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<p>A Composite Scheduling Approach for Burst Loss Minimization in Optical Burst Switched Networks <b>11 h 44</b></p> <p>Abstract — In optical burst switched</p>	<p>Phương pháp lập lịch phức hợp để tối thiểu hóa tổn hao burst trong các mạng chuyển mạch burst quang</p> <p>Optical Burst Switched Network: một số tài liệu dịch là “mạng chuyển mạch chùm quang”.</p> <p>Tóm tắt-Trong các mạng chuyển mạch</p>
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(OBS) networks, burst scheduling is one of the key issue, which affects the performance of networks. Several scheduling algorithms have been used, such as horizon and void filling based algorithms. Void filling algorithms reduces burst loss, but it has more execution time as compared to horizon algorithms. On the other hand, horizon algorithms has less execution time, but account poor bandwidth utilization. To take advantages of both the algorithms, composite scheduling can be used. In composite scheduling algorithm, at a time one algorithm is selected based on the information of current voids interval of data channels. This approach increases the bandwidth utilization and decreases time complexity. The network performance in terms of burst losses is evaluated using simulation model. The simulation results shows that composite scheduling is more effective and has less burst dropping as compared to individual scheduling algorithm contained in it. Also, it is observed that composite scheduling algorithm using LAUC and Min-EVF performs better in terms of burst loss as compared to rest of the composite scheduling algorithms.

Keywords: Optical burst switching (OBS), Wavelength division multiplexing (WDM), Horizon, Void filling (VF), Control packet (CP), Channel scheduling

## I. INTRODUCTION

The increasing demand for higher bandwidth due to the growth of

burst quang (OBS), lập lịch burst là một trong những vấn đề quan trọng ảnh hưởng đến hiệu suất mạng. Một số thuật toán lập lịch đã được sử dụng, chẳng hạn như các thuật toán horizon và thuật toán điền đầy ô trống. Thuật toán điền đầy ô trống giảm tổn hao burst, nhưng nó có thời gian thực thi dài hơn thuật toán horizon. Mặt khác, thuật toán horizon có thời gian thực thi ngắn hơn, nhưng khả năng tận dụng băng thông kém. Để khai thác những ưu điểm của cả hai thuật toán này, người ta sử dụng phương pháp lập lịch phức hợp. Trong thuật toán lập lịch phức hợp, tại mỗi thời điểm, một thuật toán được chọn dựa trên thông tin của interval (khoảng cách, lúc ngừng) của các ô trống hiện tại của các kênh dữ liệu. Phương pháp này làm tăng khả năng tận dụng băng thông và giảm độ phức tạp thời gian. Để đánh giá hiệu suất mạng theo độ tổn hao burst, chúng ta sử dụng mô hình mô phỏng. Các kết quả mô phỏng cho thấy rằng lập lịch phức hợp hiệu quả hơn và ít mất burst hơn so với khi dùng một thuật toán lập lịch. Tương tự, chúng tôi cũng thấy rằng thuật toán lập lịch phức hợp dùng LAUC và Min-EVF có hiệu suất tốt hơn xét theo độ tổn hao burst so với các thuật toán lập lịch phức hợp khác.

Từ khóa: Chuyển mạch burst quang (OBS), ghép kênh quang theo bước sóng (WDM), thuật toán horizon, thuật toán điền đầy ô trống (VF), gói tin điều khiển (CP), lập lịch trình kênh

bandwidth intensive applications such as audio, video-on-demand, video conference, online trading, and other multimedia applications motivated the search for alternatives to traditional electronic networks. Wavelength division multi-plexing (WDM) is one such technology developed to handle the future bandwidth demands [1]. Several approaches have been proposed to take advantages of optical communication and in particular switching techniques in WDM networks.

Switching techniques are broadly classified into optical circuit switching (OCS), optical packet switching (OPS), and optical burst switching (OBS) [1]. Out of these switching techniques, OBS is a promising and feasible way for the next generation optical Internet before OPS realized. The benefit of OBS over conventional OCS is that there is no need to dedicate a wavelength for the entire session between a pair of nodes. OBS is more viable than OPS as the data burst does not need to be buffered or processed at the intermediate nodes [2], [4]. An OBS based WDM networks have three nodes, namely an ingress, egress, and a network of core nodes. At the ingress node, various types of client data from the access network are aggregated into a data burst. A burst is logical aggregation of Internet protocol (IP) packets and it is transmitted entirely in the optical domain. An IP packets destined to the same egress node are aggregated into a burst. To avoid

buffering and processing of the optical data burst at the intermediate nodes, a burst header packet (BHP), with the information about the length and arrival time of the data burst, is sent in advance. BHPs are transmitted on a dedicated control wavelength, while the data bursts are sent after some time on separate wavelengths. The time gap between a BHP and the corresponding data burst sent is called the offset time. This offset time is set sufficient enough to enable the processing of BHP and to configure the switches at the core nodes. When a BHP arrives at intermediate node, efficient scheduling algorithm is used to schedule burst. BHP will provide necessary information to schedule burst onto outgoing wavelength channels. The main objectives of scheduling algorithm are to reduce burst losses and to improve performance of the networks. An ideal scheduling algorithm should be able to process BHP before corresponding data burst arrives and to find out a best suitable outgoing channel for Data Burst (DB). If reservation fails before DB arrival, the DB will be dropped. An efficient scheduling algorithm can reduce the DB loss rate and enhance the channel utilization ratio. Depending upon the channel selection strategy, scheduling algorithms can be classified as horizon and void filling algorithms. The various scheduling algorithms have been proposed to schedule burst, such as latest available unused channel (LAUC), first fit unused channel (FFUC), LAUC with void filling (LAUC-VF). LAUC is very simple, easy to implement and

widely used algorithm. A void is nothing but time gap between two successive bursts on a channel. There are several variants of LAUC-VF algorithms, such as minimum starting void filling (Min-SVF) and minimum ending void filling void (Min-EVF)[2], [3], [5].

Composite scheduling combines advantages of horizon scheduling and void filling scheduling and removes their disadvantages, discussed in section III and IV. The basic idea of the algorithm is that, it firstly determine a threshold function according to the current void interval information. Void filling algorithm is selected, if the length of arriving DB is less than the threshold function, otherwise horizon algorithm is selected. In [9] LAUC and LAUC-VF are combined. In this paper, we have devised more efficient composite scheduling algorithm as compared to devised in [9]. The detail study has been carried out by using simulation. For simulating optical burst switched network, we have used Ns-allinone-2.27 software with OBS-0.9a patch. We have tested our algorithm on NSFNET 14 node topology.

Rest of the paper is organized as follows. Section II explains the existing scheduling algorithms. In section III, we have analyzed different scheduling algorithms. Composite scheduling algorithms are explained in section IV. Comparison and simulation results are presented in section V. Finally, conclusion and future directions are

given in section VI.

## II. SCHEDULING ALGORITHMS

When a control packet arrives at a core node, a wavelength channel scheduling algorithm is executed to determine a wavelength channel on an outgoing link for the corresponding data burst. The scheduler keeps track of the availability of time slots on every wavelength channel. It selects one among several idle channels. The selection of wavelength channel needs to be done in an efficient way so as to reduce the burst loss. Existing burst scheduling algorithms are given below:

Hinh 1

i) LAUC : bursts scheduling is done by selecting the latest available unscheduled data wavelength channel. 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. Only the channels whose scheduling horizons precede the new bursts arrival time are considered available and the one with the latest scheduling horizon is chosen. The horizon is then up-dated after making the reservation for the next burst. As shown in Fig.1 DB is arrived at time  $t$ . Horizon of wavelength channel C1 to C4 is greater than burst arrival time. Hence these channels are not available for newly arrive burst. Wavelength channels C5 and C6 are available for the duration of the unscheduled burst DB. Observe that if we will schedule this burst then gap produced on C5 will be greater than C6. Thus, the arriving burst is scheduled on

outgoing data channel with the minimum gap, i.e., C6.

Advantages: Algorithm maintains one parameter which is horizon. hence, it is computationally simple.

Disadvantages: Algorithm does not uses voids on any wavelength and thus is not able to achieve the best burst dropping performance. It result in low bandwidth utilization and a high burst loss rate.

ii) FFUC: It is like FFUC. As shown in Fig.1 DB is arrived at time  $t$ . Wavelength channels C5 and C6 are available for the duration of the unscheduled burst DB. If the channels are ordered based on the index of the wavelengths the arriving burst is scheduled on outgoing data channel C5. It selects the first found wavelength channel without considering that the void generated with this selection is greater than other wavelengths. hence it is less efficient than LAUC.

i) LAUC-VF: LAUC-VF is variant of LAUC. In this algorithm, a scheduler keeps track of void for each wavelength channel and maintains start and end time of voids for each data wavelength channels. A void is the unscheduled duration between two scheduled bursts on a data wavelength channel. LAUC-VF searches for the void such that newly formed void due to new burst is very small compared to other voids.

ii) As shown in Fig.1 DB is arrive at time  $t$ . For void filling algorithm channel



C1 to C4 are available to schedule newly arrive burst DB. For various variants of LAUC-VF like Best Fit, Min-SVF, Min-EVF; DB will be scheduled on channel C2, C3, C4 respectively. Advantages: Algorithm uses voids on scheduled channel. It results in high bandwidth utilization and less burst loss rate.

iii) Disadvantages: The drawback of LAUC-VF is the high computational complexity. Information of voids has to be stored for every wavelength and to be searched every time when scheduling takes place.

iv) FFUC-VF: FFUC-VF is variant of FFUC. It is differ from LAUC-VF such that it selects the first found void without considering that the new void generated with this selection is greater than other selection. Hence it will schedule new arrive burst DB on wavelength channel C1

- Several variants of the LAUC-VF algorithm including Min-SVF, Min-EVF and Best Fit void filling (BF-VF) were pro-posed in [6]. Min-SVF minimize the new void generated be-tween the start of new reservation and an existing reservation. On the other hand Min-EVF tries to minimize the new void generated between the end of new reservation and an existing reservation while Best Fit tries to minimize the total length of starting and ending voids generated after the reservation.

- The performance of various scheduling algorithms was compared in [6], [7], which shows that LAUC-VF,



Min-SVF, Min-EVF and BF-VF have a comparable bandwidth utilization (or loss rate) which is much higher (or lower) than Horizon based algorithms. the Min-SV/EV algorithms are the most desirable among all void-filling algorithms.

### III. LIMITATIONS OF EXISTING SCHEDULING ALGORITHMS

For example consider Fig.2.a, data burst 1 scheduled on channel C1 and two data burst 2, 3 are scheduled on wave-length channel C2. Suppose a data burst 4 arrived at time  $t$ , unscheduled time of C1 is  $t_1$  which is small than arrival time  $t$ . Hence, horizon scheduling algorithm will schedule the new data burst 4 on wavelength channel C1. So we can see that execution time is very less in horizon scheduling algorithm. Hence end to end delay of data burst get reduced. If

Hinh 2

we will consider Fig.2.b, wavelength channel C1 is available at time instant  $t_1$  and wavelength channel C2 is available at time instant  $t_2$ . Suppose new data burst 5 arrives at time  $t$ . Horizon scheduling algorithm will drop the burst, because  $t$  is less than latest available unscheduled time of wavelength channel C1 and C2 i.e.  $t_1$  and  $t_2$  respectively. They do not consider the voids within a wavelength channel. Although in wavelength channel C1 as well as in C2 there exist a void between data burst 1-4 and 2-3 respectively, within which new data burst 5 could have been scheduled. Thus, horizon scheduling algorithms are

not efficient in terms of a channel utilization and gives rise to higher burst loss.

Void filling algorithms keeps the information of all void intervals of each channel by storing starting and ending time of void interval and arranges a new arriving data burst in void interval between two data bursts. As shown in Fig.3, starting time of void interval i.e.  $t_{2,1}$  less than arrival time of burst 5 i.e.  $t$  and ending time of void interval i.e.  $t_{2,1} + L$  greater than sum of arrival time of burst and length of burst. We can schedule this burst on channel C2. Thus increases the channel utilization. Thus, void filling algorithms can use bandwidth more effectively than the horizon algorithms.

Fig. 3. Void Filling Scheduling Approach.

Though void filling algorithms reduces dropping probability of data burst but it has a more execution time as compare to horizon algorithms; especially when number voids are more in numbers. Time required for void filling algorithms to search a suitable void interval for an arriving data burst will be more than the offset time of data burst, results in the failure of reservation. On the other hand, horizon algorithms does not utilize any void interval between two data bursts, so its execution time is short, but bandwidth utilization ratio is low.

The above problem of horizon



scheduling algorithms and void filling algorithms makes them unsuitable for online voice, video traffic which occupies most of the real time Internet traffic. Hence, solution is required such that it will combine advantages of horizon scheduling algorithms and void filling algorithms, at the same time will remove their disadvantages. Definitely, this solution will increase bandwidth utilization and decrease the end to end delay of data burst. Composite scheduling algorithm is proposed which combines advantages of horizon scheduling algorithms and void filling algorithms, at the same time removes their disadvantages [9].

#### IV. COMPOSITE SCHEDULING APPROACH

It is an efficient void based wavelength channel scheduling algorithm in which we can combine horizon and void filling algorithm by reducing burst loss in OBS networks. The basic idea of algorithm is that, it selects either horizon algorithm or void filling algorithm to schedule the arriving burst according to the current information of void interval available on channel. The algorithm firstly determine a threshold function according to the current void interval information.

Assume new DB with length  $L$  arrives at time  $t$  to the optical switch. The latest available time i.e. horizon of wavelength channel  $C_i$  is denoted by  $t_i$ .  $S_{i,j}$  and  $E_{i,j}$

are starting and ending time of  $j$ th void on channel  $i$ .

The pseudo code of the algorithm is given below.

Thuat Toan

Step 1: Search the Channel  
for every channel  $C_i$

If no such  $C_i$  exists, then drop the burst

We can have various composite scheduling algorithm by combining horizon algorithm with various void filling scheduling algorithm as discussed below.

#### A. Composite scheduling using LAUC and LAUC-VF

It combines LAUC as horizon algorithm and LAUC-VF as void filling algorithm in it. This composite scheduling is illustrated in Fig.4. New DB1 with duration  $L$  arrives at time  $t_1$  to the optical switch. In Fig.4.(a), the burst length is more than average void length, hence it schedules burst according to LAUC algorithm. Wavelength channels  $C_3$  and  $C_4$  have unscheduled time i.e. horizon as  $t_3$  and  $t_4$  respectively. This horizons are less than new data burst DB1 arrival time i.e.  $t_1$ . Hence, wavelength channels  $C_3$  and  $C_4$  are available for new incoming DB1.



Hence, compute gap for C3 and C4 channels as,

$$\text{Gap}_3 = t_{12} - t_3$$

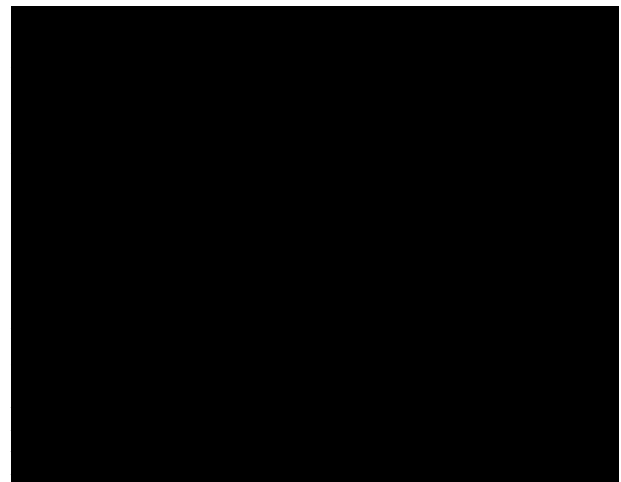
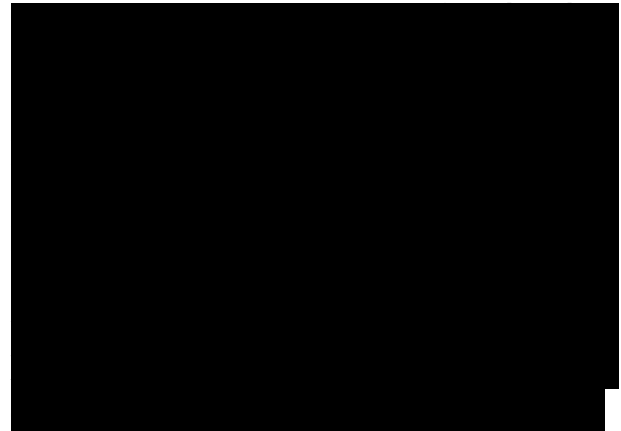
$$\text{Gap}_4 = t_{12} - t_4$$

From Fig.4.(a), we can see that  $\text{Gap}_4 \leq \text{Gap}_3$ . Hence, wavelength channel C4 is selected to carry the new DB1. And DB1 is scheduled on wavelength channel C4. As shown in Fig.4.(b), Horizon of wavelength channel C4 is updated as,  $t_4 = t_{12} + L$ . And void is created before data burst DB1 on wavelength channel C4, with starting time as  $t_{41}$  and ending time as  $t_{412}$ .

In Fig.4.(b), New DB2 with duration L arrives at time  $t_{22}$  to the optical switch. Length of new burst DB2 is less than average void length, hence schedule burst using LAUC-VF algorithm. Wavelength channels C1, C2 and C5 have void gap

Hinh 4

V1, V2 and V5 respectively. Void V1 of wavelength channel C1 has starting time and ending time  $t_{11}$  and  $t_{112}$  respectively. This void can accommodate new data burst DB2. Because starting time of void i.e.  $t_{11} \leq t_{22}$ . Ending time of void i.e.  $t_{112} \geq t_{22} + L$ . Like void V1 we can also accommodate DB2 on void V2 and V5. Hence, channels C1, C2 and C5 are available for new data burst DB2.



Hence, compute void gap before new data burst DB2 for C1, C2 and C5 channels as,

Void Gap1 is less than VoidGap2 and VoidGap5. Hence, wavelength channel C1 is selected to schedule new data burst DB2. Void that will be produced before new data burst DB2 is minimum.

#### A. Composite Scheduling using LAUC and Min-SVF

It combines LAUC as horizon algorithm and Min-SVF as void filling algorithm in it. Min-SVF is variant of LAUC-VF. It works same as the composite scheduling using LAUC and LAUC-VF. Hence, new data burst DB1 is scheduled on wavelength channel C4. Wavelength channel C1 is selected to schedule new data burst DB2 as illustrated in composite scheduling using LAUC and LAUC-VF.

#### B. Composite Scheduling using LAUC and Min-EVF

It combines LAUC as horizon algorithm and Min-EVF as void filling algorithm in it. This composite scheduling is illustrated in Fig.4. New DB1 with duration  $L$  arrives at time  $t1$  to the optical switch. In Fig.4.(a), the burst length is more than average void length, hence it schedules burst according LAUC algorithm. Wavelength channels C3 and C4 have unscheduled time i.e. horizon as  $t3$  and  $t4$  respectively. This horizons are less than new data burst DB1 arrival time i.e.  $t1$ . Hence, wavelength channels C3 and C4 are

available for new incoming DB1.

Hence, compute gap for C3 and C4 channels as,

$$\text{Gap}_3 = t1_{\square} - t3$$

$$\text{Gap}_4 = t1_{\square} - t4$$

From Fig.4.(a), we can see that  $\text{Gap}_4 \leq \text{Gap}_3$ . Hence, wavelength channel C4 is selected to carry the new DB1. And DB1 is scheduled on wavelength channel C4. As shown in Fig.4.(b), Horizon of wavelength channel C4 is updated as,  $t4 = t1_{\square} + L$ . And void is created before data burst DB1 on wavelength channel C4, with starting time as  $t41$  and ending time as  $t41_{\square}$ .

In Fig.4.(b), New DB2 with duration L arrives at time  $t2_{\square}$  to the optical switch. Length of new burst DB2 is less than average void length, hence schedule burst using void filling algorithm. In this composite we are using Min-EVF as void filling algorithm. Wavelength channels C1, C2 and C5 have void gap V1, V2 and V5 respectively. Void V1 of wavelength channel C1 has starting time and ending time  $t11$  and  $t11_{\square}$  respectively. This void can accommodate new data burst DB2. Because starting time of void i.e.  $t11 \leq t2_{\square}$ . Ending time of void i.e.  $t11_{\square} \geq t2_{\square} + L$ . Like void V1 we can also accommodate DB2 on void V2 and V5. Hence, channels C1, C2 and C5 are available for new data burst DB2.

Hence, compute void gap after new data burst DB2 for C1, C2 and C5 channels

as,

$$\text{VoidGap1} = t_{11} - t_{21} + L$$

$$\text{VoidGap2} = t_{21} - t_{21} + L$$

$$\text{VoidGap5} = t_{31} - t_{21} + L$$

VoidGap2 is less than VoidGap1 and VoidGap5. Hence, wavelength channel C2 is selected to schedule new data burst DB2. Void that will be produced after new data burst DB2 is minimum.

### C. Composite Scheduling using LAUC and BF-VF

It combines LAUC as horizon algorithm and BF-VF as void filling algorithm in it [8]. An example of this composite scheduling is illustrated in Fig.4. Like previous subsection A and C, data burst DB1 is schedule on wavelength channel C4 using LAUC.

In Fig.4.(b), New DB2 with duration L arrives at time  $t_{21}$  to the optical switch. It is scheduled using void filling algorithm. Because its length is less than average void length. In this composite we are using BF-VF as void filling algorithm.

Wavelength channels C1, C2 and C5 are available to schedule data burst DB2. Because, void of this channels has starting time less than  $t_{21}$  and ending time greater than  $t_{21} + L$ .

Hence, compute void gap before new data burst DB2 for C1, C2 and C5 channels as,

$$\text{VoidGap1} = t_{21} - t_{11}$$

$$\text{VoidGap2} = t_{21} - t_{21}$$



$$V_{oidGap5} = t2_{\square} - t51$$

Compute void gap after new data burst DB2 for C1, C2 and C5 channels as,

$$V_{oidGap1} = t11_{\hat{\epsilon}^{\circ}} - t2_{\hat{\epsilon}^{\circ}} + L$$

$$V_{oidGap2} = t21_{\hat{\epsilon}^{\circ}} - t2_{\hat{\epsilon}^{\circ}} + L$$

$$V_{oidGap5} = t31_{\hat{\epsilon}^{\circ}} - t2_{\hat{\epsilon}^{\circ}} + L$$

Fig.4.(b), C5 is the only wavelength channel which has both gap i.e. before DB2 i.e.  $V_{oidGap5}$  and after DB2 i.e.  $V_{oidGap_{\square} 5}$  less. hence schedule burst on wavelength channel C5.

## I. SIMULATION AND RESULTS

In order to evaluate the performance of void based scheduling algorithm with burst dropping probability (DP), we have used a simulation model as shown in figure ???. The following things we have considered in our simulation scenarios, to obtain the results:

- NSF(National Science Foundation) network topology is used which is backbone of US network. It consists of 8 core and 16 edge routers with 43 bidirectional links.

- Average node degree is 3.6 and average hop (H) is 3.
- A bidirectional link is realized by two unidirectional links in opposite direction.

- Each unidirectional link consist of 8 data channels and 1 control channel.

- Burst arrivals to the network are Self-Similar with rate  $\lambda$ .

- Bursts are generated by using

threshold-based scheme

with value of threshold as 60 KB.

- Packet length is 2000 bytes.
- BHP processing time ( $\delta$ ) is 1  $\mu$ s.
- Offset time of traffic is 48  $\mu$ s.

- Bandwidth per channel is 10 GB.
- Range of traffic load from 0.2 to 0.7 MB.

Now we are going to evaluate all scheduling algorithms in terms of Burst Dropping Probability. The formula used for calculation of Burst DP is given by,

Now we are going to evaluate all scheduling algorithms in terms of burst DP. The formula used for burst dropping probability (DP) is given below.

**BẢN GỐC BỊ LẬP**

(Total burst drop in the network)

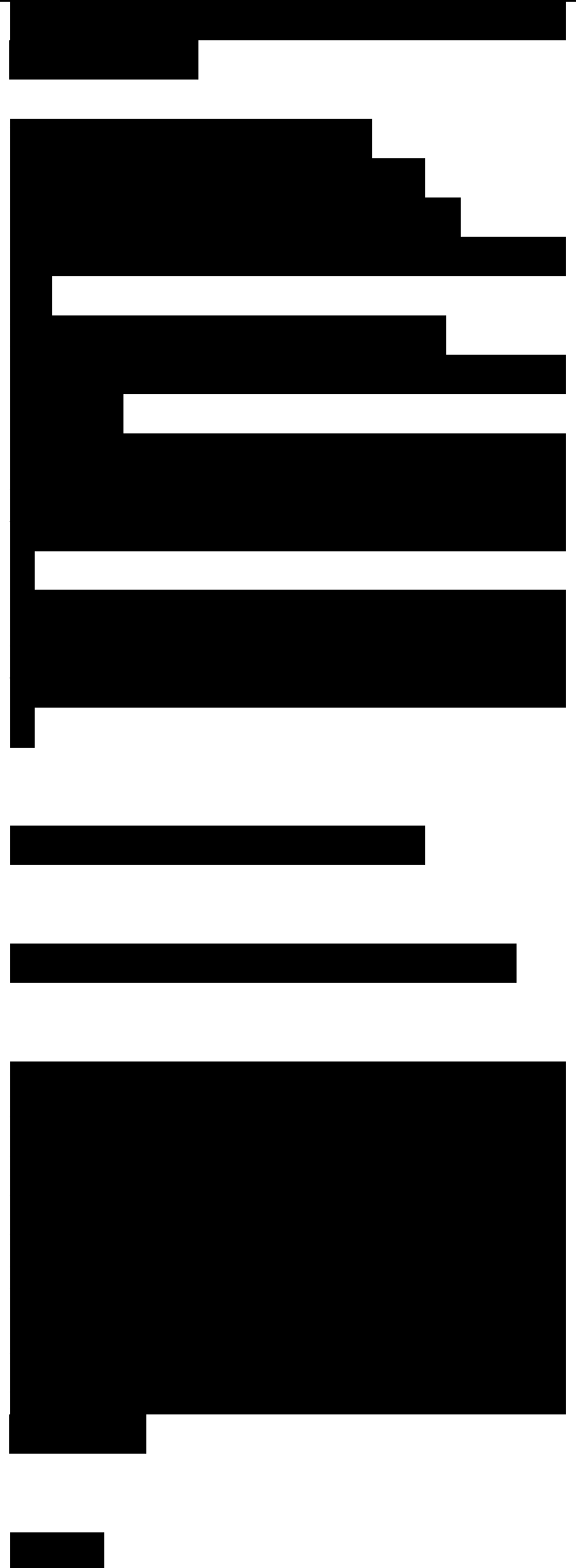
$$D.P. = \frac{\text{Total burst drop in the network}}{\text{Total number of burst sent in the network}}$$

(Total number of burst sent in the network)

From our simulation results as shown in Fig.6, we can see that FFUC has more dropping Probability as compare to LAUC. It has been observed that horizon algorithms (considering the number of channel/link is 8) FFUC has the high DP than LAUC. This is due to selection of first latest horizon available on channel. Fig.7 shows the comparison of void filling algorithms in terms of burst dropping probability.

Hinh 5

Hinh 6



LAUC-VF algorithm have less DP than FFUC-VF. As we know in FFUC-VF algorithm data bursts are scheduled first found void without considering that the new void generated with this selection is greater than other selection. Where as in LAUC-VF, data bursts are scheduled on void channel, such that placement of new data burst create minimal void between newly arrival data bursts and previous scheduled data bursts. We can see that Min-EV scheduling algorithm has less dropping probability as compare to rest of the void filling algorithms.

#### A. Performance Analysis of Composite Scheduling Algorithms

From Fig.8, 9, 10, we can see that dropping probability of composite scheduling algorithm is very less as compared to the horizon algorithm and void filling algorithms used in it. From Fig.7, we can see that composite scheduling algorithm in which we have combined LAUC as horizon and Min-EVF as void filling algorithm has less DP as compared to other

Hinh 7

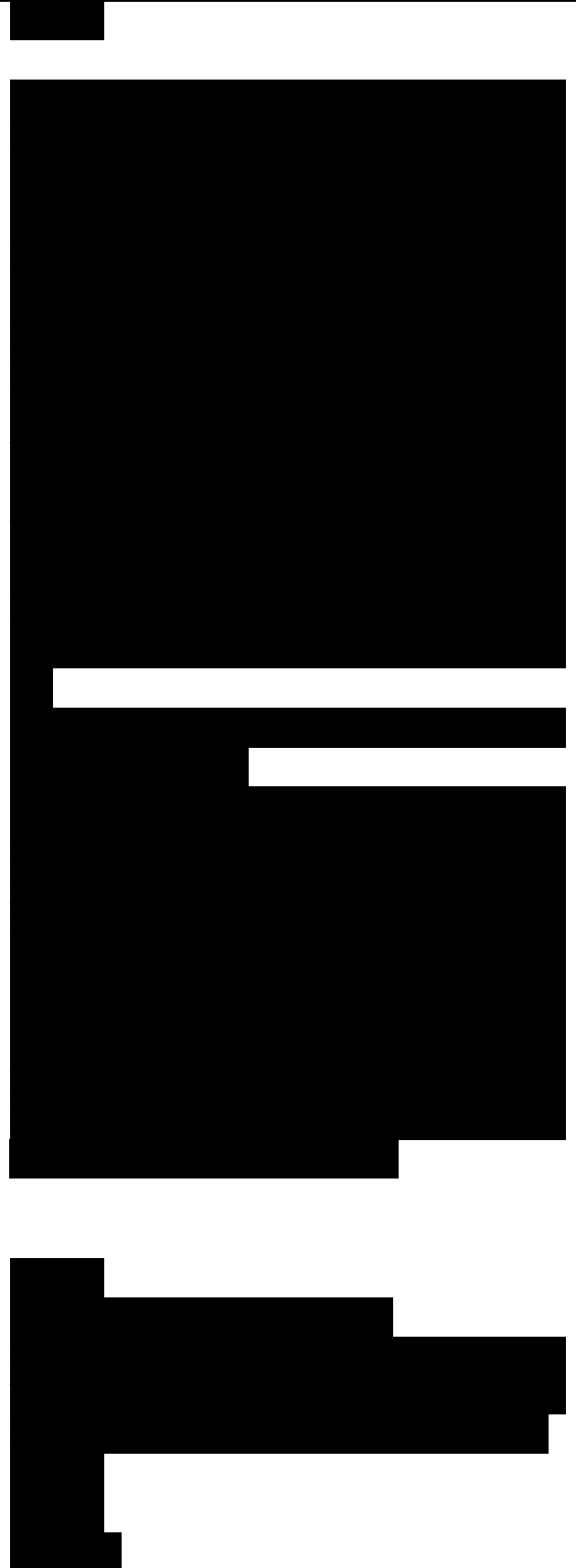
composite scheduling algorithm. This is because of Min-EVF has less dropping probability as compared to other void filling algorithms as illustrated in Fig.9.

Hinh 8

Hinh 9

Hinh 10

Hinh 11



## B. Performance Improvement in Composite Scheduling Algorithms

Fig.12 shows the comparison of performance improvement in composite scheduling algorithm with performance improvement in horizon and void filling scheduling algorithm. Composite scheduling algorithm has more performance improvement against horizon and void filling scheduling algorithms. Performance evaluation of algorithm is given below:

$$\text{(DP of LAUC) - (DP of composite algorithm) Performance} = \frac{\text{DP of LAUC} - \text{DP of composite algorithm}}{\text{DP of LAUC}}$$

(DP of LAUC algorithm)

## II. CONCLUSION AND FUTURE WORKS

In this paper we have discussed the performance of horizon and void filling scheduling algorithm. It is observed that the void filling scheduling algorithms have better performance than the horizon scheduling algorithms. Void filling scheduling algorithms also have some limitations. Hence, composite scheme is discussed. We have done analysis of composite scheme and calculated the burst dropping probability. We have compared each composite scheduling algorithm with horizon

Fig. 12. Performance Evaluation of Composite Scheduling Algorithms against Horizon and Void Filling Scheduling Algorithms.



and void filling algorithm contained in it. It is found that composite scheme has less burst loss ratio as compared to horizon and void filling algorithm contained in it. Performance improvement of composite algorithm against horizon and void filling algorithms is very high. Also, we can conclude that the composite algorithm which combines advantages of LAUC and Min-EVF is more effective and has less dropping probability as compared to rest of the composite scheduling algorithms.

Composite scheduling algorithms must be tested under different burst assembly schemes. For composite algorithms, searching method should be improved by using some genetics algorithms. So that time complexity will get reduced. The burst formation and wavelength allocation process should be synchronized so as to utilize the voids efficiently. For the same some central intelligent agent should be managed. The burst loss probability under various traffic conditions must be verified. Composite algorithm can be made more effective through priority assignment and use of FDLs.

