Multilayer (L3-L1) Collection

Multilayer (Layer 3 and Layer 1) network collection is an advanced collection configuration. This section describes how to configure collection from a multilayer network.

After this procedure, you should be able to collect and model the following information:

- Spectrum Switched Optical Networks (SSON) circuit information (central frequency ID, spectral width, sson_enabled, and prefer_lower_frequency_ids) that can be viewed and modeled in WAE Design. The L1Link attribute is also associated with central_frequency_excludelist_id and sson_enabled columns.

- L1 diversity collection

- Notification support for the EPN-M agent which updates the network model on any change in the network without running the full collection

- Topologies from DWDM networks that support Generalized Multiprotocol Label Switching (GMPLS) with non-User Network Interface (UNI) circuits

- L1 circuit paths

- L1 topology with and without amplifiers

- L1 diversity circuits. L1 circuits can be configured to be disjoint from other L1 circuits

- Unprotected and restorable paths

- Actual L1 circuit path hops

- Feasibility metrics and limits

- Inactive L1 links

- L1 node and L1 link SRLGs

- Site information

- User properties

- Aging information and last seen date. To configure aging, see Configure Aging.

After collection, you can view the model in Cisco WAE Design or from the Expert Mode: wae:networks/network/<*network_name*>/l1-model

This section contains the following topics:

- Multilayer Collection Limitations, on page 2

Multilayer Collection Limitations

The following multilayer (L3-L1) collection limitations exist:

- Multilayer collection for Cisco devices is supported only on the following platforms:

    - NCS 2000 platforms running version 10.9, 11.1 and 11.2 are supported when using the Cisco Evolved Programmable Network Manager optical agent (EPN-M optical agent) (Configure Multilayer Collection Using the EPN-M Agent, on page 4).

    - Cisco Aggregation Services Routers (ASR) 9000, Cisco Carrier Routing System (CRS), and Cisco NCS 5500 platforms running IOS-XR for L3 devices.

- Multilayer collection is limited to the collection of unprotected circuits.

- L3-L1 mapping by LMP is supported only if the controller interface name is the same as the actual L3 interface name or of the form "dwdmx/x/x/x" where the "x/x/x/x" subscript matches that of the corresponding L3 interface.

- Lambda mapping is currently supported only for circuit paths but not for path hops.

- Only one optical nimo can be configured per WAE instance. If more than one is configured, it is not guaranteed to work.

Expert Mode—Multilayer Collection

Use the topics below to configure a multilayer collection using the Expert Mode. You can also use the Cisco WAE UI (Cisco WAE UI—Multilayer Collection, on page 6) and use these topics for configuration details. To view field descriptions, hover your mouse pointer over fields in the Expert Mode or Cisco WAE UI.

Step	For more information, see...
1. Review multilayer collection limitations.	Multilayer Collection Limitations, on page 2
2. Obtain and configure L3 - L1 mapping information.	Configure L3-L1 Mapping Information, on page 2
3. Configure and run multilayer collection using the Cisco Evolved Programmable Network Manager (EPNM) optical agent.	• Configure Multilayer Collection Using the EPN-M Agent, on page 4

Configure L3-L1 Mapping Information

L3-L1 mappings can be collected in one of the following ways:

- If LMP is enabled and configured on the network, then you can get L3-L1 information by running the configuration parsing agent. See Configure the Configuration Parsing Agent Using the Expert Mode. The parse configuration agent should be specified in the optical nimo as follows:
  `networks/<multilayer_network_name>/nimo/optical-nimo/advanced/cfg-parse-agent.`

Note
- L3-L1 mapping by Link Management Protocol (LMP) is supported only if the controller interface name is same as the actual L3 interface name or in the form of "dwdmx/x/x/x" where the "x/x/x/x" subscript matches that of the corresponding L3 interface.

  - EPNM agent does not require the parse config agent to get the L1 L3 mapping.

- Manually configure L3-L1 mapping:

  - Enter the mapping of L3 nodes and interfaces to L1 nodes and ports.

  - Provide an L3 to L1 circuit. This method will discover all the L3 to L1 mappings after topology collection.

Note   You must know the L3 and L1 interfaces and ports, or the circuit names.

The following procedure describes the manual configuration of L3 - L1 mapping using the Expert Mode. The Cisco WAE UI can also be used. For more information, see Cisco WAE UI Overview.

Step 1   From the Expert Mode, in **Configuration editor**, navigate to **/wae:wae/nimos** and click the **l3-l1-mappings** tab.

Step 2   Click **l3-l1-mappings**.

Step 3   Click the plus (+) sign, enter an arbitrary name for the L3-L1 mapping group, and click **confirm**.

Step 4   To provide an L3 - L1 circuit:
  a) Click the **l3-l1-circuit-mapping** tab and click the plus (+) sign.
  b) Enter each L3 and L1 circuit names, l3-node, l3-interface, l1-node, and l1-port.
  c) Click **confirm**.

Step 5   To manually enter the mapping of L3 - L1 interfaces and ports:
  a) Click the **l3-l1-mapping** tab and click the plus (+) sign to enter each mapping.
  b) Click **Add**.
  c) Repeat these steps to enter all L3-L1 mappings.

Example

If using the WAE CLI (in config mode):

```
# wae nimos l3-l1-mappings l3-l1-mappings <mapping_name>
```

```
l3-l1-circuit-mapping <l3_circuit> <l1_circuit>

# commit
```

Configure Multilayer Collection Using the EPN-M Agent

The Cisco Evolved Programmable Network Manager (Cisco EPN Manager) agent supports Cisco Network Convergence System (NCS) 2000 platforms release 10.9, 11.1, and 11.2 for L1 devices. You must have Cisco EPN Manager version 2.2.2.1 of later running on your network to use this agent. The agent also receives notifications from Cisco EPN Manager when the status of links and circuits change and updates the network model accordingly. When using the Expert Mode, changes to the nodes, circuits, and so on can be seen in the agent-model tab from the following path:
wae:wae/agents/optical-agent:optical-agents/optical-agent/*<epnm_agent_name>*

Note   The different node types reported by EPNM are defaulted to ROADM node type.

Before you begin

.

- Confirm that you have completed all the preliminary tasks in Expert Mode—Multilayer Collection, on page 2.

- Confirm that the EPN-M server certificate is installed. For more information, see the "Security" chapter ("Install a Certificate for the EPN-M Server" topic) in the Cisco WAE Installation Guide.

- (Optional) Configure feasibility limit margins in the Cisco WAE UI or in the Expert mode (**/wae:wae/components/nimos/feasibility-limit-margins/feasibility-limit-margin**). This configuration adds the specified margin to the collected feasibility-limit for the circuits matching the specified bandwidth. For more information, see the "L1 Circuit Wavelengths" Cisco WAE Design User Guide

- (Optional) Configure central frequency blocked lists in the Cisco WAE UI or in the Expert mode (**/wae:wae/components/nimos/central-frequency-excludelists/central-frequency-excludelists**). This configuration defines the list of frequency IDs that may not serve as central frequency IDs for L1 circuit paths. For more information, see Cisco WAE Design User Guide. For information on advanced options and configuration guidelines, see the following topics:

  - L1 Circuit Wavelength Options, on page 9

  - L1 Circuit Wavelength Guidelines, on page 10

  - L1 Circuit Wavelength Configuration Examples, on page 11

Step 1   Configure and run an L3 IGP topology collection network model with the following interface options set to **true**:

- lag
- get-physical-ports

Note   For more information, see Topology Collection Using the IGP Database.

Step 2   In **Configuration editor**, navigate to **/wae:wae/agents/optical-agents** and click the **optical-agent** tab.

Step 3 Click Add (+) and enter an agent name.

Step 4 Click the **cisco-wae-optical-epnm-agent** link.

Step 5 Select the **epnm-server-conf** tab and enter the verified domain of the Cisco EPN Manager server and access group (authgroup that was configured in the NCS devices).

> **Note** Click the advanced tab to enter the L3-L1 mapping group, data recording options (if net-recorder is set to record, the file will be saved in the directory where net-record-dir is set), connection timeout, and pool-size-per-query (number of parallel queries that can be sent to EPNM per L1 element) settings.

WAE CLI (config mode) example:

```
admin@wae(config)# wae agents optical-agents optical-agent
<agent-name> cisco-wae-optical-epnm-agent epnm-server-conf epnm-server-fqdn <fqdn>
epnm-server-access <authgroup>
cisco-wae-optical-epnm-agent advanced net-recorder <net-recorder-option>
cisco-wae-optical-epnm-agent advanced net-record-dir <net-recorder-storage-directory>
cisco-wae-optical-epnm-agent advanced pool-size-per-query <number-of-queries>
cisco-wae-optical-epnm-agent advanced notification subscribe-to-notifications <true or false>
```

Step 6 Click the **Commit** button.

Step 7 If you plan to utilize Lambda ID mapping (where you can set whether channel ID, central frequency, or wavelength will be mapped to the lambda ID), then you must load the Lambda ID configuration file. Enter the following command:

```
# ncs_load -lmj /wae/agents/optical-agents/optical-agent <agent-name>/lambda-mappings
```

Step 8 To run the L1 collection, navigate back to the **cisco-wae-optical-epnm-agent** tab and click **run-collection** > **Invoke run-collection**.

Step 9 Create an L1 optical collection network model:

  a) Navigate to **/wae:networks**.

  b) Click the plus (+) sign and enter an optical network model name. We recommend a unique name that contains the source network and NIMO names; for example, networkABC_optical.

  c) Click **Add**.

  d) Click the **nimo** tab.

  e) From the **Choice - nimo-type** drop-down list, choose **optical-nimo**.

  f) Click **optical-nimo** and enter the following information:

    • **source-network**—Choose the applicable network model that contains L3 topology information collected using one of the topology NIMOs.

    • **network-access**—Choose a network access group that was previously configured.

Step 10 Click the **advanced** tab to configure the following:

    • **cfg-parse-agent**—Choose the configuration parse agent name if it was used for L1-L3 mapping.

    • **lag**—Choose true if using the configuration parse agent.

    • **feasibility-limit-margin-list**—(Optional) Choose the feasibility margin list name.

    • **central-frequency-excludelists**—(Optional) Choose the frequency excludelist.

Step 11 Click the **optical-agents** tab and add any agents that were created.

  a) Click the **advanced** tab to configure advanced features, including the following:

    • **retain-amplifiers**—Choose true if you want to include amplifiers as part of the collection.

    • **map-lambdas**—If set to true, a user table is created that displays the lambda mapping values (LambdaID, ITU channel number, G.694.1, central frequency, and wavelength) selected in the **map-lambda-id-to** field. Cisco recommends to set this value to true when collecting information from a network with L1 links supporting 96 channels.

- **use-configured-l3-l1-mapping**—Choose true if you manually configured the l3-l1 mapping (see Configure L3-L1 Mapping Information, on page 2).
- **l3-l1-mapping**—Choose the l3-l1 mapping group that you configured earlier.
- **collect-user-properties**—Set to false if you do not want to collect user properties from the agent. The default value is true.

Step 12 Configure the aggregator to consolidate the L1 and L3 network models you just created. See example for aggregator rules to pick the data from proper source network. To view a CLI configuration example of the rest of this procedure, see Aggregator and Multilayer Collection Configuration Example.

 a) Create an empty network. This will be the final consolidated network model. From the Expert Mode, navigate to **/wae:networks**, click the plus (+) sign, and enter a final network model name. For example, networkABC_L3L1.

 b) Navigate to **/wae:wae/components/dare:aggregators/aggregator** tab.

 c) Click the plus (+) sign and select the multilayer network (networkABC_L3L1) you just created from the destination drop-down list.

 d) From the sources tab, click **source**, and add the L1 and L3 network models you want to combine the collections from.

 e) Click **Commit**.

Step 13 Run the L3 collection.

 a) Navigate to **/wae:networks/network/<*network-name*> nimo/topo-igp-nimo**.

 b) From the topo-igp-nimo tab, click **run-collection**.

Step 14 Run the L1 collection.

 a) Navigate to **/wae:networks/network/<*network-name*> nimo/optical-nimo**.

 b) From the optical-nimo tab, select the L1 source network and click **build-optical-topology**.

Step 15 To verify that the merge was successful, you can open the network from WAE Design (**File** > **Open from** > **WAE Automation Server** and select the final network model).

What to do next

If archive is configured, you can also open the plan file and view L1 and L3 topology using WAE Design. You can then run the optimization tool, make changes to the network, create a patch, etc. For more information on WAE Design, see the Cisco WAE Design User Guide. For more information on archive and plan files, see the following topics:

- Configure the Archive Using the Network Model Composer
- Manage Plan Files in Archive

Cisco WAE UI—Multilayer Collection

The following workflow describes the high-level steps to configure multilayer collection when using the Cisco WAE UI. For more details on configuration options, see the Expert Mode multilayer topics or hover the mouse pointer over fields.

Before you begin

Review multilayer collection limitations.

Step 1 Unless VTXP is enabled on the network, configure L3-L1 mapping by doing one of the following:

- For LMP networks, create and configure a configuration parse agent (**Cisco WAE UI** > **Agent Configuration** and select **cfg-parse-agent**).
- Manually enter L3-L1 mapping information (**Cisco WAE UI** > **L3-L1 Mapping**).

Step 2 Configure an optical agent (**Cisco WAE UI** > **Agent Configuration** and select **cisco-wae-optical-epnm-agent**).

Step 3 (Optional) Configure L1 feasibility margins (**Cisco WAE UI** > **Feasibility Limit Margins**).

Step 4 (Optional) Configure central frequency blocked lists (**Cisco WAE UI** > **Central Frequency Excludelists**).

Step 5 Create an L3 topology collection using the IGP database (**Cisco WAE UI** > **Composer** > **Topology** and select **Topo IGP**).

Step 6 Create an L1 topology collection (**Cisco WAE UI** > **Composer** > **Topology** and select **Optical**).

Step 7 Aggregate topology collections (**Cisco WAE UI** > **Composer** > **Aggregation**, confirm L1 and L3 collections are set as "Direct", and click **Rebuild Network**.

Step 8 To verify that the merge was successful, you can open the network from WAE Design (**File** > **Open from** > **WAE Automation Server** and select the final network model).

What to do next

If archive is configured, you can also open the plan file and view L1 and L3 topology using WAE Design. You can then run the optimization tool, make changes to the network, create a patch, etc. For more information on WAE Design, see the Cisco WAE Design User Guide. For more information on archive and plan files, see the following topics:

Cisco WAE CLI—Multilayer Collection

This example shows how to configure multilayer collection using the Cisco WAE CLI (in config mode). This example includes configuration of an EPNM optical agent and manual L1-L3 mapping.

Configure EPNM optical agent

```
wae@wae(config-optical-agent-<optical_agent_name>)#cisco-wae-optical-epnm-agent
epnm-server-conf epnm-server-fqdn <FQDN> epnm-server-access <epnm_auth_group>
```

Create networks

```
wae@wae(config)# networks network <l3_network_name>
wae@wae(config-network-<l3_network_name>)# nimo topo-igp-nimo network-access <access_group>
wae@wae(config-network-<l3_network_name>)# nimo topo-igp-nimo igp-config 1
igp-protocol <ospf/isis> seed-router <seed-ip>
wae@wae(config-network-<l3_network_name>)# commit
wae@wae(config-network-<l3_network_name>)# exit

wae@wae(config)# networks network <ml_network_name>
wae@wae(config-network-<ml_network_name>)# nimo optical-nimo network-access <access_group>
wae@wae(config-network-<ml_network_name>)# nimo optical-nimo source-network <l3_network_name>
wae@wae(config-network-<ml_network_name>)# nimo optical-nimo optical-agents
<optical_agent_name>
wae@wae(config-network-<ml_network_name>)# commit
wae@wae(config-network-<ml_network_name>)# exit
```

```
wae@wae(config)# networks network <aggregator_network_name>
wae@wae(config-network-<aggregator_network_name>)# commit
```

Configure L3 topology

```
wae@wae(config)# networks network <network_name>
wae@wae(config-network-<network_name>)# nimo topo-igp-nimo collect-interfaces true
wae@wae(config-network-<network_name>)# nimo topo-igp-nimo advanced interfaces lag true
get-physical-ports true
wae@wae(config-network-<network_name>)# nimo topo-igp-nimo advanced igp isis-level both
login-record-mode playback login-record-dir /home/wae/records/
wae@wae(config-network-<network_name>)# commit
```

Configure L3-L1 mapping (repeat for each mapping)

```
wae@wae(config)# wae nimos l3-l1-mappings l3-l1-mappings <mapping_name> l3-l1-mapping
<l3_node>
<l3_interface> <l1_node> <l3_interface>
wae@wae(config)# networks network <ml_network> optical-nimo optical-agents [<agent_name>]
advanced
use-configured-l3-l1-mapping true l3-l1-mapping <mapping_name>
wae@wae(config-networks-<ml_network_name>)# commit
```

Note: Use the topo-igp-nimo network as source network for optical-nimo.

(Optional) Configure Lambda mapping

Do one of the following:

- Load from a file:

  After the optical agent is created, load (ncs_load or netconf-console --edit-config..) the lambda mapping configuration XML file (lambda-id to channel-id/wavelength/central-frequency mapping) to /wae/agents/optical-agents/optical-agent[agent-name]/lambda-mappings.

  ```
  ncs_load -lmj <file_name>

  netconf-console --edit-config <file_name>
  ```

Note	The netconf-console command requires the 'python-paramiko' system package.

- Enable Lambda mapping in the optical nimo and select the base for lambda mapping.

  ```
  wae@wae(config)# networks network <ml_network_name> nimo optical-nimo optical-agents
  <optical_agent_name> map-lambdas true map-lambda-id-to
  <channel-id/wavelength/central-frequency>
  wae@wae(config)# commit
  ```

(Optional) Configure feasibility limit margin

```
admin@wae(config)# networks network <ml_network_name> nimo optical-nimo optical-agents
<optical_agent_name>
admin@wae(config-optical-agents-<optical_agent_name>)# advanced feasibility-limit-margin-list
 <L1_circuit_bandwidth>
feasibility-limit-margin <margin_value>
```

Repeat the second command to configure multiple margin values for different bandwidths.

Configure DARE (aggregator)

```
admin@wae(config)# wae components aggregators aggregator <aggregator_network_name>
admin@wae(config-aggregator-<aggregator_network_name>)# sources source <l3_network_name>
admin@wae(config-source-<l3_network_name>)# exit
admin@wae(config-aggregator-<l3_network_name>)# sources source <ml_network_name>
admin@wae(config-source-<ml_network_name>)# commit
```

Run L3 topology collection

```
wae@wae# networks network <l3_network_name> nimo topo-igp-nimo run-collection
```

Run L1 topology collection

Start optical plug-in:

```
wae@wae# wae agents optical-agents optical-agent <optical_agent_name>
cisco-wae-optical-epnm-agent run-collection
```

Note   Aggregation runs in the background as network collections process.

Generate a plan file

```
wae@wae# wae components getplan run network <network_name> | exclude planfile-content |
save <path/for/plan/file.txt>
```

L1 Circuit Wavelength Options

The following table describes advanced options available for central frequency.

Table 1: L1 Circuit Wavelength Options

Field	Description
The following options are available in **/wae:networks/network /<*network-name*>/nimo/optical-nimo:optical-nimo/advanced/network-options**.	
anchor-frequency	Anchor frequency in THz. Default is 193.1 THz
central-frequency-granularity	Central frequency granularity in GHz. Default is 25 GHz.
central-frequency-excludelists-name	List of names given to set blocked list central frequency IDs mentioned in the central-frequency-id-excludelist table.
frequency-id-lower-bound	The lower bound of the frequency ID.
frequency-id-upper-bound	The upper bound of the frequency ID.
use-pre-configured-excludelist-per-link-type	Use the pre-defined set of frequency blocked list IDs based on the L1 link types: 80 channel, 96 channel, 80 + 96 channel, and Nyquist. The default is true.

Field	Description
The following options are available in **/wae:wae/nimos /optical-nimo:central-frequency-excludelists**.	
name	Name of the central frequency ID blocked list.
type	The channel type associated with the excludelist-80-channel, 96-channel, Nyquist or Other.
frequency-id-lower-bound	The lower bound of the frequency ID associated with the channel type.
frequency-id-upper-bound	The upper bound of the frequency ID associated with the channel type.
central-frequency-excludelist-ids	List of blocked list central frequency IDs.

Frequency Lower and Upper Bounds and Blocked list Values

- An L1 Link supporting 80 channels should **effectively** have:
    - Bounds=[-47, 113]
    - Blocked list IDs={-47, -45, -43, … , 113} (odd IDs)

- An L1 Link supporting 96 channels should **effectively** have:
    - Bounds=[-71, 121]
    - Blocked list IDs={-71, -69, … , 3, … , 121} (odd IDs)

- An L1 Link supporting 96 channels should **effectively** have:
    - Bounds=[-71, 121]
    - Blocked list IDs={-71, -69, … , 3, … , 121} (odd IDs)

- A Nyquist Link should **effectively** have:
    - Bounds=[-71, 121]
    - No Blocked list IDs

L1 Circuit Wavelength Guidelines

The following list provides information that you may find useful when configuring L1 frequency options.

1. The anchor frequency and central frequency granularity will be constant for the given agent network.

2. You can configure the global anchor frequency, central frequency granularity, upper and lower bounds, and blocked list options for each network. Default values should be used only for the anchor frequency, central frequency granularity, and global upper and lower bounds.

3. Different pre-configured blocked lists are provided and corresponds to different L1 Link types (80-channel-system; 96-channel-system; Nyquist-96-channel-system).

Note   Blocked lists include upper and lower bounds.

---

4. You can select whether or not pre-configured blocked lists are automatically associated to L1 Links. This can be specified in the **use-pre-configured-excludelist-per-link-type**configuration option. By default, this option is set to true.

5. To edit the pre-configured blocked lists, create a new blocked list entry using the **central-frequency-excludelists** configuration option and set the boolean **use-pre-configured-excludelist-per-link-type** to false.

6. Run the **build-optical-topology** action to incorporate the changes done to the network options and blocked list frequency IDs into the plan file.

L1 Circuit Wavelength Configuration Examples

The following are some L1 frequency configuration examples:

1. Do not configure anything specific to the network options or central frequency blocked list IDs. Use the default values.

```
(config)#  networks network <network-name> nimo optical-nimo
optical-agents <agent-name>
```

2. Specify the custom central frequency blocked list name for all the link types used in the network.

```
(config)# networks network <network-name> nimo optical-nimo
advanced network-options use-preconfigured-excludelist-per-link-type false
central-frequency-excludelists-name [ 80-excludelist 96-excludelist nyquist ]

wae nimos central-frequency-excludelists central-frequency-excludelist 80-excludelist

    channel-type 80-channel-system
    id-list 1,2,3,4,5,6,7,8,9,10
    !
wae nimos central-frequency-excludelists central-frequency-excludelist 96-excludelist
    channel-type 96-channel-system
    id-list 9,11,13,45,80
!
wae nimos central-frequency-excludelists central-frequency-excludelist nyquist
    channel-type nyquist-channel-system
    id-list 5,19,76
!
```

3. Configure different anchor frequency and central frequency granularity for the network.

```
(config)# networks network <network-name> nimo optical-nimo
advanced network-options anchor-frequency <anchor-frequency-value>
central-frequency-granularity <central-frequency-granularity-value>
```

4. Specify the default central frequency, but not the blocked list at the link level.

```
(config)# wae nimos central-frequency-excludelists central-frequency-excludelist my-other

    channel-type other
```

```
        id-list 5,19,76
!networks network <nimo-name> nimo optical- nimo advanced network-options
use-preconfigured-excludelist-per-link-type false central-frequency-excludelists-name [
 my-other ]
```