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PERFORMANCE COMPARISION OF AODV, DSR and ZRP ROUTING PROTOCOLS IN MANET'S

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Abstract

This paper aims to compare performance of some routing protocols for Mobile Ad-Hoc networks (MANET's). A Mobile Ad-Hoc Network (MANET) is a collection of wireless mobile nodes forming a temporary network without using any centralized access point, infrastructure, or centralized administration. Data transmission between two nodes in MANET's , requires multiple hops as nodes transmission range is limited. Mobility of the different nodes makes the situation even more complicated. Multiple routing protocols especially for these conditions have been developed during the last years, to find optimized routes from a source to some destination. This paper presents performance evaluation of three different routing protocols (AODV, DSR and ZRP) in variable pause times . We have used QualNet Simulator [1] from Scalable Networks to perform the simulations. Performance evaluation of AODV, DSR and ZRP is evaluated based on Average end to end delay, TTL based hop count and Packet delivery ratio.

Keywords: MANETS, AODV, DSR, ZRP.

I. INTRODUCTION

A routing protocol is a protocol that specifies how routers communicate with each other, disseminating information that enables them to select routes between any two nodes on a computer network. Each router has a priori knowledge only of networks attached to it directly. A routing protocol shares this information first among immediate neighbors, and then throughout the network. This way, routers gain knowledge of the topology of the network. An ad hoc routing protocol is a convention, or standard, that controls how nodes decide which way to route packets between computing devices in a network. Various routing protocols available for Ad- hoc networks are AODV, CGSR, DSDV, DSR, OLSR, WRP, ZRP etc. In this paper we are using AODV, DSR and ZRP. In the last few years, there are several researches have evaluated the performance of routing protocols for mobile Ad- Hoc network as a function of mobility rate and pause time [7] using ns2(network simulator 2) . There are lesser evaluations available using Qualnet simulator which is commercially available and faster than ns2[3]. We are using Qualnet simulator for comparison evaluation of AODV, DSR and ZRP.

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A. AODV

Ad hoc On-demand Distance Vector Routing (AODV) [2] protocol is an on demand routing protocol [8] as it determines a route to the destination only when a node wants to send data to that destination. The source broadcasts a route request (RREQ) packet when it wants to find path to the destination. The neighbors in turn broadcast the packet to their neighbors until it reaches an intermediate node that has recent route information about the destination or until it reaches the destination. An already received route request packet is discarded by the nodes. The route request packet uses sequence numbers to ensure that the routes are loop free and that the intermediate node replies to route requests are the most recent. A node records the node from which request packet received first to construct the reverse path for route reply to source node. As the route reply packet traverses back to the source, the nodes along the path enter the forward route into their tables. Due to the mobile nature of nodes, route maintenance is required. If the source moves then it can reinitiate route discovery to the destination. If one of the intermediate nodes move then the moved nodes neighbor realizes the link failure and sends a link failure notification to its upstream neighbors and so on until it reaches the source upon which the source can reinitiate route discovery if needed. AODV [3] has greatly reduced the number of routing messages in the network. AODV only supports one route for each destination. This causes a node to reinitiate a route request query when it's only route breaks. But if mobility increases route requests also increases.

B. *DSR*

Routing protocol Dynamic Source Routing (DSR) is an entirely on-demand ad hoc network routing protocol composed of two parts: Route Discovery and Route Maintenance [6]. When a node has a packet to send to some destination and does not currently have a route to that destination in its Route Cache, the node initiates Route Discovery to find a route. The source node transmits a ROUTE REQUEST [7] packet as a local broadcast, specifying the target and a unique identifier. If it is recently received REQUEST, node discards the REQUEST. Otherwise, it

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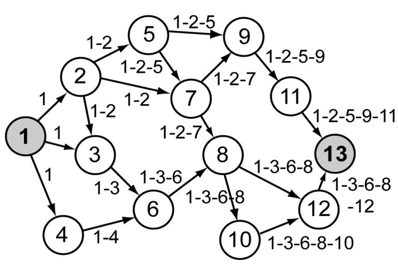
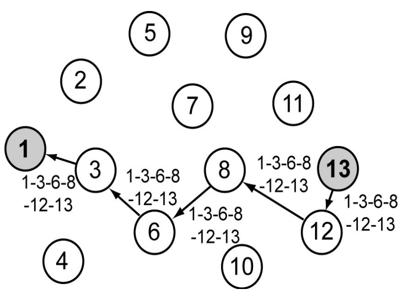
appends its own node address to a list in the REQUEST and rebroadcasts the REQUEST. When the ROUTE REQUEST reaches its target node, the target sends a ROUTE REPLY back to the initiator of the REQUEST, including a copy of the accumulated list of addresses from the REQUEST. When the REPLY reaches the initiator of the REQUEST, it caches the new route in its Route Cache. The mechanism by which a node sending a packet along a specified route to some destination detects if that route is broken is called Route Maintenance.



(a) Building of the route record



(b) Propagation of the route reply.

Figure 1: DSR Route Discovery Process.[3]

The Source lists the complete sequence of nodes from source to destination in the header of the packet. Each node along the route forwards the packet to the next hop indicated in the packet's header, and attempts to confirm that the packet was received by that next node. If, after a limited number of local retransmissions of the packet, a node in the route is unable to make this confirmation, it returns a ROUTE ERROR to the original source of the packet, identifying the link from itself to the next node is broken. The sender then removes this broken link from its Route Cache; for subsequent packets to this destination, the sender may use any other route to that destination in its Cache, or it may attempt a new Route Discovery for that target if necessary. Figure 1(a) [3] shows the route discovery process with node 1 as source node and node 13 as destination node. Figure 1(b) shows how route reply propagates from destination to source in reverse order.

C. ZRP

The Zone Routing Protocol (ZRP) [5] combines the advantages of both reactive and pro-active protocols into a hybrid scheme, taking advantage of pro-active discovery within a node's local neighborhood, and using a reactive protocol for communication between these neighborhoods. In a MANET, it can safely be assumed that the most communication takes place between nodes close to each other. The ZRP is not so much a distinct protocol as it provides a framework for other protocols. The separation of a nodes local neighborhood from the global topology of the entire network allows for applying different approaches - and thus taking advantage of each technique's features for a given situation. These local neighborhoods are called zones ; each node may be within multiple overlapping zones, and each zone may be of a different size. The ``size'' of a zone is not determined by geographical measurement, but is given by a radius of length, where is the number of hops to the perimeter of the zone. By dividing the network into overlapping, variable-size zones, the Zone Routing Protocol consists of several components, which only together provide the full routing benefit to ZRP. Each component works independently of the other and they may use different technologies in order to maximize efficiency in their particular area. Components of ZRP are IARP, IERP and BRP.

Intrazone Routing Protocol (IARP)

The first protocol of ZRP is the Intrazone Routing Protocol (IARP) [3]. This protocol is used by a node to communicate with the interior nodes of it's zone and is limited by the zones radius (the number of hops from the node to it's peripheral nodes). Due to the change in topology, local neighborhood of a node may change rapidly. Thus node continuously needs to update the routing information in order to determine the peripheral nodes as well as maintain a map of which nodes can be reached locally. The IARP allows for local route optimization through the removal of redundant routes and the shortening of routes if a route with fewer hops has been detected, as well as bypassing link-failures through multiple (local) hops.

Interzone Routing Protocol (IERP)

The global reactive routing component of the ZRP, the Interzone Routing Protocol (IERP), takes advantage of the known local topology of a node's zone and, using a reactive approach enables communication with nodes in other zones. When there is request for a route, Route queries within the IERP are issued. The delay caused by the route discovery (in contrast to IARP, where the route is immediately available) is minimized through the use of bordercasting, an approach in which the node does not submit the query to all local nodes, but only to it's peripheral nodes. A node does not send a query back to the nodes the request came from, even if they are peripheral nodes. It is necessary to disable pro-active updates for local routes to convert an existing reactive routing protocol for use as the IERP in the ZRP. The IERP needs to be able to take advantage of the local routing information provided by the IARP, as well as change the way route discovery is handled: Instead of flooding a route request to all nodes, it should instead use the Bordercast Resolution Protocol (BRP) to only initiate route requests with peripheral nodes.

Bordercast Resolution Protocol (BRP)

The Bordercast Resolution Protocol (BRP), [7] is used in the ZRP to direct the route requests initiated by the global reactive IERP to the peripheral nodes and removing redundant queries and maximizing efficiency. Bordercast tree is constructed by utilizing the map provided by the local pro-active IARP. The BRP keeps track of which nodes a query has been delivered to, so that it can prune the bordercast tree of nodes that have already received the query. When a node receives a query packet for a node that does not lie within it's local routing zone, it constructs a bordercast tree so that it can forward the packet to it's neighbors. These nodes, upon receiving the packet, reconstruct the bordercast tree so that they can determine whether or not it belongs to the tree of the sending node. If it does not belongs to the bordercast tree of the sending node, it continues to process the request and determines if the destination lies within it's routing zone and taking the appropriate action, upon which the nodes within this zone are marked as covered.

II. PERFORMANCE EVALUATION

We carried out simulations on Qualnet simulator[10]. The simulation parameters [4] are summarized in table 1. We designed the network using Random waypoint model with different pause times. We are compiling the results using 15 simulations and the application between the randomly chosen source and destination is CBR traffic.

Table 1: Parameters for simulation evaluation

No. of nodes	50
Dimension of space	1500 X 1500 m
Minimum velocity (v min)	0 m/sec
Maximum velocity (v max)	20 m/sec
Simulation Time	180s
Item size	512 bytes
Source data pattern	4 packets / sec
Pause time	30s,60s,90s,120s,150s
No. of simulations	15

The metrics used to measure the performance of AODV, DSR and ZRP are average end to end delay, average TTL based hop count and packet delivery ratio.

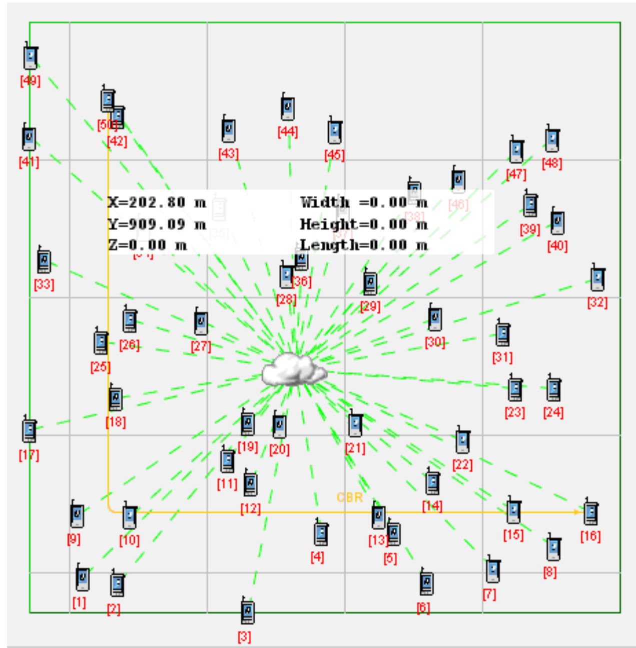


Figure 2: Snapshot of network in Qualnet Simulator

Average End to End Delay

End-to-end delay indicates how long it a packet takes to travel from the CBR source to the application layer of the destination. The average delay from the source to the destination's application layer is shown in figure3. According to our simulation results delay for AODV is always below 0.1 seconds while for DSR and ZRP is below 0.2 seconds. Best performance is shown by AODV having lowest end to end delay with a maximum delay of .05 sec. With the increase in pause time average end to end delay increases in case of ZRP but it shows a drastic increase when pause time increases from 120s to 150s.

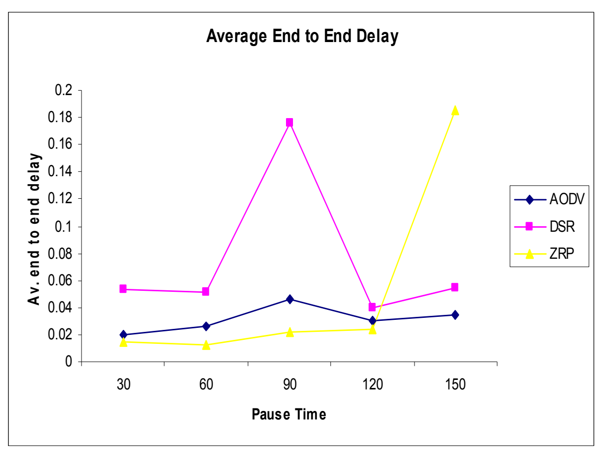


Figure 3: Simulation results of performance comparison of AODV, DSR and ZRP

TTL based average hop count

Hop count is the number of hops a packet takes to reach its destination. Figure 4 shows our simulation results for TTL based hop count. The results are a bit weird: for the DSR and ZRP the average hop count remains constant. Moreover, if we compute the AODV graph, the hop count increases continuously.

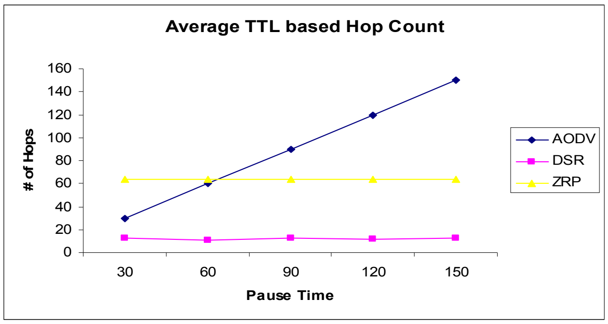


Figure 4: Simulation results of performance comparison of AODV, DSR and ZRP

Packet Delivery Ratio

Packet delivery ratio is calculated by dividing the number of packets received by the destination through the number of packets originated by the application layer of the source (i.e. CBR source). It specifies the packet loss rate, which limits the maximum throughput of the network. The better the delivery ratio, the more complete and correct is the routing protocol. The packet delivery ratio is shown in figure 5. DSR and AODV perform much better than ZRP. ZRP delivers only 40 percent of all CBR packets initiated by the source at pause time. While AODV and DSR delivers almost 90 percent of packets.

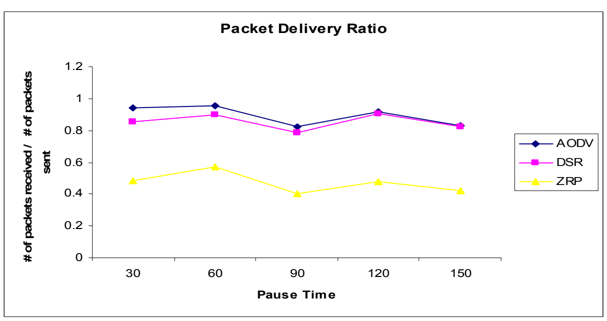


Figure 5: Simulation results of performance comparison of AODV, DSR and ZRP

III. CONCLUSION

In this paper, a performance comparison of three different routing protocols (AODV, DSR, ZRP) for mobile Ad-hoc networks is presented as a function of pause time. Different kinds of protocols are included in this comparison, as we have on demand vs. hybrid routing (ZRP), hop by hop vs. source routing and location aided routing. Three performance metrics are average end to end delay; average TTL based hop count and packet delivery ratio. AODV shows best results in measuring end to end delay and packet delivery ratio. AODV delivers almost 90 percent of transmitting packets while DSR performs best with minimum number of hops in comparing TTL based hop count. Different initial node position patterns, more sources, additional metrics (such as path length difference from shortest) may be used in future.

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