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Optical Burst Switching (OBS) for Next Generation Optical Transport Networks

Prof. Manish R. Umale
Department of Computer Science.
Lokmanya Tilak College of Engineering
Vikas Nagar, Sector 4, Koperkhairane, Navi Mumbai.
India.

Prof.Sudhakar S. Jadhav
Department of Computer Science.
Lokmanya Tilak College of Engineering
Vikas Nagar, Sector 4, Koperkhairane, Navi Mumbai.
India.

Prof. Sanjay D. Naravadkar
Department of Computer Science.
Lokmanya Tilak College of Engineering
Vikas Nagar, Sector 4, Koperkhairane, Navi Mumbai.
India.

ABSTRACT
Optical communication system will continue to play significant role in the development of emerging network infrastructure. The wavelength division multiplexing and subsequently optical burst switching networks have received a lot of attention on the research community in the recent years. Optical Burst Switching (OBS) has advantages of both Optical Packet Switching (OPS) and Optical Circuit Switching (OCS). Also it has the capability of offline signaling. It is also called as next generation internet technology. In this paper, we are going to introduce optical burst switching in details and scheduling algorithms we are going to show theoretically some scheduling approaches with the basic Latest Available Unused Channel Rescheduling Algorithm (LAUC). Advantage of doing so is that we can avoid the possible use of optical buffers to delay the bursts which are going to drop because of congested situation at any node and reducing the cost of Fiber Delay Lines FDLs which can be very high in terms of money. The algorithms are given and described with the help of example.

1. INTRODUCTION
With the explosive growth of the Internet and recent advances in Wavelength Division Multiplexing (WDM) technology, the amount of raw bandwidth available in fiber links has increased by many orders of magnitude. Meanwhile the rapid growth of Internet traffic requires high transmission rates beyond a conventional electronic router's capability. Harnessing the huge bandwidth in optical fiber cost-effectively is essential for the development of the next generation optical Internet [6], [7].

Several approaches have been proposed to take advantage of optical communications and in particular optical switching. One such approach is Optical Circuit Switching (OCS) based on wavelength routing whereby a lightpath needs to be established using a dedicated wavelength on each link from source to destination. Once the connection is set up, data remains in the optical domain throughout the lightpath. An alternative to optical circuit switching is Optical Packet Switching (OPS). In optical packet switching , while the packet header is being processed either all optically or electronically after an optical/electronic (O/E) conversion at each intermediate node, the data payload must wait in the fiber delay lines and be forwarded later to the next node. In order to provide optical switching for next generation Internet traffic in a flexible yet feasible way, a new switching paradigm called optical burst switching (OBS) was proposed in [7].Various OBS approaches with different tradeoffs have since been described. There are two common characteristics among these variants:

Client data (e.g., IP packets) goes through burst assembly/disassembly (only) at the edge of an OBS network; nevertheless, statistical multiplexing at the burst level can still be achieved in the core of the OBS network. Data and control signals are transmitted separately on different channels or wavelengths (λ's) thus, costly O/E/O conversions are only required on a few control channels instead of a large number of data channels. There are still some difficulties in realizing all optical networks, such as the optical RAM is ongoing research now, and some technologies and standards have to be designed. So the processing of IP packets in the optical domain is still not practical yet, and the optical router control system is implemented electronically. Nowadays, we are mostly studying the semi-transparent optical transport networks. In optical transport networks, the control messages are processed electronically, and the data are propagated in the high-speed transparent data channels. To realize IP-over-WDM architecture, several approaches, such as Optical Circuit Switching (OCS) [7], [8]. Optical Packet Switching (OPS) [1], [4] and Optical Burst Switching (OBS) [3], [6], [8], have been proposed. Of all these approaches, Optical Burst Switching (OBS) can be achieve a good balance between the coarse-gained circuit switching and fine-gained optical packet switching, there by combining others benefits while avoiding their shortcomings. Namely burst scheduling and contention resolution.

2. OPTICAL NETWORK EVOLUTION
The evolution of Wavelength Division Multiplexing (WDM) optical network can be classified as shown in figure 1. Among the all-optical network (AON) evolution first is the Wavelength-Routed-Optical-Networks (WRONs) whose operation consists of setting up long term circuit connections between the network nodes. These circuit connections are called `light paths'. The main constraint with WRONs is scalability. When network grows up the limited number of wavelengths becomes bottleneck to establish full mesh network. Consequently for each topology

network architects have to solve the NP-hard problem of routing and wavelength allocation (RWA) of the limited number of wavelengths in an optimized way to improve utilization. Another constraint with WRONs is its quasi-static nature due to which it is not suitable for dynamic changes in the traffic which is a key feature of Internet traffic.

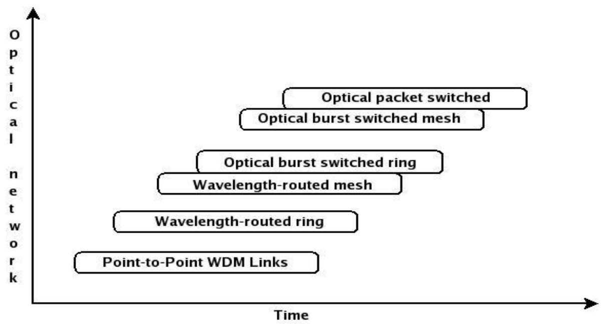

Fig. 1 Optical network evolution

Optical-Packet-Switched-Networks (OPSNs) would be the most sophisticated and seem to be an ideal architecture for future optical networks. As clear from name the traffic in OPSNs is carried in optical packets along with in-band control information. But the problem with OPSNs is the lack of optical logic and practical optical buffer [3], [6].

In AON, user data travels entirely in the optical domain. The elimination of OEO conversion in AONs allows unprecedented transmission rates. With respect to current technology presently OBS is the most suitable AON control framework. It combines the best feature of both circuit switching and packet switching.

2.1 Optical Switching Technologies

For the next generation optical transport networks, optical switching techniques can be broadly classified into optical circuit switching, optical packet switching, optical burst switching. Circuit and packet switching have been used for many years for voice and data communications. In the following, we will introduce optical burst switching in comparisons with optical packet switching and optical circuit switching.

2.2 Optical Circuit Switching (OCS)

In OCS, a lightpath is established between the source and the destination before data transmission. During transmission, there is no need for the intermediate nodes to perform complex processing of packet header and buffering of the payload. The reserved resources stay idle for the entire path setup time and account for poor resource utilization.

When wavelength routing lightpath connections are static, they may not be able to accommodate the highly variable and bursty nature of Internet traffic in an efficient manner. If traffic is varying dynamically, sending this traffic over static lightpaths would result in an inefficient utilization of wavelength. In addition, given a limited number of wavelengths, only a limited number of lightpaths can be established at the same time. On the other hand, if we attempt to set up lightpaths in a very dynamic manner, the network state information will be constantly changing, making it difficult to maintain current network state information. The way to assign wavelengths to a lightpath along its route is called Routing and Wavelength Assignment (RWA) [3], [6]. The objective for RWA is to set up lightpaths and assign wavelengths in a manner which minimizes the amount of the blocking of connections or which maximizes the number of connections that are established in the network.

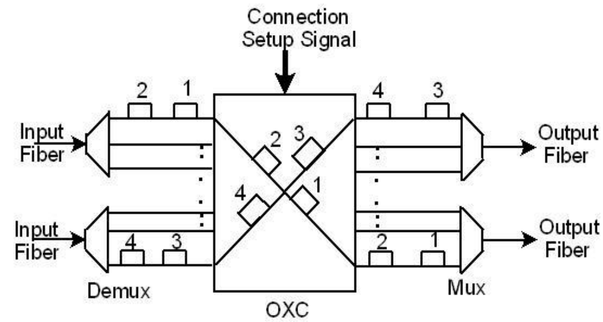

Fig. 2 An OCS node architecture

One of the main features of wavelength routing is its two-way reservation process in set-up of lighpaths, where a source sends a request for setting up a lightpath and then receives an acknowledgement back from the corresponding destination. A lightpath is set up by reserving a fixed period on a wavelength along a path from the source to its corresponding destination. The time taken for establishing such path is equal to the round trip delay. The offset time T, between a setup request and data transmission, is at least as long as 2P +δ, where P is the one-way propagation delay and δ is the total processing delay along the path.

2.3 Optical Packet Switching (OPS)

An OPS is suitable for supporting bursty traffic since it allows statistical sharing of the wavelengths among packets belonging to different source and destination pairs. When an optical packet arrives, the optical core node first departs the header from the payload and converts it into electronic domain and processes it electronically [3], [6]. The switching fabric is reconfigured based on the information contained within the header of the packet. Since it takes some time for the header to be processed and for the switch to be reconfigured, the payload should be delayed at the input port. At the output port, the header is converted into optical signal and assembled with the payload into to a new optical packet.

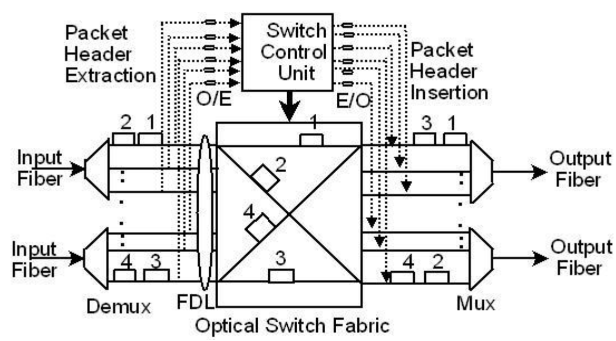

Fig. 3 An OPS node architecture

There are many challenges in realizing optical packet switching. Packet switching has large buffer requirement. For the optical domain, packet switching is not yet feasible because of optical hardware limitations. Optical RAMs do not exist yet to meet the high buffer requirements of packet switching. An optical packet can only be delayed for a limited amount of time via the use of fiber delay lines (FDLs) before the completion of the header processing. The length of each optical packet, in terms of the product of its transmission time and the speed of light, cannot exceed that of the available FDL in which the optical packet to be “stored".

Another major challenge is the stringent requirement for synchronization, both between packets arriving at different input ports of an optical switching fabric, and between packet's header and payload.

2.4. Optical Burst Switching (OBS)

OBS is proposed to achieve a good balance between the OCS and OPS. OBS combines the advantages of both OCS and OPS. Figure 1.3 shows that in OBS, data is transported in various size units, called burst which is the basic switching entity in OBS. In OBS data packets are aggregated into much larger bursts before transmission through the network. This reduces the switching overhead of multiple packets. Due to great variability in the bursts size, OBS network can be viewed as lying between OPS network and OCS network. That is, when burst size is small then it equal to duration of an optical packet, OBSN can be seen as resembling an OPSN. On other hand, when burst size is large then OBSN can be seen as resembling an OCSN [9].

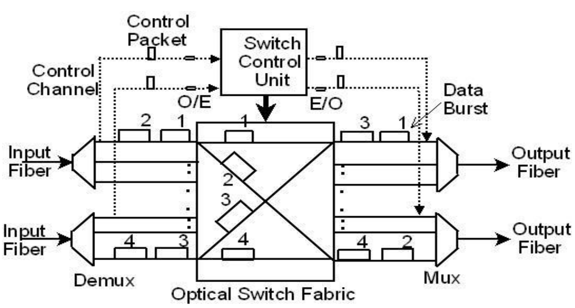

Fig. 4. An OBS Node

In OBS, there is a strong separation between control and data planes, which allows great network manageability and flexibility. As shown in figure 5, burst is transmitted on data channel and burst header packet (BHP) on control channel. The burst is preceded in time by a BHP, which is sent on a separate control wavelength. The preceded time is called as Offset Time. The control burst requests resource allocation at each switch. At each intermediate node, the BHP is processed electronically and the time taken for processing a BHP is known as the ``processing time". After processing, the BHP reserves a wavelength on an outgoing link for the burst. This reservation will be for a time period starting from the time the burst is expected to arrive to the time the burst is transmitted completely. The reservation time and duration can be calculated using the offset and the burst length. If no reservation can be made, then the BHP is dropped. If the reservation is successful, the BHP is forwarded to the next node along the path to the destination. The offset is chosen in such a way that the reservation is already made at each node before the burst arrives at that node. OBS uses one-way reservation schemes with immediate transmission, in which the data burst follows a corresponding control burst after waiting for a short offset time without waiting for an acknowledgement. The offset time gap between the BHP transmission and the burst transmission is generally used for aggregating the data packets into a data burst [1], [3], [6], [8].

By reserving resources (wavelengths and FDLs) only for a specified period of time rather than reserving resources for an indefinite period of time, the resources can be allocated in a more efficient manner and a higher degree of statistical multiplexing can be achieved [13]. Thus, optical burst switching is able to overcome some of the limitations of static wavelength allocation incurred by OCS. Furthermore, since data is transmitted in large bursts, optical burst switching reduces the technological requirement of fast optical switches which is necessary for optical packet switching [8].

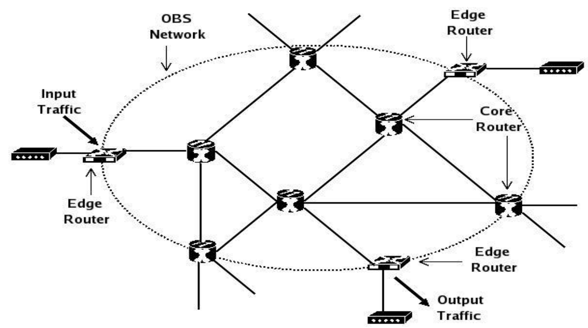

Fig. 5. OBS network architecture

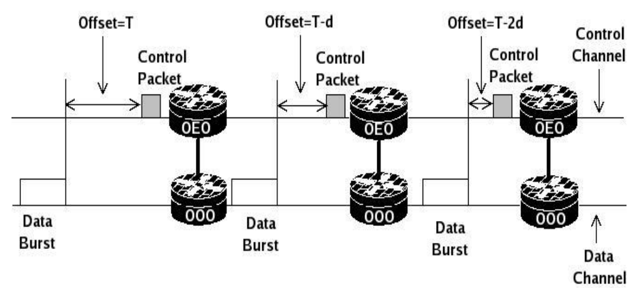

Fig. 6. Separate transmission of data and control signals

TABLE1 COMPARISON BETWEEN OCSN, OPSN, OBSN

Comparison Between OCSN,OPSN,OBSN

Type of WDM Network	Bandwidth Utilization	Latency (set-up)	Optical Buffer	Proc./Sync Overhead	Adaptivity (traffic & fault)
OCSN	Low-under low traffic	High	NR	Low	Low
OPSN	High	Low	Required	High - O/E/O at each Node & buffering is required	High-can take any path
OBSN	High	Low	NR	Low	High

[ix]

3. ARCHITECTURE AND TECHNOLOGIES OF OBS

In an OBS network as shown in figure 6, the edge routers and core routers connect with each other with WDM links. Packets are assembled into bursts at network ingress node, which are then routed through the OBS network and disassembled back into packets at network egress node to be forwarded to their next hops. Edge nodes provide burst assembly/disassembly functions as shown in figure 7. A core node is mainly composed of an optical switching matrix and a switch control unit and responsible for routing and scheduling based on the burst header packets.

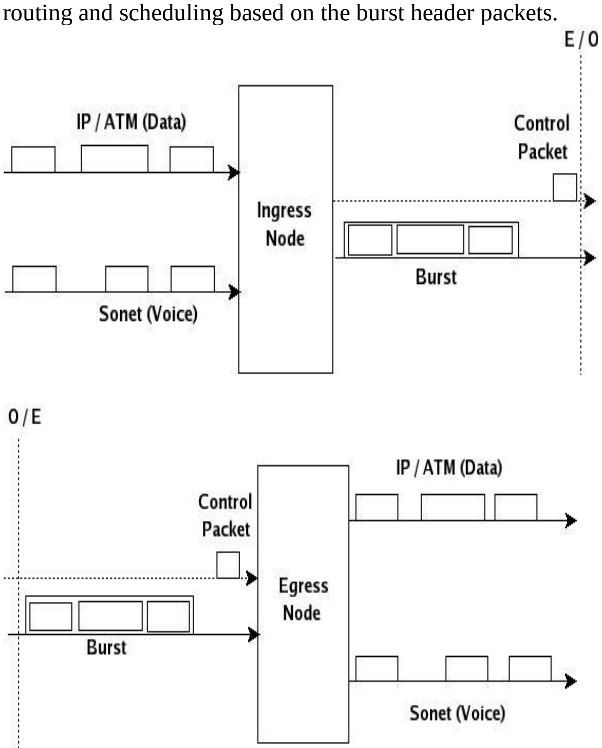

Fig. 7. Burst assembly and disassembly

Depending on the switch architecture, it may or may not be equipped with optical buffering. The fiber links carry multiple wavelengths, and each wavelength can be seen as a channel. The control packet associated with a burst may also be transmitted in-band over the same channel as data, or on a separate control channel. The burst size may be fixed to carry one or more IP packets. As shown in figure

8 and 9.When an edge node intends to transmit a data burst, it first sends a control burst on the control wavelength to the nearest core node. At the core node, the BHP is converted into electronic form by the receiver. The control fields are extracted from the BHP. The core node uses these control fields to determine the next outgoing fiber for the corresponding burst by consulting a routing table maintained locally. The burst is scheduled for transmission onto the selected outgoing link by the scheduler and the burst is buffered until the scheduled time. The scheduler maintains a BHP queue. The scheduler also reserves wavelength on the determined links for the upcoming burst. The BHP is then transmitted to the selected outgoing fiber using the optical transmitter. Just before the burst arrives, the switching element in the node is configured to connect the input port to the corresponding output port for the entire duration of the burst transmission. If the BHP is unable to reserve the wavelength for its corresponding burst, then the BHP will be dropped as well as its burst [1].

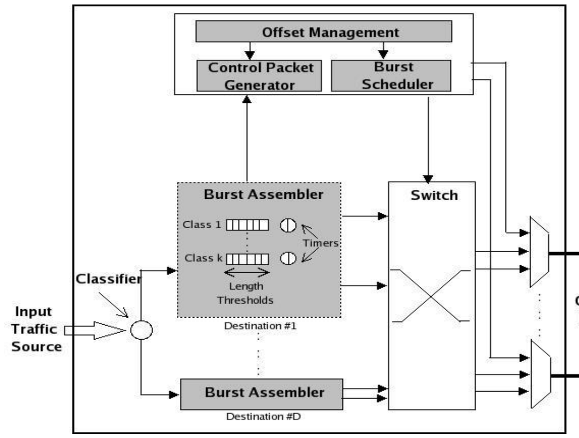

Fig. 8. OBS edge node

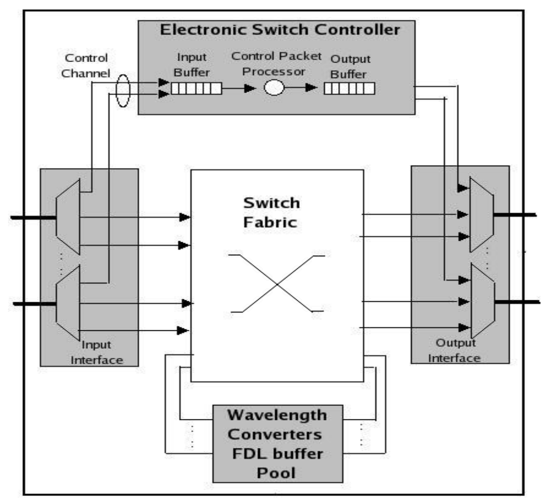

Fig. 9. OBS core node

Functions of OBS Ingress node [Figure 8] is

Aggregation of data from different clients' networks.
Assembly of burst.
Generation of BHP.
Set-up of an offset time.
Burst scheduling, resource reservation and burst transmission.

Functions of OBS Core node [Figure 9] is

Extraction and processing of BHP.
Burst scheduling and resource reservation and burst transmission.

3.1 Burst Assembly

Basically, there are three different assembly schemes, threshold-based, timer-based and hybrid-based [7], [13]. An assembly of the burst at the edge router is a challenging issue in the OBS, as it affects the network traffic.

In a timer-based scheme, a timer is started to initialize the assembly process. A burst containing all the packets in the buffer is generated when the timer exceeds the burst assembly period. While in a threshold-based scheme, a burst is created and sent into the OBS network when the total size of the packets in the queue reaches a threshold value [12].

To choose the appropriate time-out or threshold value for creating a burst is still an open issue. A smaller assembly granularity leads to a higher number of bursts and a higher number of contentions, but the average number of packets lost per contention is less and it also increases the number of BHPs. If the reconfiguration period of optical switching fabric is non-negligible, a smaller assembly granularity will lead to lower network utilization because each switched burst needs a reconfiguration period. On the other hand, a higher assembly granularity will lead to a higher burst assembly delay and the average number of packets lost per contention is larger. There is a tradeoff between the number of contentions and the average number of packets lost per contention. The selection of optimal assembly granularity is strongly correlated to the type of input packet traffic.

The drawback of the threshold-based scheme is that it does not provide any guarantee on the assembly delay that packets will experience. The drawback of the timer-based scheme is that it does not provide any guarantee on the size of burst.

To overcome the drawback of timer-based and threshold based schemes, hybrid scheme has been proposed. Hybrid assembly scheme is the combination of both threshold-based and timer-based assembly scheme. In the hybrid assembly scheme, a burst can be sent out when either the burst length exceeds the desirable threshold value or the timer expires. In our simulation, we used threshold-based assembly scheme for the burst generation.

3.2 Wavelength-reservation Schemes in OBS

In OBS networks, a control packet is sent ahead to reserve wavelength along its route for its data burst [5,13]. Two admission-control protocols for ATM networks; one is called Tell-And-Wait, in which when the source has a burst to transfer; it first tries to reserve the bandwidth along the virtual circuit by sending a short `request' message. If the requested bandwidth is granted at all the intermediate nodes along its route, an acknowledgement (ACK) from the destination will return to the source after a round-trip delay; otherwise, a negative acknowledgement (NACK) will return to the source. The source transmits its burst on receiving an ACK.

Another is called Tell-And-Go, in which the source transmits a burst immediately as soon as it receives the message from the higher layer. A copy of the message is kept at the source until the source learns that the burst has arrived at the destination successfully. The receiver sends an ACK back to the corresponding source when receives the message successfully. Otherwise, the receiver sends back a NACK so that the source can transmit the same burst again at sometime later.

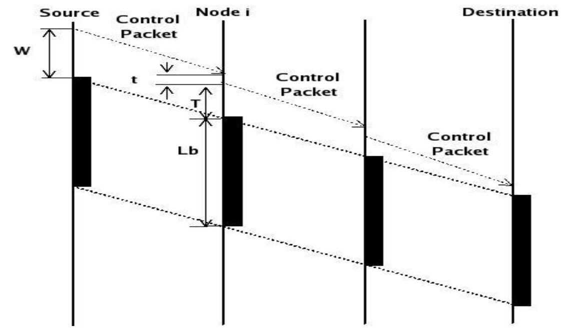

Fig. 10. JET protocol in OBS

In OBS, a signaling scheme is also required for reserving resources and configuring optical switches for burst transmission. Several wavelength- reservation schemes for OBS, such as Tell-And-Go (TAG), Just-In-Time (JIT) and Just-Enough-Time (JET) have been proposed. In a TAG scheme, a source node sends out a control packet to inform a burst's arrival. The source node then immediately sends out a data burst. In order to allow time for the processing of the control message and the configuring of the switch at each node, the burst may need to be buffered at each node.

In a JIT scheme, the data burst is buffered at the edge node where electronic memory is cheap and abundant, rather than at the intermediate switching nodes where optical delay lines are expensive and limited. A source node sends a SETUP message to reserve wavelength before data transmission and a RELEASE message to release wavelength after data transmission. An intermediate switching node will attempt to reserve wavelength immediately when receiving a SETUP message and release wavelength on receiving a RELEASE message. However, it results in a bad wavelength utilization due to that the bandwidth holding time is bigger than the burst transmission time.

Figure 10 illustrates the JET signaling technique. As shown, the ingress node waits for a long offset time before it starts to transmit the data burst. The initial offset time is set to be larger than the total processing time of the BHP along its path. It is calculates as W= h*t, where h is the number of hops between the source and the destination, t is the per-hop burst header processing time. If at any intermediate node, the reservation is unsuccessful, the burst will be dropped. Comparing with JIT, the BHP in JET contains the information of the offset time and the burst length. So the wavelength at each intermediate node will be reserved at the start of the data burst and will be released at the end of the data burst.

3.3 Types of Traffic

Traffic generation is at the heart of every data communication system analysis and design process. A traffic generator that can produce real time and real world traffic proves to be invaluable for analyzing communication systems. Traditionally, most of the simulation in OBS is based on poisson traffic. Poisson traffic uses exponentially distributed inter-arrival times. Poisson model is not very much satisfactory because real network traffic is busty in nature and this model does not support busty nature traffic. Poisson process suffers from large scale traffic analysis [8], [11].

Nowadays, the scale of the Internet enlarges rapidly, and data arrival pattern appears to be chaotic and difficult to model. It has been determined from empirical and theoretical research that the incoming traffic will follow self-similar pattern. With the help of self-similar traffic more realistic results can be obtained because it is based on the self similar nature of the real time traffic. The core idea is to use a behavioral model instead of a mathematical model. Self-similar traffic does not suffer from the lack of large time-scale analysis. Self-similar traffic is based on the idea that we aggregate more and more traffic.

4. BURST SCHEDULING ALGORITHMS

Another important factor which affects the network traffic is scheduling algorithms used for the scheduling of bursts. As the arrival of bursts at OBS node is dynamic, scheduling technique must schedule arrival burst on the available wavelength for the entire duration of burst transmission efficiently and quickly. Scheduling algorithm should be able to process the CP fast enough before the burst arrives to the node and it should also be able to find proper void for an incoming burst to increase channel bandwidth utilization. Exiting burst scheduling algorithms are given below:

4.1 Latest Available Unused Channel (LAUC) algorithm

In LAUC, bursts scheduling is done by selecting the latest available unscheduled data channel for each arriving data burst. In this algorithm, a scheduler keeps track of horizon for each channel, it is the time after which no reservation has been made on that channel. It searches for wavelength from latest available horizon for scheduling burst. It searches the wavelength by using last scheduled burst information on each channel. The scheduler assigns each arriving burst to the channel with minimum void formed by that burst on data channel.

4.2 Latest Available Unused Channel with Void Filling (LAUC-VF) algorithm

In LAUC, the voids are created between two data burst assignments on one data channel. This is termed as unused channel capacity. LAUC-VF is variant of LAUC. In this algorithm, a scheduler keeps track of void for each channel, and maintains start and end time of voids for each data channels. LAUC-VF searches for the void such that newly formed void due to new burst is very small compared to other voids.

4.3 Best-Fit (BF) algorithm

In this algorithm, a scheduler keeps track of void for each channel. It also maintains start time and end time of voids for each data channels. Scheduler tries to search for a void such that newly created void is the smallest void before and after scheduled bursts.

4.4 Minimum Starting Void (Min-SV) algorithm

In this algorithm, a scheduler keeps track of void for each channel. It also maintains start and end time of voids for each data channels. Scheduler tries to search for a void such that newly created voids are the smallest voids after scheduled bursts.

4.5 Minimum Ending Void (Min-EV) algorithm

In this algorithm, a scheduler keeps track of void for each channel. It also maintains start and end time of voids for each data channels. Scheduler tries to search for a void such that newly created voids are the smallest voids before scheduled bursts.

BF, Min-SV and Min-EV algorithms are the variants of LAUC-VF algorithm. All the void filling algorithms yields better bandwidth utilization and burst loss rate than LAUC algorithm. But the entire scheduling algorithm has a longer execution time than LAUC algorithm [2], [15].

Fig. 11 shows, how the different scheduling algorithm behaves when new burst arrives at the node. Table 2 shows the comparisons of different scheduling algorithm [14], [16].

Table 2 summarizes the above discussion using the following notations

W : Number of wavelengths at each output port.
k : Maximum number of data bursts(or reservations) on all channels.

Horizon i : Horizon of the i^{th} data channel.
S{i,j} and E{i,j} : Starting and ending time of j^{th} reservation on channel i.

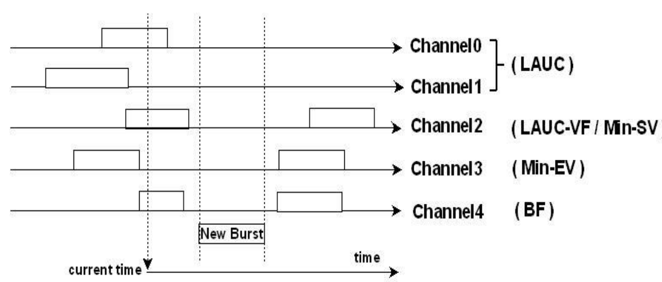

Fig. 11. An example of showing how a new burst is scheduled by different scheduling algorithms

TABLE 2
COMPARISON OF SCHEDULING TECHNIQUES

Method	Complexity	Generated Code	Burst Dropping Probability	B/W Utilization
LAUC	O(W)	Simple	High	Low
LAUC-VF	O(K+W)	Complex	Low	High
Min-SV	O(log K)	Simple	Low	High
Min-EV	O(log K)	Simple	Low	High
Best Fit	O(log K)	Simple	Low	High

5. SIMULATION TOOL

The OBS-ns simulator was released by DAWN Networking Research Lab from University of Maryland as an extension to the ns-2 simulator for OBS network. It's latest version 0.9 is unstable and it has limitations to simulate OBS network. A redesigned version of Dawn Lab's simulator is the OIRC OBS-ns Simulator, a simulation tool developed by Optical Internet Research Center (OIRC) and Samsung Advanced Institute of Technology (SAIT). It's main goals are to solve the problem of version 0.9 and improve the software, introducing new features.

As its predecessor, OIRC OBS-ns is an event-driven simulator built on the ns-2, so it inherits its properties like the still used for specifying and configuring the network simulation environment. To run an OBS network simulation it is necessary to create an OTcl script that contains besides other elements not relevant in the context of this work, the network topology, where edge and core nodes are defined as well as duplex fiber links between end nodes with specific bandwidth per channel, propagation delay, number of control and data channels, and the total number of channels. It is also necessary to build a routing table using shortest path routing and to specify traffic streams (which is done in the same manner as in ns-2). There is also an extended list OTcl parameters with default values that can be changed to specify details about the OBS network, such as the delay of optional Fiber Delay Lines (FDLs) at the end of link, the size of Burst Control Packet (CP) and DB overhead, the burst timeout, the maximum burst size, the offset time for class, the Burst Control Packet (CP) processing time in core classifier, the delay of FDL used for scheduling, the number of FDLs in a node, the maximum number of FDLs in a node, the maximum number of FDLs used per node per path, the electronic buffering option, and the edge node electronic buffer size.

Based on available documentation and our experiments, it was not possible to determine which resources reservation protocols are supported in this simulator. OBS-ns simulation output is written to statistics and trace files which can be processed using whatever tools the user desires, but in order to facilitate the process of getting results from the raw data, this simulator offers the possibility to plot graphs that analyze the throughput, delay and loss rate.

5.1 Features of OBS-NS Simulator tool

The following are the some features of OBS-ns Simulator tool:

* Simulator tool type: - ns-allinone-2.27 with obs-0.9a

* OBS Protocols: - Not known

* OBS Parameters: - 14

* Network Traffic Generation: - Application code

* Model Building: - Script

* Output Analysis: - Plot Graphs

* Animation or Real-time Viewing: - Animation

* Support/Training: - Available

* Installation Difficulty: - Medium

* Programming Language: - C++

* System Requirements :- Linux (Red hat 9)

* Download :- Available

* License Type :- Free download

Figure 12 shows a typical screenshot of 5 node ring topology for the OBS simulation.

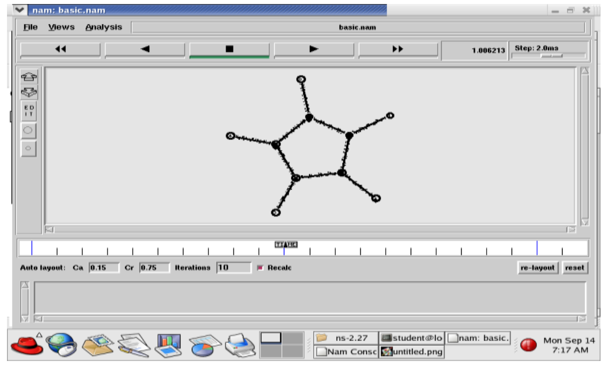

Fig. 12. Screen shot of 5 node ring topology for OBS simulation.

6. EXPERIMENT RESULTS

In order to evaluate the performance of OBS with burst dropping probability, we developed a simulation model. In our simulation, we consider ring network topology which consists of 16 core and 16 edge nodes with bidirectional links. Average node degree is 2 and average hop (H) is 5.8. A bidirectional link is realized by two unidirectional links in opposite direction. Each unidirectional link consists of 8 data channel and 1 control channel. Burst arrivals in the network are self-similar or poisson with arrival rate λ. Bursts are generated by using threshold-based assembly schemes and value of threshold is 40 KB. Packet length is kept as 2000 bytes. Shortest path is used for routing the burst from source to destination. Two different classes of traffic are considered namely class 1 (Lower priority) and class 2 (Higher priority). Control Packet (CP) processing time at each node δ is 1 μs. offset time of class 1 traffic is δH. Offset time of class 2 traffic is 10 δH which is greater than class 1 traffic. Range of traffic load is from 0.3 to 0.6. It is ensured that BHP is processed well before the data burst is transmitted. Bursts are uniformly distributed over all sender-receiver pairs.

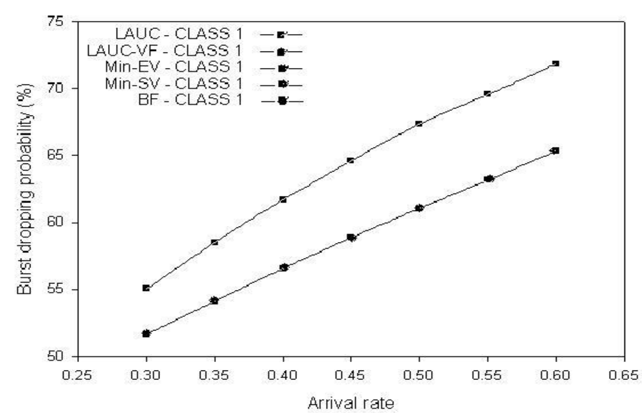

Fig. 13. Performance of class 1 traffic for various algorithms under self-similar traffic.

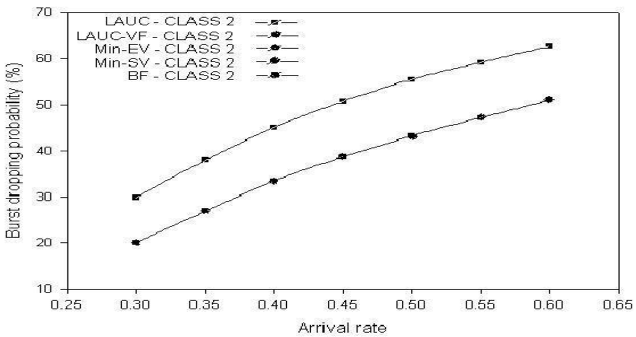

Fig. 14. Performance class2 traffic for various algorithms under self-similar traffic.

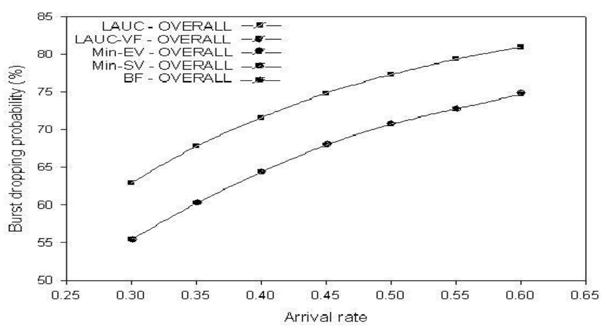

Fig. 15. Performance overall traffic for various algorithms under self-similar traffic.

7. CONCLUSION

With the introduction and comparative study of OPS, OCS and OBS, it is observed that the OBS is not only cost effective but also a viable solution for the next generation optical networks. We have included the best possible features of the NS-2 (NS-2.27 with obs-0.9a patch). All the scheduling algorithms are simulated and obtained the following results:

Under threshold burst assembly scheme with ring network, we study the characteristics of all given factor which affect burst dropping probability. The different traffic like self-similar and poisson is applied to OBS network. The performance of LAUC, LAUC-VF, BF, Min-EV and Min-SV is investigated through simulation. As threshold based scheme generate the same size of burst, all void filling algorithm like LAUC-VF, BF, Min-EV and Min-SV have the same burst dropping probability under self-similar traffic. It is also noticed that as the threshold value increases the burst dropping probability decreases. It has been noticed that the self-similar process gives us the better results with large scale analysis and generate huge amount of traffic but poisson process unable to provide it with same condition.

It is observed that the scheduling algorithm is one of the parameter to improve the QoS in OBS by reducing the burst dropping percentage if applied properly.

Rescheduling techniques [16], use of FDLS can again improve the performance of the OBS: Secure OBS (S-OBS) with Deffe-Hellman network security algorithm or other security algorithms can be advantages. This is open for further research.

S-OBS and L-OBS are untouched scenarios in the developing countries like India. Much more directions are open in this area.

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