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ANT–AODV Hybrid Protocol for MANETs

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ABSTRACT
Reconfigurable wireless networks are called Ad hoc Networks, whose topology is continuously changing, self –adapting to the connectivity and propagation conditions and to the traffic and user mobility patterns. Mobile ad hoc networks are networks formed

by mobile hosts without any infrastructure. This project combines the on demand routing capability of Ad Hoc – On demand Distance vector (AODV) routing protocol with a distributed topology discovery mechanism using ant like mobile agents. The proactive routing protocols in MANETs like AODV require knowing, the topology of the entire network. Hence they are not suitable for highly dynamic networks such as MANETs, since the topology update information needs to be propagated frequently throughout the network. AODV requires the actual communication to be delayed until the route is determined (found). This may not be suitable for real time data and multimedia communication applications. ANT like mobile agents can be used for efficient routing in a network and discover the topology, to provide high connectivity at the nodes, However ant based algorithms in wireless and ad hoc networks have certain drawbacks. In that nodes depend solely on the mobile agents to provide them routes to various destinations in the network. This may not perform well when the network topology is very dynamic and the route lifetime is small. The Hybrid protocol Ant-AODV provides high connectivity, reducing the amount of route discoveries before starting new connections. This eliminates the delay before starting the actual communication and increases the throughput also. Ant-AODV routing protocol is ideal for real time communication in highly dynamic networks such as MANETs.

Key words: Network Simulator; Ad Hoc Routing Protocol; Ant Mobile Agent; Hybrid.

Abbreviations: MANET - Mobile Adhoc Network; AODV - Ad hoc On-Demand Distance Vector; DSDV - Destination-Sequenced Distance Vector: WRP - Wireless Routing Protocol; GSR - Global State Routing; CGSR - Cluster head Gateway Switch Routing; CBRF - Cluster Based Routing Protocol; DSR - Dynamic Source Routing; TORA - Temporally Ordered Routing Algorithm; ABR - Associativity-Based Routing; SSR - Signal Stability Routing; LAR - Location Aided Routing; DCF - Distributed Coordination Function; MAC - Media Access Control Protocol; CSMA/CA - Carrier Sense Multiple Access with Collision Avoidance; CBR - Continuous Bit Rate; NS-2 - Network Simulator.

1. INTRODUCTION

A Mobile Adhoc Network (MANET) is an autonomous collection of mobile nodes, which have the possibility to connect on a wireless medium and form an arbitrary and dynamic network with wireless links. The network is decentralized and its network topology may change rapidly and unpredictably (Jochen Schiller, 1985; Minar et al., 1999). A MANET is expected to be of larger size than the radio range of the wireless antennas, because of this fact it could be necessary to route the traffic through a multi-hop path to give two nodes the ability to communicate (Matsuo and Mori, 2001). There are neither fixed routers nor fixed locations for the routers as in cellular networks – also known as infrastructure networks shown in Fig.1. Recently more attention there are neither fixed routers nor fixed locations for the routers as in cellular networks –also known as infrastructure networks shown in Fig.1.

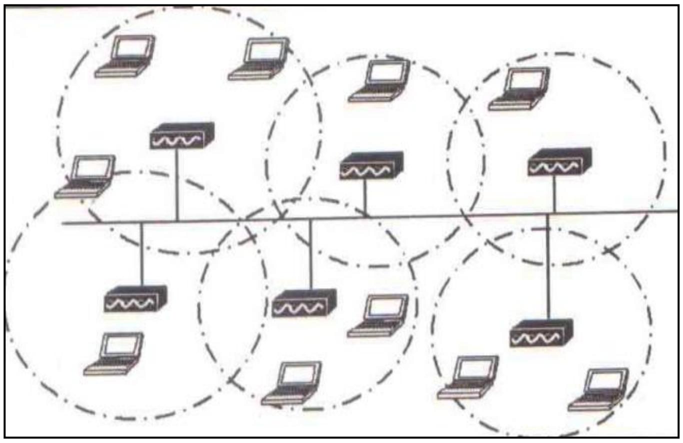
Cellular networks consist of a wired backbone which connects the base stations. The mobile nodes can only communicate over a one-hop wireless link to the base station; multi-hop wireless links are not possible (Tanenbaum, 1996). By contrast, a MANET has no permanent infrastructure at all. All mobile nodes act as mobile routers. A MANET is depicted in Fig. 2 since, the nodes are mobile; the network topology may change unpredictably over time. The network is decentralized; where all network activity including discovering the topology and delivering messages must be executed by the nodes themselves i.e. routing functionality will be incorporated into mobile nodes. MANETs have several salient characteristics: 1) Dynamic topologies 2) Bandwidth constrained, variable capacity links 3) Energy-constrained operation 4) Limited physical security. Therefore the routing protocols used in ordinary wired networks are not well suited for this kind of dynamic environment. Routing algorithms are often difficult to be formalized into mathematics they are instead tested using extensive simulation.

1.1. Manet routing protocols

Routing protocols for Mobile ad hoc networks can be broadly classified into two main categories:

1.1.1. Proactive or table-driven routing protocols

1.1.2. Reactive or on-demand routing protocols (Fig. 3)



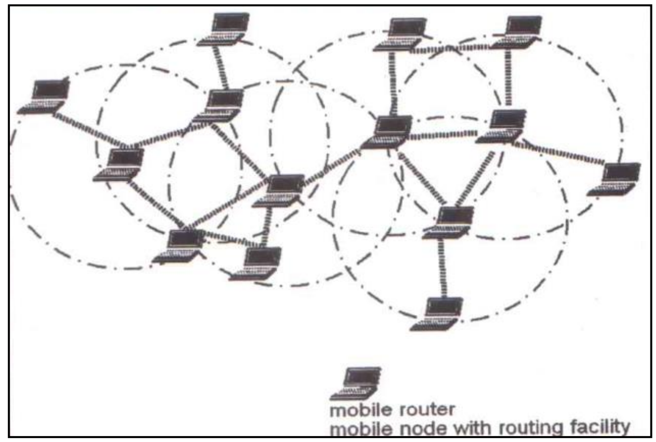


Figure 1 Infrasructure Networks

Figure 2 Mobile Adhoc Networks

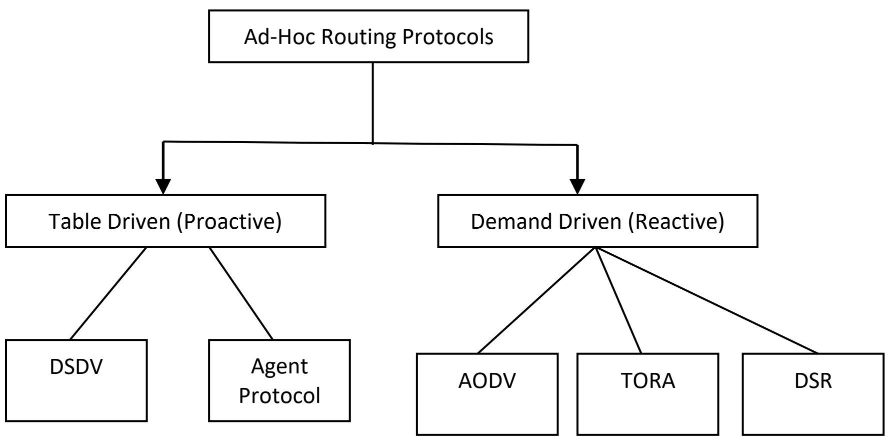


Figure 3
Ad-Hoc Routing Protocols

1.1.1. Table Driven Routing Protocols (Proactive)

In proactive or table-driven routing protocols, each node continuously maintains up-to-date routes to every other node in the network. Routing information is periodically transmitted throughout the network in order to maintain routing table consistency (Choudhary et al., 2000). Thus, if a route has already existed before traffic arrives, transmission occurs without delay. Otherwise, traffic packets should wait in queue until the node receives routing information corresponding to its destination. However, for highly dynamic network topology, the proactive schemes require a significant amount of resources to keep routing information up-to-date and reliable. Certain proactive routing protocols are Destination-Sequenced Distance Vector (DSDV), Wireless Routing Protocol (WRP), Global State Routing (GSR) and Cluster head Gateway Switch Routing (CGSR).

1.1.2. On-Demand Routing Protocols (Reactive)

In contrast to proactive approach, in reactive or on demand protocols, a node initiates a route discovery throughout the network, only when it wants to send packets to its destination. For this purpose, a node initiates a route discovery process through the network (Perkins and Royer, 2000). This process is completed once a route is determined or all possible permutations have been examined. Once a route has been established, it is maintained by a route maintenance process until either the destination becomes inaccessible along every path from the source or until the route is no longer desired. In reactive schemes, nodes maintain the routes to active destinations. A route search is needed for every unknown destination (Shivanajay Marawaha and Chen Khong Tham, 2003).

Therefore, theoretically the communication overhead is reduced at expense of delay due to route research. Some reactive protocols are Cluster Based Routing Protocol (CBRP), Ad hoc On-Demand Distance Vector (AODV), Dynamic Source Routing (DSR),Temporally Ordered Routing Algorithm (TORA), Associatively-Based Routing (ABR), Signal Stability Routing (SSR) and Location Aided Routing (LAR).

2. MATERIALS AND METHODS

2.1. General

The Ant-AODV hybrid routing protocol proposed in this project is compared with the conventional ant-based and AODV routing protocols. Network Simulator (NS-2) is used to simulate these protocols. NS-2 is a discrete event simulator. Ns-2 makes use of two languages namely the OTcl and C++. OTcl is used for configuration and setup.

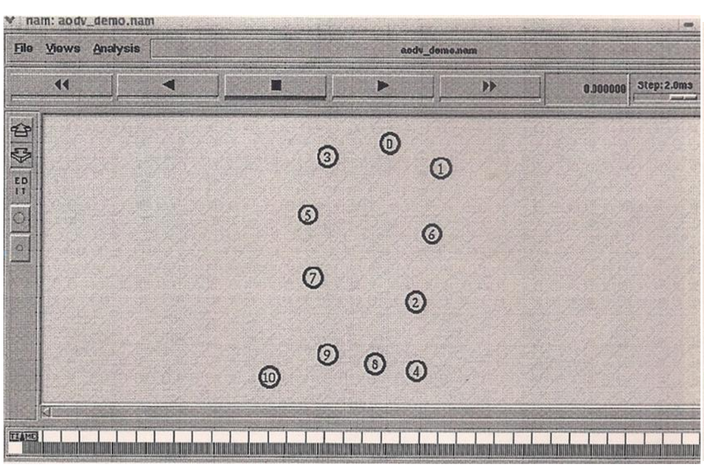
C++ is used for processing each packet of a flow and to change the behavior of existing classes. The NS-2 (ns-2.28) which can model and simulate multi-hop wireless adhoc networks was used for simulations. The physical layer for the simulation uses two ray ground reflections as the radio propagation model. The link layer is implemented using IEEE 802.11 Distributed Coordination Function (DCF), Media Access Control Protocol (MAC). It uses "RTS/CTS/DATA/ACK" pattern for unicast packets and "data "for broadcast packets. Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) is used to transmit these packets. All protocols simulated maintain a send buffer of 64 packets, containing the data packets waiting for a route.

Packets sent by routing layer are queued at the interface queue till MAC layer can transmit them, which has a maximum size of 30 data packets. The interface queue gives priority to routing packets in being served. The transmission range for each of the mobile nodes is set to 50 m and the channel capacity is 2 Mbps. Simulations were run for 600 simulated seconds. The routing table used for all the three protocols are similar. Every route entry in the routing table has a destination node address, number of hops to reach that destination, the next hop to route the packets, the sequence number of the destination and the time to live for that route.

The simulation models a network of 10 mobile nodes migrating within an area of 500m X 500 m with a speed of 0-10m/s. A rectangular space was chosen in order to force the use of longer routes between nodes than would be there in a square space with the same amount of nodes. The mobility model uses the *random way point* model in the rectangular field. The simulations were run multiple times for 5 different pause times: 100,200,300,500 and 600 seconds. Pause time is the dormant time during which the node does not move after reaching a destination. After pausing for pause time seconds it again selects a new destination and proceeds at a speed distributed uniformly between 0 and certain maximum speed.

2.2. Traffic Model

The Continuous Bit Rate (CBR) connections (traffic flows) were used for the simulations .CBR traffic sources were chosen, as the aim was to test the routing protocols. Source nodes and destination nodes were chosen at random with uniform probabilities. Each data point in the comparison results represents an average of multiple runs with identical traffic models but with different movement scenarios. Same movement and traffic scenarios were used for all the three protocols.



Figue 4 Initial Node Posotion

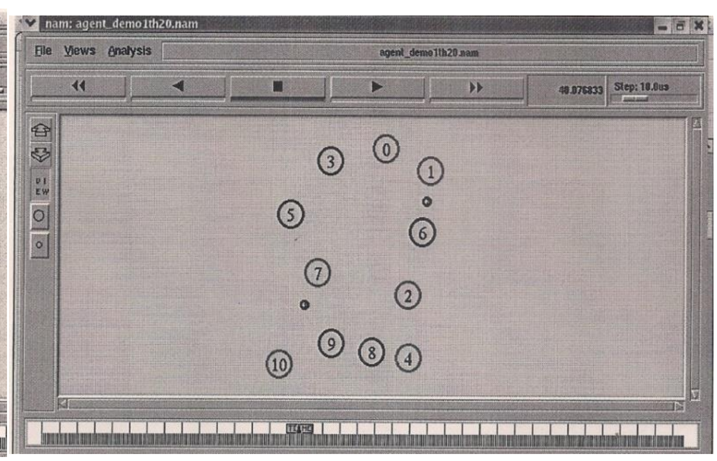


Figure 5 Hybrid protocol-7-0 communicate

2.3. Ant History Size and Ant Population

After experimenting with many combinations of ant population and history sizes, the values that gave the best performance were chosen so as to keep a balance between control overhead and efficient routing. For simulating ant based routing protocol the two ants were used with a history size of 10.

2.4. Description

The parameters which are used in the configuring of the nodes, which is done with the help of the following command.

```
$ns node-config-adhocRouting $cal (rp)
    -IIType $val (II)
    -ifqType $opt (ifq) -ifqLen $opt (ifqlen)
    -antType $opt(ant)
    -propInstance [new $opt (prop)]
    -phyType $opt (netif)
    -channel [new $opt (chan)]
    -topoInstance $topo
    -wiredRouting OFF
    -agentTrace ON
    -routerTrace OFF
    -mac Trace OFF
```

The initial node positions are shown in Fig.4. The three source destination has been designated for this topology. The one is 10& 4, the second one is 1 & 2 and the last one is 7 & 0. This source destination will start communicating after different time slots. When source node 10 wants to communicate with 4 first it will check its routing table whether there is a hop entry to node 4. If not it will start sending AODV request signal. At the same time agents are generated and let into the network to know the topology. As agent has not updated the routing table of node 10, node 10 will start sending the request signal. After receiving the reply signal from the node 4, node 10 will start sending the data packets to the destination.

At the same time, agent will visit the node and have the history of all the nodes visited. The history size is restricted to 10. As agent updated the routing table of 1 with the hop entry to 2, node 1 will start sending the data packets to the destination node without sending the request signal. Similarly as another agent updated the routing table of node 7, the node 7 will start sending the data packets to the destination node 0. This simulation is run for 100,200,300,400 and 600 sec (Fig.5).

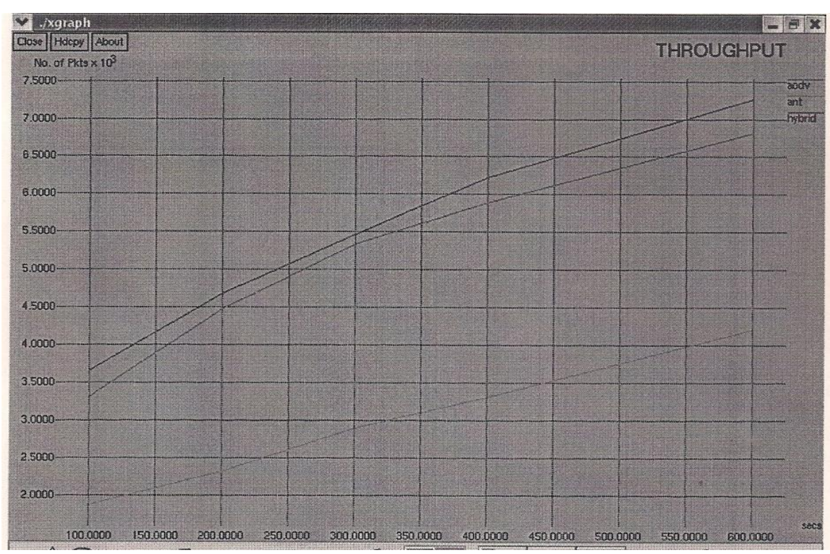


Figure 6

Throughput Graph

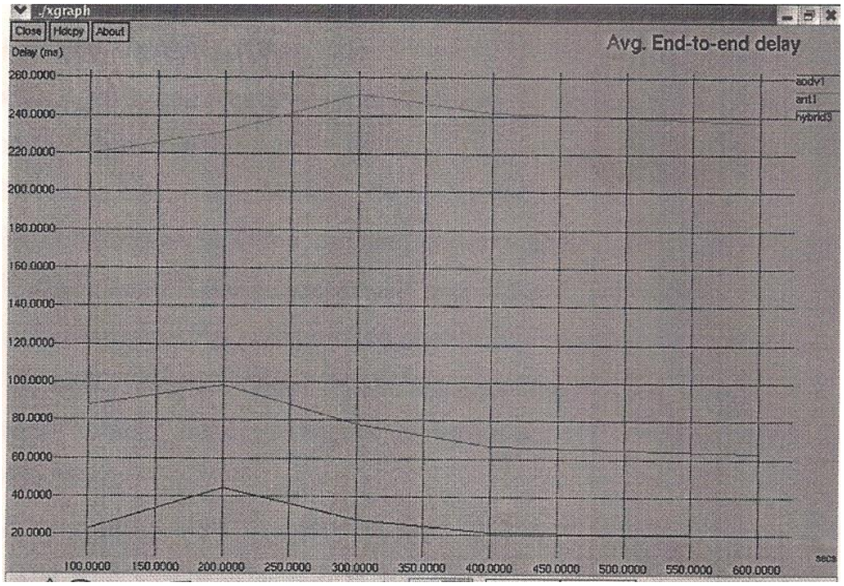


Figure 7
Delay Graph

3. RESULTS AND DISCUSSIONS

3.1. Simulation Results

Throughput is very high for Ant-AODV and AODV compared to ant based routing. The reason for high throughput is AODV and Ant-AODV consider link failure detection whereas in case of ant –based routing there is no such feature and so the source nodes keep on sending packets unaware of the link failures. This leads to a large amount of data packets being dropped which reduces the packet delivery fraction and the throughput. Also from graph given below it is that as the seconds increases the throughput increases due to less link failures (Fig.6).

End–to-end delay includes buffering delay during route discovery, queuing delay at interface queue, retransmission delays and propagation and transfer times. The average end –to – end delay for AODV and Ant-AODV hybrid protocol is very less as given in the graph below. But in case of Ant routing technique the average end-to-end delay is high. The high end-to-end delay in ant-based routing is attributed to the lack of on-demand route discovery capability of the nodes in ant routing. Due to this the packets to be sent by a node keep waiting in the send buffer till the ants visit that node and provide it with routes. Comparing Ant-AODV and AODV it can be observed that the end-to-end delay is considerably reduced in Ant-AODV as compared to AODV (Fig.7).

In Ant-AODV, ants help in maintaining high connectivity hence the packets need not wait in the send buffer till the routes are discovered .Even if the source node does not have a ready route to the destination, due to the increased connectivity at all the nodes the probability of its receiving replies quickly from nearby nodes is high resulting in reduced route discovery latency.

4. CONCLUSION

Ant-AODV hybrid protocol is able to provide reduces end-to-end delay and high connectivity as compared to AODV. As a result of increased connectivity the number of route discoveries is reduced and also the route discovery latency. This makes Ant-AODV hybrid routing protocol suitable for real time data and multimedia communication. As a direct result of providing topology information to the nodes (using ants), the foundations for designing distributed network control and management get automatically laid. The reduction in end-to-end delay and higher connectivity are achieved at the cost of extra processing of the ant messages and the slightly higher overhead occupying some network capacity.

SUMMARY OF RESEARCH

1. The proposed Ant-AODV technique forms a hybrid of ant-based routing and AODV routing protocols.
2. This work tries to overcome the shortcoming of on-demand routing protocols like AODV and ant-based routing by combining them to enhance their capabilities and alleviate their weakness.
3. Network Simulator (NS-2) is a discrete event simulator is used to simulate multi-hop wireless adhoc networks.
4. Ns-2 makes use of two languages namely the OTcl and C++. OTCL is used for configuration and setup. C++ is used for processing each packet of a flow and to change the behavior of existing classes.
5. Ant like mobile agents can be used for efficient routing in a network and discover the topology, to provide high connectivity at the nodes.
6. The hybrid protocol Ant-AODV provides high connectivity, eliminates the delay before starting the actual communication and increases the throughout also.
7. Ant-AODV routing protocol is ideal for real time communication in highly dynamic networks such as MANETs.

FUTURE ISSUES

The future work will involve adding inter agent communication and intelligence to the ant agents. This coupled with the ants providing information such as node affinity and power levels etc. to the nodes would help in taking intelligent routing decisions.

DISCLOSURE STATEMENT

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