

## Chapter 3

# The Switched Local Area Networks' Delay Problem: Issues and a Deterministic Solution Approach

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### ABSTRACT

*A large number of installed local area networks are sluggish in terms of speed of uploading and downloading of information. Researchers have, therefore, proposed the need for such networks to be designed with specified maximum end-to-end delay. This is because, if the maximum packet delay between any two nodes of a network is not known, it is impossible to provide a deterministic guarantee of worst case response times of packets' flows. Therefore, the need for analytic and formal basis for designing such networks becomes very imperative. In this regard, this chapter has discussed the switched local area networks' delay problem and related issues. It compared the two principal approaches for determining the end-to-end response times of flows in communication networks – stochastic approach and deterministic approach. The chapter goes on to demonstrate the superiority of the latter approach by using it to develop and validate the goodness of a general maximum delay packet switch model.*

### 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 commercial, research and university data communication networks. As the applications of LANs have grown, so are the demands on them in terms of throughput and reliability. (Halsall, 1992, p. 308) The literature on LANs

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is almost in a flux. However, a common challenge that has been confronting researchers for a long time now, is, how to tackle the problem of slow response of local area networks. Slow response of such networks means packets' flows from one host (origin host) to another host (destination host) takes longer time than is necessary for comfort at certain times of the day. In this regard, switched networks were quite recent developments by the computer networking community in attempts at solving this slow response challenge. While the introduction of switched networks have reduced considerably this slow response (and, hence, long delay) problem, it has not completely eliminated it. This has elicited researches into switched networks in efforts at totally eliminating this problem. These researches have been said to be important in the present dispensation because of the deployment and/or the increased necessity to deploy real-time applications on these networks. In the next and succeeding sections, theoretical concepts that are important for an understanding of the switched LANs' delay problem, and of some aspects of the solutions approaches that has been adopted by our research team are discussed. In this regard, the network calculus and traditional queuing approaches to modeling network traffic are compared and contrasted, and some elementary network components, which were proposed and characterized by Cruz (1991) are described. The chapter then went on to describe a maximum delay model of a packet switch, which, was shown to be good for the practical engineering of local area networks that meets specified maximum end-to-end delay constraints.

## **BACKGROUND**

The design of switched networks has largely been based on experience and heuristics. Experience has shown that, the network is just installed, switches randomly placed as the need arises, without any

load analysis and load computation; there are usually no performance specifications to be met. This approach, frequently leads to expensive systems that fail to satisfy end users in terms of speed in uploading and downloading of information (Kanem et al., 1999; Torab and Kanem, 1999). In other words, this approach, usually leads to long networks' delays. According to Gallo and Wilder (1981), in a network, the arrival of information in real-time to the destination point at a specified time is a critical issue. In the view of Fowler and Leland (1991), there are times when a network appears to be more congestion-prone (incurring long packets' delays) than at other times. Falaki and Sorensen (1992) has also once averred that, there have always been a need for a basic understanding of the causes of communication delays in distributed systems on a Local Area Network (LAN).

## **THE DELAYS IN COMPUTER NETWORKS**

One fundamental characteristics of a packet-switched network is the delay required to deliver a packet from a source to a destination. (Bolot, 1993) Each packet generated by a source is routed to the destination via a sequence of intermediate nodes; the end-to-end delay is, thus, the sum of the delays experienced at each hop on the way to the destination. (Bolot, 1993) Each such delay in turn consists of two components (Ming-Yang et al., 2004; Bolot, 1993; Bertsekas and Gallager, 1992, p. 150);

1. A fixed component which includes:
  - a. The transmission delay at the node,
  - b. The propagation delay on the link to the next node,
2. A variable component which includes:
  - a. The processing delay at the node,
  - b. The queuing delay at the node.

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