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A novel adaptive schema to facilitates playback switching technique for video delivery in dense LTE cellular heterogeneous network environments

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ABSTRACT

The services of the video on demand (VoD) are currently based on the developments of the technology of the digital video and the network's high speed. The files of the video are retrieved from many viewers according to the permission, which is given by VoD services. The remote VoD servers conduct this access. A server permits the user to choose videos anywhere/ anytime in order to enjoy a unified control of the video playback. In this paper, a novel adaptive method is produced in order to deliver various facilities of the VoD to all devices that are moving within several networks. This process is performed via mobility modules within the produced method since it applies a seamless playback technique for retrieving the facilities of the VoD through environments of heterogeneous networks. The performance of the simulation is tested for checking clients' movements through different networks with different sizes and speeds, which are buffered in the storage. It is found to be proven from the results that the handoff latency has various types of rapidity. The method applies smooth connections and delivers various facilities of the VoD. Meantime, the mobile device transfers through different networks. This implies that the system transports video segments easily without encountering any notable effects.

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1. INTRODUCTION

Mobile video service witnesses an enormous growth based on the fast advancement in wireless networks. The forecast represents 75 % of the worldwide mobile data traffic, which will be consumed via the video by 2020 [1]. A video on demand (VoD) system over mobile ad hoc networks (MANETs) is widely used in our daily life and needs certain particular quality of service (QoS) parameters to be conducted [2, 3]. With the fast improvement of wireless networks, people enjoy working apart from their offices. In the future, the emergence of mobile users will rise. The switch for transmission media from wired networks to wireless networks is considered an essential move in communication technologies. The development of the wireless technology, such as the Worldwide Interoperability for Microwave Access (LTE, LTE-A, WiMAX) refers to long distance communications that permits the communication within more than 10 km, Furthermore, LTE and WiMAX are considered as candidates to achieve the 4G requirements [4, 5]. IEEE 802.11 (WiFi) [6-8] is an efficient communication designed to provide the broadband for local wireless networks [9]. It is appropriate for short distance communications, and for mobile computing, such as Laptops, personal digital assistant (PDAs), Cell Phones, etc. Long Term Evolution (LTE) is a telecommunication mobile system developed to offer high data rate, high throughput and low delay comparing with 3G and 4G systems [5, 10].

This paper focuses on a system that is recognised based on the use of MANETs [11-13] and suggests a technique that could deliver VoD services through to the entire mobile nodes that are being disseminated within several types of infrastructures and networks including the smoothing playback tool for gaining access to VoD services within a heterogeneous network domain. The VoD is considered to be a system that permits users to enjoy viewing the audio/video contents, such as music and movie shows whenever users need so instead of watching the video or hearing a music at a particular broadcasting time [14, 15]. The services of the VoD scheme that depend on MANET's are developing technologies of the wireless networks to dominate broadcast domains in the future. Hence, this improvement is a comprehensive part of a rising number of users. The VoD contains several practical application areas that can be applied due to the development of the wireless technology, such as airlines that deliver VoD services within airport lounges for engaging travellers with their personal digital assistants before boarding their flights. The use of MANETs' museums introduces the services of the VoD data when needed in exhibitions. Moreover, they are widely used in education where a university can connect them on campus in order to give permission for students to view their video that is earlier recorded from lectures they were absent from [16]. There is an extensive research that is conducted for the VoD System over MANET network and many techniques are introduced to improve the system's application and quality [17-19].

Currently, there are many wireless network technologies that support the demand of accessing the internet services. One common application is the multimedia streaming through the wireless network. Nonetheless, once a user roams within a heterogeneous network, the user requires obtaining an appropriate bandwidth derived from different wireless access points. The transition between heterogeneous networks, such as WiFi and WiMAX was encountered through different locations. Accessing VOD services is highly possible for mobile clients, where a seamless and smooth delivery of the video from the server to its users. The heterogeneous network architecture should have a mechanism that could guarantee connectivity in different networks and coverage when handover occurs, VOD services can be possibly provided VOD services, so that they can allow seamless access to many heterogeneous networks. The current VOD systems still explore possible solutions for seamless switching networks. Furthermore, while switching between the networks, the server may not be able to provide suitable services since it restricts the services within a certain location. The mian problem of this domain is the lack of ensuring connectivity once users transfer from a single area to another. Accordingly, a seamless playback technique is produced in this paper for ensuring that the new requested video's playback, whenever users move from one transmission area to another. The proposed architecture is designed to work over existing network infrastructures as shown in Figure 1.

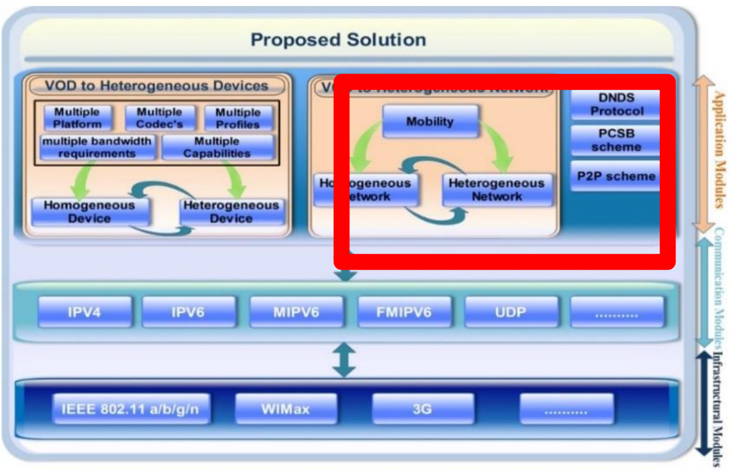


Figure 1. Modules of the system architecture

This architecture is fragmented into three modules; the infrastructure module, communication module and the application module. The infrastructure module can construct the base-line of the architecture, which is including the wireless network infrastructure, such as Wifi and Wimax with different services with their own distinctive characteristics. The communication module provides the reliability of end-to-end services regardless of different wireless technologies; while different types of communication methods can be used to provide seamless services with the advantages of underneath technologies.

The main objective of this paper is to provide solutions that are based on the application modules, such as provide VOD services to those mobile devices when they are moving through different network infrastructures for the sake of providing seamless services, such as, Wi-Fi, WiMAX. The system architecture is designed to be modular. Adding more components in the future will overcome the constraints of bandwidth and the limitation of mobile clients.

The proposed VoD system architecture in [2, 20-22] presents two major types of servers, namely, Global-Media-Forward (GMF) and Local-Media-Forward (LMF). The basic objective of both servers is to have the video transmitted through to several viewers within heterogeneous networks. LMF server is defined as the server, which is fortified in a way it is accompanied by the WiFi, while other type of server is fortified in a way it is accompanied by the WiMAX. The terms WiFi and WiMAX indicate to the domain of heterogeneous networks, which contain their own particular coverage area.

In the paper, a comprehensively defines the connectivity problems are presented in Section 2. Section 3 describes a sequence of statements for validating the produced technique. Section 4 introduces the smoothing playback technique of the heterogeneous networks. Section 5 explains the mobility model. Section 6 discusses the simulation model. Section 7 highlights the results of the conducted simulation. Section 8 draws the conclusion remarks of this research.

2. HANDOVER IN HETEROGENEOUS NETWORK ENVIRONMENTS

With the rapid improvement of the wireless technology, different types of mobile terminals and the use of high-performance mobile devices, such as portable computers, pocket PCs, mobile phones and PDAs, are rising worldwide. There are many users who enjoy connecting to the Internet for obtaining various services anytime and anywhere by using fixed IP addresses. The improvement of the mobile Internet has risen as time passes by. In order to satisfy users' requirements for the mobile Internet, the mobile IP technology needs to be further studied to achieve users' requests. A mobile IP is defined as a network layer solution, which delivers mobile functionality through to the Internet. This solution is secure, reliable and scalable where it lets the mobile node retain a continuous communication link once a user switches the link. Mobile IP applies a tool for IP routing that lets a mobile node easily connect over any link with a permanent IP. Mobile IP technology has become an important issue in the future for its frequent use in mobility, reliability and security when delivering up-to-date services as IP video and Voice over IP (VoIP). Furthermore, it maintains an extremely efficient performance with indefinite potential and distinctive value that can be improved. The Mobile IP nowadays indicates to IPv4 and IPv6 mobiles. The formation of Mobile IPv6 is an improvement of Mobile IPv4 and is utilised through several new characteristics of the IPv6 mobile. Hence, it delivers more efficient characteristics compared to the IPv4 mobile. It can completely meet the address it requires for a numerous number of mobile terminals. Handover a procedure that permits mobile devices to transfer from a single network cell to another without the need of altering their IP addresses. When a mobile to transfer from a single network cell to another, it is only by means to roam through other cells that require an authorisation and authentication from the home cell and the visiting cell. Nowadays, mobile devices are equipped with several Wireless Network Interface Cards (WNICs) in order to permit the entire mobile clients to pass through many heterogeneous wireless technologies and to outspread the service area for entering the services in a simple way once these clients are transferring from a single network to another, or from a WNIC to another [23]. Once a Mobile Client (MC) begins transferring out of the converge area, the MC begins missing the connection of the video to its access point (AP) where data is stopped being received for a number of seconds. The MC begins at this point tracing another base station (BS) or AP in order to be linked with it. This type of procedure is named handover [24, 25], which retains the frame transmission and channel connection where the movement of the MC is based on the smooth handover [23, 25]. The demand for highly pervasive information access causes the merge of several kinds of infrastructure and networks in combination to the Wireless Local Area Networking (WLAN), Wireless Fidelity (WiFi), wireless wide area network and Wireless Metropolitan Area Networks (WiMAX) such as the LTE and 3G [5, 10].

WiFi relies on the IEEE 802.11 standard [26] that is mainly referred to the Local Area Networking (LAN) technology, and which is formed to produce an in-building broadband coverage. WiFi is currently considered as the standard for broadband connectivity in public hotspot locations, offices and homes. The broadcasting range of the infrastructures and networks begins from smaller coverage regions. Radio signals that are transferred from WiFi antennas are selected via WiFi receivers, such as devices that are fortified with WiFi cards. Once a computer gets any signals in the range of a WiFi network, which is usually ranging from 30 to 100m in comparison with the IEEE 802.16 standards and the WiMAX, which overlay a region ranging from 5km to 15km for mobile centres as shown in Figure 2. WiFi wireless LAN technology is extremely simple and costless in being disseminated compared to wired systems. Accordingly, WiFi allows network access in urban and rural regions where it is not easy to install cables for a wired network. Additionally, massive types of cellular phones, media players, PDAs, laptops, cameras and cordless phones contain a built-in WiFi interface, which in return provides seamless connectivity [27].

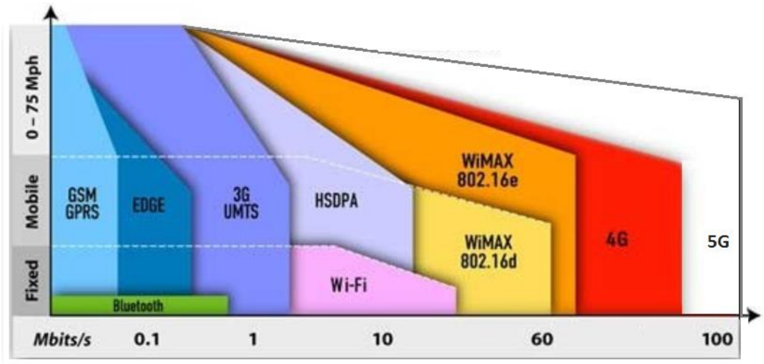


Figure 2. The categorisation of the wireless WiFi, 3G, WiMax, 4G and 5G converge regions

In order to gain access to different accessible technologies, a mobile device should support multiple wireless network interfaces. The scenario that is described in this paper for the convergence of heterogeneous networks is similar to the architecture that is presented in [28, 29]. This architecture consists of two service areas as shown in Figure 3, which comprises the WLAN connectivity (in-building) and WWAN connectivity (metropolitan area).

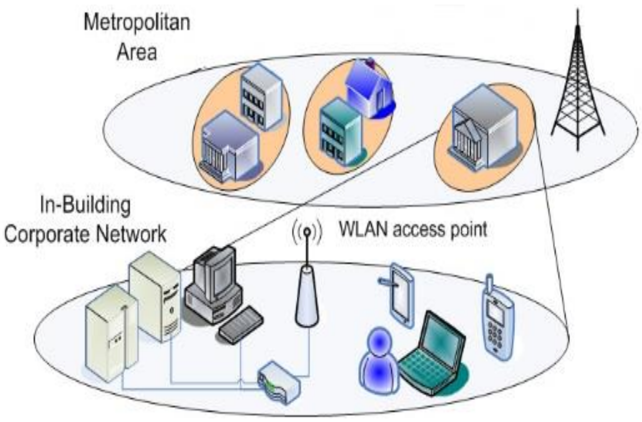
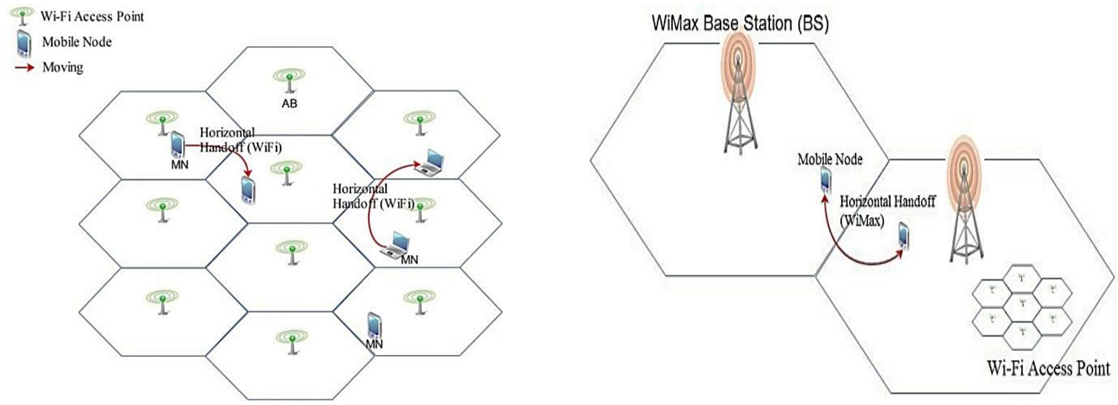


Figure 3. Overlay wireless networks architecture

Having more than one access technology available, the selection of the network to be connected to can be performed according to different criteria and therefore the mechanism to switch between access technologies must be provided. Figure 2 illustrates different standards of heterogeneous wireless networks with their intersecting nature based on the coverage. From a shared user's perception, the network connectivity and coverage are increased by the network convergence. In order to understand the requirements and considerations for a seamless handover, the following lines describe some basic concepts. Handover can be seen from different points of views. When a mobile station is transferred from a single wireless cell to another, it is named Handover or Handoff. It is categorised as vertical (inter-system) and horizontal (intra-system) [30]. When a user moves from one cell to another using the same access technology is called horizontal or homogeneous handover. A typical example includes a user transferring between two cells within a cellular system [24]. A horizontal handoff among base stations (BSs) or access points (APs) connects with each other in order to support the homogeneity pertaining to the mobile node handoff. For instance, the mobile nodes (MN) in the WiFi network domain transfers from a single AP to another as shown in Figure 4 (a) and is similar to the WiMAX network domain. MNF transfers from a single BS to another BS. The handover process relies on the IEEE working group in 2011 finalised the IEEE 802.16e standards as shown in Figure 4 (b) [31-33]. On the other hand, if the handoff happens through different networks (i.e. heterogeneous networks), the Handoff within heterogeneous networks refers to a vertical handoff. For example, a mobile node transfers from a LTE to WiMax network t or from a Wi-Fi network to a WiMax network as shown in Figure 5.



(a) (b)

Figure 4. (a) Horizontal handoff between WiFi access points (AP's), (b) horizontal handoff between WiMax base station (BS)

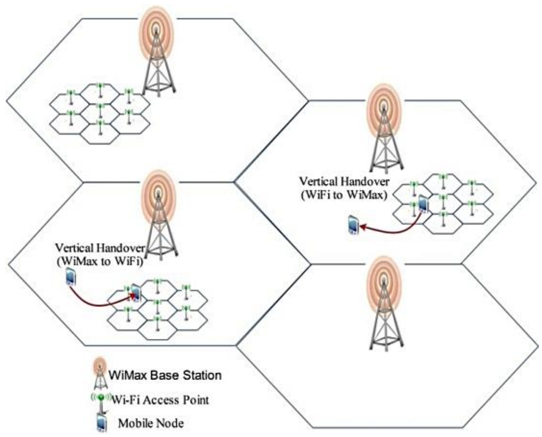


Figure 5. Vertical handover from Wi-Fi to WiMax and WiMax to WiFi

2.1. Handover smoothing algorithm

Handover is defined as the procedure of accomplishing persistent services when the user transfers among different networks. Handover is required when mobile users crossing occurs and/or when a degradation occurs with the signal quality through the new channel. Nevertheless, when a handoff occurs, there is swapping within the networks. Hence, users are transferred to another BS or another network [34]. The basics of the 5G mobile network refers to the heterogeneous networks where in these networks, seamless handover in non-negotiable [27, 35]. The handover procedure comprises of three phases, which are execution, decision and discovery. Network discovery explores a suitable network, which meets the user desired QoS. The decision phase refers to when the handoff process is considered (also called a handover initiation phase) [36, 37]. The IP-layer mobility management scheme aims at providing MNs with unceasing internet access when they transfer from a single AP domain to another. This procedure of changing the AP is named as the handover. During this procedure, the MN is incapable of either receiving or sending packets due to the handover delay process. The handover procedure contains a sequence of different tasks as shown in [38] as shown in Figure 6.

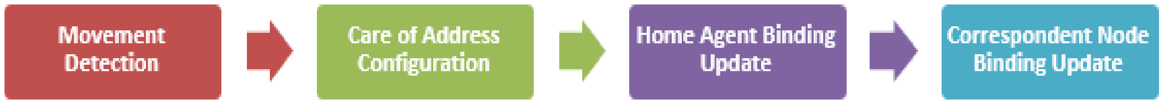


Figure 6. The general handover steps

Every task should be conducted since the mobile node is incapable to get the IP packets until the entire task is completed. The time period between the final obtained packet via the mobile node of the past connection and the first obtained packet via the mobile node in the current connection refers to the handoff latency. This period of time is affected via many contents, which comprise: the Link Layer Establishment Delay that refers to the required period of time by a physical border for creating a current organisation [38, 39]. The movement pattern of mobile users, their location, their velocity and acceleration that is changed over time is explained by the mobility model [40, 41]. The protocol's performance is efficiently selected via mobility forms. The shifting form of actual implementations is not needed for emulation in a sensible manner. Mobile nodes are presented by mobility prototypes according to free movements of these nodes (entity models). Additionally, these nodes are based on a set of methods. Few entity methods are available and are continuously utilised, including the Random walk mobility method [42], the Random waypoint mobility method [43], the Gauss-Markov mobility method [43] and the mass mobility method [44], the city section mobility method [45]. A set of methods contains the column, itinerant society and pursues group mobility method.

3. ISSUES AND ASSUMPTIONS

In this section, the issues and the assumption for the proposed smoothing playback mechanism are discussed.

3.1. Issues

The previous proposed architecture (i.e. the VoD system architecture) in [2, 20-22], which provides two servers, namely, the GMF and LMF is presented in Figure 7. The LMF server is defined as a server, which is fortified through WiFi, while the GMF server is defined as a server, which is fortified with wireless network technology (e.g. WiMAX). The terms WiMAX and WiFi indicate to the heterogeneous network domain. In fact, they have their particular coverage area. The encountered problems within this domain comprise:

- How the playback is smoothed once users transfer from a single region to another. The movement from a new region to another requires an idle period of time pertaining to the playback. Accordingly, the produced linking of the new LMF is totally not linked. Hence, the video that is transmitted is terminated. An interruption occurs to the playback.
- The way of creating a tool for the PSCB [20, 21] to smoothen the playback when users are moving within their areas.

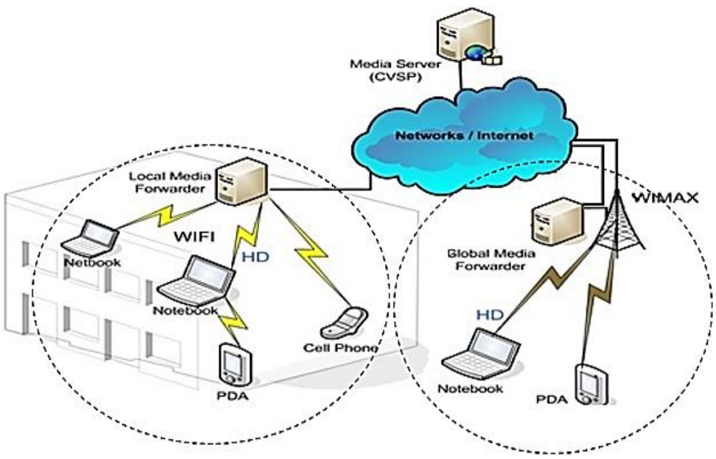


Figure 7. The overall produced method of the GMF and LMF

3.2. Assumptions

To streamline the problem, some assumptions for the work are enumerated as follows:

- The entire GMFs and LMFs store similar videos.
- The entire GMFs and LMFs are installed including a PCSB engine [20, 21].
- The LMF is used to form a main linking resource whilst delivering the services of the VoD through to interior domains.
- The GMF is used as a subordinate link resource whilst delivering the services of the VoD through outside domains. Subsequently, WiMAX is preferred to be utilised in such domains forming a main link. Nonetheless, WiFi is utilised as a subordinate link once it exists.
- The MFs are in charge of checking the values of the RSSI values for existing substructures of the MN and giving a threshold rate along to the CVSP.

The CVSP collects data about an existing link via the mobile device in order to deliver services within heterogeneous networking systems.

- The CVSP produces facilities for mobile devices based on upholding a double link derived from the GMF and LMF.

4. A NEW SMOOTHING PLAYBACK PROCEDURE FOR HETEROGENEOUS NETWORKS

When movements occur in heterogeneous networks, the critical region is put at the movement point as shown in Figure 8. When a current network takes place during the movement point, the playback should be uninterrupted. To tackle the problem, a seamless VoD playback technique is produced. The technique involves a couple of processes comprising:

- The recognised network linking process.
- The seamless playback process.

As illustrated from Figure 8, the paper produces a dissemination related to the LMF {LMF1, LMF2, LMF3... LMFk}. The LMF is defined as a stationary and dedicated device that is utilised to provide a relay for the service to a transmission coverage area of the LMF. The region is called as the local service area. This dissemination is produced for the purpose of creating interior domains pertaining to the LMF (e.g. campuses, museums, airports, etc.) and representing it as a Primary Connection (PrC) of mobile clients. The GMF {GMF1, GMF2, GMF3,.., GMFn} grants wide region services within different distributed network infrastructures (e.g. WiMAX). The services of a WiMAX network are practically utilised in outside or public locations since they are checked and recommended via service providers according to a robust link deficiency within interior domains. Additionally, the paper considers the GMF forms subordinate resource for delivering the services of the VoD through to mobile devices. Every video maintains the CVSP, which is transmitted through to the MF based on the use of the Popularity Cushion Staggered Broadcasting (PCSB) protocol [20]. The MF is utilised so that the CVSP could provide videos and transmit them within the Wireless Network Interface Card (WNIC) it owns through multiple mobile devices according to its transmission domain. Mobile devices must exist in the coverage region's range of the local forwarder for the purpose of obtain it. The CVSP is defined as a group of LMFs, which are linked together within the substructure wireless based network.

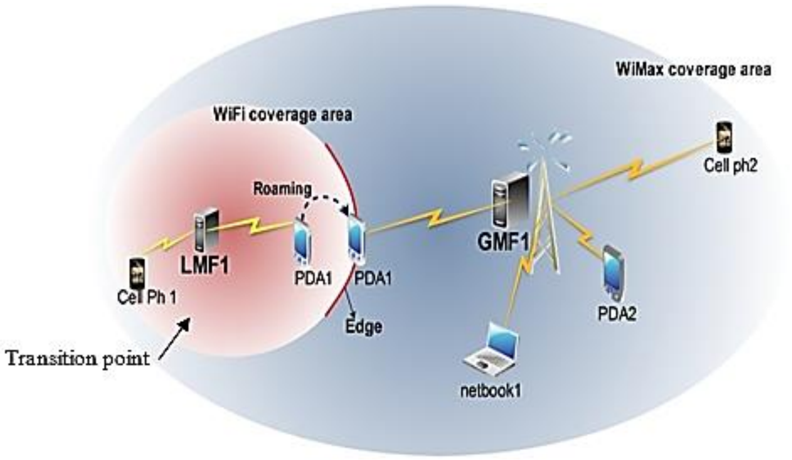


Figure 8. A paradigm of the transition point by linking the GMF and LMF

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The LMF is stated at the media forward server as K, *where* $\{K_1, K_2, K_3..., K_n\}$. The LMF applies the broadcasting channels so that video segments could be downloaded from the media forward server. Additionally, the LMF generates $2K$ sub-channels for every regular channel that is applied within a physical interface. The created sub-channels are applied in order to broadcast sub-segments that are related to the first received segment from the media server. Thus, the first segment is segmented into $2K$ sub-segments and broadcasted along through multiple sub-channels in a similar way to the PCSB when the virtual interface is being generated. If a client joins the network, its virtual interface is accordingly used for downloading the first sub-segment. Following a seamless and an effective download, it will immediately be converted to the physical interface so that other available segments could be downloaded [18]. Assume that the length of a video is L and the number of regular channels is K. The service delay is highlighted according to the followings:

$$S_{Delay} = Segment^1 * L / 2^k \quad (1)$$

Since $Segment^1 * L = L/K$, service start-up delay can be represented as follows:

$$S_{Delay} = \frac{Length\ (L)}{K * 2^k} \quad (2)$$

The client caching space is considered to represent an issue through mobile ad hoc networks as this refers to the limitations incurred in the storage of a mobile client. Consequently, streaming video with the least space of the client's side is taken into account. In MobivoD, clients possess two buffers for storing video segments as reusable and pre-fetched buffers. The reusable buffer is mainly applied for caching the first video segment. Accordingly, the buffer space should be equal to the size of the first segment where this is highlighted according to the followings:

$$B_{size} = Segment^1 * Size = S_{Delay} \quad (3)$$

Furthermore, since mobile clients represent bandwidth limited, dividing *Seg1* into *2K* segments minimises the needed bandwidth for downloading *Seg1*. Meanwhile, it minimises the client overhead for the purpose of serving multiple neighbouring nodes. Suppose that the video file size denotes to V_{size}, and the consumption rate denotes to r, then $B = SK * r$, where B denotes to the needed bandwidth. Seg1 bandwidth is provided as:

$$Segment^1 B = \frac{V_{Size}}{2^k} * r \quad (4)$$

4.1. The process of the network link creation

Mobile devices are supported in combination to several mediums of wireless communication systems (e.g. WiMAX (IEEE 802.16d) and WiFi (IEEE 802.11g)). When VoD services are initialised, the mobile node repeats existing wireless network communication services. The initial process of identifying an infrastructure choice via mobile clients is highlighted as shown in Figure 9. The client application on mobile clients recounts existing services for communications. Consecutively, it seeks existing networks based on its interfaces (e.g. WiMAX and WiFi). Accordingly, if there exist a single infrastructure, it will connect immediately, otherwise, it will seek the most effective connectivity.

The application produces connections with the most appropriate and existing main connectivity and seeks a subordinate link. In the paper, WiFi is used through interior domains representing a main link, while WiMAX is used as a subordinate link. Subsequently, within outside domains, WiMAX can be best utilised as a basic connectivity while WiFi is best utiilised as a secondary connectivity when it does exist.

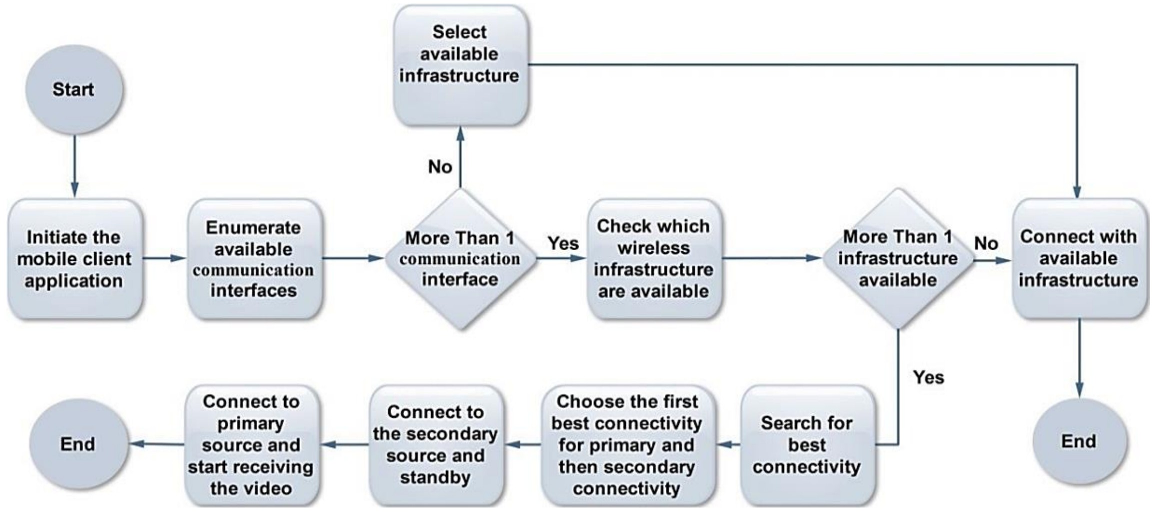

Figure 9. The preliminary procedure of choosing the network substructure

During this procedure, the CVSP collects information regarding the relay of the media forwarder for the mobile node in order to deliver services within homogeneous networks. Further, the CVSP arranges particular facilities for mobile devices by retaining a double link via GMFs and LMFs. According to the process, the server remains frequently handling the delivery of the services pertaining to the VoD for an appropriate or an active link within various substructures. Figure 10 illustrates the process. The mobile device starts communicating for accessing the services pertaining to the VoD system. The CVSP collects information about the existing connectivity from the nodes including the infrastructure as shown in Figure 10. This information is collected based on the DNDS protocol.

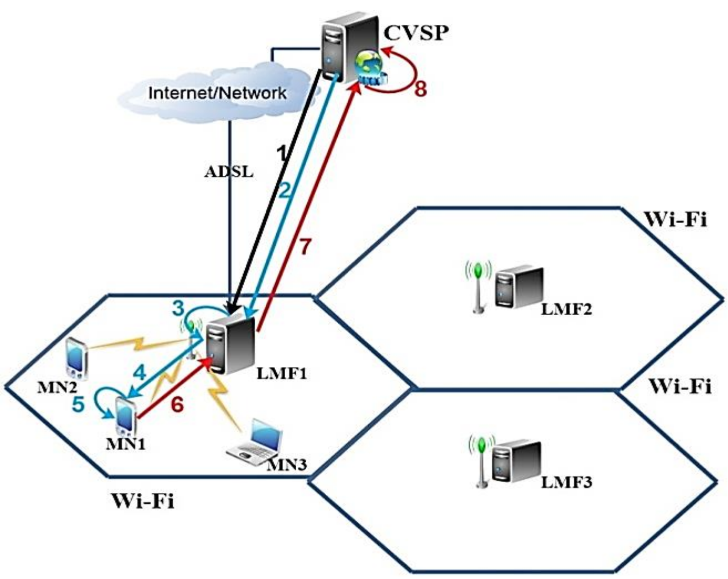

Figure 10. The CVSP's process in collecting the data of the existing link to its substructure from the mobile

The process of the CVSP collects information of the existing connectivity according to the following steps:
- The CVSP identifies the MFs within the services region.
- The CVSP orders the existing information from the MFs.
- LMF1 checks the request.
- LMF1 checks for an information regarding the existing infrastructure and connectivity from MN1.
- The MN1 collects information about the existing connectivity including the SeC, PrC and their infrastructures according to the DNDS protocol.
- The MN1 transmits the requested information to LMF1.
- The information is sent in turn by the LMF1 along to the CVSP.
- The CVSP stores and retains the information to deliver the best services within the SeC or the PrC.

The MN indicates to the mobile node, the SeC indicates to the subordinate link, the PrC indicates to the primary connectivity where LMF1 indicates to the LM Forwarder. Figure 11 clarifies the process of the user implementation for collecting data around an existing bandwidth including choosing a connectivity that is the most appropriate. Once the mobile investigates an existing bandwidth over the primary connectivity, it will examine the strength of the signal and bandwidth in terms of how adequate they are. If it appears that both are adequate, the primary link is formed from the facilities of the VOD system, connect and begin obtaining these services and begin operating the video. Once both are inadequate, the mobile device moves through the subordinate link and produce comparisons for it one more time based on the primary link. Once it seems more effective, it will immediately be connected through the subordinate link where it begins obtaining these facilities and begins operating the video. After that, it notifies the CVSP according to the DSDN where it begins obtaining and operating the facilities of the VoD.

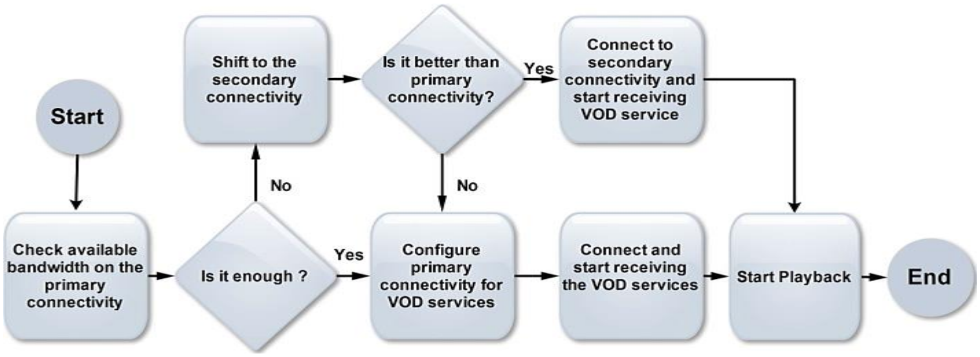

Figure 11. The connectivity determination

More information about linking among heterogeneous networks is highlighted as shown in Figures 12 and 13. The figures discuss the procedure of movable networks when entering the facilities of the VoD system. This work is introduced in order to utilise the LMF as a primary link resource for delivering VoD facilities through mobile devices within the (WLAN), which contains a smaller range of coverage. When mobile clients transfer outside the WLAN region, they must directly discover the absence of the primary link that moves the linking along through the subordinate link resource. This process makes it bring efficient VoD facilities to mobile devices within the GMF based on the utilising a large range of internet infrastructures (e.g. WiMAX). Hence, the basic notion is to convert to the secondary connectivity prior to the breakdown of the WLAN when remaining in the WLAN region as long as much as it could be due to its most effective Quality of Service and lower price. Accordingly, the Received Signal Strength Indication (RSSI) is applied in [46] and [33, 47]. The RSSI is defined as an acronym in which the signal strength indication is received to it. It is used to measure the signal power of the radio link.

The mobility component incessantly checks the values of the RSSI related to the existing infrastructures by checking whether these values reach the value of the initial threshold. Once it finds the value of the first threshold, the CVSP is acknowledged regarding the mobile devices that are outside the coverage range. After that, it starts flowing over the subordinate link. The CVSP lets the location of the flowing media be related to the subordinate link at the same location pertaining to the new streamed video along to the primary link. Once the mobile devices are close to the edge of the link, a new value of the threshold value is triggered by these devices in order to move and activate the secondary connectivity. This process is conducted by an appropriate subsequent linking for VoD facilities.

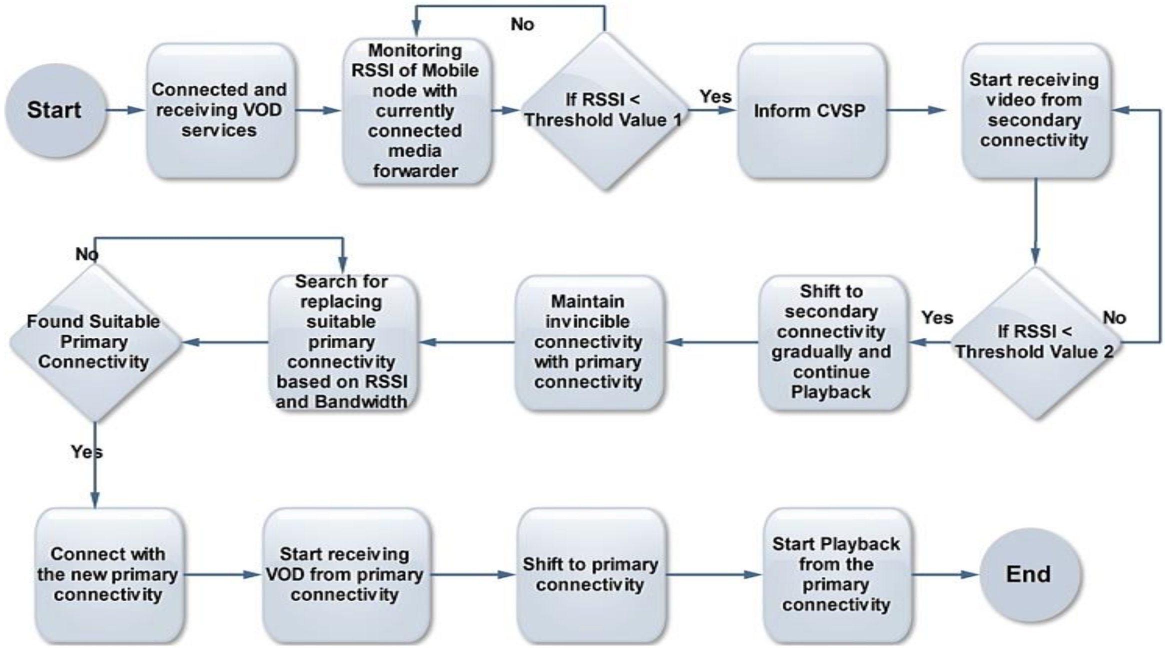

Figure 12. Substructure or network movement through mobility

4.2. The process of seamless playback

The moving paradigm of the mobile device is shown within different heterogeneous networks (e.g. WiMAX/WiFi) as shown in Figure 13. Additionally, the process of linking within different heterogeneous networks is discussed as follows:

– The video is linked and ordered by MN_1.
– MN_1 obtains the ordered segments of the video from the new PrC's (LMF1's) channel.
– LMF_1 checks the RSSI of MN_1:
  - Once the RSSI reaches the value of the initial threshold, then:
– The LMF acknowledges the CVSP regarding MN_1 in order to be transferred outside the transmission range.
  - CVSP arranges a flowing process through the "SeC" (GMF_1).
  - CVSP lets the SeC's location flow through a similar location of the "PrC" (current LMF).
– LMF_1 remains monitoring the RSSI. Once MN_1 is about to reach the targeted range, a new threshold value is triggered by the RSSI. Meantime, it performs a network linking formation process when it is linked through the current MF.
– MN_1 activates and transfers the "SeC" (GMF_1).
  - MN_1 halts operating from the new buffer and arranges a playback process from the current broadcasting channel including the current "SeC".
  - Search for the current channel in which the location seems to be definitely similar to the location of the transition point as shown in Figure 13.
– MN1 begins operating the segment of the video from the "SeC" (GMF1) within the "WiMAX" substructure.

The "PrC" denotes the primary link, "SeC" denotes the subordinate link, MN denotes the mobile device and LMF denotes the Local Media Forward. Finally, GMF denotes the Global Media Forwarder. Meantime, several manufacturers have various applicable techniques. For example, various WLAN cardshave various performances. Hence, it is very important to adaptively put the threshold for weak signals based on every performance of a card. By considering the WLAN as the primary connection mechanism, the max-min method is implemented to comply with the performance of a card, which is explained as follows: First, once a sample is made for the RSSI, the new RSSI is verified once the connection to the "WLAN" appears to be effective. Second, once the tested RSSI is less than the threshold Value 2 for some periods, for instance, 1/second, then, Value 2 is updated with the maximum RSSI according to this period of time. Meanwhile, let Value 1 = Value 2 + Δ, where Δ indicates to the margin. Figure 14 illustrates the handover process, for instance, from the primary link through the subordinate link (i.e. "WiFi "to "WiMAX").

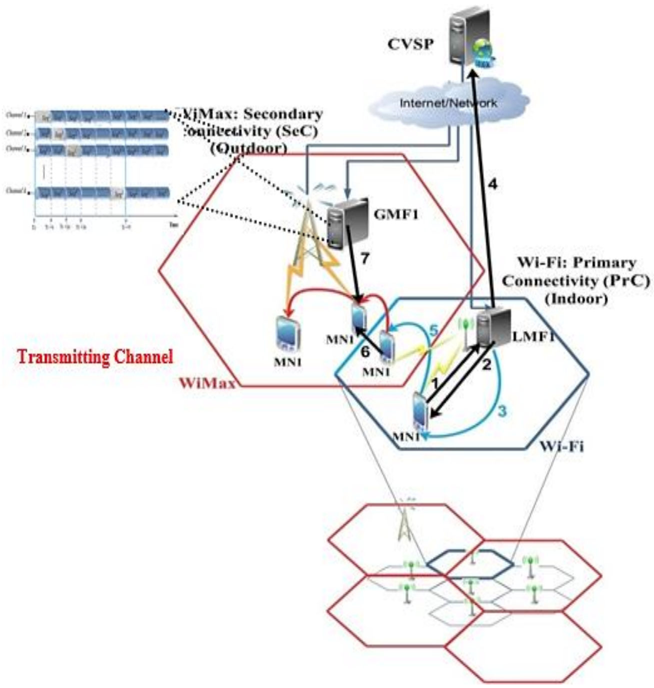

Figure 13. The moving paradigm of the MN over different heterogeneous networks

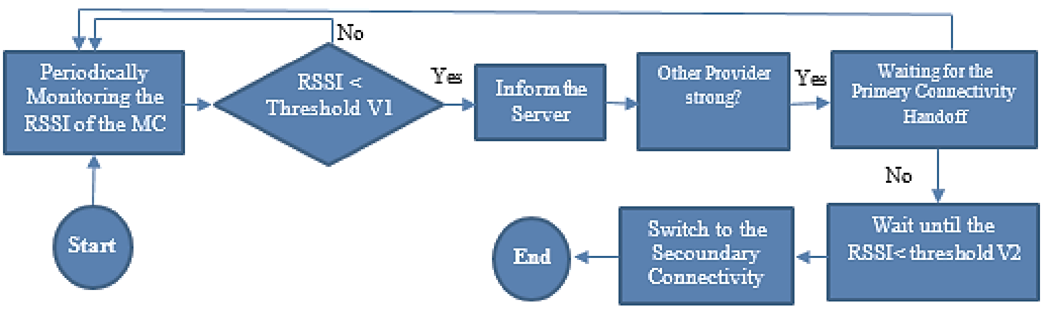

Figure 14. The discovery of the RSSI once the mobile device shifts along from the PrC into the SeC

5. THE MOBILITY TECHNIQUE

According to the proposed system, the mobile device transfers within each second having a probability "P*rob*$_{move}$" through an arbitrary region within the LMF region with a distance of the "D$_{move}$" Є (0, Move Max]. In most cases, the radio broadcasting only reaches a range from 30m–100m, when the bandwidth of the wireless network is 54 Mbps. Mobile clients can access the video within the range of this transmission through to the broadcasting channel from the MFs. The transmission region is supposed to form a 2D circle, whereas both GMF and LMF are located on (0, 0) which is the main centre, including a region of facilities of (0, 100m] that is related to the (0, 15km], the GMF and the LMF. Locations of the mobile devices are created in a random way through this circle. Additionally, mobile devices link to their service providers where at the same time, they utilise a broadcasting distance of the (0,20m), d_{LMF}= 20m that is secure distance to get the full services. This distance, in fact, permits mobile clients to have an effective bandwidth. In the GMF’s region, the area of the service is larger reaching up to 30 miles (50 km) for fixed stations, 3 to 10 miles (5 to 15km) for mobile stations including a secured broadcast with a range of d_{GMF}=5km.

Within the regions of facilities, whether through the GMG or LMF regions, mobile devices transfer a certain amount of time through either the GMG or the LMF area on a straightforward line prior to the production of a new round. The transfer time is considered a random number, which is distributed for around 5 seconds with a standard deviation reaching 0.1 second. Once mobile devices transfer and produce another round, the current angle is computed. The angle is a disseminated random number accompanied by an average number that is the same to the number of the past angle with a standard deviation of 30 degrees. In order to primarily control the client’s speed through the service region, a simulation takes into account the speed as a random number that ranges from 0.1 – 0.45 (unit/Sec) including a standard deviation reaching a value of 0.01 unit/Second. A random number is selected based on its rapidity once mobile devices transfer and produce another round. Empirical paradigms use a similar mobility track including a various rapidity pertaining to the movement of the mobile device so that the system performance could be tested as shown in Figure 15.

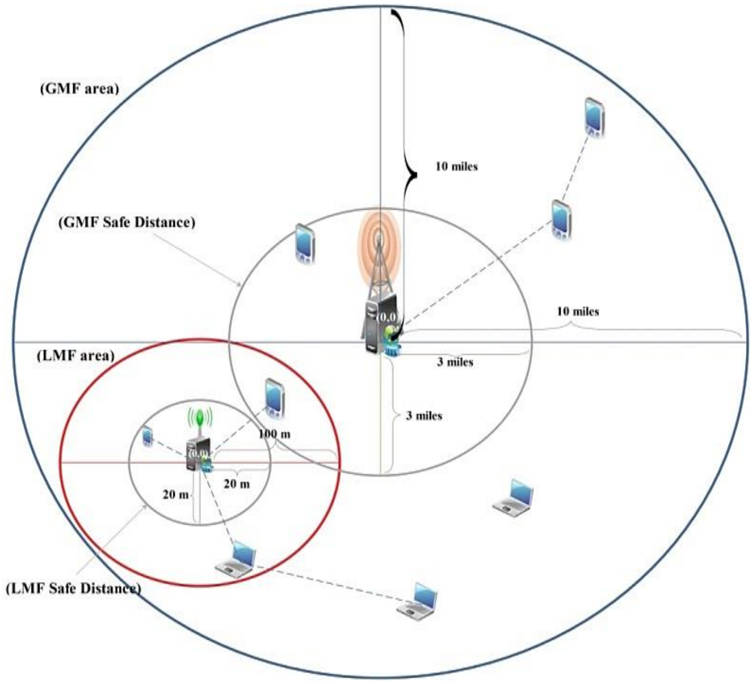

Figure 15. The mobility technique paradigm relating to the produced method

6. THE SIMULATION MODEL

The basic notion behind this model is to deliver VoD services through to mobile devices by spreading videos within different networks, which completely use all networks with their coverage so that users could stay connected as shown in Figure 16. Apart from basic parameters that affect the proposed system’s performance, there exists an adverse impact of the mobile devices’ handoff once roaming through different heterogeneous networks. When the mobile nodes arrive at the edge of the MF server, it must produce a connection handoff within the current MF into the adjacent regions. This may produce a modification over IP addresses that are related to the MN (supposing that the MN forms an IP node) and that requires to be engaged along within an "IP mobility protocol". Nevertheless, such available protocols are ineffective processes and require more time consumption. The performance of the system is minimised by these protocols. Based on the findings, the study suggests proposing an IP mobility scheme for displaying the system’s performance when a mobile client watches the broadcasted video and transfers from a single network to a following network. Further, it investigates the availability of any adverse impacts over a suitable stage.

In general, the LMF delivers VoD services to the services regions of the MN by broadcasting the segments of a video such that the LMF stores data regarding MNs including new locations. The GMF is the external network that is being visited by the MN. Once the MN moves to a secondary connectivity, it will have the services from the GMF. The GMF rebroadcasts video segments, which are transmitted to the MN via the LMF as discussed previously in Section 4.2. The MN connects with the LMF forming a primary link. Once the mobile transfers through the current position, the MN must directly explore the inexistence pertaining to the primary link where a link through the GMF is transferred in the form of subordinate link resource. Once a registration is performed by the MN to the GMF, the profile of the MN is immediately transmitted. Section 4.1 introduces many details regarding the connection formation process of the heterogeneous networks.

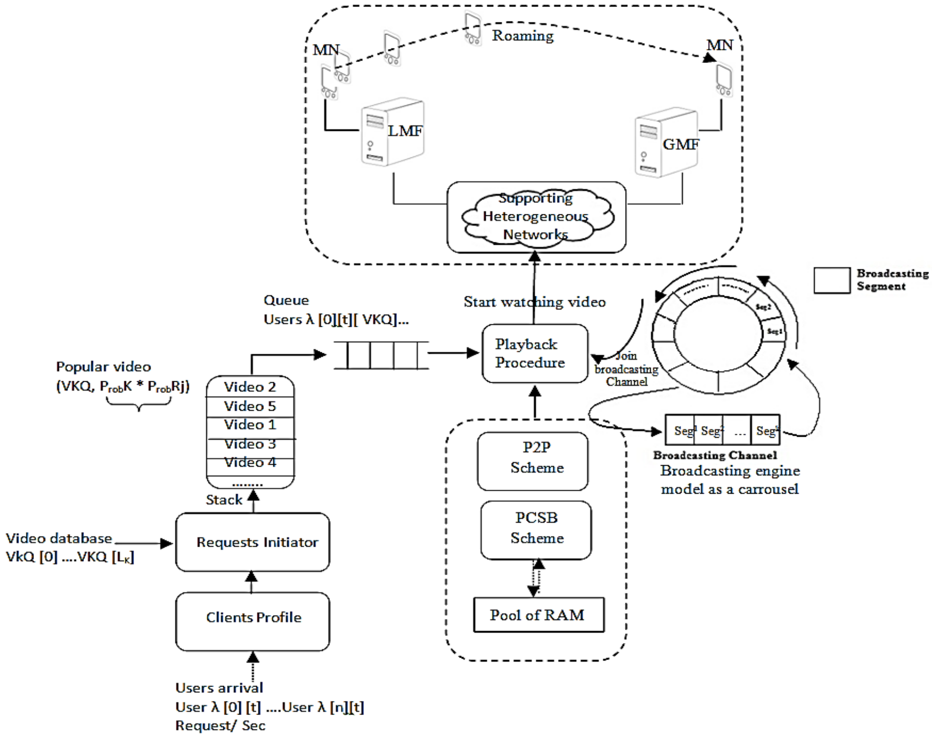

Figure 16. The overall simulation model

In this paper, the IP mobility's performance and the link handoff are expressed as "Handover latency" and "Buffer space". Handover latency is defined as a time period that is used to detach an MN within the network, where demanded facilities are not obtained. The handoff latency is able to adversely increment the delay via the MN, which must stand prior to acquiring the facility. Additionally, it can interfere the video that is flowing into the middle. The buffer space is defined as a demanded space of storage related to the IP mobility protocol for achieving its tasks. This in turn increments the space of the total cache, which is significant for applying the produced method. The aim is based on highlighting that the two factors are compatible according to its execution. The full process pertaining to the IP mobility system, which assesses the execution within the based simulation tests, which is discussed in the following section.

7. SIMULATION FINDINGS

The buffer storage usage with the handover latency time are utilised to examine the proposed system's performance. Additionally, the experiment is performed for three various paradigms in order to perform a measurement for the execution through several cases.

7.1. Experimental analysis for the handoff latency

One basic objective pertaining to the produced method is reducing the delay time of mobile clients as discussed previously in the published paper. The handoff latency time is illustrated through this subsection. A measurement id performed for the handoff waiting time by performing a calculation for the execution time starting from the initial time solicitation, which is acknowledged and ending with a required acknowledged communication. Conducting a calculation of the handoff latency for the indicated paradigm requires that a similar mobility track and the size of a packet are utilised regardless of the existence of various rapidity of the mobile device shifts. The parameters of the experimental paradigm are all given as shown in Table 1.

Table 1. The mobile device shifts of the rapidity paradigm

	Paradigm	The rapidity of mobile device shifts
1	Fast	390 Km/ hour or 20 m/s
2	Medium	21 Km/ hour or 8 m/s
3	Slow	8 Km/hour or 4 m/s

The whole paradigms utilise the mass shifts by using the simulator OMNET++ based on the shifting tracks including the size of a packet of 1024 Kbps. The experimental test is conducted in order to assess the handover latency and the number of packets that are buffered through to the temporary storage within various movement speeds. The movement speed of a mobile node is the standard for the handoff execution as it identifies the rapidity of the shifting of a mobile device from a single network to a following one. The mobile node transfers to reach three foreign networks. In every network transition, a measurement is produced for the time completion of the binding update request until the binding update is acknowledged. In order to gather the data, the packet data of a mobile node is picked up through every foreign network.

The OMNET++ delivers the feature of capturing a packet within a vector including a scalar output, which stores information (e.g. packet drops, end-to-end delay of receiving packets, the queue length over the time, etc.) while the scalar output comprises the average end-to-end delay of receiving packets, the number of packets sent, a summary statistic and the number of packets being dropped. The simulation is run frequently in every scenario. Consequently, it can be inferred from the gathered findings in terms of the runs that they are marginally varying, close by each other and are unremarkable. Consequently, a single of the results is gathered for every case such as Slow, Medium and Fast movements' mobile node (in second) as shown in tables below.

Table 2 presents the results related to fifty handoffs of the system including various mobile device shifting speeds, the slow shift of a mobile device handoff execution time reaching 4 m/s. A mobile device moves in this experiment within a mass mobility through 3 various networks, which means a mobile device conducts three handoffs within one journey including six handoffs within one round journey. The mobility rapidity for the indicated paradigm reaches 4 m/s.

It can be inferred from the results in Figure 17 that when the mobile device's speed reaches 4m/s, the delay time ranges from 1 to 1.2 seconds in the proposed system, while the MobiVoD system ranges from 1.1 to 1.5. Additionally, the handoff termination average time within the proposed technique reaches 1.102697666 seconds forming the required time of a mobile device that is switching from a single network to its adjacent one, and so on. Forthermore, the the handoff termination average in the MobiVoD system reaches 1.309872677 seconds. Accordingly, it is found to be proven from the results that this technique can present the handoff time based on concurrently applying a binding modification. The technique is assessed through the second paradigm by the "mass mobility" track where it is utilised within the size of a medium packet. Similar to the initial paradigm, a mobile device transfers along to 3 various networks where this implies that this technique performs three handoffs for one journey and six handoffs within one round. The findings of the fifty handoffs of the mass shift including the shifting rapidity of a mobile node of 8m/s. The technique can perform a sensible latency time according to the results. Moreover, the mobile node moves faster in comparison with the first scenario that affects the number of buffered packets.

Table 2. The Slow movement mobile node handover processing time (4 m/s)

No. Handover	Slow Movement Mobile node (In Second) (Proposed System)	Slow Movement Mobile node (In Second) (MobiVoD System)	No. Handover	Slow Movement Mobile node (In Second) (Proposed System)	Slow Movement Mobile node (In Second) (MobiVoD System)
1	1.03342221	1.28370006	26	1.13864819	1.25636616
2	1.17689236	1.18523820	27	1.10132009	1.49149754
3	1.1805353	1.35876949	28	1.01890202	1.43233283
4	1.0051468	1.46468703	29	1.0669737	1.49693442
5	1.12594353	1.45961333	30	1.02473235	1.23969237
6	1.07777999	1.48546251	31	1.10639593	1.48309122
7	1.12345603	1.15507370	32	1.10049534	1.16870327
8	1.01281825	1.29259774	33	1.17367566	1.39676351
9	1.07272456	1.45213630	34	1.07462367	1.43578295
10	1.11693104	1.19850459	35	1.11497363	1.49037599
11	1.0860362	1.23576159	36	1.15786377	1.31321299
12	1.09805459	1.16591540	37	1.03278763	1.25507370
13	1.18120775	1.16133305	38	1.10533115	1.41257210
14	1.14331403	1.20744499	39	1.13585967	1.27301859
15	1.20093575	1.22686392	40	1.08085522	1.42148045
16	1.08150868	1.15598163	41	1.06625376	1.17602008
17	1.09687752	1.24976501	42	1.12305398	1.21945097
18	1.17989748	1.27008118	43	1.16052816	1.17242042
19	1.09627369	1.34377270	44	1.10322325	1.27542192
20	1.16359455	1.27508011	45	1.03862007	1.32046571
21	1.10554701	1.28014313	46	1.06582052	1.32892544
22	1.09129934	1.27446059	47	1.1319531	1.28070925
23	1.0475148	1.46860714	48	1.00657478	1.49506516
24	1.0758854	1.31310617	49	1.07250797	1.16424909
25	1.19301745	1.29915616	50	1.19555083	1.23075198

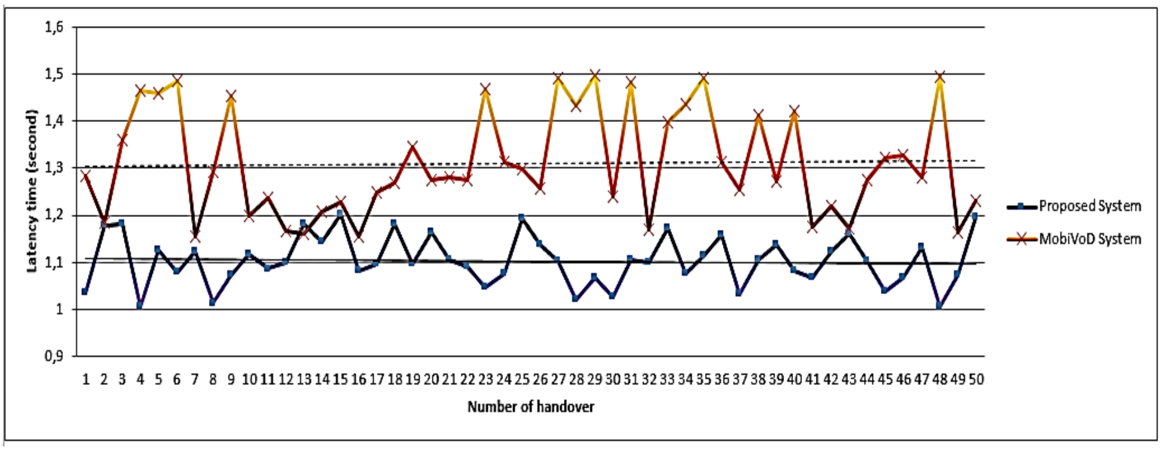

Figure 17. Slow speed mobile node handover latency (4 m/s)

It can be inferred from the results of Figure 18 that the average handover is faster in comparison with the past scenario for a speed of 4 m/s. It can also be inferred from the statistics that the movement of the mobile node's pattern does not affect the execution of the proposed technique. The average handoff time for the proposed system reaches 1.105747499 seconds where this implies that this technique can seamlessly provide several segments of a video segments regardless of any encountered problems. Furthermore, the average handoff time for the MobiVoD system reaches 1.53006623 seconds.

The results related to fifty handoffs of the system including various mobile device shifting speeds, the medium shift of a mobile device handoff execution time reaching 8 m/s. A mobile device moves in this experiment within a mass mobility through 3 various networks, which means a mobile device conducts three handoffs within one journey including six handoffs within one round journey. The mobility rapidity for the indicated paradigm reaches 8 m/s as shown in Table 3.

Table 3. Medium movement mobile node handover processing time (8 m/s)

No. Handover	Medium Movement Mobile node (In Second) (Proposed System)	Medium Movement Mobile node (In Second) (MobiVoD System)	No. Handover	Medium Movement Mobile node (In Second) (Proposed System)	Medium Movement Mobile node (In Second) (MobiVoD System)
1	1.0317432	1.79616474	26	1.1235237	1.33251228
2	1.136951	1.52820063	27	1.0301905	1.48334788
3	1.1743288	1.32143864	28	1.078921	1.59842372
4	1.1810763	1.33654561	29	1.1928488	1.65791528
5	1.2024332	1.33292642	30	1.028341	1.31821558
6	1.192246	1.52485153	31	1.1954064	1.72716605
7	1.0337308	1.55227454	32	1.0384964	1.77734855
8	1.0754551	1.23654073	33	1.0970437	1.52098025
9	1.0260482	1.40077273	34	1.1673594	1.75682180
10	1.0571495	1.51206732	35	1.1543705	1.36627338
11	1.0031849	1.35604602	36	1.1631252	1.60053041
12	1.066891	1.51601062	37	0.8976887	1.60422163
13	1.0730575	1.57867122	38	1.0217683	1.36564318
14	1.0560213	1.79326579	39	1.085309	1.51327372
15	1.1213699	1.22638539	40	1.1745342	1.51129307
16	1.0942144	1.49755455	41	1.0235617	1.32927122
17	1.0956704	1.78341655	42	1.0782965	1.68991180
18	1.1417008	1.58931272	43	1.1943117	1.34720511
19	1.0170372	1.57184698	44	1.1430289	1.67399457
20	1.1821264	1.31679312	45	1.1300683	1.49409742
21	1.1247094	1.35957518	46	1.0392696	1.47810816
22	1.1013467	1.54739494	47	1.1137245	1.49074831
23	1.123107	1.75341868	48	1.1042168	1.65078494
24	1.1227837	1.63836085	49	1.0986311	1.77610614
25	1.0026744	1.77520585	50	1.1842596	1.59109531

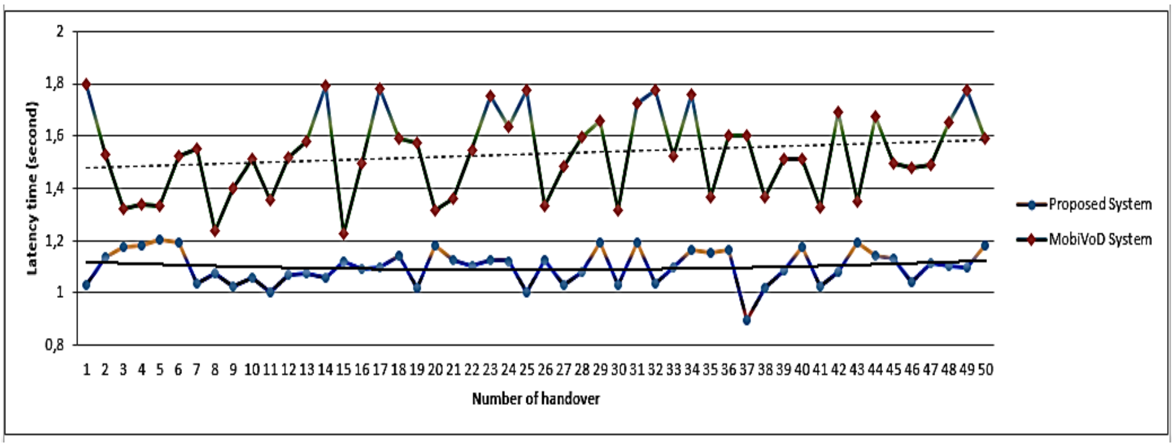

Figure 18. The medium speed mobile node average handover latency (5 m/s)

The findings pertaining to the third paradigm are presented as shown in Figure 19. The experiment results related to fifty handoffs of the system including various mobile device shifting speeds and the performance of this experiment in the rapid mobile device shift, where the mobile node speed is 20 m/s through 3 different networks. The shifting must provide six handoffs within a round trip and three handoffs within a trip as tested in the aforementioned scenarios as shown in Table 4. The movement speed of the faster mobile node needs a more rapid handoff processing time since the mobile node's movement from the new network into the destination network is shown to be more rapid. The average time latency of the proposed technique reaches 1.096463248 seconds, while the MobiVoD System reaches to 1.668225 seconds.

It is shown from Figure 20 that the system delivers an appropriate delay time for various speeds of the mobile node. These speeds are efficient for conducting an actual time for implementation. The VoD technique is considered to be an application, which functions seamlessly once a handoff occurs within various speeds. The reason behind this refers back to how this technique could deliver an efficient link when a mobile device moves from one network through to its neighbouring one.

Table 4. Fast movement mobile node handover processing time (20 m/s)

No. Handover	Fast Movement Mobile node (In Second) (Proposed System)	Fast Movement Mobile node (In Second) (MobiVoD System)	No. Handover	Fast Movement Mobile node (In Second) (Proposed System)	Fast Movement Mobile node (In Second) (MobiVoD System)
1	1.0056506	1.4484567	26	1.14800654	1.5344557
2	1.0768823	1.2588818	27	1.18019046	1.2562798
3	1.1302201	1.6461296	28	1.02776468	1.4852300
4	1.0757311	1.8881961	29	1.19554793	1.5186578
5	1.01594194	1.7674416	30	1.03274623	1.2418891
6	1.39779551	1.9578130	31	1.17742101	1.4339598
7	1.1725315	1.7542192	32	1.00433101	1.4907791
8	1.00762201	1.2722105	33	1.08898312	1.9611850
9	1.1027331	1.1820429	34	1.1054931	1.8826203
10	1.16447621	1.7988781	35	1.01640991	1.8397137
11	1.02504168	1.6906293	36	1.18624967	1.6516788
12	1.04752015	1.9302264	37	1.17833942	1.8383862
13	0.93295511	1.2676171	38	1.07631083	1.6080288
14	1.16642001	1.5094711	39	1.15631068	1.5423148
15	1.08311081	1.6186758	40	1.00309648	1.1377026
16	1.18299823	1.1212143	41	1.00598547	1.8979403
17	1.05729417	1.7751680	42	1.06911887	1.2290649
18	1.13752415	1.5871596	43	1.18841073	1.5621485
19	1.00939184	1.2287463	44	1.31254093	1.7529713
20	1.06535102	1.8798059	45	1.09686494	1.7066927
21	1.11841073	1.6387484	46	1.17773966	1.4627412
22	1.01966586	1.5614847	47	1.00857678	1.9304654
23	1.14872201	1.1917075	48	1.18765969	1.6420673
24	0.89764955	1.3696530	49	1.014675978	1.2408802
25	1.11540678	1.8332884	50	1.136586972	1.3154091

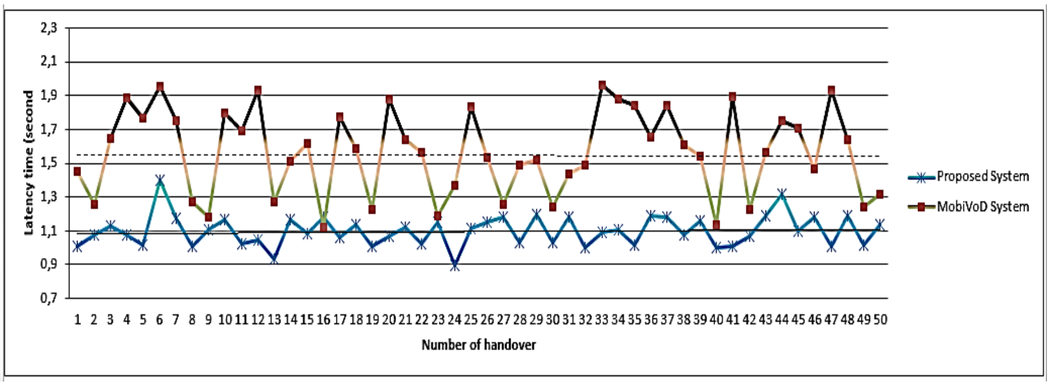

Figure 19. The rapid mobile device's average handoff time latency (20 m/s)

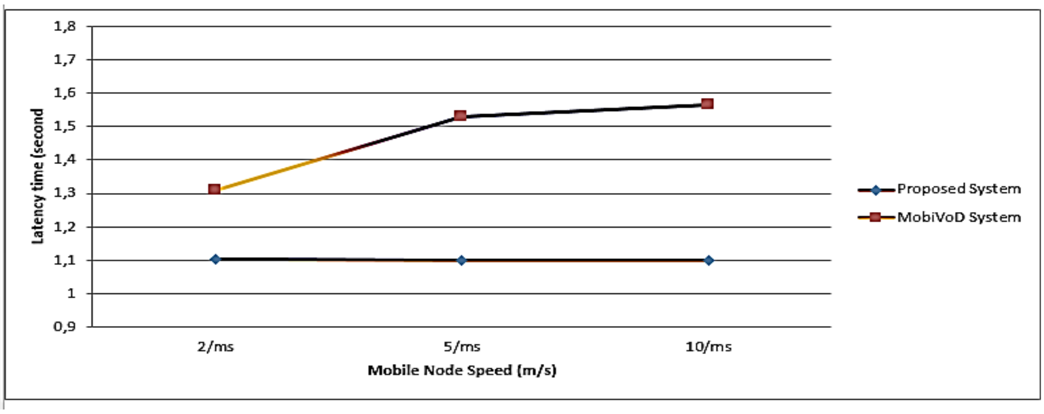

Figure 20. The average handover's latency trend

7.2. The experimental analysis of using the buffer storage

The numbers that are related to the buffered packets are measured into the method's storage. This experiment is significant in identifying the proposed system's execution once the movement of a mobile device travelling from the new network through to its destination network is not rapid. The packet buffers through the PAR once the handoff remains under process. It can be found to be proven from the results as shown in Figure 21 that once the movement of the mobile device's rapidity is ranged from 1 m/s to 4 m/s, the buffer in the proposed system and the MobiVoD Sysyem can just store a single packet into the buffering storage. A mobile node's movement speed produces delays for moving from its new network through to its destination network. Accordingly, once the mobile node is detached from its new network, it gains a waiting time for around 1 second prior to it being linked with the destination network.

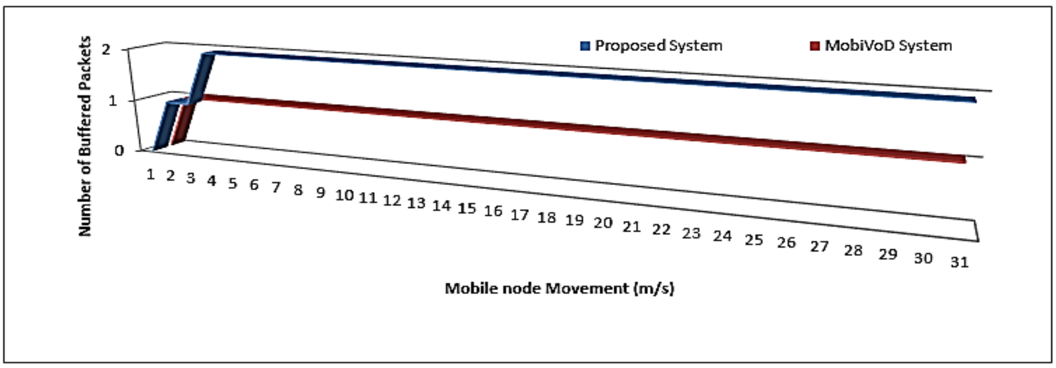

Figure 21. The numbers of different buffered packets

The case that is related to the rapidity of the mobile device affects the continuous occurrence of demanding a handoff. Such a persistent demand influences the buffered packets' numbers within the buffering storage. Two packets are stored in the storage by the buffer irrespective of the speed pertaining to a mobile device, which reaches a rapidity that is greater than 4m/s. The shifting of a mobile device speed produces interruptions over the MN according to the new network where it remains linked with the destination network within a more rapid time. Two packets are stored by the method once a MF/CN transfers a packet through the MN. Hence, a handoff is ordered within a destination accessing router producing a waiting time for about 1 to 1.5 seconds and leads a packet to remain within the buffer when a handoff completes the mobile device, while the delay time in MobiVoD System remain store a single packet into the buffering storage, which is detached from the new network and remains linked with the destination network. Accordingly, a new packet is buffered within the storage. It can be inferred from the results that the buffer storage is seen to be sensible. This means the produced method is capable of providing packets including less impairment such that no impact is encountered once a handoff occurs.

8. CONCLUSION

In this paper, an adaptive method is produced in order to deliver various facilities of the VoD for mobile devices being transferred within various infrastructures and networks. This is performed via mobility contents of the produced method where it delivers a seamless playback technique in order to access the facilities of the VoD in a heterogeneous network domain. The major contents comprise 2 servers, namely, "GMF" and "LMF". The major aim is based on transmitting a video through multiple mobile devices (clients) within various networks. The "LMF" must deliver VoD services within a limited range of transmission (e.g. within internal constructions) when utilising benchmarks as the WiFi. Additionally, the "LMF" is utilised for acting as a primary resource, which delivers VoD facilities to mobile devices for their disseminated source and their bandwidth's load balancing accompanied with the calculations that are linked to the GMF, which offers a massive region facility coverage by applying substructures (e.g. LTE, WiMAX). The GMF is utilised as a subordinate resource, which delivers VoD facilities for mobile devices that are substantially positioned nearer to their involved mobile devices. The simulation's execution is verified in order to investigate the clients' movements from a single network to another with various sizes and speeds, which are buffered into the storage. The findings show various encountered rapidity for the handoff delay. The produced method remains delivering smooth VoD connections and services, while the mobile node remains transferring from one network to another where this implies that the system can provide seamless video segments without any encountered effects. In the experimental analysis for the Slow movements mobile node handoff latency (8 Km/hour or 4 m/s) ,the mobile device's speed reaches 4m/s, the delay time ranges from 1 to 1.2 seconds in the proposed system, while the MobiVoD system ranges from 1.1 to 1.5. In the proposed technique reaches 1.1026 seconds forming the required time of a mobile device that is switching from a single network to its adjacent one. While the handoff termination average in the MobiVoD reaches 1.3098 seconds. Medium movement mobile node handoff latency (21 Km/ hour or 8 m/s). The average handoff time for the proposed system reaches 1.1057 seconds where this implies that this technique can seamlessly provide several segments of a video segments regardless of any encountered problems. While the average handoff time for the MobiVoD reaches 1.53006623 seconds. Furthermore, fast movement mobile node handoff latency (390 Km/ hour or 20 m/s). The average time latency of the proposed technique reaches 1.0964 seconds, while the MobiVoD System reaches to 1.668225 seconds

REFERENCES

[1] C. V. N. I. Cisco, "Global mobile data traffic forecast update, 2013-2018," *White paper*, 2018.

[2] Saleh Alomari, and Putra Sumar, "A video on demand system architecture for heterogeneous mobile ad hoc networks for different devices," *2nd Int Conf Comput Eng Technol*, vol. 7, pp. V7-700 – V7-707, 2010

[3] Tran D. A, Le M, and Hua K. A., "MobiVoD: a video-on-demand system design for mobile ad hoc networks," *Proceedings IEEE International Conference on Mobile Data Management*, pp. 212-223, 2004.

[4] J. G. Andrews, A. Ghosh, and R. Muhamed, "Fundamentals of WiMAX: Understanding Broadband Wireless Networking-The Definitive Guide to WiMAX Technology," *Prentice Hall Professional,* 2007.

[5] Talukdar, A. Mondal, B. Cudak, M. Ghosh, A. Fan, Wang, "Streaming Video Capacity Comparisons of Multi-Antenna LTE Systems," *71st Vehicular Technology Conference,* pp. 1-5, 2010.

[6] F. Cali, M. Conti, and E. Gregori, "IEEE 802.11 wireless LAN: Capacity analysis and protocol enhancement," *Proceedings. IEEE INFOCOM'98, the Conference on Computer Communications. Seventeenth Annual Joint Conference of the IEEE Computer and Communications Societies. Gateway to the 21st Century*, vol. 1, pp. 142-149, 1998.

[7] L. Huang and T. Lai, "On the scalability of IEEE 802.11 ad hoc networks," *Proceedings of the 3rd ACM international symposium on Mobile ad hoc networking & computing*, pp. 173-182, 2002.

[8] EEE-Std-802.11, "Wireless lan medium access control (mac) and physical layer (phy) speci_cation," 1999 Edition, 1999.

[9] Bluetooth. [Online], Available: http://www.bluetooth.com/.
[10] Abdullah M. et al., "4G and 5G Mobile Communication Networks: Features Analysis, Comparison and Proposed Architecture," *International Journal of Computer Science and Technology*, vol. 7, no. 2, pp. 154-160, 2016.
[11] Kwon J. B, and Yeom H. Y., "Providing VCR functionality in staggered video broadcasting," *IEEE T Consum Electr.*, vol. 48, no. 1, pp. 41-48, 2002.
[12] Saleh Alomari, and Sumari P., "An overview of mobile ad hoc networks for the existing protocols and applications," *Journal of Application of Graph Theory in Wireless Ad Hoc Network and Sensor Networks*, vol. 2, no. 1, pp. 87-110, 2010.
[13] Pathan A-SK, "Monowar MM, Fadlullah ZM (Eds). Building next-generation converged networks," *Theory and practice. New York: CRC Press*, 2014.
[14] Juluri P, Tamarapalli V, and Medhi D., "Measurement of quality of experience of video-on-demand services: A survey," *IEEE Communications Surveys and Tutorials*, vol. 18, no. 1, pp. 401-418, 2016.
[15] Junyi Men, Xingjun Wang and Li Ma, "The Characteristics of Video Programs," *ICIET*, pp. 216-220, 2018.
[16] S. Ghalib, et al., "Routing protocol development for quality of service optimization of video-on-demand system over mobile ad hoc networks," *International Journal of Communication systems*, vol. 31, no. 2, pp. 1-12, 2017.
[17] S. A. Alomari, and P. Sumari, "Statistical Information of the Increased Demand for Watch the VOD with the Increased Sophistication in the Mobile Devices," *Communications and Internet Penetration in Asia, International journal of Multimedia & Its Applications*, vol. 3, no, 4, pp. 183-199, 2011.
[18] S. A. Alomari, P. Sumari, and S. Atawneh, "Zero-Delay Broadcasting Protocol for Video on Demand over Mobile Ad Hoc Networks," *2nd World Conference on Innovation and Computer Sciences, AWERProcedia Information Technology & Computer Science*, 318-326, 2012.
[19] S. A. Alomari, and P. Sumari, "Multimedia Applications for MANETs over Homogeneous and Heterogeneous Mobile Devices," *In book: Wireless Communications and Networks chapter 22*, pp. 571-596, 2012.
[20] S. A. Alomari, and P. Sumari, "A novel optimized design of Popularity Cushion Staggered Broadcast over video on demand system," *International Journal of Physical Sciences*, vol. 7, no. 9, pp. 1435-1453, 2012.
[21] S. A. Alomari, and P. Sumari, "Effective Broadcasting and Caching Technique for Video on Demand over Wireless Network," *KSII Transactions on Internet and Information Systems*, vol. 6, no. 3, pp. 919-940, 2012.
[22] V. Doraisamy, et al., "Video on Demand Caching System using NIPBCS over Mobile Ad Hoc Network," *International Journal of Digital Content Technology and its Applications*, vol. 5, no. 6, pp. 142-154, 2011.
[23] Wei, W. and Zakhor, A., "Multipath Unicast and Multicast Video Communication overWireless Ad Hoc Networks," *First International Conference on Broadband Networks*, vol. 6, no. 25-29, pp. 496-505, 2004.
[24] Slawomir, H. and Maciej S., "Modeling of a Video-on-Demand System," *International conference on computer network, Computer Networks, Communication in Computer and information secience book*, vol. 431, pp. 233-242, 2014.
[25] L. Zhou, et al., "Scalable Video-on-Demand Streaming for Heterogeneous Clients in Wireless Network," 2006 *12th International Conference on Mobile Ad-Hoc and Sensor Networks*, pp. 39 - 44, 2016.
[26] Sharma Prashant, "Basic Facts about WiFi and its Advancements," *Techpluto*, [Online], Available: http://www. techpluto.com/wifi-info.
[27] Arun, A. Gourav, and M. Kabita A., "The 5th Generation Mobile Wireless Networks-Key Concepts, Network Architecture and Challenges," *American Journal of Electrical and Electronic Engineering*, vol. 3, no. 2, pp. 22-28, 2015.
[28] Mark S, "Vertical Handoffs in Wireless Overlay Networks. ACM Mobile Networking," *Mobile Networking in the Internet*, vol. 3, no. 4, pp. 335-350, 1998.
[29] Tansu, F. and Salamah, M., "On the vertical handoff decision for wireless overlay networks," *International Symposium on Computer Networks*, pp. 111-115, 2006.
[30] O. Khattab, "Vertical Handover Study on 4G Category vs. 5G Category for 3GPP Generation Mobile Systems and Non-3GPP Wireless Networks," *Transactions on Networks and Communications*, vol. 6, no. 2, 2018.
[31] M. Hamdy, A. Rahman, and N. Semary, "Evaluation of Mobile Wimax IEEE 802.16e handover load balancing trends," *International Conference on Informatics and System (INFOS2014)*, pp. 25-31, 2014.
[32] S. A. Alomari, P. Sumari, and A. Taghizadeh, "A Comprehensive Study of Wireless Communication Technology for the Future Mobile Devices," *European Journal of Scientific Research*, vol. 60, no. 4, pp. 583-591, 2011.
[33] Norakmar, A. and Zolidah, K., "Conceptual mobility model of vertical handover decision in heterogeneous networks," *Indonesian Journal of Electrical Engineering and Computer Science*, vol. 13, no. 3, pp. 1143-1151, 2015.
[34] Bindia, Ayushi Aggarwal, "Various Handover Strategies Using Fuzzy Logic," *International Journal of Scientific Research and Management*, vol. 5, no. 3, pp. 5199-5203, 2017.
[35] Pooja, D., and Parwinder, D., "Handover Optimization for wireless and Mobile Networks using fuzzy logic," *International Journal of Compute Applications*, vol. 63, no. 14, pp. 31-35, 2013.
[36] O. Abolade, A. Fakolujo, and A. Orimogunje, "Handover in Mobile Wireless Communication Network-A Review," *International Journal of Advanced Engineering, Management and Science*, vol. 3, no. 9, pp. 934-940, 2017.
[37] S. Khera, N. Turk and N. Kaur, "Enhanceing Network Coverage Using Handoff Techniques in Mobile Wireless Networks," *International Journal of Future Generation Communication and Networks*, vol. 10, no. 10, pp. 23-32, 2017.
[38] S. ferretti, V. Ghini and F. Panzieri, "A Survey on Handover Managments in monility Architictures," *Computer Networks*, vol. 94, pp. 390-413, 2016.
[39] Charles, E., and Kuang, W., "Optimized Smooth Handoffs in Mobile IP," *Proceedings in IEEE International Symposium on Computers and Communications*, pp. 340-346, l999.
[40] Camp, T., Boleng, J and Davies, V., "A survey of mobility models for ad hoc network research," *Wireless Communications and Mobile Computing*, vol. 2, no. 5, pp. 483-502, 2002.

[41] Fan, Bai and Ahmed, "A Survey Of Mobility Models, University of Southern California," *U.S.A, Book chapter, Chapter 1*, pp. 1-30, 2008.
[42] Basagni, et al., "A distance routing effect algorithm for mobility (DREAM)," *Proceedings of the ACM/IEEE International Conference on Mobile Computing and Networking*, vol. 2, pp. 76-84, 1998.
[43] Charles E. Perkins, and David B. Johnson, "IETF Internet Draft draft-ietf-mobileip-ipv6-24.txt," *International Conference. Mobile Computing and Networking*, vol. 1, pp. 27-37, 1996.
[44] Chiang K. H. and Shenoy N., "A 2-D Random-Walk Mobility Model for Location Management Studies in Wireless Networks," *IEEE Transactions on Vehicular Technology*, vol. 53, no. 2, pp. 413-424, 2004.
[45] Varga, A., "OMNeT++," Chapter in the book "Modeling and Tools for Network Simulation," *Wehrle, Klaus; Günes, Mesut; Gross, James (Eds.) Springer Verlag Berlin Heidelberg*, 2010.
[46] Bensky, A, "Wireless Positioning Technologies and Applications," *GNSS Technology and Application Series. Artech House, Inc. Boston, London. Chapter 6*, pp. 139-159, 2008.
[47] Zinonos, Z. and Vassiliou, V., "Handoff Algorithms for Industrial Mobile Wireless Sensor Networks," *Proceedings of the International Conference on New Technologies, Mobility and Security*, pp. 1-6, 2014.

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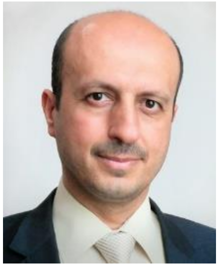

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