



SR-TE Bandwidth Optimization

The Segment Routing (SR) TE Bandwidth (BW) Optimization tool enables you to reduce the traffic utilization of selected interfaces to below a specified threshold. This ability to mitigate congestion is useful when planning for increased traffic and when determining if SLAs can be met in the event of congestion. Additionally, you can use this tool for re-optimizing bandwidth after events, such as network failures and subsequent route reconvergence.

The goal when reducing traffic is to reroute as few demands as possible. This is achieved by creating private SR LSPs for demands. The tool also creates LSP paths and segment lists for these LSP paths with the fewest node or interface segment list hops possible, with a maximum of three hops. The final hop is either a node hop or interface whose remote node is the destination of the LSP.

The tool operates on a set of constraints that determine which paths are selected, whether demands can be rerouted, and whether demand latency bounds can be surpassed. If the traffic cannot be reduced to below the threshold given these constraints, private SR LSPs are still created to route demands to reduce congestion as much as possible. If interface utilization surpasses the threshold prior to the optimization, it does not go higher. Utilization of non-congested interfaces might increase, though these will not surpass the threshold.

Note the tool reroutes existing SR LSPs only if they are private to a demand.

Operating Modes

There are two ways in which to run the SR-TE BW Optimization tool:

- **Operation**—this mode performs an optimization using a specified set of constraints.
An output plan file is produced with the optimization results. Only a single state of the network is considered. For example, if no objects are failed in the input plan file, then the optimization is performed for normal operation. If a circuit is failed in the input plan file, then the optimization is performed considering this particular failure scenario.
- **Analysis**—this mode performs multiple optimizations: one for each failure scenario within the specified failure set. The results of these optimizations are aggregated in a report.

Constraints

Both the operation and analysis modes use the same dialog box for specifying bandwidth constraints:

- **Path Selection**—When choosing demand routes, the SR-TE BW Optimization tool uses one of two criteria.

- Maximize Available BW—Paths are optimized to achieve the highest available bandwidth on interfaces (Capacity Sim - Traff Sim).
- Minimize Metric—Paths are optimized to minimize the sum of the metrics along the path with respect to delay, TE, or IGP metrics. All of these properties are configurable from an interface Properties dialog box, and delays can also be set in a circuit Properties dialog box.
- Routing Criteria—These options further enable you to fine-tune the optimization.
 - Fix Demands—Selected or tagged demands are not rerouted. This constraint is useful, for example, when you have previously optimized specific LSPs within the network and want to maintain the route of one or more existing demands.
 - Latency Bound—Demands cannot surpass their configured latency bound. This property is set in a demand's Properties dialog box.

Bandwidth Optimization Report

Upon completion of a basic optimization, the SR-TE BW Optimization tool generates a summary report to identify key changes due to the optimization. The tool tags the LSPs with *SRBWopt* and generates a new plan file named with an *-SRBWopt* suffix. This plan file opens, showing the LSPs table that is filtered to these rerouted (and newly tagged) LSPs. Saving this plan file then simplifies the process of identifying which LSPs to reconfigure in the network. Both the tags and the new plan file names are editable.

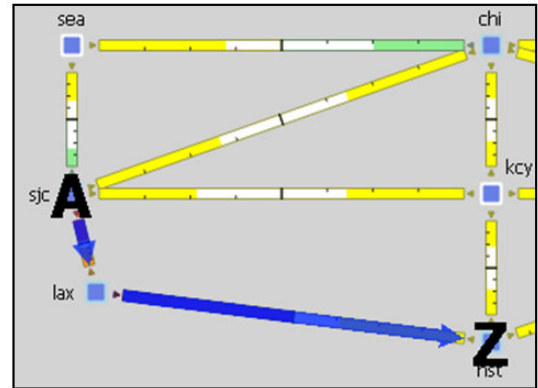
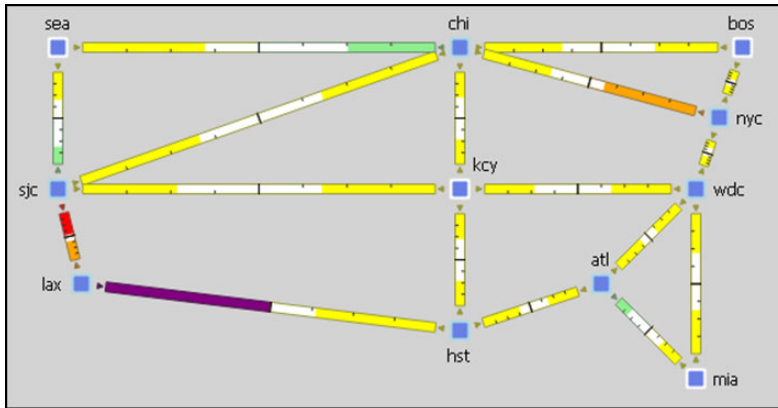
After running the bandwidth optimization, the optimizer creates a summary report identifying the following.

- Number of interfaces that exceeded the utilization both before and after the optimization
- Maximum utilization both before and after the optimization
- Number of demands that were rerouted
- Average segment list length
- Number of latency bound violations both before and after the optimization

Examples

Figure 23-1 shows a network prior to bandwidth optimization. It has no LSPs, and there is congestion between San Jose (sjc) and Los Angeles (lax), as well as between Los Angeles (lax) and Houston (hst). Sorting the Util Sim column shows the top five highest utilizations with two of them higher than 90%. Notice that the demand from sjc to hst routes directly over these highly used interfaces.

Figure 23-1 Network Before Optimization

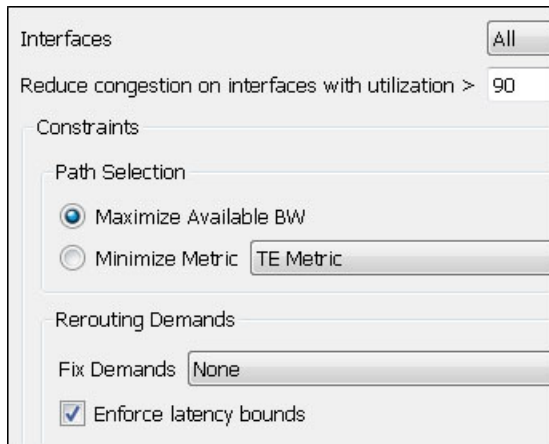


Interfaces					
Node	Interface	Remote Nod	Traff Sim	Capacity Sim	Util Sim
cr1.lax	to_cr2.hst	cr2.hst	2540.09	2488.00	102.09
cr2.sjc	to_cr2.lax	cr2.lax	2270.78	2488.00	91.27
cr2.nyc	to_cr1.chi	cr1.chi	2144.68	2488.00	86.20
cr2.lax	to_cr2.sjc	cr2.sjc	1991.40	2488.00	80.04
cr2.atl	to_cr1.wdc	cr1.wdc	1989.63	2488.00	79.97

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To optimize the maximum available bandwidth to be below 90% and to enforce latency bounds, the following parameters are set.

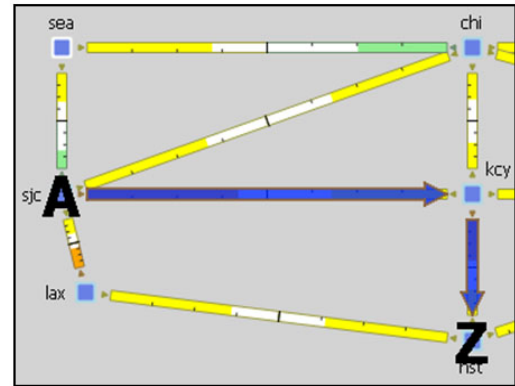
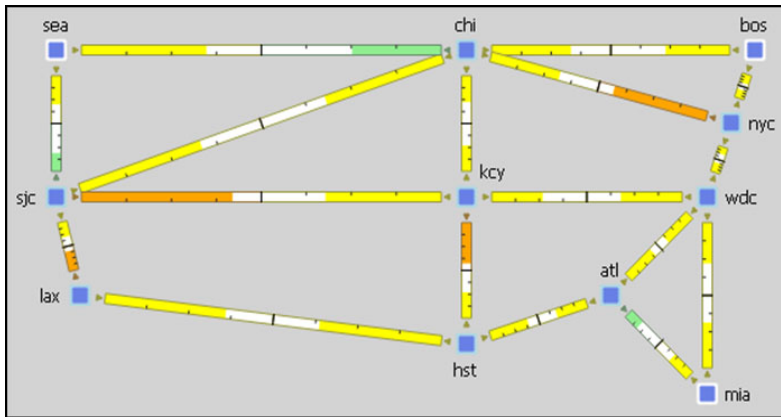
- Congestion threshold = 90%.
- Base the rerouted paths on maximizing available bandwidth.
- Enforce latency bounds.



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The result of this optimization is that no interfaces have utilization over 90%, and the interfaces with the highest utilization are different interfaces than prior to the optimization. Figure 23-2 shows this redistribution of traffic across the network. The only demand rerouted was the one between sjc and hst, which you can compare to Figure 23-1.

Figure 23-2 Network After Reducing Utilization to Below 90%



Interfaces					
Node	Interface	Remote Node	Traff Sim	Capacity Sim	Util Sim
cr2.nyc	to_cr1.chi	cr1.chi	2144.68	2488.00	86.20
cr2.kcy	to_cr1.hst	cr1.hst	2124.55	2488.00	85.39
cr1.sjc	to_cr1.kcy	cr1.kcy	2088.27	2488.00	83.93
cr2.lax	to_cr2.sjc	cr2.sjc	1991.40	2488.00	80.04
cr2.atl	to_cr1.wdc	cr1.wdc	1989.63	2488.00	79.97

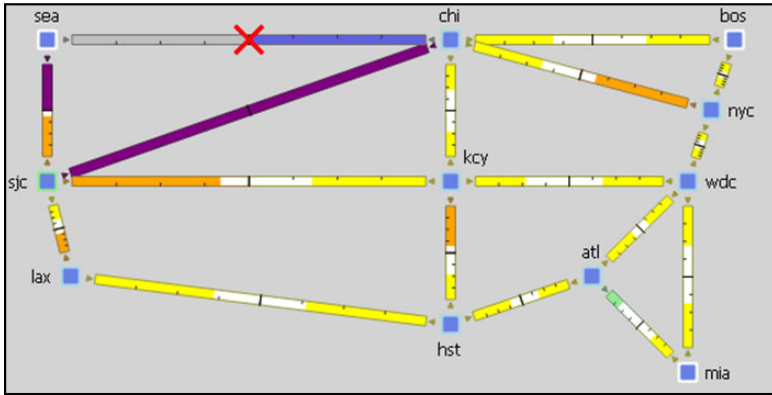
Number of Rerouted Demands	:	1

	Before	After
Number of congested interfaces:	2	0
Maximum interface utilization:	102.09%	86.2%

Figure 23-3 shows this same network, but with a failed circuit between Seattle (sea) and Chicago (chi). There are three interfaces with over 100% utilization. Here, the SR-TE BW Optimization tool was rerun using the same parameters as above except the congestion threshold was set to 100. Although congestion cannot be completely mitigated, the tool minimizes congestion as much as it can, leaving only one interface congested (over 100% utilized).

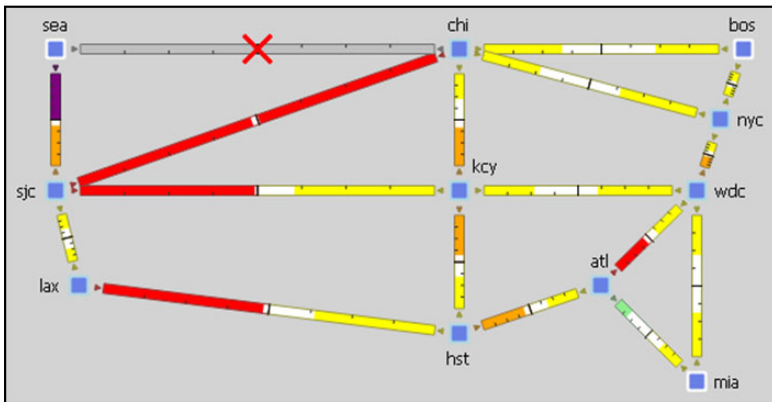
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Figure 23-3 Optimized Network Under Failure



Util Sim
136.26
129.35
113.98
87.53
86.20
85.39
83.93
80.04

Before Optimization



Util Sim
129.35
99.23
98.46
96.96
96.53
90.21
88.57
87.53

After Optimization

Number of Rerouted Demands	:	4

	Before	After
Number of congested interfaces:	3	1
Maximum interface utilization:	136.26%	129.35%

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Optimize Bandwidth

Step 1 Skip this step if using tags. You can also skip this step if you want to run the tool on all interfaces, and if you are not selecting demands to fix.

If you are fixing selected demands and/or if you are running the optimization on selected interfaces, select them before opening the dialog box.

- If you are selecting one or the other, then do so from their respective Demands or Interfaces tables.
- If you are selecting both, make your selection in one table, and then press and hold the Alt key (Option key on Mac) while making selections in another table.

Step 2 Select the Tools > SR-TE BW Optimization menu.

Step 3 Select whether to optimize bandwidth for all interfaces, selected interfaces, or tagged interfaces.

- Step 4** Specify constraints. See the [Constraints](#) section.
- Step 5** Specify whether to create and add tags to all SR LSPs rerouted during optimization. You can edit the *SRBWopt* default.
- Step 6** Specify whether to create a new plan with the results of the optimization. Unless a name is specified, WAE Design attaches an *-SRBWopt* suffix to the current plan file name. If not selected, WAE Design changes the current plan file with the updated information.
- Step 7** Click OK.

Analyze Congestion under Different Failure Sets

You can perform multiple optimizations: one for each failure scenario within a specified failure set. The results of these optimizations are aggregated in a report. This way, you can evaluate the ability of the optimizer to mitigate congestion under different failure scenarios.

- Step 1** .Navigate to Tools > SR-TE BW opt and select Analysis. By default, the analysis tool presents you with the Basic bandwidth optimization options, see the [Constraints](#) and [Optimize Bandwidth](#) sections for more information.
- Step 2** In the SR-TE BW Analysis tool, select the Failure Set tab.
- Step 3** Select one or more failure sets that you want the optimizer to consider:
 - Circuits
 - Nodes
 - Sites
 - Ports
 - Port Circuits
 - L1 Links
 - L1 Nodes
 - L1 Ports

Certain entries appear grayed out if they are not available in your design plan.

- Step 4** (Optional) Specify the Maximum number of threads.

By default, the optimizer attempts to set this value to the optimal number of threads based on the available cores.
- Step 5** Click OK.

This runs a simulation analysis and creates the optimization report. You can view additional capacity information on the Capacity Upgrades report.

Related Topics

- [Traffic Demand Modeling](#) chapter
- [MPLS Simulation](#) chapter
- [Segment Routing Simulation](#) chapter
- [SR-TE Optimization](#) chapter
- [LSP Disjoint Path Optimization](#) chapter
- [LSP Setup Bandwidth Optimization](#)
- [LSP Loadshare Optimization](#) chapter
- [Plan Objects](#) (for creating tags)

