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Asymmetric Networks over Medium Access Control Layer in MANET

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Abstract

In the near future, a computing environment can be expected to be based on the recent progresses and advances in computing and communication technologies. Adhoc networks usually refer to networks created for a special purpose. The topology in ad hoc networks may change rapidly due to the unpredictable mobility of individual devices. Mobile network include both infrastructure wireless network and infrastructure less network. Mobile Adhoc Networks is useful when infrastructure not available, impractical, or expensive and Adhoc network used in military applications, rescue, home networking etc. Mobile Ad-Hoc Network has security attacks due to its features of open medium, cooperative algorithms, lack of centralized monitoring, dynamic changing topology, and management point, and often lack of a clear line of defense.

A Wireless Mesh Network (WMN) comes under the category of Ad hoc networks that is a collection of self configuring, self-healing stationary mesh routers and mobile clients. In the dissertation deploy multiple applications in the WMN scenario that was not done in the previous research work and also to provide Internet in the network scenario used in this report. TCP Reno protocol has been used to improve the performance of symmetric networks. This protocol providing end to end link connection maintained on the network devices. It tries to detect impending congestion by tracking the average queue size in the recent past and then informs the receiver to dynamically decrease the frequency of acknowledgment so that each acknowledgment effectively acknowledges several packets.

From the proposed work, first analyze the benefits of asymmetric links and second perform a simulation study in which measure the performance of the Network scenario. All experimental results are based on OPNET base simulator implementation. We also implement a model especially designed asymmetric networks that is used to monitor network conditions and gather relevant metrics and factor values. Experimental results show that the proposed modeling technique is able to overcome the problems like Response time and throughput.

I. Introduction

Wireless Local Area Networks have important role for users and organizations. The wide spread for using wireless networks which is an open network makes the need for protection of transferred data. For protection purposes, multiple security techniques have been developed over years, these security protocols provide different services [17]. They are not completely secure, they influence substantially on the performance of the network. Any security protocol or approach used in WLAN should provide the following characteristics: Confidentiality, authentication and integrity. In Wireless networks there are number of base stations that connect users to an existing network as shown in figure 1.1.

Figure1.1: Wireless Networks

A MANET is a collection of nodes that do not rely on a predefined infrastructure to keep the network connected. Therefore the functioning of ad hoc networks is dependent on the co-operation of each and every node [18]. The nodes help each other in conveying information about the topology of the network and share the responsibility of managing the network. With the development of MANET and wireless network more security services are required.

Wireless networks are networks which provide users with connectivity regardless of their actual physical location [15, 16].

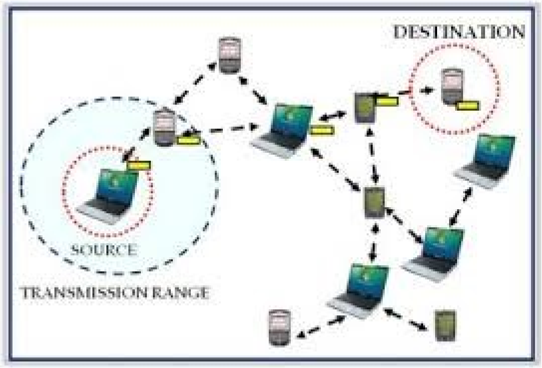

Figure 1.2 MANET

1.1 MANET framework consists of three phases: Authentication phase, Probe phase, and Association phase. And, if the station is in motion it might be necessary to perform a reassociation procedure from time to time [4].

1.1.1 Probe phase

A station may locate an access point by active scanning. Firstly the station sends a probe request packet to all the channels. The access points that hear this message will send a probe response packet back to the station. The response packet contains identification information which the station utilizes to determine what access point to address in the sequel. A second method by which a station can initialize a connection is via passive scanning. The station listens for signals that are periodically transmitted by each access point, and makes its choice based on that information [12].

I.1.2 Authentication phase

When a suitable access point has been selected, the authentication phase begins. In the IEEE 802.11 standard, two kinds of authentication mechanisms are defined: Open system and Shared key authentication. In the first method, an authentication request has been send by the station to the access point. The access point processes this request and determines whether or not to allow the station to proceed. Based upon the type of response (success or failure) from the access point, the station will either continue or discontinue the process. In second method, authentication request has been send by the station to the access point.

And Then access point generates and sends a 128 bit challenge text to the station. The station is required to encrypt this challenge and return the encrypted message to the access point. Finally, the access point tries to decrypt this packet; if it succeeds, the station may proceed with the association phase [9].

1.1.3Association phase

If the authentication phase is completed successfully, the station proceeds to send an association request packet to the access point. The access point analyses the information in this packet, and adds the station to its association table. [14].

1.2 802.11 Architecture

In OSI network model two lowest layer which are physical and data link layers specify the WLAN standard. This architecture described layering of protocols that organize the basic functions of a LAN. This standardized protocol architecture for LANs, which encompasses physical, medium access control, and logical link control layers.

Protocol Architecture

Protocols defined transmission address issues relating to the transmission of blocks of data over the network in LAN and MAN. In OSI model, higher-layer protocols are independent of network architecture and are applicable to networks such as for LANs, MANs, and WANs. Thus, a discussion of LAN protocols is concerned principally with lower layers of the OSI model. [10].

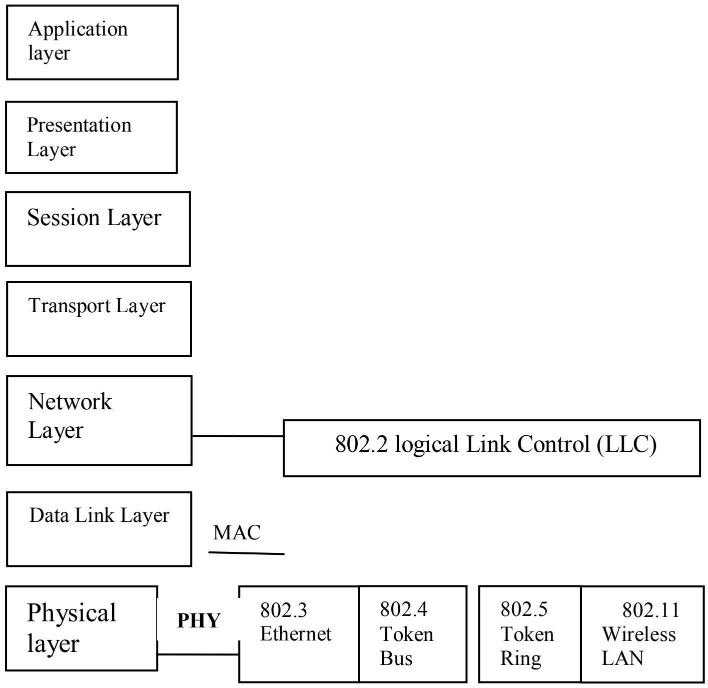

Figure 1.3: 802.11 AND OSI MODEL

1.3 Asymmetric Networks

In a symmetric computer network, all devices can transmit and receive data at equal rates. Asymmetric networks, on the other hand, support disproportionately more bandwidth in one direction than the other. Digital Subscriber Line (DSL) technology exists in both symmetric and asymmetric forms. This kind of asymmetry is more evident in wireless networks. [4, 5]Asymmetric long routes are mainly created due to routing policies and traffic engineering. [5] A packet in a provider's network but destined for a different network, is moved out of the provider's network as per the provider's policies.

1.4 MAC Layer

The design of MAC layer protocol assumes significance in Asymmetric networks because achievable capacity depends on performance of MAC protocol.

In addition to a fully distributed operation, the major problem faced by the popular CSMA/CA-based IEEE 802.11 distributed coordination function (DCF) is:

(i) hidden terminal problem,

(ii) Exposed terminal problem.

Therefore, new MAC protocols are designed for operating in multichannel systems. In traditional wireless or wired networks, each layer works with its own information making it unable to make the best use of network properties. The MAC layer protocol design should include methods to provide better network scalability & throughput capacity of network.[6,7] Most traditional medium access protocols are designed for nodes with omnidirectional antennas. Examples include Aloha, Slotted Aloha, carrier sense multiple access (CSMA), and CSMA with collision avoidance (CSMA/ CA). [8]

File Transfer Protocol: The application on the internet that allows user to transfer files to and from host or server is called FTP (File Transfer Protocol) or commonly known as FTP. The concept of FTP was given by TCP/IP for transferring files from one machine to another machine. Working of FTP: File transfer protocol is a client server system that uses two connections between the transferring machines. One connection is used for actual transfer of data between two machines and another connection is used for control information.

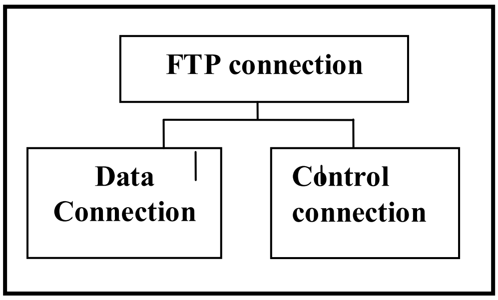

Figure 1.4 FTP Connections

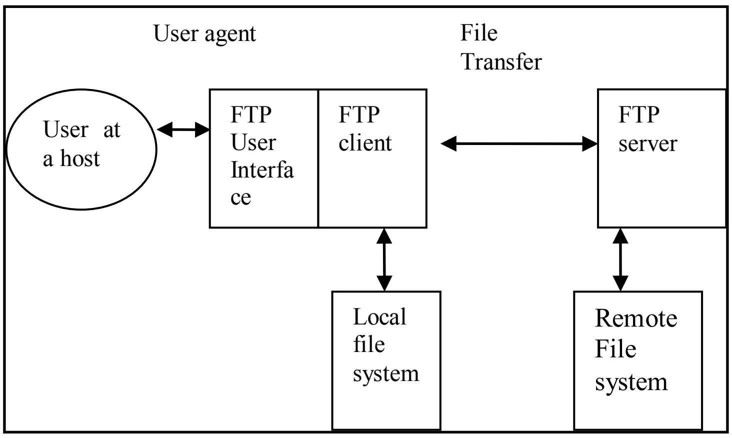

Figure 1.5 FTP moves files between local and remote file systems.

II. Related work

Increasing demand for higher rates in wireless communication systems continuously triggers major research which aims to characterize their capacities. In this section, present the Literature survey.

Paxson [1996] studied As such; the analysis and design process for deterministic schemes cannot be directly used here. Although previous research shed much light on the analysis and the design process of cooperative communication, much of them ignore the distributed random nature of cooperative communication systems in practice and assume deterministic cooperation among nodes, which may somewhat mislead the system design. It should be possible in a standardized way to create message groups (chat rooms) and address messages to a group of recipients as a whole, as well as individual recipients. Additional standardized mechanisms are expected, in order to create and delete message groups, enable and authorize members to join and leave the group and also to issue mass invitations to members of the group.

Balakrishnan H. and Venkata N [2001], discussed Link bandwidth and buffer space are two main problems that occurs because of contention in the bottleneck resources of reverse direction. It is clear that there are two key issues that needed to be addressed in order to improve TCP performance over asymmetric networks. The first issue is managing bandwidth usage on the uplink, used by ACKs. So many techniques, work by reducing the number of ACKs that flow over the upstream channel. Thus, the second issue is to avoid any adverse impact of infrequent ACKs.

Further the bandwidth allocation is not easily controlled by higher layer protocols. The only control that higher layer has is when to release packets. The MAC protocol has to account for long delays, and higher layers need to be modified if applications such as Asymmetric are to be used on these networks.

C. Zhu and M. Corson [2001] described that Bandwidth management relies on the channel access schemes used in the MAC layer. They can be divided into two categories: contention-based random access and controlled access CSMD/CA used in 802.11 is a typical contention-based channel multiple access scheme. It is simple and easy to implement. However, because each node contends to access the channel independently, it is difficult to satisfy the end-to-end QOS requirements. So, the QOS support in contention-based ad hoc networks is only soft QOS support and will not always guarantee the service level.

Mahesh K. Marina and Samir R. Das [2005] reveal some interesting behavior with regard to the performance improvements achievable by increasing the number of radios per node. Following the terminology [16], the size of the largest set IE(e) (over all edges e in the network) is called the maximum ''link conflict weight,'' denoted by Wmax. For the case of 12 available channels (as in 802.11a), as the number of radios increases from one to three, the value of Wmax drops sharply as expected.

However, as the number of radios increases beyond three Wmax begins to increase. This counterintuitive behavior occurs because the increase in radios leads to multiple common channels between neighbors, which in turn increases the number of edges in a typical set IE(e). This is because when nodes have more than one channel in common, they are allowed to communicate over all the available channels. Thus, while increasing the number of radios can increase the available capacity between neighbors, it can also have a detrimental effect on the network-wide capacity since there are now more links contending for access to the same channel.

The maximum instantaneous throughput continues to increase as the number of radios increases beyond three, however the increase is far more gradual than the rapid increase in instantaneous capacity as the number of radios is increased from 1 to 3.

Das et al. [2005] solve the channel assignment problem by formulating it as a linear program. Their objective is to find a channel assignment that maximizes the number of links that can be active simultaneously. The constraint of this linear program includes the number of interfaces on the node, and the fact that an interface cannot be assigned multiple channels. This problem turns out to be an integer linear program, since all the variables (channels, interfaces, interference) are all integer valued. Integer linear programs are exponential in complexity, hence the authors propose greedy heuristic algorithms to solve the problem.

M.Murugesan, A. Krishnan [2010] proposed and demonstrates the performance the proposed algorithm and evaluation of the performance of the algorithm based on Broadcast forwarding ratio and delivery ratio.

Ashok Kumar. S, Krishnammal. N [2012] discussed link asymmetry problem. The transmission range of the mesh router is usually larger than the transmission range of the mesh client. Hence, link asymmetry exists between the mesh router and the mesh client. The link asymmetry raises the following three problems: 1) unidirectional link problem; 2) heterogeneous hidden problem; and 3) heterogeneous exposed problem. The unidirectional link that exists in the network layer is eliminated and the heterogeneous hidden and exposed terminal problems are solved. This approach increases the network performance and throughput which is validated through simulations.

III. Problem Formulation

With the advancement of wireless communication technology, powerful wireless transceivers (low-cost) are widely used in mobile applications. Wireless networks have significant interest in recent years because of their improved flexibility and reduced costs. Compared to wired networks From the early work done in the Asymmetric networks for evaluating the performance of downstream and upward stream [5], and various Authors [1,10] extend this work by providing internet connectivity on the Asymmetric Networks. The Authors [3, 4] also worked on homogeneous and heterogeneous ranges and avoided broadcast problem and hidden station problems.

In this proposed work, further extend the above problem by modeling the Asymmetric network in MAC layer and providing internet connectivity. The early work [3, 4] used gateway and routers for providing internet connectivity but in this work used ATM (Asynchronous Transfer Mode) technology for providing virtual connectivity in between nodes and the server. The advantage of this technology over previous technology is that by using virtual connectivity the large number of nodes easily connected and transferring high quality of data without any interruption. [8]

It also eliminates the looping problem by forcing all nodes in the network to participate in some form of intermodal coordination protocol. There are also some modification in the coding part that the packets may be transmitted containing either layer-2 (MAC) addresses or layer-3 (network) addresses. Routing information is advertised by broadcasting or multicasting the packets which are transmitted periodically and incrementally as topological changes are detected (e.g., when stations move within the network).

3.1 Enhanced Approach

The objective achieved from this proposed work as:

1. Modeling the Asymmetric Networks and implemented on the MAC Layer.
2. For providing network connectivity between remote router to a local router with enabling FTP services.
3. To connect thousands of nodes by providing virtual connection in between remote and local router using ATM technique.
4. To calculate the throughput and average E2E delay between nodes and server

3.2 Experiment Scenario Used

The following parameters must be set in order to configure the simulation:

Duration: 300 seconds

Seed: 128

Values per statistic: 100

RIP Sim Efficiency: Disabled

The settings for the above parameters are shown in the following figure (see Figure 3.1)

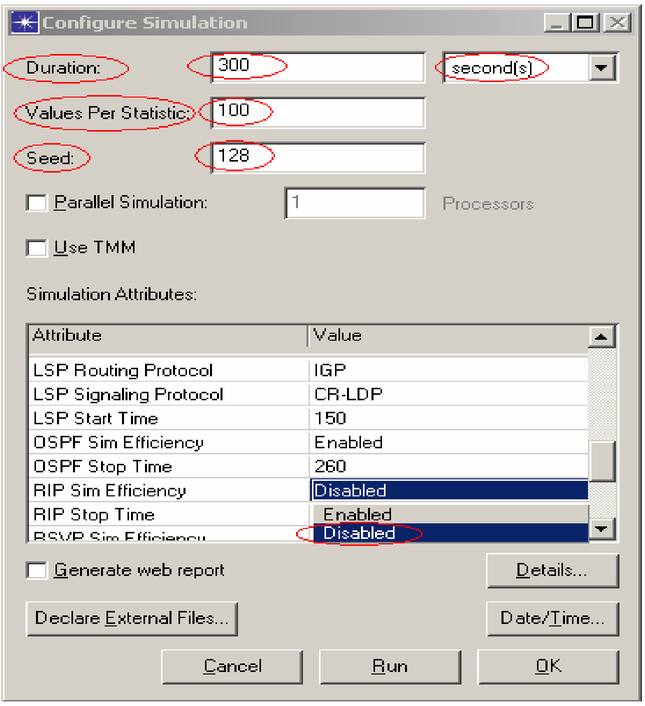

Fig: 3.1 Parameters configure for Simulation

3.3 Methodology Used

From the implementation point of view the scenario used in the above figure created by using Opnet and coding done on VC++ and some of the part of JAVA.

Results and Discussions

In this section, the results and the discussion of them are described.

4.1: Memory Usage during Simulation

OPNET IT Guru 9.1 is a modeling and simulation tool that provides an environment for analysis of memory usage during the Simulation scenario run. During the simulation of 3600 seconds it has observed that approximately 13 MB Memory used to run the overall scenario.

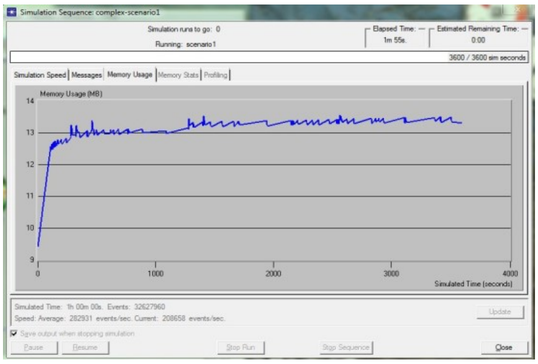

Figure 4.1: Memory Usage during Simulation

4.2: Simulation Speed

The relation between the current and the average simulation sequence speed is described in this section. In the following figures, the simulation speed for different values-seconds of background utilization can be observed.

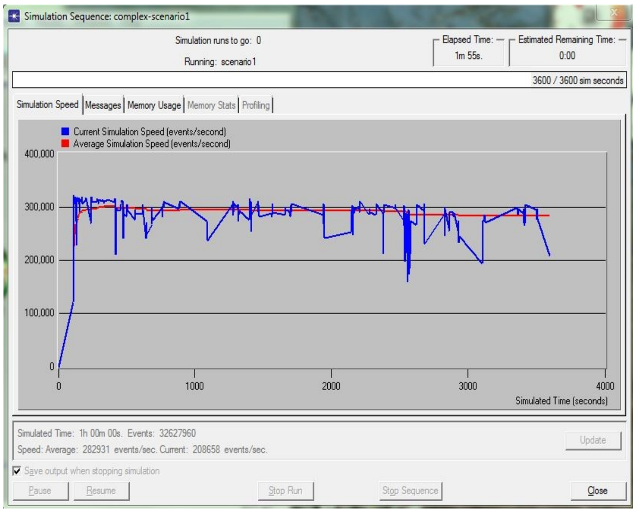

Figure 4.2: Simulation Speed

4.3 Point to Point Throughput

The Point to Point throughput represents the total number of Packets (in Packets/sec) forwarded from wireless LAN layers to higher layers in all WLAN nodes of the network. Therefore, the throughput of the whole network (Global Statistics) is expected to be less no. of losses of packets. The figure 4.1 shows the point to point throughput of remote switch to remote router.

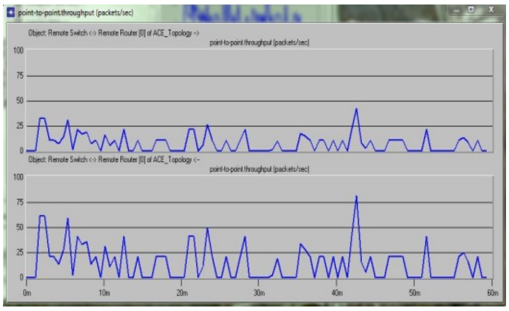

Figure 4.3: Point to Point Throughput of Remote switch and Router

4.4 Point to Point Utilization

The figure 4.2 represents the overall utilization of the devices used in the present network scenario. In this thesis it is observed that there is lesser utilization of the network used in the local scenario as compared to the Remote networks scenario because in the Remote networks chances of more of traffic due to backward

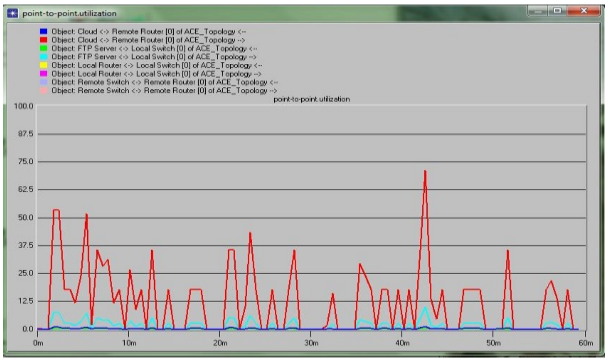

Figure 4.4: Point to Point utilization of overall Network Scenario

4.5Response Time of the Application

The response time calculated in seconds of the application in respect of FTP with loss. The calculated response time for accessing the application is minimum 6.5 sec and higher is 12 sec that means the overall the accessing time is very less and from the figure 4.4 shows that the overall response time of accessing the application is good.

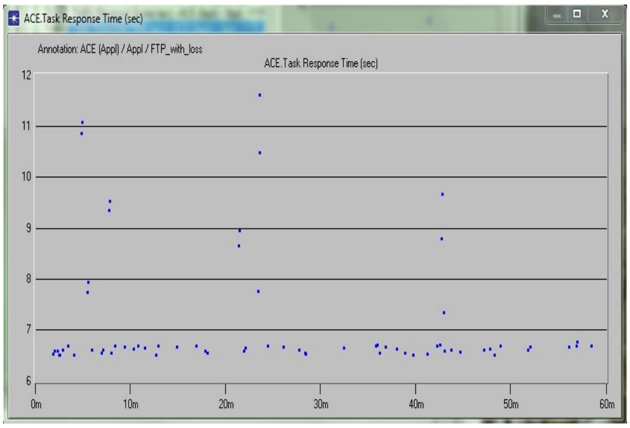

Figure 4.5: Response Time of the Application

4.6 Traffic sent and received using FTP Server

The statistics for the FTP traffic of the network include the FTP download response time (sec), the FTP upload response time (sec), the FTP traffic sent (bytes/sec) and the FTP traffic received (bytes/sec). First of all, the FTP download response time (sec) describes the time elapsed between sending a request and receiving the response packet. Measured from the time a client application sends a request to the server to the time it receives a response packet.

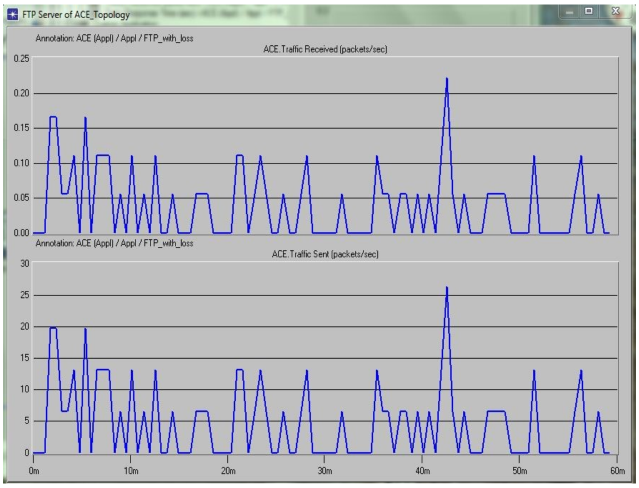

Figure 4.6: Traffic sent and received using FTP Server

Every response packet sent from a server to an FTP application is included in this statistic. In addition, the FTP upload response time (sec) represents the time elapsed between sending a file and receiving the response. The response time for responses sent from any server to an FTP application is included in this statistic.

4.7 Calculating sent and received Packets with FTP loss

In this section it was observed that the total traffic sent to the network and equally received from the network and no delay found from the figure 4.7.

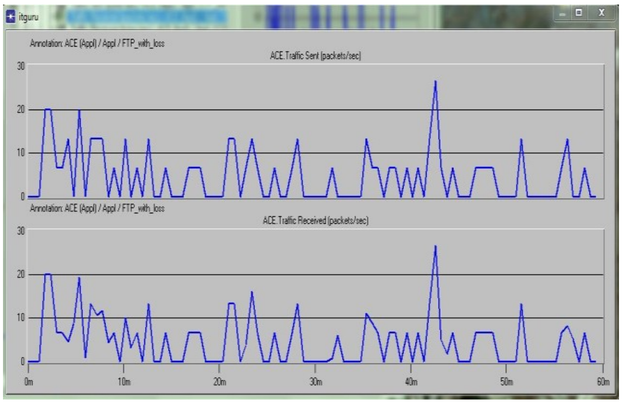

Figure 4.7: Calculating sent and received Packets with FTP loss

4.8 Response time and throughput of FTP Server and Local Switch

The overall response time all over the devices used on the network shown in the figure 4.8. It was observed that when links up means connection establish in the devices than point to point throughput degrades but when the connection established to each device than overall the performance and throughput becomes higher.

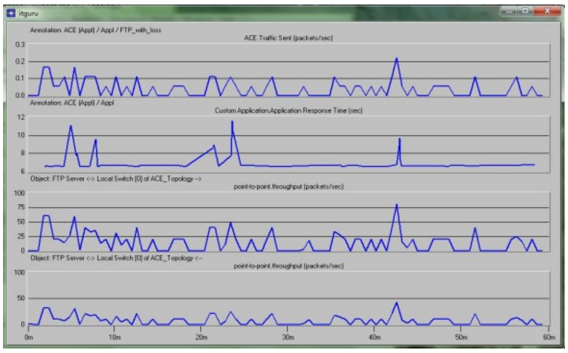

Figure 4.8: overall response time and throughput of FTP Server and Local Switch

Conclusion and Future Work

In this work, we present our framework in OPNET simulator for asymmetry networks and apply it to real Internet measurements. Thus, we compute the distribution of the routing asymmetry in the Internet at both the local and remote link/router levels. Our MAC protocol used in the implementation reduces average packet loss ratio and average delay as asymmetric links are comprehensively utilized which dominate routing in heterogeneous ad hoc networks. In addition, a test network can be setup in the laboratory once the actual Asymmetric Network hardware and software have arrived and the network analysis tool can be installed into the Networks system to analyze the results. The test scenarios generated in this study could be reproduced and actual traffic data obtained from the tested can be used to compare with the OPNET analysis performed in this study. Further research should be conducted with more realistic representations of the target network by modeling the network using the models found in the OPNET WDM Guru.

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