Identifying Infrastructure Dependencies and Interdependencies

National Protection and Programs Directorate

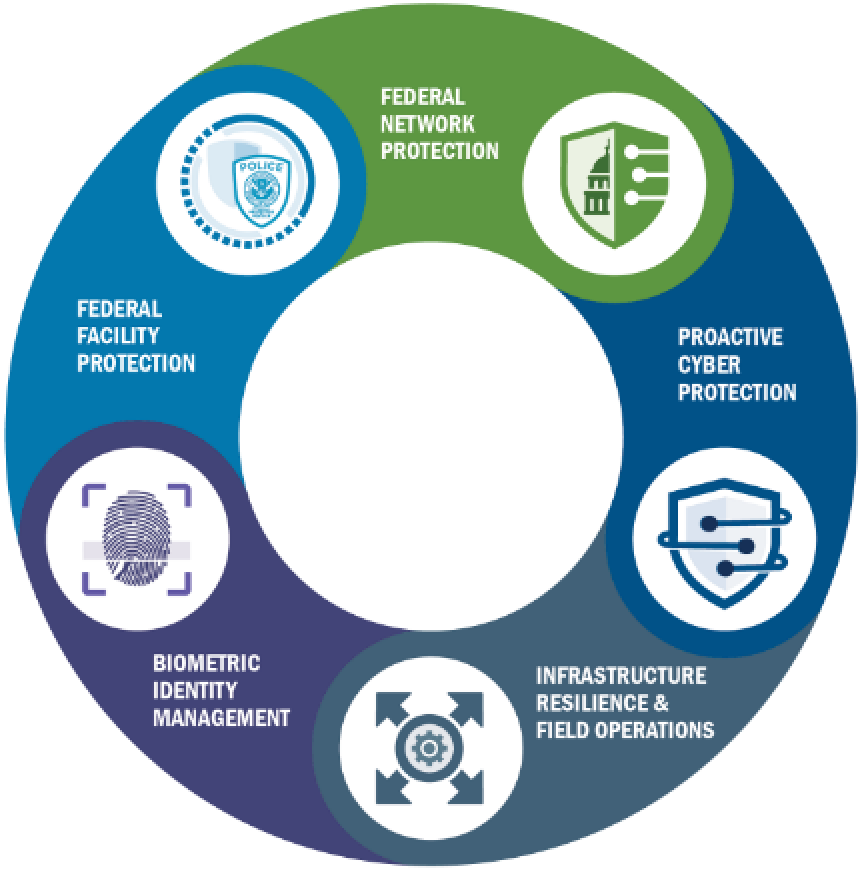
September 6, 2018

Homeland Security

NATIONAL PROTECTION AND
PROGRAM DIRECTORATE

The Nation's Risk Managers

The National Protection and Programs Directorate (NPPD) is the pinnacle of national risk management for cyber and physical infrastructure


FEDERAL NETWORK PROTECTION
PROACTIVE CYBER PROTECTION
INFRASTRUCTURE RESILIENCE & FIELD OPERATIONS
BIOMETRIC IDENTITY MANAGEMENT
FEDERAL FACILITY PROTECTION
POLICE

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Today’s Risk Landscape

America remains at risk from a variety of threats:

- ACTS OF TERRORISM
- CYBER ATTACKS
- EXTREME WEATHER
- PANDEMICS
- ACCIDENTS OR TECHNICAL FAILURES

16 Critical Infrastructure Sectors & Corresponding Sector-Specific Agencies

CHEMICAL	IP
COMMERCIAL FACILITIES	IP
COMMUNICATIONS	DHS (CS&C)
CRITICAL MANUFACTURING	IP
DAMS	IP
DEFENSE INDUSTRIAL BASE	DOD
EMERGENCY SERVICES	IP
ENERGY	DOD
FINANCIAL	DOT
FOOD & AGRICULTURE	DOA & FDA
GOVERNMENT FACILITIES	DHS (FPS)
HEALTHCARE & PUBLIC HEALTH	HHS
INFORMATION TECHNOLOGY	DHS (CS&C)
NUCLEAR REACTORS, MATERIALS AND WASTE	IP
TRANSPORTATIONS SYSTEMS	(TSA & USCG)
WATER	EPA

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The Significance of Critical Infrastructure

Critical infrastructure refers to the assets, systems, and networks, whether physical or cyber, so vital to the Nation that their incapacitation or destruction would have a debilitating effect on **national security, the economy, public health or safety, and our way of life.**

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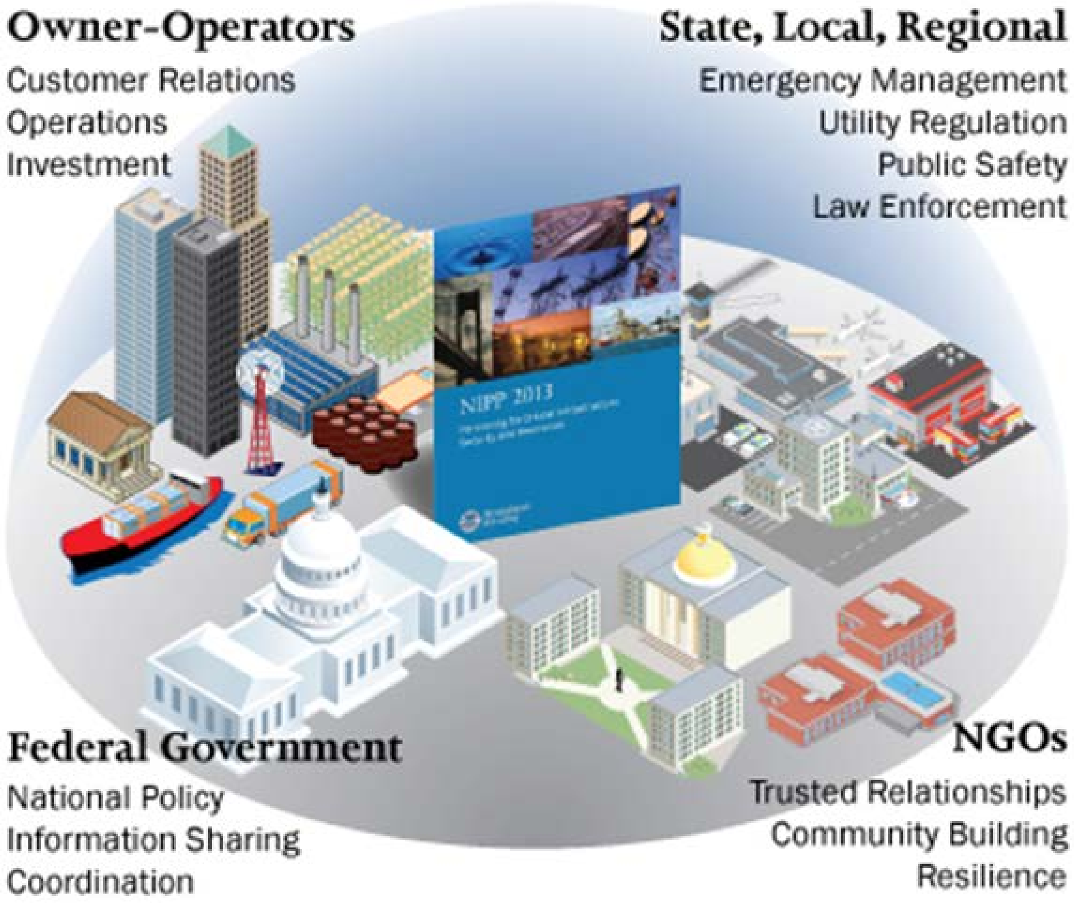
Many Stakeholders, Many Strengths

Comparative Advantage

- Engaging in collaborative process
- Applying individual expertise
- Bringing resources to bear
- Building the collective effort
- Enhancing overall effectiveness



Owner-Operators
Customer Relations
Operations
Investment

State, Local, Regional
Emergency Management
Utility Regulation
Public Safety
Law Enforcement

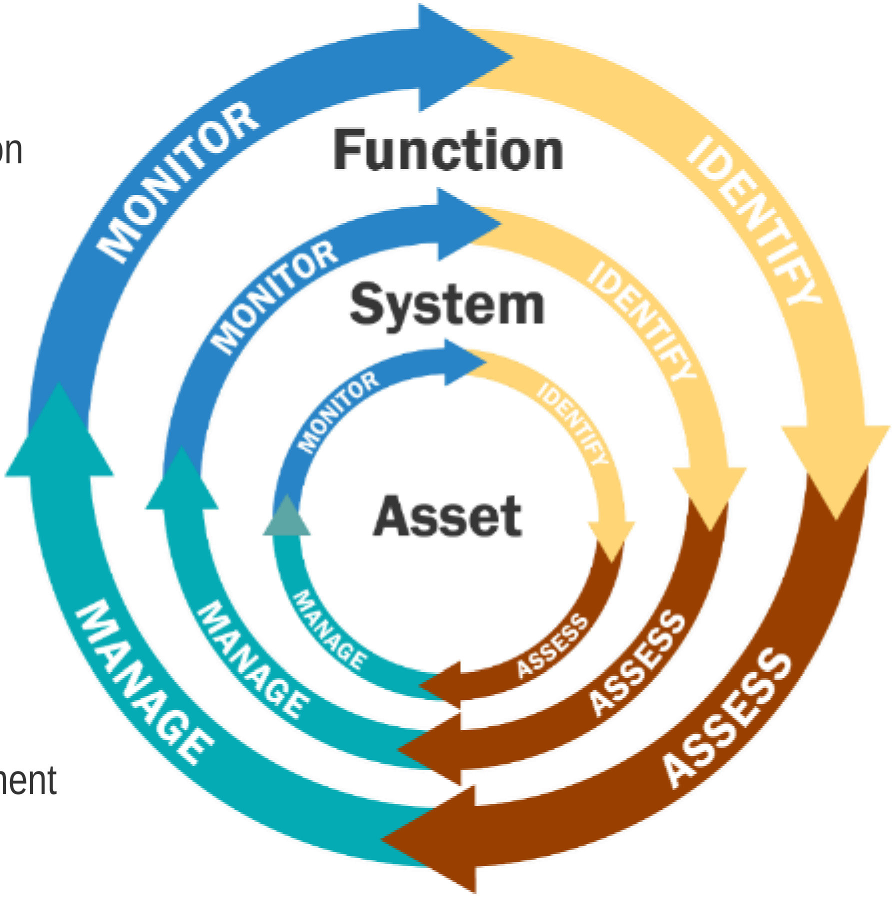
Federal Government
National Policy
Information Sharing
Coordination

NGOs
Trusted Relationships
Community Building
Resilience

Functions and Risk Management

Monitor

- Track how operational conditions impact function
- Share information and indicators of emerging systemic risk conditions



Identify

- Document national functions
- Convene stakeholder groups connected by functions
- Identify and validate scenarios of concern

Manage

- Develop collaborative strategies
- Coordinate risk management and monitoring plans

Assess

- Conduct cross-sector risk assessments
- Improve risk analysis with shared data

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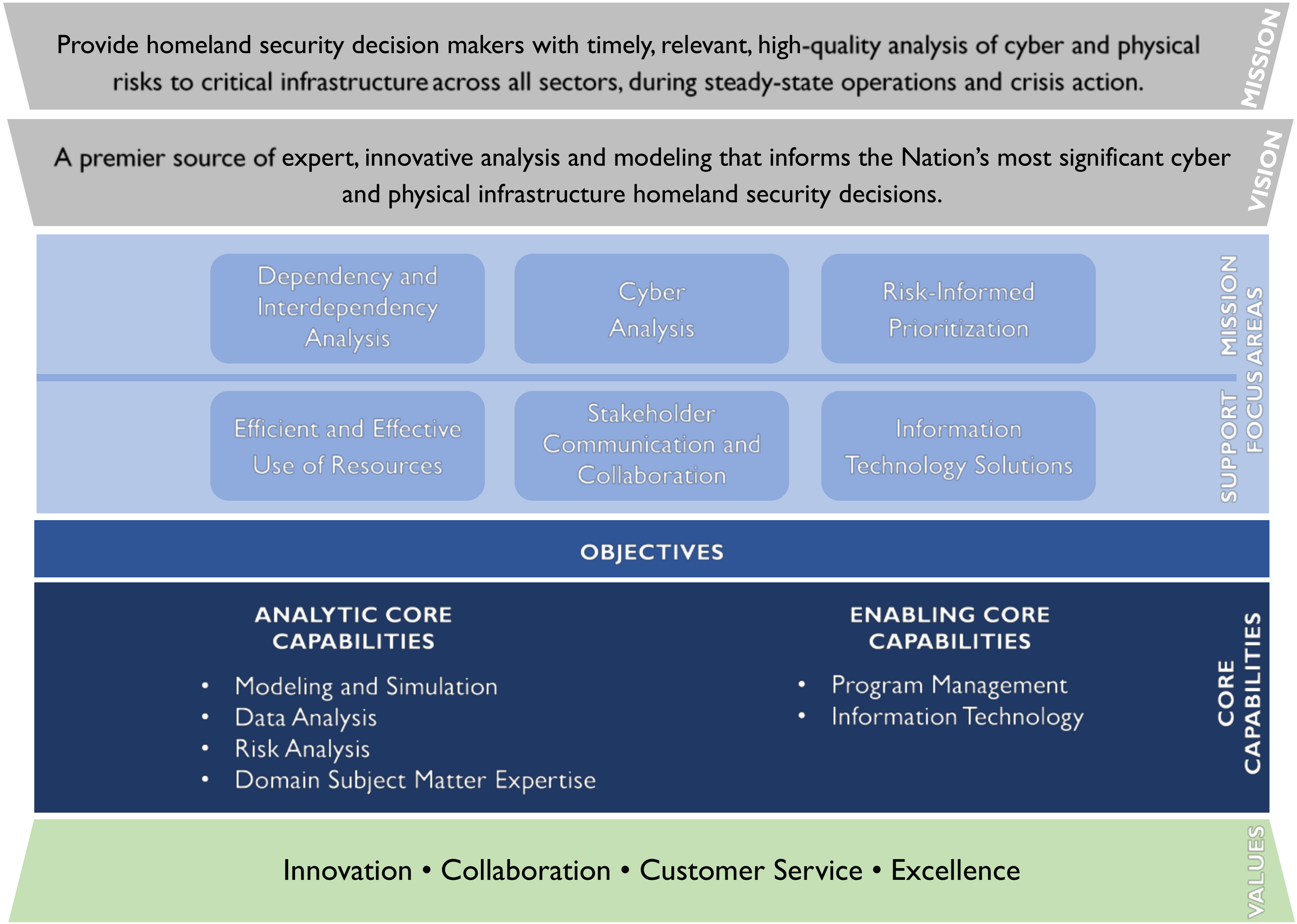
NISAC Strategic Framework



MISSION

Provide homeland security decision makers with timely, relevant, high-quality analysis of cyber and physical risks to critical infrastructure across all sectors, during steady-state operations and crisis action.

VISION

A premier source of expert, innovative analysis and modeling that informs the Nation's most significant cyber and physical infrastructure homeland security decisions.

FOCUS AREAS

MISSION

- Dependency and Interdependency Analysis
- Cyber Analysis
- Risk-Informed Prioritization

SUPPORT

- Efficient and Effective Use of Resources
- Stakeholder Communication and Collaboration
- Information Technology Solutions

OBJECTIVES

CORE CAPABILITIES

ANALYTIC CORE CAPABILITIES

- Modeling and Simulation
- Data Analysis
- Risk Analysis
- Domain Subject Matter Expertise

ENABLING CORE CAPABILITIES

- Program Management
- Information Technology

VALUES

Innovation • Collaboration • Customer Service • Excellence

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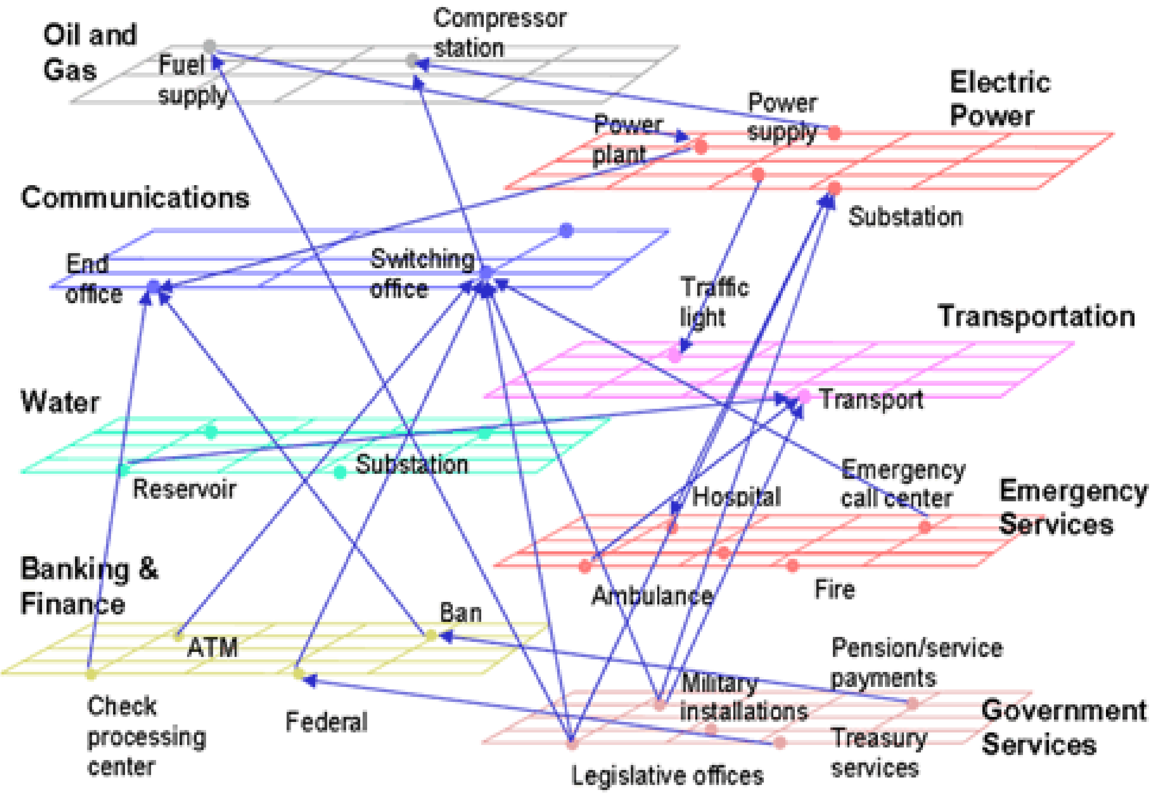
Infrastructure Dependencies

- Impacts to one infrastructure asset can cascade to other assets and systems
- Dependencies among infrastructure systems are complex
- Publicly-available data is sparse
- System owners and operators are reluctant to share detailed asset-level data



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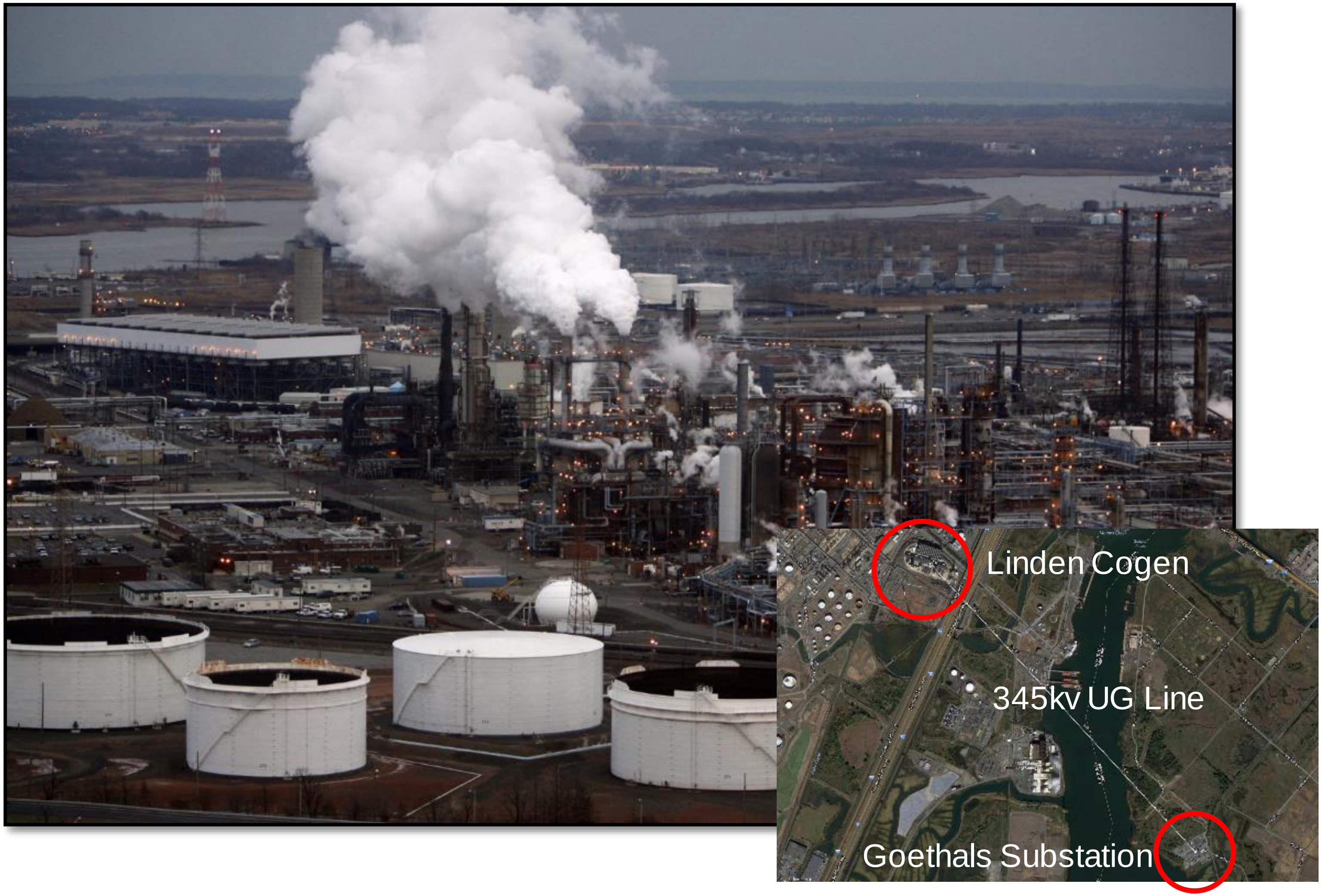
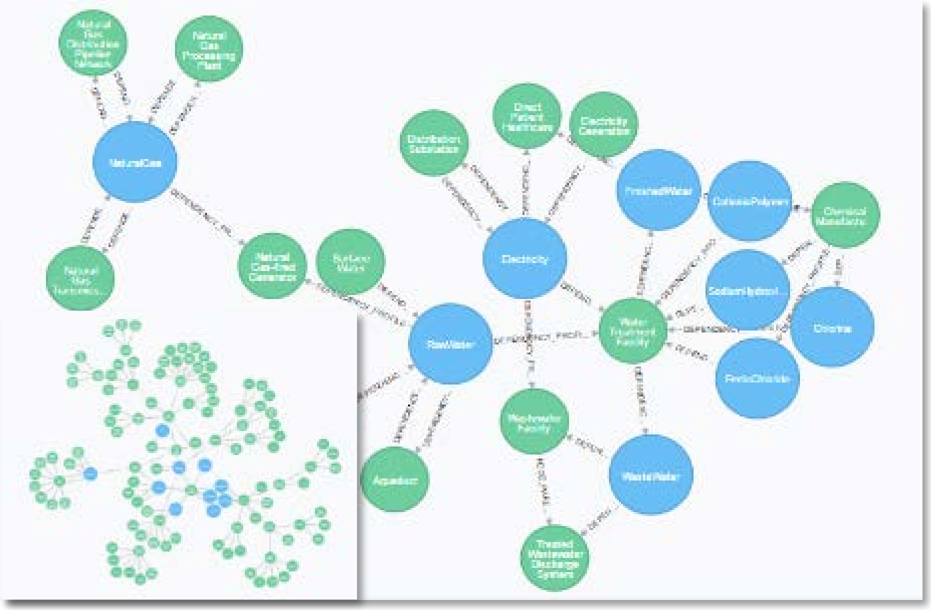
Example: Phillips 66 Bayway

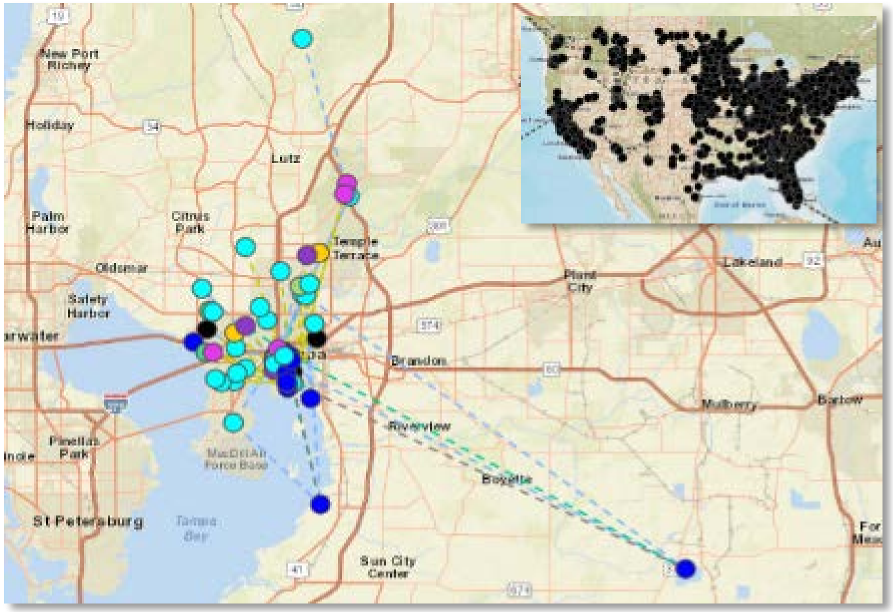


AHA Dependency Framework

- Developed by Idaho National Laboratory
- Creates a knowledge framework that learns from data and expert knowledge
- Integrates structured and unstructured datasets
- Provides both geospatial and graph visualization capability due to problem space complexity
- Enables functions-based consequence analysis useful for continuity of operations



Dependency Model



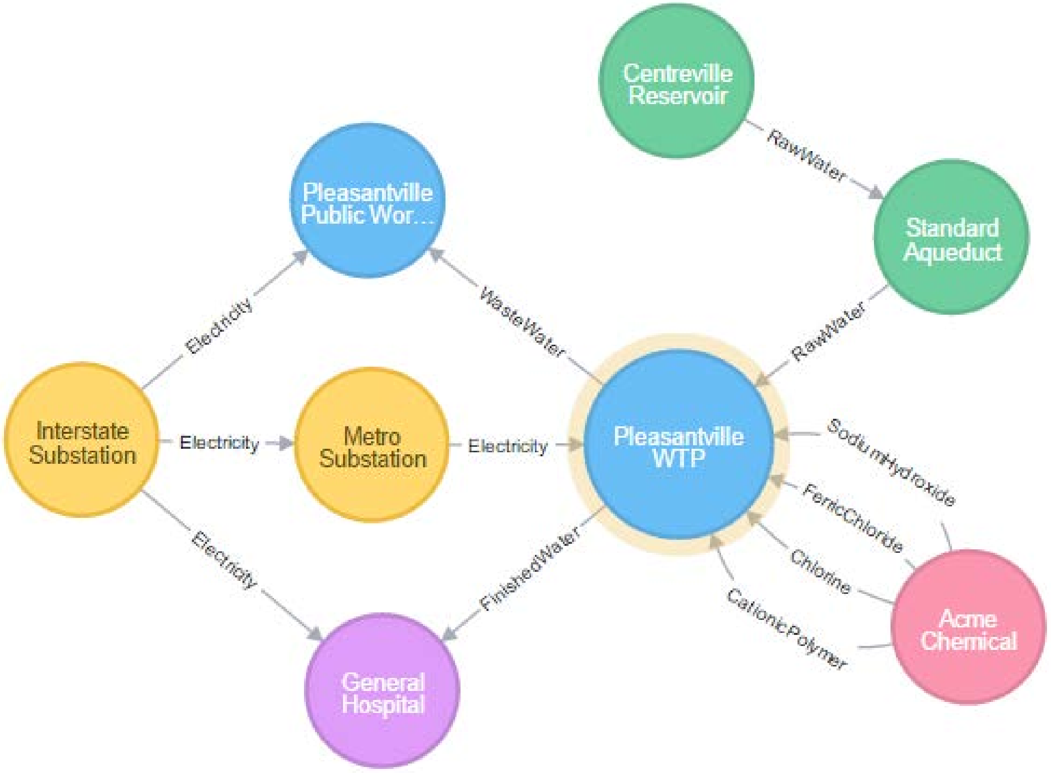
Geographic Visualization

AHA Enables Risk Decisions

- Actionable information – Getting the best available information to the right person at the right time, and in a form they can efficiently use
  - Helps proactively answer the “What if”, for when an infrastructure fails
  - Provides scale-independent functional dependency modeling
  - Includes knowledge management & knowledge transfer
  - Can become useful for decision support

Prepare | Protect | Mitigate | Respond | Recover

AHA Technical Approach



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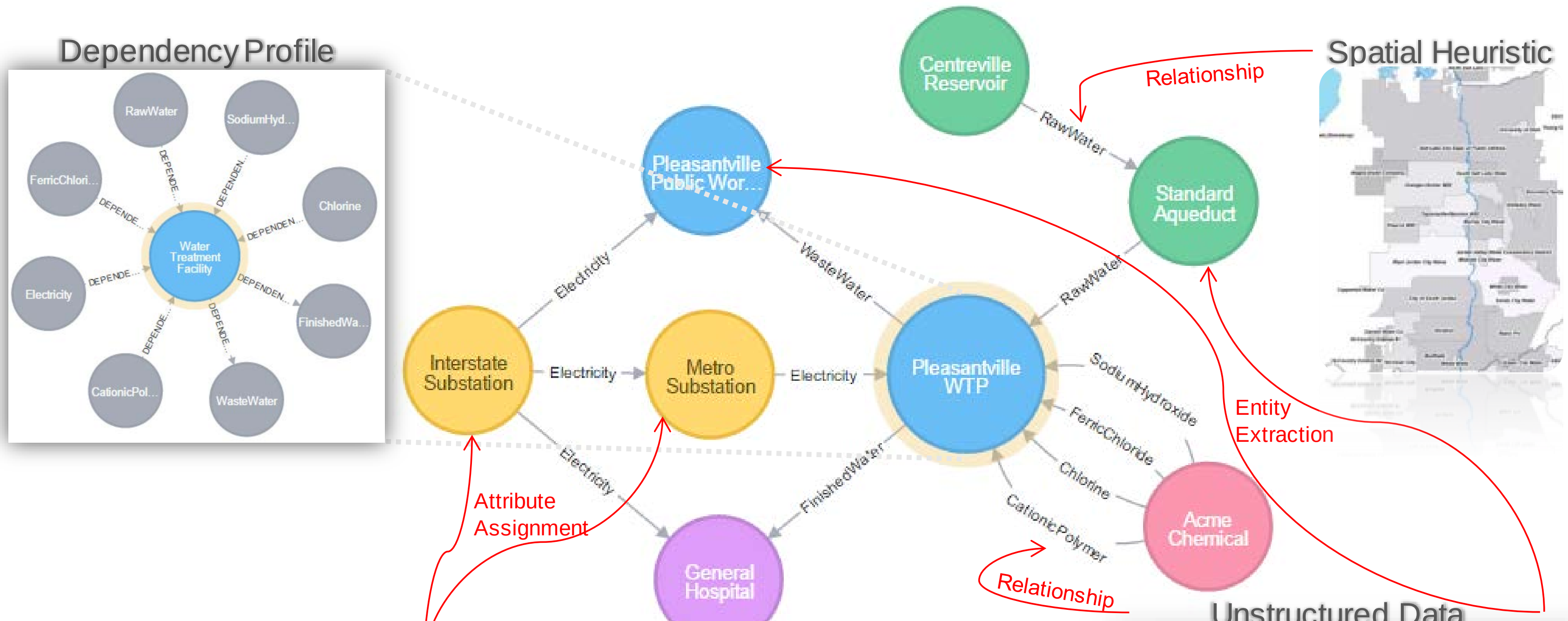
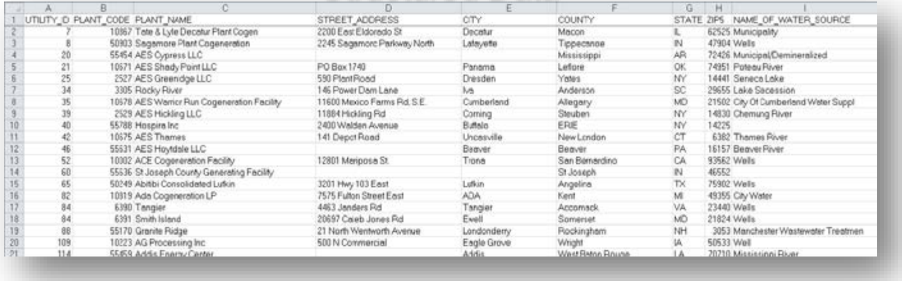
AHA Technical Approach (contd)

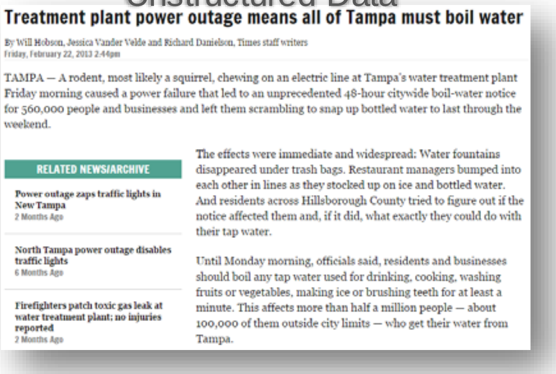


Structured Data



	A	B	C	D	E	F	G	H	I
1	UTILITY_ID	PLANT_CODE	PLANT_NAME	STREET_ADDRESS	CITY	COUNTY	STATE	ZIPS	NAME_OF_WATER_SOURCE
2	7	10867	Tate & Lyle Decatur Plant Cogen	2200 East Eldorado St	Decatur	Macon	IL	62525	Municipality
3	8	50903	Sagamore Plant Cogeneration	2245 Sagamore Parkway North	Lafayette	Tippecanoe	IN	47904	Wells
4	20	55454	AES Cypress LLC			Mississippi	AR	72426	Municipal/Demineralized
5	21	10671	AES Shady Point LLC	PO Box 1740	Panama	Leflore	OK	74951	Poteau River
6	25	2527	AES Greenidge LLC	590 Plant Road	Dresden	Yates	NY	14441	Seneca Lake
7	34	3305	Rocky River	146 Power Dam Lane	Iva	Anderson	SC	29655	Lake Secession
8	35	10678	AES Warrior Run Cogeneration Facility	11600 Mexico Farms Rd. S.E.	Cumberland	Allegany	MD	21502	City Of Cumberland Water Suppl
9	39	2529	AES Hickling LLC	11884 Hickling Rd	Corning	Steuben	NY	14830	Chemung River
10	40	55788	Hospira Inc	2400 Walden Avenue	Buffalo	ERIE	NY	14225	
11	42	10675	AES Thames	141 Depot Road	Uncasville	New London	CT	6382	Thames River
12	46	55631	AES Hoytdale LLC		Beaver	Beaver	PA	16157	Beaver River
13	52	10002	ACE Cogeneration Facility	12801 Mariposa St.	Trona	San Bernardino	CA	93562	Wells
14	60	55536	St Joseph County Generating Facility			St Joseph	IN	46552	
15	65	50249	Abitibi Consolidated Lufkin	3201 Hwy 103 East	Lufkin	Angelina	TX	75902	Wells
16	82	10819	Ada Cogeneration LP	7575 Fulton Street East	ADA	Kent	MI	49355	City Water
17	84	6390	Tangier	4463 Janders Rd	Tangier	Accomack	VA	23440	Wells
18	84	6391	Smith Island	20697 Caleb Jones Rd	Ewell	Somerset	MD	21824	Wells
19	88	55170	Granite Ridge	21 North Wentworth Avenue	Londonderry	Rockingham	NH	3053	Manchester Wastewater Treatmen
20	109	10223	AG Processing Inc	500 N Commercial	Eagle Grove	Wright	IA	50533	Well
21	114	55459	Addis Energy Center		Addis	West Baton Rouge	LA	70710	Mississippi River

Unstructured Data



Treatment plant power outage means all of Tampa must boil water

By Will Hobson, Jessica Vander Velde and Richard Danielson, Times staff writers
Friday, February 22, 2013 2:44pm

TAMPA — A rodent, most likely a squirrel, chewing on an electric line at Tampa's water treatment plant Friday morning caused a power failure that led to an unprecedented 48-hour citywide boil-water notice for 560,000 people and businesses and left them scrambling to snap up bottled water to last through the weekend.

The effects were immediate and widespread: Water fountains disappeared under trash bags. Restaurant managers bumped into each other in lines as they stocked up on ice and bottled water. And residents across Hillsborough County tried to figure out if the notice affected them and, if it did, what exactly they could do with their tap water.

Until Monday morning, officials said, residents and businesses should boil any tap water used for drinking, cooking, washing fruits or vegetables, making ice or brushing teeth for at least a minute. This affects more than half a million people — about 100,000 of them outside city limits — who get their water from Tampa.

RELATED NEWS/ARCHIVE

Power outage zaps traffic lights in New Tampa
2 Months Ago

North Tampa power outage disables traffic lights
6 Months Ago

Firefighters patch toxic gas leak at water treatment plant; no injuries reported
2 Months Ago

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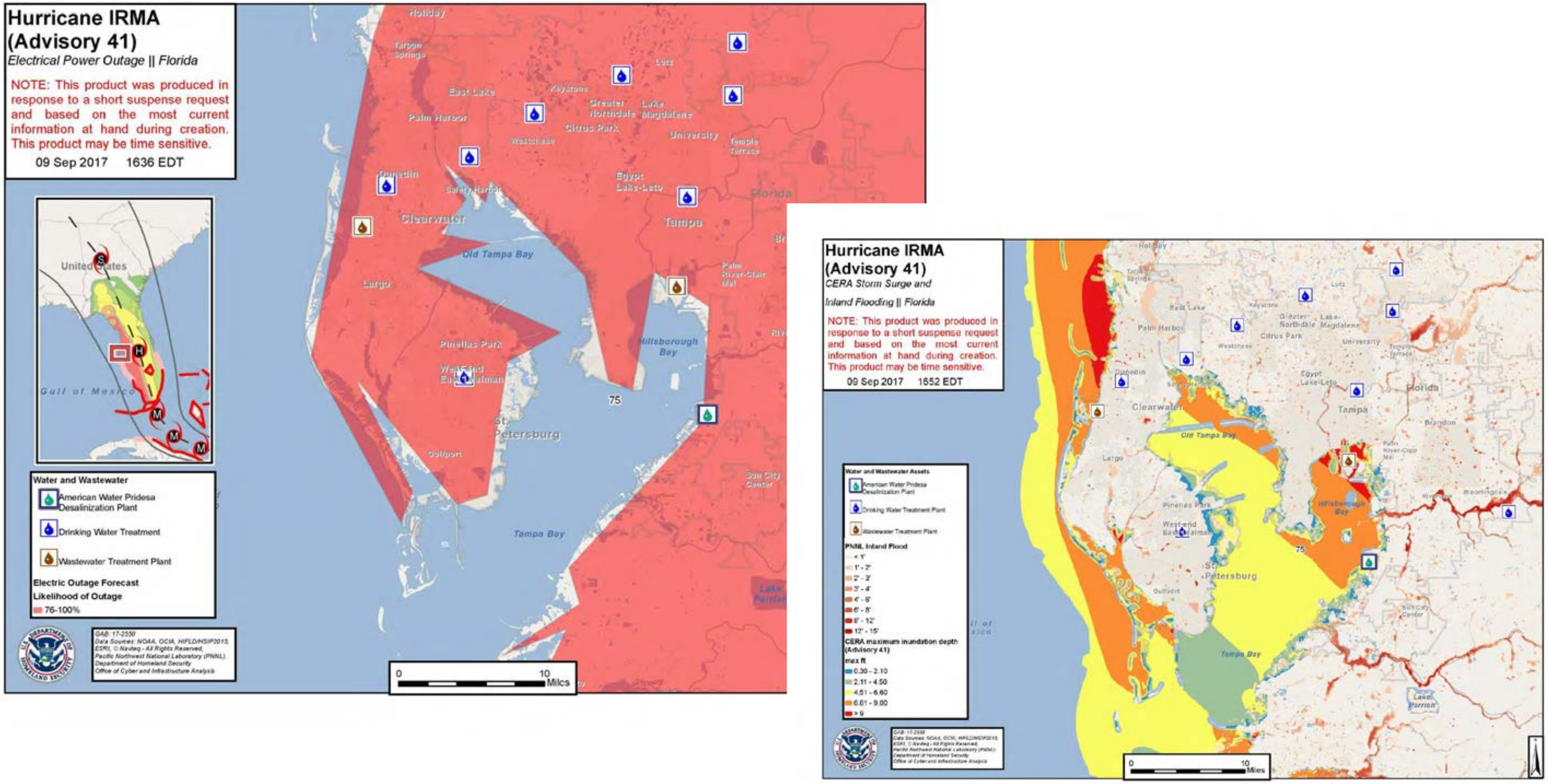
CASCADE

Example: Irma Tampa Impacts


Hurricane IRMA
(Advisory 41)
Electrical Power Outage || Florida
NOTE: This product was produced in response to a short suspense request and based on the most current information at hand during creation. This product may be time sensitive.
09 Sep 2017 1636 EDT
United States
Gulf of Mexico
Water and Wastewater
American Water Pridesa Desalinization Plant
Drinking Water Treatment
Wastewater Treatment Plant
Electric Outage Forecast
Likelihood of Outage
76-100%
OAB: 17-2550
Data Sources: NOAA, OCIA, HIFLD/HSIP2015, ESRI, © Navteq - All Rights Reserved, Pacific Northwest National Laboratory (PNNL), Department of Homeland Security, Office of Cyber and Infrastructure Analysis
Holiday
Tarpon Springs
East Lake
Palm Harbor
Keystone
Lutz
Greater Northdale
Lake Magdalene
Citrus Park
Westchase
University
Temple Terrace
Dunedin
Safety Harbor
Egypt Lake-Leto
Florida
Clearwater
Old Tampa Bay
Tampa
Largo
Palm River-Clair Mel
Pinellas Park
Hillsborough Bay
West and East Lealman
75
St. Petersburg
Gulfport
Sun City Center
Tampa Bay
Lake Parrish
0
10
Miles
Hurricane IRMA
(Advisory 41)
CERA Storm Surge and
Inland Flooding || Florida
NOTE: This product was produced in response to a short suspense request and based on the most current information at hand during creation. This product may be time sensitive.
09 Sep 2017 1652 EDT
Water and Wastewater Assets
American Water Pridesa Desalinization Plant
Drinking Water Treatment Plant
Wastewater Treatment Plant
PNNL Inland Flood
< 1'
1' - 2'
2' - 3'
3' - 4'
4' - 6'
6' - 8'
8' - 12'
12' - 15'
CERA maximum inundation depth (Advisory 41)
max ft
0.30 - 2.10
2.11 - 4.50
4.51 - 6.60
6.61 - 9.00
> 9
Brandon
Riverview
Bloomingdale

Source: OCIA Hurricane Irma: Infrastructure Impact Assessment: Water and Wastewater Systems, 09092017, 1800 EDT
Assessments based on data from National Hurricane Center Hurricane Irma Advisory 33A, 09072017, 0800 EDT

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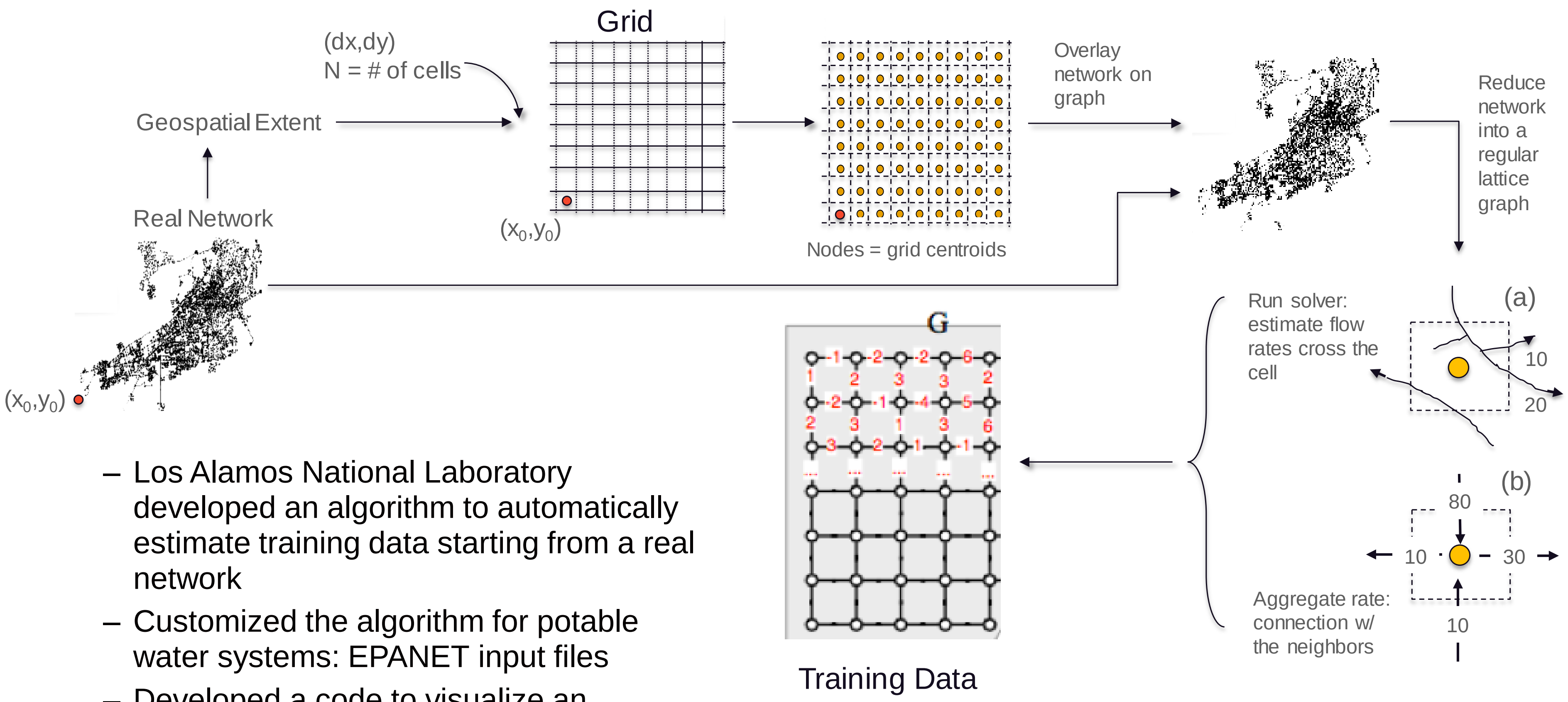
Coarse-Grained System Modeling



– Los Alamos National Laboratory developed an algorithm to automatically estimate training data starting from a real network

– Customized the algorithm for potable water systems: EPANET input files

– Developed a code to visualize an approximated graph of the training data

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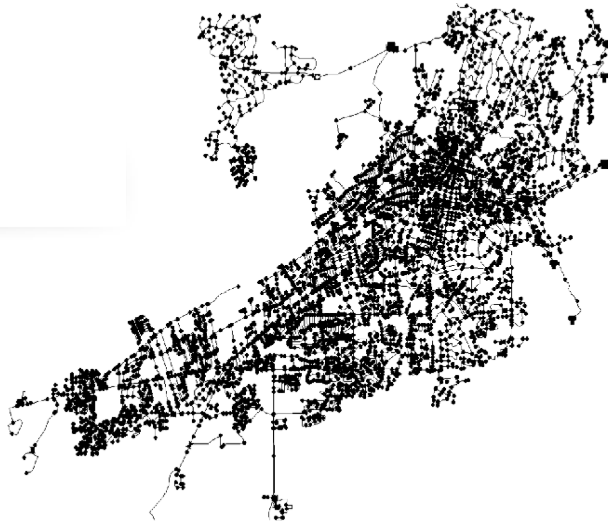
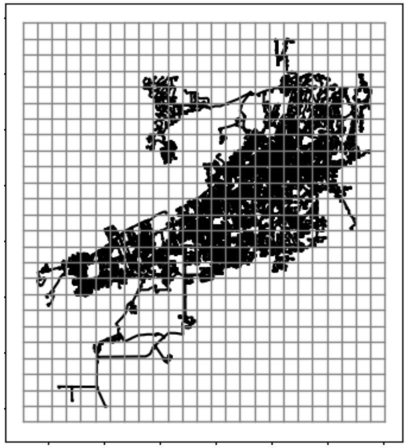
Santa Fe Water System Example

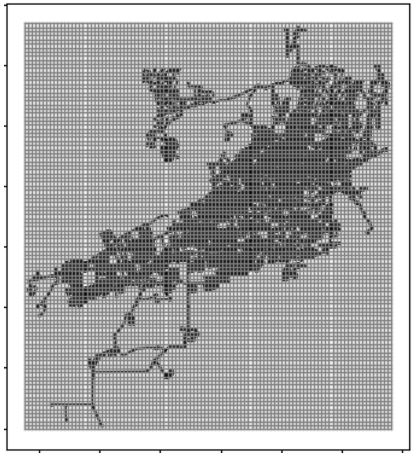


Real Network

Grid

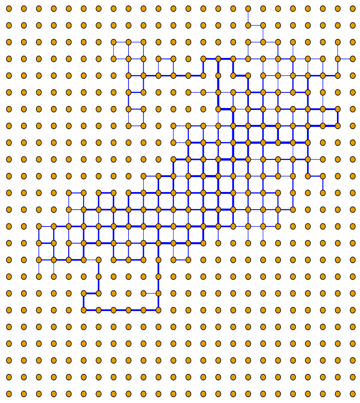


N = 25x25

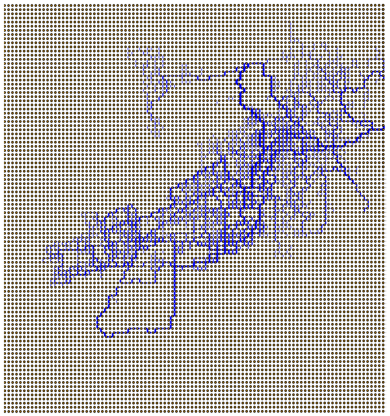


N = 100x100

Coarse-Grained Graph Flow Rates



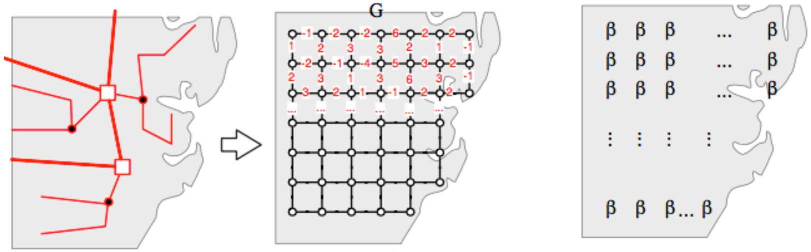
Edges thickness = log(flowrate)



Training Data

Water System Training Data

- Two types of training data
- Infrastructure-related training data
  - Obtained from real networks
  - Used only to train the model
  - Correspond to an aggregation of flows of service (water, electricity)
- Not infrastructure-related training data
  - Proxy variables
  - Publicly available
  - Used also as inputs to generate the coarse-grained model
  - Relevant data varies depending on the infrastructure



Infrastructure related training data

Not infrastructure related training data

Proxy Variables	Data source
Population density	CENSUS
Business type density*water factors	LANL database estimated from US Bureau of Economic Analysis/USGS
Elevation	Digital Elevation Models (DEM), USGS
Road	OpenStreetMap

Draft NISAC Research Interests

Dependency and Interdependency Analysis	Cyber Analysis	Risk-Informed Prioritization
Objective 1.1: Capability to identify or assign dependency relationships for lifeline sectors and assets within regionally significant industrial clusters, across all U.S. regions. **Objective 1.2**: Improve DHS's ability to provide accurate and timely analysis of the impacts of disruptions to the lifeline critical infrastructure systems. **Objective 1.3**: Improve data, information, and heuristics related to infrastructure dependencies. **Objective 1.4**: Provide DHS analysts and field personnel with analytic tools to understand infrastructure dependencies.	**Objective 2.1**: Strengthen DHS' ability to assess the impact of cyber attacks and cyber disruptions on critical infrastructure operations. **Objective 2.2**: Develop methodologies to characterize the criticality of Federal networks and better estimate the consequences of their disruption. **Objective 2.3**: Improve DHS's ability to anticipate emerging cyber risk by using innovative and advanced techniques to analyze evolving cyber threats, vulnerabilities, and trends.	**Objective 3.1**: Implement an approach to use National Critical Functions to understand dependencies and the effects of infrastructure disruptions on these functions. **Objective 3.2**: Improve DHS' capacity to identify and communicate areas of greatest strategic infrastructure risk. **Objective 3.3**: Capability to analyze and communicate nationally, regionally, and functionally significant systemic risks—including cyber risks—across and within infrastructure sectors. **Objective 3.4**: Improve homeland security decision makers understanding of how to apply risk-informed priorities.

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