

# Real-Time Phasor Visualization



A PowerWorld Retriever Update  
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# PowerWorld Retriever



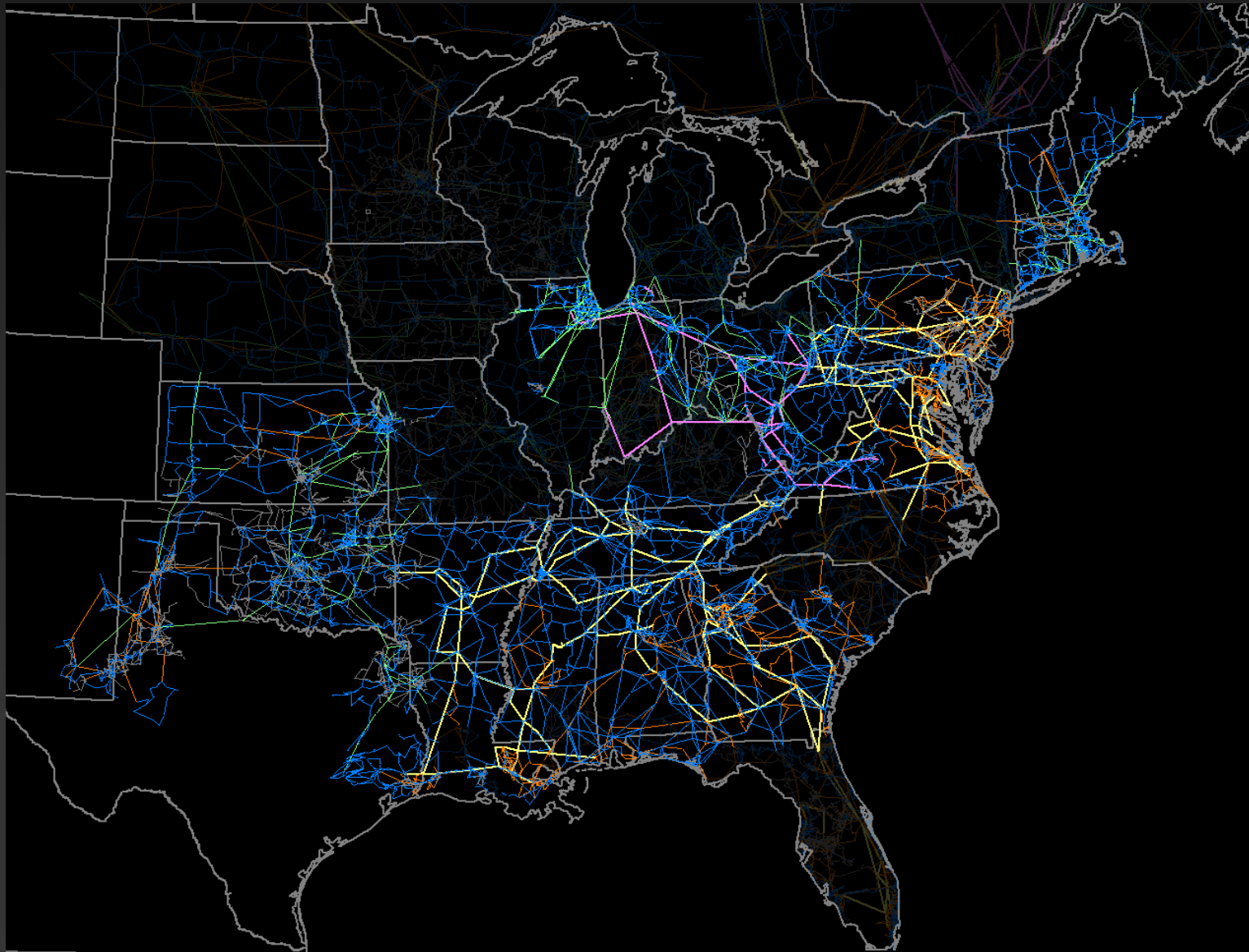
- Real-time visualization
- Provides overview of system health to enhance situational awareness
- Independent of EMS platform
- Remote and LAN access

# Deployment in Eastern Interconnect



- Covers roughly 51% of load in Eastern Interconnect
- Independent System Operators
  - PJM, ISO New England, Southwest Power Pool, ERCOT ISO
- Utilities
  - AEP, TVA, Southern Company, Alabama Power, Mississippi Power, Georgia Power, Texas Utilities, Entergy, Exelon (ComEd), SCANA, Springfield (IL) City Water Light and Power

# Retriever Deployment in Eastern Interconnect

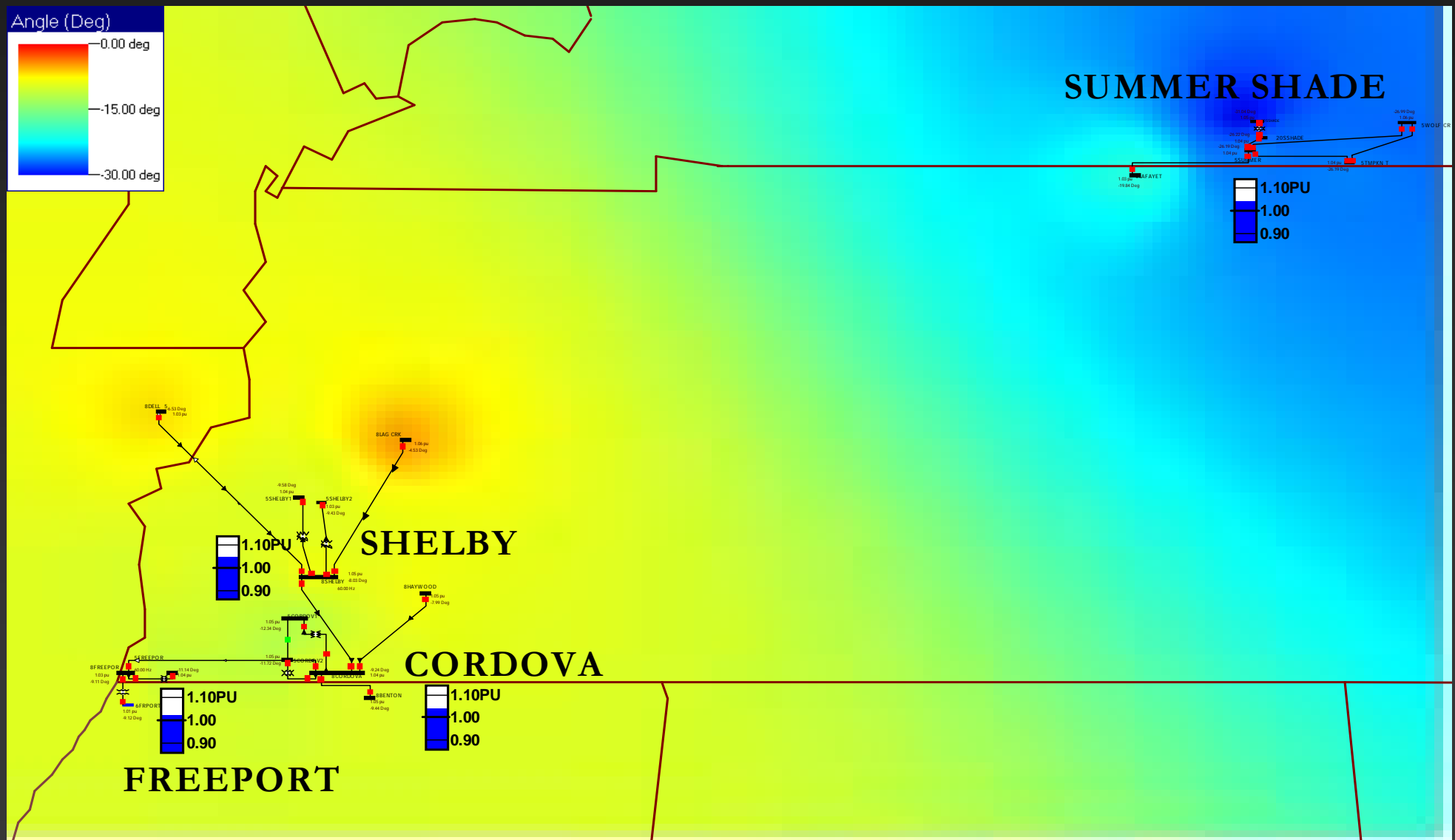


# Visualization

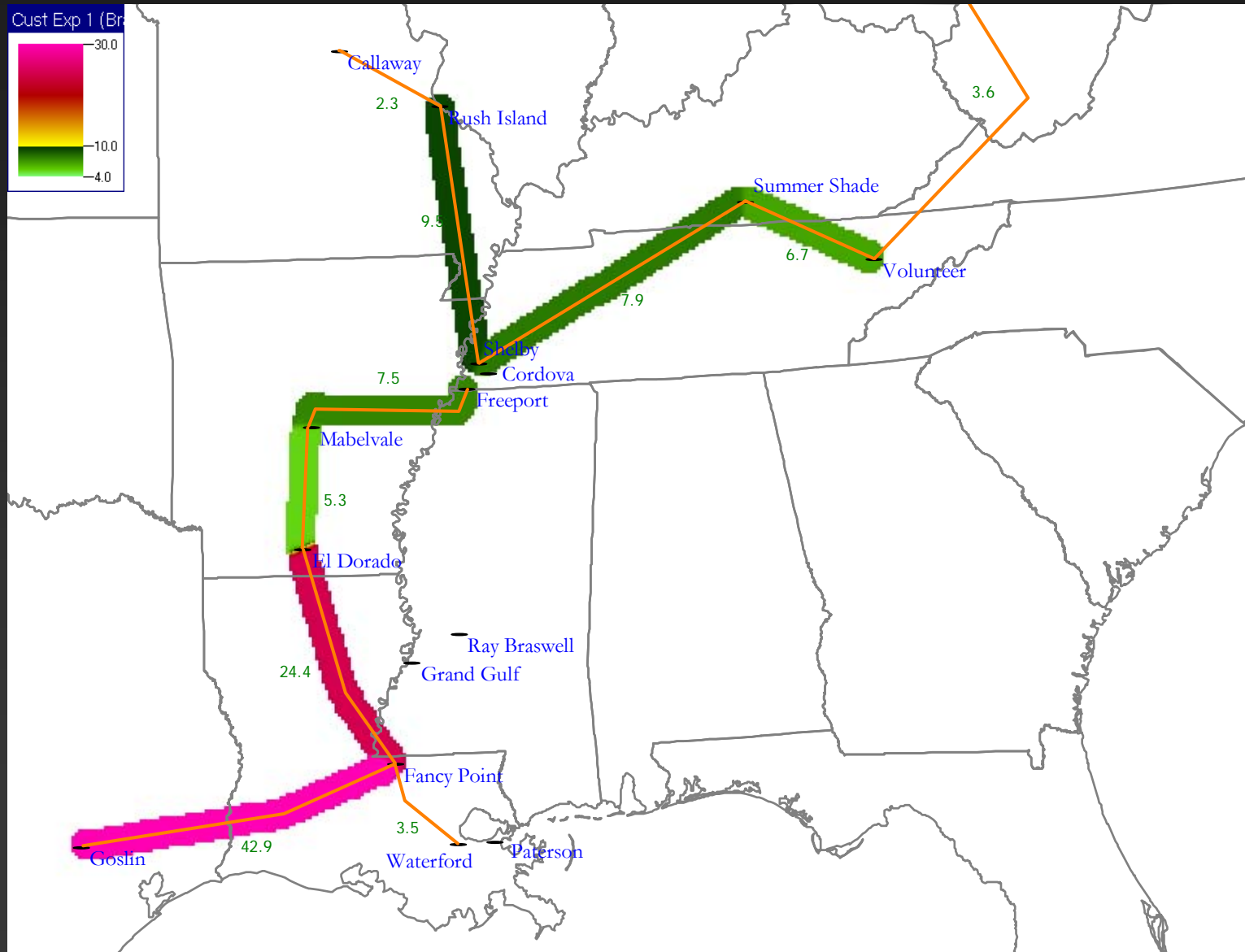


- Visualize any available numeric quantity in the power system
  - Voltage magnitude and angle, frequency, transmission line flows
  - Dynamic color contouring, flow arrows, pie charts, gauges
- Flexible specifications of reference phase angle
  - Select any bus for the angle reference
  - Change the selection in real-time with single right-click
  - Contours and text displays can show each angle relative to reference

# Voltage Magnitude and Angle



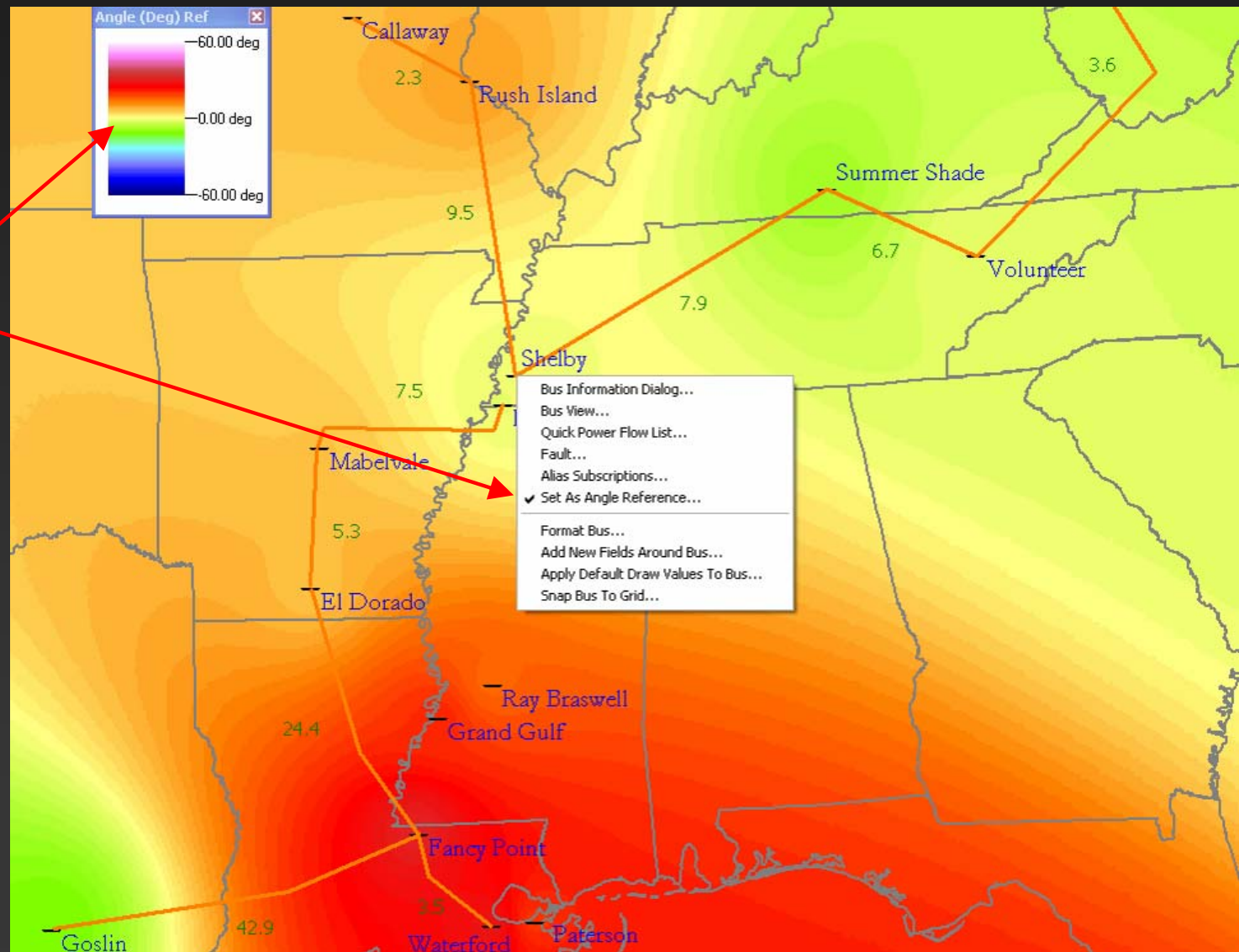
# Angle Difference Across Paths



# Set Angle Reference



- Shelby set as zero-degree reference
- other buses are contoured relative to Shelby



# Graphics



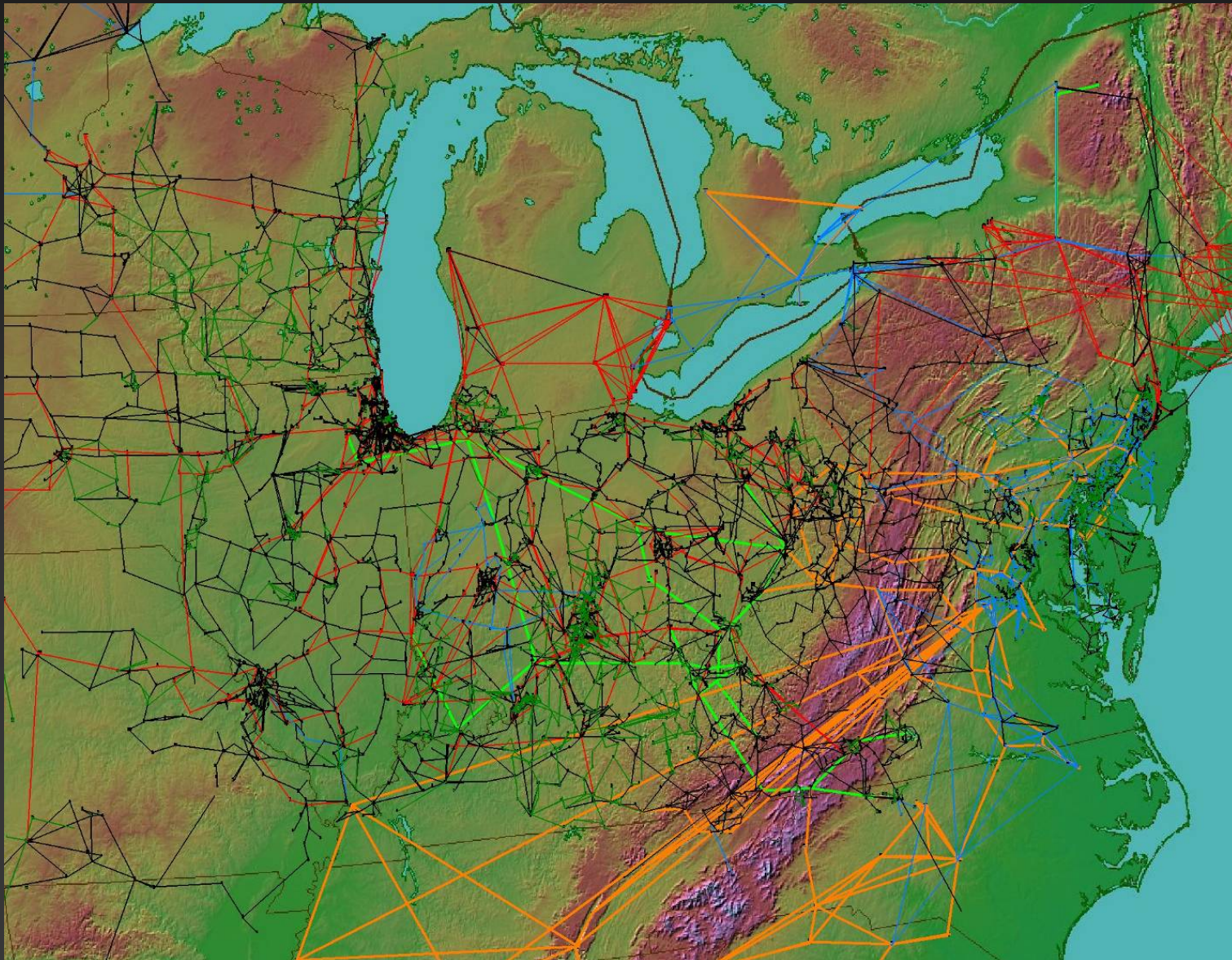
- GIS ESRI shape files
- Strip charts
- Support of free-floating windows and multi-monitor displays
- Dynamic formatting and emphasis
- Replay history at slow speed to visualize propagation of rapid changes and disturbances

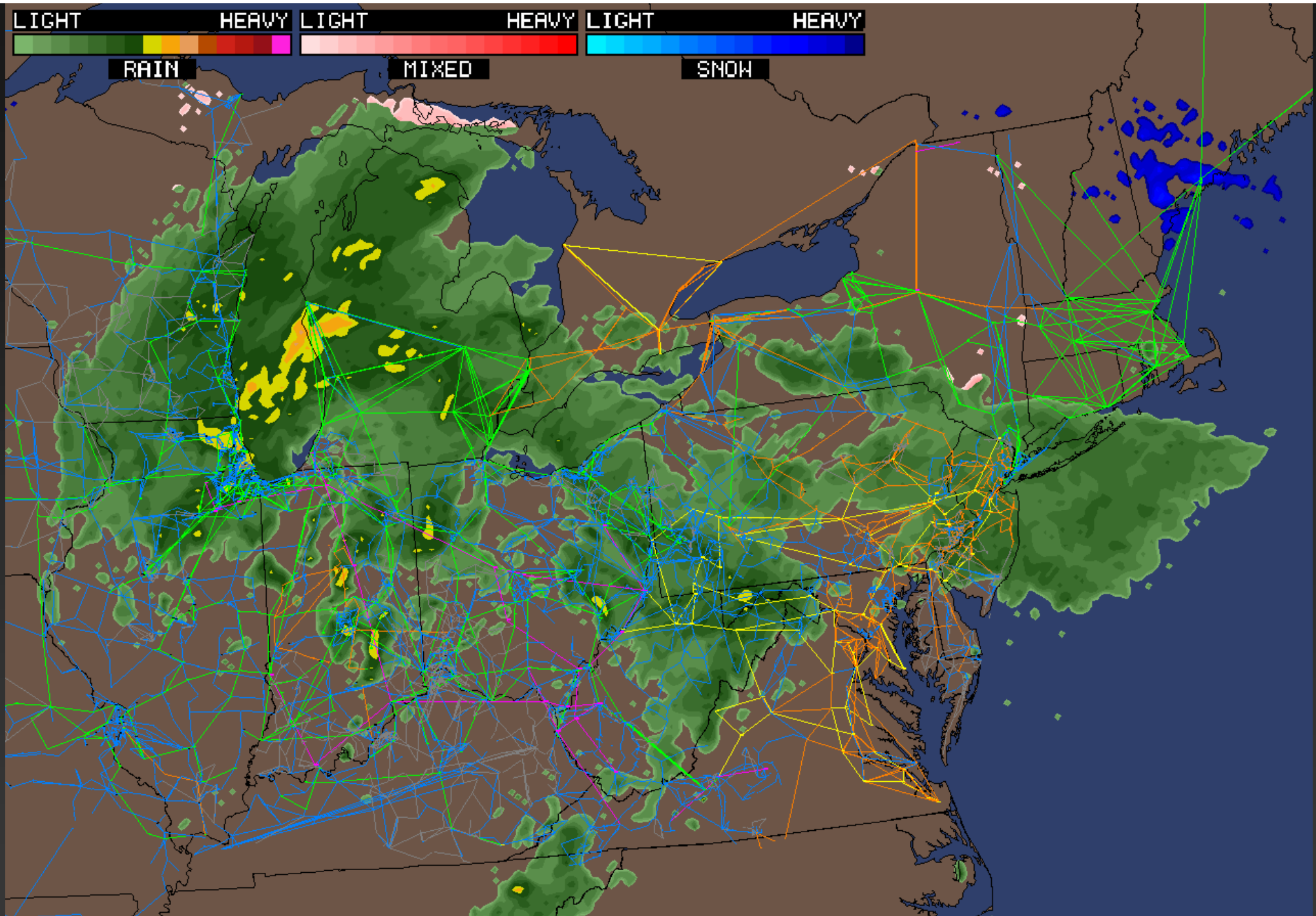
# Geographic Information Systems



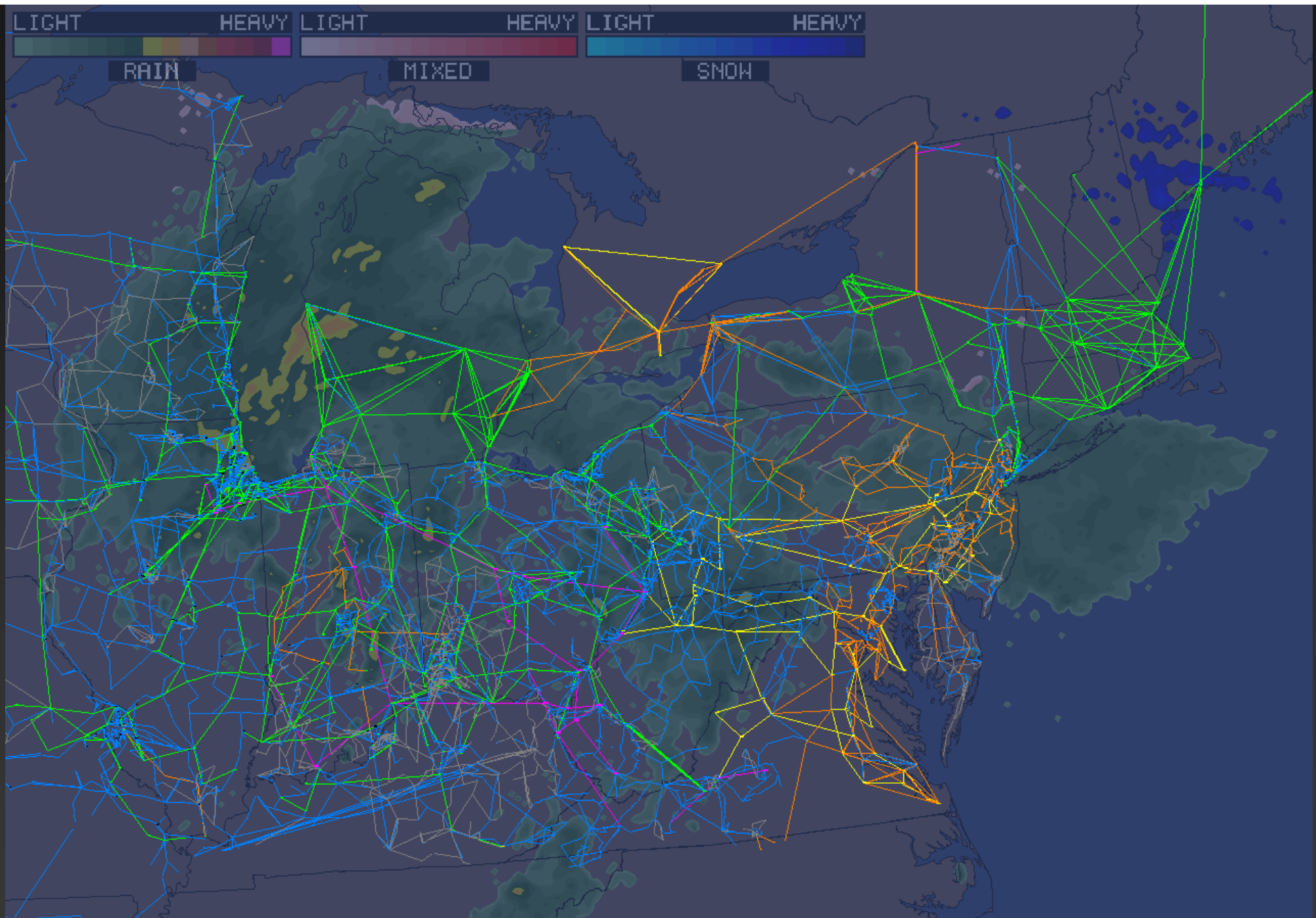
- Read ESRI shapefiles
- Convert a line from GIS data into a Transmission Line, Substation, or Bus object
- Specify latitude/longitude coordinates with Bus and Substation objects

# Topographic Map with Transmission System

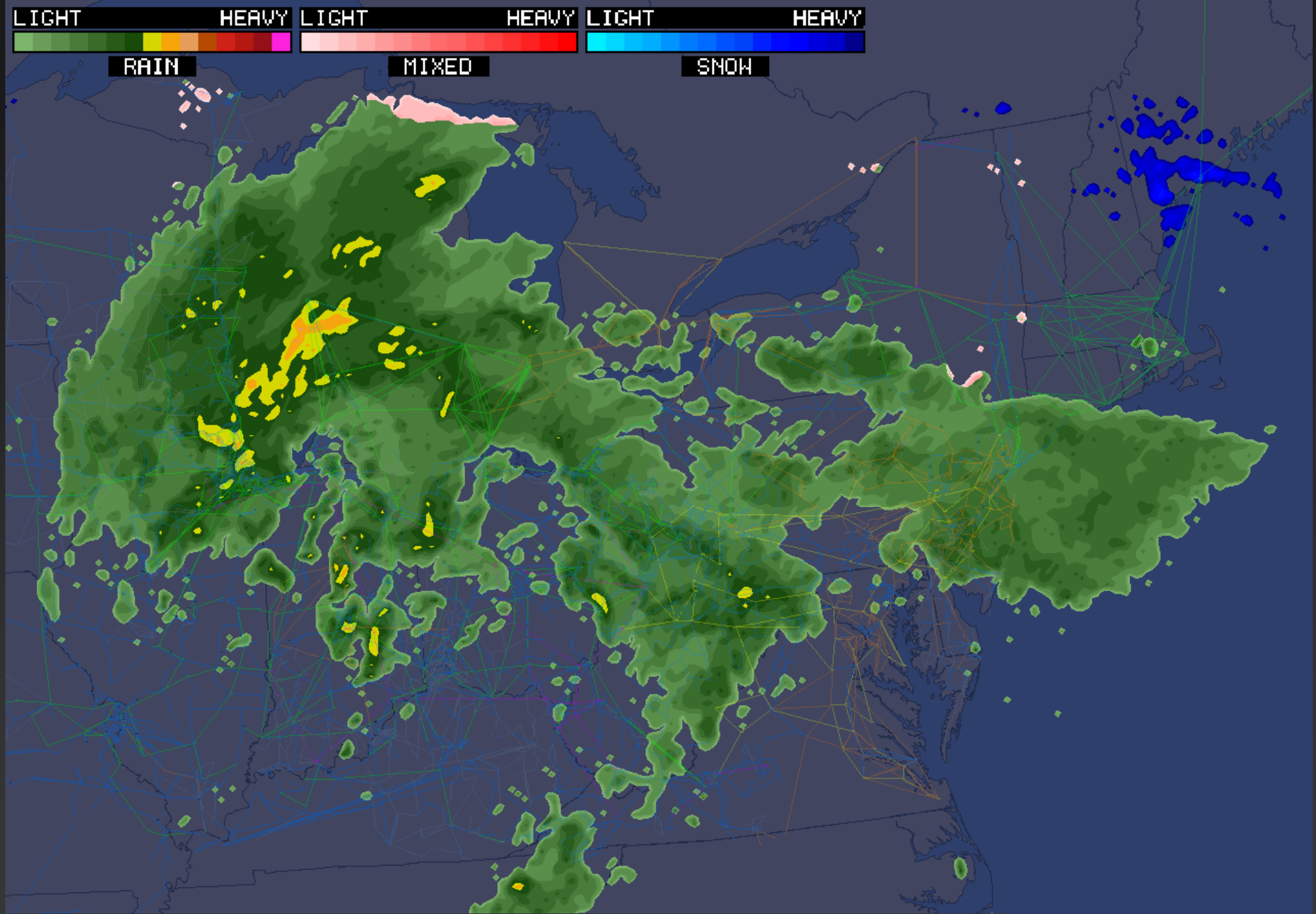




A Weather Precipitation Radar Image on a One-line



A Weather Precipitation Radar Image on a One-line:  
**Transmission System Emphasized**



A Weather Precipitation Radar Image on a One-line:  
**Weather Radar Emphasized**

# Data and Protocols

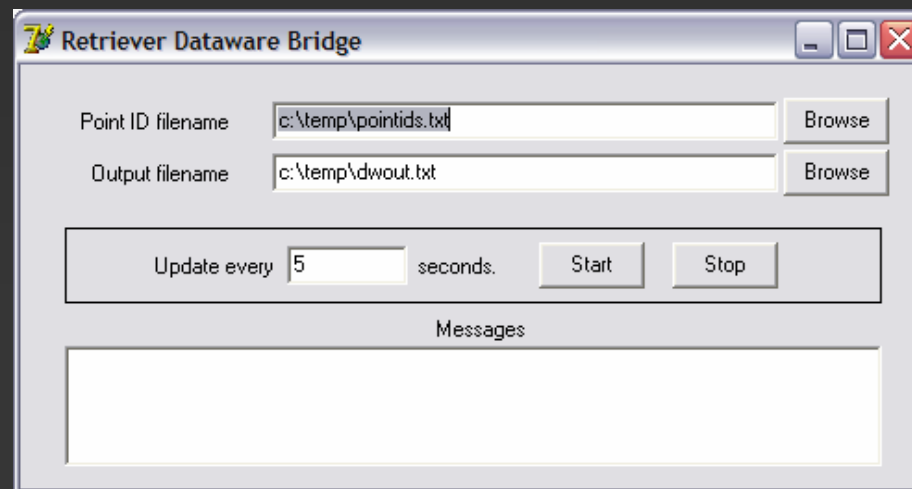


- Data formats
  - TVA DatAWare
  - Flat text
  - PowerWorld auxiliary file
  - SQL
  - In-Step eDNA
  - OSIsoft PI
- Connection protocols
  - Remote access through http, ftp
  - Secure Shell via VPN
  - OPC sources through 3rd party software (e.g. Matrikon OPC client)

# Retriever Connection: DatAWare



- DatAWare is a data archiving tool written by TVA Nuclear Operations
- Provides both a client-side and a server-side API
- PowerWorld has written a server-side DatAWare-Retriever bridge
  - Periodically queries the server for new data
  - Publishes the newly retrieved data to a flat file
  - Retriever then downloads this flat file using ftp, http, or direct disk access



# Retriever Connection: http



**Modify data source httpstest...**

Type: Flat Text  Active for live updates  
Name: httpstest  Reports by exception

Access:  LAN  FTP  HTTP

URL: http://cs.lewisu.edu/~klumpra/realtimedat

Hostname:   
IP Address:   
Timeout:  seconds

Authenticated  
Username:   
Password:

Get data only if file was updated

**Format**

Delimiter: , Quality Column: -1  
Alias Column: 1 Timestamp Column: -1  
Value Column: 2 Time Zone Correction: 0 hrs

Skip Columns:

Value Type:  Real  Integer  String

Advanced: <DELIM>, </DELIM><ALIAS>1</ALIAS><RVAL>  
Bad Quality codes: 1

# Retriever Connection: Secure Shell



- By setting up a VPN tunnel in another application , you can retrieve data via FTP or HTTP encrypted.
- Involves mapping requests against a particular local port to a port on a remote VPN server.



# Retriever Connection: OPC



- Retriever can download data from an OPC server
- Data is cached locally as it is generated at the OPC server
- Displays are refreshed at a user-specified interval

# Recent Developments



- Speed improvements
  - PI Server – can now retrieve large arrays with a single call
  - Flat text, ODBC/SQL and other formats also faster
- Tolerance of communication faults
  - Retrieval may fail a specified number of times in succession before Retriever concludes that data is bad
  - Reduces sensitivity to temporary dropouts in a measurement

# Topology Processing



- Create a power flow case from real-time state estimator data
- Phasor retrieval from state estimator or PMU
- Applications
  - operator training for emergency operation or post-mortem analysis
  - Contingency, available transfer capability, voltage stability analysis based on real system conditions

# Summary



- Retriever brings all the visualization techniques of PowerWorld to the on-line environment
- Advantages
  - Flexibility in data and display format
  - Ability to communicate complex data and trends quickly, in a manner that is easily understood by engineers and management
  - Visualization platform developed over several years and guided by hundreds of customers and research
  - Widespread usage in Eastern Interconnect