



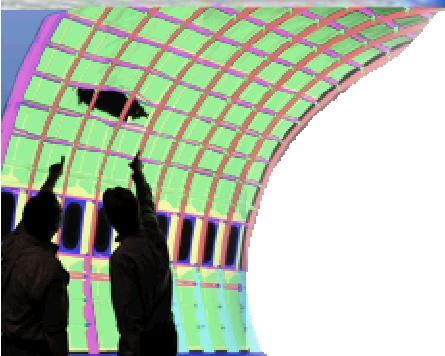
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Date 06/22/11



# Chemical Supply Chain Resilience and Security

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## A Request for Analytical Capability

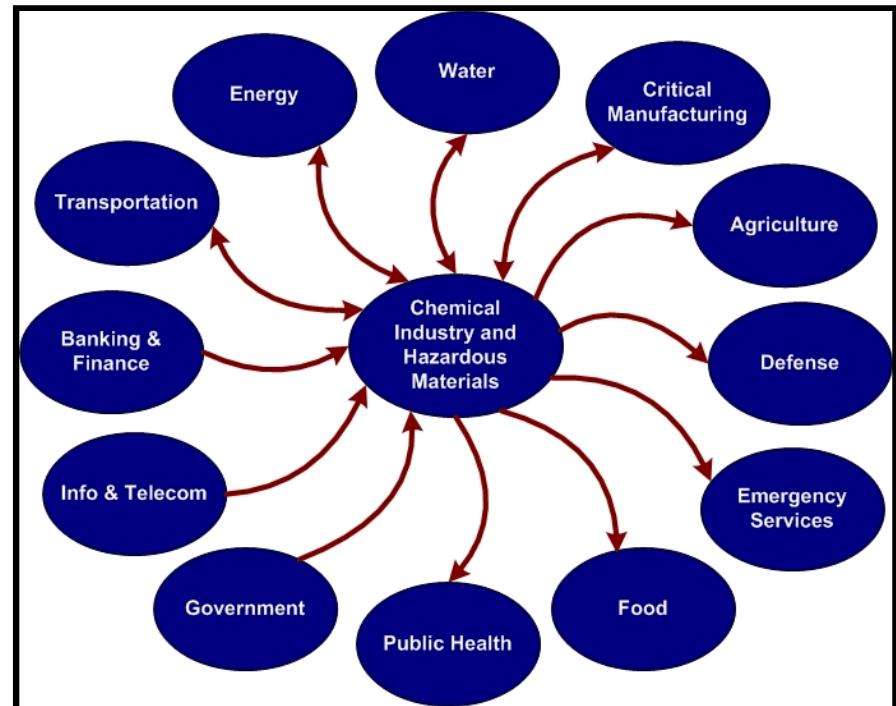
- **Chemical Sector designated critical infrastructure in 2006**

- DHS IP requested chemical supply chain analysis capability

- **DHS S&T assumed project direction and funding in 2008**

- **This effort leverages Sandia's expertise in**

- Chemical engineering
  - Infrastructure modeling & analysis
  - Economics
  - Computer science



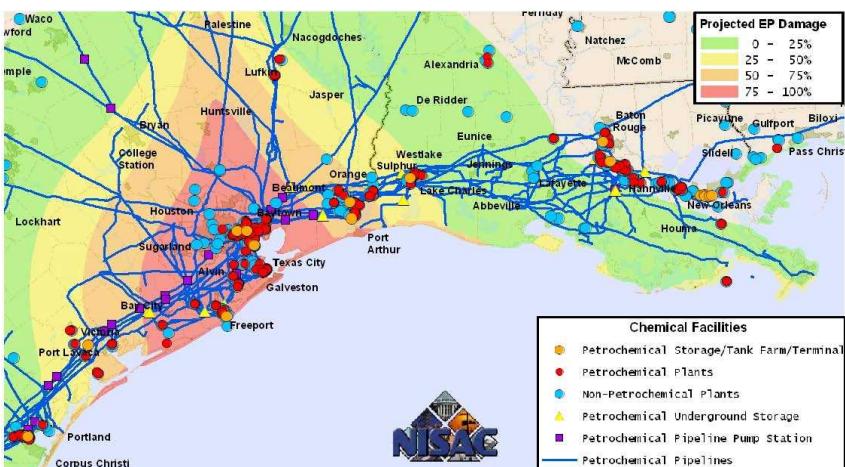
The chemical sector is highly connected to other critical infrastructures.



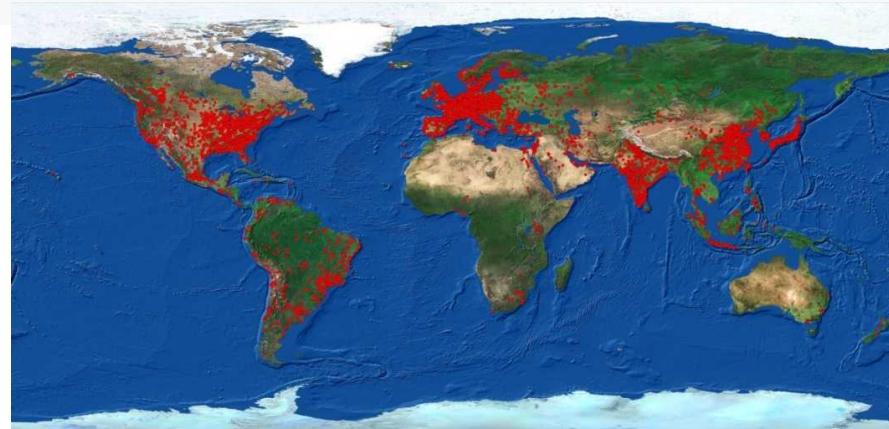
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# Scope

- Global, national, regional, and facility perspectives
- Disruptions to the chemical sector and dependent infrastructures



Incident response is a key use of the capability.



The chemical industry is truly a global market.

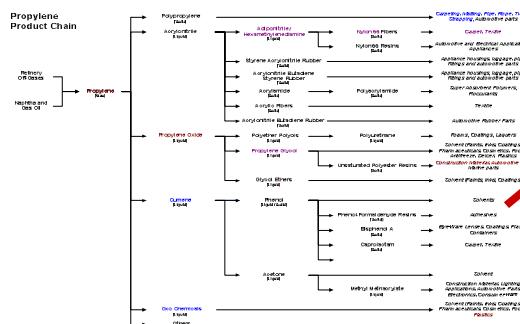
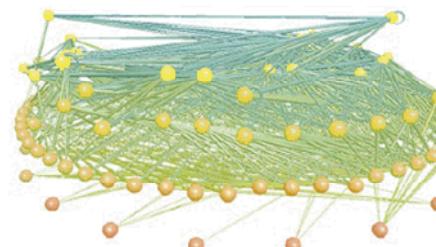
- Rapid, incident response
- Long-term, cascading impacts



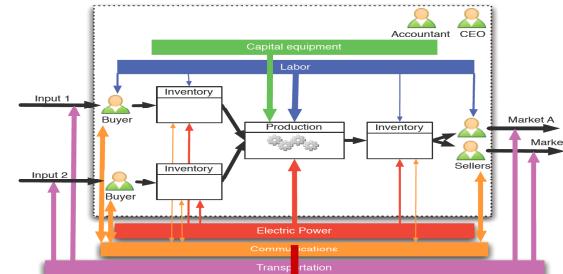
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# Capability Development

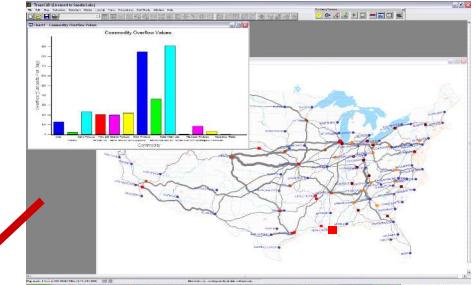
# Network Analysis



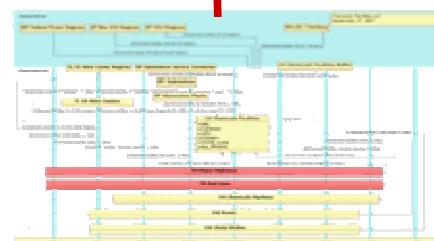
## Supply Chain/Economic Analysis



## Transportation Analysis

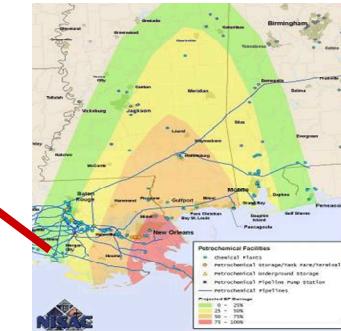


## Leveraging existing NISAC models and industry data in combination



# Systems Analysis

## Infrastructure/Interdependences Analysis



# Geospatial Analysis

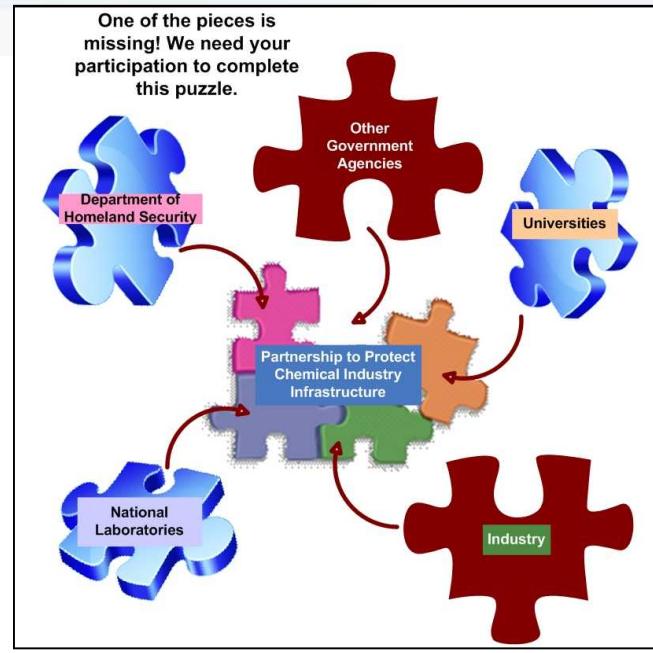


# Application and Transition

- Supported DHS IP analysis requests, as staged validation and development permits
- Capability application examples include
  - Hurricane Dean (and many others)
  - Deep Water Horizon
  - National Level Exercises
  - Super Bowl 43



Hurricane Hannah 2008



Industry workshops validate methods.

- Formal capability transfer to DHS Risk Development and Modeling Branch in August, 2011
- Transition plan includes
  - User training workshop
  - User documentation



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# Resilience Assessment

- DHS recognized the need for defensible assessment methods
- S&T tasked Sandia in 2008 to develop such methods for infrastructure and economic systems
- Requirements
  - Broadly applicable
  - Scientifically defensible
  - Peer-review

Infrastructure systems face a number of threats.

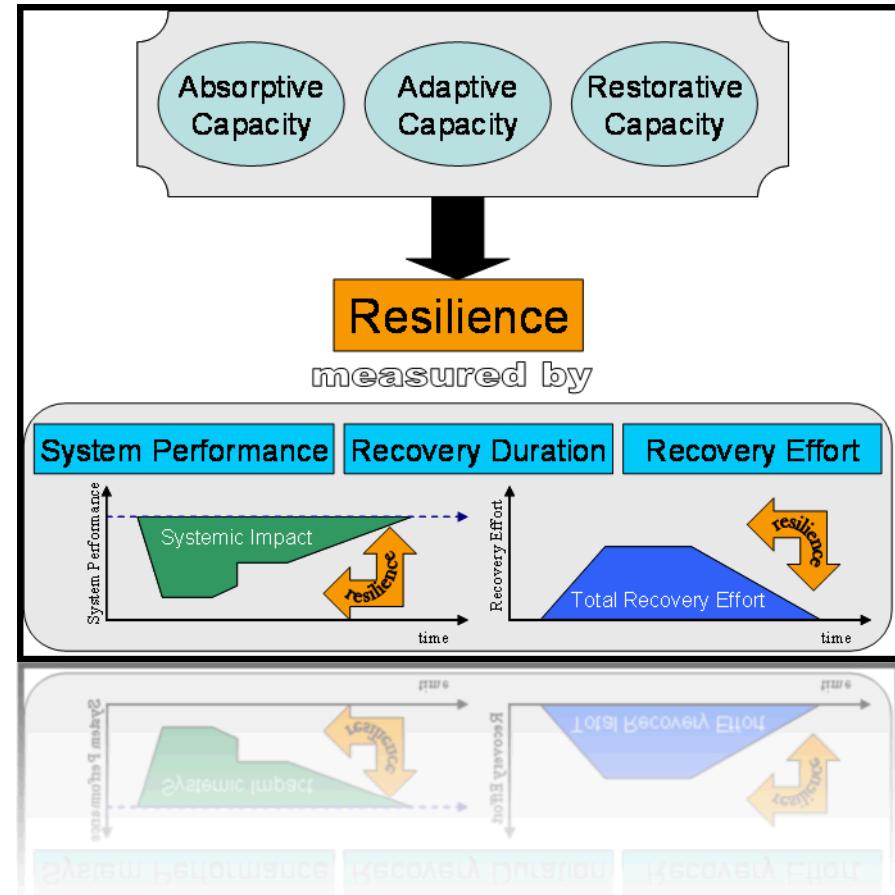


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# A Framework for Resilience Assessment

## ■ Key features include

- Mathematics of control theory
- Recovery costs and constraints
- Applicable to all infrastructure systems
- Qualitative and quantitative analysis
- Can handle dependencies

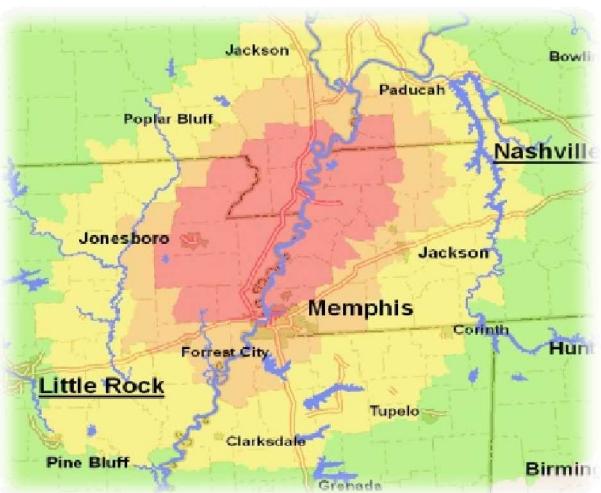




# Example Applications



Standards for DHS Policy  
Resilience Certification Program



New Madrid Earthquake Analysis for  
DHS IP



Chemical Supply Chains for SSA



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