REVIEW OF DIFFERENT TOPOLOGIES FOR NOC ARCHITECTURE USING NS2

Kalpana Pandey[1], Dr. Mahendra.A.Gaikwad[2]

[1]M.Tech student, Electronics, B.D.C.E, Sevagram, Wardha
[2]Prof. Electronics & Telecommunication, Electronics, B.D.C.E, Sevagram, Wardha

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Abstract - *Network-on-chip (NoC) is a packet switched on-chip communication network designed using layered methodology routes packets. NoCs use packets to route data from the source to the destination PE via a network fabric that consists of switches and interconnection links. NoCs are an attempt to scale down the concepts of large scale networks. The Network-on-Chip (NOC) is Network-version of System-on-Chip (SoC) means that on-chip communication is done through packet based networks. Performance of a NOC is evaluated by many parameter such as throughput, latency, packet drop probability etc. Network on Chip (NOC) architecture attempts to address different component level architectures with specific interconnection network topologies and routing techniques, some of the topologies are CLICHE, Folded Torus and BFT. Simulation provides relationship among latency, throughput and packet drop probability for NOC architectures This paper explains different topologies according to various parameters and it gives comparatively study.*

Key Words: *Network-on-Chip, Topology, Latency, Throughput*

1. INTRODUCTION

System-on-Chips (SoCs) utilize topologies based on shared buses. Dally and Towles proposed replacing dedicated, design specific wires with general purpose, (packet-switched) network [5], hence marking the beginning of network-on-chip (NoC) era. According to NoC design approach, designers use network design technology to analyze and design SoCs. In other words, designers view a SoC as a micro-network of components. Network on Chip (NoC) was introduced as an on chip communication facility and separates from computing functions. Performance of a NOC depends on many factors. Three main factors are topology, core selection and routing algorithm. Topology defines how nodes are placed and connected, affecting the bandwidth and latency of a network. Many topologies with different capabilities have been proposed for NoCs including Mesh [8], Folded Torus [7,8], Octagon [10], SPIN [11], and BFT [7]. Choosing a network topology is the principal step in designing a network as the routing strategy and flow control methods are governed heavily by the topology.

2. LITERATURE OVERVIEW

The performance of architecture is evaluated based on metrics of latency and throughput per channel under Constant Bit Rate (CBR) and Bursty traffic. The proposed architecture is 2 dimensional mesh topology and designed with Odd-Even (OE) routing algorithm. The simulation result is that the proposed architecture achieves balanced performance of latency and throughput under CBR and Bursty traffic. [1]

Two routing algorithms (Source routing and distributed routing) are used for 2 dimensional mesh topology. Evaluation results show that source routing gives higher latency and throughput performance as compared to corresponding distributed routing.[2]

A methodology based on divide conquer strategy to design routing algorithms for mesh NoC. They obtain 266 routings which outperform OE routing in transpose traffic. The plentiful routings increase the available research material of routing objects. The new routing algorithm can decrease the average packet delay up to 54.5% than the Odd-Even turn model. [3]

Analysis of packet loss during the link down in mesh interconnection network topology with source routing using simulation. They have analyzed 2D Mesh performance on the one down link for one second, and they have changed two parameters packet size and time interval and found that the ratio of packet loss on CBR traffic generator over UDP agent is constant in both cases. [4]

Compared five different topologies using distance vector routing algorithm. The SPIN and Octagon providing higher throughput and lower latency but it also has much higher drop probability which gives trade-off between low latency, high throughput and drop probability. BFT has lowest drop probability but also has lowest throughput. In CLICHÉ (mesh) and Folded Torus has moderate value all parameters so here again a trade-off between latency, throughput and drop probability. [5]

Described a simulation framework for mesh interconnection network has been designed, where the packet loss during the link down has been analyzed. Analysis and evaluation has been done on mesh interconnection networks on different traffic patterns using simulation on NS2. [6]

Described various topologies such as mesh, torus, octagon, SPIN, BFT etc. according to various parameters and it gives comparatively study of delay parameter. So the work is to compare different topologies using delay parameter. [7]

Distributed source routing, i.e., the source node determines only its neighboring nodes that are involved in message delivery. For the tree-based architectures (SPIN and BFT) the routing algorithm applied is the least common ancestor (LCA) and, for CLICHE and Folded Torus, apply the e-Cube (dimensional) routing. In the case of Octagon, adopt the hierarchical address-based routing . BFT, CLICHE, and Folded Torus provide lower throughput than SPIN and Octagon.[8]

3. TOPOLOGIES IN NOC

Chip-Level Integration of Communicating heterogeneous Elements (CLICHÉ) Figure 1 is a two-dimensional mesh network layout for NoC design. Every switch is connected to a specific resource and the number of switches is equal to the number of resources. Each switch is connected to four neighboring switches and one resource.

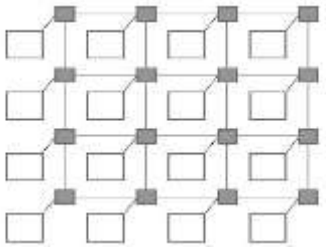

Figure 1 .Mesh Topology

Torus topology, also called a k-ary n-cube, is an n-dimensional grid with k nodes in each dimension k-ary 1-cube (1-D torus) is essentially a ring network with k nodes limited scalability as performance decreases when more nodes. k-ary 2-cube (i.e., 2-D torus) topology is similar to a regular mesh except that nodes at the edges are connected to switches at the opposite edge via wrap-around channels long end-around connections can, however, lead to excessive delays. Folding torus topology overcomes the long link limitation of a 2-D torus links have the same size.

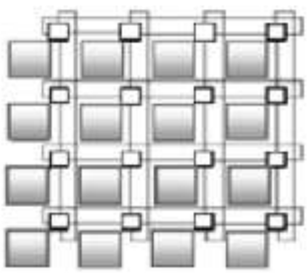

Figure2.Torus

Octagon topology is another example of a direct network messages being sent between any 2 nodes require at most two hops more octagons can be tiled together to accommodate larger designs by using one of the nodes is used as a bridge node

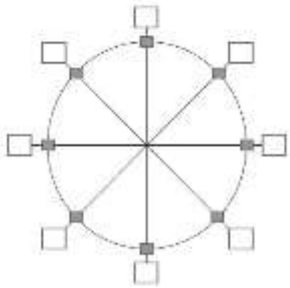

Figure 3: Octagon

Indirect Topologies each node is connected to an external switch and switches have point-to-point links to other switches. Switches do not perform any information processing, and correspondingly nodes do not perform any packet switching e.g. SPIN, crossbar topologies. Fat tree topology nodes are connected only to the leaves of the tree more links near root, where bandwidth requirements are higher

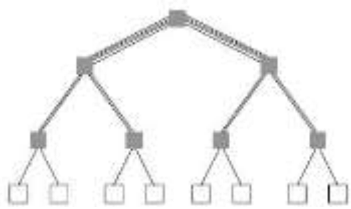

Figure 4. Fat Tree

In the Butterfly Fat Tree (BFT) topology, the layout is modeled in the form of a tree. Each node in the tree is represented by a set of coordinates (level, position) here level is the level in the tree and position is the spot in right to left ordering. K-ary n-fly butterfly network blocking multi-stage network – packets may be temporarily blocked or dropped in the network if contention occurs kn nodes, and n stages of kn-1 k x k crossbar e.g. 2-ary 3-fly butterfly network

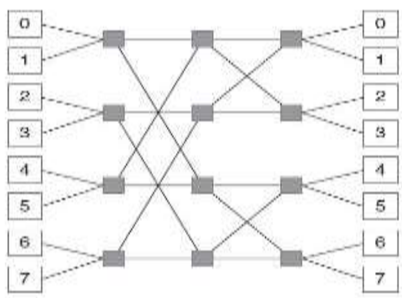

Figure 5: Butterfly fat tree

4. IDENTIFICATION

From literature it has been identified that the performance of NOC architecture for CLICHÉ, Folded Torus, BFT topologies has been evaluated by using various routing protocols. Hence there is a need to propose common routing protocol for all topologies of NOC architecture to check the performance efficiency of NOC architecture topology. We have proposed link state routing protocol for different NOC architecture topologies like CLICHÉ, Folded Torus, and BFT.

5. PERFORMANCE PARAMETERS

Throughput: It is the rate at which a network sends or receives data or amount of data that is transferred over a period of time. It is measure of the channel capacity of a communications link, and connections.

Latency: In a network latency is a synonym fort time delay along a path. It define as how much time it takes for a packet of data to get from source to destination and say that latency measures the amount of time between the start of an action and its completion . Latency can be affected by interconnecting devices

Drop probability: Drop Probability is the probability of number of packets dropped. A Drop Probability has 0 value means that a packet will never be dropped, and value 100 signifies that all packets will be dropped. The drop probability is very sensitive to communication load. As the communication load increases the drop probability or say number of dropped packet is also increases.

6. CONCLUSION

By studying the NoC topologies literature the parameters such as throughput Latency, area , delay and Drop probability This paper explains different topologies according to various parameters and it gives comparatively study of NOC topologies with different parameters. Our proposed work is to compare different NOC topologies (CLICHÉ, Folded Torus, BFT) using common routing algorithm i. e. link state routing algorithm with performance parameters latency, throughput, packet delivery ratio.

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