

Statistical characterization of a real video on demand service: User behaviour and streaming-media workload analysis

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Abstract

The video on demand service characterized in this article has surpassed 4 years of service, and the access log database stores information of more than 160,000 reproductions and 900 videos. The wide variety of subjects, the range of content lengths and a frequent update of contents (several new videos every day), clearly differentiate this study from other previous research limited to specific users, subjects or environments. We present a statistical study of user behaviour and streaming traffic, analyzing session characteristics, mistaken reproductions, amount of media delivered, number and length of pauses and jumps in the reproduction, popularity and daily access profile. The results of the analysis will allow us to develop simulation models and workload generators to evaluate different scenarios and situations of the service.

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1. Introduction

The speeds offered by the Internet access providers have been increasing continuously in recent years. As penetration grows, broadband providers in the OECD are increasingly offering voice and video services over their platforms [19]. The bandwidth enhancement in subscribers' access capabilities has given rise to the appearance of Internet audio/video services, based mainly on streaming technology. Streaming media has been widely used over the Internet for an increasingly demanding and growing consumer population [35]. Thus, the characterization of streaming access workloads has become an essential factor to evaluate the performance of these services and their implications on the rest of the services in the network.

In this paper, a user behaviour analysis and workload characterization performed on the video on demand service of www.lne.es (*La Nueva España Digital*) is presented. This digital news service is one of the most successful in Spain and its video on demand service, called *LNE TV*, has interesting characteristics, such as a wide

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variety of subjects, a wide range of content lengths, a continuous content update (several new videos every day), etc. Over a period of 4 years the access log files have been captured and stored in a database to be analyzed. The obtained results have been compared with some previous classical studies, such as [2,6,12,16,33]. The results of the analysis have been used to develop user behaviour and workload traffic models which can be integrated in video on demand service models and load generators with the aim of evaluating future situations in the service. This paper makes the following contributions:

A primary contribution of our work is its statistical analysis of user behaviour in a commercial video on demand service over a 4-year period. The mistaken reproductions, amount of media delivered, number and length of pauses and jumps in the reproduction, session characteristics, popularity and daily access profile have been characterized. Unlike most previous media workload characterizations, which are focused on an educational content, the workload analyzed consists of accesses to a news site in Spain, containing variable-length and variable-subject entertainment content. Thus, the results improve and enrich current knowledge of typical media workload patterns.

Secondly, a streaming-media workload characterization has been performed, differentiating traffic per protocol, source device, audio/video flow and workload, during both regular load and buffering time intervals. The service uses *RealNetworks* technology.

Finally, we propose a simulation model of the audio/video on demand service. This model is oriented to services with different types of information and lengths.

The rest of the paper is organized as follows: in Section 2 other related works are analyzed. A general description of the case study is carried out in Section 3. The user behaviour analysis and characterization are presented in Section 4. A measurement study and characterization of *RealMedia* streaming traffic is carried out in Section 5. In Section 6 we propose a simulation model of the video on demand service. Finally, conclusions are presented in Section 7.

2. Related work

Video on demand analysis is a relatively recent field in the research world. Video on demand services are not widely deployed on the Internet, and, therefore, analysis studies are not abundant. In spite of that, some interesting papers on streaming service analysis have appeared during the last few years. These papers study different elements of user behaviour, quality of service and content popularity.

Elements such as session length, delivered time, user's interactions, etc. have been studied in [2,6]. In [33], the study is centred on the user's connection, user's origin, and quality requested. The quality of service has been evaluated in [16,33]. Different parameters, such as packet loss, jitter, and user perceived quality have been the main study points of these papers.

Another element widely analyzed is document popularity [2,5,6,9,12,30]. The distribution of users' reproductions among the videos is compared with the Zipf-like distribution and the Θ parameter is calculated. Acharya et al. [1] characterized user accesses to video objects on the web (VOW), showing that, contrary to previous studies, popularity did not follow a Zipf distribution.

Using some of the results obtained in these analyses, other studies and tools have appeared. These were able to simulate real service behaviour and carry out performance evaluations. That is the case of [3] where the server capacity is evaluated using a simulated workload. The work of [13] follows the same line. In their paper a tool for video on demand service analysis using simulated workload is presented [31] presents a characterization of live streaming workloads from a server used by one of the top ten content providers in Brazil [27] analyzes the live streaming workload from a large content delivery network. They study the workload characterizing popularity, arrival process, session duration and transport protocol used.

Although the analysis of Internet traffic usually includes streaming multimedia traffic, there are few specific works about *RealMedia* streaming traffic [17] presents an exhaustive study of *RealAudio* traffic from a popular Internet audio service. They found that *RealAudio* traffic is dominated by specific packet sizes [6] analyzes a client-based streaming-media workload generated by clients from the University of Washington connecting to servers in the Internet. Aspects about workload characterization, such as bandwidth utilization, session characteristics and server popularity are treated in detail. Further research on *RealMedia* traffic is presented in [14]. The authors study the traffic both in the application layer and the network layer and the relationship between

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