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A Survey Report on Route Allocation for Guaranteed Data Delivery in Mobile Ad Hoc Networks

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Abstract—Mobile Ad hoc networks (MANET) carried out multi-hop communication in an environment with no fixed infrastructure, by means of mobile nodes and changing network topology. In the earlier period, hundreds of new routing protocols were designed for the various scenarios of MANET. Most existing ad hoc routing protocols are liable to node mobility, especially for large-scale networks. Provoked by this issue, this paper presents the survey on few Adaptive Position Update (APU) strategy for geographic routing, which dynamically adjusts the frequency of position updates based on the mobility dynamics of the nodes and the forwarding patterns in the network and some Dynamic Position Based Routing (DPBR) protocol which implemented in the distributed architecture and takes advantage of the stateless property of geographic routing and the broadcast nature of wireless medium dynamically. When a data packet is sent out, some of the neighbour nodes that have eavesdropped with the transmission will serve as forwarding candidates, and take turn to forward the packet if it is not in a position to receive. By utilizing such uphill backup, this paper concentrate on how the new examine model supports to reduce the packet drop as well as increase delivery ratio dynamically.

Keywords—MANETs, Ad-Hoc Networks, Geographic Routing, Adaptive Position Update,Dynamic Position Based Routing

1. INTRODUCTION:-

Since their emergence in the1970s, wireless networks have become increasingly popular inthe computing industry. This is particularly true within thepast decade, which has seen wireless networks being adaptedto enable mobility. There are currently two variations ofmobile wireless networks. The first is known as the infrastructure network (i.e., a network with fixed and wired gateways).The bridges for these networks are known as base stations. Amobile unit within these networks connects to, and communicates with, the nearest base station that is within its communication radius. As the mobile travels out of range of one basestation and into the range of another, a "handoff" occurs fromthe old base station to the new, and the mobile is able to continue communication seamlessly throughout the network. Typical applications of this type of network include office wirelesslocal area networks (WLANs).

The second type of mobile wireless network is the infrastructure less mobile network, commonly known as an ad hocnetwork. Infrastructure less networks has no fixed routers; allnodes are capable of movement and can be connected dynamically in an arbitrary manner. Nodes of these networks functionas routers which discover and maintain routes to other nodesin the network. Example applications of ad hoc networks areemergency search-and-rescue operations, meetings or conventions in which persons wish to quickly share information, anddata acquisition operations in inhospitable terrain.This article examines routing protocols designed for thesead hoc networks by first describing the operation of each ofthe protocols and then comparing their various characteristics.

Traditional routing protocols based on the link-state or distance-vector algorithms are aimed at finding optimalroutes to every host in the network, and topological changes of the network can only be reflected through the propagation of periodic updates. These protocols are not suitable for ad hoc networks. Indeed, finding and maintaining routes to every host is too expensive and almost always not necessary as each host only communicates with a subset of the hosts in the network. Furthermore, the periodic updates cannot promptly reflect the frequent topological changes in ad hoc networks, which in turn will cause a lot of undelivered packets and undermine the quality of communication. As a consequence, a mobile ad hoc networking (MANET) working group has been formed within the Internet Engineering Task Force (IETF) to develop a routing framework for IP-based protocols in ad hoc networks. Today, a number of routing protocols have been proposed for ad hoc wireless networks, derived from distance-vector or link-state routing algorithms. Such protocols are classified asproactive or reactive, depending on whether they keep routes continuously updated, or whether they react on demand.

Proactive protocols, also called table-driven protocols, attempt to continuously determine the network connectivity so that the route is already available when a packet needs to be forwarded. Examples include the Destination-SequencedDistance Vector (DSDV) protocol, Wireless Routing Protocol (WRP), Temporally-Ordered Routing Algorithm (TORA), and Lightweight Mobile Routing (LMR) protocol. The advantage of proactive schemes is that when a route is needed, there is little delay until the route is determined. However, purely proactive schemes are not appropriate for reconfigurable wireless ad hoc network environment, as they continuously use a large portion of the network capacity to keep the routing information current. Since the node movement may be quite fast and the topology changes may be more frequent than the route requests, most of this routing informationmay never be used. This results in a further waste of the network capacity.

Reactive protocols, also called on-demand protocols,onthe other hand, invoke a route determination procedure onlyon demand. Examples include the Ad hoc On Demand Distance Vector (AODV) protocol and Dynamic SourceRouting (DSR) protocol. In these protocols, when aroute is needed, some sort of global search (e.g., flooding)procedure is employed. Because route information may notbe available at the time a route request is received, the delayto determine a route can be quite significant. Furthermore,the global search procedure requires significanttraffic implying pure reactive routing protocols may not be applicable toreal-time communication.

2. THE FOUR ON-DEMAND ROUTING PROTOCOLS

As traditional routing algorithms being too costly to ad hocnetworks, a number of routing protocols have been proposed.They are classified as proactive or reactive, depending onwhether they keep routes continuously updated, or whetherthey react on demand. In this section, we focus upon the on-demand routing protocols. The basic idea of these algorithmsis to find and maintains a route only when it is used for communication. This idea proves to be especially efficient in adhoc networks where routes are usually temporary. Therefore,there is no point in keeping a route which is likely to be invalid later at the time it is used. While two of the protocols weconsider in this paper use source routing, the next two protocols avoid the routing workload at intermediate nodes, andare based on an improved distance-vector routing algorithmwhich is able to avoid routing loops.

2.1 Dynamic source routing (DSR)

The first protocol we studied is the Dynamic Source Routing (DSR) protocol. With source routing, the sender of apacket determines the complete route from itself to the destination, and includes the route in the packet. All the intermediate hosts forward the packet based on this predeterminedroute (called source route). No routing decision is made at theintermediate hosts.

DSR offers a number of potential advantages for routing inad hoc networks. First, a host dynamically discovers a routeonly when it needs to send a packet through that route. Thereare no periodic routingmessages. In addition, DSR only monitors the operations of the routes in use. Once there is a linkfailure in a route, the source (sender) of the route is notifiedimmediately. As a result, DSR can quickly adapt to topological changes caused by node movement, which may oftenoccur in a mobile wireless network. Furthermore, DSR isable to compute correct routes in the presence of asymmetric
(uni-directional) links, another possible situation in wirelessnetworks.

The two main operations of DSR are route discovery androute maintenance. When a host wants to send a packet andthere is no route to the destination currently available in itsroute cache, the host initiates a route discovery. The discovering process is straightforward. The initiator broadcasts aroute request to its neighbours. A route request contains theaddress of the destination host as well as a route record whichrecords the hosts that the request has passed. Upon receivinga route request, a host checks if it knows a route to the destination or itself is the destination. In both cases, the completeroute from the initiator to the destination is found. This routeis then replied to the initiator. Otherwise, the host appends itsaddress to the route record and re-broadcast the route requestto its neighbours. Because of the broadcasting, a host mayreceive multiple copies of the same route request. To avoidrepeatedly processing the same request, each host maintainsa list of the IDs of the recently seen requests. A host can alsodetect that a request has gone through a cycle if it finds its address already listed in the route record of the request. In bothcases, the host discards the route request and does nothingfurther.

Routes may become invalid due to the host movement. Toquickly adapt to this change, each host constantly monitorsthe links it uses to forward packets. If a host in a route findsout that it cannot forward packets to the next host in the route(many wireless networks support a hop-by-hop acknowledgment at the data link level), it immediately sends a route errorpacket to the source of the route. Therefore, the source hostis able to quickly detect an invalid route and stop using it anylonger.

2.2 Ad-hoc on-demand distance vector routing (AODV)

AODV shares the same on-demand characteristics as
DSR, but adopts a very differentmechanism to maintain routing information. In AODV, each host maintains a traditionalrouting table, one entry per destination. Each entry recordsthe next hop to that destination and a sequence number generated by the destination which indicates the freshness of thisinformation. In addition, each entry also records the addressesof active neighbours through which packets for the given destination are received. Therefore, once the corresponding linkof this entry is down, the upstream hosts using this link canbe notified immediately.

Like DSR, AODV discovers a route through network-widebroadcasting. The source host starts a route discovery bybroadcasting a route request to its neighbours. In the route request, there is a requested destination sequence number whichis 1 greater than the destination sequence number currentlyknown to the source. This number prevents old routing information being used as reply to the request, which is the essential reason for the routing loop problem in the traditionaldistance vector algorithm. UnlikeDSR, the route request doesnot record the nodes it has passed but only counts the number of such nodes. Instead, each node the request has passedsets up a temporary reverse link pointing to the previous nodefrom which the request has come, so that the reply can be returned to the source host. An intermediate node can reply toa request only if it has a route entry for the destination whichhas the same or higher destination sequence number than therequested number. A route reply contains the total hop countof the route and its destination sequence number. As a replytravels back to the source, each intermediate node sets up theforward link as a route entry and records the destination sequence number. If the node receives further route replies later,it updates its routing entry and propagates the reply back tothe source only if the reply has either a greater destination sequence number, or the same sequence number with a smallerhop count.

Route maintenance in AODV is similar to DSR. An invalidlink can be detected through link layer acknowledgement,or by letting each host broadcasting periodic hello messagesto neighbours. Hello messages can also be used to discoverneighbours. Whenever a link in use is no longer valid, the up-stream host of that link immediately notifies the active neighbours of the link, which in turn notify their active neighbours forthe route and so on until the source hosts using that link arereached. The notification is done by sending an unsolicitedroute reply with a fresh sequence number and hop countof ∞. The fresh destination sequence number makes theactive neighbours unconditionally updates their correspondingroute entries, and the∞ hop count simply means the route isno longer valid.

2.3 Preemptiveon-demand distance vector routing (PAODV)

It shares the same route discoverymechanism asAODV, but adopts the route pre-discovery using a preemptiveprotocol mechanism. Like AODV, in PAODV protocol, eachhost maintains a routing table with one entry per destination.Each entry records all the information that will be recorded inAODV, and also includes the information about a new state ofthe route entry, called *rt_pre*, which indicates that this routeentry is under the preemptive route discovery state, so that themobile host will choose the next hop which has a route entrywhich is only the route entry *rt_up* for the AODV REQUESTpacket, however other packets can still choose an entry that has a *rt_pre* state.

PAODV adopts almost all of the mechanism of AODV, including the route discovery schema, and neighbour maintaining protocol. In AODV protocol, sources will rediscovery anew route only when no route exists. If a host detects that oneof his outgoing link is going to break, it will inform his up-stream neighbour, and that neighbour will inform his upstreamneighbour, and this process continue recursively. Finally thesource which uses that link gets the information, and then it willre-discover a new route. In PAODV, instead of re-discoveringa new route when the source detects a break, it invokes thediscovery routine before the currently in-used path breaks.

Two different preemptivemechanisms are used in PAODV.One is to schedule a re-discovery in advance, where the replypacket will collect the information of the links when it goesthrough an intermediate host. When the source receives a reply message, the last information of the reply packet denotesthe lifetime of the new discovered path. Based on the lifetimeof the path, the source can schedule a rediscovery before theexpiration of the lifetime of the path and the rediscovery time($T_{rediscovery}$).

The other schema is to invoke the route discovery routineif the source receives a Warning message which indicates thatthe current path is going to break. The Warning messageis generated by monitoring two neighbouring mobile hosts.When the transfer time of a packet to a neighbour is greaterthan a predefined value, the transfer of the Hello packets ismonitored periodically1 via the Ping and Pong packets, between two ends of this link. If this monitoring mechanism indicates that this link is going to break, then a Warning packetis generated and sent to the source. Upon receiving this Warning packet, the source invokes the rediscovery routine.

In PAODV protocol, special care is also needed to managethe Warning, Ping,and Pong packets. Maybe therefore, the packet overhead of PAODV higher than AODV, however, since we overlap the rediscovery routine with the use of the current active path, the average delay per packet, in PAODV, ought tobe significantly reduced.

2.4 Cluster based routing protocol (CBRP)

Another way to reduce flooding traffic is to establish somekind of hierarchy among mobile hosts, and query only thosehigh-level hosts in the hierarchy which has the informationabout the low-level hosts under them. In the CBRP protocol, mobile hosts form clusters. The head of a clusterknows the addresses of its members. Hence, broadcastingroute requests only to the cluster heads is equivalent to broadcasting to every host in the network.

Since ad hoc network has no established infrastructureand its topology is constantly changing, the cluster formationmust be self-contained and able to adapt to host movement.In addition, the formation should not incur too much overhead both on the computation workload of the mobile hostsand on the network traffic. CBRP uses a simple cluster formation strategy. The diameter of a cluster is only two hops andclusters can overlap. The cluster head is just the node whoseIP address is the smallest among its neighbours. At any time,a node is in one of the three states: a cluster member, a clusterhead, or undecided, meaning still searching for its host cluster. Every node broadcast a hello message to its neighboursperiodically. At the beginning, all nodes are in the undecidedstate, and after a while the nodes with the smallest IP addressamong their neighbours elect themselves as cluster heads. After that, when a cluster head receives a hello message froman undecided neighbour, it sends out a triggered hello messagewhich notifies that neighbour about the existence of the cluster. Upon receiving the triggered hello message from a clusterhead, the undecided node changes its state to a member andrecords the cluster head's address. It is possible that a nodegets responses from multiple heads. In that case, the node becomes member of each of the clusters. If a cluster member has not received a hello message from any of its head for awhile, the node goes back to the undecided state and searchesfor clusters again.

In order to broadcast route requests among the clusterheads, each cluster head must knowthe addresses of its neighbouring cluster heads. This adjacent cluster discovery is doneby having each node maintains a cluster adjacency table,which stores the addresses of the neighbouring cluster headsand the gateway node throughwhich that head can be reached.

Since clusters are only two-node wide, a member node is ableto find out its neighbouring cluster heads through the hellomessages from its neighbours which are members of thoseclusters. A cluster head can then inspect the hello messagesof its members which contain their cluster adjacency tables toget the information about the neighbouring heads.

With all these information at hand, a route discovery startswith the source host broadcasting a route request to its neighbours, one of which is the cluster head. Subsequently, the request is flooded to the neighbouring cluster heads though thegateway nodes, and so on until the request reaches the clusterhead of the destination host which unicasts the request to thedestination. The route request only records the cluster headsit has passed. Therefore, upon arriving at the destination, therequest has the whole path from the source to the destinationin terms of cluster heads. The actual route is calculated duringthe returning of the route reply. Each cluster head along thereturning path tries to find out the optimal hop-by-hop route(maybe bypassing itself) from the previous node to the nextcluster head in the path.

The rest of CBRP is almost the same as DSR. CBRP usessource routing. Currently used routes are monitored and routeerrors are notified to the source host immediately. Since a hostcan detect its current neighbours through their hello messages,it always tries to find a shorter route to forward a data packetby forwarding the packet to the furtherest node in the sourceroute which has become its neighbour. As a result, shorterroutes are reflected very quickly. A host can also use theneighbour information to do local route repair. Once a link isdown, the upstream host checks to see if the next hop or somehop after that can be reached through one of its neighbours(a node's hello messages also include its neighbourhood information, so its neighbours know their two-hop away nodes).In the case where hosts are not moving very fast, this localrepair turns out to be efficient and avoids unnecessary routere-discovery.

3. TABLE-DRIVEN PROTOCOL

There are few routing table-driven protocols discussed in theliterature. In a table-driven type of protocols, oneneeds periodically to determine the network topology. If anychanges happen to the network, this information should bebroadcasted, and all of the host in this network will run theroute discovery again and store newrouting information in thetable. In general, when compared to on-demand protocols,table-drive protocols allocate one entry for each host of thewhole network, instead of only the destinations of the packets.However, in table-driven protocols, any time when a route isneeded, a route is already available in the table, therefore,table-driven can reduce the average delay per packet.

3.1 Destination sequenced distance vector (DSDV)

In the DSDV protocol, each mobile host *n* in an ad hoc network keeps the following data: the node's age or sequencenumber, a set of its current neighbours, and a routing table withentries for each host *m* in the network, including a known ageor a sequence number of the entry, a neighbour*Hn(m)*,andthecost (presented by the length of the link). Messages directedto host *m* are routed through the neighbour *Hn(m)*,whichisthe next hop along the route to *m*. The sequence number isindicative of the recentness of the route from *n* to *m*. Recentdata replace old data to reflect topology changes.

Every mobile host *n* is required to periodically advertiseits routing table to its neighbours, together with its age. Anyneighbour *p* receiving *n's* advertised routing table, updates itsown routing table. Like AODV, DSDV is also a distance vector protocol, and it triggers an update when the network ischanged. The packet will be queued under a reply came backfrom the destination.

4. COMPARISONS OF THE AD HOC ROUTING PROTOCOLS

In the previous section, we have presented five ad hoc routingalgorithms, four of them are on-demand protocols, and thelast one is table-driven protocol. The same kinds of protocols share some of the same properties, and each type of protocolshas its own advantages and disadvantages. For on-demandprotocol, it can almost always guarantee to use valid routes.(Each discovered route is stored in the route cache for a shortlife time, so there is a slight chance that they may get stale.)And in on-demand protocol, route maintenance is done byreal-timemonitoring rather than periodic updates and only theentries for the active destinations are monitored. As a result,they can quickly respond to topological changes which mightbe frequent in an ad hoc network and update less information.

In table-driven protocols, a route is always available foreach destination, and the route update is periodically or triggered by some changes of the network.

TABLE 1: AD HOC ROUTING ALGORITHMS: MAIN DIFFERENCES

Protocol	Type	No of Route	Source Routing	Broadcasting of route requests
AODV	On-demand	Less than PAODV	Not used	Network-wide broadcasting, causing large overhead
PAODV	On-demand	Most	Not used	Same as AODV
CBRP	On-demand	Less than AODV	May cause bottleneck as too many nodes use	Only broadcasts to cluster heads, but needs to establish & maintain clusters. Also a more
DSR	On-demand	Least	Same as CBRP	Network-wide broadcasting, causing large overhead
DSDV	Table-driven	No specific route discovery	Not used	Broadcast to its neighbour, if need update, then this update will broadcast to the whole network

5. SIMULATION EXPERIMENTS

As each protocol has its own advantages and disadvantages,none of them can be claimed as absolutely better than the others. To see how the features of each protocol affect their performance, we did a performance comparison using the implementations of these protocols in ns-2.

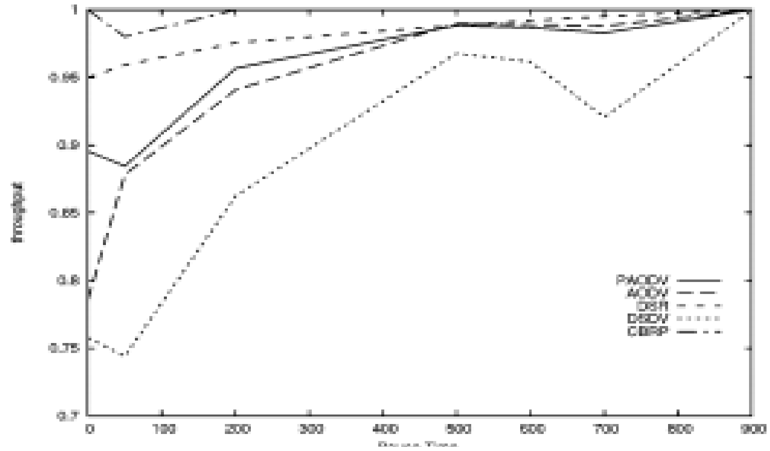

Fig 5.(a) Data packet throughput with various number of traffic sources 50 nodes, 10 connections

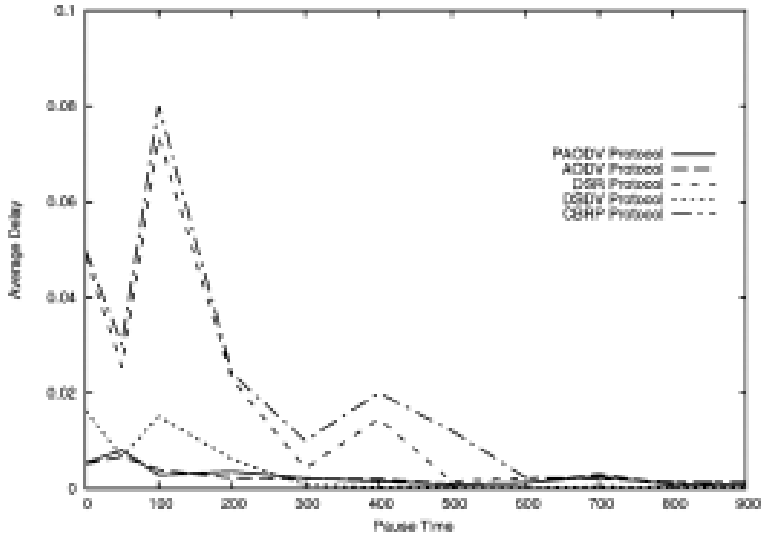

Fig 5.(b) Average data packet delay with various number of traffic sources 50 nodes, 10 connections

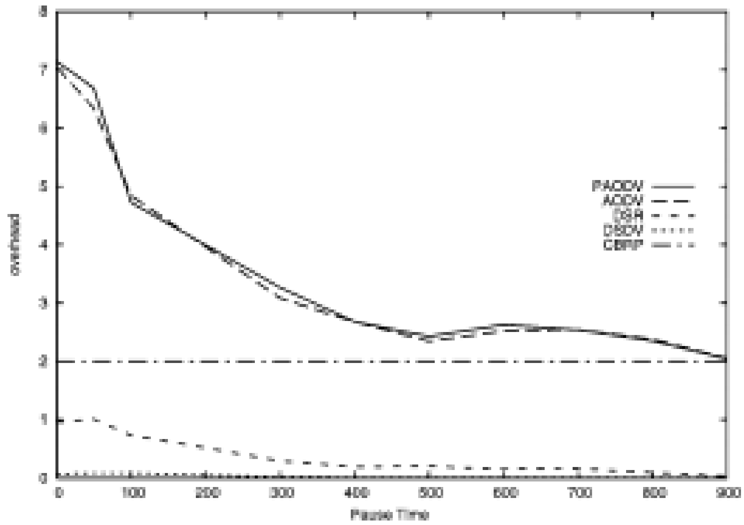

Fig 5.(c)Normalized packet overhead with various number of trafficsources 50 nodes, 10 connections

6. CONCLUSION

With the advent of wireless networking, mobile ad hocnetworks (MANET) are about the enter the main stream.Because such networks do not need any established infrastructure or centralized administration, they can be used fora variety of civilian and military applications. However,many problems remain to be solved before ad hoc networks become a commonplace. The problem of ad hoc networks isa complex one, demanding the resolution of number issues.

In this paper, we focus upon the routing problem in adhoc networks. We have discussed the differences among thead hoc routing protocols, AODV, PAODV, CBRP DSR andDSDV. We have presented an extensive simulation studies tocompare these routing protocols, using a variety of workloadsuch mobility, load and size of the ad hoc networks. Ourresults indicate that the two source routing based protocols,DSR and CBRP, have very high throughput while thedistance-vector based protocol, AODV, exhibits a very shortend-to-end delay of data packets. Furthermore, despite itsimprovement in reducing route request packets, CBRP hasa higher routing overhead than DSR because of its periodichello messages. DSR has much smaller routing overhead than AODV and CBRP, and AODVhave the largest overhead among the three protocols. Our results also indicate that the preemptive AODV protocol outperforms slightly the original AODV protocol.

As future work, we plan to investigate and study on howto improve and reduce further the routing overhead using history and setting up structures like clusters for instance. Webelieve that making the nodes more aware of its surroundingtopology is the right way to further enhance those protocols.As GPS system becomes more and more common in wirelessdevices, it will give a whole new source of information.Knowing its current location and the locations of other nodes,a node can quite efficiently reduce the area for searching itsdestination node. By combining the GPS system with the current protocols, we expect large enhancement on routingoverhead, which makes those protocols eventually practicalfor use in the real world. Finally, we plan to investigate further the preemptivemechanismfor AODV, on how to improveand reduce PAODV overhead when compared to AODV.

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