The Impact of Source Burstiness on Buffer Performance : the Burst Factor

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Extended Abstract

The quality of multimedia services that are carried by the present-day high-speed broadband communication infrastructure is to a large extent determined by the performance of the buffers that are encountered by such a stream in the various network components, such as routers, switching elements and cross-connects, modems, access multiplexers/de-multiplexers, network adapters and interfaces, and so on. The reason that such buffers need to be provided, is the highly irregular manner in which the data source(s) may inject packets into the network nodes, with multiple data streams vying for the often limited network. It is widely known that the performance of such buffers is mainly determined by the 'burstiness' of a packet source (or sources). However, how to measure and estimate the burstiness of a real source, and how to embed it in some kind of stochastic model, is often less than clear ([1]). In this contribution, we make an attempt to provide an, albeit partial, answer to these issues, by introducing the so-called *burst factor*, which is defined in a generic setting.

Let us consider a slotted system, whereby a slot represents the fundamental time unit, and let us represent by e_M the total number of packets that are generated by a source during M consecutive slots. We then define the burst factor κ_b as

$$\kappa_b \triangleq \lim_{M \to \infty} \sigma_{e_M}^2 \Big/ \left(M\sigma_{e1}^2 \right) \quad ,$$

whereby μ_X and σ_X represent the mean and standard deviation of the random variable X. Consequently, this parameter represents the variance of the total number of packet arrivals during a 'very large' time interval, relative to a scenario with i.i.d. packet arrivals. Note that this definition can be easily extended to the case where the overall packet arrival process is an aggregation of multiple, not necessarily identical, sources.

An investigation of a wide variety of queueing models ([2]) has now revealed that the burst factor plays a predominant role in the evaluation of the main buffer performance indices, such as the mean value, variance, and tail distribution of the queue length and packet delay. If we for instance represent by q the queue length in a *D-BMAP/D/c* queueing system, then one can show that

$$\mu_{q,\rho\to 1} = \sigma_{q,\rho\to 1} = \frac{\kappa_b \sigma_{e_1}^2}{2c(1-\rho)} \quad ,$$

where ρ represents the buffer utilization, and $\rho \to 1$ signifies that ρ lies close enough to 1. This result exemplifies the importance of κ_b in the assessment of the buffer behaviour.

[1] A. Rueda, W. Kinsner, 'A survey of traffic characterization techniques in telecommunication. networks', *Canadian Conference on Electrical and Computer Engineering*, 1996.

[2] B. Steyaert, 'Analysis of generic discrete-time buffer models with irregular packet arrival patterns', Phd thesis, 2008 (ISBN 978-908578-187-5).