Passive Wireless Sensor Technology Workshop

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Purpose: To bring Passive Wireless Sensor (PWS) technology developers, manufacturers and potential industry end-users together to understand the larger market drivers that will drive costs down and applications up. We will concentrate on Aerospace applications at this workshop, so capability that helps the aerospace manufacturing, mission and maintenance will be a priority.

Objectives:
1. Understand various PWST technologies, actual & potential uses, and maturity.
2. Share future applications/advantages/limitations PWST in various industries and agencies.
3. Precipitate individual & group “next step” thinking to further develop/apply PWST.

Previous (2011, 12, 13, May ’15) PWST Workshop Presentations & Summary (ISA Comm Div website):
Technology and Applications Addendum

The workshop will explore the current state of technology of passive wireless sensors tags (PWST) and their practical applications. As a quick background, a PWST has no battery, no expensive electronics at the sensor site and (of course) no need for a wired connection between the sensor and the data acquisition system. Passive Wireless Sensors could be useful at short or long range, mobile platforms or fixed, simply printed for shirt-sleeve environment or sophisticated for high performance and extreme environments. Surface Acoustic Wave(SAW)-based sensors, in a manner somewhat similar to a classic passive RFID tag, responds to a wireless interrogation signal from a reader, but unlike RFID it provides real-time sensor data along with its unique tag id, stored information and range. As time goes on, more interrogation methods are being discovered while the others are being matured. PWSTs should aspire to be manufactured in high volume – even incorporating direct write fabrication - resulting in an inexpensive devices. With its considerable potential read-range (separation distance between reader and device), compatibility with extreme environments, small size, autonomy of sensor installation, and “no onboard power” capabilities, PWSs have a wider application arena than traditional wireless sensors. Enabling technologies such as new manufacturing, materials, antennas and interrogators are encouraged to be brought forward. The workshop will explore these and other motivations for using PWSTs in a variety of fields, present and demonstrate current technologies, explore current and future applications of PWSTs in various industries (commercial buildings, industrial settings, transportation, aerospace, etc.). A key component of this two-day PWST Workshop is to facilitate discussions between end users and developers/suppliers on application areas of mutual interest.

Applications for Aerospace:

- Otherwise Impractical Measurements:
  - Rotating Parts – blades + mechanisms, hot turbines
  - Difficult Access: vehicle zones, avionics, tanks/reservoirs, chambers, balloon, parachutes
  - Remote interrogation – off-board (grnd-vehicle) and on-board (exterior/interior sensing)
  - Interrogation through structures and liquids – avoid penetrations, wiring
  - Extreme environments – hot turbines, re-entry protection, cold high altitude/space/winter conditions, vacuum, high radiation, shock/vibration/pressure

- Capability and Performance:
  - Light weight/small size – vehicle payload capacity, efficiency, system monitoring
  - Multi-path RF, other interferences/configuration dependencies, safety, directional sensing
  - Low integration cost/schedule: deferred instrumentation decisions, integrated vehicle test changes, flt/ground test temporary Instr, aging vehicle ops, condition-based monitoring
  - Convert Wired Sensors to Passive Wireless – chemical, biological, physical
  - Manufacturing/Asset data/location – embedded updatable tags, in-place direct-write tags,
  - RF compatibility with Spectrum authorized use and developing Standards
  - Use of Optical, XRay and other low/high frequencies, Magnetic field, Electrical Charge, Ultrasonic for free-space and conducted transmission

Applications for Other Industries and Government Agencies

- DOE – Buildings, Grid, Nuclear
- DOT – Roads, Bridges/tracks, Vehicles
- DOD – Vehicles, Weapons, Soldiers, Logistics, Environments, many others
- DHS – Discrete Sensing & Locating
- USDA - Forest Service, Agriculture, Food
• DNR – Wildlife, Soils, Agriculture, Water, etc
• DoC - NOAA – Weather, Quakes, Fires, etc
• DHHS – Health and Medical

**Passive Surface Acoustic Wave (SAW) and Bulk Acoustic Wave (BAW) Wireless Sensors and Systems**

**Technologies**
• Surface Acoustic Waves and Bulk Acoustic Wave based
• Sensor Performance: data rates, range, multi-sensors, reduced configuration dependencies
• Manufacturing: cost, quality, reliability, configurability, techniques (e.g. 3D) sensor & antenna
• Interrogators: cost, size, weight, interrogation rates/number of sensors, antennas, ruggedness
• Maturity/Availability: proven applications, COTS availability, technology readiness level

**Other Passive Wireless Communication/Sensing**
• RLC-based
• RFID-based
• NFC-based
• 60 GHz - based
• RF Antenna-based or Antenna only
• Physical & Optical Phenomenon – based (Ultrasound, Magnetic Field, etc)
• Other