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Enhancing Data Dissemination in Dual-Stack Enterprise Hybrid Networks through Link State Routing Protocols

Piyush Sharma[1], Renu Singla[2],

M.Tech Student, Department of CSE, Shri Ram College of Engg. & Mgmt, Palwal, Haryana, India[1]

Asst. Professor, Department of CSE, Shri Ram College of Engg. & Mgmt, Palwal, Haryana, India[2]

ABSTRACT: The objective of this paper was to investigate and improve the performance of the two most well-known link-state routing protocols when spread in IPv4/IPv6 dual-stack hybrid networks. The paper aims to make the starting step of scientific research in comparison of performance of several routing protocols in IPv4-IPv6 coexistence environment that will become well-known and predominant for a long time-space with the IPv6 arrival. This objective was dictated by the lack of research related to the performance of routing protocols in dual-stack atmosphere, and by the need to further investigate the dominating conception which specifies that OSPF is most appropriate for enterprise networks and IS-IS is suitable for ISP networks. Furthermore, under this work range, IS-IS, OSPF were selected for the comparison, as they build two proven effective routing protocols with basic routing function characteristics. The aim of the work was to provide evidence-based proposal for selecting the protocol that offers optimal performance in business hybrid enterprise networks, in the new emerging network landscape, and recommend possible move from one protocol to another. For the thesis practical work, experiments were conducted utilizing the famous OPNET network modeler. The configured OSPF and IS-IS basic enterprise configurations over a dual-sta*ck* network were selected this way, as to evaluate their performance relating IPv6 and IPv4 traffic, as well as under several Transport Layer UDP and TCP traffic patterns. The simulations results exposed the superiority of IS-IS in comparison of OSPF, as far as routing table sizes, convergence times and throughput are related, where both protocol performed closely equal in terms of jitter and end-to-end delay times. Depending on these results, it can be considered that IS-IS shows a more optimal solution for dual-stack enterprise hybrid networks as compared to OSPF, and can be assumed from companies as a migration alternative, provided also the privilege of the single instance ability and the security benefit that it provides.

KEYWORDS: IS, UDP, TCP, OPNET, OSPF

I. INTRODUCTION

Internet Protocol version 4 (IPv4) is being utilized on Internet across the world today. As the internet size and no. of end devices i.e. routers, PCs or switches etc, are increasing IPv4 address exhaustion is occurring, IPv4 network endures more and more issues, i.e. the deficiency of address space etc. IPv6 is formulated by the Internet Engineering Task Force (IETF) to cover IPv4 address exhaustion. IANA's pool of IPv4 addresses has been exhausted in February 2011, and it is computed that Regional Internet Registry's (RIR) pool would be eliminated in 2011 [1]. So migration from IPv4 to IPv6 is a requirement of time. There are three migration ways namely, Dual stack, Translation and Tunnelling. Dual-stack technique helps the simultaneous presence of IPv6 and IPv4 resulting in decrement of network device up gradation cost, thus Dual-stack method is the optimal solution. In tunnelling mechanism tunnel encapsulate the IPv6 packets in IPv4 packets are conducted to the network parts that are not IPv6 enabled. Translation techniques are generally utilized when an IPv4 only device wishes to interact with an IPv6 only device, or vice versa. As the IPv6 has huge address size it is the best option for today's Internet network. The IPv6 has huge address space because the 128 bits IP address where as it is 32 bits in IPv4, thus transition technique from IPv4 to IPv6 is studied broadly and this paper primarily concentrates on dual stack technique.

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II. DUAL STACK MECHANISM

Dual stack mechanism is one of the simplest techniques of proposing IPv6 to a network and is also the best option for IPv4 to IPv6 to coexist simultaneously before the total transformation to IPv6 only network in the future. The Dual Stack mechanism is also known as Dual IP layer or native dual stack. In dual stack, all routers/hosts managed both protocol IPv6 and IPv4 stacks this becomes the benefit of a transition mechanism. Dual stack routers/hosts are capable to interact with not only IPv6 system but also IPv4 system. The dual stack hosts utilize IPv6 address while interacting with IPv6 host and utilize IPv4 address while interacting with IPv4 hosts[8][9]. Both protocols IPv4 and IPv6 operate parallels on the same network infrastructure which does not need encapsulation of IPv4 inside IPv6 and vice versa. Outdated resources do not support IPv6, thus it becomes significant to have a network which provides support to both IPv6 and IPv4 network. Operation of modes IPv6/IPv4 are: 1. IPv4-only operation where an IPv4 node has its stack enabled and its Ipv6 stack not enabled. 2. IPv6-only operation where an IPv4/IPv6 node has its IPv6 stack enabled and its Ipv4 stack not enabled. 3. IPv4/IPv6 operation where an IPv4/IPv46 node has both stacks enabled. A basic dual-stack migration mechanism as illustrated in fig 2, builds a transition from the core to the edge. This involves enabling two TCP/IP protocol stacks on the WAN core routers. In a general dual stack migration firstly the perimeter firewalls and routers then the server-farm switches and at last the desktop access routers. Once the network provides support to IPv4 and IPv6 protocols, the mechanism will enable dual protocol stacks on the servers and then the edge entities. The dual stack doubles the interaction needs, which leads to performance reduction.

III. LITERATURE SURVEY

Febby Nur Fatah et al. [1]: In this paper writers examined the Dual Stack IPv4-IPv6 system performance in university network by utilizing of delay period and jitter in interconnection. In their work, writers computed the delay period and jitter by transmitting various files with different size. For performance analysis, technique utilized by writers is the method by direct performance evaluation on the model or network prototype. After the implementation, writers conclude that Dual Stack system is most flexible implementation for migration of IPv4 to IPv6 system. Also IPv6 system is more stable and has less jitter as compared to IPv4.

M. Mehran Arshad Khan et al. [2]: In this Research paper writers show a groundwork analyze of IPv6 in Network migration and performance analysis in comparison of IPv4 in the network surrounding, which determine that network migration mechanism is a very necessary footstep in shaping how the interaction will take place and will support with or diminish from the IPv6 policies enforcement. Writers utilized OPNET IT Guru software tool for the implementation procedure. They attempted to calculate the bandwidth usage performance and RTT (Round Trip Time). After doing several experiments and examining all the results, writers concludes that total performance of the router-to-router tunneling is greater than host-to-host tunneling. The router devices support the IPv6 architecture and have all capabilities to provide the communication throughout the network and main cause of router high performance is that it operates on the layer3 of OSI Network model and supports all the routing characteristics.

Muhammad Yeasir Arafat et al. [3]: In this paper, writers concentrates on the most significant IPv6 theoretical ideas, i.e. address allocation, addressing, routing with the BGP and OSPF protocols and performance of routing protocols in dual stack network. For simulation technique, GNS3 and Wireshark modelers are utilized. In this paper, writers compiled IPv6 address planning in large scale network, performance statistics of every network in terms of TCP throughput, packet loss rate, delay jitters and round trip time. Writers introduced thatdual stack is the better technique to migrate in IPv6 network as compared to tunneling and NATtechniques. After the results of simulation, writers concluded that For TCP throughputs, the IPv6 network does as wellas the IPv4 network with respect to end-to-end performance. In a real large-scale atmosphere, theIPv6 network throughput increased frequently in small message sizes of 256 bytes, afterwhich, it levelled out until the 768-byte message size range.

Sheetal Borse et al. [4] : Here, in this paper writers explains several mechanisms for migration of IPv4 to IPv6 protocol through dual stack technique in Local Area Network(LAN). For the implementation objective, they utilized Packet Tracer version 6.0.1 software. Performance is inquired utilizing the Round Trip Time (RTT) and Ping connectivity of IPv4/IPv6 networks and IPv4 and IPv6 packets were examined utilizing Network Protocol Analyzer tool Wireshark. After examining the results of simulation, writers conclude that transition platform IPv4 based websites can be accessed and web page is shown, yet, IPv6 based webpage can also be shown lest the webpage is available at the server side. Also, RTT (Round Trip Time) for IPv6 is lesser as compared to that of IPv4.

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Yuk-Nam Law et al. [5]: In this paper writers show comprehensive empirical evaluations of the IPv6 network performance from an end subscriber perspective. In their work writer calculate the performance differences of utilizing IPv6 vs IPv4 with respect to several network metrics i.e. network connectivity, throughput, hop count, RTT, operating systems dependencies as well as address configuration latency by transmitting probing traffic from our dual stack IPv6/IPv4 test bed to over 2000 dual stack hosts worldwide. They also investigate the performance effect of utilizing IPv6 tunneling brokers rather than native IPv6 facilities. Writers utilized both TCP and ICMP traffic to compute the IPv6 network performance. After the implementation, writers conclude that IPv6 network is capable to offer stable network connectivity for IPv6 end-subscribers. Ipv6 throughput is much greater as compared to IPv4 because of high bandwidth and low traffic load of IPv6.

IV. SIMULATION METHODOLOGY

In the flowchart of proposed methodology, an OSPF scenario has been created using 8 Cisco 7200 routers which are connected to each other using DS3 links. An application demand and four 2940 switches were applied. Dual Stack server was selected for both IPv4 and IPv6 regions.

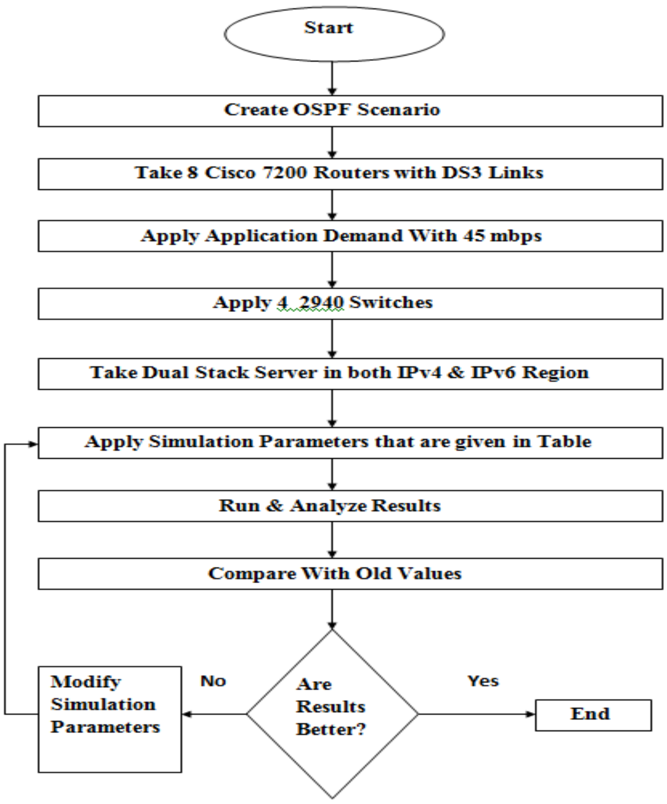

Figure 1: Flow Chart of Proposed Methodology

For the needs of the experiment a baseline small enterprise network topology was configured. As both OSPF and IS-IS are hierarchical routing protocols, a network topology consisting of three areas was designed, so that it could simulate a similar routing scenario for each one of them. The baseline topology obeyed to the commonly used in enterprise networks, Cisco three-layer hierarchical model, although the very specific functions of this model such as the security options of the *distribution layer* and the connectivity to the Internet by the *core layer* are not in the scope of this paper. Eight Cisco 7200 routers were selected for the simulation, as Cisco hardware is usually preferred by a large amount of businesses, and the connections between them were selected to be serial Digital Signal 3 (DS3) links supporting a 45 Mbps bandwidth.As is usual in enterprise networks, the *access layer* of the topology that is used to connect the end-

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devices to the main network was linked with the Distribution Layer by using Fast Ethernet 100Mbps links. Moreover, the two subnets in the first area of the baseline topology included four hosts each (OPNET *ethernet_wkstn_adv* model), and the two subnets of the second area included one Server each (OPNET *ethernet_server_adv*) for the needs of the experiments. All those end-devices were offered connectivity to the access layer routers by four simple Cisco Catalyst 2940 Layer 2 switches.

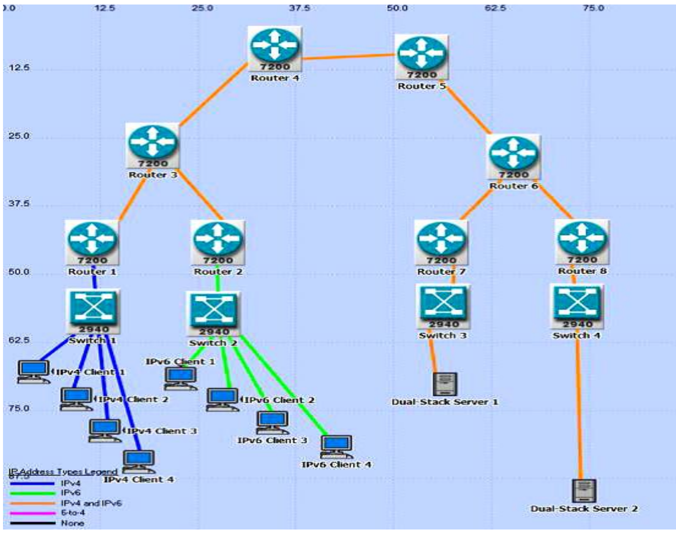

Figure 2: Simulation Model

OPNET Modeler makes able the addition of hardware by the use of its Object Palette that is shown in the following figure.Regardless, of the configured routing protocol, the concept of the experiments was based on the initial idea of designing a completely dual-stack network. Therefore, all participating routers and servers were configured manually with both IPv4 and IPv6 addresses.

V. RESULTS AND ANALYSIS

5.1 Throughput comparison of Improved OSPF and Improved IS-IS: Throughput can be described as the ratio of the total amount of data arrive a destination node from the source node. The time it consumes by the destination node to obtain the last message is known as throughput. It can be represented as bytes or bits per seconds (byte/sec or bit/sec). A greater throughput is absolute choice in each network.In fig 3, throughput comparison of enhanced OSPF and enhanced IS-IS has been done. Clearly, OSPF has greater throughput as compared to the IS-IS throughput.

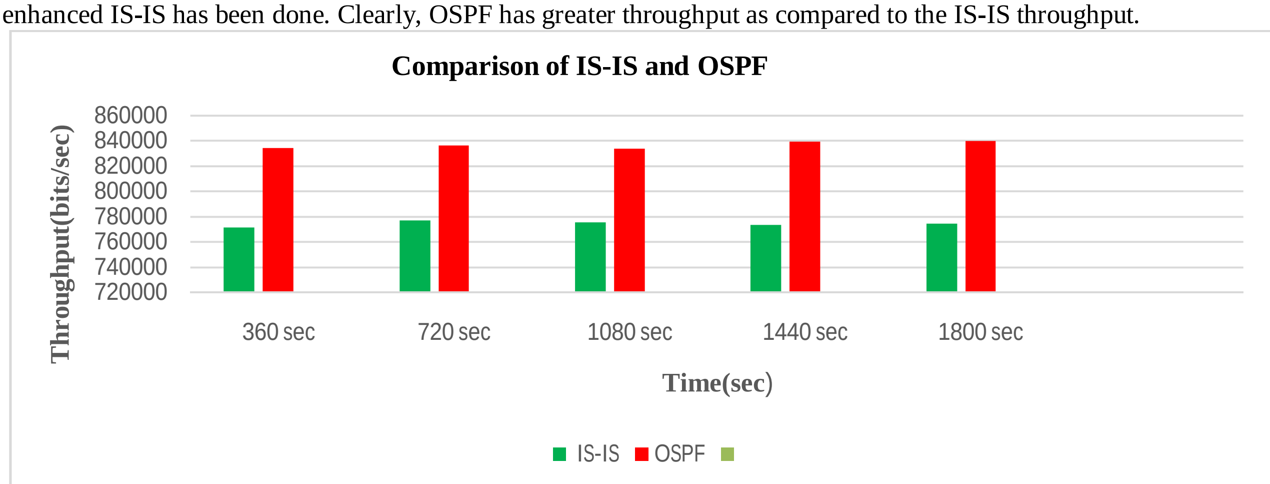

Figure 3: Throughput comparison of Improved OSPF and Improved IS-IS

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Table 1 shows the comparison of values of throughput of enhanced IS-IS and enhanced OSPF. OSPF throughput is greater as compared to IS-IS. This represents that OSPF is much effective in comparison of IS-IS.

Table 1 Throughput comparison of Improved IS-IS and Improved OSPF

Time(sec)	Improved IS-IS	Improved OSPF
360	771776	834848
720	777504	836480
1080	775808	834272
1440	773856	839712
1800	774848	840192

5.2 Network Load comparison of Improved OSPF and Improved IS-IS

Network Load is a significant parameter with a powerful impact on protocols of network. It has responsibility for traffic delay. It can be represented as bytes or bits per seconds (byte/sec or bit/sec). There are some factors that influence the throughput i.e.; existence of limited bandwidth, changes in topology, unreliable communication among nodes and restricted energy. If a routing protocol has less network load, it is known as the effective routing protocol.
In fig 4, network load comparison of enhanced OSPF and enhanced IS-IS has been performed. IS-IS has greater network load as compared to OSPF. So, OSPF is more effective in comparison of IS-IS.

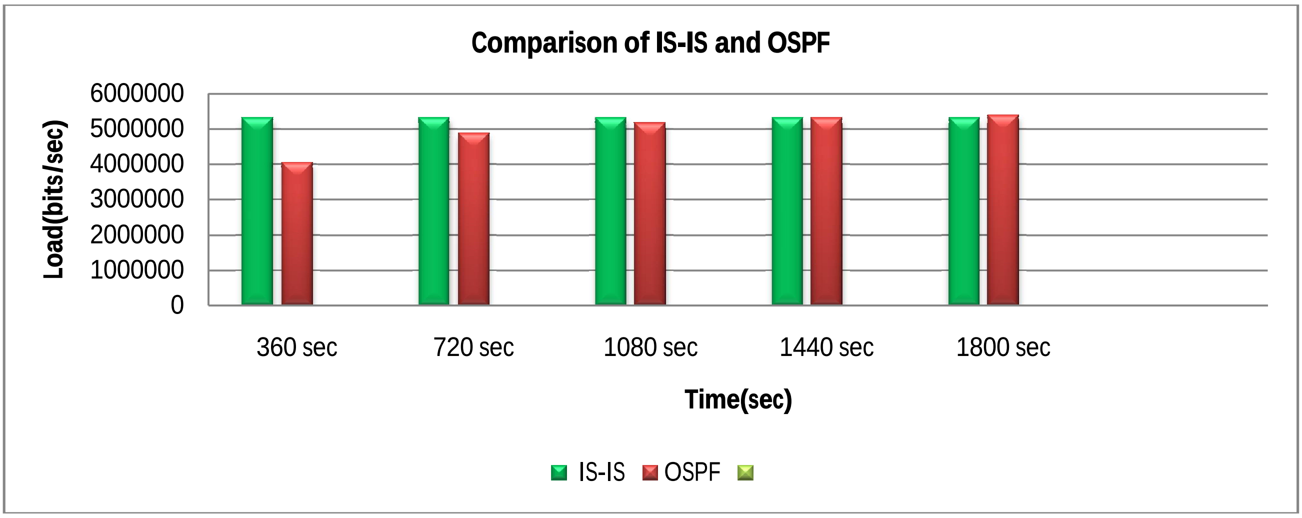

Figure 4: Network Load comparison of OSPF and IS-IS

Table 2 shows the network load of enhanced OSPF and enhanced IS-IS. Clearly, OSPF has low network load as compared to IS-IS. Thus, OSPF is more effective than IS-IS.

Table 2 Network Load comparison of Improved IS-IS and Improved OSPF

Time(sec)	Improved IS-IS	Improved OSPF
360	5328000	4046578
720	5328000	4882393
1080	5328000	5170133
1440	5328000	5315779
1800	5328000	5400181

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VI. CONCLUSION

Overall, this dissertation through literature review and experimental analysis proved that IS-IS should be reconsidered as a more efficient solution than OSPF in the near future, as it demonstrates several performance benefits compared to the latter when configured in dual-stack enterprise networks. The Literature Review of the dissertation showed that the dual-stack migration mechanism will be the most common, and an integral part of the evolution to IPv6. New application demands need to be accommodated by the IPv4 - IPv6 networks that will constitute the new networking world for a non-predictable time space until the complete prevalence of IPv6, and thus, the effectiveness of the configured routing protocol will be of great importance. In this framework, the thesis presented results which imply that IS-IS converges much faster and achieves much higher successful delivery of packets than the competing link-state protocol OSPF. The selected simulated network topology size, and the fact that the experiment results demonstrated same analogies and contrasts for IPv4-only and IPv6-only clients, as well as for both TCP and UDP traffic, enhances the idea that the dawn of the IPv6 era should bring reconsideration regarding the selection of IS-IS for enterprise networks as a first choice. It is believed that the performance and security vantages that IS-IS offers especially for the IPv4-IPv6 coexistence period outweigh the theoretical understanding difficulties, and should be elements integrated in educational networking programs in order to familiarize potential new engineers.

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