Sandia National Laboratories and the National Infrastructure Simulation and Analysis Center

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Sandia is also a federally funded research and development center (FFRDC) owned by the Department of Energy

**Key Mission Areas**
- Nuclear Weapon
- Defense Systems & Assessments
- Energy, Resources, & Nonproliferation
- Homeland Security and Defense

**Key Science Foundations include:**
- Computation, computers, and math (advanced Modeling & Simulation and analytics)
- Critical infrastructure and interdependencies analysis

http://www.sandia.gov
Established in 2000, NISAC was incorporated into the USA Patriot Act of 2001 and became part of DHS upon its inception in May 2003.

Congress mandated that NISAC serve as a "source of national expertise to address critical infrastructure protection" research and analysis.

Infrastructures are the systems that provide the things we take for granted.

http://www.sandia.gov/nisac
A Challenging if not Daunting Task

- Each individual infrastructure is complicated
- Interdependencies are extensive and poorly studied
- Infrastructure is largely privately owned, and data is difficult to acquire
- No single approach to analysis or simulation will address all of the issues
Example Natural Disaster Analysis: Hurricanes

Analyses:

- Damage areas, severity, duration, restoration maps
- Projected economic damage
  - Sectors, dollars
  - Direct, indirect, insured, uninsured
  - Economic restoration costs
- Affected population
- Affected critical infrastructures
- Propagating supply chain effects

Focus of research:
- Comprehensive evaluation of Threats
- Design of Robust Mitigation
- Evolving Resilience
Application: Industrial Disruptions

Disrupted Facilities → Reduced Production Capacity

National Supply Chain

Diminished Product Availability
**NISAC Applications**

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**Infectious Disease Spread**

Example Teen

- Extended Family or Neighborhood
- Social Networks for Teen T1
- School classes 6 per teen

**Latent**
Mean duration 1.25 days

**Infectious**
- Presymptomatic
  Mean duration 0.5 days
- Symptomatic
  Circulate Mean duration 1.5 days
  - IR 0.25 for first 0.5 day,
  - then reduced to 0.375 for final day
- Stay home
  Mean duration 1.5 days
  - IR 1.0 for first 0.5 day,
  - then reduced to 0.375 for final day

**Infectious Asymptomatic**
Mean duration 2 days
IR 0.25

**Dead**

**Immune Transition Probabilities**

- pS = 0.5
- pH = 0.5
- pM = 0

- pS(1-pS)
- pH(1-pH)
- pM(1-pM)

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**Petrochemical Interdependencies**

Capacity

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**Banking Interactions**

1. Productive agent instructs bank to send a payment
2. Depositor account is debited
3. Payment is submitted or queued
4. Payment account is debited
5. Payment account is credited
6. Depositor account is credited
7. Queued payment is submitted if there is one

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**Natural Gas Transmission**

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**Los Alamos**
Critical Infrastructures:

- Are **Complex**: composed of many parts whose interaction via local rules yields *emergent structure* (*networks*) and *behavior* (*cascades*) at larger scales
- *Grow and adapt* in response to local-to-global *policy*
- *Contain people*
- Are interdependent “*systems of systems***

Critical infrastructures are -

- **Complex**
- **Adaptive**
- **Systems of Systems**: CASoS