UNIVERSITI PUTRA MALAYSIA

PERFORMANCE EVALUATION OF FDDI NETWORK USING SYNCHRONOUS TRAFFIC

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By

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September 2000

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Faculty: **Computer Science and Information Technology**

This research project is to evaluate the network performance of fiber distributed data interface (FDDI) protocol with real-time application. In the real-time application, on-time delivery of messages is essential. Thus, a suitable media access protocol is needed to transmit both real-time and non real-time traffic simultaneously. A real-time data imposes specific delay requirements, either due to network control or reconstruction constraints. The performance study of FDDI protocol is carried throughout the simulation. Furthermore, the performance metrics such as average access delay, average message delay and maximum delay are examined in the simulation. The various target token rotation time (TTRT) values are investigated in this research. The real-time multimedia workload is complemented with non real-time traffic in the FDDI network. The real-time traffic is a periodic workload

such as voice communication and video conferencing. Non real-time workloads are used as background traffic such as file transfer and interactive terminal. The results show that synchronous packets can be successfully complemented with asynchronous packets in the FDDI network. The TTRT values of two to four milliseconds ensure optimal network performance over huge data transfer rates. This research helps to understand the protocol behaviour toward different data traffic patterns and proposes an optimal value for TTRT in the real-time implementation.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Master Sains

EVALUASI PRESTASI RANGKAIAN FDDI MENGUNAKAN TRAFIK BERTURUTAN

Oleh

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Pengerusi: **Mohamed Othman, Ph.D.**

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Projek penyelidikan ini adalah untuk mengkaji prestasi rangkaian protokol gentian agihan data antaramuka (‘FDDI’) dengan menggunakan aplikasi masa-nyata. Dalam aplikasi masa-nyata, penghantaran mesej secara segera adalah penting. Oleh itu, media capaian protokol yang sesuai perlu digunakan untuk menghantar trafik masa-nyata dan bukan masa-nyata secara serentak. Biasanya, trafik masa-nyata memberi kelambatan kepada mesej kerana penglibatan masa di dalam kawalan rangkaian atau pembinaan semula rangkaian. Kajian terhadap prestasi protokol FDDI adalah dijalankan secara simulasi. Tambahan, matrik prestasi seperti purata pencapaian token, purata mesej lewat and mesej lewat maksimum ditentukan dalam eksperimen ini. Nilai ‘target token rotation time’ (TTRT) yang berbeza telah diambil dalam penyelidikan prestasi protokol ini. Aplikasi multimedia masa-nyata bersama

dengan aplikasi bukan masa-nyata dihantar secara serentak dalam rangkaian FDDI. Trafik masa-nyata adalah seperti aplikasi komunikasi suara dan konferen televisyen. Trafik bukan masa-nyata adalah seperti penghantaran fail dan interaksi terminal. Simulasi menunjukkan bahawa paket serentak dan paket bukan serentak boleh diintegrasikan dengan sempurna dalam rangkaian FDDI. Keputusan simulasi menunjukkan bahawa nilai TTRT dari dua hingga empat milisaat memberi prestasi yang terbaik walaupun kadar penghantaran mesej adalah tinggi. Kajian ini juga untuk meningkatkan pengetahuan mengenai tingkahlaku protocol terhadap trafik-trafik yang berlainan jenis dan mencadangkan nilai TTRT yang terbaik dalam penggunaan aplikasi masa-nyata.

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September, 2000 *K. Saravanan*

I certify that an Examination Committee met on 4 September 2000 to conduct the final examination of Saravanan Kolan De Velu, on his Master of Science thesis entitled, "Performance Evaluation of FDDI Network using Synchronous Traffic" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

SARAVANAN KOLAN DE VELU
1 November 2000.

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LIST OF ABBREVIATIONS

CSMA/CD	Carrier Sense Multiple Access/ Collision Detection
FC	Frame Control
FCS	Frame Check Sequence
FDDI	Fiber Distributed Data Interface
FIFO	First In First Out
LAN	Local Area Network
MAC	Media Access Control
MPEG	Motion Picture Expert Group
PA	Preamble Byte
PD	Propagation Delay
QoS	Quality of Service
SAT	Synchronous Allocation Time
SD	Starting Delimiter
THT	Token Holding Time
TTRT	Target Token Rotation Time
VOD	Video On Demand
WIC	Warehouse Inventory Control

CHAPTER I

INTRODUCTION

In the near future, distributed computer systems will allow users to communicate and collaborate through multimedia applications. Such applications will manipulate and present audio and video data, as well as traditional text and graphics, in an integrated manner. In a distributed system, co-operative tasks may execute on different processors and communicate with each other via a network.

A network that supports time-critical applications is referred to as a real-time network (S. Bennett, 1994). In such a network, on-time delivery of messages is essential. Timely completion of tasks can only be assured when the message transmission delay over the network is predicted reasonably well. In a multimedia application, text, graphics, voice, and video images are transmitted and processed. The underlying network must ensure that all the messages will meet their deadlines. Messages missing their deadlines will result in a poorer quality of sound and video. To meet this need, network architectures and protocols are required to provide users with convenient means of guaranteeing message-transmission delay bounds. The problem to guarantee the timely delivery of messages has been studied by numerous researchers (J. Ng and J. Liu, 1993), (J. K. Ng, 1993), (C. C. Lim et. al, 1994) and (R. Jain, 1991).

The efforts have been directed mainly towards designing medium access control protocols for multi-access networks that deliver messages within timing constraints.

Among all the methods designed to integrate real-time and non real-time applications, the timed-token media access control (MAC) protocol has attracted considerable attention because of its bounded access time. The timed-token protocol groups messages into two classes: synchronous and asynchronous. Synchronous messages arrive at regular intervals and are usually associated with delivery deadlines. Asynchronous messages have no such time constraints.

The fiber distributed data interface (FDDI) is a network protocol that integrates both synchronous and asynchronous messages to guarantee on-time message delivery. In this thesis, the real-time performance of FDDI protocol, a standard proposed by the American National Standards Institute (5X3T9.5) is investigated. The goal of this study is to determine the limitations in the ability of the protocol to guarantee on-time delivery of messages for different types of traffic in a real-time application. The performance of the protocol is measured under high-speed data transfer rates. Two real-time application cases are considered, namely, voice communication and video conferencing.

Distributed Computing

In the early days of computing from the mid-1940s to early 1980s, computers were scarce, expensive and stand-alone components (W. L. Schweber, 1988). Users typically executed scientific or commercial business applications by submitting programs and data to their mainframe or minicomputer. By today's standards, most of the communications networks in use before were very slow. There were centralised systems, but they were organised around "host" mainframe computers and very sensitive toward failure. Appropriately designed distributed systems can provide superior low sensitivity to failures of specific computing and communication components compared with what is attainable with a centralised system.

The first few distributed system were homogeneous in nature, predominantly interconnected via a local area network (LAN). This allowed every computer connected to the network to interact through a common operating system that ran on each of the individual computers. Nowadays, many types of LANs are interconnected with superior high-speed networks specifically to run real-time multimedia applications. These types of networks need a suitable protocol to support the real-time workloads on high data transfer rates.

A protocol is a set of rules and conventions that define the communication framework between two or more hosts (W. L. Schweber, 1988). These hosts, known as principals, can be end-users, processes or computing systems. Depending on the technology employed, a communication channel may be used as a point-to-point connection or a shared medium, where multiple stations can access concurrently. When a network has more than one station interconnected through a transmission medium, then LAN is formed. The LAN is benefiting users in terms of file and print sharing, workload distribution, processor assignment and as communication channel.

Local Area Network

A network is a communication system that supports many users. It allows many users to share a common pathway and communicate with each other. A LAN is specifically designed for the operation over a relatively small geographical area, such as an office, factory, or in a group of close buildings. It is easier to design and to be troubleshooted than a wide area network, which can span across a country or even the entire globe.

The common LAN topologies of are star, bus and ring. These network topologies fall into one of two categories: broadcast or point-to-point. Broadcast topologies are those in which the data ripples out across the entire network from the point of insertion. There is no active data regeneration by the nodes, so data propagates independently through the network channel. Conversely, point-to-point communications makes use of the fact that each node actively regenerates the signal and passes it on to its nearest neighbour.

The typical structures adopted by broadcast systems are passive bus, tree and star topologies. In these topologies, whenever a node transmits data the signal spread out across the network until it reaches some termination points. The point-to-point topologies are the active bus and ring systems (W. L. Schweber, 1988). In these systems, the signal is passed from a node to another, undergoing regeneration at each hop. The primary concern of such systems is that a single node failure can cause the entire network to fail. The main characteristics of the above topologies are briefly discussed further.

Star Topology

The star topology uses a single central node, and all the users are connected directly to this point. The number of users can be as large as the central hub can handle (see in Figure 1.1). This can be anywhere from a few to dozens or even several thousand users. The reliability and availability of this topology is higher, since a problem with any single user does not affect other users (S. Bennett, 1994). If there is a breakdown by one or more users, the network still will be functioning. Expanding this star configuration to handle another user requires just one more link from the user to the central node.

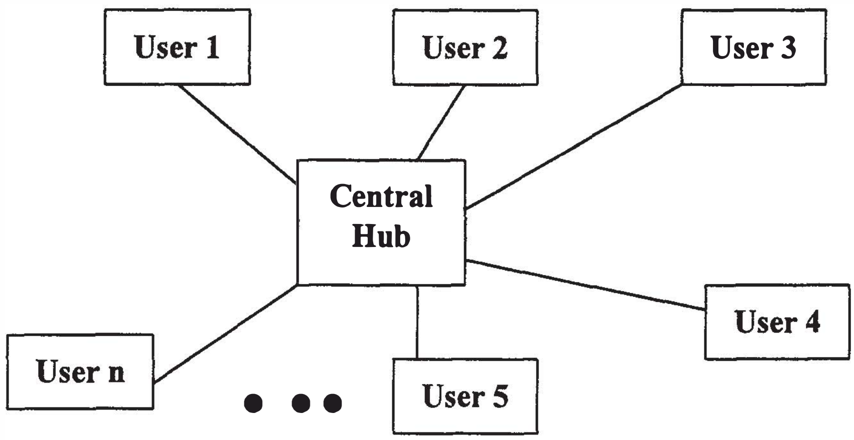

Figure 1.1: Star Topology

The weak spot in this design is the reliability of the central hub itself. The central node merely acts as a switching device to direct the data from the sender to the intended receiver. The more advanced star configuration allows the sender to tell the central node that the intended receivers are, and the central node resends the message to each of the desired receivers.

Bus Topology

The bus topology is a common pathway shared by many users (Figure 1.2). Users can be connected to the bus easily because bus topology has architecture that is flexible (W. L. Schweber, 1988). Adding a new user is mainly a matter of physically connecting the user to the nearest point on the bus. The bus is a very flexible structure because users can be put anywhere along its length and added for very low cost and with little difficulty.

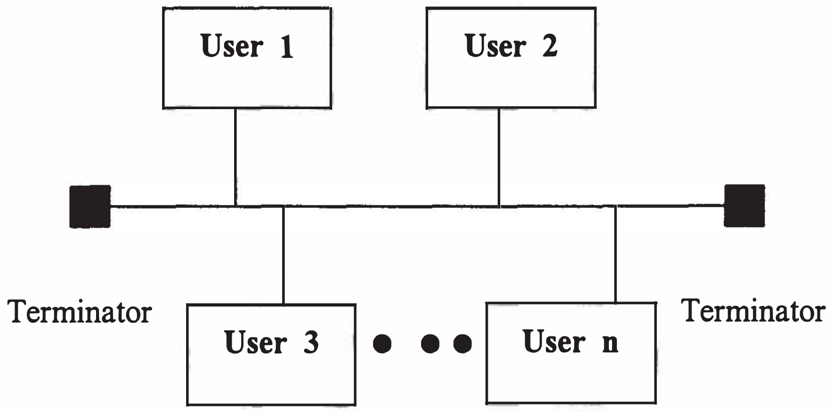

Figure 1.2: Bus Topology

The bus does have some weaknesses, besides the possibility that a failed user can stop the entire bus. Most importantly, since all the users share a common path, only one conversation or data message can be passing on the bus at a time. The Media Access Control (MAC) protocol that commonly governs such a network is specified in the IEEE 802.3 standard. This standard comes with Carrier Sense Multiple Access/Collision Detection (CSMA/CD) MAC protocol, which is not supporting a real-time system. The node has to wait until the network becomes free. Since all the users share a common path, every node have to wait for their turn in which is not suitable for time-sensitive