



## RSVP-TE Optimization

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The RSVP-TE Optimization tool creates explicitly routed LSP paths to optimize route properties such as distance, TE metrics, utilization, and disjointness. The routing decisions are centralized within the tool, in contrast to traditional RSVP-TE routing, in which routing decisions are distributed across the head-end routers in the network. Although it has fewer parameters, this tool is faster and has a more predictable run-time than the Explicit LSP Optimization tool and thus, is the recommended method for explicit RSVP-TE LSP path optimization.

The primary optimization goal is to minimize path distance (which can be based on interface TE metrics, delay, or user-defined value), while not exceeding a *bandwidth bound* defined for each interface so as to avoid congestion. Unlike RSVP-TE, LSPs are routed even if they cannot avoid exceeding bandwidth bounds for certain interfaces, though these bound violations are minimized.

You can specify different treatment for different LSPs: whether the LSPs should be rerouted to shorten the path distance, only as necessary to reduce congestion, or not optimized at all. These three LSP groups are called *Opt*, *Fit*, and *Fix* respectively. Using these input parameters allows for a variety of use cases such as the following.

- Global optimization—Minimize the path length of all LSPs subject to specified interface bandwidth constraints.
- New LSP optimization—Minimize the path length of newly created LSPs without exceeding bandwidth bounds specified for the interfaces. Existing LSPs are kept on their current paths, being moved only if necessary to prevent new LSPs from violating bandwidth bound constraints.
- Tactical congestion mitigation—Change the routing of as few LSPs as possible to bring bandwidth on all interfaces below the specified bandwidth bound.

To access the tool, select the Tools->RSVP-TE LSP Optimization menu.

Upon completion, WAE Design generates a new plan file named with a suffix, which by default is *RSVPTEOpt*. This suffix is configurable in the “New plan for result” field. As such, the tool is beneficial for off-line planning and configuration of an explicitly routed RSVP-TE network. It is also useful for providing routing decisions for a centralized, reactive network control application, such as can be implemented on the WAE platform.

This optimized plan file opens showing the LSPs table filtered to the rerouted LSPs. Saving this plan file then simplifies the process of identifying which LSPs to reconfigure in the network.

# Optimization Inputs

The RSVP-TE Optimization tool uses the LSP and interface *input properties* listed in [Table 20-1](#) to execute its optimization calculations. These properties, which are specified in user columns in LSPs and Interfaces tables, can be created in one of two ways.

- Use the tool to automatically create (initialize) the properties if they do not exist. The selections made in the Specify LSP Groups, LSP Parameters, and Interface Parameters sections populate the input properties ([Table 20-1](#)).

**Example:** If you select LSPs to optimize, to fit, and to fix, the tool creates the RSVPTEOpt::Group column in the LSPs table and sets this property to the appropriate values for each LSP (Opt, Fit, Fix). If the property already exists, then it is updated with the new value if it has changed.

**Example:** If you select to set the interface bandwidth bound based on the Resv BW property, the tool creates the RSVPTEOpt::BWBound column in the Interfaces table and for each interface, copies the Resv BW value to it. If the property already exists, then it is updated with the new bandwidth bound value if it has changed.

- Before running the tool, manually create the input properties ([Table 20-1](#)) as user columns in the LSPs and Interfaces tables. When running the tool, you must then select the “Use Existing RSVPTEOpt::<property\_name>” option. This is useful if you want to configure specific values rather than using existing properties and values. For information on creating user-defined columns, see the [User Interface](#) chapter or for more detail, see the *WAE Design Integration and Development Guide*.



## Note

Since the resulting plan file can potentially reset properties that can be used as input to optimizations, it is a best practice to run the optimization only on plan files or LSPs that have not yet been optimized. For example, by default WAE Design resets the LSP Setup BW property to 0 after optimizing LSPs, and this same property could be used as input to other optimizations.

**Table 20-1** RSVPTEOpt Input Parameters

Table	Input Property	Description and Values Used to Create the Input Property
LSPs	RSVPTEOpt::Group	LSP optimization group.  The input property is derived based on your entries in the “Specify LSP Groups” section unless you select to use the existing RSVPTEOpt::Group property. Values are Opt, Fit, or Fix. If the value is not defined, it is set to Ignore.
	RSVPTEOpt::BWReq	The bandwidth required by each LSP that is being optimized.  The input property is derived from the Setup BW, Traff Meas, or Traff Sim LSP properties unless you specify to use the existing RSVPTEOpt::BWReq value.

**Table 20-1**      *RSVPTEOpt Input Parameters*

Table	Input Property	Description and Values Used to Create the Input Property
Interfaces	RSVPTEOpt::BWBound	Sum total of LSP bandwidth routed over the interface should not exceed this value.  The input property is derived from the Resv BW, Capacity, or Capacity Sim interface properties unless you specify to use the existing RSVPTEOpt::BWBound value.
	RSVPTEOpt::Metric	Metric value used in the shortest path calculations.  The input property is derived from either the TE Metric or Delay property of the interface unless you specify to use the existing RSVPTEOpt::Metric value.

## Selecting LSP Groups

To determine how and whether LSPs are optimized, select them from the “Specify LSP Groups” section. If an LSP is in multiple groups, the first group in which it resides is how the LSP is treated.

- **Opt**—Explicitly route or reroute these LSPs to minimize their path length, while respecting the bandwidth bounds specified for the interfaces. The RSVP-TE Opt tool changes the LSP path as much as needed to find the optimal route. First, it tries to set the LSP to its shortest path, which is defined by the interface Metric parameter. The LSP is moved away from the shortest path only if needed due to congestion.

Setting all LSPs to this option is useful when trying to achieve global optimization on all LSPs.

- **Fit**—Reroute these LSPs only as necessary to respect specified bandwidth bounds on the interfaces, while accommodating the Opt group. If there is currently no explicit route or if the route is incomplete, treat like Opt LSPs.

This option is useful when attempting tactical congestion mitigation, where it is desirable to move as few LSPs as possible to remove existing congestion.

A combination of Opt and Fit or a combination of Opt and Fix is useful for targeting the optimization of new LSPs.

- **Fix**—Do not reroute these LSPs, but consider them in the optimization calculations.

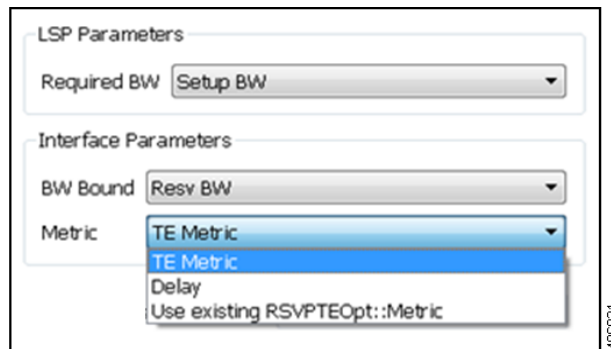
LSPs that are not selected are ignored, and as such, maintain their original configuration and are not considered in the optimization calculations. This can be useful if you have network regions that do not interfere with optimizations. Note, though, that if measured interface traffic is used in the optimizations, traffic contributions from the ignored LSPs to this measured traffic might affect the results.

Since you can set each of the “Set RSVPTEOpt::Group” selections to None, All, only selected, or tagged LSPs, you can section off specific LSPs for one optimization treatment or another.

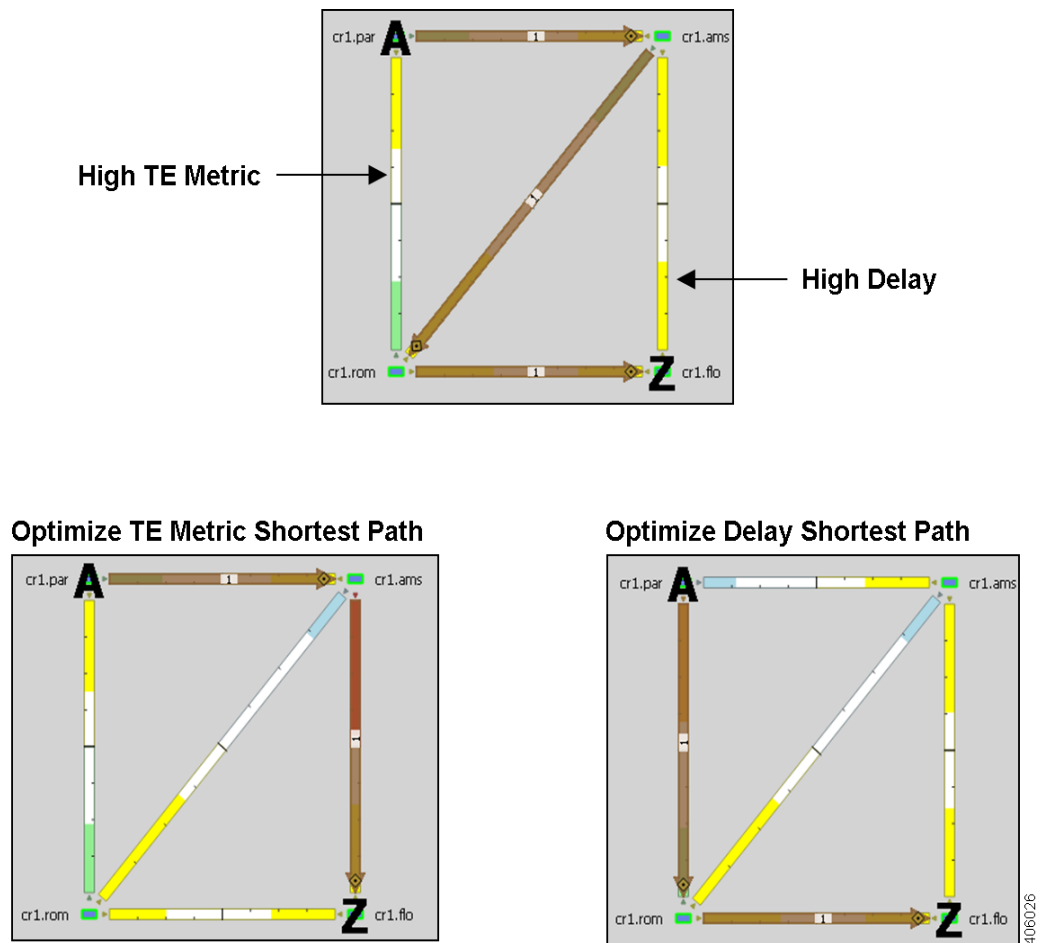
**Example:** Tag new LSPs and set them to be optimized (Opt LSPs). Select and set existing LSPs to Fit LSPs to optimize their paths only as necessary to accommodate bandwidth bound constraints.

## Setting Optimization Parameters

Optimization calculations are based on two sets of parameters that define how much bandwidth the LSPs require, how much bandwidth the interfaces have available for these LSPs, and which metric to use for shortest path. See [Table 20-1](#) for selection options.



- LSP Required BW—Specify how to determine the bandwidth required for the primary LSP paths.
- Interface parameters
  - BW Bound—Specify how much bandwidth the interfaces have available to carry LSPs. WAE Design attempts to route LSPs without surpassing this bound, but exceeds it if necessary.
  - Metric—Specify which metric to use for shortest path calculations. [Figure 20-1](#) shows an example of an LSP path that is optimized once based on the TE Metric and once based on the Delay.

**Figure 20-1** Example Shortest Path Optimization

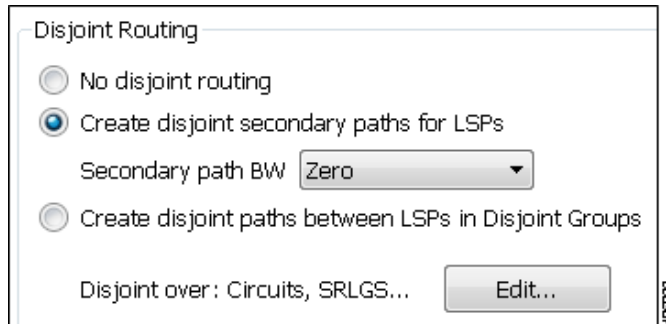
## Setting Disjoint Groups

In the Advanced tab, you can create disjoint paths or use existing disjoint paths as follows. Note that two LSP paths are *disjoint* if they do not route over common objects. These objects are configurable and can be circuits, nodes, sites, SRLGs, or L1 links.

- No disjoint routing—Do not create disjoint secondary paths and do not enforce any disjointness on primary paths.
- Create disjoint secondary paths for LSPs—Create secondary LSP paths that are disjoint from the primary LSP paths.

Additionally, specify whether to include secondary paths in the optimization. If set to Zero, their bandwidths are set to 0 and are not included. If set to Prim, their required bandwidths are set to be the same as the primary paths, and they are included in the optimization.

- Create disjoint paths between LSPs in Disjoint Groups—Create disjoint paths between LSPs that are in disjoint groups.



## Setting Post-Optimization Parameters

The Post Optimization options identify whether and how to reset the Setup BW for modified LSPs.

- Reset Setup BW to 0
- Reset Setup BW to be the same as the resulting RSVPTEOpt::BWReq value
- Keep the Setup BW the same

## Optimization Output

### Properties Created

In addition to creating the input parameters, as described in the [Optimization Inputs](#) section, the tool generates the properties listed in [Table 20-2](#). These properties provide further insight into the optimizations.

**Table 20-2** *RSVPTEOpt Parameters Used as Optimization Input*

Table	Property	Description
LSPs	RSVPTEOpt::Action	Identifies whether the LSP's path was updated (optimized).
	RSVPTEOpt::PathMetric	Sum of interface metrics on the LSP path.
	RSVPTEOpt::ShortestPath	Identifies whether the LSP is now taking the shortest path.
	RSVPTEOpt::ShortestPathMetric	Sum of interface metrics on the shortest LSP path.
Interfaces	RSVPTEOpt::BWTotal	Sum of the bandwidth required for all LSPs routed on the interface.
	RSVPTEOpt::BWBoundExceeded	Identifies whether the bandwidth bound of the interface was exceeded.

### Optimized LSPs Reconfigured

The optimized LSPs are reconfigured with the following parameters.

- Metric Type = Autoroute
- Metric and Hop Limit = na
- Setup BW = 0, the same value as the resulting RSVPTEOpt::BWReq, or unchanged, depending on how you configured the Post Optimization option in the Advanced tab
- Primary paths Standby = T (true)
- Status = Active
- FRR Enabled = T (true)
- LSP entry in the Actual Paths table is removed

## Report Generated

WAE Design writes a report containing the results of the optimization. To access this information, select the Window->Reports menu.

The report summarizes the results of the optimization, such as how many LSPs there are total compared to how many were optimized, as well as how they were optimized. It also summarizes how disjoint priorities were handled and the number of paths that exceed the interface's bandwidth bound.

## Examples

### Optimizing New LSPs Example

Figure 20-2 shows three LSPs: LSP\_A is configured with 4,000 Mbps of Setup BW, LSP\_B with 5,000 Mbps of Setup BW, and LSP\_C, which represents a newly added LSP, with 6,000 Mbps of Setup BW. Each interface has a Resv BW value of 10,000 Mbps. Without optimization, this newly added LSP\_C is using three hops to reach cr1.bos because this is the only path with sufficient bandwidth.

**Figure 20-2 Non-Optimized LSP Routes**

Node	Interface	Resv BW Sim	Remote Node
cr1.chi	to_cr1.nyc	10000.00	cr1.nyc
cr1.nyc	to_cr1.chi	10000.00	cr1.chi
cr1.wsh	to_cr1.bos	10000.00	cr1.bos
cr1.bos	to_cr1.wsh	10000.00	cr1.wsh
cr1.chi	to_cr1.wsh	10000.00	cr1.wsh
cr1.wsh	to_cr1.chi	10000.00	cr1.chi
cr1.nyc	to_cr1.wsh	10000.00	cr1.wsh
cr1.wsh	to_cr1.nyc	10000.00	cr1.nyc
cr1.nyc	to_cr1.bos	10000.00	cr1.bos
cr1.bos	to_cr1.nyc	10000.00	cr1.nyc

Name	Source	Destination	Setup BW
LSP_A	cr1.chi	cr1.bos	4000.00
LSP_B	cr1.chi	cr1.bos	5000.00
LSP_C	cr1.chi	cr1.bos	6000.00

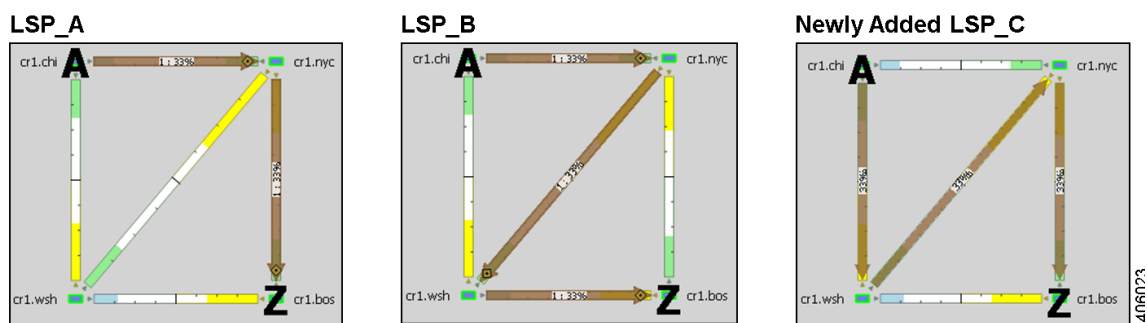
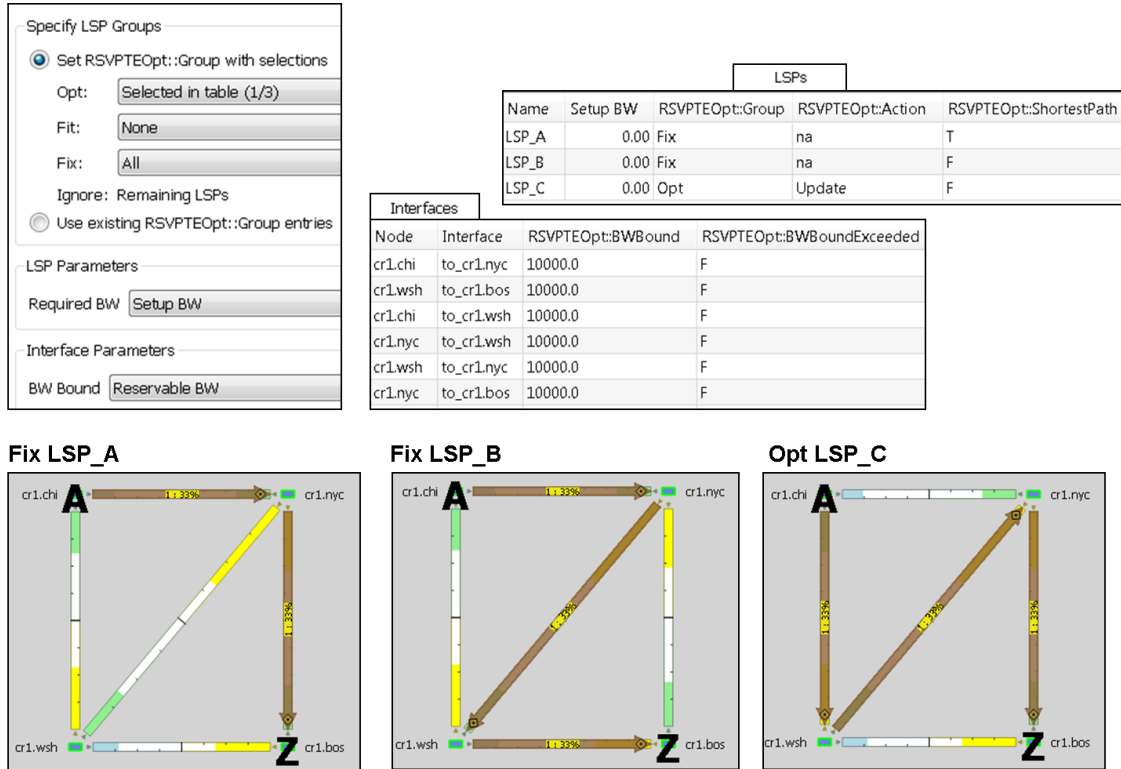
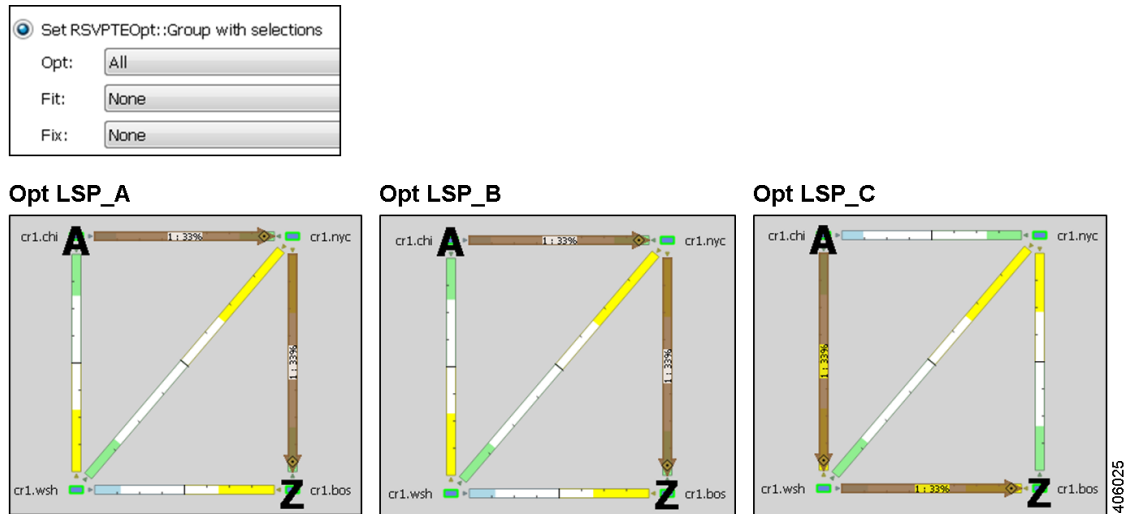


Figure 20-3 shows the results of prioritizing the optimization of the new LSP by setting it to Opt, and setting the other two LSPs to route “as is” by setting them to the Fix LSP group. The LSP Required BW parameter is Setup BW, and the interface BW Bound is Resv BW. While a primary path with explicit hops is created for LSP\_C, all LSPs remain on the same route. This demonstrates that LSP\_C cannot go on a two-hop path without exceeding bandwidth and it cannot alter this behavior by shifting the other two LSPs around because they are set to Fix. The interface bandwidth bound, however, is not exceeded, which is shown in the RSVPTEOpt::BWBoundExceeded column in the Interfaces table. The LSPs table shows that only LSP\_C was updated in the RSVPTEOpt::Action column, and that neither LSP\_B, nor LSP\_C are on their shortest path. Notice also in the LSPs table that the Setup BW values are reset to 0, which is the default behavior, and that the RSVPTEOpt::Group shows how each LSP was considered during the optimization (Fix or Opt).

Figure 20-4 shows the results of an alternative optimization where all three LSPs are set to Opt. The resulting plan file shows both LSP\_B and LSP\_C were optimized to route on shortest paths without exceeding bandwidth bounds.



**Figure 20-3** Example: No Optimization Improvements When Setting New LSP\_C to Opt and All Other LSPs to Fix

**Figure 20-4** Example: Improved Global Optimization When Setting All LSPs to Opt

## Tactical Mitigation Example

Figure 20-5 shows three non-optimized LSPs: LSP\_A and LSP\_B have 4,000 Mbps and 5,000 Mbps of Setup BW, respectively. They route the same as in Figure 20-2. LSP\_C has 12,000 Mbps of Setup BW, leaving it unable to route since all interfaces have a Resv BW of 10,000 Mbps.

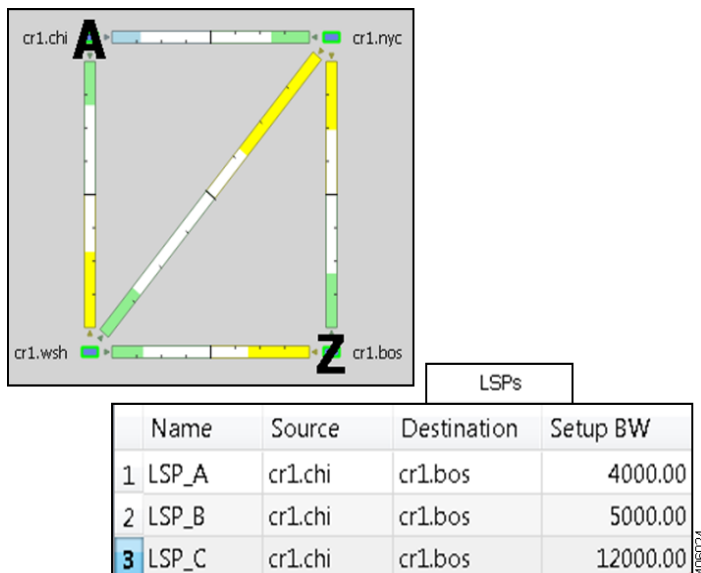
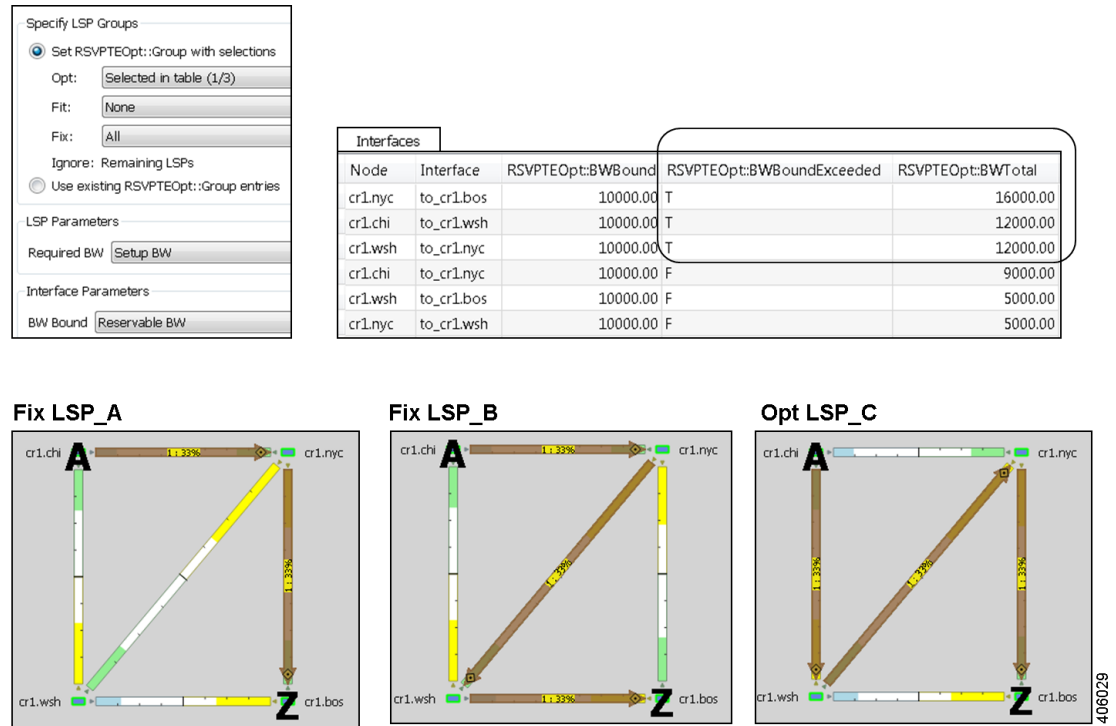
**Figure 20-5** Unroutable LSP Due to Insufficient Bandwidth

Figure 20-6 shows an optimization run to set this high-Setup BW LSP\_C to Opt and keep the other LSPs set to Fix. This results in congestion and leaves three interfaces exceeding their bandwidth bound.

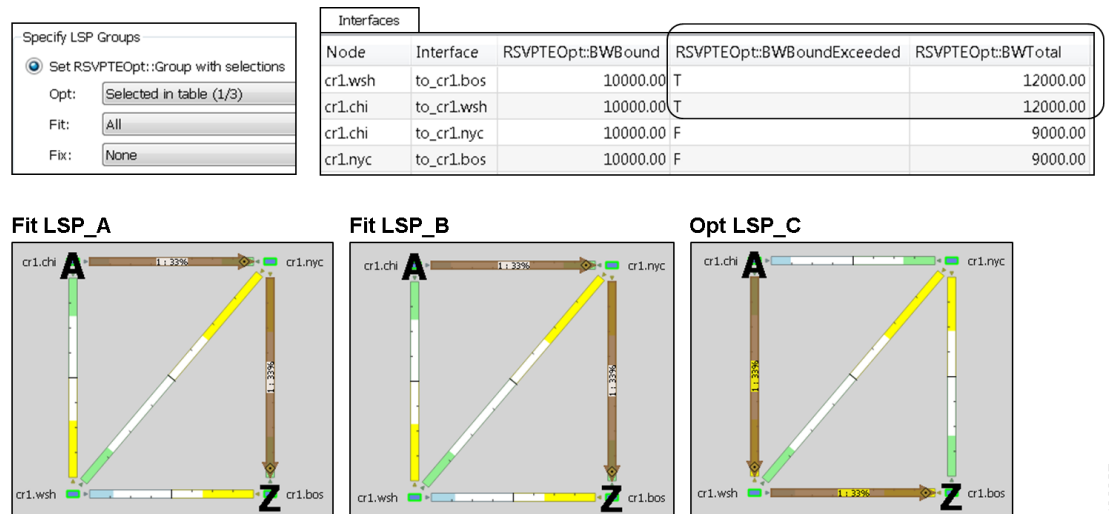
An alternative is shown in Figure 20-7, where congestion is reduced by running the optimization to set LSP\_C to Opt, while setting the other LSPs to Fit. This enables WAE Design to adjust the routes of the other LSPs as needed to achieve the best optimization possible (lowest shortest-path metric with the

least congestion). While both LSP\_B and LSP\_C route on two hops now, two interfaces still exceed their bandwidth bound, though the amount of congestion is significantly less. Note that the same result would be achieved if all three LSPs had been set to Opt.

**Figure 20-6** Example: Congestion Occurs When Settings LSPs to Fix



**Figure 20-7** Example: Tactical Congestion Mitigation Using Fit LSPs



# Workflow

## Preparation

- Step 1** If this is the first time using the tool and if you want to use your own pre-configured RSVPTEOpt properties, you must manually edit the LSPs and Interfaces tables to create them.
- LSP RSVPTEOpt::Group—Place LSPs into the Opt, Fit, or Fix groups. Any remaining LSPs are placed in the Ignore group.
  - LSP RSVPTEOpt::RequiredBW —Define an exact amount for the sum total of LSP bandwidth that is using the interface.
  - Interface RSVPTEOpt::BWBound—Define an exact amount of bandwidth that the interface can hold.
  - Interface RSVPTEOpt::Metric—Define an exact amount to use in shortest path calculations.
- Step 2** If creating disjoint paths between LSPs in the same disjoint group, the LSPs must first be added to the disjoint groups in the LSP Properties dialog box. Here, you can also assign priorities to LSPs within these groups. Higher priority LSPs are assigned shorter routes based on the metric being used for shortest path calculations. The higher the number, the lower the priority.



The screenshot shows a dialog box with two fields: "Disjoint Group:" with a dropdown menu set to "GBD" and "Disjoint Priority:" with a text input set to "1". A vertical label "381082" is visible on the right side of the dialog box.

- Step 3** If using tagged LSPs, create those tags. For information on how to create tags, see the [Plan Objects](#) chapter.

## Optimization Configuration

See the [Optimization Inputs](#) section.

- Step 4** If running the optimization based on selections, select those LSPs.
- Step 5** Select the Tools->RSVP-TE LSP Optimization menu.
- Step 6** In the Specify LSP Groups section, make selections for optimizing LSPs based on Opt, Fit, or Fix LSP groups, or based on those defined in the RSVPTEOpt::Group property. See the [Selecting LSP Groups](#) section.
- Step 7** In the LSP Required BW field, set bandwidth requirements for the primary LSP paths. See the [Setting Optimization Parameters](#) section for steps 7-9.
- Step 8** In the interface BW Bound field, set how much bandwidth the interfaces can carry.
- Step 9** In the Metric field, specify on which property to base the shortest path.
- Step 10** Optional: Specify the name of the resulting plan file.

## Optional Advanced Configurations

- Step 11** Click the Advanced tab.

- Step 12** Identify whether to create disjoint LSP paths and if so, how you want them defined. See the [Setting Disjoint Groups](#) section.
- Step 13** Specify whether to reset the LSP bandwidth after the optimization, and if so, how so. See the [Optimized LSPs Reconfigured](#) section.
- Step 14** Click OK.
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## Related Topics

- [MPLS Simulation](#) chapter
- [RSVP-TE Simulation](#) chapter
- [LSP Loadshare Optimization](#) chapter
- [LSP Optimization](#) chapter
- *WAE Design Integration and Development Guide* (for adding user columns)

