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SIMULATE THE PERFORMANCE PARAMETERS OF WIRED WND WIRELESS NETWORKS BY SOFT COMPUTING TECHNIQUE

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ABSTRACT: The wired computer network provide secure and faster means of connectivity but the need of mobility i.e. anywhere , anytime and anyone access is tilting the network users towards wireless technology. In this paper performance analysis of wired and wireless computer networks through simulation has been attempted using soft computing technique like simulation through OPNET EDITION 9.1. For wired networks, the performance parameters like delay and throughput has been invested with varying transmission links and load-balancers. From the obtained results, it is gathered that performance of wired networks is good if high speed Ethernet links like 1000 base X and server load policies are used. Where as the performance of wireless network can be achieved by studying the impact of parameters such as Request to send/ clear to send (RTS/CTS), Fragmentation threshold (FTS). For the tested simulation scenarios the performance is observed to be better with wireless network using infr-red type physical characteristics and higher buffer size (1024Kb). The parameters values in the correspondence to networks load and topology to get the best performance which is the main objective of this paper.

Keywords: OPNET, load-balancing, buffer size, physical characteristics.

I: INTRODUCTION

Networks have grown like weed over the past few decades providing a pace to the means of accessing network resources. For example, the use of Internet is gaining importance with the adoption of network technologies for purposes like education, business, banking and defence. These interconnected set of computer system permits interactive resource sharing between connected pair of systems. Rapid advances have taken place in the field of Wired and Wireless Networks. Several network models have been modelled by various researchers, using network simulators, to find out the most feasible ones. Investigations of these network models have been performed using the simulation techniques that reduce the cost of prediction, estimation and implementation of the network models. The traditional wired transmission medium poses constraints like mobility and extensive cabling. But wireless communication is a flexible data communication system implemented as an extension to or as an alternative for wired communication. The bandwidth and the services provided by the wireless communication networks are similar to that provided by the wired networks. So, as the networks are being upgraded from scratch all over the world, network planning is becoming all the more important. Computing the viability and performance of computer networks in real can be very expensive and painstaking task. To ease and comfort the process of estimating and predicting a network design, simulation and modeling techniques are widely used and put into practice. The network simulation thus becomes an indispensable tool for carrying out the design and redesign operations and for evaluating the performance of the network. A variety of simulation tools like NS-2, NetSim, and OPNET are available for the purpose of modeling and simulation but the choice of a simulator depends upon the features available and the requirements of network application. OPNET is one of the simulation software which can provide statistical analysis of data for network planning and design operations.

In this paper, the wired and wireless networks have been modelled and simulated using OPNET Modeler. The analysis helped to estimate and optimize the performance of wired and wireless networks using the proposed optimization techniques.

II. RELATED WORK

An important issue related to the network performance is congestion which may occur in a network when the number of packets sent to the network is greater than the number of packets that the network can handle. The intermediate devices like routers and switches in a network have buffers where the packets wait in a queue before and after processing. Depending on the packet arrival rate and the packet departure rate which may be higher or lesser than the packet processing rate, the size of input or the output queue may increase or decrease. This increase in queue size may lead to congestion. A key issue in designing any good network is to use congestion control mechanism. The congestion control involves two factors that measure the performance of a network: delay and throughput. Efforts have been made to analyse the effect of various parameters on the performance of both wired and wireless networks.

Wired local area networks includes several technologies like Ethernet, token ring, token bus, Fibre distributed data interface and asynchronous transfer mode local area networks. The Ethernet is a contention media access method. In its purest form, contention means that the computers are contending for use of the transmission medium. Any computer in the network can transmit at any time (first come, first serve).
IEEE 802.3 standard specifies CSMA/CD as the access method for first-generation 10-Mbps Ethernet, a protocol that help devices share the bandwidth evenly without having the two devices transmit at the same time on the network medium. When the two devices transmit at the same time the collision can occur. This collision generates a jam signal that causes all nodes on the segment to stop sending data, which informs all the devices that a collision has occurred. The collision also invokes a random back off algorithm (which determines when the colliding stations can retransmit). Each device on the Ethernet segment stops transmitting for a short time until the timers expires. Thus the collisions are overcome. This CSMA/CD protocol was created to overcome the problem of collisions that occur when the packets are transmitted simultaneously from different nodes over the same medium. The CSMA/CD network sustaining heavy collisions causes following effects: **Delay**, **Low throughput**, **Congestion**:
The evolutions of Ethernet to bridged LAN lead to the division of larger LAN into smaller networks and then connecting them by using multi-port Bridges. This provided an advantage of separate collision domains. The evolution from bridged LAN to switched LAN lead to technology of connecting multiple workstations using a device called switch. This causes the bandwidth to be shared between switch and workstation (5 Mbps each) leading to a faster switched Ethernet like 10 Base2 and 10 Base 5 Ethernets which provide half-duplex communication. But evolution from switched Ethernet (half-duplex) to full-duplex switched Ethernet increased the capacity from 10 to 20 Mbps.

Due to the various drawbacks of wired LANs like extensive cabling and immobility etc., the wireless technology gained momentum. Wireless local area networks (WLAN) enabled people on the move to communicate with anyone, anywhere, at any time, using range of multimedia services. The tremendous growth of cellular telephone and mobile systems coupled with spreading of laptop and palmtop computers indicates a bright future for such networks, both as standalone and as part of large networking infrastructure. The next stage of this development will be complementing or replacing the traditional wired network. Wireless communication technologies employ infrared, spread spectrum and microwave radio transmission techniques with varying data rates.
The demand of wireless LAN has increased over a span of time because of its comparative simplicity, flexibility, high rate access and low cost. The wireless network infrastructure is useful to provide accessibility in rough terrains and even rural areas where establishing wired infrastructure is difficult.
Wireless local area networks (WLANs) based on the IEEE 802.11 standard are one of the fastest growing wireless access technologies in the world today. They provide an effective means of achieving wireless data connectivity in homes, public places and offices. Like IEEE 802.3 (Ethernet) and IEEE 802.5 (Token Ring), the 802.11 standard focuses on the two lower layers (1 and 2)
of the Open System Interconnection (OSI) reference model. Wireless LAN protocol is based on IEEE 802.11 standard. This standard defines a medium access control (MAC) sub layer and three physical (PHY) layers. This protocol describes a wireless LAN that delivers services commonly found in wired networks, e.g. throughput, reliable data delivery and continuous network connections. The architecture of IEEE 802.11 WLAN is designed to support a network where a number of mobile stations are involved. Within the MAC layer, DCF (Distributed Coordination Function) is used as fundamental access method while Point Coordination Function (PCF) is known as Carrier Sense Multiple Access with collision avoidance (CSMA/CA) protocol. It is an
asynchronous access method based on the contention for the usage of shared channels.
PCF provides a contention free access mechanism through RTS/CTS (Request to Send/ Clear to Send) exchange. The IEEE 802.11 protocol includes authentication, association and re-association services, an optional encryption/decryption procedure, power management and time-bound transfer of
data. Though wireless technology provides convenience and advantages like ease of mobility,

scalability and flexibility but it has certain downfalls like: **Speed**, **Range, Reliability, Security, Bit Error Rate (BER), Carrier Sensing, Hidden Terminal Problem:**

Moreover, analysis and optimization is difficult in real but simulation is one of the alternative options for the same. Though wireless networks, in contrary to wired networks, are relatively a new field of research, there exist some simulators to develop networks and test the effect of change in conditions on various performance parameters. This paper has been focused on the estimation of effects on throughput & delay using varying transmission links, varying physical characteristics, load balancing and buffer size for the wired and wireless networks using OPNET. The proceeding sections involve the implementation of wired and wireless local area network models and the performance analysis of both wired and wireless local area networks using OPNET (Optimized Network Engineering Tool).

III. SIMULATION ENVIRONMENT

In this work, we use OPNET IT Guru 9.1 for our network simulations. OPNET is a powerful communication system simulator developed by OPNET Technologies [10]. OPNET assists with the testing and design of communications protocols and networks, by simulating network performance for wired and/or wireless environments. The OPNET tool provides a hierarchical graphical user interface for the definition of network models as shown in fig.1:

IV. PERFORMANCE ANALYSIS

This section describes the performance analysis of ireless and wired computer networks using simulation. The simulation was done using the network simulator - OPNET.

In case I: First of all, a comparison was done by varying the types of transmission links (Ethernet links) used in the wired networks for communication between the server and the clients. Secondly, a load balancing mechanism has been used o balance traffic load in the wired network. In this, different load balancing policies are used. Investigations were done to find the policy using which the traffic sent/ received can be balanced to improve the performance. The performance metrics focused upon in wired computer networks are:

Ethernet- Delay (sec), FTP- Traffic Received (bytes/sec), Ethernet – Traffic Received (bits/sec), HTTP – Page response time (sec).

In case II: the performance analysis of the wireless computer networks has been illustrated by tuning the Wireless local area network parameters (such as physical characteristics and buffer Size among many other parameters). Performance metrics measured in wireless computer networks are:

Wireless LAN- Delay (sec), **Wireless LAN- Media Access Delay (sec), Wireless LAN- Retransmission Attempts (packets), and Wireless LAN-Throughput (bits/sec).**

Case I: For Wired Networks

In the simulation scenario shown in Figure 2, comparison as been done by varying the types of transmission links Ethernet links) used in the networks for communication between the server and the clients in a wired local area network. Figure 2 shows the wired network being modeled and simulated for performance analysis using OPNET. The comparison was made for same number of users but different types of links like 10 Base T, 100 Base T and 1000 Base X. he analysis of performance metrics like Ethernet – Delay and average as shown in figure 3.1 and 3.2 illustrates the maximum delay occurs or 10 Base T.

The performance analysis in figure 4 of network model shown in figure 2 illustrates the impact of varying types of links on the Ethernet throughput (bits/sec) for link variation. The traffic received using 100 Base T and 1000 base X is maximum because of the reduction in delay.

IV.1 performance analysis using load balancer

In another simulation for performance analysis, the number of stations in a network is varied as shown in the figure 5, in which there is only one server, a load-balancer, a firewall and other network objects as per the specifications of the network required. When the load balancer receives a packet from a client machine, it must choose the appropriate server to handle the request. The load balancer will use the load balancing policy to determine which server is most appropriate. Following load balancing policies can be used:

Random: The load balancer chooses one of the candidate servers at random

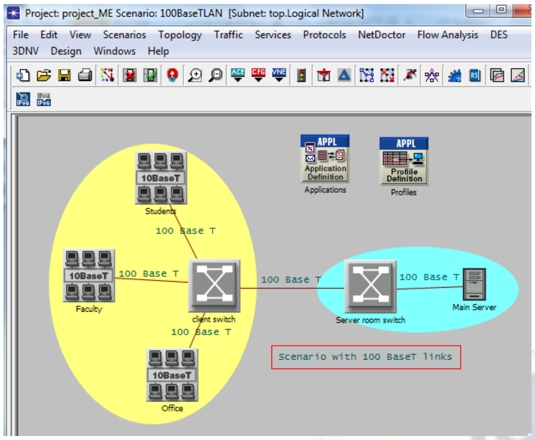

Figure 2 Wired local area network model I

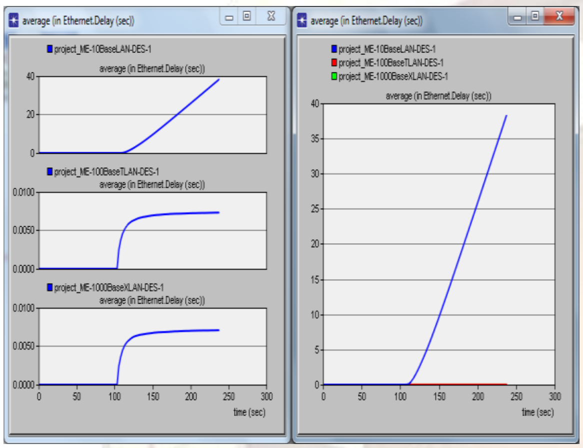

Figure 3.1 Ethernet delay (sec), fig 3.2ethernet delay (sec)

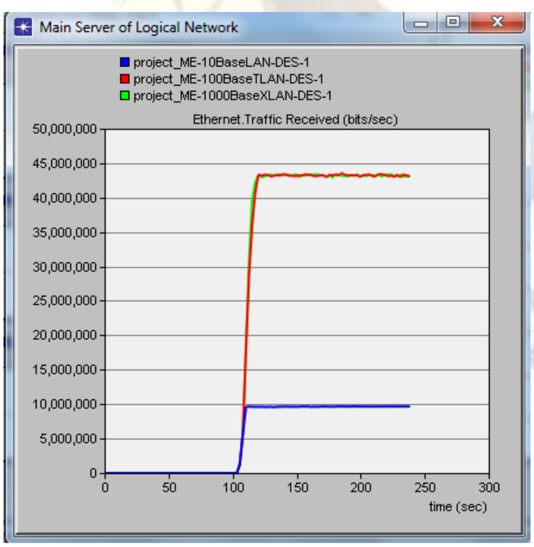

Figure 4 Ethernet traffic received (bits/sec)

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Round-Robin: The load balancer cycles through the list of candidate servers.

Server Load: The load balancer chooses the candidate server with the lowest CPU load.

Number of Connections: The load balancer keeps track of the number of connections it has assigned to each server. When a new request is made, it chooses the server with the fewest connections.

The performance analysis has been done for networks with and without load balancing policy. When no load balancing policy is used, the number of users is varied o vary the network load. Then the performance analysis was done by comparing the networks: one with maximum network load (without load balancing policy) and other network with same maximum network load (with a load balancer implementing random load balancing policy). Figure 6 shows the performance analysis for network with and without load balancer. As can be seen in Figure 6, as the number of user increases, more traffic is generated.

It is also observed that the introduction of load balancing for a single server has no effect on the level of generated. traffic. But as can be seen in figure6.1

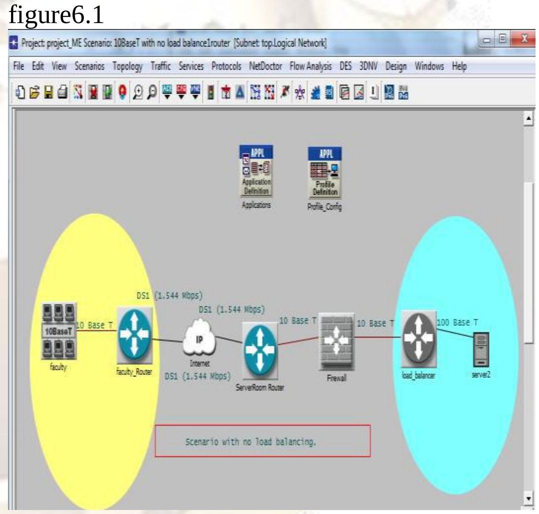

Figure 5 Wired Network using Load Balancer

IV.2 performance analysis using load-balanced multiple servers

It is also observed that the introduction of load balancing for a single server has no effect on the level of generated traffic. The network model shown in figure 7 shows implementation of wired local area networks using load balanced multiple servers. The performance analysis of the network model shown in figure 7 using various load balancing policies has been illustrated in figure 8 for the traffic sent and Figure 9 for the traffic received. The performance analysis is illustrated in figure 8 and figure 9.

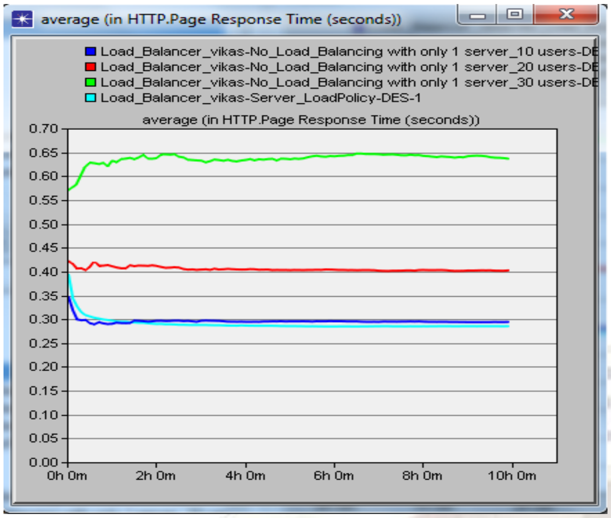

Figure 6Traffic sent (bytes/sec) for varying number of nodes

Figure 6.1response time (sec) for varying number of nodes

The investigations present that while average traffic received or sent (in bytes/sec) with the number of connections policy is more than others, the average traffic received or sent (in bytes/sec) with the server-load policy is lesser than others.

Case II: Wireless Local Area Networks In this case the wireless local area networks were simulated using OPNET as shown in figure 10.The performance analysis of wireless networks can involve the following considerations like **RTS/CTS control enable/disable, physical Characteristics, Data Rate, fragmentation Threshold, buffer size (bits).**

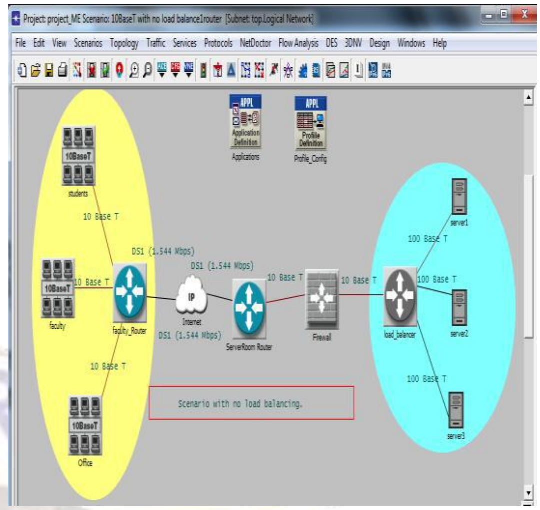

Figure 7 LAN with load-balanced multiple servers

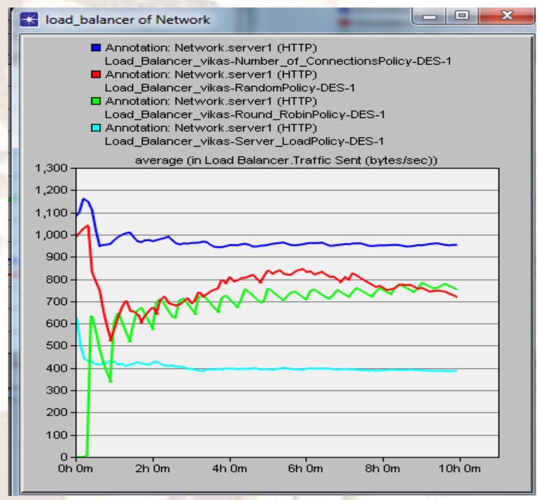

Figure 8 Traffic sent using load balancing policies

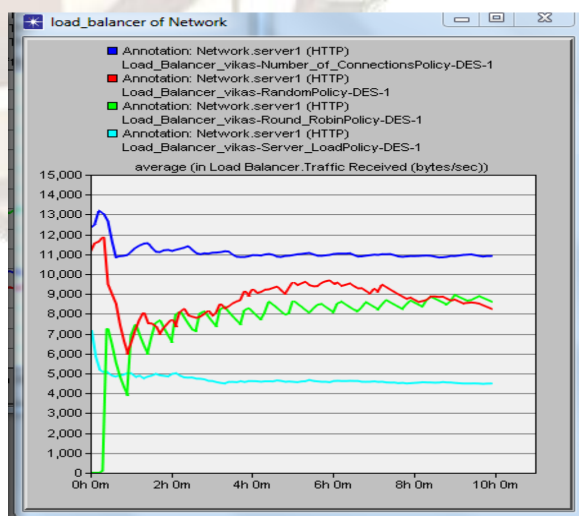

Figure 9 Traffic received using load balancing policies

In this section an insight has been provided on the variations occurring due to the change in physical characteristics and Buffer size. Various scenarios were modelled to estimate the performance of wireless networks at a constant data rate of 2 Mbps but varying physical characteristics like Frequency Hopping, Direct Sequence, Infra red and Extended Rate PHY (IEEE 802.11g).

The performance analysis for media access delay has been illustrated in figure 11. The figure 11 showing delay characteristics, figure 12 showing retransmission characteristics and figure 13 shows lower delays for IR and ERP as compared to the higher delays for DSSS and FHSS. For each packet the delay is recorded when the packet is sent to the physical layer for the first time.

The investigations show that the network attains the maximum throughput using IR layer. The worst results are achieved when IEEE 802.11 protocol uses FHSS layer. But an important thing to focus on is, that the throughput may vary according to the type of the network modeled, the network objects variation may occur in terms of number of stations, data rate and type of network load too among certain other parameters. The effect of change in physical characteristics on throughput i.e. on the bit rate sent to the higher layer is shown in Figure 13.

Buffer size (bits) specifies the maximum size of the higher layer data buffer in bits. Once the buffer limit is reached, the data packets arrived from higher layer will be discarded until some packets are removed from the buffer, so that the buffer has some free space to store these new packets. The optimum size of buffer can stabilize the queue size, the packet drop probability and hence the packet loss rate. The benefits of stabilizing queues in a network are high resource utilization. When the queue buffer appears to be congested the packet discard probability increases. On the other hand, the buffer overflow can be used to manage congestion. The performance analysis has been done for a buffer size of 256kbits and 1024kbits.

The buffer configuration defines the buffer size, the maximum allocated bandwidth and minimum guaranteed bandwidth. If an incoming flow suddenly becomes bursty, then it is possible for the entire buffer space to be filled by this single flow and other flows will not be serviced until the buffer is emptied. If the buffer size is increased, (Figure 15) then the number of retransmission attempts would be reduced. Also the size of the queue will be decreased for larger buffer due to the fact that the larger buffer will

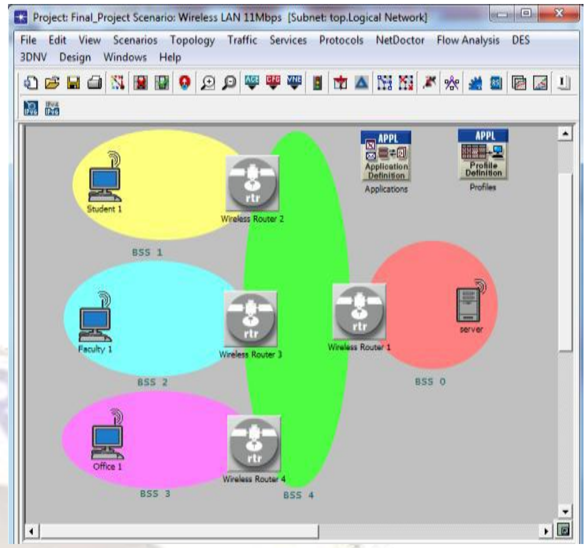

Figure 10 Network Model of the Wireless LAN

Take less time to send the packets, so the queue size will not build up continuously for larger buffer. This shows the reduction in delay as shown in Figure 14

The result of packet loss is the change of queue length. When packet loss is relatively low, packets usually can be transmitted without retransmission, so the queue length may be relatively small. But when the packet loss is high, the MAC packet retransmission (Figure 15) will prolong the delay of packet (Figure 14). So, a small buffer size can increase packet drop rate and hence change the queue length and thus impact the throughput and delay. Hence, the performance has been improved by increasing the buffer size.

The increase of packet discard rate can lead to the decrease of throughput. This happens due to frequent retransmissions of the MAC layer data packets when the packet loss rate increases. But the packet loss may happen due to low buffer size. The analysis in figure 16 shows that if buffer size is increased then the retransmission attempts would be reduced as the size of the queue is decreased for a large buffer size. The time to deliver the packets decreases, due to large buffer size. The throughput always increases monotonically with the buffer size, reaching a maximum above a threshold buffer size.

The performance analysis can be done for varying data rates as shown in figure 17.1 and, 17.2 RTS threshold and fragmentation Threshold are also shown in figure 18 and 19. Thus the throughput can be increased by increasing the buffer size because on increasing the buffer size, the packet drop may be reduced

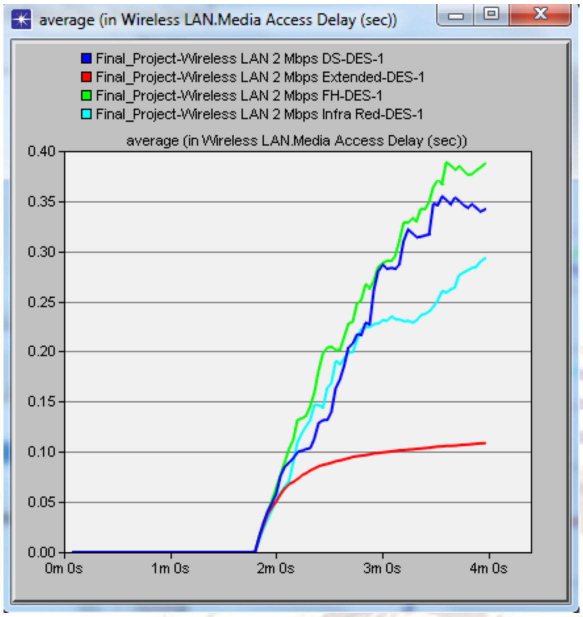

Figure 11 Media Access Delay for varying physical characteristics

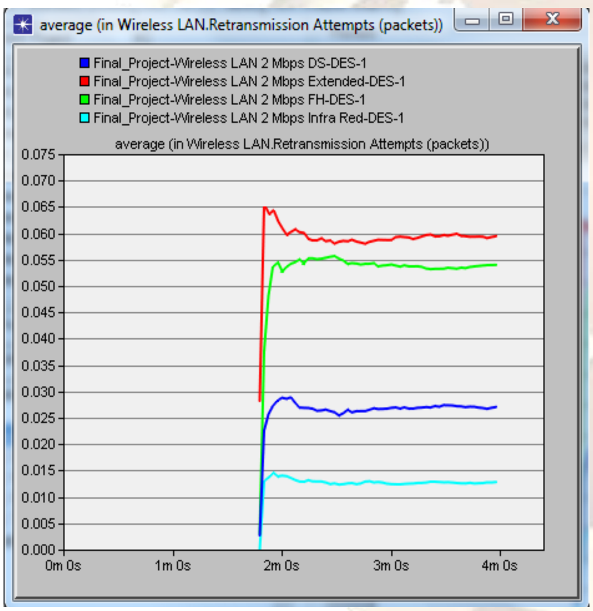

Figure 12 Retransmission Attempts for varying physical characteristics

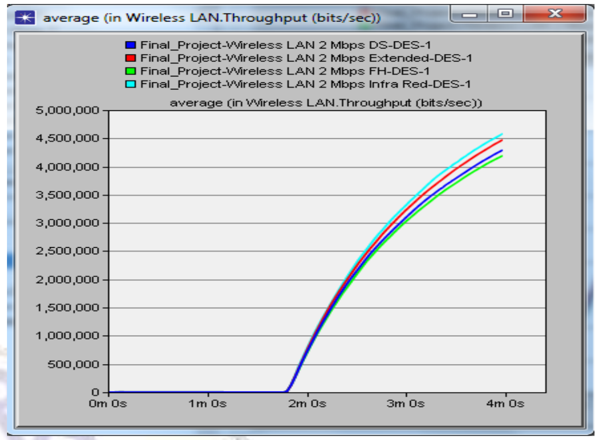

Figure 13 Throughput (bits/sec) for varying physical characteristics

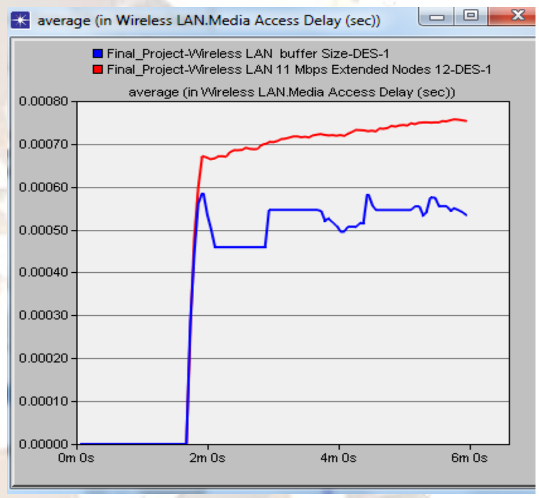

Figure 14 Media Access Delay for varying buffer size

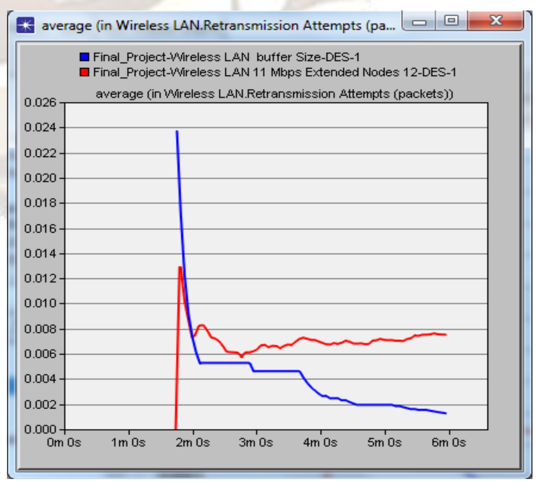

Figure 15 Retransmission Attempts for varying buffer size

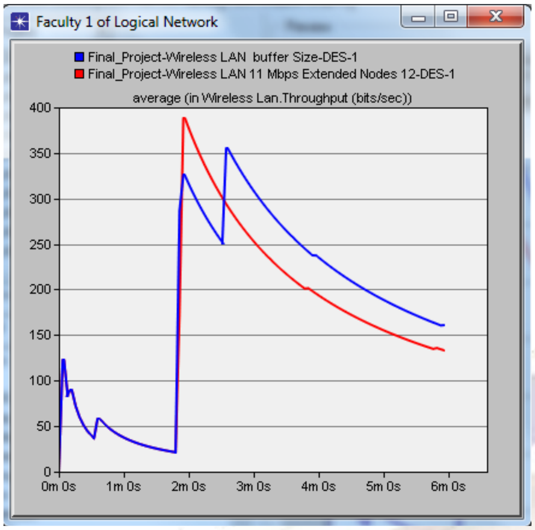

Figure 16 Throughput for varying buffer size (Node level)

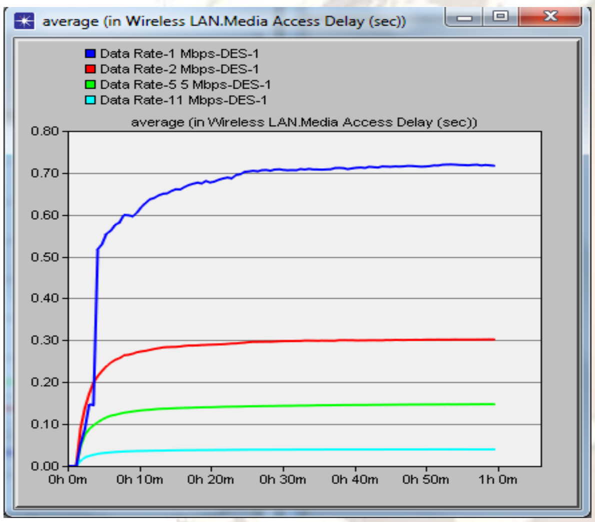

Figure 17.1 Media Access Delay for varying Data Rate

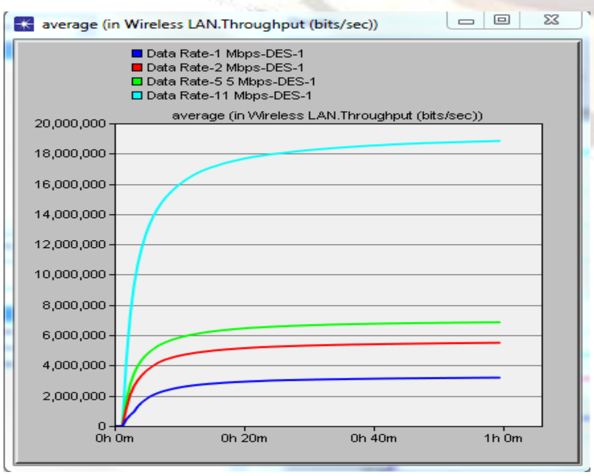

Figure 17.2 Throughput (bits/sec) for varying Data Rate (Global)

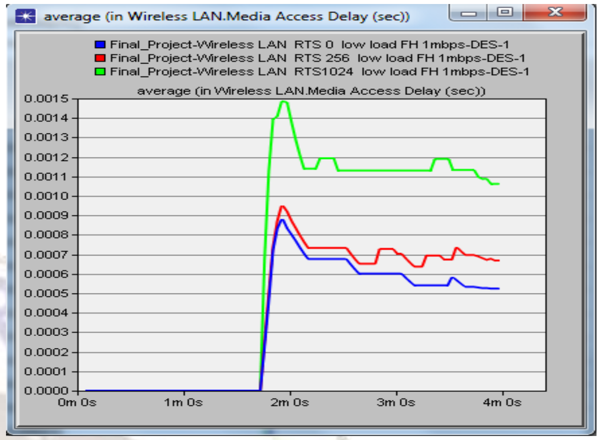

Figure18.1Media access delay for varying RTS

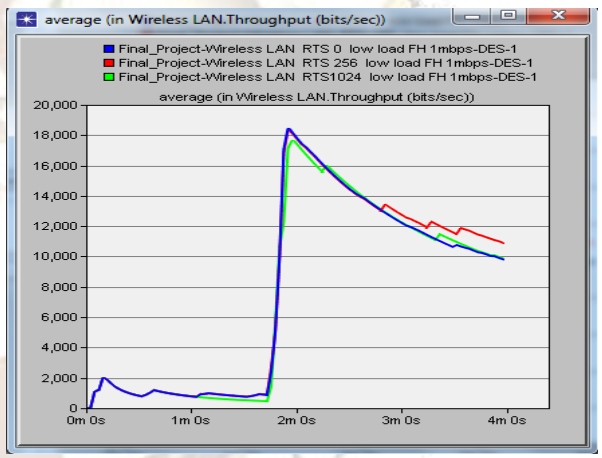

Figure 18.2 Throughput (bits/sec) for varying RTS (Global)

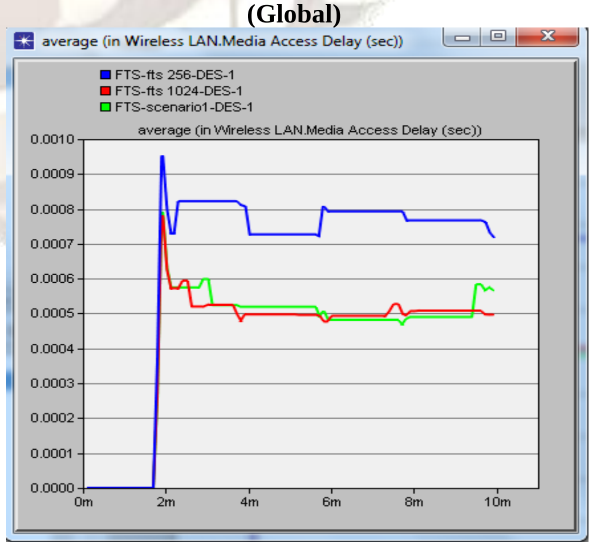

Figure 19.1 Media Access Delay for varying fragmentation threshold

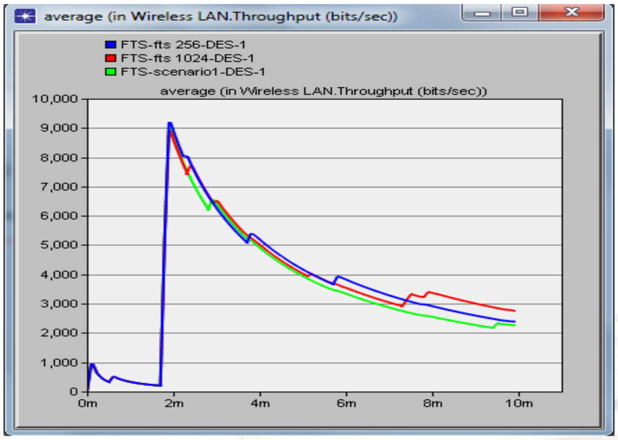

Figure 19.2 Throughput (bits/sec) for varying fragmentation threshold (Global)

V. Conclusions

The impact of various network configurations on the network performance was analyzed using the network simulator- OPNET. It has been investigated that performance of the wired Networks is good if high speed Ethernet links are used under heavy network loads. The mechanism of load balancing also improves the performance by reducing and balancing the load equally among multiple servers. This lowers the response time to access server. In addition performance analysis of wireless computer networks has been

done for improving the performance of wireless LAN. The investigations of physical characteristics reveal that the
infrared type is best in terms of throughput. The variation in buffer size varies the queue size and hence optimizes the throughput.

VI.Future Scope of Work

This thesis mainly focused on the performance analysis of wired LANs and infrastructure based WLANs. In future the work may be extended by including the schemes and techniques to:

- Optimize the security of the wired and wireless computer networks by using firewalls.
- Study Infrastructure less (Ad Hoc) Networks.
- Study the impact on performance by varying transmission powers of nodes.

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