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Open Source GIS for Hurricane  
Recovery

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# The MUNICIPAL Project

## Multi-Network Interdependent Critical Infrastructure Program for the Analysis of Lifelines

- A decision-support tool developed for the U.S. Department of Homeland Security (DHS) Coastal Hazards Center.
- Designed to aid in the restoration of critical infrastructure systems following storm events.
- Predicts damage to infrastructure components given a specific disaster scenario,
- Developed and tested in close cooperation with the New Hanover County, North Carolina Department of Emergency Management.
- Comprises a web based GIS visualization tool which is used to verify research results and train Emergency Managers in disaster recovery.

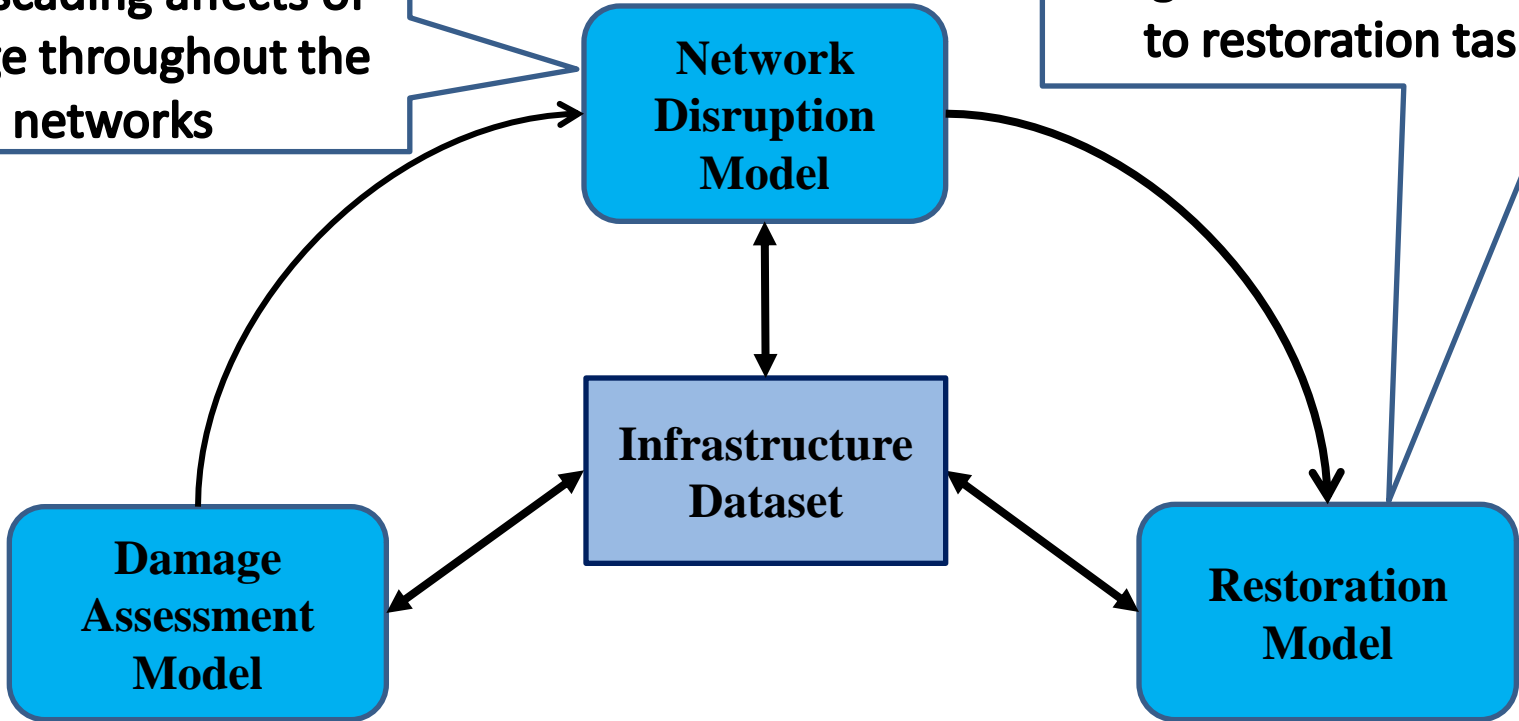
# Users and Use Cases

- The primary end user for this technology is local emergency management organizations
  - Training, drills, and exercises
  - Preparation for an imminent event
  - What-if? Analysis
  - Others potential users include infrastructure managers and designers
- Two datasets are currently being used
  - New Hanover County, NC dataset is being used to validate models and prove the technology
  - “Clarc County” artificial dataset is used to share the technology with potential users

# The Models

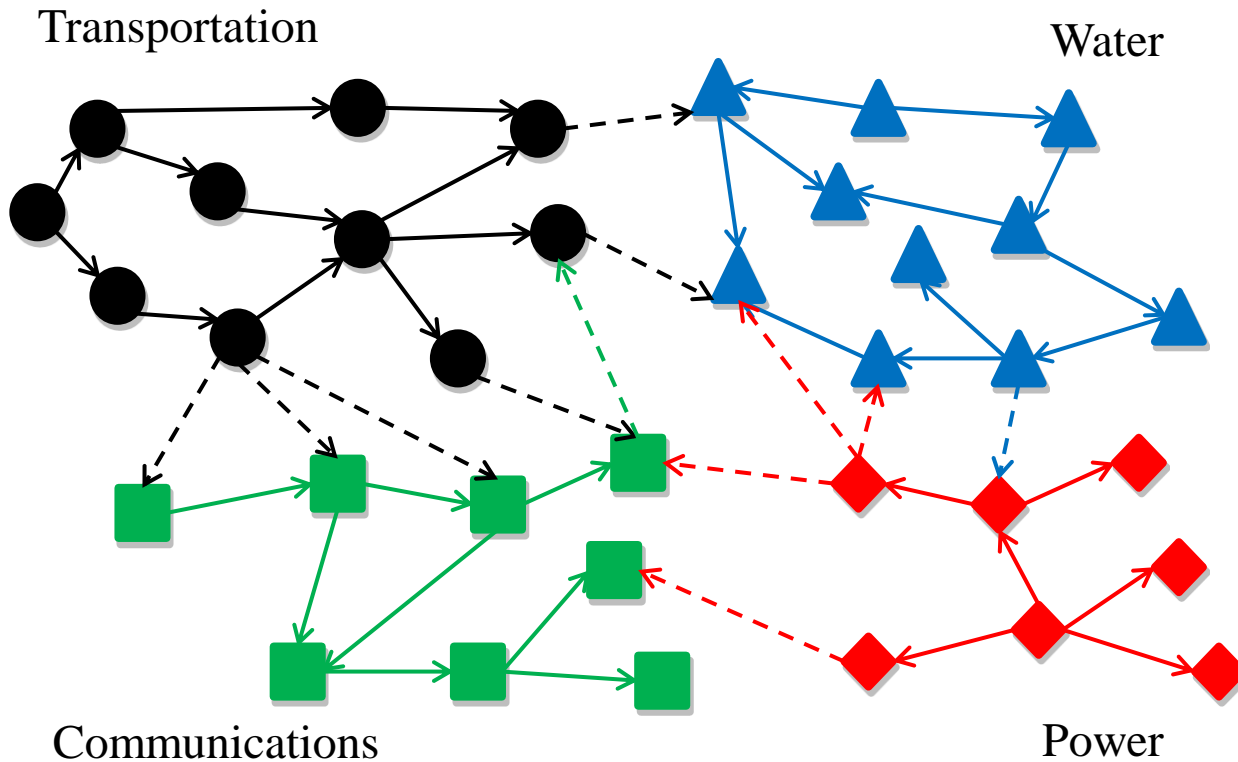
Uses mixed integer programming to solve for the optimal schedule and assignment of work crews to restoration tasks

Uses optimization techniques to determine the cascading affects of damage throughout the networks

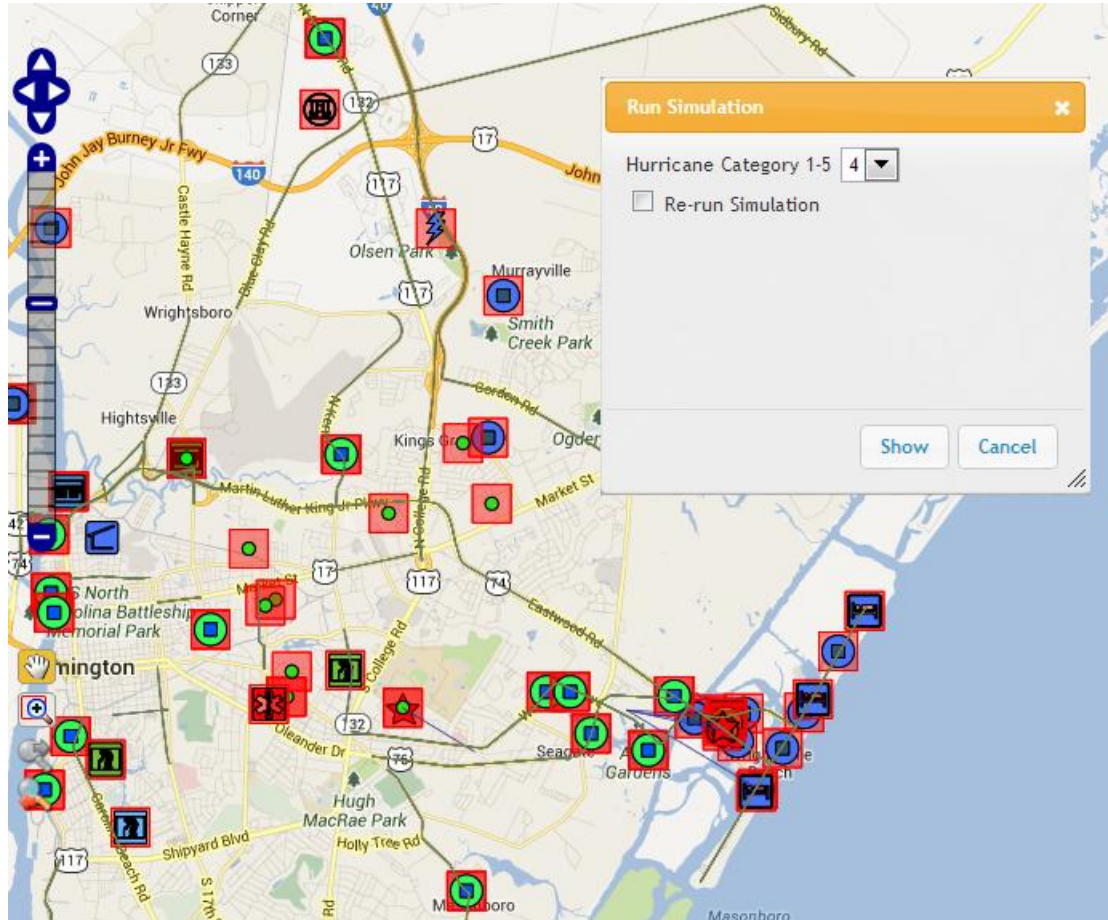


Uses simulation and statistical methods to generate a damage scenario given the parameters of the hurricane

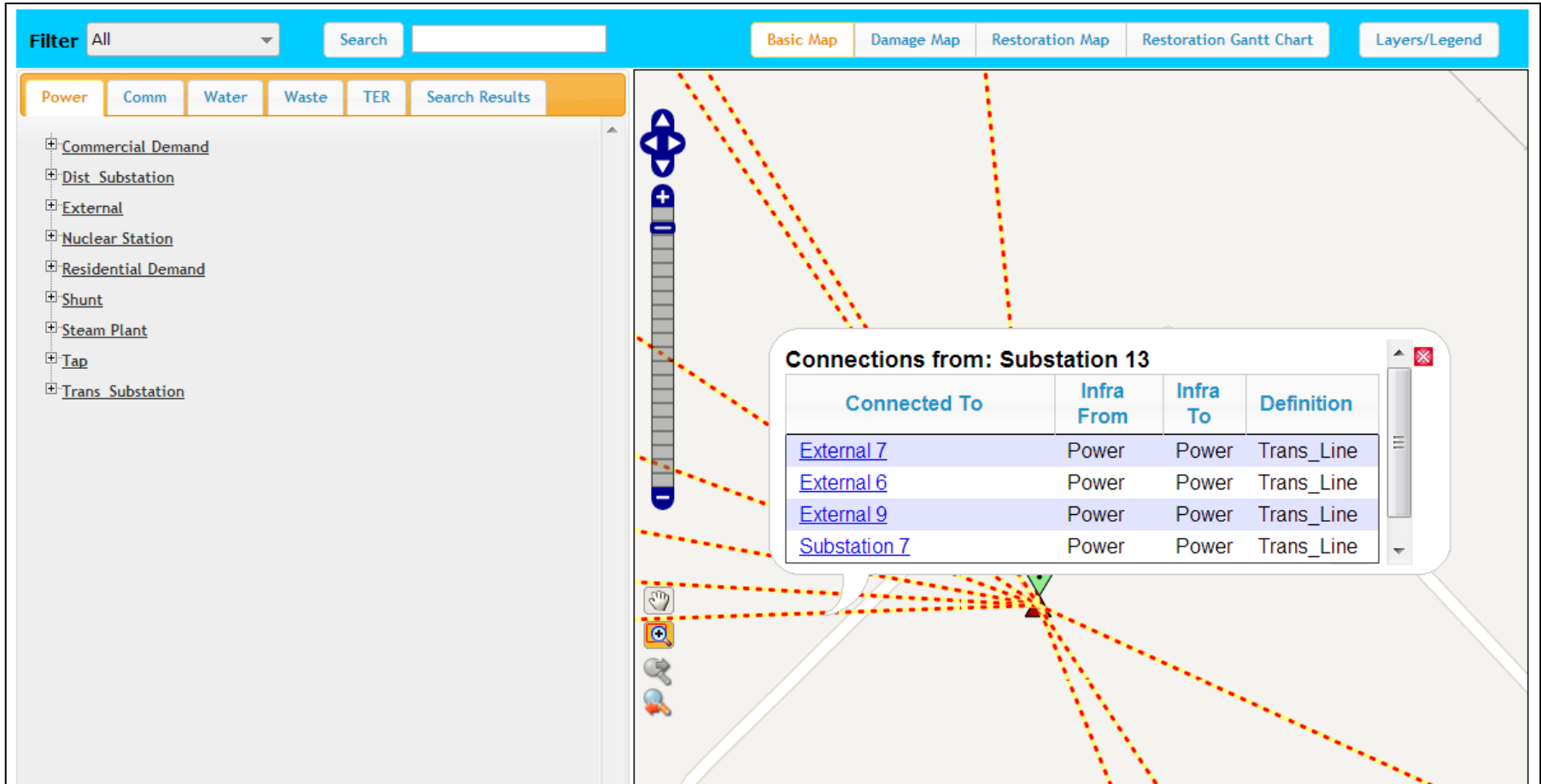
# Interdependent Infrastructure Systems



# Demo – Damage Simulator



# Demo – See Connections

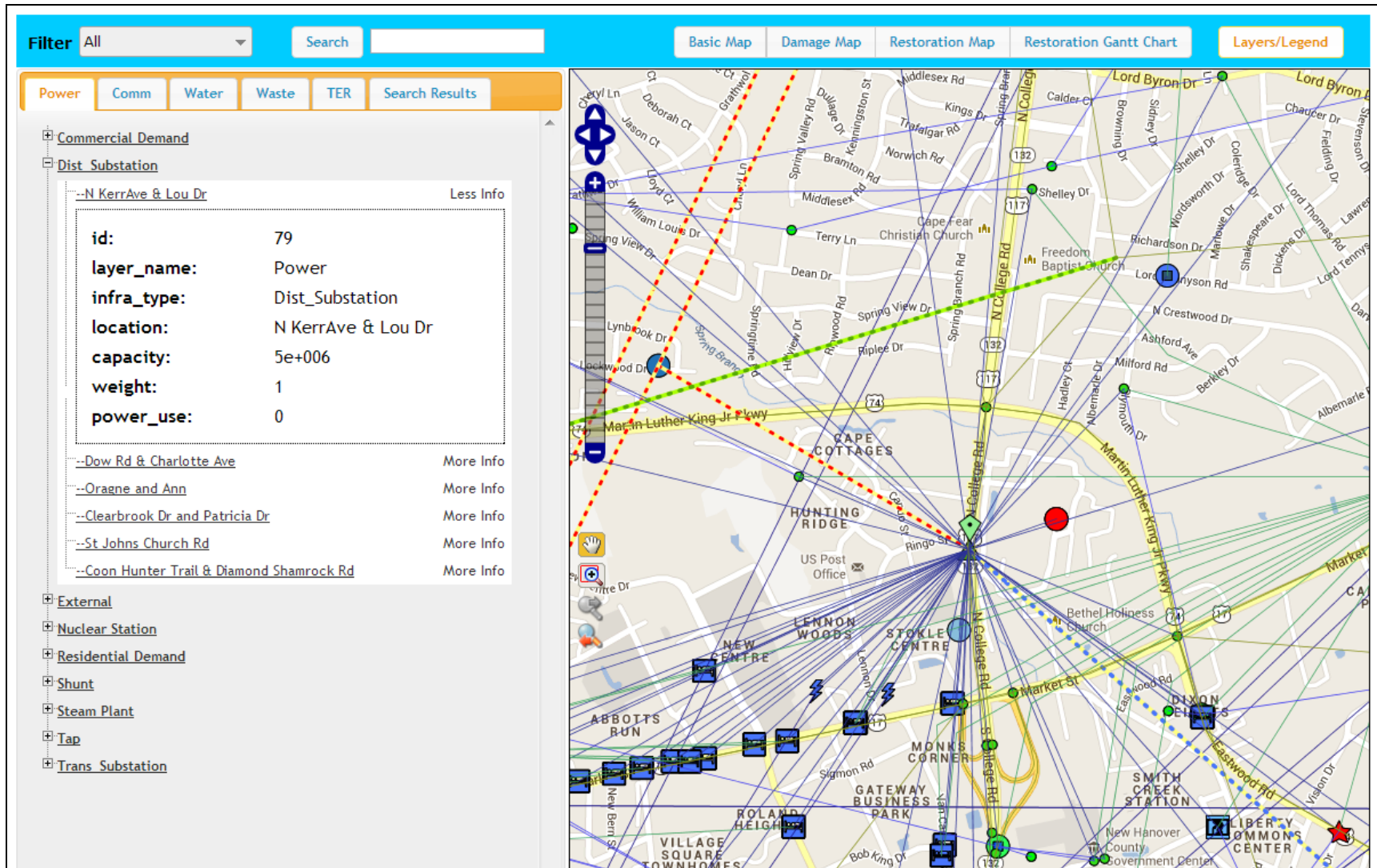


The screenshot displays a GIS application interface. At the top, there is a blue header bar with a 'Filter' dropdown set to 'All', a search input field, and navigation tabs for 'Basic Map', 'Damage Map', 'Restoration Map', 'Restoration Gantt Chart', and 'Layers/Legend'. Below the header, a secondary bar contains category tabs: 'Power', 'Comm', 'Water', 'Waste', 'TER', and 'Search Results'. On the left side, a tree view lists infrastructure types: Commercial Demand, Dist Substation, External, Nuclear Station, Residential Demand, Shunt, Steam Plant, Tap, and Trans Substation. The main map area shows a network of red dashed lines representing connections. A popup window titled 'Connections from: Substation 13' is overlaid on the map, displaying a table of connections.

Connected To	Infra From	Infra To	Definition
<a href="#">External 7</a>	Power	Power	Trans_Line
<a href="#">External 6</a>	Power	Power	Trans_Line
<a href="#">External 9</a>	Power	Power	Trans_Line
<a href="#">Substation 7</a>	Power	Power	Trans_Line

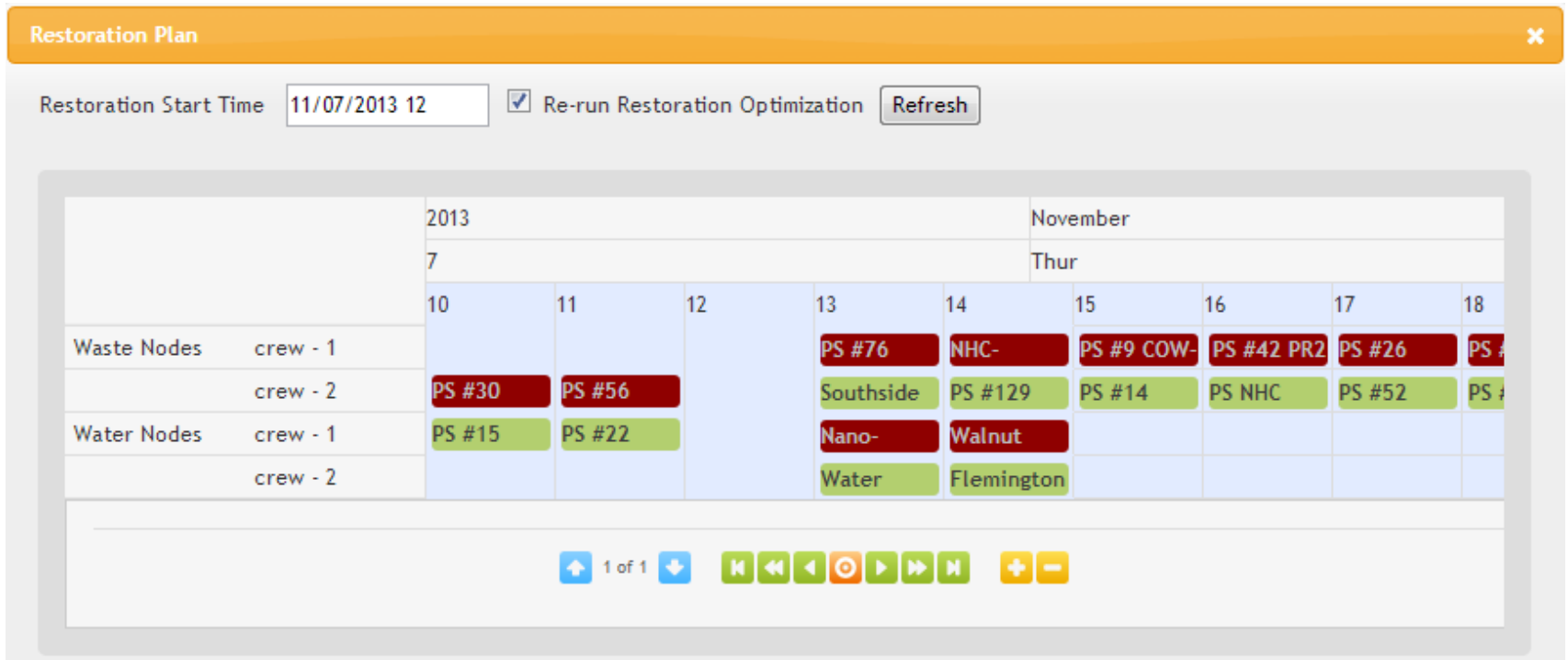


# Demo – Text and Map Connections

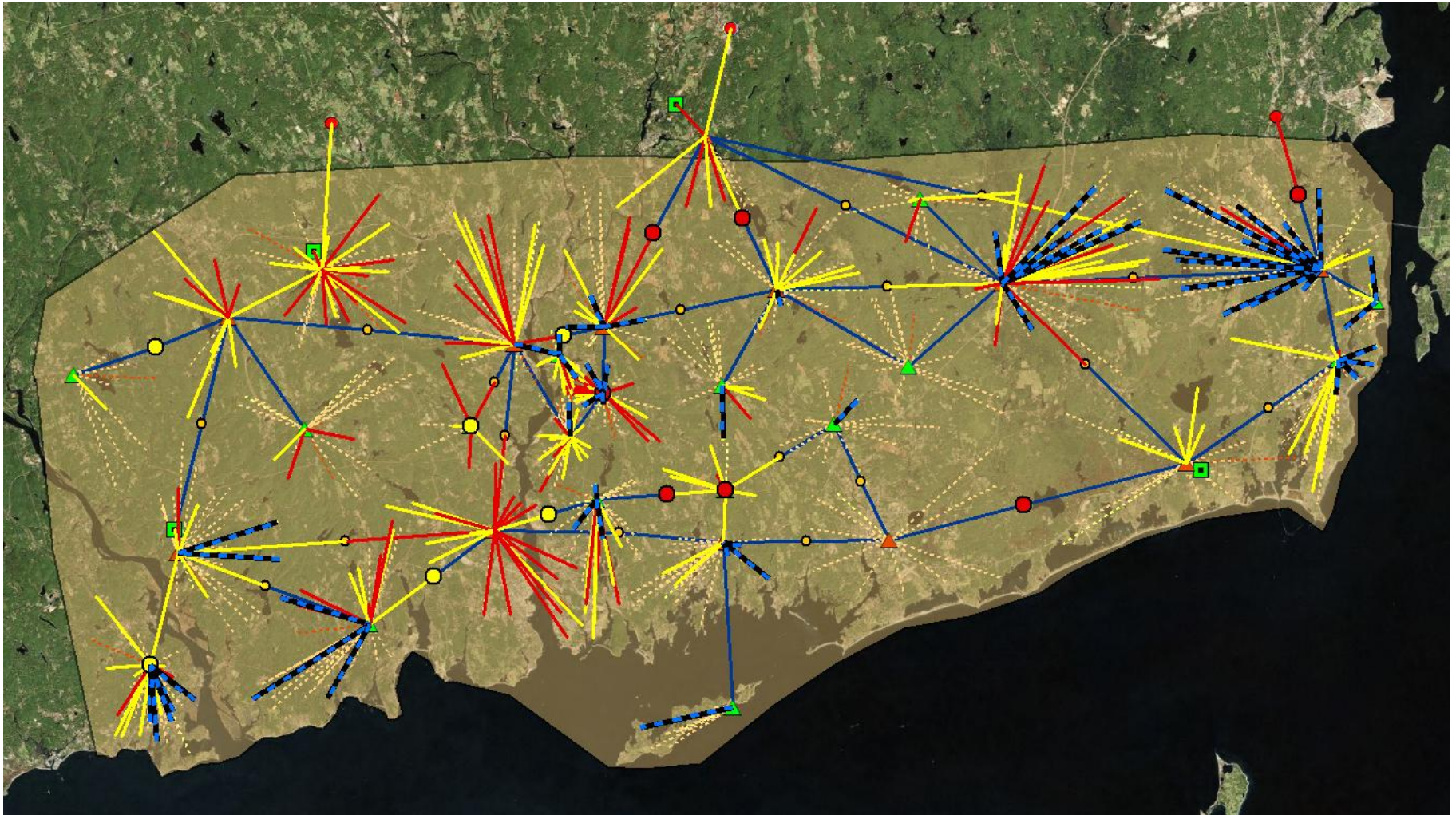




# Demo – Restoration Gantt Chart



# “Clarc” County Artificial Dataset



# The Collaboration

- RPI
- Department of Homeland Security
- New Hanover County, NC
- UNC Chapel Hill
- 408 Group
- Sandia National Laboratory

# Why Use Open Source GIS?

- **Flexibility**

- Mix and match best of breed parts for each element. Database, display, user interaction, analysis, security
- Most tools and components interoperate
- Large community of users, blogs, support forums

- **Cost**

- Reduces cost of software and may enable projects with lower budget. Software license may be a large part of projects budget.
- Cuts out time to acquire commercial software. May be a large part of the project timeline, especially in government applications.

- **Meets technical requirements of many projects**

- Ability to generate maps in an interactive online interface.
- Incorporate latest client features: interactive zoom, pan, layer manager
- Interoperability with dynamic data source or RDBMS.
- Interoperates with existing packages such as ESRI ArcMap, Arc GIS Server

- **Maturity**

- Many components have 10 year history of development and enhancements.

# GIS Software Stack or Framework

- **Geo Server** - Drawing and Rasterizing Engine
- **Client Side**
  - Open Layers GIS/Javascript Framework
  - jQuery – AJAX framework for UI interaction
  - HTML 5 controls
  - Google Maps base layer
- **Spatial Databases**
  - Postgis – Geo Enabled Postgres relational database
- **PHP** programming language on Server
- **REST** interfaces for all server side data.
- **Data conversion** tools such as OGR2OGR – to translate from ARCMAP to Postgis



# References and Links

## Modeling Methodology

- B. Cavdaroglu, E. Hammel, J. E. Mitchell, T. C. Sharkey, and W. A. Wallace, “Integrating Restoration and Scheduling Decisions for Disrupted Interdependent Infrastructure Systems,” *Annals of Operations Research*, March 2013, Vol. 203, Issue 1, pp 279-294

## Model Integration

- R. Loggins, W. Wallace, and B. Cavdaroglu, “MUNICIPAL: A Decision Technology for the Restoration of Critical Infrastructures,” *Proceedings of the Industrial and Systems Engineering Research Conference*, May 2013

# References and Links (continued)

- GeoServer - [geoserver.org](http://geoserver.org)
- Postgis Project - [postgis.net/](http://postgis.net/)
- Open Layers Project [openlayers.org/](http://openlayers.org/)
- Open Geo Application Stack - [boundlessgeo.com/solutions/opengeo-suite/](http://boundlessgeo.com/solutions/opengeo-suite/)
- jQuery Javascript Framework - [jquery.com/](http://jquery.com/)
- OGR Tools [www.gdal.org/](http://www.gdal.org/)
- 408Group – [www.408group.com](http://www.408group.com)



# A sample of other 408 Group GIS Projects

- **NYC Department of City Planning** - Parking Information for the Mobile Web
  - Expose Parking lot data sets to citizens and other government agencies
  - Reduce Traffic Congestion by allowing users to more easily locate parking
- **NYC Department of Finance** – Mobile Property Tax Assessment
  - Automate Tasks
  - Create more consistent processes for determining assessments
- **NYC Department of Homeless Services** - The Homeless Census
  - Better organize effort. Pre defined instructions and tasks
  - Better compliance with government counting requirements.