Provident Routing Scheme Rely on Swarm Astuteness for MANET

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ABSTRACT
Mobile Ad-Hoc Network dynamically changes its topology and also it doesn't have proper infrastructure. So, it is necessary to provide the route stability. Already several routing methodologies are available for MANET. But those are not take the delay occurs in the network into account. As the topology of the network is dynamically changed, the route failure occurs frequently. Alternate route should be selected to route the data to its destination. The alternate route may be shortest path or it may not be. So, the concept of swarm astuteness is included in order to route the data reliably and quickly. The hill building behavior of termite inspires to find the alternate shortest path in the dynamic environment. In biological context, the termites are using pheromone to find out the path to reach the destination. Similarly, in this paper the pheromone table is maintained for each node. The MANET uses the hill building behavior of termite to discover the route dynamically which provides better packet delivery and decreases the control overhead.

General Terms
Security, Algorithms, Routing

Keywords
MANET; swarm astuteness; reliability; pheromone.

1. INTRODUCTION
In Mobile Ad-Hoc Network all nodes are autonomous node (i.e.,) each node act as router and also all nodes are connected by wireless link, they dynamically changes its position in the network. As the position of the nodes is changes dynamically, the route failure will occur frequently. Many of the ad-hoc routing protocols will discover alternative route if any route failure occurs. More over the node in the MANET involves multi hop transmission. The delay may occur in the MANET due to link failure. Since the MANET mainly used in the critical application, it is necessary to avoid the packet delay, packet loss and should provide better packet delivery. Swarm astuteness routing methods inspire the MANET to discover optimal route. A number of protocols have been proposed in the past for mobile ad hoc networks. The basic idea of the design in AODV is to operate each Mobile Host as a specialized router, which periodically advertises its view of the interconnection topology with other Mobile Hosts within the network [1], [2], [3], [4] & [5].

Provident routing scheme is a distributed routing method for mobile ad-hoc networks. It is designed using the swarm intelligent framework in order to achieve better adaptively, lower control overhead, and better packet delivery than contemporary solutions. The scheme is inspired by the hill building behavior of termites. A social insect metaphor suggests a probabilistic routing algorithm. Information about the network environment, such as topology, link quality, and traffic congestion, is determined from the amount of pheromone, or path utility estimate, contained on each arriving packet at each node. Packets are considered to route themselves and are able to influence the paths of others by updating routing parameters throughout the network. The collection of these parameters from all nodes across the network constitutes the environment in which the packets exist. This Termite environment is a representation of the collective knowledge of all nodes. The interaction between packets and their environment implicitly spreads information about network conditions and thus reduces the need to generate explicit control traffic. In general, the method of communicating information indirectly through the environment is known as stigmergy. John S. Baras and Harsh Mehta et al 2003 [10] proposed an algorithm that uses Ant-like agents to discover and maintain paths in a MANET with dynamic topology and [8] presents a modified Ants-Routing algorithm called accelerated Ants-Routing which makes convergence speed accelerated compared with other reinforcement base algorithms[6], [7] & [9].

In this paper, hill building behavior of termite is used to discover the route in the MANET. The dynamic behavior of the Mobile AD-Hoc Network encourages the optimal dynamic routing technique. The pheromone table is maintained by each node. The pheromone is used to discover the optimal route. The pheromone should be updated dynamically and will be decayed. Based on the pheromone value each node selects the optimal route to each of its destination.

2. SYSTEM MODEL
The system model is described by using a figure below. Figure.1. shows the architecture of MANET environment. The source node transmits the data packets to destination through the nodes which are having highest pheromone value. If any route failure occurs, the failed node immediately selects the alternative path based on pheromone value. So that delay can be avoided to send the data packets while route failure occurs.

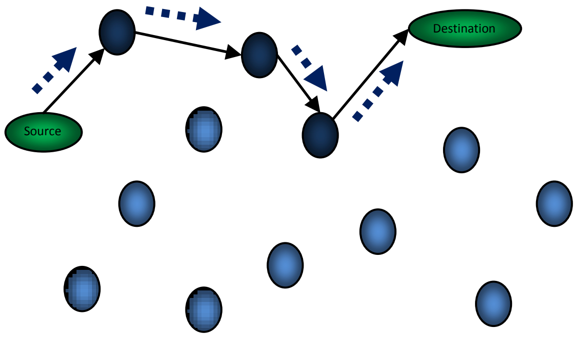

Fig 1: Architecture of MANET

2.1 Provident swarm based routing scheme

The provident routing scheme is explained in detail below, however it may be described simply as follows. Each node in the network has a specific pheromone scent. As packets move through the network on links between nodes, they are biased towards the pheromone of their destination. Packets follow this pheromone gradient while laying pheromone for their source on the links that they traverse. The amount of pheromone deposited by a packet on a link depends on the utility of the path that it has traversed. Packet pheromone is proportional to the utility of the path followed up to the current node in the network. Using this method of pheromone updating, consistent pheromone trails are built through the network. Changes in the network environment, such as topological or path quality changes are accounted for by allowing pheromone to decay over time. This requires paths to be continuously reinforced by new traffic; new information about the network is added to links. Each network node records the amount of pheromone that exists for each destination on each of its links.

2.2 Properties of Provident swarm based routing scheme

This section highlights some of the properties and variations of Provident swarm based routing scheme

2.2.1 Best-Effort examination

The random routing of packets allows known routes to be used while still exploring the network for new and better routes. There is always a chance that poor routing decisions will be made and a packet will never arrive at its destination. A packet may be routed in a loop or perhaps in an entirely wrong direction. A Time-To-Live (TTL) field is used in order to prevent the propagation or reinforcement of bad routing decisions. The probability of a packet persisting in a loop tends to zero with the length of the loop; the number of packets that are lost to looping will not adversely affect the overall routing performance. If loops cannot be tolerated, the message identification field in each packet may be used to record previously processed or overheard packets. Packets in this list will be dropped if received a second time. Provident swarm based routing scheme is designed to quickly find an acceptable routing solution and to adapt gracefully as the network changes.

2.2.2 Low difficulty

The Provident swarm based routing scheme is a simple algorithm. The memory footprint can become large, storing a maximum number of pheromone values equal to the square of the total number of nodes in the network. Computation time for next-hop probabilities may be reduced by caching probability results or reducing the frequency with which updated probabilities are calculated. Each packet is processed in one pass, including the updating of the pheromone table and the next hop computation. It is not necessary to keep track of special purpose information such as sequence numbers or route setup attributes.

2.2.3 Low Route Recovery Latency

The Provident swarm based routing scheme provides low route recovery latency. If a neighbor link is lost, future next hop calculations will simply not consider the pheromone that was on that link. Packets transmitted to neighbors that are no longer able to communicate may be retransmitted to those that can. Unless a node is entirely unaware of a particular destination, a next hop can be computed immediately. Given a sufficient amount of traffic from each node, little pheromone will decay to the point of being lost entirely from a pheromone table. Few control packets must be sent, which could delay the next hop calculation.

2.2.4. Adaptability

Provident swarm based routing scheme is able to adapt to the aggregate effects of all factors affecting throughput. Many effects influence the rate at which a message may be transmitted, and thus the rate at which messages arrive at their destinations. In order to find a shortest hop path, packets traversing a shorter path will arrive at the destination sooner than those on longer paths. This will influence packets traveling in the opposite direction to travel the shorter path, which will in turn bias more traffic onto the shorter path. In the case of variable quality links, the network will learn to avoid low quality links. For instance, in order to maintain an acceptable bit error rate (BER) across low quality links, a medium access protocol can be expected to reduce the bit rate. This will result in a lower throughput, and perhaps also increased traffic congestion at that node as transmit queues is filled. Some arriving packets lead to a lower regeneration rate of pheromone, and lower bias for packets traveling in the opposite direction.

The MAC layer may take a different approach to solving the link BER problem, such as increasing the transmit power. This may maintain an acceptable bit and error rates, but the larger transmit radius will influence traffic patterns in the area. The node will prevent others from transmitting while it is doing so. This will alter the rate at which packets are able to be transmitted between nodes and thus change the routing probabilities. Protocols have been suggested that base their routing strategies on measured topology volatility, especially that of the local topology.

Destination —	N1	N2	N3	N4	N5
Neighbors	N2	N2	N2	N2	N2
	N3	N3	N3	N3	N3
	N5	N5	N5	N5	N5

Provident swarm based routing scheme automatically measures this; many transmissions will be overheard from long-time neighbors, resulting in high pheromone levels on the links to those neighbors. Stable neighbors will be preferred for routing.

2.2.5. Multipath Routing

Provident swarm based routing scheme provides multipath routing. Each routing decision is probabilistic and independent from all other decisions. No two packets are guaranteed to take the same path through the network. After all, data packets are expected to explore the network. As a network topology becomes more stable, routes between nodes may collapse to a single high probability path. This will be the case if there is one path which is more optimal than all others, or it may simply be a matter of happenstance. In the latter scenario, the forwarding function can be tuned to equalize the link probability.

2.3 Structure of pheromone table

In order to manage the pheromone in the network, each node maintains a table recording the pheromone on each neighbor link from each destination node. Each node has a distinct pheromone scent. The table may be visualized as a matrix with neighbor nodes listed along the side and destination nodes listed across the top. Rows correspond to neighbors and columns to destinations. An entry in the pheromone table of node n is referenced by $Ph_{i,d,n}$, where i $\in$ Nn is a neighbor node, and d $\in$ Dn denotes a destination. In other words, is the amount of $Ph_{i,d,n}$ pheromone from node d on the link with neighbor i at node n. An example of a pheromone table is shown in Figure 1 Nn and Dn are the sets containing the current neighbors and destinations known to node n, respectively.

2.3.1 Pheromone Update

When a packet is received at a node n from source s and previous hop r, the Pheromone entry $Ph_{n,r,s}$ is updated in the pheromone table according to Equation 1.1 with a constant amount of pheromone $_c$. Each receiving node should update its pheromone table in this way, even if it is not the intended receiver of the packet. Using such promiscuous mode reception allows routing information to be spread more quickly.

$$Ph_{n,r,s} \leftarrow Ph_{n,r,s} \cdot \qquad (1.1)$$

2.3.2 Pheromone Decay

To account for pheromone decay, each value in the pheromone table is periodically multiplied by a decay factor . The decay rate is ≥ 0, and is a global parameter. A high decay rate will quickly reduce the amount of remaining pheromone, while a low value will degrade the pheromone slowly. The nominal pheromone decay interval is one second; this is called the decay period. Equation 1.2 describes pheromone decay.

$$\forall i \in Nn, \forall d \in Dn, Ph_{n,i,d} \leftarrow Ph_{n,i,d} \cdot e^{-} \qquad (1.2)$$

If all of the pheromone for a particular node decays, then the corresponding row and/or column is removed from the pheromone table. Removal of an entry from the pheromone table indicates that no packet has been received from that node in quite some time. It has likely become irrelevant and no route information must be maintained. A column (destination listing) is considered decayed if all of the pheromone in that column is equal to a minimum value. If that particular destination is also a neighbor then it cannot be removed unless all entries in the neighbor row are also decayed. N1 row is considered decayed if all of the pheromone values on the row are equal to a minimum value. Neighbor nodes must be specially handled because they can forward packets as well as originate packets. N1 decayed column indicates that no traffic has been seen which was sourced by that node. Since neighbors can also forward traffic, their role as traffic sources may be secondary to their role as traffic relays. Thus, the neighbor row must be declared decayed before the neighbor node can be removed from the pheromone table. If a neighbor is determined to be lost by means of communications failure (the neighbor has left communications range), the neighbor row is simply removed from the pheromone table.

2.3.3 Pheromone Bounds

There are three values governing the bounds on pheromone in the table. These are the pheromone ceiling, the pheromone floor, and the initial pheromone. When a packet is received from an unknown source, a new entry for that node is created in the pheromone table. In the case of a neighbor node, a new column and row will be created (neighbor nodes are also potential destinations). If the source is not a neighbor only a column is entered into the table. Each pheromone value in the new cells will be assigned the initial pheromone value. During the course of pheromone decay, no value is allowed to fall below the pheromone floor. This allows unused nodes to be easily detected. Likewise, no pheromone value is allowed to exceed the pheromone ceiling. These bounds prevent extreme differences in pheromone from upsetting the calculation of next hop probabilities. Each parameter may be tuned for a particular network environment.

2.4 Route Selection

In order to forward a packet towards its destination, the forwarding equation is used to determine the next hop neighbor. This formula transforms the pheromone for destination d on each outgoing link i, $Ph_{n,i,d}$, to the probability that that link will be used to forward the packet, $p_{n,i,d}$. The specific next hop neighbor is chosen randomly according to this distribution, though no packet is ever returned to the node that it arrived from, r. Thus, i is chosen from Nn − r. The forwarding equation is shown in Equation 1.3.

$$Ph_{n,i,d} = \frac{(Ph_{n,i,d+K})^F}{\sum_{j \in Nn-r}(Ph_{n,j,d+K})^F} \qquad (1.3)$$

The constants F and K are used to tune the routing behavior of Termite. The pheromone threshold, K, determines the sensitivity of the probability calculations to small amounts of pheromone. If K $\geq$ 0 is large, then large amounts of pheromone will have to be present before an appreciable effect will be seen in the routing probability. The nominal value of K is zero. Similarly, the pheromone sensitivity, F $\geq$ 0, may be used to modulate the differences between pheromone amounts. For example, F > 1 will accentuate differences between links, while F < 1 will deemphasize them. F = 1 yields a simple normalization.

2.5 Route Request Packets

Route request (RREQ) packets are sent when a node needs to find a path to an unknown destination. Route requests perform a random walk over the network until a node is found which contains some pheromone for the requested destination. In a random walk, a packet uniformly randomly chooses its next hop, except for the link it arrived on. If a route request cannot be forwarded, it is dropped. Pheromone is disregarded during a random walk. Any number of RREQ packets may be sent for each route request; the exact number of which may be tuned for a particular environment. A route request is not looking for an explicit route to the destination. Rather it is searching for the beginning of a pheromone trail to the destination. The route will be strengthened by future communications.

2.6 Route Reply Packets

Once a route request packet is received by a node containing pheromone to the requested destination, a route reply (RREP) packet is returned to the requestor. The RREP message is created such that the source of the packet appears to be the requested destination and the destination of the packet is the requestor. The reply packet extends pheromone for the requested destination back to the requestor without any need to change the way in which pheromone is recorded at each node. The reply packet is routed normally through the network by probabilistically following a pheromone trail to the requestor. Intermediate nodes on the return path automatically discover the requested node.

3. SIMULATION ANALYSIS

The proposed scheme is performance is evaluated by using NS2 Simulator. In simulation, used mobility model is the Random way point mobility model. And the system (example) has 40 nodes moving in an area of 1500m ×1500m. Each node independently moving within the area specified area.

Table 1: Simulation parameters

Parameter	Value
Simulator	NS2(Ver. 2.28)
Simulation Time	20 ms
Number of nodes	40
Routing protocol	AODV
Traffic model	CBR
Mobility speed	300m/s
Simulation Area	1500×1500
Transmission range	250m

The provident routing scheme is implemented and executed, during the simulation period the network events are traced by using the trace files. By executing the trace file, the following graphs are obtained.

The following graph shows that the comparison result of packet delivery ratio of AODV and the proposed provident routing scheme. As mentioned earlier, the proposed scheme has transmitted 534 packets within 10 ms. On the other hand AODV has transmitted 387 packets within same sample period.

Figure.3. shows the graph plotted between Time Vs No. of packets dropped. The performance of the proposed system is compared with the existing AODV protocol. The proposed scheme has low packet loss rate when compared with AODV routing scheme.

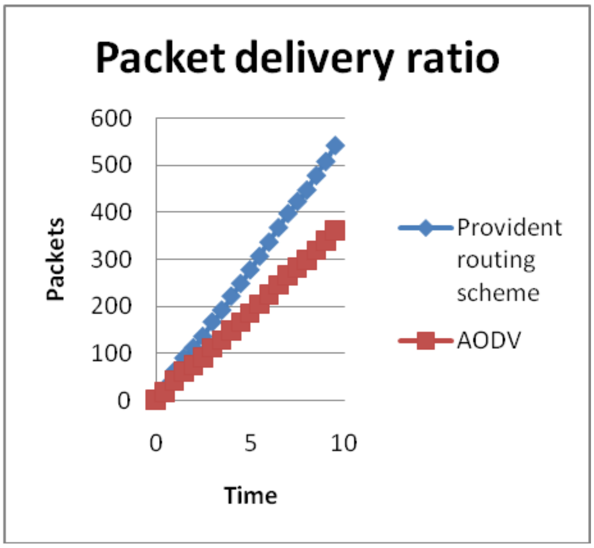

Fig 2: Packet delivery ratio analysis

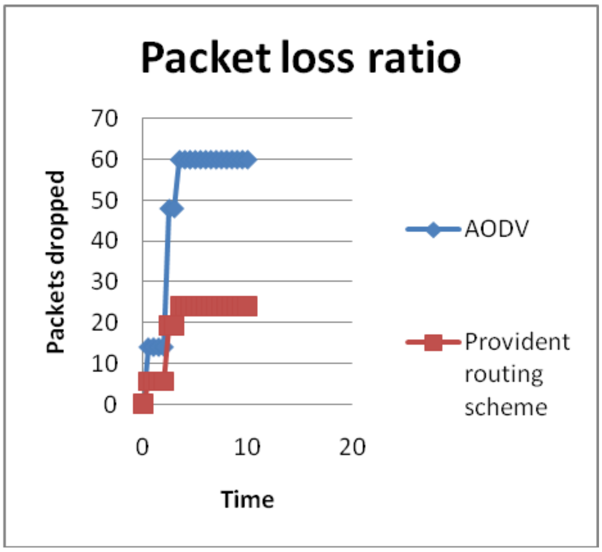

Fig 3: Packet loss ratio analysis

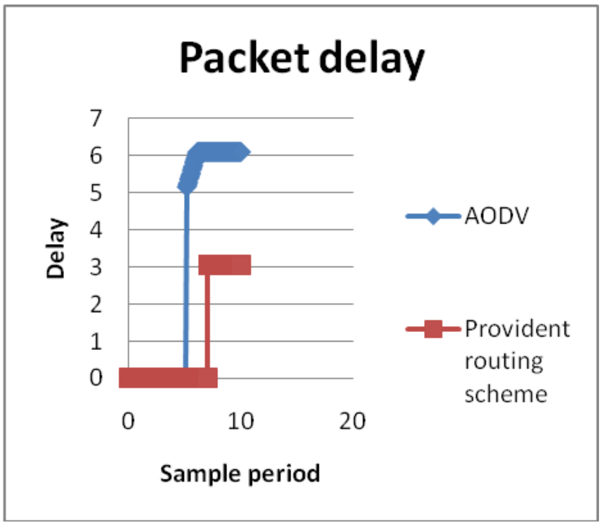

Fig 4: Delay time analysis

The delay occur in the system is determined and compared with the delay occur while using the AODV routing scheme is shown in the figure.4. The ultimate goal is to reduce the packet delay when route failure occurs. From the above graph, the provident routing scheme reduces the delay when route failure occurs.

4. CONCLUSION

This work investigates recent research trends in swarm based routing for MANETs. Route failure management attracted much attention. Many techniques were proposed to find the globally best solution in terms of routing for a mobile ad-hoc network. It is observed that due to node mobility, unstable links and limited resources in MANET, many routing algorithm found to be unsuitable for routing after link failure. To overcome this new scheme is introduced called as Provident swarm based routing scheme. This scheme is based on the hill building behavior of termites. This scheme can provide better adaptively, lower control overhead, and better packet delivery than contemporary solutions.

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