7 Transport-Layer Cost Allocation

In SP Guru Network Planner, the default link cost (used as a cost parameter in design actions such as link dimensioning) is based on a formula that incorporates a fixed cost per link, a data-rate-dependent component, and a distance-dependent component. However, when a Layer-2/3 link is mapped to a Transport connection, a more accurate cost can be calculated based on the route followed by the connection in the Transport network. For example, the physical length of the path used by a Transport connection is very likely to exceed the length of the links that connect the Layer-2/3 endpoints (nodes) of that connection.

To provide more accurate link-cost estimates, SWIM includes a cost model for Layer-2/3 links; this model considers the underlying Transport connections used by those links.

The financial cost of a Layer-2/3 link is specified using the link attribute "financial cost". The transport_link_pricer design action automatically calculates the financial cost of each link based on how it is (or could be) supported in the Transport network. You can run this design action directly (as described in the following section) or as the link_pricer subaction in the link_dimensioning design action.

Table 7-1 Transport-Layer Cost Allocation: Related Topics

Related Topic	Reference
Design actions overview	Modules > Planning and Design > Design Actions
link_dimensioning design action	Modules > Planning and Design > Link Dimensioning
End of Table 7-1	

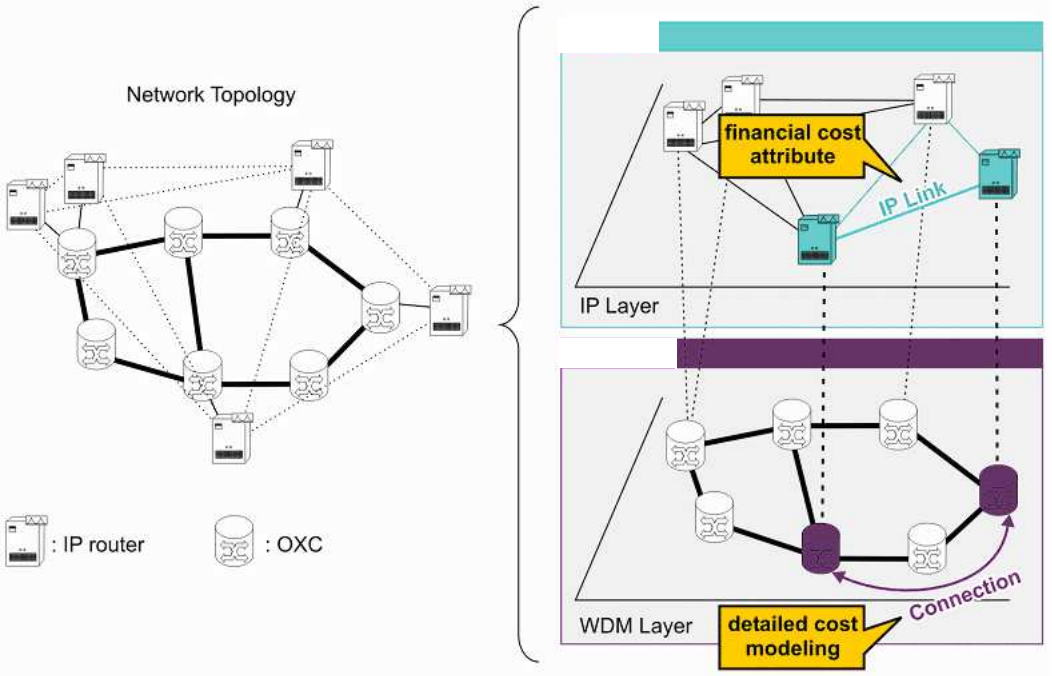
Background: Layer-2/3 Links Supported by a Transport Layer

SWIM enables you to model a Layer-2/3 network that is supported by an underlying Transport network . SWIM models the relationship between the two networks:

- Layer-2/3<—>Transport node mapping models the connection of Layer-2/3 to transport-layer equipment. For example, an IP router might be mapped to a SONET DXC.
- Layer-2/3<—>Transport connection mapping models the Transport connections between Transport nodes that correspond to Layer-2/3 endpoints. For example, a 10G Ethernet link might be carried over an STS-7-21c connection in the underlying SONET network.

Obviously, there are financial costs associated with this type of SONET/SDH connection. SP Guru Transport Planner uses a detailed cost model to calculate this cost, as described in Cost Modelling in SP Guru Transport Planner on page TC-7-3. In SP Guru Network Planner, each link has a "financial cost" attribute. When a Layer-2/3 link is supported by a transport network connection, its associated cost can be incorporated using the transport_link_pricer design action that is part of SWIM (see transport_link_pricer Design Action on page TC-7-7). This design action uses the cost models in SP Guru Transport Planner to calculate the cost of the Transport connection; then it updates the "financial cost" attribute of the Layer-2/3 link supported by that connection. The workflow to do this is described in Procedure 7-1 on page TC-7-5.

Figure 7-1 Cost Modelling in SP Guru Network Planner and SP Guru Transport Planner



Cost Modelling in SP Guru Transport Planner

The cost of a connection route has two major components:

- A *direct* or *dedicated* cost is the cost of the devices that can accommodate only one connection of the given type. For example, a DXC tributary port can accommodate one SONET connection only.

  The route cost includes the entire dedicated cost.

- An *indirect* or *shared* cost is the cost of those devices that can host several connections at the same time. For example, a DXC trunk port might accommodate multiple SONET connections.

  The route cost includes only a subset of these costs. The device cost is divided by the number of connections that the device can host. For example, four STM-4 SONET trunks can share one STM-16 trunk port, so the cost of the trunk port is divided by four.

The following sections provide an overview of the dedicated and shared costs on each of the network layers modeled in SP Guru Transport Planner.

Table 7-2 Cost Modeling in SP Guru Transport Planner: Related Topics

Related Topic	Reference
Design actions overview	"Concepts and Models" chapter SP Guru Transport Planner *User Guide*
SP Guru Transport Planner cost model	"Creating a Baseline Scenario" chapter SP Guru Transport Planner *User Guide*
End of Table 7-2	

Costs in the OCH (Optical) Layer

The direct cost for an optical route includes a dedicated node cost and a dedicated link cost.

- The *dedicated node cost* is calculated using the following formula:

```
dedicated_node_cost =
   optical_tributary_port_cost_at_source_node +
   optical_tributary_port_cost_at_dest_node +
   trunk_port_cost_at_source_node +
   trunk_port_cost_at_dest_node +
   SONET_cost_at_source_node +
   SONET_cost_at_dest_node
```

  The port costs depend on the node types used, such as OXCs or patch panels.

  The dedicated node cost includes SONET costs (for example, the cost of a DXC trunk port or an SDH terminal multiplexer) only if a connection supports SONET traffic.

- The dedicated link cost is calculated using the following formula:

```
dedicated link cost =
   (long_reach_transponder_cost +
    WDM_channel_card_cost +
    regenerator_cost)*
   number_of_optical_channels_in_route
```

All these costs are determined by the bit rate of the optical connection.

The indirect cost for an optical route also includes an indirect node cost and an indirect link cost.

- The *indirect node cost* is calculated using the base cost of the optical switching devices (such as OXCs) along the route and the number of available ports on the devices. For example, if two trunk ports are needed on an OXC with 64 ports, the indirect node cost is obtained by dividing the OXC base cost by 32.
- The indirect link cost is calculated using the following formula:

```
Indirect_link_cost =
   ((cable_cost / fibers_per_cable) + fiber_cost) /
    wavelengths_per_fiber
```

In which:

```
cable_cost = fixed_cost_per_cable +
   cost_per_length_unit_of_cable +
   cost_per_regeneration_and_amplification site
```

```
fiber_cost = fixed_cost_per_fiber +
   cost_per_length_unit_of_fiber +
   _WDM_terminal_mux_costs_at_fiber_endpoints +
   _amplifier_and_regenerator_cost_along_fiber
```

Costs in the DCL (Digital Client or Higher-Order SONET/SDH) Layer

The *direct cost* of a SONET/SDH route includes the following:

- The tributary port cost at the source and destination node of the connection (for example, a DXC or SONET/SDH TM tributary port cost)
- An LOP terminal multiplexer cost in both end nodes is added for connections that support lower-order SONET traffic.

Both costs depend on the bit rate of the SONET/SDH connection.

The *indirect link cost* of a SONET/SDH route depends on the optical channel cost of each logical SONET link along the route. These channel costs are divided by the number of SONET/SDH connections that the channel can accommodate. This means that the cost depends on the bit rates of the SONET/SDH connection and the optical channels as well. For example, one optical channel at STM-16 rate can host sixteen STM-1 SDH connections, but it can only host four STM-4 SDH connections.

The *indirect node cost* is determined by the base cost of the digital switching devices along the route (such as DXCs). For example, if a DXC can host 16 STM-1 ports and one tributary port is needed, the indirect node cost equals the DXC base cost divided by 32.

Costs in the LOP (Lower-Order SONET/SDH) Layer

The *direct LOP route cost* consists of an LOP TM tributary port cost at both source and destination node. It depends on the bit rate of the LOP connection.

The *indirect LOP route cost* consists of the cost of each SONET/SDH trunk along the route (see Costs in the DCL (Digital Client or Higher-Order SONET/SDH) Layer on page TC-7-4). These SONET trunk costs are divided by the number of LOP connections that each trunk can host. For example, one STM-1 SDH trunk can accommodate 21 LOP connections at a VC-2 rate.

Workflow Description

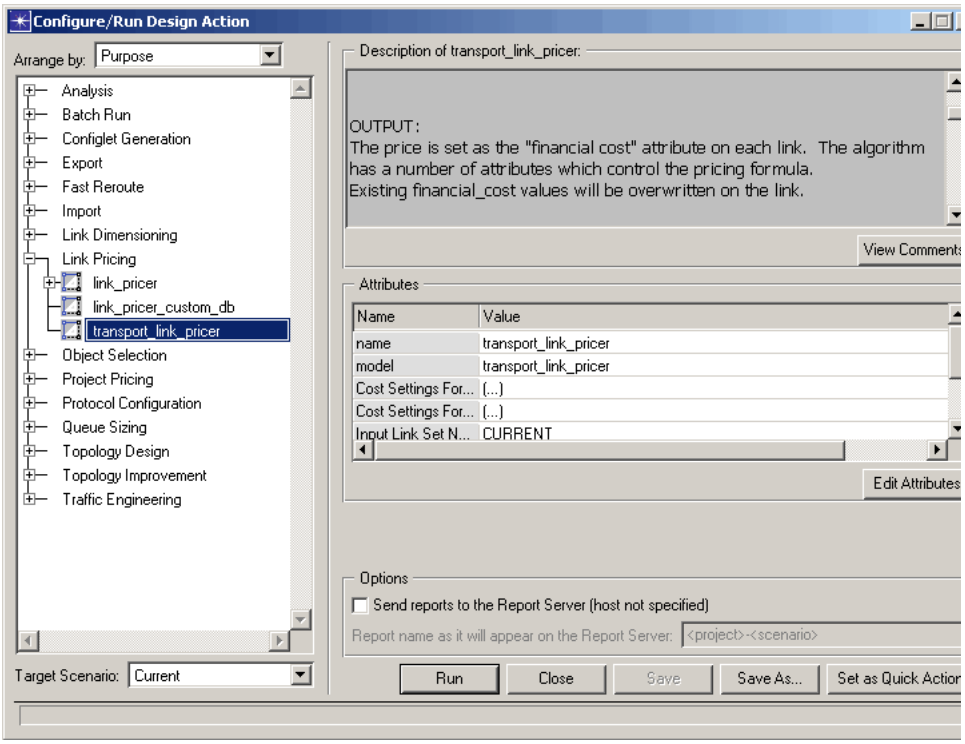
Procedure 7-1 describes how to calculate transport-layer costs associated with Layer-2/3 links and to set the financial-cost link attributes accordingly. (To run this design action with the same parameters as the last run, choose Design > Run Design Action… in step 1 and skip steps 2 through 4.)

Procedure 7-1 Configuring and Running the transport_link_pricer Design Action

1. From the Project Editor in SP Guru Network Planner, choose Design > Configure/Run Design Action…

   ➥ The Configure/Run Design Action dialog box (Figure 6) appears.

Figure 7-2 Configure/Run Design Action Dialog Box



2 Select the transport_link_pricer design action in the treeview on the left.

➥ The Description and Attributes panes are populated.

3 [*Optional*] Set the design action attributes as desired (click on any of the attributes to open the transport_link_pricer attribute table (Table 7-5 on page TC-7-9)). When you are finished, click OK to confirm the changes.

4 [*Optional*] Select the target scenario in the bottom-left corner of the Configure/Run Design Action dialog box.

5 Click Run.

➥ The Layer-2/3 links are priced and the Action Completed window appears.

6 [*Optional*] To inspect the log messages, click View Log.

➥ The Log Browser appears. To explore the log, click and/or expand elements in the treeview.

7 Close all open windows.

End of Procedure 7-1

transport_link_pricer Design Action

The transport_link_pricer design action sets the "financial cost" attribute of all Layer-2/3 links in its input set. The mapping status of a Layer-2/3 link determines the cost calculations used. For this design action, a Layer-2/3 link falls into one of the following categories:

- Mapped Layer-2/3 links whose underlying Transport connections have been set up—These are links which have been mapped using SWIM's link mapping feature, and for which the corresponding Transport connection is set up. Note that you can visualize the operational status of mapped Layer-2/3 links by choosing SWIM > Automatically Update Operational Status Visualization; the Layer-2/3 link will have no overlay icon if its Transport connection is set up.

- Mapped Layer-2/3 links whose underlying Transport connection has not been set up—These are links that have been mapped using SWIM's link mapping feature, but the underlying Transport connection is unrouted. When visualizing the operational status, such Layer-2/3 links will be overlaid with the “link unrouted” icon.

  Figure 7-3 “Link Unrouted” Icon

  For more information about link mapping in SWIM, see Chapter 5 Mapping Layer-2/3 Links to Transport Connections on page TC-5-1.

- Mappable Layer-2/3 links—These are links that have not yet been mapped to Transport connections, but have mapped endpoints, defined link models, and default link mappings. These are all the links that would appear in the SWIM - Map Links dialog box and would be mapped to Transport connections using the automatic link mapping functionality (that is, using the Auto>> button).

  This dialog box is described in SWIM - Map Links Dialog Box on page TC-5-6.

- Unmappable Layer-2/3 links—These are links that have not been mapped to a Transport connection, and for which
  - — One or both endpoints are unmapped, or
  - — The default link-mapping settings do not specify a Transport layer and bit rate to map it to

Table 7-3 and Table 7-4 describe the cost calculations used for specific links. The WDMG cost calculation (`cost_spg_tran_plan` in the formulas) is also influenced by the settings of the "Include All WDMG Layers" and "Include WDMG Shared Elements Cost" parameters described in Table 7-5 on page TC-7-9.

Table 7-3 Link Calculations in SP Guru Network Planner

Link Category	Cost Calculation
Unmappable Layer-2/3 links	cost = cost_spg_nw_plan cost_spg_nw_plan = fixed_cost + cost_per_kb * bit_rate_spg + cost_per_km * distance_link_spg_nw_plan
Mapped Layer-2/3 links (connection has been set up) Mapped Layer-2/3 links (connection has *not* been set up) Mappable Layer-2/3 links	cost = cost_spg_nw_plan + wdmg_multiplier * cost_spg_tran_plan cost_spg_nw_plan = fixed_cost + cost_per_kb * bit_rate_spg + cost_per_km * distance_conn_wdm cost_spg_tran_plan = cost of connection as defined by the SP Guru Transport Planner cost model
End of Table 7-3	

Table 7-4 Connection Calculations in SP Guru Transport Planner

Link Category	Cost Calculation
Mapped Layer-2/3 links (connection has been set up)	The cost of the underlying connection as calculated in SP Guru Transport Planner will be used as cost_spg_tran_plan.
Mapped Layer-2/3 links (connection has *not* been set up)	The design action determines whether the underlying connection can be routed using the existing capacity of the WDMG network. This is similar to finding routes with SP Guru Transport Planner's routing wizard (see the "Manual Routing" section in the Transport Planner User Guide). The SP Guru Transport Planner cost for the candidate route will be used as cost_spg_tran_plan.
Mappable Layer-2/3 links	The design action determines whether a connection for the WDMG layer can be routed using a bit rate specified in the SWIM default link-mapping settings. If it can, the candidate route's cost is used as cost_spg_tran_plan.
End of Table 7-4	

transport_link_pricer Attribute Descriptions

Table 7-5 describes the configurable attributes of the transport_link_pricer design action.

Table 7-5 transport_link_pricer Attributes (Part 1 of 2)

Attribute	Description
Cost Settings for Native SPG Links:	Cost settings for unmappable Layer-2/3 links
• Fixed Cost	A fixed cost independent of any Layer-2/3 link attribute or property
• Cost Per Kb	Cost per kb of Layer-2/3 link bandwidth
• Cost per Km	Cost per km of the Layer-2/3 link. The distance is computed as the straight-line (great circle) distance between the Layer-2/3 link's end points.
Cost Settings For SPG Links Supported By WDMG:	Cost settings for all mapped and mappable Layer-2/3 links
• Fixed Cost	A fixed cost independent of any Layer-2/3 link attribute or property, and independent of its mapping status or Transport connection.
• Cost Per Kb	Cost per kb of Layer-2/3 link bandwidth
• Cost Per km	Cost per km of the Layer-2/3 link. For mapped or mappable links, this is the distance covered by the Transport connection in the Transport network.
• WDMG Connection Cost Multiplier	Value used to multiply the Transport cost. This can be useful in some situations-for example, when the WDMG network and the design action use different monetary units in their cost settings (such as euros and dollars).
• Include All WDMG Layers	A Transport connection can be supported by other connections on lower network layers within SP Guru Transport Planner. For example, a groomed DCL connection will be supported by OCH connections. Use this attribute to account for those lower-layer costs: • Yes—All Transport costs will be considered, by recursively adding costs on all lower Transport layers. • No—Only the costs on the layer of the connection itself will be considered.
• Include WDMG Shared Elements Cost	Some resources in the Transport network are not exclusively reserved for a particular connection. This is the case for DXC/OXC node equipment: all connections use the core of the cross-connect, regardless of the line cards used to enter or leave the node. Use this setting to determine how these shared resources are considered: • Yes—The shared resources' cost will account for a fraction corresponding to how much the connection uses it. For example, the cost of a DXC is divided by the number of line cards it can contain; this divided cost is then added to the cost of WDMG connections that enter/leave the node on an interface card. • No—Do not account for shared resources.

Table 7-5 transport_link_pricer Attributes (Part 2 of 2)

Attribute	Description
Input Link Set Name	The links to price. If CURRENT is selected (the default setting), the design action prices all links in the current Layer-2/3 network.
Input Node Pair Name	Endpoints of a link to price.
Monetary Units	String identifying the cost unit. Note—Transport costs are dimensionless. Therefore, make sure that all cost parameters in the Transport network are based on the same monetary unit.
End of Table 7-5	