DIFFERENCE BETWEEN LAYER 2 and LAYER 3 VPN in MPLS

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ABSTRACT

Multiprotocol Label Switching(MPLS) is a method for fast packet forwarding within a network. It uses label instead of IP for forwarding of packets. Virtual Private Network (VPN) is implemented to provide an end-to-end connectivity among non directly connected nodes. VPN is used in MPLS to provide a connection oriented service over non-connected nodes of a network. Layer 2(L2) MPLS and Layer 3(L3) VPN is based on logical implementation of tunnels for forwarding of packet.
L2 VPN customer sites appear to be on same LAN even if sites are geographically dispersed whereas L3 VPN enable service providers to offer many value added services.
Layer 3 VPN networks allow multiple customer sites to communicate securely at the IP level over a provider managed MPLS network. L3 VPN is connected to one or more provider routers and each associated provider router maintain a separate IP forwarding table for each VPN known as virtual forwarding table (VRF).

KEYWORDS– MPLS , VPN ,VRF ,LER , LSR

I. LAYER 2 VIRTUAL PRIVATE NETWORK: Layer 2 Virtual private network (L2 VPN) can be used with single node or multiple nodes. Service Access Points (SAPs) are used for distribution of data in nodes, whereas service distribution points(SDPs) are used collect data from network and pass it to various SAPs based on their MAC addresses. When L2 VPN span a single node, subscriber data is distributed through multiple service access point (SAP) on the node. L2 VPN on a single node doesn't require a service distribution point(SDP).
L2 VPN with multiple sites, customer data enter the service through using at least one SAP on each node. Data is transported among the nodes through service tunnel [2]. A L2 VPN require at least one SDP at each node. L2 VPN service switch traffic based on MAC addresses associated to appropriate SAP. Tunnel label, VC label and optional control word label is used for encapsulation fields whereas other labels are used for customer frame in the frame header of L2 VPN frame shown in fig.1.

Tunnel label	Virtual circuit label	Optional control word	MAC DA	MAC SA	VLAN Tag	Origina ether net Type	Data	CRC

Fig 1. L2 VPN Frame

MPLS layer 2 encapsulation which is known as Martini encapsulation scheme use transportation of layer-2 frames across MPLS services.
First label is tunnel label used to carry frame across provider network. Second label is bottom of stack is virtual circuit label, used by egress LER to determine how to process the frame and where to deliver it on destination network. Hence above two labels are necessary in MPLS encapsulation. Control word is used for frame relay and ATM AAL5. It contain flag bits that are based on information copied from the layer 2 headers of original layer 2 protocol data unit (PDU). In frame relay it is used to relay the congestion notification bits while in ATM AAL5 it is used to relay the cell type as well as the congestion information. Control word also contain length bits and sequence bits for ordered control.

II. WORKING OF L2 VPN

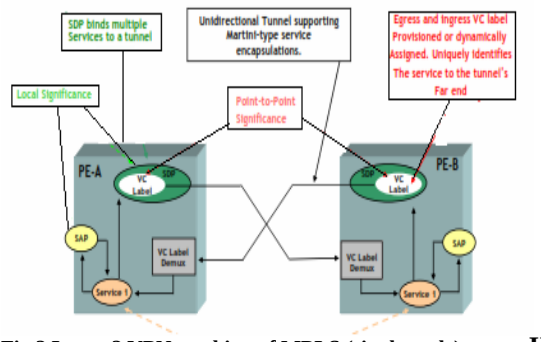


Fig 2 Layer 2 VPN working of MPLS (single node)

Service access point (SAP) is a logical entity that serve as customer access point to the services fig 2 [5]. Each subscriber service is configured at least one SAP. A SAP can be configured on port configured as access port. SAP is local to the router and is uniquely identified by physical ethernet port or packet over SONET /SDH (POS) port and channel, encapsulation type and encapsulation identifier (ID) and it is provisioned on access port. Depending on encapsulation used, a physical port or POS, channel can have more than one SAP associated with it. Using dot1q encapsulation or POS channels, the router can support multiple services for a customer or services for multiple customers. Whereas service distribution path (SDP) is a logically unique ID number and give the system address of originating and far end router. SDP is used for directing traffic from one router to another through unidirectional service tunnel. An SDP originating on one node terminates at the destination node, which then directs incoming packet to the correct service egress SAPs on that node.

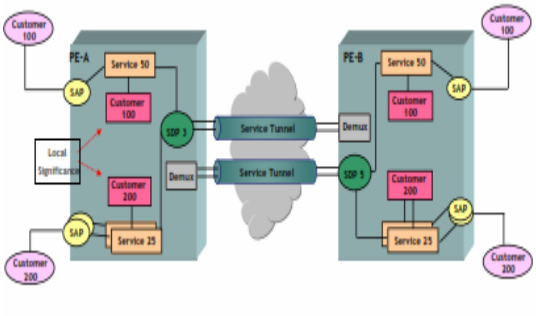


Fig. 3 Layer 2 VPN working of MPLS (multiple node)

A multi node service fig. 3 needs at least one SAP and SDP on each node [5]. For a service to be bi-directional, a SDP must be provisioned on each node participating in the service. A service tunnel is used by SDP to direct traffic one router to another. SDPs uses the system IP address to identify far end destinations. SDP is not specific to one service; many services can use the same SDP. All services bound to an SDP use the same encapsulation as defined by that SDP(GRE or MPLS). The service tunnel is provisioned with an service requirement.

III. LAYER 3 VIRTUAL PRIVATE NETWORK

RFC 4364 describe a method to provide a layer 3 VPN service by providing customers with facilities[1] :

1.) distributing the customer's routing information between sites
2.) forwarding customer originated data packet to appropriate destination
3.) providing secure layer 3 routing connectivity between the various customer sites

In L3 VPN there are customer edge devices that act as an interface between customer and service provider network. These customer edge devices exchange routing information with other customer routers and provider routers at the same site by means of a common routing protocol .
Provider edge devices known as Label Edge Routers (LER) act as an interface between customer edge and service provider networks, these devices are directly connected to customer edge devices. The provider edge devices exchange provider core IP routing information with other provider routers by means of a core protocol it also exchange customer routes (L3 VPN) with other PEs by running a common routing protocol with other provider edge. Provider edge devices may be connected to one or more customer edge devices and its different ports may be part of same or different L3 VPN services.
The provider routers known as Label Switch Router (LSR) which form the internal provider core network. These devices are connected to either other provider or provider edge routers. They exchange the routing information by means of IGP protocols. These routers are unaware of L3 VPNs.

There may be one or more MPLS label applied to any customer packet in the provider core in L3 VPN.

Layer 2	LSP Label	VPN Label	IP Data

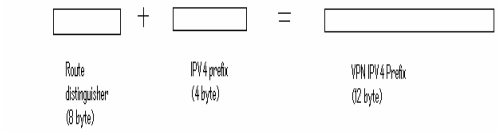
Fig 5 MPLS label with L3 VPN

L3 VPN services uses a label stack consisting of two labels as shown in fig 5. Outer label is known as top, LSP label and used to identify the transport tunnel between Provider Edges. The inner label is known as service or VPN label and identifies the customer VPN or service [3].

L3 VPN provides an end to end service between customer sites utilizing a transport tunnel between across a provider core
Each provider edge router maintains separate logical routing table for each layer3 VPN, this table referred as VPN routing and forwarding (VRF). This table separately isolates the routing information of one customer from the next and also from routes of the provider core network. Each provider edge router may maintain a separate VRFs based on customer sites it connect to .
L3 VPN functionality can be divided into two parts:
1.) control plane
2.) data plane
Control plane function is to exchange the routing and label signaling information in the provider core. These function are handled by separate protocols, based on administrative distance.
Second function of L3 VPN is to ensure customer integrity and security. The service provider is offering services to multiple customers and it must ensure that routing information for each customer is kept distinct and isolated and not exchanged with other router. Data plane function allows customer packets to flow between intended sites after previous two functions have been successfully implemented.
The L3 VPN routing control plane provides the necessary exchange of routing information between devices aware of L3 VPN. Customer Edge routers maintains a standard IP routing table containing routes for L3 VPN to which it belongs. The label signaling control plane function of L3 VPN provides the necessary signaling to allow for the exchange of MPLS labels between all devices in the provider core. A transport tunnel is established based on these labels across the provider core to define the data path for customer packets between PEs.

The data plane function of L3 VPN is the actual forwarding path across the provider network. The data plane forward data between customer sites. Customer data uses MPLS or GRE encapsulation, based on tunnel type in use.

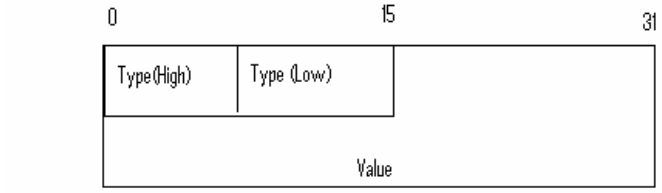
ROUTE DISTINGUISHER– Route distinguisher are used for global unique of IP prefixes. VPN IPv4 address is 12 byte composed of 8 byte of route distinguisher followed by 4 byte IPv4 address .



The address structure allows multiple distinct routes for same IPV4 destination address to coexist as the addition of route distinguisher prefix to the IPV4 address ensure that is made unique.
Route distinguisher consists of three fields : type, administrator(length) and assigned number (value). Type is 2 byte in length and length and value field combined to 6 byte, both are not fixed. Example - 54321:1

MULTIPROTOCOL BGP EXTENSION: BGP routing protocol is used to forward IP packet but discard VPN IPV4 packets for them multiprotocol BGP extension protocol is used. Separate address family are viewed as different protocols in MP-BGP.

BGP EXTENDED COMMUNITIES : The BGP extended community attribute provide mechanism for including additional information to be carried in BGP updates [4].



BGP Extended Community

There can be only one route distinguisher per route and there can be multiple route target per route .

IV. REFERENCES

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