Setting the Standard for Automation™

802.11 Wireless Ethernet as a Process Control Network Backbone

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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
  - Married with 2 teen children
    - Eldest a freshman in the EE program at WVU

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Topics

- Ethernet in Process Control
- 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

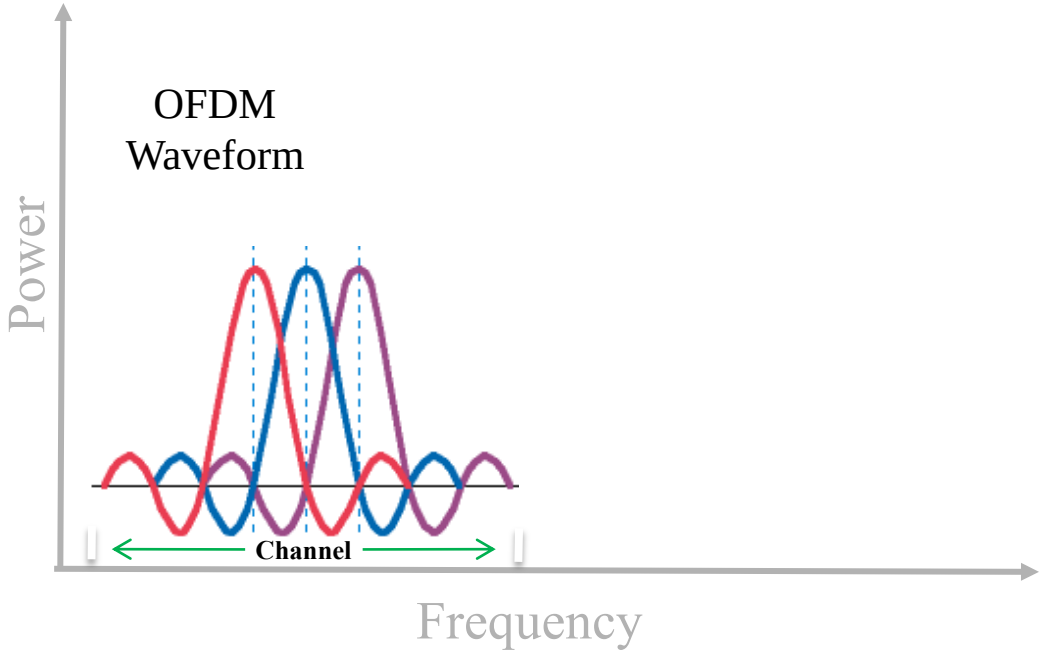
- Older plants = No network infrastructure
- Ethernet copper links limited in distance
  - 100 meter limit
- Longer runs require Fiber Optics
  - FO Cables, FO Repeaters/Switches
- Very high cost of conduit design & installation
- Fiber cable subject to environmental damage
  - Where is the break? Time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

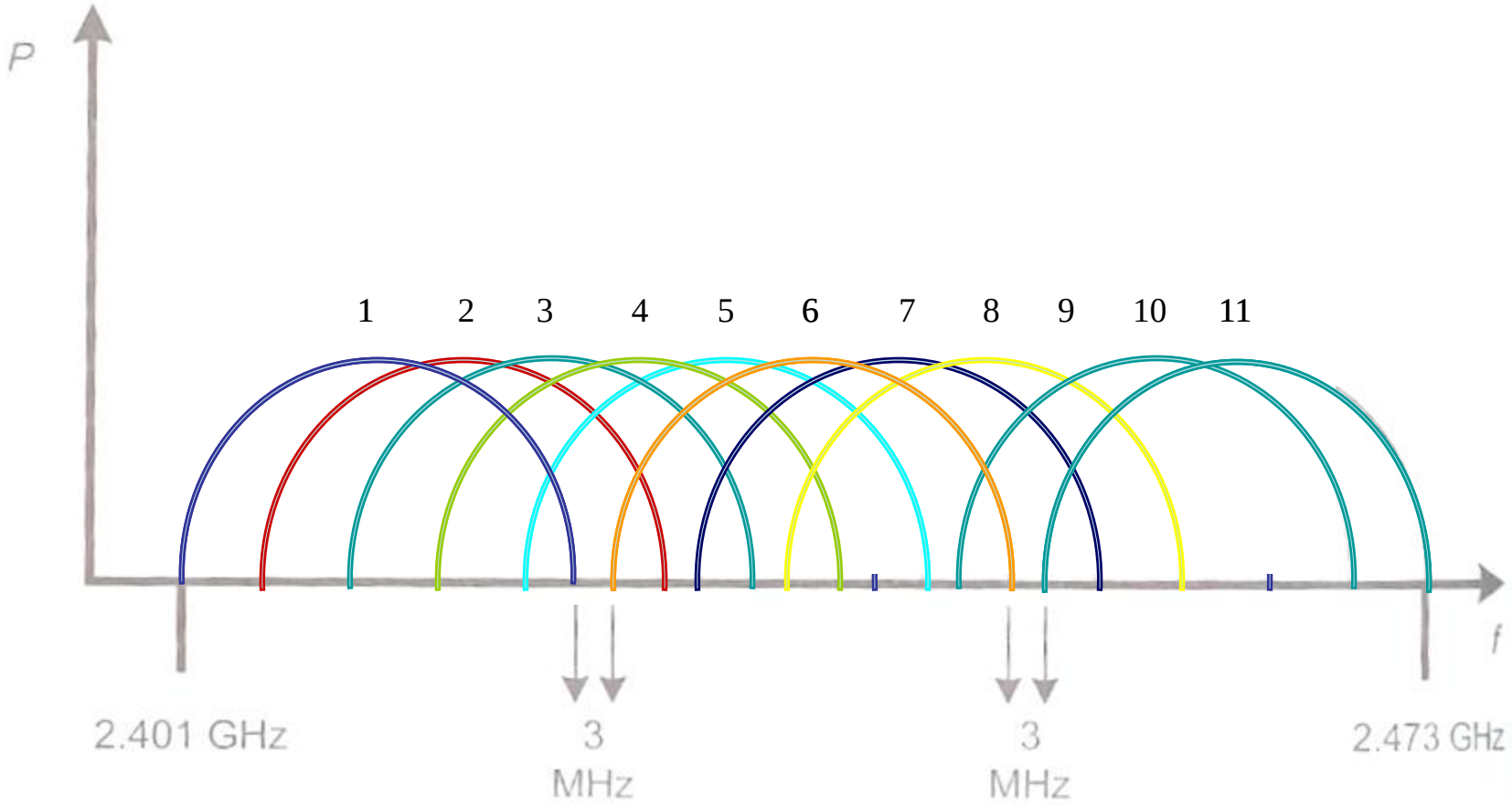
IEEE 802.11a/g/n Technologies

- 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)

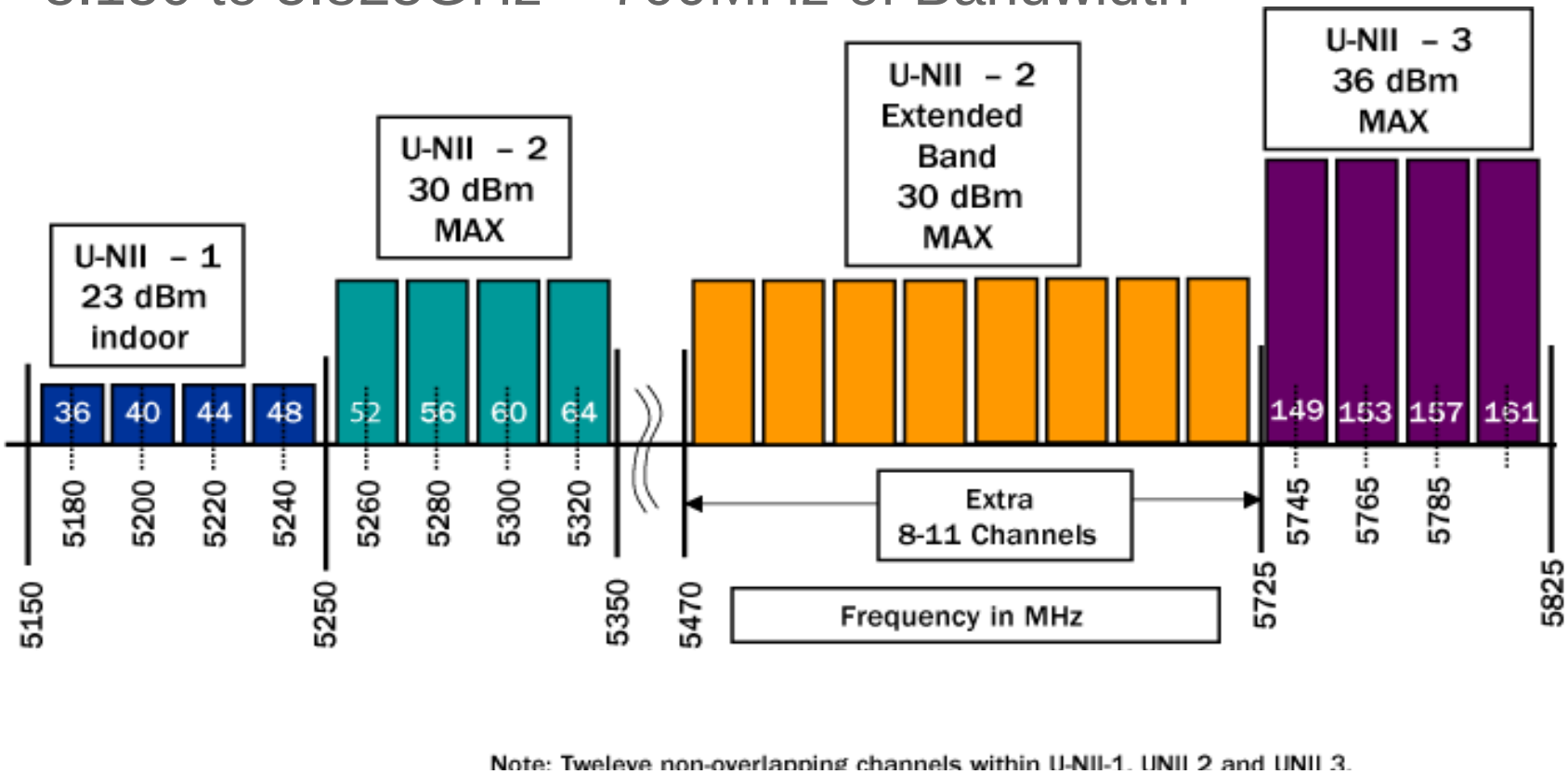


Only 3 non-overlapping channels in 2.4 GHz!

802.11a/n Frequency Channels

RF Bands –5 GHz

- 5.150 to 5.825GHz – 700MHz of Bandwidth



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

Over 20 non-overlapping channels in 5 GHz band

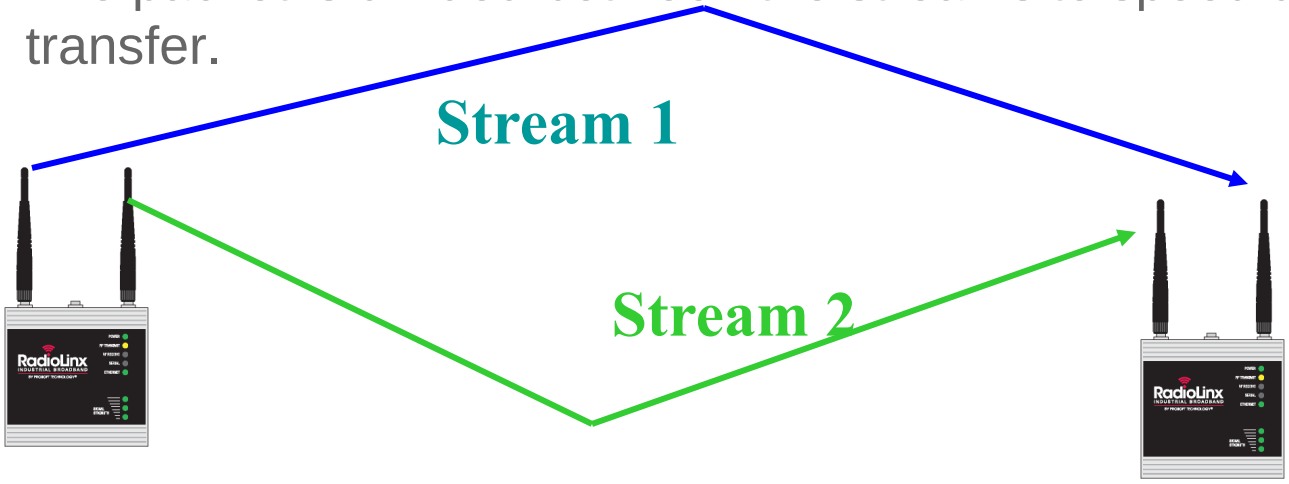
802.11n – What's New

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.

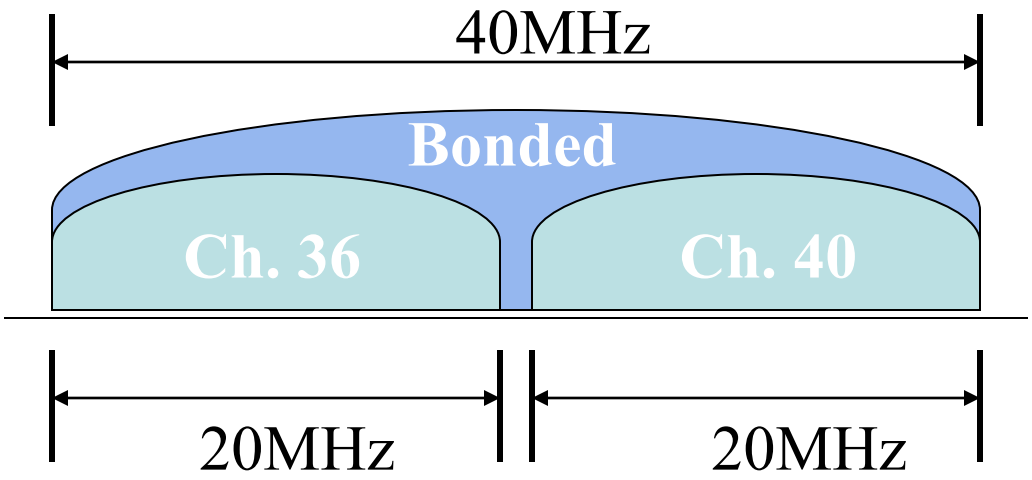


802.11n – MIMO Antennas

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

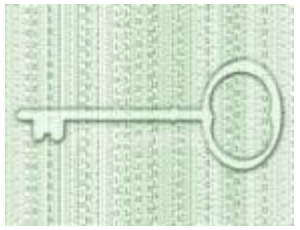
802.11n – Channel Bonding

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



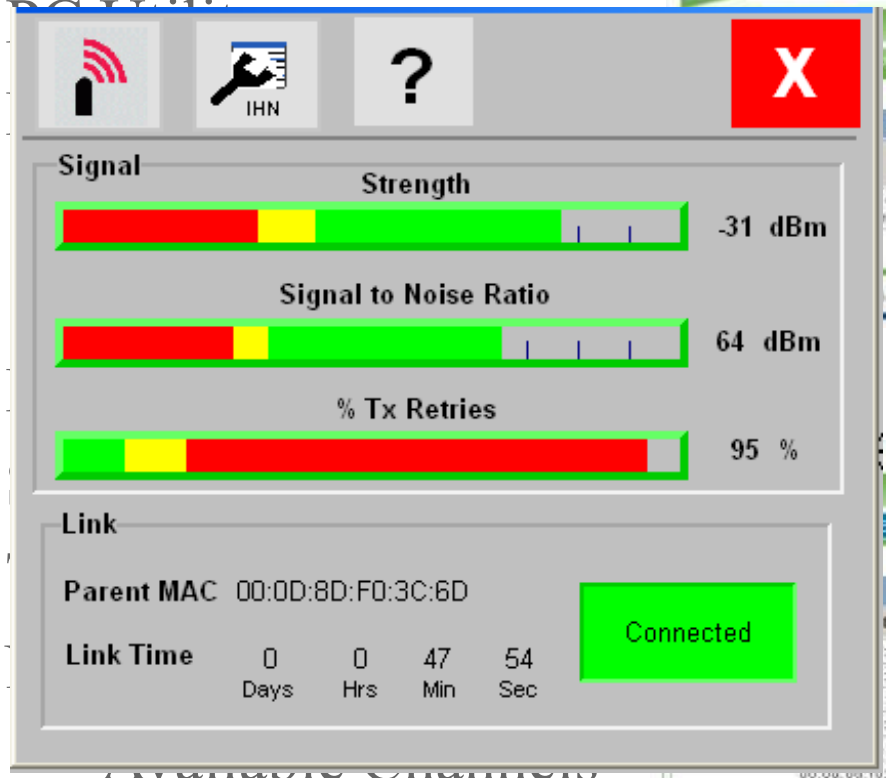
802.11 Security

- 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
  - Passphrase – WPA2-PSK
  - RADIUS Service – WPA2-Enterprise



802.11 Diagnostics

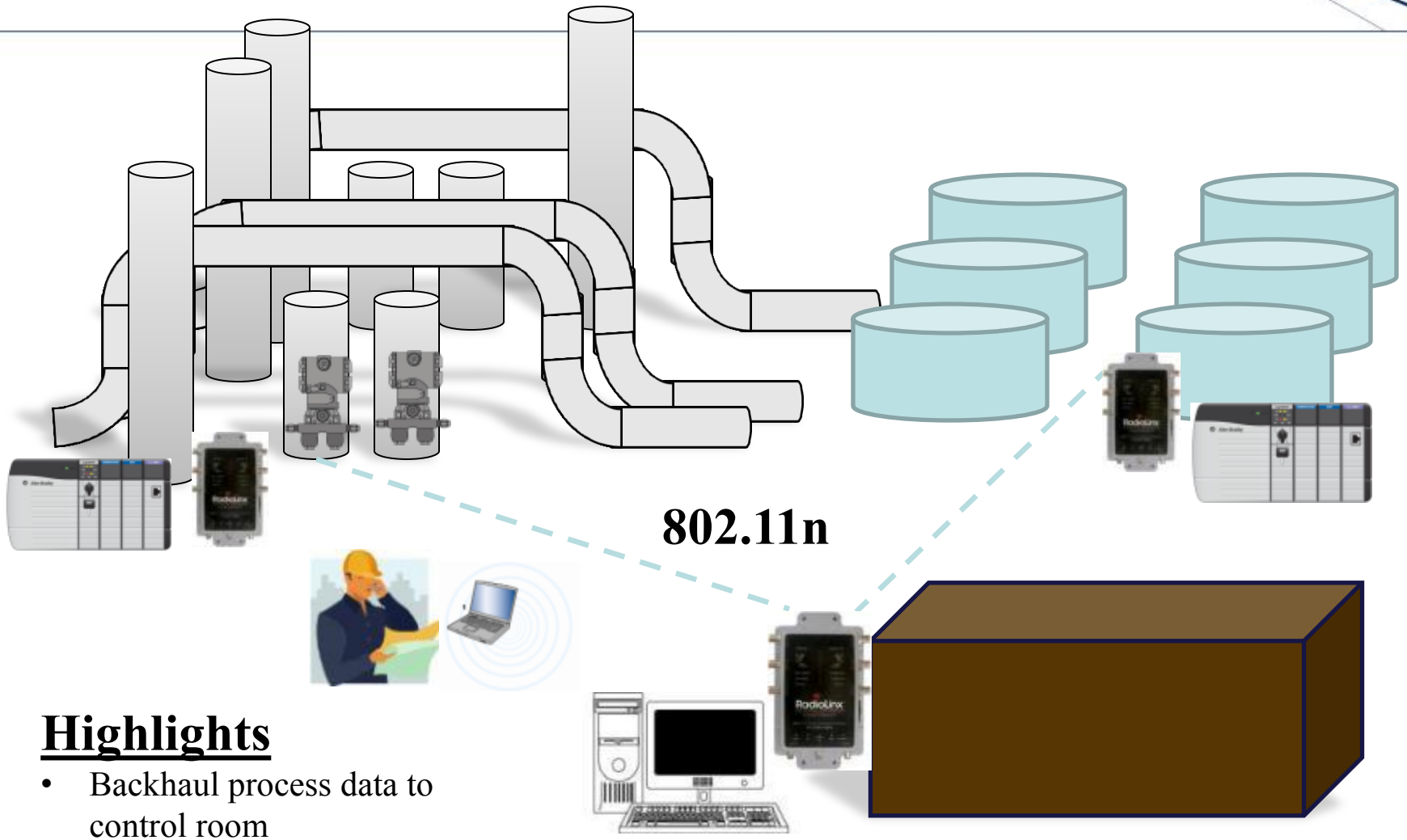
- Web server
- PC Utility
- Available Channels



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



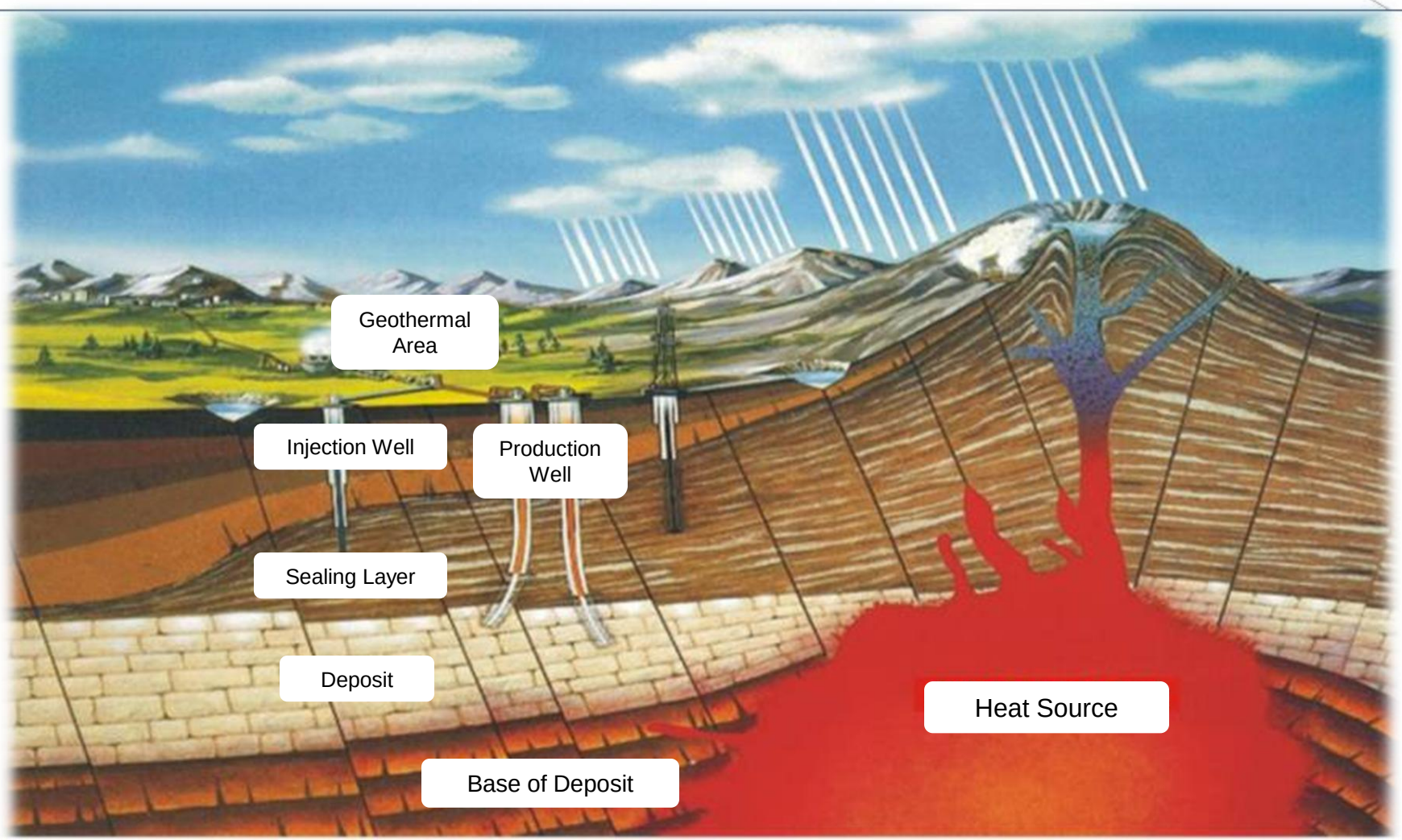
Highlights

- Backhaul process data to control room
- Video for monitoring plant
- Mobile worker

CFE - Cerro Prieto Geothermal Field

Cerro Prieto, Mexico

Geothermal Power Generation

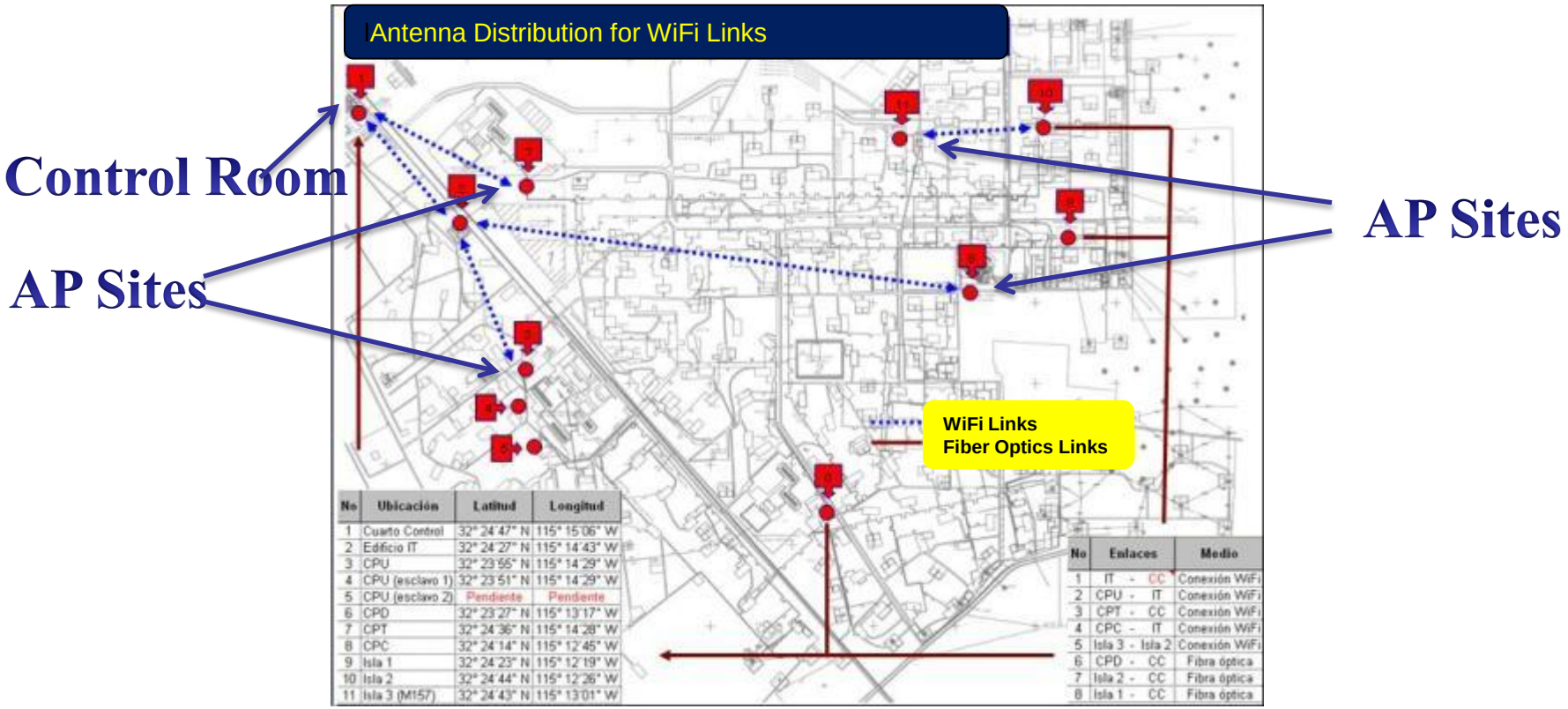


Plant History

- 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



No	Ubicación	Latitud	Longitud
1	Cuarto Control	32° 24'47" N	115° 15'06" W
2	Edificio IT	32° 24'27" N	115° 14'43" W
3	CPU	32° 23'55" N	115° 14'29" W
4	CPU (esclavo 1)	32° 23'51" N	115° 14'29" W
5	CPU (esclavo 2)	Pendiente	Pendiente
6	CPD	32° 23'27" N	115° 13'17" W
7	CPT	32° 24'36" N	115° 14'28" W
8	CPC	32° 24'14" N	115° 12'45" W
9	Isla 1	32° 24'23" N	115° 12'19" W
10	Isla 2	32° 24'44" N	115° 12'26" W
11	Isla 3 (M157)	32° 24'43" N	115° 13'01" W

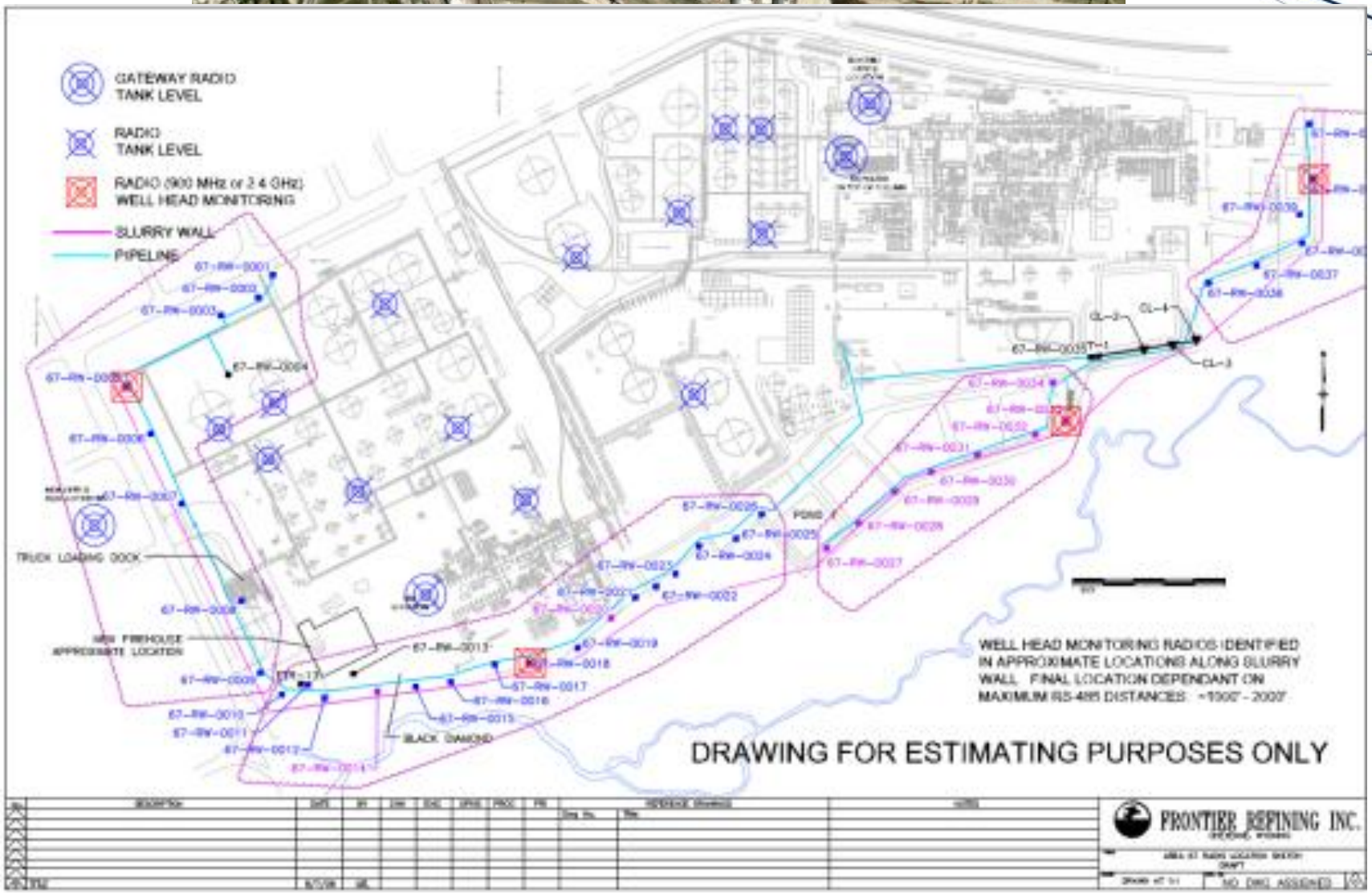
No	Enlaces	Medio
1	IT - CC	Conexión WiFi
2	CPU - IT	Conexión WiFi
3	CPT - CC	Conexión WiFi
4	CPC - IT	Conexión WiFi
5	Isla 3 - Isla 2	Conexión WiFi
6	CPD - CC	Fibra óptica
7	Isla 2 - CC	Fibra óptica
8	Isla 1 - CC	Fibra óptica

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

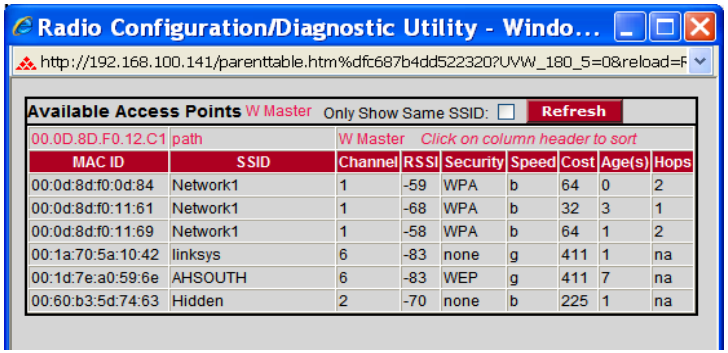
Frontier Oil Refinery -Wyoming



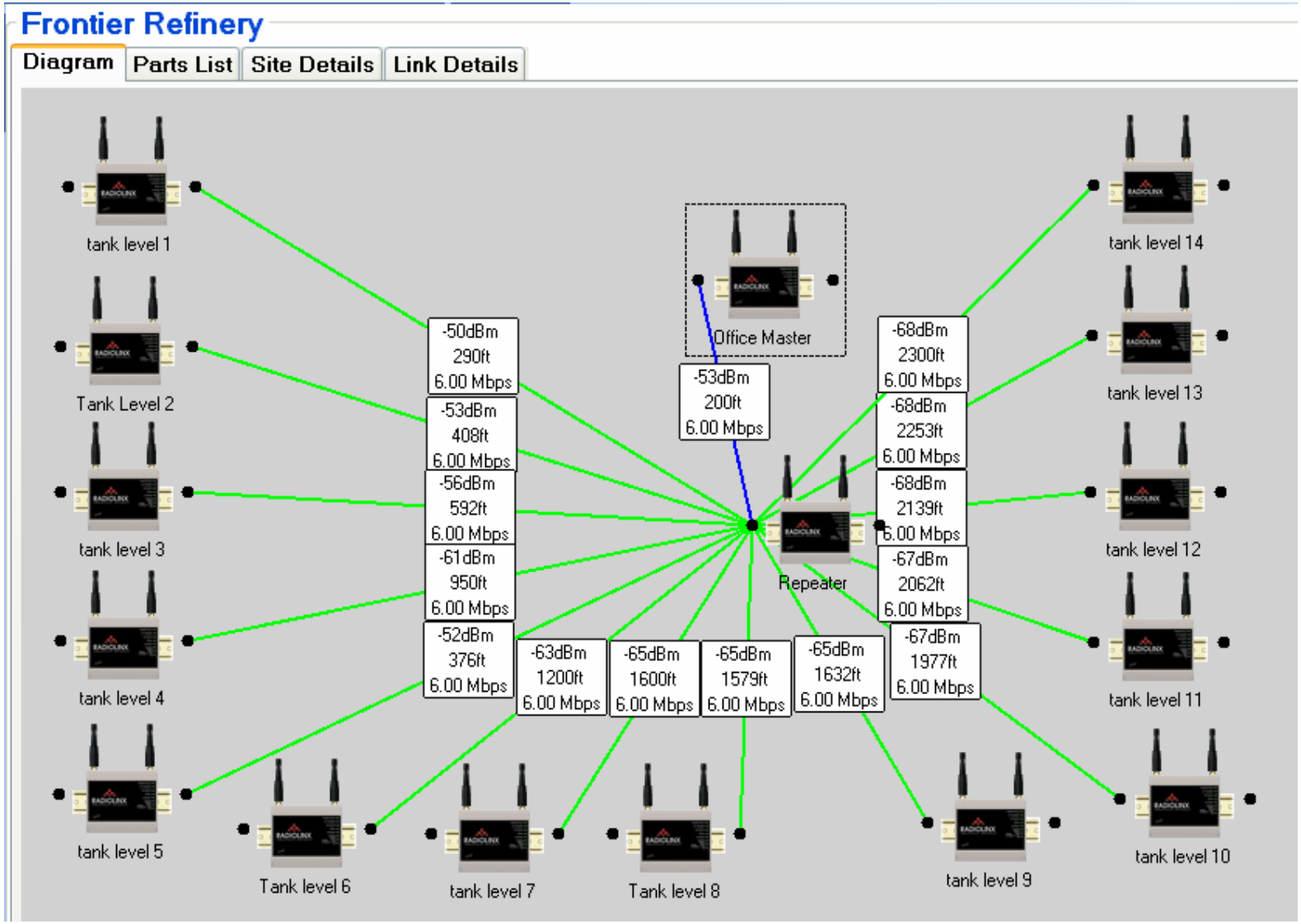
Network Design Steps

- 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

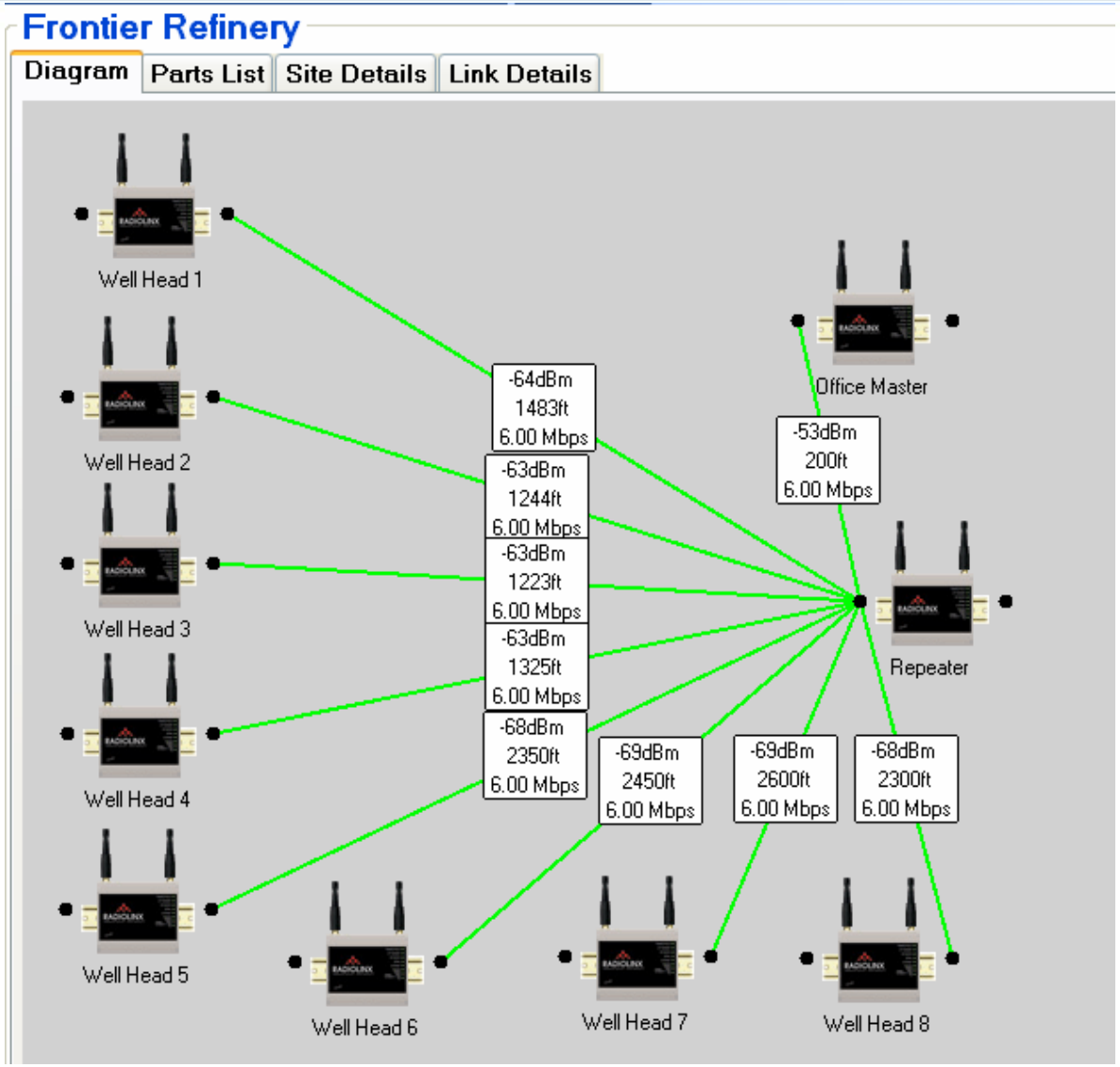
Frontier Oil Refinery



Tank Level System



Well Head System



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Questions?

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