A Survey on ACO Based Fault Tolerant Routing Scheme For Network on Chip

Shahina KH\textsuperscript{1} & Abdul Ali\textsuperscript{2}

\textsuperscript{1} M.Tech scholar, Department of Computer Science & Engineering
Ilahia College of Engineering & Technology, India
\textsuperscript{2} Asst. Professor, Department of Computer Science & Engineering
Ilahia College of Engineering & Technology, India

\textbf{Abstract}: Network on chip is a scalable fast communication system used by multi core systems. However, research has shown that metallic interconnects cause high latency and consume excess energy in NoC systems. Ant colony optimization is a new fault tolerant routing algorithm introduced for network on chip systems. It is based on the concept of behavior of natural ants. If a node is faulty it will find out new path based on amount of pheromone deposited.

\textbf{Keywords}— Network on chip (NOC), Ant colony optimization (ACO), Chip Multi Processore (CMP)

\textbf{I. INTRODUCTION}

The Network-on-Chips (NoCs) design paradigm solves several of the problems of traditional bus based networks, including limited bandwidth and scalability. Regular NoCs topologies such as meshes and tori are implemented using metallic links that are energy efficient and provide high date rate links at short communication distances. However, as the links become longer, the global interconnects suffer from higher energy usage (extra hops) and longer propagation delays [1].

Ant Colony Optimization (ACO) is a bio-inspired algorithm extensively applied in optimization problems. The performance of Network-on-Chip (NoC) is generally dominated by traffic distribution and routing. With more precise network information for path selection by using pheromone, ACO-based adaptive routing has higher potential to overcome the unbalance and unpredictable traffic load.

Routing algorithm determines a path that each packet is transferred from a source to a destination in NoC systems. Adaptive routing is composed of routing function and selection function. Firstly, the routing function returns a set of output channels based on the turn models [4]. Then, the selection function chooses an output channel of the candidate channels from the routing function according to the different network information. Obtaining more detailed network information can improve the selection efficiency and the balance of traffic distribution. Therefore, the selection function affects the performance critically for all adaptive routing algorithms.

In order to make traffic more balance, Ant Colony Optimization (ACO)-based adaptive routing is proposed in NoC systems [6]. ACO is a bio-inspired algorithm that imitates the process of an ant colony that finds the shortest path from their nest to a food. Ants diffuse the pheromone on the path to communicate with each other, and the pheromone is accumulated faster on the shorter path. In the long run, ants can reach to the food with the shortest path. ACO is extensively applied in optimization problems. ACO can also enhance selection efficiency with the current and the historical local buffer state for traffic balancing[4].

\textbf{II. RELATED WORKS}

\textbf{A.WiNoC}

A-WiNoC is a scalable wired/wireless hybrid architecture with adaptable links. A wired/wireless hybrid is used to supplement the wireless bandwidth as well as provide more energy-efficient communication. Wired links help provide the required high bandwidth demands of CMPs as well as the desired energy-efficiency at short distances. Wireless links, on the other hand, can provide high energy efficiencies at long distances. Another unique advantage of wireless links is their adaptability. We use adaptability in A-WiNoC since this can improve channel utilization [1].

\textbf{(i) NoC Design}

The NoC Design consists of N cores and each core is connected to at least one router. Routers are organized into sets in order to systematically distribute static and dynamic wireless links. The architecture is divided into four sets, each with four...
routers. Routers 0-3 are in Set 0, routers 4-7 are in Set 1, routers 8-11 are in Set 2, and routers 12-15 are in Set 3 (also seen in Fig. 2). Each router has four transmitters: \( T_{ij} \), which indicates a transmitter from Set \( i \) to Set \( j \). The next section on communication will explain that all the routers in each set share these four wireless transmitters[1].

Figure (1): WiNoC Design

Routing is based on the distance from the packet’s source node to its destination node. If the distance is only one wired hop then a wired link is used. If the distance is greater than one wired hop then a wireless link is used in order to reduce packet latency and power.

Figure (2): The logical wireless communication between sets.

(B) ACO-based Deadlock-aware fully-adaptive Routing

Ant Colony Optimization (ACO) is a problem-solving technique inspired by the behavior of real-world ant colony. ACO-based routing also has high potential on balancing the traffic load in the domain of Network-on-Chip (NoC), where the performance is generally dominated by traffic distribution and routing. Since the pheromone in ACO provides both spatial and temporal network information[2]. If a packet face a fault in their path it will find a new shortest path, by considering the following factors.

(i) Setting the threshold of conditional detour \( ThCD \)

The empirical value of \( ThCD \) is around the average packet length, which is the approximated expected value for a packet to hold the output channel.

(ii) Counting the waiting time

The definition of the waiting time \( T_{wait} \) is the same as previous which starts from the time a packet arrives at the head of the input buffer, requesting for an output channel.

(iii) Detouring

The conditional detour is triggered if the waiting time \( T_{wait} \) exceeds the threshold of conditional detour \( ThCD \), forwarding the packet through a non-minimal path[2].

(c) Regional ACO-based Routing for Load-Balancing in NoC Systems

ACO-based adaptive routing has been applied to achieve load-balancing effectively with historical information. However, the cost of the ACO network pheromone table is too high, and this overhead grows fast with the scaling of NoC. Regional ACO-based routing (RACO) with static and dynamic regional table forming technique to reduce the cost of table, share pheromone information, and adopt look ahead model for further load-balancing[3].

Figure (3): (a) The information sharing problem of original ACO. (b) Merged A and B into one entry on the routing table.

(D) ACO-Based Cascaded Adaptive Routing
In this method searching is done by using cascaded points. Initially we want to find out the observation region. If the destination is belong to the same observation region route the packet otherwise find another observation region by considering other cascade point. The cascade point is find out by using fixed and random search as shown in the above fig(3).

Random searching chooses the cascaded point from the candidate points are between the source and destination with the minimal path. However, these searching methods do not consider the traffic status. The packets that might be forwarded to the busy cascaded point that brings about the traffic congestion. In order to search a better cascaded point, adaptive searching determines the cascaded point that has minimum number of ant packet being passed through a router in the observation region[4].

![Figure(4): The flow of cascaded routing.](image)

III. CONCLUSION

Ant colony optimization based fault tolerant routing algorithm is a new routing algorithm implemented on NOC systems. Here routing is based on the concept of pheromone updation. When a packet is coming to the network the source routers will route the packet to the destination by using shortest path.

ACKNOWLEDGMENT

I would like to thank all the faculty members and students of Ilahia college of Engineering and technology for their immense support. Also I like to express gratitude towards friends and family and all other good hearts for their motivation and support to this work come true.

REFERENCES


