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An Effective Self-Adaptive Policy for Optimal Video Quality over Heterogeneous Mobile Devices and Network Discovery Services

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Abstract: The Video on Demand (VOD) system is considered a communicating multimedia system that can allow clients be interested whilst watching a video of their selection anywhere and anytime upon their convenient. The design of the VOD system is based on the process and location of its three basic contents, which are: the server, network configuration and clients. The clients are varied from numerous approaches, battery capacities, involving screen resolutions, capabilities and decoder features (frame rates, spatial dimensions and coding standards). The up-to-date systems deliver VOD services through to several devices by utilising the content of a single coded video without taking into account various features and platforms of a device, such as WMV9, 3GPP2 codec, H.264, FLV, MPEG-1 and XVID. This limitation only provides existing services to particular devices that are only able to play with a few certain videos. Multiple video codecs are stored by VOD systems store for a similar video into the storage server. The problems caused by the bandwidth overhead arise once the layers of a video are produced. The replication codec of a similar video and the layering encodes require further bandwidth storage and transmissions. The main objective of this paper is to propose a mechanism that can adapt an optimal video service according to mobile devices features and specifications. Therefore, it can save the CPU and RAM to be used on the server side. This paper proposed a novel adaptive policy to deliver the services of the VOD for several heterogeneous mobile devices. Additionally, the emphasis on introducing an up-to-date policy for profiling a video and an advanced protocol, namely the DNDS protocol, which is significant to propose a technique that depends on the collected data that delivers the most effective VOD facilities through cellular devices. This protocol is created to function over the whole current proposed systems components. Moreover, the DNDS protocol is applied and performed between the mobile clients, media forwarders and main servers. The performance of the proposed system is validated by examining two factors that rely on the RAM and the CPU. It can be found to be proven from the results that the proposed server contains lesser overload as the CPUs and RAMs servers is not important for converting every on-line video for every ordered device profile.

Keywords: Video on demand, heterogeneous mobile devices, media forwarders, DNDS , CVSP, VQHetM

1 Introduction

The VOD system is an interactive multimedia system to make the users to enjoy their time and make them select any video from their chose at anytime and anywhere. VOD provides wide pervasive services to many users, particularly for mobile nodes, on a daily basis. For example, the VOD system makes university students view informative videos for which they are interested in online anytime and anywhere. Additionally, it makes them view earlier recorded videos from lectures they have not attended. This system lets people at the airport to promptly view videos via their PDAs whilst waiting to board their flights [1,2,3,4]. There exist other several VOD applications, such as medical information services, E-learning (digital video library) [5], YouTube [6,7], IPTV [8], Facebook [9], Educclip [10], on-line shopping and etc. Depend of the Cisco predicts that by 2018, 84 % of the consumer internet traffic will come from video [11].Cisco Visual Network, a video will be continue the to dominate IP traffic and overall Internet traffic growth, representing 80% of the all Internet Traffic by 2021, up from 67% in 2016[12].

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There are different mobile cellular devices (heterogeneous devices) that are needed to for accessing the services of the VOD through the network, such as Smartphone, wearable computers and PDAs that have lately emerged with different device specifications. This paper presents the scheme that can provide an efficient quality video to users devices according to the mobile devices specifications. The server can provide different video qualities that can suit the devices resources (users profile). For instance, in case of displaying capabilities, notebook devices can present 480p 848x480 videos, while several smart phones only have QVGA 320x240 displays. The GSmart t600 PDA phone is fortified with a VGA 640 x 480 displays, while the cellular handset of type Nokia N90 just contains a QVGA 320x260 display. Recently, the HTC Desire HD mobile handset contains a resolution of 480x800 WVGA along with the Android 2.2 platform. There exist various kinds of mobile handsets, which contain various abilities that permit utilising various groups related to the video codec for various resources and standards. As an example, the new production of laptops can decode various kinds of coding qualities including high resolutions (e.g. the H.264/AVC at High Definition (HD) resolutions where PDAs can support appropriate video codes based on their own platforms of lesser resolutions (e.g. the WMV7 of 320x240 resolutions). Such features influence both bandwidth and distribution service. For instance, in YouTube, the video is broadcasted in the server by reserving a High-quality video. To flow into a Low-level video standard and medium, a server must minimise the frame-per-second with the size that is related to the selected video on-line for acquiring the most effective broadcast of various profiles along towards a mobile client [13,14,15]. The system needs to switch every video on-line for every ordered mobile device profile that will use more CPU and RAM at the server side [6,8][10]. This is due to the fact that mobile clients with different capabilities and platforms are not taken into account by the MobiVoD system [16]. The main problem is how to deliver the most effective quality of video for various kinds of devices according to their features and capabilities.

Accordingly,[17] proposes two-tier queuing model architecture in order to estimate the number of copies and to identify the most appropriate video through every disseminated server. Local users are permitted for per-caching a video via shared scheme rather than maintain different videos into many servers to appear as objects. Nonetheless, flowing facilities are considered in homogenous domains based on many previous related methods. This implies that the entire mobile devices are maintained and accompanied with different features (e.g. the downstream bandwidth). Further, heterogeneity must be increased through internet admittance. The link is given via a network through many mobile devices where various technologies and bandwidths are taken into account.

Several codecs and video streams are maintained in servers according to an approach, namely, the replication approach [18]. Many quality video streams are supported by servers along with an identical content but with various data rates. Accordingly, clients only obtain suitable video streams based on the network regulations and restrictions. However, the storage quantity is possibly incremented according to several codecs of a similar video. Hence, layered encoded videos that are utilised are the base of many quality video streams based on studies conducted by [19,20]. Despite the fact that the storage of several video codecs related to a similar video contains and requires an extra storage compared to the layering scheme. The problems of bandwidth overhead have emerged once producing different layers of a video. The replication codec of a similar broadcasting video including the layered encoding requires further implementation of the bandwidth, RAM and CPU transmissions. Consequently, a few restrictions are caused within these approaches when users obtain optimal videos. Mobile computing produces simplicity based on reduced devices and the existence of wireless communications. It is important to have computerisation of inherently mobile actions and further mobile workforces to many applications in order to integrate with conventional shared systems.

The encoder is software or a device in which signals are compressed. The software or the device in which a signal is decompressed is named the decoder. A couple of a decoder/encoder is commonly called a codec [21]. A video codec indicates to a process, which minimises a videos original size in order to be immediately played in a computer within its related network. Currently, the need for these services has acquired further popularity. Based on the continuous developments in the internet technology and digital technology, users require more effective multimedia service delivery. The majority of video codecs utilises lossy compression to reduce the large quantity of data that is linked with a video. The basic drive is not based on losing any information that can influence senses of a viewer. A few video codecs are totally applied in software where other video codecs need a particular type of hardware. The codecs performance is greatly based on the compression format that is used by the codec. The codec (the program) must not be disorganised with a compression format, standard or coding. The format is a document (a standard) and a method of storing data where a codec is software (an implementation) that writes or reads particular files. Accordingly, the codec itself is not considered a format where there can be many codecs, which apply a similar compression feature. For instance, an interleaved Distributed Transcoding (IDT) scheme used to stream the video to mobile peers that had a limited capability as well as differ in their capabilities, as well as the IDT scheme is built on H.264/AVC baseline profile [22]. The Scalable Video Coding (SVC) proposed as an extended of H.264/AVC, that allows temporal, spatial and quality scalability video streams, the scalability consent devices-capability adaptation and media-rate adaptation without the need of transcoding and trans-rating [23,24] Furthermore, many of the latest codecs such as, H.262, H.263, MPEG-1, MPEG-2 and MPEG-4 [25,26,27]. The MPEG-1 codec does not perform a quality/size ratio compared to the codec, which applies further contemporary H.264/AVC features [23,24] every codec provides an inappropriate quality degree for a certain set of frames in a video sequence. Frequent factors are significant to function in this variability. First, the whole codec contains a bit rate control technique, which identifies the quality and the bit rate on a per-frame basis. The bit rate forms a rate of the data that is transmitted from a single location to a further one. In other words, the amount of data that is transferred is calculated in a provided time (e.g. Mbps, bps and Kpbs). Additionally, this type of rate explains the standard of a video. For instance, once the file of the video is compacted at 2000 Kbps, the standard of the video (i.e. image resolution) is considered more effective compared to the video of a similar compressed file at 500 Kbps. The variance between the Constant Bit Rate (CBR) and the Variable Bit Rate (VBR) produces a trade-off among a reliable quality through the entire frames and a further constant bit rate that is needed for a few applications. Second, a few codecs differentiate between various kinds of frames, such as non-key frames and key frames when differing in their significance within the entire visual quality and the level to which they can be entirely compressed. Third, quality is based on pre-filtration, which are involved in the entire present-day codecs. Other factors make effects [21]. The procedure of minimising the amount of video indicates over a video compact or the video codec [28]. The video standards cost provides a compact for a lesser standard (e.g. the frame rate) and an inexact depiction based on image pixels where slighter resolutions are adequate to implement many applications. Accordingly, bridging the gap over inadequate bandwidth networks including massive quantities of graphical data for a shared video is considered an essential function of a video coding [29]. Several video coding qualities (e.g. MPEG-2, MPEG-4, MPEG-1 and H.263 [25,26,27][30]are all introduced. Hardware and software solutions are important for conducting a video coding. Such solutions are named codec solutions. A bandwidth that is needed to transfer a numerical video is effectively minimised via the codec. As an example, compression has a type, which is named the MPEG-2 (standard codec) that compresses a couple of hours for a video within 15-30 rounds. Once the image standard is created, a massive standard of a normal definition video is formed. Various video applications involve many standards of a video coding.

2 The Adaptive Policy Environment

This section presents a summary of explanations according to the ways of delivering ideal VOD facilities through varied cellular devices by proposing a novel protocol named the Device and Network Discovery Services (DNDS) protocol, which is utilised to collect necessary information from cellular devices in order to organise and deliver ideal VOD facilities through different environments of the cellular devices. A scenario related to different cellular devices within a construction (i.e. interior location) is illustrated in Figure 1.

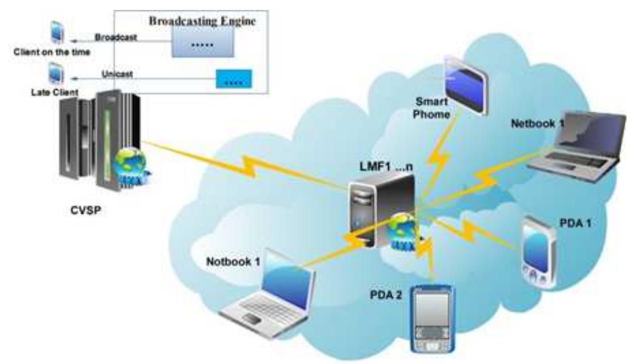


Fig. 1: The overall development of the heterogeneous clients

3 The Device and Network Discovery Services (DNDS) Protocol

The DNDS protocol is introduced in detail. It provides necessary and needed data, which is collected to deliver ideal VOD facilities through different cellular devices. This protocol is formed to be applied through the entire objects related to the current scheme. The protocol is applied and performed through a core server, GMF/LMF and cellular devices. The component of a link oriented based server is implemented from the media forwarders (GMF and LMF) and the server in order to explore the protocol, which collects the necessary needed information from every newly joined mobile client. The DNDS protocol is designed in order to remain within the servers. The DNDS protocol gathers the necessary information from mobile clients along towards the media forwarders. The information is gathered in the media forwarder part from the nodes and is transmitted through to the CVSP server. The service of the DNDS protocol delivers the required information in the mobile clients to the CVSP server the media forwarder. The protocol will repossess the operating system device, processing resourcing, existing codec information and so on. Consequently, mobile clients profile is after that assigned. The proposed structure is illustrated in Figure 2.

```
Structure_Device_ Profile
    {
    Byte [ ] Codec_Types;
    Byte Net_Type;
    Byte O_System;
    Byte Dev_Type;
    Char *Device_ID;
    Long int Reserve One;
    Long int Reserve Two;
    };
```

Fig. 2: The function of a profile

An MF uses the profile data to deliver ideal facilities of a VOD through to the mobile clients. The structure fields are explained according to the followings:

–**Device_ID:** The device_id denotes the unique identity information, which is utilised to trace the mobile clients when passing within different networks via the CVSP.
–**Dev_Type:** Dev_type field differentiates and classifies mobile devices within various pre-defined types(see Table 1). Hence, the paper proposes a technique that utilises a standard video codec for storing stored videos, which are produced within these formats. The application of the mobile client starts operating this function through the pre-phase that is related to its implementation. Various kinds of computerised systems (e.g. cellular) contain diverse abilities allowing the use of various groups of video codec over many resources and qualities.

–**Network_Type:** This profile type denotes a new existing network substructure related to cellular devices. The information helps a server in considering various connections and support possible bandwidths, which can deliver VOD facilities through cellular devices. The types of network domain information are presented in Figure 3.

–**Available_Codec_Types:** The indicated domain presents a set of the entire existing including appropriate audios and video codecs, which are maintained within various electronic systems (e.g. 3GPP, WMV9, H.264, etc.).

Table 1: The information of a profile

Types of a Profile	Codec Requirements
Notebook_Profile_L	XVID (mediumQuality) x265 (mediumQuality) Open H.264 lowprofiles DIVX (LowQuality) FLV1 (medium Quality) WMV8 (mediumQuality) MPEG4 AVG (Full HighQuality)
Notebook_Profile_P	Open H.264 (Full HD) MPEG4/AVG (Full HighQuality) XVID (HighQuality) DIVX (HighQuality) Libvpx (HighQuality) FLV (Full HighQuality) x265 (HEVCH.265) WMV9 (Optional)
Cellph_Profile PDA_Profile	3GPP1 and 3GPP2 Open H.264 low profiles 3GPP2 3GPP1 MPEG4/AVG (LowQuality) MPEG4/AVG (Full HighQuality) WMV8 (Low or MedQuality) FLV (LowQuality)

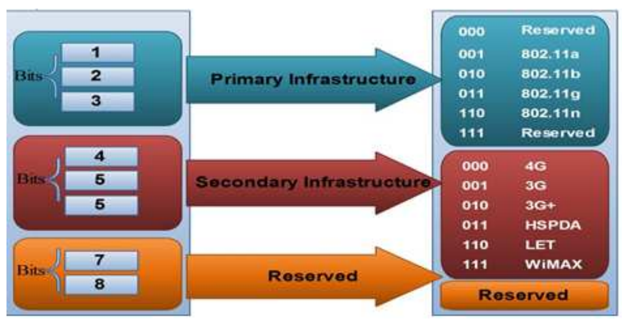


Fig. 3: Different networking domain types explanations.

–**OS:** The OS gives information regarding the OS of a device, (e.g. Windows 7, Windows XP, Windows mobile 6.1, and so forth).
–**Resolution:** The Resolution gives information regarding the screens size for mobile devices as shown in Figure 4. The resolution represents the total number of pixels on a screen, such as 120160 pixels (many Motorola phones), popular resolutions for normal cell phones, which involve 10180 pixels (many Sony Ericsson phones), and 128128 pixels (some Samsung phones). There is an extensive work to be performed for Smart phones. The iPhone includes a 320480 pixel screen. The HTC Venus includes a whopping 800480 pixel screen. The Palm Pre includes a 320480 pixel screen. The HTC Touch

Pro includes a 480640 pixel screen. The BlackBerry Storm includes a 360480 pixel screen. Many of these screens are able to seamlessly present a standard web site, where 240 x 320 forms the overall of the dominant screen size, 7201280 is the most common mobile screen resolution in 2016 [30,31].

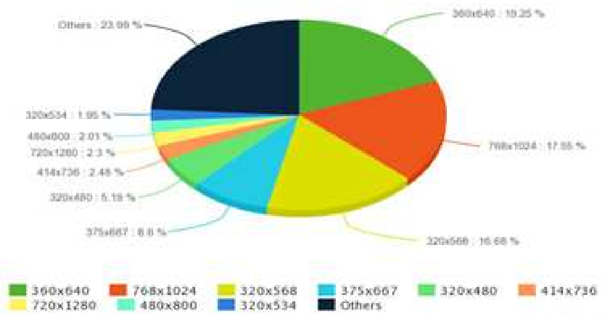


Fig. 4: The significant standard screen sizes, ranging from the small size to the large size [31].

– **RAM and CPU :** The indicated domains give information about the Random Access Memory (RAM) and the Central Processing Unit (CPU) of any mobile device. The field forms a comprehensive computation engine that is created on one chip, where it is a design of a computer data storage in which devices permit to maintain the data for accessing any given request. When the usage of the RAM and CPU are increased, the devices performances are also increased.
– **Reserve1 and reserve1 :** The indicated domains are earmarked for upcoming developments. As an example, the PDA_Profile is explained in Table 2 for cellular devices that are having an access to the facilities of the VOD. The kind of information is requested via an MF in order to optimally stream the content along towards the end user.

Table 2: A device profile example

Device_ID	5b21a31231
Dev_Type	Profile PDA (equal to values 3)
Network_Type	3G and 4G
Availability_Code_Type	MWV9, MPEG4, 3GPP and FLV
OS_Tyep	Windows Mobile v10
Resolution	230x320 pixel
CPU and RAM	520MHz and 64MB

4 Sustaining Heterogeneous Cellular Handsets for Obtaining an Ideal Video

In the produced method, various cellular electronic systems contain diverse abilities. There exist a single major standard codec, which is maintained within a platform. For instance, mobile devices (e.g. ios, wind and android) maintain one kind of codec, such as the MPEG. Additionally, a minimum supported resolution is available. This is similar to other devices and the notebook. Furthermore, the proposed system evades the use of various codec types within the main server. Windows, IOS, Android and Symbian maintain the MPEG version due to its standardisation feature. Nevertheless, the WMV is just maintained in the screen of a cellular electronic system, while the FLV is maintained within the android, and IOS might contain its particular presentation. Accordingly, a normal codec is maintained by diverse standard resolutions for delivering the ideal video based on the capabilities of various cellular electronic systems. Table 3 gives an example of android mobile devices including their profiling pertaining to every cellular type. Such examples of profiling for screens based devices are illustrated in Table 4.

Table 3: Examples of different Android cellular electronic systems including the profiling pertaining to every cellular type

Android	Version 3x	CPU	500 MHz	Profile 1	i.e.Standard Codec	Low Quality(240p)
		RAM	256 MB			
	Version 2.3	CPU	528 MHz			
		RAM	128-192 MB			
	Version 4.1	CPU	1 Ghz	Profile 2		Mid Quality(360p)
		RAM	512 MB			
	Version 4.0	CPU	900 MHz			
		RAM	256 MB			
	Version 5.1	CPU	1.5 GHz Dual Core	Profile 3		High Quality(480p)
		RAM	1024 MB			
	Version 5.0	CPU	1.2 GHz Dual Core			
		RAM	1024 MB			
	Version 7.1	CPU	2.2 GHz	Profile 4		Full High Quality(1080p)
		RAM	256 MB			
	Version 7.0	CPU	2 GHz			
		RAM	256 MB			

Based on the perspective of the ability or mobile platform, the bandwidth is inadequate for sending it through into the cellular client. This indicates to the existence of upper and lower limits. For instance, once the video gets encoded within different stages, a low quality of the video is broadcasted for keeping users profile low such that high quality video is broadcasted for the capacity of high users profile). The simulation task utilises the video resolution (video size) and the codec based on the use of various video sizes (mainly, the size of a video relies on the video resolution and the codec).

Table 4: Examples of screens for cellular profiles

Windows phone	Windows phone 4, 2003,CE	CPU	<800 MHz	Profile 1	Low Quality(240p)
		RAM	<= 500 MB		
	Windows phone 6.5, 6.1 and 5	CPU	800 MHz¡CPU >1.2 Ghz	Profile 2	Mid Quality(360p)
		RAM	1GB <RAM >512MB		
	Windows phone 8, 7	CPU	<= 1.2Ghz Doul-Core	Profile 3	High Quality(480p)
		RAM	<1 GB		
	Windows phone 9, 10	CPU	1.2 MHz<CPU >2. 1Ghz	Profile 4	Full HD(1080p)
		RAM	>= 1 GB		

For example, in order to deliver an ideal video, a notebook includes a higher processing and resolution, which makes the video appear into that format. The mobile phone contains fewer processes and resolutions compared to a notebook, and obtains a fewer video sizes. It will currently form one for all forming 100 Mbps speed of a video for a mobile device and the notebook. This implies that the notebook can acquire speeds of 30 Mbps and 150 Mbps or fewer regarding a cellular electronic system. The aim of that is based on providing comparisons for this factor so that particular notebooks and mobile devices could be identified for acquiring a similar ideal video according to their abilities. Based on the proposed protocol of this paper, an ideal video is acquired according to the devices abilities. According to the simulation, an INI file determines what video must be broadcasted over a cellular electronic system. Various video capabilities for particular devices are shown in Table 5.

Based on the implemented simulation, the server provides a decision based on the appropriate profile version of a video to be transmitted to particular devices according to the information that is transmitted by the client device beforehand. The quantity of the RAM and CPU represents the precise information of the server for classifying any forthcoming orders sent from cellular electronic systems. Nonetheless, cellular systems are classified according to how their OS functions through a server. The motive behind this refers to the information of the RAM and CPU is not able to be transmitted through to the hand-shaking procedure between the server and client in their real application. Therefore, the media forwarder and the mobile client create the needed contents in order to understand each other. Consequently, the devices ability (i.e. the RAMs and CPUs ability) is predicted in the paper in order to transmit the video type according to the information of the OS/OS version. It is important to shed the light on this simulation to the best knowledge of the research that there is no method for simulating the codec when only including the data.
The idea of utilising various codecs includes many abilities for handling the devices. Diverse resolutions and codecs are based on the data size. Additionally, it is important to consider that the quantity usage of the RAM and CPU causes a major problem for acquiring the appropriate video of the profile and the smooth video broadcasting on the side of the client. If the CPU/RAM is insufficient or does not satisfy the videos needs, frame drops are encountered and video will miss its smoothness. Nevertheless, when the devices are profiled according to the OS, it could produce many problems. For example, a high profiling OS is created within a medium level for profiling cellular electronic system.

Table 5: The levels regarding many video abilities for various cellular electronic systems

Profile	Level	Quality	Video Resolution	Fit Bandwidth
(1)	Low	240p	432x240Px (Windscreen), 426x240px (Stander)	256 kbps
(2)	Mid	360p	640x360px(Windscreen) ,480x360px (Stander)	268 kbps – 1 Mbps
(3)	Hight	480p	848x480px(Windscreen), 640x480px (Stander)	768 Kbps – 1.5Mbps
(4)	Full HD	1080p	1080x1920px(Windscreen), 1440x1080px (Stander)	<2Mbps

This is considered an encountered problem for this simulation, which must be handled by a series of various experiments and simulations to effectively classify the new profiling system. Furthermore, it is significant to consider that the quantity of the RAM and CPU in the simulation does not include their architecture. Each RAM or CPU might include various architectures where this implies that a current architecture and a CPU of 1 GHz could include a more effective performance of the video. Therefore, they might involve an ideal video broadcasting that is more effective than the CPU with the new architecture.

5 The Process of Delivering a Video Based on the Profile of a Cellular Electronic System

The construction for transmitting an order for the VOD facility between the MF and the mobile client is depicted in Figure 5. As an example, the process of a Client_P in which a video is requested from the MF is represented. The MF delivers an ideal video based on particular abilities of Client_P. The playback process for delivering video services based on the client's profile comprises the followings: The process of gathering a cellular electronic system profile via a GMF/LMF from cellular devices is illustrated (see Figure 6). When the existing media is requested by the mobile client from the GMF or LMF, the request is accordingly processed where the information is requested from a cellular device, which collects different information to transfer it through an MF, which will in turn request the required component based on the cellular devices profile for delivering an ideal video facility from the core server procedure (the CVSP). The CVSP processes any order in order to deliver an appropriate video through an MF, which caches the video. At the end, the information regarding the transmitting channel of the requested video is provided, and the client will connect

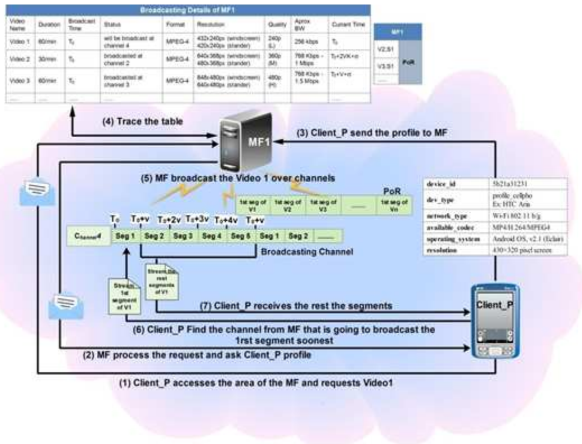


Fig. 5: Different paradigms for Client_P requesting the video where MF replies with an ideal video based on users abilities

Begin

A Client_P request the Video 1 from the MF.

Then, the request is processed by the MF processes and Client's profile is also requested.

If Client_P's profile is exits

The profile is transferred by Client_P along into the MF (see Figure 2).

Else

The MF will keep tracking the Client_P until get the profile

The table is tracked by the MF to determine the appropriate video for the request of Client_P where:

-The MF obtains the profile of Client_P and tests Client's abilities.

- The MF tests its OS and its power electronic system. For instance, once the RAM and CPU get high, a high standard video is produced (the LMF is based on a higher bound border pertaining to the maintained resolution of a video that is being transmitted) based on the resolution's lower bound limit that is transmitted (see Figure 5).

- The MF obtains the appropriate profile of a video through Client_P and this video is obtained in return.

IF the MF transmitted the Video 1 through to particular channels

Then, the Client_P connects a single channel in a direct manner.

Else

The 1st segment is played by Client_P and is switched to the 2nd segment, and keeps connecting a similar channel till the video terminates.

End the broadcasting channels are after that terminated.

through to the channel in order to playback and cache the desired video.

The ability to explore existing contents of the mobile

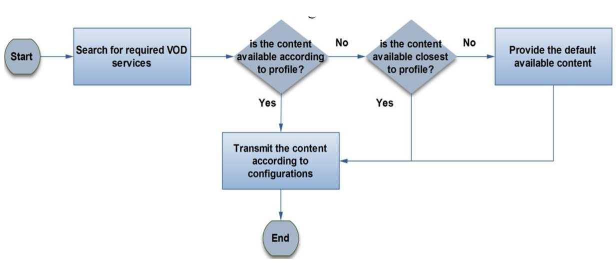


Fig. 6: The process of the media request

clients based on their profiles is shown in Figure 7. The mobile clients can either explore the appropriate components based on their profile or can explore the nearest components. Finally, the forwarder will send the services based on the configurations of the mobile client.

The supposition here is that the MF and the client create

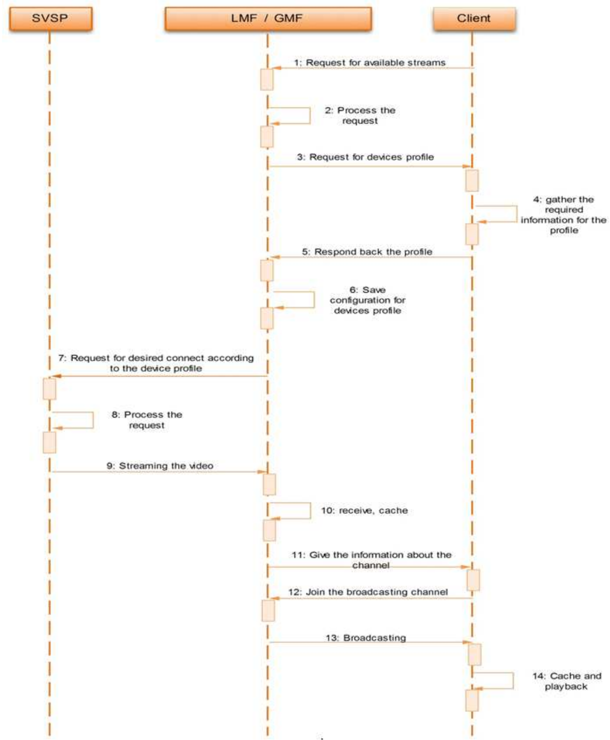


Fig. 7: Searching for required VOD services

the requested contents in order to comprehend each other. Any client can access the MF if they include such contents. The aim is to acquire the services such that a verification is not given since WiFi connections cover it (access point, APs). Just particular mobile devices that are legal for an AP admin link them together. Figure 8 shows the procedure of a media order, which begins from a cellular device accessing a particular region of the network that waits for a video to be played back by the client. The details of steps 3-6 are illustrated (see Figures 8-11) for specifically determining which cellular devices require collecting their profile, the way a profiles packet construction is provided at given period of time, and the way a few streaming actions are classified including a few construction mapping tables.

Figures 12 and 13 show a further paradigm including sufficient resources of the GMF or LMF, which perform an actual time transportation for a media with fewer handling cellular systems. Additionally, the stimulating function aims at utilising the FHDVoD over cellular devices. The paper utilises a high standard facility for the VOD including a profile, named, the $Profile\_notebook\_P$. The reason behind this refers back to the robust notebook machine, which decodes the video stream in a flexible manner with sufficient bandwidth for catering the needs.

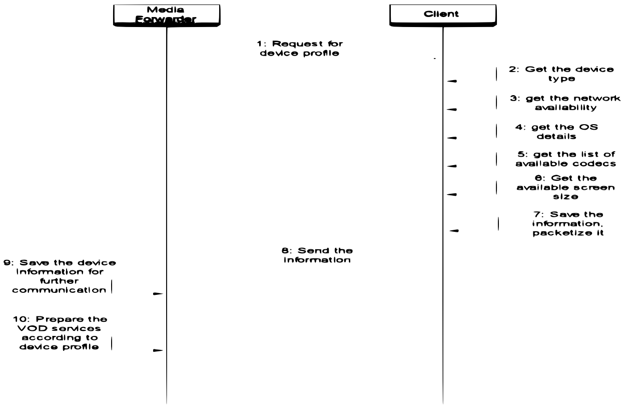


Fig. 8: Profile detection

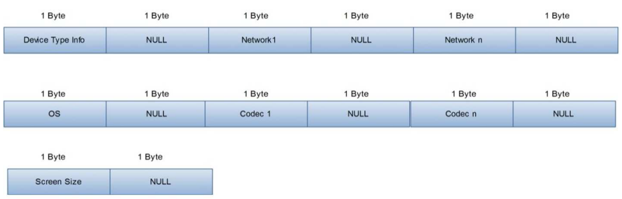


Fig. 9: A packet construction of the profile at a demanded period of time

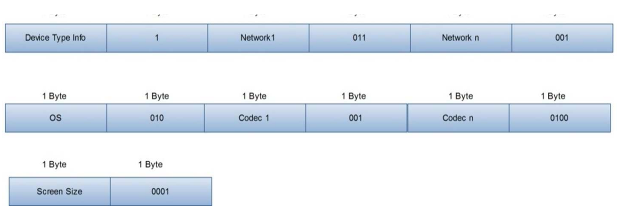


Fig. 10: A packet construction of the profile at a reply period of time

This profile utilises the H.264, which depends on the format of the media. For a few robust devices, lower resolutions of a video with 3GPP and MPEG-4 are also obtained.

6 Investigative Models of MFs and CVSP Server

This section introduces the entire performance of the VQHetM system from the MFs and the CVSPs sides in order to deliver the VOD services, and to explain the analytical calculations that could evaluate the performance according to the systems bottleneck, asses common videos of various video profiles and assess the existing bandwidth between the MF and the CVSP.

000	4G
001	3G
010	3G+
011	HSPDA
110	LTE
111	WiMax

(a) network type (Secondary Infrastructure)

000	Reserved
001	802.11 a
010	802.11 b
011	802.11 g
110	802.11 n
111	Reserved

(b) network type (Primary Infrastructure)

OS	Values
Android	1
Windows Mobile 5	2
Windows NT	3
Linux	4
Mac	5
IOS	6
Reserved	- - - - -

(c) Operating systems type

Codecs	values
H.264 low profiles	1
MPEG4/AVG (Full HD)	2
FLV (Med-Quality)	3
3GPP1 and 3GPP2	4
WMV8 (Optional)	5
DIVX (Low-Quality)	6
Reserved	- - - - -

(d) Codecs type

Screen Size	values
320x240px	1
640x480px	2
1280x800px	3
1080x1920px	4

(e) Screen size type

Version(Android)	values
7.1, 7.0	1
5.1, 5.0	2
4.0, 4.1, 4.2	3
2.3, 3x	4

(f) OS version (Android)

Version (Windows)	values
9 or 10	1
8 or 7	2
6.5, 6.1 or 5,	3
4, 2003, CE	4

(g) OS version (Windows)

Fig. 11: A number of illustrations related to the construction-mapping table

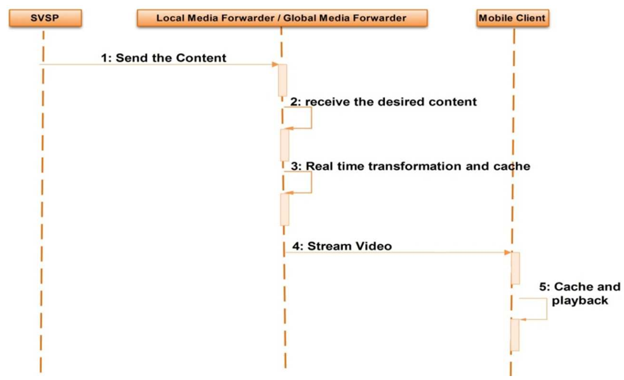


Fig. 12: An actual time for media conversion

Assume that Video k with a Q^{th} quality refers to VkQ that is encoded at rate S_{KQ}^{rate}, which is formed as follows:$S_{K1}^{rate}, S_{K2}^{rate}, S_{K3}^{rate}, \ldots S_{kQL_k}^{rate}$. The paper identifies whether the video is kept in the MF or not. Consider that the$P_{rob}R_j$ indicates to the probability of the users who are ordering the VkQ $\forall K$, where,$k \sum_{Q=1}^{QL_k} P_{rob}R_j = 1$. In the proposed system, the MF stores the most common videos in order to increase the caching hits. The MF is mapped as MF_{KQ}, which is being utilised to explain the video profiles subsets within its cache. The MF_{KQ} is set to 1 if the VkQ exists in the MF. Otherwise, it is set to 0. Consequently, the cache hits the optimisation issue, which is expressed as follows:

$$\sum_{k=1}^{k} \sum_{Q=1}^{QL_k} P_{pop}K * ProbRj * MF_{KQ}, \qquad (1)$$

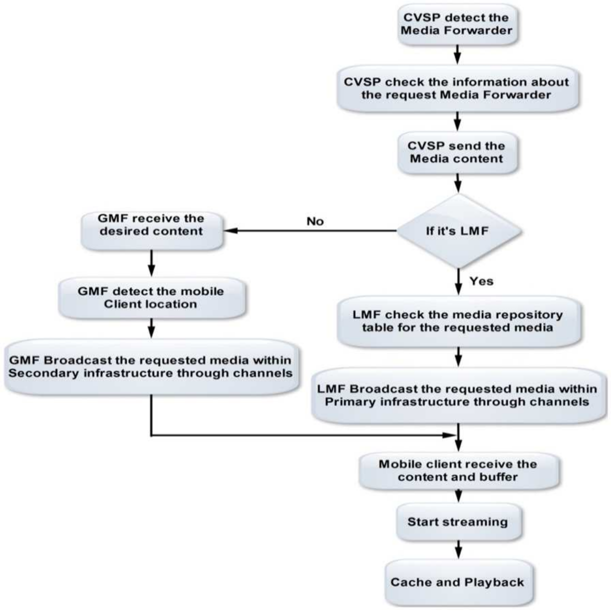


Fig. 13: The flowchart for LMF/GMF providing an actual time for media conversion

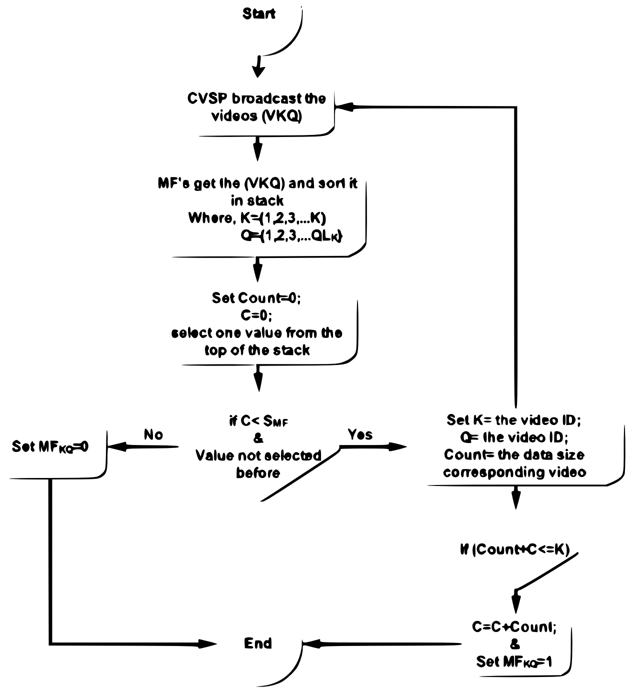


Fig. 14: A process for identifying what video must be cached into an MF

Where, the $P_{pop}K$ denotes the videos popularity, and $P_{rob}R_j$ denotes the users request probability.

$$\sum_{k=1}^{k}\sum_{Q=1}^{QL_k} S_{KQ} * MF_{KQ} \leq S_{MF} \quad (2)$$

Where, the S_{KQ}denotes the size based on Video k, which is encoded into the Q^{th} quality (bits), while S_{MF} denotes the MFs size.

According to Figure 14, the V_{KQ} is transmitted from the CVSP through different MFs. The V_{KQ} is ascending organised via multiple MFs over a stack depending on how popular is the following formula $P_{pop}K * P_{rob}R_j$. Every value within the stack includes a $(V_{KQ}, P_{pop}K * P_{rob}R_j)$ pair. Every value above the stack is chosen by every iteration. Once it exists within an MF, a cache is considered higher when accepting any requested video component. Hence, the V_{KQ} pertaining to a video is inserted with a fixed value 1, or the procedure persists to be chosen from a stack based on the following value till an entire caching space is allotted.

When the V_{KQ} is explored by increasing the efficiency of a cache, the portions of requests are determined. This fraction increases to reach the CVSP that belongs to devoted flows. When particular orders saturate an MF from a transmitting channel within a scheduled time, remaining requests are provided to the PoR. Equation 3 calculates the arrival rate that is related to these requests. However, the delivery of numerous video flows can be provided from an MF, PoR and CVSP through cellular devices, the average streaming rate is calculated in Equation 4.

$$\lambda_{stream}^{rate} = \lambda \left[\begin{array}{c} 1 - (\sum_{K=1}^{K} \sum_{Q=1}^{QL_k} P_{pop}K * P_{rob}R_j * V_{kQ} \\ + \sum_{Q=1}^{QL_k} P_{pop}K \end{array} \right] \quad (3)$$

Where,λ_{stream}^{rate} denotes the received rate of a devoted flow (order per second) for a transmission.

$$AS^{rate} = \frac{\lambda}{\lambda_{stream}^{rate}} \sum_{K=1}^{K} \sum_{Q=1}^{QL_k} (P_{pop}K * P_{rob}R_j) - \sum_{Q=1}^{QL_k} P_{pop}K * S_{kQ}^{rate} * \overline{MF}_{KQ} \quad (4)$$

Where, the AS^{rate} denotes the average stream rate of the determined stream (Bit/Sec) of the transmission. S_{kQ}^{rate} denotes the streaming rate of the video k including the Q^{th} is the quality-profile-level (Bits/Sec) and the $\overline{MF}_k Q$ denotes the complement of the MF_{KQ}.

Moreover, scalability problems are encountered by the CVSP due to the systems bottleneck when large amounts of video flows are transmitted or functioned. Accordingly, the paper focuses on the CVSP and MFs/PoRs performance for the purpose of delivering seamless VOD facilities. An existing bandwidth between an MF and CVSP indicates to b. Both maintain an amount of video streams (N_{vi}). Meantime, the amount relies on

Equation 5. Further, consider the service time $T = \frac{Di}{Tr}$ for every video stream is exponentially disseminated with a rate service $\mu = (\frac{1}{T} \Leftrightarrow \frac{No.of\,packet}{service time})$, when the changing length of different videos is taken into account.

$$N_{vi} = \frac{b}{AS^{rate}}, Where, vi = 1,2,3,4,5...K \tag{5}$$

The probability of the bottleneck is formalised as shown in Equation 6. If the bandwidth from the mobile clients to the MF is enormous, and theres no any requests are blocked, the entire systems bottleneck probability is provided by Equation 7 as follows:

$$P_{rob}b^{r} = \sum_{z=0}^{Nvi} \frac{(\frac{\lambda^{rate}_{stream}}{\frac{1}{T}})^{Z} * (\frac{\lambda^{rate}_{stream}}{\frac{1}{T}})^{Nvi}}{z * Nvi} - (\frac{\frac{\lambda^{rate}_{stream}}{T} * b^{r}}{\frac{1}{T}}) \tag{6}$$

$$P_{rob}OA^{rate} = \frac{\lambda^{rate}_{stream} * P_{rob}b^{r}}{\lambda} \tag{7}$$

Where, $P_{rov}OA^{rate}$ denotes the entire systems bottleneck probability and λ denotes the arrival rate (request/ second) of the system.

7 Analytical Models of the PCSB Broadcasting Scheme

By applying the broadcasting and caching techniques, the development on the performance is obtained. Apart from storing common videos in the MF, some common videos are transmitted to the clients through the PoR. For instance, a low quality video is transmitted through the transmitting channels where the higher encoded version of the similar video is sent to the mobile clients over dedicated channels. Hence, it is significant to provide a decision for determining which type of video is possible to be transmitted through transmitting channels as the aim is based on developing an entire execution for the VOD system [1,2][33] including caching and broadcasting schemes. Any effective protocols, e.g. The Popularity Cushion Staggered Broadcasting (PCSB) technique of a cellular VOD device ensures a delay time of a viewer is less compared to the existing methods [33,34].

The entire video is classified into K equal size segments $(Seg^1, Seg^2, Seg^3, ...Seg^k,)$. The duration time for every segment is $D_{uration}i = V_1/K_{nch}$. The numbers of each logical broadcasting $C_{hannel}i$ should be ranged between $(C_{hannel}i = 1 \leq i \leq K_{nch})$. It is assumed that the provider bandwidth is $Pb * K_{nch}$ for the 2^{nd} video and so forth. This bandwidth is divided into physical channels $C_{hannel}i$ frequently by transmitting the video from Seg^1 till the end of Video Seg^k with a transmission rate (Tr) that is equal to the playback rate (Pb) (see Figures 15 (a) and 15 (b)). The Client_x can connect to $C_{hannel}1$ and wait for the start of the 1^{st} segment Seg^1 in order to download and playback it. Client_x switches to the following segment Seg^2 for play backing it. This procedure is recurred for the following segments until the last segment Seg^k is downloaded from $C_{hannel}1$.[35] Equations 8 and 9 follow the definition as follows:

$$D_{uration}i = \frac{V_i}{K_{nch}} + \sum_{i=1}^{Seg_k} Pb * K_{nch}, \quad where, (Seg^1, Seg^2, ...Seg^k) \tag{8}$$

$$V_i = \sum_{K_{nch}}^{i=1} D_{uration}i \tag{9}$$

Where, the $D_{uration}i$ denoted as the duration of every segment, the V_i denoted as the length of the video and K_{nch} is referred as the number of the channels.

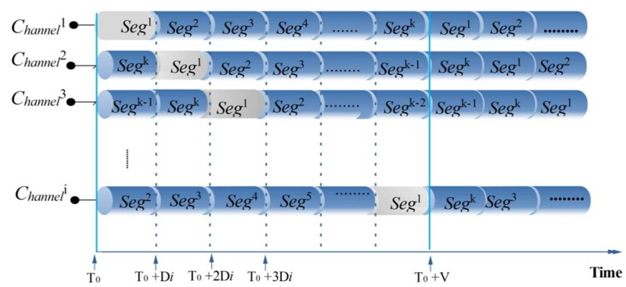


Fig. 15: Video segments repeatedly broadcast on one channel

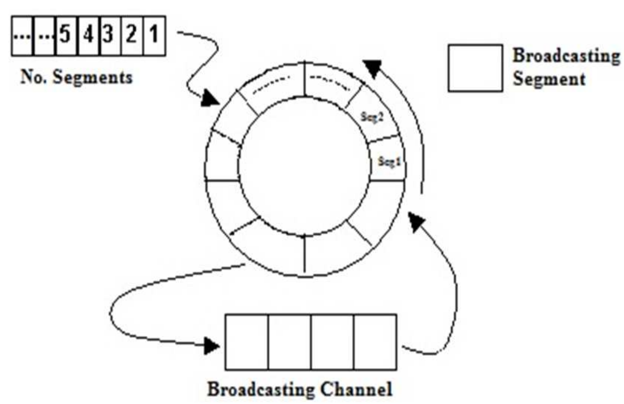


Fig. 16: Broadcasting video segments at the server/media forwarders

Based on Figure 15 and 16, every channel is transmitted by the radio waves within its service region. The MFs connect to the whole transmitting channels, and thus, obtains all transmitted segments from the core server. A transmitting timetable of an MF is similar to the core server that can retransmit all segments through available cellular devices into their facility region. The first playback process of a cellular device that connects through the transmitting channel tracks a seamless process as follows:

Initial procedure for a client playback:

Begin
Cellular device enter into the transmission area
Searching to the nearest MF
Check the information about the detected MF
If the detected the MF
Cellular device will find the transmitting channel from MF,
which is start broadcasting the first segment of the request video soonest
Then,
The device will directly join the channel to,
Playback the requested video from 1st segment until Seg^k
Else
Keep searching to the detect the MF
Quit this channel
End

PCSB channels (K^{PCSB}={$C_{hannel}{}^1$, $C_{hannel}{}^2$,...$C_{hannel}{}^k$})indicate to the number of channels, which is needed for the PCSB scheme for video transmission purposes where the start-up latency is not sensitive to the mobile nodes. Additionally, it is supposed that every receiver is provided with a sufficient number of buffers to apply the effective broadcasting protocol. In order to select the most suitable and common video, it must be transmitted through the broadcasting channels where the X_{kQ} is utilised to examine if the V_{kQ} is previously transmitted or not yet transmitted. The consumption bandwidth for transmission is calculated depending on Equation 10 as follows:

$$b^{brod} = \sum_{K=1}^{K}\sum_{Q=1}^{Q} S^{rate}_{kQ} * K^{PCSB} * \overline{MF}_{kQ} * X_{kQ} - \sum_{Q=1}^{QL_k} + P_{pop}K_{+}V_{KQ} \quad (10)$$

Where,b^{brod} denotes the bandwidth needed for broadcasting, K^{PCSB} denotes the amount of available channels. $\overline{MF}_{kQ}$ denotes the supplement of a flowing rate once Video k contains the Q^{th} quality level per-bits (MF_{kQ}).

Likewise, X_{kQ} is determined based on the MF caching for transmitting channels depending on how popular they are. For instance, the videos are sorted according to how common they are. The most common video indicates to that the first video in the stack is transmitted. Suppose that the transmitting bandwidth is conserved, it will find that the video X_{kQ} including the transmitting bandwidth is not greater than the capacity of the available bandwidth. This means that the needed transmitted bandwidth must not exceed or be equal to the conserved transmitting bandwidth $(b \leq conserved)$. This process is encountered occurs since a few replicated videos are being transmitted. Equation 11 represents the arrival rate for the devoted channels. The arrival rate is equal to this rate of the system minus the arrival rate in the MF including the arrival rate to the transmitting channels. Hence, Equation 12 gains the average streaming rate of the devoted channels.

$$\lambda^{brod}_{stream} = \lambda\left(\sum_{k=1}^{k}\sum_{Q=1}^{QL_k} P_{pop}k * P_{rob}R_j * MF_{KQ}\right) - \overline{MF}_{KQ} \quad (11)$$

$$\lambda^{brod}_{stream} = \left(\sum_{k=1}^{k}\sum_{Q=1}^{QL_k} P_{pop}k * P_{rob}R_j * \overline{MF}_{KQ} * X_{KQ}\right) + \left(\sum_{Q=1}^{QL_k} P_{pop}k * P_{rob}R_j\right) \quad (12)$$

$$AS^{broad} = \frac{\lambda}{\lambda^{rate}_{stream}} \sum_{k=1}^{k}\sum_{Q=1}^{QL_k}\left(P_{pop}K * P_{rob}R_j * \frac{S^{rate}_{KQ} * \overline{X}_{KQ}}{b - b^{brod}}\right)$$
$$where, \left(S^{rate}_{K1}, S^{rate}_{K2}, S_{K3}rate, ...S^{rate}_{KQL_K}\right) \quad (13)$$

Where, λ^{rate}_{stream} denotes the arrival rate to the transmitting channels, AS^{broad} denotes the average broadcasting rate for the devoted channels, and the $\overline{X}_{KQ}$ denotes the completion of the X_{KQ}.

Moreover, b denotes the existing bandwidth. The number of streams, which is simultaneously maintained by the $CVSP$ is calculated as:$N^{brod} = \frac{b-b^{brod}}{AS^{broad}}$ as depending on Equation13. By referring back to Equations 6 and Equations 7, the entire probability of the blocking is directly explored into a Poisson procedure [33][[34].

8 Simulations and Results

In this subsection, an arrangement pertaining to the produced method is highlighted. The systems simulation is divided into five categorisations including the metrics and performance categorisation, the simulation strategy for the methods authentication categorisation, the software and hardware simulation setup categorisation, the factor of installing a simulation categorisation and the simulation design, which is utilised for processing a simulation for a model categorisation. Both categorisations the simulation design for the model verification categorisation and the software and hardware simulation setup categorisation are reused without any changes. The categorisation the parameter for setting up the simulation categorisation is utilised with some additions and changes of a few parameters. The remaining categorisations, which are the simulation model that is utilised for simulating the system categorisation and the metrics and performance categorisation are highlighted in the following subsections where a comprehensive information of the simulation preparation is discussed.

8.1 The Design of a Simulation

A number of basic contents for the simulation design are illustrated in Figure 17.

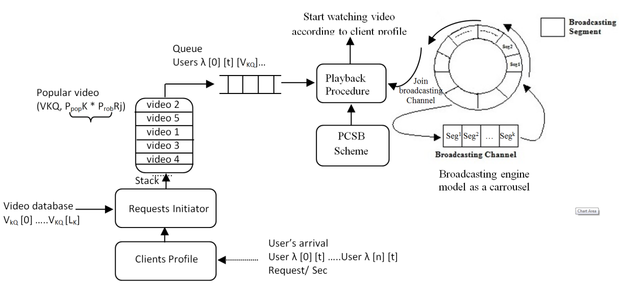


Fig. 17: The simulation design

The basic aim of this design is based on delivering VOD facilities for various kinds of cellular electronic systems (various profiles) according to the features and abilities they have. The simulation design utilises similar investigative computations of a transmission, MFs and CVSP are entirely discussed in Sections 6 and 7. The simulation begins through an order from the received cellular device for a selected video including an order of probability $P_{rob}R_j$. An MF obtains an order where it transfers an acknowledgement through a cellular device along with the request for the device information (Profile) as described in Section 3. After that, the client transfers an acknowledgement including the devices type, the OS version, and continuously to the MF as shown in Table 2. The MF obtains the profile and choses the most effective and appropriate profiled videos from the client profile table within the server (see Figure 8). The channel begins transmitting the video, connects to the channel and monitors the designated video. For the MFs, assume that Video k with a Q^{th} quality indicates to V_{KQ} that is encoded at rate S^{rate}_{KQ}, and which indicates to$(S^{rate}_{K1}, S^{rate}_{K2}, S_{K3}rate, ...S^{rate}_{KQL_K}$. There exist two kinds of activities within this simulation. The MF begins processing the acknowledgments and requests from the mobile clients, and tries searching for the most effective and suitable video profiles for transmitting an ideal video. After that, the cellular devices side, which is depending on their OS is classified via a server for a single profiled video (e.g. low standard, high standard, medium standard and full high definition standard without considering the power of the device when those videos are being played.

8.2 The Simulation Results

According to the results, the produced systems performance is checked from the side of the server (RAM and CPU). During the implementation, the quantity of the RAM and CPU is utilised via a number of pages including a video (I-Frame), which is obtained from a hardware server depending on the assistance of ASP.NET programming (see Figure 18).

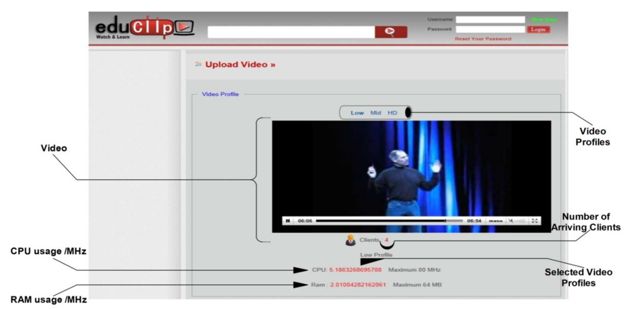
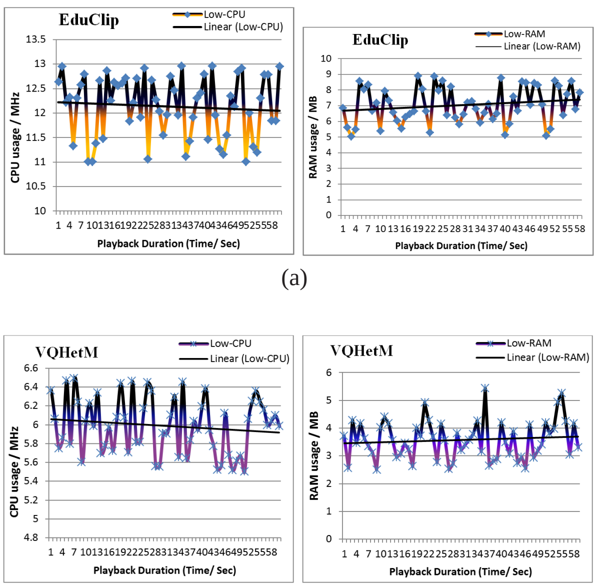


Fig. 18: An Educlip interface

The usage of the RAM and CPU is derived based on the process.sys of the hardware server information. Additionally, the entire signals for the RAM and CPU are averaged and band-passed from the entire centres. The application of available server construction that transmits a video via preserving a single video to form higher standards through a server [7][10]. Flowing into four various video standards allows a server to minimise the frame-per-second including the size related to the selected video on-line for acquiring the ideal transmission of various profiles through to the mobile clients. Nevertheless, the video profiling is produced over the side of the server once a simulation gets created. The procedure is based on maintaining a selected video including normal setups through four stages for the frame-per-second including the size of the designated video. This gives every device four different qualities of a video (Full-HD, High, Medium and Low). A simulation for the Educclip.com with the produced system are frequently being implemented for the purpose of checking the RAM and CPU for clients $\{1, 2, 3, ...10\}$. It is found to be proven that the gathered results are somewhat and mostly unobserved in the average. Hence, one set of the results is determined from every received mobile client.

During the testing process, the system computes the quantity of the RAM and CPU when the clients view the video based on the profile that is being utilised by them. The results illustrate one sample of the four profiles derived the testing process, once a number of cellular devices reaches 10 clients where a time period reaches sixty seconds. A highest frequency for the CPU is devoted through a web-hosting for representing an educclip.com of (80 MHz) when the RAM reaches (64 MB).

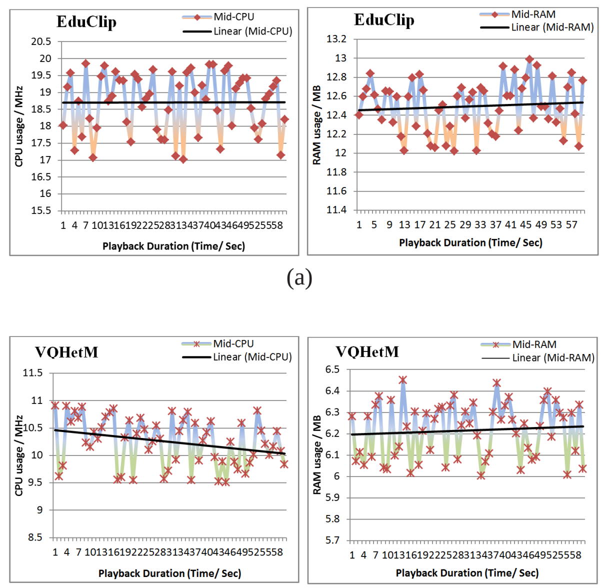


(a)

(b)

Fig. 19: Low standard profile (a) The use of the RAM with the CPU in the EduClip system. (b) The use of the RAM with the CPU in the produced VQHetM system.

The EduClips and VQHetM methods performance including low standard profiles are highlighted (see Figures 19). The findings are calculated according to a number of cellular devices by ordering a selected video within a particular time. It can be inferred from the results that the average execution for the EduClip method. The RAM is (4.380535226 MB) and the CPU is (11.00464636 MHz), when the number of cellular devices reaches 10 devices. Meantime, the utilisation of the CPU reaches 6.043346174 MHz where the RAM reaches 3.167677477MB in the VQHetM method. However, it can be found to be proven from the gained findings that an available server construction of the EduClip is being frequently utilised for the RAM and CPU. Nonetheless, a server is rarely being utilised through the profiling as there is no need for it to switch every video on-line for every ordered cellular profile. Additionally, an execution including the medium standard profile is shown in Figure 20. It can be shown from the results that the average usage of the RAM with the CPU for both systems somewhat rose when the number of clients had arisen. Nonetheless, the rise of the RAM and CPU through the produced method is yet sensible in comparison with the Educlip method. An average use for the RAM nearly reaches 6.21780527207361 MB and an average use for the CPU nearly reaches 10.2374119782995 MHz. In the Educlip system, and the RAM reaches 10.4930573950179 MB and the average usage of the CPU reaches 19.7028211988258 MHz. In return, it is obviously shown from the produced system that it indicates to a better effectiveness including a value modification of 9.45 MHz through the CPU including 4.27 MB through the RAM.



(a)

(b)

Fig. 20: The medium standard profile (a) The use of the RAM with the CPU in the EduClip, (b) The use of the RAM with the CPU in the produced method (the VQHetM system.

In the previous experimental findings, the high standard profile is illustrated in Figures 21, while the produced method delivers facilities including a little use of the RAM with the CPU in comparison with other previous systems. An average use of the CPU nearly reaches 12.0130922878765 MHz where the RAM nearly reaches 9.67160427202848MB. Through the Educlip method, an average use of the CPU reaches 21.8278775423616 MHz, while the RAM reaches 16.5364228847761 MB. On the other hand, the produced method provides a better effectiveness including a value modification of 9.81 MHz within the CPU including 7.86 MB within the RAM.

The Full High Definition (F-HD) standard profile is shown in Figures 22. It can be shown from the results

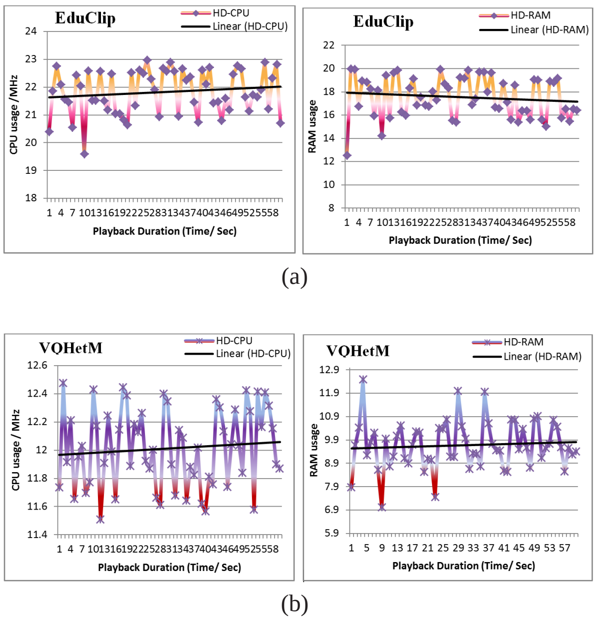


Fig. 21: The high standard profile (a) The use of the RAM with the CPU in the EduClip, (b) The use of the RAM with the CPU in the produced method (the VQHetM system.

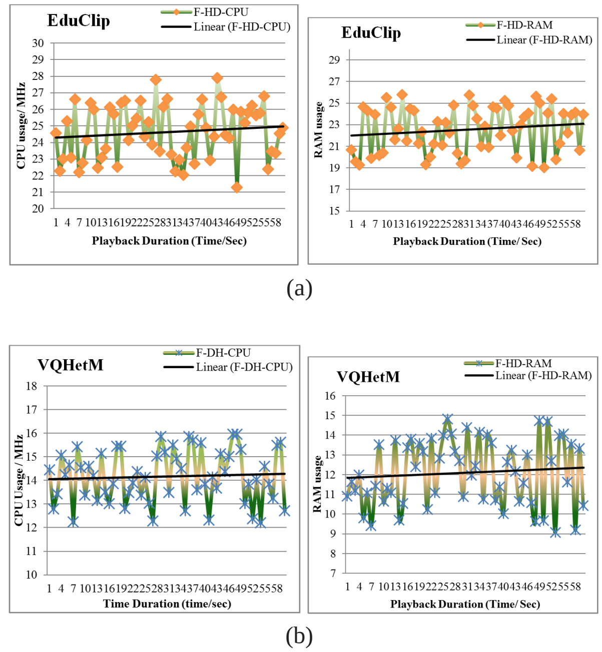


Fig. 22: The Full high definition standard profile (a) The use of the RAM with the CPU in the EduClip, (b) The use of the RAM with the CPU in the produced method.

that the average usage of the RAM with the CPU for both systems somewhat rose when the number of clients had arisen. However, the rise of the RAM and CPU through the produced method is still sensible in comparison with the Educlip method. The average use for the RAM is 12.09396842 MB and an average use for the CPU nearly reaches 14.17311764 MHz. In the Educlip system, and the RAM reaches 22.54019920 MB and the average usage of the CPU reaches 24.6335389 MHz. In return, it is obviously shown from the produced system that it indicates to a better effectiveness even when used F-HD.

It can be inferred from the simulation results that there a lower overload for the produced server since the server of the RAM and CPU are not needed to switch every video on-line for every ordered device profile. It only determines the most appropriate video from the installed profile, and immediately delivers it through to the ordered devices based on their abilities. Consequently, it consumes extra storage from the server-side instead of converting the video on-line and consuming the RAM and CPU that are related to the server.

9 Summary

Possible solutions for creating a VOD system through heterogeneous devices are explored in this paper. Hence, the enhancement pertaining to the paper is based on integrating and developing different transmission methods, which are joined with many MFs. Additionally, standard and caching coded methods of various video standards are investigated. Various system configurations are applied, such as unicast/broadcast, centralized/distributed and standard coding with many video qualities in order to deliver an ideal video profile to mobile clients. This paper introduces a novel self-adaptable VOD system for mobile devices in order to deliver ideal video quality services for various kinds of devices including various platforms, video qualities, capabilities and features. Moreover, the focus is based on proposing a novel video profiling strategy including a novel protocol, namely, the DNDS protocol such that a method that depends on various data is required for collection through delivering ideal VOD facilities through cellular devices. This protocol is formed so that it can be applied with the entire objects of the produced method. Additionally, the protocol is applied and performed among cellular devices, media forwarders and main servers. This paper, proposed a novel policy is proposed to seamlessly deliver VOD facilities to various kinds of devices (different profiles) according to their features and abilities. The performance of the DNDS protocol is examined by checking two factors related to the RAM and CPU. It can be found to be proven from the results that the proposed server is of a lower overload.

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Author Contributions

The corresponding Author made considerable contributions to this research by interpreting the data; System design and analysis, running experiments, he also contributed in critically reviewing the manuscript for significant intellectual content.

Ethics

This manuscript is original work and has not been submitted for publication elsewhere. The corresponding Author ensures that his colleague have read and approved the manuscript and no ethical issues involved.

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