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Reducing Crosstalk in an Optical Multistage Interconnection Network

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ABSTRACT
Crosstalk is the major problem with optical interconnections; it not only degrades the performance of network but also disturbs the path of communication signals. This paper presents a new optical interconnection network named as crosstalk free modified omega network (CFMON) and its routing algorithm. The proposed routing algorithm reduces the crosstalk problem and provides a crosstalk free optical interconnection network only in two passes.

Keywords
Multistage Interconnection Network, Optical Multistage Interconnection Network, Crosstalk, Time Domain Approach, Crosstalk Free Modified Omega Network.

1. INTRODUCTION
In parallel processing system, interconnection network work as a key element [1-7]. It provides an enthusiastic way to switching and communication applications. Multistage Interconnection Networks establish a reliable communication between source and destination but now these days electro-optic technologies have built optical communication a reliable and fast network that fulfill the increasing demands of users. Although, there are various characteristics are same of electronic multistage interconnection network and optical multistage interconnection network, but fundamentally they have some difference [1-11].

The critical challenges with optical multistage interconnections are optical loss, path dependent loss and optical crosstalk [10,11]. Optical crosstalk is caused by coupling two signals within a switching element. In this research work we have proposed a new optical interconnection network named as crosstalk free modified omega network. It reduces the crosstalk problem and do the transmission of communication signals from any source to any destination without any crosstalk. Also we have presented a new routing algorithm; it is based on time domain approach and makes the network crosstalk free only in two passes. The proposed interconnection network is the combination of optical omega and optical clos network [8,9].

The rest of the paper is organized as follows: Section II discusses the previous related work. Section III provides the network description of proposed OMIN and its routing algorithm. Section IV is followed by conclusion, future work and references.

2. RELATED WORK
In the literature [1-11] we have studied lot of approaches and algorithms, these algorithms work efficiently against crosstalk problem but still they are unable to resolve the crosstalk problem e.g. Fast Zerox Algorithm, Address Selection Algorithm (ASA) and Route Selection Algorithm (RSA). The ASA [10] and RSA [11] select some specific source addresses for the first pass and select the rest of the source address for the second pass. If crosstalk occurs after the second pass then the conflicted source addresses will be passes in the next pass in case of ASA and RSA algorithm. In this way in both algorithms (ASA and RSA) it is not fixed that in how many passes we will get a crosstalk free network. This story is same for other time domain algorithms but in case of our approach, we make the network crosstalk free only in two passes. In this way the proposed approach is effective and less time consuming.

3. PROPOSED OMIN
In this research work, we have proposed a new interconnection network named as crosstalk free modified omega network. The architecture of proposed network is based on optical omega network and optical clos network.

3.1 Structure of CFMON
The proposed optical interconnection network is able to reduce crosstalk problem in only two passes and therefore, it is named as crosstalk free modified omega network (CFMON). In figure 1, at the source side we have all the source addresses and destination side we have all the destination addresses. Stages are shown by Stage1, Stage2 and Stage3 in figure 1. In this network each SE is represented by S_{ij}. Here I represent the stage and j represent the SE e.g. S_{11} shows, it is first SE which exist in first stage, S_{33} shows, it is third SE which exist in third stage.

The size of all SEs is n×n in first stage, n×k in second stage, k×n in third stage. Here the value of n is 2 and value of k is 4 i.e. number of SEs in last stage. Now in first stage every SE has 2 input and 2 output links and the upper output links of all the SEs are connected with the upper input links of the SEs of next stage and these connecting links are shown by red colour. In the same way, the lower output links of all the SEs are connected with the lower input links of all the SEs of next stage and these connecting links are shown by green colour in figure 1.

In second stage every SE has 2 input and 4 output links and all the four output links of each SE is connected with all the SEs of next stage as shown in figure 1. In the same way, each SE of third stage has 4 input links and 2 output links and these output links show the destination address.

In this network, every SE which exists in first stage is connected with two source addresses and these addresses are shown by red and green colour.

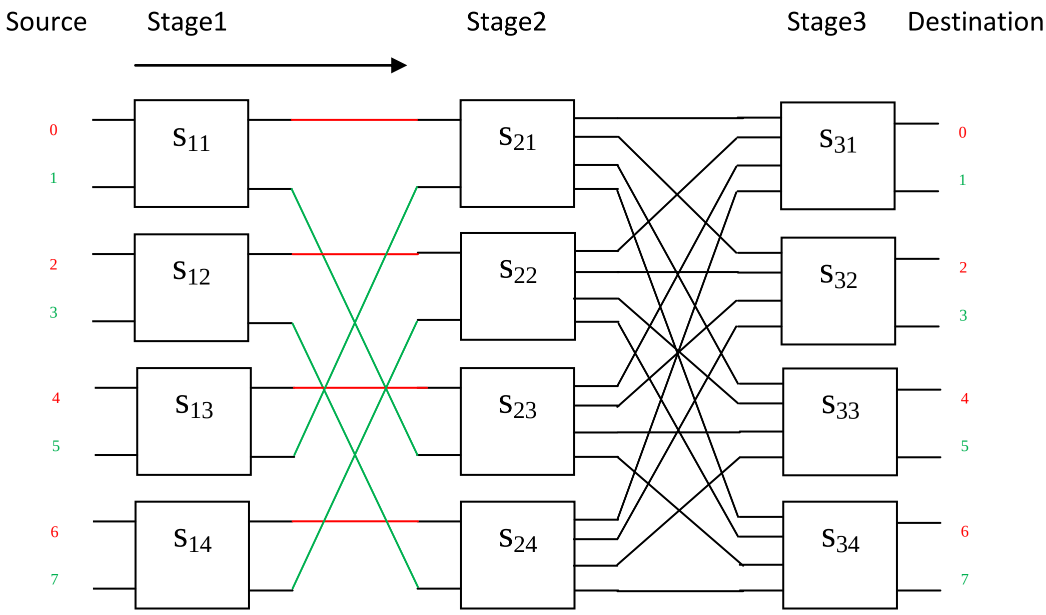

Fig 1: 8×8 Crosstalk Free Modified Omega Network

3.2 Routing Procedure of N×N CFMON

Routing of communication signal or data is easy in CFMON. In first stage, the addresses which are in red colour will follow the upper sided route and addresses which are in green colour will follow the lower sided route. It is clear in figure 2.

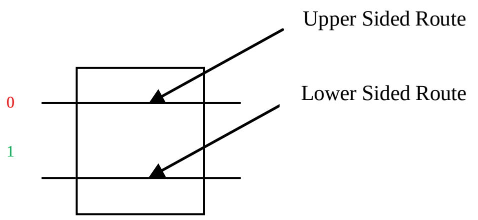

Fig 2: 8×8 Passing Communication Signal through SE

In second stage, the data move according to the given routing table 1. In the same way, we can obtain the routing table for large networks e.g. 32×32, 64×64 etc. To get this table for the large network, only we have to consider the value of k because n is constant in every case. Let us suppose destination addresses are 3 and 7 then according to the routing table 1. If communication signal arrives at upper input link (for destination address 3). It is clear in figure 3. If communication signal arrives at lower input link (for destination address 5). It is clear in figure 4. In the third stage, if destination address is in red colour then follow the upper sided route otherwise follow the lower sided route as given in table 2. Here US stands for upper sided route, LS stands for lower sided route. In the same way, we can obtain table for the large network.

Table 1. Routing Table for SEs of Middle Stage for 8×8 network.

Destination Address	Active Output Link
0 →	1
1 →	1
2 →	2
3 →	2
4 →	3
5 →	3
6 →	4
7 →	4

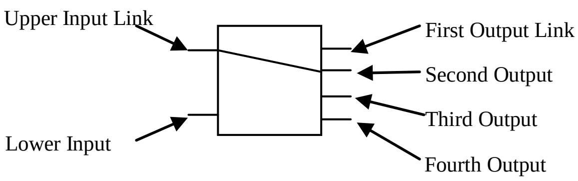

Fig 3: Passing Communication Signal through SE

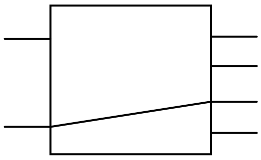

Fig 4: Passing Communication Signal through SE

Table 2. Defined Table .

Destination Address	Colour	Route to be followed by communication signal
0	Red	US
1	Green	LS
2	Red	US
3	Green	LS
4	Red	US
5	Green	LS
6	Red	US
7	Green	LS

3.3 Routing Algorithm of CFMON

In the routing process, firstly obtained the source and its corresponding destination address. In next step do the colouring of source and destination addresses as mentioned in step second and third of algorithm. In next step store the source addresses which are of same colour in variables SR and SG. SR stands for "store red source address", SG stands for "store green source addresses". Transmit these addresses in first and second passes respectively and get the crosstalk free optical network. This algorithm is based on time division approach.

Algorithm_CFMON

1. Begin

2. Obtain the source and its corresponding destination addresses.

3. Show the destination addresses in red and green colour as mentioned in Defined table.

4. Show the first source address in red colour, second source address in green colour and repeat this process up to last source address.

5. Store the red source addresses in a variable SR.

6. Store the green source addresses in a variable SG.

7. Transmit the source addresses which are stored in variable SG in first pass.

8. Transmit the source addresses which are stored in variable SR in second pass.

9. End.

Example1: Let the source and destination address as follows :

Source	Destination
000	111
001	110
010	101
011	100
100	011
101	010
110	001
111	000

Passing these addresses in the existing omega network:

In figure 5, the SE which is facing crosstalk problem, is shown by light blue colour. Here all SEs are facing crosstalk problem.

Now applying the proposed routing algorithm on the proposed CFMON:

Algorithmic Step1:Begin

Algorithmic Step2: In this step, all the source and destination addresses are obtained and therefore we will get:

Source	Destination
000	111
001	110
010	101
011	100
100	011
101	010
110	001
111	000

Algorithmic Step3: In this step, all the destination addresses will be coloured as mentioned in Defined Table and therefore:

Source	Destination
000	111
001	110
010	101
011	100
100	011
101	010
110	001
111	000

Algorithmic Step4: In this step, the first, third, fifth and seventh source addresses are shown by red colour and second, fourth, sixth and eighth source addresses are shown by green colour as mentioned in the algorithm.

000	111
001	110

010	101
011	100
100	011
101	010
110	001
11	000

Algorithmic Step5: Now the red addresses are stored in a variable SR and therefore SR will contain the addresses 000,010,100 and 110.

Algorithmic Step6: In this step, the green addresses are stored in a variable SG and therefore SG will contain the addresses 001,011,101 and 111.

Algorithmic Step7: Now pass the addresses which are stored in SG and therefore the CFMON is as shown in figure 6.

Algorithmic Step8: Now pass the addresses which are stored in SR and therefore the CFMON is as shown in figure 7.

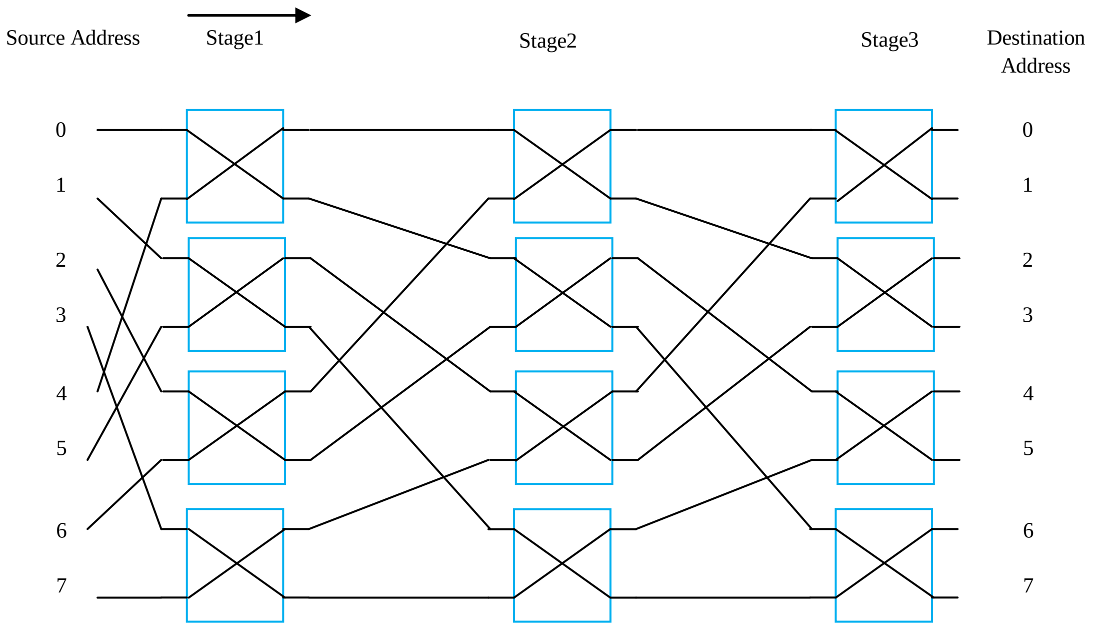

Fig 5: 8×8 Omega Network with Crosstalk

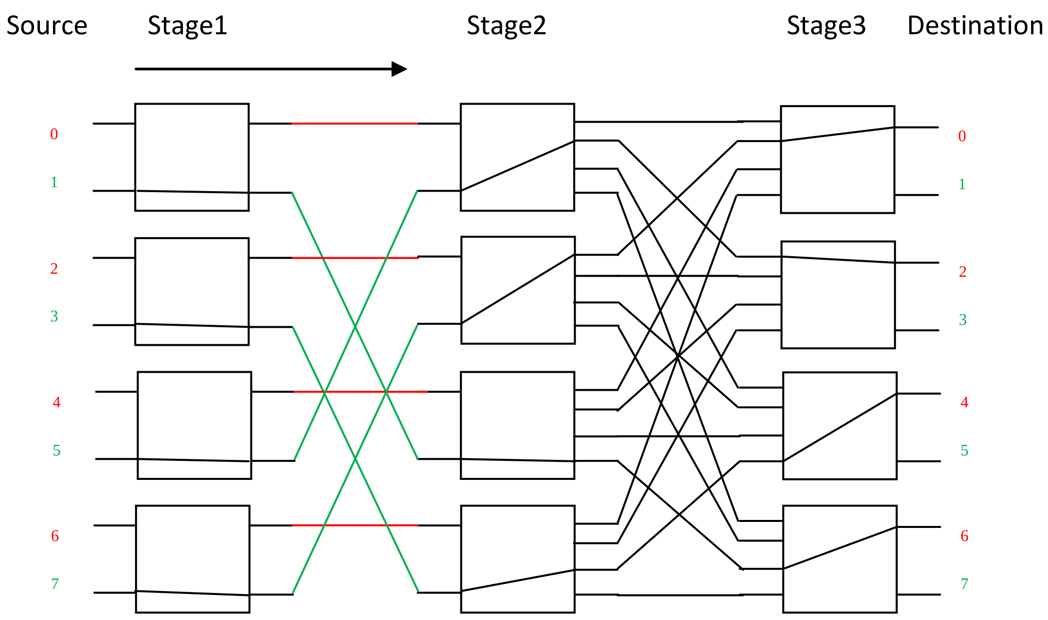

Fig 6: Crosstalk Free CFMON in First Pass

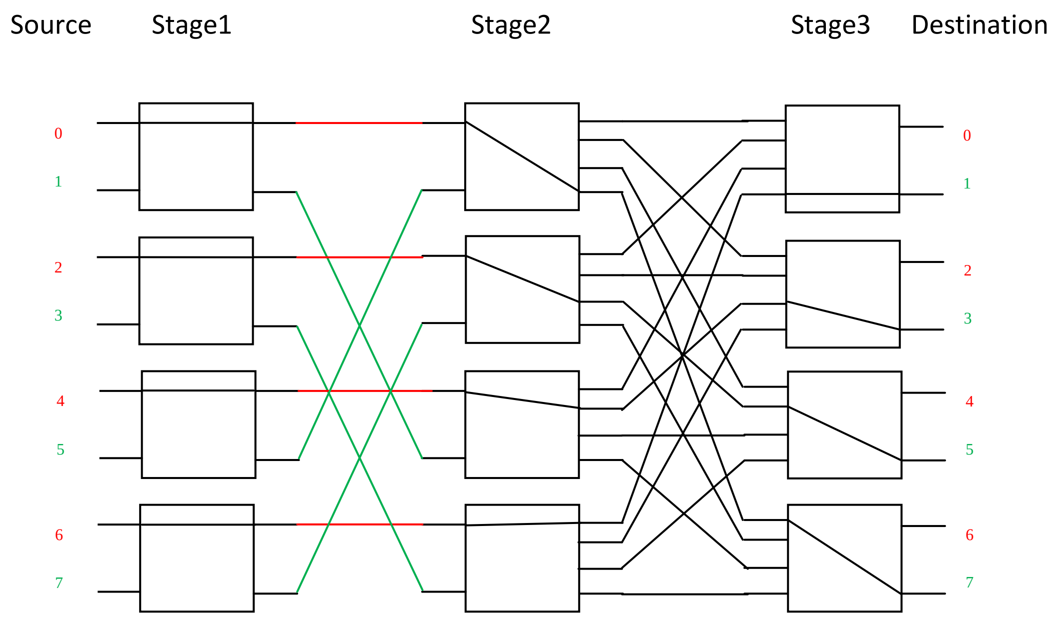

Fig 7: Crosstalk Free CFMON in Second Pass

4. CONCLUSION AND FUTURE WORK

Crosstalk is a challenging problem in optical interconnection networks. It degrades the performance of the network. The communication signals do not get their proper destination because of this problem. The proposed interconnection network and its routing algorithm is an attempt in order to reduce this challenging problem of optical interconnections. The main advantage of this approach it passes the communication signals in only two passes for all types of network without the crosstalk.

The example that we have taken in this research work clearly proves our statement. This interconnection pattern can be applied to other interconnection network to avoid the crosstalk problem. The study can be extended to irregular optical networks. The proposed OMIN is little costly, in future this network can be used as a base network in order to obtain a crosstalk free less costly network.

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