Title

Establishing a Multi-Spatial Wireless Sensor Network to Monitor Nitrate Concentrations in Soil Moisture

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Establishing a Multi-Spatial Wireless Sensor Network to Monitor Nitrate Concentrations in Soil Moisture

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Overview: From an individual 'pylon' to a multi-spatial sensor array

To create the remote network each node or 'pylon' consists of a MICA2 microprocessor (Crossbow Technology, Inc., San Jose, CA) outfitted with a suite of commercially available sensors to measure temperature, precipitation, and soil moisture and nitrates. These battery-powered nodes process, then transmit their data wirelessly at regular intervals by single- or multi-hop routing to the base station for relay to a local computer. Initially, this network simply forwards raw data. The network not only transmits raw sensor data, but is also capable of running simulations and processing queries from the user in order to predict soil moisture and nitrate transport from both historical and real-time data.

From Concept to Deployment: Establishing a wireless sensor network in the Mojave Desert

From Networked Sensor Node(s)

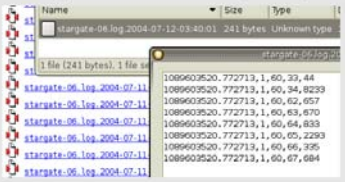
- MICA2 mote or network node.
- MDA300 environmental monitoring board.
- Sensors for measuring temperature, precipitation, moisture, nitrate.

To Base Station

- Measurements are transmitted directly or via multi-hop to a solar-powered base station.
- A Stargate microprocessor, Globetrotter GPRS card, and Cingular wireless account forward data to a local machine.

To Database

- Data archived on server.
- Sensor measurements time-stamped and examined (below).



- Real-time graphing, GUIs in development.

Network Mechanics: Spatial distribution, system software, and network tasking

Network Tasking

- Pylons / nodes send data to base station.
- The base station compares sensor-based observations to flow and transport simulations.
- Local flow and transport parameters identified with a decent-based model inversion algorithm.
- Continuous estimate of the moisture, temperature, and nitrate levels.
- Following calibration, predictive simulations through a nonlinear optimization routines identify the optimal application rate for subsequent irrigation events.

Mote Software: TinyOS

- Developed at UC – Berkeley
- Open-source software with component-based architecture.
- Designed for wireless networks with minimal hardware.
- http://www.tinyos.net

Base-Station Software: EmStar

- Linux-based software framework.
- EmStar Components:

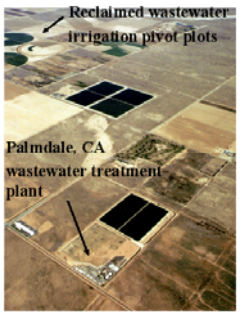
hostmoted – driver to interface with a mote attached to base station that communicates with deployed motes.
motenicd – provides network interface
EmRun – start, stop, and manage an EmStar system
DSE Server – forwards user queries to motes, listens for and logs data

- EmStar Services (future implementation):

Link/Neighborhood estimation – node connectivity
Time Synchronization – relate events from nodes
Routing – innovative, hybrid transport/routing protocols

- http://cvs.cens.ucla.edu/emstar/

Node Distribution



- Pylon spacing will be an irregular grid with spacing intervals of 2, 5, 10, 20, 50, and 100 m.
- Sampling locations to examine soil variability, network design, and calibration algorithms.