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The Office of Infrastructure Protection

National Protection and Programs Directorate
Department of Homeland Security

National Infrastructure Simulation & Analysis Center (NISAC)

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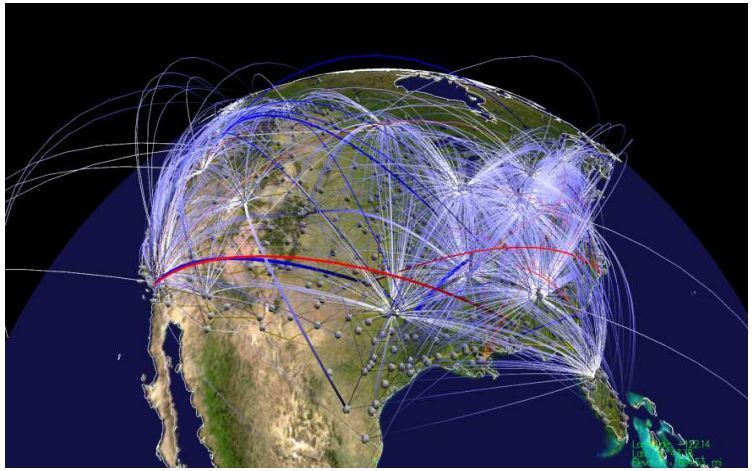
NISAC History & Mission

- Patriot Act identified NISAC as the center for Critical Infrastructure Interdependency Modeling, Simulation, and Analysis.
- Provide a common, comprehensive view of U.S. infrastructure and its response to disruptions.
- Operationally-tested DHS rapid-response capability.
  - 24/7 crisis action analysis
- Devolution site for DHS/OCIA

Los Alamos

Sandia National Laboratories



NISAC is a critical component in DHS/NPPD/IP's analytical capability

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NISAC Structure

- Department of Homeland Security Program, jointly executed by Sandia and Los Alamos National Laboratories
- Draws upon the expertise of 40-50 individuals located across the two sites
- Uses the unequalled and extensive reachback capabilities of Sandia and Los Alamos National Laboratories as premier United States National Security Laboratories

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Goal of Infrastructure Simulation and Analysis

Provide fundamentally new modeling and simulation capabilities for the analysis of critical infrastructures, their interdependencies, vulnerabilities, and complexities.

NISAC performs a range of infrastructure simulation and analysis tasks for and through DHS

- Conducts incident consequence analyses
  - Planned analyses
  - Ad-hoc analyses
- Provides support for national and regional exercises
- Conducts capability development to support analysis

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Critical Infrastructure Systems Face an Array of Threats

Natural

- Drought
- Earthquake
- Flood
- Heat Wave
- Hurricane
- Ice Storm
- Landslide
- Pandemic
- Space Weather
- Tsunami
- Wildfire

Terrorist

- Biological
- Chemical
- Cyber
- Explosive
- IED
- VBIED
- Aircraft
- Insider
- Nuclear
- Physical Assault
- Radiological

Hurricane Flooding

Terrorist Attacks

Wildfire

Pandemic Flu

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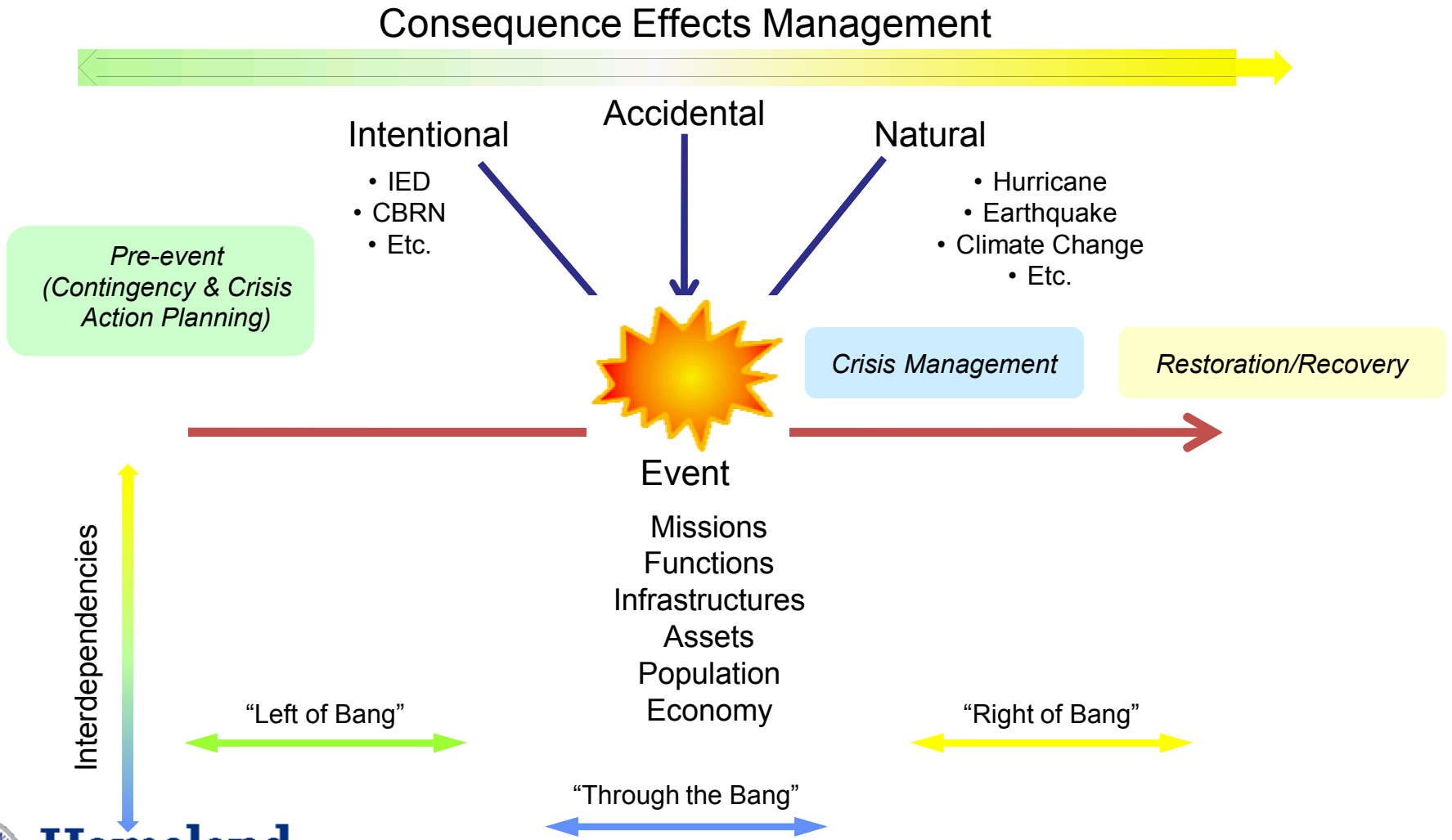
The Disruptive Event Lifecycle



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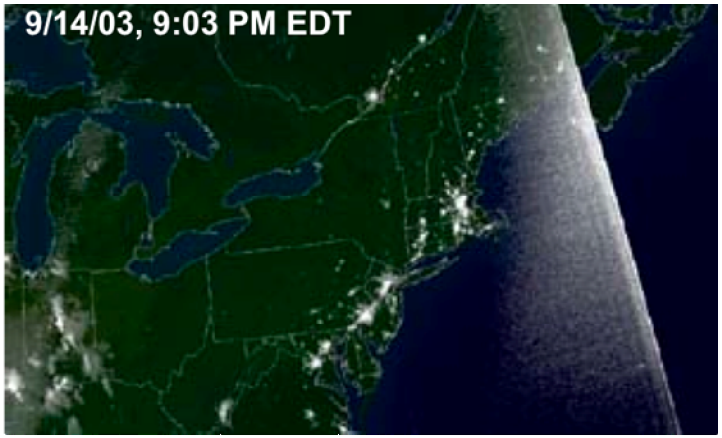
Critical Infrastructures are Massively Interconnected

- **Interconnections exist**
  - Within an infrastructure sector
  - Across infrastructure sectors
- **This includes**
  - Dependencies
  - Interdependencies
- **These dependencies and interdependencies include**
  - Humans in the loop
  - Rules and other constraints
    - Functionally specific
    - Geographically specific
    - Treaties, regulations, etc.
- **Dependencies and interdependencies can result in**
  - Unexpected consequences
  - Cascading failures and impacts
- **History is increasingly full of long-tail events**

Sandy 10 days post-landfall



Northeast blackout image courtesy of NOAA

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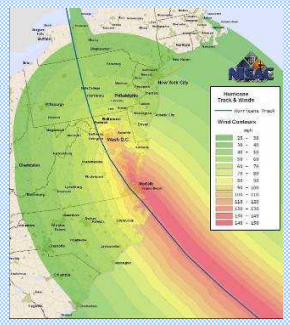
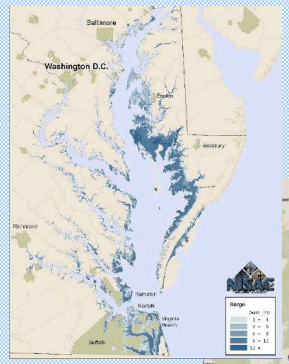
Hurricane Analysis Sequence

Mid-Atlantic Scenario



Projected Wind Contours

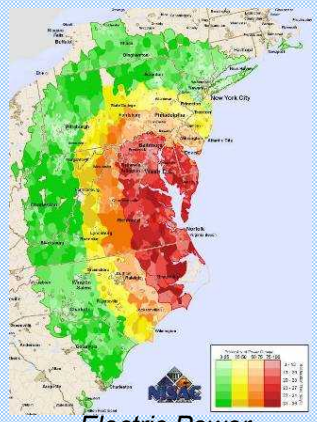


Storm Surge and Flooding

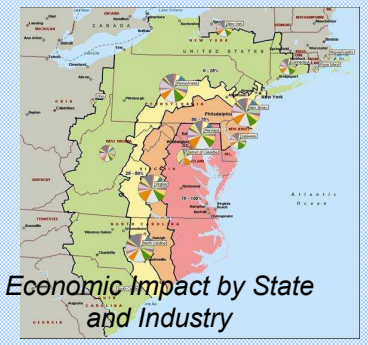
Data	Infrastructure Modeling, Simulation, and Analysis	Consequence Assessment

• National Hurricane Center: storm data
  • Wind
  • Surge
• Flood maps
• Infrastructure information (asset locations, capacities, and so forth)
• Regional-/temporal-specific conditions and issues
	Infrastructure outage/ restoration
	• Assets/capacity outaged
	• Economic impacts
	• Sector-specific impacts
	Dependency and interdependency analyses
		• National, regional, and local impacts
		• Short- and long-term impacts
		• Impacts of infrastructure disruptions
		• Commodity flow/supply chains

Electric Power Outage Areas

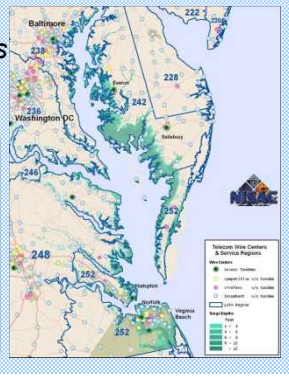


Electric Power Restoration

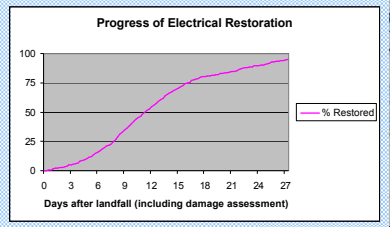


Economic Impact by State and Industry

Affected Petrochemical Facilities



Telecommunications Assets in Surge



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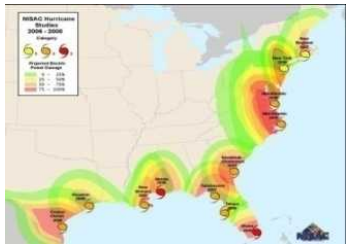
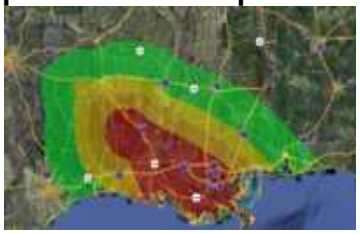
Example Types of NISAC Analysis - Hurricanes

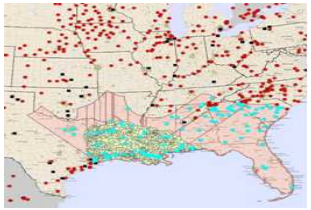
- Planning Scenarios

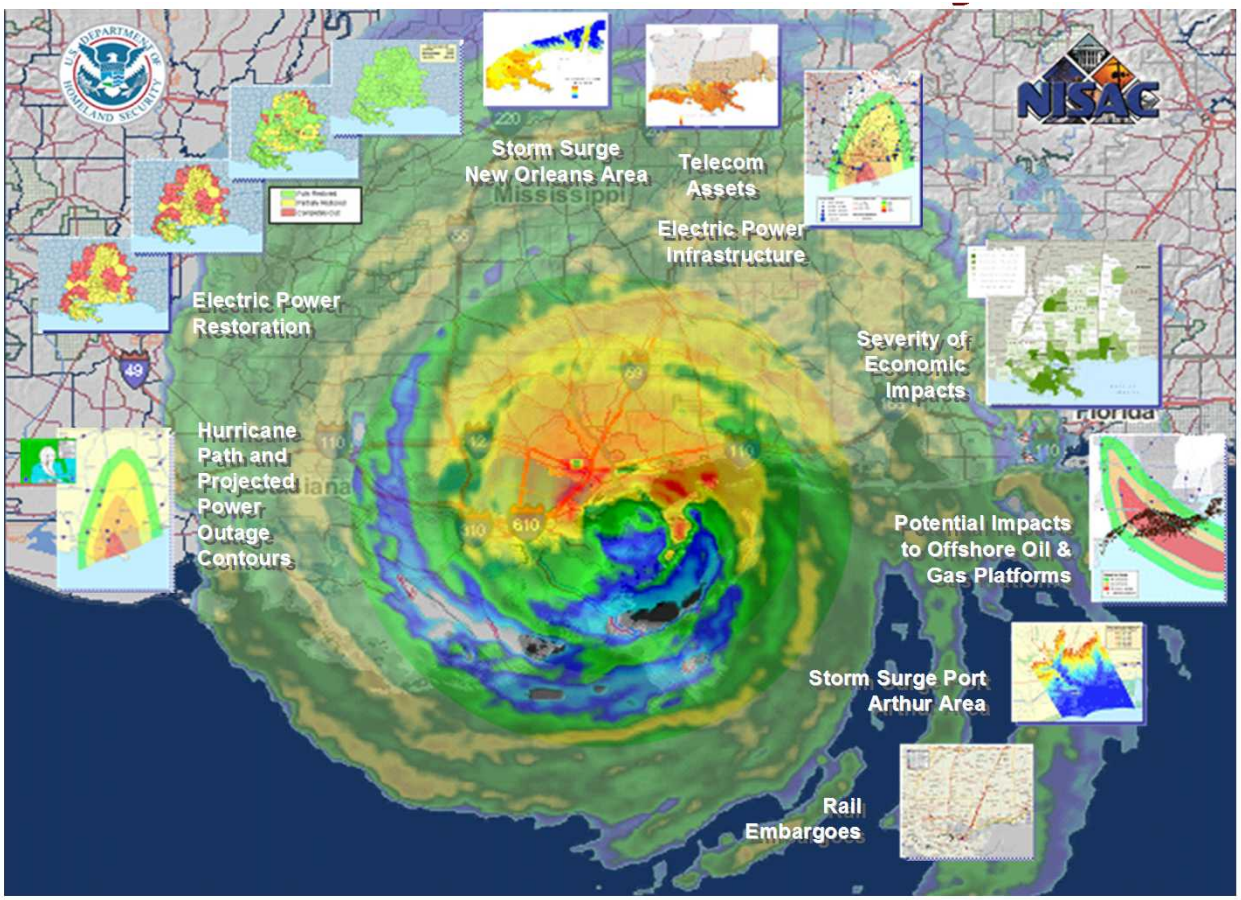


- Pre-Landfall Infrastructure & Population Impacts



- Post-Landfall Response & Recovery Issues





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Range of Models/Simulations to Inform Decisions

Realistic → Abstract

Decreasing detail, computation and development time

Data on system elements	High-fidelity models - individual infrastructure elements	Systems models of aggregate supply - demand dynamics	Generic, highly abstracted network models
Only know what is measured or monitored - limited to specific set of conditions	Detailed simulation of changes in conditions or behaviors	Effects of conditions and limitations on system operation	Simulation and identification of vulnerabilities of different network topologies to disruptions
For existing systems only	For complex systems and detailed phenomenology	For trade-studies and planned systems	For quick-turnaround answers

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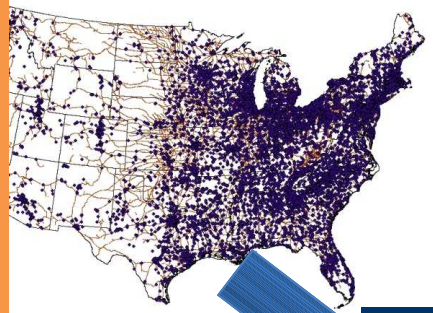
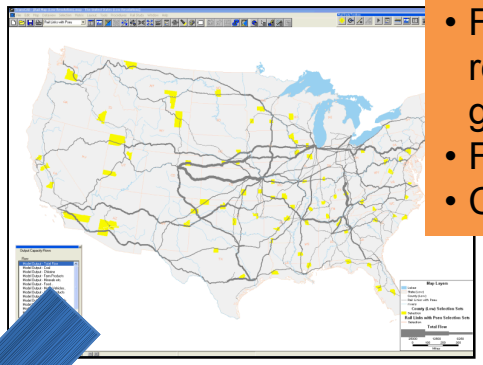
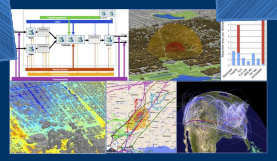
Perspective Drives Process

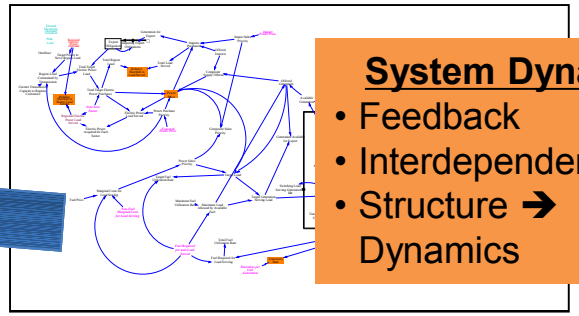
Spatial/Physical
- Location of key infrastructure assets
- Asset Characteristics
- Co-location



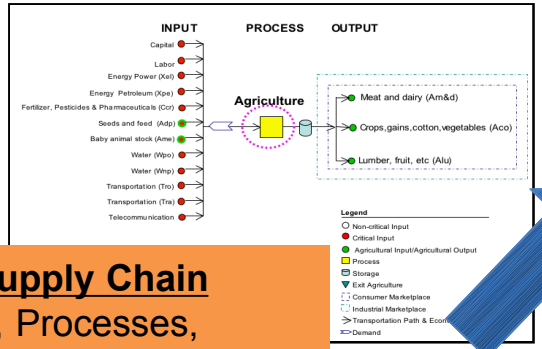
Network
- Flow of resources and goods
- Flow Capacity
- Critical Nodes



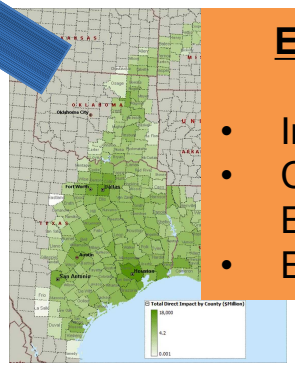




System Dynamics
- Feedback
- Interdependencies
- Structure ➔ Dynamics



Supply Chain
- Inputs, Processes, Outputs
- Process ➔ Infrastructure
- Dependencies



Economics/Human Behavior
- Input-Output modeling
- Computable General Equilibrium modeling
- Evacuation

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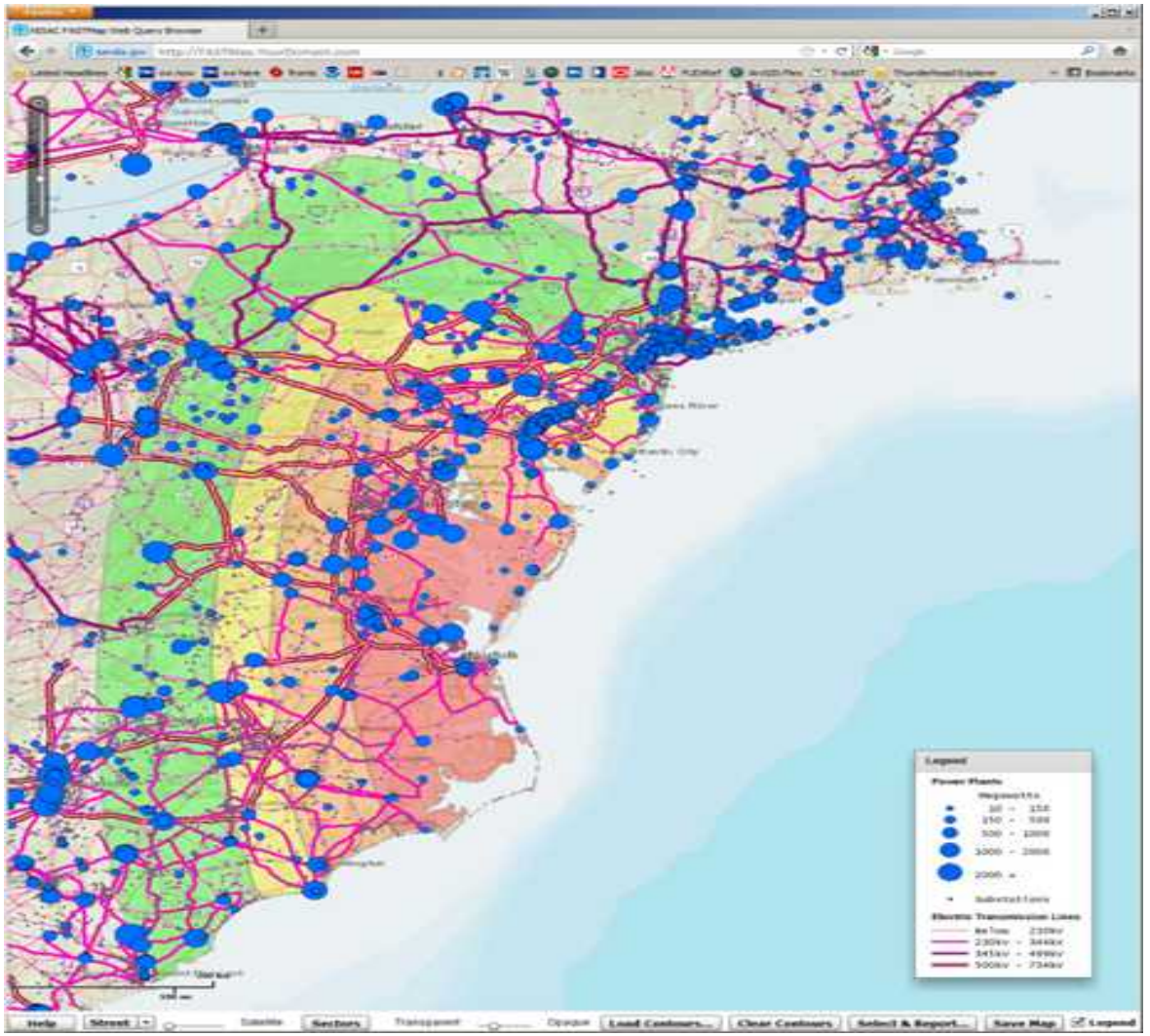
Example Tool: FASTMap

- Seamless nationwide data
- Mobile platforms (iOS and Android)
- Infrastructure and assets depicted on an inter-active map in context with any area of disruption or analysis area
- Channel technology allows instant broadcast of dynamic maps as well as collaborative exchange
- Geospatial reports containing lists and statistics on assets at risk



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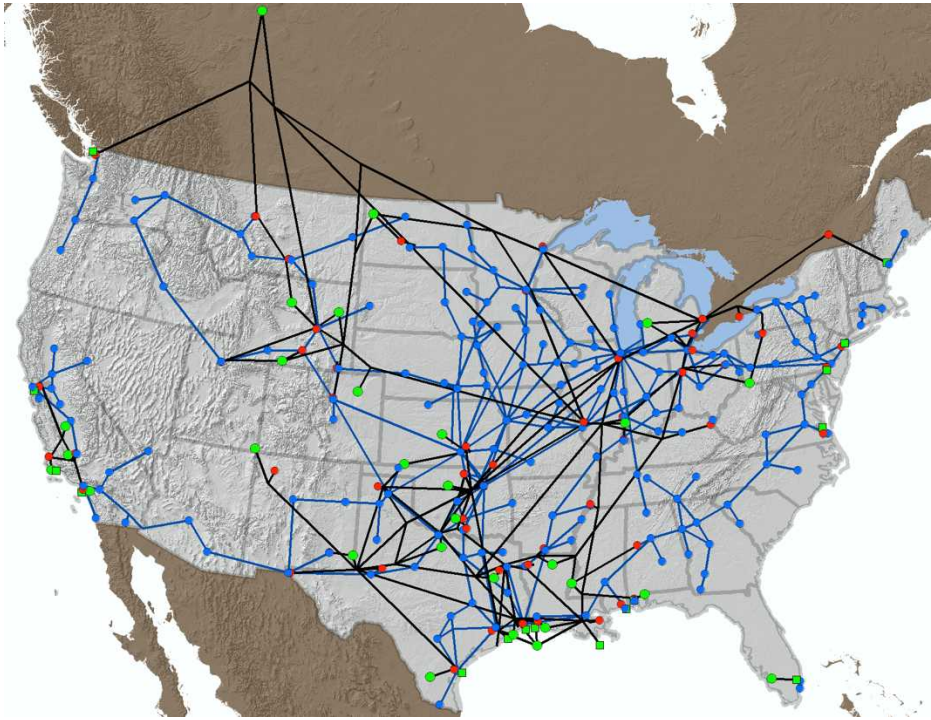
Example Model: National Transportation Fuels Model

- Model includes:
  - Crude production
  - refining nodes,
  - pipeline linkages
  - Terminals
  - ports
- Designed to answer questions of the form:
  - Which regions of the United States would experience shortages of transportation fuel after a specified disruption to one or more components of the fuel infrastructure?
  - What would be the duration and magnitude of the shortages?



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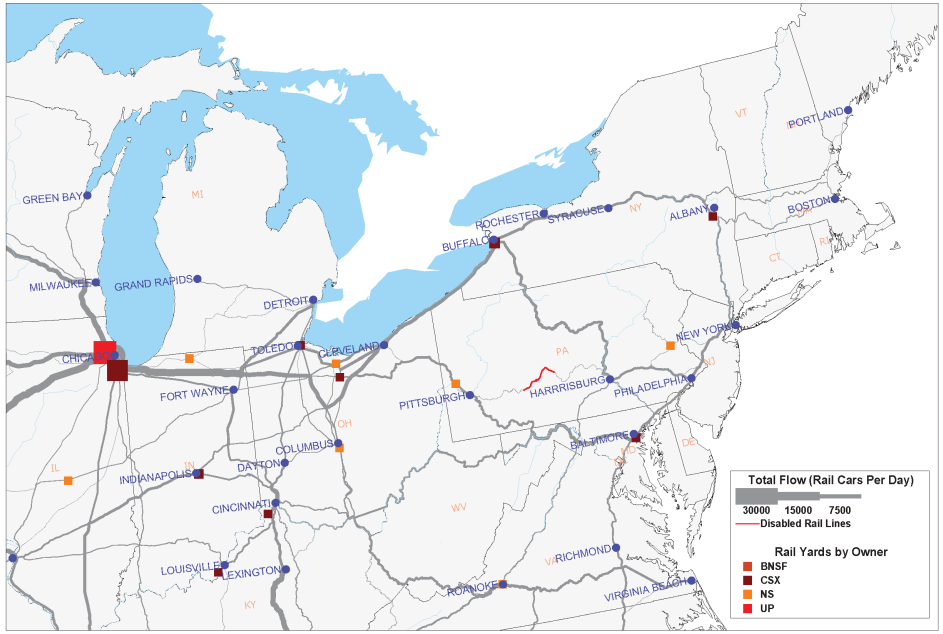
Example Model: (R-NAS) Rail-Network Analysis System

- **Model includes:**
  - National-level perspective
  - Best available commodity data
  - Optimization model for commodity flow prediction
- **Designed to answer questions of the form:**
  - How would the loss of one or more major assets in the rail network affect its ability to maintain service?
  - Which commodities (and in what quantity) could not be shipped or received?
  - How would transportation costs increase if rerouting rail traffic were required?
  - Could the rail system support additional demand if another transportation mode were disrupted (i.e., water shipping)?



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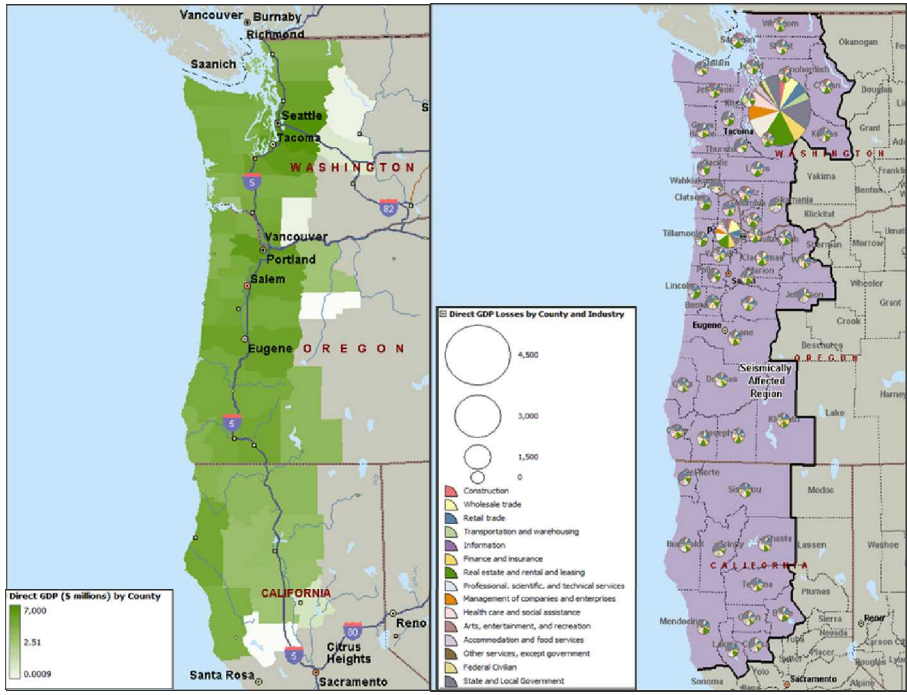
Example Model: (REAcct) Regional Economic Accounting

- **Model includes:**
  - Economic data permitting the identification of geographical impact zones, allowing for differential magnitude and duration estimates to be specified for regions affected by a simulated or actual event
  - Uses public data from Department of Commerce and Census Bureau
- **Designed to answer questions of the form:**
  - Due to reported or modeled disruptions, which regions could have larger economic losses?
  - Which industries or counties are estimated to be most affected by an infrastructure disruption?
  - What are the estimated impacts to firms that are directly affected by the change to baseline conditions?



Challenges or What's Next?

- Answers are expected to be provided
  - Faster
  - With more fidelity
  - To a broader audience
    - Who in turn expect a series of area specific answers
  - At lower cost
- Understanding and helping decision makers anticipate the evolution of infrastructure and options they have to increase resiliency before the fact (as opposed to addressing vulnerabilities identified afterward)
- Identifying and modeling global dynamics in infrastructures and their impacts on US infrastructures (energy, climate, finance, food, etc)
- Increasing our ability to support nonfederal stakeholders (regional, state, or local entities)