11   Optical Express Layer

The purpose of an optical express layer is to provide express links between nodes that exchange a lot of traffic; this reduces the amount of switching equipment (and the cost) in intermediate nodes. The optical express layer uses fiber routing to define new links, which can be used to route traffic at a lower cost.

This concept is similar to grooming, which provides optical express links for DCL traffic demands. However, optical express layering and grooming differ in the following ways:

- Grooming uses optical channels to create express links in the DCL layer; optical express layering uses fiber bypasses to create express links in the OCH layer.

- A grooming operation works on one DCL traffic matrix, and the resulting links are designed exclusively for that DCL traffic matrix; optical express links create bypass fibers that can support all traffic (DCL and OCH) defined in the network.

- Grooming creates a set of express DCL links that are implemented through wavelength routing and provisioned through OXCs. These links are more dynamic than optical express links, which are static OCH links implemented through fiber routing.

Workflow Description

You can use the wizard (Design > Express Layer Design) to create and size an express layer based on your physical topology, traffic, and cost parameters. You can override the wizard's suggestions and design the express layer manually. This wizard consists of three main steps that construct the express layer:

1) Add or remove gateway nodes between which express links will be created.

    The first step is to select the gateway nodes between which express links can be created. The Express Layer Design Wizard enables you to select the gateway nodes based on the estimated amount of traffic processed in the nodes. Gateway nodes are typically nodes that collect and exchange a lot of traffic; these nodes act as the on-ramp for the optical express layer.

    For more information, see Select Gateway Nodes Dialog Box on page TrP-11-3.

2) Add or remove the express links between the gateway nodes.

The Express Layer Design Wizard enables you to select express links based on the estimated amount of traffic supported by these links. You need to select links between gateway nodes that are not physically adjacent—that is, links that have a direct fiber between them. These links will be implemented by fiber routing, as described in Fiber Routing on page TrP-3-21. (Links between adjacent gateway nodes are included in the express layer automatically.)

For more information, see Select Express Links Dialog Box on page TrP-11-6.

3) Select the fiber routes that implement the express links.

The last step is to decide how to implement the express links you have selected. SP Guru Transport Planner uses fiber routing for this purpose—that is, it establishes a new OCH link between two gateway nodes. An express link is supported by a fiber pair in the OMS layer. Because it bypasses any intermediate nodes, an express link avoids the expensive switching cost in intermediate nodes. Keep in mind that fiber routing is applied for express links between non-adjacent gateway nodes only; adjacent gateway nodes are already connected by a direct fiber pair.

For more information, see Implement Express Links Dialog Box on page TrP-11-10.

After you define the express layer, you can apply network design functions such as routing, dimensioning, and so on. SP Guru Transport Planner considers express links as it does other OCH links, and favors an express link over paths that consist of non-express links.

Note—If you define an express layer in a SONET-only network, ECC nodes that are selected as gateway nodes are transformed to EOCC nodes to allow optical switching of channels between express links within that node.

Note—You can use the Express Layer Design Wizard to create or modify the express layer only if there is no capacity currently equipped in the network.

Select Gateway Nodes Dialog Box

The Select Gateway Nodes dialog box appears when you choose Design > Express Layer Design in the Project Editor. The treeview lists all nodes in the network and enables you to select or unselect the nodes that will act as gateway nodes.

Note—You cannot unselect a gateway node if it currently connects any express links. If you select an ECC node as a gateway node, it becomes an EOCC node to allow optical routing over the express layer.
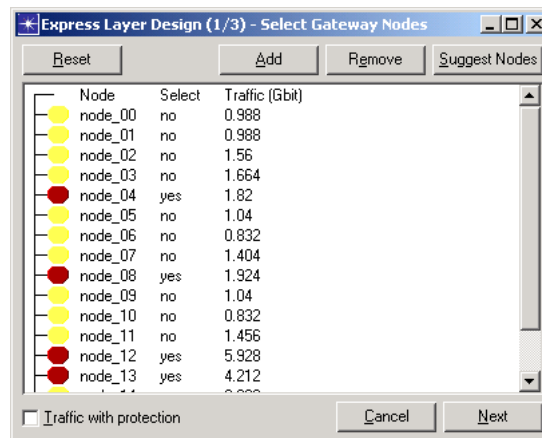
Figure 11-1   Select Gateway Nodes Dialog Box

Table 11-1   Select Gateway Nodes Dialog Box

Control	Description
Node column (in treeview)	Name of the node.To indicate that a node is a gateway icon, SP Guru Transport Planner uses a red icon in the treeview and a red square in the Project Editor workspace.
Select column (in treeview)	Indicates whether the node is selected as a gateway node.
Traffic (Gbit) column (in treeview)	The estimated amount of traffic switched in the nodes on the express link when all traffic (OCH and DCL) is routed along the shortest path. You can use these values to select the most appropriate gateway nodes.
Traffic with Protection	If protected routing is required, you can select the Traffic with protection option. With this option selected, the traffic values are calculated based on the shortest-cycle routing of all traffic.

Table 11-1   Select Gateway Nodes Dialog Box (Continued)

Control	Description
Add	Add selected node(s) to the set of gateway nodes. You can also double-click on a node in the treeview to add/remove it.
	To add multiple nodes, select the nodes in the Project Editor workspace and click Add.
Remove	Remove a node from the set of gateway nodes. You can also double-click on a node to add/remove it.
	To remove multiple nodes, select the nodes in the Project Editor workspace and click Remove.
Suggest Nodes	Obtain a suggested set of gateway nodes (see Calculate Gateway Nodes Set Dialog Box on page TrP-11-4)
Reset	Reset all node selections
Next	Proceed to the next window (see Select Express Links Dialog Box on page TrP-11-6)
End of Table 11-1	

Calculate Gateway Nodes Set Dialog Box

This dialog box appears when you click Suggest Nodes in the Select Gateway Nodes Dialog Box. You can use this dialog box to calculate a suggested set of of gateway nodes.
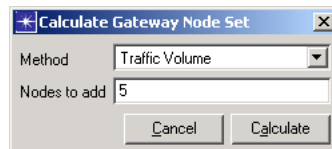
Figure 11-2   Calculate Gateway Nodes Set Dialog Box

Table 11-2   Calculate Gateway Node Set Dialog Box

Control	Description
Method	The method used to select the gateway nodes. You choose one of the following: • Traffic Volume—This method is based on the traffic volume (in Gbps) processed in each node. Using this approach, SP Guru Transport Planner selects the nodes with the most add/drop and transit traffic. • Traffic Relationships—This method is based on the traffic relationships between the nodes. In this case, SP Guru Transport Planner selects the set of nodes between which most traffic is routed (using the shortest paths). SP Guru Transport Planner constructs this node set iteratively by adding each node to the set that exchanges the most traffic with the current set of nodes.
Nodes to add	The number of nodes to add to the current set of gateway nodes
End of Table 11-2	

Select Express Links Dialog Box

The Select Express Links dialog box appears when you click Next in the Select Gateway Nodes Dialog Box. The treeview lists all links in the network and enables you to select or unselect the links that will act as express links.
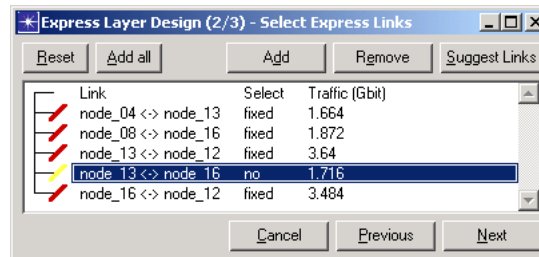
Figure 11-3   Select Express Links Dialog Box

Table 11-3   Select Express Links Dialog Box

Control	Description
Link column (in treeview)	Name of the link. A red icon indicates that the link is selected as an express link. The Project Editor window also highlights the link in red.
Select column (in treeview)	Indicates whether the link is selected as an express link. The possible settings are: • Yes—Link is selected as an express link • No—Link is not selected as an express link • Fixed—Link is an express link by definition because there is a direct fiber between both nodes (this setting cannot be changed)
Traffic (Gbit) column (in treeview)	The estimated amount of traffic on the express link when all traffic (OCH and DCL) is routed along the shortest path. You can use this information to determine the most appropriate express links.
Add	Add selected link(s) to the set of express links. You can also double-click on a link in the treeview to add/remove it. To add multiple links, select the links in the Project Editor workspace and click Add.
Add all	Adds all possible express links (that is, a full mesh) between the selected gateway nodes
Remove	Remove a link from the set of express links. You can also double-click on a link to add/remove it. To remove multiple links, select the links in the Project Editor workspace and click Remove.
Reset	Reset all link selections

Table 11-3   Select Express Links Dialog Box (Continued)

Control	Description
Suggest Links	Obtain a suggested set of express links (see Calculate Express Link Set Dialog Box on page TrP-11-8)
Next	Proceed to the next window (see Implement Express Links Dialog Box on page TrP-11-10)
Previous	Return to the previous window (see Select Gateway Nodes Dialog Box on page TrP-11-3)
End of Table 11-3	

Calculate Express Link Set Dialog Box

This dialog box appears when you click Suggest Links in the Select Express Links Dialog Box. You can use this dialog box to calculate a suggested set of express links. SP Guru Transport Planner selects express links based on traffic or cost using the specified options, with no topological constraints.

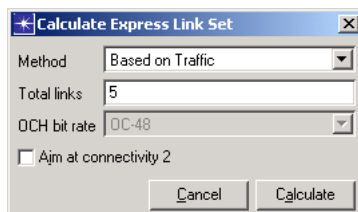**Figure 11-4   Calculate Express Link Set Dialog Box**

Table 11-4   Calculate Express Link Set Dialog Box

Control	Description
Method	The method used to select the express links. You choose one of the following: • Based on Traffic—This method is based on the expected amount of traffic (in Gbps) over each express link when shortest-path routing of all traffic is applied. SP Guru Transport Planner selects the links that exchange the most traffic between nodes . • Based on Cost (quick)—Use the "Based on Cost" algorithm without recalculating the shortest paths (see Based on Cost Algorithm on page TrP-11-9) • Based on Cost (precise)—Use the "Based on Cost" algorithm while recalculating the shortest paths (see Based on Cost Algorithm on page TrP-11-9)
Total links	The total number of express links (including existing express links) to select
OCH bit rate	If the "Based on Cost" method is selected, this option specifies the OCH bit rate to which the DCL demands between EOCCs are groomed.
Aim at connectivity 2	If this option is selected, SP Guru Transport Planner adds express links between nodes with a low node degree in the express layer. You should select this option if you plan to apply protected routing over the express layer.
End of Table 11-4	

Based on Cost Algorithm

If you select the "Based on Cost" algorithm, SP Guru Transport Planner selects express links using an iterative algorithm. This algorithm adds the express links that are expected to result in the highest cost savings.

In each iteration, the algorithm compares—for each node pair—the relative cost savings of fiber routing over an express link versus wavelength routing over the existing topology with no express links. The algorithm considers the OCH bit rate used to groom the DCL traffic to the appropriate number of wavelengths. (The OCH bit rate is specified in the Calculate Express Link Set dialog box, shown in see Figure 11-4 on page TrP-11-8).
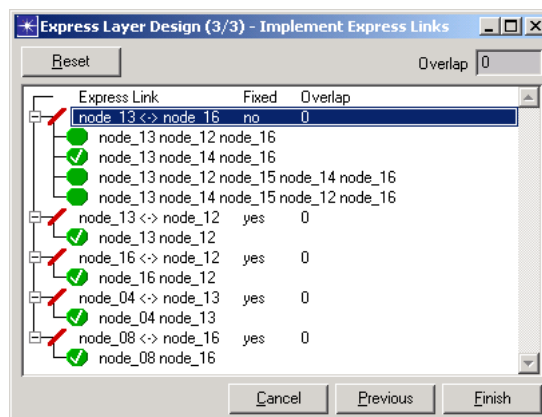
The algorithm has the following workflow:

- In iteration 1, SP Guru Transport Planner selects the node pair with the highest cost savings as the first express link.

- In subsequent iterations, SP Guru Transport Planner considers the express links of previous iterations and recalculates the cost savings for each node pair. In each iteration, the algorithm selects the new express link with the highest cost savings. You can specify whether the algorithm recalculates the shortest path when it recalculates the cost savings (see Figure 11-4 on page TrP-11-8):

  — If the algorithm recalculates the shortest path, it recomputes all shortest paths while considering express links.

  — If the algorithm does not recalculate the shortest path, SP Guru Transport Planner reroutes connections between the end nodes of express links only. This option requires less calculation time but the results are less precise.

Implement Express Links Dialog Box

The Implement Express Links dialog box appears when you click Next in the Select Express Links Dialog Box. The treeview lists all express links (as determined by the previous steps in the wizard) and enables you to decide how to implement these links. SP Guru Transport Planner uses "fiber routing" for this purpose—that is, it establishes a new OCH link between two gateway nodes. This link is supported by a fiber pair in the OMS layer and bypasses any intermediate nodes. This avoids the expensive switching cost in intermediate nodes.

Note—Fiber routing is applied for express links between non-adjacent gateway nodes only. Adjacent gateway nodes are already connected by a direct fiber pair.

Figure 11-5   Implement Express Links Dialog Box

Table 11-5   Implement Express Links Dialog Box

Control	Description
Express Link column (in treeview)	Name of the express link.
	The possible fiber routes for the link appear as children of each link. Initially SP Guru Transport Planner selects the fiber route that results in the lowest cost and overlap.
	• To visualize a route in the Project Editor workspace, select the route in the treeview.
	• To select a different route, double-click on the route in the treeview.
Fixed	Shows the fixed fiber routes of express links. Fiber routes are fixed if the express links already has direct fibers between its end nodes, or the fiber route has already been chosen as an express link. This means that you cannot modify existing fiber routes unless you remove the express links first.
Overlap (treeview)	The number of fibers in the selected route that overlap with other express-link routes.
Overlap (field above treeview)	Total number of overlapping fibers of all selected fiber routes
Reset	Restore the default fiber-route selections for all express links
Previous	Return to the previous window (see Select Express Links Dialog Box on page TrP-11-6)
Finish	Implement the specified express links in the network
End of Table 11-5	

Viewing the Express Layer

When the Express Layer Design wizard is open, the Project Editor window highlights gateway nodes and express links using red squares and lines.

After you design express layer using the Express Layer Design wizard, the gateway nodes and express links appear the same as other nodes and links in the OCH layer. To highlight them again, right-click in the Project Editor workspace and choose OCH Express Layer, as shown in Figure 11-6 on page TrP-11-12. To undo the highlighting, right-click in the Project Editor workspace and choose OCH.

Figure 11-6   Viewing the Express Layer