International Journal of Scientific Research Engineering & Technology (IJSRET)
Volume 1 Issue 5 pp 124-129 August 2012 www.ijsret.org ISSN 2278 - 0882

Performance Evaluation of Mesh with Source Routing for Packet Loss

[1]Lalit Kishore Arora, [2]Rajkumar,
[1]Assistant Professor, Ajay Kumar Garg Engg College, Ghaziabad, UP.
[2]Assistant Professor, Gurukul Kangri University, Haridwar, UK.
l_k_a2000@yahoo.com
rajbhatiagkv@gmail.com

ABSTRACT

The data loss is considered as measure performance parameter for evaluating the network topologies in interconnection network design. In the source routing, route computation for packet transmission from source to destination is done before the transmission. The paper evaluating the performance on the basis of packet loss in Mesh interconnection with source routing using different traffic generation mechanisms for parallel transmissions with handshaking concept. Paper analyzes the results which are useful for designing the interconnection networks.

Keywords: *Mesh Topology, Torus topology, interconnection networks, source routing.*

1. INTRODUCTION

Meshes and torus based interconnection networks have been utilized extensively in the design of parallel computers in recent years. Computer architects have always strived to increase the performance of their computer architectures. High performance may come from fast dense circuitry, packaging technology, and parallelism. As the density of processor package increases; the length of the link connecting a certain number of processors decreases [1]. Although numerous studies have examined NoC implementation and performance, few have examined packet loss. Flow control in interconnection networks has mainly been an issue to prevent buffer overflow and packet loss. Packet loss occurs when one or more packets of data traveling across a network fail to reach their destination. Packet loss can be caused by a number of factors including buffer overflow, congestion, corrupted packets rejected in-transit, faulty link, faulty nodes or deadlocks. In addition to this, packet loss probability is also affected by down of links and distances between the transmitter and receiver [19].

In [18] paper, we have analyzed 2D Mesh performance on the one down link for one second, and changed two parameters packet size and packet generation interval and found that the ratio of packet loss is constant in both cases where traffic generator with acknowledgement is not be considered. But on the other hand when acknowledgement is considered in both cases, no packet loss has been found. There fore the network with the traffic agent which uses acknowledgement mechanism is more reliable, and more secure. But the delay of transmission due to the link down will be occurring.

This paper mainly attached different traffic agents where acknowledgement mechanism is uses by mesh interconnection topology, and we have also down the link only for 0.1 second when the first acknowledgement is going to receive by the sender. The mechanism where traffic agents use only acknowledgement mechanism is referred as handshaking mechanism. Simultaneously three source-destination pairs are communicating in simulation for the evaluation.

The remainder of this paper is organized as follows. In section II, related literatures are discussed. Section III, describes the system model of mesh interconnection network, which implemented and designed in NS2 and section IV, evaluate the performance and shows the results of simulation. Finally some conclusion has been drawn in section V.

2. RELATED WORK (MOTIVATION)

The numerous studies have done related to simulation on Mesh topologies. Recently, the NoC has been introduced as a new research area that emphasis on modeling and analyzing the on-chip interconnect. Sophisticated networks that have specialized switches and routers and defined topologies are the main NoC points for analysis and optimization [17]. Recently, NoC architectures have been surveyed and compared for different performance metrics. In the paper [11], a

International Journal of Scientific Research Engineering & Technology (IJSRET)
Volume 1 Issue 5 pp 124-129 August 2012 www.ijsret.org ISSN 2278 - 0882

simulation-based approach using the NS-2 simulator was used to analyze a NoC mesh interconnects topology. It is based on the Chip level Integration of communicating Heterogeneous Element [12].

NS-2 is used to construct the topology and generate different traffic scenarios using an exponential traffic generator [19]. Packets are sent at a fixed rate during ON periods, and no packets are sent during OFF periods. Using this traffic generator, common network performance metrics such as drop probability, packet delay, throughput and communication load are analyzed against different buffer sizes and traffic injection rates [19].

Another paper [13], about the Mesh NoC has been presented, it is similar to [11] but with different results. Metrics such as latency and packet loss rate were presented as a function of the communication load and the buffer size, using the NS-2 simulator. In [14] authors compared the Ring, Irregular Mesh and Spidergon topologies using a discrete-driven simulator (OMNET++) based on the wormhole switching technique. Their analysis has shown that the Spidergon NoC outperforms others, including average latency and throughput. The type of traffic has not been mentioned despite of its prime importance in NoC. In [15], an Application Specific NoC (ASNoC) design methodology was proposed, that is, using a customized topology to fit the requirements of specific applications. In that work, the OPNET simulator is used to compare the proposed structure with a Mesh topology, using a HDTV decoder SoC as application example. An analytical model using queuing theory is introduced in [16] to evaluate the traffic behavior of the Spidergon NoC. Simulations to verify the model for message latency under different traffic rates and variable message lengths are presented in that work.

3. SYSTEM MODEL

The simulation interconnection architecture model consists of m × n mesh of switches. Switches consists a slot for a resource. A resource may be a processor core, a memory block, an FPGA, a custom hardware block or any other peripheral devices, which fits into the available slot and compiles with the interface with the network. We assume switches in network have buffers to manage data traffic. Figure-1 shows the architecture of simulation model with 16 nodes where connection of switches (S) and resources (R) are shown.

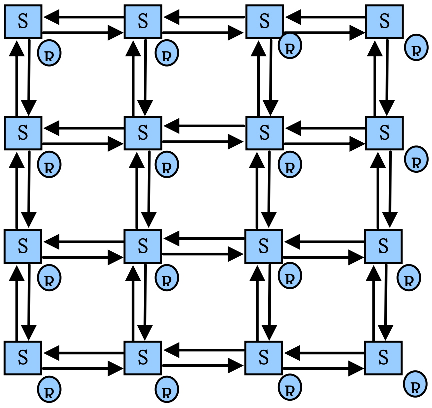


Figure-1 4 x 4 Mesh Architecture

A. Topology

A 4 x 4 two-dimensional mesh topology was modelled and simulated using network simulator NS2. This topology is easily scaled to different sizes. Different resources have their unique communication addresses, so here assumed that all switches has attached processor core as resources therefore treated similarly except that a traffic generator can be attached to resources. Switch, resource and link are three basic elements in the topology. Assume that the each resources has infinite buffer size but finite in switches. It means that the packet being dropped or lost cannot occur in resources but only take place in switches.

B. Communication Links

An inter-communication path between the switches is composed of links. Each node is connected with point-to-point bidirectional links. The bandwidth and latency of the link is configurable. When any link down between two nodes it implies that the packet cannot be travel between these nodes in any direction. This assumption was used in [10] and is realistic, because bidirectional links are actually implemented by using a single wire.

C. Routing

An inter-communication path is composed of set of links identified by the routing strategy. This simulator models a 16-node 2-D mesh (4x4) in which routing decision will be takes at source node using source routing methodology. A shortest communication path has been selected for each traffic pair before a simulation starts.

4. PERFORMANCE EVALUATION

In this section, to evaluate the performance of the mesh interconnection networks we develop a

International Journal of Scientific Research Engineering & Technology (IJSRET)
Volume 1 Issue 5 pp 124-129 August 2012 www.ijsret.org ISSN 2278 - 0882

simulation model in NS2 with only built-in options. Tcl is used for specifying the Mesh interconnection network simulation model and running the simulation. We have used existing routing algorithm to compute the path and for packet generation.

Our implementation of mesh interconnection networks uses the source routing to send packets from source node to destination node. In source routing the information about the whole path from the source to the destination is pre-computed and provided in packet header [3][4][5].

A. Simulation Environment
For the evaluation, a detailed event-driven simulator has been developed. This simulator models a 16-node 2-D mesh (4x4) in which routing decision will be takes at source node using source routing methodology. Each node is connected with point-to-point bidirectional serial links. The bandwidth of link is set to 1 Mb and latency/delay is set to the 10 ms. All these topology parameters can be describe as a script file in Tcl, as shown below:

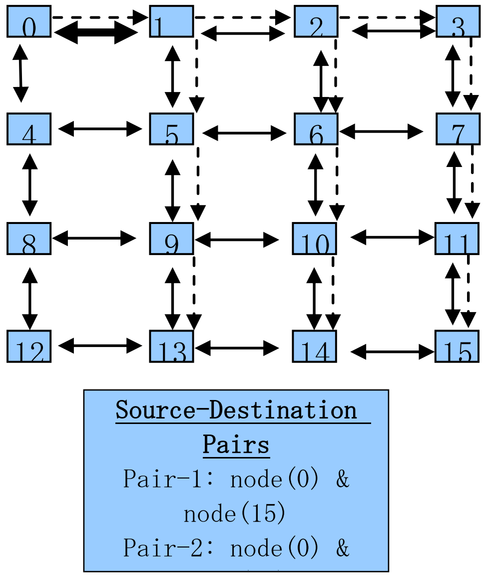
```
#Default Values for topology
set n 16;            # Total number of nodes
set max_bw 1Mb; # maximum link band width
set linkDelay 10ms;      # delay on each link
#configuration for links between the nodes in topology
$ns duplex-link $node(i) $node(i+1) $max_bw
$linkDelay DropTail
```

In this environment, we fixed the source, destination node and link for down for a particular period, 0.1 second when the first acknowledgement is going to receive by the sender. The time window of simulation is fixed 0.5 to 4.5 seconds and time of link down and link up is 0.6 and 0.7 second respectively after the starting the simulation. We assume that when link is down, this link can not be used in any of its directions. This assumption was used in [10] and is realistic, because bidirectional links are actually implemented by using a single wire.

In the simulation environment, the source and destination pairs are fixed, where pair-1: *node(0)* & *node(15)*, pair-2: *node(0)* & *node(14)*, and pair-3: *node(0)* & *node(13)*, and link *(0)* to *(1)* for down for a particular period, 0.1 second when the first acknowledgement is going to receive by the sender. Here model uses a common source *node (0)* for every pair to use at least one common link, which is *(0)* to *(1)*. See figure-2, where dotted arrows show the path for each pair, and darked bi-directional arrow shows the link which down for 0.1 second. The simulation time is fixed for 5 seconds, where packet generation window is from 0.5 to 4.5 second and time of link down and link up is 0.6 and 0.7 second respectively after the starting the simulation. Here assume that when link is down, this link can not be used in any of its directions.

Figure-2 Path and Link down in Mesh

Scenario-1 Packet generation using constant bit rate mechanism



In this experiment simulation model uses the packet generation of traffic in a constant rate where the packet size and interval of packet generation are fixed. The following Tcl code shows the traffic configuration setting for constant bit rate packet generation:

```
#Traffic Configuration: Constant bit rate traffic source
set cbr0 [new Application/Traffic/CBR]
$cbr0 set packetSize_ 500
$cbr0 set interval_ 0.0625
```

Scenario-2 Packet generation using file transfer protocol mechanism
In this scenario simulation model uses the packet generation of traffic using file transfer protocol(FTP) mechanism. FTP represents a bulk data transfer of large size where the packet size and interval of packet generation are fixed. The following Tcl code shows the

traffic configuration setting for FTP packet generation:
#Traffic Configuration: File transfer protocol source
set ftp0 [new Application/FTP]
$ftp0 set packet Size_ 500
$ftp0 set interval_ 0.0625

B. Simulation Results

Scenario-1:

In the first scenario Simulation model uses the packet generation in a constant bit rate mechanism where the packet size and interval of packet generation are fixed. The source-destination pairs started the simulation for 5 seconds. The after receiving the acknowledgement from destinations, source node sent the packets to destination node. Total 65 packets are generated and received by the source and destination nodes of each pair.

On the next step, we down the first link of the path from source to destination for 0.1 second, when source node going to receive first acknowledgement from the destination node and evaluated the packet loss using two and three parallel transmissions separately.

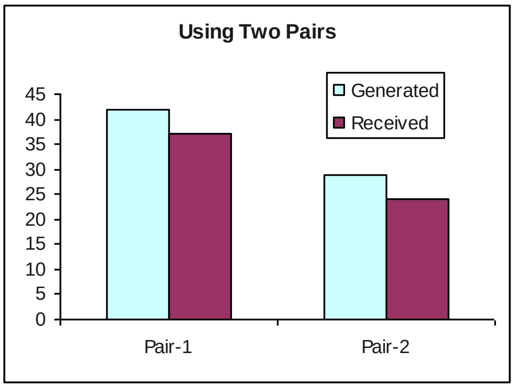
i) Using two parallel transmission

Using two parallel transmissions, results show that the total packet generated by source node is 42 packets and received by the destination node is only 37 packets in pair-1 and in pair-2, total 29 packets are generated by source and 24 are received by the destination. The generation of packets from source is decreases as well as 5 packets has been lost due to the link down for 0.1 second. But when increases time of the simulation window from 5 seconds to 6 seconds, the packet generated and the packet received is gone to maximum i.e. 65 packets.

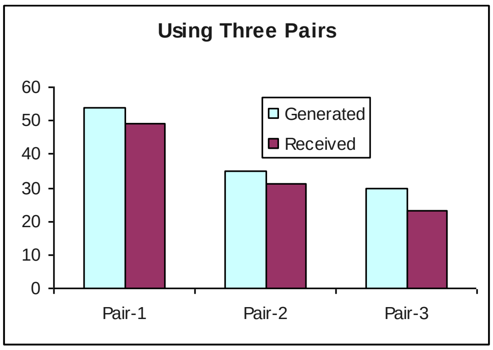
ii) Using three parallel transmission

In this experiment, simulation model uses all three pairs for transmission, results show that pair-1 total 54 packets generated and 49 received, in pair-2 total 35 packets generated and 31 are received, and pair-3 total 30 packets generated and 23 are received. The generation of packets from source is decreases as well as ratio of packet loss has been varied due to the link down for 0.1 second. Figure-3 shows the evaluation for both cases.

But when increases time of the simulation window from 5 seconds to 6 seconds, the packet generated and the packet received is gone to maximum i.e. 65 packets.



(a) Parallel communication in Two Pairs



(b) Parallel communication in Three Pairs

Figure-3 Simulation graphs for constant bit rate transmission mechanism

Scenario-2: In the second scenario simulation model uses the packet generation of traffic using file transfer protocol (FTP) mechanism. FTP represents a bulk data transfer of large size.

Like first scenario, made the pairs of the source, destination nodes and started the simulation for 5 seconds. After receiving the acknowledgement from each destination, source node sent the packets to destination node. As we know the FTP used to transfer the bulk data, total packet are generated and received by the source and destination node are different in two and three parallel transmission.

Using two parallel transmission, pair-1 generate and receive total 246 packets and pair-2, generate and receive total 220 packets.
Using three parallel transmission pair-1 generate and receive total 188 packets, pair-2, generate and receive total 167 packets and pair-3 , generate and receive 150 packets.
On the next step, followed the same technique to down

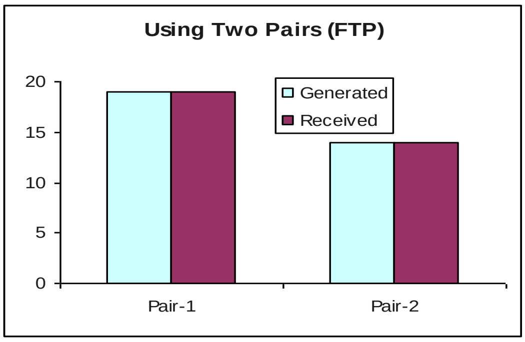
the first link of the path from source to destination for 0.1 second, when source node going to receive first acknowledgement from the destination node it shows the packet loss using two and three parallel transmissions separately.

i) Using two parallel transmission

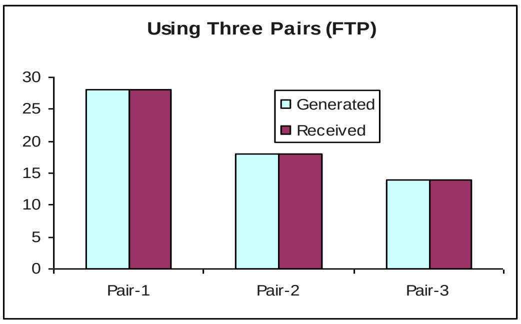
Using two parallel transmissions, results show that the total packet generated and received in pair-1 is 19 packets and in pair-2, total 14 packets are generated and received. Therefore, no loss is found here and also no changes found to increases the time of the simulation window from 5 seconds to 6 seconds, the packet generated and the packet received was same.

ii) Using three parallel transmission

Like above, using three parallel transmission, results show that the in pair-1, 28 packets, in pair-2, 18 packets and in pair-3, total 14 packets are generated and received. Therefore, no loss is found here and also no changes found to increases the time of the simulation window from 5 seconds to 6 seconds, the packet generated and the packet received was same.



(a) Parallel communication in Two Pairs



(b) Parallel communication in Three Pairs

Figure-4 Simulation graphs for file transfer protocol mechanism

Figure-4 shows, the parallel transmission using file transfer protocol mechanism is reliable and secure. It sends more data then constant bit rate mechanism and also no loss occurs.

5. CONCLUSION & FUTURE SCOPE

In the above experiments, 2D Mesh of size 4x4 has been evaluated, and found that the performance of FTP mechanism is better than the constant bit rate mechanism for parallel transmission. The FTP mechanism has not been lost any packet while constant bit rate mechanism lost few packets in parallel transmission. And if we increases the time of the simulation window from 5 seconds to 6 seconds, in the constant bit rate mechanism, no loss will be found but delay occurs. Therefore FTP mechanism is most secure and reliable when parallel transmission is considered with handshaking concept in the Mesh interconnection networks. In the next step we are going the analysis the packet loss on torus interconnection networks.

REFERENCES

[1] Zhu Ding, "Adaptive Hybrid Switching Technique for Parallel Computing System", 2000

[2]http://pages.cs.wisc.edu/~tvrdik/5/html/Section5.html

[3] Dally W.J. and Towles B., "Principles and Practices of Interconnection Networks", Morgan Kaufmann Publishers an Imprint of Elsevier Inc. ISBN: 0-12-200751-4. 2004.

[4] Axel Jantsch and Hannu Tenhunen, "Networks on Chip", Kluwer Academic Publishers. ISBN: 1-4020-7392-5. 2003.

[5] J. Flich, P. lopez, M. P. Malumbers and J. Duato. "Improving the Performance of Regular Networks with Source Routin", Proceeding of the IEEE International Conference on Parallel Processing. 21-24 Aug. 2000. Page(s) 353-361.

[6] Palesi M., Holsmark R., Kumar S. and Catania V., "Application Specific Routing Algorithms for Networks on Chip", IEEE Transactions on Parallel and Distributed Systems, Vol. 20, No. 3, March 2009.

[7] Ge-Ming Chiu. "The Odd-Even Turn Model for Adaptive Routing" IEEE Transactions on Parallel and Distributed Systems, Vol. 11, No. 7, July 2000.

[8] A. Patooghy, H. Sarbazi-Azad, "Performance comparison of partially adaptive routing algorithms. In 20th International Conference on Advanced Information Networking and Applications", 2006. AINA 2006. Volume 2, 18-20 April 2006.

[9] Palesi M., Holsmark R., Kumar S. and Catania V., "A Methodology for Design of Application Specific Deadlock-free Routing Algorithms for NoC Systems",

In International Conference on Hardware-Software Codesign and System Synthesis, Seoul, Korea, October 22-25, 2006.
[10]M.E. Gomez, P. Lopez, J.Duato, “A Memory-Effective routing Strategy for regular Interconnection Networks”, in Proc. Int. Parallel and Distributed Prossing Symp., 2005.
[11] Y-R. Sun, S. Kumar, and A. Jantsch, "Simulation and evaluation of a network-on-chip architecture using NS-2," Proceedings of the IEEE NorChip Conference, 2002.
[12] S. Kumar et al., "A network-on-chip architecture and design methodology," Proceedings of the International Symposium on VLSI (ISVLSI), 2002, pp. 117-124.
[13] A. Hegedus, G. M. Maggio,, and L. Kocarev, "A NS-2 simulator utilizing chaotic maps for network-on-chip traffic analysis," Proceedings of the IEEE International Symposium on Circuits and Systems (ISCAS), vol. 4, 2005, pp. 3375-3378.
[14] L. Bononi and N. Concer, "Simulation and analysis of network-on-chip architectures: Ring, Spidergon, and 2D Mesh," Proceedings of Design, Automation and Test in Europe (DATE) Conference and Exhibition (Designers' Forum), 2006, pp. 154-159.
[15] J. Xu, W. Wolf, J. Henkel, and S. Chakradhar, "A design methodology for application-specific networks-onchip," ACM Transactions on Embedded Computing Systems, vol. 5, May 2006, pp. 263-280.
[16] M. Moadeli, A. Shahrabi, W. Vanderbauwhede, and M. Ould-Khaoua, "An analytical performance model for the Spidergon NoC," Proceedings of the 21st International Conference on Advanced Information Networking and Applications, 2007, pp. 1014-1021.
[17] S. Suboh, M. Bakhouya, S. Lopez-Buedo, and T. El- Ghazawi., “Simulation-based approach for evaluating on-chip interconnect architectures”, SPL Proc., pages 75–80, 2008
[18] Lalit Kishore Arora, Rajkumar, “Simulation and Analysis of Packet loss in Mesh Interconnection Networks”, IJCA Proceedings on Development of Reliable Information Systems, Techniques and Related Issues (DRISTI 2012), DRISTI(1):35 - 38, April 2012. Published by Foundation of Computer Science, New York, USA.
[19] Saad Mubeen, "Evaluation of source routing for mesh topology network on chip platforms", Master of Science Thesis, 2009.