Scheduler (LAS). Basic Device do not have this capability.





H1 Link Active Scheduler

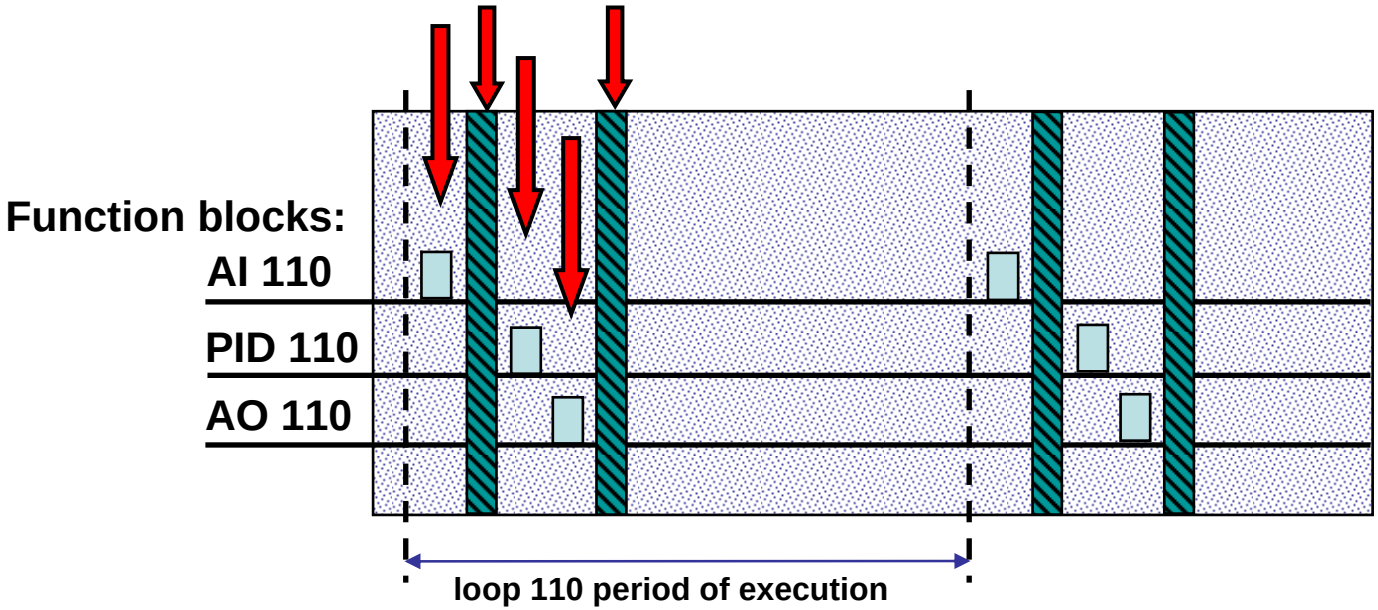
1. LAS provides scheduled communication(*) control on the H1 network.
2. LAS provides unscheduled communication(**) control on the H1 network.
3. LAS maintain a live list (devices that response to the pass token) it uses to recognize devices on each H1 Link.
4. Provides Data Link Time Synchronization so that all devices have exactly the same data link time.
5. Insures LAS Backup or LAS Redundancy. If one LAS fails, one of the Link Master will become the LAS and operation continues.

(*) Sends a compel data (CD) message to a device which allows the device to publish specific data when it receives the CD message.

(**) Issues a pass token to a device which allows the device to send message until it has finished or the token hold time expires.

H1 Link Active Scheduler

1. PID Loop scheduled and unscheduled communication.



Scheduled

Closed loop control

Unscheduled

Alarms/Events
Maintenance/Diagnostic Information
Program Invocation
Permissives/Interlocks
Display Information
Trend Information
Configuration

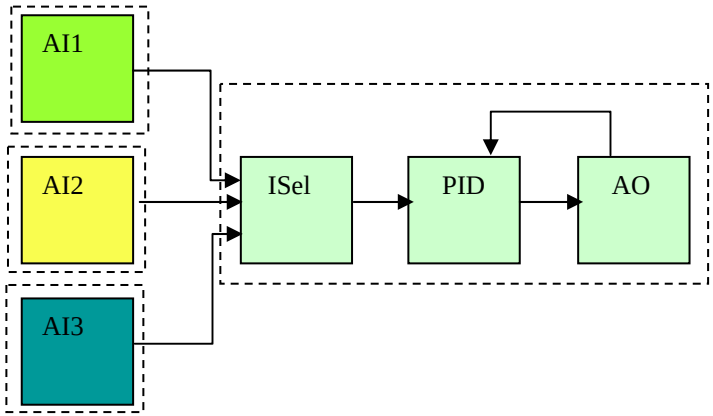
Link Schedule Optimization

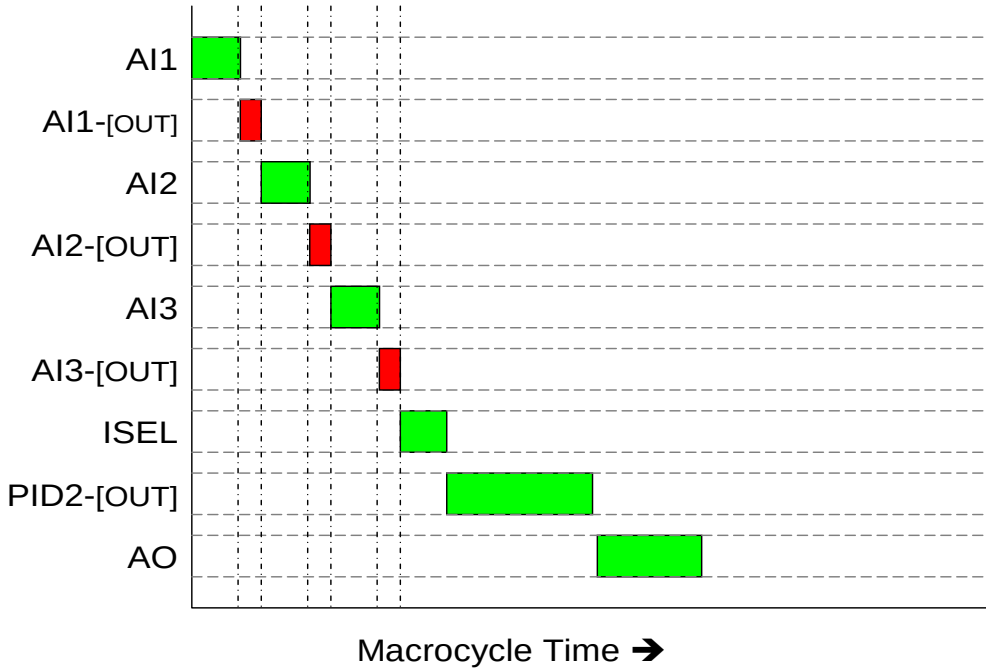
1. Makes effective use of Fieldbus bandwidth.
2. Important for Control on the Wire.
3. Allow for better time management on the Link.
4. Link Schedule Optimization provides a quantum improvement in the efficiency of Fieldbus Link bandwidth use.

Link Schedule Optimization

Optimizing Fieldbus Link Schedules Makes a Difference!

- An Example - Triple Transmitters (Un-optimized)

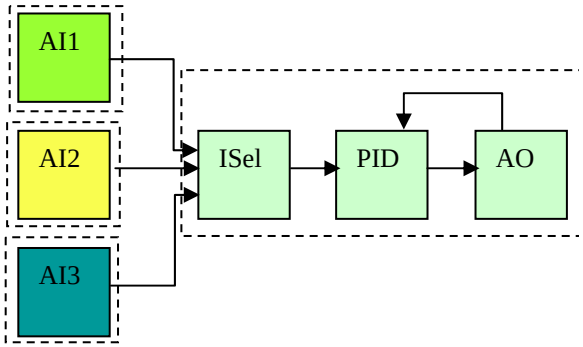


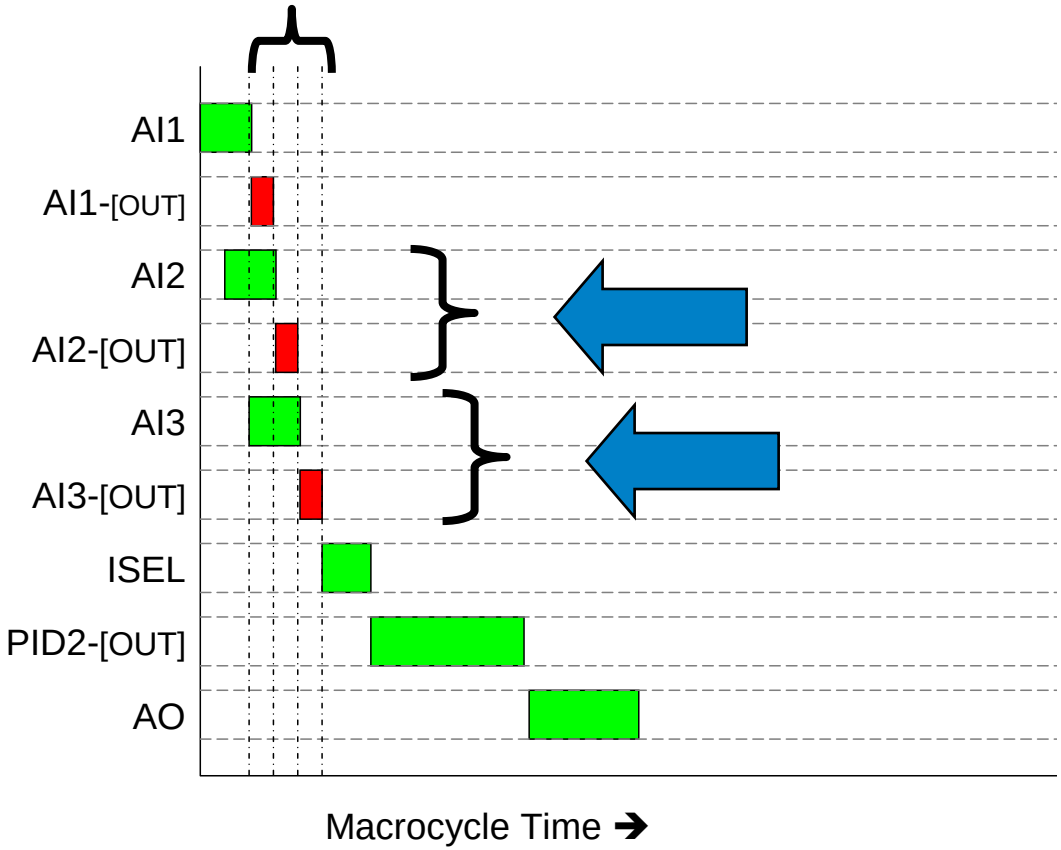


Link Schedule Optimization

Optimizing Fieldbus Link Schedules Makes a Difference!

- An Example - Triple Transmitters (Optimized)





- **More uninterrupted communications intervals.**
- **Better unscheduled throughput.**
- **Faster display call-ups, etc.**
- **Reduced latency.**

Demostration

(5 to 10 minutes)

Thank You

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