Optimized Multi Attribute Algorithm for Heterogeneous Networks

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Abstract: *Over the past few years, rapid advance in wireless broadband networks have been driving the evolution of communication and network technologies towards next generation omnipresent computing environments. Now days, a number of wireless communication technologies like Wi-Fi, LTE(Long Term Evolution), WiMAX are available and major issue is to maintain the quality of service (QoS) in heterogeneous wireless network where heterogeneity is defined in terms of WiMAX and Wi-Fi Networks. A mobile user required always best connected services anytime and anywhere. Due to increase in number of user on particular network, load is increased on a network. Due to high load handover is required but in many situations unnecessary handoff and handoff failure is initiated, which lags the performance of a network. To overcome this problem we have used RSS and load balancing attribute for vertical handover decision method to improve the performance in 4G heterogeneous networks.*

Keywords: *Received Signal Strength (RSS), Vertical Handoff Decision Algorithms, Worldwide interoperability microwave access (WiMAX).*

1. Introduction

The term Wireless means transmitting signals using radio waves as the medium instead of wires. The rapid growth of radio access technologies demands the interoperability and better mobility management techniques to fulfill the requirements of users. Recent advances in wireless communication have been evolving various wireless networks technologies where WiMAX and Wi-Fi are the two techniques widely used in wireless network to provide users with promising applications. These networks are considered independently and vary extensively in terms of their service parameters like throughput, coverage area, accessing delay etc. The rapid increase of access technologies demands interoperability and better mobility management techniques to fulfill the requirements of users. The big challenge in now days is to keep the mobile station connect anytime and anywhere with best connections. In Recent years, mobile terminals are prepared with multiple interfaces and can access a wide range of applications offered by multiple wireless networks. To access the communication services anytime, anywhere with best quality of service and at less cost heterogeneous wireless communication system is a best resolution.

A seamless handover algorithm between heterogeneous wireless networks is one of the most critical techniques. The heterogeneous wireless networks include wireless personal, local, and broadband networks. Out of these technologies we will discuss two emerging technologies WiMAX and Wi-Fi. WiMAX and Wi-Fi are the major 3G technology to perform high speed communication over the network. It is one of the fastest growing mobile technology in which different of data is transferred over the network. But when a mobile node moves outside the coverage area of its base station, it is required to switch to some other base station. This process is called handover. When work with dissimilar networks, it is called Vertical Handover [1][2]. Among several candid ate technologies for the numerous wireless broadband networks, IEEE 802.16-operated WiMAX shows promising potentials. IEEE 802.16 Fixed WiMAX has been developed by the IEEE 802.16 standard activities. Because it cannot support the mobility of terminals, IEEE802.16 Fixed WiMAX is not suitable for mobile computing environments. Thus, to support mobility on terminal stations, IEEE 802.16e Mobile WiMAX standard is proposed [1][3]. IEEE 802.16e-2005 Mobile WiMAX, an interworking scheme between heterogeneous networks, i.e., vertical handover is essentially required and to fulfill this requirement, the paper addresses a basic vertical handover algorithm for interworking between IEEE 802.11 WLAN and IEEE 802.16e Mobile WiMAX.

Traditionally handoffs decision was based on RSS (received signal strength) method but in RSS method decision of handover was taken on basis of measurement of received signal strength. In case of RSS the signal gets fluctuated due to path loss in wireless medium, due to path loss there is unnecessary handoffs occurs and unnecessary handoffs leads ping pong effect . In this paper to reduce this problem, proposed a vertical handoff decision method which is based on RSS and Load balancing on the network and with additional parameters such as signal to noise ratio, bandwidth and data rate. This algorithm provides different set of parameters to provide better handoff.

1.1 WiMAX

The term WiMAX stands for worldwide interoperability microwave access which is a most promising telecommunications technology that offers transmission of wireless data via a number of transmission methods; such as portable or fully mobile internet access via point to multipoint links [4]. The WiMAX technology offers around 72 Mbps without any need for the cable infrastructure [5]. WiMAX is based on IEEE 802.16 standard, it usually also called as Broadband Wireless Access (BWA); which has spectral efficiency of 3.7 (bits per second) per hertz. In mid June 2001 to encourage compliance and interoperability of the WiMAX IEEE 802.16 standard, WiMAX Forum created the name for WiMAX technology. As compared to conventional cable and DSL lines, WiMAX technology is based on delivery last mile broadband access anywhere anytime.

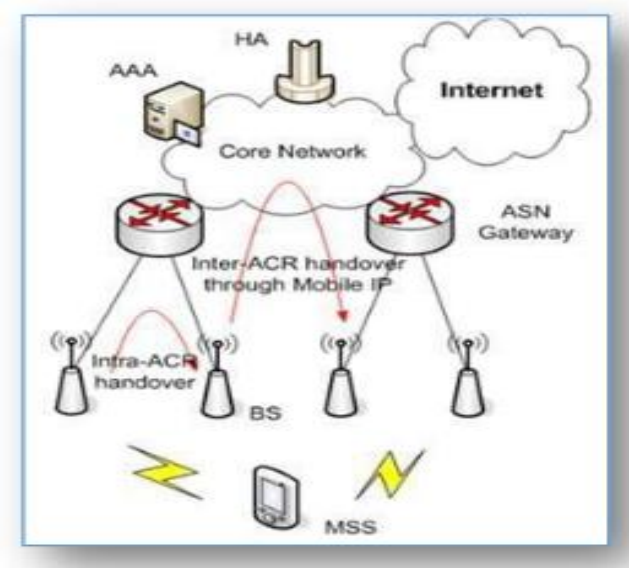

Figure 1: Network Architecture of Mobile WiMAX [4] [6]

Figure 1 shows the architecture of mobile WiMAX network in terms of the network elements and their functions [4][6]. There are four main components in the architecture: MSS (Mobile Subscriber Station), BS (Base Station), ASN (Access Service Network) gateway, and core network.

MSS (Mobile Subscriber Station)

The MSS communicates with the BS using IEEE 802.16e wireless access technology. The mss also provides the functions of MAC processing, Mobile IP, authentication, packet retransmission, and handover.

BS (Base Station)

The BS provides wireless interfaces for the mss and takes care of wireless resource management, QoS (Quality of Service) support, and handover control.

ASN (Access Service Network) gateway

The ASN gateway plays a key-role in IP-Based data services including IP packet routing, security, QoS and handover control. The ASN Gateway also interacts with the AAA (Authentication, Authorization, and Accounting) server for user authentication and billing. It supports handover among the base stations (BSs) to provide mobility for the MSS while the mobile IP provides handover among ASN Gateways as shown in Figure 1

1.2 Wi-Fi

The term Wi-Fi stands for Wireless Fidelity is a wireless technology which provides internet connectivity or connectivity among the users. In 1997 IEEE provide a set of specification and standards for Wi-Fi which is under the title IEEE 802.11 that explains the structure of the comparatively short range radio signal for Wi-Fi service. After that several specifications came and most commonly used specifications today are 802.11b, 802.11g and 802.11a [5]. Out of these three, 802.11a can provide higher speeds within the various radio frequencies. IEEE is now working for a new standard 802.11n which is more reliable, secure and faster than the other standard .Originally Wi-Fi was created for wireless extension for the wired LAN. So that the distance between the Wi-Fi access point and user equipment (UE) is limited to indoor and outdoor around 100 feet and up to 300 feet respectively [4]. So if a user moves its computer to a new location, he/she should find a new access point for continuing the communication. Due to the cheap availability of the equipment and its maintenance and servicing cost, Wi-Fi is widely accepted throughout the world and it is widely used in a restaurants, hotels, airports and school campuses. It is also work well in the auditoriums, meeting rooms and small businesses. Internet service providers also use it for individual home connectivity and connectivity to the commercial complexes.

The Table 1 given below gives the detailed relative analysis of the two broadband wireless access networks (Wi-Fi and WiMAX):

Table 1. Comparison between WiMAX and Wi-Fi [7]

Feature	WiMAX(IEEE 802.16a)	Wi-Fi(IEEE 802.11b)	Wi-Fi(IEEE 802.11a/g)
Primary Application	Broadband Wireless Access	Wireless LAN	Wireless LAN
Frequency Band	Licensed/Unlicensed 2GHZ to 11GHz	2.4 GHz ISM	2.4 GHz ISM(g) 5 GHz U-NII(a)
Bandwidth Efficiency	<=5 bps/Hz	<=0.44 bps/Hz	<=2.7 bps/Hz
Modulation FEC	BPSK,QPSK,16,64,256-QAM Convolution Code Reed-Solomon	QPSK None	BPSK,QPSK Convolution Code
Encryption	Mandatory-3DES	Optional-RC4	Optional- RC4
Mobility	Mobile WiMAX(802.16e)	in development	In development
Mesh	Yes	Vendor Proprietary	Vendor Proprietary
Access Protocol	Request Grant	CSMA/CA	CSMA/CA

1.3 Handover

Different processes are required in order to perform a Vertical Handover (VHO).VHO process into three phases: i) Handover information gathering, ii) Handover decision, and iii) Handover execution [2][4]. The information gathering phase is in charge of collecting relevant information from diverse context sources such as network capabilities, access points, user equipments, and user preferences. The most critical phase in a vertical handoff (VHO) process is the decision phase since, depending on the network candidate chosen; the performance of the system could improve or decrease. This decision should consider several parameters in order to choose the best candidate network to hand over to [8]. The execution phase is in charge of committing the VHO itself. In this process the UE (User Equipment) leaves the current network and gets attached to a new network in a seamless manner, experiencing low latencies and minimal packet loss.

2. Related Work

In the year 2006, Ahmed H. Zahran et.al[9] presented a paper on "Signal Threshold Adaptation for Vertical Handoff in Heterogeneous Wireless Networks" they discussed that the seamless and efficient handoff between different access technologies (vertical handoff) is essential and remains a challenging problem. They also proposed a RSS based VHD algorithm using lifetime metric which decreasing number of superfluous handoffs and enhanced average throughput for the users. Its drawback is high packet delay.

In the research paper [10] presented by A.B. Pontes et al. on "HANDOVER MANAGEMENT IN INTEGRATED WLAN AND MOBILE WIMAX NETWORKS", they performed the work on the most recent research efforts in the area of handover management in integrated WLAN and wireless metropolitan area networks (WMANs). In which the handover decision algorithm is based on Media- Independed Handover (MIH) framework without considering packet delay and bandwidth while handoff is occurring.

Sunil Kr. Singh et.al [11] presented a research paper on "Architectural Performance of WiMAX over Wi-Fi with Reliable QoS over Wireless Communication", they described that in wireless communication network quality of service (QoS) is a bigger challenge as compared to wired network because wireless networks are generally less efficient and irregular. The Wi-Fi network has limited bandwidth, higher packet error rate, and higher packet overheads that in total to limit the capacity of the network to offer guaranteed QoS. In wireless network, for the improvement in QoS, researchers have made significant modifications in the legacy IEEE 802.11 standards to make possible QoS to end users. IEEE 802.16 standard known as WiMAX has emerged as the strongest competitor for broadband wireless technology with promises to give guaranteed QoS to wireless application end users over Wi-Fi wireless technology. Authors also explained architectural performance issues of WiMAX over Wi-Fi wireless communication in the term of wireless network design.

In research paper on "A QoS Oriented Vertical Handoff Scheme for WiMAX/WLAN Overlay Networks ", presented by Dong Ma et.al designed A seamless and proactive vertical handoff scheme [16] based on the architecture that aims to provide always the best QoS for users. Proposed algorithms derived by authors are to estimate the conditions of both WiMAX and WLAN networks in terms of available bandwidth and packet delay; and the results obtained prove the feasibility and effectiveness of the proposed schemes.

In the year 2016, Sonia and Gurpreet Singh Saini presented a research paper on "Optimized RSS based Algorithm for Heterogeneous Networks", they proposed a vertical handover algorithm and also shows simulation results[12].

In [IJRASET] 2014, Jitender Chauhan et.al presented a paper on "Implementation of Vertical Handoff between WiMAX and Wi-Fi Networks", they discussed that in the wireless telecommunication system problem starts when a node moves from the cluster and when outside the range of base station i.e. handoff mechanism. They work on the selection of the base station in case of handoff without the loss of connectivity in heterogeneous networks and analysis is performed respective to the effective throughput and the delay [17].

In [IEEE] 2007, Wonjun Lee presented a research paper on" Movement-Aware Vertical Handoff of WLAN and Mobile WiMAX for Seamless Ubiquitous Access" were address a movement-aware vertical (MAV) handover algorithm between WLAN(Wi-Fi) and Mobile WiMAX for seamless ubiquitous access. A movement-aware vertical handover algorithm is proposed in this paper to exploit movement pattern for avoiding unnecessary handovers in the integrated wireless networks. If a mobile station (MS)'s velocity is high with irregular movement pattern, unnecessary handovers likely occur more frequently. Therefore, the MS velocity and it's moving pattern are important factors for the handover decision. To avoid unnecessary handoffs in wireless network, this algorithm adjusts the dwell time accordingly and predicts the residual time in the cell of target base station. Simulation shows that reduction of unnecessary handovers by leads to significant throughput improvements [13]

In year 2013, Rupam Deb et.al presented a research paper on "Performance Improvement of Seamless Vertical Handover in Heterogeneous Wireless Network", they discussed Seamless vertical handover between different access technologies is a great challenge as it needs to obey different performance constraints and they proposed a new algorithm that has better performances compared with other algorithms and they also gives simulation results[14].

In year 2015, Tehmina Karamat et.al presented a research paper on "ALGORITHM FOR SEAMLESS HANDOVER BETWEEN WIMAX AND WLAN RADIO ACCESS TECHNOLOGY USING NS2", they discussed that to maintain QoS is a challenge in a heterogeneous network and

they proposed an algorithm based on the speed of the mobile node, bandwidth and packet class priority for handover between WiMAX and Wi-Fi [15].

3. Problem Description

The traditional method used RSS (Received Signal Strength) based algorithm in which the received signal strength measurement is used to take decision for selection of appropriate target network base station. In RSS based algorithm handover is taken based on calculated received signal from nearest base station. When a mobile station is in one network it continuously receives good quality signal from base station but when mobile station is moving away from base station the signal gets weaker. Before the signal gets totally weak we need to handover the call to another network. The mobile station continuously measures the received signal strength using moving average method:

RSS current network > RSS old network

In the case of homogeneous networks, RSS based handoff algorithm is very useful for network selection criteria. In the case of heterogeneous network, RSS based handoff algorithm is not appropriate to decide handoff because wireless medium there are fluctuations in signal due to path loss, this is known as fading. Due to large variation in signal unnecessary handoffs are initiated which degrades the performance of network. So for better handover management only RSS based vertical algorithm is not sufficient. We need to use some more parameters to measure the network conditions for the handoff. So in the paper, used RSS and load balancing on network i.e. base station parameter to decide handoff mechanism.

4. Proposed Vertical Handoff Decision Algorithm

In this paper proposed algorithm is based on RSS based Algorithm for Heterogeneous Networks presented by Sonia and Gurpreet Singh Saini, in which they developed a vertical handoff algorithm to enhance the performance of network with additional parameters such as bandwidth, SNR, data rate.

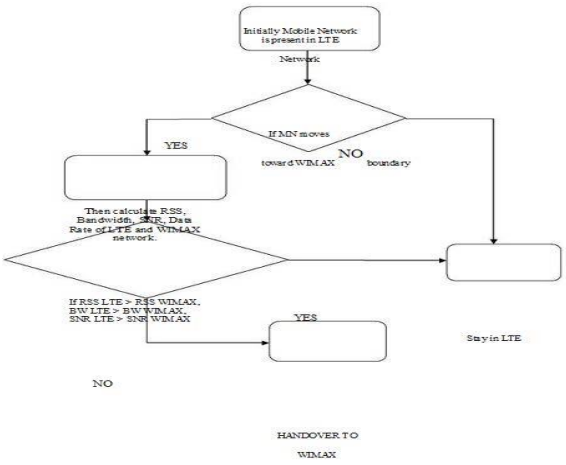

Figure 2 Sonia and Gurpreet Singh Saini algorithm[12]

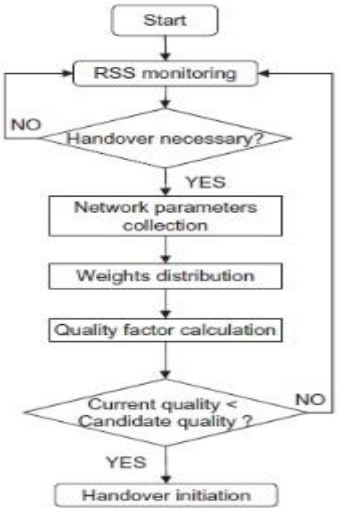

Figure 3: Hasswa et al. VHD heuristic algorithm [18]

The figure 3 shows the traditional algorithm for vertical handoff decision.

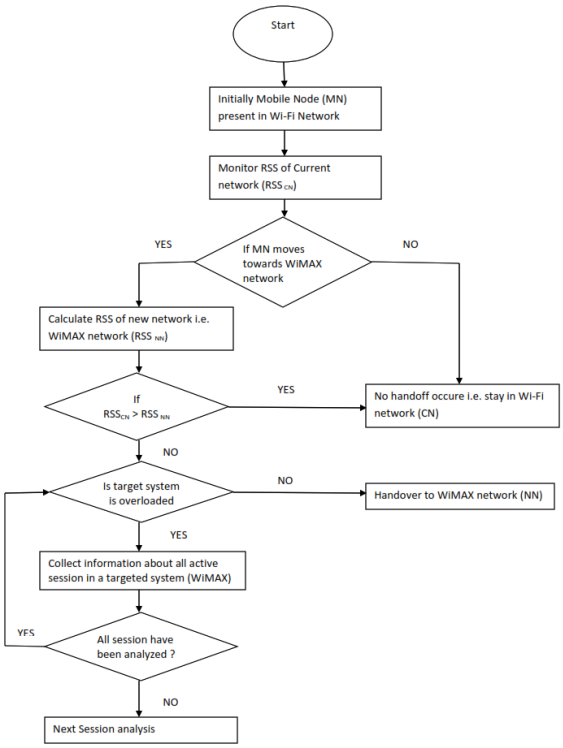

Figure 4: Proposed algorithm flow chart for VHD

Algorithm:

Step1: Search all network and initialize all network parameters like RSS, Bandwidth, Network load capacity, Cost, Latency, Data rate, Security , throughput, Power Consumption and set the min_rss, max_cost, max_latency, min_datarate, min_security , max_network load etc.

Step2: Monitor the RSS of current Network (RSS_{CN}) if MN doesn't moves towards new network go to Step-7.

Step3: If MN moves towards new network (NN) than calculate RSS of new network i.e. RSS_{NN}

Step4: If RSS value of current network i.e. RSS_{CN} is greater than RSS value of new network i.e. RSS_{NN} goto step 7.

Step5: check the new network or targeted network is overloaded or not i.e. Network load, if overloaded than goto step 8

Step6: if new network is not overloaded than initiate handoff to new network than goto step9

Step7: No handoff occurs i.e. stay in current network

Step8: Collect information about all active session in a targeted network or new network (NN) and all session have been analyzed again goto step 5

Step9: stop

5. Simulation Scenario

For vertical handover, Mobile Node (MN) moving from WiMAX to WLAN (Wi-Fi) network or WLAN (Wi-Fi) to WiMAX network an algorithm is proposed in the paper based on the Received Signal Strength (RSS) by MN and Network Load of the Base Station (BS). On the basis of these two parameters the decision is made whether to trigger the handover or the MN should remain with the current network.

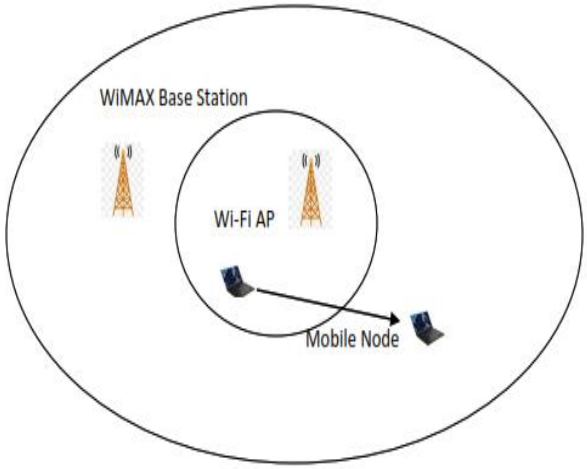

Figure 5 Simulation Scenario

6. Simulation Result

The proposed vertical handoff algorithm analyzed the two heterogeneous networks such as Wi-Fi and WiMAX and used NS2 tool for the simulation. For simulation, created Wi-Fi and WiMAX network where Wi-Fi is a microcell in WiMAX network area. Following scenario represents the simulation results performed in NS-2

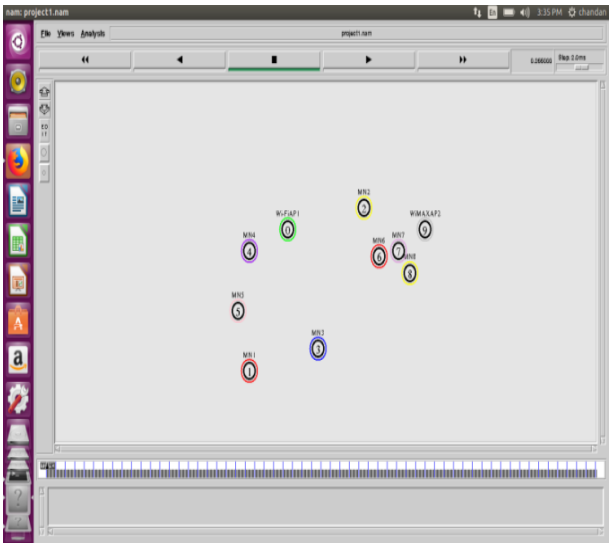

Figure 6 Initial States of Mobile Nodes (MNs)

Figure 6 shows initial location of all the MNs and wireless networks in NAM (Network animator). After the initial position of each MN they will start to move the range of WiMAX network which results the start of vertical handoff process. Finally, figure 7 shows the result of final movement of all available MNs in the range of WiMAX network.

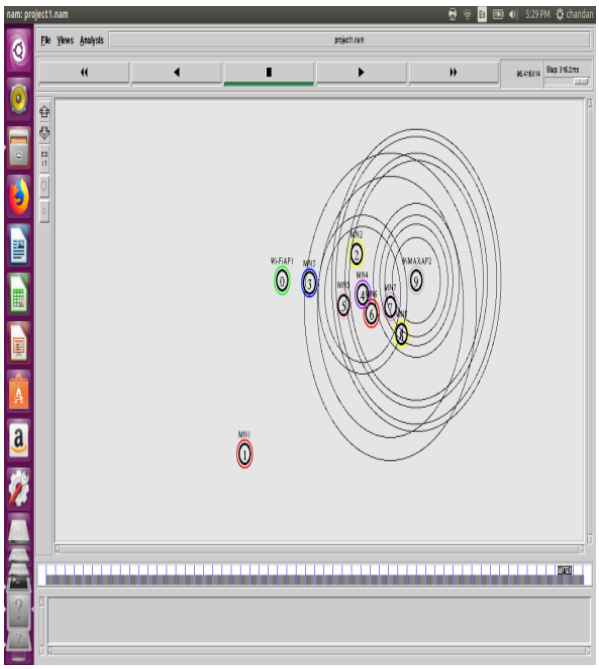

Figure 7: Final State of MNs

7. Result Analysis:

Following results are obtained after the simulation process performed in NS-2, using X-Graph.

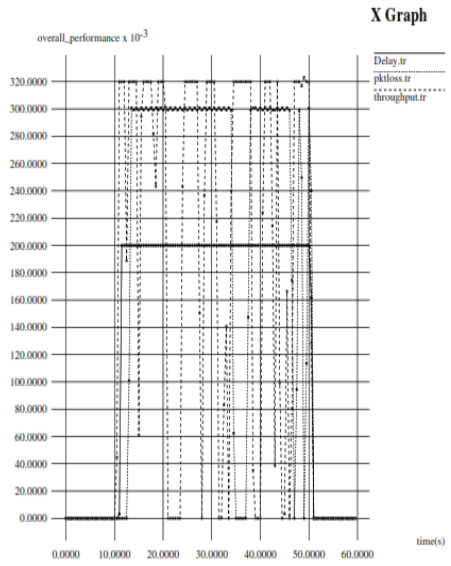

Figure 8: X Graph without Applying proposed Algorithm

Figure No 8 shows that throughput in Mbps, packet loss and delay without applying proposed algorithm. Also, Figure No 9 shows the result of throughput in Mbps, packet loss and delay after introducing proposed algorithm.

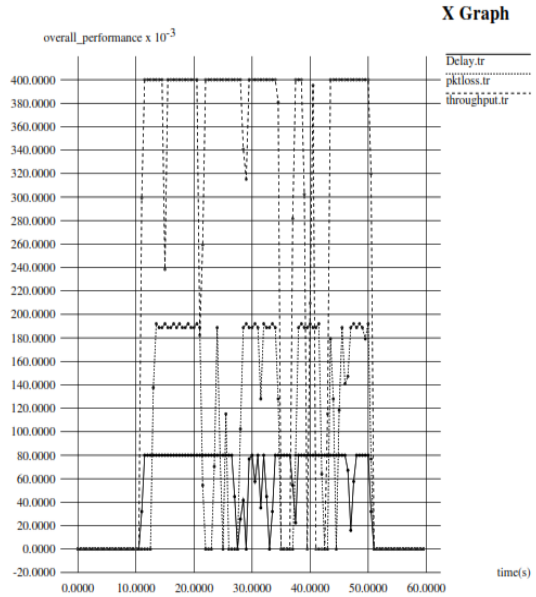

Figure 9: X Graph of Through put, Delay, packet Loss by applying Proposed Algorithm

As depicted in figure 8 and 9, it can be concluded that for the range of time period (10 sec-20 sec) without using proposed algorithm throughput, delay and packet loss 320 mbps, 200 sec, 200 packets respectively. While, using the proposed algorithm the throughput, delay, and packet loss are 400 mbps, 80 sec, and 193 packets respectively for the same range. The values of same parameters can be determined for further ranges from figure 8 and 9.

As for the better results throughput should be high and delay as well as packet loss should be less. This can be obtained by proposed algorithm.

8. Conclusion

In heterogeneous wireless communication network design of efficient handover decision technique plays an important role to improve Quality of Service (QoS). Due to the high mobility of vehicle speed the performance degrades. In present scenario the best QoS cannot achieved only with RSS based decision algorithm, so to obtain best performance in heterogeneous networks proposed handoff algorithm is used with additional parameter network load is used with RSS scheme. By using proposed method, achieved better performance of vertical handover with throughput, packet loss and bandwidth as compare to previous method that improve data rates and offering best quality services to mobile users.

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