Vertical Handover and Video Streaming Over Cloud in 4G Heterogeneous Overlay Wireless Networks

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Abstract — 4G enables the integration and interworking of all wireless systems. The users always think of seamless streaming of multimedia over various networks. The proposed technique focus on providing "non-terminating" video streaming for mobile users while moving over various networks, the adaptive mobile streaming over mobile networks helps to provide streaming of video . The streaming delays can be reduced by constructing private agents using cloud to provide adaptive video streaming to mobile devices, some algorithm like SVC H.264f is used to reduce buffering during streaming and also in switching over one network to another network. Vertical Handover is carried out in order to reduce handoff by constructing MDP based algorithms using the QoS parameters such as bandwidth, delay, jitter, bit error rate and cost.

Keywords- 4G, H.264 f, MDP, jitter, bandwidth

I. INTRODUCTION

The Multi-access seamless mobility solution enables mobile operators to tie their networks, such as wireless LANs and GPRS, together. Mobile users can then move freely from one network to another without having to reconnect, change settings or lose connection at any point. Users need to stay connected while moving between networks of different access technologies. This is not easy when it comes to data sessions because during intersystem handovers, e.g. 2G↔3G the data session is terminated and resumed after the mobile station has camped on the target cell.

The 4G cellular, interworking with other broadband wireless solutions, such as WiMAX or Wi-Fi, offering converged services across different network types, and cutting the cost of delivering rich high-data-rate multimedia applications (e.g., real-time gaming or videoconferencing; streaming entertainment quality audio and video) to mobile users. Some of the more advanced cellular generations (including 2.5G and 3.5G, which are incremental improvements on 2G and 3G) are already deployed, while 4G is still evolving in standards. Recently, due to the rapid development of mobile communication technology, more and more people are attracted to enjoy video streaming services on phones and tablets while moving in the cars, buses and trains. Despite the desperate efforts of network operators to enhance the wireless link bandwidth (e.g., 3G/4G), the soaring video traffic demands from mobile users are rapidly overwhelming the wireless link capacity.

While accessing video streams via 3G/4G mobile networks, users often wait for long buffering delays (dozens of seconds) but still suffer from intermittent interruptions due to the bandwidth variation and the link fluctuation, which are caused by multi-path fading and user mobility. It is crucial to improve the Quality of Service (QoS) of mobile video streaming while utilizing the networking and computing resources efficiently.

Cloud computing techniques provide flexibly to scalable resources to content/service providers, and process offloading to mobile users. Thus, cloud data centers can easily provision for large-scale real-time video services as investigated. Several studies on mobile cloud computing technologies have proposed to generate personalized intelligent agents for servicing mobile users, e.g., Cloudlet and Stratus. This is because, in the cloud, multiple agent instances (or threads) can be maintained dynamically and efficiently depending on the time-varying user demands.

Mobile video streaming services should support a wide spectrum of mobile devices; they have different resolutions, computing powers, wireless links (like 3G and LTE) and so on. Also, the available link capacity of a mobile device may vary over time and space depending on its signal strength, other user's traffic in the same cell. Storing multiple versions (with different bit rates) of the same video content may incur high overhead in terms of storage and communication. To address this issue, the Scalable Video Coding (SVC) technique (Annex G extension) of the H.264 AVC video compression standard defines a base layer (BL) with multiple enhance layers (ELs).

Traditional video streaming techniques designed by considering relatively stable traffic links between servers and users perform poorly in mobile environments [1]. Thus the fluctuating wireless link status should be properly dealt with to provide 'tolerable" video streaming services. To address this issue, we have to adjust the video bit rate adapting to the currently time-varying available link bandwidth of each mobile user, Adaptive video streaming techniques can effectively reduce packet losses and bandwidth waste.

II. RELATED WORKS

Fragkiskos Sardis et all [1] Cloud based Media Environments with Service-Populating and QoS-Aware Mechanisms and tablets are believed to replace personal computers. It is done by mixing both the network connectivity, mobility, and software functionality. These devices are expected to seamlessly switch between different network providers using vertical handover mechanisms in order to maintain network connectivity at all times. This functionality enables the devices to access Cloud Services without interruption as users move around. Current service is about mobile devices moving from one geographical location to another will keep accessing those services from the local Cloud of their previous network, which leads to moving a large volume of data over the Internet backbone over long distances. This highlights the fact that user mobility will result in more congestion on the Internet. This degrades the Quality of Service and the Quality offered by the services in the Cloud and especially multimedia services that have very tight temporal constraints in terms of bandwidth and jitter. Different approach are required to manage resources efficiently, by improving the Quality of Service and Quality of Experience of mobile media services. The major Cloud service providers such as Amazon EC2 cloud and iCloud Apple's cloud also about the SaaS such as office 365, windows Azure of Microsoft. The author says about analytical video on demand format over cloud to access through mobile. Thus through this he says about the various challenges faced over video on demand services.

Muhammad Shiraz et all [2] Technological development in mobile device and the mobile cloud computing is one of the latest developments that had made smartphones as the future computing devices. Mobile devices have still low potential computing devices, in terms of CPU potentials, memory capacity and battery life. The best solution for alleviating this incapacitation by extending the services and resources of computational clouds to Smart Mobile Devices on demand is the Mobile Cloud Computing. The objective is to highlight issues and challenges to existing distributed application processing, implementing, and executing computational intensive mobile applications within Mobile Cloud Computing domain. Further, it investigates commonalities and deviations in such frameworks on the basis significant parameters like, migration granularity, partitioning approach, offloading scope and migration pattern.

Xiaofei Wang et all [3] proposed the system about the video streaming over the cloud, from his contribution about the cloud we can be able to know more about how to transfer video service over cloud environment by building a private cloud service the demands of video streaming services over the mobile networks have been souring over these years, the wireless link capacity cannot practically keep up with the growing traffic load. The gap between the traffic demand and the link capacity, along with time-varying link conditions, results in poor service quality of video streaming services over the mobile networks, such as intermittent disruptions and long buffering delays. Due to the rapid development of mobile communication technology, more and more people are attracted to enjoy video streaming services on phones and tablets while moving in the cars, buses and trains. Despite the desperate efforts of network operators to enhance the wireless link Bandwidth (e.g., 3G/4G), the soaring video traffic demands from mobile users are rapidly overwhelming the wireless link capacity.

- Does not consider about the vertical handover Transfers between different networks with little delay on video display.
- Only small amount of transmission has less delay.

S.Reddy Vamshidhar Reddy et all [3] says about the decision making over vertical handover in the heterogeneous network, The desired characteristic of next generation wireless communication is convergence of various heterogeneous technologies. By integrating heterogeneous technologies user will be provided high data rates, good service and connectivity. In this paper we consider the integration of wireless local area network (WLAN) in 3G network. We evaluate performance of two vertical handoff (VHO) algorithms for an integrated 3G and WLAN network. The number of handoffs and decision delay are estimated as the mobile terminal (MT) moves from the centre of 3G network base station (BS) towards the AP(access point) of WLAN with hysteresis and dwell timer approaches. We consider the log normal distribution which describes the shadow fading effect and Mapping of resources between heterogeneous networks. We consider Received signal strength (RSS) based vertical handoff taking two wireless systems in concern: 3G cellular network and WLAN. We present analytical frame work to evaluate VHO-algorithms. We propose two VHO-algorithms, hysteresis and dwell timer based handoff decision algorithms with hysteresis margin (H) =4 dB, dwell timer = 5sec. in order to reduce the number of handoffs and to avoid the ping pong effect. We consider two main performance evaluation metrics number of handoffs and handoff delay. Effect of standard deviation of shadow fading (σdB) and velocity of MT on the performance is also explicated. The author also explains the following in 3G networks, channel and time slots are allocated to a MT beforehand by its BS, so it can be assumed that the bandwidth is constant when the MT moves within hundreds of meters. In 802.11 WLAN systems, the data rate is chosen based on achievable RSS to meet a certain link quality, so the bandwidth is dynamic. Measured signal strength has three parameters namely

- Path loss
- Large-scale fluctuations (shadow fading)
- Small-scale fluctuations (multipath fading)

Multipath fading is not considered (average, low-pass filter) to avoid unnecessary handovers and no termination (hang-up) probability is considered. The author says about the Hysteresis based VHO-algorithm and Dwell timer based WHO-algorithm to evaluate vertical handoffs and decision delay for 3G and WLAN integrated network model. From his results it is clear that dwell timer will eliminate ping pong effect by reducing the effect of shadow fading, so dwell timer algorithm produced less number of handoffs and less decision delay comparing to hysteresis based algorithm. Hysteresis VHO-algorithm is suitable for abrupt decay environment. Here the author says only about the vertical handover algorithm used between the 3G and WLAN and he does not include about 4G network also clearly says about the ping pong effect and how it can be eliminated.

Tarik Taleb et all [4] says about the bandwidth Aggregation-Aware Dynamic QoS Negotiation for Real-Time Video Streaming in Wireless Networks dynamic QoS negotiation scheme that allows users to dynamically negotiate the service levels required for their traffic and to reach them through one or more wireless interfaces. Such bandwidth aggregation (BAG) scheme implies transmission of data belonging to a single application via multiple paths with different characteristics, which may result in an out-of-order delivery of data packets to the receiver and introduce additional delays for packets reordering. His QoS negotiation system aims to ensure the continuity of QoS perceived by mobile users while they are on the move between different access points, and also, a fair use of the network resources. The performance of the proposed dynamic QoS negotiation system is investigated and compared against other schemes. The obtained results demonstrate the outstanding performance of the proposed scheme as it enhances the scalability of the system and minimizes the reordering delay and the associated packet loss rate. The performance of the proposed bandwidth aggregation-aware dynamic QoS negotiation mechanism in three different parts. Firstly, we verify the applicability of the proposed mechanism to exchange users' profiles. Secondly, we demonstrate the necessity for the BAG control mechanism. Finally, we showcase the merits of the proposed TS-EDPF scheduling algorithm. To verify the effectiveness of his proposed multi-path scheduling algorithm TS-EDPF, as comparison terms, we used the three most suitable algorithms for the proposed QoS negotiation system, namely weighted round robin (WRR), weighted interleaved round robin (WIRR), and earliest delivery path first (EDPF) scheduling algorithms. WRR and WIRR are able to use the knowledge of the negotiated bandwidth through each available path for an accurate and effortless distribution of packets among them. On the other hand, the EDPF scheduling algorithm additionally makes use of the delays between the network proxy and the BSs to estimate the delivery times of packets via each available path. Proposed a new scheme that allows users to dynamically negotiate QoS profiles with different networks. The proposed scheme supports initial negotiation, renegotiation, bandwidth aggregation, and mobility. A new method to inform the QoS profile of a user to BS towards which the user is moving was presented, and its applicability was demonstrated through computer simulations. We showed that the proposed scheme achieves the shortest negotiation delays and reduces overhead in terms of both signalling messages and state information storage. The bandwidth aggregation mechanism mitigates the resource constraints in wireless networks. It helps users to negotiate their desired service levels and reach them by using one or more interfaces. Finally, an enhanced version of the EDPF scheduling algorithm was proposed to adapt it to the bandwidth allocation scheme implemented in our QoS negotiation system. We demonstrated via simulations that the proposed TS-EDPF scheduling algorithm largely mitigates the packet reordering issue and the packet loss rate.

YU ZHANG et all [5] says about that cost based method to solve the vertical handover this is also one of the best method which is used to solve the vertical handover problem which occur. Seamless mobility and transmission in heterogeneous wireless networks, a vertical handoff technique is required to guarantee an Always Best Connected. This paper thus presents a cost-based vertical handoff algorithm with combination prediction of SINR (CPSVH) in heterogeneous wireless networks to make handoff decision. Our approach involves two steps, first SINR is predicted by combining GM (1,1) and BP neural network for accurate timing to trigger handoff, and then a handoff decision on the optimal network is made by way of a cost function. The cost function, on basis of multi attribute QoS consideration, is composed of SINR, user preference, user traffic cost and available bandwidth from accessible networks, with the weight of each attribute in the cost function calculated by a fuzzy judgment matrix constructed for this purpose. Meanwhile, the stability period (defined as the waiting time before handoff) is also taken into regard to reduce unnecessary handoffs The accuracy of predictive SINR exerts great influence to handoff event, and a wrong handoff decision will be made if the SINR estimation is not accurate, yet it is difficult to achieve a higher accuracy using single prediction methods. Consequently, a combination of different single prediction methods can make full use of the information acquired by each single prediction method, reducing randomness and improving prediction accuracy significantly. In the vertical handover algorithm based on combination prediction of SINR and cost function mainly consider about only the downlink traffic that requires a higher bandwidth than the uplink traffic is considered, which suits the multimedia services in particular. Here in this they consider only about the QoS monitoring decides whether handoff even should trigger and network selection determines which candidate network should be chooses. Finally the paper is concluded about the Qos monitoring so that the mobile users can roam over various network and it does not say more about other factors.

III. SYSTEM ARCHITECTURE

A. Real Time Multimedia Streaming

Media streaming has become one of the most important part of our day to day life and even though it can be viewed through our mobile devices itself, so in order to avoid the delay in streaming the video the proposed system is used. Fig 1 shows the architecture of real-time multimedia streaming using cloud.

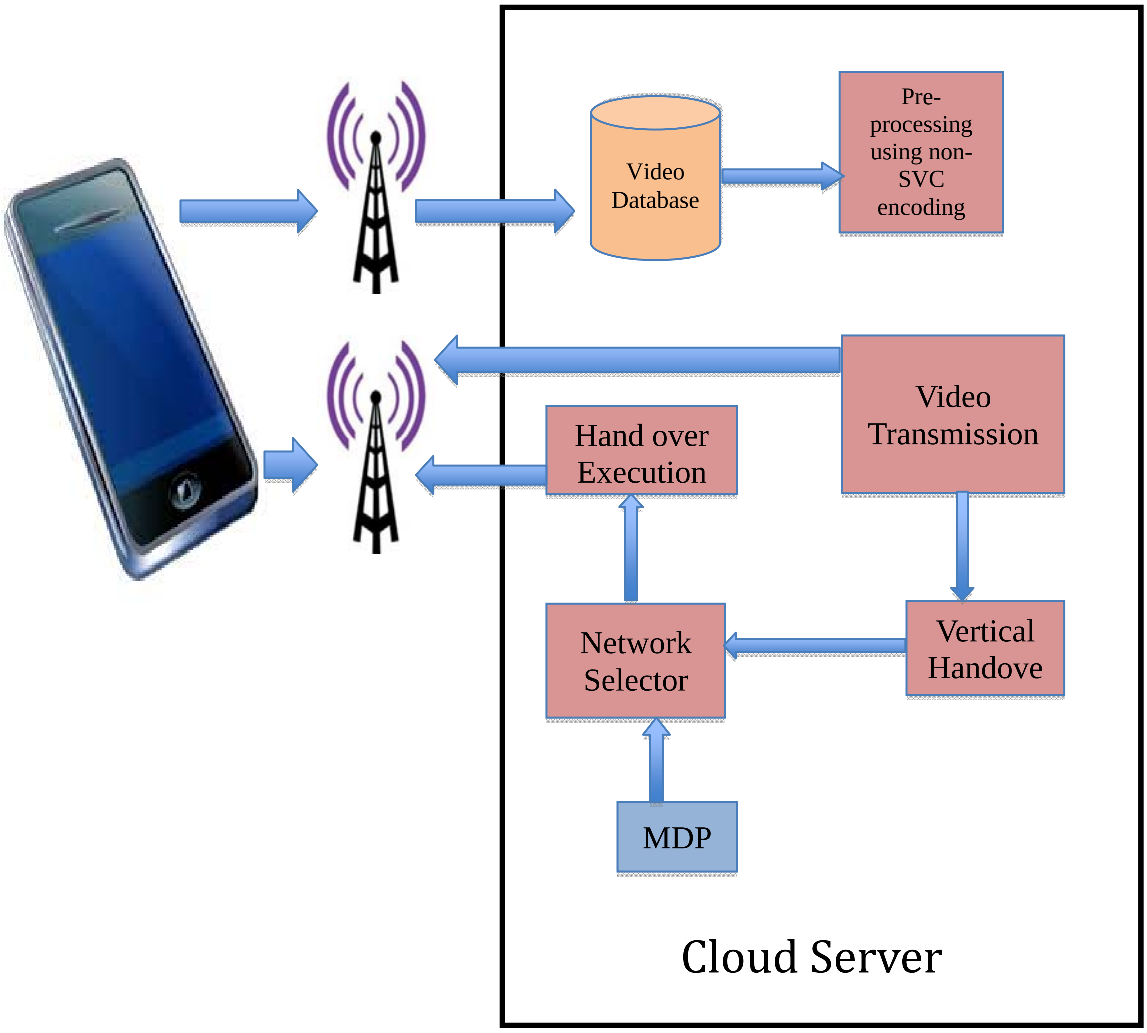

Fig. 1 Real-Time Multimedia Streaming Architecture

The mobile node request the video through Wi-Fi or 3G or 4G from the server, if the video requested by the mobile node is available in the server it is being played. If only one node is requesting the video there is no problem and if more than one user access the same video then there arises a problem in delivering the requested video to all the mobile nodes, hence occurs some delay in playing the video and the user gets annoyed. In order to reduce this new technique being employed that is the video are stored over the cloud so that if the number of video request increase the delay are being reduced.

Another main aim of this system is that when the user changes his or her network say from Wi-Fi to 3G or 3G to Wi-Fi the delay which must be reduce and the content must not load from the beginning of the video so as not to waste the time.

1) Video Database

A video database that contains all the video stored over the cloud, which is mainly used to act like a data warehouse, which contains all the video, stored so that it can satisfy the user request.

2) Preprocessing

Here preprocessing refers to adaptive video streaming of the requested video in order to satisfy the user need. Here two types of encoding methodology are done; they are non-SVC and encoding using H.264 encoding technique. Both of them are done and given access to end node.

3) Video Transmission

After the preprocessing the next step is video transmission. The video is transmitted by depending on the network which the end node may be using. The end node may use 4G, 3G, and UMTS (Universal Mobile Telecommunication System) transmission schemes.

4) Handover Execution

This is the most important part of the system, the handover execution takes place when a end user node switches form one network environment to another network environment say for 4G to Wi-Fi .

The network selector is mainly responsible for helping to find the bandwidth and everything also depends on the result of network selection only, the handover execution part takes place and gives the result to the end node.

The proposed algorithm choose the Policy Iteration algorithm and Q-Learning algorithm which is found to be more efficient in Markov Decision Process algorithm to handle the vertical handover

5) MDP

The vertical handover part is done by Markov Decision Process algorithm by calculating the following such as RSS measurement, bandwidth calculation, packet loss etc.,

6) Cloud Server

The entire process is placed over the private cloud in order to reduce the delay in accessing the video as well as to find the delay time in no minutes.

7) Adaptive Video Streaming

Adaptive Streaming Algorithm (ASA) is used in the streaming server. Streaming server controls two transmission parameters: the streaming rate and the encoding rate.

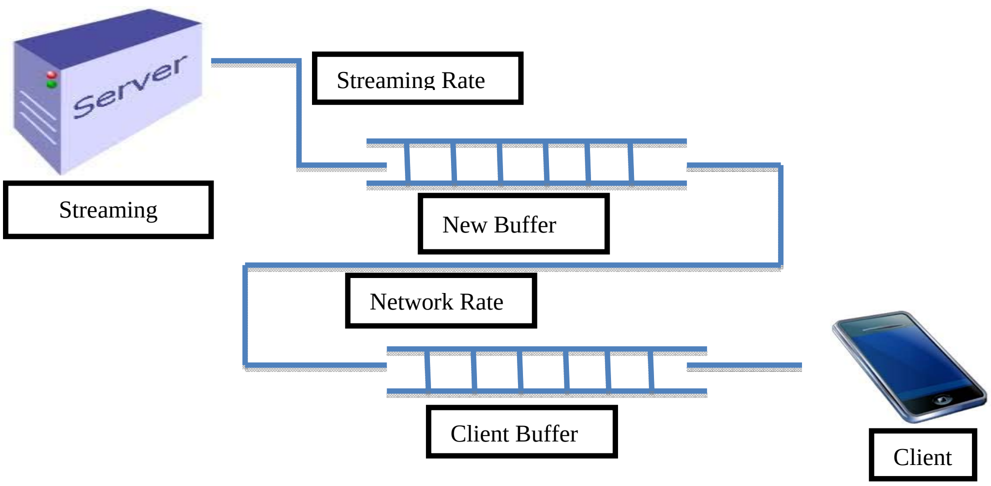

Fig.2 Adaptive Video Streaming Flow Diagram

In conventional streaming servers, these two rates are equal to each other, which mean that the video clip is streamed at the same rate as it was encoded. The equality of this rate imposes an unnecessary restriction on the system, which causes sub-optimal utilization of the network resources. In the proposed algorithm, this restriction is removed. This enables a full utilization by flexible adaptation to the network resources as shown in Fig 2.

B. Vertical handover and QoS

There are many vertical handover algorithms to handle the vertical handover here we choose the Policy Iteration algorithm and Q-Learning algorithm, which is found to be more efficient in Markov Decision Process algorithm to handle the vertical handover. Fig 3 shows the flow diagram needed for selection of video that needs handover.

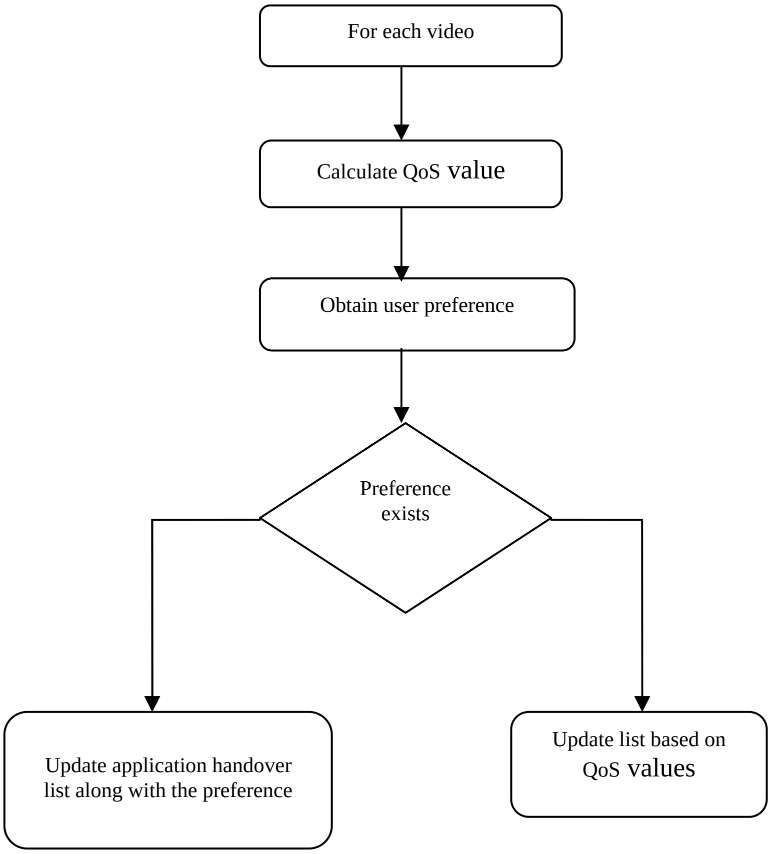

Figure 3 shows the flow diagram needed for selection of video that needs handover

The QoS value for each video is calculated based on the throughput, loss, delay and jitter received. User preference is then obtained. If user has preferred any application for handover, then the application handover list is updated with the selected application at top followed by application with lower QoS value. If no user preference exists, the video handover list is updated with video with low QoS value to high QoS value.

The following six steps explain the basic algorithm that is followed for performing the Quality of Service:

1. Discover the various networks under the coverage of the mobile Node.

2. The parameters such as Throughput (B), jitter (J), delay (D), loss (L) and Preference (Peff) are considered.

3. Threshold (th) values for the different parameters are set.

4. Consider the QDS function, defined below

1) Quality Decision Score (QDS) metric

QDS (Quality Decision Score) is described by the function given in Equation (3.1) and is dependent on the characteristics of the communication channel.

$$\text{QDS} = QoS^{i}_{grade} + QoE^{i}_{grade} \tag{1}$$

Where $QoS^{i}_{grade}$the Quality of Service is grade for network i and QoE^{i}_{grade} is the Quality of Experience grade for network i.

2) Network Quality of Service Grade

$$QoS_{grade} = \text{w1} * Throughput^{i}_{grade} + \text{w2} * Loss^{i}_{grade} + \text{w3} * Delay^{i}_{grade} + \text{w4} * Jitter^{i}_{grade} + \text{w5} * Peff^{i}_{grade} + \text{w6} * \text{Velocity} \tag{2}$$

$$Throughput^{i}_{grade} = {(maxgrade * Throughput^{i}_{t})}/{RcdRate} \tag{3}$$

Equation (3) represents the throughput received by the communication channel in the time interval.

$$Loss^{i}_{grade} = {maxgrade}\Big/{1 + ({lossrate^{i}_{t}}/{maxlossrate_{t}})^{QL}} \tag{4}$$

$$\text{Loss rate} = \frac{loss_t^i}{Recdrate * Rateshare^i} \quad (5)$$

Equation (5) represents the average loss recorded by the client on communication channel in the time interval and is expressed in Mbps. Equation (4) represents the loss as a fraction of the total data rate transported by channel. The maxloss rate represents the maximum allowed loss expressed as a fraction of the received rate.

$$Delay_{grade}^i = \frac{maxgrade}{(1 + (\frac{delay_t^i}{DThreshold})^{QD}} \quad (6)$$

$$Jitter_{grade}^i = \frac{maxgrade}{(1 + (\frac{Jitter_t^i}{JThreshold})^{QJ}} \quad (7)$$

Equation (6) and (7) represent the average delay and jitter measured by the client on communication channel during the time interval t. DThreshold and JThreshold are thresholds specified by the application and represent the maximum delay and jitter accepted while still preserving a minimum quality.

$$Peff_{grade}^i = \frac{maxgrade}{e^{PMb*P}} \quad (8)$$

Equation (8) represents the energy efficiency score of communication channel with respect to the MN power usage.

The components of QoS_{grade} are also weighted to offer maximum flexibility to meet the different requirements. For accurate results weights normalization is required, so the condition given below needs to be respected

$$\sum w_i = 1 \quad (9)$$

3) User's Perceived Quality Grade

$$QoE_{grade}^i = QoE_{overall} * Rateshare^i \quad (10)$$

5. Find the cost offered by each network available.

6. Optimal Solution

The optimal solution is the one, which bids low cost and high QDS grade.

IV. IMPLEMENTATION AND RESULT

There are three major operations in Real-time video streaming they are client video request, network selection and vertical handover decision. The process starts with the video request to the cloud database and then the search is being made for the request, if the requested video is found then it streamed back to the user, this streaming is done by using adaptive video streaming algorithm as the result it uses the H.264 encoding technique to stream the video to the user end mobile device.

The implementation of Real-Time Video Streaming over cloud in 4G heterogeneous network vertical handover is done by using MATLAB. It includes the various QoS parameter calculation and graph plots. Cloud deployment and synthesis is carried out using Eucalyptus which is an open source private cloud software for building private and hybrid clouds that are compatible with AWS APIs. With AWS-compatibility, the open source software pools together existing virtualized infrastructure to create private or hybrid cloud resources for compute, network, and storage.

A. Vertical Handover - Test Cases

TABLE 1, 2, 3 shows the test cases that are being used over the system in order to calculate the various QoS parameters are described.

TABLE 1. Offered QoS parameters of WiFi, WiMax and LTE

Network	**Throughput (Mbps)**	**Loss (Mbps)**	**Delay (msec)**	**Jitter (msec)**	**Power (J)**	**Velocity (m/s)**
WiFi	10	200	160	200	137	10
WiMAX	12	140	120	150	68	20
LTE	18	110	100	100	52	60

TABLE 2. Cost by each network

WiFi	**WiMAX**	**LTE**
0.2	0.4	0.6

TABLE 3. Threshold parameters

DThreshold	**JThreshold**
100	50

Based on the above given values, each Network (WiFi, WiMAX and LTE) bid its QDS value for the MN. The optimal is then chosen.

1) Video Streaming – Qos List

The QOS parameters of conversational and streaming are calculated and it is described in TABLE 4.

TABLE 4. QOS parameters of conversational and streaming

Parameter	**Throughput (Mbps)**	**Loss (Mbps)**	**Delay (msec)**	**Jitter (msec)**
Conversational	30	200	150	60
Streaming	45	500	250	120

B. Performance Analyses of Real-Time Multimedia Streaming

1) Bandwidth Calculation

Fig 4 shows how the bandwidth is being estimated also the graph between the data transfer and time.

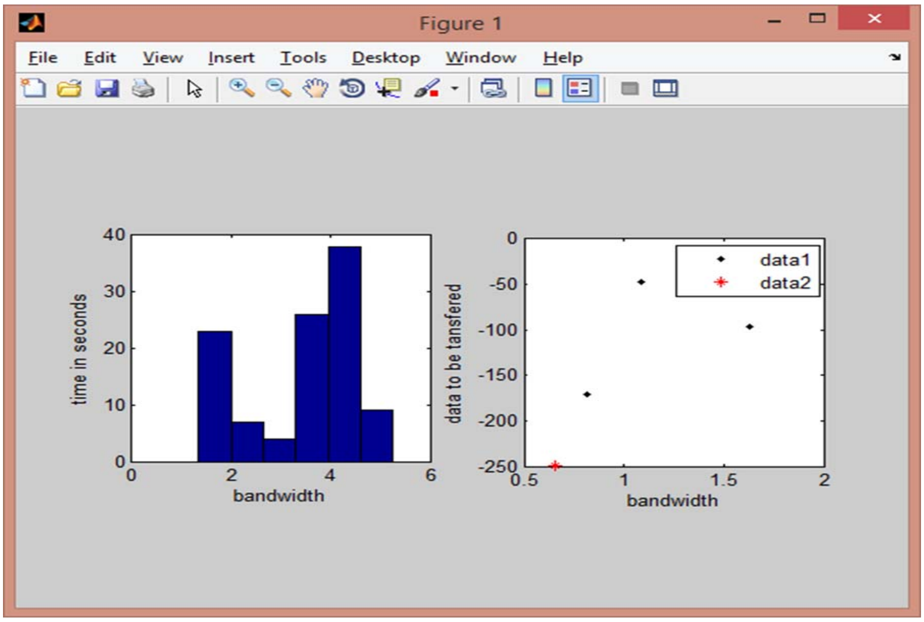

Fig 4. Vertical Handover Calculation Bandwidth Graph

2) Jitter value Calculation

Fig 5 shows Jitter value Calculation.

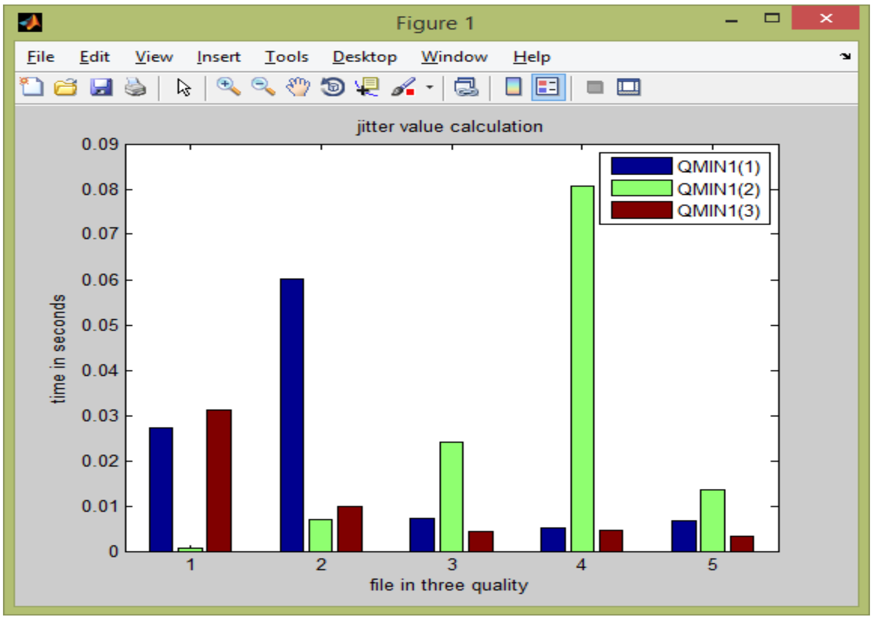

Fig 5. Jitter and loss calculation graph

3) Throughput Vs Throughput Grade

Fig 6 shows the graph between Throughput and throughput grade of each network (WiFi, WiMAX and LTE). It can be inferred from the graph that throughput grade of LTE is better than that of WiFi and WiMAX.

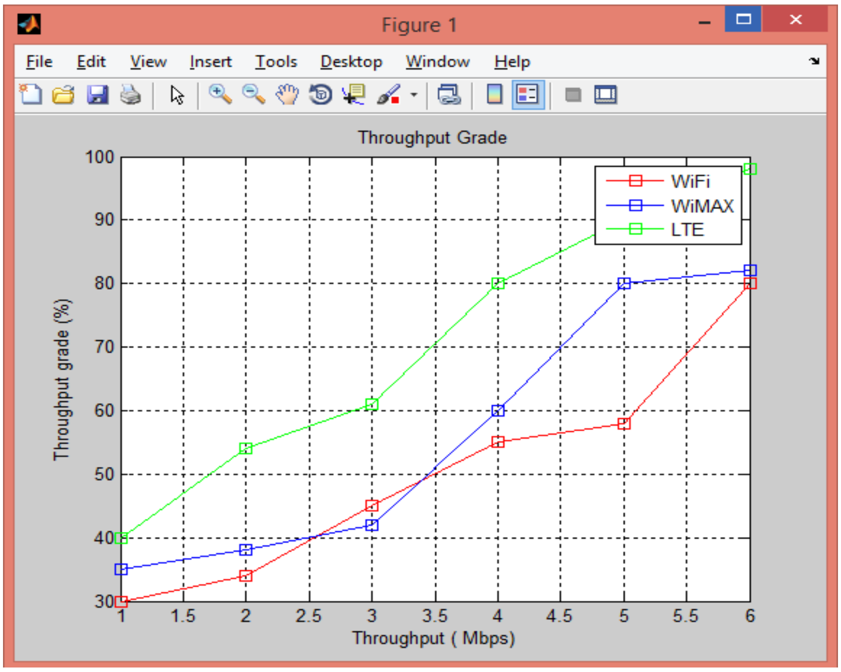

Fig 6. Throughput Vs throughput grade

V. CONCLUSION

Our work on calculating the bandwidth estimation and the jitter value for real-time video streaming over cloud and vertical handover has been implemented successfully. As a result, when moving from one network to another network it would be easy for the end user to check the quality of the video and delay during playing the video. Our future work is to improve all the parameters more to increase the video quality.

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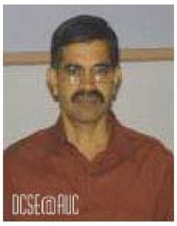

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