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Maximum Burst Size of Traffic Determination for Switched Local Area Networks

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INTRODUCTION

The rapid establishments of standards relating to Local Area Networks (LANs), coupled with the development by major semi-conductor manufacturers of inexpensive chipsets for interfacing computers to them, has resulted in LANs forming the basis of almost all organizations' data communication networks. Switched LANs are quite recent developments by the computer networking community, in attempts, at solving, the slow response challenge of, formerly, traditional bus-based, including the hub-based, and token ring-based LANs; and, switched LANs have almost, if not completely, replaced these classes of LANs. Even at the MANs (Metropolitan Area Networks) and the WANs (Wide Area Networks) level, layer 3 switches are now taking over from routers. As the applications of switched LANs has grown, so is the demands on them to be connected to MANs and/or WANs, the Internet, inclusive. This has led to the issue of service provisioning agreements, also called, Service Level Agreements (SLAs), usually based on, agreed, QoS (Quality of Service) parameters, between, the operators of the MANs/WANs and the owners of the switched LANs that need these connections.

One of the parameters of these SLAs is the burst tolerance, which must be agreed upon, during a flow set-up phase, or, in the case of special service offerings like Carrier Ethernet services, the Committed Burst Size (CBS) specification agreed upon in the bandwidth profile definition. However, there is no general agreement in literature on how to characterize bursty traffic. Put differently, how should a value for burst tolerance or CBS be, arrived at, by a manager of a switched LAN that need to be connected to a MAN and/or WAN that is operated by another organization, for the purpose of arriving at a contract agreement? The maximum burst size of traffic determination problem has been discussed in this article, and a formula that can be used to calculate a switched LAN's traffic maximum burst size, in the context of connecting it to the Internet, Carrier networks, and, other similar communication subnets has been derived. A practical application of the derived formula is also illustrated.

BACKGROUND

In the context of service provisioning, the Internet supports the guaranteed and controlled-load services. While the guaranteed services class is designed for real-time traffics that need guaranteed maximum end-to-end delays, the controlled-load services class is designed for traffics that does not require this guarantee, but are, nevertheless, sensitive to, overloaded networks, and to the danger of losing packets. A file transfer session is an example of traffic that does not need real guarantee, while real-time audio and video transfers are examples of traffic that needs real guarantees. Both classes of services operate on the principle of 'admission control', in which a flow is set-up, which must conform to the IETF's (Internet Engineering Task Force's) T-SPEC. The admission control principle operates as follows: (Le Boudec & Thiran, 2004, p.75)

- In order to receive either type of service, a flow must first perform a reservation during a flow set-up.

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- A flow must conform to an arrival curve of the form σ(t) = min (M + pt, rt + b). In Intserv (Integrated Services) jargon, the 4-uple (p, M, r, b) is called a T-SPEC or traffic specification. In order words, the T-SPEC is declared during the reservation phase. Here, M = maximum packet size, p = peak rate, b = burst tolerance, r = sustainable rate.
- All routers along the path accept or reject the reservation. With the guaranteed service, routers accept the reservation only if they are able to provide a service curve guarantee and enough buffer for loss-free operation. The service curve is expressed during the reservation phase.

Similarly, Carrier Ethernet service providers define a Bandwidth Profile, which allows the service providers to bill for bandwidth usage and engineer their network resources to provide performance assurances for in-profile Service Frames. The CBS is one of the four parameters of this profile. Therefore, a major issue that has to be dealt with by both services' providers and managers of organizations' switched LANs, desiring these services, is, agreeing on the values for these parameters. However, empirical determination of the burst tolerance parameter of the T-SPEC and the CBS of a Bandwidth Profile has been a major challenge. For example, Sven, Ales and Stanislav (2008) have asserted that, metrics for traffic burstiness have not yet been defined, and, that methods to monitor traffic burstiness are not well understood. Ryousei et al. (2006) have also averred that, there is no consensus on a quantitative definition of data traffic burstiness.

Researchers have also, generally been confronted by the challenge of determining the maximum burst size of the traffic flowing in switched networks. For example, Georges, Divoux and Rondeau (2005), Song et al. (2002) used the Ethernet frame length as the value for maximum burst size for computational purposes in their study of switched Ethernet networks. But, the Ethernet frame length cannot be the value of the maximum size of burst traffic that flows in switched Ethernet networks. What is being inferred here is that, presently, it has not yet been possible to predict by any means that, from the on-set of a communication session, this is the maximum size of traffic bursts that will flow during the session.

Sven, Ales and Stanislav (2008) has however, contended that, network traffic tends to be bursty for a number of reasons, including: protocol design, user behavior and traffic aggregation; while Khalil and Sun (1992) have once argued that, traffic generated within token ring and Ethernet LANs are very bursty, due to the widespread use of distributed applications, and, high-speed computers, capable of transmitting large amount of data in a very short period of time. One of our goals in this article is, to derive an empirical formula, that can be used to determine the burst tolerance and CBS values of the traffic emanating from switched LANs for the purpose of preparing SLA contracts, in the context of connecting such LANs to Carrier networks. To the best of our knowledge, such a formula (or formulas) does not yet exist in literature.

BANDWIDTH PROFILES AND SERVICE LEVEL AGREEMENTS

In the context of Carrier Ethernet service provisioning, bandwidth profiles specifies, the average rate of 'committed' and 'excess' Ethernet Service Frames allowed into the provider's network at the UNI (User Network Interface). (Santitoro, 2013) Service Frames sent up to the 'committed' rate are allowed into the provider's network and delivered as per the service performance objectives; for example, delay, loss and availability, specified in the SLA or Service Level Specification (SLS). These Service Frames are referred to as 'in-profile' or 'conformant' to the bandwidth profile. In other words, when a customer is set up, the user and the subnet (that is, the customer and the carrier) agree on a certain traffic pattern or shape for that circuit; as long as the customer fulfills his/her part of the bargain, and only sends packets according to the agreed-on contract, the carrier promises to deliver them all in a timely fashion. (Tanenbaum, 2006, p.400) SLAs are not so important for file transfers, but are of great importance for real-time data, such as audio and video connections, which have stringent QoS requirements. Five typical parameters of bandwidth profiles are: Committed Information Rate (CIR), Committed Burst Size (CBS), Excess Information Rate (EIR), Excess Burst Size (EBS), and Access Rate.