Contention Resolution in Optical Burst Switched Networks

Major Project Report

Submitted in partial fulfillment of the requirements

for the degree of

Master of Technology

in

Electronics & Communication Engineering

(Communication Engineering)

BY

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Ahmedabad-382481

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May 2017

Declaration

This is to certify that

a. The thesis comprises my original work towards the degree of Master of Technology in Communication Engineering at Nirma University and has not been submitted elsewhere for a degree.

b. Due acknowledgment has been made in the text to all other material used.

- Darshit Pandya

14MECC12

Certificate

This is to certify that the Major Project entitled **"Contention Resolution in Optical Burst Switched Network"** submitted by **Darshit Pandya (14MECC12)**, towards the partial fulfillment of the requirements for the degree of Masters of Technology in Communication Engineering, Nirma University, Ahmedabad is the record of work carried out by him under our supervision and guidance. In our opinion, the submitted work has reached a level required for being accepted for examination. The results embodied in this Project, to the best of our knowledge, havent been submitted to any other university or institution for award of any degree or diploma.

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Abstract

In our day to day life high speed data transfer network is becoming ubiquitous. To meet this demand optical networks are the best solution. In optical networks, Optical Burst Switched(OBS) networks provides the best feasible solution to meet the most advantages of all optical networks. To perform the OBS network a lot of challenges are faced that have to be solved, contention is one of them.The network contention is a limitation in realization of optical burst switched networks. Many approaches were evolved for its resolution. Adaptive network contention resolution has drawn the attention of many researchers as it offers high data burst utilization and reduces the burst drop rate of the network. Contention can be measured by the burst drop rate in the network.

In this thesis work, we developed a solution to solve the problem of contention in OBS network using adaptive contention resolution approach. In this technique, data burst size is changed adaptively according to the burst drop rate in the network. That leads to contention resolution in the network. Extensive simulations are carried out for measuring the reduction in burst contention and increase in throughput. The result obtained through simulation on NS-2 platform shows that burst drop rate is being reduced from 0.014% to 0.009% and increases in throughput of the network as the number of packets received successfully, increases from 1100083 to 1462713.

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Chapter 1

Introduction

Optical communication is the large distance communication, using light as carrier for the information. An optical communication system uses a transmitter, which encodes the message information to the optical domain, a channel, which carries the optical signal to its destination and a receiver, which reproduce the signal when received from channel. The first electrical device to receive an optical signal was photophone, which was invented in 1880.

Optical fibers can be used as a medium for telecommunication because it is low in weight, small in dimensions and can be bundled as cables. The main advantage of the optical fibers is that light propagates through the fiber with very low attenuation. The benefits of the optical communication systems were known for quite a while but not until the invention of wavelength-division multiplexing (WDM) that the potential of optical fiber was fully realized. In fiber optic communication, WDM is a technology which multiplexes a number of optical carrier signal onto a single optical fiber by using different wavelengths of the light. This enables the bidirectional communication in a single fiber.

The evolution of the WDM network is as shown in the Fig. 1.1.

Current WDM networks operate over point-to-point link, in which optical to electronic

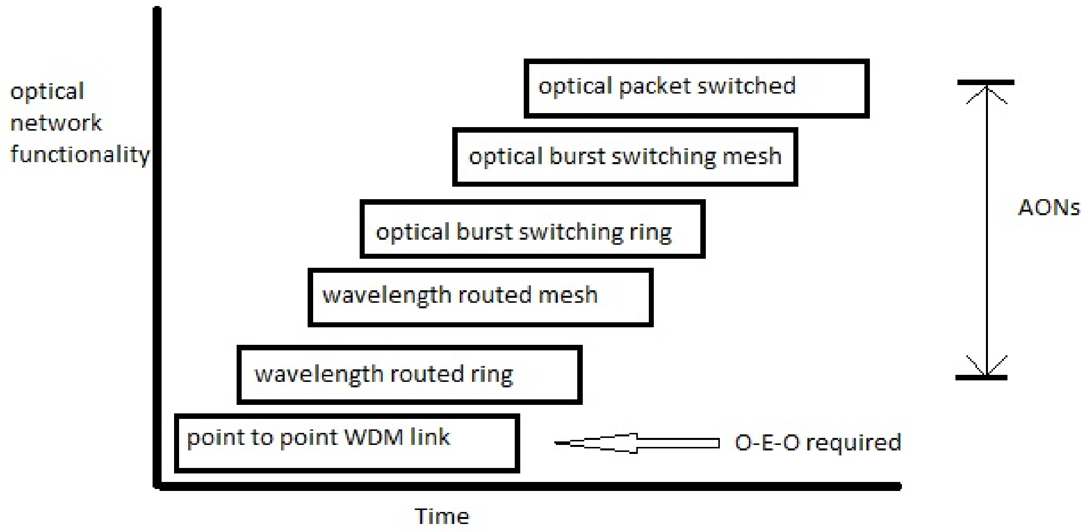

Figure 1.1: Evolution of Optical networks. [1]

to optical (O-E-O) conversion is required at each step. All future WDM designs are focused on all optical networks (AONs) where data is in optical domain throughout the transmission from the source to destination. The elimination of OEO conversions allows the higher transmission rate in the network. AONs are further classified in the: Wavelength Routed Networks (WRNs), Optical Burst Switched networks (OBSNs) and Optical Packet Switched Networks (OPSNs).

The AONs evolution begins with WRNs, whose operation consists of setting up circuit connection, light-paths between the network nodes. The main constraint of WRNs is the limited number of wavelength per fiber, and that is the reason why in larger WRNs, makes it impossible to create a full mesh of light-paths between all end users.

In OPSNs user traffic is carried in optical packets along with in-band control information. The control Information is extracted and processed in the electrical domain at each node. This is a desirable architecture because electronic packet switched networks are characterized by high throughput and easy adaptation to failure, but the problem with OPSNs is the lack of practical optical buffer technology. Why optical burst switching is best feasible solution currently is shown in Fig.1.2

Optical Switching (paradigm)	Bandwidth Utilization	Latency (set-up)	Optical Buffer
Circuit	low	high	not required
Packet/Cell	high	low	required
Burst	high	low	not required

Figure 1.2: Comparision of different optical communication switching schemes [3]

As we can see from Fig. 1.2 Burst switching provides high bandwidth utilization and less latency without the need of optical buffer in the network.

1.1 Optical Burst Switched Networks

In OBSNs, data is transported in various size units, called 'burst'. Due to the great variability in the duration of bursts, the OBS networks are viewed as lying between OPSNs and WRNs. That is, when the duration of the bursts are small as optical packets, it can be seen as OPSN and when the duration of the bursts is too large then it can be seen as WRN. In OBS there is a strong separation between the control and data plane which allows great network flexibility.

Optical burst switching (OBS) is a promising new technique which attempts to address the problem of efficiently allocating resources for bursty Internet traffic. Circuit switching and packet switching have been used for many years for voice and data communication, respectively. OBS can combine the best of the coarse-grained circuit switching and the fine-grained packet-switching paradigms while avoiding their shortcomings, thereby efficiently supporting bursty traffic generated by upper level protocols or high-end user applications directly.

In circuit switching, a dedicated path has to be established between two nodes before any data transmission takes place. The time taken for establishing such path is equal to the round-trip delay. The reserved resources stay idle for the entire path setup time and account for poor resource utilization. The benefit of Optical Burst Switching (OBS) over conventional circuit switching is that there is no need to dedicate a wavelength for each end to end connection. In addition to this, the path setup time is much less than the round-trip delay. In packet switching, the data is broken into small packets and transmitted. The data is transmitted using store and forward technique. The resources can be shared by different sources. End stations can send/receive data at their own speed. The individual packet can be individually switched or a virtual circuit can be set up. Packet switching has large buffer requirement and complex control and sync issues. For the optical domain, packet switching is not yet feasible because of optical hardware limitations. Optical RAMs do not exist yet to meet the high buffer requirements of packet switching. In addition, optical burst switching seems to be more viable than optical packet switching since burst data does not need to be buffered or processed at intermediate nodes. This allows the strengths of optical switching technologies to be leveraged effectively and the problem of buffering in the optical domain to be circumvented. OBS combines the advantages of both circuit and packet switching and ensures efficient bandwidth and resource utilization.

In general, OBS network consists of interconnected core nodes that transports data from edge nodes. The users consist of an electronic router and an OBS interface, while the core OBS nodes require an optical switching matrix, a switch control unit and routing and signaling processor.

1.2 Advantages and Issues in OBS

1.2.1 Advantages

More efficient bandwidth utilization:

In OCS, light-path needs to be established between source and destination, if the data is short lived then the bandwidth might not be efficiently utilized.

While in OBS, it does not require end-to-end light-path setup and thus more efficient bandwidth utilization is achieved.

Removes throughout limitation:

In OPS scheme we use Just Enough Time(JET) scheme which limits the throughput in an edge router in OPS systems.

Reduces processing requirement and core network energy consumption:

In OPS, a core optical router would have to perform processing operation for every arriving packet where else in the OBS, the router performs processing for arriving bursts, which contains several packets, but still due to the lack of the components required in all-optical networks i.e. OPS which is the technology for All-Optical Communication can not be practically feasible and thus OBS provides the best feasible solution to the current problem in All-Optical Communication network.

1.2.2 Issues

Traffic Grooming,

Data burst scheduling policies,

OBS architecture feasibility,

Contention Resolution,

Packet delay control,

Signaling characteristics,

Multicasting and QoS support,

Internet implementation over OBS,

Topologies.

This all are the issues concerned with the OBS networks and from all of them, we are focusing on 'Contention Resolution'.

1.3 Contention Resolution

Contention resolution means deciding which device gains access to a resource first when more than one wants to gain access of the resource at the same time. In Optical networks, contention resolution is used to decide which device gains access to the resource first, when more than one devices need to use the network at the same time. In Optical Burst Switched(OBS) network data is transported in buffer-less network, so there are more chances of contention among the bursts and the solution to that is termed as 'Contention Resolution'. Contention in the OBS network is measured by the burst drop rate of the network.

Contention resolution is necessary for handling certain cases where two or more packets try to reserve the same link and the same wavelength for the same time. This is called external blocking. In packet switching, this is avoided by buffering the contending packets. In OBS, when two or more packets contend for the same wavelength and for the same time duration, only one of them is allotted the bandwidth. In such case, one or a combination of the following three major options for contention resolution can be applied in addition to the option of dropping the unsuccessful bursts:

1. Wavelength domain: By means of wavelength conversion, a burst can be sent on a different wavelength channel of the designated output line.
2. Time domain: By utilizing an FDL buffer, a burst can be delayed until the contention situation is resolved. In contrast to buffers in the electronic domain, FDLs only provide a fixed delay and data leave the FDL in the same order in which they entered.
3. Space domain: In deflection routing, a burst is sent to a different output link of the node and consequently on a different route towards its destination node. Space domain can be exploited differently in case several fibers are attached to an output line. A burst can also be transmitted on a different fiber of the designated output line without wavelength conversion.

An alternative approach to reduce network contention is by proactively attempting to avoid network overload through traffic management policies.

1.4 Burst Segmentation

When two or more bursts contend for the same wavelength at the same time, all of them except the one with the highest priority, are usually dropped. Instead of dropping the entire burst, if the burst that has lower priority is switched onto the wavelength after the transmission of the current burst, so at least a part of that burst can be sent. Bursts contains the IP packets, so at least few packets can be delivered at the destination with such approach.

This approach is 'Burst Segmentation', it also improves the packet delivery rate at the IP layer.

Advantage of Burst Segmentation:

It reduces the delay due to retransmission and burst assembly by delivering at least some of the packets of the bursts. It reduces the packet loss probability.

Chapter 2

Literature Survey

“The exponential growth of Internet has resulted in an increased instance for higher data rate and faster switching technologies. Switching in core optical networks is performed using high speed electronic or all-optical switches. Switching with high speed electronics requires optical-to-electronic(O/E) conversion of the data stream making the switch a probable bottleneck of the network as the transmitting node converts electronic data into optical signal(E/O) and sends it on the optical fiber link. Then, the receiving node converts the optical signal back into electrical domain(O/E) for electronic processing.[1,2]”.

Regarding network performance, simulators are the most frequently used instrument, in comparision with analytical tools and in-site measurements. OBS is a new paradigm where the use of modeling and simulation tools are important. For that I have studied four most relevant simulators used in scientific and academic research to model OBS network: network simulator - 2(ns-2), OBS-ns Simulator, NCTUns and OBSsimulator. Its important to identify the parameters and protocols for the simulator that we are going to use, whose performance analysis on OBS network is critical and needs to be studied. We have used nOBS(extended version of ns-2) to simulate our network.[4]

There are three types of conventional burst assembly algorithm: timer based, burst length based and mixed timer-burst length based. For timer based data burst assembly algorithm, timer starts as soon as the first packet arrives on the optical node. A fixed time period T is set, for which packets are aggregated into burst. Timeout has to be set with care as small T will create many small bursts in the network and high T will result in high delay in the network.[4]

In burst length based scheme, queue length of the burst is set. So, when the queue length reaches the threshold value defined, a burst is created. In this strategy, there is no prediction for assembly delay time as the burst will not be created till the queue reaches the threshold value.[4]

Third algorithm is mixed timer-burst-length based algorithm. In this algorithm, time period, T and queue length both are fixed. burst is created when either timer or queue length reaches their respective threshold. All the mentioned algorithm suffers from low burst utilization and high contention in the network. To overcome this, adaptive data burst assembly algorithm is used. In this algorithm, according to offered traffic load, data burst length is adjusted.[4]

2.1 Adaptive Data Burst Assembly Algorithm

To overcome the disadvantage of the mentioned algorithms Adaptive data burst algorithm is used. In the adaptive data burst assembly algorithm, input traffic is classified in two priorities : Low priority & high priority. The burst size is decided either discretely or continuously. Because the function of the control is critical in OBS. Fig. 2.2 shows that, when the cross-over count reaches its upper limit, the burst size increases by one step and when reaches the lower limit same is decreased by one step.[2]

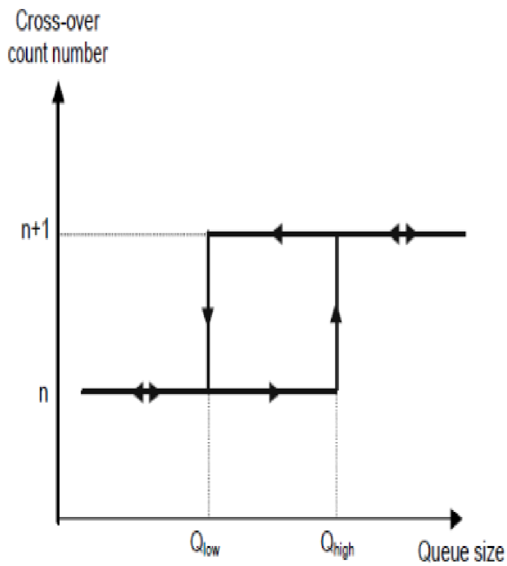

Figure 2.1: Characteristics of cross-over count number transitions [4].

2.1.1 Procedure for Adaptive Data Burst Assembly

- Timer starts as soon as first packet arrives at the queue. Then it starts to classify the priority of the incoming packet.
- If the packet's priority is low(class 0) and timer reaches threshold value(Thi), a new burst including class 0 packet is created.
- If the packet's priority is high(class 1) and timer reaches threshold value, a new burst including class 1 packet is created.
- For the high priority packets queue, if the queue size is greater than Q_h, the counter number is increased by 1.
- The cross-over count number is compared with the upper limit. If it crosses over th upper limit, the burst size is increased by one step, otherwise it is not changed.
- Reset the timer to 0 and go back to first step.

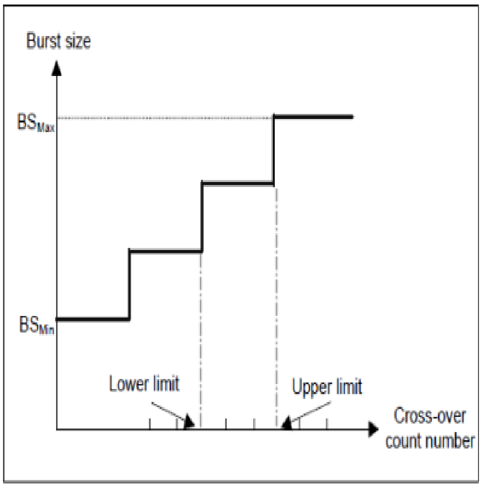

Figure 2.2: Discrete-type burst-size decision scheme [4]

- By this way, the burst size is adaptively changed according to the input traffic to enhance the data burst utilization.
- The overall flowchart of the adaptive data burst assembly algorithm is as shown in Fig. 2.3.

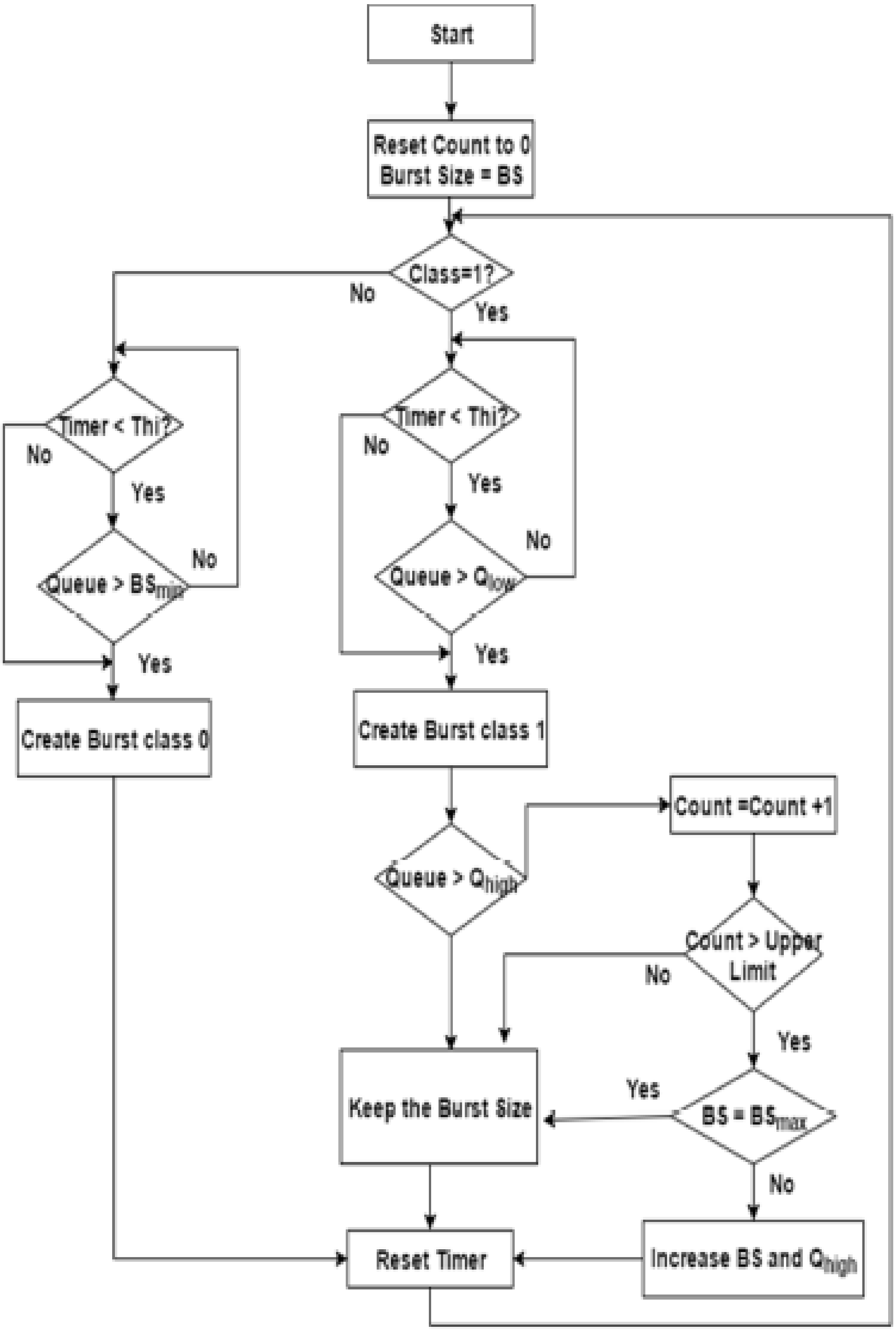

Figure 2.3: Flow diagram for adaptive data burst assembly [4].

2.2 Literature Summary

In the literature survey, we understood the core concept of OBS and contention resolution techniques. A data burst assembly algorithm which depends upon data burst size adaptation according to the offered load by taking into consideration the QoS for multiple priority classes. From the paper simulations, comparing all cases we can verify that proposed algorithm changes the data burst size according to the offered load leading to an increase in data burst utilization. Using adaptive data burst assembly algorithm it limits the end-to-end burst delay, increases the data burst utilization and decreases data burst drop rate by decreasing burst contention go high priority traffic. So, adaptive data burst assembly algorithm can be used for applications which reqiure low end-to-end delay and low burst drop rate like voice over IP(VoIP) or video streaming applications.

Chapter 3

Tools and Methodology

Evaluation of OBS networks for TCP traffic is under intense study since majority of internet traffic is of TCP. NS2 has been widely used for the evaluation of TCP/IP networks because of its reliability and publicly available simulator, but the majority of the components for simulating OBS networks are missing from NS2. nOBS is NS2 based simulation tool, built for studying burst assembly, contention resolution and scheduling in OBS networks.

3.1 nOBS

nOBS enables performance analysis of OBS networks with wavelength converters and FDLs while carrying TCP traffic, and it implements various burst assembly, scheduling and routing algorithms. nOBS is basically an extended version of ns2 used for simulaiton of OBS networks. Using nOBS, TCP goodput is increased significantly when edge routers with multiple burstifiers per destination are used, and the goodput increases as the number of burstifiers increase and this holds true for different TCP versions, different number of flows, different topologies and different loss probabilities.[3,4].

We used nOBS in this thesis, in order to study the effect of the burst size on the burst drop rate as well as contention in the network. Simulation shows that increasing the number of packets per burst, it reduces the burst drop rate in the network and thus contention in the network is also resduced. nOBS can be used for different TCP versions as well. As nOBS is an extended version of NS2, here are the steps to extend NS2 to enable simulation of optical burst switched networks.

Steps to extend ns-2 to enable simulation of optical burst switch networks:

Install and compile a fresh copy of ns version 2.35
Copy the "optical" folder to ns-2.35 folder.
Replace the files under "routing, tcl, queue, tcp, common, mdart" folders. Add the following code to OBJ-CC in Makefile.
optical/op-delay.o
optical/op-queue.o
optical/op-burst-agent.o
optical/op-classifier.o
optical/op-classifier-hash.o
optical/op-classifier-sr.o
optical/op-sragent.o
optical/op-queue2.o
optical/op-schedule.o
optical/op-converterschedule.o
optical/op-fdlschedule.o

Recompile ns.

3.2 Sample example using NS-2

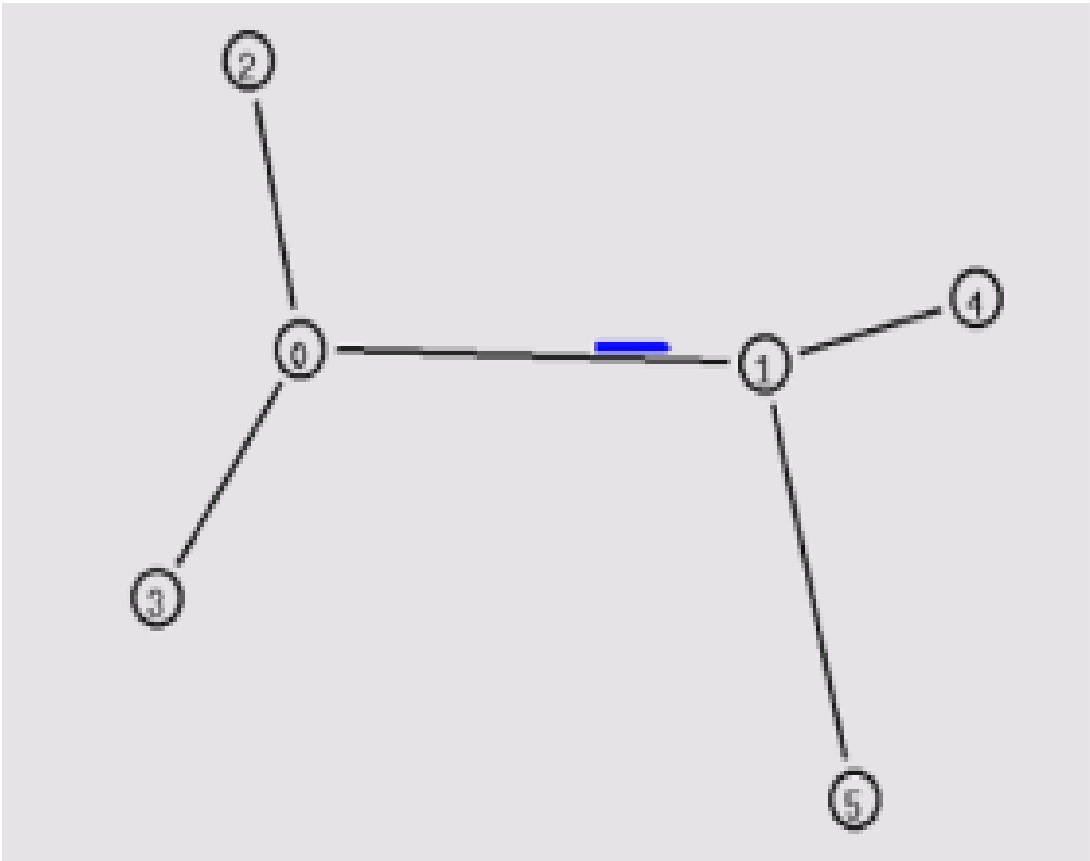

Figure 3.1: dumbell topology using NS-2.

As we can see from Fig. 3.1 a dumbell topology is created using NS-2 platform. Using NS-2 as the simulator, we can actually get the packet drop rate, throughput and all the other information of the network. We can get the every minor detail regarding the network like at which time a packet is being sent, received or dropped. We can also log this detail using awk scripting and plot using gnuplot.

Code for the Fig. 3.1 is as below:

set ns [new Simulator]

```
$ns color 0 Blue
$ns color 1 Red
$ns color 2 Black

set nf [open new.nam w]
$ns namtrace-all $nf
set tf [open testout.tr w]
$ns trace-all $tf

set n0 [$ns node]
set n1 [$ns node]
set n2 [$ns node]
set n3 [$ns node]
set n4 [$ns node]

$ns duplex-link $n0 $n1 0.01Mb 5s DropTail
$ns duplex-link $n1 $n2 0.01Mb 5s DropTail
$ns duplex-link $n2 $n3 0.01Mb 5s DropTail
$ns duplex-link $n3 $n4 0.01Mb 5s DropTail
$ns duplex-link $n4 $n0 0.01Mb 5s DropTail

$ns queue-limit $n0 $n1 2
$ns queue-limit $n1 $n2 2
$ns queue-limit $n2 $n3 2
$ns queue-limit $n3 $n4 2

set tcp [new Agent/TCP]
$ns attach-agent $n0 $tcp
```

```
set sink [new Agent/TCPSink]
$ns attach-agent $n3 $sink
$ns connect $tcp $sink
$tcp set fid_1

set ftp [new Application/FTP]
$ftp attach-agent $tcp
$ns at 1.0 "$ftp start"
$ns at 4.0 "$ftp stop"

proc finish
global ns nf
$ns flush-trace
close $nf

exec nam new.nam &
exit 0

$ns at 5.0 "finish"
$ns run
```

Given code will generate the trace file which will contain the details regarding the network performance. Using this, we will be able to generate the optical topology also and using adaptive contention resolution approach in OBS, we will verify the results.

Chapter 4

Adaptive Contention Resolution Technique

In OBS different burst assembly algorithms are like timer based, burst length based and mixed timer burst length based. In timer based algorithm, after a new assembly period, timer starts at a fixed time. T. packets arriving at the optical egress node are aggregated into a burst. But this timeout has to be set with care, because small T will create many small bursts and larger T will result in high packet delay. In burst length based scheme, queue length is set, when the queue length surpasses that limit, the burst is created. Drawback of this scheme is that there is no prediction for the burst assembly delay time. As the burst will not be created till the queue size does not reach the specified limit. In mixed timer-burst-length based algorithm, proper time T and proper burst length is set such it reduces the delay and overhead on the network. When the ordinary algorithms yield small bursts, this causes high overhead network processing and when yield larger bursts, it causes contention in the network.

All these mentioned algorithms of data burst assembly have a common disadvantage because they depend on fixed time or fixed burst length size, which leads to high contention and low burst utilization. Adaptive Data burst assembly algorithm is also introduced to reduce this problems in OBS, but in adaptive data burst algorithm, traffic is treated by priority. Low priority packets are ignored or we can say only high priority packets are considered for the contention resolution or end-to-end delay solution. So, we proposed a new technique to overcome the problem of contention in the OBS network. In this technique, traffic is not prioritize, all the packets are treated as same. Thus, every source in the network gets the better performance for the transmission of the data, irrespective of the priority.

In this technique, we first need to put the minimum (BS_{min}) and maximum (BS_{max}) limit for data burst length as the minimum length (BS_{min}) does not lead to many small bursts and maximum length (BS_{max}) does not lead to high delay. Here, we use this technique for the entire traffic of the network, without classifying the traffic in the network.

The data burst size should be modified according to the burst drop rate of the network so that the contention in the network gets reduced. The burst size is decided either discretely or continuously. Because the function of the control is critical in OBS. We use a discrete type burst-size decision, that uses a simple transition method to relax the data burst-size adaptation process for burst drop rate network. Figure shows that, when the burst drop rate reaches its upper limit, the burst size is increased by one step.

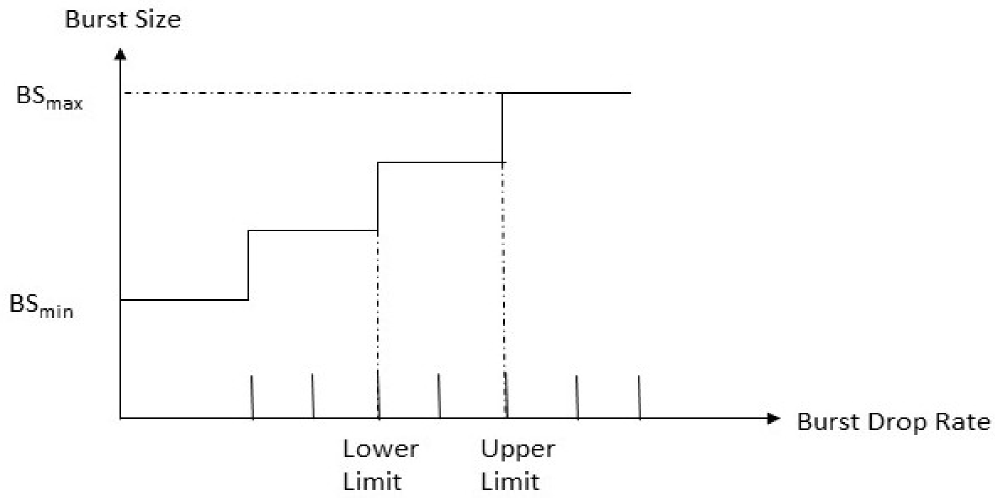

Figure 4.1: Discrete type Burst Size decision scheme

The pseudo algorithm for the adaptive contention resolution technique is illustrated in the Fig. 4.2.

Fig. 4.3 shows the flow chart for the implementation of algorithm shown in Fig.4.2.

```
Pseudo algorithm
A physical optical network topology is
required.
Set: default burst length size (50)
transmission is done for the first time.
Find: Burst Drop Rate (BDR) of the network for
default burst size. (BS = 50)
Check: BDR >= R1; Set BS = BS1(300)
       BDR >= R2; Set BS = BS2(200)
       BDR >= R3; set BS = BS3(100)
Otherwise, Set BS = BS4(50)
Determine BDR after each flow of particular
BS.
After each transmission of the bursts through
the network, burst drop rate is found and
accordingly burst size is adjusted.
```

Figure 4.2: Pseudo algorithm for adaptive contention resolution technique

The procedure for the Fig.4.3 can be explained as follows:

- The network starts transmission of the burst for the first time, prior to any knowledge of the burst drop rate of the network, burst size is taken as default for the first transmission.
- After the first transmission of the bursts into the network, burst drop rate is calculated.
- According to the burst drop rate of the network, burst size is adjusted in the network.
- As we can see from the figure, after finding the burst drop rate of the network, burst size will be adjusted in such a manner that drop rate is decreased in the network as well as contention is also resolved.

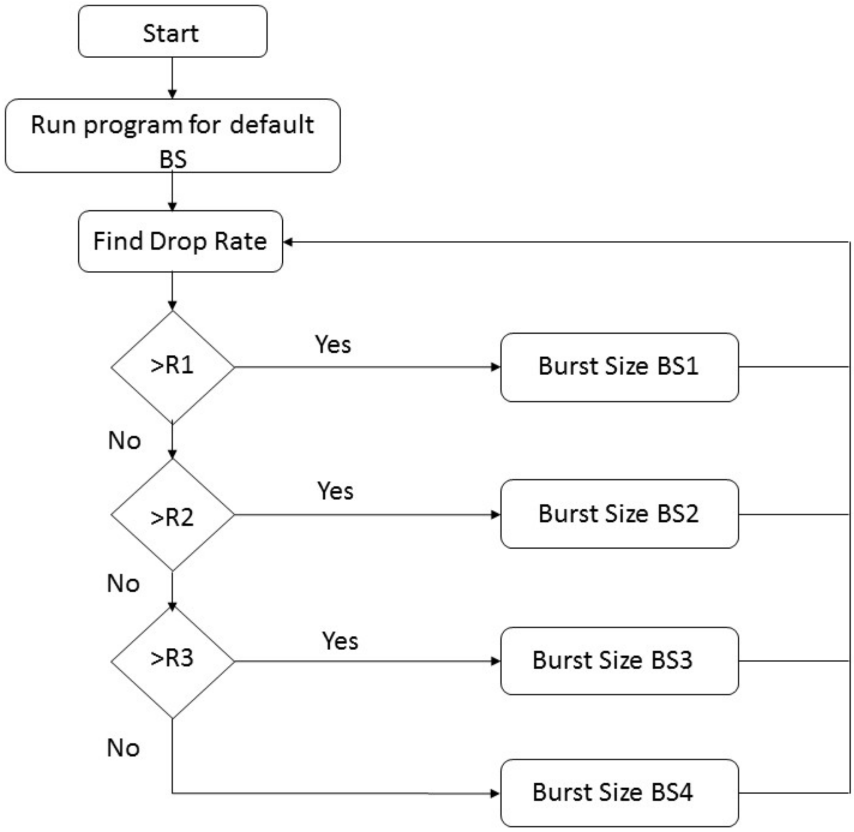

Figure 4.3: Flow diagram for adaptive contention resolution technique

- We have set three threshold values, i.e. R1, R2, R3 of the burst drop rate for this paper, and for each range we have set the burst size BS1, BS2 and BS3 accordingly.
- After transmission for a particular burst size in the network it will again monitor the burst drop rate of the network and accordingly set the burst size.

Chapter 5

Simulation and Results

In order to verify the effectiveness of algorithm, extensive simulations were carried out using NS-2. We generated TCP traffic from 40 different sources. We set the default value of burst size to 50 packets per burst. After the first run, burst size will be variable according to the burst drop rate of the network.

To get several and different simulation results, simulation is carried out with two different cases:

- Without using adaptive contention resolution technique.
- Using adaptive contention resolution technique.

Fig. 5.1 shows the network topology which consist of 40 electronic transmitter nodes, 7 optical nodes connected with fiber links and 40 receiver electronic nodes.

5.1 Simulator Setup

The simulator accepts different input parameters such as burst size, burst arrival rate, number of wavelengths per fiber, propagation delay, processing delay, maximum

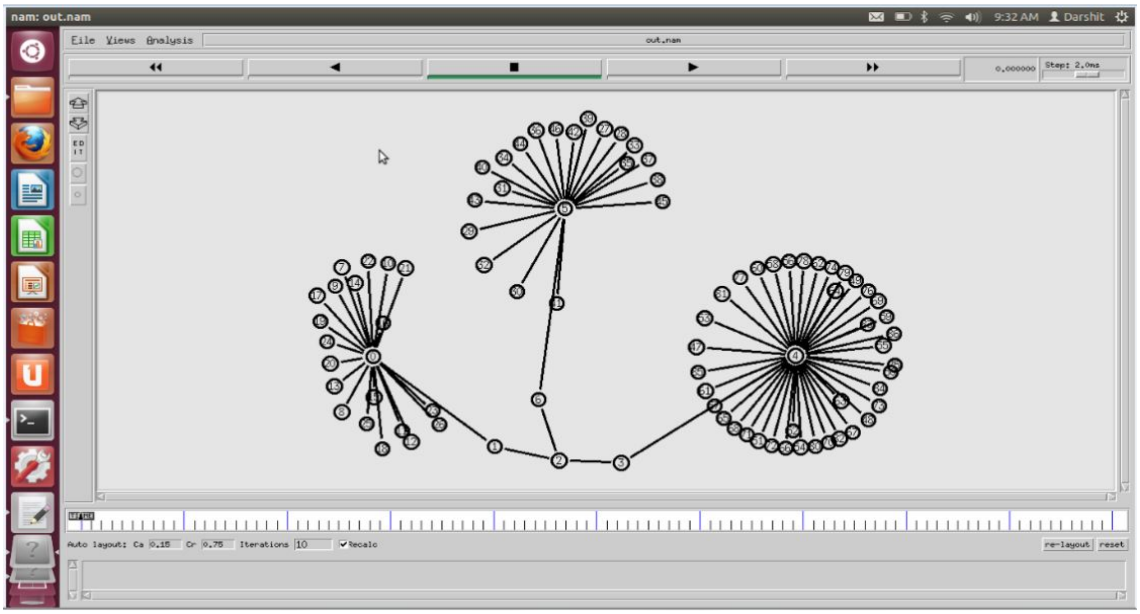

Figure 5.1: Otical Burst Switching Network Topology

queue length and offset choice. During the simulation, if the requests are not satisfied successfully due to any of the given parameters limit, then the corresponding bursts are dropped. The output of the simulation gives the burst loss rate and success rate for the specified parameters. Burst loss rate is the ratio of total number of bursts blocked to the total number of bursts that arrived at all the nodes in the network. Burst drop rate is also called as the blocking probability. Bursts that are lost in the network are not taken into any consideration.

5.2 Simulation Parameters

Burst sending timeout - 7ms

Maximum Destination - 87

Maximum number of bursts delayed in the reservation - 5

Maximum wavelength per link - 1
7 Optical nodes (0-6) with converters and Fiber Delay Lines (FDLs) in the node
80 electronic nodes (7-87)
queue length - 10000
Bandwidth of the fiber links - 1000Mb.

5.3 Simulation Results

After using adaptive contention resolution technique, burst drop rate and throughput, these two parameters are computed and results are plotted. Fig. 5.2 shows that burst drop rate decreases as burst size is increased in the network, and thus throughput is also increased with that as shown in Fig. 5.3

Here, in simulation we have all the electronic nodes, that are transmitting at the same time to the connected optical node, from where the tcp packets are combined into the Optical bursts and then bursts travels through out the network. Within the network, this bursts can not be separated and they are separated only at the receiving end of the optical network. From where each packets will go to its destination electronic node.

As shown in Fig. 5.1, we can see that two optical edge nodes are connected with 20 electronic source node and one optical edge node is connected with 40 electronic destination node. In the simulation, we have assumed that all the source node are transmitting at the same time, so that we can have better result for the contention resolution. Here we have taken the worst case scenario for the contention in the network when all the source node in need for transmission line at the same time.

5.3.1 Burst drop rate:

To verify that adaptive contention resolution technique actually reduces the burst drop rate of the network. First, for default burst size (BS = 50), transmission is done and burst drop rate is found to be 0.01435 %. Then, using our technique and setting the thresholds for the network we can actually reduce the burst drop rate of the network. As we can see from the Fig.5.2 it is clear that burst drop rate is being decreased. For default value of burst size (BS=50) burst drop rate is fixed at 0.01435, but when we use adaptive contention resolution technique, burst size is increased and with that burst drop rate of the network comes down to 0.0987% for the burst size of 300. We have used four burst size, i.e. 50, 100, 200, 300.

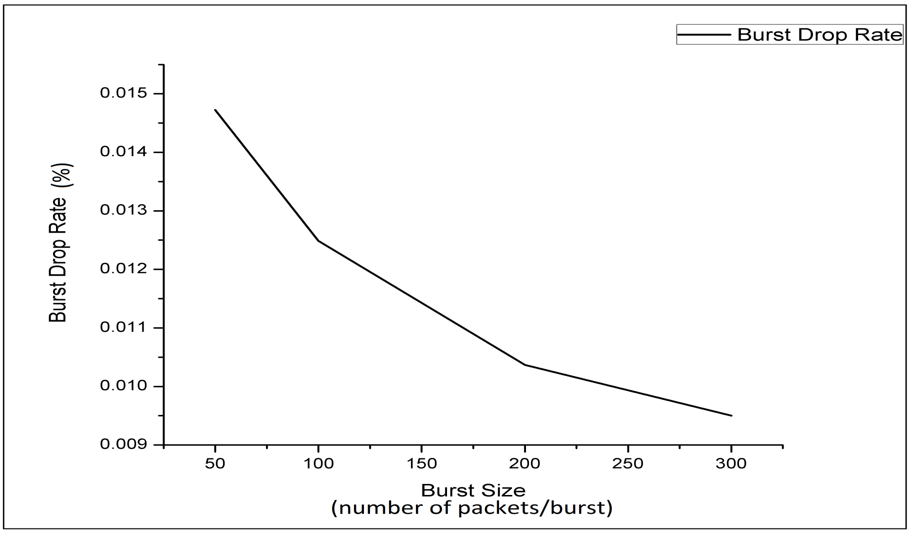

Figure 5.2: Burst Drop rate vs Burst Size

As we can see from the Fig. 5.2, increasing the burst size leads to the decrement of the burst drop rate of the network. Table 1 also shows the burst drop rate values for the particular burst size.

Table I: Burst drop rate with Burst Size

Burst Size (No. of packets/burst)	Burst drop rate (%)
50	0.01435
100	0.01248
200	0.01029
300	0.00987

5.3.2 Throughput:

As the burst drop rate of the network decreases with the increase in burst size using adaptive contention resolution technique, throughput of the network also increased.

As shown in Fig. 5.3, using adaptive contention resolution technique it leads to increased throughput of the network. While using fixed burst length based algorithm burst drop rate and throughput of the network, both were bouded to the fix value but using adaptive contention resolution technique, we can actually have better performance of the network.

When we use the default burst size (BS=50), no. of successfully received packets are obtained to be 1100083 and with increase in the burst size it is found to be 1462713 for burst size of 300.

Table II: Throughput with Burst Size

Burst Size (No. of packets/burst)	Throughput (No. of packets received)
50	1100083
100	1184955
200	1369328
300	1462713

From this results, we can say that using our technique in OBS we can actually overcome the problem of contention in the OBS network that also leads to the increase in the throughput of the network and hence the performance of the optical network can be better.

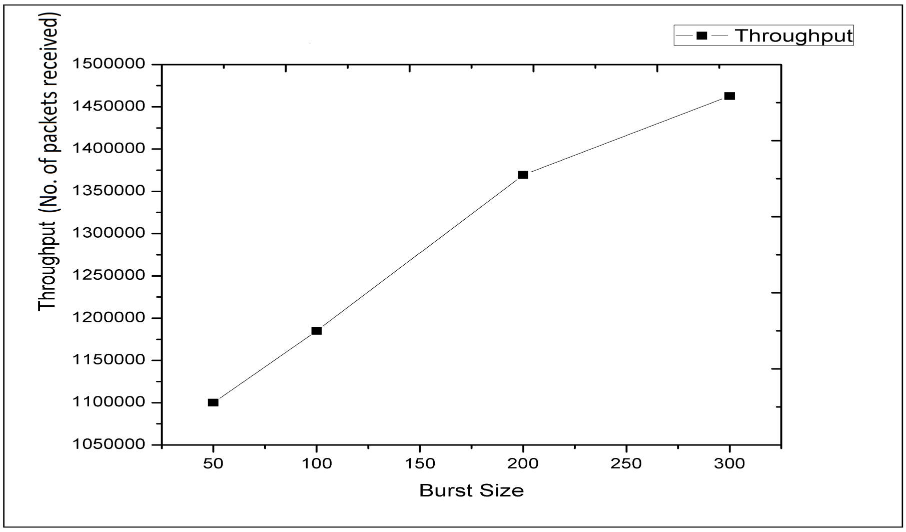

Figure 5.3: Throughput vs Burst size

Chapter 6

Conclusion and Future scope

6.1 Conclusion

In this thesis, we discussed the core concept of OBS. An adaptive contention resolution technique is proposed that depends on data burst size adaptation according to the burst drop rate in the network. We simulated this technique and the results showed that using this technique, burst drop rate of the network is decreased and throughput of the network is increased. From results, it is verified that our proposed algorithm changes the data burst size according to the burst drop rate and also leads to an increase in throughput. Finally, our technique proves that it limits the contention in the network and increases throughput of the network. So, our proposed technique can be used for the application which requires the low packet drops networks like video streaming or voice over IP (VoIP).

6.2 Future scope

Currently we have simulated this algorithm for the resolution of contention for the fixed traffic in the OBS network. We can simulate the same for the varying traffic scenario in the network. Currently using adaptive contention resolution technique we are getting the burst drop rate upto 0.009%, we can look to improve that and throughput of the network. In the proposed approach, we are adapting the burst size according to the burst drop rate in the network. We can also implement it using adaptation according to the offered load of the network.

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