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Throughput based handover in a Wi-Fi 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. Several issues need to be taken into account while considering a wireless network. Quality of service (QoS) is one of the most important among all.In this paper we have purposed a handover mechanism for IEEE 802.11 to study the QoS in terms of throughput. The objective of the paper is to study the variations in average throughput with several factors like speed of the moving node, packet size, interval etc. with the help of Network Simulator Version 2 (NS-2) software.**

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

I. INTRODUCTION

Wireless networking is an emerging technology now adays. 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. 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.QoS in an application depends mainly on the following factors:

1) End to End delay
2) Jitter
3) Throughput
4) Packet loss

For the simulation purpose, in this paper we are using the NS 2 (Network simulator version 2) software. The focus of this paper is basically on throughput. The objective is to derive the variations of throughput with a number of parameters like speed of the node when it moves from one base station to another base station in a Wi-Fi network environment, the packet size of data to be transferred, interval etc.

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. OVERVIEW OF THE TECHNOLOGY

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.

Wi-Fiis trademark of the Wi-FiAlliance. The technical term "IEEE 802.11" has been used interchangeably with Wi-Fi, however Wi-Fi has become a superset of IEEE 802.11 over the past few years. The 802.11 family includes over-the-air modulation techniques that use the same basic protocol. The most popular are those defined by the 802.11b and 802.11g protocols, which are amendments to the original standard. 802.11-1997 was the first wireless networking standard, but 802.11b was the first widely accepted one, followed by 802.11g and 802.11n. Security was originally purposefully weak due to export requirements of some governments and was later enhanced via the 802.11i amendment after governmental and legislative changes. 802.11n is a new multi-streaming modulation technique. Other standards in the family are service amendments and extensions or corrections to the previous specifications.

The IEEE 802.11 standard provides low cost and effective wireless LAN service. The deployment of high speed network (11Mbps in 802.11b and 54Mbps in 802.11a/g) can be easily established by the free and unlicensed spectrum (2.4GHz in 802.11b/g and 5GHz in 802.11b). The IEEE 802.11b standard

is one of the most commonly used standards for the WLAN. There are 11 available channels in this standard and 3 of them are non-overlapping channels. On the PHY layer, it employs the Direct Sequence Spread spectrum (DSSS) technique with Complementary Code Keying (CCK) modulation scheme. This standard operates in two modes: one is Ad Hoc mode and the other is Infrastructure mode.

The Ad Hoc mode of operation allows the computing devices within range of each other to discover and communicate in peer to peer fashion without involving central access points. In an infrastructure type of a WLAN, an Access Point is used to connect computing devices to connect wired nodes.

III. HANDOFF

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.

A special case is 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. In this paper we have taken into account, a horizontal handover in a WLAN network.

IV. 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.

V. SIMULATION ENVIRONMENT

In this paper we have make use of NS2 software for the simulation purpose. 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.

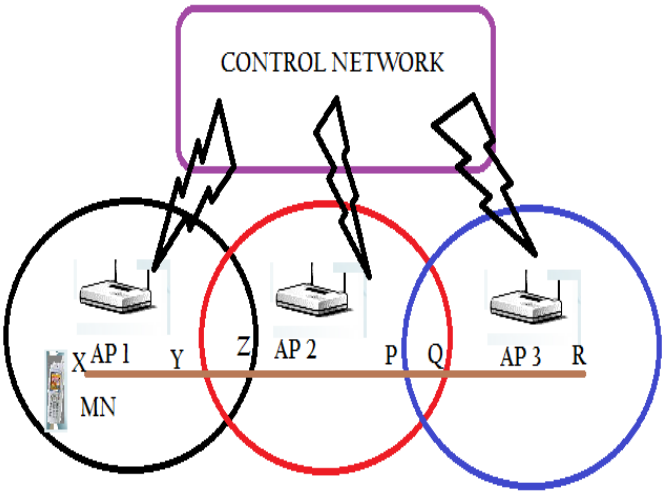

Fig.1. Network Scenario

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 and Z corresponds to maximumrange 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 varying the three parameters which are speed with which the mobile node moves from R2 to R4, packet size of the data and the interval of the CBR traffic source.

A. *Throughput with varying speed of mobile node*

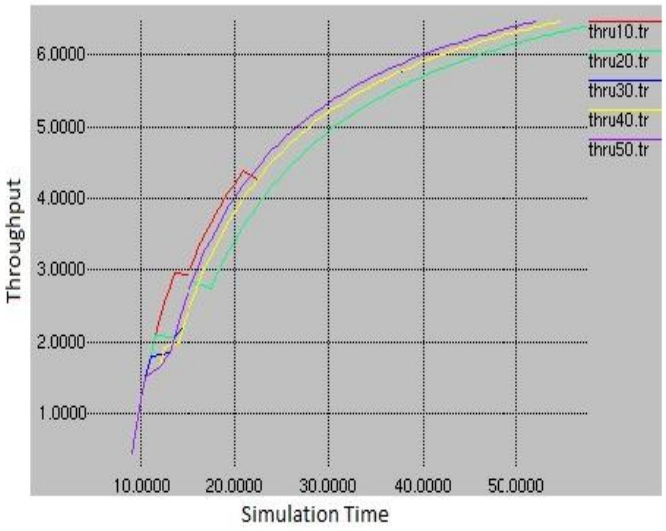

Fig.2. Throughput comparison for different speeds of mobile node

In above figure thru10.tr represents throughput corresponding to 10m/s speed of mobile node, similarly thru20.tr, thru30.tr, thru40.tr and thru50.tr represents throughput corresponding to 20m/s, 30m/s, 40m/s and 50m/s speed of the mobile node. Figure 2 represents the variations of throughput in a Wi-Fi network environment. From the figure we analyis that as the speed of the mobile node is increasing the throughput isdecreasing. The slight consistency in graph represents the handoff from one base station to another.

B. *Throughput with increased packet size*

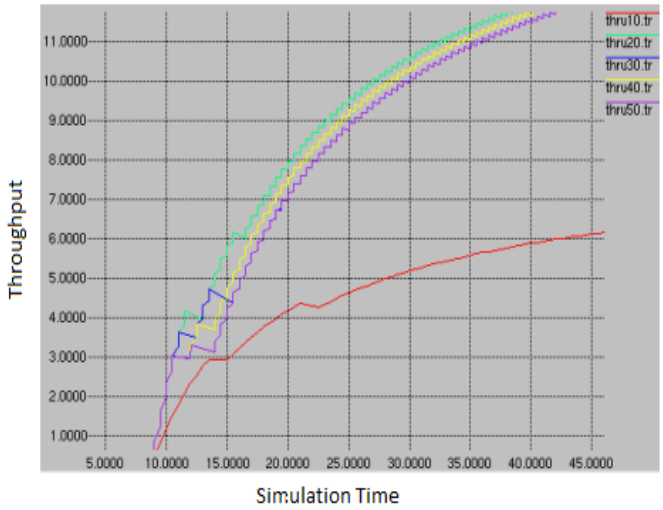

Fig.3. Throughput comparison for different speeds of mobile node with increased packet size

In above figure thru10.tr represents throughput corresponding to 10m/s speed of mobile node, similarly thru20.tr, thru30.tr, thru40.tr and thru50.tr represents throughput corresponding to 20m/s, 30m/s, 40m/s and 50m/s speed of the mobile node. Fig.3. represents the variations of throughput for different speeds of mobile node but also with increased packet size of the CBR traffic source which provides the data to be transferred. Initially packet size has been considered to be 500. But in the present case it is increased to 2000. In this figure we observed that with increased packet size upon increasing speed of the mobile node, throughput is also increased slightly.

C. *Throughput with decreased interval*

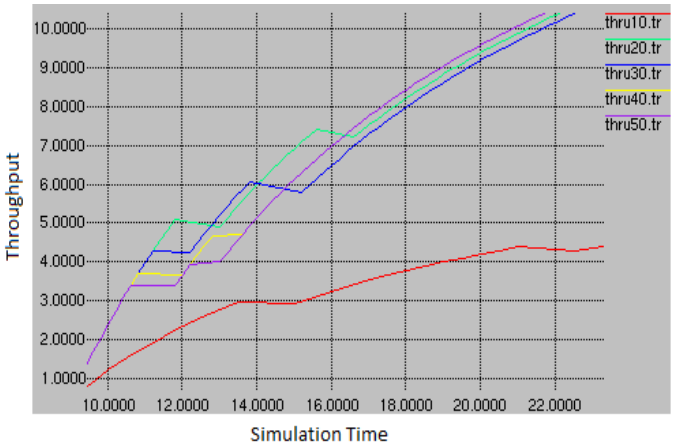

Fig.4 Throughput comparison for different speeds of mobile node with decreased interval

Once again thru10.tr in the figure represents throughput corresponding to 10m/s speed of mobile node, similarly thru20.tr, thru30.tr, thru40.tr and thru50.tr represents throughput corresponding to 20m/s, 30m/s, 40m/s and 50m/s speed of the mobile node. Fig.4 represents the variations of throughput for different speeds of mobile node but with decreased interval of the CBR traffic source. In the 1st case interval value was 0.5. Now it is reduced to 0.2 and result is a slight increase in throughput.

D. *Throughput with increased packet size and decreased interval*

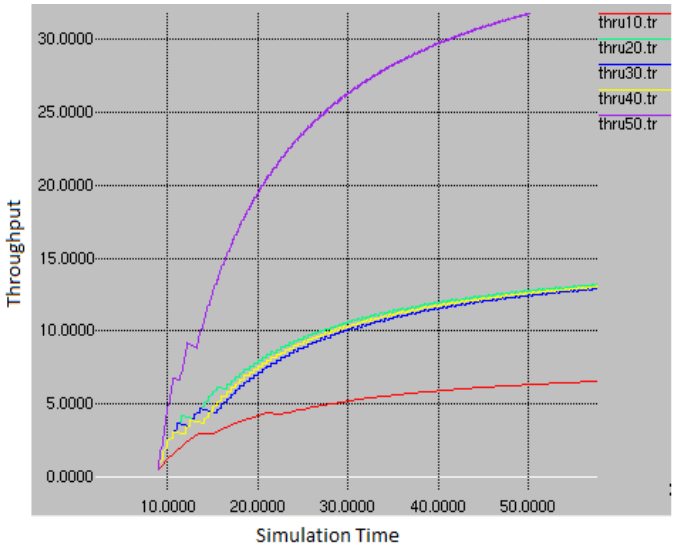

Fig.5 Throughput comparison for different speeds of mobile node with increased packet size and decreased interval

In above figure thru10.tr represents throughput corresponding to 10m/s speed of mobile node, similarly thru20.tr, thru30.tr, thru40.tr and thru50.tr represents throughput corresponding to 20m/s, 30m/s, 40m/s and 50m/s speed of the mobile node. Fig.5 represents the variations of throughput for different speeds of mobile node also with increased packet size and decreased interval. Throughput is again increased slightly.

VII. CONCLUSION

In this paper we have studied the performance characteristics of a Wi-Fi network in terms of throughput variations using NS2. Frequent handovers for a short time period mean a higher chance of adversely affecting the overall throughput. But as a result of this paper we have concluded that if the speed of the mobile node is increasing, if we use a greater packet size and a small interval for the CBR traffic source, we can achieve an increase in throughput

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