International Journal of Innovative Computing, Information and Control
Volume **3**, Number **3**, June **2007**

ICIC International ©2007 ISSN 1349-4198
pp. **495–507**

SELF-SIMILAR PROPERTIES UNDER THE BANDWIDTH RESTRAINMENT

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Received July 2006; revised December 2006

Abstract. *The scale-invariant burstiness or self-similarity has been found in real networks. Relation between self-similarity and networks and/or system parameter is the center of discussion in the context of application layer. This self-similarity is caused by the file size of Web servers or the duration of user sessions. In addition, self-similar burstiness has been characterized by the transport layer protocol. Traffic dynamics, however, are mainly generated by physical conditions such as the resource restrainment. In this paper, we have investigated the property of self-similar traffic under the resource restrainment to make the network parameter vary using the network simulator. The main finding in analyzing the simulated results is that self-similar property is more sensitive to packet loss rate than to throughput. In addition, the following properties have been found; firstly, the packet loss rate at the boundary of releasing the restriction of bottleneck bandwidth suddenly drops from* 10% *to* 1% *in TCP traffic; secondly, estimated Hurst parameter depicts unstable fluctuation at over* 4% *packet loss rate, with linear slope at under* 4% *packet loss rate in both TCP and UDP traffic; thirdly,* 4% *packet loss rate changes the average energy from unstable fluctuations at finer scale to smooth linear relation in TCP.*

Keywords: Self-similarity, Resource restrainment, Network simulation, Error rate, Bandwidth

1. **Introduction.** Since the seminal study of Leland, et al. [1], the scale-invariant burstiness or 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. Relation between self-similarity and network and/or system parameter is 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 or the duration of user sessions, and ftp traffic has the heavy-tailed property of Pareto distribution with $0.9 \leq \alpha \leq 1.1$[3].

As these previous works mainly referred to passive measurement data or observation of the application layer, the discussion was confined to application layer or user activity.