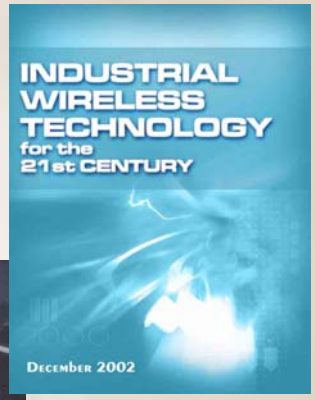
WINA

Characterizing the Industrial Environment



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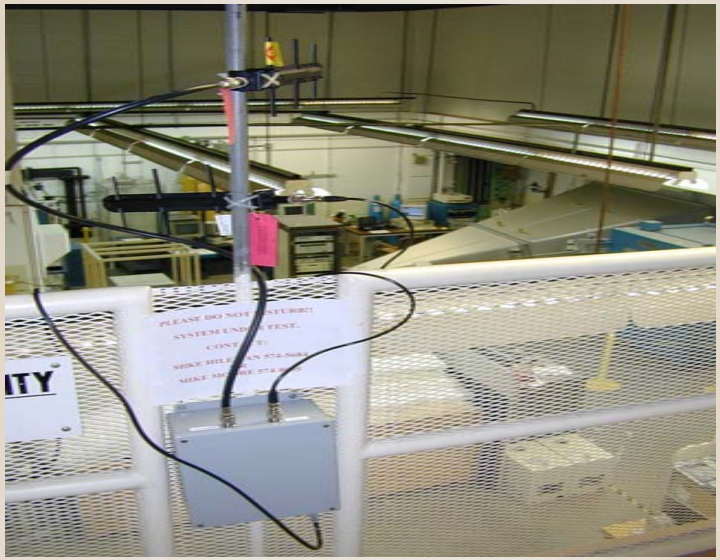
Wireless Industrial Sensor Networks – Multidisciplinary!

- **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**

Data – The Coin of the Realm!

Industrial Wireless – The Good, the Bad, and The Ugly

- **Immune – Wireless solves these (at least mitigates).**
- **Exacerbated – Wireless makes it worse! It's there but usually hidden.**
- **Neutral – Has impacts whether wired or wireless – BE CAREFUL!**



Sorry - There is no ONE industrial environment!

Soooo – What Do You Do!?

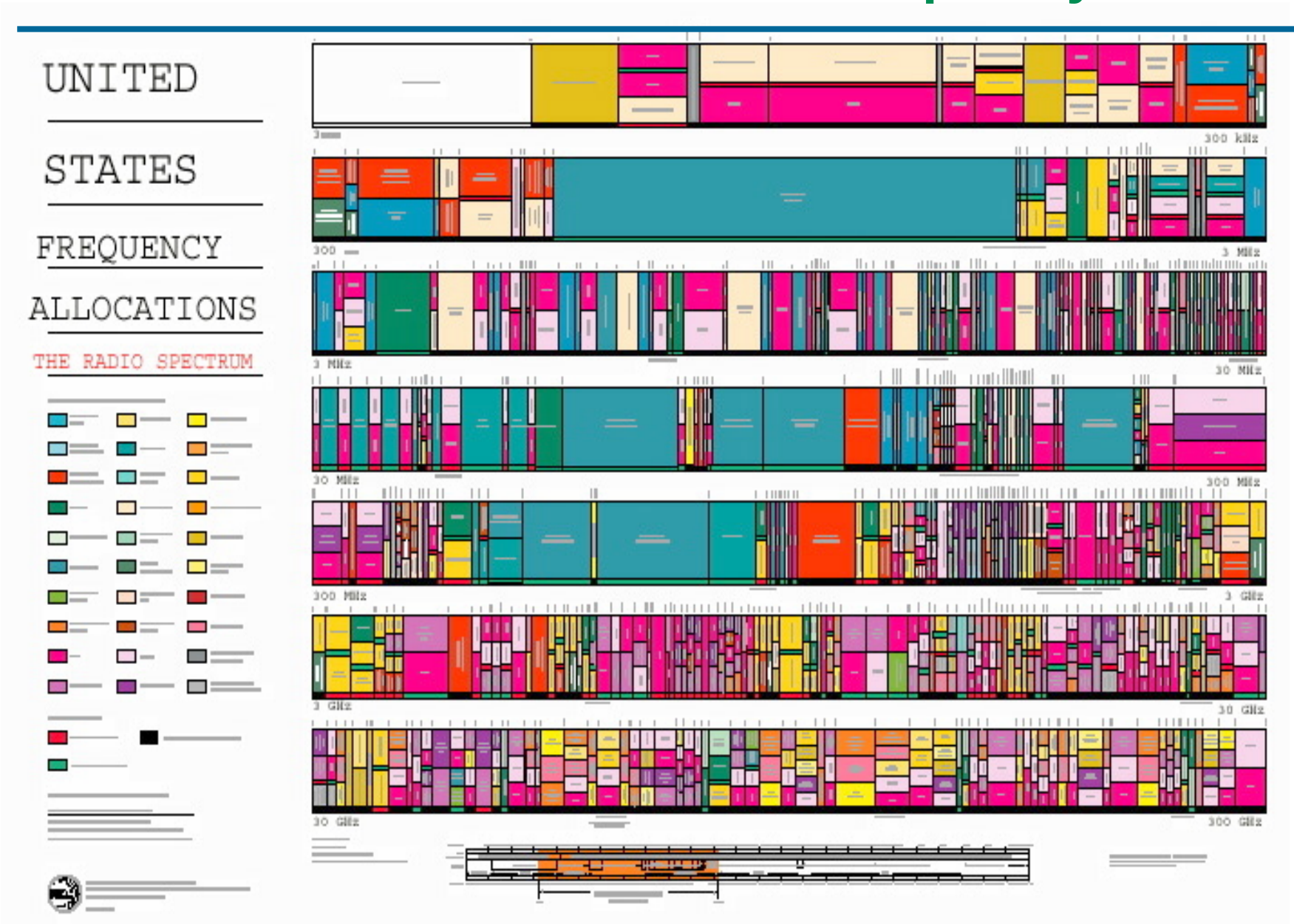
- **Problem Solved – some environments are well characterized and solutions exist**
- **Problem Solved – Almost – Assume your environment looks like one above**
- **Problem Solvable – GET THE DATA**
- **Can You Hear Me Now? – Try it and see**

Guess What – WINA helps in all of these!

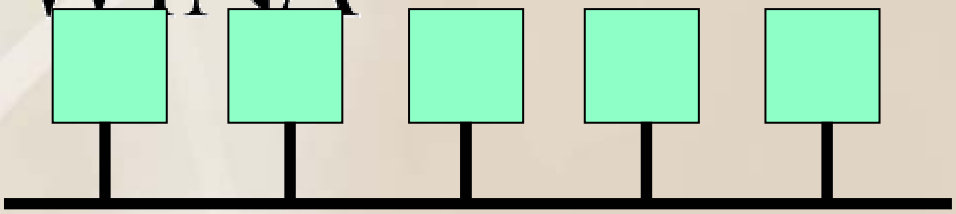
Lots of Options – Once You Understand The Issues

Optimizing Around things like ….

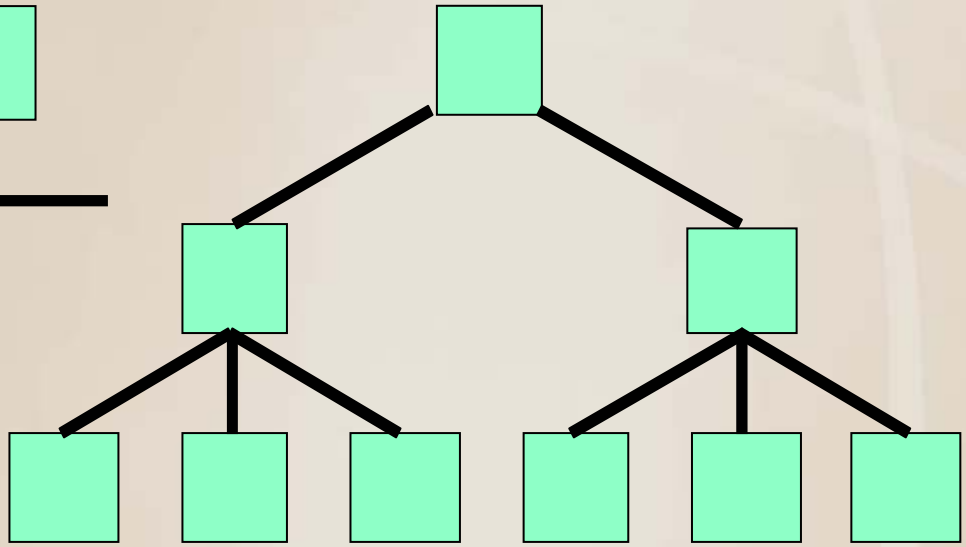
Choose the Frequency



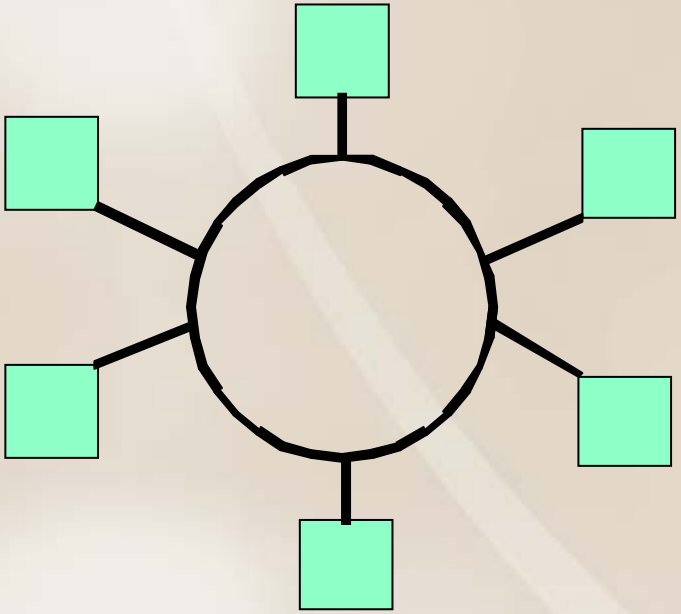
Possible Sensor Network Topologies



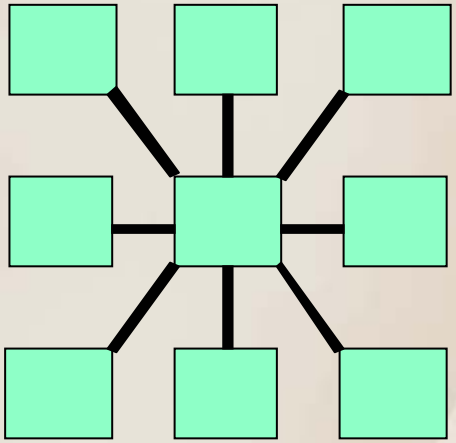
Bus Network



Tree Network

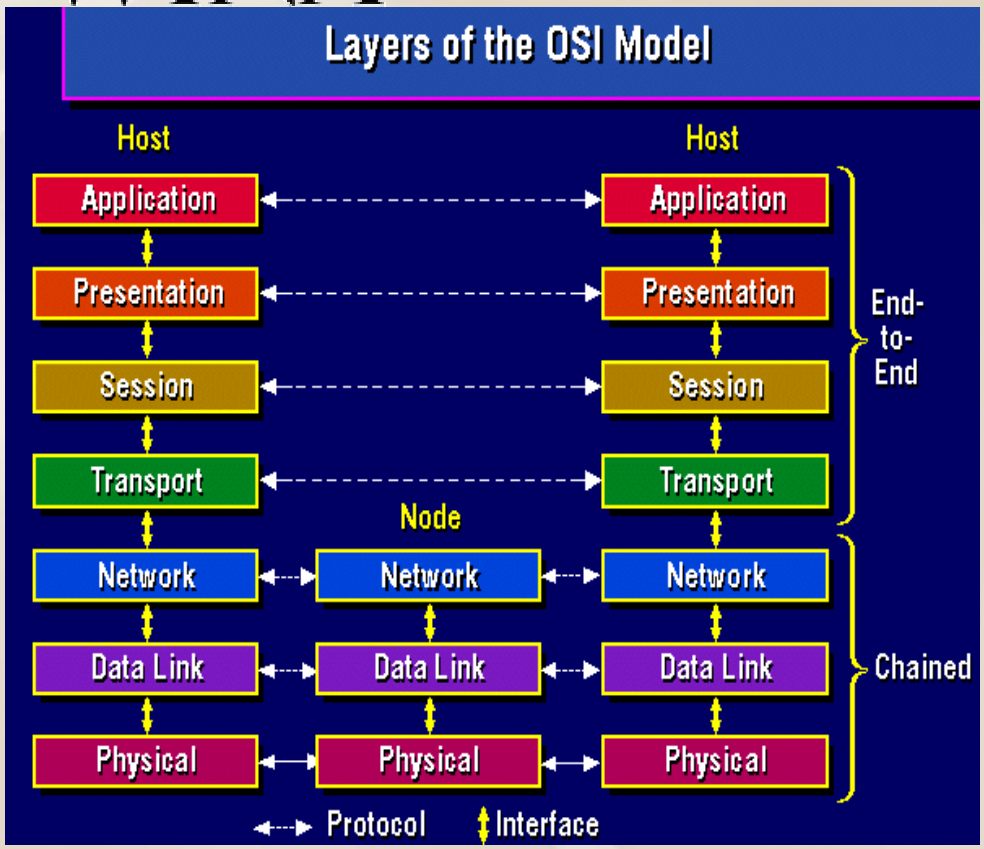


Ring Network

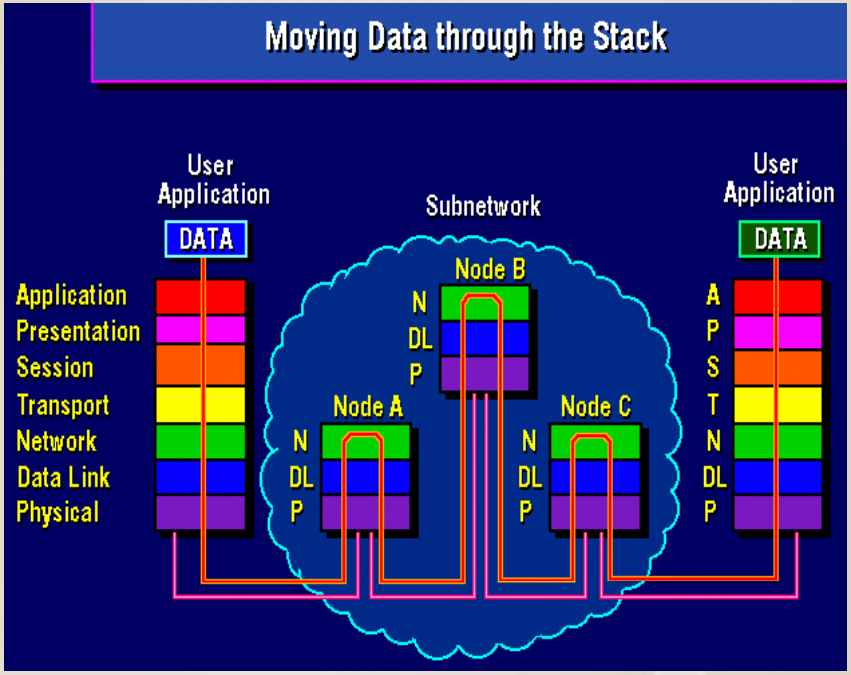


Star Network

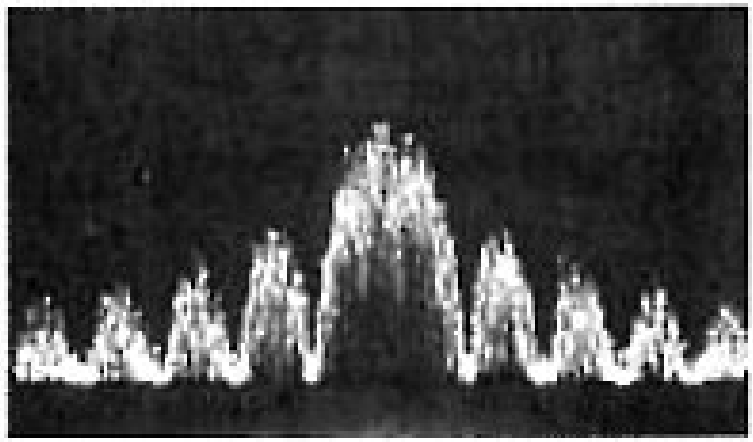
A few details…



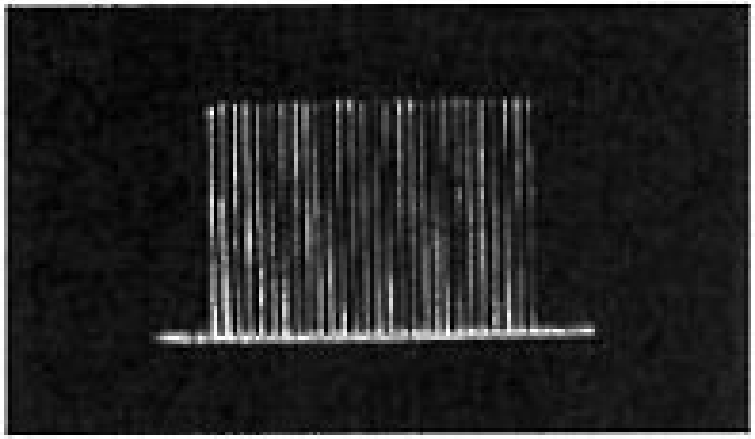
Layered Communications



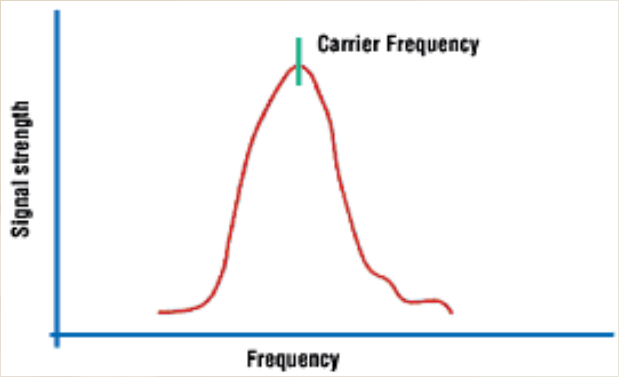
Narrowband? Spread Spectrum (what flavor) ?



DSSS



FHSS



NarrowBand

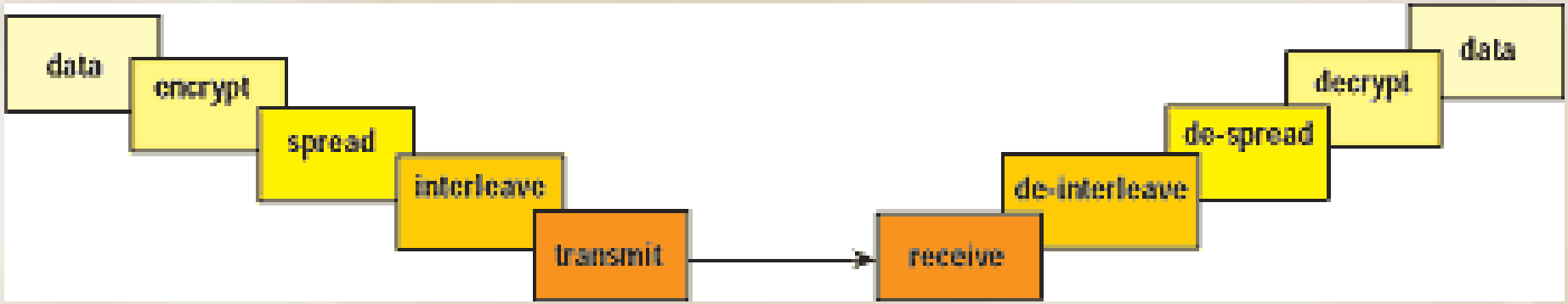
The Implementation:

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

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.

Organizations Are Standing By

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.

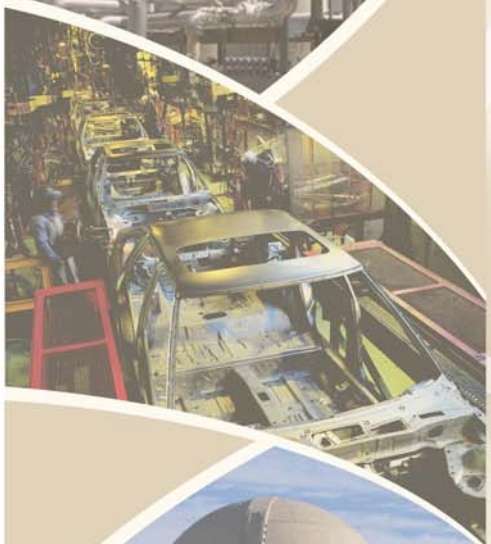
www.wina.org

Wireless Industrial Networking Alliance

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

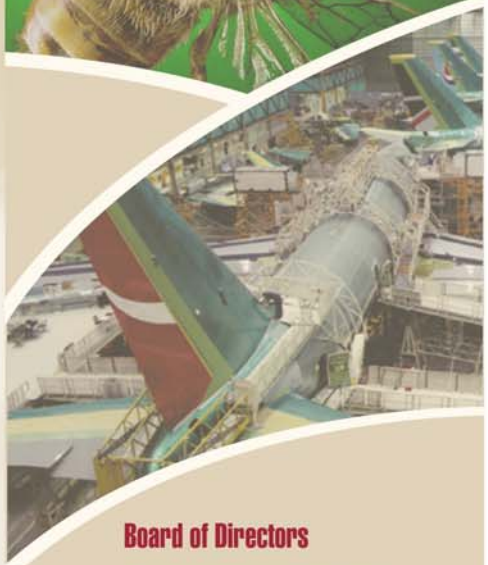
UWB

1451.5

cyber-security

Bluetooth®

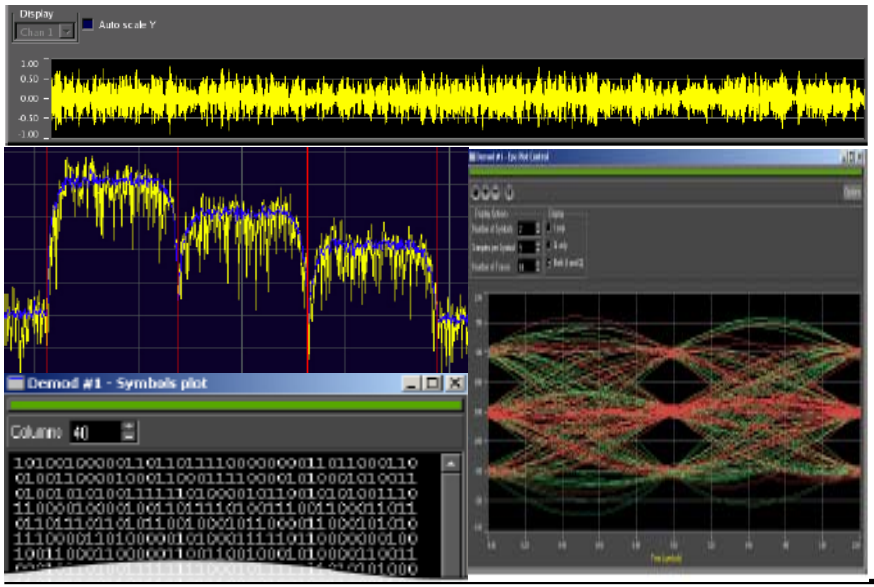
WWW.WINA.ORG



Board of Directors

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

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:

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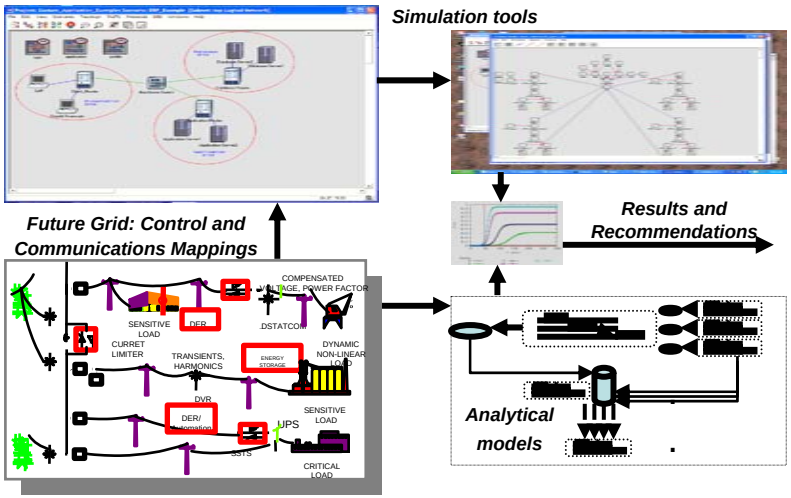
Assuring the Communications Infrastructure for the Electric Grid of the Future



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:

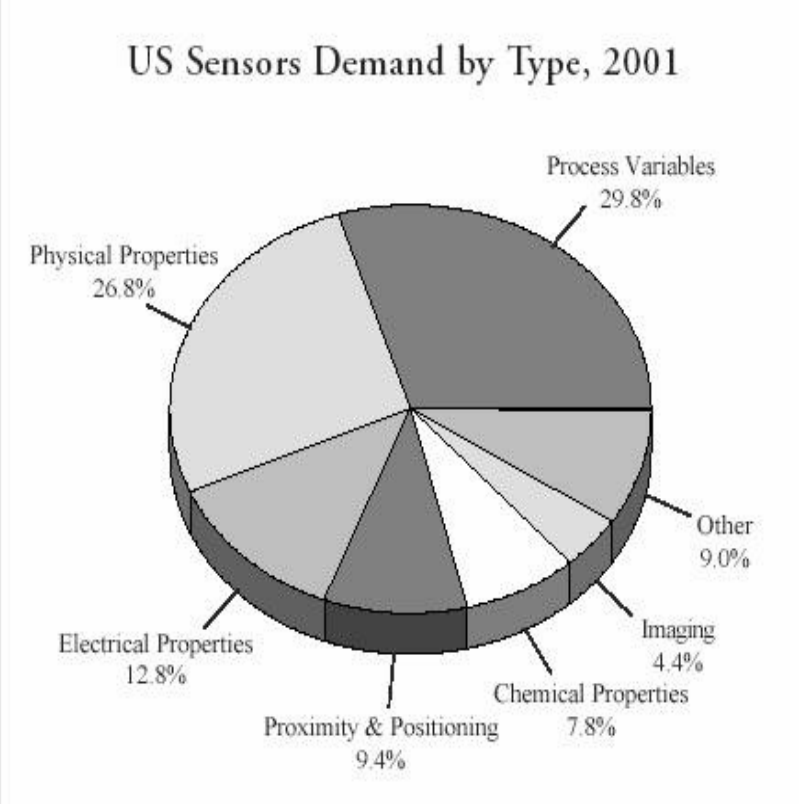
Key Milestones: Implementation of 1st generation application to assess current communications of a defined electric grid; Delivery of full spectrum communications simulation and modeling tool for electric grids (current and future).

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.

Bottom Line: Critical Issues Are Not Just Wireless Related

- Immune – ground loops, bad connectors, wires crossed, broken wires
- Exacerbated – Density, EMC, Integration, Standards, Power
- Neutral – Power quality, Sensor fidelity, sensor sensitivity, Vomit of data, network latency, throughput, security, reliability



Freedonia Group report on Sensors, April 2002