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A study of H.263 traffic modeling in multipoint videoconference sessions over IP networks

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Abstract

This manuscript is a contribution on the modeling of H.263 traffic in multipoint videoconference sessions over IP Networks. Our study includes analysis and modeling assessment of extensive data gathered during realistic videoconference sessions between commercial H.263-compliant terminal clients (with different videoconference software packages installed). All terminal clients were communicating through a Multipoint Control Unit (software or hardware MCU) at 'switched presence' mode and for comparative purposes the same typical videoconference content (a person speaking, with mild movement and occasional zoom/span) was used. The analysis of the H.263 data at the frame level suggests that the traffic from the different terminals to the MCU can be represented by a stationary stochastic process with an AutoCorrelation Function (ACF) rapidly decaying to zero and a Gamma formed marginal frame-size Probability Distribution Function (PDF). An accurate analysis of the H.263 traffic from all terminals (with the same visual content and different videoconference software used) shows indicative differences in the ACF and PDF of different terminals' traffic and insights that no generic traffic model can be applied for all cases. Aiming at a realistic, reusable and simple H.263 traffic model, conservative enough for queueing analysis and network estimation, this study discusses methods for calculating the appropriate model parameters from the observed traffic data and proposes a new technique for unconventional fitting of the PDF. The presented modeling and queueing results indicate the suitability of the proposed models for H.263 traffic modeling in IP networks.

Keywords: H.263 traffic modeling; Multipoint videoconference; MCU; Queueing

1. Introduction

Videoconference traffic modeling has been extensively studied in literature and as a result a wide range of methods (linear and non-linear) can be found. Successful traffic modeling can provide valuable insights about the resulting network load and enables a theoretical assessment of the network performance. However, the variation of the videoconference session parameters (number of participants, video bit rate, frame rate) and visual contents as well as the differences in the implementations of the video coding algorithms turn accurate video traffic modeling into a complex procedure.

The results of earlier studies as [2,3,16,19,21], concerning variable bit-rate video streams in ATM networks, indicate that the histogram of the vbr video frame sizes exhibits an asymmetric and of Gamma form shape and that the autocorrelation function decays quickly (approximately exponentially) to zero. An important body of knowledge in vbr traffic modeling is the approach in [13] where the DAR(1) [9] model is introduced. In this study, the authors noted that AR models of at least order two are required for a satisfactory modelling of the examined H.261 encoded traffic patterns. However, in the same study, the authors observed that a simple DAR(1) model, based on a discrete-time, discrete state Markov Chain performs better—with respect to queueing—than a simple AR(2) model. In the same study, the parameters of the DAR(1) model were matched to the frame-size sequence histogram (fitted to a Gamma probability distribution function by the method of

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moments) and the exponential autocorrelation decay rate (derived from the AR(2) model). Several other models have been proposed for vbr video traffic modeling such as the GBAR(1) [5] and the SCENIC model [6]. The GBAR model could be a solution for H.263 traffic modeling, as it was especially designed for videoconference and its performance with respect to queueing was found to be similar to DAR(1). On the contrary, SCENIC is oriented to full motion video and not to a typical videoconference content with no abrupt scene changes.

Newer studies of vbr video traffic modeling reinforce the general conclusions obtained by the above earlier studies, by evaluating and extending the existing models and also proposing new methods for successful and accurate modeling. Of particular importance for our work, is the approach in [23] where a continuous version of DAR(1) model was proposed, named C-DAR(1). The C-DAR(1) model combines an approach utilizing a discrete-time Markov chain with a continuous-time Markov chain. The C-DAR(1) model is suitable for theoretical analysis using the fluid flow method [27]. Furthermore, in [20], a 'stuffing' method was used for grouping frames into variable frame periods. In this study, the use of movies, like Starwars, as visual content, led to frames generation with an approximate Gamma PDF (more complex when a target rate was imposed) and an ACF quickly decaying to zero. In [10], H.263+coded vbr video traffic in ATM networks was studied and the authors proposed a new model called DAR(M) which is a compound DAR(1) model. The DAR(M) model analyses the number of cells in each type of macroblock (MB) of a frame separately (I-coded, P-coded and N-coded). The final model is the mean of the DAR(1) models for each type of MB. For the purpose of PDF modeling and correlation coefficients estimation (in the same study), the authors used the typical methods of DAR(1). A scene-based MPEG traffic modeling was proposed in [17]. In this study, the authors used a simple scene detection algorithm that models scene changes by a state transition matrix and the number of GOPs of a scene by a geometric distribution. A shifting level process was applied in [18] to capture the Long Range Behavior of vbr video traffic. In this study, the authors proposed a compound ACF consisting of an exponential function, in the small lag, and a hyperbolic function in the large lag region. Long range dependence, however, is an issue of no interest here as videoconference traffic has been found to be only asymptotically self-similar [7], at a time scale not affecting queueing. This fact makes the short-range dependent method of DAR(1) and extensions of it appropriate for H.263 traffic modeling. Furthermore, a study of measurement and simulation of videoconference traffic (H.261 and H.263) in [4] indicated the influence of the session parameters (codec, quality, frame rate, maximum bandwidth) on the generated traffic pattern. Again, the PDF of H.263 traffic (at the frame level) was found to be of Gamma form and the ACF was decaying quickly to zero. A normal mixture distribution for vbr video traffic was proposed in [11] instead of the Gamma–Pareto distribution that was claimed to perform better than the simple Gamma and lognormal distributions (although it is rather complex). Towards the modelling of videoconference traffic encoded by the ViC Intra-H261 encoder, the author in [26] proposed a DAR(p) model using the Weibull instead of the Gamma density for the fit of the sample histogram.

Relevant recent studies are also [14] and [15]. In [14], the authors proposed a new marginal matching technique that produces a generalized model better than the GBAR and other DAR models. An AR-based analysis is performed in [15] for the modeling of MPEG video at GOP layer in ATM packet switching networks. GOP-based models proposed were tested with movies (like Star Wars) and seemed to perform satisfactorily.

Today, a large number of videoconference platforms exist, the majority of them over IP-based networking infrastructures and using practical implementations of the H.263 standard [8] for video coding. H.263[1] is extensively used because of its suitability for transmission over low bandwidth pipes (ADSL, ISDN) and its low processing demands (applicable to hand-held devices). In comparison to the previous implementation of ITU, H.261, it is generally confirmed and experimentally proved [4] that the H.263 encoder is intended to be used on links with smaller capacity (less than 64 Kbps) and thus produces frames which are in the average shorter than the frames generated by H.261 applications. Moreover, concerning the H.263 video codec, there are several problems of interoperability, due to the existence of different coding 'flavors'. There are H.263 draft, H.263 final and H.263+ implementations. This being the case, it is of great importance to know whether the models established in literature (for H.261, H.263 and vbr video traffic modeling) are appropriate for traffic modeling of the various implementations of the H.263 coding algorithm. It is a point of question whether all the existing H.263 versions generate similar traffic so that a common model could be applied. If not, new or alternative models should be proposed for each case. Moreover, videoconference, as a service for entertaining (video chat), educational (virtual classrooms) and communicating (through voice or sign language) purposes, is now held through Multipoint Control Units (software or hardware) that employ a centralized management for better quality of the sessions. In such a case, the traffic from the clients to the MCU is highly influenced by the parameters of the possible scenarios-modes of the MCU (codec used, number of participants, video bit rate, frame rate). Most of these factors (as will be commented upon later) change the statistical

[1] Although newer versions of the H.263 codec exist, namely, H.263+, H.264 they are not yet widely used and most videoconference clients do not support them.