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A Complete Study on Energy Efficient Routing Protocols DSR, ZRP and DSDV In Mobile Ad Hoc Networks

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Abstract

In wireless network can classified in two ways one is infrastructure network and another is infrastructure less. Infrastructure less wireless network is known as Ad-hoc network. Instead of relying on a base station to coordinate the flow of messages to each node in the network, the individual network nodes forward packets to and from each other. In computer networking, an ad-hoc networks all nodes are mobile and can be connected dynamically in an arbitrary manner. All nodes of these networks behave as routers and take part in discovery and maintenance of routes to other nodes in the network. In this paper, the three routing protocols are studied i.e. DSR, ZRP, DSDV

Keywords—Mobile ad hoc network, DSR, ZRP and DSDV

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1. Introduction

A mobile ad-hoc network (MANET) group has been formed within IETF. The primary focus of this working group is to develop and evolve MANET specifications and introduce them to the Internet standard track. The goal is to support mobile ad-hoc networks with hundreds of routers and solve challenges in this kind of network. Some challenges that ad-hoc networking faces are limited wireless transmission range, hidden terminal problems, packet losses due to transmission errors, mobility induced route changes, and battery constraints. Mobile ad-hoc networks could enhance the service area of access networks and provide wireless connectivity into areas with poor or previously no coverage Connectivity to wired infrastructure will be provided through multiple gateways with possibly different capabilities and utilization. To improve performance, the mobile host should have the ability to adapt to variation in performance and coverage and to switch gateways when beneficial. To enhance the prediction of the best overall performance, a network layer metric has a better overview of the network. Ad-hoc networking brings features like easy connection to access networks, dynamic multihop network structures, and direct peer-to-peer communication. The multihop property of an ad-hoc network needs to be bridged by a gateway to the wired backbone. The gateway must have a network interface on both types of networks and be a part of both the global routing and the local ad-hoc routing. Users could benefit from ubiquitous networks in several ways. User mobility enables users to switch between devices, migrate sessions, and still get the same personalized services. Host mobility enables the users' devices to move around the networks and maintain connectivity and reachability.Wireless networks can be classified in two types: First, infrastructure network which consists of a network with fixed and wired gateways. A mobile host communicates with a bridge in the network (called base station) within its communication radius. When it goes out of the range of one base station, it connects with a new fixed base station and starts communicating through it. Second, infrastructure less (ad-hoc) networks fig. 1: In ad-hoc networks all nodes are mobile and can be connected dynamically in an arbitrary manner.

All nodes of these networks behave as routers and take part in discovery and maintenance of routes to other nodes in the network. In ad hoc network for some time for connecting to each other through this mobile ad hoc network. They do not use any base station and router in this network. There are number of routing protocols for ad hoc networks, they are categorized into two: Proactive Routing and Reactive routing.

A. Classification Of Routing Protocols:

The routing protocols can be classified into two parts: 1. Proactive (Table driven), 2. Reactive (Source or Demand driven) and 3. Hybrid Routing Protocols while depending on the network structure these are classified as flat routing, hierarchical routing and geographic position assisted routing. Flat routing covers both routing protocols based on routing strategy. The three ad hoc routing protocols are used, DSR, ZRP and DSDV. ZRP is Hybrid Routing Protocols DSR is Reactive Protocol (Source driven) and DSDV is Proactive (Table driven) Routing protocol.

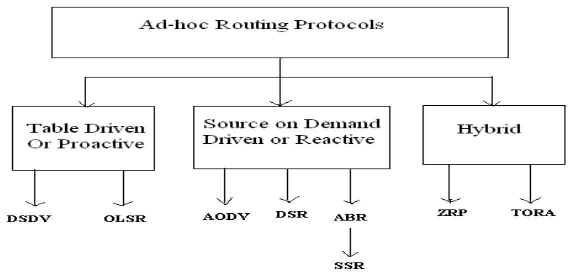


Fig 1. Adhoc Networking Protocols

A.1 Pro-active vs. reactive

The IETF MANET Working Group has researched and developed a number of protocols for mobile ad-hoc networks, which have been described. These protocols can generally be categorized into two groups: *pro*-active and *re*active protocols. Pro-active protocols follow an approach similar to the one used in wired routing protocols. By continuously evaluating the known and attempting to discover new routes, they try to maintain the most up-to-date map of the network. This allows them to efficiently forward packets, as the route is known at the time when the packet arrives at the node. Pro-active or table-driven protocols, in order to maintain the constantly changing network graph due to new, moving or failing nodes, require continuous updates, which may consume large amounts of bandwidth – clearly a disadvantage in the wireless world, where bandwidth is often sparse. Even worse so, much of the accumulated routing information is never used, since routes may exist only for very limited periods of time. The family of Di

stance-Vector protocols, including Destination-Sequenced Distance-Vector Routing, fall into the category of pro-active protocols. In contrast, reactive protocols determine the proper route only when required, that is, when a packet needs to be forwarded. In this instance, the node floods the network with a route request and builds the route on demand from the responses it receives. This technique does not require constant broadcasts and discovery, but on the other hand causes delays since the routes are not already available. Additionally, the flooding of the network may lead to additional control traffic, again putting strain on the limited bandwidth. These reactive (or on-demand) protocols include Dynamic Source Routing (DSR) and Ad-hoc On demand Distance Vector Routing (AODV), as well as the classical flooding algorithms.

A.2. Hybrid Routing Protocol

Hybrid protocols are the combinations of reactive and proactive protocols and takes advantages of these two protocols and as a result, routes are found quickly in the routing zone.Example Protocol: ZRP (Zone Routing Protocol), TORA (Temporally-Ordered Routing Algorithm)

2. Related Work

The problem of routing in MANETs has received attention among researchers, and many routing protocols devoted to MANETs have been proposed. According to their approaches for creating and maintaining routes, these protocols can be divided into two main categories; proactive protocols and reactive ones. The proactive protocols, also called table driven, establish routes in advance, and permanently maintain them, basing on the periodic routing table exchange.

Table *1:* Comparison of Reactive and Proactive routing protocols

Reactive protocols	Proactive Protocols
A route is built only when required.	Attempt to maintain consistent, up-to-date Routing information from each node to every other node in the network.
No periodic updates. Control information is not propagated unless there is a change in the topology	Constant propagation of routing information periodically even when topology change does not occur.
First-packet latency is more when compared with table-driven protocols because a route need to be built	First packet latency is less when compared with on-demand protocols
Not available	A route to every other node in ad-hoc network is always available

Table *2:* Comparison of different routing protocols

Protocol	Route	Route selection criteria	Beacon	Maintenance	Route discovery
DSR	Multiple	Shortest path	No	Global, notify source	Global
ABR	Single	Link stability	Yes	Local, bypass broken link	Global
SSA	Single	Signal strength	Yes	Global, notify source	Global
AODV	Single	Shortest path	Yes	Global, notify source	Global
LAR	Multiple	Shortest path	No	Global, notify source	localized

3. Description Of Selected Routing Protocols

A. Dynamic Source Routing (DSR)

Dynamic Source Routing (DSR) is a routing protocol for wireless mesh networks and is based on a method known as *source routing*. It is similar to AODV in that it forms a route on-demand when a transmitting computer requests one. Except that each intermediate node that broadcasts a route request packet adds its own address identifier to a list carried in the packet. The destination node generates a route reply message that includes the list of addresses received in the route request and transmits it back along this path to the source. Route maintenance in DSR is accomplished through the confirmations that nodes generate when they can verify that the next node successfully received a packet. These confirmations can be link-layer acknowledgements, passive acknowledgements or network-layer acknowledgements specified by the DSR protocol. However, it uses source routing instead of relying on the routing table at each intermediate device. When a node is not able to verify the successful reception of a packet it tries to retransmit it. When a finite number of retransmissions fail, the node generates a route error message that specifies the problematic link, transmitting it to the source node. When a node requires a route to a destination, which it doesn't have in its route cache, it broadcasts a *Route Request (RREQ)* message, which is flooded throughout the network. The first RREQ message is a

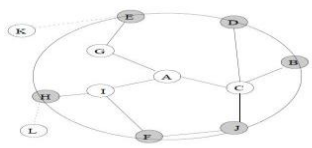
broadcast query on neighbors without flooding. Each RREQ packet is uniquely identified by the *initiator's address* and the *request id*. A node processes a route request packet only if it has not already seen the packet and its address is not present in the route record of the packet. This minimizes the number of route requests propagated in the network. RREQ is replied by the destination node or an intermediate node, which knows the route, using the *Route Reply (RREP)* message. The return route for the RREP message may be one of the routes that exist in the route cache (if it exists) or a list reversal of the nodes in the RREQ packet if symmetrical routing is supported. In other cases the node may initiate it owns route discovery mechanism and piggyback the RREP packet onto it. Thus the route may be considered unidirectional or bidirectional. DSR doesn't enforce any use of periodic messages from the mobile hosts for maintenance of routes. Instead it uses two types of packets for route maintenance: Route Error (RERR) packets and ACKs. Whenever a node encounters fatal transmission errors so that the route becomes invalid, the source receives a RERR message.
ACK packets are used to verify the correct operation of the route links. This also serves as a passive acknowledgement for the mobile node. DSR enables multiple routes to be learnt for a particular destination. DSR does not require any periodic update messages, thus avoiding wastage of bandwidth.

A. Advantages and Disadvantages

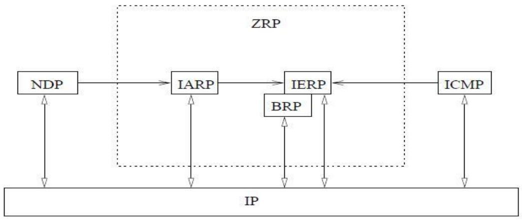
DSR uses a reactive approach which eliminates the need to periodically flood the network with table update messages which are required in a table-driven approach. The intermediate nodes also utilize the route cache information efficiently to reduce the control overhead. The disadvantage of DSR is that the route maintenance mechanism does not locally repair a broken down link. The connection setup delay is higher than in table-driven protocols. Even though the protocol performs well in static and low-mobility environments, the performance degrades rapidly with increasing mobility. Also, considerable routing overhead is involved due to the source-routing mechanism employed in DSR. This routing overhead is directly proportional to the path length.

B. Zone Routing Protocol (ZRP)

The *Zone Routing Protocol*, or ZRP, as described in this document combines the advantages of both 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. As mentioned earlier, 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* (hence the name); 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, as one might expect, 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, ZRP avoids a hierarchical map of the network and the overhead involved in maintaining this map. Instead, the network may be regarded as flat, and route optimization is possible if overlapping zones are detected. While the idea of zones often seems to imply similarities with cellular phone services, it is important to point out that each node has its own zone, and does not rely on fixed nodes (which would be impossible in MANETs).



C. Destination-Sequenced Distance-Vector Routing (DSDV)

Destination-Sequenced Distance-Vector Routing (DSDV) is a table-driven routing scheme for ad hoc mobile networks based on the Bellman-Ford algorithm. It eliminates route looping, increases convergence speed, and reduces control message overhead.

$$\text{if } \{d_{ik}(X)\} = \min \{d_{ij}(X)\}$$

Parameter	DSDV	DSR	ZPR
Source routing	No	Yes	No
Periodic message	Yes	No	Yes(Locally)
Functioning proactively	Yes	No	Yes(Locally)
Functioning Reactively	No	Yes	Yes (Globally)

Table 3: Parameter comparison for DSR, DSDV, and ZRP

Table 4: Property comparison for DSR, DSDV, and ZRP

Protocol property	DSDV	DSR	ZRP
Loop free	Yes	Yes	Yes
Multicast routes	No	Yes	No
Distributed	Yes	Yes	Yes
Unidirectional link support	No	Yes	No
Multicast	No	No	Yes
Periodic broadcast	Yes	No	Yes
QoS support	No	No	No
Routes maintained in	Route Table	Route Cache	Route Table
Route cache / table timer	Yes	No	Yes
Reactive	No	Yes	Yes

In DSDV, each node maintains a next-hop table, which it exchanges with its neighbors. There are two types of next-hop table exchanges: periodic full-table broadcast and event-driven incremental updating. The relative frequency of the full-table broadcast and the incremental updating is determined by the node mobility. In each data packet sent during a next-hop table broadcast or incremental updating, the source node appends a sequence number. This sequence number is propagated by all nodes receiving the corresponding distance-vector updates, and is stored in the next-hop table entry of these nodes. A node, after receiving a new next-hop table from its neighbor, updates its route to a destination only if the new sequence number is larger than the recorded one, or if the new sequence number is the same as the recorded one, but the new route is shorter. In order to further reduce the control message overhead, a settling time is estimated for each route. A node updates to its neighbors with a new route only if the settling time of the route has expired and the route remains optimal.

4. **IV.SIMULATION BASED ANALYSIS USING NETWORK SIMULATOR (NS-2.34)**

A. Simulation Tool

The simulation tool used for analysis is NS-2.34 which is highly preferred by research communities. NS is a discrete event simulator targeted at networking research. NS provides substantial support for simulation of TCP, routing, and multicast protocols over wired and wireless (local and satellite) networks. NS2 is an object oriented simulator, written in C++, with an OTcl interpreter as a frontend. This means that most of the simulation scripts are created in Tcl (Tool Command Language). If the components have to be developed for ns2, then both Tcl and C++ have to be used.

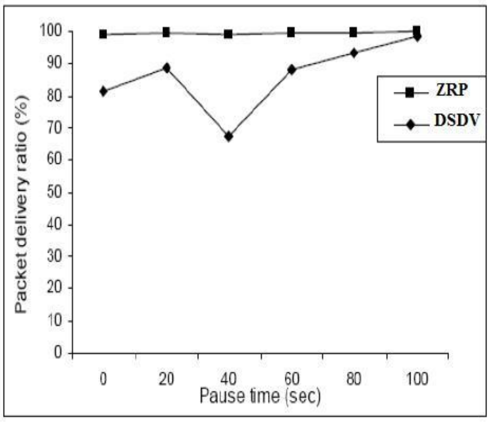


Fig *4.* Packet delivery fraction vs. Pause time for 50- node model with 15 sources.

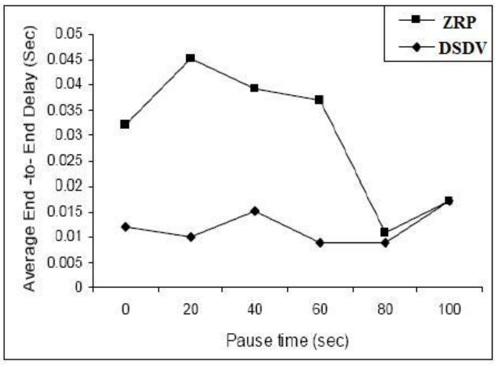


Fig *5.* Average End-to-End Delay vs. Pause time for the 50-node model with 15 sources.

5. Conclusion

It is difficult for the quantitative comparison of the most of the ad hoc routing protocols due to the fact that simulations have been done independent of one another using different metrics and using different simulators. This paper does the realistic comparison of three routing protocols AODV, TORA and DSDV. The significant observation is, simulation results agree with expected results based on theoretical analysis. As expected, reactive routing protocol DSR performance is the best considering its ability to maintain connection by periodic exchange of information, which is required for ZRP and DSDV based traffic. DSDV performs predictably. Meanwhile DSDV was very good at all mobility rates and movement speeds. Compared the On-Demand (DSR) , Table-Driven (DSDV) routing protocols and hybrid routing protocol (ZRP) by varying the number of nodes and measured the metrics like end-end delay, dropped packets, As far as packet delay and dropped packets ratio are concerned, DSR performs better than DSDV and ZRP with large number of nodes. Hence for real time traffic DSR is preferred over ZRP and DSDV. For less number of nodes and less mobility, DSDV and ZRP's performance is superior.

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