A Sensor-cyber Network Testbed for Plume Detection, Identification, and Tracking

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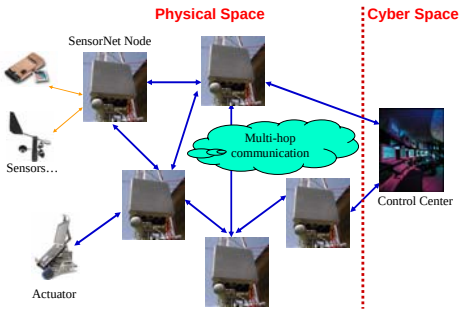
Introduction

- Under the national SensorNet initiative, Oak Ridge National Lab, in conjunction with its University collaborators, has carried out the initial deployment of a **d**etection, **i**dentification, and **t**racking **s**ensor-**c**yber **n**etwork (DITSCN) in the Washington D.C. and Memphis Port areas, against radiational, biological and chemical attacks.

- DITSCN combines various modalities of sensors and cyber networks
  - – Sensors network provides information about the physical space
  - – Cyber network provides storage and computational resources to predict plume propagation based on realistic dispersion models
  - – Decisions regarding future sensing and communications are made in cyber network and carried out in the physical space

DITSCN Architecture



Research Tasks

1. **Convergence** between physical and cyber spaces
   - – Effectively gather information about the physical space
   - – Communicate most useful data to the cyber space given bandwidth, delay and signal attenuation constraints
   - – Enable the cyber space to task and activate sensors to collect high-quality data
2. Acknowledge the **existence of uncertainty** and enable decision making processes to deal with uncertainty in a robust fashion
   - – Corporate physical environment: terrain elevation, land cover, and meteorological conditions
   - – adequate modeling of physical phenomena (e.g., plumes with respect to the absorption, propagation, and dispersion coefficients).
3. Support for **deeply embedded operations**
   - Ability to integrate system components in an open, ***plug-and-play*** manner, through the use of open data, control and communication interfaces

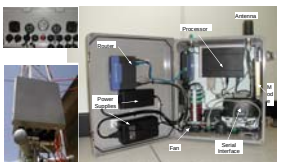
Physical Space

RFTrax RAD Sensor to detect the presence and intensity of the plume source

Plume Source

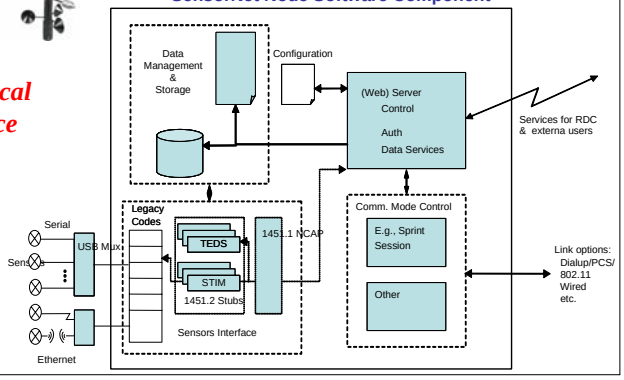
- Sensor data communicated through RS-485 or 802.11x interfaces to the Sensor-Net Node
- *IEEE 1451* interface to configure sensors at runtime.

SensorNet Node



WMS Wind Sensor to monitor the wind speed and direction

SensorNet Node Software Component



•Multi-hop communication over 802.11x wireless network
• AODV routing

Cyber Space

- Realistic **SCIPUFF** plume dispersion model support for analysis and rendering of plume propagation in a real terrain
- Dynamically update plume propagation with variations in wind speed or direction
- Dynamically update the topology and routes in the multi-hop wireless sensor network
- **Tasking** mobile sensors (ER-1 robots) to collect high-quality and relevant data
- Dynamically update the positions of ER-1 robots

- **ER-1 Robots** supporting autonomous and programmable movement are guided by the cyber space, using commands sent over 802.11x wireless network.
- **Tasking** enables sensor mobility to increase the coverage of a high-risk location.

ER-1 Robots