Congestion Control Strategy in Optical Burst Switching Networks

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ABSTRACT
Optical burst switching (OBS) is developed as an alternative switching technology, which contains advantages of both Optical circuit switching (OCS) and Optical packet switching (OPS). The most important design goal in Optical Burst Switching (OBS) networks is to minimize the congestion in the network as a result of resource contention. This paper will propose a mathematical model using Erlang's B formula to calculate the congestion in the optical burst switching network. Results show that with the increase in the value of congestion, blocking probability also increases but its effect is negligibly small. The results will prove that this strategy is better than the conventional techniques.

Note: Simulation is done using MATLAB software.

General Terms
Blocking Probability, Optical Network et. al.

Keywords
Blocking Probability, Congestion, Erlang's B formula, Traffic intensity

1. INTRODUCTION
Due to bandwidth efficiency & implementation simplicity, Optical Burst switching networks (OBS) is considered as a up and coming improvement for data transfer in optical networks [1]. Optical Burst Switching is a high-speed switching technology that combines the advantages of optical circuit switching and optical packet switching. In OBS network, multiple IP packets with the same address (destination) are captured into a burst at an ingress OBS node and this burst payload is transmitted through the optical medium, along with a corresponding control packet (Burst Header) for each data burst. Burst Header are transmitted on a physical or logical channel which is different from the burst payload and are processed electronically in each node. Transmission of headers and bursts in an OBS network are separated by a time difference called a header-offset. Burst Header leads the data burst by an offset time and reserves wavelength resources for its data burst and thus eliminates the need for buffering of the data burst while processing of the control packet and configuring the switch. The packet was processed electronically at each node and activates the switch fabric to connect the associated burst to the appropriate output port [2]. The main motive was to aggregate incoming packets from the access network into defined size bursts. Tell-And-Wait (TAW) and Tell-And-Go (TAG) protocols were used to perform optimal scheduling schemes. With the deployment of technology, several critical issues which affect the network performances were addressed and also congestion in network was observed

2. PREVIOUS RESEARCH
The fundamental purpose of a communication system is to exchange information between two or more devices. Such system can be optimized for voice, data, or both. In its simplest form, a communication system can be established between two nodes that are directly connected by some form of transmission medium. A station may be a personnel computer, telephone, fax machine, mainframe, or any other communicating device. This may, however, be impractical, if there are many geographically dispersed nodes or the Communication requires dynamic connection between different nodes at various times.

Se-yoon Oh [3] present a novel data burst generation algorithm that uses hysteresis characteristics in the queuing model for the ingress edge node in optical burst switching networks. Simulation with Poisson and self-similar traffic models shows that this algorithm adaptively changes the data burst size according to the offered load and offers high average data burst utilization with a lower timer operation. It also reduces the possibility of a continuous blocking problem in the bandwidth reservation request, limits the maximum queuing delay, and minimizes the required burst size by lifting up data burst utilization for bursty input IP traffic.

S.Y. Wang [4] proposes using a modified TCP decoupling approach as a congestion control mechanism for optical burst switched networks. The TCP decoupling approach is a novel way that can apply TCP congestion control to any traffic flow in a network. Since this approach is generic, it has found applications in several areas. In the optical burst switching (OBS) area, because the basic mechanism of the TCP decoupling approach matches the mechanism of the OBS very well, he propose using a modified TCP decoupling approach to congestion-control the traffic load offered to an OBS switch and regulate the timing of sending bursts. The simulation results show that this approach enables an OBS switch to achieve high link utilization while maintaining a very low packet (burst) drop rate.

Lae Young Kim [5] proposes a novel congestion control scheme based on the highest (called peak load) of the loads of all links over the path between each pair of ingress and egress nodes in an OBS network. Also proposes an algorithm that dynamically determines a load threshold for adjusting burst sending rate, according to the traffic load in a network. Simulation results show that the proposed scheme reduces the burst loss rate significantly compared to existing OBS protocols, while maintaining reasonable throughput and fairness.

Pallvi Garg [2] used Modified Erlang's Loss Formulae to control the congestion in Optical Burst Switching Networks. This control of congestion is done by controlling the blocking probability. The blocking probability is also related to Traffic Intensity. Simulation results show that with the value of traffic intensity either less or more, blocking probability increases.

Farid Farahmand [6] describe a feedback-based OBS network architecture in which core switch nodes send explicit messages to edge nodes requesting them to reduce their transmission rate on congested links. Within this framework, we introduce a new contention avoidance mechanism called Source Flow-rate Control (SFC). Through admission control, the SFC proactively attempts to prevent the network from entering the congestion state**.**

Mushi Jin [7] designs a novel heuristic congestion control scheme in order to achieve desired QoS for optical burst that flows through the adjustment of burst assembly intervals. The method is simple and easy to implement. The simulation results demonstrate that a stable network throughput can be maintained.

PROPOED MATHEMATICAL MODEL

Various algorithms were used to control or avoid congestion. But they control congestion up to some extent. In this thesis, we have proposed congestion control algorithm using Erlang's B formula. In earlier algorithms, Erlang formula was used as the relation between blocking probability and traffic intensity which was given as

$$B = \frac{\frac{A^n}{n!}}{\sum_{i=0}^{n} \frac{A^i}{i!}} \quad ....(i)$$

Where, n = Number of channels

B= Blocking Probability

A= Traffic Intensity

To control congestion, we have modified the Erlang's Loss Formula. We have developed the relation between Congestion, C_g and blocking probability B. From literature review, it came into light that demand is directly proportional to congestion. As demand of the signal increases, congestion increases and vice-versa. Also, demand, D is directly proportional to traffic intensity, A. These points can be represented mathematically by equation (ii) & (iii).

$$D \alpha A \quad .... (ii)$$

$$D = cA \quad .... (iii)$$

Where, $c$is constant.

The Traffic Intensity is given as:

$$A = \lambda h = \lambda W = \frac{\lambda}{\mu} \quad .... (iv)$$

Where, h or W= Call holding time

λ= Call arrival rate

μ= Average number of requests processed per time

Hence,

$$D = c\lambda h = c\lambda W = c\frac{\lambda}{\mu} \quad .... (v)$$

Congestion is directly proportional to traffic intensity.

So,

$$D = c\lambda h = c\lambda W = c\frac{\lambda}{\mu} = C_g \quad .... (vi)$$

Now, the Erlang Loss Model can be modified as given in equation (vii) is:

$$B = \frac{\left(\frac{C_g}{C_1}\right)^n / n!}{\sum_{i=0}^{n} \left(\frac{C_g}{C_1}\right)^i / i!} \quad .... (vii)$$

Where, B= Blocking Probability

C_g= Congestion

C_1= Constant value

n= Number of channels

For congestion control, the function of modified Erlang's Model is developed in MATLAB Software. Now a program is written to calculate blocking probability in terms of congestion. First the relation between number of servers (n) and blocking probability (B) will be calculated. Secondly the relation between traffic intensity (ρ) and blocking probability (B) will be calculated. Then, the relation between congestion (C_g) and blocking probability will be generated.

The above shown mathematical equation is the mathematical model which has been proposed in this thesis for congestion control. The congestion can be easily controlled by using the above mentioned model and by using the algorithm which has been proposed and can be easily explained by using figure-1. The figure below shows that in the first stage the source destination pair is being selected and the entire path is being searched which can be used between the selected source destination pair. The traffic and congestion is then checked for and the blocking probability is calculated for every path. The path with the least congestion and blocking probability is selected and the congestion can be controlled in this manner.

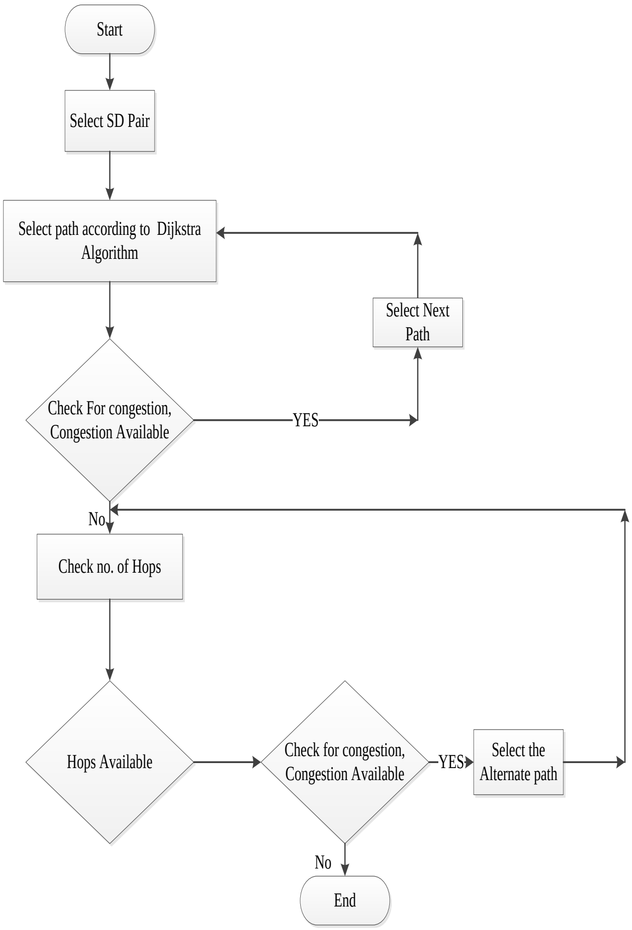

Fig 2.1 Flowchart of Proposed Algorithm

3. SIMULATION AND RESULTS

The results are calculated as shown in the figure below using MATLAB simulator**.** The results which are getting through proposed algorithm are better than the conventional methods which were developed earlier**.**

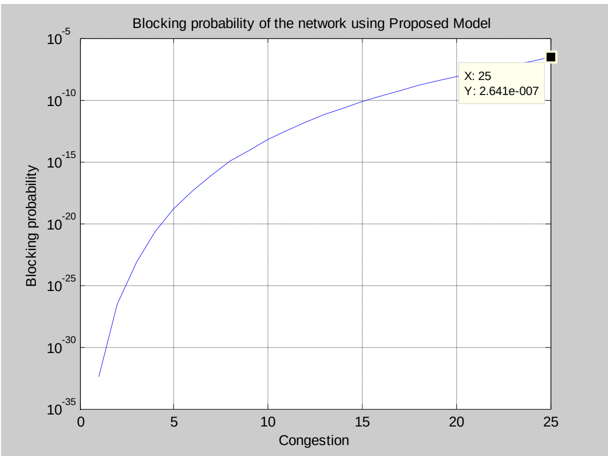

Figure 3.1 Graph showing Blocking probability versus congestion=25

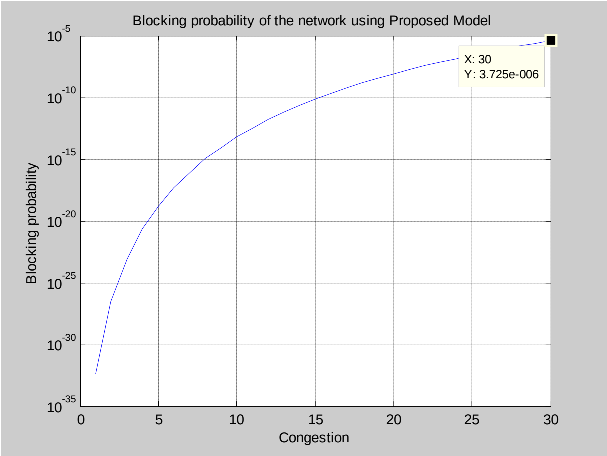

Figure 3.2 Graph showing Blocking probability versus congestion=30

Graph in the figures 3.1 and 3.2 shows the representation of the blocking probability with respect to the congestion. As the value of congestion increases, blocking probability is also increases. But in the proposed mathematical model, by increasing the value of congestion, blocking probability increases in negligible manner.

From the above results it is observed that by increases the value of congestion from 25 to 30, the value of blocking probability increases from 10^{-7} to 10^{-6} which is quite negligible. Therefore the proposed model is better than the previously developed model.

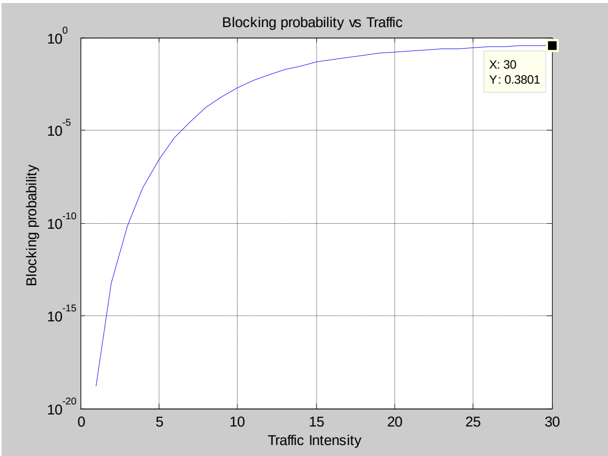

Fig 3.3 Graph showing Blocking probability versus Traffic intensity=30

Graph in the figures 3.3 and 3.4 shows the representation of the blocking probability with respect to the varying traffic intensity. The traffic intensity is plotted in x axis and blocking probability is plotted in y axis.

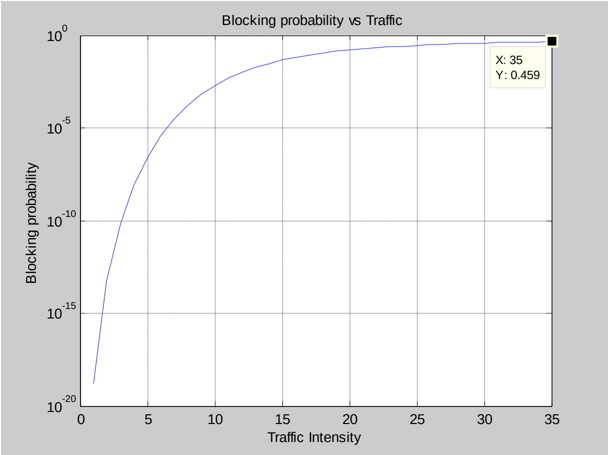

Fig 3.4 Graph showing Blocking probability versus Traffic intensity=35

Graph in the figures 3.3 and 3.4 shows the representation of the blocking probability with respect to the varying traffic intensity. With the increase in the value of traffic intensity, the value of blocking probability also increases. But in the proposed mathematical model, by increasing the value of traffic intensity from 30 to 35, the value of blocking probability increases from 0.38 to 0.45, which is very less as compared to the maximum value of blocking probability which is 1.

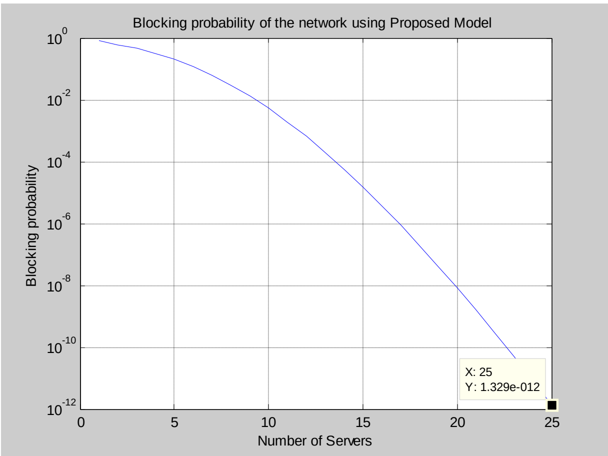

Fig 3.5 Graph showing Blocking probability versus Number of Servers=25

Graph in the figures 3.5 and 3.6 shows the representation of the blocking probability with respect to the number of servers. The number os servers is plotted in x axis and blocking probability is plotted in y axis.

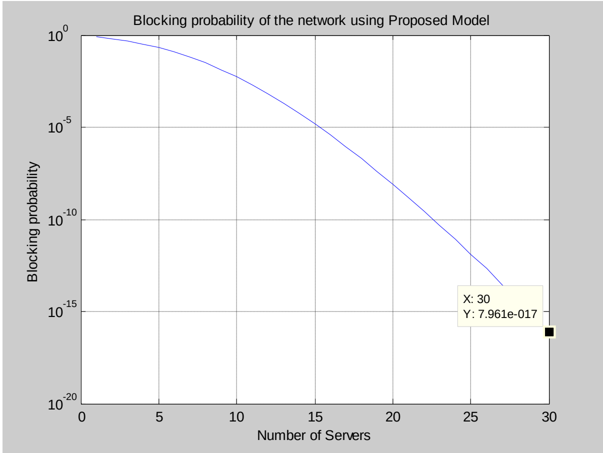

Fig 3.6 Graph showing Blocking probability versus Traffic intensity=30

Graph in the figures 3.5 and 3.6 shows the representation of the blocking probability with respect to the number of servers. We know that as the number of server increases, blocking probability decreases. But in our proposed model, by increasing the number of servers from 25 to 30, we have reduced the blocking probability from 10^{-12} to 10^{-21} which is quite less.

4. CONCLUSION

This paper has proposed a mathematical model for congestion control in Optical Burst Switching Network. The experimental results have shown that the comparison is made on the basis of different parameters like traffic intensity, congestion and blocking probability. It is analyzed that with the increase in congestion in the network, the blocking probability is increasing but in negligible manner. Also, with the increase in the value of blocking probability, traffic intensity increases but negligibly. Therefore, the blocking probability is reduced upto maximum extent through this model. So the proposed model for congestion control performs better than the previous developed models.

5. FUTURE SCOPE

In Future work can be extended in the following directions:

- To work on the different parameters.
- Applying new formulas for the minimization of blocking probability on the different parameters.
- The work can be enhanced for other networks also like passive optical networks, packet optical switching networks, multi protocol label switching networks etc.

6. REFERENCES

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