US EPA ARCHIVE DOCUMENT

ensor Networks & Performance Management

National Environmental Monitoring Conference
13 August 2008

Michael Brody
- Environmental Protection Agency
- brody.michael@epa.gov

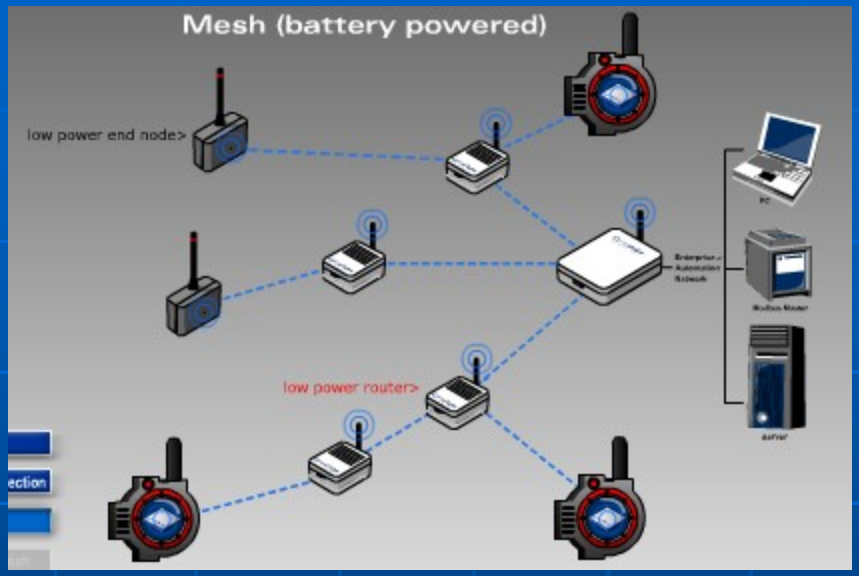
Stuart Nagourney
- New Jersey Department of Environmental Protection
- stu.nagourney@dep.state.nj.us

Marissa McInnis
- Environmental Protection Agency
- mcinnis.marissa@epa.gov

US EPA ARCHIVE DOCUMENT

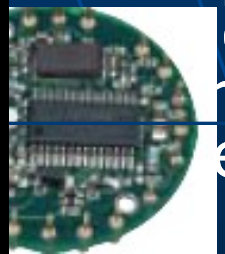
What is a Sensor Network?

Scientific American



Courtesy of Crossbow Technology

"...a wireless network consisting of spatially distributed autonomous devices using sensors to cooperatively monitor physical or environmental ditions, such as temperature, sound, ration, pressure, motion or pollutants, at erent locations."



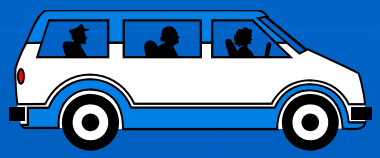
US EPA ARCHIVE DOCUMENT

EPA Strategic Plan 2006-2011

- "Through distributed sensor networks, we could collect and transmit data faster and more frequently, improve data quality, enhance data integration, and improve data sharing…"
- "This technology could support our Report on the Environment, advance our foresight capabilities, and provide data that accurately portrays environmental conditions on a real-time basis."
- Advanced sensor technologies was the one emerging issue that arose most frequently during a series of futures/strategic planning workshops

US EPA ARCHIVE DOCUMENT

Traditional Sampling

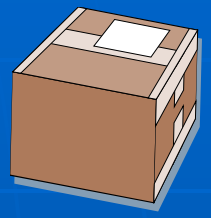


Travel to Site

→

Collect Sample

→

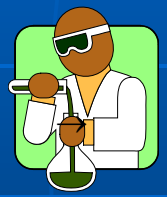


Pkg. Sample for Shipment

→

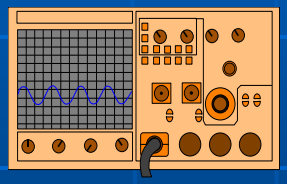
Mail Sample to Lab.

→



Prepare Sample for Analysis

→

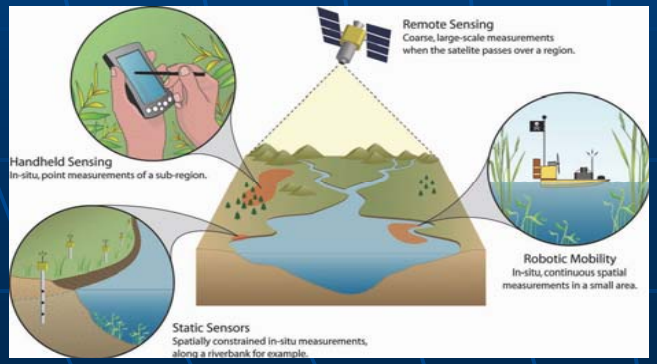


Analyze Sample

→

Review Results

Sensors



Sensor Collects Data in Field;
Without Discrete Sample -
Transmits Info. Directly

US EPA ARCHIVE DOCUMENT

Enable Dramatic Improvements

Performance Measurement, Program Management & Environmental Monitoring

- More easily understand dynamics
  - Spatial and temporal complexity
- Real-time data
  - Enable quick notification and response time to worsening conditions
- Smart sensors
  - Automate responses to threats to human health and the environment
- Reduce costs
  - Minimize traditional monitoring when sensors show that conditions are within acceptable tolerances
- Target sampling times and frequencies
  - Produce data best suited to achieve compliance

US EPA ARCHIVE DOCUMENT

Sensors & Traditional Monitoring

- Traditional sampling and analysis methods
  - For now – perhaps more precision of individual measurement
  - But can be misleading about a site
- Sensors gather much more data
  - Useful information on temporal and spatial variations in contaminant levels
  - Real time data availability
  - Ability to evaluate trends
  - Sensors may cost more at first
    - Lower analytical costs over time

US EPA ARCHIVE DOCUMENT

Sensor Data Issues

- Data Quality & Acceptability
  - Data comparability to traditional methods
  - Accuracy & precision
- Certification and Regulatory acceptance
- What is More Valuable
  - More significant digits or timeliness
  - System-level characterization of a site or ecosystem?
- Depends on the Decision to be Made

US EPA ARCHIVE DOCUMENT

Moving Forward
Demonstration Projects Should

- Be a catalyst for change
  - Broad national interest
- Contribute to the adoption of advanced sensor technologies in a regulatory environment
- Existing monitoring efforts already underway for comparison purposes
- Sensor(s) chosen must be reliable and durable
- Demonstrate ability to capture spatial and/or temporal complexity

Potential Areas of Application
in Aquatic Ecosystems

- Septic Systems
- Non-Point Source Runoff
- Beach Water Quality
- Combined Sewer Overflows
- Concentrated Animal Feeding Operations
- Rapid tracking groundwater plumes

US EPA ARCHIVE DOCUMENT

US EPA ARCHIVE DOCUMENT

TYPES OF SENSORS

Sensor Category	Parameter	Cost ($)	Field-Readiness
Physical	Temperature	50-100	High
	Moisture, Content	100-500	High
	Flow Rate, Flow Velocity	1,000-10,000	High
	Pressure	500-1,000	High
	Light Transmission (Turbidity)	800 -2,000	High
Chemical	Dissolved Oxygen	800-2,000	High
	Electrical Conductivity	800-2,000	High
	pH	300-500	High
	ORP	300-500	Medium
	Major Ions (Cl^-, Na^+)	500-800	Low-Med
	Nutrients ($NO3^-$, $NH4^+$)	500-35,000	Low-Med
	Heavy Metals	NA	Low
	Small Organic Compounds	NA	Low
	Large Organic Compounds	NA	Low

Examples of environmental sensors: cost (NA=Not Available). (From: Distributed Sensing Systems for Water Quality Assessment and Management, WWC & UCLA/CENS; February 2007)