Dynamic rate control in wireless video communications

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Abstract

We are witnessing a gradual integration of video communication services into low bit-rate mobile links. However, these services (e.g. streaming video) are not yet as popular as they should be. Transmission of real-time video in wireless networks still faces several challenges. This paper reports some our experience with a mechanism which provides a context-aware rate control for the handling of wireless video communication. Our mechanism is based on a couple of java agents which supervise the state of the link and propose an adequate regulation of the video flow. Our experiences are done with the ITU-T H.263+ standard. The peak signal-to-noise ratio (PSNR) is used as an objective image quality measure.

`keywords`: Wireless video transmission, dynamic regulation, responsive control.

1 Introduction

In recent years, the development and the apparition of real time application as well as multimedia applications have witnessed an exponential increase. The real time constraints of these applications present a big challenge for their integration. They need different levels of QoS adapted to the data transmission. Real time constraints of applications like video-phone, videoconference, audio and video cause few problems for their integration into networks using the IP protocol. One major point is the lack of an acceptable quality when the video communication goes across the wireless Network. The problem could be solved by adapting the video communication's rate to the channel's current situation, with an adequate and responsive regulation mechanism. This paper is focused on the handling of video communication with the responsive rate control approach. The application context we consider is shown in figure 1. Our tests have

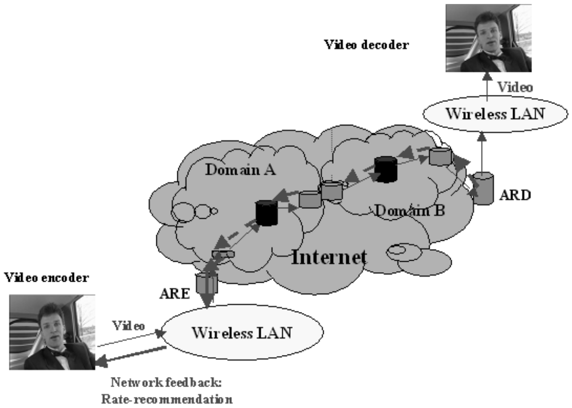

Figure 1: Network-based rate-control

been carried on an active network plate-forme *a la* ANTS [17], [18]. This plate-forme is used as a prototyping tool, and it serves to emulate the error-prone wireless link as well.

Before presenting our mechanism, we will first give an overview of video communications over the wireless network. Following that, we present the various components of the proposed framework. Experimental results demonstrate the performance of our mechanism in Section 4. Finally, conclusions are stated in Section 5.

2 Wireless video communications

The handling of video communications is still a focus of investigation with today's cellular networking infrastructure, like GSM-GPRS, UMTS [1], [3], or CDMA-2000 [5]. This is because video traffics are real-time, burst and (selectively) sensitive to loss, and so need to be handled with a minimum of QoS control. The third generation partnership project (3GPP) has choused several multimedia codecs for the inclusion into its multimedia specifications [15]. H.263 and MPEG4 have been integrated to provide basic video service in the first release of the 3G wireless systems.

The generic architecture for multimedia traffic in mobile terminals has been standardized in H.324 [6], [2] and [10], the key element for traffic handling is the use of RTP/RTCP [12], H.245 control [8] and H.223 multiplex [7]. H.324 was primarily established by the ITU-T for low bit-rate circuit-switched modem links [10]. Error prone extensions for mobile circuit switched low bit-rate conversational services have been later added. For IP-based packet-switched communication, 3GPP has chosen to use SIP and SDP for call control [14] and RTP for media transport [11].

Future wireless multimedia applications will likely work over an open, lay-

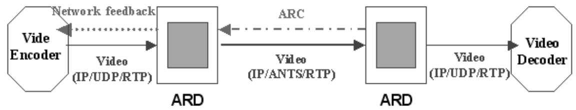

Figure 2: The Active Regulation Mechanism architecture

ered, Internet-style network with a wired backbone and wireless extensions. The protocol RTP is mainly designed to deliver the video bitstreams with synchronized audio from a server to a terminal. It provides end-to-end transport functions and insures the integrity of the video stream. This is achieved through some fields in the RTP-header such as the Sequence Number (NS) field and the Timestamp (TS) field.

3 Our framework

Our architecture, named *ARM (Active Regulation Mechanism)* [4], is presented in figure 2. The main entities handling a RTP-based video flow are : the ARE (the Active entity closet to the Encoder) and the ARD (the Active entity closet to the Decoder). Both ARE and ARD can be dynamically installed on various equipments (terminals as well as routers) using the active network approach, or the WeB Service approach. The role of each agent depends on its location: the main role of ARD is to take information about the local link state, including particularly bandwidth, loss ratio and loss pattern, as well as the delay jitters. The main role of ARE is to decide the rate-control to be taken, according to the current link state.

4 Experimentation and results

Our experience has been carried on a variant of the ANTS platform [17, 18]. As said before, we use active network since we have in this way a tool for fast prototyping and for emulate wireless link errors as well.

The video traffic is a QCIF (176 x 144 pixels) full rate (15 frames/s) H.263+ [9] sequence at 150 kbps. The codec is developed by France Telecom, with a special function allowing the real-time rate regulation through a pre-fixed UDP port. The widely known test sequences Carphone and Coastgrd are used for the experiments.

In figure 3, we evaluate the performance of the proposed framework. Results are illustrated at QCIF resolution using 6 seconds of video at 15 fps for the sequences Carphone and Coastgrd and packet loss rates of 4%. The peak signal-to-noise ratio (PSNR) is used as an objective image quality measure.

First, we investigate the loss prediction performance of our ARM mechanism. In this test, the active control and rate regulation are performed using the original frames of the Carphone and Coastgrd sequences. The left of figure

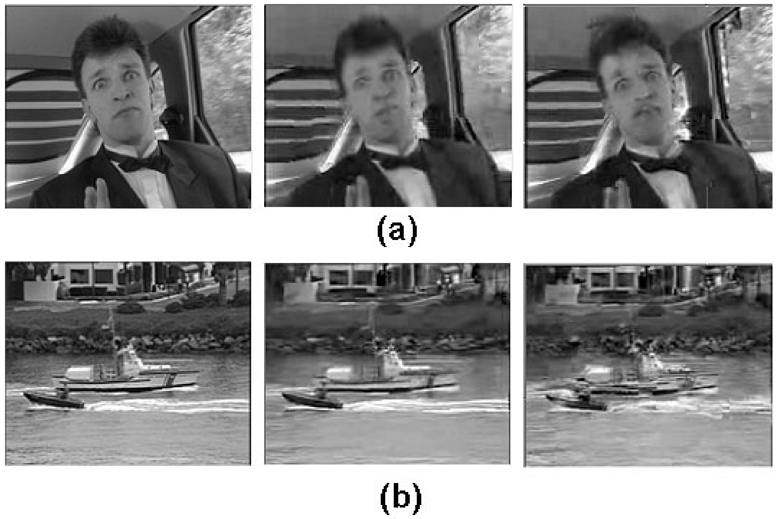

Figure 3: (a) Carphone test: the 215th frame, in the left the original frame, the middle is the ARM (23.51dB) and in the right the RTCP environment (18.40dB). (d) Coastgrd test: the 89th frame, in the middle the ARM correction (27.74dB) and in the right the RTCP correction (18.36dB)

3 shows the original 215th Carephone frame and the original 89th Coastgrd frame. The middle of this images shows the proposed framework. Finally, the right images show the correction done with the RTCP protocol. It can be seen that the ARM mechanism anticipates the loss of packets appearing with the existing correction mechanism, (figure 3, the right images (a) and (b)).

Our experiments show one major advantage of our active regulation mechanism, which is the fact that the active entity can adapt the video traffic to the currently available bandwidth in a responsive manner, with a whole vision of the link. With our controlling framework, we are able to react faster than the existing correction mechanism.

5 Conclusion

In this paper we have presented some results of a dynamic rate control mechanism. This latter is context-aware in the sense that it takes into account in real-time the situation of the link. In Our experimental results show that our approach does offer a responsive control of the video communication by reacting to the variation of the resources in the link. We believe thus it is a good candidate for handling video-communications over wireless links. It is to mentioned also that our experiences have been done with a codec accepting direct rate control (instead of the much lower RTCP-based control loop). The active network is used as a prototyping tool in our experiences.

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