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# A PCA based QoE model of HTTP smooth streaming for IPTV network

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***Abstract*— Recently, there has been a global trend among the telecommunication industry on the rapid deployment of IPTV (Internet Protocol Television) infrastructure and services. For IPTV video data transfer, most appropriate method is HTTP adaptive streaming. And also user perspective, service provider need to focus on QoE of their product. Network providers can evaluate subscriber's QoE using server logs some analyzed values derived which is from the proposed model, and control QoE as deduce parameters(missing fragment rate, Quality drop rate etc) associated with QoE. We will explore the possibility of utilizing server logs of video smooth streaming to find the QoE of IPTV network purposes including troubleshooting and performance evaluation, and also the user likability of the services.**

***Keywords- IPTV, QoE, Principal Component Analysis, HTTP smooth Streaming***

## I. INTRODUCTION

Everyone is expanding towards an "everything over Internet Protocol (IP)" world, Cisco appraises that device's quality joined with IP systems will be twice as high as the worldwide populace in 2015 [4]. As of late, there has been a worldwide pattern among the telecom business on the fast organization of IPTV (Internet Protocol Television) framework and Services. These IPTV administrations incorporate feature on interest (VoD), triple play, voice over IP (VoIP), and Web/email access, which are extended from conventional HQ TV administrations.

The working of IPTV is similar to video streaming concept. Live TV videos chunks are encoded into IP packets and delivered to users via the home area broadband access network and set-top boxes (STB). Video streaming allows people to access video content over the Internet [1]. There is understanding among expanding industry and academic institutes that enhancing clients' quality of experience (QoE) is crucial to maintain these income models, particularly as client desires of video quality are relentlessly rising.

Dynamic HTTP video streaming is a prevalent approach to convey video substance to clients. The profits of HTTP segment streaming incorporate its versatility, scalability, high performance and easy deployment, particularly the likelihood to reuse the officially deployed HTTP infrastructure. Consumers are not concerned with traffic priority and dropped packets: they want their device to be clear and their IPTV programs to be smooth and free from visual impairments. From this perspective, it is the users' opinion that really matters [1].

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There is an inconceivable measure of both client produced and professional video content accessible, and OTT video together with IPTV speaks to another method for sitting in front of the TV Users can now decide to watch their most favorite videos paying regardless of time and place, and on most devices. Keeping the goal of accomplishing good level of QoE, different OTT service providers do utilization inventive streaming video solutions. Some QoE models are restricted to numbers of subscribers, so increasing numbers of subscribers' is bottleneck for models.

The objective is to utilize the likelihood of using HTTP Adaptive streaming logs in the IPTV by discovering the QoE to serve Network administration, execution assessment and client satisfaction. Specifically, we break down CDN Server Logs and for smooth streaming and finishing up the QoE parameters and utilizing them to figure out last QoE Index as one. We clarify our commitments in points of interest as takes after.

## II. RELATED WORK

### A. *Factors of QoE Assessment*

Every service of multimedia with characterized utilization situation is emphatically controlled by the context. Besides, the subjective view of individual users is unequivocally affected [7]. The context of interactive media services comprises of three principle components: technical system, environment and media content.

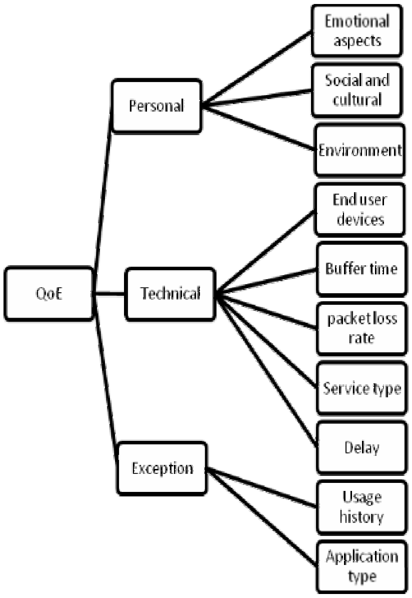


Figure 1. Different factors correlated to QoE.

### B. QoE Measurement Approaches

There are two major approaches for QoE assessment which are proper rally identical for industry research groups, commonly referred as Content-based Measurement and Network-based Measurement. The approaches of objective and subjective content inspection measurement are necessary to find distortions that can occur at any stage in multimedia delivery.

In subjective assessment, one test is performed on users. Numbers of persons are usually asked to see a set of video contents and rate those videos based on what they have seen and experienced. The rating is calculated in accordance with the Mean Opinion Score (MOS), which generated from a subject which evaluates if the video quality is poor, average, or good [5]. Because of social contrasts in understanding, results from subjective experiments are not illustrative. Also, due to cultural differences in interpretation, results from subjective experiments are not internationally representative [6].

From the perspective of input data into a model, target quality assessment models can be arranged as takes after: Full-reference (FR) models, No-reference (NR) models, Reduced-reference (RR) model. Numerous choices have been proposed in regards to classification of systems for video assessment there is more nonexclusive arrangement, which considers the video quality assessment methods as well as different classes of measurements not specifically identified with saw video quality. The two distinct sorts of measurements are, i) Direct Matrices, and ii) Indirect Matrices.

Direct metrics consider factors that directly affect video quality. Direct metrics are gotten from different sorts of information identified with network parameters, for example, delay varieties or packet (frame) drops related with system execution Peak Signal to Noise Ratio (PSNR), Structural Similarity index (SSIM) and Video Quality Metric (VQM), and codec data as dictated by the application as Mean Opinion Score (MOS).

Indirect metrics cons ider factors that affect the multimedia experience, but that are not directly related to the quality of the multimedia content. Here the focus has been clearly centered in the network performance and in direct metrics assessment. All things considered, as the multimedia applications keep on extending; this research area will turn out to be all the more engaging sooner rather than later.

Indirect metrics consider variables that influence the media experience, yet that are not specifically identified with the quality of content of video. It is detectable that indirect metrics have not been considered in subtle element in the networking background, where the center has been obviously focused in the system execution and in direct metrics assessment. Originality, Engagement time, Start-up time typed matrices are used as indirect impact on network. All things considered, as the multimedia applications keep on extending; this research area will turn out to be all the more engaging sooner rather than later.

## III. THE QOS PARAMETERS ANALYSIS RELATED TO ENDUSER EXPERIENCE

In adaptive streaming, service provider always tries to improve client controller, i.e., on optimizing the representation selection for each user. The controller behavior is generally driven by an estimate of the network dynamics and on the state of the client buffer. The general objective is to maximize the Quality of Experience (QoE) for the users while avoiding unnecessary quality fluctuations.

Here we have used the Microsoft implementation for delivering a video Smooth Streaming as a content provider, We are going to encode on-demand and live Smooth Streaming video using Microsoft Expression Encoder. As a content provider, one can use IIS Media Services to serve the encoded Smooth Streams. And as a content consumer (client), you can play the Smooth Streams video content using compatible client software, such as Microsoft Silverlight. At the starting stage, we are taking input as smooth streaming server logs as given format in table 1. Then process the log files and create the user session by sorting mechanism based on three parameters: Client IP, URL and Timestamp.

As per Smooth Streaming (Microsoft) technology, a video chunk of every 2 seconds is delivered to the client (Video Player on Browser) over the HTTP. The details of related to quality/video resolution as well as the information of fragment (fragment start time) would be logged along with the URL. That means from URL we can get some of the important information like,

1. Quality Level value and fluctuation in the Quality Levels (up/down)
2. Information related to the Throughput
3. Information related to Buffering Time during the user session

Identify applicable sponsor/s here. *(sponsors)*

4. Information related to Missing Fragments during video session for Audio and Video

TABLE 1. SMOOTH STREAMING SERVER LOG FORMAT FOR REGULAR HTTP DELIVERY

| Field | Description | Example |
|---|---|---|
| Current-Time | Time at which the Request was received | [20/Feb/2012:00:29.510+0200] |
| Client-IP | IP address of the requesting client | 103.0.153.4 |
| Server-IP | IP address of the Server | 127.0.0.1 |
| s-contentpath | Server Content Path where Data is physically stored | C:\inetpub\wwwroot\DespicableMe\DespicableMe.ism |
| sc-status | HTTP Status Code | 200, 404, ... |
| | URL of content which contains<br>• Service Engine<br>• Content Type (Video or Audio)<br>• Quality Levels<br>• Fragment Start Time | /DespicableMe/DespicableMe.ism QualityLevels(1700000)&Fragments(video=434183750) |
| sc-bytes | Byte transferred from server to client | 53915 (Bytes) |
| cs-bytes | Byte transferred from client to server | 370 (Bytes) |
| TimeTaken MS | Time taken for Actual Data Transferred | 21 (milliseconds) |

From above information, we derived 7 QoE Parameters those describe below:

1. *Quality Level Drop Rate (Video) QLDr* :

Quality Level Drop QL: It's the event where the encoded bit rate Quality Level drops from higher to lower

Quality Level Drop Rate: Quality Level Drop Rate is the Rate achieved by dividing total number of QL Drops by the total number of Fragments.

$$\text{Video QLD}_r = \frac{\sum QL}{\sum Fr} \quad . \tag{1}$$

2. *Missing FR Rate (Audio/Video) MFr:* Missing FR Rate is Rate achieved by dividing numbers of missing fragments and Total numbers of Fragments during Session. It can be calculated for audio and video fragments separately.

$$\text{Audio MF}_r = \frac{\sum FR}{\sum Fr} \tag{2}$$

$$\text{Video MF}_r = \frac{\sum FR}{\sum Fr} \tag{3}$$

3. *Throughput Below Avg Rate (Audio/Video) TbAr:*

Throughput Th: It is total number of bytes transferred per milliseconds per fragment

$$\text{Th} = \frac{Bytes/MilliSec}{Fr} \tag{4}$$

*Average Throughput:* It is defined as Total bytes transferred during session / total time taken in milliseconds for it.

$$\text{Th}_{avg} = \frac{\sum Bytes}{\sum MilliSec} \tag{5}$$

Throughput Below Avg Rate: Throughput Below Avg Rate is calculated by dividing total numbers of fragments which have Throughput Below Avg and total number of Fragments.

$$\text{TbA}_r = \frac{\sum FrwithThavg}{\sum Fr} \tag{6}$$

4. *Buffering Rate (Audio/Video) BFr:* It is the Rate achieved by dividing the Engagement Delta by Engagement Time.

$$\text{BF}_r = (\Delta E / Ea) \tag{7}$$

Engagement Time: It is the time obtained by subtracting the timestamp of the first record from the timestamp of the last record. This time can be referred as the actual time taken by the user to view the content

$$Ea = Et_{last} - Et_{first} \tag{8}$$

Video Duration Ed: It is the time obtained by subtracting the Fragment Start Time, extracted from the fragment information in the URL (which is generally observed as 2 seconds for the smooth streaming logs), of the first record from the Fragment Start Time of the last record for the Video fragments

$$\text{Video Ed} = EF_{r\ last} - EF_{r\ first} \tag{9}$$

Audio Duration: It is the time obtained by subtracting the Fragment Start Time, extracted from the fragment information in the URL (which is generally observed as 2 seconds for the smooth streaming logs), of the first record from the Fragment Start Time of the last record for the Audio fragments

$$\text{Audio Ed} = EF_{r\ last} - EF_{r\ first} \tag{10}$$

*Engagement Delta:* Buffering Duration is the difference of time achieved by subtracting the minimum of the Engagement Time or the Video duration from the Engagement Time. So if

Video Duration > = Engagement Time, the Buffering Duration will be 0.

$$\Delta E = (Ea - \min (E \quad , Ed)) \tag{11}$$

Experience Score/Quality of Experience (QoE): QoE score is the statistic that describes the user experience while watching the video based on quality of the video played on user's browser.

## IV. PROPOSED MODEL

Dimension reduction is a fundamental phase in the powerful analysis of large amount of high-dimensional data sets. It might be the principle target in the analysis for perception of the high-dimensional data or it might be a middle step that empowers some different investigation, for example, data mining. PCA (Principal Component Analysis) is likely the most seasoned and surely the most popular method for registering lower-dimensional representations of multivariate data.

The PCA algorithm consists of 5 main steps:

Step 1: Get Initial data

I am going to use my own made-up data set. It's got 7 dimensions:

X1= Quality Drop Rate for video QLDr,

X2= Missing Fragments Rate for Video MFr,

X3= Missing Fragments Rate for Audio MFr,

X4= Buffering Rate for Video BFr,

M5= Buffering Rate for Audio BFr,

X6= Throughput Below Avg for Video TbAr,

X7= Throughput Below Avg for Audio TbAr

So, Dimension Matrix values for each client's sessions can be derived by

$$X = \begin{bmatrix} X11 & \cdots & X1n \\ \vdots & \ddots & \vdots \\ X71 & \cdots & X7n \end{bmatrix} \tag{12}$$

Step 2: Subtract the mean

The mean subtracted matrix is derived by the average across each dimension. So, all the X values have X □ (the mean of the X values of all the data points) subtracted. This produces a data set whose mean is zero.

$$\text{Mean Vector } M = \frac{1}{n}\sum_{k=1}^{n} Xn \tag{13}$$

Step 3: Calculate the covariance matrix

We have chosen 7 dimensions; the covariance matrix will be 7 × 7

$$C = \sum_{k=1}^{n} (X - M)(X - M)^T \tag{14}$$

Where, X= Dimensions Matrix

M= Mean Matrix

Step 4: Calculate the eigenvectors and eigenvalues of the covariance matrix

Covariance matrix is square, mathematically we can calcluate the values for eigenvectors and eigenvalues

$$C\ v = \lambda v \tag{15}$$

Where C= Covariance Mtrix, λ = Eigen Value, v = Eigen Vector

Step 5: Choosing components and forming a feature vector

Now the notation of reduced dimensionality comes in picture. The eigenvectors and eigenvalues from the previous step , the 7 eigenvalues are different. Truth be told, it just so happens the eigenvector with the highest eigenvalue is the principle component can be chosen for data set. It is the most trustworthy relationship between the all fractures.

All in all, once eigenvectors are derived from the covariance matrix, reorder them by eigenvalue, highest to lowest. Presently, in the event that you like, you can choose to disregard the dimension of lesser significance. You do lose some data, yet in the event that the eigenvalues are small, you can ignore lost data . In the event that you discard a few components, the final data set will have less measurements than the orginal. To be exact, in the event that you initially have n dimensions in your data, and you derive n eigenvectors and eigenvalues, and afterward you pick just the first p eigenvectors, then the final data set has just p dimensions.

$$Feature\ Vector = (eig1, eig2, \ldots, eigp) \tag{16}$$

Step 5: Deriving the new data set

Once decision of chosen the components (eigenvectors) is made, formed a feature vector simply take the transpose of the vector, next is to multiply it on the left of the original data set, transposed.

$$y = W^T \times X \tag{17}$$

Where X= original Matrix,

$W^T$= Mean adjusted Transpose Matrix

W^T= Mean adjusted Transpose Matrix

## V. CONCLUSIONS AND FURTHER STUDY

We expect to demonstrate how to better utilize Server logs to manage a large-scale IPTV network. Up to now, all researchers involve the user to create any type of QoE model either in lab environment or through the Questionnaires. the main variation for all other QoE model that this proposed model is dynamic which learns form its own performance and give updated output for every time interval. Trough this model, network providers can predict subscriber's QoE in provided network environment and analogize service environment which meet the optimum QoE on the contrary.

We can further include several extensions to current model. We can scale up proper modeling for the large network containing CND for adaptive video streaming used in IPTV. That also expect that large amount of data to be handled at server side and so that this model can scale up to BIGDATA platform. Users' activities and opinions change over time as IPTV providers introduce more features. It would be also interesting to analyze such changes and perform new computation for new features impose on IPTV systems.

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