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QoS Guaranteed metrics for Dynamic Scheduling through Void filling and Burst Segmenting in OBS Networks

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Abstract*— Optical burst switching (OBS) is an optical networking technology which consolidates the advantages of optical packet switching and optical circuit switching, while at the same time keeping away their limitations. Since OBS utilizes one –way reservation scheme, hence, due to contention bursts might be dropped at the intermediate nodes before they reach the destination. Hence, the burst dropping ratio is the critical performance estimation in OBS networks. The majority of the scheduling models in contemporary literature aimed to attain scheduling optimality are based on optimal utilization of their idle time. Not very many contributions endeavored to choose channels through any of the quality metric, and remarkably less contributions offer on wavelength allocation to lessen the burst drop ratio. In this regard, this manuscript endeavored to attain optimal wavelength allocation under divergent metrics that denoted as QoS metrics for dynamic scheduling through Void Filling and Burst Segmenting (QDS-VF).The proposed model is compared to the other contemporary model depicted in recent literature and found that burst loss ratio is lower in the proposed scheme.

***Index Terms*—Optical Burst Switching, OBS Networks, Burst drop ratio, Void filling, Burst Scheduling.**

1. INTRODUCTION

At present times, media transmissions still experience huge quantity of traffic. With a view to manage traffic growth, telecom operators swung to optical fiber as a transmission clairvoyant having an immense capacity with provision of bandwidth. With the explosive and fast development of the internet, wavelength division multiplexing (WDM) in optical network has made conceivable throughput backbone network. Optical burst switching [1] is a step towards the extreme objectives of optical packet switching (OPS) in next era and it is proposed to gain an awesome balance between wavelength routing and OPS in WDM optical networks.

Circuit-switching model is the most prominent optical-switching models currently being implemented in commercial networks. The circuit-switching model sets up a light path from the switch to switch for a longer duration. The network is also termed as WR-network and accommodates light-paths through the fibers. Further, these paths vary based on their respective projected wavelengths. However, the traditional WR model is relatively less effective in times of huge traffic and its performance varies over time. This is due to the fact that a wavelength routed (WR) light-path is a bandwidth assured tunnel, resulting in insufficient or unused bandwidth due to inefficient information transmission.

OBS is based on a one-way reservation protocol where the packets are assembled into a burst that follows a corresponding control packet (CP) without waiting for an acknowledgement. In OBS networks, a burst has two segments: payload and control [2]. Payload is the actual data transmitted and the CP carries the header information. Since OBS uses one-way reservation scheme, bursts may be dropped at intermediate nodes due to contention and there is no guarantee that bursts sent will reach its destination.

The functional diagram of OBS network shown in figure 1 has two types of nodes: edge nodes and core nodes. Edge routers can be an egress router (egress node) or an ingress router (ingress node).At the ingress node, data from access network destined to the same egress node is accumulated into large data bursts at the ingress node.

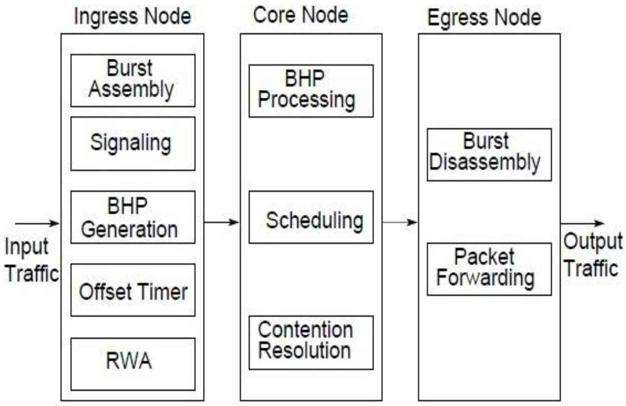

Fig 1: Functional diagram of an OBS Network

The model considers a burst switching entity comprising of a cluster of data-packets transmitted between nodes. This burst dropping in the OBS environment can evoke from numerous issues including unavailability of data channels, path congestion and data contention. Accordingly these issues can prompt to lower network utilization and also affects network throughput. Primarily, in OBS networks, the bursts are lost on account of the failure of resources reservation, which implies that there is a large number of reservation attempts than the number of available resources.

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The contemporary literature presents several studies focusing on burst based models and associated switching framework. Further, data contention also remains one of the interesting study areas in the OBS context [3]. In addition to managing fairness challenges, the environment can challenge the ability of multiplexing along with switching.

2. RELATED RESEARCH

The research in [4] put forward a bi-state Markov Chain approach to manage burst dropping in JET context. It utilized the FF-VF filling context as a path sequencing program. The study in [5] built a loss chance estimation tool in view of various FDLs buffering granularities. Researchers in [6] and [7] developed the estimation tool through retransmission and deflection models. The study in [8], an advanced variant of JET signaling is suggested and the authors named it as VFO. The VFO time sequences the burst considering its initial arrival time. Further, a different variant of JET signaling, termed as S-JET is suggested in [9], which reduces the processing duration for JET when registration occurs at the last of the list. The authors in [10] designed an asymptotical scenario for the null burst drop possibility with respect to various projected wavelengths. This assists in recognizing areas having small burst drop chances.

The study in [11] developed a probabilistic method for determining the burst loss possibility in the context of channel usage convertor sharing is implemented. The method regards the burst onset as the Markovian-arrival procedure to manage diverse traffic distributions. The volume of the burst is apparent to be swiftly distributed. The study in [12] developed an optimal burst sequencing code. The code depends on invariable time burst rescheduling method. The method primarily deletes the deviations in offset durations. Accordingly, the duration based priority mechanisms are not supported. Data contention and loss possibilities are researched in the context of multiple routing codes [13]. In [14], the study built a lowered load fixed-point method to assess the chances of data loss. The method functions for both JIT and JET concepts associated with data segmentation along with path-based priorities. The concept suggests that data segmentation results in the least loss possibility while the path-based priority concept also resulted in increased loss reduction, but the outcome was not significant.

Another important area of focus has been achieving fairness in OBS networks with Pre-emption being mostly used [15]. The study in [16] put forward LHP mechanism for handling unfairness issues in the environment. According to the study, if the cumulative count of hops is more than the preset threshold, it can preempt another burst at the final hop. However, due to the preemption being executed only at the final hop, the method is ineffective to function in OBS environment. As an alternative to this solution, the authors in [17] presented an in-between hop preemption concept. This concept is based on two predetermined threshold levels. Further, in [18], a fair FPP model is suggested. It is built on the basis of first offset duration, mean burst volume, successful hops and leftover hops. In the context of data contention, pre-emption is executed through FPP method to trade off both network fairness level and throughput value. Experimental study of the model depicted superior performance of the FPP model as compared the approaches put forward in [15] and [16].

The authors in [19] suggested FCSA sequencing program for attaining tradeoff among fairness and blocking efficiency. The algorithm integrates a dynamic priority with every burst. The related priority determines the key attributes of any burst. Further, in the context of data contention, the suggested approach utilizes these priorities to select a desirable burst and ignore another burst. In [20], the researchers included the possibility that a subcarrier being engaged in the path capacity.

The study in [21] utilized sequencing mechanisms to incorporate a huge volume of users for super speed paths. The program attempted to enhance short-term fairness and distributes the available bandwidth on the weighted fair basis. In [22], DPCC mechanism is put forward, which balances the rate and reliability through proper distribution of traffic and resources. Further, the method also alters the message transmission speeds and reliability. For altering these parameters, it relies on traffic congestion, pricing and feedback data. Because the model relies on feedback data, it faces the challenge of obtaining this information. Accordingly, certain bursts face high loss rates, in particular, when restricting their input flows. This can result in biased network usage. In [23], route based on ant scenario, wavelength, and time-slot distribution program is suggested to lower the burst drop ratio and achieve an overall high efficiency.

Within the Just-Enough-Time (JET) scheme, there is a probability of a burst being blocked by any other burst that is scheduled to reach later because the offset time differs as per the path length. This phenomenon is known as retro-blocking [24] in step with which the bursts with large offset time are successful in reserving the wavelength earlier than the burst control packet (BCP) of a burst with smaller offset time arriving. This idea outcome within the decline in throughput at the side of resource usage. Further it is able to also result in big unfairness. Though the essential advantage of JET is in lowering end-to-end transmission delay, however, it results in higher burst loss [25], [26], [27].

The previously mentioned research works fundamentally endeavored to decrease the burst loss possibilities, thereby enhancing the overall network throughput. This manuscript endeavors to advance another model that enables the effective utilization of void depicted in channels that already scheduled.

3. QOS METRICS FOR DYNAMIC SCHEDULING THROUGH VOID FILLING AND BURST SEGMENTING

The proposed burst scheduling method for OBS networks that referred as “QoS metrics for dynamic scheduling through Void Filling and Burst Segmenting (QDS-VF)” is depended on Void filling, which indicates the unused capacity of a channel is adapted as an essential process in the proposed solution.

Let the time taken to process the control frame fc_i be $s(lf_i)$ and the time taken by the lf_i to reach the scheduler from the assembler be $\tau(lf_i)$ and $\tau(b_i)$ be the assessed time to transmit burst b_i from assembler to scheduler. The total expected transmission time $tett(b_i)$ will be measured as shown in equation 1.

$$tett(b_i) = s(lf_i) + \tau(lf_i) + \tau(b_i) \quad (1)$$

Scheduling a burst must be of transmission quality in particular but often the scheduled wavelength is not optimal under all quality metrics considered. The quality metrics adapted to evaluate the wavelength optimality ratio are investigated following:

Wavelength arbitration rate (war):

This metric shows the ratio of elapsed schedules of the wavelength to the number of times that wavelength scheduled which can be measured as follows:

$$war(w_i) = \frac{ls(w_i)}{ts(w_i)} \quad (2)$$

The notation *war* (w_i) in equation 2 denotes wavelength arbitration rate, *ls* (w_i) is the elapsed schedules of wavelength w_i against total schedules $ts(w_i)$.

B. Desertation rate (der):

This metric indicates observed unsuccessful transmissions to the total number of times, the corresponding wavelength scheduled which can be measured as follows:

$$der(w_i) = \frac{ds(w_i)}{ts(w_{i)}} \quad (3)$$

The notation $ds(w_i)$ in the equation denotes the number of deserted transmissions with respect to the total schedules $ts(w_i)$.

C. Transmission realization rate (trr):

This metric is the ratio of transmission realizations to the total number of times that wavelength was scheduled, which can be measured as follows:

$$trr(w_i) = \frac{ts(w_i) - ds(w_i)}{ts(w_i)} \quad (4)$$

The notation *trr* (w_i) in equation 4denotes transmission realization rate of wavelength w_i which is the difference between total schedules $ts(w_i)$ and the disserted schedules $ds(w_i)$.

D. Inference rate (irr):

The wavelength in given range that is distinct at given threshold from the other wavelengths that scheduled in parallel measuring of wavelength compatibility is as follows:

$$irr(w_i) = \sqrt{(w(i) - nw(i))^2} \quad (5)$$

The notation $nw(i)$ denotes the nearest wavelength in nanometers.

E. Wavelength data rate (wdr):

This metric is the important Qos factor and the data compatibility can be measured as follows

$$wdr(w_i) = adr(w_i) - cdr(w_i) \quad (6)$$

Here the notation $adr(w_i)$ denote the data rate available at w_i and $cdr(w_i)$ is the data rate required for the corresponding burst.

F. Wavelength existence span (wes):

Except the existence span of the wavelength is extra than the residual life span of corresponding burst, the respective wavelength isn't always match to schedule. This can be measured as follows:

$$wes(w_i) = sea(w_i) - lsr(w_i) \quad (7)$$

The notation $sea(w_i)$ denotes the existing span of the wavelength w_i, and the notation $lsr(w_i)$ indicates the residual life span of burst b to transmit target burst.

4. ASSESSMENT OF OPTIMAL RATIO OF WAVELENGTHS

Let *war*, *der*, *trr*, *irr*, *wdr*, and *wes* as a set of QoS metrics

$N=\{[war(w_i),\ der\ (w_i), trr\ (w_i), wdr\ (w_i), wes\ (w_i)]\ \forall\ i=1\ldots x\}$ of available projected wavelengths $W=\{w_1, w_2, \ldots w_x\}$ under scheduler s_k.

The scope of each wavelength for Qos factors $wdr(w_i)$, $wes(w_i)$ are assessed as follows. Initial process normalizes the bandwidth compatibility and existence span as follows:

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step 1. $\overset{x}{\underset{i=1}{\forall}}\{w_i \exists w_i \in W\}$ Begin
step 2. $diff \leftarrow rdrt- wdr(w_i)$ // the set diff contains the difference between residual data rate $wdr(w_i)$ of each wavelength $w_i$ against residual bandwidth threshold rdrt
step 3. $diff_{abs} \leftarrow abs(diff\{w_i\})$ // the set $diff_{abs}$ contains absolute values of entries in diff
step 4. End
step 5. $\overset{x}{\underset{i=1}{\forall}}\{w_i \exists w_i \in W\}$ Begin
step 6. wavelength data rate normalized such that wavelength with optimal in regard to data rate is between 0 and 1.
step 7. End
step 8. $\overset{x}{\underset{i=1}{\forall}}\{w_i \exists w_i \in W\}$ Begin
step 9. $diff \leftarrow est- wes(w_i)$
step 10. $diff_{abs} \leftarrow abs(diff[w_i])$
step 11. End
step 12. $\overset{x}{\underset{i=1}{\forall}}\{w_i \exists w_i \in W\}$ Begin
step 13 $wes(w_i) = 1 - \frac{1}{(diff\{w_i\}+\max(diff_{abs})+1}$
step 14 End
step 15 $\overset{x}{\underset{i=1}{\forall}}\{w_i \exists w_i \in W\}$
        Begin
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step 16 $ps(w_i) = 1 - (wdr(w_i) \times wes(w_i))$
step 17 End
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For each of the projected wavelength, further the model delineates the wavelength optimality rate *(wor)* as follows.

$\overset{x}{\underset{i=1}{\forall}}\{w_i \exists w_i \in W\}$ Begin // for each projected wavelength

$$\mu(w_i) = \frac{\{W_{ps}\{w_i\} + W_{war}\{w_i\} + W_{der}\{w_i\} + W_{trr}\{w_i\} + W_{irr}\{w_i\}\}}{|Q|} \quad (8)$$

The equation 8 assess the mean of the indices for multiple metrics of wavelength w_i

$$d(w_i) = \sqrt{\begin{array}{c} \frac{1}{|Q|}\{(\mu(w_i) - W_{ps}\{w_i\})^2 + \\ (\mu(w_i) - W_{war}\{w_i\})^2 + \\ (\mu(w_i - W_{der}\{w_i\})^2 + \\ (\mu(w_i - W_{trr}\{w_i\})^2 + \\ (\mu(w_i) - W_{irr}\{w_i\})^2\} \end{array}} \quad (9)$$

The notation $\mu(w_i)$ indicates corresponding wavelength w_i those obtained for different Qos metrics.

$$wor(w_i) = \frac{1}{d(w_i)}$$

The optimal entries of the set W_{ps} are chosen, which the projected wavelengths are having primary score greater than the given threshold. Further these wavelengths are sorted in descending order of their wavelength in regard to schedule the corresponding burst. Here in QDS-VF, it first endeavors to follow the optimum wavelength under the effect of divergent Qos metrics.

5. EXPERIMENTAL SETUP AND EMPIRICAL ANANLYSIS & RESULTS

The simulation study and the results from the phase are cited in this chapter. The NSF-network structure is assessed by interconnecting 38 senders by means of one-way communication path, enabling two-way order by using JAVOBS [28]. Every burst size is fixed as a group of 1,024 data-packets with every data-packet consisting of 64 bytes size. The simulations have been conducted over the suggested approach QDS-VF along with similar approach sharing similar concept, but having divergent approach called POCS-VF [29].

Topology	NSF
Data Sources	25
Transmission channels	19
Dedicated channels for control packets transmission	9
Burst Sizes range	32KB to 1024KB
Range of bandwidth allocated per channel	2 mb/s
Error scope of the thresholds used	± 0.25
Up time of the network	900,000 μs
Range of time frames	10 μs to 50 μs

Table 1: Statistics of the simulation environment

The parameters used to assess the performance are; a. burst loss ratio (BLR) against divergent burst load and fixed size of time frame; b. burst loss ratio against divergent sizes of time frames and fixed burst load; c. channel utilization ratio against divergent burst loads and fixed size of the time frame; d. channel utilization ratio (CUR) against divergent sizes of the time frames and fixed burst load; e. and average scheduling duration.

A. Performance assessment:

The outcomes accomplished from the simulation study delineates that the proposed model called QDS-VF is out preformed compared to benchmark model called POCS-VF that compared under different metrics as stated above. The BLR against varied bursts as shown in the figure 2 states that QDS-VF is 7% less than the burst loss that observed for POCS-VF.

The BLR against divergent time frames with fixed sizes of burst as shown in the figure 3 states that QDS-VF is 6% less than burst loss that observed for POCS-VF.

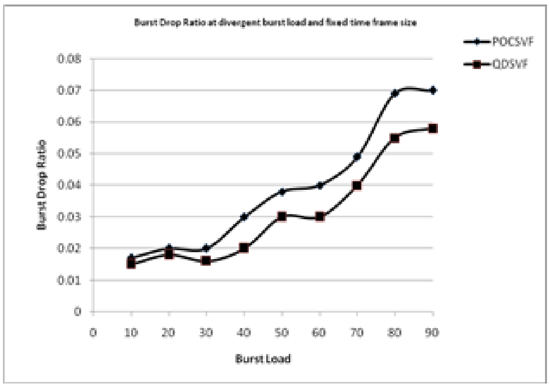

Fig 2: Burst Drop ratio against divergent burst load and fixed timeframe of size of 35 µs

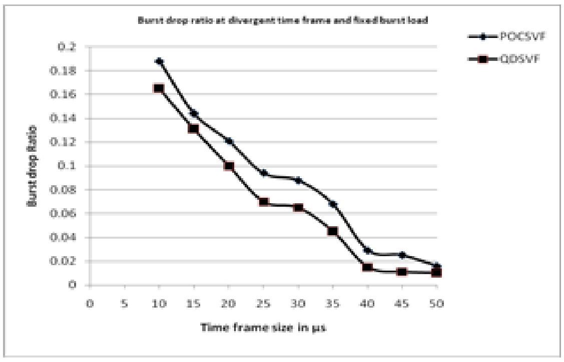

Fig 3: Depiction of Burst Drop Ratio against Divergent size of timeframes and fixed burst size of 35480 bytes

The CUR against divergent burst loads and fixed size of the time frame as depicted in figure 4 is average of 3% more in QDS-VF than POCSVF.

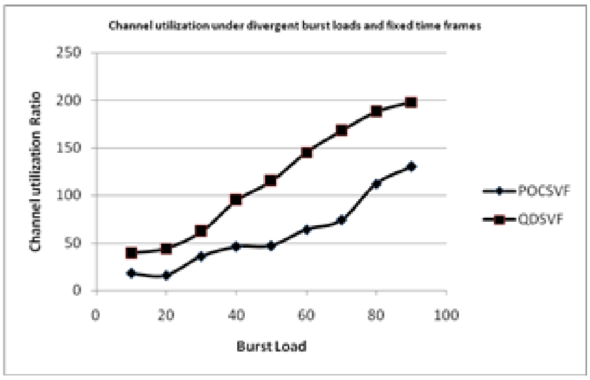

Fig 4: Depiction of Channel utilization ratio under divergent burst load and fixed timeframe of size 35 µs

The scheduling time against divergent burst loads and fixed size of the time frame and varied time frame sizes with fixed burst load as depicted in figure 5 is average of 9% less in QDS-VF than POCSVF.

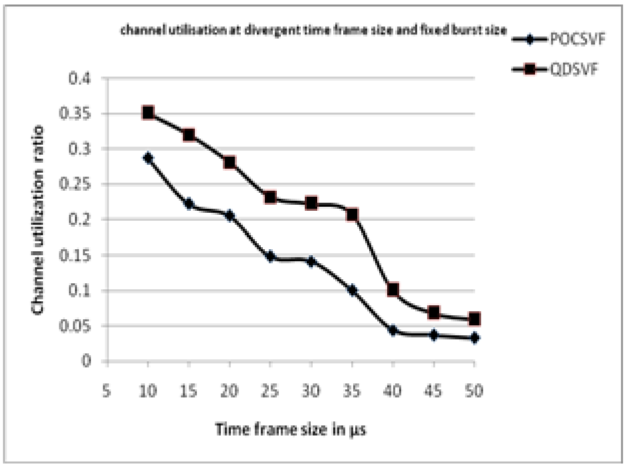

Fig 5: Depiction of Channel Utilization under divergent sizes of timeframes and fixed burst load of 35680 bytes.

Further in figures 6 and 7, the mean time to schedule the burst is nearly same, but the time taken by QDS-VF is lower than POCSVF.

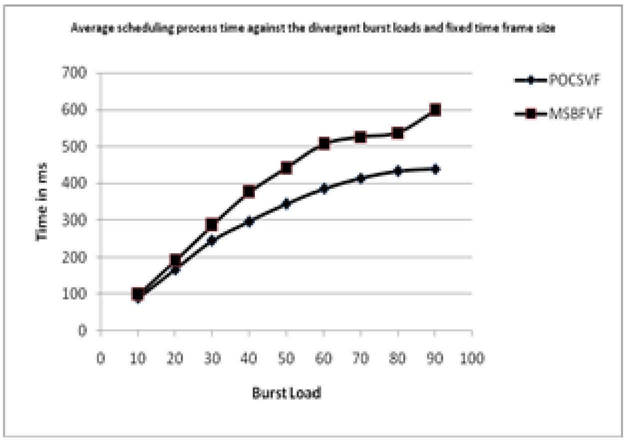

Fig 6: Depiction of Average time to schedule bursts: divergent burst loads with fixed timeframe of size 35 µs

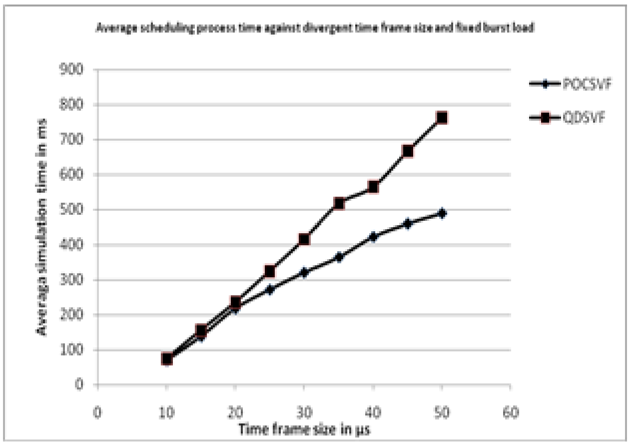

Fig 7: Depiction of Average time to schedule bursts divergent sizes of timeframes and fixed burst load of 35680 bytes

6. CONCLUSION

This manuscript is a novel burst scheduling model which is termed as "QoS metrics for dynamic scheduling through Void Filling and Burst Segmenting (QDS-VF)". The core competence of the manuscript has tried to raise the channel utilization with extreme throughput under divergent burst sizes in addition to volatile time frames. It is clearly evinced from the simulation results that the proposed model is simplifying the process of scheduling with minimal burst drop ratio.. While the proposed model considers only limited channels which are often not true, future work can incorporate batch scheduling through multiple nodes.

REFERENCES

1. C. Qiao and M. Yoo. Optical Burst Switching (OBS) - A New Paradigm for an Optical Internet. Journal of High Speed Networks (JHSN), 8(1):69 - 84, 1999.
2. Y. Chen, C. Qiao, and X. Yu. Optical Burst Switching: A New Area in Optical Networking Research. IEEE Network Magazine, 18(3):16 -23, 2004.
3. Lamba, Rohit, and Amit Kumar Garg. "Survey on contention resolution techniques for optical burst switching networks." International Journal of Engineering Research and Applications 2.1: 956-961, 2012.
4. Kaheel, Ayman Malek, Hussein Alnuweiri, and Fayez Gebali. "A new analytical model for computing blocking probability in optical burst switching networks." IEEE Journal on Selected Areas in Communications 24.12 (2006).
5. Zhu, Xiaoming, and Joseph M. Kahn. "Queueing models of optical delay lines in synchronous and asynchronous optical packet-switching networks." Optical Engineering 42.6: 1741-1748, 2003.
6. Zhang, Qiong, et al. "TCP over optical burst-switched networks with controlled burst retransmission." Photonic Network Communications 22.3 (2011): pp. 299-312, 2011

7. Hsu, Ching-Fang, Te-Lung Liu, and Nen-Fu Huang. "Performance analysis of deflection routing in optical burst-switched networks." INFOCOM 2002. Twenty-First Annual Joint Conference of the IEEE Computer and Communications Societies. Proceedings. IEEE. Vol. 1. IEEE, 2002.
8. Li, Jikai, et al. "Maximizing throughput for optical burst switching networks." IEEE/ACM Transactions on networking 15.5 (2007): pp. 1163-1176, 2007
9. Sansò, Brunilde, Felisa Vázquez-Abad, and Eloim Gutiérrez-Cabrera. "S-JET: efficient reservation scheduling algorithm for optical burst switches." Journal of Optical Networking 4.8 (2005): 476-498.
10. Andrew, L., et al. "The asymptotics of optimal OBS wavelength assignment." ACM Sigmetrics: Performance Evaluation Review 31 (2003): 14-16.
11. Akar, Nail, EzhanKarasan, and Kaan Dogan. "Wavelength converter sharing in asynchronous optical packet/burst switching: an exact blocking analysis for markovian arrivals." IEEE Journal on Selected Areas in Communications 24.12 2006.
12. Chen, Yuhua, Jonathan S. Turner, and Pu-Fan Mo. "Optimal burst scheduling in optical burst switched networks." Journal of Lightwave Technology 25.8 (2007): pp. 1883-1894, 2007.
13. Yuan, Penghui, and Anshi Xu. "Two lower bounds on the burst loss probability in optical burst switching networks." Photonic Network Communications 20.2 (2010): 113-119.
14. Tintor, Vladica, PetarMatavulj, and Jovan Radunović. "Analysis of blocking probability in optical burst switched networks." Photonic Network Communications 15.3: pp. 227-236, 2008.
15. Loi, Chi-hong, Wanjiun Liao, and De-nian Yang. “Service Differentiation in Optical Burst Switched Networks." In Proceedings of GLOBECOM, 2002.
16. Ueda, Masayuki, Takuji Tachibana, and Shoji Kasahara. "Last-hop preemptive scheme based on the number of hops for optical burst switching networks.", 2005.
17. Ueda, Masayuki, Takuji Tachibana, and Shoji Kasahara. "Intermediate-hop preemption to improve fairness in optical burst switching networks." IEICE transactions on communications 91.3 (2008): pp. 710-721, 2008.
18. Gao, Xingbo, Mostafa A. Bassiouni, and Guifang Li. "Addressing conversion cascading constraint in OBS networks through proactive routing." Photonic Network Communications 18.1 (2009): pp. 90-104, 2009.
19. Hsu, Ching-Fang, and Li-Cheng Yang. "On the fairness improvement of channel scheduling in optical burst-switched networks." Photonic Network Communications 15.1 (2008): pp. 51-66, 2008.
20. Guo, Songtao, Yunqiang Zhang, and Yuanyuan Yang. "Distributed power and rate allocation with fairness for cognitive radios in wireless ad hoc networks." Global Telecommunications Conference (GLOBECOM 2011), 2011 IEEE, 2011.
21. Chrysos, Nikolaos, et al. "Tandem queue weighted fair smooth scheduling." Design Automation for Embedded Systems 18.3-4 (2014): pp. 183-197,2014.
22. Zhang, Tairan, et al. "A Dual Price-Based Congestion Control Mechanism for Optical Burst Switching Networks." Journal of Lightwave Technology 32.14 (2014): pp. 2492-2501, 2014.
23. Coulibaly, Yahaya, et al. "QoS- aware ant- based route, wavelength and timeslot assignment algorithm for optical burst switched networks." Transactions on Emerging Telecommunications Technologies 26.11 (2015): 1265-1277.
24. T. Venkatesh and C. S. R. Murthy, An analytical approach to optical burst switched networks. USA: Springer, 2010
25. I. Baldine, G. N. Rouskas, H. G. Perros, D. Stevenson, ‘JumpStart: a Just-In-Time Signaling Architecture for WDM Burst-Switched Networks,” *IEEE Communications Magazine*, vol. 40, no. 2, pp. 82-89, 2002.
26. I. Baldine, A. Bragg, G. Evans, M. Pratt, M. Singhai, D. Stevenson, R. Uppalli, “JumpStart Deployments in Ultra-High-Performance Optical Networking Testbeds,” *IEEE Communications Magazine*, vol. 43, no. 11, pp. S18-S25, November 2005.
27. K. Dolzer, C. Gauger, “On Burst Assembly in Optical Burst Switching Networks - A Performance Evaluation of Just-Enough-Time,” *Proceedings of the 17th International Teletraffic Congress, (ITC 2001)*, pp. 149-160, 2001.
28. O. Pedrola, S. Rumley, M. Klinkowski, D. Careglio, C. Gaumier and J. Solé-Pareta: Flexible simulators for OBS network architectures, in Proc. ICTON 2008, Athens, Greece, June 2008
29. Kishen Ajay Kumar, K. Suresh Reddy, M.N. Giri Prasad. “POCS-VF: Proximate Optimum Channel Selection through Void Filling and Burst Segmenting for Burst Scheduling In OBS Networks”. Journal of Theoretical & Applied Information Technology, vol 96, no.4, pp.8-10, 2017.