

Setting the Standard for Automation™

802.11 Wireless Ethernet as a Process Control Network Backbone

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Standards Certification Education & Training Publishing Conferences & Exhibits

Presenter

- Jim Ralston
 - Strategic Product Manager Wireless
 - Over 16 years in Industrial Wireless market
 - Field Engineering/Support
 - Wireless System Design
 - Sales
 - Product Marketing
 - Resides in Pittsburgh, PA
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 - Eldest a freshman in the EE program at WVU

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Topics



- Benefits of 802.11 Wireless Ethernet
- Comparison of 802.11 wireless standards
- Wireless design considerations
- CFE Geothermal Power Generation Project
- Frontier Well Head & Refinery Wireless Project
- Questions?



Popularity of Industrial Ethernet

- Industrial Ethernet popularity growing...
 - Field proven
 - ModBus TCP/IP, EtherNet/IP protocols
- High speed, low latency network
 100/1000Base-T
- Open standard, commercially available hardware (lower cost)
- Accommodates multiple data types

- Process, commands, workstation, video, IT

Challenges of Ethernet Infrastructure

- Older plants = No network infrastructure
- Ethernet copper links limited in distance
 100 meter limit
- Longer runs require Fiber Optics
 FO Cables, FO Repeaters/Switches
- Very high cost of conduit design & installation
- Fiber cable subject to environmental damage
 Where is the break? Time to repair?
- High cost may limit system scope

Benefits of Wireless 802.11

- Saves money by reducing plant wiring costs
 - Plant wire installation may cost as much as \$100 to \$2,000 per foot!
 - 802.11 supports long links (2+ km)
- Saves time
 - No cable to install
- Redundancy
 - Economic self-healing networking
- Support for mobile workers
 - Wi-fi enabled workstations, laptops, SmartPhones, etc





IEEE 802.11a/g/n Technologies

- Open standard "Wi-Fi"
 - OFDM modulation
 - 20 MHz Wide channel = fast data rate (up to 150 mbps)

- Low latency microseconds
- CDMA (collision detection listen first)



802.11g/n Frequency Channels RF Bands –2.4 to 2.483 GHz (83 GHz of bandwidth) P 1 2 3 4 5 6 7 8 9 10 11 2.401 GHz 2.473 GHz MHZ MHz

Only 3 non-overlapping channels in 2.4 GHz!

802.11a/n Frequency Channels

RF Bands –5 GHz

• 5.150 to 5.825GHz - 700MHz of Bandwidth



Note: Tweleve non-overlapping channels within U-NII-1. UNII 2 and UNII 3.

Over 20 non-overlapping channels in 5 GHz band

802.11n – What's New

Feature		802.11a/g	802.11n
•	RF Rates	6-54 Mbps	6-300 Mbps
•	Antennas	1(2)	1 - 3
•	Bands	g (2.4GHz) a (5 GHz)	ng (2.4GHz) na (5GHz)
•	UDP Stream	3,500 pps	13,000 pps
•	TCP/IP Rates	1,000 pps	4,000 pps

802.11n offers significant higher packets per second (pps)!

802.11n – Streams

- More than one data streams
- 802.11n radios can send 2 streams of data at a time if the conditions are right.
 - At least 2 antennas must be connected to each radio.
 - Multipath is important to keep the streams separate the different streams take (slightly) different paths
- The packet is divided between the streams to speed data transfer.



802.11n – MIMO Antennas

- Multiple Input Multiple Output (MIMO)
 - One antenna, three elements
 - Intentionally creates multiple paths (reflections)
 - Required for multiple streams
 - Three antenna leads
 - Omni-directional & directional





802.11n – Channel Bonding

- Channel Bonding
 - 2 Adjacent Channels can be used at the same time
 - Twice the data can be sent at a time





802.11 Security

- Security components
 - Authentication allow those certified
 - Encryption scramble data to make it unreadable
 - Integrity protect against false data
- Standards Progression
 - WEP 64 & 128 (2000) Weak, known faults
 - WPA TKIP (2004) Software patch to WEP
 - WPA2 AES (2006) Robust standard
 - adopted by NIST & US Govt.,
 - approved by NSA for secure communications
- 802.11i & WPA2

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- Passphrase WPA2-PSK
- RADIUS Service WPA2-Enterprise





802.11 Diagnostics

• Web server

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802.11 Industrial "Best Practices"

- Perform site testing
 - Existing wireless systems
 - RF paths/Antenna placement
- Use a "clear channel"
 - Consider 5 GHz band
 - Coordinate with IT (spectrum management)
- Design redundant RF paths, self-healing
- Select 802.11i security, turn it on!
- Select hardened hardware (environment/vibration)
- Weatherproof all connections
- Utilize diagnostics (monitor RF health/packets)

Oil & Gas - Refinery



- Video for monitoring plant
- Mobile worker

DCS



CFE - Cerro Prieto Geothermal Field





5.5km

Cerro Prieto, Mexico

3.8km

Geothermal Power Generation



Plant History

- Installed Wireless HART devices and Foundation Fieldbus
 - Monitoring 17 steam wells
- Data sent back to DCS
- Reliability of fiber was not meeting requirements
- 8,000 meters of fiber replacement too expensive
- Fiber survives only 4-6 months and the time for repair is around 3 months.



802.11g Wireless Retrofit

 Central Control Room communicating to 4 gateways over the 802.11g



Solution Installed



CFE Network Results

- Wireless performing very well for over 2 years
- Plans to add 5 more Access Point
 - Ease of expandability- reduced costs to improve monitoring



Frontier Oil Refinery -Wyoming



Network Design Steps

- Preliminary System Design
 - PWD Software Design
- Site Verification Process
 - Visual Inspection of Sites
 - Channel Availability
 - Critical Link Verification
 - Verify Estimated Signal Strength
 - Battery power unit
 - Bill of Materials Generation
- Effort Estimate
 - System Design: 1 day
 - On-site testing: 2 days
 - On-going Support: 2 days

Frontier Oil Refinery



C	Radio Confi	guration/Diagr	ostic	Uti	lity - '	Wind	lo					
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	00:0d:8d:f0:11:69	Network1	1	-58	WPA	b	64	1	2			
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Tank Level System



Well Head System



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Questions?

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