Comparative Study OF Media Streaming Protocols over Wireless IP Network

AL-SAMARRAIE HOSAM1, TALAL JAMEEL3, HUSSEIN QASIM 2, MERZA ABBAS1
[1]Center for IT and Multimedia, Universiti Sains Malaysia, Penang, Malaysia
[2]The University of Mustansiriyah colleg of pharmacy
[3] Department of Medical Lap. Science and Technology, Al Yarmouk University College,

Abstract
The growth of mobility networking has made a popular research topic. Several academic researches evaluate protocols and its performance by assuming varying degrees of mobility within a bounded space, nodes within a few hops, and nodes sending data at a constant rate. The IP network moves independently in any direction while the user moves by changing its links to other devices frequently. Meanwhile UDP and TFRC are commonly used for streaming audio and video such as (Windows Media audio, Real Player, and so on). Both protocols offer a transfer speed for the media files over IP network. Different issues have been reported during the packets transfer over wireless IP network, which indicated that there is no form of flow control or error correction of these packets. This is the main reason why streaming media is not high quality. Hence, this study aimed to investigate the performance of UDP and TFRC over wireless IP networking. Network simulator was employed in this study for measuring the packet loss, packet delay, and jitter. The result indicated that TFRC protocol is recommended in transferring packets, while UDP has disadvantage in transferring packets through home agent to connecting Mobile Hosts.

Keywords:
Mobile-IP network, TFRC, UDP, NS, IP network, Jitter, Throughput, Computing flow

1. INTRODUCTION

In the recent years, emerging market, emerging technologies are meant to be a servant of Mobile IP network [11]. Many fields in our life, without knowing, are based on wireless technologies, and devices are interconnected through mobile IP network. For all of us, mobile communication became so essential, till we do not even realize that we use mobile communication device. Furthermore, internet has become major source of information, sharing information and exposing our selves are just few among the number of activities that we do daily [12]. As internet availability is rapidly growing, possible adopting of technologies to provide internet is applied. As every significant research we are obliged to meet certain requirement in order to provide reliable studies. Different studies have focused on measuring and evaluation the performance of TCP in provide a particular importance which give inherent shared nature of Grid services and to the limited capabilities based on hardware and software tools that are typically available to satisfy a client's request. Moreover, measuring the performance on the online environments need always to apply an effective techniques for these measurements such as QoS for measuring the client's satisfaction on the online environments of e-Business and e-Science environments. The complexity of the web over local area network has been produced different patters to measure and elaborate the business logic of the application. Measuring the network performance in multiple environments will reflect, to a large extent [8].

More specifically, the Transmission Control Protocol (TCP) is used by the users to adjust the sending rate in response to changing network conditions. In a network the computers communicates with the help of IP-address. In an organization the transmission of data has to be very much secured [9]. The organizations may use Dynamic IP addressing [10], to reduce the conflict that occurs between the computers by giving them different IP address such that the data reaches to the destination. On the Dynamic network the IP address of the client machine keeps on changing. So, it's difficult that data packets reach the correct destination [6] [7].

In development of human life, internet has contributed the most in the late 20th century, and so in the 21st century. In the early 90s when internet became well known publicly, cable connection was in the favorite of all. Then the evolution of cable connection took place, connected by dial-up, and then ISDN followed by DSL connection, while today it is normal to have fiber cable coming till household, provide real time experience. The next step of having this convenience is to step towards mobility. Mobility is essential nowadays, everything is happening fast, and internet is needed in areas which would be not cost efficient to be covered by cable connection, therefore as a cost efficient answer for the emerging need wireless technology can be implemented [5].

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2. RESEARCH ISSUE

Nowadays, networking has reached to its new era, in which we are facing even greater challenges than before. This new era of computing has led to wireless technologies which enables great extent of mobile application regardless size or place of the mobile device, the need for being connected is top priority.

Experimental studies are highly in need in various ways. Each application has its own needs, in terms of availability, data transfer, and bandwidth. Each application requires different transfer protocol, therefore applicability of transfer protocols need to be examined. In accordance with the aim of this study, TFRC and UDP protocol is the main focus of experiment. It is essential to understand that different protocols are handling dataflow in different manner. Jitter, packet delay and packet loss are just few among the most important features to examine in order to select the best transfer protocol that suits to the application's requirements.

The increasing number of ways of applying wireless technologies led to the existence of certain way of maintaining connections. Nowadays, most of our houses are facilitated with Wireless Local Area Network (WLAN) that enables home users to be mobile within limited space, using different devices for transmitting information. It uses a radio wave technology to enable communication between devices. Within a certain area, devices are furnished with radio signal that connects nodes to Router/Wireless access point. These access points are using different method of delivering data to nodes. Hence this study aimed to achieve the following objectives:

- To investigate the performance analysis of TFRC and UDP over mobile IP network.

3. SCOPE

This study has adopted two phases of experiment. First phase presents the UDP connection using wireless technology between three mobile devices (nodes) and Access Points (AP) which address the nodes movements from Access Point (A) to Access Point (B), moreover, measuring the packet loss, packet delay, and jitter. The second phase of the experiment was conducted on the topology and structure of TFRC.
Every network interface has a MAC address (Media Access Controller) also known as the physical address. Hence, mobile-IP network used for achieving these measurements based on the actual network equipment. TFRC and UDP protocol used in this study as a data transfer over the mobile-IP network. Furthermore, NS2 simulator was employed in this study to measure the relationship between the packet resources and the mobile nods during the data transfer.

4. THEORETICAL FRAMEWORK

Figure 1 presents the proposed framework for measuring the performance of TFRC and UDP in mobile IP network. The elements of the packet transfer over the mobile IP layers, TFRC and UDP protocol applied in order by identifying the IP nods in the selected network..

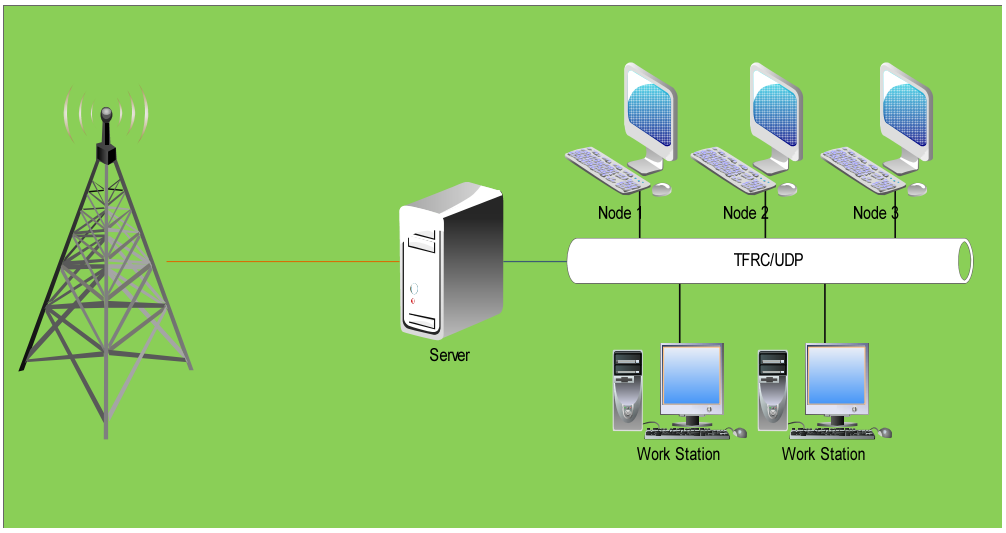

Fig 1. Theoretical Framework of the Study

4.1. Mobile IP Network

Recently, emerging market, emerging technologies are meant to be a servant of Mobile IP network. Mobile communication became so essential, till we do not even realize that we use mobile communication device. Furthermore, internet has become major source of information, sharing information and exposing our selves are just few among the number of activities that we do daily. As internet availability is rapidly growing, possible adopting of technologies to provide internet is applied. Some provider gives fixed internet landline, but the future trend is based on mobile technologies.

4.2. Mobile Node

Mobile nodes are part of the whole system, and they are important part. Mobile nodes are the users of the system, and the system has to be prepared for handling their behavior [4], they have different statuses, and these statuses need to be handled. There are several featured identified by Rhoton in [3]. First and foremost, every mobile node is associated with a home network. On the home network, it is essential to have a home agent, which handles the node within the home network, moreover to perform certain action for the mobile node, such as addressing, letting the node enter and leave the home network.

4.3. TFRC

TCP friendly rate protocol (TFRC) is designed for streaming application, where bandwidth distribution is more equal among the competing connections. Its sending rate is nearly the same like TCP connection, but when it comes to bottleneck competition over bandwidth it enables a more equal distribution over the available bandwidth.
Real time application requires a smooth transition rate of data flow, in this case, as congestion control algorithm TFRC can provide this feature for IP protocols [2]. TFRC works in the following manner:

- The receiver measures the loss event rate and returns it to the sender.
- The sender uses this feedback messages to calculate the RTT.
- The sender uses the RTT and the loss event rate to calculate the transmit rate.
- The sender adjusts its sending rate accordingly.

The following equation used to understand TFRC

$$\lambda = \frac{s}{RTT * \left(\sqrt{2 * \frac{p}{3}} + \left(12 * \sqrt{3 * \frac{p}{8}} * P * (1 + 32 * p^2)\right)\right)}$$

Where λ is the transmission rate in bytes/sec, s is the packet size in bytes, and p is the loss event rate. TFRC uses the loss event rate to model a protocol that reduces its data window once per congestion notification [1].

5. RESEARCH METHOD

Data collection, scheduling and orientation method applied in accordance with the need of this study. Research method is a crucial point of this study, since it determines how the study will be conducted with a precise time schedule, and a clearly defined approach by which the study will be carried out. Systematic Simulation Study was customized in order to perform simulation, as well as to perform comparison between two network protocols (UDP and TFRC) over wireless IP network [13].

- ***Define problem and objective:*** used to identify and report the existing network problems and transfer lacks in packets among the applied TFRC and UDP protocol.
- ***Design network model and select fixed parameters:*** used to identify the network model for a certain data transfer which composed from various traffic models, transport-layer protocols, network-layer protocols, and medium access control (MAC) layer protocols, etc. These components enable NS-2 to simulate different types of networks and their topologies.
- ***Select performance metrics:*** used to identify the packet delivery ratio that received from the MAC sub layer, Hop delay of the transaction time to a one-hop neighbor, and overhead packets that have been sent to the other packets within the same network over RTS/CTS.
- ***Select variables parameters:*** used to select the packet parameters of each data transfer with its own set of parameters by specifying the name of the deployed service to get a report about one particular running process.
- ***Construct model and set fixed parameters in software:*** used to understand and set a fixed parameters of TFRC and UDP protocol for all the rate control.

- ***Configure software to produce relevance performance data:*** used to identify the require configuration step for success simulator installation (NS2) which present an effective phase for measuring the network performance level along with TFRC and UDP protocol.

- ***Execute simulation and collect performance data:*** presents the implementation of NS2 simulator for IP mobile network based on TFRC and UDP protocol. The performance progress of transferring the packets has generated from this phase.

- ***Present and interpret result:*** finally, this phase presents the result of applying TFRC and UDP protocols in IP mobile network.

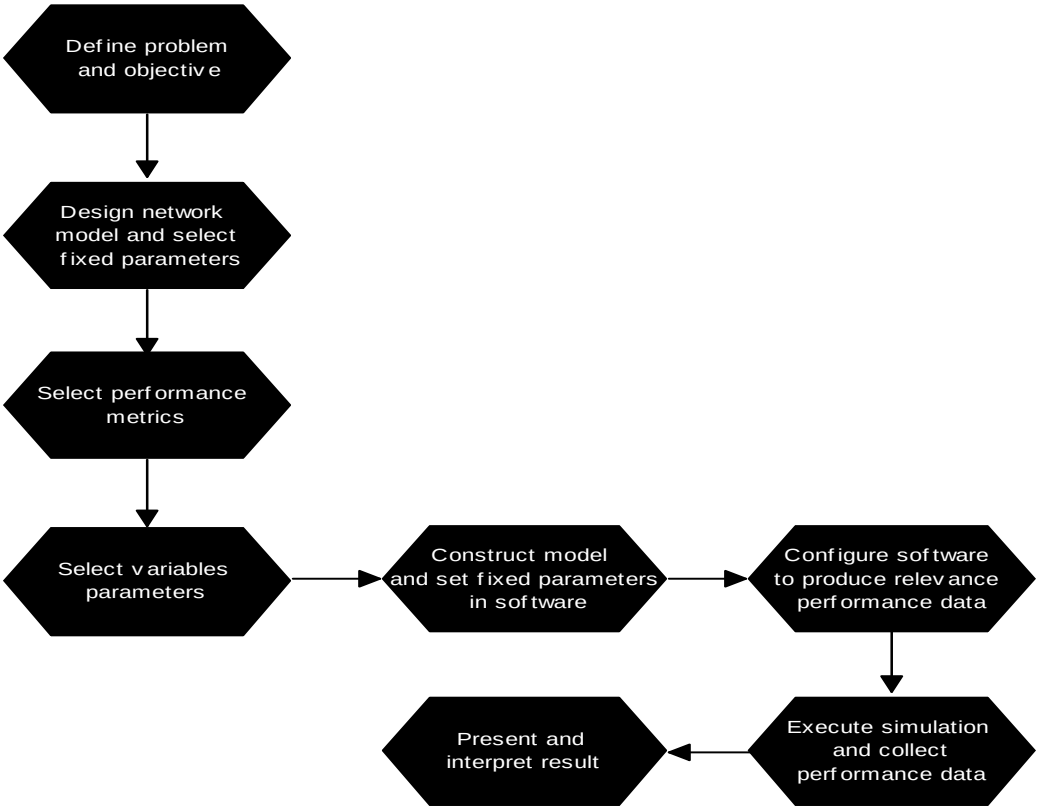

Fig 2. Simulation steps

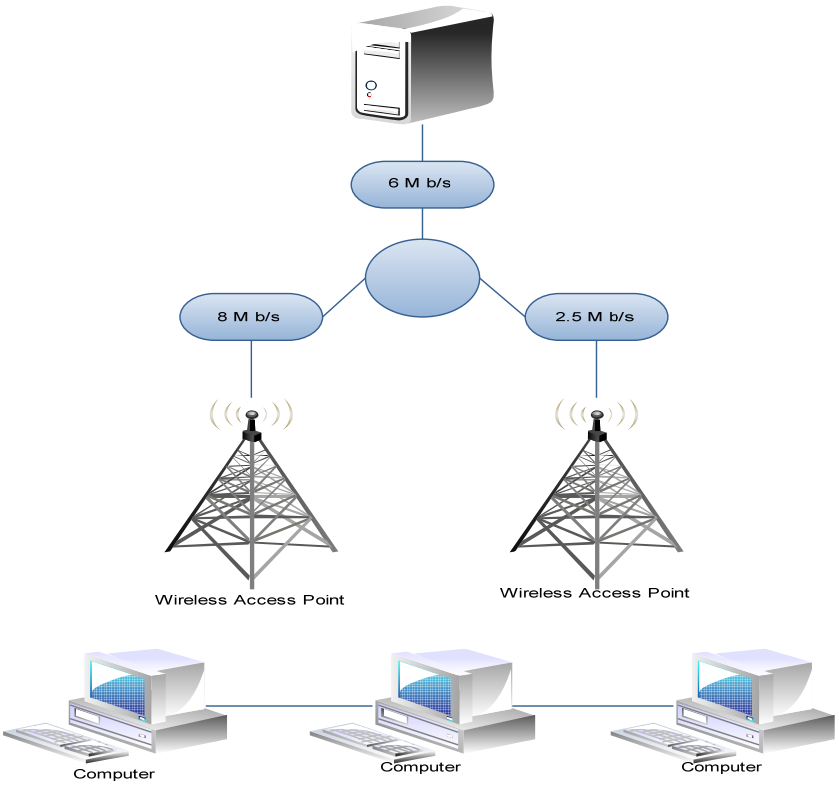

Fig 3. Experiment topology

6. RESEARCH DESIGN

6.1. Network Simulator 2 (NS-2)

There are many different network simulators, but undoubtedly the most famous among is the development and product of Information Science Institution at the University of Southern California. NS-2 is a discrete event simulator that provides a powerful tool to perform network research. It is essential to understand that the power of NS-2 is in the compatibility provided by handling two different programming languages. NS-2 is an object oriented simulator. The combination of two languages allows handling two different engines. It is necessary to handle two different languages, because of the complexity of debugging of certain errors within one language.

It is perfect software for conducting modeling and simulation in this paper, because it allows splitting object within two sides, such as interpreted hierarchy and complied hierarchy. The main simulator element that is built in NS-2 is nodes, links, agents and applications. Having these elements at one place enables to generate data, send them by links through access point to nodes, moreover to move nodes between access points and measure their performance metrics as it was described earlier.

6.2. System Design

Broadband wireless access (BWA) has received much more attentions in recent years. Research in the area of wireless networks increasing as the number of wireless network devices will soon surpass the number of wired network devices. Fixed BWA systems, such as the local multipoint distribution service (LMDS), provide multimedia services to a number of discrete subscriber sites with IP and offer numerous advantages over wired IP networks. Figure 4 shows the design phase of this study with node movement from access point to another access point.

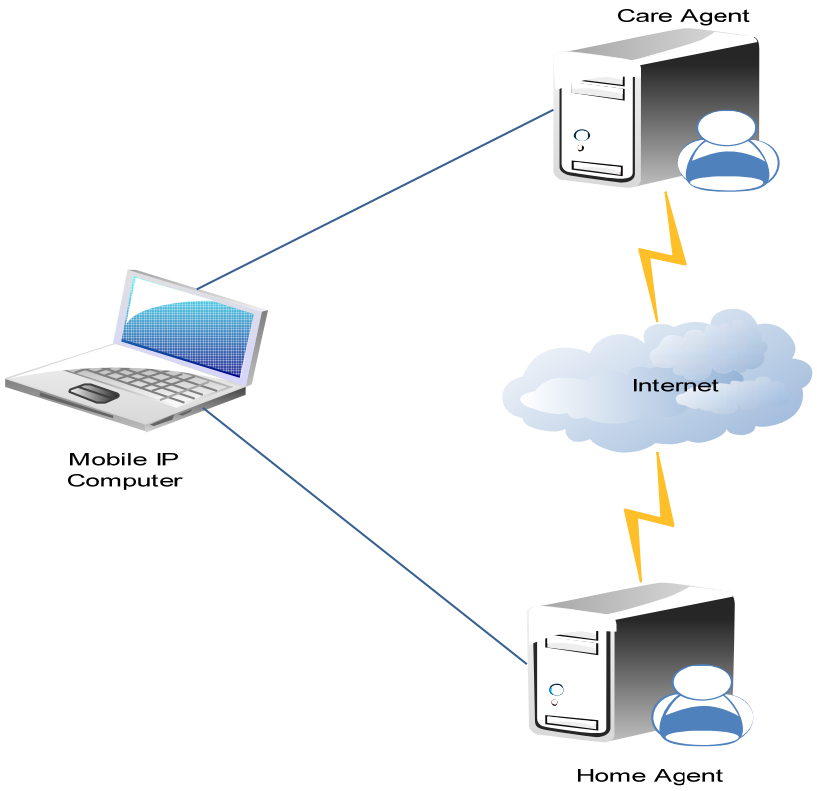

Fig 4. System design with node movement from Access Point to Access point

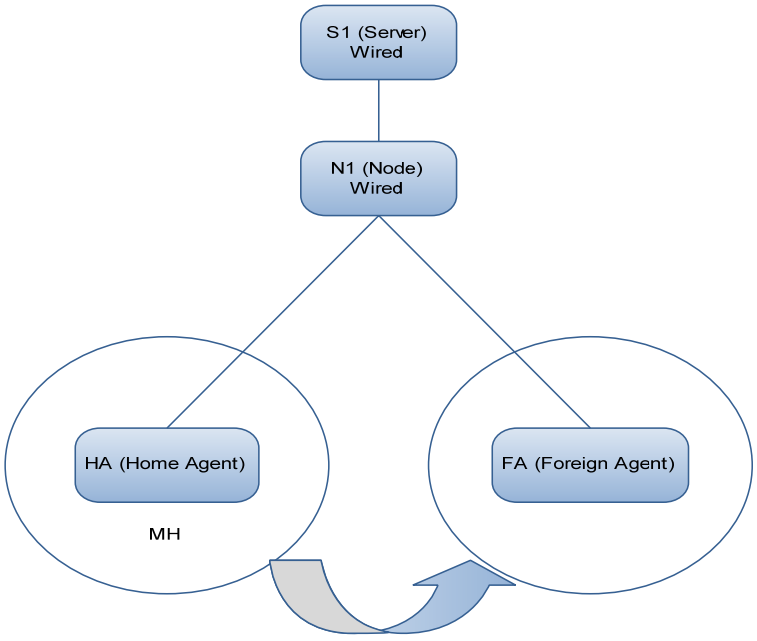

Fig 5. Simulation scenario

6.3. Simulation Scenario

As the experiment has been set up. The wired network ends up in a mobile wireless network, by distributing the connection into two nodes with a home and foreign agent. A mobile host is moved within the mobile IP network coverage. Packets will be exchanged between a wireless and a wired via agents. The moving mobile node is roaming between the host and foreign agent.
According to the above scenario, the topology of the system consist two wired points, S1 and N1 from which mobile signal is distributed through foreign and home agents. MH is moving host within home and foreign agents, and the main purpose is to observe competing flows by sending packets from S1 to MH while MH is moving between home and foreign agents. The given scenario is modeled in two environments where the settings are the same, but applied transfer protocol is UDP and TFRC. In the first simulation UDP connection is being observed, while in the second case, TFRC connection is being observed.

7. RESEARCH RESULT

7.1. Simulation execution

In both scenarios the transferred data had been 200 packets per sec, and the length of experiment was 250sec. Figure 6 shows sum of number of TFRC sent packages while figure 7 shows sum of number of UDP sent packages.

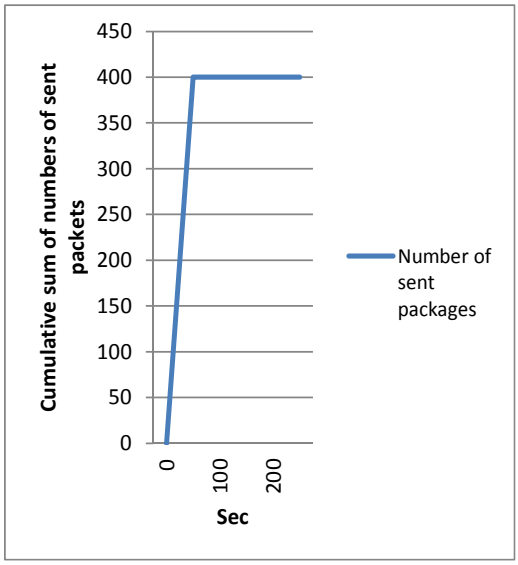

Fig 6. Numbers of TFRC packets

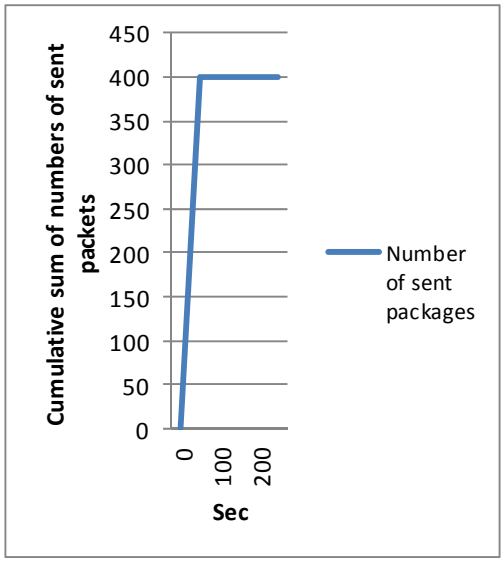

Fig 7. Numbers of UDP packets

7.2. Performance Metrics Result

This section present the result of performance metrics acquired from NS2. Two sessions were conducted (UDP and TFRC). The measuring phase begun with competing flow distribution and data packet sending from S1 (server) to the MH (Mobile Host). In the transport layer, respective transport protocol is embedded. At the home agent three mobile nodes are placed, while one mobile node is moving out of the coverage of home agent, and perform roaming in the coverage area of foreign agent.

- **Packet Loss**

Packet loss was measured as first milestone of the simulation. There is a measurable loss in terms of packet loss.

Table 1. Packet Loss

Packet loss			
Node No.	No. of packet sent	No. of packet loss	Packet loss %
Node 1	10328	207	2.00426
Node 2	117	91	77.7778
Node 3	44001	36660	83.3163

Node 1 presents the TFRC performance rate. Table 1 shows the number of the transferred packets (10328), and its loss rate (2.00426%. It has shown that TFRC adequately good. Meanwhile, node 3 presents the UDP performance rate, its shown that both of the transferred packet and packet loss are nearly same, albeit the moving host experiences more loss in the event of moving compared to remaining nodes.

- **Packet Delay**

As it has been described earlier, Node 1 is a moving TFRC, and node 2 shows the remaining MH. According to Figure 8, node 1 moving session results lower average delay for the moving node, while in UDP. Node 2 shows adequately same result as the remaining node 3. Therefore the application of TFRC protocol is recommended in transferring media files over wireless IP network where the packet delay matters. In this manner, UDP has disadvantage of distributing sent packages through home agent to connecting Mobile Hosts. While TFRC protocol carries better performance metrics when Mobile Host moving from home agent to foreign agent. It is important to note that less packet delay result better quality in connection, especially when each packet has to reach to the addressee within a given time. For instance, in banking application, lower packet delay results more secure data transfer, while UDP connection could be better utilized in online streaming, or chatting modules.

Table 2. Packet Delay

Packet Delay	
Node No.	Average Delay
Node 1	351.544
Node 2	510.44
Node 3	511.37

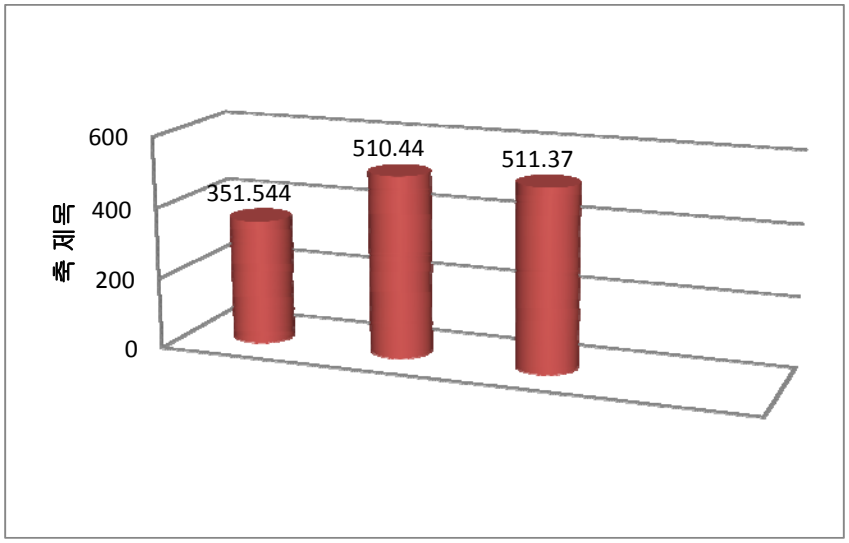

Fig 8. Average Packet Delay

- **Jitter**

Jitter has been observed. Node 1 presents the TFRC movements to MH, while node 2 is the remaining MH. According to Figure 9 and figure 10 jitter increased when the flow of packet starts.

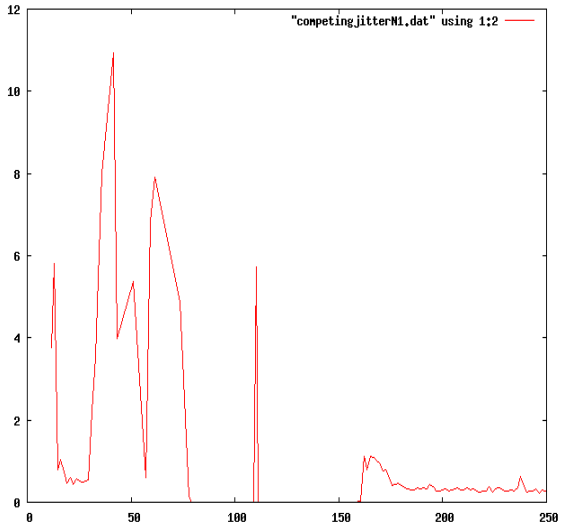

Fig 9. TFRC MH Jitter (Moving MH)

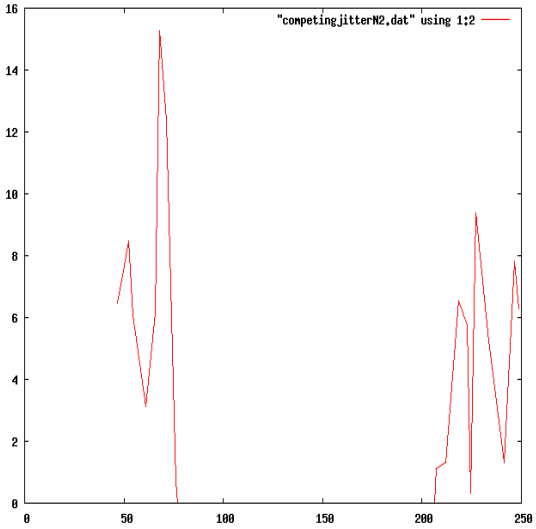

Fig 10. TFRC MH Jitter (Non-moving MH)

It probably explains that TFRC protocol is focusing on the smoother packet exchange for moving node, while remaining nodes get lesser attention. In the case of UDP session, it has been exemplified that jitter is adequately the same for moving as well as for non-moving nodes.

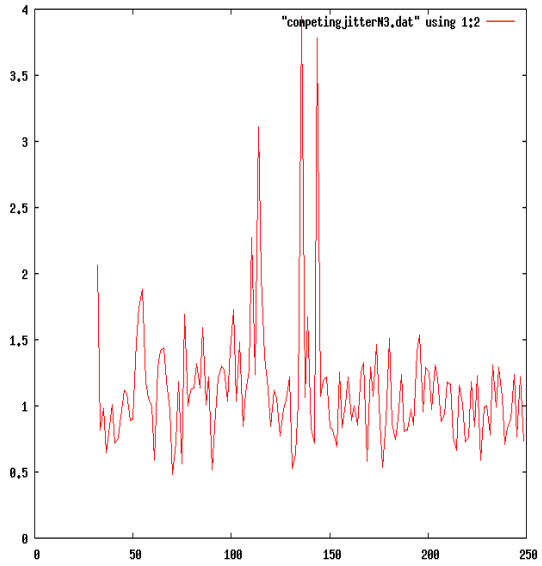

Fig 11. UDP MH Jitter (Moving MH)

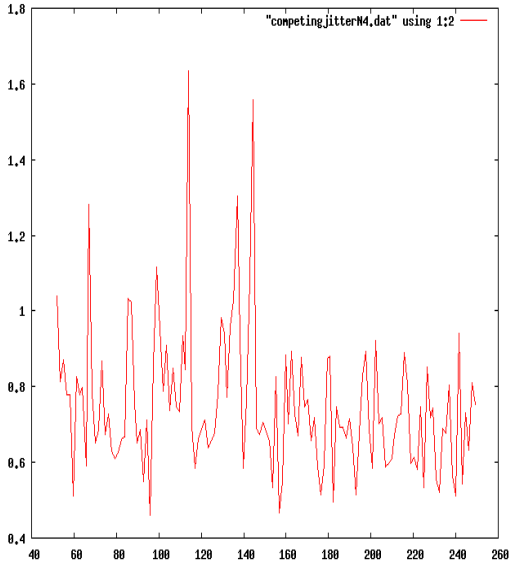

Fig 12. UDP Jitter

7.3. Comparison of TFRC and UDP protocols

According to Figure 14, TFRC and UDP jitter has adequately the same rate, but the peak of jitter value in the case of TFRC session falls to the first half of experiment. In the middle of experiment the rate of jitter is nearly the same, and it is obviously low, approaching zero at some point.

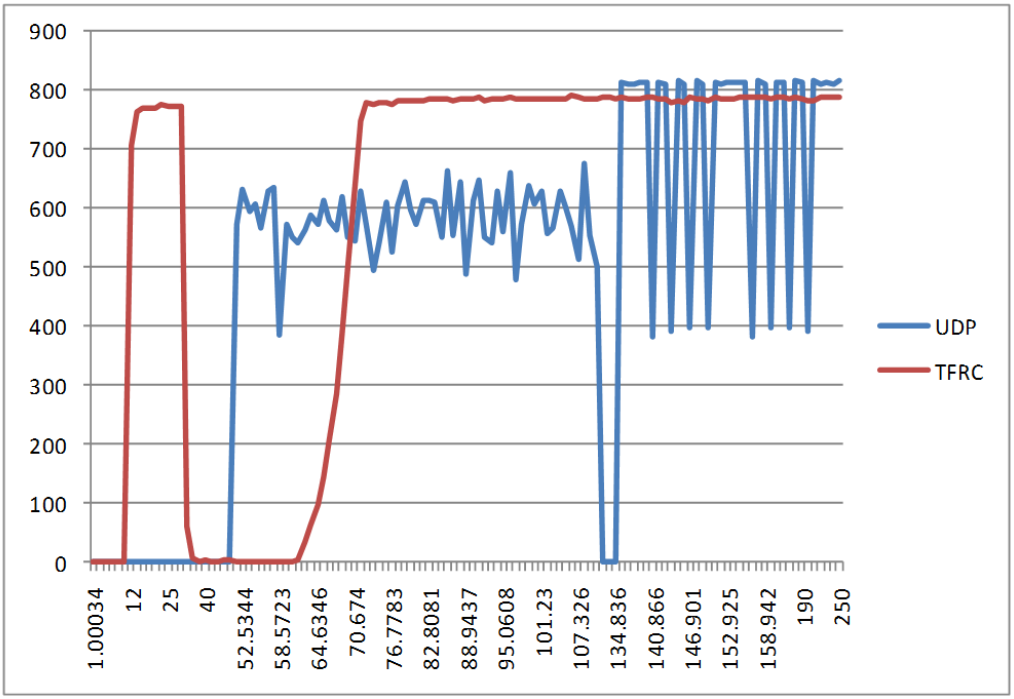

Fig 13. Throughput session UDP and TFRC comparison

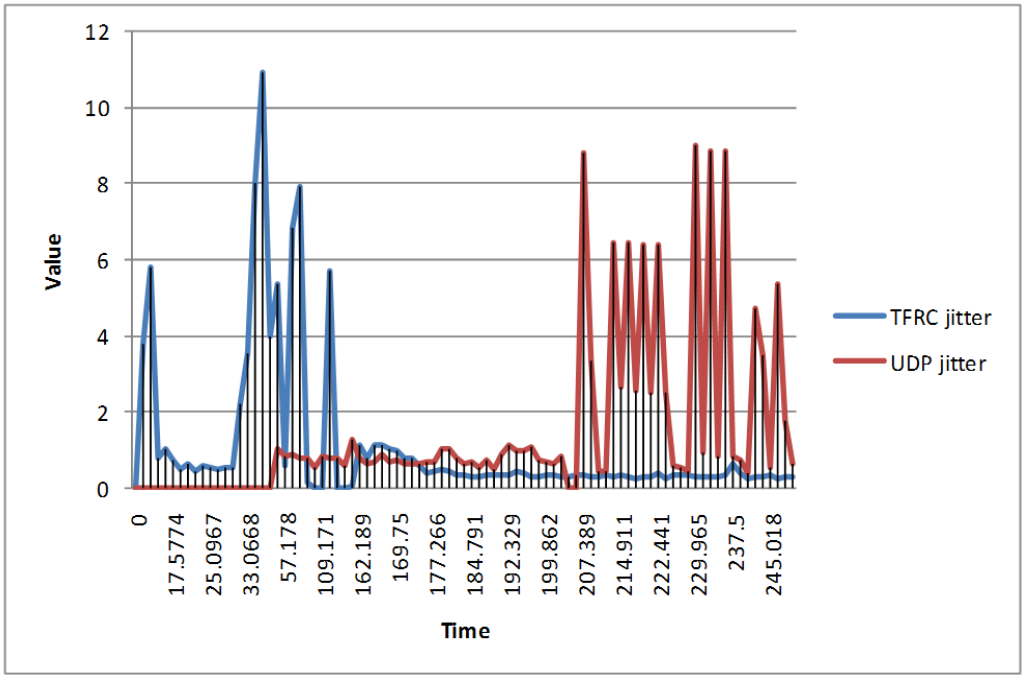

Fig 14. TFRC and Jitter

8. CONCLUSION

This study aimed to evaluate the packet loss, packet delay, and jitter metrics for TFRC and UDP with computing flows. Network Simulator has been used for testing and measuring the protocols performance over wireless IP network. The result conducted that TFRC is recommended in transferring packets, while UDP has disadvantage in transferring packets through home agent to connecting Mobile Hosts.

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Mr. Hosam Alsamarraie received his Bachelor Degree in Computer Engineering from Iraq (2006) and his Master in Information Technology from University Utara Malaysia (UUM). His research interests in Network Security, Ontology classification, Multi Agent System, and DBMS. He has presented papers in International conferences.

Ass. L. Mr. Talal Talib Jameel received his Bachelor Degree in statistics from Iraq (1992) and his Master in Information and communication Technology (ICT) from University Utara Malaysia (UUM). Currently, he is working in university of al Yarmouk College as a assistant lecture His research interests in Network Security, Routing Protocols and Electronic learning. He has produced many publications in Journal international rep and also presented papers in International conferences.

Ass. L. Mr. Hussein Salem Qasim received his Bachelor Degree in Computer science from Iraq (2004) and his Master in Information Technology from University Utara Malaysia (UUM). Currently, he is working in university of Mustansiriya college of Pharmacy as an assistant lecture His research interests in Network Security and Relational Database.

Assoc. Prof. Dr. Merza Abbas is working as a head researcher in centre of IT and Multimedia, USM, Malaysia. He served for 30 years as a lecturer in University Sainse Malaysia and other international institutes. He has produced many publications in Journal of international repute and also presented papers in International conferences.