

Strategic Solutions for High-Density and Interdependency Visualization

Rob Edsall

Geospatial R&D Scientist (robert.edsall@inl.gov)

Kent McGillivray, Ryan Hruska, and Shane Cherry

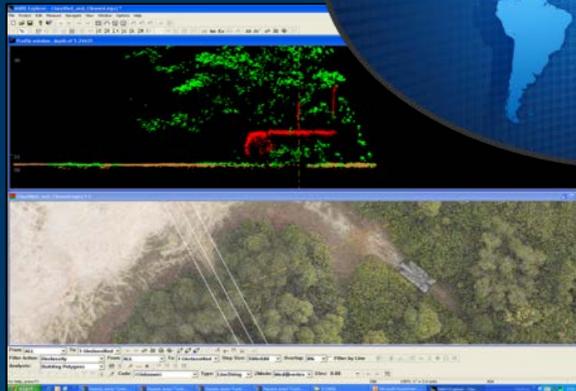
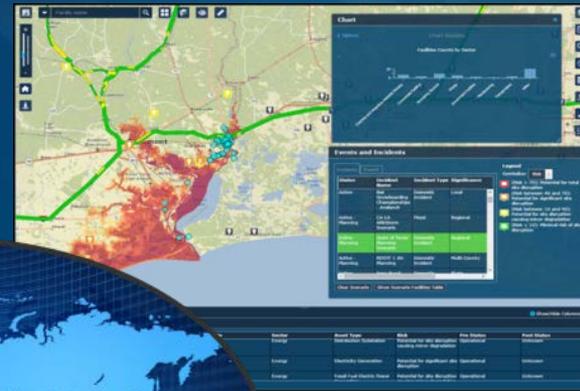
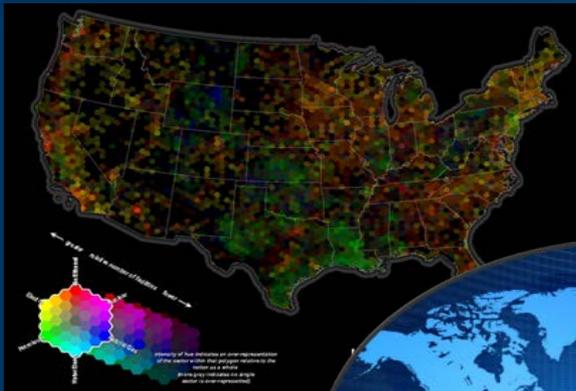
Homeland Security Division, Idaho National Laboratory

*Resilience Week: 2016 Resilient Critical Infrastructure
August 18, 2016*

www.inl.gov

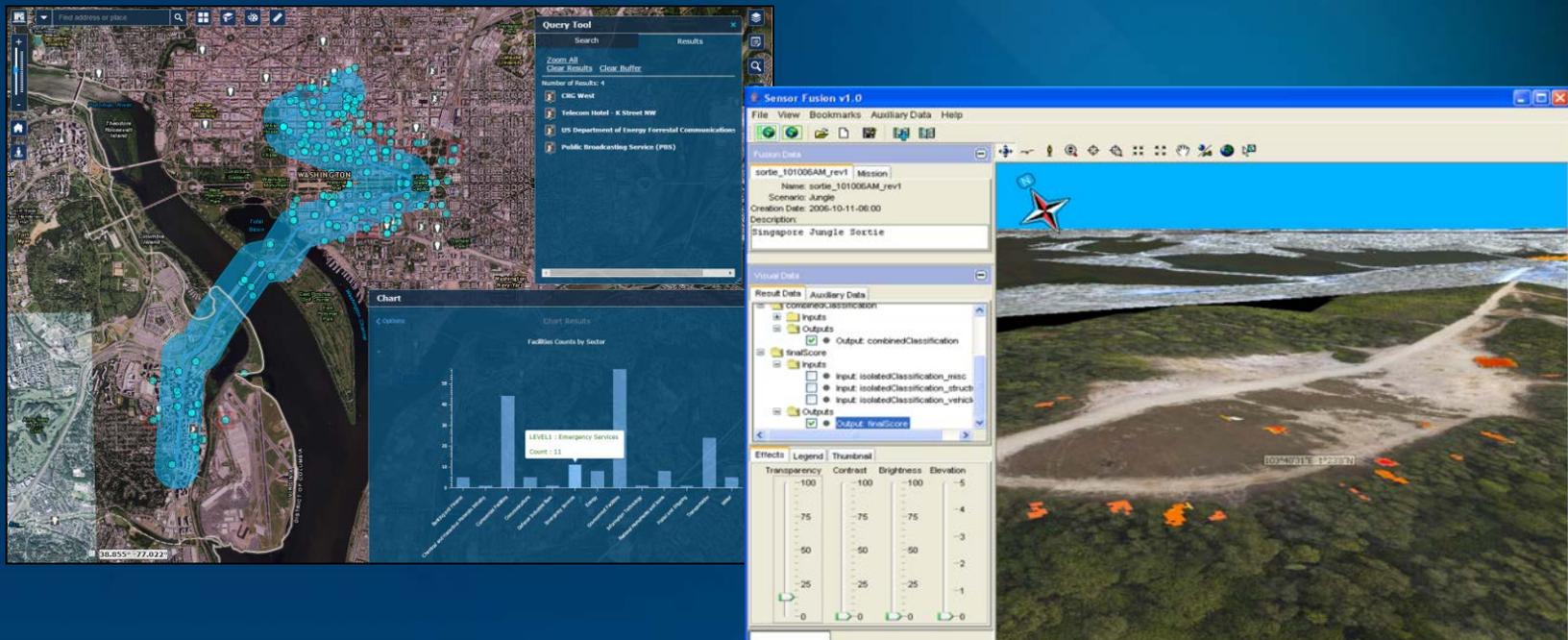


INL's Geospatial Technologies and Visualization Core Capability

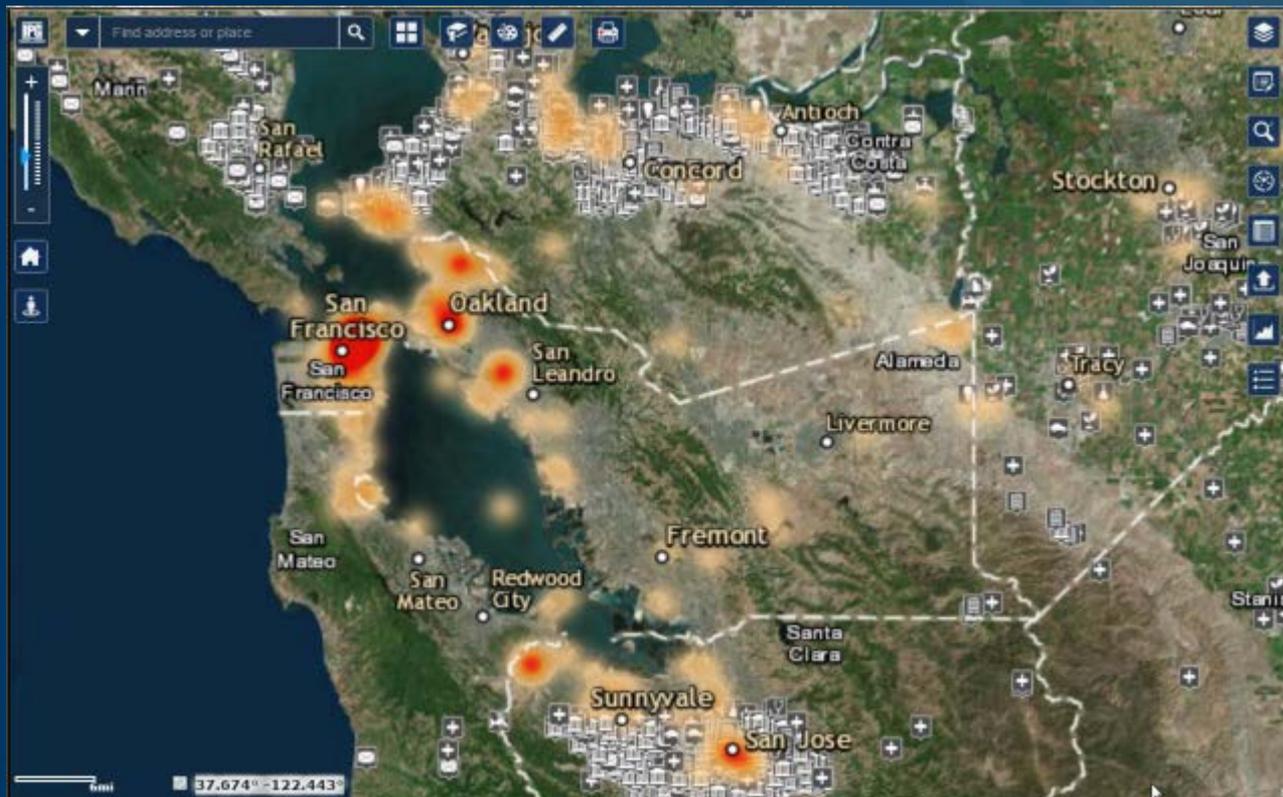


Geovisual Analytics

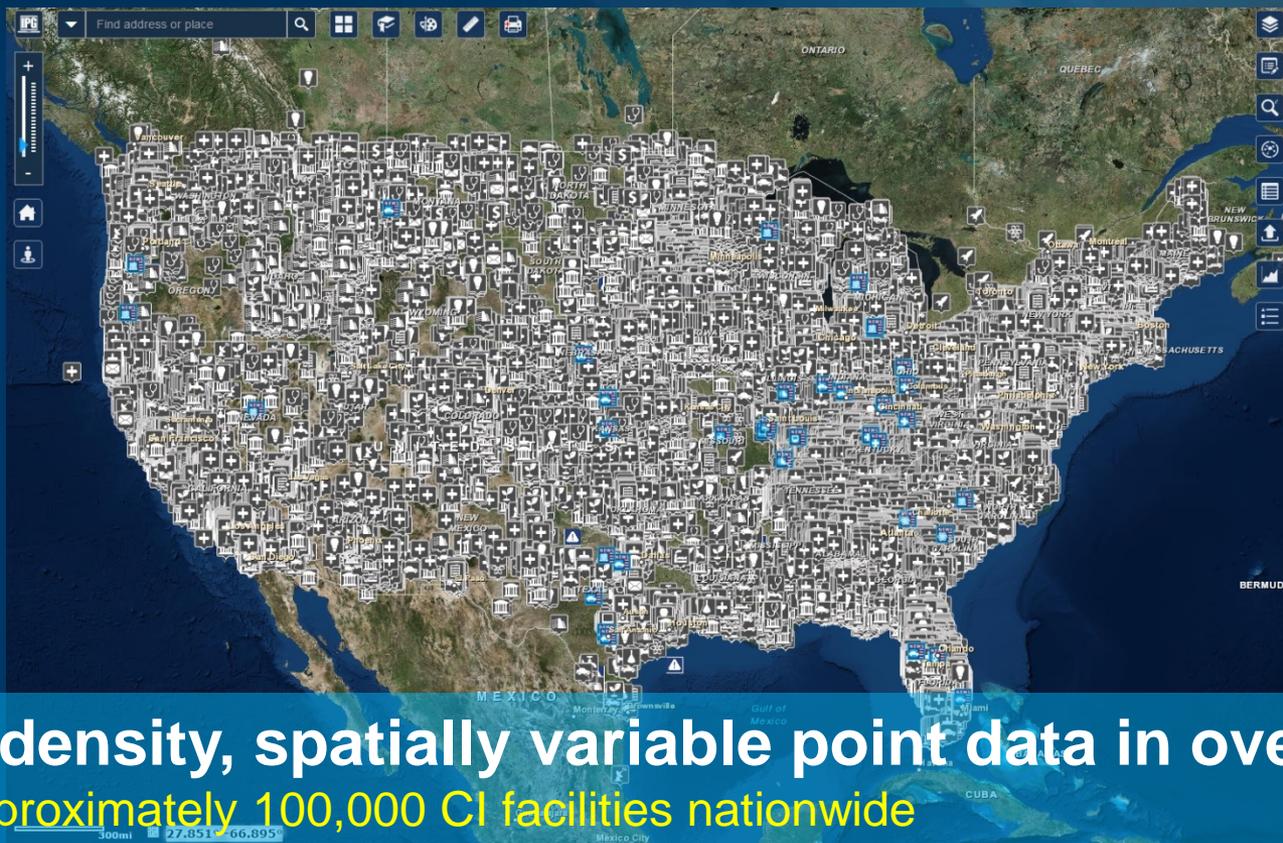
- Representing, analyzing, modeling and extracting meaning from complex heterogeneous geospatial datasets
 - addresses problems of data volume, data modeling for context-specific problem solving, and temporal variability of geospatial data (*Andrienko et al 2016; Roth and MacEachren 2015; Thomas and Cook 2005*)



DHS Infrastructure Protection Gateway

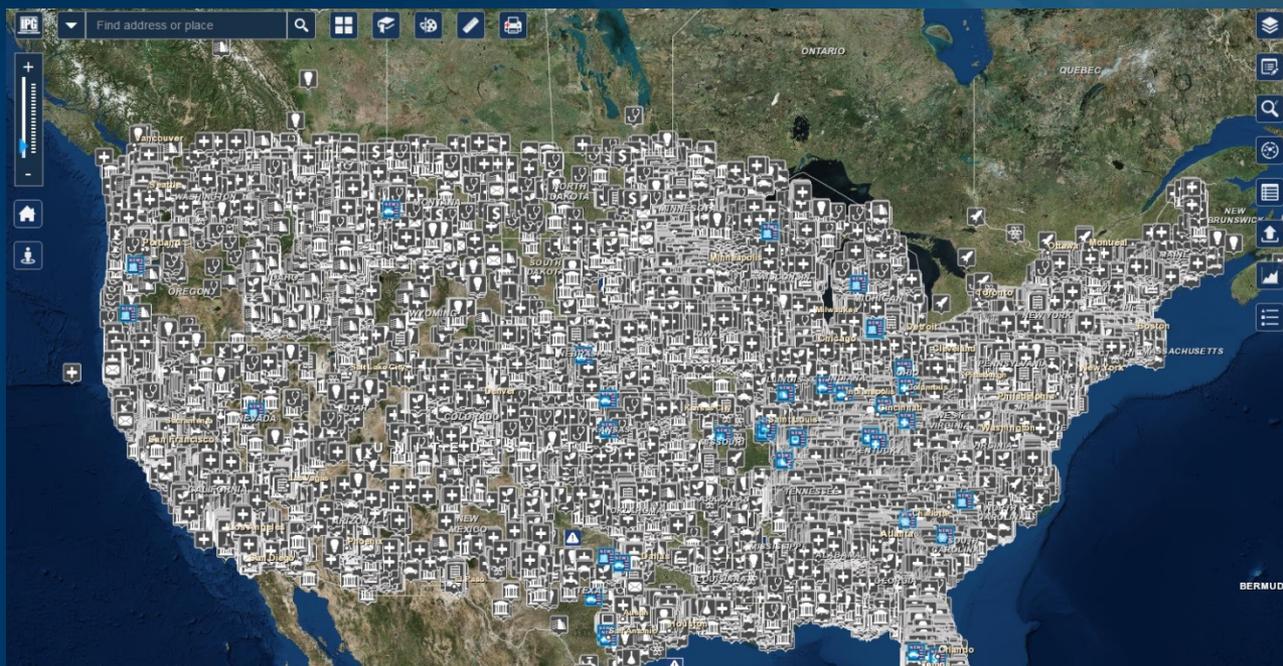


DHS Infrastructure Protection Gateway data visualization challenges



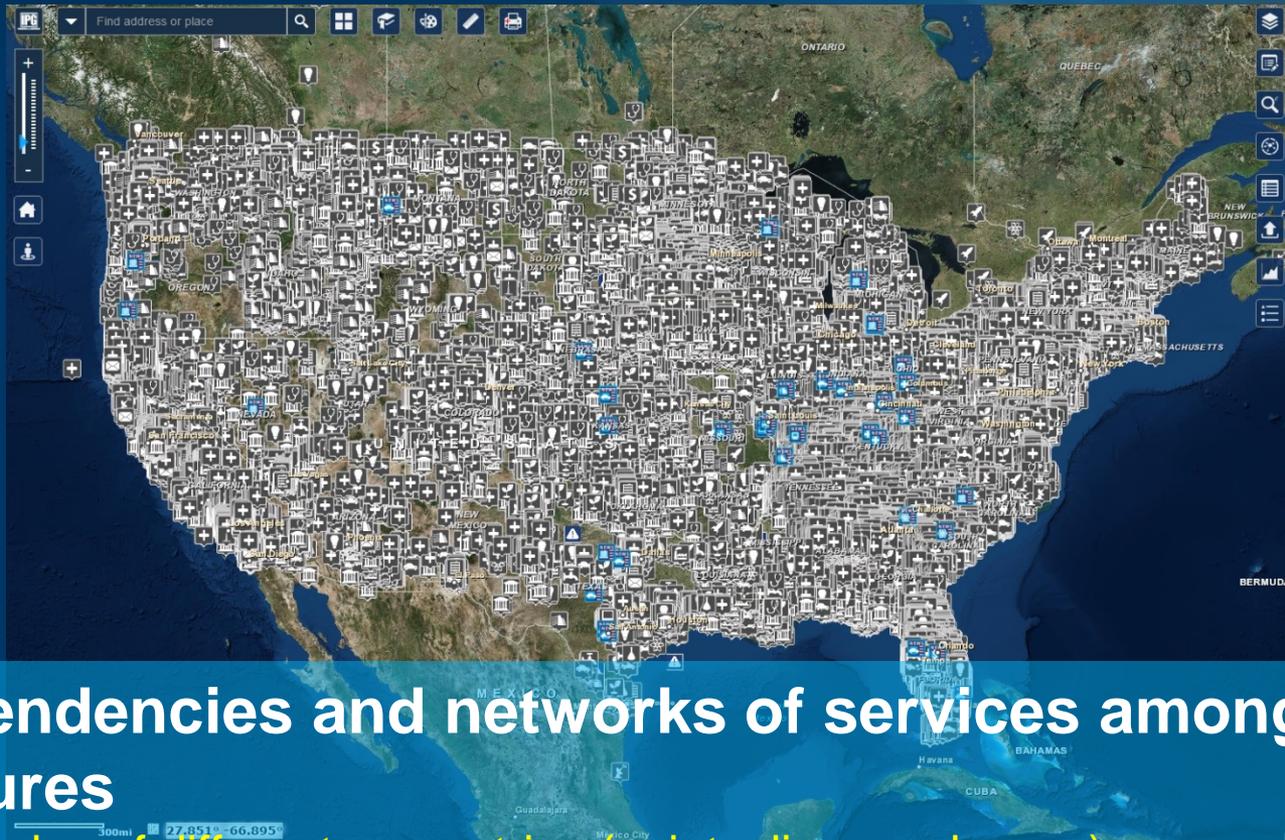
- **high-density, spatially variable point data in overview**
 - approximately 100,000 CI facilities nationwide
 - clusters, missing data, nationwide situational awareness

DHS Infrastructure Protection Gateway data visualization challenges



- multiple attribute information for each feature and any aggregation
 - both quantitative and qualitative dimensions (risk level, sector designation, criticality, etc.)
 - and incident awareness

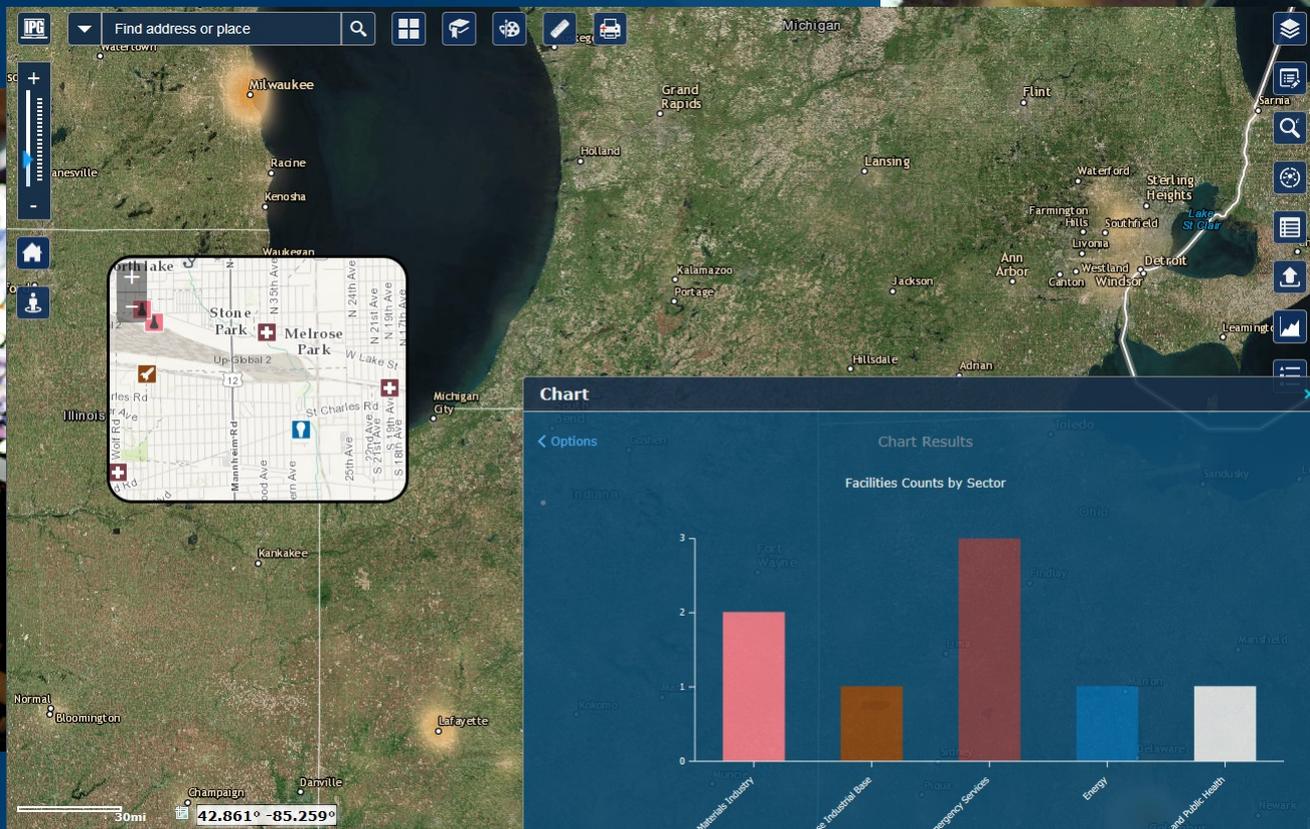
DHS Infrastructure Protection Gateway data visualization challenges



- dependencies and networks of services among features
 - nodes of different geometries (points, lines, polygons)
 - multiple orders and directions of dependencies

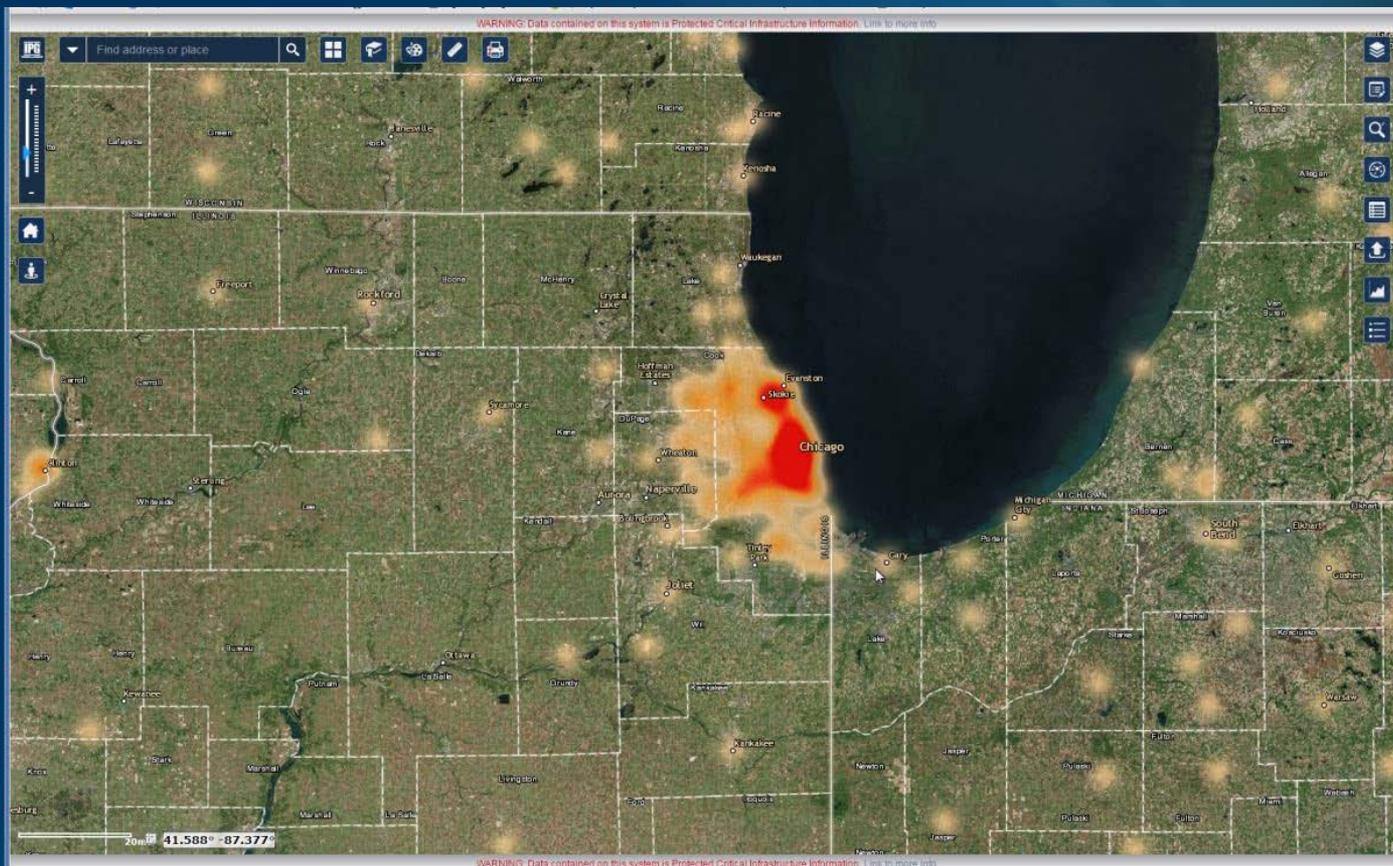
Focus while preserving context:

“Spyglass” tool



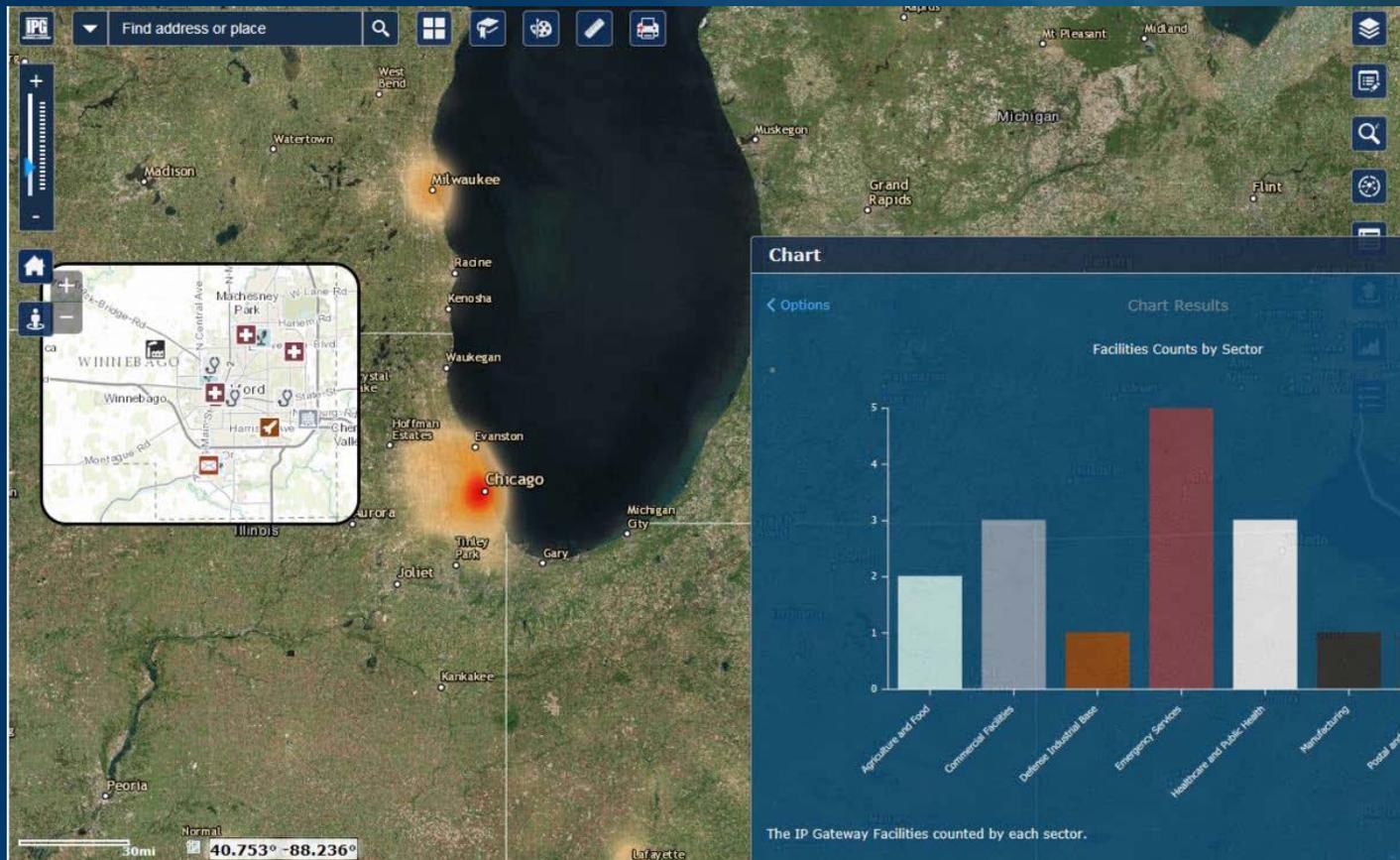
Focus while preserving context:

“Spyglass” tool



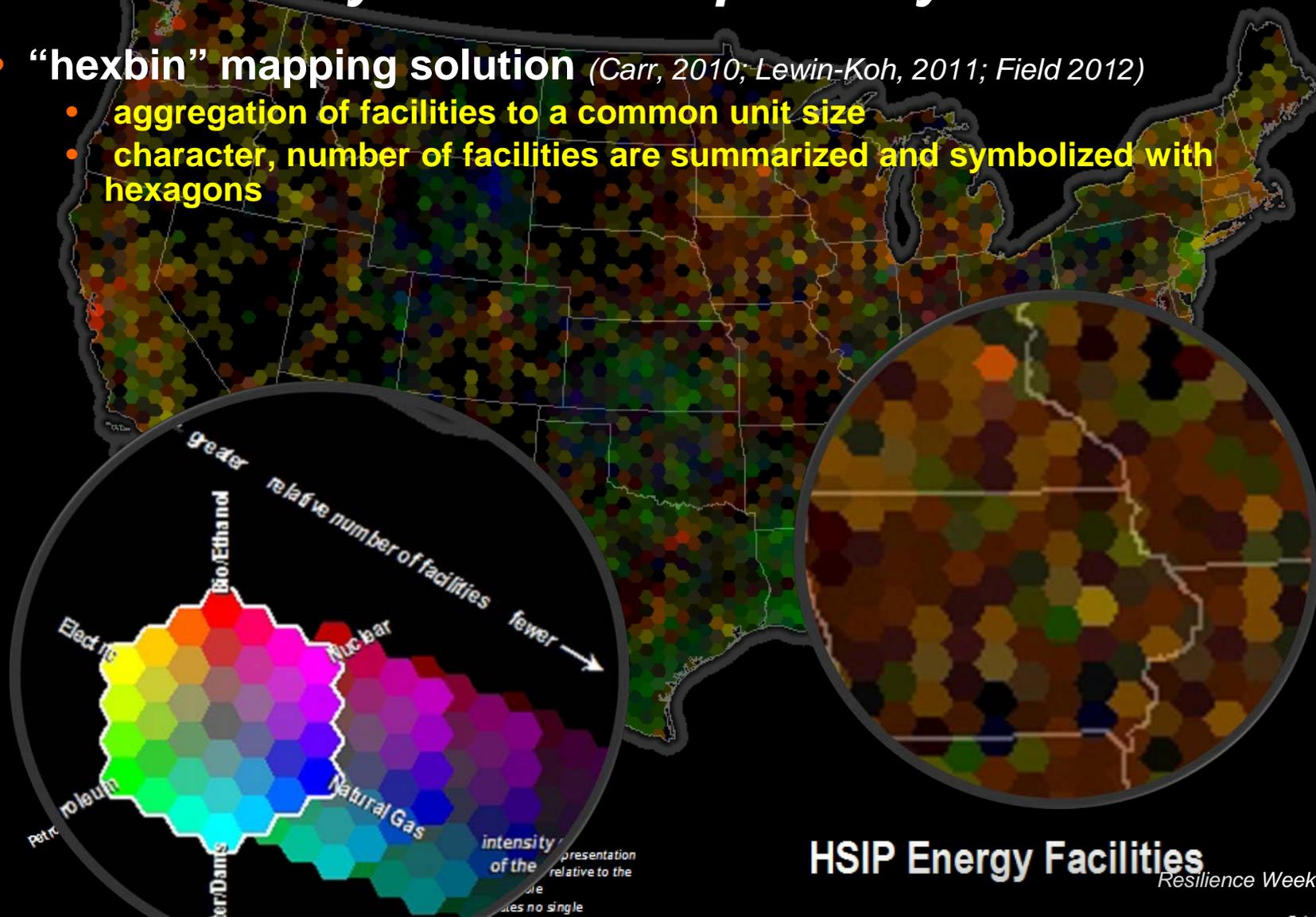
Focus while preserving context:

“Spyglass” tool



Asset density and sector plurality visualization

- “hexbin” mapping solution *(Carr, 2010; Lewin-Koh, 2011; Field 2012)*
 - aggregation of facilities to a common unit size
 - character, number of facilities are summarized and symbolized with hexagons





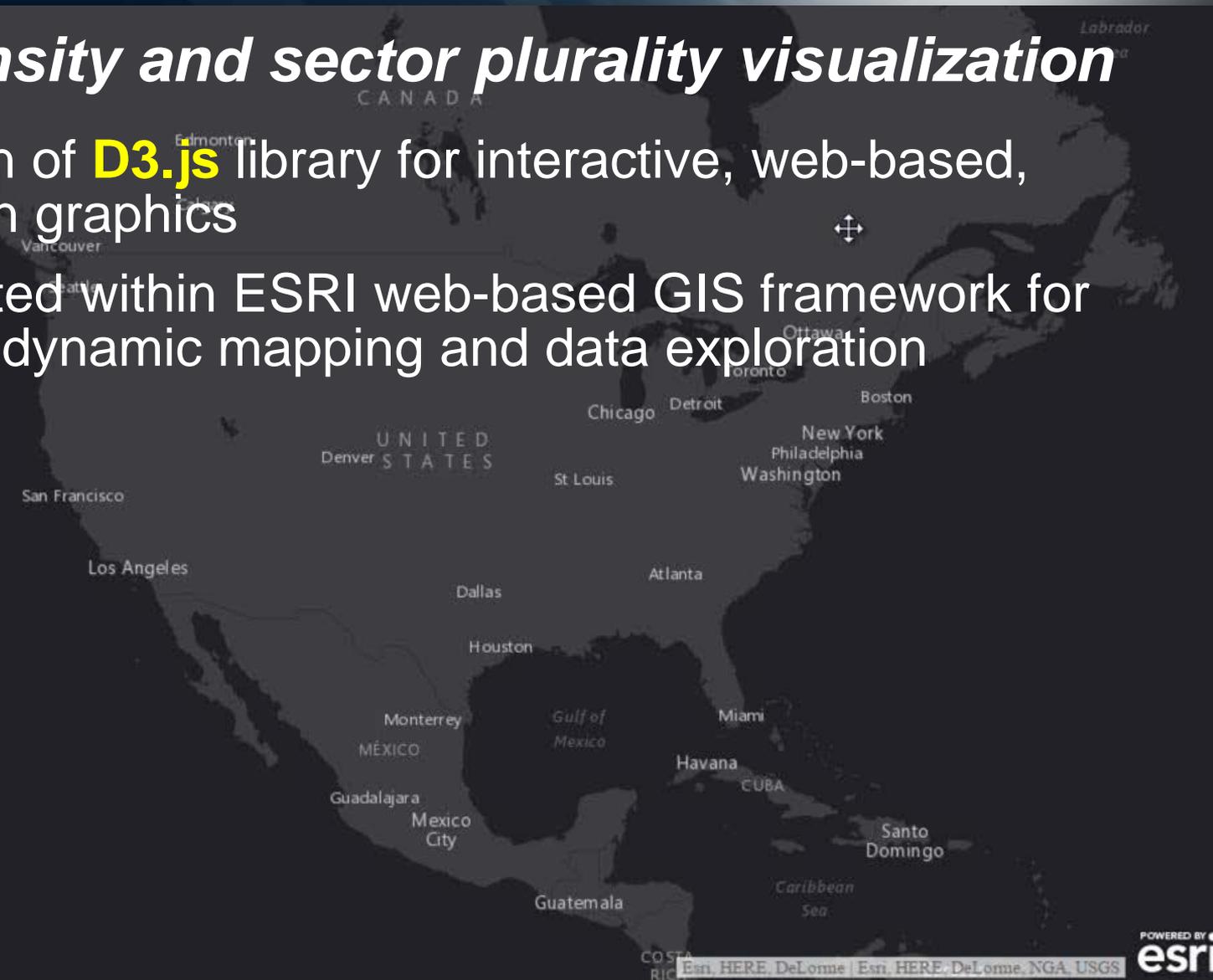
Asset density and sector plurality visualization

- adaptation of **D3.js** library for interactive, web-based, data-driven graphics
- incorporated within ESRI web-based GIS framework for enhanced dynamic mapping and data exploration

IPG Facilities Sectors

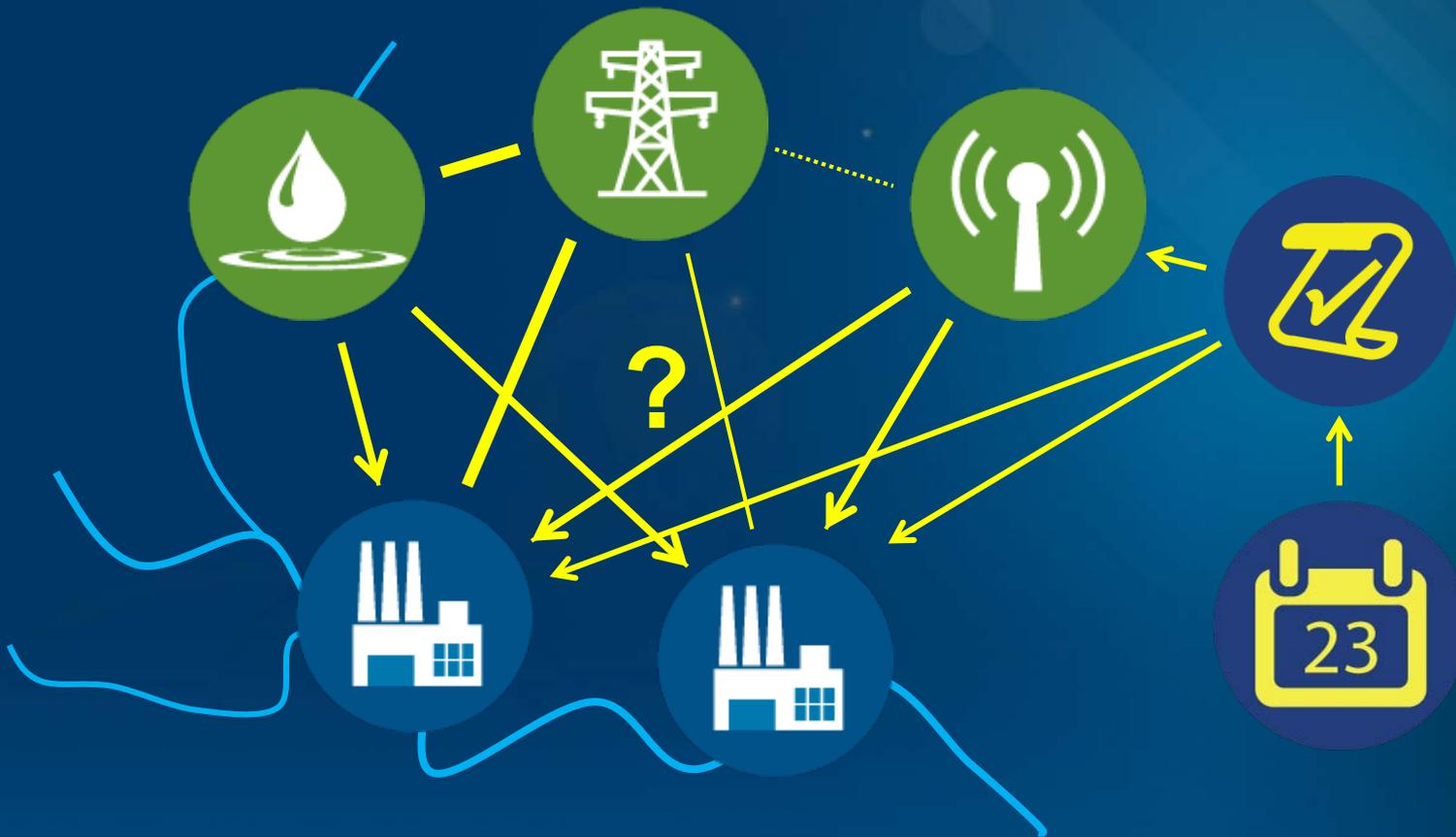
■	Agri/Food (A/F)
■	Bank/Fina (B/F)
■	Chem/Haza (C/H)
■	CommFaci (CF)
■	Communic (C)
■	Dams (D)
■	DefeInduBase (DIB)
■	EmerServ (ES)
■	Energy (E)
■	GoveFaci (GF)
■	Heal/Publ (H/P)
■	InfoTech (IT)
■	Manufact (M)
■	NatiMonu/Icon (NM/I)
■	NuclReacMate (NRM)
■	Post/Ship (P/S)
■	Transpor (T)
■	Water (W)

hue of hex indicates dominant sector
 hex bins with no dominant sector are more gray
 intensity of facilities indicated by opacity



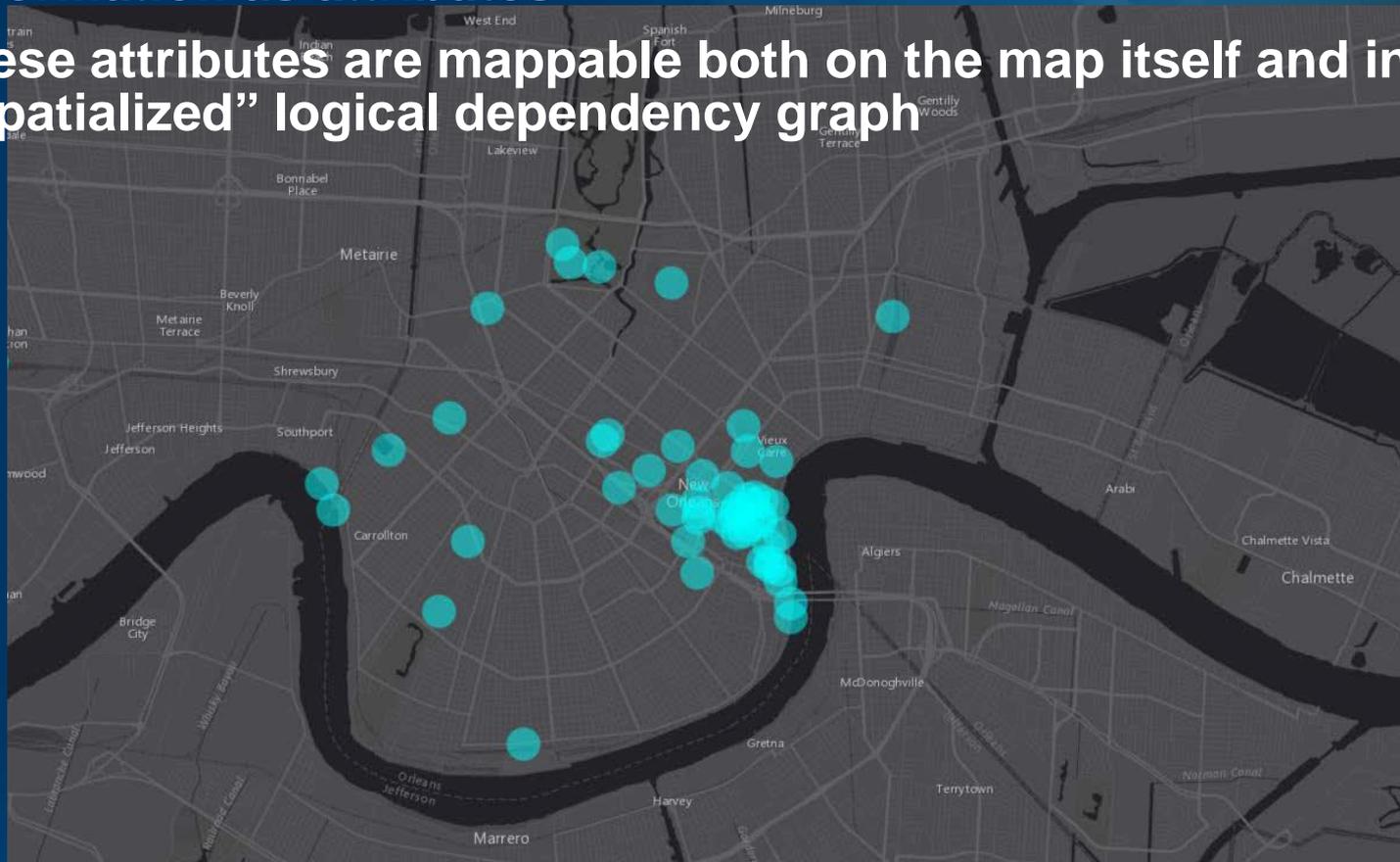
Interdependency visualization

- what aspects of dependency relationships are important?
 - **spatial relationships: proximity, context, direction**
 - **non-spatial relationships: degree, connectivity; non-spatial entities**



Interdependency visualization

- so far, only a relative few assets have facility dependency information as attributes
- these attributes are mappable both on the map itself and in a “spatialized” logical dependency graph





contact: robert.edsall@inl.gov