Scalable Video Content Adaptation

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Abstract

Scalable Video Coding technology allows the efficient distribution of videos through heterogeneous networks. In this work a method for automatically adapting video contents, according to the available andwidth and user preferences, is proposed and evaluated. By exploiting video stream scalability, the proposed solution uses bridge firewalls to perform adaptation. The scalable bitstream is packetized by assigning different Type of Service values, according to the corresponding spatial, temporal and quality resolutions. According to the given bandwidth constraints, an intermediate bridge node, which provides Quality of Service functionalities, discards high resolutions information by using appropriate Priority Queueing filtering policies. A real testbed has been used for the evaluation, proving the feasibility and the effectiveness of the proposed solution.

Keywords:

Scalability, MPEG-21, IP protocol

Introduction

The distribution of a given video content to several clients, characterized by having different rendering capabilities and connected by means of links with different bandwidth restriction, is in general a heavy task. Till today, this goal has been achieved mainly using two alternative methods: by using video transcoders, properly placed in the nodes of the distribution network or by encoding and successively distributing different coded version of the same content. These methods are clearly inefficient; in the first case a high computational power is required for successively adapting the content while in the second there is a waste of storage space and channel bandwidth. Additionally, these solutions are not effective in case of dynamic bandwidth variation.

The recently developed Scalable Video Coding (SVC) methods [1], [2], are a key technology to overcome these limitations. SVC codecs generate a bitstream with a unique feature, the possibility of extracting decodable sub-streams corresponding to a scaled version, i.e. with a lower spatiotemporal resolution or a lower quality, of the original video. Moreover, this is achieved providing coding performances comparable with those of single point coding methods and requiring a very low sub-stream extraction complexity, actually comparable with read and write operations. Scalability is then suitable to ease video content adaptation when there are bandwidth fluctuations or when the bandwidth required to transmit the requested resolution is not available. In these situations, only a bit-stream subset can be transmitted, or forwarded by one of the node in the network to the clients.

Scalable Video Coding is a relatively new technology and a commonly adopted delivery method has not been defined yet. However, several solutions have been proposed, concerning different aspects of a complete scalable video streaming chain. In [3], a MPEG4-FGS scalable stream, with one spatial resolution and multiple quality layers, is transmitted using a client-server collaborative system with the aim of avoiding congestion. The client estimates the rate of occupancy of its receiving buffer, which is assumed to depend on the congestion level. The estimation is then transmitted to the server, on a feedback channel, which dynamically adapts the quality of transmitted video in order to avoid congestion at the client's side. Similar approaches have been proposed by Nguyen et al. [4] and by Hillestad et al. [5] in the context of wireless video streaming. In [6] the use of Differentiated Services (DiffServ) [7] of IP protocol is used to provide QoS with MPEG4-FGS and H.264-SVC. The main drawback is that only two classes of service are used, Expedited Forwarding (EF) for base layer and Assured Forwarding (AF) with three groups of priority to differentiate the types of pictures (I, P and B) in the enhancement layer. In [8] a real-time system based on the scalable extension of H.264 (H.264-SVC) scalable and MPEG-21 Digital Item Adaptation (DIA) is proposed. In particular QoS is obtained using Adaptation QoS (AQoS) and Universal Constrain Description (UCD) tools of MPEG-21 DIA. The main drawback of this approach is the complexity of MPEG-21 descriptors determination, which depends on the content itself, needed for the configuration of the adaptation nodes.

This work also aims at providing solutions for scalable video content adaptation by considering a real client-server application framework. The network architecture, here considered, is composed by a server that can store and send the video contents, different clients and a bridge that adapts the transmitted stream according to the available bandwidth. The key aspect of the proposed application, with respect to the work described in [8], is the way video adaptation is realized. Instead of using dedicated extractors for scaling the distributed stream, the system relays on the packet filtering policies realized by network Quality of Service (QoS).

The presentation is organized as follows. Section II provides some hints on Scalable Video Coding focusing on the generated bitstream structure. Section III describes the structure and the elements of the considered distribution network. In Section IV the obtained results are presented.

Conclusions

In this paper an efficient method for automatically adapting a scalable video stream has been proposed. Adaptation is performed by opportunely using the functionalities provided by Quality of Service systems. Different configurations have been evaluated, in order to enable flexibility and adaptation with respect to client's preferences concerning the preferred scalability dimension. It has been shown that, thanks to the characteristics of the proposed congestion management method and of the scalable video streams, it is possible to decode a video sequence at a lower spatial resolution or frame rate preserving good quality also in presence of strong bandwidth reduction. The advantage of proposed method compared with other works in literature is the low complexity of the adaptation device, the use of well known mechanisms for providing Quality of Service as Packet Filter, the absence of feedback channel and no needs of bandwidth estimation algorithms. Future works could address the robustness against the errors on communication channel and consider the retransmission of lost packets which are important issues in real video streaming applications.

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