METHOD FOR AUDIO/VIDEO STREAMING TESTBED DEFINITION AND MODEL DEVELOPMENT

Xabiel G. Pañeda, Roberto García, David Melendi, Manuel Vilas, Víctor G. García
Computer Science Department, University of Oviedo
Campus Universitario de Viesques. Sede Departamental Oeste, 33204 Xixón-Gijón, Asturies

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Abstract: This paper presents a method to develop lab experiments for audio/video services, both using testbed and simulation models. Audio/video services in the Internet have special characteristics which make them very difficult to configure. Our research group has designed a methodology (Pañeda, 2004) for video-on-demand service analysis and configuration. In this methodology, the analysis phase is divided into two independent parts, one which works on data extracted from the behaviour of the real service, and another which works on predictions. The latter uses simulation models and testbeds to evaluate situations which may appear in a near future. In all the cases, a method must be used to specify the experiments. This method must determine elements such as: goals establishment, experiment generation process, the input data for the workload definition, etc.

1 INTRODUCTION

The emergence of the World Wide Web has changed the Internet world. This service has become a powerful communication medium. Daily, an important number of web accesses is produced and a huge volume of information is delivered. The bandwidth increase in subscribers' access capabilities has given rise to the appearance of a new complementary service: the Internet audio/video. There are two types of audio/video services on the Internet: live-audio/video and audio/video-on-demand. Both of them are usually based on streaming technology. The special characteristics of the audio/video services, such as, delivering continuous information, allowing user interaction, sending the information exclusively for each request, etc make these services difficult to configure. Achieving a good configuration is a hard task which can only be based on a good analysis. Our research group has designed a methodology (Pañeda, 2004) for video-on-demand service analysis and configuration. In this methodology, the analysis phase is divided into two independent parts, one which works on data extracted from the behaviour of the real service, and another which works on predictions. The latter uses simulation models and testbeds to evaluate situations which may appear in a near future (Jin, 2001). To obtain good results, these experiments (Arias, 2002) must be developed following a clear method adapted for this type of services. Several questions have to be defined. It is necessary to have accurate information about user behaviour in order to characterize the system workload accurately. It is important to define the steps for the application process, determine the goals and analyze the results.

The method presented in this paper covers all these goals and, moreover, it can be integrated in the analysis and configuration methodology designed in the previous stage of our research.

The rest of the paper is organized as follows: Section 2 provides a detailed description of the method, and, finally, conclusions are presented in section 3.

2 METHOD DESCRIPTION

The designed method is oriented to clearly specify all the steps necessary to perform a lab experiment for an audio/video service. Its aim is to generate accurate tests which provide important information to the analysis task of the methodology presented in (Pañeda, 2004).

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2.1 Application process

The application process, shown in figure 1, is divided into different steps. The first one is in charge of specifying the service. Its type and its characteristics have to be determined. The second is the goals definition. At this time it is necessary to decide what kind of information the experiment has to provide. Once the goals are clear, it is necessary to decide which type of experiment is more adequate: to use a simulation model or a testbed. The following phase is the experiment definition, which is composed of different tasks: workload definition, resource definition, architecture definition, parameters definition and values definition. After that, the experiment is completely specified and it is time to execute it. Finally, an analysis of the results must be performed.

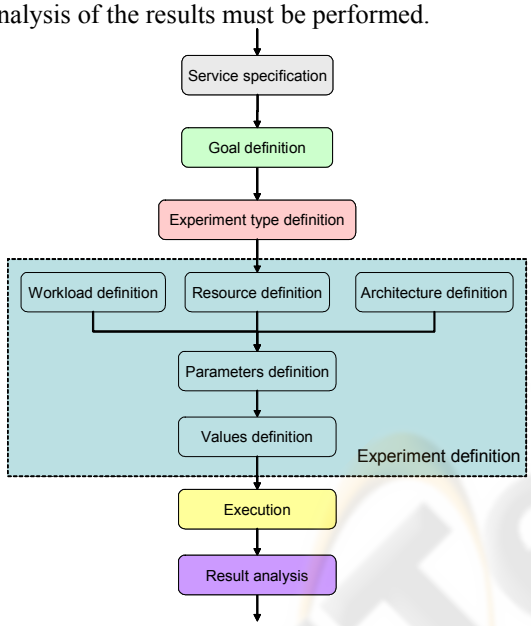

Figure 1: Application process

2.2 Service specification

There are two different types of services based on streaming technology: audio/video on demand and live audio/video. The first step for this method is to define what type of service is going to be analyzed. Depending on this type, different parameters must be established.

Table 1 Types of service

	On-demand	Live
Audio	Jukebox	Internet radio
Audio/video	Video-on-demand	Internet-TV

Table 1 shows four types of services, classified depending on the type of information and the delivery method.

2.3 Goal definition

The second step is to answer the following questions: what is the aim of the experiment? What information are we interested in?

To answer these questions, the outputs of the experiment must be defined. These outputs will be expressed by means of the metrics defined in (Pañeda, 2004). Elements such as bandwidth consumed in a point of the network, throughput, CPU utilization, etc will be considered.

2.4 Type of experiment definition

The third step in the method application process is the definition of the type of experiment. Two types of experiments can be performed: to use a simulation model or a testbed.

2.5 Experiment definition

The experiment definition is composed of five tasks. Three of them, workload, architecture and resource definition, are oriented to define the base for the experiment. The others, parameters and values definition, are used to characterize the analysis which is going to be performed.

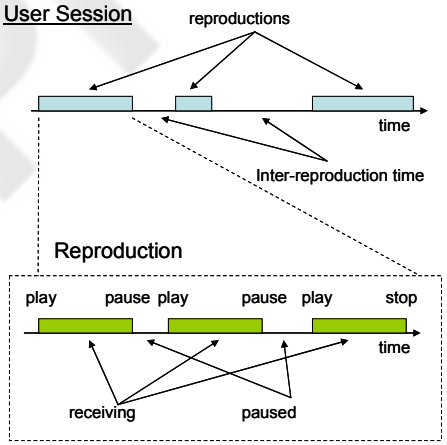

Figure 2: User behaviour

Workload Definition

To perform a useful experiment, an accurate workload must be defined (Cherkasova, 2004), (Pañeda, 2005). Most of the necessary data is extracted from real services. The rest must be established as parameters which will be defined later using different values to characterize the experiment.

The workload definition is divided into two different parts: user behaviour and content characteristics.

Figure 2 shows the behaviour of a user in a service based on streaming technology. To clearly define an experiment, all the following parameters must be specified:

- **Media delivered time**: audio/video time delivered throughout the reproduction.
- **Pause number**: number of pauses in a reproduction.
- **Pause time**: length of a pause.
- **Pause start-time**: time in the audio/video when the pause appears.
- **Inter-reproduction time**: time between two reproductions of the same user.
- **Reproductions per session**: number of reproductions made by a user in a given period of time.
- **Inter-session time**: time between two user sessions.

If the service is a jukebox or a video-on-demand service, it is necessary to define:

- **Length, position and number of forward jumps**.
- **Length, position and number of backward jumps**.

The content characteristics have the following elements:

- **Quality of the audio and the video stream**: This parameter can either be defined using: Frames per second and frame size, or bandwidth consumed per second.
- **Number of audio/videos**: number of audio/video files offered in the service.
- **Popularity of the audio/videos**: criteria used to decide which audio/video the user selects. In figure 3 an analysis to characterize this parameter using a generalized Zipf-like distribution is shown.

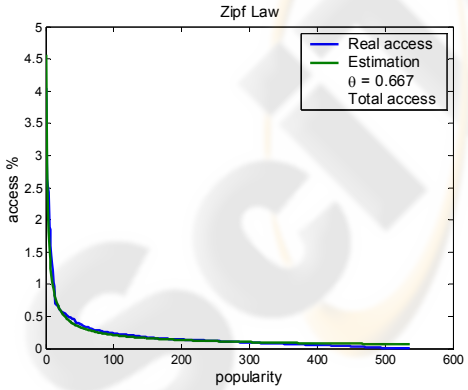

Figure 3: Popularity of the audio/videos

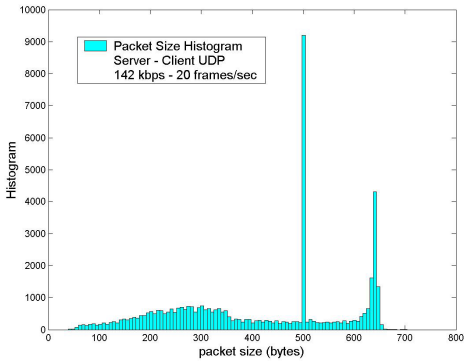

Figure 4: Packet size histogram

If the service is a jukebox or a video-on-demand service it is also necessary to define:

- **Length of the audio/videos**.

If the type of experiment is a simulation model the following parameters have also to be defined:

- **Packet size**: size of the audio and video packets. Sometimes, there are different sizes due to the codec used to generate the audio or the video stream, as shown in figure 4.
- **Inter-packet time**: time between two packets of the same type.

Another additional parameter can be necessary in some types of experiments, where the main goal is to test the service behaviour in a network where other types of traffic compete with the service's own traffic:

- **Background traffic**: traffic which is going to be fed into the analyzed network, not generated by the service under study.

Architecture definition

This phase includes two different parts that must be taken into consideration. The first is the network architecture, and the second is the service architecture. Figure 5 shows a typical diagram where an experimental architecture is defined.

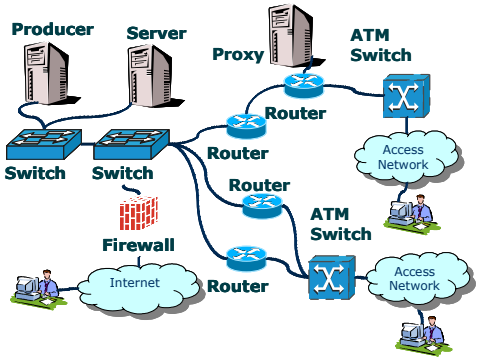

Figure 5: Service Architecture example

Different questions must be determined when dealing with service and network architectures:

- Number of servers, location in the network, and load balancing policies.
- Number of proxies, location in the network, and cache or splitting policies.
- Transport protocol between each service device (TCP, UDP, etc).
- Number of clients and location in the network.
- Number of producers and location in the network (Only in live services with online generated information)

Resource Definition

In this step the quantity of resources, both in service devices (servers, proxies, etc) and in the communication network must be established.

Parameters Definition

In this phase one or more elements must be determined as parameters. The values for these parameters are not extracted from the real services, instead, they will be defined arbitrarily depending on the goal of the experiment.

Values Definition

In this phase a set of values for each parameter of the experiment must be defined. The process is, first to determine the maximum and minimum values and second to establish the criteria for the intermediate values. For instance, determining the gap between them: Linear; Exponential; Free.

When there is more than one parameter, there are two possibilities to combine them:

- **Blind combination**: generating all the possibilities with all the parameters.
- **Intelligent combination**: eliminating those combinations that are not interesting.

2.6 Results analysis

The last phase is the results analysis. The results obtained from lab experiments are not different from the analysis of the information gathered from the real service. This analysis is performed using the tests defined in (Pañeda, 2004).

3 CONCLUSIONS

Lab experiments are very important to predict the future performance of an internet service. In the case of audio/video this is even more true because of the high quantity of resources necessary to provide the contents with an acceptable quality. Defining a method to specify the experiments is necessary to reach accurate results and interesting conclusions.

Nowadays this method is being used to perform lab evaluations of two real services: **LNE TV**, the audio/video service of *La Nueva España* –which is a video-on-demand service–, and **Asturies.com Radio**, the Internet radio service of *Asturies.com* –a live audio service–. Several qualities for the audio and video contents, service architectures and quantity of resources are being analyzed. Figure 6 shows the bitrate temporary evolution in the server output in an experiment for the evaluation of an Internet radio. Each line represents this evolution for a different number of users (100 to 700).

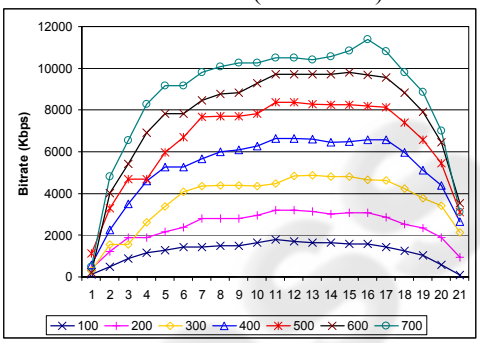

Figure 6: Internet Radio evaluation

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