Comparative Analysis on Fully Adaptive Routing Algorithm and Pseudo Adaptive Routing Algorithm for E-RiCoBiT(Enhanced-Ring Connected Binary Tree)

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Abstract.

Owing to the current happenings in the world, it is said that there may come a time in future, where a billion transistorASIC(Application Specific-Integrated Circuit)might be usedto enhance the performanceof various systems leading to High Performance Systems.Taking this into considerationas an important objective, it is realized that High Performance Systems are becoming an integral part of our day to day life. Earlier, single core systems were designed using the normal bus architectures but today multiple coresystems are used instead so as to run many applications. But still the thirst of having to use as many cores as possible on a single chip is still not over. This problem can be resolved bybuilding a chip based on an important concept called Network On Chip(NOC). It ispurely a network oriented technologyused for communication between the nodes of a chip. So this paper is proposed mainly to use the Network On Chip(NOC) concept to present two routing algorithms namely, Fully Adaptive Routing Algorithm and Pseudo Adaptive Routing Algorithm thereby comparing theirabsolute outcomes. The idea of building a chip using many coresin order to attainthe goal of High Performanceis getting competitive day by day.Pertaining to the project, while arranging the nodes in a particular topology, we have used RiCoBiT which is known tohave achieved the highest performance so far. Achieving scalability, abiding and implementing the concept of Network On Chip(NOC) and comparing the analysis of the aforesaid routing algorithms are the important aspects which accounts to this paper.

Keywords. Performance Systems, Network on Chip, Routing algorithms, RiCoBiT Topology

1. INTRODUCTION

In our day to day life there seems to be a significant necessity to use different kinds of electronic inventions. The communication between the chip composites are known to be the basis of this aim. The significant communication that occurs when a packet is being transferred from a given source to destination and the behavior of the packet transferal is being elaborated here. The type of routing algorithms on the basis of which a device workshas to meet different kind of requirements.The major need to satisfy the expected

results is attained by using the two routing algorithms- Fully Adaptive and Pseudo Adaptive respectively. Hence different kinds of routing algorithms have been implemented. The big concern that holds here is whether the algorithm meets our expected desires or not. There are certain essentials based on which the concept of Network On Chip implementation works. There are in fact two such essential requirements known as Performance Requirements and Architectural Requirements. As the name suggests, the Performance requirements are small latency(delays), assured throughput, the ability to take up a different path in case there are any broken nodes, strong transfer capacity and limited amount of power consumption. Coming to the Architectural requirements namely, high performance, generality and configurability. The ability of tolerance against faults or disturbances are also said to be relied on the Quality of Service.

In this competitive ongoing current world the aspect of accuracy holds a lot of weightage in fact that is one of the main objectives of building any electronic integrated chip. The accuracy that we meet through our implementations are the ones which prove that our chip is capable of High Performance. Implying on the topology which we have used here is one of the most important facets. The RiCoBiT Topology is the main probability on which we study the communication and behavior of the packet being transferred from source to destination. The ring connection in binary tree theory says that packet travels in the form of nodes based on implying around the given source and destination.This RiCoBiT topology has a beautiful architecture which is elaborated further. The inventions of today's various innovations solely rely on the design and implementation which is proposed in this paper accurately.

2. LITERATURE SURVEY

[1] Sanju. V and Niranjan Chiplunkarproposed a springerpunconf paperwhich explained the concept of RiCoBiT Architecture needed for Network-on-chip based Systems. In this, they have given a clear cut picture on RiCoBiT Topology, how the addressing is done and finally the non-adaptive routing algorithm implementation respectively.In addition they have proved the efficiency of RiCoBiT by giving a comparison of each of the performances of various other topologies based on determining the maximum Hop Count, maximum Hop(Average case), number of wire segments and wire lengths. Further, they have also discussed real-time parameters like latency and throughput.

[2] C. Koushika, R. Sharmili and Sanju. Vproposed a paper known as "Design and Implementation of a network on chip-based simulator : a performance study" in the year 2014 which shows the simulator design and implementation. The verification and testing is also shown distinctly. So here the implementation of the simulation is used to help describe the characteristics and the internal working of the topologies. Based on the analysis performed, it is proved that RiCoBiT is outstandingly efficient compared to mesh and torus topologies.

[3] Niranjan Chiplunkar and Venkata Krishna, Sanju. V had proposed a "Routing in Network On Chip-A Review" paper to discuss the various topologies involved in the concept of NOC namely-bus, mesh, torus, RiCoBiT, tree, butterfly and polygon. Further the strategies in routing and the problems that might come up during routing were also

discussed. The major view on how Network on Chip concept acts as a back bone in the case of high performance integrated circuits is also briefly elaborated.

[4] Ville Rantala, Teijo Lehtonen and Juha Plosila proposed " Network On Chip Routing Algorithms" which very briefly explains the various topologies on Network on Chip, the flow control of the routing algorithm and the problems that come up on routing as well. Here a vast description on the Router Architectures is also provided.

3. PROPOSED MODEL

As the name of the paper suggests, a comparative analysis between pseudo adaptive and fully adaptive routing algorithms are made which are used in this Network on Chip based Systems. A tremendous topology called RiCoBiT is being used here to make sure that the nodes communicate with each other smoothly. In this scenario, there are a number of nodes connected to each other in the form of a ring. In addition, each node of the previous ring is connected to two other nodes of the next ring, thereby successfully forming a binary tree, hence the name Ring Connected Binary Tree.

Now to proceed further, let's see the working of the project. To begin with, nodes in the chip are placed RiCoBiTically for a smooth network communication. Now when dug deep into the concept, let's see how communication really takes place between the nodes. Suppose, we consider that a packet is being sent from a source node to a destination node and we see how efficiently the packet reaches the respective destination. We check whether the packet has reached successfully without any delay or not. We also note that there is a definite throughput and also the time taken by the packet to reach the destination. Now to proceed further, there is also a need to check whether the packet reaches the destination even if there are issues or difficulties during the process. Such issues which interrupt during the communication are termed as "Broken Nodes". Hence the need for a packet to adapt the quality of path diversity and guaranteed throughput is very significant. Such quality parameters are being proved through the absolute outcomes as shown in the results given below. Here, we have shown a comparative analysis on scenarios based on all that is, zero broken nodes, one broken node and two broken nodes respectively.

This paper ensures us good scalability and prevents any routing algorithmic problems concerned.

Design Objectives

The best network communication is attained by working out these possible affirmations as follows :

- Performance requirements which is massive requirement that is small latency, absolute throughput, path diversity, sufficient transfer capacity and low power consumption.
- Data communications between segments of chip are packetized and transferred through the network.

Routing Algorithm

The design of the topology plays a very important aspect as it directly proportional to the data communication that occurs between the nodes of the chip. Hence formulating the algorithms on the basis of topology must be precise and accurate. To make a comparative analysis we have designed two kinds of algorithms namely- fully adaptive and pseudo adaptive routing algorithms. Let us learn further on how they work.

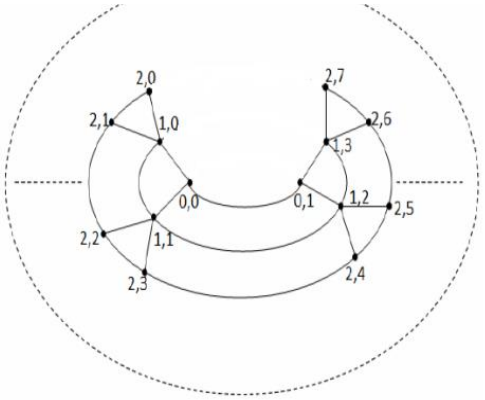

Figure 1: E-RiCoBiT Topology.

Coming to the types of routing algorithms which we have used here, there are certain affirmations that needs to be discussed further. TheFully adaptive routing algorithm and the pseudo adaptive routing algorithm play a significant composite while building a chip which yields maximum scalability. In addition, it also prevents any kind of routing problems which might come up during the respective network communication.

In the aforesaid RiCoBiT topology, after deciding the number of rings (k), further there are three cases yet to be decided wherein the packet has to be traversed from source to destination. The three cases to be configured are as follows :

1. One source to one destination(1:1)
2. One source to all destinations(1:n)
3. All sources to all destinations(n:n)

The probability of the packets reaching the destinations while using any other topologies is quite less. But in RicoBiT it is assured that there will be a guaranteed throughput.

After determining the case in which our packet will be traversed, then the nodes pertaining to that case will be concerned next.

4. RESULTS

Considering the significant aspects of the paperconcerned, it appears that the type of topology used that is E-RiCoBiT, adversely effects the performance of the chip advantageously. Thus we draft out the various nodes concerned according to their coordinates through three cases involved and the results are noted thereafter.

High Performance as a main objective is being laid out through these outputs as shown below. The parameters namely total time, average time, maximum time and the path are being extracted successfully and a primitive comparison is made between the two that is fully adaptive and pseudo adaptive routing algorithms effectively.The varied outcomes of each scenario gives a meaningful insight about the differences of the two routing algorithms respectively.

Here are the three main cases illustrated with their specific type of algorithms:

Fully Adaptive Routing Algorithm based on all the three cases-

[1]One source to One Destination

[2]One source to All Destinations

[3]All sources to All Destinations

Through either zero broken node, one broken node or two broken nodes respectively.

LEVEL NUMBER	SOURCE NODE	DESTINATION NODE	BROKEN NODE	ONE SOURCE TO ONE DESTINATION			
				TOTAL TIME	AVG TIME	MAX TIME	PATH
1	(1,0)	(1,1)	0	13	12	13	2 1
2	(2,1)	(2,3)	0	34	32	34	6 5 4
3	(3,3)	(3,7)	0	76	72	76	14 6 5 4 10
4	(4,6)	(4,14)	0	138	132	138	29 14 6 5 4 10 21
5	(5,12)	(5,18)	0	200	192	200	59 29 14 6 5 4 10 21 43

Fig. Fully Adaptive(one source to one destination)(no broken node)

LEVEL NUMBER	SOURCE NODE	DESTINATION NODE	BROKEN NODE	ONE SOURCE TO ONE DESTINATION			
				TOTAL TIME	AVG TIME	MAX TIME	PATH
1	(1,0)	(1,1)	(1,1)	1	0	1	2 1
2	(2,1)	(2,3)	(2,2)	51	48	51	6 2 1 4
3	(3,3)	(3,7)	(2,3)	94	90	94	14 13 12 11 10
4	(4,6)	(4,14)	(3,7)	160	154	160	29 28 13 12 11 10 21
5	(5,12)	(5,18)	(4,14)	248	240	248	59 58 28 13 12 11 10 21 43

Fig. Fully Adaptive(one source to one destination)(one broken node)

LEVEL NUMBER	SOURCE NODE	DESTINATION NODE	BROKEN NODE	ONE SOURCE TO ONE DESTINATION			
				TOTAL TIME	AVG TIME	MAX TIME	PATH
2	(2,1)	(2,3)	(1,0)(2,0)	34	32	34	6 5 4
3	(3,3)	(3,7)	(2,3)(1,1)	94	90	94	14 13 12 11 10
4	(4,6)	(4,14)	(3,7)(2,1)	160	154	160	29 28 13 12 11 10 21
5	(5,12)	(5,18)	(4,14)(2,2)	272	264	272	59 58 18 13 12 11 10 21 43

Fig. Fully Adaptive(one source to one destination)(two broken nodes)

LEVEL NUMBER	SOURCE NODE	BROKEN NODE	ONE SOURCE TO ALL DESTINATIONS			
			TOTAL TIME	AVG TIME	MAX TIME	PATH
1	(1,0)	0	13	13	13	2 1
2	(2,1)	0	135	27	50	6 5 4
3	(3,3)	0	573	44	76	14 6 5 4 10
4	(4,6)	0	2348	80	138	30 14 6 5 4 10 21
5	(5,12)	0	7537	123	200	62 30 14 6 5 4 10 21 43

Fig. Fully Adaptive(one source to all destinations)(no broken node)

LEVEL NUMBER	SOURCE NODE	BROKEN NODE	ONE SOURCE TO ALL DESTINATIONS			
			TOTAL TIME	AVG TIME	MAX TIME	PATH
1	(1,0)	(1,1)	0	0	0	-
2	(2,1)	(2,3)	101	20	34	2 1 4
3	(3,3)	(2,2)	569	43	95	14 6 2 1 4 10
4	(4,6)	(3,5)	2344	80	138	30 14 6 5 4 10 21
5	(5,12)	(4,8)	7423	121	200	62 30 14 6 5 4 10 21 43

Fig. Fully Adaptive(one source to all destinations)(one broken node)

LEVEL NUMBER	SOURCE NODE	BROKEN NODE	ONE SOURCE TO ALL DESTINATIONS			
			TOTAL TIME	AVG TIME	MAX TIME	PATH
1	(1,0)	-	-	-	-	-
2	(2,1)	(1,0)(2,0)	85	17	34	6 5 4
3	(3,3)	(2,3)(1,1)	527	40	94	14 13 12 11 10
4	(4,6)	(3,5)(2,1)	2394	82	138	30 14 6 5 11 10 21
5	(5,12)	(3,7)(4,8)	7612	124	249	62 30 29 28 13 12 111 10 21 43

Fig. Fully Adaptive(one source to all destinations)(two broken nodes)

ALL SOURCE TO ALL DESTINATION

LEVEL NUMBER	NO OF BROKEN NODES	BROKEN NODE	TOTAL TIME	AVG TIME	MAX TIME
1	0	0	26	6	12
2	0	0	782	13	48
3	0	0	8094	22	90
4	0	0	68218	39	154

Fig. Fully Adaptive(all source to all destination)(no broken node)

ALL SOURCE TO ALL DESTINATION

LEVEL NUMBER	NO OF BROKEN NODES	BROKEN NODE	TOTAL TIME	AVG TIME	MAX TIME
1	1	-	-	-	-
2	1	(1,0)	627	13	64
3	1	(2,3)	7888	24	126
4	1	(4,9)	65296	39	154

Fig. Fully Adaptive(all source to all destination)(one broken node)

Pseudo Adaptive Routing Algorithm based on all the three cases-

[1]One source to One Destination

[2]One source to All Destinations

[3]All sources to All Destinations

Through either zero broken node, one broken node or two broken nodes respectively.

LEVEL NUMBER	SOURCE NODE	DESTINATION NODE	BROKEN NODE	ONE SOURCE TO ONE DESTINATION			
				TOTAL TIME	AVG TIME	MAX TIME	PATH
1	(1,0)	(1,1)	0	12	3	12	1 2
2	(2,1)	(2,3)	0	32	3	32	4 5 6
3	(3,3)	(3,7)	0	72	3	72	10 4 5 6 14
4	(4,6)	(4,14)	0	132	3	132	21 10 4 5 6 14 2 9
5	(5,12)	(5,18)	0	120	0	120	43 21 10 4 5 6 14 29 59

Fig. Pseudo Adaptive(one source to one destination)(no broken node)

LEVEL NUMBER	SOURCE NODE	DESTINATION NODE	BROKEN NODE	ONE SOURCE TO ONE DESTINATION			
				TOTAL TIME	AVG TIME	MAX TIME	PATH
1	(1,0)	(1,1)	(1,1)	1	0	1	-
2	(2,1)	(2,3)	(2,2)	48	5	48	4 1 2 6
3	(3,3)	(3,7)	(2,3)	90	5	90	10 4 5 12 13 14
4	(4,6)	(4,14)	(3,7)	154	3	154	21 10 4 5 6 13 28 29
5	(5,12)	(5,18)	(4,14)	120	0	120	43 21 10 11 24 49

Fig. Pseudo Adaptive(one source to one destination)(one broken node)

LEVEL NUMBER	SOURCE NODE	DESTINATION NODE	BROKEN NODE	ONE SOURCE TO ONE DESTINATION			
				TOTAL TIME	AVG TIME	MAX TIME	PATH
1	(1,0)	(1,1)	(1,1)	-	-	-	-
2	(2,1)	(2,3)	(1,0)(2,0)	32	3	32	4 5 6
3	(3,3)	(3,7)	(2,3)(1,1)	90	5	90	10 4 5 12 13 14
4	(4,6)	(4,14)	(3,7)(2,1)	154	3	154	21 10 11 5 6 12 28 29
5	(5,12)	(5,18)	(4,14)(2,2)	120	0	120	43 21 10 4 1 2 6 14 13 28 58 59

Fig. Pseudo Adaptive(one source to one destination)(two broken nodes)

LEVEL NUMBER	SOURCE NODE	BROKEN NODE	ONE SOURCE TO ALL DESTINATIONS			
			TOTAL TIME	AVG TIME	MAX TIME	PATH
1	(1,0)	0	24	24	12	1 2
2	(2,1)	0	224	44	32	4 5 6
3	(3,3)	0	1044	80	92	10 4 5 6 14
4	(4,6)	0	4356	150	132	21 10 4 6 14 30

Fig. Pseudo Adaptive(one source to all destinations)(no broken node)

LEVEL NUMBER	SOURCE NODE	BROKEN NODE	ONE SOURCE TO ALL DESTINATIONS			
			TOTAL TIME	AVG TIME	MAX TIME	PATH
1	(1,0)	(1,1)	0	0	0	-
2	(2,1)	(2,3)	192	38	32	4 1 2
3	(3,3)	(2,2)	1080	83	90	10 4 1 2 6 14
4	(4,6)	(3,5)	4488	154	132	21 10 4 5 6 14 30

Fig. Pseudo Adaptive(one source to all destination)(one broken node)

LEVEL NUMBER	SOURCE NODE	BROKEN NODE	ONE SOURCE TO ALL DESTINATIONS			
			TOTAL TIME	AVG TIME	MAX TIME	PATH
1	(1,0)	-	-	-	-	-
2	(2,1)	(1,0)(2,0)	160	32	32	4 5 6
3	(3,3)	(2,3)(1,1)	1088	77	90	10 4 5 12 13 14
4	(4,6)	(3,5)(2,1)	4576	157	132	30 14 6 5 11 10 21

Fig. Pseudo Adaptive(one source to one destination)(two broken nodes)

LEVEL NUMBER	NO OF BROKEN NODES	BROKEN NODE	TOTAL TIME	AVG TIME	MAX TIME
1	0	0	48	24	12
2	0	0	1472	49	48
3	0	0	15336	84	90

Fig. Pseudo Adaptive(all sources to all destinations)(no broken nodes)

5. CONCLUSION

The brief description on Network On Chip is given along with the topology being used. The optimal routing algorithms used to make a comparative analysis are also mentioned. The performance analysis proves that RiCoBiT topology is the best topology that can be used in this scenario. Whereas other topologies are a bit disadvantageous and can also have routing problems concerned. So RiCoBiT makes sure that the packet takes up the shortest length there is and also assures that any kinds of routing problems are prevented. The maximum scalability and the assured throughput are the basic advantages provided. The concept of adaptiveness increases the efficiency of routing by making sure that the packet has different directions to traverse through in order to reach the destination thereby lessening the amount of time taken by it to reach. By this, we conclude that the paper provides a vast analysis by comparing the efficiency of two routing algorithms- fully adaptive and pseudo adaptive while using RiCoBiT topology for a perfect kind of network communication to take place.

6. REFERENCES

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