ADTRAN Operating System

Configuring Carrier Ethernet Terminal Loopback in AOS

Configuration Guide

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Revision History

Rev A	August 2020	Initial release of this document.

Table of Contents

1. Overview

This configuration guide describes the use and configuration of the ADRAN Operating System (AOS) Carrier Ethernet terminal loopback feature. This feature can be used to test and verify network quality and traffic management services configured for end user traffic that typically ingresses the Metro Ethernet Network (MEN) from the User Network Interface (UNI) of a remote AOS device at the customer side of the MEN. Included in this guide are an overview of the terminal loopback feature, the steps necessary to configure a terminal loopback test, and options for troubleshooting loopback test configurations.

2. Terminal Loopback Introduction

In a terminal loopback test, traffic is generated from a device on the administrative side of the MEN (as shown in *Figure 1*) and sent upstream to a remote AOS device at the edge of the customer's network. The traffic is then looped back just prior to egressing the UNI interface on the remote AOS unit and is returned to the originating AOS device. Generating traffic from the administrative side of the network, and then looping it back at the customer network, allows you to visualize the egress queue management and classification rules applied to customer traffic as it traverses the network. Terminal loopbacks are commonly used to validate how a remote device performs Quality of Service (QoS) classification on downstream traffic by providing insight into rate limiting functionality on configured policers, traffic prioritization in egress queues, and traffic shaping.
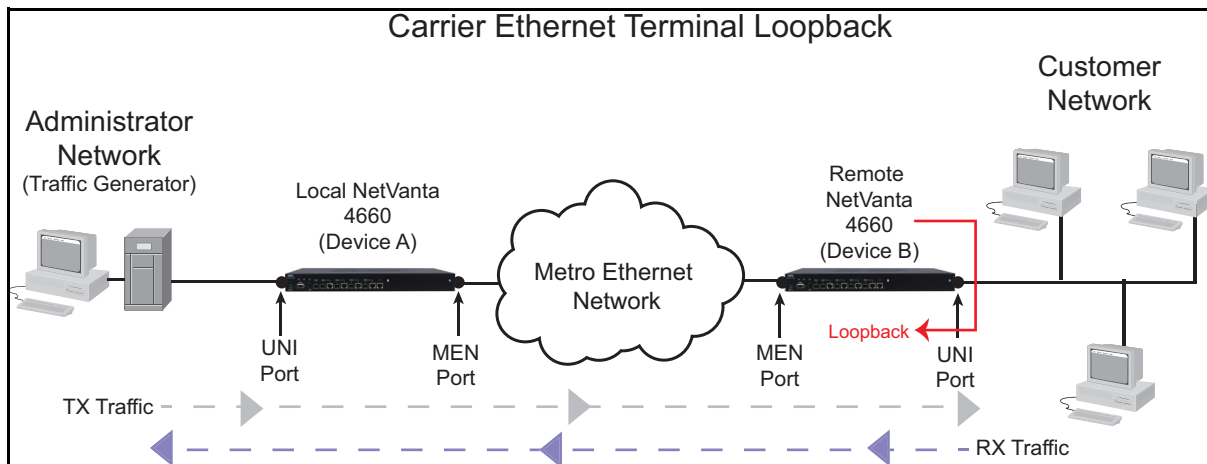

Figure 1. Carrier Ethernet Terminal Loopback in the Network

Loopbacks and MAC Address Swapping

Because Ethernet address rules do not allow frames containing the same source media access control (MAC) address to arrive from different ports on a device, the AOS unit performing the loopback test must swap the destination and source MAC address of packets that are returned (looped back) during a terminal loopback test. The source MAC address and destination MAC addresses in the frame are swapped when the data is looped back so that the incoming source and destination addresses become the outgoing destination and source addresses, respectively.

Terminal Loopback versus Facility Loopback

AOS supports both facility and terminal loopback tests as part of support for RFC 2544. Facility loopback tests are used to verify circuit connectivity, isolate faults, and analyze characteristics of Ethernet data flow as traffic ingresses the remote device on the Metro Ethernet network (MEN) port. These loopback tests turn traffic flows ingressing the MEN port back toward that interface immediately upon entering the switch fabric, and incorporate only the traffic conditioning associated with the device's MEN port interface (shaping). These

tests are useful for validating round-trip data flow between two AOS devices. *Figure 2* can be used to visualize a facility loopback test.
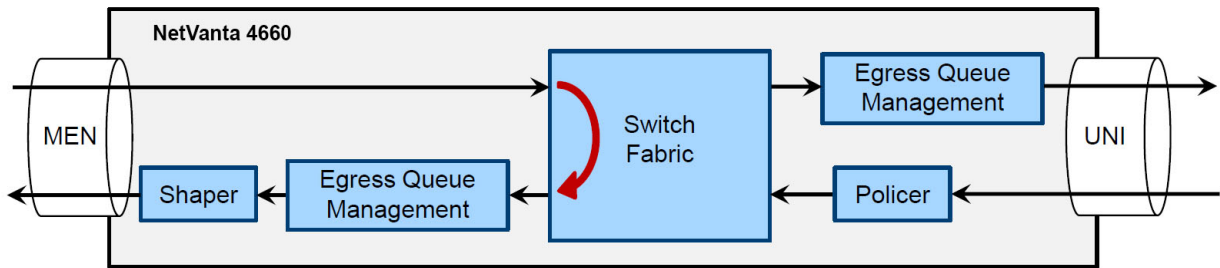

Figure 2. Facility Loopback Traffic Flow

Terminal loopback tests, however, are used to test traffic for network service functionality and are performed as close to the remote device's UNI port as possible. In these loopback tests, a flow about to egress the UNI port of a remote AOS device is turned back towards to the MEN port, to function as simulated end user traffic, and is subject to any configured policers, egress queues, and shapers, thus providing a method for testing the configured services experienced by end users on the network. *Figure 3* can be used to visualize a terminal loopback test.
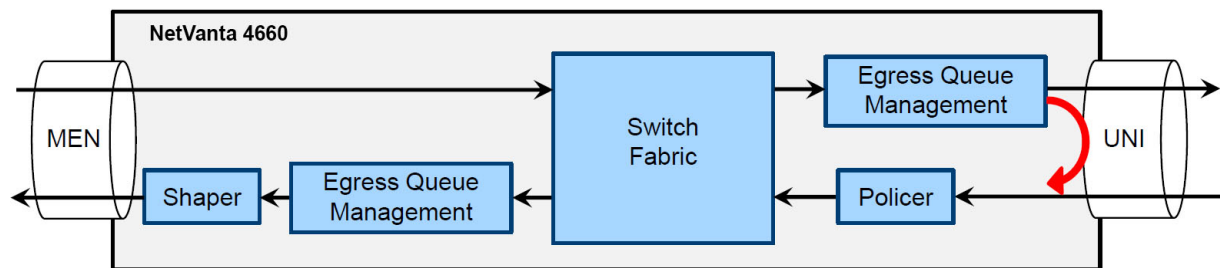

Figure 3. Terminal Loopback Traffic Flow

The information in this guide focuses on the configuration and use of terminal loopback tests; for more information about facility loopback tests, refer to the *MAC Swap Loopback* configuration guide, available online at https://supportcommunity.adtran.com.

3. Hardware and Software Requirements and Limitations

The Carrier Ethernet terminal loopback feature is available on AOS devices running AOS versions R13.7.0 and later as outlined in the *AOS Feature Matrix*, available online at https://supportcommunity.adtran.com.

Terminal Loopback and Ethernet Virtual Circuits (EVCs)

When a loopback test changes configuration, or transitions to or from the running state, the applicable EVCs are evaluated to determine if any of their UNI port interfaces need to be inhibited. If the traffic specified on an EVC's UNI port interface is fully encompassed by a loopback, that interface will be inhibited from carrying EVC traffic.

> **ℹ NOTE**
>
> *The system management EVC always takes precedence over the Ethernet loopback. If a loopback is created that specifies only an interface and that interface is being used by the system management EVC, the loopback will begin running. However, management traffic will continue to flow and will not be looped back. If a loopback is created that specifies the same S-tag being used by the system management EVC, the loopback will not enter the running state.*

Terminal Loopback and UNI Traffic

The terminal loopback traffic is always given priority over end user traffic on the UNI, whether Tx or Rx traffic. In addition, the terminal loopback test remains functional even when the UNI is down, thus helping to aid troubleshoot end user network issues.

4. Configuring a Terminal Loopback Test

In a terminal loopback, test traffic sent in an upstream direction is looped back at the UNI of a remote AOS device to determine what the end user traffic is subjected to and determine what may be causing network issues. Looped-back traffic packets are captured on the local AOS device for analysis. To configure the terminal loopback test, you must configure an EVC for the looped traffic and an EVC map this is applied to the UNI of the remote device, and then configure and enable the actual terminal loopback test on the remote device's UNI.

The following sections describe the steps necessary to configure a terminal loopback test:

Configuring a System Loopback MAC Address (Optional)

To facilitate loopback testing, you can optionally configure a system loopback MAC address and use it for multiple loopback tests. Using a system MAC address eliminates the need to repeatedly enter the same destination MAC address in certain CLI commands (the keyword **system** is used instead).

> **ℹ NOTE**
>
> *A system loopback MAC address cannot be the same address assigned to any management, logical, or physical interface on the unit.*

To assign a system loopback MAC address, enter the **ethernet loopback system mac address [**<*mac address*> **| none]** command from the Global Configuration mode. The <*mac address*> parameter specifies a valid 48-bit MAC address. MAC addresses should be expressed in the following format: **xx:xx:xx:xx:xx:xx** (for example, **00:A0:C8:00:00:01**). The **none** parameter specifies that the system loopback MAC address is not assigned. Use the **no** form of this command to delete the system MAC address when it is no longer needed.

Enter the command as follows to define a system loopback MAC address:

```
(config)#ethernet loopback system mac address 00:A0:C8:00:00:01
```

Configuring an EVC for Looped Traffic

A Carrier Ethernet EVC connects two endpoints (for example, the MEN port and the UNI) and passes both Layer 2 and Layer 3 Ethernet service frames through these endpoints for carrier Ethernet services. The EVCs prevent data transfer between subscriber sites that are not part of the same EVC, thus providing data privacy and security similar to a Frame Relay or an asynchronous transfer mode (ATM) permanent virtual circuit (PVC).

Each EVC has an associated subscriber tag (S-tag). This tag is the service provider virtual local area network (VLAN) ID and the outer tag in Q-in-Q VLAN tagging, whose VLAN ID is unique among other EVCs in the MEN. This unique S-tag allows the EVC to be identified and separated from other EVCs within the MEN. The S-tag exists only within the MEN and is not transmitted from or received at the customer edge of the network. Configuring an EVC for looped traffic helps to test the QOS-related issues at the remote end of the network for that particular service (i.e.S-tag).

Because the terminal loopback test occurs on traffic just before it egresses the UNI port on the remote AOS device, and must traverse back across the MEN between the two AOS devices, the UNI interface associated with the terminal loopback test must be associated with the EVC that handles customer traffic. This association occurs by using the same S-tag value (VLAN ID) in the EVC, EVC map, and terminal loopback configurations.

The configurable attributes of the EVC necessary for terminal loopback tests include the EVC name, the MEN port to which the EVC is connected, the S-tag associated with the EVC, and whether the EVC is enabled. Once these parameters are configured for the EVC, the EVC must be associated with a MEN port for traffic to flow. The EVC is configured on the local (administrator) AOS device and applied to the remote AOS device.

To configure the EVC used for the terminal loopback, follow these steps:

1. From the Global Configuration mode, use the **evc** *<name>* command from the Global Configuration mode prompt to create an EVC as shown below. Use the **no** form of this command to delete the EVC from the AOS device.

   ```
   (config)#evc TESTEVC1
   (config-evc-TESTEVC1)#
   ```

2. Next, in the EVC's configuration mode, specify the MEN port and S-tag associated with the EVC using the **connect men-port gigabit-ethernet** *<slot/port>* and **s-tag** *<vlan id>* commands as shown below. The *<slot/port>* parameter specifies the slot and port associated with the MEN port, and the *<vlan id>* parameter specifies the EVC's VLAN ID. The VLAN ID specified as the EVC's S-tag is used as matching criteria in the EVC map to match traffic for the terminal loopback test. Valid *<vlan id>* range is **2** to **4094**.

   ```
   (config-evc-TESTEVC1)#connect men-port gigabit-ethernet 0/4
   (config-evc-TESTEVC1)#s-tag 200
   ```

   These commands are the minimum EVC configuration needed for use with the Carrier Ethernet terminal loopback, and specify the MEN port associated with the EVC (in this example, Gigabit Ethernet interface **0/4**) and the VLAN ID used by the service provider (in this example, VLAN **200**).

3. After configuring the MEN port and S-tag for the EVC, enable the EVC using the **no shutdown** command from the EVC's configuration mode as follows:

   ```
   (config-evc-TESTEVC1)#no shutdown
   ```

The EVC is now configured and enabled, and you can begin to configure an EVC map to associate with the UNI port on which the terminal loopback will be configured.

Configuring an EVC Map and Associating it with the UNI

After configuring the EVC for looped traffic, begin configuring an EVC map to associate with the UNI port being used in the loopback test. The EVC map provides a traffic filter that matches Layer 2 traffic based on specific criteria, and associates that traffic with a specific EVC. Each map is associated with a single EVC and UNI, and is used not only to classify traffic for a specific EVC, but also for rate limiting by the EVC Policer Policy (if configured).

Configuration of EVC maps used for terminal loopback traffic generally include specifying the map name, the UNI associated with the map, and the EVC associated with the map. Once the EVC map is configured, the map must be associated with both an EVC and a UNI.

To create an EVC map for use with the terminal loopback feature, follow these steps:

1. Create an EVC map, and enter the EVC Map Configuration mode, by entering the **evc-map** *<name>* command from the Global Configuration mode prompt as shown below. Use the no form of this command to remove the EVC map configuration from the device.

   ```
   (config)#evc-map MAP1
   (config-evc-map-MAP1)#
   ```

2. Next, specify the EVC and the UNI to which this EVC map is applied using the **connect evc** *<evc>* and **connect uni gigabit-ethernet** *<slot/port>* commands as shown below. The *<evc>* parameter specifies the EVC to which this map is associated. This value should match the S-tag VLAN ID specified in the EVC. The *<slot/port>* parameter specifies the slot and port associated with the UNI port on which the terminal loopback is applied. Use the **no** form of either command to remove the EVC and UNI from the EVC map's configuration. Enter the commands as follows:

   ```
   (config-evc-map-MAP1)#connect evc 200
   (config-evc-map-MAP1)#connect uni gigabit-ethernet 0/3
   ```

3. Enable the EVC map using the no shutdown command as follows:

   ```
   (config-evc-map-MAP1)#no shutdown
   ```

The EVC map is now configured for use with the terminal loopback feature. You can now begin configuring the terminal loopback test.

> **i** **NOTE**
>
> *EVC map configuration can also include specifying matching criteria to send traffic to the associated EVC. While the commands discussed above are the basics used for the Carrier Ethernet terminal loopback feature, should you need to configure additional match statements for the EVC, refer to the Carrier Ethernet Services in AOS configuration guide (available online at https://supportcommunity.adtran.com) for more detailed information regarding EVC map configuration.*

Creating and Configuring a Terminal Loopback Test

After configuring the EVC and EVC map for the terminal loopback test, you can create and configure the terminal loopback test itself. Terminal loopback test configurations specify the UNI port interface that will loop back egressing traffic during the terminal loopback test and the match criteria for the types of egressing traffic that will be looped back. The terminal loopback is configured on the remote AOS device closest to the end user network.

To create and configure a terminal loopback test, follow these steps:

1. From the Global Configuration mode, use the **ethernet loopback terminal** *<name>* *<slot>* command to create a terminal loopback test and enter the Carrier Ethernet Terminal Loopback Configuration mode.

The *<name>* and *<slot>* parameters specify the name of the terminal loopback test and the slot identifier for the loopback test, respectively. Use the **no** form of this command to remove the terminal loopback configuration from the AOS device. Enter the command as follows to create a terminal loopback test named **TERMINAL** on slot **0**:

```
(config)#ethernet loopback terminal TERMINAL 0
Terminal loopback "TERMINAL" created
(config-eth-lbk-term TERMINAL 0)#
```

2. Next, in the Carrier Ethernet Terminal Loopback Configuration mode, use the **set interface** *<interface>* command to specify the UNI port interface that will loop back traffic. Interfaces are specified in the *<interface type>* *<slot/port>* format. For example, for a Gigabit Ethernet interface, use **gigabit-ethernet 0/1**; for an EFM bonding group, use **efm-group 1/1**. Type **set interface** *<interface>* **?** to display a list of valid interfaces.

Traffic egressing this interface will be looped back if it matches the match criteria specified in the terminal loopback configuration. If no match criteria is specified, all traffic egressing the interface will be looped back. Use the **no** form of this command to remove the terminal loopback test from the interface.

Enter the command as follows to specify the Gigabit Ethernet **0/3** interface as the UNI port interface that will loop back traffic:

```
(config-eth-lbk-term TERMINAL 0)#set interface gigabit-ethernet 0/3
```

> **i** **NOTE**
>
> *The interface specified as the UNI port interface for the terminal loopback test should match the UNI interface specified in the EVC map (refer to Configuring an EVC Map and Associating it with the UNI on page 9).*

3. Optionally you can specify that the terminal loopback will filter traffic based on the destination MAC address. When configured, packets egressing the UNI port interface specified will be looped back if the packet's destination MAC address matches the specified MAC address. To filter traffic based on the destination MAC address, enter the **match destination mac address [system |** *<mac address>***]** command from the Carrier Ethernet Terminal Loopback Configuration mode prompt.

The **system** parameter of this command specifies that the system loopback MAC address is the destination MAC address used for filtering loopback traffic egressing the UNI port interface. This keyword can only be used if a system loopback MAC address has been specified (refer to *Configuring a System Loopback MAC Address (Optional) on page 7*). The *<mac address>* parameter specifies a valid 48-bit MAC address as the destination MAC address to use for filtering loopback traffic. MAC addresses should be expressed in the following format: **xx:xx:xx:xx:xx:xx** (for example, **00:A0:C8:00:00:01**). Use the **no** form of this command to disable this feature.

Enter the command as follows to specify that traffic egressing the UNI port interface should be filtered based on the destination MAC address **00:AO:C8:00:00:02**:

```
(config-eth-lbk-term TERMINAL 0)#match destination mac address
  00:A0:C8:00:00:02
```

4. Next, use the **match single-tag s-tag** *<vlan id>* command to filter the traffic egressing the UNI port interface based on the service provider's VLAN ID. This value should be set to the same as the S-tag specified in the EVC configuration (refer to *Configuring an EVC for Looped Traffic on page 8*). Valid *<vlan id>* range is **2** to **4094**. Packets egressing the specified UNI port interface will be looped back if the packet's S-tag matches the VLAN ID specified by the command. Use the **no** form of this command to disable this feature.

Enter the command as follows to specify that traffic egressing the UNI port interface should be looped

back if it has an S-tag value of **200**:

```
(config-eth-lbk-term TERMINAL 0)#match single-tag s-tag 200
```

> **ℹ️ NOTE**
>
> *The terminal loopback test can still be configured even if the S-tag has not been specified in an EVC. If the terminal loopback test is enabled, and the S-tag has not been defined in an EVC, a test status of "Enabled and Not Running - Interface plus S-tag Does not exist" is displayed.*

After configuring the terminal loopback test, you can enable the terminal loopback to start the loopback test.

Starting and Stopping the Terminal Loopback Test

To start the Carrier Ethernet terminal loopback, enter the **no shutdown** command from the Carrier Ethernet Terminal Loopback Configuration mode. If the configuration is valid and there are no conflicts with other loopbacks or traffic flows, the loopback will enter the running state. All traffic egressing the specified UNI port interface and filtered by the configured matching criteria will be looped back with the source and destination MAC addresses swapped.

Enter the command as follows:

```
(config-eth-lbk-term TERMINAL 0)#no shutdown
```

Once the terminal loopback test has been enabled, you can begin to capture traffic and view the status and output provided by the loopback test.

> **ℹ️ NOTE**
>
> *To view and analyze the loopback traffic to determine any network issues, traffic must be captured on the UNI interface of the local AOS device, at the administrator end of the network. If the test traffic is initiated from a traffic generator, the packet capture process is completed by the traffic generator. If a traffic generator is not being used, to view and analyze the loopback test traffic you will need to configure a packet capture on the UNI interface of the local AOS device. Refer to the* Configuring Packet Capture in AOS *configuration guide, available online at* https://supportcommunity.adtran.com*, for more information regarding packet capture configuration.*

To stop a terminal loopback test, enter the **shutdown** command from the Carrier Ethernet Terminal Loopback Configuration mode as follows:

```
(config-eth-lbk-term TERMINAL 0)#shutdown
```

5. Troubleshooting

You can use various **show** commands to aid in troubleshooting the configuration of terminal loopback tests. Troubleshooting commands, and their output, as well as status messages that identify any issues with the terminal loopback configuration are provided in the following sections.

Viewing the Status and Output of Loopback Tests

To view the status and output of various terminal loopback tests on the device, use the **show ethernet loopback terminal [slot** *<slot>* **|** *<name> <slot>***]** command from the Enable Configuration mode. If no optional parameters are specified, information for all configured terminal loopback tests is displayed. Using

the optional **slot** *<slot>* parameter specifies that only terminal loopback tests configured on the specified slot are displayed. Using the optional *<name>* *<slot>* parameters specifies that output for a single terminal loopback test is displayed.

To display information for all configured terminal loopback tests on the AOS device, enter the command as follows:

```
#show ethernet loopback terminal
```

To display information for all terminal loopback tests on slot **0**, enter the command as follows:

```
#show ethernet loopback terminal slot 0
```

To display information only for the terminal loopback test **TERMINAL** on slot **0**, enter the command as follows:

```
#show ethernet loopback terminal TERMINAL 0
```

Example Carrier Ethernet Terminal Loopback Test Output

The following example shows the status and output of the terminal loopback object **TERMINAL** on slot **0**:

```
#show ethernet loopback terminal TERMINAL 0
eth-lbk-term "TERMINAL" 0 is Enabled and Running
Matched S-tag: 200
Matched P-bit: na
Matched MAC: DA 00:A0:C8:00:00:01
System MAC: false
Interface: gigabit-ethernet 0/3
```

Carrier Ethernet Terminal Loopback Status Messages

Status messages appear on the first line of the loopback test status output (as shown above) and can provide information about the operational status of the loopback test. If the loopback test is not operating as expected, status messages can help you determine the cause. The following table shows the loopback status messages that can appear.

Table 1. Loopback Status Message

Status	Definition
Disabled	The loopback administrative state is disabled.
Duplicate Loopback	Another loopback exists with the same configuration.
Enabled and Running	The loopback is running and looping back traffic as configured.
No Interface	The loopback does not have an interface assigned.
No System MAC Address	The loopback is configured to match on the system loopback MAC address, but no system MAC address has been configured.
Out of Resources	The device cannot support this loopback due to a resource limitation; the administrative state will be forced to "disabled".
Specified Interface Not a UNI	The interface specified isn't configured as a UNI port interface.
S-tag Does Not Exist	The configured S-tag does not match any configured EVCs.
Terminal Loopback Conflict	A terminal loopback exists that is configured to loop back the same traffic.
System Management Conflict	The specified S-tag is used by the system management EVC.

6. Terminal Loopback Configuration Example

The following is sample configuration for a terminal loopback test configured in the network described in *Figure 4*. In this example, terminal loopback test is configured on the remote device's UNI interface (Gigabit Ethernet 0/3), used to verify downstream traffic conditioning between the two AOS devices. The EVC and EVC maps are configured on the local AOS device (Device A), and the terminal loopback test is configured on the remote AOS device (Device B).
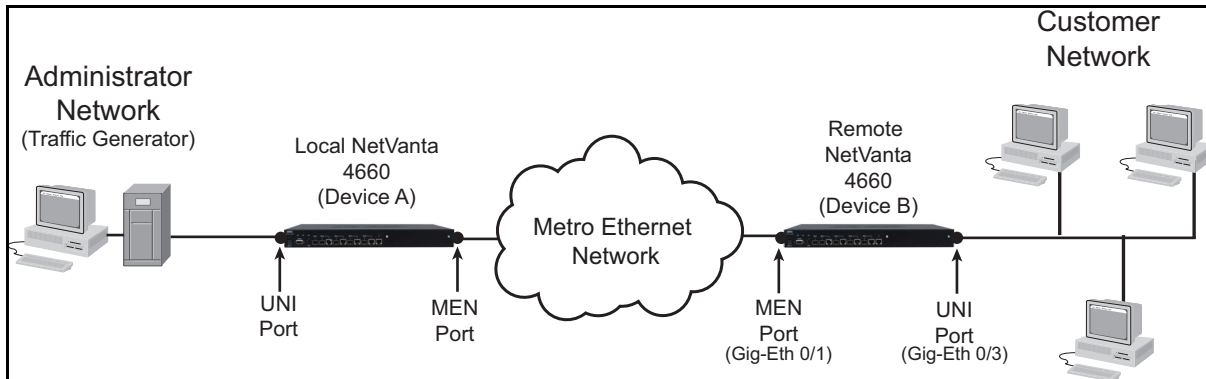

Figure 4. Terminal Loopback Test Network Topology

Device A Configuration:
```
evc EVC1
EVC "EVC1" created
  s-tag 200
  connect men-port gigabit-ethernet 0/1
  no shutdown
!
evc-map MAP1
EVC map "MAP1" created
  connect evc 200
  connect uni gigabit-ethernet 0/3
  no shutdown
!
```

Device B Configuration:

```
ethernet loopback terminal TERMINAL 0
Terminal loopback "TERMINAL" create
  set interface gigabit-ethernet 0/3
  match single-tag s-tag 200
  no shutdown
!
```

The **show ethernet loopback terminal** command can verify that the loopback test is enabled and running. If the status displayed indicates the test is not running, refer to *Table 1 on page 12* for an explanation of the status message displayed, and correct the configuration accordingly:

```
#show ethernet loopback terminal TERMINAL 0
eth-lbk-term "TERMINAL" 0 is Enabled and Running
Matched s-tag       : 200
Matched P-BIT       : na
Matched MAC DA      : na
System MAC          : false
Interface           : gigabit-ethernet 0/3
```

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