Capacity Planning Optimization

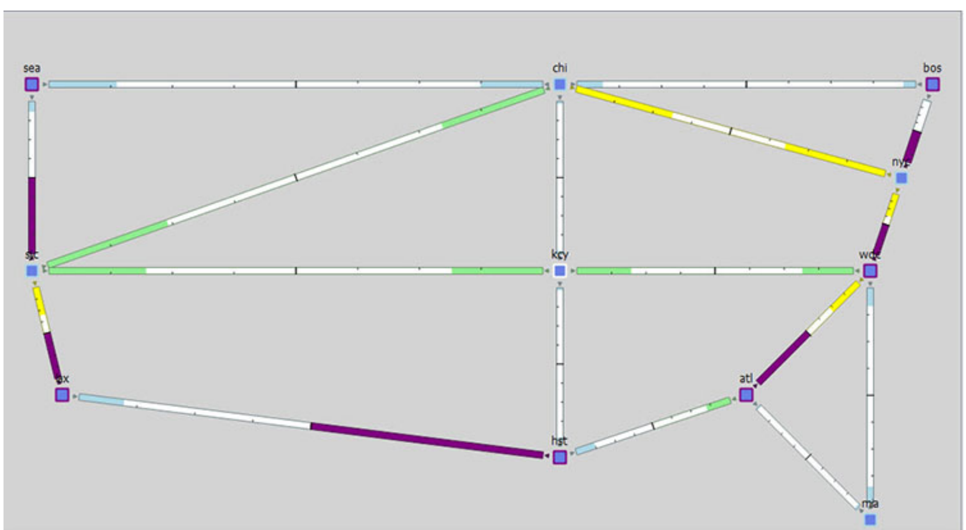
As demand grows on your network you need a way to address the additional traffic and congestion. To alleviate congestion, you can:

- Upgrade existing circuits by adding more capacity to them
- Augment these circuits with associated port circuits
- Add parallel circuits to existing circuits
- Specify new adjacencies between nodes that were not initially connected

To perform these planning optimization investigations, WAE Design includes a capacity planning optimization tool. The goal of a capacity planning optimization is to minimize the addition of any required capacity to be installed on the network. The capacity planning optimizer operates on both Layer 1 and Layer 3 network elements, as well as across failure sets, so you can use a combination of elements in a layered fashion to reach an acceptable solution to meet maximum utilization requirements.

Figure 1: Design Before Optimization, on page 1 shows an example of a network design before optimization, where extra demands were placed on the network. As a result, you can see congested interfaces in purple.

Figure 1: Design Before Optimization



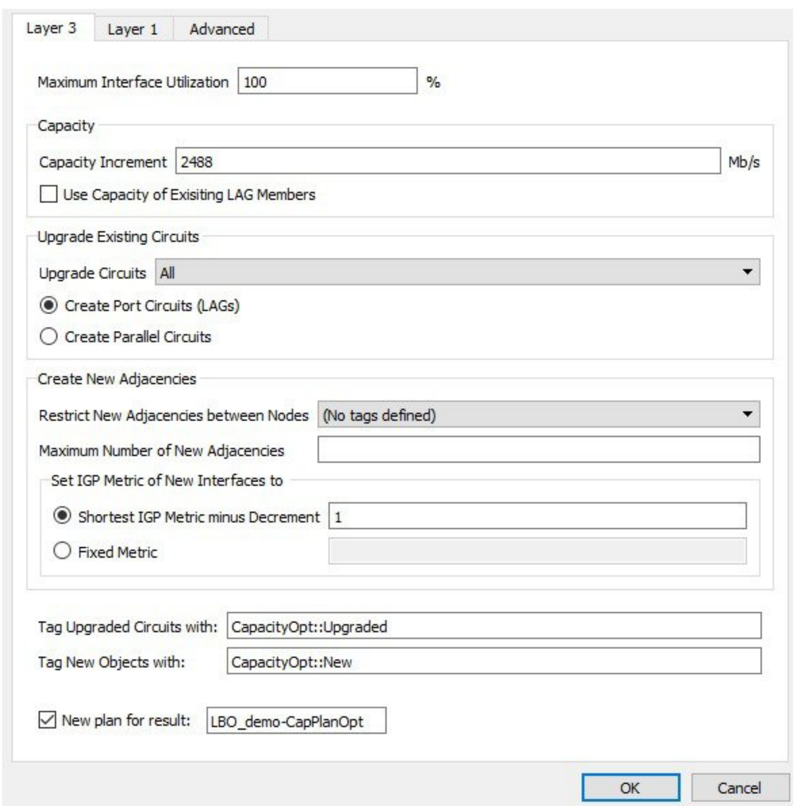
This section contains the following topics:

Workflow

You can set optimization parameters to relieve network congestion and augment capacity. You start by defining a maximum utilization threshold for a specified set of interfaces and then layering additional options that operate on Layer 3, Layer 1, and across failure sets.

Note Some of the optimizer options are mutually exclusive; for example, if you tell the optimizer to create port circuits, it cannot create parallel circuits at the same time. Other options are complementary; for example, you can specify the creation of parallel circuits and new adjacencies together.

Step 1 Choose **Tools** > **Capacity Planning Optimization**



Step 2 In the Layer 3 tab, define the maximum utilization threshold that you want to use for all interfaces in the network.

Step 3 Decide on the Layer 3 optimization options to use. (Options are described in Table 1: Layer 3 Optimization Options , on page 6.)

- Specify the capacity parameters to use when upgrading circuits, creating port circuits, or creating parallel circuits.

Note You can specify both the capacity increment and the existing capacity of LAG circuits in tandem.

- Specify circuit upgrade parameters.

You can upgrade all existing circuits or a subset of these circuits. If you want to allow the upgrade of just certain circuits, indicate those circuits to be modified. This is useful if you want to limit your upgrades to a certain geographical location in the network.

To create new port circuits or parallel circuits, choose one of the following options:

- Create new port circuits (LAGs). In this case, the optimizer augments the existing circuits with associated port circuits (LAGs) with additional port circuits. The optimizer converts non-LAG circuits to LAGs.
- Create new parallel circuits. In this case, the optimizer creates new circuits that are parallel to existing circuits.
- Create new adjacencies.

By default, the optimizer does not create new adjacencies. If you specify a set of candidate nodes for it to use, the optimizer proposes new adjacencies. The optimizer restricts a new adjacency between the specified candidate nodes. For example, you might require that only core nodes be directly connected. In this case, specify only core nodes as your candidate nodes. Additionally, you can impose a limit on the maximum number of new adjacencies that the optimizer creates.

To create new adjacencies:

- Choose all the nodes in the table or just a subset of the nodes that you want to optimize.
- Specify the Maximum Number of New Adjacencies threshold.

Note You can apply the IGP metric to new adjacencies, but not to parallel circuits.

- Specify the IGP metric type for new interfaces, which can be either:

Decrement (default): The metric of new interfaces is equal to the shortest path minus the value specified in the metric option.

Fixed: The metric of new interfaces is equal to the value specified in the Fixed Metric field.

Step 4 (Optional) On the Layer 1 tab, check **Create L1 Circuits**. See for the Layer 1 options and Table 2: Layer 1 Optimization Options , on page 7 see Creating Layer 1 Circuits, on page 8 for more information.

Step 5 (Optional) On the Advanced tab, choose options to provide additional capacity planning and describe the cost for the various elements in your design.

Step 6 (Optional) On the Layer 3 tab, override the defaults for how circuits are tagged or for how new optimized plan files are named.

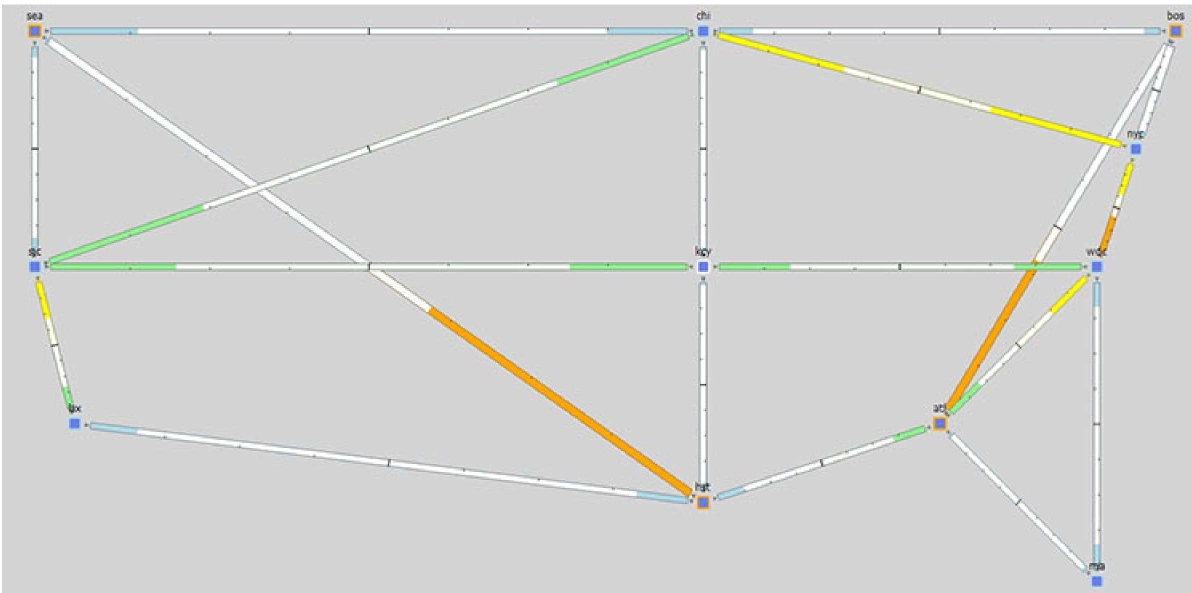
Step 7 Click **OK** to create the capacity planning optimization reports.

WAE Design routes the traffic and looks at the utilization threshold you specified, and any other optimization parameters you specified. After running an optimization, you can look at the summary report to see what the optimizer did to remove congestion. The key metric to look at is the Total Capacity Added (Mb/s).

Figure 2: Design After Optimization, on page 4 shows the design after optimization using the parameters specified in Step 1. In this case, the optimizer proposes to set up two new adjacencies:

- One between Seattle (sea) and Houston (hst)
- One between Atlanta (alt) and Boston (bos)

Figure 2: Design After Optimization



Reports

The Reports window provides a summary report and a capacity upgrades table.

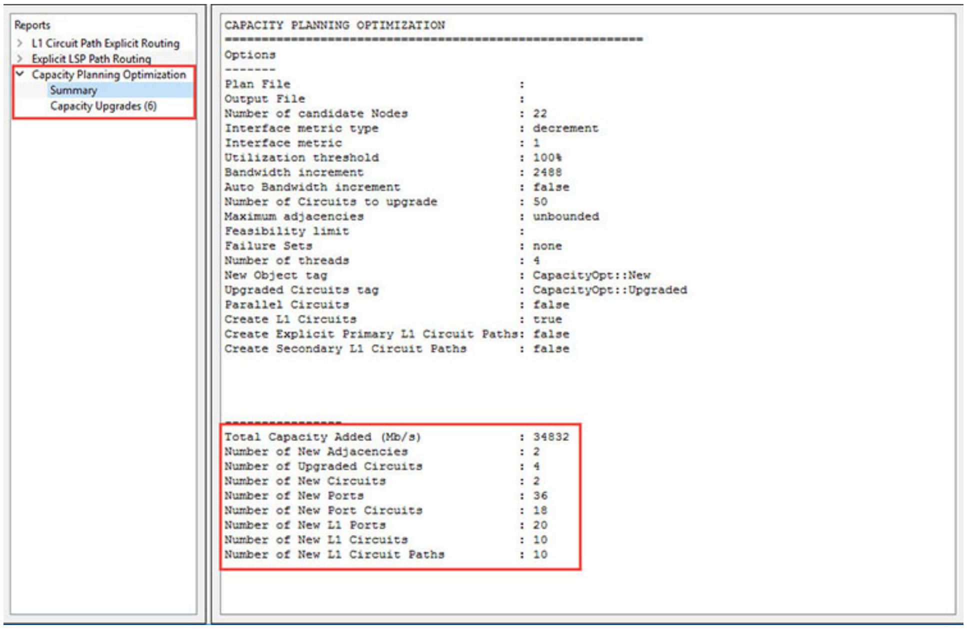
Summary Report Example

After running the optimization, the summary reports provide useful metrics at a glance. Using the previous design as an example with the default utilization threshold of 100%, the decrement interface metric type, and unbounded adjacencies, this report provides details on the:

- Total capacity added as a result of the optimization (in this example, 34832 Mb/s)
- Number of new adjacencies (in this example, 2)
- Number of upgraded circuits (in this example, 4)
- Number of new circuits (in this example, 2)
- Number of new ports (in this example, 36)
- Number of new port circuits (in this example, 28)
- Number of new L1 ports (in this example, 20)
- Number of new L1 circuits (in this example, 10)

- Number of new L1 circuit paths (in this example, 10)

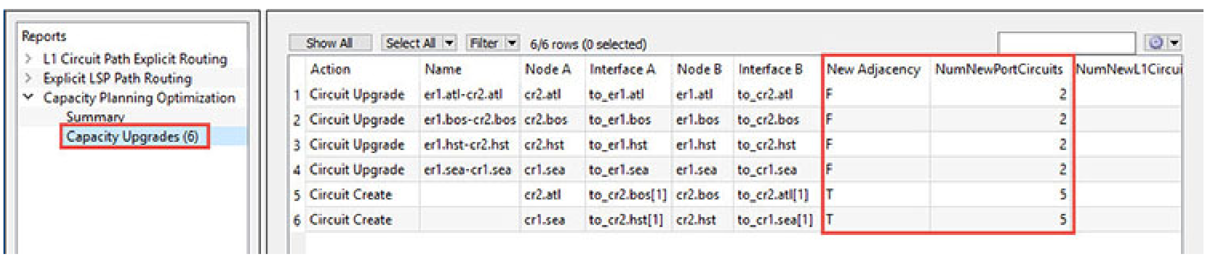
Figure 3: After Optimization Summary Report Example



Capacity Upgrades Report Example

Click **Capacity Upgrades** for details on how the optimizer upgraded circuits. Using the previous optimized design as an example and using the default utilization threshold of 100%, the decrement interface metric type, and unbounded adjacencies, this report provides details on the six circuit upgrades that it suggests to meet your optimization parameters.

Figure 4: After Optimization Capacity Upgrades Report Example



In this example, out of the six upgrades listed, there were two new port circuits created for each upgraded circuit.

Layer 3 Optimization Options

You have several Layer 3 options for capacity planning. These parameters tell the optimizer what your preferences are in terms of utilization thresholds, capacity increments, and whether to upgrade existing circuits, create new adjacencies between nodes, create port circuits, or create parallel circuits.

Table 1: Layer 3 Optimization Options

Option	Description
Maximum Interface Utilization	Defines the congestion threshold for all interfaces in the network. By default, the capacity planning optimizer sets the threshold at 100% congestion. However, for future planning purposes, you might want to set the utilization to a lower number, such as 90%.
Capacity Increment	Defines the bandwidth increment value (that is, the allowed capacity increment). You can think of this value as the capacity of the ports. The default is 100000 Mb/s.
Use Capacity of Existing LAG Members	Augments capacity based on the capacity already defined in the existing LAG Members instead of using the Capacity Increment.
Upgrade Circuits	Upgrades all circuits, or just a subset of circuits or those circuits with certain tags to reduce congestion. By default, the optimizer assumes that you want to upgrade all circuits. To indicate that you want to use a subset of these circuits, you can choose them using tags or by choosing a subset of them from the WAE Design tables.
Create Port Circuits (LAGs)	Creates port circuits to reduce congestion. If a non-lag circuit is upgraded, the optimizer creates a port circuit with the initial capacity (existing L1 circuits are reassigned to this port circuit) and new port circuits are created.
Create Parallel Circuits	Creates parallel circuits to reduce congestion. If you tell the optimizer to create parallel circuits, you cannot also tell it to create port circuits and vice versa.
Restrict New Adjacencies between Nodes	By default, the optimizer does not create new adjacencies. If you specify a set of candidate nodes for it to use, the optimizer proposes new adjacencies. The optimizer restricts a new adjacency between the specified candidate nodes. For example, you might require that only core nodes be directly connected. In this case, specify only core nodes as your candidate nodes.
Maximum Number of New Adjacencies	Specifies the maximum number of adjacencies to create between candidate nodes. By default, this is an unbounded number.
Set IGP Metric of New Interfaces to Shortest IGP Metric minus Decrement	Sets the IGP metric of the interfaces corresponding to new adjacencies to be the shortest IGP metric minus the decrement of 1. This is how the IGP metric of such interfaces is set by default. The IGP metric of new interfaces due to parallel circuit upgrades is the same as the metric of the parallel interfaces.
Fixed Metric	Defines a fixed IGP metric to use when creating new interfaces. Enter a positive integer as a value in this field.
Tag Upgraded Circuits with	Defines tags any upgraded circuits. By default, the optimizer tags upgraded circuits with the label *CapacityOpt::Upgraded* .
Tag New Objects with	Defines tags for any new objects the optimizer creates. By default, the optimizer tags upgraded circuits with the label *CapacityOpt::New* .
New plan for result	Specifies a name for the new plan file. By default, the optimizer appends the input plan filename with *-CapPlanOpt* .

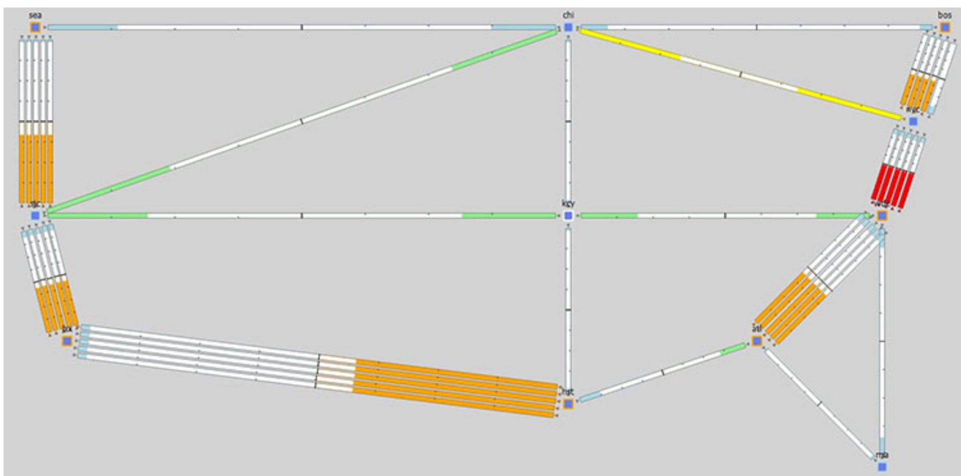
Parallel Circuits Design Example

Figure 5: Adding Parallel Circuits to Increase Capacity, on page 7 shows the first design in this chapter with parallel circuits added to increase capacity. In this case, the optimizer proposes five sets of parallel circuits:

- One between Houston (hst) and Los Angeles (lax)
- One between Los Angeles (lax) and San Jose (sjc)
- One between San Jose (sjc) and Seattle (sea)
- One between Boston (bos) and New York City (nyc)
- One between Atlanta (atl) and Washington, D.C. (wdc)

Because the utilization threshold was set to 100%, utilizations over 90% (shown in red) are acceptable solutions.

Figure 5: Adding Parallel Circuits to Increase Capacity



Layer 1 Optimization Options

The Layer 1 options tell the optimizer to create new L1 circuits.

Table 2: Layer 1 Optimization Options

Option	Description
Match Explicit Routes of Parallel Primary L1 Circuit Path	Assigns L1 circuit path hops to new primary L1 circuit paths to match the explicitly specified routes of existing parallel L1 circuits. By default, paths are dynamically routed.
Create non-standby Secondary L1 Circuit Path	Creates secondary L1 circuit paths to simulate optical restoration capabilities.
Feasibility Limit	Ignores new L3 adjacencies with no possible route in the L1 topology that is lower than the specified feasibility limit. The default is unbounded.

Option	Description
Acceptance Threshold	If the total feasibility metric on the L1 links on the L1 circuit path exceeds the feasibility limit, WAE Design rejects the path. The metric on the L1 link is not entirely fixed; it might contain some noise. You can specify how much noise to take into account when testing the path metric against the metric limit. When WAE Design proposes new L1 circuit paths between two L1 nodes, it's important that the feasibility metric limit is not violated. Therefore, you can specify what acceptance threshold to use when considering new L1 circuit paths. Each L1 circuit path has its own feasibility threshold.

Creating Layer 1 Circuits

If you know exactly where you want to place L1 circuits, you can use explicit routing. To simulate optical restoration capabilities, you can create secondary L1 circuit paths.

Step 1 In the **Capacity Planning Optimization** tool, click the **Layer 1** tab.

Step 2 Check **Create L1 Circuits**.

Step 3 (Optional) Specify whether you want to use explicit routing, create secondary L1 circuit paths, or both. See Table 2: Layer 1 Optimization Options , on page 7 for the Layer 1 options.

Step 4 (Optional) In the Feasibility Limit field, enter a positive number.

The optimizer takes into account the *feasibility limit* of each Layer 1 circuit path; that is, how far it can travel and what impairments it can suffer.

Because of the feasibility limit, the optimizer might, for example, recommend adding five 10-GB circuits instead of a single 100-GB circuit.

Step 5 (Optional) In the Acceptance Threshold field, enter a positive number. Lower thresholds increase the risk that the L1 circuit path is not feasible in the network. The default is 3.

Step 6 Click **OK**.

Advanced Optimization Options

Use the advanced options to:

- Choose whether to optimize for capacity or cost.
- Define what failure scenarios to consider.

Step 1 In the Capacity Planning Optimization tool, click the **Advanced** tab.

Step 2 Click one of the following radio buttons:

- Minimize Capacity—(Default) Minimizes the capacity that is added to your network.

- Minimize Cost—Runs the optimization with the objective of reducing the overall cost when adding new capacity. Click **Insert** to manually enter a cost unit for capacity, L3 and L1 ports, and the feasibility limit. Alternately, click **Import** to import cost values from a file.

When you run an optimization, the tool generates a report on the overall cost—including the cost of the added ports—and recommends the most cost-efficient solution.

Step 3 In the Failure Sets area, choose options that you want the optimizer to consider (circuits, nodes, sites, and so on). Entries appear dimmed if they are not available in your design plan.

Step 4 (Optional) Specify the maximum number of threads. By default, the optimizer tries to set this value to the optimal number of threads based on the available cores.

Step 5 Click **OK**.

This action creates the capacity planning optimization report showing the results of the increased capacity. The optimizer takes into account whether it makes sense to upgrade existing circuits or set up new adjacencies, and considers capacity increments, cost options, and feasibility limits.