A NEW ALGORITHM FOR CR PROTOCOLS IN AD-HOC NETWORKS

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Abstract

Mobile nodes communicate with each other using multi-hop wireless links in a Mobile Adhoc Networks (MANET). There is no base station. Adhoc network can be shaped by mobile computers with wireless interfaces which communicate among themselves without any help of the structure. In the network each node acts as a router for forwarding data packets to other node. Of course in adhoc network the mobile nodes agree to serve up as both routers and hosts. Over the past few years, the research community has developed several protocols and submitted them as drafts to the IETF’s Mobile Adhoc Networking (MANET) group. During comparison of Ad-Hoc On demand Distance Vector (AODV), Destination-sequenced Distance Vector (DSDV) shows that AOMDV is noteworthy packet delivery portion and almost corresponding throughput.

Index Terms: AODV, DSDV, AOMDV, MANET, GSM, Protocol

1. INTRODUCTION

A central challenge in the design of ad hoc networks is the development of Dynamic routing protocols that can efficiently find routes between communicating nodes. The routing Protocol must be able to keep up with the high degree of node mobility that often changes the network topology drastically and unpredictably. Such networks have been studied in the past in relation to the defense research, often under the name of packet radio networks [2]. An ad hoc network is formed by mobile computers (nodes) with wireless interfaces that communicate among themselves without the help of any infrastructure. The network without infrastructure also known as ad hoc network is formed by mobile stations (nodes) inside of restricted area which communicate without the need of access point [3]. In an ad hoc network, mobile nodes agree to serve both routers and hosts. These nodes can animatedly leave and join the network, frequently without warning and possibly troublesome communication among other nodes [38]. Much wireless technology is based upon the principle of direct point to point communication. In most popular communication models such as wireless local area network (WLAN) and group standard for mobile communications (GSM), mobile nodes use an approach where communicate takes place to each other via some centralized access points. Therefore, centralization and infrastructure are a part of characteristics of such networks where necessarily needed for their configuration and operation [1]. Also, there is a existence of another approach where mobile nodes utilizing each other as access points or relays for traffic when they cannot establish a direct communication with end points. That model of communication is called mobile adhoc networks (MANETS). These networks can be set up randomly and when needed (on demand). In MANETS nodes have to announce their presence periodically and listen for their neighbors’ announcements broadcasts to discover and learn how to reach each other. Therefore, mobility and scalability are the main challenges in the infrastructure less networks.

Hence there is need for efficient routing protocols to allow the nodes to communicate over multi-hop paths, consisting of several links, dynamic and non Predictable topology in a way that doesn’t use any more of the network resources then necessary [1].

2. OVERVIEW OF ADHOC ROUTING PROTOCOLS

In MANETS, the main purpose of the convention or standard protocols is to control the way in which the mobile nodes decide how to transfer the route packets to each other. These protocols are broadly classified into three main categories namely proactive, reactive and hybrid protocols. Proactive protocols maintain routes to all nodes, including nodes to which no packets are sent. Proactive protocols include DSDV, OLSR and WRP. In reactive protocols, routes between hosts are determined only when they are explicitly needed to forward packets. Reactive protocols include AOMDV, AODV, DSR, TORA and CBRP. Hybrid methods combine proactive and reactive methods to find efficient routes, without much control overhead.
2.1 AODV

AODV is a reactive and a single path routing protocol. It allows users to find and maintain routes to other users in the network whenever such routes are needed. The adhoc on demand distance vector routing protocol provides unicast, broadcast and multicast communications in adhoc networks. AODV initiates route discovery whenever a route is needed by the source node or whenever a node wishes to join a multicast group. Routes are maintained as long as they are needed by the source node or as long as the multicast group exists and routes are always loop free through the use of sequence numbers. AODV maintains a route table in which the next hop routing information for destination nodes is stored [6]. Route discovery in AODV follows a route request / reply cycle. A source node in need of route broadcasts a route request (RREQ) packet across the network. Any node with a current route to the destination itself can respond to the RREQ by unicasting a route reply (RREP) to the source node. When the source node desires to send message to some destination node and does not already have a valid route to that destination, it initiates a path discovery process to locate the other node. It broadcasts a route request (RREQ) packet to its neighbors, which then forward the request to their neighbors, and so on, until either the destination or an Intermediate node with a “fresh enough” route to the destination is located. Figure 1(a) illustrates the propagation of the broadcast RREQs across the network. AODV utilizes destination sequence numbers to ensure all routes are loop-free and contain the most recent route information.

![AODV route discovery process](image)

Each node maintains its own sequence number, as well as a broadcast ID. The broadcast ID is incremented for every RREQ the node initiates, and together with the node’s IP address, uniquely identifies an RREQ. Along with its own sequence number and the broadcast ID, the source node includes in the RREQ the most recent sequence number it has for the destination. Intermediate nodes can reply to the RREQ only if they have a route to the destination whose corresponding destination sequence number is greater than or equal to that contained in the RREQ. During the process of forwarding the RREQ, intermediate nodes record in their route tables the address of the neighbor from which the first copy of the broadcast packet is received, thereby establishing a reverse path. If additional copies of the same RREQ are later received, these packets are discarded [18].

Once the RREQ reaches the destination or an intermediate node with a fresh enough route the destination / intermediate node responds by unicasting a route reply (RREP) packet back to the neighbor from which it first received the route request (RREQ)[18]. Once the source node receives the RREP, it can begin sending data packets along this route to the destination [6]. Figure 1(b) is the illustration of RREP messages back to the source node and subsequent route selected by the source node to the destination. As the RREP is routed back along the reverse path, nodes along this path setup forward route entries in their route tables which point to the node from which the RREP came. These forward route entries indicate the active forward route. Associated with each route entry is route timer which will cause the deletion of the entry if it is not used within the specified life time. Because RREP is forwarded along the path established by the RREQ, AODV only supports the use of symmetric links [18]. As the nodes are moving, link breaks are likely to occur. When a link breaks in an active route occurs, the node upstream of the break broadcasts a route error (RERR) message containing a list of all destinations which are now unreachable due to the loss of the link. The RERR is propagated back to the source node. Once the source node receives the message, it may initiate the route discovery if it still needs a route [6]. However, AODV adopts a very different mechanism to maintain routing information. It uses traditional routing tables, one entry per destination. AODV uses sequence numbers maintained at each destination to determine freshness of routing information and to prevent routing loops. These sequence numbers are carried by all routing packets. An important feature of AODV is the maintenance of timer-based states in each node, regarding utilization of individual routing table entries. A routing table entry is expired if not used recently. A set of predecessor nodes is maintained for each routing table entry, indicating the set of neighboring nodes which use that entry to route data packets. These nodes are notified with RERR packets when the next-hop link breaks. Each predecessor node, in turn, forwards the RERR to its own set of predecessors, thus effectively erasing all routes using the broken link [2].
2.2 AOMDV

Ad-hoc On-demand Multipath Distance Vector Routing (AOMDV) protocol is an extension to the AODV protocol for computing multiple loop-free and link disjoint paths [11]. Multipath routing is a technique provides multiple alternative paths between each source and destination in a network. The benefit of such technique is a fault tolerance, bandwidth increasing, and security improvement. Overlapping, looping (infinity loop) and optimum disjointed paths or node-disjointed are the main issue in such algorithms [1]. The routing entries for each destination contain a list of the next-hops along with the corresponding hop counts. All the next hops have the same sequence number. This helps in keeping track of a route. For each destination, a node maintains the advertised hop count, which is defined as the maximum hop count for all the paths, which is used for sending route advertisements of the destination. Each duplicate route advertisement received by a node defines an alternate path to the destination. Loop freedom is assured for a node by accepting alternate paths to destination if it has a less hop count than the advertised hop count for that destination. Because the maximum hop count is used, the advertised hop count therefore does not change for the same sequence number [11].

When a route advertisement is received for a destination with a greater sequence number, the next-hop list and the advertised hop count are reinitialized. AOMDV can be used to find node-disjoint or link-disjoint routes. To find node-disjoint routes, each node does not immediately reject duplicate RREQs. Each RREQs arriving via a different neighbor of the source defines a node-disjoint path. This is because nodes cannot be broadcast duplicate RREQs, so any two RREQs arriving at an intermediate node via a different neighbor of the source could not have traversed the same node [11].

Several changes are necessary in the basic AODV route discovery mechanism to enable computation of multiple link disjoint routes between source destination pairs. Note that any intermediate node I on the route between a source S and a destination D can also form such multiple routes to D, thus making available a large number of routes between S and D. In the route discovery procedure a reverse path is set up backwards to the source via the same path the route request (RREQ) has traversed. If duplicates of the RREQ coming via different paths are ignored as before, only one reverse path can be formed. To form multiple routes, all duplicates of the RREQ arriving at a node are examined as each duplicate defines an alternate route. See Figure 2 each of these alternate routes may not be disjoint.

![Figure 2. Second copy of RREQ is transmitted over the dotted link](image)

The first hop information needs to be included in the RREQ packet as an additional field. Each node remembers the first hop of each RREQ (in a first hop list) it has seen with the same source id and broadcast id. A reverse path is always formed when the first hop is unique. However, as in regular AODV, only the first copy of the RREQ is forwarded. Thus there is no additional routing overhead. All these reverse paths can be used to propagate multiple RREPs towards the source so that multiple forward paths can be formed. Note that all such paths are node disjoint [34].

![Figure 3. The second copy of RREQ via B is suppressed at intermediate node I.](image)

In the hope of getting link disjoint paths (which would be more numerous than node disjoint paths) the destination node adopts a “looser” reply policy. It replies up to k copies of RREQ arriving via unique neighbors, disregarding the first hops of these RREPs.

Unique neighbors guarantee link disjointness in the first hop of the RREP. Beyond the first hop, the RREP follows the reverse routes that have been set up already which are node disjoint (and hence link disjoint). Each RREP arriving at an intermediate node takes a different reverse route when multiple routes are already available. Note that because of the
“looser” reply policy it is possible for the trajectories of RREPs to cross at an intermediate node.

2.3 DSDV

Destination sequence distance vector is a proactive routing protocol. It provides a single path to a destination, which is selected using the distance vector shortest path routing algorithm. In order to reduce the amount of overhead transmitted through the network; two types of updates are used. These are known as “full dump” and incremental packets. The full dump carries all the available routing information and the incremental packets carry only the information changed since last dump. The incremental update messages are sent more frequently then the full dump packets. However, DSDV still introduces the large amount of overhead to the network due to the requirement of the periodic update messages and the overhead grows [5].

The DSDV routing algorithm is based on the idea of the classical bellman ford algorithm with certain improvements. Every mobile station maintains a routing table that lists all available destinations the number of hops to reach the destination and the sequence number assigned by the destination node. The sequence number is used to distinguish the stale routes from the new ones and thus avoid the formation of loops. The stations periodically transmit their routing tables to their immediate neighbors. A station also transmits its routing table if a significant change has occurred in the table from the last update sent. So update is both the time driven and event driven [4].

3. SIMULATION MODEL

In our study and evaluation for the three protocols AOMDV, AODV and DSDV we have used the radio propagation model which is the ns - 2 [25] (Version 2.34) default model.

The IEEE 802.11 protocol [19] distributed coordination function (DCF) is used as the MAC layer protocol. Random waypoint mobility model is used, where the node once reaches the desired destination, it stops for a pause time interval and then another random destination is targeted with same or different speed. The relative speeds of the mobiles are affected by varying the pause time.

For fairness across the three protocols identical scenarios in mobility and traffic are used and repeated for multiple times. Therefore, each data point in this paper graphs represents an average. Also, in this model we assume that each node has sufficient power to function properly throughout the simulation time. The following is the simulation models summary (essential parameters) that is used in the study.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value</th>
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</thead>
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<tr>
<td>Simulation time</td>
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</tr>
<tr>
<td>Terrain Area</td>
<td>4096 node / Km²</td>
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<tr>
<td>Number of nodes</td>
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<tr>
<td>Queue type</td>
<td>Drop Tail</td>
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<tr>
<td>Pause time</td>
<td>0 - 100 sec</td>
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<td>Antenna Model</td>
<td>Omni directional</td>
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</tbody>
</table>

4. PERFORMANCE METRICS

The primary metrics we carried out to evaluate the performance of the three protocols were Packet Delivery Fraction (PDF), Instant Jitter and Generate Throughput. The detailed description of the parameters is as follows:

4.1 Packet Delivery Fraction (PDF)

It is the ratio of the received packets by the CBR sink at the destination over the sent packets by constant bit rate source. This metric actually tells us how much reliable the protocol is. It describes the loss rate that will be seen by the transport protocol, which in turn affects the maximum throughput the adhoc network can support [1]. PDF= Σ CBR received packets x100 Σ CBR sent packets.

4.2 Instant Jitter

It is defined as the difference between the delay of the current package and the next package. Being S(i) the time that the package i was sent and R(i) the time that the package i was received, jitter (i) = [R(i+1) - S(i+1)] - (R(i) - S(i)]. If the net is capable to send all of the blocks with a uniform sequence, then each block should arrive in the destiny after a uniform
delay. Variations in the delay are common and caused for many factors, such as: differences in time of processing the packages, differences in time of access to the network and differences in time of enquiry [3].

4.3 Gen Throughput

It is a data transmission measure that determines the amount of data moved from one node to another in a certain period of time [3].

5. Simulation Results

We have divided our study into different set of experiments that is variation is being done if the pause time is varied and we have varied the pause time within the range of 0-100 seconds. The performance of three protocols is presented below.

Figure 4 Packet delivery fractions versus Nodes

Figure 4 shows the result of packet delivery fraction for the three protocols. This set of study describes the performance of AOMDV, AODV and DSDV with zero pause time. The graph shows number of nodes in horizontal axis and packet delivery fraction as vertical axis. The packet delivery fraction for AODV, AOMDV and DSDV are very similar when the numbers of nodes are very less. As the numbers of nodes are increasing the packet delivery fraction decreases in AODV and DSDV. The packet delivery fraction is less for AODV routing protocol whereas DSDV performs better than AODV whereas AOMDV has a better PDF than both single path routing protocols. As AOMDV is a multipath protocol, it can divert its path or it can choose alternate path as the congestion occurs or if the current link has broken but single path protocol cannot. So we can grade that AOMDV performs better then AODV and DSDV routing protocols in the aspect of packet delivery fraction.

Figure 5 Packet delivery fractions versus Pause Time

In figure 5 the set of study describes that AOMDV and AODV performs better than the DSDV protocol by giving almost similar packet delivery ratio whereas constant ratio is given by DSDV but still far less than the AOMDV and AODV.

Figure 6 Packet delivery fractions versus Pause Time

In figure 6 the graph represents that AOMDV still performs better than AODV with 50 nodes with 0-100 seconds pause time and DSDV still lags behind in performance of pdf.
In figure 7 the graph represents that AOMDV still performs better and provides constant response than AODV with 100 nodes with 0-100 seconds pause time and DSDV still lags behind in performance of pdf.

5.2 Instant Jitter

Figure 8 shows the result of instant jitter versus nodes. The graph shows the instant jitter in vertical axis and number of nodes in horizontal axis. This set of study describes the performance of AOMDV, AODV and DSDV with zero pause time. The jitter metric is obtained calculating the variation of the delay and its analysis allows observing if a network presents a constant behavior or if it has a lot of variations. The above graph represents the average values of instant jitter for each routing protocol is analyzed. Almost all the protocols gives the same performance after the mid of the nodes. As AOMDV gives abrupt rise in delay from nodes 50 to 70 and after that delay is increased in DSDV. So we can conclude that the performance is almost the same as size of the network is increased up to 50 and AODV gives better results in instant jitter rather than AOMDV and DSDV.

The above graphical representation shows AOMDV provides much higher delay rather than AODV and DSDV. Thus single path protocol performs better than multipath protocols due to the fact that congestions might occur in the path while selecting the multiple routes or if the link is broken.

Figure 10 represents that AODV performs better in the instant jitter with 50 nodes and 0-100 seconds pause time. so overall AODV performs better in the instant jitter.
For 100 nodes with 0-100 seconds pause time the above graph shows a linear behavior for all the three Protocols with different values. From that again, we conclude that AODV performs better for the package of 512 bytes.

5.3 Generate Throughput

The graphical representation of throughput shows the different behavior if the pause time is varied. AOMDV provides constant throughput while better throughput is obtained through AODV protocol and least performance is given by DSDV protocol.

Above graph presents the deprivation in performance of all the three protocols when the numbers of nodes are increased from 16 to 50. However, they are showing almost constant behavior. In this also AODV performs better than other two protocols. Here the performance of AOMDV has increased as we can see that the difference between these two protocols for throughput is very less.

From the figure 15, we can see the drastic change in the performance of throughput in AOMDV. Here AOMDV performs much better than AODV and DSDV protocols. As the load is increased from 50 nodes to 100 nodes there is an improvement in the performance of AOMDV. Thus, AOMDV performs much better than the other two protocols.
6. CONCLUSION & FUTURE WORK

We have simulated and compared the two reactive protocols AOMDV and AODV and one positive protocol i.e. DSDV in different simulation scenarios and observing their performance in terms of three significant parameters i.e. Packet delivery fraction, Instant Jitter and Gen throughput in order to find out which one should be preferred when the mobile adhoc network has to be set up for the particular duration. The whole simulation scenario consisting of minimum 2 and maximum of 100 nodes is created by writing the OTCL script in NS-2 (version 2.34) and analyzing the parameters Packet delivery ratio, Instant Jitter and Gen throughput with the help of generated X Graph. By studying and analyzing the outputs appeared in X Graph we come to this conclusion that AOMDV must be preferred over AODV and DSDV for the packet delivery fraction as it is outperformed well due its ability to search for alternate routes when the current links breaks down while in terms of instant jitter, the performance of AODV is better than other two protocols as the network size has increased and in terms of Gen throughput all the three protocols have almost the same performance for zero pause time but if the network size is increased and also pause time is varied, AOMDV performs better than other two routing protocols. In the future, the work can be extended on the other categories of the routing protocols such as Reactive (on demand routing protocols) particularly Multipath routing protocols, proactive and hybrid routing protocols in order to find the appropriate protocol in their category on the basis of the varied simulation time.

It can be further extended by implementing the scenario with the different mobility models, different network and traffic scenarios and observing the behavior of protocols by varying the simulated time. Also the behavior of the protocols can be studied further by carrying the simulations on different parameters like varying the number of mobile nodes, the topology area choice of the traffic type between the mobile nodes other than the simulation time.

The continuity of this work could be accomplished through the evaluation of others routing protocols (secure and not secure) particularly multipath routing protocols. It could be analyzed the impact caused in value of QoS metrics when using different mobility patterns, because due to the increasingly mobility, the tendency is a degradation in values of QoS metrics. Another interesting work that could be developed is to analyze the acting of security routing protocols in an Ad hoc network composed by malicious nodes.

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BIOGRAPHY

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