Multimedia Gateway Architecture for Adaptive Content Distribution

– Work in Progress –

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Abstract

In this talk we present our ongoing and future work towards a multimedia delivery system based on the Internet standard protocols RTSP and RTP. The proposed system consists of several multimedia gateways which provide an adaptation service for mobile clients. The adaptation is done by using different transcoding methods at the gateway which can be loaded at runtime.

1 Introduction

Digital video plays an increasingly important role on the Internet. Advances in video and audio coding make multimedia streaming across a wide range of different networks possible. But the transmission of digital audiovisual data still needs high bandwidths which results in high resource requirements at the consuming client. Especially mobile devices often cannot comply with such requirements. To overcome this problem, the multimedia streams needs to be adapted to the capabilities and requirements of mobile devices. One promising approach to meet the requirements of such devices is to transcode each stream either into another or into the same coding format with other coding parameters. Two different approaches for providing a transcoding service for mobile clients can be distinguished: server-based and proxy-based transcoders. The server-based solution provides only limited flexibility because transcoding is only available for those streams which are hosted on multimedia servers that have such transcoding capabilities. Another disadvantage of this approach is that the transcoding process has to be adapted to each existing streaming server implementation. Yet it would reduce the network load on the path from the server to the client because the bandwidth of a stream is reduced before it is sent over the network. Moreover, a server-based solution would allow the transcoding process to access even more information about the video that is not contained in the precoded stream. In a proxy-based solution only the media stream could be used for transcoding. However, this kind of transcoder provides the most flexibility because a client could get a transcoded stream from every reachable server through the proxy. Another advantage of a proxy-based transcoder is that it can be located closer to the client and therefore closer to the communications bottleneck, the wireless connection. This gives the transcoding process the ability to react more quickly to the varying bandwidth of the client's device.

2 Transcoding

The largest amount of data in a multimedia stream is occupied by the video part of the stream. Additionally the limitations of mobile devices usually restrict the presentation of video streams. Therefore the most promising approach to adapt a multimedia stream is to transcode the video part to the requirements of the client. Although an optimal adaptation could be reached by also transcoding the audio part, in this work we concentrate on video transcoding. Nevertheless, due to its flexibility, our proposed gateway system does not restrict the transcoding process to the video part.

The idea of video transcoding is to adapt visual streams to the requirements of clients which are not able to receive and display high-quality streams due to their limited resources. The most straight forward way to transcode a video stream is to decode the high-quality stream, manipulate the raw video data if necessary and reencode it with more constrained parameters to suffice the client's capabilities. This architecture is commonly called *Cascaded Pixel Domain Transcoder* (CPDT). As each frame of the video is decoded completely, a wide range of operations could be performed on the raw pixels which leads to great flexibility of this architecture. Yet this approach has a rather high complexity and leads to quality degradation during the reencoding process. Therefore this approach is unsuitable for realtime transcoding. Thus, several specialised transcoding architectures and techniques which focus on different aspects of transcoding were proposed. A comprehensive overview of the research area dealing with those transcoding techniques is given in [1]. All of those proposed transcoding approaches attempt to prevent the decoding process as much as possible. But there is no best transcoding practice to meet the requirements of the clients. Therefore a flexible solutions needs to be developed to combine these different transcoding techniques to be able to use an optimal method for each request of a client.

3 Gateway System

Our proposed multimedia delivery system consists of one or more multimedia gateways which provide a transcoding service for mobile clients. By using different transcoding techniques the gateways are able to adapt multimedia streams to a wide range of requirements. Each transcoding technique is implemented as a transcoding module which can be loaded by the gateway at runtime. This provides a high level of flexibility, because the set of supported transcoding methods is not limited by the system. The modules are not even limited to use transcoding methods. Also other stream manipulation methods such as stream composition or watermarking can be implemented as a module which can be loaded by the gateway.

Our project is currently in an early state but we already have implemented a RTSP/RTP proxy which is capable of loading transcoding modules at runtime. Inside this proxy the data of a stream is sent through a datapath consisting of several StreamHandlers. A StreamHandler (SH) is a small data processing unit which can consume and generate data units. Each of those SHs in the datapath can manipulate the multimedia stream. This architecture of connected SHs is also used for the transcoding modules. A transcoding module contains at least one SH which is plugged into the datapath of the proxy.

4 Future Work

The future directions of our system are to include mechanisms for gateway location, capability exchange, gateway handoff and caching. A gateway location mechanism is needed for a client to find an appropriate gateway without user interaction. Capability exchange mechanisms will be used to automatically send information about the capabilities and requirements of the client to the gateway. This information is needed to decide which transcoding module to use at the gateway. In order to support the mobility of connecting devices we also need a gateway handoff mechanism to migrate an active multimedia session from one gateway to another. This mechanism is also useful to implement a load balancing between several gateways in the network. We have also planned to include caching mechanisms at the gateway in order to reduce the network load. In contrast to multimedia caching without transcoding we have to find appropriate strategies to decide which stream and especially which version of the stream should be cached.

References

[1] A. Vetro, C. Christopoulos, and H. Sun, "Video transcoding architectures and techniques: an overview," *IEEE Signal Processing Magazine*, vol. 20, pp. 18–29, Mar. 2003.