



Wireless Sensor Networks for Precision Agriculture

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Corporate Overview



Global Leader in Sensory Systems

- Founded 1995
- MEMS-Based Inertial Systems
- Wireless Sensor Networking

85 Employees World Wide

- Offices in California, China, Japan, Switzerland



World Leader in WSNs

- Partnerships/Investment
 - Cisco Systems, Intel, Microsoft
 - Morgenthaler Ventures, Paladin Capital



Microsoft

Why Precision Agriculture? Why WSNs?



Environmental concerns.

- Water quality and availability.
- Climate change.
- Minimal use of chemicals and fertilizer.
- Regulations

Agriculture is a business.

Better understanding of the process leads to a better business.

- Resource usage
- labor
- Yields
- Quality of product

You can't manage unless you can measure.

What can WSN offer?

- Cables are expensive!
- Monitor areas with no infrastructure
- Flexibility for temporary or problem-solving deployments
- Get more data, consistent data



Typical Applications for Environmental Monitoring



■ Microclimates

- Monitoring Local Temperature/Humidity for
 - Frost detection
 - Pest and mold breakout



■ Irrigation Management

- Soil Moisture to monitor water delivery to specific Irrigation blocks
- Soil Moisture monitoring for Stress irrigation to improve crop quality.
- Remote Irrigation Control (valve actuation, pump control)
- Monitoring Irrigation line flow/pressure
 - Water delivery to correct destination

Example: Vineyard Soil Moisture Monitoring



- Task:
 - Get best value from the vineyard
- Issue:
 - Water an expensive resource
 - Grape **quality** improved by stress irrigation.
 - Crop damaged quickly if overstressed
 - Other measurement opportunities



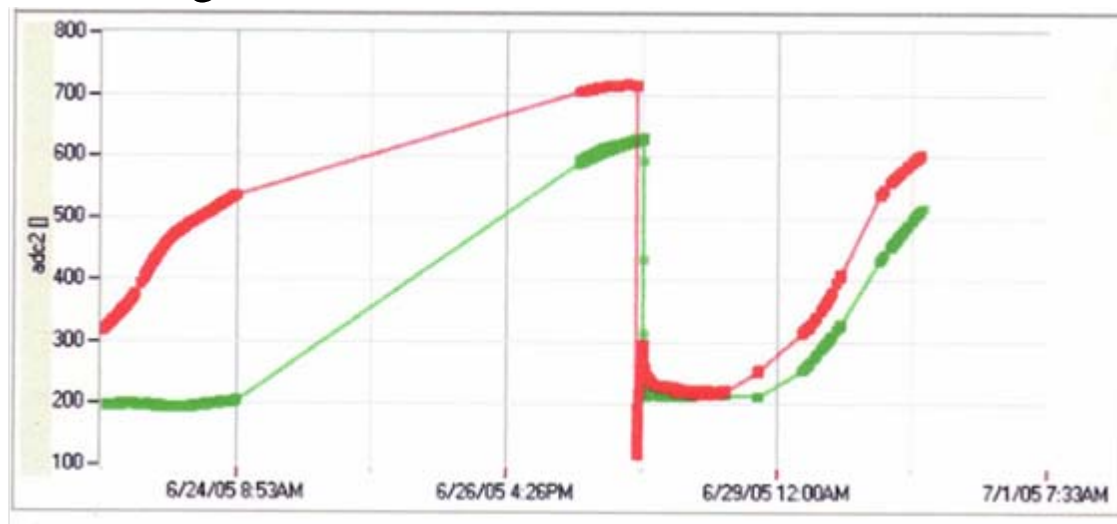
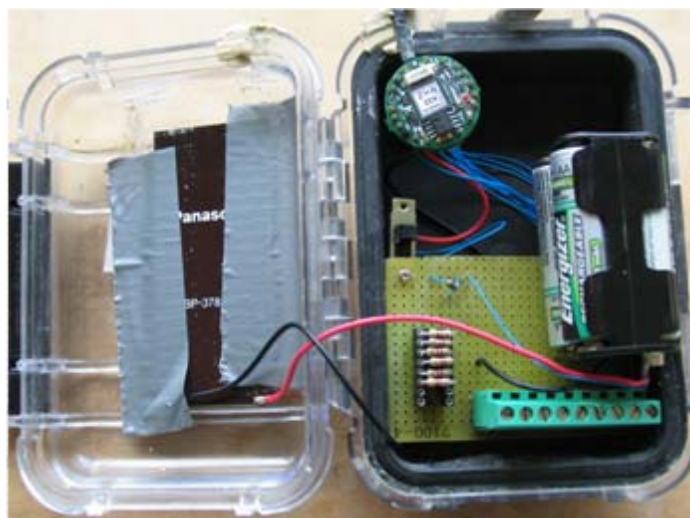
3 MHa of vineyards in Europe

Camalie Vinyard Solution (2005 – 2006)



Custom Irrigation Monitoring System

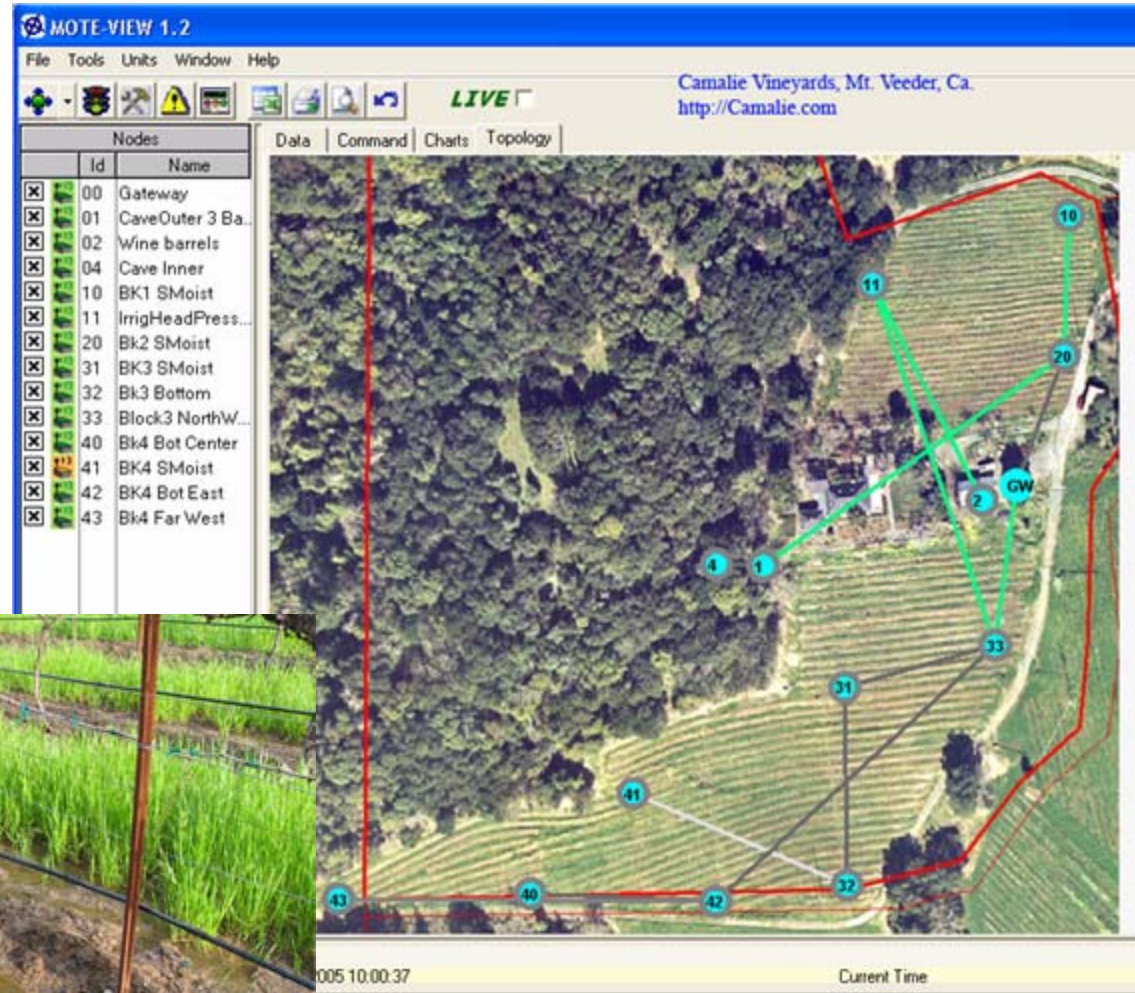
- Crossbow MICA2dots interfaced to sensors:
 - Soil Moisture
 - Soil Temperature
 - Water Flow, Pressure
 - Temperature sensors
- Data sent back wirelessly
- XServe used to make a live website with data
- MoteView alternate viewer/network management



Camalie Vineyards Deployment (2005 – 2006)

■ The Deployment

- Area: 4.4 acres
- 12 distinct « sectors »
- 30 Nodes
- Also water pressures, storage temperatures





■ Impact and Benefits

- Control irrigation
 - Found shorter, more frequent irrigation kept water shallow.
 - Managed water supply to produce high-quality grapes
 - Less total water usage per grape
- Doubled yield while maintaining quality.
 - Yield went from 4 tons/acre 2005 -> 9 tons/acre 2006
 - Maintained high quality, thus high price for grapes
- Monitored health/effectiveness of irrigation hardware
- Managed system from remote access
 - Owner does not live on site, now could work from home!
- Competitive advantage when selling to wine makers

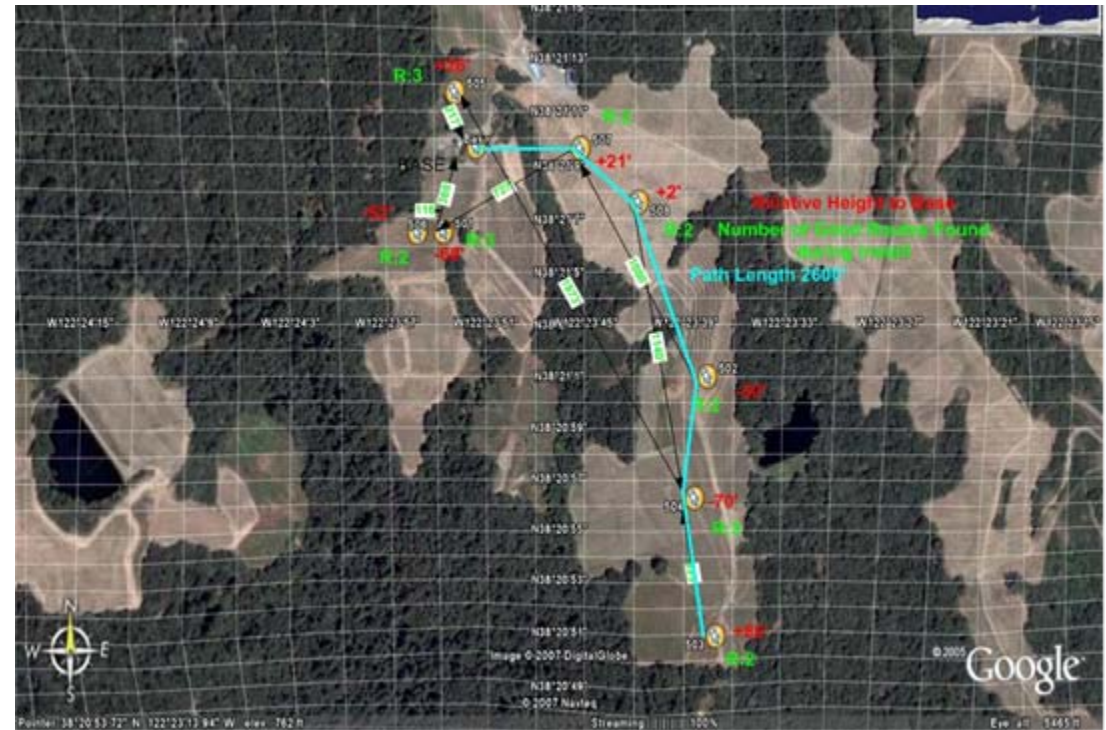
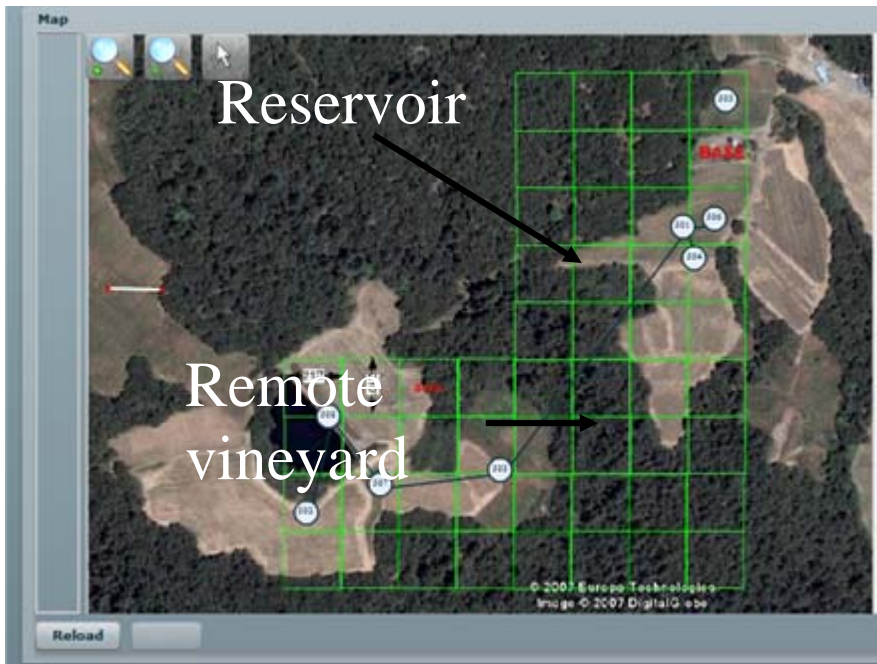


New Deployment (2006 – 2007)



New system based on IRIS mote (MEP2 Kit)

- 8 nodes monitoring 2 vineyards and remote reservoir.
- Radio links up to 1200' with multiple paths
- Soil moisture/temperature
- Air pressure, temperature, humidity
- Solar powered

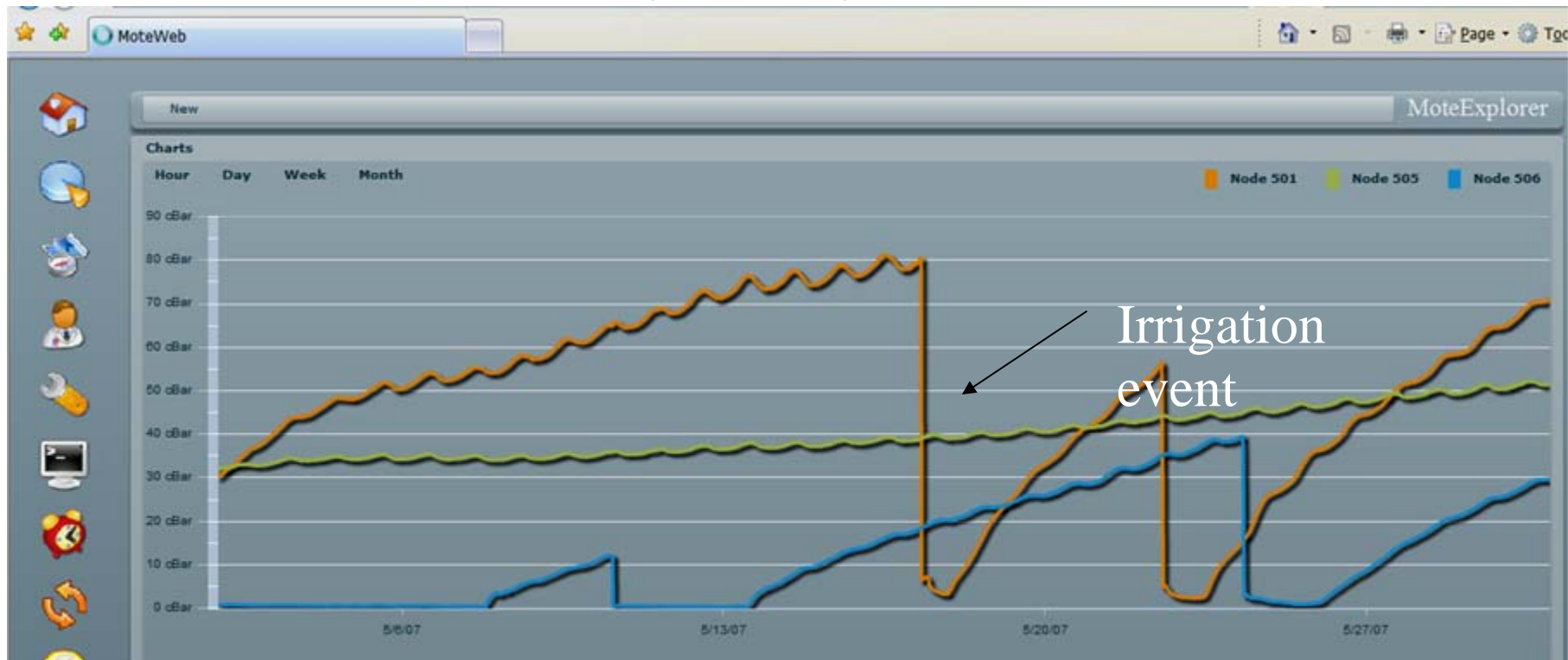


Remote Soil Moisture Monitoring



Web interface to monitor and control network

- Sensor data
- Network health
- Send commands or program images into the network



<http://www.camalie.com>

Other Environmental Monitoring Ideas



Watershed Management

Understand how water is absorbed by soil

- Local measurements of soil moisture, temperature
- Local measurements of humidity, pressure, temperature
- Impacts flood prediction
- Understand farm run-off
- Impacts water quality for fish and wildlife



Dike/levee monitoring

Direct local measurement of soil conditions in dike

- Monitor and predict failure conditions



Forest Fire Prediction/Management

Direct measurement of environmental conditions contributing to start and spread of forest fires

- Deploy before fire to warn of dangerous conditions
- Deploy at fire to predict spread





MoteWorks in MS Visual Studio

- Full Support of Visual Studio
- No more TinyOS
- IMote2: 32 bit XScale Processor

Easy, familiar development environment

IMote2 aimed at data rich or computationally demanding applications

- FFT, photo capture, distributed intelligence

