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Comparative Analysis of OSPFv3/IS-IS and RIPng/IS-IS Mixed Protocols for Real-Time Applications in IPv6 Communication Networks

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Original Research Article

ABSTRACT

In network designs, the decision made when implementing dynamic routing protocols is very paramount to the speed of the network. To make the best choice of protocol to deploy, several decisions has to be considered. Usually, these decisions are made based on the performance of the routing protocol with respect to some quantitative parameters. The protocol that performs better than other protocols involved in a research is selected for routing purposes. In this research paper, performance comparison of two mixed protocols namely OSPFv3/IS-IS and RIPng/IS-IS in IPv6 network has been made. Their performances have been measured and comparison made by simulation using Riverbed Modeller Academic Edition. The objective of this paper is mainly to determine which of the mixed protocols will be more suitable to route traffic in IPv6 network. The main motivation for this paper is to find out if the difference in the routing algorithms of RIPng and IS-IS will offset and produce a better performance than a combination of two routing protocols of the same routing algorithm (thus OSPFv3 and IS-IS). To achieve this paper's objective, the simulation was divided into two scenarios. The first scenario was an OSPFv3/IS-IS configured IPv6 network topology. The second scenario is a copy of the first scenario but configured with RIPng/IS-IS. The two scenarios were simulated and the effect of using each of the scenarios to separately route the selected applications was measured and recorded. The performance comparison of the mixed protocols was based on the following quantitative parameters: database query response time, database query traffics received, email upload/download response time, ftp upload/download response time, ftp traffic received, http page response time, remote login response timeandIPv6 traffics dropped. The results obtained from the simulation indicated that RIPng/IS-IS scenario performed better in email download/upload response time, remote login response time, IPv6 traffics dropped and remote login response time while the mixture of OSPFv3/IS-IS performed better in database query response time, database query traffics received, ftp download/upload response time, ftp traffic received and http page response time. Hence OSPFv3/IS-IS is the better option when the choice is between RIPng/IS-IS and OSPFv3/IS-IS for most of the quantitative parameters involved in this paper. This is because the combination of RIPng and IS-IS took a longer time to converge, affecting the speed on the network scenario. The time the RIPng/IS-IS combination took to access most of the application servers is slower than that of OSPFv3/IS-IS network scenario. On the basis of database query and ftp traffics received, the simulation results showed that network configured with OSPFv3/IS-IS performs better than RIPng/IS-IS. This is because the OSPFv3/IS-IS received the highest database and ftp traffics. The mixture of OSPFv3/IS-IS sent and received more application packets because it had very high throughput values which had an effect on the total quantity of application traffics received. Although the OSPFv3/IS-IS network scenario recorded

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the highest database and ftp traffics, this could not affect its speed to become lower than the RIPng/IS-IS scenario.

Keywords: Dynamic routing; OSPFv3; IS–IS; RIPng and IPv6; route redistribution.

General Terms: Performance; communication networks; routing algorithm; network simulation; quantitative parameters.

1. INTRODUCTION

The current explosive growth of internet users has resulted in IPv4 address space being exhausted. This has made IPv6 legitimate and inevitable in IP networks. With its large address space, IPv6 has become suitable as the next-generation of Internet Protocol and will be used to replace the legacy IPv4 in the near future. Interest for IPv6 utilization is rising bit by bit and will never again be a discretionary errand however obligatory, particularly for institutions that will require extension later on. IPv6 was completely designed on the basics of IPv4. However, some existing features in IPv4 are replaced with newly enhanced features in IPv6, and this has changed the packet layout of IPv6 making it different from IPv4 packet layout. The distinction in the packet arrangement or structure of the two protocols implies that IPv6 traffic routing will never again be bolstered by regular routing protocols that exist in IPv4; consequently, new directing conventions that will be good to route IPv6 packets must be utilized [1]. Routing insecurity is observed to be one of the real reasons for network debasement in the performance of internet services. Any disruption in a network for a couple of few microseconds can disturb video and voice communication amid the convergence of the protocol. For instance, voice packets can delay, get lost or experience the ill effects of jitter making the network debase in execution. Along these lines, to proficiently and viably route data in communication systems, deploying the appropriate dynamic routing protocol(s) is a basic attainment element to accomplish superior outcome.

Also, in today’s real-world networks, combining two or more routing protocols for better routing of packets has become the best practices among network engineers and administrators [2].This practice has become common in IPv4 networks. This is because there are numerous publications that express a better performance when several routing protocols are combined on an IPv4 network for some quantitative parameters. However, the same cannot be said about IPv6 routing; only few literatures exist. The change in IPv6 protocol structure that has made it differ from its IPv4 counterpart has made it necessary to investigate the performance of a mixture of IPv6 supported routing protocols as well. In this paper, the performance of RIPng/IS-IS and OSPFv3/IS–IS has been assessed and a comparison is made for some applications namely remote login, database query, email, file transfer and web browsing. The performance of these mixed protocols was evaluated based on remote login response time, database query response time, database query traffic received, ftp upload/download response times, ftp traffic received, http page response time, email download/upload response time, and IPv6 traffics dropped as the main parameters. Two of the three routing protocols use the same routing algorithm while one of them uses a different algorithm. All these two algorithms have advantages and disadvantages. Hence pairing two of the routing protocols of different routing algorithm and comparing with another pair with the same routing algorithm on a single network topology is very vital to select the more suitable hybrid protocol for routing IPv6 network traffic.

2. RELATED WORK

A lot of simulation-based investigations have been conducted to assess the behaviour of routing of various routing protocols with the greater part of the examination being directed at OSPF, RIP and IS-IS because of their versatility over different types of routing. Investigating the performance of a mixture of these dynamic protocols on an IPv6 network is scarcely available. An observation of other related research papers supposes that there actually is no perfect document that explicitly compares the performance when two protocols of different routing mechanism are combined on a network as opposed to two different routing protocols with the same routing mechanism on an IPv6 network topology. These researches are collected and summarized below:

A performance evaluation of IS-IS, EIGRP, OSPF and the combination of EIGRP/IS-IS and IS-IS/OSPF based on simulation was done by Pandey et al.,[3]. The response time for the email download, throughput and http object response time were the quantitative indicators used to measure the routing behaviour on a particular network. In their study, a network topology was designed. Four more copies of this network topology were done so that each of the five routing protocol scenarios will be simulated on the same network topology. At the end of their simulation, the combination of IS-IS/EIGRP routing protocols performed better than the other scenarios. Their network was simulated with the use of Optimized Network Engineering Tool (OPNET).

Hilal, R [4] have performed a performance evaluation of OSPFv2/OSPFv3, IS-IS and RIPv2/RIPng protocols combinations on dual stack, 6to4 automatic tunnel and manual tunnel IPv4 to IPv6 transition mechanisms based on simulation. In their research, they simulated these combinations on the same network to ascertain which of the mixed protocols can singly route packets of some network applications better than the other as well as the robustness of each of the protocols. To achieve this, they used several quantitative metrics which includes delay, delay variation, and packet loss as the quantitative parameters. They used the OPNET as their simulation tool for their research. Their research showed that, for the three combinations dual stack network combination performed better for all the quantitative metrics used.

By using OPNET, Rani & Kaur [5] have performed a different evaluation with IS-IS, RIPng/IS-IS and RIPng routing protocols based on simulation. Their analysis was carried out on the same network topology with the following metrics: email upload/download response time, http object response time, http page response time, video end to end delay, voice end to end delay, remote login response time, MOS value and jitter. In their research, it was observed that, aside the video end to end delay that RIPng performed better and the MOS value being almost the same for the various scenarios, the RIPng/IS-IS performed better in the rest of the quantitative parameters, namely email upload/download response time, http object response time, http page response time, voice end to end delay, remote login response time and jitter.

Kaur et al, [6] performed a comparative analysis of OSPFv3, IS-IS and a combination of OSPFv3 and IS-IS based on simulation. In their study, they used three scenarios of the same kind on which OSPFv3, IS-IS and theOSPFv3/IS-IS combination were respectively configured. Packet end-to-end delay and jitter in delay, voice and video traffic were the quantitative parameters they used in measuring the performance. Looking at the obtained results from their research, it came out that when it comes to video end-to-end delay, IS-IS does better than OSPv3 and the OSPFv3/IS-IS combination. The performance of OSPv3 outweighs that of IS-IS and OSPFv3/IS-IS for jitter (variation) in delay. The OSPFv3/IS-IS combination also does better than OSPFv3 and IS-IS when it comes to voice and end-to-end delay. In order to get this, the simulation tool, OPNET was used by them.

Susom A., [7] carried out a simulation-based research on the efficiency of routing protocols for some networking scenarios. In his research he evaluated the effectiveness of RIPv2, EIGRP, OSPF and a mixture of these three protocols for different sized networks through the use of Graphical Network Simulator-3 (GNS3). By using the four qualitative parameters which are packet length, packet loss, throughput and jitter, the comparison of these protocols was done. The performance of the individual protocols and a mixture of them were measured and recorded. From his findings, it was observed that EIGRP performs better than RIPv2 and the hybrid protocol whereas the RIP/OSPF protocol records the smallest average throughput. Again, EIGRP obtains the least value in loss of packet whilst the hybrid of RIP/OSPF/EIGRP records the smallest jitter value.

In this paper, performances of OSPFv3/IS-IS and RIPng/IS–IS have been measured for some enterprise applications in IPv6 network. Performance assessment was undertaken based on the following parameters: database query response time, database query traffics received, email download response time, email upload response time, ftp download response time, ftp upload response time, ftp traffic received, http page response time IPv6 traffics dropped and remote login response time.

2.1 Open Shortest Path First Version 3 (OSPFv3)

OSPFv3 is the third version of the primary OSPF routing protocol developed by Interior Gateway Protocol working group of the Internet Engineering Task Force for IP networks. The primary version of OSPF found in RFC 1131 was published in 1989. The second version was introduced in 1998 and was outlined in RFC 2328. In 1999, OSPFv3 that supports IPv6 was delineated in RFC 2740. OSPFv3 is basically used for the supply of routing capabilities and has become a focal routing protocol in IPv6 networks. Like OSPFv1 and 2, OSPFv3 is a link state routing protocol designed to distribute information internal to a particular autonomous system. It is used widely nowadays as the interior routing protocol in TCP/IP networks. The fundamental idea is to find out the least cost by computing the best path within the network that is the shortest path available from the source to the destination network [8].

Each router will maintain a database; this database will contain the entire information of the routing domain. The database basically consists of the topology of the autonomous system which includes the vertices and edges. This database is maintained by each of the routers. The vertices comprise of the router and network while the edges may represent two routers linked with one other by direct point-to-point connection or a router with a straightforward connection to a network. A router computes the least-cost path to all the destination networks with the use of Dijkstra’s algorithm and the forwarding process uses only the next hop to the destination.

2.2 Intermediate System to Intermediate SYSTEM (IS-IS)

Intermediate System to Intermediate System (IS-IS) is also a link state routing protocol like OSPFv3 that the International Organization for Standardization (ISO) introduced and became a routing protocol for standard use since 1992. This protocol is centred on the routing method DECnet Phase V, where routers known as intermediate systems exchange routing information with the use of a single metric to decide the topology of the network [8]. IS-IS version 1 was designed to route packets as described in RFC 1142 within the ISO Connectionless Network Protocol (CLNP) networks. In the OSI context, in contrast to an End System (ES) referring to a node, intermediate system refers to a router. In the End System to Intermediate System (ES-IS) protocols, routers and nodes are allowed to detect and communicate with each other. However, in IS-IS only nodes that are used to route packets are allowed to identify each other. To form a routing domain, both intermediate systems and end systems are arranged and configured as one. Similar to OSPF, routers configured with IS-IS protocol store information about the state of their links and uses the information obtained to computes the shortest path to the desired destination. Each IS-IS router periodically sends link state information to the IS-IS routers connected to their interfaces. This information enables the routers to maintain identical topology information. Other metrics can be used to detect delays in the network, cost and some errors in any of the links.

Like OSPFv3, IS-IS determines the shortest path to a destination using the Dijkstra’s algorithm. Each of the IS-IS routers uses the link state information obtained from each neighbouring router of a network to build their own topology database. In IS-IS protocol, each of the routers forming a routing domain sends a Link-State-Packet (LSP). This LSP contains information that describes the router sending it as well as information about the links connected to it. The information in the LSP is encoded in a data structure of variable lengths consisting of data type, length and value usually known as TLV. TLVs are the IS-IS PDUs' extensible parameter portions used in carrying different information types. In addition, the protocol provides support for networking arranged hierarchically in order to separate bigger network domains into logical segments called areas. In at least one area, each intermediate system resides there. The hierarchy defines two levels used in bigger routing domains to organize routers. These two levels are levels 1 and 2. The level 1 routers are identical to OSPF intermediate routers. Two or more routing areas are connected together using Level 2 routers [9].

2.3 Routing Information Protocol Next Generation (RIPng)

As mentioned by Komal et al, [10] RIP is one amongst the protocols designed within the early stages of distance-vector routing. Hop count is employed by this protocol to work out the routing metric. For the dodging of routing loops, RIP implements a limit on the allowed variety of hops that ought to exist during a path from the supply to the destination host. The best variety of hops that's allowed is 15. This implies that once a packet traverse somewhat fifteen hops in its path to the destination, the packet is discarded. However, the existence of hop count has resulted in the size of RIP designed networks being restricted. A hop count of fifteen or additional is regarded as an infinite distance subsequently the route is taken as unable to reach route. Split horizon, route poisoning and hold down techniques are utilized in RIP to forestall unauthentic route information from being transmitted through the network. The count-to-infinity downside may be restrained by using the

Routing Information Protocol with Metric Based Topology (RMTI) algorithm. This RMTI rule provides a prospect for detecting any possible loop by performing some computations. RIP has three versions, namely: RIP version 1(RIPv1), RIP version 2 (RIPv2) and RIP next generation (RIPng).

The original features of RIP detailed in RFC 1058, was published in 1988. It implements classful routing. This suggests that its periodic updates don't comprise information regarding subnets. Therefore, RIPv1 lacks the potential to support Variable Length Subnet Mask (VLSM). The RIPv1's inability to support VLSM has made it unable to possess subnets of varied sizes inside the same network class. Therefore, all the subnets that exist in an exceedingly network category should have a similar size. RIPv1 doesn't have support to certify routers. This has created it at risk of totally different attacks. These limitations to the RIPv1 resulted within the emergence of RIPv2 designed in 1993 accepted as a typical in 1998. To Associate in Nursing extent, RIPv2 came to correct the downsides RIPv1 by providing support for Classless Inter-Domain Routing (CIDR). to produce support for RIPv1, RIPv2 maintained the hop count limit of fifteen.[9].

The RIPng was developed as an extension to the RIPv2 for the support of IPv6 networks. As elaborated in RFC 2080, RIPng was designed with the intention of permitting routers for data exchange required to cypher routes in IPv6-based networks. just like the earlier versions of RIP, RIPng may be a distance vector protocol. to totally implement RIPng, routers should be directly connected to every alternative. this can be as a result of this protocol depends on data obtained concerning every of the networks to cypher the metric. This metric is a number from one to fifteen. additionally, every of the networks has an IPv6 destination address prefix still as prefix length associated with it. The supervisor sets these parameters to effectively deploy RIPng for the required network [10].

3. METHODOLOGY

3.1 The Simulation Tool Used

The main simulation tool for this analysis is Riverbed Modeller Academic Edition 17.5. This modeller was chosen for this paper as a result of its ability to present the user with an object orientated and a graphical interface to simulate real world systems in a very graphical form. Additionally, it contains a complete documentation, detailed model library and an analysis tools that enables the user to present simulation results in a desired form for presentation. This modeller organizes simulations into project basis. One project will contain one or additional scenarios during which the user is bestowed with network devices and links, configuration utilities, an object that permits the user to pick totally different network application whose traffic on the network will be measured. The nodes and links enclosed within the simulation represent network devices within the globe that are used as an input for simulation performance. This modeller a limited Edition of Riverbed Modeller used for learning purposes [11].

3.2 The Simulation Design

This paper compares two mixed protocols namely OSPFv3/IS-IS and RIPng/IS-IS in IPv6 network. In order to achieve this, a network model is designed and configured with IPv6. This network model is duplicated to obtain two scenarios. One of the network models is configured with OSPFv3 at one side of the network and IS-IS is configured at the other side. The second copy of the network is configured with RIPng at one side and IS-IS at another side of the network. These scenarios were simulated and the effect of using each of the mixed protocols to route the applications selected for this research work was measured and recorded. The following quantitative parameters were used to compare the performance of both protocols:

- FTP download and upload response times;
- IPv6 traffics dropped;
- Email download response time;
- Database query response time and Traffics received;
- Remote login response time;
- HTTP page response time.

The intent of examining these mixed protocols is to ascertain that one among the mixed protocols can work higher than the other for the chosen quantitative parameters in IPv6 networks.

3.3 Network Topology and Connections

Fig. 1 represents the topology of the network by simulation. This topology simulates an IPv6 backbone network that consists of fifteen routers, two switches, five servers and four workstations. The routers are interconnected using PPP DS1 duplex link while a 100BaseT duplex link is used to connect the workstations to the switch. The servers are also connected to another switch with the use of the 100BaseT duplex link. The switches are connected to the routers with this same link.

3.4 Application Configuration

To specify applications that are selected and additionally to generate the network traffic for the chosen applications within the network topology, the profile definition objects and also the application definition is enclosed within the workspace of the modeller shown in Fig. 1. The application definition is organized to support remote login (high load), ftp (high load), database (high load), http (heavy browsing) and email (high load). Configuring applications within the application definition object is done in the "Attributes" of this object. The configuration for ftp with the application definition object is shown in Fig. 2. The ftp application is organized by right clicking the application definition object and choosing "Edit Attributes" from the pop-up menu. Once the attributes window is displayed, the "Application Definitions" row was enlarged by clicking it. The application name was set to "ftp" and its corresponding description was set to "high load".

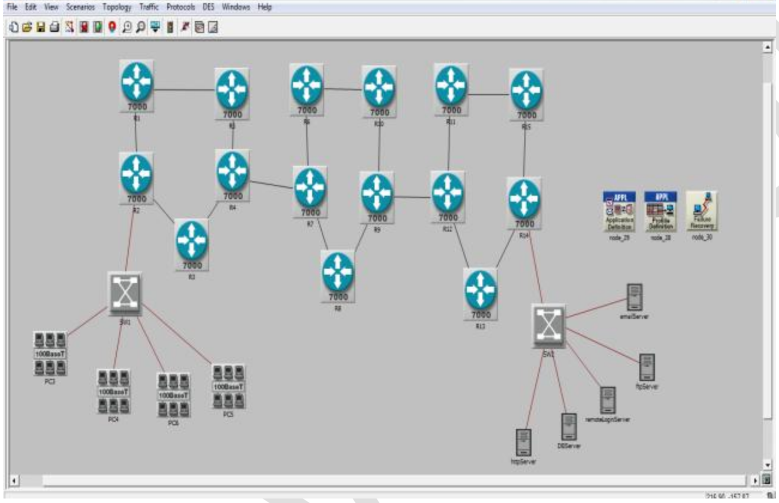
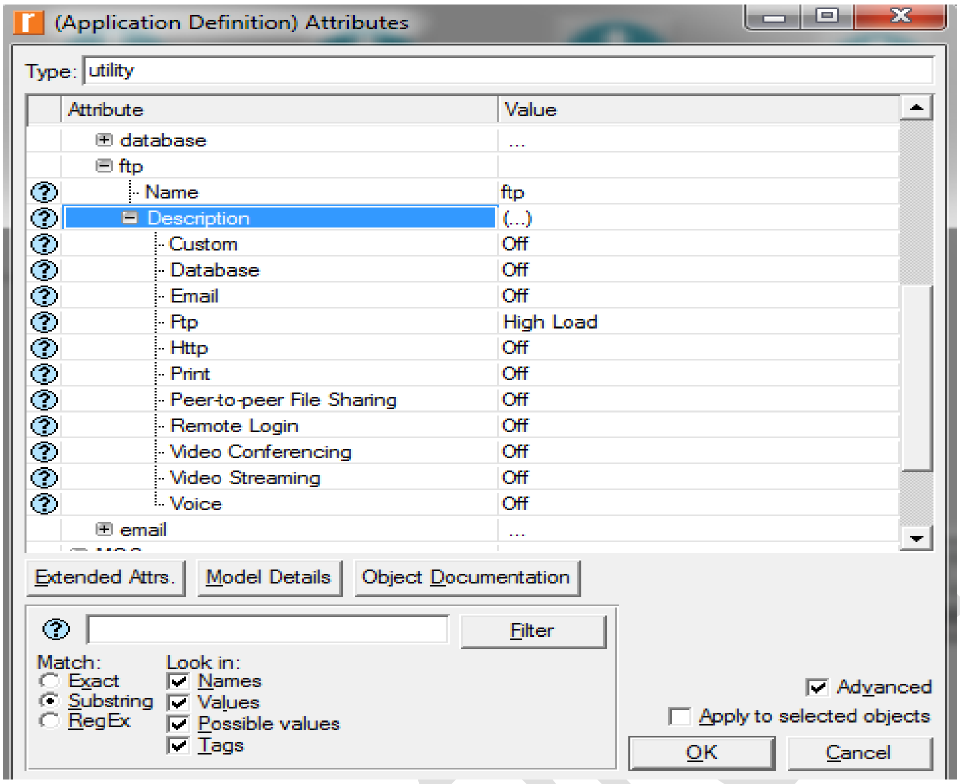


Fig. 1. Network topology



(Application Definition) Attributes

Type: utility

Attribute	Value
⊞ database	...
⊟ ftp	
Name	ftp
⊟ Description	(...)
Custom	Off
Database	Off
Email	Off
Ftp	High Load
Http	Off
Print	Off
Peer-to-peer File Sharing	Off
Remote Login	Off
Video Conferencing	Off
Video Streaming	Off
Voice	Off
⊞ email	...

Match:
○ Exact
● Substring
○ RegEx

Look in:
☑ Names
☑ Values
☑ Possible values
☑ Tags

☑ Advanced
☐ Apply to selected objects

Fig. 2. ftp Application configuration

3.5 The Profile Configuration

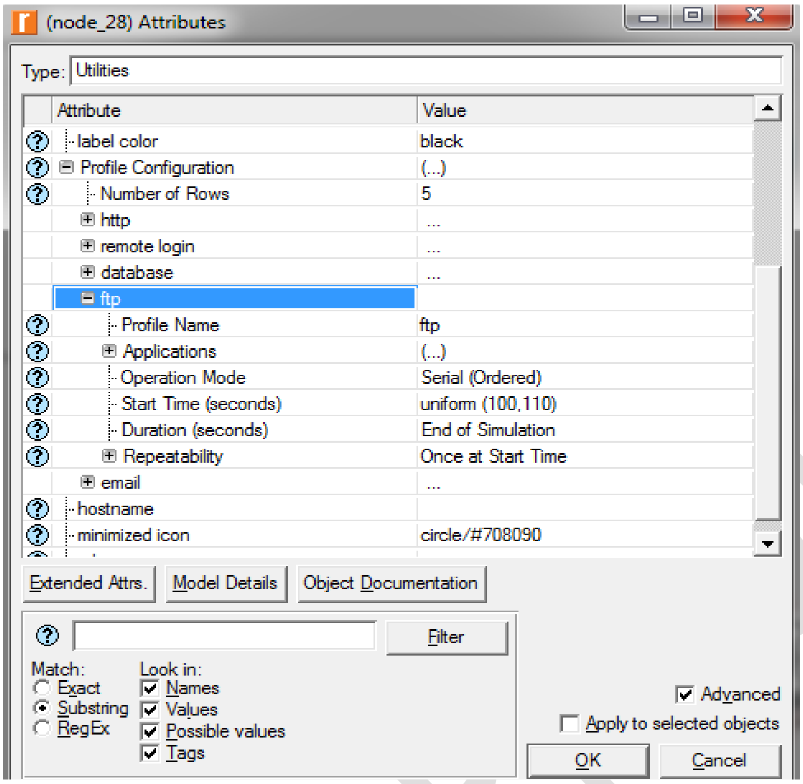
To generate the applications' network traffic, the profile configuration object was used. Five profiles were set for the support of each of the applications that were selected when the object for the application configuration was configured. Doing this was by right-clicking the profile configuration object and selecting "Edit Attributes" from the menu that popped up. When the "Attributes" window got opened, "Profile Configurations" that appeared in the menu was selected. The "Number of Rows" field was set to 5 so that network traffic for each of the five applications can be configured. The five "Enter Profile Name" fields were set to contain each of the five applications' traffic. In order to produce a corresponding traffic for each of the applications, the "Applications" found under "Profile Configurations" was expanded and each of the applications defined in the application configuration object was selected. Fig. 3 shows the Profile Definition Configuration for ftp application.

3.6 Failure Recovery Configuration

Aside from configuring the applications and therefore the network traffic for every one of the applications, failure recovery was additionally organized within the network topology. In this, some links are set to fail and recover. This aim was attained by using the Failure Recovery object. The link between router 12 (R12) and router 9 (R9) was configured to fail at 240 seconds and later recover at 480 seconds. This configuration was done by right-clicking the Failure Recovery object and choosing "Edit Attributes" from the pop-up menu. The "Link Failure/Recovery Specification" that appeared among the menu within the attributes window was expanded. The "Number of Rows" was set to two. The link between the two routers was selected and their statuses (fail and recover) and times (240 and 480) were respectively indicated. The configuration for failure recovery is shown in Fig. 4.

3.7 Node Configuration

The nodes that comprises of the workstations and servers were also configured to model a completely practical network. Every of the 5 servers were designed to support one in every of the varied application designed with the application definition object. This was achieved by right-clicking the server and choosing "Edit Attributes" from the pop-up menu. "Applications" beneath the attributes was enlarged and therefore the application that the server supports were selected beneath the “Supported Services”. Fig 5 shows how the ftp server was configured.



Type: Utilities

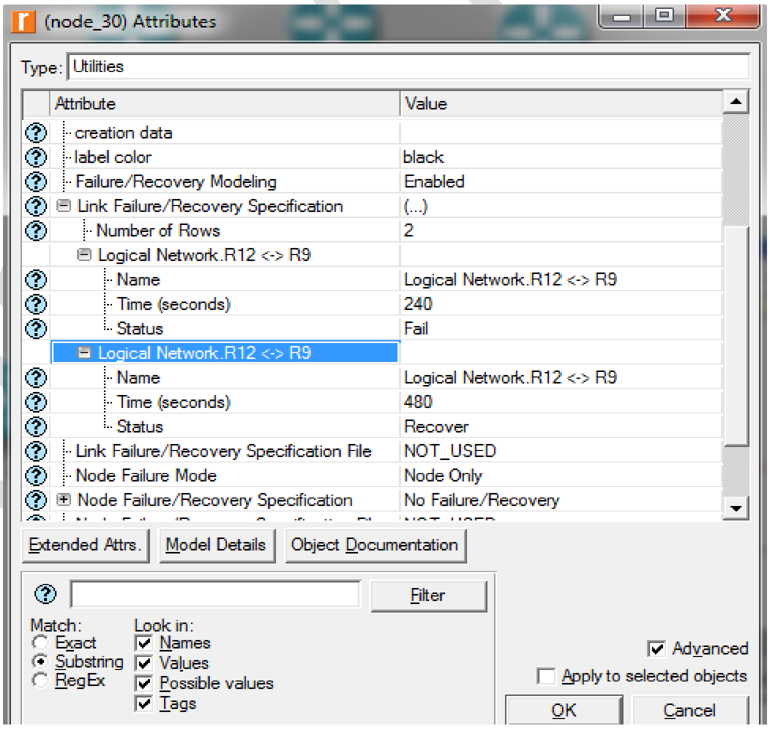
Attribute	Value
label color	black
⊟ Profile Configuration	(...)
Number of Rows	5
⊞ http	...
⊞ remote login	...
⊞ database	...
⊟ ftp	
Profile Name	ftp
⊞ Applications	(...)
Operation Mode	Serial (Ordered)
Start Time (seconds)	uniform (100,110)
Duration (seconds)	End of Simulation
⊞ Repeatability	Once at Start Time
⊞ email	...
hostname	
minimized icon	circle/#708090

Match:
○ Exact
● Substring
○ RegEx

Look in:
☑ Names
☑ Values
☑ Possible values
☑ Tags

☑ Advanced
☐ Apply to selected objects

Fig. 3. ftp profile configuration



Type: Utilities

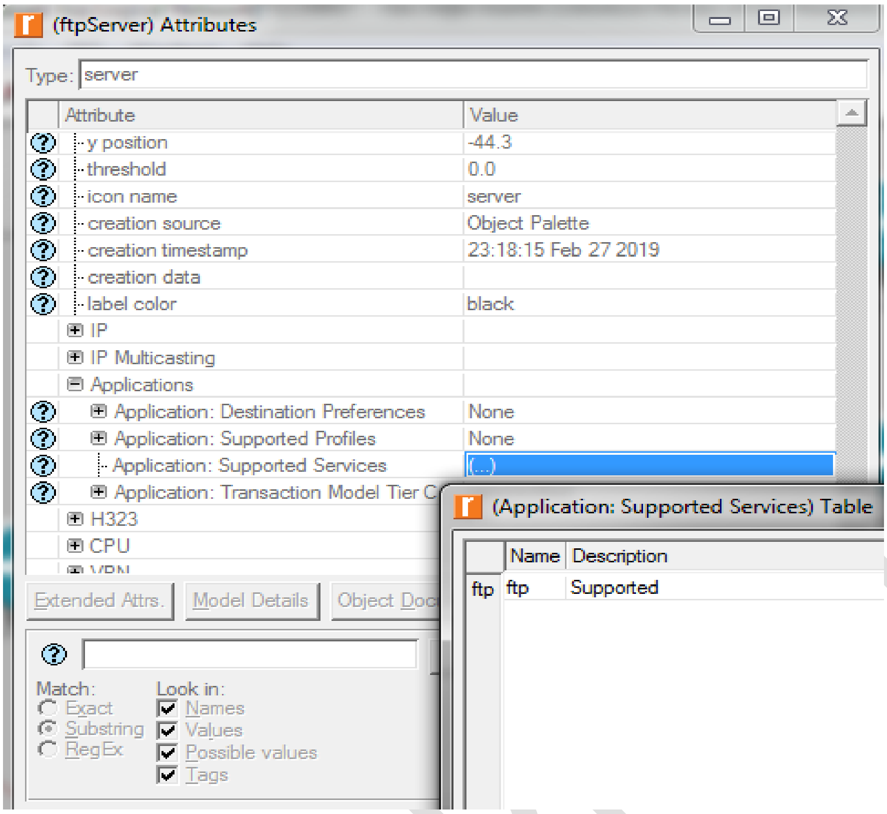
Attribute	Value
creation data	
label color	black
Failure/Recovery Modeling	Enabled
⊟ Link Failure/Recovery Specification	(...)
Number of Rows	2
⊟ Logical Network.R12 <-> R9	
Name	Logical Network.R12 <-> R9
Time (seconds)	240
Status	Fail
⊟ Logical Network.R12 <-> R9	
Name	Logical Network.R12 <-> R9
Time (seconds)	480
Status	Recover
Link Failure/Recovery Specification File	NOT_USED
Node Failure Mode	Node Only
⊞ Node Failure/Recovery Specification	No Failure/Recovery

Match:
○ Exact
● Substring
○ RegEx

Look in:
☑ Names
☑ Values
☑ Possible values
☑ Tags

☑ Advanced
☐ Apply to selected objects

Fig. 4. Configuration for failure recovery



(ftpServer) Attributes

Type: server

Attribute	Value
y position	-44.3
threshold	0.0
icon name	server
creation source	Object Palette
creation timestamp	23:18:15 Feb 27 2019
creation data	
label color	black
IP	
IP Multicasting	
Applications	
Application: Destination Preferences	None
Application: Supported Profiles	None
Application: Supported Services	(...)
Application: Transaction Model Tier C	
H323	
CPU	

(Application: Supported Services) Table

	Name	Description
ftp	ftp	Supported

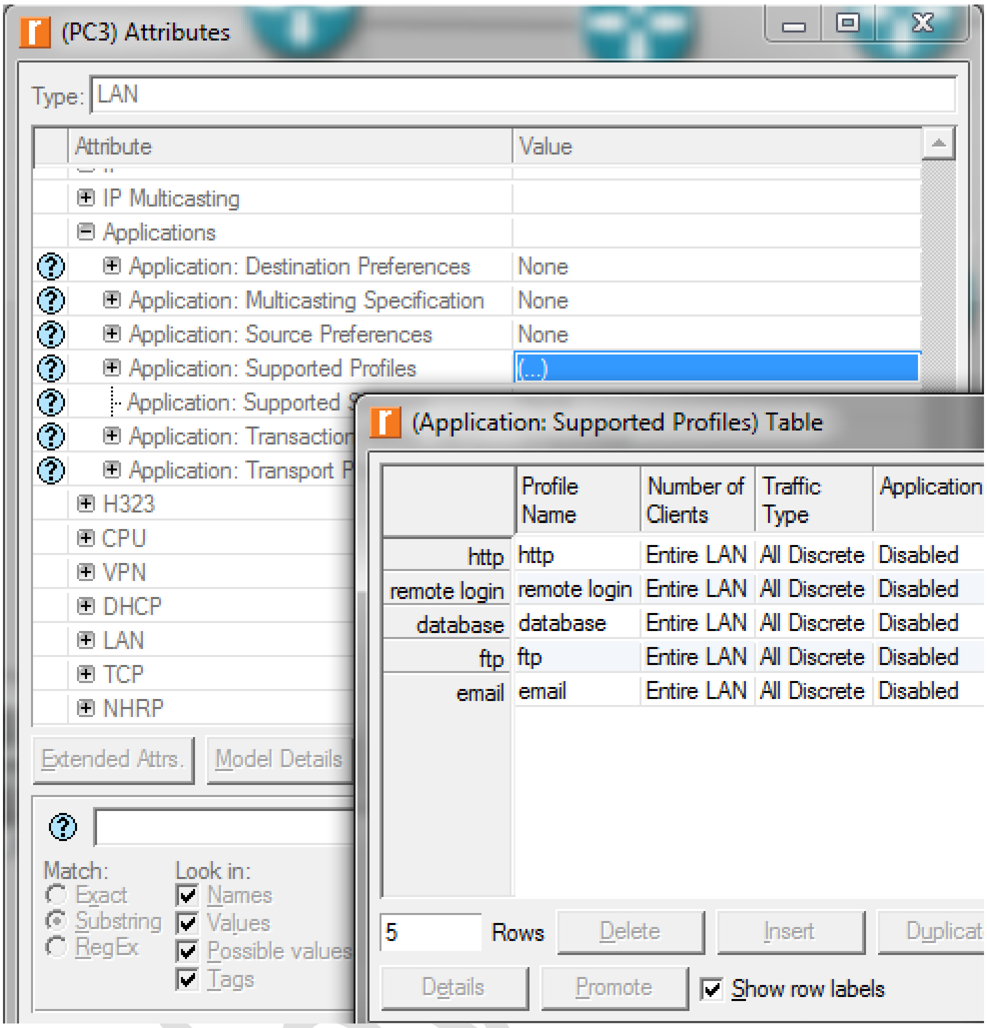
Fig. 5. Ftp Server configuration

Similarly, each of the workstations was also configured to send and receive traffic of all the applications that was set in each server. This configuration was done by right-clicking a workstation and selecting “Edit Attribute” found in the menu that popped up. When the “Attributes” window got opened, entire applications that were defined in the Application Configuration object were carefully chosen under the “Application Supported Profiles”. This whole process was repeated for all of the other workstations in the network topology. The workstations configuration is shown in Fig 6.

3.8 OSPFv3/IS-IS Scenario

The main focus of this paper is to analyse the network configured with OSPFv3 and IS-IS routing protocols on the same network topology and deduce the advantage of using these protocols together. Fig. 8 represents the OSPFv3/IS-IS scenario that was used in the research. It has equal network topology to the one explained in Fig. 1. Nevertheless, some portion of the network was configured with OSPFv3 while the other portion used IS-IS in this topology. Since both protocols supports IPv6 routing, IPv6 addresses were assigned on the interfaces before the protocols were configured. Both of the protocols used route redistribution to exchange routing information between each other. This route redistribution feature allows routing information to be exchanged among multiple protocols and sessions [12]. The performance of this mixed routing protocol is measured and analysed.

After the IPv6 Addresses and OSPFv3/IS-IS were enabled, the various statistics needed were chosen for each one of the quantitative parameters. These parameters are the Response Times for database query (sec), Traffics Received (bytes/sec), Response Time for Remote Login (sec), the Response Times for Email downloads and uploads (sec), the Response Times for ftp uploads and downloads(sec), Traffics Received for ftp (bytes/sec), Response Times for http Pages (sec) and amount of Traffics Dropped of IPv6 (packets/sec). After the parameters were chosen, the entire simulation duration was configured to last 30 minutes for the two scenarios. The simulation was then run. At the end, the simulation results for the various quantitative parameters were measured and recorded at some instances of the simulation process.



(PC3) Attributes

Type: LAN

Attribute	Value
⊞ IP Multicasting	
⊟ Applications	
⊞ Application: Destination Preferences	None
⊞ Application: Multicasting Specification	None
⊞ Application: Source Preferences	None
⊞ Application: Supported Profiles	(...)
Application: Supported S	
⊞ Application: Transaction	
⊞ Application: Transport P	
⊞ H323	
⊞ CPU	
⊞ VPN	
⊞ DHCP	
⊞ LAN	
⊞ TCP	
⊞ NHRP	

(Application: Supported Profiles) Table

	Profile Name	Number of Clients	Traffic Type	Application
http	http	Entire LAN	All Discrete	Disabled
remote login	remote login	Entire LAN	All Discrete	Disabled
database	database	Entire LAN	All Discrete	Disabled
ftp	ftp	Entire LAN	All Discrete	Disabled
email	email	Entire LAN	All Discrete	Disabled

5 Rows

☑ Show row labels

Fig. 6. Workstation configuration

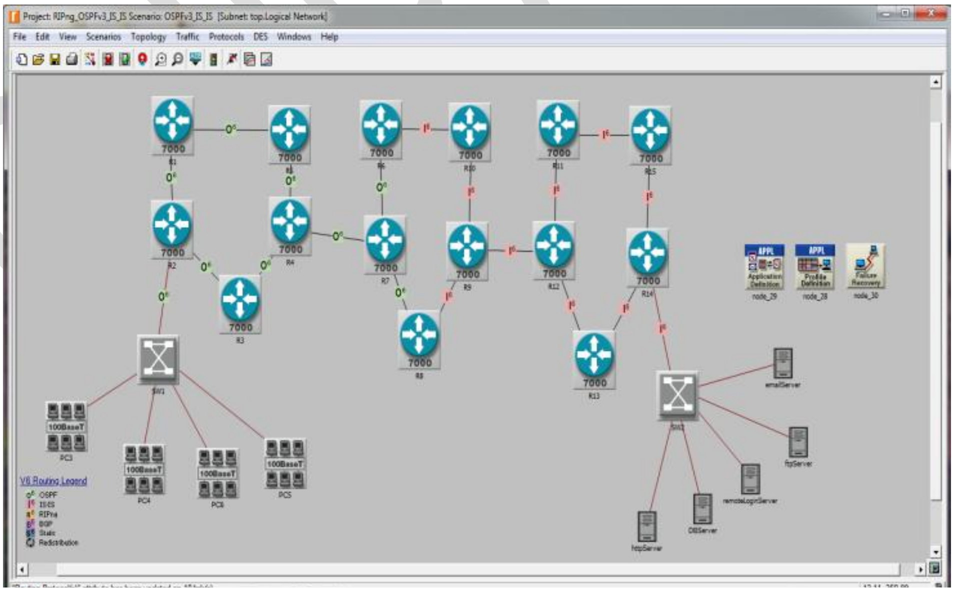


Fig. 7. OSPFv3/IS-IS Scenario

3.9 RIPng/IS-IS Scenario

The other focus of this paper is to analyse the performance when RIPng and IS-IS are combined on the same network topology. As shown in Fig. 8, one part of the network is configured with RIPng routing protocol and the other part of the network is configured with IS-IS. The main purpose of this combination is to measure the performance of the network when RIPng and IS-IS are configured on a single network. Route redistribution is enabled on the network in order to exchange routing information between these two protocols.

After the IPv6 Addresses and RIPng/IS-IS were configured and the various quantitative parameters were selected, the simulation was run. At the end, the simulation results for the various quantitative parameters were measured and recorded at some instances during the simulation. The numerical values representing the simulation instances and their matching results were tabulated.

The recorded values that represent the response time of database queries by the two scenarios is tabulated as shown in Table 1. The time interval at which the recordings were made and the equivalent values that were recorded at these instances measured in seconds were shown.

The recorded values that represent the traffics received for database queries by the two scenarios is tabulated as shown in Table 2. The time interval at which the recordings were made and the equivalent values that were recorded at these instances measured in bytes/seconds were shown.

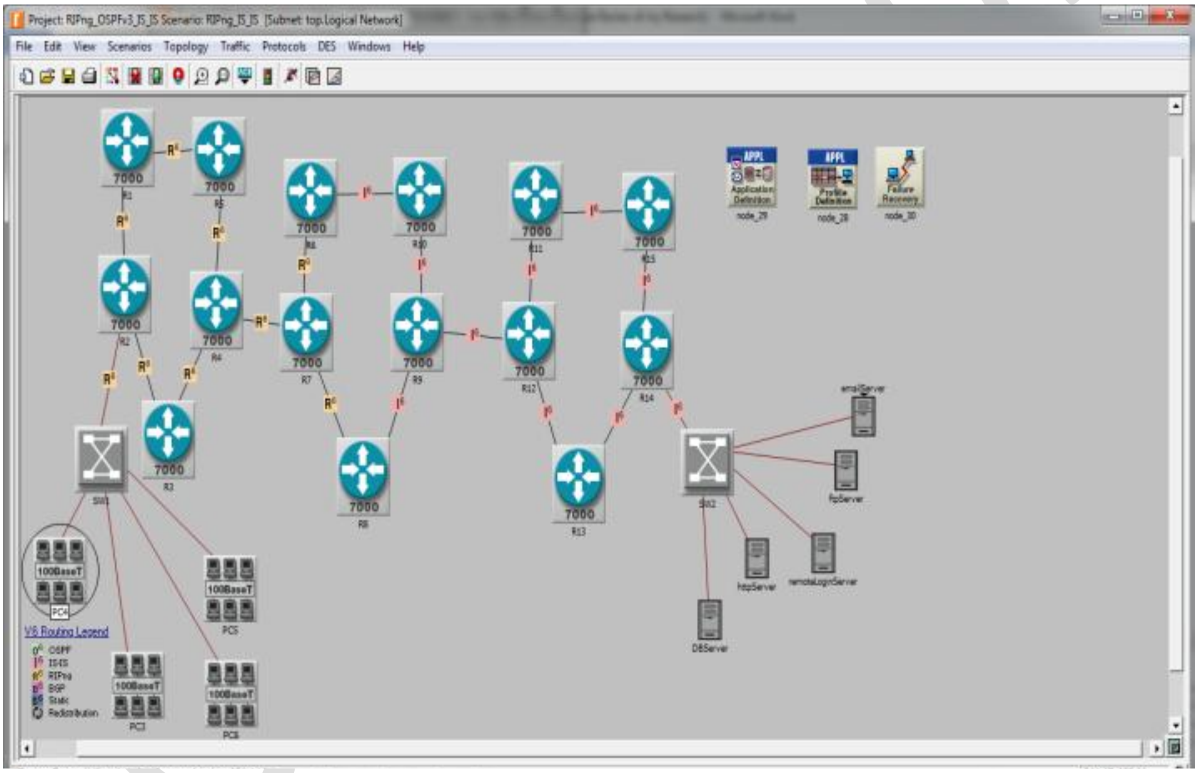


Fig. 8. RIPng/IS–IS Scenario

Table 1. Database query response time for both scenarios

Simulation time (minutes)	OSPFv3/IS-IS (sec)	RIPng/IS-IS(sec)
2	0.06	0.10
5	0.11	0.48
15	1.17	0.2
22	0.15	0.37
30	0.19	0.19

Table 2. Database query traffic received for both scenarios

Simulation time (minutes)	OSPFv3/IS-IS (bytes/sec)	RIPng/IS-IS (bytes/sec)
5	31,000	25,000
10	34,000	32,000
15	36,500	34,500
20	38,000	35,000
30	40,000	35,500

The recorded values that represent the response times for email downloads by the two scenarios is tabulated as shown in Table 3. The time interval at which the recordings were made and the equivalent values that were recorded at these instances measured in bytes/seconds were shown.

The recorded values that represent the response times for email uploads by the two scenario is tabulated as shown in Table 4. The time interval at which the recordings were made and the equivalent values that were recorded at these instances measured in seconds were shown.

The recorded values that represented the response times for ftp downloads by the two scenarios was tabulated as shown in Table 5. The time interval at which the recordings were made and the equivalent values that were recorded at these instances measured in seconds were shown.

The recorded values that represent the response times for ftp upload by the two scenarios is tabulated as shown in Table 6. The time interval at which the recordings were made and the equivalent values that were recorded at these instances measured in seconds were shown.

Table 3. Email download response time for both scenarios

Simulation time (minutes)	OSPFv3/IS-IS (sec)	RIPng/IS-IS (sec)
0-22	0.007	0.00070
23	0.011	0.00079
25	0.010	0.00078
30	0.010	0.00077

Table 4. Email upload response time for both scenarios

Simulation time (minutes)	OSPFv3/IS-IS (sec)	RIPng/IS-IS (sec)
2	0.07	0.061
4	0.12	0.089
15	0.11	0.11
30	0.10	0.10

Table 5. ftp Download Response Time for both scenarios

Simulation time (minutes)	OSPFv3/IS-IS (sec)	RIPng/IS-IS (sec)
2 – 4	0.14 - 0.10	0.095
7	0.12	0.07
15	0.13	0.16
20	0.12	0.15
30	0.13	0.15

Table 6. ftp Upload Response Times for both scenarios

Simulation time (minutes)	OSPFv3/IS-IS (sec)	RIPng/IS-IS (sec)
0.23-2.6	0.27 – 0.34	0.27
3	0.29	0.34
5	0.30	0.32
15	0.25	0.32
25	0.26	0.28
30	0.26	0.29

The recorded values that represent the traffics received for ftp by the two scenarios is tabulated as shown in Table 7. The time interval at which the recordings were made and the equivalent values that were recorded at these instances measured in bytes/seconds were shown.

The recorded values that represent the response times for http pages by the two scenarios is tabulated as shown in Table 8. The time interval at which the recordings were made and the equivalent values that were recorded at these instances measured in seconds shown.

The recorded values that represent the average IPv6 traffic dropped by the two scenarios is tabulated as shown in Table 9. The time interval at which the recordings were made and the equivalent values that were recorded at these instances measured in packets/second were shown.

The recorded values that represent the response times for remote login by the two scenarios is tabulated as shown in Table 10. The time interval at which the recordings were made and the equivalent values that were recorded at these instances measured in seconds were shown.

4. SIMULATION RESULTS AND DISCUSSION

The focus of this section is on the obtained results after the simulation. The simulation tool used in this research provided features that was put together to produce a pictorial representation of the obtained results from the quantitative parameters for the two scenarios.

4.1 Response Time for Database Query

Fig. 9 illustrates an overlaid statistic of the response times of the database queries. The response time for the database query is a factor that is used to measure the length of time taken by a database query application to send a request and get response from the database server. Looking at the obtained results after the simulation, it can be observed that the combination of OSPFv3 and IS-IS performed better than RIPng and IS-IS combined. When the simulation reached 3 minutes, the response time for database query for the OSPFv3/IS-IS combination increased from 0.06 to 0.08 whereas the combination of RIPng/IS-IS increased from 0.05 to 0.47. Between 10 minutes and 25 minutes, the database query began to decrease for both mixed protocols. OSPFv3/IS-IS reduced from 0.20 to 0.15 while RIPng/IS-IS also reduced from 0.36 to 0.20. The OSPFv3/IS-IS combination kept decreasing until the end of the simulation. The performance of RIPng/IS-IS combination is slow due to how long the protocols take to converge at the expense of OSPFv3/IS-IS which affected the speed.

4.2 Received Traffics from Database Queries

An illustration of the traffics received from database queries for the two scenarios is showed in the overlaid statistics of Fig. 10. It shows the average of database query traffics that are sent in every second to the application for database request that enters the server at transport layer. Conclusion can be made in the figure that OSPFv3/IS-IS combination performs better than RIPng/IS-IS. When the simulation reached 2.5 minutes, database requests traffic of 15,500 bytes were obtained in the two cases. As the simulation continued, at about 7 mins into the simulation, database query traffic of 32,050 bytes were obtained in the IS-IS and OSPFv3 scenario while that of the combination of RIPng and IS-IS was 25,005 bytes. The traffics received for database query further increased to 40,000 bytes for OSPF/IS-IS scenario and remained almost the same as the simulation ended. Around that same time, RIPng/IS-IS combination obtained a database traffic received of around 30,000 bytes. The results obtained from the conclusion of the simulation shows that show that IS-IS and OSPFv3 is an improved performer on RIPng/IS-IS as far as database query traffic received is concerned.

Table 7. ftp traffics received for both scenarios

Simulation time (minutes)	OSPFv3/IS-IS (bytes/sec)	RIPng/IS-IS (bytes/sec)
2-3	0-11,000	8,000
5	7,000	3,400
10	5,000	3,000
16	4,000	3,400
30	3,500	3,000

Table 8. http page response time for both scenarios

Simulation time (minutes)	OSPFv3/IS-IS (sec)	RIPng/IS-IS (sec)
3	0.4	0.29
5	0.7	0.92

8	0.6	0.68
12	0.6	0.60
25	0.55	0.54
30	0.50	0.50

Table 9. Average IPv6 traffic dropped for both scenarios

Simulation time (minutes)	OSPFv3/IS-IS (packets/sec)	RIPng/IS-IS (packets/sec)
0	4.9	2.10
2.5	4	6.10
4	9.2	4.50
17	5	4.10
30	4.5	4.05

Table 10. Average Remote Login Response Time for both scenarios

Simulation time (minutes)	OSPFv3/IS-IS (sec)	RIPng/IS-IS (sec)
2-3	0.061-0.051	0.055
10	0.053	0.051
15	0.052	0.051
20	0.053	0.052
25	0.052	0.052
30	0.053	0.052

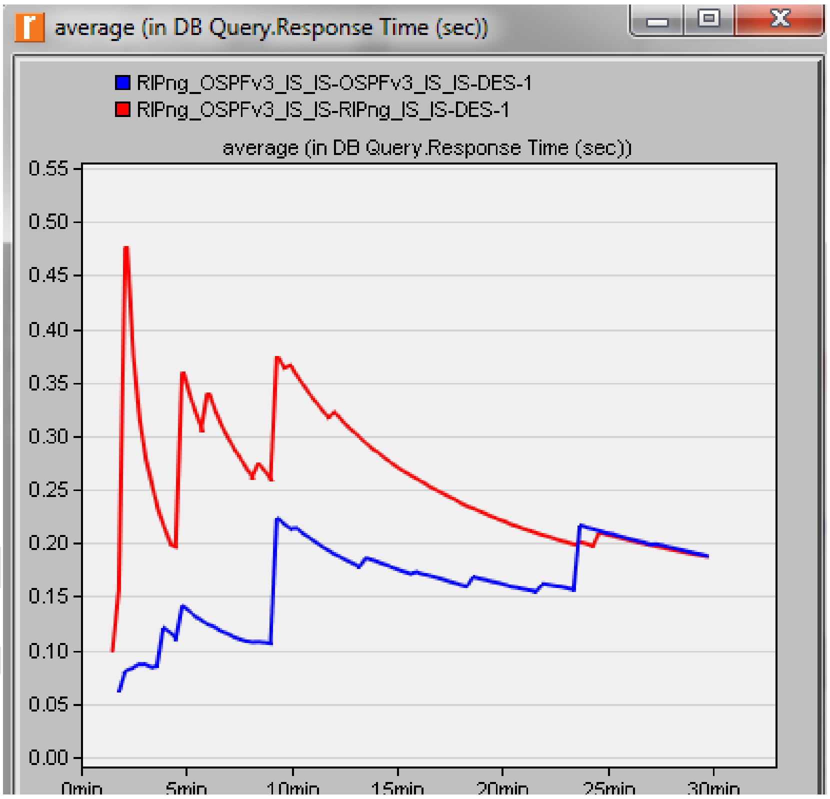


Fig. 9. Database query response time (seconds)

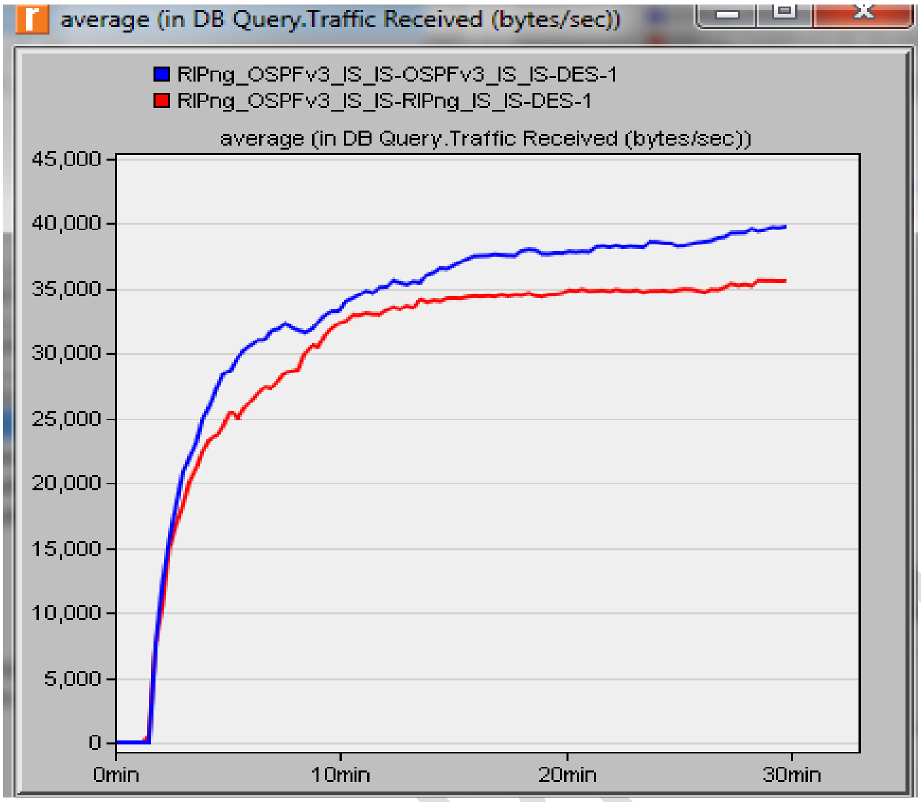


Fig. 10. Database query traffics received (bytes per second)

4.3 Response Time for Email Downloads

Fig. 11 captures the end of the simulation results of the download time for the email for the mixed combination. This measures the time taken by a workstation to receive an email from the server of an email in a network. The simulation process experienced response time for an email download for both instances, fairly constant at 0.007 seconds from 2 minutes to 20 minutes. Nevertheless, when the simulation reached around 23 minutes, this parameter increased from 0.007 to about 0.011 seconds for OSPFv3/IS-IS as that of RIPng/IS-IS also increased from 0.007 to around 0.008 seconds. As the simulation ended at 30 minutes, the OSPFv3/IS-IS combination reduced to 0.010 for this parameter but for the same parameter RIPng/IS-IS also decreased but slightly below 0.008. From the results, it is concluded that the RIPng/IS-IS combination responds faster to email download than OSPFv3/IS-IS.

4.4 Response Time for Email Upload

Fig. 12 shows overlaid statistics of how OSPFv3/IS-IS and RIPng/IS-IS combinations respond to email upload. This indicator measures the time it will take a client to send an email to the email server in a network. The simulation results show that RIPng/IS-IS combination performs better than OSFFv3/IS for this parameter. From the figure, at 2 minutes of the simulation, OSPFv3/IS-IS logged the higher response time for email upload sending at 0.07 seconds whereas that of the RIPng/IS-IS combination recorded 0.06 seconds. OSPFv3/IS-IS further increased to 0.12 seconds as the simulation approached 5 minutes as the RIPng/IS-IS combination only rose to 0.10 seconds. When the simulation reached 5 minutes and towards the completion of the simulation, the mixed scenarios remained in between 0.10 and 0.11. Although the difference is not so clear as the simulation moved toward the end, a critical observation of the result shows that RIPng/IS-IS responds to email uploads faster than OSPFv3/IS-IS which was clearly shown at the early stages of the simulation.

4.5 Response Time for ftp Download

The Fig. 13 captures the result gotten from the simulation for the response time for ftp download. The parameter is useful for measuring the time it will take every ftp applications to enable it send and receive requests from the ftp server in a network. For ftp download response timeOSPFv3/IS-IS performs better than RIPng/IS-IS for the network. At 2.5 minutes of the simulation, OSPFv3/IS-IS logged a value of 0.14 secs as its maximum whereas at same time, RIPng/IS-IS logged a value of 0.088 secs as its minimum. However, OSPFv3/IS-IS scenario reduced to 0.10 seconds and remained in between 0.10 and 0.13 as that of RIPng/IS-IS rose to 0.16 seconds and stayed in between 0.14 and 0.16 seconds until the simulation ended in 30 minutes. It can be concluded from the results that, OSPFv3/IS-IS transmits ftp traffic better than RIPng/IS-IS combination in a network.

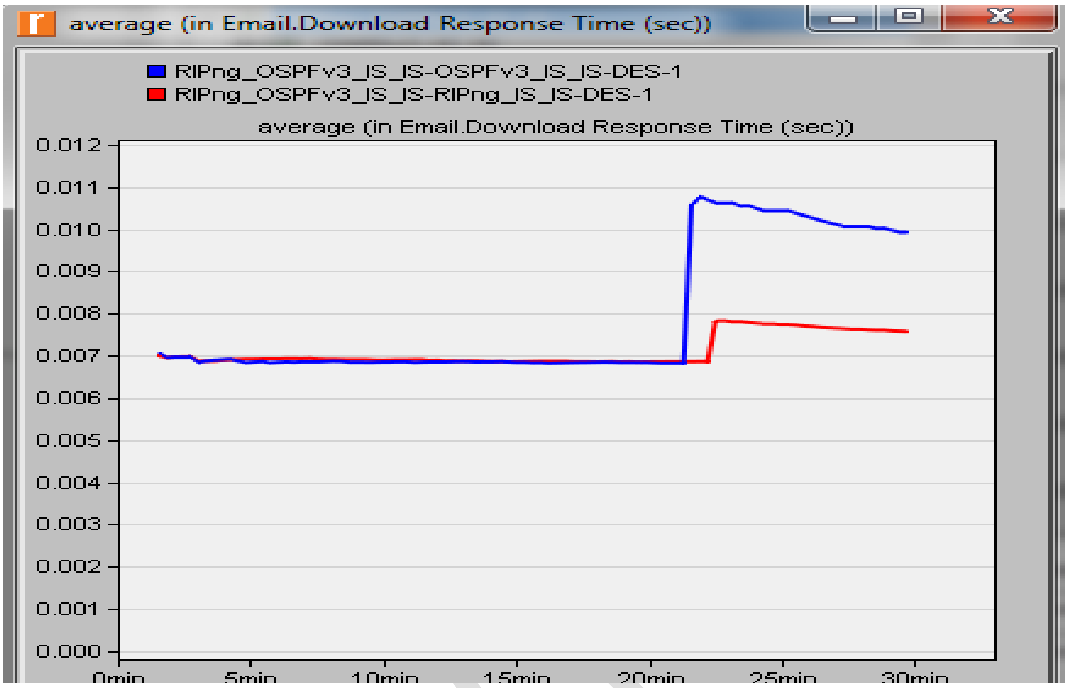


Fig. 11. Response time for email download (seconds)

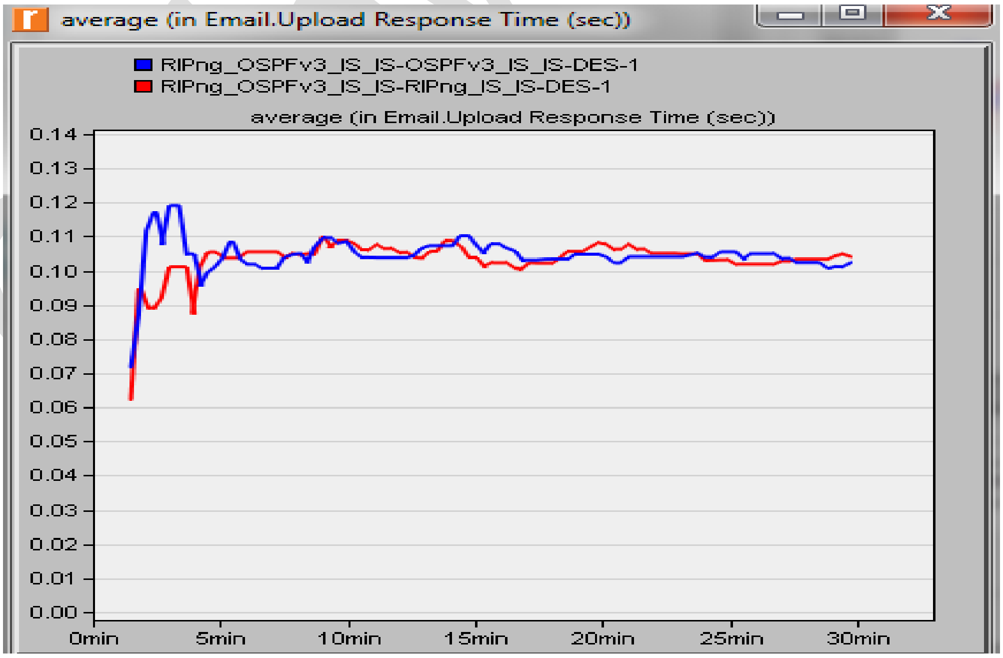


Fig. 12. Response time for email upload (seconds)

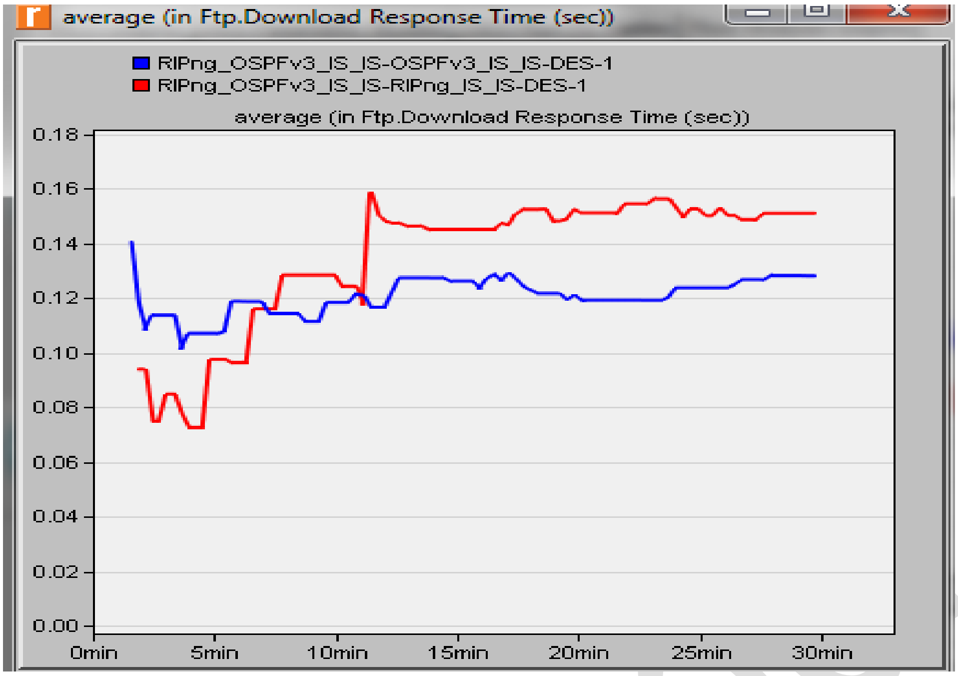


Fig. 13. Ftp download response time (seconds)

4.6 Response Time for ftp Upload

The results gotten from the simulation of the two network scenarios for ftp upload response time is represented in Fig. 14. The figure shows that the performance of OSPFv3/IS-IS is better than RIPng/IS-IS for this parameter. Between the times of 2-3 mins into the model process, IS-IS/OSPFv3 scenario logged a peak value of 0.34 seconds when that of RIPng/IS-IS was rising from 0.26 seconds value. The value of OSPFv3/IS-IS reduced to 0.27 seconds after 8 minutes of simulation when the RIPng/IS-IS scenario has reached its peak value of 0.36 seconds. As the simulation approached its completion, the response time values for both the OSPFv3/IS-IS and RIPng/IS-IS scenarios remained fairly stable at 0.25 and 0.30 respectively. Hence the combination of OSPFv3/IS-IS is faster than RIPng/IS-IS when the choice is based on the response time for ftp upload.

4.7 Traffic Received for ftp

Fig. 15 represents the performance of the mixed protocols with respect to the received ftp traffics for both scenarios. In this simulation, “received ftp traffic” is used to measure the entire ftp traffics (measured in byte) transmitted in the time of one second. When the simulation reached 3 minutes, all the two scenarios obtained their peak value. OSPFv3/IS-IS combination recorded 10,900 bytes per second while RIPng/IS-IS received 8,000 bytes per second as the total ftp traffic received. As the simulation approached its end, both mixed protocols decreased in this parameter. Although there was decrement in both scenarios, at 10 minutes OSPFv3/IS-IS recorded a total ftp traffic received of 5,000 whereas RIPng/IS-IS recorded about 3,100 bytes per second. This proportion in decline continued to the end of the simulation when OSPFv3/IS-IS obtained 3,500 bytes per second while RIPng/IS-IS recorded 3,000 bytes per second. The results discussed shows that OSPFv3/IS-IS combination performs better than RIPng/IS-IS in the same network topology.

4.8 Response Time for http page

Fig. 16 shows the results obtained from the simulation of both scenarios for http page response time. This is a measure of the time it will take to receive a web page with all the inline objects that it may contain. The figure shows that OSPFv3/IS-IS performs better than RIPng/IS-IS in responding to http page. At 2 minutes, the simulation recorded 0.390 seconds and 0.295 seconds for OSPFv3/IS-IS and RIPng/IS-IS simulations respectively. As the simulation continued, OSPFv3/IS-IS reached a peak value of 0.75 seconds at 5 minutes whereas the RIPng/IS-IS scenario also logged the maximum value which was 0.92 seconds at 7.5 minutes. Both scenarios reduced from their peak values in the course of the simulation but at no occurrence did the OSPFv3/IS-IS scenario recorded a higher response value than RIPng/IS-IS until the simulation reached an end in 30 minutes. The results of this model, establishes that a combination of OSPFv3/IS-IS is a better performer than RIPng/IS-IS for this parameter.

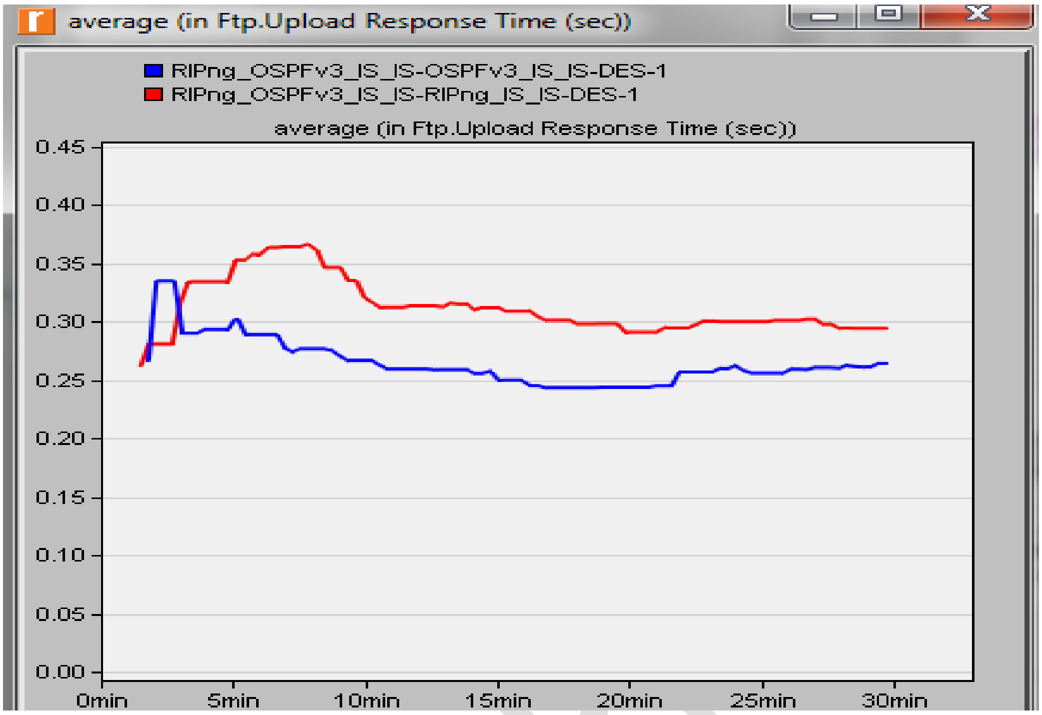


Fig. 14. Response Time for ftp Uploads (seconds)

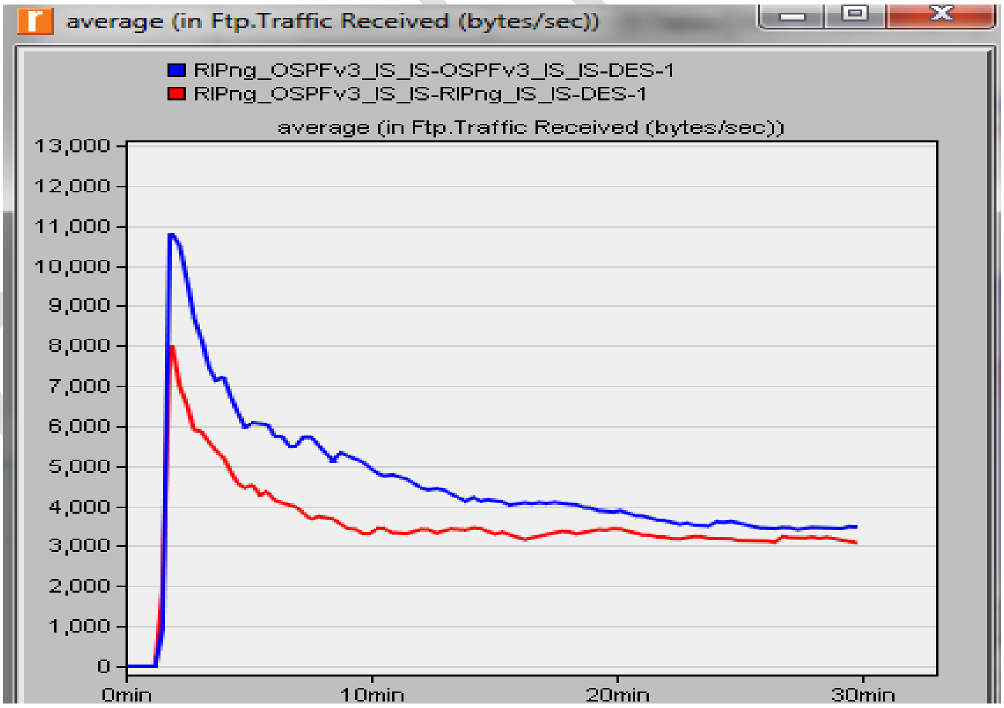


Fig. 15. Traffic Received for ftp (bytes/seconds)

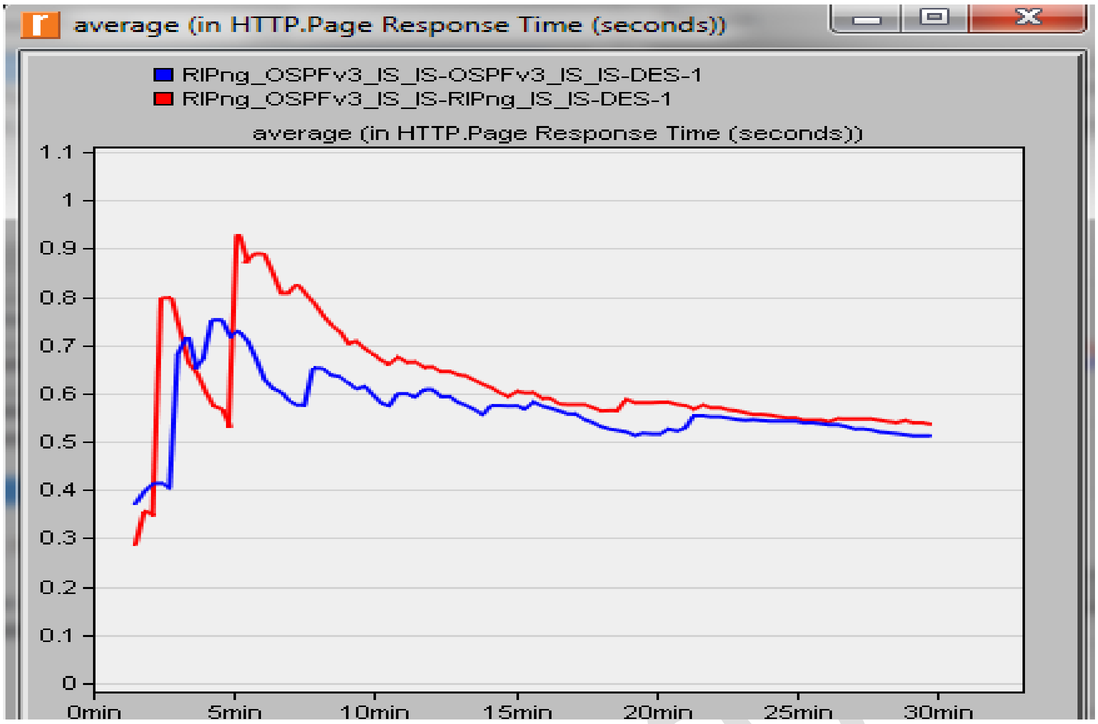


Fig. 16. Response Time for http Page (seconds)

4.9 IPv6 Traffics Dropped

The performance of the two scenarios for this parameter is shown in Fig. 17. The “IPv6 traffics dropped” is used to measure the overall quantity of traffic for IPv6 that is dropped at all the nodes in the network. This may cause by congestion that occurs when more packets are sent through the network resulting in the high bandwidth utilization. In a network that is congested, there is a delay in packet delivery, leading to some of the packets being dropped and subsequently not reaching their destination. The overlaid statistics in Fig. 12 shows that both RIPng/IS-IS and OSPFv3/IS-IS scenarios dropped 9.85 and 4.9 IPv6 packets per second at the early stages of the simulation. After 5 minutes of the simulation, the OSPFv3/IS-IS has reached its maximum value of 9.2 seconds while RIPng/IS-IS has reduced to 5.5 seconds. As the simulation advanced to its conclusion, both scenarios reduced in this parameter significantly until the simulation ended. Although when the simulation was getting to its conclusion, RIPng/IS-IS scenario recorded a significant reduction for this parameter, there were more drops of IPv6 traffics at the beginning of the simulation for this scenario than the OSPFv3/IS-IS scenario. The cause of more traffic received in the RIPng/IS-IS network scenario may be as a result of a possible congestion in the network.

4.10 Response Times for Remote Login

The remote login response time measures the length of time it will take a client application to send a request packet and receive a response packet from a remote login server. Fig.18 shows overlaid statistics of the performance of both scenarios for this parameter. From this figure, the performance of RIPng/IS-IS scenario was higher than OSPFv3/IS-IS case for response time for remote login. At 3 minutes into simulation, the IS-S and OSPFv3 scenario logged 0.0615 secs as maximum value whereas RIPng/IS-IS scenario logged 0.0555 secs as maximum value at 4 minutes of the simulation period. However, the OSPFv3/IS-IS network reduced significantly to 0.051 secs at 4 minutes and remained in between 0.0515 and 0.0535 seconds till the simulation ended. On the other hand, the RIPng/IS-IS network also recorded a reduction from its peak value but remained fairly stable between 0.051 and 0.0519 seconds until the simulation reached an end in 30 minutes. Although both simulations showed a similar behavior within the simulation duration, RIPng/IS-IS network recorded a smaller average response time than OSPFv3/IS-IS network. Hence RIPng/IS-IS scenario responds to remote login faster than OSPFv3/IS-IS scenario.

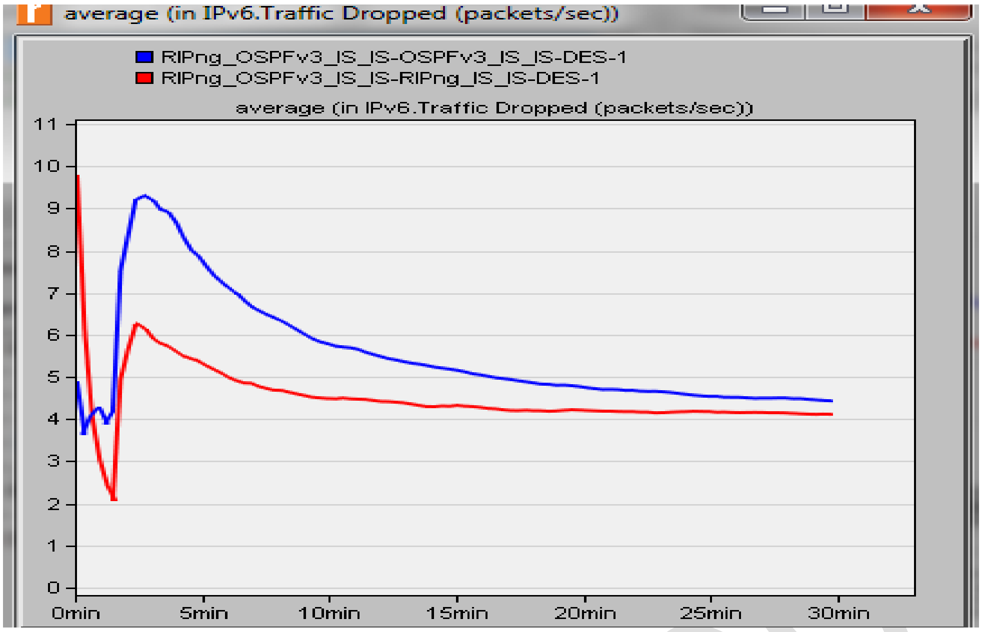


Fig. 17. Traffics dropped for IPv6 (packets/second)

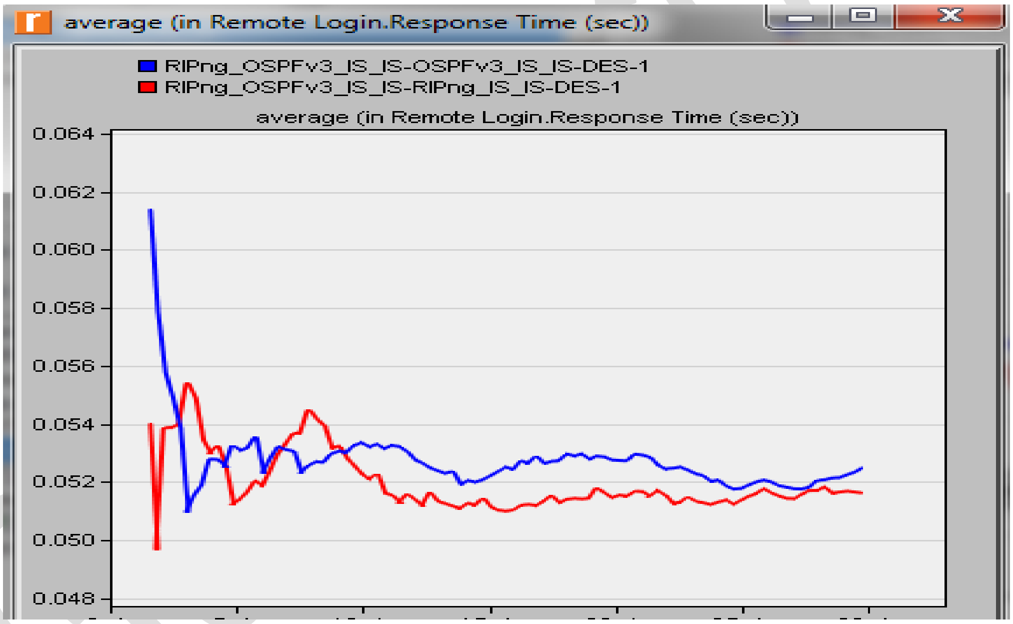


Fig. 18. Remote login response time (seconds)

5. CONCLUSION

This paper features the work output of two mixed protocols namely, OSPFv3/IS-IS and RIPng/IS-IS for IPv6 configured network which have been quantified and compared for some selected applications based on simulation.

The results obtained from the simulation indicated that, RIPng/IS-IS performed better in email upload/download response time, IPv6 packet dropped and remote login response time. While OSPFv3/IS-IS network performed better in the remaining quantitative parameters. RIPng/IS-IS network received more traffic than OSPFv3/IS-IS leading to network congestion which resulted in the RIPng/IS-IS network dropping more IPv6 traffics. However, as the simulation progressed, OSPFv3/IS-IS dropped more IPv6 traffic than RIPng/IS-IS in most part of simulation.

The combination of RIPng and IS-IS took a longer time to converge, affecting the speed on the network scenario. The time the RIPng/IS-IS combination took to access most of the application servers is slower than that of OSPFv3/IS-IS network scenario. The mixture of OSPFv3/IS-IS sent and received more application packets because it had very high throughput values which had an impact on the overall quantity of application traffics received. Although the OSPFv3/IS-IS network scenario recorded the highest database and ftp traffics, this could not affect the speed of the mixture of routing protocols to become lower than the RIPng/IS-IS scenario.

Therefore, based on the overall performance of the two scenarios, it can be concluded that OSPFv3/IS-IS performed better than RIPng/IS-IS.

6. FUTURE RESEARCH

Analysing the performance of the mixture of routing protocols namely RIPng/IS-IS and OSPFv3/IS-IS was done and it was observed that, there was a better performance with OSPFv3/IS-IS combination under this research. In the future, research can be done to join OSPFv3 and IS-IS routing protocols so that a single forward-looking routing protocol can be developed, by evaluating the source-code of all protocols and modifying the codes as well.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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