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Routing Algorithms for MANET: A Comparative Study

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Abstract*— this paper presents a comparative study of existing routing algorithms for MANET. A mobile ad-hoc network (MANET) is formed with autonomous self-configured mobile nodes which communicate over radio in infrastructure less network. Each node plays a role of router in the MANET as it must forward the traffic to other nodes. We list the working mechanism, advantages and disadvantages of existing routing algorithms in mobile ad-hoc network. In this paper DSDV, OLSR, AODV, DSR, LAR, ZRP are analysed.

***Index Terms*—MANET, Proactive Routing Algorithms, Reactive Routing Algorithms, Hybrid Routing Algorithms, DSDV, OLSR, AODV, DSR, LAR, ZRP.**

I. INTRODUCTION

The term routing is very important for a network. Routing is a process of finding an efficient, reliable and secure path from a source node to a destination node via intermediate nodes in a network. Routing in MANET is a challenge due to dynamic topology in network as mobile nodes can move in any direction in the MANET [2]. Mobile ad-hoc networks are easy to deploy and configure which causes its popularity in comparison to wired networks. Instant network setup is the main feature of MANET. MANET is useful in places that have no communications infrastructure or when that infrastructure is severely damaged. A small network for sharing resources can be setup by mobile nodes (laptop, personal digital assistant, smart phones) [5] [6]. Routing algorithms in MANET should provide following primary expectations:

- Stable loop free connectivity
- Secure routing
- Reduced control overhead
- Have scalability and distributed routing
- Support QoS traffic prioritization
- Respond to changes in node mobility [7].

Routing algorithms in MANET are categorized in three heads: Proactive routing algorithms, reactive routing algorithms and hybrid routing algorithms [3].

II. LITERATURE REVIEW

A. *Proactive routing algorithms for MANET*

Proactive routing algorithm maintains routes to destination even if they are not required. Proactive routing algorithms maintain up-to-date routing information on every node in the network periodically. Advantage of proactive routing algorithm is that connection time is fast as path is already available on each node in the network. A disadvantage of proactive algorithm is that they continuously use resources to communicate routing information, even when there is no traffic which causes the overhead of control information [8].

1) ***Destination-Sequenced Distance Vector (DSDV)*** *[9]*

- Each node maintains a table with an entry for every possible destination.
- Nodes exchange their routing tables with their neighbors periodically.
- Based on the received tables, nodes update their routing tables.
- Each entry in table specifies
  - i) Destination identifier.
  - ii) Next hop on the route to the destination.
  - iii) Distance (in terms of hops) to the destination.
  - iv) A sequence number that specifies how fresh the route is.

1.1) ***Advantages***

Route from source node to destination node is always available as each node has path from other nodes from itself.

1.2) ***Disadvantages***

Large routing overhead, Uses only bidirectional links. Suffers from count to infinity problem.

2) ***Optimized Link State Routing protocol (OLSR)*** *[10] [11]*

In figure 1, node C and E are multipoint relay (MPR) of node A

- Multipoint relays of A are its neighbors such that each two-hop neighbor of A is a one-hop neighbor of one multipoint relay of A
- Nodes exchange neighbor lists to know their 2-hop neighbors and choose the multipoint relays

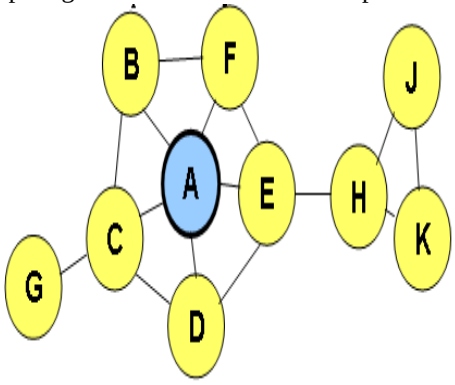

Fig 1 Example of OLSR

In Figure 2

- Nodes C and E forward information received from A
- Nodes E and K are multipoint relays for node H
- Node K forwards information received from H

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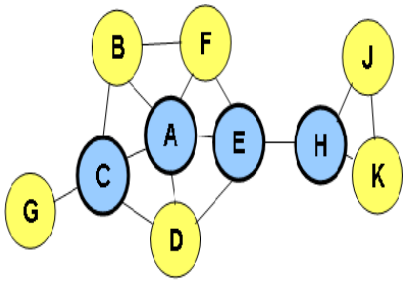

Fig 2 MPR node C and node E of node A

2.1) ***Advantages***

- Reduces control information
- Efficiently minimizes broadcast traffic bandwidth usage.

2.2) Disadvantages

- Although OLSR provides a path from source to Destination, it is not necessarily the shortest path, because every route involves forwarding through a MPR node
- OLSR also has routing delays and bandwidth overhead at the MPR nodes as they act as localized forwarding routers.

B. Reactive routing algorithms for MANET

In Reactive routing algorithm routing tables are not updated up-to-date. Instead, a node tries to find a route only when it wants to send a packet. The advantage of reactive routing algorithms is that it reduces the traffic needed for routing. A disadvantage of reactive routing algorithm is that it introduces a delay when the first packet is sent to a host as path is not readily available.

1) ***Ad hoc on-demand Distance Vector (AODV)*** *[12] [13]*

Three message types are used in the AODV which are route request (RREQ), route reply (RREP), and route error (RERR).

- In figure 3, node 1 desires to communicate to node 8.
- Node 1 flood the network with route request (RREQ) messages.
- Each node receiving a RREQ message stores the previous hop and distance to source for the originating RREQ and forwards the RREQ to its neighbors.
- When the RREQ message reaches the designation node 8, the destination sends a unicast route reply (RREP) message back to the source using the previous hop on which it received the RREQ.
- Each node receiving the RREP message in turn forwards it to the next hop with the smallest distance to the source as shown in Figure 4.
- This process effectively builds the routing table at each node, and when any source destination pair establishes a route, the intermediate nodes learn the route as well.

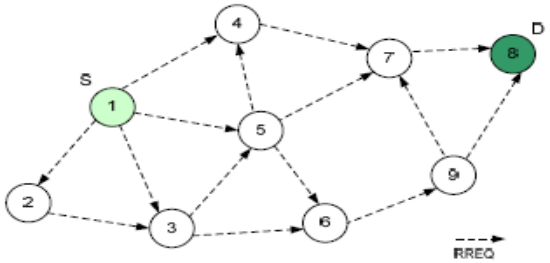

Fig 3 Route Request (RREQ) Flooding

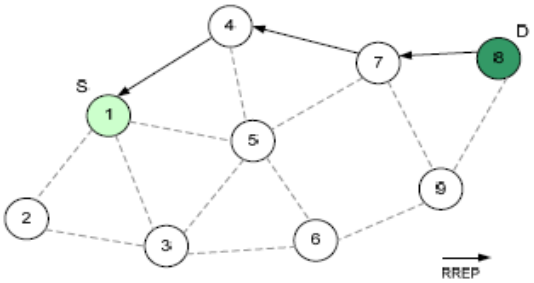

Fig 4 Route Reply (RREP) Propagation

1.1) ***Advantages***

AODV creates routes only on demand, which greatly reduces the periodic control message overhead associated with proactive routing protocols.

1.2) ***Disadvantages***

Route setup latency is exist when a new route is needed. ADOV queues data packets while discovering new routes and the queued packets are sent out only when new routes are found. It causes throughput loss in high mobility scenarios, because the packets get dropped quickly due to unstable route selection.

2) ***Dynamic source routing algorithm (DSR)*** *[3]*

A complete ordered route is maintained in the packet in dynamic source routing (DSR). This makes it easy to control the route from the source node and guarantees loop-free paths.

- In figure 5, node S wants to send a packet to node D, but does not know a route to D, node S initiates a route discovery
- Source node S floods Route Request (RREQ) Each node *appends own identifier* when forwarding RREQ
- In figure 6, Destination D on receiving the first RREQ, sends a Route Reply (RREP)
- RREP is sent on a route obtained by reversing the route appended to received RREQ
- RREP includes the route from S to D on which RREQ was received by node D
- Node S on receiving RREP, caches the route included in the RREP
- In figure 7, when node S sends a data packet to D, the entire route is included in the packet header hence the name source routing
- Intermediate nodes use the source route included in a packet to determine to whom a packet should be forwarded

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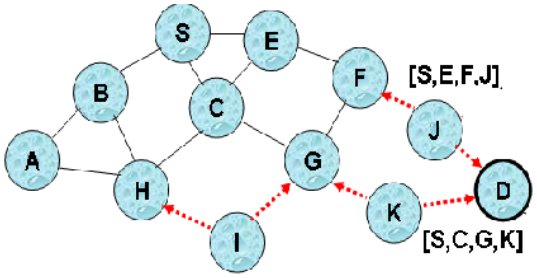

Fig 5. RREQ Is Flooded and Path is Found

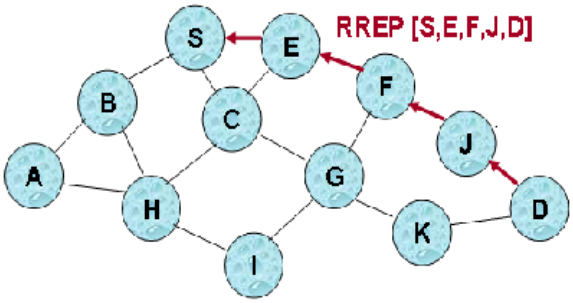

Fig 6. RREP Is Sent By Node D and Path is Setup

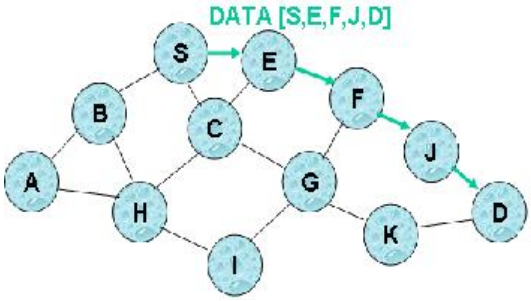

Fig 7. Data Transmission

2.1) *Advantages*

- Does not flood the network with table update messages periodically.
- Intermediate nodes also utilize the route cache information efficiently to reduce the control overhead.

2.2) *Disadvantages*

- Route maintenance mechanism does not locally repair a broken link.
- Connection setup delay is higher than in table-driven protocols.
- Performance degrades rapidly with increasing mobility.
- Routing overhead is involved due to the source-routing mechanism employed in DSR. This routing overhead is directly proportional to the path length.

C. Hybrid routing algorithms for MANET [15]

Hybrid routing algorithm combines the advantages of both reactive and proactive routing algorithms. Initially proactive approach is used to have route information then reactively demand of the route is served to the needy node.

1) *Location-Aided Routing (LAR) [14]*

Location-aided route discovery based on limited flooding. LAR [14] Use location information to reduce the number of nodes to whom route request is propagated. Location information may be obtained using Global Positioning System (GPS)

- LAR Exploits location information to limit scope of route request flood using GPS
- Expected Zone is determined as a region that is expected to hold the current location of the destination. Expected region determined based on potentially old location information, and knowledge of the destination's speed
- Route requests limited to a *Request Zone* that contains the Expected Zone and location of the sender node
- In figure 8, Request Zone
  - i. Define a Request Zone
  - ii. LAR is same as flooding, except that only nodes in request zone forward route request
  - iii. Smallest rectangle including S and expected zone for D

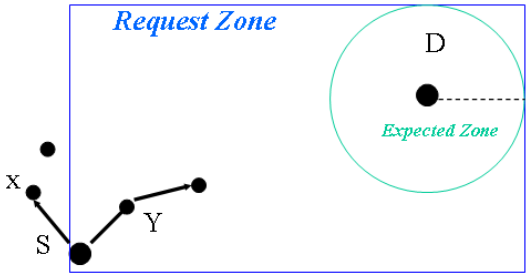

Fig 8. LAR- Request Zone

1.1) *Advantages*

- reduces the scope of route request flood
- reduces overhead of route discovery

1.2) *Disadvantages*

- Nodes need to know their physical locations
- Does not take into account possible existence of obstructions for radio transmissions

2) Zone Routing Protocol (ZRP) [16]

Zone routing protocol is hybrid routing algorithm which use the advantages of both proactive and reactive routing algorithms. ZRP was proposed to reduce the control overhead of proactive routing protocols and decrease the latency caused by route discovery in reactive routing protocols.

- All nodes within hop distance at most d from a node X are said to be in the routing zone of node X.
- All nodes at hop distance exactly d are said to be peripheral nodes of node X's routing zone
- Intra-zone routing: Proactively maintain routes to all nodes within the source node's own zone.
- Inter-zone routing: Use an on-demand protocol (similar to DSR or AODV) to determine routes to outside zone.
- In figure 9, node S perform route discovery for node D. First, the packet is sent within the routing zone of the source node to reach the peripheral nodes (Intra zone routing).

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- Then the packet is sent from the peripheral nodes towards the destination node.(inter zone routing)
- Each node collects information about all the nodes in its routing zone proactively. This strategy is similar to a proactive protocol like DSDV.
- Each node maintains a routing table for its routing zone, so that it can find a route to any node in the routing zone from this table.
- Each node periodically broadcasts a message similar to a hello message kwon as a zone notification message.

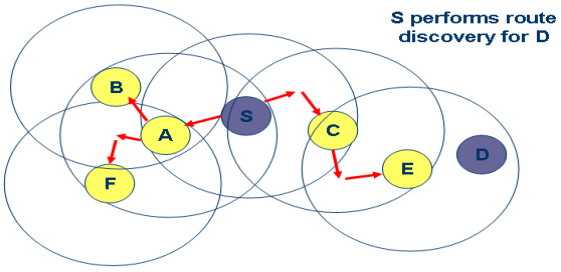

Fig 9. RREQ Broadcasting

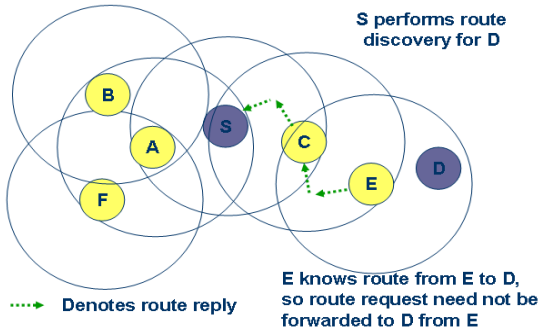

Fig 10. RREP from Node E

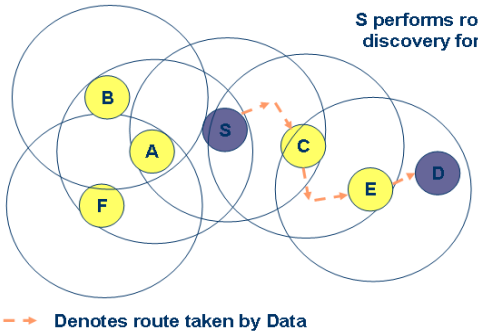

Fig 11. Data Transmission

1.1) *Advantages*

Less control overhead as in a proactive protocol or an on demand protocol.

1.2) *Disadvantages*

Short latency for finding new routes.

III. CONCLUSION

Simulations results are used from the existing research papers listed in the references; we compare these routing algorithms on the basis of dynamics in number of nodes, pause time, end-to-end delay, and throughput. We assume 1 very high, 2 for high, 3 for moderate, 4 for Very Low.

Table I pause time Dynamics: Summary

Metric	End-To-End Delay	Throughput	Total
DSDV	2	3	5
OLSR	2	4	6
AODV	4	2	6
DSR	3	3	6
LAR	2	1	3
ZRP	2	2	4

With the change in pause time, LAR shows the best performance in all metric followed by ZRP. DSDV is moderate and AODV, DSR, OLSR are average.

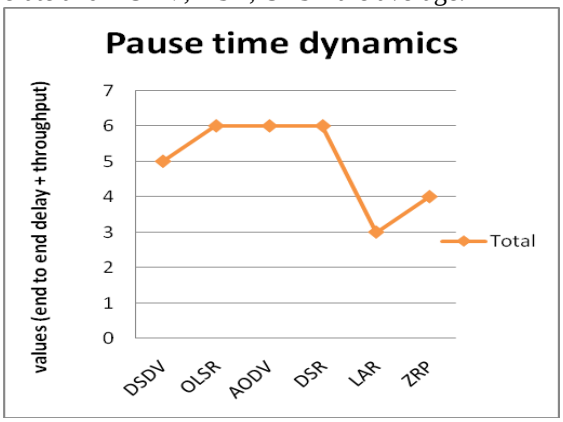

Fig 12 Pause Time Dynamics Analysis

Table II Number of Nodes Dynamics: Summary

Metric	End-To-End Delay	Throughput	Total
DSDV	2	2	4
OLSR	1	3	4
AODV	3	2	5
DSR	2	3	5
LAR	2	1	3
ZRP	3	2	5

When numbers of nodes are changed then LAR is good, DSDV and OLSR are Moderate and AODV and DSR are average.

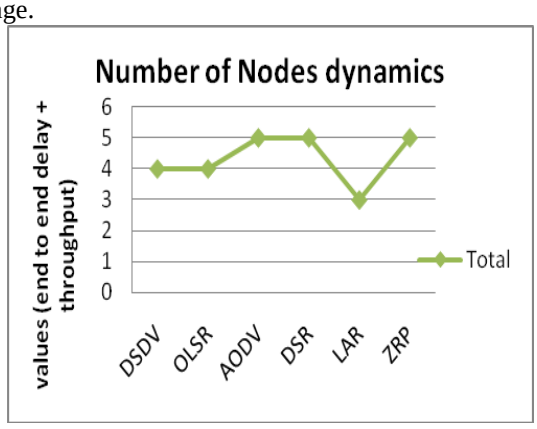

Fig 13 Number of Nodes Analysis Along With Algorithms

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