backbones. The technical considerations and experimental results strongly emphasized the better scalability and reliability of the MPLS/BGP model that seems to be the most promising approach for the provisioning of VPN services on the future Giga-speed optical backbones.

Dumka et al [9] studied the difference between Layer 2 and Layer 3 VPN in MPLS. As per study, 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).

Khan et al [10] focused on using MPLS VPN as a Wide Area Network (WAN) technology with full support of QoS. Their analysis showed that implementing MPLS VPN with DiffServ showed a better performance over IP and MPLS without DiffServ. Using a real testbed consisting of Cisco Routers, results showed that end-to-end delay, jitter and packet loss in different packet transmission rates and in different traffic types had very low variations or was almost constant. Also MPLS TE utilized links much more than when a traditional IP network was used.

6. Traditional IP Networks

In traditional IP networks, routing protocols are used to distribute Layer 3 routing information. Regardless of the routing protocol, packet forwarding is based on the destination address alone. Therefore, when a packet is received by the router, it determines the next-hop address using the packet's destination IP address along with the information from its own forwarding/routing table. This process of determining the next hop is repeated at each hop (router) from the source to the destination.

7. Benefits of MPLS

The various notable benefits or advantages of MPLS are given as:

(a) Speed
(b) Optimal Traffic Flow
(c) Traffic Engineering (TE)
(d) Quality-of-Service (QoS)
(e) Overlapping Address Pools
(f) Better IP over ATM Integration

8. Comparison between Traditional IP Network and MPLS

The comparison between Traditional and MPLS Network is summarized below:

Traditional IP Networks/Routing	MPLS network
In traditional IP networks, each router must process every packet to determine the next hop that the packet must take to reach its final destination	In an MPLS network, only edge routers fully process each packet. Label switches within the network simply forward packets based on the label. This decreases latency experienced by traditional routed networks performing standard IP routing.
There is no such separation.	There is a separation of the control and data planes in MPLS.
IP based networks lack the quality-of-service features available in circuit-based networks, such as ATM and Frame Relay	MPLS support QoS. MPLS replaces the virtual circuits (VC) which reduces the hardware components for connection between routers in the ATM network. MPLS provides an increase in the performance enhancements and service creation capabilities to the network.
There is no such provision in traditional IP network.	In MPLS, routing table for every customer is separate from other routing table for another customer.
Traditional IP routing/networks has poor support for traffic engineering.	MPLS has good support for traffic engineering.
Traditional IP routing/networks has poor integration support with Layer 2 backbones already existing in large service provider networks.	MPLS has good integration support with Layer 2 backbones.
Traditional IP routing/networks is not scalable as compared to MPLS.	MPLS does not have any scalability issue.
Traditional IP routing/networks clearly fits in OSI Model.	MPLS does not fit in OSI Model.
Poor IP over ATM integration	Better IP over ATM integration
There is no provision of Overlapping Address Pools in case of traditional IP routing/networks	Overlapping Address Pools can exists in MPLS networks

9. Conclusion

The comparison between traditional IP networks and MPLS is made on focusing on QoS, Traffic Engineering (TE), Scalability, Overlapping IP addresses etc. Based on the theoretical study it can be concluded that MPLS has significant advantages over traditional IP networks and provides the best solutions because of the following reason:

- MPLS takes less processing time in forwarding the packets due to label switching.
- Implementing MPLS with TE minimises the congestion in the network and provides the better utilizations of network links.
- MPLS suffers minimum delay and provides high throughout compared to traditional/conventional IP network.

- MPLS support overlapping IP addresses. It means same IP address scheme can be given to two or more different VPNs.
- MPLS VPNs are more scalable than traditional IP VPNs.
- MPLS provides better IP over ATM integration.
- MPLS provides better results when configured with Multicasting than traditional IP networks with Multicasting.

Because of these few notable benefits of MPLS, the service providers are adapting MPLS in their networks.

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