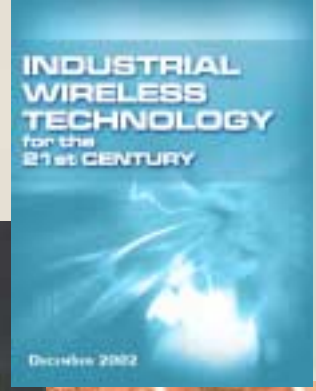
Sensors for Manufacturing Efficiency Workshop



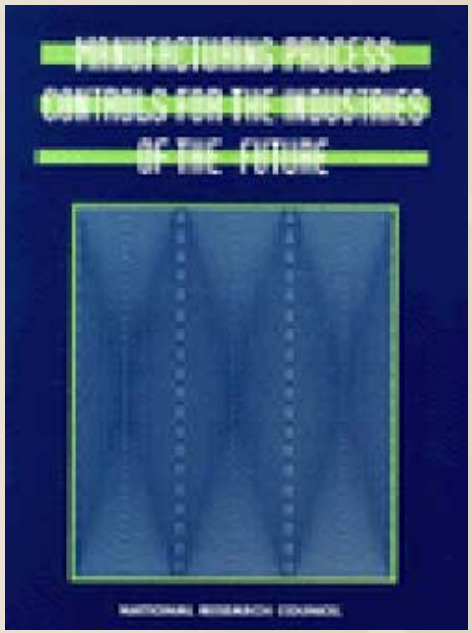
DOE Sensors & Automation 2005 Annual Portfolio Review

The Extreme Measurement Communications Center – EMC^2 What's In It For You?

Wayne W. Manges

Oak Ridge National Laboratory

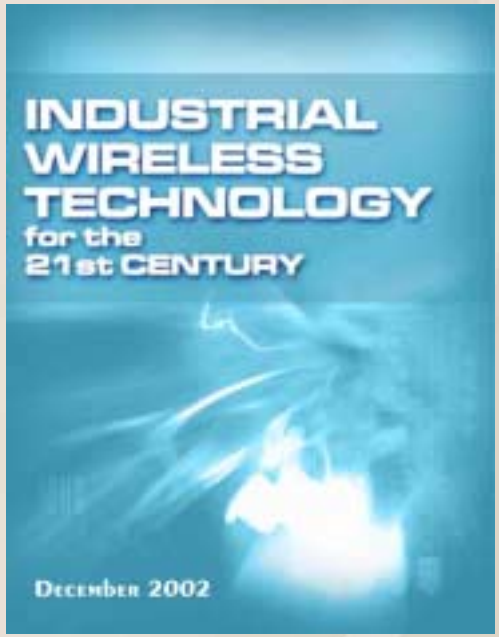
EMC² – Industrial Deployment is Key



- **National Academy of Sciences Identified Needs**
  - Interference rejection – Hybrid Spread Spectrum
  - Security – Not just encryption
  - Standards – IEEE 1451.5, ISA SP100
  - Reliability - Qualification, Awareness
- **Goal – Acceptance, market penetration**
- **Core Technology – Ubiquitous, wireless sensing**
- **Novel/Transformational Elements – Low cost, reliable, secure communications**
- **Initial Industry for Application – Electric motors**
- **Key Project Deliverables – Deployment in Three sites with DOE project partners**

EMC² – Strategy Focuses on Supporting Wireless Vision For Industrial Wireless

- **WINA –**
  - Self-sufficient – paying members, end users
  - Standards-based – de facto and de jure
  - Ubiquitous sensing business models – low cost, extensible
- **DOE Projects –**
  - Eaton - Refinery
  - Honeywell – chemicals processing
  - GE – material processing
- **Users' Expectations –**
  - Characterizations – RF, environmental
  - Simulation – playback of combinations
  - Qualification – standards and proprietary

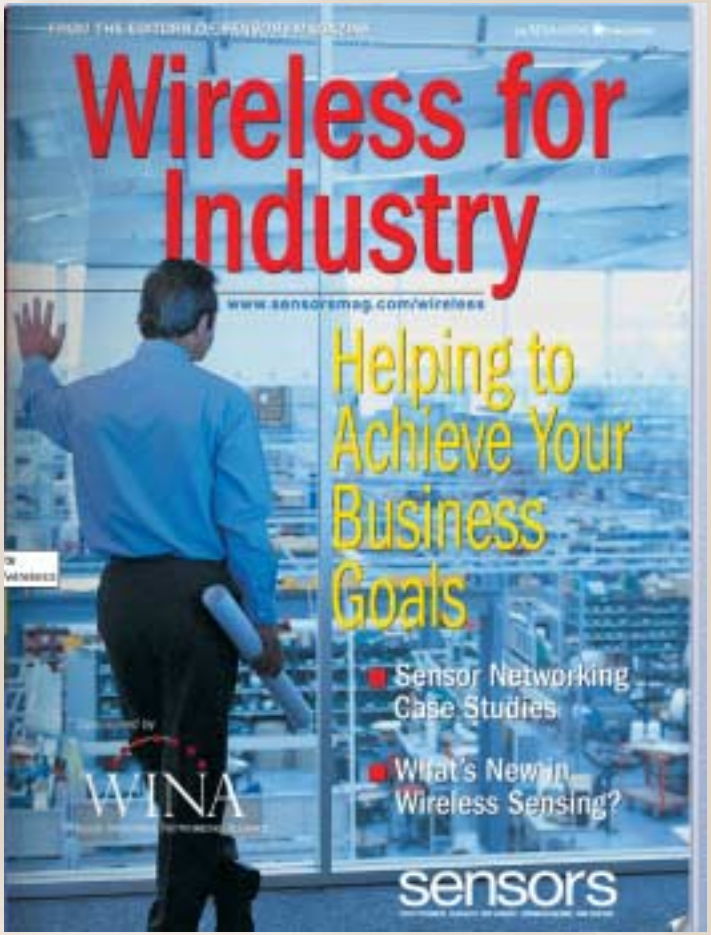


Exploiting Defense and Commercial Wireless For Industrial Applications

- **Reliability -**
  - Mesh – Billions of $ from DOD
  - Spread Spectrum – FHSS, DSSS, Ultra-Wideband
- **Power**
  - Harvesting – vibration, RF, PV
  - Low-power Designs – ASICs, FPGAs, DSP
  - Protocols – Low-duty cycle - ZigBee

- **Security**
  - Encryption – AES, WPA, WEP
  - Physical – RF layer, FIPS 140-2
  - Integrated – impacts on throughput, latency, reliability

Barriers and Pathways – Acceptance and Deployment



- Demonstrations – DOE Three Projects at refineries and other processing sites
- Publications/Presentations – EPRI and Comanche Peak, Sensors Magazine, ISA Show and Sensors Expo
- Standards – IEEE 1451.5 to be voted this year, ISA SP100 draft in early 2006
- Qualification – against standards, environments, interoperability, co-existence
- Simulations – vs "Can you hear me now?"

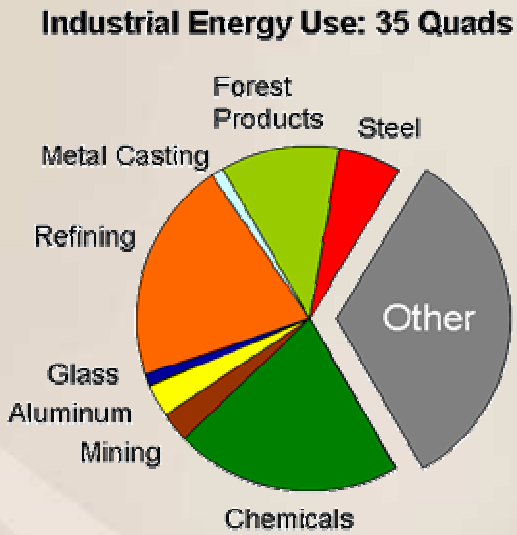
Strong Relationships with ISA & Sensors

OAK RIDGE NATIONAL LABORATORY
U. S. DEPARTMENT OF ENERGY

Energy Savings Projected By Presidential Advisors in 1997 → 10% of 35Q

- Improved Monitoring and Control through low cost, ubiquitous sensing – motors, compressors, processes, utilities, etc.
- Assumes Ubiquitous/Pervasive Market Penetration – Moore's Law?, cost of ownership – not just initial cost
- Current Energy Consumed in Industry = 35 Quads

Presidential Advisors also predicted 15% reduction in emissions with wireless sensors!



Important Metrics – Deployment vs Cost

- **Wiring - $20 per foot at low end, $200 per foot nominal, over $2000 per foot in nuclear power plant**
- **Current Wireless Systems - $1,000 per point per year in nuclear power plant**
- **True Moore's Law – lower cost + more capability every year with re-sale into same market**

For real impact – likely need about $200/pt/yr!

Accomplishments to Date - Partnerships

- **WINA - 19 dues-paying members - approaching self-sufficiency**
- **SP100 – 60 members, end-user co-chair**
- **Sensors Magazine – wireless supplements, website, and Sensors Expo sessions**
- **EMC² Facility/Capabilities - $0.75M instruments characterizing sites and components – paid services for non-ITP industries.**

Honeywell

Next Project Steps – Deployment Support

- **SP100 – First Draft in 2006**
- **WINA – book, paper, standards – late 2006**
- **Partners – characterization of environments, components, systems**
- **Simulations – improving likelihood of successful deployments – early 2006**

- **Standardized methodology to**
  - Assess environment – light to harsh, RF and other
  - Assess application – latency, throughput, etc.
  - Assess options – technologies, products, standards
  - Assess deployment – initial stability, ease
  - Assess performance – against requirements
  - Maintain – tools, costs, upgrades

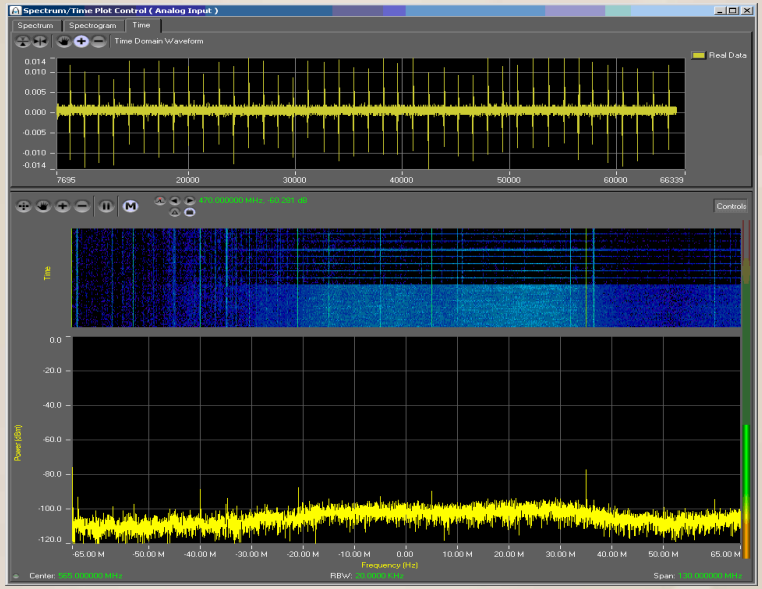
Future Milestones

- **WINA – self sufficiency – September 2005**
- **SP100 – First Draft – January 2006**
- **EMC^2 – simulation of complex co-existence environments – April 2006**
- **EMC^2 – Collaborative R&D Environment – September 2005**

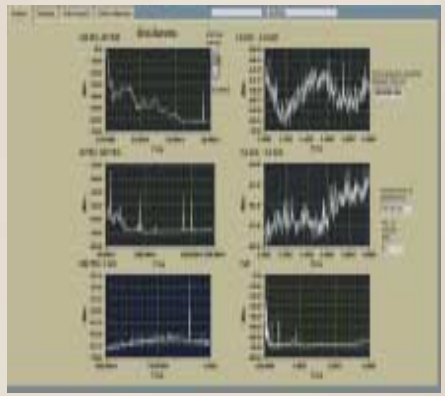
WINA and EMC^2 to become qualification center for ZigBee, Bluetooth, and IEEE 1451.5

Continuation after ITP-Sponsored Project

- EMC^2 – self-sufficiency for industrial wireless support
- WINA – funded R&D at ORNL through WINA
- Partnerships – continued university partnerships
- Technology – Hybrid Spread Spectrum, embedded intelligence, power efficient designs, and embedded security supports industrial deployment

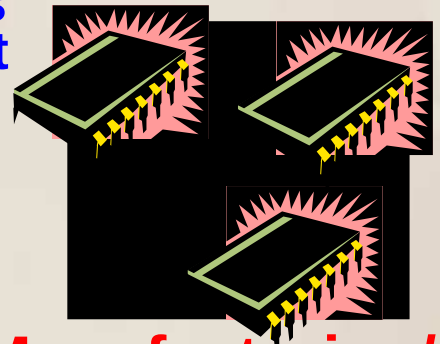


A Broadband Noise Source detected



Everybody Wins

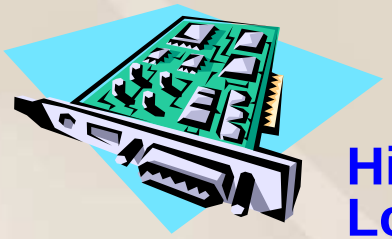
Wireless Intelligent Network



Consumer Market
High Quality
High Volume
Low Cost
Low Integrity

Government Labs
Academia
Industry

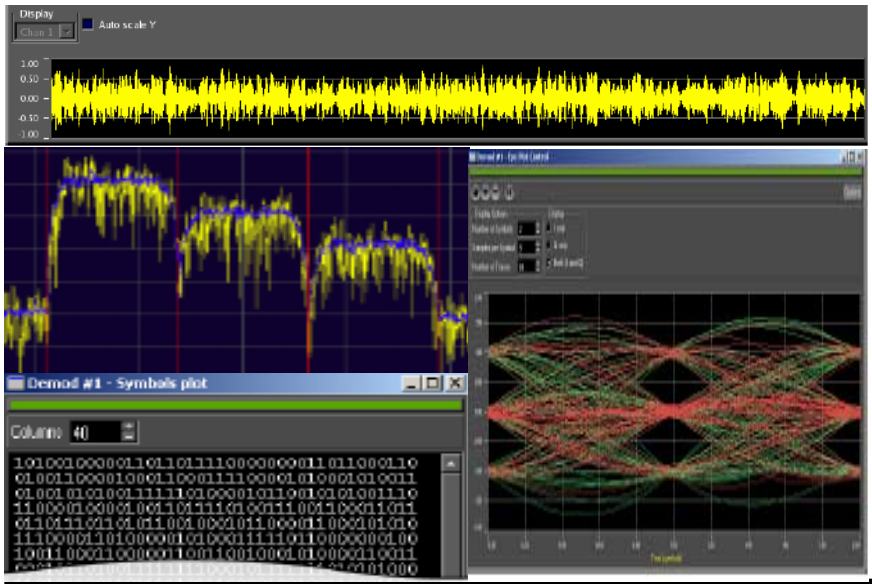
Manufacturing/ Industrial Markets
High Quality
Low Cost
High Volume
High Integrity



National Defense
High Cost
Low Volume
High Quality
High Integrity

Wireless Warrior

Extreme Measurement Communications Center (EMC²)



Operational Capability

The DoE EMC² provides modeling, simulation and characterization support for industrial wireless networks.

This facility is equipped with parallel computing resources as well as state-of-the-art measurement equipment for high performance wireless and wired network characterization from the physical layer to the application layer

Broadband RF record and playback instrument can simulate and generate characteristic waveforms to help in-lab study of the wireless device's behavior in harsh industrial environments

EMC² Program Benefits:

- EMC² formalizes the testing of industrial wireless networks to quantify the latency, throughput, security and fault-tolerance (Interference and Noise)
- Wireless Industrial Networking Alliance (WINA) has accepted EMC² as its product testing and characterizing center to member companies
- Currently supports exhaustive modeling and simulation of the communication infrastructure for future electric grid
- Help develop or improve existing standards in industrial wireless networks to include measurement, verification and reliability of network and device parameters
- The center is being developed both as a user facility and an on-site testing provider using portable test equipment

Milestones, Deliverables, & Contact:

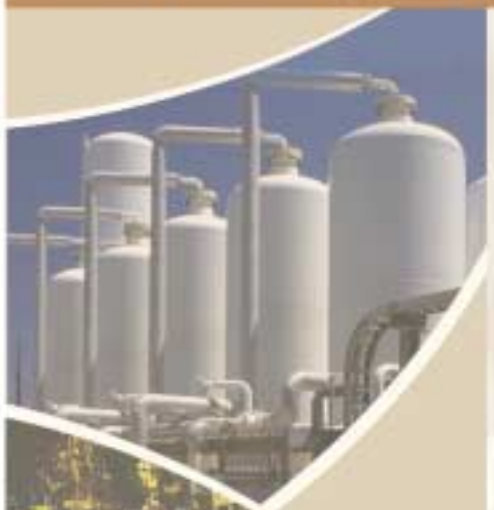
Key Milestones: Alliance with WINA and member companies for technology assessment and characterization; Provides modeling and simulation support for developing fault-tolerant electric-grid communication infrastructure

Deliverables: Standards-based report generation for different wireless devices and network layouts; Software development for characteristic network testing;

Contact Information:

Wayne Manges
mangesww@ornl.gov, 865-574-8529

Accelerating the adoption of wireless technologies in industry



WINA

WIRELESS INDUSTRIAL NETWORKING ALLIANCE

ISM frequencies

ZigBee™ 802.11 a/b/g

802.15.4

spread spectrum

UWB

1451.5

cyber-security

Bluetooth®

www.WINA.org

Board of Directors

- 3e Technologies International
- Eaton Corporation
- Ember Corporation
- Honeywell International
- Invensys
- Oak Ridge National Laboratory
- Omnex Controls
- RAE Systems
- ZigBee Alliance

Commercial/Technical Risks Remaining

- Technical – security, latency, reliability
- Commercial – acceptance, cost
- Political – assumptions of either too hard or too easy

Solving a multi-disciplinary problem!

- Wireless – radio, packaging, antenna
- Industrial – harsh environment, fault tolerant, safety related, cost
- Sensor – filters, sampling, sensitivity, interferers, controls
- Networks – real-time, latency, throughput, security, integrity, vertical integration