Implementation of Rank Based ACO approach with Load Balancing in Ad hoc Network for Multipath Routing Mechanism

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***Abstract*— Ad-Hoc wireless networks are self-organizing multi-hop wireless networks. Mobile ad hoc networks have some challenges like the design of an efficient routing protocol. The multipath routing protocol with load balancing provides a solution for the congestion network. Ad Hoc networks are setup as needed since they do not depend on the infrastructure. Ad Hoc networks are self–organizing multi hop wireless with low cost. To consider that the use of multiple paths simultaneously for transmission data allows to improve the network performance, we propose a protocol LB-AOMDV (Load Balancing-AOMDV), a solution to achieve better load balancing mechanism and also apply the Ant Colony optimization technique to the routing problem, after that we apply a extension of ACO that is ranked based ACO approach. We refer to the new modified protocol as the LB-AOMDV Rank Based Ant Colony Optimization algorithm .The main goal in the design of the protocol was to reduce the routing overhead, response time, end-to-end delay and increase the performance.**

Keywords-Ad-Hoc Networks; load balancing, Ant Colony Optimization Algorithm; AOMDV; LB AOMDV

I. INTRODUCTION

Ad hoc network is a collection of wireless mobile nodes without any fixed base station infrastructure and centralized management. Each node acting as both a host and a router moves arbitrarily and communicates with others via multiple wireless links. Therefore, the network topology changes greatly. In such a dynamic network, it is a challenging issue to be able to get route in time. The routing protocols proposed so far can be classified into two categories: proactive routing protocol and reactive routing protocol. Reactive routing protocol, which initiates route computation only on demand, performs better than proactive routing protocol, which always maintains route to destination by periodically updating, due to its lower control overhead. Ad hoc network presents many specific problems which had influence on solution that assure QoS. The main problems are: node mobility and link failure. However, node mobility provides dynamic change topology and route breaks occur frequently providing degradation of upstream on wireless network because not only high loss of packets but also delay occurs to search new route. The routing problem is to determine an optimal forwarding for data packet according to some criteria of QoS. In ad hoc network, the challenge is to find a forwarding method for high number of nodes in environment distinguished by their limited power, processing, and memory resources as well as high degree of mobility. [1]

The multipath routing appears an efficient solution for the ad hoc networks [2]. It can provide load balancing and route failure protection by distributing traffic among a set of diverse paths [3, 4]. The routing problem is to determine an optimal forwarding for data packet according to some criteria of QoS. In ad hoc network, the challenge is to find a forwarding method for high number of nodes in environment distinguished by their limited power, processing, and memory resources as well as high degree of mobility. Ant colony optimization (ACO) is a population-based met heuristic that can be used to find approximate solutions to difficult optimization problems. In ACO, a set of software agents called artificial ants search for good solutions to a given optimization problem. To apply ACO, the optimization problem is transformed into the problem of finding the

best path on a weighted graph. Ant colony algorithms consider the ability of simple ants to solve complex problems by cooperation. Ants do not need any direct communication to find the solution The authors of [5], [6], [7] have introduced a routing algorithm based on ant colony optimization that explores the network aiming to build routing tables while keeping them adapted to network conditions. In this paper, we analyze the performance of (Load Balancing-AOMDV), Rank Based Ant Colony Optimization algorithm.

II. ANT COLONY OPTIMIZATION FOR MANET

Ant colony optimization (ACO) is a population-based met heuristic that can be used to find approximate solutions to difficult optimization problems. In ACO, a set of software agents called artificial ants search for good solutions to a given optimization problem. To apply ACO, the optimization problem is transformed into the problem of finding the best path on a weighted graph. The artificial ants (hereafter ants) incrementally build solutions by moving on the graph. The solution construction process is stochastic and is biased by a pheromone model, that is, a set of parameters associated with graph components (either nodes or edges) whose values are modified at runtime by the ants. Ant algorithms are multi-agent distributed algorithm, which consists of agents that simulates the behavior of individual ants [9].

A. Ants Mechanism

The basic idea of the ant colony optimization is taken from the food searching behavior of real ants. When ants are on their way to search for food, they start from their nest and walk toward the food. When an ant reaches an intersection, it has to decide which branch to take next. While walking, ants deposit pheromone, which marks the route taken. In the natural world, ants (initially) 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. Especially, the dynamic component of this method allows a high adaptation to changes in mobile ad-hoc network topology, since in these networks the existence of links are not guaranteed and link changes occur very often [10]. 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.

III. ROUTING ON ADHOC NETWORK

The Mobile Ad Hoc Networks are formed by wireless hosts which may be mobile and there is no pre-existing infrastructure. The routing is a method which attends to forward the information to destination along the network. It consists to determine an optimal forwarding for packets along the network according to certain criteria (hop number, e.g.). The problem consist to find the investment with minimum cost of nominal capacity and reserve that provide the routing of nominal traffic and guarantee its reliability in case of any failure of link or node. On other hand, the routing on Ad Hoc network is far away to be evident because the environment imposes news limitations compared to wired environment. The routing strategy must take the usual change of the topology, the bandwidth (which is limited) and other factors into account.

The Ad hoc network, that we consider, is multi hopes. In these networks, the communication range of a node is often limited and not all nodes can directly communicate with one another. Nodes are required to relay packets on behalf of other nodes to facilitate communication across the network. Therefore, if a mobile want to communicate with another that don't reach, the message must be transmitted to neighboring step by step to reach the destination. The basic technique to ensure the forwarding of packets is the flood. But certainly, the flood consumes many resources such as Bandwidth and energy.

IV. AOMDV PROTOCOL: ADHOC ON DEMAND MULTIPATH DISTANCE VECTOR

The AODV (Ad-Hoc On-Demand Distance Vector) routing protocol is a reactive routing protocol that uses some characteristics of proactive routing protocols. Routes are established on-demand, as they are needed. The AODV (Ad-Hoc On-Demand Distance Vector) routing protocol is a reactive routing protocol that uses some characteristics of proactive routing protocols. Routes are established on-demand, as they are needed. To reduce interruption of communications in ad hoc network, the discover procedure of routes must be efficient especially with the continuous mobility of the nodes and also the frequent change of network topology, many routing protocols are proposed such as AOMDV: the multipath routing protocol [8] that extends the single path AODV protocol to compute multiple path routing.

A. Routing Definition

The main idea in AOMDV is to compute multiple paths during route discovery procedure for contending link failure. In fact, the main goal to concept this protocol is to search multiple routes during the same route discovery procedure, but only the best path based on some metric (number of hop) is chosen and is used for data transmission between source and destination. The other paths are used only when the primary path fails. This protocol is intended for ad hoc network where the mobility of nodes is very important and consequently the route breaks frequently. AOMDV use the information available in AODV, but to compute multiple paths it adds additional number of control packet "overhead". AOMDV is based on two essential mechanisms: • A route update to establish and maintain multiple Loop-free paths at each node. • A distributed protocol to find link-disjoint paths. In such protocols a link failure in the primary path, Through which data transmission is actually taking place, causes the source to switch to an alternate path instead of initiating another route discovery. A new route discovery occurs only when all precompiled paths break. The problem with these Multipath protocols [10] is that although during the route discovery process multiple paths are discovered, only the best path based on some metric is chosen and is used for data transmission.

V. LOAD BALANCING-AOMDV RANK BASED ACO APPROACH

In this part, we propose an extension to AOMDV Protocol in order to support certain mechanism and technique to improve its performance.

A. *A new proposed metric*

In the new proposed metric, the methodology targets the route stability and current load on the node. The stability of the paths can be assured by the use of received signal strength and the queue length in the node. The weighted formula is used to calculate the load of the node, which will be carried by the ants.

Load = alpha * signal strength + beta * queue length + gamma*active path count

Here "alpha", "beta" and "gamma" are constants and alpha + beta + gamma =1. They are the weight coefficients. Load formula is used to distribute load over network. Path with minimum load are selected for data transmission. In normal AOMDV path with minimum hop count is taken primary. But the propose approach will concentrate on paths with least load. So the selected path by the proposed approach will be most stable and least loaded path. Strength will be used to decide the weight of pheromones on the link (pheromone is nothing but the routing information or data about links) once the route discovery phase is over AOMDV picks three paths. One is used as primary and other two are used as backup routs. To meet the quality of service requirements of mobile users, several metrics can be considered for selecting a source destination routing path. [37]

Signal strength: -Packet receives value. It should be high. If the signal strength value is low then packet drop ratio should be high.

Queue Length:-The number of data packets in a buffer. The queue length gives us the idea about how busy our route is. Its higher value depicts high load on the route. It determine heavily loaded route.

Active Path Count: - In the active path count we use the path with minimum load out of different paths.

B. Pseodocode

```
Step 1 (Load Calculation)
If
{
    Request packet weight< previous weight}
Then
{
Send reply
}
Else if
{
Request packet weight=req packet weight+ weight calculation function}
Step 2 (Forward Ant)
Forward ants are broadcasted with route request for a destination.
If (Destination_reply==index)
{
Forward_ant();
}
Else
 {
Forward_reply();
}
//Recv forward ant routine
Recv_forward ant()
 {
If(ant_destination==index)
{backward();
}}
Step 3 (Backward Ant)
The ants travel back to the source through the paths with load information
Recv_backward_ant()
{
If(back_ant_destination==index)
{
Sort_path by rank();
 }
Else
{
Forward ant();}
```

VI. PERFORMANCE EVALUATION

We have used ns-2 for our simulations. As mentioned earlier, we have performed our study with Load Balancing AOMDV and the proposed protocol Ranked Based ACO Approach. NS is a name for series of discrete event network simulators, specifically **ns-1**, **ns-2** and **ns-3**. All of them are discrete-event network simulators, primarily used in research and teaching. Ns-3 is free software, publicly available under the GNU GPLv2 license for research, development, and use. The goal of the ns-3 project is to create an open simulation environment for networking research that will be preferred inside the research community.

A. Parameter to evaluate

With the aim to evaluate our Rank based ACO LB-AOMDV protocol, we compare it with AOMDV protocol l. We study the variation effect on the following metrics:

i) Routing Overhead
ii) End to end Delay

B. Simulation results

i) Traffic Overhead

Number of routing packet with respect to data. Excess of data packets**.** In Fig 1 shows that the traffic overhead decreases as compared to AOMDV by the use of best route. In AOMDV have more traffic .With the use of Ant AOMDV we get better result.

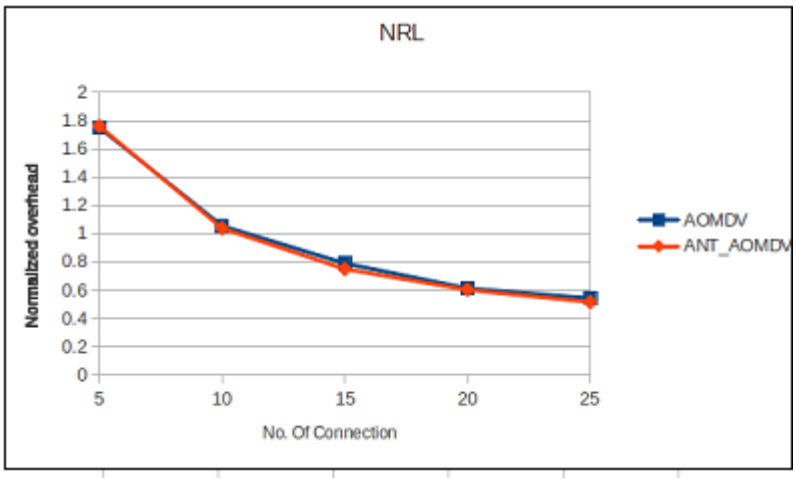

Fig 1 : Traffic Overhead vs Number of Connections

ii) End to end Delay

This is the average overall delay for a packet to traverse from a source node to a destination node. This includes the route discovery time, the queuing delay at a node, the transmission delay. Fig 2 shows that the average end to end delay decreases as compared to AOMDV by the use of the less congestion route selection mechanism which distribute traffic load fairly across routes selected between source and destination.

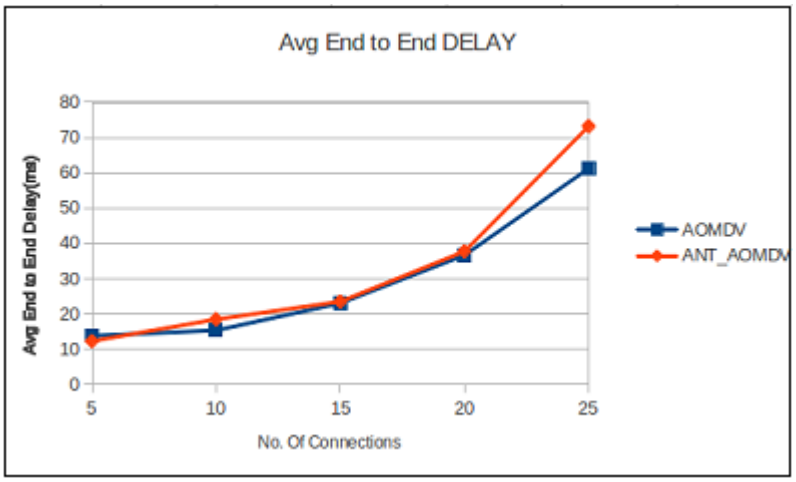

Fig 2: Avg End to End Delay Vs Number of Connections

VII. CONCLUSION

In this paper, we use the rank based ACO approach to find better result and modify the route discovery mechanism of AOMDV for load balancing in Mobile Ad hoc Network by estimating Signal Strength and Active Path Count of node to provide stable energy aware routing. We have focused on load balancing Mechanism to fairly distribute the traffic on different active routes selected between source and destination nodes. we also design and implement Rank Based Ant System (AS rank) optimization technique to find the best path out of the multiple paths obtained from route discovery. To compare and analyze the proposed approach with the existing different routing protocols to find the better result in the form of traffic overhead and end to end delay.
In the future work, we would like to find the another parameters like end to end delay and throughput to achieve the better result and increase the performance

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