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Comparison of RIP, EIGRP, OSPF, IGRP Routing Protocols in Wireless Local Area Network (WLAN) by using OPNET Simulator tool - A Practical Approach

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Abstract: *In Adhoc Network group communication is more important, in which routing protocols play a vital role for data transmission. With/Without using central server or access point, the Wireless network form a temporary network with collection of wireless nodes in which, each node changes randomly at different times. In order to establish data transmission between nodes, multiple hops are needed because of limited range i.e. transmission rate. In this paper, we have analyzed and simulated a proposed Wireless Local Area Network (WLAN) using different routing protocols. The performances of different protocols are compared and analyzed using Optimum Network Performance (OPNET) simulator tool in which metrics like delay, throughput, packet delivery, load, Ethernet delay, are measured.*
Keywords: *Adhoc Networks, OPNET, WLAN, RIP, OSPF, IGRP, EIGRP, Routing Protocol*

I. Introduction

Nodes communicate with one another by using multi-hop wireless link in Adhoc networks. Routing plays an important role of moving the data from source to destination i.e. takes place in the network layer of Open System Interconnection (OSI) reference model. Routing is divided into two techniques i.e. Static routing and Dynamic Routing [3], [5]. In static routing, the routing is done manually, whereas in the dynamic routing, the routing it is an interior and exterior routing protocols. Wireless Local area network provides high speed data transmission which can be accessed from any location. Applications like video conferencing, voice chatting, file transferring can be done in Wireless Local Area network with high transmission speed [1], [7]. In this paper, a Wireless Local Area Network (WLAN) is designed and various routing protocols like Routing Information Protocol (RIP), Enhanced Interior Gateway Routing Protocol (EIGRP), Open Shortest Path First (OSPF), and Interior Gateway Routing Protocol (IGRP) are used and compared for testing the performance [9].

II. Literature Survey

Performance analysis of Wireless Local Area Network (WLAN) was performed by using OPNET simulator earlier through delivery traffic. Several authors have given suggestions how to improve the performance e.g. increasing the buffer size. Using high priority traffic, throughput of Wireless Local Area Network (WLAN) is evaluated [5]. In this section, we summarize the basic procedure assumed in multicast protocols and then the Adhoc routing protocols are proposed in the literature survey. Multicast protocols which include the tree-based protocol and mesh-based protocol in which the tree based protocols construct a tree structure for forwarding the packets more efficiently among the neighbors. The work in [2], [3], attempts to improve the transmission i.e. data over a large network without any link breaks. As the focus of our approach, a comparison with routing protocols for Adhoc networks is done by using OPNET simulator tool, so that the performance metrics like packet delivery, delay and throughput are measured for a large network [6]. The HRPM [5] and SPBM [7] are more related work in which the design ideas like decomposition of large groups and distributed geographic hashing to construct a table for better data transfer. Different from general multicasting, the destination are groups of receivers to which all the destinations receive the packet with constant rate depending upon the various routing protocols [9].

III. Routing Protocols

In computer networks, the routing protocol specifies how routers communicate to select the routes for information or data transfer for that, the routing algorithm is more important [7]. First, the routing protocol informs or shares the information with their associative neighbors and then throughout the network, in which topology is determined [5] – [10]. Different types of routing protocols are as follows,
OSPF & IS-IS-> Interior gateway routing using link state routing protocol

RIP & EIGRP -> Interior gateway routing using Distance vector routing protocol
BGP -> Exterior gateway routing using path vector routing protocol

3.1 Routing Information Protocol (RIP)

RIP stands for Routing Information Protocol in which distance vector routing protocol is used for data/packet transmission. In Routing Information protocol (RIP), the maximum number of Hop is 15, because it prevents routing loops from source to destination. Mechanism like split horizon, route poisoning and holdown are used to prevent from incorrect or wrong routing information. Sally Floyd and Van Jacobson [1994] suggest that, without slight randomization of the timer, the timers are synchronized overtime [6]. Compared to other routing protocol, RIP (Routing Information Protocol) is poor and limit size i.e. small network. The main advantage of using RIP is it uses the UDP (User Datagram Protocol) and reserved port is 520 [10].

3.2 Enhanced Interior Gateway Protocol (EIGRP)

EIGRP stands for Enhanced Interior Gateway Protocol which allows router to share information to the neighboring routers which are within the same area. Instead of sending the entire information to the neighboring router, the information which is needed are shared which reduces the workload and amount of data needs to be transmitted. EIGRP (Enhanced Interior Gateway Protocol) designed by CISCO system which can be used only in CISCO routers, but in 2013 it became open source, so it can be used in other routers [5] –[7]. Neighbor table and Topology table are maintained by the EIGRP (Enhanced Interior Gateway Protocol) [10].

3.3 Open Shortest Path First (OSPF)

OSPF stands for Open Shortest Path First which uses link-state routing algorithm. Using the link state information which is available in routers, it constructs the topology in which the topology determines the routing table for routing decisions [7]. It supports both variable-length subnet masking and classless inter-domain routing addressing models. Since it uses Dijkstra's algorithm, it computes the shortest path tree for each route. The main advantages of the OSPF (Open Shortest Path first) is that it handles the error detection by itself and it uses multicast addressing for routing in a broadcast domain [8].

3.4 Intermediate-System to Intermediate - System (IS- IS)

IS-IS stands for Intermediate-system to Intermediate - system which uses link-state routing algorithm for high speed data transmission. IS-IS (Intermediate-system to Intermediate system) uses Dijkstra's algorithm in which independent database built by each IS-IS router for computing the best path for transmission in a network. It is standardized by ISO, but later IETF (Internet Engineering Task Force) standardized as the Internet Standard in RFC 1142 [3], [6], [10].

3.5 Interior Gateway Routing Protocol (IGRP)

IGRP stands for Interior Gateway Routing protocol which uses distance vector protocol (interior) to exchange data within a system [4]. It supports multiple metrics for each node which includes delay, load and bandwidth, in order to compare the 2 routes which are combined into single metrics. The port number for IGRP is 9 which are used for communication and by default every 90 seconds it updates the routing information [5].

3.6 Comparison of Routing Protocols

	RIP v1	RIP v2	IGRP	EIGRP	OSPF	IS-IS	BGP
Interior/Exterior?	Interior	Interior	Interior	Interior	Interior	Interior	Exterior
Type	Distance Vector	Distance Vector	Distance Vector	Hybrid	Link-state	Link-state	Path Vector
Default Metric	Hopcount	Hopcount	Bandwidth/Delay	Bandwidth/Delay	Cost	Cost	Multiple Attributes
Administrative Distance	120	120	100	90 (internal) 170 (external)	110	115	20 (external) 200 (internal)
Hopcount Limit	15	15	255 (100 default)	224 (100 default)	None	None	EBGP Neighbors: 1 (default) IBGP Neighbors: None
Convergence	Slow	Slow	Slow	Very Fast	Fast	Fast	Average
Update timers	30 seconds	30 seconds	90 seconds	Only when change occurs	Only when changes occur; (LSA table is refreshed every 30 minutes, however)	Only when changes occur	Only when changes occur
Updates	Full table	Full table	Full table	Only Changes	Only Changes	Only changes	Only changes
Classless	No	Yes	No	Yes	Yes	Yes	Yes
Supports VLSM	No	Yes	No	Yes	Yes	Yes	Yes
Algorithm	Bellman-Ford	Bellman-Ford	Bellman-Ford	DUAL	Dijkstra	Dijkstra	Best Path Algorithm
Update Address	Broadcast	224.0.0.9	224.0.0.10	224.0.0.10	224.0.0.5 (All SPF Routers) 224.0.0.6 (DR's and BDR's)		Unicast
Protocol and Port	UDP port 520		IP Protocol 9	IP Protocol 88	IP Protocol 89		TCP port 179

"Table." 1 Comparison of routing protocols

IV. Performance Metrics

- **End to End Delay** -> *Sum of the node delay at each node + link delay at each link on the path*

$$\frac{\sum_{1}^{n}(CBR\_sent\_time - CBR\_receive\_time)}{\sum_{1}^{n} CBR\_received}, \quad \textbf{(1)}$$

- **Throughput** -> *Total size of packets received at destination nodes which measured in Kbps (kilo bits per second)*
- **Packet delivery** -> *Ratio of data packets delivered to the destination generated by CBR.*

$$PDR[\%] = \frac{\sum_{i}^{n} CBR\_received}{\sum_{1}^{m} CBR\_sent} \times 100, \quad \textbf{(2)}$$

- **Routing** -> *Ratio of routing protocol to the total number of packets generated by the source.*

$$NRL = \frac{\sum_{1}^{k} Routing\_packets}{\sum_{1}^{n} CBR\_received}, \quad \textbf{(3)}$$

V. Experimental Setup And Result Analysis

In this paper, the proposed network has been simulated by using OPNET simulator tool and the performances of different routing protocols were analyzed. Components for the network design, WLAN parameters and profile configuration parameters are used in our experiment are shown in table 1, table 2 and table 3 respectively. The performance like load, delay, throughput for various protocols were taken and analyzed.

COMPONENT	MODEL
Application Configuration	Application Config
Profile Configuration	Profile Config
Ethernet Server	Ethernet Server
Connection	10BaseT connector
Access Point	Wlan_ethernet_router
Nodes	Wlan_wkstn_adv
Protocol	RIP, EIGRP, IGRP, OSPF

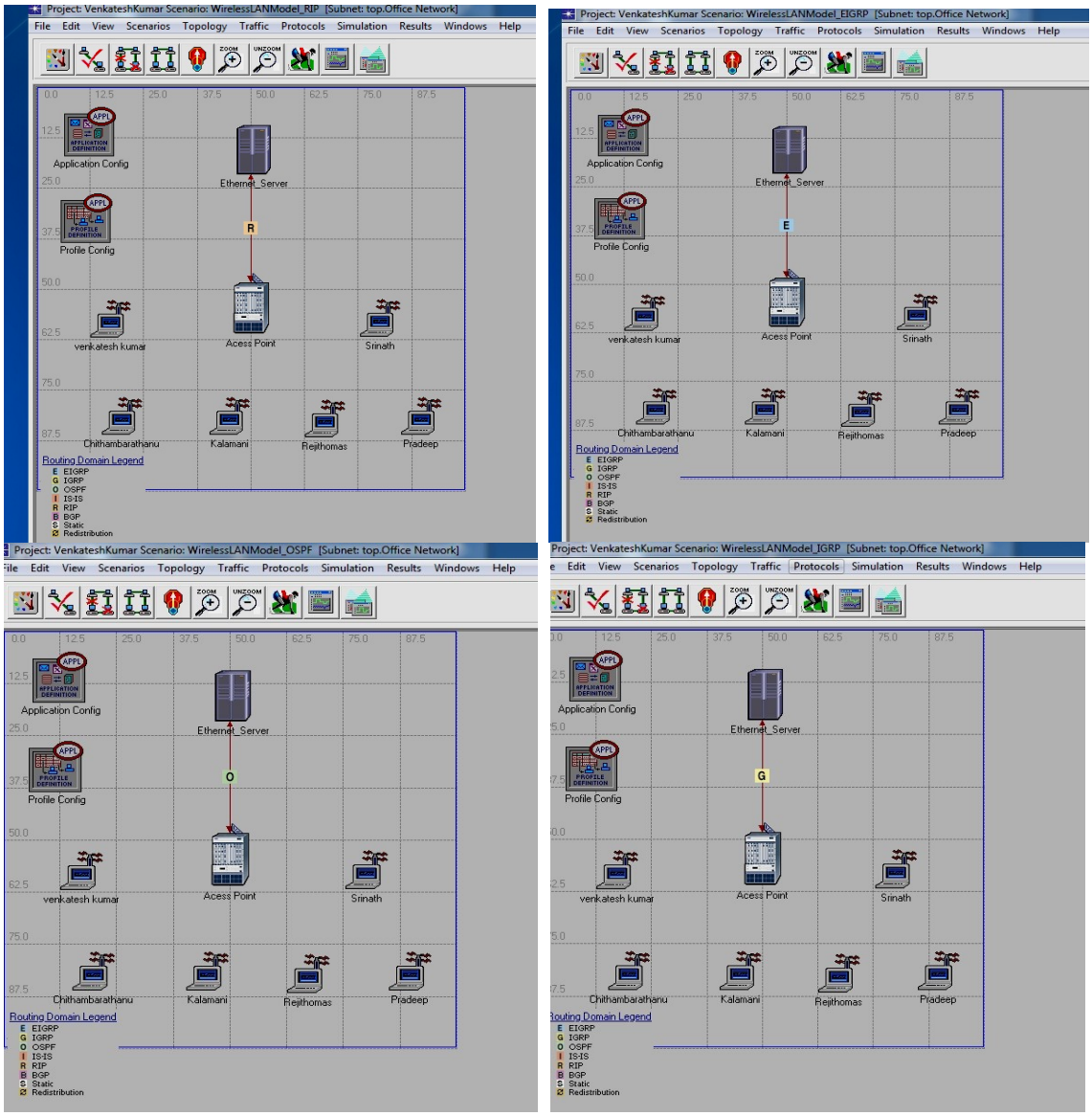
"Table." 2 Components for the network design

ATTRIBUTE	VALUE
BSS Identifier	Auto Assigned
Access Point Functionality	Enabled
Buffer size (bits)	256000
Data rate (bps)	1Mbps, 11Mbps

"Table." 3 WLAN parameters

ATTRIBUTE	VALUE
Profile Configuration	Profile Config
Profile name	Web application, Wireless application
Operation mode	Serial (ordered)
Start time	Uniform(100,110)
Duration	End of Simulation
Repeatability	Once a start time

"Table." 4 Profile Configuration parameters

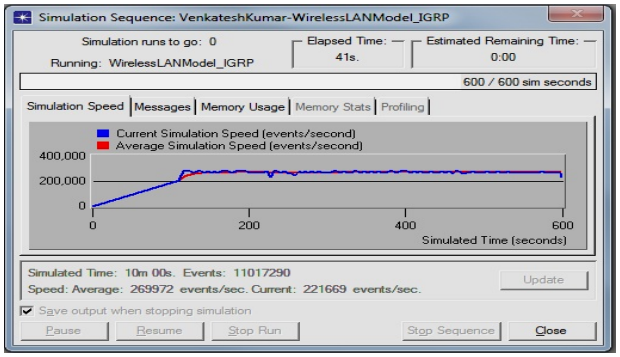


"Fig." 1, 2, 3 and 4 represents final design network of RIP (Top Left), EIGRP (Top Right), OSPF (Bottom left) and IGRP (Bottom Right)

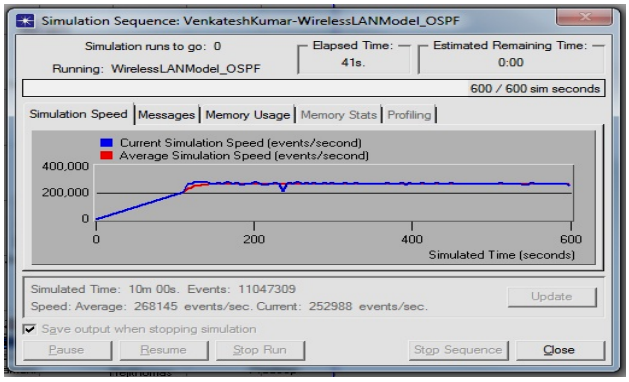
5.1 Result analysis

In this section, the procedure for collection of statistics and the execution performance are described which collected from individual nodes i.e. node statistics and global statistics. The following results like simulation sequence diagram, delay, throughput, packet delivery, Ethernet delay, traffic send /receive were analyzed.

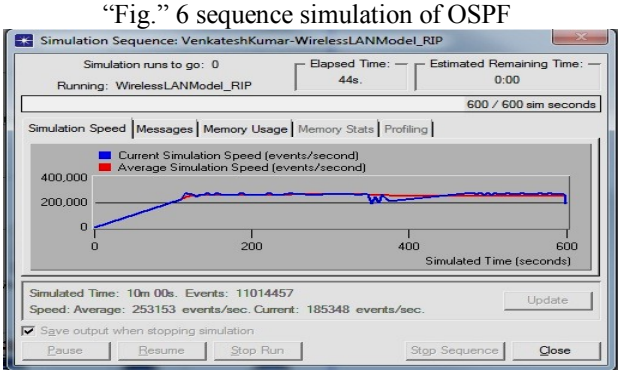
5.1.1 Sequence Simulation



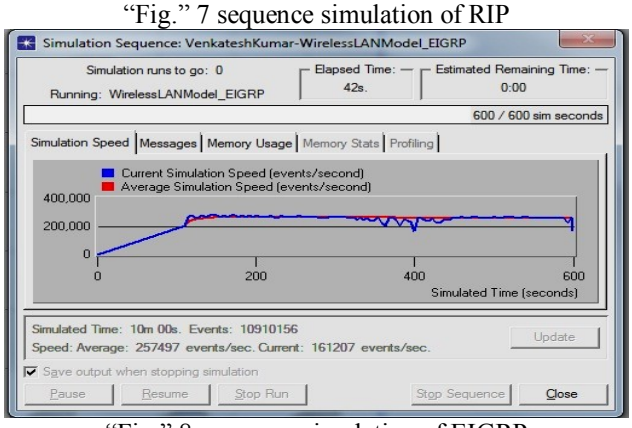
"Fig." 5 sequence simulation of IGRP



"Fig." 6 sequence simulation of OSPF



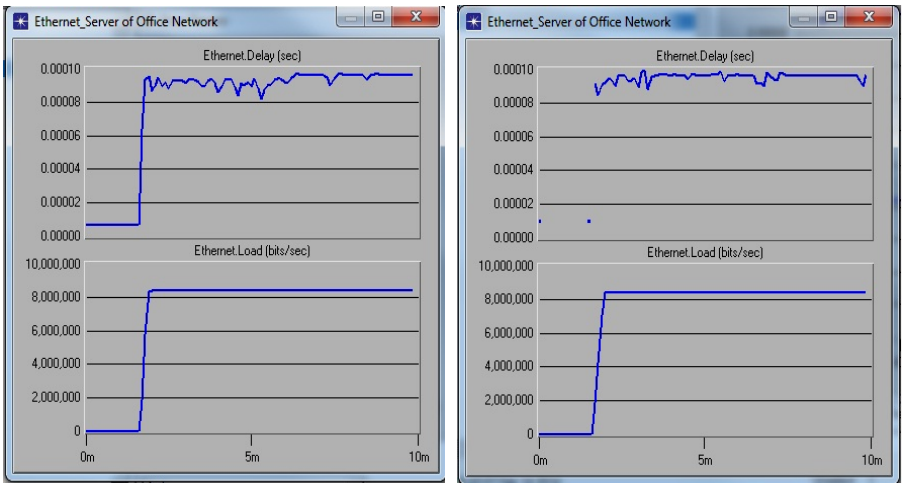
"Fig." 7 sequence simulation of RIP

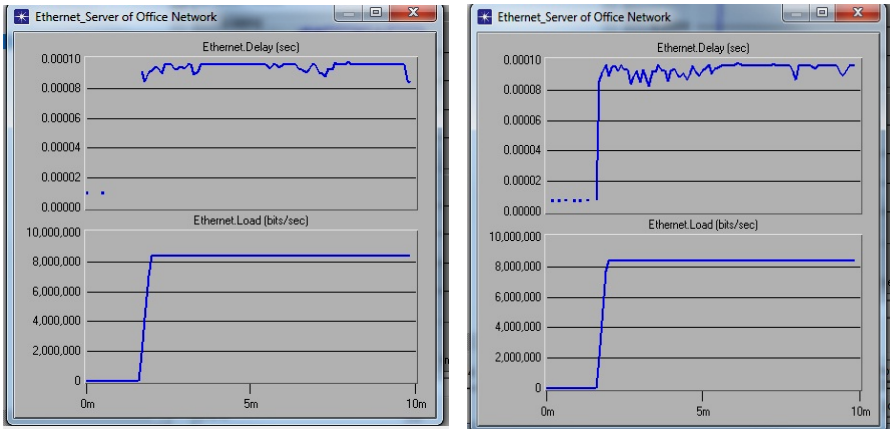


"Fig." 8 sequence simulation of EIGRP

5.1.2 Ethernet Delay

It represents the end-to-end delay of all packets received by all the nodes. The average time Ethernet delay of the entire network for different values percentages is observed. We can analyze that the average time delay increases as the back utilization increases [4].

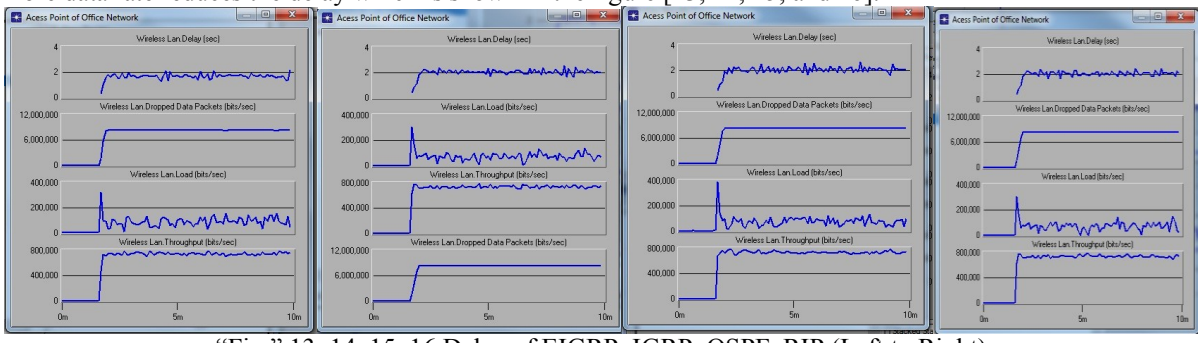




"Fig." 9, 10, 11, 12 Ethernet delay of EIGRP (Top Left), IGRP (Top Right), OSPF (Bottom Left), RIP (Bottom Right)

5.1.3 WLAN Delay (Access Point)

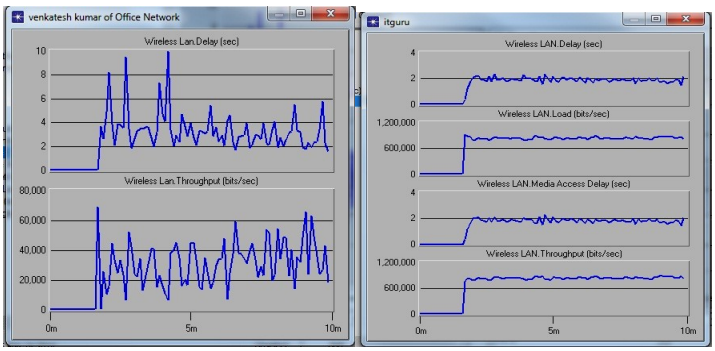
Delay is gathered for 10 minutes of simulation time for different routing protocols. Delay represents the end-to-end delay of packets which is received by the WLAN MAC's of all the nodes which is forwarded to the higher layer [1] - [5]. The access point is enabled, so that the delay includes the medium access delay at the source MAC. At 1Mbps data rate, the end-to-end delay is increasing when compared to the 11Mbps data rate. More data rate reduces the delay which is shown in the figure [13, 14, 15, and 16].

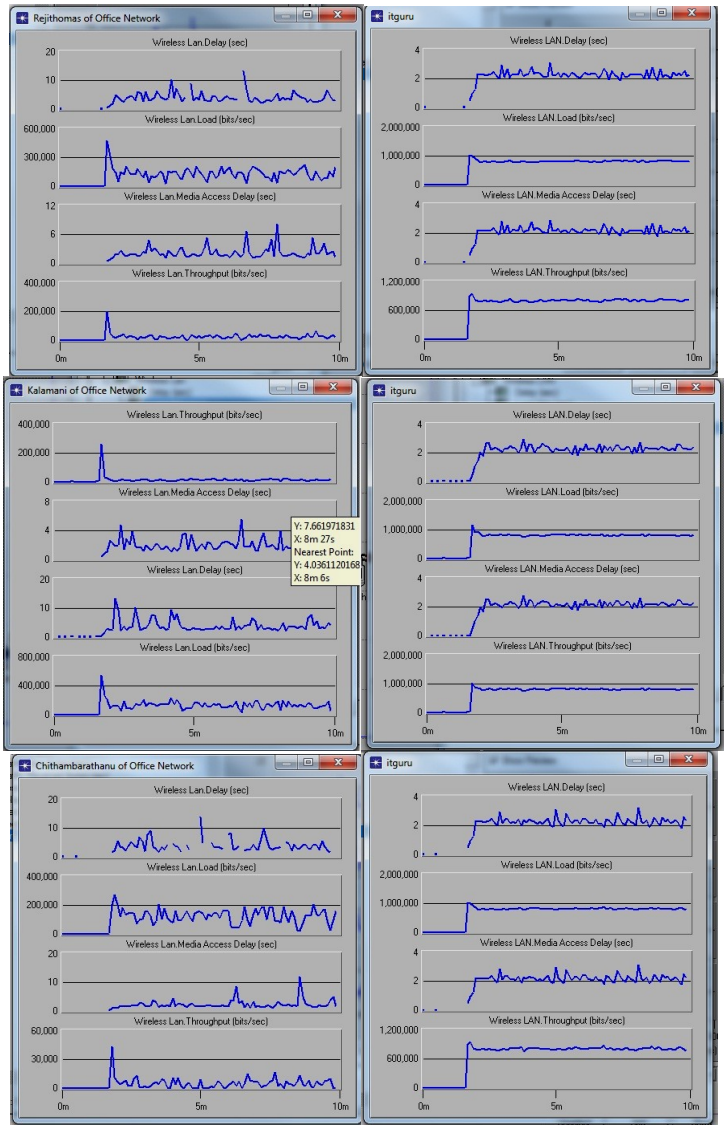


"Fig." 13, 14, 15, 16 Delay of EIGRP, IGRP, OSPF, RIP (Left to Right)

5.1.4 Load and Throughput

The generation rate of data is 1Mbps according to the proposed system and the relationship between the load and throughput is discussed in this section. Load is defined as the total load submitted to the WLAN nodes in (bits/sec) where as, the throughput is total number of bits forwarded from wireless LAN to all WLAN nodes in the network. From the figure. [17-24] shows the load is greater than the throughput for different routing protocols and the load is fixed, so that the throughput is improved at different data rates.





"Fig 17, 18, 19, 20, 21, 22, 23, 24 Load & Throughput

VI. Feasibility Study

In the feasibility study, three considerations like economical feasibility, technical feasibility and social feasibility are analyzed.

Economic feasibility -> Cost
Technical feasibility -> Requirements & Resources
Social feasibility -> Protection & Security

VII. Conclusion

The main objective of this paper is about the WLAN (Wireless Local Area Network) and their technologies, routing protocols and operation modes. In this paper, the performance of WLAN is evaluated by using OPNET simulator and performance metrics like load, delay, throughput, packet delivery were obtained for different routing protocols like EIGRP, RIP, IGRP and OSPF. From the result, we analyzed that the delay is improved by increasing the transmission rate. EIGRP and OSPF is more efficient than other routing protocols in terms of throughput and load. A comparison between different protocols were analyzed and we can suggest that markets like large enterprises, educational institutes, industrial sites can implement EIGRP and OSPF routing protocol for better performance and key catalyst like 802.11a, 802.11g can accelerate the WLAN(Wireless Local Area Network) with the speed upto 54Mbps [2] – [7].

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