Performance of a Realnetworks Video Streaming System over an Internet Infrastructure in Mexico

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Abstract. Nowadays, streaming technology has become the most efficient way of distributing video over the Internet. The application of this technology requires a system of video diffusion, where the video quality received by users-clients depends largely on the server and the codec used. This paper presents the experimental evaluation of the RealNetworks video streaming system over an Internet infrastructure in Mexico. Each element that defines the diffusion architecture of video streaming is studied and its performance evaluated, particularly, the study is focuses in the characterization and analysis of the video streaming server performance. On demand and live are two types of streaming video analyzed in this work. The server performance is obtained based on the perception of quality video received by clients, the subjective metric used is the mean opinion square MOS. The results obtained provided information about optimal diffusion architecture of streaming video in Mexico.

Keywords: Streaming, networking, video, realnetworks.

1 Introduction

Currently, the video streaming systems have been implemented in many parts of the world and applied on a wide variety of applications. The penetration of this technology in the market has increased due to the advantages offered with respect to other means of diffusion and their interactivity. However, although this technology has taken an important place in some countries, in Mexico, the infrastructure and the bandwidth offered by Internet providers have not reached a level that gives support to the streaming systems in an efficient way. According to the OECD (Organization for Economic Co-Operation and Development) statistics [1], Mexico has the lowest rank places in Internet speed.

In order to obtain the best performance of an IPTV system (Internet Protocol TV) in Mexico under his present conditions of the infrastructure of telecommunications, it is important to make an analysis that takes into account the different parameters that influence the implementation of this system. Although there are several works in

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Latin America that evaluate some aspects of a streaming diffusion system [2-3], there is a lack of analysis that considers the different aspects as an integral system.

Of the three dominant commercial streaming media products (Microsoft Windows Streaming Media, RealNetworks RealSystems, and Apple QuickTime), RealNetworks [4] produces the most popular streaming media clients (Real Player) and servers (Helix Server) in the world. The Helix server supports multiple video diffusion formats and is available for the most operating systems. Therefore, the present work is focus on RealNetworks system solution. The aim is to experimentally measure the behavior of system under various Mexican network conditions with particular attention in the characterization and analysis of the video streaming server performance.

In this article the section 2 explain the video streaming technology; the section 3 describes the methodology for the experimental tests and the used metrics; section 4 analyzes the data obtained from experiments. Finally, section 5 summarizes our conclusions.

2 Video Streaming Technology

The streaming term represents a bundle of technologies that enable the PC or set top box for IPTV to deliver media files in real-time, with no download wait over the internet [5-6]. The content is read while it is stored in a video buffer. The streaming is base on a client-server model that allows multimedia data stream should arrive and play out continuously without interruption. The general principle of this set of technologies is that the audio/video content is coded according to a predefined format and bit-rate. Then, this coded content is sent via Internet. The audio/video bit-stream is fragmented to a series of network packets, which are sent out to the user, via Internet protocol (IP) [6]. The client can access to the video content via media player. This is an application that, while it memorizes a video or audio segment (~ 6 to 10 seconds of content), it display this information and so on. The figure 1, show the main stages involved on the streaming transmission process [5,6-7]. The streaming server can store content and/or deliver it to the clients. It can stream two types of diffusion [5,7]: *Streaming on demand* and *Streaming live*.

In general, streaming technologies support the latest digital media standards based on MPEG-4 AVC/H.264 [8-9].

3 Evaluation Methodology

The performance of a video streaming diffusion system depends largely on the performance of each element that composes the system, mostly the video codecs, network infrastructure and streaming servers used.

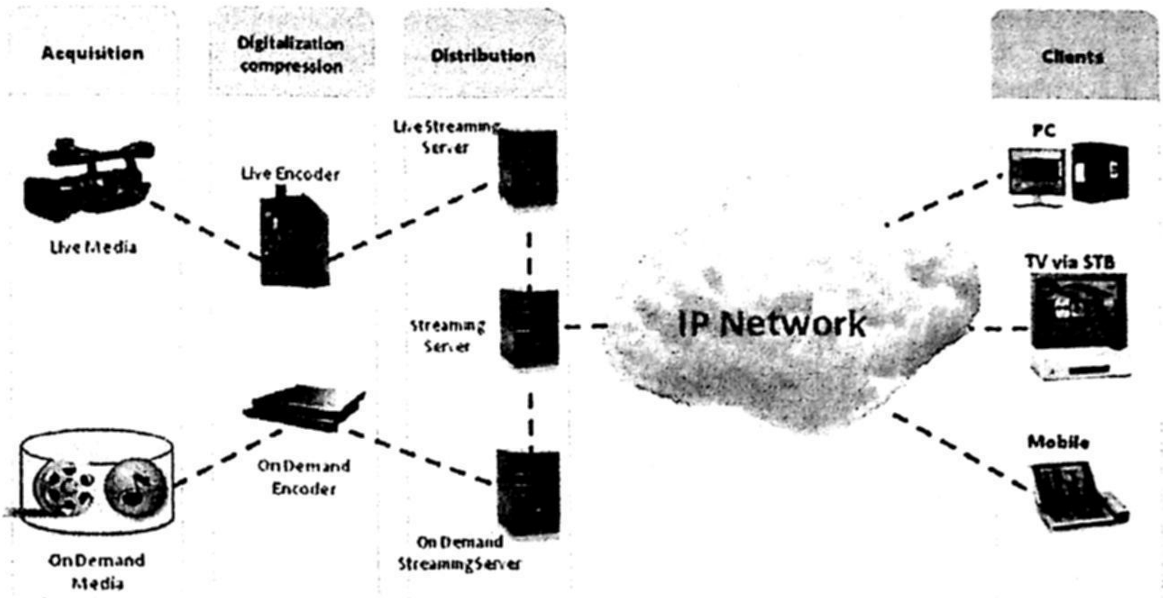

Fig. 1. Video Streaming Architecture.

3.1 Test Sequence Library

To evaluate codecs and streaming server we collect test material established and made available by the technical community. The test library contains original video sequences in ITU-R 601 format [10], raw video YUV 4:2:0 format. (see tables 1 and 2).

Table 1. Test sequences for QCIF resolution.

Resolution: QCIF (176x144 pixels). Application: video conference and video phone		
Sequence	Frames per second	Frame Numbers
Hall	30	300
News	30	300
Foreman	30	300

These sequences are widely used within of the video compression community due to their variation content of motion and texture [7].

Table 2. Test sequences for CIF resolution.

Resolution: CIF (352x288 pixels). Application: video web		
Sequence	Frames per second	Frame Numbers
Mobile	30	300
News	30	300
Stefan	30	300

3.2 Evaluation Metrics

3.2.1 Metric for Video Codecs

With the aim to compare codecs, we choose the PSNR (Peak Signal Noise Ratio) to measure the video quality and degradation of encoding sequences. PSNR is one of the most widespread objectives metric used to evaluate video quality on video codecs [7]. PSNR measures the error between a reconstructed image and the original one.

3.2.2 Metric for Streaming Server

The evaluation of the streaming servers, unlike the evaluation codecs, is based on the video quality received by clients under different restricting conditions of bandwidth. The measure of quality in the video was subjectively measured, that is, based on human perception. ITU [11] has proposed *Mean Opinion Score* (MOS) as a measure of perceived video quality. The participants are then asked to score the perceived quality of the shown media content from 1 ("worst") to 5 ("best"). The mean of the scores (MOS) provides a quantitative indicator of the perceived quality [11]. In this work we suggest an alternative evaluation for measuring performance server, analyzing strictly technical details that arise during testing of diffusion video streaming such as latency time to start, handling buffers, latency time in jumping, handling the bandwidth and the video quality [12]. The latter is valued according to the characteristics and defects presented in the pictures that make up the videos and test is conducted toward a possible mapping the value MOS. The following describes the mapping.

- MOS = 1, constant freezing on the image.
- MOS = 2, blocks effect, the image freezes and blurring.
- MOS = 3, constant video with small defects.
- MOS = 4, few robotic movements and blocks effect during abrupt changes of scene.
- MOS = 5, clients don't see video defects.

3.3 Platform Configuration

The number of supported streams, the protocol used for the application, the supported video formats and the compatibility with multiple operating systems are the most important features of the streaming servers. The streaming server Helix [4], evaluated in this study has the advantages over other servers: support of multiple video diffusion formats, version to unlimited number of clients and is available for the most operating systems known. To evaluate its performance, several tests were achieved on Local Area Network (LAN) architecture. The platform testing topology used for the experimental evaluation is shown in figure 2.

- **Video Streaming on demand.** When a video is requested to the server, it searches in its hard drive the requested file. The file has been previously encoded. Once located, it is encoded and packed in a suitable format. Then it is send to the client as streaming packets through the IP network.

- **Video Streaming Live.** The video is captured in raw format and sent it to the encoding tool in real-time. Subsequently, the encoded video is sent to the server. Then it sends to the client the file as streaming packets through the IP network. The client can access the content through the IP address set by the server, only during the event.

In both types of diffusion, the bandwidth in the reception side has been limited by software. The purpose of this is to simulate various network connectivity conditions of a public network (Internet) in Mexico. They were used application protocols (MMS, RTSP and HTTP). The server and clients were implemented on a two types of computers. The characteristics are shown in the table 3.

Table 3. Characteristics of equipment used.

Operating System: Microsoft Windows XP Pro V 5.1.2600 Service Pack 2
RAM Memory: 2.048,00 MB
Features of the computer for the streaming server
Processor: Dual x86 CORE™ 2 Authentic AMD ~2812 MHz
Features of the computers for the clients
Processor: Dual x86 Intel® CORE™2 Genuine Intel ~2400 MHz

3.4 Coding Process

The test sequences are coded at different bitrates (20, 56, 64, 128, 150, 256, 350, 500, 750, 1000, 2000 bps), QCIF/CIF resolutions [7] and three video streaming formats supported for Helix server: Real Media (.rm), Windows Media (.wmv) and Quick Time (.mov). It is crucial identify and use the codec that represent the best video quality with the fewest bits. For the video diffusion with the Helix servers usually used the following codecs:

- RealNetworks [7], Real Video 10 – This codec is suspected to be based on H.264 standard.
- Microsoft [7], Windows Media Series 9 Series 9.00.00.2980 – Codec, VC-1 standard, SMPTE 421M [13].
- Apple [7], Quick Time 7 Pro – Codec, H.264 standard.

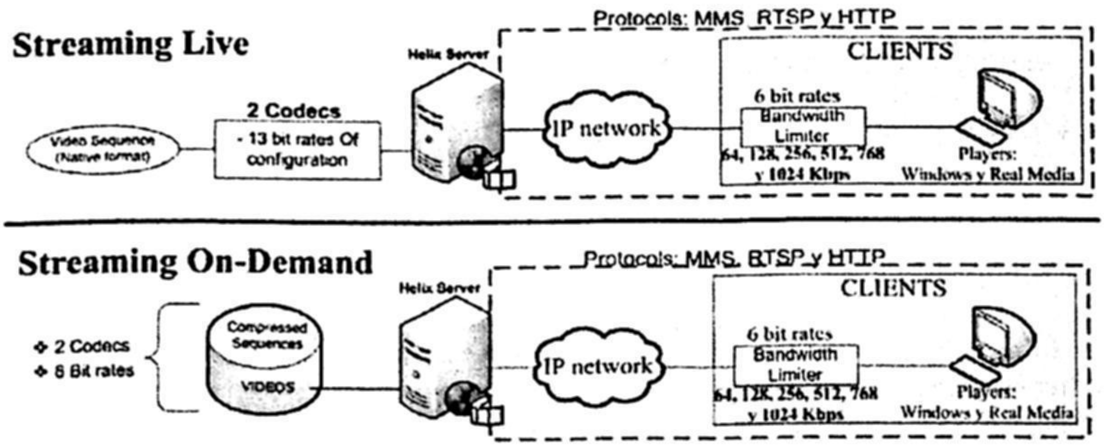

Fig. 2. Schematic of the platform used for testing.

4 Experimental Results

4.1 Streaming Server

In each video received by clients, it was measured subjectively the video quality to determinate the best platform over an Internet infrastructure in Mexico.

4.1.1 Evaluation for Streaming on Demand

The following points are the results of tests on streaming clients (Windows Media Player and Real Media Player).

Referring to the quality of the video: -For low bit rates (until 256 Kbps), the WMV format (MOS=3), showed the highest perceptive video quality. The RM format showed defects on the image (MOS=2). -For high bit rates (after 2000 Kbps), the sequences received as RM format had no defects (MOS=5). The diffusion tests with WMV format showed some defects (MOS=4).

As regards the bandwidth management: it was observed that clients Real Media maintain a dynamic bit rate value during transmission depending of the available bandwidth, i.e. send packages in advance when the bandwidth is allowed. In addition, when the videos are encoded at a bit rate higher than available bandwidth, the server slows down the speed of client-server connection to a value of less than 20 Kbps. With respect to the Windows client, it maintains the connection speed client-server close to the narrow bit rate of the request video, even where it is not possible to deploy any image (MOS = 1).

The video requests in RM format have a start time of almost zero. However, requests for video format WMV generate latency higher than eight seconds.

4.1.2 Evaluation for Streaming Live

The tests results for this type of diffusion were the following (Windows Media and Real Media).

Referring to the quality of the video: Similarity with the diffusion test of video streaming on demand, for video transmitted to low bit rates (until 256 Kbps), the WMV format presented the best subjective quality.

As regards the bandwidth management: There are differences in bandwidth management and planning when using different video formats. The RM format has values close to the dynamic bit rate encoding. By contrast, the bit rate is maintained at a stable value with WMV format.

Through evaluation tests, it was noted that the bit rate used to encode the videos, it must maintain a margin to be lower that available bandwidth, to obtain an acceptable visual quality for clients (MOS $\geq$ 3). The table 4 shows the maximum bit rate encoding used in diffusion tests to maintain fluently video for different conditions of bandwidth between client-server.

Table 4. Limited bandwidth.

Available bandwidth between server-client is: (kbps)	Optimal bit rate to encode and transmit is: (kbps)
100	80
128	100
150	120
256	220
350	310
500	460
750	700
900	835
1024	910

5 Conclusions

The aim of this paper was to present and to discuss the performance of a video streaming architecture based on Helix server and three compatible commercial proprietary codecs used in the video streaming technology over an Internet infrastructure in Mexico.

The tests realized with the different combinations from coders, players, protocols (MMS, RTSP, HTTP), and bandwidths among others parameters, gave as a result a hybrid architecture. This one is the one that better adapts to the infrastructure of Internet in Mexico (see figure 3), to offer a service of correct video streaming.

The tests of this architecture also confirmed the results of the codec evaluations [7]: for live broadcasting, the Windows Media Codec 9 Series had the best performance in both quality and compression. However, for diffusion on demand, Real Video codec 10 had the best performance.

This hybrid architecture presented an extraordinary performance in tests for both types of distribution of video streaming.

For live diffusion, the best solution consists of an encoder Windows Media Series 9. It sends the encoded content to Helix server. Then the server sends to the client the file as streaming packets through the IP network using MMS application protocol. The content may be received and reproduced by any client Windows Media.

For diffusion on demand, it is required to encode files with Real Producer RealVideo10 codec. It sends the encoded content to Helix server. Then the server sends to the client the file as streaming packets through the IP network using RTSP application protocol. The content may be received and reproduced by any client Real Media.

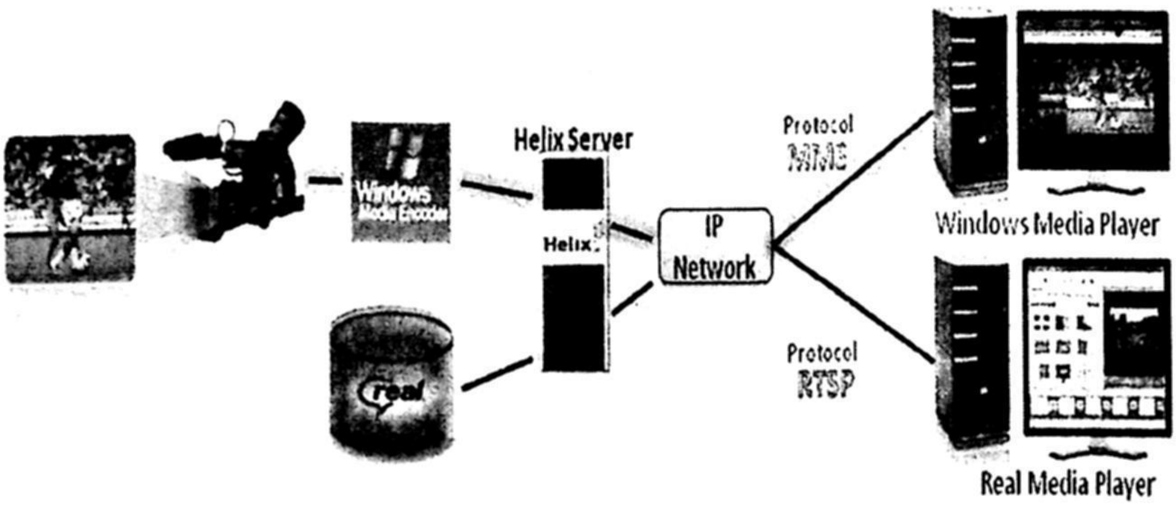

Fig. 3. Proposal architecture.

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