



Wireless Industrial Networking Alliance

***CHOOSING THE RIGHT WIRELESS TECHNOLOGY
FOR INDUSTRIAL APPLICATIONS***

What You Need to Know About WirelessHART and ZigBee

WINA's July 2009 Webinar

Presentation and Live Q&A

www.wina.org



Webinar Instructions

- Participants are in a 'listen-only' mode
- Ask questions via the chat window anytime during presentation and they will be queued for the live Q&A at end of the presentation
- If you have technical difficulties, please refer to WebEx technical support at <http://support.webex.com>



WINA Overview

Steve Toteda, President - WINA

- WINA Board of Directors
- VP of Marketing – Dust Networks



Who We Are...

Wireless Industrial Networking Alliance - WINA

- A nonprofit coalition of leading industry vendors and research institutions that serves as a trusted source of information by providing balanced coverage of industry issues across a wide range of manufacturing industries.
- Through its extensive network and educational outreach programs, WINA provides end users with current, timely and relevant information about the enhanced productivity, efficiency and safety of industrial wireless applications.



Our Mission...

- Our mission is to promote the adoption of wireless technologies and solutions that improve the efficiency, productivity and safety of industrial manufacturing and processes.





Meet Our Presenters



Gary Mintchell – Editor in Chief, Automation World

- Overview of why wireless technologies matter



Steve Toteda – WINA President

- A comparison of WirelessHART and ZigBee technology



Tim Cutler – Vice President, RFM

- ZigBee case study

Chris Herzog – CEO, Software Technologies Group

- WirelessHART case study



Wireless Industrial Networking Alliance



Gary Mintchell
Editor in Chief
Automation World

Why Wireless Technologies Matter





Wireless technology is often called a “game changer” in process automation.





Information is the
key...



...to running efficient and profitable operations.





Wireless Technology

CHOOSING THE RIGHT WIRELESS TECHNOLOGY FOR INDUSTRIAL APPLICATIONS

What You Need to Know About WirelessHART and ZigBee

Criteria to consider:

- Application characteristics – the “job description”
- Key performance characteristics – scalability, reliability, power consumption, security and ease of installation and maintenance



About ZigBee

- ZigBee Specification Governed by ZigBee Alliance
 - Defines a general-purpose, self-organizing network that can be used for embedded sensing applications such as home automation
 - ZigBee Alliance maintains ZigBee, ZigBee Pro, and recently added RF4CE (for consumer grade remote controls)
- History of the Specification
 - ZigBee 1.0 specification was ratified in December 2004
 - Subsequently modified on several occasions, most recently in 2007 (prior versions of the standard made obsolete)
 - ZigBee 2007 contained stack profile 2 - called ZigBee Pro
 - ZigBee Alliance governs compliance testing



About WirelessHART

- HART Communication Foundation is Governing Body
 - Defines bi-directional data access between intelligent field instruments and host systems
 - A host can be a technician's hand-held device to a plant's process control, asset management, or safety system
 - WirelessHART adds highly reliable mesh networking
- History of the Specification
 - Wired HART first Introduced in the late 1980's
 - Formal industry standard in 1993 (formation of HCF)
 - WirelessHART introduced in 2007, part of HART Version 7
 - Submitted to the IEC for global standardization in 2008
 - HCF governs compliance testing



Technology Overview

ZigBee and WirelessHART Based on Similar Underlying RF Technology (Physical Layer)

IEEE 802.15.4 – Ideal for Sensing Applications

- A radio standard introduced in 2003
- Designed for limited power consumption and relatively low throughput requirements
- Designed with 802.11 co-existence in mind (16 Channels)
- Direct Sequence Spread Spectrum (DSSS) technique
 - Spreads RF energy to improve noise immunity
 - Lowers signal to noise (acts as “good neighbor”)

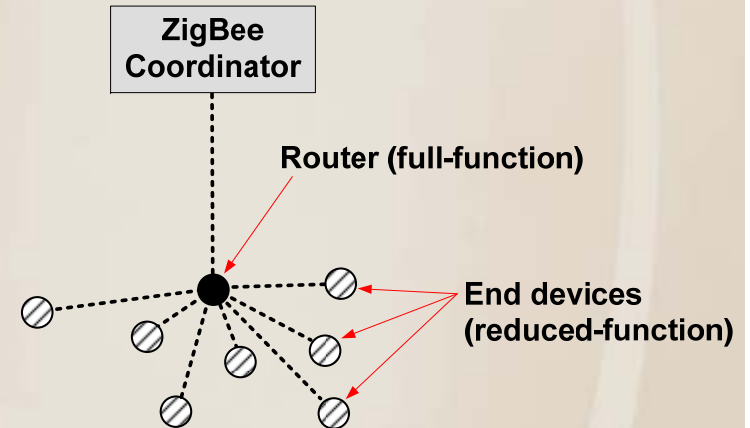


ZigBee Network Formation

ZigBee Based on “Cluster Tree” Networking

Network elements Include:

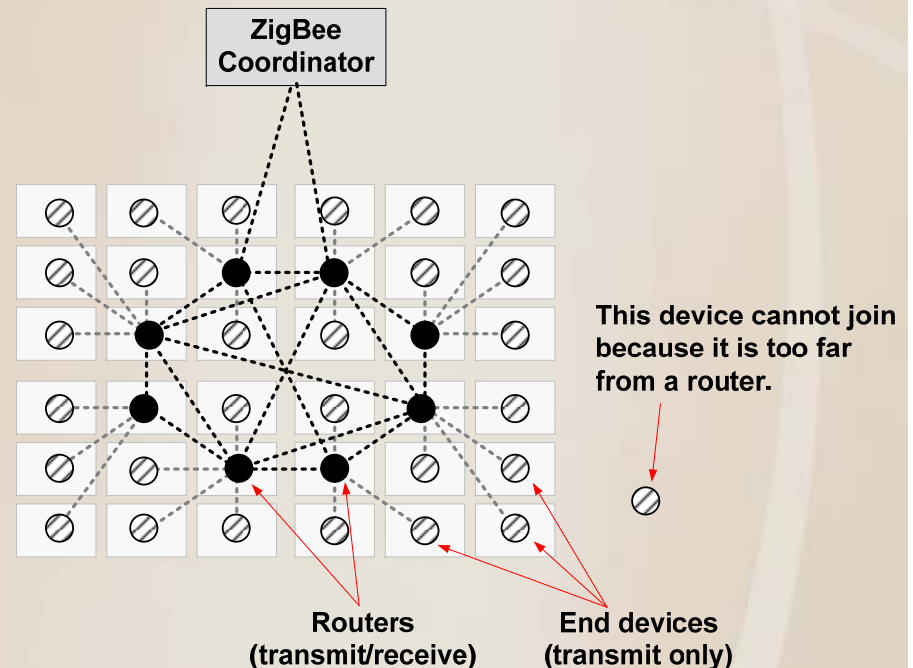
- **ZigBee end device:** Contains just enough functionality to talk to the router or coordinator; it cannot relay data from other devices.
- **ZigBee router:** Acts as an intermediate router, passing data from other devices. Requires line power.
- **ZigBee coordinator:** Most capable device, which forms the root of the network tree



ZigBee Network Formation

Additional Devices Join By:

- Communicating directly with a line powered router
- Line powered routers capable of creating a mesh network
- Commonly called Hybrid-Star Mesh Network



Requires Careful Planning for Line Powered Router Placement



WirelessHART Network

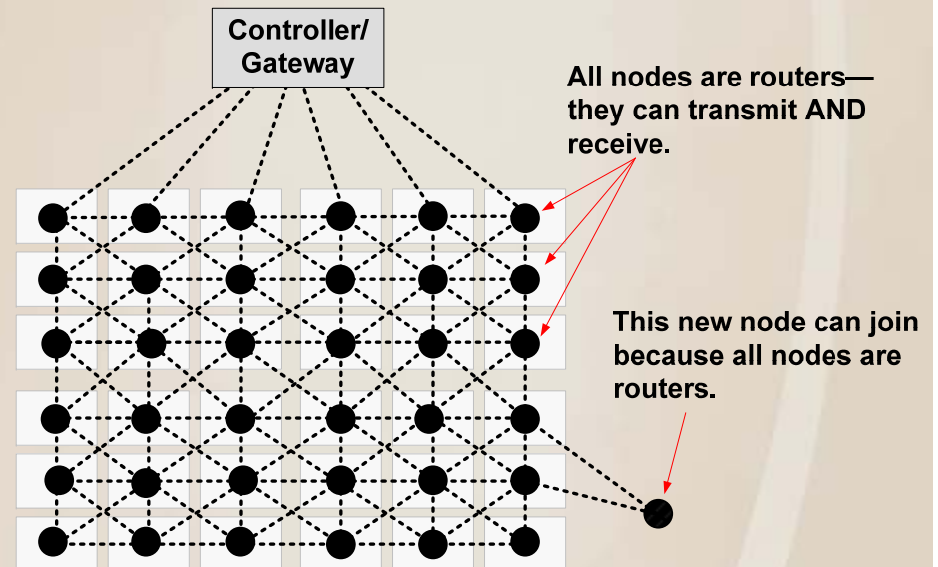
WirelessHART Based on “Mesh-to-Edge” Networking

Network elements Include:

- **Field devices:** low-power field devices that use an onboard radio to send the packets to neighboring devices
- **Gateway:** The gateway coordinates routing, aggregates mote packets, collects network statistics, and publishes data to the host application

Additional Devices Join By:

- Communicating with any device





ZigBee Reliability

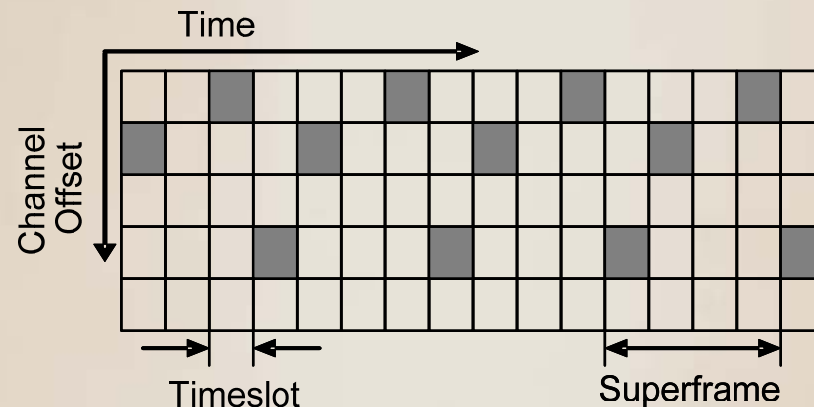
- Implements “Listen Before Send”
 - Avoids transmitting data when there is activity – called Carrier Sense, Multiple Access with Collision Avoidance (CSMA-CA).
 - If activity is detected on the channel, the node delays the transmission for a random amount of time and listens again
- Transmission Acknowledgements
 - Receiving device sends an acknowledgement
 - If an acknowledgement is not received within a certain time interval, device resends the original message
- Networks Form Around Specific Frequency (Channel)
 - Network Coordinator can signal devices to reform around a new channel if interference causes a significant portion of device to become “lost” – called Frequency Agility



WirelessHART Reliability

- Based on Time Synchronized Communications

- Avoids transmitting data when another device is transmitting
- Timeslots scheduled for each device, permitting ultra low power operation
- Deterministic network performance



- Transmission Acknowledgements

- Data and control traffic sent with network and application layer acknowledgement

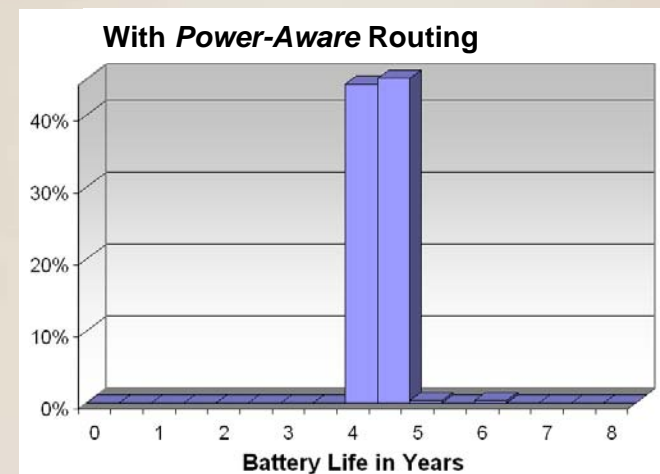
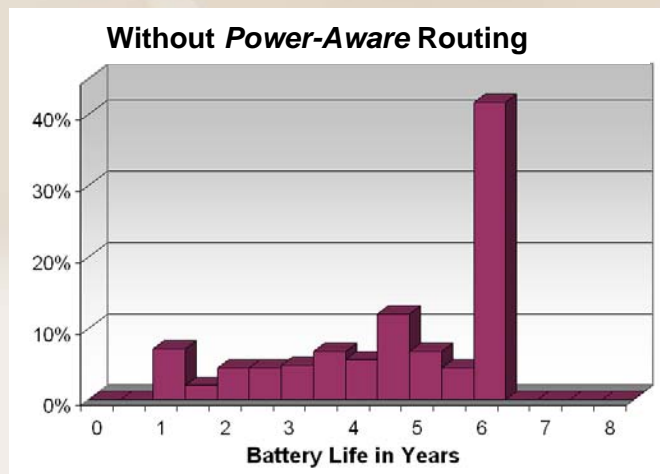
- Channel Hopping Technique Enhances Performance

- All channels are available for node to node communications
- High reliability in electrically “noisy” environments or in areas with high multi-path interference (i.e. metal, glass and steel)



Power Consumption

- ZigBee
 - End devices capable of 2 years or more battery power
 - ZigBee routers require line power
- WirelessHART
 - All field devices can be battery powered, typically 5 – 7 years
 - Per device power consumption can be managed across the network to provide predictable per device power consumption





Comparison Summary

	WirelessHART	ZigBee Pro
Mesh Architecture	Full mesh	Hybrid Star Mesh
Self-forming, self-healing network	Yes	Central network coordinator
Battery life of end devices	Years	Years
Battery life of mesh routers	Years	n/a (Hours?)
Devices requiring line-power	Gateway	ZigBee Routers ZigBee Coordinators
Deterministic power management	Yes	No
Reliability and stability in harsh environment	High	Low
Multiple access scheme	Time Synchronized	CSMA
Channel hopping	Yes	No
Routing capability	Any-to-any, full mesh	End device to paired router Any to Any mesh router



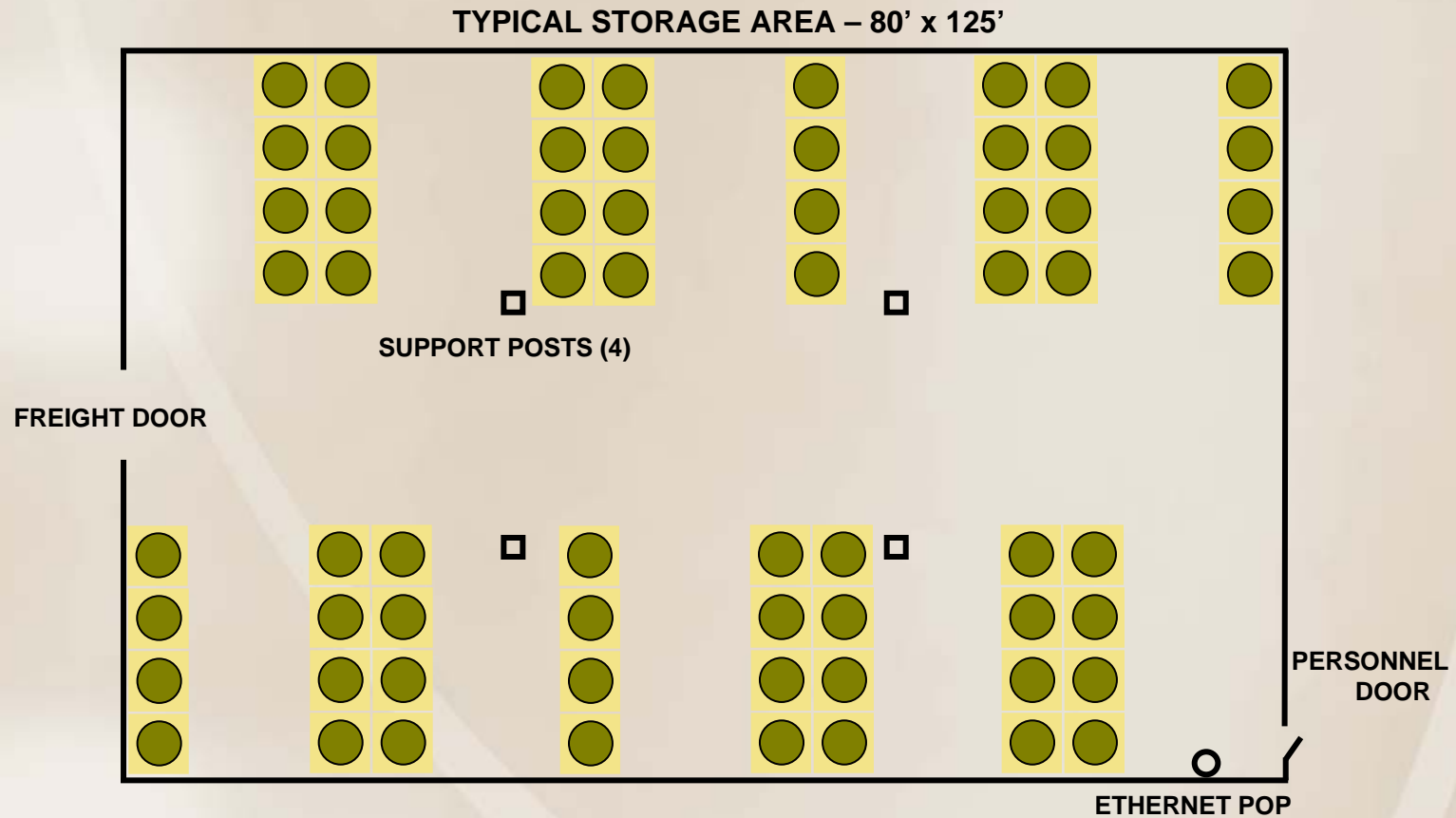
ZigBee Application



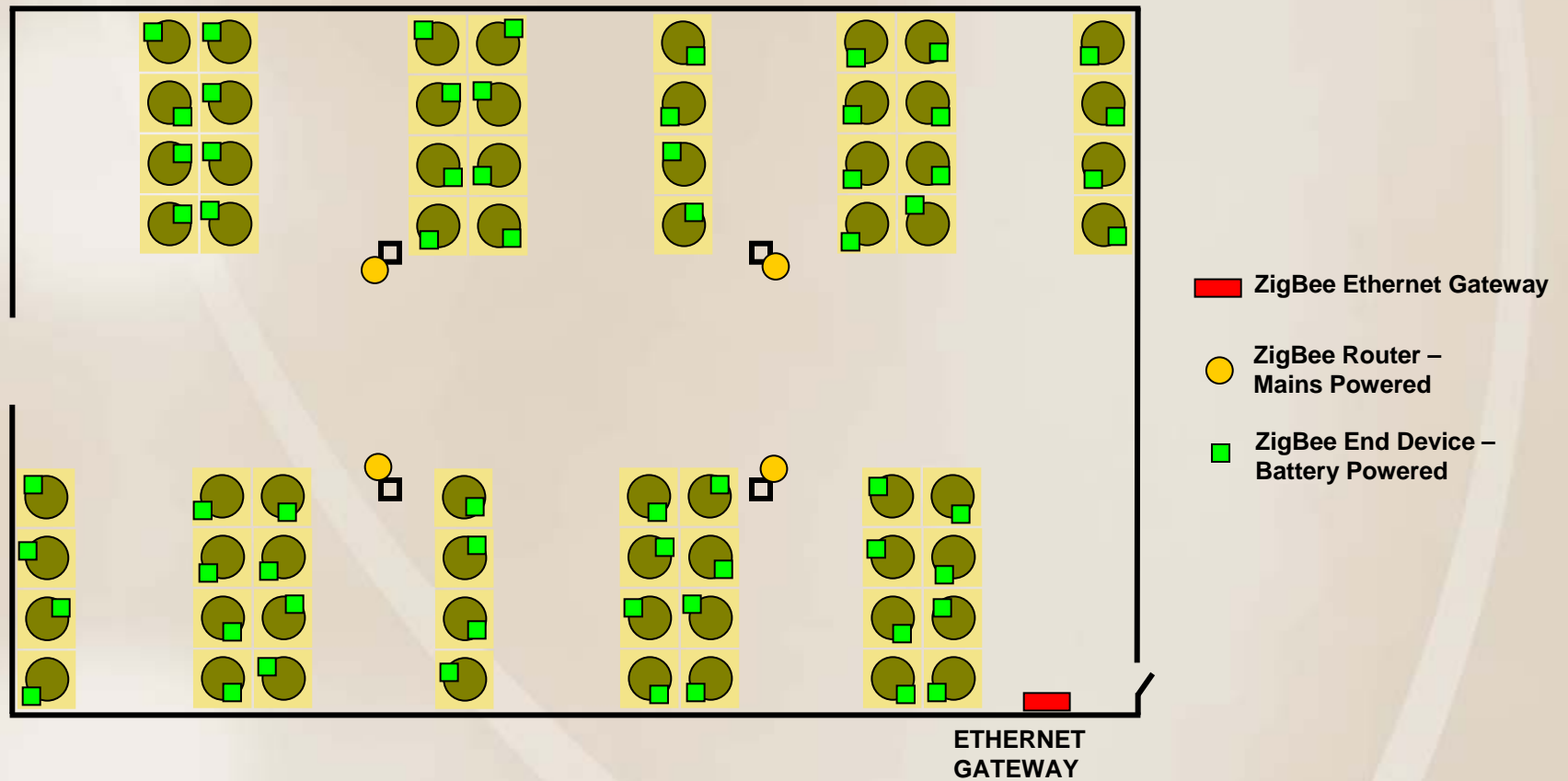
- **Storage Container Temperature Monitoring**
 - Report temperature of 64 containers in a storage area every 15 minutes
 - Typical storage area ~ 10,000 Square Feet
 - Temperature monitoring unit battery operated with 5 year battery life
 - Containers rarely move but are removed and new containers added – temperature monitoring unit removed from containers when they leave and are put on newly arrive containers
 - Ethernet gateway take-out point

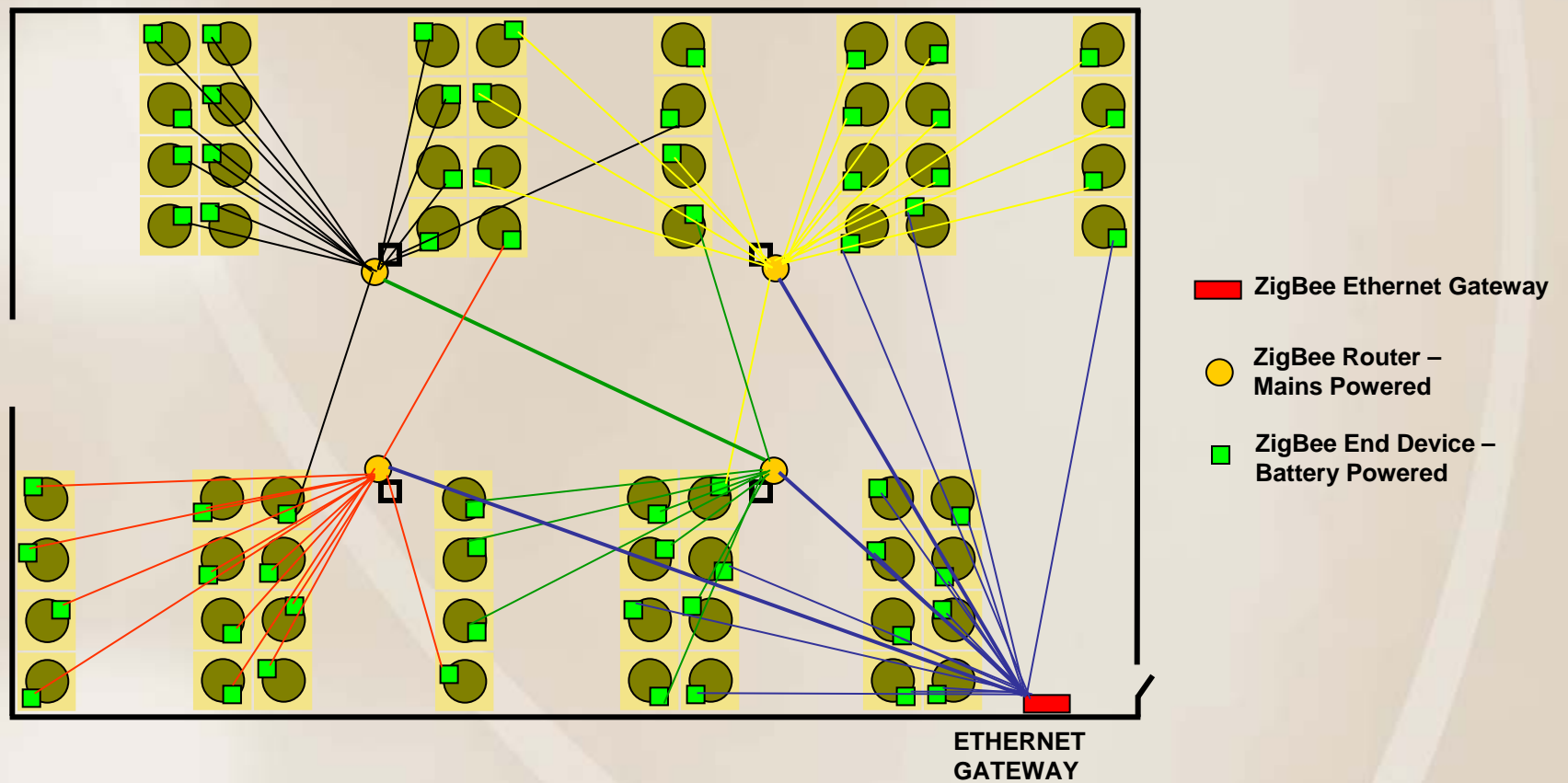


ZigBee Application



ZigBee Application







ZigBee Application



- Many to One Application
 - All data from temperature modules is sent to a single concentrator
- Routers obtain power from mains connection on storage area support posts
- Temperature modules contain sleeping ZigBee End Devices that wake-up every 15 minutes and send data unsolicited to the Ethernet Gateway which is the Coordinator
- Alarm conditions are reported immediately



ZigBee Application



- Why ZigBee Fits
 - Moderate number of nodes with relatively infrequent data transmissions
 - Mains power readily available for routing nodes
 - Nodes are portable not mobile
 - Low power end nodes meet battery consumption target
 - Periodic reporting and alarms without application polling



ZigBee Application



- Other ZigBee Capabilities
 - Meshing where routers can communicate directly
 - Nodes can come and go
 - Support for network manager to change frequency channel – Frequency Agility
 - Multiple take-out points
 - Source routing minimizes route table sizes



WirelessHART Application



Valve Actuator Application

- Control and monitoring of electrically powered valve actuators for the process industry
- Several cost components per installed actuator
 - Physical cost of actuator
 - Installation costs of actuator
 - Mechanical installation
 - Power connection (power is generic)
 - Cost of establishing the control link (control is **not** generic)



WirelessHART Application



Valve Actuator Application

Why wireless?

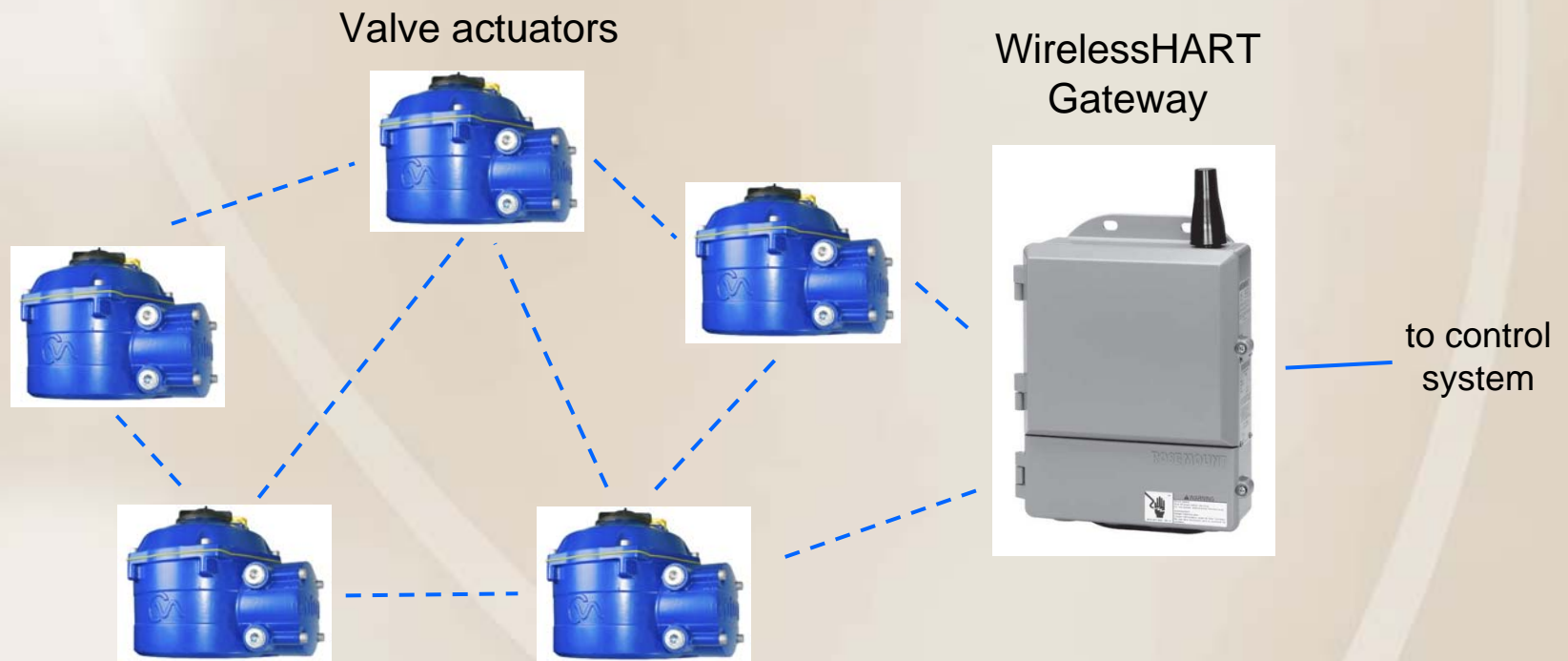
- Often times the control connection is one of the most expensive aspects of installation
 - Run over long distances and around many obstacles
 - The longer, the more expensive
 - May be installed in a hazardous environment where very specialized and costly procedures must be adhered to
- What if you could drive the control connection installation cost to near zero?



WirelessHART Application

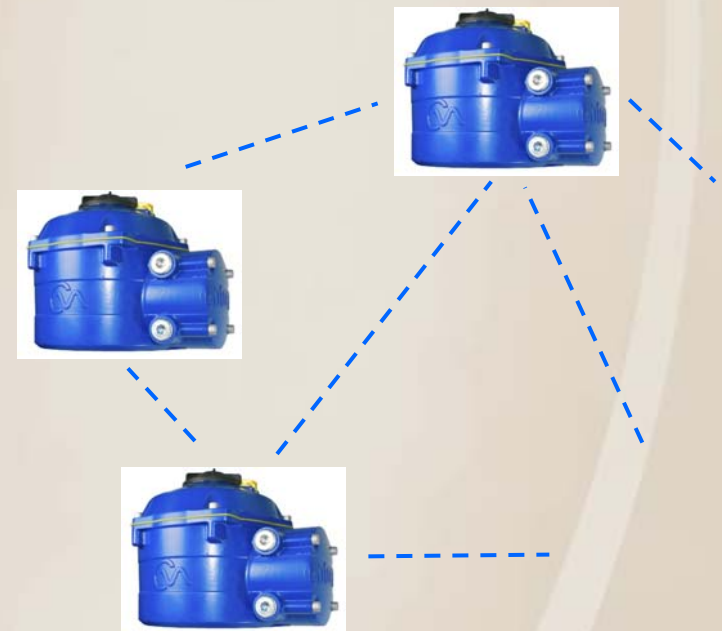


Valve Actuator Application – From 5,000 feet



Valve Actuator Application – From close-up

- Each WirelessHART device extends the network and can help enhance the mesh
- Multiple simultaneous paths provide a high level of redundancy
- Environment is very prone to reflections and interference from other 2.4GHz devices
- We already have power readily available but with a wireless control link, we've cut installation costs dramatically





WirelessHART Application



Why WirelessHART?

- High degree of reliability
 - Use of multiple channels within the band
 - Very high resistance to active interferers
 - Even **higher** resistance to passive interferers like multipath
 - Simultaneous use of more than one channel increases throughput
 - Multiple links maintained between devices
 - “Slotted” communications help control and reduce latency
- Well accepted and easily integrated into industry standard control and monitoring infrastructures
 - Probably (one of the most critical aspects to a successful deployment!)
 - Provides a wireless infrastructure which can be easily added to later



WirelessHART Application



Summary

- Know your application
 - Reliability
 - Throughput
 - Power
- Know your customer
 - What does this sort of customer accept?
 - Are there existing standards or systems that must be integrated with?
 - Try not to swim “upstream”
- Know your environment
 - What are the wireless conditions?
 - Active **and** passive



Wireless Industrial Networking Alliance

Questions & Answers

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A Member Organization of the Automation Federation