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BEE BASED ROUTING PROTOCOL FOR MANET

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Abstract – Mobile Ad HOC networks (MANET'S) are networks in which all nodes are mobile and communicate with each other via wireless connections. Nodes can join or leave the network at any time. There is no fixed infrastructure. Research and industries are recently more interesting and attracting to the VANET and MANET development domain. A vehicular ad hoc network (VANET) is a subclass of MANET. In this paper, we propose Bee Routing Protocol for Ad Hoc Network, in which a new quality of service multipath routing protocol adapted for the VANET. This algorithm is a reactive source routing algorithm and consumes less energy as compared to DSDV, AODV, DSR routing algorithms because a fewer control packets for routing are sent as compared to other networks.

Keywords – MANET, VANET, Routing algorithms, Swarm Bee Communication, QoS.

I. INTRODUCTION

Routing in MANETs is a challenging task because we cannot use protocol of wired networks due to dynamic topology of the network. Making use of a number of relatively simple biological agents like bees, a variety of different organized behavior are generated at the system level from the local interaction among the agents and with the environment. Bee communication systems have recently become a source of inspiration for design of distributed & adaptive algorithms.

VANET represents a special kind of Mobile Ad Hoc Network(MANET). It aims to provide communications among vehicles via Inter-Vehicle Communication and between vehicles and fixed equipment described as roadside base stations via Roadside-to-Vehicle Communication. It is distributed, adaptive network, characterized by very high node mobility, high speed variation of vehicles, and limited degrees of freedom in the mobility patterns. This situation leads to very fast and very frequent change of network topology. In this field, one of the most important requirements is the quality of service (QoS - end to end delay and bandwidth) that provides information needed in time to passengers in order to make safe decisions.

II. ISSUES OF ADHOC NETWORK

The most important challenge in designing algorithms for Ad Hoc Network are mobility and limited battery capacity of nodes. Mobility of nodes results in continuously evolving new topologies and consequently the routing algorithms have to discover or update the routes in real time but with small control overhead. The limited battery capacity requires that the packets if possible be distributed on multiple paths, which would result in the depletion of batteries of different nodes at an equal rate and hence as a result the life time of networks would increase.

Therefore an important challenge in Ad Hoc Network is to design a routing algorithm that is not only energy efficient but also delivers performance same or better than existing state of art routing protocols.

A. ISSUES RELATED TO MANET

[1] Routing

Routing is one of the most complicated problems to solve as ad hoc networks have a seamless connectivity to other devices in its neighborhood. Because of multi hop routing no default route is available. Every node acts as a router and forwards each other's packets to enable information sharing between mobile nodes.

[2] Security

Obviously a wireless link is much more vulnerable than a wired link. The science of cracking the encryption and eavesdropping on radio links has gone on since the first encryption of radio links was established. The user can insert spurious information into routing packets and cause routing loops, long time-outs and advertisements of false or old routing table updates. Security has several unsolved issues that are important to solve to make the ad hoc network into a good solution.

[3] Quality of Service(QoS)

QoS is a difficult task for the developers, because the topology of an ad hoc network will constantly change. Reserving resources and sustaining a certain quality of service, while the network condition constantly changes, is very challenging. The challenges of supporting QoS in ad hoc networks are how to reserve bandwidth and how to guarantee the specified delay for real-time application data flows. For wireless transmissions, the channel is shared among neighbors. Therefore, the available bandwidth depends on the neighboring traffic status, as does the delay.

III. PROBLEM RELATED TO QOS IN MANET

[A] Unpredictable link properties

Wireless media is very unpredictable and packet collisions are an unavoidable consequence of wireless networks. Signal propagation faces difficulties such as fading, interference, and multipath cancellation. These properties of the wireless network make measurements such as bandwidth and delay of the link unpredictable.

[B] Limited battery life

There is limited power of the devices that establish the nodes in the ad hoc network due to limited battery life time. QoS should consider residual battery power and rate of battery consumption corresponding to resource utilization. The technique used in QoS provisioning should be power aware and power efficient.

[C] Node mobility

Movement of nodes in the ad hoc network creates a dynamic network topology. Links will be dynamically formed when two nodes moves into transmission range of each other and are torn down when they move out of transmission range. Node mobility makes measurements in the network even harder and measurements as bandwidth is essential for QoS.

[D] Route maintenance

The dynamic nature of the network topology and the changing behavior of the communication medium make the precise maintenance of network state information very difficult. Because of this, the routing algorithms in MANET must operate on imprecise information. Since the nodes can join and leave the ad hoc network environment as they please, the established routing path may be broken at any time even during the process of data transfer. Thus, the need arises of routing paths with minimal overhead and delay. Since the QoS-aware routing would require reservation of resources at the routers (nodes), the problem of a heavily changing topology network might become cumbersome, as reservation maintenance with updates along the routing path must be done.

[E] Security

Without adequate security, unauthorized access and usage may violate QoS negotiations. The nature of broadcasts in wireless networks potentially results in more security exposure. The physical medium of communication is inherently insecure, so it is important to design aware routing algorithms for MANET.

IV. ISSUES RELATED TO VANET

1) High mobility and rapid changing topology

Vehicles move very fast especially on roads and highways. Thus, they remain within each other communication range for a very short time, and links are established and broken fast which results to rapid changes in network topology. Moreover, driver behavior is affected by the necessity to react to the data received from the network, which causes changes in the network topology. The rapid changes in network topology affect the network diameter to be small, while many paths may be disconnected before they can be used.

2) Variable network density

The network density in VANET varies depending on the traffic load, which can be very high in the case of a traffic jam, or very low, as in suburban areas.

V. ARTIFICIAL INTELLIGENCE TECHNIQUES

Swarm intelligence which is part of Artificial Intelligence, is any attempt to design algorithm and distributed problem solving devices inspired by the collective behavior of any social insect colonies or other animal societies. Various algorithms are: Ant Colony Optimization, Particle Swarm Optimization, Intelligent Water Drops, The Bees, Bat, Termites. Sample applications of these are : Travelling Salesman, Crown Simulation, Ad Hoc Networks.

BEEADHOC ARCHITECTURE

BeeAdHoc is an on-demand multi path routing algorithm for mobile adhoc networks inspired from the foraging principles of honey bees. The bees are domestic insects live in colony which is divided in a single breeding female (Queen), a few thousands of males (Drones), a several thousands of sterile females (Workers), and many young bee larvae (Broods). They share a communication language based on dances which are performed by the worker called "Scout" when it finds food.This dance aims to recruit others by the transmission of the distance, direction and quantity of found food with a visual, tactile and olfactory perception. Thus, some bees are recruited and then, become "foragers".

BeeAdHoc works with types of agents: packers, scouts, foragers and swarms. The packers locate a forager and hand over the data packet to the discovered forager. Scouts discover new routes from the launching node to the destination node. Foragers, is the main workers. The BeeAdHoc Architecture is shown in figure 1.

A. PACKING FLOOR

The packing floor is an interface to the upper transport layer (e.g., TCP or UDP) . Once a data packet arrives from transport layer i.e., sender sends the data, a matching forager for it is looked up on the danced floor. If a forager is found then the data packet is encapsulated in its payload . Otherwise, the data packet is temporary buffered waiting for a returning forager. If no forager comes back within a certain predefined time, a scout is launched which is responsible for discovering new routes to the packet destination.

B. ENTRANCE

The entrance handles all incoming and outgoing packet. Action on the dance floor depends on the type of packet entered the floor from the MAC layer. If the packet is the forager and the current node is its destination, then the forager is forwarded to the packing floor; otherwise, it is directly routed to the MAC interface of the next hop node. If the packet is a scout, it is broadcast to the neighbor nodes if its TTL timer has not expired yet or if the current node is not its destination. If a replica of previously received scout arrives at the entrance floor , it is removed from the system.

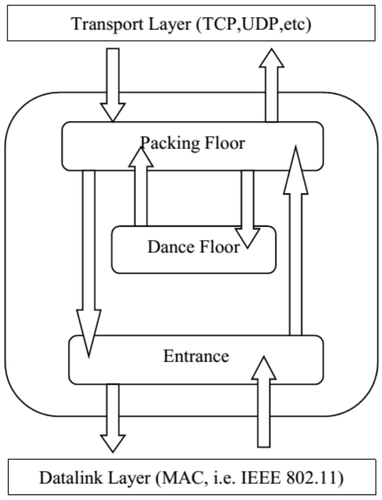

Figure 1: BeeAdHoc Architecture

C. DANCE FLOOR

The dance floor recruits new forager by "dancing" according to the quality of the path it traversed. It sends matching foragers to the packing floor in response to a request from a packer. The foragers whose lifetime has expired are not considered for matching. If multiple path be identified for matching, then a forager is selected in a random way. This helps in distributing the packets over multiple paths, which in turn serves two purpose : avoiding congestion under high loads and depleting batteries of different nodes at comparable rate. If the last forager for a destination leaves a hive then the hive does not have any more route to the destination. Nevertheless if a route to the destination still exists then soon a forager will be returning to the hive if no forager comes back within reasonable amount of time, then the node has probably lost its connection to the destination node. In this way fewer control packets are transmitted resulting in less energy expenditure.

VI. QoS BEE ROUTING PROTOCOL

A. QoS Bee Routing Packet Type

Scout and forager are the two major kinds of packets used in the protocol.

1) Scout

This control packet is used in the route request. First, it is called forward scout until finding the food (destination). Thus, it returns to the beehive (source node) to inform its nest mates (data packets). In the back way, it's named backward scout.

Forward Scout

It ensures the exploration of the VANET in order to find the destination. It is launched from the source node to nodes in neighborhood and so on until finding the destination. It marks temporarily its itinerary in the routes tables of the visited nodes in order to be used on the backway. A forward's scout identifier is unique; in fact, it's constructed as an incremental value. Forward scout includes also the beehive identifier. A unique identification of the route request is represented by the conjunction of these last two identifiers. It prevents the route request duplication.

This control packet contains also the food identifier, the minimum bandwidth requested and the maximum delay allowed by the source node, and a lifespan field used to limit number of hops to be done by the packet. Thus, if reached, the forward scout will be dropped. It ensures the loop-free propriety of the route request. Note that lifespan field will be increased if the beehive doesn't receive any response after the waiting time expiration. Forward scout records a hop count field which is the number of hops carried out from the source node to the node handling this scout. In addition, it includes stamp field used to save the transmission time which employs to compute available bandwidth and measured delay and then to decide if the network satisfy the QoS guarantees.

Backward Scout

Once the route is found, the node propagates the scout in backward scout form toward the source node along the reverse path. Backward scout includes the same fields as forward scout such as: the scout identifier, the beehive identifier, the food identifier, the minimum bandwidth requested and the maximum delay allowed by the source node. Backward scout employs the hop count field in order to indicate number of hops from the source node to the destination. This field is initialized using the hop count field of the forward scout when finding the desired route. Furthermore, the stamp field is used to inform the source node by the bandwidth and the delay carried out between the source node and the destination. It contains the trip time estimated by the forward scout.
Backward scout takes advantage of lifespan field as a time to life field. It represents the time validity of the route in the backward scout trip.

2) Forager

This packet type represents data packet used to transmit the communication data. Data packets are queued until the discovery process of the desired route is terminated, and then they will be launched to the destination.

B. QoS Bee Routing Phases

1) Neighborhood connection discovery phase

In this phase, each node informs its neighbors that the links are active. All nodes in the VANET broadcast a refresh packet periodically with its immediate neighbors. When a neighbor node receives the refresh packet, all route entries in its routes table regarding the sender will be consider as valid.

If the node does not get information from the node's neighbor for specified amount of time, then the routing information in the routes table is marked as lost. In this case, the bandwidth and delay of the relevant entry will take the infinity value. Hence, an error scout packet is generated and sent to inform others of the link breakage.

2) Route discovery phase

When one node is responsible to transmit data, it first checks whether the route is present in its routes table and the QoS requirements are satisfied. If this is a case and there is a sufficient forgers, the source node transmits the data. If there is no forager, data wait recruiting foragers.

In the case of no QoS route exists, beehive generates and clones several forward scouts from one and unique forward scout. It launches and broadcasts them stochastically to its immediate neighbors. Stochastic broadcasting means the transmission of forward scouts to a limit percentage(=80%) of neighbor nodes. The cloned forward scouts have the same scout identifier, the beehive identifier, the food identifier and the maximum lifespan of the route request. Consequently, the current node checks the QoS validity and thus, the route discovery is continued, else the exploration is denied and the forward scout will be dropped.

If intermediate node has already received a forward scout with that same scout identifier and beehive identifier then it will discard it, else current node records in the routes table entry the forward scout identifier and the source node identifier at the prior hop field. It prevents from the duplication of scout. After that, it checks for available rout in its routes table, if any rout is found, it sends a backward scout to the source node along the reverse path; else it rebroadcasts stochastically the forward scout in the same manner such as the source node.

In return, the backward scout records the next hop at the tables' route entry to indicate its sender. After the backward scout arrives at the source node, the link weight is calculated and recorded at the routes table entry using the stamp field. Now, the source node recruits a number of forager according to the quality of the route discovered. Consequently, waiting data are sending using foragers. Note that the routes are selected to transmit simultaneous data according to the link weight factor. This will reduce the network congestion and then, increases the bandwidth and decreases the delay. The following diagrams figure 2. explain the route discovery phase.

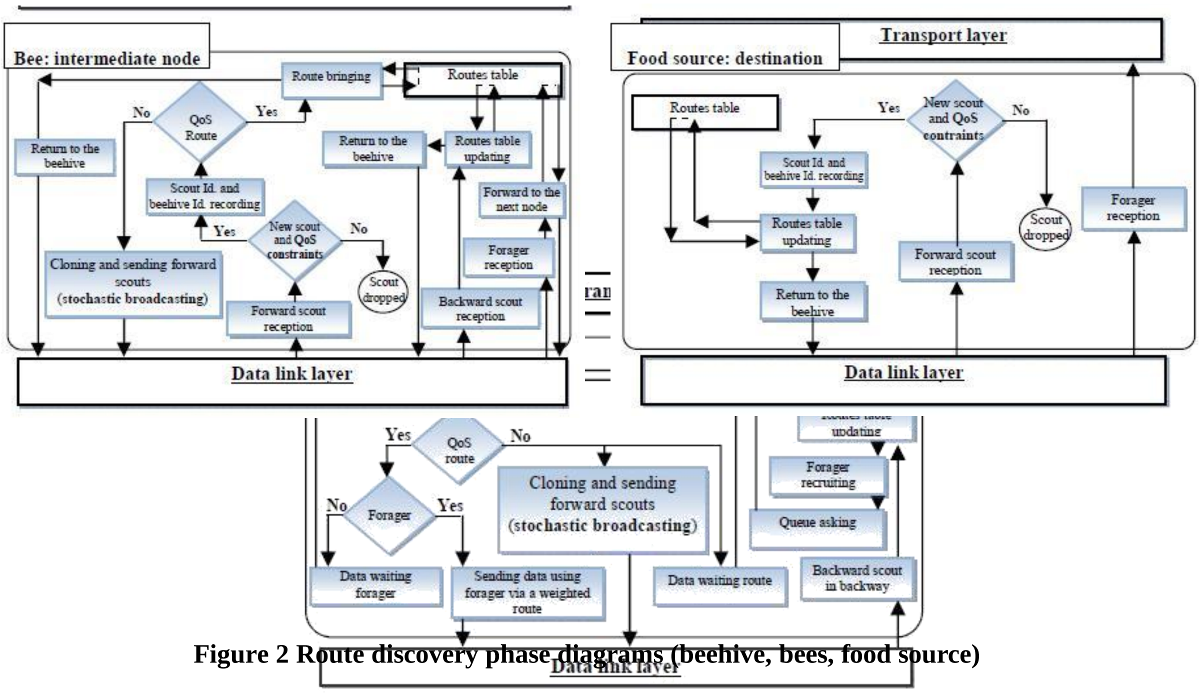

Figure 2 Route discovery phase diagrams (beehive, bees, food source)

3) Route maintenance phase

In route maintenance phase in VANET, the periodic sending of refresh packet between node and its neighbors ensures the stability of connections and also the links safely in the transmission range of node. Otherwise, the node detects a link breaks and then, any route passing this broken link is considered disconnected. Besides, the node can detect a QoS requirements violation (bandwidth insufficiency or large delay). In these cases, the detector node of this failure sends an error scout to the source node via the prior hop and so on. The goal here is to inform any node in the reverse route about the broken link to remove it from its routes table and to rediscover a new QoS route by the source node if needed.

VII. CONCLUSION

Research and industries are recently more interesting and attracting to the VANET and MANET development domain. A vehicular ad hoc network (VANET) is a subclass of MANET. From this paper, we conclude that Bee Ad Hoc Network employs a simple bee behavior to monitor the validity of the routes. When compared to other algorithms the battery level of BeeAdHoc is better because it tries to spread the data packets over different routes rather than always sending them on the best routes. This protocol is reactive, distributed and topology based protocol which provides QoS guarantees in VANET compare to AODV, DSDV such as end-to-end delay and bandwidth in VANET due to transmitting fewer control packets and by distributing data packets on multiple path.

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