# TOWARDS REDUCING HANDOFF TIME IN SOFTWARE DEFINED WI-FI NETWORKS


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DEPARTMENT OF ELECTRICAL ENGINEERING
MIRPUR UNIVERSITY OF SCIENCE TECHNOLOGY
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**FYP REPORT SUBMITTED IN FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF B.SC ELECTRICAL ENGINEERING**


**DEPARTMENT OF ELECTRICAL ENGINEERING**
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**MIRPUR AJ&K**


**2018-2022**

## CERTIFICATE OF APPROVAL

It is certified that the research word titled "**Towards Reducing Handoff Time in Software Defined Wi-Fi Networks**" carried out by **Muhammad Faizan**, **Shoaib Akhtar, Zain Ramzan** bearing **FA18-BEE-014, FA18-BEE-021, FA18-BEE-026** respectively, under the supervision of **Dr. Sohaib Manzoor** at Mirpur University of Science & Technology, (MUST) Mirpur is fully adequate, in scope and in quality, as a FYP report for the degree of B.Sc. in Electrical Engineering.

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Title of Project: TOWARDS REDUCING HANDOFF TIME IN SOFTWARE DEFINED WI-FI NETWORKS

Field of Study: ENGINEERING

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## ABSTRACT

In Wi-Fi connection handoff procedure plays an important role in providing continuous service to the mobile users where the routers routers (Aps) are in a large number. In general Wi-Fi connection handoff procedure is started by mobile station and it takes few seconds, but these few seconds can cause a big loss especially when we are dealing with applications like live streaming and real time data like audio and video calling. In order to overcome lag, we proposed a DiDe theory which provide the solution related to handoff-time in SD Wi-Fi connection. In general Wi-Fi connection received-signal-strength-indicator RSSI is only one parameter for the selection of a finest station Ap. In DiDe we use centralized SDN-controller which contain the overall view of the network. In DiDe theory selection of a finest station Ap is done based on received-signal-strength-indicator RSSI value and traffic load on Ap. Value of received-signal-strength-indicator RSSI is obtained through RSSI Manager and information about traffic load is collected through simple-network-management-protocol SNMP. In DiDe approach handoff decisions are taken by SDN-controller instead of mobile stations. Centralized SDN-controller controls the Start of handoff that is called detection-phase and selection of destination AP that is called discovery-phase. For implementation of DiDe theory a large-scale simulation runs are executed on Mininet OMNeT++ Wi-Fi simulator. Simulation proves that DiDe theory minimize the handoff-times significantly by 59.9 to 69.9% and average number of re transmission by 3.99 to 48.9% and retain the performance of time related application like live video streaming when compared with general Wi-Fi network, channel-measurement-based-access-selection-scheme (CMAS) and (DL-SINR) downlink-signal to interference-plus-noise-ratio AP selection scheme, Dynamic auto scaling algorithm scheme (DASA).

# TABLE OF CONTENTS

# LIST OF FIGURES

This list contains the titles of figures, together with their page numbers, which are listed in the text. For e.g., figures in Chapter 3 are numbered sequentially: Figure 3.1, Figure 3.2.

For title of list tables use *other title* and *TOC1* for style.

## LIST OF TABLES

This list contains the titles of tables, together with their page numbers, which are listed in the text. The numbering system is according to chapter, for e.g.: tables in Chapter 3 are numbered sequentially: Table 3.1, Table 3.2.

## LIST OF SYMBOLS AND ABBREVIATIONS

For examples:

| | | |
|---|---|---|
| CC | : | Central canal |
| DAB | : | 3,3’-diaminobenzidine |
| HRP | : | Horseradish peroxidase |
| MS222 | : | Tricaine methanesulfonate |
| | : | |
| | : | |

## LIST OF APPENDICES

# CHAPTER 1: INTRODUCTION

In the last ten years, Wi-Fi connections have quickly expanded thanks to their inexpensive cost and straightforward technological setup. The ease of connectivity offered by Wi-Fi connections has drawn the attention of numerous researchers. Wi-Fi connections available in public spaces, such campuses, businesses, and hospitals facilities, aid a huge amount of mobile Stations, which negatively affects the presentation of A-Ps. The mobile local area connections (M-L-A-C) family of Standards includes the 8,02.11 protocols, which are the most extensively used. The 8,02.11 Distributed_Coordination_Function (D-C-F) presentation evaluation has been the subject of research. To S-T-Ability the burden in elevated density S-D-Wi-Fi, techniques have been presented. Administering window magnitude of an M-L-A-C enables coexistence of broad body area connections (B-B-A-C) and M-L-A-C in the smart health industry and improves Q-o-S for mobile transmission of E-C-G. The mobile Stations are linked to an AP with Open Flow functionality. Discontinuation and packet dropping rate are two presentation parameters that are measured. The suggested approach adjusts system parameters like packet charge and packet production times to gain a deeper understanding of the load burden. By presenting simulation outcome based on the OMNEt++ simulator, the paper adds to a better understanding of mobile load burden and S-D-Wi-Fi presentation for hospitals with dynamic burden conditions.

By 2023, most mobile Stations (about 70 percent) will approach the internet via Wi-Fi connections. Because of their simple technical implementation, easy connectivity, and cheap cost network development, M-L-A-Cs have grown in significance during the past ten years. The Distributed_Coordination_Function (D-C-F) protocol, which is equipped with a two-way handshake, a basic approach mechanism, and a four-way handshake request-to-send/clear-to-send (RTS/CTS) mechanism, is the most significant and fundamental approach mechanism in the I-E-E-E 8,02.11 medium approach control (MAC) layer. In contrast to Bianchi's model, which used a distinct-time Markov renewal operation to analyze each Head-of-Line (H-O-L) packet's behavior, Dai recently provided a unified analytical approach for I-E-E-E 8,02.11 D-C-F connections. The analytical approach demonstrating the clarity and precision of the model of I-E-E-E 8,02.11 D-C-F connections has been evaluated using NS-2. In contrast to the D-C-F's basic approach mechanism, the RTS/CTS mechanism necessitates the exchange of RTS and CTS short frames to reserve the channel, which reduces the network's capacity for small data packets. Because of this, I-E-E-E 8,02.11 standards include a workable parameter, namely RTS threshold, for nodes to activate the RTS/CTS mechanism for data packet lengths that won't negatively impact M-L-A-C network presentation. To achieve elevated throughput on M-L-A-Cs, it is essential to switch between the proper an approach modes. Many studies have concentrated on finding the best RTS threshold for I-E-E-E 8,02.11 M-L-A-Cs. To determine the RTS threshold, a series of intricate equations that is non-linear built on the traditional mode of Bianchi were applied. The findings demonstrate that the RTS threshold rises as the amount of nodes or data rate decreases. The link between RTS and important system parameters is unknown because of various network assumptions and the implicit structure of the solution, which makes it extremely challenging to switch between the basic and RTS/CTS methods in real-world M-L-A-Cs. Students, programmers, and researchers use simulations to investigate the behavior of real-time systems and gain flexibility in terms of repeatability, manageability, and S-T-Ability. Positive trends in reproducibility, a low cost environment, and least complexity can be seen in NS-2, NS-3, and OMNEt++. These simulators' disadvantage is that they are less realistic than test bed tools like Planet Lab.

The two most often used simulators today are NS-3 and OMNEt++. With a Python scripting join and a modular type structure written in C++, NS-3 aids in the provision of a real-time simulation environment and promotes software (programme) integration. OMNEt++ is a component-based, modular, and extendable Library of C++ with GUI aid that makes it simple to integrate the kernel into user programmers. The I-E-E-E 8,02.11 modules in both simulators adhere to the MAC and D-C-F rules and regulations. Because of its complexity, relatively few studies have taken into account the validation of NS-3 and OMNEt++ PHY/MAC layer. The research that aids NS-3 and OMNEt++'s PHY and MAC layers. We offer two investigations. The first is a simulation comparison analysis using NS-3 and OMNEt++ of the unified I-E-E-E 8,02.11 D-C-F analytical model. A Linux-based test bed is built up to check the mathematical analysis and the simulation outcome, and the Wi-Fi modules of the two simulators are compared in detail. The MAC/PHY layers of NS-3 and OMNEt++ are validated against Dai's model using different network situations, diverse topologies, distinct system characteristics, and two approach modes. In the second study, we address the unresolved problem of achieving the best throughput presentation in a network by automatically and precisely switching between the basic approach and RTS/CTS mechanism. In I-E-E-E 8,02.11 M-L-A-Cs, the ideal RTS threshold is expressed explicitly. In keeping with Dai's approach, a closed-form solution is employed to connect the RTS threshold to four important network parameters: the data rate (RD), the amount of nodes (n), the initial back off window magnitude (W), and the basic rate (RB). The outcomes also demonstrate that the network throughput presentation attained using the ideal RTS threshold is better than the default configuration. To the best of our knowledge, this work is the first of its kind that can validate the NS-3 and OMNEt++ MAC model for I-E-E-E 8,02.11 D-C-F connections and is extendable to practical implementation because the A-Ps can gather the ideal RTS threshold with the aid of a closed-form expression and choose the proper approach mode.

Because of its low cost and aid for potency, I-E-E-E 8,02.11 mobile local area connections (M-L-A-Cs) have gained popularity all over the world since they first appeared more than 20 years ago for providing mobile Internet approach to a variety of customers in houses, businesses, and public areas. An approach point (AP) connected to a wired framework and a few mobile Stations(S-T-As) connected to the AP make up the basic service set (BSS) of the simplest M-L-A-C. More stringent user needs, particularly for entertainment contents like online games, virtual reality, and elevated definition visual, have increased along with the amount of Stations attempting to use M-L-A-C technology to approach the Internet. As a result, because of the presence of places where the received power from the AP is low and thus the achievable presentation, classic single-AP M-L-A-Cs deployed in apartments, i.e., House Wi-Fi connections, may crash to give an acceptable adventure. The best way to increase coverage in those areas is still to deploy more A-Ps, even though I-E-E-E 8,02.11ac (Wi-Fi 5), I-E-E-E 8,02.11ax (Wi-Fi 6), and I-E-E-E 8,02.11be (Wi-Fi 7) amendments offer improvements on physical (PHY) and medium approach control (MAC) protocols. These improvements may increase M-L-A-C efficiency and also increase coverage by using beam forming. In multi-AP deployments, only one AP (the major AP) typically has Internet connection, therefore the other A-Ps (hence referred to as Extenders) must use a wired or mobile backhaul network to transmit the data to it. Extenders communicate potency with the primary AP because it is not always practical to assume the existence of a wired network. In this instance, at least two radios, typically using different bands, are present on the primary AP and Extenders. When there are numerous AP/Extenders available, a new problem arises: how to choose the best AP/Extender for each specific S-T-A. The default Wi-Fi AP selection procedure states that S-T-A will begin the association operation with the AP/Extender that has the elevatedest received signal strength indicator (R-S-S-I) value after receiving beacons from an amount of A-Ps and extenders. Although straightforward and simple to use, this approach ignores the impact of load burden, which can result in network congestion and reduced throughput in scenarios with a large amount of S-T-As. The operation of choosing an AP has been extensively studied in the context of burden stabilizing, which aims to more effectively distribute S-T-As among the available AP/Extenders in a M-L-A-C. Although many useful solutions have been put out in the literature, the most of them have little chance of being really implemented because they call for alterations to the current I-E-E-E 8,02.11 Standards and/or the mobile cards used by S-T-As. The goal of the channel burden aware AP/Extender selection method described in this article is to improve M-L-A-C presentation by taking channel burden into account during the S-T-A association operation. To accomplish this, only already developed I-E-E-E 8,02.11 amendments—I-E-E-E 8,02.11k for information gathering from AP/Extenders in the M-L-A-C and I-E-E-E 8,02.11v for notifying each S-T-A of its own prioritized list of AP/Extenders—are taken into consideration. The primary contributions of the current work, in particular, might be summed up as follows:

• A review and classification of several AP/Extender selection methods that are currently in use, as well as some background data on the application of I-E-E-E 8,02.11k/v

• Creation of a workable, useful, and adaptable AP/Extender selection method that is channel burden aware and aided by I-E-E-E 8,02.11k/v amendments.

• Simulation-based testing of the channel burden-aware AP/Extender selection method, examining the presentation benefits of utilizing Extenders in conjunction with the suggested fix. We concentrate on comprehending how the quantity and placement of Extenders, the percentage of S-T-As aiding I-E-E-E 8,02.11k/v, and the burden on the approach and backhaul links affect the system's throughput and lag.

• Verification of the proposed solution on a real test bed, demonstrating similar trends in presentation enhancements as those attained through simulation.

Users now expect speedy internet connectivity because there are more mobile applications available, when dealing with real-time importantly audio and visual. The scenario seems confusing when looking at conventional Wi-Fi connections because it is very difficult to programmed for aid of potency, manageability, and burden stabilizing. Because of their convenient approach wherever and anytime, Wi-Fi connections have seen a sharp rise in popularity over the past ten years. Wi-Fi connections are frequently seen in smart houses, smart learning facilities, smart healthcare facilities, and smart malls. The network's approach points (A-Ps) are installed haphazardly, leading to elevated fluctuating AP densities and unequal burden distribution among the A-Ps. The basic service set (BSS), which is the smallest Wi-Fi network block, uses an AP to operate as a bridge for mobile stations to offer approach to the network. The mobile stations move from one BSS to another while requesting re-association from fresh A-Ps nearby. Among the connected BSSs, seamless roaming is aided by the I-E-E-E 8,02.11 standard. One extended service set has all of the BSSs separately (ESS). The mobile Stations can move around freely inside an ESS without affecting the network setup. At the client end, the R-S-S-I values are taken into account for making roaming and association decisions. This approach, known as the client driven method, tends to lead to an uneven burden allocation among the A-Ps. The ESS has a large amount of A-Ps that overlap one another, yet even so, the overburdened A-Ps deteriorate network Q-o-S presentation while the A-Ps in the neighboring ESS remain under burdened. Since no standardized technique has been developed to solve this issue, stabilizing the burden among the A-Ps in an ESS for elevated density S-D-Wi-Fi continues to be a concern. Depending on who makes decisions on which A-Ps to associate with, the burden stabilizing techniques currently used for Wi-Fi can be divided into centralized and client-driven. The majority of prior research has been on client-driven techniques, in which the mobile Station learns the AP burden and makes association decisions on its own. Because they lack a comprehensive understanding of the complete network, client-driven approaches for burden stabilizing are unable to make accurate decisions. A lot of repeated associations are necessary to achieve the perfect burden stabilizing S-T-Ate, increasing the lag factor. On the other hand, centralized techniques effectively contribute to burden stabilizing decisions by either managing the association management mechanism or modifying the AP's coverage area. Some of the centralized techniques rely on a distributed strategy, in which the custom hardware and the A-Ps must exchange several messages. The other centralized solutions rely on a centralized regulator, which is overburdened by the excessive amount of pointless AP association and de-association choices. It is nearly impossible to perform burden stabilizing activities in dense Wi-Fi connections with heterogeneous Stations from different vendors and no common protocols or hardware. Recently, a new paradigm called S-DN has been employed to overcome the issues in conventional Wi-Fi connections. With S-DN's independent control and data planes, network management responsibilities are made simpler, mobile Stations may now be programmed, and new network functions and applications are introduced. Many suppliers, including Microsoft, Google, HP, and Cisco, have decided to implement Open

Flow Standards because of the abstraction of the control plane from mobile Stations. We think that the hybrid software (programme) defined Wi-Fi connections (S-D-Wi-Fi) architecture can incorporate better burden stabilizing strategies rather than depending on bespoke protocols/hardware design by examining the existing literature on burden stabilizing approaches in Wi-Fi and the S-DN. To enhance overall network presentation, we present a Q-o-S-aware burden stabilizing technique for elevated density Wi-Fi connections in this research. To gather data from the OA-Ps and determine the burden level at which the OA-Ps can make association decisions independently of the centralized regulator, the S-DN regulator harvests an overall view of the network. There is some literature that describes how burden stabilizing operations in Wi-Fi connections are carried out using a specialized centralized regulator. Our approach adds uniqueness in three different ways. The centralized burden stabilizing techniques currently in use cede all AP, R-S-S-I-based association and de-association choices to the regulator. Outcome from our test bed and simulation demonstrate that complete reliance on the centralized regulator increases operationing times for AP association and de-association and further overburdens the regulator. By constantly modifying the burden level in accordance with the network conditions, the suggested technique enables OA-Ps to decide on association decisions on their own. The second feature of the proposed study is that, rather than depending solely on one metric, in this case R-S-S-I, the destination OAP is chosen using a multi-metric criteria (packet dropping rate, R-S-S-I, and throughput), satisfying the least burdened conditions. Finally, our method is suitable to any mobile Station that complies with the Open Flow specifications and doesn't call for any hardware modifications.

S-DN is a new network paradigm that offers a viable strategy to address an amount of problems in mobile connections. In software (programme)-defined Wi-Fi connections with large densities, burden stabilizing is a significant problem. A single regulator might not be able to compute flow rules and deploy them to S-DN switches in the presence of several load flows. To alleviate the presentation bottleneck at the network control plane, it makes sense to install numerous S-DN regulators. For burden stabilizing in software (programme) defined Wi-Fi connections, we present a dynamic two-tier burden stabilizing strategy in this study (S-D-Wi-Fi). In our multi-regulator S-DN design, a global regulator is tasked with keeping track of the CPU, burden, and reaction times of the other regulators. This switch inspects the initial flow packet upon the arrival of a new flow and categorizes it into various kinds. To determine the corresponding flow policies, the switch asks the global regulator. For flow operationing, this global regulator may send the request to a local regulator. Under-burdened clusters (ULC), idle-burdened clusters, and overburdened clusters are the three types of clusters that the global regulator is in charge of managing (ILC). To achieve an elevated request operationing rate and a short response time, the global regulator uses the Analytical Hierarchical Operation method based on the status of local regulators to dispatch the flow request to an appropriate local regulator for computing the flow polices and then deploy the policies back at the switch. For speedy and precise decision-making, AHP has been utilized in numerous planning, resource allocation, and priority setting applications in the past, like selecting the best S-DN regulator from a selection of regulators.

The feature of centralization is constrained by the double nature of the control and data planes in the current Wi-Fi architecture. Computer connections are intricate and challenging to control. From routers and switches to middle boxes like firewalls, network address translators, server burden stabilities, and intrusion detection systems, these connections are equipped with a broad variety of hardware. Complex, distributed control software (programme) that is often closed and proprietary is operated on routers and switches. The software (programme) uses network protocols that have been through extensive testing for interoperability and standardization over the years. Individual network stations are often configured by network managers using configuration joins that differ across vendors and even between various products made by the same vendor. Despite providing a centralized point of view for network administration, some network management solutions nonetheless function at the level of individual protocols, operations, and configuration joins. With this form of operation, innovation has stalled, complexity has increased, and the capital and operational costs of running a network have climbed. The way we design and maintain connections is changing because to Software (programme) Defined Networking (S-DN). S-DN is distinguished by two factors. First, an S-DN separates the data plane from the control plane, which selects how to handle load (which forwards load according to decisions that the control plane makes). An S-DN also unifies the control plane, allowing a single software (programme) control application to manage numerous data plane components. Through a well-defined Application Programming Join, the S-DN control plane directly manipulates the S-T-Ate of the network's data-plane components (like routers, switches, and other middle boxes) (API). One well-known example of one of these APIs is Open Flow. One or more tables of packet-handling rules are present in an Open Flow switch. The load that fits a rule is subject to specific actions, like dropping, forwarding, or flooding. Each rule matches a subset of load. An Open Flow switch can act like a router, switch, firewall, network address translator, or something in between depending on the rules that a regulator program installs. S-DN has significantly increased its market traction in recent years. The Open Flow API is aided by a lot of commercial switches. HP, NEC, and Pronto were among the first suppliers to offer Open Flow; however, this list has since grown significantly. There are many different regulator platforms now. Many applications, including dynamic approach control, server burden stabilizing, network virtualization, energy-efficient networking, seamless virtual machine migration, and user potency, have been developed by programmers using these platforms. Early commercial achievements like the Network Virtualization Platform from Nicira and Google's broad-area load management system have attracted a lot of industry attention. The Open Networking Foundation and the Open Daylight project are two of the S-DN industry consortia that include most of the biggest information technology organizations in the world (like cloud providers, carriers, equipment makers, and financial services companies). Most of the concepts behind S-DN have developed over the past twenty years (or more!) even if the hype surrounding it has increased during the past few years. S-DN borrows certain concepts from early telephony connections, which streamlined network administration and the rollout of new services by clearly separating the control and data planes. Open joins, like Open Flow, however, allow for more creativity in regulator platforms and applications than was previously allowed on restricted connections created for a certain subset of telephony services. Other than putting a focus on programmable data planes, S-DN is similar to earlier research on active networking, which outlined a vision for programmable connections. The earlier research on dividing the control and data planes in computer connections is equally relevant to S-DN. In this essay, we outline the philosophical development of programmable connections that led to the modern S-DN. We document the development of important concepts, the current application "pulls" and technological "pushes," and lessons that can direct the future round of S-DN breakthroughs. Along the way, we dispel common misconceptions and prejudices about each technology and explain how S-DN interacts with related technologies like network virtualization. Our tale began twenty years ago, while the Internet was only starting to gain popularity. At that time, monitoring and upgrading the network framework was difficult because of the Internet's phenomenal growth. While acknowledging that advancements in other fields, like distributed systems, operating systems, and programming languages, were occasionally the catalyst for these innovations, our focus is on advancements made in the networking community (whether by researchers, Standards bodies, or businesses).The long-running endeavor to aid programmable packet operationing at elevated speeds is clearly related to the attempts to build a programmable network architecture. We warn the reader that any history is imperfect and more complex than a single plotline could imply before we start our story. In fact, a large portion of the work that we discuss in this article was completed before the name "S-DN," which was first used in a publication about stanford's open Flow project. The term "S-DN" has a complicated provenance, and while it was first used to characterize stanford's open Flow project, its definition has now been expanded to encompass a considerably larger range of technologies. (Sometimes, industry marketing teams have even appropriated the phrase to refer to unrelated concepts that existed before stanford's S-DN research.) Therefore, instead of seeking to assign direct influence amongst projects, we emphamagnitudethe development of the connections among the concepts that serve as the defining features of S-DN, regardless of whether they had a direct impact on any particular future research. Even while some of these early theories may not have directly impacted later ones, we think the linkages between the ideas we include are important, and these old initiatives may still have something to teach S-DN in the future.

In Wi-Fi connections, hand-offs entail the mobile Station disassociating from one AP and re-associating with another AP. When dealing with lag-sensitive applications when using email or online browsing, the hand-off operation of a few seconds may appear well managed, but the user could lose crucial information during visual/audio streaming. The rapid development of mobile Internet applications, location-based services, Wi-Fi calling, cloud services, and I-E-E-E 8,02.11-based mobile LANs (M-L-A-Cs/Wi-Fi) have all attracted a lot of attention in recent years because they offer an affordable alternative to cellular connections for aiding Internet approach services with elevated throughput. The amount of data load produced by smart mobile Stations, which will primarily be off burdened to Wi-Fi, will reach about 197,000 petabytes (PB) by 2019, according to a Juniper Research analysis. In the meantime, some cell operators have started setting up Wi-Fi hotspots in densely populated regions to counteract the threat of LTE spectrum that is getting close to Shannon's capacity limit. A amount of additional demands, including seamless transition, quality of service (Q-o-S), elevated throughput, burden stabilizing, and ubiquitous network approach , have been prompted by the growth in Wi-Fi users. Unfortunately, the unstructured nature of the current Wi-Fi framework may contribute to the current potency management problems.

There are a few significant problems:

(1) the close coupling between the control and data planes in the current M-L-A-C topology prevents the integration of cutting-edge network applications, services, and policies. As a result, it is challenging to execute the intelligent potency management functions in accordance with the real-time network S-T-Ate that is necessary for future network S-T-Ate awareness.

(2) There is no built-in feature for centralized network management in the conventional I-E-E-E 8,02.11 A-Ps. As a result, users must go through a time-limited authentication operation while switching between A-Ps. When a timeout occurs, the network connection is broken.

(3) The placement of A-Ps in a constrained area to cover up signal gaps between A-Ps with the intention of giving the user a flawless and continuous connection while they are moving. Signal interference, on the other hand, is what leads to the installation of A-Ps in a nearby area.

The MTs obtained a long list of SSIDs after scanning several A-Ps within radio range using the I-E-E-E 8,02.11 standard. The user must choose an SSID to connect, and most likely, they are just dependent on the strongest received signal strength indication (R-S-S-I). If the user is associated with an AP that is already busy, throughput may be limited. Because there is no burden stabilizing mechanism in the I-E-E-E 8,02.11 standard, the network is completely instability, which leads to throughput deterioration at the expense of packet dropping ratio. The aforementioned problems prevent Wi-Fi from being used to its full potential to meet future Internet requirements, which has an adverse effect on potency management. A promising approach to personifying the mobile network that allows A-Ps to have configurable control plane and data plane is the software (programme)-defined network (S-DN) idea. These capabilities improve M-L-A-C presentation in terms of fine-grained packet management and offer an open Flow configuration join. The regulator can set several tasks for the open Flow-based switch depending on predefined rules, like acting as a router, firewall, NAT, or other user-defined functionalities. Existing applications may add handover parameters into the open Flow, which might result in a smooth presentation for handover activity. To enable the S-DN programmable control plane in I-E-E-E 8,02.11 AP and improve the current handover procedure in a mobile network, Open WRT aids in reconfiguring mobile protocols. Additionally, it is strongly recommended that network function virtualization (NFV) be implemented within the S-DN platform to provide service providers and user/mobile terminals with a amount of advantages (MT). The NFV has been regarded as a practical abstraction to hardware features to lower the cost of framework and also useful to reduce power consumption. It follows that the introduction of potency management features like seamless handover, mobile resource optimization, centralized management, and fine-grained controllability has the potential to help create the future M-L-A-C environment. In the current research, we offer an NFV-enhanced Logical AP-based Potency Management (LAPM) scheme for M-L-A-C in the S-DN environment, which better explains how to construct an appropriate potency management environment for M-L-A-C. We build the logical AP (LAP) using an expanded S-DN/NFV abstraction, which frees up the complexity of the I-E-E-E 8,02.11 protocol stack and directs operations to the central regulator. A MT connected to the AP corresponds to each LAP. The LAP performs network aid activities as the virtual AP (VAP), an abstraction of the real AP (PAP). To facilitate the seamless changeover that can be performed when MT associated with numerous PA-Ps in the signal overlapping range, the LAP has the capacity to maintain the same VAP for each associated MT with neighboring PA-Ps concurrently. We also compare the effectiveness of traditional handover versus our suggested algorithm, LAPM. This study also focuses on the burden stabilizing of A-Ps that share a signal interference area. To assess PAP's functioning, we create a testing environment based on S-DN and NFV technologies. The assessment findings show that the suggested method might greatly reduce M-L-A-C handover discontinuation after applying the LAPM scheme in a test bed with actual user load.

Additionally, the LAPM system provides seamless handover while still maintaining the burden S-T-Ability. This experimental investigation aids in assessing the effectiveness of installed PA-Ps for further QoE improvement.

The first factor that causes a lag is a hand-off choice made by mobile Stations during the detecting phase. Low R-S-S-I values cause packet dropping, which leads to the hand-off choice being made. With the flexibility to scale network resources in lockstep with application and data needs, software (programme)-defined networking (S-DN) enables enterprises to deploy applications, enable flexible delivery, and lower CapEX and OpEX costs. S-DN is a cutting-edge method for designing, implementing, and managing connections that separates network control (control plane) and forwarding (data plane) operations for a better user adventure. In terms of network flexibility and controllability, this network segmentation offers an amount of advantages. On the one hand, it enables the fusion of the benefits of system virtualization and cloud computing, and on the other, it enables the development of a centralized intelligence that enables making a clear visibility over the network for the purposes of simple network management and maintenance as well as improved network control and reactivity. The implementation, configuration, and troubleshooting of connections in the traditional framework necessitate elevated technical network and system engineer intervention, which incurs operating expenses associated with provisioning and managing massive multivendor connections. In reality, if there are frequent network failures and no backup plans are foreseen within the framework, the diversity and complexity of network parts make their maintenance elevated expensive and the aiding framework less dependable. S-DN makes network administration and management simpler by separating the routing and forwarding decisions of networking components (like routers, switches, and approach points) from the data plane. This is because the control plane only deals with information pertaining to logical network topology, the routing of load, and other related topics. The network load is orchestrated by the data plane in contrast to the control plane's established setup. In S-DN, a regulator that sets the network policy centralizes control operations. Such open source regulator platforms as Floodlight, Open Daylight, and Beacon are common. There are various layers on which network administration can be accomplished (i.e., application, control, and data plane). For instance, service providers can build up physical network elements on the data plane, create and modify network policies and logical entities on the control plane, and assign resources to customers via the application layer. In recent years, software (programme)-defined networking has gained attention. However, from the middle of the 1990s, the idea behind this strategy has been changing. The management architecture Ethane and the network flow protocol open Flow have given birth to a true S-DN implementation. A regulator joins with switches and routers and provides a standardized method of regulating load through the use of the Open Flow protocol. A flow table that specifies how to handle and pass packets across the network and an exposed open Flow application programming join (API) that manages communications between switch/router and regulator make up the two logical parts of the Stations implementing open Flow. The Open Networking Foundation has established Open Flow as a standard. There are additional southbound joins that are now in use that are comparable, including the Locator/ID Separation Protocol, Soft Router, Path Computation Element, and the Internet Engineering Task Force's standardized Forwarding and Control Element Separation. Furthermore, there is a sharp rise in demand for cloud services in all their forms. These services, despite being centralized in data centers, present significant difficulties for service providers. The operator must adapt to the rapidly increasing customer expectations by taking into account more servers, network components, elevated quality of service, and secure architecture adhering to the standards. This typically comes first at the expense of making a significant effort to address brand-new problems that arise within the core network, which S-DN leads and controls. The following challenges and issues, in particular, seem to be of utmost significance in the S-DN environment:

(1)Manageability: First this describes S-DN's capacity to manage and operation an expanding work burden, specifically in the control plane. Manageability tries to increase the S-DN's capacity by putting in place techniques like devolving, clustering, and elevated operationing to handle the increasing burden.

(2) Reliability: The S-DN is regarded as trustworthy if it alerts users in real time when data delivery attempts crash. For the delivery of crucial data in such a network, there should be a defined minimum dependability. S-DN regulators must be able to meet real-time demands for timely and reliable delivery in today's installations.

(3) Elevated availability: HA refers to the idea that a service or resource should always be available whenever a consumer demands it. Typically, availability is stated as a percentage of annual uptime. Services can frequently become unavailable because of network outages or system failures. To provide HA, network providers typically employ redundant server hardware, server operating systems, network components, and so on.

(4) Elasticity: The power of S-DN to dynamically respond to changes in work burden by scaling up or down the available resources is known as elasticity. In general, elasticity, which may also be referred to as manageability, is frequently concentrated on the control plane.

(5) Security: S-DN security entails safeguarding data from dropping, tampering, or damage to hardware and software (programme) as well as interruption of services. S-DN security includes safeguarding the hardware's physical integrity as well as thwarting potential network or data-based logical threats. S-DN vulnerabilities are the front door for security assaults, whether they are deliberate or unintentional.

(6) Presentation: The quantity of tasks completed by S-DN components in relation to the time/resources (like CPU and RAM) required is referred to as presentation. Since each network has a unique nature and architecture, there are numerous ways to gauge its presentation. The key metrics for S-DN include jitter, discontinuation, jitter, bandwidth, and throughput.

(7) Resilience: Resilience is the capacity to guarantee and sustain a reasonable level of service even in the event of a service, network, or node failure in S-DN. The network should offer a continuous operating service with the same presentation when an S-DN element crashes. To secure the services, prospective risks and problems must be identified to make S-DN more resilient.

(8) Dependability: Availability and reliability concepts have a significant impact on the dependability of S-DN. S-DN dependability focuses mostly on fault prevention and fault tolerance implementation to ensure service delivery even at a degraded level. Integrity and maintainability are two additional key dependability characteristics in addition to elevated availability and reliability.

The detection phase isn't as each vendor specific equipment oversees it. A growing amount of data is being generated and distributed across social connections as a result of the development of Social Network Services (SNSs). We currently interact with physical activities, social interactions, and cyber resources through multidimensional, all-encompassing systems that offer computing, communication, control, commerce, etc. Advanced mobile and sensing technologies in particular make it simple to gather social data as records of social events, which can then be analyzed to provide a greater insight of users' everyday activities, social connections, lifestyles, etc. As a result, numerous research have been conducted with an emphasis on creating community-centric applications based on data analysis that incorporates social, mobile, and big data technologies, including Cyber-Physical-Social Systems (CPSSs). In the CPSS paradigm, an important technology and typical class of applications for delivering tailored and intelligent services are intelligent recommender systems.

In detection phase the variation is caused by the different R-S-S-I threshold values in mobile Stations set by different vendors. The discovery phase, during which the mobile Station checks every available channel to connect to the best AP, also adds to the hand-off discontinuation. After that, the mobile Stations must wait for the AP's probe response message, which outcome in a significant lag given the volume of load on the A-Ps. Because of their approach ability and affordability, I-E-E-E 8,02.11 mobile local area connections, usually referred to as Wi-Fi connections, have been more popular on a global scale during the past ten years. An I-E-E-E 8,02.11 network is made up of several basic service sets (BSSs), which are akin to cellular connections. In each BSS, a amount of mobile stations(referred to as "nodes" in this document) send to or receive from a single approach point (AP). In contrast to cellular connections, I-E-E-E 8,02.11 connections utilize a random approach procedure at the medium approach control layer called Distributed_Coordination_Function (D-C-F). Each node independently chooses when to transmit and backs off if its transmission crashes or it detects other ongoing transmissions, requiring the least amount of cooperation from the AP. Since mobile media is broadcast, BSSs may interfere with one another if they share the same frequency band. In the current I-E-E-E 8,02.11 standard, a frequency division strategy is used to reduce the so-called co-channel interference, where the frequency band is divided into several sub channels for BSSs to operate on. Different techniques have been proposed to reduce the elevatedest effective channel utilization or the interference among A-Ps and nodes, presuming a central regulator is available for channel assignment optimization. Distributed channel allocation schemes were created for scenarios where BSSs do not coordinate with one another. In these schemes, each AP chooses its best sub-channel based on estimations of network parameters like the amount of active nodes in its BSS or measurements of its local energy, interference levels, and quality of adventure.

Figure 1 shows the typical hand-off scenario. Because the client S-T-Arts the hand-off but doesn't know which AP to connect to, the quality of service (Q-o-S) suffers, and the hand-off takes a long time. To overcome the issues in conventional Wi-Fi connections, a new paradigm known as software (programme) defined connections has recently been established.

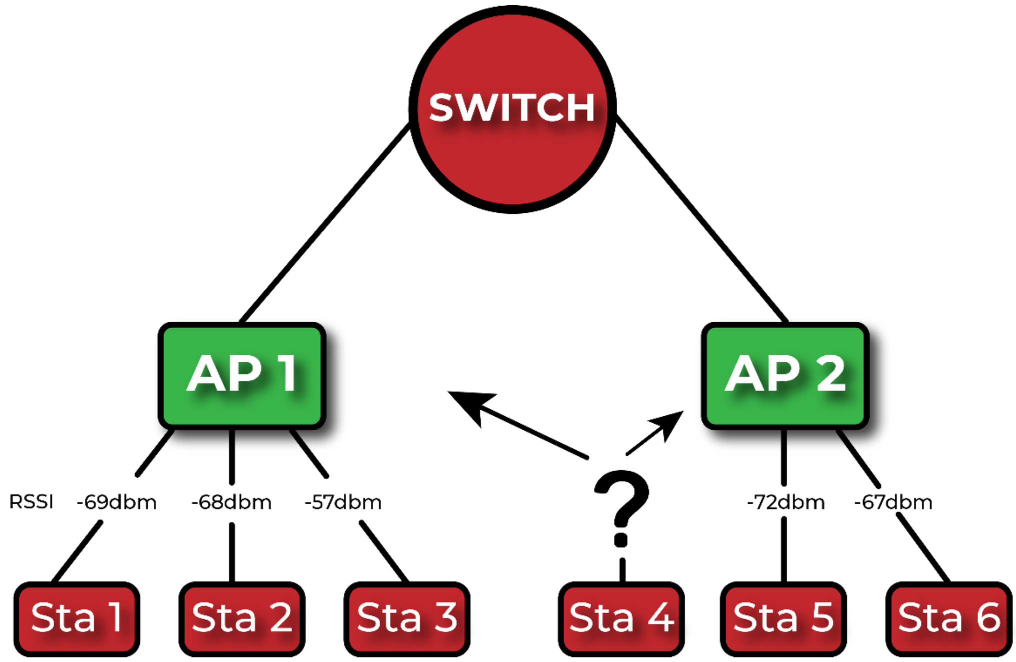



FIGURE 1 Handoffs in WiFi networks

Both cellular and Wi-Fi connections are aided by S-DN. The control and data planes are separated, allowing for logically centralized management. Through the provision of programmability, the central regulator controls the network. In comparison to other communication technologies, networking technologies have traditionally progressed more slowly. Switches and routers are examples of network equipment that manufacturers have historically created. Each vendor creates their own proprietary and closed firmware and other software (programme) to run their own hardware. When new services, technologies, or hardware needed to be installed within existing connections, this resulted in an increase in management and operating costs, which hindered the advancement of networking technology breakthroughs. The control plane, data plane, and management plane are the three major logical planes that make up the architecture of modern connections. Hardware for connections has so far been created with control and data planes that are closely connected. Thus, it is well known that traditional connections follow the "within the box" concept. The complexity and expense of managing and administering connections are greatly increased by this. To rethink the design of conventional connections, networking research communities and industry market leaders have worked together. As a result, ideas for a new paradigm in networking, known as programmable connections, have surfaced (like active connections and Open Signaling (Open Sig)). Software (programme)-Defined Networking (S-DN) has recently become more well-liked in both academia and business. S-DN is not a novel idea, but rather a revision of past suggestions that were looked at a few years ago, primarily programmable connections and initiatives to separate the control and data planes. It is the result of a protracted operation that was started by the desire to "think outside the box" using network. S-DN's major goals are to consolidate network intelligence and S-T-Ate and to segregate the control plane from the data plane. Routing Control Platform (RCP), 4D, Secure Architecture for the Networked Enterprise (SANE), and more recently Ethane are a few S-DN precursors that aid control-data plane separation. The S-DN philosophy is based on logically centralizing network intelligence and S-T-Ate (at the regulator) and separating control from the network forwarding components (switches and routers). It also abstracts the underlying network architecture from the applications. The Open Flow protocol and S-DN are frequently mentioned together. The latter serves as a foundation for S-DN since it makes it possible to create a global picture of the network and provides a uniform, system-broad programming join for configuring network Stations from a central location. After the Clean Slate Project, Stanford University created the open protocol known as Open Flow. To allow researchers to run experimental protocols in the campus connections they regularly use, OpenFlow was first proposed in. Currently, the advancement of S-DN and the standardization of Open Flow, which is currently published under version 1.4.0, are actively aided by the Open Networking Foundation (ONF), a non-profit industry consortium.

Because the association and disassociation are handled at the regulator end rather than the client end, hand-off detection and discovery times are shortened. We think that the hybrid software (programme) defined Wi-Fi architecture (S-D-Wi-Fi), when compared to custom hardware/protocol solutions, can feature shorter hand-off times after examining the existing Wi-Fi and S-DN literature. Using the benefits of S-DN to enhance overall network presentation, we present a DeRy strategy in this research that attempts to decrease detection and discovery times during the hand-off operation. The S-DN regulator, who has a comprehensive picture of the network, gathers AP information using S-N-M-P and R-S-S-I management. S-N-M-P supervisor offers the A-Ps' load data, while R-S-S-I Manager gives the A-Ps' R-S-S-I values. The S-DN regulator makes the association/deassociation actions to reduce hand-off times after gathering AP reports. When the hand-off is ready to begin, the regulator determines (during the detection phase) and reassociates the mobile Stations with the proper AP (discovery phase). Our approach adds uniqueness in three different ways. Traditional connections only use one statistic to determine hand-offs, which is R-S-S-I. Research has shown that using just one indicator for hand-offs leads to congested hotspots. The use of portable computers, including laptops, tablets, and smartphones, has significantly increased during the past few years. The demand for more dependable mobile communication approach is being driven by the popularity of these Stations as well as the emergence of several cutting-edge mobile applications and online services. Despite the maturation of mobile radio technologies like 3G and 4G, Wi-Fi still offers many mobile customers a more affordable, quicker, and reliable connectivity option. Operators are currently looking to off burden load from their cellular connections to Wi-Fi connections in addition to the mobile consumers. Additionally, the utilization of Wi-Fi will be crucial in future 5G systems, which will integrate a variety of Radio Approach Technologies (RATs) to improve the quality of the user adventure (QoE). In fact, 4G connections are already transitioning to 5G by incorporating a variety of tiny nodes, like Pico and femto cells with a range similar to Wi-Fi, as well as Wi-Fi connections. Network densification is another name for this integration that was presented in the context of 5G. The broad spread use of Wi-Fi technology has also spread to workplaces and public areas like train Stations, airports, and college campuses. Radio Frequency (RF) overlapping Wi-Fi Approach Points (A-Ps) are used to construct large-scale Wi-Fi connections to provide users with reliable signal coverage and redundant connectivity. IT managers are in charge of these contemporary enterprise Wi-Fi connections, and they are continually up against the problem of meeting the growing demand from network users for greater capacity and better connectivity. Enterprise Wi-Fi connections are particularly dynamic since mobile users can join and depart at any time, unlike wired connections where the network magnitudes set and the volume of load can be expected. More significantly, because each mobile user may be using a different application, the load inside these connections is characterized by varied Quality of Service (Q-o-S) needs and varying transmission rates. Furthermore, as new bandwidth-hungry services are launched, these demands are growing with time. The Wi-Fi spectrum is a limited resource, therefore a considerable increase in mobile load will eventually cause network congestion, which will lower network presentation and lower the quality of coverage. The effects of this are already being felt in the present.

By considering both the A-Ps' R-S-S-I values and load burden, our approach aims to shorten hand-off times. The frequency of hand-offs is reduced by taking the load burden into account since the destination AP that the regulator chooses ensures the quality of service. In contrast to earlier research where only client side or AP side information was considered separately, the second component of the proposed study is that both the client side and AP side3 are controlled for lowering the hand-off times. Finally, our method is suitable to any mobile Station that complies with the OpenFlow specifications and doesn't call for any hardware modifications. The following are the study's major contributions:

- We suggest DeRy to shorten S-D-Wi-Fi hand-off times by using S-N-M-P and R-S-S-I administrators. While the R-S-S-I manager sends the A-Ps' R-S-S-I information to the regulator, the S-N-M-P manager sends the load information to the S-DN regulator. The regulator chooses which destination AP to associate to and when to initiate hand-off (detection phase) after gathering these reports (discovery phase).
- To shorten hand-off times and guarantee Q-o-S, we provide a multi-criteria method based on R-S-S-I and load burden to choose the best destination AP.
- To test the DeRy presentation evaluation for multiple associations, we develop a simulation environment (connections).

# CHAPTER 2: RELATED WORK

## 2.1 Hand-off in Wi-Fi Connections

The client-driven approaches let mobile Stations start the hand-off operation on their own, but they don't provide a comprehensive view of the network, which outcome in considerable hand-off time lags. Because of the broad spread adoption of smartphones, mobile data load is dramatically growing. The first quarter of 2013 saw an increase in mobile data load from 750 PB to 1,500 PB, according to an Ericsson Potency analysis. Numerous mobile carriers aimed to supply a sizable share of mobile data through Wi-Fi A-Ps to accommodate the rising demand for mobile load. As a result, Wi-Fi A-Ps are not just employed in houses but also as important load off burdening nodes that offer consumers in public spaces fast Internet connection while also costing service providers less to install. Wi-Fi, in contrast to cellular connections, employs ISM bands, which are generally available to everyone. As a result, both mobile carriers and private AP installers randomly distribute approach points. Because of the aforementioned allocation characteristic and increased Wi-Fi AP installation in public areas, mobile communications are severely hampered, which reduces the down burden speed for mobile Stations. For instance, the majority of mobile Stations immediately connect to the AP with the strongest signal, although strong signal strength is not always a guarantee of the mobile Stations receiving quality Internet service. It is true that receiving data packets with more sophisticated modulation schemes is more likely when the received signal strength (RSS) is elevated. However, such a linear relationship is only possible in the ideal situation without any multipath fading or interference. Elevated levels of noise or interference in the signal intensity make it difficult to decode received packets with elevated probability, leading to elevated packet error rates (PER), which reduce mobile Station transmission rates. Therefore, it's important to prevent poor mobile quality from selection operations that are blind to the quantity of interference. Although there are numerous research projects that aim to increase Station down burden speeds, there have only been a small amount of studies that focused on AP connection management for the reasons listed below. First off, because the I-E-E-E 8,02.11 standard was initially created for the mobile extension of local area connections, it was not intended to be used in very crowded public spaces. Second, unlike cell towers, which offer appropriate input for greater synchronization and fairness to communication nodes, Wi-Fi A-Ps essentially only supply extremely restricted sorts of feedback to mobile Stations. Despite the fact that I-E-E-E 8,02.11 calls for a BSS burden element that carries data on AP burden, the variable is optional, and many A-Ps currently do not provide the value to Stations.

Before a Q-o-S-satisfying condition is reached, repeated affiliations and re-associations are necessary. To achieve seamless data transfer and hand-offs simultaneously, a two Wi-Fi join mechanism is modified. We are seeing enormous expansions in the areas covered by 8,02.11 mobile local area connections (M-L-A-Cs) as a result of their commercial success. As a result, we are urged to move around within the range of the 8,02.11 M-L-A-Cs since real-time services necessitate strict quality-of-service standards. The 8,02.11 hand-off has been the subject of numerous studies for this reason, as it is the technology that enables the Station (S-T-A) to cross cell boundaries without experiencing service interruptions. A well-designed hand-off operation can also help to lower S-T-As' energy usage in mobile situations, according to recent studies. Three operations are required for the 8,02.11 hand-off operation, according to the 8,02.11 standard: scanning, authentication, and re-association. An 8,02.11 S-T-A searches nearby approach points using the 8,02.11 scanning operation (A-Ps). Among the scanned A-Ps, the scanning S-T-A may select the most suitable AP for its hand-off. Validation and connection establishment for the scanning S-T-A are done using the authentication and re-association methods, respectively. In and, it is objectively demonstrated that, out of the three steps that make up the 8,02.11 hand-off, scanning takes the longest amount of time.

Because of this, studies on the 8,02.11 hand-off have concentrated on lowering the scanning time, as will be covered in more depth below. In an effort to maintain communication between a scanning S-T-A and a serving AP, Brik et al. and Ramachandran et al. aimed to remove scanning lag. They suggested using multiple radios to implement 8,02.11 hand-off methods for this reason. S-T-As are built to test out scanning techniques with a single radio for solely scanning purposes. For typical 8,02.11 operations, like 8,02.11 frame exchanges, the other radios are employed. The possibilities for 8,02.11 frame droppings and frame transmission lags during the scanning operation are significantly decreased by their systems. Although most commercial S-T-As only have one radio, the suggested approaches limit their benefits by requiring S-T-As to have at least two radios. In contrast, we suggest that A-Ps have many radios, whereas a S-T-A only has one radio. An AP's radios are configured to share a single basic service set identity1 (BSSID). One of them is set up to function solely on a channel designated for scanning. In other words, the reserved channel is being used by one radio on each AP. An S-T-A doesn't need to scan any other channels after that; it only searches the reserved channel. Therefore, regardless of how long the scanning time is, we do not need to be concerned about it. This is so that a typical scanning S-T-A with a single radio can continue to use the serving AP for standard 8,02.11 operations. We use empirical evidence to demonstrate that the suggested hand-off suffers from fewer packet droppings than the other hand-off systems. In addition, while assuming that a user switches from one AP to another AP, we analytically assess the aggregate packet droppings that each hand-off strategy may cause.

The idea of two joins is constrained because the A-Ps available on the market only have one Wi-Fi join. The location of the mobile Stations and the neighboring A-Ps is used to reduce the hand-off times. With connection-based random approach, a connection is established before data packet transmission, in contrast to traditional packet-based random approach methods where each data packet must compete for channel approach. The characterization of such a threshold has received little attention, despite the general opinion that there exists a crucial threshold of the data packet transmission time, only above which establishing a connection is advantageous. To characterize the requirements for advantageous connection establishment, a comparison study on the optimal throughput presentation of packet-based random approach and connection-based random approach will be presented in this work. For both packet-based and connection-based Aloha and Carrier Sense Multiple Approach, precise representations of the maximum effective throughput are achieved using a unified channel-centric paradigm (CSMA). The analysis demonstrates that the ability of nodes to sense has a significant impact on whether connection formation is advantageous. It is discovered that the threshold of data packet transmission time with Aloha is significantly lower than that with CSMA, proving that the throughput advantage brought about by connection formation is more substantial when sensing is not present. The analysis provides crucial insight into the machine-to-machine (M2M) communication approach design. Random approach has been broadly embraced in a variety of mobile communication connections, including Wi-Fi and cellular connections, as a fundamental sort of multiple approach. Each node chooses when to approach in a distributed way with random approach. When there are several concurrent transmissions, transmission failures may happen as a result of a lack of coordination among nodes. Both connection-based random approach and packet-based random approach have many uses. For instance, the basic approach mechanism and request-to-send/clear-to-send (RTS/CTS) approach mechanism of the Distributed_Coordination_Function (D-C-F) in Wi-Fi connections are examples of packet-based random approach and connection-based random approach, respectively. Each node in the RTS/CTS approach mechanism transmits an RTS frame to connect to the approach point before sending each data packet. Transmission errors therefore only affect RTS frames, which are significantly smaller than data packets. However, gains from a decrease in transmission failure time may not always outweigh the cost of connection establishment, particularly if each data packet's transmission duration is brief. Growing concerns about the necessity of connection establishment have arisen with the rise in popularity of machine-to-machine (M2M) communications, where a typical scenario is large machine-type Stations (MTDs) sending brief packets. Many are calling for the adoption of grant-free (i.e., packet-based) random approach protocols.

The decision to choose an AP in the coverage region rests with the A-Ps (selective scan). The AP that the mobile Stations are currently attached to chooses the destination AP. This study models and improves approach point (AP)-Station (S-T-A) relationship via airtime usage control to manage and enable service customization across many internet service providers (ISPs) sharing the common physical framework and network capacity in virtualized Wi-Fi connections. To be more precise, an optimization problem is defined based on the transmission probabilities of the S-T-As to maximize network throughput as well as to ensure ISPs airtime consumption. Because of the proposed optimization problem's intrinsic non-convexity, an algorithm to find the best solution is created by repeatedly combining geometric programming with monomial approximation. The improved distributed channel approach (EDCA) protocol's suggested three-dimensional Markov-chain model forms the basis for this discussion, which also covers how to precisely implement each S-T-A's optimal transmission probability using MAC parameters. Through numerical findings, the effectiveness of the developed association and airtime control scheme is assessed. Numerical findings demonstrate presentation benefits of the proposed approach in enhancing throughput and maintaining airtime usage guarantees for both homogeneous and non-homogeneous S-T-A distributions.

Following a series of messages exchanged between the nearby A-Ps, the destination AP is chosen. Elevated hand-off times are a result of the needless message lags between the A-Ps. The AP channels are switched between using dynamic frequency selection (DFS) for a smooth hand-off. Two Wi-Fi joins—one for passive monitoring and the other for load monitoring—are used in the method. The data is gathered by the joins and sent to the BIGAP server for hand-off management. Scanners need a lot of channels, and the hardware they employ has a set hand-off time reduction limit. We demonstrate BIGAP, a cutting-edge architecture that offers enterprise I-E-E-E 8,02.11 connections outstanding network presentation as well as flawless handover. To accomplish the former, co-located A-Ps can be given alternative channels to make the most of the available radio spectrum. The latter is accomplished by utilizing I-E-E-E 8,02.11's Dynamic Frequency Selection (DFS) feature to provide a method for handover below the MAC layer. In essence, BigAP pushes customers to switch A-Ps even when they "think" they are just changing channels. BIGAP is completely 8,02.11 compliant and doesn't call for any changes to the mobile clients. Today's workplace I-E-E-E 8,02.11 mobile connections (Wi-Fi) must aid users that are genuinely mobile (smartphone/tablet) and as a result, they need much stronger indoor and outdoor potency aid. The requirement for capacity-hungry innovative applications like multimedia streaming apps, mobile HD visual, social networking, and cloud storage means that merely offering coverage is no longer sufficient. To solve this problem, enterprise IT departments deploy approach points (AP) very densely so that each client Station (S-T-A) can connect to an AP that is situated quite nearby. Neighboring A-Ps are run on different RF channels to prevent co-channel interference and competition between co-located A-Ps. This is a promising strategy since, even with dense AP deployments, the new 8,02.11ac standard's additional increase in the amount of 5 GHz spectrum makes it possible to reuse channels and partition A-Ps into independent collision domains.

In vehicular connections with 5G capability, tasks are off burdened and scheduled adaptively. The social Internet of Vehicle (SIoV) is quickly gaining popularity as a study issue in both academic and commercial circles because to its huge potential to guarantee load safety and enhance the driving adventure. The need to offer consumers a variety of security-related and user-oriented vehicular applications has grown as a result of the ever-increasing variety, quantity, and intelligence of on-board equipment, as well as the ever-increasing demand for service quality of automobiles. The design of a service approach system in SIoVs, which focuses on a reliability assurance approach and quality optimization method, is the major topic of this work. First, a dynamic approach service assessment scheme is looked into in place of the instability of vehicular Stations, which analyses the possible relevance of cars by building their social ties. To deal with an unstable network topology and a elevated rate of disconnection in SIoVs, this work then examines a trajectory-based interaction time prediction algorithm. Finally, a cooperative quality-aware system model for service approach in SIoVs is put forth. Outcome from simulations show how effective the suggested plan is.

| **Abbreviations** | **Description** |
|---|---|
| **AP** | Access Point |
| **DeRy** | Detection and Discovery |
| **DFS** | Dynamic Frequency Selection |
| **Dpid** | Daemon Process ID |
| **LAP** | Logical Access Point |
| **MIB** | Management Information Base |
| **OCLB** | Online Controller Load Balancing |
| **QoS** | Quality of Service |
| **SD-WiFi** | Software-defined WiFi network |

| | |
|---|---|
| **SNMP** | Simple network management protocol |
| **TALB** | Traffic aware load balancing |
| **UDP** | User datagram Protocol |

Taxi real-time tracking is used to show how well the scheduling discipline works. By improving the current broad body area connections, a low-cost health monitoring system for the house is developed. The rapid development of the Internet of Medical Things (IoMT) encourages broad spread connections for in-house health monitoring. However, overbearing patient demands lead to a lack of spectrum resources and a communication overburden. A promising paradigm to overcome this challenge is 5G health monitoring facilitated by Mobile Edge Computing (MEC). In this research, we divide the IoMT into two sub-connections, namely intra-Mobile Body Area Connections (B-B-A-Cs) and beyond-B-B-A-Cs, to develop a cost-effective in-house health monitoring system. The cost of patients varies on medical importance, the Age of Information (AoI), and energy usage, underscoring an aspect of IoMT. A cooperative game is created to distribute the mobile channel resources for intra-B-B-A-Cs. While for beyond-B-B-A-Cs, a decentralized non-cooperative game is suggested to reduce the system-broad cost in IoMT, taking into account individual rationality and potential selfishness. We establish the Nash equilibrium capability of the suggested algorithm. Additionally, a theoretical formula is used to determine the maximum algorithm time complexity and the amount of patients who will benefit from MEC. Presentation assessments show the efficiency of our suggested algorithm in terms of the cost to the entire system and the amount of patients receiving MEC. The Nash equilibrium is reached using a game theory technique, which outcome in a trade-off between cost and patients' utilization of mobile edge computing.

## 2.2 Hand-offs in software (programme) defined connections

Using flow tables, S-DN is used to S-T-Ability the incoming load at the A-PS. When compared to the conventional burden stabilizing method, server burden stabilizing based on S-DN can significantly improve presentation while reducing implementation complexity. Open flow is the S-DN switch's south join protocol. The dynamic construction of Open flow tables is the foundation of server burden stabilizing based on S-DN. This work proposes a dynamic flow table design technique based on the combination of single flow table and group flow table, where single flow table can efficiently monitor client load while group flow table can categorize client hosts. In addition to avoiding too many flow tables and improving the problem of a flow table matching range that is too large, experiments demonstrate that this approach has strong viability and improves network load scheduling presentation. Using burden stabilizing technology to address this issue has evolved in recent years with the explosive growth of the Internet economy into a backend server essential measure. The burden stability serves as a link between the network and the server; it typically needs to know the server's health status but isn't required to be able to configure the network protocol or read or modify packet content information. Traditional burden stabilizing Stations are designed with the operation conditions of the server computer equipment (like CPU utilization) in mind. However, because there is currently little network load, there is little need for fine-grained monitoring and scheduling. This is primarily because the network framework is a relatively closed system. Although the conventional router has a thick chain of control, it may divide bandwidth among various pathways. Professional burden stabilizing servers typically require two to seven layers of data operationing, making it simple for them to become the system's bottleneck as a whole.

The flow table uses a set of IP addresses. The S-T-Ate of the clients influences the operationing decisions. If all the customers have the same status, the procedure becomes complicated. The research ignores the affiliation and re-association times on behalf of the scheduling approach. The multi-regulator burden is reduced via a burden information method. One of the ideas for the Internet of the future that is currently seen as holding the most promise is software (programme) defined networking (S-DN). There is no flexible mechanism to S-T-Ability burden among regulators, despite the fact that the availability and manageability issues that a single, centralized regulator faces could be resolved by using numerous regulators. This study suggests a burden stabilizing approach for numerous distributed regulators based on a burden informing strategy. With the help of the mechanism, a regulator can quickly decide how to S-T-Ability burdens locally. Experiments using floodlights demonstrate that our system can dynamically S-T-Ability the burden on each regulator and shorten the burden stabilizing period. To provide programmability and simpler management, software (programme) defined networking (S-DN) has evolved as a fresh and promising paradigm that is migrating from traditional connections to the Future Internet. A centralized control plane in S-DN has numerous advantages, including allowing a single node to manage the whole network and isolating the underlying network architecture from the applications. But the use of a single, central regulator introduces possible manageability and reliability problems. To minimize this bottleneck, some research studies have designed the deployment of multiple regulators. These techniques potentially solve the problem, but they all have one major drawback: a statically constructed mapping between a switch and a regulator makes it difficult for the control plane to adapt to uneven burden distribution. The restriction will result in decreased network efficiency. Thus, it is crucial to resolve the situation. Currently, the research work about burden stabilizing decisions of multiple regulators can be divided into two categories: the centralized decision and the distributed decision. For the centralized decision there are two essential operations: one is collecting burden information of all local regulators and the other is sending burden stabilizing commands to the local overburdened regulator. The time efficiency of burden stabilizing is not very elevated because of these two procedures. Every regulator can decide on a stability locally for distributed decisions, eliminating the need to send burden stabilizing commands. However, the current distributed decision-making mechanism requires gathering data on other regulators' burdens before allowing an overburdened regulator to make a choice. This procedure makes burden stabilizing take longer to complete. We provide a burden stabilizing mechanism to quickly restore S-T-Ability to an overburdened regulator. The distributed decision is used. In the meantime, it is built on a burden informing technique where each regulator actively informs its burden information on a periodic basis. Additionally, it handles and saves burden data that is provided by other regulators. Additionally, an inhibitory algorithm is proposed to lessen the frequency of informing to reduce the overhead of communication and message operationing produced by the technique. The average message arrival rate is used to estimate the strain on the regulators and A-Ps. Message arrival rate determines the sequence in which the switches are set. The regulator's generated instructions are used to migrate the switches. However, the current distributed decision-making mechanism requires gathering data on other regulators' burdens before allowing an overburdened regulator to make a choice. This procedure makes burden stabilizing take longer to complete. We provide a burden stabilizing mechanism to quickly restore S-T-Ability to an overburdened regulator. The distributed decision is used. In the meantime, it is built on a burden informing technique where each regulator actively informs its burden information on a periodic basis. Additionally, it handles and saves burden data that is provided by other regulators. Additionally, an inhibitory algorithm is proposed to lessen the frequency of informing to reduce the overhead of communication and message operationing produced by the technique.

The optimal switch selection leads to mitigation of unnecessary resource utilization. During the switch migration unnecessary messages are exchanged between the switches and the regulators, which lead towards the factor. For switch selection, the discovery and detection times are not taken into consideration. The game model is used for AP movement in games. A viable method for scalable software (programme)-defined networking is the distributed control plane (S-DN). To manage peak switch load utilizing available control resources, live switch migration from overburdened regulators to underutilized regulators may be an option. To effectively utilize the CPU, bandwidth, and memory resources that are available, such migration must be carried out through a well-designed operation. In this article, we first present a resource model for S-DN and then reduce the decision to migrate switches to a centralized resource maximization problem with CPU, bandwidth, and memory limitations. Second, we demonstrate the similarity between the maximization of game players' profits in the setting of non-cooperative game theory and the problem of maximizing resource use in an S-DN. The player policy dictates how switches are moved among the control plane, treating regulators and switches as game players and commodities, respectively. Finally, we put into practice a GAME-Switch Migration proof of concept (GAME-SM). The numerical tests performed with the Mininet emulator confirm the beneficial characteristics of our game model in improving S-DN control plane presentation. S-DN has gradually been implemented with a distributed control plane, allowing operators to deploy a amount of regulators in a network, because of the fact that the first S-DN paradigm with a single regulator is deployed in a small-scale network. All regulators serve local requests without contacting any remote ones and share the same consistent network-broad views. Such an architecture fixes the mappings between regulators and switches, despite the fact that it could reduce the flow setup time. Even when it is overburdened, a switch cannot transition from its original regulator to another. The work burden of switches, however, can easily alter, resulting in an instability control plane where some regulators are overcommitted and others are underutilized.

The sole factor taken into consideration for migration is the A-Ps' utilization ratio. Although the game theoretic strategy appears to be the ideal one for AP migration, it entails various intricate mathematical calculations that make it possible for lots of malicious requests to enter the network. The handover times are not considered during AP migration. Online regulator burden stabilizing decreases the regulator response time (OCLB). A popular method for enhancing the manageability of software (programme)-defined data center connections is the distributed control plane. Since the network flows are erratic, understanding how to evenly distribute the burden across the regulators is still a challenging problem. To solve this problem, we suggest an online regulator burden stabilizing (OCLB) system. To reduce the average regulator response time, we first construct the burden stabilizing problem as an optimization problem. Then, we break it down into a series of switch migrations, each of which aims to cut the average response time as much as feasible based on the distribution of real-time requests. Based on the derived optimality and termination conditions of switch migration, an OCLB algorithm is developed and shown to be nearly optimal with a constrained competitive ratio. Evaluations show that our method can online burden S-T-Ability the control plane in a manner that is close to ideal. The goal of software (programme)-defined networking (S-DN), a new paradigm in networking, is to separate the control plane from the data plane. S-DN is gaining popularity in business and data center connections thanks to its aid for quick innovation and adaptable management. A centralized regulator is used by S-DN to create network policies based on the overall network perspective. A single centralized regulator adventures scaling issues, just like the majority of centralized systems. The major problem with manageability is typically regulator overburden brought on by the emergence of additional flows in the network, which causes unacceptably slow response times for requests for flow establishment. Numerous distributed control planes with a cluster of regulators have been proposed as solutions to this problem. By assigning switches to various regulators, they divide the network into a amount of domains, with each regulator only accountable for the network events and flow setup requests relevant to the switches in its domain. In this manner, the burden on the regulators is divided among several regulators, reducing the reaction time. However, because the flows in actual data center connections are unevenly distributed and fluctuate often, the static assignment of switches to regulators may lead to an instability burden on the regulators, lengthening the time it takes for the flow setup. The best method for achieving burden stabilizing is dynamic regulator assignment, which chooses the best switch-regulator relationship based on the distribution of flow requests. Unfortunately, they are frequently represented as integer programs, and the algorithms used to solve them typically have an elevated level of computational complexity, making them less responsive and difficult to adjust to flow bursts and extreme flow fluctuations. For instance, the assignments produced by these algorithms based on the original request distribution may not be ideal when applied to the current pattern because the request distribution is changing over time.

30 Using OCLB based on AP migration, the distributed control plane's manageability is improved. The AP migration ignores the hand-off times required to cut down on discontinuation. S-DN and artificial intelligence (AI) approaches are used in an Internet of Things (IOT) context to correct multimedia transmission issues. In the previous few years, multimedia load has significantly increased. The Internet of Things (IoT), one of the most recent concepts to be presented, also introduces new load and application types. S-DNs, or software (programme)-defined connections, enhance network management's capacity. When used in conjunction with S-DN, artificial intelligence (AI) can offer solutions to network issues based on approaches for classification and estimate. In this research, we provide an AI system for detecting and fixing multimedia transmission faults

in an IoT surveillance environment connected by an S-DN. Details about the S-DN's architecture, algorithm, and messages are provided. The test-bed and data set are explained, along with the design of the AI system. There are two distinct components to the AI module. The first one is a classifying component that determines the kind of network load. The second component is an estimator, which advises the S-DN regulator on the type of action to be taken to ensure the adventure and service quality. According to the outcome, the network may minimize jitter by up to 70% on average and droppings can be cut in half from 9.07 percent to around 1.16 percent by taking certain actions. Additionally, the proposed AI module has a 77 percent accuracy rate for detecting essential load. All other users who wish to utilize this content for commercial or promotional purposes, create new collective works for selling or redistribution to servers or lists, or reuse any copyrighted elements of this work in other works must first receive I-E-E-E's permission. In the previous few years, multimedia load has significantly increased. The Internet of Things (IoT), one of the most recent concepts to be presented, also introduces new load and application types. S-DNs, or software (programme)-defined connections, enhance network management's capacity. When used in conjunction with S-DN, artificial intelligence (AI) can offer solutions to network issues based on approaches for classification and estimate. In this research, we provide an AI system for detecting and fixing multimedia transmission faults in an IoT surveillance environment connected by an S-DN. Details about the S-DN's architecture, algorithm, and messages are provided. The test-bed and data set are explained, along with the design of the AI system. There are two distinct components to the AI module. The first one is a classifying component that determines the kind of network load. The second component is an estimator, which advises the S-DN regulator on the type of action to be taken to ensure the adventure and service quality.

## 2.3 Handoffs in Software-defined Wi-Fi connections

Mobility support is an important factor to overcome the handoff-times in software defined Wi-fi connections. Reliability of control section (reliability of control section meaning a small system can be changed into large system to obtain new demands of system and improves the system) is improved using the different techniques because it is a critical issue to design a scalable SDN control section due to increase in the publicity of Wi-Fi connections defined on software. For software defined control section, we give a matric of scalability and try to know about the details of three control sections architecture. These architectures are centralized, decentralized and hierarchical architectures. We develop a model of execution for time response based on which we estimate reliability of these three structures. With the help of mathematical models, we compare these models. For results we performed numerical estimation. Scalability is a property of Information technology IT which helps to stable the function when its size and volume changes. Scalable control functions are supported by Wi-Fi connections defined on software. Mainly used techniques are machine learning and heuristic techniques. There are four types of machine learning that can be classified as supervised, semi supervised, unsupervised and reinforcement. Machine learning is a technique in which a model is trained by giving the input and results are obtained based on training given to the model.

Machine learning already increased speed of software defined wide areas connection SD-WAN because software applications require high speed connection. Applications like chatbots and upcoming series of these application require fast internet connection that’s why we use machine learning to operate with real time data efficiently. Machine learning through SD-WAN has two advantages. It is expensive and provide the quality-of-service Qos to meet the requirements of latest applications.

Heuristic techniques are used to solve the problem using the practical method or a shortcut method that may not be suitable but enough to solve the problem under the specific given time. There are several heuristic techniques which can be classified as trial and error, historical data analysis, guesswork and process of elimination. These techniques are used to solve a problem when other general methods cannot find an appropriate solution of a problem. It does not provide a better solution all the time but can find the approximation of correct solution. There are two types of controllers are used which are global controllers and local controllers. Both perform the different functions. The load of local controller is controlled by the global controller. These controllers are employed in double-edged architecture. Data flow priority is given to global controller with the help of support vector machine and type 2 fuzzy techniques.

Support vector machines are the models that are trained by the supervisor with the help of associated algorithm which analyse data for data classification and regression. Support vector machine is also used in banking application for example they can recognize original ATM cards and fake ATM cards. Support vector machines have their applications in medical field for example it can be used for the examination of gene extracted from tumor sample.

Fuzzy techniques are used to deal with uncertain data. when we have to deal with noise voltage or a distorted signal then we use Fuzzy techniques. Type 2 fuzzy techniques are more suitable to deal with uncertain data more efficiently than type 1 fuzzy techniques. Type 2 Fuzzy techniques have many applications in the field of control and classification etc. Usually, we use Fuzzy system because it can deal with uncertain data efficiently and Fuzzy techniques can be used to model nonlinear data.

Traffic amount on Access point AP does not come into account. Continuous service is given to the mobile station by tools and protocols that are called logical access points in information technology. These tools and protocols play role in identification, authentication, authorization, and accountability. It requires login password, personal identifications digits, bio metric verification, security tokens, other authentication element. Based on these factors, it allows or deny the mobile station to connect with a Wi-Fi connection. For access selection a parameter is used call received signal strength indicator (RSSI) that is not enough for better performance execution. Received signal strength indicator RSSI provide the service to detect new users and then make their connection to the available connection by using the adaptive load balancing scheme.

Unbalanced traffic amount reduces the performance of system, so an Adaptive load balancing scheme is used to balance the traffic amount on different access points Ap's. When many people gathered at a public place like campus, hospital, markets etc. Then load on Wi-Fi Ap is imbalanced. In order to balance load on Wi-Fi Ap we use adaptive load balance scheme. It includes event identification mechanism and adaptive load balancing algorithm. It provides the solution based on traffic amount and number of users on Aps. Time consumed during the connection of mobile station to destination Access point Ap is not come into account.

Traffic-aware-load-balancing scheme (TALB) is a scheme used to balance the traffic amount form machine to machine and this scheme is very important for traffic carrier when there is a lot of traffic amount on Ap’s. TALB scheme improves the quality-of-service Qos by identification and providing the alternative paths to traffic amount and improves the performance of system by 50 percent as compared to non SDN load balancing scheme.SDN-controller with a traffic aware load balancing strategy contain the overall view of connection. It contains all information about received signal strength indicator RSSI and traffic amount on Aps. Having all these information traffic priorities are retained and time related traffic is done first and then send it to destination server based on priority. TALB does not require medium it supports mobile medium. TALB controls recent traffic and upcoming traffic at a same time. Load is balanced on first SDN standard called Open Flow (A programable protocol that manage the traffic amount and makes traffic function independent of hardware.). that allow SDN-controller to interact directly with advanced section of connection devices like switches and routers by traffic using probability distribution. OpenFlow helps to connect the device and controller. TALB helps to balance the traffic amount on data carrier, but handoff-time gets no attention.

The motion of mobile station is detected by proposing the received signal strength indicator RSSI and fuzzy based solutions. Quality of service Qos decreases with the mobility of mobile statins. To improve the quality of service and minimize handover is very important field of study in Wi-Fi connections defined on software. The occurrence of handoff-time is decided by the motion of mobile station. The server which provides the service takes the decision of re-association depending upon the received signal strength indicator RSSI values and bandwidth consumed. Mobile station maintains the threshold of received signal strength indicator RSSI evaluate solution depends upon dependent relationship created between clients and seller as when handoff takes place the threshold needs to be updated with time in mobile station thus hindering the legerity and workability. In Wi-Fi connections handoff-time is conduct by giving the software defined connection SDN-based solutions. Interchange of communication between the software defined connection SDN-controller and access points Ap's authorize to conduct the handoffs. To check the traffic amount between multiple channels in every access point Ap two wi-fi interfaced are used. To obtain the Mechanism of interact directly with advanced data section of device that is called Open Shortest path first (OSPF) a solution to check the total load of logical software defined connection SDN-controller called adaptive solution is given using software defined connection SDN. To obtain the better routing path matric calculation is put through to load in the connection. To correct the load between the access points Ap's mathematical data of connection are utilized. There is a very less support is available for unwired Wi-Fi connections defined on software as compared to wired connection. Open Flow protocol also do not support the unwired connection. In academic and industrial level mobile connections attain less attention as compared to wired connection. Which causes a big problem in the development of heterogeneous unwired Wi-Fi connections defined on software. We show the performance of unwired Wi-Fi connections defined on software by creating and testing a handoff application. For load balancing decisions mathematical data is calculated by using the software defined connection SDN-controller. Software defined connection SDN-controller also decides the destination access point Ap to connect the unconnected mobile station. This mechanism crashes to determine when the handoff should take place. The Wi-Fi used to improve Wi-Fi connection design, management and presentation called carrier Wi-Fi, which is used to execute seamless handover that takes place from one cell to other without understandable interface of radio connection, balance the traffic amount, loading the traffic amount onto another device and unified attestation. Using the new local area architecture that uses Software defined connection with hardware device called Software access points the connection between Ap and mobile station is abstracted. handoff-time is ignored during the study of seamless handovers. M-SDN management scheme is used to minimize the traffic break off due to handoff. Handoffs are started by utilizing the set of ordered pathways from present Ap to destination Ap. A common problem for connection monitoring tools called duplication packets are utilized for each Ap which are eliminated when the handoff is completed once. N-casting produce multiple data-packets to turn around in connection leading to irrelevant nervousness among the SDN-controller and Ap's.

# CHAPTER 3: DIDE

In software defined Wi-Fi systems, there are two important phases called discovery-phase and detection-phase. Discovery-phase is a procedure that permits server like computers and users like devices to detect each other when they are in a same region. It is a first step to connect the device with the computer. There are three different layers in discovery-phase.

1. First layer is called simple-network-management-protocol SNMP.
2. Second layer is called link layer discovery protocol.
3. Third layer is called ping.
    i. With the help of discovery, we can exchange information between computer and devices. This feature automatically switched on when we are connected to a private connection. This feature automatically switched off when we are connected to a public connection, and we don't permit our systems to be discoverable on public connections. Detection-phase collects data about our capacity to find a connection, knowing the oppositional procedures and then using these capacities to find when an opponent reacts. This procedure happens when collected data is tested and difficulties are detected. There are several types of phase detection which includes

1. malwares.

2. Convolutional Neural Connections.

3.Intrusion Detection System.

4.Sensor Node.

5.Received Signal Strength.

6.Training Phase

These two phases (discovery-phase and detection-phase) usually play an important role to affect the handoff lag. By increasing the efficiency of these two phases we can minimize the handoff lag. DiDe theory plays an important role in Wi-Fi connections defined on software to upgrade the handoff-time. In DiDe theory we apply different techniques to make our system fast. For the betterment of the handoff-time, we use the SDN-controller. SDN-controller acts as brain of the systems. SDN-controller performs several functions. SDN-controller takes all the decisions about re-association of mobile stations with a finest station router Ap. SDN-controller helps in sending the data-packets (a smallest unit of data) to connect the controller with the switch that is called OpenFlow. OpenFlow basically connect helps the server to guide the connection about sending information. Each connection has a specific software, and it guides software about what to do. SDN-controller have all the information like received-signal-strength-indicator RSSI and the traffic amount on each Ap. Received-signal-strength-indicator RSSI values are collected with the help of received-signal-strength-indicator RSSI Manager. received-signal-strength-indicator RSSI value is not a visible thing to the supervisor of device receiving received-signal-strength-indicator RSSI values. received-signal-strength-indicator RSSI values can change greatly and can influence the performance of a software defined Wi-Fi connections. RSSI is usually taken out in the intermediate frequency (IF) stage before the IF amplifier. In zero-IF systems, it is taken out in the baseband signal chain, before the baseband amplifier. RSSI output is usually a DC analog degree. It can also be illustrated by an interior analog-to-digital converter (ADC) and the resulting values construct available directly or via peripheral or interior processor bus. In short words SDN-controller have an overall view of connection that takes two important decisions.

(1) When to start the handoff-time means that when the traffic amount on Ap increases and the traffic amount crosses the certain limit that can be set according to capacity of router let’s suppose 39.9Mbps then SDN-controller disconnects the mobile station from that Ap with the traffic amount more than 39.9Mbps. Because when the traffic amount crosses a certain limit router Ap cannot provide a proper service to the mobile users. Functionality of router Ap is affected when the load on router is more than an allowed limit. Under these conditions, router cause the loss of information. The process of information loss due to increased traffic amount on router is called loss of data-packets. When loss of data-packets occurs, we have to send again our information to router Ap. The process of resending a same information again and again by the mobile station to router Ap is called retransmission. Mean of retransmissions is inversely proportional to the performance of Wi-Fi connections defined on software. This means that when mean of retransmissions increases then the performance of Wi-Fi connections defined on software decreases. In order for the betterment of the efficiency of Wi-Fi connections defined on software we have to reduce the mean of retransmissions. To reduce the mean of retransmissions traffic amount on router Ap must not increase than certain defined limit that is 39.9Mbps.

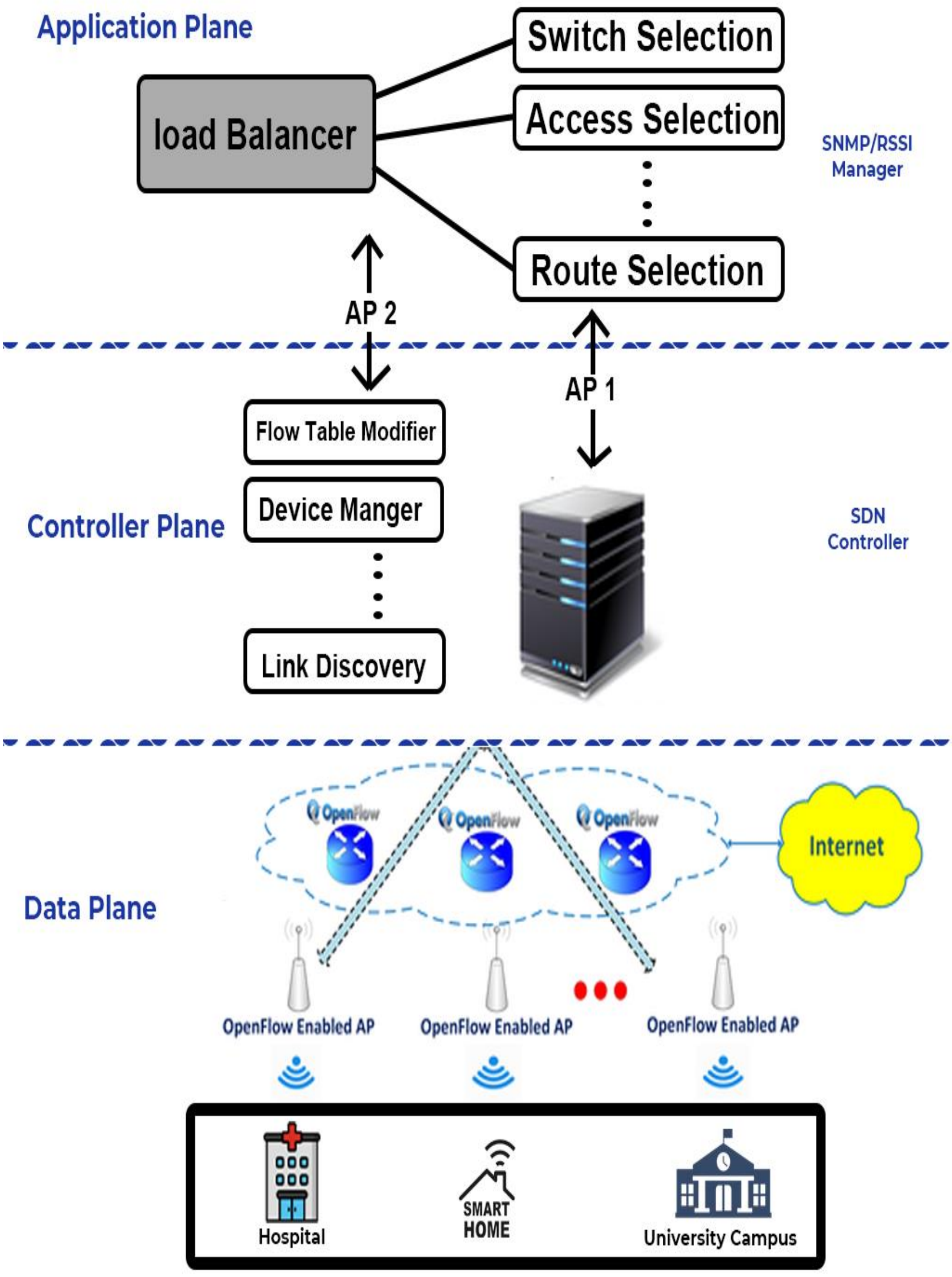
(2) Selection of a finest station Ap that is selected on the behalf of two requirements that are received-signal-strength-indicator RSSI and traffic amount on the Ap. To manage traffic amount SDN-controller plays an important role. When traffic amount increases on a certain limit on router Ap then it selects another a finest station router AP with a suitable received-signal-strength-indicator RSSI values and traffic amount. Details about the traffic amount is collected through simple-network-management-protocol SNMP. The main function of SNMP protocol is to allow mean checking and control of all elements of a computer connection. For this purpose, it set out the

construction of the essential information packages and the data flow between the middle station and single devices.

Connection handling through SNMP depends upon an agent manager model. The main handling station is the system from which the controller checks and controls the several connection members. For this purpose, management software is put that provides SNMP data repossession and the start of certain actions. The agents, which are also applications, are the equivalent on the side of the single connection element. we enter the relevant data on the target device and pass it on to the management station, but we can also make settings by ourselves and perform certain actions. Most popular Windows and Linux systems have these kinds of agent applications already in use by default

To exchange of information between server and user there are seven possible message types:

1. GET request
2. GETNEXT request
3. GETBULK request
4. SET request
5. GET response
6. SNMP trap
7. INFORM request:




Architecture of DiDe is shown in Figure # 2.

In the architecture of DiDe there are three sections.

1. First section is called Application section.

2. Second section is called Control section.
3. Third section is called Data section.

An Application section is a top-level section in Wi-Fi connections defined on software In application section applications depend upon connections to entertain service for end mobile users. It also perform applications like intrusion detection systems, load balancing and firewalls. In Application section there is a received-signal-strength-indicator (RSSI) manager that receives the information from Aps about their signal strength. Received-signal-strength-indicator RSSI manager performs several functions on behalf of received-signal-strength-indicator RSSI values. Received-signal-strength-indicator RSSI manager is used for switch selection. Received-signal-strength-indicator RSSI manager is used for route selection. And Received-signal-strength-indicator RSSI manager is also used for access selection in Wi-Fi connections defined on software.

Second section in the architecture of DiDe there is a control section. A Control section is intermediate section in the architecture of DiDe. A Control section is basically SDN-controller that also performs the several functions based on the information of traffic amount and Received-signal-strength-indicator RSSI. Control section helps to modify the OpenFlow table. Control section helps in link discovery. It also acts as a device manager. SDN-controller have all the information about received-signal-strength-indicator RSSI and traffic amount on routers Ap's. So, SDN-controller select the better station router for the mobile stations. Control section controls the exchange of data from input link to output link. Control section manages the traffic amount by defining the traffic routes. Control section is programmable, it helps to manage Wi-Fi connections defined on software in a better way by reducing the efforts of the manual configuration of every component.

Third section is called Data section. In Data section is the last section in DiDe architecture. In Data section, there are Wi-Fi regions like home, hospital, and university campus etc. where the mobile stations associated with Wi-Fi connections experience the handoffs. Data section acts as a traffic amount carrier of users. In Data section there, are mainly mobile users. When a lot number of mobile users stay at a same place their mobile stations increase the traffic amount on routers Aps and handoff takes place in such places due to many servers. To overcome handoff-times, we use SDN-controller in the structure of DiDe.  These mobile stations exchange information about Received-signal-strength-indicator RSSI values with Received-signal-strength-indicator RSSI Manager through OpenFlow enabled routers Aps that are available for data flow. Calculation is done with these Received-signal-strength-indicator RSSI values that is called computation. After computation SDN-controller in the control section takes the decision about the selection of a a finest station Ap for the reassociation of mobile stations that are disconnected. Received-signal-strength-indicator RSSI values are taken out from the smallest unit of data called packets that is interchanged between mobile stations and routers Aps. In Application section simple-network-management-protocol SNMP helps to collect information about the traffic amount on routers APs. simple-network-management-protocol SNMP is internet protocol that is used to check the connection, finds error in the connection and sometime remote devices can be Configured with simple-network-management-protocol SNMP. Information about the traffic amount collected by simple-network-management-protocol SNMP helps the SDN-controller for the selection of a finest station router Ap. Received-signal-strength-indicator RSSI values and simple-network-management-protocol SNMP values stored in the application section that is a top section of DiDe exchange the information with the SDN-controller .By getting the report about Received-signal-strength-indicator RSSI values and simple-network-management-protocol SNMP , SDN-controller select the most a finest station router Ap to reconnect the disconnected mobile stations.

## 3.1 Reducing Handoff-times

All decision taken by SDN-controller for the selection of a a finest station router to reconnect the disconnected mobile stations are given in Figure # 3.

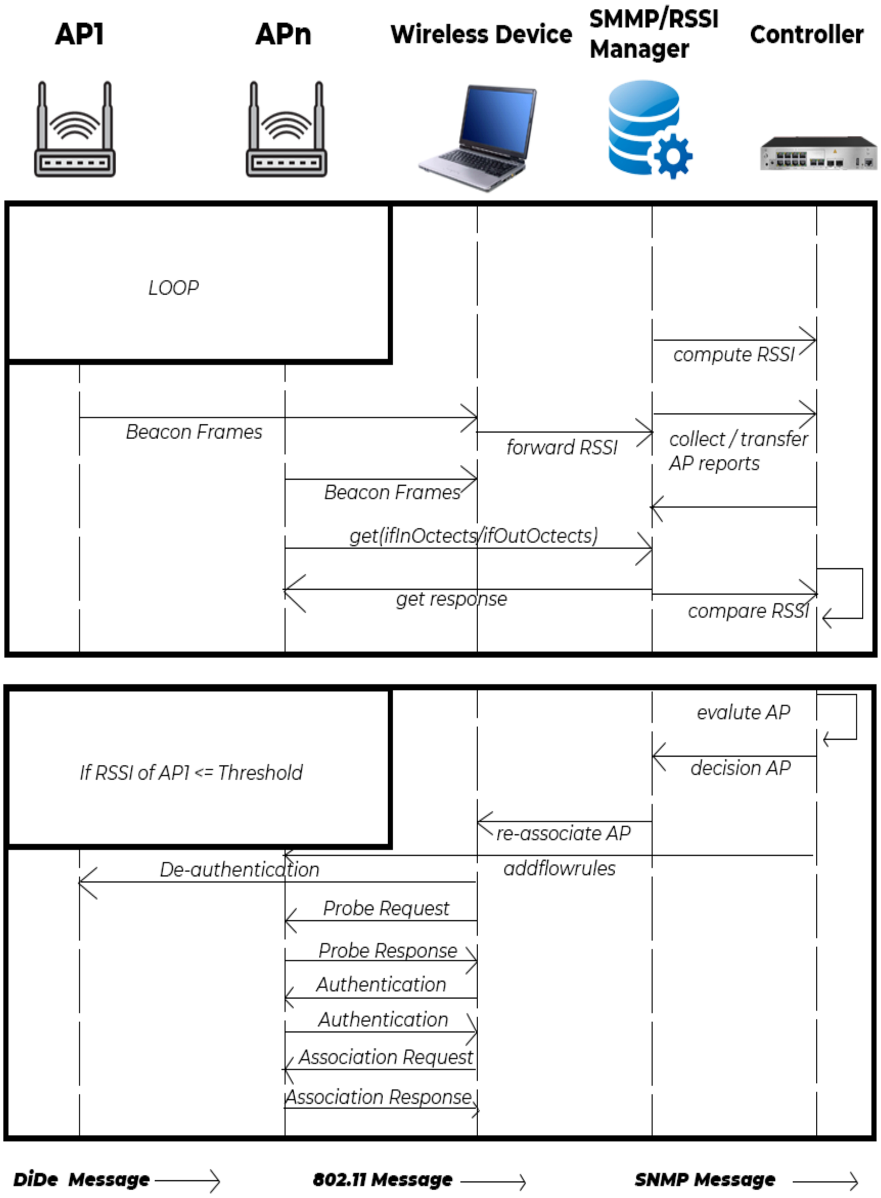



FIGURE # 3 Sequence diagram of proposed DiDe approach.

Figure # 3 is also called sequence diagram because all the components used in Figure # 3 are given in a sequence. There are two routers Aps in sequence diagram. Router First Ap is used as a source Router Ap. While Router Second Ap is used as a station Router Ap. Router Ap with which the disconnected mobile stations are reconnected is called station Router Ap. Received-signal-strength-indicator RSSI values are taken and report about Received-signal-strength-indicator RSSI values are exchanged with Received-signal-strength-indicator RSSI Manager. This process of taking out Received-signal-strength-indicator RSSI values and then forwarding them to Received-signal-strength-indicator RSSI Manager is called forward RSSI. Received-signal-strength-indicator RSSI Manager exchange Received-signal-strength-indicator RSSI values with the controller for further calculation. This process of exchanging Received-signal-strength-indicator RSSI values from Received-signal-strength-indicator RSSI Manager to SDN-controller is called computation RSSI. Comparison of Received-signal-strength-indicator RSSI values is made with router First Ap, which is called source router Ap. This process of comparison of Received-signal-strength-indicator RSSI values with source router Ap is called compare RSSI. Likely, and simple-network-management-protocol SNMP collects the report about the traffic amount on each router Ap. Report about the traffic amount on each router Ap is interchanged with SDN-controller. This process of collecting the report about traffic amount on each router Ap and sending it to SDN-controller is called collect transfer Ap reports. Getting all data report about the traffic amount on each router Ap and Received-signal-strength-indicator RSSI values SDN-controller takes the decision for the selection of a a finest station router Ap to reconnect the disconnected mobile stations. After selection, SDN-controller sends report back to routers that are available to transmit data called OpenFlow enabled routers Aps. This process is replicated continuously until we obtained the threshold value of Received-signal-strength-indicator RSSI. Threshold value of Received-signal-strength-indicator RSSI grant permission to router Ap that disconnects the mobile stations when it is under the specific Received-signal-strength-indicator RSSI value. There are three possible actions that SDN-controller takes in DiDe theory.

(1) when Received-signal-strength-indicator RSSI of First Ap that is called source Ap is greater than threshold then SDN-controller takes no action.

(2) when Received-signal-strength-indicator RSSI of First Ap that is called source Ap is smaller than threshold but greater than Received-signal-strength-indicator RSSI value of Second Ap that is called station Ap then SDN-controller also takes no action.

(3) when Received-signal-strength-indicator RSSI of First Ap that is called source Ap is smaller than threshold and lower than the Received-signal-strength-indicator RSSI value of Second Ap that is called a station Ap then SDN-controller set off the handoff.

Better station Ap must be chosen by SDN-controller to reconnect the mobile stations that are disconnected. If there is only one router Ap in the environment of mobile stations, then it will be the station router Ap because there is no choice for the selection of a a finest station Ap. But when there are several routers are available in the surroundings of mobile stations. In such cases, selection of a a finest station Ap is done by using several measurement standards. Station Ap is chosen on behalf of when Received-signal-strength-indicator RSSI values and traffic amount on each router Ap by SDN-controller. SDN-controller chooses the station router Ap by getting the values of when Received-signal-strength-indicator RSSI and traffic amount. This process of selecting a finest station router Ap is called evaluate Ap. During the process in the selection of a finest station router Ap, SDN-controller must face two situations keeping in view the value of traffic amount within a certain amount of time.

These two situations are given as.

(1) when Received-signal-strength-indicator RSSI of source router Ap is higher than threshold and from Received-signal-strength-indicator RSSI values of other routers Aps and value of traffic amount is smaller than 39.9Mbps that is maximum allowed traffic amount then no handoff takes place.

(2) when Received-signal-strength-indicator RSSI of source router Ap is still higher than threshold and from Received-signal-strength-indicator RSSI values of other routers Aps, but value of traffic amount is greater than 39.9Mbps that is maximum allowed traffic amount then SDN-controller moved towards router Ap which has greater Received-signal-strength-indicator RSSI value and traffic amount on Ap is minimum and SDN-controller choses Ap with these qualities as a finest station router.

After the selection of a finest station router Ap controller sends the report to Received-signal-strength-indicator RSSI Manager and simple-network-management-protocol SNMP. This process of sending report to Received-signal-strength-indicator RSSI Manager and simple-network-management-protocol SNMP is called decision Ap, and introduce flow rule (two approaches are used to introduce flow rule at switches called proactive and active approaches) at the station Ap. The process of introducing flow rule is called add flow rules. Handoff is started by the internet protocol that is used between SDN-controller and the switch called OpenFlow that receives a message from SDN-controller to the source router Ap with service set identifier (SSID is a connection name that allows mobile stations to connect with wanted connection when there are several connections in the environment of mobile stations) of the station Ap. This process is called re-association of Ap. The service set identifier SSID is of the station Ap the mobile stations essentially reconnect to. After getting data mobile station implement "iwconfig wlan0 essid SSIDname" command.

This command works with dual fold actions.

(1) In the first step mobile stations disconnects from the source Ap.

(2) Management frames that spreads in air have service set identifier SSID of the station Ap so only the router Ap with the service set identifier SSID details answers with the area of availability called prob response frame.

Discovery and Detection-phase are handled by SDN-controller in proposed DiDe approach. It is significant to focus on that maximum permitted traffic amount and received-signal-strength-indicator RSSI threshold makes possible to control the connection and connection becomes combination of software and hardware and it is not concerned who developed them.

## 3.2 Traffic evaluation at APS

Traffic amount is main thing that is calculated on Aps in DiDe approach for the selection of a finest station Ap. For data examination it is mandatory to put two elements from Management-information-base (MIB) on the working routers Aps. These two elements are 'ifinoctects' total number of bytes receiving the interface and 'ifoutoctects' total number of bytes sending the interface. After every 15 s the values of these two elements are changed and received at the same time when simple-network-management-protocol SNMP start the job. For the calculation of traffic amount value of octects is used after every 15 s. By subtracting the value of current octect from past octect value of current traffic amount on router Ap can be calculated.

Selection of a finest station Ap is done based on received-signal-strength-indicator RSSI and traffic amount on Aps. For the calculation of traffic amount on router Ap simple-network-management-protocol SNMP use value of 'ifinoctects' (total number of bytes receiving the interface) and 'ifoutoctects' (total number of bytes sending the interface). When simple-network-management-protocol SNMP calculate the traffic amount on router Ap it takes total sum of 'ifinoctects' and 'ifoutoctects'. Data about traffic amount is upgraded after every 15 s. Gap of 15 s helps to make the procedure periodic and aids in measuring the upgraded traffic amount on Aps. We considered the recent traffic amount on Ap is equal to recent values of octect minus past values of octect.

### 3.3 OpenFlow extension message formats

To minimize the handoff-time in software defined Wi-Fi, the connection between device and controller plays a vital role in exchange of information between the SDN-controller and the Aps available for data exchange .OpenFlow information patterns used are given in Figure # Information patterns are weights of size 0.512 kbytes which are used to carry the received-signal-strength-indicator RSSI and traffic details from the router APs to the controller, the outputs evaluated from the SDN-controller reverse to the routers APs and SDN-controller takes the actions . The received-signal-strength-indicator RSSI detail is withdrawn from the packets (smallest unit of data) interchange between the routers APs and the mobile stations whereas the traffic details send back the total number of bytes arriving the router AP interface and total number of bytes leaving the router AP interface. The weight APStat_prefix@ is used to transfer the routers APs received-signal-strength-indicator RSSI amount and traffic details to the controller. The field consist of back-end process that cannot be directly controlled by user called daemon process ID (Dpid), service set ID (SSID), the MAC-address of the source APs (APMAC_1), the received-signal-strength-indicator RSSI and the traffic information.

The weight Result prefix@ and APStat prefix@ are mostly like each other with the deviations that Result prefix@ carries the detection and discovery outputs. The handoff field convey the decisions for handoffs, new flow rules field carries the updated flow rules for the new selected station AP and station AP field mean that the SDN-controller has selected a finest station AP based on received-signal-strength-indicator RSSI and traffic details. The last weight is the DiDe Prefix@ which is used to execute the SDN-controller decisions. The details carried in the fields is the routers APs MAC address (gives a procedure and channel access so that each node of connection can exchange information with other node on connection), specific router Ap and the MAC-address of selected disconnected mobile stations takes the action and reconnected. Connection and disconnection guideline arrangement carried by the carrier field to SDN-controller carry flexible bits according to connection situation.

## 3.4 PLATFORM FOR DiDe

Several methods are available to check the performance of wired Wi-Fi connections defined on software. Wired Wi-Fi connections defined on software means connections where physical circuits are available. And different nodes connect to each other through wires. To check the performance of such circuits is possible by several methods. But in Wi-Fi connections defined on software where there is no physical electrical circuit. To check the performance of such connections is not easy. To check the performance of such circuit's simulation is done. To simulate the proposed DiDe theory we use OMNeT++ Wi-Fi simulator to monitor handoff performance.

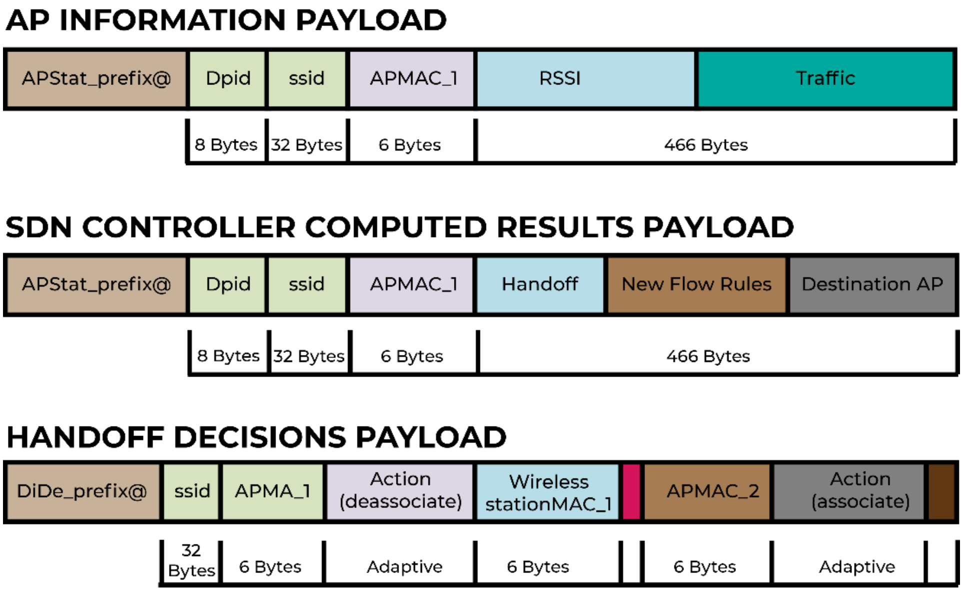



FIGURE # 4 OpenFlow messages formats

### 3.4.1 OMNeT++

To execute examination for SDN Mininet emulator (equipment or programming that permits program composed for one program to be run on the other PC) is utilized which relies upon a Linux based stage. OMNeT++ has colossal guide for the OpenFlow switches (switches that are utilized to interface the gadget and regulator) yet an exceptionally low for medium which doesn't have wires. To display an ongoing IEEE 802.11 channel, OMNeT++ is coordinated to Mininet. SD Wi-Fi is reenacted involving Mininet-NS3-WiFi.42 In NS-3 the constant imitating mode licenses to incorporate the ongoing gadgets to the reproduction code. The imitating clock and reproduction clock are line up with one another. The relationship of the close to one Mininet hubs utilizing a Mininet-OMNeT++-Wi-Fi direct is displayed in Figure #5. The connections are supported by the NetDevice (A gadget that comprise of two sections noticeable head and secret part and screen the data) and TapBridge (goes about as a way to change IP and MAC address) ports. The hub in the Mininet has particular Linux name and particular association convention stack. To connect with the OMNeT++ channel the Mininet intersection utilize the Linux Tap Net Device. NetDevice grants OMNeT++ to connect with a furthest constant point of interaction by performing reproduction of the layer 2 association interface. The SD-Wi-Fi execution can undoubtedly be estimated utilizing the Mininet-OMNeT++-Wi-Fi stage.

Wireshark (Protocol or application that is utilized to catch information from association) is utilized to look at the results. To compute the absolute traffic made by remote stations Iperf server is put in association design. The underlying time in complete handoff-time compares to the last client datagram convention (UDP) bundle (littlest unit of information) traded from the remote station to the regulator while the remote gadget is as yet related to the source AP and the last time compares to the main client datagram convention UDP parcel the remote station sends to the regulator while it is as of now in related with the station AP. The worth of gotten signal strength RSSI edge is set to-70 dBm. In the wake of getting the edge esteem, the SDN-regulator plays out the handoff cycle. The most extreme allowed traffic is set at the pace of 39.9 Mbps. The AP with a traffic sum in excess of 39.9 Mbps isn't chosen as the station AP. The reproduction prerequisites are given in the Table 2.

# CHAPTER 4: PERFORMANCE EVALUATIONS

To check the performance of proposed DiDe theory we compare it with the general Wi-Fi connections. In general Wi-Fi connections decisions about discovery-phase and detection-phase are taken by mobile stations. To monitor the performance of DiDe with respect to discovery-phase and detection-phase distinct simulation planar are developed. In detection-phase received-signal-strength-indicator RSSI in only requirement for the selection of a finest station Ap.

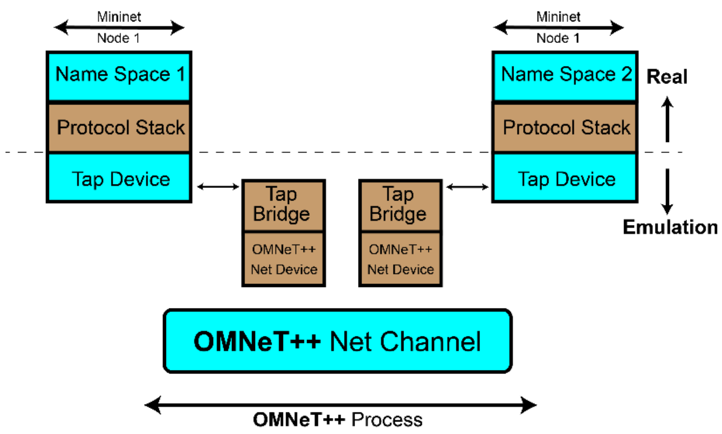



FIGURE # 5 Mininet-OMNET++-WiFi platform

While in discovery-phase a an additional Ap is added in the architecture to check the performance of DiDe. In discovery-phase selection of a finest station Ap is done based on received-signal-strength-indicator RSSI and traffic amount on Ap.

**Table 2. List of requirements along their values**

| Requirement | Values |
|---|---|
| **Area** | 100.1 m^2 |
| **SDN-controller** | 1, floodlight |
| **Total Access points** | 3.0 |
| **Orbit of transmission for every Ap** | 3300 mm |

| | |
|---|---|
| **Total number of mobile stations** | 1.0 |
| **Maximum permitted traffic** | 39.9Mbps |
| **Received-signal-strength-indicator**<br><br>**RSSI Threshold** | -70.0dBm |
| **Maximum transmission unit** | 1.500 Kbytes |
| **Simulator** | Mininet-OMNeT++-Wi-Fi |
| **Operating system** | Linux. Ubuntu 18.04 |
| **Wi-Fi standard** | IEEE. 802.11 “g |
| **Test time** | thirty min |
| **Mobility** | 5-10 mps |

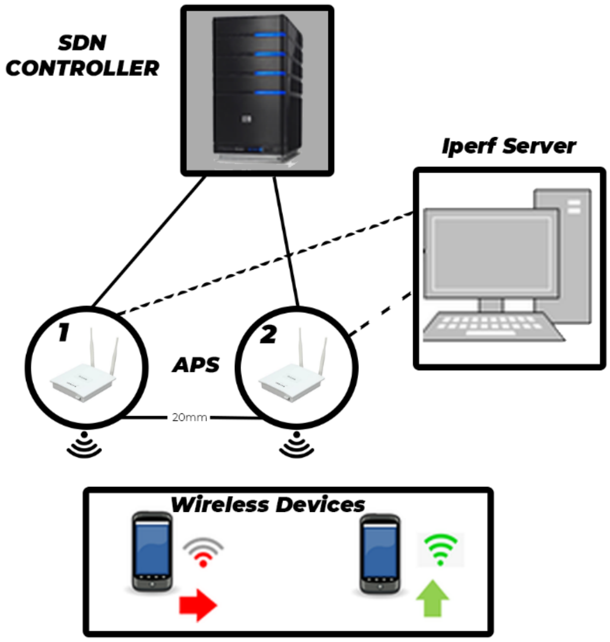
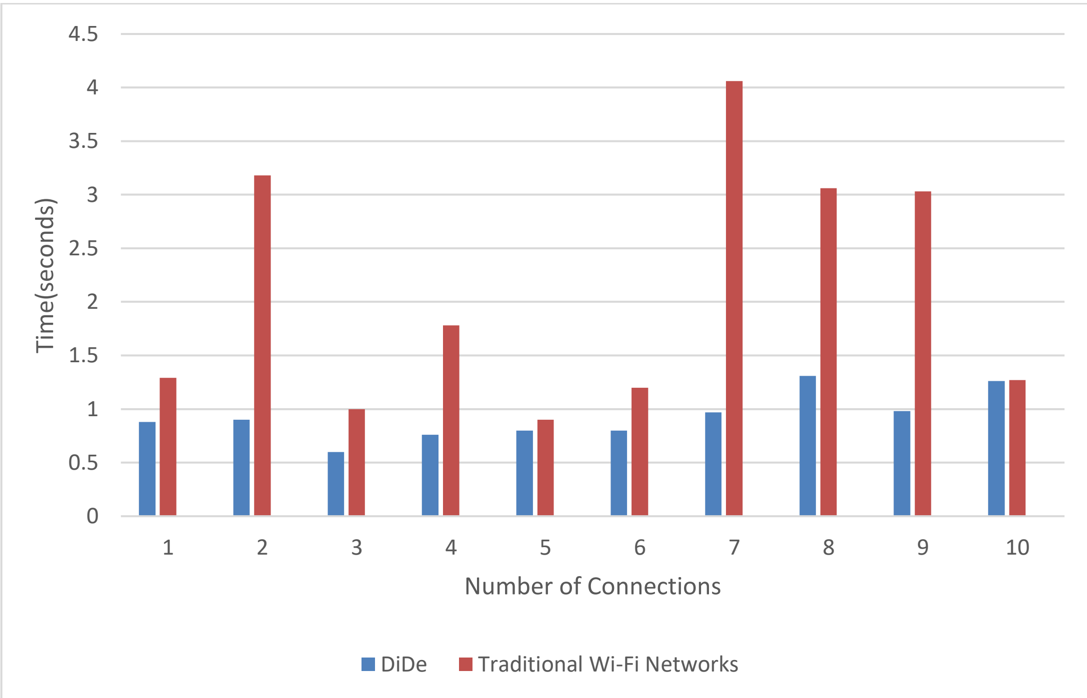



FIGURE # 6 Network Design for Detection Phase

### 4.1 Detection-phase

Mathematical expression for mathematical modelling is created to monitor the performance of DiDe theory with respect to the detection-phase. The arrangement of mathematical modelling in shown in the Figure # 6. Two-time mathematical modelling was carried out, one time for general Wi-Fi connections where the interconnection decisions are taken by the mobile stations and second time simulation is done with respect to the DiDe theory where the station Ap is selected by the decision requirement that is called received signal strength (RSSI). Start of the simulation the connection of mobile station was made to First Ap. Slowly the mobile station switched towards Second Ap, disconnects from source First Ap and connects to Second Ap. Similarly, the identical policy was replicated from Second Ap to First Ap.10 connections results when the procedure of connecting mobile station from source First Ap to Second Ap was replicated five times and vice versa.

FIGURE # 7 performance of handoff-Time



A comparison is made for the handoff-time efficiency of DiDe approach with that of general Wi-Fi connections in Figure # 7. And we observed that the handoff-time are efficient and more or less when compared with the handoff-time of general Wi-Fi connections. In some connections we observed that the handoff-time for the general Wi-Fi connections is almost 60% much higher than the DiDe approach which could cause the more lag especially when dealing with the time related applications where a small lag could cause a big problem like live video streaming. This is also important when we deal with real time data like audio or video calling. Also, in the applications where we need one time password OTP. These are some applications where lag could cause pain for the users.

FIGURE # 8 RSSI values at time of starting handoff.

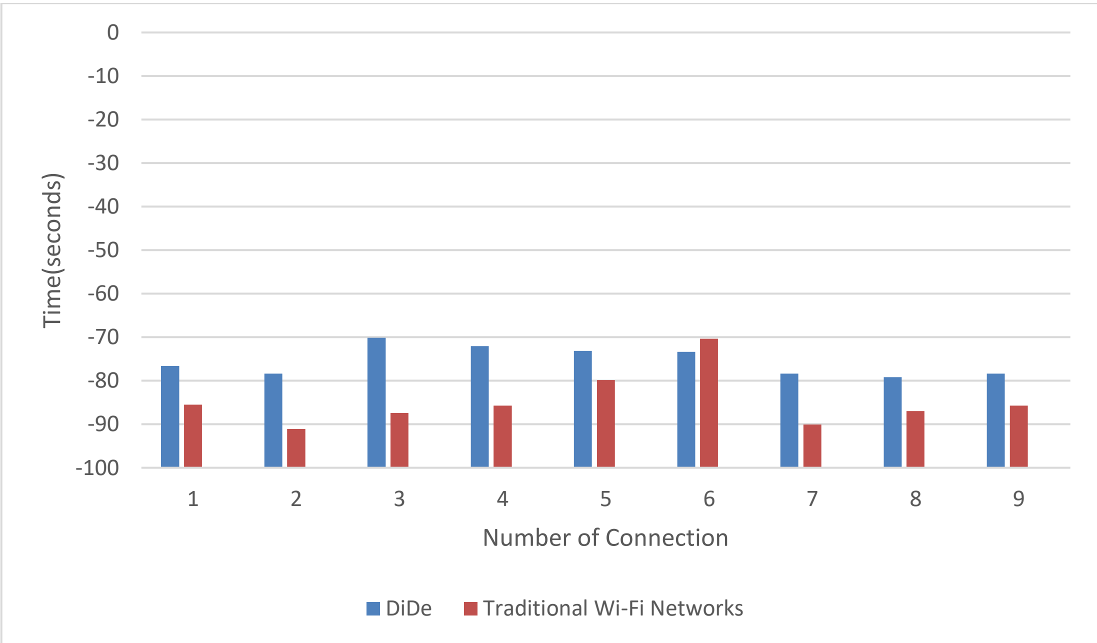



Figure # 8 shows the received values of received-signal-strength-indicator (RSSI) at the start of simulation time. During the simulation we observed that number of times received-signal-strength-indicator RSSI values of Second Ap was greater than first Ap, but mobile station did not initiate handoff. There is not a proper decision for the handoff-time whether to or whether not to start. This improper decision for the handoff-time causes the loss of information called packets during the exchange of information which results the resending of lost or damaged data-packets. resending of lost or damaged data-packets is called retransmission in computer networking. On the other hand, DiDe theory set off the detection-phase with the help of centralized controller which have all information or overall view of the connection which maintain the Quality-of-service (Qos).

## 4.2 Discovery-phase

Detection-phase and discovery-phase are two important phases to check the efficiency of DiDe theory in Wi-Fi connections defined on software. To monitor the performance of DiDe with respect to the discovery-phase a simulation setup is developed. In detection-phase received-signal-strength-indicator RSSI is only the requirement to select a finest station Ap. But in the discovery-phase amount of traffic amount is also considered in the selection of a finest station Ap. In discovery-phase an extra Ap called third AP is added in the simulation setup. The design of Simulation setup is shown in Figure # 9. The distance between First Ap and Second Ap is 12m and the distance between First Ap and Third Ap is 20m. Design consist of 3 sections. In section 1 there is SDN-controller, in section 2 there are 3 Ap's connected to Iperf server and in section 3 there are mobile stations. Signal strength of Third Ap was enhanced to 25dBm while the signal strength of First Ap and Second Ap is same that is 9dBm. The measurement authorized to have the different values of received-signal-strength-indicator RSSI within the simulation surroundings. Ten simulations were carried out. In the start of simulation mobile station was connected to the source First Ap. Slowly mobile station switched towards Second Ap and Third Ap. In the discovery-phase SDN-controller selects the station Ap from the Second Ap and Third Ap. Figure # 10 shows when traffic amount at Third Ap is less or equal to 39.9 Mbps. In discovery-phase handoff is improved by 69.9% in DiDe

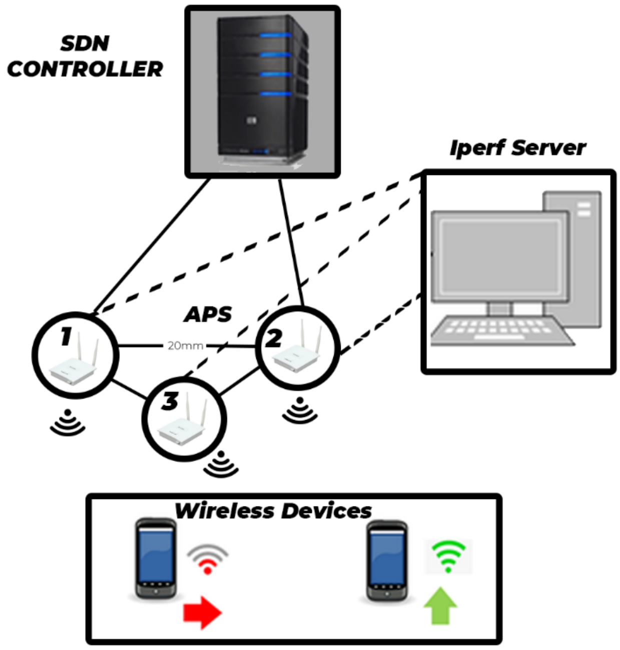



FIGURE # 9 Network Design for Discovery Phase

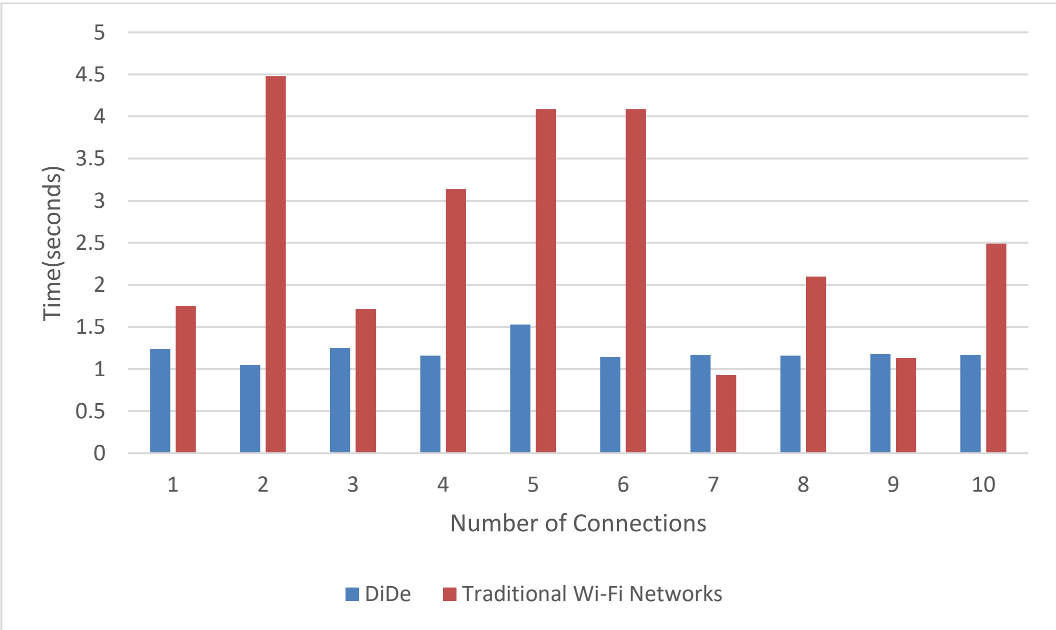



FIGURE # 10 Handoff-times when traffic of THIRD AP $\leq$ 39.9 Mbps

theory when compared with general Wi-Fi connections. When the traffic amount is more than 39.9Mbps then the behavior is shown in Figure # 9.Except some points performance of the handoff is more or less same where the DiDe overtop the general Wi-Fi connections by 69.9%.In detection-phase SDN-controller select Third Ap as a station

Ap because received-signal-strength-indicator RSSI value of Second Ap is smaller than received-signal-strength-indicator RSSI value of Third Ap in discovery-phase SDN-controller select the Second Ap as a station Ap because in discovery-phase there are two requirements to select a finest station Ap. These requirements are received-signal-strength-indicator RSSI values and the traffic amount on Ap's. Second Ap is selected by SDN-controller as a finest station Ap because traffic amount on Third Ap cross the allowed limit. In general Wi-Fi connections a finest station Ap is selected based on received-signal-strength-indicator RSSI and traffic amount is neglected in the selection of a finest station Ap. So in general Wi-Fi connections Third Ap is selected as an a finest station Ap because the received-signal-strength-indicator RSSI of Third Ap is greater than received-signal-strength-indicator RSSI of Second Ap .when we use several measure standard to select a finest station Ap we observe that DiDe theory play an important role to reduce handoff-time during interval 1 and 1.5 s. Handoff-time in DiDe were still lower than the general Wi-Fi connection .It is essential to focus on that when a finest station Ap is to be selected caused reduction Quality-of-service Qos which causes the loss of information, lag or blocking of new connections and handoff-time increased to 6 s.

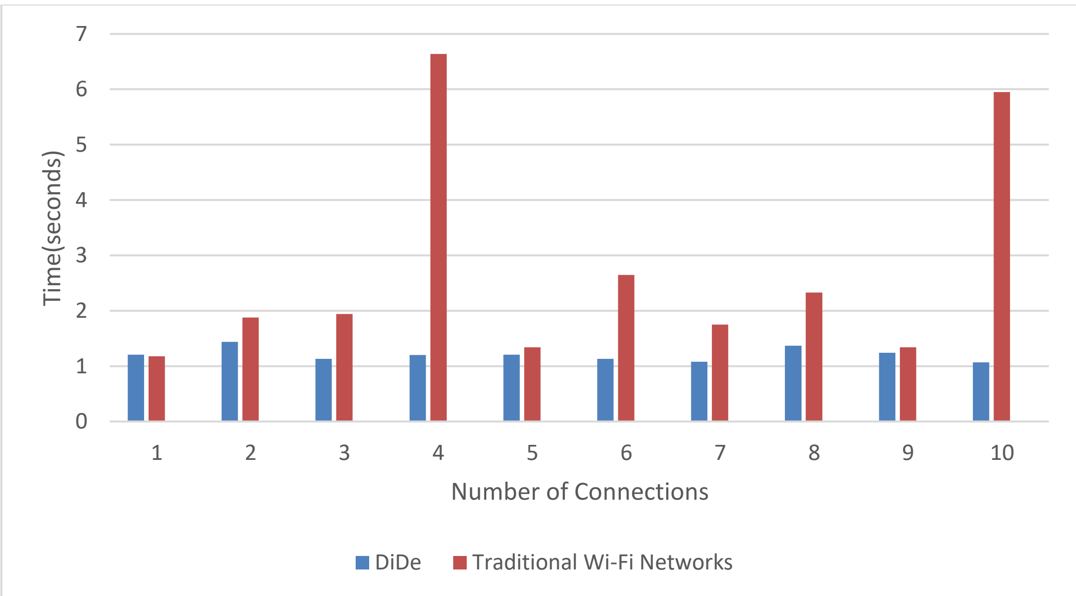



FIGURE # 11 Handoff-times when traffic of THIRD Access Point ≥ 39.9 Mbps

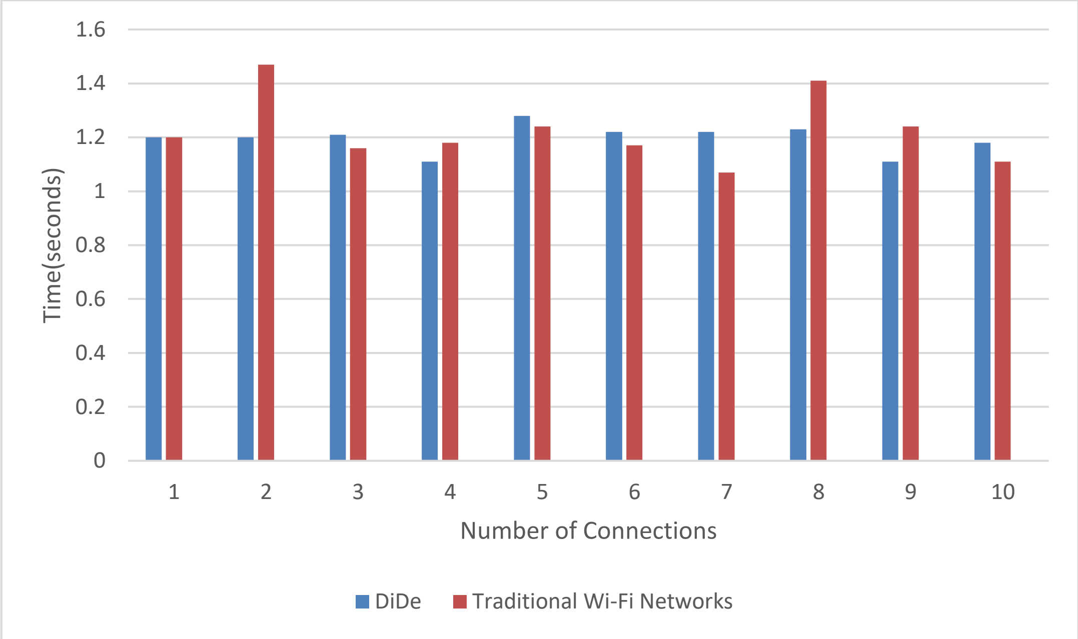



FIGURE # 12 Effect of RSSI and (RSSI + traffic) on Handoff-times.

When we deal with time related application like live video streaming and real time data like audio and video calling and applications that require one time password OTP this lag of 6 s causes the loss of information and data-packets. To observe how many effects of several measure standards on the handoff-time two simulation runs were achieved. In first simulation to select a finest station Ap received-signal-strength-indicator RSSI is only the requirement to decide a finest station Ap. In second simulation to select a finest station Ap received-signal-strength-indicator RSSI and traffic amount on Ap's are the two  requirements to decide a finest station Ap. when the mobile stations are connected to Ap this means that Ap is loaded and traffic amount on Ap is above than 39.9Mbps then SDN-controller select the alternate Ap with the traffic amount less 39.9Mbps but with a lower received-signal-strength-indicator RSSI .It can be noted that in Figure # 12 when we use several measurement standard for the selection of a finest station Ap handoff-time reduced by 20% in the comparison of when received-signal-strength-indicator RSSI is selected as only requirement to select a finest station Ap. At the end we observe that only received-signal-strength-indicator RSSI as a requirement to select a finest station Ap is not enough to ensure the quality-of-service Qos. For the betterment of quality-of-service Qos traffic amount on Ap's is also considered with received-signal-strength-indicator RSSI as a requirement to select a finest station Ap. In general Wi-Fi connections only received-signal-strength-indicator RSSI as a requirement to select a finest station Ap that is not enough to ensure the quality-of-service Qos. In SDN-controller for the betterment of quality-of-service Qos traffic amount on Ap's is also considered with received-signal-strength-indicator RSSI as a requirement to select a finest station Ap.

## 4.3 Mean of Retransmissions.

Retransmissions is resending of data-packets that lost during the communications. Figure # 13 shows the output of mean of retransmissions. When the handoff-time increases more data-packets lost during the communication, as a result the mean of retransmissions also increases. So, we observe that handoff-time causes a lag that is directly proportional to mean of retransmissions. We compared proposed DiDe theory with channel-measurement-based-access-selection scheme (CMAS), (DL-SINR) downlink-signal to interference-plus noise-ratio AP selection scheme, Dynamic auto scaling algorithm (DASA) and the general Wi-Fi connections. Mean of retransmissions is directly proportional to the increasing number of connections as the number of connections increases the mean of retransmissions also increases.

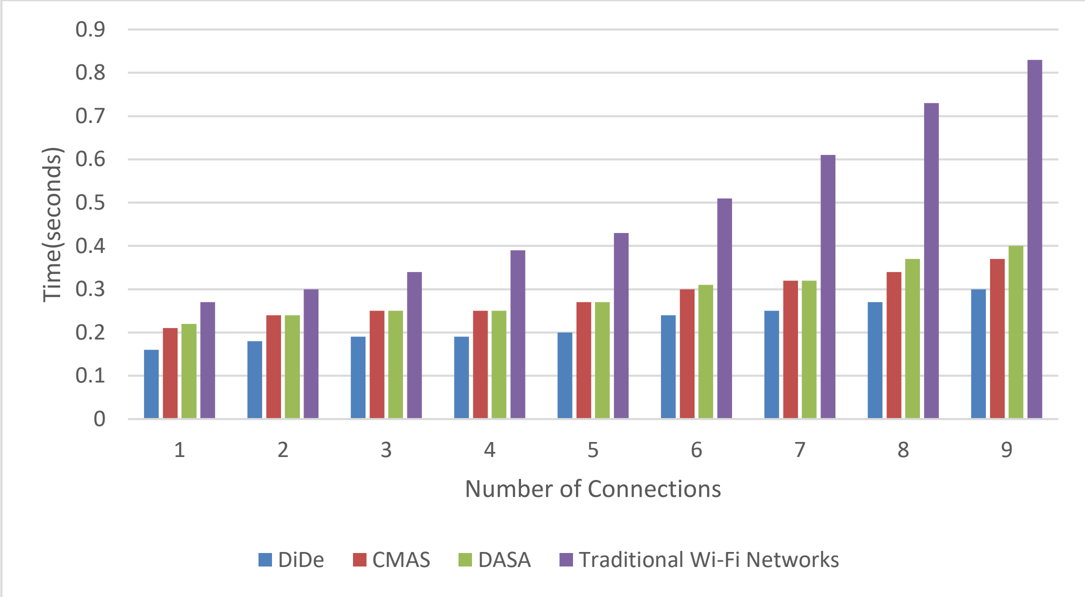



FIGURE 13 Performance of average number of retransmissions

For DiDe theory the mean of retransmissions is smaller than the channel measurement-based access selection scheme (CMAS), (DASA) and general Wi-Fi connections by 3.99%, 6.99% and 48.99% respectively. From these results we can observe that DiDe theory is better than channel-measurement-based-access-selection scheme (CMAS), (DASA) and general Wi-Fi connections. In channel measurement-based-access-selection-scheme (CMAS) are little greater because devices to collect and monitor data are used to calculate the load on routers Ap's.

The output of mean of retransmissions for Dynamic Auto Scalability Algorithm (DASA) is less or more same when compared with channel measurement-based-access-selection scheme (CMAS). For the selection of a finest station Ap an extra boundary is used that is called (DL-SINR) downlink-signal to

Interference-plus noise-ratio. In general Wi-Fi Received-signal-strength-indicator is only the requirement to select a finest station Ap that causes the Handovers in Wi-Fi connections. Due to these handovers' significant information and data-packets lost and mean of retransmission increases. In DiDe theory traffic amount along with the received-signal-strength-indicator RSSI is used for the selection of a finest station Ap. Due to multiple measurement standards handover is overcomes and lag is smaller which reduces the mean of retransmissions in Wi-Fi connections defined on software.

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# APPENDIX

(Please delete this part): Appendices consist of additional illustration of data sources, raw data and quoted citations which are too long to be placed in the text. The appendix supports the written text of the research report/dissertation/thesis. Research instruments such as questionnaires, maps or computer programmes are parts of appendix too.

Appendices can be divided into Appendix A, B, C.

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