Development of Irregular Routing Algorithms for Parallel Computing Environment

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ABSTRACT

In this paper, a review of various regular and irregular parallel computing networks routing algorithm is done. Since irregular networks are usually less costly and multipath in nature as compared to regular Parallel computing networks, hence analysis of irregular and regular Parallel computing networks is important. It can be deduced from the analysis that irregular Parallel computing networks performs better than regular ones.

In this paper, a new class of irregular fault-tolerant multistage interconnection network named fault tolerant interconnection (FTI) network is also proposed and analyzed. The FTI network can achieve significant tolerance to faults and good performance with relatively low costs and a simple control scheme. The construction procedure of the FTI network, algorithms for allocation of path length, routing along with the routing procedure, fault-tolerance aspect is described too.

Keywords:- Permutation passability, Multistage Interconnection Network

I. INTRODUCTION

In the present era of technology and development, it is very much possible to design and develops multi-processing system with many of multi-processors[10]. Multistage Interconnection network (MIN) play an important role in these systems, which enables processors to communicate with themselves and with memory modules. Multistage Interconnection network consists of more than one stage of switching elements, links that interconnect them[12].

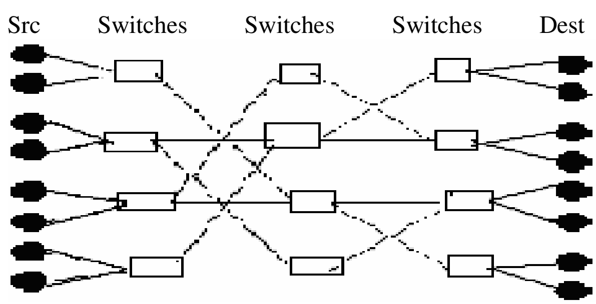

Figure 1: A 3 Stage Interconnection Network

An MIN with 3 stages is illustrated in fig 1. In this paper, a new MIN is designed which is irregular and more cost-effective and simple in a way. Regular network has equal number of switching elements per stage so they impose equal time delay to all requests passing through them. Irregular network has unequal number of switching elements per stage, so for a given source to destination pair, there are different path lengths available in this network[9].

Different networks are available offering varying degrees of reliability, efficiency, and cost and fault tolerance. The flip network, omega network, indirect binary n-cube network, and regular SW banyan network (S = F = 2) are topologically equivalent. CROSSBAR, OMEGA[2][4][13][14] are the examples of regular MIN. MDOT, RMDOT, FT, FTD, ESC[5] are the examples of irregular MIN. These all kind of networks is studied, analyzed in details. They all have some kind of limitation. The reliability, performance and limits of these MINs is stated by [6][8][13].So attempt to find out a new network which proves to be more fault tolerant and cost effective too. FTI algorithm is developed which is very fault tolerant and cost effective too for parallel computing system.

2. FTI: ROUTING ALGORITHM FOR IRREGULAR PARALLEL COMPUTING SYSTEM

In MIN, more than one path from a source to destination is available. Here, request is routed through an alternative path if the most favorable path is not available due to any reason like faulty switches in path or busy path[7][11]. An important performance parameter in the MIN is permutation passability[1]. Desirable characteristics of a network are that maximum requests should get matured with the shortest favorable path so less time is taken to reach to its destination. So we developed an algorithm, which will fulfill these desired requirements of the network. At a particular moment of time if more than one request occurs at source or demands to reach at the same destination than less fault occurs and all the requests will be matured. This paper is aimed at addressing this kind of problem, which arises when multiple requests are made for the same destination in a network or more than request is made from the same source for different destinations. This paper is an attempt to solve the permutation passability problem in MIN imposed. In order to solve it, we design an algorithm, which will help in maturing maximum number of requests by giving an alternate path if one is busy or faulty. In the next section, we detailed the assumption we made for the algorithm and then the algorithm is explained.

Our algorithm is mainly based on two main parameters i.e. number of requests matured i.e. reaching the destination and average path length is calculated on the basis of how many switches it has to pass through to complete the request. A simulation of permutation passability is applied on the other available networks also to calculate the requests matured and average path length is calculated for them, which clears to us that our algorithm is very fault tolerant and cost effective as compare to others.

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2.1 Algorithm For FTI Network:

In a FTI network, each source and destination is connected with multiplexers, demultiplexers. A FTI network of size $2^n * 2^n$ consists of 2^n multiplexers and 2^n demultiplexers. Each MUX and DEMUX is of size 2*1 and 1*2 respectively. In FTI network, we are using switches of size 3*3 also so that if primary switch is faulty then the request can be routed to the conjugate switch connected to this due to which less fault are occurred and request still can be matured.

2.1.1 Assumptions

- Multiplexers are simple with no routing capability.
- Switches have routing capability based on destination tags.
- More than one source destination pair cannot have the same values.
- No looping takes place between conjugate pair of switches.
- Path matrix is used for storing the paths of respective pairs.
- FCFS algorithm is used for serving the requests.

2.1.2 Routing algorithm

In the MIN, there are multiple paths available for a given source to destination, minimum path length is checked if available then routed through it else other route is taken.

Let S be the source and D be the destination of the network and

S=SnSn-1_ _ _ _ _ _S2S1S0

D=DnDn-1_ _ _ _ _ D2D1D0

Then to check if the minimum path is available for each S to D, XORing of each source to destination is performed

(S0DO) XOR (S1D1) XOR (SnDn) = 0

if it equals to zero then there is a minimum path available else the request has to pass through alternate path which will be comparative longer. If there is a minimum path exists between each S to D then Set min_path_flag_array to 0 which signifies that there a minimum path exists between S to D and other possible path is also available. In other case, if this flag values not equal to zero then it means that no any path length with minimum route is available but the path with maximum length is available (length can maximum be 10). Now, for routing to take place if switches in the route are not faulty then routing is done through it. But in other case if switches in the routing path are faulty then request is routed to the conjugate switch connected to it.

3 PERFORMANCE EVALUATION OF FTI ALGORITHM

The simulation of permutation passability behavior of a network will generate the number of requests appearing on source side at a particular instant of time and out of these total requests, how many of them are getting matured and the length of the path taken by the requests is calculated. These are the basic parameters for the simulation.

Simulation environment:

- For the simulation, we are assuming that there are 16 nodes on each side i.e. there is 16 sources and 16 destinations for each network.
- The values are inputted using the algorithm of each network.
- This simulation analysis of permutation passability behavior is checked for 50 times. For the simulation, different values are inputted for 50 times for each network and thus the result is calculated.

Results of Simulation:

Figure 2 shows the average path length of various networks. Path length is calculated on the basis of total switches a request has to go through in the path to reach to its destination.

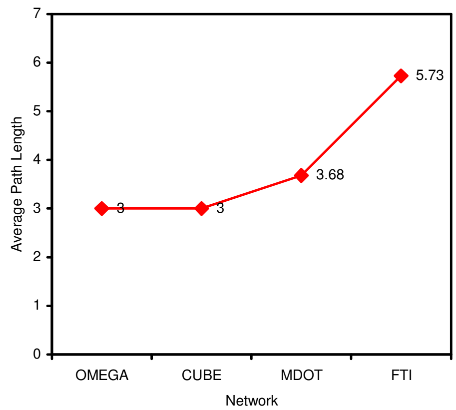

Figure 2: Comparison of Average Path Length of various Networks

The results of simulation show that Average path length of regular networks like OMEGA, CUBE is fixed at 3 because here number of switches in each stage is equal while it varies for the irregular networks. In irregular network like MDOT, FTI network, because here numbers of switches vary for each stage so path length also varies. In our FTI network, path length is more, as a request has to pass through the conjugate switch if the switches in the shortest path are faulty or busy. It results a long path and maturing maximum requests.

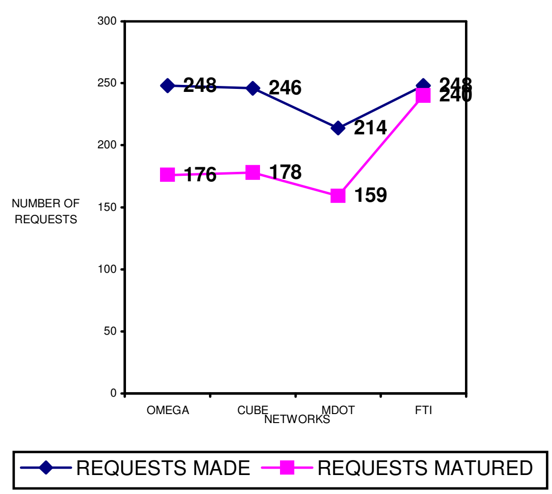

Figure 3: Comparison of Requests made and Requests matured for various Networks

Figure 3 tell about the requests sent and requests matured. The results of simulation shows that in our FTI algorithm total requests matured are almost equal to the requests sent to it. In omega network, total requests made are 240 amongst them 176 requests are matured. And in cube network out of total 246 requests 178 are matured at the time. It is also seen that if destination of more then one requests appears at the same block then only one request gets matured. But in our proposed network, this problem is eliminated. In this way, performance is improved.

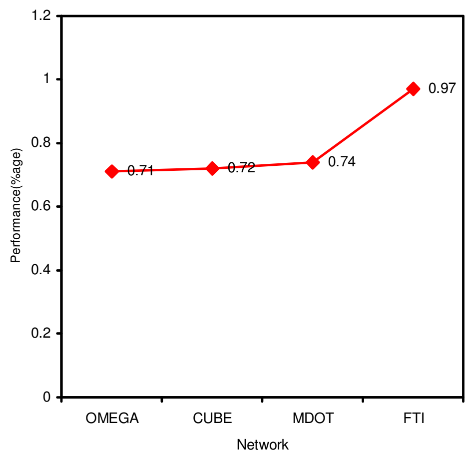

Figure 4: Comparison of performance of various networks

Figure 4 helps in showing the performance improved using our algorithm. Omega network is providing 0.71% performance while cube's performance is 0.72% and irregular network MDOT's performance is somewhat better than these regular ones. MDOT provides 0.74% performance. In our FTI network, performance is improved. FTI provides the 0.97 % performance. It improves the performance from regular ones by approximately 25 % and from other irregular MDOT network by 23 %.

4. CONCLUSION

In this paper, we have analyzed the permutation passability behavior of FTI network, which is an irregular network. An irregular MIN is more cost effective and efficient than a regular MIN also they are as reliable and fault tolerant as other similar regular ones. Also we know that the minimum path length in MDOT Network is 2 whereas regular MINs like Omega have minimum path length 3. It can be depicted that irregular MINs have better performance in terms of average path length. Thus, it makes them a strong candidate of permutation passibility analysis.

FTI network has the highest permutation passability. We have calculated the number of requests successfully maturing and it has been found that if more number of requests are having the same destination or more number of requests are having the destination values that are lying in the same block then it resulted in more the number of clashes but FTI achieves more fault tolerance as sources and destinations are connected to MUX, DEMUX directly so fault is tolerated at both the ends even when the request has to be routed on the alternate path.

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