https://doi.org/10.26552/com.C.2004.4.80-83

KOMUNIKÁCIE
COMMUNICATIONS

Peter Kvačkaj – Ivan Baroňák *

SUBMISSION TO CAC

Asynchronous transfer mode (ATM) is the base for future telecommunication network. The greatly variable requirements for different applications, especially in video and data traffic, make high demands on the development of traffic control in ATM networks. Speaking about Quality of Service (QoS), in ATM there is a traffic control mechanism, which ensures the standard requested by a new application or service. In the following paper an introduction to traffic control mechanism in ATM known as a connection admission control (CAC) and appropriate CAC method are presented.

Keywords: ATM, traffic contract, Quality of Service QoS, CAC method

1. Introduction

ATM is technology designed for broadband communication infrastructure. It ensures transmission of synchronous and asynchronous signals and provides a wide scale of services and applications. It links together advantages of fast packet switching and asynchronous time division. ATM provides universal communication environment for voice services, data and video transmission.

2. Traffic management

Each of the services has its own requirements for transmission. That is why the ATM must regard these requirements in the case of connection assembly and then during the transmission.

Traffic management used in the ATM technology has an important role before the connection is completed. Traffic management realizes the process of agreement between the user and communication network on QoS – *traffic contract*.

Traffic contract is a deal between the user and communication network. Traffic source characteristics are described with *traffic parameters*. After the realization of contract some of them become points of agreement, so called *QoS parameters*:
- *Peak Cell Rate* – PCR,
- *Sustainable Cell Rate* – SCR,
- *Maximum Burst Size* – MBS,
- *Minimum Cell Rate* – MCR,
- *Cell transfer delay* – CTD,
- *Maximum Cell transfer delay* – MaxCTD,
- *Cell loss ratio* – CLR.

Five categories of services in ATM are defined according to these parameters:
- *Constant Bit Rate* – CBR,
- *real time Variable Bit Rate* – rt-VBR,
- *non real time Variable Bit Rate* – nrt-VBR,
- *Available Bit Rate* – ABR,
- *Unspecified Bit Rate* – UBR.

The user guarantees not to exceed the QoS parameters presented in the contract (for example peak cell rate), but the network guarantees it only in the case of the QoS conditions adherence. The requirements of different applications are greatly variable. Consequently it is necessary to admit mechanisms which prevent the network from congested states and from signal degradation. These mechanisms are part of traffic management and they can be divided into two groups.

1. *Reactive mechanism* reacts only in cases when the capacity of a link is exceeded.
2. *Preventive mechanism* tries to prevent the network from overload situation with statistical estimation of possible on-coming network status in the case of new connection admission or with traffic monitoring and controlling.

In this paper we review possibilities of one of the preventive mechanism: the connection admission control CAC.

3. The chosen method of analysis

CAC method deals with the question whether a network node can admit a new connection or not with respect to QoS requirements of new connection and the connections in multiplex.

Some of the methods are based on mathematical models with exploitation of knowledge in the field of probability and statistics. Other methods are based on the traffic measurements or on the buffer exploitation analysis in the network nodes. CAC methods are also implemented in the environment of neural networks or using fuzzy systems.

Some of the methods need a specific traffic model others use a set of traffic parameters, for instance PCR and SCR.

* **Peter Kvačkaj, Ivan Baroňák**
Faculty of Electrotechnical and Informatics, STU, Ilkovičova 3, 812 19 Bratislava, Tel.: +421-2-68279604.
E-mail: kvackaj@ktl.elf.stuba.sk, baronak@ktl.elf.stuba.sk

3.1 Effective bandwidth method

This principle is one of the most popular. This method is difficult to compute in real conditions, so there is need to use simplified formulae for effective bandwidth estimation for on-off traffic models. For the buffer size B and a number of N connections, in this case the estimated effective bandwidth for i-th connection is:

$$C_i = R\,\frac{y - B + \sqrt{(y+B)^2 + 4yaB}}{2y} \qquad (1)$$

where

$$y = (-\ln \varepsilon)\left(\frac{1}{\beta}\right)(1-a)R \qquad (2)$$

where R is source peak cell rate, a is a source activity factor and $1/\beta$ is burst length.

The question of admitting a new connection is expressed in this simple formula

$$\sum_{i=1}^{N} C_i(\varepsilon_i) \le C \qquad (3)$$

The simplified formulas (1, 2, 3) are not exact when the buffer size is small or moderate. Either estimation of effective bandwidth is higher than the one used in real traffic. That is why compromise was made using the continuous traffic model and calculating effective bandwidth from the Gaussian approximation. The use of continuous traffic model fails to account the statistical multiplexing gain, but the result is a lower bandwidth estimation. The required bandwidth for the Gaussian approximation equals

$$C_B = \sum_{i=1}^{N} \lambda_i + \left(\sqrt{-2\ln(\varepsilon) - \ln(2\pi)}\sum_{i=1}^{N} \delta_i\right) \qquad (4)$$

where λ_i is the mean rate of cell interarrival time and σ_i is the variation of cell interarrival time for each i-th connection. The result is the required bandwidth C_B given by the Gaussian approximation. Finally, the estimated bandwidth for i-th connection is

$$\min\{C_i, C_B\} \qquad (5)$$

The result of this estimation for each connection is: admission or rejection of the new connection.

3.2 Simulation of effective bandwidth method

3.2.1 Traffic model

It is necessary to create an on-off traffic model to verify functionality of the effective bandwidth method. A source is able of transmission on two possible states: the source is active and transmits with cell rate equal to its QoS parameter PCR, or is passive and does not transmit.

Traffic generated with the source is characterized with parameters of peak cell rate (PCR) and sustainable cell rate (SCR). If the traffic is monitored during the time interval T, the formulae demonstrated below are obtained. For specification of time T the following condition must be taken into account

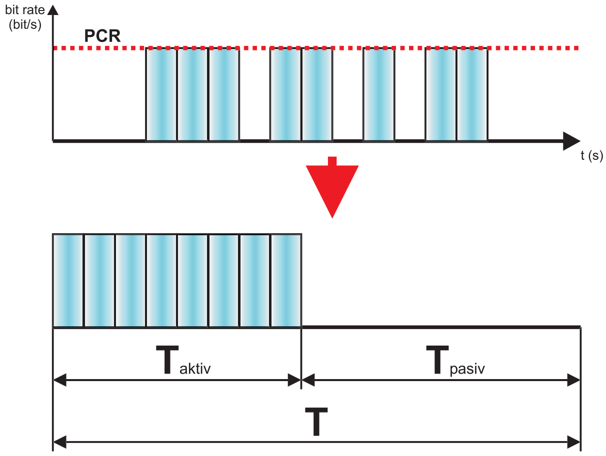

Fig. 1 Time of source active state

$$T >> \frac{1}{PCR} \quad \text{(s)} \qquad (6)$$

The time of active state of the source is obtained from its traffic parameters

$$T_{aktiv} = \frac{SCR}{PCR}\cdot T \quad \text{(s)} \qquad (7)$$

and the time of source passive state

$$T_{pasiv} = T - T_{aktiv} \quad \text{(s)} \qquad (8)$$

The parameters mentioned above are used for designation of the following parameters – cell burst length

$$\beta^{-1} = T_{aktiv} \quad (\text{s}^{-1}) \qquad (9)$$

and the source activity factor

$$a = \frac{\theta}{\theta + \beta} \qquad (10)$$

where

$$\theta = 1\backslash T_{pasiv} \quad (\text{s}^{-1}) \qquad (11)$$

The parameters mentioned above are necessary for estimation of the effective bandwidth for traffic generated with the certain source.

3.2.2 Method simulation

An abstract traffic model is characterized by the vector si for each i-th connection

$$s_i = (x_1, x_2, \ldots, x_i, \ldots, x_M) \ \text{ for } \ i = 1, 2, \ldots, N$$
$$\text{where } \ x_i \in \{0, PCR_i\} \qquad (12)$$

in the case of N connections, where M stands for a number of discrete cell rate measurements during the time interval T and x_l represent concrete values. Supposing two cases of traffic, in the first case the PCR value for each connection is generated with the formula

$$PCR_i = (c/N) \cdot k \qquad (13)$$

in the latter case the PCR value is different for each connection

$$PCR_i = (c/2^i) \cdot k \qquad (14)$$

where N stands for a number of connections and the value of constant k is a set to exceed capacity of an output link. SCR can gain values between 0 and PCR (0 and PCR value included) of this connection using the formula

$$SCR_i = \frac{\sum_{l=1}^{M} x_l}{M} \qquad (15)$$

The simulation parameters are:

- buffer size $B = 1$ *cell*,
- output link capacity $C = 155$ Mbit/s
- number of connections $N = 100$,
- number of discrete patterns of connections cell,
- required cell loss probability $CLP = 0.1$ for each of the connections.

The results of simulation are presented in graphs (Figure 2 and 3). From left to right there are:

1. PCR and SCR generated values.
2. Effective bandwidth estimation for each of the connection.
3. Generated traffic with output link capacity.
4. Estimation of needed capacity for certain number of connections in multiplex.

Each of the N connections is characterised with its peak cell rate PCR and sustainable cell rate SCR (1. Connection requested PCR and SCR). All the connections in the multiplex generate VBR traffic (3. VBR data flow). The peak cell rate PCR and the sustainable cell rate SCR are input parameters for calculations of

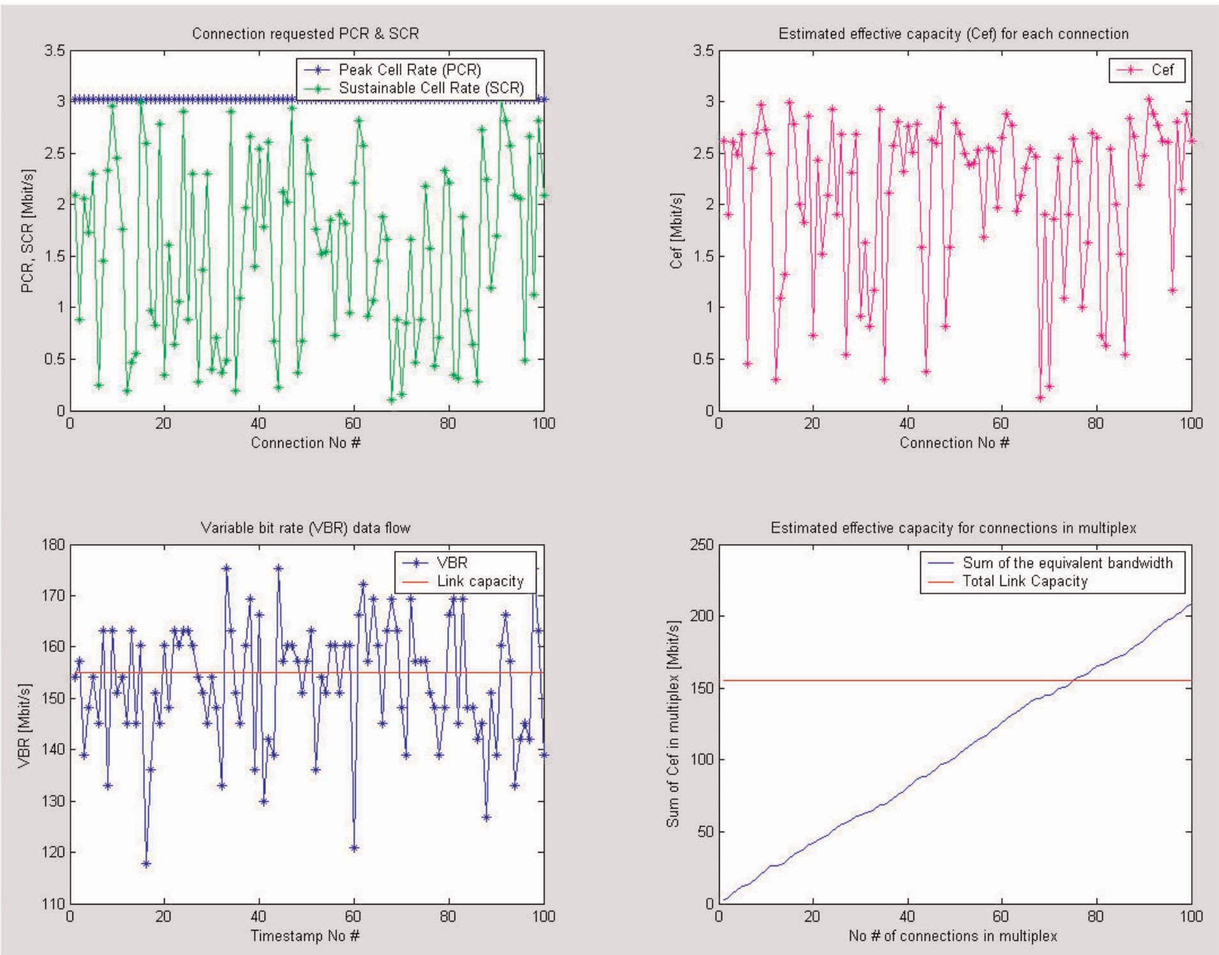

Fig. 2 Simulation results for first case of traffic state (constant PCR)

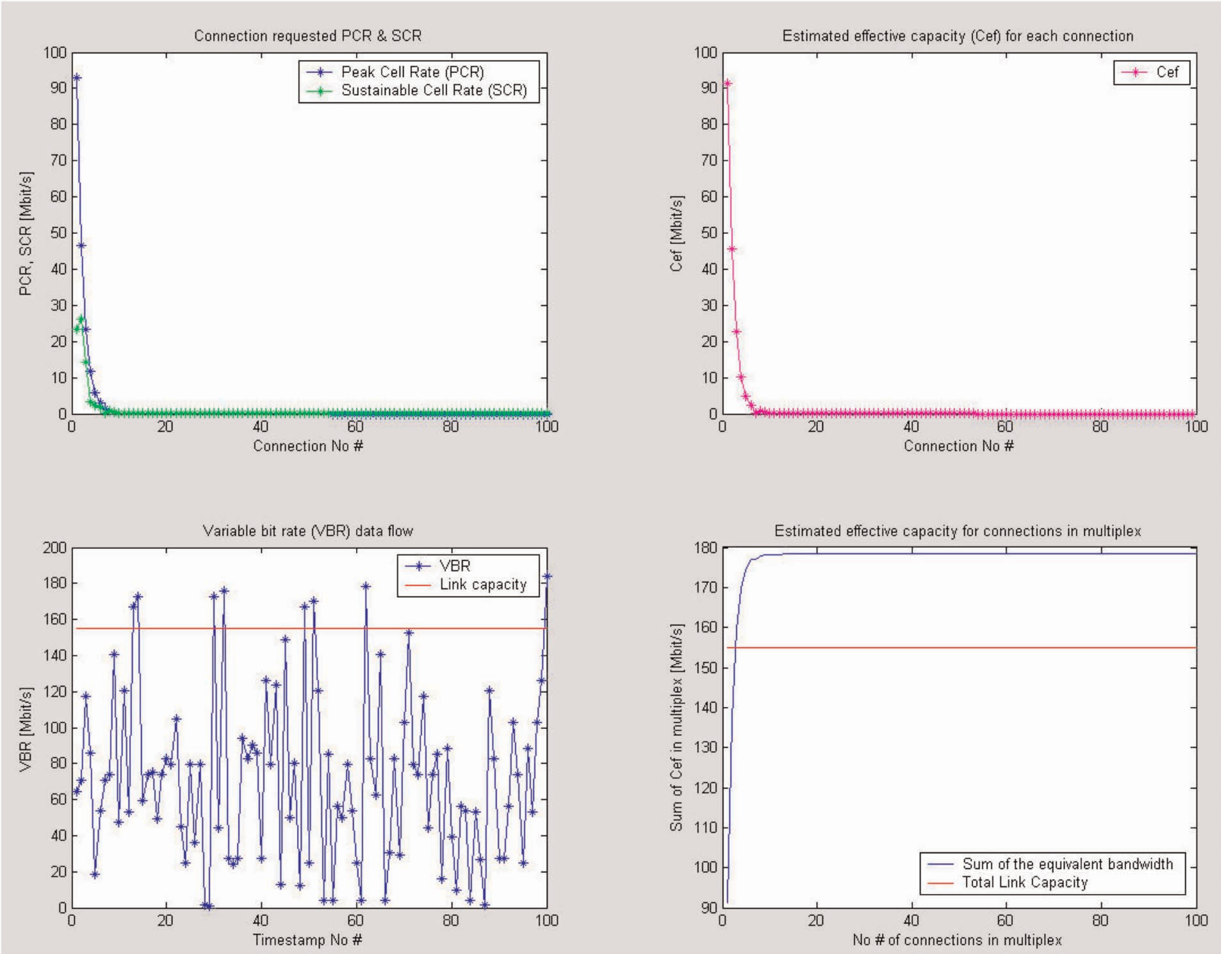

Fig. 3 Simulation results for second case of traffic state (variable PCR)

the CAC method. As a result, the CAC method returns an estimation of the needed effective bandwidth for each connection (2. Estimated efficient capacity). The summation of estimated bandwidths can not exceed the output link capacity or the connections will be rejected (4. Estimated efficient capacity for connections in multiplex).

Estimation of the CAC method in the first case enables admission to multiplex for approximately 76 connections, others will be rejected.

In the second case the first two connections take whole output link capacity. Admission for other connection will be rejected.

4. Conclusion

A properly created abstract model enables to visualize results obtained from simulation. By means of the results we can assume whether the CAC method is suitable for given environment or not. In real systems the choice of a suitable CAC method is a strategic point for effective exploitation of link capacity and QoS guarantee.

References

[1] BAROŇÁK, I., KAJAN, R.: *Management of Broadband ATM Network* (in Slovak). In.: TELEKOMUNIKACE 97, International Scientific Conference Brno, VUT, 12 June 1997, pp. 6–12.

[2] BAROŇÁK, I.: *The Pilot Project – ATM Network*. In: Bridging East&West Through Telecommunications. Acapulco, Mexico, 22–25 May 2000, pp.760–763.

[3] GELENBE, E., MENG, X., ONVURAL, R.: *Diffusion based statistical call admission control in ATM,* Journal Performance Evaluation, 1996, No. 27&28, pp. 411–436.