Overview On Optical Burst Switching By Using Scheduling Algorithms

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Abstract

Optical Burst Switching (OBS) network is efficiently used in high data transmission. OBS is combination of Optical Packet Switching (OPS) and Optical Circuit Switching (OCS). OBS includes brust assembly, wavelength allocation, contention resolution, QoS and scheduling scheme. Basically there are two types of scheduling algorithms, horizon and void filling scheduling algorithm used for scheduling in OBS network. Horizon scheduling algorithms like FFUC and LAUV are simple to implement but bandwidth utilization is low where as void filling scheduling algorithms are like FFUC-VF and LAUV-VF complex to implement but bandwidth utilization is high as compared to horizon scheduling algorithm.

1. Introduction

Today the use of the internet services is increasing tremendously which resulted in demand of data transfer speed. The various fields which required high data transfer speed are remote information access, video-on-demand, video conferencing, on-line banking, on-line auction and other multimedia applications. Wavelength Division Multiplexing (WDM) is one such technology developed to handle the future bandwidth demands. In WDM networks, the huge bandwidth offered by fiber is managed by splitting it into a number of wavelengths.

WDM optical network can be classified (AON) evolution first is point-to-point WDM link which comprised of several point-to-point links at which all traffic arriving to the node is dropped and undergoes O/E/O conversion before departing from the node. It minimizes network cost and all-optical devices can be used. Second generation is wavelength-routed-optical-network (WRON)[10]. WRON 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. Next are Optical-packet-switched-networks (OPSN). OPSN is the most sophisticated and seem to be an ideal architecture for future optical networks. The traffic in OPSNs is carried in optical packets along with in-band control information, and problem with OPSNs is the lack of optical logic and practical optical buffer. Also, each step of the optical evaluation being with a simple ring design before moving on to the more general mesh technology[9].

OBS is switching technique for the next generation optical networks. However, there are certain issues such as burst aggregation, scheduling, contention resolution and QoS that needs to be addressed in OBS[6].

In OCS wavelength routing light path which needs dedicated wavelength. The connection establishment into source and destination data remains in optical domain. But in this circuit establishment time is more than the duration of transmission due to which it is not bandwidth efficient. In OPS at each intermediate node data is converting into O/E hence data payload must be waiting in the fiber and be forwarded later to next node. This resulted in hop by hop store and forwarded scheme due to which processing and buffering takes place at each node.

The optical burst switching (OBS) is the combination of circuit switching and packet switching which gives the advantages of both. Burst is a variable length data packet, assembled at an ingress router by aggregating a number of IP packets, which may be received from a single host or from multiple hosts belonging to the same or different access networks[6]. Optical burst switching is a technique for transmitting bursts of traffic through an optical transport network by setting up a connection and reserving resources end-to-end only for the duration of a burst[3,1]. A burst has two components: control and payload.

The control packet carries the header information. Thus, the control component incurs an overhead, referred to as control overhead. Payload is the actual data transmitted. Functional diagram of OBS is shown in Fig. 1. The ingress node is responsible for burst assembly, routing, wavelength assignment, scheduling of burst at edge node. The core node is responsible for signalling, scheduling, resolving contention. The egress edge node is responsible for disassembling network layer and Comparison of three switching technology is given in Table 1.[3].

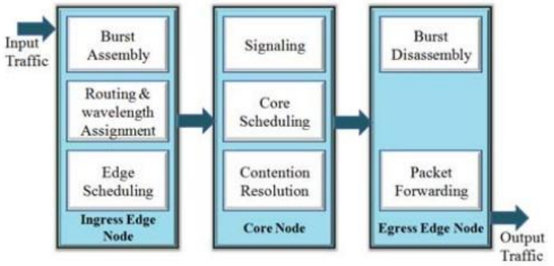

Fig 1: Functional diagram of OBS

2. OBS Network Architecture

An optical burst-switched network consists of optical burst switching nodes that are interconnected via fiber links. In each fiber link capable of supporting multiple wave-length channels using wavelength division multiplexing (WDM) as shown in Figure. This architecture consists of Edge node and core node[8].

Table 1: Comparison of Optical Switching Technologies [3]

Optical Switching Technology	Bandwidth Utilization	Setup	Optical Buffer Latency	Adaptively (Traffic and Fault)
OCS	Low	High	Not Required	Low
OPS	High	Low	Required	High
OBS	Low	High	Not Required	High

OBS Edge Node consists of an electronic router and an OBS interface. It collects upper layer traffic based on destination addresses and aggregates it into variable sized bursts. Also, It is responsible for setting up connections for a burst. This procedure contains signalling, routing and wavelength allocation. A signalling is procedure by which services are provisioned by using signalling protocols. The control packet can be reserved for resources of the corresponding data burst which are guiding it through a routing path. Routing takes fixed path where physical route is predefined for each pair of OBS edge nodes. Wavelength allocation is done for the bursts as per availability and scheduling. When an edge node intends to transmit a data burst, first it sends control burst on the control wavelength to the nearest core node. Core node classifies traffic and sends it to brust assembler. Then offset management schedule brust moves towards to output line. In this way core node architecture work.

Core node has two layers. The upper layer is responsible for processing control packets and configuring the switching fabric[1]. It requires optical switching matrix control unit, port forwarding table (look up table) and link scheduling module which known as electronic control path layer. The control path contains O/E/O processing, cell switch and BHP processors (BPs). The cell switch maps input link to output according

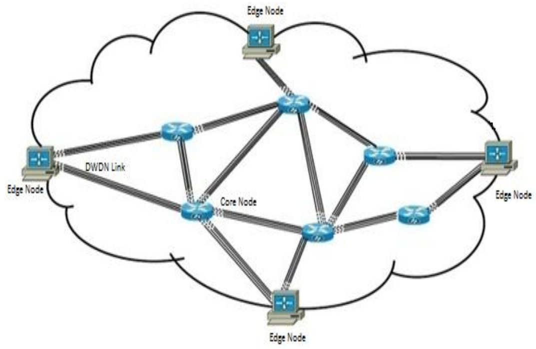

Fig 2: OBS Architecture

to destination of data burst[7]. The lower layer consists of optical ports, wavelengths, optical to optical connections, FDLs and optical cross connects. This layer is known as optical data path layer. The optical cross connects are having capability of wavelength conversion. Function of OBS core nodes are extraction and processing of header, burst scheduling, resource reservation, burst transmission and release resources.

3. Processes in OBS

Burst Assembly/ Disassembly process in optical brust switching occurs at the edge and core node[7,1]. First control packets are sends and it reserved the wavelength for the data packets along its route for its data burst using Tell And Wait (TAW) and Tail And Go (TAG) protocols[3]. Burst scheduler takes care of incoming bursts which are scheduled on multiple wavelengths at the desired output port. In Contention Resolution the bursts can be resolved in three ways: deflection, dropping and pre-emption.

3.1 Brust assembly scheme

It is process of assembling data from higher layer into brust at ingress edge node of the OBS network. Brust assembly and disassembly process shows in figure 3. In this to egress node IP packets and sonnet voice are assembled in ingress node and control packets and data brust will generated, through (E/O) conversion. In other hand particular control and data packets are disassembled into previous packets through (O/E) conversion[5,7]. Most common brust assembly techniques are time based and threshold base. The timer-based scheme is used to gives uniform gap between successive brust. In threshold base assembly limit is placed on the maximum number of packet contain each brust. Also it will be generated at the network edge and non-periodic time interval. Main problem in brust assembly is how to choose the appropriate time and threshold value for certain brust in order to minimize packet loss probability in OBS network.[3]

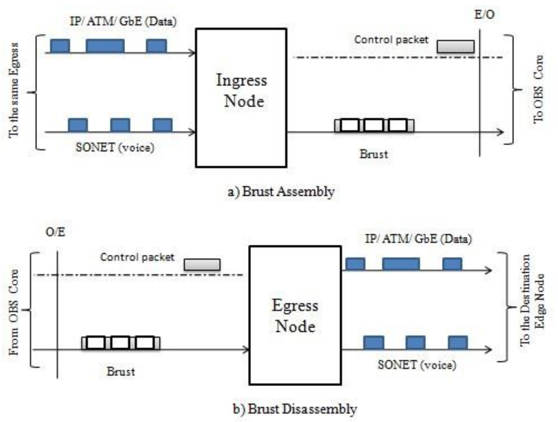

Fig 3: a) brust Assembly b) Brust Disassembly

3.2 Wavelength reservation scheme

Wavelength reservation is a technique in which when and how wavelength is reserved is define. In this two types are there immediate reservation or Just in Time (JIT) and delay reservation. Delay reservation also contains void filling or Just Enough Time (JET) and no void filling or Horizon. In immediate reservation output wavelength reserved immediately after arrival of a BHC. If any case wavelength cannot reserved at that time BHC and respected brust are dropped. In delay reservation output wavelength is reserved for a brust just before arrival of first bit of brust. BHP arrived and if it determined that no wavelength can be reserved at the appropriate time then the BHC is discarded and brust is dropped.

4. Scheduling algorithms in OBS

Optical Burst Switching is a brighter technology in Optical Network. The key problem is to scheduled data burst in data channels by an optimal way. The main aim is to reduce the brust loss in data channel so that more brust can be scheduled. When a control packet arrives at a core node channel scheduling algorithm determine a wavelength of channel for outgoing link for the corresponding data burst. The information required for the scheduler is the expected arrival time of the data burst. The scheduler keeps track of the availability of time slots on every wavelength channel and selects idle channels. The selection of wavelength channel is such a way that burst loss is less. At the same time, the scheduler must be simple and should not use complex algorithm because the routing nodes operate on very high-speed burst traffic. A complex scheduling algorithm work on the early data burst arrival situation if the data burst arrives before its control packet is processed then the data burst is dropped.

Different algorithms exist to schedule data burst on data channels. Algorithms differ in their complexity and performance in terms of burst loss. Algorithms which consider unscheduled channels are called Horizon algorithm [3]. A channel is said to be unused for the duration of voids between two successive data bursts and after the last data burst assigned to the channel. Algorithms which consider voids within channels are called void filling algorithm. According to scheduling strategy used scheduling algorithms can be classified as Horizon or without void filing and with void filling.

Horizon algorithms are: First Fit Unscheduled Channel (FFUC), Latest Available Unused Channel (LAUC) and that of void filling algorithms are: First Fit Unscheduled Channel with Void Filling (FFUC-VF)], Latest Available Unused Channel with Void Filling (LAUCVF) and Minimum End Void (Min-EV)

Latest available unscheduled channel with void filling and minimum end void are the best among other existing non-segmentation based void filling algorithms. Hence it gives less burst loss, but not utilizing the existing voids efficiently. In this paper we propose a new approach, which will give less burst loss and also utilize voids in efficient way. Also analyze the performance of this proposed scheduling algorithm and compare it with the existing void filling algorithms with respect to burst loss by simulation. It is shown that the proposed algorithm gives some better performances compared to the existing algorithms.

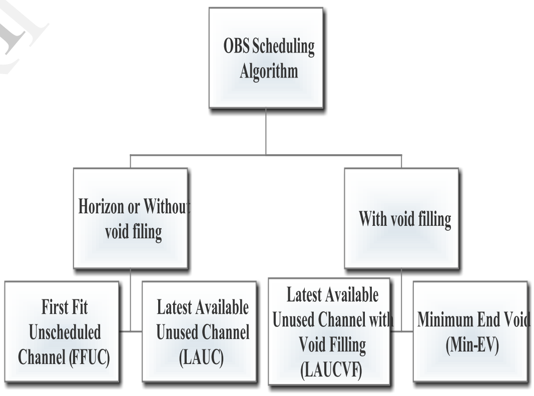

Fig 4: OBS scheduling algorithms

A) First Fit Unscheduled Channel (FFUC):

The FFUC scheduling algorithm keeps track of the LAUT (or horizon) on every data channel. A wavelength is considered for each arriving burst when the unscheduled time (LAUT) of the data channel is less than the burst arrival time. The FFUC algorithm searches all the channels in a fixed order and assigns the first available channel for the new arriving burst. The primary advantage of FFUC is the simplicity of the algorithm and that the algorithm needs to maintain only one value for each channel[3,8,7]. The time complexity of the FFUC algorithm is O(log W).

B) Horizon or Latest Available Unscheduled Channel (LAUC):

The LAUC or Horizon scheduling algorithm keeps track of the LAUT (or horizon) on every data channel and assigns the data burst to the latest available unscheduled data channel. It based on the data channels and is available for the duration of the unscheduled burst. Also, the arriving burst is scheduled on outgoing data channel with the minimum gap[8,3,1]. The time complexity of the LAUC algorithm is O(log W).

C) First Fit Unscheduled Channel with Void Filling (FFUC-VF):

The FFUC-VF scheduling algorithm maintains the starting and ending times for each scheduled data burst on every data channel. The goal of this algorithm is to utilize voids between two data burst assignments. The first channel with a suitable void is chosen. Based on the all the data channels and are available for the duration of the unscheduled burst. If the channels are ordered based on the index of the wavelengths the arriving burst is scheduled on outgoing data channel If is the number of bursts currently scheduled on every data channel, then a binary search algorithm can be used to check if a data channel is eligible[3,8]. Thus, the time complexity of the LAUC-VF algorithm is O(Log(WNb)).

D) Latest Available Unscheduled Channel with Void Filling (LAUC-VF):

The LAUC-VF scheduling algorithm maintains the starting and ending times for each scheduled data burst on every data channel. The goal of this algorithm is to utilize voids between two data burst assignments. The channel with a void that minimizes the gap is chosen[2,7,4]. The time complexity of the LAUC-VF algorithm is O(Log(WNb)).

Table 2 : Comparison of scheduling Algorithms

Algorithms	Time Complexity	State Information	Bandwidth Utilization
FAUC	O(log W)	Horizon	Low
FFUC-VF	O(Log(WNb))	Sij,Eij	High
LAUC	O(log W)	Horizon	Low
LAUC-VF	O(Wlog M)	Sij,Eij	High

: The performance of various scheduling algorithms was compared in, which shows that FFUC, FFUC-VF, LAUC and LAUC-VF have comparable bandwidth utilization (or loss rate) that is much higher (or lower) than Horizon-based algorithms. The running time complexity of different scheduling algorithms was also analyzed.

Table 2 summarizes the above discussion using the following notations

* W -Number of wavelengths at each output port

* M - Maximum number of data bursts (or reservations) on all channels

Horizon: Horizon of the ith data channel S{ij} and E{ij}: Starting and ending time of the jth reservation on channel i.

5. Conclusion

Optical brust switching is currently used for high data transmission. In this paper we studied comparison of optical switching technologies considering bandwidth utilization, setup and traffic, in that we observed OBS is better performance that OCS and OPS. Also we studied various issues in OBS network like brust assembly, wavelength reservation and various scheduling algorithms. We considering various scheduling techniques to scheduled the control and data brust. This paper summarizes the various algorithms with their time complexity, state of information and bandwidth utilization. Algorithms without void filling having horizon and its bandwidth is less and with void filling using start and end time of arriving brust and considering void having high bandwidth. Hence it shows for high bandwidth void filling technique is better than without void filling.

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