Introduction to PowerWorld Simulator: Interface and Common Tools

I6: Contouring and Advanced Visualization

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Contouring and Advanced Visualization

- Contouring
  - Underlay your oneline with an image
  - Detailed examples covered
- More Advanced Features will be demonstrated
  - Geographic Data Views
    - Auto-created geographic data visualization
  - Emphasis of Display Objects
    - Make specific objects standout on your oneline
  - Dynamic Formatting
    - Allows for Conditional Dynamic Formatting of Onelines and Case Information Displays
  - Geographic Information System (GIS) Support
    - Reading ESRI Shapefiles (*.shp/*.dbf/*.shx groups)
    - Writing and reading KML files (used by Google Earth)
    - Read existing coordinate data

Contouring Visualization

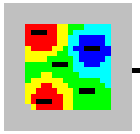
Contouring Visualization

- What is Contouring used for?
- Using the Contour Options Dialog
- Examples
  - Bus Voltage Magnitudes
  - Line MVA Percentage Loadings
  - Line PTDFs
  - Many more…
- Recommendations on using Contouring

Uses of Contouring

- Analyze large amounts of information all at once
- Get an overview at a glance
- Monitoring data
- Presenting data

Contour Options Dialog

- Contour Options Dialog is used to control the contouring used on a oneline
- Note: Contouring is available in Run Mode and Edit Mode
- Contour Options Dialog can be viewed by
  - Contouring option on oneline local menu
  -  **Onelines** ribbon tab → **Contouring**

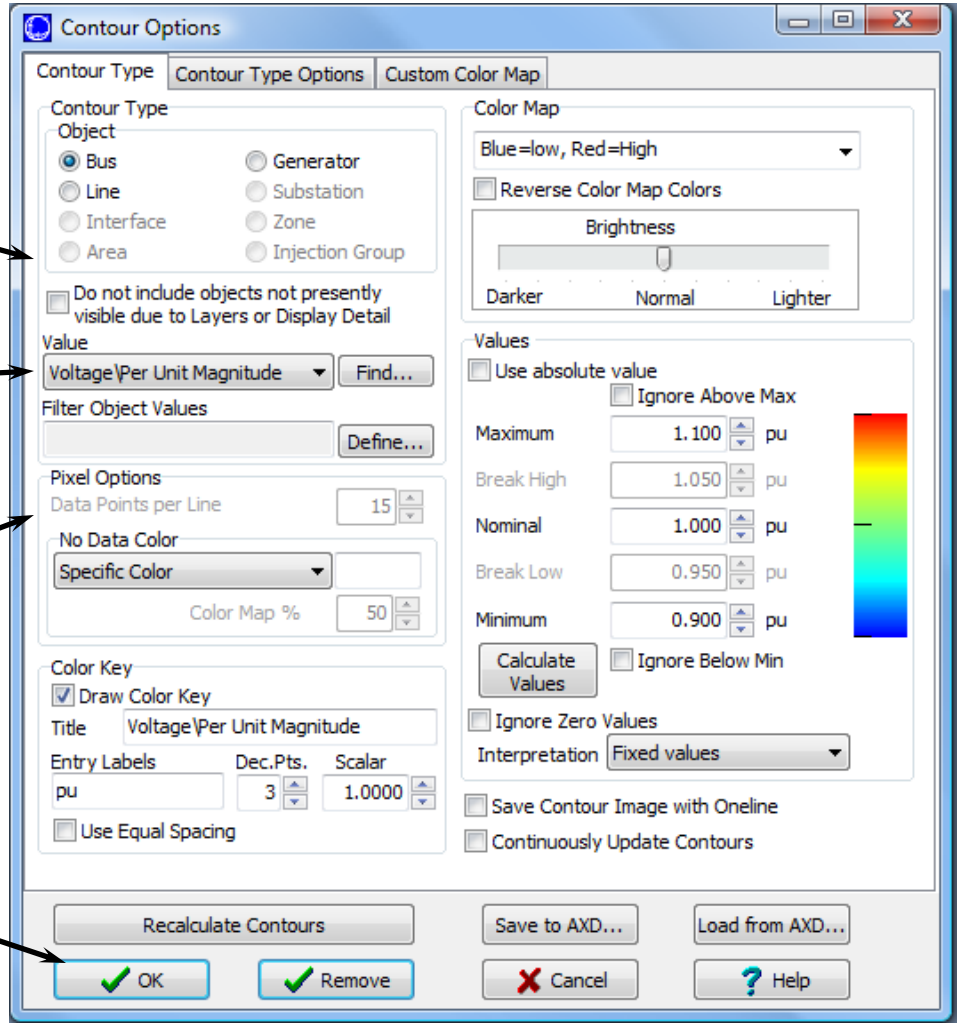
Contour Options Dialog - Contour Type Left Side

Select object type to contour. Only object types currently present on the oneline will be displayed.

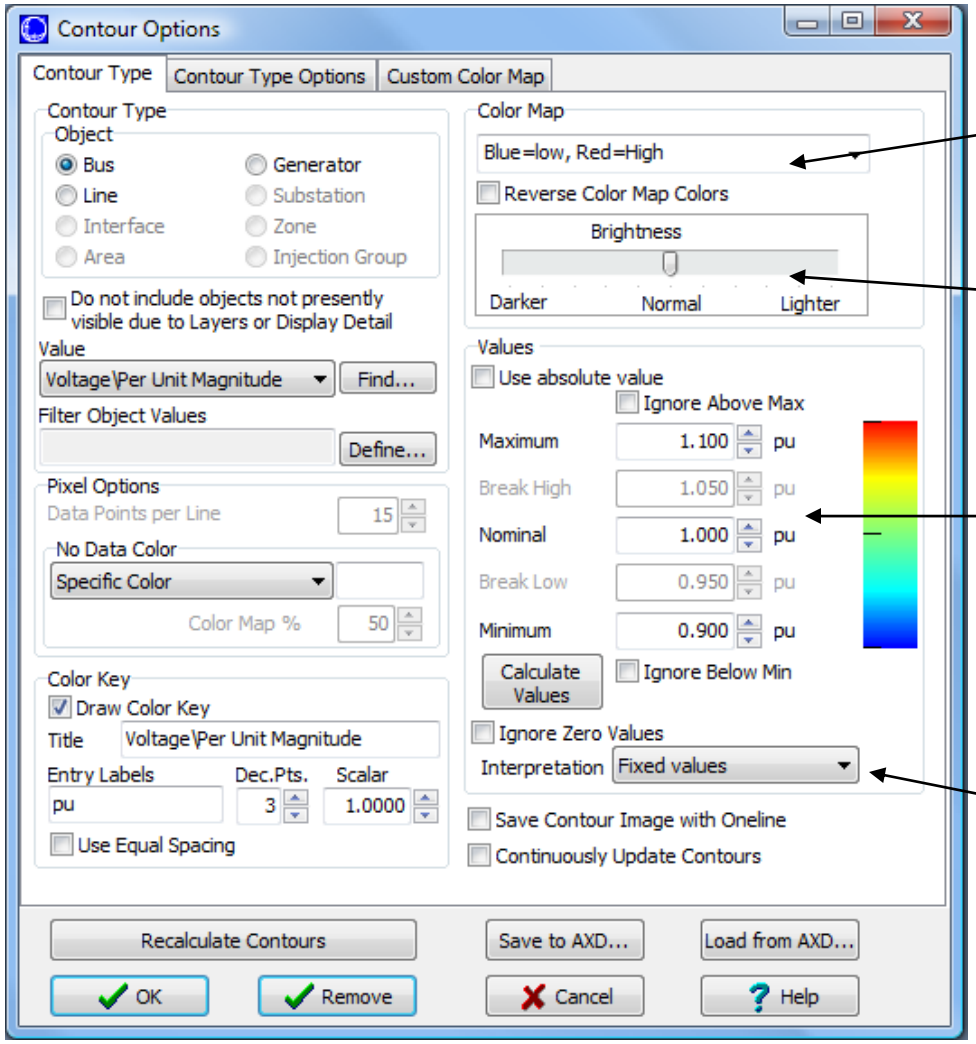
Select the value you want to contour

Used for doing “line contours”

Recalculate does the same thing as OK, but does not close the dialog.



Contour Options Dialog - Contour Type Right Side



Choose the Color Map you want

Set the brightness of the colors

Define the range of values in the color map

How to interpret the color map values

Contour Options Dialog - Interpretation

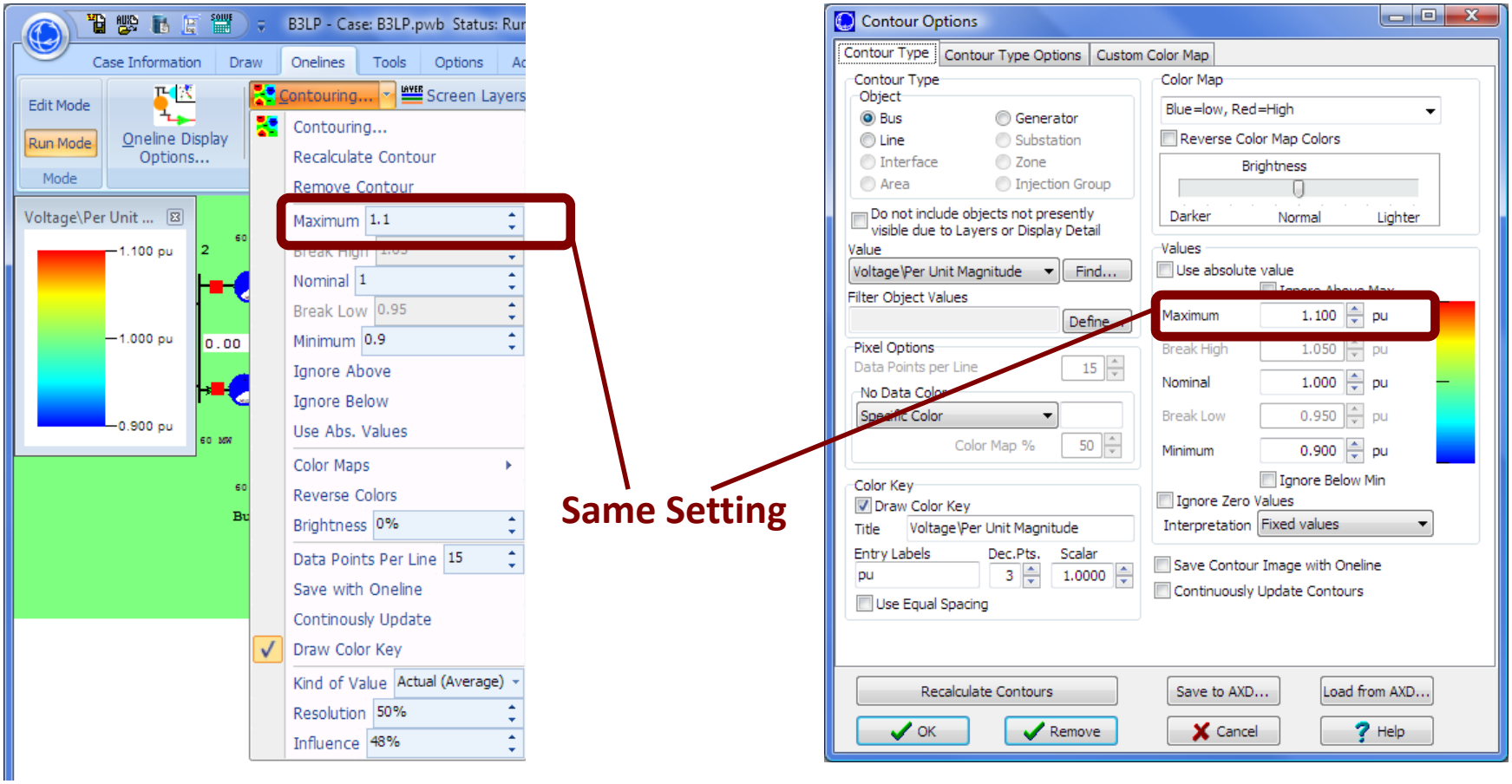
- Options for interpreting the Contour min, max, break high, break low, and nominal values
- Fixed Values (Default)
  - Use user input values
  - User input values have the same units as the contoured quantities
- Dynamic Values
  - Automatically determine min, max, nominal, etc.
  - Max = maximum data point value
  - Min = minimum data point value
  - Nominal = Average data point value
  - Break high = (Max+Average)/2
  - Break low = (Min+Average)/2

Contour Options Dialog - Interpretation

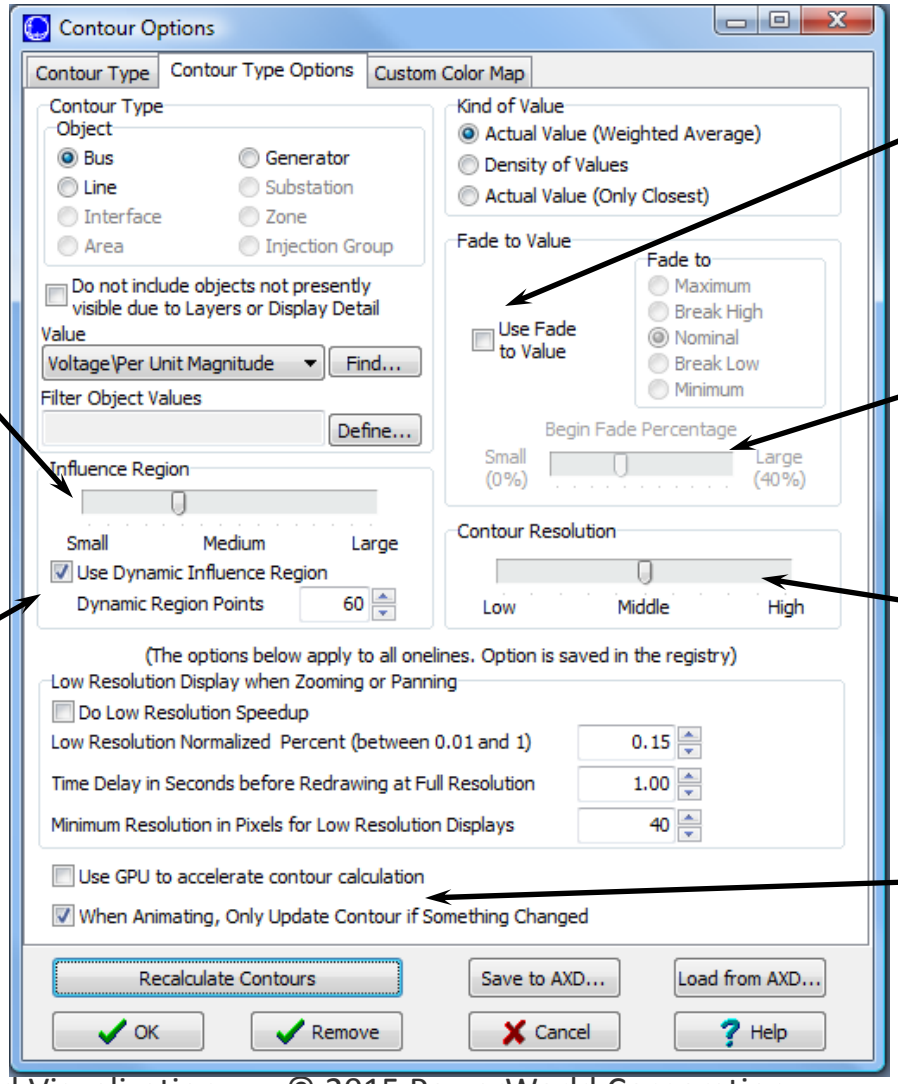
- Standard Deviations
  - Calculate mean, standard deviation
  - Put all values in terms of standard deviations away from the mean
  - User input values for min, max, etc are used with units of standard deviation (stdev)
- Percentiles
  - Sort data points from lowest to higest
  - Give the greatest data point a value of 100
  - Give the smallest data point a value of 0
  - User input values are used with units of percent (pct)

Contour Options Toolbar

- Select the contouring drop-down to show the same options available in the dialog.



Contour Options Dialog - Contour Type Options



Area of influence about each contoured point

Dynamic contouring adjusts influence region according to density of data points

If **Use Fade To Value** is checked, then

Percentage at which contour begins to fade towards the **Fade To Value**

Set contour resolution

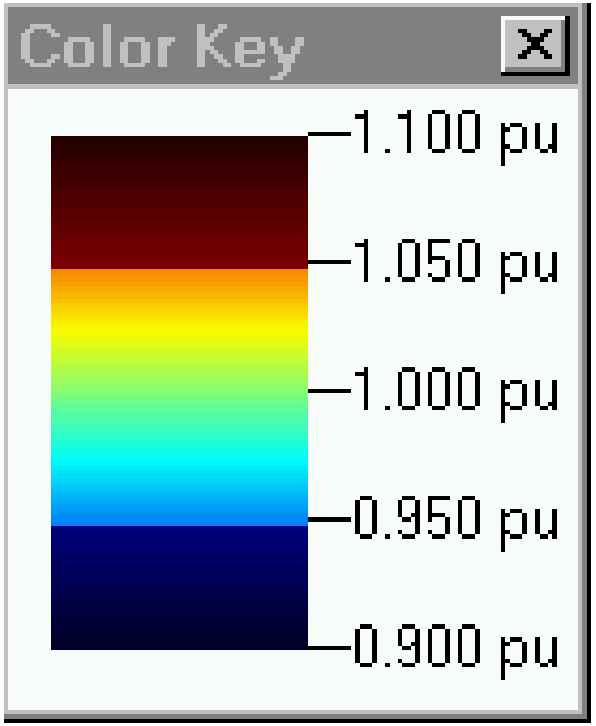
Using Graphics Processing Unit can greatly speed up contouring. Option will automatically be disabled if graphics card cannot handle contouring acceleration.

Contour Type

- Specify the type of display object that should be used for contouring
- Specify the value of the respective object to use
- Specify an Advanced Filter… to reduce what is contoured.

Values

- These define the values used in the color maps. (The color key displays the values)



Maximum

Break High

Nominal

Break Low

Minimum

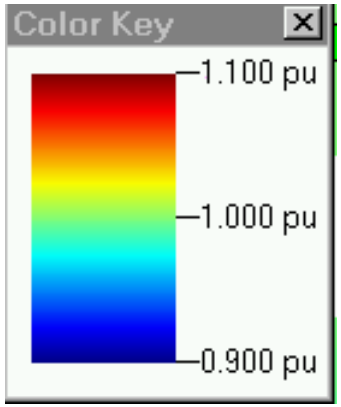
(all values above are mapped to dark red)

(all values below are mapped to dark blue)

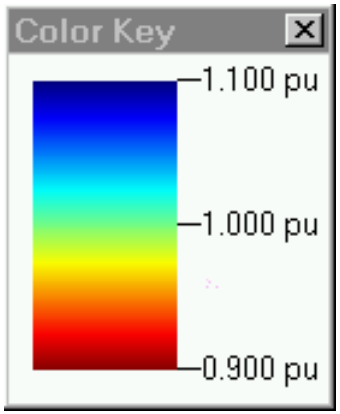
Color Maps

- Simulator offers several default Color Maps
- For contours for which both low and high values are of significance (such as Bus Voltages) the following color maps are recommended

Blue = Low,
Red = High

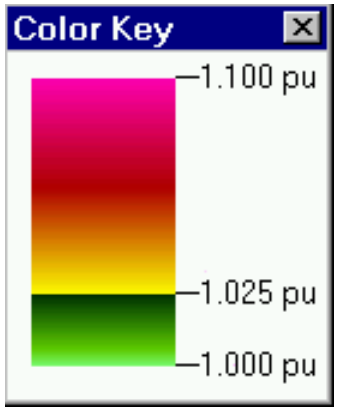


Reverse Colors
To get this

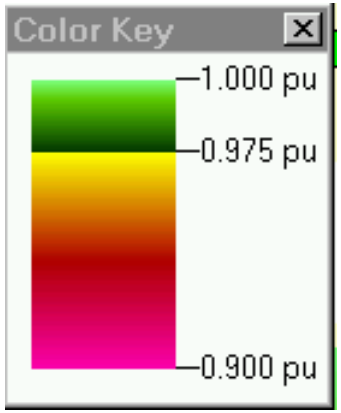


Color Maps

- For contours for which only high values are significant, Radar Map High Limits is recommended

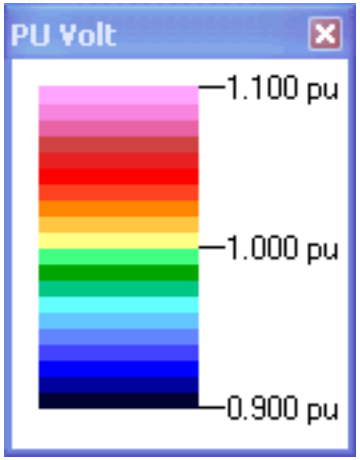


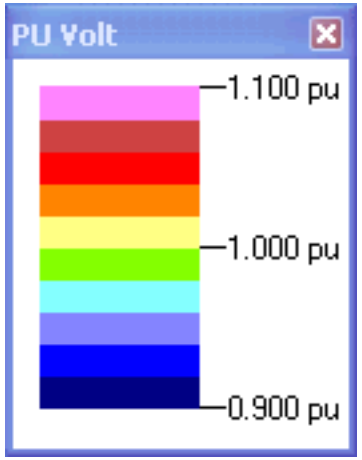
- For contours for which only low values are significant, Radar Map Low Limits is recommended

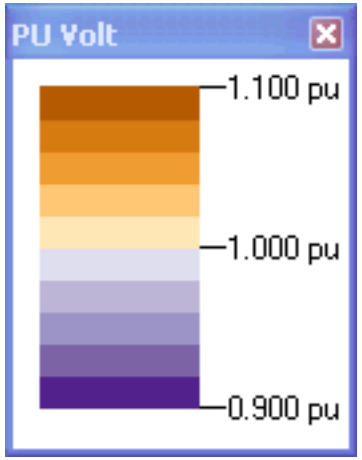


Discrete Color Maps

- Simulator also comes with several discrete color maps.
- Some examples are shown below.

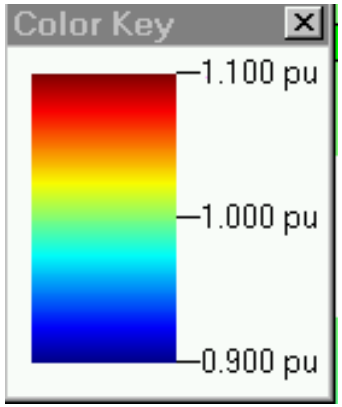






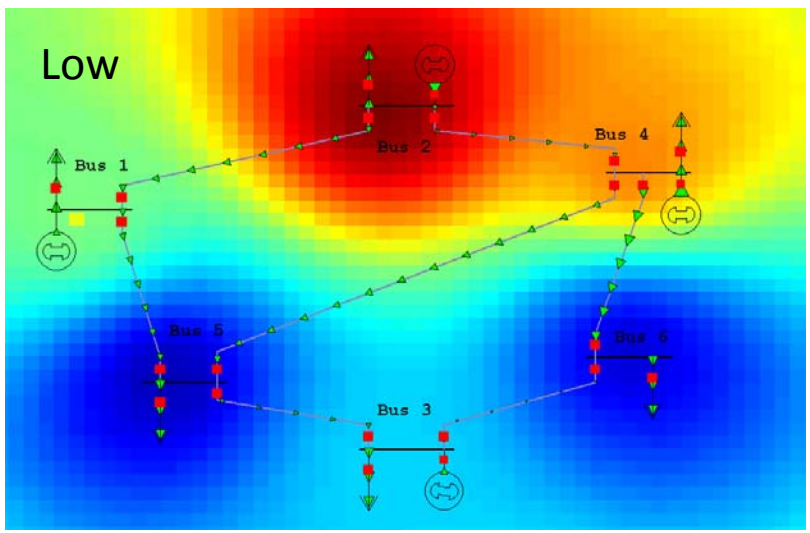
Draw Color Key

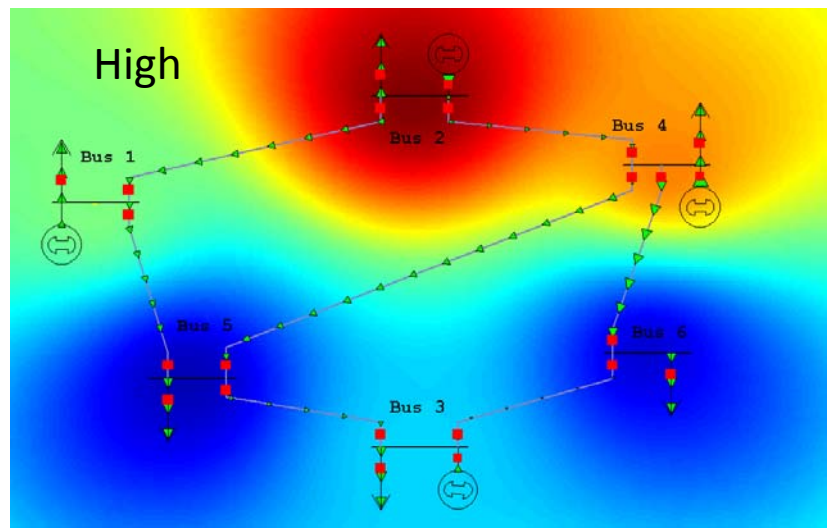
- Checking Draw Color Key tells Simulator to draw a “color key dialog” along with the contour
- The color key dialog looks like:



Contour Resolution

- Sets the resolution of the contour
- High means a better picture with more computation time required
- Low means a “grainy” picture with less computation time

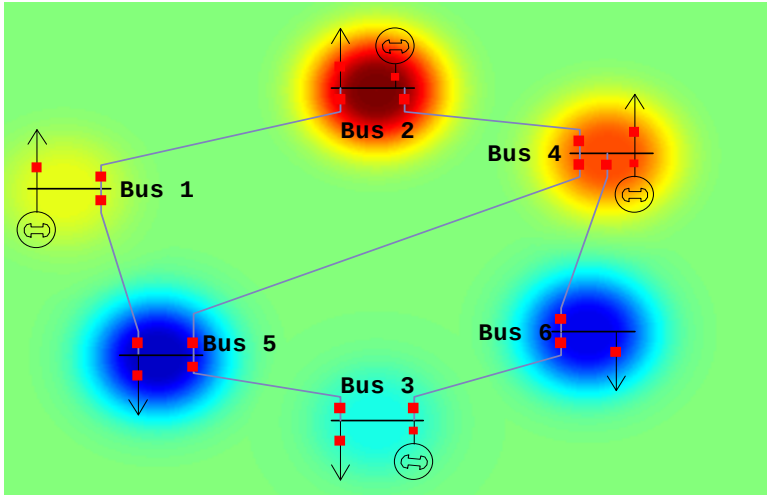




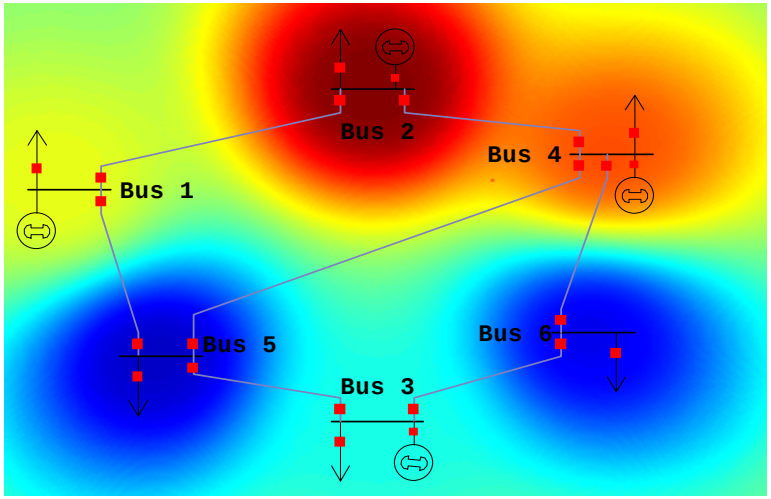
Influence Region

- Controls how large the “influence distance” is for a data point.

Influence Region Small



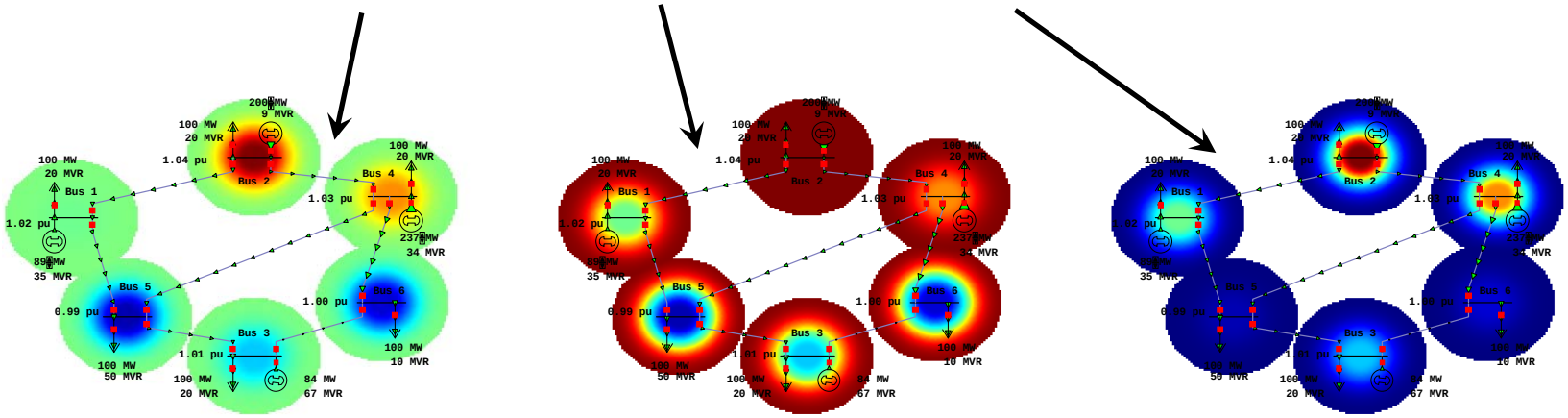
Influence Region Large



Note: These images are using the **Fade To Value**

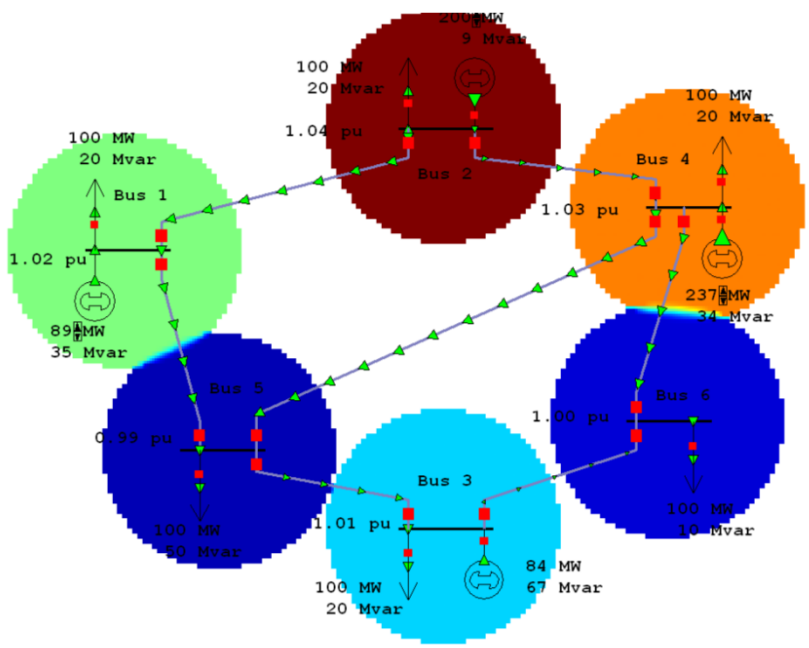
Fade To Value

- As a value's influence moves away from the actual data point, the value "fades" to a user-specified value.
  - The same data is contoured in the figures below with different Fade To Values
  - Nominal, Maximum, Minimum



Use Fade To Value

- Uncheck the **Use Fade To Value**
  - Same picture as previous slide but we are no longer *fading*

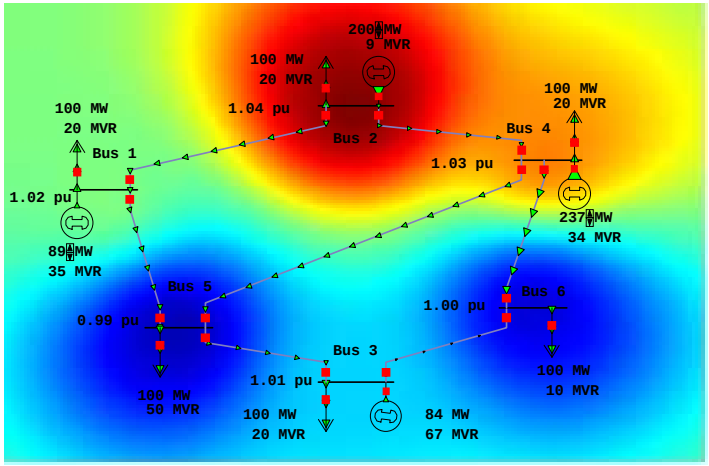


Kind of Value: Actual Value

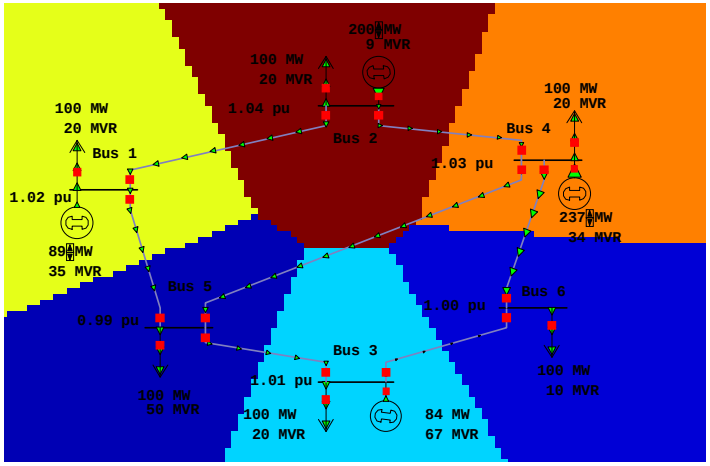
Contour 6 Bus.pwb

- Actual Value (Weighted Average) and Actual Value (Only Closest) both attempt to visualize the values of particular points.

Weighted Average creates a gradient by weighting colors by their distance from data points



Only Closest creates a color based only on the value of the closest data point



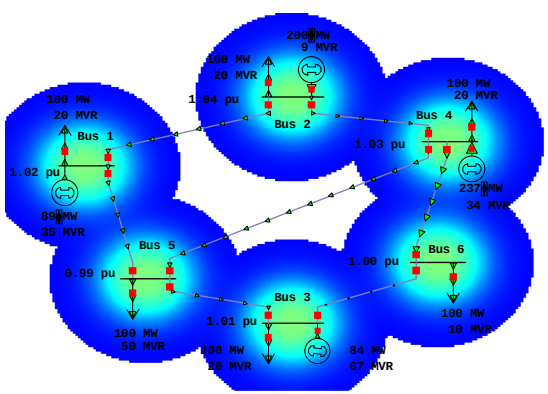
Kind of Value: Density of Values

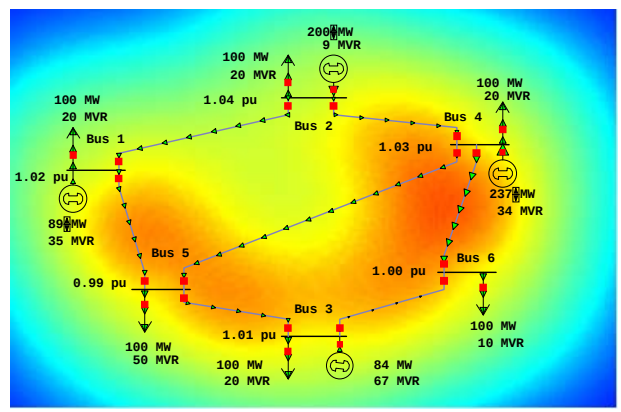
- Density of Values causes the colors on the contour to represent a Weighted Sum
- Useful when you want the following two situations to be equivalent
  - 1 bus with 600 MW of load
  - 6 buses next to each other with 100 MW of load each

Contour 6 Bus.pwb

Kind of Value: Density of Values

- When using this option, the Influence Region has a great impact on the contour image created
  - Increasing the Influence Region, will cause the "sum" to be taken over a larger number of data points which will increase the values shown in the contour.

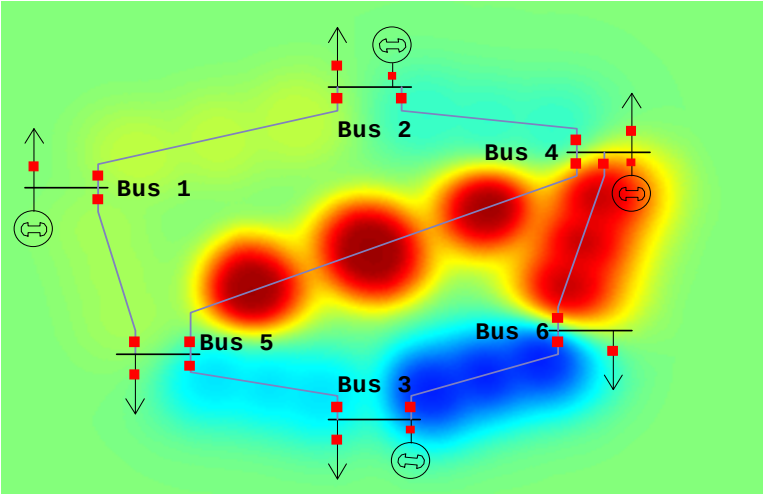




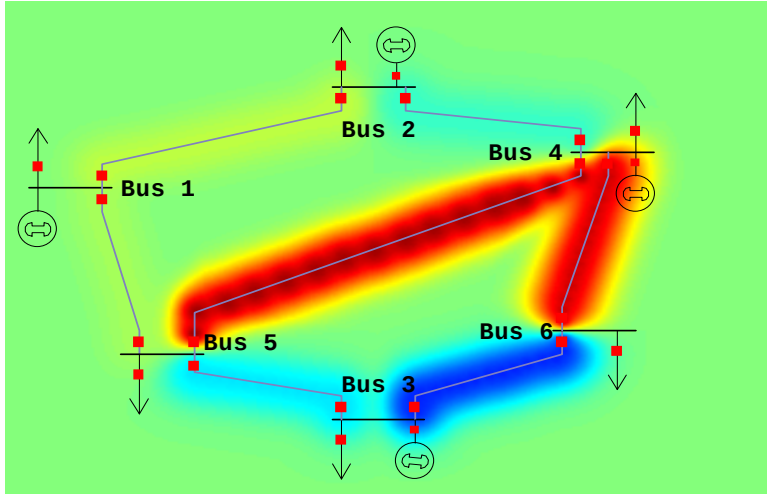
Data Points Per Line

- Specifies the number of points used to represent a line in the contour algorithm

Data Points Per Line = 3



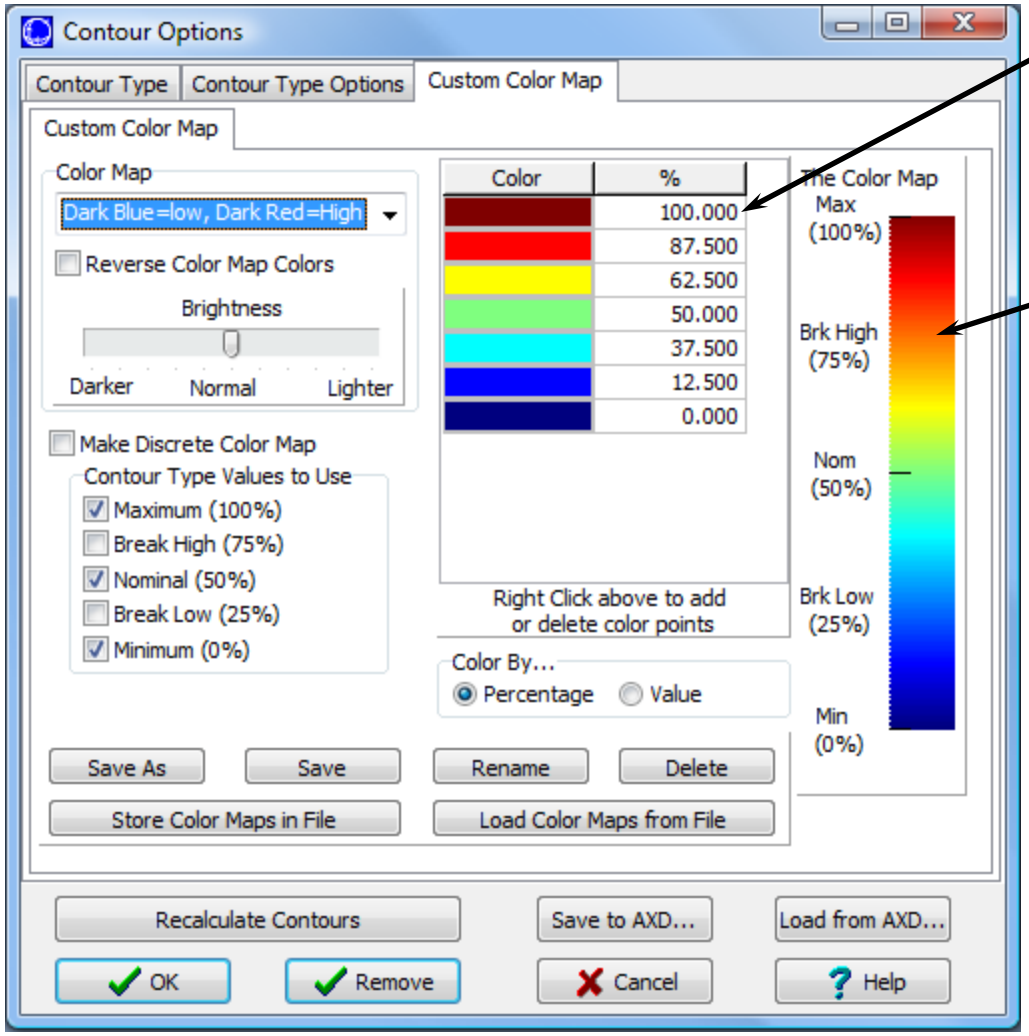
Data Points Per Line = 15



Continuously Update Contours

- Sets Simulator to regenerate a contour each time the system is updated.
- You can animate the contour by checking this
- Note: Because Simulator must now calculate the contour at each time step, this may slow down the simulation
  - Try reducing the resolution to speed up the animation

Custom Color Maps



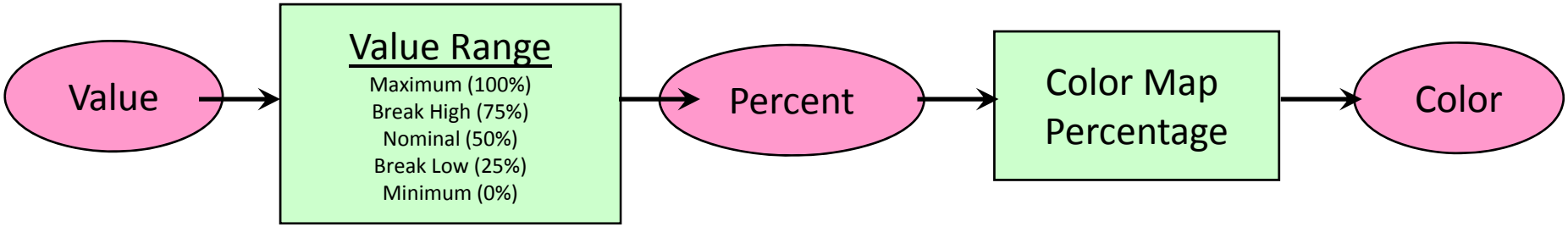
Set range of color map

Shows custom color map as changes are made

Create custom color maps designed to show any contoured values highlighted in a specific manner

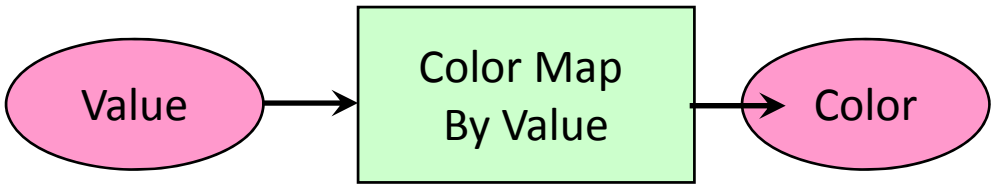
Color By… Percentage

- Color by Percentage takes the Value and maps it to a Percentage using the Maximum,… Minimum Values specified on the first tab
  - The percentage is then mapped to a color using the Color Map
  - Advantage: Color Maps can be reused
    - Bus Per Unit Voltage, Marginal Cost, anything can use same
  - Disadvantage: You can only specify 5 values that map to specific colors



Color By…
Value

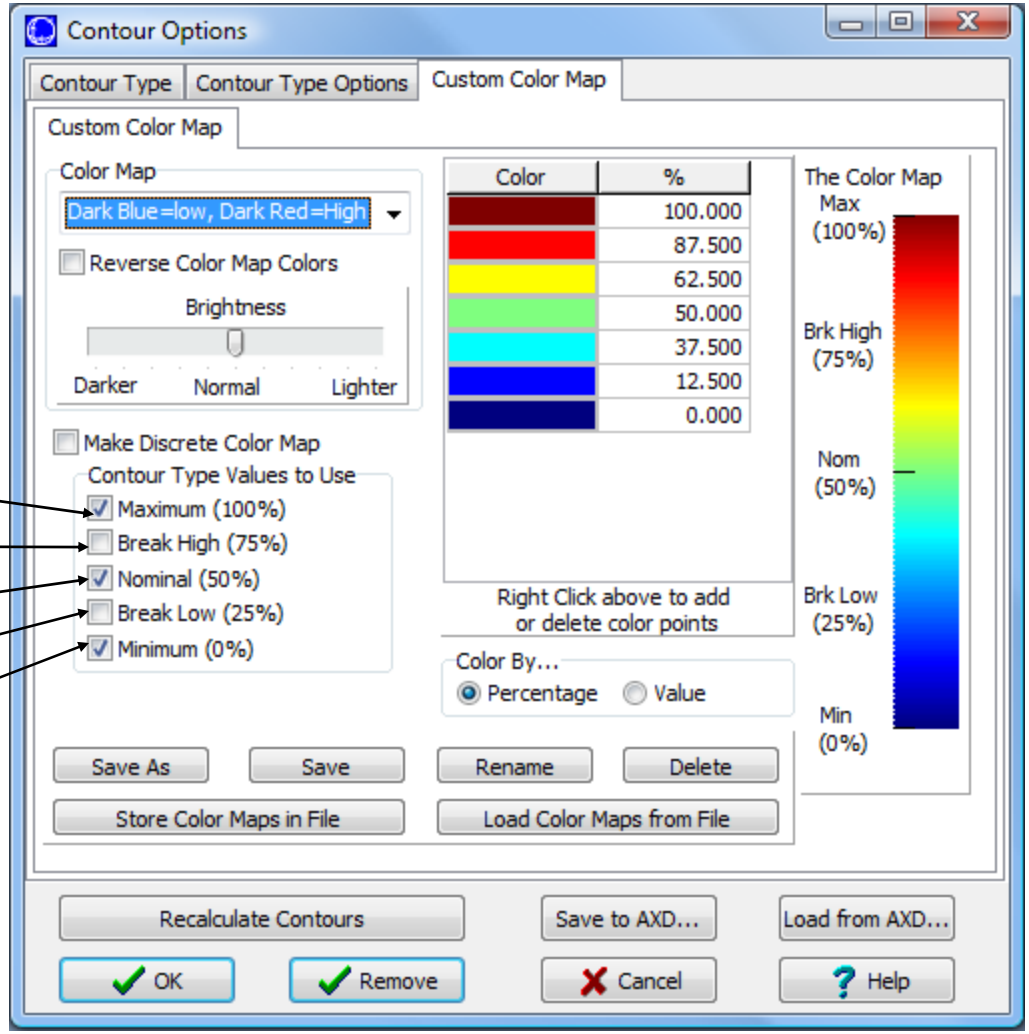
- Color By Value removes the intermediate percentage
  - Value is mapped directly to Color using the Color Map
  - Advantage: You can be more precise with your coloring
    - You want to color bus objects by AREA Number using 20 specific colors
  - Disadvantage: You can't easily reuse the Color Map.



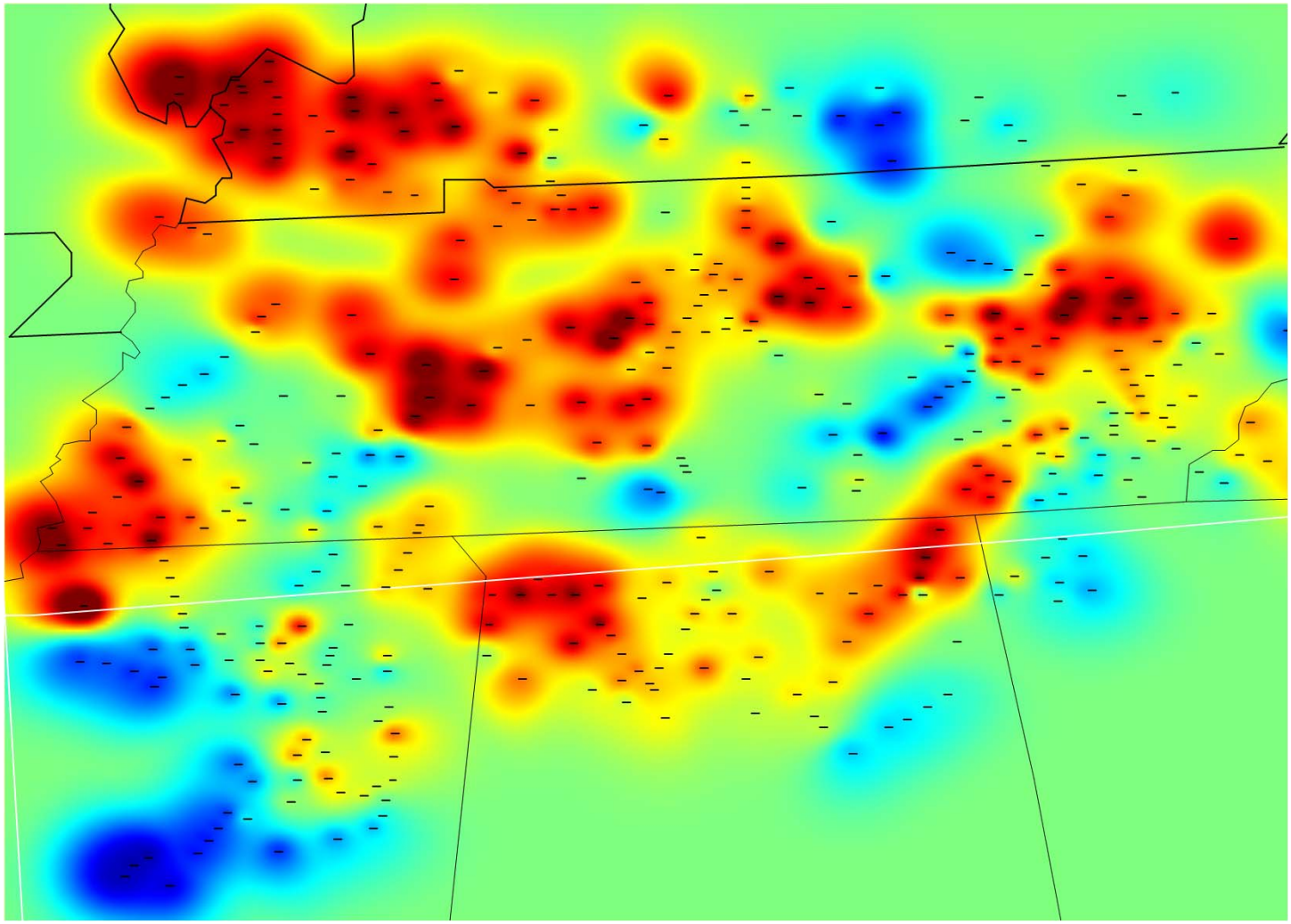
Defining the Color Map

- "Percentages" map to values defined on Contour Type Tab.

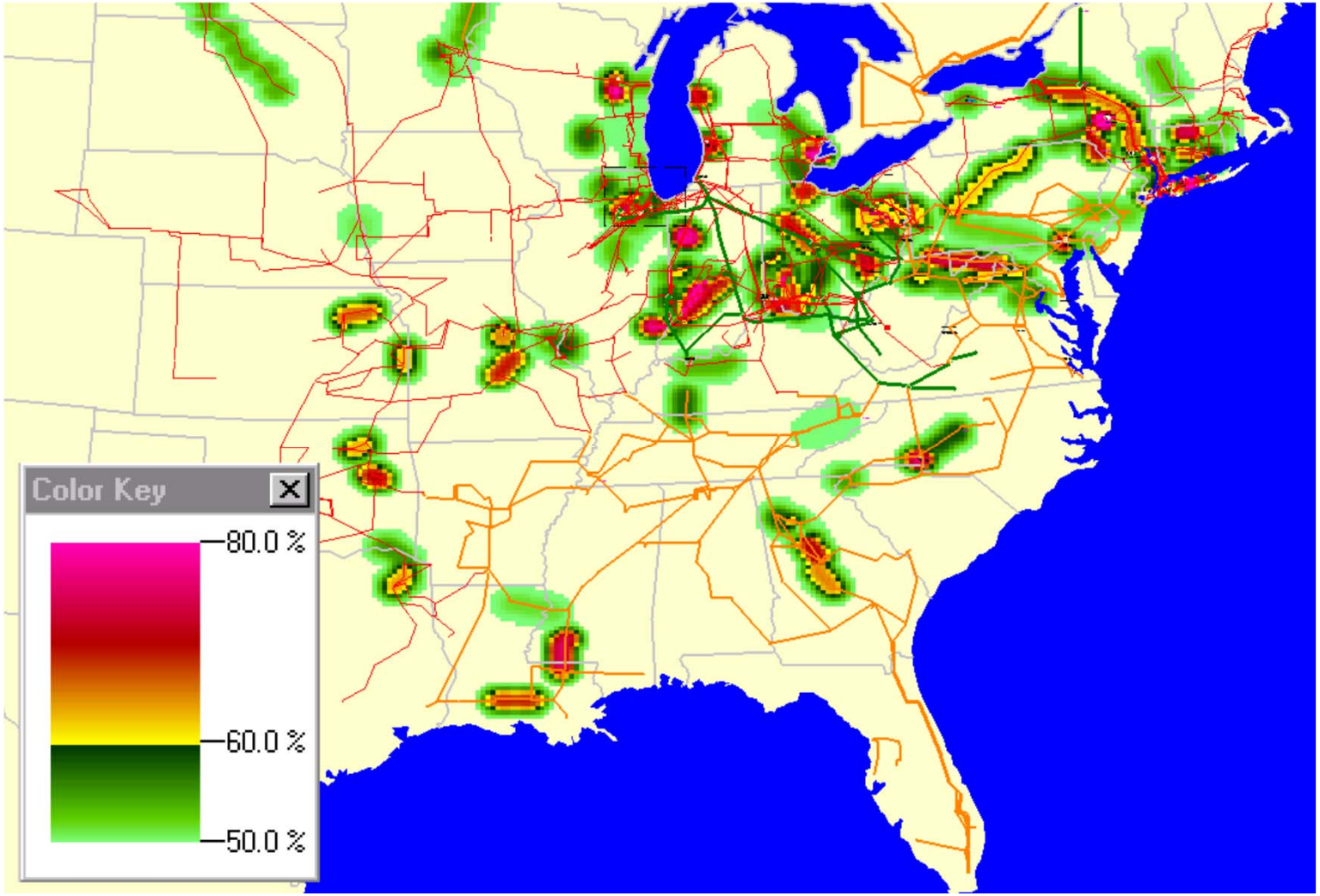
Abs Max = 100%
Lim Max = 75%
Nominal = 50%
Lim Min = 25%
Abs Min = 0%



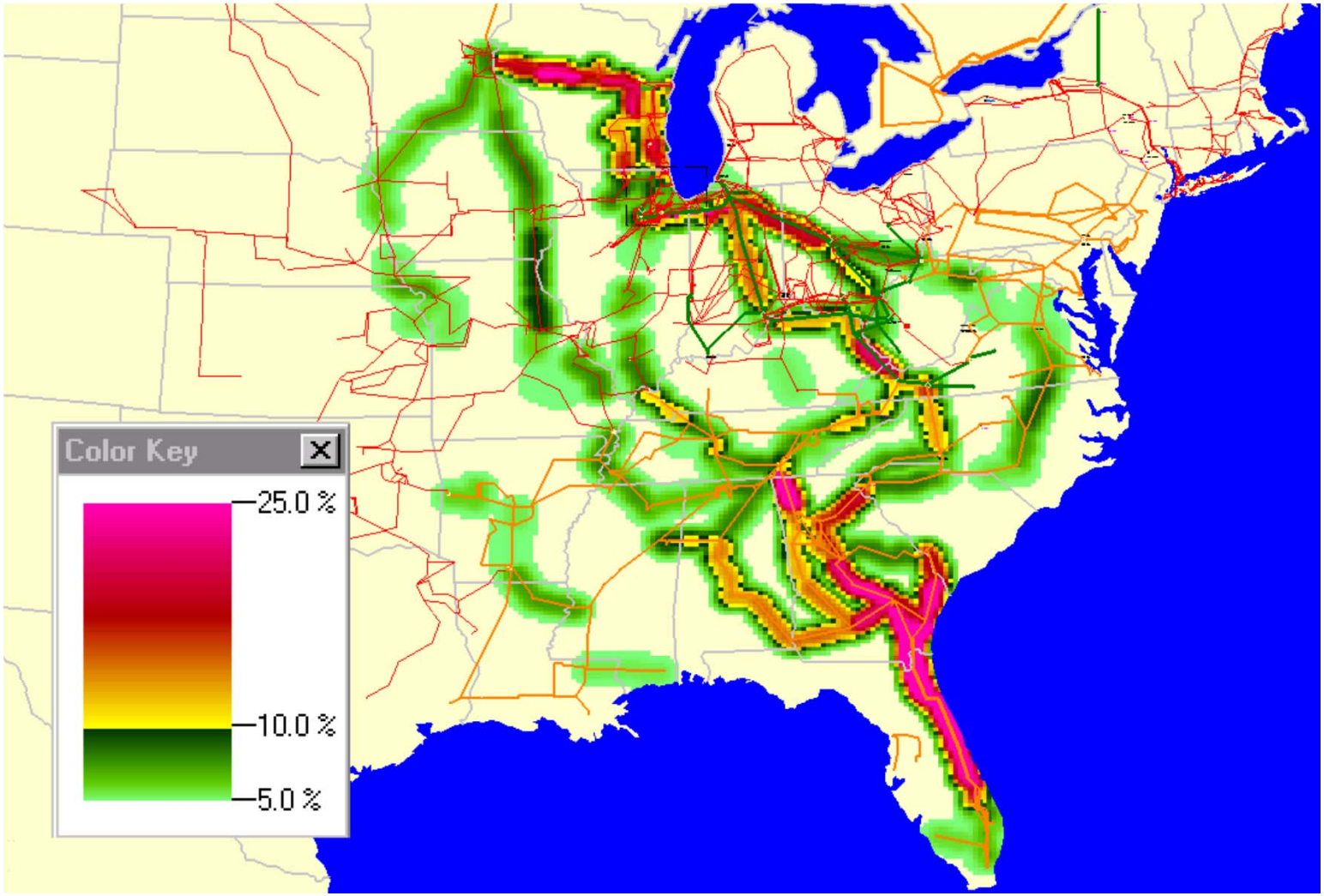
Bus Voltages in TVA at 161 kV



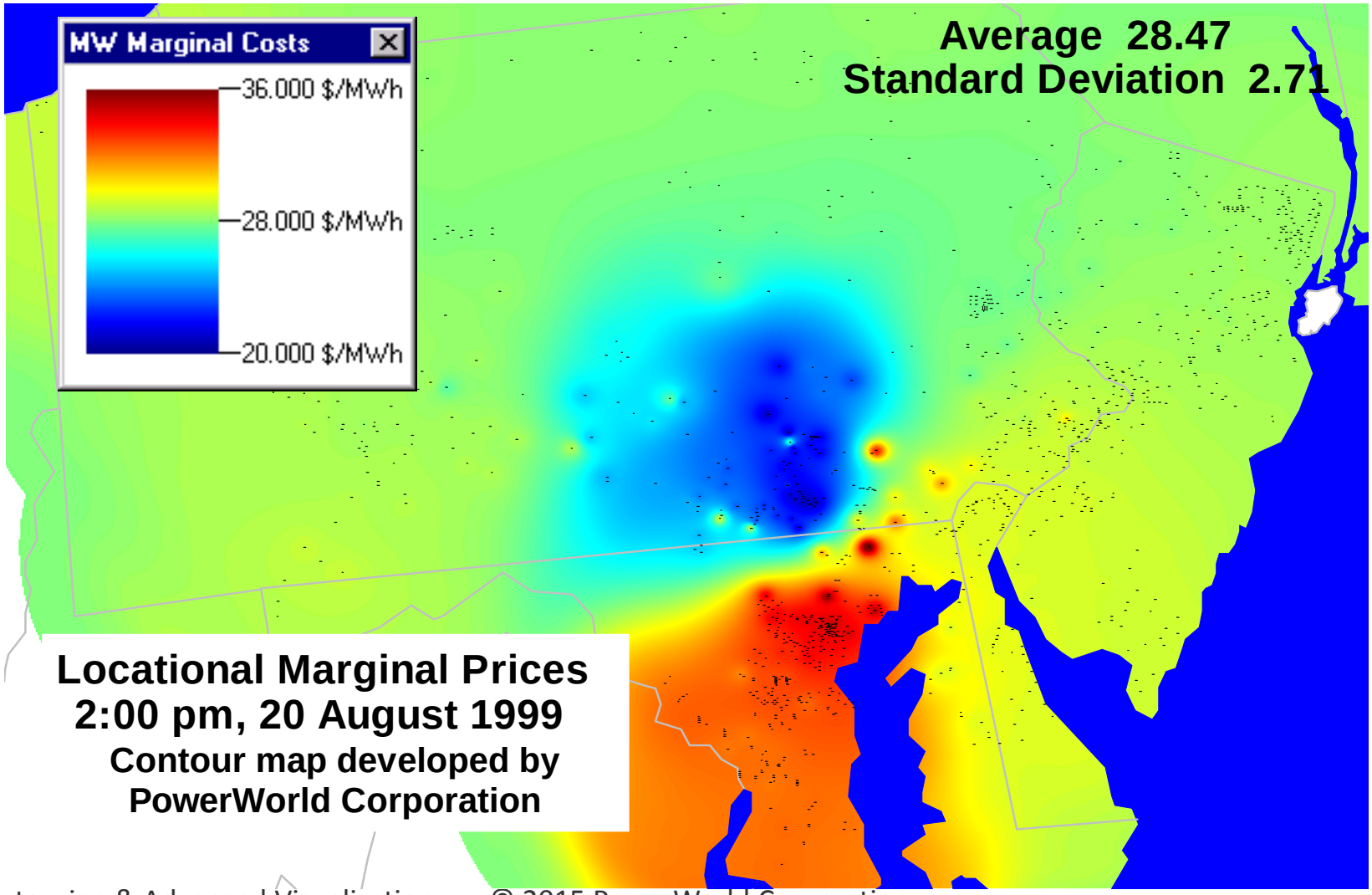
Line MVA Flow Percentage in the Eastern Interconnection



Power Transfer Distribution Factors (PTDFs)



Marginal Prices in PJM for 2:00 PM on August 20, 1999



Recommendations for Contouring

- Task-specific displays
  - Make your onelines so that they only convey one idea
  - For instance, don’t show line pie charts on a bus voltage display. This creates clutter.

Voltage Contouring

- Sometimes run into strange contours due to LTCs.
- To avoid this, create onelines that only have one voltage level's buses displayed
  - Can create a different oneline for each voltage level if desired

Demo Only

Geographic Data Views

- Allow quick creation and formatting of graphical representations of devices
  - Buses, generators, loads, switched shunts, transmission lines, substations, areas, zones, super areas, and injection groups
- Longitude and latitude coordinates must be specified with bus and/or substation records to place objects geographically on a display

Demo Only

Geographic Data Views

- Data field values used to format objects based on different attributes
  - Line Thickness, Line Color, Fill Color, Total Area, Rotation Angle, Rotation Rate, Visibility

- Options for creating available from the Case Information Toolbar under the **Geo** menu
- Geographic data view objects can be added to existing or new onelines

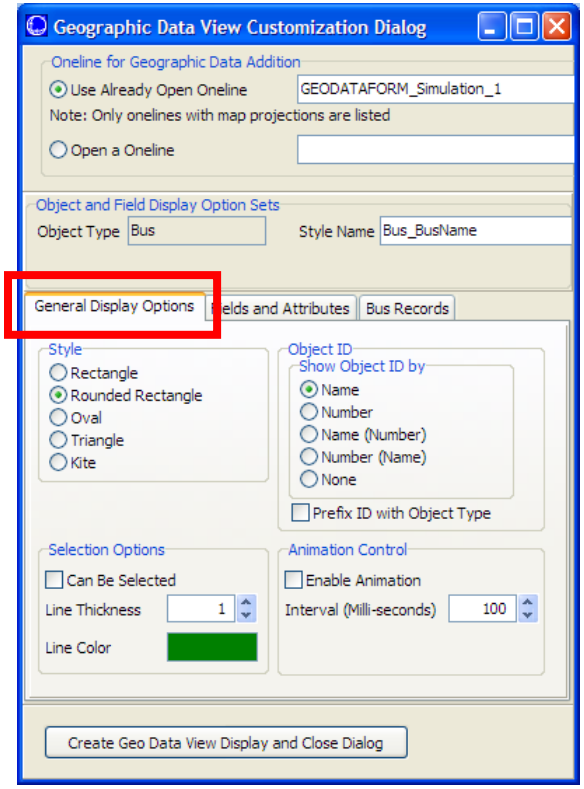
Demo Only

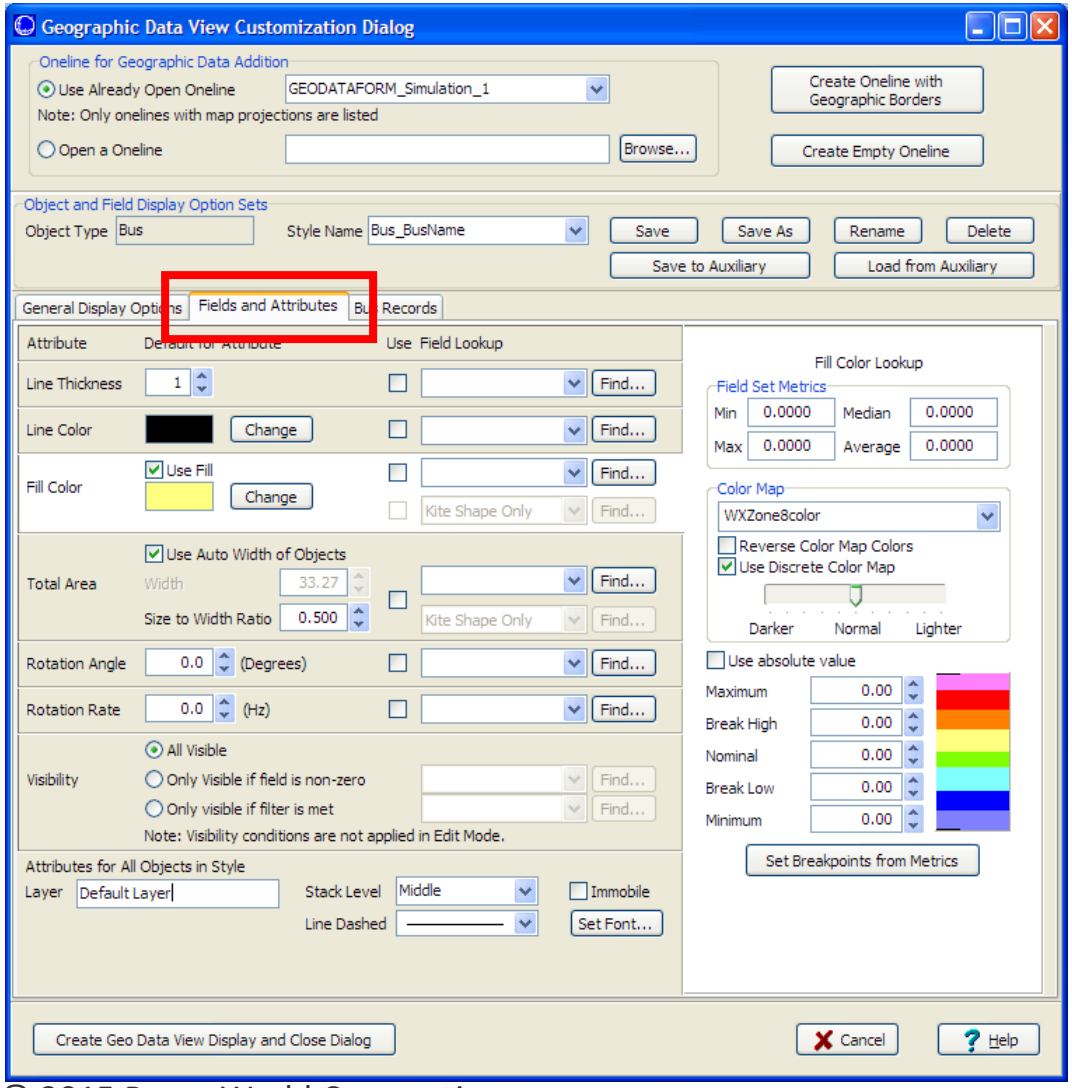
Geographic Data Views

- Geographic Data View Styles contain the set of options that dictate how a Geographic Data View object will look
  - Multiple objects will use the same style
  - Styles are dependent on the type of object being displayed

Demo Only

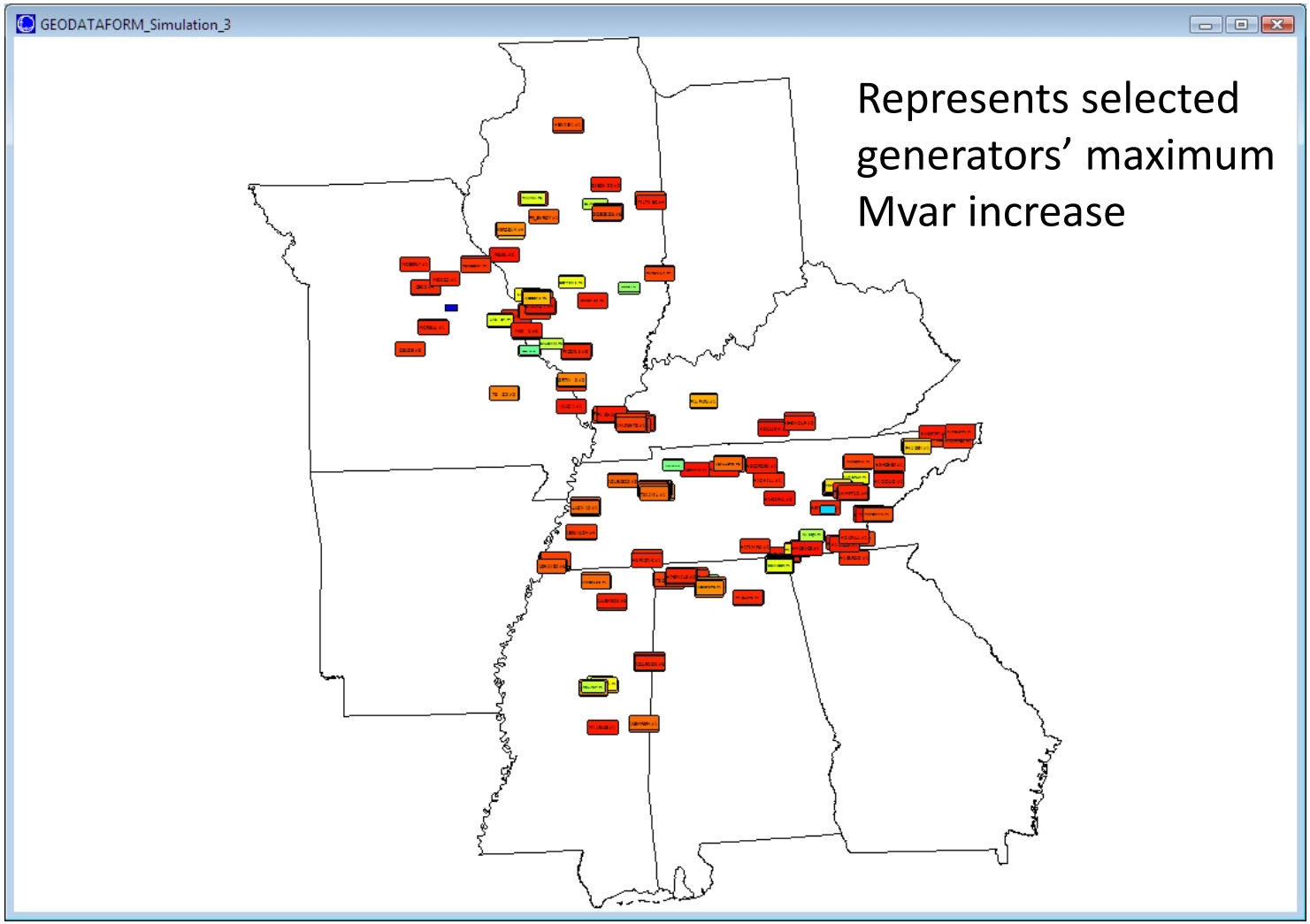
Geographic Data Views: Customization Dialog





Demo Only

Geographic Data Views



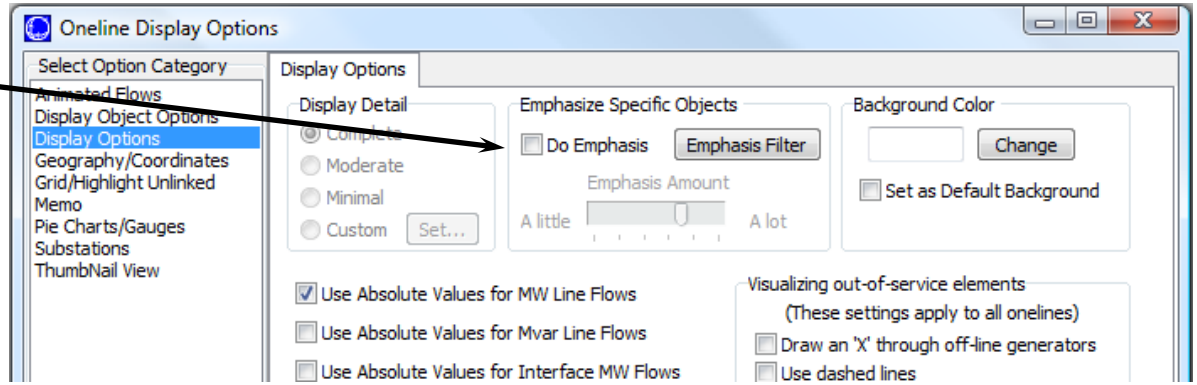
Demo Only

Emphasis of Display Objects

Demo Only

Emphasis of Display Objects

- Emphasis of Display Objects
  - Make specific objects standout on your oneline
  - Builds on the Select by Criteria abilities
  - Combines this with the use of graphical *alpha blending* which merges two images together
  - To get to this
    - Go to the **Options** ribbon tab and select **Oneline Display Options** and click **Emphasis Filter** on **Display Options** page



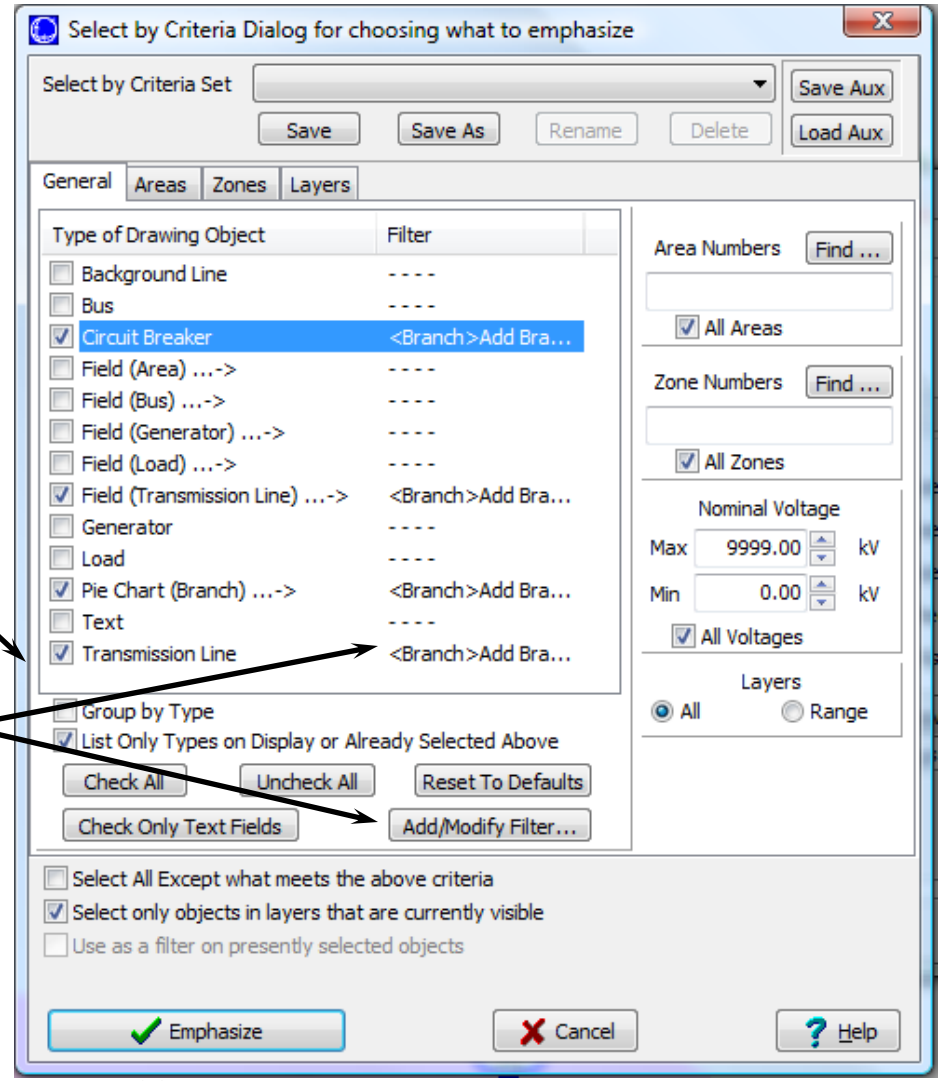
Demo Only

Select by Criteria Dialog for choosing what to emphasize

- Selecting what to emphasize works just like Select by Criteria

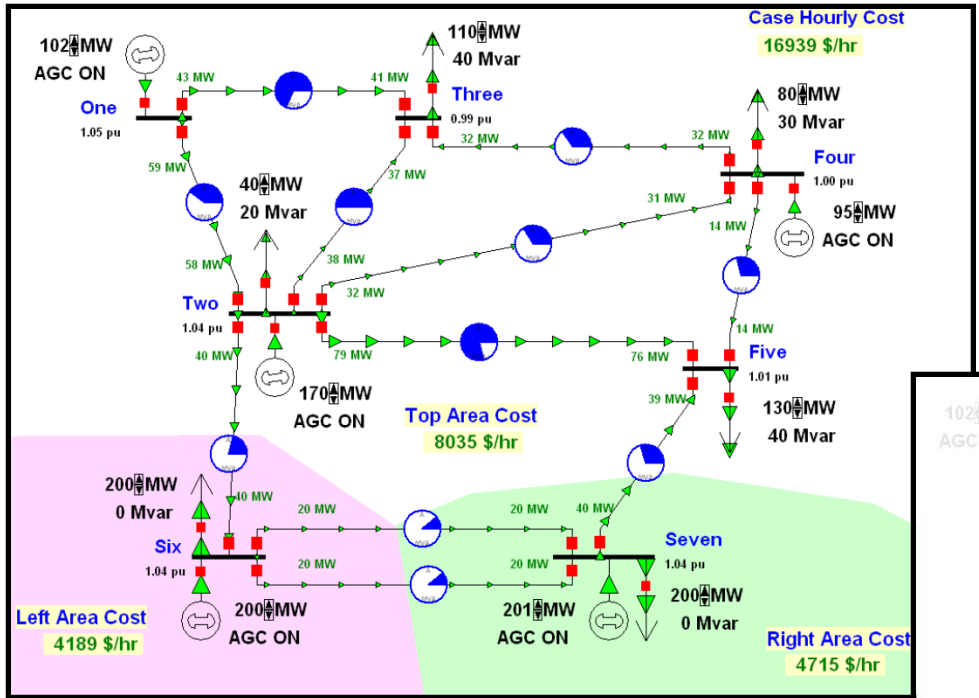
Choose all Transmission Line Objects

Click Add/Modify Filter to define an Advanced Filter called *Add Branches >50%*

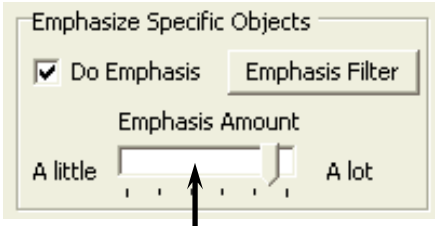


Demo Only

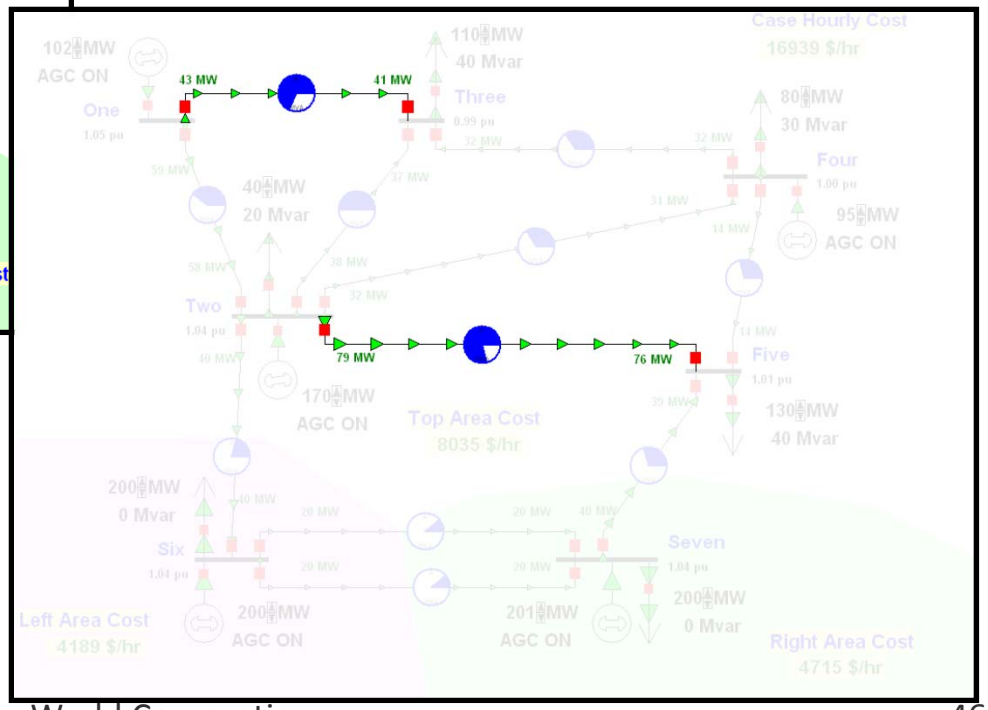
Example image using the b7flat.pwb case and diagram



Lines above 50% loading are emphasized



Vary the amount of emphasis



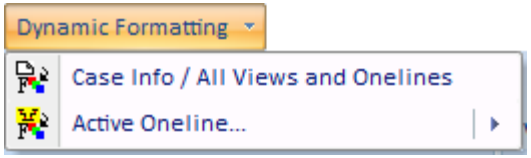
Demo Only

Dynamic Formatting

Demo Only

Dynamic Formatting

- Allows for Conditional Dynamic Formatting of Onelines and Case Information Displays
- Builds on existing features: Select by Criteria AND Advanced Filtering
- Go to the **Onelines** ribbon tab and select **Dynamic Formatting**, then pick which of the two levels of formatting you want
  - With the Case: **Case Info / All Views and Onelines**
    - Can apply to case information displays, bus views, sub views, and ALL onelines
  - With Individual Oneline: **Active Oneline**
    - Will apply to only a single oneline



Demo Only

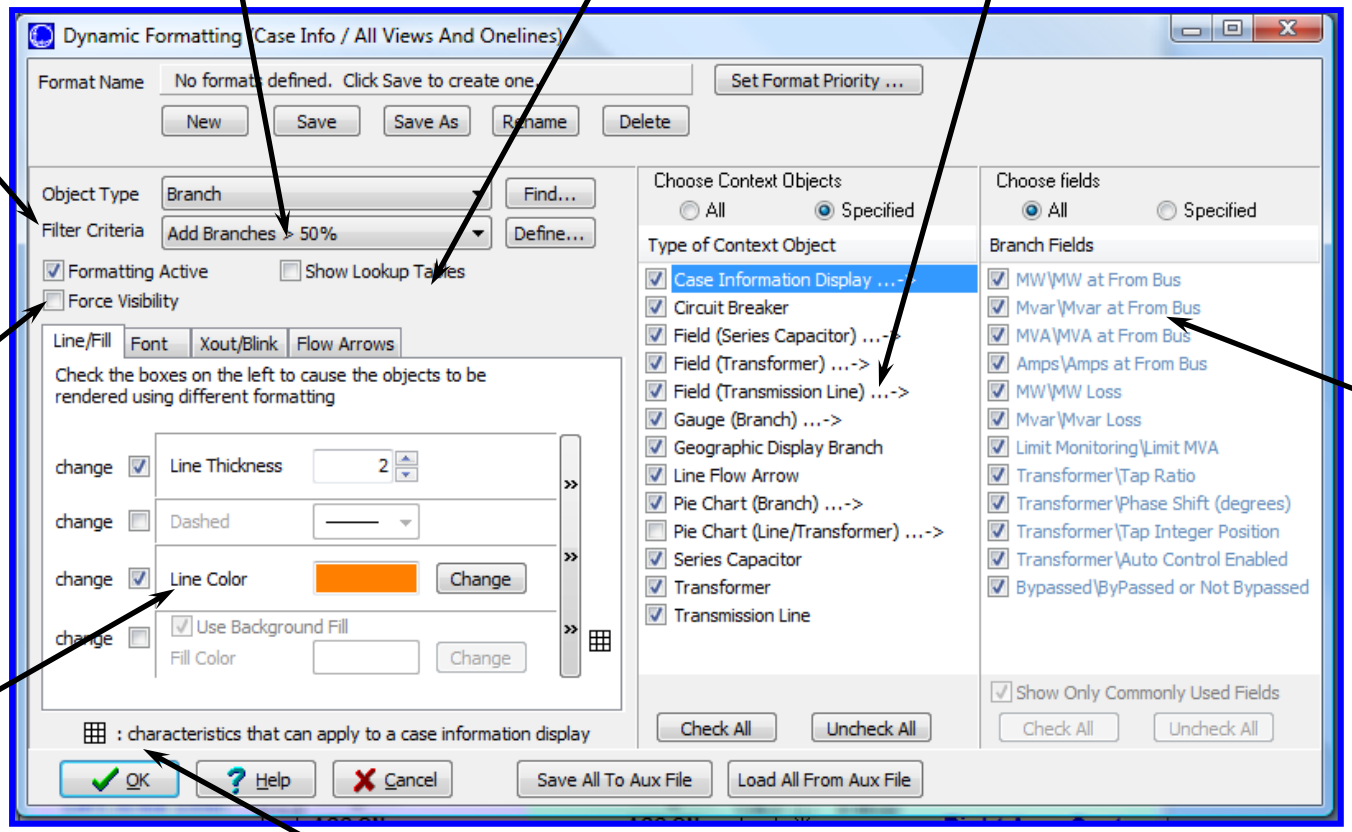
Dynamic Formatting Dialog: Case Info / All Views And Onelines

Choose Object Type

Choose an Advanced Filter

Choose the screen objects this should apply to→or case information

Temporarily make the formatting not active



You can also FORCE an object to be visible

Choose Format Attributes

Choose Fields to apply to for some kinds of objects

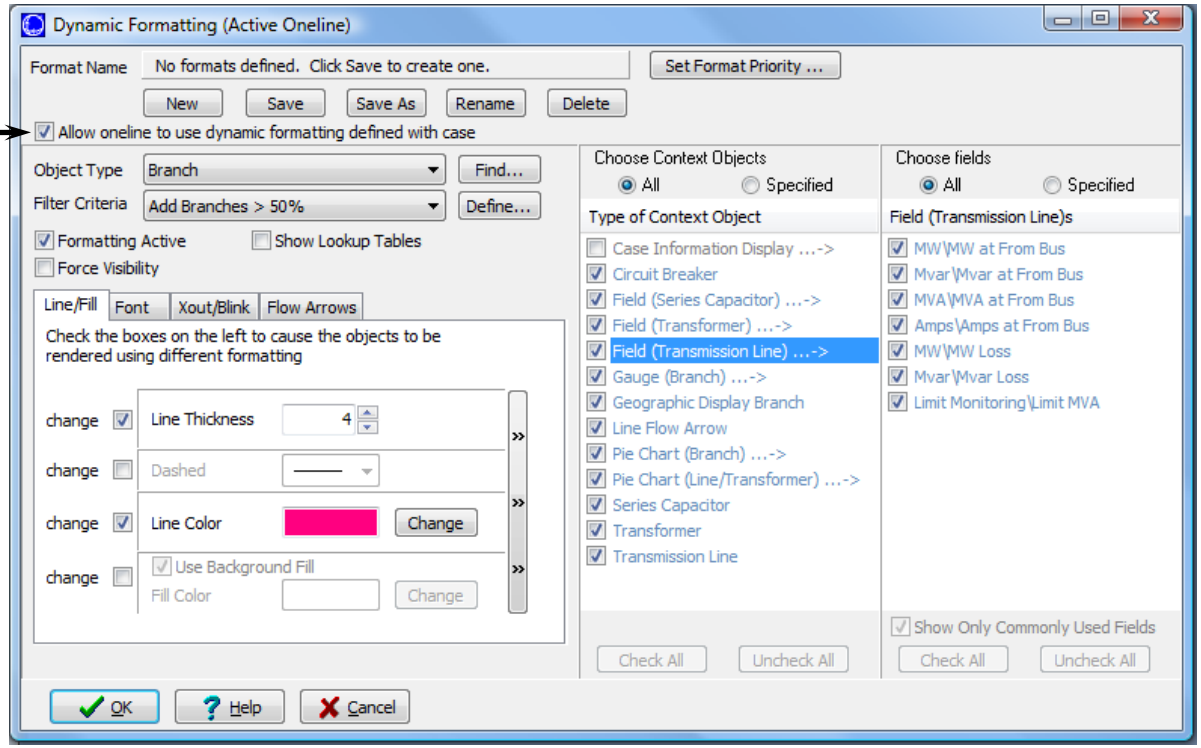
Only some attributes apply to case information displays

Demo Only

Dynamic Formatting Dialog: Active Oneline

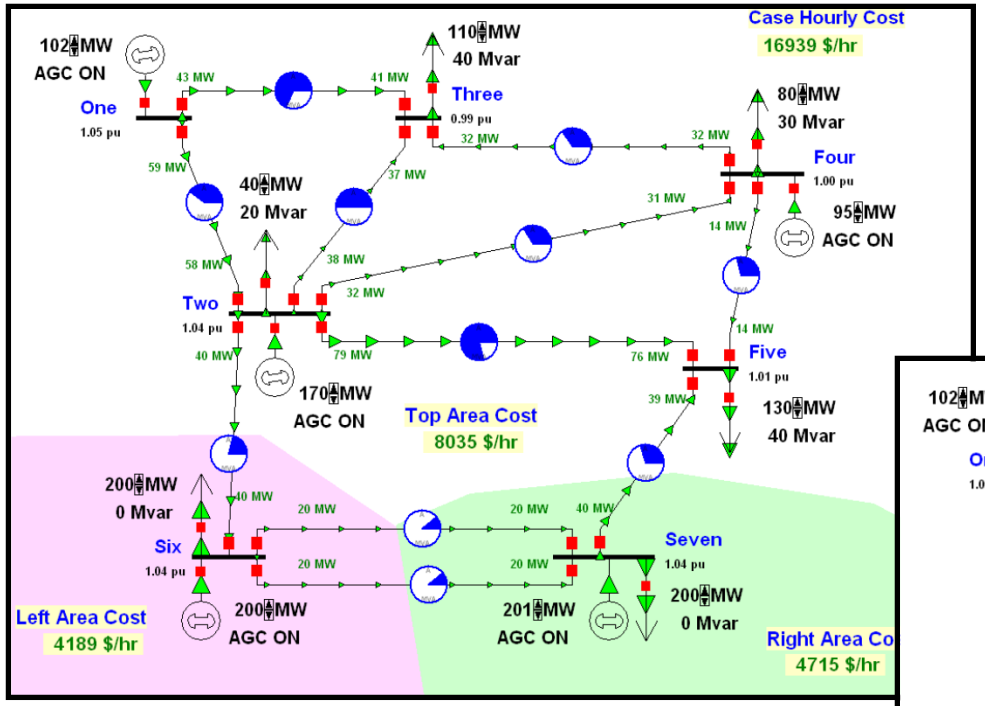
- For an active oneline formatting, it's the same, except that it only applies to this oneline

Specify whether the oneline makes use of the dynamic formatting defined with the case

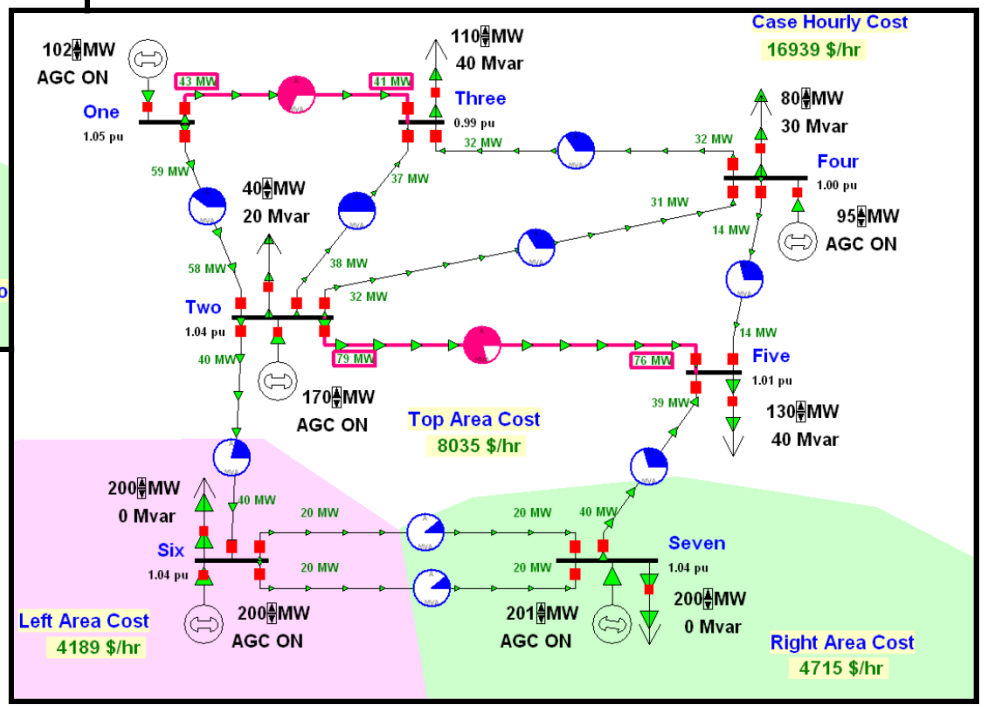


Demo Only

Example Formatting of Lines Loaded above 50% in Pink

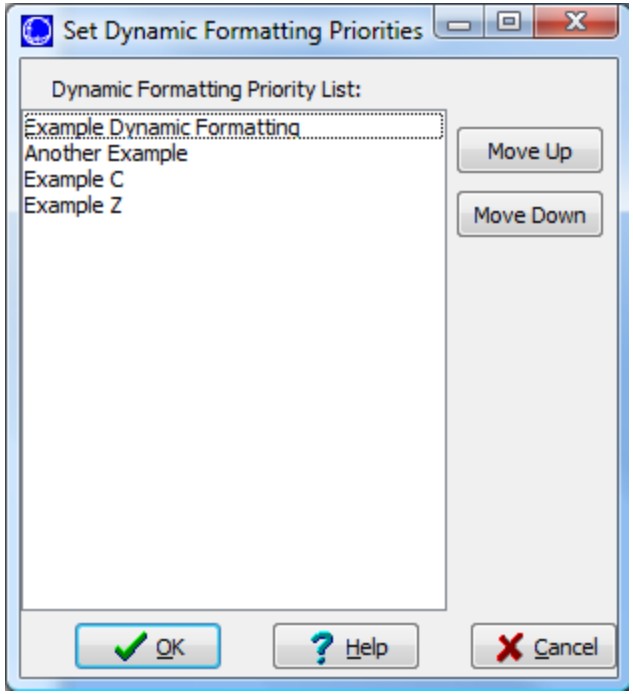


Lines above 50% loading are thick and pink



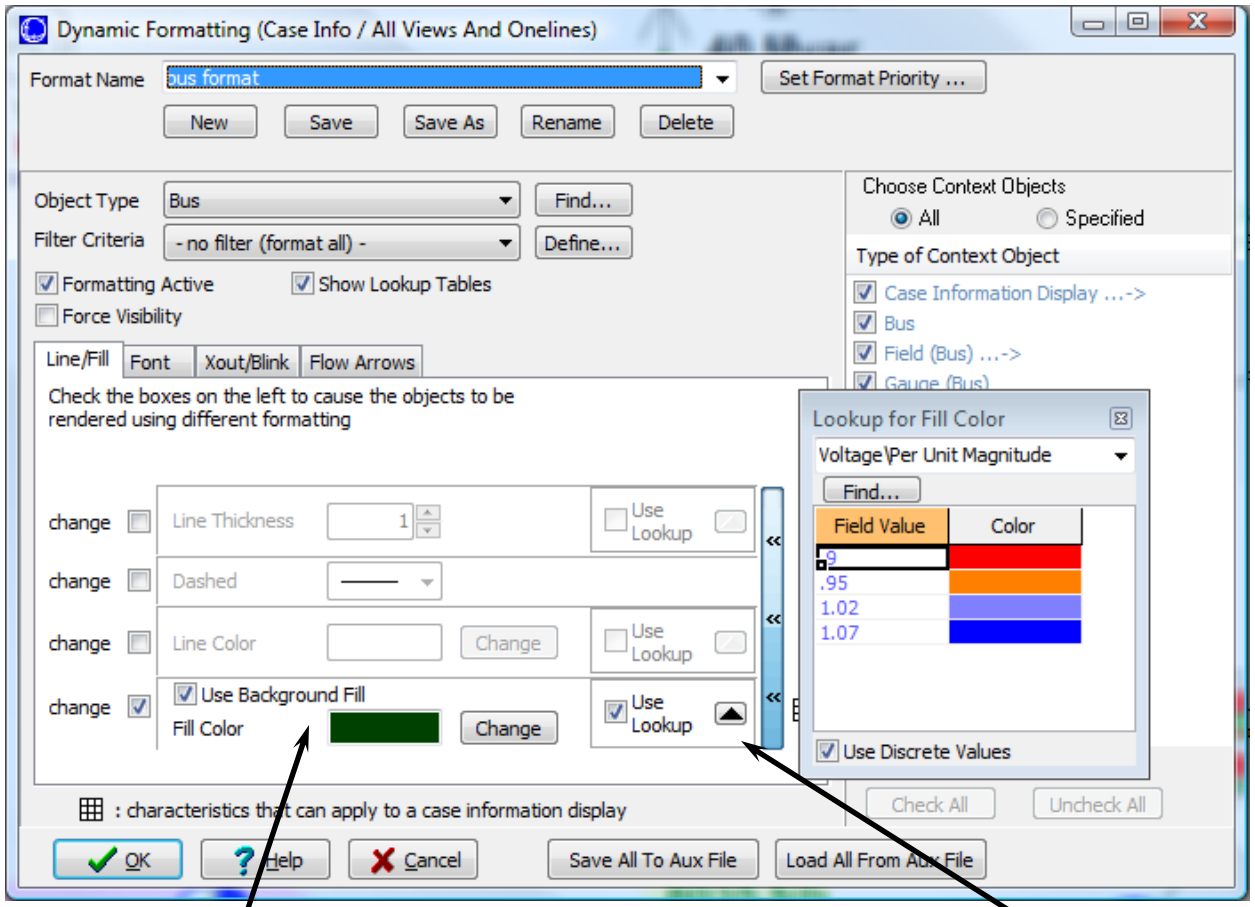
Dynamic Formatting Priority

- You can specify several dynamic formatting choices.
- It is possible that they will “conflict” with one another.
- A priority must be specified.
  - Specific oneline dynamic formats always have priority over case dynamic formats
  - Within the individual class, you must click the Set Format Priority… Button to give a priority order.



Demo Only

Dynamic Formatting Lookup Tables



Lookup tables allow the definition of a table of field values and corresponding characteristic values. For this example, bus object line color will change based on the value of the per unit voltage magnitude.

Color if field value is less than the lowest defined value in the table

Must check Use Lookup

Demo Only

Geographic Information System (GIS) Support

Demo Only

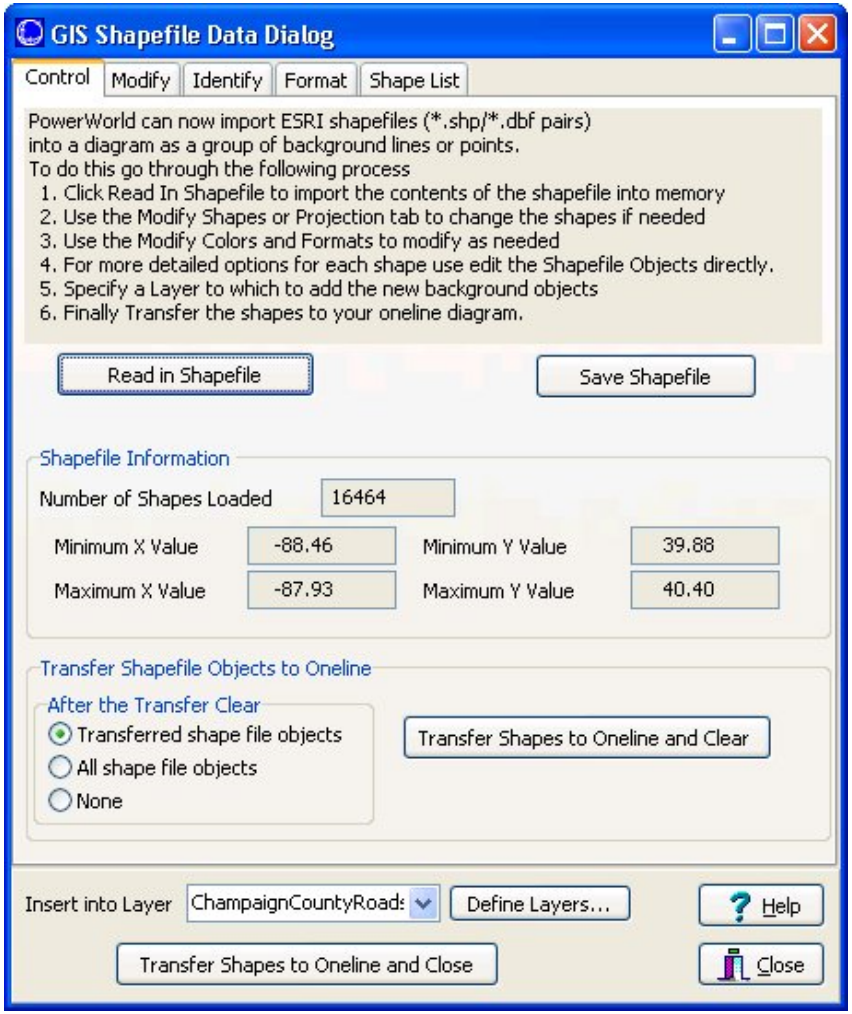
Geographic Information System Support

- Geographic Information System (GIS) Support
  - Reading ESRI Shapefiles (*.shp/*.dbf/*.shx groups)
    - To open a shapefile go to the **Onelines** ribbon tab and select **GIS Tools → Insert GIS Data from Shapefile**
  - Additional options under **Onelines → GIS Tools**

Demo Only

GIS Shapefile Data Dialog: Control Tab

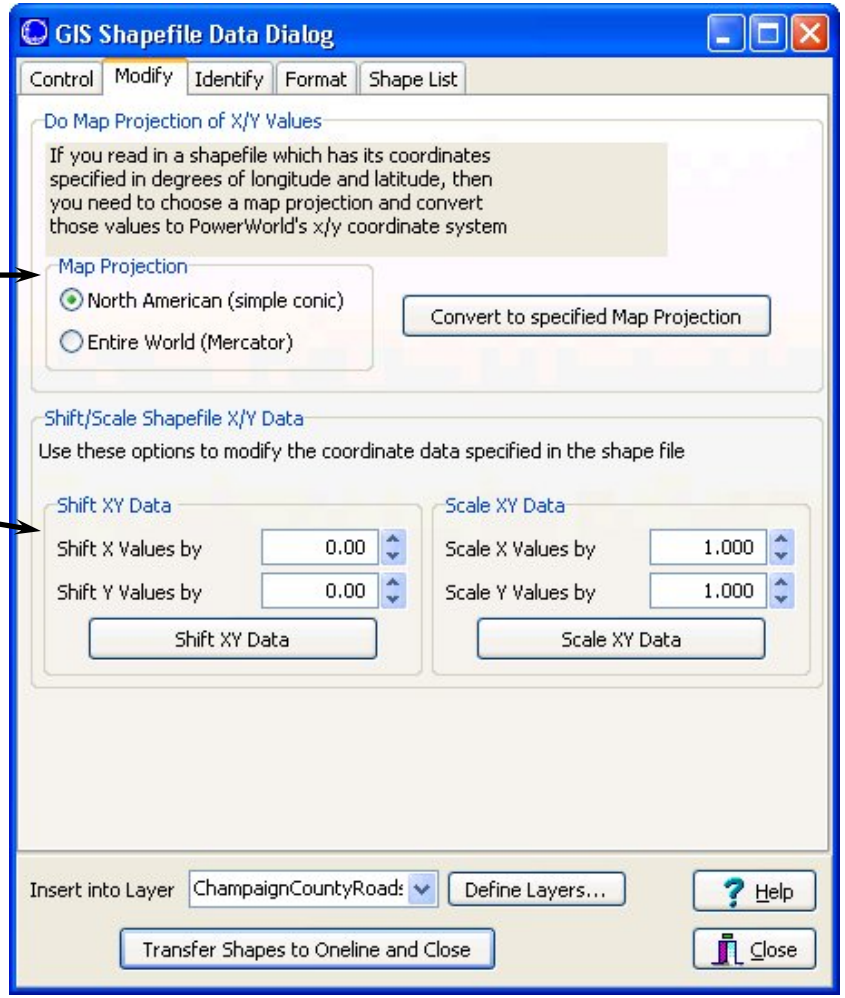
- Click on **Read in Shapefile** to import the Shapefile contents into Memory
- Use the **Modify** tab to modify the x/y coordinate of shapes
- Use the **Identify** tab to assign identifier for display auxiliary files and link supplemental data
- Use **Format** tab to modify the colors and format of the shapes
- **Shape List** tab lists all of the objects in the file and their corresponding attributes
- Click **Transfer Shapes to Oneline…** to place shapes on the oneline



Demo Only

GIS Shapefile Data Dialog: Modify Tab

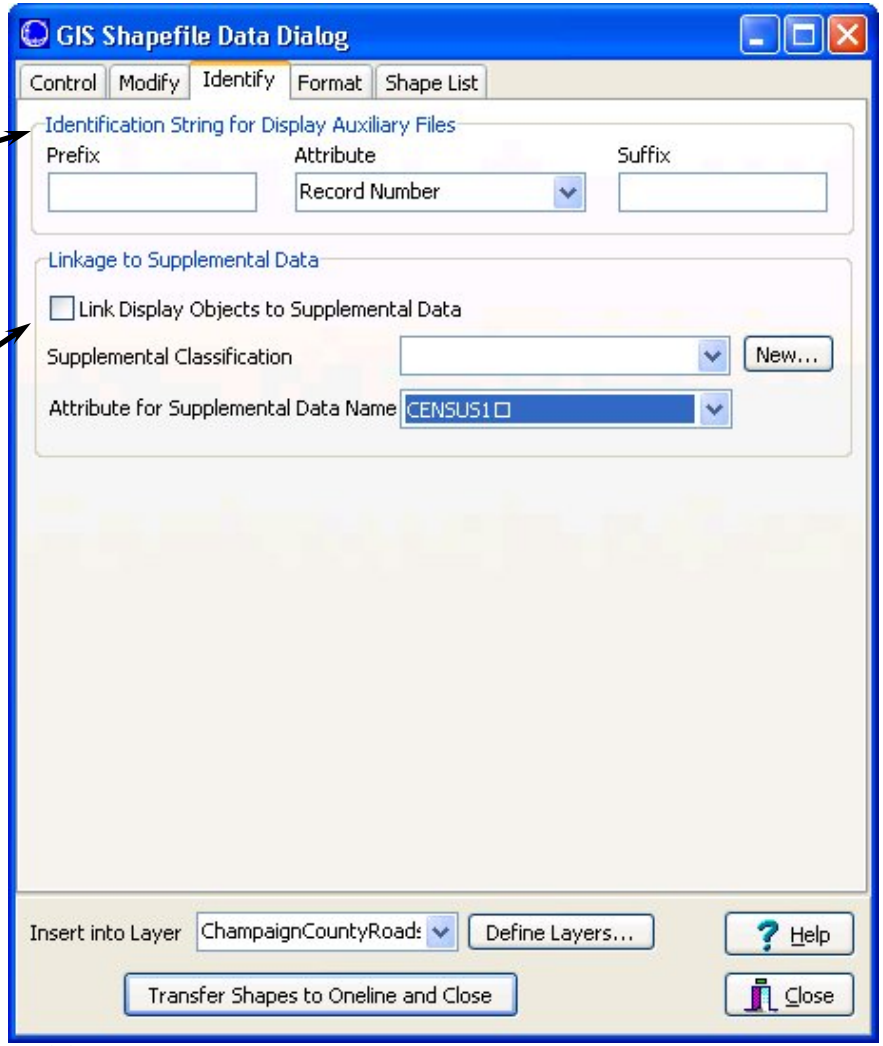
- If Shapefile is specified in Longitude/Latitude Coordinates, Convert to a map projection
- You may also modify the XY data by shifting or scaling it.



Demo Only

GIS Shapefile Data Dialog: Identify Tab

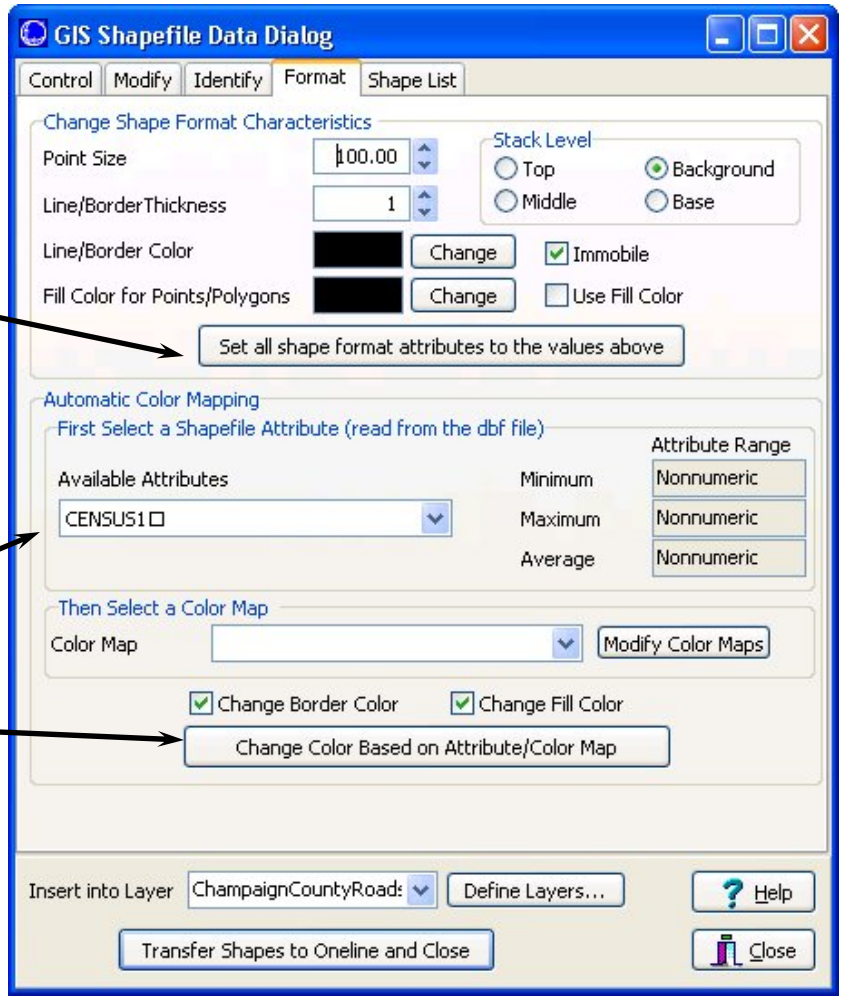
- Specify identifying string to use for uniquely identifying objects in display auxiliary file
- Link to supplemental data to provide identification for filtering, dynamic formatting, Select by Criteria, and custom hints



Demo Only

GIS Shapefile Data Dialog: Format Tab

- Modify the format of all the objects by choosing new attributes and clicking the button
- You may color using a Color Map if one of the data columns from the *.dbf file can be mapped accordingly



Demo Only

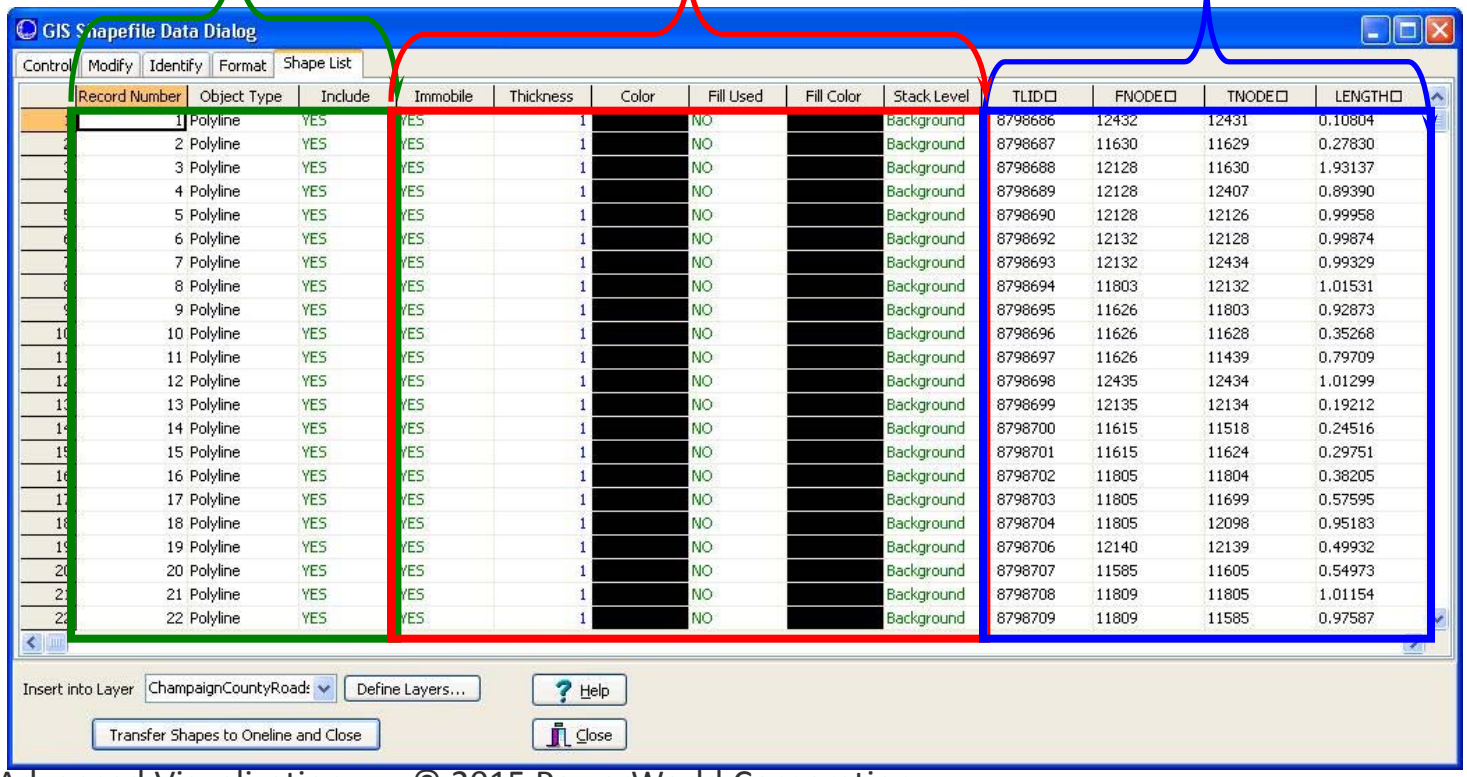
GIS Shapefile Data Dialog: Shape List Tab

- Finally, if you want more control, modify the attributes of the shapes directly.

Info from *.shp file

Specify the Format of each shape

Data from *.dbf file

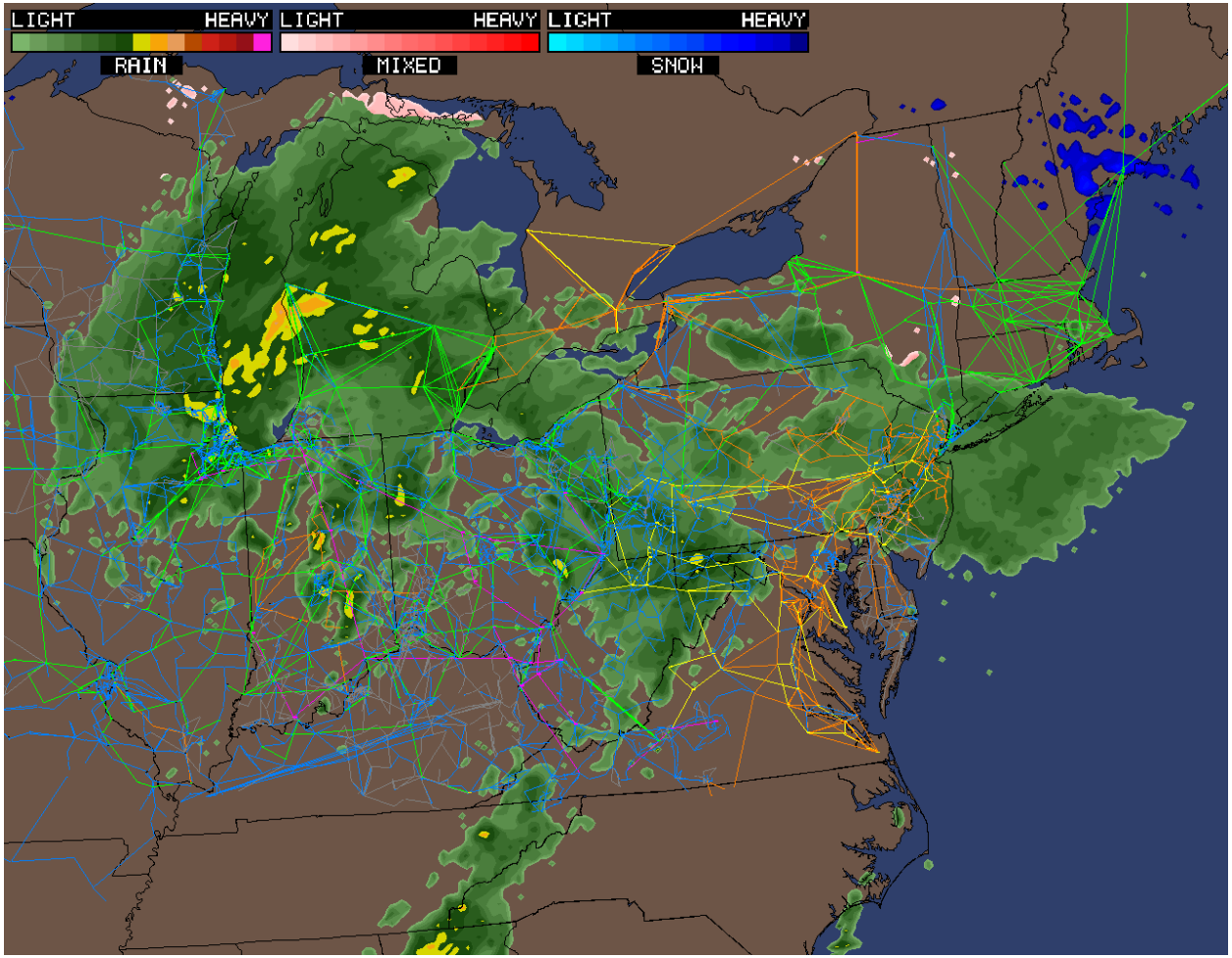


Record Number	Object Type	Include	Immobile	Thickness	Color	Fill Used	Fill Color	Stack Level	TLID	FNODE	TNODE	LENGTH
1	Polyline	YES	YES	1		NO		Background	8798686	12432	12431	0.10804
2	Polyline	YES	YES	1		NO		Background	8798687	11630	11629	0.27830
3	Polyline	YES	YES	1		NO		Background	8798688	12128	11630	1.93137
4	Polyline	YES	YES	1		NO		Background	8798689	12128	12407	0.89390
5	Polyline	YES	YES	1		NO		Background	8798690	12128	12126	0.99958
6	Polyline	YES	YES	1		NO		Background	8798692	12132	12128	0.99874
7	Polyline	YES	YES	1		NO		Background	8798693	12132	12434	0.99329
8	Polyline	YES	YES	1		NO		Background	8798694	11803	12132	1.01531
9	Polyline	YES	YES	1		NO		Background	8798695	11626	11803	0.92873
10	Polyline	YES	YES	1		NO		Background	8798696	11626	11628	0.35268
11	Polyline	YES	YES	1		NO		Background	8798697	11626	11439	0.79709
12	Polyline	YES	YES	1		NO		Background	8798698	12435	12434	1.01299
13	Polyline	YES	YES	1		NO		Background	8798699	12135	12134	0.19212
14	Polyline	YES	YES	1		NO		Background	8798700	11615	11518	0.24516
15	Polyline	YES	YES	1		NO		Background	8798701	11615	11624	0.29751
16	Polyline	YES	YES	1		NO		Background	8798702	11805	11804	0.38205
17	Polyline	YES	YES	1		NO		Background	8798703	11805	11699	0.57595
18	Polyline	YES	YES	1		NO		Background	8798704	11805	12098	0.95183
19	Polyline	YES	YES	1		NO		Background	8798706	12140	12139	0.49932
20	Polyline	YES	YES	1		NO		Background	8798707	11585	11605	0.54973
21	Polyline	YES	YES	1		NO		Background	8798708	11809	11805	1.01154
22	Polyline	YES	YES	1		NO		Background	8798709	11809	11585	0.97587

Demo Only

Example GIS Shapefile: Reading a Radar Image

A Weather Precipitation Radar Image on a Oneline

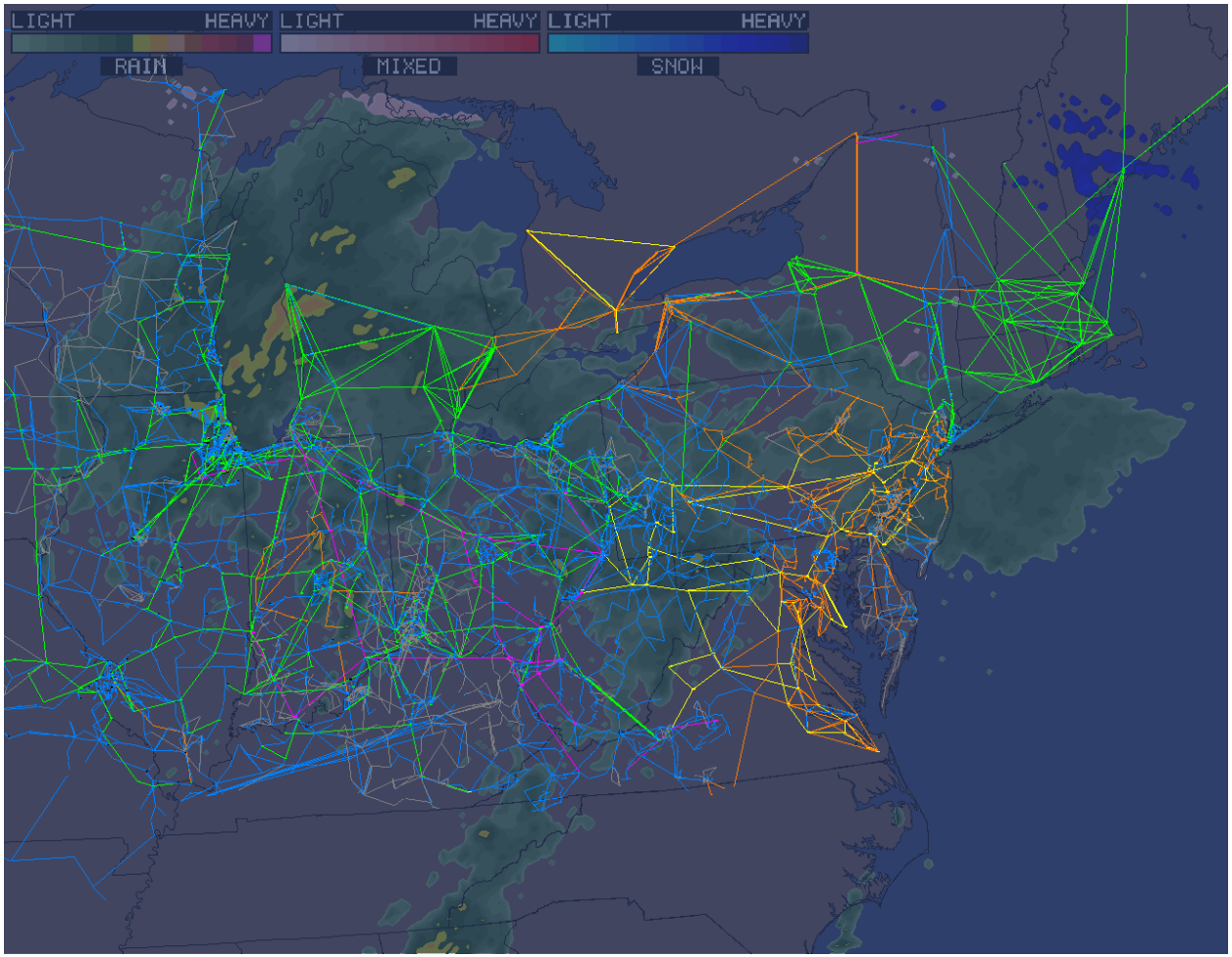


Demo Only

Combining GIS and Emphasis: Transmission System Emphasized

A Weather Precipitation Radar Image on a Oneline

Transmission System Emphasized

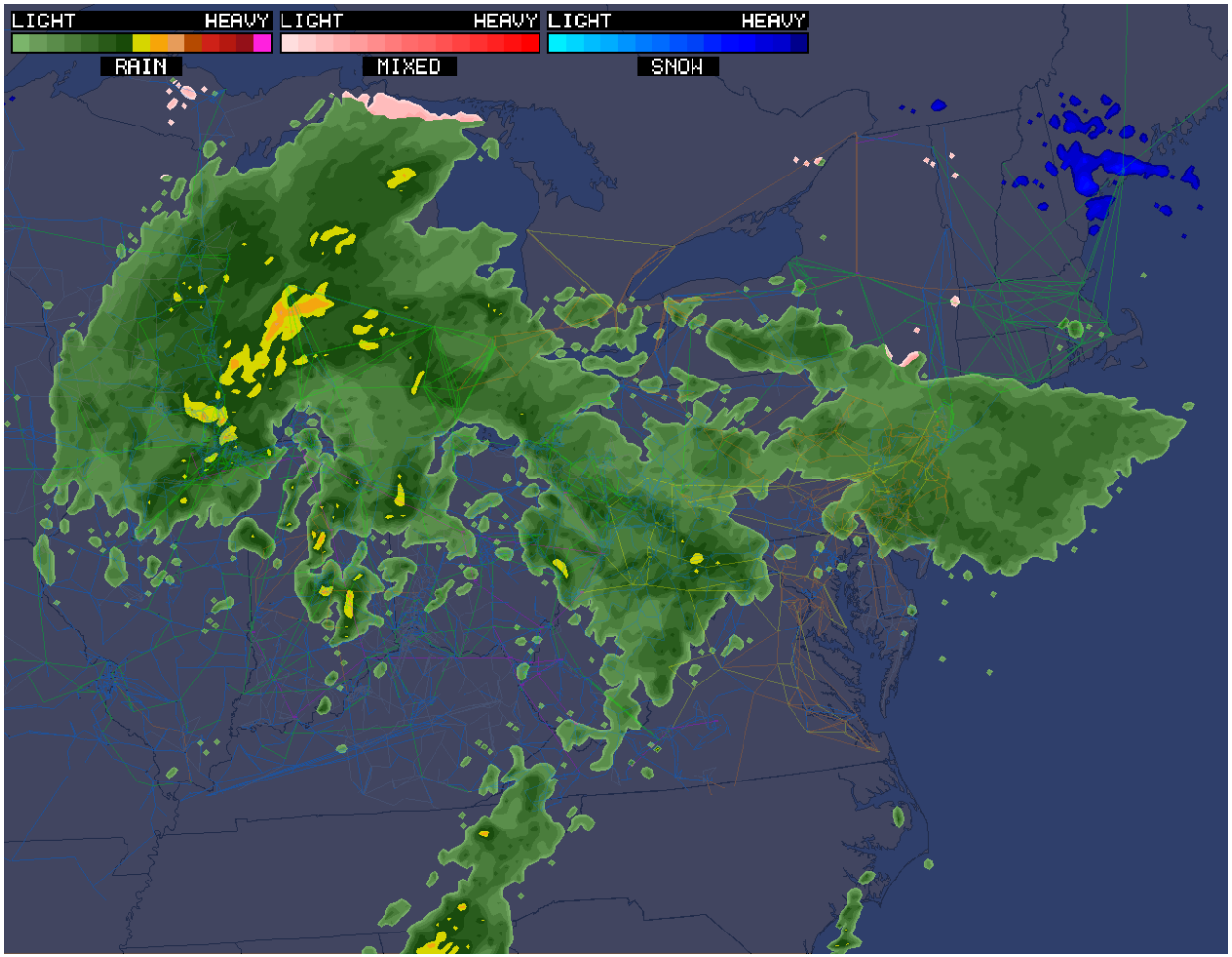


Demo Only

Combining GIS and Emphasis: Weather Radar Emphasized

A Weather Precipitation Radar Image on a Oneline

Weather Radar Emphasized



KML Export and Import

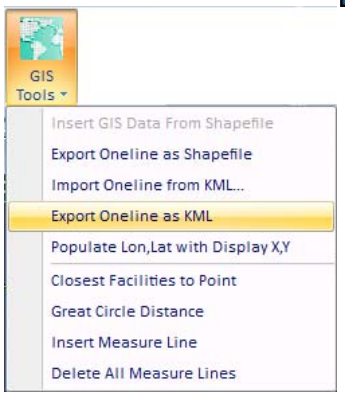
- KML is the file format supported by geographical software such as Google Earth
- Simulator can write to KML files
  - Specify what objects and fields to export- small files are better
  - These files can be opened and viewed in Google Earth
- Simulator can read from KML files
  - The key fields must be correctly specified
  - Reads in one-line display object locations and format, does not modify fields of power system objects
  - Example, intended use of this feature:
    - Create KML files with Simulator
    - Modify objects, save as a new KML file, import back in
    - Ex., routing transmission lines, placing substations

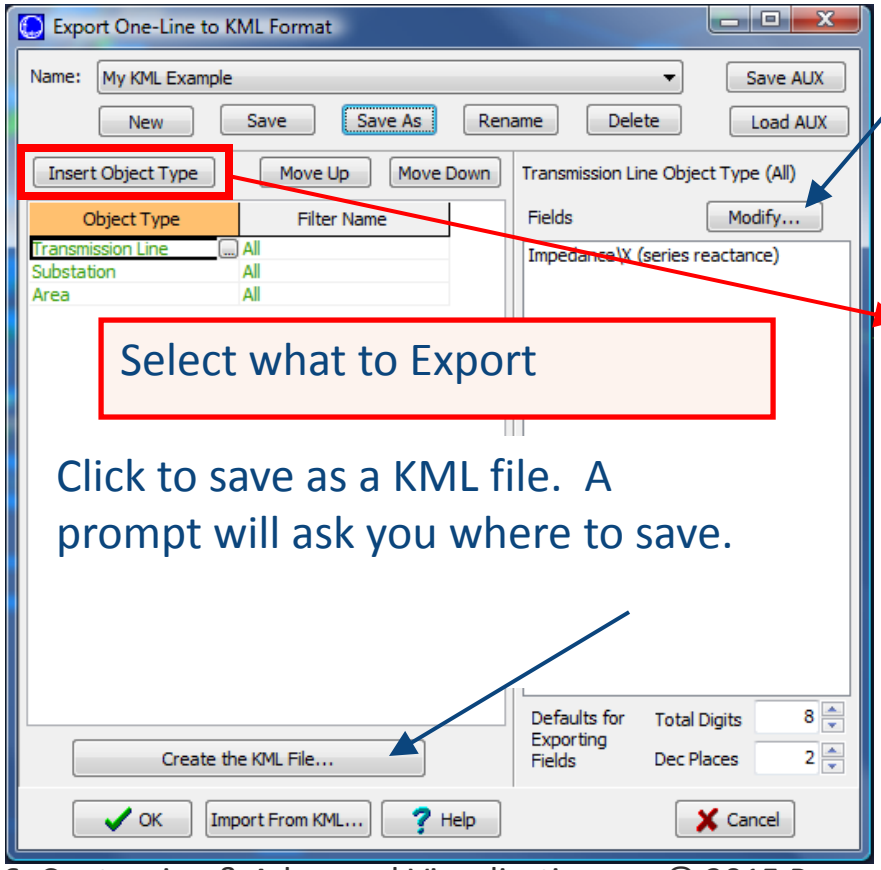
KML Export and Import

- Onelines must have a valid map projection
  - Objects must be associated with a latitude and longitude
  - You can use the **Populate Lat,Lon with Display X,Y** tool
- Key fields are exported by default to allow you to read your files back in
  - Icons and placemarks with information appear for different object types
  - Objects are emphasized when mouse is over them
- Recommendations
  - It seems to be easier to work with several small KML files instead of one large file
  - Use filters, and limit what object types and fields you export and import
- For more information about KML, see Google's KML Reference: http://code.google.com/apis/kml/documentation/kmlreference.html

KML Export

On the **Onelines** ribbon tab, choose **GIS Tools→ Export Oneline as KML**

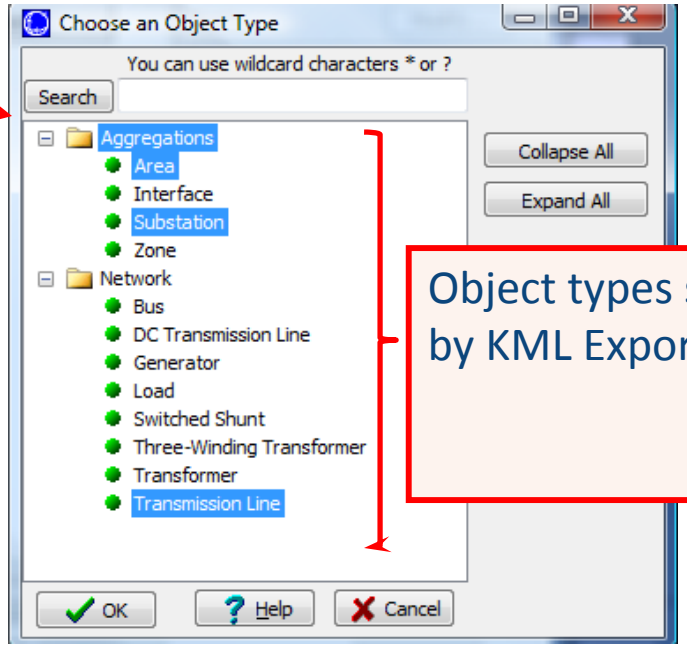




Select what to Export

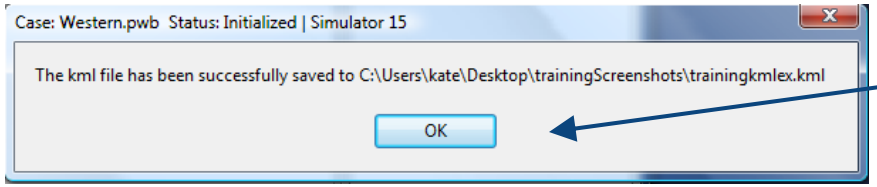
Click to save as a KML file. A prompt will ask you where to save.

Optionally, add extra fields to export

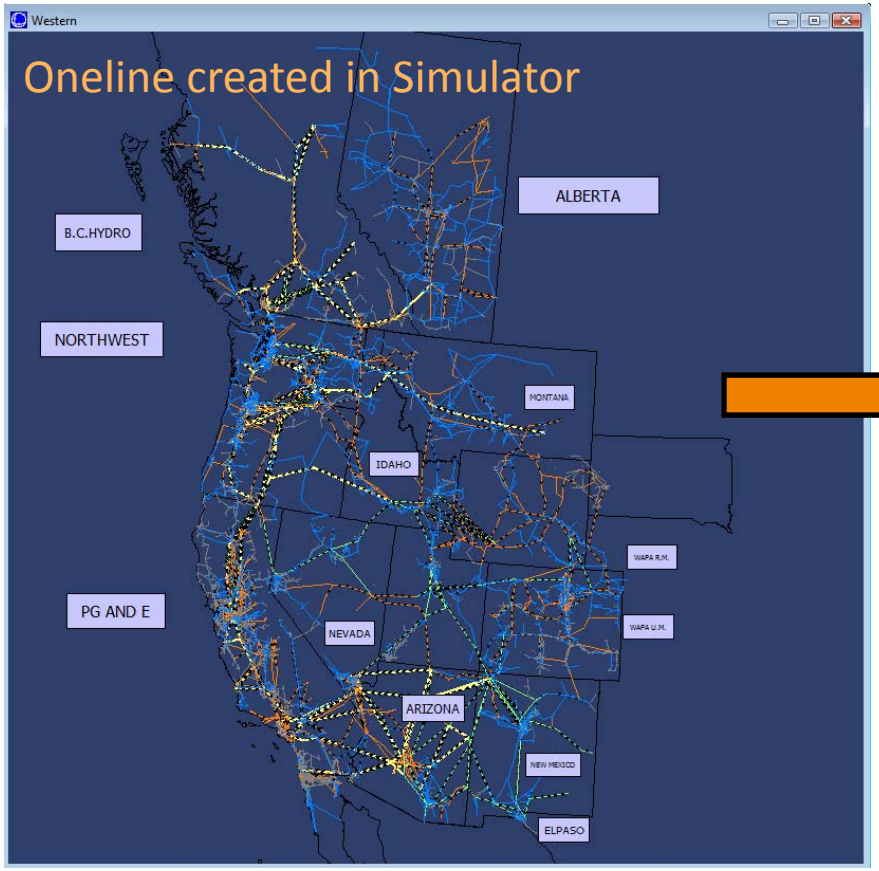


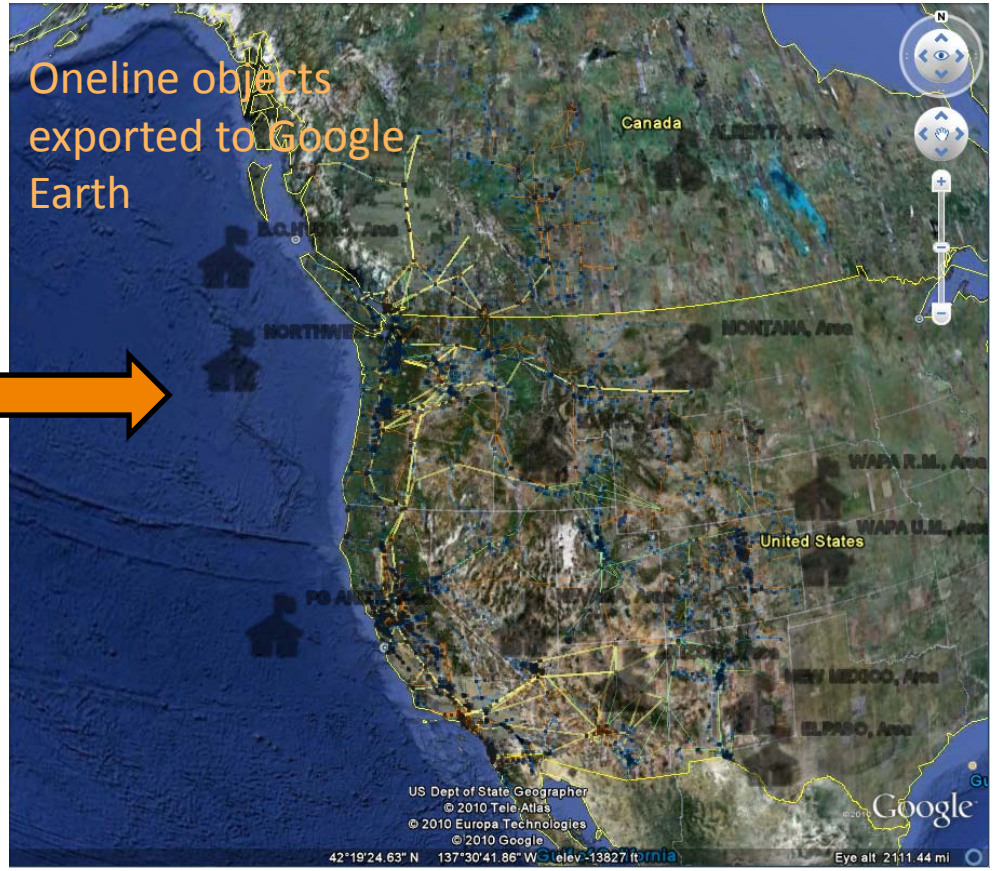
Object types supported by KML Export

Viewing Exported KML Files

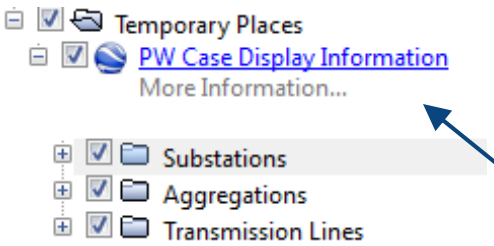


A dialog will appear when the export is complete

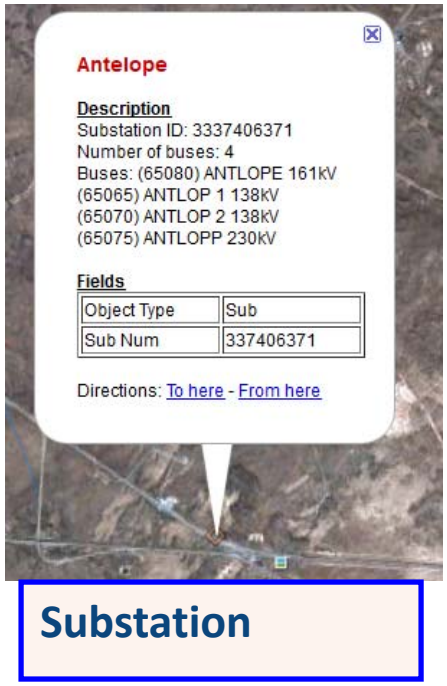


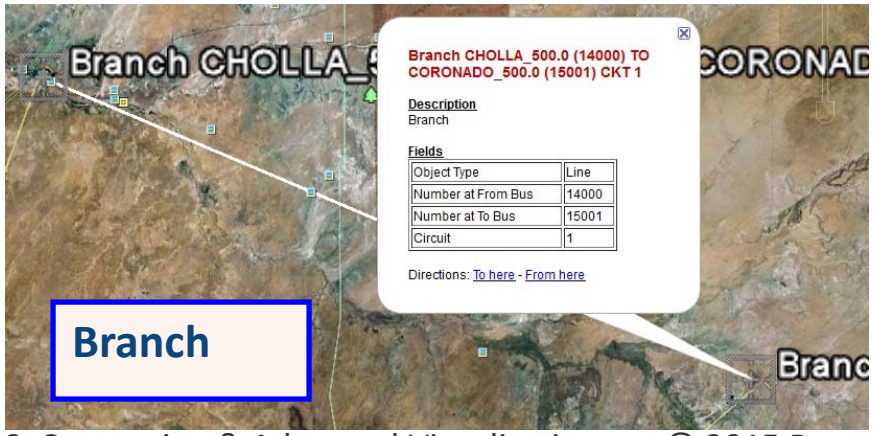


Viewing KML Placemarks



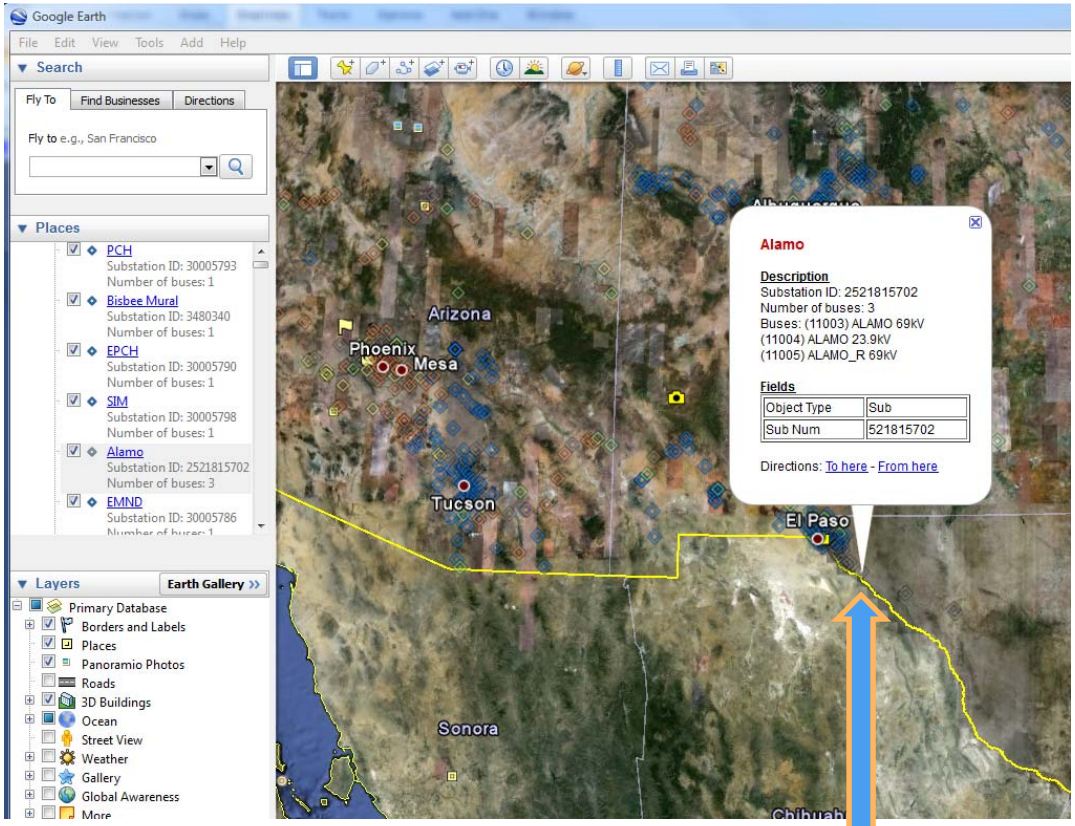
In the KML file, folders appear for each exported object type under the "PW Case Display Information" header

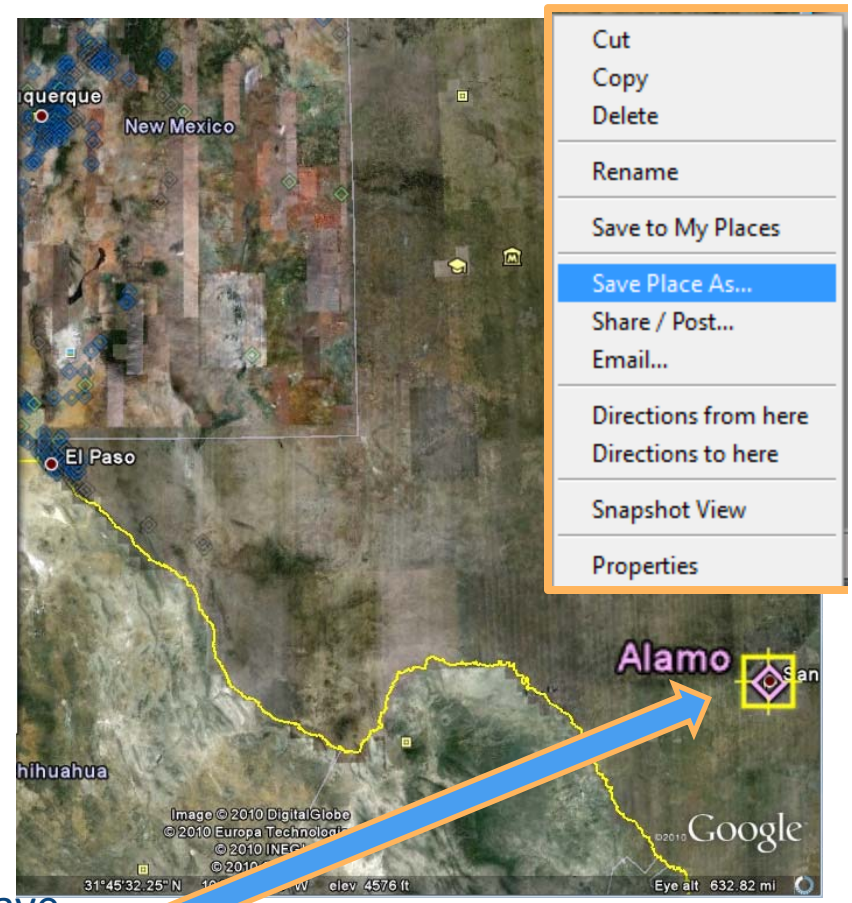




A placemark is created for each object with a description and a table of fields

Importing from KML

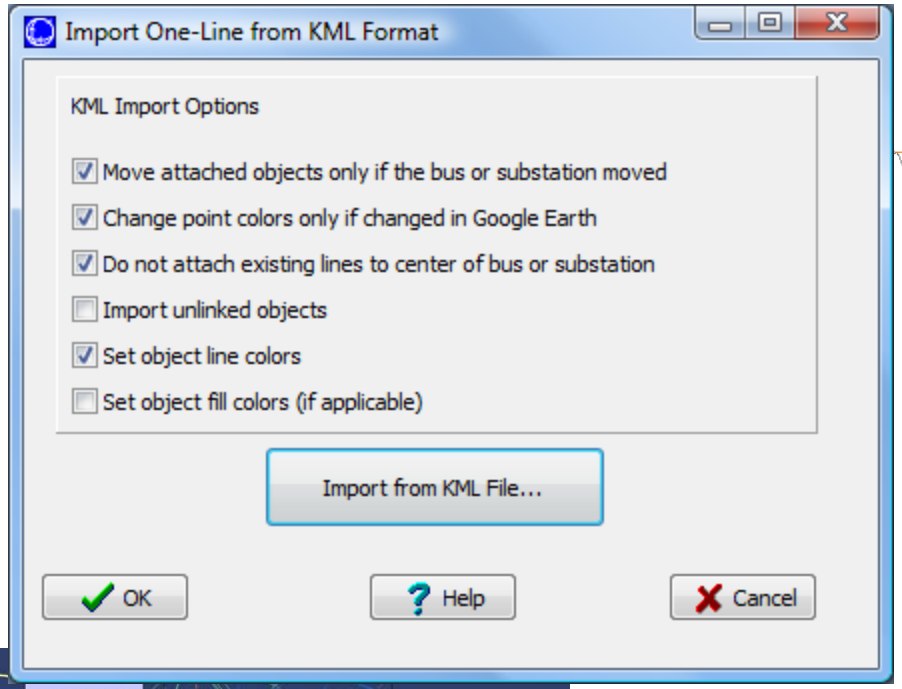




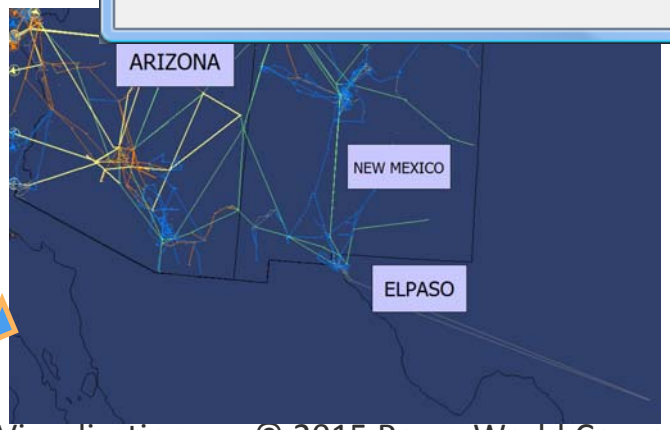
Ex: Move substation to new location and save it as a KML file.

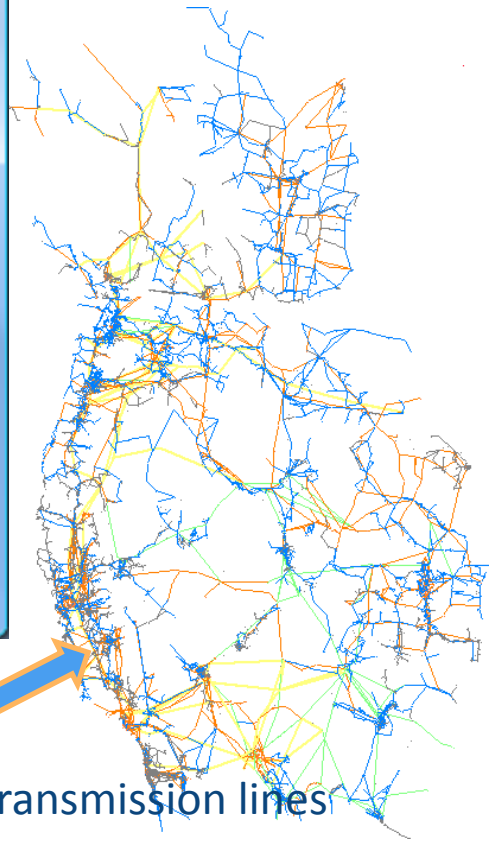
Importing from KML

- Import to any oneline
- Objects can be linked or unlinked
- Importing can create objects



Ex: Importing the moved substation





Ex: Importing transmission lines to a new oneline

Demo Only

Additional GIS Tools

- Export Oneline as Shapefile
  - Create shapefile containing a single type of display object from a oneline display
- Great Circle Distance
  - Calculate the distance between two points of longitude, latitude
- Measure Lines
  - Measure the distance between points on the display by drawing a line connecting them
- Populate Lon,Lat with Display X,Y
  - Populate the Longitude and Latitude fields of buses and substations with location of the corresponding object on the oneline display
- Display shapefile database information with object created from shapefile
  - Right-click on object and select local menu option Show Shapefile Fields

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