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Research Article

The Impact of QoS on Stored Video Streaming Over a Heterogeneous Network

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ABSTRACT

Most of the mobile devices have been supported by the multiple wireless technologies that were in vogue. Majority of the mobile users while traveling within the different networks are anticipating an uninterrupted audio/video streaming facility. The heterogeneous network has come across with the vertical handoff (VHO) owing to the mobility of devices in various networking coverage environments. It is difficult job to provide a continuous online video streaming i.e., service continuity throughout handoffs. We have assessed handoff by making use of cross-layer (MIH) framework for smooth mobility. We have streamed both the stored video and data, and assessed the effect of Quality of Service (QoS) by an objective method of video quality assessment metrics, like data metrics and picture metrics.

Keywords: Vertical handoff, MIH, QoS.

I. Introduction

Now a days, the demand for a heterogeneous networking with built-in access technologies to bolster mobile networks has grown manifold. Mobile devices that support multiple wireless technologies have been favoured and now dominating in the market includes smart phones, notebooks, laptops, etc. The above referred devices could synchronize Wi-Fi besides cellular.

Majority of the telecommunication system have been supporting the vital application of video streaming in a multimedia traffic environment. With this growing deployment of quality of the ongoing video sessions throughout seamless handoff is a problem to be dealt with. One more defiance in heterogeneous network is vertical handoff prerequisite. VHO is to switch mobile nodes among different types of wireless networks.

Following the VHO metric and network selection, handoff occurred, resulting in the transmission of streaming videos to the target network. So, a viable proposal is to apply a MIH procedure standardized by the IEEE with 802.21 specifications. MIH is the most effective technique in the heterogeneous networking environment. This paper enumerates a MIH based VHO that aims at maintaining the QoS for multimedia services in Cellular and WIFI networks.

Video quality assessment has received a great attention within research community for evaluating different algorithms and methods for compression and transmission of digital video. The aim of objective method of research in a video quality assessment is meant to design metrics that predicts the quality of video.

Sections from II to VII in this article deals with MIH, streaming, containers and codecs, simulation setup overview, simulation results and conclusion respectively.

II. MEDIA INDEPENDENT HANDOVER

The Heterogeneous network under the MIH proclaimed the framework and a mechanism to empower the handoff. Corresponding networks encompases of wired, wireless, 802 and cellular networks. With a standard link layer communication and with associated networks information, handover optimization will be achieved with upper layer, under this MIH model.

MIH stipulates three types of services for expediating the vertical handoff. These services include MIES, MICS and MIIS. The module that implemented the above services are called the MIHF function. The MIHF function can be either situated on a mobile node or on a network side. MIH users are objects that accept MIHF services.

The Event Services (ES) stipulates dynamic information on link characteristics akin link status, and link quality. This (ES) is classified into two types: link event, MIH event. Link events commence at the lower layer (L2 or lower) and propagate to MIHF. The MIH event is encompassing with the upper layer (higher than L3) in MIHF. Examples of MIES were Link_Up, Link_Down, Link_Going_Down, Link_Detected, and so on.

The Command Service (CS) essentially allows MIH users to accomplish and control link actions associated with handover and mobility. Commands may pass on from an upper layer to a lower layer. Like the (ES), there would be linked commands and MIH commands. Examples of MICS were Link_Action, HO_Commit, and others rest on network search, operator policy.

Information services (IS) enable network operators to select better networks with policy and network information. The MIIS specify MIH information server along with a list of neighboring networks, access networking information, and so on.

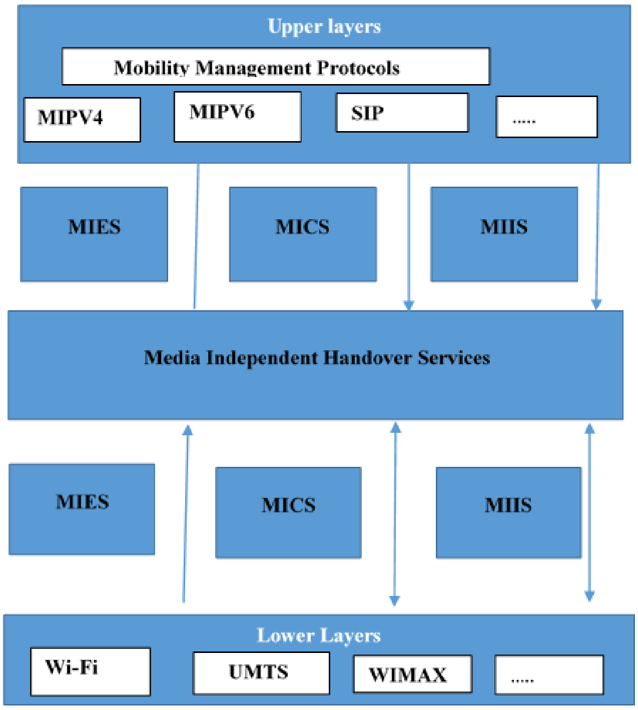


Fig: - MIH

III. STREAMING

Streaming of video insists user to glance video clips stored in a server without downloading the entire file. Media could be accumulated in the cloud on a computer, a media server, or a network storage device (NAS) in our home network. The Network media players or media streaming devices could ingress and play those files. We do not have to move or copy files to a device that plays a file. Similarly, the video that we request to play can come from online websites.

Video sites like Netflix and Viu, Dailymotion, Vimeo and music sites like Pandora, Tunein, Google play are examples of websites that stream movies and music to computers by networked media players that streams video. Streaming is stratified into two types: 1. On-demand /stored 2. live.

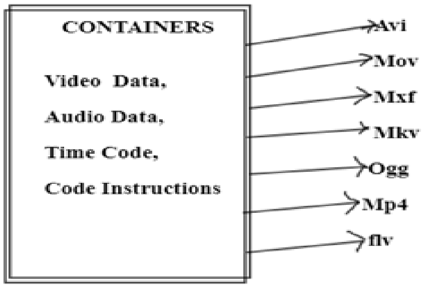
Whenever viewer wishes to see the video on-demand the same would be transmitted immediately from the server. During broadcasting time live streams were available to look at, E.g. IPL matches.

IV. Case Study

The Indian government chose 5G this year, and implementation will take some time to reach the country's rural and urban areas. During this movement, there is a vertical handoff issue as well as some streaming video issues. Observe below fig, the UE 2 interfaces (cellular and WiFi) are active during mobility.

V. Overview of video compression and video coding standard

Containers are used merely to group all audio, video and codec files into an organized package. In addition to, the container generally encompasses of chapter information for DVD or Blu-ray movies, subtitles, metadata and/or additional audio files for distinctive spoken languages. Containers use the .bat files to indicates the operating system (OS) that there are executable commands to be executed together to achieve the desire result. E.g. MKV, Flash Video (.flv, .swf). In this paper we are taking MP4 contanier for transmitting video. MP4 container utilizes H.264 for encoding into AAC or AC3 for audio.



Codec

A codec is an encoding tool for processing video (or encoder / decoder) and storing it in a "byte stream". In this paper we are considering H.264 codec for encoding/decoding video. Either Loss or Lossless compression algorithms was make use in H.264 codec.

Loss compression algorithm differentiates between quality loss and files size of a video. After compression or decompression the status of a file will not be changed under lossless compression algorithm.

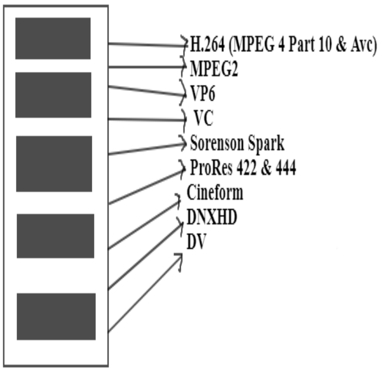


Fig: - Popular Codecs

The video codecs comprise of' 'Intra coded-I', 'Predictive coded-P' and 'Bi predictive coded-B' frame structures in Group of Pictures (GOP). Depending upon the transmission error, the type of frame loss decides the number of other frames affected, results in length of the loss to video.

VI. Simulation set up overview

6.1 *Streaming stored video*

We streamed a YouTube's stored video namely, 'Heidi, Girl of the Alps' video, in our simulation [3],[4]. Transmutation of a input video file as YUV 4:2:0 format. YUV is a video data format that determines the association of Y, U and V components for each pixel. Predominantly this data is stored in a MP4 container. It shows the luminance by the appraise of Y and color (chromaticity) by the appraise of U and V. Pixel size format of CIF used in mobile devices. Number of frames are 1102.

NS-2 cannot be simulated video file directly. As a result, we use the EvalVids framework and toolkit to perform an integrated assessment of video transmission quality.

6.2 *A video trace is produced by following these steps*

Convert the stored video into YUV, by using the following command

$ ffmpeg -i Heidioriginal.mp4 -f rawvideo -vcodec rawvideo -pix_fmt yuv420p -s 1902x1080 Heidi_cif.yuv

Converting to YUV and resizing video by using the following command

$ ffmpeg -i Heidioriginal.mp4 -f rawvideo -vcodec rawvideo -pix_fmt yuv420p -s 352x288 Heidi_cif2.yuv

Using mplayer to play YUV: We must specify the frame size and pixel format because this information does not appear in the file to play the raw video correctly.

$ mplayer Heidi_cif2.yuv -demuxer rawvideo -rawvideo w=352:h=288: format=i420

H.264 creates compressed raw videos with 15 frames per second, a GOP length of 15 frames

$ x264 -I 30 -B 64 --fps 15 -o a03.264 --input-res 352x288 Heidi_cif2.yuv

MP4-Container

$ MP4Box -hint -mtu 1024 -fps 15 -add a03.264 a03.mp4

Create a reference video: With the help of reference video the quality of the video can be assessed.

$ ***ffmpeg -i a03.mp4 a03_ref.yuv***

The mp4trace tool from EvalVid can transmit the intended mp4 file to UDP to the specified target node.

$ ***./mp4trace -f -s 224.1.2.3 12346 a03.mp4 >Heidi.***

It sends the H.264 track from a03.mp4 to UDP port 12346 on host 224.1.2.3. The output of the mp4trace will be required later, so it is readdressed to a file namely 'Heidi'.

$ ns video.tcl. NS-2 generates two files (i.e 'Send_time_file' and 'Recv_time_file') after simulation that records the transmission and the receiving time of a packet.

The video and trace files are filtered by etmp4 to restore the transmission video as seen by the receiver.

*$. /****etmp4 -f -o -c sender receiver Heidi a03.mp4 Heidi_cif_recv.mp4***

The created video deletes all lost and corrupted frames from the original video track.

VII. SIMULATION RESULTS

NS2 with NIST's IEEE 802.21 module are applied to simulate and analyse video streaming performance throughout handoff. MN's are configured to make use of interfaces like cellular, WiFi, Ethernet. Video traffic is sent in between the server and MultiFace node. When the simulation starts, it will first communicate with the server through the cellular base station as depicted in this figure.

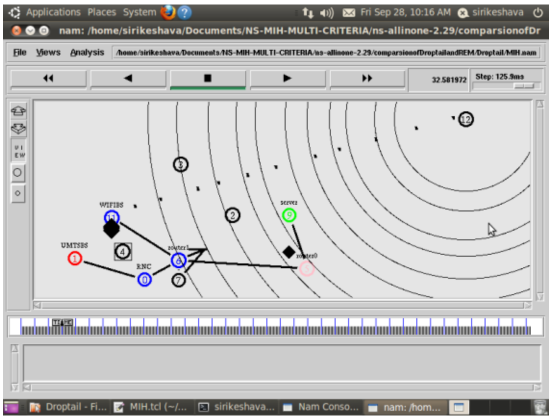


Fig: Heterogeneous Network

After 10 seconds, MT moves through APs with a speed of 1 meter per second to the destination point. When the MT moves towards WLAN access point, it received the beacon signal which was forwarded by the AP. The RcvAgent in MT obtains the AP information, sends it to the calculation module for the next stages of handoff. We use MIH and utility based algorithm to compare the handover results. The simulation is accomplished for a period of 500 sec. The simulation topology was depicted in this Figure, with an overlapped communication area. The bandwidth, propagation delay of wired links was 100Mbps, 15ms respectively. The bandwidths and Transmission Time Intervals (TTIs) of cellular for both uplink and downlink were 384mbps and 10ms, respectively and the bandwidth of a Wi-Fi link is 60Mbps.

In the MIH handoff scheme, the handover module is set to WLAN as the preferred candidate network. If L2 discovers signals from WLAN AP, then it triggers the link detect event and sends it to the MIHF function. The handoff module chooses the change of access network from cellular to WLAN. The movement of the MT has a significant impact on the simulation of video streaming results.

Video quality evolution plays an important role in all aspects of video processing, such as video transmission, video compression and video blurring, etc. Subjective and objective methods are used to appraise quality of the video. The video quality test with human observers is acknowledged as a subjective method as it evaluates video quality to greater precision. But the goal is to develop objective methods, since subjective methods were time-consuming and expensive compared with objective methods that can quickly confirms by attempting to access the status of video.

Objective methods can be cleaved as three types:

- Full reference (FR) method- In this method we will take entire video into consideration and compares the processed video with 'original' video.
- Reduced-reference (RR) method- In this method we will take some features of original video besides suitable information sent from the server side then we will compare the reduced information from 'original' video with the 'processed' video information.
- No-reference (NR) method -In this method we will not take the 'original' video but explore for relevant aspects under bitstream based approach.

7.1 PERFORMANCE OF OBJECTIVE VQA Metrics:

We have ascertained the subsequent objective VQA metrics with data metrics, picture of metrics.

7.1.1 *Data Metrics*:

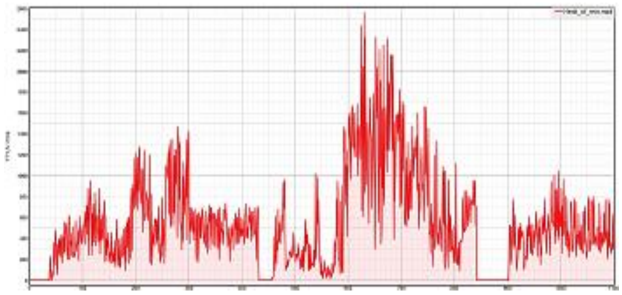
7.1.1.1 *Mean Squared Error (MSE)*

Mean square error is the objective method of measuring status of video, but it is still widely used, irrespective of its drawbacks. The staple drawback is that the predictable human visual system (HVS) is pensive in MSE model. But this is a very simple measurement to estimate. MSE is an error in between the 'original ' and 'processed' video. MSE uses 'Full reference (FR)' functionality.

Fig: MSE video quality assessment

$$\textbf{MSE} = \frac{1}{N*M}\sum_{i=0}^{N-1}\sum_{j=0}^{M-1}[X(i,j) - Y(i,j)]^2$$

From the above equation, let X and Y denote two arrays of size N × M, X represents reference frames and Y represents frames of encoded/damaged frames, respectively.



The above graph explains that, If Y is similar to X, MSE is small. We will come to know the Similarity when MSE is zero.

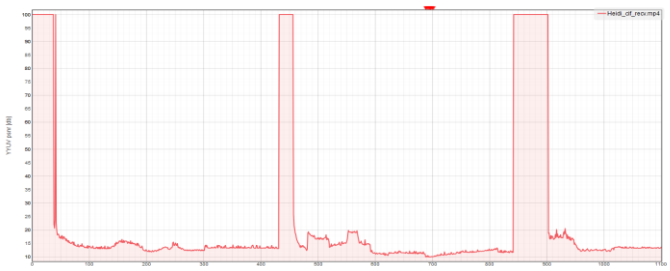
7.1.1.2 *Peak Signal Noise Ratio*

The Mean square error function is used to derive PSNR. The 'original' and 'processed' video provides a baseline for objective VQA. Full reference (FR) method is used in PSNR to arrive at the required results.

Fig: PSNR Video Quality Assessment

$$\textbf{PSNR}=10\ \log_{10}\frac{L^2}{MSE}$$

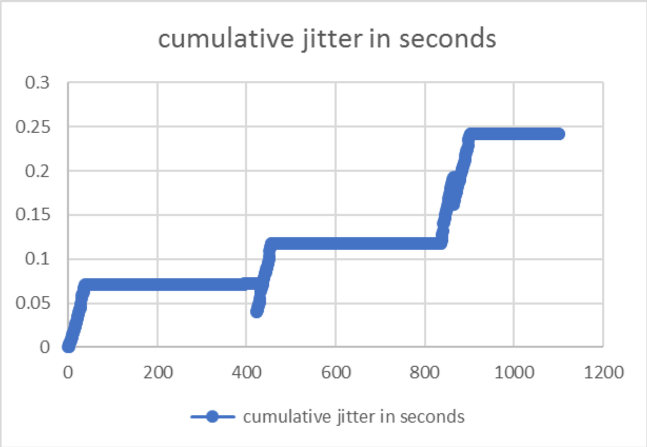
Decibels results have been obtained with the above formula, then a small mean square error results in high peak signal noise ratio. When MSE is zero, the PSNR is infinite.



In the above graph the similarity is accomplished when PSNR value is 100.

7.1.1.3 *Cumulative inter-frame jitter:*

Cumulative interframe jitter was applied to figure out the amount of playback delay avert frame drops (I, P, B) throughout streaming of video with the user concerned.



7.1.2 *Picture of Metrics:*

7.1.2.1 *SSIM Index:*

SSIM index rested upon the progress of three segments namely brightness, contrast and structural similarities and combines them in value results. SSIM uses the full reference feature (FR). In SSIM figure, the bright areas corresponds to greater differences.

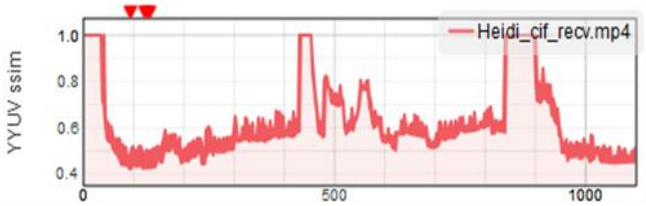
Fig: SSIM Index

The SSIM metric has two constants. They rely on the maximum value of the image colour component. It is computed by the consequent equations:

C1 =0.01*0.01*video1 Max * video 2 Max

C2= 0.03 *0.03* video1 Max* video2 Max

Where video1Max is the utmost value of this color component for the first video, for second video the video2Max is the utmost value for the color component.



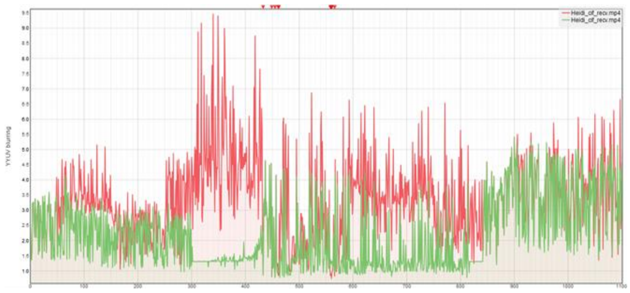
Higher values in the graph above are better, and 1 indicate that similarity of videos is determined.

7.1.3 *Bitstream metrics:*

7.1.3.1 Blurring:

We can use this metric to compare the blur effects of both videos. The blurring function uses the NR function (two files are required for measurement visualization).

Fig: Blurring



The above graph represents the metric value of original video is more than the processed one, indicating that of the processed video is blurry than the original one.

VIII. CONCLUSION

An integrated environment tool has been utilised to evaluate the performance of streaming H.264 video over cellular, WiFi, Ethernet networks. The quality of video was determined with data metrics, picture metrics and bitstream metrics. There is an inverse relation within PSNR and MSE to measure the video quality. The average PSNR value for Heidi video streaming is 14.43 dB, indicating poor quality and the average MSE is 533.83 dB. The PSNR values could be predicted by SSIM and vice versa. PSNR and SSIM are basically differ in the degree of sensitivity to the video degeneration. The average SSIM of Heidi video streaming is 0.91. Both PSNR and SSIM have a similarity and degree of sensitivity to the blur effect to be improved. Video quality was degraded due to increase in the cumulative inter-frame jitter throughout handoff, which must be reduced. The loss percentage of I,P frames are huge, because of congestion that should be reduced in future. More observation is needed to bitstream metrics for its development in the near future.

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