Simulation and Analysis of Packet loss in Mesh Interconnection Networks

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ABSTRACT
The data loss is the measure performance parameter for evaluating the network topologies in NoC. In the source routing, route computation for packet transmission from source to destination is done before the transmission. In this paper we analysis the packet loss during the link down in mesh interconnection network topology with source routing using simulation.

Keywords
Interconnection Networks, Mesh, Source Routing, NoC.

1. INTRODUCTION
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.

In this paper we designed a framework for mesh interconnection networks, where we analysis the packet loss during the link down. We have analysis mesh interconnection networks on different traffic patterns using simulation on NS2.

The remainder of this paper is organized as follows. In section II, we have relate our work with previous work done. Section III, explain the routing algorithm used in the simulation. Section IV we describe the framework designed in NS2 and shows the results and analysis of simulation.

2. RELATED WORK(MOTIVATION)
NoC has been introduced as a new research area that emphasis on modeling and analyzing the onchip 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. For example, in [11] a simulation-based approach using the NS-2 simulator was used to analyze a NoC Mesh interconnect topology. It is based on the Chiplevel Integration of communicating Heterogeneous Element [12].

NS-2 is used to construct the topology and generate different traffic scenarios using an exponential traffic generator. 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.

In [13], another paper 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 NoC 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.

A very large number of routing algorithms have been proposed in literature [6][7][8][9]. All the proposals so far fall under distributed routing type. Source routing has not been so far considered for NoCs, due to its apparent large overhead to store path information in the header. Since, paths in source routing are pre-computed offline, therefore source routing can provide no or limited path adaptivity in the case of faults and traffic congestion. In spite of these disadvantages, we feel that source routing has many advantages over distributed routing and they are not discussed here.

3. PERFORMANCE EVALUATION

In this section, to evaluate the performance of the mesh interconnection networks we develop a simulation model in NS2. 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. To implement the source routing in NS2 we have set the routing protocol as static. 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. In the first experiment we assume the packet size of 500 bytes and varying the interval of traffic generation with CBR traffic over UDP and TCP agent. In the next experiment we fixed the interval of traffic generation with CBR traffic over UDP and TCP agent and varying the size of packets. We have also fixed the source, destination and link for down. The time of simulation is fixed by 5.0 seconds and time of link down and link up is 1.0 and 2.0 second after the starting the simulation respectively. 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.

B. Simulation Results

In the first experiment we assume the packet size of 500 bytes and varying the interval of traffic generation with CBR traffic over UDP traffic agent.

TABLE I. **PACKET LOSS USING CBR OVER UDP WITH FIXED PACKET SIZE**

Interval for Packet Generatio n (Sec)	Packets generated at source	Packets received at destinatio n	Packet loss	Lost Ratio (%)
0.500	8	6	2	25%
0.250	16	12	4	25%
0.125	32	24	8	25%
0.0625	64	48	16	25%
0.03125	128	96	32	25%

Due to decrement of interval for packet generation increases the rate of generation of packets as shown in the table-1. According to increase of packet generation also increases the packet loss but the ratio of packet loss is fixed, which is 25%, see chart-1.

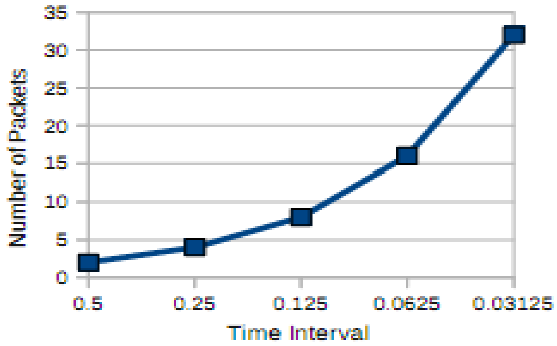


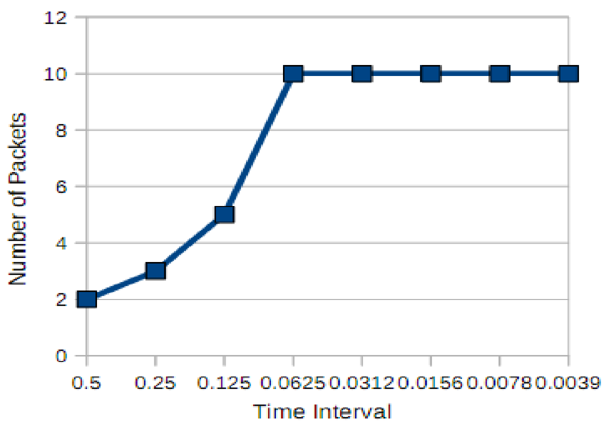
Chart 1: Packet loss using CBR over UDP with fixed packet size

In the above experiment we changed the traffic agent TCP instead of UDP and remaining parameters are remain same. Like above experiment, decrement of interval for packet generation increases the rate of generation of the packets as shown in the table-2. But the result shows that after a standard interval the packet loss and the rotio of loss is not changed, see chart-2.

TABLE II. **PACKET LOSS USING CBR OVER TCP WITH FIXED PACKET SIZE**

Interval for Packet Generatio n (Sec)	Packets generate d at source	Packets received at destinatio n	Packet lost	Lost Ratio (%)
0.500	20	18	2	10.00%
0.250	37	34	3	8.10%
0.125	71	66	5	7.05%
0.0625	139	129	10	7.19%
0.0312	263	253	10	3.80%
0.0156	275	265	10	3.63%
0.0078	275	265	10	3.63%
0.0039	275	265	10	3.63%

Chart 2: Packet loss using CBR over TCP with fixed packet size

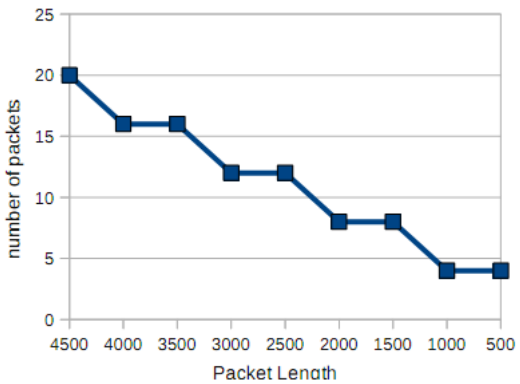


In the Second experiment we assume the packet generation interval is fixed to 0.250 sec and the packet size varying its length with CBR traffic over UDP protocol. Due to the decrement of packet size the number of packet is also decreases as shown in the table-3. According to decrease of packet size also decreases the packet loss but the ratio of packet loss is fixed, which is 25%, see chart-3.

TABLE III. PACKET LOSS USING CBR OVER UDP WITH FIXED INTERVAL

Packet Length (bytes)	Packets generated at source	Packets received at destination	Packet loss	Lost Ratio (%)
4500	80	60	20	25%
4000	64	48	16	25%
3500	64	48	16	25%
3000	48	36	12	25%
2500	48	36	12	25%
2000	32	24	8	25%
1500	32	24	8	25%
1000	16	12	4	25%
500	16	12	4	25%

Chart 3: Packet loss using CBR over TCP with fixed packet size

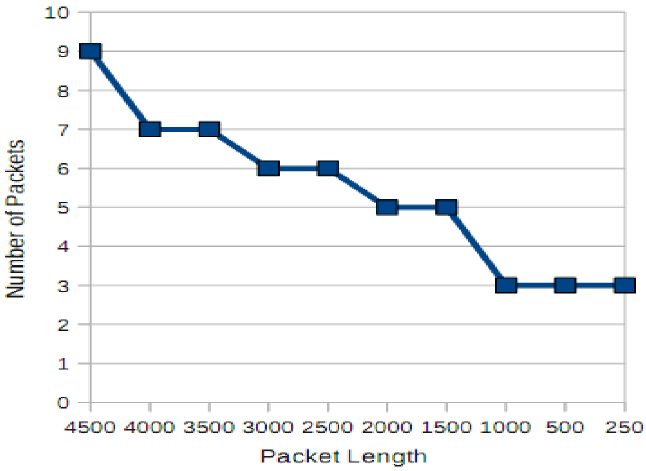


In the above experiment we changed the traffic agent TCP instead of UDP and remaining parameters are remain same. Like above experiment, decrement of packet size also decreases the rate of generation of the packets as shown in the table-4. But the result shows that after a standard interval the packet loss and the ratio of loss is not changed, see chart-4.

TABLE IV. PACKET LOSS USING CBR OVER TCP WITH FIXED INTERVAL

Packet Length (bytes)	Packets generated at source	Packets received at destination	Packet loss	Lost Rati (%)
4500	170	161	9	5.29%
4000	138	131	7	5.07%
3500	138	131	7	5.07%
3000	104	98	6	5.77%
2500	104	98	6	5.77%
2000	70	65	5	7.14%
1500	70	65	5	7.14%
1000	37	34	3	8.11%
500	37	34	3	8.11%
250	37	34	3	8.11%

Chart 4: Packet loss using CBR over TCP with fixed packet size



4. CONCLUSION & FUTURE SCOPE

In this paper, we have analyzed 2D Mesh performance on the one down link for one second, and we 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.

But on the CBR traffic generator with TCP agent the ratio of packet loss is varying but after an interval both cases achieved a fixed ratio of packet loss.

In the next step we are going the analyze the packet loss on the case of more than one parallel communication at same time, which following the path with some common nodes. And also we are trying to implement these concept to torus interconnection networks.

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