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# Wireless Sensor Networks for Industrial Applications

# Outline

- The Wiring Problem
- Challenges
- Applications
- WirelessHART
- Summary



# The Wiring Problem

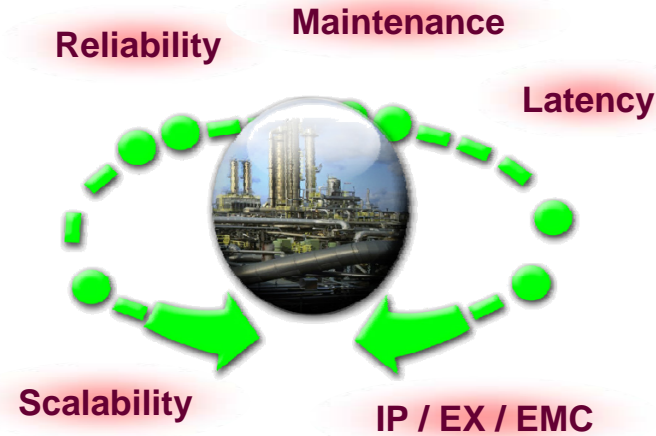
## All “Wired Up” but No Where to Go

- Installation & Planning
  - “Cheap” sensors, but costly to plan and install
- Cable and Connector Wear
  - Harsh environments
  - Impossible to wire, or cause of frequent failures
- Spare Capacity
  - To accommodate future plant modifications
- Inflexible
  - Tuning and upgrades
  - Design flexibility
  - Mobility



# The Wiring Problem

## The World is becoming Wireless



### Wireless World

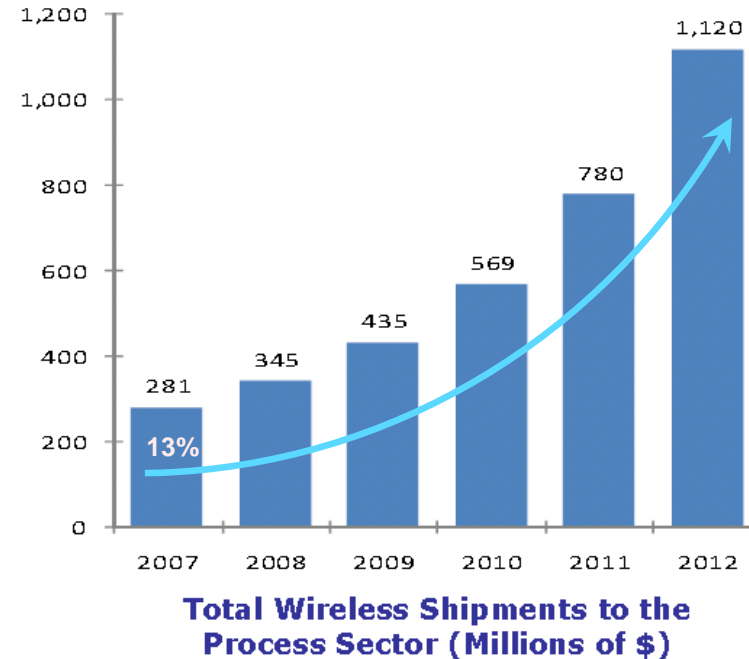
### Wireless Automation



# The Wiring Problem

## Wireless Market Drivers

- Business Drivers
  - Need to increase productivity
  - Declining capital investment
- Barriers Removed
  - Available technology
  - Emerging standards
- Benefits
  - Reduced engineering, commissioning and maintenance costs
  - Improved productivity and compliance



### Wireless Process Sensing

The largest change in the market over the next 5 years will be in wireless process sensing.



Source: ARC 2008

# Wireless Success Factors

**Low Cost** —————  
**CapEx Justification:** Equal or lower cost of installation than wired solution

**Simplicity** —————  
**Easy Deployment:** Simple to plan and commission

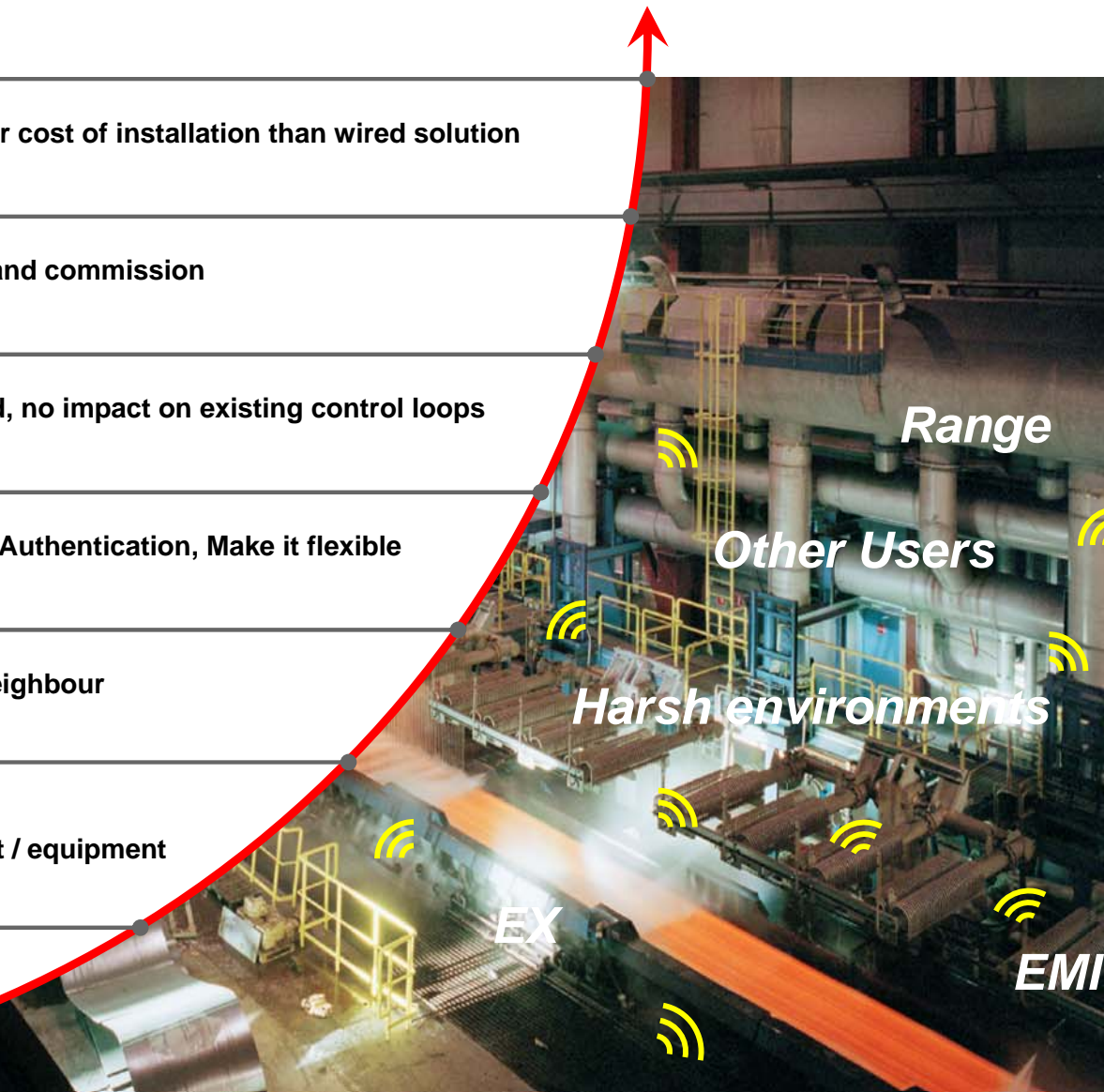
**Retrofit** —————  
**Existing Installation:** Simple to add, no impact on existing control loops

**Secure** —————  
**It Must be Secure:** Encryption and Authentication, Make it flexible

**Co-Exist** —————  
**Co-existence:** Good Worker and Neighbour

**Open Standard** —————  
**Multi – Vendor Support:**  
Choose most appropriate instrument / equipment

**Reliable** —————  
**Changing Radio Environment**  
Frequency agile systems, self healing networks, ...



# Wireless Applications

## Examples – *Asset Management & Service*

### Asset Management

#### ***Maintenance monitoring***

- Add a wireless adaptor (*WirelessHART*)
- Detect maintenance conditions
- Route messages (CMMS – pager)



#### **Positioner**

- Add Adaptor - Use 4-20mA for control
- Read Valve position & compare to SP
- Read diagnostic data: Stroke counter, sticktion, time outs...

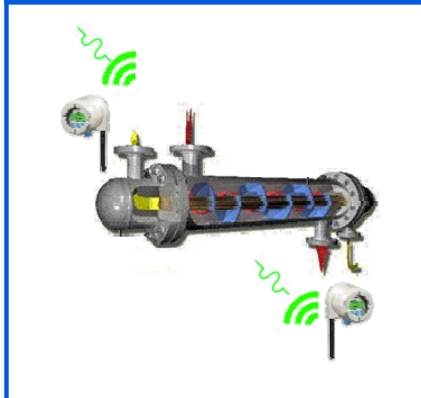
#### **Pressure**

- Add Adaptor – Use 4-20mA for PV monitoring
- Read HART PV compare to 4-20mA (Over range/Calibration)
- Read diagnostic data Over pressure/temp

### Temporary Measurements

#### ***Increase process visibility***

- Low cost wireless solution (*WirelessHART*)
- Ad-hoc connectivity
- Non-intrusive



#### **Heat Exchanger**

- Identify location of blockage
- Use spare thermo wells or surface measurement

#### **Column**

- Replace local gauge with wireless instrument
- No need to run long or difficult to run cables

Process Automation

Process Automation

# Wireless Applications Examples – *Mobile ICT*

## Mobile Device Interface

- Point-to-point wireless communication
- Standard Bluetooth communication
- Standard mobile clients (PDA / Laptop)

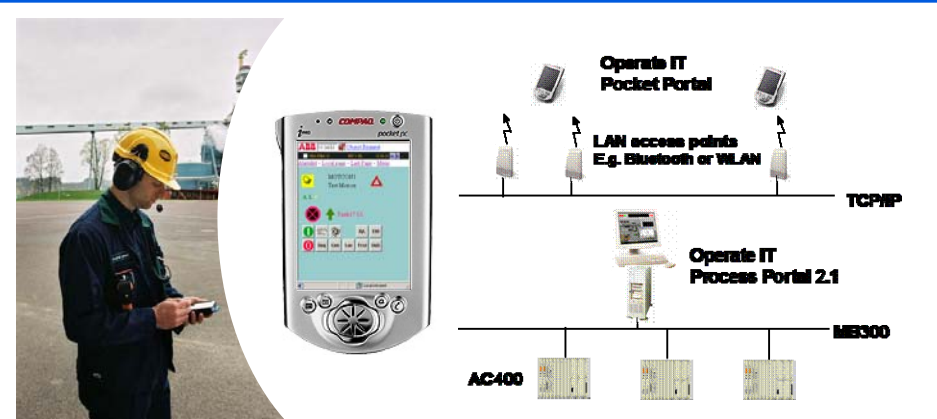


## Low Voltage Breaker

- A plug-in module enables wireless connectivity
- Simplify/manage configuration/recorded data on site
- Easy access to the circuit breaker even when installed in harsh or hard to reach places
- Sophisticated graphical displays by utilizing modern PDA devices

## Mobile Plant Interface

- Wireless network access to Process Portal
- Standard 802.11 WLAN communication
- Standard mobile clients (Tablet PC / PDA)



## Mobile Connection to Operate IT

- Efficient operations (reduce commissioning time, troubleshooting, ...)
- “Carry the control room in your pocket”
- Connection of AC 400 functional units to mobile device
- Alarms, faceplates, object requests, ...
- Location dependent services and profiles
- Configuration mapped to existing aspect objects

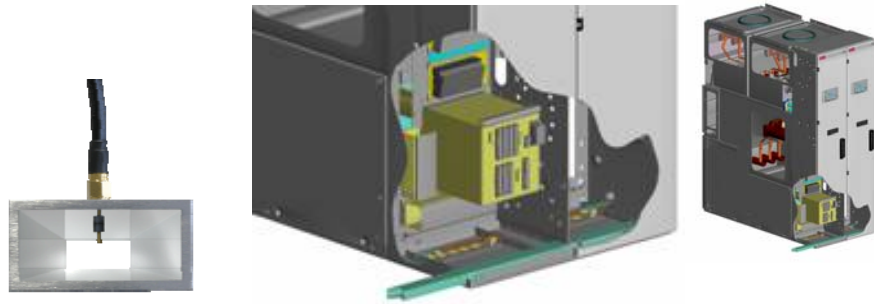


# Wireless Applications

## Examples – *Wireless Control*

### Communication Backplane

- Waveguide as a communication backplane
- “Standard” 802.11 communication
- Redundancy and time synchronization



### MV Switchgear

- IEC61850 GOOSE messages to transmit breaker trip commands, convey lockout commands, breaker failure initiation, and re-closing initiation
- Low cost galvanic isolated communication system
- No radiation and interference from external systems
- MTBF is increased dramatically due to less components and replacement by rugged components

### Wireless Sensors & Actuators

- WISA-com: wireless real-time communication
- WISA-power: wireless (magnetic) power supply
- No cables or batteries required to sensors / actuators



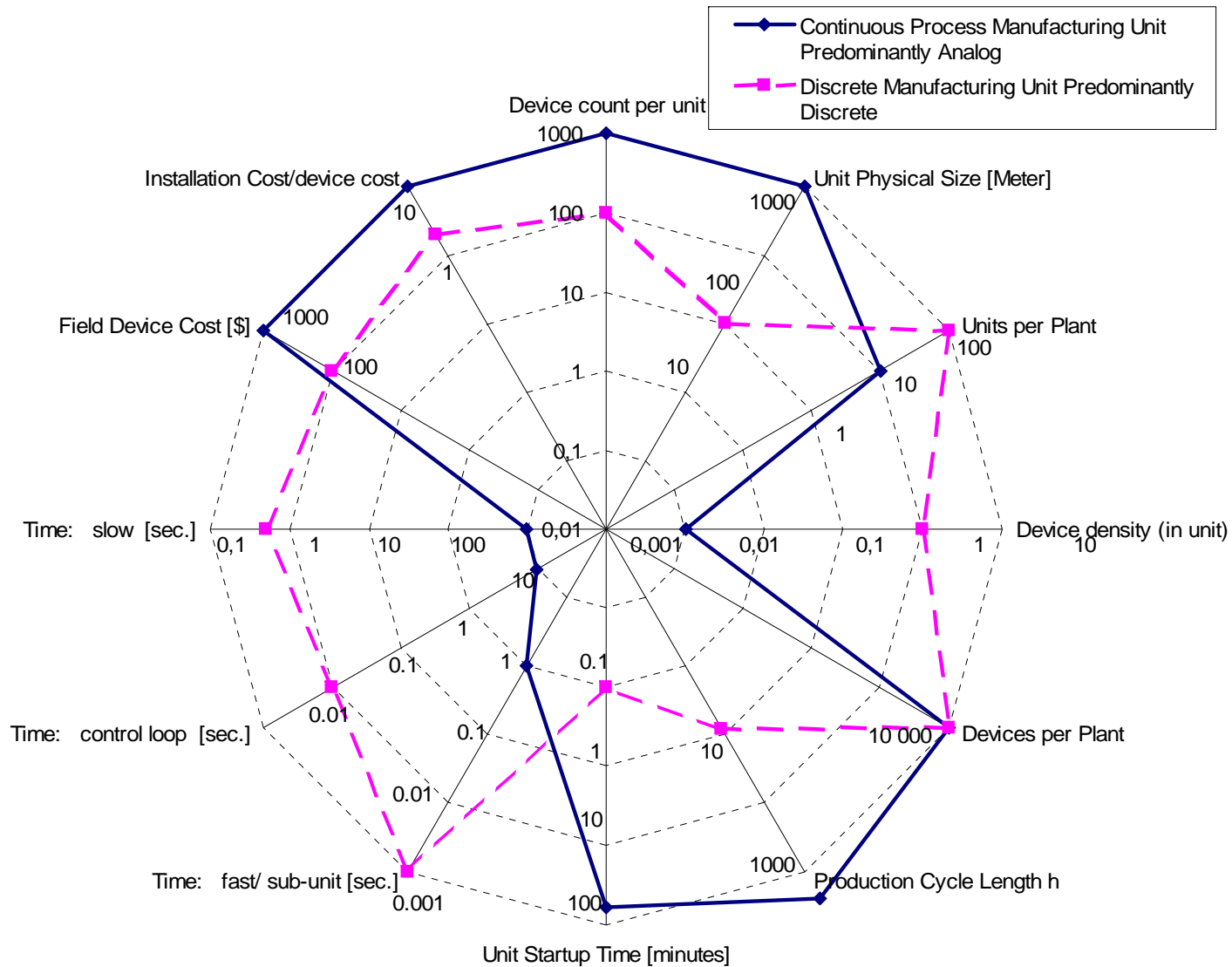
### Proximity Switch

- Reduced material and engineering cost
- Increased reliability (no cable/connector related errors)
- Faster installation and commissioning
- Easy reconfiguration (adding, removing, repositioning)
- Scalable solution (not limited to the existing cabling)
- Fully mobile operation, unrestricted by cables
- Reliable changeover of tooling (without connectors)

Substation Automation

Discrete Manufacturing

# Wireless Technology Process Attributes – Impact on Wireless



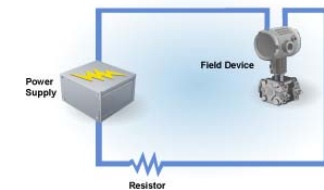
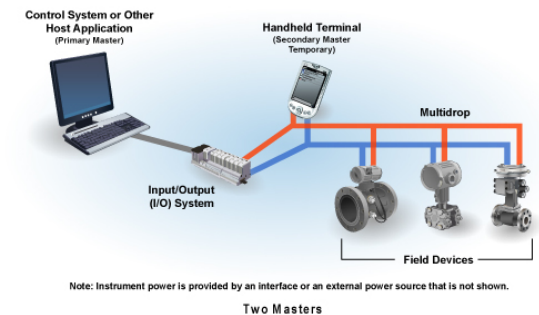
**Note:**  
logarithmic  
scale!



# HART Communications Protocol



- HART – Highway Addressable Remote Transducer
  - Digital communication protocol on top of a 4-20mA analog signal
  - Frequency Shift Keying (FSK)
  - Over 30 million installed devices
  - Stable and backward compatible
- HART Communication Foundation (HCF)
  - Founded 1993
  - Independent
  - Not for profit
  - 200 member companies (ABB, Emerson, Siemens,...)
  - Support for application of the HART protocol
    - Ensures that it is openly available
    - Training
    - Certification of devices



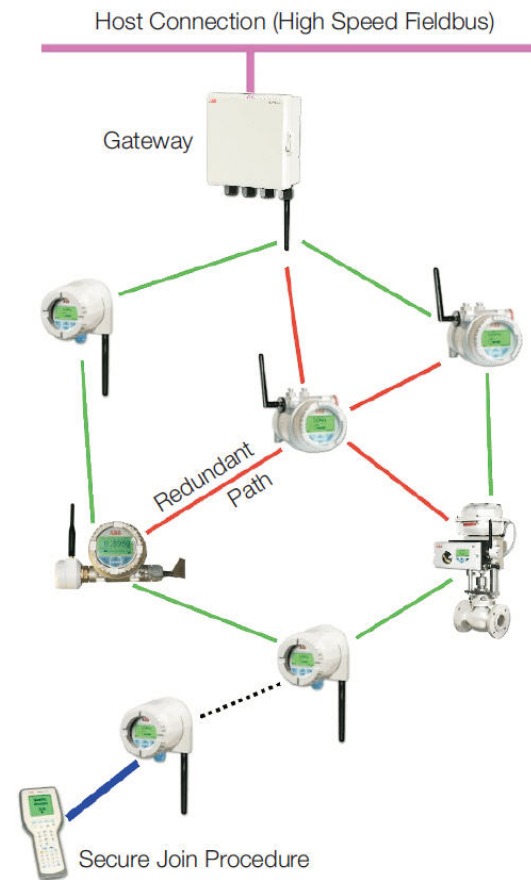
# WirelessHART design guidelines



- Principle objectives
  - Compatibility with existing HART Application Layer
  - Leverage existing host applications and the large installed base
  - Must be HART-like: simple, reliable, secure, easy-to-use
  - Supply end-users with new capabilities
  - Provide more flexibility for installing and operating process automation equipment
- Interoperability
  - *“is the ability for like devices from different manufacturers to work together in a system and be substituted one for another without loss of functionality at the host system level”*
- Designed to compliment, not replace, wired HART!

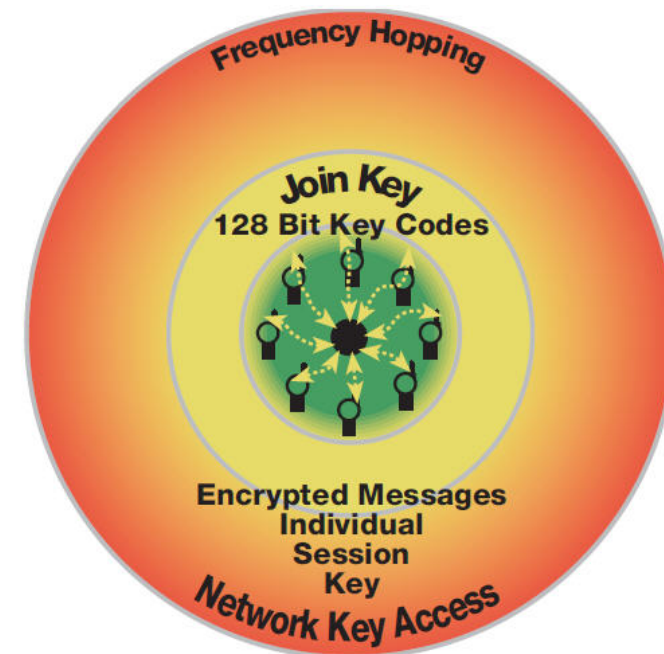
# WirelessHART features

- Based on IEEE802.15.4-2006 standard
  - Only 2.4 GHz frequency spectrum – global
- Frequency hopping
  - Slow hopper: transaction by transaction basis
- Mesh network
  - All nodes must have the ability to route
- Time synchronized
  - TDMA medium access – no collisions
  - Reduces power consumption
  - CSMA medium access possible to use



# WirelessHART features

- Wireless Security
  - AES128 bit encryption of payload
  - Authentication and integrity checks
- Channel blacklisting
  - Avoid the use of certain channels
- Command aggregation
- Prioritized communication
- Block Data Transfer
  - Efficient transfer of large amounts of data



# WirelessHART devices



- Field device
  - Connected to the process
- Router device
  - Not connected to the process
- Adapter
  - Provides wireless connection for wired devices

# WirelessHART devices



- Gateway (including Access Point)
  - Connection to plant automation system
  - Acts as a proxy (caching data)
  - Clock source for WirelessHART
- Network manager
  - Management – joining/leaving/bandwidth
  - Scheduling – routes/channels/communication-slots/etc
  - Optimization – energy consumption/latency/etc
- Security Manager
  - Generation and management of security keys
- Handheld device
  - Used for configuration of other devices





# Wireless Technology Standardization



**WirelessHART**  
Expanding the Possibilities

## Process Automation

- *WirelessHART*® first industrial wireless standard released in 2007
- IEC 65C/507A/PAS (*WirelessHART*®)
- ISA100.11.a (draft specification)
- Fieldbus Organizations refer to either *WirelessHART* and/or ISA100

## Discrete Manufacturing

- Working groups on WSA in Factory Automation are being established
- PNO WSA selected ABB's WISA technology as basis for factory automation
- IEC discussions
- ISA100 work group



## General-purpose Wireless Standards

- WLAN (IEEE 802.11): Dominant standard in discrete manufacturing plants, but less in process automation due to the challenges of covering large geographical areas
- Bluetooth (IEEE 802.15.1): Short range point-to-point technology suitable for local HMI type and remote I/O
- ZigBee (IEEE 802.15.4): Originally covered industrial automation, but now focuses on home automation systems for energy management / electric demand response
- Wide Area Networking: GSM, GPRS, WiMax, etc. for remote monitoring applications
- RFID: primarily used in factory automation and inventory management

# ABB WirelessHART Adapter Video

<http://www.abb.com/cawp/gad02181/fc5fdbb2f4ef2042c12576080032c377.aspx>

# Summary

## The Automation World is becoming Wireless

- Market Drivers
  - There is a real value in wireless as an enabler to increase productivity
- Applications
  - Wireless can be deployed throughout the automation system, ranging from non-critical (monitoring) to critical (control) applications
  - Wireless will become an integrated part of the automation hierarchy
- Standardization
  - The technology is here today
  - Emerging standards in Process Automation enable multi-vendor solutions and ensure coexistence
  - Difference between process and manufacturing
- Success Factors
  - Reliable, Open, Secure, Easy to Deploy and Retrofit, Co-existence

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for a better world™**

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