3 Creating a Baseline Scenario

A *baseline scenario* is a fully-defined network scenario (topology, network properties, traffic, and cost parameters). After you define your baseline scenario, you can run design operations such as routing and dimensioning as described in later chapters. It is good practice to create a baseline scenario in the following order:

1) Create a new project or scenario (see Creating a New Project or Scenario on page TrP-3-8).

2) Define the network topology.

   You can create and place nodes, then connect nodes with links, using simple drag-and-drop operations as described in Defining a Network Topology on page TrP-3-9. You can also import specific types of data from external files as described in Chapter 5 Importing and Exporting Data on page TrP-5-1.

3) Specify cable splitters and fiber routes (*optional*).

   You might want to specify cable splitters and fiber routes if you want to create a network that has different topologies at different network layers. For more information, see Configuring Cable Splitters and Fiber Routes on page TrP-3-19.

4) Specify the general properties of your network.

   After you create a new scenario, you need to set some properties that apply to the entire network during the entire design cycle for that scenario: transparency mode, node types, and default equipment properties. For more information, see Network Properties on page TrP-3-23.

5) Specify the equipment properties you want to use.

   SP Guru Transport Planner considers your equipment and cost parameters when you run design operations such as routing, dimensioning, and grooming. You can use the default settings for these parameters or you can specify your own settings. For more information, see Equipment Properties on page TrP-3-30.

6) Configure individual objects.

   You might want to set the properties of specific objects such as nodes and links. For example, you might want to configure the equipment type used by a specific node. For more information, see Configuring Individual Objects on page TrP-3-45.

7) Design the physical 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.

8) Create one or more traffic matrices.

   A traffic matrix specifies the level of traffic between every node pair in your topology. You usually specify a traffic matrix when you run an action such as routing; SP Guru Transport Planner then tries to *set up* the matrix—that is, to establish connections that accommodate the traffic between each node pair. For more information, see Creating Network Traffic on page TrP-3-26.

Editor Windows

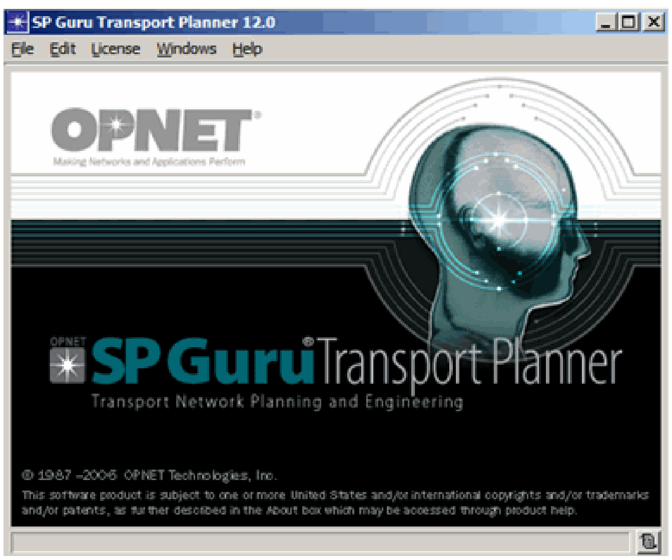
This section describes the functions of the two primary types of windows in SP Guru Transport Planner: the Main SP Guru Transport Planner Window and one or more Project Editor windows.

Main SP Guru Transport Planner Window

The main window appears when you start SP Guru Transport Planner. This window has the following menus:

- File—Create new projects, open existing projects, run batch commands, specify model directories, and exit the program
- Edit—Edit and set global preferences
- License—Perform license operations using the License Manager (see the Licensing chapter for more information on licensing)
- Windows—Navigate all open SP Guru Transport Planner windows
- Help—Access online documentation and tutorial, open error and log files, and view general information on the program

Figure 3-1 Main SP Guru Transport Planner Window

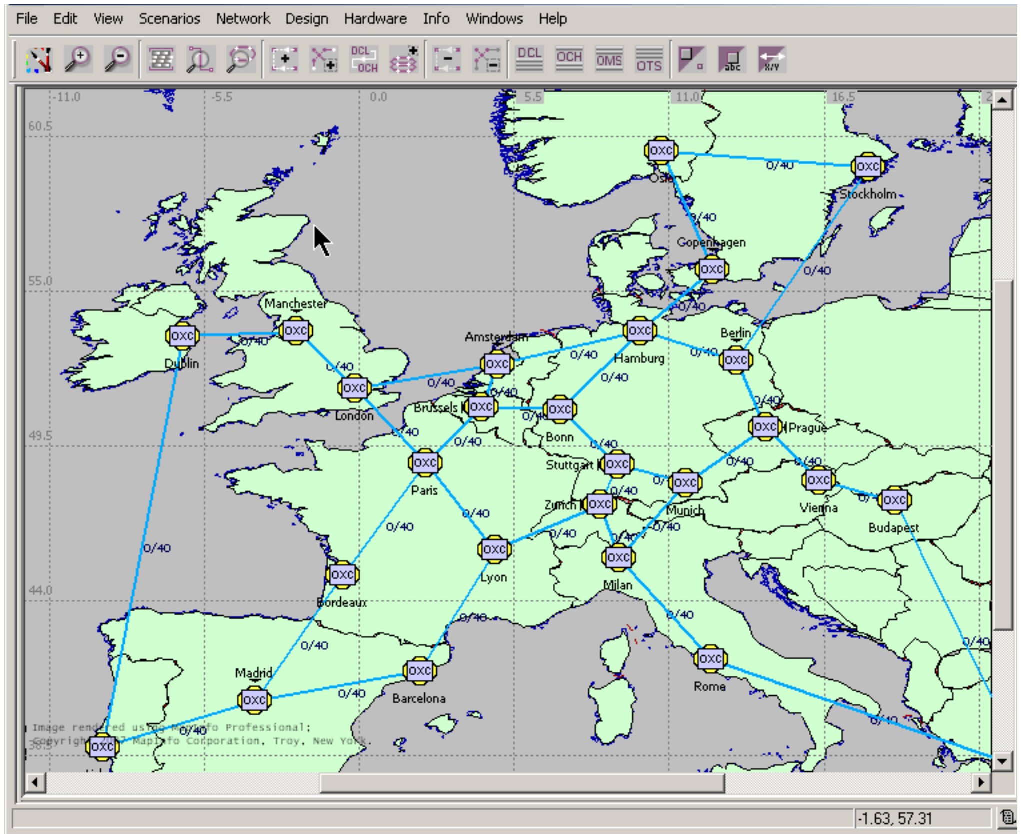


Project Editor

Figure 3-2 shows the SP Guru Transport Planner Project Editor window. A *project* contains one or more *scenarios*. A scenario contains the data you need to run a network-design study: topology, hardware, link/fiber data, traffic patterns, cost parameters, and so on. You can extract and compare network metrics (such as network cost and capacity) across multiple scenarios within a project.

You can have multiple Project Editor windows open during a session of SP Guru Transport Planner. A Project Editor window shows one scenario within the project; to switch between scenarios within a project, choose Scenarios > Switch to Scenario > *scenario_name*.

Figure 3-2 The Project Editor Window



A project can have multiple scenarios. Each scenario contains of a set of network data (topology, traffic matrices, cost parameters) that is local to that scenario. The Scenarios menu includes the following operations:

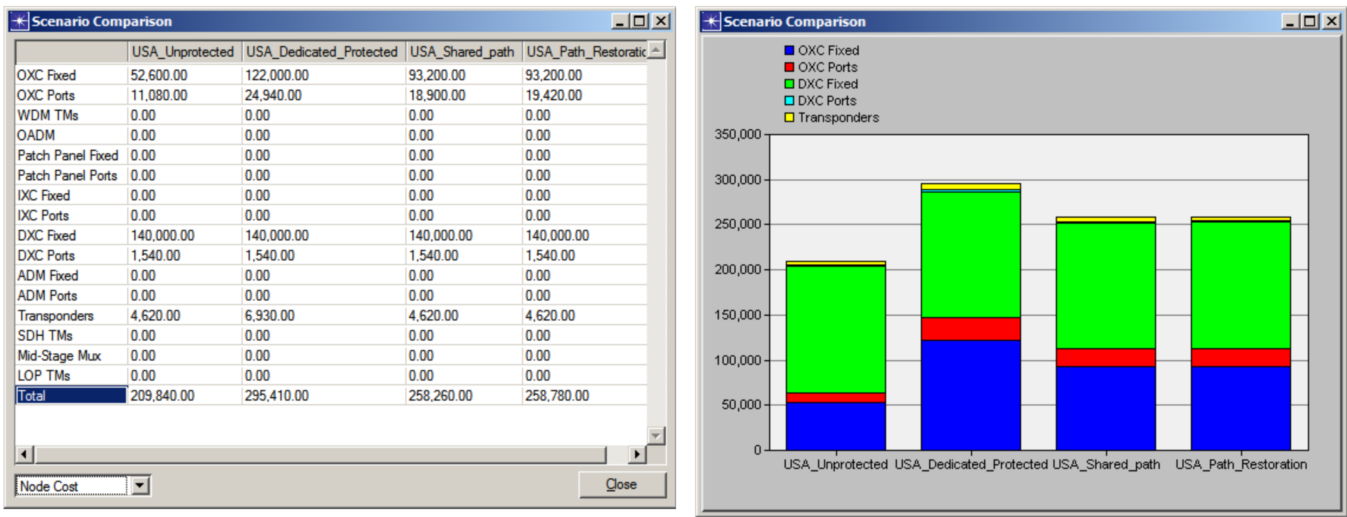
- New scenario—Create a new, “empty” scenario
- Duplicate scenario—Create a copy of the current scenario
- Manage scenarios—Rename, delete, reorder, create, and duplicate any number of scenarios
- Compare scenarios—Collect a set of network statistics (such as network cost and capacity) for multiple scenarios and show the results using tables and graphs
- Switch to scenario—Show a different scenario in the Project Editor
- Scenario components—Import or export a scenario. These operations make it easy to exchange scenarios between projects.

In the Import dialog box (Scenario Components > Import), only the options Network Model or Project are relevant to SP Guru Transport Planner. In the Export dialog box (Scenario Components > Export), only the option Network Model is relevant.

Using the Compare Scenarios operation, you can inspect various network metrics across different scenarios. These metrics are: total cost, node cost, link cost, and topology information (such as capacity and utilization) at different layers.

In Figure 3-3, the scenarios are compared by node cost. When you select an item in the table, the graph updates automatically. To export graph data to an Excel spreadsheet, right-click in the graph window.

Figure 3-3 Comparing Scenarios Within a Project



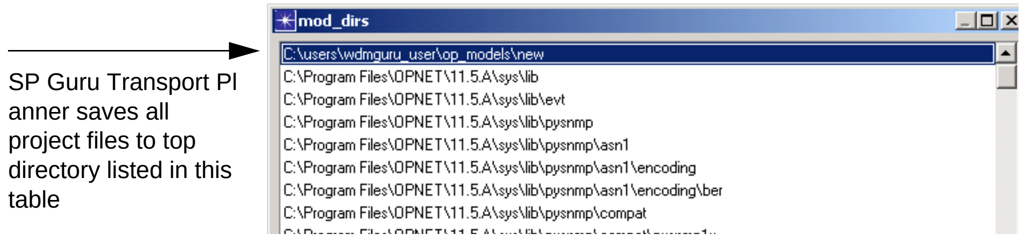
	USA_Unprotected	USA_Dedicated_Protected	USA_Shared_path	USA_Path_Restoratic
OXC Fixed	52,600.00	122,000.00	93,200.00	93,200.00
OXC Ports	11,080.00	24,940.00	18,900.00	19,420.00
WDM TMs	0.00	0.00	0.00	0.00
OADM	0.00	0.00	0.00	0.00
Patch Panel Fixed	0.00	0.00	0.00	0.00
Patch Panel Ports	0.00	0.00	0.00	0.00
IXC Fixed	0.00	0.00	0.00	0.00
IXC Ports	0.00	0.00	0.00	0.00
DXC Fixed	140,000.00	140,000.00	140,000.00	140,000.00
DXC Ports	1,540.00	1,540.00	1,540.00	1,540.00
ADM Fixed	0.00	0.00	0.00	0.00
ADM Ports	0.00	0.00	0.00	0.00
Transponders	4,620.00	6,930.00	4,620.00	4,620.00
SDH TMs	0.00	0.00	0.00	0.00
Mid-Stage Mux	0.00	0.00	0.00	0.00
LOP TMs	0.00	0.00	0.00	0.00
Total	209,840.00	295,410.00	258,260.00	258,780.00

Saving Projects

When you choose File > Save, SP Guru Transport Planner prompts you for the filename and destination of the project. You can save a file in any directory that is listed in your mod_dirs global preference. To view and change this preference, choose Edit > Preferences and scroll the Preferences table down to the mod_dirs entry.

Note—If you change your mod_dirs preference, always verify that your model/file directory is the first (top) directory in the mod_dirs table.

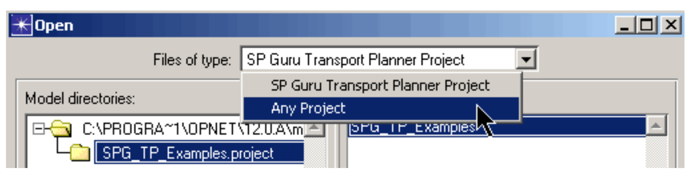
Figure 3-4 Model Directories (mod_dirs) Table



Starting with SP Guru Transport Planner version 11.0, every SP Guru Transport Planner project file (such as project1.prj) has a companion file with the extension of ".wdmg" (such as "project1.prj.wdmg"). This companion file indicates that it is a SP Guru Transport Planner project and not a project from another OPNET analysis software application. This file contains no data; it simply distinguishes SP Guru Transport Planner projects from other projects. Starting with SP Guru Transport Planner 12.0, all files for a project are kept within the same directory with a naming convention of *<project>.<scenario>*.

By default, the Open File dialog box shows only SP Guru Transport Planner projects with a ".wdmg" companion file. This means that you might not see projects created with older versions of SP Guru Transport Planner. To open one of these older projects, set the Files of Type to Any Project.

Figure 3-5 Opening Older SP Guru Transport Planner Files

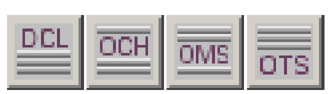


Network Layers

SP Guru Transport Planner represents a WDM network in multiple layers You can switch between layers in three ways:

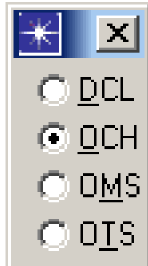
1) Click on a network-layer button in the toolbar.

Figure 3-6 Network Layer Buttons in Toolbar



2) Click on a layer radio button in the Layer Selector. To show this window, choose View > Show Layer Selector. To hide this window, click the Close button on the upper right corner.

Figure 3-7 layer Selector Window



3) Right-click in the network background and choose the network layer from the pop-up window. In addition to the standard network-layer views, you can also choose one of the following custom views:

   a) OCH Express Layer—Shows the express links and nodes in red (for more information, see Chapter 11 Optical Express Layer on page TrP-11-1)

   b) DCL Mesh Only—Shows only meshed DCL links and capacity

   c) DCL Ring Only—Shows only DCL links that belong to rings and the usable ring capacity on these links

You can hide or show node icons, node names, and link captions by selecting View > Show Annotations in Subnet or clicking the icon in the toolbar.

Figure 3-8 Show/Hide Buttons in Toolbar

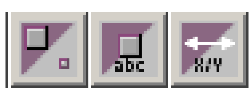


Table 3-1 Network Layers in SP Guru Transport Planner

Abbrev	Description	Link Caption
LOP	Lower-Order Path layer of SONET/SDH. This represents the VT/VC-level bit rates (such as VT-1.5 or VC-12).	None (the LOP layer is not represented as a separate layer in the Project Editor)
DCL	Digital Client Layer or SONET/SDH Higher-Order Path layer. This represents the STS/STM-level bit rates (such as STS-1 or STM-1). This layer can contain two types of links: • Logical links created by wavelengths routed in the OCH layer • Physical links between nodes without OCH counterparts	Used/total capacity in equivalent STS-1 or STM-1 units (example: 32/48)
OCH	Optical Channel layer Optical line systems and cross-connects	Used / total capacity, in number of optical channels (example: 2 / 16)
OMS	Optical Multiplex Section layer Fiber data (equipped / dark fibers and fiber-termination (FT) points)	Equipped / total fiber pairs (example: 1 / 50)
OTS	Optical Transmission Section layer Physical objects (Buildings and cables)	Total fiber pairs in cable
End of Table 3-1		

Creating a New Project or Scenario

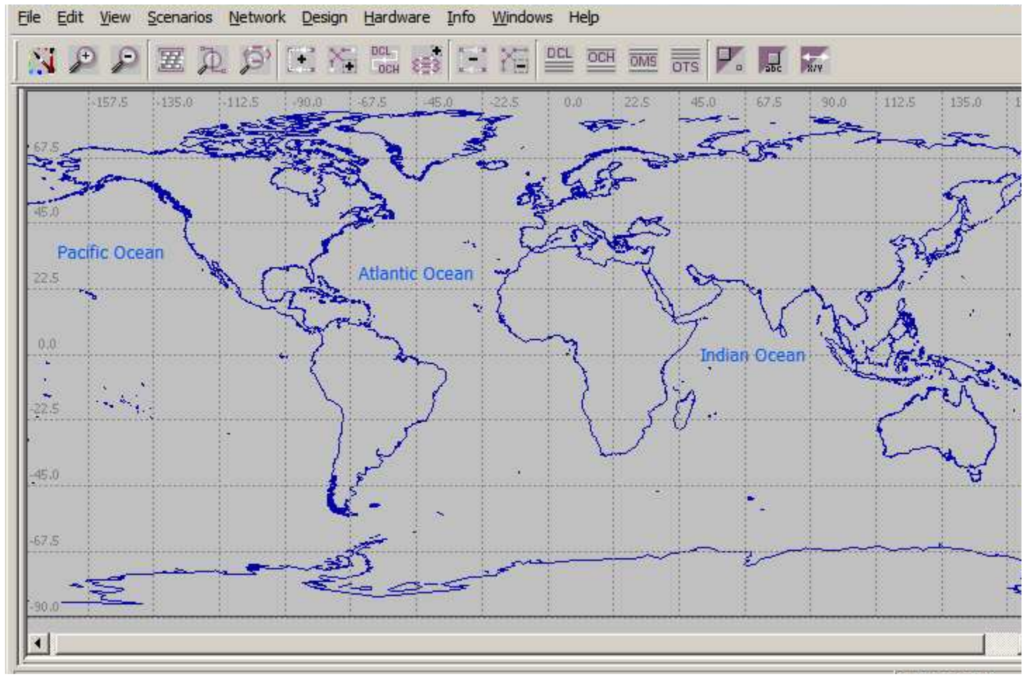
To create a new project, choose File > New; this creates a new project and a new scenario within that project. To create a new scenario within an existing project, choose Scenarios > New Scenario. In both cases, SP Guru Transport Planner prompts you for the following information:

- Project name (new project only)
- Scenario name
- TDM nomenclature (SONET vs. SDH)
- Distance units (km or miles)
- The geographic location of your network (the View field). You can specify a logical network or a network based on a geographic map (select the map from the pull-down menu).

Defining a Network Topology

After you create a new project and specify the required information in the Startup Wizard, the Project Editor opens an empty topology, as shown in Figure 3-9. One important step in the design process is to define the network topology—that is, to create node objects and connect the nodes with link objects.

Figure 3-9 An Empty Topology

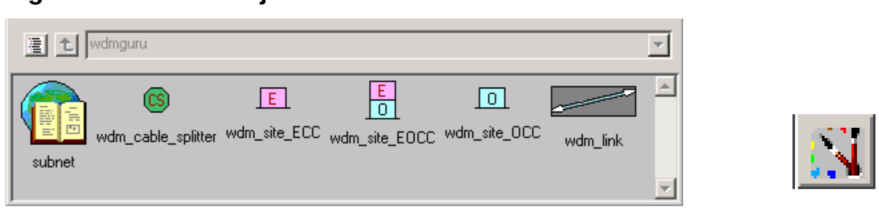


There are two methods for creating a topology in SP Guru Transport Planner. You can define a topology manually, as described in this section. You can also import some or all of a topology, as described in Chapter 5 Importing and Exporting Data on page TrP-5-1.

The Object Palette

You define nodes and links in your network using the *object palette* (shown in the following diagram). To open this window, click the Open Object Palette toolbar button.

Figure 3-10 The Object Palette



Object palette with subnet, cable splitter, ECC, OCC, EOCC, and link

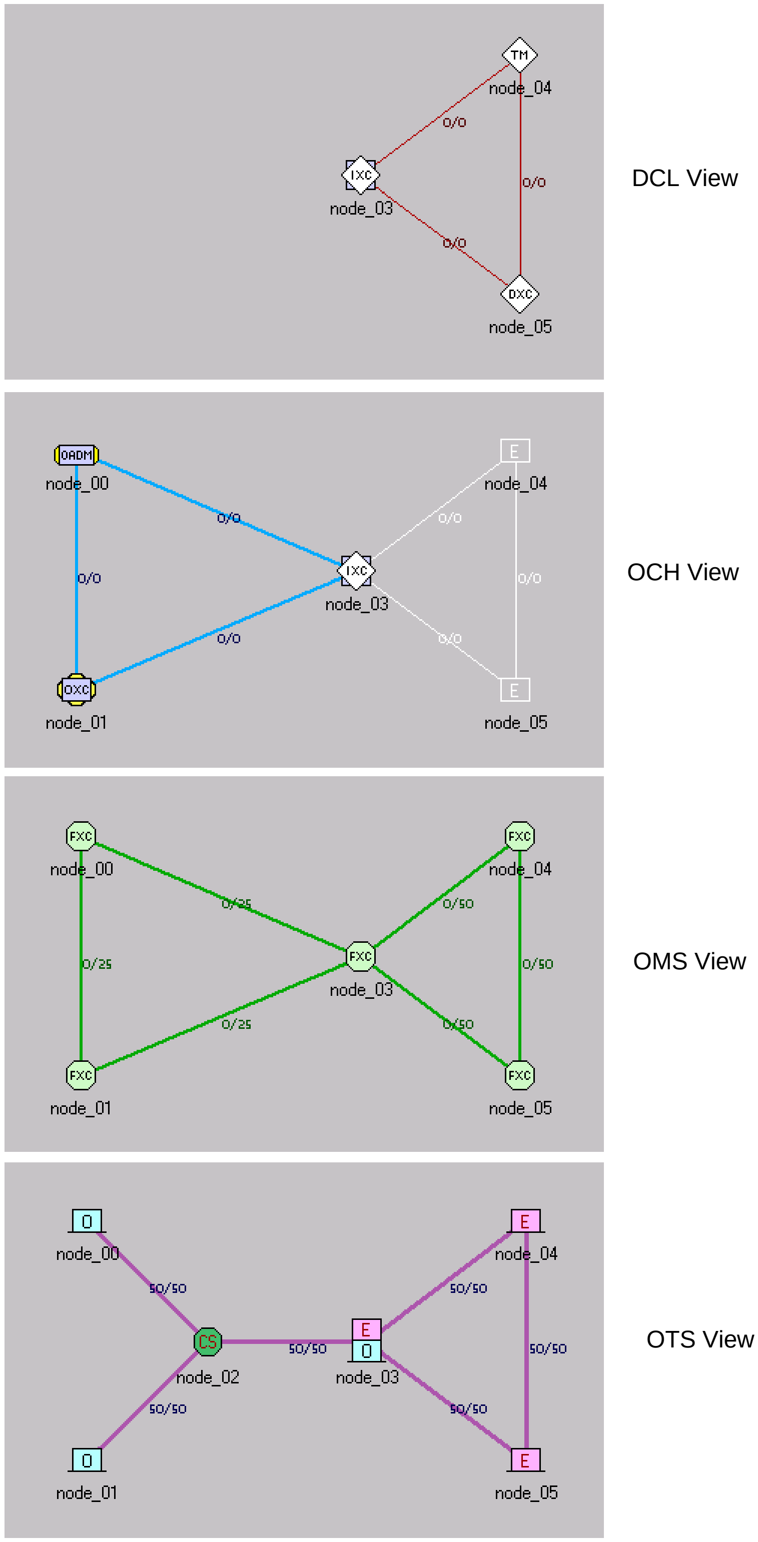
"Open Object Palette" toolbar button

You can create the following types of objects using the object palette:

- *ECC* (Electrical Cross-Connect) nodes switch SDH/SONET traffic only and do not have an optical counterpart. These nodes are not visible in the OCH layer.
- *OCC* (Optical Cross-Connect) nodes can switch wavelengths only and do not have an electrical counterpart. These nodes are not visible in the DCL layer.
- *EOCC* (Electrical-Optical Cross-Connect) nodes switch both SDH/SONET traffic and wavelengths. These nodes are visible in both the DCL and OCH layers.
- A *cable splitter* node is a bifurcation point for optical fiber pairs; it switches fiber pairs at the OTS layer, as described in Configuring Cable Splitters and Fiber Routes on page TrP-3-19.
- A *subnet object* is used to include annotations in a scenario. It is good practice to include annotations in a scenario, so that others can understand the details and objectives of the scenario.

The network topology can appear different according the network layer in which it is being viewed, as shown in Figure 3-11 on page TrP-3-11. For more information about ECCs, OCCs, and EOCCs, see Chapter 2 Concepts and Models on page TrP-2-1.

Figure 3-11 DCL, OCH, OMS, and OTS Views of a Multi-Tiered Topology



Creating Nodes

When you drag a node model icon into the workspace, or select a link icon and connect two nodes, you create an *instance* (copy) of that model.

Procedure 3-1 Creating a Node Using the Object Palette

1 Open the object palette.

2 Click on the node model icon in the object palette, then move the cursor into the Project Editor workspace.

➥ A square icon outline appears around the cursor to indicate that you are now in "node creation mode."

3 Click the location in the workspace where you want to place the new node.

➥ SP Guru Transport Planner creates the node in the workspace and gives it a default name. The node's appearance varies depending on the current network-layer view and the node type (as described in Node Model Icons on page TrP-3-18).

The default name is a text string followed by a number that is incremented each time another object is created. To rename a node, right-click on it and choose Set Name.

4 To create another node of the same type, click at a new location. Repeat this step for each node of the same type that you want to create.

5 When you are finished creating nodes, right-click to end the operation.

6 If you want to configure individual nodes, open the Node Browser (see Node Browser on page TrP-4-14 for more information).

End of Procedure 3-1

Creating Links

Links are the communication channels between nodes. You should always add links in the OTS layer. Depending on the type of end nodes, a link looks different at different network layers. There are two types of links, *optical* links and *electrical* links.

- Links between OCC-OCC, OCC-EOCC, and EOCC-EOCC node pairs are *optical* links (that is, OCH links not visible in the DCL layer) on which WDM line systems are deployed.

- Links between EOCC-ECC and ECC-ECC node pairs are *electrical* links (DCL links drawn in white in the OCH layer) on which SONET/SDH line systems are deployed. These are physical DCL links.
  SP Guru Transport Planner can also create logical DCL links between EOCC-EOCC node pairs as a result of routing non-native OCH connections between two nodes.

Note—You cannot create links between OCC-ECC node pairs.

Note—Links that connect a cable splitter do not appear at other layers before the cable splitter is configured to specify the number of fibers routed between its end nodes.

You can create as many links as you want between the same end nodes. You can right-click on a link in the OTS layer to add a *parallel link*. This results in separate cables between the nodes (for example, to provide protection paths). These cables use separate ducts. You can also create a parallel link manually from the object palette.

When you add a link in lat/long mode, SP Guru Transport Planner calculates its length (in km) using the coordinates of the nodes. If you move the nodes after adding a link, or change the path of the link, the link length does not adjust automatically; you must change the length manually using the OTS Link Browser. You can also redefine the path of a link. To do so right-click on the link, and select “Redefine Path”. Then draw the path of the link in the project editor by clicking where you want to define the bend points of the link. For more information, see Link Browser on page TrP-4-2.

Procedure 3-2   Creating a Link

1. If the object palette is not already open, click the Open Object Palette toolbar button.

2. Click on the link model icon in the object palette, then move the cursor into the Project Editor workspace.

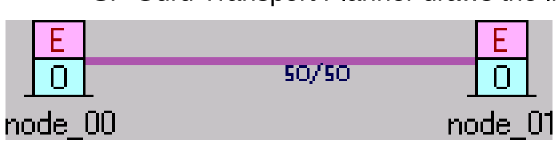
   ➥A diagonal line appears to the upper-right of the cursor to indicate that you are in link-creation mode.

3. To create a link between two nodes:

   3.1 Click on the first node.

   3.2 Click on the second node.

   ➥SP Guru Transport Planner draws the link between the two objects.



3.3 If you want to redefine the link, right-click on the link, and select "Redefine Path". Then draw the path of the link in the project editor by clicking where you want to define the bend points of the link.

End of Procedure 3-2

Deleting, Cutting, Copying and Pasting Nodes and Links

The Edit menu includes commands for copying and pasting selected objects.

Note—You can perform these actions in the OTS layer only.

Cutting and Deleting

The Edit menu includes commands for cutting and deleting network objects. If you cut or delete objects that currently support traffic, SP Guru Transport Planner does the following:

- Tears down traffic that runs through a cut/deleted node
- Deletes traffic that originates in a cut/deleted node

When you perform a cut/delete operation, SP Guru Transport Planner shows how the proposed change will affect traffic so you can identify and reroute the affected traffic after the topology change.

Procedure 3-3 Cutting/Deleting Network Objects

1 Click the OTS toolbar button to show the OTS layer (you must be in this layer to delete network objects).

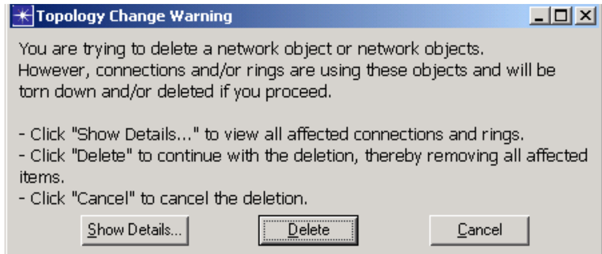
2 Select the objects you want to delete by clicking on them (hold down the Shift or Control key on your keyboard to select multiple objects).

3 Cut or delete the selected objects.

- To cut, choose Edit > Cut or press Ctrl+X.
- To delete, choose Edit > Delete or press the Delete key on your keyboard.

➥ The Topology Change Warning window appears (Figure 3-12). This window states that connections and/or rings are affected by the objects you are trying to delete.

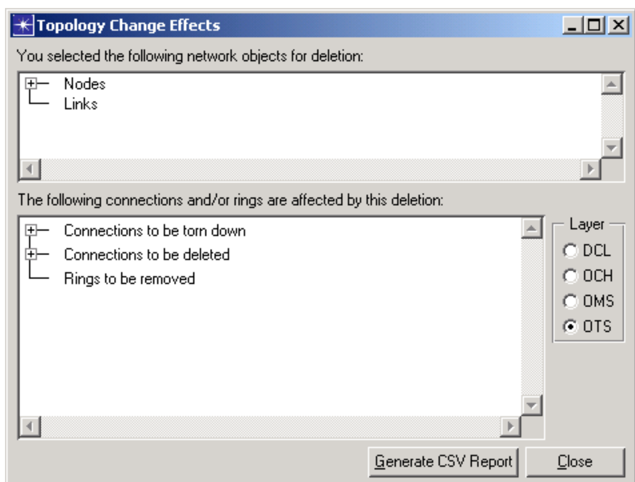
Figure 3-12 Topology Change Warning Window



4 Click “Show Details …” to view details of the affected connections and rings.

➥ The Topology Change Effects window appears (Figure 3-13). The top treeview lists the objects you selected to cut/delete. The bottom pane includes two treeviews that show the connections to be torn down and deleted. Another treeview shows the rings to be removed as a result of the topology change. The bottom treeviews are as similar to those used in the Connection Browser (Table 4-11 on page TrP-4-25) and the Ring Browser (Table 4-15 on page TrP-4-29).

Figure 3-13 Topology Change Effects Window



5 Examine the “Connections to be torn down,” “Connections to be deleted,” and “Rings to be removed” treeviews to see the effects of the topology change. Use the Layer buttons to see how the topology is affected at each layer. To view a csv report of this data, click Generate CSV Report.

6 Click Close to return to the Topology Change Warning window.

7 Click Delete (to delete the selected objects) or Cancel (to cancel the operation).

➥ When you click Delete, SP Guru Transport Planner deletes the selected nodes and links, tears down and deletes affected connections, and removes rings.

8 Close the Topology Change Warning window.

9 Reroute the connections that were torn down using the existing SP Guru Transport Planner design functionality such as routing, dimensioning, grooming, and so. You might want to split the unrouted connections into a residual traffic matrix.

End of Procedure 3-3

Creating Custom Network Documentation

In some cases, you might want to create custom documentation for individual network objects. Each node, link, and subnet object has a Documentation attribute that can specify plain-text descriptions and external files that include additional documentation. Examples of useful documentation might include:

- A plain-text description that describes important configuration settings for a router
- An external code or data file used to configure an object
- An image file that shows the topology of a subnet

To view and edit custom documentation for an object, right-click on the object and choose Edit Documentation. In the resulting dialog box (Figure 3-14), you can enter a plain-text description and/or attach external files such as images, data files, and Word documents.

Figure 3-14 Edit Documentation Dialog Box, "Attachments" Tabbed Page

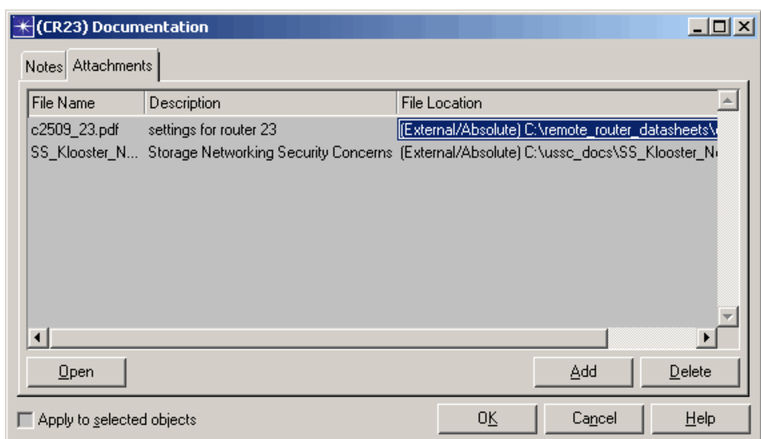


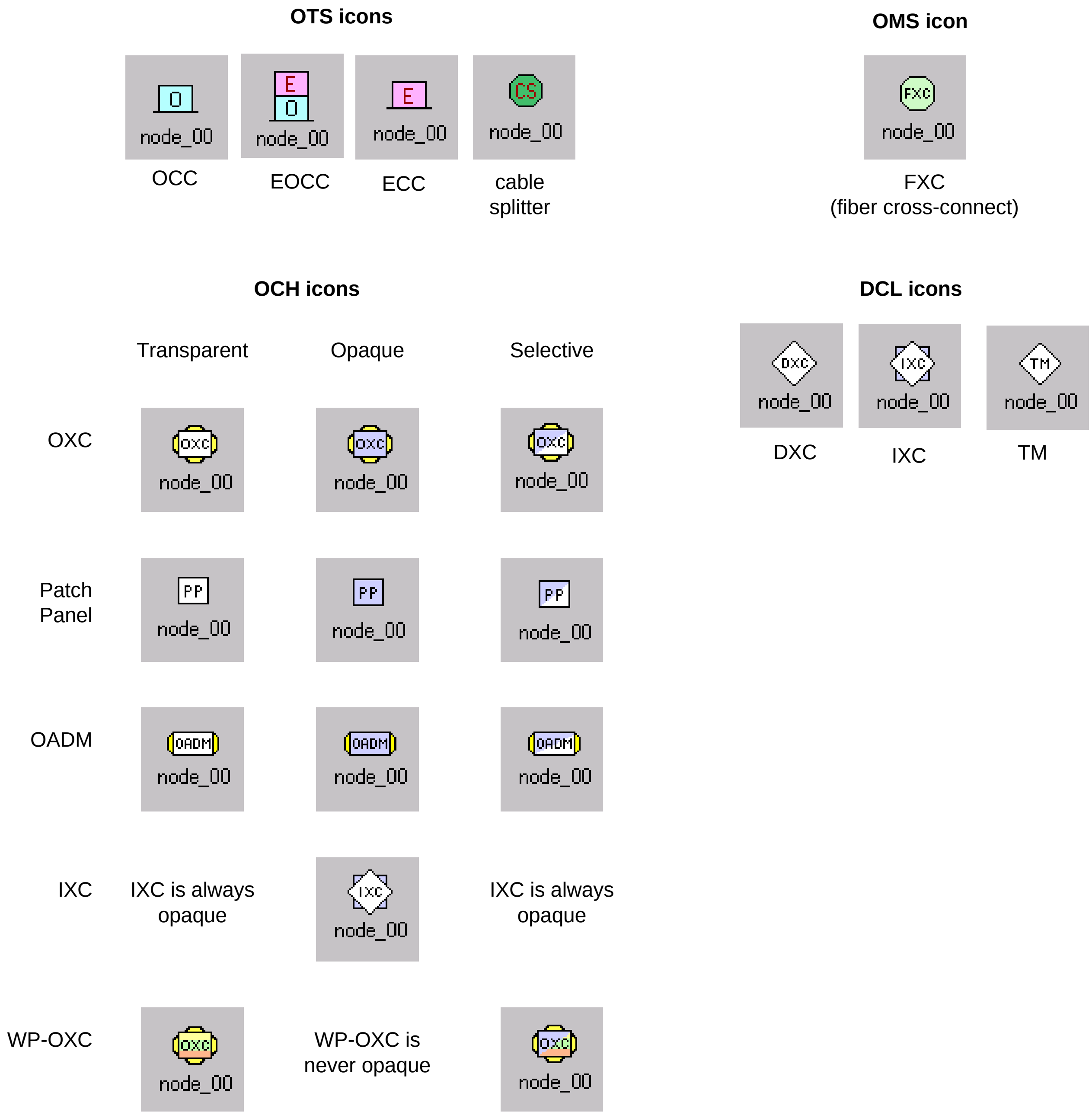
Table 3-2 “Edit Documentation” Dialog Box

Item	Description
Notes tabbed page	Use this page to view and edit plain-text descriptions. You can use the standard keyboard combinations for cutting, copying, and pasting text.
Attachments tabbed page:	
• File Name	Name of the external file. This field is not editable.
• Description	Enter a description of the external file here.
• File Location	Location of the external file. You can specify one of the following options from the pull-down menu: • Local to Scenario—When you initially add an external file, the software retains a link to the file. If you select the Local to Scenario option, OPNET analysis software creates a local copy of the file in the scenario directory. (The copy occurs after you click OK.) This option is useful if you want to move the scenario to another location, or if you want to edit the external file with information that applies to a specific set of network objects. • External/Absolute—Retains a link to the external file; the location is specified using an absolute path. Use this option if you do not need to create a local copy of the file. **NOTE—**If you select External/Absolute or External/Relative and the external file is moved or renamed, the link will be broken. • External/Relative—Retains a link to the external file; the link is specified using a relative path from the current scenario directory. You might want to use this instead of External/Absolute if you store your files in an external directory that always has the same relative path from the scenario directory. For example, you might want to add a /doc subdirectory to the project directory (which is the parent of the scenario directory). In this case, you could use relative links (`./doc/<filename>`) and then move the entire project without breaking those links.
“Apply to selected objects” checkbox	Select this option if you want to apply the documentation to all selected objects.
End of Table 3-2	

Node Model Icons

A node icon varies according to the network layer view and the node type, as shown in Figure 3-15. In the OCH layer, the icon color varies depending on whether the node is opaque, transparent, or selective.

Figure 3-15 Node Icons in OTS, OMS, OCH, and DCL Layers

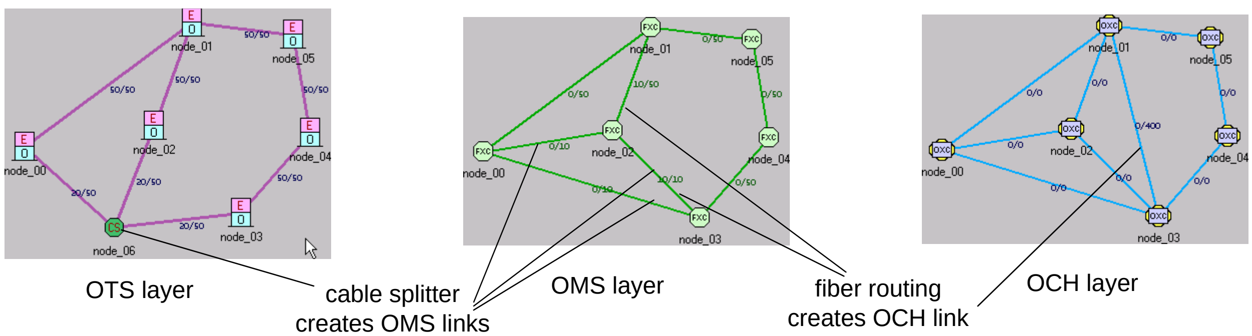


Configuring Cable Splitters and Fiber Routes

If a network contains cable splitters and fiber routes, it has different topologies at lower layers (OCH, OMS and OTS). In such networks there are multiple ways to implement protected routing, depending on the layer at which link disjointness of working and protecting paths is requested. If a network has no cable splitters or fiber routes, OTS, OMS, and OCH topologies are identical. For more information about protected routing and link disjointness, see Link Disjointness for Working and Protection Paths on page TrP-6-6.

Figure 3-16 shows how cable splitters and fiber routes can result in different topologies at different network layers. At the OTS layer, the cable splitter in node_00 has been configured to create three OMS links between its adjacent nodes. At the OMS layer, a fiber route through node_02 results in an OCH link between node_01 and node_03.

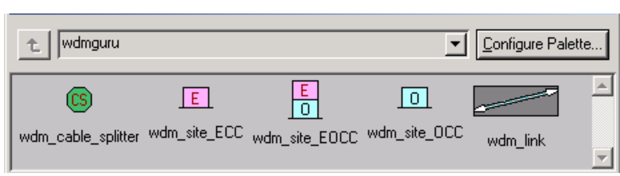
Figure 3-16   Creating OMS and OCH Links Using Cable Splitters and Fiber Routing



Cable Splitter

A cable splitter is a bifurcation point for optical fiber pairs; it allows links to share a common conduit before they take different directions. To add a cable splitter to your network, open the object palette and drag the “CS” icon into the network.

Figure 3-17   Cable Splitter Model in the Object Palette



Procedure 3-4   Creating OMS Links Using a Cable Splitter

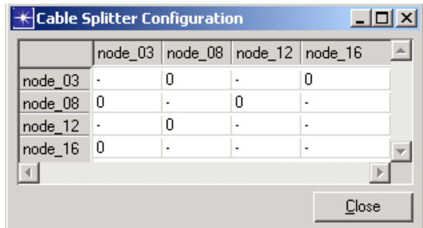
1 If you have not already done so, define the network topology, including all cable splitters and OTS links between nodes.

2 Click the Show OTS Layer menu button to switch to the OTS layer view.

3 Right-click on the cable splitter and choose Configuration.

➥ The Cable Splitter Configuration dialog box appears. This window shows a matrix that specifies the number of fiber pairs to be configured between the nodes adjacent to the cable splitter.

Figure 3-18 Cable Splitter Configuration Dialog Box



	node_03	node_08	node_12	node_16
node_03	-	0	-	0
node_08	0	-	0	-
node_12	-	0	-	-
node_16	0	-	-	-

4 Enter the number of fibers you want to configure for each node pair.

Note the following rule:

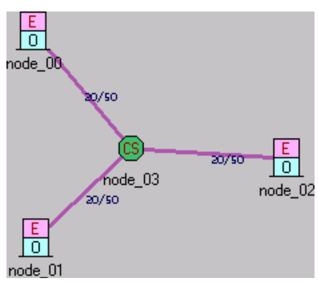
- You cannot create links between ECC and OCC nodes.

5 Click Close to return to the Project Editor.

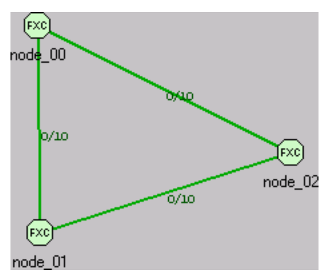
End of Procedure 3-4

After you configure a cable splitter, new links appear in the OMS layer. Figure 3-19 shows a cable splitter for which 10 fiber pairs have been configured between each of the adjacent node pairs. As a result, three links are created in the OMS layer; each link has a capacity of 10 fiber pairs.

Figure 3-19 Creating OMS Links Using a Cable Splitter: Example



OTS layer view



OMS layer view

Fiber Routing

A cable splitter configures fibers at the OTS layer and thereby creates links at the OMS layer; *fiber routing* enables you to configure fibers at the OMS layer and thereby create links at the OCH layer.

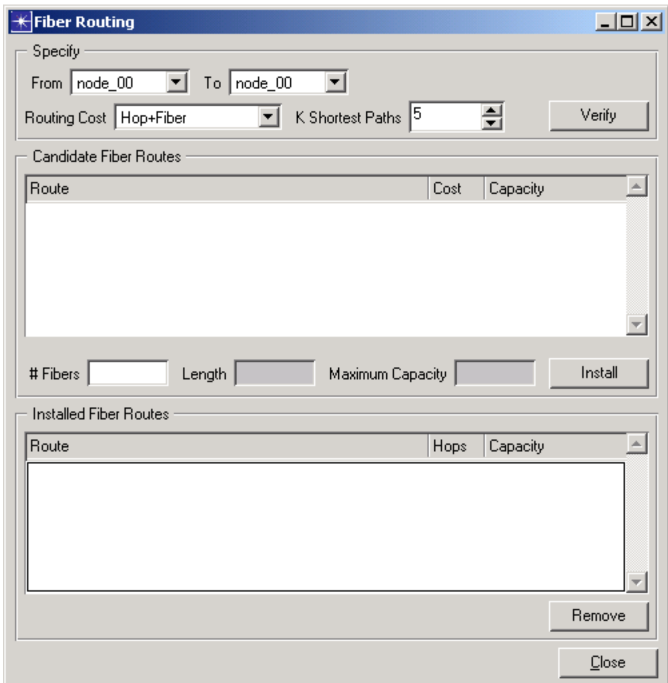
Procedure 3-5   Creating a Fiber Route

1 If you have not already done so, define the network topology.

2 Choose Design > Fiber Routing.

➥ The Fiber Routing dialog box appears.

Figure 3-20   Fiber Routing Dialog Box



3 Under Specify, select the From and To nodes between which you want to create a fiber route.

4 Select the Routing Cost for calculating the shortest paths, and the number of shortest paths to add to the candidate list (K Shortest Paths). For more information, see Routing Cost on page TrP-6-13.

5 Click Verify to calculate the candidate paths.

➥ The Candidate Fiber Routes table shows the routes, costs, and capacities of the candidate routes.You can view a route in the network by selecting it in this table.

6 In the # Fibers fields (under Candidate Fiber Routes), enter the number of fibers to be lit (using the default WDM line system). The number of fibers can be zero; in this case the fiber route is established, but no fibers are equipped yet.

7 Click Install to establish the fiber route. The Installed Fiber Routes table at the bottom of the dialog box shows all established fiber routes.

End of Procedure 3-5

After you create the fiber route, a new link is created in the OCH layer. You can handle this link like any other OCH link: you can specify lit fibers on it using the Link Browser, route traffic over it, or expand it using the dimensioning or grooming algorithms.

Procedure 3-6 Removing a Fiber Route

Note—You can clear a fiber route only if no traffic is accommodated on that route.

1 Choose Design > Fiber Routing.

➥ The Fiber Routing dialog box appears, and the network layer view changes to OMS.

2 The Installed Fiber Routes table shows all fiber routes. Select a route in this table and click Remove.

End of Procedure 3-6

Network Properties

Every network scenario has default settings that apply to the entire network-design workflow. You can view and change these settings in the Network Properties dialog box (Network > Network Properties). You must specify these settings before you apply network design operations such as routing, grooming, and dimensioning. For references to information about these settings, see Network Properties Dialog Box on page TrP-3-23.

Figure 3-21 Network Properties Dialog Box

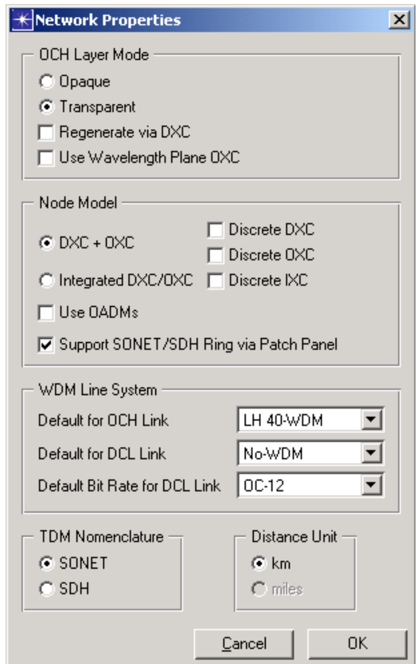


Table 3-3 Network Properties Dialog Box

Step	Reference
OCH Layer Mode	The OCH Layer Mode on page TrP-3-24
Node Model	The Node Model on page TrP-3-25
WDM line system	Default Values for Line System and Bit Rate on page TrP-3-26
TDM Nomenclature	TDM Nomenclature on page TrP-3-26
Distance Unit	Distance Units on page TrP-3-26
End of Table 3-3	

The OCH Layer Mode

You can specify two different modes for the OCH layer:

- Opaque mode represents a network in which optical channels are regenerated at every node in the OCH layer. This regeneration is done by the long-reach transponders that terminate the channels on the WDM line systems. This opaque mode enables you to combine different types of WDM line systems with the same network, because the line systems interact seamlessly through the opaque nodes.
- In transparent mode, regeneration of optical channels does not occur at every node in the OCH layer. You can define three node types in a transparent network:
  - Opaque node—The node behaves like any node in opaque mode: regeneration occurs for every channel that passes through the node.
  - Transparent node—Regeneration is not possible in the node; a channel passes through the node without being regenerated.
  - Selective node—The node is transparent, but selective channels can be regenerated when needed.

  In transparent network mode, transparent pass-through of a signal through a node is only possible if the incoming and outgoing fiber of the signal are equipped with the same WDM line system. If a signal transfers between fibers of different WDM line systems, regeneration is always performed in the intermediate node.

Transparent Options

You can specify the following options in transparent mode:

- If the “Regenerate via DXC” checkbox is checked,
  SP Guru Transport Planner regenerates using transponders that interconnect the OXC tributary ports with the DXC trunk ports. If this checkbox is not checked, SP Guru Transport Planner regenerates using a separate bank of transponders which is interconnected with the OXC tributary ports. See Selective Regeneration (SR) on page TrP-10-2 for more information.
- The “Use Wavelength Plane OXC” option enables you to specify the use of WP-OXCs in transparent mode. If this option is checked,
  SP Guru Transport Planner changes all unused OXCs (that is, OXCs that have no fibers attached) to WP-OXCs. See Optical Nodes: WP-OXC on page TrP-2-26 for more information.

The Node Model

You can set the Node Model buttons to determine how SP Guru Transport Planner models EOCCs:

- If you choose the DXC + OXC model, the EOCC node uses a DXC to switch SONET/SDH traffic and a separate OXC to switch wavelengths. The DXC trunk ports connect to the OXC tributary ports so nodes can transport SDH/SONET traffic over WDM wavelengths.
- If you use the integrated DXC/OXC (IXC) model, the EOCC node uses one electrical cross-connect that can switch both at the SONET/SDH level and (in an opaque way) at the wavelength level.
- You can set the Use OADMs option to use OADMs in degree-two OCH nodes (that is, nodes that terminate two links). One OADM terminates at most two fibers using the same line system. This means that, for each WDM line system that terminates on one or both links of a node, SP Guru Transport Planner counts one OADM. This also means that, in opaque mode, a node can include OADMs of different line system types.
- If “Support SONET/SDH Rings Via Patch Panel” is selected, the optical channels that support the overlay SONET/SDH rings are switched via a patch panel. If this option is not selected, these channels are switched via the OXC, IXC or OADM (depending on the node model).

The Discrete DXC, Discrete OXC, and Discrete IXC check boxes enable you to use a discrete node model for each type of node equipment. If this option is not selected for a node type, SP Guru Transport Planner uses a continuous node model instead.

- If you are using a discrete node model, specify a range of discrete node types (each characterized by its throughput and cost) in the equipment properties. SP Guru Transport Planner can consider these discrete node sizes when routing (where the node sizes are constraints) or dimensioning (where the nodes need to be dimensioned).
- If you use the continuous node model, nodes are assumed to scale continuously: SP Guru Transport Planner assumes that all node types exist (16x16 ports, 17x17 ports, etc.) and calculates the cost using a base cost and per-port cost.

Note—The settings in this section specify the default model of a node. You can override these settings for individual nodes using the OCH Node Browser, as described in OCH Node Browser on page TrP-4-15.

Default Values for Line System and Bit Rate

You can also specify default values for line system types and bit rates:

- The “Default for OCH Links” option determines the default WDM line system used on OCH links (e.g. when upgrading a link during dimensioning).
- The “Default for DCL Links” option specifies which line system type is used by default on physical DCL links (between ECC-ECC or EOCC-ECC nodes). The default setting is No-WDM, which means that no WDM is used on the fiber; instead, the fiber is directly equipped with SONET/SDH gear.
- The “Default Bit Rate for DCL Links” option specifies the bit rate of the SONET/SDH gear used to equip the DCL links. For example, suppose that the default line system for DCL links is No-WDM and the default bit rate for DCL links is STM-16. Each newly-added DCL link will be equipped with one fiber without WDM, but with STM-16 terminal equipment.

Note—These default values are used to equip newly-added fibers, but can be edited in the Link Browser. For more information, see Link Browser on page TrP-4-2.

TDM Nomenclature

You can set the “TDM Nomenclature” options to specify whether you are working in SONET or SDH mode. SP Guru Transport Planner translates SDH bit rates to SONET bit rates and vice versa. You can change this mode only if no traffic is routed.

Distance Units

The “Distance Unit” setting determines the units (in kilometers or miles) used in the scenario. You can only change this setting only when you create a new project or scenario.

Creating Network Traffic

Most design actions (such as routing, dimensioning, and grooming) require a set of traffic demands as input. After you create your network topology, you must specify the traffic demands of your scenario. Defining traffic can be a one- or two-step process:

1) Creating Custom Bit Rates—You might want to create custom bit rates that can support data services more efficiently than the standard bit rates defined in SP Guru Transport Planner. This step is optional and only needs to be done once for each new bit rate

2) Creating a Traffic Matrix—Most design operations (such as routing or dimensioning) require a traffic matrix; SP Guru Transport Planner views the matrix as a traffic demand forecast and configures the network to meet this forecast.

Creating Custom Bit Rates

You can create custom bit rates at the different layers of traffic (OCH, DCL, and LOP).

At the OCH layer, you can create new wavelength services. In case these wavelength services should support higher-layer (DCL) traffic, you should also specify the multiplex factor as the number of equivalent OC-1 (SONET) or STM-1 (SDH) units.

At the DCL and LOP layer, you can create so-called concatenated bit rates. You can use these bit rates to support data services in a more capacity-efficient way over SONET/SDH. For example, an STS-48 (2.5 Gb/s) circuit can support 1-Gigabit Ethernet service in the existing SONET hierarchy. However, this is inefficient because more than half of the capacity of the circuit is not used. Therefore, you might want to define a new concatenated bit rate of 21 STS-1 containers (21 x 50.112 Mb/s = 1.052 Gb/s) so that the capacity is used more efficiently and with finer granularity.

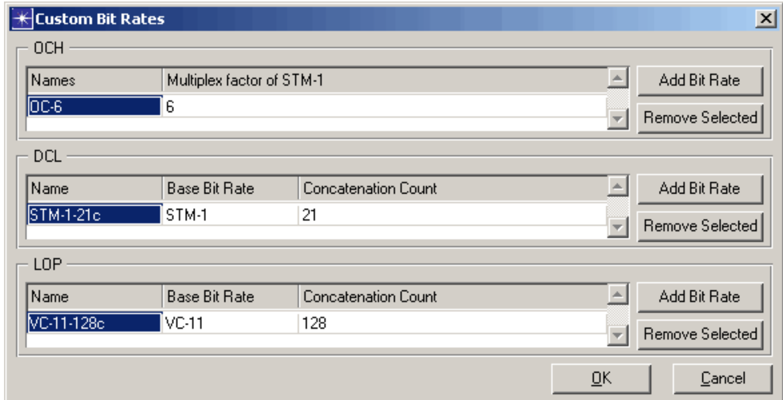
To define a new bit rate, choose Network > Custom Bit Rates. To create a new bit rate, click Add Bit Rate. For a new bit rate at the OCH layer, you must define a name and a multiplex factor (that is the amount of equivalent OC-1 or STM-1 units). For a new bit rate at the OCH layer, you must define a name, base bit rate, and concatenation count (that is, the scaling factor applied to the base rate).

If you define a custom OCH bit rate with a name such as "OC-X" (SONET) or "STM-X" (SDH), SP Guru Transport Planner sets the multiplex factor to X automatically.

If you define a concatenated bit rate with a name using the conventional naming scheme (<*standard_base_bit_rate*>-<*concatenation_count*>-<*c_or_vc*>), such as "STS-X-Yc", SP Guru Transport Planner sets the base bit rate to STS-X, and the concatenation count to Y automatically.

After you define a set of custom bit rates, you can use them as you use any other bit rate: you can define traffic with this bit rate and route it in the network. You can also save the defined set of custom bit rates in the user settings to reuse them again in other projects (for more information, see Importing and Exporting User Data Settings on page TrP-5-27).

Figure 3-22   Concatenated Bit Rates Dialog Box



Creating a Traffic Matrix

After you create a baseline topology, you must create one or more traffic matrices. A traffic matrix specifies the amount of traffic between each node in the topology. Most design operations (such as routing or dimensioning) require a traffic matrix; SP Guru Transport Planner views the matrix as a traffic demand forecast and configures the network to meet this forecast.

Every traffic flow in a traffic matrix is bidirectional and symmetrical: the amount of traffic between two nodes is always equal in both directions.

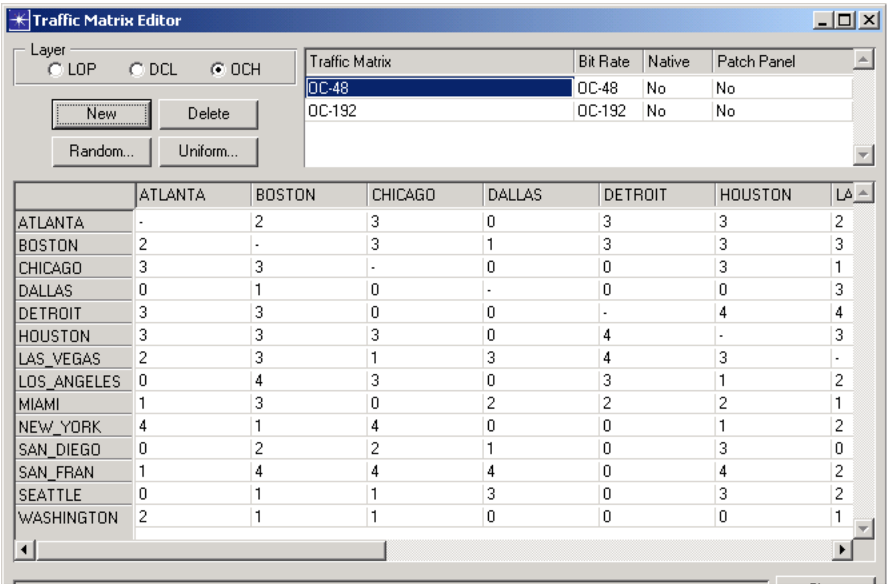
Procedure 3-7   Creating a Traffic Matrix

1 Create a baseline topology with all nodes and links that you want to populate with traffic.

2 Choose Network > Traffic Matrix Editor.

➥ The Traffic Matrix Editor (shown in the following diagram) appears.

Figure 3-23 Traffic Matrix Editor



Traffic Matrix	Bit Rate	Native	Patch Panel
OC-48	OC-48	No	No
OC-192	OC-192	No	No

	ATLANTA	BOSTON	CHICAGO	DALLAS	DETROIT	HOUSTON	LA
ATLANTA	-	2	3	0	3	3	2
BOSTON	2	-	3	1	3	3	3
CHICAGO	3	3	-	0	0	3	1
DALLAS	0	1	0	-	0	0	3
DETROIT	3	3	0	0	-	4	4
HOUSTON	3	3	3	0	4	-	3
LAS_VEGAS	2	3	1	3	4	3	-
LOS_ANGELES	0	4	3	0	3	1	2
MIAMI	1	3	0	2	2	2	1
NEW_YORK	4	1	4	0	0	1	2
SAN_DIEGO	0	2	2	1	0	3	0
SAN_FRAN	1	4	4	4	0	4	2
SEATTLE	0	1	1	3	0	3	2
WASHINGTON	2	1	1	0	0	0	1

3 Choose Layer to select the layer (LOP, DCL, or OCH) of the traffic matrix you want to create. The nodes that appear in the Selected Matrix depend on this setting: OCH matrices contain all OCC and EOCC nodes, LOP and DCL matrices contain all ECC and EOCC nodes.

LOP, DCL, and OCH matrices represent different traffic demands at different layers: SONET/SDH lower-order demands at the LOP layer, SONET/SDH higher-order traffic demands at the DCL layer, and optical-wavelength demands at the OCH layer. The following points summarize the differences and similarities between these matrix types:

- You can groom LOP traffic to DCL traffic. You cannot run a routing or dimensioning operation directly on LOP traffic; you need to translate it to DCL traffic first.For more information, see Chapter 9 Grooming LOP to DCL Traffic on page TrP-9-1.
- You can run a routing operation with either a DCL or an OCH traffic matrix. Routing affects only the used capacity at the layer (DCL or OCH) at which the routing took place. For more information, see Chapter 6 Routing on page TrP-6-1.
- You can only run a dimensioning operation with a DCL traffic matrix in a network that contains ECC nodes (no OCC or EOCC nodes) or with an OCH traffic matrix. For more information, see Chapter 7 Dimensioning on page TrP-7-1.
- You can run a grooming operation with a DCL matrix only. For more information, see Chapter 8 Grooming DCL to OCH Traffic on page TrP-8-1.

4 You can set the Native check box for DCL/OCH traffic. The option is set by default.

A connection is called *native* if it affects only the layer on which it is defined. A non-native connection is trailed towards the higher layer and becomes a link at that layer.

A native OCH connection represents pure optical traffic; a non-native OCH connection represents optical traffic that can support SONET/SDH traffic. Hence a non-native OCH connection becomes a logical link at the DCL layer.

You can also define native and non-native DCL traffic. A non-native DCL connection is trailed towards the LOP layer. LOP traffic is always native, since this is the top layer in the hierarchy.

5 If you want to rename the matrix, double-click the current name, enter a new name, and press Enter.

6 Specify the Bit Rate of the matrix.

7 Click either Random (to specify varying traffic levels between nodes) or Uniform (to specify a uniform traffic level for every pair of nodes).

8 Specify the level of traffic you want in the resulting dialogue box, then click OK to return to the Traffic Matrix Editor.

➥ The Selected Matrix table fills with integer values. These values specify the number of bidirectional wavelength demands (OCH layer) or bidirectional time slots (LOP or DCL layer) at the specified bit rate.

9 Click New to create another traffic matrix, or OK to close the Traffic Matrix Editor and accept your changes.

Note—After you set up a traffic matrix, you cannot change it in the Traffic Matrix Editor. A message below the matrix warns that it cannot be renamed, deleted, or modified. To change the traffic matrix, you must apply the Tear Down operation first. See Chapter 6 Routing on page TrP-6-1 for more information about setting up and tearing down traffic matrices.

End of Procedure 3-7

Note—Besides defining traffic manually via the traffic matrix editor, you can also import traffic, as a traffic matrix or as a list of connections. For more information, see Traffic Matrix Data Files on page TrP-5-14 and Connection List Data Files on page TrP-5-17.

Equipment Properties

SP Guru Transport Planner can optimize networks based on several criteria. One of the most important criteria is cost minimization.

SP Guru Transport Planner uses a generic cost model for physical, optical and electrical equipment. The cost values and equipment properties you set determine how SP Guru Transport Planner optimizes the network. These parameters also determine the total cost statistics generated when you create a Bill of Material (see Bill of Materials on page TrP-15-6) or evaluate network costs (see Overview Total Cost on page TrP-15-19). You can customize the default values for these parameters.

You set cost parameters using the Equipment Properties dialog boxes (Network > Equipment Properties). The cost model consists of three sets of parameters: link costs, WDM equipment properties, and SONET/SDH equipment properties.

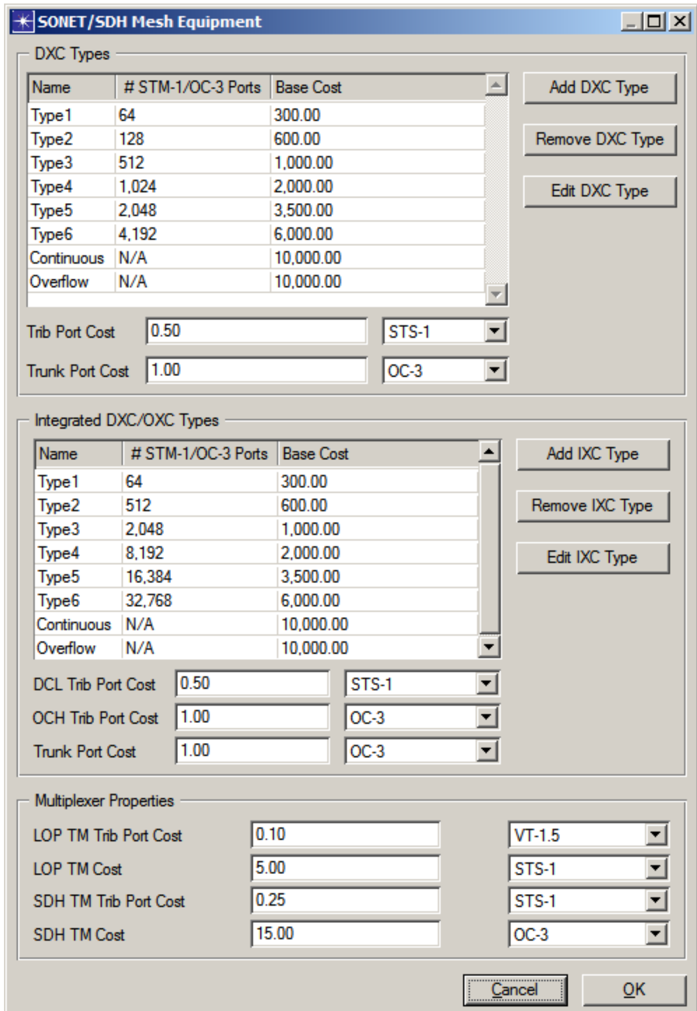
Note—All costs are for bidirectional equipment: an amplifier amplifies the signal in both directions, a multiplexer also demultiplexes, a transponder transmits and receives, etc.

When you change cost values in a dialog box, click OK to store the current settings; these settings are now part of the scenario. To change the default values used for new projects and scenarios, use the Save Current as Default and Load Default operations (on the Network > Equipment Properties submenu).

SONET/SDH Mesh Equipment Properties

You can set parameters for DXC types, for IXC types, and for SONET/SDH multiplexers in the SONET/SDH Mesh Equipment Properties dialog box (Network > Equipment Properties > SONET/SDH Mesh Equipment).

Figure 3-24 SONET/SDH Mesh Equipment Dialog Box

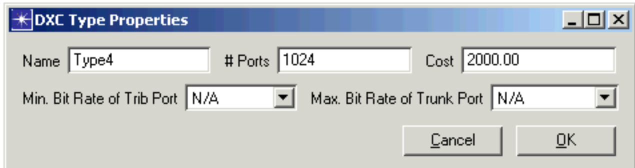


You can add as many DXC or IXC types as you want. By default, two types are always present:

- Continuous type (when you are using discrete node types, as described in The Node Model on page TrP-3-25)
- Overflow type (when you are using discrete node types and the largest specified XC type is not large enough)

You can also define custom DXC and IXC types in addition to the default continuous and overflow types. To create a new type, click Add DXC/IXC Type. To edit the type properties, click Edit DXC/IXC Type. The number of ports you specify is the number of equivalent STM-1/OC-3 ports. This defines the throughput of the node. The DXC/IXC cost defines the base cost of the switch matrix only. Port costs are specified independently of the DXC/IXC type.

Figure 3-25 DXC Type Properties Dialog Box



The DXC is used for switching traffic at the SDH/SONET level. It terminates wavelengths or direct SDH/SONET trunks (in the case of two-tier networks) at its trunk ports, and SDH/SONET traffic at its tributary ports. The size of the switch is specified in equivalent STM-1/OC-3 ports. A 1024 STM-1/OC-3 port switch can terminate:

- 3072 STS-1 ports
- 1024 STM-1/OC-3 ports
- 64 STM-16/OC-48 ports
- 4 STM-64/OC-192 ports
- A combination of different ports

The IXC is similar to the DXC, except that it switches traffic at both the SONET/SDH and the wavelength levels. This means the IXC also takes optical traffic at its tributary ports. Typically IXCs have a larger throughput than DXCs.

You can specify a minimum bit rate for the tributary ports and a maximum bit rate for the trunk ports of both the DXC and the IXC. To limit the total number of ports on a DXC/IXC, you can specify a minimum bit rate for the tributary ports (in other words, to allow OC-48 and higher bit rate ports only). Any traffic with a lower bit rate is attached to a terminal multiplexer (also called an *aggregator*) and is not fed directly in the DXC/IXC. This multiplexer aggregates traffic up to the minimum bit rate for the tributary ports. Similarly, you can limit the trunk bit rates of the DXC/IXC ports. The maximum bit rate of trunk ports could be OC-48, for example, while wavelengths in the network use a OC-192 rate. Such a configuration requires a so-called mid-stage multiplexer to multiplex OC-48 ports coming out of the DXC/IXC to OC-192 channels carried on a single wavelength.

Besides a base cost for the switch matrix, the DXC and IXC switches also have a bit rate-dependent cost for their tributary and trunk ports. For the IXC, a further distinction is made between electrical tributary ports (for SONET/SDH traffic) and optical tributary ports (for wavelength services).

Finally, you need to specify the cost of the SONET/SDH terminal multiplexers (TMs) and the cost of their tributary ports. The LOP TM multiplexes LOP traffic into a DCL bit rate. The cost of the LOP TM depends on the DCL bit rate it multiplexes towards. Each tributary port on the LOP TM has a cost depending on the bit rate of the LOP traffic it multiplexes. The SDH TM multiplexes DCL traffic into an OCH bit rate. The cost of the SDH TM depends on the OCH bit rate it multiplexes towards. Each tributary port on the SDH TM has a cost depending on the bit rate of the DCL traffic it multiplexes.

SONET/SDH Ring Equipment

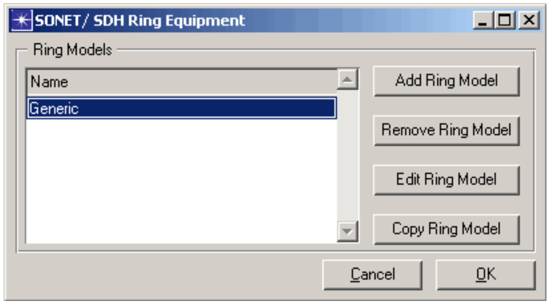
There are two types of node equipment that can be used to support SONET/SDH rings:

- Add-Drop Multiplexers (ADMs). The types and properties of the ADMs are specified in Network > Equipment Properties > SONET/SDH Ring Equipment.
- Multi-Service Switching Platforms (MSSPs). These are in fact DXCs that also support ring switching functionality. The types and properties of the DXCs are specified in Network > Equipment Properties > SONET/SDH Mesh Equipment.

You can create different ring models in SP Guru Transport Planner. A ring model should be applied to each SONET/SDH ring in the network. Each ring model can have different cost properties for its ADMs.

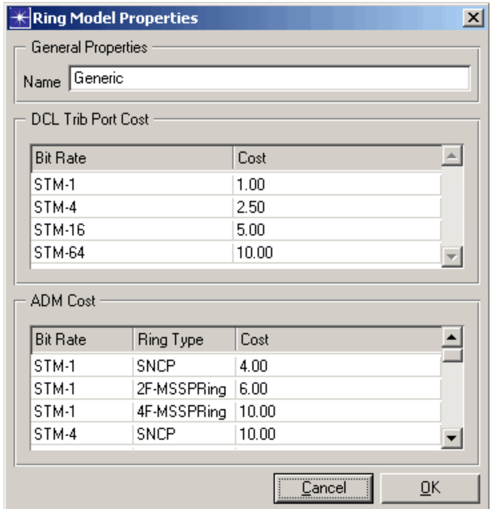
- In the SONET/SDH Ring Equipment dialog (Network > Equipment Properties > SONET/ SDH Ring Equipment), you can specify the ring models to be used in the network model.

Figure 3-26 SONET/SDH Ring Equipment Dialog Box



- To set the cost properties of the ring model, click Edit Ring Model. You can set a cost per ADM, which depends on the Ring Type (UPSR, 2F-BLSR or 4F-BLSR) and the bit rate of the ring. In addition, you can set a cost per tributary port that is used on the ADM at a certain bit rate.

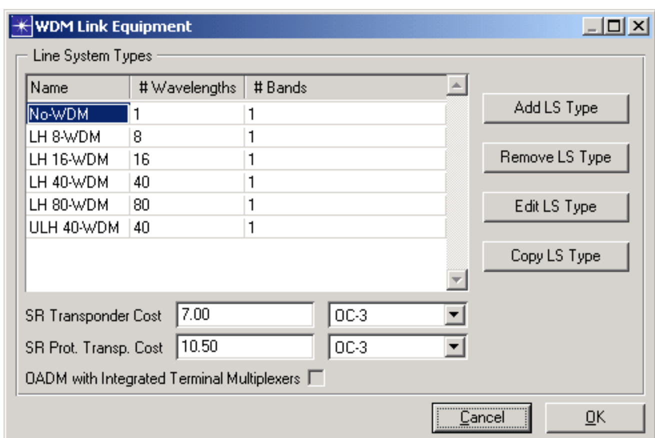
Figure 3-27 SONET/SDH Ring Equipment Dialog Box



WDM Link Equipment Properties

You can use the WDM Link Equipment Properties dialog box (Network > Equipment Properties > WDM Link Equipment…) to add, remove, and edit the WDM line systems.

Figure 3-28 WDM Link Equipment Dialog Box

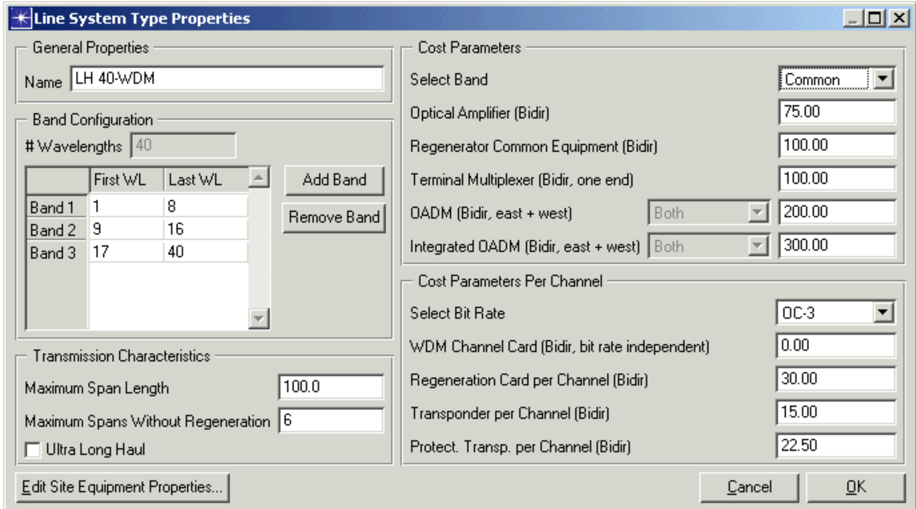


Procedure 3-8 Specifying WDM Link Equipment Properties

1. Choose Network > Equipment Properties > WDM Link Equipment to open the WDM Link Equipment dialog box.
2. Select the line system in the Line System Types table.
3. Click the Edit LS Type button.

   ➥ The Line System Type Properties dialog box appears.

Figure 3-29 Line System Type Properties Dialog Box



4 Specify the Band Configuration options.

The band-configuration table lists the number of bands per system and the first and last wavelength per band. You can install wavelength bands to allow a more modular upgrade of capacity on the system.

You can define as many bands as you want for a specific line system. To add an extra band, click Add Band.

You can edit the last wavelength of the last band only. The total number of wavelengths (# Wavelengths) of the system is equal to the last wavelength of the last band. To remove the last band, click Remove Band.

5 Enter data in the Transmission Characteristics section.

Note—This section appears dimmed and cannot be edited if one or more fibers in the network have been equipped with a WDM line system type.

- Number of wavelengths (#Wavelengths) available on the system. This value is not editable: it is the sum of the number of wavelengths used over all bands.
- Maximum Span Length (distance before amplification)
- Maximum Number of Spans without Regeneration

6 Enter data in the Cost Parameters section. This section enables you to define cost values for the equipment components per band. If only the first band of a system is used, only the cost values of this first band are counted. You can also set a “common” cost for the entire system, which is independent of the number of bands used.

- Select Band—The band whose cost parameters are being specified
- Optical Amplifier (Bidir)—A cost for the optical amplifier of the WDM system or a band
- Regenerator Common Equipment (Bidir)—A cost for the common equipment in a regeneration site

- Terminal Multiplexer (Bidir, one end)—A WDM terminal multiplexer cost counted at the end-points of the WDM system and at the regeneration sites
- OADM (Bidir, east + west)—A cost for an OADM of this WDM system or a band. The OADM components per band can be one of the following types:
  - Add-Drop (allows only add-drop of the wavelengths on the band)
  - Transit (allows only transit of the wavelengths on the band)
  - Both (allows only add-drop and transit of the wavelengths on the band)
- Integrated OADM (Bidir, east + west)—A cost for an integrated OADM (that is, an OADM that contains the WDM terminal multiplexers)

7 Enter data in the Cost Parameters Per Channel section:

- Select Bit Rate—The bit rate whose cost parameters are being specified
- WDM Channel Card (Bidir, bit rate independent)—A bit-rate-independent WDM channel card, counted per channel at the WDM terminal multiplexer.
- Regeneration Card per Channel (Bidir)—A bit-rate-dependent regeneration card, counted per channel in the in-line regeneration sites.
- Transponder per Channel (Bidir)—A bit-rate-dependent, long-reach transponder card, counted per channel at the WDM multiplexer in opaque mode. In a transparent node, these long-reach transponders are used when adding/dropping traffic or for selective regeneration of transit traffic.
- Protect Transp. per Channel (Bidir)—A bit-rate-dependent, long-reach protection transponder card used for optical 1+1 protection at the tributary side of the OXC (in a transparent node).

8 If desired, click Edit Site Equipment Properties to specify the physical characteristics of the system floor space and power supplies.

Note—The fields in the Site Equipment Properties dialog box appear dimmed and cannot be edited if one or more fibers in the network have been equipped with a WDM line system type.

End of Procedure 3-8

Other Link Equipment Options

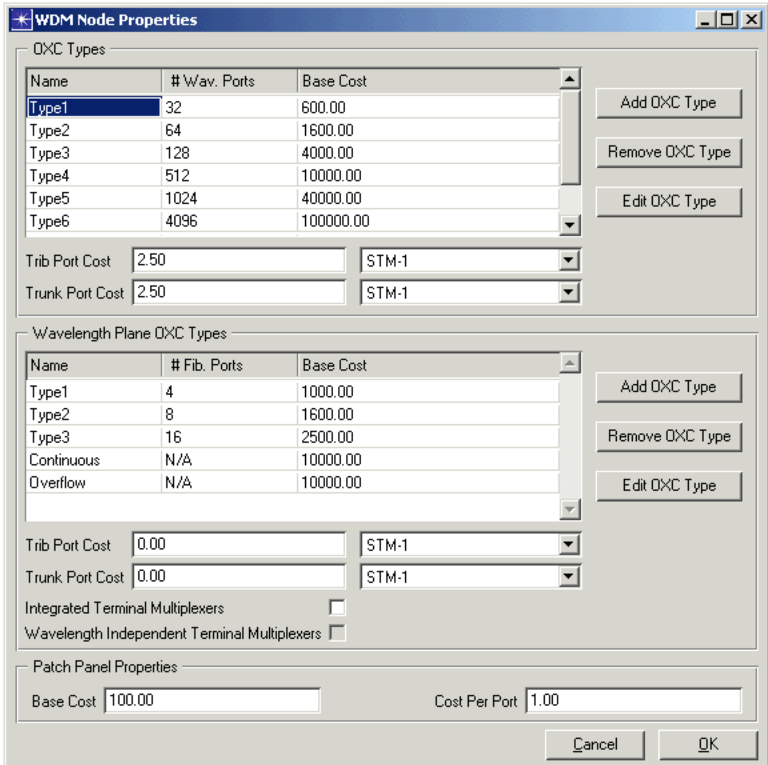
In opaque mode, short-reach transponders (= gray interfaces) are used at the tributary sides of the OXC. The cost of these transponders is independent of the WDM line system and is specified in the WDM Link Equipment dialog box.

Besides options for specifying cost parameters for transponders, this dialog box includes the option “OADM with integrated terminal multiplexers”. If this option is selected, the OADM terminates two fiber pairs at both trunk ports and no additional WDM terminal multiplexers are counted. If this option is not selected, the OADM uses wavelength ports at the trunk side, and SP Guru Transport Planner counts two additional terminal multiplexers at each side to multiplex/demultiplex the wavelengths. SP Guru Transport Planner counts wavelength ports at the tributary side regardless of whether this option is selected.

WDM Node Equipment Properties

You can use the “WDM Node Equipment” dialog box to add, remove and edit non-blocking OXC types and wavelength plane OXC types (see Optical Nodes: WP-OXC on page TrP-2-26 for descriptions of these types).

Figure 3-30 WDM Node Equipment Dialog Box



You can add as many OXC types as you want. By default, two types are always present: the Continuous OXC type (when you are using discrete node types, as described in The Node Model on page TrP-3-25) and the Overflow type (when you are using discrete node types and the largest specified OXC type is not large enough).

Procedure 3-9 describes how to specify the OXC types next to the line systems. You should always perform this procedure, especially when you are working with discrete node types.

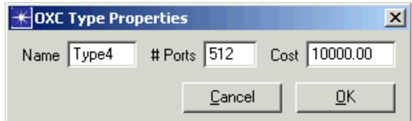
Procedure 3-9 Specifying OXC Types

1 In the WDM Equipment Properties dialog box, select the OXC type in the “OXC Types” table.

2 Click the Edit OXC Type button.

➥ The OXC Type Properties dialog box appears.

Figure 3-31   OXC Type Properties Dialog Box



3. Edit the OXC type. Specify the Name, the number of (bi-directional) wavelength ports (# Ports), and the cost of the OXC switching matrix (Cost). Then click OK to return to the WDM Equipment Properties dialog box.

4. Specify a bit rate and a bit-rate-dependent cost per OXC tributary (Trib Port Cost) and trunk port (Trunk Port Cost). These values are the same for all OXC types.

End of Procedure 3-9

Discrete WP-OXCs are specified in terms of fiber ports. An OXC with eight fiber ports has eight wavelength ports per wavelength plane.

Procedure 3-10   Specifying Wavelength Plane OXC types

1. In the WDM Node Properties dialog box, select the OXC type in the Wavelength Plane OXC Types table.

2. Click the Edit OXC Type button.

   ➥ The OXC Type Properties dialog box appears.

3. Edit the OXC type. Specify the Name, the number of (bi-directional) fiber ports (# Ports), and the cost of the OXC switching matrix (Cost). Then click OK to return to the WDM Node Properties dialog box.

4. Specify a bit rate and a bit rate-dependent cost per OXC tributary (Trib Port Cost) and trunk port (Trunk Port Cost). These values are the same for all WP-OXC types.

5. You can set the Integrated Terminal Multiplexers checkbox to integrate the WDM terminal multiplexers in the WP-OXC and thus create virtual fiber ports.The fibers connect to the WP-OXC directly instead of demultiplexing the wavelengths using a terminal multiplexer.

   - If this checkbox is enabled, the WP-OXC uses fiber ports and the trunk fibers can be directly interconnected to the WP-OXC. In this case, external terminal multiplexers are required at the tributary side to multiplex the add/drop wavelengths towards the tributary fibers.

   - If this checkbox is disabled, the WP-OXC uses wavelength ports, and external terminal multiplexers are used to multiplex/demultiplex the wavelengths from the trunk fibers to the WP-OXC ports.

6. If there are integrated terminal multiplexers, you can set the Wavelength Independent Terminal Multiplexers checkbox to specify that the terminal multiplexer inputs at the WP-OXC tributary side are wavelength-independent.

- If this checkbox is enabled, each port on the terminal multiplexer can take any wavelength as input. Combined with tunable transponders, this enables the node to use any port on the terminal multiplexer at any wavelength with the constraint that each wavelength can be used only once on the terminal multiplexer.
- If this checkbox is disabled, the input wavelengths of the terminal multiplexers are fixed, and each port on the terminal multiplexer uses a fixed-wavelength transponder.

End of Procedure 3-10

Specifying Patch Panel Properties

Some traffic can be hardwired. In this case, a patch panel is used in the node and the base cost and cost per port of the patch panel must be counted. Open the WDM Node Properties dialog box; in the Path Panel Properties section, specify the Base Cost and Cost per Port parameters.

Generic Link Costs

Use the Generic Link Costs dialog box (Network > Equipment Properties > Generic Link Costs…) to set the following parameters:

Table 3-4   Link Cost Parameters

Parameter / Description
Cable Costs: • Fixed—Fixed cost, per cable • Per Length Unit—Additional cost per length unit • Per Amplifier Site—Cost of each amplifier site • Per Regenerator Site—Cost of each regeneration site
Fiber Costs: • Fixed—Fixed cost per fiber pair • Per Length Unit—Additional cost per length unit
Optical Channel Costs: • Fixed Channel Cost—Fixed cost, per channel • Per Length Unit—Additional cost per length unit
End of Table 3-4

Delay Settings

You can model the delay of a signal across a link or node in the network and investigate the resulting end-to-end delay of a connection through the network. To set the delay parameters, choose Network > Delay Settings to open the Delay Settings dialog box (Figure 3-32 on page TrP-3-42). After you specify delay settings, you can see the impact on links in the following browsers:

- In the Link Browser, the “Delay” column lists the delay on each fiber link.
- In the DCL and OCH Connection Browser, the “Delay” column shows the delay of each connection.

Figure 3-32   Delay Settings Dialog Box

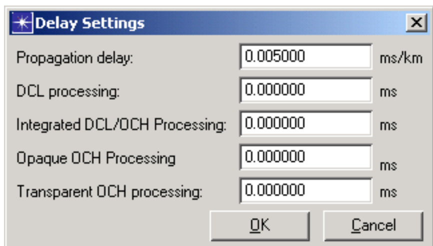


Table 3-5   Delay Settings Dialog Box

Item	Description
Propagation delay	The delay (in ms/km or ms/mile, depending on the project settings) of a signal on a fiber link
DCL processing	The delay (in ms) of a signal when passing through an electrical node in the DCL layer
Integrated DCL/OCH processing	The delay (in ms) of a signal when passing through an integrated cross-connect node (IXC) at both the DCL and OCH layers
Opaque OCH processing	The delay (in ms) of a signal when passing through an opaque node in the OCH layer
Transparent OCH processing	The delay (in ms) of a signal when passing through a transparent node in the OCH layer
End of Table 3-5	

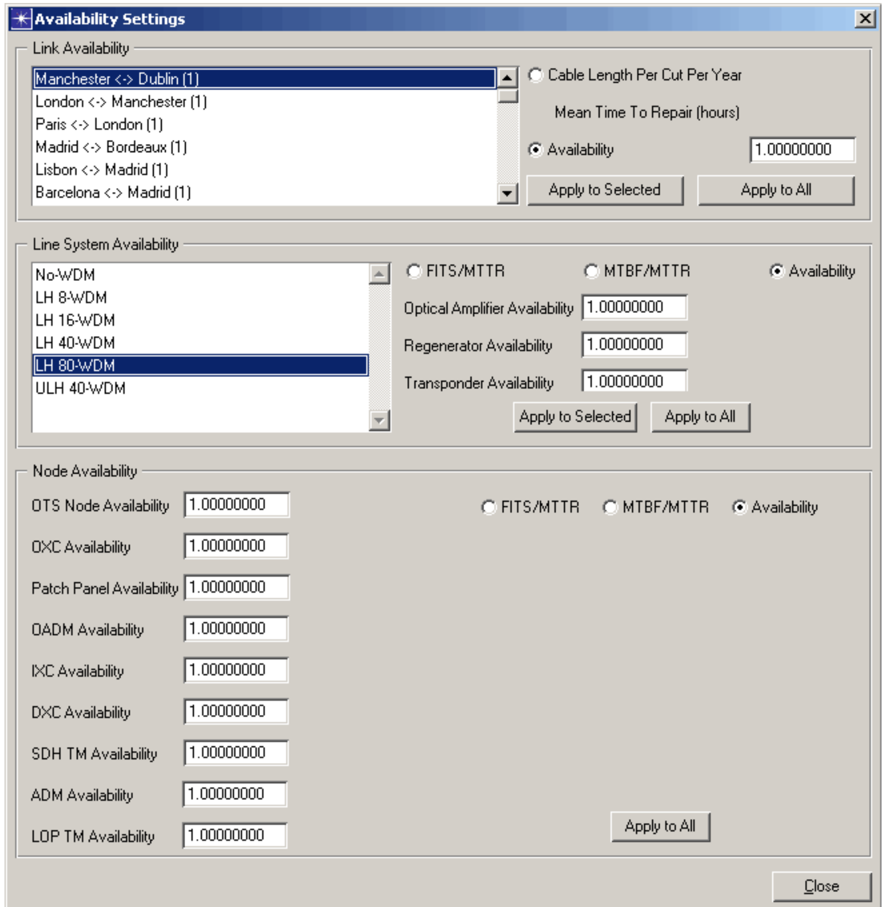
Availability Settings

Availability settings (Network > Availability Settings…) specify the relative amount of time that network equipment is working in a fault-free condition. The availability properties are used for three purposes:

- To determine the path with maximum availability (if “Highest Availability” is selected as routing cost, see Routing Algorithm on page TrP-6-8)
- To calculate the availability of a path in the routing wizard (see Manual Routing on page TrP-6-24)

- To calculate the availability of a connection depending on the recovery method applied (see Service Availability on page TrP-14-2).

Figure 3-33 Availability Settings Dialog Box



Link Availability Properties

You can use either of two models to specify the availability property of links:

- Cable length cut model: Select the “Cable Length Per Cut Per Year” radio button, then specify
  - — The average estimated cable length (in km) within which you expect a single cable cut to occur over a year
  - — The Mean Time To Repair (MTTR) the cable cut, in hours

    If you specify a cable cut of 300 kilometers and an MTTR of 24 hours, for example, a cable cut will occur at some point every 300 kilometers over the link over the next year, and each cut will take 24 hours to repair. Thus, a link that is 900 km long will experience three cuts over the next year, with a total down time of 72 hours (24 hours per cut).

- Availability model: Check the Availability radio button, then enter a number between 0 and 1 to indicate the relative amount of time a cable is available (0 means “never available” and 1 means “always available.”)

You can apply the availability property to a selected link (click Apply to Selected) or to all links (click Apply to All).

Line System Availability Properties

For each line system specified in the WDM Link Properties dialog box (see WDM Link Equipment Properties on page TrP-3-35), you can specify the availability properties for the amplifiers, regenerators, and transponders. You can use any of three models to specify these values:

- FITS/MTTR—The failure rate is specified as failures-in-time (FIT). 1 FIT equals one failure every 10e9 hours (about 114 to 115 years). The Mean Time To Repair (MTTR) specifies the number of hours needed to repair a failure.
- MTBF/MTTR—The availability is calculated based on the Mean Time Between Failures (MTBF) and Mean Time To Repair (MTTR), both specified in hours.
- Availability—The availability is specified as a number between 0 and 1, indicating the relative amount of time the equipment is available (0 means “never available” and 1 means “always available”).

You can apply the availability property to a selected line system type (click Apply to Selected) or to all line system types (click Apply to All).

Node Availability

You can specify the availability of the different node devices using the same three models as for a line system type component. this can be done for the following devices: an entire OTS node, an OXC, a patch panel, an OADM, an IXC, a DXC, an SDH terminal multiplexer, an ADM and an LOP terminal multiplexer. Note that if an OTS node fails, all switching devices in that node are failing. The availability you specify applies to all devices of that type.

Note—The Availability Settings dialog box can also be opened by selecting the Availability Settings button in the Evaluate Availability dialog box (see Service Availability on page TrP-14-2).

Configuring Individual Objects

In some cases, you might want to override the general equipment settings for specific objects. The object browsers (for nodes, links, connections, and rings) support operations for setting the properties of individual objects. Generally, you can right-click on an object in the browser treeview and choose an operation for the menu.

Table 3-6 Configurable Properties for Individual Nodes and Links: References

Item	Properties	References
Nodes	DCL node type:TM/DXC/IXC DCL ring configuration: ADM/MSSP OCH node type: OXC/WP-OXC/IXC/OADM/PP OADM configuration (OCH) Transparency settings (OCH) ECC/EOCC/OCC type (OTS) Name and location (OTS) Cable splitter configuration (OTS)	DCL Node Browser on page TrP-4-20 OCH Node Browser on page TrP-4-15 OTS Node Browser on page TrP-4-14
Links	DCL capacity OCH capacity (equipped fiber pairs and bands) Fiber length, total fiber pairs, user-specified cost (OTS) Link design (OTS) Designations and subdesignations (on all layers)	DCL Link Browser on page TrP-4-11 OCH Link Browser on page TrP-4-7 OTS Link Browser on page TrP-4-2
Connections	Routing constraints Topological constraints Hardwired settings in nodes Required availability Designations	Connection Browser on page TrP-4-23
End of Table 3-6		

Link Design

When you create a new link in your network, it is unequipped. You can use the Link Design operation to place amplification and regeneration sites along the link span, based on the transmission characteristics of the selected WDM line system.

Always design links before you do any network-design operations that affect the OCH layer. This step is a *prerequisite* to design operations in transparent networks, and is *strongly recommended* for design operations in opaque networks. If you dimension a network without designing the links first, the dimensioning algorithms do not include the cost of amplifiers and regenerators in its calculations.

Two parameters determine the number of regenerators and amplifiers on a link, which are specified in the Link Design Dialog Box:

- The maximum span length before regeneration
- The maximum number of amplification spans before regeneration

With these parameters, SP Guru Transport Planner calculates the number of required amplification and regeneration sites as follows:

total sites = *fiber_length / max_span_length_before_amplification* – 1

regeneration sites = *#_total_sites / max_#_amplification_spans_before_regeneration*

amplification sites = *#_total_sites – #_regeneration_sites*

Procedure 3-11 describes how to design the links in your network. You can also design links by importing the data for amplification and regeneration sites, as described in Optical Amplifier and Regenerator Locations Data Files on page TrP-5-10.

Procedure 3-11 Designing Links

1 Choose Design > Link Design to open the Link Design dialog box.

2 For each link in your network:

2.1 Choose the type of link you want to design (OTS links or fiber routes). If you choose to design fiber routes, all intermediate nodes through which fibers are routed, will also be considered as possible amplification/regeneration sites.

2.2 Choose the link you want to design in the Link menu, or choose ALL LINKS to design all links at once. If you chose to design OTS links, you can also choose ALL DCL LINKS, ALL OCH LINKS, or SELECTED LINKS.

2.3 Choose the line-system type on the selected link in the LS Type pull-down menu. This menu lists all line systems defined in the WDM Equipment Properties dialog box (described in WDM Link Equipment Properties on page TrP-3-35). You can also choose “All LSTYPES” from this menu, to specify a “worst-case” link design.

2.4 Set the Site Locations menu to specify the placement of sites along the link.

2.5 Set the Regeneration Locations menu to specify which sites act as regeneration sites.

2.6 Click Design.

➥ A window appears to show the number of OAs and regenerators added to the selected link.

3 Repeat these steps until you have designed all links in the network. To determine whether a link is designed, select the link and view the Designed field. You can also browse for undesigned links in the Link Browser; for more information, see Link Browser on page TrP-4-2.

End of Procedure 3-11

Link Design Dialog Box

Choose Design > Link Design to open the Link Design dialog box (Figure 3-34 and Table 3-7 on page TrP-3-48). For more information, see Procedure 3-11 Designing Links on page TrP-3-46.

Figure 3-34 Link Design Dialog Box

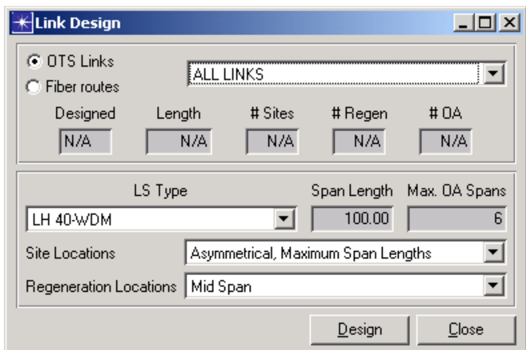


Table 3-7 Link Design Dialog Box

Item	Description
OTS Links / Fiber Routes	Click the OTS Links or Fiber Routes button to set the options in the pull-down menu; then select a link or fiber route to design from the pull-down menu. If you select a fiber route, the action designs all constituent links in the fiber route. SP Guru Transport Planner considers intermediate nodes along the fiber route to be candidate regeneration or amplification sites. The functionality deployed in an intermediate node depends on the reach of the line system and the distance between the next and the previous regeneration or amplification site. The fields below the menu show the following information about the selected link or fiber route: • Designed—Indicates whether the link was already designed • Length—Link length, in meters • # Sites—Number of in-line sites (total) • # Regen—Number of regeneration sites that can regenerate and amplify signals • # OA—Number of amplification sites that can amplify only
LS Type	Design the link for a specific line system type, or for all line system types (a worst-case design). The fields on the right show the following information about the selected system type: • Span Length—Span length (in km) for the selected LS type. This is the maximum length that an optical signal can be transmitted before it must be amplified. • Max OA Spans—Maximum number of OA spans on a link before the signal must be regenerated
Site Locations	Determine the placement of sites along the link. This menu has three options: • Equal Span Length—Position all sites on an equal distance (*fiber_length* ÷ *total_sites*) from each other • Asymmetrical, Maximum Span Length—Position all sites (except the last) according to the maximum span length before amplification • Symmetrical, Maximum Span Length—Position all sites according to the maximum span length before amplification (except the first and last sites, which are placed on an equal distance from the end nodes)
Regeneration Locations	Determine which sites act as regeneration sites. This menu has two options: • Mid Span—Place regeneration sites so that the regeneration spans created are of equal length • Asymmetrical—Place all regeneration sites (except the last site) according to the maximum number of amplification spans before regeneration
End of Table 3-7	

Recalculating Link Lengths

Dragging nodes in the project workspace changes their locations but does not automatically change the link lengths. If you move the nodes in your network, you must run this operation to adjust the link lengths so that they correspond to the physical distances represented in the network topology.

To recalculate the length of the OTS links, choose Design > Recalculate Link Lengths. Recalculating the link lengths removes the in-line sites along the OTS links. Then choose Design > OTS Link Design to recalculate the in-line sites based on the new link lengths.