ISSN 2229-5518

Improving the IEEE 802.11 WLAN Handoff process to support multimedia traffic

Nidhi Sanghavi, Rajesh S.Bansode

Abstract— The multimedia services such as Voice over IP(VoIP), video conferencing, live telecast, video streaming can be provided to clients or users in IEEE 802.11 WLAN. Mobility management is an important problem of IEEE 802.11 WLAN. For deployment of fast real-time services, it needs stringent Quality of Services(QoS) requirements such as for bandwidth, throughput, delay, jitter and packet loss rate. . The provisions for improving the IEEE 802.11 handoff latency, there are area of improvements in the following three parameters transmission delay, delay variation and packet loss ratio. This proposed protocol improves the overall handoff interruption time as compared to MISH protocol and legacy handoff protocol along with delay of 77.67ms abiding the stringent requirements for seamless running multimedia services of less than 150ms delay for IEEE 802.11 WLAN users.

Index Terms— Delay, fast handoff, IEEE 802.11, interrupt, MAC, NS2, WLAN

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1 Introduction

THe wireless local area networks (WLAN) are supported by IEEE 802.11 standards for wireless local area networks. The 802.11 family consists of a series of half-duplex over-the-air modulation techniques that use the same basic protocol. 802.11- 1997 was the first wireless networking standard in the family, but 802.11b was the first widely accepted one, followed by 802.11a, 802.11g, 802.11n and 802.11ac. IEEE 802.11 defines the basic service set (BSS) as the building block of a wireless LAN. A basic service consists of stationary or mobile wireless stations and an optional central base station, called as the access point (AP). An extended service set (ESS) consists of two or more BSSs with APs. Here, the BSSs are connected through a distribution system, which is mostly a wired LAN. The distribution system connects the APs in the BSSs.

IEEE 802.11 defines two MAC sub-layers: the distributed coordination function (DCF) and point coordination function (PCF). The MAC sub layer is responsible for the channel allocation procedures, protocol data unit (PDU) addressing, frame formatting, error checking, and fragmentation and reassembly

In our existing 802.11 IEEE handoff procedure, the scanning phase can exceeds duration of 200ms and packet loss can exceed 10%. Thus, for IEEE 802.11 WLAN to provide user mobility and support provisioning Quality of services (QoS) for multimedia applications is crucial.

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This letter is organized as follows: in Section II, we overview he related work done. In Section III, we brief the methodology used. In Section IV, we discuss simulation set-up and results. Finally, in Section V, we conclude this letter.

2 Related Work

2.1 How Well Can the IEEE 802.11 Wireless LAN Support Quality of Service?

This paper [1], analyzes the network's performance such as maximum protocol capacity or throughput, delay and packet loss rate. The authors H.Zhai, X.Chen and Y.Fang described that the channel busyness ratio provides precise network status, which can be utilized to facilitate QoS provisioning

2.2 An Empirical Analysis of the IEEE 802.11 MAC Layer Handoff Process

In this paper [2], authors M.Shin, A.Mishra and W.A.Arbaugh present an empirical study of handoff process at the link layer. This paper describes the three basic functions of handoff process (Probe, Authentication and Re-association), where probe latency contributes to 90 % of overall handoff latency. Also, it shows large variation in latency from one handoff to another between different stations and APs of different vendors.

2.3 Improving the IEEE 802.11 MAC Layer Handoff Latency to Support Multimedia Traffic

This paper [3] by Y.Pawar, V.Apte proposes a mechanism for MAC viz layer-2 fast handoff with help of Background scanning, Restricted channel list and pre- authentication that does not need code modification at APs. This paper defines the use of MadWifi open source Linux drivers. This mechanism shows latency of less than 10msecs with negligible packet loss and

ISSN 2229-5518

thus makes mobile multimedia applications possible.

2.4 Improving the latency of 802.11 Handoffs using Neighbor Graphs

Here, the authors M.Shin, A.Mishra and W.A.Arbaugh of this paper [4] describe an effective Discovery method using neighbor graphs and non-overlap graphs. This method decreases the total number of probed channels and thus reduces overall probe time efficiently and also number of non-overlapping channels is increased.

2.5 Using Smart Triggers for Improved User Performance in 802.11 Wireless Networks

In this paper [5], authors V.Mhatre and K.Papagainnki propose an approach to handoff that is based on continuous monitoring of wireless links of all APs. A client measures the signal strength of received beacon of all the APs operating on the current, and the overlapping channels. Depending on the long term and short term trends in these signals, handoff decision is taken. The authors propose a range of handoff algorithms and claim to reduce more than 50% average handoff delays.

2.6 The Design of an AP-Based Handoff Scheme for IEEE 802.11 WLANs

This paper [6] by Y.Chan and D.Lin defines a novel seamless handoff scheme for IEEE 802.11 networks by equipping Access Points (APs) with multiple Wireless Network Interface Cards (WNICs), one of which is set to operate for normal transmission and the others listen or receive Station (STA) packets for signal measurements. The handoff decision is placed in the AP and transmit management frames are sent between APs using Inter Access Point Protocol (IAPP).

2.7 Fast Scanning schemes for IEEE 802.11 WLANs in virtual AP environment

In this paper [7], the authors S.Jin, M.Choi, S.Choi and L.Wang define a scanning scheme composed of two phases : 1.Channel selection phase 2. AP search phase in order to accelerate AP-finding process. In this paper, two algorithms are developed to improve scanning latency i:e near best-fit and first-fit algorithm. Near best-fit algorithm helps the scanning station to find AP providing the highest data rate among neighboring APs. First-fit algorithm enables scanning station stop its scanning when it discovers an AP that satisfies its requirements

2.8 SynScan : Practical Fast Handoff for 802.11 Infrastructure Networks

In [8], authors I.Ramani and S.Savage have proposed a solution called SyncScan. Clients can passively scan the channel by switching the channels. Some kind of beacon broadcast arrangement is done for time syn- chronization. After this beacon some delta time APs doesn't send any data to clients which avoids loss of data frames which are destined to client. By periodic switching to each channel all nearby access points can be found out and thus eliminating the need of discovery of APs at the time of handoff.

2.12 Techniques to reduce the IEEE 802.11b Handoff time

This paper [9], by H.Velayos and G.Karlsoon divides the handoff process into three parts : detection, search and excecution. This papers shows that link-layer detection time can be reduced to three consecutive lost frames. Also, search time can be reduced atleast 20% using active scanning with two timers that controls its duration set to 1ms and 24.10ms.

3 METHODOLOGY

The Figure 3.1 below describes the fast handoff solution protocol. The proposed Fast handoff solution is described in detail with algorithm. The proposed system is based on handoff process occurring in IEEE 802.11 WLAN. Here, The methodology is explained with help of one Mobile Node(STA) and three Access Points(APs) APx, APy and APz working in three distinct channels in WLAN bandwidth. The following sequence diagram figure 3.1 explains the exact communication proceeding connecting a mobile node and an access point when handoff occurs in the network.

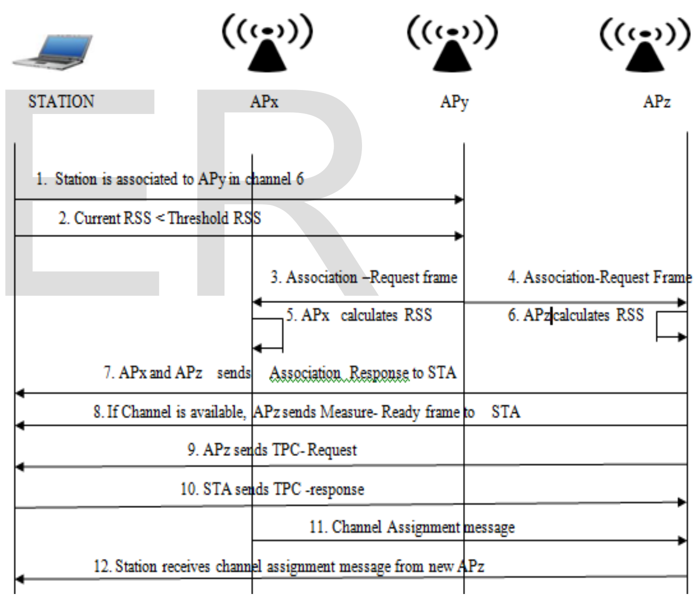

Figure 3.1 fast handoff solution protocol

ALGORITHM :

Step 1 : Station is associated to APy in Channel 6

Step 2 : The current RSS of Station's packets < Threshold RSS (thus need for handoff)

Step 3 & 4 : Station sends association requests to neighbouring APs

Association –request frame 1. Station's Position 2. MAC address of Station

Step 5 & 6 : Neighbouring APS calculate RSS

RSS calculation depends on transmitted power and distance between Station and respective AP

Step 7 : Neighboring APs sends back Association-Response

If Channel is available ,
AP Adds Node ID, channel ID, RSS, distance to channel list

If Channel is not Available,
Station sends Association-Request Frame to AP in other Channel

Step 8 : AP with Highest threshold (here APz) sends Measure-Request Frame to the station

Measure – Ready Frame
1.Node ID
2.Channel ID
3.RSS

Step 9: APz then sends TPC-Request to the Station

TPC-Request Frame
1.Channel List (header of packet)
2.MAC address of the station

Step 10 : Station sends TPC- Response to APz

Step 11: Old AP(APy) sends a STA-Assign Frame to new chosen AP(APx)

STA-Assign Frame
1 .MAC address of station
2. Messages- Station' previous authentication and association messages

When an AP receives STA-Assign Frame, it checks the received packet details:

1. Received power
2. Node is a mobile node
3. RSS value
4. Packet contains data

Step 12 : Finally, Old AP(APy) sends a Channel Assignment-frame to the station

Channel-Assignment -frame
CSA (Channel Switch announcement) here, CSA= 1 (because station has to switch association from channel 6 to channel 1).
To Notify the Station about following changes to be done;
1) Destination MAC address
2) To receive beacon frames from new AP now
3) Change old Association ID to new ID(new ID is present in STA-assign Response Frame)

4 Results and Discussions

The Fast handoff solution protocol in previous section is tested with four performance parameters mainly delay, jitter, packet delivery ratio, and energy spent and compared with MISH protocol and legacy handoff protocol. The stringent quality requirements for IEEE WLAN to support multimedia services given to users is compared to final result of proposed Fast handoff solution protocol through the NS- 2 and it indicates the following results as mentioned.

Table 4.1 : Simulation Parameter Table

Parameter	Value
Simulator	NS-2
Simulation area	1000*1000m
MAC Protocol	Modified 802.11(802_11_STA)
Packet size	512 bytes
Simulation Time	200 secs
No Of nodes	50
Traffic Sources	Udp (CBR)
Interval (Pause between movements)	0.05
Radio range	250m
MaxChannelTime	40ms
MinChannelTime	20ms

The figure 4.1 displays the 50 nodes which are used for simulation. There are 10 Mobile nodes(MN) and 40 Access Points(AP). The green circles depict the mobile nodes whereas yellow circles depict the access points. The figure 4.2 displays the broadcasting area or range of each access point and the association of each mobile node with the nearest access point

ISSN 2229-5518

in accordance to the distance.

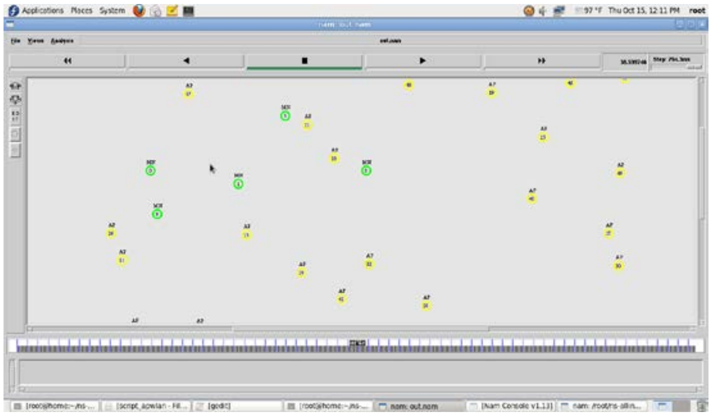

Figure 4.1 : Wireless mobile nodes

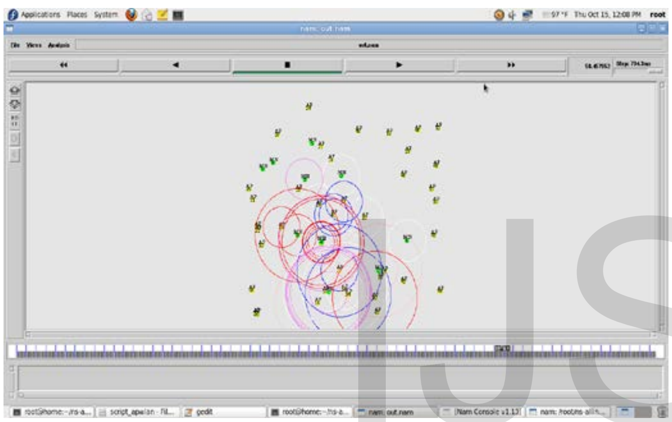

Figure 4.2 : The mobile nodes associates to respective access points

Table 4.2 : Result summary Fast handoff solution protocol

Parameter	Value
No of packets send	3700
No of packets received	3688
PDR(Packet Delivery ratio)	99.67
Delay	77.67 ms
Throughput	591840 bytes/sec
Jitter	0.50 ms
No of Packets dropped	12
Packet dropping ratio	0.324
Energy consumed	0.813 mjoules/sec

The table 4.2 summarises the performance parameters for the ast handoff solution measuring the no of packets sent and received, packet delivery ratio, delay, jitter, throughput, no of packets dropped, packet dropping ratio and the energy spent for 50 nodes in wireless networks.

The following graph results, figure 4.3, the handoff interruption time is compared for the Fast handoff solution, MISH protocol, and handoff legacy protocol. Thus, it is observed that Fast handoff solution has handoff delay of 77.67ms, whereas MISH protocol interruption time is 200ms and legacy handoff protocol is more than 300ms. [1], [3]

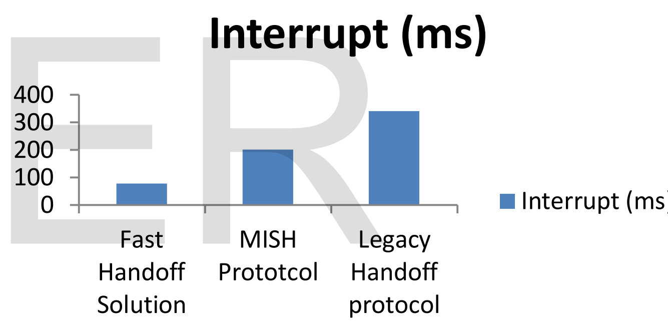

Figure 4.2 : The mobile nodes associates to respective access points

The proposed methodology achieves reduced overall handoff latency by implementing handoff delay duration less than 150ms which is the need for seamless service in IEEE 802.11 WLAN [1]

5 Conclusion

IEEE 802.11 WLAN provides multimedia services like live telecast, video streaming, video conferencing, Voice over IP (VoIP) to its users. For deployment of these fast real time services, it needs stringent Quality of service (QoS) requirement such as delay, jitter, packet loss. The mobility service for users come with cost of handoff process required when mobile stations get connected from 1 Access point(AP) to another for continuous service. The proposed methodology achieves reduced overall handoff latency by implementing handoff delay duration less than 150ms which is the need for seamless service in IEEE 802.11 WLAN

ISSN 2229-5518

The mobility management is an important factor IEEE 802.11 provides to the users. For seamless services like video conferencing, VoIP, there is stringent requirement of less than 150ms handoff delay. The legacy handoff protocol provides handoff delay for more than 300ms. Thus there is a need for Seamless handoff protocol that would provide continuous services without interruption to clients in IEEE 802.11 WLAN. Thus the Fast handoff solution protocol have been successful in meeting this Qos requirements since handoff delay is 77.67 ms

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