

# Real-Time Displays of Aggregate Data in Electric Power Systems



A PowerWorld Retriever Overview  
EIPP Work Group Meeting  
March 29-30, 2004

Scott R. Dahman, P.E.  
1816 South Oak St  
Champaign, IL 61820  
weber@powerworld.com



**PowerWorld**  
Corporation

(217) 384-6330

<http://www.powerworld.com>

# Retriever's History



- PowerWorld Simulator 3.1 released in 1996.
- Development of Simulator's off-line planning tool continues – version 10.0 released in 2004
- Users express interest in applying the visualization of Simulator to the real-time environment
- June, 2000: ComEd and CWLP (Springfield, IL) begin separate projects
  - Interface to PI data source
- January, 2001: TVA
  - Interface to flat-text data source
- Ongoing development with ComEd & TVA
- New projects with ERCOT and PJM
- Possible projects with MISO, BPA, and Southern Company

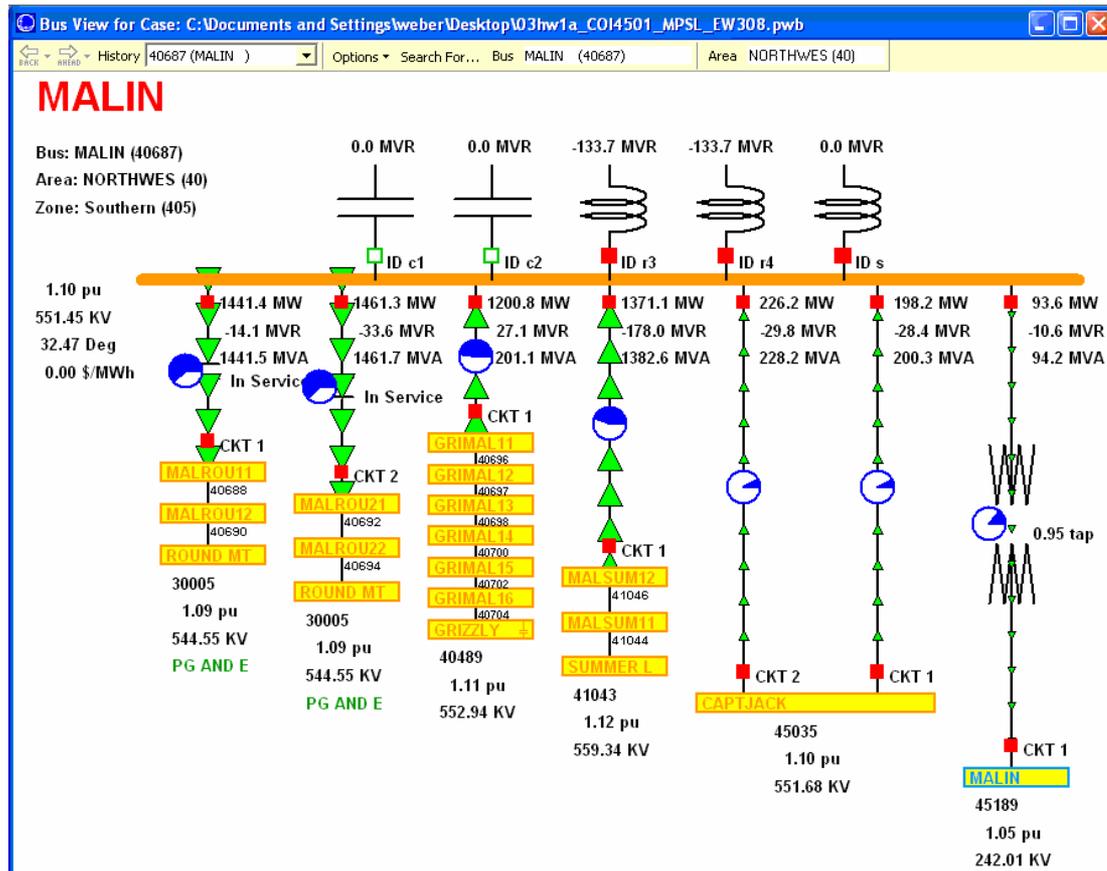
# PowerWorld Visualization Techniques



- Wide area geographic views
- Local and sub-topology views
- Built-in displays
  - Bus View
  - Numeric/Text Displays
- One-line diagrams
  - Animated Flows
  - Dynamically-Sized Pie Charts
  - Color Contouring
  - 3D Visualization

# Bus View One-line

- Automatically created one-line which shows the connections at a single bus



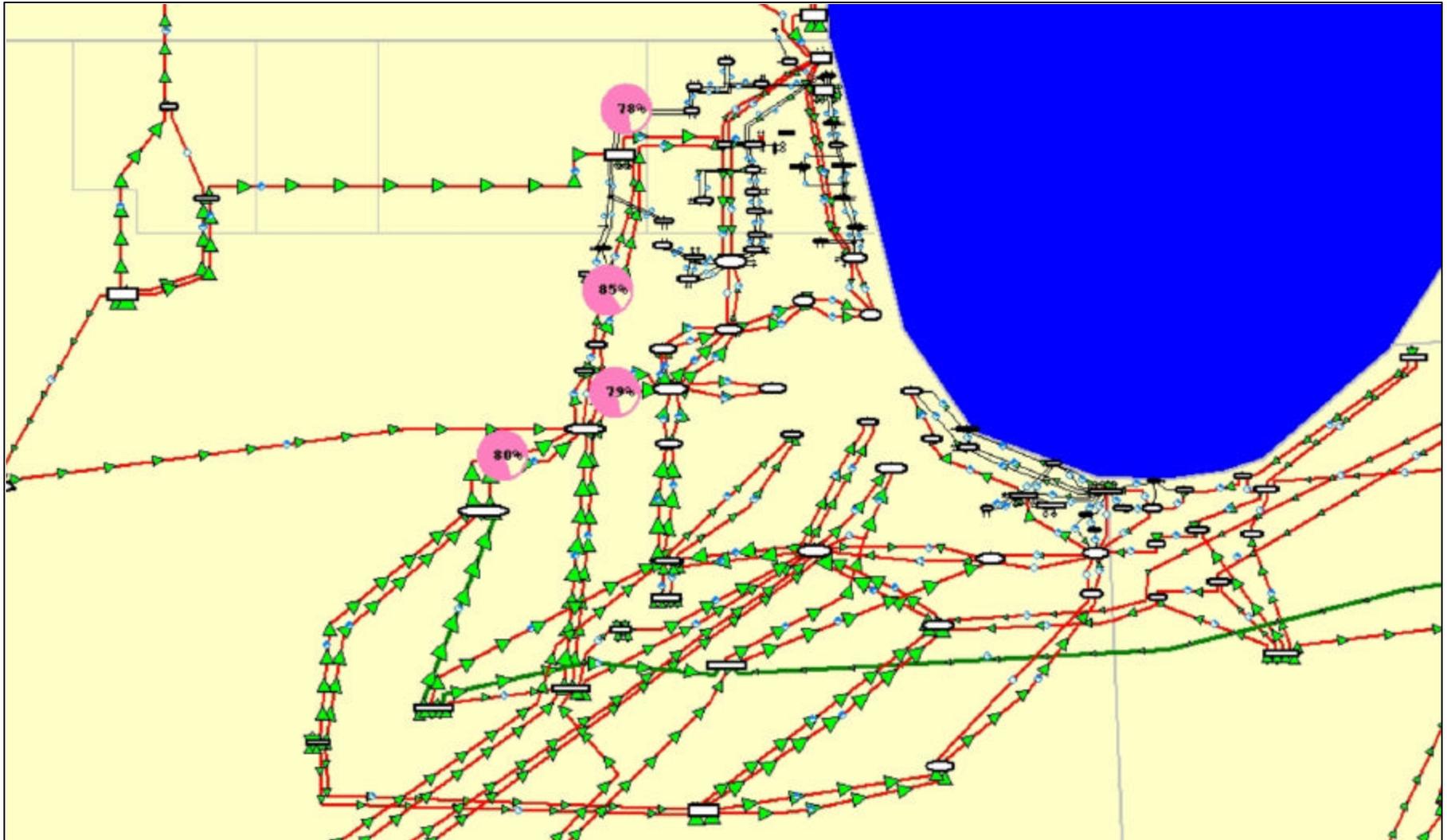
# Case Information Displays



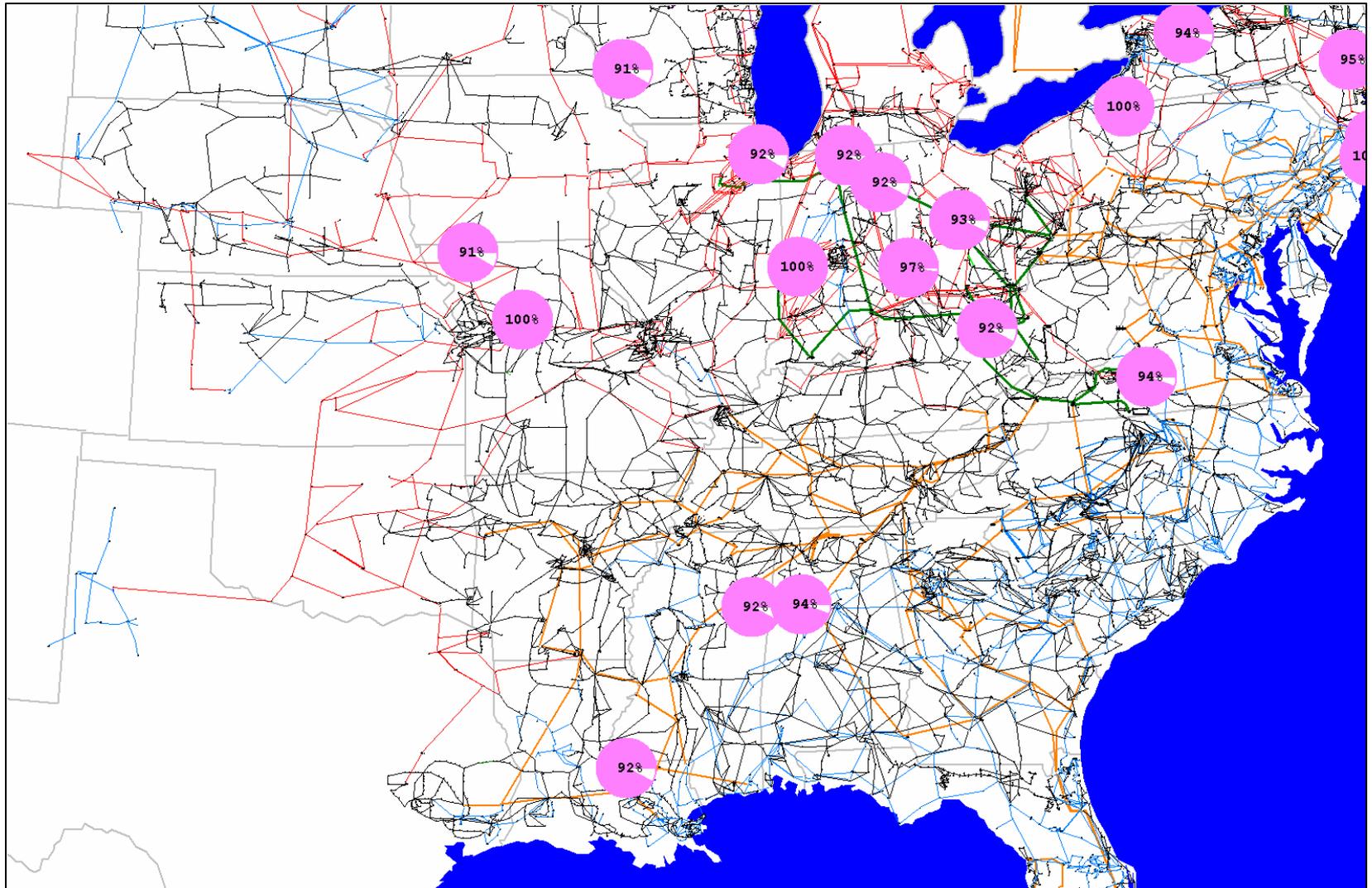
- “Spreadsheet-like” tables which show numeric and text information

Gen Records															
	Number	Name	ID	Status	Gen MW	Gen Mvar	Set Volt	AGC	AVR	Min MW	Max MW	Min Mvar	Max Mvar	Cost Model	Part. Factor
1	239	BSQSUTH2	1	Closed	150.00	50.56	1.03	YES	YES	0.00	160.00	-112.00	54.00	Cubic	1.99
2	244	WHITNEY1	1	Closed	15.00	-4.71	1.03	YES	YES	0.00	15.00	-5.00	7.00	Cubic	0.17
3	245	WHITNEY2	2	Closed	15.00	-4.71	1.03	YES	YES	0.00	15.00	-5.00	7.00	Cubic	0.17
4	247	BSQSUTH1	2	Closed	150.00	50.56	1.03	YES	YES	0.00	160.00	-112.00	54.00	Cubic	1.99
5	251	BSQSUTH3	2	Closed	150.00	10.96	1.03	YES	YES	0.00	160.00	-112.00	54.00	Cubic	1.99
6	253	BSQSUTH4	2	Closed	90.00	10.96	1.03	YES	YES	0.00	120.00	-90.00	40.00	Cubic	1.40
7	332	MILLER1	1	Closed	70.00	17.05	1.04	YES	YES	18.50	88.00	-36.00	48.00	Cubic	0.88
8	333	MILLER2	2	Closed	120.00	26.95	1.04	YES	YES	37.00	138.00	-40.00	73.00	Cubic	1.34
9	334	MILLER3	3	Closed	190.00	46.74	1.04	YES	YES	65.00	240.00	-96.00	115.00	Cubic	2.40
10	335	MILLER4	4	Closed	104.00	23.37	1.04	YES	YES	0.00	130.00	-112.00	54.00	Cubic	1.99
11	336	MILLER5	5	Closed	104.00	23.37	1.04	YES	YES	0.00	130.00	-112.00	54.00	Cubic	1.99
12	344	MORSHEP	1	Closed	12.00	1.84	1.01	YES	YES	0.00	12.00	-5.00	6.00	Cubic	0.13
13	345	MORSHEP2	2	Closed	12.00	1.84	1.01	YES	YES	0.00	12.00	-5.00	6.00	Cubic	0.13
14	366	TENASKA	1	Closed	172.00	41.49	1.02	YES	YES	20.00	200.00	-84.00	100.00	Cubic	2.00
15	367	TENASKA	2	Closed	86.00	20.62	1.02	YES	YES	20.00	116.00	-70.00	68.00	Cubic	1.16
16	503	NTEXAS1	1	Closed	15.00	5.00	1.01	YES	YES	5.00	18.00	-2.90	5.00	Cubic	0.22
17	504	NTEXAS2	2	Closed	15.00	5.00	1.01	YES	YES	5.00	18.00	-2.90	5.00	Cubic	0.22
18	505	NTEXAS3	3	Closed	35.00	7.82	1.01	YES	YES	15.00	40.00	-16.00	15.00	Cubic	0.44
19	719	WFEC 12G	1	Closed	20.00	7.07	1.01	YES	YES	12.00	20.00	-8.00	15.00	Cubic	0.25
20	719	WFEC 12G	2	Closed	20.00	7.07	1.01	YES	YES	12.00	20.00	-8.00	15.00	Cubic	0.25
21	720	WFEC 34G	3	Closed	20.00	7.07	1.01	YES	YES	12.00	20.00	-8.00	15.00	Cubic	0.25
22	720	WFEC 34G	4	Closed	20.00	7.07	1.01	YES	YES	12.00	20.00	-8.00	15.00	Cubic	0.25
23	798	TAMUGEN1	1	Closed	28.00	15.00	1.02	YES	YES	5.00	32.00	-5.00	15.00	Cubic	0.40
24	837	NEWMAN5	1	Open	0.00	0.00	1.01	YES	YES	15.00	40.00	0.00	17.00	Cubic	0.44
25	838	NEWMAN3	1	Open	0.00	0.00	1.01	YES	YES	6.00	17.00	0.00	8.00	Cubic	0.18
26	839	NEWMAN4	1	Open	0.00	0.00	1.01	YES	YES	6.00	17.00	0.00	8.00	Cubic	0.18
27	840	NEWMAN1	1	Open	0.00	0.00	1.01	YES	YES	3.00	8.00	-2.00	4.00	Cubic	0.08
28	841	NEWMAN2	1	Open	0.00	0.00	1.01	YES	YES	3.00	8.00	-2.00	4.00	Cubic	0.08
29	842	OLINGR1	1	Closed	70.00	23.21	1.03	YES	YES	20.00	80.00	0.00	40.00	Cubic	0.88
30	843	OLINGR2	1	Closed	102.70	44.43	1.03	YES	YES	25.00	110.00	0.00	55.00	Cubic	1.34
31	844	OLINGR3	1	Closed	140.00	66.82	1.03	YES	YES	45.00	150.00	0.00	75.00	Cubic	1.74
32	845	OLINGR4	2	Open	0.00	0.00	1.03	YES	YES	0.00	75.00	0.00	55.00	Cubic	1.12
33	886	ATKINS3	1	Closed	12.00	1.00	1.00	YES	YES	5.00	12.00	1.00	10.00	Cubic	0.12
34	887	ATKINS6	1	Closed	50.00	10.26	1.03	YES	YES	12.00	50.00	2.00	20.00	Cubic	0.64
35	888	ATKINS7	1	Closed	9.50	2.98	1.03	YES	YES	4.00	20.00	1.00	10.00	Cubic	0.30
36	890	ATKINS4	1	Closed	22.00	2.11	1.03	YES	YES	5.00	22.00	1.00	10.00	Cubic	0.23
37	891	ATKINS5	1	Closed	25.00	2.37	1.03	YES	YES	5.00	25.00	1.00	10.00	Cubic	0.29
38	892	DANSBY14	1	Closed	110.00	24.20	1.03	YES	YES	25.00	114.00	5.00	40.00	Cubic	1.25
39	920	SPNCER1	1	Closed	12.00	2.84	1.03	YES	YES	4.00	12.00	0.00	6.00	Cubic	0.14
40	921	SPNCER2	1	Closed	12.00	3.44	1.03	YES	YES	4.00	12.00	0.00	6.00	Cubic	0.14

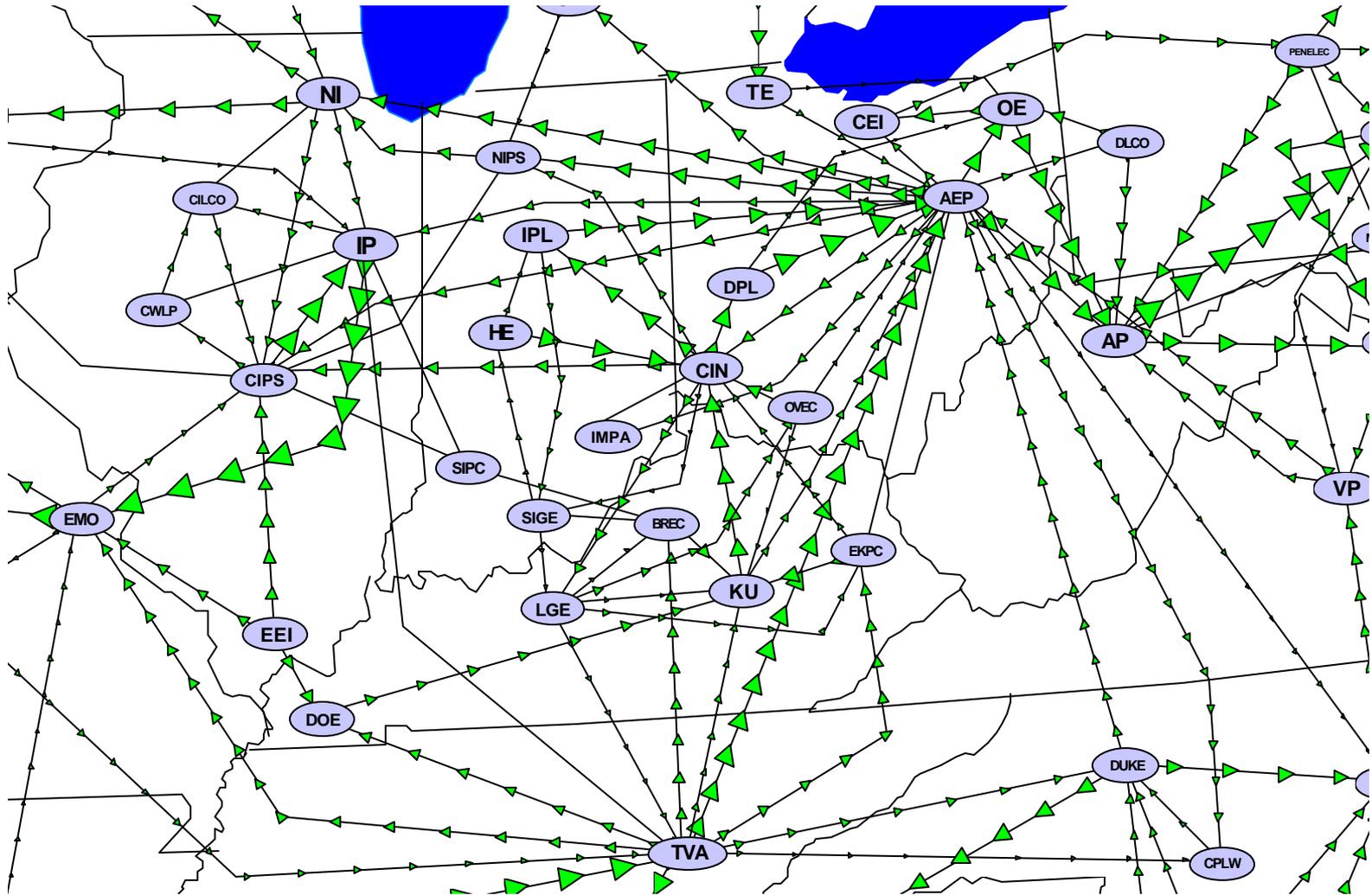
# Animated Flow Arrows



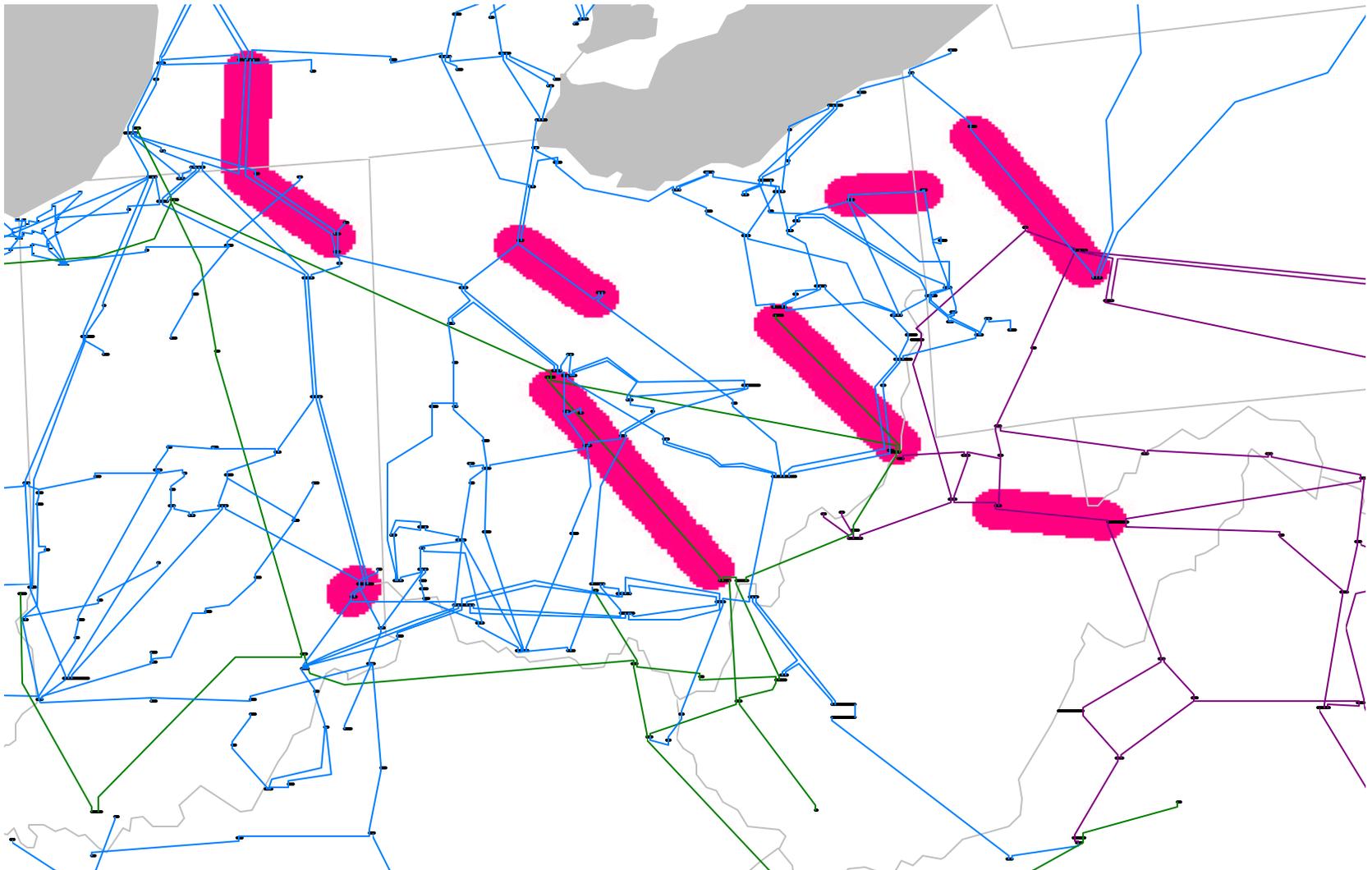
# Dynamically-Sized Pie Charts



# Bubbles For Areas and Arrows for Tie-Line Interface Flows



# Highlighting of Out-Of-Service Transmission Line

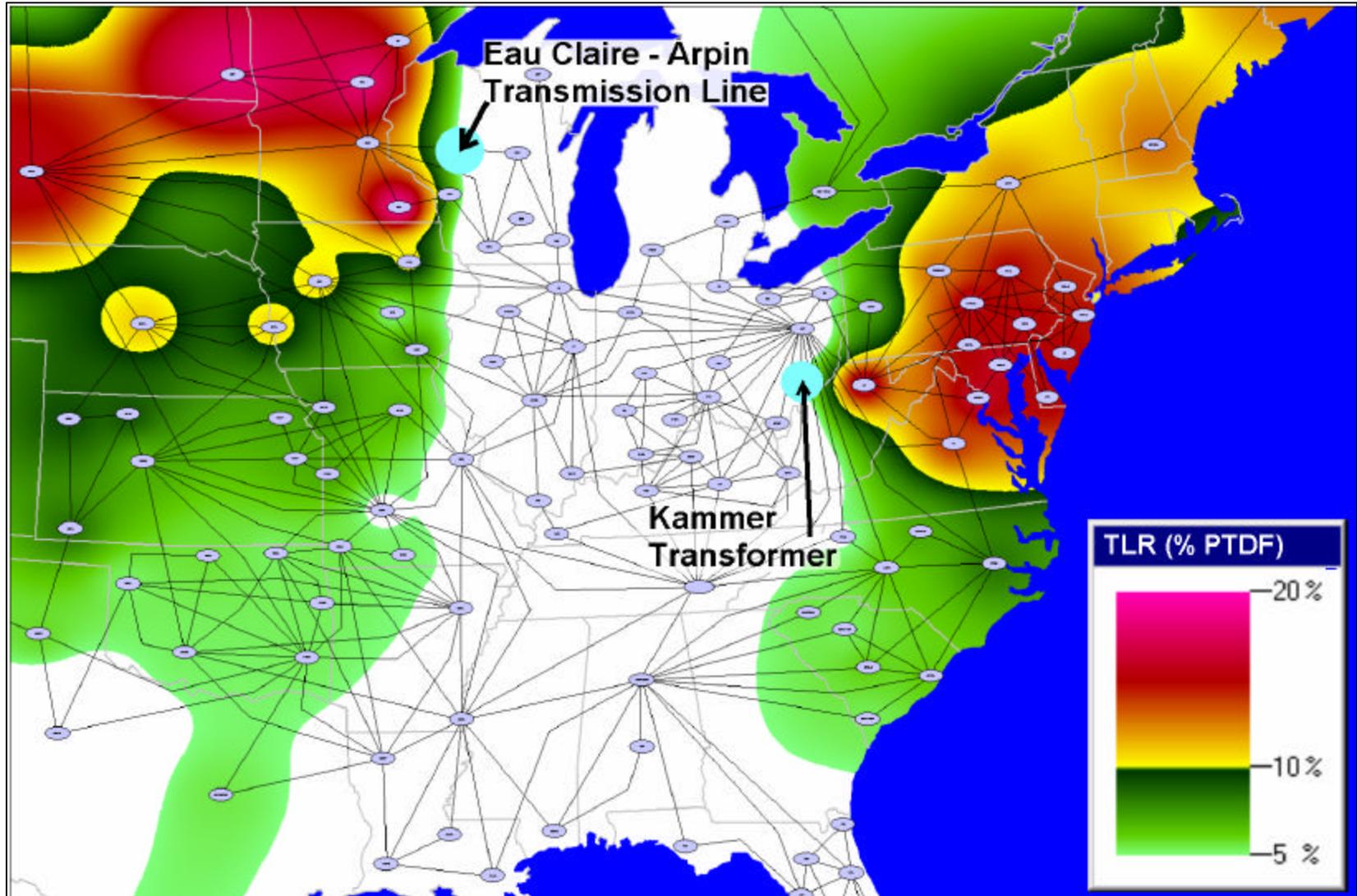


# Contouring and 3D Columns

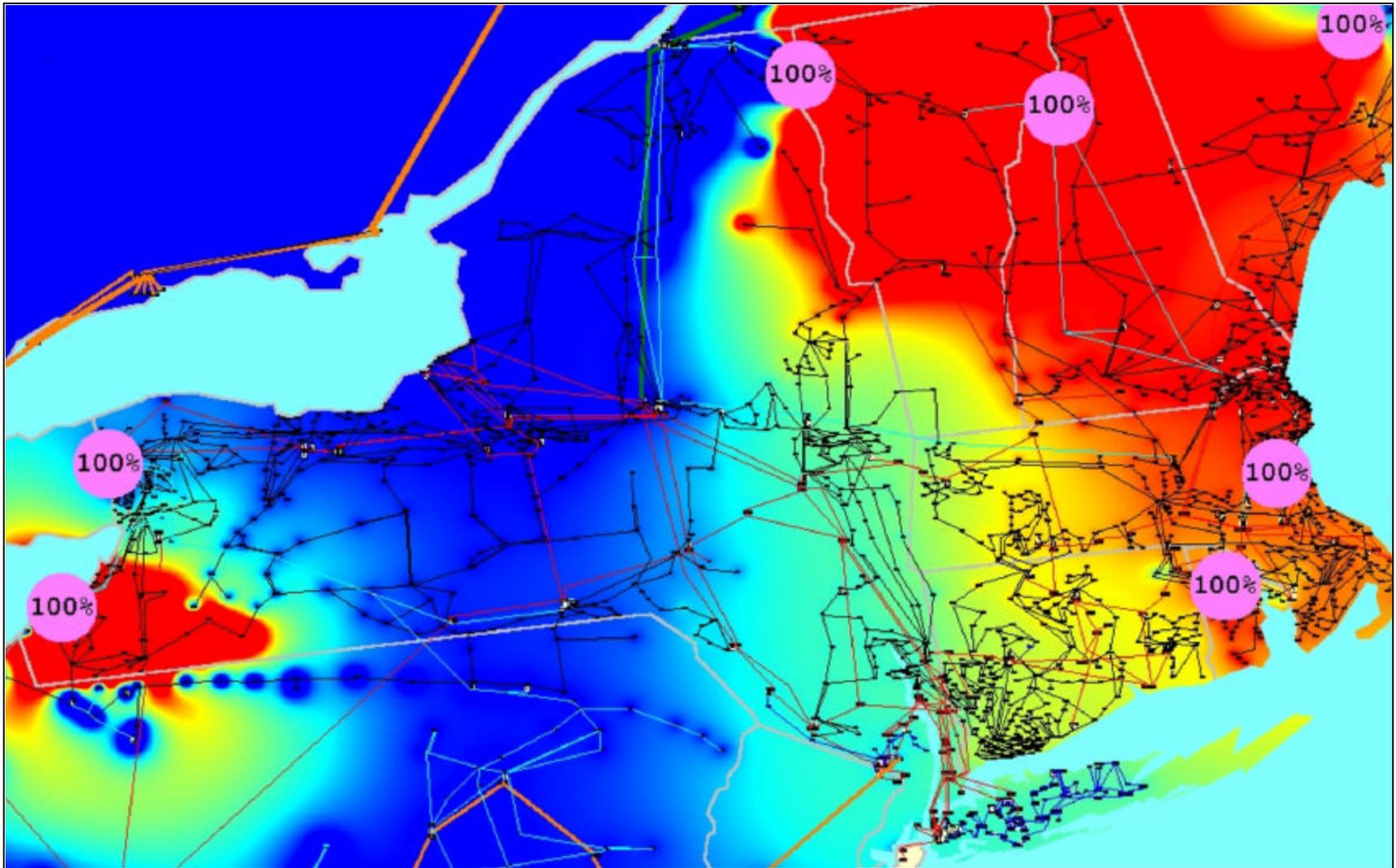


- Color contouring can visualize any numerical data that can be captured in real time
  - Bus per unit voltage or angle
  - Angle difference across transmission line
  - Locational marginal prices
  - Transmission line or transformer loading
- 3D columns can show related quantities
  - Reactive power output and reserves
  - Area real and reactive power load

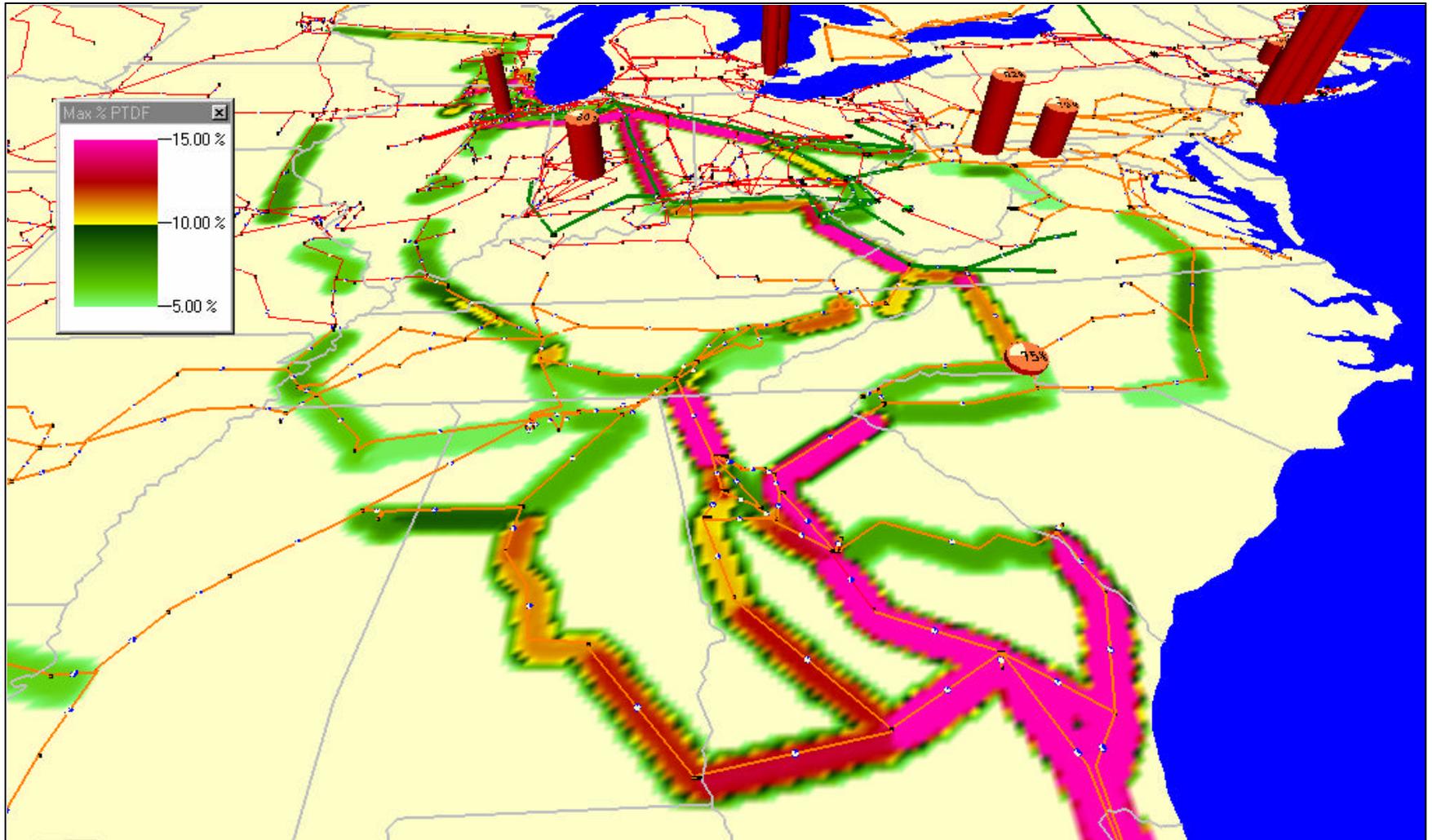
# Contouring – Area TLR Sensitivities



# Price Contouring



# Contouring with 3D Columns

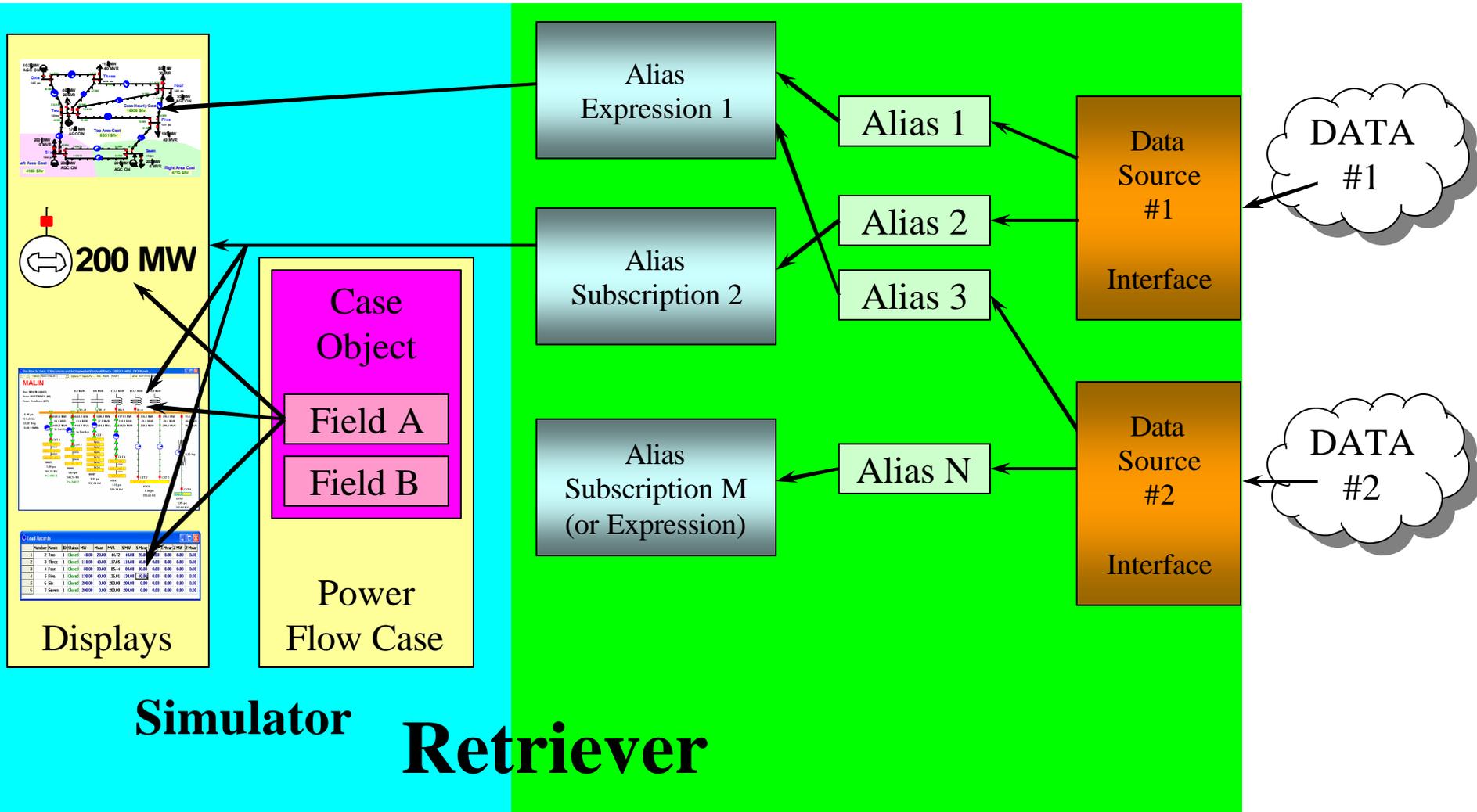


# Data Retrieval Architecture



- Built on top of PowerWorld's Simulator product line
  - Component: System component represented on one-lines and in list displays
  - Attribute: a particular attribute of an object
- Retriever adds new definitions and linkages which modify the Simulator visualizations so that they display data from an external source instead of the power flow model.
  - OSIssoft PI
  - SQL
  - Flat text file

# Retriever Flow Chart



# 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