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Survey on MANET Routing Protocol and Multipath Extension in AODV

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ABSTRACT
The innovative ideas to overcome the problems in case of routing in a wireless platform are key points that can potentially raise the throughput of the network in different scenarios. The protocols introduced by IEEE 802.11s draft are divided into Proactive, Reactive or Hybrid Mesh categories. One key popular protocol is called ad-hoc On Demand Vector (AODV) [51] protocol which is based on on-demand path selection in which the tree size is increasing in a Proactive manner. As competent, AOMDV [52] protocol focuses on Ad-hoc on demand Multi-Path Distance Vector routing challenging AODV in performance. In this synopsis, we propose to enhance the Ad hoc On-demand Multipath Distance Vector (AODV) routing protocol for MANETs to a delay-aware multi-path protocol. The focus area is to improve the QoS in MANETs by creating a protocol, which considers delay requests of real-time multimedia applications (voice and video) in making routing decisions. For this we will use NS-2 (Network Simulator-2) as test bed.

Keywords
Wireless Sensor Network, Adhoc On Demand Distance Vector, Network Simulator.

1. INTRODUCTION
MANET is a self-organized, decentralized wireless network with mobility as core functionality. The network is ad hoc because it is built spontaneously as devices are connected, and so the determination of which nodes forward data is made dynamically based on the network connectivity. This is in contrary to wired networks where routers perform the task of routing. It is also different from managed (infrastructure) wireless networks, in which a special node known as an access point manages communication among other nodes.

In modern era, there is a tremendous growth in the sales of communication with computation capability devices such as Laptop, mobile, portable computers etc. Recently many network researchers are studying networks based on new communication techniques, especially wireless communications. Wireless networks allow hosts to travel without the constraints of wired connections. Hosts and routers in a wireless network can move around. Therefore, the network topology can be dynamic and unpredictable. Traditional routing protocols used for wired networks cannot be directly applied to most wireless networks because some common assumptions are not valid in this kind of dynamic network. For example, one assumption is that a node can receive any broadcast message sent by others in the same subnet. However, this may not be true for nodes in a wireless mobile network. The bandwidth in this kind of network is usually limited. Thus, this network model introduces great challenges for routing protocols.

Generally speaking, traditional routing protocols that are used in wired networks can support routing in fixed wireless networks and mobile networks with fixed access points. Only one-hop routing is required over a link in a wireless network with fixed access points and many fixed wireless network. Routing in mobile ad hoc networks and some fixed wireless networks use multiple-hop routing. Routing protocols for this kind of wireless network should be able to maintain paths to other nodes and in most cases, must handle changes in paths due to mobility. Traditional routing cannot properly support routing in a MANET.

For this MANET uses different types of protocol such as DSR, DSDV, AODV, ZRP, AMRIS, and AM Route etc. Ad Hoc On-Demand Distance Vector Routing Protocol (AODV) is a routing protocol for mobile ad hoc networks. AODV [27] [28] is most popular routing protocol among others. It is On-demand type routing protocol and its performance is better than other routing protocols in MANET environment.

This research paper focus on AODV routing protocol to enhanced the break avoidance mechanism. AODV is an On-demand type routing protocol and most of on-demand routing protocols reestablish a new route after a route break will occur [29]. The simplest method to avoid route breaks each intermediate node on an active route sense danger link failure and notifies to an upstream node and re-builds a new route before a route break [30].

We proposed enhanced route maintenance and break avoidance. In this method we add new metrics (behavior) to existing [8] for better performance in high mobility environment.

With the rapid proliferation of wireless networks and mobile computing applications, Quality of Service (QoS) for mobile ad hoc networks (MANETs) has received increased attention.

2. TERMINOLOGY AND BACKGROUND
Because radio range is usually limited and the network components may have some mobility, the topology of a wireless network can vary with time. According to the relative mobility of hosts and routers, there are three different types of wireless networks.

1. **Fixed wireless network**. Fixed hosts and routers use wireless channels to communicate with each other and form a fixed wireless network. An example is a wireless network formed by fixed network devices using directed antennas, as shown in Figure 1.

2. **Wireless network with fixed access points**. Mobile hosts use wireless channels to communicate with fixed access points, which may act as routers for those mobile

hosts, to form a mobile network with fixed access points. An example is a number of mobile laptop users in a building that access fixed access points, as illustrated in Figure 2

3. **Mobile ad hoc network**. A mobile ad hoc network is formed by mobile hosts. Some of these mobile hosts are willing to forward packets for neighbors. Examples include vehicle-to-vehicle and ship-to-ship networks that communicate with each other by relying on peer-to-peer routings, as shown in Figure 3.

A MANET (Mobile Ad Hoc Network) consists of a collection of mobile nodes communicating in a multi-hop way without any fixed infrastructure. MANET has the following properties-

1. No fixed Infrastructure.
2. Decentralized.
3. Self configuration
4. Dynamic nature

There are different criteria for classifying routing protocols for wireless ad hoc networks. For example, what routing information is exchanged; when and how the routing information is exchanged, when and how routes are computed and so on [1]. Figure 1 show the MANET environment.

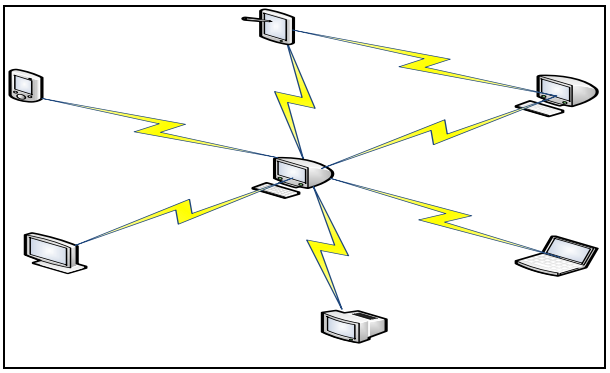

Figure 1. MANET

Pro-active (table-driven) routing

Pro-active protocols (or table-driven protocols) work in a way similar to wired networks: they try to maintain an up-to-date map of the network, by continuously evaluating known routes and attempting to discover new ones. This way, when a path to a destination is needed at a node, or a packet needs to be forwarded, the route is already known and there is no extra delay due to route discovery [2].

2.1 Reactive (on-demand) routing

Re-active protocols (on-demand protocols) only start a route discovery procedure when needed. When a route from a source to a destination is needed, some sort of global search procedure is started. This does not require the constant updates being sent through the network. . In some cases the desired route(s) are still in the route cache maintained by nodes. When this is the case there is no additional delay since routes do not have to be discovered.[2] It is the responsibility of the route request receiver node to reply back to the source node about the possible route to the destination. The source node uses this route for data transmission to the destination node.

2.2 Hybrid (both pro-active and reactive) routing

Hybrid protocols combine the advantages of both pro-active and re-active routing, by locally using pro-active routing and inter-locally using re-active routing. This is partly based on the assumption that most communication in mobile ad hoc networks takes place between nodes that are close to each other, and the assumption that changes in topology are only important if they happen in the vicinity of a node. When a link fails or a node disappears on the other side of the network, it has only effect on local neighborhoods, nodes on the other side of the network are not affected.[2]The Ad Hoc On-Demand Distance Vector (AODV) [25], Routing Protocol is a reactive routing protocol. AODV is the use of a destination sequence number for each routing table entry. The sequence number is created by the destination node. Sequence numbers are used by other nodes to determine the freshness of routing information [3]. There are following Operation performs by AODV protocol. RREQ – Route request, RREP – Route reply, RERR – Route error

RREQ – Route Request: A RREQ message is broadcasted when a node needs to discover a route to a destination. When a route is not available for the destination, a route request packet (RREQ) is flooded throughout the network. The RREQ contains the following fields. Figure 2.1 shows the propagation of RREQ.

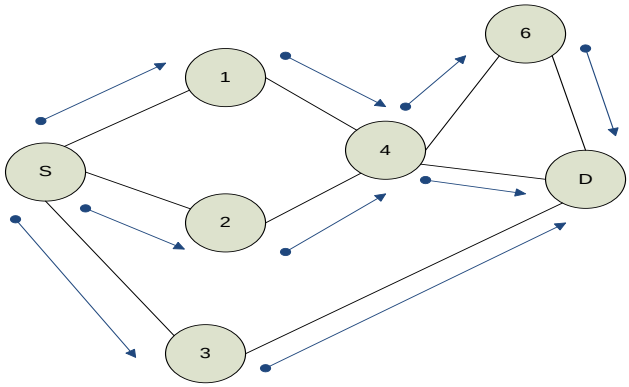

Figure 2.1 RREQ Propagation

The request ID is incremented each time the source node sends a new RREQ, so the pair (source address, request ID) identifies a RREQ uniquely. On receiving a RREQ message each node checks the source address and the request ID. If the node has already received a RREQ with the same pair of parameters the new RREQ packet will be discarded. Otherwise the RREQ will be either forwarded (broadcast) or replied (uni-cast) with a RREP message-

•If the node has no route entry for the destination or it has one but this is no more an up-to-date route, the RREQ will be rebroadcasted with incremented hop count.

•If the node has a route with a sequence number greater than or equal to that of RREQ, a RREP message will be generated and sent back to the source [5].

RREP – Route reply If a node is the destination, or has a valid route to the destination, it unicasts a route reply message (RREP) back to the source. This message has the following format [5].

If a node receives a route request for a destination, and either has a fresh enough route to satisfy the request or is itself the destination, the node generates a RREP message and unicasts it back to the source node[4]. Figure 2.2 show the route reply message (RREP) by destination D to source S.

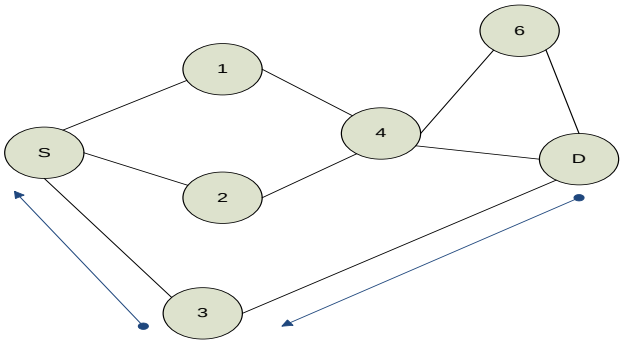

Figure 2.2 Propagation of RREP

RERR – Route error

All nodes monitor their own neighborhoods. When a node in an active route gets lost, a route error message (RERR) is generated to notify the other nodes on both sides of the link of the loss of this link [5].

RREP is forwarded to the source; the Hop Count field is incremented by one at each hop. A node initiates a RERR message in three situations

a. If it detects a link break for the next hop of an active route in its routing table, or
b. If it gets a data packet destined to a node for which it does not have an active route, or
c. If it receives a RERR from a neighbor for one or more active routes

For cases (1) and (2)-

1. The destination sequence numbers in the routing table for the unreachable destination(s) are incremented by one
2. Then RERR is broadcast with the unreachable destination(s) and their incremented destination sequence number(s) included in the packet

For case (3), the node

1. Updates the corresponding destination sequence # and invalidates the route for the destination [4]

Figure 2 show the working or RREQ and RREP of AODV protocol.

2. One advantage of AODV is that AODV is loop-free due to the destination sequence numbers associated with routes. The algorithm avoids the Bellman-Ford "count to infinity" problem [25]. Therefore, it offers quick convergence when the ad hoc network topology changes which, typically, occurs when a node moves in the network [25]. Similar to DSR, poor scalability is a disadvantage of AODV [26].

3. RELATED WORK

Routing is the process of selecting paths in a network along which to send network traffic. Guaranteeing delivery and the capability to handle dynamic connectivity are the most important issues for routing protocols in wireless mobile ad hoc networks. Once there is a path from the source to the destination for a certain period of time, the routing protocol should be able to deliver data via that path. If the connectivity of any two nodes changes and routes are affected by this change, the routing protocol should be able to recover if an alternate path exists. There are some other issues related to routing in wireless ad hoc networks. Whether to consider them depends on the specific environment or application. For example, overhead is particularly important in a wireless network with limited bandwidth [1, 2, 3, 4, 5, and 6]. Power consumption may also be a problem in an ad hoc network with battery-powered nodes [7, 8, 9, 10]. Quality of service may be required in an ad hoc network supporting delay sensitive applications such as video conferencing [11, 12, 13, 14]. A routing protocol may need to balance traffic based on the traffic load on links [15, 16]. Scalability of routing protocols is an important issue for large networks [17, 18]. The routing protocol may need to implement security to protect against attacks, such as sniffer, man-in-the-middle, or denial of service [19, 20, 21]. Routing protocols may rely on information based on other layers. For example, the Global Positioning System (GPS) can be used in wireless ad hoc networks deployed in battlefields or connecting vehicles [22, 23]. Mobility prediction can improve routing in wireless networks with known movement patterns, such as the IRIDIUM system satellite network [24].

Survey on Multipath AODV:

[29] The multipath routing technique is a preferred solution for sensor networks with objectives to achieve better energy efficiency and network robustness in case of node failures. In multipath node search more than route to destination (multipath) these multiple paths served many purpose such as either for reliable data delivery using alternate route, i.e., a node switches to an alternative path when the current path fails or simultaneously for load balancing by using several paths at the same time [2]. AODV [25] most popular protocol among MANET Routing scheme, lots of modification and enhancement had been applied on it for better performance since its development.

In AODV-BR [30] each neighboring node of the primary route maintains a backup route to the destination. When a link in the primary path fails, data packets are sent to a neighbor who salvages the packet and sends it to the destination. It is not really a multipath protocol in the sense that nodes only maintain one path per destination.

CHAMP [31] is a similar but more sophisticated protocol. Each node maintains multiple shortest loop-free paths to the destination. When a node can't forward a data packet the upstream node salvages the packets and sends them via an alternative route. Neither AODV-BR nor CHAMP considers path disjointness.

[32]The bigger challenge to provide QoS in MANET environments are dynamic variation of network topology, common and shared radio channel, limited resource availability (energy) and ad hoc nature. It is due to the nodes mobility results in continuously evolving new topologies and to the MANET nature. [33] To avoid frequent route discovery and maintaining QoS in MANET, various multipath routing protocols has been proposed based on the existing unicast

path routing protocol in ad hoc networks. Ad hoc On-demand Multipath Distance Vector (AOMDV) [34] is one of extensions of Ad hoc On Distance Vector (AODV) [25].

To decrease route discovery rate in single path routing, some multipath routing protocols have been proposed to extend AODV [25], [30], [34] and [35]. However, [25] does not perform well by increasing the number of communication sessions. [4] Selects node-disjoint paths, and it only performs well with high density of mobile nodes. [34] Tries to find link-disjoint paths. But it cannot always find all of existing reverse paths.

[36] Proposed a new concept of multipath routing with load balancing capability based on periodical packet distribution rate control. Packet distribution rate of each route adapts to delay cost calculated by using channel utilization of base stations on this route.

Author of [37] modified to AODV-2T [38].The major cause of link failures in Ad hoc wireless network is the dynamic movement of the mobile nodes themselves and the other might be battery running out. AODV-2T [38] is an improved AODV designed to compromise this problems by applying a conservative and circumspect concept. By investigating received RF signal and the battery power, AODV-2T could overcome the problem by preparing a backup route just-in-time before link breaking. This makes it is able to switch packet transmission to the backup route without any delay with a bit of additive overhead. Although AODV-2T performs rather well compared to the early proposed protocols in term of overhead and number of route break but AODV-2T is not capable to construct a multi-hop backup route. Then [37] add multi hop features on it and named it multi hop AODV-2T.

[38] Concluded that, in the scenarios where the network is loaded at a high density and average mobility, the contribution of the use of Multi-Path Routing Protocols is very impressive compared to conventional AODV and DSR Protocols which would result in poor performance of network in congestion, making the topology not reliable and low in capacity. Improved results from the simulation of high load and density networks versus low load and density networks for Multi-Path Routing Protocols allowing ease congestion, increasing reliability and network capacity by increasing the rate of Successfully Delivered Packets and the Total Throughput of the network. The only drawback of Multi-Path Routing Load Balancing Protocols such as AOMDV and MSR is the use of a large number of control packets for calculating and maintaining multiple routes between a source and destination but such disadvantage is minimized in the network conditions as the rate of control packets generated by MSR or AOMDV is slightly higher than the rate generated by the Single-Path protocols at high load and density nodes.

[39] Selection of route is determined by the metrics used in the routing protocol. Initial protocols use hop count as a primary metric [40] [41], although delay often implicitly impacts route choices [40]. More recent protocols suggest the use of extended metrics such as signal strength [42], stability [43] and load [44] [45], all of which impact performance and so implicitly impact 3energy consumption [46]. Energy can also be used explicitly to choose routes that minimize energy consumption [47] [48] or avoid nodes with limited energy resources [49] [50].

4. PROPOSED SOLUTION

In this synopsis, we propose to enhance the Ad hoc On-demand Multipath Distance Vector (AODV) routing protocol for MANETs to a delay-aware multi-path protocol. The focus area is to improve the QoS in MANETs by creating a protocol, which considers delay requests of real-time multimedia applications (voice and video) in making routing decisions. For this we will use NS-2 (Network Simulator-2) as test bed.

The project is implementing multipath extension with QoS to DYMO. DYMO_MQ is an on-demand multipath routing protocol which can discover multiple loop-free node disjoint paths with QoS constraints that can be used in networks with limited resources such as bandwidth, energy consumption and computational power.

4.1 Algorithms

4.1.1 Multiple Route Discover Phase:

In this phase T_delay is calculated which is maximum delay for a transmission from a source node or an intermediate node forwarding the RREQ packet to the sink node. The T_delay can be used to decide the maximum hop can be visited in idle network where node movements are predicted as WSN is considered to be not a rapid changing topology network.

Once the delay is calculated and then the T_error is calculated as show in the paper. T_error gives the current situation of the route. This helps in deciding the node to be selected or not.

4.1.2 Route Maintenance

RERR packet is broadcasted whenever there is breakdown in the link. This help to maintain the route and reduce the errors in communication. The link breakdowns are updated into the routing table so that the route selection is optimized and QoS is improved.

The tool we use for simulation is **NS-2.**

5. CONCLUSION

In this paper, we surveyed on different reactive routing protocols of MANET. Like AODV, AOMDV. Then we proposed our solution to improve multipath functionality in pure AODV protocol that will help to improve the performance of routing protocol for selecting best route and identification of misbehaving nodes. Objective is to reduce the frequency of route discovery providing resilience (fault tolerance) that is especially helpful in scenarios with node mobility in WSN and the assurance of quality of service (QoS) defined by the delay and the error rate metrics in order to improves the reliability of data communication and prolong the network lifetime.

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