Design Benefits

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On behalf of
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Design Benefits

Applying Foundation Fieldbus in a project offers several benefits over using other technologies.

This presentation will explore some of these benefits in design:
- due to the concept of the technology
- associated to the bus structure
- by being digital
- due to available verification tools
- due to already-proven intrinsic safety
- due to eliminated Marshalling
Benefits by Concept

Foundation Fieldbus is a new concept
- connecting many instruments on the same segment
- allowing various hazardous area methods on the same segment (e.g. Ex d and Ex i using fieldbus barriers)
- providing intelligent field instruments regardless their function, whether temperature, ON/OFF valves, flow, pressure, etc.
- using standardized device configuration methods DD and EDDL

(We heard about these in earlier presentations)
Benefits in wiring and infrastructure

Foundation Fieldbus uses a common FF power supply (or FF IS power supply) compared to multiple isolators and individual wiring.
Conventional wiring

2\textsuperscript{nd} level  1\textsuperscript{st} level
junction box

Multicore cables
Fieldbus system wiring

2nd level
junction box

1st level
Fieldbus power supplies

Control system

System cable

Multipair (multiple trunks)
Lower Cost: Fewer Connections to be Made

- **Hardwired**
  - 160 connections
  - 8 barriers
- **Fieldbus**
  - 55 connections
  - 1 barrier

If devices have more signals, such as position feedback or auxiliary inputs, the reduction becomes even more dramatic.
Benefits by Concept

The benefits of this are:

- reduced cabling (wiring)
- reduced infrastructure and components involved
- eliminate the variety of isolators and converters needed for DI/DO/AI/OA/RTD/etc
- no marshalling required for grouping DI/DO/AI/OA/RTD/etc
- provide high levels of diagnostics, not just LB/SC
- Get rid of manufacturer-dependent configuration tools
Benefits by Higher Integrity

Foundation Fieldbus combines all components of the control loop (e.g. AI, PID, AO) on the same cable pair (segment).

Conventional: A “loop” is often considered the arrangement of equipment between DCS and field device (I/O card, isolator, field instrument, cabling). It is usually *not* the “logical” loop (e.g. AI, PID, AO).
Design – Perception of single loop integrity

HMI

CPU: Performs PID function

DCS

AI

AO

non Ex

non Ex

4-20mA

4-20mA

IS barrier (Intrinsic safety) for wiring into hazardous area

Pipeline

Freedom to Choose. Power to Integrate.
Design - Single loop integrity on FF

- HMI
- Redundant H1 card
- Redundant FISCO
- Device Coupler

Freedom to Choose. Power to Integrate.
Benefits by Bus structure

- Foundation Fieldbus enables single Loop Integrity
  - AI, PID and AO on the same cable
  - Major components are redundant
    - FF H1 card (host)
    - Redundant FF power supply
  - In conventional (particularly I.S.), more components are involved, so more prone to failure

→ Fieldbus is less prone to failure
Benefits by Being Digital

- Digital communication increases signal transmission accuracy
  - Analogue loop: A/D (sensor to device) – D/A (device to cable) – A/A (signal isolator / I.S. barrier) – A/D (DCS) – D/A (DCS) – A/A (signal isolator / I.S. barrier) – A/D (cable to device) - D/A (device to actuator)
  - Fieldbus loop: A/D (sensor to device) - D/A (device to actuator)
    (Note that all transmission and DCS calculation is all-digital)
  → Higher accuracy by design
Validation of Design

- Easy verification of segment power distribution using software tools
- Individual loop calculations (with individual voltage and current parameters) are not required
- Spur calculations negligible (spur voltage drop is < 0.1V)
- Exact lengths do not need to be known
Validation of Design

Fieldbus signal:

- Ex parameters standardized
  - FISCO: 17.5V, 380mA, 5.32W (IEC 60079-27)
  - Entity: 24V, 250mA, 1.2W (FF-816)

- Input voltage at field instrument: 9V (IEC 61158-2)

- Device currents: typical 17mA (AG-181 Rev 3.1), formerly 20mA assumed.

A study suggests 15.29 mA calculated average, and 63% of registered devices having 15mA current or less.

Validation of Design

Conventional signal:
- I.S. barrier Ex parameters \((U_0, I_0, P_0, C_0, L_0)\) (all different)
- Cable Ex parameter \((C_C, L_C)\)
- For each device:
  - Device Ex parameters \((U_I, I_I, P_I, C_I, L_I)\) (all different)
  - Actual device current requirement (4-20mA: maximum 22/24mA)
  - Minimum input voltage requirement (all different)
- Actual output voltage of barrier (all different)
- Actual cable resistance (specific resistance and distance)

Fieldbus signal:
- FISCO or not (if not, then Ex parameters as above)
- Assumed typical device current (as per AG-181 Rev. 3.1, 17mA)
- Planned number of instruments per segment
- *Estimated maximum* trunk cable length (maybe “5 worst cases” can cover the whole plant)
- Actual output voltage of FF power supply (same for all segments)
- Actual cable resistance (specific resistance and distance)
Validation of Intrinsically Safe Design

Verification of intrinsic safety
- eliminated using FISCO
  - I.S. demonstrated by following the design rules
- easy for Entity using fieldbus barrier
  - Point-to-point connection (spur)
  - Max. 120m spur length allows to calculate worst case cable parameters, reducing the verification to a simple comparison

\[ U_0 \geq U_f \]
\[ I_0 \leq I_f \]
\[ E_0 \leq E_f \]

FISCO

\[ C_0 = C_{c0} + C_c \]
\[ L_0 = L_{c0} + L_c \]

FBT1-IS
Benefits of Validation

- Validation using readily available tools is simpler, and hence less time consuming.
- Bus structure simplifies calculations:
  - Only 1 trunk with 1 trunk current vs. many signals in a multicore with different voltages and currents.
- IS verification not necessary (FISCO) or simple (entity on fieldbus barrier).
Benefits by Eliminating Marshalling

Flexibility to handle changes and additions late in the project
- Fieldbus is designed with “spares” provisions (spare spurs, spare trunks)
- Signals do not need to be grouped by type (AI/AO/DI/DO/RTD/…), and can simply be connected to any segment
- Change a on/off valve to electric actuator to control valve late in the project without changing I/O cards, drawings, wiring, etc
- Adding further non-control related signals (e.g. for monitoring) does not require infrastructure
- Adding signals does not require change of cabinet drawings
- Fewer intermediate wire connections in the panel simplifies drawings
Summary

Foundation Fieldbus is technology enabling a number of benefits.

Some benefits are derived due to the concept of the technology, being digital, having a bus infrastructure, allowing mixtures of protection methods, and having many devices on the same cable allowing different topologies.

Other benefits indirectly derived from the network structure, like eliminated marshalling, less components, reduced drawings, greater flexibility, etc.
Summary

The main benefits in the design phase are:

- Faster and easier to design
- Greater flexibility
- Reduced validation
- Higher accuracy (digital data throughout)
- Reduced components
- Less prone to failures
- Diagnostics are included, and do not need to be designed-in