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REDUCING COMPLEXITY IN OPTICAL NETWORK

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ABSTRACT: The future of optical network technology will depends on efficient optical communication. Bandwidth improvement is based on latency and more power consumption by electronic circuitry. so there is dramatic growth in alternate technology like optics and optoelectronics in the digital world. The photonic switching is the first step towards low latency and low power consumption in the digital world. Here our approach is to optimize the number of switches in the optical interconnection network by using the wavelength division multiplexing (WDM).In this paper I have analyzed work of v Chaudhry who have proposed an optical interconnection network where the numbers of switches are significantly reduced as compared to the existing interconnection networks. This reduction in switches in turn helps in reducing the hardware complexity, power consumption and latency in the transmission system. Particularly in case where input communication lines are significantly large. This is verified analytically. Further, He has discussed the control mechanism of the purposed network in details. In this paper the work of Benjamin A. An analysis of the cost and complexity of multiple stage optical interconnection networks has been applied to Network.

KEYWORD: Optical Switching, Interconnection Network, Optical, Multiplexing, Close Network, Benes Network.

1. INTRODUCTION

Optical interconnection networks provides basic solutions to many of the problems associated with scaling the performance of the microprocessor from single-chip multiprocessors, and multiprocessor to board-scale processor–memory systems, to large -scale high- performance computing systems and data centers. Optical transmission systems offer bandwidth transparency that does not depend on signal frequencies. Optical components do not consume much power, in contrast with traditional electrical systems. Optical interconnection networks enable immense bandwidth scalability offered by wavelength-division multiplexing, where the multiple wavelength-parallel optical data streams may be transmitted in a single optical fiber. Also the networks simultaneously leverage time- division multiplexing, where optical data streams are combined serially on the same wavelength channel to form higher aggregate bandwidths. These techniques increase the bandwidth densities far beyond what is possible with conventional electrical transmission systems**.** Large scale high-performance computing systems, which have processor-processor and processor-memory communication, require high bandwidth and low latency. Optical interconnections are capable of transmitting Terabits of data per second and have recently been considered as possible solution to the electronic communication bottleneck in interconnection network[1- 3].

In this paper we have proposed an optical interconnection network in order to reduce the number of switches as used in the traditional non-blocking interconnection networks such as Clos [4], Benes [5] and Cross Bar [6].

The proposed network consists of two stages and four blocks. The First stage is meant for input and the second stage is for output. The Input and output stages are further divided into two blocks. These blocks have equal number of lines that is if total number of input lines in the network are N then total number of lines in a block will be n=N/2. The header information H1 controls the switches of stage 1 whereas the header information H2 controls the switches of stage 2. The control information in both the headers must be different for all the input which is explained in the Reservation Table 1&2. The input line consists of an optical demultiplexer to separate the header and data from incoming packets.

After getting separated, headers from all input lines reaches at optical multiplexer. And output of it reaches at optical demultiplexer to divide the header into H1 and H2. Now H1 reaches at splitter 1 and splitter 1 sends these signals to all the switches of stage 1. Similarly H2 reaches at splitter 2 and splitter 2 sends these signals to all the switches of stage 2.

Headers activate the corresponding switches therefore input data reaches at their desired output line. Input data remains in the loop until the switches are not getting connected.

DATA	HEADER1	HEADER2

Figure 1: Packet forma

As shown in figure 1. There are six (N=6) input line. And all the working of this network is as described in the above paragraph.

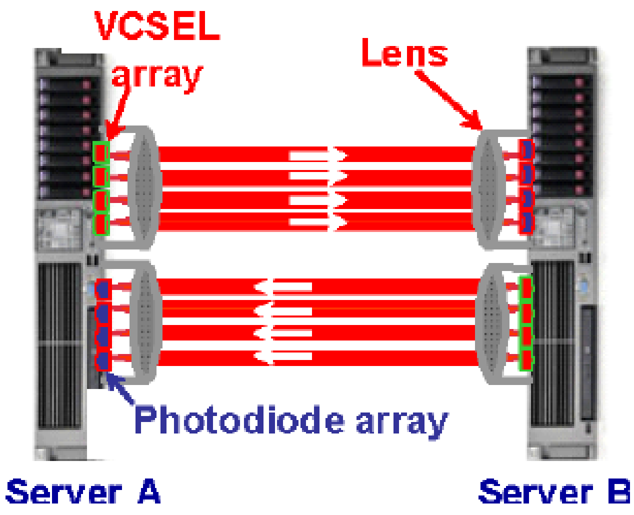


Figure 1: Optical Interconnection Network

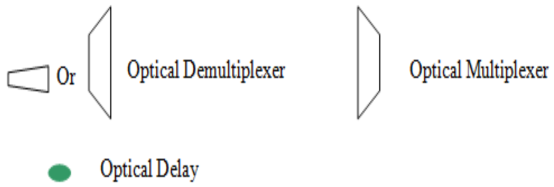


Figure 2: Optical Interconnection Network Components

Wavelength assignment to different switches:

Since each switch will be controlled by a particular wavelength so we have assigned different wavelength to each switch as shown in reservation tables. Two of the most common methods for wavelength assignment are First Fit and Random Fit. First Fit chooses the available wavelength with the lowest index. Random Fit determines which wavelengths are available and then chooses randomly amongst them.

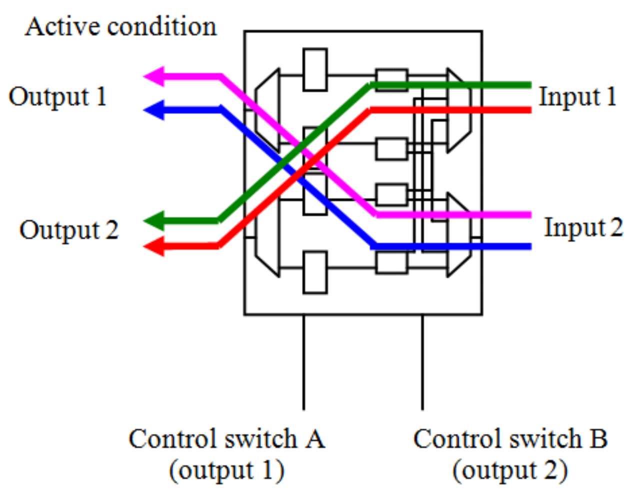


Figure 4: Optical Switch

Switches at stage one will be controlled by the wavelengths assigned in reservation table 1. All of these wavelengths will be a part of first header (H1).
Switches at stage two will be controlled by the wavelengths assigned in reservation table. All of these wavelengths will be a part of first header (H2).

2. ANALYSIS OF OPTICAL INTERCONNECTION NETWORK

In ideal case, this optical interconnection network has two stages and each stage consists of two blocks for N input/output lines. And each block will have N switches. It implies that total numbers of switches in the network are 4N.

If each stage consists of three blocks (m=3) then total number of switches in entire network will be 6N. Similarly if a network consists of four blocks (m=4) at each stage then total number of switches in the entire network will be 8 N.

If we have m blocks at each stage and n input lines in a block then number of input lines for particular block is given by

$n=N/m$ (1)

Each block has N switches. And each stage consists of m blocks so total number of blocks in entire network is 2m. Total number of switches =2mN (2)

From (1) and (2) we get the

Total number of switches $=2N^2/n$ (3)

From (3) we concluded that if the number of lines n in a block increases, then total number of switches in the network will decrease.

So in ideal case we take m=2 blocks and n=N/2 number of lines respectively.

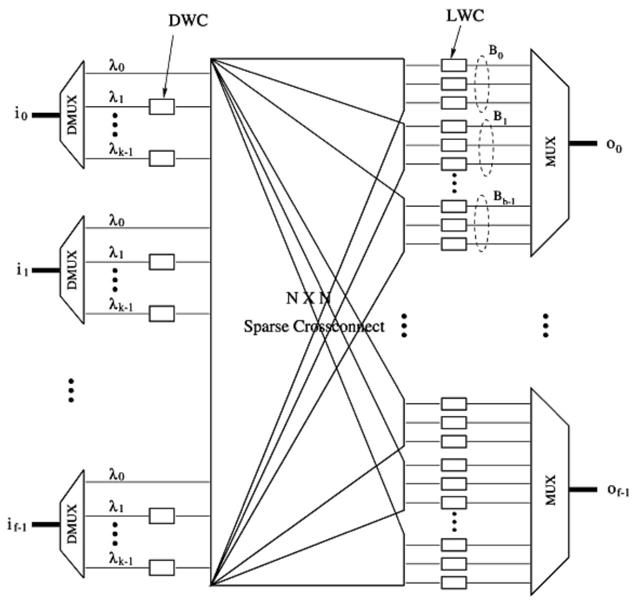
From above we get the total number of switches

$S = 2N^2/(N/2) = 4N$ (4)

If m=1 it means there is one block in input stage and one block in output stage. Input stage is now irrelevant. We only need switching at output stage and output stage is like a cross bar were we have the N^2 switches.

For best performance m should be equal to 2.

If m greater than two performances will decrease.



3. COMPARISON WITH OTHER NON-BLOCKING INTERCONNECTION NETWORKS

The graph given below it is clear that in the proposed optical interconnection networks by increasing the number of input lines the requirements for the numbers of switches will be minimum as compared to other interconnection networks.

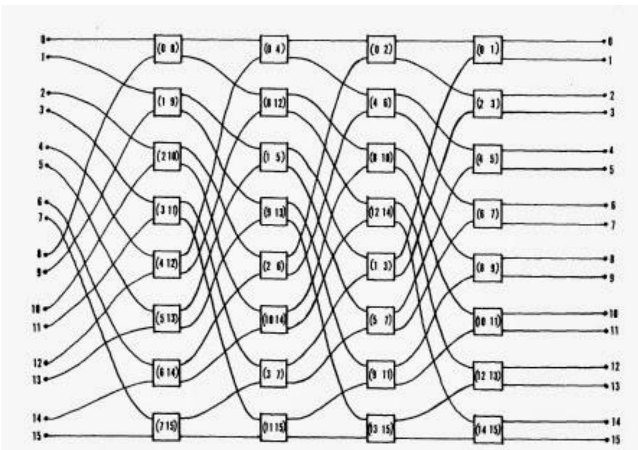


Figure 5: No. of Switches requirements for different interconnection networks

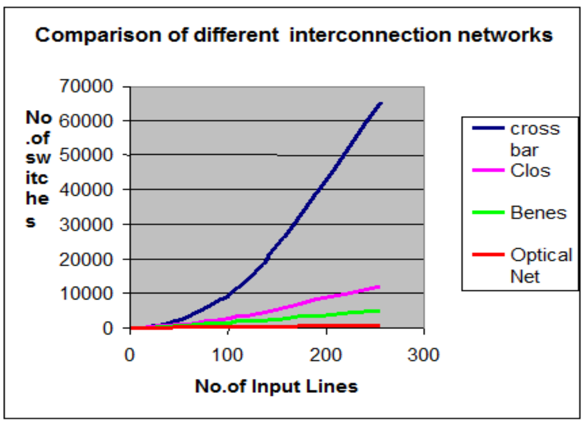


Figure 6: Comparison of different interconnection networks

4. COST ANALYSIS

Thus, the number of switching gates or elements scales as the square of the switching node degree:k^2, k for input and output ports. The cost and complexity of other components, such as the splitter and coupler, generally scale linearly with switching node degree. Therefore, a cost function can describe the relative complexity of switching nodes of differing degree-

$$c(k) = k^2 + \alpha k$$

The number of gates reduces are 4.7%

INPUTS	NODE ORDER	NO OF STAGES	NO OF GATED
2048	2X2	11	45056
2048	3X3	7	43029

TABLE : NO OF GATES REDUCTION

5. CONCLUSIONS AND FUTURE WORK

In this paper we have presented that by using optical communication and switching technologies sufficient number of switches could be reduced in the interconnection networks keeping in view of cost function .it is extremely beneficial when the number of input line increases but cost function decreases.. Although we have reduced the number of switches up to 4N but we hope in the future it could be reduced further and cost function wills also reduced .one of the limitation in our network is that the structure of the network could not be implemented in the electrical environment. But few other network structures can be used in both the environments. This will not affect much as the world is moving toward the optical technology.

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