

# VPLS: The Switched Ethernet

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## Executive Summary

*VPLS is becoming a popular networking option. Its inherent Ethernet any-to-any connectivity model makes VPLS a popular choice for enterprises adding or deleting sites. Existing Ethernet users may have a simple implementation by modifying existing Ethernet equipment, which will also scale easily to meet future bandwidth needs. Although it has many advantages, VPLS may not be right for every business. This paper explains VPLS and discusses when it is a good networking solution.*



VPLS, or Virtual Private LAN Service, is a widely used term in today's networking environment. Often referred to as "the network of the future", VPLS seems to be evolving into the next "in" technology. When discussing the topic, it is important to understand the user's definition.

### Virtual Private LAN or Line?

Although it is growing in popularity today, in fact, VPLS has been available for some time and care should be taken to understand how the term is defined. Some believe VPLS stands for Virtual Private Line Service, and may consider it to be any long-haul service. Services such as Frame Relay, Asynchronous Transfer Mode (ATM), switched Ethernet and MPLS VPNs are sometimes referred to as VPLS.

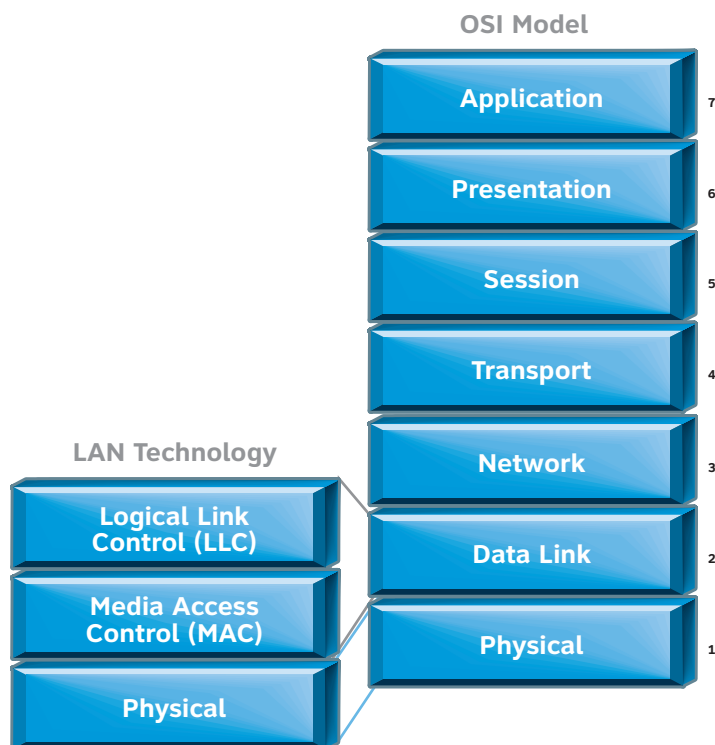
### AT&T's Definition

However, as a Virtual Private LAN Service, VPLS generally refers to any-to-any architecture that has virtual connections in a switched environment. AT&T defines VPLS as any-to-any Ethernet that can be either metro or long haul. Since Ethernet is an integral part of VPLS, it is important to understand how Ethernet works and can be used within an enterprise network.

### Ethernet

Ethernet has been used to create Local Area Networks for many years and has since evolved to support Metropolitan Area Networks (MANs) as well as Wide Area Networks (WANs). A LAN is a generally small, privately owned network in a small geographic area that interconnects computerized devices within a company, providing high-speed access to users for the purposes of sharing information. LANs relate to the OSI model at the two lowest layers, the Physical and Data Link Layers. Ethernet supports the Physical Layer of the OSI Model, as well as the

Figure 1



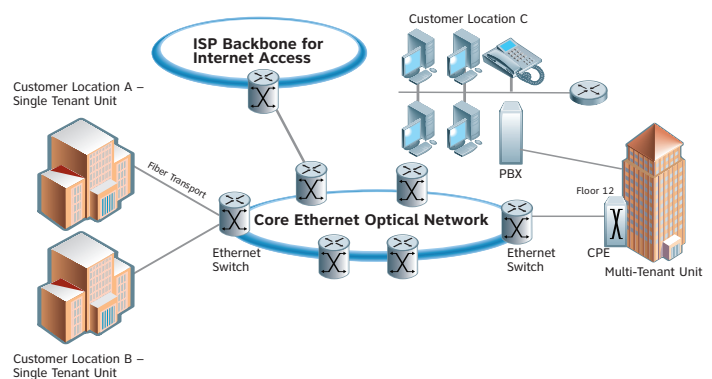
This figure depicts the 7 layers of the OSI Model.

bottom half of the Data Link Layer. The Data Link Layer uses Media Access Control (MAC) Addresses to identify endpoints and it formats data in frames (see Figure 1).

Ethernet can use either layer 2 or layer 3 services to create a networking solution providing high-bandwidth connectivity between locations within a metropolitan area, between two cities or across a WAN. Ethernet can be implemented either as an access method to a layer 3 technology, or as a point-to-point, point-to-multi-point or any-to-any service. As a point-to-point, layer 1 service, Ethernet can provide a dedicated connection within a metropolitan area, or as configured service channels on a Metropolitan SONET Ring.

Generally speaking, multi-point and any-to-any services are switched Ethernet, which use switches to connect individual hosts or segments. With traditional Ethernets, sometimes referred to as shared Ethernets, hosts compete for the same bandwidth. Switches allow dedicated roads to be created between individual users or small groups of users and their destination. Individual ports are provided and each frame that arrives on a port has a Destination Address which tells the port where it needs to go. Switches examine each frame's Destination Address and send the information only to the port attached to the destination device. Since many "conversations" can go through the switch simultaneously, network bandwidth is utilized more effectively. Switched Ethernets provide any-to-any high bandwidth support for LAN connectivity and are a convenient and effective way to extend the bandwidth of existing Ethernets (see Figure 2).

Figure 2



This diagram depicts an Ethernet Virtual Private Network supporting Local Area Network (LAN) to LAN connectivity. This service addresses transparent LAN needs.

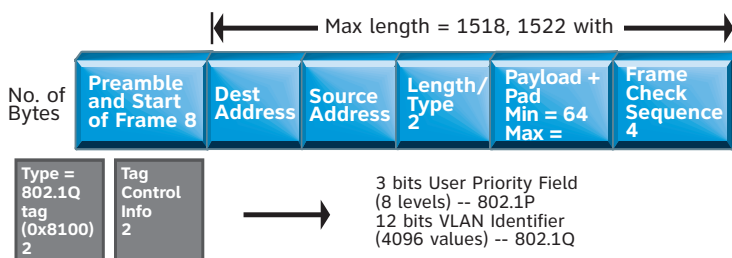
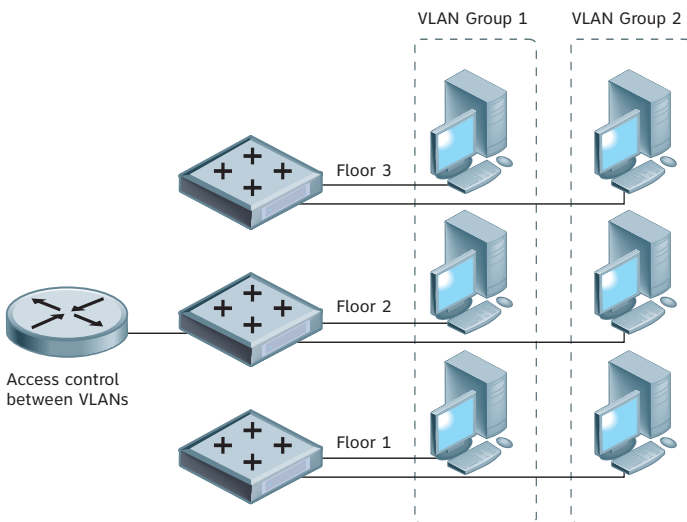
Multipoint services can be delivered in two different methods.

1. A carrier can deploy Ethernet switches and switch Virtual LANs (VLANs) in a similar manner to the way a business would within a single location. VLANs allow a group of devices on different physical LAN segments to communicate with each other as if they were all on the same physical LAN segment. They map workstations on a method other than by geography, such as by department or application (see Figure 3).

Because VLANs divide a network into separate broadcast domains, VLANs reduce the need to have routers deployed on a network to contain broadcast traffic. As a result of confinement of broadcast domains on a network, traffic on the network is significantly reduced. With this arrangement, workstations can be added and traffic can be managed easier than with a physical LAN, reducing administration costs. An extra layer of security is provided using VLANs because routers direct communication and firewalls between VLAN groups.

VLAN tags can be inserted into an Ethernet frame. A VLAN tag is a 2-byte field inserted into the Ethernet frame that contains 3 bits for the user priority and 12 bits for the VLAN ID (See Figure 3). Each customer's traffic is confined to a separate VLAN, which is indicated on the tag carried in the frame. VLANs restrict the number of locations that receive communication, which is beneficial to companies with visibility concerns who need to secure certain information from certain parties. VLANs are limited by the numbers of values they can represent. This can be a problem for larger networks with many locations that need to participate within a VLAN.

Figure 3

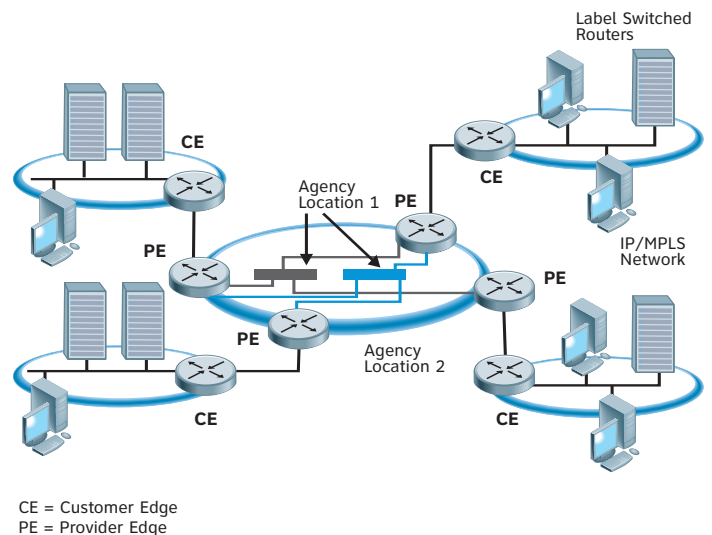


This figure shows a VLAN and the VLAN tags used to control information.

2. A second implementation method for multipoint services is by offering a service such as VPLS, where a provider uses a MPLS backbone to create an any-to-any Ethernet connectivity model (see Figure 4). With VPLS, the provider's network creates the mesh of connections over MPLS. Since VPLS emulates Ethernet, users of the technology will realize the same benefits that would be received

from Ethernet. Although the service uses a MPLS backbone, the enterprise does not interface to the provider at layer 3. The provider does not see the enterprise's IP routes and is simply providing an any-to-any layer 2 service with the customer managing the routing. Switched Ethernet is called VPLS when in the any-to-any configuration. AT&T does not consider a hub-and-spoke arrangement or point-to-point connection to be VPLS. VLANs can be used with VPLS to provide separation.

Figure 4



This picture illustrates a VPLS implementation over MPLS. In this illustration, separate VLANs were created to support different groups within a company. Each individual in each VLAN only has access to the information and people on that VLAN.

**How does VPLS Work?**

VPLS emulates the functionality of a LAN across the wide area network. With VPLS, an enterprise has Ethernet access to a VPLS provider edge router that encapsulates an Ethernet Frame into MPLS and forwards the packet across the network to the appropriate outgoing interface. In short, VPLS transports the Ethernet Frame as MPLS across the network. Each customer's edge (CE) device connects to a Provider Edge (PE) router that looks up the destination Ethernet address and adds a virtual channel label to the packet. Packets are directed through the MPLS network via MPLS Label Switched Routers to the PE router at the other end.

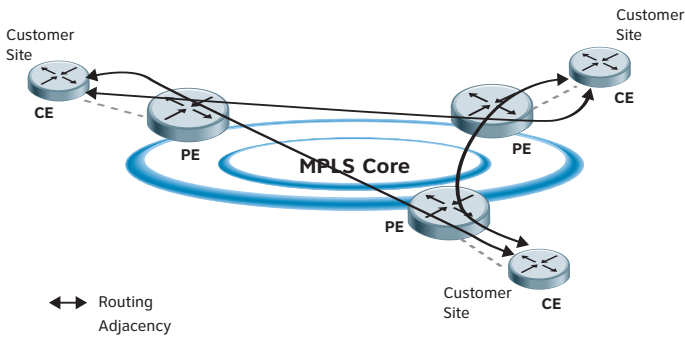
VPLS emulates the functionality of the Ethernet switch by:

1. Forwarding Ethernet Frames
2. Forwarding information to all ports on the Virtual LAN (VLAN)
3. Dynamically learning Media Access Control (MAC) addresses (unique addresses associated with LAN adaptors) for the end-stations

Ethernet LANs are broadcast domains, or restricted areas where information can be transmitted for all devices to receive. By using MAC addresses, any device can send to any other device on the same broadcast domain and identify the sender of the material. This enables the packet to be traced to ensure it was sent.

Known as a "transparent LAN service" (TLS), VPLS enables all connections to appear as one Ethernet network. The network solution appears as a single LAN across cities and countries, extending the network beyond the metropolitan area. Figure 5 shows an Ethernet WAN solution via VPLS.

**Figure 5**



This illustrates an Ethernet WAN Solution via VPLS.

### The Value of VPLS

VPLS provides the benefits of Ethernet, allowing enterprises to scale bandwidth from megabits to gigabits. Equipment is easy to uplift, enabling faster responses to bandwidth needs. Scaling to a higher-speed service may be as simple as making minor changes to existing equipment. Many businesses already have Ethernet equipment in place, making VPLS a cost effective solution. In addition, migration between copper and fiber is not needed to achieve higher speeds. The service is protocol independent, supporting IP, IPX and other protocols.

One of main benefits of VPLS is its routing flexibility and control. The inherent Ethernet any-to-any connectivity model simplifies the addition or deletion of sites. Once connected to the network, businesses can reach any location on the network. Similar to an Ethernet switch, VPLS updates its address tables when a new site is brought online. No additional changes are needed with existing sites on the network to enable communication with a new site.

With VPLS, the enterprise maintains control over routing and does not share layer 3 routing tables with the carrier. This is a benefit for security-conscious businesses that do not want to share routes. In addition, since VPLS is a layer 2 service, enterprises do not need to worry about the presence of routing protocols, such as Border Gateway Protocol (BGP), because they are transparent. VPLS also supports legacy protocols, such as SNA, NetBIOS and Apple Talk.

Finally, since Ethernet is widely used, little or no training is needed for an enterprise's IT staff when implementing VPLS.

### When is VPLS a Good Solution?

VPLS is a good solution if an enterprise requires meshed connectivity and the ability to scale the network. Because IP routes are not shared with a provider, it is a good fit for customers who want to control routing and manage their own networks and connectivity. Usually this reflects a smaller, less complex networking environment. Businesses can take advantage of existing local Ethernet interfaces and extend their network into the Wide Area Networks.

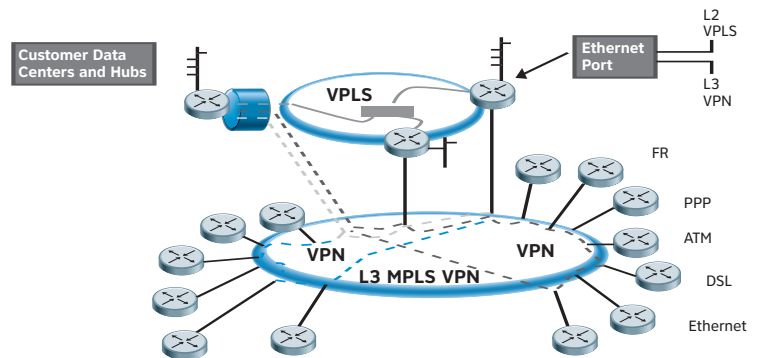
VPLS may not meet the needs of networks that are not meshed, where Ethernet connectivity is not needed, in cases where a large number of sites need to communicate within a network, or when an enterprise wishes to advertise IP Routes. Because Ethernet has some geographic coverage limitations, it can be used to supplement larger networks in specific regions, but many not meet the needs of many geographically-dispersed locations. In addition, there are limitations to the number of MAC addresses that routers can maintain. For larger networks requiring many routes, Layer 3 MPLS VPN with IP addressing may be a better fit.

VPLS is similar to Layer 3 MPLS VPN in that it requires cloud monitoring tools for troubleshooting. Other layer 2 services have clear dmarcs that show when a connection is up or down. Also similar to Layer 3 MPLS VPN, VPLS route changes must propagate through provider routers and route reflectors at layer 3. Access failures may take a little longer to recover with VPLS than with traditional layer 2 services.

### Summary – One Size Does Not Fit All

VPLS is becoming more popular due to its easy-to-scale architecture, flexibility and affordability. As with many technologies available today, the needs of the enterprise must be considered to determine if VPLS is a good solution. In some cases, a mix of solutions may be required (see Figure 6).

**Figure 6**



This figure illustrates the use of both Layer 3 MPLS VPN and Layer 2 VPLS. The customer wanted to maintain control of routing for the data centers to streamline the ability to move the centers. By using VPLS for the data centers, the customer remains in full control of data center routing. A Layer 3 MPLS VPN is used for remote site connectivity to the data centers.

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