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A Modified Buffered Adaptive Algorithm for Routing in Optical Benes Network

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***Abstract* – The Benes network is capable of setting its own switches dynamically which makes it a best example of a self routing network. The network is capable of realizing a rich class of permutations. In this paper there is an overview of the how routing is done in Benes network and a new algorithm is proposed for routing of the data packets in order to turn into a non-blocking network.**

***Keywords*— Blocking, Non-blocking networks, Rearrangeable networks, Benes networks.**

I. INTRODUCTION

With the demand of high computational power, parallel processing systems play an essential role in various areas. In parallel computers, the communication between processors and memory modules rely entirely on the interconnection network. Hence there occurs a need for optical interconnection networks to meet the increasing demands as they provide high bandwidth, cost-effective and reliable way of communication.

The rearrangeable network is a dynamic network, in which every input and output pair connection can be realized for a given permutation by setting a set of switching elements. Hence routing algorithms play a very important role in rearrangeable networks to ensure that the data packets reach the required destination. Benes network is a long established rearrangeable network to connect large switching elements. This network has the characteristic of providing multiple paths for same output request. For providing different paths several routing algorithms have been proposed [3],[4],[11],[14],[15], [17], [18].

The rest of the paper is organized as follows: In section 2, the routing in rearrangeable non-blocking conditions for the optical networks has been presented. The proposed algorithm has been presented in section 3 and the conclusions are given in section 4.

II. ROUTING IN REARRANGEABLY NON-BLOCKING NETWORKS

A. Rearrangeably non-blocking networks

The Benes network [19] is one of the choices for optical networks because of its simple topology and easy scalability with low degree. An N×N Benes network is a well-known rearrangeable multistage interconnection network (MIN), with (2n-1) stages ($n=\log_2 N$), that can connect its N inputs to its N outputs in all possible ways thus enabling non-blocking communication between any pair of idle terminals through reassigning the exiting links. The network B (n) consists of a stage of N/2 binary switches followed by two copies of the network B(n-1), followed by another stage of N/2 binary switches. An example of the Benes network is given in the fig.1.

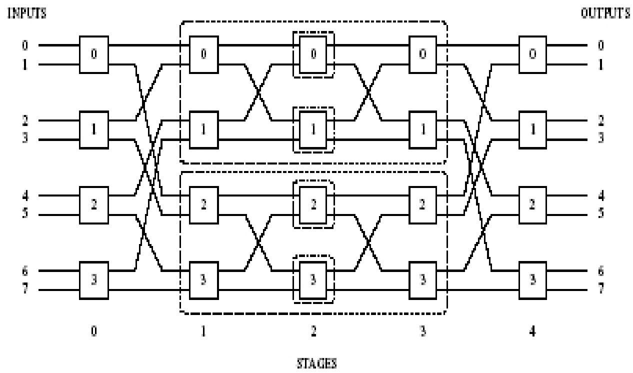

Fig 1 A Benes Network

In (2n-1) stage re-arrangeable networks, the routing time for any arbitrary permutation is Ω (n^2) compared to its propagation delay O (n) only. So the attempt is to identify the sets of permutations, which are routable in O (n) time in these networks. Therefore, in all these cases, the time needed to realize an arbitrary permutation in rearrange able networks is dominated by the set-up time as the path needs to be rearranged dynamically according to the network traffic. However, in a Benes network, many useful permutations, often required in parallel processing environments are found to be self-routable [7]. The self-routable (SR) permutations are classified into four categories namely:

(i) Top-Control Routable set of permutations (TCR)
(ii) Bottom-Control Routable set of permutations (BCR)
(iii) Least-Control Routable set of permutations (LCR)
(iv) Highest-Control Routable set of permutations (HCR)

Different types of algorithms [3], [4], [11], [14], [15], [17], [18] have been proposed that would enable routing in the rearrangeable networks in order to ensure that the network is a non-blocking one.

III. MODIFIED BUFFERED ADAPTIVE ALGORITHM FOR ROUTING IN A BENES NETWORK

The proposed algorithm uses the concept of buffers in order to remove the limitation of the existing routing algorithms that only enabled the routing of only one data packet at a time. This means that whenever two inputs try to route through the same path and there occurs a routing conflict, then this can be avoided by allowing only one input at a time to use the path and storing the other input information in the buffer maintained at the switching node of a particular stage at which the conflict arises. With this approach, multiple inputs can be routed at the same time and thus can be helpful in improving the performance of the network.

Modified Buffered Adaptive Routing Algorithm for N×N Benes network:

Index Terms:

a) Current node: the current node is given by : C(position, stage)

b) Destination node: the destination node is represented by : D(position, 0)

c) $N = 2k$.

d) p ($1 \leq p \leq k$) is an integer.

e) Buffer(x, y): the buffer at x position and y stage

A. *Routing Procedure:*

If

local node address(y >= 0 && < k - 1)

Then

select any one of the two output ports of the current switching node.

Else

If

(Local node address y == (2k - p))

{

(Destination node address x / 2^{p-1} % 2 == 0)

Then

Select the upper output port of the current switching node

{

If

The upper output port is already occupied

Then

Move data packet to buffer (current x, current y)

}

else if

The destination node address x/ 2^{p-1}%2==1)

then

Select the lower output port of the current switching node.

If

{

The lower output port is already occupied

Then

Move data packet to buffer (current x, current y)

}

For all buffers! = NULL at stage y-1, move data packets for each according to step 6. To enable the routing of multiple data packets using the proposed algorithm, there was a need to make some enhancements to the network hardware. This includes an addition of buffers to stage 2 and stage 3 switching nodes as shown in Fig. 2 below.

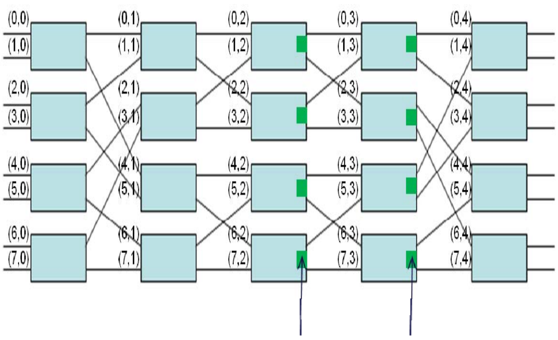

Fig. 2 New Modified Buffered Approach for Routing

Routing done using the modified algorithm is illustrated below using an example:

Data at (2,0) to be sent to (6,4)

Data at (6,0) to be sent to (5,4)

Data at (7,0) to be sent to (1,4)

1. Initially the data are at (2,0), (6,0), (7,0) as shown in the Fig. 3.

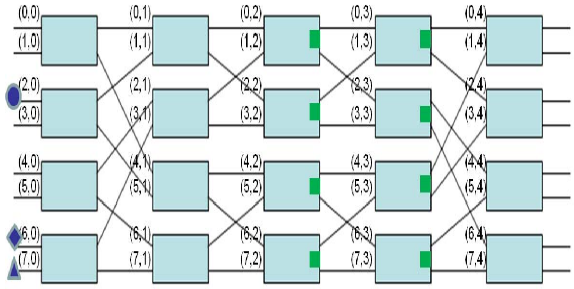

Fig. 3 Data at (2,0), (6,0), (7,0)

2. According to the algorithm, the data packets adopt the upper port of the nodes and consequently move to the next stage as shown in the Fig. 4.

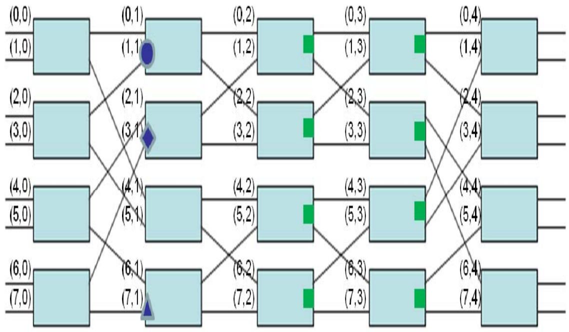

Fig. 4 Data at (1,1), (3,1), (7,1)

3. Following the same step again, the data packets are routed onto the next stage as shown in the Fig. 5.

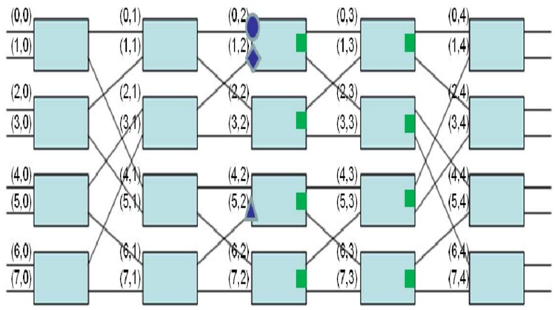

Fig. 5 Data at (0,2), (1,2), (5,2)

4. The else part of the algorithm now comes into practice and the packets are routed onto the next stage. According to the algorithm, the first data packet utilizes the lower output port and reaches the next stage at (2,3). The second data packet also wants to use the same path that is already occupied by the first data packet so instead of blocking the network, the routing information of the second data packet waits in the buffer maintained at the second stage till the path becomes free and then moves onto the next stage as shown in the Fig. 6 given below.

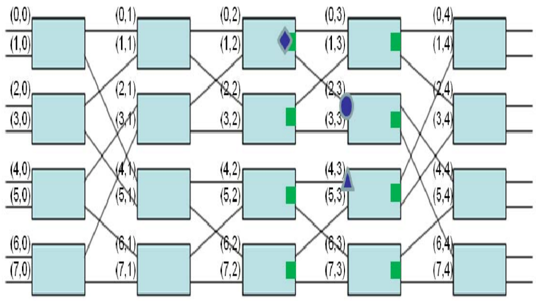

Fig. 6 Data at (2,3), buffer(1,2), (4,3)

5. In the next step, the first data packet will move to the next stage and will free the path that it was earlier utilizing. The second data packet now will move to (2,3) position and free the buffer. The third data packet moves to the next stage accordingly as shown in the Fig. 7.

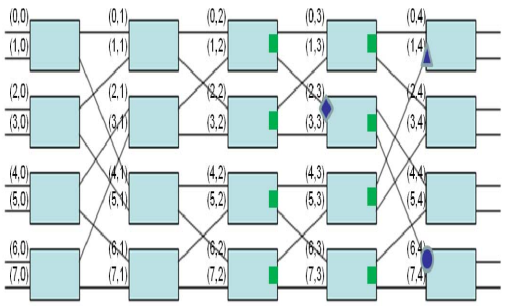

Fig. 7 Data at (6,4), (2,3), (1,4)

6. In the next step, both the first and the third data packet will reach to their required destination while the second data packet gets delayed by one cycle as illustrated in the Fig. 8 given below.

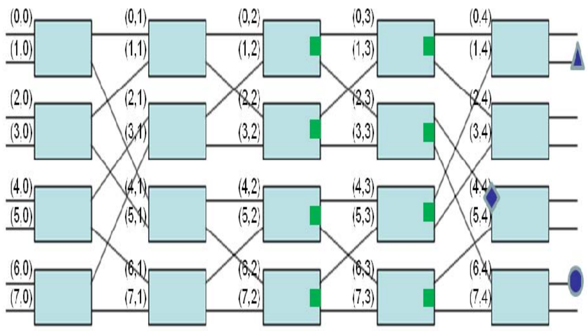

Fig. 8 Data at 6, (4,4), 1

7. Finally in the last step, the second data packet also reaches its required destination as shown in the Fig. 9.

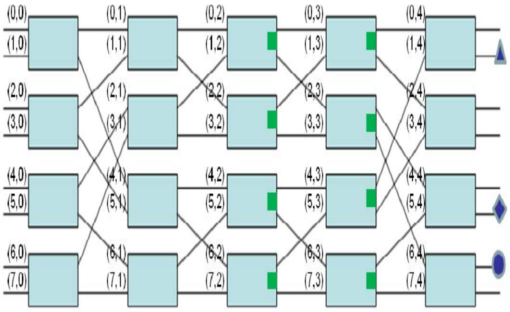

Fig.9 Data at 6, 5, 1

IV. CONCLUSION

The new modified buffered algorithm that has been proposed solves the problem of the routing conflict that was earlier occurring with the previous routing algorithms. The proposed algorithm is also capable of handling multiple inputs simultaneously while the earlier routing algorithms only handled one input at a time which affected the performance of the network to a great extent.

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