XFA Routing Algorithm for Network on Chip

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ABSTRACT:

The routing algorithm is one of key researches of interconnection networks. Routing algorithm plays as important role in performance of network on chip. A routing algorithm defines a route which packets traverses to get to destination. In this paper present proposed routing algorithm. This algorithm provides the better performance of network on chip. This algorithm avoids the congestion and deadlocks problem.

Keywords **-** EDA, Routing, Distribution, Network on Chip.

I. INTRODUCTION

System on chip (SoC) grows in complexity with the advance of semiconductor technology enabling integration of dozen of cores on a chip. However as the number of component in a single chip increases at a speed, low energy and performance communication between them become the bottleneck. Due to the availability of various Electron Design Automation (EDA) tools for designing and producing electronics systems. It is possible to design complex digital system. The concept of SoC emerges, as time requires. SoC is a highly complicated Very Large Scale Integrated (VLSI) circuit [1]. Network on Chip (NoC) is a new paradigm for System on Chip design. Increasing integration produces a situation where bus structure, which is commonly used in SoC, becomes blocked and increased capacitance poses physical problems. In NoC architecture traditional bus structure is replaced with a network. Data communications between segments of chip are packetized and transferred through the network. The network consists of wires and routers. Processors, memories and other IP (Intellectual Property) blocks are connected to routers. A routing algorithm plays a significant role on network on Chip. Routers make the routing decisions based on the routing algorithm.

Different devices with different purposes have different requirements for routing algorithms. Thus there have been designed several routing algorithms with various features and purposes. Routing, as an act of moving from a source to a destination through intermediate nodes, is a fundamental task for networks. Routing algorithm mainly classified source and distributed routing. Source routing chooses the path centralized path. The source routing is determined by the source router prior to sending a packet. It is very simple routing but it does not allow the network to use alternate routes in case of congestion. Distributed algorithms the path is chosen in a distributed manner at the intermediate routers. Routing decisions are made in each router by looking up the destination addresses in a routing table or by executing a hardware function. XY routing algorithm defines the single path. In case of non uniform traffic the performance of routing in terms of latency and throughput is very poor. When using the multi path routing, then performance of routing in terms of delay and throughput is very good and deadlock free [2].

In paper present adaptive multi path routing algorithm called XFA (XY Fully Adaptive) algorithm. In XFA algorithm, the based on the fully adaptive routing algorithm. XFA technique operates based on the usage of the shortest route between sources to destination, and has the ability to send the traffic through minimal path towards the destination.

II. RELATED WORKS

In NoCs, routing algorithms are used to determine the path of a packet from the source to the destination. These algorithms are classified as deterministic and adaptive routing. Although the implementation of deterministic routings is simple but they are not able to balance load in non-uniform and busty traffic. However, adaptive routing requires network path diversity between the source and the destination nodes to facilitate load balance. Adaptive routing can effectively avoid hotspots or faulty components and can reduce the possibility of packets being continuously blocked. An Adaptive routing algorithm gives better communication performance like packet latency and throughput than a deterministic routing algorithm, especially at higher network loads and it makes a packet avoid passing from a congested links.

Adaptive routing contains routing and selection functions. The routing functions supply a set of output channels based on the positions of current and destination nodes and the selection function chooses an output channel from the set of channels given by the routing function [3]. The selection function can be classified as either congestion-oblivious or congestion-aware schemes [4]. The introduced a static routing algorithm for two-dimensional meshes which is called XY [3]. In this routing algorithm, each packet first travels along the X and the Y direction to reach the destination.

An adaptive routing algorithm named turn model is introduced by Class and Ni [5] and based on which another adaptive routing algorithm called 0dd-even is proposed by Chiu [6]. To avoid deadlock, Odd-Even method restricts the position that turns are allowed in the mesh topology. Another algorithm called DyAD is introduced by Hu and Marculescu [7] which is a combination of a static routing algorithm called OE-fix and an adaptive routing algorithm based on the odd-even turn algorithm. Depending on the congestion condition of the network corresponding to the input buffers occupation, one of the routing algorithms is selected. Congestion flags information is exchanged between neighbor routers. If the router neighbors are not congested, the DyAD router work on deterministic mode, otherwise the adaptive mode is used.

An adaptive deadlock free routing algorithm called Dynamic XY (DyXY) has been proposed by Li et al [8]. This algorithm is based on the static XY algorithm, a packet is sent either to the X or Y direction depending on the congestion condition. An application specific routing algorithm named ASPRA has been proposed by Palesi et al. [9]. ASPRA exploits communication information to maximize the adaptively while ensuring deadlock free routing for an application. Ebrahimi et al. [10] proposed an agent-based Network-on-Chip to determine the congested areas in the network and route packets through the less congested areas based on the local/non-local congestion information. Salehi et al. [11] proposed a novel fully adaptive routing algorithm for avoiding congested areas using a fuzzy-based routing decision. Each of the metrics has strengths and weakness for congestion avoidance.

III. PROPOSE ROUTING

Proposed routing technique called XFA is a multipath distributed algorithm with high adaptability. In XFA method, the based on the fully adaptive routing algorithm. The fully adaptive algorithms are based on analyzing the direction in which packets can turn in network. The algorithm avoided the deadlock problems without virtual channels. The fully adaptive routing restricts the location at which some turn can be taken so that deadlock is avoided.

An important issue to be considered in choosing the routes in multipath algorithms is that selecting different routes must prevent deadlocks from happening while the lowest possibility of conflicting packets of different paths is provided. XFA technique operates based on the usage of the shortest route between sources to destination, and has the ability to send the traffic through minimal path towards the destination.

1. THE CURRENT IS THE SOURCE NODE

Because the base of XFA algorithm is on choosing the minimal route, consequently maximum of two outgoing routes will be specified. After running the fully adaptive routing algorithm there will be two different scenarios based on the number of admissible output directions:

First scenario: If destination address x greater than of current address x head flit moves North-East else it takes North-West turn upto destination address x is less than current address x.

Second Scenario: If destination address y is greater than current address y then packet's header flit moves towered South-West else North-West up to destination address y is less than current address y.

For the , (1,1) is the source address and (8,2) is the destination address in a 8x8 mesh topology NoC, allowed paths using XFA algorithm.

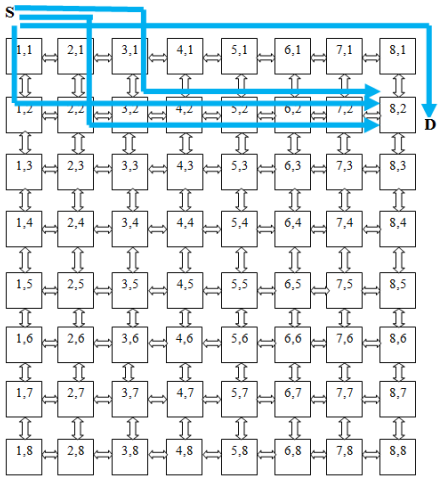


Fig. 1. XFA routing multipath output directions

2 PSEUDO CODE OF PROPOSED ROUTING

Pseudo code defines the algorithm coding in System C language.

Inputs:
Source address (Cx, Cy),
Destination address (Dx, Dy
Output: Selected output channel

```
if (Dx <= Cx && Dy== Cy)
return routing XY (source, destination)
if (Dx > Cx) {
directions North-East;
}
else if (Dx < Cx) {
directions North-West;
}
else if (Dy > Cy) {
directions South-West;
} else {
```

directions North-West;
}
return directions;
}

IV. NoC ROUTER

Fig.2 shows a schematic of a router for a mesh-based network on chip implementing our proposed routing algorithm. As shown, the router consists of a set of input buffers for each direction and an input buffer for the traffic locally generated. A routing algorithm is used when a routing has to be made, when the header reaches the input buffer. The output of the routing algorithm block is the selected output channel is used by the arbiter to setup the crossbar interconnection that connects input to the proper output directions [12].

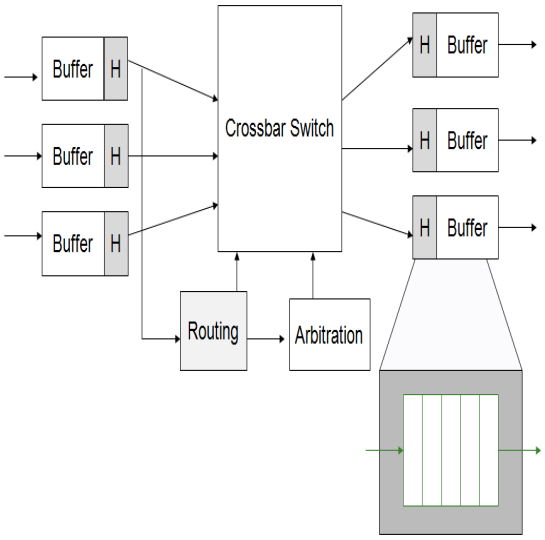


Fig. 2.Noc Router Schematic diagram

V. EXPERIMENTAL RESULT

For the evaluation of the performance of the routing algorithms are implemented and compared. We have used an open source simulator called Noxim. Noxim is an open source SystemC simulator of a mesh-based NoC, which is capable of calculating the average delay, the average throughput and the power dissipation of the packet transposition. The simulator is capable of simulating different traffic schemes.

3. SIMULATION ENVIRONMENTAL

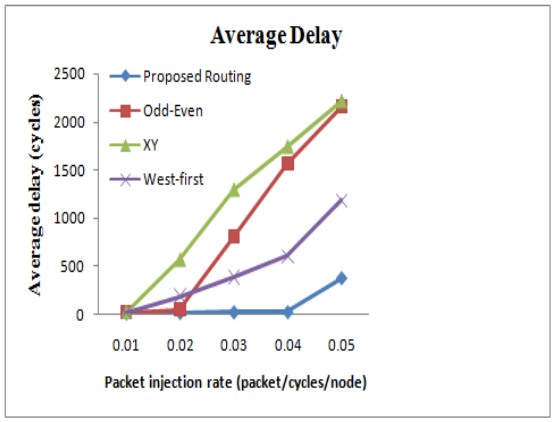
Simulation is performed on 8*8 mesh NoC and each node has 6 slots buffer and generated 8 flits packets with an exponential distribution. Simulation runs for 1000 cycle for a warm-up and executes for 20000 cycles. Noxim simulator in data width set 32 bit [13].

4. TRAFFIC SCENARIO

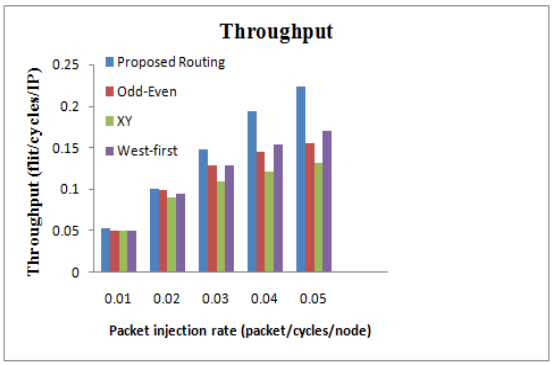
The evaluate XFA routing approach on both synthetic and real traffic scenarios. As synthetic scenarios consider transpose and bit reversal. For each traffic, average delay and throughput and power consumption with various packet injection rate has been evaluated.

Fig 3 shows the simulation results for transposed traffic. In this traffic, a node (i,j) in mesh network topology only sends packets to a node (N-1-i, N-1-j) [14], where N is the size of the mesh topology. In transposed traffic (Fig.3), XY performs weakly because of its determinism in distributing packets. XFA provides the better performance of compare to others routing.

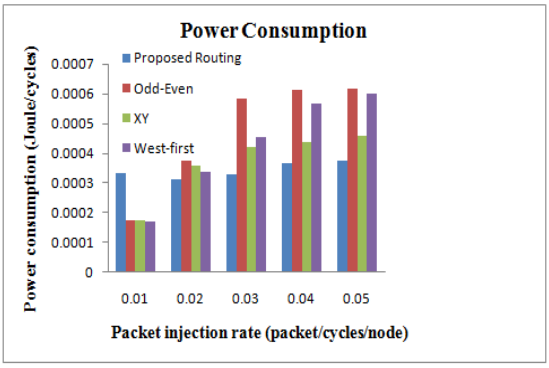
Fig 4.shows the simulation results for bit-reversal traffic. In this traffic a node sends message to the node with its reversal coordinates. Bit reversal traffic distribution in XFA provides the better performance. Average delay less and increases the throughput with increase the packet injection rate.



A) Average delay variations

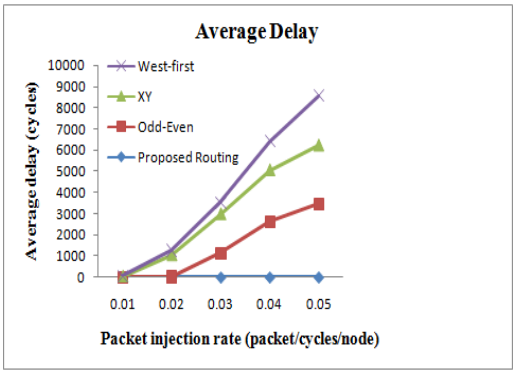


B) Average Throughput Variations

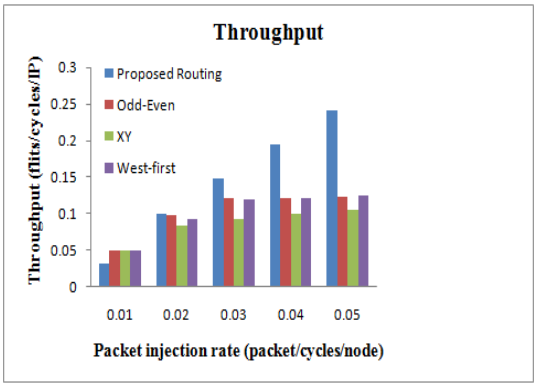


C) Power consumption variations

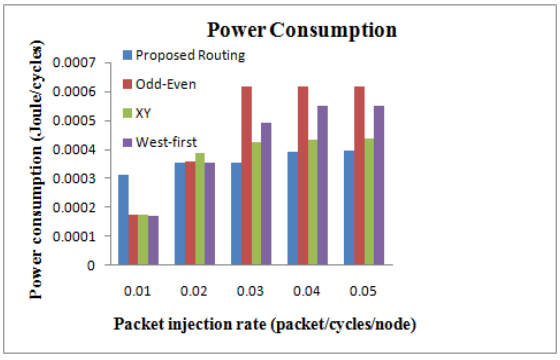
Fig.3. Simulation results for Transpose1



A) Average delay variations



B) Average Throughput variations



C) Power consumption variations

Fig4. Simulation results for Bit reversal

VI. CONCLUSION

In this paper present the proposed routing algorithm based on fully adaptive routing. Performance evaluation based on two traffic distribution, transpose1 and bit-reversal. Performance metrics used are Average delay, Throughput and Power consumption. Result obtained after analysis shows that proposed routing gives better result than other routing in all distribution. Average delay, Throughput and Power consumption varies for each algorithm on varying packet injection rate. Proposed routing having less average delay compare to other routing but Throughput is high both traffic distribution. Power consumption increases and decrease in traffic distribution for proposed routing. But overall performance of proposed routing is better than other routing algorithm.

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