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Performance Analysis of Routing Protocols for Real Time Application

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Abstract: Routing protocols are used to determine the shortest path to the destination. Information on network is delivered using dominant interior routing protocols like RIP, OSPF, EIGRP and IGRP but knowledge for selection of right protocol is must to experience better performance on network services like VOIP, Video Conferencing, HTTP and FTP. In this paper, Comparison among Interior Gateway Protocols (IGP) protocols is done with weighted-faired queuing (WFQ) technique on different scenarios using OPNET (Optimized Network Engineering Tool) as a simulation tool which provides guidelines to network engineers to decide which protocol should be deployed for a custom specific application as per individual's choices. Results show that EIGRP will be the best choice for FTP, Email and DB access as compared to other protocols for non real time applications whereas OSPF and IGRP gives better performance in case of real time application.

Keywords: Routing protocols, OPNET, FTP, HTTP, Video conference, Voice

I. INTRODUCTION

Routing protocol is combination of rules and procedures that allows routers to exchange information about changes in the network with each other within an Autonomous System. The dynamic routing protocols like RIP, OSPF, EIGRP, IS-IS and IGRP keeps track of paths using routing algorithms for better performance. But now a days, increase in large networks increases routed traffic and reduces the stability of the network. The major causes for the degradation of the service performance in internet are network congestion, link failures, and routing instabilities [1]. In [1], it has been found that most of the disruptions occur during routing changes. A few hundred milliseconds of disruption are enough to cause a disturbance in voice and video [5]. A disruption lasting a few seconds is long enough for interrupting web transactions [2]. Hence, during routing convergence data packets are dropped, delayed, and received out-of-order at the destination resulting thus in a serious degradation in the network performance [1].

To effectively and efficiently distribute data, the choice of the routing protocol becomes very critical factor to define the success of the network over time [3]. Routing protocols are the main factors contributing to speed-up data transfers within the network. In this paper, RIP, OSPF, EIGRP, IS-IS and IGRP are evaluate on different scenarios for real time applications. WFQ queuing technique is used as it always shows better performance in case of traffic drop, file receiving, voice data receive and video conferencing [5]. Simulations have been done in OPNET for evaluating these routing protocols against different parameter.

II. INTERIOR GATEWAY PROTOCOLS

There are two main types of algorithms for IP routing: Distance Vector Routing and Link State Routing. Basically,

A. Distance Vector Protocol

Distance vector protocol finds the best path on how far the destination is, while Link State protocols are capable of using more sophisticated methods taking into consideration link variables, such as bandwidth, delay, reliability and load [6]. Distance can be hops or a combination of metrics calculated to represent a distance value [6]. The IP Distance Vector routing protocols still in use today are: Routing Information Protocol (RIP v1 and v2) and Interior Gateway Routing Protocol (IGRP). To work in small networks, Distance-vector routing protocols are simple and efficient. However, they have poor convergence and improper scale, which has led to the development of more complex but more scalable link-state routing protocols for use in large networks.

B. Link State Protocol

A Link-state routing is a concept used in routing of packet-switched networks in computer communications. Link-state routing works by having the routers tell every router on the network about its closest neighbours [16]. The entire routing table is not distributed from any router, only the part of the table containing its neighbours. Some of the link-state routing protocols are the OSPF, IS-IS and EIGRP. This type of routing protocol requires each router to maintain at least a partial map of the network. When a network link changes state, a notification, called a link state

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Vol. 3, Issue 1, January 2014

advertisement (LSA) is flooded throughout the network. All the routers note the change, and re-compute their routes accordingly. Link State Routing protocols provide greater flexibility and sophistication than the Distance Vector routing protocols. They reduce overall broadcast traffic and make better decisions about routing by taking characteristics such as bandwidth, delay, reliability, and load into consideration, instead of basing their decisions solely on distance or hop count [6].

III. LITERATURE SURVEY

Many routing protocols have been proposed for [1-9] but it can still be addressed that there are very few comparison and analysis on all IGP protocols for real-time application have been made. For the most part, previous studies of different routing protocols such as EIGRP and OSPF have been done based on simulation [8], in which the authors have concentrated on comparative performance and in detailed simulation study carried out in the IP network. In this paper, in terms of selecting the right protocol, comparison and evaluation of the routing protocols have been done based on performance metrics such as network convergence, network convergence activity, CPU utilization, throughput, queuing delay, and bandwidth utilization. In the area of interior routing protocols, numerous studies have been published about the behavior of OSPF, RIP, IS-IS and EIGRP [1-9] and how VoIP performance can be affected by different routing behaviors [10]. These studies have contributed with a lot of potential insights of interior routing protocols which has drawn similar attention to work in that direction. In this paper, we are going to present the effect of IGP protocols such as RIP, OSPF, IGRP and EIGRP for the real and non real-time applications like FTP, HTTP, Video conference, voice, etc.

IV. SIMULATION

OPNET Modeler is a commercial product which is freely available worldwide to qualifying universities. OPNET has probably the largest selection of ready-made protocol models. It enables simulation of heterogeneous networks by employing a various protocols [12].

A. Network Topology

Here we have used OPNET IT Guru Academic Edition for simulation. The simulated network shown in Fig. 1 consists of six subnets connected to each other with Point to Point Protocol (PPP) using Digital Signal 3 (DS3). One subnet is acting as server at center and remaining subnets are connected to it as shown in Fig 1. Each subnet consists of Ethernet4_slip8_gtwy routers, switches and 10BaseT LANs. These nodes are connected with Ethernet 100BaseT cables as shown in Fig 2. Server subnet is consists of three servers, two workstations and switches as shown in Fig 3. The network topology design in Fig. 1 is configured for RIP, OSPF, IGRP and EIGRP protocols with two scenarios Fail and No Fail with weighted-faired queuing. In order to analyse the network in terms of different parameters like upload and down load response time, CUP utilization, packet end to end delay, throughput, etc., the global, node and link statistics are configured accordingly.

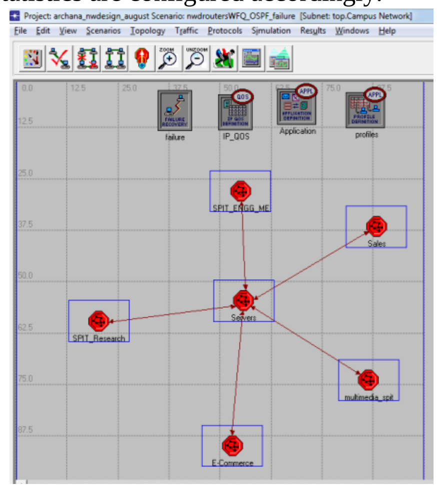

Fig.1. OPNET simulated network topology.

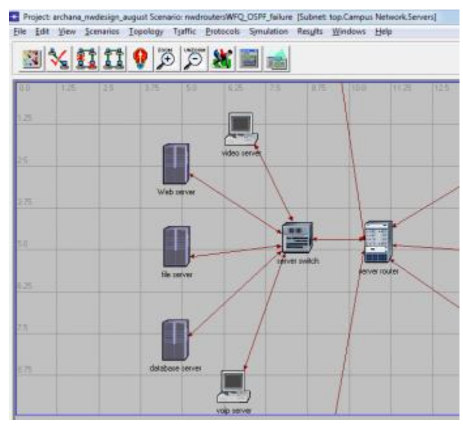

Fig. 1.LAN network setup

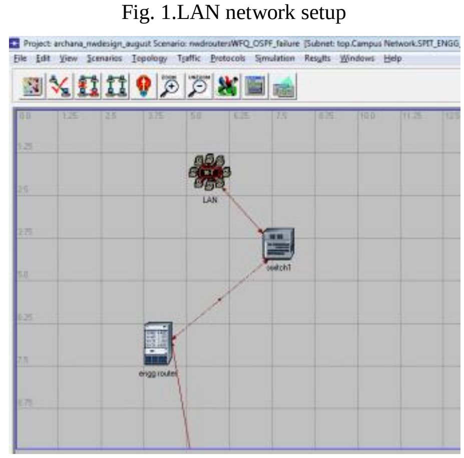

Fig.3. Design of server subnet

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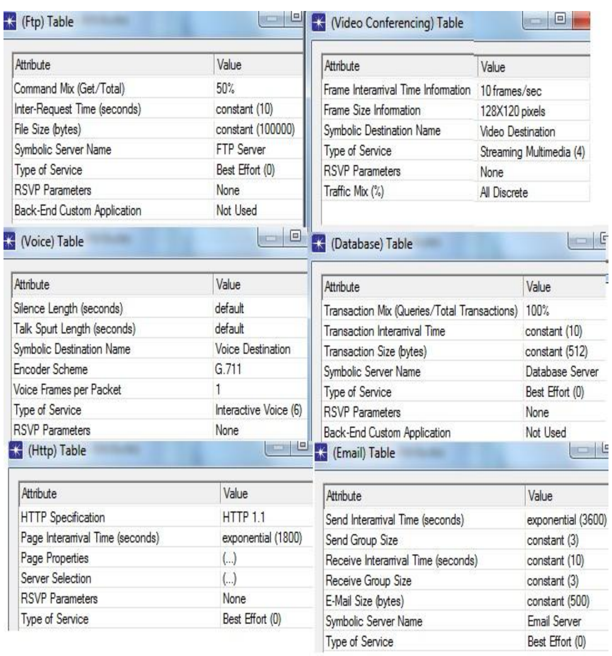
Vol. 3, Issue 1, January 2014

B. Design Parameters & simulation results

The selections of the design parameters are depend on the type of applications as it can real time or non-real time application. It is necessary that we understand the effect of choice in routing protocols, the QoS that it offers, the effect of number of simultaneous users and applications which would add to the server load and hamper the QoS of real-time applications which work on a low latency QoS. The OPNET Modeller is used extensively to decide which protocols would be best suitable for applications. The metrics used for network performance are network convergence, queuing delay, throughput, QoS and CPU utilization. We consider a random network design so as to have a standard network with different profiles such as student, research, marketing, etc each of which would require different applications, some of which would be real time while others non-real time. We start with the analysis of non-real time applications where on the topology shown in fig.1. The configuration of server subnet is also seen in fig.4.



(Ftp) Table

Attribute	Value
Command Mix (Get/Total)	50%
Inter-Request Time (seconds)	constant (10)
File Size (bytes)	constant (100000)
Symbolic Server Name	FTP Server
Type of Service	Best Effort (0)
RSVP Parameters	None
Back-End Custom Application	Not Used

(Video Conferencing) Table

Attribute	Value
Frame Interarrival Time Information	10 frames/sec
Frame Size Information	128X120 pixels
Symbolic Destination Name	Video Destination
Type of Service	Streaming Multimedia (4)
RSVP Parameters	None
Traffic Mix (%)	All Discrete

(Voice) Table

Attribute	Value
Silence Length (seconds)	default
Talk Spurt Length (seconds)	default
Symbolic Destination Name	Voice Destination
Encoder Scheme	G.711
Voice Frames per Packet	1
Type of Service	Interactive Voice (6)
RSVP Parameters	None

(Database) Table

Attribute	Value
Transaction Mix (Queries/Total Transactions)	100%
Transaction Interarrival Time	constant (10)
Transaction Size (bytes)	constant (512)
Symbolic Server Name	Database Server
Type of Service	Best Effort (0)
RSVP Parameters	None
Back-End Custom Application	Not Used

(Http) Table

Attribute	Value
HTTP Specification	HTTP 1.1
Page Interarrival Time (seconds)	exponential (1800)
Page Properties	(...)
Server Selection	(...)
RSVP Parameters	None
Type of Service	Best Effort (0)

(Email) Table

Attribute	Value
Send Interarrival Time (seconds)	exponential (3600)
Send Group Size	constant (3)
Receive Interarrival Time (seconds)	constant (10)
Receive Group Size	constant (3)
E-Mail Size (bytes)	constant (500)
Symbolic Server Name	Email Server
Type of Service	Best Effort (0)

Fig.4 Application Design & Profile attributes of applications.

To get best effort data delivery, normally Standard networks are configured using default settings. This makes the network to have the minimum complexity as possible. In a network that continuously grows, the increased demand of bandwidth from the host does not make the network to deny the services but as more applications are introduced in the network, then mostly it degrades. This is not a problem when the only applications in a network are client server type such as FTP, E-mail or Database. These applications can cope vary easily with delay variations. Instead it is of great concern when multimedia applications such as voice and video are present, applications which cannot cope with delay variations since they are peer to peer applications and are more bandwidth dependent for better QoS.

Email: The simulation is run for the same duration and the results for all the protocols are collected. The parameters that are considered for Email are Download response time and Upload response time.

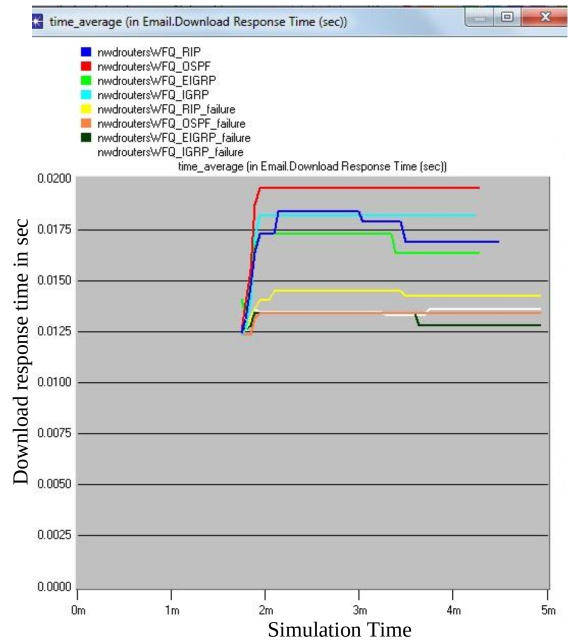


Fig.5. Email down load response time (sec)

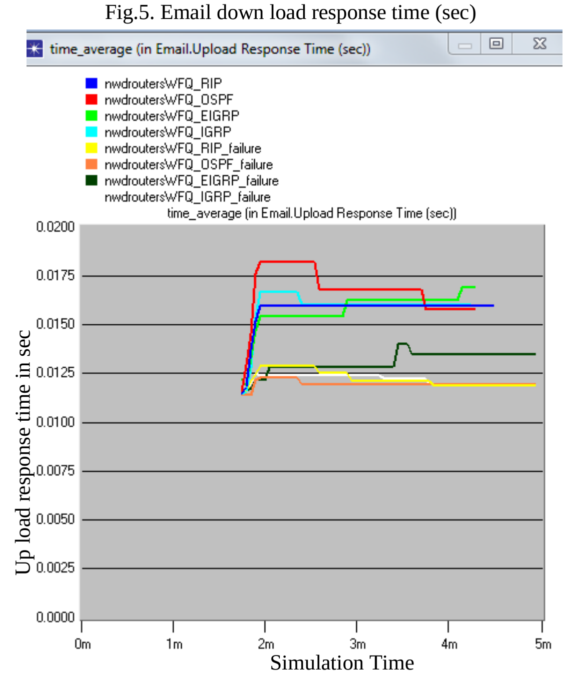


Fig.6. Email Upload response time (sec)

On the basis of above results and we observe that for Email based the average of the upload and download response time for any standard simulation network comprising of these nodes if we run all the routing protocols

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simultaneously we obtain a comparative analysis that EIGRP is the best in terms of resource optimization, latency and convergence.

HTTP web browsing: The parameters are Page response time and Object response time.

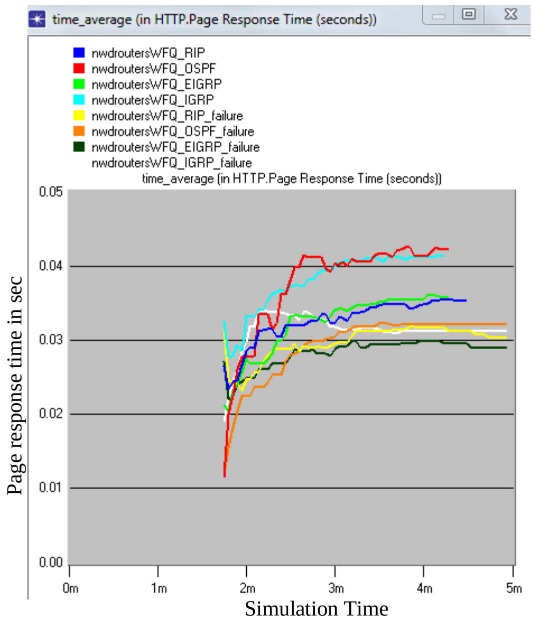

Fig.7. HTTP page response time (sec)

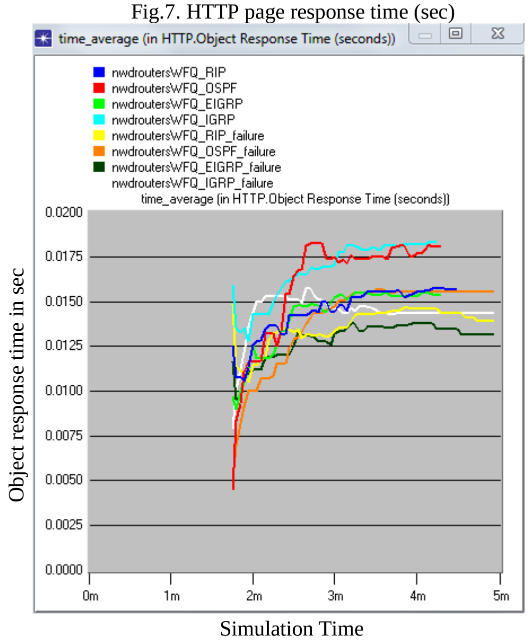

Fig.8. HTTP object response time (sec)

The web browsing requires heavy as well as light traffic due to which scheduling of packets and congestion changes with time. The simulation for HTTP Web Browsing takes both load conditions into account. We average the upload & download response time for the page and the object response time and based on comparative results shown above we can say that for HTTP load the best suited protocols for the parameters considered is EIGRP.

FTP: It is necessary to determine how background traffic is affecting the ftp application, so we model the ftp traffic based on fig 4. Applications like ftp create massive packets or trains of packets which move through the network like a single packet. These packets tend to congest the flow through the network and affect the higher priority traffic despite of them being low priority traffic.

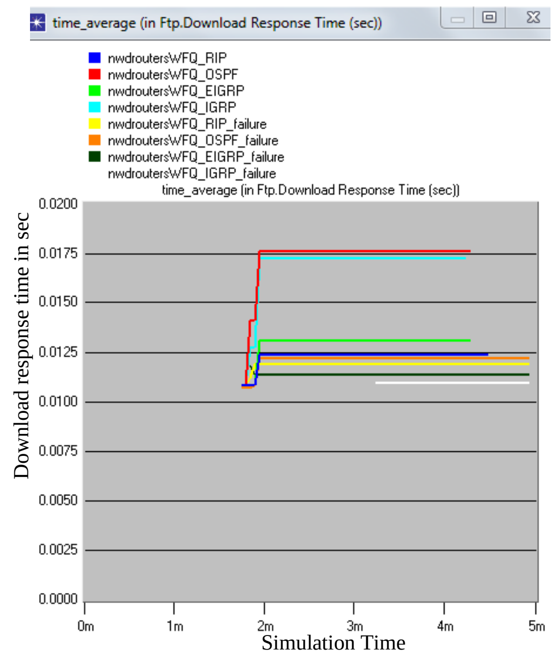

Fig. 9.FTP Download response time (sec)

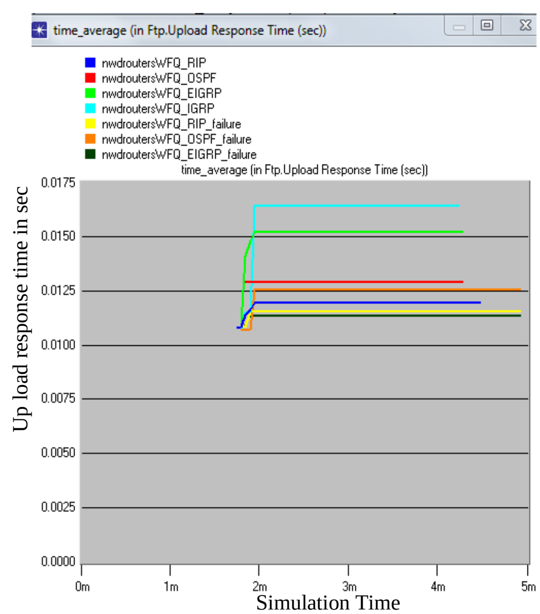

Fig. 10.FTP Upload response time (sec)

We consider the average of FTP upload and download times and run all the routing protocols to determine which

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would provide the most optimum results for ftp. The parameters considered here are Download response time and Upload response time.

On basis of above results we could conclude that ftp would work best for EIGRP protocol based on averaging of the parameters selected under standard network design.

IP Traffic Dropped: Simulations have also been executed in terms of packet dropping. Fig. 11 shows traffic dropping statistics, where it can be observed that packet drop for RIP is higher and for EIFRP is lowest in both the cases Fail and No Fail.

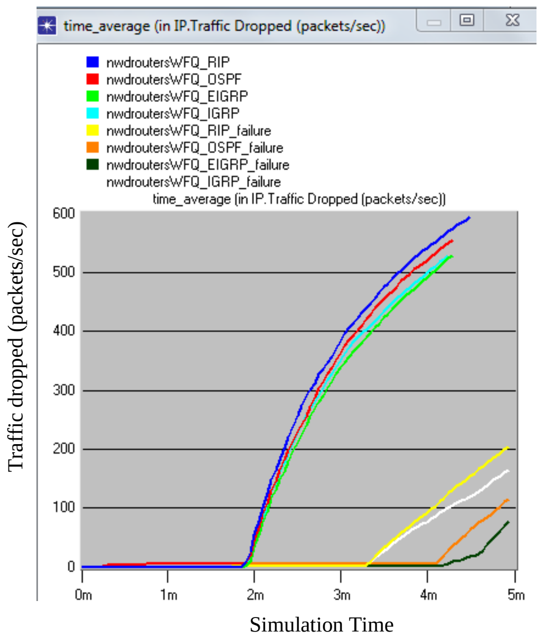

Fig. 11.IP Traffic dropped (packets/sec)

Real time applications

As seen in fig 3 the profile of real time applications such as VoIP and video conferencing application are based on a peer to peer network and hence also can be termed as high bandwidth resource utiliser with improved QoS to meet demands of the user satisfaction.

VoIP: Voice over IP technology integrates data and voice networks and offers flexibility by supplying device interoperability using standards-based protocols. Routing is an essential data networking function that provides an efficient real-time data delivery VoIP requires [12]. Best-effort networks leverage Interior Gateway Protocol technologies to determine paths for routing packets between hosts [12]. The main challenges facing the deployment of VoIP in large enterprise networks are the interoperability, security and bandwidth management issues. The VoIP performance metrics include delay, jitter, packet loss and Mean Opinion Score (MOS). However these have been reported and hence we look at the following parameters and use their outcomes to decide the bottom top approach where the design layout or the schematic is already laid out and we need to run up routing attributes individually to decide the best for the same. The parameters chosen for the same are as Voice Packet End-to-End delay and Voice Packet delay variation

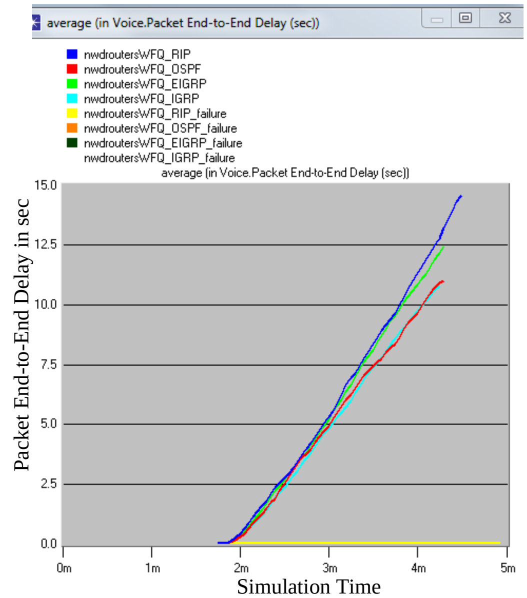

Fig. 12 voice packet End-to-End Delay (sec)

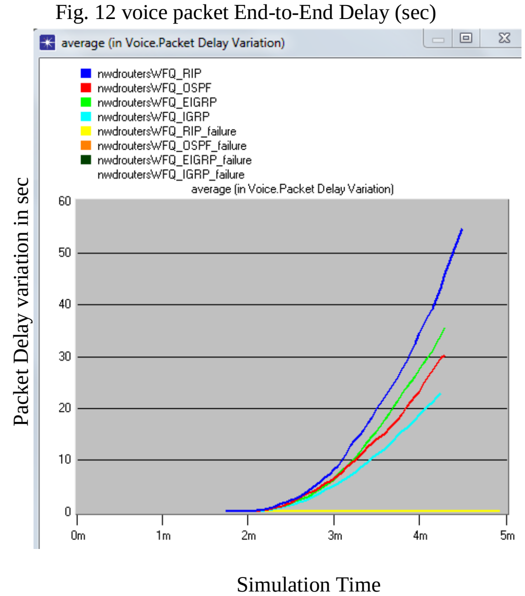

Fig. 13 voice packet Delay Variation (sec)

As expected, RIP carries out low-efficient routing in the network with a bottleneck transmission link as it does not take bandwidth into consideration. In contrast, RIP and EIGRP perform with excellence as they are devoted to computing the fastest possible route. Results show that with the same network specifications it is likely that EIGRP and OSPF have chosen the same route for the VoIP application. On the basis of the above results we can conclude that based on the voice encoder schemes selected and the IGP protocols

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the most optimal routing algorithm would be OSPF and IGRP for real time VoIP application.

Video Conferencing: The selection of the appropriate protocol in real-time applications is more apparent, increasing in real-time demands, parameters such as Packet Delay Variation and End-to-End delay, can even lead to received video packets loss and sound quality reduction at the receiver side. Packet delay variation and end to end delay are some other parameters under consideration. These are based on profiles configured in fig.5 for video conferencing. These parameters can also be set for streaming multimedia. The collated results are as seen in fig.14, fig.15.

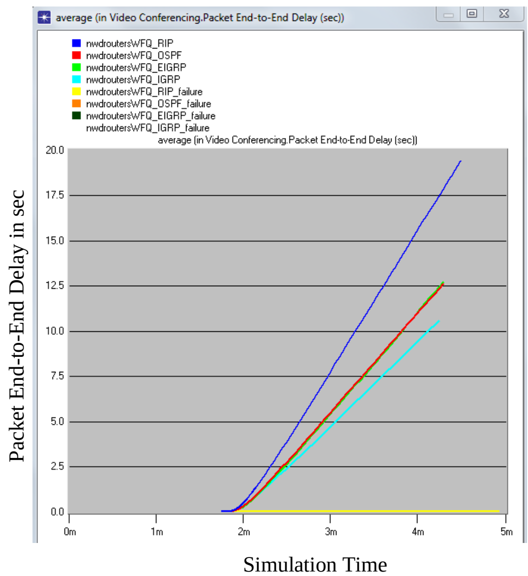

Fig. 14 video conferencing packet End-to-End Delay (sec)

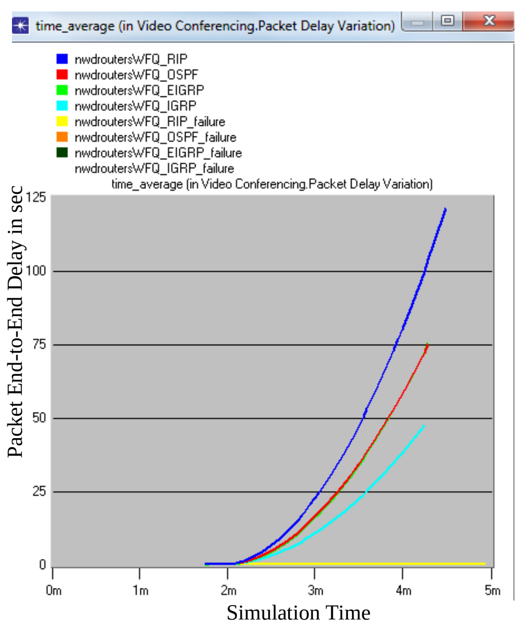

Fig. 15 video conferencing packet Delay Variation (sec)

On the basis of above results for video conferencing we can conclude that real time application such as video conferencing and streaming would work best with IGRP routing protocol.

V. CONCLUSIONS

This paper, we use a bottom-up-top design approach where we would like to find which routing protocols would serve best based on applications currently running in the networks. Once the application profiles are analysed we start running attributes of different protocols on the same standard model network created for uniformity of protocol behaviour. The applications are classified into real time and non-real time where RTP protocols are simulated over IGP protocols. We can conclude that EIGRP will be the best choice for FTP, Email and DB access. We then use the live requirement of video & voice applications to work with specific QoS to meet the stringent requirement of low latency and packet dropping. The best results for VOIP are getting by using OSPF and IGRP protocols whereas for video it is obtained by IGRP. This is a design of a scalable network where design creation has already been done however we need to study the effect of newer applications on server load as well effect of nodes on QoS of applications. This will be done based on current scenario in the network using this profile as a guideline.

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