Comparison of DSDV, DSR and ZRP Routing Protocols in MANETs

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ABSTRACT
A mobile adhoc network is a collection of wireless mobile nodes dynamically forming a network topology without the use of existing network infrastructure or centralised administration. Routing is a significant issue and challenge in MANET. Routing is a task of directing data packets from a source node to a destination node. Many routing protocols has been proposed like DSDV, OLSR, AODV, DSR, ZRP, and TORA so far to improve the routing performance and reliability in MANET. This paper presents a comparative performance analysis of Proactive, Reactive, and Hybrid protocol based on performance metrics like Packet Delivery Fraction (PDF), average end-to-end delay, normalised routing load and throughput by varying network size.

Keywords
MANET, DSDV, OLSR, AODV, DSR, ZRP and TORA

1. INTRODUCTION
Manet [1][2] are the wireless network of mobile computing device without any support of a fixed infrastructure or a base station. The mobile nodes in a MANET organises themselves in an arbitrary manner because the network topology keep on changing rapidly. In MANET every node acts as a host and a router at the same time. This means each node participating in MANET commits itself to forward data packets from a neighbouring node to another untill destination is reached. The challenge in the design of MANET is the development of dynamic routing protocols that can efficiently find routes between two communicating nodes. Many routing protocols have been proposed for the mobile adhoc network and are classified as Proactive or Table Driven Routing Protocols, Reactive or On Demand Routing Protocols or Hybrid Protocols.

1.1 Proactive or Table Protocols
Proactive or Table Driven routing protocols require each node to maintain up-to-date information, kept in tables. These tables are periodically updated whenever network topology changes. These protocols uses link-state routing algorithms which frequently flood the link information about the neighbours. The drawback of proactive routing protocol is the usage of bandwidth and the other network resources since an updated routing table has to maintained by every node, even if node is not used. Also queues are filled with control packets and there are more packet collision due to more network traffic. Some existing proactive routing protocols are DSDV[3] and OLSR[4].

1.2 Reactive or On-Demand Routing Protocols
In reactive routing protocols Route discovery mechanism initiates only when route to destination is reachable or until the route is no longer needed or only when the route to destination is required. All nodes are not required to maintain up-to-date routing information. Some of the existing reactive routing protocols are AODV[3], DSR[5]. The drawback of reactive routing protocol is high-latency time in route finding. Also excessive flooding leads to Network clogging.

1.3 Hybrid Routing Protocols
Hybrid Routing Protocols combine the advantages of both proactive and reactive routing protocols. Some existing hybrid protocols are ZRP[6] and TORA[7]. The main disadvantages of such algorithms is that advantage depends on number of Mathavan nodes activated and reaction to traffic demand depends on gradient of traffic volume.

2. ROUTING PROTOCOL DESCRIPTION
2.1 Destination Sequenced Distance-Vector Routing
The Destination-Sequenced Distance-Vector (DSDV)[3]. Routing Algorithm is based on the idea of the classical Bellman-Ford Routing Algorithm with certain improvements. The improvements made to the Bellman-Ford algorithm include freedom from loops in routing tables. Each node 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 old routes from new ones and thus avoid the formation of loops. Consistent Routing tables are maintained by updating them periodically. The stations periodically transmit routing tables to their immediate neighbours. A station also transmits its routing table if a significant change has occurred in its table from the last update sent. So, the update is both time-driven and event-driven. The routing table updates can be sent in two ways a full dump or an incremental update. A full dump sends the full routing table to the neighbors and could span many packets whereas in an incremental update only those entries from the routing table are sent that has a metric change since the last update. If there is space in the incremental update packet then those entries may be included whose sequence number has changed. When the network is relatively stable, incremental updates are sent to avoid extra traffic and full dump are relatively less frequent. In the dynamic network, incremental packets can grow big so full dumps will be more frequent.

2.2 Dynamic Source Routing
The Dynamic Source Routing (DSR) [5] is an on-demand routing protocol that is based on the concept of source routing. The Dynamic Source Routing protocol comprises of route discovery and rout maintenance mechanisms. Route Discovery is the mechanism by which a source node wishing to send a packet to a destination node, discovers a source route to the destination. Route Maintenance is the mechanism by

which a node wishing to send a packet to a destination is able to detect, while using a source route to the destination, if the network topology has changed. A routing entry in DSR contains all the intermediate nodes information of the route rather than just the next hop information maintained in DSDV and AODV. When a mobile nodes wishes to send a packet to the destination, initially it concern its route cache to determine whether it already has a route to destination. If exist, it uses the route to send the packet. But if the node does not have such route then it initiates a route discovery mechanism by broadcasting route request (RREQ) packet. The route request contains the address of the destination, source node address and a unique identification number. Every node receiving the packet checks whether route to destination exist or not. If it does not, it adds its own address to the route record of the packet and then re-broadcast the packet to its neighbouring nodes.. Any node that has a path to the destination in question can reply to the RREQ packet by sending a route reply (RREP) packet. The reply is sent using the route recorded in the RREQ packet. The RREP routes itself back to the source by traversing this path backward. The roué carried back by the RREP packet is cached at the source for future use. If any link on a source is broken, the source node is notified using a route error (RERR) packet. The source removes any route using this link from its cache. A fresh route discovery mechanism will be initiated by the source if the route is still needed.

2.3 Zone Routing Protocol (ZRP)

ZRP was proposed to reduce the control overhead of table-driven routing protocols and decrease the latency caused by routing discover in on-demand routing protocols. ZRP defines a zone around each node consisting of its k-neighbourhood . In ZRP, the distance and a node, all nodes within -hop distance from node belongs to the routing zone of node. ZRP is formed by two sub-protocols, a proactive routing protocol; Intra-zone Routing Protocol (IARP) [9] is used inside routing zones and a reactive routing protocol: Inter-zone Routing Protocol (IERP) [10] is used between routing zones, respectively. A route to a destination within the local zone can be established from the proactively cached routing table of the source by IARP, therefore, if the source and destination is in the same zone, the packet can be delivered immediately. Most of the existing proactive routing algorithms can be used as the IARP for ZRP. For routes beyond the local zone, route discovery happens reactively. The source node sends a route requests to its border nodes, containing its own address, the destination address and a unique sequence number. Border nodes are nodes which are exactly the maximum number of hops to the defined local zone away from the source. The border nodes check their local zone for the destination. If the requested node is not a member of this local zone, the node adds its own address to the route request packet and forwards the packet to its border nodes. If the destination is a member of the local zone of the node, it sends a route reply on the reverse path back to the source. The source node uses the path saved in the route reply packet to send data packets to the destination.

3. COMPARITIVE STUDY OF ADHOC ROUTING PROTOCOLS

A. Metrics of Performance Comparison

MANET has number of qualitative and quantitative metrics metrics that can be used to compare adhoc routing protocols. The table a illustrates the comparison of DSDV, DSR, and ZRP routing protocols. This paper has been considered the following metrics to evaluate the performance of adhoc network routing protocols.

1. Average End to end delay [6]: The metrics represents average end-to-end delay and indicates how long it took for a packet to travel from the source to the application layer of the destination. This includes all possible delays caused by buffering during route discovery latency, queuing at the interface queue, retransmission delays at the MAC, and propagation and transfer times of data packets. Calculate the send(S) time (t) and receive (R) time (T) and average it.
2. Packet delivery fraction [11]: The fraction of all the received data packets successfully at the destinations over the number of data packets sent by the CBR sources is known as Packet delivery fraction.
3. Media Access Delay [3]: The time a node takes to access media for starting the packet transmission is called as media access delay. The delay is recorded for each packet when it is sent to the physical layer for the first time.
4. Path optimality [12]: This metric can be defined as the difference between the path actually taken and the best possible path for a packet to reach its destination.
5. Normalised Routing Load [12]: This metric describes how many routing packets for route discovery and route maintenance need to be sent so as to propagate the data packets.
6. Throughput [13]: Throughput is defined as the average number of message successfully delivered per unit time i.e. average number of bits delivered per second.

Table 1. Comparison of Adhoc routing protocols

Performance Constraints	**DSDV**	**DSR**	**ZRP**
Category	Table Driven or proactive	On Demand or Reactive	Hybrid
Protocol Type	Link State	Distance Vector	Link Reversal
Route maintained through	Routing Table	Routing Table	Routing Table
Loop Freedom	Yes	Yes	Yes
Route Mechanism	Flat	Flat	Flat
Multiple Route	No	No	Yes
Multitask Capability	Yes	Yes	No
Frequency of update transmissi	Periodically and as needed	Periodically	Periodically and as needed

on			
Message Overhead	Minimum	Moderate	Moderate
Requires sequence data	No	Yes	Yes
Routing metrics	Shortest Path	Shortest Path	Shortest Path
Route Configuration Methodology	Control message sent in advance to increase the reactiveness	Erase Route notify Source	Link reversal route repair
Summary	Control message for Link Sensing, Neighbour (MPR) Detection, Multiple Interface Detection, Route calculation	Route Discovery, Expanding Ring Search, Setting Forward path	Link Reversal, Route Discovery, Route Update packets

Table 2. Routing performance in low mobility and low traffic

Low Mobility and Low Traffic				
Protocol	**End-to-end delay**	**Packet Delivery ratio**	**Path Optimality**	**Routing Overhead**
DSDV	Low	High	Good	Good
DSR	Average	High	Average	Low
ZRP	Low	High	Good	Average

Table 3. Routing performance in high mobility and high traffic

High Mobility and High Traffic				
Protocol	**End-to-end delay**	**Packet Delivery ratio**	**Path Optimality**	**Routing Overhead**
DSDV	Low	Average	Average	Low
DSR	Average	Average	Average	Low
ZRP	High	Low	Average	Average

4. CONCLUSION

This paper presents the comparative study and performance analysis of various ad hoc routing protocols (DSDV, DSR and ZRP) on the basis of end-to-end delay, packet delivery ratio, media access delay, path optimality, routing overhead performance metrics. The study of these routing protocols shows that DSDV is more efficient in high density networks with highly sporadic traffic. DSDV requires that it continuously have some bandwidth in order to receive the topology updates messages. As well, DSR keeps on improving in packet delivery ratio with dense networks. The performance of all protocols was almost stable in sparse medium with low traffic. ZRP performs much better in packet delivery owing to selection of better routes using acyclic graph. It has been concluded that performance of ZRP is better for dense networks. The DSR is better for moderately dense networks where as the DSDV performs well in sparse networks. The future work suggested that the effort will be made to enhance ad hoc network routing protocol by tackling core issues.

5. ACKNOWLEDGMENTS

We would like to take this opportunity to express our sincere and profound gratitude to our mentor Prof.(Dr.) Kamal Ghansala and Prof.(Dr.) Sanjay Jasola for their constant encouragement and guidance throughout the course of my work.

And finally thanks to all those who inspired us directly or indirectly.

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