Traffic Sensitive Dynamic Source Routing Protocol for Mobile Ad hoc Networks

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ABSTRACT

Mobile Ad-Hoc Networks (MANETs) are characterized by multi-hop wireless connectivity, frequently changing network topology and the need for efficient dynamic routing protocols. Routing must maintain required paths in such an environment with an acceptable overhead. On-Demand routing protocols discover paths only when they are requested by flooding the request through the network at great cost. Caches are used to reduce the frequency of flooding route requests. Many routing protocols exist for MANETs. On-demand routing protocols have attracted more attention because of their less overhead and wide applicability. This study is on the behavior of DSR protocol, which is based entirely on on-demand behavior.

Multipath routing is gaining importance as it increases reliability and aids in load balancing. More traffic than that can be handled by the IFQ of a node reduces throughput and increases routing overhead . In this work an effort is made to integrate the benefits of multipath routing and traffic sensitive routing. Simulation studies show enhanced throughput for Traffic Sensitive Dynamic Source Routing (TSDSR) when compared to DSR.

Keywords*:* Dynamic Source Routing (DSR), Mobile Ad-Hoc Network, On-Demand routing protocols, Traffic Sensitive Dynamic Source Routing (TSDSR).

1. INTRODUCTION

As networks rapidly developed, mobile wireless networks have been widely deployed in the computing industry. There are currently two types of mobile wireless networks, one is infrastructure network and the other is infrastructure less, mobile network. The first requires wired gateways or base stations. The latter is known as an Ad-hoc network. In an Ad-hoc network, there are no stationary infrastructure networks such as base stations or fixed routers. All nodes can freely move and can be dynamically connected to other nodes. Moving nodes can communicate with each other using multi-hop wireless links. Nodes themselves act as routers that discover and maintain routes to others in an ad hoc network [1][11].A number of routing protocols have been developed for MANETs [2]. These protocols can be classified into two broad categories, table driven and on demand [1][4][5]. On demand mechanism in MANET allows the network to dynamically adapt the level of routing protocol activity required to correctly handle the traffic .On demand routing protocols must use some type of routing cache to avoid the need to rediscover routes for each packet. Therefore caching is important for any routing protocol of wireless ad hoc network. But the cache itself may contain outdated information indicating that links exist between nodes, when they are no longer within the transmission range of each other. This stale data in the cache may degrade performance. If more reliable paths are stored in the cache, it is possible to improve performance of DSR. This can be ensured by storing discovered paths in the cache selectively. Multipath routing in is proposed for MANETs [12][13][14][15] for improving efficiency. The study of Birinder singh and Dr. Gurpal singh enhances DSR protocol by reducing network traffic [10].In another enhancement of DSR [16] traffic is reduced by reducing RREQ packet retransmission and truncating the route after predetermined number of hops .The number of packets dropped depends on traffic in the area. The exact nature of effect is presented in the work of R. Poonia, A.K. Singh and D. Singh [17]. Mr.Ali Ali. N and B.B. Ustundaghe modified DSR [18] by converting multi distribution of data packets into general distribution of data packets. It results in a new protocol with less network traffic which requires the use of more bandwidth. We propose a novel scheme , to modify and extend DSR protocol so that DSR discovers and accumulates only those paths which are node-disjoint and have less traffic routed through them .The routes stored in the cache are therefore more reliable and have less routing overhead.

2. DESCRIPTION OF DSR PROTOCOL

DSR protocol is composed of two"on-demand" mechanisms [3][4][5] , which are requested only when two nodes want to communicate with each other. Route Discovery and Route Maintenance are built to behave according to changes in the routes in use, adjusting them when needed. Along with these mechanisms, DSR allows multiple routes to any destination, thus facilitating load balancing or increased robustness.

2.1 Route Discovery

Route Discovery [3] is the mechanism by which a node S (Source) which wants to send a packet to Destination node D obtains a source route to D. Route Discovery is used only when S attempts to send a packet to D and does not already know a route to D. The source first has to check in its"Route Cache" [6][7] if it has a suitable route to the destination. If no route is found, it will have to start a route discovery process to find a route to the destination. The route discovery itself consists of a chain of locally broadcasted Route Requests (RREQ). The broadcasting occurs until one of the broadcasted RREQ reaches either the destination node or a node which knows a route to that destination. When a node receives a RREQ, it checks in its Route Request Table if the same RREQ has already been received. In that case, the packet is discarded. Hence, if an intermediate node knows a route to the destination, the source may receive more than one route to the destination. Otherwise, the Route Discovery allows only one path to one destination .A Route Request contains a unique request identification determined by the initiator of the Request, and a target destination .If a node receives a RREQ and it is not the target it appends its own address to the route record in the RREQ and propagates it by transmitting it as a local broadcast. If a node receiving the RREQ has recently seen another RREQ message from this initiator bearing the same request identification and target address, or if this node's own address is already listed in the route record in the RREQ, this node discards the Request. The Route Reply (RREP) is then emitted. It is assumed here that links are symmetric; hence, the RREP uses the reversed route from the RREQ. When the source receives this RREP, it caches this route in its Route Cache [8].

The source node in particular, and any node in general, caches routing information received from packets or simply overheard [9]. This use of explicit source routing allows the sender to select and control the routes used for its own packets, and supports the use of multiple routes to any destination. Moreover, the Route Cache should support storing more than one route to each destination.

2.2. Route Maintenance

Route Maintenance [3] is the mechanism by which node S is able to detect, while using a source route to D, if the network topology has changed such that it can no longer use its route to D because a link along the route no longer works. When Route Maintenance indicates a source route is broken [2], S can attempt to use any other route it happens to know to D, or can invoke Route Discovery again to find a new route for subsequent packets to D. Route Maintenance for this route is used only when S is actually sending packets to D. Each node is responsible for its own links, i.e. each node must confirm that data can flow over the link from that node to the next hop. This information can be provided by an acknowledgement from different sources. As an existing standard part of the MAC protocol in use, by a passive acknowledgement [2] a node overhears a transmission of the packet it has just forwarded. If a built-in acknowledgment mechanism is not available, the node transmitting the packet can explicitly request a DSR-specific software acknowledgment to be returned by the next node along the route. This software acknowledgment will normally be transmitted directly to the sending node, but if the link between these two nodes is unidirectional, this software acknowledgment could travel over a different, multi-hop path. A link is considered to be broken when a node has been unable to verify the reachability of a next-hop node after reaching a maximum number of retransmission attempts . The broken link is then removed from the cache of the former node, and a Route Error is sent to every node which uses the broken link and which is in its Route Request Table. A node may salvage a packet if it knows another route to the packet's destination. However, a count is maintained in the packet of the number of times that it has been salvaged, to prevent a single packet from being salvaged endlessly [11].

3. PROPOSED METHODOLOGY

3.1 Traffic Sensitive DSR

Traffic sensitive DSR will discover and cache paths that are node disjoint and have less traffic routed through them.

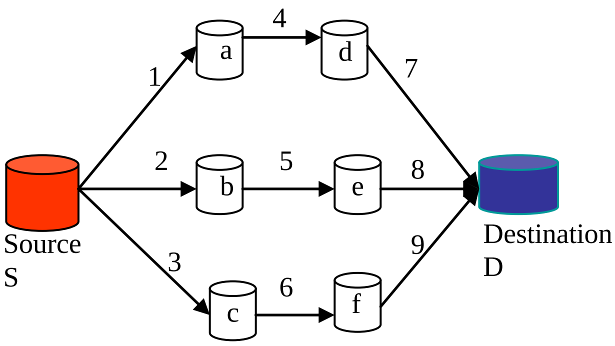

Figure 1 : Node Disjoint paths

We modify DSR to find node disjoint paths in increasing order of IFQ occupancy (traffic),such that IFQ occupancy at none of the intermediate nodes crosses the threshold value (60 % of IFQ capacity).TSDSR selects and stores in cache multiple node disjoint paths in increasing order of traffic they are currently carrying. In figure 1 the three node disjoint paths are : S → a → d → D , S →b →e → D and S → c → f → D .
Whenever a source node S has packets to send, it generates the RREQ (Route Request) packets and broadcasts them as in normal DSR protocol.

When intermediate nodes receive route request packets, there are two posibislities; -- a) the intermediate node checks to see if the source has its own address. If the the source has the intermediate node's address then the node drops the RREQ packet, to avoid duplicate RREQ's as in normal DSR. b) If the intermediate node's address is not there in the source route then the node adds its address and forwards the RREQ packet to the next, hop after recording the IFQ occupancy at the node. Even if the intermediate node has address to the destination in its route cache, it does not send RREP (Route Reply) to the source node (as in normal DSR) because Traffic sensitive DSR needs to accumulate multiple paths to the destination at the source node. The destination node is configured to receive the maximum number of routes. Node D considers the path of first RREQ it receives as the best path because this path has the least delay. After receiving the RREQ, the destination node reverses the path in the source route of RREQ packet and sends the RREP to the source node. While RREP is traveling to the source node the IFQ occupancy at each intermediate node it visits is checked. If IFQ occupancy exceeds the threshold (60 % of IFQ capacity) then the intermediate node will not forward the RREP packet, thus avoiding that path.

When the source receives the RREP, it caches the path for use. The maximum number of paths from the source to any destination is restricted to three.

Once source gets multiple paths it starts data transmission using the path that has least traffic. When reverse routes are used in all probability, source will first receive the least traffic path, as the path taken by RREP packet is also along the nodes with lesser traffic. Route breaks should initiate the source to switch to the second path if this also breaks then source switches to the third cached path. If all the three paths break, then only route discovery is initiated by the source node.

4. SIMULATION RESULTS

The simulations were carried out using publicly available NS 2 network simulator. The simulation environment used 50 nodes moving according to random waypoint model in an area of 1500 X 300. All the nodes are similar in capabilities like Transmission range, available Memory and the Battery power associated with the nodes. The nodes in the network can move a distance of [0, MaxDist] in any direction in a simulation clock tick. Number of Sources is increased from 10 to 50 in steps of 10. CBR traffic is used and Packet size is selected as 512 bytes .The MAC protocol DCF along with LUCENT WAVELAN radio model are used for simulation. All simulations were run for 900 seconds of simulated time. The simulations were repeated 25 times and the average values from 25 runs were used to plot the graphs.

To measure the performance of proposed algorithm the following parameters are identified:

Throughput: It is the Number of Packets delivered to the destination per unit time.

Packet Delivery Fraction: It is the Ratio of Packets received at the destination to Packets sent by the source.

Normalized Routing Load: Number of routing packets required for delivering a packet to the destination.

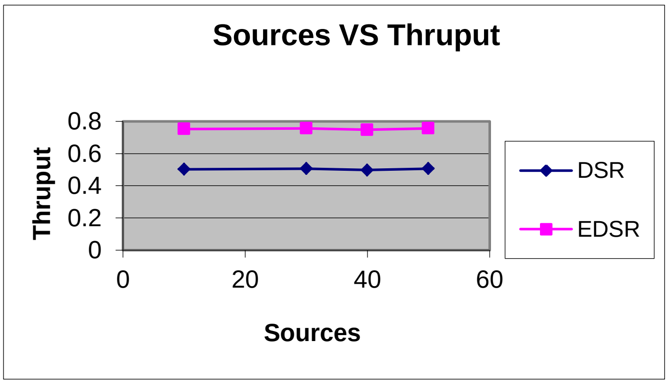

Figure 2: Throughput of DSR and TSDSR

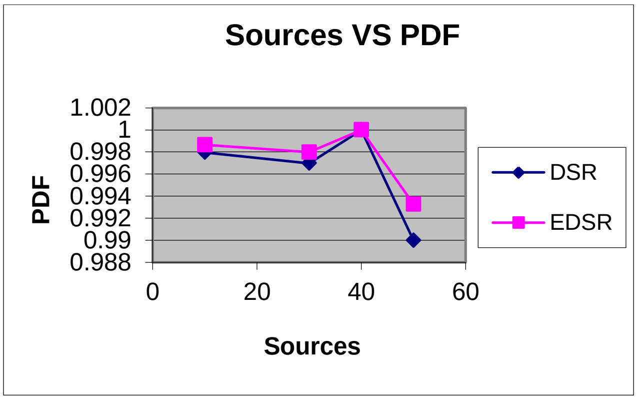

Figure 3: PDF of DSR and TSDSR

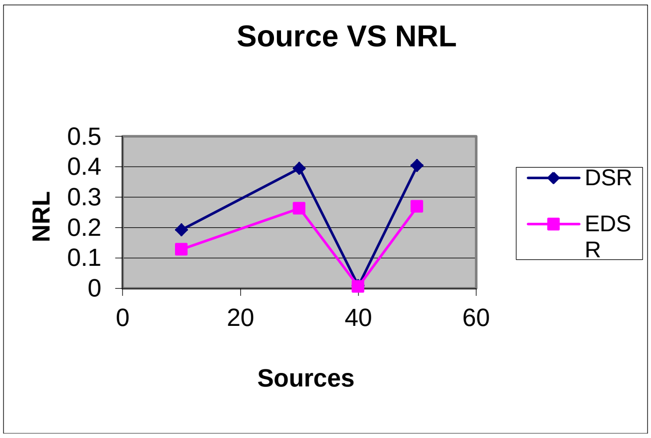

Figure 4: NRL of DSR and TSDSR

From the above graphs it is clear that TSDSR outperforms DSR in all the three testing parameters. Throughput of TSDSR improves when compared to DSR because in DSR paths are not node disjoint .Breakage of one path will result in the use of next cached path which may also soon break. If paths in cache are exhausted then route discovery is initiated which will reduce throughput. .Similarly when compared to DSR enhanced DSR will have improved PDF.

The Normalized routing load of TSDSR is less when compared to DSR .This is because in DSR when a route breaks it generates RERR packet, which will be sent to the source node. Also when there is no route in the cache ,the source initiates route discovery by flooding the network with RREQ packets .When RREQ reaches the destination it sends back RREP packet containing route to the destination .In TSDSR, in route discovery phase the source is able to cache 3 node disjoint paths to the destination. If first route breaks then the second route in the cache will be used .As this path is node disjoint, the probability of its failure is less. As routes break less frequently, the frequency of RREQ packets flooding the network is also reduced in TSDSR. As the number of routing packets is reduced TSDSR has reduced routing load when compared to DSR.

5. CONCLUSION

Simulation results show that TSDSR the throughput, packet delivery fraction of TSDSR are more than that of DSR. Also Delay and Normalized routing load of TSDSR are less than that of DSR. This is because TSDSR selects multiple node disjoint paths. If one path breaks then an alternative and reliable path is present, as the paths are node disjoint. This will not adversely affect the performance of TSDSR which can happen in DSR because DSR selects least hop-count paths which may not be always reliable.

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