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Implementation Diversity and Partial Connection of Routers in Application –Specific Network-On-Chip Synthesis

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Abstract: The partial connection and the implementation diversity of routers are exploited. Network on chip has emerged as a promising solution to future System on Chip (SOC). Network on Chip (NOC) topology synthesis determine the connection of the routers. In the existing topology synthesis method consider only a single implementation for each size of the router. To tackle this drawback, we propose a Novel NOC topology synthesis method where the implementation diversity of the routers is exploited to produce optimal topologies in terms of area and or the power consumption. Here the algorithm used produces a single optimised route which reduces the route discovery time, number of hops, and the energy consumption.

Index Terms: network on chip (NOC), system on chip (SOC), synthesis, routers.

I. INTRODUCTION

Due to ever-increasing complexity of System-on-Chip (SoC) integration and poor scaling of metal wire, on-chip communication architectures have been eagerly researched by both academics and industry. On-chip interconnection network, also called Network-on-Chip (NoC), was proposed in, it has emerged as a promising solution to many-core processors and very large scaled SoCs.The underlying philosophy of NoC is to replace the traditional ad-hoc on-chip wiring with more structured and modular architectures with routers and links. Research topics for NoC including the topology, packet routing, router design, and application mapping. NoC is advantageous to the systems which are dedicated to or emphasized on specific applications. The existing topology synthesis methods have aimed at the algorithms (or design space exploration) to find the best topology for the target application. They typically require several information as inputs, such as physical distances among is and router library which contains physical characteristics (delay, area, and power) of on-chip routers of all sizes.

The existing system two way routing uses single buffer policy which uses only one threshold value for the transmission of high priority and the low priority packets and the rate of data transmission will be less, to overcome this a new system called NWAY routing is developed which uses dual buffer policy which has two threshold values Qmin and Qmax for transmission of high priority and the low priority packets and the rate of data transmission will be more.

The steps which are done are: Design and Simulation of Node Deployment Algorithm which is responsible for placement of nodes in the WSN network. Design and Simulation of Routing table Formation Algorithm which is responsible for generating the routing tables in the WSN network. Design and Simulation of Packet Generation algorithm to assign the HP and LP packets for the nodes in the buffer. Design and Simulation of 2 way routing Algorithm for routing of the packets from the source node to the destination node in the network using per destination queue and single buffer threshold policy. Design and Simulation of N way routing Algorithm for routing of the packets from the source node to the destination node in the network using shadow queue and dual buffer threshold policy. Comparison of the 2 way routing algorithm with the N way routing algorithm like Packet Delivery Ratio, Energy Consumption and end to end delay.

II. RELATED WORKS

In the paper titled “A survey on sensor networks” the authors F. Akyildiz, W. Su, Y. Sankarasubramaniam and E. Cayirci describe that wireless sensor network is an autonomous system of numerous tiny sensor nodes equipped with integrated sensing and data processing capabilities. Sensor networks are distinguished from other wireless networks by the fundamental constraints under which they operate, i.e., sensors have limited and unreplenishable power resources making energy management a critical issue in wireless sensor networks.

Therefore sensors must utilize their limited energy as efficiently as possible. In the paper titled “Active Trust Transmission Mechanism for Wireless Sensor Network”, the authors XiongFei, Xu Qi Jian. Describe that Network security and node's trust evaluation is another vital issue in WSN. The nodes captured by opponents behave as malicious nodes, and attack the network by misreporting,

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modifying or dropping useful data packets. The trust based framework Probalistic Broadcasting the packet loss and routing overhead by eliminating the compromised nodes.

III. MOTIVATION

In this section examples which show the necessity of the proposed work are given first in the existing system i.e., two way routing the following functions are done:-

1) Multiple routes between the source node and the destination node will be discovered
2) The type of network used less is the heterogeneous network
3) Heterogeneous networks are the network where inter communication both are possible
4) The number of routes discovered will be equal to the number of nodes in the network

The main drawback in the existing system is the discovery of the multiple routes when multiple routes are discovered, more time will be consumed and the energy required for the discovery of multiple routes will also be very high as a result residual energy of the system comes down.

The drawback of consumption of high motivated me to select the existing system and to propose a system which has a slight modification compared to the existing System
The new system will overcome the following drawbacks i.e. instead of discovering multiple routes, it will discover a single optimised route. Since only the single optimised route is discovered which is appearably the best route, the time will be saved I.e. is the time for discovering the multiple routes will be more compared to the time required to the time required for the discovery of single optimized route and when only a single optimized route is discovered the nodes which participate in the routing will also be less and hence the Consumption if energy will also be reduced.

IV. EXISTING SYSTEM AND THE LIMITATIONS OF EXISTING SYSTEM

In the 2 way routing algorithm the data is routed to make more packets arrive at the destination within a limited period of time. The 2 way routing algorithm looks into the buffer of the immediate neighbors and then picks a forward node in such a way that the node with high link weight is chosen to move forward. This approach is good because it finds a route which has more packets to send over a destination.

Secondly the back pressure algorithm will make use of single buffer threshold policy. If the buffer exceeds certain threshold then only high priority packets are removed from the buffer and moved forward. If the buffer is having packets less than threshold then a certain number of both high priority and low priority packets are send.

The following are the limitations of the 2way routing algorithm: the back pressure takes into consideration only the immediate neighbors because of which only limited link capacity is exploited rather than over all weight being used. It has single buffer threshold policy because of we can send only high priority packets as compared to low priority packets. The packet delivery rate in the 2 way routing algorithm is very less. It takes more time to reach a zero packet stage. Each node maintains queue for the destination because of which the over queue cost is high.

V. PROPOSED SYSTEM AND THE METHODOLOGY USED IN THE PROPOSED SYSTEM

The proposed approach is the N way routing. N WAY ROUTING algorithm will pick the next forward node based on the overall link capacity of the route i.e. nodes which have more packets will be chosen so that the overall traffic is handled in a stipulated fashion for a Wire line network. For a wireless network the N WAY ROUTING algorithm will find a set of 1- hop neighbors, measures the link weight and the node which is having highest link weight is chosen as the next forward node similar to back pressure. Secondly the N WAY ROUTING algorithm makes use of dual threshold buffer policy which is responsible for the sending more packets to destination as compared to back pressure algorithm.

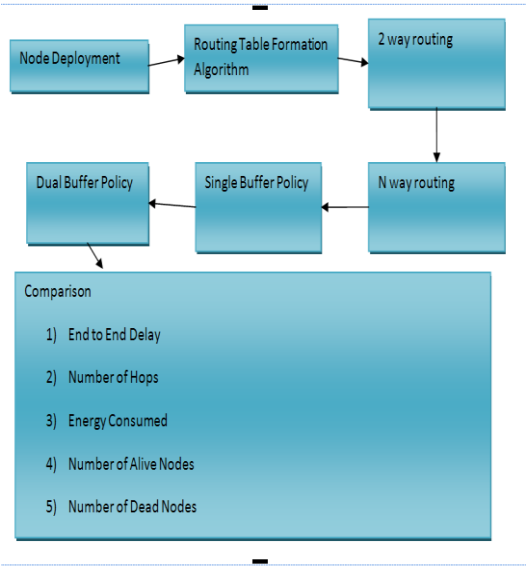

Figure: 1 data flow representation

Node Deployment
The Node Deployment is the algorithm which is used to place the nodes in the network Routing Table Formation.

The routing table formation algorithm helps in route discovery process from the perspective of neighbor discovery. The routing table formation process can be divided into following phases

1) Global Routing Table flowchart
2) Individual Routing Table flowchart

Global Routing Table flowchart
The Global Routing Table flowchart is responsible for generation of routing tables for all the nodes in the network.

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Individual Routing Table flowchart
The individual routing table flowchart is responsible for generating the routing table for the specific node in the network.

Neighbor Nodes in the Network
This Module is used to deter NWAY the Neighbor Nodes in the Network. These are the set of nodes which are within the transmission Range.

TWO Way Routing
The 2 way routing algorithm will make use of measure of queue length present in buffer. The forward nodes are picked in such a way that the time of reply is less. Like this process is repeated until the destination is reached. When the communication is between 2 autonomous system then the process is performed from source node to a node closer to router and then from the router to destination. The algorithm makes use of LHNL list which stands for Last Hop Neighbor List which is the previous hop of the current node. This process is repeated until destination is reached.

Single Buffer policy
2 way routing algorithm will make use of single buffer threshold policy. In single buffer threshold policy the buffer size is checked. If buffer size is less than threshold the certain number of HP packets and number of LP packets are removed. If the buffer size is higher than threshold then only HP packets are removed

N way routing
The N way routing algorithm will find the neighbor lists. If the neighbors does not have destination then stop the process otherwise pick a neighbor which has lowest buffer and reply time. Like this process is repeated until destination is reached

Dual Buffer Policy
Dual Buffer Policy is a process makes use of 2 thresholds namely $q_{\min}$ and $q_{\max}$. If the buffer size lies between 1 to $q_{\min}$ then remove both HP and LP packets. If the buffer size lies between $q_{\min}$ to $q_{\max}$ then remove both HP and LP packets and if the buffer size is greater than $q_{\max}$ the remove only HP packets.

Comparison: Comparison block consists of following parameters:

1. End to End Delay
End to End Delay is the time taken for the RREQ to go from the source node to destination node and then send back the RRPLY from destination node to source node.

$$E2E_{delay} = t_{stop} - t_{start}$$

Where,

$t_{stop} = This\ is\ the\ Time\ at\ which\ RRPLY\ is\ recieved$

$t_{start} = This\ is\ the\ Time\ at\ which\ RREQ\ is\ send$

2. Number of Hops
The Number of intermediate links from the source node to destination node is called Number of Hops.

3. Energy Consumption
The energy wasted for delivering the packets from the source node to destination node. The total energy consumption is given as follows

$$TE_c = \sum_{i=1}^{l} E_i$$

Where,

$l = number\ of\ links$

$E_i = Energy\ consumed\ by\ the\ i^{th}\ link$

The energy consumed by the i^{th} link given by

$$E_c = 2E_{tx} + E_{amp}\ d^{\gamma}$$

$E_{tx} = energy\ required\ \ for\ data\ transmission$

$E_{amp} = energy\ required\ \ for\ data\ generation$

$d = distance\ between\ two\ intermediate\ nodes$

$\gamma = environment\ \ factor$

$0.1 \le \gamma \le 1$

$The\ Standard\ environment\ \ factor$

4. Number of Alive Nodes
This is defined as the count of set of nodes whose battery level is greater than or equal to B/4
Where B is initial Battery Power

5. Number of Dead Nodes
This is defined as the count of set of nodes whose battery level is less than B/4.Where B is

6. Residual Energy
The residual energy of the network is defined by using the following equation

$$RE = \sum_{i=1}^{N_{nodes}} RE_i$$

Where,

$RE_i = Residual\ energy\ \ for\ \ Node\ i$

$N_{nodes} = Number\ of\ \ nodes$

5.1 Building blocks and results of the NWAY routing algorithm

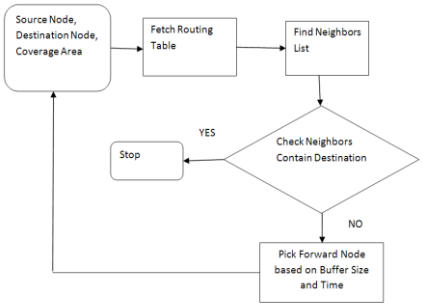

Figure 2: flowchart of NWAY routing algorithm

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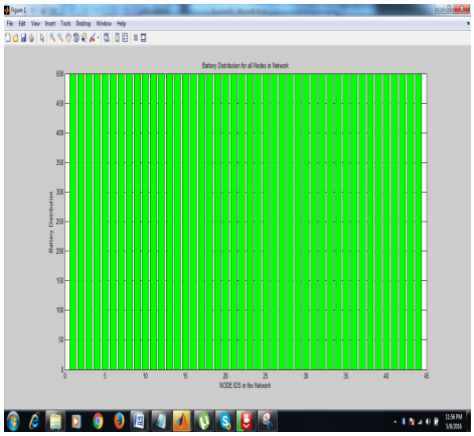

Fig 3: Battery Distribution

The above window shows the battery distribution for all the nodes in the network. Since we have initialized the initial energy for all the nodes in the network as 500mj, all the nodes in the network are initialized with the same energy i.e. 500mj.In the above figure the x axis indicates the battery distribution and the y axis indicates the node id's in the network. Node id's are the names given to the nodes in network

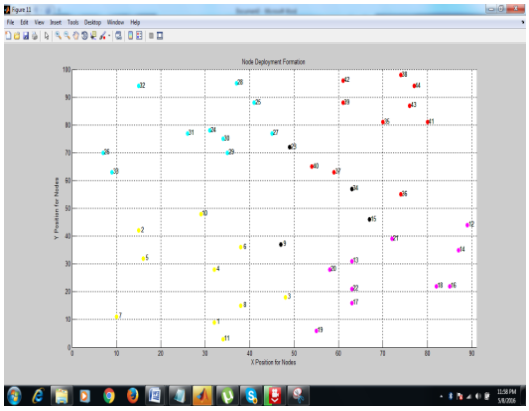

fig 4: node deployment

The above window shows the deployment of nodes in the network.The network is divided into 4 quadrants withn the random number of nodes in it which is epresented by 4 different colors in the above figure The extra 4 nodes which is represented by brown color in the above figures represents the routers, which is responsible for the intercommunication of the nodes.

Since it is a NWAY routing it finds only a single optimized route between the source node and the destination node.The above figure shows a single optimized route between the source node and the destination node.

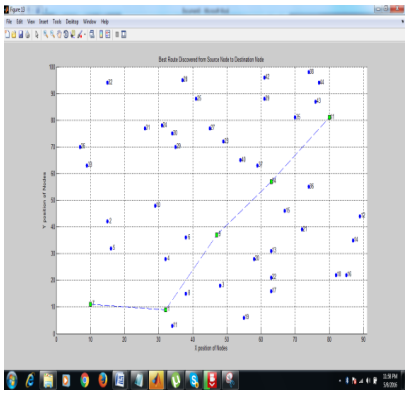

fig 4: single optimized route

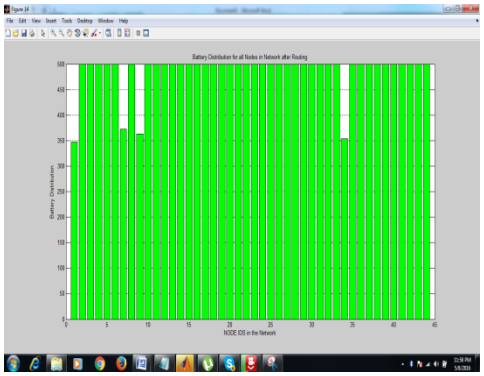

fig 5: battery distribution after routing

The above figure shows the distribution of battery of the nodes in the network. The battery distribution of the nodes which participate in the routing is reduced compared to the battery distribution of the other nodes which do not participate in routing.

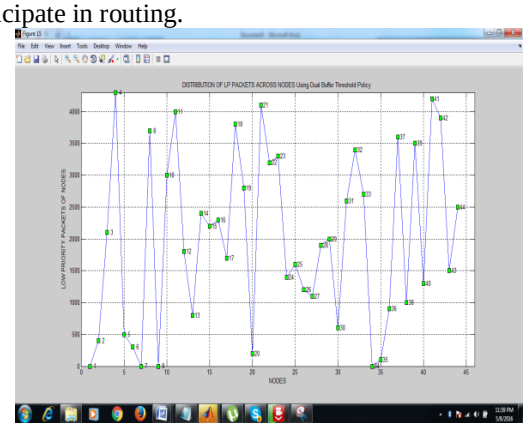

fig 6: battery distribution after routing

The above figure indicates the distribution of low priority packets across the nodes using dual buffer policy. If the

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threshold is below Qmin then both LP and HP packets are removed and if the threshold is between Qmin and Qmax the number of LP+Adjustment factor and the number of HP+Adjustmnt factor is removed.

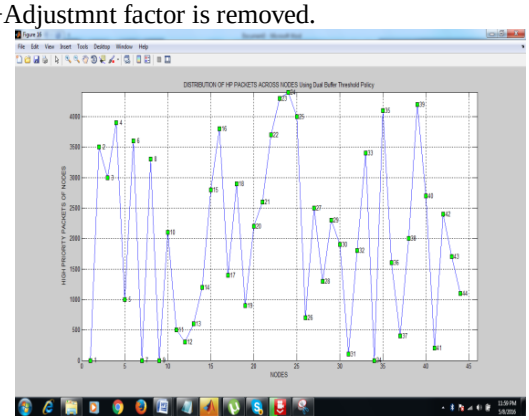

fig 7: distribution of HP packets

The above figure shows the distribution of high priority packets across the nodes.
If the value is greater than Qmax then only high priority packets are removed..

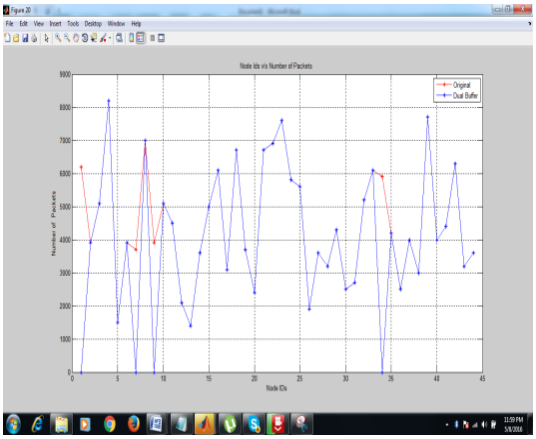

Fig 8: comparison of the number of LP and HP before and after applying dual buffer policy

The above figure shows the number of packets both LP and HP before applying dual buffer policy and after applying dual buffer policy.

VI. EXPERIMENT RESULTS

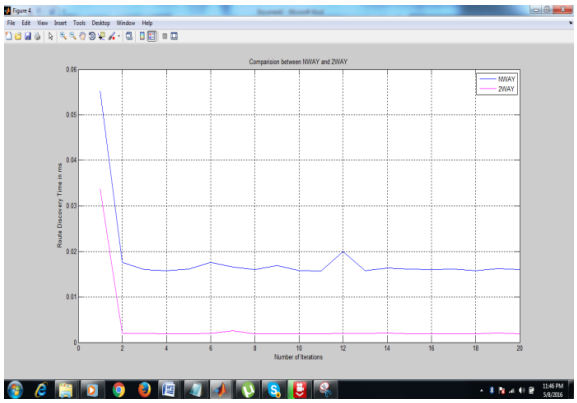

Fig 9: comparison of TWOWAY and NWAY in terms of route discovery time

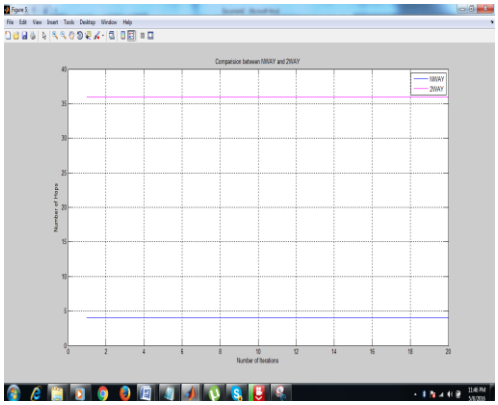

fig 10: comparison of TWOWAY and NWAY in terms of number of hops

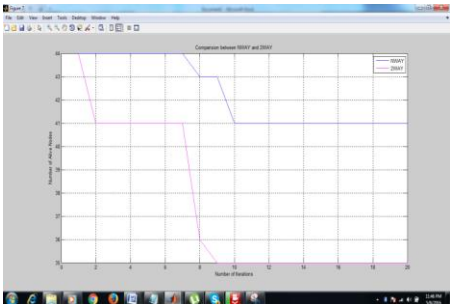

fig 11: comparison of TWOWAY and NWAY in terms of number of alive nodes

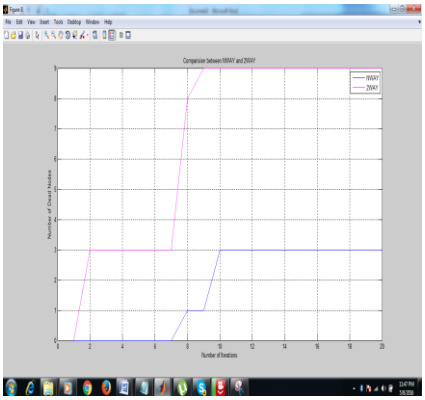

fig 12: comparison of TWOWAY and NWAY in terms of number of dead nodes

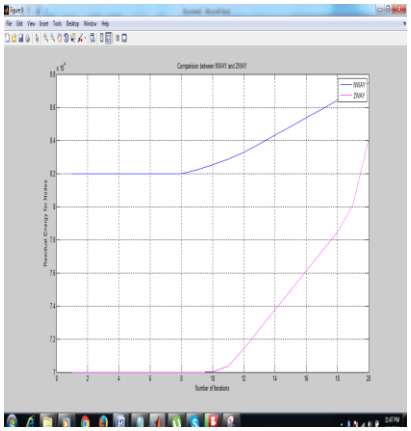

fig 13: comparison of TWOWAY and NWAY in terms of residual energy

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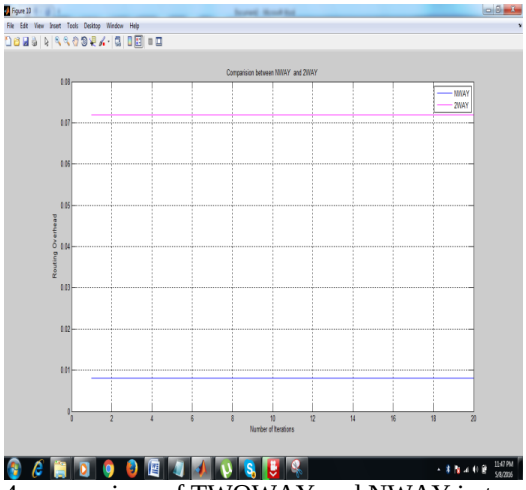

fig 14: comparison of TWOWAY and NWAY in terms of routing over head

The number of iterations should be given to specify the number of times between which the TWOWAY routing and the NWAY routing algorithm which has to be compared. The following factors are compared between the TWOWAY and NWAY routing algorithms:

1) As shown in the above figure the **ROUTE DISCOVERY TIME for** TWOWAY routing algorithm is more compared to the NWAY routing algorithm.
2) The **NUMBER OF HOPS** for TWO WAY ROUTING is more compared to the NWAY routing algorithm.
3) The **RESIDUAL ENERGY** for NWAY routing is more compared to TWO WAY routing.
4) The number of **ALIVE NODES** for NWAY routing algorithm is more compared TWO WAY routing algorithm.
5) The number of **DEAD NODES** for TWO WAY routing is more compared to the NWAY routing.
6) The **ROUTING OVERHEAD** of NWAY routing algorithm is less compared to the TWO WAY routing algorithm.

VI. CONCLUSION

In this project two algorithms have been simulated using MATLAB. Randomized (2 Way routing) and LHNL based routing. From the simulation results one can see that randomized routing finds the multiple routes and then it will the route which has the lowest time taken.

The disadvantages are that multiple routes must be discovered and it also does not take into consideration packets residing in the nodes memory.

The proposed method discovers the single optimized route from source node to destination node based on packet length, hop length and exhaust time. Also in this project single buffer policy and dual buffer policy have been implemented and the packets delivery status is also computed.

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