International Journal of Scientific Engineering and Research (IJSER)
www.ijser.in
ISSN (Online): 2347-3878, Impact Factor (2014): 3.05

Hub-and-Spoke MPLS Layer 3 VPN (L3VPN) Topology

Akshay[1], Pooja Ahlawat[2]

[1]M.Tech. Student, Department of Computer Science & Engineering, R.N. College of Engineering & Management, Maharshi Dayanand University, Rohtak, Haryana, India

[2]Assistant Professor, Department of Computer Science & Engineering, R.N. College of Engineering & Management, Maharshi Dayanand University, Rohtak, Haryana, India

Abstract: ***There are two kinds of MPLS L3VPN topologies: Mull-Mesh and Hub-and Spoke. This paper gives the theoretical understanding of Hub-and-Spoke MPLS Layer 3 VPN Topology and its implementation using GNS3 simulator. This paper will also discuss its merit and demerits and comparison with Full-Mesh.***

Keywords: MPLS, VPN, GNS3, Hub-and-spoke

1. Introduction to Hub-and-Spoke MPLS L3VPN Topology

The most commonly encountered topology is a hub-and-spoke topology, where a number of remote offices (spokes) are connected to a central site (hub. The remote offices usually can exchange data (there are no explicit security restrictions on inter-office traffic), but the amount of data exchanged between them is negligible. The hub-and-spoke topology is used typically in organizations with strict hierarchical structures, for example, banks, governments, retail stores, international organizations with small in-country offices, and so on.

Often, customers do not want their sites to have full interconnectivity. This means they do not want or need the sites to be fully meshed. A typical scenario involves one main site at a company with many remote sites. The remote sites or spokes need connectivity to the main or hub site, but they do not need to communicate between them directly. Perhaps the connectivity is possible but not wanted for security reasons. This scenario is commonly referred to as the *hub-and-spoke scenario*. It can also be achieved across MPLS VPN, but care must be taken.

2. Implementation of Hub-and-Spoke MPLS L3VPN

To implement the Hub-and-spoke MPLS L3VPN Topology, the following is needed:

(a) The spoke sites can communicate only with the hub site.
(b) Spoke-to-spoke traffic needs to be sent to the hub site first.

To achieve this, the following things are needed:

(a) Two different RTs
(b) Different RDs

When hub-and-spoke connectivity is required, two different RTs are required. One RT is used to identify routes (re)advertised from the hub site, and another is required to identify routes advertised from the spoke sites.

The PE router connected to the hub site CE router imports routes advertised from the spoke sites, and the PE routers connected to the spoke site CE routers import routes (re)advertised from the hub. Crucially, spoke sites do not import routes directly from other spoke sites.

In addition, it is important to note that the PE router connected to the hub site CE router requires two VRFs for the VPN, whereas the PE routers connected to the spoke site CE routers requires only one VRF for the VPN.

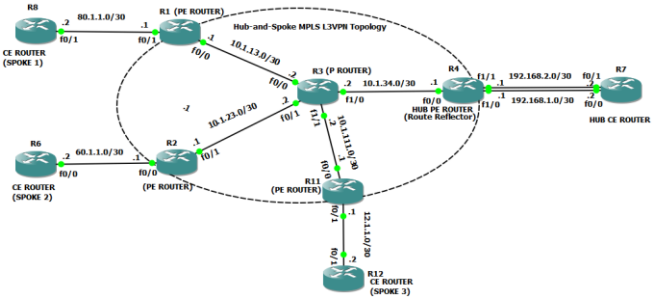

Figure 1: Hub-and-Spoke MPLS L3VPN Topology implemented using GNS3

Here, there are four 7600 series Routers running as a PE routers. Out of these four PE routers, one PE router, R4 acts as a Route reflector for other PE routers, namely R1, R2 and R11. All these PE routers, R1, R2, R4, and R11 have LDP neighbourship with P router R3.

The advantage of configuring R4 router as a RR (Route Reflector) is that all PE routers (R1, R2, and R11) have exactly only and only one MP-BGP session with router R4, thus avoiding one MP-BGP session for each PE router. The VPNv4 routes learnt from one PE router will be reflected to other PE routers by a Route Reflector (R4 Router).

Table 1: Address table

PE/P/CE	ROUTER	INTERFACE	IP ADDRESS	SUBNET
PE	R1	F0/0	10.1.13.1	255.255.255.252
		F0/1	80.1.1.1	255.255.255.252
	R2	F0/0	10.1.34.1	255.255.255.252
		F1/0	192.168.1.1	255.255.255.252
		F1/1	192.168.2.1	255.255.255.252
	R4	F0/0	10.1.34.4	255.255.255.252
		F0/1	10.1.1.4	255.255.255.252
	R11	F0/0	10.1.111.1	255.255.255.252
		F0/1	12.1.1.1	255.255.255.252
P	R3	F0/0	10.1.13.2	255.255.255.252
		F0/1	10.1.23.2	255.255.255.252
		F1/0	10.1.34.2	255.255.255.252
		F1/1	10.1.111.2	255.255.255.252
CE	R6	F0/0	80.1.1.22	255.255.255.252
	R7	F0/0	192.168.1.2	255.255.255.252
		F0/1	192.168.2.2	255.255.255.252
	R8	F0/1	80.1.1.2	255.255.255.252
	R12	F0/1	12.1.1.2	255.255.255.252

Here, in this implemented Hub-and-Spoke MPLS L3VPN topology, the R4 is a hub PE router, having direct point-to-point connectivity (direct connectivity) with Hub CE router. The R4 (Hub) PE router has two connections (Fast Ethernet connections) with Hub CE router.
On R4 Router, two VRFs are created, one VRF is for importing routes from all Spokes (CE Routers), and other VRF is for exporting routes to all spokes.

With Hub-and-Spoke, the manageability of customer location is better. Whenever, a new spoke site is provisioned, we make route-target entries into these two VRFs on the Hub PE (R4) router.

Here, in this implemented Hub-and-Spoke topology, BGP is used as a PE-CE routing protocol between R4 (Hub) Router and R7 (Hub) CE Router, OSPF is used as a PE-CE routing protocol in between rest of PE-CE connectivity.

Whenever, any CE pings other location IP, it always goes through Hub CE (R7) router.

For example, R8 router does a trace route and it goes through R7 as:

R8# traceroute 12.1.1.2

Type escape sequence to abort.
Tracing the route to 12.1.1.2

1 80.1.1.1 80 msec 44 msec 56 msec
2 10.1.13.2 [MPLS: Labels 19/32 Exp 0] 140 msec 156 msec 152 msec
3 192.168.2.1 [MPLS: Label 32 Exp 0] 216 msec 168 msec 136 msec
4 192.168.2.2 136 msec 168 msec 120 msec
5 192.168.1.1 188 msec 176 msec 124 msec
6 10.1.34.2 [MPLS: Labels 18/26 Exp 0] 336 msec 280 msec 260 msec
7 12.1.1.1 396 msec 276 msec 296 msec
8 12.1.1.2 268 msec * 268 msec
R8#

The above entry, in red colour, is the IP address of HUB CE Router (R7).

3. Hub-and-Spoke MPLS L3VPN Benefits

The following are the benefits of Hub-and-spoke MPLS Benefits:

(a) It is very easy to add a new site/router, as no changes to the existing spoke or hub routers are required.
(b) Reduces the hub router configuration size and complexity.
(c) Scales the network through scaling of the network at specific hub point.
(d) Hub-and-spoke topology is much economical than other MPLS topologies.

4. Disadvantages of Hub-and-Spoke MPLS L3VPN (Layer 3 VPN) Topology

(a) Route distribution between a set of VRFs in a VPN with Hub-and-spoke connectivity is a little more complicated than that required for full-mesh connectivity (topology) [1].
(b) SP implementations of hub-and-spoke MPLS VPNs can force spoke site traffic to route through a centralized hub site to reach other spoke sites. Creating a hub-and-spoke topology adds a level of complexity to the service.

5. Conclusion

This paper concludes that Hub-and-spoke MPLS L3Topology is very beneficial when certain central site services for a particular VPN, such as Internet access, Firewalls, server farms, and so on, are housed within hub site. Or it may be because this particular VPN customer requires that all connectivity between its sites be through the central site.

The Hub-and-Spoke topology is considered where cost is a factor.

The above factors prohibit customer to deploy/provision Full-Mesh topology.

But the Full-Mesh VPN Topology is still in use.

The Hub-and-Spoke topology has other side too. The Hub-and-Spoke topology adds another level of hierarchy which become more complex than Full-Mesh.

References

[1] Mark Lewis, "Comparing, Designing and Deploying VPNs", Cisco Press