A Video on Demand System Architecture for Heterogeneous Mobile Ad Hoc Networks for Different Devices

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***Abstract*—this paper proposed new system architecture for Mobile Ad Hoc Networks (MANETs) on heterogeneous network to provide optimal Video on Demand (VoD) services to difference types of devices with optimal bandwidth utilization. And at the same time it will provide separate VoD services to different type of devices. and proposed a new conceptual model whereby a MANET node is possible to move through heterogeneous networks and infrastructures, there are also several nodes connected and receiving VOD services in different communication and infrastructural approach also we proposed for our system architecture Global Media Forwarder to provides wide area services through deployed infrastructures such as 3G and WIMAX as well as a new protocol call (DNDS) will be used for accumulating the required information from the MANET nodes and Media Forwarders for configuring and providing optimal services to the MANETs users, implemented and executed between Media Forwarders, CVSP and the MANETs nodes.**

***Keywords*—Video on Demand System, Ad hoc network, Staggered Broadcast, Mobility, DNDS protocols, CVSP, GMF, MANETs, High Definition (HD).**

I. INTRODUCTION

Nowadays, with the rapid deployment of the wireless networks the people like to work outside their office, and in the future in the next generation we will see the rapid deployment of mobile users. In these days after the extension of transmission media from Wired to the wireless network became major advance in communication technology. after that we have seen many of the wireless techniques such as Worldwide Interoperability for Microwave Access (802.16 WiMAX)[1], this technology is for the long distance communication , which allows to communicate more than 10 of kilometers, IEEE 802.11 (WiFi) [2][3][4] is a good communication for the small local wireless network and Bluetooth [5] it's suitable for the short distance communication, and then for mobile computing such as Personal Digital Assistant (PDAs), Cell Phones, Laptops etc.

The wireless and the mobile make a lot of clients to enjoy in their time, to make them watch what they want at anytime and anywhere, the using of wireless technology allows the user move freely within the coverage area, especially after the researcher developed the designs such as a Video on Demand (VoD), and such as this system became an interactive multimedia system and has a lot of practical application can implemented due to the advancement of wireless technology, some of these application became use to make the users enjoy ubiquities entertainment service such as play a game or maybe they need to watch a video of their interest online at any place they are, and became use it in education, a university could also install such a system on campus to allow students to watch video recorded earlier from lectures they were not able to attend, airlines could provide VOD services in airport lounges and in recorded video information on the previous activities in public carnival etc.

II. RELATED BACKGROUND

Current trends have drastically impact on video on demand services due to deployment of various types of network infrastructures and availability of different types of mobile devices. The applications of using this technology are useful from education to entertainment industry. Furthermore, present vogue is directing towards the digital media distribution en route for the Internet. Wireless communications provide next level of freedom for accessing these technologies without any boundaries. This document provides a general overview of proposed solution which will demonstrates the system architecture for VOD for heterogeneous MANETs. And to supporting a video on demand application over mobile ad hoc network is more challenging than the traditional networks due to lack of proper infrastructure and different types of devices. MANET consists of mobile hosts which are capable of limited energy and unpredictable topology. In recent years, user demand for these services has gained more popularity.

Video on demand system is an interactive multimedia system to make client to enjoy in their time and to make them chose any video at anytime and anywhere at their convenient for the large video database storage at distance video server. And the current VoD can be divided into three part the Client/Server, Peer to peer (P2P) and then the Periodic Broadcast and also there's many existing VOD techniques [6] [7] [8] [9] [10] [11] [12], are based on the client/server approach, but this approach it's not suitable for Mobile ad hoc network simply because wireless bandwidth cannot support a lot of clients using separate connection channels. And then use the P2P approach for VOD techniques [13] [14] is not suggested either since transmitting a long video from a wireless node to another through more than one wireless hop is inefficient in terms of bandwidth and energy used. And then used the broadcast approach to avoids the bottleneck problem in the client and server and in the same time service vulnerability of the P2P approach, and later we will clarify the periodic broadcast more in section part *C*.

A. *Wireless Ad Hoc Networks*

Mobile Ad Hoc Network (MANETs) is a collection of two or more devices or nodes or terminals with wireless communications and networking capability that communicate with each other without the aid of any centralized administrator also the wireless nodes that can dynamically form a network to exchange information without using any existing fixed network infrastructure. and all the nodes in a wireless ad hoc network act as a router and host as well as the network topology is in dynamically, because the connectivity between the nodes may vary with time due to some of the node departures and new node arrivals. The special features of MANETs bring this technology great opportunity together with severe challenges [15]. All the nodes are responsible to organize themselves dynamically the communication between the each other and to provide the necessary network functionality in the absence of fixed infrastructure or we can call it ventral administration, It implies that maintenance, routing also management, and so on .have to be done between all the nodes. This case Called Peer level Multi Hopping and that is the main building block for Ad Hoc Network.

In the past few years, the people became realized to use all the technology so widely and the people's future living environments are emerging, based on information resource provided by the connections of different communication networks for clients also we have seen a rapid expansion in the field of Mobile Computing because the proliferation not expensive, widely available wireless devices .A new small devices such as personal communication like laptops, PDAs, cell phone, handhelds, and also there are a lot of traditional home appliances such as a digital cameras, cooking ovens, refrigerators, with computing and communicating powers attached. Expand this area to became a fully pervasive and so widely. With all of this, the technologies must be formed the good and new standard of pervasive computing, that including the new standards, tools, services, devices, protocols and a new architectures. In this days the internet users in ad hoc network through increase in the use of its advantage is that not involve any connection link and the wiring needed to save space, and building low cost, and improve the use, and can be used in mobile phone, because of these advantage local wireless network architecture readily. And also beads in these advantages the wireless network can be used in the local area network terminal part of the wireless [16].

B. *Wireless Mobile Network Approaches*

The past decade the Mobile Network is the only one much important computational techniques to support computing and widespread, also advances in both software techniques and the hardware techniques have resulted in mobile hosts and wireless networking common and miscellaneous. Now we will discuss about to distinct approaches very important to enabling Mobile wireless Network or IEEE 802.11 to make a communication between each other [17][18][19]. Firstly, infrastructure wireless networks also called Cellular where the communication between nodes must through the Base Station. Basically the Cellular supported by a wired fixed infrastructure and the communication only occurs within the single hop. Secondly, infrastructureless wireless networks is knows as mobile network commonly known as Ad Hoc Networks, unlike the cellular nodes the ad hoc network dynamically from a temporary network without nay support of any network infrastructure based wireless LANs [20]. The communication between the nodes is the network is in a P2P style. The source node will forward a packet of data directly to the destination node if both nodes in within the transmission range. Otherwise, the intermediate node is use forward the message towards the destination node if the source node is unable to send the message directly as well as each node work as end hosts and as router because of the mobility of the node and the unfixed network topology. In figure 1 Illustrations the difference between two types of wireless networks, for the cellular and Ad Hoc networks.

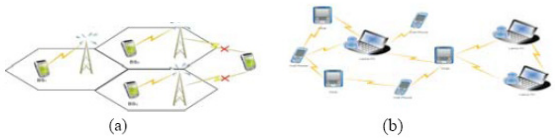

Figure.1 Illustrations different types of wireless network (a) infrastructure wireless networks also called Cellular (b) Ad Hoc Networks

C. *Video on Demand Mobile Wireless*

The broadcasting protocol is the appropriate protocol for the user to download the broadcast segments from the server, it's unlike the weird network, the they offered several bandwidth of communication wireless network in a local area such as a (IEEE 802.11 a, b, g) and the best bandwidth offered in the wireless network it's not more than 54 Mbps (IEEE802.11g), in Table 1 we will described the current wireless networks.

TABLE Ⅰ. THE CURRENT WIRELESS TECHNOLOGIES

Current Wireless	Maximum Bandwidth	Coverage Range
Bluetooth	1 Mb	10 m
Cellular Digital packet Data (CDPD)	19.2 Kb	Coverage area of host Net
High Speed Circuit Switched Data	27.6 Kb	Coverage area of host Net
IRDA	16 Mb	1 m
IEEE 802.11a	54 Mb	33 m
IEEE 802.11b	11 Mb	50 m
IEEE 802.11g	54 Mb	35 m

D. Periodic Broadcasting Scheme

There are a lot of approach using the Periodic Broadcasting scheme [21], [22], [23], [24], [25], a video is divided into several segments, each repeatedly broadcast on a separate communication channel, and the main reasons divide the video to small segments are to save the server channel bandwidth, minimize the latency and save the storage space in the buffer, A client receives a video by tuning to one or more channels at a time to download the data. The broadcast schedule at the server and playback synchronization protocol at the client ensure that the broadcast of the next video segment is available to the client before the playback of the current segment runs out; actually we use the periodic broadcasting scheme to accommodate any number of clients.

Nowadays, many other broadcast protocols have been proposed but the original or popular from all of these protocols is the Staggered Broadcasting [26, 27], SB is a simple periodic broadcast, and they focus on a singles Video Table 2, we will shown the analytical performance for some of the current Periodic Broadcasting protocols a 120 minute video with b equal to 1.5 Mbps (MPEG-1) we assume the number of the channels is 10 and each channel bandwidth is equal the playback rate.

TABLE Ⅱ. CLIENT RESOURCE REQUIREMENTS IN PERIODIC BROADCASTING SCHEMES

Broadcast	Access latency	Download channels	Storage space (% of the Video)
Staggered [26]	12	1	0
Skyscraper [28]	0.85	2	36
Harmonic [29]	12	10	37
Pyramid [30]	7.04	2	70
GDB(i) [31]	9.31	4	46

We recognized from this table, the SB is the suitable as a broadcasting protocol for the mobile Video on Demand System. The broadcasting protocol scheme just requires users to download the broadcast segments from one channel at a time. In this scheme does not require user buffer space, however, this scheme causes high access latency to the length of video divide by the channel allocated to broadcast the video.

E. Codec

A device or program that compresses a signal is an encoder and the device or program that decompresses a signal is a decoder. An encoder/decoder pair is known as CODEC [32]. Video Codec is an approach whereby the procedure reduces the size of original video so that it can be playback directly on a computer or over the network. Almost all video codecs use lossy compression to minimize the huge amount of data associated with video. The goal is not to loss information that affects the viewer's senses. And the quality of the codec can achieve is heavily based on the compression format the codec uses. A Codec is not a format, and there can be multiple codecs that implement the same compression specification for example, MPEG-1 codecs typically do not achieve quality or size ratio comparable to codecs that implement the more modern H.264 specification. Furthermore different types of devices can decode different types of video codecs swiftly accordingly to their resources. For example, current generation of notebooks is capable of decoding various types of coding standard at high resolution such as H.264 at High Definition (HD) resolutions whereas PDA devices may be able to support suitable video codecs according to their platform and with lower resolution such WMV7 with 320x240 resolution. These factors also impact on service delivery and bandwidth.

III. PROPOSED WORK

Recently, there are some works for using Video on Demand on Mobile Ad-Hoc networks (MANETs). The existing systems [33] [34] [35] [36] have proposed various VOD solutions for MANETs. These systems have built the basis for VOD services for MANET, but are still lacking the essential components for practical deployed of VOD systems. Furthermore some researchers also explore some of the possible solutions for mobility in MANETs [36].

The traditional approach of the MobiVoD is a framework for implementing a VOD system in mobile ad hoc network environment. The proposed VOD solution consists of three components, a video server, clients and local forwarders. As the method of connectivity is through wireless infrastructure, hence local forwarders as dedicated computer must be installing to relay service with the server.

MobiVod proposes to use scatter of local forwarders for covering wider area. Every local forwarder receives the packet from the server and forwards it to the client through its wireless NIC. Whenever a client joins the system, it waits for receiving a subsequent segment of video. Afterwards it switches to next segment and the process continues until the end, in this case if the client within the area of the Local Forward the former able to receive the video packets broadcast as well as this system work depend on what working environments the system running in be the location of the LF_k determined. Periodic broadcasting ensures scalability with increase in number of clients. Conversely the period a new client waits for receiving a segment may be substantial. The system proposes two caching polices to cope with the segment waiting problem. These caching policies are Random-Cache and Dominating-Set Cache. By using these polices, a newly join client can playback video immediately. The simulation result shows MobiVod could work well on current wireless technologies using IEEE 802.11b and g

standards. In MobiVod proposed solution, it is assumed that all the bandwidth is available to be used for the VOD service. It also assumes that all the MANET nodes have similar features and stream single quality VOD to them. Furthermore there is no mechanism by which it can gather information from the clients and accordingly to devices features it delivers the services. It also allow to do mobility within same infrastructure i.e. WIFI. Following are the problems that we have found in the current system.

- Generally, there can be different types of mobile devices such as notebook, cell phone and PDA which are required to access the VOD services through heterogeneous networks. Current systems for MANET are providing VOD services to devices using a single coded video content without considering different devices platforms and specifications. This limitation makes the services only available to specific devices which are capable of playing that specific video.
- The transition between different networks through different locations while accessing the VOD services is highly possible for MANET users. Current systems either lack support for mobility or still exploring possible solutions for seamless switching networks in MANET [33] [34 [35] [36]. Furthermore while switching networks, local media forwarder may not be adequate for providing services as it restricts the services within a certain location.

This paper initiates to address emerging issues related to video on demand services over heterogeneous Mobile Ad-Hoc network. It proposes component base architecture to resolve those issues. In the first problem we propose a self-adaptable VOD services architecture for MANETs on heterogeneous networks. The component based architecture will be capable of providing VOD services to different types of devices with optimal bandwidth utilization. It will provide separate VOD services for different types of devices. Hence on a same network it will be possible to have High Definition (HD) and low resolution VOD services through media forwarders to different MANET nodes. Figure 2 illustrates the general scenario in which our proposed system will provide VOD services to different types of devices accessing through different network infrastructures. Our propose system uses following three main components:

A. *Central VOD Services Provider*

Central VOD Services Provider (CVSP) is a Server or cluster of servers as a main entity for providing VOD services to the end MANET clients. It has storage of VOD services. It provides VOD service to the end client through media forwarders. CVSP is also responsible for monitoring all the clients through different media forwarders. It tracks moving MANET nodes through different infrastructure for providing services seamlessly.

B. *Media forwarders*

The Local Media Forwarders (LMF) are responsible to provide VOD services within a limited range such as inside buildings while using IEEE 802.11x (WIFI) standards. It is proposed to be use in indoor environments such as buildings. The Global Media Forwarder (GMF) provides wide area services through deployed infrastructures such as 3G and WIMAX. WIMAX and 3G services are practical to use mainly in public or outdoor locations as it is tested as well as suggested by the service providers due to connectivity deprivation drastically in indoor environments [37]. Furthermore we propose to use LMF as a primary source for providing VOD services to the MANET node due to distributed resource sharing or load balancing for bandwidth and computation with the GMF. This is being considered due to limited bandwidth availability in case of wider deployment of the services. The connectivity between media forwarder and the MANET node will be established using IPv4/IPv6 communication. The rationalization to have Global Media Forwarder is to provide services seamlessly beyond the boundaries of indoor environments.

C. *Mobile Ad Hoc Networks (MAETs) Clients*

The MANET clients such as notebooks, PDAs and mobile phones are capable of multiple communication interfaces such as WIFI and WIMAX interface cards. It can access VOD services through 3G, WIFI, WIMAX and the Bluetooth networks. Optimal VOD service for MANET node depends on available network infrastructure, available bandwidth and client's resources.

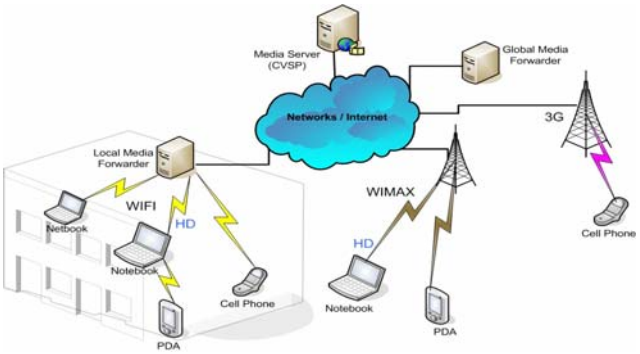

Figure 2 Mobile Ad Hoc network through heterogeneous network infrastructure.

We are also proposing to use cluster-head for node mechanism by which a capable MANET node can serve to provide services to other MANET users for extending the range of the services as well as to make lesser load on the local media forwarder. It may also be useful to use in static outdoor location for providing load balancing with the Global Media Provider. Also we proposed a new protocol (DNDS Protocol) will be used for accumulating the required information from the MANET nodes for configuring and providing optimal services to the MANET node users. In addition, there will be a variable

dynamic cache mechanism to ensure smooth delivery of VOD services on different devices through different infrastructures.

There have been tremendous works done on different types of cache mechanism for VOD services [38] [39]. We will explore to integrate the suitable cache solution which can provide dynamic cache mechanism for MANET nodes as well as to media forwarders. Furthermore it may be required to update the suitable existing cache solution to cater our proposed solution while MANET node moves through heterogeneous networks.

D. Cluster-Head

A cluster-head node is an MANET node which can have enough resources to provide VOD services to other device. Any MANET node can also be a cluster head if it is opted for performing that duty and possess enough resources. This characteristic of a MANET node can provide several benefits such as extension of network and load balancing with the local or global media forwarder. In figure 3 illustrate this approach whereby notebook 2 is working as a cluster head and providing services to PDA1 and Cell pon1.

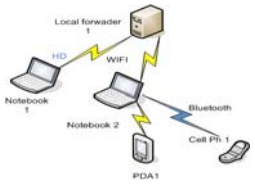

Figure 3 Cluster head mechanism

E. Device and Network Discovery Services Protocol

There is a need of mechanism by which information needs to be gathered for providing optimal VOD services to MANET users. We propose a new protocol call (DNDS Protocol) will be designed to run on all the entities of our proposed architecture. It will be implemented and will be executed between media forwarders, Server and the MANET nodes.

Be executed from the server and the media forwarders (local and global) to instigate the protocol for assembling the required information from each newly joined MANET node. DNDS protocol component on the server side will be responsible for collecting information from MANET nodes through Media forwarders (local and global). On Media forwarder part, this protocol will be used to collect information from the nodes and send it to the server. On MANET nodes, DNDS protocol service will be providing required information to the Server and Media Forwarder. Protocol will retrieve device operating system, available codec information, processing resourcing and so forth and accordingly assign the profile of the MANET node.

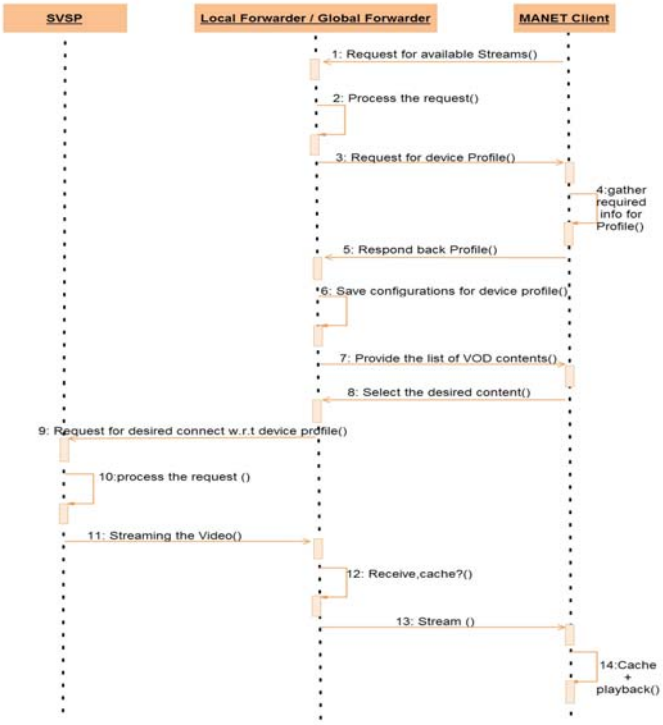

Figure 4 process of media request

Figure 4 illustrates the procedure in which a device profile is collected by the Local or Global Media Forwarder from the MANET client; then request is send to the server for providing device type specific media content. Server processes the request and accordingly sends data to the media forwarder which pushes the data to the MANET client.

In a general deployment scenario, it is essential to provide VOD services to MANET users which are moving through different networks. This can be achieved by mobility component in our proposed architecture whereby it will provide a mechanism for accessing VOD services through different networks. Mobility component will continuously monitor the suitable available networks and shifts the infrastructure when required. This procedure will not disturb VOD service. This approach is explained in detail in later section. We propose to divide the services load into three tiers, Global Media Forwarder, Local Media Forwarder and the cluster head node. Local media forwarder is a primary source for providing VOD services while using IEEE 802.11x (WIFI) in our proposed architecture. Global media forwarder which is providing services through IEEE 802.16x (WIMAX) and wireless broadband based

infrastructures can only be accessed by the MANET nodes while moving through different metropolitan locations. Each metropolitan location provides VOD services using LMFs. Cluster head node is proposed to provide load balancing of resources as well extension of range within LMFs location.

By considering the current practical scenario, we present a conceptual model whereby a MANET node is possible to move through heterogeneous networks and infrastructures as illustrated in Figure 5. There are several nodes connected and receiving VOD service in different communication and infrastructural approach. Two separate buildings KLCC and KL Sentral have different numbers of local media forwarder installed as local media forwarder A and B. These local media forwarders directly communicate with the CVSP through high speed Internet connection. Local media forwarders will be servicing to MANET nodes through WIFI connectivity. Furthermore, there will be number of global media forwarder also deployed for wider accessibility of VOD services through WIMAX and 3G infrastructures as well as for load balancing. At the location KLCC; Notebook 1, Notebook 2, Notebook 3, Netbook 2, PDA 1, PDA 3 and Cell Ph 1 will be accessing VOD services through local media forwarder A. At the location KL Sentral; Notebook 4 and Netbook 3 will be accessing VOD services through local media forwarder B via multicast technology. MANET node Netbook 2 at a public location accesses services from global media forwarder. At the Mono Rail station, Notebook 3 and PDA 2 MANET users will be accessing the VOD services through global media forwarder using WIMAX infrastructures. Netbook 2, Cell ph 2, Cell ph 3 and PDA 4 MANET users are mobile users retrieve the services through WIMAX and 3G infrastructures at different locations. MANET node PDA 3 will be accessing the VOD services from local media forwarder A at KLCC. It moves outside the building and shifts to global media forwarder through WIMAX infrastructure while retrieving the services. Afterwards PDA 3 goes to Mono Rail station while accessing the services and takes Mono Rail to KL Sentral. When PDA 3 user enters the building, it shifts to local media forwarder B while accessing the services seamlessly through WIFI connectivity. Furthermore we also demonstrated in Figure 5 that Notebook 2 as a cluster head under local media forwarder A can provide services through multicast and can extend as well as perform load balancing with the local media forwarder A.

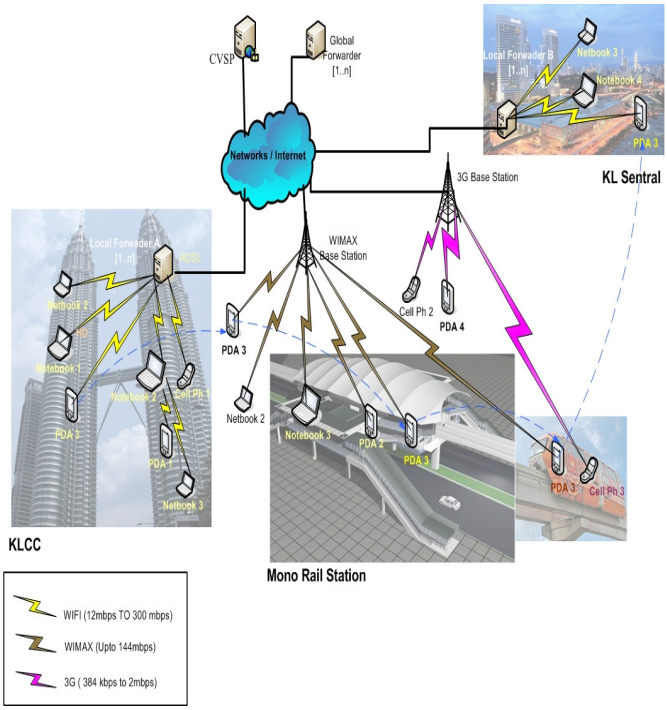

Figure 5 Conceptual model for Mobility

We proposed to use MANET nodes with multiple wireless communication medium such IEEE 802.11x (WIFI), IEEE 802.16x (WIMAX) and 3G. A MANET node during initialization of VOD services iterates available wireless communication services. And we explain the initial procedure of determining infrastructure selection by the MANET node. The client application on MANET node enumerates available communication interfaces. Consecutively it searches for available networks according to interfaces such as WIFI and WIMAX. Application connects with the most suitable primary connectivity available and then searches for secondary connectivity. In our proposal work, for indoor environments we prefer to use WIFI as a primary connectivity and WIMAX or 3G as a secondary connectivity. Consequently for outdoor environments, we prefer to use WIMAX as a primary connectivity and WIFI as a secondary connectivity if available. During this process CVSP also gather information about relaying media forwarder for MANET node for providing services through different networks. CVSP also prepare the services for MANET node by maintaining dual connectivities from LMF and GMF. By this approach server always aware of shifting the VOD services to active or suitable connectivity through different infrastructures. This procedure is highlighted in figure 6.

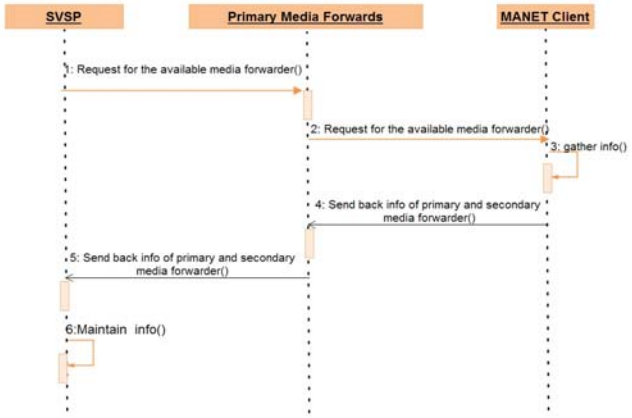

Figure 6 CVSP information gathering

When a MANET node initiates communication for accessing VOD services, the CVSP gather information from the node about available connectivity to infrastructure. This information is gathered through DSDN protocol. Figure 7 illustrates the client application procedure for gathering information about the available bandwidth and selecting suitable connectivity. Afterwards it informs the CVSP through DSDN protocol and start retrieving and playing back the VOD service.

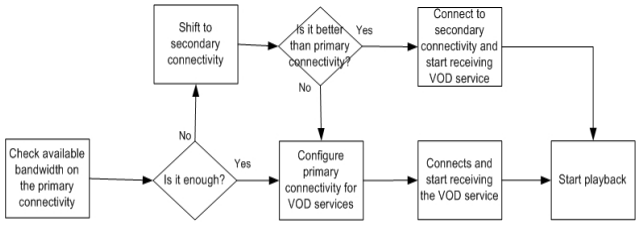

Figure 7 connectivity selection

Figure 8 explains the process of shifting networks while accessing the VOD services. The mobility component continuously monitors the received signal strength indication (RSSI) values of available infrastructures. While monitoring, if the RSSI value reaches to the first theorshold value it informs CVSP about the MANET node going out of range and prepare for streaming through secondary connectivity. CVSP will make the position of the streaming media of secondary connectivity at the same position of currently streaming video for primary connectivity. When the MANET node reaches near to the edge of connectivity, it will trigger another theorshold value for shifting and activating the secondary connectivity. This procedure will be carried on by the subsequent suitable connectivity for the VOD service.

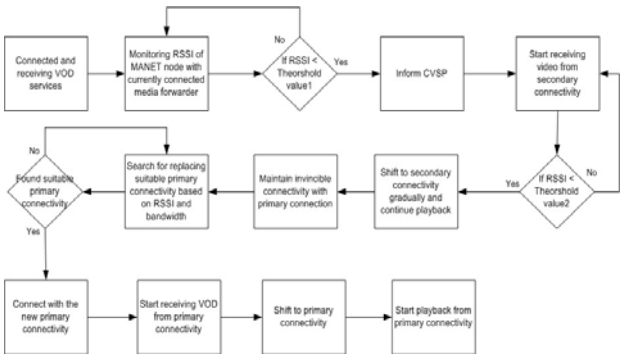

Figure 8 Infrastructural or network shifting while mobility

IV. CONCLUSIONS

We have given an overview of our proposed system architecture which will provide seamless VOD services to various types of devices within heterogeneous networks. This proposal proposes a DNDS protocol for collecting required information from MANET nodes, and to provide it to media forwarder and the server (CVSP) for streaming optimal VOD to the nodes. By the procedure, different types of devices will get video according to their device specifications. This proposal also explains about the mobility for MANET nodes which will allow MANET nodes to access VOD service while moving between different networks.

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