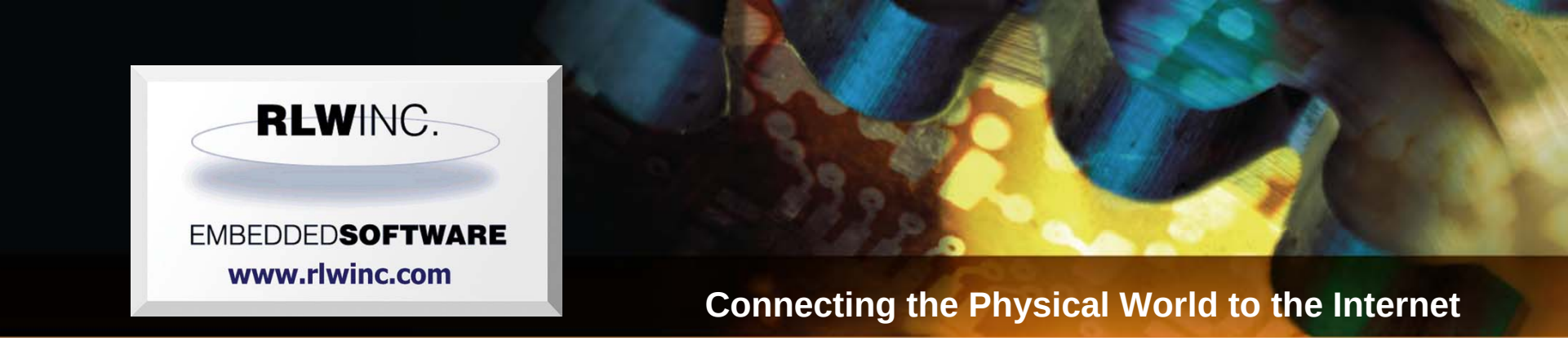


Wireless Devices for CBM

Prepared for

Penn State Center of Excellence in Structural Health Monitoring

Inaugural Meeting

April 12-13, 2007

University Park, PA

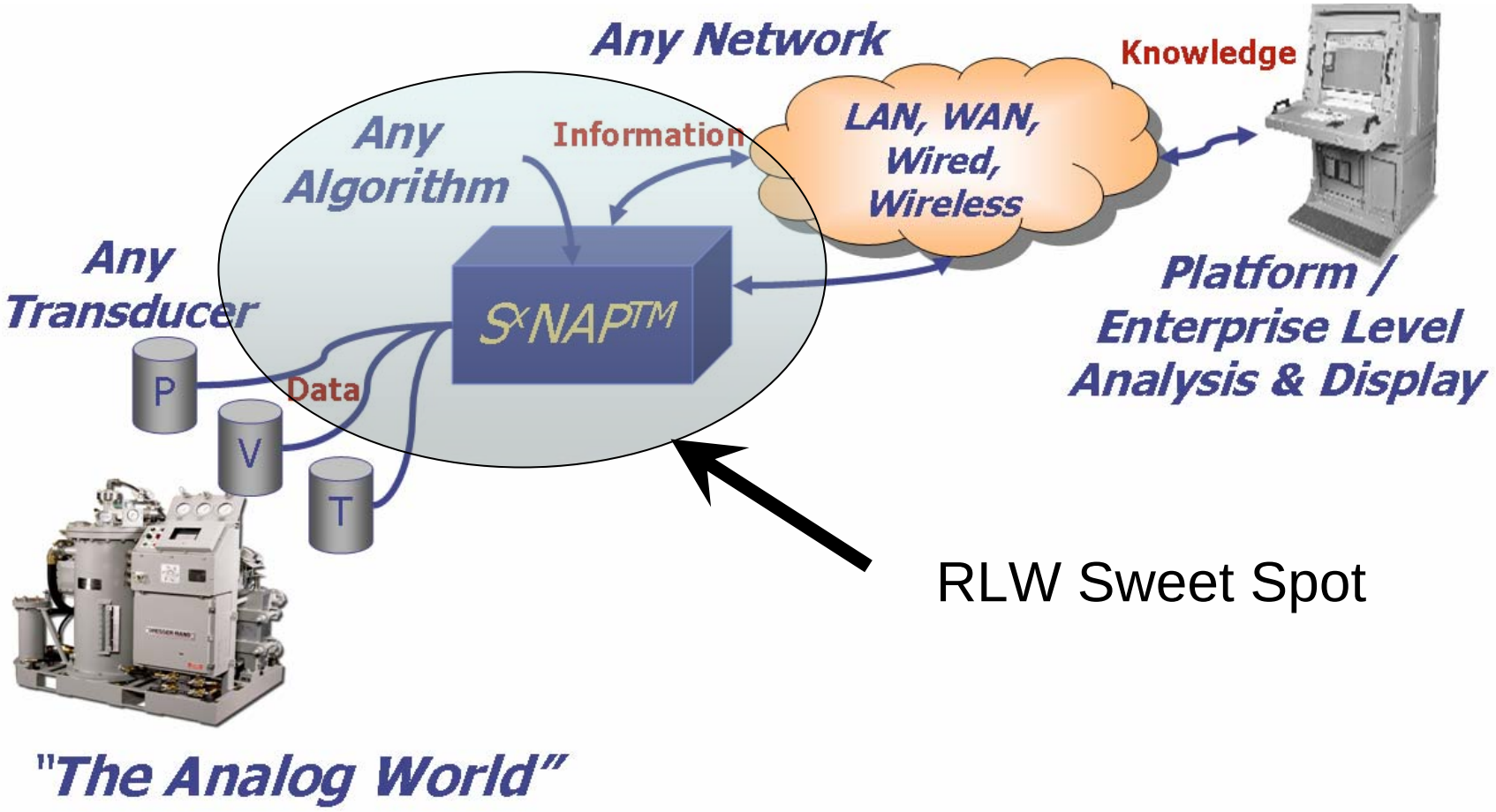
Presentation Outline

- **Who we are**
- **What we've done**
- **Where we're going**

RLWINC.
EMBEDDEDSOFTWARE
www.rlwinc.com

Open Platform for Condition Monitoring

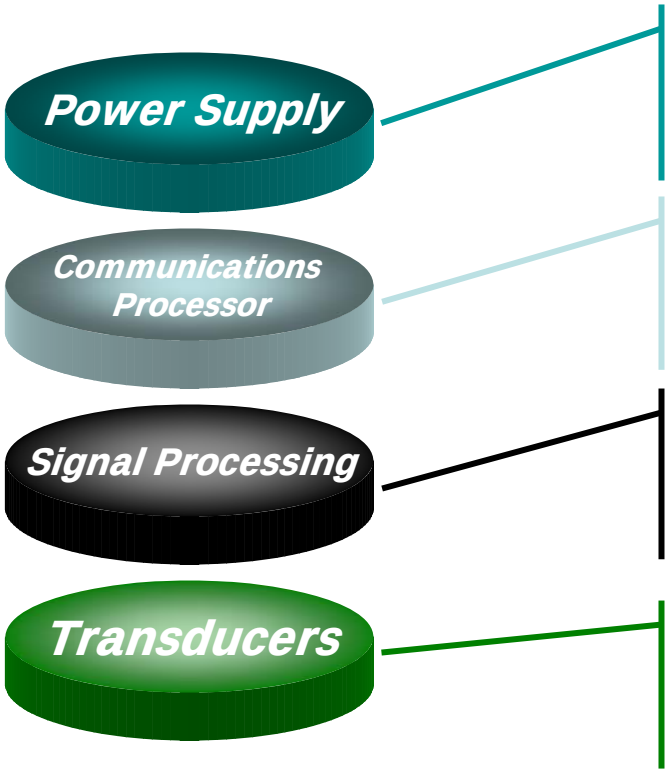
Connecting the Physical World to the Internet



S^XNAP™ Concept

Connecting the Physical World to the Internet

"Small, smart, networkable appliance to
"connect the physical world to the Internet"™



Micro-Generator or Battery

Any wireless/wired network + Internet

Local processing – reduce data to information

Analog electrical signal proportional to physical parameter

S2NAP® - Baseline Product

Connecting the Physical World to the Internet

S²NAP®

- XML Interfaces [S2NAP® XML Schema]
- 8 Sensor Channels
- Tachometer Input
- 2 Analog Output Channels
- 1 Relay Contact Output
- 2 EIA-232 Serial Ports. (Optional EIA 422/485)
- Dual Processor Architecture
- Wi-Fi (IEEE 802.11b) Wireless Network

s2nap@rlwinc.com

Derivative Products

Connecting the Physical World to the Internet

S5NAP

- **Power from ambient vibration**
- Dual Channel - temp & vibe
- 802.15.4 wireless radio
- Low power 16 bit microcontroller
- Commercial sale pending

S6NAP

- **Battery-Powered – 2 Year Life**.
- **802.11b Wireless**
- **2 Channels**:
- Raw Data to host computer via connector software
- Network host interface - XML in/out

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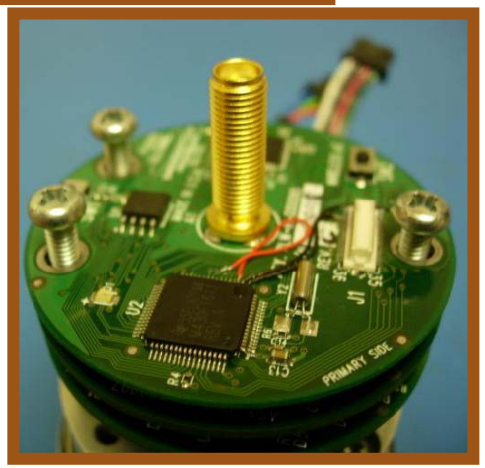
S5NAP™ Prototype

Connecting the Physical World to the Internet



Giga-Ant 2.4 GHz. Antenna

Chipcon CC2420 802.15.4 Radio

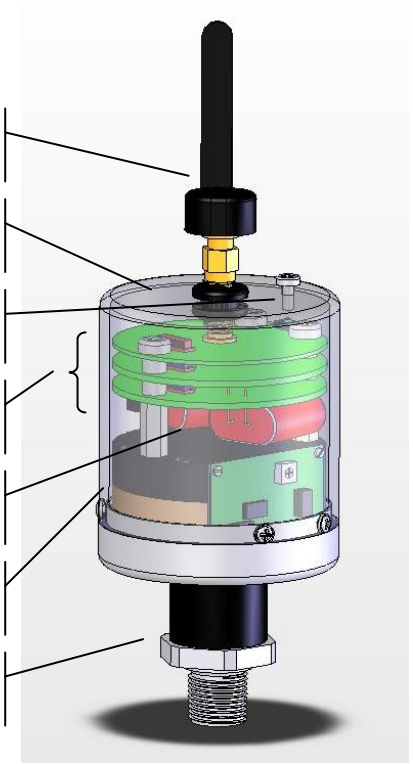
Reset button access screw

3 board PCB stack

Supercapacitors (x2)

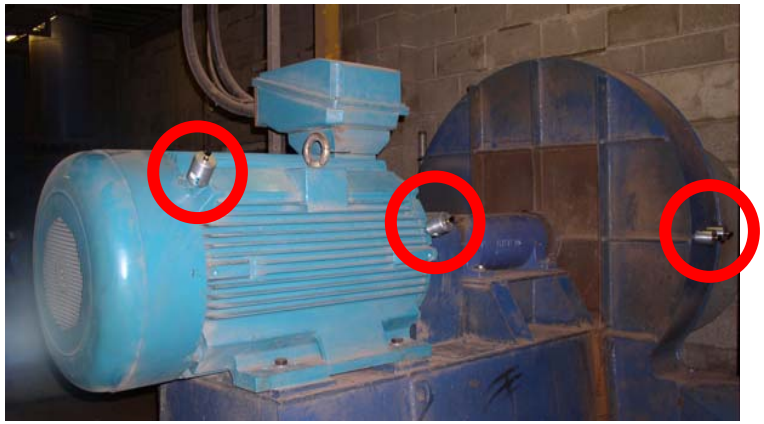
Power Generator

Pressure Transducer



Vibration Condition Monitoring

- **Using Perpetuum PMG7**
- **6 kBytes of data**
- **3 customer orders**
  - 2nd US Navy Contract
  - Major UK Water Utility
  - International Oil Company



- **Successful trials in Nov 2005**

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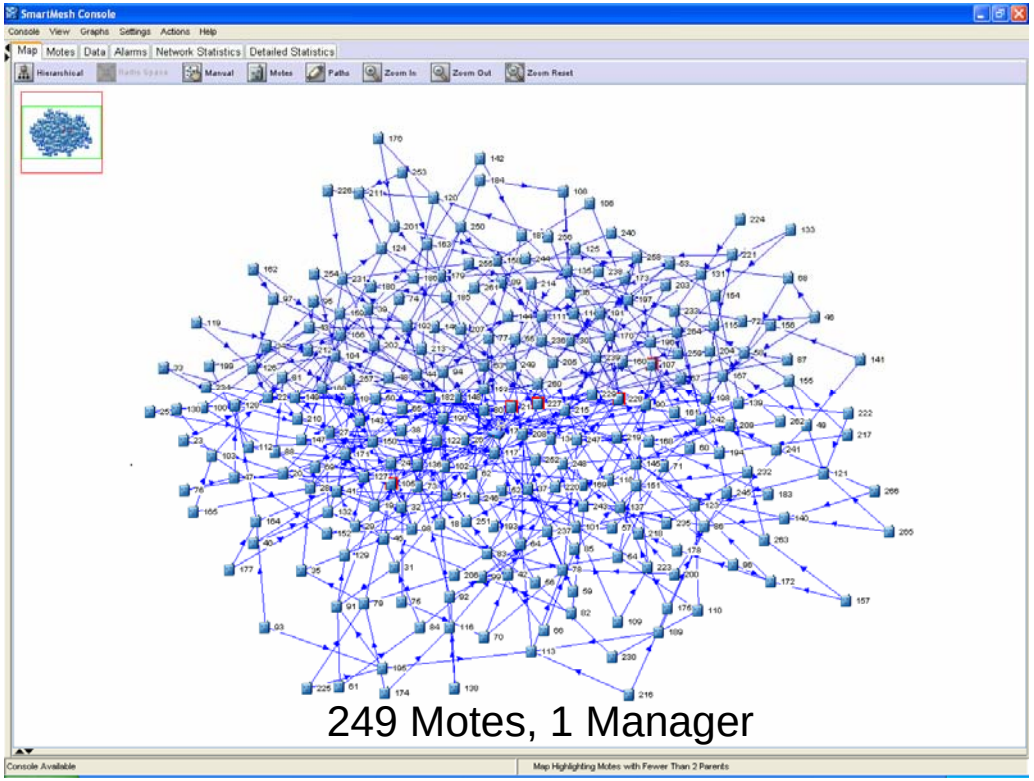
KCF Generator Powered

Connecting the Physical World to the Internet

S5NAP™ Powered by KCF Generators in Industrial test facility

Dust Wireless Mesh Network

Connecting the Physical World to the Internet



249 Motes, 1 Manager

- Presently proprietary network
- 2.4GHz, Time Synchronized Mesh Protocol (TSMP)
- Committed to move to ISA SP 100 Standard when released
- Chip version motes sampling now, available summer 07
- RLW's devices will remain "network agnostic" until full interoperability is realized through standards

"…We are committed to working with leading OEMs and industry organizations to ensure that wireless sensor networking technology is both easy to implement and fully interoperable.

http://www.dustnetworks.com/about/standards.shtml

S&T Leapfrogs Commercial Baseline

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Connecting the Physical World to the Internet

S&T Leapfrog

Info-sensor

- Co-design algorithms and mixed signal IC
- Highly efficient SP Algorithms
- Sub-threshold and saturation CMOS Analog SP Circuit Design

Dynamically Optimized Network

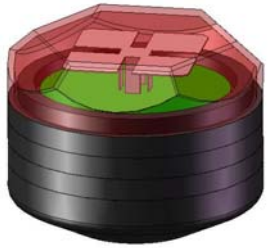
- Optimize network lifetime vis-à-vis node life
- Decentralized optimization without knowledge of entire network
- Ensure application level vice link level QoS

Emergent Intelligence

- Linked nodes of limited intelligence know own state but not overall
- Collective intelligence emerges through iterative goal achievement without central cognitive model

N02-064

Commercial R&D Partnership



June 2006

- TRL 6
- Per Customer

- Major Oil Company
- Mainstream condition monitoring player
- RLW Inc.
- Perpetuum

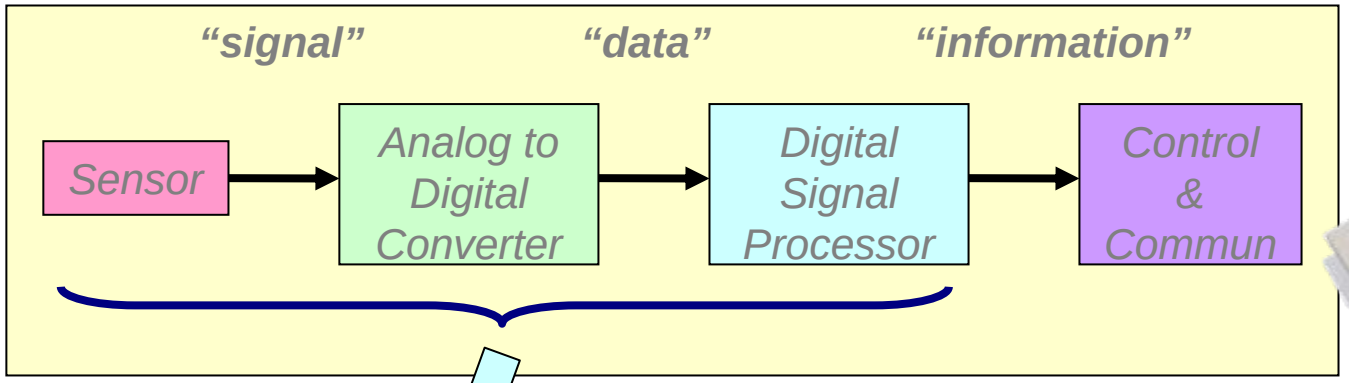
August 2007 - Production

- Open dynamic, self-healing mesh network
- Intrinsically safe
- Separate sensor
- Integral antenna
- Report to Condition Monitoring Software

Information Sensing

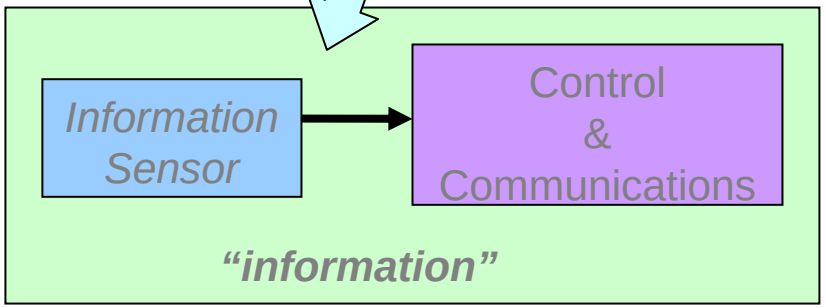
Connecting the Physical World to the Internet

Traditional Wireless Sensors



Moteiv "mote"

New Info-sensor



Valtronic flip chip package

ADVIS Inc./University of Rochester

First Generation Info-Sensor

Connecting the Physical World to the Internet

- Implements Sentry Circuit on board – Always monitoring, sensing not duty-cycled
- Integral sensor, battery, processor, radio
- Hermetically sealed package
- Demonstrate Sep 07, 10 node network

1 Step away from 1 cubic inch goal!