CBM – The Next Killer App for Industrial Wireless?

Wayne W. Manges

DOE/ITP Industrial Wireless Program Manager

Dr. Glenn Allgood

EPRI Advanced Condition Assessment

June 2, 2004

OAK RIDGE NATIONAL LABORATORY
U. S. DEPARTMENT OF ENERGY

UT-BATTELLE

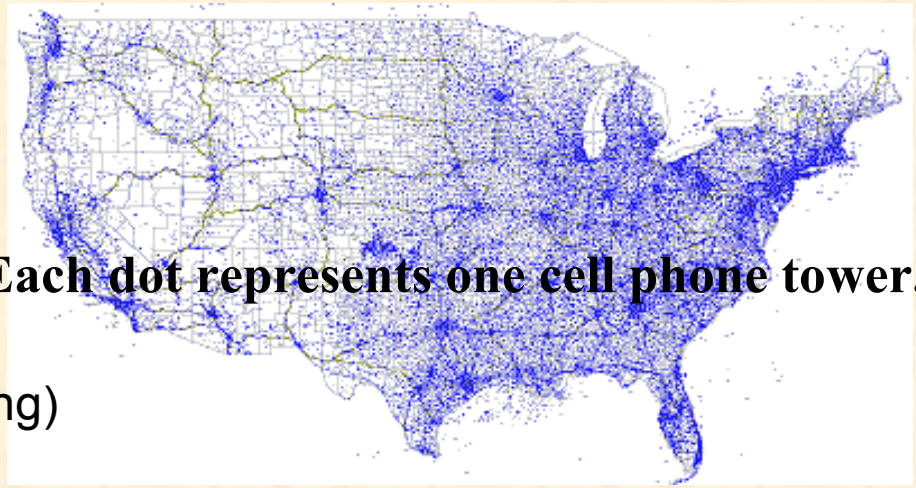
Why, Why, Why?

- Why are we here? – Vision, Unique needs
- Why Now? - Market forces, Technology Nexus
- Why Us – EPRI, DOE, NRC, Users, WINA

www.oldcolo.com

Wireless Sensor Networking

…it's not cellular telephony



Each dot represents one cell phone tower.

…it's not WiFi

...(and it just may be the next big thing)

Wireless devices circa 1930

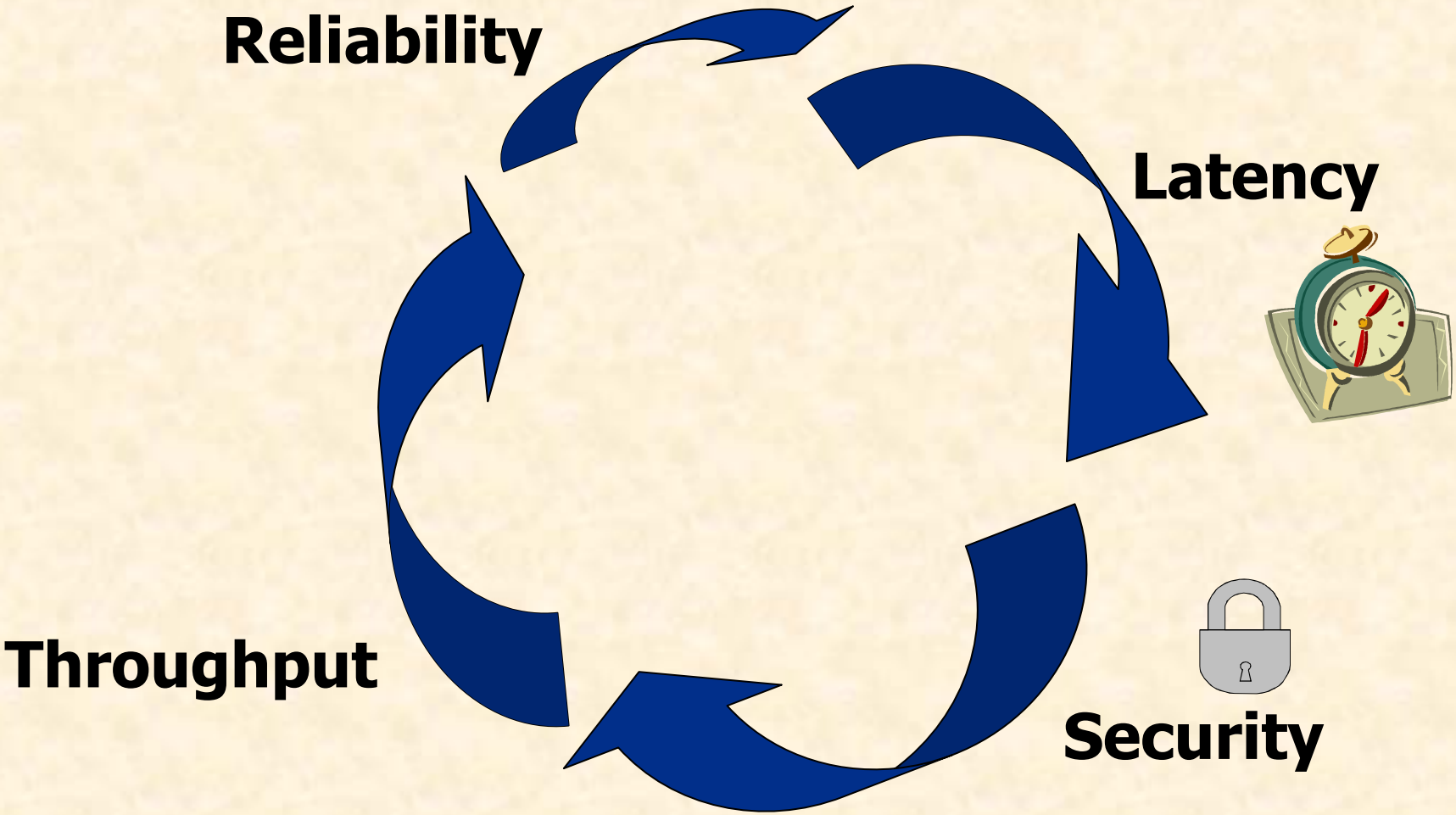
RF Tags – expected to be >$2.6B by 2005

Wireless CBM – Who Cares?

- EPRI/Users – Wire is at $2,000 per foot and increasing, New Agility, Mobility, Flexibility - scream for deployment!
- Suppliers – cheap hardware, ready market, broad impact potential – scream for deployment
- Government – Opportunity for impact on environment, conservation, global competitiveness and jobs!

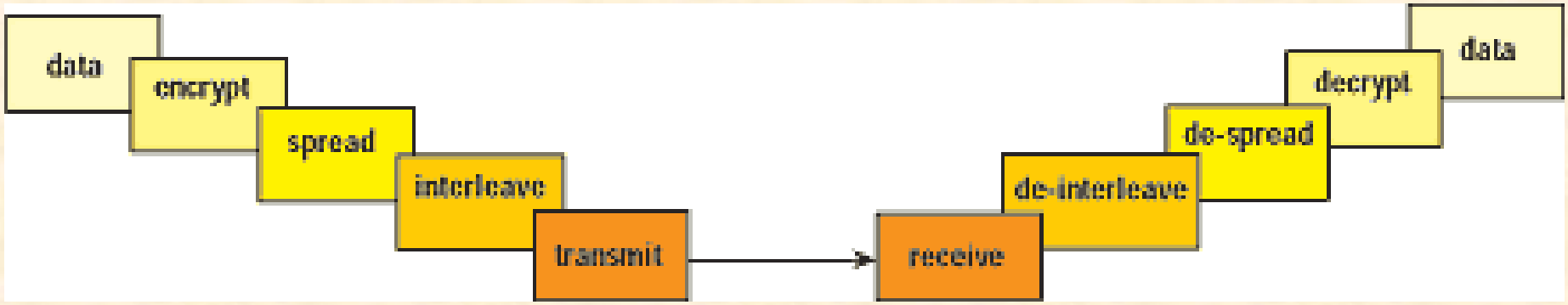
So, What's the Holdup??!

Deployment Demands Performance



Market Forces Determine Performance Balance and Cost!

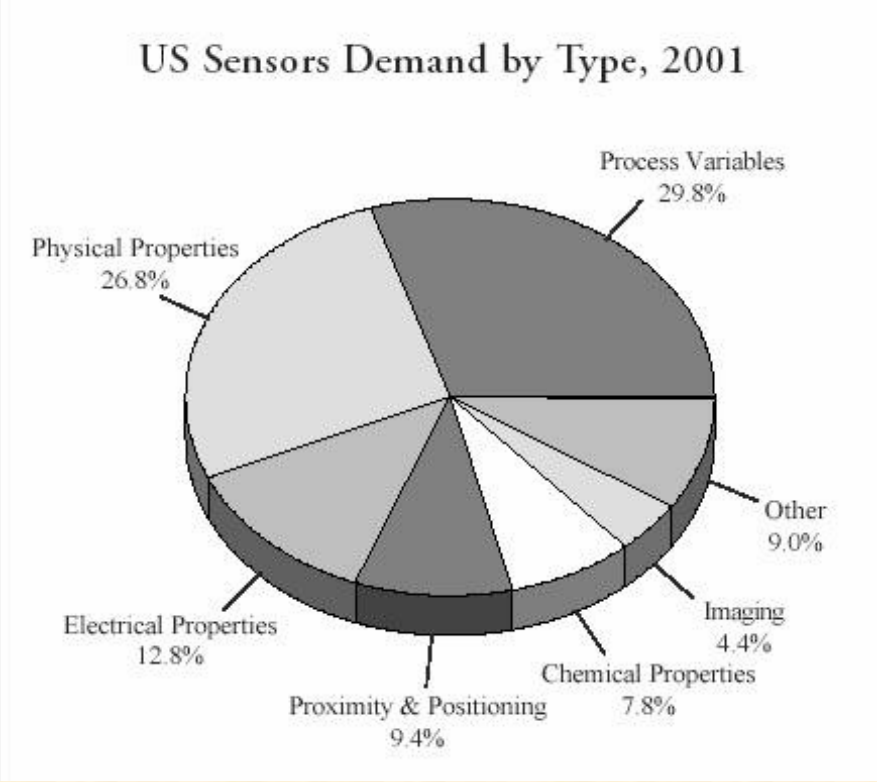
Wireless Data Security: Encryption, Spreading, Interleaving – 1 for 3 Today



Wireless networks use a variety of techniques to enhance security, such as spreading and interleaving. These techniques can make the signal virtually undetectable without prior knowledge about the network. This can improve the security of the network by orders of magnitude.

Why Not Just Let the Market Decide?

- Beta Vs VHS – I still have Beta HiFi on my set top and it's still better!
- Ethernet on the factory floor – Took 20 Years to get the performance required!
- Fragmented Market not Appealing – We hang together or we hang separately?

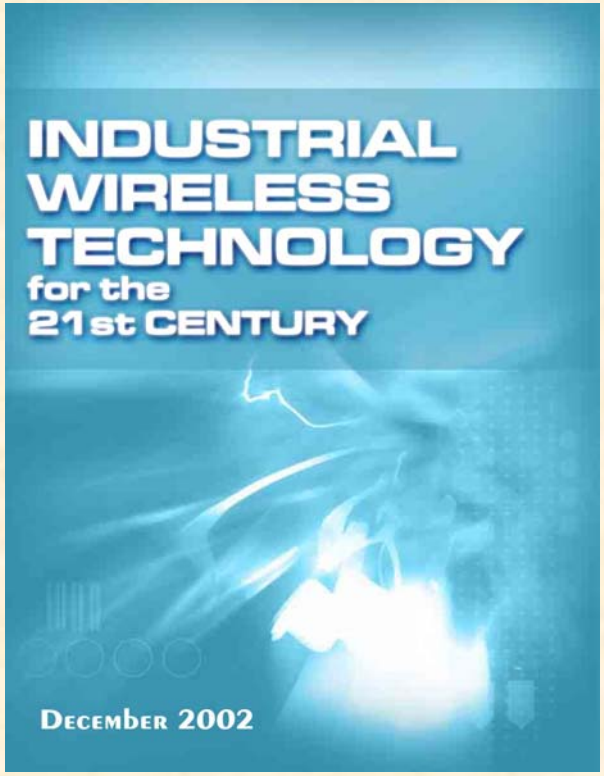


Freedonia Group report on Sensors, April 2002

Industrial Wireless Technology for the 21st Century

US DOE Industrial Technology Vision Workshop led to published vision document:

- **Potential benefits to industry**
- **Wireless technology today**
- **Long-term goals for industrial wireless**
- **Existing barriers to long-term goals**



http://www.eere.energy.gov/industry/cfm/fullarticle.cfm/id=714

WINA Formation

WIRELESS
INDUSTRIAL
NETWORKING
ALLIANCE

WINA

In the spring of 2003, the Wireless Industrial Networking Alliance (WINA) was formed to promote the adoption of wireless networking technologies and practices that will help increase industrial productivity and efficiency.

So Why WINA?

- Dance of the Elephants – users, suppliers, government, standards, technologists
- Focus – Deployment, deployment, deployment – everyone wins
- Impact – Reduced cost, increased profits, improved efficiencies in energy, raw material, and emissions control

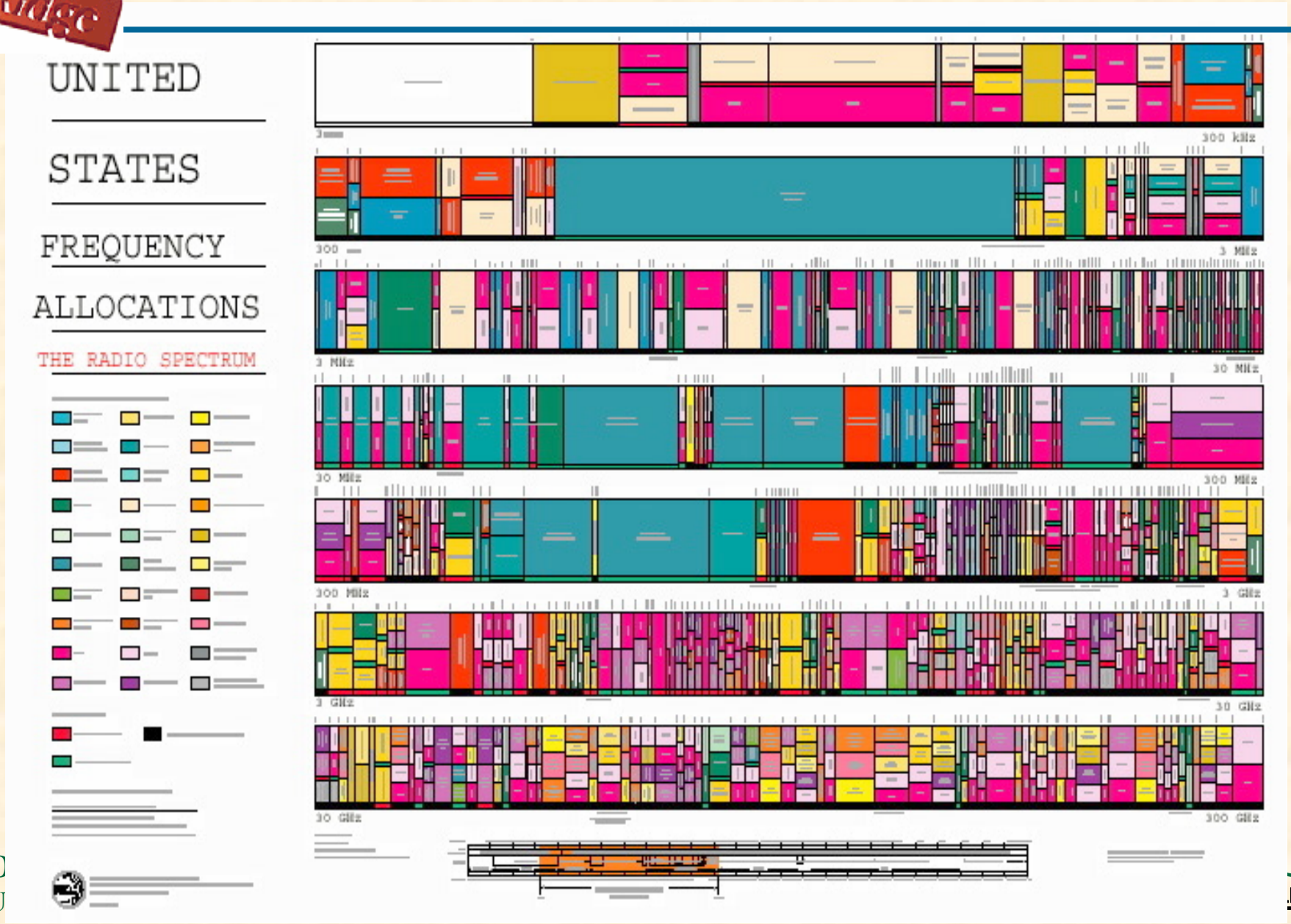
WINA

WIRELESS INDUSTRIAL NETWORKING ALLIANCE

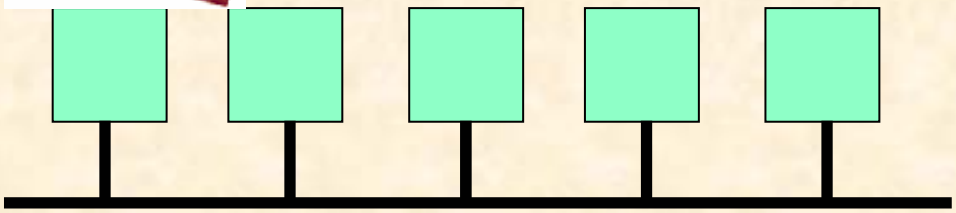
The End User (a.k.a the Customer)

Is frequently asked to decide between things like…

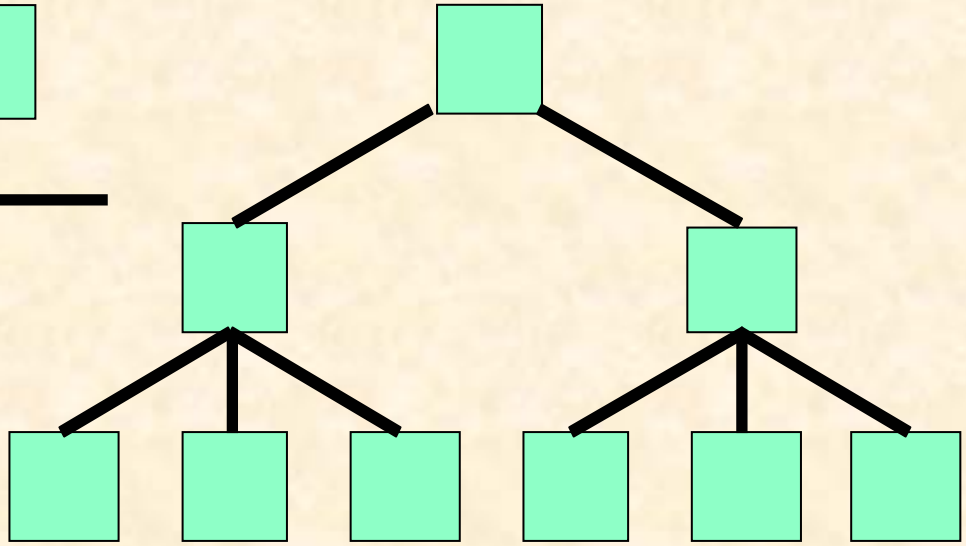
Choose the Frequency



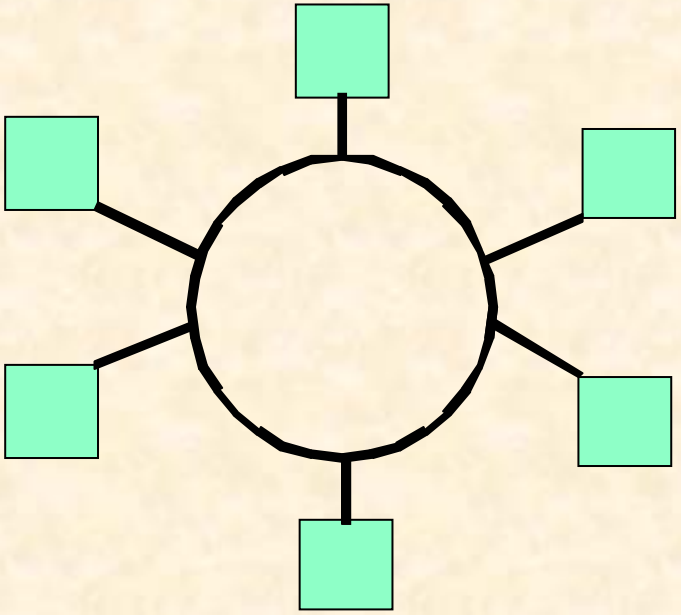
Possible Sensor Network Topologies



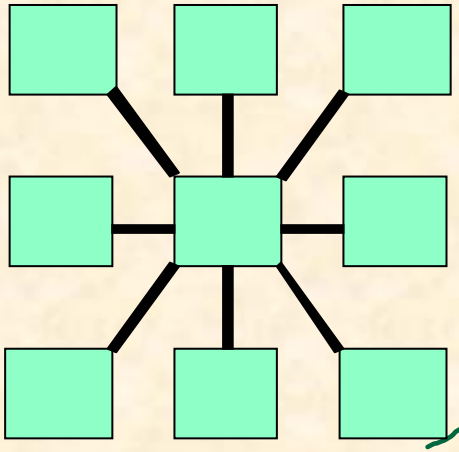
Bus



Tree Network

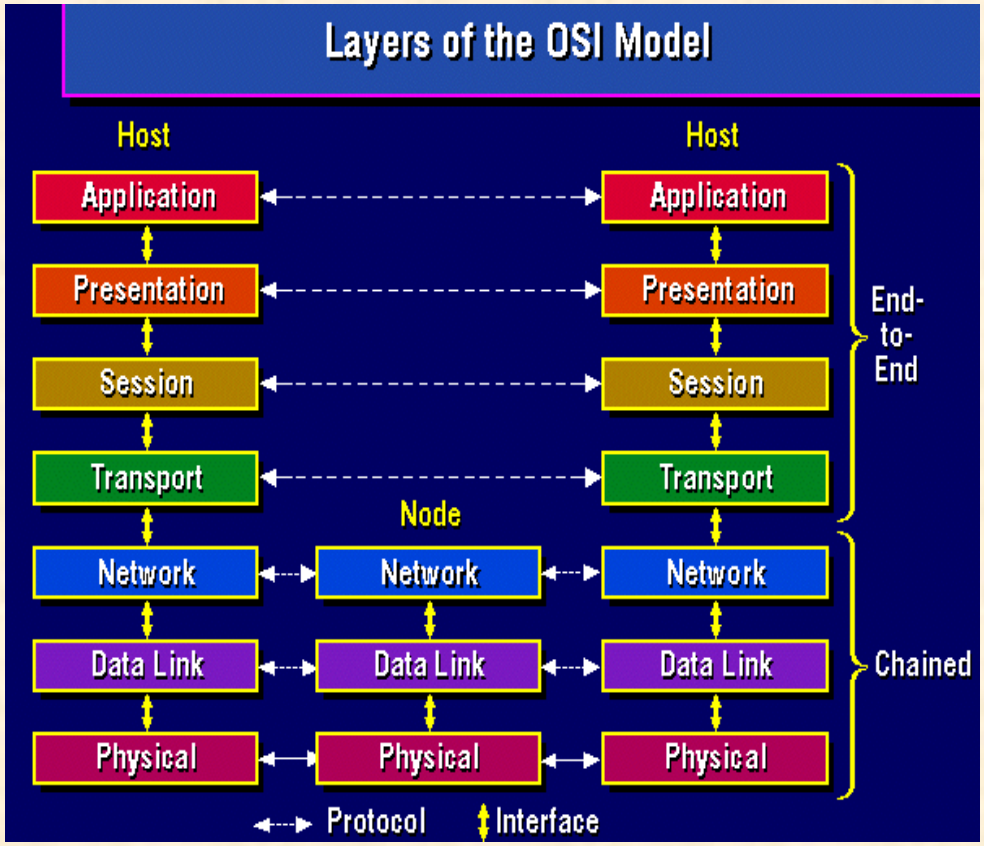


Ring Network

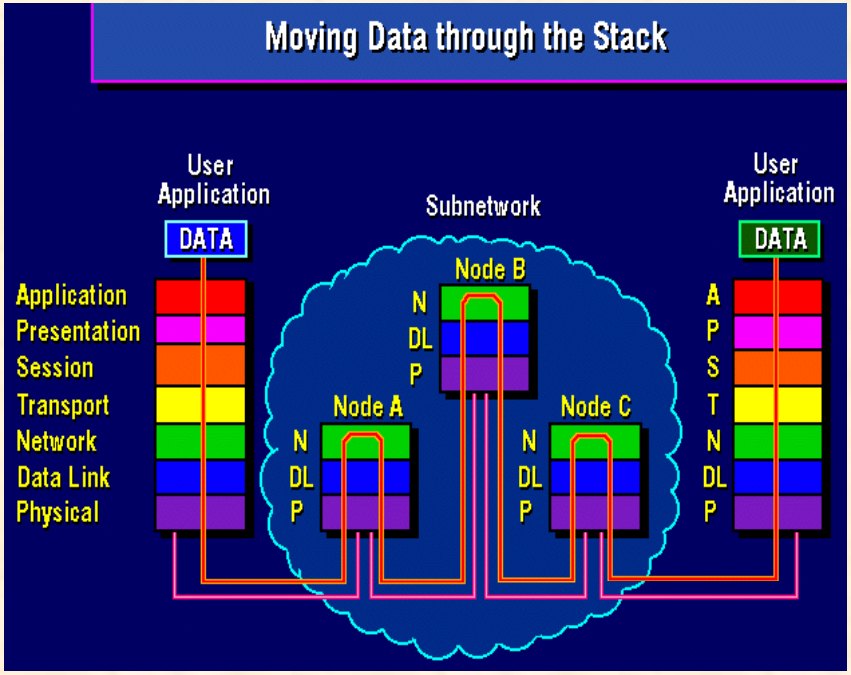


Star

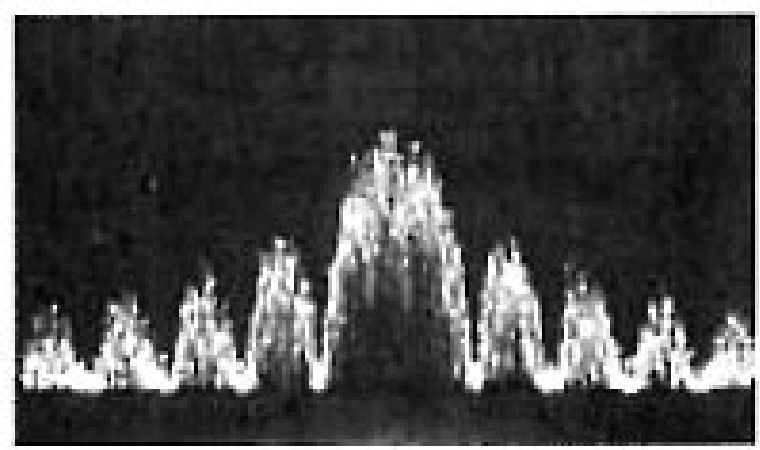
A few details…



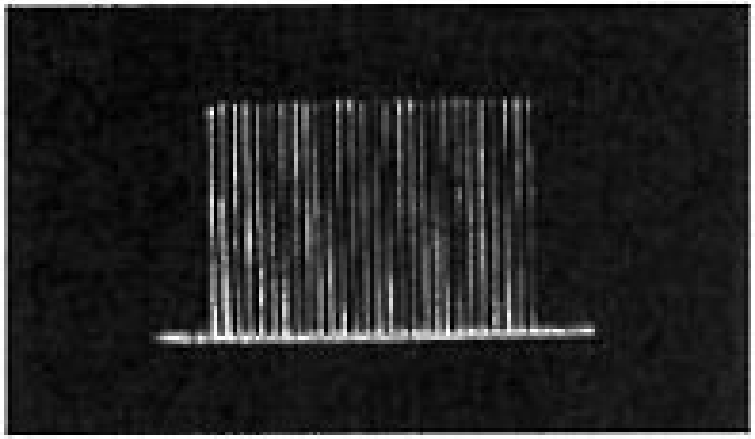
Layered Communications



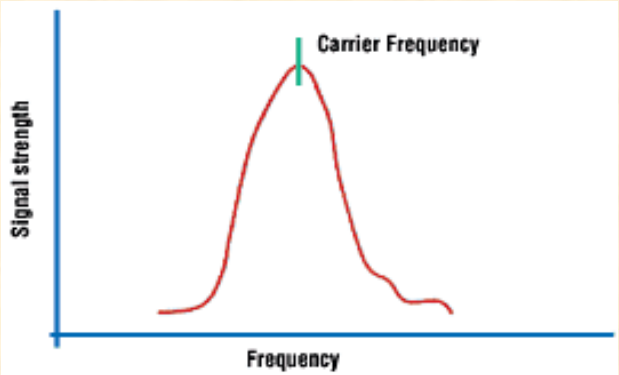
Narrowband? Spread Spectrum (what flavor) ?



DSS



FHS



NarrowBan

The Implementation:

Selected ISM Frequencies

Frequency (MHz)	Bandwidth (MHz)	Applicable Countries	Regulatory Institute	Reg Doc
433.5-437.9	1.740	Europe	ETSI	ETS300/220
868.0-868.6	0.600	Europe	ETSI	ETS 300
902-928	26	USA	FCC	
2400-2483.5	83.5	Europe,USA	FCC/ETSI	ETS300/228

Frequency (MHz)	Max Rad Power EIRP	Channel Spacing	Modulation technique	Bitrate
433.05-434.79	10mW/10dBm	not defined	free	free
868.0-868.6	25mW/14dBm	25kHz	free	free
868.0-868.6	25mW/14dBm	100kHz	SS	free
902-928	1W/30dBm		FHSS/DSSS	
2400-2483.5(US)	1W/30dBm		FHSS/DSSS	
2400-2483.5(Eur)	100mW/20dBm	100kHz	FH/DSSS	>250kbps
2400-2483.5(Eur)	10mW/10dBm	free	free	free

As A WINA Member, You Get To…

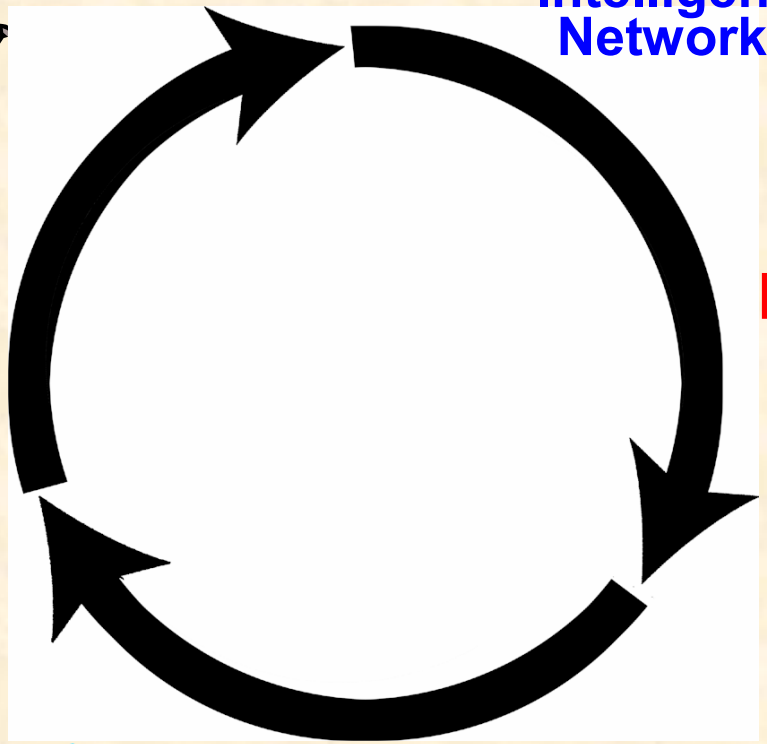
- Influence Standards – 1451.5, ZigBee, Bluetooth, others
- Influence Markets – suppliers, features, performance
- Influence National Research Agenda – DOE, DOD, NSF, NIST
- Influence WINA – technical, user, and marketing subcommittees
- Access – experts in all areas sited above

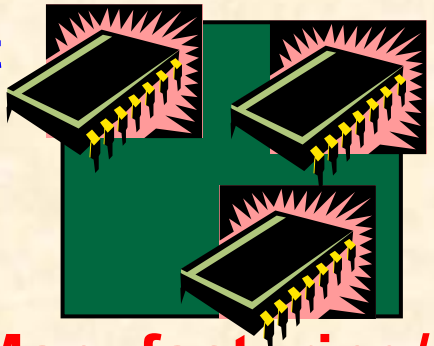
WINA

WIRELESS INDUSTRIAL NETWORKING ALLIANCE

Can Commercial Grade Cut It?

Wireless
Intelligent
Network



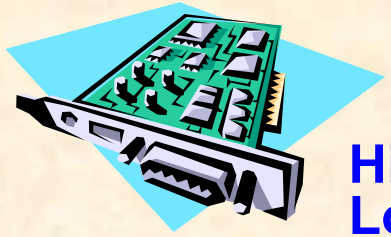


Manufacturing/ Industrial Markets

High Quality
Low Cost
High Volume
High Integrity

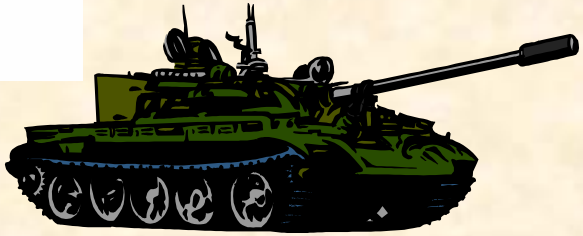
Consumer Market

High Quality
High Volume
Low Cost
Low Integrity



National Defense

High Cost
Low Volume
High Quality
High Integrity



Wireless
Warrior

Organizations Are Standing By

WINA

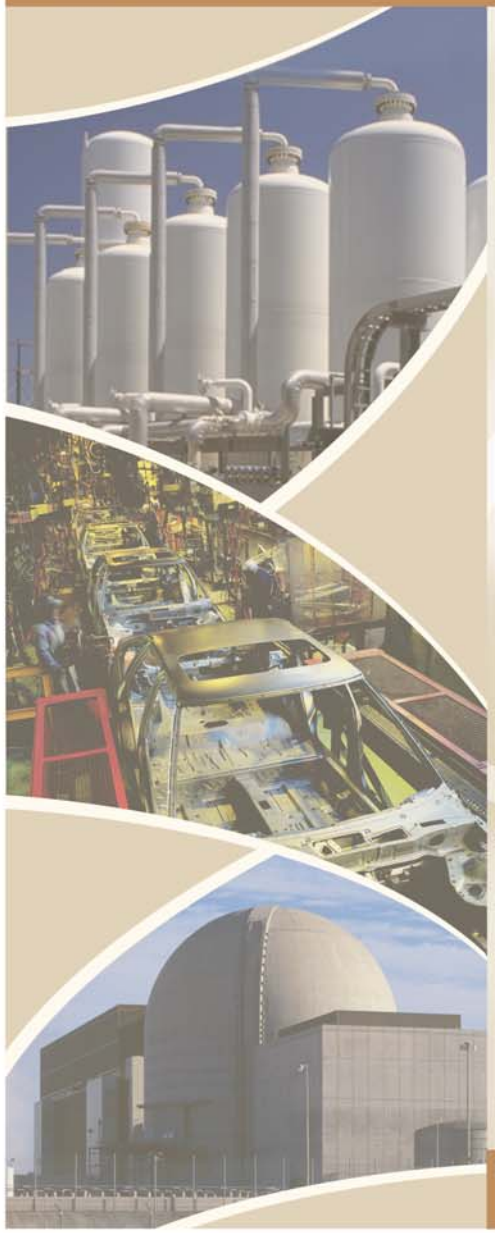
In the spring of 2003, the Wireless Industrial Networking Alliance (WINA) was formed to promote the adoption of wireless networking technologies and practices that will help increase industrial productivity and efficiency.

www.wina.org

EMC^2

Available at ORNL in June 2004 – DOE/EERE Extreme Measurement Communications Center – providing technological tools for engineered solutions to sensor networks and communications in harsh environments.

Accelerating the adoption of wireless technologies in industry



WINA

WIRELESS INDUSTRIAL NETWORKING ALLIANCE

ISM frequencies

ZigBee™ 802.11 a/b/g

802.15.4

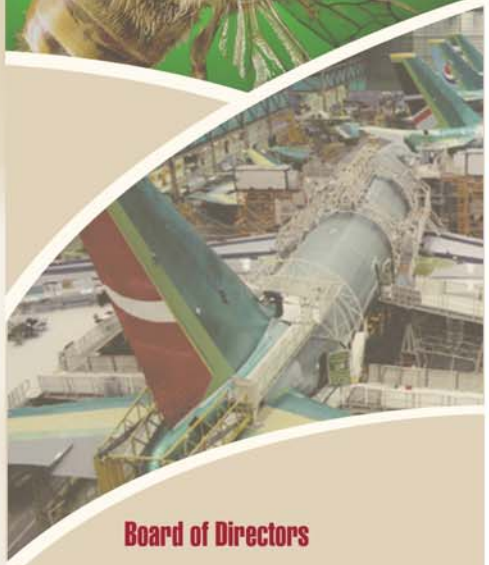
spread spectrum

UWB

1451.5

cyber-security

Bluetooth®

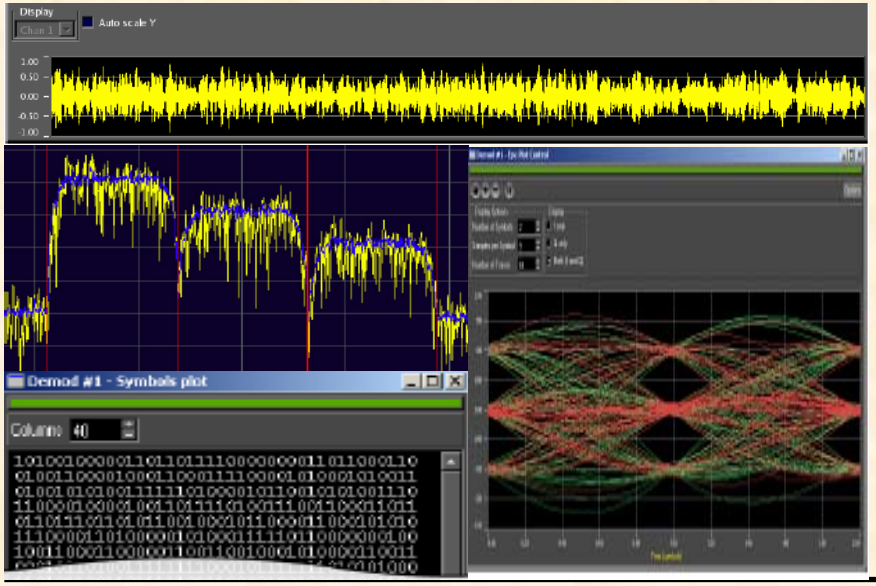


Board of Directors

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

WWW.WINA.ORG

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:

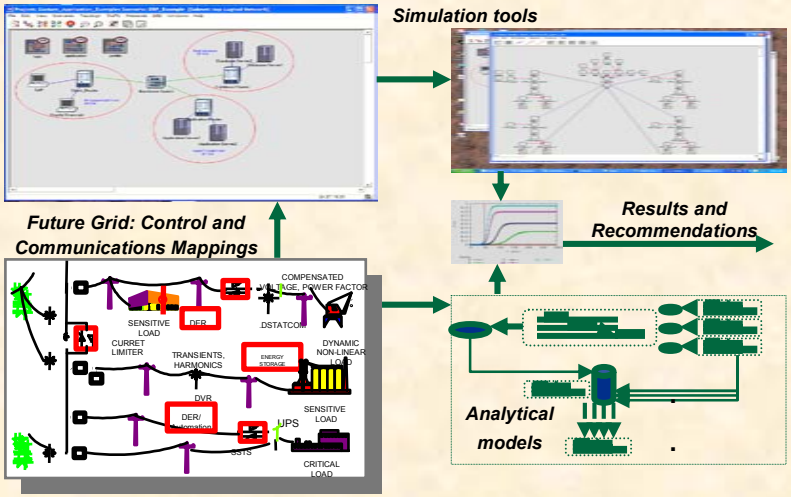
Key Milestones: Alliance with WINA and member companies for technology assessment and characterization; Provides modeling and simulation support for developing fault-tolerant electric-grid communication infrastructure

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

Assuring the Communications Infrastructure for the Electric Grid of the Future



PROBLEM: Currently, there is no effective high performance communications model with sufficient detail to provide analysis and confirmation of real-time communications and control for the Electric Grid.

SOLUTION: Develop a high fidelity, simulation tool to assess the impact of communications protocols and architectures on control and performance of the electric grid of the future.

- Develop a communications systems simulation tool to conduct studies of affordability & tradeoffs.
- Conduct uncertainty analysis to mitigate risk.
- Identify modeling & simulation needs and conduct studies to support electric grid needs & requirements.

BENEFITS:

- Develop a communications simulation tool that can be applied to current & future electric grid topologies.
- Provide confirmation & support for a communications architecture for a full spectrum electric grid needs.
- Quantify full comms system performance expectations: aggregate system measures & impacts.
- Toolkit for risk mitigation, uncertainty analysis, and affordability studies.
- Roadmap of modeling & simulation needs for the electric grid and preliminary studies to provide initial parameters.
- Develop fault tolerant communications architectures supported by solid analytics.

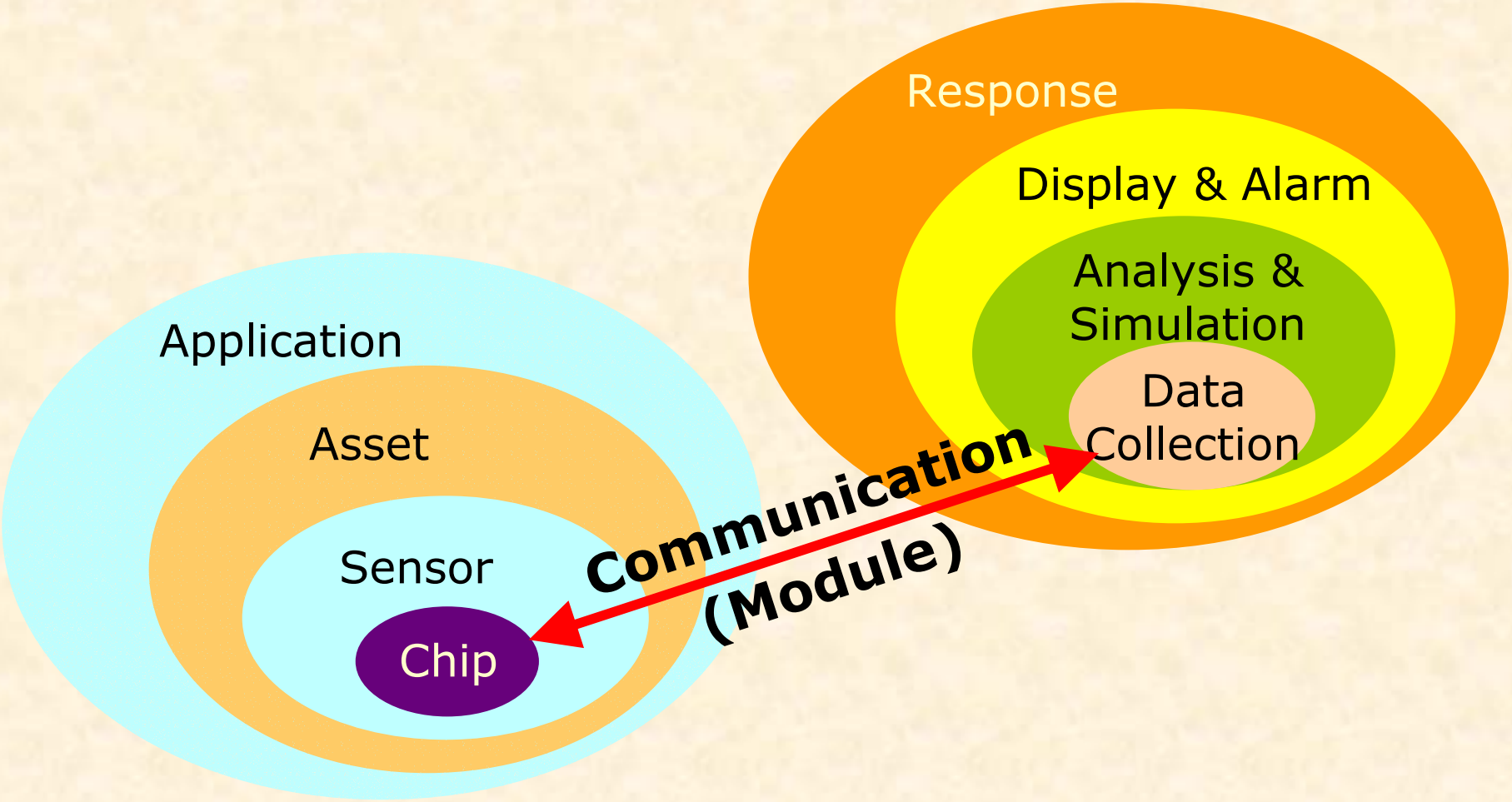
MILESTONES, DELIVERABLES, & SCHEDULE:

Key Milestones: Implementation of 1st generation application to assess current communications of a defined electric grid; Delivery of full spectrum communications simulation and modeling tool for electric grids (current and future).

Deliverables: Year 1: 1st generation analytic toolkit for risk and affordability studies; architecture risk assessment on current architectures; Year 2: high fidelity/performance simulation and analysis toolkit based on OPNET; conduct scalability study for future grid scenario.

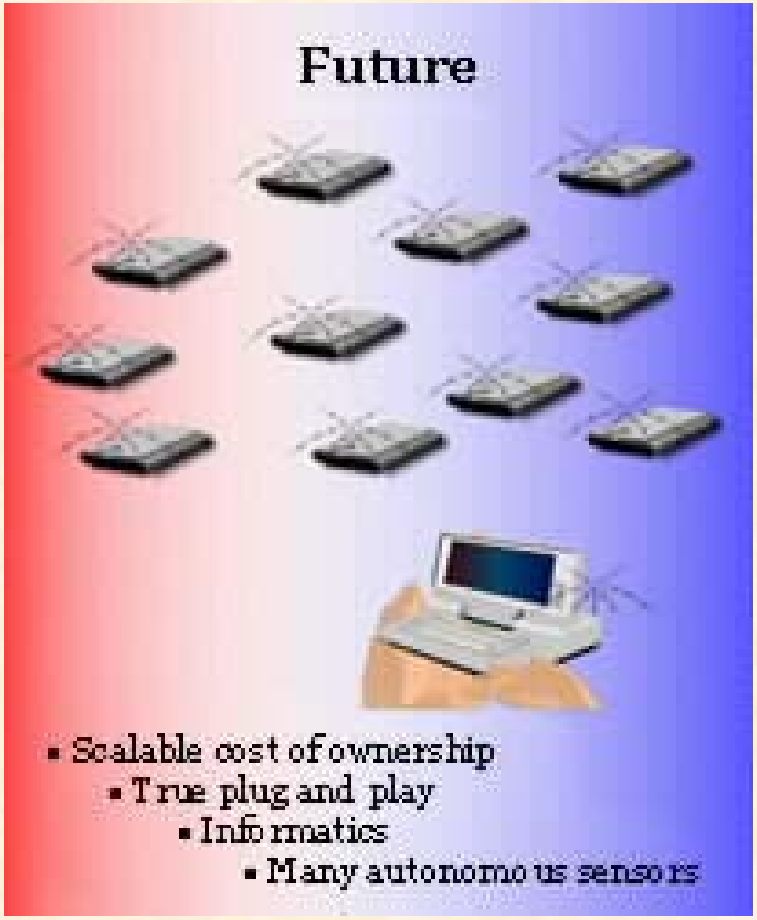
Schedule: Total 24 Month Duration. Oct 03-Aug 04, 1st Generation Application; Sept 04-Aug 05, High Fidelity OPNET based simulation and analysis tool.

Replacing the Wire - Only the First Step!

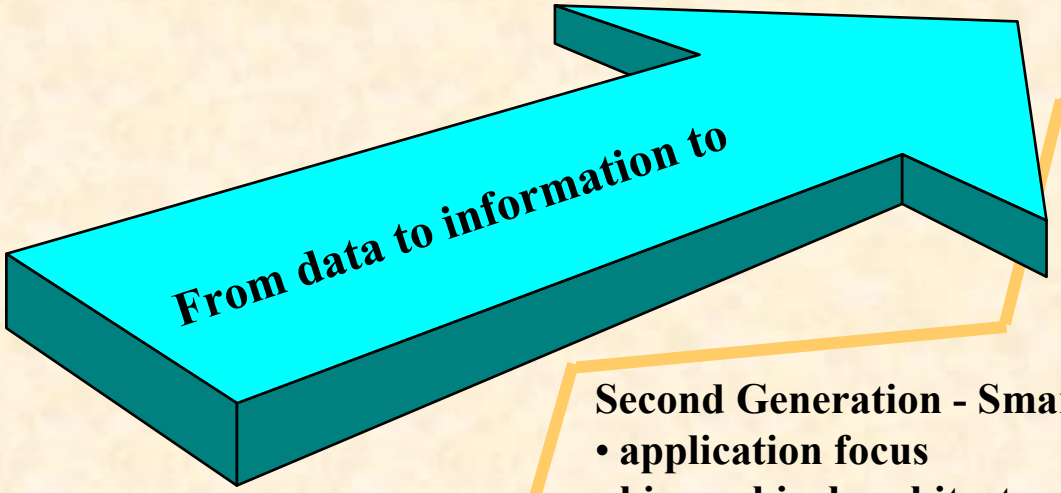


Wireless Enables Ubiquitous Sensing!

- A Completely New Paradigm!
  - Efficiency
  - Safety
  - Asset Management
  - Hostless architectures



What Is The Next Generation ?



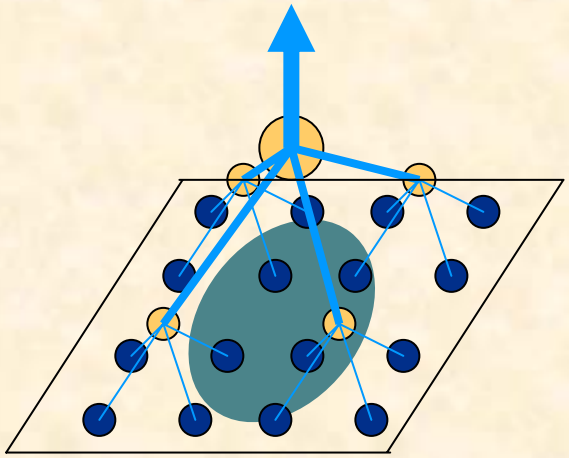
Third Generation - Sensor
- goal focus
- dynamic architecture
- network intelligence

Second Generation - Smart
- application focus
- hierarchical architecture
- local intelligence

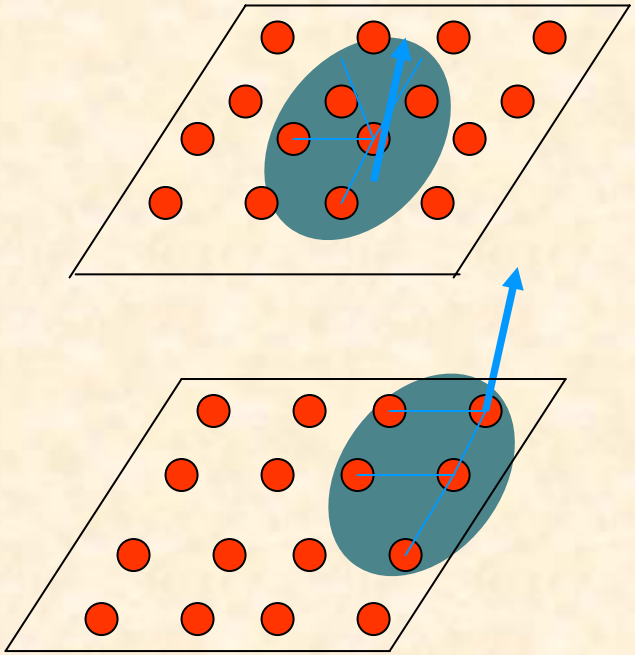
First Generation - Dumb
- data focus
- flat architecture
- no intelligence

How Will You Know It When You See It?

Present-day systems have fixed hierarchy

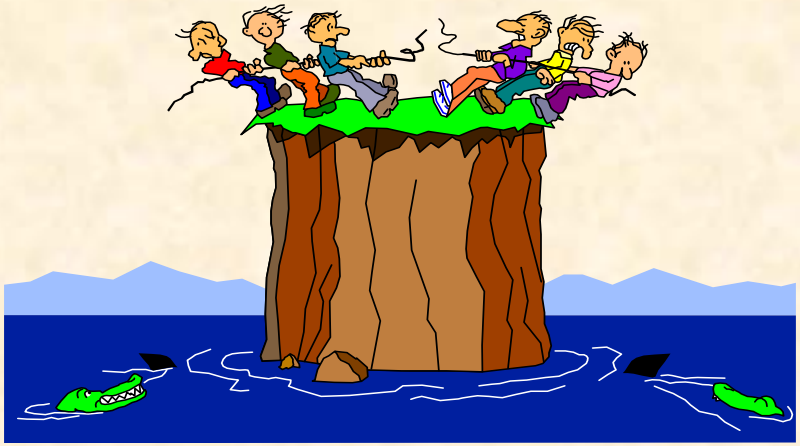


Next generation network will self-organize in response to specific events



Who Will Lead, Who Will Follow, Who Will Whine?

- Technology is ready - driven by cellular personal/business communications
- Market is ready - $2000/ft for wires in some plants
- Are we ready? - partnerships, consortia, standards, and collaborations



"CBM Is the Next Killer App For Wireless"
– Dr. Jay Lee, Fortune Magazine, July 2002