Wireless Instrumentation
FOR INDUSTRIAL SENSORS

# *Wireless Sensors*

# *For*

# *Industrial Applications*

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# *Outline*

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Why Wireless Sensors?

Wireless Background

What is Wireless?

Characteristics of Successful Wireless Sensors

Evaluating Current Wireless Solutions

Applications Field Experiences

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# *Why Wireless Sensors?*


- Cut instrumentation installed costs 90%
- Gain measurement flexibility and rapid installation
- Access measurement points as easily as installing a gauge
- Now, you can actually make the measurements you really need !

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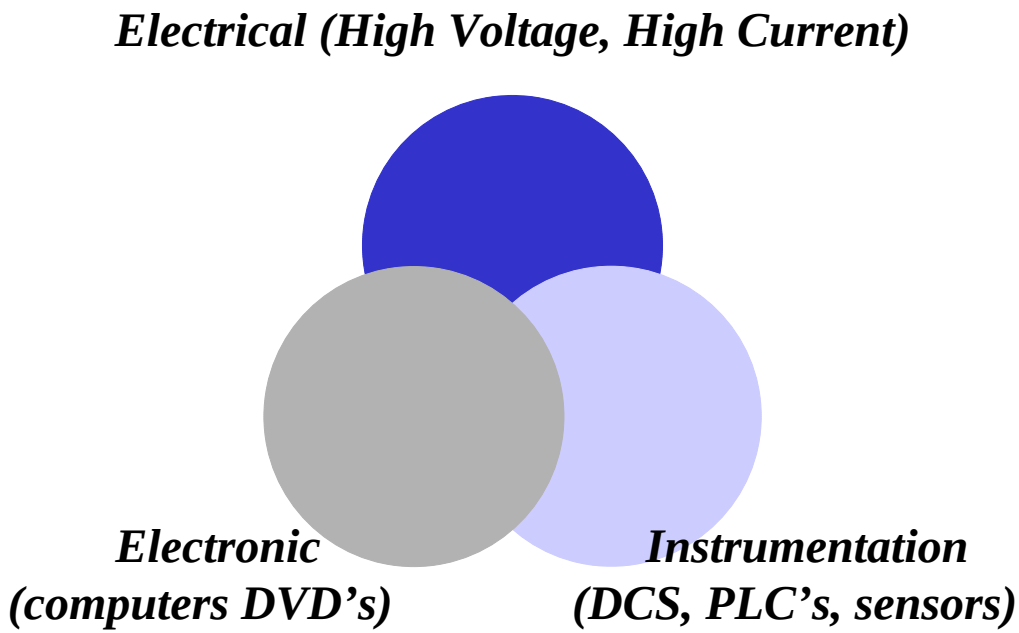
# *What is Wireless?*

- Wireless is an adjective
- Industrial Wireless sensors are in an early adoption phase.
- Wireless sensors have striking similarities to the early uses of electricity.

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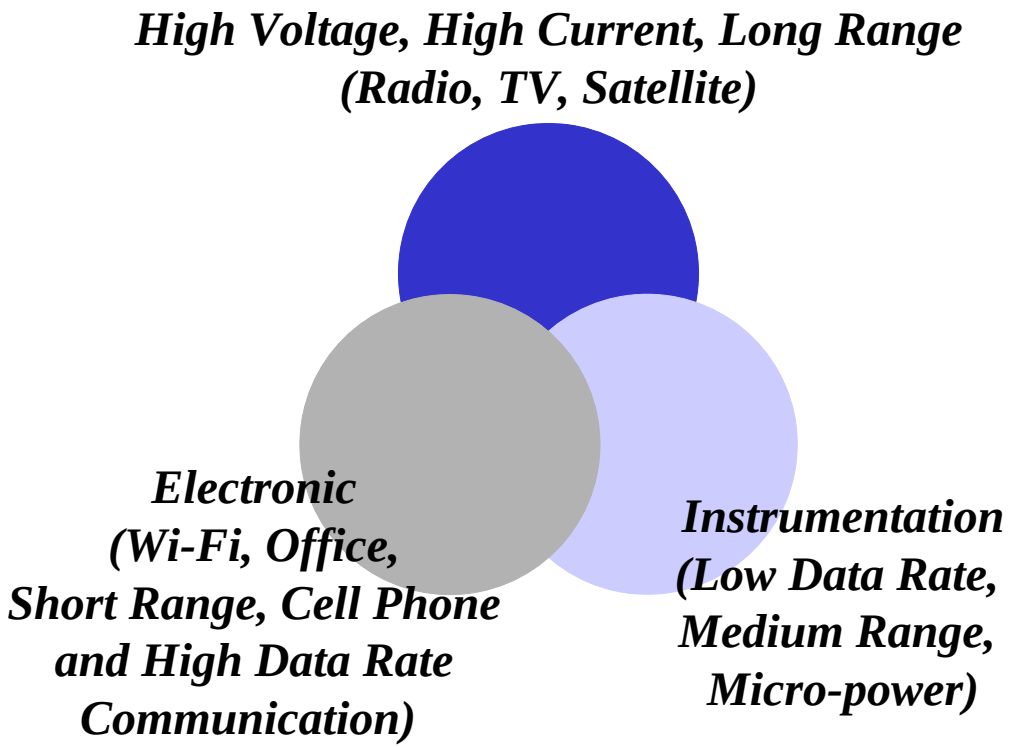
# *What is Wireless?*

- Look at Wireless Sensors compared to other wireless technology applications.



# *Wireless Background*

- Wireless Communications is simply a radio signal
- Radio transmitter is a simple device
- Electrons moving in metallic materials jump electron orbits and when they do they give off a electro-magnetic wave
- An alternating current gives off a sinusoidal electro-magnetic wave

# *Wireless Background*

- Superimposing a voice frequency onto a “base carrier” frequency made radio communication ready for commercialization in the 1920’s
- But it did nothing to stop radio interference
- This was done by regulation
- Regulations effectively froze technology advancement in commercial radio frequencies <300MHz
- All radio technology in the past 85 years has focused on high frequency communication >300MHz

# *Wireless Background*

- So you can see why it is so easy to disrupt a commercial radio signal. There has been no technology advancement in almost 100 years
- All commercial radio operators rely on the government to restrict the interference

# *RF Communications in the Fresnel Zone*

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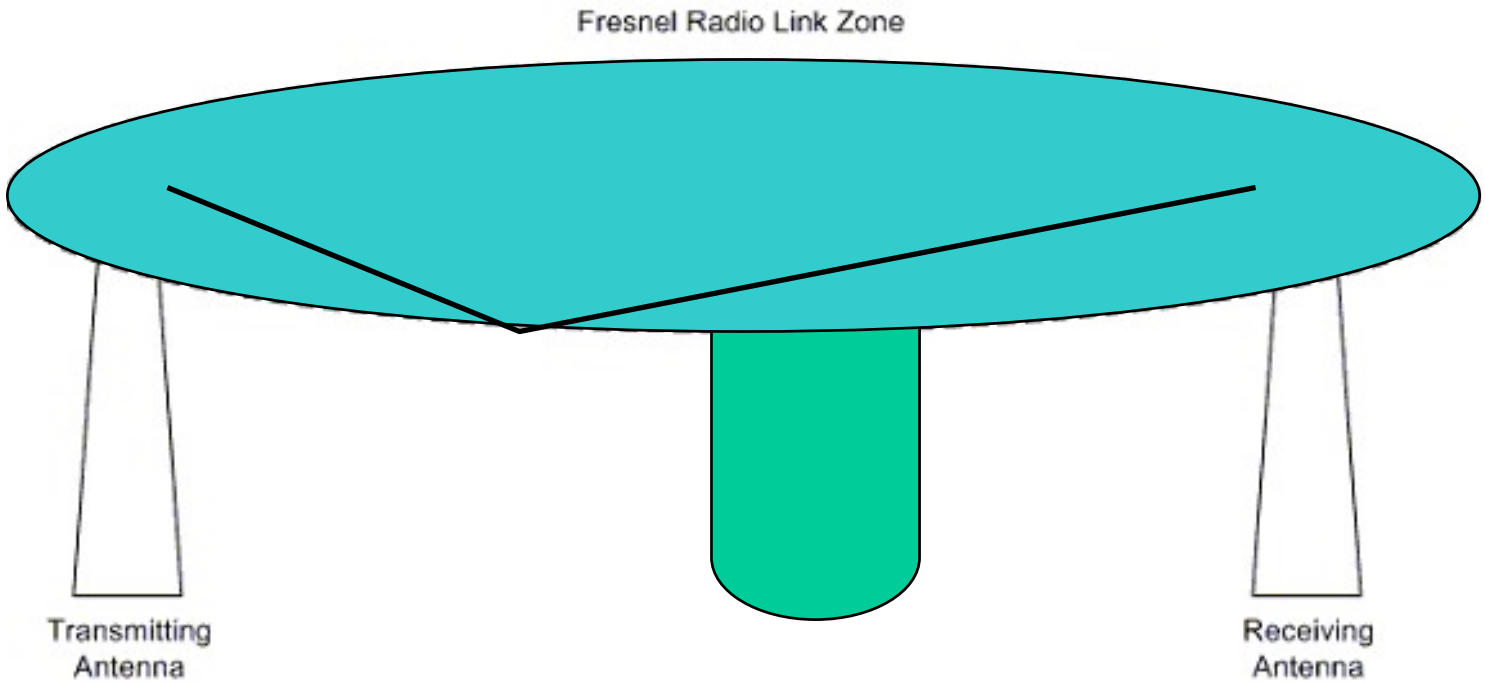
- Optimal low-power RF communications are achieved with obstruction-free Fresnel Zone

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# *Characteristics of Industrial Wireless Sensors*

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No wires, at all, in the field

Rated for Class I, Div I Areas

Medium range (100 ft to 1 mile)

Long-life on batteries or power source (5 year)

Moderate to fast update rates ≈ 1/second

Low data rates: Less than 3,000 bits per second is sufficient for virtually any sensor

Not affected by electrical noise

Secure

Communicate through obstructions

Scalable Network

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# *Why Wireless Sensors?*

- US Department of Energy, December 2002

  "Industrial Wireless Technology for the 21st Century" Study, page 1
- "Wireless sensors could improve industrial production efficiency by 10% and reduce emissions by more than 25%"

# *How to Make Industrial Wireless Work*

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- Use Low Power
- Digital Communications Format
- Add Frequency Filters
- Use Multiple Frequencies
- Add Identification and Security Codes
- Add Message Check-Sums
- Make all radio nodes transceivers

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# *Non-Industrial Wireless Protocols*

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| Characteristic | 802.11 Family | Bluetooth | Zigbee | Industrial Wireless |
|---|---|---|---|---|
| Data Speed | > 50,000,000 bps | 720,000 bps | ≈ 100,000 bps | 3,000 bps/node |
| Range | ≈ 100 ft | ≈ 30 ft | ≈ 300 ft | 1,000 ft typical |
| Battery Life | ≈ 2 hours | ≈ 3 days | ≈ 6 months | ≈ 5 years |
| Deterministic Data Timing | No | No | No | Yes |
| Redundant Data Path | No | No | No | Yes |
| Acknowledgement Support | No | No | No | Yes |
| Class I, Division 1 | Difficult | Difficult | Possible | Necessary |

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# *Successful Industrial Wireless Instrumentation Installations*

- Successful industrial wireless requires a protocol designed for the environment
- Use of non-industrial technology leads industrial users to conclude that "Wireless will not work in this plant"
- All familiar protocols are not industrial
- Understanding of the RF environment is part of successful application

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# *Industrial Wireless Sensors*

Application Case Summaries

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# *Safety Shower Monitoring*

- Safety policy requires alarm indication when safety showers are activated
- A single Multi-input field unit detects eyewash and/or deluge activation through proximity switch closure
- Total cost to instrument multiple safety showers is less than half of alternative hard-wired systems

# *Relief and Shut-off Valve Monitoring*

- Major European Refinery:  3 year experience
  - 19 Relief and Shut-off valves
  - saved 11,000,000 pounds of process gas per year using Acoustic Monitors

  $1,500,000 per year benefit
- Estimated wireless leak detector investment $38,000
- Additional benefits
  - Reduced emissions
  - Lower maintenance cost
  - Longer inspection intervals

# *Steam Trap Monitoring at Remote Metering Stations*

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- Major Metro Utility
- Automated remote metering
- Safety mandated monthly steam trap inspections
- Wireless acoustic monitors detect OK, blowing, cold
- Base radio provides status to flow computer
- Technician visits now limited to repair only - $5million per year savings

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# *Steam Trap Monitoring - General*
# *Typical ROI less than 1 year*

- Example of Energy Saving ROI
  - Average cost of steam $8 per 1000 pounds
  - Traps surveyed every 12 months
  - Average orifice 0.125”
  - Average pressure 250 psig
  - Malfunction rate 15%
- **ROI - 0.7 years**

# *Equipment Monitoring*
# *Confined Space Environment*

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- Large utility tunnel with both steam and gas transmission piping
- Existing RTU for gas metering
- Confined space presents safety hazards for inspections
- Steam trap monitors installed with base radio output to RTU
- Similar application for fuel pipe tunnel to oil fired power plant
- 400’ tunnel under major roadway

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# *Rotating Equipment*

- **Large scale rotating drum dewatering process**
- **High temperature thermocouple**
- **Analog output**

**Precision tumble dryer**

- **Temperature control is critical to product quality**
- **High accuracy wireless RTD measures actual dryer temp**
- **Improved yield of high value product**

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# *Tank Level Alarm Monitoring East Coast Refinery*

- Tank farm adjacent to refinery experiencing overfilling events
- Cost to install and wire high level alarms >$500,000
- Mechanical level switch with Multi-signal field units installed cost <$50,000
- Installation time < 1 hour per tank

# *Tank Level Monitoring – General*

Integrated Sensors

- Gauge Pressure
- Differential Pressure
- Submersible
- Resistance Tape

Local Powered Instruments

- Ultrasound
- Radar
- Laser

# *Pressure relief valve monitoring*
# *West coast refinery*

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- Air Quality Board rule 1173 mandates PRV monitoring
- Approved options:
  - Pipe to closed collection system
  - 3X daily sniffer inspections
  - Continuous electronic monitoring
- Wireless acoustic monitors cost less than 5% of piping option
- Less than 10% of alternative hard wired monitoring equipment

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# *Pressure Relief Valve Monitoring Gas Pipeline*

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- Compressor station partially supervised
- Need to know if PRV opens and duration of event
- High level of flow induced vibration
- Use Wireless pressure sensor switch on valve outlet


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# *Pressure Relief Valve Monitoring*
# *Gulf Coast Petrochemical Plant*

- 2500 PRV
- Estimated loss through leakage 5 million pounds per year of high value products
- 5 year valve inspection interval
- 10% of inspected valves leak significantly
- Up to 30% have some leakage
- $millions per year savings for one time investment of $150,000 using acoustics

# *Valve Position Verification*

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- Customer required positive verification of on/off valve position in hazardous chemical service
- Rotary switch assembly provides multi-input unit with contact closure
- 70 valves were instrumented to provide remote verification for less than $50,000
- Installation time less than 1 hour per valve


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# *Flare Monitoring*

- Flares:  A know source of emissions and product losses.  In refinery operations, flare losses are documented to account for one-half of total known product losses.  Loss of product is big $$.
- Continuous monitoring of relief valves for leaks and releases can identify and quantify flare sources.
- Temperature monitoring can also be accomplished without the costs associated with field wiring.

# *Portable Diagnostic Measurements*

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- Gas pipeline service company monitors DP, Pressure and Temperature to provide performance optimization recommendations
- Setup of traditional transmitters takes up to a week – data collection is done over two days
- Wireless instrument set up is about 4 hours

- Pump service company measures temperature, inlet, outlet and seal pressure to diagnose high maintenance pumps.
- Wireless instruments enable set up in hazardous area

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# *General Pressure Temperature and Flow Monitoring in Process Piping*

- Add high accuracy remote transmitters as easily as installing a local indicating gauge or thermometer

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# *Conclusion*

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# *Thank you!*

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