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On the Changes of Self-similar Traffic through Optical Burst-Switched Networks*

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Summary

The changes of self-similar traffic through an optical burst-switched network were completely investigated for the first time. The results showed that the burst assembly/disassembly can change neither the self-similar nature of the traffic, nor the degree of self-similarity; they just change its short time-scale behaviors.

1 Introduction

IP over WDM has been regarded as the architecture of the next generation Internet, and optical packet switching (OPS) seems to be its basic switching mechanism. But due to the inefficiency of current optical technology, Optical Burst Switching (OBS) [1] is considered as the most possible approach to implement IP over WDM at present. This is mainly attributed to its following characteristics: the first is its intermediate switching granularity, which is between OPS and optical circuit switching (OCS or wavelength routed) and thus decreases the burden of optical switching matrix (compared to OPS) simultaneously improving bandwidth utilization (compared to OCS). The second is its separated transmission of data (or payload) and control (or header), and the delayed reservation mechanism which replaces the stored and forwarded mechanism of current IP and makes optical buffer unnecessary.

In 1990s, a lot of empirical studies of traffic measurements from a variety of working packet networks, including local and wide area networks [2–4], have convincingly showed that actual network traffic is self-similar or long-range dependent in nature. It is much different from the Poisson model commonly assumed for traffic modeling. The traffic properties affects the network performance greatly, especially when self-similar traffic model is adopted, the buffer designs and packet loss ratio predictions are faced with new challenges. Since OBS paradigm was proposed in 1999 [1], it has been extensively studied. The traffic properties change at the edge of OBS network is one of the main issues since it is concerned with packets assembly at the ingress and disassembly at the egress. But most of the previous work was focused on the impact of aggregation or assembly mechanism at the ingress, little was done for the effect of the whole network, and some conclusions are even problematic. Luo [5] investigated the arrival process and durations distribution of the aggregated bursts under two different assembly policies, but input traffic was still assumed to be Poisson process. The initial work on the burst traffic characteristics with self-similar traffic as inputs are reported by Xiong [6]. He has noticed the difference of burst traffic's behaviors in short and long term, and pointed out that smaller Hurst parameter at low aggregation level did not necessarily mean the traffic burstiness was substantially reduced. But only assembly was considered and it is not his focus either. Ge [7] claimed their timer-based assembly algorithm could reduce the self-similarity of traffic, but their result was questionable, mainly due to their evaluation method of Hurst parameter and limited time scales. Unfortunately, their conclusion is still cited until recently [8]. We feel it necessary to address this issue. Can the assembly really reduce the degree of self-similarity? Can the disassembly increase the degree of self-similarity? This paper is to answer these two questions explicitly.

2 Description of Self-similar traffic and network model

2.1 Definition, description and generation of self-similar traffic

Firstly, we review the definition and description of self-similar traffic.

Let $X = (X_t : t = 1; 2; \ldots)$ be a covariance stationary stochastic process with mean μ, variance σ^2 and autocorrelation function $r(k)$, $k \geq 1$. Assuming that X has an

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