International Journal For Technological Research In Engineering
Volume 1, Issue 9, May-2014 *ISSN (Online): 2347 - 4718*

OPTICAL BURST SWITCHING NETWORK INTRODUCTION, CHALLENGES AND SOLUTION

Dilip H. Patel[1](Research Scholar), Dr. Jaymin K. Bhalani[2](Professor& HOD),
Dr. Ved Vyas Dwivedi[3](Pro Vice Chancellor)
[1, 3]C U Shah University, Surendranagar, Gujarat.
[2]Electronics and Communication Department
Babariya Institute of Technology, Baroda, Gujarat, India.

Abstract: In this review paper we have classify different optical transport technology & shows how burst assembly will be carried out, moreover we define challenges faced at practical implementation of OBS including burst contention & proposed its unique solution at the edge node.
Index Terms: OBS Network, Burst Assembly.

I. INTRODUCTION

Given the current state of the technology, the Optical Burst Switched (OBS) network is the most practical all-optical architecture. The user data is transmitted in variable size data packets, called bursts, which travel as an optical signal along the entire route. The control information for each burst is transmitted prior to its corresponding burst and it is electronically processed at each hop along the route.

The dynamic nature of OBS allows for network adaptability and scalability, which makes it very suitable for the transmissionofInternet traffic. The following topics highlight fundamental concepts, challenges that are being faced by research community around the globe and their proposed solution in open literatures for the OBS Networks. In addition, this paper identify a unique proposed technique to resolve all the current challenges by carefully handling the burst assembly unit of the edge node rather than the core node inside the OBS network.

II. CLASSIFICATION OF ALL OPTICAL NETWORK

The potential of optical fiber was fully realized with the invention of dense Wavelength Division Multiplexing (WDM). The evolution of WDM optical networks can be classified as shown in Figure 1. Current WDM networks operate over point-to-point links, where optical-to-electrical-to-optical (OEO) conversion is required at each step. Future WDM designs focus on All-Optical Networks (AON) where the user data travels entirely in the optical domain.

The elimination of the OEO conversion in AONs allows for unprecedented transmission rates. AONs can further be categorized as wavelength-routed networks (WRN), Optical Burst Switched Networks (OBSN) or Optical Packet Switched Networks (OPSN). Also, each step of the optical evolution begins with a simpler ring design before moving on to the more general mesh topologies. The following paragraphs briefly outline the pros and cons of future all-optical architectures.

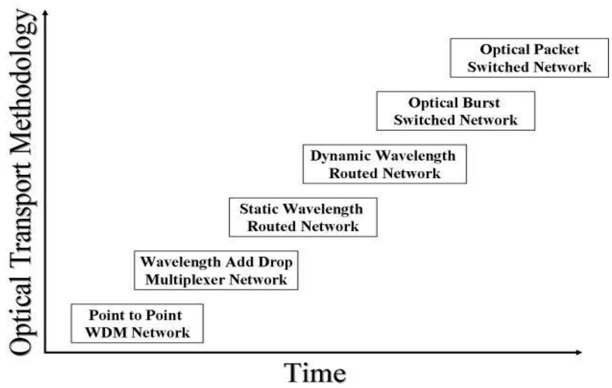

Fig 1. Optical Network Evolution, Courtesy [5]

The AON evolution begins with the WRNs, whose operation consists of setting up long-term circuit connections, called light paths, between the network nodes. The main constraint of the WRNs, typical of any optical communication, is the limited number of wavelengths per fibre. In a large size WRN this scarce number of wavelengths makes it impossible to create a full mesh of light paths between all source destination pairs. Consequently, for each WRN topology, the network architects have to solve the NP-hard problem of routing and wavelength allocation of the light paths in order to optimally satisfy the user traffic. Another challenge for WRNs is their quasi-static nature, which prevents them from efficiently supporting constantly changing user traffic. The proposed signaling protocol for WRNs is the Generalized Multi-Protocol Label Switching (GMPLS) [1]. The most sophisticated AON is the OPSN [2], where the user traffic is carried in optical packets along with in-band control information. The control info is extracted and electronically processed at each node. The OPSN is a desirable architecture because it is a well-known fact that electronic packet switched networks are characterized by high throughput and easy adaptation to congestion or failure. The problem with OPSNs, however, is the lack of practical optical buffer technology. The OBS networks fall between the WRNs and the OPSNs in the AON evolution. The name optical burst switching comes from the fact that the data is transported in variable size units, called bursts [3]. Due to the great variability of the duration of a burst, they can be viewed as lying between OPSNs and WRNs. That is, when all bursts durations are very short, equal to the duration of an optical packet, then the OBSN can be seen as resembling an OPSN. On the other hand, when all burst durations are extremely long, i.e. they may last several months, and then the OBSN can be seen as resembling a WRN. With respect to the current state of the technology, the OBS network has the most practical AON architecture. It combines the best features of circuit switching and packet switching [4]. Its dynamic nature allows for network adaptability and scalability, which makes it very suitable for the transmission of Internet traffic.

III. OPTICAL BURST SWITCHING

An OBS network consists of core nodes and end-devices interconnected by WDM fibers as shown in Figure 2. An OBS core node consists of an optical cross connect (OXC), an electronic switch control unit, and routing and signalling Processors [6]. An OXC is a non-blocking switch that can switch an optical signal from an input port to an output port without converting the signal to electronics. The OBS end devices are equipped with an OBS interface and could be electronic IP routers, ATM switches, switches, etc. Each OBS end-device is connected to an ingress OBS core node.

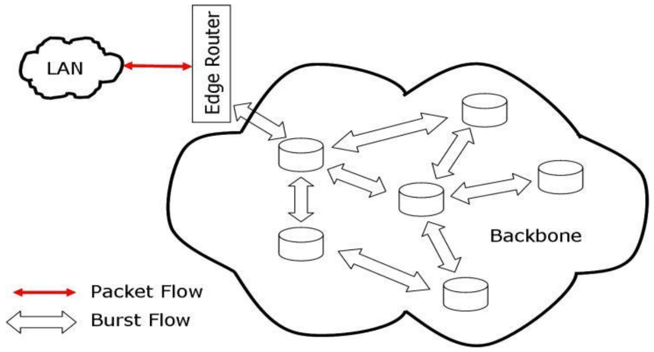

Fig 2. The OBS Network

The end-device collects traffic from various electronic networks (such as ATM, IP, frame relay, etc.). It sorts the traffic per destination OBS end-device address and assembles it into larger variable-size units, called bursts. For each burst,the end-device also constructs a control packet, which contains information about the burst, such as the burst length, burst destination address, etc. The OBS edge router shown in figure 3.

This control packet is immediately sent along the route of the burst and it is electronically processed at each node. The function of the control packet is to inform the nodes of the impending data burst and to set up an end-to end optical path between the source and the destination. After a delay time, known as the offset, the end-device transmits the burst itself. The burst travels as an optical signal over the end-to-end optical path set up by its control packet. This optical path is torn down after the burst transmission is completed.

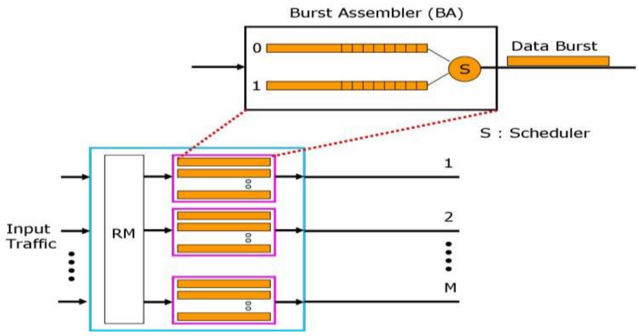

Fig 3. OBS Edge Router, Courtesy [6]

This separation of the control information and the burst data isone of the main advantages of OBS. It facilitates efficientelectronic control while it allows for a great flexibility in theformat and transmission rate of the user data. This is becausethe bursts are transmitted entirely as an optical signal, whichremains transparent throughout the network. In general, thetime it takes the control packet to reach the destination enddevice is equal to the end-to-end propagation delay plus thesum of all the processing delays at all the intermediate corenodes. On the other hand, the time it takes for a burst toreach the destination end-device is only equal to the end-toend propagation delay. The reason is that the burst is transmitted as an optical signal that goes through the OBS switches without any processing or buffering delays. The transmission of a burst is delayed by an offset so that it always arrives at an OBS node, after its switch control unit has had the chance to process the control packet associated with the burst and configure its optical switch fabric. The offset, therefore, is a function of the number of hops that the control packet has to traverse end-to-end.

IV. BURST AGGREGATION ALGORITHM

The burst aggregation algorithm at the end-devices can greatly impact the overall OBS network operation because it sets the burst characteristics and therefore shapes the burst arrival traffic. The algorithm has to consider the following parameters: a pre-set timer, a maximum burst length and a minimum burst length. The timer determines when the end device is to assemble its collected traffic into a new burst. The maximum and the minimum burst length parameters shape the size of the bursts. The maximum burst length is necessary since very long bursts hold on to the resources of the network for a long time and cause the unfair loss of other bursts. The minimum burst length is necessary because very short bursts may give rise to too many control packets. This situation can overload the control unit of the OBS node. The burst aggregation algorithm may use bit-padding if there is not enough data to assemble a minimum size burst. In the OBS network, one of the biggest challenges is to implement different Class of Services. One way to provide Classes of traffic in OBS is to implement priority queues at the edge of the network during the burst aggregation. Based on the class of service, the end-devices sort the upper layer traffic into different queues [7]. As a result, each end-device will have C*N priority queues, where C is the number of service classes and N is the number of possible destinations. This solution of an appropriate scheduling algorithm guarantees that these queues are served according to their priority.

V. SIGNALING, ROUTING AND WAVELENGTH ALLOCATION

Signalling is an important aspect in any network. It specifieshow the connections are established and it determineswhether or not the resources are utilized efficiently. In mostOBS variants, the signalling of connections is accomplished using a one-way signalling scheme, i.e., the burst is transmitted after an offset without any knowledge of whether the optical path has been successfully established end-to-end, as illustrated in Figure 4. End-devices source and destination are connected via two core OBS nodes. The vertical lines represent a time line so as to show the actions taken by each node. Source transmits a control packet to its ingress OBS node. The control packet is processed at the ingress node. If the connection can be accepted, it is forwarded to the next node. The control packet is received by the next OBS node, and is processed. Assuming that the node can accept the connection, it is forwarded to the destination end-device. In the meantime, after an offset delay, end-device a starts transmitting the burst, which is propagated through the two OBS nodes to the destination as an optical signal without any buffering. In this example, the transmission of the burst begins before the control packet had reached the destination.

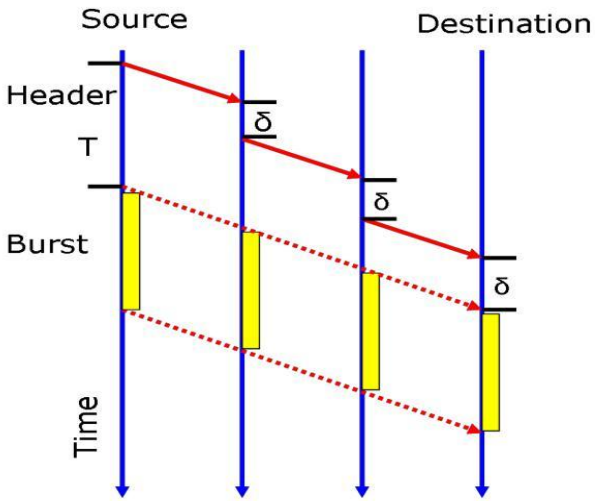

Fig 4. End to End Reservation

Note that in a one-way signaling scheme, it is possible that a burst may be lost if the control packet is not able to reserve resources at any of the OBS nodes along the bursts route. The OBS architecture, however, does not retransmit lost bursts as this job is left to the upper protocol layers. Note that it is very important that the offset is calculated correctly. If the offset is too short, then the burst may arrive at a node prior to the control packet and thus be lost. On the other hand, offset that are too long reduce the throughput of the end-device. One of the major problems with this one-way signaling scheme and lack of buffers is that it leads to burst loss in the OBS network. That is, the control packets may be unsuccessful at reserving resources at some of the intermediate OBS nodes. Buffer-less transmission is important in OBS because electronic buffers require optical-to-electrical-to- optical conversion, which slows down the transmission while optical buffers are still quite impractical. In fact, as of today, there is no practical way to buffer light and the only possible optical buffering is to delay the signal through very long fiber delay lines (FDLs). One possible solution found in Research papers is use of FDLs could potentially improve the network throughputs [8, 9, 10]. Another interesting strategy to reduce the burst loss in OBS is deflection routing. In case of resource contention at an output port of an OBS node, a burst is not dropped but instead it is re-routed on an alternative path to its destination [11, 12, 13]. An OBS network also needs an effective routing algorithm. One approach is to route the bursts on a hop-by-hop basis, as in an IP network, using a fast table lookup algorithm to determine the next hop. Another approach is to use multiprotocol label switching (MPLS) [14]. The MPLS idea is to assign the control packets to forward equivalent classes (FECs) at the OBS end-devices in order to reduce the processing of the routing info to the time it takes to swap the labels. A third approach is to use explicitly pre-calculated routes for the connections, which can be established via protocols such as CR-LDP or RSVP-TE. Explicit routing is very useful in a constrained-based routed OBS network, where the traffic routes have to meet certain QoS metrics such as delay, hop-count, BER or bandwidth. In addition, in order to deal with node or link failures, OBS routing should also be augmented with a fast protection and restoration schemes. Unfortunately, this is a weak point for explicit routing schemes because sometimes the routing tables may become outdated due to the long propagation time until a failure message reaches all of the OBS nodes. The OBS protection and restoration schemes are still an open research problem. In the open literatures [11, 12] suggest A1+1 restoration and protection plan, which can be beginning for OBS Network. As in any other type of optical network, each OBS network has to assign wavelengths at the different WDM fibers along the burst route. This wavelength allocation in OBS depends on whether or not the network is equipped with wavelength converters, which are devices that optically convert signals from one wavelength to another. In an OBS network with no wavelength converters, the entire path from the source to the destination is constrained to using the same wavelength. With a wavelength conversion capability at each OBS node, if two bursts contend for the same wavelength on the same output port, then the OBS node may optically convert one of the signals from an incoming wavelength to a different outgoing wavelength. Wavelength conversion is a desirable characteristic in an OBS network as it reduces the burst loss probability; however, it is still an expensive technology. An OBS network will most likely be sparsely equipped with wave length converters, i.e., only certain critical nodes will have that ability. C. Gauser [9] proposed solution that OBS core node have shared converter pool and a shared EDL buffer for minimizing burst losses, both shared can be utilize for the optimal outcome. In [9], they have verified first by analytical model with bursty arrival process (IPP) and secondly by Simulation (Event based). There result matches by both the method for reducing burst loss probability with proper mixing of shared converter pool and buffer. Another important question with respect to the OBS Wave length allocation scheme is the fairness achieved between the successful transmissions of bursts over long versus short paths. The fairness issue is inherent to all optical networks, not just OBS networks, and it is due to the fact that it is easier to find free wavelengths along all of the links of a short path rather than a longer one. Therefore, the proposed all optical architectures should consider heuristics that try to improve the fairness among the connections with different number of hops. For example, Ogushi et al. [15] proposed a parallel wavelength reservation scheme as a solution to the fairness problem in an OBS network. This scheme achieves better fairness by segmenting the usage of the resources, i.e., the longest connections utilize the entire set of wavelengths while the short connections are limited to a subset of the Wave lengths.

VI. RESERVATION AND RELEASE OF THE RESOURCES

Upon receipt of a control packet, an OBS node processes the included burst information. It also allocates resources in its switch fabric that will permit the incoming burst to be switched out on an output port toward the destination. In [16] classify the resource reservation and release schemes in OBS based on the amount of time a burst occupies a path inside the switching fabric of an OBS node. There are two OBS resource reservation schemes, namely, immediate reservation and delayed reservation. In the immediate reservation scheme, the control unit configures the switch fabric to switch the burst to the correct output port immediately after it has processed the control packet. In the delayed reservation scheme, the control unit uses the offset parameter to calculate the time of arrival tb of the burst at the node, and it configures the switch fabric at tb. There are also two different resource release schemes, namely, timed release and explicit release. In the timed-release scheme, the control unit uses the burst length information to calculate when the burst will completely go through the switch fabric. When this time occurs, it instructs the switch fabric to release the allocated resources. This requires knowledge of the burst duration. An alternative scheme is the explicit release scheme, where the transmitting end-device sends a release message to inform the OBS nodes along the path of the burst that it has finished its transmission. The control unit instructs the switch fabric to release the connection when it receives this message.Combining the two reservation schemes with the two release schemes results in the following four possibilities: immediate reservation and explicit release, immediate reservation and timed release, delayed reservation and explicit release & delayed reservation and timed release, see Figure 5. Each of these schemes has advantages and disadvantages. For example, when timed release is implemented the OBS core node knows the exact length of the burst. Thus, it can release the resources immediately upon burst departure. This results in shorter occupation periods and thus higher network throughput than in the explicit release. The difficulty, however, is that the timed-release schemes require complicated scheduling and their performance greatly depends on whether the offset estimates are correct. On the contrary, the immediate reservation/explicit release scheme requires no scheduling. It is easier to implement, but it occupies the switching fabrics for longer periods than the actual burst transmission. Therefore, it may result in a high burst loss.

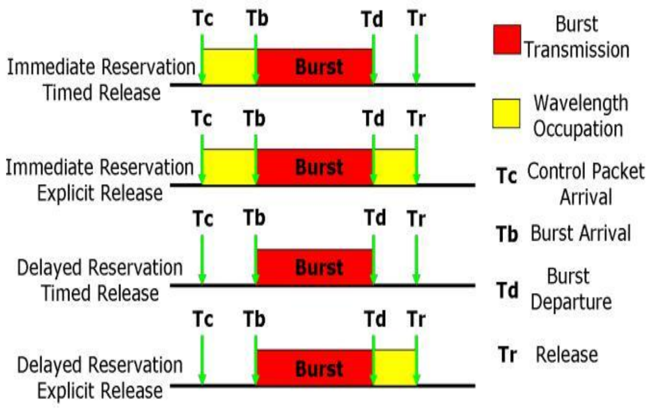

Fig. 5 Reservation and Release Policy.

In the OBS literature, the three most popular OBS variants are Just-In-Time (JIT) [17], Just-Enough-Time (JET) [3] and Horizon [18]. They mainly differ based on their wavelength reservation schemes. The JIT protocol utilizes the immediate reservation scheme while the JET protocol uses the delayed reservation scheme. The Horizon reservation scheme can be classified as somewhere between immediate and delayed. In Horizon, upon receipt of the control packet, the control unit scheduler assigns the wavelength whose deadline (horizon) to become free is closest to the time before the burst arrives. Here the challenge how to reduce the high burst loss with JET and complicated scheduling with JIT as these scheme follows immediate reservation and delayed reservation respectively. In [18] they suggest horizon, which not only improve over the burst loss and heavy scheduling tasks but provide optimum solution in term of end to end delay and throughput. However, in [18] they suggest few more versions of horizon to ponder upon.

VII. CURRENT CONTENTION RESOLUTION METHODS

Contention in OBS networks occurs when two or more bursts arriving at a given OBS node request the same resources at the same time. To resolve contention at OBS nodes, several techniques were proposed and investigated. Clearly, the major goal of these techniques is to resolve contention at intermediate OBS nodes such that bursts can be forwarded as efficiently as possible toward their destination. Several methods for resolving contention in OBS networks have been proposed in the literature. An overview of these methods is discussed in this section.

A. Fiber Delay Line

As of now, it is not possible to store the light in optical domain. It is shown in the literature that the use of fiber delay lines (FDLs) could improve the network throughput [8], where in optical buffering can be achieve by delaying the signal through very long FDL. For contention resolution, the Delay line technique is much needed help. For a fixed time, a burst can be delayed using the FDLs in OBS. For a given burst the variable timing can be performs by putting FDLs in parallel [4] or stages of multiple line [3]. Some research papers presents the design of larger buffers by cascading multiple stages of delay lines without adding the number of delay lines [6, 7]. In [7], the buffer size is increased by use of non-degenerate buffers in which the length of the delay lines may be greater than the number of delay lines in the buffer. This approach lacks the correct ordering of the packets but reduce data loss probabilities. In FDLs based optical buffer scheme, the buffer size is extremely limited by signal quality and by physical space constrains. For example, 1 ms delay generation for a burst needs fiber length greater than 200 km. In bursty traffic load, the buffer size limitation loads the core node in OBS network.

B. Wavelength Conversion

The contention in OBS network can be resolve by wavelength conversion process, converting optical burst destined for the same output port to different wavelengths. Wavelength converters are devices that convert an incoming burst‟s wavelength to a different outgoing wavelength. This increase the *wavelength reuse*, i.e., the same wavelength may be spatially reused to carry different connections in different fiber links in the network. With less number of wavelengths, Wavelength converters offer a 10%-40% increase in reuse values. [14]. In OBS, contention is reduced by introducing the multiple wavelengths per link [7,] with wavelength conversion method. A contending burst may be shifted to any of the available wavelengths for the outgoing link. The multiple wavelengths can be fully utilized to minimize contention. For example, two data bursts are destined reach same output port at the same time. By allocating, two different wavelengths both the burst can be successfully transmitted. In future, there will be as many as 160-320 wavelengths per fiber. Hence, multiple wavelengths method could be a potential solution for resolving the contention in optical network.

C. Deflection Routing

The contention is resolved by routing burst to an output port other than the intended output port, in deflection routing. Due to long looping and out-of-sequence delivery of packets, the deflection scheme not favored in packet-switched networks [9]; but, in OBS with limited buffer capacity, the deflection is very much useful. At present, the research is going on for testing the effect of deflection on burst-switched networks. In deflection routing, a deflected burst may takes a longer route for its destination, result in the increased delay and a degrade the signal quality. In addition, this additional delay may generate the congestion as the burst may create a long loop within the network. Hence, some sort of implementation like, a maximum-hop counter or a constrained set of deflection alternatives, must be made in order to prevent big path lengths. The optical buffer with variable length packets has been studies for deflection in [10]. Where in, choice of the deflection port is very much limited to prevent looping. In optical network, a common technique for selecting loop less deflection is given in [11]. Deflecting bursts may leads to insufficient proper offset time between the header and payload. These is due to fact that, the deflected burst travel a more number of hops than if the burst is not deflected, which result in failure of initial offset time as it is not sufficient for the header to be processed towards reconfiguring the switch before the data burst arrives to the switch. In order to resolve the insufficient offset time problem, one can simply to discard the burst if the offset time is insufficient. In addition, FDLs based buffering method may be considered; however, it may load optical layer with heavy order of complexity.

D. Burst Segmentation

In current OBS approaches, when contention between two bursts cannot be resolved through other means, one of the bursts will be dropped in its entirety, even though the overlapbetween the two bursts may be minimal [18]. In some applications which follow stringent delay conditions but relaxed packet loss requirements, the loss of few packets can be tolerated than losing the complete burst. In [15], a new contention resolution technique, called burst segmentation presented, which minimizes packet losses by dividing the burst into small segments and dropping only those segments which contend with another burst. The burst segmentation allows bursts to be pre-empted by other bursts which helps tohandle the contention in the prioritized fashion. In burst segmentation, each segment has its header and a payload. The segment header (Fig. 6) includes fields for synchronization bits, source and destination information, error correction information and segment length (variable length segments). The transparency between data and format must be maintained in order to minimizing data loss [18]. In this case, the optical layer must be aware of segment boundaries besides segment payload data. Also, the greater degree of differentiation can be possible by considering segmentation with deflection. The choice of deflection for the newly arriving contending burst, or the tail of the burst currently being transmitted, made based on priorities scheme [18].

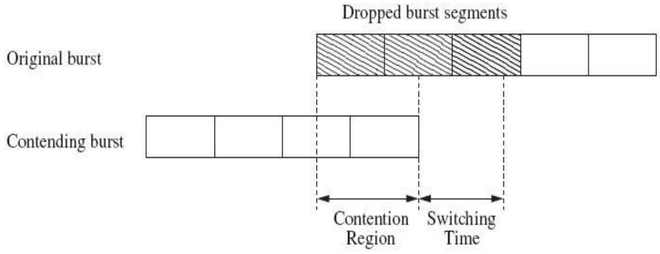

Fig. 6 Selective segmentation for two burst

In Segment and drop policy (SDP) the original burst is segmented, and its segmented tail may be deflected if an alternate port is free, otherwise it is dropped. Based on research work of [15], segment and drop policy perform better than all other in low and high traffic condition, in general. Hence, in this paper, we are focusing only on the SDP for comparing with simulation of proposed model (PM).

VIII. PROPOSED MODEL & SIMULATION PLATFORM

In transmission, larger burst have many packets with longer delays due to queuing at the node in the OBS network. The packet size of traffic is P1, P2,Pn...Pn+k with each packet have fixed „m" units. So, for lower traffic, delay T increases with increase of burst length. The Burst assembling delay [8] for the lower traffic TLower can be expressed as inequation 1 and with the higher traffic load the Burstassembling delay THigher can be expressed as in equation 2.

$$\boldsymbol{TLower} = \boldsymbol{X}.\ \boldsymbol{B}(\mathbf{1}-\boldsymbol{\rho})/\boldsymbol{CF}(\mathbf{1})$$

For higher load, the assembly traffic act as constant rate. So, it can be modeled as normal queuing system.

$$\boldsymbol{THigher} = \mathbf{1}/\boldsymbol{\mu CF} - \boldsymbol{\lambda} = 1/\boldsymbol{\mu}(\mathbf{1}-\boldsymbol{C}) = \mathrm{k}2/\boldsymbol{K3} - \boldsymbol{\rho}(\mathbf{2})$$

Where 1/μ is the mean packet size in bits in burst, λ is the mean flow in packets/sec in the burst. So with the help of the delay at lower and higher traffic load shown in equation 1 and 2 respectively, the average delay *T* can be calculated as in equation 3

$$\boldsymbol{TDelay} = [\boldsymbol{R} + \boldsymbol{BN}/\boldsymbol{CF}]\ [(\boldsymbol{K1B}/\boldsymbol{CF}(\mathbf{1}-\boldsymbol{\rho})) + (\boldsymbol{K2}/\boldsymbol{K3}-\boldsymbol{\rho})]\ /\ \boldsymbol{BN}\ /\ \boldsymbol{CF}(\mathbf{3})$$

From the equation 3, we can easily calculate the average delay (T **delay**) by varying the burst size for minimum blocking from a given link capacity.

For simulation following parameters are considered as given below
R = Round Trip Time = 1ms
B = Burst Length=30 kb to 200kb
N = Number of nodes= 5
CF = Fiber Capacity = 1.25 to 5 GB/s
ρ = Traffic Load (Maximum Load 100 Erlang)
K1 = Constant, K2 Inversely Proportional to c &λ , K 3 ≈ 1.

Following assumptions are made in the simulation
- The exponentially generated random number representsburst length.
- The length of burst approximated to the close integer multiple of the fixed packet length, with an average burstlength of 120 microsecond.
- Arrivals of burst assumed to be Poisson traffic.
- Switching time is 10 microsecond.
- The node does not have any buffering or wavelengthconversion.
- The uniformly distributed Traffic for all sourcedestinationpairs.
- The (Fixed) shortest path routing is used between all nodepairs.

Table 1: DELAY OF DIFFERENT FIBER CAPACITY AND BURST LENGTH FOR PROPOSED SOLUTION

Burst Length	**Fiber Capacity with Delay (ms)**			
	1.25 Gbps	**2.25Gbps**	**4 Gbps**	**5 Gbps**
30 Kb	***2.24***	***2.15***	***2.1***	***2.06***
50 Kb	***2.4***	***2.2***	***2.15***	***2.1***
100 Kb	***2.8***	***2.4***	***2.25***	***2.2***
200 Kb	***3.6***	***2.6***	***2.5***	***2.4***

Up till now, we have discussed different methods of contention resolution like; the burst lost problem can be solved by fiber delay line, wavelength conversion, deflection routing and burst segmentation, in the OBS network. Instead of resolving all the above contention techniques in the core OBS network frame work, we have proposed an easy way of dealing with all the issues at the burst assembly unit Ingress Node itself. Just to illustrate the proposed solution, we have taken a delay problem in OBS network. Instead of using the expensive and bulky FDLs inside the network, we can resolve the contention issue by controlling length of burst at the burst assembly using equation-3 at edge node [17]. Above table I, shows different delays with different fiber capacity according to burst length. At the network level we knows the capacity of fiber lines and required delay to resolve the burst lost probability (contentions), we can directly set the burst length to fulfil the above constraint by suitably means of controlling the burs length at burst assembly unit at the edge node of OBS network. For example if we have 5 Gbps of fiber lines in network, and the required delay for minimum burst blocking probability is 2.4 ms, then burst length comes out to be 200 Kb which can be directly handle by the burst assembly unit at the ingress node, rather than inside the network by using FDL or burstsegmentation in the OBS network.

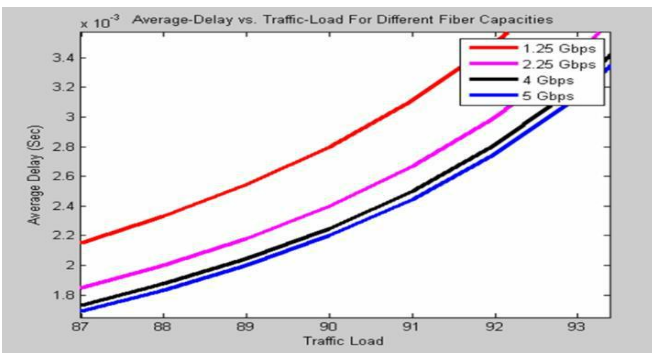

Fig. 7Average delay versus traffic for fiber capacities

IX. SIMULATED RESULTS

The comparison has been made for SDP and PM to verify the OBS performance under contention. From Fig. 8 it can be seen that PM is performing better than SDP in very low loads (The points for 10 to 40 percentage of offered load) and PM performs extremely better than SDP in higher loads (The points for 50 to 80 percentage of offered load). During contention in the OBS network, this result indicates that the degradation in performance of SDP is rapid and drastic, while for PM, it is more gradual and stable. In addition, from fig. 8, it can be clearly understood that PM delivers these burst at lower delay for a low loads along with an increasingly lower delay at higher loads compare to SDP. Fig. 8 clearly show easiness of proposed concept that simply by the knowledge of offered load one can easily calculate the required delay for given link with minimum blocking. It shows that at higher load the high link capacity produce lower delay that the low link capacity.

X. CONCLUSION AND FUTUREWORK

This review paper highlights the different challenges and their possible solution in the OBS network. Also, this paper highlights the different methods for contention resolution and their solution based on open literature, in the OBS network.

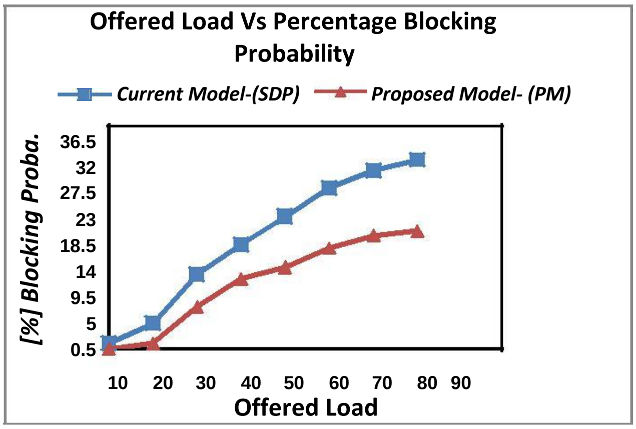

Fig. 8 Simulated outcome of SDP and Proposed model for contention resolution

In addition, it gives a unique proposed solution to resolve the contention by carefully handling the burst assembly unit in the ingress node of OBS network. The illustrated example of delay parameter proves the efficiency of the proposed concept. Simulation has been performed and the result shows that proposed model performs better than SDP for end-to-end burst delivery and end-to-end delay. It has been observed that the variable burst assembly mechanism of PM enables effective control over the transmission of burst, and thus more responsive to contention as compared to SDP. Hence, PM drastically reduces the network resource utilization. In terms of contention resolution, the simulated results shows that proposed model perform better under low and high offered traffic load without using any expensive FDL or burst segmentation for optical burst switched network. In future, it is highly probable that the proposed model could be a potential solution to critical challenges of OBS networks.

REFERENCES

[1] C. Qiao and M. Yoo. ”Optical burst switching (OBS)- a new paradigm for an Optical Internet”. *Journal of High Speed Networks*, 8(1):69-84, January 1999.
[2] L. Berger, “Generalized multi-protocol label switching (gmpls) signaling functional description”, *IETF RFC 3471*, January 2003.
[3] LisongXu George Rouskas. Emerging Optical Network Technologies: Architectures, Protocols, and Performance, chapter Optical Packet Switching, pages 111-127. Springer, 2004.
[4] T. Battestilli and Harry Perros, “An introduction to OBS”, *IEEE Optical Communications*, August 2003
[5] V.M. Vokkarane, J.P. Jue, and S. Sitaraman, “Burst segmentation: an approach for reducing packet loss in optical burst switched networks”. *In Procd of IEEE International Conference on Communications (ICC)*, vol 5, pp 2673–2677, April 2012.
[6] D. K. Hunter, M. C. Chia, and I. Andonovic. “Buffering in optical packet switches”. *IEEE/OSA Journal of Light wave Technology*, 16(12), pp 2081–2094, December 1998.
[7] D. K. Hunter, W. D. Cornwell, T. H. Gilfedder, A. Franzen, and I. Andonovic. “SLOB: A switch with large optical buffers for packet switching.” *IEEE/OSA Journal of Light wave Technology*, 16(10):1725–1736, October 1998.
[8] I. Chlamtac, A. Fumagalli, L. G. Kazovsky, and et al. CORD: “Contention resolution by delay lines”. *IEEE Journal on Selected Areas in Communications*, 14(5):1014–1029, June 1996.
[9] Z. Haas. “The „Staggering Switch‟: An electronically controlled optical packet switch.” *IEEE/OSA Journal of Light wave Technology*, 11(5/6):925–936, May/June 1993.
[10] Chlamtac, A. Fumagalli, and C.-J. Suh.” Multibuffer delay line architectures for efficient contention resolution in optical switching nodes.” *IEEE Transactions on Communications*, 48(12):2089–2098, December 2000.
[11] C. Gauger, K. Dolzer, and Michael Scharf, “Reservation strategies for FDL buffers in OBS networks” *IEEE International Conference on Communications*, 2002.
[12] M. Yoo, C. Qiao, and S. Dixit, “The effect of limited fiber delay lines on QoS performance of optical burst switched WDM networks” *Proceedings of the IEEE International Conference on Communications*, vol 2, pp 974-979, 2000.
[13] Ching-Fang Hsu, Te-Lung Liu, and Nen-Fu Huang. On the deflection routing in QoS supported optical burst-switched networks, IEEE International Conference on Communications, 34:2786-2789, 2010.
[14] Sungchang Kim, Namook Kim, and Minho Kang, “Contention resolution for optical burst switching networks using alternative routing” *IEEE International*

Conference on Communications, 37:2678 -2681, 2009.

[15] V. Vokkarane, J. Jue, and S. Sitaraman, "Burst segmentation: an approach for reducing packet loss in optical burst switched networks", *IEEE International Conference on Communications*, vol 5, pp 2673-2677, 2009.

[16] Ilia Baldine, George Rouskas, Harry Perros, and Dan Stevenson. Jumpstart, "A just-in time signaling architecture for WDM burst switched networks", *IEEE Communications Magazine*, 40(2):82 - 89, February 2002

[17] Das, A, Banerjee, P, Das, A.K, "Performance evolution in optical burst switched networks", *5th IFIP International Conference on Wireless and Optical Communications Networks, WOCN '08,* pp 1 – 5, May 2008.

[18] Qiong Zhang, Neal Charbonneau, Vinod M. Vokkarane, and Jason P. Jue, "TCP over Optical Burst-Switched Networks with Controlled Burst Retransmission", Springer Photonic Network Communications, 22(3), 299-312, 2011.

