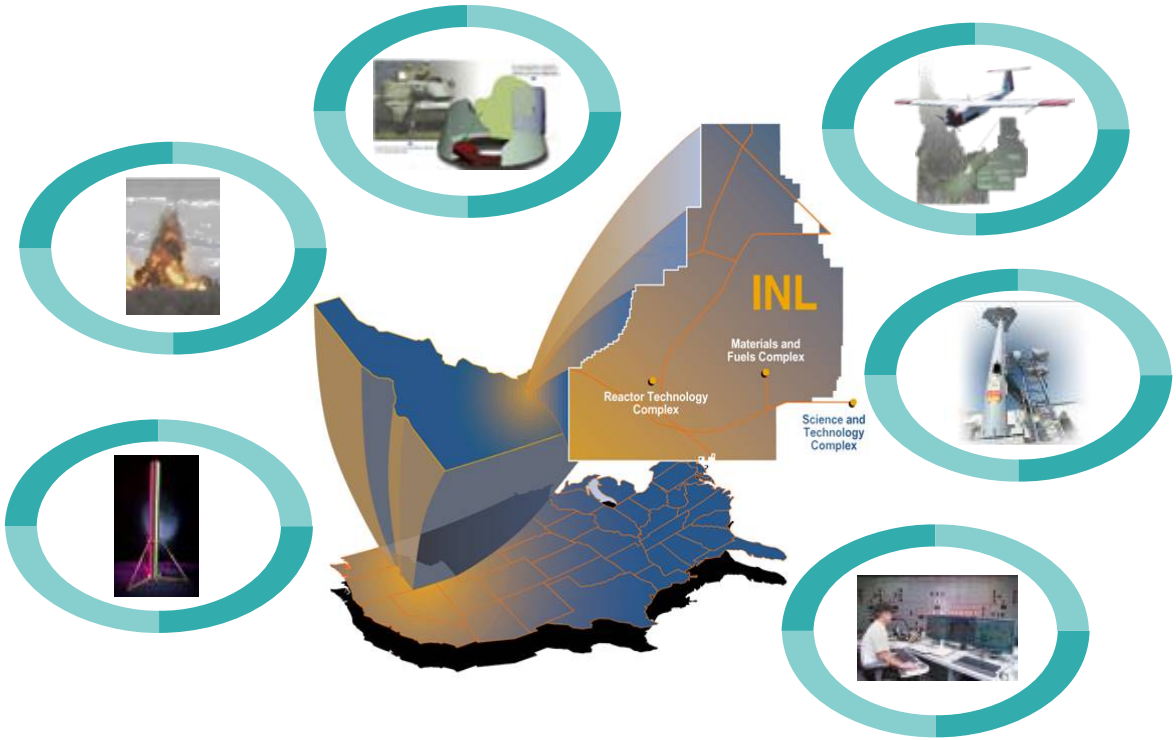
Critical Infrastructure Protection/Resilience



4th Annual Carnegie Mellon Conference on Electricity Industry
Future Energy Systems: Efficiency, Security, Control
March 10, 2008

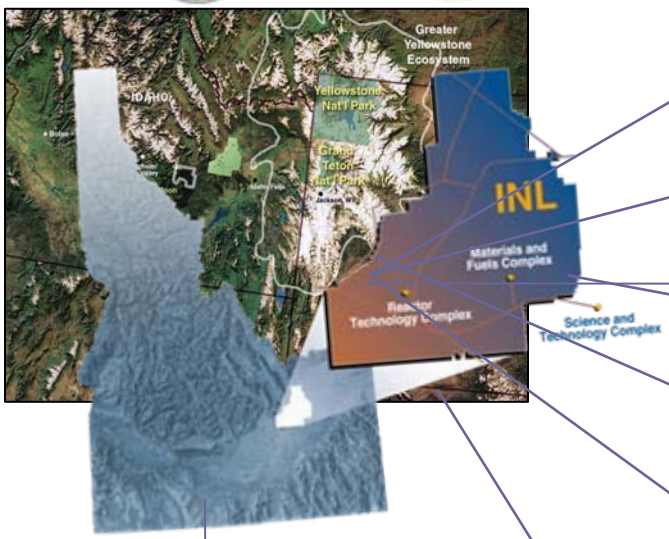
Bobby Jeffers and Rita Wells – Advanced Modeling Framework for Grid Reliability, Security and Training
Idaho National Laboratory - National & Homeland Security

Idaho National Laboratory

INL

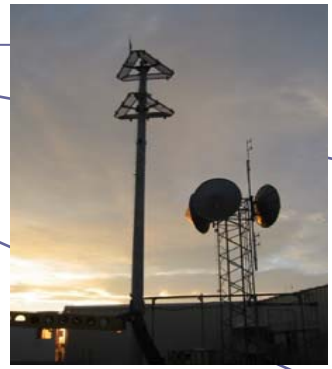
Idaho National Laboratory National and Homeland Security

Protecting the Nation's Infrastructure



Physical Security Test Bed

Contraband Test Bed



Wireless Test Bed

Training and Exercises

UAV Test Bed

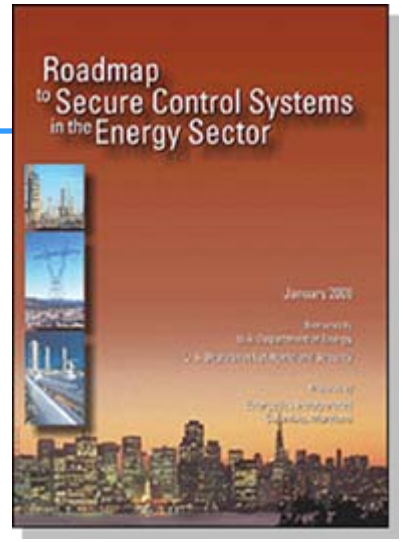
Cyber Test Bed

Power Grid Test Bed

SCADA Test Bed

Idaho National Laboratory

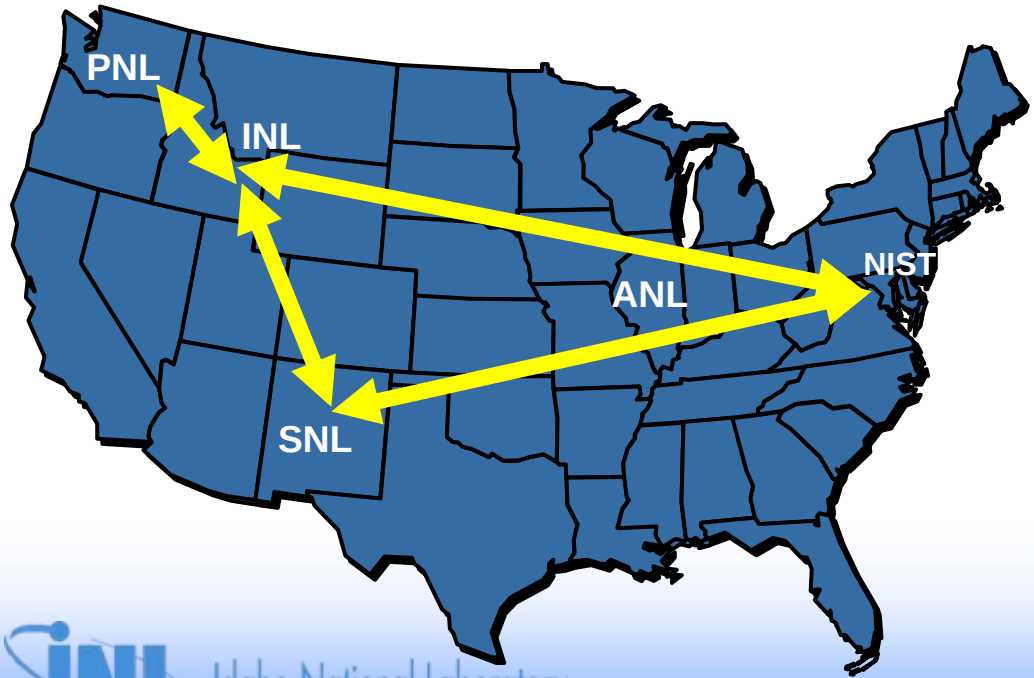
National SCADA Test Bed



…established in 2003

DOE multi-laboratory program designed to:

Support industry and government efforts to enhance control systems cyber security across the energy infrastructure



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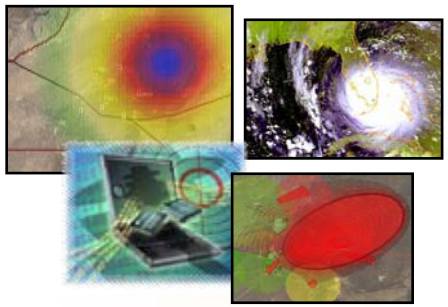
Key Program Areas

- ***Assess and mitigate energy control systems vulnerabilities***
- ***Develop advanced secure control systems technologies***
- ***Support development of standards and best practices***
- ***Conduct outreach and awareness***

Critical Infrastructure Protection/Resilience Simulator



Hazard Modeling and Damage Assessment

Power Grid Modeling

Situational Awareness and Decision Support

DoD-OSD sponsored: coordination of response and recovery efforts

Successful demonstration October 2007 and will be used in national exercises

CIPR SIM

- Federated High Level Architecture
- Incorporates real-time fidelity models, running simultaneously with asynchronous intercommunication
  - Cross-sector interdependency analyses
- GIS-based user interface
  - Multi-resolution: view varying levels of detail
  - Display of asset information, model results, and real-time interactive control of models
  - Customizable via GIS editors
- Visualize events in temporal and spatial context

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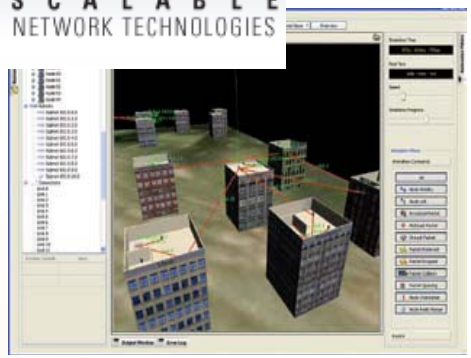
Technology Foundations

DoD Sim Framework & Visualization

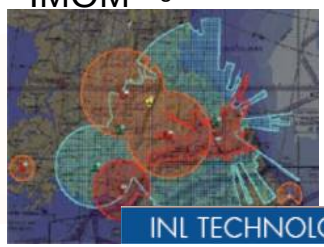
Scene Generation

Power Grid Modeling



Wireless Communication Modeling

IMOM Engineer



Flight Planning & Restoration Analysis

CIPR

Wildfire models

HAZUS MH

SLOSH MODEL

PC Tides

Disaster Models

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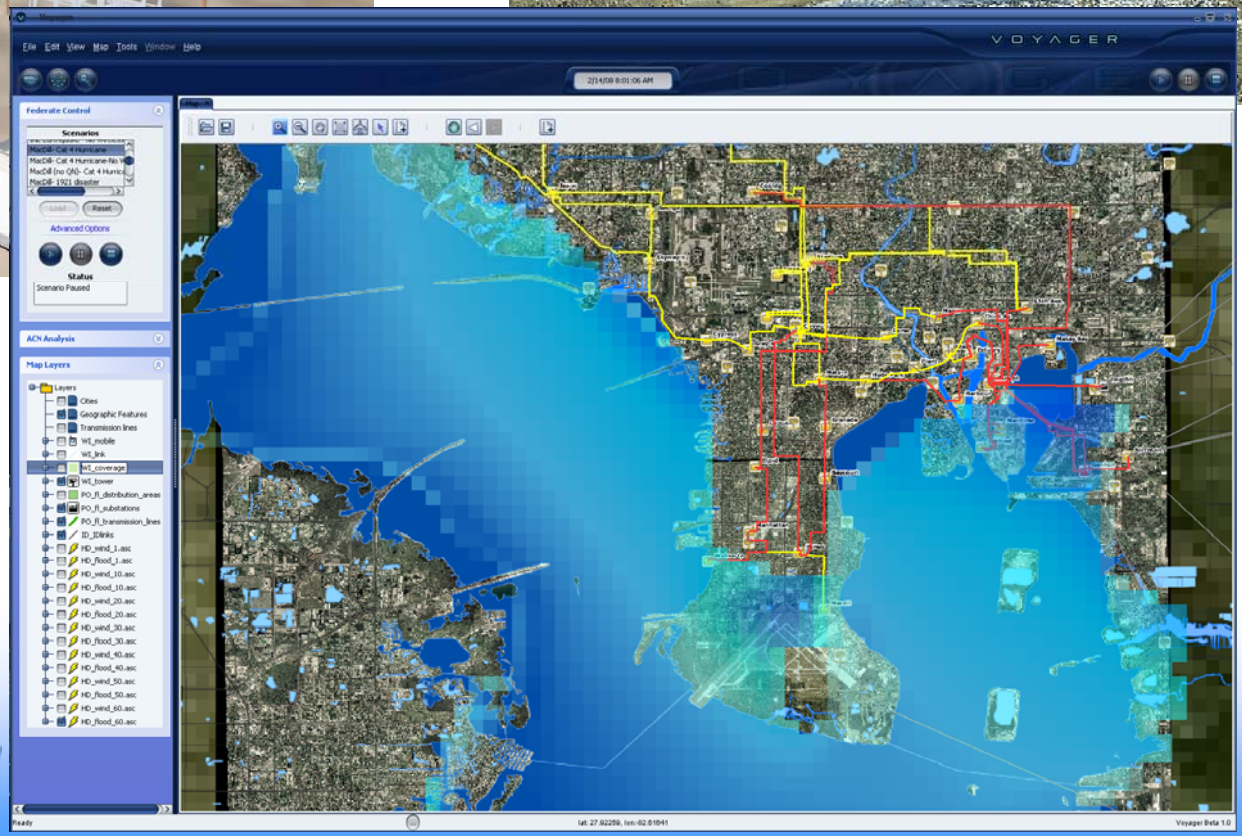
Customizable Interface



CIPR SIM

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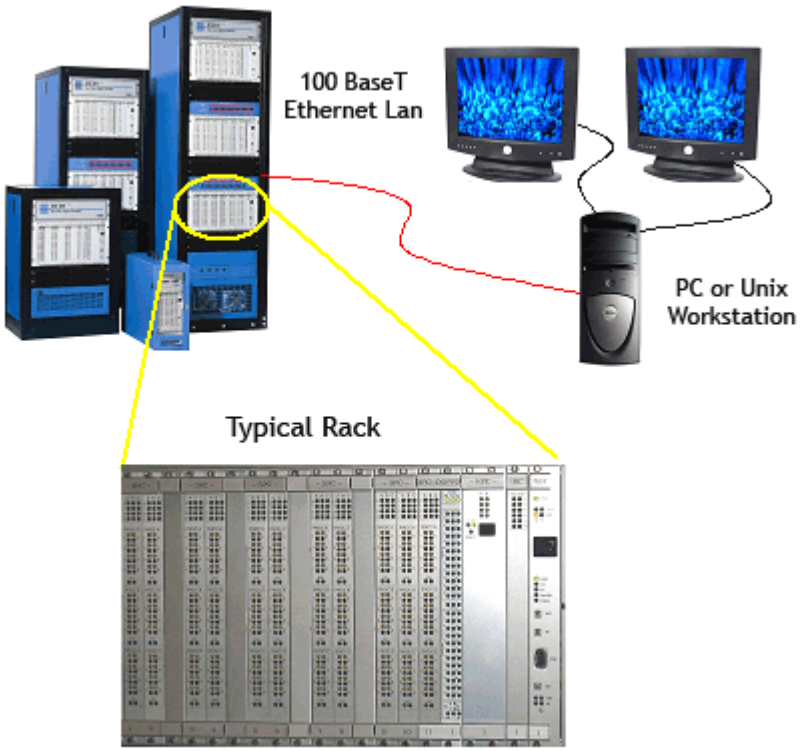
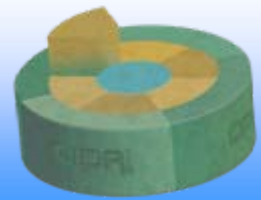
Physics Based Power Modeling
Real Time Digital Simulation

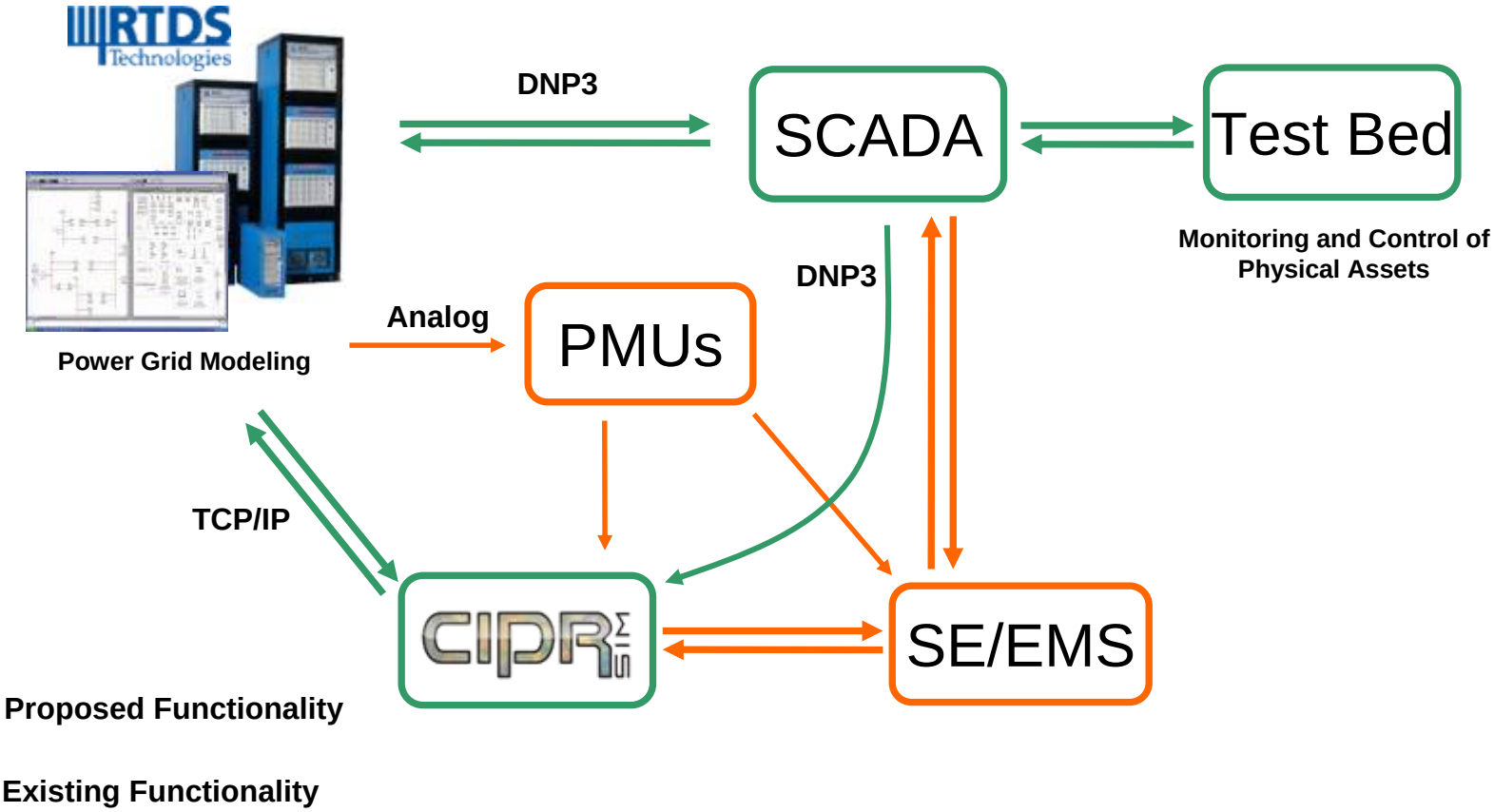


RTDS™ Technologies

- Simulation hardware dedicated to solving complex power system electromagnetic transient equations
- Modeling software (RSCAD) installed on PC workstation able to accurately describe analog power components in a “digital” language and communicate with RTDS
- The RTDS “rack” contains the power processors and communication hardware necessary to solve the complex system of equations generated by RSCAD
- Real Time – simulation is fast and accurate enough for hardware-in-the-loop functionality

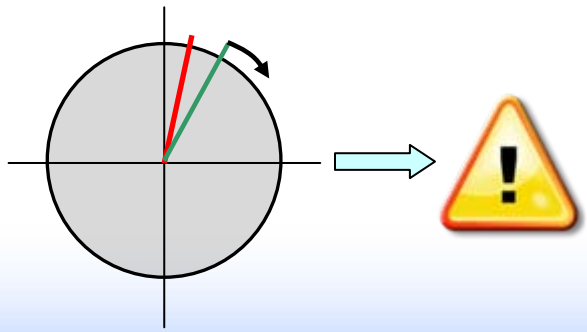


Underlying Hardware Architecture



PMU Integration Issues

- Identify data timing and network fidelity gaps
- Dynamic and static model benchmarking and validation
- Demonstrate optimal use of PMU data for applications
  - Wide Area Measurement Systems - network situational awareness
  - Real time control
  - SCADA/EMS: Determine optimal short term plan for operator awareness
    - Voltage, angle, frequency, thermal overload alarm
    - Improved restoration awareness



http://www.naspi.org/vision.stm

P. Overholt, *Wide Area Measurement Systems*, CMU 2007 Conference

Training Emulator

- System operators will be exposed to a vast number of complex training scenarios
  - Blackstart training
  - Low occurrence, high consequence scenarios
- Beyond event recording – offers dynamic human-system interaction
  - Testing and evaluation of switching orders
  - Heuristic event analysis
- Interface to existing operator training simulators

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