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Quality of Service Based Handover Approach in a WLAN network

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***Abstract* -** As the technology is improving so are the demands of end users and their applications increasing. A wide variety of new applications are being invented daily. These applications have different demands from the underlying network protocol suite. High bandwidth internet connectivity has become a basic requirement to the success of almost all of these areas. For the following concern Wireless networks have recently received a lot of attention. The most promising issue that needs to be taken into account while considering a wireless network is Quality of service (QoS). In this paper work we have considered a handover mechanism for IEEE 802.11 Wi-Fi and perform some modifications in that like firstly we increased the range of the access point and secondly increases the speed of Mobile Node (MN) and then study the effect of these changes on QoS in respective throughput delay and jitter. For the simulation purpose we have make use of wireless simulator NS-2 (Network Simulator version 2). Thus aim of this paper is to study the variations in average throughput, delay and jitter with the increased range of access point and increasing speed of mobile node with the help of NS-2 software.

***Keywords*—** Homogeneous network, QoS (Quality of service), IEEE 802.11, Wi-Fi, Network simulator version 2.

I. INTRODUCTION

Wireless communication has become the most promising way to connect people. Cellular systems have experienced exponential growth over the last decade and there are currently around two billion users worldwide. The first digital network based on packet radio, ALOHANET, was developed at the University of Hawaii in 1971. The Defense Advanced Research Projects Agency (DARPA) invested significant resources to develop it. In 1990, the first digital communication based cellular system was introduced. Since then, Radio technology advanced rapidly to enable transmissions over larger distances with better quality and less power. It enabled mobile communications and wireless networking.

Wireless networking is an emerging technology now a days. Support for mobility in Internet access is gaining significant interest as wireless/mobile communications and networking are proliferating, especially boosted by the widespread use of laptops and handheld devices. Wireless Local Area Networks (WLANs) has become one of the most promising and successful technology in recent years. WLANs provide free wireless connectivity to end users, offering an easy and viable access to the network and its services.

Wireless networks are superior to wired networks with regard to aspects such as ease of installation and flexibility. They do, however, suffer from lower bandwidth, higher delays, higher bit error rates and higher costs than wired networks. With the advent of Wireless Local Area Networks (WLANs), bandwidth has increased and prices have decreased on Wireless networking solutions. These factors have made WLANs a very popular Wireless networking solution.

WLANs have revolutionized the way people are using their computers, to communicate. As WLANs eliminate the need of wires for connecting end users, they provide a very easy, viable access to the network and its services. A wireless LAN or WLAN is a wireless local area network, which is the linking of two or more computers without using wires. WLAN utilizes spread spectrum modulation technology based on radio waves to enable communication between devices in a limited area, also known as the basic service set. This gives users the mobility to move around within a broad coverage area and still be connected to the network. Wireless has become popular due to ease of installation and mobility.

Now when a mobile node is moving, it can roam around a single network means from the range of one base station to another. Also it can move from one network to another network. This process in technical terms is known as handoff.

When the mobile node switches between base stations or access points within the same wireless networks is called horizontal handoff and the network environment is known as homogeneous network. When it switches between heterogeneous networks is called vertical handoff. Viz., the handoff within Wi-Fi is known as horizontal handoff and the handoff from Wi-Fi to WiMAX is known as vertical handoff. When a mobile node undergoes a handoff, a major issue that needs to be considered is the QoS (Quality of service). Quality of service is the ability to provide different priority to different applications, users, or data flows, or to guarantee a certain level of performance to a data flow. QoS in wireless networks is usually managed at the MAC layer.

For the simulation purpose, in this paper we are using the NS-2 (Network simulator version 2) software. The focus of this paper is on QoS in terms of throughput, delay and jitter. The objective is to study the variations of QoS parameters with the increased range of access point and increased velocity of the Mobile Node when it moves from one base station to another base station in a Wi-Fi network environment.

Beyond local area network, the first technology which comes into existence for wireless networking is Wi-Fi. WLAN is based on short-range RF communications, standardized in the USA by one of the Institute of Electrical and Electronics Engineers (IEEE) working groups.

II. ARCHITECTURE OF WLAN

As wireless networking grows in popularity, various radio access technologies have been developed to provide better environment for user data service. Most of all, IEEE 802.11 Wireless Local Area Network (WLAN) is one of the dominant wireless technologies to support high-speed network access nowadays. The WLAN basically forms an infrastructure with two network components, Access Point (AP) and Station (STA). An AP is generally distributed at a fixed location, and the WLAN infrastructure connects STAs to a wired network via the AP within their communication range. AP's signal range is denoted by Basic Service Set (BSS) or hotspot which generally provides coverage within a few ten-meter radius.

WLAN works in the lower two layers of the OSI model. First on is the physical layer which takes care of transmission of bits through a communication channel by defining electrical, mechanical and procedural specifications. Second one is the data link layer which is sub-divided into two layers: Logical Link Layer (LLC) and Medium Access Layer (MAC). Only MAC layer is considered as the part of wireless LAN functions.

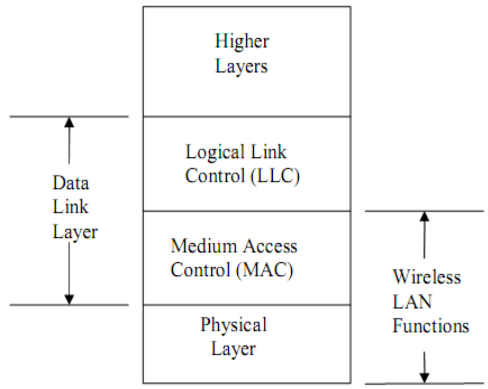

Fig. 1. Logical Architecture of WLAN

A. *Medium Access Control (MAC) Sub layer :*

The primary function of a MAC protocol is to define a set of rules and give the stations a fair access of channel for successful communication. Many MAC protocols provide the standardized medium access and physical layer protocols for WLAN and it is the most widely employed standard in wireless networks.

Medium access control enables multiple wireless devices to share a common transmission medium via a carrier sense protocol similar to Ethernet. This protocol enables a group of wireless computers to share the same frequency and space. A wireless LAN Medium Access Control protocol provides reliable delivery of data over somewhat error-prone wireless media.

B. *Physical Layer :*

The physical layer provides the transmission of bits through a communication channel by defining electrical, mechanical and procedural specifications. Modulation, which is a Physical layer function, is a process in which the radio transceiver prepares the digital signal within the network interface card (NIC) for transmission over the airwaves. Spread spectrum “spreads” a signal’s power over a wider band of frequencies, sacrificing bandwidth in order to gain signal-to-noise performance. This contradicts the desire to conserve frequency bandwidth, but the spreading process makes the data signal much less susceptible to electrical noise than conventional radio modulation techniques. Other transmission and electrical noise, typically narrow in bandwidth, will interfere with only a small portion of the spread spectrum signal, resulting in much less interference and fewer errors when receiver demodulates the signal. Spread spectrum modulators commonly use one of two methods to spread the signal over a wider area: Frequency hoping or direct sequence. Main layer to be analysed is MAC layer.

III. HANDOFF

In future, wireless network environments will be heterogeneous and mobile nodes will have to roam around many different access technologies. Handoff is the one which enables this feature. Seamless handoff also called as soft handoff is one in which connection with old network is released only after establishing connection with new network (make-before-break), whereas hard handoff is one in which connection with old network (break-before-make).

In cellular telecommunications, the term handover or handoff refers to the process of transferring an ongoing call or data session from one channel connected to the core network to another. The most basic form of handover is when a phone call in progress is redirected from its current cell (called source) and its used channel in that cell to a new cell (called target) and a new channel. In terrestrial networks the source and the target cells may be served from two different cell sites or from one and the same cell site (in the latter case the two cells are usually referred to as two sectors on that cell site). Such a handover, in which the source and the target are different cells (even if they are on the same cell site) is called inter-cell or vertical handover. The purpose of inter-cell handover is to maintain the call as the subscriber is moving out of the area covered by the source cell and entering the area of the target cell. The vertical handover is also known as heterogeneous handoff.

Another situation is also possible, in which the source and the target are one and the same cell and only the used channel is changed during the handover. Such a handover, in which the cell is not changed, is called intra-cell or horizontal handover. The purpose of intra-cell handover is to change one channel, which may be interfered, or fading with a new clearer or less fading channel. Horizontal handover is also termed as homogeneous handoff.

In this paper work, we have considered a Mobile Node (MN) undergoing Horizontal handoffs with in a Wi-Fi network.

IV. QUALITY OF SERVICE

In general, QoS depends upon the following factors:

A. *Average Throughput* :

Network throughput is the average rate of successful message delivery over a communication channel. This data may be delivered over a physical or logical link, or pass through a certain network node. The throughput is usually measured in bits per second (bit/s or bps), and sometimes in data packets per second or data packets per time slot. The system throughput or aggregate throughput is the sum of the data rates that are delivered to all terminals in a network. The maximum throughput is equals to the TCP window size divided by the round-trip time of communications data packets. The maximum throughput is calculated as:

$$\text{Throughput} = \frac{\text{RWIN}}{\text{RTT}}$$

where RWIN is the TCP Receive Window and RTT is the round-trip time for the path. The Max TCP Window size in the absence of TCP window scale option is 65,535 bytes.

B. *Delay* :

Delay is sometimes also referred as handoff latency. Whenever a mobile node enters to the range of a new base station, connection with the old base station is disconnected and it begins movement detection and address configuration which includes handoff latency. This latency or delay should be minimum for seamless handoff. It includes a total of queuing and contention delays of the data. One-way delay should be less than 150ms, so that users would not notice the delay.

C. *Jitter* :

Jitter can be defined as the variation of transmission time of voice packets that occurs due to congestion and queuing in a network. The effects of jitter can be reduced by storing voice packets in a buffer on the receiving endpoint device before playing them out.

V. SIMULATION ENVIRONMENT

A MAC protocol should provide an efficient use of the available bandwidth while satisfying Quality of Service (QoS) requirements of both data and real-time applications. Real-time services such as streaming voice and video require a certain quality of service such as low packet loss, low delay and high throughput to perform well. To provide QoS for such kind of application, service differentiation is must. Service differentiation means that different types of traffic have different requirements on the network. Various mechanisms have been developed to support quality of service. A lot of efforts have also been made to implement latest techniques in NS-2 software. This paper is an effort to study the results obtained for Quality of Service in a Wi-Fi network by wireless simulator NS-2. NS2 is an object oriented discrete-event simulator for networking research which maintains list of events and executes one event after another. Back end of the NS2 is C++ event scheduler and front end is oTCL. It provides substantial support to simulate a bunch of protocols like TCP, UDP, FTP, HTTP and DSR.

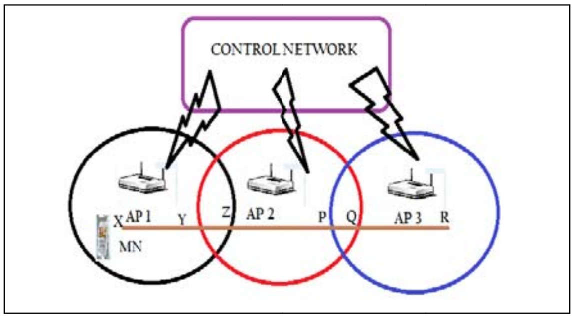

Fig.2. Network Scenario

In the considered network, we have taken a CN (Control network), a router, a mobile node and three base stations. AP1, AP2 and AP3 stands for access point 1, access point 2 and access point 3 respectively. Mobile node (MN) is moving from AP1 to AP2. X is any point inside the range of AP1, Y represents the outer range of AP2, Z corresponds to maximum Range of AP1, P is the maximum range of AP3 and Q represents the outer range of AP2. Y-Z represents the overlapping region between AP1 and AP2 and P-Q represents the overlapping region between AP2 and AP3.

VI. RESULTS AND DISCUSSION

For the given scenario we have observed the following results upon increasing the range of access point and speed of Mobile Node when it moves from the range of Access Point 1 (AP1) to AP2 and then from AP2 to AP3..

A) Throughput with varying ranges of Access Point

Fig. 3 represents the variations of throughput with changing range of access point in a Wi-Fi network. In this figure 30mps, 50mps, 60mps, 75mps and 100mps represents throughput for the respective ranges of access point. After applying simulation, from the figure we analyse that as the range of the access point is increasing the throughput is increasing. The slight consistency in graph represents the handoff from one base station to another. Thus throughput is increased when we increase the range of access point.

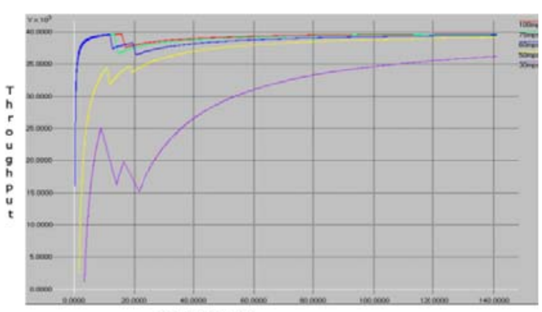

Fig.3 Throughput comparison for different ranges of access point

B. Throughput with increased velocity of mobile node

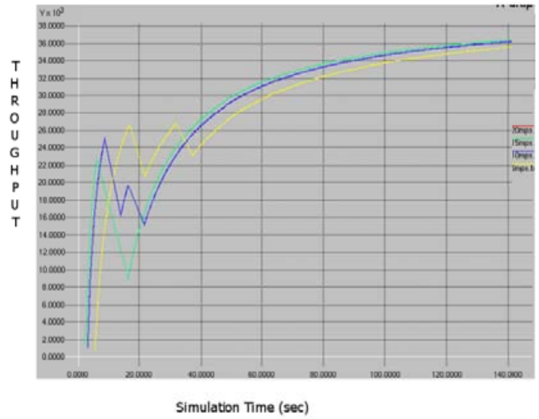

Fig.4. Throughput comparison for different speeds of mobile node with

Fig. 4 represents the variations of throughput with increasing velocity of mobile node in a Wi-Fi network environment. In this figure 5mps.tr represents a velocity of 5m/s, 10mps.tr, 15mps.tr and 20mps.tr represents a velocity of 10m/s, 15m/s and 20m/s respectively. After performing simulation, from the figure we analyse that as the velocity of mobile node is increasing throughput is decreasing.

C. Delay with varying ranges of Access Point

In the above figure 30mps, 50mps, 60mps, 75mps and 100mps represents the delay for different ranges of access point. Fig. 5 represents the variations of delay with increasing range of access point in a Wi-Fi network. Upon applying simulation, from the figure we analyse that as the range of the access point is increasing the delay is introduced at an earlier simulation time and with the increasing range delay is reducing in the respective Wi-Fi environment.

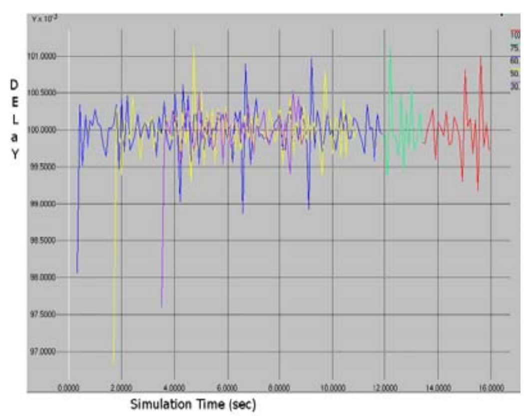

Fig. 5 Delay comparison for different ranges of access point

D. *Delay with increasing speed of mobile node*

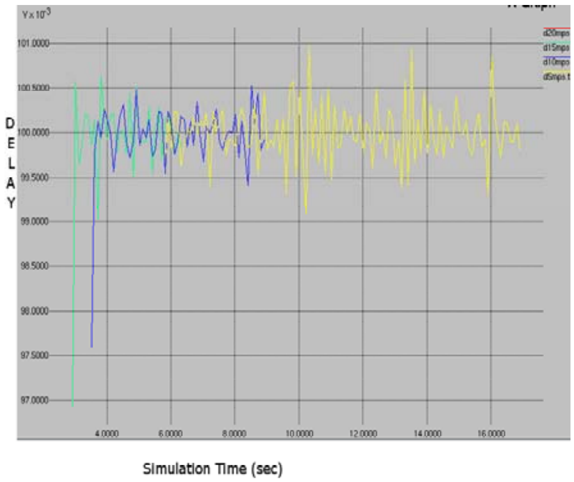

Fig. 6 Delay comparison for different speeds of mobile node

Fig. 6 represents the variations of delay with increasing velocities of mobile node in the Wi-Fi network. In the above figure d5mps.tr, d10mps.tr, d15mps.tr and d20mps.tr represents the delay with 5m/s, 10m/s, 15m/s and 20m/s speeds respectively. From the figure we conclude that at earlier simulation times, delay is more at higher speeds but as simulation time is increasing delay is increased at smaller speeds.

E. *Jitter with varying ranges of access point*

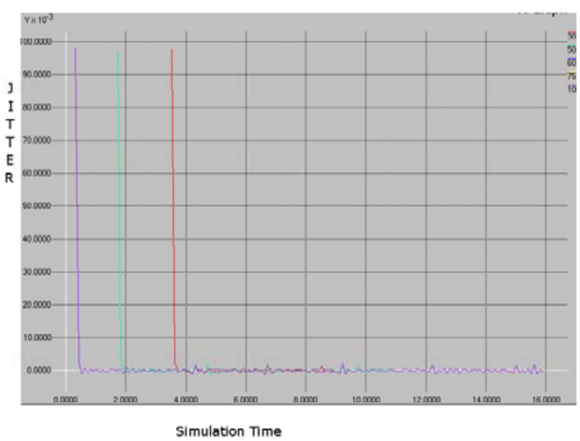

Fig. 7 Jitter variations for various ranges of access point

In Fig. 7, we represent the variations in jitter level upon increasing range of the used access point. 30mps, 50mps, 60mps, 75mps and 100mps represents jitter level to the corresponding ranges of access point. From the figure we conclude that for the increasing ranges of access point jitter level is almost same but jitter is introduced at comparatively latter simulation times for smaller ranges in comparison to higher ranges.

F. *Jitter with varying speeds of mobile node*

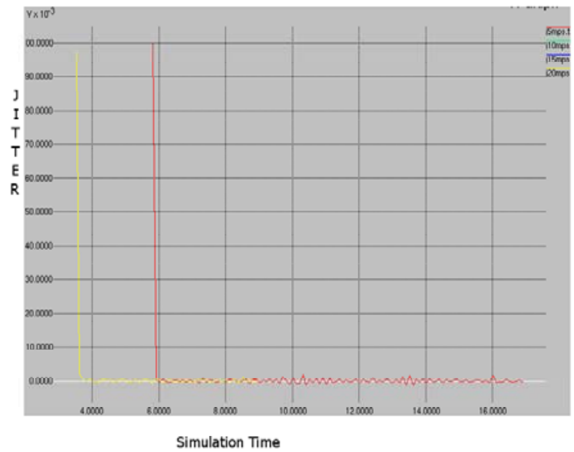

Fig. 8 Jitter variations for increasing speed of mobile node

In Fig. 8, we represent the variations in jitter level upon increasing speed of the mobile node. j5mps.tr, j10mps.tr, j15mps.tr and 20mps.tr represent jitter level to the corresponding 5m/s, 10m/s, 15m/s and 20m/s speeds of mobile node. From the figure we conclude that as the speed is increasing jitter level is reduced but is introduced earlier.

VII. CONCLUSION

In this paper we have studied the performance characteristics of a Wi-Fi network in terms of throughput, delay and jitter using NS2. Frequent handovers for a short time period mean a higher chance of adversely affecting the overall QoS. But as a result of this paper we have concluded that as the range of the access point is increase there is an appreciable increase in throughput, decrease in delay and also jitter is introduced at greater simulation times. But when speed of the mobile node is increasing, throughput is reduced, delay is also increased but jitter is introduced at increased simulation times and it is reduced.

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