Industrial Data Communications and Fieldbus: HART, Foundation Fieldbus, Profibus and Ethernet

19 – 30 September 2027
Dammam - Eastern Province five-star



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Introduction:

Industrial data communications and fieldbus networks fail quietly: a HART device answers with the wrong range, an H1 segment runs short of voltage after one more transmitter, a Profibus line drops telegrams on a missing terminator, or a switch loop floods the control network. This Core Concept course takes instrument and automation engineers from 4-20 mA and HART through Foundation Fieldbus, Profibus and Modbus to industrial Ethernet, wireless instrumentation and secure plant network architecture. Each participant builds a Fieldbus Segment and Plant Network Design Package for a unit at their own site.

Course Objectives:

- Configure, test and diagnose HART smart transmitters with handheld communicators, multiplexers and asset management software
- Design Foundation Fieldbus H1 and Profibus PA segments with correct power, terminator, spur and device count calculations
- Diagnose physical layer faults on RS-485, H1 and Profibus cable caused by grounding, shielding, termination and noise
- Specify industrial Ethernet networks for Modbus TCP, EtherNet/IP and Profinet with managed switches, VLANs and ring redundancy
- Plan wireless instrumentation with WirelessHART or ISA100.11a and plant Wi-Fi within a zoned and secured OT network
- Select field communication protocols for greenfield and brownfield projects and document the resulting network design

Target Audience:

- Instrument engineers responsible for smart transmitter configuration, loop checks and device integration
- Control and automation engineers responsible for fieldbus segment design and plant network architecture
- Senior instrument technicians responsible for commissioning and fault finding on HART, fieldbus and serial links
- Project and commissioning engineers responsible for field network specifications on new units and revamps
- OT network specialists responsible for switches, redundancy and zone separation below the control system

Course Outline:

Day 1: Plant Network Layers, 4-20 mA Loops and Serial Communication

- Plant Communication Hierarchy: Field Device, Control, Supervisory and Enterprise Network Layers
- OSI Reference Model Mapped to Fieldbus Physical, Data Link and Application Layers
- 4-20 mA Loop Anatomy: Loop Power Budget, Load Resistance and Live Zero Diagnostics
- RS-232 Point-to-Point Versus RS-485 Multidrop Wiring, Biasing and Line Termination
- Modbus RTU Frames: Function Codes, Register Addressing, CRC Checks and Exception Responses

Day 2: HART Protocol and Smart Transmitter Configuration

- HART Physical Layer: Bell 202 FSK Signal Superimposed on the 4-20 mA Loop
- Point-to-Point and Multidrop Modes: Fixed 4 mA Current and Up to 15 Devices per Loop
- HART Command Structure: Command 0 and Command 11 Identification, Read and Write Commands
- Handheld Communicator Setup of Tag, Range Values, Units, Damping and Sensor Trim
- HART Multiplexers and Asset Management Software for Device Status and Configuration Records

Day 3: Foundation Fieldbus H1 Segment Design and Field-Resident Blocks

- H1 at 31.25 kbit/s Versus HSE Linking Devices in the Fieldbus Architecture
- Segment Hardware: H1 Interface Cards, Fieldbus Power Supplies and Power Conditioners
- Trunk and Spur Topology, Two Terminators per Segment and Spur Length Limits
- Resource, Transducer and Function Blocks Resident in Field Devices for Control in the Field
- Link Active Scheduler, Macrocycle Timing and Publisher-Subscriber Traffic

Day 4: Profibus DP and PA, Cabling, Grounding and Physical Layer Diagnostics

- Profibus DP on RS-485: 9.6 kbit/s to 12 Mbit/s, 150 Ohm Cable and Segment Repeaters
- DP-V0 Cyclic, DP-V1 Acyclic and Alarm, and DP-V2 Isochronous Service Levels
- Profibus PA on MBP at 31.25 kbit/s: DP/PA Couplers and Bus-Powered Instruments
- Cable Shielding, Single-Point and Multi-Point Grounding and Noise Coupling on Fieldbus Trunks
- Physical Layer Measurements: Oscilloscope Waveforms, Signal Level, Noise and Jitter

Day 5: Week-One Guided Case: Brownfield Tank Farm with HART, Modbus and H1 Links

- Case Data Pack: Instrument Index, Loop Drawings and Segment Layouts for a Tank Farm
- Guided Exercise: H1 Segment Voltage Drop and Current Budget Check for Added Devices
- Guided Exercise: HART Transmitter Reading Out of Range Diagnosed and Reconfigured
- Guided Exercise: Modbus RTU Timeouts Traced to Biasing and Termination Faults
- Week-One Findings Log and Capstone Network Scope for Each Participant Unit

Day 6: Industrial Ethernet: Modbus TCP, EtherNet/IP and Profinet

- Ethernet Frames, IP Addressing and Subnet Planning for Plant Device Networks
- Modbus TCP Encapsulation and Gateways Between Serial and TCP Devices
- EtherNet/IP on the Common Industrial Protocol: Producer-Consumer Traffic and Packet Intervals
- Profinet RT and IRT Timing, Conformance Classes CC-A to CC-D and GSDML Files
- Linking Devices and Protocol Gateways from H1 and Profibus to Ethernet Backbones

Day 7: Switched Networks, Ring Redundancy and OT Security Zones

- Managed Industrial Switches: Port Settings, IGMP Snooping and SNMP Diagnostics
- VLAN Segmentation of Control, Safety and Maintenance Traffic
- Ring Redundancy with MRP Recovery Under 50 ms and Link Failure Tests
- Zones and Conduits Model of IEC 62443 Applied to Fieldbus Gateways and Switches
- Remote Access Paths, Firewall Rule Sets and Device Write Protection on Field Networks

Day 8: Wireless Instrumentation, Plant Wi-Fi and OPC UA

- WirelessHART: IEEE 802.15.4 Radios, 2.4 GHz Channel Hopping and Self-Healing Mesh
- ISA100.11a IEC 62734 Networks Compared with WirelessHART IEC 62591
- Wireless Gateway, Network Manager, Battery Life and Update Rate Planning
- Plant Wi-Fi Site Survey: Coverage, Interference and Hazardous Area Access Points
- OPC UA at Overview: Information Model and Secure Data Exchange from Field Networks

Day 9: Protocol Selection, Network Health Benchmarking and Troubleshooting Labs

- Protocol Selection Matrix for Greenfield Units: Speed, Power, Hazardous Area and Lifecycle Cost
- Brownfield Migration Options: HART Retention, Remote I/O and Fieldbus Retrofit
- Network Health Indicators: Retries, Error Counters, Segment Noise and Communication Availability
- Troubleshooting Lab: Profibus Telegram Capture and Faulty Terminator Diagnosis
- Troubleshooting Lab: Ethernet Packet Capture, Duplicate IP and Broadcast Storm Isolation

Day 10: Capstone: Fieldbus Segment and Plant Network Design Package

- Capstone Build: Protocol Selection and Network Architecture Drawing for the Participant Unit
- Capstone Build: H1 or Profibus PA Segment Design with Power, Spur and Terminator Calculations
- Capstone Build: Switch, VLAN, Ring Redundancy and Security Zone Plan
- Capstone Test: Injected Faults Diagnosed on HART, Fieldbus and Ethernet Links
- Design Package Presentation, Commissioning Handover Notes and Peer Technical Review

Skills You Will Gain:

- HART Device Configuration
- Fieldbus Segment Calculation
- Physical Layer Fault Diagnosis
- Serial Protocol Analysis
- Industrial Switch Configuration
- Wireless Instrument Network Planning
- Field Network Protocol Selection
- OT Network Zoning

Why Attend This Course:

- Return with a Fieldbus Segment and Plant Network Design Package for a unit at your own site
- Cut fault-finding time on dead segments, lost telegrams and unstable transmitters by testing each layer in order
- Move from 4-20 mA, HART, Foundation Fieldbus and Profibus in week one to Ethernet, wireless, redundancy and security in week two
- Compare field network practice with instrument and automation engineers from oil and gas, chemicals, power, water and manufacturing

Conclusion:

Field networks carry every measurement and valve command a plant depends on, so their design and diagnosis need the same discipline as the instruments themselves. The first week covers loops, serial links, HART, Foundation Fieldbus H1, Profibus and the physical layer. The second week adds industrial Ethernet, switching and ring redundancy, security zones, wireless instrumentation, OPC UA, protocol selection and troubleshooting labs. The capstone turns both weeks into a Fieldbus Segment and Plant Network Design Package ready for review at the participant's site.