

## CISCO ONS 15302 AND ONS 15305 ETHERNET OVER SDH CONNECTION SERVICES

*A simple solution to efficiently connect geographically dispersed local-area Networks (LAN) by leveraging existing SDH infrastructure.*

### EXECUTIVE SUMMARY

The Cisco® ONS 15302 and Cisco ONS 15305 multiservice customer access platforms enable transport of Ethernet and time-division multiplexing (TDM) traffic over optical networks. The simple approach to integrate Layer 2 Ethernet intelligence with embedded optical transport technology allows cost-effective delivery of advanced Ethernet connection services using an existing SDH infrastructure. Together with the Cisco ONS 15454 platform, the Cisco ONS 15302 and Cisco ONS 15305 platforms provide an end-to-end solution for multiservice transport over SDH networks.

### CHALLENGE

Telecom access networks were originally built to deliver voice services. As demand for data communications has grown, service providers have been required to adapt their infrastructures to meet changing customer needs. Hence, Ethernet communication services often require an adjustment of interfaces and protocols at the user site to adapt to a service provider's TDM-only user-to-network interface (UNI). For example, businesses might be required to use a router with E1 or DS3/E3 interfaces to interconnect their 10/100-Mbps Ethernet LAN to a 2-, 34-, or 45-Mbps leased line. This way, enterprise users adjust their data traffic to the service provider's network. Although these services allow telecom companies to extend the usefulness of TDM networks, it exposes them to competition from service providers that build new data-optimized networks and are therefore able to offer more flexible services and at more competitive prices.

### SOLUTION

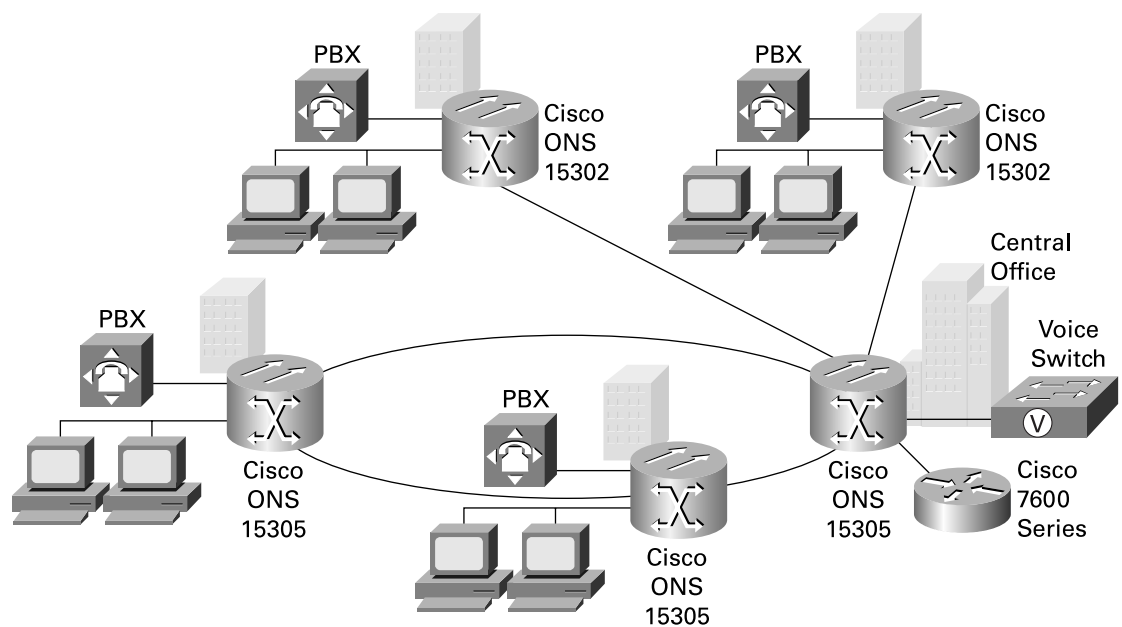
Cisco Systems® has designed the Cisco ONS 15302 and Cisco ONS 15305 multiservice access platforms to transport Ethernet and TDM traffic inside an SDH frame for metropolitan-area network (MAN or metro) applications (Figure 1). The Cisco ONS 15302 platform can be used as a customer-located terminal device to deliver voice and data traffic for switched services, Internet access, and private networks. The Cisco ONS 15305 can be used as a central office aggregator, consolidating STM-1 access links from Cisco ONS 15302 systems as well as from directly connected customer TDM or data traffic. The Cisco ONS 15305 can also be deployed at a medium- or large-sized customer location—collecting voice and data traffic from each site for switched services, interoffice connections, and Internet

access—for transport over an STM-1, STM-4, or STM-16 SDH uplink to the central office. The Cisco ONS 15305 can be used as an add-drop multiplexer in ring topologies as well as a terminal device in a point-to-point connection.

The Cisco ONS 15302 and Cisco ONS 15305 are each able to serve as a multiservice UNI between enterprise customers' Ethernet LANs and service providers' SDH infrastructures. Different from traditional methods of providing data services over transport networks, the Cisco ONS 15302 and Cisco ONS 15305 allow users to connect to service provider networks with native LAN interfaces. Furthermore, data transport over the SDH backbone can be in 2-Mbps increments up to line rate, as opposed to the rigid speeds of E1, E3, and DS-3 circuits.

**Figure 1**

Cisco ONS 15302 and Cisco ONS 15305 Multiservice over an SDH Access Network



The Cisco ONS 15302 economically delivers E1 and Ethernet services to small and medium-sized customers.

The Cisco ONS 15305 aggregates multiservice traffic from other edge devices and delivers higher-bandwidth services to large customers or in multitenant buildings.

### **BUSINESS BENEFITS**

As data communication becomes increasingly important for businesses and new technologies such as voice and video over IP become more prevalent, telecommunications service providers are seeing an increase in demand for services that allow ubiquitous Ethernet LAN to be connected between geographically dispersed locations. With the advent of new data-optimized carrier networks that offer LAN connections at native speeds—and competitive prices—it is no longer an option for incumbents to limit their services to the rigid hierarchy determined by the embedded SDH infrastructure.

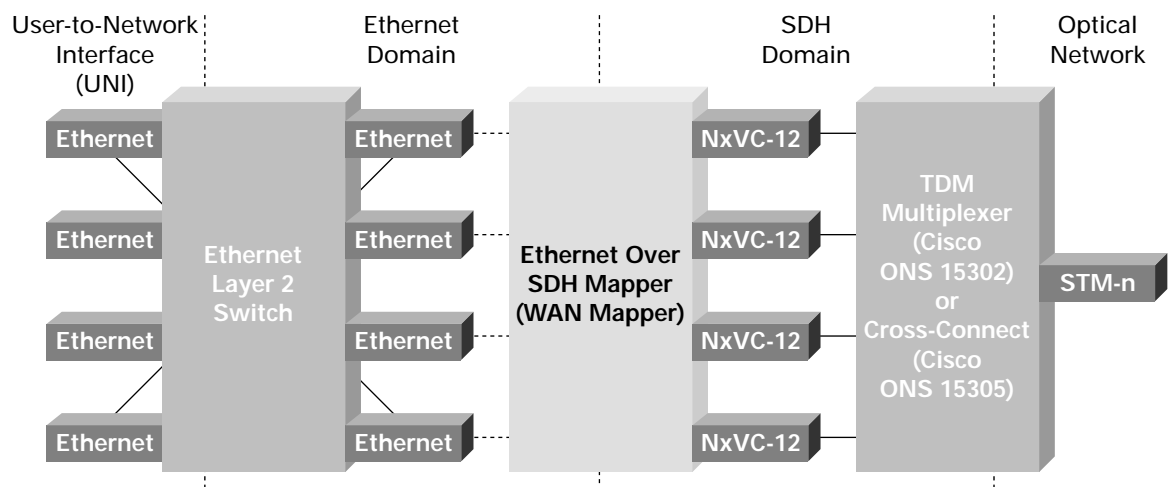
The transport of Ethernet packets over SDH networks with the Cisco ONS 15302 and Cisco ONS 15305 extends the benefits of the prevalent metropolitan and regional optical transport infrastructure to the ubiquitous Ethernet networks at customer locations. This enables a wide variety of revenue-enhancing services that improve data communications by increasing throughput, reliability, and flexibility. Multiservice access networks can also reduce costs. No longer are separate networks needed for traditional voice and data traffic. This consolidation eliminates duplicate operations, administration, maintenance, and provisioning costs in the service provider infrastructure. The Cisco ONS 15302 and Cisco ONS 15305 enable carriers to use their existing SDH infrastructures efficiently to transport Ethernet traffic, provide valuable services, and remain competitive against service providers with newer networks.

## ARCHITECTURE

### Ethernet over SDH Process Flow

Figure 2

Cisco ONS 15302 and Cisco ONS 15305 Ethernet over SDH Process Flow



One of the primary features of Cisco ONS 15302 and Cisco ONS 15305 products is their ability to map Ethernet traffic onto the SDH frame so it can be integrated with TDM traffic over an optical uplink. Figure 2 describes at a high level the process an Ethernet packet is submitted to from the moment it enters the system through an IEEE 802.3 10/100BASE-T or Gigabit Ethernet interface until it exits encapsulated in the SDH frame.

### User-to-Network Interface

The Cisco ONS 15302 has a fixed configuration with four Ethernet ports that can be configured for 10BASE-T, 100BASE-T, or auto-negotiation of the line speed. These interfaces provide Ethernet connection to the Cisco ONS 15302 from a hub, switch, or router. In the Cisco ONS 15305, this connection is through an 8-port 10/100BASE-T or a 2-port Gigabit Ethernet service module. These modules may be optionally inserted in any of four service slots.

## Ethernet Domain

On both systems, Ethernet traffic from the UNI is connected to a Layer 2 switch that supports the following features:

- MAC switching
- Self-learning MAC addresses
- Static MAC entries
- Up to 24,000 MAC addresses
- Automatic aging for MAC addresses
- MAC multicast
- Transparent bridging
- Full IEEE 802.1Q virtual LAN (VLAN) tagging compliance
- VLAN by port and VLAN by port and protocol
- Head of line blocking prevention
- Back pressure and flow-control handling
- Internet Group Management Protocol (IGMP) support
- Spanning Tree Protocol according to IEEE 802.1D
- Mirroring port
- IEEE 802.1p priorities
- IEEE 802.3ad link aggregation

The switched traffic is then forwarded to WAN SDH mappers (also known as WAN mappers) that encapsulate Ethernet traffic into ITU-T G.707-compliant VC-12 virtual containers.

## SDH Domain

The Cisco ONS 15302 has four WAN mappers connected to the Layer 2 switch. A port on the Layer 2 switch that connects to a WAN mapper is called a WAN port. Each WAN mapper can be independently configured to support “N” VC-12 virtual containers carrying an Ethernet payload, where “N” can be any number from 1 to 50. Similarly, the Cisco ONS 15305 can have 8 or 16 WAN mappers, also independently configurable to support up to 50xVC-12 virtual containers. The WAN mappers also connect to a TDM resource that integrates the virtual containers onto the SDH frame. The Cisco ONS 15302 has a TDM multiplexer that maps the TDM and Ethernet VC-12 containers onto an STM-1 uplink. The Cisco ONS 15305 has a 64 x 64 STM-1, fully non-blocking VC-12/VC-3/VC-4 Digital Cross-Connect (DXC) to switch the VC-12 encapsulated Ethernet traffic together with other virtual containers onto STM-1, STM-4, or STM-16 uplinks.

## Optical Network

For connection to the optical fiber network, the Cisco ONS 15302 has a fixed configuration of either one or two ITU-T G.957-compliant S1.1 interfaces. The Cisco ONS 15305 provides optional service modules that support the following ITU-T G.957-compliant interfaces:

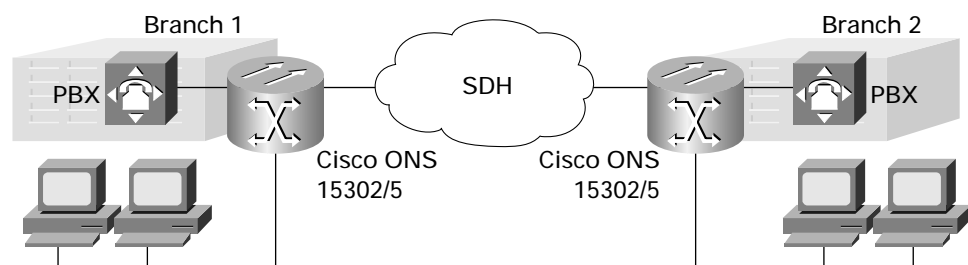
- S1.1
- S4.1
- L4.2
- S16.1
- L16.2

### Ethernet over SDH Connection Services

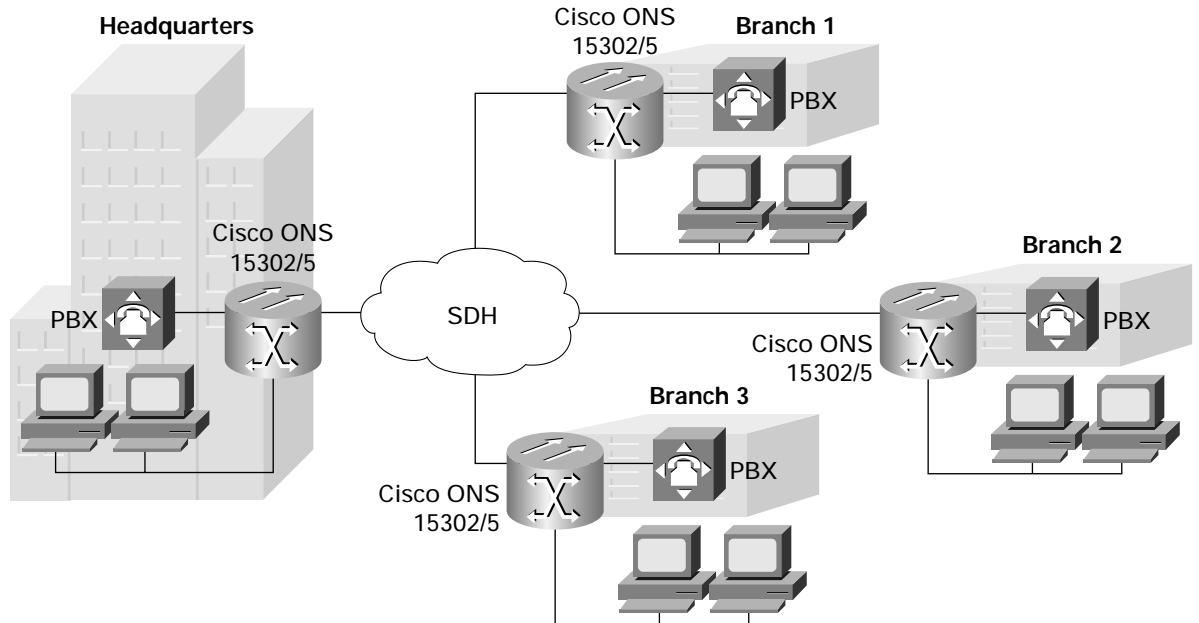
Ethernet over SDH connection services allow for point-to-point or point-to-multipoint Ethernet circuits between customer sites over the service provider network. This service is typically required when multiple customer sites are sufficiently distant from each other that the service provider network is the preferred medium to connect separate Ethernet LANs. Some examples of customers that require Ethernet over SDH connection services are businesses that need to connect headquarters with remote branches, retail chains, government offices, geographically distributed industrial plants, and university campuses.

To enable Ethernet over SDH connection services, the user's customer premises equipment (CPE) is connected to one of the LAN ports of the Cisco ONS 15302 or Cisco ONS 15305, which act as the UNI on one side and connect to the service provider SDH network on the other side. IEEE 802.1q trunks as well as VLAN-unaware traffic may be transported over the optical network. The Cisco ONS 15302 and Cisco ONS 15305 today support point-to-point Ethernet over SDH connections (Figure 3) and point-to-multipoint connections (Figure 4).

**Figure 3**  
Point-to-Point Ethernet Connection Services Between Two Corporate Branches



**Figure 4**  
Point-to-Multipoint Ethernet Connection Services Between Corporate Headquarters and Remote Office Branches

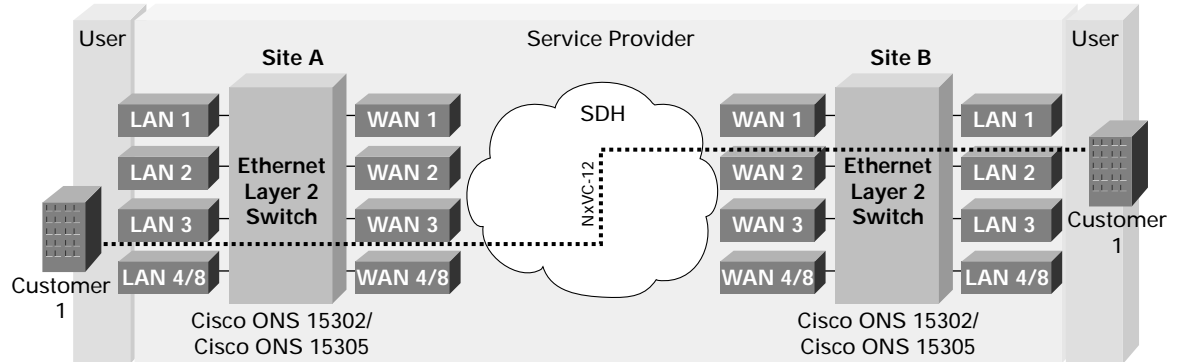


Bandwidth to transport Ethernet over the SDH network can be assigned in 2-Mbps increments by mapping Ethernet packets into NxVC-12 virtual containers where “N” can be any number from 1 through 50. The Cisco ONS 15305 also supports Gigabit Ethernet transport over SDH. Using 802.3ad link aggregation, the 50xVC-12 bandwidth capacity of up to eight WAN mappers can be combined to support Gigabit Ethernet connection services. Note that the Layer 2 switch will read destination MAC addresses and use forwarding tables to filter local traffic and optimize the use of SDH network bandwidth. Additionally, the Cisco ONS 15302 and Cisco ONS 15305 support flow control to manage burst traffic that might temporarily overflow an undersubscribed NxVC-12 SDH path.

#### Point-to-Point Connection Services

The simplest topology for Ethernet connection services is connecting only two sites. As Figure 5 illustrates, a Cisco ONS 15302 or Cisco ONS 15305 is located at Site A and collects Ethernet traffic through LAN Port 3. A single WAN mapper connected to WAN Port 3 is used in this case to encapsulate and de-encapsulate Ethernet packets that come from LAN Port 3 and Site B, respectively. An NxVC-12 SDH path is created to connect Sites A and B through the service provider network. At Site B the WAN mapper connected to WAN Port 2 de-encapsulates and encapsulates Ethernet traffic coming from Site A and LAN Port 2, respectively.

**Figure 5**  
Point-to-Point Ethernet Connection Services

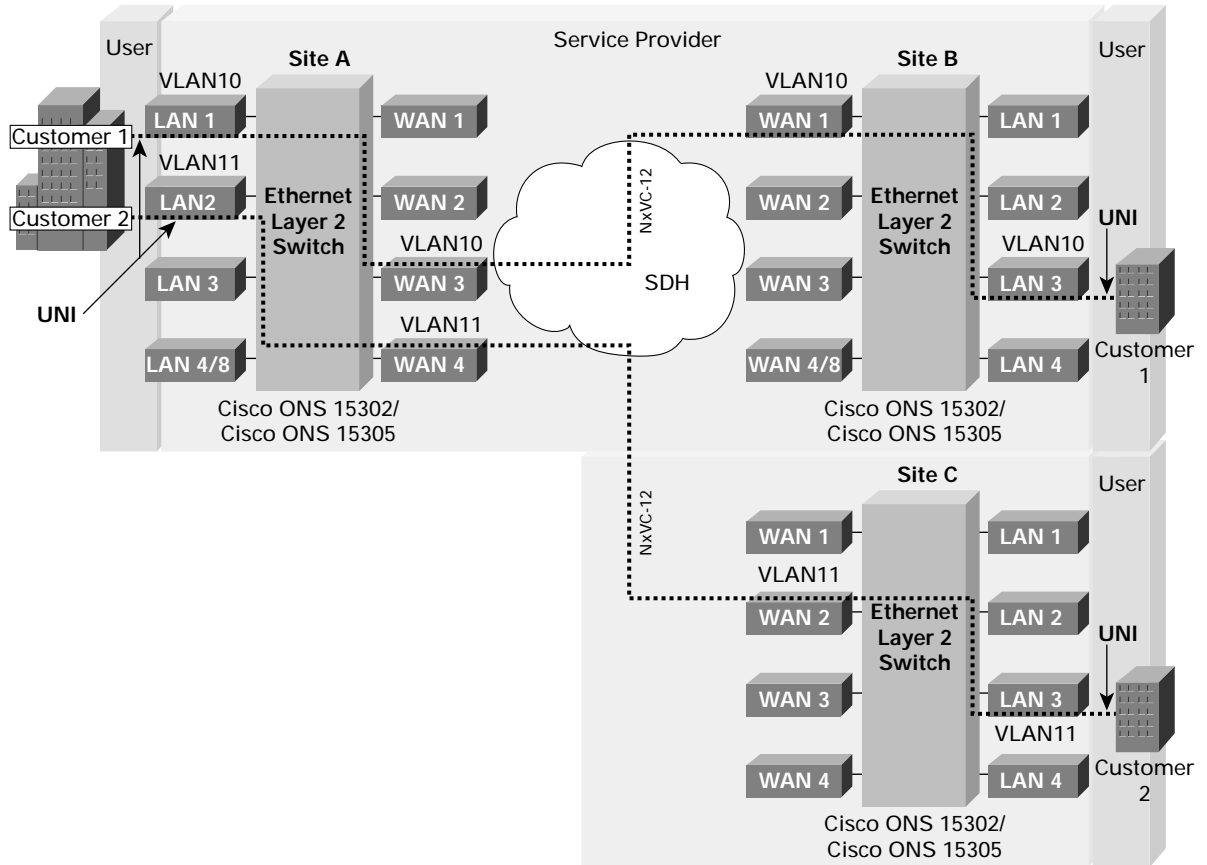


A single Cisco ONS 15302 or Cisco ONS 15305 may be used to collect traffic from multiple Ethernet LAN and provide connection services to more than one customer at a single location. The Layer 2 switch inside the Cisco ONS 15302 or Cisco ONS 15305 can create IEEE 802.1q VLAN to separate traffic from multiple customers. By defining LAN and WAN ports as members of a VLAN, virtual networks are created inside the switch and specific customer traffic is directed toward a desired SDH path. Note that the traffic entering the LAN port may be VLAN-unaware; it need not be a VLAN trunk. Ethernet connection services for VLAN trunks are explained later in this document.

In the example in Figure 6, two different customers are interfacing with the service provider network in Site A. Each customer uses a different LAN port on the Cisco ONS 15302 or Cisco ONS 15305 as a UNI. VLAN10 is set up for Customer 1, and LAN Port 1 and WAN Port 3 at Site A are members of VLAN10. The WAN mapper on WAN Port 3 is configured for an NxVC-12 SDH path to the WAN mapper on WAN Port 1 of the device at Site B. LAN Port 3 is the UNI for Customer 1 at Site B, and both LAN Port 3 and WAN Port 1 are members of VLAN10 at Site B.

Similarly, a service is provided to connect the Ethernet LAN of Customer 2 between Sites A and C. VLAN11 is set up for Customer 2, and LAN Port 2 and WAN Port 4 of the Cisco ONS 15302 or Cisco ONS 15305 in Site A are members of VLAN11. The WAN mapper on WAN Port 4 is configured for an NxVC-12 SDH path to the WAN mapper on WAN Port 2 of the device at Site C. LAN Port 3 is the UNI for Customer 2 at Site C, and both LAN Port 3 and WAN Port 2 are members of VLAN11 at Site C.

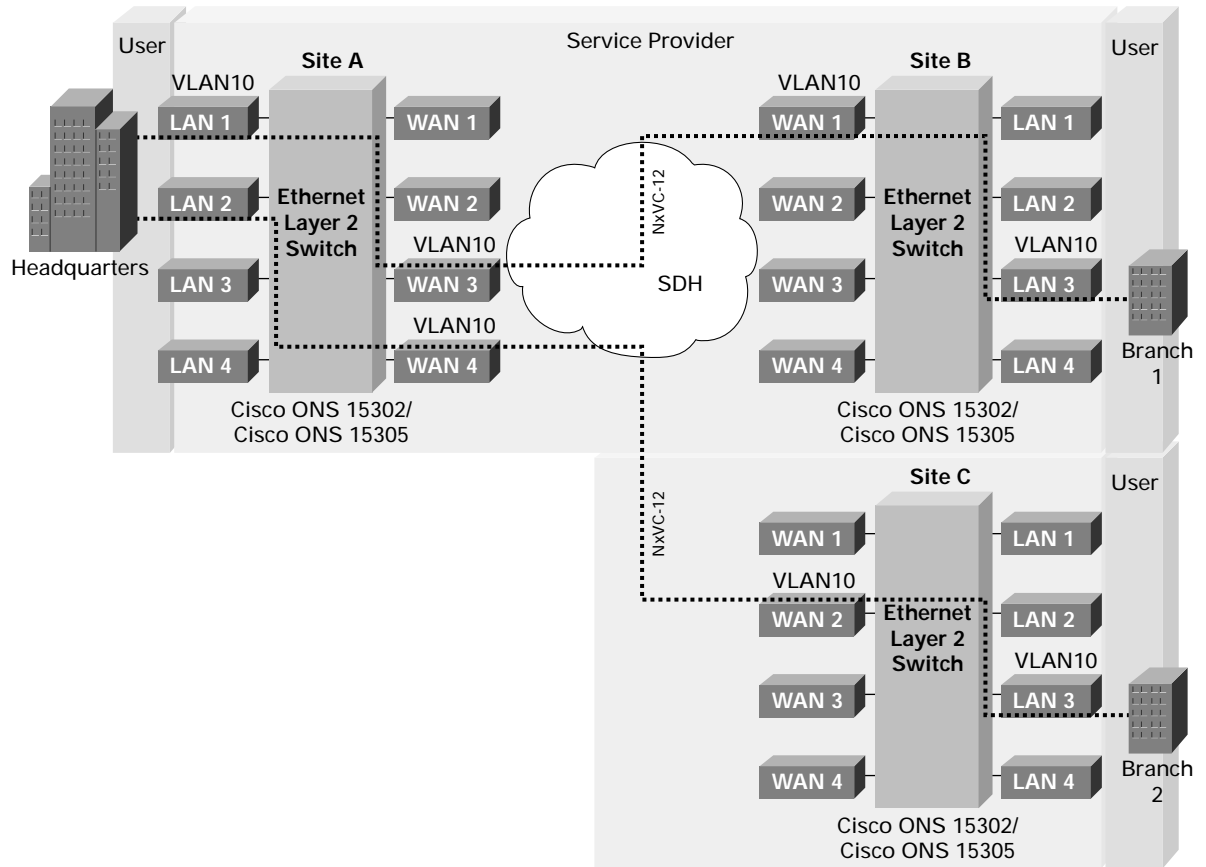
**Figure 6**  
 Access to Multiple Ethernet Connection Services from a Single Cisco ONS 15302 or Cisco ONS 15305



### Point-to-Multipoint Connection Services

Point-to-multipoint Ethernet connection services are enabled by using multiple SDH paths to transport traffic from a single LAN port. As the example in Figure 7 shows, LAN Port 1, WAN Port 3, and WAN Port 4 are all members of the same VLAN10. Depending on the destination MAC address of each packet, the Layer 2 switch will direct traffic collected at the UNI (LAN port 1) to WAN Port 3, WAN Port 4, or back to LAN Port 1. An NxVC-12 SDH path over the service provider network connects WAN Port 3 in Site A to WAN Port 1 in Site B. Similarly, a different SDH path connects WAN Port 4 in Site A with WAN Port 2 in Site C. At Site B, WAN Port 1 and LAN Port 3 are both members of VLAN10, thus, all traffic from WAN Port 1 will be directed to LAN Port 3. Similarly, at Site C, WAN Port 2 and LAN Port 3 are both members of VLAN10, thus, all traffic from WAN Port 2 will be directed to LAN Port 3 at Site C.

**Figure 7**  
Point-to-Multipoint Ethernet Connection Services



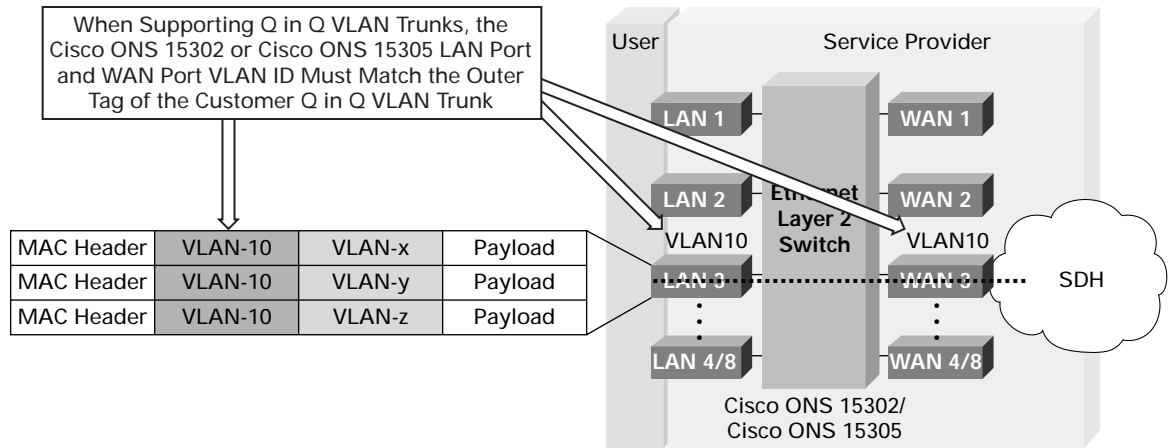
Note that a third NxVC-12 SDH path could be created between the Cisco ONS 15302 or Cisco ONS 15305 in Sites B and C. This would allow faster, more efficient communication of traffic between Branch 1 and Branch 2 and would avoid unnecessarily using up capacity between these sites and headquarters. The Cisco ONS 15302 and Cisco ONS 15305 also support 802.1D Spanning Tree Protocol to support redundant paths without creating loops in the network.

### Ethernet Connection Services for VLAN Trunks

The Cisco ONS 15302 and Cisco ONS 15305 also support Ethernet connection services for IEEE 802.1q VLAN trunks. If the VLAN trunk comes from a Layer 2 switch that supports Q in Q, the Cisco ONS 15302 or Cisco ONS 15305 will read only the outer tag. Hence, the VLAN ID of the LAN and WAN ports of the Cisco ONS 15302 or Cisco ONS 15305 must match the outer tag of the customer Q in Q VLAN trunk because only frames with this VLAN ID will be forwarded. Additionally, tagging must be enabled on the LAN and WAN ports because otherwise tagged frames on the ingress will be discarded. In Figure 8, for example, LAN Port 3 is the UNI for a Q in Q VLAN trunk with an outer tag "10". The Cisco ONS 15302 or Cisco ONS 15305 are configured so that LAN Port 3 and

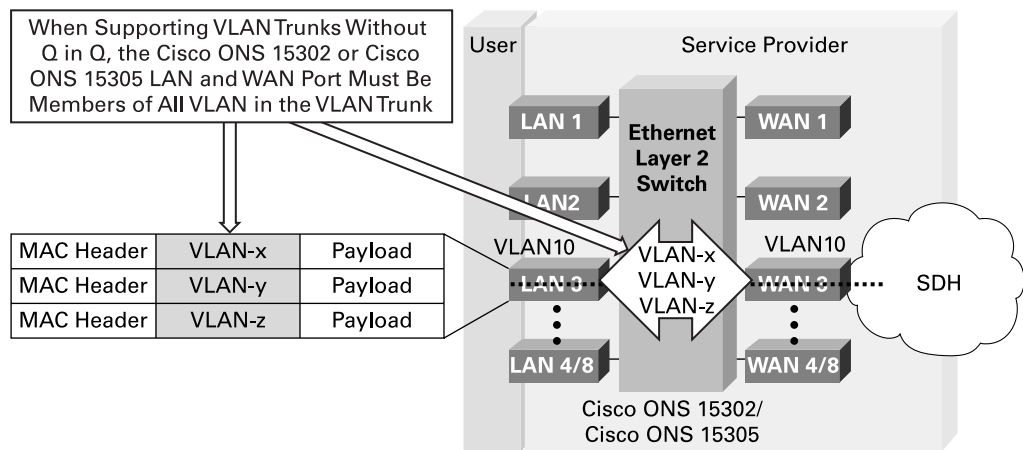
WAN Port 3 have tagging enabled and are members of VLAN10, which matches the outer tag of the customer Q in Q VLAN trunk. The inner tags—VLAN-x, VLAN-y, and VLAN-z—are tunneled through the network until reaching a far-end Layer 2 switch that supports Q in Q and is configured to remove the outer tag.

**Figure 8**  
Ethernet Connection Services for Q in Q VLAN Trunk



When the Layer 2 CPE does not support Q in Q, the Cisco ONS 15302 or Cisco ONS 15305 LAN and WAN ports must be members of all VLAN ID in the 802.1q trunk that need to be transported over the service provider network and must have tagging enabled to separate traffic at the egress. LAN ports operating in tagged mode will only accept frames tagged with the VLAN ID of which the port is a member. Untagged frames and frames with a different VLAN ID from those a port is a member of will be discarded at the ingress.

**Figure 9**  
Ethernet Connection Services for VLAN Trunk Without Q in Q



In Figure 9, LAN Port 3 receives traffic from an 802.1q trunk with VLAN-x, VLAN-y, and VLAN-z to be transported over an NxVC-12 SDH path from WAN Port 3. LAN Port 3 and WAN Port 3 will discard frames from VLAN they are not members of, and so they must be configured as members of VLAN-x, VLAN-y, and VLAN-z. Should VLAN-w be added to the trunk, for example, and LAN Port 3 not be configured as a member of VLAN-w, packets from this virtual network will be dropped at the ingress.

## **INTELLIGENT INFORMATION NETWORK**

The Cisco ONS 15302 and Cisco ONS 15305 are part of the Cisco Intelligent Information Network solution:

### **Resilient**

- Supports 1+1 multiplex section protection optical protection
- Provides subnetwork connection protection optical protection
- Supports 802.1D Spanning Tree Protocol
- Includes power module protection

### **Integrated**

- The Cisco ONS 15302 and Cisco ONS 15305 solutions are capable of terminating traditional TDM and native Ethernet traffic, making these ideal service delivery devices.
- Cisco Systems supports unified network management across all optical platforms with Cisco Transport Manager.

### **Adaptable**

- Cisco Edge Craft provides an easy-to-use, powerful monitoring, configuration, and provisioning tool.
- Cisco Transport Manager provides a comprehensive end-to-end optical network management tool.
- The Cisco ONS 15302 and Cisco ONS 15305 platforms provide self-learning system configuration.
- The Cisco ONS 15302 and Cisco ONS 15305 offer a small form factor (1 rack unit) and low power dissipation, making them ideal for customer premises and small central offices.
- The Cisco ONS 15302 and Cisco ONS 15305 solutions can be deployed in various network topologies (point-to-point, or point-to-multipoint, for example)

## **SUPPORTING SOLUTIONS OR PRODUCTS**

- Cisco ONS 15454 SDH Multiservice Provisioning Platform (MSPP)
- Cisco Transport Manager

## **WHY CISCO**

The Cisco ONS 15302 and Cisco ONS 15305 platforms provide a differentiated solution for Ethernet over SDH connection services by combining the following features in a 1 RU platform with low power dissipation, making it ideal for customer locations and small central offices at the edge of the network:

- STM-1 (155 Mbps) through STM-16 (2.5 Gbps) speeds provide scalability
- Platforms support Ethernet, Fast Ethernet, and Gigabit Ethernet interfaces
- Integrated Layer 2 Ethernet bridge allows multipoint configurations

- SDH network bandwidth is configurable in 2-Mbps increments and up to Fast Ethernet line rate (100 Mbps)
- The Cisco ONS 15305 high-density optical module for edge aggregation of Ethernet over SDH traffic allows up to 16 unprotected or 8 protected STM-1 links to be terminated on a single system
- The Cisco ONS 15305 high-density electrical modules allow additional TDM service collection or aggregation; up to 189 E1 or 18 E3/T3 interfaces may be configured in a single system
- Dual power modules allow for extra reliability

#### FOR MORE INFORMATION

For more information about the Cisco ONS 15300 Series products visit:

<http://www.cisco.com/en/US/products/hw/optical/ps2001/index.html>

or contact your local account representative.



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