"Development of Wireless Sensor Technology for Machine Monitoring"

Dr. Mark F. Bocko
Oceana Sensor Technologies
Virginia Beach, VA
Presentation Outline

• Machine monitoring applications of wireless intelligent sensors
• Wireless intelligent sensor architecture
• Role of IEEE1451 in OST developments
• Summary
Proposed Approach

The equipment tells the people when it will need attention -

• Intelligent platforms built from
• Intelligent systems built from
• Intelligent components

……. in an open architecture
Types of sensing in machine monitoring

- Vibration
- Force
- Pressure
- Temperature
- Electrostatic, magnetic (particulates)
- IR spectroscopy (fluid condition)
- .....
Typical Industrial Instrumentation Costs

Wiring Installation

Sensor

Cables

Wiring installation costs (including documentation) is limiting installation of needed sensors

M. Bocko - Oceana Sensor Technologies - 6/4/01
Machine Health Monitoring Application

Platform
Platform Health Monitoring

SHM
System Health Monitor

ICHM™
Intelligent Component Health Monitors

ICHM™ 1
Bearing Health Monitor

ICHM™ 2
Exhaust Debris Monitor

RF Wireless Link

User Interface

Information Network (Internet)

• CPU & Controllers
• Information Network Interface
• Information Archive, Prognostics

ICHM™ “N”
Oil Condition Monitor

M. Bocko - Oceana Sensor Technologies - 6/4/01
The layers of an...

“Intelligent Component Health Monitor”

- Communications
- System Control
- Diagnostic Processing
- Signal Processing
- Signal Conditioning
- Power Interface/Generation
- Sensing Elements
- Actuator (self-calibration)
**Wireless Intelligent Sensor Architecture**

- **STIM**
  - Sensor TEDS
  - ADC ASIC
  - Signal Cond.
  - A/D
  - Serial Interface

- **NCAP**
  - MCU
    - DSP
    - App.
    - HS
    - Memory
    - IEEE 1451.2
    - TEDS
  - Bluetooth Radio

**Present (2” x 3”)**
- 6 sensors, DSP, Bluetooth

**Target (2 chips)**

*M. Bocko - Oceana Sensor Technologies - 6/4/01*
Bluetooth Wireless

- Bluetooth may become de facto standard
- Digital spread spectrum, encrypted data
- Flexible ad hoc networking
- Up to 760 kbit/s
- 1 mW -10 m ; 100 mW - 100m, ISM band
- Will be single chip (CMOS) soon

M. Bocko - Oceana Sensor Technologies - 6/4/01
Bluetooth Networking

scatternet

ENTRY TO WIRED NETWORK

piconet

M. Bocko - Oceana Sensor Technologies - 6/4/01
Wireless Issues in Industrial Automation

• Over-the-air Interoperability
• Synchronization
• Latency
• Physical, Electro-Magnetic Environment
• Security

OST chairs a Bluetooth SIG Working Group to address these issues.
Typical Sensor Integration Costs

Sensor integration costs (including documentation) is limiting installation of needed sensors

M. Bocko - Oceana Sensor Technologies - 6/4/01
IEEE1451 in the OST development plan

Network Capable Application Processor

IEEE1451.2

IEEE1451.1

Network

Smart Transducer Interface Module

Network Driver

Transducer Driver

Smart Transducer Object Model

Logic

ADC

DSP

Sensor

Actuator

M. Bocko - Oceana Sensor Technologies - 6/4/01
IEEE-1451

Transducer Interface Standard

- **IEEE 1451.1**  
  - Defines the Transducer Object Model
- **IEEE 1451.2**  
  - Defines the interface for integration of specific smart sensors to microprocessors  
    - Physical interface  
    - TEDS  
    - Protocol
- **IEEE 1451.4**  
  - Defines an interface to bring TEDS functionality to legacy sensor systems
Demonstration

www.senseblue.com
Data carrying wires may be eliminated; can we remove power connections too?

- **Power grid is not always available**
- **Derive power from environment?**
  - Vibration
  - Magnetic induction (rotating machines)
  - Solar
  - Thermal Energy Scavenging (hot machines)
“Plug and Play” → “Play”

- **Key elements of strategy**
  - Wireless communication
  - Open interoperable standards
    - IEEE1451
    - Bluetooth wireless
  - Power scavenging