IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 8, Issue 3, March 2019

Low-Cost Collaborative Mobile Charging For Large-Scale Wireless Sensor Networks

Surya Kumar S1, Surya B[2], Praveen Kumar D[3], Regin R[4]

Adhiyamaan College of Engineering, Hosur, Tamil Nadu[1,2,3,4]

Abstract: Wireless communication plays a significant role in our life as it provides mobility and flexibility as well as scalability. Handoff delays make a serious problem. A lot of research has been done in last few years to reduce the handoff delays occur in the different levels of wireless communication. Due to the mobility of devices handoff is an important aspect in WLAN and cellular communications and in WLAN this aspect is much more important due to limited range of APs, WLAN also provides sufficient bandwidth for real time streaming services. In the literature a number of handoff schemes have been proposed to reduce the handoff latency and support fast handoff in IEEE 802.11 wireless networks. In this article, we review these fast handoff schemes and analyze their advantages and disadvantages qualitatively. Our aim is to make available groundwork for future research on reducing the handoff latency for Intelligent Transport Systems (ITS) in vehicular scenarios and give emphasis on requirement of fast handover for seamless connectivity. i comprise here various techniques to reduce handoff delays.

Keywords: Intelligent Transport Systems (ITS), Wireless Local Area Networks (WLANs), Internet Protocol (IP), Inter Access Point Protocol (IAPP)

I. INTRODUCTION

The deployment of the Wireless Local Area Networks (WLANs) is much easier and easy to maintain compared to the wired networks hence it is becoming essential component of the networks. WLAN is a local area network that uses high frequency radio signals to transmit and receive information over a distance. In physical and link layers many protocols can be adopted to build a wireless network to make available wireless connection for example IEEE 802.1, Bluetooth, WiMax, etc. To support various important applications such as VoIP, video conferencing live telecast, video streaming etc 802.11 wireless networks have enough bandwidth and supports 2Mbps practical data rates. For VoIP 90 Kbps is sufficient bandwidth. VoIP stands for voice over Internet Protocol (IP) and it is the methodology for delivery of voice communications and multimedia sessions over IP network such as Internet. Mobility needs to be supported to provide seamless connections and uninterrupted services to the users if they are moving around. Supporting user mobility in WLAN remains a challenging task. Mobile wireless stations (STA) require frequently handoff between different cells due to limited range of the Access Points (APs).

When the ongoing connection between mobile node and corresponding node from one point of attachment is transferred to another neighbouring point of attachment due to poor signal quality, is called handoff. These points of attachment are called Access Points (APs) in 802.11 WLAN and APs range is limited. In WLAN, handoff is the mechanism of transferring the ongoing connection from one AP to another AP. In the process of handoff mainly three entities are participating namely station, prior-AP, and posterior-AP. Prior-AP is the AP to which the STA had the connectivity prior to the handoff whereas the AP to which the STA gets connectivity after the handoff process is posterior-AP. The state information consists of the client credentials and some accounting information is transferred. Inter Access Point Protocol (IAPP) or a proprietary protocol is used to transfer the state information. There are two basic types of handoff are defined namely Hard and Soft handoff. When the STA must break from the ongoing connection with prior-AP before joining the posterior-AP (break before-make), it is called hard handoff. In IEEE 802.11 and cellular systems hard handoff is employed using Time Division Multiple Access (TDMA) and Frequency Division Multiple Access (FDMA). If the old connection is maintained until the new connection is established (make-before-break), it is known as soft handoff.

Soft handoff is adopted by CDMA. According to the transition in different wireless networks handoff can be classified into two parts: Horizontal handoff and Vertical handoff. Horizontal handoff is the intra-system handoff like transferring the ongoing connection from one AP to another in different BSS in WLAN whereas in vertical handoff ongoing connection is transferred between different wireless networks or systems (inter-system) such as WLAN to cellular or WLAN to GPRS systems etc. The roaming STA can access the wireless network through various APs and it is recognized at Medium Access Control (MAC) layer (L2) and network layer (L3).

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 8, Issue 3, March 2019

II. LITERATURE REVIEW

"A Seamless Handoff with Multiple Radios in IEEE 802.11 WLANs, Sunggeun Jin, Sunghyun Choi, et al (2013)",
It is obvious that seamless handoff should be pursued for better services. For this reason, we design a novel and feasible 802.11 handoff scheme for the 802.11 WLANs. In the proposed handoff scheme, the 802.11 Access Points (APs) have multiple radios. One of the multiple radios is exclusively reserved for scanning purpose. It certainly helps the 802.11 mobile Stations (STAs) easily search neighbouring APs. Moreover, the reserved exclusive channel is available for data frame exchanges. Consequently, STAs can be serviced with minimized data frame losses while they are performing the proposed handoff.

Propose a novel scanning scheme for the 802.11 handoff, and then implement the proposed scanning scheme with mad wifi. The experimental results show that the proposed scanning scheme greatly reduces data frame losses while the scanning time maintains unchanged. We estimate the number of packet losses depending on the handoff schemes by numerically analyzing the performance of the handoff schemes. "Improving the IEEE 802.11 MAC Layer Handoff Latency to Support Multimedia Traffic, Yogesh Ashok Powar and Varsha Apte, et al, (2010)",

Multimedia applications can be offered to mobile users on the IEEE 802.11 WLAN, if their bandwidth, delay and jitter requirements are met, even in the presence of handoffs. Applications such as VoIP require a delay of less than 150 msecs and packet loss less than 3%. Studies have shown that the latencies achieved by existing handoff implementations can exceed 200 ms and packet loss can exceed 10%. Thus, there is a need for fast handoff solutions, that can meet multimedia traffic requirements. Propose a mechanism for layer-2 fast handoff with the help of background scanning, restricted channel set and pre-authentication which does not require any code modification at the access points.

"Eliminating handoff latencies in 802.11 WLANs using Multiple Radios: Applications, Vladimir Brik, Arunesh Mishra, Suman Banerjee, et all, (2009"), Deployment of Voice-over IP (VoIP) and other real-time streaming applications has been somewhat limited in wireless LANs today, partially because of the high handoff latencies experienced by mobile users. Our goal in this work is to eliminate handoff latency by exploiting the potential of multiple radios in WLAN devices. Our proposed approach, called Multi-Scan, is implemented entirely on the client-side, and, unlike prior work, Multi-Scan requires neither changing the Access Points (APs), nor having knowledge of wireless network topology.

Multi-Scan nodes rely on using their (potentially idle) second wireless interface to opportunistically scan and pre-associate with alternate APs and eventually seamlessly handoff ongoing connections. In this paper we describe our implementation of Multi-Scan, present detailed evaluations of its effect on handoff latency and evaluate performance gains for Multi-Scan-enhanced wireless clients running Skype, a popular commercial VoIP application. It is not surprising that network nodes with multiple network interfaces can experience better performance than nodes with a single network interface. Many hard-to overcome limitations of 802.11 wireless networking (such as short communication range, vulnerability to environmental noise, A handoff occurs when a station (STA) moves beyond the radio range of its access point (AP), and enters another BSS. Management frame exchange takes place between the STA and the AP during the handoff procedure. Consequently, the handoff process incurs some latency, during which the STA is unable to send or receive traffic.

III. EXISTING SYSTEM

In the 802.11 standard, a handoff procedure consists of scanning, authentication, and re-association. For the scanning, passive scanning and active scanning are defined. An ST adopting the passive scanning should receive APs' beacon frames, which are transmitted every beacon interval. Typically, a beacon interval is 100 ms. On the contrary, an STA with the active scanning should broadcast probe request frame(s) in a channel and then wait for probe response frames, with which nearby APs receiving the probe request(s) reply.

3.1 Architecture

The test bed is a typical desktop computer equipped with two wireless adapters, i.e., CISCO's aironet 802.11a/b/g wireless adapters2 in which Atheros AR5520 chipset is embedded. Each test bed has two PCI-to- PCMCIA interface cards converting the electrical signals of a wireless adapter supporting the PCMCIA interface into the electrical signals for the PCI interface. For an STA, we utilize Combine two wireless adapters into a single AP MAC entity having multiple radios by modifying a madwifi device driver. Prior to further explanation, we present an overview of madwifi v0.9.4, which we adopt for our implementation Madwifi is an open-source project that supports Atheros chipsets in Linux Operating System. It provides well-organized software architecture for the logical 802.11 MAC entity working as an STA or an AP.

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 8, Issue 3, March 2019

We first set the MAC addresses of multiple adapters to a single one by using the script as follows:

1) ip link set dev wifi1 down;
2) macchanger−−mac 00 : 40 : 96 : B5 : 52 : 30 wifi1;
3) ip link set dev wifi1 up.

From this script, we change the MAC address of the wireless adapter controlled by radio object *wifi1*. Make a logical software switch connecting a single AP MAC entity and one of two radio objects for each associated STA. When a radio object receives an 802.11 frame from an associated STA, the logical software switch is switched to the radio object that has received the 802.11 frame. According to the proposed scanning procedure, prior to switching to a different channel for scanning, an STA should transmit a null frame to enter PSM.

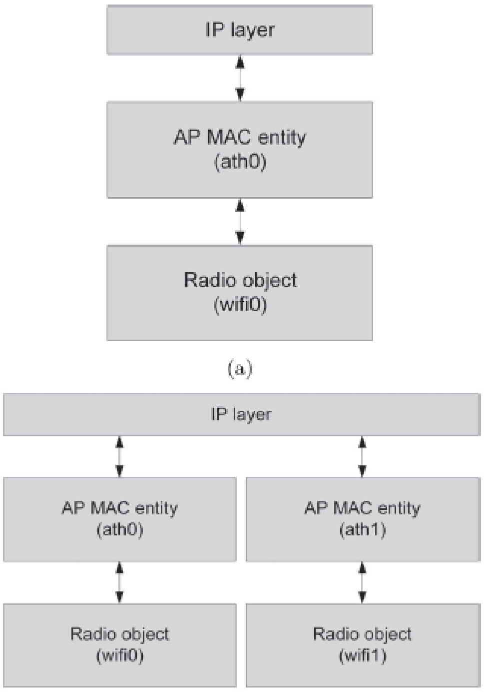

Figure 1 Architecture flow chart

Therefore, it is guaranteed that the AP successfully sends 802.11 frames to the associated STA via the connected radio object when the AP has 802.11 frames destined for the STA. Whenever the AP MAC entity makes an association with a new STA, it generates a new logical switch for the newly associated STA. Therefore, this architecture is valid in general cases when the AP MAC entity manages multiple STAs iterating over two channels for scanning.

3.2 Observations on Packet Losses

I performance is configured to generate UDP packets every 10 ms in an uplink or downlink direction, respectively. I observe uplink and downlink packets separately. In all the figures here, the *y*-axis represents the time intervals between two consecutive packets. The *x*-axis indicates the packet sequence number that insert in the payload of UDP packets. Downlink UDP packets when the MWNIC scanning is employed. The host continuously sends UDP packets to the laptop computer. We can observe the latency marked with There is two reasons for this. First, a single packet is lost during channel switching operation. Second, the new AP accepting the scanning STA defers packet transmission until successful STA's channel switching.

IV. PROPOSED SYSTEM

4.1 Handoff Process

The Handoff is the process of transferring the ongoing session between mobile STA and corresponding node from one point of attachment to another point of attachment or the same. Due to the mobility of devices, the handoff is an essential aspect in WLAN and cellular networks. Scanning also called probing is the first phase of handoff process and it is the process of selecting a suitable AP from neighbouring APs to handoff. Detection phase is considered the first phase of handoff in some works. Need for the handoff is determined by the detection phase as shown in the fig-2.

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 8, Issue 3, March 2019

RTS/CTS mechanism is used after failed frames to overcome probable radio fading or collisions in a burdened cell. The station conform the out of range status after various unanswered requests and starts the search phase. Suggested another approach in which STA starts search phase directly by excluding the reason for failure of collisions because above detection procedure is long as shown in and if the selected AP by search phase is current one then handoff will not be executed. Handoff process allows a user to move around without interrupting the ongoing connection between STA and corresponding node. It changes the current channel in the current cell to a new channel in the different cell or in the same. The time interval in the complete handoff process is known as handoff latency.

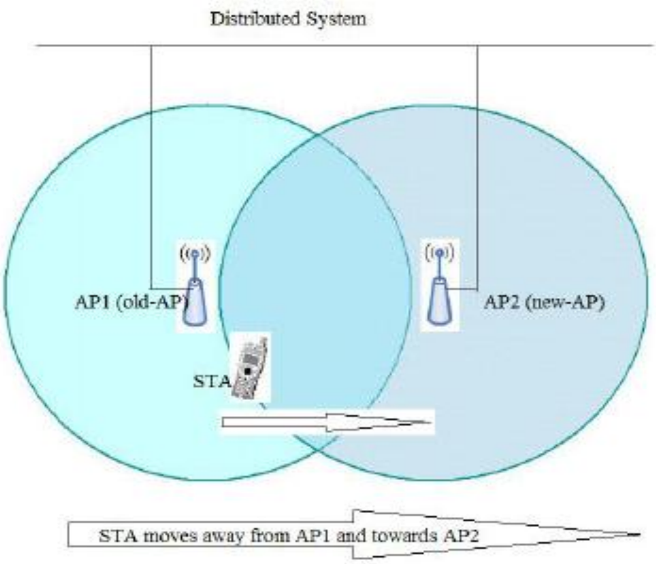

Figure 2 hand off process

Handoff affects the quality of service directly. Handoff occurs if the signal quality falls below a predefined threshold level. The Quality-of service (QoS) and capacity of the network may be affected due to handoff. There are some requirements to reduce the adverse effect of handoff such as handoff latency must be as low as possible, the total number of handoff should be minimal.

4.1.1 Handoff Procedure in WLAN

In WLAN handoff is the mechanism of transferring the ongoing connection from one AP to another due to poor signal quality. Handoff is the process of disassociating from the prior-AP and establishing a connection with the posterior-AP. The necessity of handoff is detected if the received signal strength (RSS) from current AP falls below the certain threshold level. The L2 handoff of WLAN is hard-handoff and divided into three phases: scanning, authentication, and re-association. The complete handoff process can be classified into two different logical steps, (1) Discovery (scanning), (2) Re-authentication. An authentication and re-association to the posterior AP are collectively called Re-authentication. The handoff latency or delay is the sum of delay incurred by search and re-authentication phase. The overall handoff delay is the sum of the delays incurred by m individual phases given by following equation:

$$Handover\ Delay = \sum_{i=1}^{m} Delay_i$$

Scanning phase is the most time consuming phase in the entire handoff process which is more than 90% of the overall handoff delay and the primary cause of MAC layer handoff latency is probing of available channels. Scanning can be defined into two types: active and passive. In passive scanning each channel is listened by STA for the beacon frames for a fixed amount of time (usually 100msec). In most WLAN deployments generally passive scanning is used and it is power efficient. In active scanning, the STA broadcast the ”Probe Request” to all IEEE 802.11 channels and wait for response called ”Probe Response” from probed. In active scanning, the STA sets a timer to MinChannelTime and waits for response if the channel is during MinChannelTime then there is neither the response nor the any traffic in the channel.

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 8, Issue 3, March 2019

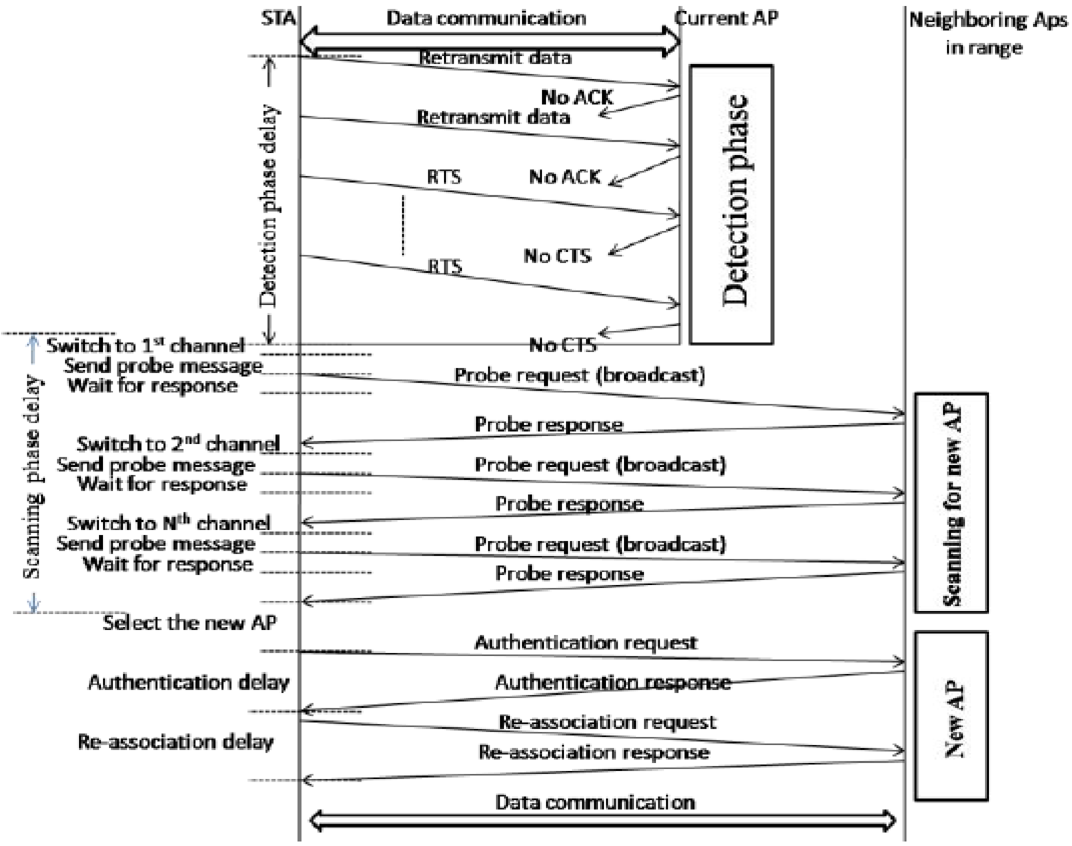

Figure 3 possible Handoff scenarios in The IEEE 802.11 WLAN

In the complete handoff process the sequence of messages typically observed is Complete handoff latency can be divided into three delays:

1. Scanning or Probe Delay: It is time taken by the STA to scan all the IEEE 802.11 channels; it is the composition of mainly three times namely switch to channels, send probe request and wait for response for all channels. During the probe process the actual number of messages may vary from 3 to 11.
2. Authentication Delay: Authentication service may be used by all STAs to establish their identity to STAs with which they communicate, in both ESS and IBSS networks. Only after the successful authentication establishment re-association can be established. Time interval during the exchange of authentication frames is authentication delay.
3. Re-association Delay: Re-association is the service that enables an established association (between STA and AP) to be transferred from one AP to another or the same AP. Time interval during the exchange of re-authentication frames is re-authentication delay. Handoff process is completed after the re-association response in the answer of re-association request from the new AP.

4.2 TECHNIQUES TO REDUCE HANDOFF LATENCY

4.2.1 Distributed Handoff Mechanism

To reduce the handoff latency in IEEE 802.11 based WN, an efficient MAC layer handoff protocol is presented. In example of Distributed Handoff scheme, to scan all the available channels, a mobile node selects several neighbouring nodes before it starts initiating the MAC layer Handoff process. All channels are grouped and these groups are scanned by selected neighbouring nodes separately. In each node the number of scanning channels is reduced and minimized the scanning latency.

To define the largest distance from the STA to its neighbour nodes RSSG is used. This scheme consist three main components, group construction, distributed scan mechanism and cache scheme. When the RSS is lower than RSSH, grouping process is triggered in group construction. STA inspects neighbour nodes in range r as the assistant nodes; so, nodes N0, N1, N2, N3, and N4 are selected in the given example as shown in given fig-3 [27]. AP information based on the result of distributed scan mechanism can be stored in the cache structure, since it is also possible for assistant nodes to re-associate with the same AP after a short time interval due to closeness of the assistant nodes to the STA. The assistant nodes will save the new AP in its caching structure with a lease time *Tlease* in the response of the broadcasted message with the new AP from STA to all assistant nodes. .

 DOI 10.17148/IJARCCE.2019.8303

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940
International Journal of Advanced Research in Computer and Communication Engineering

Vol. 8, Issue 3, March 2019

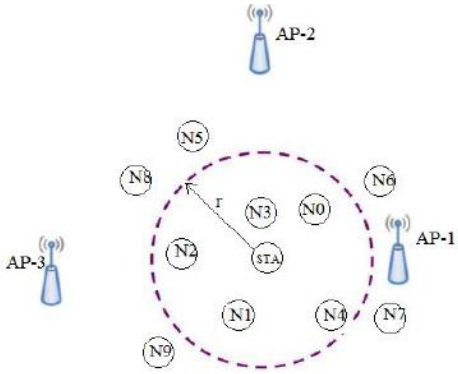

Figure 4 Distributed Handoff Mechanisms

Only the latest AP is saved in the cache, and the old AP is usually overwritten. When the assistant node wants to initiate handoff, in the first it will try to re-authenticate with the AP stored in the cache during the T-lease time. Scanning time is saved if the AP accepts the assistant node and directly can re-associate with the AP. If the T-lease time is expired then the assistant node should start a complete distributed handoff mechanism. Channels are grouped and assigned to the closest neighbour nodes to scan instead of scanning of all channels by STA only and each node scan only a few channels.

4.2.2 Pre-active Scanning Scheme

Scanning phase is the most time consuming phase, it has more than 90% of the overall handoff total delay. By using the Pre-active Scanning scheme which works during normal connectivity, we can reduce the handoff delay time in detection and search phase. In Pre-active scan STA start execution phase directly without delay in the detection and search phase, it has advantage of traffic load sharing and STA take decision to start handover to new AP which is providing higher quality than the previous AP. Traffic load is increased in this scheme due to reserve time to broadcast “Probe Request” frame and wait for “Probe Response” frame from (to) neighbour APs in range. Throughput is decreased and traffic load is increased in the Pre-active scan scheme.

4.2.3 Distance Measurement Technique

The Hexagonal cell concept is used to accelerate the handoff process. The position of mobile node is obtained by using GPS or some other localization technique in terms of coordinates (r, θ). It is well known fact that power of radio frequency signal is inversely proportional to the square of distance. The mobile node can update the values of (r, θ) in regular intervals and maintain a cache. Now, the instantaneous distance Ri between mobile node and APs is calculated by using

$$R_i = \sqrt{r^2 + D^2 - 2rD\cos\left((2i-1)\frac{\pi}{6} - \theta\right)}$$

Where, $D = \sqrt{3}R$

When the distance between mobile node and current AP is greater than a fixed threshold level then the handoff process is initiated and the AP which is nearest is selected for association by mobile node. There is no need of handoff when the mobile node is in the in-circle of the cell while the circum-circle defines the range of individual AP.

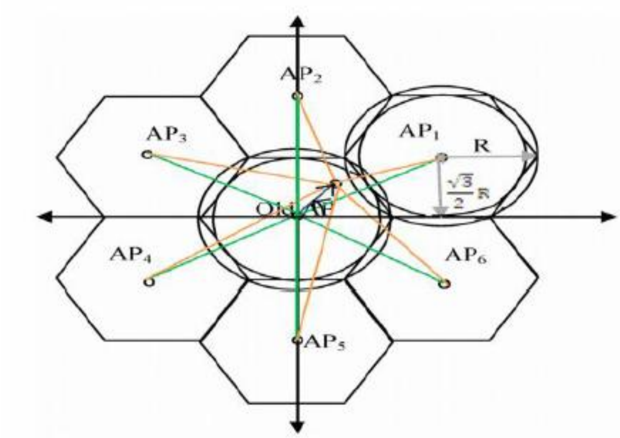

Figure 5 Distance Measurement Technique

 DOI 10.17148/IJARCCE.2019.8303

4.2.4 Selective Channel Scan

By reducing the number of channels to be scanned, handoff delay in scanning phase can be reduced. Using certain criteria the limited number of channels can be selected to scan, is known as selective channel scanning. Orthogonal principle can be used as the selection criteria . The channels Ch1, Ch6 and Ch11 are non-overlapping channels in the IEEE 802.11 spectrum which are called orthogonal channels. According the equation-4 if f (n) = 1; the particular channel will be scanned then only, means f (n) decides whether channel number n is to be scanned. Selective channel scan scheme following advantages:

1. Saves scanning time, therefore reduces overall handoff delay.
2. It offers interference-free communications due to non- overlapping channels used.
3. Reduces packet loss due to collisions due to this reduce need of re-transmissions.
4. Almost all APs can be reached because most of the APs are operating on these orthogonal channels.
5. Dedicated processing power and memory space should not require.

Disadvantage of this scheme is that only scanning of the orthogonal channels shall miss the AP which has the greater quality. Pre-scanning is introduced to in to extend selective scanning. Available channels marked by the mask are scanned by STA before the handoff is triggered. Then it is saved in the dynamic cache structure. STA tries to associate with APs in the cache structure if signal strength falls below threshold. Handoff latency is minimized much more by using this technique.

4.3 NETWORK MODEL

The network is assumed to be consisting of mesh nodes, wireless links and gateway. Multi-radio mesh refers to a unique pair of dedicated radios on each end of the link. This means there is a unique frequency used for each wireless hop and thus a dedicated CSMA collision domain. This is a true mesh link where maximum performance without bandwidth degradation in the mesh and without adding latency can be achieved. Such a WMN is shown in Figure1. Figure 1: Multi –radio WMN, which has an initial channel assignment as shown

4.3.1 Drawbacks of existing approaches

Earlier approaches confine the network changes to be as local as possible. It cannot opt for entire network settings. Even though the approach called greedy channel assignment resolves the above drawback it still has ripple effects which result in the neighbouring node settings even if a local change occurs. While considering the QoS, the channel and scheduling algorithms can provide optimal configurations in the network. But this may result in network disruptions. Cross layer interaction can reduce the detouring overhead but has to take extra care in reducing the interference. Existing work on security-enhanced data transmission includes the design of cryptography algorithms, system infrastructures and security-enhanced routing methods. Their common objectives are often to defeat various threats over the Internet, including eavesdropping, spoofing, session hijacking, etc. All such security treatments make the entire network implementation complicated. The existing systems can only deal with large organizations and cannot deal with small ones. Static IP allocation along with dynamic allocation makes the system applicable in small as well as large organizations.

4.3.2 Architecture of ARS

ARS undergo localized reconfiguration together with the QoS aware planning. Autonomous reconfiguration is done only after monitoring the link quality. To include rerouting for the reconfiguration planning, the prescribed system interacts across the network and link layers. The flow chart shown in Figure 2 gives the diagrammatic explanation of the entire work. The diagrammatic representation of the steps to be followed is shown in Figure 2. Distance vector –based algorithm is used for dynamic routing. A dynamic routing algorithm that could randomize delivery paths for data transmission is proposed here. The algorithm is easy to implement and compatible with popular routing protocols, such as the Routing Information Protocol in wired networks and Destination-Sequenced Distance Vector protocol in wireless networks, without introducing extra control messages. In previous systems such messages were present. Dynamic routing describes the capability of a system, through which routes are characterized by their destination, to alter the path that the route takes through the system in response to a change in conditions. The adaptation is intended to allow as many routes as possible to remain valid (that is, have destinations that can be reached) in response to the change.

4.3.3 Functions of ARS

ARS undergo localized reconfiguration together with the QoS aware planning. ARS systematically generates the reconfiguration plans into three processes like feasibility, satisfiability and optimality together with different constraint levels. The constraints used are connectivity, QoS demands and utilization. The plans thus formulated should be feasible since they are necessary to search all the required link changes in a faulty area. The initial step to be done by the ARS is to detect the faulty links or channels. The system considers three primitive link changes S R and D. Channel

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 8, Issue 3, March 2019

switch S is used to simultaneously change the tuned channel, radio switch R is used to to switch and associate one radio in node A with another in B. Routing switch D is to redirect the traffic along the faulty link to another path. ARS follows a two-step approach-generation of feasible plans per link using the primitives and then combines a set of feasible plans that enable a network to maintain connectivity.

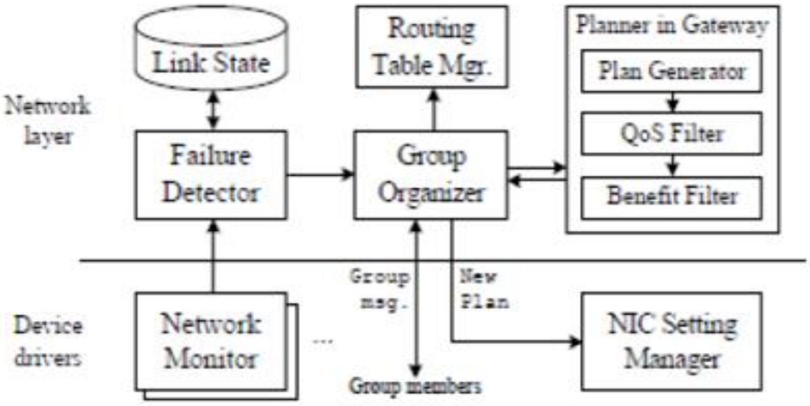

Figure 6software architecture of ARS

V. SIMULATION RESULTS

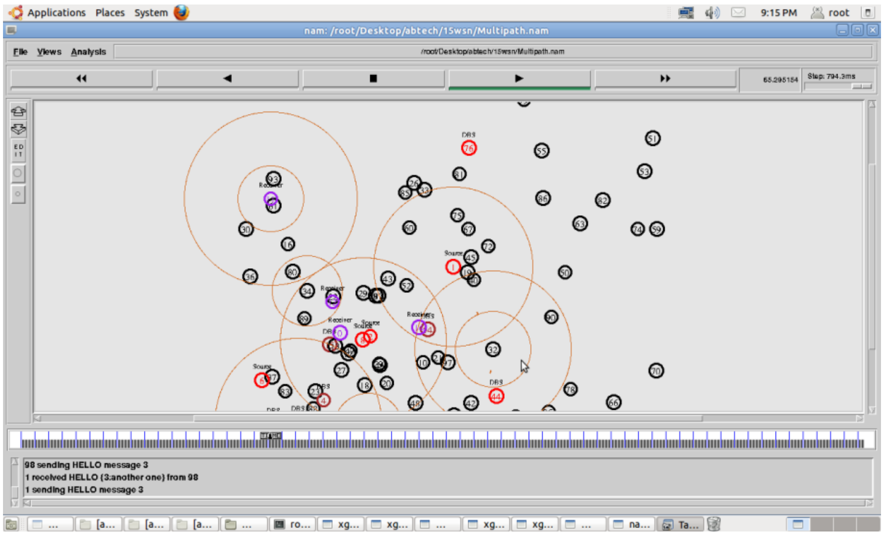

Figure 7 communicate node for handoff operation

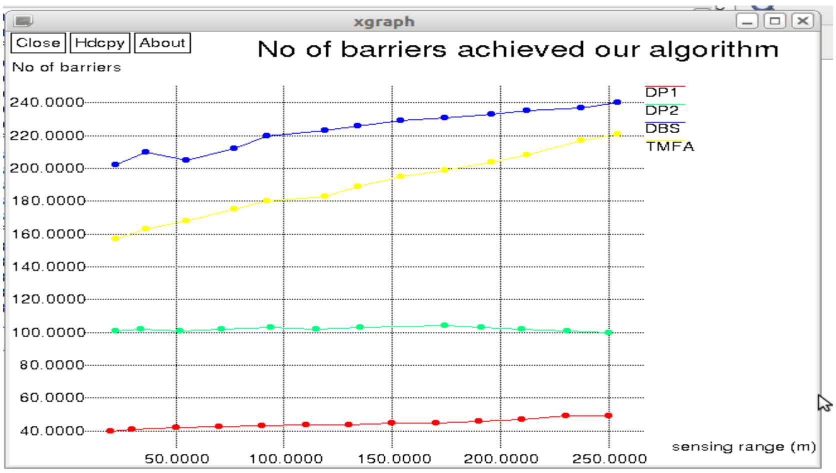

Figure 8 No of Barriers achieved

IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 8, Issue 3, March 2019

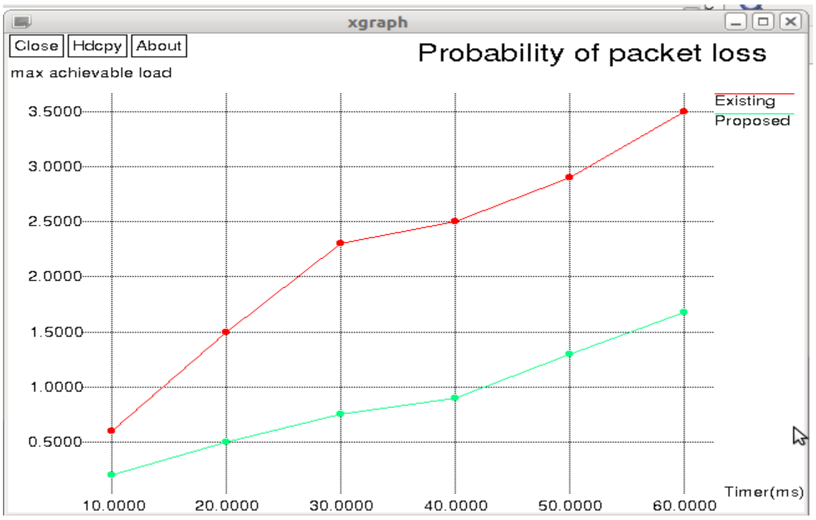

Figure 9 Probability of packet loss

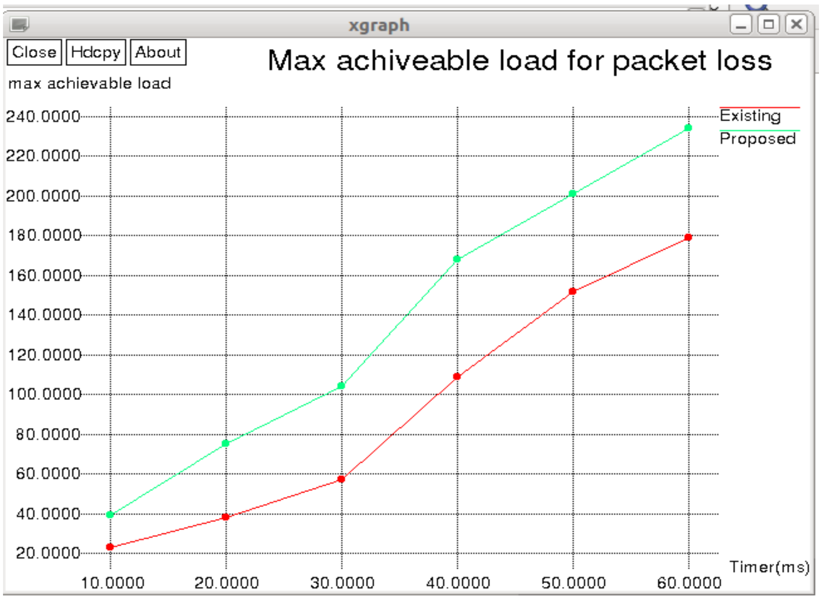

Figure 10 Max achievable load for packet loss

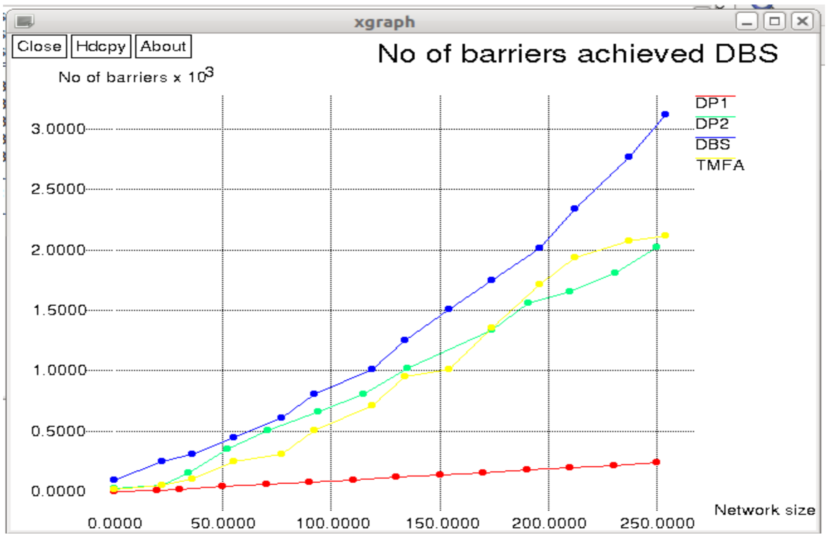

Figure 11 No of barriers achieved DBS

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 8, Issue 3, March 2019

Can observe the latency marked with There is two reasons for this. First, a single packet is lost during channel switching operation. Second, the new AP accepting the scanning STA defers packet transmission until successful STA's channel switching. Immediately after the packet transmission with the delay marked with the packets buffered at the new AP rush toward the laptop computer with very short intervals. Find another latency mark with. However, it has nothing to do with the handoff itself since the delay is caused by retransmission trials due to channel error. Consequently, we find only a single packet loss during MWNIC scanning.

VI. CONCLUSION

A comprehensive survey on handoff latency in IEEE 802.11 wireless LAN is provided. In have introduced various types of handoff latency reducing techniques, also included there advantages and disadvantages. Our aim is to prepare a platform for future research on reducing the handoff latency. This report provides the understanding of handoff in IEEE 802.11 WLAN and brief description of different handoff schemes that gives the reader good foundations on handoff in IEEE 802.11 WLAN. We can provide the serial number to APs in a particular area and make a data base. Using the trajectory information this prepared database. Reduce the handoff latency much more. Handoff latency can be reduced using the location detection in IEEE 802.11 WLAN in near future. We can detect the location of the STA using the location detection techniques in 802.11 WLAN and using this location information, we will reduce the handoff latency in near future. Can also combine the movement pattern with location information and will reduce the handoff latency in IEEE 802.11 WLAN in future. We will also reserve some fixed or adaptively changing number of channels for handoff only. By using this technique we will reduce the handoff latency and packet loss also in future.

REFERENCES

[1]. A. Kurs, A. Karalis, R. Moffatt, J. D. Joannopoulos, P. Fisher and M. Soljacic, "Wireless power transfer via strongly coupled magnetic resonances," Science, vol. 317, no. 5834, pp. 83–86, 2007.
[2]. K. Kang, Y. S. Meng, J. Breger, C. P. Grey and G. Ceder, "Electrodes with high power and high capacity for rechargeable lithium batteries," Science, vol. 311, no. 5763, pp. 977–980, 2006.
[3]. X. Lu, D. Niyato, P. Wang and D. I. Kim, "Wireless charger networking for mobile devices: Fundamentals, standards, and applications," IEEE Wireless Communications, vol. 22, no. 2, pp. 126–135, 2015.
[4]. Y. Peng, Z. Li,W. Zhang and D. Qiao, "Prolonging sensor network lifetime through wireless charging," in RTSS, pp. 129–139, 2010.
[5]. S. Zhang, Z. Qian, F. Kong, J. Wu and S. Lu, "P3: Joint optimization of charger placement and power allocation for wireless power transfer," in IEEE INFOCOM, pp. 2344–2352, 2015.
[6]. W. Xu, W. Liang, X. Lin and G. Mao, "Efficient scheduling of multiple mobile chargers for wireless sensor networks," IEEE Transactions on Vehicular Technology, vol. PP, no. 99, pp. 1–1, 2015.
[7]. J. Johnson, E. Basha, and C. Detweiler, "Charge selection algorithms for maximizing sensor network life with uav-based limited wireless recharging," in IEEE ISSNIP, pp. 159–164, 2013.
[8]. L. Fu, P. Cheng, Y. Gu, J. Chen and T. He, "Minimizing charging delay in wireless rechargeable sensor networks," in IEEE INFOCOM, PP, no. 2922–2930, 2013.
[9]. L. He, L. Fu, L. Zheng, Y. Gu, P. Cheng, J. Chen, and J. Pan, "Esync: An energy synchronized charging protocol for rechargeable wireless sensor networks," in ACM MOBIHOC, pp. 247–256, 2014.
[10]. S. Guo, C. Wang, and Y. Yang, "Joint mobile data gathering and energy provisioning in wireless rechargeable sensor networks," IEEE Trans. on Mobile Computing, vol. 13, no. 12, pp. 2836–2852, 2014.
[11]. C. Wang, J. Li, and Y. Yang, "Low-latency mobile data collection for wireless rechargeable sensor networks," in IEEE ICC, pp. 6524– 6529, 2015
[12]. L. He, P. Cheng, Y. Gu, J. Pan, T. Zhu and C. Liu, "Mobileto- mobile energy replenishment in mission-critical robotic sensor networks," in IEEE INFOCOM, pp. 1195–1203, 2014.