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COMPARISON OF ENERGY EFFICIENT ROUTING FOR MULTIPATH PROTOCOLS IN MOBILE AD-HOC NETWORK

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Abstract- This paper shows four key Mobile Ad-hoc Network (MANET) protocols that mobile nodes can use: AODV, AODVM, ZD-AOMDV, and MMRE-AOMDV. However, one of the key limits of this goal is energy support. Indeed, the fundamental constraint in wireless communications is the short lifespan of mobile nodes, whose energy supply is frequently electric, and their capacity is limited. This constraint is much more relevant in MANETs, as mobile nodes use their energy to route data packets to other mobile nodes. Energy consumption is a crucial component in the life of the network and mobile nodes in MANET because resources are limited. The energy constraint in multipath routing is presented, along with a summary of the main energy-constrained routing methods in the literature. The major goal of these protocols is to boost MANET performance by extending the network's life as much as feasible. We will examine the performance of routing protocols based on the Ad hoc On-demand Distance Vector(AODV) in terms of loss path and energy efficiency. Then, talk about the crucial features in the routing protocols that can affect energy consumption. This will be the starting point for presenting and analyzing simulations.

Keywords: Routing Protocol, AODV, MANET, Network Lifetime, and Energy Efficiency.

1. INTRODUCTION

The unstable topology and the lack of a centralized routing organization in [1] have caused challenges in these networks. Many MANET protocols are trying to provide a standard routing algorithm that can balance the important criteria of a route. Most use step count (AODV) [2] and DSR [3] prominent routing protocols as the basis of path selection, but the time step count method exists in congestion paths and in bottleneck networks, so it is not possible. Therefore, the metric of a selected route must be such that it considers all aspects of a network, whether from the node itself, the neighboring node, or the selected route, etc. Traditional ad hoc routing protocols can be classified into two types. For example, On-Demand or Reactive or active and Proactive type of protocols. The type of active routing maintains the consistency of each node's routing information by advertising it throughout the network.

However, using the information gathered at the global level, it is always possible to find a route to the destination (if any). The active method generally requires many packet transfers, which consume significant nodes.

In contrast, Only when the source requests a reactive protocol can discover a route from the source to the destination [4]. The use of appropriate metrics can greatly impact the efficiency of path selection [5]. Most energy consumption routing protocols consider the selection of the appropriate metric to select a route with high performance. Therefore, most of the structure is in this AODV Multipath routing protocol, the traditional protocol of the article, by examining some energy consumption routing protocols. We will do a comparative study and evaluate the efficiency of each of the protocols. In the simulation study, we will express the results. AODV is the organization protocol.

2. ENERGY CONSUMPTION IN MANET

Energy consumption [2] is a primary criterion in routing protocols for MANET; the mobile nodes operate with electric batteries whose capacity is limited. Also, changing or recharging batteries in sensitive situations is often difficult (e.g., battlefields, sinister areas, etc.). In MANET, mobile nodes generally use stand-alone energy storage equipment to provide energy and therefore have a limited lifetime [3]. In fact, in MANET, the exhaustion of the energy of a node affects its capacity to receive or transmit and its ability to convey data to the other nodes, which can reduce the node's performance. Network or isolate specific segments of the network [4].

3. MOBILE NODE AND ENERGY CONSUMPTION

A mobile node typically possesses several hardware components that consume energy: the processor, disk, display, and communication interface without the need for any other hardware. According to the interface, wireless consumes up to 50% of the global energy of the mobile node [5]. The low-energy routing protocols proposed in the literature for MANET seek either to minimize the energy dissipated during active communications (during transmission and reception operations, including routing), or Consumed in idle periods (when the interface does not disregard any communication) [6].

4. MULTIPATH ROUTING PROTOCOLS WITH ENERGY EFFICIENT

The main purpose of a routing protocol is to ensure routing in a network for as long as possible. This goal can be accomplished by minimizing the power of the mobile node not only during active communication but also in inactive mode [7]. The routing metric is based on energy in the main reagent multipath routing protocol. On the one hand, the main objectives of these protocols are to ensure the maintenance of the MANET's connectivity and to manage better the entire network's energy consumption [8]. On the other hand, they improve the network's life; they are fable and enhance its performance. These protocols are AODV, AODVM, ZD-AOMDV, and MMRE-AOMDV.

4.1. The AODV Protocol

The routing protocol with the AODV [9] is a unicast reactive routing protocol. It is considered an improvement of the Destination-Sequenced Distance-Vector (DSDV) protocol [10]. It creates a path to a destination node on demand, unlike DSDV, which maintains a path to all known destinations. Once the path is discovered and valid, the nodes not on the active path do not keep any routing information and do not participate in any update exchange. Because of the mobility of the nodes in the MANET, the paths frequently change so that the paths maintained by specific nodes become invalid. A sequence number makes it possible to use the most current paths (new routes) to force the updates if necessary and avoid the formation of routing loops [11].

AODV distributes route maintenance by retaining a routing table at each intermediary node along the found path. This consists of broadcasting to the entire network an RREQ (Route Request) message propagated step by step by all the network nodes. The RREQ message contains the number of hops made from the source in its header. Each node participating in the propagation of this message updates its routing table to the source and propagates the request by incrementing the "hop count" field of the message header. The message arrives there if the destination is accessible, possibly by several paths. The destination responds to the request with an RREP (Route Reply) message. Figure 1 shows an RREQ to the destination, responds with an RREP, and describes this path discovery process.

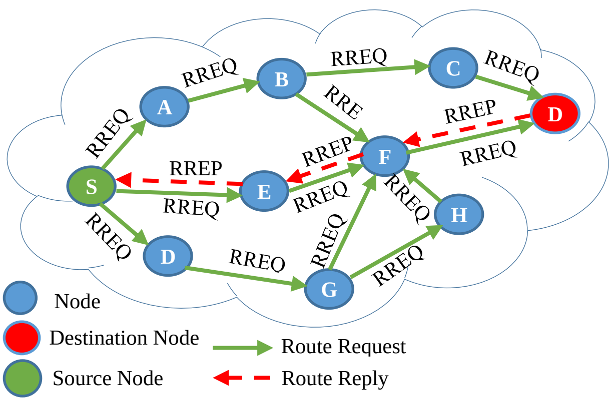

Figure 1. Multipath routing in AODV [10]

4.2. AODVM Protocol

Ad hoc On-demand Vector Distance Multipath (AODVM) [11] is the first modified version of the AODV protocol capable of constructing multiple paths with disjoint nodes between a source and a destination. The method of calculating paths with disjoint nodes is the subject of several articles, particularly thanks to the independence property provided by this type of path. AODVM is said to be more fable and performs better than AODV. AODVM is a multipath routing protocol that aims to find paths with disjoint nodes. It is based on AODV. The RREQ message distribution with the nodes' energy follows the same rule as the AODV. Each node maintains a table containing all the neighbors and the corresponding path costs (in several hops) to the source. Figure 2 shows an RREQ to the destination responds with an RREP, and AODVM builds roads via the distribution.

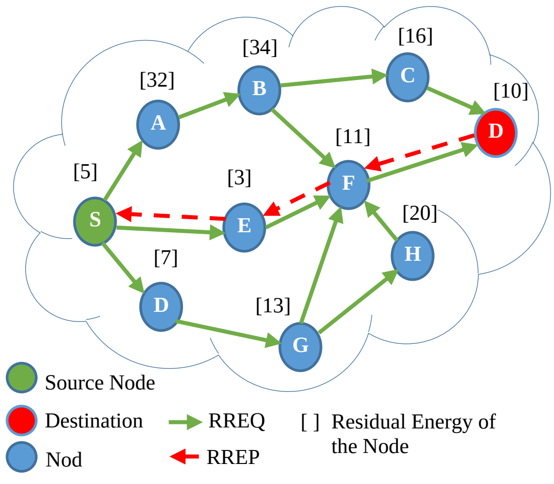

Figure 2. AODVM builds roads via distribution [11]

4.3. The MMRE-AOMDV Protocol

Maximal Minimal Residual Energy Ad hoc On-demand Multipath Distance Vector (MMRE-AOMDV) [12] is a routing system that uses the maximum of the minimums of the nodes' leftover energy. It sets an energy consumption balance for all network nodes.

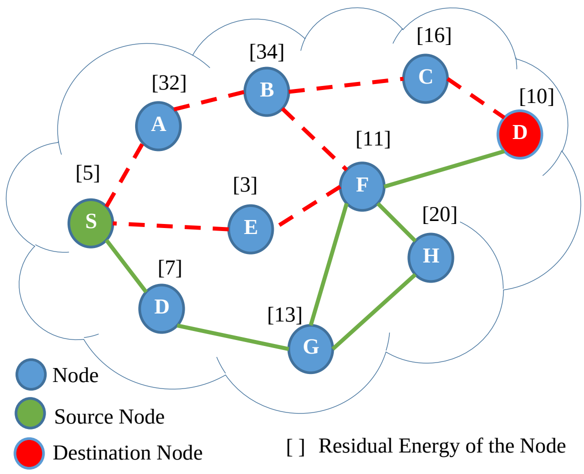

Figure 3. Discovery of paths [12]

The MMRE-AOMDV has two basic goals: first, determine the least residual energy of the nodes for each route during path discovery. Second, to send data packets, arrange the nodes' remaining energy in decreasing order and choose the path with the greatest residual energy. Figure 3 depicts the finding of pathways.

4.4. The ZD-AOMDV Protocol

Zone-Disjoint Ad-hoc On-demand Multipath Distance Vector (ZD-AOMDV) [13] identifies distinct pathways between a source and a destination to simultaneously transmit data packets over these paths. Because of the processes of access to the sharing channel in networks without wireless, the discontinuous pathways are not independent of one another. The number of active neighbors is computed using a well-defined technique. The suggested method counts the number of active neighbors for each route and selects the pathways with the fewest active neighbors for data transmission. A node's active neighbors are nodes that have previously received the RREQ request. The ZD-AOMDV routing protocol is based on the AODV fundamental routing protocol. Figure 4 shows the RREQ receipt by destination.

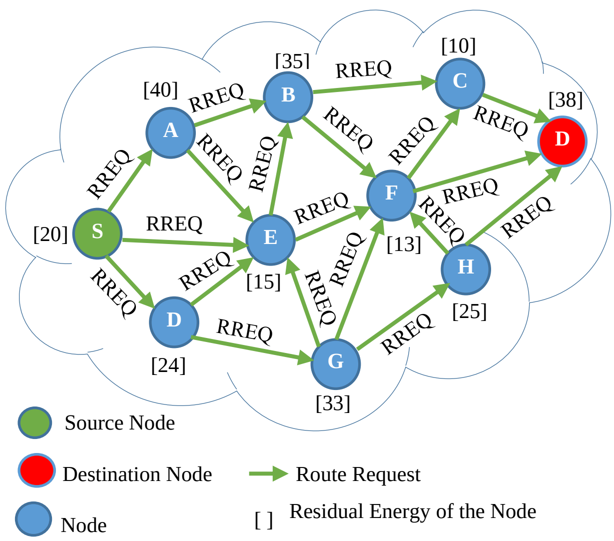

Figure 4. Receipt of RREQ by destination [13]

5. COMPARISON AMONG PROTOCOLS IN TERMS OF ENERGY CONSUMPTION

The Management of invalid or congested roads. The possibility of AODVM offering multiple routes is an important asset when congested roads are detected [14, 15]. On the other hand, considering mobility, the problem of obtaining invalid roads remains virtually the same as with the AODVM cache: this can prevent the use of a congested link but not the use of invalid roads [16, 17]. On the contrary, the more possible paths saved in the cache, the greater the number of unsuccessful attempts to join the destination [18, 19].

So hostile cache and multiple routes significantly improve AODVM but may sometimes have perverse effects in mobility situations [20]. In these same situations, AODV seems better able to control invalid paths more finely since it uses the expiratory route timers that periodically purge routes considered too old and force new road discoveries (sometimes unnecessarily) [21]. This device is also available in MMRE-AOMDV and ZD-AOMDV since, in these protocols, a routing table is constructed by transmitting update messages (periodically and when communication has begun) [22, 23]. The primary elements can be described in Table 1.

Table 1. Comparison of the characteristics of the four protocols

Characteristics	AODV	AODVM	ZD-AOMDV	MMRE-AOMDV
Topology	Full	Full	Full	Full
Computational Complexity	$O(X)$	$O(E)$	$O(2d)$	$O(2N)$
Control Packet Overhead	Low	Low	High	Moderate
Distributed	Yes	Yes	Yes	Yes
Forwarding Strategy	Greedy Forwarding	Store and Forward	Multipath	Multipath
Route Updates	Periodical	Periodical	Periodical	Periodical
Recovery Strategy	Range Forwarding	Range Forwarding	Flooding	Flooding
Broadcast	Full	Full	Full	Full

6. SIMULATION AND EXPERIMENTAL RESULTS

The simulation parameters accustomed to estimating routing protocols' performance are shown in Table 2.

Table 2. Simulation configuration and setup for MANET

Parameter Name	Value
Environment Size	840 m x 840 m
Simulator Version	NS 2.35
Number of Nodes	0, 10, 20, 40, 50, 60, 70, 80
Simulation Time	40 minutes (2400 sec)
Maximum Speed of Nodes	5 m/s
Mobility Model	Random Waypoint
CBR Packet Size	50 KB
Packets Rates	2 packets/s
Routing Protocols	AODV, AODVM, ZD-AOMDV, MMRE-AOMDV
Transport Layer	TCP, UDP
Traffic Type	CBR, FTP
Initial Energy	25-50 joule
MAC Protocol	IEEE 802.11
Type of Interface Queue	Queue/ PriQqueue / DropTail
Transmit Energy	1.4 Joule
Antenna Type	Antenna/Omnidirectional

Figure 5 depicts the energy usage of routing systems as node speeds rise. These findings suggest that procedures like AODV and MMRE-AOMDV use less energy than other protocols. When there is no traffic on the network, the AODV and MMRE-AOMDV protocols do not consume. In contrast, other protocols consume energy constantly by route calculations, even if no packet is sent. The AODV and MMRE-AOMDV protocols are thus less sensitive to the displacement of the nodes. In addition, setting up new multipoint relays when the network topology changes make AODVM a little more consumer than ZD-AOMDV.

Figure 6 shows that the AODV and MMRE-AOMDV protocols still surpass the AODVM and ZD-AOMDV protocols when the number of nodes develops, even if AODV is less stable than the MMRE-AOMDV. But if AODVM consumes a lot, ZD-AOMDV consumes even more and irregularly. The more significant number of nodes, the more the AODVM and ZD-AOMDV protocols suffer update. AODVM reduces the number of broadcasts to the multipoint nodes only, AODVM can surpass ZD-AOMDV. Still, globally, these protocols pose the problem of scalability in an extensive network.

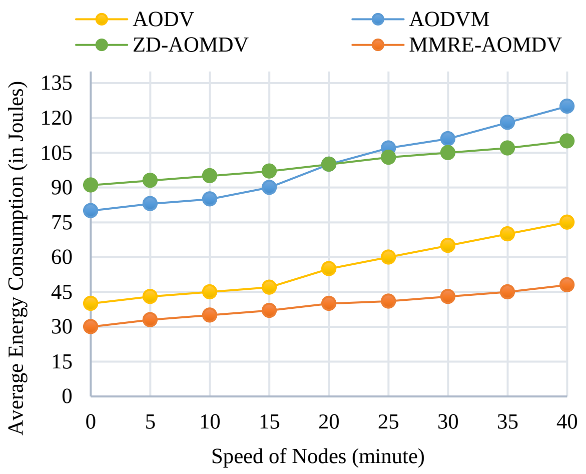

Figure 5. Energy consumption as a function speed of nodes

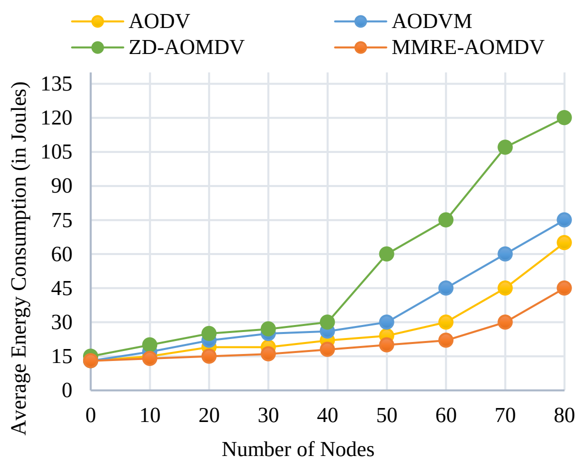

Figure 6. Energy consumption as a function number of nodes

The distinction between protocols disappears when the size of the different networks is. In Figure 7, although MMRE-AOMDV still exhibits regular behavior, AODV consumes more than the AODVM and ZD-AOMDV protocols. With the nodes being more spaced, the routing is more important.

On the other hand, Figure 8 shows a similar routing protocol behavior since the varied parameters relate to traffic, and the results are identical. As traffic increases, ZD-AOMDV and AODVM see their energy decline steadily, with a clear advantage for AODVM. They somehow make setting up the routing table workable since road discoveries have already been made globally.

Finally, in Figure 9, MMRE-AOMDV, even if it is relatively stable when the number of packets grows, reacts badly when the number of sources increases. In the first case, the paths are the same, and the number of packets varies. In the second case, new road discoveries must be initiated to establish communication between the source and its recipient. On a larger scale, the same problem appears with AODV since AODV also shows its weaknesses when the traffic grows and even more blatantly than with MMRE-AOMDV.

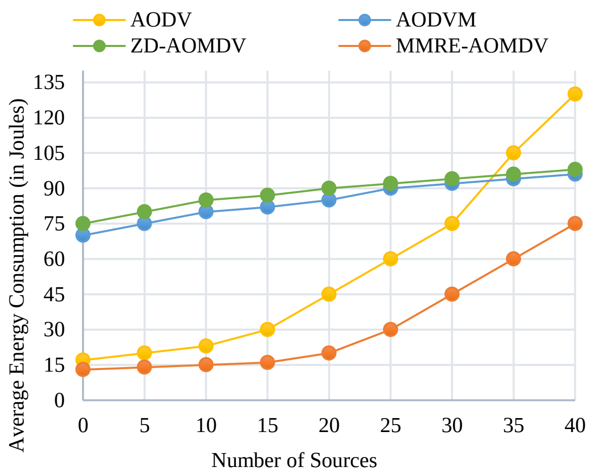

Figure 7. Energy consumption as a function size of network

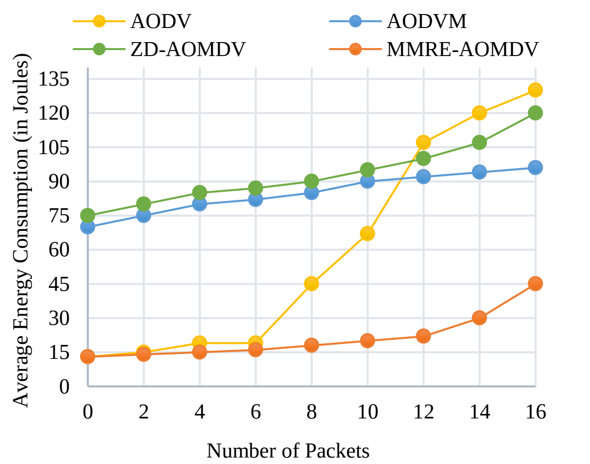

Figure 8. Energy consumption as a function number of packets

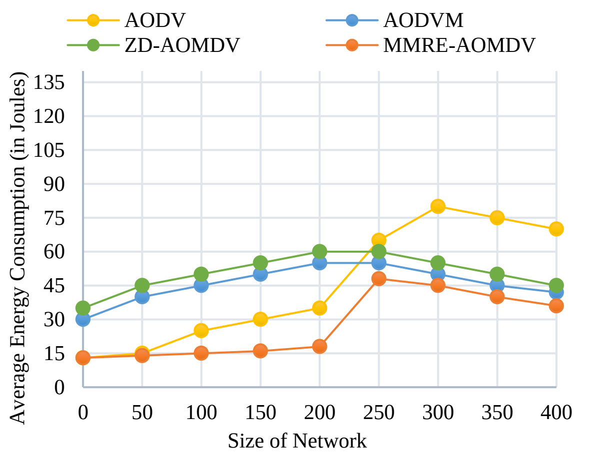

Figure 9. Energy consumption as a function number of sources

The ZD-AOMDV is efficient in a predictable but ineffective scenario in a high mobile scenario. AODVM is a good compromise because it never has the worst results (but never the best ones). MMRE-AOMDV is efficient with a mobility scenario but routing at the source causes a significant overhead increase. Finally, AODV is mobility efficient and partially eliminates routing overheads. Still, road discovery is mandatory and without learning globally, making this protocol more expensive in consumption than MMRE-AOMDV. Since mobile terminals have finite energy due to the limited energy capacity, power consumption should be a critical issue when designing a routing protocol to maximize the energy life and, therefore, the entire network.

7. CONCLUSION

The different energy-efficient routing mechanisms are identified as resource-restricted in MANET, where frequent link failures and path breaks occur. The regular topology changes quickly deplete node batteries with limited power, leading to network partitioning and performance. Our approach is to extend the AODV routing protocol. Alternative paths are discovered in advance. When a break in a link occurs, one of the alternative paths is selected Though at least one other path is available) to transmit the data packets. The path choice depends on a weighted function for all the paths discovered. The path's minimal residual and mean energy are the criteria for calculating this weighted function. The evaluation and studied performance routing protocols by comparing them. According to the simulation, the MMRE-AOMDV protocol uses less energy than the AODV, ZD-AOMDV, and AODVM protocols, improving it to 95%, 90%, 89%, and 85%, respectively. We see that the MMRE-AOMDV protocol provides high reliability and scalability, and compared to the other three routing protocols, the overall performance is somewhat better.

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