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Comparative Analysis of Two Prominent Routing Protocols in IPv6 Network: OSPFv3 & EIGRPv6

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Abstract

Due to the huge demand of Internet, computer network has been transited from IPv4 to IPv6 environment. New routing protocols are also needed in IPv6 network. Among them two are very prominent: IETF's OSPF and Cisco's EIGRP. In IPv6 network, they are known as OSPFv3 and EIGRPv6 respectively. Though several researchers have worked in these area, but this paper have analyzed the comparisons between these two routing protocols more intensively. In this paper, packet loss, routing convergence speed and end to end delay have been considered as the parameters of the comparisons. The comparisons have been evaluated in Cisco's simulation environment; Packet Tracer.

Keywords: IPv4; IPv6; OSPF; OSPFv3; EIGRP; EIGRPv6.

1. Introduction

IPv6, the latest version of Internet Protocol was first introduced in 1998. 128 bits are being used in IPv6, on the other hand, our running IPv4 is using 32 bits. Internet user is increasing day by day. Till the year 2000, 50% of total IPv4 space were used. To support upcoming generations, Internet protocol addressing system is needed to implant some up gradation [1]. By measuring these matters, IETF (Internet Engineering Task Force) started to develop another version of Internet Protocol to support IPv4 at 1994, which is known as IPv6 now. In the year 1998, the basic protocol (RFC 2460) was published [2].

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There are many features in IPv6 as like [3, 4]:

- In IPv6, IP header is better optimized by removing facultative fields by replacing them after IPv6 header. Here the IPv6 header is easily passable between the routers.
- IPv6 has a very large addressing space with 128 bits. This is for giving the addressing and sub-netting an up gradation.
- There might be no need of NAT (Network Address Translation) when IPv6 is fully applied.
- For ISP (Internet Service Provider), more effective addressing and routing Infrastructure is provided.
- With IPv6, a host can be configured automatically with the Link-local address.
- IPSec is mandatory in IPv6. So there will be built in Internet security.
- IPv6 is totally compatible for implementing new features by adding extension headers.

Routing IPv6 traffic is not supported by existing IPv4 routing protocols [5]. Development of IPv6 dynamic routing protocols are essential due to the importance upon reliability and scalability in many networks. Dynamic routing protocols are much better than the static routing protocol due to the ability to automatically adjust to network topological changes. These changes are included like failed components and rerouting traffic through alternative paths. There are several interior routing protocols are available for IPv6 network. Among them 2 are very prominent. One of them is OSPFv3 (Open Shortest Path First version 3) and another one is EIGRPv6 (Enhanced Interior Gateway Routing Protocol version 6).

There are several works have been done with these routing protocols. In [6], the authors have analyzed RIP and OSPF in IPv6 network. The authors in [7] have compared and discussed OSPF and EIGRP routing protocols with the IPv6 network and IPv4 network. IKram Ud Din and Saeed Mahfooz [8], shown the performance analysis of various routing protocols like RIP, OSPF, IGRP and EIGRP with the parameters such as packets dropping, traffic received, end to end delay and jitter in voice. Some other related works have been done in [9-13].

The entire paper has been organized as: section 1 introduces the paper, section 2 will show the theoretical comparison between the routing protocols, section 3 will show the simulation network topology. Results will be analyzed in section 4 and the paper will conclude in section 5.

2. Comparison of Routing Protocols

This section will discuss the two interior routing protocols for IPv6 network and also their theoretical comparisons.

2.1. OSPFv3

OSPF (Open Shortest Path First) is also an IGP (Interior Gateway Protocol), which may be the most widely used in large networks. It has mainly replaced the older RIP (Routing Information Protocol) [14]. There are three versions of OSPF. This protocol keeps a routing table which contains the shortest path for going to a remote network. The path is calculated using Dijkstra’s algorithm. If there is any change learned by an OSPF router in the network environment and if the shortest path is changed, then the router multicast the latest information to all other router situated in the Open Shortest Path Fast (OSPF). All routers in the OSPF network gets the same routing table containing the shortest path to other routers by this way. RIP or BGP (Border Gateway Protocol) to be connected with other routers, which run on other protocols than OSPF. OSPF protocol number is 89.OSPF multicast address is 244.0.0.5 for all routers and 244.0.0.6 for the designated router. In IPv6, ff02::5 is being used for all SPF routers and ff02::6 is for designated routers [15].

2.2. EIGRPv6

Enhanced Interior Gateway Routing Protocol, in short EIGRP is the upgraded version of IGRP. EIGRP just has an improved architecture than IGRP but most of the features remain same [16]. As like, fundamental or basic distance information remains unchanged. The operating efficiency or the convergence properties is improved in EIGRP. EIGRP first introduced in 1993 by CISCO. EIGRP is a distance vector routing protocol. So the routers in EIGRP automatically shares information between the routers about the routing path. For finding the best routing path to a remote network, DUAL (Diffusing Update Algorithm) is used which prevents calculating errors. For finding best path, Bandwidth, Load, Delay, Reliability and MTU (Maximum Transmission Unit) is noticed. Reliable Transport Protocol (RTP) of Cisco is used in EIGRP instead of User Datagram Protocol or Transmission Control Protocol [17]. So in EIGRP, no port number is used to identify traffic but it supports maximizing efficiency and also multicasting. EIGRP protocol number is 88 and multicasting address in IPv4 is 244.0.0.10 and in IPv6 is ff02::a, which.

We can see the comparison table for better understanding:

Table 1: Comparison between OSPFv3 and EIGRPv6

Point	**OSPFv3**	**EIGRPv6**
Protocol Type	Link-State	Hybrid
Protocol Number	89	88
Default Metric	Path Cost	Bandwidth/ Delay
Algorithms	Dijkastra	DUAL
Update Operation	In every 30 mins, LSA (Link-State Advertisement) table is updated	Only at time of occurring changes
Updating address	244.0.0.5 & 244.0.0.6 (DR & BDR)	244.0.0.10
Hop-Count (Limit)	None	244 (100 default)
VLSM Supporting	Yes	Yes
Convergence	Fast	Faster
Administrative distance	110	External=170, Internal=90
Updating Part	Only Changes	Only Changes

3. Simulation Network Topology

For the analysis of the performance between the routing protocols, Packet Tracer 6.2.2 has been used. For the simulation purposes, Cisco's router, switch and general computers have been used. Standard IPv6 addresses have been used in these topologies.

3.1 Implementation of OSPFv3

For the simulation purpose of OSPFv3, the following topology has been used:

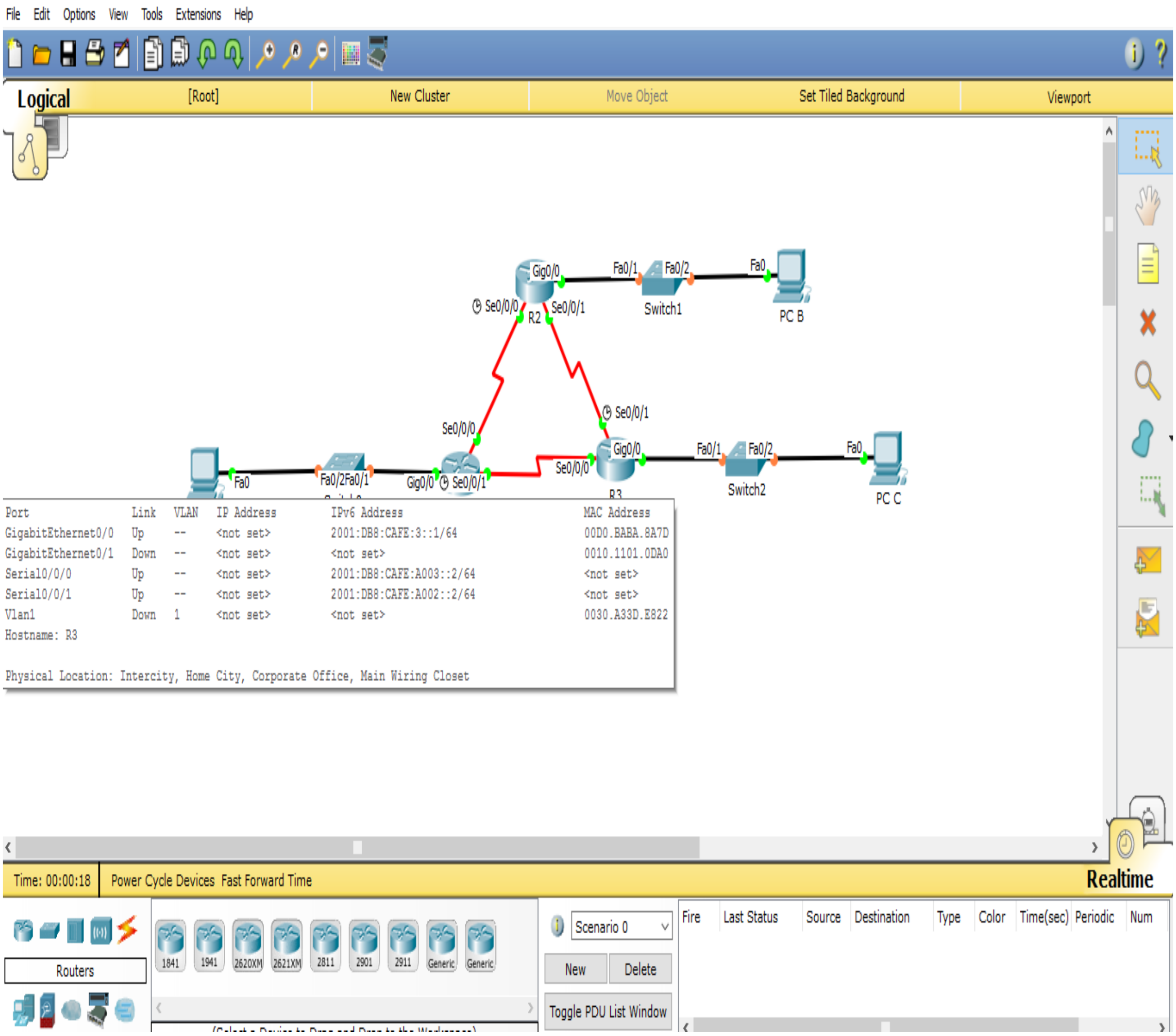

Figure 1: Topology for the OSPFv3

After run the simulation, the followoing situation has been found:

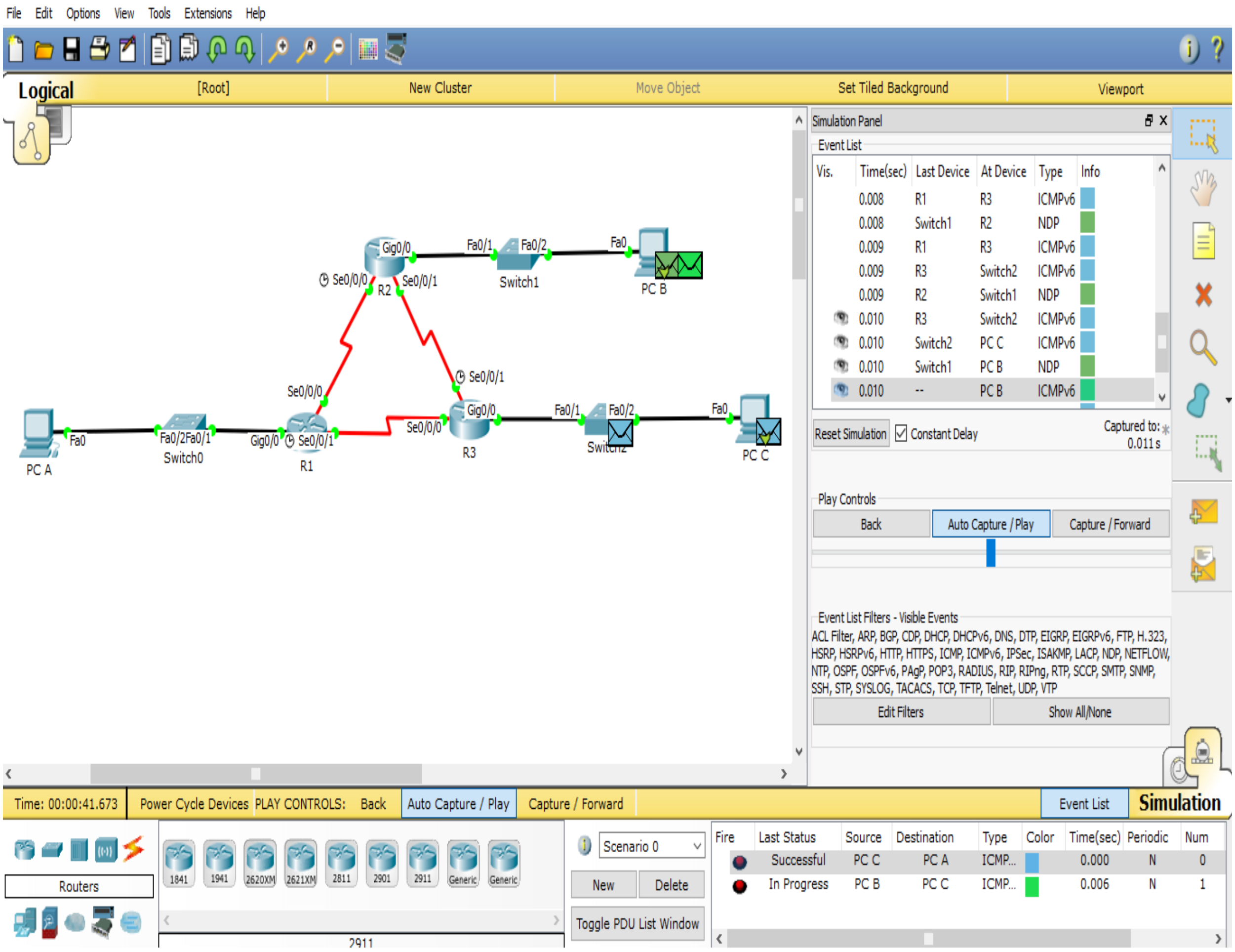

Figure 2: Simulation of the OSPFv3 routing protocols

The following codes have been used in Packet Tracer 6.2.2 for the above topology.

Only the routing protocol related codes have been shown here:

Table 2: Packet Tracer Code for the OSPFv3 Simulation (summarized)

For Router 1	For Router 2	For Router 3
ipv6 unicast-routing	*ipv6 unicast-routing*	*ipv6 unicast-routing*
ipv6 router ospf 10	*ipv6 router ospf 10*	*ipv6 router ospf 10*
router-id 1.1.1.1	*router-id 2.2.2.2*	*router-id 3.3.3.3*
exit	*exit*	*exit*
int g0/0	*int g0/0*	*int g0/0*
ipv6 ospf 10 area 0	*ipv6 ospf 10 area 0*	*ipv6 ospf 10 area 0*
int s0/0/0	*int s0/0/0*	*int s0/0/0*
ipv6 ospf 10 area 0	*ipv6 ospf 10 area 0*	*ipv6 ospf 10 area 0*
int s0/0/1	*int s0/0/1*	*int s0/0/1*
ipv6 ospf 10 area 0	*ipv6 ospf 10 area 0*	*ipv6 ospf 10 area 0*

3.2 Implementation of EIGRPv6

For configuring EIGRP using IPv6, there must be a router ID preconfigured before it is available to run.

The network statement is unavailable in EIGRP while using IPv6. Network interfaces could be directly configured without using any global IPv6 address.

IPv6 EIGRP has 'shutdown' feature like network interfaces.

So for starting the routing process "no shut" command has to be made. Following topology has been considered for the performance analysis.

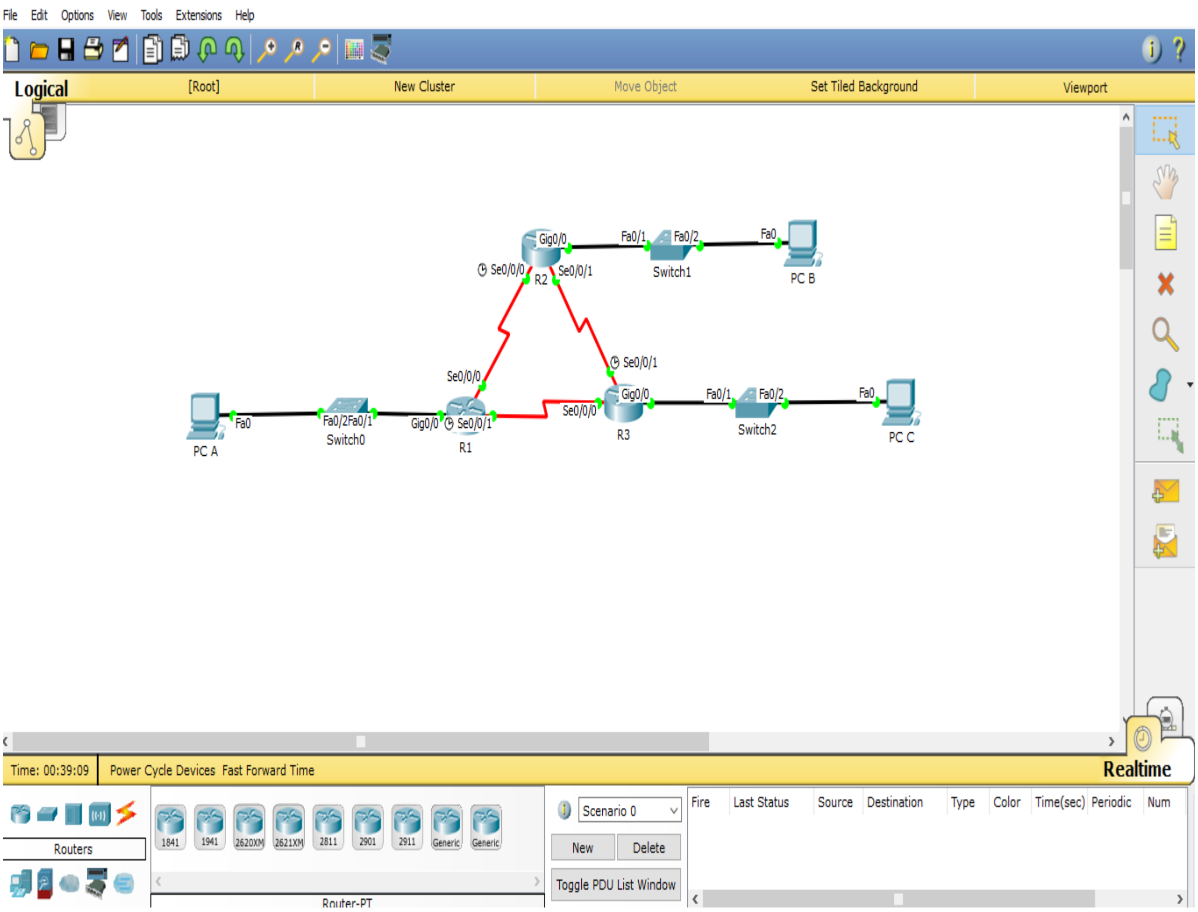

Figure 3: Topology for the EIGRPv6

After do the simulation, the followoing situation has been found:

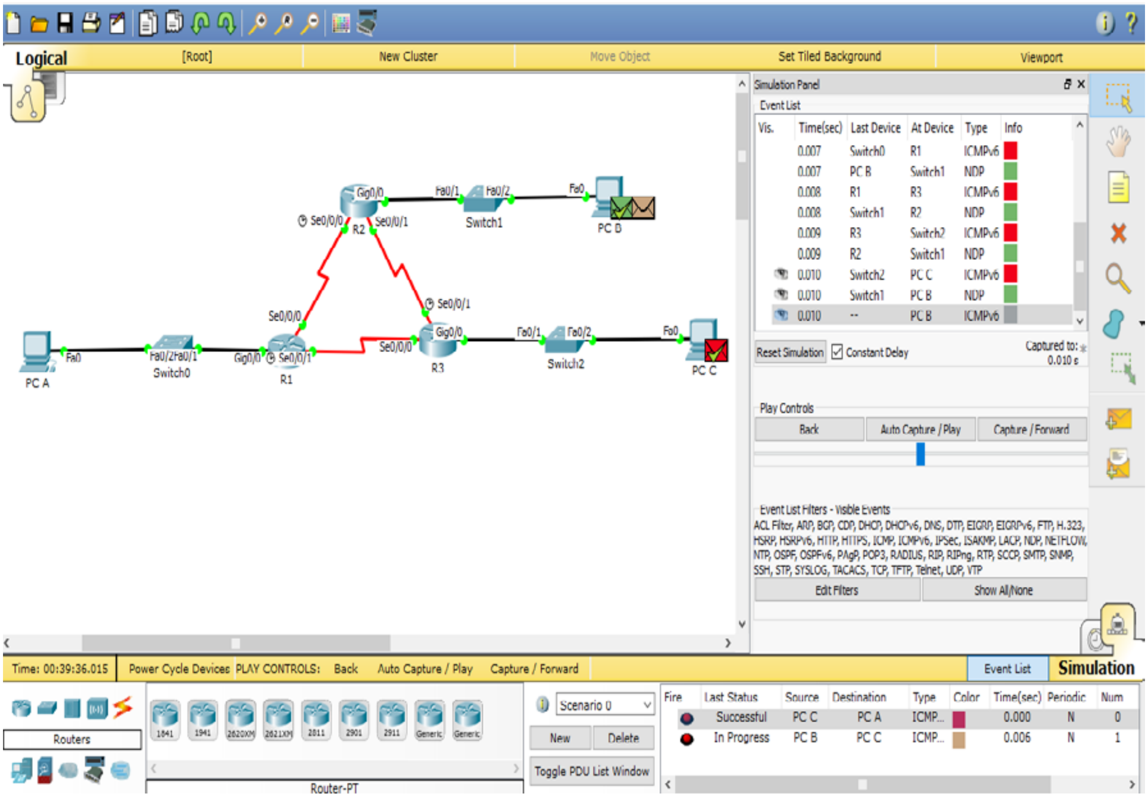

Figure 4: Simulation of the EIGRPv6 routing protocols

The following codes have been used in Packet Tracer 6.2.2 for the above topology. Only the routing protocol related codes have been shown here:

Table 3: Packet Tracer Code for the EIGRPv6 Simulation (summarized)

For Router 1	For Router 2	For Router 3
ipv6 unicast-routing	*ipv6 unicast-routing*	*ipv6 unicast-routing*
ipv6 router eigrp 1	*ipv6 router eigrp 1*	*ipv6 router eigrp 1*
no shut	*no shut*	*no shut*
eigrp router-id 1.1.1.1	*eigrp router-id 2.2.2.2*	*eigrp router-id 3.3.3.3*
exit	*exit*	*exit*
int g0/0	*int g0/0*	*int g0/0*
ipv6 eigrp 1	*ipv6 eigrp 1*	*ipv6 eigrp 1*
int s0/0/0	*int s0/0/0*	*int s0/0/0*
ipv6 eigrp 1	*ipv6 eigrp 1*	*ipv6 eigrp 1*
int s0/0/1	*int s0/0/1*	*int s0/0/1*
ipv6 eigrp 1	*ipv6 eigrp 1*	*ipv6 eigrp 1*

4. Results & Analysis

In this section, the results got from the above simulations have been analyzed. In our simulation we have used complex ‘ping’ packet.

4.1 Analysis of packet loss comparison

In the first analysis, we have increased the transmitted packet size for both the topologies. Packet loss occurs when one or more packets of data travelling across a computer network fail to reach their destination. Packet loss is typically caused by network congestion failed to choose the alternative paths immediately. It has been found that, increasing the packet size will result the increasing the number of packet loss. In Figure 1, it is shown that the packet loss is more for the OSPFv3 network than the EIGRPv6 network. So, for the packet loss perspective, EIGRPv6 performs much better than OSPFv3.

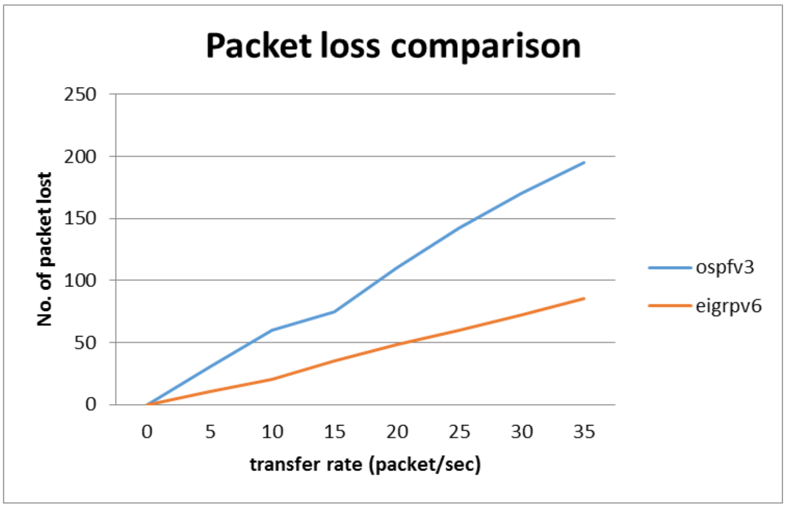

Figure 5: Packet loss comparison between OSPFv3 and EIGRPv6

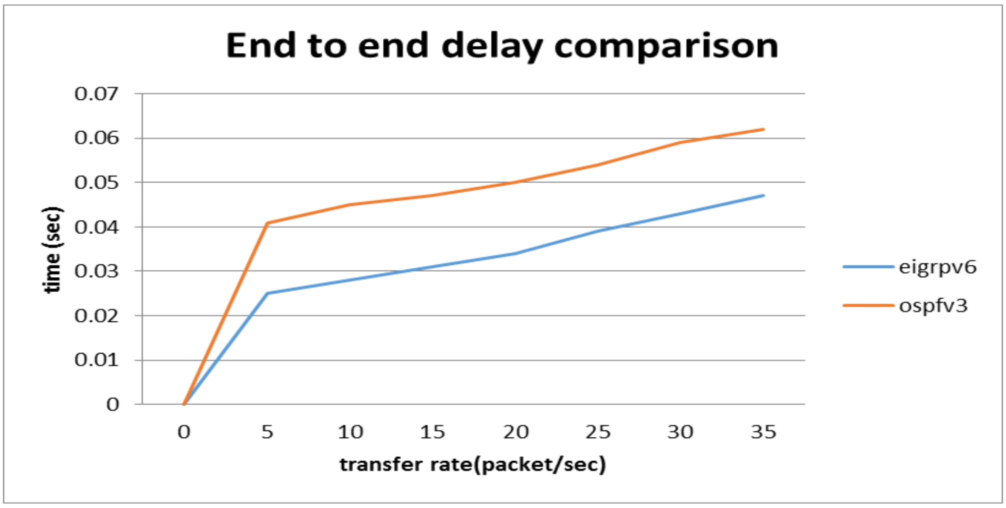

Figure 6: End to end delay comparison between OSPFv3 and EIGRPv6

4.2 Analysis of end to end delay comparison

End-to-end delay is referred as the time taken for a packet to be transmitted across a network from source to destination. It is a common term used in IP network monitoring. In Figure 2, it is shown that increasing the packet size will increase the end to end delay, because the increasing of congestion and the routing delay. In this Figure 2. OSPFv3 has more end to end delay than EIGRPv6. So here also EIGRPv6 performs the better.

4.3 Analysis of convergence time comparison

Convergence is the state of a set of routers that have the same topological information about the internetwork in which they operate via the implemented routing protocol. In Figure 3, we have found that OSPFv3 takes around 9 seconds while EIGRPv6 takes 6 seconds. So, in the case of convergence time, EIGRPv6 is also the faster than the OSPFv3.

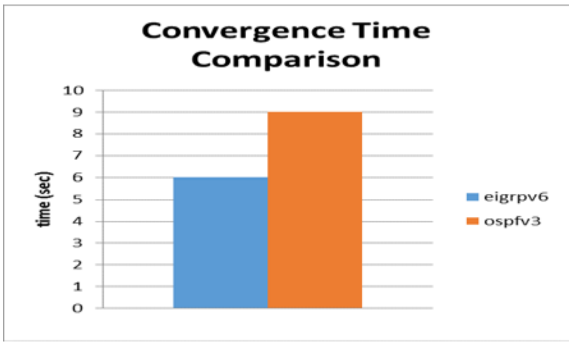

Figure 7: Convergence time comparison between OSPFv3 and EIGRPv6

This is due to EIGRP uses DUAL to provide fast convergence whilst OSPF detects topology changes using hello timers and interface changes. This triggers LSA to update neighbors, optimizations to convergence in OSPF are done by changing timer values.

5. Conclusion

The paper has been discussed two eminent interior routing protocols. Their performances have been analyzed considering the parameters of packet loss, end to end delay and convergence timing. In our analysis, we have found that EIGRPv6 performs much better that OSPFv3 in all these three cases. So our recommendation is to use EIGRPv6 as an interior routing protocols in IPv6 network. But the main disadvantage of EIGRPv6 is that, this routing protocols can only be used in the Cisco's routers only. In this case, OSPFv3 is the best alternative. In future, we will compare these routing protocols with considering the security issues of IPv6. The work will be also extended to the real life devices.

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