COMP8270

SD-WAN VS MPLS

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Group assessment cover sheet

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GRADE

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INTRODUCTION

Based on everything used from a device, through accessing the internet, to printing out a document or downloading an attachment from an email or the web, networks are an essential tool of today's society (network-types,2021). Networking can help you establish a new business or grow an existing one, it is about interacting with people and engaging them for mutual benefit. (Networking in business,2021) There are different ranges of networks in today's use, which include but are limited to: Personal Area Network (PAN) this is a small and basic type of network involving one person in one building, Local Area Network (LAN) most frequently discussed network, Wireless Local Area Network (WLAN) make use of wireless network technology such as Wi-Fi, Software- Defined Wide Area Network (SD-WAN) and Multiprotocol Label Switching (MPLS) (network-types, 2021).

The report will outline the specific networks SD-WAN and MPLS. It would be comparing the two together in a way that would be discussing:

- Definition
- Functionality
- Network traffic referring to the amount of data moving across a network at a given point of time (What is Network Traffic, 2021),
- Costs
- The Security consists of the policies, processes and practices adopted to prevent, detect and monitor unauthorized access, misuse, modification, or denial of a computer network and network-accessible resources (Network security - Wikipedia, 2021)
- Connectivity the ability to connect to or communicate with another computer or computer system (Definition of CONNECTIVITY, 2021)
- Reliability
- Usability and Management
- Scalability of both SD-WAN and MPLS.
- Overall Comparison

DEFINITION

SD-WAN is an acronym for Software-Defined Wide-Area Network. This type of software is the latest yet of WAN technology. It can connect many branch locations of a business to a central hub or cover multiple locations in a large area such as a school, university campus or retail chain (What is SD-WAN, 2021). The idea of SD-WAN is to simplify the management and operation of a WAN by removing the networking hardware from its control mechanism. One of the main benefits of this is to allow companies to build higher performance WANs using lower-cost and commercially available internet access (What is SD-WAN, 2021). SD-WAN relies on four central components:

- Edge connectivity abstraction
- WAN virtualization
- Centralized management
- Elastic traffic management

Its architecture can be cloud-based, cloud-based with a backbone, or on-premises only. It can reside on COTS hardware instead of specialized equipment, reducing capex. Its benefits include simplified management, better network visibility, reduced cost, and less vendor lock-in. It was preceded by MPLS, which is still used in some instances where security is a concern. (Lessing, 2021)

According to Forcepoint, their definition of Multiprotocol Label Switching also known as MPLS is data forwarding technology that increases the speed and controls the flow of network traffic. (What is Multiprotocol Label Switching, 2021). Multiprotocol label switching is a way to ensure reliable connections for real-time applications, but it is expensive, leading enterprises to consider SD-WAN as a way to limit its use (Johnson, 2021). In relation to MPLS, data is directed through labels instead of needing complicated lookups in a routing table at every stop. Scalable and protocol independent, this technique works with Internet Protocol (P) and Asynchronous Transport Mode (ATM) (What is Multiprotocol Label Switching,2021).

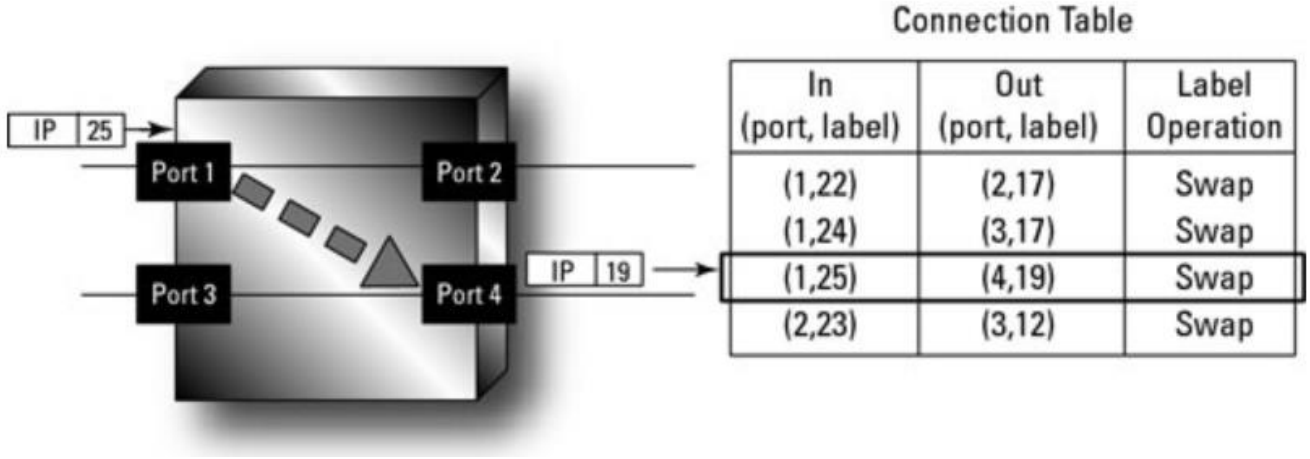
FUNCTIONALITY

In information technology, functionality is the sum or any aspect of what a product, such as a software application or computing device, can do for a user (What is functionality,2021). In this part of the report, we will be pointing out the functionality of the two networks SD-WAN and MPLS.

Beginning with SD-WAN, an SD-WAN deployment can include existing routers and switches or virtualized customer premises equipment (vCPE) all running some version of software that handles policy, security, networking functions and other management tools, depending on vendor and customer configuration (Johnson,2021). An SD-WAN enables cloud-first enterprises to deliver a superior application quality of experience (QoEX) for users. Using intelligence and by identifying applications, an SD-WAN provides application-aware routing across the WAN. Each class of applications receives the appropriate QoS and security policy enforcement, all in accordance with business needs (SD-WAN Explained, 2021).

In relation to MPLS, as packets are forwarded in a label-switching framework, MPLS routers encapsulate the packets with special headers called labels. A label basically tells the router which LSP it belongs to. The router can then use the ingress port and the LSP information to determine where the next hop in the LSP is. (The Function of Labels in MPLS Networks, 2021)

Figure 1. A Label connection table



NETWORK TRAFFIC

MPLS works as network switches and routers. It sits in the intermediate layer between 2 and 3 and it is often regarded as the 2.5th layer of the network systems. It often makes use of the packet forwarding techniques and labels for making the decisions of forwarding the data. MPLS is known for its reliable package delivery at the package destinations paired up with high service quality and a very low record of package loss, while it sits between the 2nd and 3rd layer of the network (Wood 2017). MPLS is also helpful for keeping the flow of traffic on and its reliability proves to be extra beneficial in case of voice and video transfer. This involves real-time protocols instead of internet protocols or VoIP (voice over IP). MPLS achieves its signature reliability by virtually isolating packets by the use of labels during the forwarding phase. Alongside the use of labels, MPLS providers can also assign priority to network traffic. Prioritization of the network traffic helps in identifying the high and low priority traffic. The network can thus determine which traffic will require more bandwidth and which shall require less (Shah 2019). This also helps in sorting out the most important traffic such that they can be passed on before all the others. In a network, identification of the traffic helps in improving the entire process of networking. Due to the aforementioned priority benefits the network traffic is predictable, which means that the network paths that are taken by the packages are already predetermined, and they can only travel through those parts to reach the destination. This helps in increasing the time efficiency and also helps in ensuring the security of the packages up to a certain extent knowing that the chances of getting lost are very less. This is slightly different in case of SD WAN. The SD-Wan makes use of a centralized control function which helps in directing the traffic intelligently and securely across the wide Area Network. The application performance increases, and the highly secured network traffic is delivered. This increases productivity, reduces costs and improves the agility of the systems.

COST

Alongside these benefits MPLS has one glaring downside. This is the fact that MPLS has a high bandwidth cost. The modern-day customers are more leaned towards multimedia like augmented reality, virtual reality, artificial intelligence, machine learning, and makes use of the high-definition videos which are very bandwidth consuming. MPLS charges very high for every megabit of bandwidth which can quickly go out of reach. SD WAN in this situation is much better as compared to a traditional MPLS (forcepoint.com 2021). This is because of the fact that SD WAN has made the geographic boundaries almost irrelevant when it comes to the networking. It provides major benefits like better scalability, visibility, and enhanced control and performance. Unlike MPLS SD WAN does not have any bandwidth penalties (Yang et al. 2019). This is a huge bonus for the customers who can easily update and upgrade their network by adding or removing links without making any huge change to the network or the infrastructure. Another feature which makes SD WAN popular is the fact that it provides a cost-effective match and mixed network links depending upon the type of content or its priority. The cellular connection and the internet broadband for SD WAN is much less than MPLS which serves as great benefit to the customers, especially for the low priority traffic which can be very costly in case of MPLS network links (Michel and Keller 2017).

SECURITY

On top of this, the MPLS network lacks built-in data protection. This means that if it is implemented in the wrong way then it could expose the network to various vulnerabilities and breaches in the network and the data. The primary advantage provided by SD WAN in this situation is the virtualization of the security in the network. Every organization in the contemporary world prefers network architecture which has integrated policies, securities, and orchestrations (Alhaqbani and Liu 2017). SD WAN security is perfect for this purpose as it provides a unified and secured connectivity approach. The end-to-end encryption which is provided across the entire network of the SD WAN architecture is extremely beneficial for the organization. This process of encryption lets the communicating users decrypt the data and get the

information that has been transferred. The sender encrypts the data, and it can only be decrypted by the receiver. Although the third party can store that information, they will not be able to decrypt them. This helps in assuring the users that their data is secure with the SD WAN services, which was not possible considering the MPLS method (Goulamghoss and Bassoo 2021). With the internet being encrypted every end point and devices connected across it gets authenticated completely due to the software-defined security and a key exchange functionality which is highly scalable.

CONNECTIVITY

MPLS sits between layers 2 and 3 and functions similarly to switches and routers. (MPLS is often referred to as layer 2.5.) Data forwarding decisions are made using packet-forwarding technologies and labels. Between the Layer 2 (data link) and Layer 3 (network) headers, the label is imposed. MPLS runs on proprietary hardware. MPLS is characterized by its dedicated private lines, while SD-WAN connections can be either dedicated lines or public networks. The network functions that operate on the network infrastructure are virtualized by an SD-WAN and run as software on commodity hardware. The ability to handle multiple connections, from MPLS to broadband to LTE, is one of SD-WAN's most important features. (Craven, 2017)

SD-WAN does this by aggregating various transport media and optimizing routing protocols across available transport links, such as broadband Internet, mobile networks, and even MPLS circuits. Due to the use of multiple transport media, SD-WAN can adapt if a specific connection is inaccessible or provides poor performance. (LUCIANI, 2019)

SD-WAN allows enterprise WANs to properly use broadband connections while ensuring efficiency and reliability. Using SD-WAN provides dependable and stable connections to public cloud providers. In the midst of active sessions with multiple communication links, SD-WAN will direct application on a per-packet basis. This aids in improving the applications' efficiency and reliability. (Mitchell, 2019)

RELIABILITY

Any application's data packets must reach their intended destination in order for it to function. A carrier-grade MPLS network will carry packets at a rate of 99.9%, which means that only one out of every thousand packets will be lost in transit. Packet loss of one percent or more is common when data is transmitted over the public internet, implying that one out of every hundred packets is missing. On an MPLS network, quality of service is respected from beginning to end, ensuring that the prioritization established on one end is maintained throughout the network and at the receiving end. (FASTMETRICS BUSINESS BLOG, n.d.) MPLS circuits provide highly reliable network connectivity which might be required for mission-critical applications. (Checkpoint, n.d.)

If designed and executed properly, an SD-WAN solution may provide packet transmission that is similar to that of an MPLS network. If an SD-WAN prioritizes applications for transmission over the internet, they are prioritized when they leave one end. Then they are exposed to the wild network, which may or may not result in packets arriving in the same order at the other end or might even get lost. To address this issue, SD-WAN uses Forward Error Correction. Forward Error Correction (FEC) incorporates parity bits into packets in the data flow which allows SD-WAN to retrieve packets that might have been lost or reordered along the route. (FASTMETRICS BUSINESS BLOG, n.d.)

When it comes to preventing packet loss and keeping an organization's most valuable traffic flowing, MPLS can send packets to their destinations very reliably by providing a high level of service. Because of the labels it uses for forwarding, MPLS has a high level of reliability. Packets are virtually isolated by the labels. This is particularly important for real-time protocols like Voice over IP (VoIP) to preserve their quality. Today's companies rely heavily on VoIP services. (Craven, 2017)

USABILITY and MANAGEMENT

SD-WAN decouples the control and management processes of the network from the underlying hardware and allows them to be managed by software, making deployment and configuration easier, as opposed to MPLS which requires much more in-depth knowledge. (Cooney, 2019) SD-WAN creates a network overlay which decouples network software resources using a software abstraction. This abstraction makes it easy for network operators to monitor and maintain their networks. To make network administration easier, the overlay provides an interface across various physical components. The functionality of software-defined wide area networks is split into two planes: data and control. Application and user data are carried in the data plane. The packet routing decisions are made by the control plane. Multiple instances of the data plane are served by a single logical instance of the control plane.

The separation of layers in SD-WAN provides many advantages:

- The control plane is responsible for managing a larger number of data plane components.
- As intelligence moves from the data plane to the programmable control plane, agility increases.
- It uses OpenFlow protocols to enable communication between the control plane and data plane components.
- Using an application programming interface, applications can program the network as an abstraction.
- SD-WAN architectures being based on cloud gateways, reduces the need for data centre upgrades or overhaul costs. (Mitchell, 2019)

SCALABILITY

The scalability can be seen in two ways:

- Scalability in the number of devices or branches that can be added as the organisation grows.
- Scalability in the services offered by a corporate network

Scalability in the infrastructure

In Figure 2. We can see an example of a model that uses SD-WAN technology, but part of the network also uses MPLS.
MPLS is a tagged routing protocol. This protocol is usually between Layer 2 and Layer 3, which means that it operates in hardware, so it runs over dedicated networks only. The different branches are connected through a dedicated network to a central data centre.
In terms of scalability, it means that expanding the network will simply adding more hardware and changing its configuration. To add a new branch, we will have to add a new hardware connection to the data centre. This can be expensive, time-consuming, and requires trained personnel to be done.

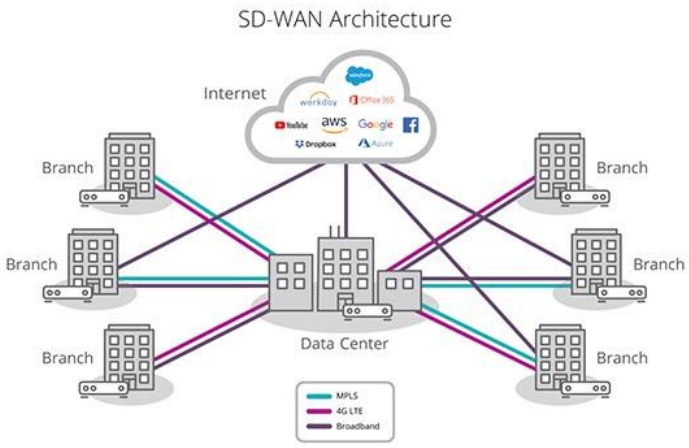


Figure 2. Hybrid model with SD-WAN and MPLS

SD-WAN technology does not necessarily need to go through the Data Centre. It uses all the channels that our network offers to connect the branches. A new branch can be added through our Internet Service Provider or even through existing MPLS.
SD-WAN technology can be particularly useful when the new branches to be added are in remote locations. Like different cities or countries. Because the connection can be over the internet, and it is created through software, its implementation will be quicker and less expensive.

Scalability of services

By separating the Control plane from the management plane, it is possible to create virtual overlays that define the necessary characteristics and security policies for each type of service. For example, Figure 3. shows a platform that offers the SD-WAN service. The platform will also use multiple available connection channels. In the example it uses the existing MPLS, the internet provider and a backup 4G cellular network. Virtualized networks can be divided in the way that best suits or requirements and get most of the resources.

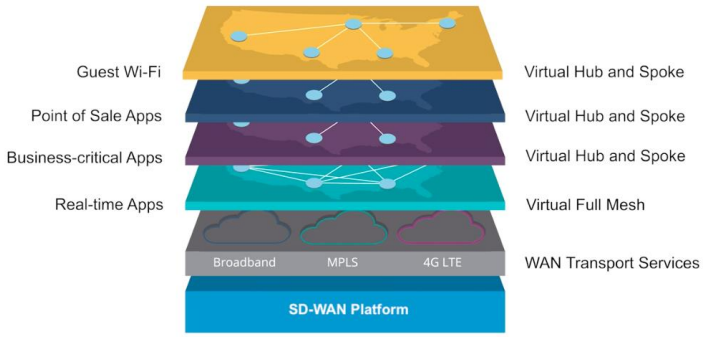


Figure 3. Virtualized networks in an SD-WAN platform

In the example can be seen virtual subnets for applications that require real-time connection, like VoIP or video-conferences software that require low latency and low delay, a second one for business-critical apps that require high availability at all times, a third for applications that contain Sensitive data to increase security through segmentation and even a separated one for guest Wi-Fi that will be isolated from everything else.

When the organisation needs to incorporate a different type of applications to the current existing ones, an SD-WAN model will create a virtual overlay that meets their requirements and could be done remotely.

On the other hand, MPLS bases its connection on labels, so new services will need to be configured this way in every router.

OVERALL COMPARISON

SD-WAN	MPLS
Runs on local or public networks	Runs over dedicated networks and it implemented by hardware
Virtualized functions performed by software	Security can be based on
High Scalability	High QoS
Cheaper to implement	Less loss of packets
Security based on encryption	Managed by the service provider

CONCLUSIONS

Despite their differences, SD-WAN and MPLS are not at odds.

In fact, SD-WAN technology can use the existing infrastructure created under MPLS as one of its communication channels. MPLS can be used for specific applications with QoS requirements, security or in small networks that do not have as much need for SaaS.

Understanding the characteristics of each of the approaches will help us to choose more appropriately what to use in each scenario. Hybrid models can be applied to get the best of each approach in an organisation network.

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