# 7 Dimensioning

You can dimension your network topology according to one or more traffic matrices. In general, SP Guru Transport Planner does “upgrade” dimensioning: it upgrades the network capacity to meet the input traffic but does not change or remove existing facilities or traffic.

The following steps outline the basic workflow:

1) Design the links.

   This operation places amplification and regeneration equipment along a link. Make sure you design the links before you dimension your network. For more information, see Link Design on page TrP-3-45.

2) Dimension the network—For more information, see Dimensioning a Topology.

3) Strip network capacity *(optional)*.

   This operation enables you to strip traffic or capacity from the network to undo the effects of a dimensioning operation. For more information, see Strip Capacity on page TrP-7-13.

## Dimensioning a Topology

When you dimension a network at a network layer, SP Guru Transport Planner installs the required node and link equipment to support a traffic matrix at that layer. SP Guru Transport Planner performs upgrade dimensioning: it upgrades the network equipment to meet the new traffic demands, but retains existing equipment and traffic. SP Guru Transport Planner can dimension at two layers:

- The DCL layer of a network that contains ECC nodes only. This type of network can accommodate DCL traffic only. When you dimension for a DCL traffic matrix, SP Guru Transport Planner equips the fibers with the appropriate SONET/SDH systems at a specific bit rate and accommodates the nodes with the correct SONET/SDH switches.
- The OCH layer of a network that contains EOCC and OCC nodes. When you dimension for an OCH traffic matrix, SP Guru Transport Planner equips the fibers with the correct WDM line systems and accommodates the nodes with the correct regeneration equipment (if the network is transparent) and optical switches (OXCs, OADMs, etc.).

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**Note—**If your network contains a mix of ECC, EOCC, and OCC nodes, a dimensioning operation at the DCL layer can affect multiple network layers. A multi-layer design is accomplished by a grooming action instead of a dimensioning action.

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You can apply the dimensioning algorithms multiple times in the same network for different traffic matrices and protection strategies, as shown in the following equation. You can dimension for multiple traffic matrices simultaneously if these traffic matrices have the same protection type and routing option. For each subsequent matrix that is added, SP Guru Transport Planner uses spare capacity on existing line facilities and adds new systems as needed. The different traffic matrices might also represent the different time frames for which you want to design the network.

| | | |
|---|---|---|
| Matrix A + Matrix B | dimension with 1 + 1 protection | adds X1 line facilities at cost Y1 |
| Matrix C + Matrix D | dimensioned with restoration | adds X2 line facilities at cost Y2 |
| Matrix E + Matrix F | dimensioned unprotected | adds X3 line facilities at cost Y3 |

# Dimension DCL/OCH Layer Dialog Box

To dimension your topology, choose Design > Dimension DCL/OCH Layer; this opens the Dimension DCL/OCH Layer dialog box.

**Figure 7-1 Dimension DCL/OCH Layer Dialog Box**

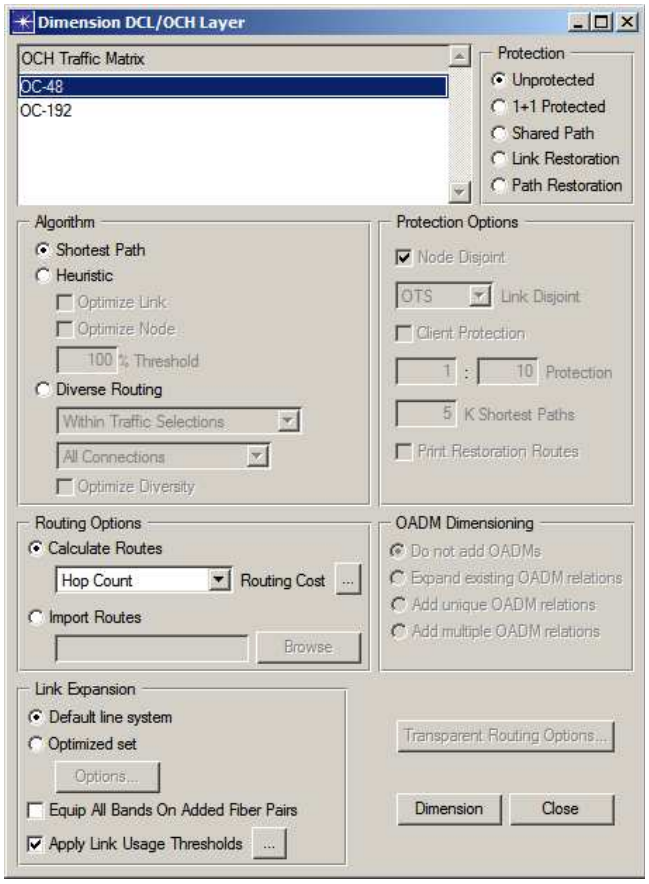


**Table 7-1 Dimensioning Dialog Box**

| Item | Description | Reference |
|---|---|---|
| Algorithm | Shortest path—Dimension using lowest-cost paths for each connection as specified by the Routing Cost setting<br><br>Heuristic—Dimension using a heuristic algorithm that optimizes the network cost<br><br>Diverse routing—Try to route all related connections with the minimal amount of overlap between routes, to ensure that not all related connections fail simultaneously if a network element fails | Shortest-Path Dimensioning on page TrP-7-9<br><br>Heuristic Dimensioning on page TrP-7-9<br><br>Diverse-Route Dimensioning on page TrP-7-10 |
| Link Expansion | Default Line System (or Trunk Bit Rate)—Dimensions all links in the network using the default WDM line system (OCH dimensioning) or the default bit rate for a DCL link (DCL dimensioning). These default settings are specified in the Network Properties dialog box.<br><br>Optimized Set—Selects the least costly combination of WDM line systems or trunk bit rates for each link (based on the system cost and required capacity for that link)<br><br>Equip All Bands on Added Fiber Pairs:<br>• If selected, the dimensioning operation equips all wavelength bands of a newly added fiber. This ensures that the full capacity on the system is available.<br>• If not selected (the default setting), the dimensioning operation equips only the required wavelength bands. This results in a more cost-optimal upgrade.<br><br>Apply Link Usage Thresholds—With this option only part of the available link capacity (specified as a maximum percent of the total link capacity) can be used. | Link Expansion on page TrP-7-10<br><br>Link Usage Threshold on page TrP-6-29 |
| OADM Dimensioning | Specifies how OADMs are added when dimensioning a transparent network. | OADM Dimensioning on page TrP-7-12 |
| OCH Traffic Matrix | Select the traffic matrices to use as the basis for the dimensioning run. This table lists all OCH traffic matrices that are unrouted and partially routed. | — |
| Protection | Unprotected—Dimension topology without protection<br><br>1 + 1 Protected—Dimension using a dedicated working path and a dedicated protection path.<br><br>Shared Path—Dimension using a dedicated working path and a shared backup path. | Unprotected Dimensioning on page TrP-7-6<br><br>1 + 1 Protected Dimensioning on page TrP-7-6<br><br>Shared Path Protection on page TrP-7-6 |

**Table 7-1 Dimensioning Dialog Box (Continued)**

| Item | Description | Reference |
|---|---|---|
| | Link Restoration—Dimension using a working path and add spare capacity to handle single link failures by rerouting traffic locally around the failed link<br><br>Path Restoration—Dimension using a working path and add spare capacity to handle single link failures by rerouting traffic between the end points of the failed connections | Link and Path Restoration on page TrP-7-7 |
| Protection Options | Node Disjoint—If selected, working and protection paths can have no nodes in common. If not selected, link disjointness only is guaranteed.<br><br>Link Disjoint—The lowest layer at which link disjointness is guaranteed.<br><br>Client Protection—If selected, protection occurs at the client. If not selected, protection occurs in the network.<br><br>N:M Protection—The sharing rate for protection paths of shared-path protection | Protected Dimensioning on page TrP-7-6<br><br>Link Disjointness for Working and Protection Paths on page TrP-6-6<br><br>Shared Path Protection on page TrP-7-6 |
| | K Shortest Paths—The number of alternatives considered for the restoration path<br><br>Print Restoration Routes—If selected, SP Guru Transport Planner exports restoration routes to a text file | Link and Path Restoration on page TrP-7-7 |
| Routing Options | Specifies the method for routing the traffic matrix. Options are:<br>• Calculate routes—Calculate the lowest-cost route using the selected Routing Cost algorithm<br>• Import routes—Route the traffic using the routes in a predefined data file | Routing Cost on page TrP-6-13<br><br>Importing and Exporting Route Data Files on page TrP-5-29 |
| Transparent Routing Options | Options for dimensioning transparent networks | Transparent Routing Options Dialog Box on page TrP-10-12 |
| **End of Table 7-1** | | |

## Protection Strategies

You can dimension a network with or without reserving spare capacity for failure recovery. The following dimensioning strategies are available:

- Unprotected Dimensioning
- 1 + 1 Protected Dimensioning
- Shared Path Protection
- Link Restoration
- Path Restoration

### Unprotected Dimensioning

In unprotected dimensioning, SP Guru Transport Planner routes the traffic without protection using either the shortest-path, heuristic-optimization, or diverse-routing algorithm, as described in Dimensioning Algorithms on page TrP-7-9.

### Protected Dimensioning

**1 + 1 Protected Dimensioning** If the Protection option is set to 1 + 1 Protection, SP Guru Transport Planner calculates the shortest cycle for each connection (using the lowest-cost pair of disjoint routes between the end nodes) and dimensions the network based on the lowest-cost cycles. The dimensioning allocates enough capacity to route the connections using 1+1 protection.

You can specify the degree of disjointness of the working and protections paths for each connection. You can specify the network layer down to which you want to guarantee link disjointness, as described in Link Disjointness for Working and Protection Paths on page TrP-6-6.

If the Node Disjoint option box is selected, SP Guru Transport Planner ensures that the paths are both node and link disjoint. If this option is not selected, SP Guru Transport Planner ensures only that the paths are link disjoint.

You can specify that the traffic is client-protected. If the Client Protection check box is checked, protection switching occurs at the client side and the client hands off two interfaces that should be disjointly routed. If this option is not selected, the client hands off one interface and protection switching occurs in the network.

**Shared Path Protection** If the Protection option is set to Shared Path, SP Guru Transport Planner uses a fixed dedicated working path and a fixed—but shared—protection path for each connection.

With shared path protection enabled, the protection path is fully disjoint from the working path; however, SP Guru Transport Planner sets up the protection path only when a failure occurs (in contrast with 1 + 1 protection). As a result, the required capacity for one protection path can be shared with other protection paths. The dimensioning algorithm ensures that the network can restore all traffic if one link fails.

The two Protection fields specify an M:N protection ratio. This specifies that at most M working paths (left field) can share N protection units (right field) along their protection paths.

### Link and Path Restoration

The restoration strategy has two steps:

1) SP Guru Transport Planner calculates the required capacity to accommodate the working paths of the selected traffic matrix in the network. For this purpose SP Guru Transport Planner routes along the lowest-cost path (as defined by the Routing Cost setting).

2) SP Guru Transport Planner adds enough restoration capacity to ensure that, in the event of any one link failure, the network can restore all connections fully.

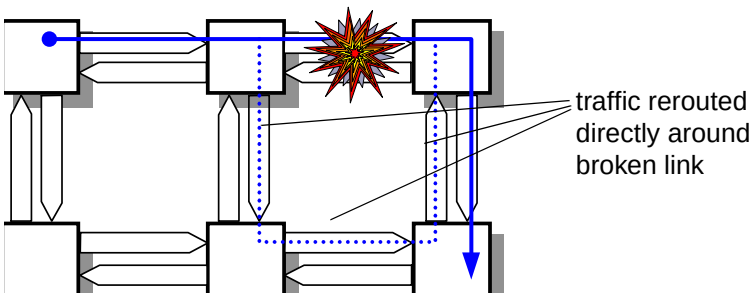
You can specify either Link Restoration and Path Restoration modes when using Restoration dimensioning.

**Table 7-2 Restoration Options**

| Option | Reference |
|---|---|
| Link Restoration | Link Restoration on page TrP-7-7 |
| Path Restoration | Path Restoration on page TrP-7-8 |
| • K Shortest Paths—The number of alternative paths to consider for the restoration routes in the restoration algorithm<br>• Print Optimization Routes—Creates a file in the following directory: <*TransportPlanner_user_home*>/op_admin/SP Guru Transport Planner Reports/Interim Reports<br>For every failed link, this file lists the restoration routes for the connections | — |
| **End of Table 7-2** | |

**Link Restoration** Figure 7-2 shows the principle of link restoration. When a link fails, the network reroutes the traffic *between the end-nodes of the failed link*. This strategy typically consumes a lot of spare capacity near the failed link; however, the same spare capacity can often protect multiple links. In some cases the final route traverses the same link in both directions.

**Figure 7-2 Link Restoration (Example)**



The dimensioning algorithm for link restoration ensures that the network can restore all traffic if one link fails. The traffic can share the spare capacity needed to survive different single link failures. However, if multiple links fail simultaneously, the network probably cannot restore all traffic.

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**Note—**This algorithm restores traffic affected by failed links only. It cannot restore traffic affected by failed nodes.

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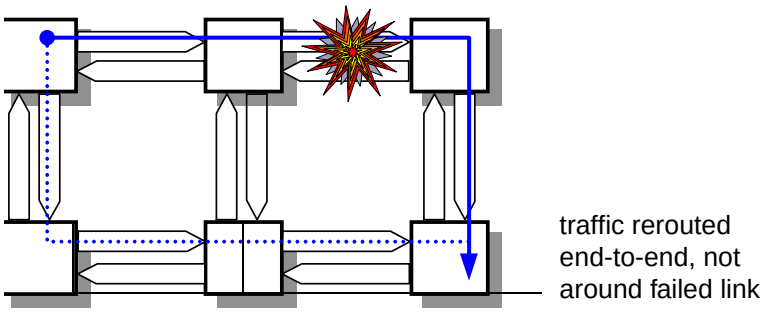
**Path Restoration** Figure 7-3 shows the principle of path restoration. A link failure results in multiple path failures, and path restoration reroutes each of these paths between their end nodes. The network re-routes the traffic between source and destination, regardless of where the link failure occurred. Therefore, the new path might not be near the failed link.

**Figure 7-3 Path Restoration**




The dimensioning algorithm for end-to-end path restoration guarantees that for all single link failures, the corresponding affected connections can be restored through an end-to-end diverse route. Note that this algorithm might not find a unique set of restoration paths, independent of the failing link, for each connection.

Path restoration differs from shared-path protection in that path restoration might have different backup paths, depending on the failure. (With shared path protection, the protection path is fully disjoint from the working path; thus the protection path is fixed and independent of the failure.) Path restoration is also more flexible in surviving from multiple failures.

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**Note—**Both link and path restoration use an amount of shared restoration capacity per traffic matrix that is using link or path restoration. This means that connections within the same traffic matrix can share the restoration capacity of that traffic matrix. However, connections of different traffic matrices cannot share the same restoration capacity.

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## Routing Cost

For descriptions of these options, see Routing Cost on page TrP-6-13.

## Dimensioning Algorithms

The following algorithms are available:

- Shortest-Path Dimensioning
- Heuristic Dimensioning
- Diverse-Route Dimensioning

### Shortest-Path Dimensioning

The Shortest Path algorithm dimensions the network using the lowest-cost routes for each connection. See Routing Algorithm on page TrP-6-8 for information on routing costs.

### Heuristic Dimensioning

The Heuristic algorithm dimensions the network using the shortest-path algorithm, and includes an additional optimization step. To remove inefficiently used link and node facilities, SP Guru Transport Planner tries to reroute connections that occupy capacity on these facilities. If rerouting the connections results in a cheaper solution—that is, if the extra routing cost is less than the savings in the link or node facility's cost—SP Guru Transport Planner removes the link or node facility and reroutes the traffic.

**Table 7-3 Heuristics Options**

| Option | Description |
|---|---|
| Optimize Link | When enabled, the optimization algorithm tries to remove or reduce redundant line systems (or wavelength bands) |
| Optimize Node | When enabled, the optimization tries to remove or reduce redundant discrete node types |
| Threshold | When utilization on a given resource (line system or node type) exceeds the specified threshold, the algorithm stops trying to optimize that resource. The default value is 100 percent, which means that SP Guru Transport Planner optimizes all resources (unless there is no excess capacity). |
| **End of Table 7-3** | |

**Diverse-Route Dimensioning**

This option is available when Unprotected dimensioning is selected. The diverse route algorithm ensures that if there is a failure, not all related connections fail simultaneously.

If you want SP Guru Transport Planner to do the optimization step, select the "Optimize Diversity" option. For more information, refer to Diverse Routing Algorithm on page TrP-6-10 in the *Routing* chapter.

## Link Expansion

The dimensioning algorithm equips the fibers with link facilities to provide the required link capacity. In the OCH layer, these are WDM line systems with a capacity in wavelengths. In the DCL layer, these are SONET/SDH systems at a certain bit rate.

The following methods are available for constraining the link-expansion behavior of a dimensioning operation:

- You can define multiple line system types in the WDM Link Equipment dialog box (see WDM Link Equipment Properties on page TrP-3-35).
- You can also specify one type as the default in the Network Properties dialog box (see Network Properties on page TrP-3-23).
- You can set one bit rate as the default bit rate for SONET/SDH systems on DCL links (see Default Values for Line System and Bit Rate on page TrP-3-26).
- You can set up a default line system type to use on an OCH link in the OCH Link Browser (see OCH Link Browser on page TrP-4-7).

The Link Expansion buttons enable you to specify one of two options:

- Default line system or trunk bit rate—SP Guru Transport Planner always uses the default WDM line system on that link when it adds capacity to an OCH link, or the default trunk bit rate when it adds capacity to a DCL link.
- Optimized Set—-For each link, SP Guru Transport Planner selects the optimized set of line systems (OCH dimensioning) or trunk bit rates (DCL dimensioning). It starts with the shortest-path routing algorithm, and determines the capacity required on the given link. Then it calculates a cost-optimal combination of line system types or trunk bit rates that provides at least this capacity on the link. This calculation depends on two factors:

  a) The cost of equipping a link with a line system or SONET system at a specific bit rate. This cost typically includes a component that is affected by distance (cost of amplifiers/regenerators on the link) and a component that is not (terminal equipment). Thus the cost also depends on the number of amplifiers and regenerators required for a specific

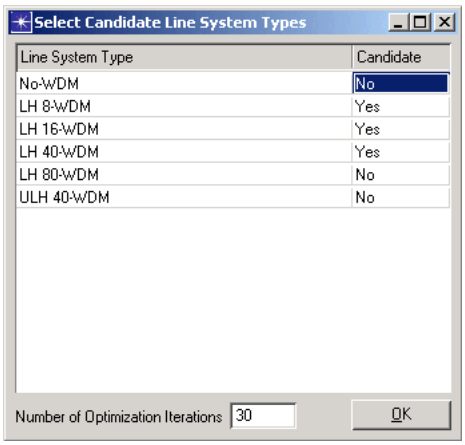
system type. For this reason, you must perform OTS link design to ensure that SP Guru Transport Planner takes the correct costs into account (see Dimensioning a Topology on page TrP-7-1 for more information).

b) The capacity required on the link

When you click on the Options button in the Link Expansion area, the Select Candidate Line System Types dialog box appears (Figure 7-4). Here you can select the candidate line system types or trunk bit rates to consider for the optimized set. To exclude a system, click in the Candidate field for that system and set it to No. You can also set the number of iterations for the heuristic algorithm that determines the optimized set; higher numbers result in better solutions but require more calculation time.

If the Optimized Set option is enabled, the heuristic optimization algorithm also searches for inefficiently used line systems and tries to replace each system it finds with a more suitable type.

**Figure 7-4 Selected Candidate Line System Types Dialog Box**




If the “Add All Bands on Added Fiber Pairs" option is selected, WDM systems with more than one wavelength band (as specified in the WDM Link Equipment Dialog Box) will be fully equipped; this means that all bands are equipped even if they are not all needed for the current traffic matrix.

If this option is not selected (the default setting), only the required wavelength bands are equipped, which results in a more cost-optimal upgrade. Also, the heuristic dimensioning algorithm tries to optimize the number of used bands per system (that is, it tries to remove inefficiently used bands).

When the “Apply Link Usage Thresholds” option is selected, link usage thresholds are considered during the dimensioning process so that no link is utilized more then the defined threshold percentage. Refer to the Link Usage Threshold on page TrP-6-29 in the *Routing* chapter for more details.

## Dimensioning Transparent Networks

If you want to dimension while in transparent-network mode (specified in the Network Properties dialog box), you might want to specify some additional options. To access these options, click the Transparent Routing Options button (see Transparent Routing Options Dialog Box on page TrP-10-12 for more information).

## OADM Dimensioning

The OADM Dimensioning options control how OADMs are added during dimensioning. These options refer to OADMs in higher-degree nodes and are available in transparent network mode only (for more information, see Optical Nodes: OADM on page TrP-2-29).

**Table 7-4 OADM Dimensioning Options**

| Option | Description |
|---|---|
| Do not add OADMs | Dimensioning does not add OADMs, except in complete OADM nodes (degree 2 or lower). |
| Expand existing OADM relations | Dimensioning can add new OADMs in a node, but only in those directions for which there were already OADMs present.<br><br>For example, assume a degree-four node that has an OADM defined between a fiber in link 1 and a fiber in link 2. In this case, dimensioning can add new OADMs between fibers of link 1 and link 2 but cannot add OADMs for other link relations. |
| Add unique OADM relations | Dimensioning can add new OADMs in a node, even if no OADMs were defined previously. However, a link can have a unique OADM relationship with one other link only.<br><br>The dimensioning algorithm adds those OADM directions that are most cost-effective within these constraints. The cost of adding OADMs is compared to the cost of performing the switching without OADMs and OADMs are only added if they result in cost savings.<br><br>For example, assume a degree-4 node with no OADMs defined yet. In this case, dimensioning can add new OADMs between fibers of link 1 and link 2. However, this change will exclude fibers on link 1 and link 2 from having any OADM relationships with fibers on any other links. Therefore, the only other possible OADM relationship that can be added on top of this is between fibers of link 3 and fibers of link 4. |
| Add multiple OADM relations | Dimensioning can add new OADMs in a node, even if no OADMs were defined previously. There are no constraints on possible OADM relations. The dimensioning algorithm adds those OADM relations that result in the highest cost savings compared using no OADMs. |
| **End of Table 7-4** | |

# Strip Capacity

You can undo the effects of a dimensioning action using the Strip Capacity dialog box (Design > Strip Capacity). This dialog box includes options for tearing down traffic and stripping network capacity.

**Figure 7-5 Strip Capacity Dialog Box**

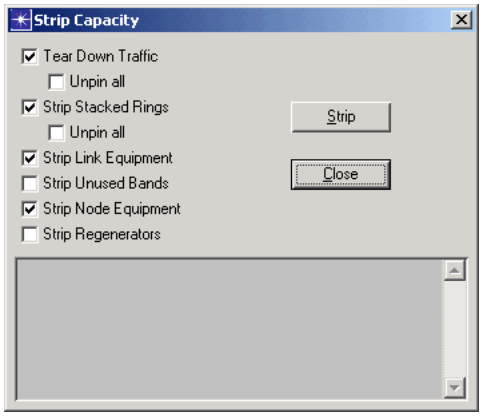



**Table 7-5 Strip Capacity Dialog Box**

| Control | Description |
|---|---|
| Strip Link Equipment | Remove all unused line systems on DCL and OCH links and convert them to dark fiber. You can use this operation in combination with Strip Traffic to ensure that all line systems are removed and that no equipped fibers remain in the network. |
| Strip Node Equipment | Remove all excess node capacity in discrete OXC, DXC and IXC node types. This operation replaces any underutilized discrete node with a lower-throughput node type that can still handle the existing traffic. For example, if your network uses a discrete OXC of type 2 (64 ports), but only 20 of the ports are used,<br>SP Guru Transport Planner replaces this with an OXC of type 1 (32 ports). |
| Strip Regenerators | Remove all unused regenerator capacity in the OCH nodes. This option is relevant in transparent network mode only. |

**Table 7-5 Strip Capacity Dialog Box (Continued)**

| Control | Description |
|---|---|
| Strip Stacked Rings | Remove all unused SONET/ SDH rings. Use this operation in combination with Strip Traffic to first tear down all traffic before stacked rings are removed. |
| Tear Down Traffic | Tear down all DCL and OCH traffic in the network |
| Unpin All | This option can be selected with the Tear Down Traffic and Strip Stacked Rings options.<br><br>If this option is selected with Tear Down Traffic,<br>SP Guru Transport Planner unpins all pinned connections so that all connections (pinned and unpinned) are torn down. Otherwise<br>SP Guru Transport Planner tears down unpinned connections only.<br><br>If this option is selected with Strip Stacked Rings,<br>SP Guru Transport Planner unpins all pinned rings so that all rings (pinned and unpinned) are stripped. Otherwise<br>SP Guru Transport Planner strips unpinned rings only.<br><br>For more information, see Pinning and Unpinning Connections on page TrP-6-19. |
| **End of Table 7-5** | |