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Research Article

AODV- An Efficient MANET Routing Protocol

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Abstract

A high reliability and performance can be given to mobile Ad Hoc networks with the help of efficient routing protocols. AODV (Ad hoc On-demand Distance Vector) that works dynamically to set up and sustain routes, adapting quickly to changing link conditions. AODV is an on-demand routing protocol as requested routes are made between source nodes. This paper includes the functionality and features of AODV to make it an efficient routing protocol to MANET. This paper also includes some features which can be incorporated in order to make AODV more efficient.

Keywords: *AODV, DSDV, DSR, Flooding, TTL, PDF*

1. Introduction

Wireless communication technology is steadily and rapidly increasing. People wish to use their network terminals (laptops, PDAs, etc.) anywhere and anytime. Wireless connectivity gives users the freedom to move where they desire. There exist numerous different wireless networks varying in the way the nodes interconnect. They can be classified in two main types: Networks with fixed infrastructure and Ad hoc wireless networks (Prashant Kumar Maurya, 2012)Mobile ad hoc network is collection of wireless computers (or nodes) establishing a network in which nodes communicate with each other by forwarding packets within and outside range of direct wireless transmission. Such type of networks also known as Mobile Ad Hoc multi-hop wireless networks does not have any requisite for fixed infrastructure or central control such as base station or access point, and can be set up according to the demand anywhere as required (Anju Gill, 2012). Mobile Ad-Hoc network is a kind of wireless network and self-configuring network of moving routers associated with wireless network (Asma Tuteja, 2010). Efficient routing protocols make MANETs reliable (Gurpreet Singh, n.d.) Due to the mobility of nodes, MANETs have a dynamic topology where links are formed and made to break with time. These links can be unidirectional or bi-directional. Due to high level of dynamism, reliable, fast and energy efficient routing of data packets from the source to the destination is an area of great concern for researches. Science it is an infrastructure network, one cannot rely on use of access points or other infrastructure for routing, thus leaving only one option of building multi-hop routes from source to destination, where in between nodes act as routers. To perform Routing in MANETs involves designing a protocol which helps using routing data packets from source to destination with minimum possible hops and minimum battery power consumption of nodes. In MANET some of the challenges faced at different layers (K.Prabhu, 2012). Mobile Ad-hoc Network (MANET) is an infrastructure less and decentralized network which need a robust dynamic routing protocol (Sachin Kumar Gupta, 2011)

Routing Protocols

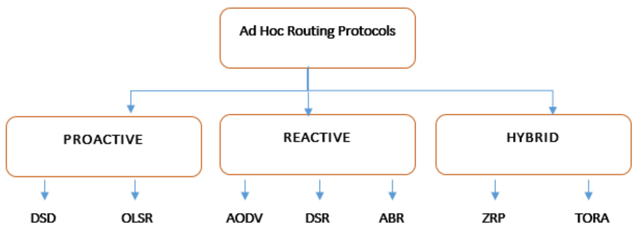

Figure 1

A routing protocols is needed whenever a packet needs to be transmitted to a destination via number of nodes and numerous routing protocols have been proposed for such kind of Ad hoc networks. These protocols search a route for packet delivery and deliver packet to the destination. Basically, routing protocols can be broadly classified into three types as

A) Table -driven (or) proactive routing protocol,
B) On-demand (or) reactive routing protocol
C) Hybrid routing protocol.

A). Table-Driven (or) Proactive routing protocols

Every node maintains the network topology information in the form of routing tables by periodically exchanging routing information. Routing information is flooded in the whole network whenever a node requires a path to the destination node. It runs a best suitable path-finding

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algorithm on the topology information it maintains. Some of the existing table-driven (or) proactive protocols are DSDV, WRP, CGSR, OLSR, STAR, FSR, HSR, and GSR.

B). On-Demand (or) Reactive routing protocols

Protocols that fall under this category in which the network topology information is not maintained. By the help of a connection establishment process the necessary path is obtained when required. The routing information is not exchanged periodically by these protocols. Some of the existing routing protocols that belong to this category are DSR, AODV, TORA, ABR, SSA, FORP, and PLBR.

C). Hybrid routing protocol

Protocols belonging to this category combine the best features of the previous two types. Nodes within a certain distance from the node concerned or within a particular geographical region are said to be within the routing zone of the specified node. For routing inside this zone a table-driven technique is used. For nodes that are located beyond this zone an on-demand technique is used. Some of the protocols under this area are CEDAR, ZRP, and ZHLS.

AODV and ITS working

AODV routing protocol is a reactive routing protocol which establish a route when a node requires sending data packets. AODV accept a very different apparatus to maintain routing information. It uses conventional routing tables, one entry per purpose (Salman Abdullah Alhamoodi, 2012) AODV is proficient of both unicast and multicast routing. The working of the protocol is divided in two functions:

1. Route discovery and
2. Route maintenance.

When there is a route needed to some destination, the protocol initiate route discovery. After that the source node sends route request message to all its neighbours. And if those nodes do not have any information about the destination node, they will send the message to all its neighbours and so on. And during this if any neighbour node contains the information about the destination node, the node will send route reply message to the route request message initiator. With the help of this process a path is recorded in the intermediate nodes. This path recognize the route and is called the reverse path. Since each node over network forwards route request message to all of its neighbours, more than one copy of the original route request message can approach at a node. A unique id is allotted, when a route request message is created. When a node received, it will check this id and the address of the initiator and discarded the message if it had already processed that request. Node that contains information about the path to the destination sends route reply message to the neighbour from which it has received route request message. This neighbour does the same. Due to the reverse path it can be possible. Then the route reply message flows back using reverse path. When a route reply message will reach the initiator the route is ready and the initiator can start sending data packets (Mina Vajed Khiavi, 2012). This protocol requires all nodes to reserve big enough memory spaces to store possible routing entries for active sources.

And destinations. As most routes are formed on demand, network latency is quite high (S H Manjula, 2008).

Message types

AODV defines 3 message types

- Route Requests (RREQs)
- Route Replies (RREPs)
- Route Errors (RERRs)

RREQ messages are used to initiate the route finding process.

RREP messages are used to finalize the routes.

RERR messages are used to notify the network of a link Breakage in an active route. The AODV protocol is only used when two endpoints do not have a valid active route to each other. Nodes keep a “precursor list” that contains the IP address for each of its neighbours that are likely to use it for a next hop in their routing table. The routing table fields used by AODV are:

- Destination IP Address
- Destination Sequence Number
- Valid Destination Sequence number flag
- Other state and routing flags
- Network Interface
- Hop Count
- Next Hop
- List of Precursors
- Lifetime(TTL)

Working

With the help of example:
Circle represents the nodes and lines represent the connection.

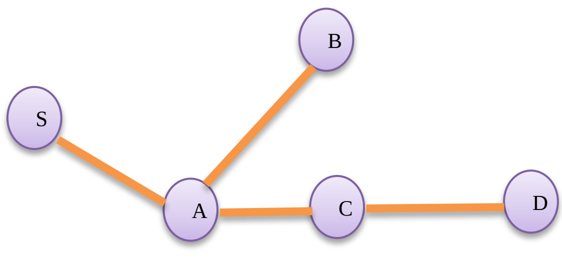


Figure 2

- Node S needs a route to D
- Creates a Route Request (RREQ)
  Enters D’s IP addr, seq#, S’s IP addr, seq#, hopcount (=0)

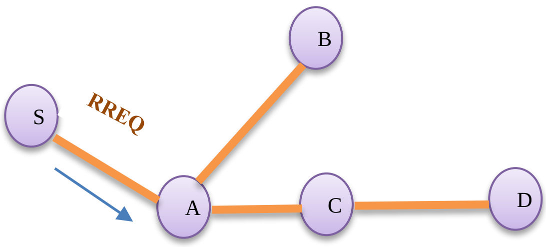


Figure 3

- Node S needs a route to D
- Creates a Route Request (RREQ)

  Enters D's IP addr, seq#, S's IP addr, seq#, hopcount

  (=0)
- Node S broadcasts RREQ to neighbours

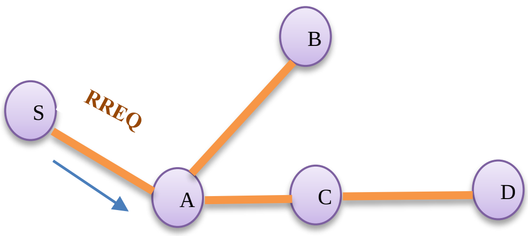


Figure 4

- Node A receives RREQ

  Makes a reverse route entry for S

  dest=S, nexthop=S, hopcount=1
- It has no routes to D, so it rebroadcasts RREQ

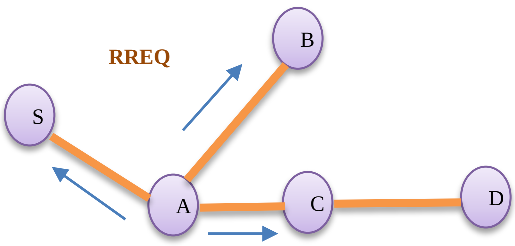


Figure 5

- Node A receives RREQ

  Makes a reverse route entery for S

  dest=S, nexthop=S, hopcount=1
- It has no routes to D, so it rebroadcasts RREQ

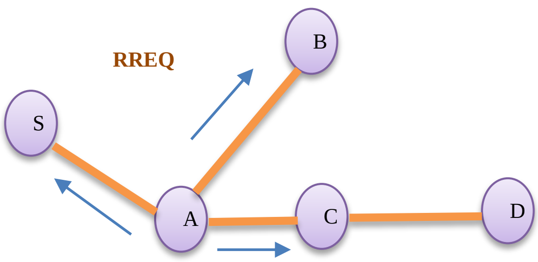


Figure 6

- Node C receives RREQ

  Makes a reverse route entry for S

  Dest=S, nexthop=A, hopcount=2
- It has a route to D, and the seq# for route to D is >= D's

  seq# in RREQ

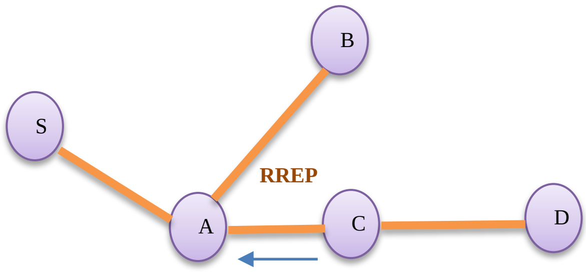


Figure 7

- Node C receives RREQ

  C creates a Route Reply (RREP)

  Enters D's IP addr, seq#, S's IP addr, hopcount to D

  (=1)
- Unicasts RREP to A

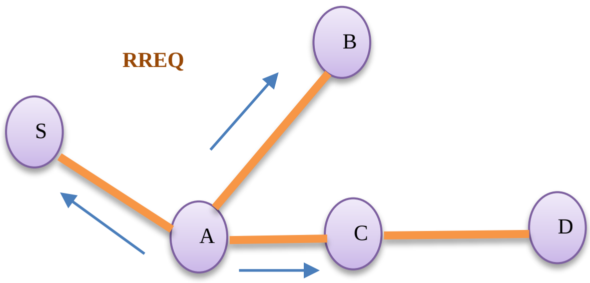


Figure 8

- Node C receives RREQ

  C creates a Route Reply (RREP)

  Enters D's IP addr, seq#, S's IP addr, hopcount to D

  (=1)
- Unicasts RREP to A

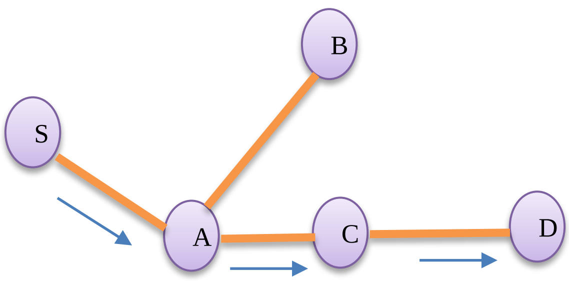


Figure 9

- Node A receives RREP

  Makes a forward route entry to D

  dest=D, nexthop=C, hopcount=2
- Unicasts RREP to S

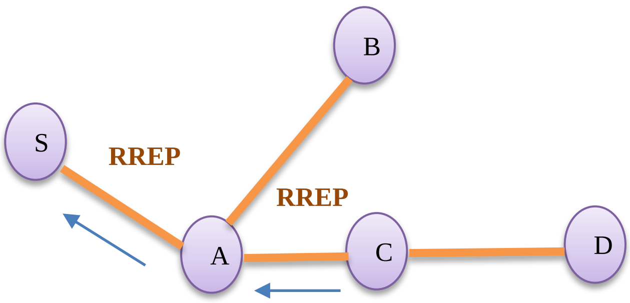


Figure 10

- Node S receives RREP
  Makes a forward route entry to D
  dest=D, nexthop =A, hopcount = 3
- Sends data packet on route to D

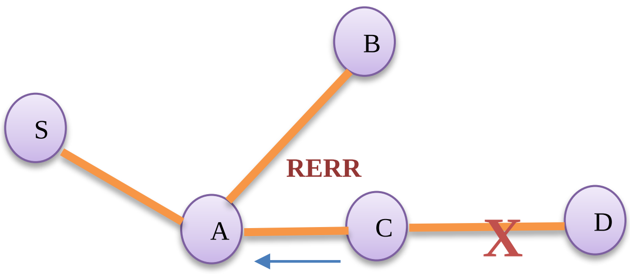


Figure 11

1. Link between C and D breaks
2. Node C invalidates route to D in route table
3. Node C creates Route Error message
   - Lists all destinations that are now unreachable
   - Sends to upstream neighbours

Properties

1. The AODV routing protocol does not need any central administrative system to control the routing process. Reactive protocols like AODV tend to reduce the control traffic messages overhead at the cost of increased latency in finding new routes (Prashant Kumar Maurya, 2012)
2. AODV discovers routes as and when necessary
   Does not maintain routes from every node to
   Every other
3. Routes are maintained just as long as Necessary
4. Every node maintains its monotonically Increasing sequence number -> increases every time the node notices change in the neighbourhood topology
5. AODV utilizes routing tables to store routing information
   A Routing table for unicast routes
   A Routing table for multicast routes
6. The route table stores: <destination addr, next-hop addr, destination sequence number, life_time>
7. For each destination, a node maintains a list of precursor nodes, to route through them
8. Precursor nodes help in route maintenance
9. Life-time updated every time the route is used
10. If route not used within its life time -> it expires

Benefits of AODV over other protocols

There are some benefits of AODV over other on demand routing protocols. These were presented on the basis of simulation over network simulator 2(NS2) discussed in next section. Some of them which make AODV as an efficient routing protocol are:

1. Stable End To End delay
2. Stable routing load
3. Faster routing protocol over other such as DSR and DSDV

Simulation

The simulation (Khandakar, 2012) here is basically done over three routing protocols these are DSR, DSDV and AODV based on the performance metrics.

1. Packet Fraction Delay(PDF)
2. END to END Delay

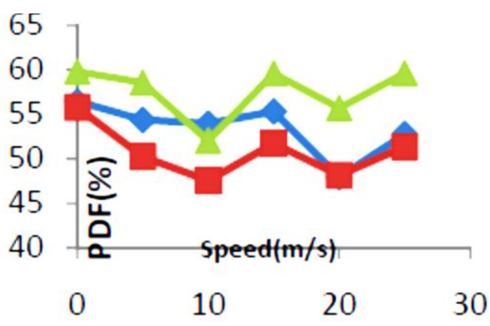
Simulation parameters

Table 1

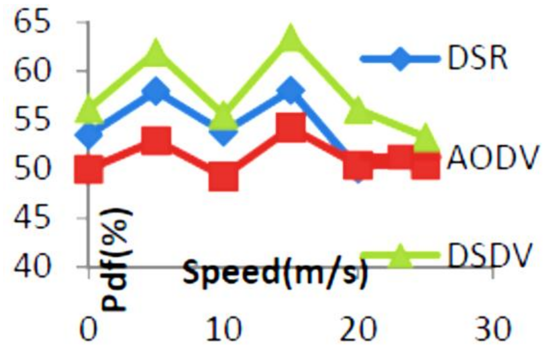
Simulator	Ns-2
Studied Protocols	AODV,DSDV and DSR
Simulation Time	100 Seconds
Simulation Area	500 m X 500m
Node Movement Model	Random Waypoint
Speed	0-25 in steps of 5 m/s
Traffic Type	CBR(UDP)
Node Pause Time	0-100s in steps of 20s
Data Payload	1000 bytes/Packet
Packet Rate	250K
Number of Nodes	15, 30 and 45
Number of Source Destination	4 and they are fixed and not randomly selected using ns2 tools

Comparison on the basis of keeping pause time constant and varying speed.

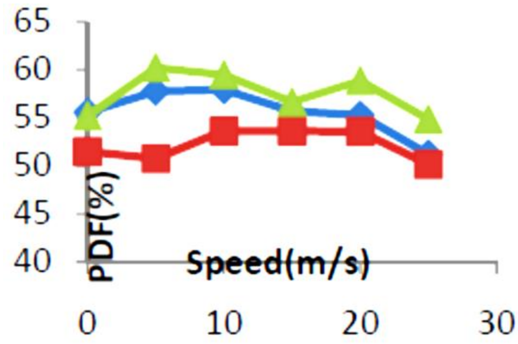
In the images of comparisons, lines refers to:
Red -> AODV
Green -> DSDV
Blue -> DSR
Packet Delivery Fraction



Number of nodes: 15(figure 12)



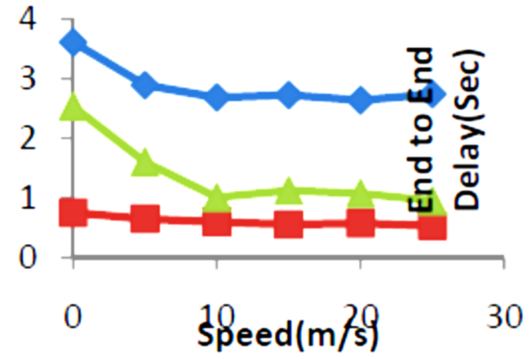
Number of nodes: 30(figure 13)



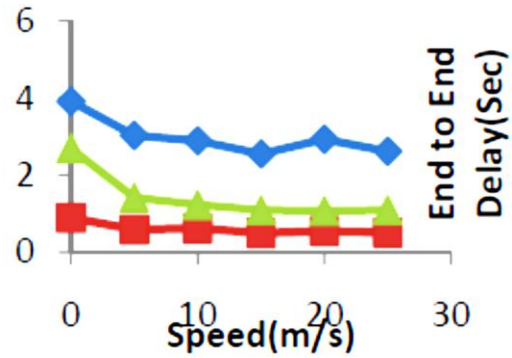
Number of nodes: 45(figure 14)

AODV is fresh and more reliable route from the above seen.

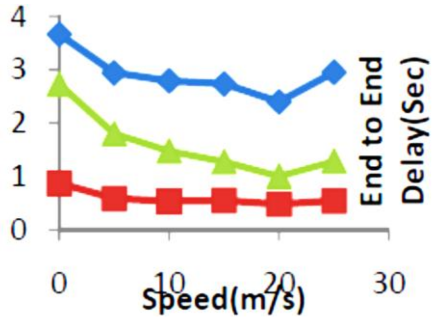
END to END Delay



Number of Nodes: 15(figure 15)



Number of Nodes: 30(figure 16)

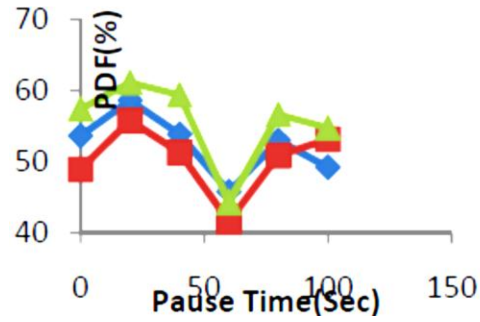


Number of Nodes: 45(figure 17)

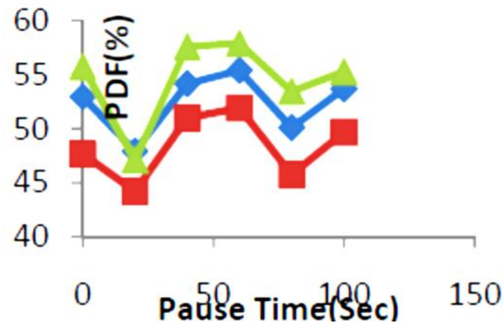
From the above images it can be seen that END to END delay is lowest in AODV in mobility as compared with other two protocols.

Comparison on the basis of keeping the speed constant and varying pause time.

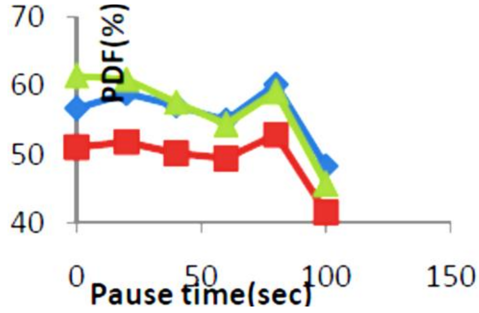
PDF (Packet Delivery Fraction)



Number of nodes: 15(figure 18)

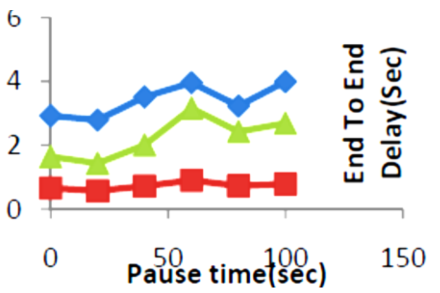


Number of nodes: 30(figure 19)

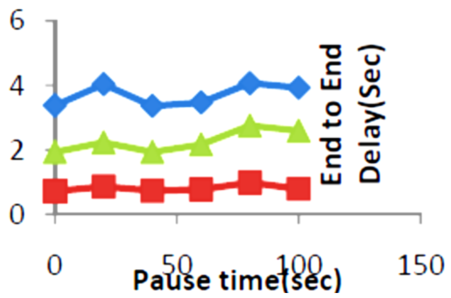


Number of nodes: 45(figure 20)

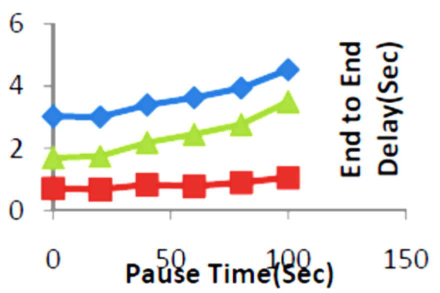
From the above figures AODV is fresh and most reliable route.
END to END delay



Number of nodes: 15(figure 21)



Number of nodes: 30(figure 22)



Number of nodes: 45(figure 23)

From the above figures AODV has lowest and most stable END to END delay in mobility.

Conclusion

Here below, on the basis of simulation there are some results on the basis of which it can be concluded that AODV is the most efficient protocol for MANET. However there are some drawbacks also there but we can follow some points which can make it more efficient.

Table 2 Comparison conclusion

S.no	Parameters	AODV	Other Protocols
1	END to END Delay	Lowest and most stable End to End delay	Higher in DSR and DSDV
2	Packet Delivery Fraction	Most fresh and reliable route	Slightly more PDF than AODV
3	Reliability	Most Reliable	Less reliable such as DSR
4	Stability	Most stable End to End delay	Less stable(DSR,DSDV)

Points to make AODV more efficient

- The behaviour of(incrementing TTL) keeps network utilization down so this must be improved in order to make efficient
- Flooding process is used in AODV which sometimes lead to collision so if one entry of a node in a table is made there should not be the entry of that node in any other node table.
- Whenever the message is flooded there must be proper technique of finding the minimum path to the destination so that the process of sending the data will be fast.

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