



## **Cisco WAE Design 6.2 Tutorials**

July 2015

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## Overview

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These tutorials take you through the WAE Design GUI in a structured way so that you quickly get an overview of the user interface, including the basics of failure simulations.

[Getting Started with WAE Design](#)—Introduces you to the basic elements of the GUI, such as how to manipulate plot views and display objects, and how to use the basic controls and menus. Additionally, this tutorial shows you the basics of how to modify simulated traffic (demands).

[Getting Started with Simulation Analysis](#)—Demonstrates how to generate failure scenarios and how to examine your network for component failure vulnerabilities.

## Related Topics

- *WAE Design User Guide*
- *WAE Network Visualization Guide*
- *WAE Design Integration and Development Guide*
- Sample plan files are in `$(CARIDEN_HOME)/samples`, where `$(CARIDEN_HOME)` is the directory containing the software (on Linux, the default is `/opt/cariden/software/mate/current`)





## Getting Started with WAE Design

This tutorial introduces you to the WAE Design GUI, which operates on *plan files*, or *plans*, that contain the components of information that display the network. In this tutorial, you use sample plan files that come with the WAE Design application. Topics include the following.

- WAE Design GUI display and behavior, including network plot, toolbars, tables, selection methods, and shortcuts.
- Customizing displays for circuit capacities and traffic utilizations.
- Traffic *demands*, which are the foundation for network modeling and simulation in WAE Design.



### Note

WAE Design works on both measured and simulated traffic. Traffic is simulated through demands (which are explained in the [Simulate Traffic Using Demands](#) section). Unless otherwise noted, the instructions and diagrams are for simulated traffic.

## Launch WAE Design and a Open Plan File



### Note

Throughout this tutorial, `$CARIDEN_HOME` is the directory in which the software is installed. The Linux default `$CARIDEN_HOME` is `/opt/cariden/software/mate/current`.

To view the network topology and perform WAE Design operations, you must open a plan file. To use WAE Design effectively, it is helpful to understand the main GUI components.

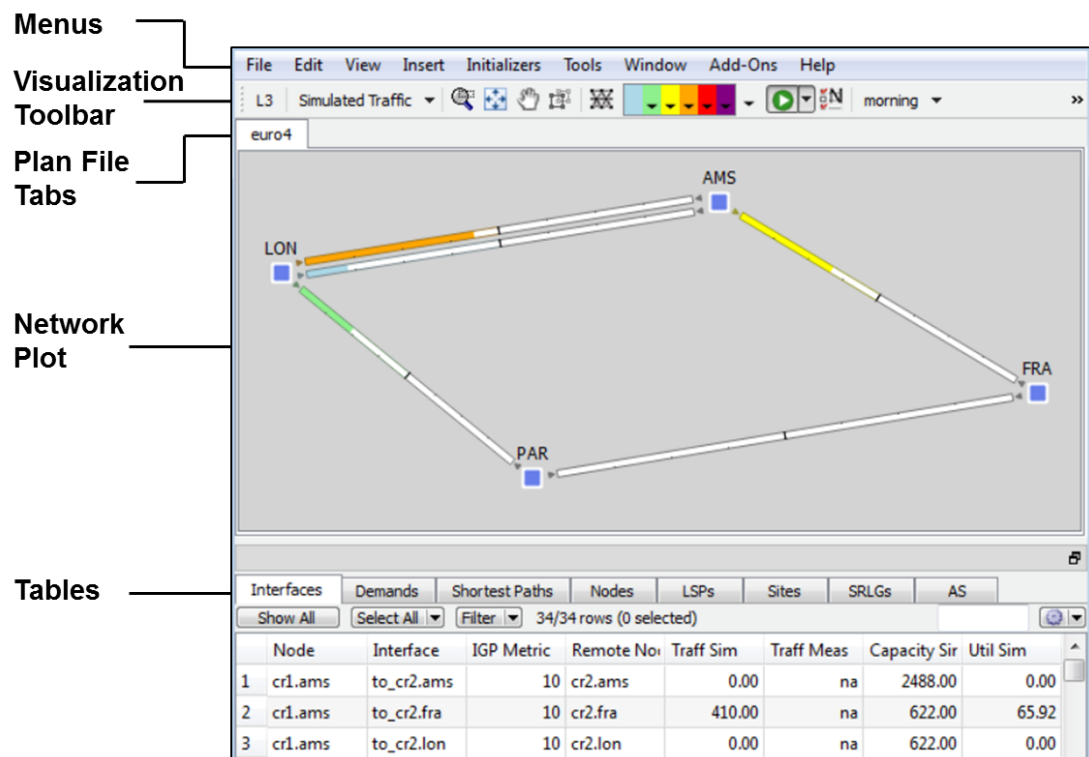
**Task:** Launch WAE Design, open a plan file, and develop a basic understanding of the GUI.

- Step 1** Double-click the `mate` icon in the `$CARIDEN_HOME` directory, which is the directory in which WAE Design is installed.
- Step 2** If a license message is displayed, click OK to continue since you do not need a license to use the sample plans.
- Step 3** Select the File->Open menu.
- Step 4** Browse to the `$CARIDEN_HOME/samples` directory and open the `euro4.txt` file, which is a sample European network.
- Step 5** Locate each of the following GUI components ([Figure 2-1](#)).
  - Menus—Menu selections for network modeling, simulation, and optimization.

- Visualization toolbar—Drop-down lists and icons that control how the network is displayed.
- Network plot—Displays a visual representation of the network topology.
- Tables—Display network properties, including both measured and simulated information, for the network plan.
- Context menus—Enable you to right-click anywhere in the plots or tables to view a list of actions that you can take.

**Step 6** If continuing with these tutorials, keep this plan open for the next task. If stopping here, select the File->Close menu to close this file without saving it.

**Figure 2-1** Main Components of WAE Design GUI



Right-click anywhere in the plots or tables for a context menu.

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## View Network, Site, and Interface Plots

Upon opening the plan file used in this tutorial, the network plot shows sites (square icons) that appear to be connected by circuits, though they actually connect to nodes (routers) within each site. The nodes within the sites are connected with intrasite circuits. Each circuit consists of two interfaces that are delineated by the line in the middle of the circuit.

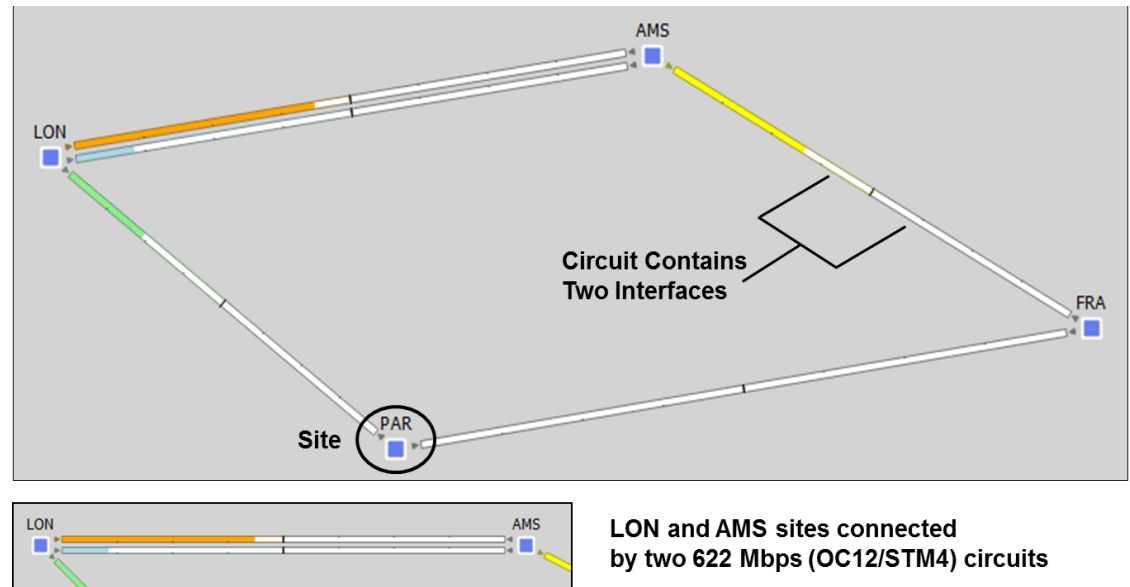
Note that sites can also contain other sites, and nodes do not have to be contained within sites.

**Task:** View network, site, and interface plots.

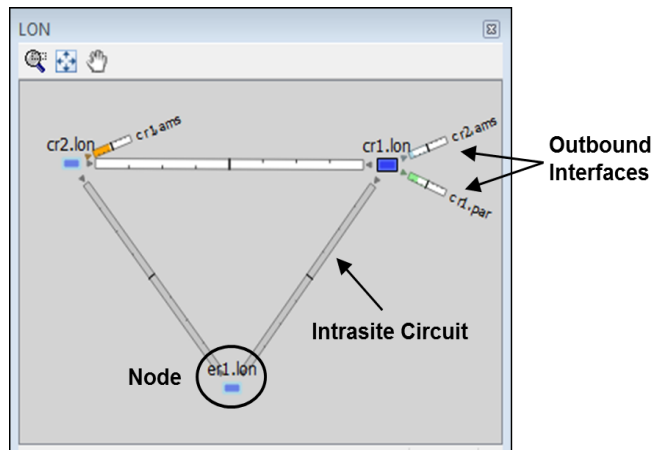


- Step 1** If `euro4.txt` file is not open, select the File->Open menu. Browse to the `$CARIDEN_HOME/samples` directory and open the `euro4.txt` file.
- Step 2** In the network plot (Figure 2-2), notice the four sites. These are connected by 622 Mbps (OC12/STM4) circuits. LON and AMS are connected by two such circuits. This information is listed in the Capacity Sim column of the Interfaces table.

**Figure 2-2** Network Plot of Sample European Plan File



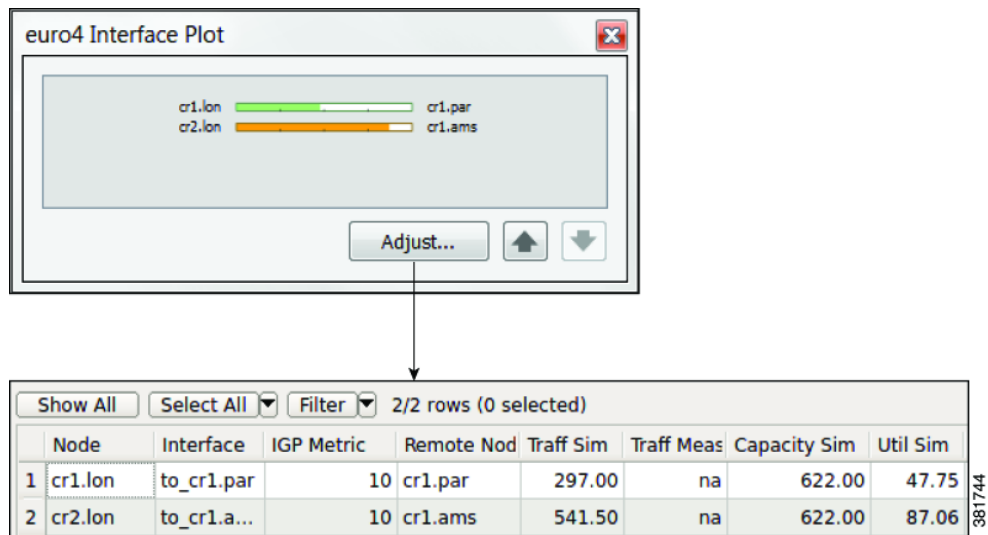
- Step 3** Open a site plot.
- Double-click on the LON site to see its details. Notice that the LON site contains three nodes connected by intrasite circuits.
  - Click each of the outbound interfaces and notice the selection (blue highlight) of the same interface in the network plot.
  - Close the site plot by clicking on the top, right X.
- Step 4** Open an interface plot.



- Click the orange interface coming out of LON and going towards AMS.
- Press and hold the Ctrl key (Cmd on Mac) while selecting the green interfacing coming out of LON going towards PAR. Both interfaces are now selected.
- Right-click on either of these interfaces and select Plot Interfaces from the context menu. An interface plot appears (Figure 2-3).
- Click in an ow plot area to deselect them from both the interface and the network plots.  
Now click on each of the interfaces in the interface plot and notice that they are selected in the network plot.
- Close the interface plot by clicking on the top, right X.

**Step 5** If continuing with these tutorials, keep this plan open for the next task. If stopping here, select the File->Close menu to close this file without saving it.

**Figure 2-3** Interface Plot

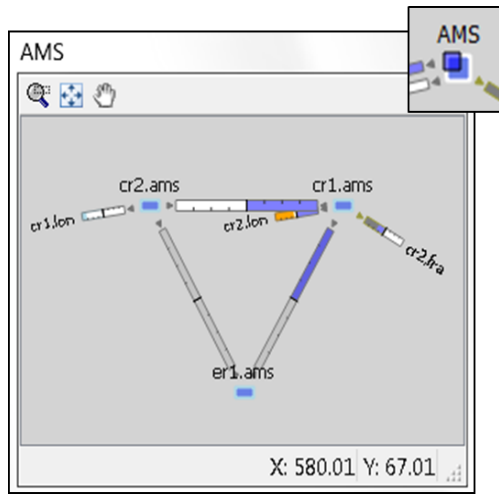


# Work with Tables and Object Selections

This section familiarizes you with the basic dynamics between tables and objects, such as nodes, sites, circuits, interfaces, and ports. When you select an object in a table, it is automatically selected in the network plot. Conversely, whatever you select in the network plot is selected in the tables.

**Task:** Show different tables and select objects. Each time you make a selection, observe what happens in the tables and in the network plot to see their relationships.

- 
- Step 1** If `euro4.txt` file is not open, select the File->Open menu. Browse to the `$CARIDEN_HOME/samples` directory and open the `euro4.txt` file.
- Step 2** Notice that the Interfaces tab is selected. Click on the Sites tab to show the Sites table.
- Step 3** In the network plot, click on various sites, and each time notice the blue highlight in the left column of the Sites table. Also notice that each time you select a new site, the other is no longer selected. This is because selecting an individual object deselects all others.
- Step 4** Show the Circuits table, which is not in the default table tabs.
- Right-click on any of the table tabs and select Show/Hide Tables from the context menu.
  - Click on the empty F (false) box on the Circuits row to turn this F to T (true).
  - Click OK. The Circuits table tab appears.
  - Click on the Circuits tab to show the Circuits table.
- Step 5** In the Circuits table, select on the PAR-LON circuit. Press and hold Ctrl (Cmd on Mac) while clicking on the AMS-FRA circuit. Notice that both rows are highlighted as are the corresponding circuits in the network plot.
- This selects four interfaces, which is two interfaces per circuit. To verify these selections, in the Circuits table right-click on either of the two selected circuits, and select Filter to Interfaces from the context menu. The Interfaces table shows the four interfaces that are selected in the network plot.
- Step 6** In the Interfaces table, click the Show All button.
- Step 7** Click the top row of the Interfaces table. Press and hold Shift while clicking on the fourth row. All four interfaces are selected both in the table and in the plot. Two of these interfaces are intrasite as indicated by the small square appearing on top of the AMS site.
- Double-click on the AMS site to see the selected interface.
  - Close the site plot by clicking on the top, right X.
  - Click in an empty plot area to deselect the interfaces.



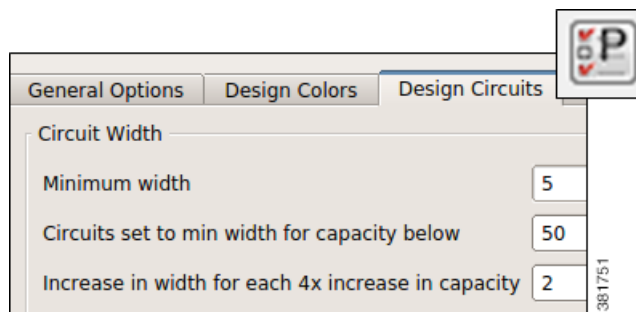
- Step 8** If continuing with these tutorials, keep this plan open for the next task. If stopping here, select the File->Close menu to close this file without saving it.

## Change Circuit Capacity Width

Circuits are drawn to show the relationship of their capacity to their utilization. By default, the width of the circuit is proportional to the capacity, down to a predefined minimum width, and the interfaces appear without explanatory text. The Plot Options icon opens a dialog box where you can change the relationship between width and capacity, and control the minimum width and rate at which the width changes for different capacities.

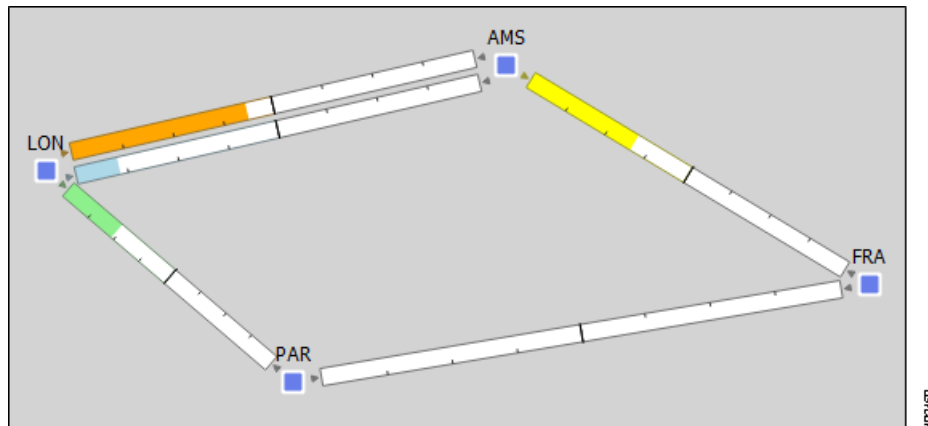
**Task:** Change the relationship between circuits' width and their capacity.

- Step 1** If `euro4.txt` file is not open, select the File->Open menu. Browse to the `$CARIDEN_HOME/samples` directory and open the `euro4.txt` file.
- Step 2** Click the Plot Options icon in the top, right of the visualization toolbar; a Plot Options dialog box appears.



- Step 3** In the Design Circuits tab, change the value in the “Circuits set to min width for capacity below” field from 580 to 50, and click OK.

- Step 4** Notice that all circuits are wider than the minimum now because their capacities all exceed 50 Mbps. Notice how much wider the circuits are now.



- Step 5** Double-click on the LON site to open its site plot. Notice that some circuits show at the minimum width with no fill color; this is because these circuits do not have a specified capacity.
- Step 6** Re-open the Plot Options dialog box and change the setting back to the default of 580, and press OK.
- Step 7** If continuing with these tutorials, keep this plan open for the next task. If stopping here, select the File->Close menu to close this file without saving it.

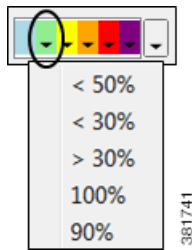
## Determine Traffic Utilization

WAE Design shows either measured network traffic or simulated traffic, depending on the view. The color fill of an interface shows the bandwidth utilization for traffic leaving that interface in proportion to the interface capacity. That is, it shows the *traffic utilization*.

The exact utilization of any circuit is listed in the tables where all the quantitative parameters of the network are available. The colors and thresholds are fully customizable from the Utilization Color menu.

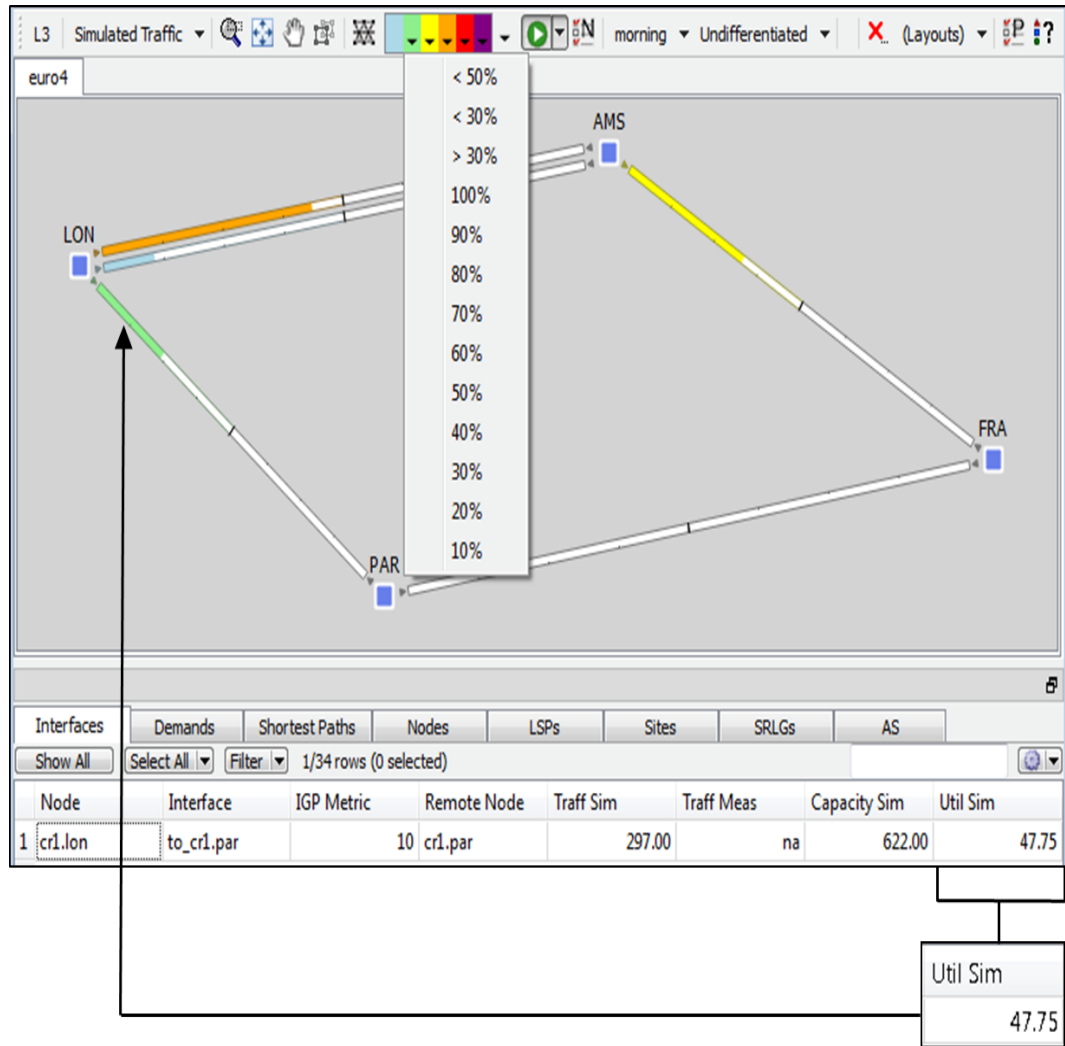
**Task:** Determine the traffic utilization threshold using color fills, Util Sim column, and textual representations.

- Step 1** If `euro4.txt` file is not open, select the File->Open menu. Browse to the `$CARIDEN_HOME/samples` directory and open the `euro4.txt` file.
- Step 2** Select the green drop-down list in the Utilization Color menu. The range indicates that if an interface is green, its traffic utilization is between 30-50%.



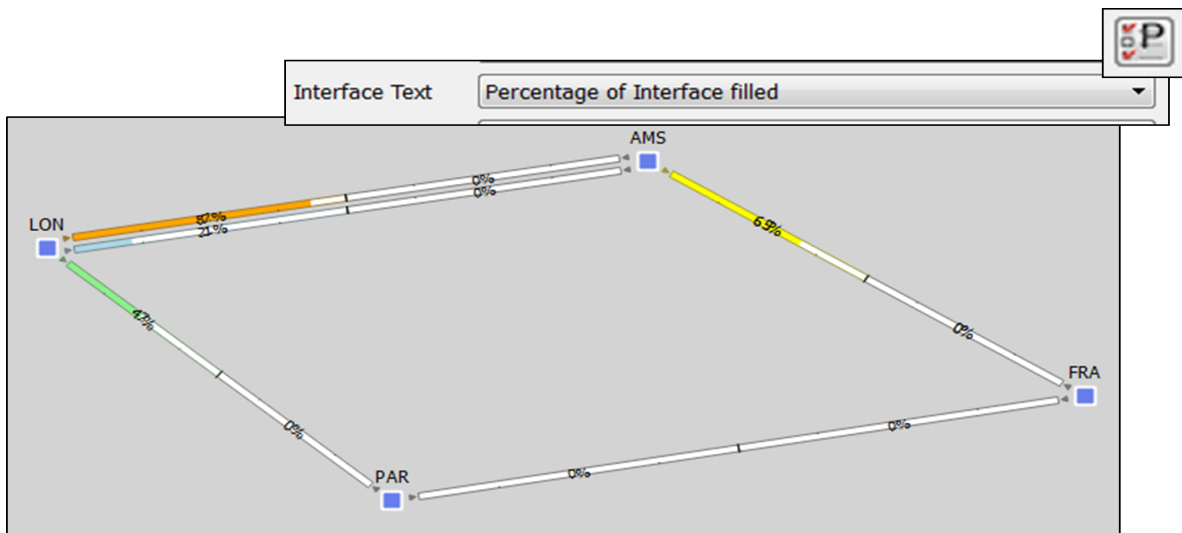
- Step 3** In the network plot, select the green part of the circuit between LON and PAR. Right-click on this same interface and select Filter to Selection from the context menu. The Interfaces table opens and shows only this interface.
- Step 4** Note that the Util Sim (simulated) column shows a utilization of 47.75% for this interface, which is between the 30-50% level denoted by green as shown in the Utilization Color drop-down menu (Figure 2-4). The interface is filled with green that extends to fill almost half of this interface. The other half of the circuit displays the traffic utilization for the reverse direction, which is 0% for this interface.
- Step 5** In the Interfaces table, click the Show All button.
- Step 6** Identify the percentages by displaying them on all interfaces.
- Click on the Plot Options icon; the Plot Options dialog box appears.
  - In the Design Circuits tab, Interface Text list, select “Percentage of interface filled.”
  - Click OK. The interfaces now show the numeric utilization percentage (Figure 2-5).  
Compare these numbers to those in the Util Sim column to see they are the same.
  - Re-open the Plot Options dialog box, change the Interface Text back to None, and click OK.
- Step 7** If continuing with these tutorials, keep this plan open for the next task. If stopping here, select the File->Close menu to close this file without saving it.

Figure 2-4 Traffic Utilization on cr1.lon-cr1.par Interface



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Figure 2-5 Traffic Utilization in Text Format



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## Most Highly Utilized Interface

There are two ways to identify the most utilized interfaces, which is useful when analyzing large, complex networks.

**Task:** Determine the most highly utilized interfaces in the network using each of the following methods.

**Method:** Sort Util Sim Column

- 
- Step 1** If `euro4.txt` file is not open, select the File->Open menu. Browse to the `$CARIDEN_HOME/samples` directory and open the `euro4.txt` file.
- Step 2** In the Interfaces table, click on the Util Sim column heading to sort the interfaces by descending order. Click it two more times to notice this is a toggle for sorting columns between ascending and descending order.

Util Sim
87.06
65.92
47.75
21.14

381755

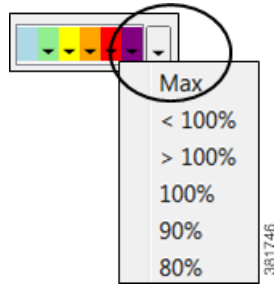
- Step 3** Notice that the most utilized interface is at 87.06% of capacity, which is the top row. Select this top row. The interface highlighted in the plot is the most highly utilized interface.
- Step 4** Use the down arrow to move downward row to row, each time finding the next most highly utilized interface. Each selection is highlighted in the plot and its exact utilization value is visible in the Util Sim column of the selected row.



**Step 5** Click in an empty plot area to deselect the interfaces.

### Method: Select Max Value in Utilization Color Menu

**Step 1** Select the purple drop-down list in the Utilization Color menu to see that the maximum utilization value is 100%. Select Max. This resets the maximum threshold percentage to the most highly utilized interface, which color fills that interface, cr2.lon-cr1.ams, to purple.



**Step 2** Select the purple drop-down list again to see that maximum is now 87.06%. Verify this by reading its Util Sim value in the Interfaces table, which is also 87.06% (Figure 2-6).

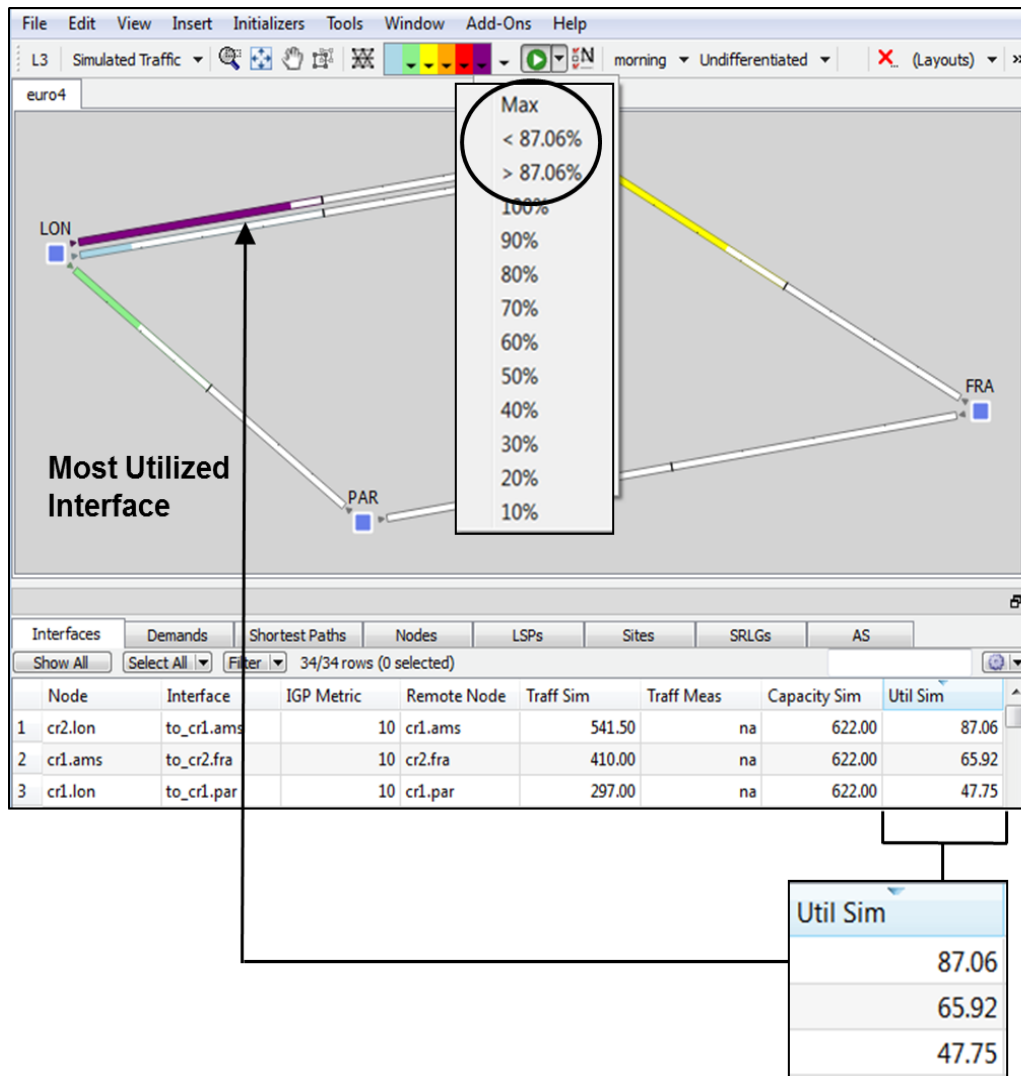
**Step 3** In this same purple drop-down list, select <87.06%. This highlights the second most highly utilized interface, which is cr1.ams-cr2.fra.

**Step 4** Set the maximum utilization back to 100% by restoring the system default colors.

- a. Select the Edit->Plot->Plot Options->Apply System Defaults menu.
- b. Select the purple drop-down list again to see that maximum is now 100%.

**Step 5** If continuing with these tutorials, keep this plan open for the next task. If stopping here, select the File->Close menu to close this file without saving it.

Figure 2-6 Interface with Highest (Max) Utilization



## Simulate Traffic Using Demands

Several WAE Design tables have columns that identify how much traffic is being carried or what percentage of the capacity is being utilized. For example, the Interfaces table has a Util Sim column that reflects simulated traffic utilization. The two basic inputs to the simulation are the network configuration itself and a set of traffic *demands*. A demand is a request for a specified amount of traffic to be sent from one node, the *source*, to another node, the *destination*. The routes taken are based on traffic, topology, network health, as well as the protocols used.

**Task:** Determine which service classes are associated with demands, read demand traffic and latency, and identify demands route in the network plot.

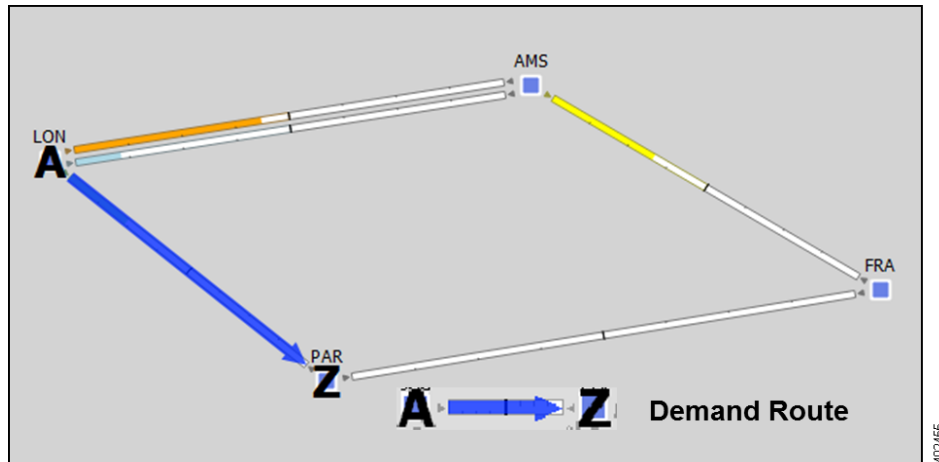
- Step 1** Select the File->Open menu. Browse to the `$CARIDEN_HOME/samples` directory and open the `euro4.txt` file.
- Step 2** Click the Demands tab to show the Demands table. Notice that this network contains only six demands, all from the `er1.lon` edge node in the LON site to the edge nodes in other sites.
- Step 3** Show the Service Class column (Figure 2-7).
- Right-click on any heading in the Demands table and select Show/Hide Columns.
  - In the top, right Search field, enter the word “service” and press Enter. The search feature locates all columns and column descriptions containing this word.
  - Click the empty F (false) box on the Service Class row to turn this F to T (true).
  - Click OK. The Service Class column appears.

**Figure 2-7 Search for and Show Column Names**

Shown	Order	Name	Description
<input checked="" type="checkbox"/> T	8	Service Class	Service Class
<input type="checkbox"/> F	30	Util Conformant	No interfaces on path violate QoS Bound fo...

- Step 4** Click the Service Class column heading to sort demands by service class, noting that half the demands represent Internet traffic and half represent voice traffic.
- Step 5** Read the Traffic column values to determine how much traffic each demand is attempting to route.
- Step 6** Determine the sum of the delays for all the interfaces on the longest path taken by each demand.
- In the Demands table, right-click the Maximum Latency column heading to see that its sum value is zero.
  - Verify this value by reading the Delay Sim column in the Interfaces table. They, too, are zero.
    - Select the Interfaces table tab, and then right-click on any of its headings and select Show/Hide Columns.
    - Click the empty F (false) box on the Delay Sim row to turn this F to T (true).
    - Click OK. The Delay Sim column appears.
    - Right-click this Delay Sim column heading to see that its sum value is zero.
- Step 7** In the Demands table, select the demand from `er1.lon` to `er1.par`. The network plot shows this demand from LON to PAR sites using a blue arrow to show the route, an A to show the source, and a Z to show the destination (Figure 2-8).

Figure 2-8 Single-Path Demand Route



**Step 8** Use the up and down arrow keys to move from row to row in the Demands table, highlighting each demand and showing its routing in the network.

Notice the er1.lon to er1.ams demand takes two equal-cost multipath (ECMP) routes along two parallel circuits. Two blue lines show 50% of the traffic flowing through each of these circuits (Figure 2-9).

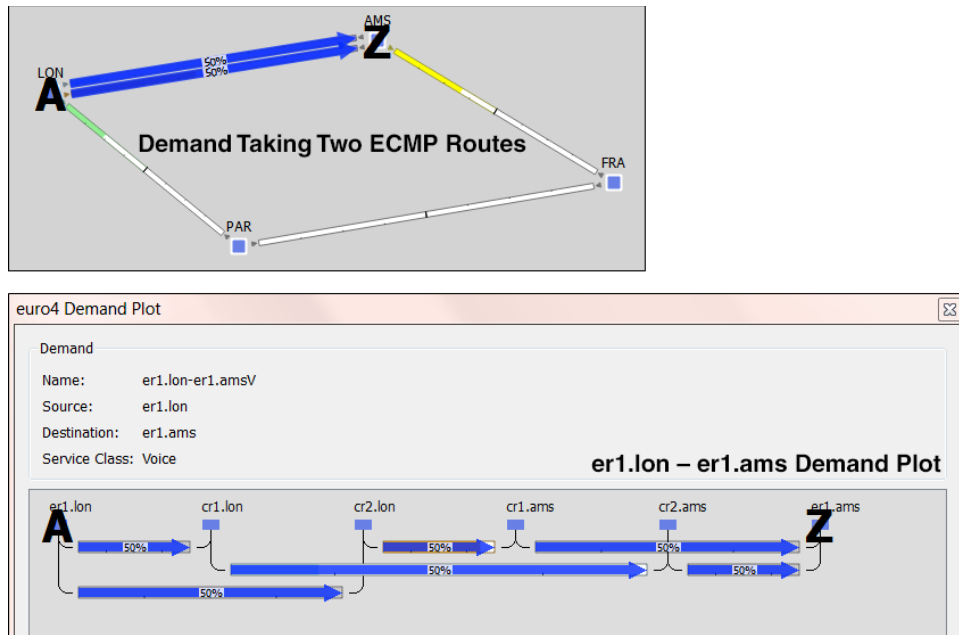
**Step 9** Right-click the er1.lon to er1.ams demand, and select Plot Demand from the context menu. This view shows the details of the demand route (Figure 2-9).

**Step 10** Close the demand plot.

**Step 11** Click in an empty plot area to deselect the demand.

If continuing with these tutorials, keep this plan open for the next task. If stopping here, select the File->Close menu to close this file without saving it.

Figure 2-9 ECMP Demand Route and Associated Demand Plot



## Modify Demand Traffic

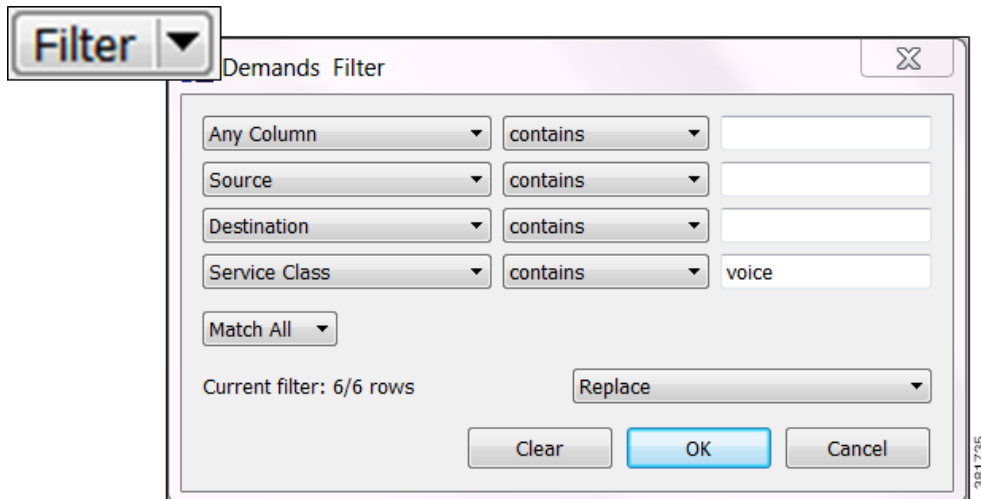
You can modify demand traffic to determine the effects such changes in traffic have on the network. These modifications can be applied to regions or sites, or they can apply uniformly over the network, such as in the following task.

For instance, you might increase demand traffic to plan for future traffic growth by simulating an overall traffic growth trend. Another example use might be to determine the network impact of an anticipated increase in sales of a particular service, such as video on demand.

**Task:** Simulate an increase in voice traffic by 50%.

- 
- Step 1** Select the File->Open menu. Browse to the `$CARIDEN_HOME/samples` directory and open the `euro4.txt` file.
- Step 2** Locate all voice demands by filtering to them.
- Click the Demands tab to show the Demands table.
  - Click the Filter control menu; the Filter dialog box appears (Figure 2-10).
  - In the empty field on the Service Class Contains row, enter voice.
  - Click OK. The Demands table shows only three demands representing voice traffic.
  - Notice the values listed in the Traffic column are 63, 89, and 142 Mbps.

Figure 2-10 Filter to Voice Demands



- Step 3** Increase the demand traffic for all voice demands by 50% (Figure 2-11).
- Select all rows that are currently showing in the Demands table by select one demand and then pressing Ctrl-A (Cmd-A on Mac).
  - Right-click on any row and select Modify Demand Traffic from the context menu.
  - Enter the value “50” in the “Change traffic by \_\_\_ %” field, and click OK.

Figure 2-11 Modify Voice Demand Traffic

	Traffic	ECMP Min %	Maximum Latency	Diff Min Possible Lat	Path Metric	Routed
1		63.00	50.00	0.00		
2	er1.lon	er1.fra	142.00	100.00	0.00	
3	er1.lon	er1.par	89.00	100.00	0.00	

Traffic Level: morning

Number of Selected Demands: 3 / 6

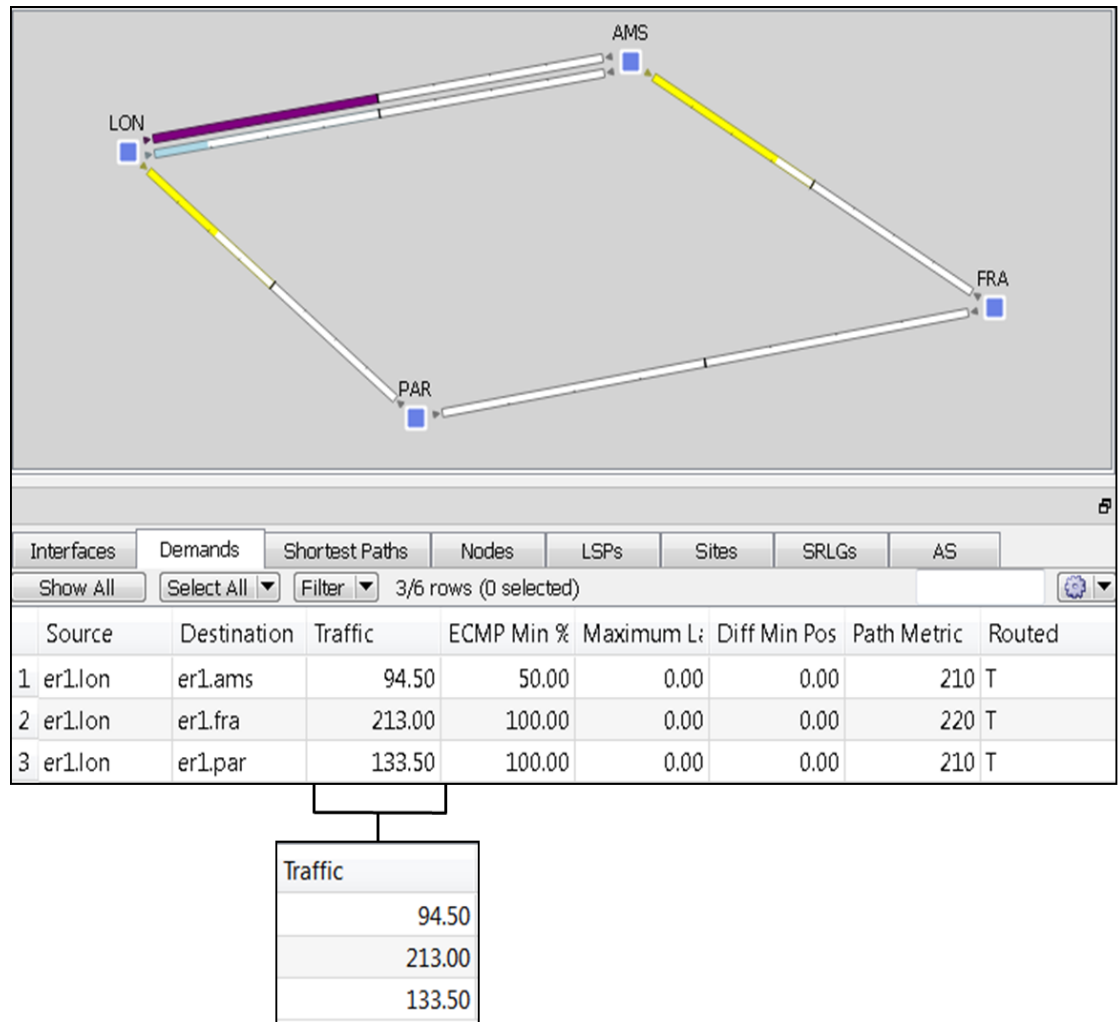
Total Traffic (Mbps): 294.00

Change traffic by 50 %

- Step 4** Click anywhere in the empty plot area to remove the demand selections.

- Step 5** Read the values in the Traffic column and note they have increased by 50% to 94.5, 133.5, and 213 Mbps. The plot shows that modifying this traffic created severe congestion between LON and AMS as noted by the purple color fill (Figure 2-12). Compare, for example, the color of interfaces between LON and AMS to those prior to the simulated traffic increase (Figure 2-8).
- Step 6** Select the File->Close menu to close this file without saving it.

**Figure 2-12** Voice Demand Traffic Increased by 50%



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## Edit Topology

WAE Design tools enable you to edit the network topology so that you can add, delete, and move objects. Some tools, such as the duplication function, can greatly simplify the redesign of a complex network.

Once topology changes are made, demands are rerouted, showing the resulting utilization changes in the new network.

**Task:** Create a new site by duplicating an existing one, place it in its geographically correct location, and observe how traffic is rerouted as a result of the topology change.

- Step 1** Select the File->Open menu. Browse to the `$CARIDEN_HOME/samples` directory and open the `euro4.txt` file.
- Step 2** Since you are determining the effect of adding a site, view the demand route before editing the topology.
- Click the Demands tab to show the Demands table.
  - Select the `er1.lon-er1.fra` demand. Notice that the demand goes from LON (source) through AMS and to FRA (destination)
  - Click anywhere in the empty plot to deselect the demand.
- Step 3** Create a BRU site by duplicating the AMS site.
- Right-click on the AMS site, and select Duplicate from the context menu.
  - Enter BRU as the name of the new site, and click OK. The new site appears with the same intrasite and intersite circuit structure.
  - Double-click on the new BRU site to see that the nodes have been duplicated from the old site, but renamed appropriately. Close this site plot.
  - Right-click on the newly created BRU site, and select Properties from the context menu. The Properties dialog box appears (Figure 2-13). The Location was copied as AMS, and the Longitude and Latitude fields give the airport location code for AMS.
    - Change the Location field to BRU and **press Enter** (do not press OK yet). The Location, Longitude, and Latitude fields update to show the airport location for Brussels.
    - Click OK.

**Figure 2-13** Duplicate AMS Site and Name it BRU

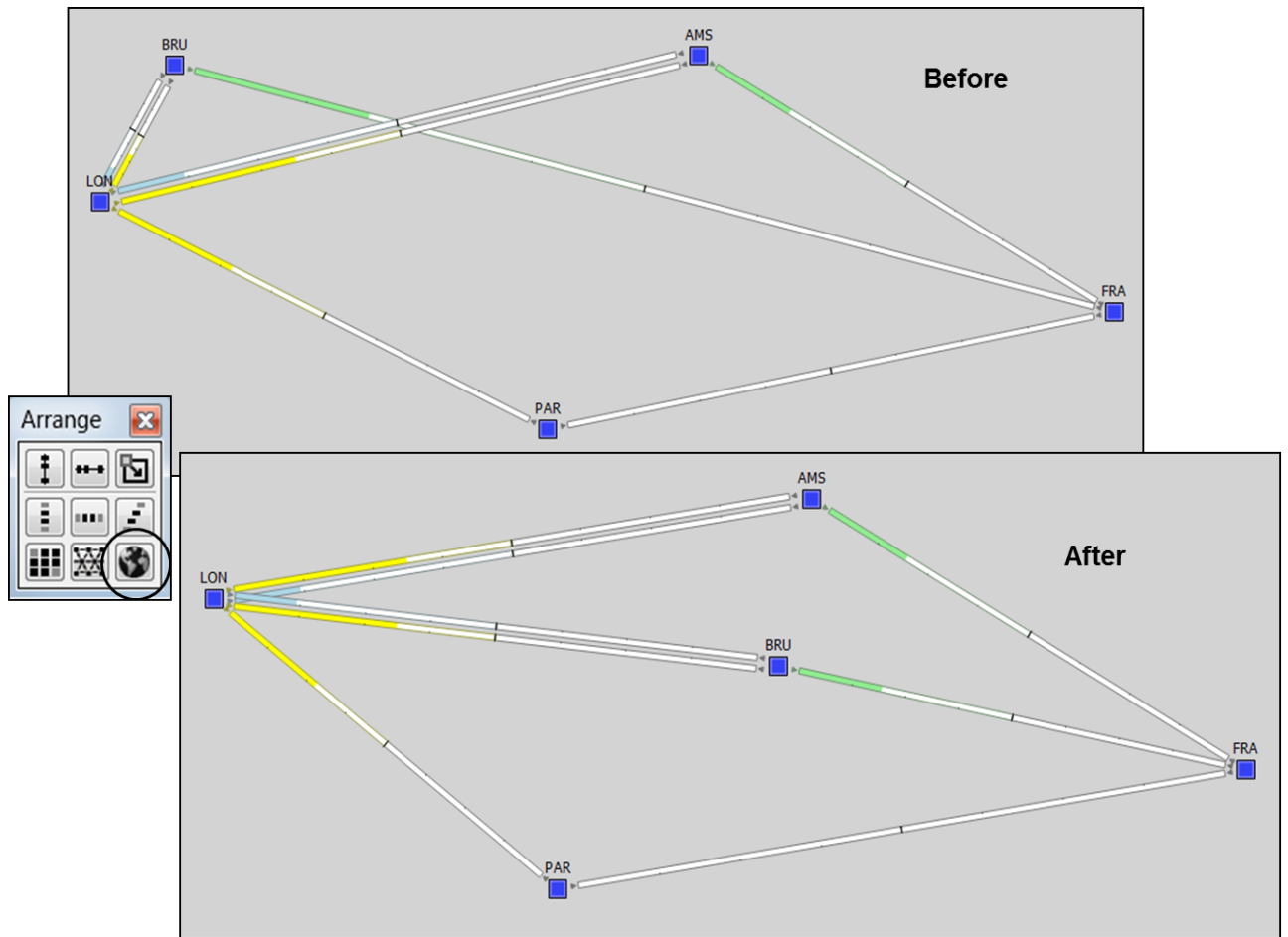
Name: BRU Display Name: Parent Site: <input type="checkbox"/> Protected <input checked="" type="checkbox"/> Active <input type="checkbox"/> Failed Geographic location Location: AMS <small>'Enter' replaces Location with best match from database. 'Alt-Enter' brings up a lookup dialog.</small> Longitude: 4.78 Latitude: 52.32 Plotting Screen X: 561.134 Screen Y: 48.134	Name: BRU Display Name: Parent Site: <input type="checkbox"/> Protected <input checked="" type="checkbox"/> Active <input type="checkbox"/> Failed Geographic location Location: BRU - Brussels Natl (Belgium) <small>'Enter' replaces Location with best match from database. 'Alt-Enter' brings up a lookup dialog.</small> Longitude: 4.48444 Latitude: 50.9014 Plotting Screen X: 561.134 Screen Y: 48.134
--	---

- Step 4** Place the site on the plot using its newly updated geographic location (Figure 2-14).
- Click on the Sites table tab to show the Sites table.
  - Click the Show All button.
  - In the Sites table, select one site and then press `Ctrl-A` (`Cmd-A` on Mac) to select all the sites.



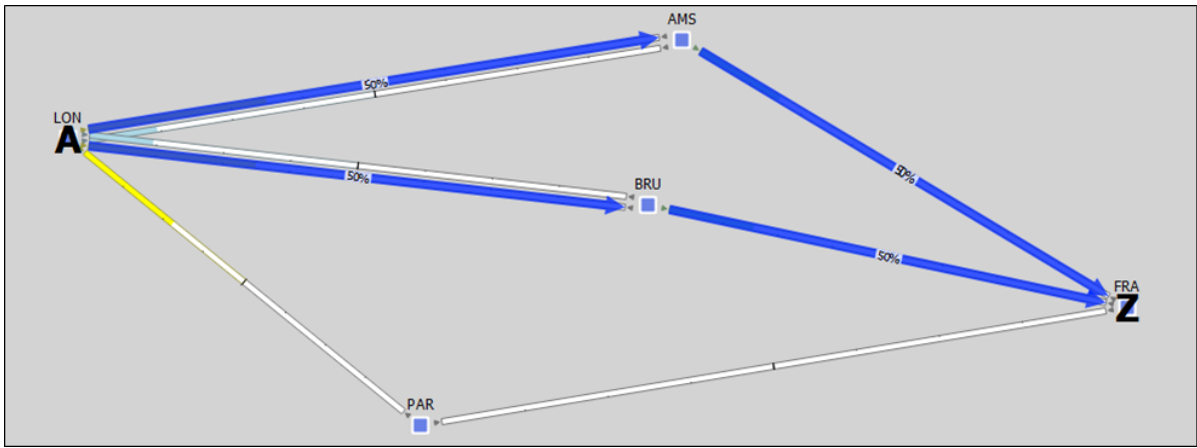
- d. Right-click the plot background, and select Arrange from the context menu.
- e. Click the Earth icon. The BRU moves to its proper geographic location. The `$CARIDEN_HOME/samples/euro4_bru.txt` file shows the same network with this change.

**Figure 2-14** New BRU Site



- Step 5** Observe the effect of adding this new site as it reroutes the er1.lon-er1.fra demand.
- a. Click on the Demands tab to show the Demands table.
  - b. Select the er1.lon-er1.fra demand (Figure 2-15). Half the traffic now routes through AMS and half through BRU.
- Step 6** Select the File->Close menu to close the file without saving it.

Figure 2-15 Rerouted Demand





## Getting Started with Simulation Analysis

WAE Design Simulation enables you to perform several types of failure analysis, which can be useful in long-term planning and short-term maintenance preparation. For instance, WAE Design simulates reroutings and changes in traffic utilization under individual failure events, as well as across multiple failure scenarios causing worst-case utilizations. This tutorial guides you through a sample of these failure analysis tasks.

For more detailed information about simulating and analyzing failures, see the *WAE Design User Guide*.

### Failures



#### Note

Throughout this tutorial, `$CARIDEN_HOME` is the directory in which the software is installed. The Linux default `$CARIDEN_HOME` is `/opt/cariden/software/mate/current`.

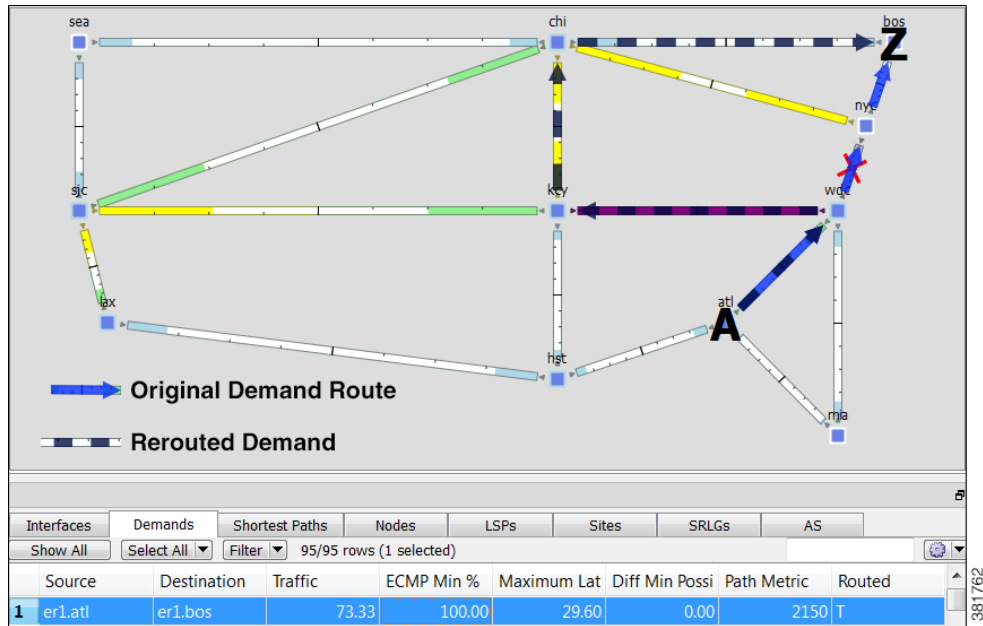
One of the most useful features of WAE Design is its ability to show network behavior when one or more objects fail. For example, your network might show utilizations are well under 100% under normal operation. But what happens under failure?

**Task:** Determine the effects on the network if a single circuit were to fail.

- Step 1** Select the File->Open menu. Browse to the `$CARIDEN_HOME/samples` directory and open the `us_wan.txt` file.
- Step 2** Notice all traffic utilization is under 100%. You can tell this in two ways. None of the interfaces are purple, which by default means over 100% utilized. The Util Sim column in the Interfaces table shows no values over 100.
- Step 3** Right-click on the wdc side of the wdc-nyc circuit (cr2.wdc-cr1.nyc interface), and select Filter to Demands Through Interfaces->All from the context menu.
- Step 4** Select the er1.atl to er1.bos (first) demand to see its route. The solid blue arrow shows the demand path.
- Step 5** Right-click on the wdc-nyc circuit and select Fail from the context menu. The red cross appearing on the circuit indicates a failure. Notice the difference in traffic utilization colors in the plot. For example, the key-wdc circuit is now congested.
- Step 6** Notice how the demand has been rerouted. The dashed line shows the current demand path under failure ([Figure 3-1](#)). Continue clicking on different demands to see how they are rerouted.
- Step 7** To restore the failed circuit, right-click on it and select Recover.
- Step 8** Click anywhere in an empty plot area to deselect the demand.

- Step 9** If continuing with this tutorial, keep this plan open for the next task. If stopping here, select the File->Close menu to close this file without saving it.

**Figure 3-1 Reroute of Demand Under Circuit Failure**



## SRLGs Failures

An SRLG (shared-risk link group) is a group of objects that would likely fail due to a common cause. In a live network, the most common type of SRLG is one that contains circuits that share a common fiber. If the fiber fails, all circuits will fail.

Several WAE Design tools enable you to simulate SRLG behavior, such as Simulation Analysis, which can provide a worst-case analysis of utilizations over SRLG failures. Metric Optimization can optimize routing over failure scenarios that can include SRLGs.

**Task:** Create an SRLG and fail it to observe the consequences to network traffic.

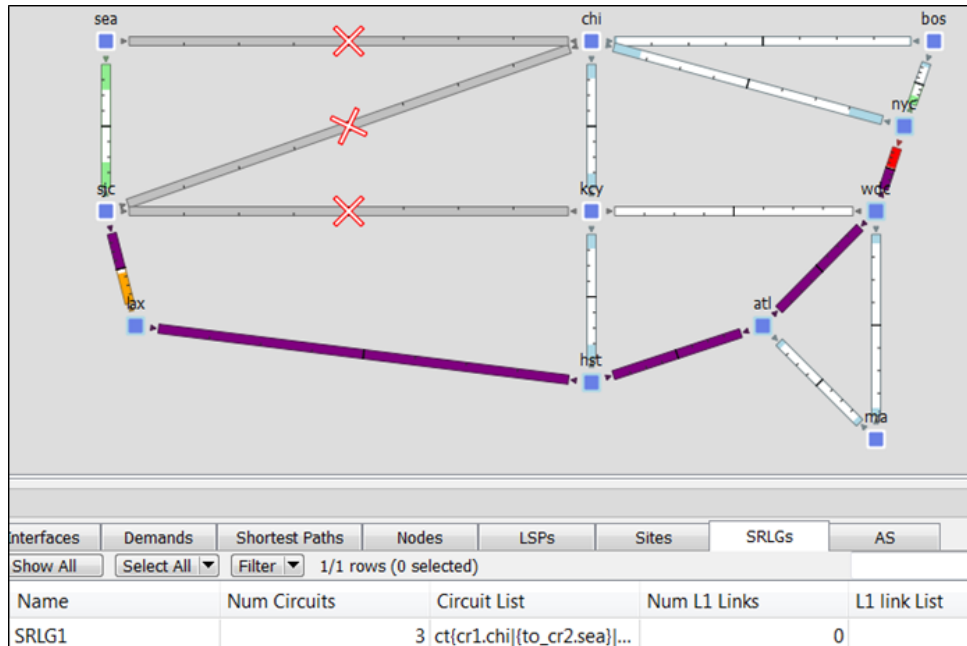
- Step 1** If `us_wan.txt` file is not open, select the File->Open menu. Browse to the `$CARIDEN_HOME/samples` directory and open the `us_wan.txt` file.
- Step 2** Create an SRLG.
- Select the Insert->SRLG menu to open a New SRLG dialog box.
  - Select Circuits from the Object Type list, and click the F on the rows for each of these circuits to set them to T (true).
    - cr1.sjc-cr1.key
    - cr2.chi-cr1.sjc
    - cr1.chi-cr2.sea

- c. Keep the name created by default (SRLG1), and click OK.

Included	Circuit	Site A	Site B	Node A	Node B
1	T cr1.chi-cr2.sea	chi	sea	cr1.chi	cr2.sea
2	T cr1.sjc-cr1.kcy	kcy	sjc	cr1.kcy	cr1.sjc
3	T cr2.chi-cr1.sjc	sjc	chi	cr1.sjc	cr2.chi

- Step 3** Verify the SRLG1 is in the SRLG table.
- Step 4** Right-click on SRLG1 and select Fail from the context menu. **Figure 3-2** shows the circuits that belong to this SRLG failed and the resulting severe congestion occurring as a result. The red crosses with white fill mean these circuits are still active, but are not operational because of other failures.
- Step 5** To restore the SRLG, right-click in an empty plot area, and select Recover.
- Step 6** Keep this plan open and continue to the next task. If you are stopping here and plan to continue later, select File->Save As and save the plan file to a different location.

**Figure 3-2 SRLG Failure**

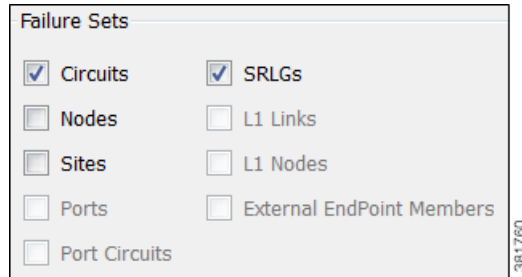


# Simulation Analysis

The Simulation Analysis tool simulates network behavior across multiple failure scenarios, multiple traffic levels, and over multiple service classes.

**Task:** Determine the network repercussions of failing single circuits and SRLGs to their worst-case utilizations.

- Step 1** This task uses the `us_wan.txt` file containing the SRLG created and saved in the last section. If it is not open, select the File->Open menu, browse to its location to open it.
- Step 2** Select the Tools->Simulation Analysis menu. A dialog box appears that allows you to select the set of failure scenarios over which the analysis will be run.
- Step 3** Select both the Circuits and SRLGs options.

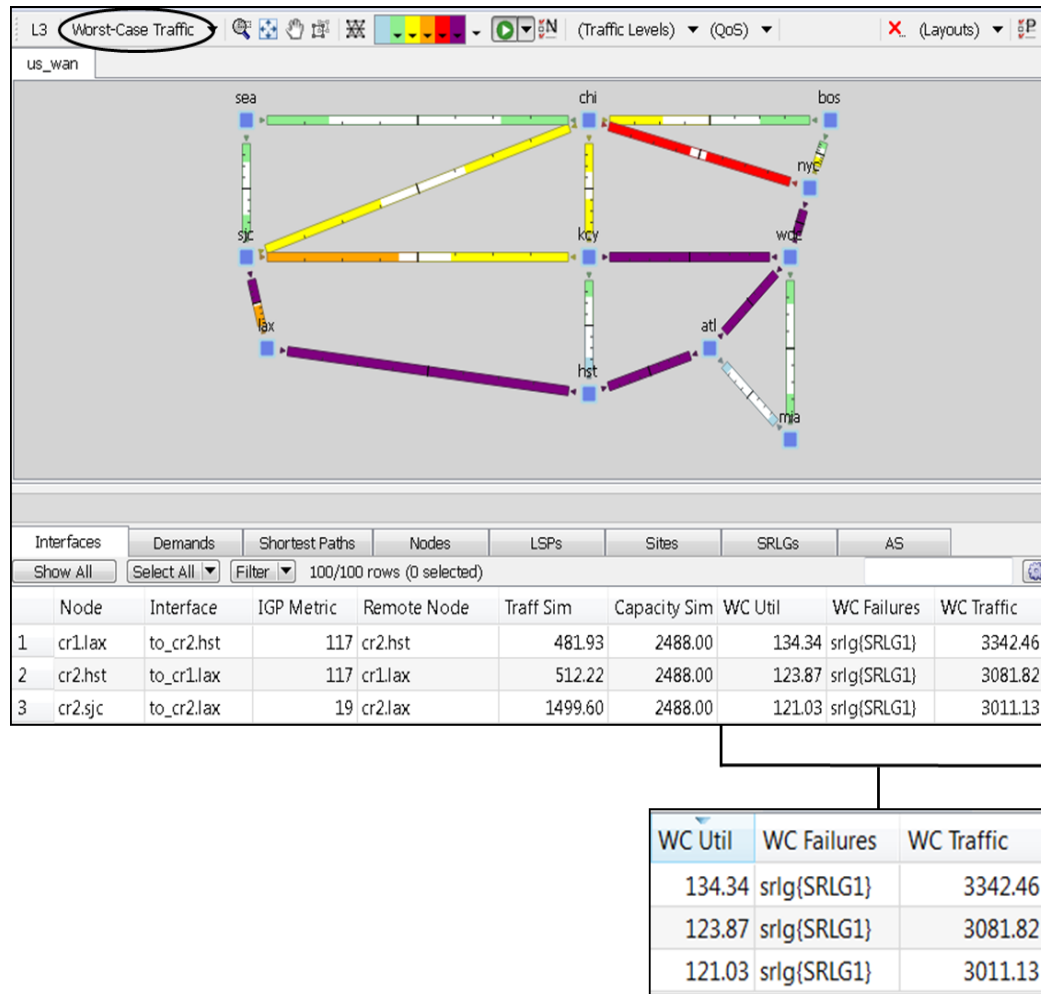


- Step 4** Leave all defaults, and click OK. By default, the tool records up to 10 failure scenarios per interface that cause the worst-case utilization.

WAE Design now performs a simulation for each possible circuit failure and each SRLG failure in the network, and calculates the utilization for these failure scenarios. The plot shows the resulting congestion in the Worst-Case Traffic view, which is located in the upper, left corner of the Visualization toolbar (Figure 3-3).

- Step 5** Find the interface
- Step 6** When all the simulations are complete, a report opens to display the results.
- Within this Report window, select the Simulations table from the left navigation pane. Each row in the table represents one of the simulations that was performed to construct the analysis. The first three columns describe the failure scenario, service class, and traffic level used in the simulation. The next two columns show that under none of these scenarios were there any break points in the network (there was always complete connectivity in the network), and that all demands were always able to be routed.
  - Notice details are listed by failure. To find which failure scenario causing the highest utilization, click the MaxUtil column to sort from highest to lowest.
  - Close the Report window.
- Step 7** Keep this plan open for the next task.

Figure 3-3 Worst-Case Simulation



## Worst-Case Failure Analysis

In the Worst-Case Traffic view the interfaces are colored based on their worst-case utilizations over all the scenarios specified for the simulation analysis (Figure 3-4). This view is very useful for seeing which circuits would become congested under different failure scenarios, and for discovering the cause of their worst-case loading on a circuit-by-circuit basis.

To better understand the meaning of the plot, imagine that for each simulation case (here, each possible circuit or SRLG failure) a transparent plot was generated. After all scenarios are run, the plots are placed on top of one another and the worst-case utilization for all circuits is displayed in the plot. It is likely that different failure scenarios produce the worst-case utilization for different circuits.

**Task:** Determine which interface had the worst-case traffic utilization under this failure scenario, and determine the failures causing it.

- 
- Step 1** Continue using the `us_wan.txt` file on which you created an SRLG and ran a worst-case simulation analysis. If you are re-opening the file, it must contain the SRLG, and you must perform the previous task that runs a simulation analysis to fail circuits and SRLGs to their worst case.
- Step 2** To find the interface with the worst-case utilization over all failure scenarios calculated for this simulation analysis, click on the WC Util column heading in the Interfaces table to toggle it to the highest-to-lowest sort order. The `cr1.lax to cr2.hst` interface has the most with 134.34% (Figure 3-3).
- Step 3** Look at the WC Failures column to note which failures result in this worst-case utilization on this interface. Here, it is the failure of SRLG1 that is the culprit.
- Step 4** Keep this plan open for the next task.

**Task:** View the failure scenarios that cause the worst-case utilization for the `cr1.nyc to cr2.wdc` interface and simulate one to determine how the network would react to this failure.

- 
- Step 1** Continue using the `us_wan.txt` file on which you ran a worst-case simulation analysis across circuits and SRLGs.
- Step 2** In the Interfaces table, right-click on the interface going from node `cr1.nyc` to `cr2.wdc`, and select Fail to WC from the context menu. The dialog box that appears lists two failures that would cause worst-case utilization on this interface. Select the first one, `ct{cr1.kcy|{to_cr1.sjc}|cr1.sjc|{to_cr1.kcy}}`, and click OK.

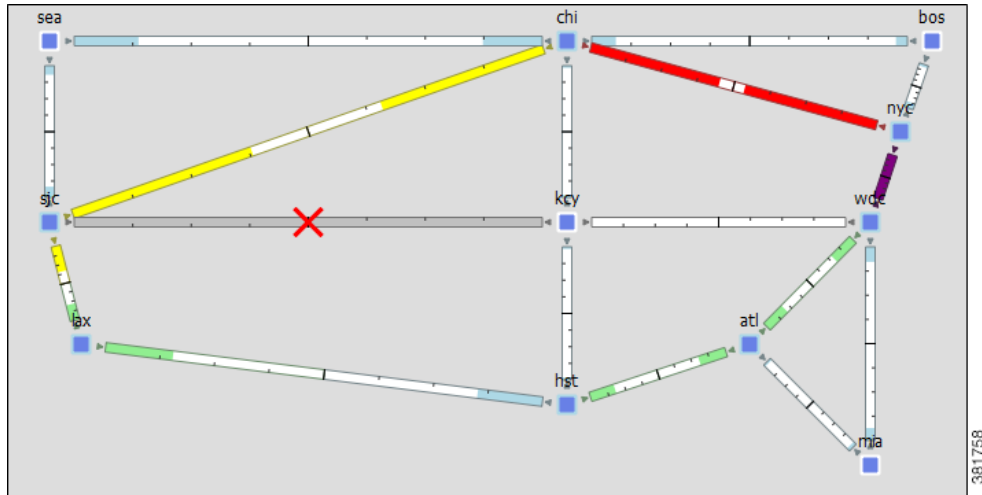
The plot now shows the effects of this failure scenario, and therefore changes to a Simulated Traffic view (Figure 3-4).

	Failure	WC Util (%)	QoS Violation (%)
1	<code>ct{cr1.kcy {to_cr1.sjc} cr1.sjc {to_cr1.kcy}}</code>	100.02	0.02
2	<code>ct{cr1.kcy {to_cr1.wdc} cr1.wdc {to_cr1.kcy}}</code>	100.02	0.02

- Step 3** To restore the failed circuit, right-click in an empty plot area and select Recover.
- Step 4** Keep this plan open for the next task.

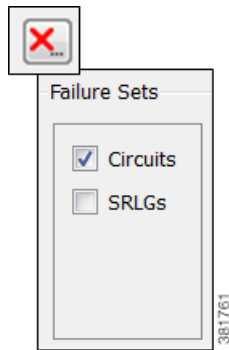


**Figure 3-4** Fail cr1.nyc-cr2.wdc to a Worst-Case Failure



**Task:** View the worst-case information over a subset of the failure set without re-running the analysis.

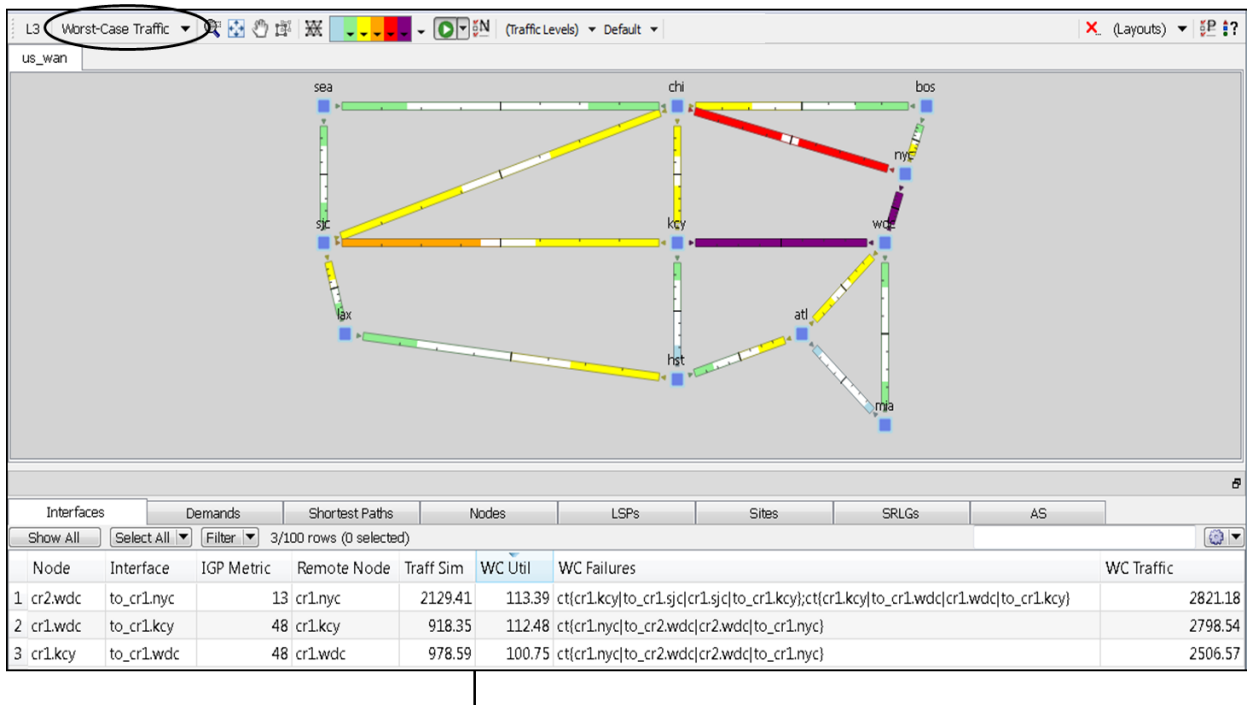
- Step 1** Continue using the `us_wan.txt` file on which you previously ran a worst-case simulation analysis across circuits and SRLGs.
- Step 2** Select the Worst-Case Traffic view from the Network Plot View drop-down list (in the top left visualization toolbar).
- Step 3** Click the red cross in the top, right of the visualization toolbar. A dialog box appears, allowing you to select a subset of the simulated failure scenarios to view.
- Step 4** Deselect the SRLGs option, and click OK.



The network plot changes to reflect utilizations over circuit failures only (Figure 3-5). The WC Util column in the Interfaces table changes to show maximum utilizations over circuit failures only. The WC Failure column shows only circuit failures resulting in these utilizations.

- Step 5** Keep this plan open for the next task.

Figure 3-5 Worst-Case Analysis for Circuit Failures Only



WC Util	WC Failures	WC Traffic
113.39	ct{cr1.kcy to_cr1.sjc cr1.sjc to_cr1.kcy};ct{cr1.kcy to_cr1.wdc cr1.wdc to_cr1.kcy}	2821.18
112.48	ct{cr1.nyc to_cr2.wdc cr2.wdc to_cr1.nyc}	2798.54
100.75	ct{cr1.nyc to_cr2.wdc cr2.wdc to_cr1.nyc}	2506.57

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## Failure Impact Analysis

The Failure Impact view colors each node and circuit to the maximum utilization level that would be caused elsewhere in the network if it were to fail. For example, by default red means a circuit is between 90 to 100% utilized. Thus, a circuit that is red in the Failure Impact view means that if that circuit were to fail, it would cause other nodes or circuits to go to 90-100% utilization. This Failure Impact analysis is automatically calculated each time you run Simulation Analysis.

**Task:** View the Failure Impact to note the impact circuit failures would have on the network.

- Step 1** Continue using the `us_wan.txt` file on which you ran a simulation analysis in the previous task on circuits only. If you are re-opening the file, you must run a worst-case simulation analysis that fails only circuits.
- Step 2** Select Failure Impact from the Network Plot View drop-down list in the visualization toolbar.
- Step 3** Show the Failure Impact row in the Interfaces table.
  - a. Right-click on any of the column heading and select Show/Hide Columns from the context menu.
  - b. Click on the empty F (false) box on the Failure Impact row to turn this F to T (true).

c. Click OK.

**Step 4** Study the plot to determine potential problems for the network should a circuit fail (Figure 3-6).

a. There are 10 interfaces (representing 5 circuits) showing purple in the network plot, but there are 12 interfaces showing utilization over 100% in the Failure Impact column. (By default, purple indicates over 100% utilization.)

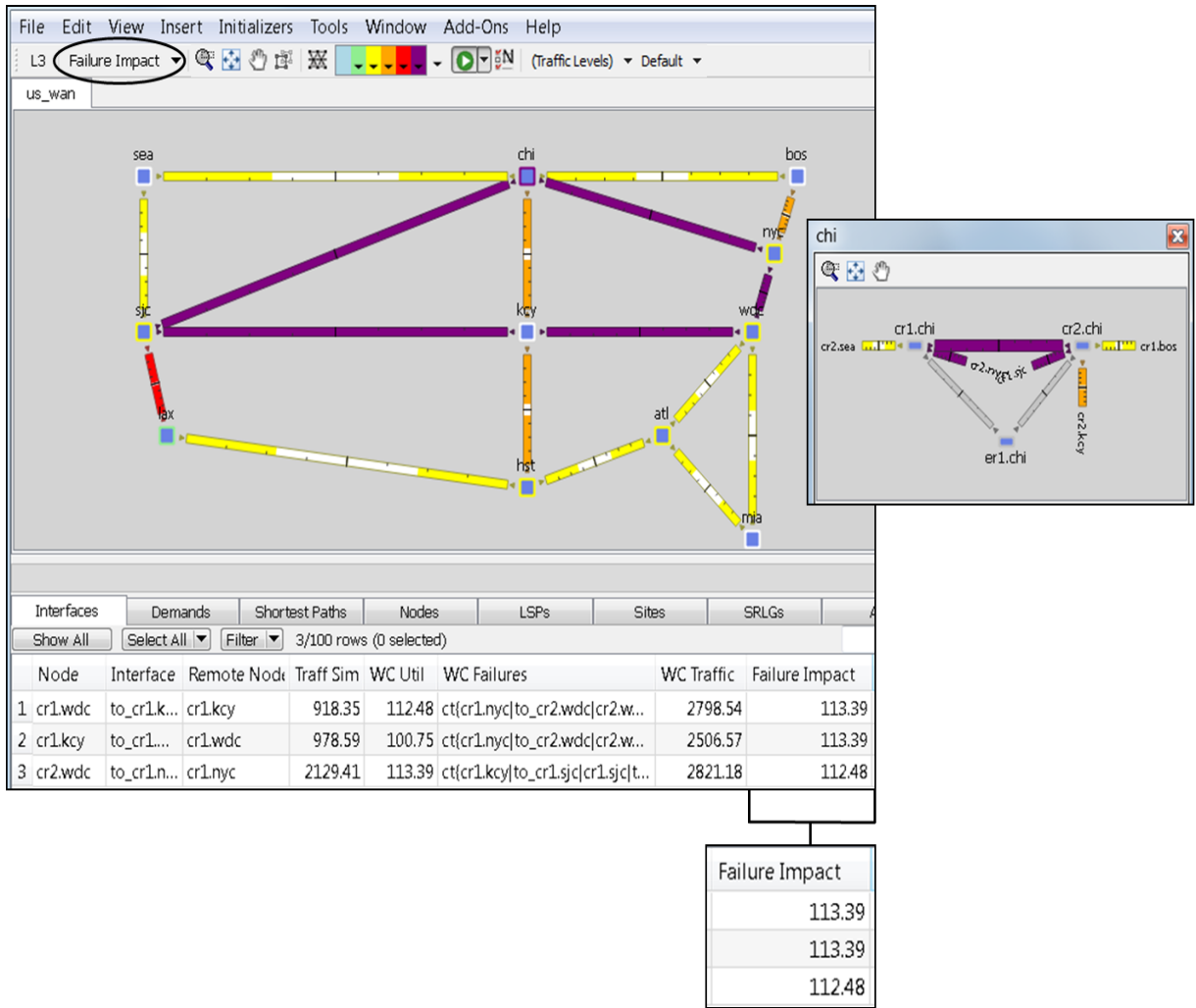
Double-click the chi site to see this sixth purple circuit.

- If any one of these purple circuits were to fail, it would cause another circuit in the network to spike to over 100% utilization.
- The cr2.lax-cr2.sjc circuit shows red, indicating that if it were to fail, another circuit would increase its utilization to 90-100%.

b. Notice the various circuit colors and borders surrounding the sites. If you do not remember what each of these colors mean, use the drop-down color utilization lists to find their utilization range.

**Step 5** Select the File->Close menu to close the file without saving it.

**Figure 3-6 Failure Impact View**



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