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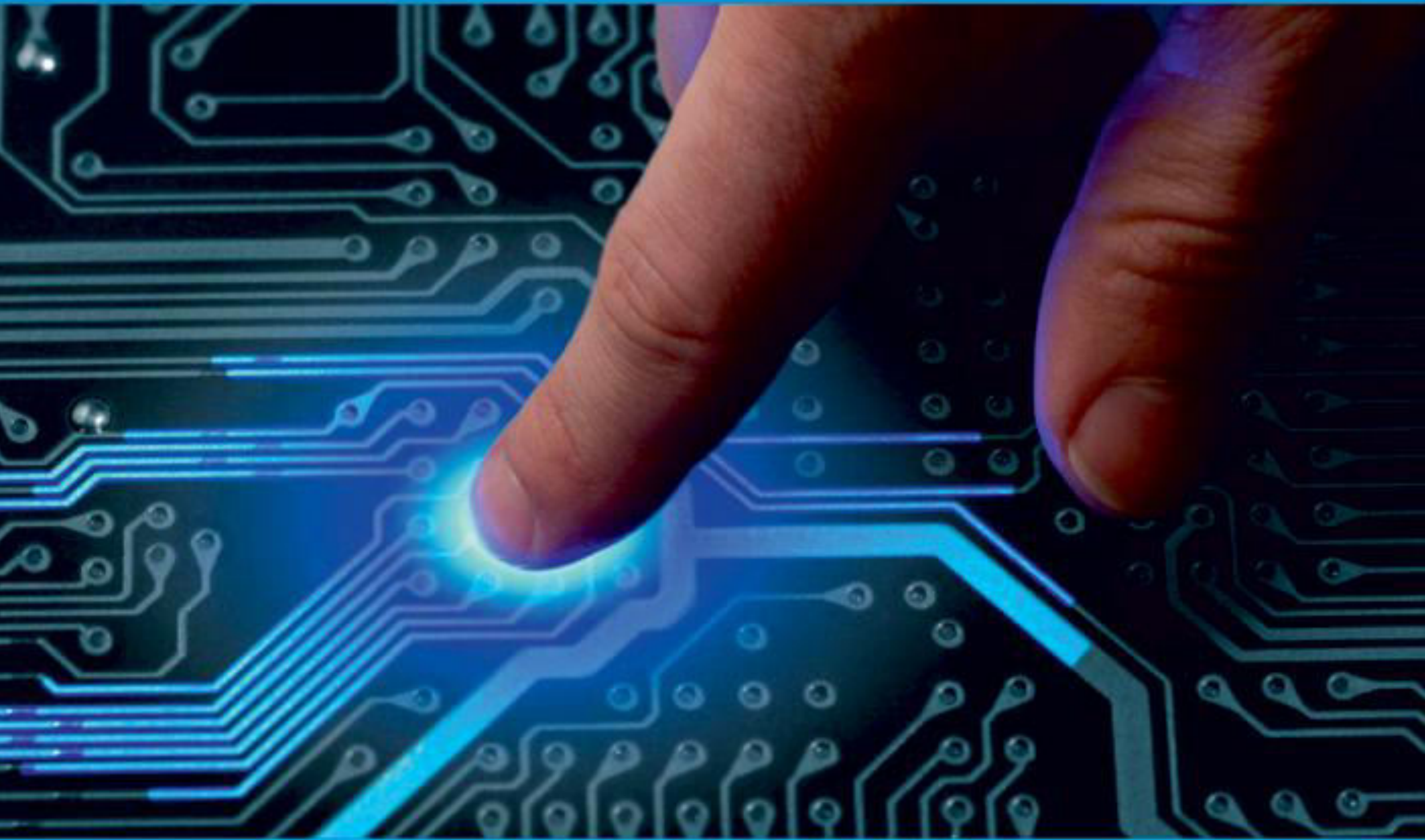

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Deployment of Segment Routing Over IPV6 Network

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ABSTRACT: Segment Routing (SR) is a new technique for providing traffic engineering (TE) by simplifying control plane procedures. A node uses SR to direct a packet via an ordered sequence of instructions known as segments. Some extensions of the internal gateway protocol can be used to apply SR to an IP/MPLS or IPv6 network without using the signal protocol. SR over IPv6 (SRv6) is gaining popularity. The increased demand for IP address allocation has resulted in a significant reduction in the number of available IP addresses, particularly for IPv4 distribution. Internet Protocol version 6 (IPv6), an internet protocol, has been approved as the next-generation Internet technology to handle IP address requests. The existence of routing cannot be isolated from the exchange of IP addresses in a computer network. EIGRP, or Enhanced Interior Gateway Routing Protocol, was built with IPv6 in mind (EIGRPv6). Cisco routers can help with EIGRP for IPv6 by having load balancing functions that evenly distribute network traffic. The routing protocols OSPF (Open Shortest Path First) and EIGRP (Enhanced Interior Gateway Protocol) are members of the IGP (Interior Gateway Protocol). EIGR and OSPF.

KEYWORDS: Segment Routing; EIGRP;Enhanced Interior Gateway Routing Protocol; IPV6; Routing Protocol; EIGRP Metric

I. INTRODUCTION

Segment Routing (SR) is a flexible, scalable way of doing source routing. Segment routing is a method of forwarding packets on the network based on the source routing paradigm. The source chooses a path and encodes it in the packet header as an ordered list of segments. Each segment is identified by the segment ID (SID) consisting of a flat unsigned 32-bit integer. With segment routing, the network no longer needs to maintain a per-application and per-flow state. Instead, it obeys the forwarding instructions provided in the packet. Segment Routing relies on a small number of extensions to Intermediate System-to Intermediate System (IS-IS) and Open Shortest Path First (OSPF) protocols. Segment routing for traffic engineering (SR-TE) takes place through a policy between a source and destination pair. Segment routing for traffic engineering uses the concept of source routing, where the source calculates the path and encodes it in the packet header as a segment. Each segment is an end-to-end path from the source to the destination, and instructs the routers in the provider core network to follow the specified path instead of the shortest path calculated by the IGP.

An IP address is a string of numbers separated by periods. IP addresses are expressed as a set of four numbers. Each number in the set can range from 0 to 255. So, the full IP addressing range goes from 0.0.0.0 to 255.255.255.255. IP addresses are not random. They are mathematically produced and allocated by the Internet Assigned Numbers Authority (IANA), a division of the Internet Corporation for Assigned Names and Numbers (ICANN). IPv6 was developed by Internet Engineering Task Force (IETF) to deal with the problem of IPv4 exhaustion. IP v6 is 128-bits address having an address space of 2^128, which is way bigger than IPv4. In IPv6 we use Colon-Hexa representation. Initially, the computers in the network are using IPv4 addressing method. So, each computer can communicate with the other using it's IP address as the identity while connected to the network. However, IPv4 has much limitations, such of the number of address that can be used and some much address cannot be employed because it has been reserved for some purpose. Because of limited IPv4 addresses that can be used, then the developing IPv6 has been done and there is much number of ip addresses can be used compared to IPv4 ip address.

Routing Protocols are the set of defined rules used by the routers to communicate between source & destination. They do not move the information to the source to a destination, but only update the routing table that contains the information. Network Router protocols helps you to specify way routers communicate with each other. It allows the network to select routes between any two nodes on a computer network. Enhanced Interior Gateway Routing Protocol

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(EIGRP) is a unique Cisco innovation. Highly valued for its ease of deployment and fast convergence, EIGRP is commonly used in many large Enterprise networks. EIGRP is a simple protocol to understand and deploy. It's IPv6-ready, scales effectively in a well-designed network, and provides extremely quick convergence times. EIGRP is an enhanced distance-vector protocol, relying on the Diffused Update Algorithm (DUAL) to calculate the shortest path to a network. It performs a much easier transition with a multi-address family. It supports both IPV4 and IPV6 networks. It provides encryption for security and can be used with iBGP for WAN routing. It reduces network traffic by making use of 'need-based' updates. The convergence time of EIGRP is faster than OSPF because EIGRP network can learn the topology information and updates more rapidly. As a result, data packets in EIGRP network reach faster to the destination compared to OSPF network.

II. RELATED WORK

In [1] Segment routing is designed to operate over either an MPLS or an IPv6 control plane. SR-MPLS and its instantiation over MPLS, encodes a path as a stack of labels inserted in the packet header by the ingress node. This overhead may violate the Maximum SID Depth (MSD), the equipment hardware limitation which indicates the maximum number of labels an ingress node can push onto the packet header. Currently, the MSD varies from 3 to 5 depending on the equipment manufacturer. Therefore, the MSD value considerably limits the number of paths that can be implemented with SR-MPLS. The consequence may be an inefficient network resource utilization and may also lead to congestion. Hence, the two types of SR-MPLS paths label encoding algorithms are proposed, namely SR-LEA and SR-LEA-A. Both algorithms compute the minimum label stack to express a segment routing path. Their performance has been evaluated over real topologies. In addition, also proved that they are efficient in alleviating the impact of the MSD.

In [2] it describes that as Segment Routing (SR) is emerging as an innovative traffic engineering technique compatible with traditional MPLS data plane. SR relies on label stacking, without requiring a signal protocol. This greatly simplifies network operations in transit nodes. However, it may introduce scalability issues at the ingress node and packet overhead. Therefore, specific algorithms are required to efficiently compute the label stack for a given path. Hence, this paper introduced two algorithms (i.e., SR-D and SR-R) for effective segment list computation in SR networks. Both algorithms provide the minimum segment list depth. However, algorithm SR-R guarantees lower packet overhead. The algorithms were applied on a number of network topologies to evaluate the scalability performance of SR.

In [3] Network operators anticipate the offering of an increasing variety of cloud-based services with stringent Service Level Agreements. Technologies currently supporting IP networks however lack the flexibility and scalability properties to realize such evolution. This paper present Segment Routing (SR), a new network architecture aimed at filling this gap, driven by usecases defined by network operators. SR implements the source routing and tunneling paradigms, letting nodes steer packets over paths using a sequence of instructions (segments) placed in the packet header. As such, SR allows the implementation of routing policies without per-flow entries at intermediate routers. This paper introduces the SR architecture, describes its related ongoing standardization efforts, and reviews the main use-cases envisioned by network operators.

In [4] the author has described that Segment routing (SR) is a new routing paradigm to provide traffic engineering (TE) capabilities in an IP network. Despite the benefit that SR brings, introducing a new technology into an operational network presents many difficulties. In particular, the network operators consider both capital expenditure and performance degradation as drawbacks for the deployment of the new technology; for this reason, an incremental approach is preferred. In this paper, we face the challenge of managing the transition between a pure IP network to a full SR one while optimizing the network performances. We focus our attention on a network scenario where: 1) only a subset of nodes are SR-capable and 2) the TE objective is the minimization of the maximum link utilization. For such a scenario, an architectural solution, named SR domain (SRD) is proposed, to guarantee the proper interworking between the IP routers and the SR nodes and also proposes a mixed integer linear programming formulation to solve the SRD design problem, consisting in identifying the subset of SR nodes; moreover, a strategy to manage the routing inside the SRD is defined.

In [5] attention has been devoted to the question of whether/when traditional network protocol design, which relies on the application of algorithmic insights by human experts, can be replaced by a data-driven (i.e., machine learning) approach. This paper focuses on the classical setting of intradomain traffic engineering and observed that this context poses significant challenges for data-driven protocol design. The preliminary results regarding the power of

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data-driven routing suggest that applying ML (specifically, deep reinforcement learning) to this context yields high performance and is a promising direction for further research. The experimentation result shows that extracting information from the history of traffic scenarios to generate good routing with respect to future traffic scenarios is an interesting approach.

III. SIMULATION RESULTS

Simulations are performed using GNS3 and Packet Tracer software. In this study we are making use of cisco packet tracer version: 8.0.0.0212 simulation software to create a network simulation that runs virtualization but does not change and reduce device features as the original with a Cisco Router 1941/K5, IOS version 15.1 (4) M4. To deploy segment routing over ipv6 network using EIGRP routing protocol, authors use 4 routers with each router having LAN network connected to the client. EIGRP routing is the Cisco proprietary routing protocol, which means it can only be run by a Cisco router device. The EIGRP protocol can be categorized as the best routing protocol in the world today, because the only routing protocol capable of offering a backup route feature, where if there is a change in the network, EIGRP does not have to reconfigure to find routes and complete their routing table.

Segment routing can be deployed using EIGRP routing protocol by using IPV6 address as the SID (Segment Identifier) rather than using OSPF routing protocol. As OSPF protocol is difficult to configure and it needs more memory requirements. EIGRP routing also provides routing using IPv6 allocations. IP address version 6 (often referred to as IPv6 address) is a type of network addressing used in the TCP / IP network protocol that uses the IP version 6. The total length is 128-bit, and theoretically can address up to 2128 = 3.4 x 1038 host computers worldwide. An example IP version is 21BA:00A3: 0000:2F3B:02AA: 00FF:FE28: 9C5A.

As shown in the Figure 1, Network topology is designed by Connecting 4 Routers R1, R2, R3 and R4. Each Router is connected to LAN through Copper Straight – Through cable. All Routers are Connected to each other through Serial cables. Each LAN has the client PC. Initially all the devices are connected and IPV6 addresses are allocated to all the network. To form the relationship between all the routers EIGRP (Enhanced Interior Gateway Routing Protocol) is used. IPV6 configuration in router is bit different compared to IPV4 router configuration. Ipv6 configuration has to be made in router console using the appropriate commands. IPV6 - IP Address Specification is assigned to the network topology as shown in the Table -1.

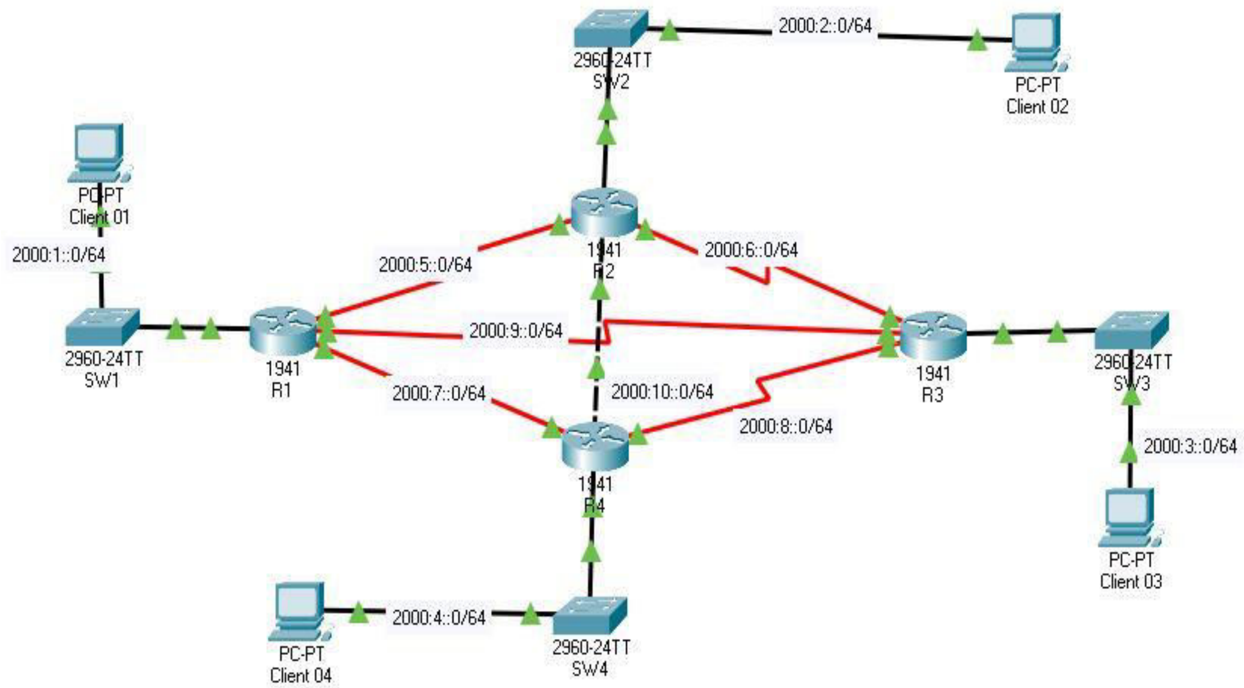

Figure 1: Network Scheme

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Table 1: IP Address Specification

Router	Interface	Ip Address
R1	G0/0	2000:1::2/64
	S0/0/0	2000:5::1/64
	S0/0/1	2000:7::1/64
	S0/1/0	2000:9::1/64
R2	G0/0	2000:2::2/64
	G0/1	2000:10::1/64
	S0/0/0	2000:5::2/64
	S0/0/1	2000:6::1/64
R3	G0/0	2000:3::2/64
	S0/0/0	2000:8::2/64
	S0/0/1	2000:6::2/64
	S0/1/0	2000:9::2/64
R4	G0/0	2000:4::2/64
	G0/1	2000:10::2/64
	S0/0/0	2000:8::1/64
	S0/0/1	2000:7::2/64

IV. METRIC CALCULATION

The EIGRP metric is a combination of a measure of the entire path's cumulative delay, and the minimum bandwidth across the entire path. The delay value is value assigned to each 'hop' based upon that interface's speed. Metrics in EIGRP is determined by computing bandwidth, reliability, delay and load for each link connected to the router. The metric also includes factoring the interface's load and reliability, but this is often left disabled. Formula with default K value (k1=1, K2=0,K3=1,K4=0,k5=0) is as shown below:

Metric= [K1*BW+ ((K2*BW)/ (256-Load)) +K3*DELAY] *256

This is all controlled by what is known as "K values", each "k value" controls weather each of the following are considered in the EIGRP metric calculation. By default, the values of K1 and K3 are set to 1, and K2, K4 and K5 are set to 0. Hence the above equation is deduced to as shown in the figure 2.

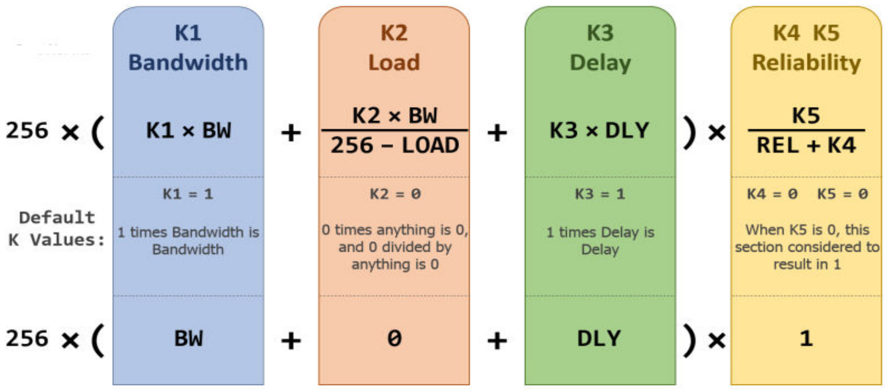

Figure 2: EIGRP composite metric

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If we re-write it with different spacing and add pretty colours and apply the default K Values, we can easily understand how it gets simplified to just Delay and Bandwidth as below:

EIGRP Metric = 256*(Bandwidth + Delay)

The Bandwidth value is based upon the minimum bandwidth link across the entire path. But because metric values in any routing protocol consider a lower value to be superior, a formula has to be used to convert a higher bandwidth to a lower resulting metrics. That formula is as follows:

- Bandwidth = 10^7 / BW in Kbps
- Delay = Sum of delay in µsec/10

V. RESULTS AND DISCUSSIONS

As our project aims that if the primary path failure occurs between source and the destination router. then the router should automatically pick the alternative path for providing service and transmitting packets without any delay. Figure 3 shows the different paths available between routers for many purposes such as communication, Packet transfer, facilitating required services, etc. Based on the bandwidth, delay and metric calculation in all paths default path will be identified. Default path can also set by identifying shortest path. To differentiate the paths, path cost is assigned to each interface between routers as 1,2,3,4,5 and 6.

Simulation tool itself calculates the EIGRP composite metric by selecting minimum bandwidth, cumulative delay and Hop count as shown in the table 2. and we can plot the graph by considering data given in the Table 2. we can identify the best path based on the metrics value plotted in a graph

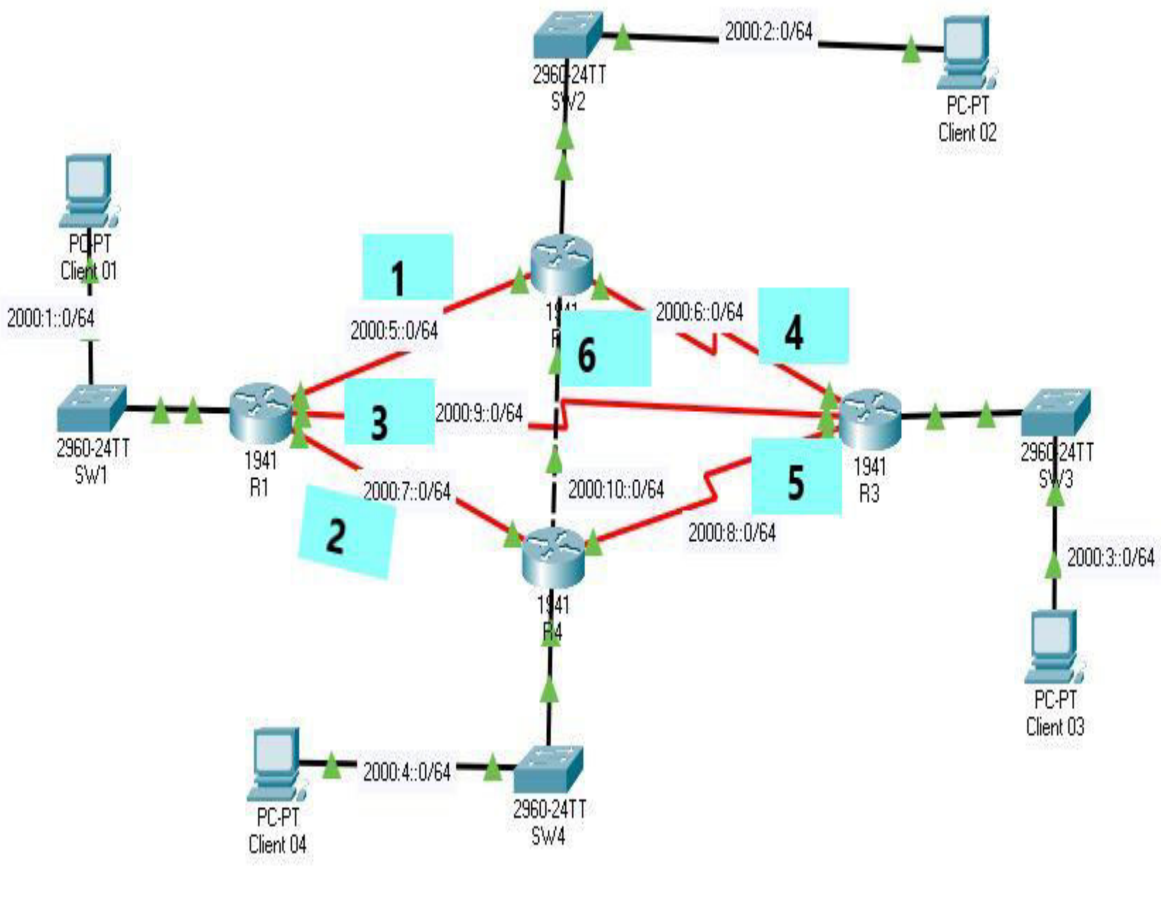

Figure 3: Paths available in network scenario

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Table 2: Metrics value for different Paths

Bandwidth in mbps	Delay in milliseconds	Hop count
1	60.1	3
1	80.1	4
1	100.1	5

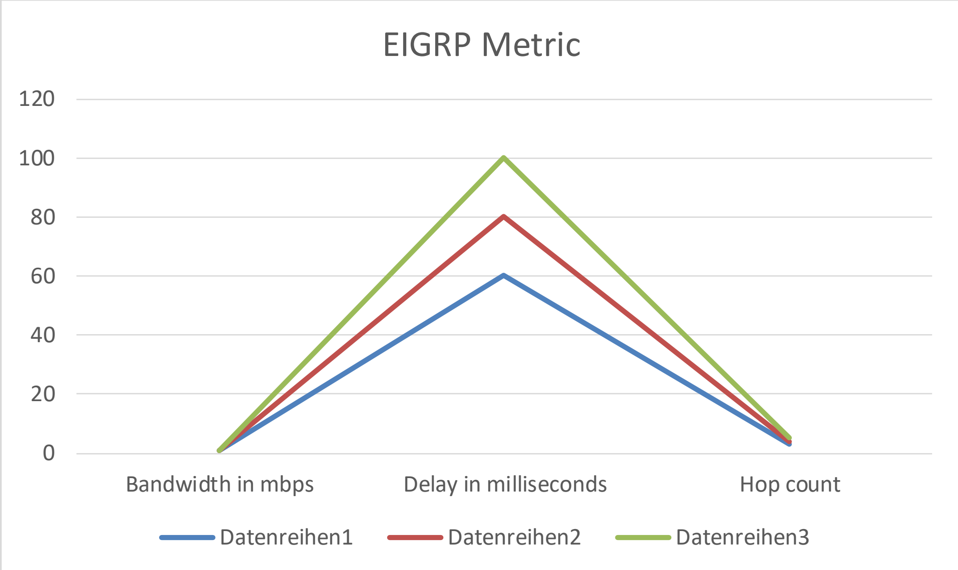

Figure 3: Graph Representation

VI. CONCLUSION AND FUTURE WORK

This network design shows the deployment of Segment routing over ipv6 network using EIGRP protocol. This workflow is resultant in the network simulation tool which also can be implemented in the real-time using the network devices for the future scope. The number of packet loss is smaller when using EIGRP as compared with OSPF. Whether it's using an IPv4 addressing or IPv6 addressing. This is because EIGRP uses DUAL algorithm that includes a successor when a route is lost. By using EIGRP, the packet loss ranging from 1 to 3. Meanwhile, when using OSPF, packet loss ranging from 2 to 4. The route chosen by the router is the route with the least metric. This can be seen from the results of a traceroute performed on several PCs.

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