

# Open Flow Controller Architecture for Seamless Connectivity and Virtualization Technologies

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## Abstract

The study aims to provide insights into the benefits and potential risks associated with its adoption. The findings will be valuable for organizations considering transitioning to SDN, offering guidance on how to effectively leverage this technology while addressing the challenges that may emerge during implementation. Furthermore, we detail the proposed control architectures, showing how the peculiar characteristics (and related goals). In the architecture design, we point out hybrid Control Architectures as a notable trend in SDN solutions targeting Wireless Scenarios. The Researcher provides his idea on the Open Flow Control diagram (OFC), managing heterogeneous networks and hybrid connection networks for seamless connectivity. It has become very complex and hard to manage due to upgrade and interoperability challenges. Software-Defined Network (SDN) addresses this problem by decoupling virtual resources from the physical resources. The goal of our research is to offer distributed Management Systems that can help with orchestration, dynamically partition access points and cell radios. Also, the work explores new approaches to controllers' Virtual Connectivity within complex and hybrid infrastructure network technologies, in order to overcome the shortcomings of the current infrastructure. The proposed algorithm is arranged to cover all requirements for seamless positioning in future wireless networks.

## Keywords

Networks and Communication, Network Architecture, Seamless Connectivity, Software-Defined Networks, Network Control

## 1. Introduction

The coexistence of SDN and traditional networks may lead to compatibility issues, requiring custom solutions or middleware. Software-Defined Networking (SDN)

represents a transformative shift in how networks are designed, managed, and optimized [1]. The IEEE 802.21 Standard for media independent handover (MIH) has been adopted in this research to provide a unified framework for the interworking of the heterogeneous networks. The architecture of our proposals is provided in **Figure 4**. The figure represents the target network architecture for the interworking of wireless networks such as WLAN, WIMAX, UMTS, and satellite networks. In the architecture, it is assumed that the mobile node supports multiple interfaces and can use any network when it is available. This is important for a mobile node roaming into other networks, to have seamless mobility across different networks. In this area, we provide different levels of solutions [2] [3]. The general solution is mainly featured in the system architecture as the global solution at present for the seamless connectivity problem: soft Open Flow Hybrid Network Controller (OFHNC) [4] [5]. SDN has come to light in recent years. However, the concept of this approach has been evolving since the mid-90s. Ethane [6] (management architecture) and OpenFlow [7] (protocol for network flow) have given birth to a real implementation of SDN. OpenFlow is standardized by the Open Networking Foundation (ONF) [8]. There are other similar existing south-bound interfaces, such as the Forwarding and Control Element Separation (CES) [9] [10] standardized by the Internet Engineering Task Force (IETF), Path Computation Element (PCE) [11], the Locator/ID Separation Protocol (LISP) [12], and Soft Router [13], pose important challenges for service providers [14]. With the rapid growth of the clients' demands, the operator is required to respond accordingly by considering additional servers, network components, high quality of service and secure architecture [15], abiding by the standards. In particular, the challenges and issues appear to be of paramount importance in the SDN environment.

## 2. Background and Motivation

Researchers in this article present an efficient mobility-based proactive caching simplified model for addressing a distributed solution that targets less popular, personalized, or dynamic content requests by prefetching data in small cells based on aggregated user mobility prediction information [16]. Another important problem dimension regards service charges [17] [18]. Users can become very unhappy with charging mechanisms that aim to control demand peaks. In a more recent study in [19], the authors show that a large portion of web traffic is dynamically generated and per-data located in the field of connectivity perspective. In addition, the rest of proactive solutions use mathematical solutions to optimize prospective results, approximation for the non-tractable distribution of "content placement" [20], which is also recognized in [21]. These solutions are centralized, mobility, or employ a static adaptation of popular temporal locality, even the work in [22] that does consider mobility. The rest of this report discusses and explains the different approaches and proposes several variations of a new model that uses contextual information [23]-[25]. Furthermore, Seamless Mobility and roaming are essential features of today's networks and can be attained by a handoff mech-

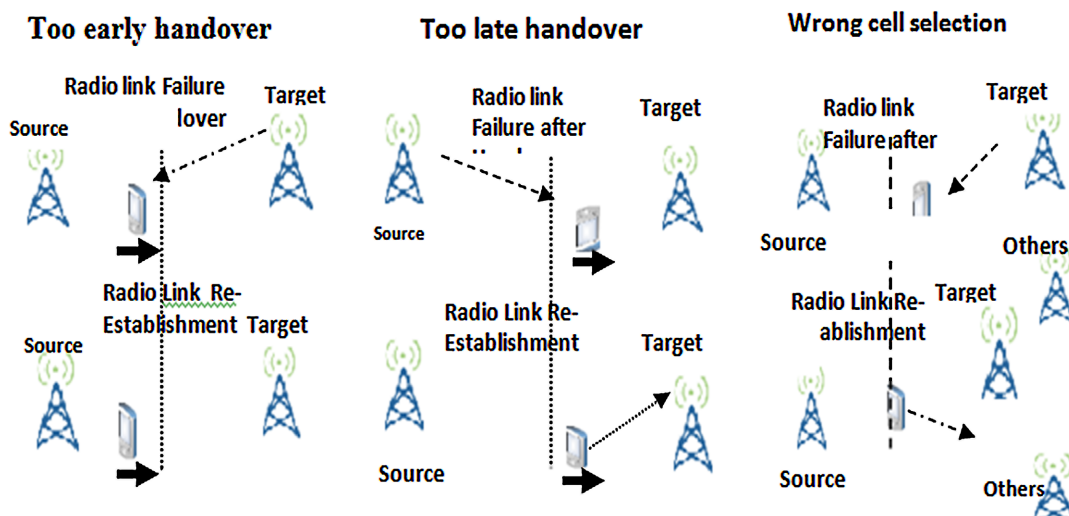
anism in wireless networks. In addition, handover represents an essential process of maintaining users in an active session when the mobile terminal changes its point of attachment [26]. Currently, a mobile user has multiple interfaces and can access a wide range of applications provided by multiple wireless networks. Therefore, to achieve this goal and select the best network, it is necessary to have a good decision-making Strategy for a specific application [27] [28].

A simple prediction model uses a person's location preferences (a history of her previously visited locations) [29]. Population mobility models are introduced, and their practical applicability is demonstrated. In particular, techniques that focus on the detection of incorrect human mobility predictions are analyzed. Among these techniques, an ensemble learning algorithm, called LOTUS, is designed and evaluated. Different hierarchical approaches are further defined, and their performance is evaluated. Ekman *et al.* create a composition of different mobility models that describe the daily life of an individual [30] [31]. Their model includes home activity, office activity, evening activity, and transport sub\_models that address the mobility differences of individuals over a day. Similarly, Nguyen *et al.* propose, instead of using one predictor for different human mobility prediction tasks [32] [33], providing an architecture and methods for a seamless experience across a user's multiple environments. Passive components for multiple communication channels are also considered. Lei *et al.* proposed the creation of community networks [34]. In this scenario, a service provider such as a hospital is responsible for providing a service in a specific region.

### 3. Proposed System Architecture

#### 3.1. Connectivity Management

The extreme heterogeneity existing today means that the problem of mobility management has now become more complex. In fact, the fact that a handover procedure is not directly related to physical parameters like coverage and movement speed has as a consequence that mobility has now become a logical concept rather than a physical one. This means that today, mobility refers not only to the user's geographic position but also to the change of a logical location with respect to network access points. The target in this case is to come to an optimal global decision with reference to a set of local and distributed requirements such as: Vertical handover decision modeling and handover triggering. As stated above, the vertical handover further consists of three main parts, *i.e.*, handover triggering/initiation, network selection, and handover triggering, referring to a phenomenon of initiating handover at the appropriate location. **Figure 1** shows the main idea of handover transaction triggering (too early, too late, and wrong cell handover [35]). The decision user's selection process in a heterogeneous network becomes harder, because there are different characteristics provided by different networks, such as resource reservation area. Almost all schemes are based on multiple parameters from different networks to fix this problem, focusing on proposing heuristic algorithms that simplify the risks that occur through connectivity.



**Figure 1.** Problems in RSS-based handover triggering.

There are various parameters used to trigger a handover. The MN periodically checks the value of these parameters and compares them with a predefined threshold. If the value of the parameter drops below a pre-defined threshold, then the MN initiates the handover process. Various traditional handover approaches are based on the RSS value of the current network. The MN periodically checks the RSS level of the current AP/BS; if it drops below a certain predefined threshold, the MN initiates the handover. However, calculating and finding the exact location for triggering a handover process is a challenging task, because the time between the handover triggering and execution is very short [36] [37].

### 3.2. Issue in Hand-Off

We suppose that when an MT starts moving, crossing the boundary area from the start point to end point, the mobile client requires the information about the foreign networks for choosing the strongest signals at all times. The decision is based on an average measurement of the received signal. Relative signal strength with hysteresis and threshold hands a user over to a new base only if the current signal level drops below a threshold and the target base station is stronger than the current one by a given hysteresis margin. A rapid decrease in received signal strength may cause the call to drop, and this cannot be supported by handoff algorithms. The nature of the decaying signal can be determined by the slope or tangent of the angle subtended by the two corresponding points on the signal line with respect to two axes. Slope ratio ( $S_r$ ) can be defined as the ratio between normal and actual signals, and depicted in **Figure 2** [38] [39].

From the geometry of the figure, slope of the normal signal can be represented as

$$\text{Tan } \theta_2 = \frac{\Delta \text{RSS}}{\Delta S_2}$$

Hence, the slope ratio of the normal to actual signal can be represented as

$$S_r = \frac{\tan \theta_1}{\tan \theta_2}$$

For different values of  $\theta_1$  and  $\theta_2$ , various values of  $S_r$  are obtained. But for handoff to take place,  $\theta_2$  must always be greater than  $\theta_1$ .

### 3.3. Case Study

Figure 3 provides a case study for seamless connectivity demand. Given the diversity of network applications running on mobile devices, knowledgeable network resource planning and operation is needed, in turn calling for a framework that allows users and their applications to access patterns aimed at maximizing resource usage and increasing user satisfaction. In this case study, users need to be aware of available access networks and to choose the one they want to connect with, based on very rudimentary information such as signal quality. If MNs can collect timely and consistent information about the state of all available networks in range and control their network connectivity, then a whole range of possibilities

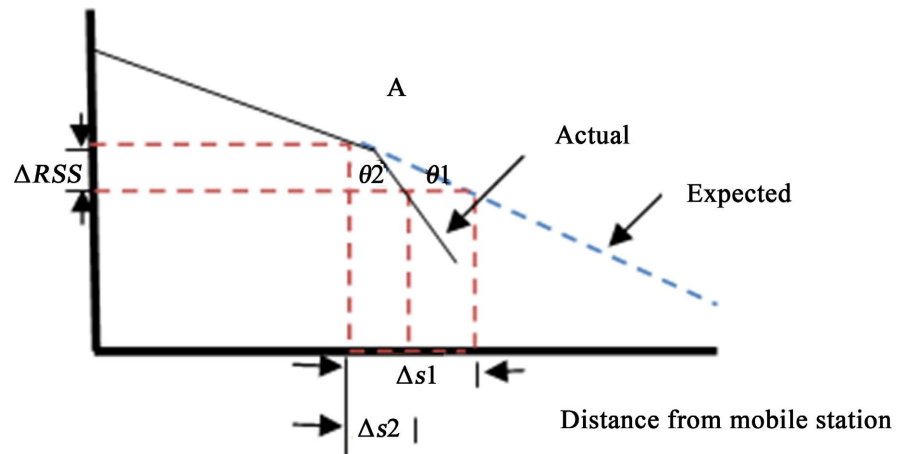


Figure 2. Slope of actual signal and expected signal.

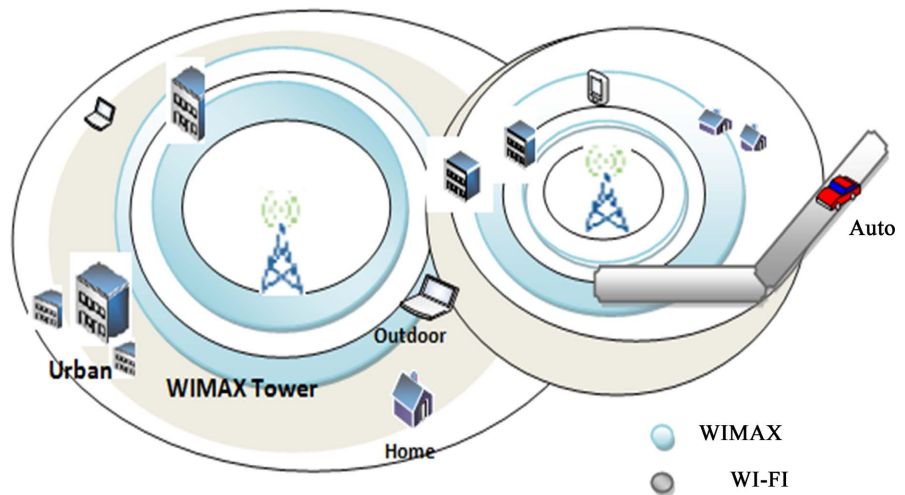


Figure 3. Example scenario with a heterogeneous overlapping wireless network.

would become available. Operators who can switch a user's session from one access technology to another could better manage their networks and better accommodate the service requirements of their users [40].

## 4. System Architecture

The proposed architecture provides four sectors, represented in different parts. The first part is a network side or terminal side, and the second part is the open follow hybrid core, the third part is satellite system, and finally, the last part presents monitoring surveys to different parts of the global network systems equipped to observe the capital area. On the network side, the controller supports network systems of each side, monitoring, such as location information and user profiles. Furthermore, in the open follow hybrid core, the highest network connectivity should be more flexible and offer seamless connectivity between recognized domains, which enables the satellite in the third coverage to extend to each other. The main purpose of the monitoring area is to obtain optimal observation of all transactions between any MT connection in different situations, static or dynamic. Nevertheless, the efficiency of the whole part should use appropriate radio technologies through which service can be obtained as much as possible. Thus, both the network and terminal contribute useful information that should be combined to provide efficiency of QoS in order to facilitate MT in making an optimal decision. **Figure 4** explains the target architecture network developed from the source [41] [42].

In addition, see **Figure 4**, the architecture applied, offering the capability of scaling network resources in lockstep with application and data needs. Software-defined network (SDN) facilitates organizations in deploying applications and enables flexible delivery. The Open Flow Controller (OFC), based on SDN, is designed with a standard interface for the SDN controller to allow programming of forwarding tables, network element registration, and maintenance. Improving network availability provides better control and performance. Some switches support compatibility issues with the controller. The OpenFlow specification defines the protocol that enables the controller to command switches and routers. However, the architecture is referred to as the OpenFlow model control. Permits network operators to set flow rules, which are essential for network management, by breaking the coupling between network control and global visibility. It helps to reduce internal communication between the control and data planes.

### 4.1. Network Virtualization

Network virtualization and open flow controller, see **Figure 5** & **Figure 6**, allow multiple networks with different characteristics and functions to operate over the same physical network. The reliable transmission of high-priority data can be achieved by centrally managing the communication quality of multiple wireless and wired networks by dynamically selecting the appropriate routing. The virtualization technology copes with network congestion caused by a heavy traffic load

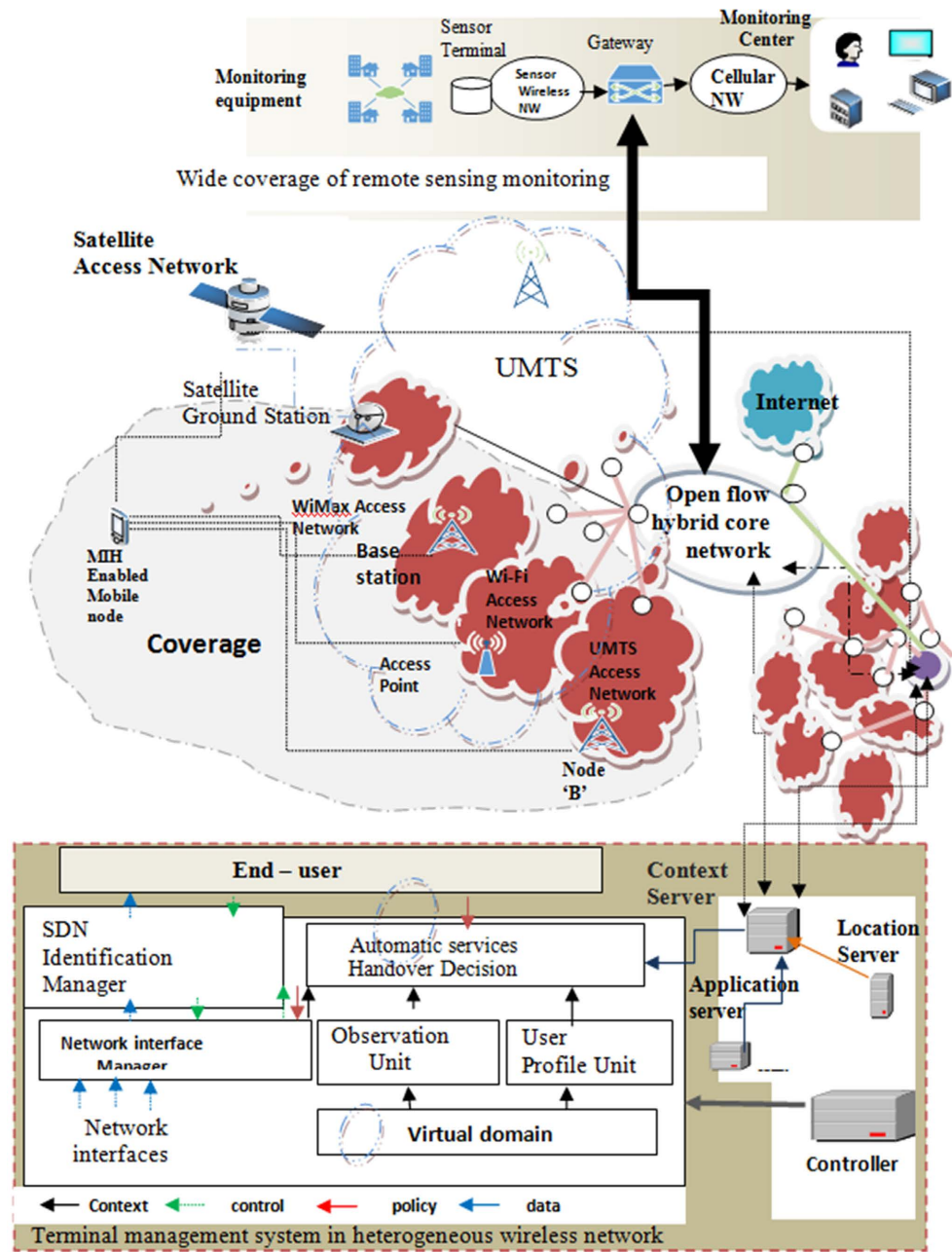


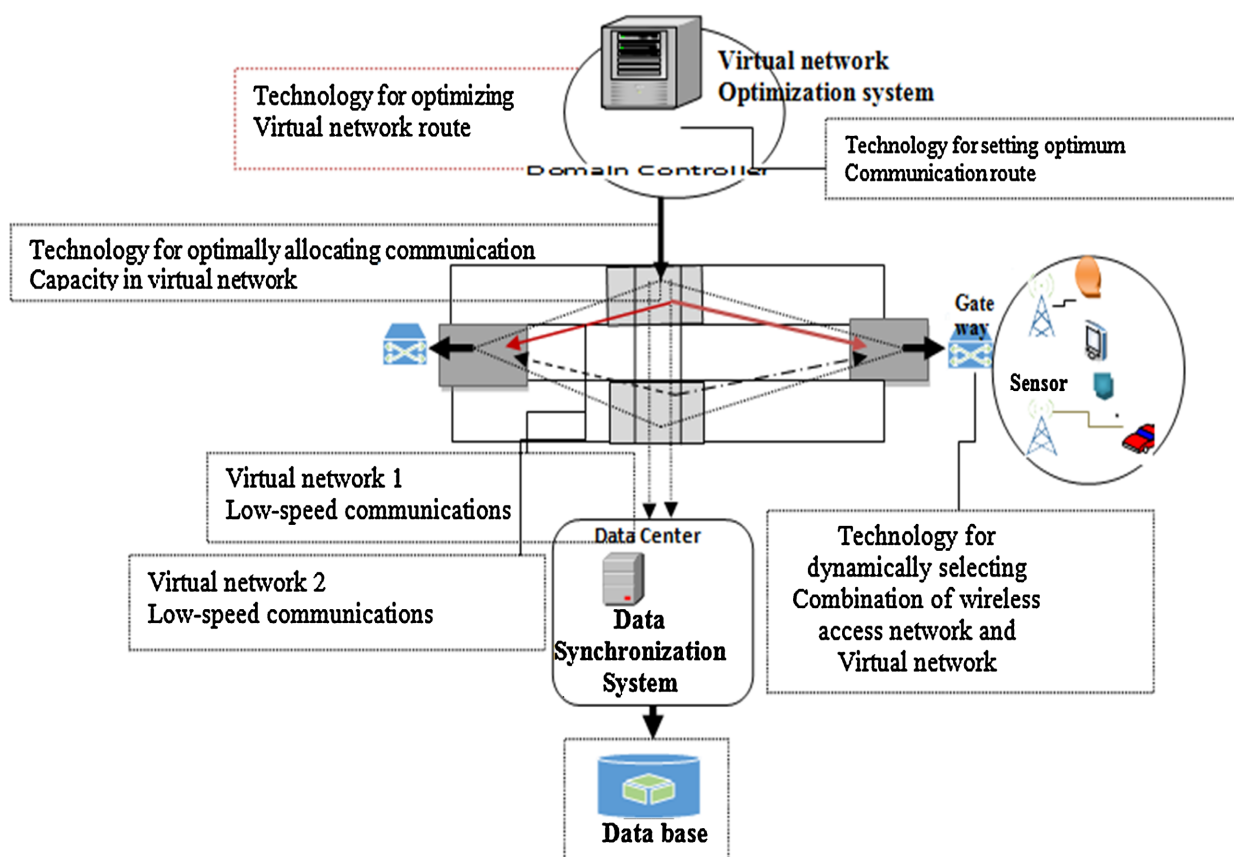
Figure 4. Target network architecture.

in a particular part of the network by connecting automatically to other types of networks, thereby increasing the potential for services to continue operating [43].

The following figure represents the accessories of the home network (core network). The objective of this case is to propose a solution for automatic management of the future, through the use of virtualization as well as automatic service deployment and network reconfiguration using an automatic service virtual plan (VP).

#### 4.2. Open Flow Controller

Managing heterogeneous networks has become very complex and difficult to



**Figure 5.** Network virtualization technologies.

manage due to upgrade and interoperability challenges. Software defines networks (SDN); address this problem by decoupling virtual resources from physical resources, abstracting control planes and data forwarding planes, and automating network management while enabling centralized orchestration. This offers network scalability and expansion. Adding SDN networks to the existing networks can provide scalable LAN segmentation to effectively manage cloud infrastructure environments. In addition, SDN can also enable much shorter development times and easier management of the network through the utilization of common, general-purpose hardware, while providing a holistic way of managing and controlling the network [44].

In the case of the present SDN OpenFlow controller, another important challenge that needs to be addressed is the communication latency and load between the SDN controller and the switches. If the network has one centralized controller, then all connection setup requests, as well as exception traffic, are forwarded to the controller. This increases the load on the controller significantly, and the resulting latency caused by the communication may be unacceptable for latency-sensitive applications. Furthermore, our goal is to develop a flow approach that harnesses local intelligence to scale traffic flow. The SDN solution also addresses network management challenges, supporting fast, seamless voice, data, and video transition from 3G/4G networks to Wi-Fi networks.

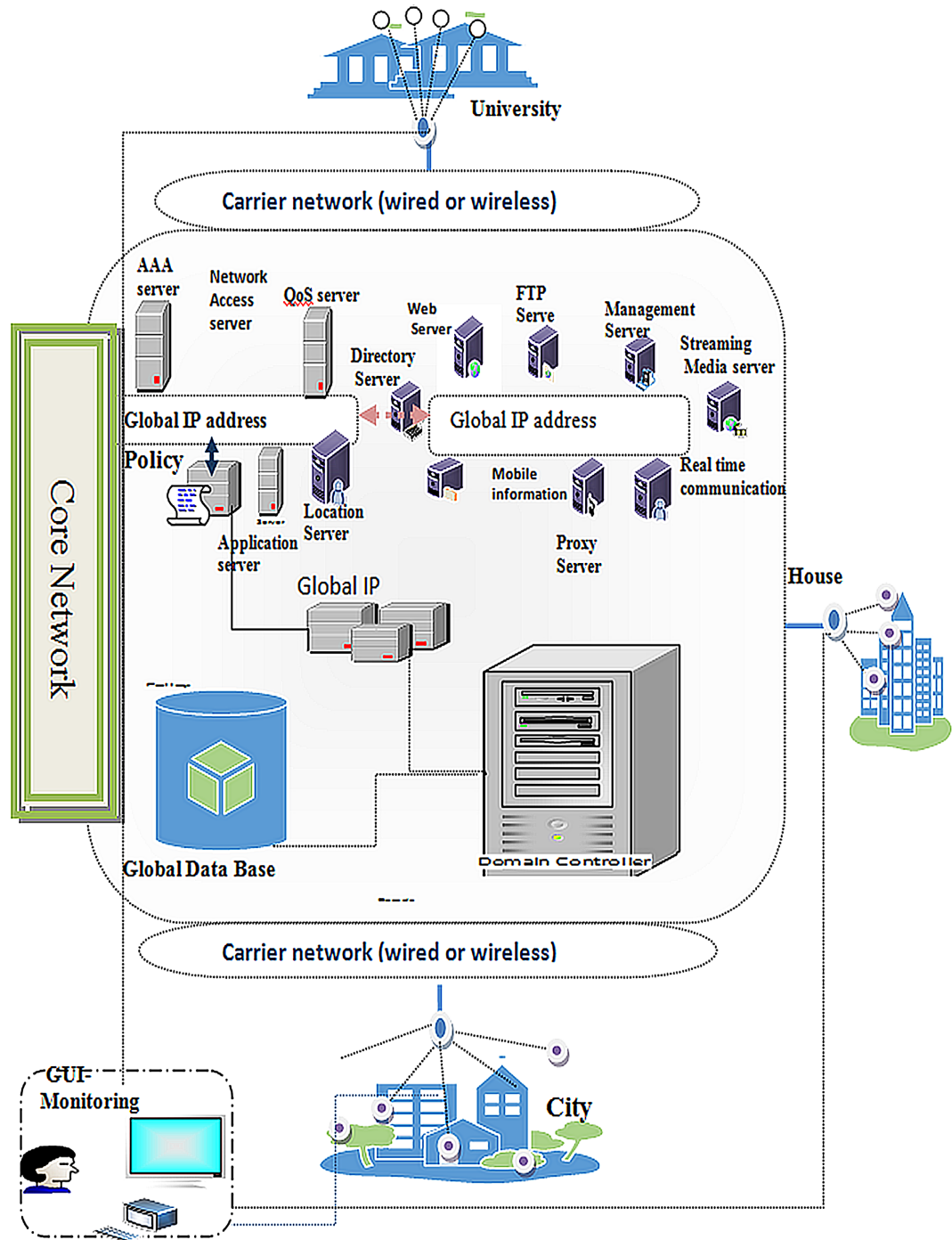


Figure 6. Open flow controller contains.

Figure 7 refers to the transparent transition between multiple Radio Access Technologies (RATs), which is usually referred to as vertical handover (VHO). Where the signal is distorted due to physical phenomena, it is necessary to characterize the channel. It was previously mentioned that it is clear that the environment will be different for different locations of the transmitter and receiver [44]-[48].

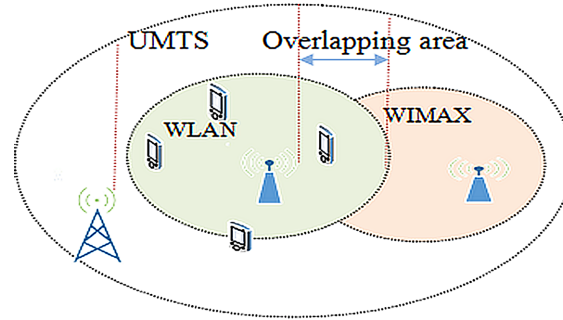


Figure 7. Hotspot scenarios.

$$RSS[k] = \frac{1}{W_{av}} \sum_{i=0}^{W_{av}-1} RSS[k-i][k+i] \quad (1)$$

The  $RSS[k]$  is represented by calculating the average of the single strength at time instant  $k$ , and  $W_{av}$  is the window size of the variable that changes with the velocity of the mobile terminal. The lifetime metric  $EL[k]$ , represented by  $[k-i][k+i]$  estimation of  $i=0$ , the RSS change rate  $\mathcal{S}[k]$ , and a parameter called Application Single Strength Threshold (ASST) are as follows.

$$EL[k] = \frac{RSS[k] - ASST}{\mathcal{S}[k]} \cdot \left( \frac{1}{RSS[k] - ASST} / \mathcal{S}[k] \right)^{\frac{1}{2}} \quad (2)$$

The RSS indicator rate  $\mathcal{S}[k]$  varies with the window size of the slope estimator and the RSS sampling interval. ASST is an application-dependent parameter that represents a composite of the channel bit error rate and application QoS requirements. In the scenario, when the mobile terminal moves towards a WLAN cell, the handover is triggered, if the signal strength between the mobile terminal and the point of attachment is in the available bandwidth of the required bandwidth by the application. Then the process of imitation depends on intersection midpoint algorithm of intersection midpoint and flowchart proposed flowchart algorithm; see **Figure 8**.

In this scenario, the radio network analysis algorithms evaluated signal strength and network performance, and calculated the quality of service of the area by dividing users into groups; this technique uses a priority queue searching counter. Additionally, user demand estimates from traffic database are used to calculate the network performance; see the flowchart algorithm proposed for the arrangement of RSS triggering handover, see **Figure 9**.

In Addition, mobility characteristics may cause a service on MS to migrate between different Data Centers (DCs); otherwise, the geographical distance between MS and the DC leads to delays in packet transmission between the sender and receiver, resulting in interrupted service when the MT moves from one position to another position [49]. In this section, to offer a seamless service migration framework as mentioned above, we consider the network topology shown in **Figure 4**, including a private controller device that can be an independent entity, or software embedded into DCs. A simple formula can be computed as:

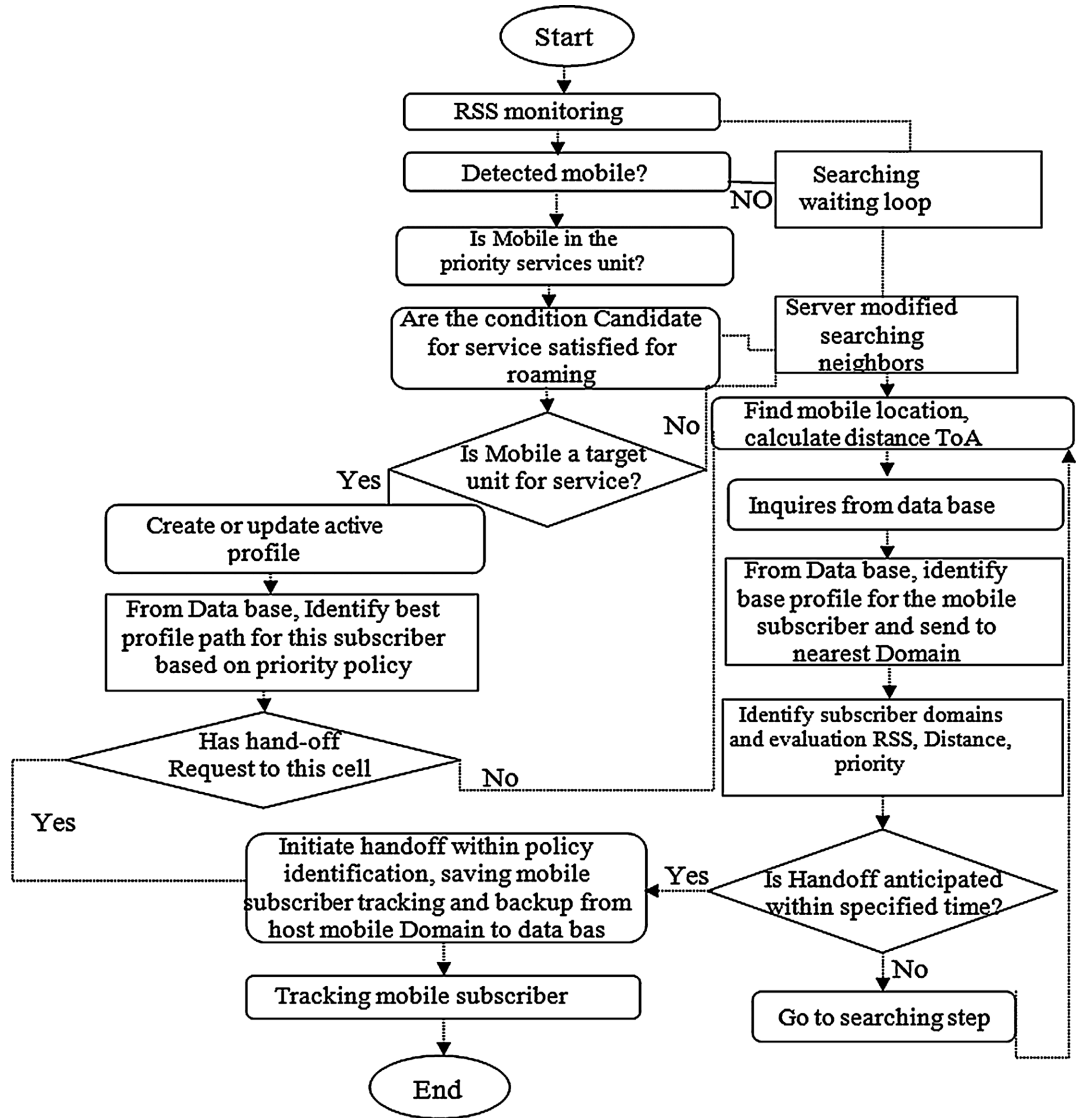


Figure 8. Proposed algorithm—handover initiation process.

$\theta = [x_i, y_i]^T (i = 1, \dots, m)$  As the coordinate of the RN, (known)  
 $\Phi = [X_j, Y_j]^T (j = 1, \dots, N)$ . The distance between  $(i, j)$  is represented by  $R_{i,j}$ , and  $R$  is the distance denoted by

$$R_{i,j} = \sqrt{(x_i - X_j)^2} + \sqrt{(y_i - Y_j)^2}, i = 1, \dots, M; j = 1, \dots, N \quad (3)$$

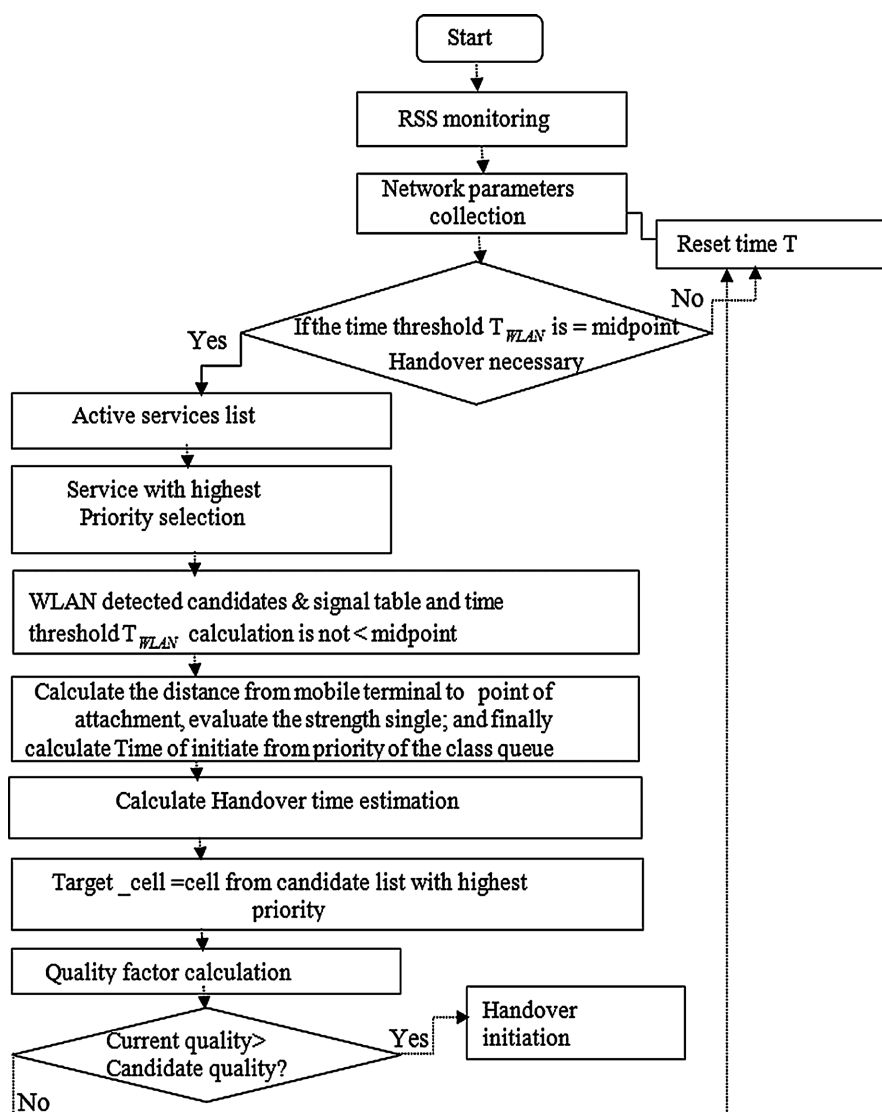
were

$$\Gamma = \sqrt{D_n^2 - (x - x_N)^2} \quad (4)$$

$$X \rightarrow \min \Delta = \sum_{i=1}^{\infty} \alpha_{i,j} \Gamma_i^2$$

$\alpha_i \rightarrow \text{weightvalue}$

$$D_i = \sqrt{r^2 (a+c)^2 - (ad-bc)^2 / (a+c)^2}$$



**Figure 9.** RSS triggering handover.

were

$$a = v_i \cos \Theta_i - v_j \cos \Theta_j, b = x_i - x_j, c = v_i \sin \Theta_i - v_j \sin \Theta_j, d = y_i - y_j$$

The following diagram shows the main procedures of the seamless connectivity process represented in **Figure 10** (Controller entity & Distributed Data Center), represented by the virtual connection point (VCP). In this procedure, we mention that any MS can switch to another network and continue to reserve the former session from (GLOBAL IP Domain service). The MT can keep a temporary IP address when it is moving from one AP to another, and it can also move seamlessly from one network to another. The service is identified automatically by the location domain to another location independent of a unique name, instead of the network address; therefore, the MS can access the service without any awareness of the location policy service. Furthermore, when users encounter some obstacles or disconnection in some areas, users can send message request to the server con-

troller for neighboring strength access. If not. The controller can assist by virtual machine connection (VMC) moving the machine. The control server sends to the moving machine the coordinator location of the users, and automatically, the machine can reach the users' location. The connectivity holds automatically according to the distance of signals. The confirmation between the controller and DC is updated by such an acknowledgement confirmation (ACK). In the figure, a controller is responsible for any trigger handover message from any mobile service [50]-[53].

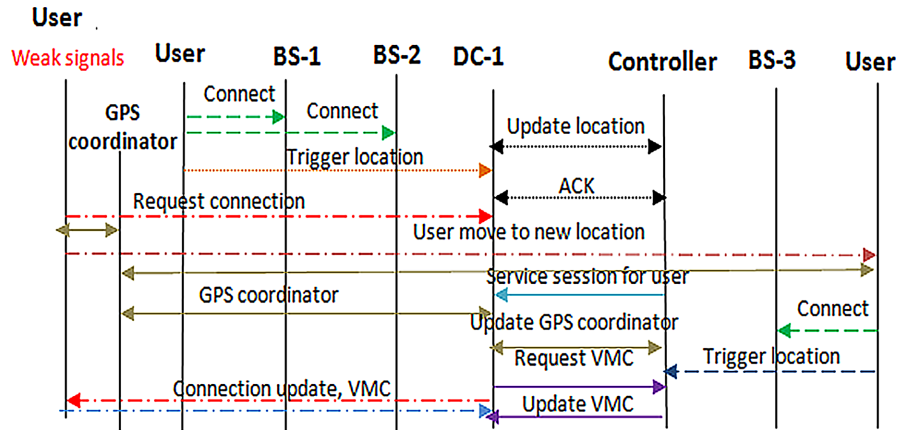


Figure 10. Procedure of service migration.

The prediction of handover in a wireless network can be based on several approaches, such as the target base station to which the handover is attempted to connect, with algorithms focusing on the history of all mobile associations based on the transaction movement, as shown in Figure 10 & Figure 11. Furthermore, the target number of successfully predicted handovers has been analyzed, and the number of handovers is represented by the matrix (see Table 1). The matrix is represented by number of rows( $x$ ), and number of columns ( $y$ ), and  $(x, y)$  to represent the number of neighboring BS. Any field in the matrix represents the number of handovers between  $BS_x$  (serving BS) and  $BS_y$  (target BS), within the observation time, the stage of connectivity, when a mobile is a target to connect to the next BS. For example, the field in the second row from BS2 to BS4 (handover account is equal to 30). Also, we can calculate the opposite direction handover prediction from BS4 to BS2 [54]-[56].

**Table 1.** The matrix representing the number of handovers among BSs (scenario with 7 neighboring BSs).

The probability prediction of handover calculated from  $BS_x$  to target  $BS_y$  ( $p_{x,y}$ ) is according to the following formula:

$$P_{x,y} = \frac{P_{(x,y)^{n+1}} HO_{x,y}}{\sum_{y=1}^{n+1} HO_{x,y}} \rightarrow P_{x,y} = \sum_n^{n+1} P_{x,y \rightarrow \sum_{y+1}^{x+1} HO_{x,y}} \quad (6)$$

$HO_{x,y}$  represents the number of handovers from  $BS_x$  to  $BS_y$  and is the amount

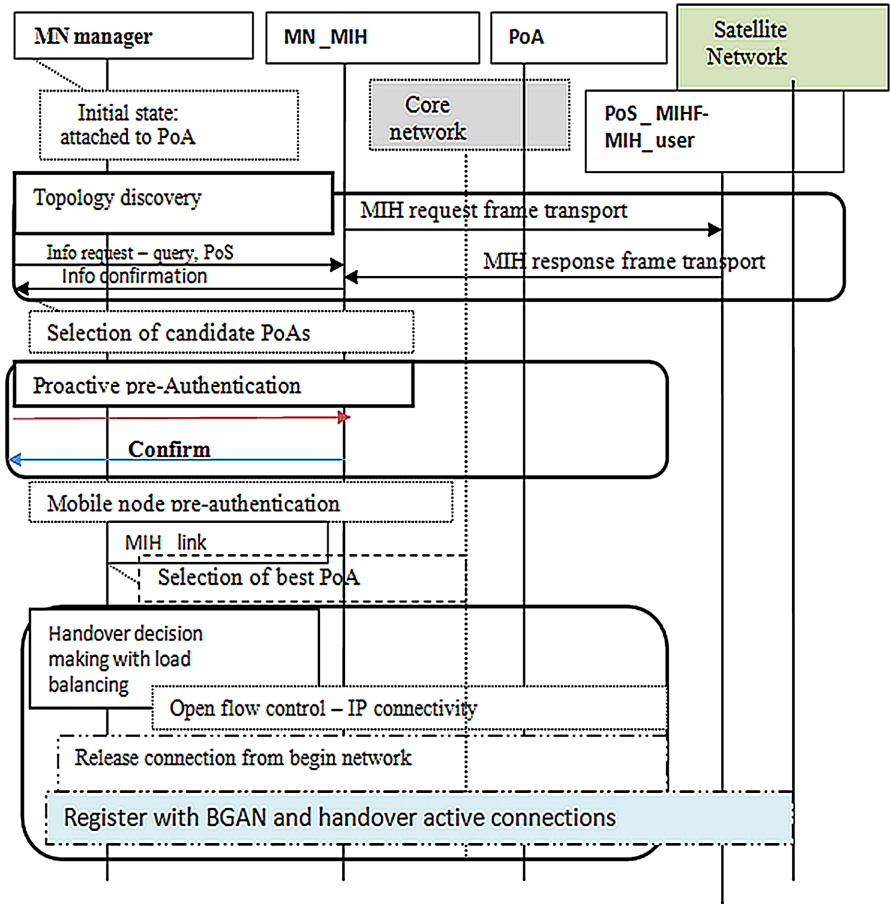


Figure 11. Pre-authentication using Open (MIH), frame seamless.

Table 1. Scenario with 7 neighboring BS.

HO counter	BS1	BS2	BS3	BS4	BS5	BS6	BS7
BS1	X	34	0	28	38	0	0
BS2	21	X	49	30	0	0	0
BS3	0	17	X	52	0	31	0
BS4	8	32	16	X	19	11	14
BS5	29	0	0	45	X	0	26
BS6	0	0	31	39	0	X	30
BS7	0	0	0	26	41	33	X

of neighboring BS. The probability of handover from  $BS_x$  to  $BS_y$  can be rewritten as:

$$P_{x,y} = \begin{cases} \alpha, & y \in NS_x \\ 0, & y \notin NS_x \end{cases}$$

where  $0 \leq \alpha \leq 1$ .  $\alpha$  is the present number of BS and the number of layout monitoring [44] [45]. We suppose that in a real system, the number of handovers in a time at infinite future ( $t \rightarrow \infty$ ) can be formulated as in the formula:

$$P_{x,y} \Big|_{x=const, t \rightarrow \infty} = \sum_{y=1}^{n+1} HO_t^{n+1} P_{x,y} = 1, \quad t \leq 0 \leq 1$$

Then the handover probability over a finite time interval is presented as in formula:

$$0 \leq \sum_{n=1}^{n+1} HO_n P_{x,y} \leq 1, \quad t < \infty \rightarrow \sum_{HO \rightarrow}^{n+1} \sum_t HO P_{x,y} \quad (8)$$

where  $p_{x,y}$  is present, a formula functions on time  $t$ .

The parameters of the scenario of the handover prediction based on the handover history are presented in **Table 2**.

**Table 2.** Presents the scenario of the handover prediction.

Parameter	Value
Number of BS [-]	7
Number of MS [-]	100
MS speed [m/s]	2
Simulation duration [s]	86,400
Mobility model	Randomly
Size of simulation area [m]	200 × 200

### 4.3. Localization Connectivity Scenario

To evaluate the performance of the proposed service migration framework, we implement our simulation result strategy for 1000 users localized in the whole area of the simulation, 15 km × 20 km, BS = 63, distance from BS to BS = 2.5 km, coverage area for any BS = 5000 = km<sup>2</sup>. Using the possibility of the localization is the use of angular estimates instead of distance estimates; using trigonometry and geometry, triangulation is used to find and determine the location of the point (MT) by measuring angles to it from two known reference points, based on localized users.

$$\text{User} = X, Y = \left( \frac{X_1 + X_2 + X_3}{N}, \frac{Y_1 + Y_2 + Y_3}{N} \right) \quad (9)$$

### 4.4. Localized Handover Management

The technique used in handover proposal management for seamless connectivity is Make Before-Break handoffs, which enables lossless handoff. The Mobile node can complete the handoff in advance before losing connection with the previous Access Router; if the mobile node temporarily loses connection, it can receive the signal from neighboring emergency services or restore the previous service. Using a vertical handoff timing algorithm based only on the signal strength to finalize the handoff immediately, see **Figure 11**, **Figure 12** and **Figure 14**. Coverage area represented by 100 users distributed throughout the entire area represented, see **Figure 15**. The connectivity connection and connectionless are identified and presented in the color of the real connection; users result in being disconnected, see **Figure 16** and **Figure 17**. Distributed throughout the location of the bandwidth

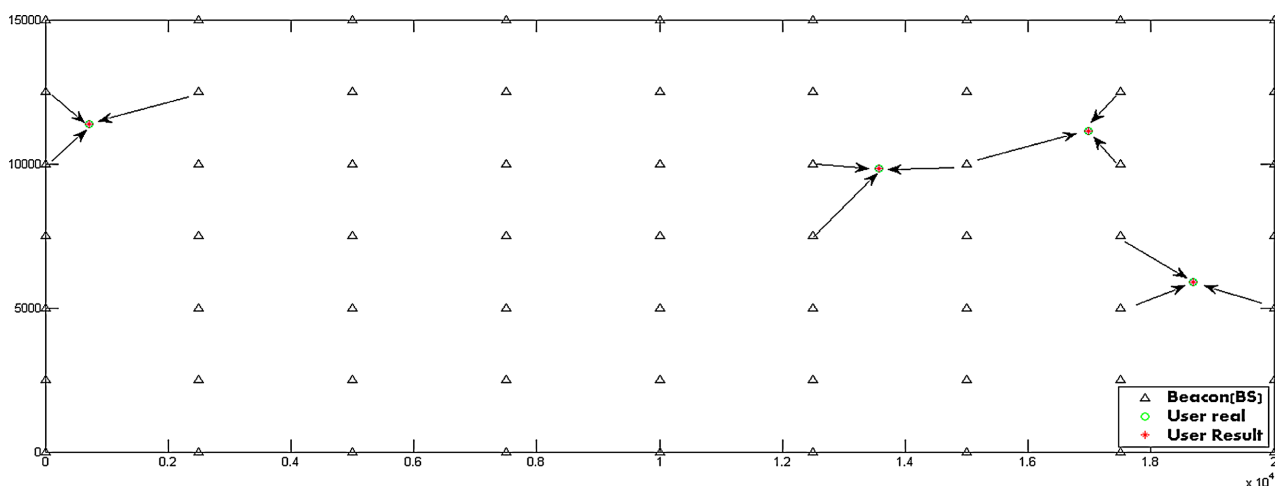
area and of the error connection based on the user's random movement.

#### 4.5. Location Based Task Distribution Framework

We identified a task map; here is a unique ID, a mobile terminal can receive the task map from the sensing system and obtain the task ID. Nonetheless, high user density and high bandwidth requirements, such as those in airports, business districts, shopping centers, industrial areas, amusement parks, trade fairs, exhibition centers, sports complexes, etc., are represented in the figure previously. In these kinds of scenarios, efficient radio resource management becomes critical in order to provide the required QoS to the highest number of users with the limited available resources. The mobile node can move around the whole area, as shown in the figure; the random walk model is used with a random direction and speed. In order to find the exact track position of the MT, and the distance between the BS and the tracking point, the estimated RSS is evaluated according to the following ranging model see [Figure 13](#).

The Model architecture of open flow switches uses functions to rearrange the virtual network topology over the physical topology. The primary goals are to simplify roaming of MT moving through virtual addresses, such as requiring virtual routers to be reconfigured, and disturbing virtual IP-level topology. Furthermore, this entity is able to define the new physical topology of the virtual network, which will simplify seamless connectivity for the users. To maintain the immigration environment, we must create new neighbors as the same virtual node migrates from the new physical node topology. Each virtual router has its own forwarding table from the Domain, and each table is a copy of the original forwarding table that was created by routing software. Open Flow switches run a shared data plane, which is the concatenation of the forwarding tables of each virtual network. [Figure 6](#) represents the main concept of the open flow diagram.

#### 4.6. Simulation Results



**Figure 12.** It explains the triangulation technique used to localize a point of BS; the figure is explain how the Base Station (BS) localizes connectivity for users' connections.

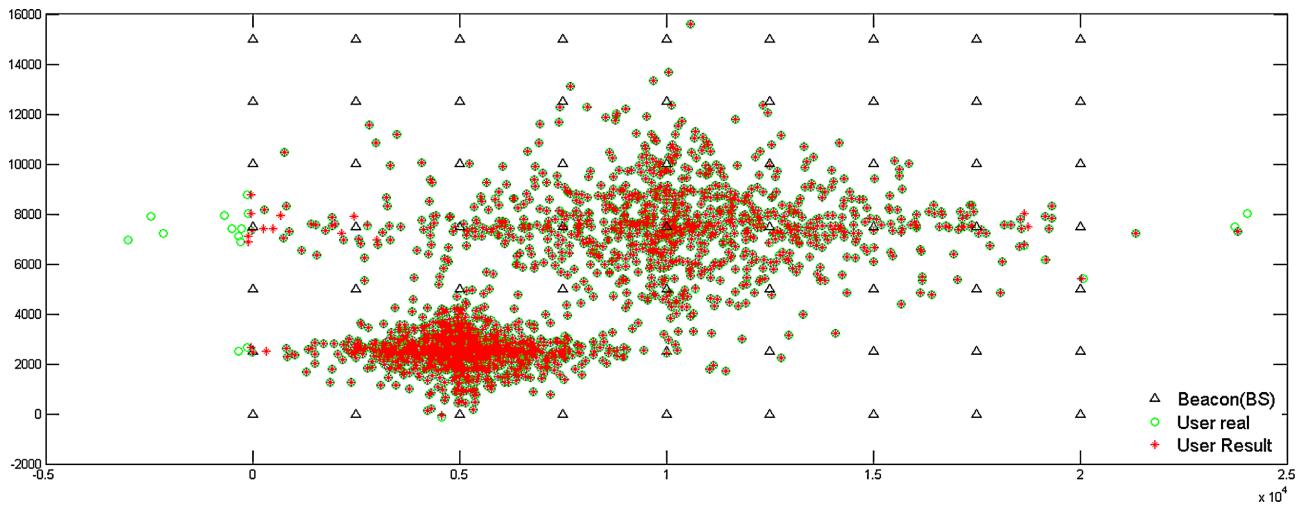


Figure 13. Distributed users in several BS show the stage of the user’s connectivity.

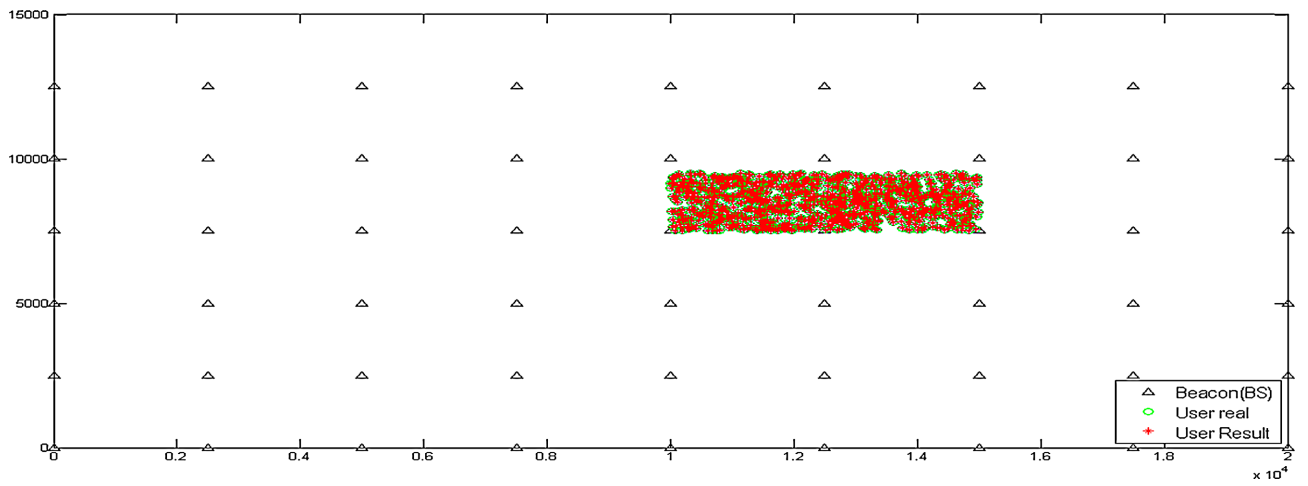


Figure 14. High\_density area localized connect with BS resource limitation.

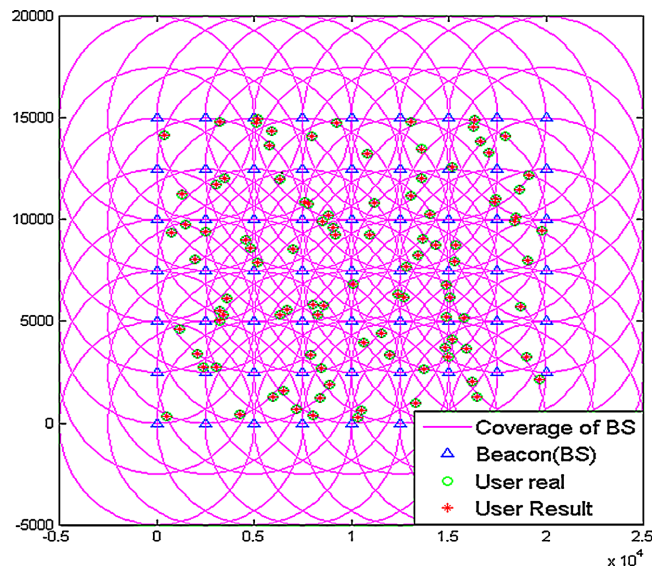
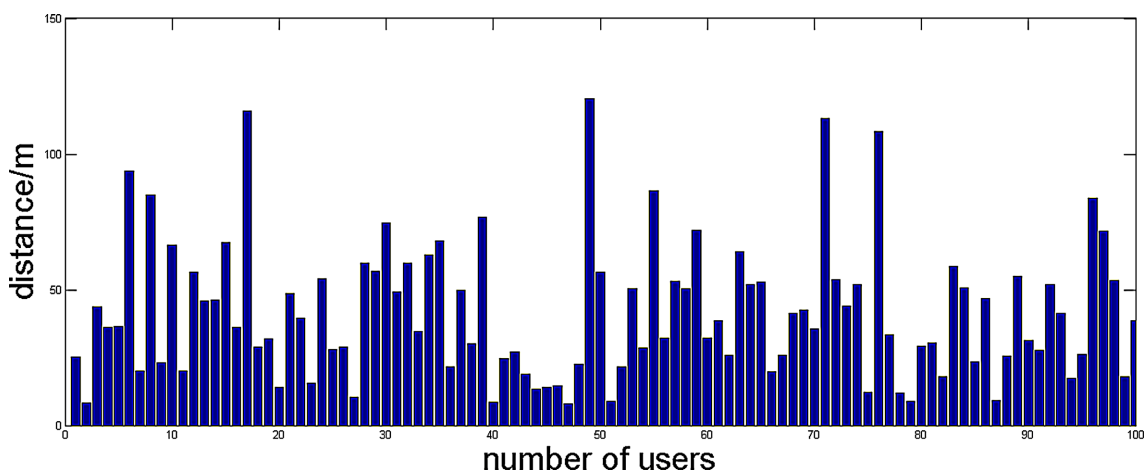
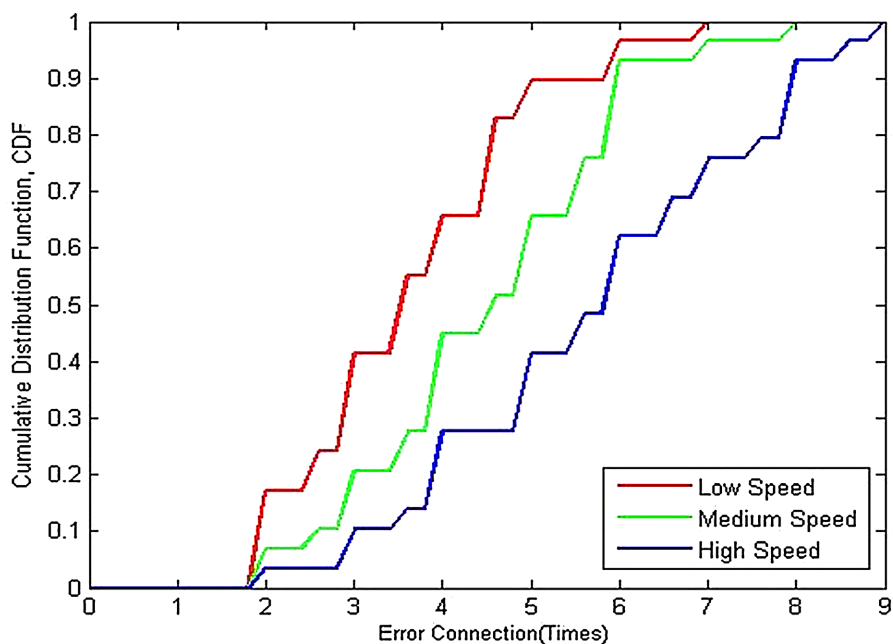


Figure 15. Example of coverage area represented by 100 users distributed in throughout the entire area.



**Figure 16.** Example of coverage area representing 100 users distributed throughout in the location of the bandwidth area of the location distance.



**Figure 17.** Example of the error connection with different BS in the simulation area.

The graph is shown as an error connection. Depending on the user category, there exist [low speed, Max Speed, and Medium Speed] based on the user's random movement; the resulting graph is described in **Figure 17**. Using 165db, represent and provide the prediction of the accuracy of handover percentage, the result also refers to the type of handoff assignment. In addition, the graph provides an explanation of the handover percentage simulated at different times.

#### 4.7. Final Remark

The architecture represents future post-IP generation educated with strong authentication, where customers can obtain perfect privacy. In our architecture, we introduce different planes based on automatic networking, associated with knowledge

plane and intelligent system. The system will be able to control the whole QoS flawlessly in IP networks, and it will consequently respond to users' requirements. Hence, flexibility and extensibility in composition protocol stacks should be deployed and instantiated on a need basis. The OpenFlow model is an alternative initiative approach to providing facilities to test and evaluate network architecture.

#### **4.8. Discussion**

In the vision of open access networks, where users can connect to any available access network of any operator, a more flexible and open solution is required to interwork the networks to offer real global interworking and roaming facilities. To this end, we aim to design a Roaming Interworking Intermediary (RII) platform which support all combinations of different radio technologies in a multi-operator environment by using software defined network (SDN), open flow controller (OFC), SDN is an innovative approach to design, implement and manage networks that separates the network's control (Control plane) and forwarding process (Data plane) for a better user experience. This network segmentation offers numerous benefits in terms of network flexibility and controllability. On the one hand, it allows combining the advantages of system virtualization and implementation of centralized intelligence that enables clear visibility over the network for easy network management and maintenance as well as enhanced network control, as represented in **Figure 4**.

#### **5. Conclusion**

In wireless networking, a heterogeneous network is composed of several wireless technologies; similarly, in frame-based architecture, together they constitute a network that connects users to the internet. The core network, sometimes called the backbone network, joins all access networks together. The technologies utilized in core and access networks may be different, resulting in different characteristics. In this study, research provides extra router capacity and bandwidth to ensure smooth performance. A mechanism where the network decides whether to accept or reject a new flow based on available resources, ensuring that existing QoS guarantees are not violated. In addition, this paper provides suggestions on how to prioritize a measurement process related to the location and bandwidth management mechanisms to measure and control traffic flows on the network. Preventing the network from exceeding its capacity allows for network congestion avoidance. Depending on the provider, the above services and controls can be managed and consolidated. QoS can be applied in wireless networks to ensure reliable performance for critical applications by managing bandwidth allocation and prioritizing traffic, even in environments with variable signal quality and interference. Ultimately, QoS mechanisms give network administrators the power to prioritize applications as determined by the needs of the business. This makes it easy to assign higher importance to particular data delivery types over others.

Future networks will offer more customized services at higher quality level preferences. With the increasing capabilities in devices, an obvious question is whether the users' terminal can control and manage the handover across different access technologies. However, such a terminal-controlled handover requires an interworking architecture where mobility management becomes a service independent of access network operator domains. Intelligent access network selection in the terminal is required to aid users in selecting the best access network.

## Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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