Wireless Network Protocols for Environmental Sensor Networks (ESNs)

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Why Environmental Sensor Networks (ESN’s)?

- Networks ofwirelessly connected environmental sensor nodes enable real-time distribution ofmesoscale data.
  - Environmental monitoring is well within the capabilities of today’s low-complexity, inexpensive nodes.
  - Addresses large problem: The scarcity of existing data due to the high recurring costs of conventional data communications.

GOAL: “Research and evaluate ad-hoc networking technologies and sensor hardware, develop software to enable an impromptu network solution for gathering and disseminating mesoscale weather data”
  - Create an ESN as part of a Mesoscale data network
  - Florida Road Weather Information System as an ESN “Backbone”
Road Weather Information System

Primary sites on FDOT towers
Off tower sensors

Road Weather Research Facility

RWIS Research Facility
UNF/FSU Grant
“JIMINI…the Cricket Project”

Hardware: Add a “cricket” & software to a sensor.. to make it wireless & Web-enabled.
- Java RMI and JINI enabled CPU Technology…
  with TCP/IP packet radios and eventually GPS chips
Tiny Microprocessors…JAVA native…TCP/IP radio

Cricket Characteristics…

- Very low power consumption (order 0.1 watt)
- Low data rate, rugged, reliable, relatively inexpensive, expendable
- Wireless 900 MHz spread spectrum radio development
- JAVA & JINI “discover and join” network enabled
- “Store and forward data” (low power…redundant)
- Use GPS to “know where they are” (serialized)
An ESN as part of a Mesoscale Data Network

Research: Protocols / Setup

- Physical / MAC: IEEE 802.15.4.
- Data Link Upper: IEEE 802.2
- Network: physical addressing, routing choice...
  - Zone Routing Protocol (ZRP): Hybrid Proactive / Reactive approach
  - Cost Adaptive Method (CAM):
- Node Placement: # of Neighbors – reliability vs. congestion
- Power Consumption vs. Performance:
  - Throughput vs. RTT vs. base and source node sleep duration.
  - Frequency of transmissions
- Reliability: Multiple base nodes?
The Future: A Bigger Picture

- This NWS project is one of many uses of Sensor Networks
- Currently these are ‘lost’ treasures of information
  - Only available / known to those involved in specific projects
  - Data needs to be shared across domains – aggregate related info.
  - Lessons learned can be re-applied to new situations
- The Internet has been highly successful in provided access to distributed data
  - Could this be extended to provide access via ‘portals’ to sensor networks
Other Applications: Google Earth...

- Immensely popular online global mapping software
- BUT... How long before people want more?
  - Many areas only show a large scale map; more detailed maps required - mesoscale data
- Addition of Real-time information
  - How busy are certain areas?: crowd / traffic flow information
  - Live Weather
  - Audio / video capture - link to security systems

Integration of Information: Personal Home Page

Concept only - Not recommended as a website design template!

- Outside Temperature: 12 degrees
- Inside Temperature: 20 degrees
- Hot Water Tank Status: Hot
- Outside Noise Level: 5dB

Security Incidences: None

```plaintext
View Fridge Cam...  Set Oven Timer...
View Latest Security Report...

>>>Digital Video Broadcast Recorders<<<
Recording Status: Recording Big Brother (C4 20:00-20:30)
Next Scheduled Record: Friends, C4 21:00
Free Space: 1.5 Terabytes
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SUMMARY

- ESN goals can be achieved at the software level with use of Java & Jini software technology.
- ESN goals can be achieved more effectively with use of the IEEE 802.15.4 protocol and modern ESN tailored routing and addressing protocols.
- A standard open source solution enables users to ‘plug in’ to existing networks, share and integrate data.
  - Standardization of protocols and integration of research - key to progress.
- WPAN solution based on standards such as 802.15.4 would allow an Internet of wireless devices, communicating ad-hoc to share resources.

Questions?