EXPLORE
iJET International Journal of Engineering & Technology
CENTRE OF PROFESSIONAL RESEARCH PUBLICATIONS
ISSN 2049-3444

International Journal of Engineering and Technology Volume 2 No. 2, February, 2012

A Fast Handoff Mechanism for Wireless LAN

Sushama Rani Dutta, Rohit Vaid
Markandeshwar University Mullana, Ambala, Haryana (India)

ABSTRACT

Wireless Local Area Network (WLAN) is the current technology which provides services with high bandwidth and low latency. It is one of the reasons for which it is preferred over several other wireless data networks. However, there are a few problems associated with it. Handoff is one such problem. Handoff process takes place when a mobile terminal moves from one access point to another. Existing methods require around 400ms for the handoff process, which causes serious problems for multimedia applications like audio and video streaming and real time applications like Voice over IP (VoIP). We use the concept of Triangulation which is used by Global Positioning System (GPS). It helps in efficiently predicting the next most likely access point with-out actual handoff, thereby almost eliminating discovery delay which poses almost 50 to 80% of the delay.

Key words: *Handoff, WLAN, VOIP, MN, Data Networks, Access Point.*

1. INTRODUCTION

WLANs are being set up not only in private spaces such as the home and workplace, but also in public spaces such as waiting areas and coffee shops as hotspots. Thus, WLANs that are independently managed by different organizations are starting to complementarily cover wide areas such an entire city. In WLAN the communication is disconnected due to the change in Internet Protocol (IP) address of the Mobile Node (MN) required for handover. Handoffs can be classified as follows:

- *Hard Handoff*- A hard handoff is one in which the channel in the source cell is released and only then the channel in the target cell is engaged. Thus the connection to the source is broken before the connection to the target is made.
- *Soft Handoff*- A soft handoff is one in which the channel in the source cell is retained and used for a while in parallel with the channel in the target cell [1]. In this case the connection to the target is established before the connection to the source is broken.

1.1 Existing WLAN Handover Decision Criteria

Handover decision criteria used by existing mobility management technologies can be classified according to the information measured on upper/lower layers. In this section, we clarify characteristics of the existing handover decision criteria on upper/lower layers.

1.1.1 Handover Decision Criteria on Upper Layers

Packet loss (including data/signaling packets) and round-trip-time (RTT) are commonly used as handover decision criteria in existing handover technologies. Through simulation experiments, it has been shown that the communication quality has already been degraded even when an MN starts the handover process just after detecting the occurrence of a packet loss or an increase of RTT. In a WLAN, communication quality is degraded due to deterioration in the wireless link condition even if packet loss does not occur or RTT does not seriously increase. Therefore, these criteria on upper layers cannot detect abrupt fluctuations of wireless link condition reliably and promptly [2]. To avoid degradation of communication quality at handover initiation, it is essential to effectively detect deterioration in the wireless link condition.

1.1.2 Handover Decision Criteria on Lower Layers

Wireless signal strength is usually considered as a handover decision criterion on lower layers. Signal strength can provide information about a wireless link condition directly from the Physical Layer [3]. However, properly detecting deterioration in communication quality caused by fluctuations of signal strength is very difficult for an MN, because the signal strength may fluctuate abruptly due to the distance from an Access Point (AP) and any interfering objects located between the MN and the AP.

1.2 Data Networks

The handoff process in 802.11 networks attempts to include all the information necessary to transition a MT from one BS to another with minimal (ideally none) loss of data. The logical steps of the handoff process are:

1.2.1 Discovery

The Mobile Terminal (MT) actively finds additional BSs in the area by sending Probe Requests on all channels and listening for responses. A MT can also passively find additional BSs in the area by receiving Beacon frames. As a MT receives either a Probe Response or a Beacon, it determines the signal strength(s) and the bit error rate(s) (BER) for each Base Station (BS).

1.2.2 Authentication

The MT will then send Authentication Request frames to all BSs in area that have an acceptable signal strength and BER. The MT will then receive a frame either confirming or denying the authentication to that BS.

1.2.3 Re-association

The MT will then send a Disassociation frame to the BS that it is currently associated to and an Association Request frame to the new BS that it has previously authenticated to. To complete the re-association process, the new BS communicates over the distribution medium to the originating BS to indicate the handoff has occurred. The originating BS acknowledges this by sending any buffered frames to the newly associated BS.

The table below shows the time taken for different phases in a Layer2/ Media Access Control (MAC) handoff scheme.

Table 1. Time Taken for different Phases

Phase	**Time**
Scanning/Discovery	350-500 ms
Authentication	< 10ms
Association	< 10ms
Wired Update	< 20ms
Mobile Node Identification	7.5 to 500 ms
IP Address Assignment	
Duplicate Address Detection	Order of 1 Sec

2. PROBLEM STATEMENT

The main problem of this thesis is to reduce the handoff delay incurred during a handoff in 802.11 Wireless Local Area Network. In this approach a MN estimates its next probable AP using a method called Triangulation which is generally used in Global Positioning System (GPS). By continuously tracking the location and movement of the mobile client, we can predict the next access point and by the time the MN is ready for handoff the new access point will be equipped with information necessary for the MN to authenticate and Re-Associate. At the same time the mobile client will have the parameters of the new AP before actual handoff process, so that the MN can directly go through the authentication and re-association phase, reducing almost 50 to 80% of the delay caused by discovery phase.

3. LITERATURE SURVEY

M.S. Bargh, R.J. Hulsebosch, E.H. Eertink and A. Prasad, H. Wang, P. Schoo in [4] presents an overview of fast authentication methods when roaming within or across IEEE 802.11 Wireless-LANs. Besides this overview, the paper analyses the applicability of IEEE 802.11f and Seamby solutions to enable fast authentication for inter-domain handovers. They introduced an Extended Service Set(ESS) which is basically a hotspot with a collection of Access Points. They intend to reduce the latency as it may occur due to the ex-change authentication messages Fast Authentication in Interdomain Handovers. They analyzed three techniques viz. Straightforward Extension of IAPP, Inter-domain Proactive Key Distribution and Pre-authentication over Multiple Domains for minimizing latency involved in authentication during a handover.
Ishwar Ramani and Stefan Savage in the paper Sync scan [5] proposed a practical method which is both for-ward and backward compatible. Sync scan is a low-cost technique for continuously tracking nearby base stations by synchronizing short listening periods at the client with periodic transmissions from each base station. 802.1l-based access points periodically broadcast special beacon packets to identify themselves to potential clients and to synchronize state information with currently associate clients. This is used to synchronize clients with the timing of beacon broadcasts on each channel. In essence, arrangement is made so that the clients can passively scan by switching channels exactly when a beacon is about to arrive. The main essence lies in creation of a staggered periodic schedule of beacon periods spread across channels. We call this approach synchronized scanning, or Syncscan. A mobile client can then utilize this property to efficiently locate all the access points in its neighbor-hood.

4. PROPOSED APPROACH

4.1 Voronoi Diagrams

Out approach is mainly focused on predicting the next AP before actually taking a handoff. Generally, during a MN's movement, the coordinates of the AP's and MN are to be considered for predicting the next AP. Initially, the MN is close to its parent AP. We consider the scenario by drawing a Voronoi diagram as shown in Figure 1. Simply, a Voronoi Diagram can be defined as "if we are given a set of points S, and the Voronoi diagram for N is the partition of the plane which associates a region V(p) with each point p from N in such a way that all points in V(p) are closer to p than to any other point in N". In general, the set of all points closer to a point c of S than to any other point of N is the interior of a convex polytope called the Dirichlet domain or Voronoi cell for c. The set of such polytopes tessellates the whole space, and is the Voronoi tessellation corresponding to the set N. Voronoi diagrams have a surprising variety of uses:

4.1.1 Nearest Neighbor Search

For a query point q, finding its nearest neighbor from a fixed set of points N is simply a matter of determining which cell in the Voronoi diagram of S contains q.

4.1.2 Facility Location

Suppose we have to look for a location, and to minimize interference with existing similar locations, it should be located as far away from the current location as possible. This location is always at a vertex of the Voronoi diagram, and it can be found in a linear-time search through all the Voronoi vertices.

4.1.3 Largest Empty Circle

Suppose you needed to obtain a large, contiguous, undeveloped piece of land on which to build a factory. The same condition used for picking McDonald's locations is appropriate for other undesirable facilities, namely that it be as far as possible from any relevant sites of interest. A Voronoi vertex defines the center of the largest empty circle among the points [6].

4.1.4 Path Planning

If the sites of N are the centers of obstacles we seek to avoid, the edges of the Voronoi diagram define the possible channels that maximize the distance to the obstacles [7]. Thus in planning paths among the sites, it will be "safest" to stick to the edges of the Voronoi diagram.

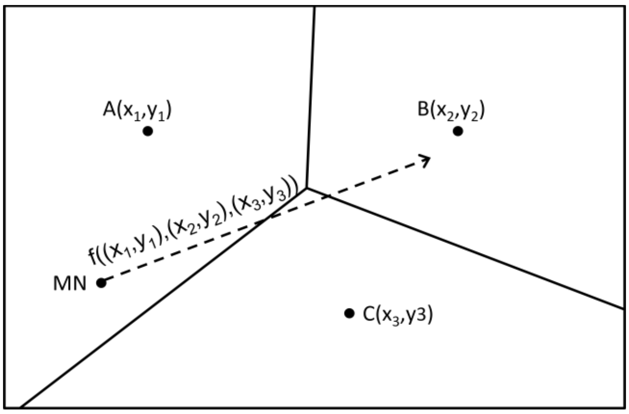

Figure 1. Voronoi Diagram with three AP's and a MN

The voronoi diagram with three AP's (A(x1, y1), B(x2, y2) and C(x3, y3)) and a MN is given in Figure 1. The MN is moving and its path can be given by f((x1,y1),(x2,y2),(x3,y3)). Initially, we can see that the MN is closer to its parent AP A. After some time, the MN enters the Voronoi cell of its neighboring AP i.e., C and then into B's Voronoi cell. So, the effective movement is from the Voronoi cell A to B.

5. ALGORITHM

Normally every AP periodically broadcasts its information in its range so that it can serve the covered area. But, in this approach, each AP broadcasts periodic beacons with extended range by increasing the power level so that the extended range overlaps with the adjacent APs coverage area. After the access points increase their coverage, each of its range overlaps with the adjacent access points range.
This extended range is used by the MN in the overlapped areas to listen to the adjacent APs' channel for the periodic beacons. As the MN is equipped with two antennas, one will be always attached with the home AP for routing and communication while the secondary antenna will be scanning the adjacent channels [8] . To start the pre-handoff process we introduce a threshold called pre-handoff threshold (PTH) which is higher than the handoff threshold. Whenever the MN's RSSI is below the PTH then the secondary antenna starts scanning for the periodic broadcasts of the neighboring APs. In this way, the Mobile nodes secondary antenna receives all the adjacent channels broadcasts frames.
Figure 2 shows the process in which two MNs receive signals from neighboring APs. Mobile node 1 (MN1) receives signals from all the three APs since it is in the overlapped extended range of all the three APs [9].

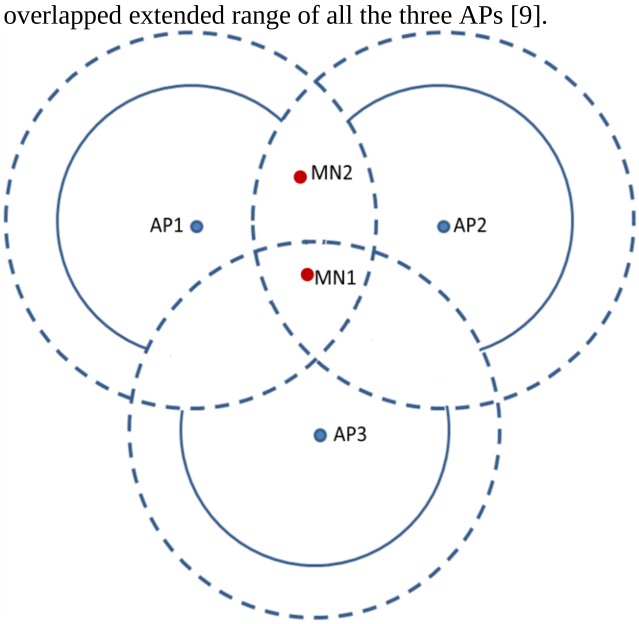

Figure 2. MNs receiving Signal from 3 Aps

But, N2 receives signals only from two APs that is AP1and AP2 since it falls in the extended range of AP1 and AP2 [10]. The MN then calculates its distance from each of the adjacent APs (as in Triangulation) using the path loss exponent models [11]. These path loss exponent models based distance estimation for wireless sensor networks given, which can be used to for WLAN also. The secondary antenna calculates its distance periodically as it receives the broadcasts. So, when a MN moves, the distance from some AP constantly reduces, thereby giving a clue that it is going to enter the vicinity of that AP. The MN creates a set N of probable APs depending on the reduction in the distances. Whenever, the MN's RSSI goes below the threshold for handoff, it selects an AP from N whose rate of change of distance is the Maximum from the ones available in N. The general steps involved in the pre-handoff process are given in the form of an algorithm below.

Step 1: Initialize N = Φ where N contains the set of probable AP_s.

Step 2: If RSSI < PTH then

a. Calculate Distance estimate vector 'D_i' of each 'AP_i' among the periodic receiving signals.
b. If 'D_i' progressively decreases add 'AP_i' to N if 'AP_i' is not present in N.
c. Repeat steps a and b until RSSI > Handoff Threshold.

Step 3: Select 'AP_i' with MAX 'r_i' where 'r_i' represents the rate of change of distance of 'AP_i'.

Where

N - Set of probable APs.
D - Distance estimate vector of each 'APi' among the periodic receiving signals.
r_i - Rate of change in distance of 'APi'

6. IMPLEMENTATION AND RESULTS

We have simulated our approach in a simulator called NCTUns 4.0. It is a new graphical based simulator designed by S. Y. Wang from National Chiao Tung University, Taiwan. As far as NCTUns is considered, it is one of the best which supports Handoffs. NCTUns is a software tool that integrates user-level processes, operating system kernel, and the user-level simulation engine into a cooperative network simulation system [12]. It is an open-system network simulator and emulator.
The simulation results are shown in the below figures. As we can see from the results, out approach clearly shows that there is around 50% improvement over the Normal Handoff approach in terms of delay. If we observe from the graph of Figures 3 and Figure 4 both approaches takes handoff at the same time. But our approach recovers from handoff in half the time as when compared to Nrmal approach. At the same time, we also can observe that as and when our approach has recovered from a handoff, it has the full utilization of channel and the throughput increases drastically, and the increased throughput is continued till the other node recovers from its handoff. By monitoring the Broadcast packets we also can see that Normal Strategy requires more number of Broadcast packets when compared with Pre-Handoff approach. It's clearly evident that our approach requires a single broadcast packet for a Handoff, as it already receives the information from the other Antenna.

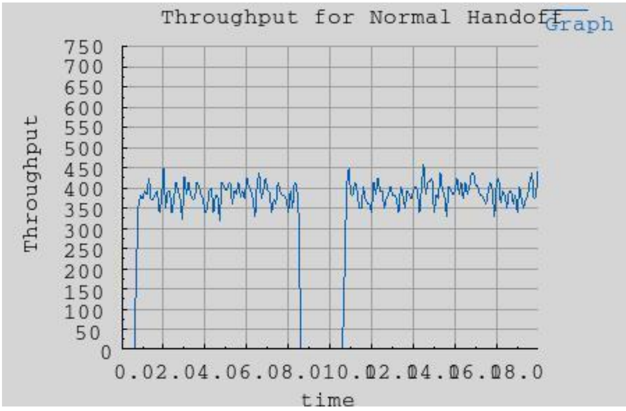

Figure 3. Throughput of the Mobile Node during a Normal Handoff Process

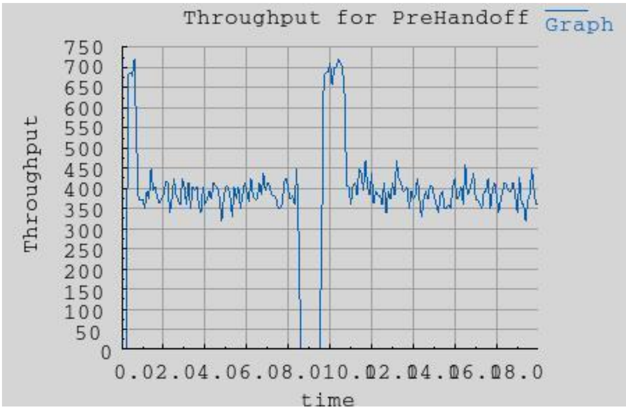

Figure 4. Throughput of the Mobile Node during a Pre Handoff Process

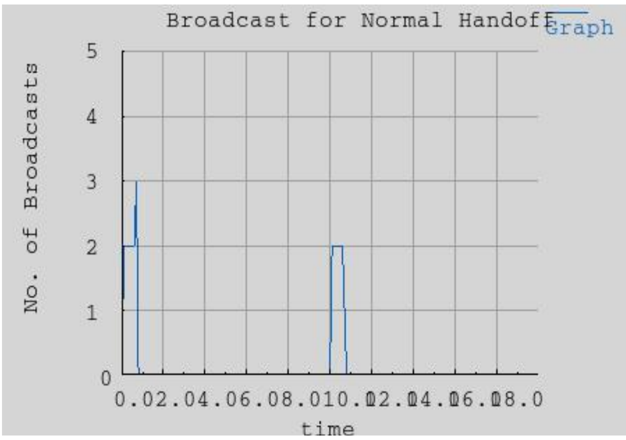

Figure 5. Number of Broadcast Packets during a Normal Handoff Process

By monitoring the Broadcast packets in Figure 5 and Figure 6, we also see that Normal Strategy requires more number of Broadcast packets when compared with Pre-Handoff approach. It's clearly evident that our approach requires a single broadcast packet for a Handoff, as it already receives the information from the other Antenna.

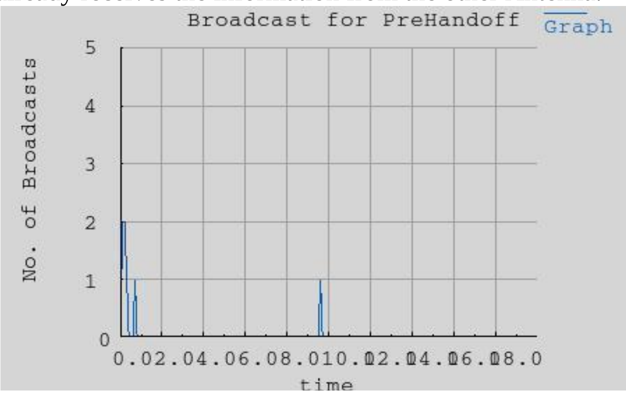

Figure 6. Number of Broadcast Packets during a Pre-Handoff Process

7. CONCLUSIONS AND FUTURE WORK

The main challenge of this 802.11 network is reducing the latency while maintaining handoff issue. This proposal describes a location based handoff approach which predicts the next probable AP from among the adjacent AP's based on the direction of the MNs movement. This can work using the existing infrastructure with a very little change in it. Because of the use of two antennas on the MN, we can achieve a seamless handoff capability. At the same time the secondary antenna also can be used for any other purposed like routing, debugging etc besides scanning for channels. This proposal can be modified to incorporate handoffs in heterogeneous networks.

AUTHORS BIOGRAPHY

Sushama rani Dutta pursueing her M. Tech. degree from Maharishi Markandeshwar University Mullana, Ambala, Haryana (India). Her research interests are in Mobile Computing, Network security, Wireless Sensor Networks, etc.

Rohit Vaid received his M. Tech. degree from Maharishi Markandeshwar University Mullana, Ambala, Haryana (India) respectively. He has number of publications in International journals/Conferences to his credit. He is currently supervising 8 M. Tech students. His research interests are in Mobile & Distributed Computing, Mobile Agent Security and Fault Tolerance, Cluster Computing, Wireless Sensor Networks, etc.

REFERENCES

[1] Chun-Ting Chou and Kang G. Shin, "An Enhanced Inter-Access Point Protocol for Uniform Intra and Intersubnet Handoffs", IEEE Proceedings 2005.

[2] Andrea G. Forte, Sangho Shin, Henning Schulzrinne, "Improving Layer 3 Handoff Delay in IEEE 802.11 Wireless Networks", WICON' 06, The 2nd International Wireless Internet Conference ACM August 2009

[3] Arunesh Mishra, Minho shin, William Arbaugh, "An Empirical Analysis of the IEEE 802.11MAC Layer Handoff Process", UMAICS Tech Report Number UMIACSTR-2002-75.

[4] M.S. Bargh, R.J. Hulsebosch, E.H. Eertink, A. Prasad, H.Wang, P. Schoo, "Fast Authentication Methods for Handovers between 802.11 WLAN", WMASH'04 October 1, 2010

[5] Ishwar Ramani, Stefan Savage, "Syncscan: Practical Fast Handoff for 802.11 Infrastructure Networks" IEEE Proceedings, 2005, Pages: 675-684.

[6] Ling-Jyh Chen, Tony Sun, Mario Gerla, "USHA: A Practical Vertical Handoff Solution", IEEE Proceedings 2005, Pages: 83-87.

[7] Ping-Jung Huang and Yu-Chee Tseng, "A Fast Handoff Mechanism for IEEE 802.11 and IAPP Networks", www.cs.nctu.edu.tw/ yctseng/papers.pub/mobile73-fast-handoff-vtc2006-spring.pdf.

[8] Chien-Chao Tseng, Kuang-Hui Chi, Ming-Deng Hsieh, Hung-Hsing Chang, "Location-based Fast Handoff for 802.11 Networks", IEEE Communication Letters, Vol. 9, No. 4, April 2005 Pages: 304-306.

[9] Guoqiang Mao, Brian D. O. Anderson, Baris Fidan, "Path loss exponent estimation for wireless sensor network localization", ACM Computer Networks: The International Journal of Computer and Telecommunications Networking, Vol. 51 Issue. 10 July 2007, Pages: 2467-2483.

[10] Chih-Yu Wen, Robin D. Morris, William A. Sethares, "Distance Estimation Using Bidirectional Communications WithoutSynchronous Clocking", IEEE Transactions on Signal Processing, Vol. 55, No. 5, May 2007 Pages: 1927-1939.

[11] Kishore Ramachandran, Sampath Rangarajan and John C. Lin, "Make-Before-Break MAC Layer Handoff in 802.11 Wireless Networks" IEEE ICC Proceedings 2006, Pages: 4818-4823.

[12] Yong Liao, Lixin Gao, "Practical Schemes for Smooth MAC Layer Handoff in 802.11Wireless Networks", Proceeding of the 2006 International Symposium on a world of Wireless, Mobile and Multimedia Networks (WoWMoM'06).

