WirelessHART

- for ease of plant operation and maintenance
WirelessHART Based on User Requirements

- NAMUR NE124

Wireless for Process Applications

- Availability and Reliability
- Real-time Capability
- Security
- Coexistence
- Interoperability
- Transparent Integration
- Version Management
- Long Battery Life
- Diagnostics
- Industrial Grade
- Familiar Tools
- Certification

FieldComm Group
Connecting the World of Process Automation
Application Classes

Areas where wireless technology is applied
### NAMUR NE124 Application Classes
- Complementing Wired Measurements

<table>
<thead>
<tr>
<th>Application Class</th>
<th>Description</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Functional safety</td>
<td>Time-critical applications in the area of functional safety, process interventions and interaction with other applications and systems are governed by the requirements of critical safety applications.</td>
</tr>
<tr>
<td>B</td>
<td>Process management/control</td>
<td>Time-critical, deterministic applications which must meet high requirements with regard to availability and reliability. Interactions with other applications and process interventions are included.</td>
</tr>
<tr>
<td>C</td>
<td>Display monitoring</td>
<td>Applications which are not time-critical and exclusively provide additional information. Interactions with other applications and systems are excluded.</td>
</tr>
</tbody>
</table>

- **Most wireless applications are class ‘C’:**
  - Reliability/Maintenance: Condition Monitoring
  - Energy Efficiency: Energy Management & Loss Control
  - HS&E: Situational Awareness
  - Production: Productivity
Condition Monitoring
- Improved Reliability and Reduced Maintenance Cost

- Heat exchangers
- Pumps
- Blowers
- Air cooled heat exchangers
- Non-process centrifugal compressors
- Cooling towers
- Filters
- Pipes & vessels
- etc.

Pre-engineered packages using WirelessHART and multiparametric software algorithms for process equipment diagnostics
Health, Safety, and Environmental
- Reduce HS&E Incidents

Situational Awareness
Eliminate blind spots, operator rounds
Energy Efficiency

- Steam trap failure
- Heat exchanger fouling (inefficiency)
- Cooling tower fan speed optimization
- Air cooled heat exchanger fan speed optimization
- Relief valve leak monitoring
- Unit-wise consumption accountability:
  - Water
  - Air (compressed)
  - Gas (fuel)
  - Electricity
  - Steam
  - etc
Enhanced Production and Recovery

- Production wellhead
  - Casing/annulus pressure
  - Gas lift
    - Water wash
  - Chemical injection
- Injection wellhead
  - Gas
  - Water
  - Chemical
  - Steam
- Separator
- Storage tank

- Pressures
- Temperature
- Differential pressure
- Valve position

- Central operation
- Optimization
- Reservoir modeling

* Also known as: Smart Fields, e-Field, i-Field, Digital Oilfield, Intelligent Oilfield, Field of the Future and Intelligent Energy
Availability and Reliability

Ability to work uninterrupted in a plant environment
Not All Wireless Are the Same
- Topology is Key to Reliability

Home / Office Wireless
- Star topology (Point to Point)
  - Cordless phone
  - Mobile phone
  - R/C toy car
  - Wi-Fi

Industrial Wireless
- Mesh topology

Even SCADA systems

Topology Technical White Paper Available

Before mesh topology nobody put wireless IN the plant
Industrial Wireless: Unique Self-Organizing Full Mesh Topology

- Redundant data pathways eliminate single points of failure
  - Actual installations consistently demonstrate >99% data reliability
  - Dense plant environment
- Routing at device-level
  - Unique full-mesh, 7 hop path depth
  - No backbone router infrastructure
  - No hazardous area power required
  - True wireless: low cost, low risk
- Unique automatic reconfiguration
  - No manual routing configuration
- Each hop 50-250 m depending on obstruction
  - More with high gain antenna
Wireless Network Topologies

- Star Topology with Backbone
- Full Mesh Topology
  - Low cost
  - Low risk

- Proprietary backbone protocol over Ethernet
- Builds its own infrastructure
- Every device is a repeater
Proven in Extreme Applications

- Magnetic/Electric
- Abrasion/Dessert
- Vibration/Rotating
- Heat
- Cold
- Wet/Offshore
Large-Scale Plant-Wide Infrastructure
- Network Segmentation

- Currently at 100 transmitters per gateway
  - Just like an I/O card
- Multiple gateways coexist around the plant
- Logically placed per plant area and controller
  - Just like the DCS I/O
  - On top of LER/FAR/SRR
- Not all eggs in one basket
- Large number of transmitters per plant
Large Scale Infrastructure
- Thousands of Devices in a Plant

- Standard Ethernet or Wi-Fi control/plant network
  - Standard Modbus/TCP, EtherNet/IP or OPC protocol for PV
  - Standard HART-IP protocol for access to full device information:
    - Configuration/setup
    - Diagnostics
    - Internal variables
    - Calibration
User Requirement:

Real-time Capability

Ability to provide the data at the rate required by the application
Supported Update Period

- WirelessHART technology enables 100 ms update periods
- First generation products supported 16 s update period
- Current products support 1 s update period
- Individually configurable for each point, on the same network

<table>
<thead>
<tr>
<th>Update Period</th>
<th>2007</th>
<th>2009</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 ms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>250 ms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>500 ms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 s</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 s</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 s</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 s</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16 s</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32 s</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1...60 min</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Repeater Function is Independent of the Measurement Function

- Ultra-low power radio turns on as often as required to relay data from remote sensors

<table>
<thead>
<tr>
<th>SENSOR Sampling Period</th>
<th>Flow 1 Second</th>
<th>Temperature 1 Minute</th>
<th>Vibration 1 Hour</th>
<th>Gateway N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>RADIO Transmission Interval</td>
<td>1 Second</td>
<td>1 Second</td>
<td>1 Second</td>
<td>Always On</td>
</tr>
</tbody>
</table>
Coexistence

Ability to work alongside other wireless/radio technologies
Robust and Tolerant to All Types of Interference

- Based on IEEE 802.15.4 radio standard
  - Channel hopping
  - DSSS modulation
  - Clear channel assessment
  - Channel black listing
- Non-interfering
  - Low transmit power
  - Very short messages bursts
- Coexists with other wireless 2.4 GHz networks such as IEEE 802.11b/g Wi-Fi
Security

Ability to prevent unauthorized devices/people from overhearing, modifying, inserting, or disrupting communication
## Unique ‘Always-On’ Security

<table>
<thead>
<tr>
<th>Protection</th>
<th>Support</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encryption</td>
<td>✓</td>
<td>Scrambled, message is kept secret (AES-128)</td>
</tr>
<tr>
<td>Authentication</td>
<td>✓</td>
<td>Login/Password (Network ID / Join key) to join network. Not over the air</td>
</tr>
<tr>
<td>Verification</td>
<td>✓</td>
<td>Data integrity checksum: Not tampered with</td>
</tr>
<tr>
<td>Anti-Jamming</td>
<td>✓</td>
<td>Channel hopping</td>
</tr>
<tr>
<td>Key Management</td>
<td>✓</td>
<td>Encryption keys rotate automatically (hard to crack), access control list (ACL)</td>
</tr>
<tr>
<td>Sequence Number</td>
<td>✓</td>
<td>Messages cannot be replayed later</td>
</tr>
</tbody>
</table>

- ISA99 / IEC 62443 security
- Security is always on
  - Cannot be turned off
- No direct TCP/IP addressing
User Requirement:

**Interoperability / Interchangeability**

Ability of products to work together / Ability to replace one device with another without undue effort
International Standard
- With Products Available

- Managed by the FieldComm Group (FCG)
  - More than 200 I&C member companies

- Based on process user needs
Multiple Applications
- Mix & Match with a Common Protocol

Temperature

Vibration

Pressure

Corrosion

Discrete

Position

HART Adapter: Loop

HART Adapter: Battery*

Acoustic / Steam Trap
WirelessHART Gateway Infrastructure From Multiple Vendors

- A WirelessHART gateway connects your existing DCS to WirelessHART transmitters from different manufacturers.
User Requirement:

Transparent Integration in Master Automation Systems

Ability to connect to historian, DCS/PLC/RTU, and Intelligent Device Management (IDM) software without undue effort
Native Integration in DCS

- Single common protocol
- PVs integrate to the DCS the same way for all transmitters
- Native integration without drivers
- Auto-detection of transmitters
- No parameter mapping
- Point-and-click transmitter setup and diagnostics

Using multiple ‘tunneled’ protocols would instead mean:
- Multiple gateways
- Multiple drivers
- Multiple ways to map data
User Requirement:

Version and Lifecycle Management

Ability to keep the system up to date with new types and versions of devices
Easy System Administration
- Keeping the System Up to Date

- Download EDDL file
  - HART Communication Foundation site
  - Device manufacturer site
- Load EDDL file on the system
- PV, SV, TV, and QV accessible without DD
User Requirement:

Power Supply

Ability to operate for long periods without battery replacement
Up to 10 Year Battery Life

- Built on IEEE 802.15.4 radio
- Sleep mode between measurements
- Low power radio = long battery life
  - Radio has much lower power consumption than the sensor
  - Battery life depends on sensor type and update period
    - No so much on topology
Easy Battery Replacement

- Field replaceable
  - Intrinsically safe power module
  - Zone 0/1/2
- No mixing new and used cells
  - Low risk
- Non-volatile memory
  - No loss of configuration
- Keyed insertion
  - Fool-proof
- Temperature range
  - –40 to 85 °C
Power Management

- Relaying communication from neighboring devices only turns on the radio
  - Mesh topology no major impact on battery life
- LCD indicator, sensor, and measurement circuits are not turned on for relaying
- Battery life determined by sensor type and update period
Battery Status

- Battery health continuously monitored by the device management software
  - Early warning
  - Critical warning
- Ability to zoom into detail
Self-Monitoring and Diagnosis

Ability to manage the network itself
Network Management
- Validation and Troubleshooting Tool

- Communication statistics – takes the place of the DMM

<table>
<thead>
<tr>
<th>Sr no</th>
<th>HART Tag</th>
<th>Active neighbors</th>
<th>Reliability</th>
<th>Missed updates</th>
<th>Path stability</th>
<th>RSSI</th>
<th>Joins</th>
<th>Join Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>395 Repeater</td>
<td>wihartgw</td>
<td>100.00%</td>
<td>0</td>
<td>100.00%</td>
<td>-64 db</td>
<td>2</td>
<td>2012-10-05 17:48</td>
</tr>
<tr>
<td>2</td>
<td>395 REPEATER 2</td>
<td>wihartgw</td>
<td>100.00%</td>
<td>0</td>
<td>100.00%</td>
<td>-43 db</td>
<td>2</td>
<td>2012-10-05 17:40</td>
</tr>
<tr>
<td>3</td>
<td>395AFPSV051</td>
<td>wihartgw</td>
<td>100.00%</td>
<td>0</td>
<td>100.00%</td>
<td>-50 db</td>
<td>1</td>
<td>2012-10-04 19:11</td>
</tr>
<tr>
<td>4</td>
<td>395AFPSV052</td>
<td>wihartgw</td>
<td>100.00%</td>
<td>0</td>
<td>100.00%</td>
<td>-60 db</td>
<td>1</td>
<td>2012-10-04 19:12</td>
</tr>
<tr>
<td>5</td>
<td>395AFPSV053</td>
<td>wihartgw</td>
<td>100.00%</td>
<td>0</td>
<td>100.00%</td>
<td>-62 db</td>
<td>1</td>
<td>2012-10-04 19:10</td>
</tr>
<tr>
<td>6</td>
<td>395AFPSV054 A/B</td>
<td>wihartgw</td>
<td>100.00%</td>
<td>0</td>
<td>100.00%</td>
<td>-67 db</td>
<td>1</td>
<td>2012-10-04 19:11</td>
</tr>
<tr>
<td>7</td>
<td>395AFPSV055</td>
<td>wihartgw</td>
<td>100.00%</td>
<td>0</td>
<td>100.00%</td>
<td>-56 db</td>
<td>1</td>
<td>2012-10-04 19:10</td>
</tr>
<tr>
<td>8</td>
<td>395AFPSV056</td>
<td>wihartgw</td>
<td>100.00%</td>
<td>0</td>
<td>100.00%</td>
<td>-57 db</td>
<td>1</td>
<td>2012-10-04 19:07</td>
</tr>
<tr>
<td>9</td>
<td>395AFPSV057</td>
<td>wihartgw</td>
<td>100.00%</td>
<td>0</td>
<td>100.00%</td>
<td>-50 db</td>
<td>1</td>
<td>2012-10-04 19:14</td>
</tr>
<tr>
<td>10</td>
<td>395AFPSV058</td>
<td>wihartgw</td>
<td>100.00%</td>
<td>0</td>
<td>100.00%</td>
<td>-60 db</td>
<td>1</td>
<td>2012-10-04 19:12</td>
</tr>
<tr>
<td>11</td>
<td>395AFPSV326 A/B</td>
<td>wihartgw</td>
<td>100.00%</td>
<td>0</td>
<td>100.00%</td>
<td>-71 db</td>
<td>1</td>
<td>2012-10-04 19:03</td>
</tr>
<tr>
<td>12</td>
<td>395AFPSV327 A/B</td>
<td>wihartgw</td>
<td>100.00%</td>
<td>0</td>
<td>92.30%</td>
<td>-84 db</td>
<td>1</td>
<td>2012-10-04 19:04</td>
</tr>
<tr>
<td>13</td>
<td>395AFPSV651 A/B</td>
<td>wihartgw</td>
<td>100.00%</td>
<td>0</td>
<td>100.00%</td>
<td>-54 db</td>
<td>1</td>
<td>2012-10-04 19:09</td>
</tr>
<tr>
<td>14</td>
<td>395AFPSV652A/B</td>
<td>wihartgw</td>
<td>100.00%</td>
<td>0</td>
<td>100.00%</td>
<td>-43 db</td>
<td>1</td>
<td>2012-10-04 19:12</td>
</tr>
<tr>
<td>15</td>
<td>413AFPSV113A</td>
<td>FCC Repeater 4</td>
<td>100.00%</td>
<td>1</td>
<td>97.60%</td>
<td>-48 db</td>
<td>4</td>
<td>2012-10-06 02:38</td>
</tr>
<tr>
<td>16</td>
<td>413AFPSV112B</td>
<td>413AFPSV113C</td>
<td>100.00%</td>
<td>0</td>
<td>100.00%</td>
<td>-49 db</td>
<td>4</td>
<td>2012-10-06 02:42</td>
</tr>
</tbody>
</table>
Equipment and Components

Ability to fit in your existing plant
Unique Ease of Adoption
- Same Familiar Tools, Same Procedures

- WirelessHART devices use the same tools as 4-20 mA and FOUNDATION fieldbus devices
  - Same handheld communicator
  - Same documenting calibrator

- Same procedures
  - Configuration/setup
  - Calibration
  - Diagnostics
  - Viewing internal variables

No proprietary tool required for Commissioning
Wireless Gateway

- 100-250 devices
- Integration protocols
  - OPC
  - Modbus/RTU
  - Modbus/TCP
  - EtherNet/IP
  - HART-IP
- Redundancy
- ISA99 / IEC 62443 security
- Standard antenna connector
  - For remote antenna
- Zone 2 mounting
- 12 or 24 VDC
- Easy firmware update
- Power over Ethernet
Wireless Adapter: Unleash Intelligence in 4-20 mA/HART Devices

HART Adapter: Loop

HART Adapter: Battery*
Network Design Tool

- Validate network robustness before installation
  - Make sure design rules are met
- Free online version

http://www.emersonprocess.com/wirelessplanning
Configuration / Commissioning

Ability to setup device using familiar software
Native Integration in Intelligent Device Management Software

[Image of a user interface showing the status of a device, indicating it is in a good condition with connected communications and a pressure reading of 8.64 psi.]
Service and Maintenance

Ability to maintain devices using familiar software
Device Diagnostics: Whatever the Device Has, WirelessHART Can Transport It

- The amount of diagnostics depends on the device type
- WirelessHART can transport any amount of diagnostics

8 bits in Every response

“More Status Available”

200 bits of More Status Available

Any amount of data in specific commands

Temperature: Sensor Fail

Flow Transmitter: Meter Verification Report

Positioner: Valve Signature
Unique HART Wire Terminals as Standard
- Use Existing Common Tools

- Using the same tools as for 4-20 mA/HART and FOUNDATION fieldbus devices
  - Handheld field communicator
    - Zone 1
  - Laptop software
  - Documenting calibrator
User Requirement:

Certification

Independent verification of compliance with standard
Independent Third Party Interoperability Testing

Wireless transmitters independently verified by the HART Communication Foundation
Conclusion
WirelessHART Meeting User’s Needs

- NAMUR NE124

- NAMUR NE124

Wireless for Process Applications

- Mesh Topology
- Availability/Reliability
- Real-time Capability
- Security
- Coexistence
- Interoperability
- Transparent Integration
- Version Management
- Long Battery Life
- Familiar Tools
- Industrial Grade
- Diagnostics
- Independent Testing
- Encryption
- Authentication
- Verification
- Key Rotation
- Sequence Number
- Ch. hopping
- DSSS
- Short messages
- Ch. black listing
- Low TX power

IEC 62591

- IEEE 802.15.4 radio
- Sleep mode
- Status indication
- EDDL
- Planning tool
- Config. & diag. tools

Same tools as 4-20 mA/HART and fieldbus

- Intrinsically safe
- Comm. stats
- Adapters
- Planning tools
- MB/Profibus/OPC
- Conf. & diag. tool

- Comm. stats
- 8 bit response code
- 200 bits of MSA
- Specific commands

Independent Testing

Certification
Driven from Process User Needs - WirelessHART Development Process

- Built to meet process users’ needs:
  - Availability/Reliability
  - Coexistence
  - Security
  - Interoperability
  - Battery Life

User Requirements Defined → Technology Developed → Multi-vendor Field Trial → Products → Thousands of Installations

Source: HART Communication Foundation
NAMUR Confirms WirelessHART for Process Applications in 2009

- Extensive multi-vendor field test:
  - ABB, Emerson, E+H, MACTek, P+F, and Siemens
- BASF Ludwigshafen, Germany
- WirelessHART meets the user needs:
  - NAMUR NE124 "Requirements for Wireless Automation"
  - NAMUR NA115, “IT Security for Process Automation Systems”

- Availability/Reliability/Coexistence
- Security
- Interoperability
- Battery Life
I’m Listening...

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