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# A Review on AODV Based Backup Routing Schemes in Mobile Ad Hoc Network

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***Abstract— Mobile ad hoc network (MANET) is characterized as a dynamic, multi-hop wireless self-organized distributed ad hoc network. Because of node mobility and power limitation, the network topology changes frequently which leads to path breakage. Hence a dynamic routing protocol is required for ad hoc networks to function properly. Reactive on -demand routing protocols becomes very popular because it established routes only when they are needed but most of them use single route and do not have backup routes to transmit the packet during failure. Therefore, some on-demand protocols with alternate path has been proposed to improve the performance in ad hoc network. In this paper, we discuss different schemes based on AODV protocol which provide multiple alternate routes by using the broadcast nature of wireless nodes and compare their performance on basis of various parameters.***

***Keywords— MANET, alternate routes, AODV-BR, AODV-ABR, AODV-ABL, AODV-GBR, AODV-BRL***

## I. INTRODUCTION

Wireless technology is one of the rapidly evolving technology in the field of networking. It helps to transfer the information or establish communication between two end devices without any support of physical connectivity [9]. Wireless technologies provided the freedom of mobility to nodes which led to development of various wireless equipment such as mobile, global positioning system, satellite television etc. The explosive growth of wireless system increases the technical challenges to design a reliable and robust wireless network that can deliver the necessary performance to support the emerging applications.

MANET is a self-configuring and self-organizing wireless network whose topology keeps changing. It consists of collection of mobile nodes which communicate independently with each other via wireless connections. It is an infrastructure-less network without any centralized administration [1]. Mobile node in MANET act as both router and host to forward packets from one node to another node in a multi- hop fashion.

Routing in MANET is one of the complex and challenging task due to frequent topology changes, limitation of resources like bandwidth or power source and absence of central coordination [2]. Hence, to handle these issues various protocol has been designed. Generally, MANET is classified into two types which are table-driven and on-demand routing protocols. Table driven protocol are also known as proactive protocol such as DSDV (destination sequenced distance vector routing protocol) and OLSR (optimized link state routing protocol). In this, every node maintains the routing table which contain information about network topology. These routing tables are updated periodically whenever there is change in network topology [3]. The process of maintaining information about all the nodes through periodic updates creates high routing overhead in large network.

On-demand routing protocol does not need to maintain routing tables in all the node. It discovers the route only when needed [5]. On-demand routing protocol also known as reactive protocol decreases routing overhead as no distribution of information is done. Therefore, reactive on-demand routing protocol where route discovery is initiated on demand basis are the recent trend in ad-hoc network such as AODV (ad hoc on demand vector routing protocol).

In AODV [16] a route to destination is determined only when source need to send data. Routes are maintained only for the node which are in active communication. It offers quick adaption to topology change and determines unicast route to destination within the ad hoc network. It uses destination sequenced number to ensure loop freedom and maintain freshness of routes [16]. AODV has two phases route discovery phase and route maintenance phase.

In Route discovery phase, when a source node need to send data to the destination node and valid route is not available in the routing table then source initiates route discovery phase. It broadcast RREQ packet to its neighbors which then forward it to their neighbor and this process continues until the packet reaches to the destination. Every node has unique broadcast id and sequence number which is incremented after every RREQ initiation. This combination of broadcast id and sequence number help to discard the duplicate RREQ packet received at intermediated node or destination node. When a node first time receives the RREQ packet, it creates or updates the routing table and setup the reverse route to the source node. When the RREQ packet is received by destination node, it creates RREP packet and unicast it back to source from the reverse path. When the RREP packet reaches the source node, a route from source to destination is established to transmit the data packets.

 

In Route maintenance phase, when a link break in an active route is detected by a node, then RRER message is used to notify the other nodes and invalidate the route. RRER message propagates to all the precursor nodes and when it reaches to source, a new route discovery is initiated. During path breakage, route disconnects and too many packets are dropped during this period until a new route is established. As it has no alternate routes available to transmit data packets, dropping of packets leads to degradation of performance.

In this paper, we discuss various algorithms that utilizes the mesh structure to provides multiple alternate paths. Multiple paths can reduce both route discovery latency and routing overhead. Alternate paths are beneficial to ad hoc networks as they are prone to packet collisions, route breakage, high error rate and signal interference.

The rest of the paper is organized as follows. In Section II, we briefly present the description of various schemes of backup routing using wireless nature of nodes. Section III describes the comparison of these algorithms. Finally, section IV summarizes this paper with conclusion.

## II. AODV BASED BACKUP ROUTING SCHEME

### *A. AODV-BR*

AODV-BR scheme was proposed by Sung-Ju Lee and Mario Gerla [9] to improve the existing on-demand protocol by introducing mesh structure and multiple alternate paths. This scheme can easily be integrated to any reactive routing protocols.

In this algorithm, route request procedure of AODV is not changed but to create mesh structure and establish multiple paths, slight modifications has been done to the route reply procedure of AODV. In AODV-BR, nodes can overhear the packet transmission of neighboring nodes. When a node which is not a part of primary route, overhears the packet transmitted to other node by the neighboring node on primary path, it records that neighbor as the next hop to the destination in its alternate routing table. Primary path is setup when RREP reaches to source from destination and used for data transmission. All the nodes become part of mesh, which has an entry of destination in their alternate route table. Therefore, primary path and alternate routes together form a mesh structure which looks like fish bone shown in fig 1.

AODV-BR scheme effectively used when breakage of primary path is detected on which data packets are transmitted. Whenever a link breakage is detected by a node, it starts one hop data broadcast with its immediate neighbors. In this procedure, link disconnection is specified in the header of data packet by the node. When neighboring nodes receive this packet, they check their alternate route table for the entry to this destination and unicast the packet to their next hop. Hence, data packets are not dropped when route breaks and can be delivered to one or more alternate routes. AODV-BR have better throughput than AODV. AODV-BR is effectively and efficiently used in lightly loaded networks because increase number of packet results in collision and contention problems.

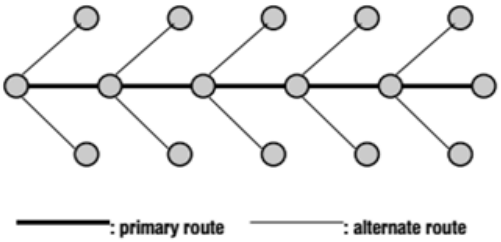


Fig 1. Multiple routes forming fish bone structure

### *B. AODV-ABR*

AODV-ABR is AODV with adaptive backup routing proposed by Wei Kuang Lai, Sheng-Yu Hsiao, Yuh-Chung Lin [7]. This scheme modifies AODV-BR scheme by constructing alternate routes, by overhearing RREP packets as well as data packets transmitted from the neighbouring nodes. This mechanism maintains the hop count information in both primary and alternate routing table. It also adds the hop count information in the header of each packet.

When a node detects link break in AODV-ABR, it performs handshake process with immediate neighbours instead of one hop data broadcast. The handshake process consists of two one hop control signals which are backup route request (BRRQ) and backup route reply (BRRP). BRRQ is a broadcast message and BRRP is a unicast message. This process is explained in fig 2.

When link break occurs between node B and C, node B will broadcast one hop BRRQ to its neighbours. Neighbour node E and F have the route to destination. They reply with a one hop BRRP signal which include hop count of destination to node B. Node B will choose any one node E or F as the next hop to the destination, which is based on the minimum hop count and transmit the packet through the route.

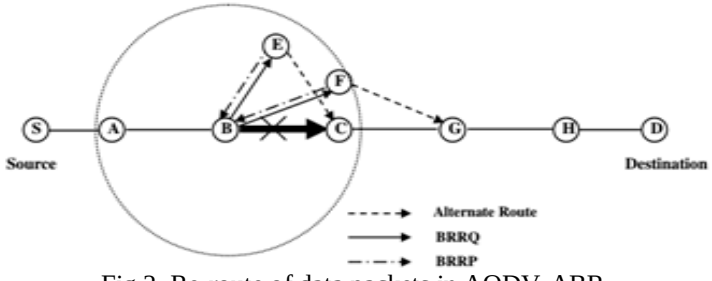


Fig 2. Re-route of data packets in AODV-ABR

 

AODV-ABR uses ageing technique for alternate route maintenance. An alternate route information will be renewed for a time period, after the interval expires node removes alternate route entry from the alternate route table. AODV-ABR is adaptive to variations of network topology and has low control overhead.

### *C. AODV-ABL*

AODV- ABL scheme is a combination of AODV- ABR and local repair algorithm [7]. It is proposed to increase the searching range of repair which is wider in AODV-LR (local repair) [29]. It has a greater tendency to find alternate routes than AODV-ABR. According to AODV-ABL scheme, when distance between broken link and destination is less than MAX_REPAIR_TTL hops then it repairs the link by broadcasting RREQ control signal. If the distance between broken link and destination is larger than MAX_REPAIR_TTL hops, then AODV_ABL repair the link by handshake process with the help of neighbours. AODV-ABL transmit packet by using either local repair or handshake process when route breaks. AODV-ABL have the advantage of both AODV-ABR and AODV-LR scheme which provide high stability to mobile node connections and achieve highest performance under high node mobility.

### *D. AODV-GBR*

AODV with guaranteed bandwidth route (AODV-GBR) was proposed by Kilhung Lee [10], modifies the route request and route reply messages to create the backup path with required service quality. In this scheme, additional messages and various AODV extensions are used to setup QOS path such as route repair request message, route repair reply message, route clear message and status message.

A RREQ message originates from source and broadcasted to all the nodes in the network. Each neighbouring node of source adds and updates the routing table and re-forward the message again if the node can provide required quality of service which is specified in the request message. After receiving RREQ message, destination replies with RREP message to the source. When the intermediate node receives RREP message, it selects one of the route which provide required quality of service and has minimum hop count. After selecting the route, node sends the RREP to the next hop of the selected route. After sending the RREP message, node broadcast the status message to all the nodes which contains the information of new route. All the neighbouring nodes receive this message, stores the route as backup path in their routing table.

When a node detects a link failure and data cannot be send, then AODV-GBR starts the repair procedure using a one hop search scheme. In this process, each node search for one hop neighbours and allow maximum two hop local restoration. It includes two one-hop signals for repair procedure are route repair request message and route repair reply message. AODV-GBR has better data delivery ratio and low end to end delay.

### *E. AODV-BRL*

AODV-BRL is backup routing scheme with LHF, is an adaption of AODV-BR scheme, proposed by Liu Yujun and Han Lincheng [12]. It creates alternate routes by extended HELLO messages as well as RREP messages. AODV-BRL broadcast RREP messages and extended HELLO messages in one hop distant neighbouring nodes. Nodes which receive RREP packet creates alternate route table with the destination node and next node information. Therefore, alternate routes are established by route reply packets and mesh structure is created by extended HELLO messages. During route reply phase, when reverse routes are setup between source and destination, intermediate nodes of the path adds the destination node information in the extended HELLO message and send it to neighbours. Neighbouring node creates the alternate route table and enters the destination node and the next node information in it from the received extended HELLO message.

To repair the broken links, AODV-BRL proposed extending routing tables which stores the multi-hop routing information. It helps the intermediate nodes to find the substitute node to replace the unreachable node. AODV-BRL reduces the repair delay by determining the optimal substitute node with the help of least hop count first (LHF) principle. This principle chooses the nodes as optimal substitute node, whose length to the destination is minimum. AODV-BRL has higher packet delivery ratio and low routing overhead than AODV-BR.

## III. COMPARISON OF VARIOUS AODV BASED SCHEMES

General attributes and performance measures of various AODV based backup routing schemes are analyzed and compared in the following tables. Table I describe general characteristics of these schemes such as failure handling mechanism, alternate path mechanism etc. It describes and differentiates the routing process of different schemes.

In table II, these backup routing schemes are compared on basis of different performance metric such as throughput, end to end delay and control overhead. This table shows their performance in increasing order from I to VI, where I stands for lowest values of performance parameter and it increases to VI which is highest values. For best performance, scheme should exhibit high throughput, low end to end delay and low control overhead. Here, Column I shows AODV have low throughput, low end to end delay and low control overhead while column VI shows AODV-ABL have highest throughput, high end to end delay and high control overhead.

Table I: Comparison of Various AODV Based Schemes

| SCHEME | AODV-BR | AODV-ABR | AODV-ABL | AODV-GBR | AODV-BRL |
|---|---|---|---|---|---|
| **Mesh structure** | Yes | Yes | Yes | No | Yes |
| **Multipath** | Yes | Yes | Yes | Yes | Yes |

 

| | | | | | |
|---|---|---|---|---|---|
| **Extra control message** | No | Yes | Yes | Yes | Yes |
| **Establishment of Alternate path** | Overhear RREP messages | Overhear RREP and data packets | Overhear RREP and data packets | Use new message type and extensions | Use RREP message and extended hello message |
| **Link failure handling mechanism** | One hop data broadcast | Handshake process | Local repair or handshake process | One hop search method with two hop local restoration | Extended routing table and LHF principle |
| **Adaptive** | No | Yes | Yes | No | Yes |
| **Advantage** | Suited for lightly loaded networks | Use ageing technique for alternate route maintenance | Suited for high load networks | Provide required quality of service | node choice policy to find the optimal path. |

Table II: Performance Analysis of AODV Based Schemes. Schemes are ranked in increasing order from I to VI.

| PARAMETER | I(Lowest) | II | III | IV | V | VI(Highest) |
|---|---|---|---|---|---|---|
| **Throughput** | AODV | AODV-BR | AODV-BRL | AODV-ABR | AODV-GBR | AODV-ABL |
| **End to End delay** | AODV | AODV-BRL | AODV-GBR | AODV-BR | AODV-ABR | AODV-ABL |
| **Control Overhead** | AODV | AODV-BRL | AODV-BR | AODV-GBR | AODV-ABR | AODV-ABL |

*Throughput* refers to the amount of data received by the node. In this table, AODV-ABL shows the best performance by having maximum throughput than AODV-GBR and AODV-ABR in high mobility. AODV-BR and AODV have minimum throughput.

*End to end delay* is the average time of the data packet to be successfully transmitted from source to destination. At high node mobility, AODV has lowest end to end delay. AODV-ABR and AODV-ABL shows highest end to end delay as they try to repair the broken routes locally.

*Control overhead* is the total number of routing packets transmitted by the routing protocol. AODV has lowest overhead as it does not repair the broken links while AODV-ABR and AODV-ABL have the highest overhead due to broadcast nature of local repair schemes.

## IV. CONCLUSION

In this paper, we have compared and analyzed various AODV based schemes. These schemes incorporate multiple alternate paths by using broadcasting nature of wireless nodes in AODV routing protocol. Most of them utilizes mesh structure by overhearing AODV messages while some of them added various extensions to create alternate paths. These schemes are compared on basis of general features and characteristics in table I. In table II, various performance parameters like throughput, end to end delay and control overhead is used to analyze and compare their performance in high node mobility with each other. It is observed from the comparison tables that AODV-ABL performs best among all other schemes. It has the highest throughput but also has low end to end delay and control overhead due to reparation process of broken routes. AODV protocol performs worst as it simply dropped the data packet when routes disconnect.

These schemes are appropriate for routing in MANET as it utilizes the alternate routes created during the path discovery phase to deliver data packets to the destination. Most of them are adaptive to changing topology and also provide required quality of service. These schemes efficiently utilize the advantage of broadcast nature of wireless mobile node in mobile ad hoc network.

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