Computational Science and Engineering Division Overview

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Computational Sciences and Engineering Division

OAK RIDGE National Laboratory

CSED Is Committed to the Knowledge Discovery Agenda

- **Entire Research Division Focused on Knowledge Discovery**
  - 130 full-time staff
  - 50 subcontractors
  - 50 students
- **Outstanding Resources:**
  HPC, Networking, MRF, JICS
- **LDRD Initiative in Knowledge Discovery**
- **Programmatic efforts well-aligned with this science agenda**

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ORNL Focus in Knowledge Discovery

- **Actionable insights from massive, dynamic, disparate data sources**

  Orchestration and control of distributed, disparate information sources

  High speed analysis and fusion of text, video, audio, and sensor data streams

  Geospatial and temporal data science

- **Ability to ask more complex questions and detect more complex processes using increasingly higher data resolution**

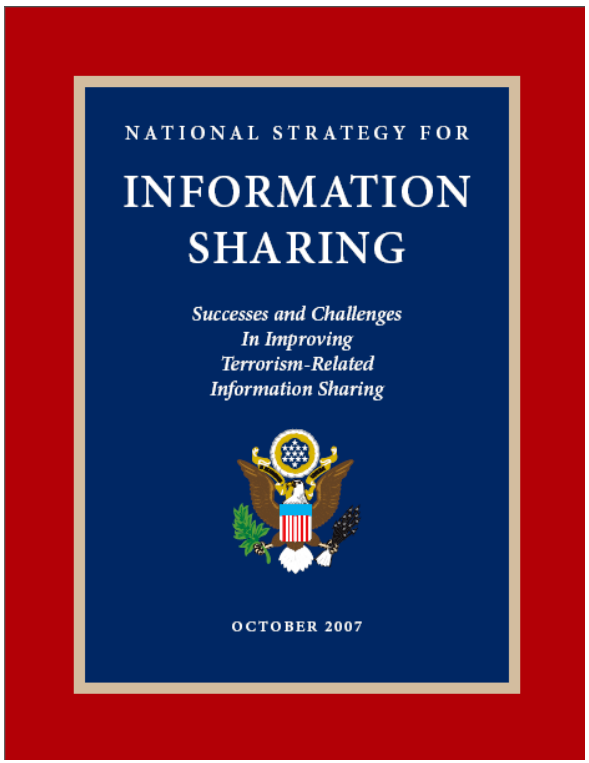
  Population models and population data development

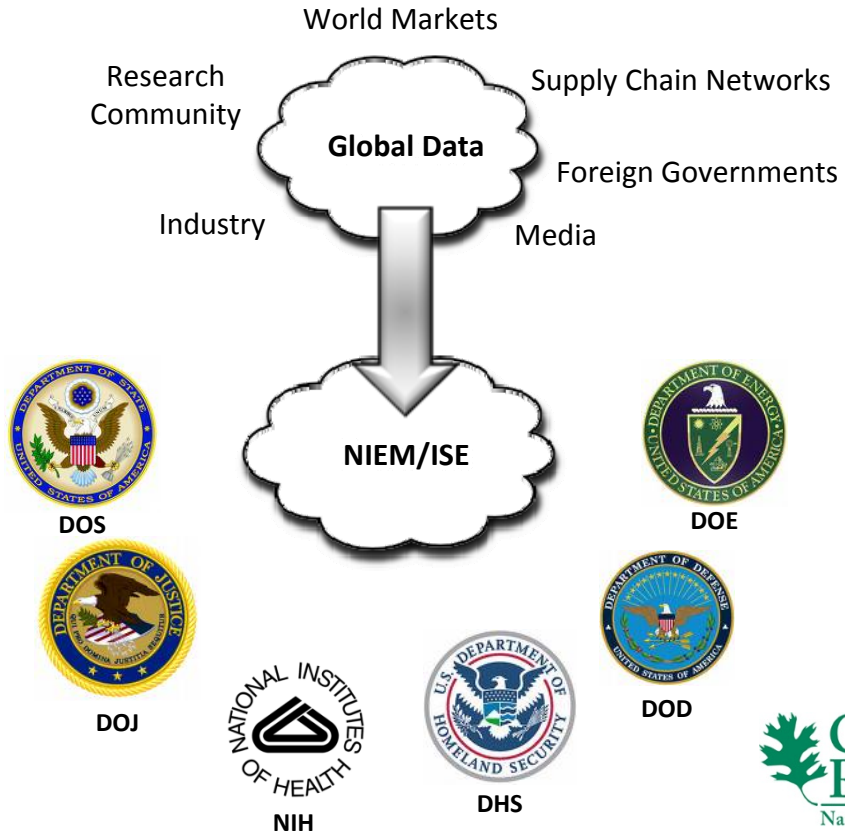
  Modeling and simulation of emerging behavior in complex systems (e.g., social systems)

  Real-time data driven simulations (take advantage of data resolution and availability)

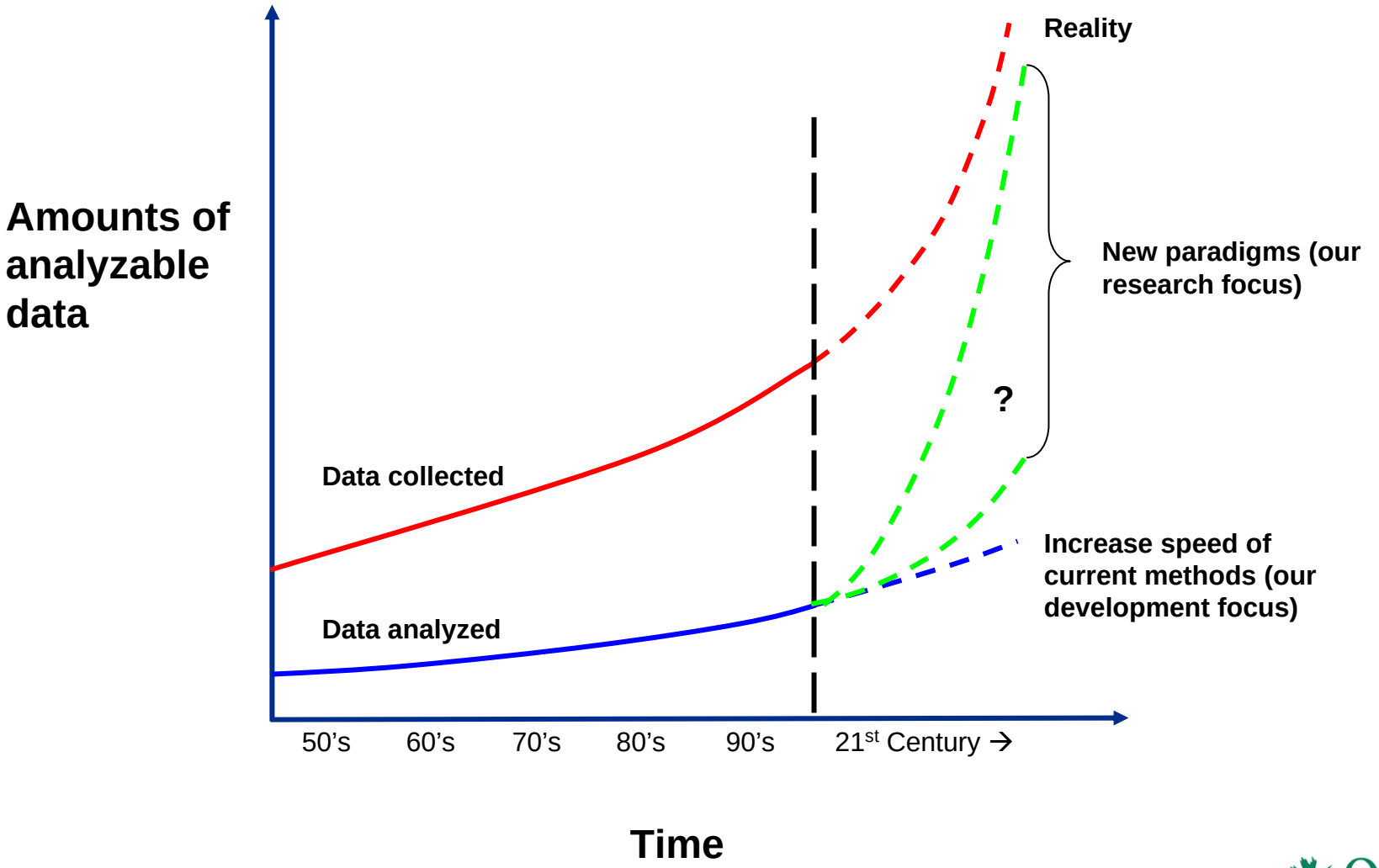
Knowledge Discovery Challenge

How to trigger and coordinate a discovery process across data held by industry, academia, and government agencies within and outside the United States



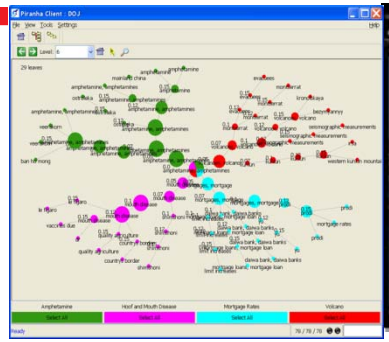


Knowledge Discovery Challenge



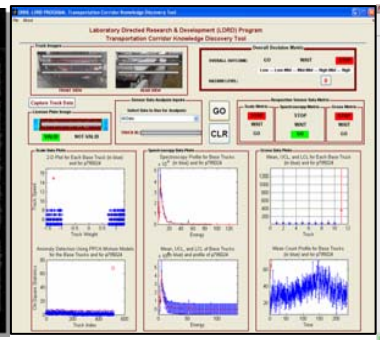
Research and Development Focus Areas

Sensor Networks

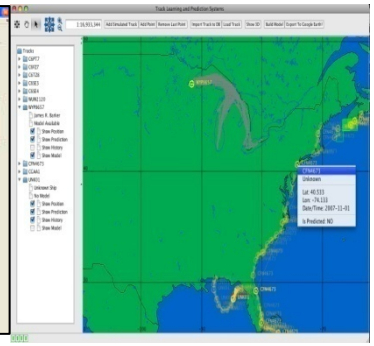


Analysis in Network

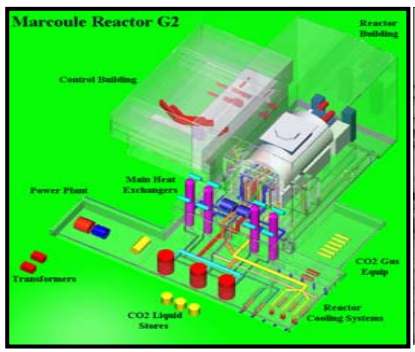
Persistent Surveillance



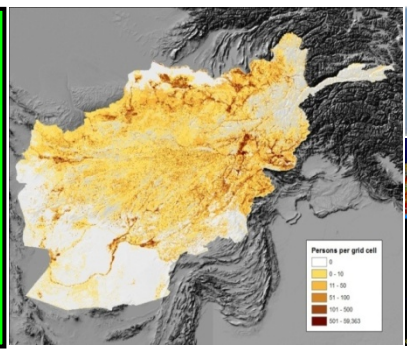
Data Fusion



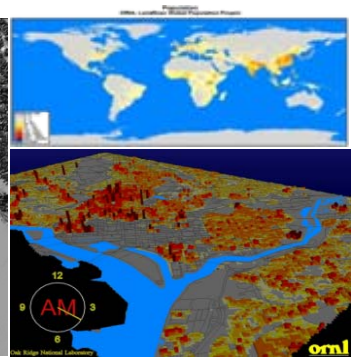
Anomaly Detection



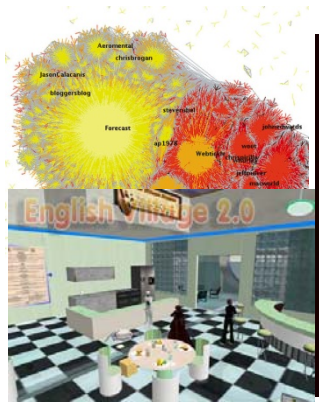
Predictive Analysis



Emergent Behavior



Population Dynamics



Social Data Analysis

Quantum Information

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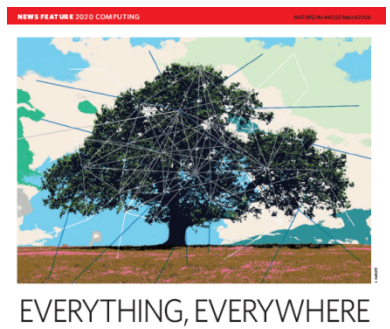
Our largest set of projects relate to collection, analysis, and dissemination of sensor data.

- **Interdiction, detection, emergency response**
  - ❖ **Mobile, Transportation Corridors, Ports, Military Bases**
- **Real-Time Data Management**
  - ❖ **Collection, Dissemination, Archiving**
- **Pre-deployment analysis**
  - ❖ **Cost, Performance Prediction, Risk vs Benefit**
- **Wide-area ubiquitous sensing, actuation, and deployment**
  - ❖ **Orchestrating the functionality across a large system of distributed sensors/processors (eg Electric Grid, Autonomous robotic systems)**
- **Cross-agency and cross-administrative boundary data-sharing and interoperability**
  - ❖ **Standards and policies**
- **Net-Centric Services**
- **Security, Access Controls**



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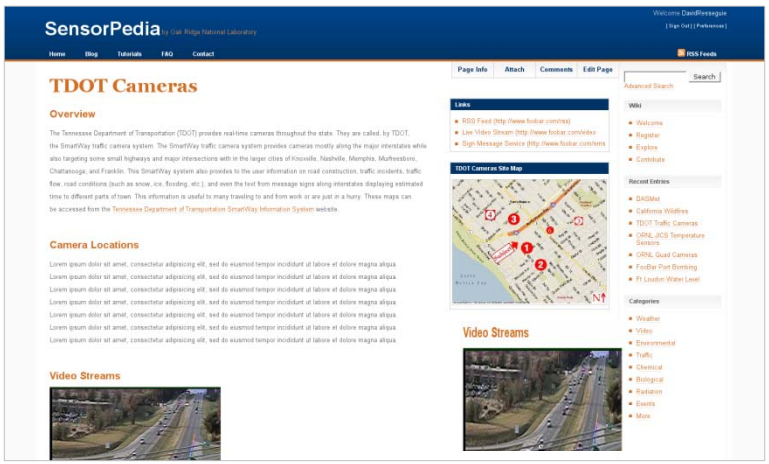
Social Network for Sharing Sensor Data



SensorPedia

Addresses the ability to access and fuse data from disparate sensor networks

Use of Web 2.0 "social networking" technologies (e.g., RSS, wikis, podcasts, mashups, blogs, and streaming video)

Key identity management and credentialing standards

Data owner controls publishing and subscribing

Explores how volunteered sensor data is being used and shared

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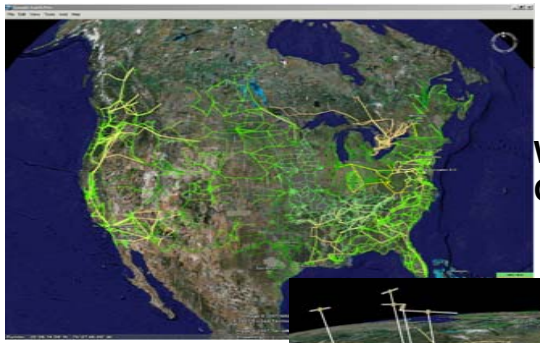
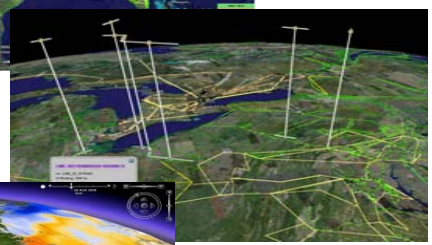
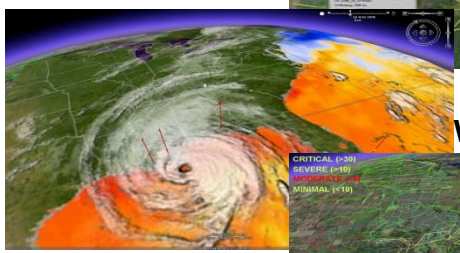
Knowledge Representation for Situation Awareness of the Electric Grid



Wide-area Grid View

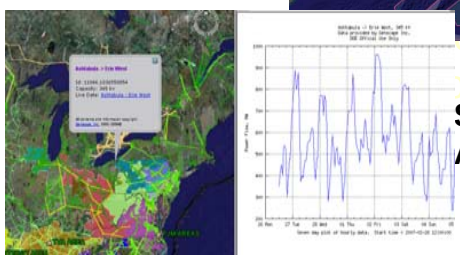


Outages



Weather

Impacts



Streaming Analysis

- **Organize, stream, and fuse data from various sources through an analysis pipeline**
- **Present an intuitive visualization of the status to end-users**

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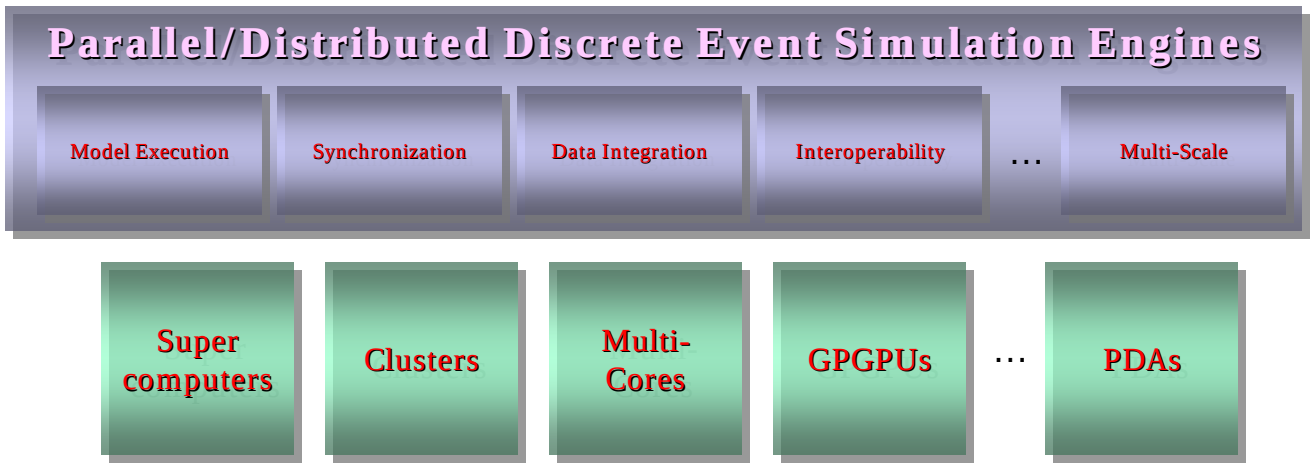
Where are all my local, state, and federal assets?

- What assets can I track at all times
- How well can I estimate the location of non-tracked assets
- What computational resources will be required
- What are the uncertainties

RealSim



IBM Blue Gene Award for scalable algorithms

Best Paper Award for agent-based methods

Tackling DTRA 105 persistent surveillance grand challenge**

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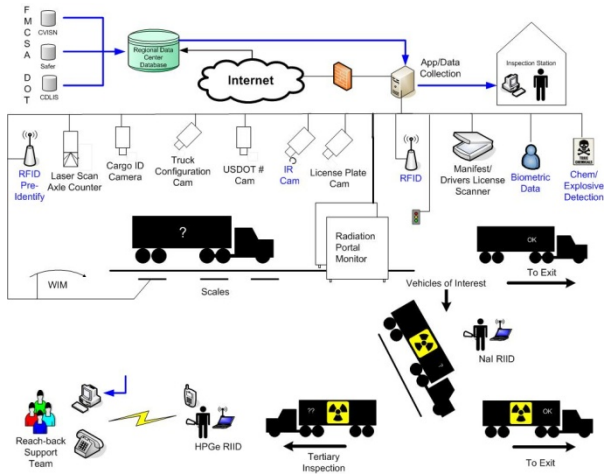
Large scale data exploration constrained by wall-clock time to provide decision support.

- **Detect anomalies**
- **Data dip into structured and unstructured data**
- **Inductive hypothesis generation**
- **Human interaction enhanced by real-time data support**
- **Threat anticipation**



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Achieving Systematic Situation Awareness

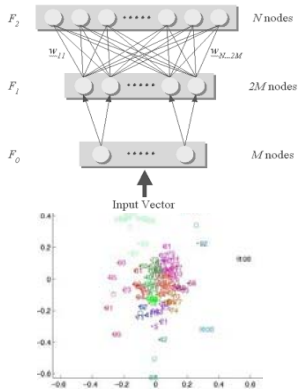
1 Collect

Syndromic Surveillance

Field Sensors

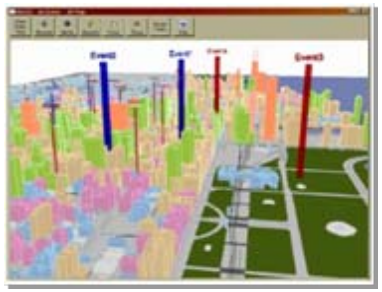
Monitoring

2 Integrate



Knowledge Base

3 Detect

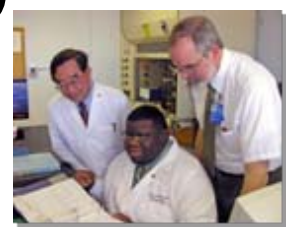


Anomaly Detection

4 Network/Share

Across Agencies

5 Evaluate/Assert



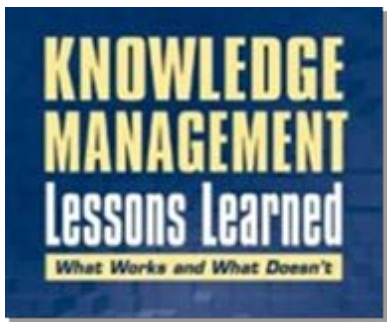
Cross Check

6 Respond

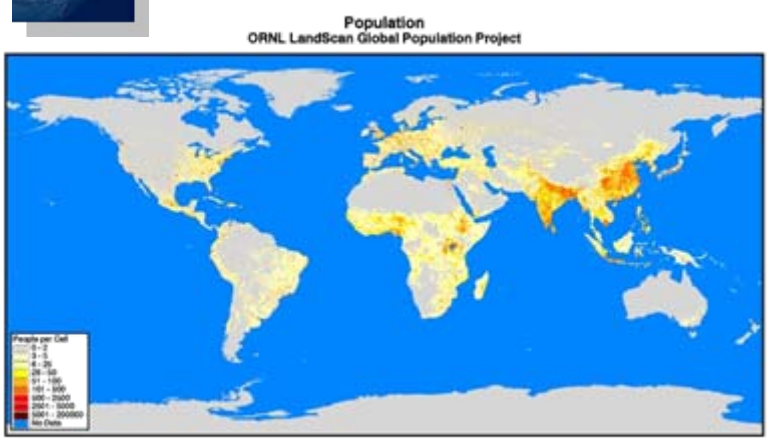
National Institutes of Health

U.S. Department of Homeland Security

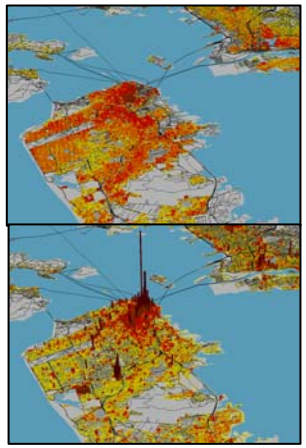
7 Reconcile



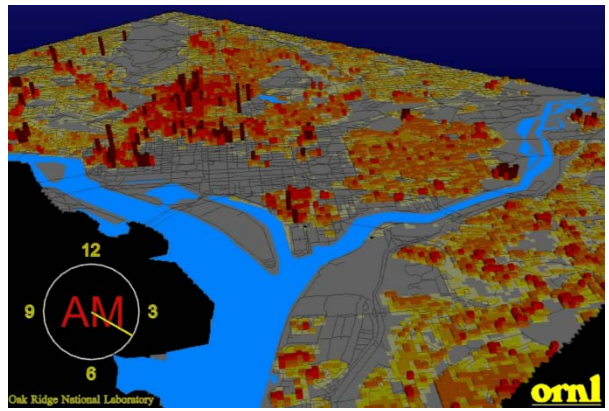
Population Data and Models



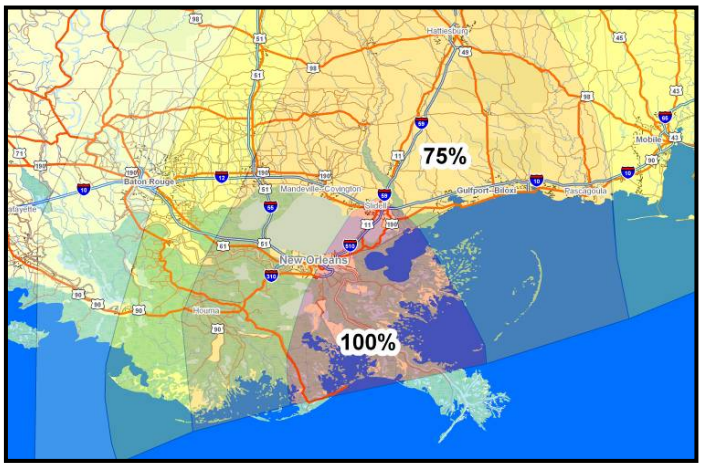
LandScan Global 30”x30”



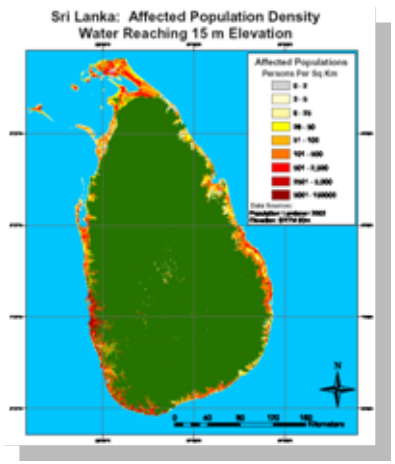
LandScan USA Day/Night 3”x3”



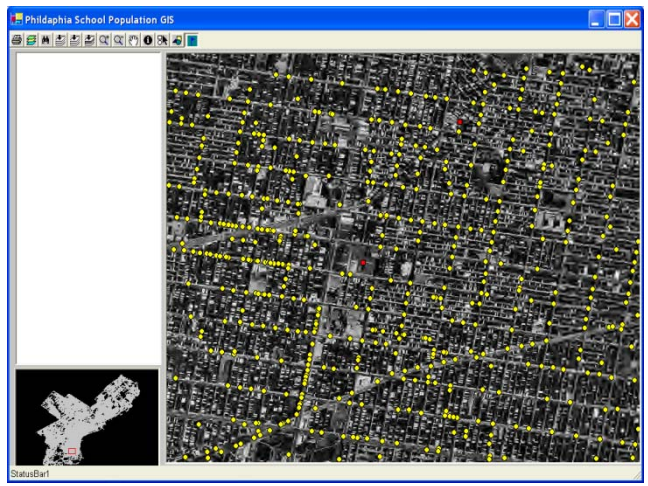
Nominal 24-hour variation



Hurricane Impacts



Tsunami Impacts



Exposure Impacts

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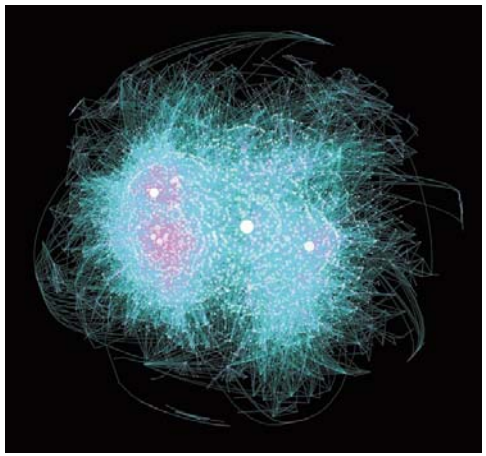
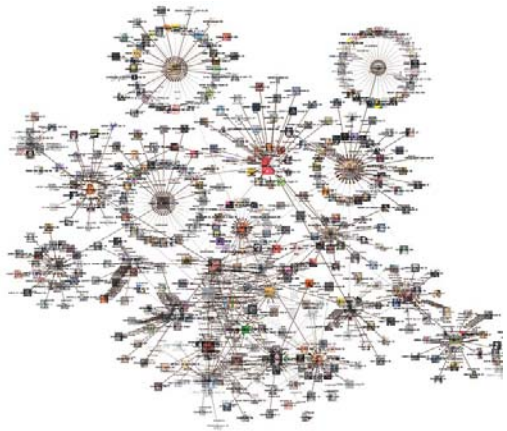
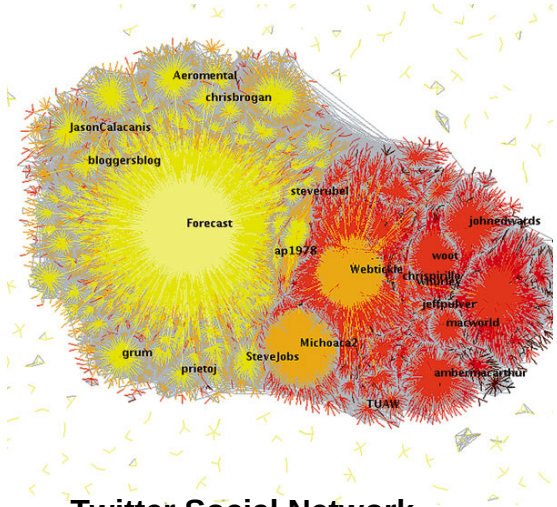
Social Networks Analysis



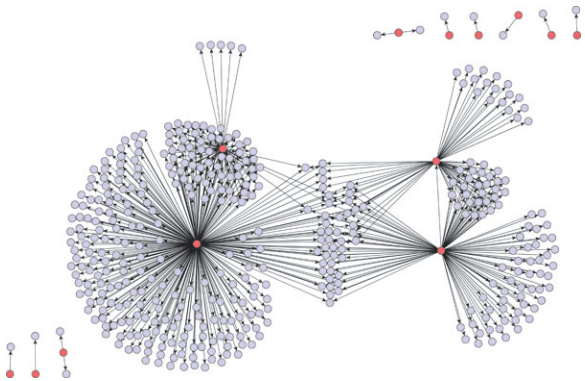
Blogosphere



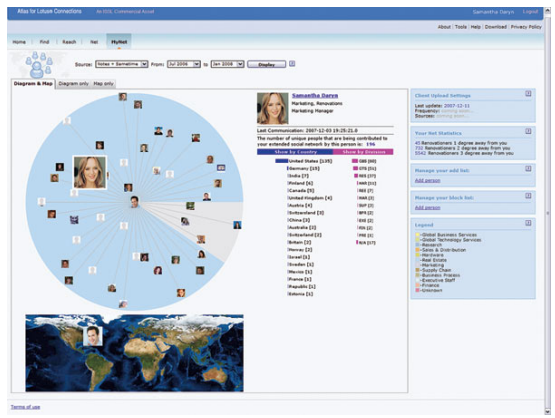
Comment Flow



Twitter Social Network



Viral Marketing



Workplace Networks

Images from Technology Review, Vol 111/No 2. March/April 2008

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Virtual Worlds to Explore Social Behaviors

Second Life – Linden Lab

Education

Tourism

Collaboration

Shopping

Interviews

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Thank You

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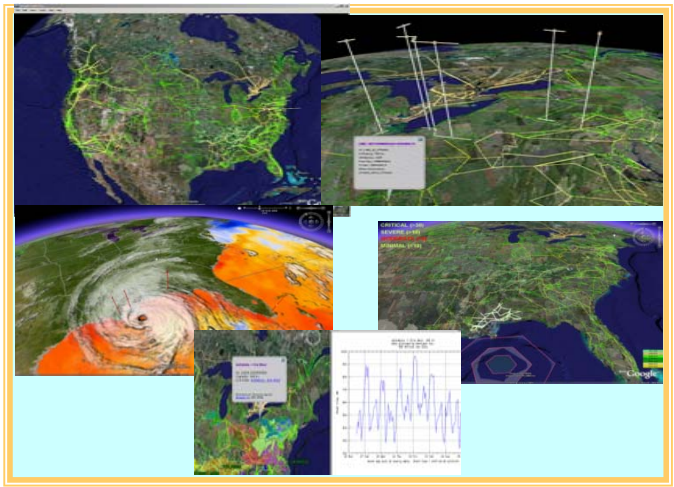
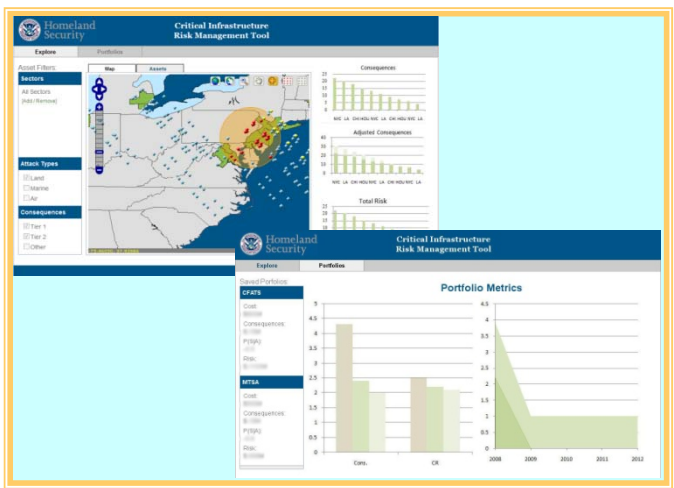
Data collection & knowledge discovery

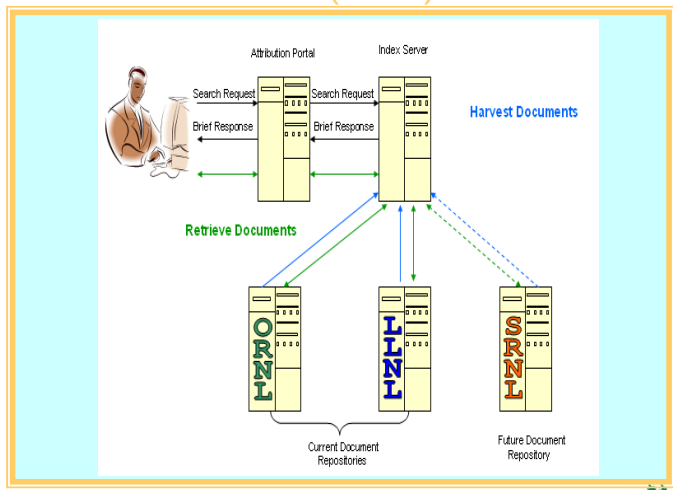


Modernizing the Electric Grid

Chemical Security Assessment Tool (CSAT)



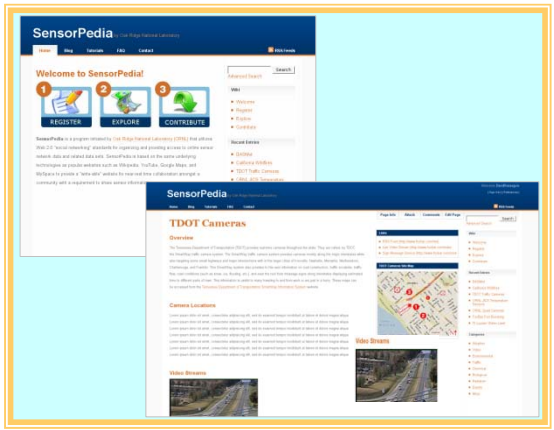
Critical Infrastructure Risk Management Tool



Knowledge Management & Analysis System (KMAS)

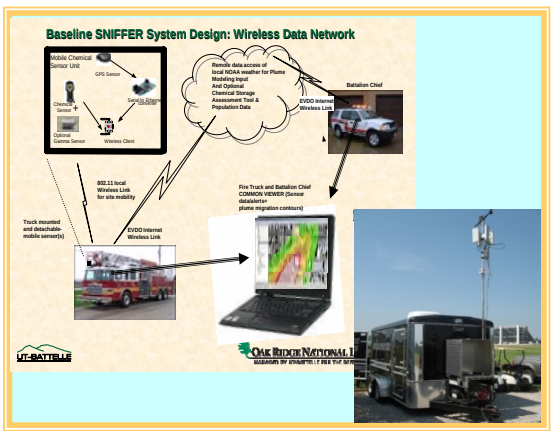
Sensor networks, data integration, & software applications (SensorNet and spinoff projects)

SensorNet

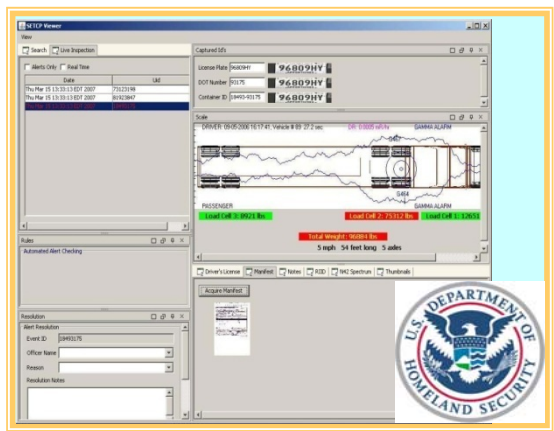


SensorPedia

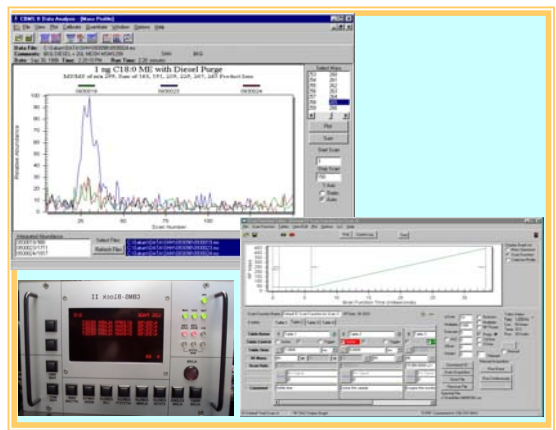
Bragg Experimental SensorNet Testbed (BEST)



SensorNet for Fire & First Responders (SNIFFER); Sensor Network Area Protection System (SNAPS)



Southeast Transportation Corridor Pilot Program (SETCP)



Software Modules for Block II Chemical Biological Mass Spectrometer (CBMS)

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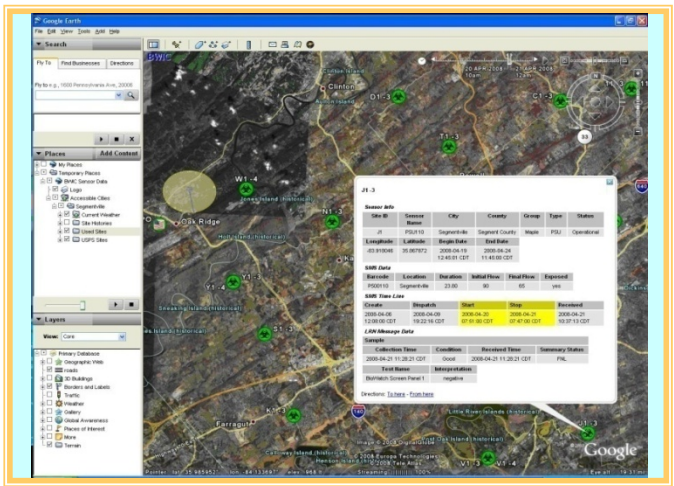
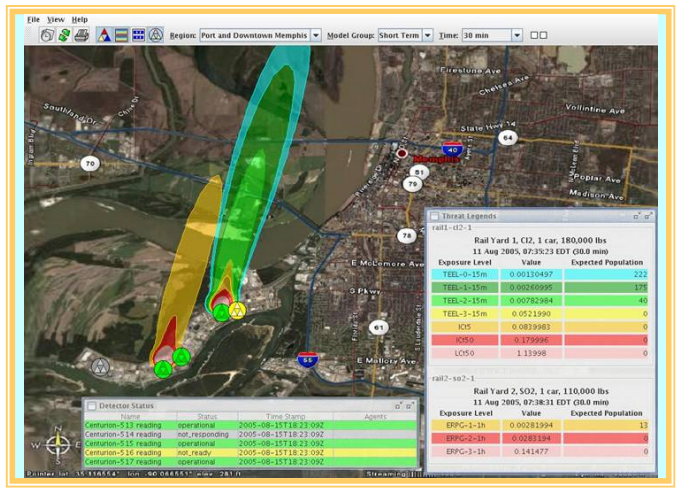
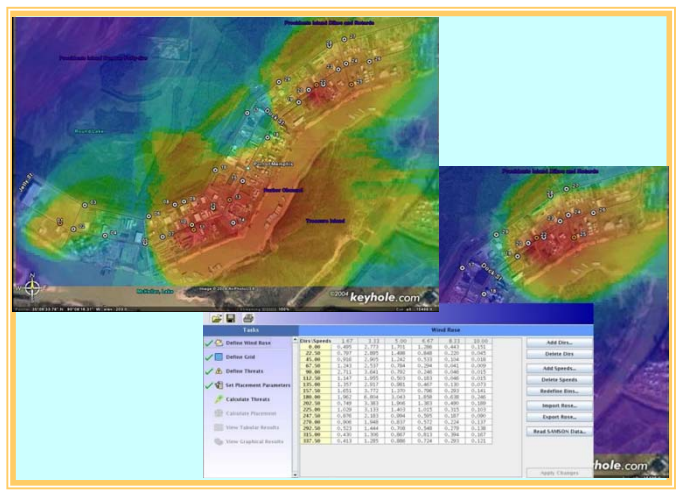
Emergency response systems and technologies



Biological Warning and Incident Characterization (BWIC) Environmental Monitoring System



Threat Detection and Analysis System (TDAS)



Risk-Based Sensor Placement Methodology and Software Tool

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