IMPLEMENTATION OF A HYBRID BURST CONTENTION RESOLUTION ALGORITHM FOR OPTICAL BURST SWITCHING NETWORKS

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DEDICATION

I dedicate my dissertation work to my family. A special feeling of gratitude to my loving parents, Emhemed Bashir Elhaddad and Khiria Ali Latrish whose words of encourgement and push for tenacity ring in my ears. My brothers and sisters have never left my side and are very special. And the rest of my relatives. May the mercy and the blessings of Allah (SWA) shower upon all of you.

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ABSTRACT

Optical burst switching is one of the optical switching technologies beside optical circuit and optical packet switching. It is considered as the optical switching paradigm that can be used in the near future before the technology that will support optical packet switching becomes mature. Optical burst switching has many good features. However, issue specifically burst contention which results in burst loss still become unresolved issue. A major component in optical burst switched networks is the core node whose main functions are burst scheduling and contention resolution. As traffic on the network increases, the contention at the core nodes also increases. This usually leads to burst drop at the core node if no suitable contention resolution technique is used. Many contention resolution techniques have been proposed by researchers with varying burst loss performances. In this study, a hybrid burst contention resolution technique that is capable of reducing burst loss is developed. The new hybrid technique is composed of two parts; wavelength conversion and burst segmentation. These techniques are used in a strict order when contention occurs. Wavelength conversion will always be the first technique to be invoked in order to resolve contention whenever it occurs. A successful resolution of the contention by the first part of the hybrid technique implies that the second part is skipped otherwise it must invoke the second part which is the burst segmentation technique. This research experiments were conducted through extensive event-driven simulation. Results obtained from simulations using the hybrid technique showed the burst loss reduction. It is shown that the hybrid technique has resulted in to an improved overall network throughput.

ABSTRAK

Pensuisan letusan optik adalah salah satu dari teknologi pensuisan optik di samping pensuisan litar optik dan paket optik. Ia dianggap sebagai paradigm pensuisan optik yang akan digunakan pada masa terdekat sebelum teknologi yang menyokong pensuisan paket optik menjadi matang. Pensuisan letusan optik mempunyai pelbagai ciri-ciri yang baik. Walaubagaimana pun isu khususnya pertelagahan letusan yang menyebabkan kehilangan letusan masih menjadi isu yang belum diselesaikan. Komponen utama dalam rangkaian pensuisan letusan adalah nod teras yang fungsi utamanya adalah sebagai penjadualan letusan dan penyelesaian pertelagahan. Apabila trafik di rangkaian meningkat, pertelagahan di nod teras juga bertambah. Ini menyebabkan kehilangan letusan pada nod teras jika teknik penyelesaian pertelagahan yang kurang sesuai digunakan. Terdapat berbagai teknik penyelesaian pertelagahan yang dikemukakan oleh berbagai penyelidik dengan prestasi kehilangan letusan yang berbagai. Dalam kajian ini, teknik penyelesaian pertelagahan hibrik yang mampu mengurangkan kehilangan letusan dibangunkan. Teknik hibrik baru ini mempunyai dua bahagian; pertukaran panjang-gelumbang dan segmentasi letusan. Teknik-teknik ini digunakan secara ketat bila berlaku pertelagahan. Pertukaran panjang-gelumbang selalunya menjadi teknik pertama dilaksanakan untuk menyelesaikan pertelagahan apabila ia berlaku. Kejayaan penyelesaian pertelagahan oleh bahagian pertama teknik hibrik ini membolehkan bahagian kedua diabaikan, sekiranya tidak bahagian kedua iaitu segmentasi letusan perlu dilaksanakan. Ujikaji kajian ini dijalankan secara simulasi yang meluas. Hasil keputusan simulasi menunjukkan teknik hibrik mengurangkan kehilangan letusan. Keputusan juga menunjukkan teknik hibrik ini meningkatkan truput rangkaian secara keseluruhannya.

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LIST OF ABBREVIATIONS

ABBREVIATION	MEANING
ACK	Acknowledgement
AR	Anticipated Retransmission
BSC	Burst Segmentation Conversion
BS	Burst Segmentation
DDP	Deflect and Drop Policy
DR	Deflection Routing
DP	Drop Policy
DSDP	Deflect, Segment and Drop Policy
FF	First Fit
FDL	Fiber Delay Line
GUI	Graphical User Interface
IP	Internet Protocol
JET	Just-Enough-Time
LRU	Least Recently Used
MB	Megabyte
NACK	Acknowledgement
NCTUns	National Chiao Tung University Network Simulator
NSFNET	National Science Foundation Network
OBS	Optical Burst Switching
OCS	Optical Circuit Switching
OPS	Optical Packet Switching
OXC	Optical Cross Connect
PPJET	Preemptive Priority Just-Enough-Time
PS	Priority Set

QAC	Admission Control
QoS	Quality of Service
RAM	Random Access Memory
SD	Segmentation with Deflection
SDDP	Segment, Deflect and Drop Policy
TAG	Tell-And-Go
TAW	Tell-And-Wait
WC	Wavelength Conversion
WDM	Wavelength Division Multiplexing

CHAPTER 1

INTRODUCTION

1.1 Overview

Optical burst switching (OBS) is an intermediate switching technology that lies between optical circuit switching and optical packet switching. It inherits their advantages while leaving behind their disadvantages. It is considered as the optical switching technology that can be used in the near future before the technology that will support optical packet switching becomes matured. Optical burst switching network has a burst which consists of many packets inside it. These bursts will be switched through out of the network optically when it is sent from source to destination. In OBS control packets are first sent reserve resources for its burst. After a fixed amount of time known as the offset time, the burst is sent into the network. The original design of Optical burst switching does not consider optical buffering at intermediate nodes (Qiao and Yoo, 1999). In case of any contention between bursts, OBS uses one of the contention resolution techniques to solve the contention (Jue and Vokkarane, 2005) or the data must be dropped.

The optical burst switching network architecture consists of edge (ingress/egress) node and core nodes (Qiao and Yoo, 1999; Xiong, Vandenhoute, and Cankaya, 2000) when an ingress node sends the bursts to an egress node, the burst must pass through the core nodes in order to reach its destination. A core node has the ability of full wavelength conversation. Also core nodes include optical buffers which can delay bursts for a specified time only. For example to delay a burst for 1ms requires 1 kilometer of optical fiber. There are core nodes that also function as edge nodes because they are connected to access networks that accept Internet Protocol (IP) traffic. Depending on the way how edge node acts can be called ingress node or egress node (Jue and Vokkarane, 2005).

Contention is one of the major issues faced in OBS Network. It occurs when two bursts try to use the same wavelength at the same time. Optical Burst Switching Network does not have buffer device, so researchers have proposed many contention resolution techniques to solve contention. Techniques such as wavelength conversion, deflection routing and fiber delay line are implemented to prevent the congestion of the network. These techniques are still suffering from their limitations especially due to heavy traffic. Hence, solving contention is required in Optical Burst Switching Network (Nandi *et al.*, 2008).

Hence, a new hybrid Bust Contention Resolution algorithm was built from two previous techniques which are Wavelength Conversion and Burst segmentation in OBS networks, by using the new hybrid algorithm optical burst switching network become more reliable in transferring bursts between end users.

1.2 Problem Background

The possibility of contention occurring between two or more bursts is high in Optical burst switching networks, because it is connectionless transport. Contention in traditional electronic network is solved by using buffer. In the optical network is hard to implement buffer, because there is no optical equivalent of random access memory (Jue and Vokkarane, 2005). This section discusses previous researches which resolve or avoid contention in OBS networks.

Farid et al. (2004) describes a feedback-based contention resolution mechanism called flow-rate control. The main purpose of this scheme is to control in flow of data which can reduce packet loss probability in the network. The idea of using SFC is to reduce network utilization because of invoking admission control during network congestion. The simulation shows that the network throughput is reduced because of admission control. Source flow rate improves the overall performance in links that have more congestion but all that cost delay time in high traffic.

A study was done by Nandi et al. (2008) in which they proposed a contention resolution algorithm to reduce packet loss in Optical Burst Switching. It divides network to clusters, each cluster contains head node controls receiving and sending bursts between the clusters. Cluster head node keeps track of the available resources that allow sending bursts. Head node has the ability to update the status of the resources. When one of the cluster nodes needs to send burst out of the cluster, it will ask permission from head node by sending request signal, if there is available wavelength, head node will send reply message with wavelength available else it sends no wavelength available. If there is unused wavelength, sending node will send control burst followed by payload. If there is no free wavelength, sending node waits for a specified time and then tries to send new request signal to head node again. Because of cluster head nodes are responsible to send bursts between clusters this can reduce the contention of bursts. Updating resources of wavelengths status between head nodes and signal of receiving and replying messages can consume bandwidth of the network which leads to congestion between bursts to occur contention.

The above mentioned algorithms have the ability to minimize contention of bursts which can reduce burst lose but they are still insufficient in applications that have overload. Because of increasing internet users and no optical buffer sufficient to delay bursts for requested time, that contention resolution techniques are requested.

Among all the algorithms mentioned above, none of them implemented wavelength conversion first followed by a burst segmentation technique at the same time. In this study, hybrid contention resolution technique, that is wavelength conversion and burst segmentation techniques are used. This technique employs wavelength conversion first then followed by burst segmentation in the event it fails to resolve the contention. This hybrid algorithm can reduce burst loss ratio and enhance network throughput performance.

1.3 Problem Statement

Burst loss has being a source of major concern and study in the field of optical burst switching technology. This loss has being found to be caused due to burst contention occurring at the core nodes in the optical switched networks as a result of the unavailability of limited network resources. This research will focus on utilizing the existing contention resolution techniques to further minimize burst loss occurring at the core nodes of optical burst switching networks in order to increase the utilization of the limited network resources.

1.4 Project Aim

The aim of this project is to minimize contention which leads to lower burst loss and thereby enhance the optical burst switched network performance. This will be achieved using the available contention resolution techniques (wavelength conversion, deflection routing, burst segmentation, and fiber delay lines) to enhance the overall performance of the Optical Burst Switched network by combining their good features in the hybrid algorithm while overcoming their weaknesses.

1.5 Objectives of the Study

The objectives of this study are:

i. To study the existing contention resolution techniques of optical burst switching networks.
ii. To propose and develop a hybrid contention resolution technique by combining wavelength conversion and burst segmentation techniques in this sequence to reduce contention rate which will lead to a reduced burst loss ratio in optical burst switching network.
iii. To evaluate and compare the proposed algorithm with the existing techniques.

1.6 Scope of the Study

The scope of this study is:

i. This study will focus mainly on the implementation of two contention resolution technique in OBS network.
ii. The Just-Enough-Time (JET) signaling technique is used.
iii. Multiple Wavelengths per fiber was used.
iv. The NCTUns 6.0 Simulation tool was used.
v. The C++ programming language was used for the implementation of the proposed as well as the existing contention resolution techniques in the NCTUns 6.0 simulator.
vi. Optical buffers were used in the implementation of the existing technique which was then used for the evaluation and comparison with the proposed hybrid contention resolution technique.

1.7 Significance of the Study

The importance of the study resides in the fact it will:

i. Avoid contentions inside OBS network.
ii. Reduce burst loss probability.
iii. Ability to transfer bursts on OBS without delay among end users.
iv. Provide a high bandwidth in overloaded networks which make internet using more practical

1.8 Organization of Report

Chapter 1 presented an introduction to the research, Problem background, Problem statement, Project aim, Objectives of the study, Scope of the study, significance of the study and Organization of the report.

Chapter 2 discussed the literature related to this study. It highlights the relevant background of optical burst switching network, and describes some concepts, such as contention resolution techniques such as fiber delay line, wavelength conversion, and burst segmentation.

Chapter 3 describes the methodology of this study; the framework is organized into stages with each stage explained in detail.

Chapter 4 shows the implementation process of the proposed hybrid contention resolution algorithm.

Chapter 5 analyzed, discussed and evaluated the results of the experiments performed.

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