Study of Dependencies between Structure and Performance in BISDN

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Abstract – **The services in the telecommunication network supplied suppose an increasing change in the character of the input traffic causing changes in the conditions of servicing. The changes in the quality of servicing of the subscribers are assessed and determined in a particular structure of servicing according to the characteristics of the input traffic for a set of different services under the conditions of wide-band integral networks.**

Keywords – **BISDN, ATM, QoS, Traffic flows**

I. Introduction

The concept of Quality of Service – QoS is defined by ITU–T (G.106) as the sum effect of the possibilities of the services which determine the degree of satisfaction of the consumer of these services, i.e. the quality of servicing is defined as a complex estimate of the consumer of the performance of the network supplying a certain set of services in realizing the chosen service by him. In practice QoS is defined by means of many different parameters. Part of them is quantitatively definable which allows for their standardizing, while the rest of the parameters are subjective (depend on the actions of the subscriber) and are hard to standardize.

Network Performance ITU – T defines as an ability of the network or part of it to secure the communications between the consumers. It is a set of parametres, which are used for its design, configuration, functioning and maintenance. It is important that the consumer oriented parametres of QoS, although forming an important basis for network design need not necessarily directly be used. Similarly, the parametres of network functionality determine QoS from the point of view of the subscriber-consumer.

The delay of the information "end to end" in ATM is formed by: transfer delay, packaging delay, switching delay (fixed and variable), equalization delay.

The total losses of the information by its transfer through ATM network end to end are formed by: header losses, multiplexing and switching losses.

The criteria for QoS (the delay and losses of information which are standardized for each type of traffic) of ATM layer are determined by: cell transfer delay, the dispersion of the delay time, the probability of cell loss, and the probability of errors in the cells.

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II. Simulation Model and Results

A basic function of the multiplexer is the multiplexing in an output ATM line of flows of cells generated by the separate sources (primary multiplexers) or coming from input ATM lines (secondary multiplexers). The multiplexer is a buffer (queue) with a certain size and the server from traffic point of view of ATM layer, which transfers by the output ATM line the cells, which are in the buffer according to the accepted serving discipline. The transfer rate depends on the speed of the output line; the transfer time (processing) of each cell is a constant, because of its fixed size.

The functions performed by the ATM switch are translation of the headers (addresses) of cell (asynchronous switching with time division), routing of the consumer information transferred (spatial switching) and buffering. Buffers are installed to the switches for buffering for waiting cells with the purpose of reducing cell losses.

The traffic capacity of a fragment of an ATM network can be assessed quantitatively by using a simulation model by means of the parametres of QoS, which is achieved for the different services in the conditions of servicing of wide-band traffic [1], [2]. Fig. 1 shows the structure of the serving ATM system.

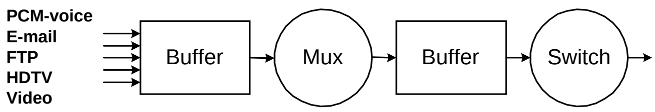


Fig. 1. Structural diagram of the servicing ATM system

TABLE I
PARAMETERS OF INPUT TRAFFIC

	PCM - voice	E-mail	FTP	HDTV	Video
α_c	1000-2000 μs	50-100 μs	400-600 μs	1-2 μs	20-40 μs
b	1	1	1	2-5	2-5
α_0	3-10	2-6	1-5	1-3	1-3
t_0	31,3-46,9 *ms*	33,3 *ms*-520,1 *s*	15,6 *ms* - 104,1 *s*	33,3 - 93,3 *ms*	1 - 156,3 *ms*
v	64 *kbit/s*	9,6 *kbit/s*-1,5 *Mbit/s*	9,6-64 *kbit/s*	155 *Mbit/s*	64 *kbit/s*-2 *Mbit/s*

This system is simulated with parametres of traffic shown on Table I and under the following conditions:

- The services referred (we assume that traffic sources have exponential distribution) are: PCM-voice, E-mail, FTP, Video, and HDTV;

- The traffic flows in BISDN studied have a tree-layer structure and for the purpose of the research all tree layer are studied (call, activity, cells).

- The servicing of the cells in the queues of the system is according to the FIFO discipline; the switch is with input queue.

In Table I the symbols meaning:

α_c - average value of the intervals between the arrival of successive cells;

b - ratio between activity and pause (at activity layer);

α_0 - average value of the intervals of arrival between two independent calls;

t_o - average value of the time length of one call;

v - average speed of the input flow.

Time servicing of cells and queue length is shown in Table II.

TABLE II
TIME SERVICING OF CELLS AND QUEUE LENGTH

	Queue Length	Time Servicing, μs
Multiplexer	$Q_m = 1 - 60$	$\tau_m = 2{,}73$
Switch	$Q_s = 1 – 60 \; (100)$	$\tau_s = 100$

The following delays and losses of information are not an object of investigation: transfer delay - depends only on the physical transfer environment, packetizing delay - depends on terminals, fixed delay from switching - depend concrete hardware realization of the switch, equalization delay, error losses in the information field of cells - they do not depend on the specifics of ATM as a method for information transfer, error losses in the header of the cells.

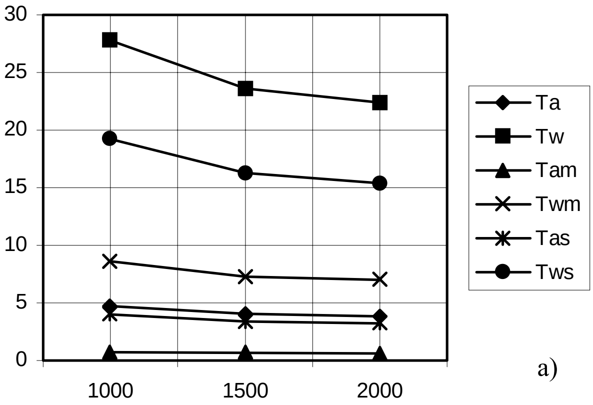
For determining the traffic characteristics of services the following losses and cell delays characterizing the behaviour of the ATM network are collected from the model according to the parametres of the input traffic sources flows: variable delay from switching - its due to buffering used in ATM switches and multiplexers, and depends on the loading of the network, losses of cells in multiplexing and switching. Because of the limited capacity of the buffers in the ATM multiplexers and switches and the stochastic character of the input flows of cells, it is possible that they overflow which leads to loss of the cells on the input in that moment. Part of the results obtained is shown on Fig. 2.

The meaning of the symbols on the figure is: T_a – average waiting time of all cells in the whole system; T_w – average waiting time of the cells having waited in the whole system; T_{aM} – average waiting time of all cells in the multiplexer queue; T_{wM} – average waiting time of the cells having waited in the multiplexer queue; T_{as} – average waiting time of all cells in the switch queue; T_{ws} – average waiting time of the cells having waited in the switch queue.

III. CONCLUSION

The results obtained allow for the following conclusions:

1) At a constant speed of the intervals between the arrival of two successive cells α_c and change of the intervals of the arrival of the calls α_0 the delays are minimal at minimal intervals of arrival of the calls.



a)

b)

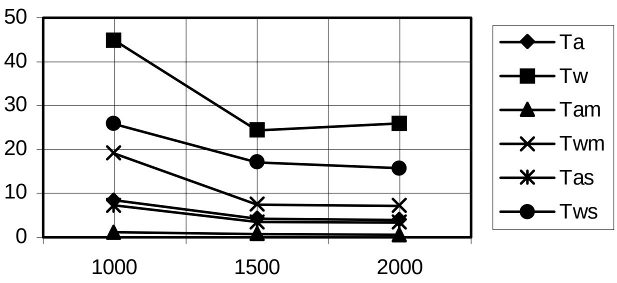


Fig. 2. Correlation between delay time and α_c for $\alpha_0 = 3\ \mu s$, $t_0 = 35\ ms$, $b = 1$, $Q_m = 2$, $Q_s = 2$ (a) and for $\alpha_0 = 10\ \mu s$, $t_0 = 35\ ms$, $b = 1$, $Q_m = 2$, $Q_s = 2$ (b).

2) At a constant speed of the intervals of the calls α_0 and a change of the intervals between the arrivals of two successive cells α_c the delays decrease with the increase of the intervals between the arrivals of two successive cells.

3) At constant speeds of the arrival intervals of the calls α_0 and of cells α_c and a change in the size of the buffers the losses of the cells and the delays of the cells are zero when the size of the buffer (the queue) is larger then 60 which is due to the high processing speed of one cell by the multiplexer. The switching network at buffer size about 100 meets the requirements for losses and delays. Although by little the reduction of the buffer leads to a significant increase of cell losses with is due to the small capacity of the switch.

The analysis of the results obtained can serve the purposes of the teletraffic design of communication networks, which serve not only telephone traffic.

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