



Bandwidth on Demand (BWoD)

The Bandwidth on Demand (BWoD) function pack provides a bandwidth-aware Path Computation Element (PCE) to derive SR policy paths with requested bandwidth when available. Computed paths are deployed to the network through SR-PCE. BWoD continuously monitors link utilization to ensure no congestion occurs along the path. If conditions change in the network which causes link utilization to exceed the congestion threshold set by the user, BWoD automatically reoptimizes the policy path.

BWoD utilizes a near real-time model of the network along with a demand matrix derived from telemetry-based Segment Routing Traffic Matrix (SRTM) reporting to ensure BWoD policies meet their bandwidth constraints. Users may fine tune the behavior BWoD, affecting the path it computes, through the selection of application options including network utilization threshold (definition of congestion) and path optimization objectives. The BWoD function pack works as a bandwidth-aware PCE for SR policies created through the Crosswork Optimization Engine UI, and for SR policies created through CLI configuration on a headend with delegation to SR-PCE. In the latter case, SR-PCE will subdelegate the SR policy with bandwidth constraint to BWoD for path computation and relay the computed path returned by BWoD to the headend for instantiation.

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Operation Modes

There are two modes of operation for BWoD based on the "Priority" option setting for the application. In non-Priority mode, BWoD takes into account all traffic in the network when computing a path for a SR policy with bandwidth constraint. In this case, BW SR policies compete with all other traffic for resources and may be provided a path that is longer to avoid congestion on links along the shortest path. Note that



Note In non-Priority mode, BWoD *should not* be enabled at the same time as the Bandwidth Optimization function pack to ensure they do not conflict.

The Priority mode allows BWoD to ignore all other traffic in the network that is not flowing through a BWoD SR policy and give its policies priority treatment when computing paths. This means that BWoD policies are

only contending for resources with other BWoD policies and will likely take the shortest path unless there are links that include a significant amount of other BWoD traffic.



Note To mitigate any congestion that may occur by ignoring other traffic, the Bandwidth Optimization application *should* be used in conjunction with BWoD in the Priority mode to shift other traffic away from any hotspots caused by the BWoD traffic.

The other traffic may then be sent over alternate (possibly longer) paths to mitigate congestion in this case, while BWoD maintains its policies along the shortest paths.

Important Notes and Limitation for BWoD

Consider the following notes and limitations when using BWoD:

- If BWoD cannot find a path for a policy that guarantees its requested bandwidth, BWoD will attempt to find a *best effort* path. The best effort path may not meet the requested bandwidth for the policy.
- BWoD temporarily pauses operation whenever the Optimization Engine model is unavailable due to an Optimization Engine restart or a rebuild of the topology from Topology Services. Any requests to BWoD during this time are rejected. When the model becomes available and BWoD receives 2 traffic updates from the Optimization Engine, BWoD will resume normal operation.
- BWoD uses simulated traffic based on measured SRTM data to determine link utilizations for computing BWoD paths. The simulated interface utilization BWoD utilizes should closely align with the SNMP-based interface utilization that is displayed in the Optimization Engine UI. However, due to various factors, including SNMP polling cadence and rate averaging techniques, they may differ at times. This can result in scenarios like a link along a BWoD path appearing to be congested in the UI and BWoD not re-optimizing it.

Configure Bandwidth on Demand

Do the following to enable and configure Bandwidth on Demand.

Before you begin

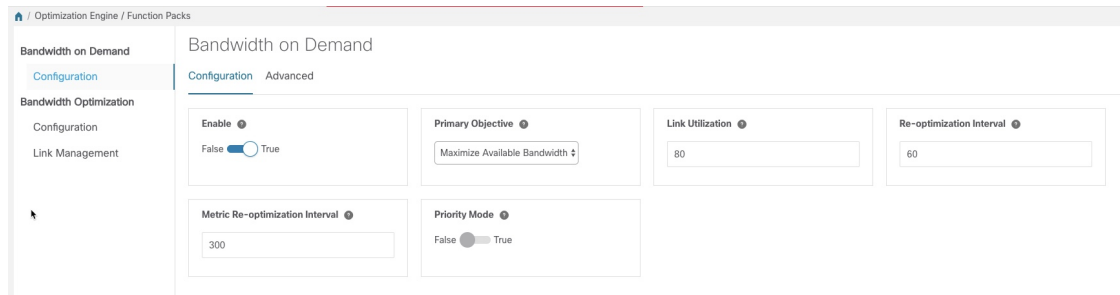
Bandwidth on Demand must be installed.



Note If a policy is configured on the router with affinity constraints, they are not considered in the **Bandwidth on Demand** optimization calculation.

Step 1 From the main menu, choose **Optimization Engine > Function Packs > Bandwidth on Demand**.

Figure 1: Bandwidth on Demand Configuration Window



Step 2 From the **Enable** tile, toggle the slider to **True**.

Notice that each time a tile is updated it turns blue.

Step 3 Select one of the following **Primary Objectives**:

- **Maximize Available Bandwidth**—Computes an SR policy path maximizing the overall available bandwidth in the network. This setting generally attempts to maximize usable network capacity at the expense of potentially longer paths.
- **Metric Minimization**—Computes an SR policy path minimizing the metric selected. This setting generally results in the shortest available paths for a metric type.

Step 4 In the **Link Utilization** tile, enter the congestion constraint (in percentage). When the Bandwidth on Demand application searches a path for the policies being delegated, it will avoid any paths that may exceed the congestion utilization threshold.

Step 5 In the **Reoptimization Interval** tile, enter the duration (in seconds) after which the paths will be reoptimized if conditions in the network change. This is a count down timer where the BWoD policy will wait to reoptimize until this duration has expired.

Step 6 In the **Metric Reoptimization Interval** tile, enter the duration (in seconds) after which the paths can be reoptimized for metric optimization. If the bandwidth constraint is still being met, but a shorter IGP or TE path is available, BWoD will not run reoptimization until the timer has expired. This value is meant to dampen frequent path changes and reoptimizations in the network.

Step 7 From the **Priority Mode** tile, toggle the slider to **True** if you have also enabled Bandwidth Optimization. See [Operation Modes, on page 1](#) for more information on Priority Mode.

Step 8 Click the **Advanced** tab for more advanced configuration (see the following table for field descriptions).

Step 9 Click **Commit Changes** to save the configuration.

Table 1: Advanced Bandwidth on Demand Fields

Field	Description
Private New SR Policies	If True , all policies that are created using Bandwidth on Demand are private.

Field	Description
SR Policy Traffic	<p>Determines the type of bandwidth optimization that is performed with each policy.</p> <ul style="list-style-type: none"> • Simulated—Uses the current simulated traffic on the BWoD provisioned SR policies for optimization calculations. • Measured—Uses the current measured traffic of BWoD provisioned SR policies for optimization calculations. • Max Simulated Requested—Uses the maximum value between the current simulated traffic on BWoD provisioned SR policies or the amount of bandwidth requested for optimization calculations. • Max Measured Requested—Uses the maximum value between the current measured traffic on BWoD provisioned SR policies or the amount of bandwidth requested for optimization calculations.
Deployment Timeout	The time (in seconds) to wait for a PCE dispatcher response.
Update Throttle	When enabled, this option throttles updates from and instructs BWoD to only accept 1 update per x seconds. Set it to 0 to disable the throttle.
Optimizer Event Threshold	This option sends a Warning alert to the UI if the optimizer runs longer than the time (in seconds) entered in this field.
Debug Optimizer	
Debug Opt Max Plan Files	The maximum number of debug plan files you would like to save.
Debug Opt	If True , debug log files will be saved. See the "Collect and Share Cisco Crosswork Network Automation Logs and Metrics" topic in the <i>Crosswork Optimization Engine User Guide</i> .

What to do next

Create a Bandwidth on Demand SR policy (see [Create Bandwidth on Demand SR Policies, on page 4](#)).

Create Bandwidth on Demand SR Policies

This task creates a dynamic path steering policy that finds the optimal path that requires a persistent bandwidth and IGP, TE, or delay metrics.

Before you begin

You must have the Bandwidth on Demand function pack installed and enabled.

Step 1 From the **SR Policies** table, click **Create**.

Step 2 Enter the following SR policy values:

a) Required fields:

- **Headend**—Where the SR policy is instantiated. Note: You can either select a node (from the map or drop-down list) or enter part of the node name to filter the headend and endpoint node entries.

- **Endpoint**—The destination of the SR policy.
- **IP Address**—After the endpoint is selected, the SID list is populated and you can select the loopback IP address.
- **Color**—A numerical value that distinguishes between two or more policies to the same node pairs (Headend – Endpoint). Every SR policy between a given headend and endpoint must have a unique color.
- **Path Name**—Enter a name for this SR policy path. SR policy paths from the same headend must be unique. Policy path names are not case sensitive.

b) Optional values:

- **Description**—Enter details or a description of this policy.
- **Explicit Binding SID**—The binding segment is a local segment identifying an SR policy. Each SR policy is associated with a binding segment ID (BSID). The BSID is a local label that is automatically allocated for each SR policy when the policy is instantiated. If you wish to use a specific segment ID, rather than the default one that is automatically assigned, then enter it here.
- **Profile ID**—Identification used to associate an SR policy with a set of features applied to the policy by the headend. It should correspond with a profile configured on the headend.

Step 3 Under Policy Path, click **Bandwidth On Demand**.

Note This option is only available when the Bandwidth on Demand function pack is installed and enabled.

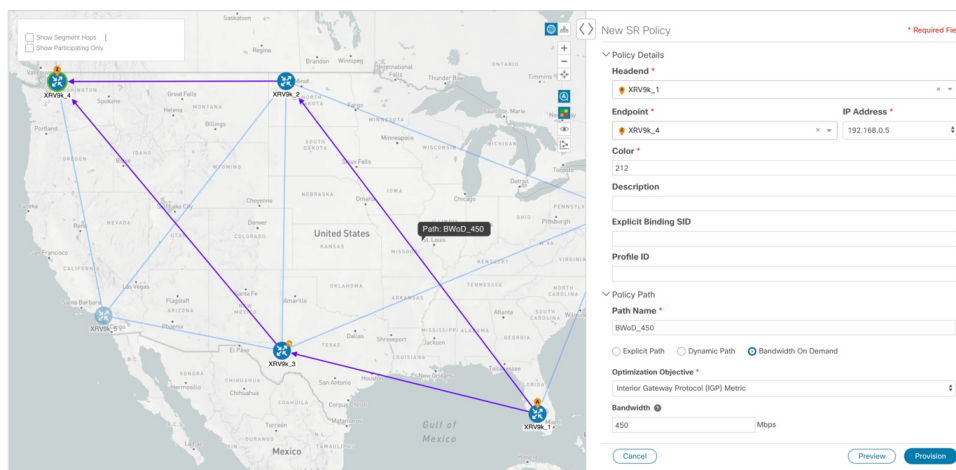
Step 4 **Optimization Objective**—Depending on the bandwidth constraint chosen (see [Configure Bandwidth on Demand, on page 2](#)), select the specific metric to optimize for Bandwidth on Demand

- **Interior Gateway Protocol (IGP) Metric**—Minimizes total path IGP metric.
- **Traffic Engineering (TE) Metric**—Minimize total path TE metric.
- **Latency**—Minimize total path latency.

Step 5 **Bandwidth**—Enter the requested bandwidth amount.

Step 6 Click **Preview**. The path is highlighted on the map.

Figure 2: Bandwidth on Demand SR Policy Example-update screen**



Step 7 If you are satisfied with the policy path, click **Provision**.

Step 8 When the policy is provisioned successfully, a window appears with the following options:

- **View SR Policy List**—Displays the **SR Policies** table that lists all SR policies including the one that was just created.
- **Create New**—Allows you to create another SR policy.

Troubleshoot BWoD

The following are some of the most common error conditions for BWoD and some possible corrective actions that may fix the issue.

Table 2: Errors

Error Event Message	Possible Causes and Recommended Corrective Action
OptimaModelError	<p>The network model used by BWoD from the Optimization Engine is corrupt or is missing key data that is needed to properly support BWoD. Possible causes include network discovery issues or synchronization problems between the Optimization Engine and Topology Services. Try restarting the Optimization Engine pod to rebuild the model.</p> <p>This error can also occur if the time required to discover a policy and add it to the model after it has been deployed exceeds the Deployment Timeout option set for BWoD. The default is 30 seconds which should suffice for small to medium sized networks. However, larger networks may require additional time.</p>
NATSTimedOutError	<p>The deployment of a bandwidth policy through SR-PCE exceeds the Deployment Timeout option set for BWoD. Increase the Deployment Timeout option to allow for additional time for deployments in larger networks.</p>
Traceback or other errors found in the log file	Please contact your Cisco service representative.