SAND2009-5742P

Critical Infrastructure Protection

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Sandia National Laboratories
Systems Research, Analysis, and Applications

HOMELAND SECURITY & DEFENSE

Sandia is a multiprogram laboratory operated by Sandia Corporation,
a Lockheed Martin Company, for the United States Department of Energy's
National Nuclear Security Administration under contract DE-AC04-94AL85000.

Sandia National Laboratories

Sandia's Critical Infrastructure Protection Activities

Complex Events MSA (CEMSA)
$1.25M SNL ($2.5M Total, LANL)
DHS S&T

Integrated Modeling, Mapping, Simulation (IMMS)
$2.5M
DHS S&T

Chemical Econ Supply Chain
$1.7M
DHS S&T

National Infrastructure Simulation & Analysis Center
NISAC
$9M SNL ($20M Total, LANL)
DHS IP

Econ Criticality of Chemical Facilities
$250K
DHS ISCD

Aviation Security Model
$250K SNL ($500K Total, ANL)
TSA

VA Threat Analysis
$750K
Veterans Affairs (VA)

Related Programs

Cyber-Scada Impacts
DHS

V&V for Human, Social, Cultural, Behavioral (HSCB) Models
$560K, OSD

DoD Critical Infrastructure Protection (CIP)
$300K, DoD

DOE Infrastructure & Power Grid

FAA Next Gen

LDRD Investments

Intrinsic Security Principles
1yr, $175K

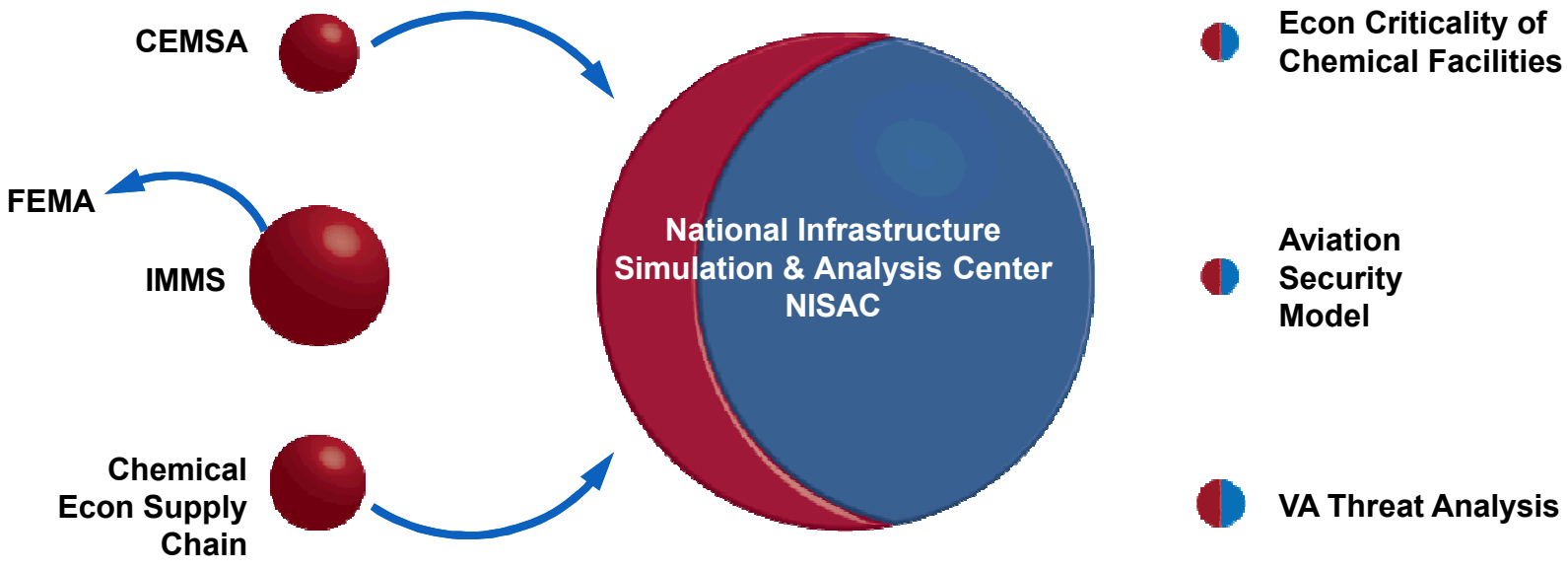
Risk-based Security Cost-benefit Analysis
2yr, $1M

Vulnerability of Multinetwork infrastructure to Cascading Failure
3yr, $1.3M

Engr Framework for Complex Adaptive SoS
3yr, $1.9M

Measurement of Systemic Resilience
1yr, $100K

We Span Development and Operational Support



Development

Operational

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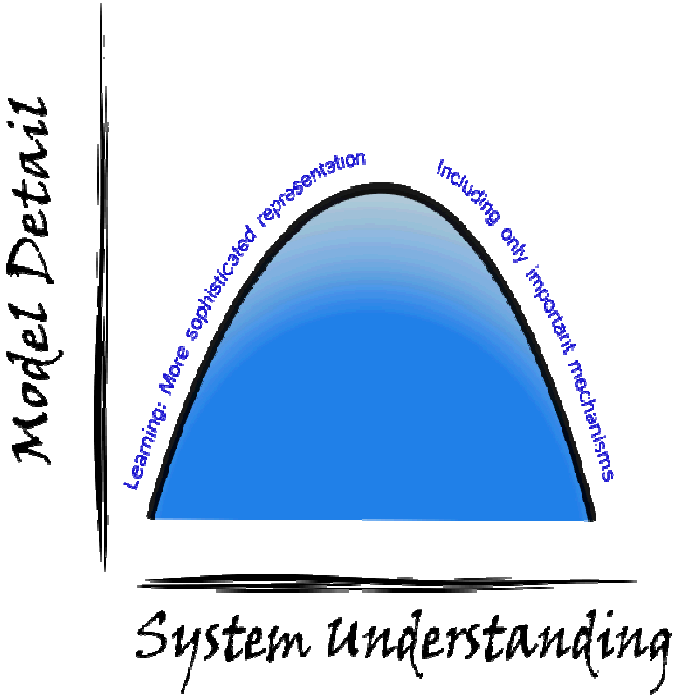
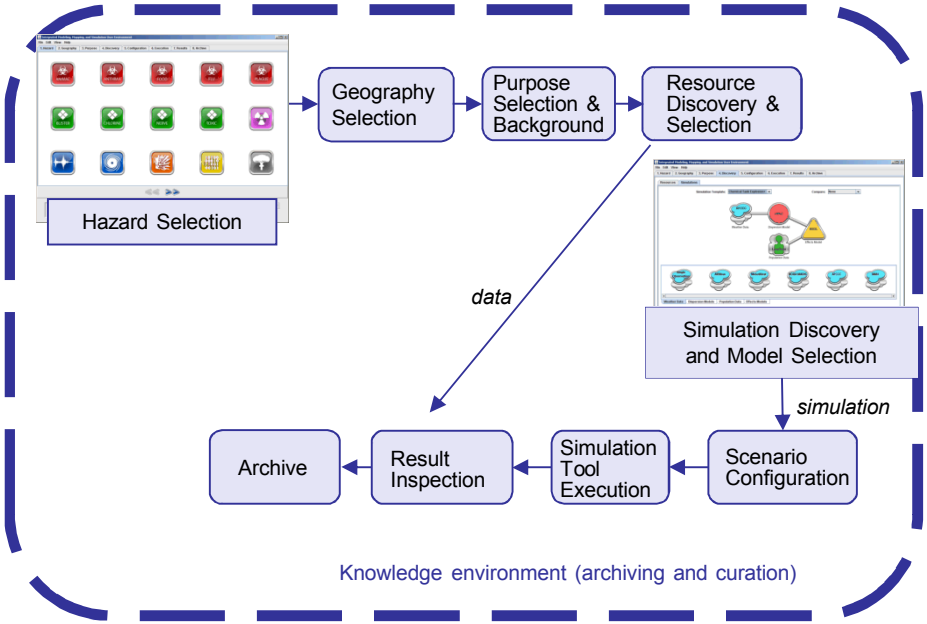
Complex Events Modeling, Simulation, & Analysis (CEMSA)

- **Customer: DHS S&T IGD**
- **Motivation**
  - Provide DHS with a ready capability to model and analyze infrastructure impacts from multiple simultaneous attacks or disasters under a wide variety of scenarios and any combination of infrastructures and key assets, including compounding events and infrastructure interdependencies
- **Goals**
  - Develop theoretical basis for modeling infrastructure behaviors and interactions, including risk, consequence, disruption, mitigation and recovery
  - Develop and acquire capabilities for systematically and thoroughly searching across the space of possible infrastructure behaviors to identify tipping points that could drive high-consequence failures
  - Develop a general tool to enable the seamless representation of links and inter-dependencies among the elements of multiple events, population response and the cascade of multiple disruptions through multiple infrastructures using any combination of models



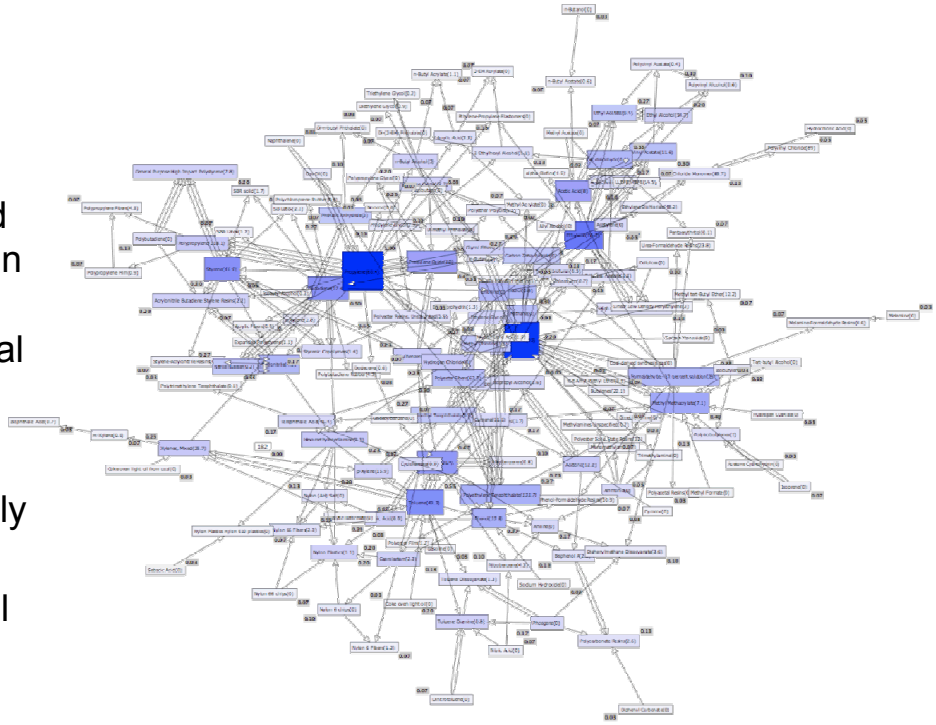
Integrated Modeling, Mapping, & Simulation (IMMS)

- **Customer: DHS S&T IGD**
- **Motivation**
  - FEMA-identified capability gaps (Incident Management IPT)
  - HSPD-8: continuous improvement of Nation's preparedness to respond to catastrophic events
- **Goals**
  - Allow discovery of models/data/expertise applicable to specified hazard, region, and objective
  - Enable simulations that can be rapidly localized to a specified region by facilitating their connections to foundational data
  - Enable connection (federation) of diverse modeling components
  - Enable integrated display of data and simulation results
  - Explore advanced collaboration, delivery and deployment mechanisms



Chemical Econ Supply Chain

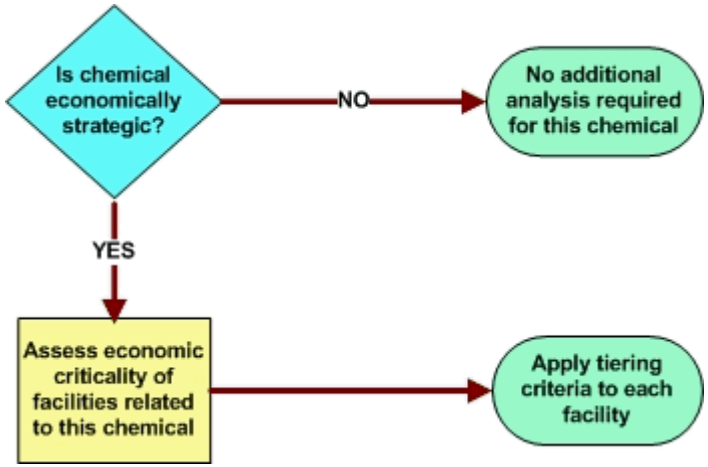
- **Customer: DHs S&T IGD**
- **Motivation**
  - Build the capability necessary to evaluate and understand the consequences of disruptions in the chemical sector, and the effects of disruptions of other infrastructures on chemical supplies and distribution
- **Goals**
  - Develop detailed model and analysis of supply chain of domestic chlorine
  - Develop detailed model and analysis of global supply chain of ammonia and derivatives
  - Develop a quantitative methodology for economic resilience with respect to these supplies
  - Future: Expand the chlorine and ammonia supply chains into the agricultural chemicals, pharmaceutical, and specialty chemical supply chain analyses



Chemical Commodity Network

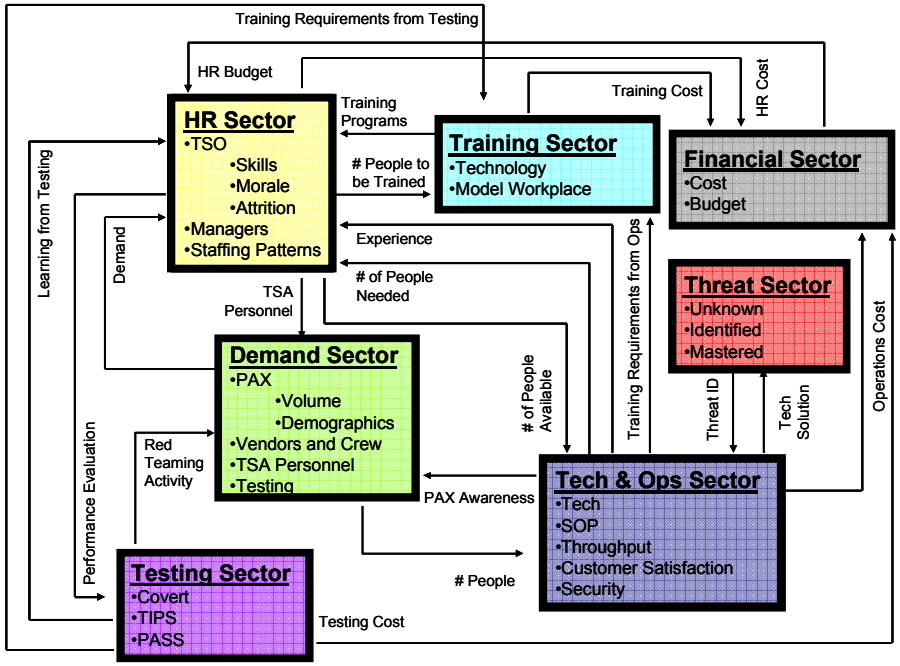
Economic Criticality of Chemical Facilities

- **Customer: DHS ISCD**
- **Motivation**
  - Because of the dependence of so many industries (manufacturing, energy, public health, etc.) on the chemical industry, terrorist acts targeted at chemical facilities could have cascading impacts and potentially significant economic consequences on a national scale
- **Goals**
  - Develop a defensible methodology for evaluating a chemical facility's economic criticality. This methodology will:
    - Identify chemical facilities with high degrees of economic criticality
    - Measure economic consequences resulting from the disabling of these facilities
    - Organize the facilities into tiers of varying criticality



Aviation Security Model

- **Customer: TSA**
- **Motivation**
  - Develop a system dynamics model that will help TSA effectively allocate resources to improve the performance of their security checkpoint operations
- **Goals**
  - Construct a broad, systems-level model that captures performance improvement subject to investment in 3 interdependent areas
    - Personnel proficiency
    - Operating procedures
    - Technology deployment
  - Exercise model to identify high leverage points where relatively modest investment can yield significant improvements to system performance

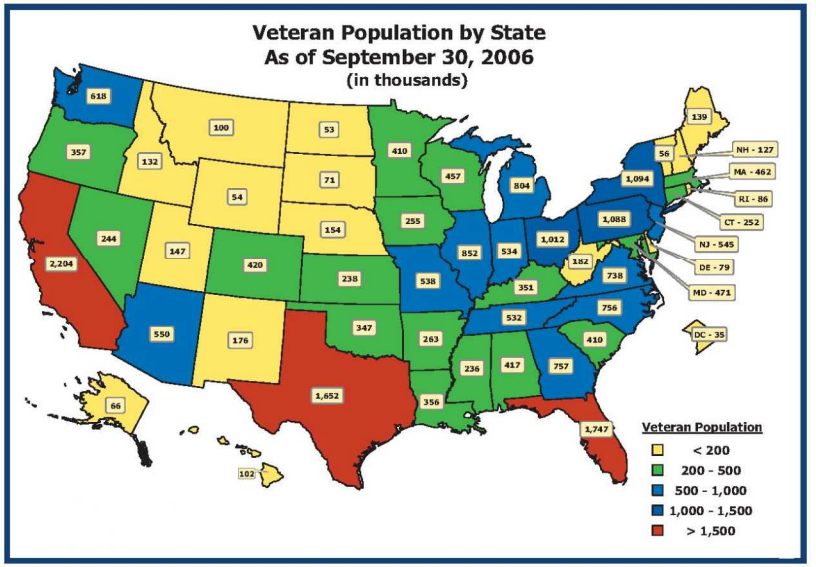


VA Threat Analysis

- **Customer: Veterans Affairs**
- **Motivation**
  - The VA needs a flexible, usable, tailored system model adapted to test threat scenarios important to their operations and an approach for using it that will fulfill the objectives of saving lives, preventing harm, and allowing VA/VHA to perform necessary missions
- **Goals**
  - Apply the Sandia CaSOS construct to meet the VA needs
    - Work with the VA as a collaborative team to enumerate threats and conceptualize the VA health Care System as a CaSOS
  - Use model and analysis to rank policy options, determine robustness of policy choice, and identify critical enablers for system resiliency

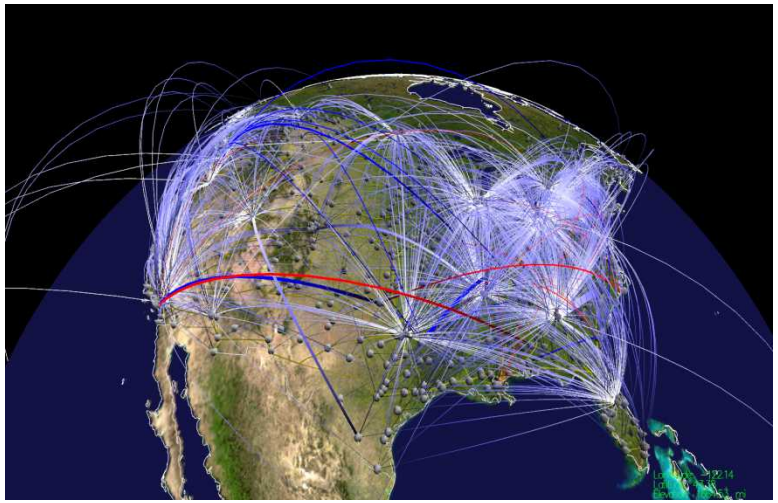
EXHIBIT 4 – VETERAN POPULATION BY STATE

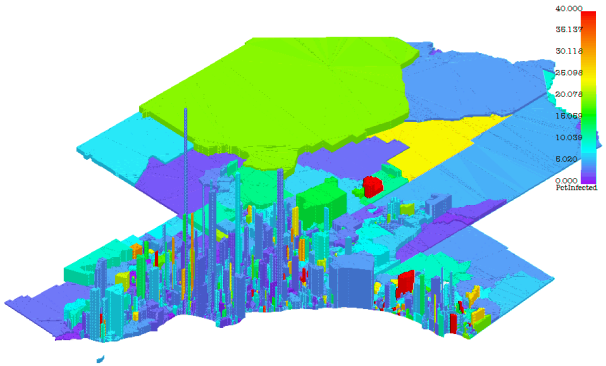
Source: Vet Pop 2004 Version 1.0 VA Office of the Actuary Data as of September 30, 2006



NISAC Mission

- **Improve the understanding, preparation, and mitigation of the consequences of infrastructure disruption.**
- **Provide a common, comprehensive view of U.S. infrastructure and its response to disruptions.**
  - Scale & resolution appropriate to the issues.
  - All threats.
- **Built an operations-tested DHS capability to respond quickly to urgent infrastructure protection issues.**
  - New IASD HITRAC, NISAC, and IMAC rapid analysis collaboration.
  - 24/7 when needed.

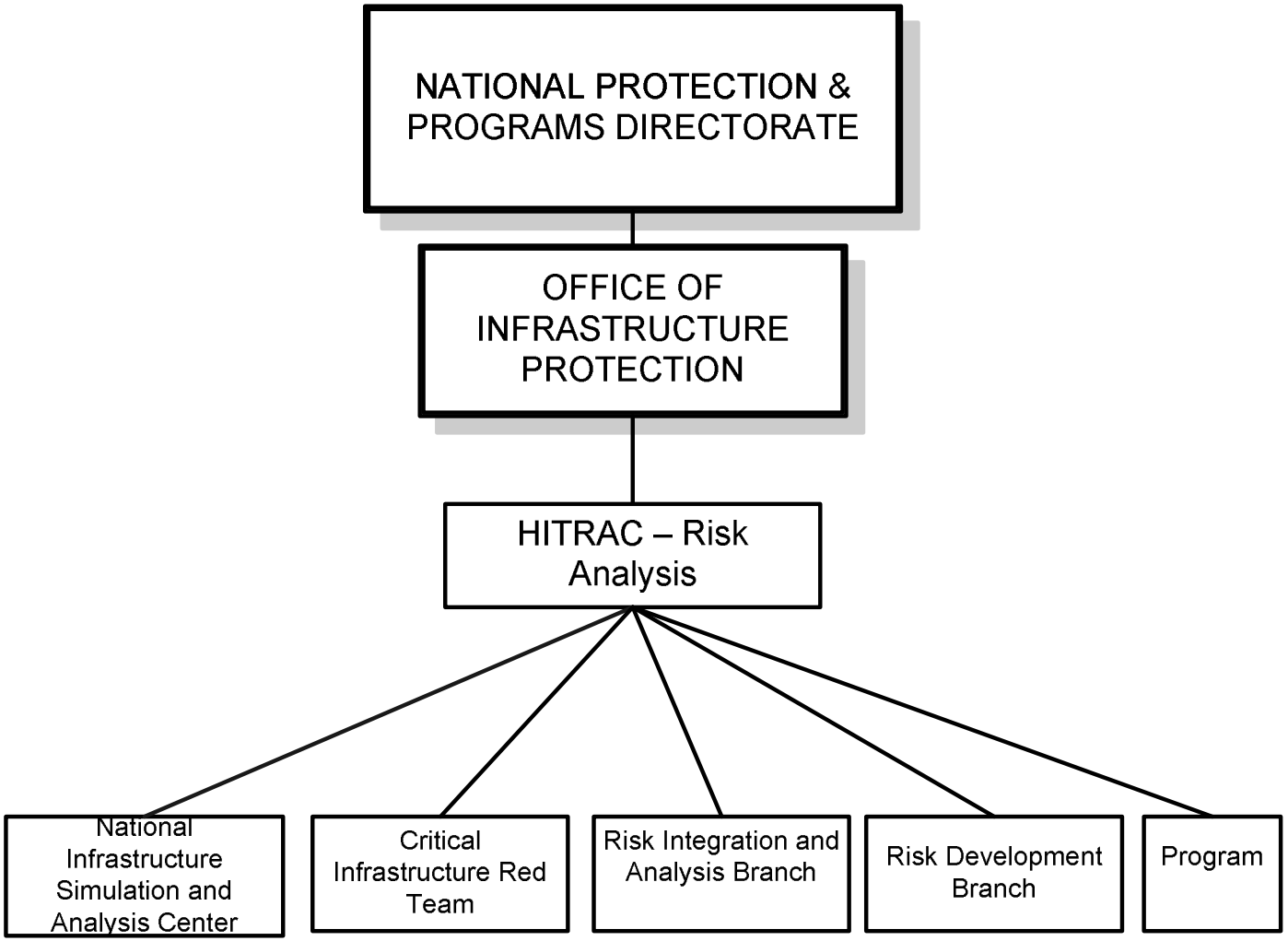




NISAC Project

- **DHS-directed program executed by 70 scientists & researchers from Sandia & Los Alamos National Laboratories; joint project; building on Kirtland AFB, New Mexico**
- **NISAC initiated work in the 90s, formally established by 2001 Patriot Act**
- **2007 Homeland Security Approp. Act expanded NISAC mission**
  - "**source of national expertise** to address **critical infrastructure protection…"**
  - … **counterterrorism, threat assessment, and risk mitigation**
  - … **natural disaster, act of terrorism, or other manmade disaster**
  - …**modeling, simulation, and analysis** … to **enhance preparedness, protection, response, recovery, and mitigation activities**."
  - The act directs that NISAC analyses be made available to Federal agencies with departments having critical infrastructure responsibilities under HSPD-7 (NIPP partners)

DHS – NPPD



Homeland Infrastructure Threat & Risk Analysis Center

HITRAC – Risk Analysis

Program Support

Incident Management Response Team (IMRT)

Coordinates incident management and exercise roles and responsibilities.

Risk Integration and Analysis Branch (RIAB)

Conducts decision support analysis and prioritization for Federal, State, local, tribal, territorial, and private sector partners.

Critical Infrastructure Red Team (CIRT)

Enhances partner understanding of terrorist threats to infrastructure by emulating their operational planning and intelligence capabilities.

National Infrastructure Simulation and Analysis Center (NISAC)

Congressionally mandated modeling, simulation, and analysis center that applies modeling and simulation-based analysis techniques to identify likely consequences to infrastructure from terrorist attacks and natural disasters.

Risk Development Branch (RDB)

Advances the art and science of risk and risk-informed analysis through the development of methodologies, tools, and approaches designed to improve the ability of infrastructure protection community members to make informed risk management choices.

HITRAC is a leading DHS provider of infrastructure-related consequence, and risk analysis.

NISAC's History in DHS

- **Designated in the Patriot Act as the center for Critical Infrastructure Interdependency Modeling, Simulation, and Analysis.**
  - Established in 2000 and transferred to DHS in Homeland Security Act of 2003.
  - Collaboration between DHS/IP and its National Laboratory Partners (Los Alamos and Sandia National Laboratories) in the area of Critical Infrastructure Protection.
  - The Laboratories have a long history of national security missions, including a specific focus on the modeling, simulation, and analysis of critical national infrastructures.
  - NISAC leveraged Laboratories' infrastructure research and development activities to "jump start" the Center; lab-wide R&D keeps the technical cutting edge necessary to address evermore complex questions.
- **DHS HITRAC depends on the existing NISAC partnership with Los Alamos and Sandia National Laboratories.**
  - NISAC is the primary "go-to" for subject matter expertise and innovative analytical approaches to the increasingly complex questions faced by DHS and growing public and private infrastructure interdependencies.
  - NISAC products range from multi-year detailed analyses to 24/7 support during national incidents.
  - As a result of this dependence, the Center's operational tempo has increased significantly over the last few years in response to events both potential and actual, both man-made and natural.
    - Over 200 quick response analysis products to DHS in FY08 (2009 rate is higher so far).

NISAC is a critical component in DHS-IP/HITRAC's analytical capability.

National Infrastructure Simulation and Analysis Center's (NISAC) History

- **2001 Patriot Act formally established NISAC, but around since 90s**
- **2007 Homeland Security Appropriation Act expanded NISAC mission**
  - "source of national expertise to address critical infrastructure protection…"
  - … counterterrorism, threat assessment, and risk mitigation
  - … natural disaster, act of terrorism, or other manmade disaster
  - …modeling, simulation, and analysis … to enhance preparedness, protection, response, recovery, and mitigation activities."
  - Directs NISAC share with Federal agencies with departments with critical infrastructure responsibilities under HSPD-7 – NIPP partners
- **NISAC has been part of DHS President's Budget since 2003**
- **NISAC is jointly executed by Sandia and Los Alamos National Laboratories**

What we want to know about infrastructures

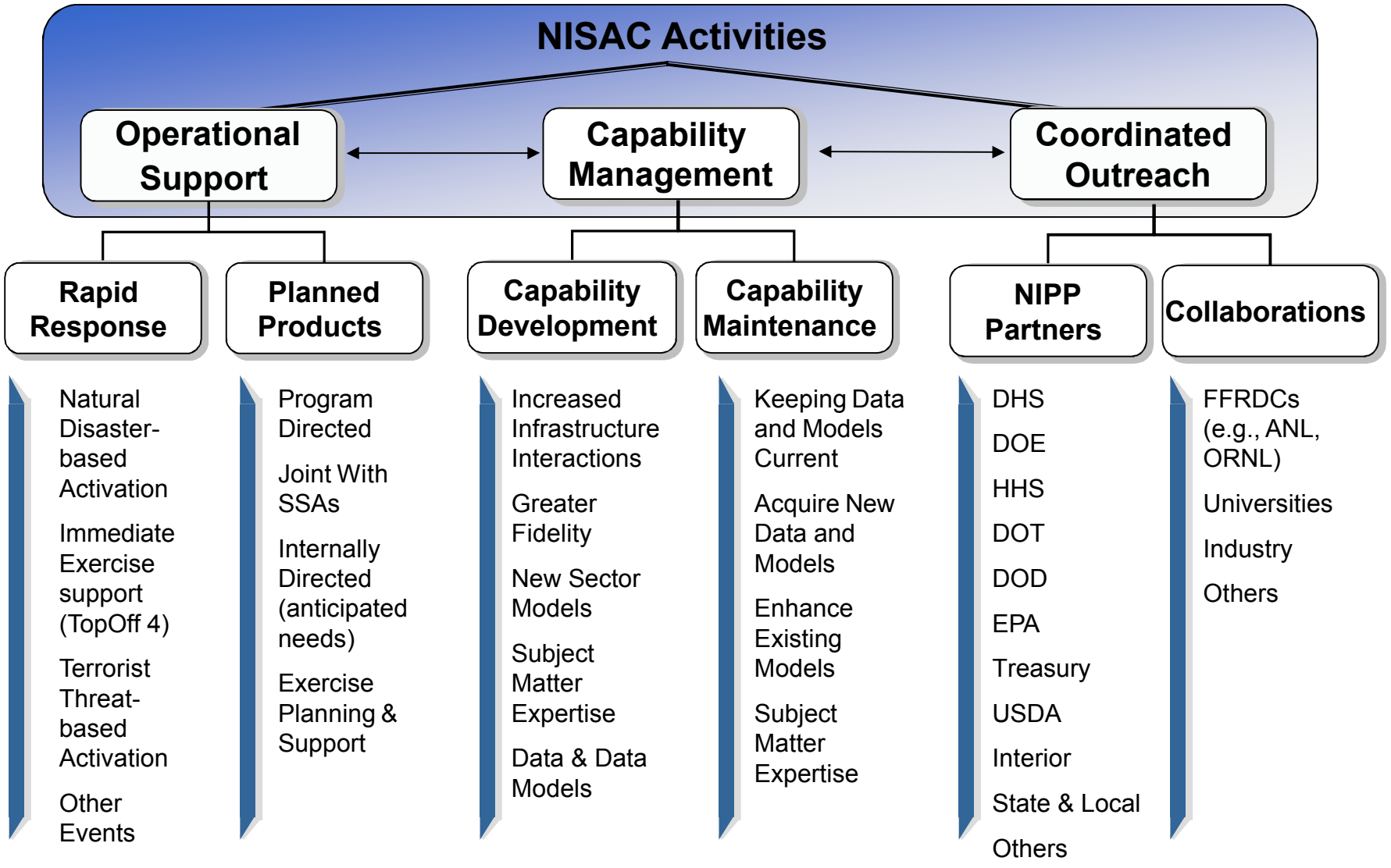
- **Are certain systems, networks, parts of the country more at risk than others? Why?**
- **Have interdependencies increased the risks or have they changed them?**
  - What conditions have to exist to cause cascading failures?
  - What size of event has to occur to initiate cascading failures?
- **Are there trends in the evolution of the infrastructures toward more vulnerable conditions or configurations?**
- **Are we repeating any mistakes from the past or have we really learned from them?**
- **How do the risks to infrastructures impact national s**
- **How can we reduce the risks to infrastructures?**
  - Can we afford to reduce those risks?
  - Over what timeframe?

Multiple Viewpoints

Realistic → ***Decreasing detail, computation and development time*** → **Abstract**

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 **FASTMap** **FAIT** **REAcct** **EPRAM**	Detailed simulation of changes in conditions or behaviors **N-ABLE** **R-NAS, ATOM** **IEISS** **MIITS, N-SMART** **EpiSims** **TRANSIMS** **Loki-Natural Gas** **CICLOPS**	Effects of conditions and limitations on system operation **Port Simulators** **Petroleum** **Natural Gas** **Agriculture** **TelecomOps** **TDF**	Simulation and identification of vulnerabilities of different network topologies to disruptions and effective mitigation **Loki-Infect** **Loki-Transaction** **Loki-Power**

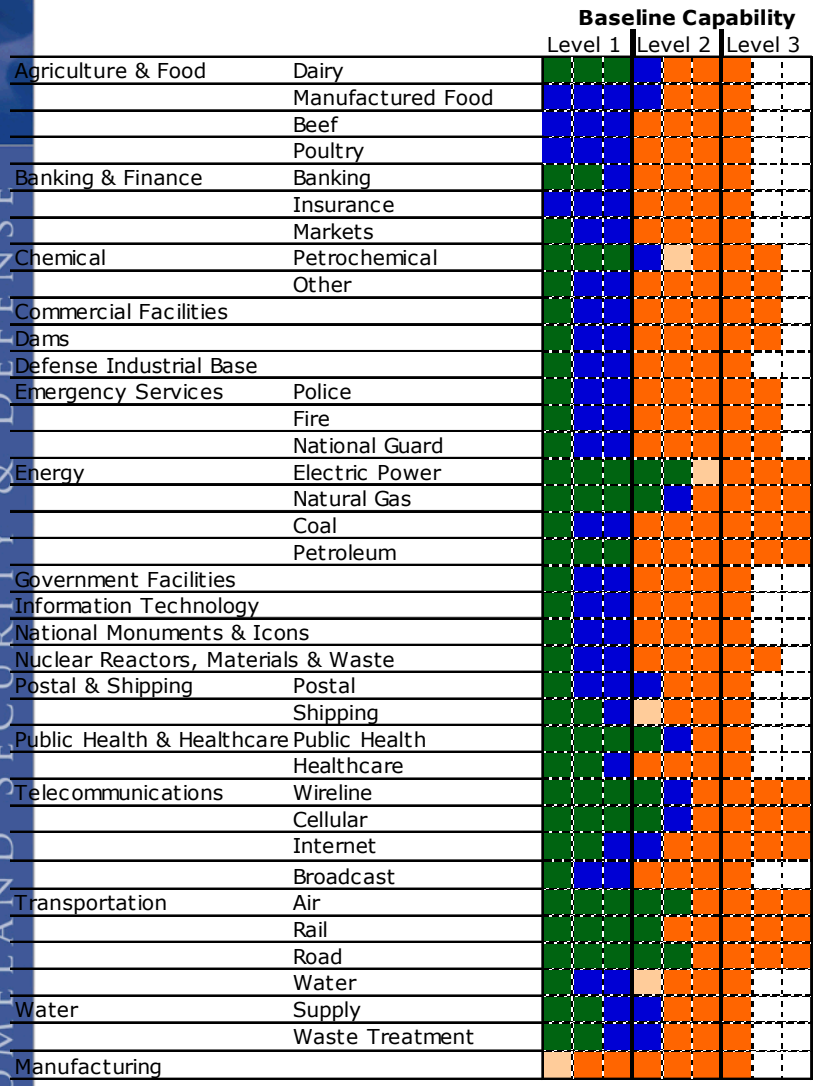
Categories of NISAC Activities



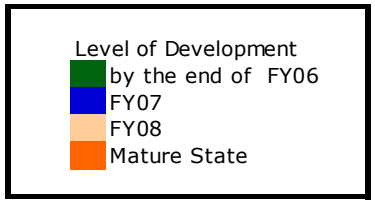
Capability Development Strategy

Highly Connected and Interdependent Infrastructures	Essential and Highly Dependent Infrastructures	Economic Sectors	Assets
• Energy • Banking & Finance • Telecommunications • Transportation	• Health Care • Ag & Food • Water • Government • Chemical	• Residential • Commercial • Industrial	•Power lines •Banks •Central offices • Bridges •Many more…
Commerce and national economic security depend on these infrastructures	Human health and safety depend on these infrastructures	Source of demand and labor for infrastructures	Potential targets

Sector Modeling Capability



- **Level 1 - Initial screening capability (sector data, aggregate models, single asset or general operation models)**
- **Level 2 - Enhanced screening and priority analysis capabilities (network models with limited asset level representation, intra-sector dependencies and confidence)**
- **Level 3 – Mature screening and analysis capabilities (detailed, fully-featured, dependency, interdependency, large-scale system, nation-wide coverage and high-degree of confidence**



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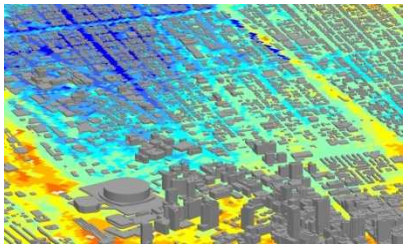
NISAC Infrastructure Models

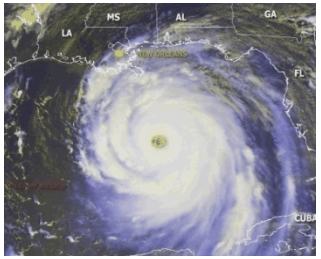
- **Transportation:**
  - FastTrans (Road Transportation).
  - Rail Network Analysis System (R-NAS).
  - Air Transportation Optimization Model (ATOM).
  - System for Import/Export Routing and Recovery Analysis (SIERRA).
  - Container Port Operations (Seattle, Portland, Houston).
- **Energy:**
  - Interdependent Energy Infrastructure Simulation System (IEISS).
  - National Petroleum System (CIPDSS-National Petroleum).
  - National Natural Gas Network (Loki-GAM).
  - National Natural Gas System.
- **Water:**
  - Water Infrastructure Simulation Environment (WISE).
- **Telecommunications:**
  - Metropolitan Information Telecommunications Simulator (MITS).
  - Telecommunications Modeling Suite (N-SMART).
- **Public Health and Healthcare:**
  - EpiSimS (Disease Transmission).
  - Loki-Infect.
  - Healthcare System (CIPDSS-Healthcare).
- **Emergency Services:**
  - Resource Allocation Models.
- **Chemical Sector:**
  - Petrochemical network model (Loki-Petrochemical).
  - Global Petrochemical supply chain (N-ABLE).
  - Chlorine supply chain (N-ABLE).
- **Banking and Finance:**
  - Global Financial Network (Loki – GFN).
  - Large Transaction Network (Loki-Transact).
- **Dams:**
  - Dam Inundation.
  - Dam System.
- **Agriculture and Food:**
  - Beef Cycle (CIPDSS – Ag).
  - Dairy Cycle and Supply Chains (CIPDSS – Ag).
  - Corn Cycle (CIPDSS – Ag).
  - Manufactured Food Supply Chain (N-ABLE).
- **Multiple Infrastructures:**
  - NISAC Agent-Based Laboratory for Economics (N-ABLE).
  - Fast-Analysis Infrastructure Tool (FAIT).
  - Loki toolkit.
  - Urban Infrastructure Suite.
  - Critical Infrastructure Protection Decision Support System (CIPDSS)

Fast-Turnaround Analysis Examples

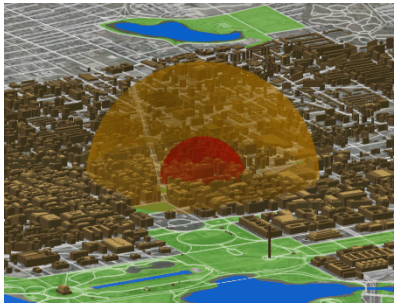
- **2009**
  - South Dakota Flooding
  - Risk Management Document Reviews
- **2008**
  - Hurricane Impacts (Gustav and Ike)
  - Midwest Flooding
  - National Level Exercise 2 - 08
  - Transportation corridors analysis
  - International asset analyses
- **2007**
  - Minnesota oil pipeline explosion
  - California wildfires
  - TOPOFF IV
  - I-35W Bridge Collapse
  - Rail car TIH release scenario
  - Ardent Sentry exercise support



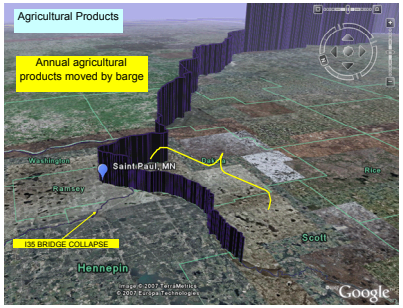
Flooding

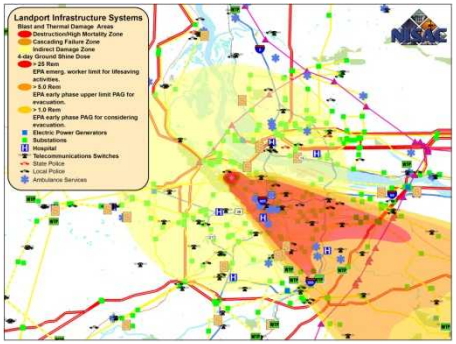


Hurricane



Improvised Nuclear Device





Infrastructure and Population Impacts

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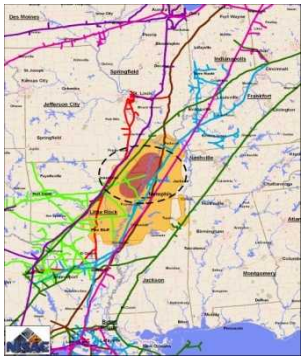
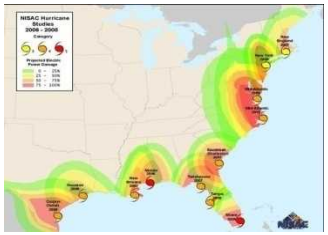
Example Planned Analysis Products

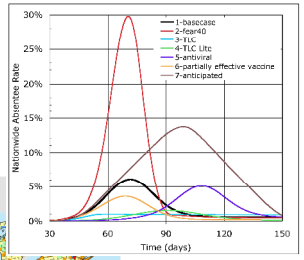
- **2008**
  - Asset prioritization analyses
    - Electric Power
    - Telecommunications
  - California and New Madrid Earthquake Impacts
  - Petrochemical global supply-chain disruption impacts
  - Hurricane Scenario for Corpus Christi
- **2007**
  - Earthquake Impacts
  - Long-term economic impacts of Hurricane Katrina
  - Dam failure impacts – case studies
  - Hurricane Scenarios for Savannah and North Florida
- **2006**
  - Pandemic Influenza Impacts and Mitigation Design
  - National Hazards Mitigation
  - Regional Economic Impacts
  - Air Transportation disruption impacts
  - Hurricane Scenarios for Mid-Atlantic, Mobile, Houston, Tampa, New York and Miami

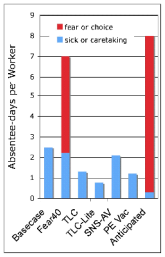


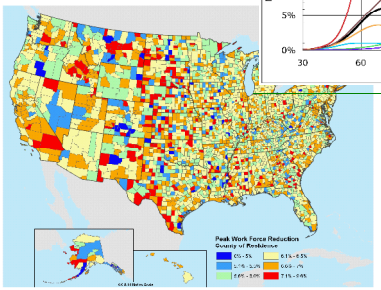


Key Results – Workforce

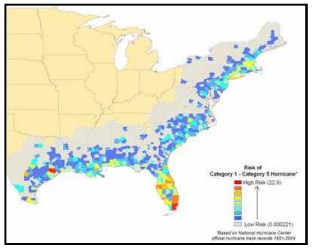
- Analysis quantified absenteeism impacts on infrastructures and economic sectors nationally by county







- Counties are impacted by absenteeism differently due to demographic differences (e.g., household size)



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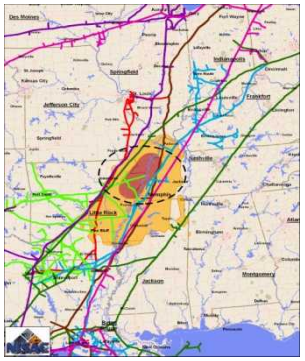

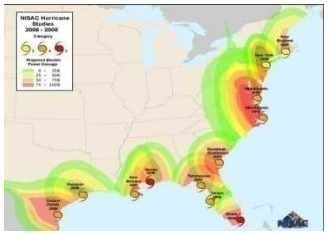

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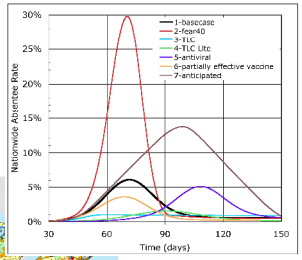
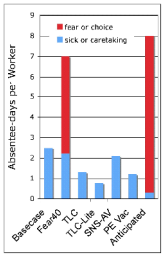
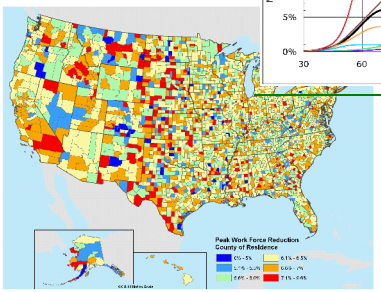
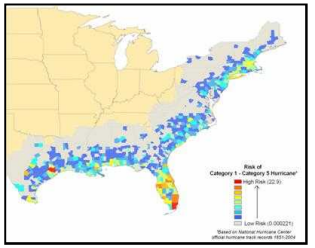






- Counties are impacted by absenteeism differently due to demographic differences (e.g., household size)



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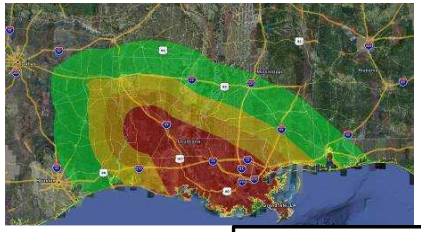
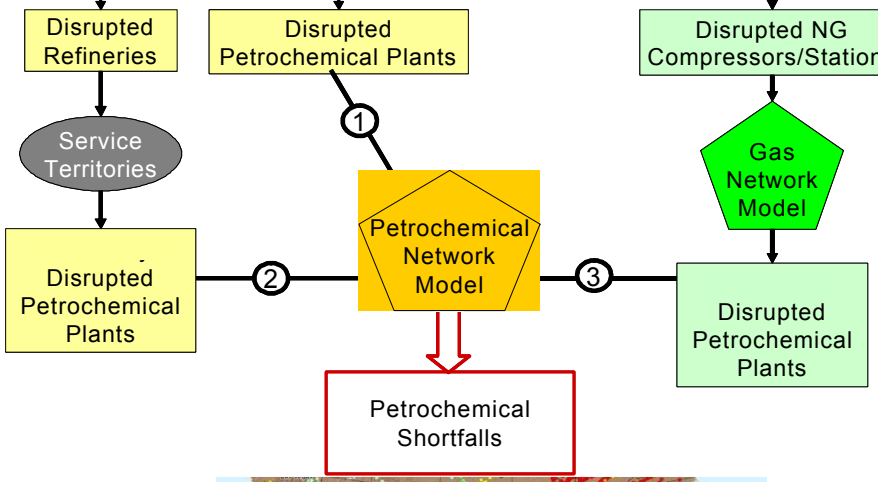
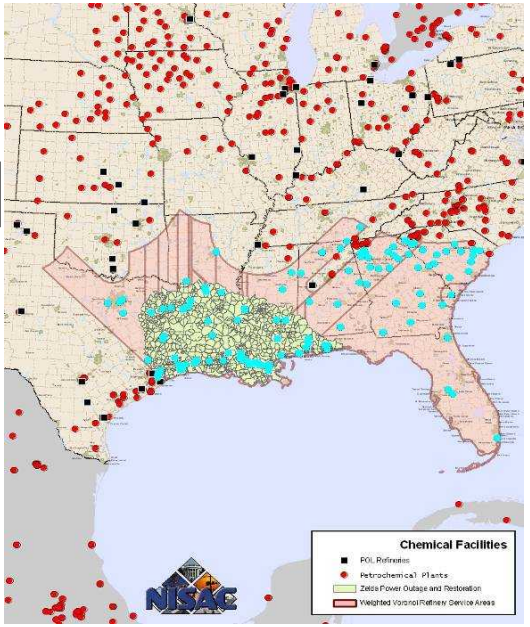
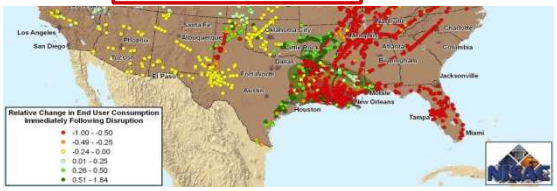
Analyzing Cascading Impacts – Petrochemical









A variety of data and models may be needed to assess the impact of disruptive events

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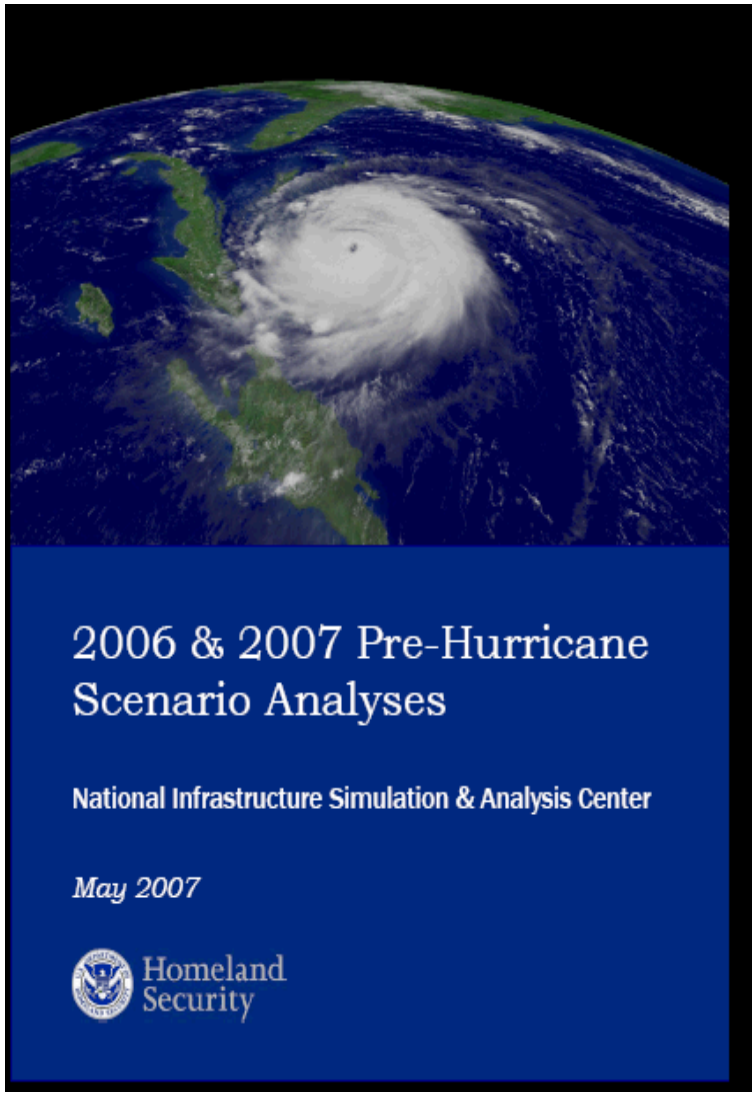
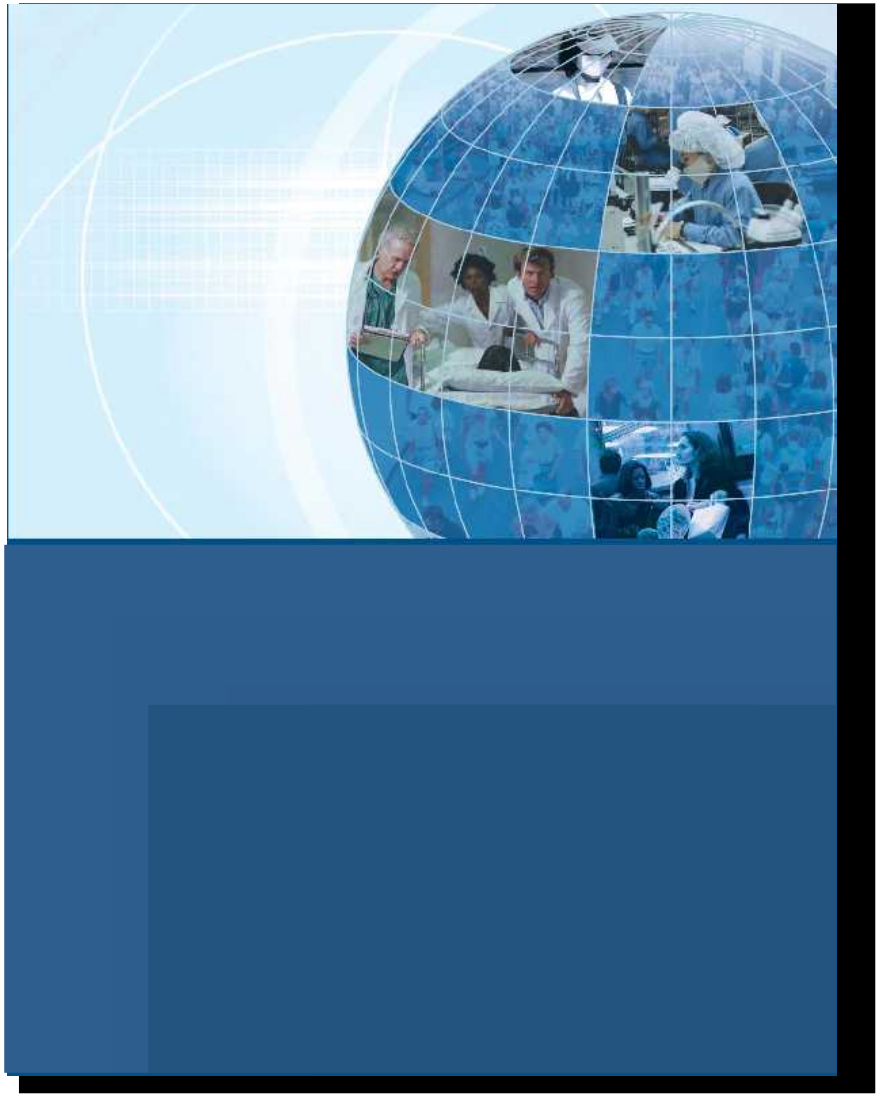
Examples of NISAC's Impact

- **New Madrid Earthquake Impacts** - Infrastructure impact analysis contributing to development of the National Strategic Plan for a NMSZ event, better informing planning efforts and design of mitigation measures at all levels (local, regional and national).
- **Pandemic Influenza** – Provided DHS input to the national plan for PI and influenced CDC/HHS community containment strategy (developed as part of the national planning effort).
- **Asset Impact Analysis** - Provides justification for inclusion/exclusion of specific sites on DHS security priority lists.
- **National Network Asset Ranking Studies** - Provides quantification of asset impacts and rankings for DHS asset priority lists for Electric Power, Telecommunications and Road Transportation.
- **Hurricane Pre- and Post-landfall Impact Analyses** - Informs DHS pre-event planning and deployment for the events and post-event security priorities.
- **I-35 Bridge Collapse Impact Analysis** - Informed DHS event response.
- **National Rail Bridge Impact Analyses** - Refined DHS rail asset security priorities.
- **National Chlorine Transportation Security Policy Analysis** - Identified consequences of transportation security policies under consideration; influenced implementation decisions.

Outreach – Example Publications





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Collaborations

University of Minnesota
USC – CREATE
University of Maryland
Cornell
Columbia
UC Berkeley
UC Santa Barbara
UCLA
UC Riverside
University of Washington
Rice University
University of Illinois
University of Utah
Carnegie-Mellon University
University of Texas at Austin
University of Washington
Virginia Tech
University of New Mexico
University of Arizona
MIT
Duke University
SUNY Albany
University of Nebraska
Illinois Institute of Technology
Ohio State
Georgia Tech

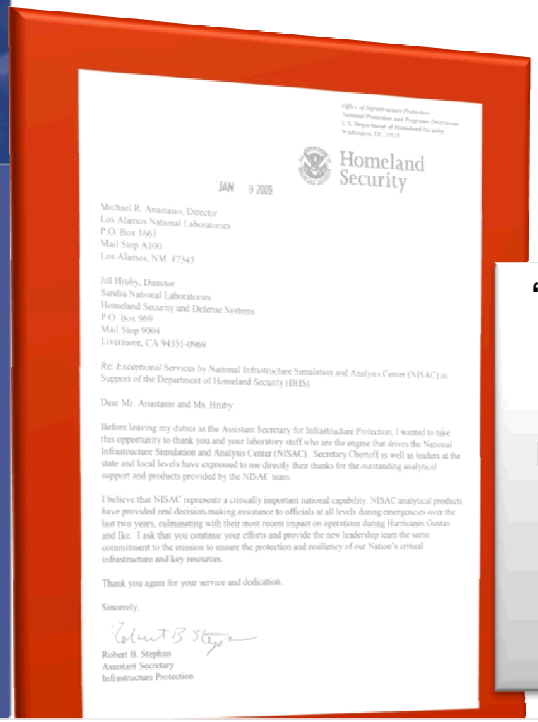
CERA
NSTAC
Goodyear
AON
RMS
SRI-C
Veterans Administration
AIR
Lucent/Alcatel (Bell Labs)
Microsoft Research
SAMSI
Scalable Networks
Motorola
Metatech
Telcordia
Pacific Northwest Economic Region
Port of Portland
Port of Seattle
Portland METRO

Central European Bank
Bank of Finland
ETH Zurich
Nankai University
University of Vienna
DSO Singapore

Global-Level Events Impact CI

For this

Kudos…


Homeland Security

JAN 9 2009

Michael R. Anastasio, Director
Los Alamos National Laboratories
P.O. Box 1663
Mail Stop A100
Los Alamos, NM 87545

Jill Hruby, Director
Sandia National Laboratories
Homeland Security and Defense Systems
P.O. Box 969
Mail Stop 9004
Livermore, CA 94551-0969

Re: Exceptional Services by National Infrastructure Simulation and Analysis Center (NISAC) in Support of the Department of Homeland Security (DHS)

Dear Mr. Anastasio and Ms. Hruby:

Before leaving my duties as the Assistant Secretary for Infrastructure Protection, I wanted to take this opportunity to thank you and your laboratory staff who are the engine that drives the National Infrastructure Simulation and Analysis Center (NISAC). Secretary Chertoff as well as leaders at the state and local levels have expressed to me directly their thanks for the outstanding analytical support and products provided by the NISAC team.

I believe that NISAC represents a critically important national capability. NISAC analytical products have provided real decision-making assistance to officials at all levels during emergencies over the last two years, culminating with their most recent impact on operations during Hurricanes Gustav and Ike. I ask that you continue your efforts and provide the new leadership team the same commitment to the mission to ensure the protection and resiliency of our Nation's critical infrastructure and key resources.

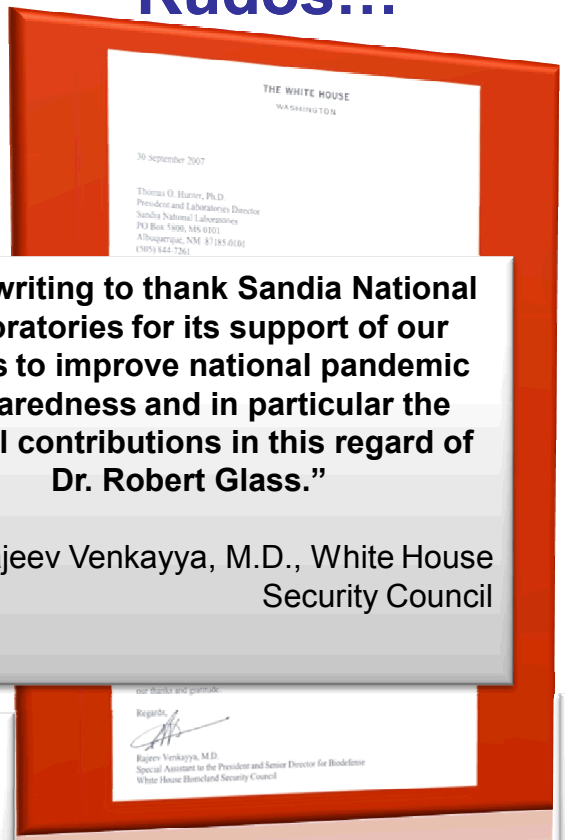
Thank you again for your service and dedication.

Sincerely,

Robert B. Stephan
Assistant Secretary
Infrastructure Protection

"Secretary Chertoff as well as leaders at the state and local levels have expressed … their thanks for the outstanding materials and products provided by the NISAC team."

Bob Stephan, ASIP


THE WHITE HOUSE
WASHINGTON

30 September 2007

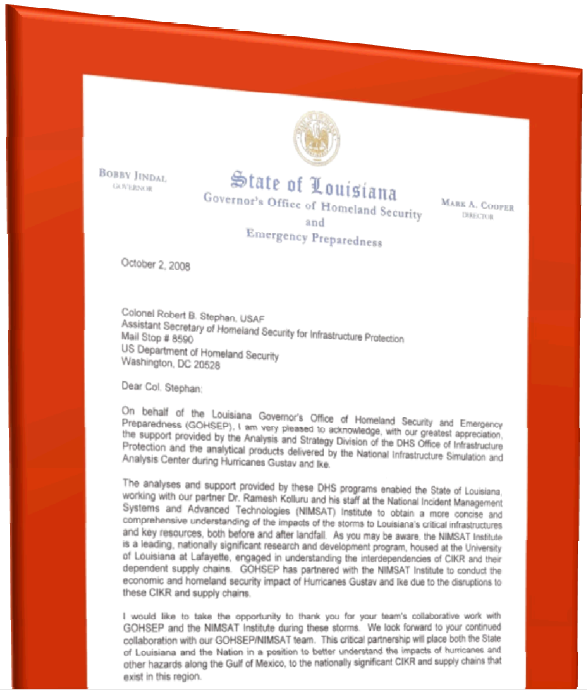
Thomas O. Hunter, Ph.D.
President and Laboratories Director
Sandia National Laboratories
PO Box 5800, MS 0103
Albuquerque, NM 87185-0101
(505) 844-7261

Regards,

Rajeev Venkayya, M.D.
Special Assistant to the President and Senior Director for Biodefense
White House Homeland Security Council

"I am writing to thank Sandia National Laboratories for its support of our efforts to improve national pandemic preparedness and in particular the pivotal contributions in this regard of Dr. Robert Glass."

Rajeev Venkayya, M.D., White House Security Council


Bobby Jindal
Governor

State of Louisiana
Governor's Office of Homeland Security
and
Emergency Preparedness

Mark A. Cooper
Director

October 2, 2008

Colonel Robert B. Stephan, USAF
Assistant Secretary of Homeland Security for Infrastructure Protection
Mail Stop # 8590
US Department of Homeland Security
Washington, DC 20528

Dear Col. Stephan:

On behalf of the Louisiana Governor's Office of Homeland Security and Emergency Preparedness (GOHSEP), I am very pleased to acknowledge, with our greatest appreciation, the support provided by the Analysis and Strategy Division of the DHS Office of Infrastructure Protection and the analytical products delivered by the National Infrastructure Simulation and Analysis Center during Hurricanes Gustav and Ike.

The analyses and support provided by these DHS programs enabled the State of Louisiana, working with our partner Dr. Ramesh Kolluru and his staff at the National Incident Management Systems and Advanced Technologies (NIMSAT) Institute to obtain a more concise and comprehensive understanding of the impacts of the storms to Louisiana's critical infrastructures and key resources, both before and after landfall. As you may be aware, the NIMSAT Institute is a leading, nationally significant research and development program, housed at the University of Louisiana at Lafayette, engaged in understanding the interdependencies of CIKR and their dependent supply chains. GOHSEP has partnered with the NIMSAT Institute to conduct the economic and homeland security impact of Hurricanes Gustav and Ike due to the disruptions to these CIKR and supply chains.

I would like to take the opportunity to thank you for your team's collaborative work with GOHSEP and the NIMSAT Institute during these storms. We look forward to your continued collaboration with our GOHSEP/NIMSAT team. This critical partnership will place both the State of Louisiana and the Nation in a position to better understand the impacts of hurricanes and other hazards along the Gulf of Mexico, to the nationally significant CIKR and supply chains that exist in this region.

The analyses and support provided … a more concise and comprehensive understanding of the impact of the storms to Louisiana's critical infrastructure and key resources, both before and after landfall."

Clayton Rives, Assistant Dep. Dir. Homeland Security