Review of various Bio- Inspired Routing Algorithm for Load Balancing in Mobile Adhoc Networks(MANETs)

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Abstract - Mobile Ad hoc network (MANETs) is a collection of wireless mobile nodes dynamically forming a temporary network without the use of any existing network infrastructure or centralized administration. Routing in such network is very challenging and difficult due to the mobility of the nodes. Thus there is a need to choose a routing protocol that transfers the packet from source to destination in the most efficient manner. This paper reviews various routing algorithm that lead to high degree of stability in the network and improve the load balancing in Mobile Adhoc Networks.

Keywords *- Mobile Adhoc network, multipath routing, cluster, load balancing, Ant colony based, Bee colony based, Bird flocking and Opt-Termite based routing algorithms*

I. INTRODUCTION

Mobile adhoc networks (MANETs) are self-configuring infrastructure less network of mobile devices connected by wireless links. Each device in a MANET is free to move independently in any direction and therefore the links between nodes will be changing frequently. These mobile adhoc networks are very simple to setup and support scalability, i.e. nodes can be added or removed anytime. At the same time, the nodes show a high mobility which implies frequent changes to the network topology. Each node will be forwarding traffic, and therefore each node acts as a router as well. The maintenance of routing information by the nodes is a challenging task as the network topology will be changing frequently in a MANET.

The routing protocols in MANETs can be classified into 3 categories: **reactive, proactive and hybrid routing protocols**.

Proactive routing protocols often need to exchange control packets among mobile nodes and continuously update their routing tables. This has a high overhead congestion of the network, which requires lots of memory. The advantage of proactive protocols is that nodes have correct and updated information. Reactive routing protocols only seek a route to the destination when it is needed. The advantage of these protocols is that the routing tables located in memory are not continuously updated. On the other hand, they have the disadvantage that they cannot establish connections in real time. Hybrids are derived from a mixture of these two protocols, and for this reason, they share some of their advantages. Some of the routing protocols for MANETs are DSDV, Dynamic Destination Sequenced Distance Vector protocol (proactive), AODV, Adhoc On-Demand Distance and DSR, Dynamic Source Routing (reactive).

In this paper various algorithm has been discussed for route finding. Recently, a new class of routing algorithms based on Swarm Intelligence has emerged. These algorithms are inspired by nature's self-organizing systems like ant colonies, bird-flocks, honey-bees, school of fish, spiders and fireflies. The characteristics of such algorithms are their capability of self-organization, adaptation to the changing conditions, self-healing and local decision making.

Biologists observed that biological systems have the ability to self-organize. For example, ants build their nest with a very complex structure that suggests a level of management beyond the capacity of an individual ant, through simple pheromone based communications between individual ants; the colony builds a fully functional nest. The idea here is to derive inspiration from these biological systems and apply them to the mobile adhoc networks. As in the case of biological systems which do not have a pre-defined way of communicating with each other, achieve the same with the help of the concept, stigmergy. Stigmergy is a mechanism of indirect coordination between agents or actions. The principle is that the trace left in the environment by an action stimulates the performance of a next action, by the same or a different agent. This stigmergy exhibited by the biological systems can be used in our networks for defining new routing protocols for MANETs. The MANETs are very similar to the colonies of ants or termites, where these insects work independently like the nodes in a MANET, the interesting feature is the communication that happens between these insects, who don't even know the existence of the other insect. This communication happens through a chemical substance (pheromone) excreted by these insects. These pheromones are used during the nest building process of the ants (trail pheromone), while searching for the food (aggregation pheromone) as well as to inform the fellow colony mates about any threat (alarm pheromone) that might have occurred and they need protect themselves from it. This concept of pheromone can be used to reduce the control traffic in the network. These systems exhibit a positive feedback and negative feedback during their communication. Positive feedback means the deposition of pheromone that indicates other insects to follow the same and thereby achieve the global objective of either food collection or nest building.

Negative feedback means the evaporation of the pheromone deposited earlier which eliminates the trails of a route when it is no longer being used and thereby allows for new routes to emerge. The bio-inspired routing has immense potential as it is proved to work in the nature and so it does if incorporated in our network systems.

II. ROUTING ALGORITHMS

A lot of work has been done on bio-inspired routing algorithms. These algorithms are mostly inspired from the behavior of the organisms in nature like ants, honey bees, bird flocks, etc. Here, we discuss in brief some of those routing algorithms.

A. Ant Colony Routing algorithm

The basic idea of the ant colony optimization (ACO) is taken from the food searching behavior of real ants. When ants are on the 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 a pheromone. The concentration of pheromone on a certain path is an indication of its usage and hence affects the moving decisions of the ants. After a short time the pheromone concentration on the shorter path will be higher than on the longer path, because the ants using the shorter path will increase the pheromone concentration faster. Thus, the ant's collective behavior leads to global intelligent behavior and helps in optimizing the path to the food. The routing algorithms based on ants, mimic this very nature in order to provide an efficient routing mechanism.

(a) Ant Hoc Net

It is a hybrid ACO routing algorithm. It combines reactive route setup with proactive route probing, maintenance and improvement. It also takes into account the dynamic topology and other characteristics of ad-hoc networks. When the network topology changes, then it must be restored quickly and this is achieved through a new route discovery process. The algorithm tries to find paths characterized by minimal number of hops, low congestion and good signal quality between adjacent nodes. It mainly concentrates on path exploration but suffers from large control overhead as it needs to find path frequently and for which it broadcasts forward ants.

(b) ARA

It is Ant-Colony based Routing Algorithm. It is purely a reactive algorithm where the forward and backward ants setup the paths to the nodes; the routing tables are updated by the data packets, reducing the control overhead. This algorithm takes special care of the load in the network. This algorithm uses two colony of ant, Red colony ant chooses the path where concentration of red pheromone is high and blue colony ant chooses the path where concentration of blue pheromone is high. Its performance is slightly better than AODV but worse than DSR in highly dynamic environments. Many routing algorithms have been proposed based on the ant behavior such as Ant-AODV, Probabilistic Emergent Routing Algorithm (PERA), etc.

B. Bee colony based routing algorithms

The main algorithm here is the Bee Adhoc. It is inspired by the honeybee behavior in its design of agents and their interaction. It is a reactive algorithm. It has 4 types of agents as in a beehive, packers, scouts, foragers and bee swarms. The packer mimics the food stores and its main task is to find a forager for the data packet at hand. The task of scouts is to find new routes from their launching node to their destination node. These scouts are broadcast with a TTL value; if they don't return within a timeout then new scouts are sent with a greater TTL value. When the scouts return, they assign forager for the route they just found which is similar to the waggle dance of scout-bees in nature. The foragers are the main workers in Bee Adhoc; they receive data packets from packers and deliver them to their destinations in a source routed modality. The bee swarms are explicitly used to drop the foragers back to their source nodes in case of unreliable protocol like UDP.

In Bee Adhoc, each node contains a software module called hive at its network layer. It has 3 parts: the packing floor, the entrance floor and the dance floor as shown in Fig. 1.Bee Adhoc delivers the same or better performance than that of the state-of-the-art algorithms like AODV, DSR and DSDV, but at significantly smaller overall energy expenditure.

C. Bird flocking based routing algorithms

Birds travel long distances in flocks which are 'V' shaped where all the burden is on the sphere head of the flock which reduces the up thrust required by the rest of the birds in the flock. Thus, it reduces the amount of energy required by the birds behind the wing of the sphere head to fly. This is the reason why birds travel long distances by losing minimum amount of energy. As the energy of the sphere head reduces, the sphere head is replaced by the other bird to take the burden of the V shape No specific bird directs the movement of flock. Instead, each bird takes its cue to turn in one direction or another from those immediately surrounding it. BFBR is a hybrid routing algorithm and uses Encounter Search algorithm for routing.

D. Optimized Termite Algorithm

Opt-Termite uses concept of stigmergy for self-organization, thereby reducing the control packet overhead. Opt-Termite mainly concentrates on load balancing for optimization. With Opt-Termite, a route with less loaded mobile nodes in terms of traffic will be chosen to reach destination. The routing information a teach node gets influenced by the movement of packets and the routing table will be updated accordingly. It also allows the use of multiple paths and each packet is routed randomly and independently. Opt-Termite is implemented in ns-2 and its performance is compared with traditional routing protocol AODV. Opt-Termite's performance has been promising.

The Termite algorithm is based on termites' activity of hill building. Termites' colonies use decentralized, self-organized systems of activity guided by swarm intelligence to exploit food sources and environments that could not be available to any single insect acting alone.

The hill building nature of termites is briefly explained below for the convenience. Consider a flat surface upon which termites and pebbles are distributed. The termites would like to build a hill from the pebbles. Termites act independently of all other termites, and move only on the basis of an observed local pheromone gradient. A termite is bound by these rules:

1. A termite moves randomly, but is biased towards the locally observed pheromone gradient. If no pheromone exists, a termite moves uniformly randomly in any direction.
2. Each termite may carry only one pebble at a time.
3. If a termite is not carrying a pebble and it encounters one, the termite will pick it up.
4. If a termite is carrying a pebble and it encounters one, the termite will put the pebble down. The pebble will be infused with a certain amount of pheromone.

Termite retains most of the main features of the general ACO meta-heuristic such as pheromone tables, probabilistic decisions, pheromone evaporation, etc. In Termite, forward ants (RREQ) are unicast and follow a random walk. Backward ants (RREP) do not necessarily follow the forward path backwards, but are also routed stochastically. Most importantly it overcomes the disadvantage with the ant based algorithms by having a low control packet overhead.

III. CONCLUSION

This paper reviews various bio-inspired routing algorithms that perform better in frequently changing conditions like, mobile adhoc network, as they are adaptive to the situations. Ant Routing Algorithm based on the theory of ant colony optimization performs fairly well in controlling congestion in MANET. In this algorithm two colony of ant chooses different path for particular destination. One colony of ant is also repulsed by another colony of ant. This way load is shared by two colonies of ants. This algorithm is very useful where the bandwidth of the packets sent by a node exceeds the bandwidth of channel.

Opt-Termite is one of the routing protocols inspired by the behavior of termites in their hill building process. It has a low control overhead as well as it offers multiple paths. It also takes care of the congestion that could be caused by the usage of the same route for a long period of time.

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