TRAFFIC EFFECT ON INGRESS NODE OF OPTICAL BURST SWITCHING

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***ABSTRACT*:** *Optical Burst Switching (OBS) is considered as a promising switching technique for the next generation of optical networks. In optical burst switching, the wavelength resources are shared between different connections. The results of traffic model are compared with existing Engset model. The proposed model gives lower burst blocking ratio as compared to existing model for the same amount of waiting time. By reducing burst loss ratio and analyzing results of model we can choose burst length and burst aggregation time according to traffic such that minimum resources are required in network.*

Keywords— OBS, Ingress Node, Traffic Modelling.

1. INTRODUCTION

The development of optical burst switching relies on the successful development of several key technologies, including all-optical switches, burst mode receivers, and optical wavelength converters. While development in these areas has progressed over the past several years, additional work may be required before such technology is available for use in practical systems. Regardless of what type of technology is eventually used in the design of optical burst-switched networks, network designers must still take into consideration any physical-layer constraints imposed by the selected device and component technologies.

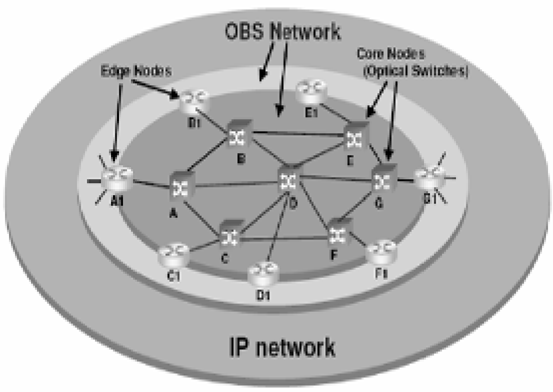

Fig 1 Typical OBS Network

An optical burst-switched network consists of optical burst switching nodes that are interconnected via fibre links. Each fibre link capable of supporting multiple wavelength channels using wavelength division multiplexing (WDM). Nodes in an OBS network can either be edge nodes or core nodes as shown in Fig 1. Edge nodes are responsible for assembling packets into bursts, and scheduling the bursts for transmission on outgoing wavelength channels. The core nodes are primarily responsible for switching bursts from input ports to output ports based on the burst header packets, and for handling burst contentions.

2. PROPOSED BURST ASSEMBLY MODELS

In Engset model traffic calculation is static and has a higher burst loss ratio for larger burst and higher burst formation time. To reduce the burst loss ratio we proposed a partial burst model. We modified static traffic scheme in which we consider fibre capacity, burst length, number of wavelength which leads to better results of burst loss ratio.

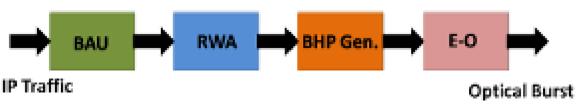

Fig 2 Procedure of IP to Optical Conversion

Fig 2 shows procedure of converting IP packet into optical burst. When IP packet arrives at ingress node it is sorted according to its destination and then its class. In second stage the packets of same destination and same class are aggregated together and a burst is formed. The resource reservation are done along the selected route on which burst will be sent. Next burst header packet is generated and append ahead of burst. And then electrical to optical conversion is to be carried out.

Steps to Calculate Burst Loss Ratio

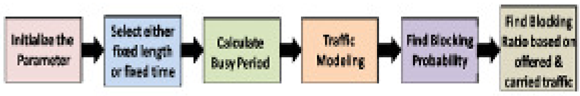

Fig 3 General Procedure to Find Burst Loss Ratio

Fig 3 shows steps to calculate burst loss ratio.

- Initialize various network parameters like round trip time, number of wavelength, mean packet arrival time etc.
- Select either of the burst assembly techniques
  - Timer Based
  - Threshold Based
- Calculate busy period of the buffer.
- Calculate average or static traffic (Traffic Modelling)
- Calculate blocking probability of burst
- Calculate blocking ratio based on offered traffic, carried traffic and blocking probability.

3. TRAFFIC MODELLING

To calculate traffic, on-off Modelling is used in the Engset model which gives static traffic, which is not sufficient. With the help of static traffic we calculate average traffic rate and time for one burst then we multiply together to get actual traffic rate.

Traffic Model with Engset Modelling

To calculate busy period of buffer and length of burst equations of Engset model are used. Static traffic is calculated based on on-off modelling as per equation 1.

$$\alpha \approx \frac{T_{RTP} + T_b}{1/(T_p + T_d)} \quad (1)$$

Now based on calculated static traffic, average traffic rate and time for a burst have been calculated as per equation 2 and 3 respectively. Actual traffic is calculated as shown in equation 4.

$$\lambda = \frac{\alpha C_F}{K N_c L_b} \quad (2)$$

$$\mu = \frac{1}{L_b} \quad (3)$$

$$\rho = \lambda \mu \quad (4)$$

In Engset, static traffic to calculate loss probability has been used. But here ρ has been used to calculate loss probability as per equation 5.Equation is same in both cases only difference is here ρ is used instead of α.

$$P_k = \frac{{}_B C_k \cdot \rho^k}{\sum_{q=0}^{k} ({}_B C_q \cdot \rho^q)} \quad (5)$$

Offered traffic to the network, carried traffic by the network, and burst loss is calculated same as Engset model as per equation 6, 7 and 8 respectively.

$$O_T = \rho \cdot \sum_{k=0}^{K} (B - k) \cdot P_k \quad (6)$$

$$C_T = \sum_{k=0}^{K} k \cdot P_k \quad (7)$$

$$B_L = \frac{O_T - C_T}{O_T} \quad (8)$$

Performance Evaluation

We set the mean packet size R_{in}/L_p=400B, output rate R_{out}=1Gbps, number of Wavelength K=32, for simulation purpose we vary parameters accordingly mean packet arrival time =2 μs, round trip time = 5 ms, fibre capacity C_F=1.25 Gbps, number of class N_C=5 and number of buffers =50.

Table 1 Simulation Parameters for the Traffic Model

Parameter Symbol	Description	Numerical Values
R_{in}/L_p	Mean packet size	400B
R_{out}	Output rate of traffic by network	1Gbps
B	Number of buffers	50
K	Number of wavelength	32
C_F	Fibre Capacity	1.25 Gbps
N_C	Number of Class	5
T_d	After this much of time packet is sent to reserved wavelength	0 - 100 ms
T_{RTP}	Round trip time	5 ms
T_p	Mean packet arrival time	2 μs

I. Blocking Ratio v/s Waiting Time for Traffic Model and Engset Model

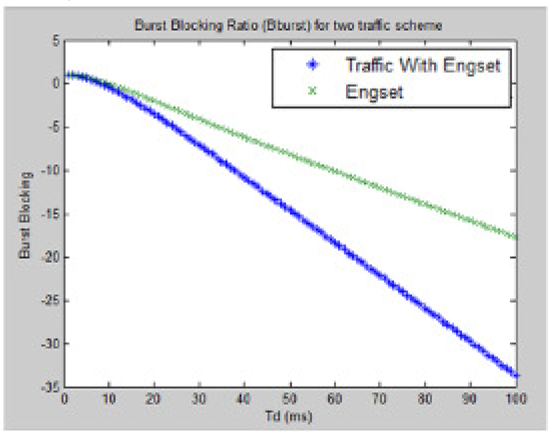

Fig 4 Burst Loss Ratio v/s waiting time for New Traffic Model and Engset Model

We have estimated burst blocking ratio of new traffic model with Engset model by changing the waiting time T_d for the round trip time of 5 ms, mean packet arrival time of 2 µs, number of wavelength is 32, fibre capacity of 1.25 Gbps, number of classes are 5 and buffer size of 50, and then compared with original Engset model as shown in Fig 4. It is observed that new traffic model gives higher blocking probability as compare to Engset model for a particular value of waiting time.

II. Burst Length v/s Waiting Time for Traffic Model and Engset Model

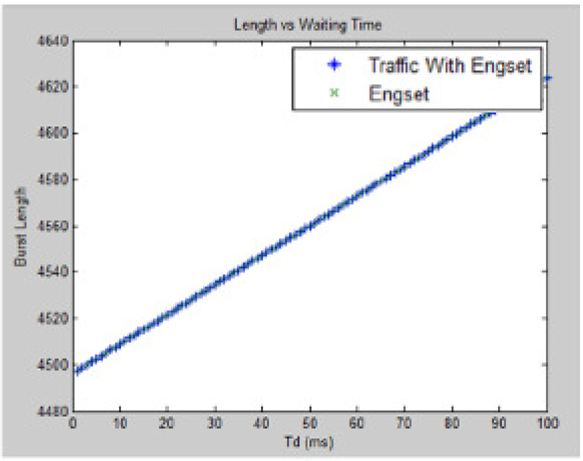

Fig 5 Burst Length v/s waiting Time for New Traffic Model and Engset Model

We plot the value of burst length L_b against waiting time T_d for round trip time T_{RTP} of 5 ms, mean packet arrival time of 2 µs, number of wavelength per fibre is 32, fibre capacity of 1.25 Gbps, number of classes are 5 and buffer size is 50. We plot for the new traffic model and Engset model for the same value of parameter as shown in Fig 5. We can see that the length of assembled burst L_b is not depending on the probability model scheme for any value of waiting time T_d.

III. Blocking Ratio v/s Burst Length for Traffic Model and Engset Model

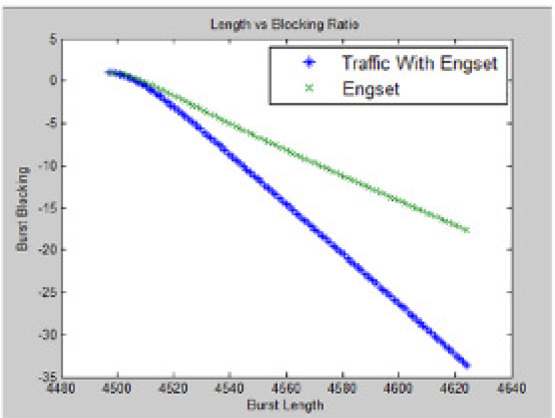

Fig 6 Burst Loss Ratio v/s Burst Length for New Traffic Model and Engset Model

We plot the burst loss ratio B_L against burst length L_b for new traffic model and Engset model for the value of round trip time T_{RTP} is 5 ms, mean packet arrival time of 2 µs, number of wavelength per fibre is 32, fibre capacity of 1.25 Gbps, number of classes are 5 and buffer size is 50, shown in Fig 6, observe that blocking probability B_L is higher for the Engset model as compare to new traffic model at same burst length L_b. Here it is seen that as the burst length increases blocking ratio decreases but physical waiting time is increased of first packet to form such large burst.

So here for burst length no matter which probability and traffic scheme we are using, but when we calculate burst loss ratio based on the burst length at that time probability and traffic model makes difference. For example at 50 ms of waiting time burst length is 4560 kb, which is independent of probability scheme. Now observe Fig 6 for same value of burst length the new traffic model gives -15 burst loss ratio and Engset model gives -8 burst loss ratio.

Table 2 Different Burst Length According to Waiting Time for Traffic with Engset

Model Type	Burst Length (kb) for Waiting Time		
	40 ms	60 ms	80 ms
Engset	4540	4570	4600
Traffic	4540	4570	4600

Table 3 Different Burst Blocking Ratio According to Burst Length for Traffic with Engset

Burst Length(kb)	Burst Blocking Ratio for Two Models	
	Engset	Traffic
4540	-5	-10
4570	-10	-19
4600	-15	-26

Traffic Model with Partial Burst

Here in this subsection along with the traffic model, the scheme of probability from Engset to partial burst is used which is described below.

To calculate busy period of buffer and length of burst equations of Engset model are used. Static traffic is calculated based on on-off modelling as per equation 1.

Now based on calculated static traffic, average traffic rate and time for a burst have been calculated as per equation 2 and 3 respectively. Actual traffic is calculated as shown in equation 4.

Loss probability is calculated as shown in equation 9 & 10.

$$B_{LN} = P / \rho \tag{9}$$

$$P = \sum_{i=1}^{\infty} i * P(k+i) \tag{10}$$

And P(k+i) is the probability that (k+i) servers are busy in model. Since in that model, the number of busy servers is Poisson distributed with parameter A (the traffics load), P(k+i) is given by equation 11.

$$P(k+i) = \frac{\rho^{k+i} / (k+i)!}{\sum_{m=0}^{k+i} \rho^{m} / m!} \tag{11}$$

Offered traffic to the network, carried traffic by the network, and burst loss is calculated same as Engset model as per equation 12, 13 and 14 respectively.

$$O_T = \rho \cdot \sum_{k=0}^{K} (B-k) \cdot B_{LN} \tag{12}$$

$$C_T = \sum_{k=0}^{K} k \cdot B_{LN} \tag{13}$$

$$B_L = \frac{O_T - C_T}{O_T} \tag{14}$$

Performance Evaluation

We set the mean packet size R_{in}/L_P = 400B, output rate R_{out}= 1Gbps, number of Wavelength K = 32, for simulation purpose we vary parameters accordingly mean packet arrival time = 2µs, round trip time = 5 ms, fibre capacity C_F= 1.25 Gbps, number of class N_C= 5 and number of buffers = 50.

I. Blocking Ratio v/s Waiting Time of Different RTP for Traffic with Partial Burst Model

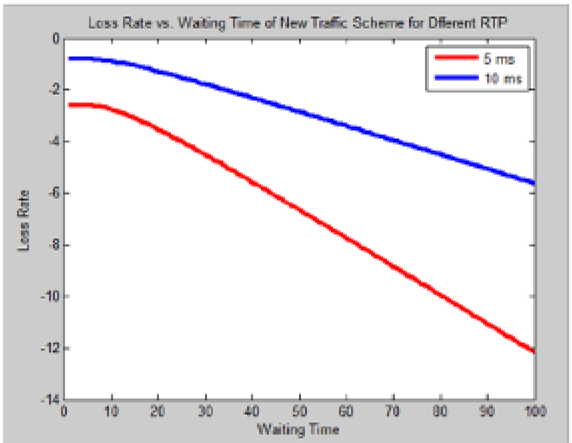

Fig 7 Burst Loss Ratio v/s Waiting Time for Different RTP of New Traffic Model with Partial Burst

We estimated burst lost ratio B_L by changing waiting time T_d for different values of round trip time T_{RTP}= 5 ms, 10 ms as shown in Fig 7 . It is observe that burst loss B_L increases as the round trip time T_{RTP} is increases for the same value of waiting time T_d. This is one of the characteristic of the network, loss increases as round trip time increases so to check the correctness of model we need to check this.

II. Blocking Ratio v/s Waiting Time for Traffic with Partial Burst and Engset Model

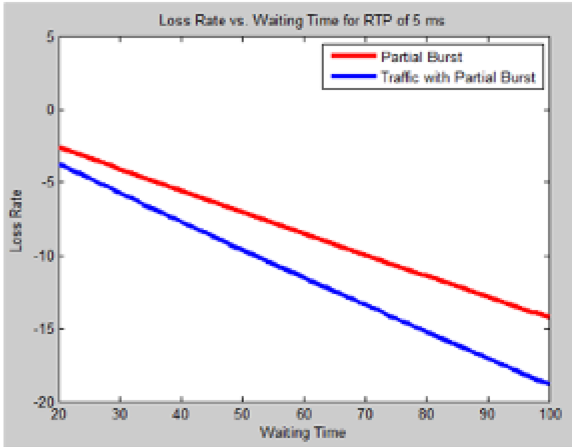

Fig 8 Burst Loss Ratio v/s Waiting Time for New Traffic Model and Partial Burst Model

We compare blocking ratio of new traffic scheme with Partial Burst model for that we estimate burst lost ratio B_L by changing the waiting time T_d for the roundtrip time of 5 ms, mean packet arrival time of 2 µs, number of wavelength is 32, fibre capacity of 1.25 Gbps, number of classes are 5 and buffer size of 50 as shown in Fig 8. It is observed that new traffic model gives higher blocking ratio as compare to Partial Burst model for a particular value of waiting time.

III. Burst Length v/s Waiting Time for Traffic with Partial Burst and Engset Model

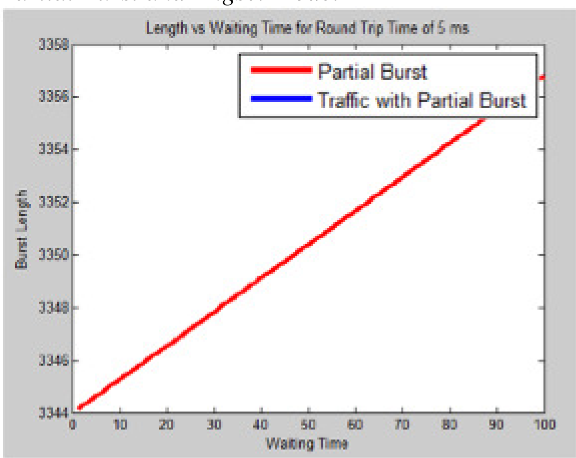

Fig 9 Burst Length v/s Waiting Time for New Traffic Model and Partial Burst Model

We plot the value of burst length L_b against waiting time T_d for round trip time T_{RTP} of 5 ms, mean packet arrival time of 2 µs, number of wavelength per fibre is 32, fibre capacity of 1.25 Gbps, number of classes are 5 and buffer size is 50. We plot for the new scheme and Engset model for the same value of parameter as shown in Fig 9. We can see that the length of assembled burst L_b is not depending on the traffic model for any value of waiting time T_d.

IV. Burst Loss Ratio v/s Burst Length for Traffic with Partial Burst and Engset Model

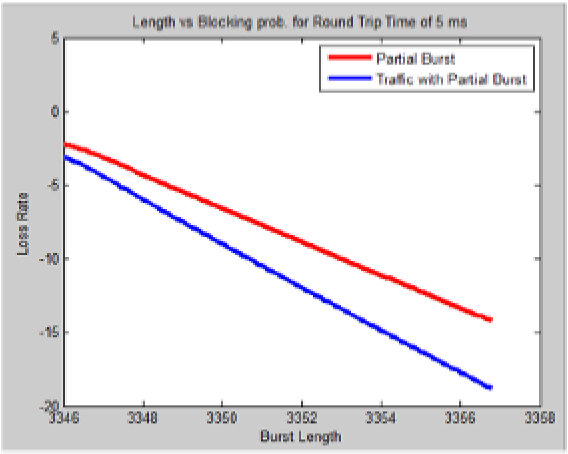

Fig 10 Burst Loss Ratio v/s Burst Length for New Traffic Model and Partial Burst Model

We plot the burst loss ratio B_L against burst length L_b for new traffic model and Partial Burst model for the value of round trip time T_{RTP} is 5 ms, mean packet arrival time of 2 µs, number of wavelength per fibre is 32, fibre capacity of 1.25 Gbps, number of classes are 5 and buffer size is 50, shown in Fig 10 observe that blocking ratio B_L is higher for the normal partial burst model as compare to new traffic model with partial burst at same burst length L_b.

So here for burst length no matter which probability and traffic scheme we are using, but when we calculate burst loss ratio based on the burst length at that time probability and traffic model makes difference. For example at 60 ms of waiting time burst length is 3351 kb, which is independent of probability scheme. Now observe Fig 10 for same value of burst length the new traffic model with partial burst gives -11 burst loss ratio and partial burst model gives -7 burst loss ratio.

Table 4 Different Burst Length According to Waiting Time for Traffic with Partial Burst

Model Type	Burst Length (kb) for Waiting Time		
	40 ms	60 ms	80 ms
Traffic in Engset	3349	3351	3353
Traffic in Partial Burst	3349	3351	3353

Table 5 Different Burst Blocking Ratio According to Burst Length for Traffic with Partial Burst

Burst Length(kb)	Burst Blocking Ratio for Two Models	
	Partial Burst	Traffic in Partial Burst
3349	-5	-7
3351	-7	-11
3353	-10	-14

4. CONCLUSION

The aim is to show that the effect of buffer size, round trip delay, queuing time delay (burst formation time), etc. on the burst blocking probability through mathematical model, traffic scheme and burst formations models.

In traffic model instead of using static traffic directly we can calculate traffic based on the calculated traffic rate and time of one burst. Results show this model also helps to reduce the burst blocking ratio at the edge node. More over based on the result we can say that burst length is independent from traffic and probability scheme.

5. REFRENCES

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