Estimation of a Required Size of a Buffer of Telecommunication Equipment at Serving Fractal Traffic

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Abstract - **The On/Off model of the Ethernet fractal traffic has been considered. The On/Off model tuning to describe actual Ethernet traffic has been done. The experimental estimates of the average size of a buffer of telecommunication equipment at condition of serving both actual and synthesized according to On/Off model Ethernet traffics have been received.**

Keywords - **Ethernet traffic, mathematical model, On/Off processes, buffer size.**

I. Introduction

Over the past decade, a number of empirical studies have demonstrated that network traffic, generated by multimedia applications, exhibits self-similar nature [1]. Therefore, during development of telecommunication equipment, we need to take into account the fractal properties of this kind of traffic in order to serve it with an appropriate level of quality. There are several models of Ethernet traffic have been proposed. The subject of this paper is analysis of effectiveness of applying On/Off processes to modeling of Ethernet traffic.

II. Mathematical Model

On/Off processes are used to model traffic generated by a single source. Any On/Off process alternates between two stages: the On, during which a source generate traffic at a fixed rate, and the Off, during which a source remains silent. Let X_j and Y_j denote the duration of the j-th On and Off state, respectively. Most On/Off type models assume each of the X_j and Y_j to be i.i.d according to a heavy-tail distribution such as Pareto or Weibull.

The Pareto survival function equals Eq. (1):

$$P(X > x) = \begin{cases} (\frac{x_m}{x})^k, & x \ge x_m, \\ 1, & x < x_m, \end{cases} \quad (1)$$

where $x_m > 0$ is a constant and $k > 0$ is a tail index.

The Hurst parameter of the On/Off process equals [2] Eq. (2):

$$H = \frac{3 - \min(k_0, k_1)}{2}, \quad (2)$$

where $k_0, k_1 \in (1, 2)$ are tail indices of the On and Off durations, respectively. If the On or Off durations have finite variance then the corresponding tail index is taken as 2 when calculating H. An On/Off process is self-similar if corresponding Hurst parameter satisfies $0.5 < H < 1$, then at least one of the On or Off durations has to be heavy-tail distributed.

To estimate parameters of Pareto distributions, corresponding to On/Off stages, we used the Ethernet traffic BC-pOct-89 [3]. According to aggregated beforehand traffic data with the aggregation parameter $\Delta = 1$ ms, it were constructed histograms of distributions of time intervals, during which arrived less than 500 bits (modeled by Off stage), and time intervals, during which arrived more than 500 bits (modeled by On stage). Further going analysis of the histograms, yields us the estimates of Pareto indices: $k_0 = 1.49$, $k_1 = 1.32$.

Experimental dependencies of the average queue length q on the load (service ratio) ρ produced by the actual and generated traffics are shown in Fig. 1. To describe the buffer operation we used the following recurrent equation Eq. (3):

$$q_t = q_{t-1} + X_t - r_t, \; r_t = \begin{cases} c\Delta, & q_{t-1} \ge c\Delta, \\ q_{t-1}, & q_{t-1} < c\Delta, \end{cases} \quad (3)$$

where q_t is the queue length in bytes, X_t is an input traffic, c is an output channel capacity.

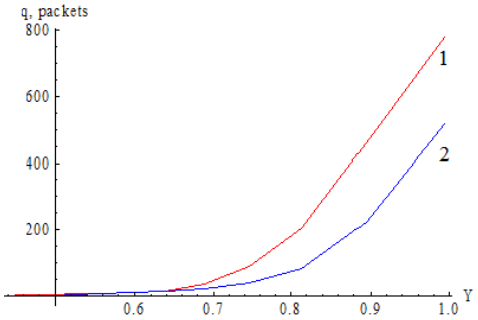

Fig. 1 The average queue length dependence on the input load: 1 – traffic generated according to the On/Off model, 2 – actual traffic.

III. Conclusion

The On/Off model allows us to estimate the average size of a buffer of telecommunication equipment, necessary to serve the fractal traffic with the demanded quality. The appropriate estimates have been done.

References

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