Wireless Technology & Application

Paul Mercier – Project Engineer
Wireless Technology

Our Company
- HQ – Blomberg, DE
- USA – Harrisburg, PA
- Regional Tech Centers
It All Starts Here with Phoenix Contact
Leading Developer of Industrial and Electronic Technology
Phoenix Contact - USA
US-based Logistics and Manufacturing

U.S. Headquarters

PHOENIX CONTACT USA Inc.
Harrisburg, Pennsylvania

Founded: 1981
Employees: 700
Wireless Made Easy

AGENDA:
• Background Basics
• Signal Basics
• Technology
• Security Issues
• Applications
Wireless Technology enabled by IEEE

- Wireless has become a standard in everyday life, thanks to IEEE
  - Commercially, for convenience
  - Industrially, to solve problems
- Developments in industrial wireless are accelerating very rapidly
  - New technologies are in development
  - Standards are being created specifically for industry
Benefits of Wireless

- Lower installation costs (than wired solutions)
  - Labor savings
  - Permits and delays
  - Material cost
- Faster installation vs. traditional cabling
- More application flexibility
- Enable mobile computing
- Extend Ethernet beyond the reach of cables
Wireless IP Solutions: Utilities

Energy Management Systems, Advanced Metering and more

- Metering and Monitoring (commercial & industrial customers)
- SCADA for Transmission and Distribution Applications

• **End Users**
  - Electric, gas, water, sewage, rail

• **Benefits Realized**
  - Reduced outages
  - Improved asset management and predictive maintenance
  - Improved customer service
  - Increased employee safety
  - Increased profit margins
Utility T&D Wireless Radio SCADA

HIGH VOLTAGE
GENERATION

HIGH VOLTAGE
SUBSTATION

DISTRIBUTION
SUBSTATION

POWER DISTRIBUTION
CONTROL CENTER

INDUSTRIAL
AREAS

RESIDENTIAL
AREAS

INDUSTRIAL
AREAS

RESIDENTIAL
AREAS

REMOTE RADIO AND RTU
- Monitors and controls the electrical network

MASTER REPEATER STATION
- Extends radio system to outlying areas

POLING REMOTE STATION
- Collects data for usage at the control center

POLE OR PAD MOUNT DISTRIBUTION SWITCH
- Used for isolation or connection of power distribution circuits
Solving Utility Needs with Wireless Technologies
Technology By Application

- Enterprise
- SCADA
- Plant
- Remote Sensor
- Instrumentation
- Programming
Choosing Wireless Technology

- The decision is made much easier by outlining the requirements for a product and technology.

- **RF Requirements**
  - Network Topology
  - Device Connectivity
  - Network Size

There is no one-size-fits-all for wireless!!
There are several key factors in determining a technology’s performance:

- Distance
- Data rate/volume
- Interference

All 3 are interdependent.

Users must find the correct balance.
Transmission range is affected by:

- Operating frequency: as frequency increases, range decreases
- Over-the-air speed: as speed increases, range decreases
- Interference: as interference increases, range decreases
- RF Power: Higher power goes farther, may be limited by technology or government
Site Planning

- Software path study will model paths and identify obstructions
- Field test will validate software data
- Antenna Selection
  - Omni:
    - Use when multiple sites have to connect
    - Typically used on master location
    - As gain increases, “donut” flattens
  - Directional/Yagi:
    - Use when sending/receiving to a specific location
    - Typically used on remote site
    - As gain increases, “beam” becomes narrower
    - Can be used to reduce effects of interference
Choosing Wireless Technology

- The decision is made much easier by outlining the requirements for a product and technology

- RF Requirements
- Network Topology
- Device Connectivity
- Network Size
Network Topologies

- **Point-to-Point**
  - Information is exchanged between 2 points

- **Star / Point-to-Multipoint**
  - A central station communicates with multiple remote devices

- **Repeaters**
  - Repeaters receive a weak or low-level signal, then retransmit the weak or low-level signal at a higher level so that the signal can cover longer distances or avoid obstacles
Network Topologies

- **Mesh networking**
  - Data is routed between multiple nodes. Allows self-healing reconfiguration around broken or blocked paths by “hopping” from node to node

- **Trunk Networking**
  - Use break-off connection points to leverage existing infrastructures, and add bandwidth capabilities
Network Topologies

- It may not be initially possible to determine a specific architecture is needed—it may be defined by the chosen technology
  - Should consider things that can’t be implemented, i.e. no repeater location sites are available
Choosing Wireless Technology

- The decision is made much easier by outlining the requirements for a product and technology.

- RF Requirements
  - Network Topology
  - Device Connectivity
  - Network Size
Device Connectivity

- What type of data?
  - Ethernet
  - Serial
  - I/O

- How much data?
  - Megabytes or kilobytes
  - Bytes or bits

- Use case
  - Convenience
  - Monitoring
  - Control
wireless remote I/O

master

RTU

Ethernet

analog I/O

digital I/O

pulse I/O

PHENIX
CONTACT
INSPIRING INNOVATIONS
wireless device server

class master

class RTU

Ethernet

RS232/485
wireless Ethernet

master

RTU
Device Connectivity

- Enterprise
- SCADA
- Plant
- Remote I/O
- Instrumentation
- Programming
## Industrial Wireless Usage

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<th>Remote I/O</th>
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Security Issues
Reducing Accessibility

Security Issues

- Transmit Technologies
- Encrypt/Authenticate
- Installation Practices
Transmission Technologies

Frequency Hopping Spread Spectrum
- Military Technology Declassified in 1980’s
  - Low probability of intercept
  - Anti-jamming techniques with frequency agility
Encrypt and authenticate
Encryption puts a ‘secret code’ around messages and network

authentication
1. listen
2. synchronize
3. follow hop sequence
4. send join request
5. receive join acknowledge
PASSWORD ESSENTIAL

128-bit AES
Installation Practices Secure Network

- Use best antenna – get coverage, but not too much
  - Keep radio signal narrow with directional antennas
  - Use minimal gain on omni antennas
  - Turn down transmit power to minimum acceptable level
Solving Utility Ethernet Networking application issues

Ethernet infrastructure – optimizing performance with the right fit

Ethernet over wireless - WLAN

- Open wireless Ethernet standard WiFi (802.11)
- Interoperable, multi-vendor support
- Distance limited to hundreds or thousands of feet
- High bandwidth, high speed applications

Examples:

- Video surveillance
- Mobile worker (using iPads, etc on site)
- General extension of wired Ethernet networks
- Extension of DNP3.0 and Ethernet/IP networks

Industrially rated WLAN radios and accessories
Solving Utility Ethernet Networking application issues

**Ethernet infrastructure – optimizing performance with the right fit**

**Ethernet over wireless - Bluetooth**

- Ethernet over open Bluetooth 2.1 (802.15)
- Interoperable, multi-vendor support
- 32mW (15dBm) transmit power
  - Several hundred feet maximum
  - DNP3.0 and Modbus compatible
  - Reliably replace wired applications for local programming and diagnostics
  - Eliminate slip-ring connections
- Coexistence with WLANs, blacklisting, etc.

*Example: mobile worker needs to be able to perform remote site Diagnostics at substation without entering property or utilizing Ethernet cable. Results in reduced risk and safer work environment.*
Solving Utility Ethernet Networking application issues

Ethernet infrastructure – optimizing performance with the right fit

Ethernet over wireless – 900MHz Trusted Wireless

- Proprietary Manufacturer Specific Product
- 30dBm (1 Watt) of transmission power
- Optimized for SCADA
  - Several miles transmission distance
  - Modbus/TCP (polling)
  - Ethernet/IP (Explicit messaging only)
  - DNP3.0
- Slower than WiFi, but perfect for SCADA (<500kbps)

Example: SCADA networking (Utility Recloser Monitor)
Solving Utility Ethernet Networking application issues

Ethernet infrastructure – optimizing performance with the right fit

Ethernet over cellular wireless – GSM, CDMA
- World-wide range...just need a cellular signal
- GSM (AT&T), CDMA (Verizon) capable
- Security with VPN, Firewall functionality
- Lower capital cost than traditional radio systems
- Enables traditional, as well as cloud-based architectures
- Incurs monthly data plan charge from cellular provider

Example: Connecting remote assets to SCADA, where the high capital costs associated with traditional radios systems (building tower, etc) is not desirable.
Application Challenge: Ethernet Networking application issues

Ethernet infrastructure – Appropriate technologies for unique application needs

Monitoring a distant substation or RTU – 5 miles away

Challenges:
- Distance is too far for copper (Cat 5/6 cable)
- Currently no fiber run to this site (in this example)
- Currently no wired internet access (in this example)
- Mature 30’ pine trees block line-of-sight to a municipality-owned water tower which is 3 miles away, and can be seen from the Control Center.

Additional information:
- RTU with Ethernet interface is at substation
- The utility has an existing SCADA that they would like to tie this site into.
- The utility doesn’t own any FCC licenses, none are available per search

Remote monitoring of a distant RTU station
Solving Utility Ethernet Networking application issues

Ethernet infrastructure – Appropriate technologies for unique application needs

Monitoring a distant substation – 5 miles away

Option 1 – Proprietary 900MHz Wireless Ethernet Radios

- Qty 3 needed
  - One in the substation panel, with RTU plugged into it
    - Directional antenna
  - One at the water tower, acting as a repeater
    - Omnidirectional antenna
  - One at the Operations Center, plugged into the SCADA’s Ethernet network
    - Directional antenna
- Tower to be built at substation to get antenna above treeline, enabling line-of-sight from this antenna to the water tower’s omni antenna.
- Ethernet/IP (Explicit messaging), Profinet, Modbus/TCP (polling) all possible.
Solving Utility Ethernet Networking application issues

Ethernet infrastructure – Appropriate technologies for unique application needs

Monitoring a distant sub-station RTU – 5 miles away

Option 2 – Cellular Router / VPN

- Qty 1 needed
  - One in the RTU Rack/Cabinet panel, with RTU or IED plugged into it
- Cellular antenna
- VPN tunnel formed with existing networking gear or hardwired version of mGuard in WWTP
- No tower necessary as long as there is a cellular signal at the lift station (AT&T, Verizon, Sprint, T-Mobile).
- Monthly charge incurred for cellular data plan.
- Ethernet/IP (Explicit messaging), DNP3.0, Modbus/TCP (polling) all possible.
Solving Utility Automation applications with quality components, systems and solutions

Excellent products

Innovative systems

Inspiring industry solutions
Wireless Accessories

- RTU Cabinet
  - NEMA 4X Enclosure
  - Power supply and UPS
  - Surge protection
  - Empty DIN rail for any radio

- Antennas, Cables, and Adapters
  - Use the
    - Antenna Selector Guide Web
    - Wireless Selector Guide brochure

- Remember: A system is only as strong as its weakest link.
There are several key factors in determining a technology’s performance:
- Distance/Obstructions
- Data rate/volume
- Interference/RF noise

All 3 are interdependent.

Users must find the correct balance.
Choosing/Using Wireless Technology

- The decision is made much easier by outlining the requirements for a product and technology
  - RF Requirements
    - Network Topology
    - Device Connectivity
    - Network Size

There is no one-size-fits-all for wireless!!
Any Questions?

www.phoenixcontact.com/wireless

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Thank you!
Phoenix Contact Wireless