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PROPERTIES OF THE CORRELATION BETWEEN QUEUE LENGTH AND CONGESTION WINDOW SIZE UNDER SELF-SIMILAR TRAFFICS

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Abstract. *Research into self-similar traffic is classified into four categories; measurement-based traffic modeling, physical modeling, queueing analysis and traffic control. Research regarding queueing analysis plays an important part in the establishment of basic performance boundaries, which are found by investigating queueing behavior with long-range dependent input. The aims of this research are to expand the observation of queueing behavior, to explore managing queueing activity for self-similar traffic using the network simulator in different conditions, and to clarify the causes of different features focusing on the bottleneck link. We attached the Pareto on/off traffic over TCP on ns-2 simulator and observed temporal queue length and congestion window size of TCP on the source node, from which certain properties were extracted. Self-similar property is preserved on the non-restricted bottleneck link even if the congestion window on TCP is consumed on the source node for long-range dependent input. On the other hand, small increase of traffic flow leads the property of self-similarity on the bottleneck link to disappear. The bursty TCP traffic creates the situation for long-range dependent traffic consuming the queue resource less.*

Keywords: Queue length, Congestion window size, Self-similar traffics, TCP

1. **Introduction.** Since the seminal study of Leland et al. [1], the scale-invariant burstiness, otherwise known as self-similarity has been found in real network. Currently, self-similarity of network traffic has been widely adopted in the modeling and analysis of network performance. The relation between self-similarity and network and/or system parameter has been mainly discussed in the context of application layer. Crovella et al. [2] indicate that this self-similarity is mainly caused by the file size of Web servers, and the ftp traffic has heavy-tailed property of Pareto distribution with $0.9 \leq \alpha \leq 1.1$ [3]. In addition, we measured file size of the top page on diverse Web servers and observed heavy-tailed distribution of file sizes [4]. These measurement-based traffic modeling require the verification of the mathematical modeling and the simulation-based modeling.

In their research into simulation-based modeling, Park et al. [5] conducted the simulation to evaluate network performances of self-similar traffic by varying network resources such as bottleneck bandwidth and buffer capacity. In an environment with fully equipped buffer size, Park et al. [5] observed a gradual increase in the packet loss rate as α approaches to 1, meaning that performance declines drastically as self-similarity is increased, as measured by packet loss rate in UDP-based non-flow-controlled environment. We discovered that packet loss rate gradually increases as α approaches 1 just before the bottleneck restriction causes the larger packet loss rate in both TCP and UDP heavy-tailed traffics. In addition, our simulation showed that throughput also increases gradually as α