

Optimization With Congestion Aware Routing In Mesh Topology

Saranya Mani¹, Ranjana Ponraj²

¹Computer and Communication Engineering/ Hindustan University/ Chennai, Tamil Nadu/ India

²Computer Science Engineering/ Hindustan University/Chennai, Tamil Nadu/India

Abstract

Wireless mesh networks (WMNs) have emerged as a key technology for next-generation wireless networking. Because of their advantages over other wireless networks, WMNs are undergoing rapid progress and inspiring numerous applications. Wireless mesh networks are a promising way to provide Internet access to fixed and mobile wireless devices. Wireless mesh networks (WMNs) consist of mesh routers and mesh clients, where mesh routers have minimal mobility and form the backbone of WMNs. They provide network access for both mesh and conventional clients. Routing in wireless mesh networks (WMNs) has been an active area of research for the last several years. Routing can be referred to as the process of determining the end-to-end path between a source node and a destination node. For satisfying users' quality of service requirements optimizing network resource utilization is the primary focus. Congestion control in wireless multi-hop networks is challenging and complicated due to inference and dynamically changing routing paths. The proposed work is focused on the design and development of efficient congestion avoidance and routing algorithm framework in Wireless Mesh Networks (WMNs). This can be achieved using with help of congestion aware ant colony optimization algorithm (CACO). The CACO study the use of biologically inspired agents to effectively route the packets in WMNs. CACO uses AntMesh, a distributed interference-aware data forwarding algorithm which enables the use of smart ants to probabilistically and concurrently perform the routing and data forwarding in order to stochastically solve a dynamic network routing problem algorithm. The CACO algorithms has capability to effectively perform in terms of routing load and end to end delay, throughput. This CACO routing algorithm also avoids congested areas by routing packets away from the congestion.

Keywords: Congestion, Routing, Wireless Mesh network..

1.Introduction

Mesh topology is the one where every node is connected to every other node in the network. This type of topology is very expensive as there are many redundant connections. It is commonly used in wireless networks.

1.1 . Wireless Mesh Network(WMN)

The concept of wireless mesh networks has emerged as a promising technology for the provision of affordable and low cost solutions for a wide range of applications such as broadband wireless internet access in developing regions with no or limited wire infrastructure, security surveillance, and emergency networking; where public safety teams like firefighters can still be connected with the help of just-in-time mesh nodes mounted on tree poles. The main reason for this vast acceptance of mesh networks in the industry and academia is because of its self-maintenance and resiliency feature and the low cost of wireless routers. In addition, the self-forming feature of WMN makes the deployment of a mesh network easy thereby affording scalability to the network. Mesh networks of most commercial interests are characterized as fixed backbone WMNs where mesh nodes are generally static and are mostly supplied by a permanent power source.

1.2 Wireless Sensor Network(WSN)

The WSN is built of nodes from a few to several hundreds or even thousands, where each node is connected to one or many sensors. Each such sensor network node has typically several parts a radiotransceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery or an embedded form of energy harvesting. The cost of sensor nodes is similarly variable, ranging from a few to hundreds of dollars, depending on the complexity of the individual sensor nodes. Size and cost constraints on sensor nodes result in corresponding constraints on resources such as energy, memory, computational speed and communications bandwidth. The topology of the WSNs can vary from a simple star network to an advanced multi-hop wireless mesh network. The base stations are one or more components of the WSN with much more computational, energy and communication resources. They act as a gateway between sensor nodes and the end user as

they typically forward data from the routers, designed to compute, calculate and distribute the routing tables.

2. Problem addressed in Routing

The problem is WMN is the problem of packet routing for efficient data forwarding. Since most of the traffic in a mesh network usually flows between regular nodes and a few Internet gateways. This can result in an uneven loading of links and can cause certain paths to be saturated. Similarly, the existence of inter-flow interference among the nodes and intra-flow interference within a transmission path may affect traffic loads on mesh nodes in a multi-radio WMN. The main objective of any mesh routing protocol is thus to effectively distribute the traffic by selecting channel diverse paths with less inter/intra flow interference. Different routing protocols may impose different requirements on the design of their routing metrics. Hence, it is necessary to first understand what routing protocols best fit mesh networks to understand the necessary properties of routing metrics to support effective routing in mesh networks. Depending on when routes are calculated, the possible routing protocols for mesh networks can be divided into two categories: on-demand routing and proactive routing. Based on how packets are routed along the paths, proactive routing can further be divided into two subcategories: source routing and hop-by-hop routing. All of these different routing protocols have different costs in terms of message overhead and management complexity. In this section, we examine the advantages and disadvantages of using these routing protocols in mesh network one of the on-demand routing and source routing is discussed in the following section. There were several routing algorithms like Ad hoc On-Demand Distance Vector Routing, Dynamic Source Routing (DSR), Adaptive Routing Algorithm (ARA) there all these algorithm has drawbacks. In ADOC Another such feature is that if a route request fails, another route request may not be sent until twice as much time has passed as the timeout of the previous route request. congestion occurs when neighboring nodes carrying different flows compete for channel access when they transmit on the same channel. To reduce this type of interference, whenever a node is involved in a transmission, its neighboring nodes should not communicate at the same time with other nodes on the same channel. An interference-aware routing protocol designed to improve load balancing by avoiding inter and intra flow interference in a typical mesh backbone network. AMIRA is based on the framework of Ant Colony Optimization (ACO) which is a meta-heuristic approach for stochastically solving a problem. Here this paper totally dealing about the intra and inter flow interference in the same node. But it doesn't tell anything about the neighboring node congestion. It is the main drawback during the more number of data transmission. so, this problem can be taken and addressed.

3. Related work

There were several protocols existing for routing and congestion some of them are

3.1. Ad hoc On-Demand Distance Vector Routing(AODV)

In AODV, the network is silent until a connection is needed. At that point the network node that needs a connection broadcasts a request for connection. Other AODV nodes forward this message, and record the node that they heard it from, creating an explosion of temporary routes back to the needy node. When a node receives such a message and already has a route to the desired node, it sends a message backwards through a temporary route to the requesting node. The needy node then begins using the route that has the least number of hops through other nodes. Unused entries in the routing tables are recycled after a time. When a link fails, a routing error is passed back to a transmitting node, and the process repeats much of the complexity of the protocol is to lower the number of messages to conserve the capacity of the network. For example, each request for a route has a sequence number. Nodes use this sequence number so that they do not repeat route requests that they have already passed on. Another such feature is that the route requests have a "time to live" number that limits how many times they can be retransmitted. Another such feature is that if a route request fails, another route request may not be sent until twice as much time has passed as the timeout of the previous route request.

The advantage of AODV is that it creates no extra traffic for communication along existing links. Also, distance vector routing is simple, and doesn't require much memory or calculation. However AODV requires more time to establish a connection, and the initial communication to establish a route is heavier than some other approaches.

3.2. Distance Source Routing(DSR)

Dynamic Source Routing (DSR) is a routing protocol for wireless mesh networks. It is similar to AODV in that it forms a route on-demand when a transmitting computer requests one. However, it uses source routing instead of relying on the routing table at each intermediate device.

Determining source routes requires accumulating the address of each device between the source and destination during route discovery. The accumulated path information is cached by nodes processing the route discovery packets. The learned paths are used to route packets. To accomplish source routing, the routed packets contain the address of each device the packet will traverse. This may result in high overhead for long paths or large addresses, like IPv6. To avoid using source routing, DSR

optionally defines a flow id option that allows packets to be forwarded on a hop-by-hop basis.

This protocol is truly based on source routing whereby all the routing information is maintained (continually updated) at mobile nodes. It has only two major phases, which are Route Discovery and Route Maintenance.

Consider a source node that does not have a route to the destination. When it has data packets to be sent to that destination, it initiates a Route Request packet. This Route Request is flooded throughout the network. Each node, upon receiving a Route Request packet, rebroadcasts the packet to its neighbors if it has not forwarded it already, provided that the node is not the destination node and that the packet's time to live (TTL) counter has not been exceeded. Each Route Request carries a sequence number generated by the source node and the path it has traversed. A node, upon receiving a Route Request packet, checks the sequence number on the packet before forwarding it. The packet is forwarded only if it is not a duplicate Route Request. The sequence number on the packet is used to prevent loop formations and to avoid multiple transmissions of the same Route Request by an intermediate node that receives it through multiple paths. Thus, all nodes except the destination forward a Route Request packet during the route construction phase. A destination node, after receiving the first Route Request packet, replies to the source node through the reverse path the Route Request packet had traversed. Nodes can also learn about the neighboring routes traversed by data packets if operated in the promiscuous mode (the mode of operation in which a node can receive the packets that are neither broadcast nor addressed to itself).

3.3.Adaptive Routing Algorithm

Dynamic Routing describes the capability of a system, through which routes are characterized by their destination, to alter the path that the route takes through the system in response to a change in conditions. The adaptation is intended to allow as many routes as possible to remain valid in response to the change. Systems that do not implement adaptive routing are described as using static routing, where routes through a network are described by fixed paths (statically). A change, such as the loss of a node, or loss of a connection between nodes, is not compensated for. This means that anything that wishes to take an affected path will either have to wait for the failure to be repaired before restarting its journey, or will have to fail to reach its destination and give up the journey.

Issues faced in the existing algorithm are as follows.

- It progress the shortest path of the system but, doesn't process about the congestion and interference briefly[1].
- It reduce the traffic in the network but still there is some congestion in the packet transmission[2]
- It doesn't deals anything about detection and controlling factors of congestion .
- The main source of this is complexity in flexibility[8].
- CSAP performs the best because it can guarantee QoS flows with the minimum bandwidth requirements, and share the residual bandwidth more fairly with all flows in the ad hoc network.Its doesn't tell any other technical aspects. It only referred the QoSfactor[7].
- It doesn't tell anything about the neighboring node congestion. It is the main drawback during the more number of data transmission. so, this problem can be taken and addressed[2][3].
- Ant algorithm was implement in MANET network. This can be implement in wireless mesh network to increase the packet transfer, decrease the congestion, traffic analysis as like as this MANET network[4].
- Congestion in wireless sensor network[4][5].

Congestion is a problem of paramount importance in resource constrained Wireless Sensor Networks, especially for large networks, where the traffic loads exceed the available capacity of the resources. Sensor nodes are prone to failure and the misbehavior of these faulty nodes creates further congestion. The resulting effect is a degradation in network performance, additional computation and increased energy consumption, which in turn decreases network lifetime.

4. Proposed work

The proposed routing algorithms are simple yet efficient. The routing optimization is driven by the minimization of total latency during packets transmission

4.1 Congestion aware ant colony algorithm(CACO)

This algorithm is a member of the ant colony algorithms family, in swarm intelligence methods, and it constitutes some meta heuristic optimizations. the first algorithm was aiming to search for an optimal path in a graph, based on the behavior of ants seeking a path between their colony and a source of food. The original idea has since diversified to solve a wider class of numerical problems, and as a result, several problems have

emerged, drawing on various aspects of the behavior of ants.

In the natural world, ants wander randomly, and upon finding food return to their colony while laying down pheromone trails. If other ants find such a path, they are likely not to keep travelling at random, but to instead follow the trail, returning and reinforcing it if they eventually find food.

Over time, however, the pheromone trail starts to evaporate, thus reducing its attractive strength. The more time it takes for an ant to travel down the path and back again, the more time the pheromones have to evaporate. A short path, by comparison, gets marched over more frequently, and thus the pheromone density becomes higher on shorter paths than longer ones. Pheromone evaporation also has the advantage of avoiding the convergence to a locally optimal solution. If there were no evaporation at all, the paths chosen by the first ants would tend to be excessively attractive to the following ones. In that case, the exploration of the solution space would be constrained.

4.2 Describing The Properties

Let us consider what kind of ants would be suitable for creating network paths in defining an ant based routing algorithm for MWNs. We argue that a routing algorithm based on smart ants designed for mesh networks should have the following desirable properties:

- The smart ants while creating paths should take into account the two types of interferences that inherently exist in mesh networks namely inter-flow interference among the nodes and intra-flow interference along the path of a flow.
- The CACO should be able to evaluate the load on nodes in order to properly qualify the outgoing links. This would help in detouring the packets to new route and hence would result in a more load balanced network.
- Since network nodes in a WMN can be equipped with multiple radios, a CACO should be able to discover channel-diverse paths in order to reduce the interference and effectively improve the overall network throughput. CACO are designed to exhibit the above mentioned desirable properties and it is because of

these properties which make our ants smart intelligent and that is why we call them CACO. In the following, we show how to incorporate these desirable properties in our smart ant based routing algorithm (CACO).

5. Results and Discussions

The proposed CACO algorithms has capability to effectively perform in terms of routing load and end to end

delay, throughput. This CACO routing algorithm can also be applied in congested areas by routing packets away from the congestion. The performance of the existing AODV in terms of packet loss algorithm is shown in Fig.5.1

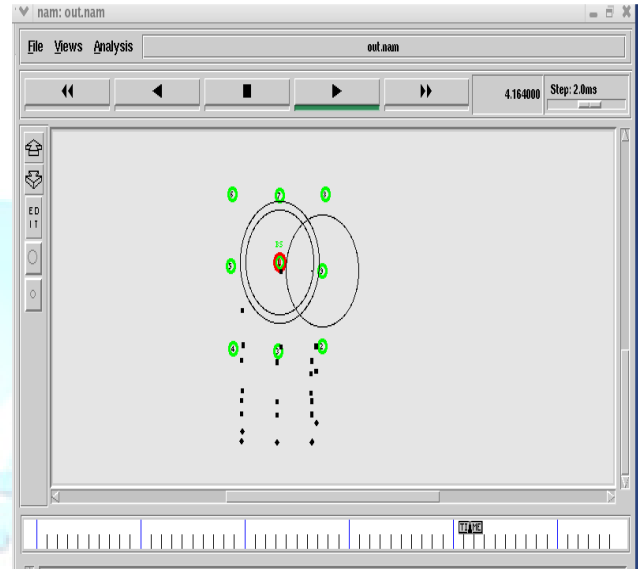


Figure 5.1 Packet Lose in AODV

. The performance of the existing DSR in terms of packet loss algorithm is shown in Fig.5.2

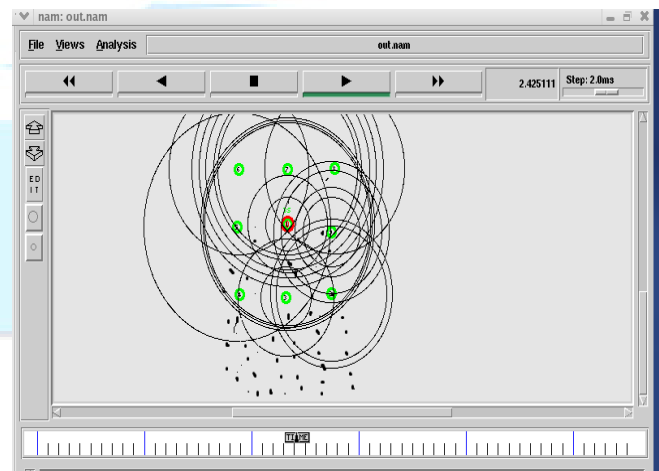


Figure 5.1 Packet Lose in DSR

The proposed CACO algorithm using AODV for packet delivery ratio is shown in Fig 5.3

5.3 Using(CACO)Algorithm In AODV

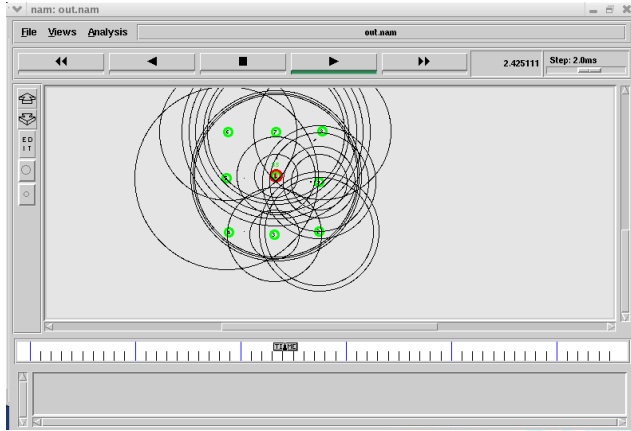


Figure 5.3 Using(CACO)Algorithm In AODV

The proposed CACO algorithm using DSR for packet delivery ratio is shown in Fig 5.4

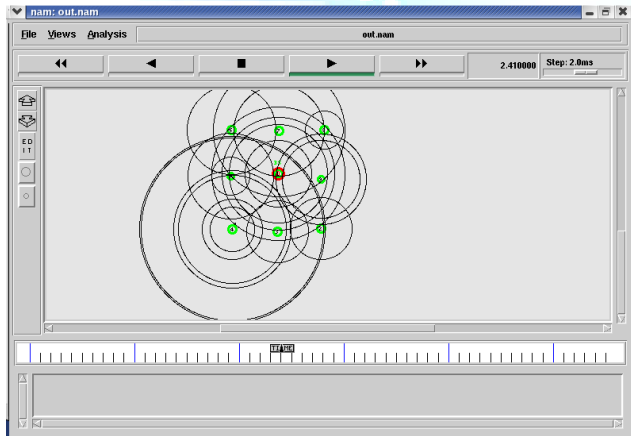


Figure 5.4Using(CACO)Algorithm In DSR

Thus the CACO routing algorithm can also be applied in congested areas by routing packets away from the congestion .It will provide high network throughput and packet delivery ratio when compared with standard routing protocols in reasonable WMNs environment.

6.Graph

The following graph diagram compared the performance analysis of the routing protocols AODV and DSR with CACO.

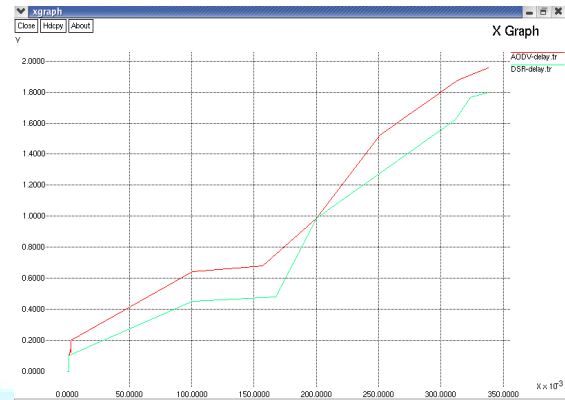


Figure 6.1 shown End to End delay

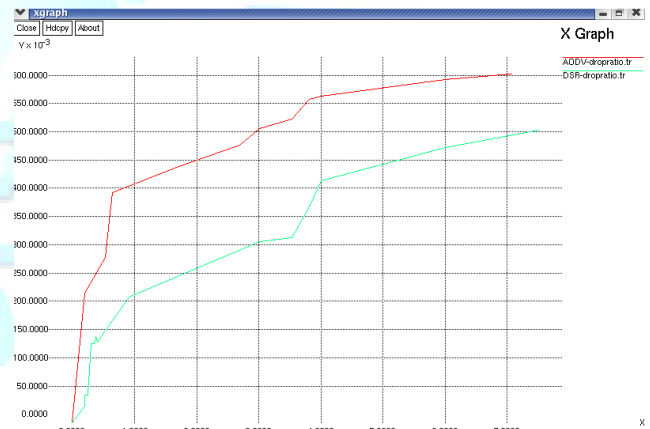


Figure 6.2Packet loss ratio

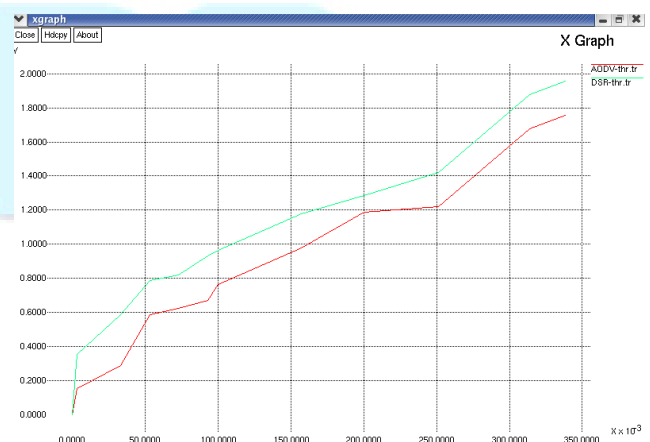


Figure 6.3 Throughput

7. Conclusion

The techniques specified in this paper mainly focus on routing algorithms and congestion protocols which gives more efficient data transmission in between the networks. CACO algorithm behaves better when compared to other competing approaches in mesh networks. In addition, the promising results shown in the paper underline the need for a real-life tested evaluation on which we are currently working on.

Reference

- [1]. B. Baran and R. Sosa,(2000) “A new approach for Ant Net routing,” Proceedings of the 9th Int. Conf. Computer Communications Networks, Las Vegas, NV.
- [2]F.Correia, T.Vazao,(2010) “Simple ant routing algorithm strategies for a (Multipurpose) MANET model,” Elsevier Ad Hoc networks, pp 810- 823.
- [3] G. Di Caro, D. Gambardella,(2005) “Ant Hoc Net: an adaptive nature-inspired algorithm for routing in mobile ad hoc networks,” European Transactions on Telecommunications, 2005, vol. 16, no. 5, pp.443–455.
- [4] FawazBokhari and GergelyZaruba,(2012) International Journal of Wireless & Mobile Networks (IJWMN) Vol. 4, No. 2, April 2012,’ On The Use Of Smart Ants For Efficient routing In Wireless Mesh Networks’.
- [5] Dr. GergelyZáruba (2012) The University of Texas at Arlington,’ Routing And Channel Assignment Schemes For Interference Avoidance In Wireless Mesh Networks’.
- [6] M. Gunes, U. Sorges, I. Bouazizi,(2002) “ARA-the ant-colony based routing algorithm for MANETs,” Proc. International Conference on Parallel Processing.
- [7] Hsi-Lu Chao,(2004) Student Member, IEEE and Wanjiun Liao, Member, IEEE, IEEE Transactions On Wireless Communications, Vol. 3, No. 6, November 2004,’ Fair Scheduling With Qos Support In Wireless Ad Hoc Networks’.
- [8] Mihail L. Sichitiu Dept. of Electrical and Computer Engineering, North Carolina State University Raleigh, Nc 27695, Usa,’ Wireless Mesh Networks Opportunities And Challenges’.
- [9] Rainer Baumann, Simon Heimlicher, Vincent Lenders, Martin May,Computer Engineering and Networks Laboratory, ETH Zurich, Switzerland, Department of Electrical Engineering ,Princeton University, NJ, USA’ Routing Packets into Wireless Mesh Networks’.
- [10] A. Raniwala and T.-C.Chiueh,(2005) “Architecture and algorithms for an IEEE 802.11-based multichannel wireless mesh network,” Proc. of the IEEE INFOCOM, 2005, pp. 2223-34.
- [11] P. Subramanian,(2006) M. M. Buddhikot, and S. C. Miller, “Interference aware routing in multi-radio wireless mesh networks,” IEEE Workshop on Wireless Mesh Networks (WiMesh), Sept. 2006, pp.55–63.