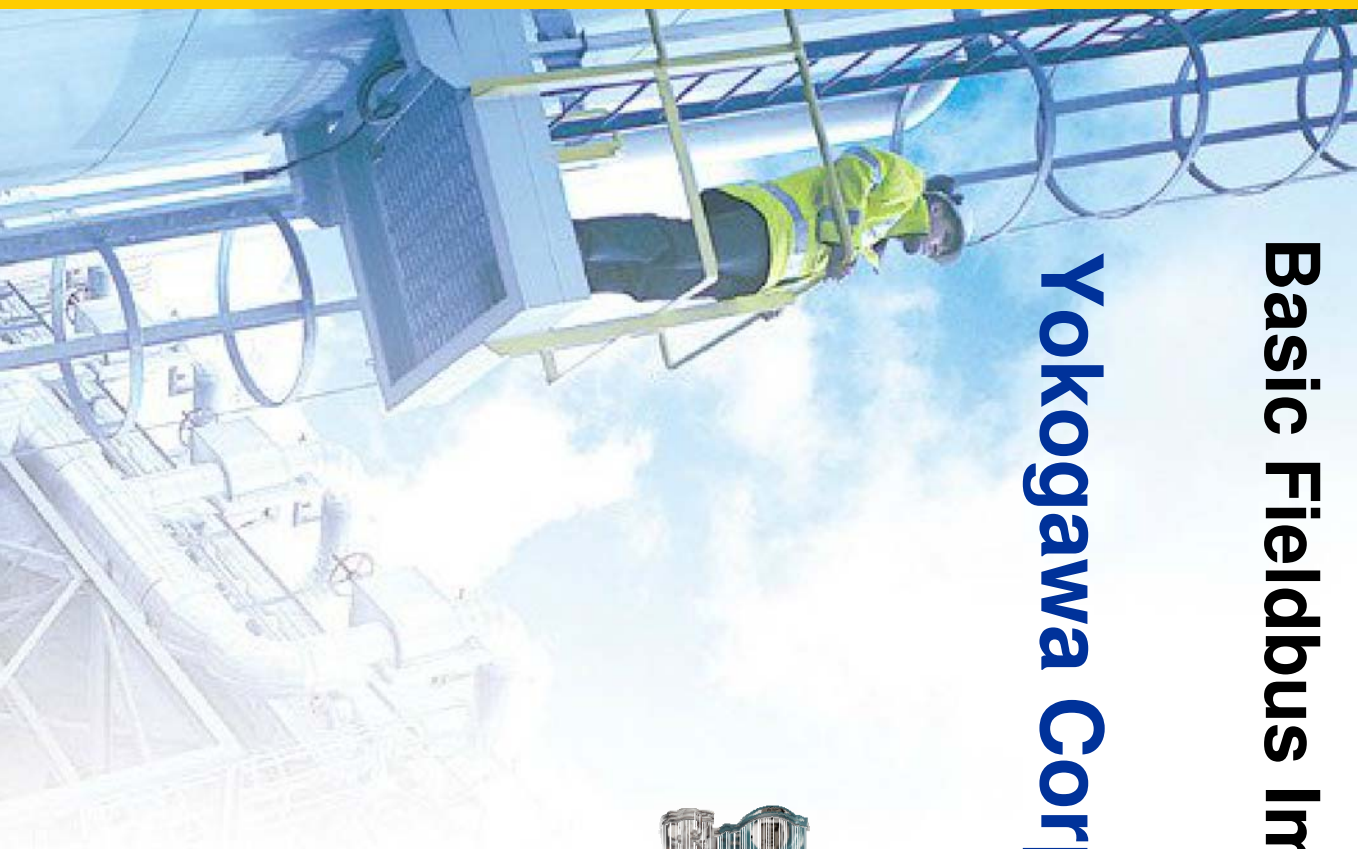


Basic Fieldbus Implementation



Yokogawa Corporation of America



Hoag Ostling
Chief Application Engineer
Field Instruments Business Unit



What is a fieldbus?



- Digital networking technology applied to field device communication
 - FOUNDATION fieldbus
 - Profibus
- Digital process values
- Digital bi-directional communication

Who is the Fieldbus FOUNDATION?



- Global organization of users, device vendors, and host vendors working together to provide an interoperable international fieldbus.
 - Providing diverse product interoperability
 - Flexibility to choose the best device
 - Supported by device and control system vendors



What is FOUNDATION fieldbus?



- Digital bus for field devices
- Interoperable Standard
- Utilizes Device Description Technology
- 3rd Party Tested & Registered
- Contains Standard Function Blocks
 - Enable Custom Function Blocks
- Provides Control in the Field

Interoperability:



- Ability to substitute field devices on any host without manufacturer dependence
 - Freedom to choose the best device for an application, or control function
 - Vendor flexibility to innovate and add new and useful features
 - Elimination of proprietary protocols, custom software drivers, and costly upgrades



Device Testing and Registration



- Device interoperability is assured by the Fieldbus FOUNDATION
 - FF performs device interoperability testing
 - 3rd party objectivity
 - Assures all registered FF devices will work on your system!



Rule of thumb:

- Make sure your devices have the checkmark!



Device Description Technology

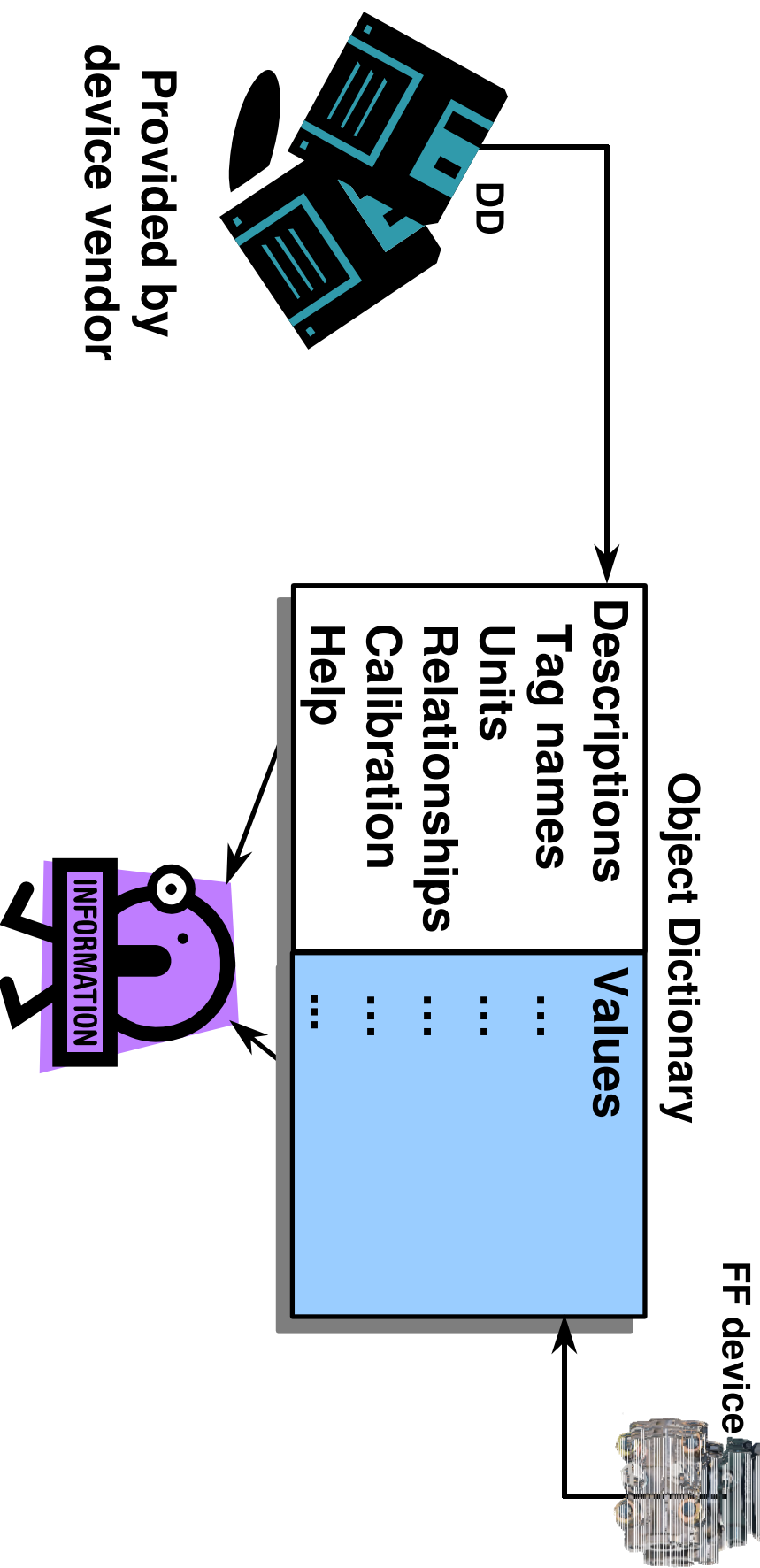


- Device description (DD) files describe all the device capabilities (provided by the device vendor)
- DD services (host side) use the DD file to provide all the device information to the host
- DD Benefits:
 - Common user interface
 - Maintenance needs only one configurator
 - The key to interoperability

Device Description



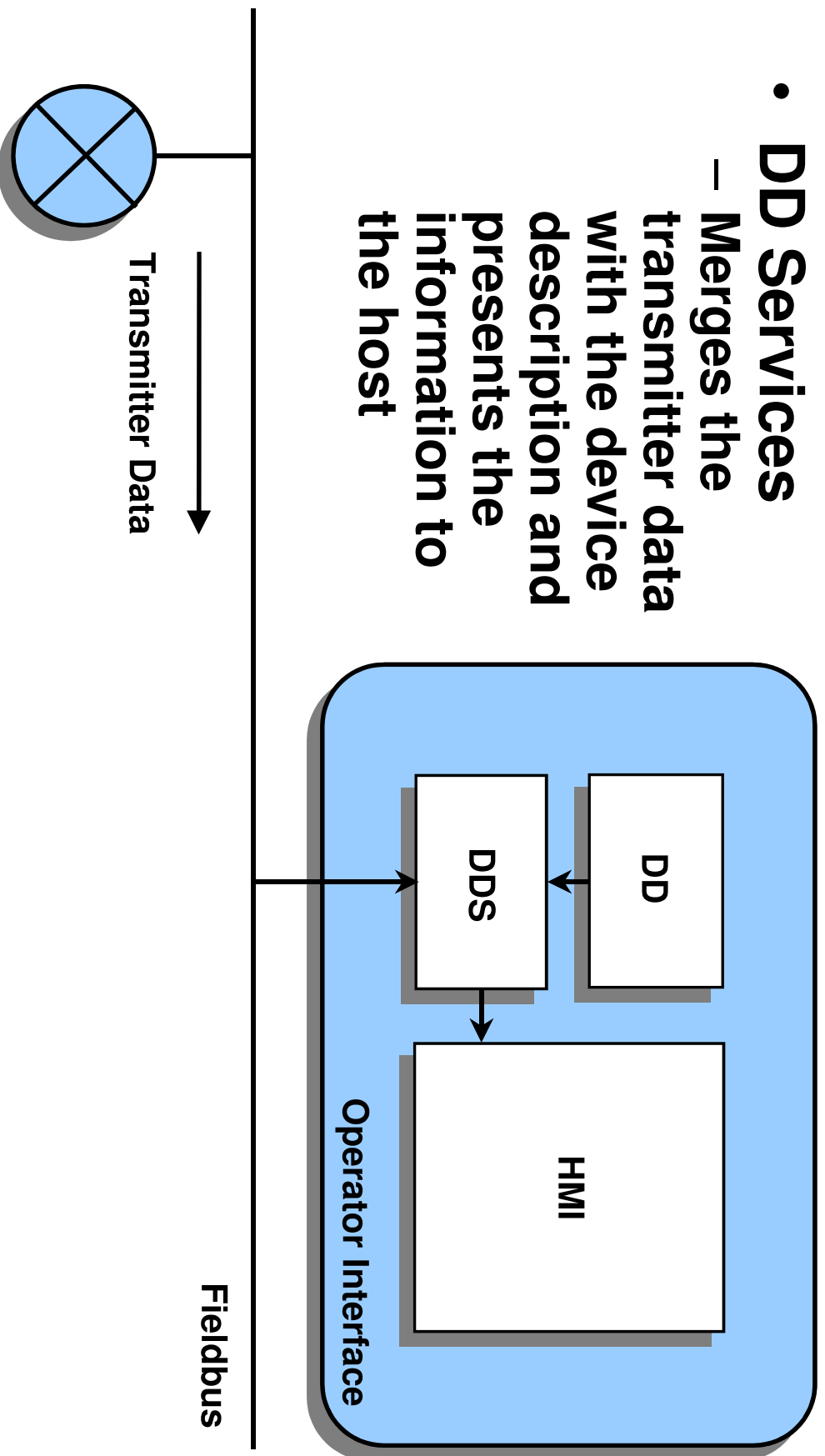
- Structured text description for each device that precisely defines the format of its data



Device Description Services



- **DD Services**
 - Merges the transmitter data with the device description and presents the information to the host





FOUNDATION

DD Registration



Official Fieldbus FOUNDATION registration mark:



Registration mark assures interoperability



FOUNDATION

Function Block Introduction



- Standard Function Blocks
 - Execute pre-defined procedures
 - Function Blocks may reside in any device
 - Function Blocks may execute virtually anywhere on the network.
 - Enable true distributed control in field
- Enhanced Function Blocks
 - Enabled by a device vendor to do specialty functions
 - Flow Computer
 - Totalization function

10 Standard Function Blocks

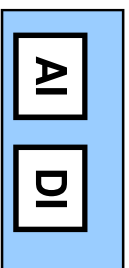


Name	Symbol	Function
Analog Input	AI	Provides AI from Sensor
Analog Output	AO	Accepts MV from control
PID Control	PID	PID control
Control Selector	CS	Override Control
Discrete Input	DI	Provides DI from device
Discrete Output	DO	Accepts DO from control
Manual Loader	ML	Manual Control
PD Control	PD	PD control
Ratio Control	RA	Ratio control
Bias Gain	B	Scaling

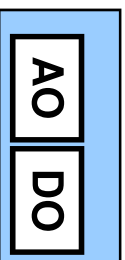


FOUNDATION

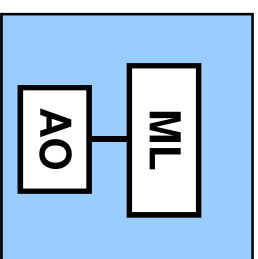
Function Block Applications



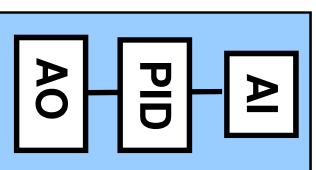
Input



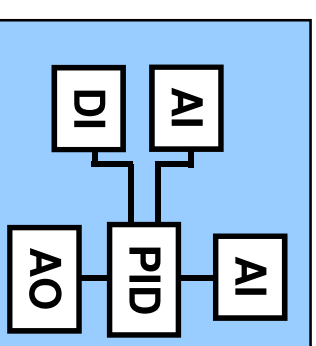
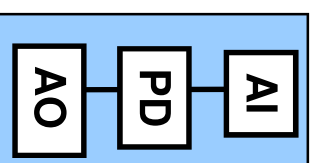
Output



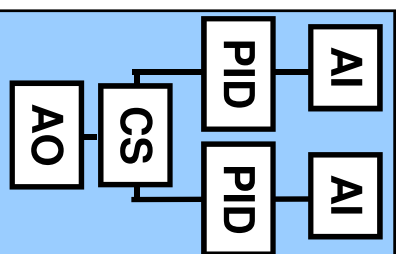
Manual Control



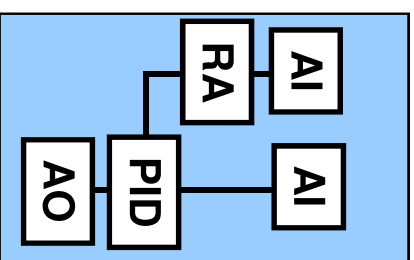
Feedback Control



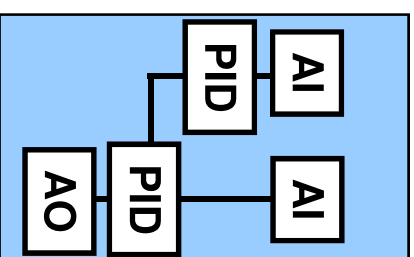
Track, Feedforward
Capability in Control



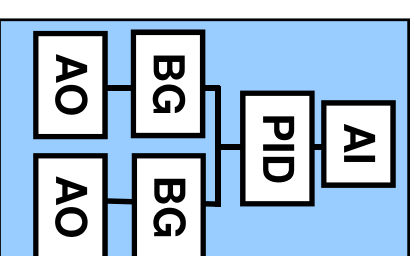
Override Control



Ratio Control



Cascade Control



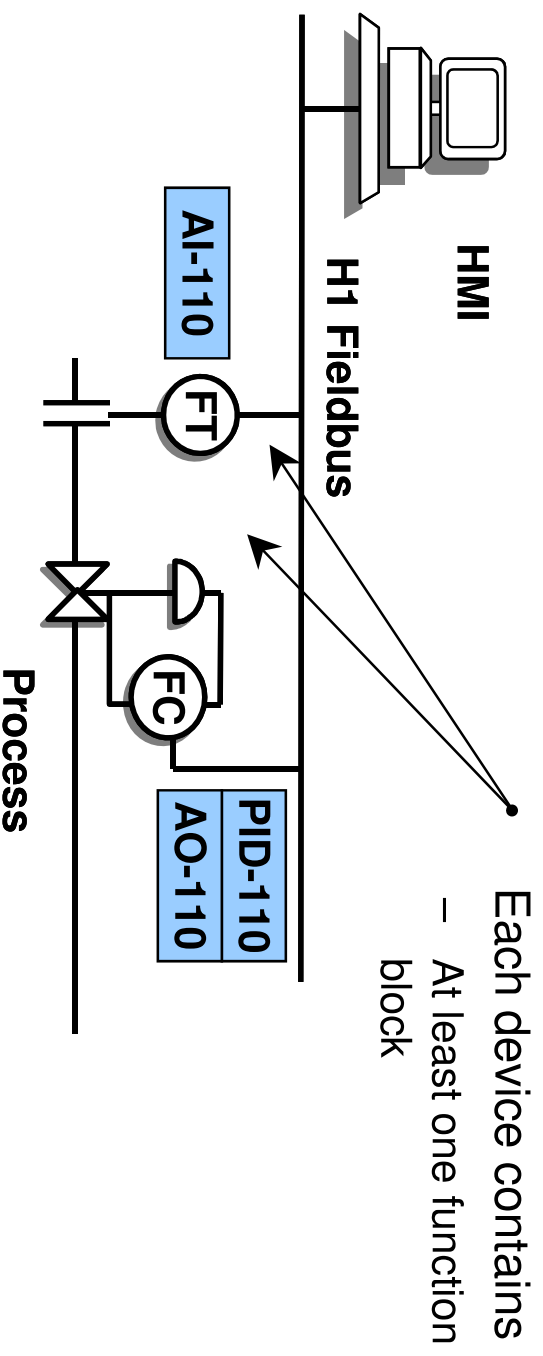
Split Range Control



Function Blocks



- Function blocks:
 - Encapsulate basic automation functions
 - Reside in device or in host
 - Are connected and provide deterministic control



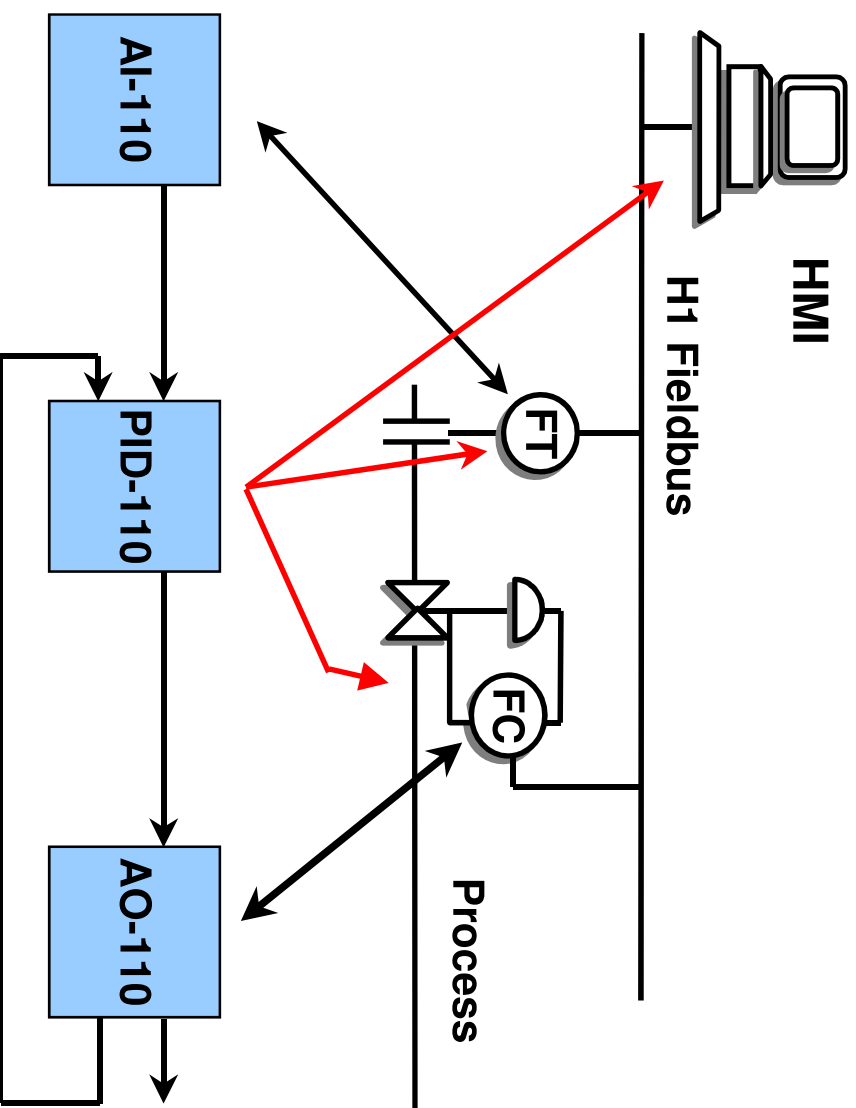


FOUNDATION

Function Blocks



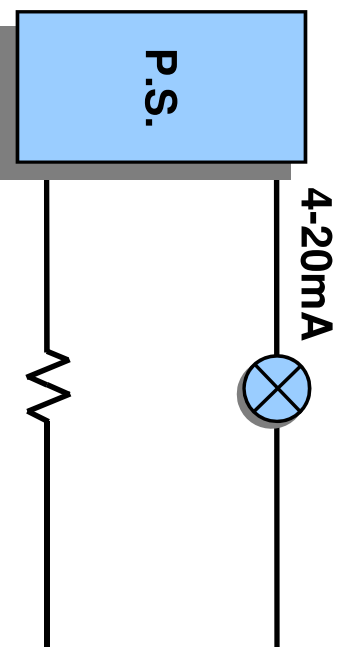
A location-independent model for distributed control



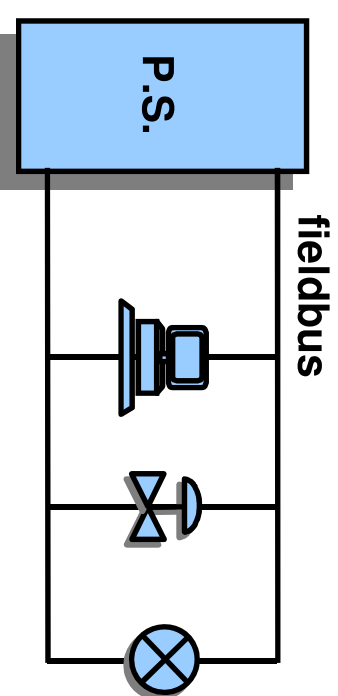


FOUNDATION

Fieldbus vs. 4-20mA



- One pair of wires for each device
- A single analog PV
- Device status unknown



- Parallel connections
- Digital bus
- Multiple PV's per device
- Bi-directional information
- Data available across the network
- Device status insures only good data is used for control

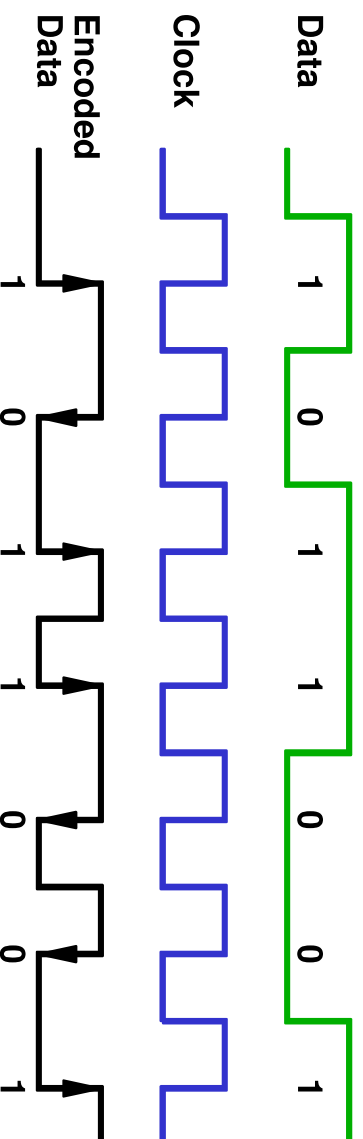


FOUNDATION

FOUNDATION Fieldbus Benefits



- More Accurate
 - No analog conversion errors
 - Digital communication error correction
- Manchester Bit level encoding
 - puts a time reference on a signal to determine bit boundaries

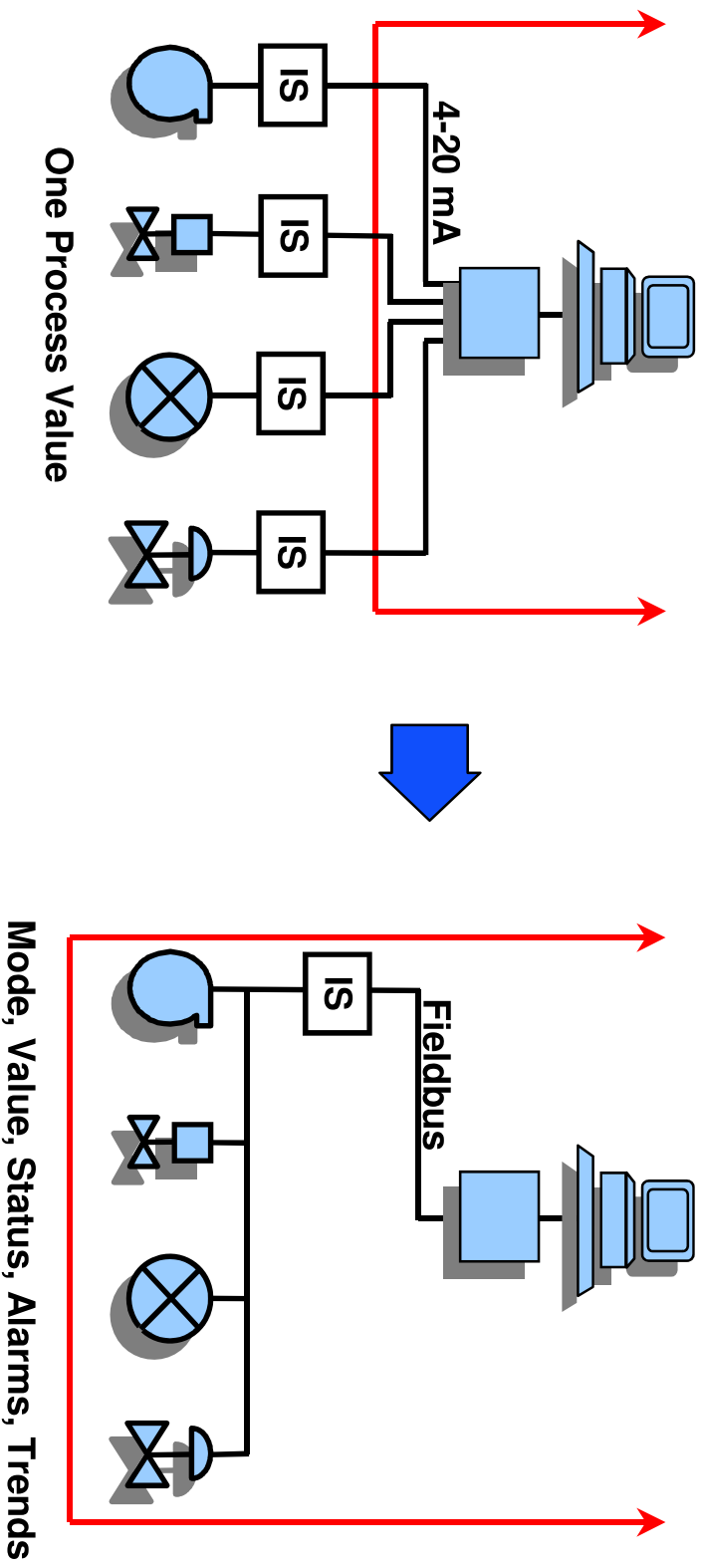




FOUNDATION Fieldbus Benefits



- Reduced wiring and installation costs (CAPEX)

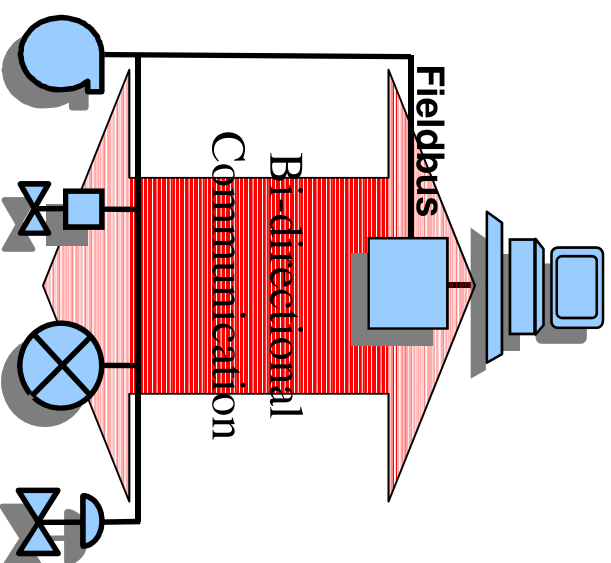




FOUNDATION Fieldbus Benefits



- Reduced engineering and maintenance costs (OPEX)



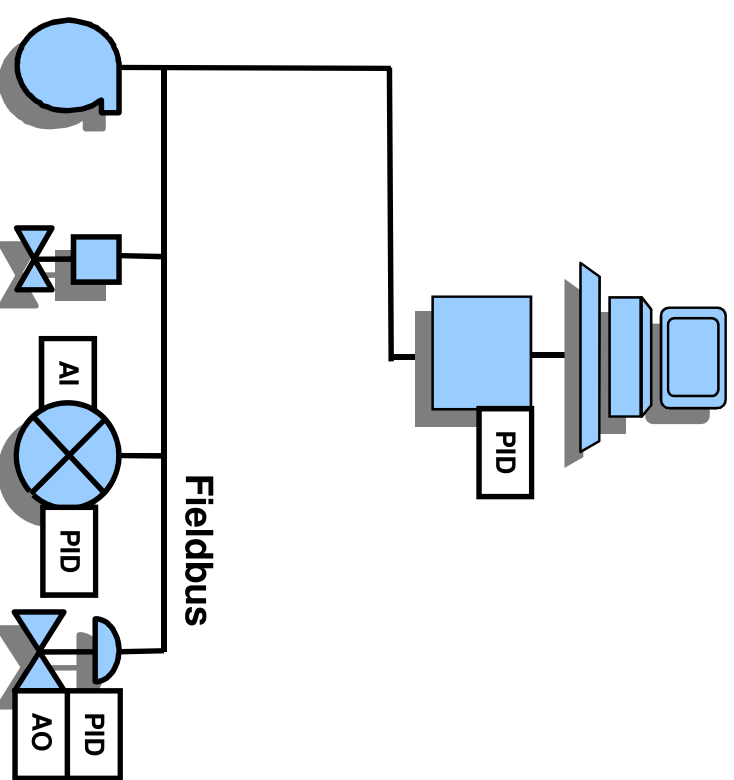
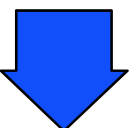
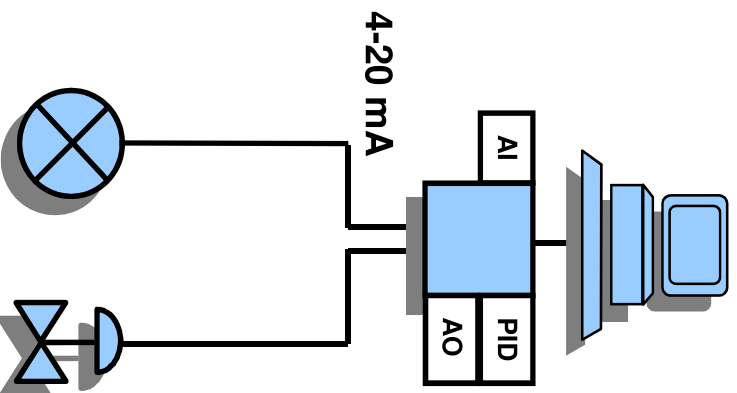
Mode, Value, Status, Alarms, Trends



FOUNDATION Fieldbus Benefits



- Distribution of functions



Control functions all reside in central controllers.

Fieldbus can be used in the same way, but fieldbus also enables control and I/O functions to be distributed to field instruments.



FOUNDATION

Physical Connections



- Wire
- Junction Box, Terminal Blocks, Connectors
- Power Supplies
- Power Conditioners
- Terminators
- Intrinsic Safety Barriers
- Polarity
- Grounding
- Lightning protection



FOUNDATION

Cable Types / Bus Segment Length



- Fieldbus H1 Segment Cable

Cable Type	Wire Gauge	Max. Length
A. Twisted Shielded Pair	#18 AWG	1900 meters
B. Multi-Pair individually twisted and shielded	#22 AWG	1200 meters
C. Unshielded Twisted Pair	#22 AWG	400 meters

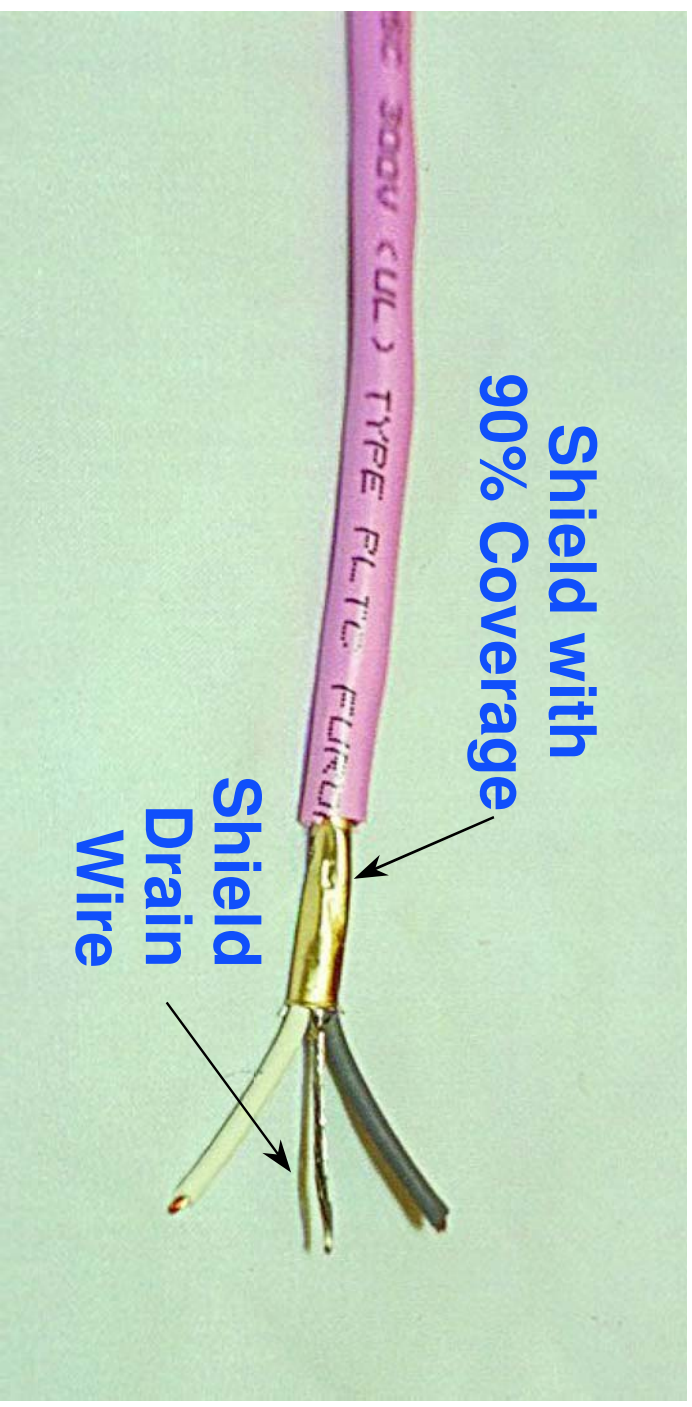


FOUNDATION

Shielded Twisted Pair Cable



- Typical shielded twisted pair
 - 90% shield
 - Drain wire
 - Color coded

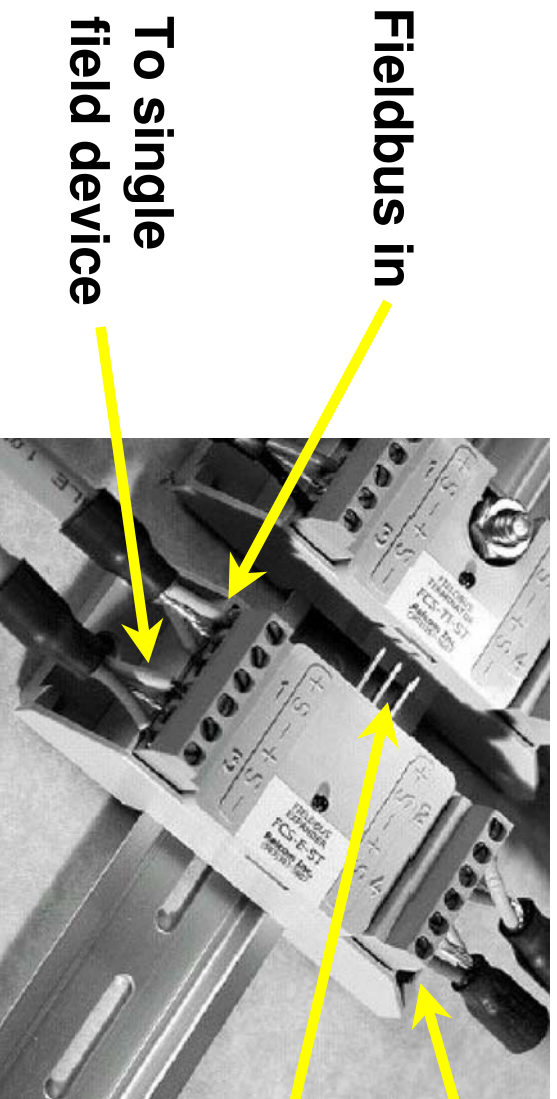




FOUNDATION

Fieldbus Terminal Blocks

- Screw, plug, or compression terminals
- Color coded terminals
- Options:
 - Terminators
 - Power LED
 - Short circuit protection



To field device or
next junction box

To single
field device



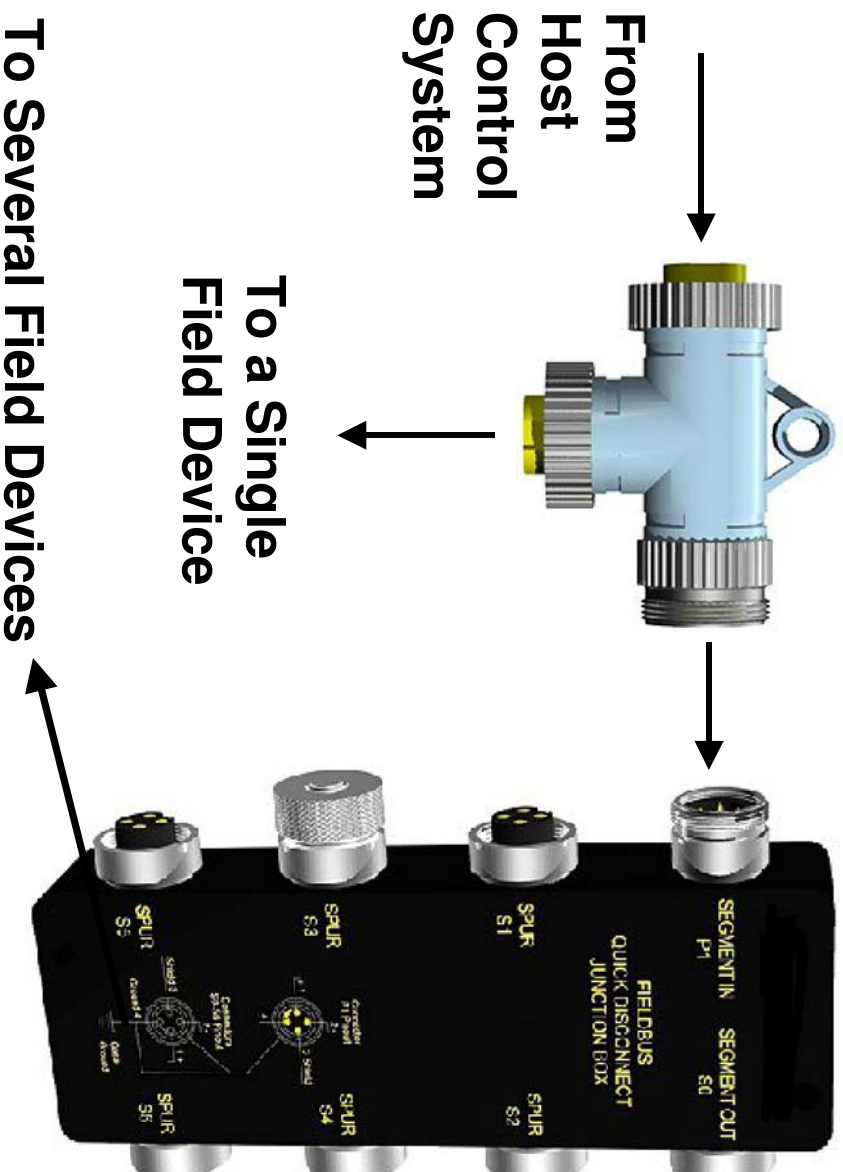
FOUNDATION

Fieldbus Terminal Blocks



Technology
made
intuitive

- Plug and Play wiring
 - NEMA 4X – no J-box required!



To next
connector, or
terminator can
be screwed in
here

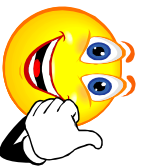




FOUNDATION

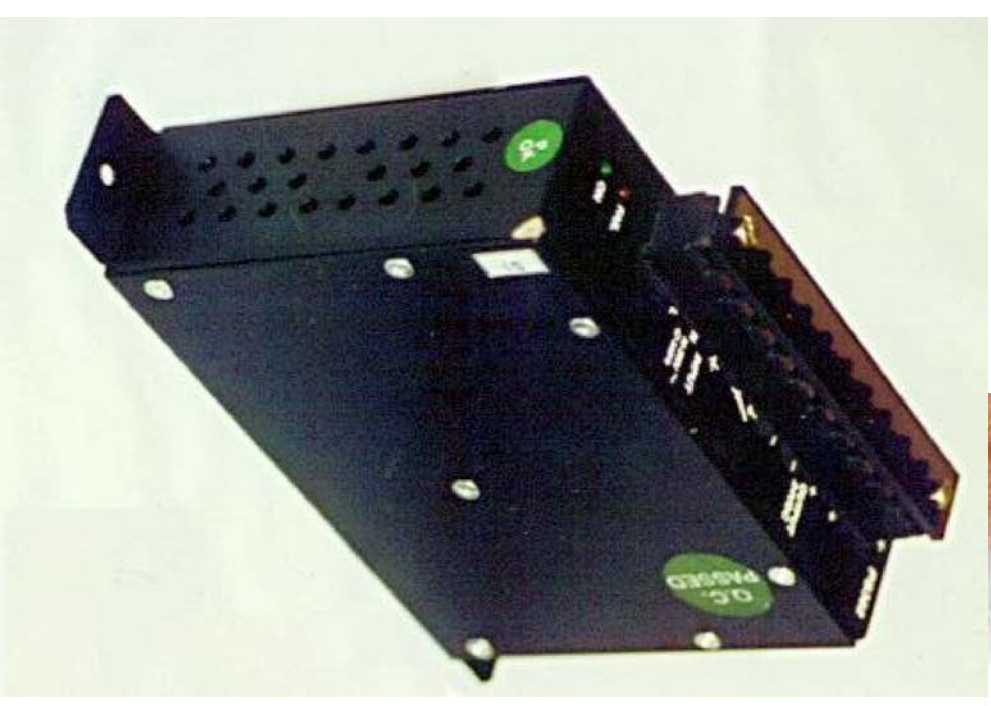
Power Supply

- 9 to 30 Vdc
- Power conditioning required
- Power supplies may be redundant



Rule of thumb:

- Select power supply with integral
- Terminators and/or conditioners
- Switch selectable



Power Conditioner

- A power conditioner:
 - Matches impedance to the network
 - May be integral to the power supply



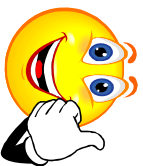


FOUNDATION

Terminators



- Impedance matching device used at each end of a fieldbus segment to prevent signal reflection
- Two terminators required per segment (and only two)



Rule of thumb:

- place terminators as far apart as possible





FOUNDATION

Intrinsic Safety Barriers



- A Fieldbus segment may be used Intrinsic Safety barriers
- Field device must be designed and certified to meet appropriate standards

Intrinsic Safety Barrier



Polarity



- Fieldbus devices may be sensitive to polarity, confirm with device vendor
- Fieldbus cables require conductor color coding



Rule of thumb:

- Assume all FF devices are polarity sensitive
- Maintain consistent wire color coding

Fieldbus Grounding



- Follow current company/plant standard practices and applicable international standards
- Shield grounded at one point only
- Data wires should never be grounded
- Shield never used as a power conductor
- Intrinsically Safe installations have additional specific requirements



Lightning/Surge Protection



- Often taken for granted and not specified!
- Surge Protection may be installed at the device or junction box
- Provides a low cost method to reduce Operating Expenses (OPEX)



Rule of thumb:

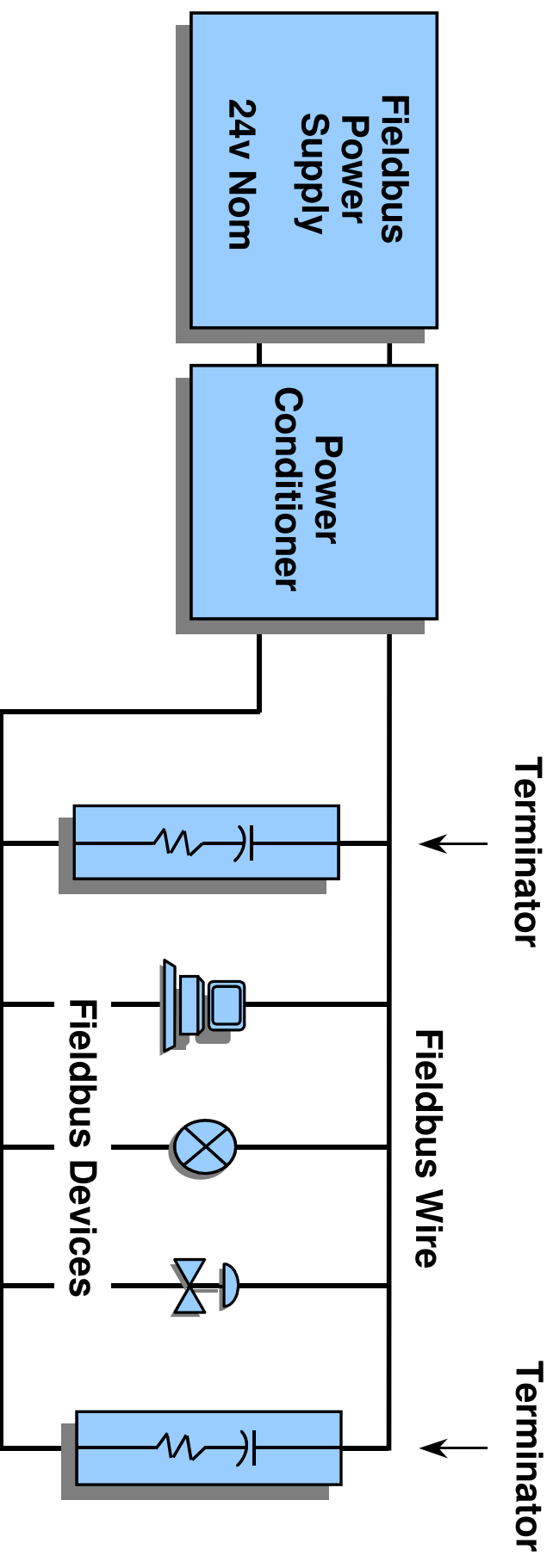
- Specify and install surge protection



Fieldbus wiring layout



- Typical Fieldbus segment (detail)

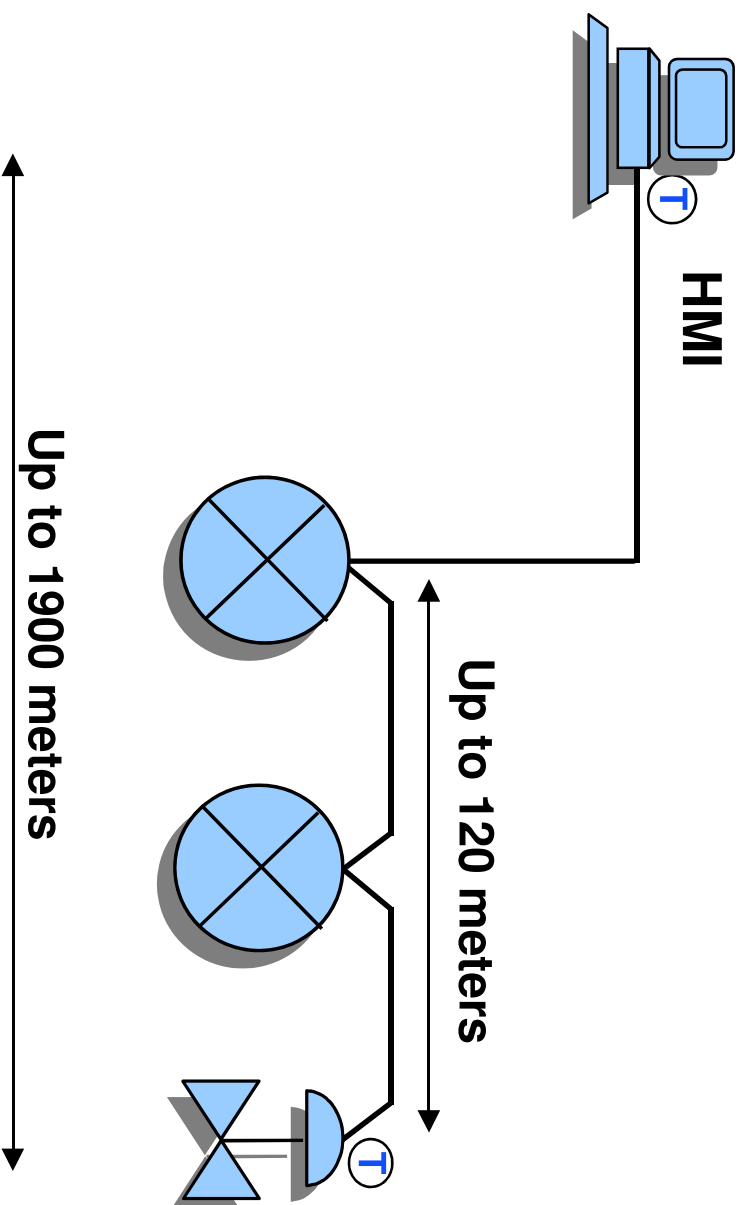




Wiring Topology



- Daisy chain topology



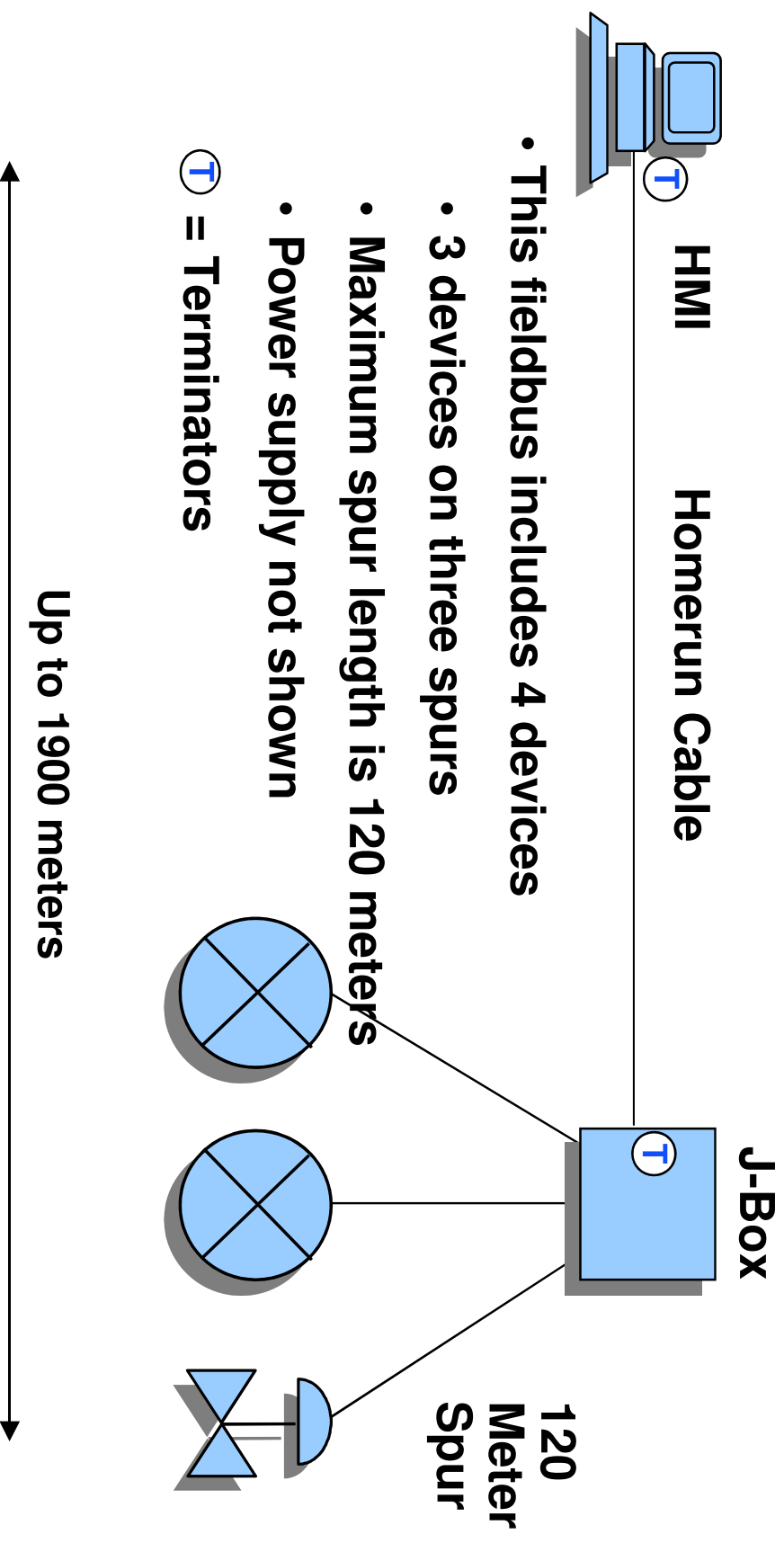


FOUNDATION

Wiring Topology



- Tree topology



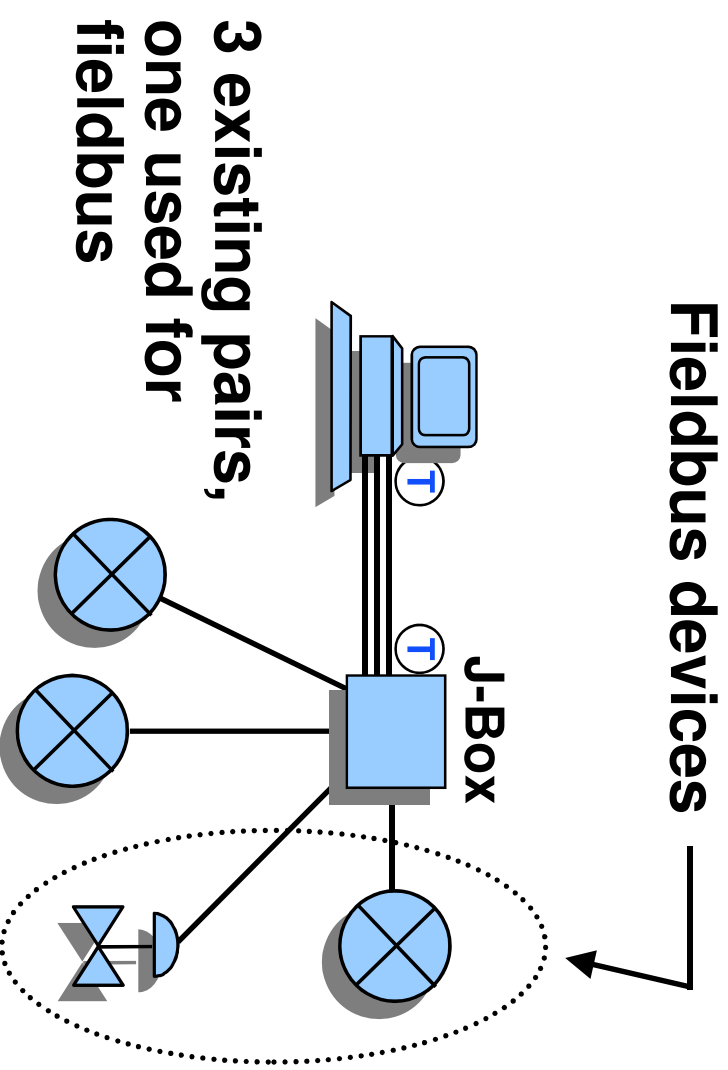
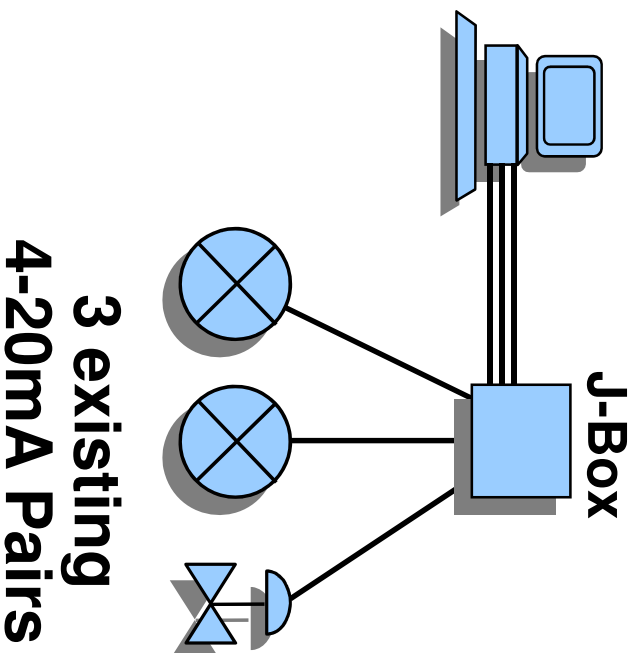


FOUNDATION

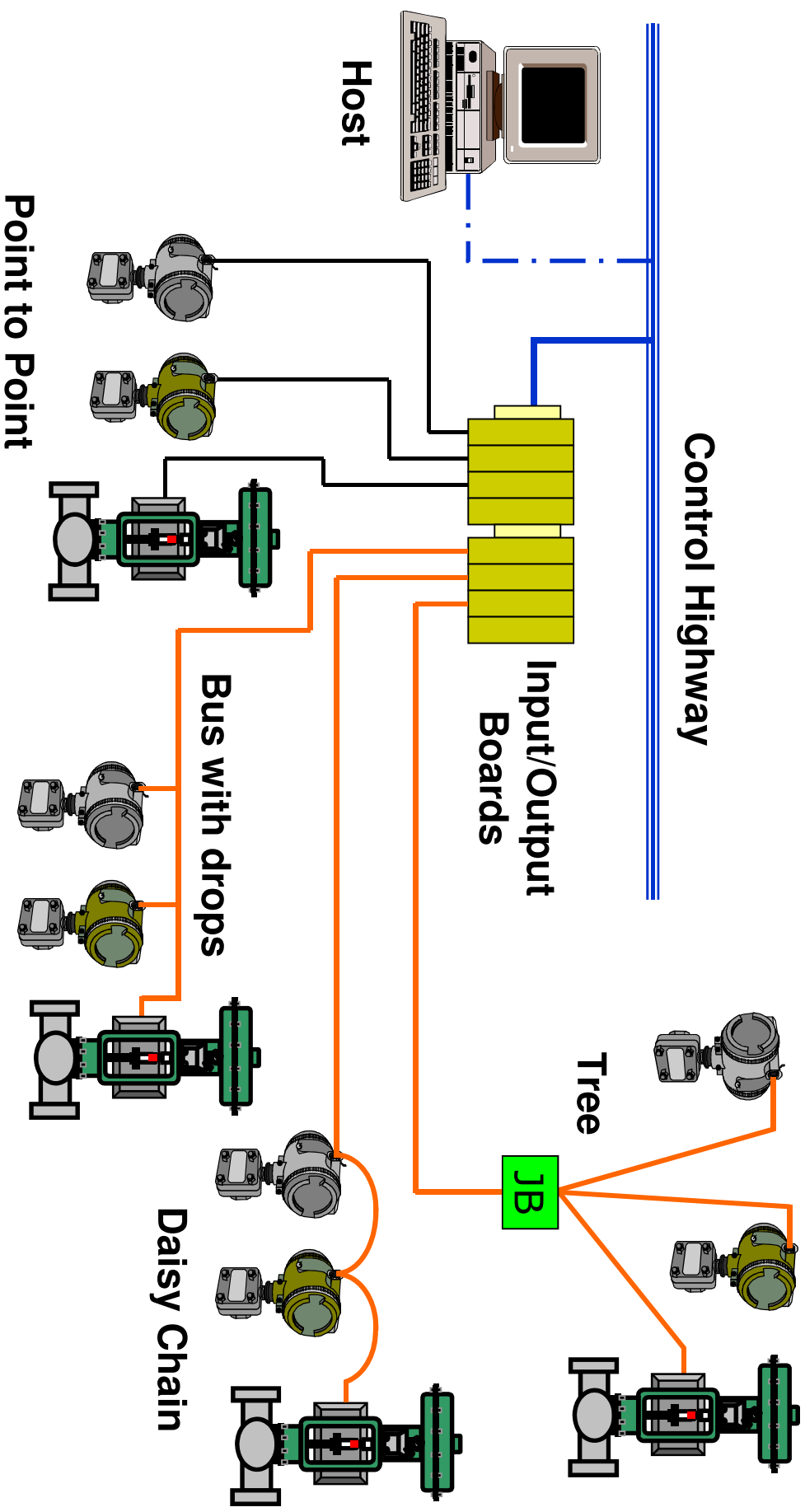
More Control with Installed Wires



- Expansion flexibility



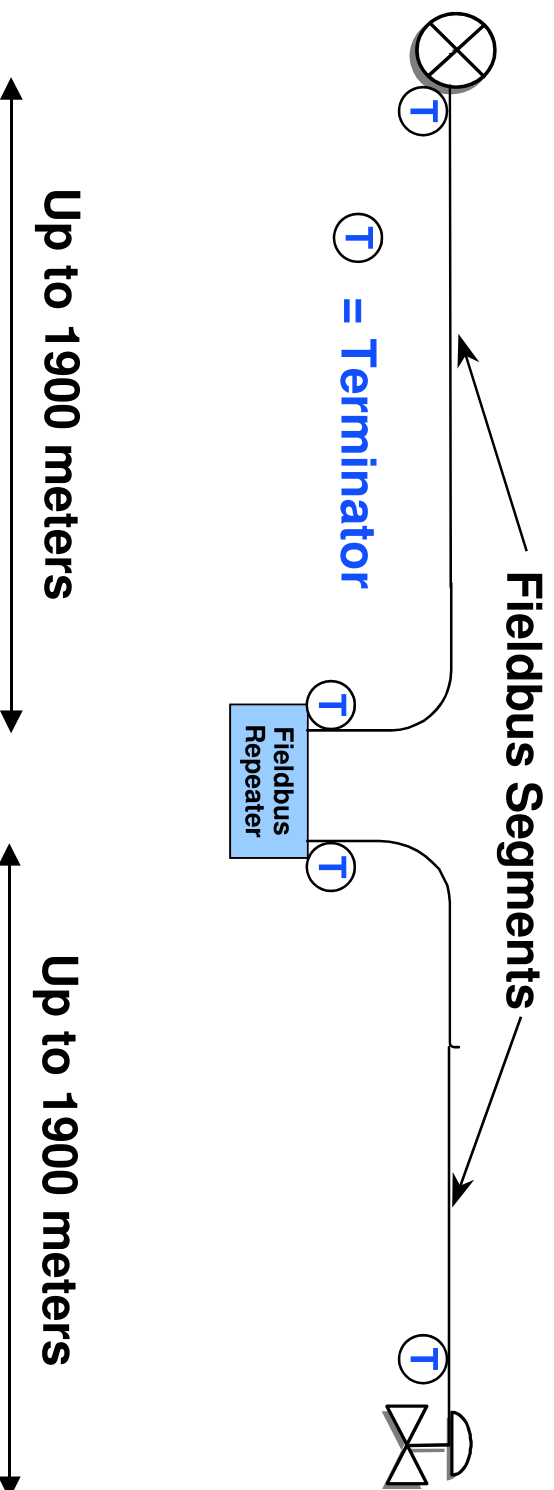
Physical Layout Examples



Increasing the Length of a Segment



- A repeater is an active device used to extend the length of a fieldbus



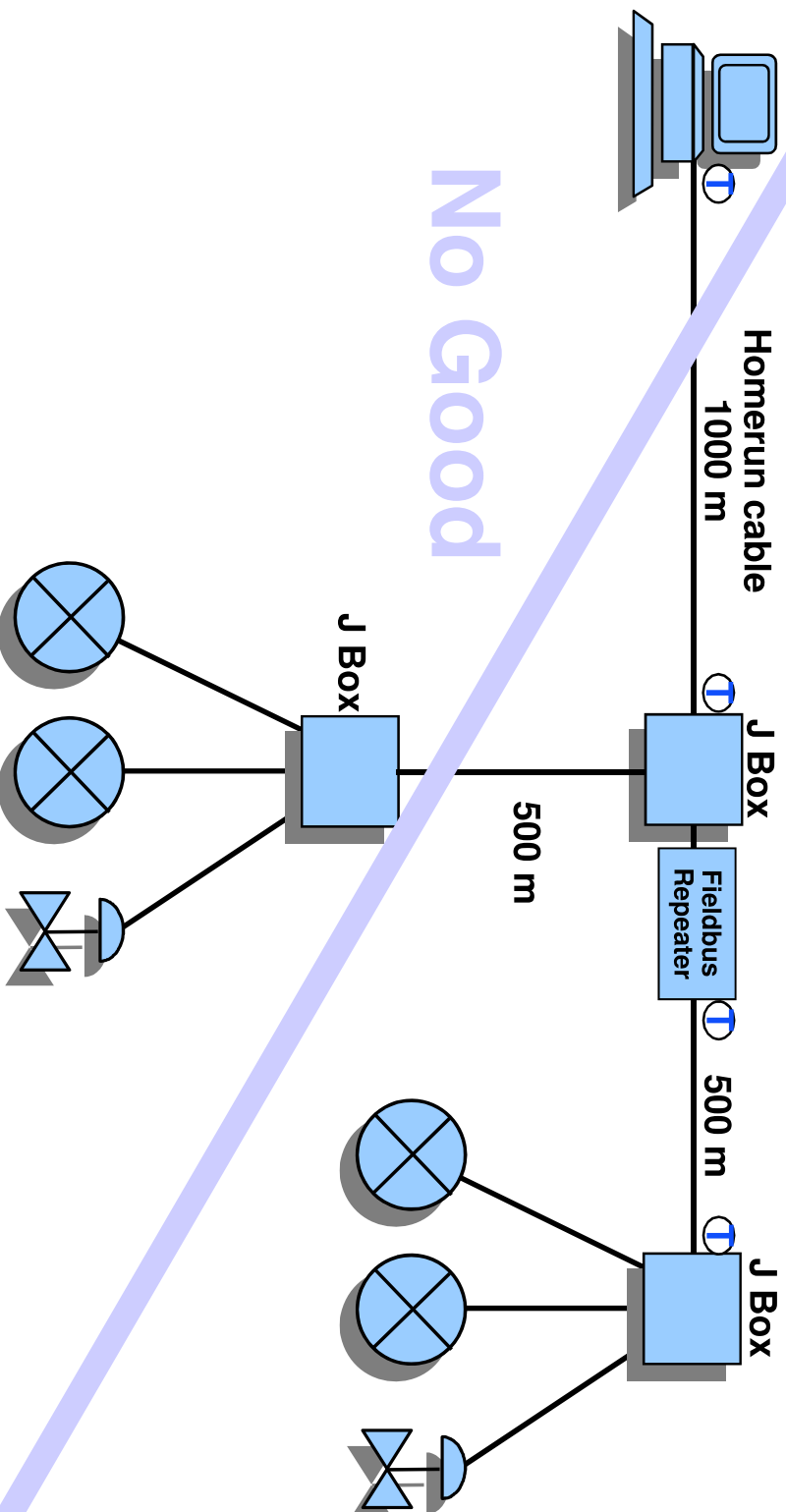


FOUNDATION

Network Extension



- Spur Length too long (500+ m)



- Repeater resolves excess spur length



FOUNDATION

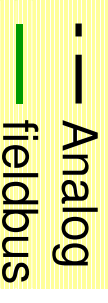
Fieldbus Trouble Shooting



- Power: bus voltage is displayed
- LAS activity: displays LAS signal level
- Device count: displays active device count
- Low: displays device with weakest signal
 - ($> 150\text{mV}$ OK)
- Noise: displays average and peak values
 - ($< 75\text{ mV}$ OK)



**Technology
made
intuitive**



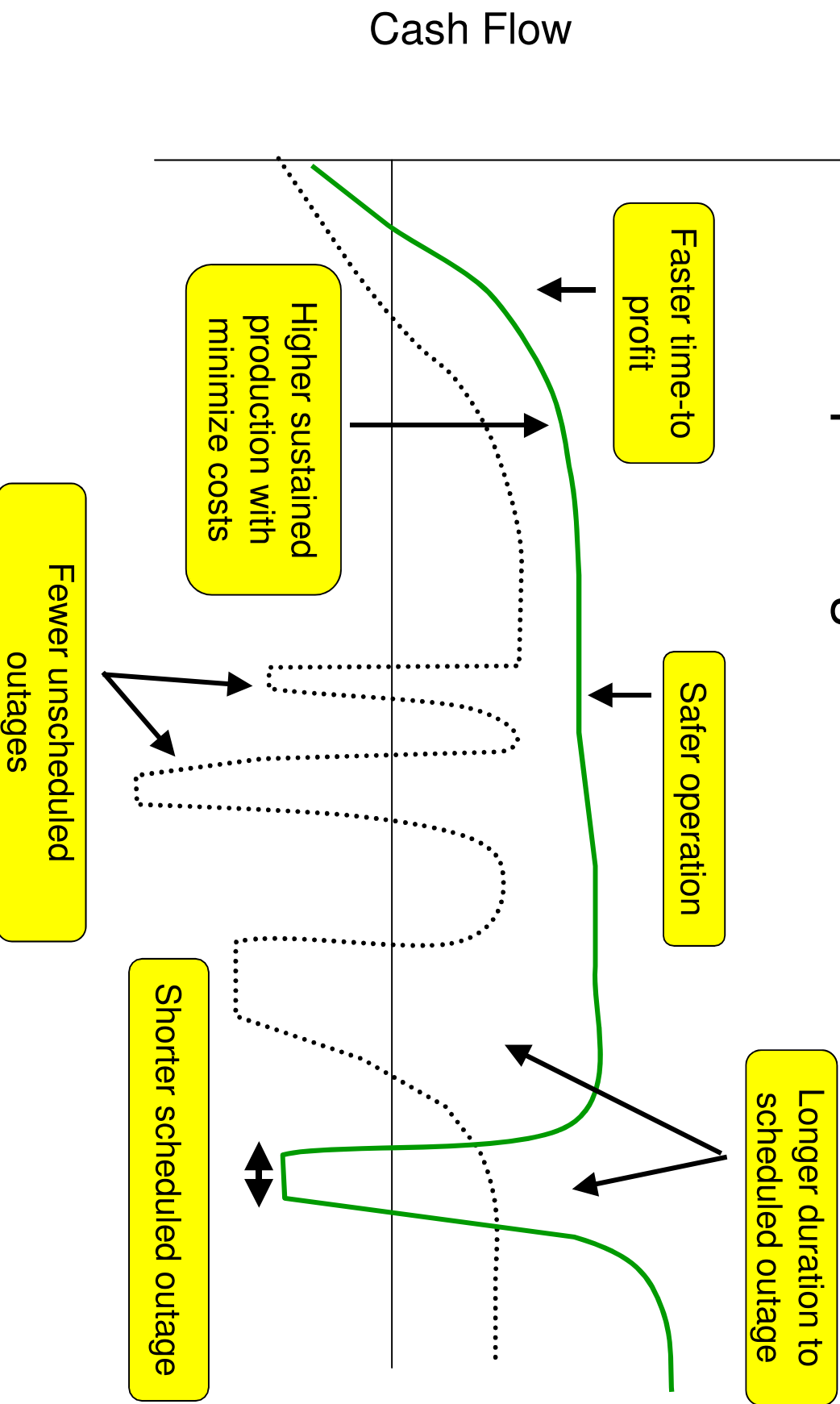


FOUNDATION

Operations & Maintenance



- Reduced operating costs



Fieldbus Project Costs



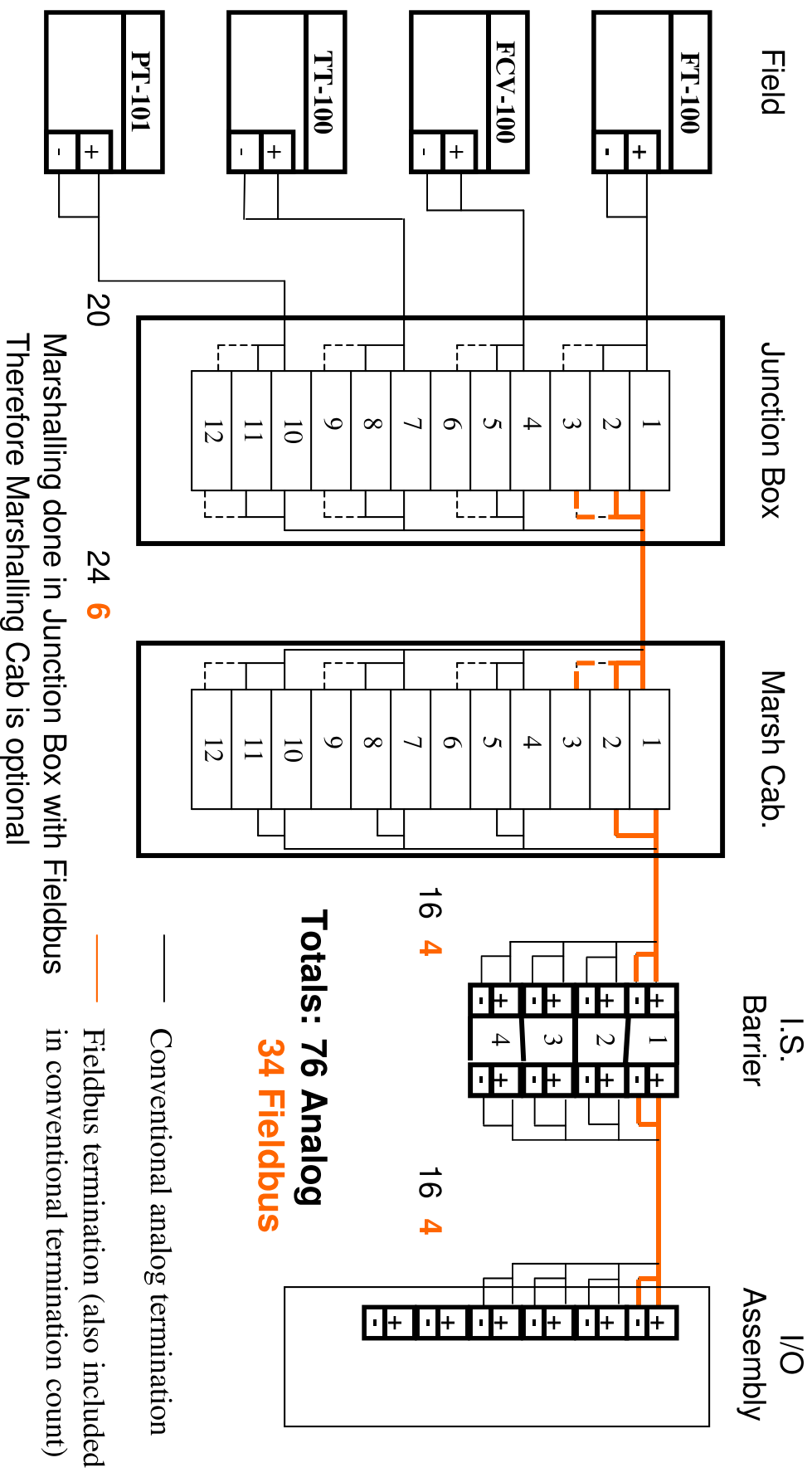
- Estimated Project Savings
 - Materials/Field Devices: Increased +25%
 - Installation Labor: Reduced -50%
 - Commissioning: Reduced -75%
 - Engineering: Reduced -50%
- Overall Capital Savings: **25 – 30%**
 - However savings will only be realized if the project is planned as a fieldbus project



Termination count



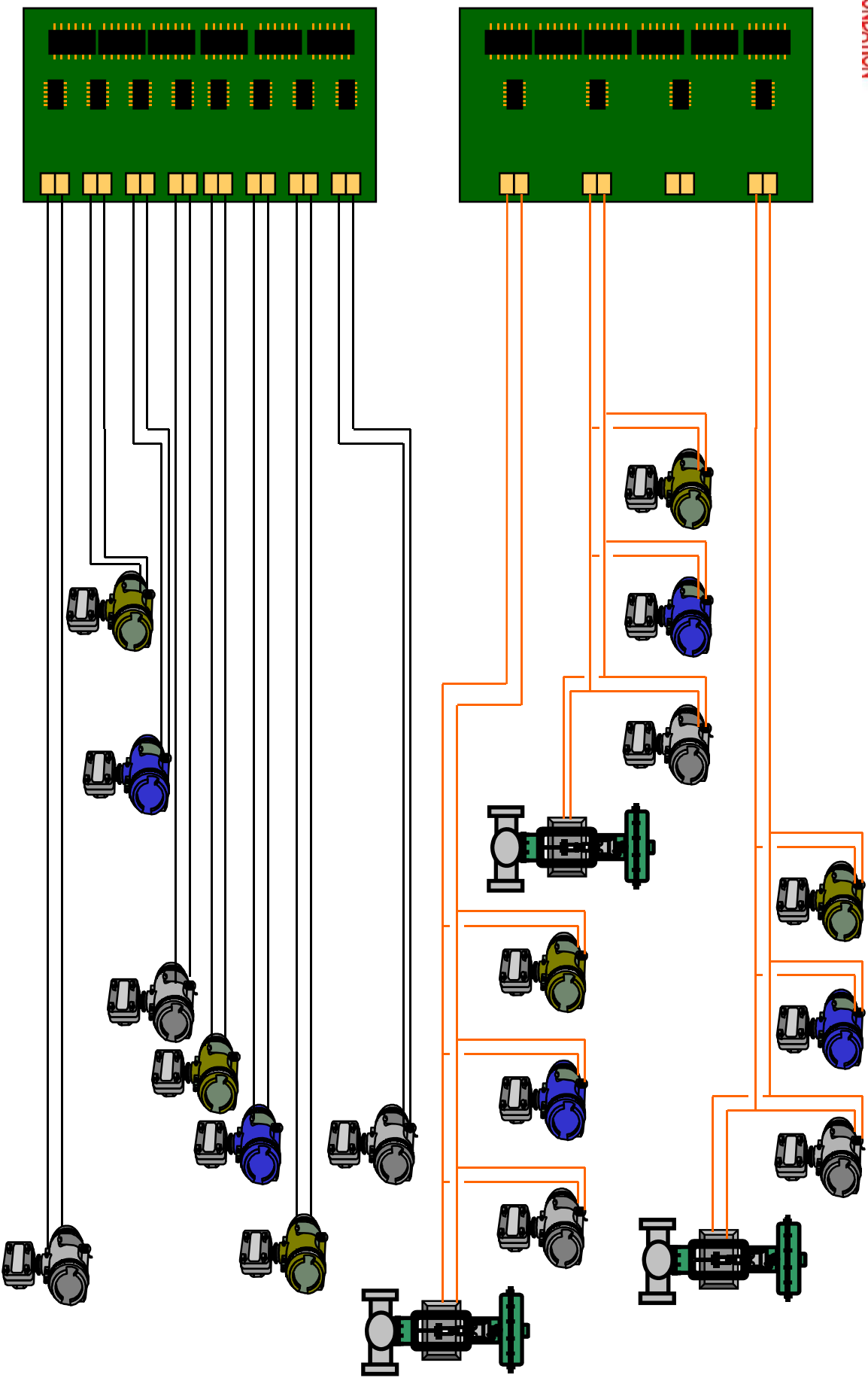
- Reduced termination count





I/O Card Savings

Technology
made
intuitive





FOUNDATION

Reduced Space Requirements



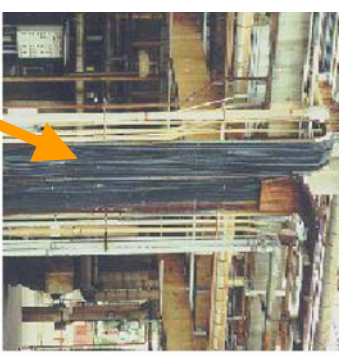
- Wiring & Rack
- Cable cost
- Junction box
- Conduit
- Cable Installation
- Marshalling
- I.S. Barriers

Conventional System

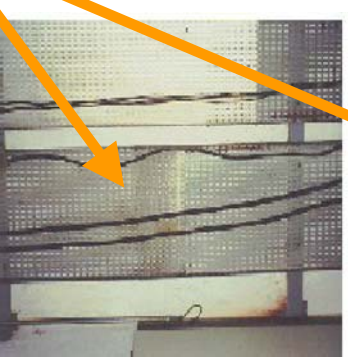
Cabinet



Cable



Fieldbus System



Case of 350 I/O points

Courtesy of Yokogawa Corporation



FOUNDATION

Startup Cost Savings



- Commissioning Costs Without fieldbus:

**2 hours / device
for 2 technicians**



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

Startup Cost Savings



- Commissioning Costs With fieldbus:

**25 minutes / device
for 1 technician**



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



FOUNDATION

Multivariable Measurements

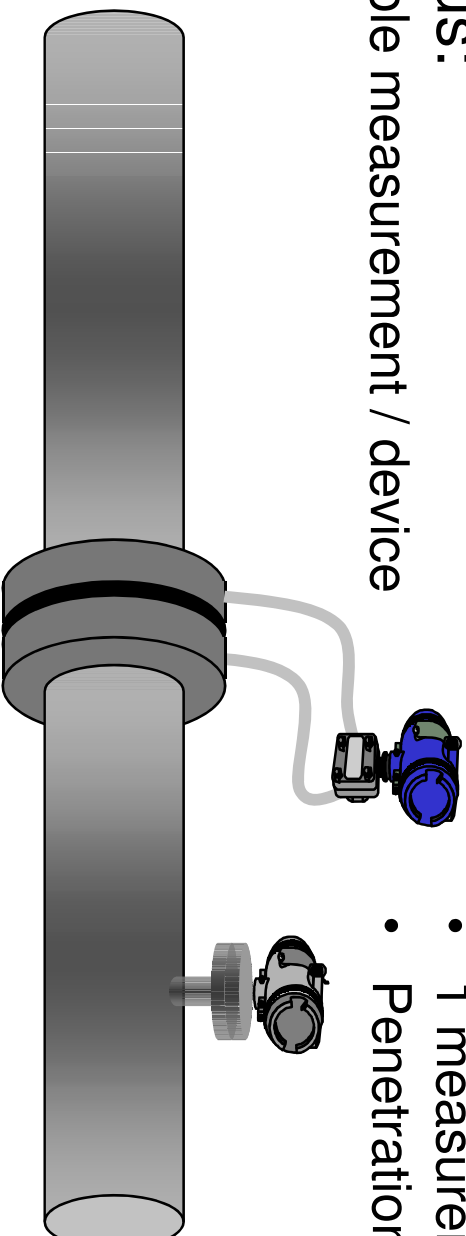


Fieldbus:

- Multiple measurement / device

Conventional:

- 1 measurement / device
- Penetration / signal



Fieldbus:

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

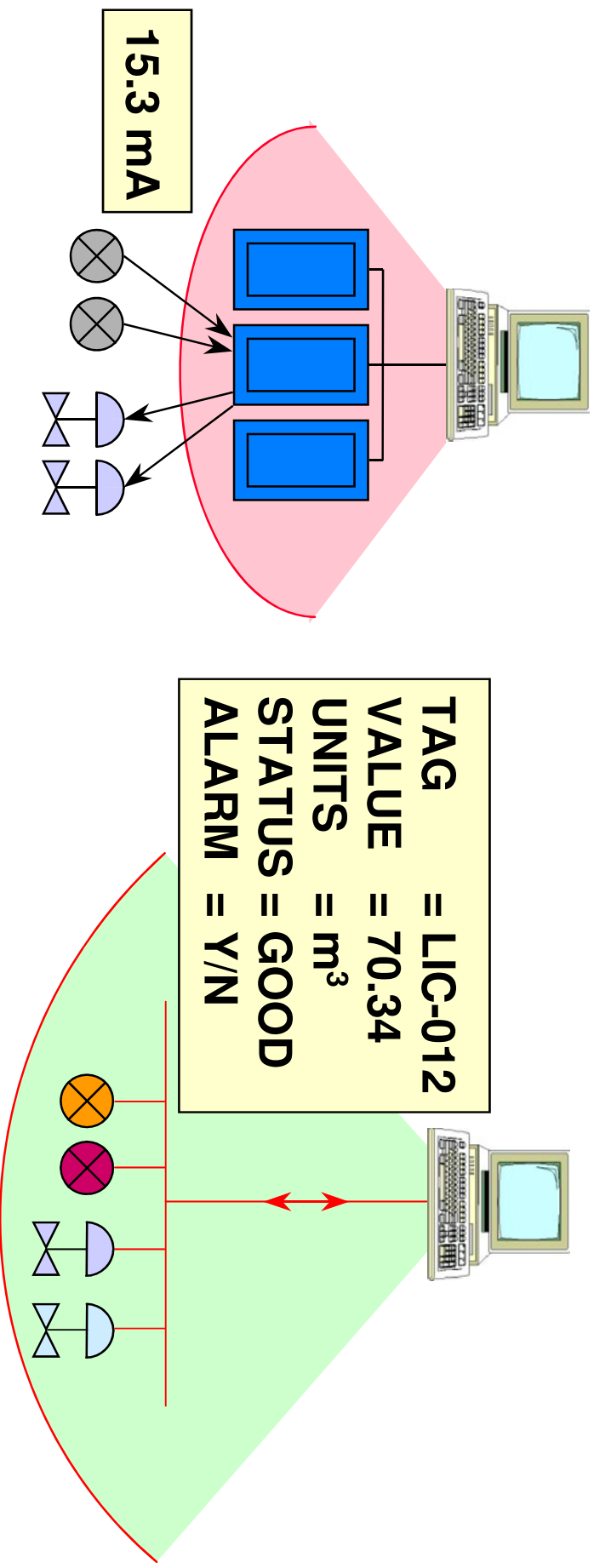


FOUNDATION

Expanded View



- Expanded device diagnostics



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

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

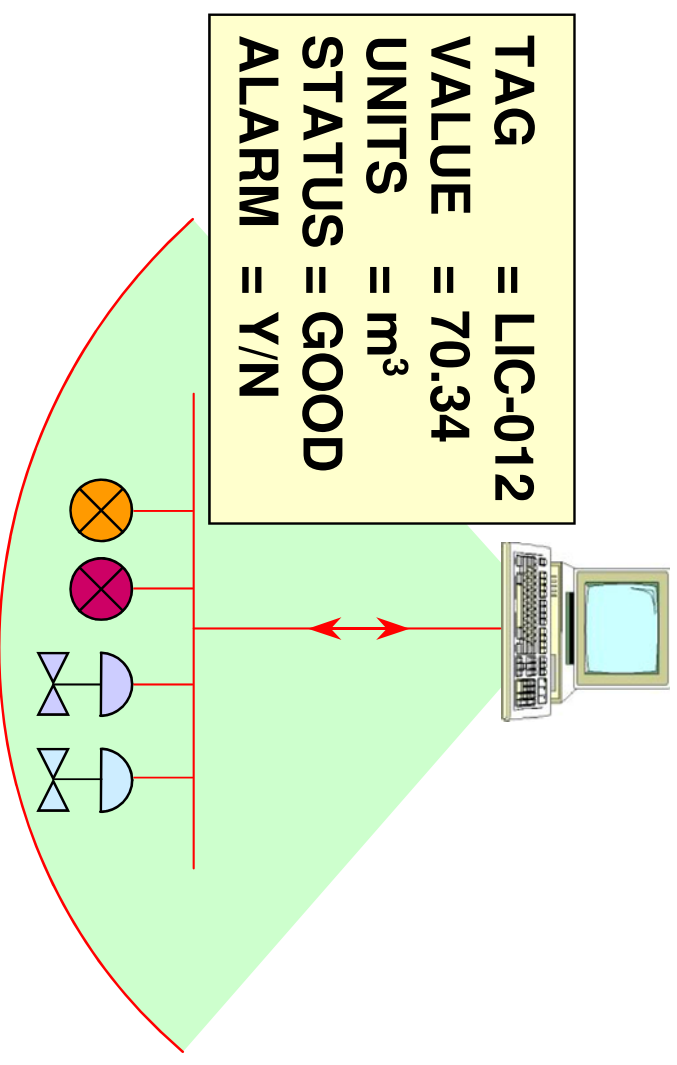


FOUNDATION

Increased Information



- Analog system
 - PV only
 - 4 - 20 mA has very limited information content
- Fieldbus system
 - Multiple PV's
 - Instrument TAG
 - Device status
 - Ambient conditions
 - Diagnostics
 - Configuration
 - Calibration Record



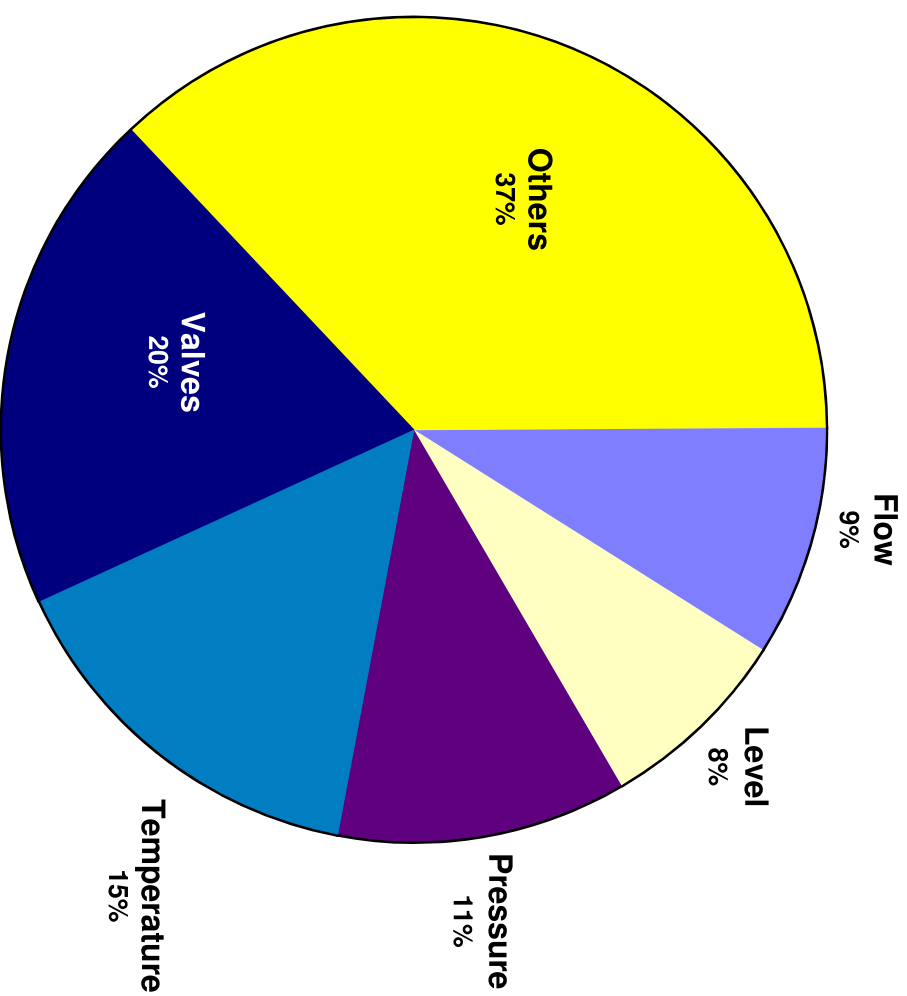


FOUNDATION

Typical Refinery Instruments Count



• Flow	1100
• Level	950
• Pressure	1400
• Temp.	1900
• Valves	2400
• Others	4600



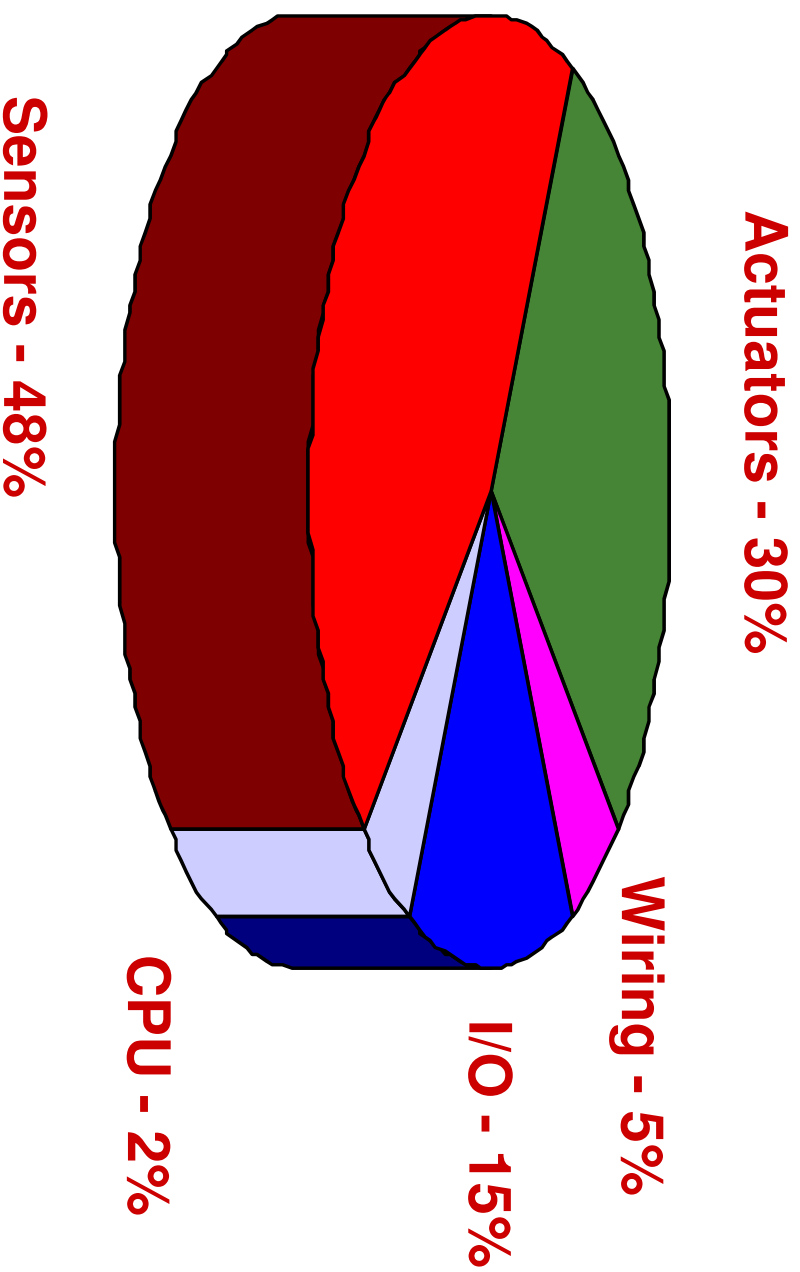


FOUNDATION

Areas of failures



- Fieldbus diagnostics give us access to 80% of the failure areas.



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

From ARC Independent Research

Asset Management Benefits



- Users Need Maintenance Cost Reduction
 - 40% of Mfg. Cost is Maintenance
 - 50% of Maintenance Is Repair
 - 10 times More Costly Than Preventative Maintenance
 - 25% of Maintenance Is Preventative
 - 5 Times More costly Than Predictive Maintenance
 - 60% of Preventative Maintenance is Unnecessary
- Asset Management Tools
 - Identify maintenance waste
 - Create predictive maintenance algorithms

From ARC Independent Research

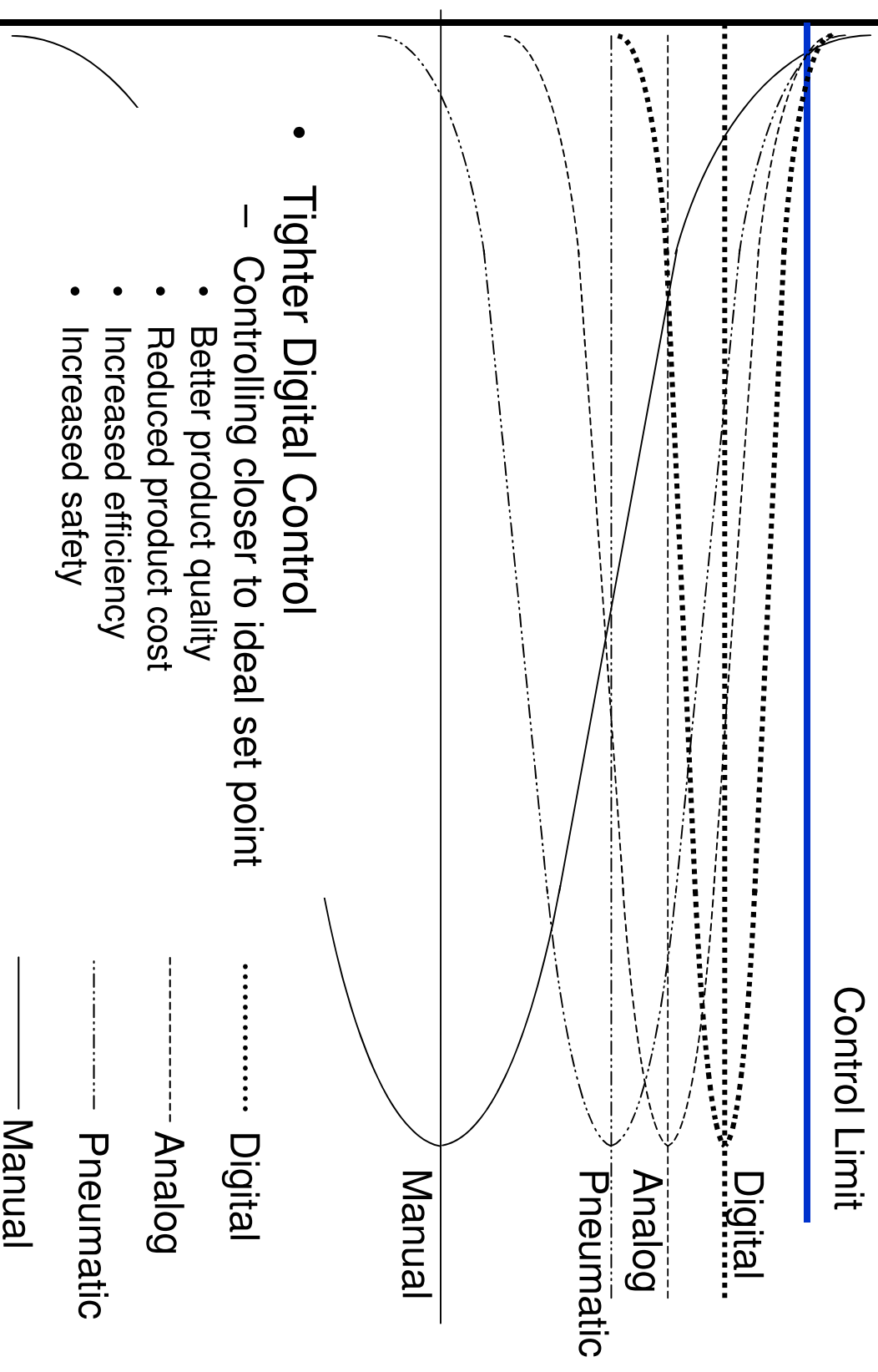
Operational Improvements



- Operational efficiency improved by up to 2%
- Predictive maintenance
 - schedule maintenance based on device diagnostics
 - increase plant availability
- Predictive Maintenance Algorithms
 - Impulse line blockage detection
 - Pump cavitation
 - Heat tracing failure

From ARC Independent Research

Operational Improvements





FOUNDATION

Questions



Thank you for your attention