



Transparent LAN Service over Cable

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This document describes the Transparent LAN Service over Cable feature, which enhances existing Wide Area Network (WAN) support to provide more flexible Managed Access for multiple Internet service provider (ISP) support over a hybrid fiber-coaxial (HFC) cable network. This feature allows service providers to create a Layer 2 tunnel by mapping an upstream service identifier (SID) to an IEEE 802.1Q Virtual Local Area Network (VLAN).



Note

Cisco IOS Release 12.2(33)SCA integrates support for this feature on the Cisco CMTS routers. This feature is also supported in Cisco IOS Release 12.3BC, and this document contains information that references many legacy documents related to Cisco IOS 12.3BC. In general, any references to Cisco IOS Release 12.3BC also apply to Cisco IOS Release 12.2SC.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to <http://tools.cisco.com/ITDIT/CFN/>. An account on <http://www.cisco.com/> is not required.

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Prerequisites for Transparent LAN Service over Cable

The Transparent LAN Service over Cable feature has the following prerequisites:

- You must know the hardware (MAC) addresses of the cable modems that are to be mapped to IEEE 802.1Q VLANs.
- You must create a bridge group for each separate customer on the Layer 2 bridge aggregator, so that traffic from all of the Customer Premises Equipment (CPE) devices for the customer is grouped together into the same ATM or 802.1Q tunnel.

Restrictions for Transparent LAN Service over Cable

- Configuring ATM L2VPN or 802.1q for a particular cable modem removes any previous cable modem configuration on the Cisco uBR7246VXR router. For example, if TLS with 802.1q is configured on the router for a particular cable modem, and then you configure ATM L2VPN for the same cable modem, the Cisco uBR7246VXR router supports the latter and removes the former with no additional warning or system messages.
- We strongly recommend that TLS over Cable only be used when Baseline Privacy Interface (BPI) is enabled in the environment. If BPI is not enabled when using the TLS feature, traffic can flow between multiple virtual private networks (VPNs), and become vulnerable to denial-of-service attacks or snooping. We also recommend that remote networks be isolated with a gateway or firewall router when BPI is not enabled.

Commencing in Cisco IOS release 12.3(13a)BC, and later releases, when the TLS feature is used with Layer 2 VPNs, the participating cable modems *must* have the Baseline Privacy Interface security feature (BPI) enabled. Otherwise, the Cisco CMTS drops such Layer 2 traffic in the upstream or downstream.

- Packets are mapped to their Layer 2 tunnel only on the basis of Layer 2 information (the cable modem's MAC address and primary SID). Layer 3 services, such as access lists, IP address source-verify, and IP QoS, are not supported as packets are sent through the tunnel.
- All traffic from a cable modem is mapped to the same Layer 2 tunnel. It is not possible to differentiate traffic from different customer premises equipment (CPE) devices behind the cable modem.
- CPE learning is not available when using the Transparent LAN Service over Cable feature. When a cable modem is mapped to a Layer 2 tunnel, the **show interface cable modem** command shows that the IP addresses for its CPE devices are "unavailable."
- DOCSIS QoS is supported across the Layer 2 tunnel only on the primary SID. Traffic using secondary services uses the same Layer 2 tunnel as the primary SID.
- The Spanning Tree Protocol (STP) cannot be used with devices (cable modems, their CPE devices, and the endpoint CPE devices) that are using this feature. In particular, Spanning Tree Protocol cannot be used between the VLAN bridge aggregator and the endpoint customer devices.
- The following restrictions apply to Layer 2 tunnels over an ATM interface:
 - The virtual connections (VC) on the ATM interface must be configured to use ATM Adaptation Layer 5 (AAL5) IEEE 802.1a Subnetwork Access Point (SNAP) encapsulation. On Cisco routers,

this means that each PVC endpoint must be configured for the proper encapsulation using the **encapsulation aal5snap** command.

- The following restrictions apply to Layer 2 tunnels over an Ethernet IEEE 802.1Q VLAN interface:
 - IEEE 802.1Q tunnels are supported only on Ethernet, Fast Ethernet, Gigabit Ethernet and 10 Gigabit Ethernet interfaces.
 - The Cisco CMTS router supports a maximum of 4095 VLAN IDs, but the switches acting as the bridge aggregator might support a lower number of VLAN IDs. If this is the case, the Cisco CMTS should be configured only for the maximum number of VLANs that are supported by the bridge aggregator switches.

Information About Transparent LAN Service over Cable

This section contains the following:

Feature Overview

The Transparent LAN Service over Cable feature enables service providers to provide Layer 2 tunnels for traffic to and from cable modems. This allows customers to create their own virtual local area network (VLAN) using any number of cable modems in multiple sites.

On the Cisco CMTS, you map each cable modem (on the basis of its MAC address) to the appropriate VLAN. The CMTS then creates an internal database of this one-to-one mapping of cable modems to VLANs, and uses it to encapsulate packets for the appropriate VLAN.

The CMTS encapsulates the CPE traffic from mapped cable modems using the following method:

- IEEE 802.1Q Mapping—The cable modem's MAC address is mapped to an IEEE 802.1Q VLAN on a specific Ethernet interface, so that all traffic from the cable modem is tagged with the specified VLAN ID.

Traffic to and from this group of cable modems is bridged into a single logical network (the VLAN) by the bridge aggregator, creating a secure Virtual Private Network (VPN) for that particular group of cable modems. Traffic in one VLAN cannot be sent into another VLAN, unless specifically done so by an external router.

The switch acting as the Layer 2 Bridge Aggregator uses the VLAN tagging to forward the traffic to the appropriate destination. This frees up service providers from needing to know the addressing, routing, and topological details of the customer's network.

Transparent LAN Service and Layer 2 Virtual Private Networks

In addition, service providers can provide a Layer 2 VPN with only minimal configuration changes on the provider's routers. The service subscriber does not need to make any changes to their private network or cable modems, nor does the service provider have to provide any special DOCSIS configuration files to enable this feature.

Cisco IOS Release 12.3(13a)BC introduces the following changes or requirements for the TLS feature with Layer 2 VPNs:

- When the TLS feature is used with Layer 2 VPNs, the participating cable modems must have the Baseline Privacy Interface security feature (BPI) enabled. Otherwise, the Cisco CMTS drops such Layer 2 traffic in the upstream or downstream.
- Information about Customer Premises Equipment (CPE) does not display in the output of the **show cable modem** command.

IEEE 802.1Q Mapping

This section describes the mapping of cable modems to an IEEE 802.1Q VLAN, as it is available in the Transparent LAN Service over Cable feature:

Overview

The Transparent LAN Service over Cable feature enables service providers to provide Layer 2 tunnels over an Ethernet network, using IEEE 802.1Q standard tags. This allows customers to create their own virtual network using any number of cable modems in different sites.

On the Cisco CMTS, you map each cable modem (on the basis of its MAC address) to the appropriate VLAN. The CMTS then creates an internal database of this one-to-one mapping of cable modems to VLANs, and uses it to encapsulate packets for the appropriate VLAN.

The CMTS encapsulates the CPE traffic from mapped cable modems using VLAN tags, as defined in [IEEE 802.1Q-1993, IEEE Standards for Local and Metropolitan Area Networks: Virtual Bridged Local Area Networks](#). The switch acting as the Layer 2 Bridge Aggregator uses the VLAN tagging to forward the packets to the appropriate destination.

Traffic to and from this group of cable modems is bridged into a single logical network by the bridge aggregator, creating a secure Virtual Private Network (VPN) for that particular group of cable modems. Traffic in one VLAN cannot be sent into another VLAN, unless specifically done so by an external router.

Details of IEEE 802.1Q Mapping

To implement the Transparent LAN Service over Cable feature using IEEE 802.1Q VLANs, a service provider must perform the following configuration steps:

- 1 Identify the cable modems and their MAC addresses that should be mapped to the IEEE 802.1Q VLANs.
- 2 Create the required VLANs on the router that is acting as the bridge aggregator.
- 3 Enable Layer 2 mapping on the Cisco CMTS, and then map each cable modem on that Cisco CMTS to the appropriate VLAN.

After the Transparent LAN Service over Cable feature has been enabled and configured to use IEEE 802.1Q mappings, the Cisco CMTS immediately begins mapping traffic between the associated cable modems and VLANs. For efficient mapping, the Cisco CMTS maintains an internal database that links each cable modem's primary service flow ID (SFID) and service ID (SID) to the appropriate VLAN and Ethernet interface. This ensures that all service flows from the cable modem are routed properly.

When the Cisco CMTS receives a packet on an upstream, it looks up its SID to see if it is mapped to a VLAN. If so, and if the packet's source MAC address is not the cable modem's MAC address, the Cisco CMTS inserts the appropriate IEEE 802.1Q VLAN tag into the packet's header and forwards the packet to the appropriate Ethernet interface. If the packet is not being mapped, or if the packet originated from the cable modem, the Cisco CMTS routes the packet using the normal Layer 3 processes.

When the Cisco CMTS receives a packet from a WAN interface that is encapsulated with an IEEE 802.1Q VLAN tag, it looks up the packet's SID to see if it belongs to a cable modem being mapped. If so, the Cisco CMTS strips off the VLAN tag, adds the proper DOCSIS header, and transmits the packet on the appropriate downstream interface. If the packet is not being mapped, the Cisco CMTS continues with the normal Layer 3 processing.

Benefits

The Transparent LAN Service over Cable feature provides the following benefits to cable service providers and their partners and customers:

- Provides Layer 2 level mapping, which is transparent to Layer 3 protocols and services. This means that service providers do not need to know the details of their customers' network topologies, routing protocols, or IP addressing.
- Allows service providers to maximize the use of their existing ATM or Ethernet WAN networks. Multiple customers can be combined on the same outgoing interface, while still ensuring that each customer's network is kept private while it is transmitted over the tunnel.
- Provides a highly flexible and scalable solution for multiple customers. The service provider needs to create only one bridge group for each VPN, and then only one VLAN mapping for each cable modem should participate in that VPN tunnel.
- Customers retain full control over their private networks, while service providers retain full control over cable modems and the rest of the cable and ATM networks. Only the CPE traffic from the cable modems is mapped into the ATM tunnel, while traffic originating at the cable modem continues to be processed as normal by the service provider's network.
- Allows service providers to mix tunneled and non-tunneled cable modems on the same DOCSIS cable network.
- Allows customers to create a single, secure virtual network with Ethernet Layer 2 connectivity for multiple sites.
- Allows multiple tunnels from different customers and endpoints to be aggregated into a single bridge, so as to maximize the use of bandwidth and other network resources.
- Supports the tunneling of multiple Layer 3, non-IP protocols, and not just IP Layer 3 services, as is the case with Layer 3 solutions, such as Multiprotocol Label Switching (MPLS) VPNs.
- All DOCSIS services, including BPI+ encryption and authentication, continue to be supported for all cable modems.

How to Configure the Transparent LAN Service over Cable

This section contains the following:

Configuring IEEE 802.1Q VLAN Mapping

This section describes how to enable Layer 2 mapping on the Cisco CMTS, and then to map particular cable modems to an IEEE 802.1Q VLAN.

Enabling and Configuring Layer 2 Tunneling for IEEE 802.1Q Mapping

This section describes how to enable Layer 2 mapping on the Cisco CMTS, and then to map particular cable modems to IEEE 802.1Q VLANs on an Ethernet, Fast Ethernet, or Gigabit Ethernet interface.

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	cable l2-vpn-service dot1q or cable l2-vpn-service xconnect nsi dot1q Example: Router(config)# cable l2-vpn-service dot1q or Example: Router(config)# cable l2-vpn-service xconnect nsi dot1q	Note Use cable l2-vpn-service xconnect nsi dot1q command at this step, for Cisco IOS Release 12.2(33)SCC and later. Use cable l2-vpn-service dot1q command, for Cisco IOS Releases 12.2(33)SCA and 12.2(33)SCB. Enables Layer 2 tunneling for IEEE 802.1Q VLAN mapping. Note It is not required to configure VLAN trunking on the Cisco CMTS. Though VLAN trunking is supported, be aware of additional impact of VLAN trunking on the Cisco CMTS.
Step 4	cable dot1q-vc-map mac-address ethernet-interface vlan-id [cust-name] Example: Router(config)# cable dot1q-vc-map 0000.0C04.0506 FastEthernet0/0 10	Maps the specified MAC address of a cable modem to the indicated VLAN and Ethernet, Fast Ethernet, or Gigabit Ethernet interface. Note Repeat this command for each cable modem that is to be mapped to an IEEE 802.1Q VLAN.
Step 5	end Example: Router(config)# end	Exits global configuration mode and returns to privileged EXEC mode.

Creating the IEEE 802.1Q VLAN Bridge Group

This section describes the minimum configuration needed to configure a Cisco router, which is acting as an IEEE 802.1Q VLAN bridge aggregator, so that it can terminate the VLANs being used with the Transparent LAN Service over Cable feature.

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: <pre>Router> enable</pre>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: <pre>Router# configure terminal</pre> Example:	Enters global configuration mode.
Step 3	interface [Ethernet FastEthernet GigabitEthernet TenGigabitEthernet] x/0 Example: <pre>Router(config)# interface fastethernet 1/0</pre> Example: <pre>Router(config-if)#</pre>	Enters interface configuration mode for the Ethernet interface that is in slot <i>x</i> .
Step 4	ip address <i>ip-address mask</i> Example: <pre>Router(config-if)# ip address 10.10.10.85 255.255.255.0</pre>	Configures the interface with the specified IP address and subnet mask.
Step 5	interface [Ethernet FastEthernet GigabitEthernet TenGigabitEthernet] x/0.y Example: <pre>Router(config)# interface fastethernet 1/0.10</pre> Example: <pre>Router(config-if)#</pre>	<p>Creates a subinterface on the Ethernet interface that is in slot <i>x</i>. The valid range for <i>y</i> is 1 to 4294967293, with no default.</p> <p>Note Note 1: To simplify network management, set the subinterface number to the same value as the VLAN ID that will use this subinterface (which in this case is 10). The valid range for the subinterface number is 1 to 4095. Note 2: The steps to create a subinterface is not essential for dot1q tagging of frames but it is recommended.</p>
Step 6	bridge group <i>number</i>	Configures this subinterface to belong to the specified bridge group.

	Command or Action	Purpose
	Example: Router(config-if)# bridge group 20	The valid range for number is 1 to 255, with no default. Note Repeat steps Step 5 through Step 7 for each subinterface to be created and bridged.
Step 7	end Example: Router(config-if)# end	Exits interface configuration mode and returns to privileged EXEC mode.

Configuration Examples for Transparent LAN Service over Cable

This section lists sample configurations for the Transparent LAN Service over Cable feature on a CMTS router and on a Cisco router acting as an ATM bridge aggregator:

Example: Configuring IEEE 802.1Q VLAN Mapping

The following partial configuration for a Cisco uBR7246VXR router shows a typical configuration that shows a number of cable modems being mapped to two different IEEE 802.1Q VLANs.

```

cable l2-vpn-service dot1q
! Customer 1
cable dot1q-vc-map 000C.0e03.69f9 GigabitEthernet 1/0 10 Customer1
cable dot1q-vc-map 0010.7bea.9c95 GigabitEthernet 1/0 11 Customer1
cable dot1q-vc-map 0010.7bed.81c2 GigabitEthernet 1/0 12 Customer1
cable dot1q-vc-map 0010.7bed.9b1a GigabitEthernet 1/0 13 Customer1
! Customer 2
cable dot1q-vc-map 0002.fdfa.137d GigabitEthernet 1/0 20 Customer2
cable dot1q-vc-map 0006.28f9.9d19 GigabitEthernet 1/0 21 Customer2
cable dot1q-vc-map 000C.7b6b.58c1 GigabitEthernet 1/0 22 Customer2
cable dot1q-vc-map 000C.7bed.9dbb GigabitEthernet 1/0 23 Customer2
cable dot1q-vc-map 000C.7b43.aa7f GigabitEthernet 1/0 24 Customer2
cable dot1q-vc-map 0050.7302.3d83 GigabitEthernet 1/0 25 Customer2
...

```

Example: Configuring IEEE 802.1Q Bridge Aggregator

The following example shows a router being used as a bridge aggregator to transmit VLANs across the same Fast Ethernet interface, using IEEE 802.1Q tagging.

```

!
interface GigabitEthernet0/1
ip address 10.10.10.31 255.255.255.0
duplex full
speed auto
!
interface GigabitEthernet0/1.10
description Customer1-site10
encapsulation dot1Q 10
bridge-group 200

```



```

interface GigabitEthernet0/1.11
  description Customer1-site11
  encapsulation dot1Q 11
  bridge-group 200
interface GigabitEthernet0/1.12
  description Customer1-site12
  encapsulation dot1Q 12
  bridge-group 200
interface GigabitEthernet0/1.13
  description Customer1-site13
  encapsulation dot1Q 13
  bridge-group 200
!-----
interface GigabitEthernet0/1.20
  description Customer2-site20
  encapsulation dot1Q 20
  bridge-group 201
interface GigabitEthernet0/1.21
  description Customer2-site21
  encapsulation dot1Q 21
  bridge-group 201
interface GigabitEthernet0/1.22
  description Customer2-site22
  encapsulation dot1Q 22
  bridge-group 201
interface GigabitEthernet0/1.23
  description Customer2-site23
  encapsulation dot1Q 23
  bridge-group 201
interface GigabitEthernet0/1.24
  description Customer2-site24
  encapsulation dot1Q 24
  bridge-group 201
interface GigabitEthernet0/1.25
  description Customer2-site25
  encapsulation dot1Q 25
  bridge-group 201
!
bridge 200 protocol ieee
bridge 201 protocol ieee
...

```

Additional References

Related Documents

Related Topic	Document Title
ATM Interface Configuration	Configuring ATM in the <i>Cisco IOS Wide-Area Networking Configuration Guide</i> , Release 12.2, at the following URL: http://www.cisco.com/en/US/docs/ios/12_2/wan/configuration/guide/fwan_c.html
ATM Interface Configuration	Configuring ATM in the <i>Cisco IOS Wide-Area Networking Configuration Guide</i> , Release 12.2, at the following URL: http://www.cisco.com/en/US/docs/ios/12_2/wan/configuration/guide/fwan_c.html

Related Topic	Document Title
ATM Interface Command Reference	ATM Commands in the <i>Cisco IOS Wide-Area Networking Command Reference</i> , Release 12.2, at the following URL: http://www.cisco.com/en/US/docs/ios/12_2/wan/command/reference/fwan_r.html
Virtual LAN Configuration	Virtual LANS in the <i>Cisco IOS Switching Services Configuration Guide</i> , Release 12.2, at the following URL: http://www.cisco.com/en/US/docs/ios/12_2/switch/configuration/guide/fswtch_c.html
Virtual LAN Command Reference	<i>Cisco IOS Switching Services Command Reference</i> , Release 12.2, at the following URL: http://www.cisco.com/en/US/docs/ios/12_2/switch/command/reference/fswtch_r.html
Cisco IOS Release 12.2 Command Reference	Cisco IOS Release 12.2 Configuration Guides and Command References, at the following URL: http://www.cisco.com/en/US/products/sw/iosswrel/ps1835/products_installation_and_configuration_guides_list.html http://www.cisco.com/en/US/products/sw/iosswrel/ps1835/prod_command_reference_list.html

Standards

Standards	Title
SP-RFIV1.1-108-020301	Data-over-Cable Service Interface Specifications Radio Frequency Interface Specification
IEEE 802.1Q, 1998 Edition	IEEE Standards for Local and Metropolitan Area Networks: Virtual Bridged Local Area Networks

RFCs

RFCs ¹	Title
RFC 1163	A Border Gateway Protocol
RFC 1164	Application of the Border Gateway Protocol in the Internet
RFC 1483	Multiprotocol Encapsulation over ATM Adaptation Layer 5 (AAL5)

RFCs ¹	Title
RFC 2233	DOCSIS OSSI Objects Support
RFC 2283	Multiprotocol Extensions for BGP-4
RFC 2665	DOCSIS Ethernet MIB Objects Support
RFC 2669	Cable Device MIB

¹ Not all supported RFCs are listed.

Technical Assistance

Description	Link
Technical Assistance Center (TAC) home page, containing 30,000 pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for Transparent LAN Service over Cable

Use Cisco Feature Navigator to find information about platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to <http://tools.cisco.com/ITDIT/CFN/>. An account on <http://www.cisco.com/> is not required.



Note

The below table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 1: Feature Information for Transparent LAN Service over Cable

Feature Name	Releases	Feature Information
Transparent LAN Service over Cable	Release 12.2(11)BC3	<p>This feature was introduced for Cisco uBR7100 series and Cisco uBR7246VXR universal broadband routers to support Layer 2 encapsulation over ATM networks.</p> <p>The following sections provide information about this feature:</p> <p>The following commands were introduced or modified:</p> <ul style="list-style-type: none"> • cable dot1q-vc-map • cable l2-vpn-service atm-vc • cable l2-vpn-service dot1q • cable vc-map • debug cable l2-vpn • show cable l2-vpn vc-map
IEEE 802.1Q Virtual Local Area Network	Release 12.2(15)BC2	<p>Support was added for IEEE 802.1Q Virtual Local Area Network (VLAN) tagging on the Cisco uBR7246VXR universal broadband router. Support was also added for identifying mappings with a customer name.</p> <p>The following commands were introduced or modified:</p> <ul style="list-style-type: none"> • show cable l2-vpn dot1q-vc-map
Transparent LAN Services	Release 12.3(9a)BC	<p>Support was added for Transparent LAN Services (TLS) for the following Cisco CMTS platforms:</p> <ul style="list-style-type: none"> • IEEE 802.1Q on the Cisco uBR10012 router with Cisco uBR10012 PRE2 performance routing engine modules • ATM on the Cisco uBR7246VXR router