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PERFORMANCE ENHANCEMENT IN IRREGULAR NETWORK USING MULTIPLE ROOT

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PERFORMANCE ENHANCEMENT IN IRREGULAR NETWORK USING MULTIPLE ROOT

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Abstract - Irregular network is one of cheaper option for high-parallel performance computing from chip level to large workstation. Irregular networks provide wire flexibility as well as scalable system. But Irregular network always have problem of deadlock in routing and channel utilization. Different solution has been already proposed such as Prefix Routing [1], Up/Down Routing [1], L-turn routing [2], cut Through Switching [9],Wormhole switching [3]. But all these algorithms have different performance in different networks means their performance is depended on network topology and root that is selected during routing in directional routing and prefix routing. In this paper we have proposed a methodology by which we can select a better root for spanning tree, some solution to improve over all utilization of channel for Up/down algorithms and prefix Routing [1].

Keywords*-component; Prefix Routing[1],Up/Down[1],Centre of graph,Autonet[4],Spanning tree,Multiple root,Cut through Switching[9],Worm Switching[3]*

I. INTRODUCTION

Switch Based network is become in recent time in high-parallel performance computing since high performance computing require low latency time to deliver packets. Switches and workstation connect many LANs and make different topology and most of them are irregular.

Irregular network is a network in which you can not define any mathematical relation between it's nodes and their channel. Irregular network become popular in NoC as well. Irregular Network provides wire Flexibility and scalability in network. In Irregular network switch is connecting component between nodes and it have very small size of buffer hence it cannot use store and forward switching method for routing. When a large message are send by any node then it is divided into small flits to send to next node and that fill buffer of switch of that port ,and hence that channel is reserve for that message and this is reason of deadlock.

In figure 1(a) channel is acquire by different channel and make situation of deadlock, figure (b) representing channel as a node and message as branch of graph,. In figure 2 dark line represent acquire channel and dash line represent channel for which message is waiting

Directional Routing [8] is one of popular solution of deadlock prevention. Prefix Routing [1], Up/Down Routing[1], Left/Right Routing-turn Routing [2] all are type of directional routing algorithm and all sharing common methodology. These entire algorithms are work on loop free assignment of channel. Since all share common methodology hence they share common drawback such fault tolerance and conjunction at root node.

II. CLASSICAL ROUTING

A. Prefix Routing [1]

Prefix routing is one of most simple algorithm of deadlock prevention in irregular network .It is distrusted algorithm but it not provide very little adaptability in network. This algorithms use spanning tree of graph as backbone of algorithms and branches of graph are used as shortcut for delivering packet. Below we have shown to level the node and rules for forwarding packet to next node.

In prefix Routing leveling of node is done in different way, first we select a root node and make spanning tree by Traversing graph in BFS order. Root will be level as "1".For the other node if parent have "N" as Id then it's child node will be level as N||K if node is k_{th} child of parent node, here || is concatenate operation . Suppose S is source node of graph, D is the destination node and L is neighbor node of S that is working as intermediate node for D. Next node is chosen by fallowing rules:

- If level of node L is prefix of D, then L will be next node for packet forwarding.
- If Level of any neighbor node of current node is not prefix of D then packet is forwarded to parent node

B. Up/Down Routing [1]

Up/Down Routing is deadlock prevention algorithm used in Autonet [4] Network. It use spanning tree of graph to deliver packet in which you give some direction to each channel and by leveling nodes of graph and apply some restriction in flow of packet. This is Distributive deadlock free algorithm that provides partial adaptability. Rules of assigning direction to channel are given below. Advantage of

this method is that each node's hardware and software implementation is easy and it gives some sort of adaptability.

Direction of channel is decided by these rules:

- Up direction of channel assign to node that more closer to root node.
- If there is tie between two nodes, then the node that have lower id will get Up direction.

In Up/Down Routing packet a restriction is implemented in forwarding packet to next node that is packet are no allowed to take Up channel once it down channel. Up/Down channel remove some restricted turn from graph hence utilization of channel is improved in comparison to prefix routing.

It has some disadvantage such as it provide minimal path to destination. Direction of channel decided by root node, large number of packet passing through root node, hence root node will have congestion problem in heavy traffic. This algorithm is not robust because root is single element of graph on which packet flowing depend. If root node get down most part of the system is get down.

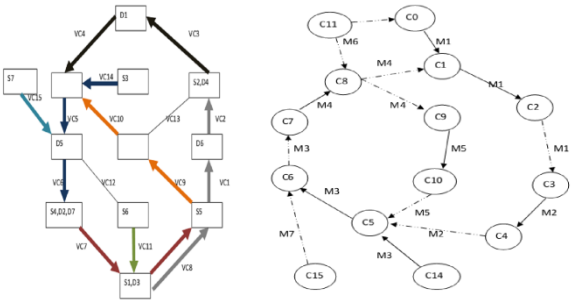

Figure1. (a)"Multiple Deadlock" that is occur due to message M1, M2...M7,(b)Deadlock of network is shown by consumer wait graph

All directional routing algorithms performance depends upon root of node and topology of network. Since direction of channel decided by distance from roots and mostly packet are passing through root of graph. In high traffic network root node get congested in Up/Down Routing and Prefix Routing and most of time messages are waiting for channel to free and hence performance of the algorithms drop in these networks. Since these algorithms are guided by root of graph that we choose in early stage, hence if root node get down due to heavy congestion or any other reason, about most part of system will not work.

Selection of root of graph is first step of making spanning tree. Since in Prefix Routing, Up/Down Routing most of the packet are travel through root hence selection of root is one of the deciding factor of channel utilization. So in next section we will show new proposal of selection of root.

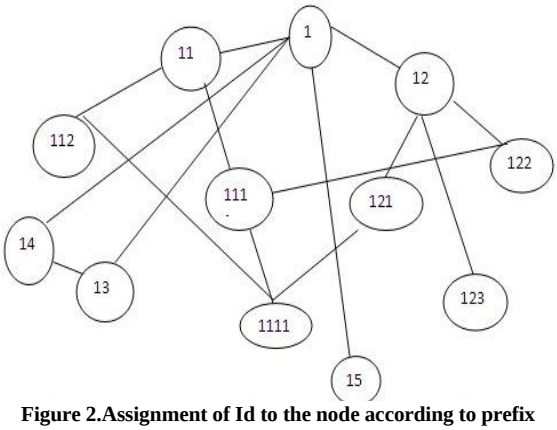

Figure 2.Assignment of Id to the node according to prefix routing

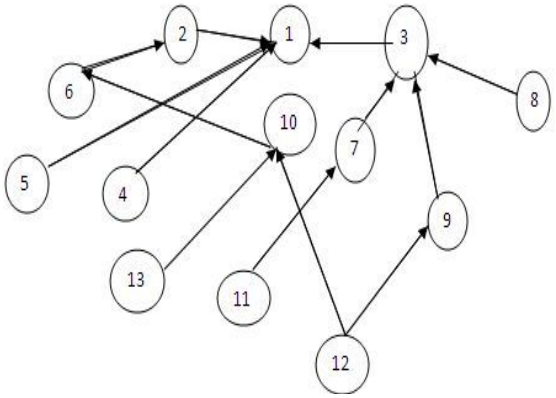

Figure 3.Assigment of Id the node according to Up/Down routing

III. SELECTION OF ROOTS :NEW PROPOSAL

Selection of root in spanning tree actually decides the performance. Since direction of channels are decided by distance from root. Root of graph should be at minimum distance from all nodes that will decrease average distance from the graph. Centre of graph have minimum average distance from root of graph. Centre of graph is a node of graph from where maximum distance from all other node is minimum. Graph can have more than one centre in graph.

$$R = \text{Min}\{\text{Max}\{dis_{uv}(U, V)\}\} \quad \text{----- (1)}$$

R is radius of graph and U,V is vertices of graph.dis is a distance function that calculate distance function between node U,V. Min,Max is Minimum and Maximum function to get respective. Select node that has R as maximum distance from all nodes and that node will be centre of graph. it may be possible that more than one node can satisfy this condition then one of them as centre of graph.

In figure number 4 you can see that node number 1, 6, 7 are satisfying the condition being root. All three are centre of graph. Centre of graph should be selected as root node since it has minimum distance from other nodes

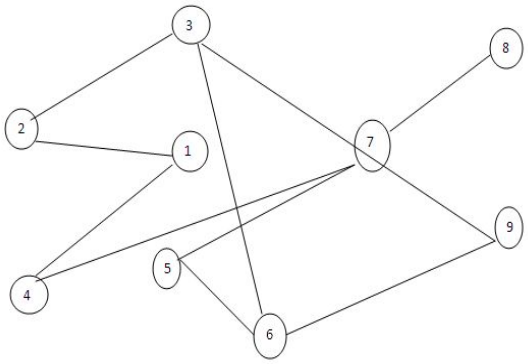

Figure 4.1,5,7 is centre of graph

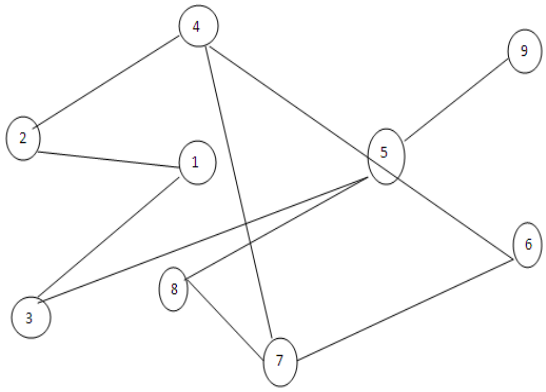

Figure 5.Id of node after leveling using BFS traversal

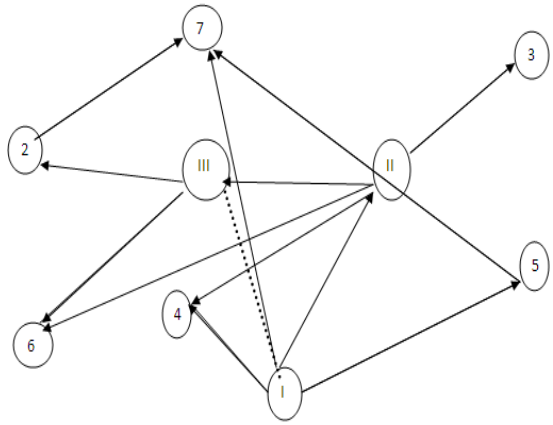

Figure 6.Network after connecting all roots of graph

from graph. Suppose we select node 1 as root node and level according to Directional Routing as explain in section II. Then level of node will be like given below figure.

If node 9, 8, 3 want send packet to node 2, packet will travel through node 1.It is small network to show congestion of root node, in large network congestion of network will increase exponentially.

In Prefix and Up/Down Routing performance of network is not good because of congestion at root node that can reduce by selection multiple roots. Multiple root of graph will distribute load in between them. Below we will explain selection multiple nodes as root.

Select multiple nodes as root node in graph according to equation 1, those have minimum value of R will be better option for that. In figure number 4 we have selected node number 1, 6, 7 as root node. If these node are connected completely then network will like as shown above. Here some rules are given to traverse the graph to make spanning tree and level each node.

- Start with root nodes and traverse each node in BFS fashion.
- All these nodes are considered as single entity and each adjacent node of root nodes are considered equal. Level these nodes as explain in section II for directional routing.

After traversing whole graph by above rule, Graph look like as shown in figure 6. Packet forwarding to next node will take place in same way as explain in section II for the rest of graph but for root node that are working as single entity we cannot apply algorithm of packet forwarding of section All these node have same id so we cannot decide direction of channel. Hence to solve this problem we give Id to these root nodes in increasing order and direction of channel is decided on these ids in between root node. After assigning unique id to these roots in increase order, direction of channel can be easily decide. Now if node 5 wants to send packet to node 2, then route of packet will be

R1=5→7→2

R2=5→I→III→2

IV. PERFORMANCE EVALUATION

In this section, evaluate performance of Up/Down Routing, Prefix Routing algorithms in computer Network Simulation using above proposed method and compare with old performance.

C. Network model

A flit-level simulator Omnetpp 4.2 is written in Otcl and C++.Topology, number of node, size of packet, channel capacity is changed by changing parameter of network. Each node represent switch of network and it contain two modules, one is for switching and other for flow control.

Topology contains total 18 networks as target network. In which number of node in network vary from 16 to 42. These networks have more than N+1 channel in network and each one connected where N is number of node in graph.We have conneted to node of network to make condition to have deadlock.

D. Simulation parameters

Destination address generate dynamically and uniformly at each node. We ignore first 10000 clock of simulation because at starting phase of simulation network is not stable. Up/Down algorithms are adaptive algorithm but prefix algorithm is not adaptive algorithm hence it will choose a fix path for destination but Up/down will may choose dynamically. Hence Up /Down[1] algorithm have better performane.

V. CONCLUSION

Performance of directional routing algorithm is depending upon topology but our proposal method decrease average distance of network. Hence performance of any algorithm will improve if they you this idea. Many ideas is already proposed to improve performance of directional routing algorithms such as In-transit Buffer [6], Smart routing [7], DFS methodology [5] but this method need large buffer that is limited in switch. But still Fault tolerance is not improved not improved in muti-root solution. Adding extra channel to graph will increase cost of network but it improve performance of network.

Table 1.Simulation parameter of network

Simulation parameters	values
Simulation Time	3000000 clock
The number of External channel	Depend upon root's connectivity
Packet length	fgdsfdsgfg128 to 256
Switching tech	wormhole
Traffic pattern	uniform

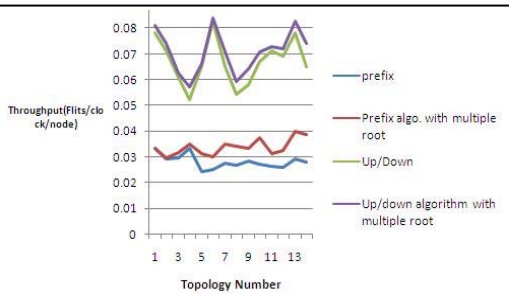

Figure 7.Throughput of different irregular network

Table 2.Average distance of network

	Average distance
Prefix Routing	5.65
Prefix Routing (proposed)	5.61
Up/Down	4.71
Up/Down (proposed)	4.13

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