CCITT SGXV
Working Party XV/1
Experts Group for ATM Video Coding

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SOURCE : UK
TITLE : Comparison of network loading models for two-layer variable bit rate coding
PURPOSE : Information

1. Introduction

There is increasing debate on the relevance of some of the candidate network loading models currently being used as an aid to variable bit rate (VBR) coding studies. Network loading models are needed to evaluate the efficiency of a variable bit rate coding scheme from a network operator's point of view. Two main issues are of concern; which model is best and what should be modelled? This document compares the results from two network loading models currently under consideration and discusses what should realistically be modelled.

2. A comparison of network models

Three network loading models are currently under study within Europe. The first is based on the peak and mean bit rate of a source and is termed the 'Large Deviation' model. The other two models use the mean bit rate and variance of a source. One uses a Gaussian distribution and the other is based on the 'Method of Equivalent Bursts'.

The Large Deviation model (adopted by CCITT SGXV as its first candidate) is reported to be more pessimistic with regards to the number of simultaneous sources that a defined network capacity will support compared to the other models based on mean and variance.

However, two important points should be considered when making a comparison between these models.

1) The two models that use mean and variance achieve greater network utilization by better modelling of the source and thus reducing the margin between the total network loading and the network capacity. However they make assumptions about the shape of the sources. If the sources do not conform to this assumed shape then the models become erroneous. On the other hand, the Large Deviation model, using only the peak and mean bit rate of the sources, guarantees a quality of service (QOS), because the model incorporates the most demanding source shape as one of its parameters. It is therefore a 'safe' or conservative model and will never overestimate the number of simultaneous connections that can be supported through the assumed shapes being different from the actual shapes.

   The price paid for this safety is the lower number of connections in comparison with the models which attempt to obtain higher loadings by incorporating assumed source profiles.

2) ATM network experts are presently only considering policing the peak and possibly the mean bit rate of a source, as parameters such as variance and standard deviation are difficult to determine until the completion of a call connection. Consequently, it is highly likely that call admission will be based on a source's required peak and mean bit rates.

Hence until such time as the ATM networks change their views on policing mechanisms the Large Deviation model is the most useful.

3. Comparison between probability of saturation and cell loss ratio

There is concern that modelling the probability of network saturation (P_{sat}) is pessimistic and does not provide a true representation of network loading. Some think that a better candidate would be based on true cell loss ratio (CLR).

P_{sat} evaluates the probability of the total bit rate for the number of sources exceeding the channel capacity (ie. congestion probability), whereas CLR evaluates the probability of a lost cell, on a particular call, when the total bit rate for the number of sources exceeds the channel capacity.

3.1 Results

A comparison has been made for two-layer coding on the effect of Psat and CLR on the network loading. The equation for the Large Deviation model for CLR is given in appendix A.

The plots shown in figures 1, 2, 3 and 4 were derived from source data of a two-layer coder , a sample of which is shown below in Table 1. The figures highlight the discrepancy between P_{sat} and CLR for each network model and are summarized in Table 2. The studies were carried out using the 2-layer codec data for two test sequences, Table Tennis and Jack-in-the-Box, for a network capacity of 599 Mbit/s.

Sequence Name	CBR Mean Bit Rate (kbit/s)	VBR Mean Bit Rate (kbit/s)	VBR Peak Bit Rate (kbit/s)	VBR Std. Dev (kbit/s)
Table Tennis	1856	1282	3341	1046
Jack-in-the-Box	320	284	1532	364

Table 1: Bit rate results for a 2-layer CBR/VBR codec

Sequence Name	$P_{sat} = 10^{-3}$		CLR = 10^{-3}	
	Large Dev. No. of calls	Equiv. Bursts No. of calls	Large Dev. No. of calls	Equiv. Bursts No. of calls
Table Tennis	166	176	172	182
Jack-in-the-Box	880	933	913	958

Table 2: Comparison of P_{sat} and CLR.

The results show that the cell loss ratio is about two orders of magnitude less than the congestion probability. However the results show that when this discrepancy is represented as a difference in the number of simultaneous calls the difference is no more than 5%.

4. Conclusions

The network loading model currently adopted by CCITT SGXV provides a lower limit on the number of calls accepted onto a network.

The model has been updated to calculate the actual cell loss ratio. The results show that the discrepancy between using P_{sat} and CLR is small.

Appendix A : The method of Large Deviations

The source is assumed to be alternately active, transmitting at a peak rate of P, and silent. The relative durations of the on and off periods is chosen such that the mean rate of the model matches the mean rate of the source. No account is made of the variance of the source.

The equation of the model is

$$P_{sat} = \exp(-n * k)$$

where P_{sat} is the probability of saturation
n is the number of simultaneous calls

$$k = (a * \ln(a/p)) + ((1-a) * \ln((1-a)/(1-p)))$$

where $p = MVBR / PVBR$

and PVBR is the peak variable bit rate component of the codec
MVBR is the mean variable bit rate component of the codec

$$a = AV\_CAP / (n * PVBR)$$

where AV_CAP is the network capacity available for the VBR component

$$AV\_CAP = CAP - (n * CBR)$$

where CAP is the capacity of the network
CBR is the constant bit rate component of the codec.

The cell loss ratio (CLR) is given by the equation

$$CLR = P_{sat} / (n * MVBR * \ln ((a * (1-p))/(p * (1-a)))).$$

Note ln = log to the base 'e'.

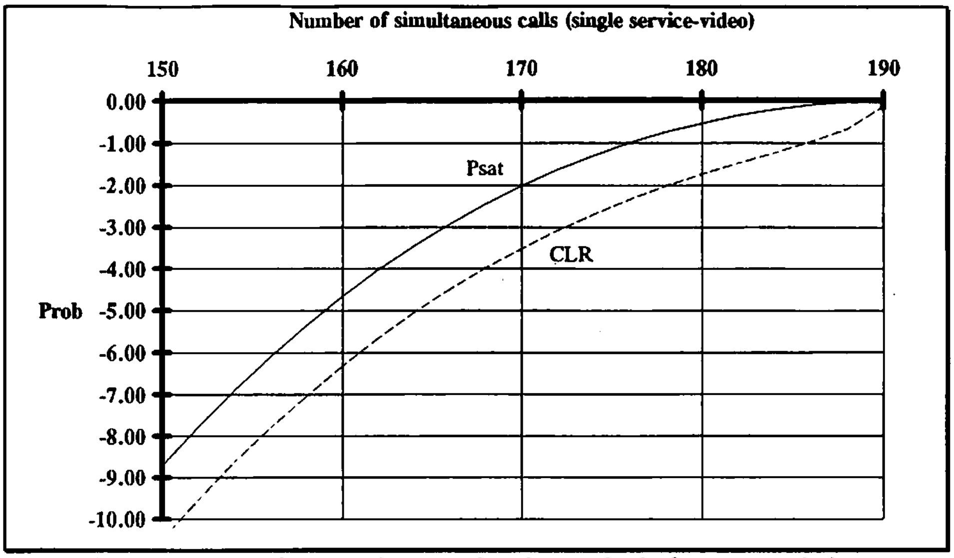

Figure 1: Plots of P_{sat} and CLR using the Method of Large Deviations
(Sequence : Table Tennis, Network Capacity = 599 Mbit/s)

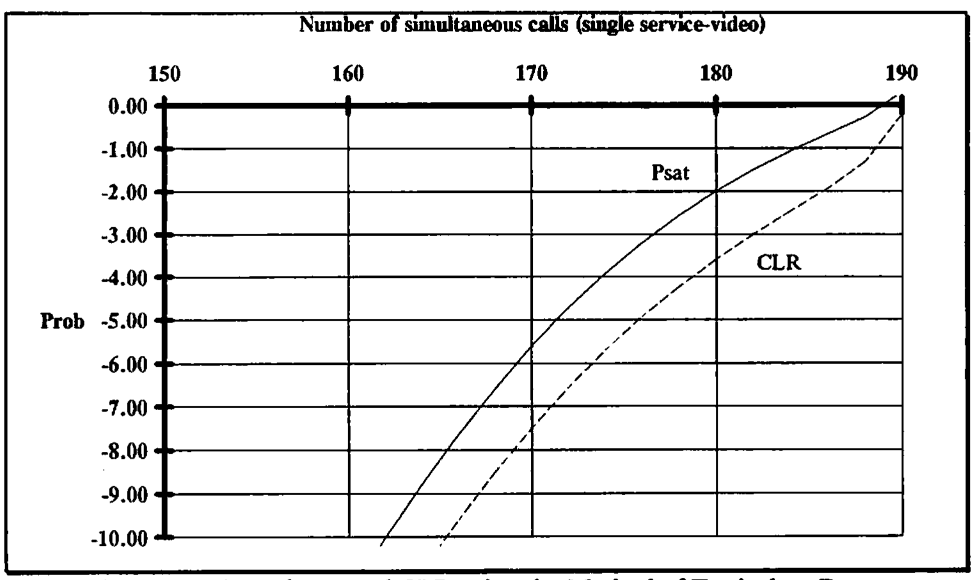

Figure 2: Plots of P_{sat} and CLR using the Method of Equivalent Bursts
(Sequence : Table Tennis, Network Capacity = 599 Mbit/s)

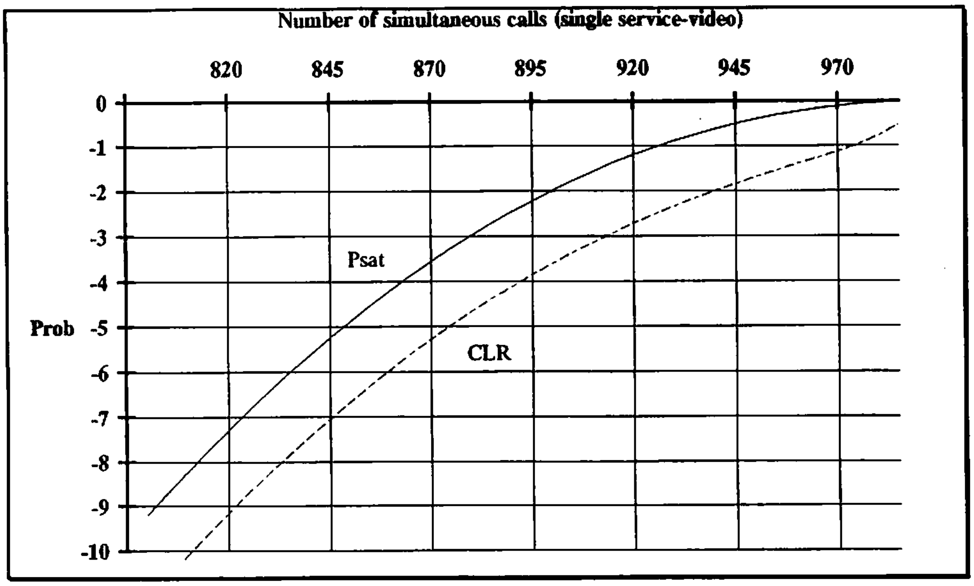

Figure 3: Plots of P_{sat} and CLR using the Method of Large Deviations
(Sequence : Jack-in-the-Box, Network Capacity = 599 Mbit/s)

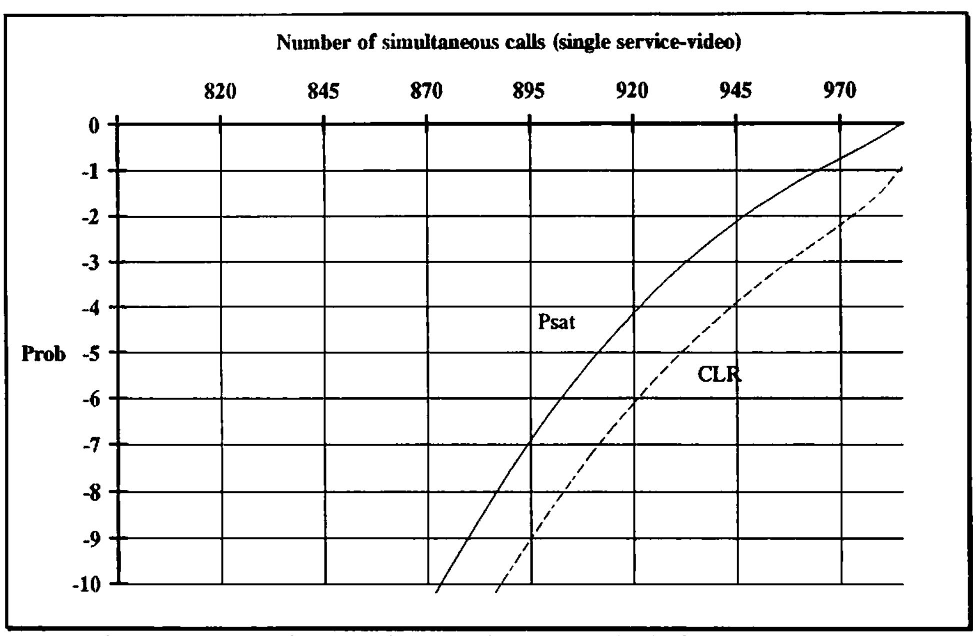

Figure 4: Plots of P_{sat} and CLR using the Method of Equivalent Bursts
(Sequence : Jack-in-the-box, Network Capacity = 599 Mbit/s)