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A NOVEL MOBILITY ADAPTIVE ROUTING PROTOCOL FOR MANETS

[1]YOUNES BEN CHIGRA, [2]ABDERRAHIM GHADI, [3] MOHAMED BOUHORMA

[1]Information Systems and Telecommunication Laboratory (LIST), Department of Computer Science,
Faculty of Sciences and Techniques, Abdelmalek Essaadi University, Tangier, Morocco

[2] Information Systems and Telecommunication Laboratory (LIST), Department of Computer Science,
Faculty of Sciences and Techniques, Abdelmalek Essaadi University, Tangier, Morocco

[3] Information Systems and Telecommunication Laboratory (LIST), Department of Computer Science,
Faculty of Sciences and Techniques, Abdelmalek Essaadi University, Tangier, Morocco

E-mail: [1]younesbenchigra@gmail.com, [2]ghadi05@gmail.com, [3]bouhorma@gmail.com.

ABSTRACT

Mobile Ad Hoc network (MANET) is a collection of smart mobile nodes, which form a dynamic and autonomous system. Since mobile nodes are free to move, they cause frequent changes in network topology and decrease the overall network performances. Therefore, the task of finding and maintaining a reliable route constitute the main issue in the design of efficient routing protocol for MANET. In this paper, we introduce a novel Mobility Adaptive AODV routing protocol (MA-AODV), which uses the degree of mobility time variation and the local route repair approach to mitigate the influence of high mobility and improve routing performances. We implemented the MA-AODV on network simulator NS2. Then, we evaluated the performance of MA-AODV and AODV based on node mobility variation such as speed and pause time. The comparison of performance metrics, such as Packet delivery Ratio, Throughput, routing overhead and communication delay demonstrates that MA-AODV outperforms AODV in high mobility environments.

Keywords: *Mobile Ad Hoc Networks (MANET), Adaptive Routing, Mobility, metric, routing performances.*

1. INTRODUCTION

In a few years, advanced communication and networking technologies have occupied a major part our life. This is noticeable in the way people interact, shop and do business. In this context, MANETs have emerged as an intelligent system to offer communication services in the area where there is no pre-established network infrastructure. MANET offers a wide range of applications such as in military communications in battlefields, emergency services like rescue operations [1], [2]. In MANET, limited transmission range of mobile node requires nodes to act as router and cooperate to establish multi-hop path between a pair of source and destination. Therefore, various routing protocols were developed in order to overcome network constraints and guarantee the quality of service required by applications. There are some challenges that make the design of routing protocols in MANET a tough task; for example node mobility causes frequent topology changes and network partitions. In this context, different routing strategies have been adopted. The First strategy named proactive consist of updating the whole topology information. Thus, each node keeps freshest routing information in its routing table, which permits any to any communication at any time without delay. However, routing table entries will be updated each time network topology change. Thus a high routing overhead will be generated and decrease network performance. The second strategy is reactive protocols that are designed to discover the routing path only when needed. Consequently, the reactive protocols produce a smaller amount of overhead since they do not periodically broadcast the control packets. This category is quit adapted to high dynamic environment [3]. The third approach is hybrid routing. It combine the advantages of both

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proactive and reactive routing protocols to achieve less delay as in proactive type and less overhead as in reactive type.

In this paper we introduce a new routing protocol named mobility adaptive Ad hoc On Demand Distance Vector (MA-AODV). It uses degree of mobility time variation DMV to set up the most stable route and exploit local route repair using common neighbor linkup to reduce the impact of mobility and thus improve network performances.

The rest of this paper is organized as follows: Section 2 is dedicated to problem statement. In section 3 we present previous work that tried to handle node's mobility issues, and then we present the system model and the details of proposed routing approach in section 4 and 5. In section 6 is reserved to implementation details of different modules of MA-AODV. The section 7 is devoted to highlight performance metrics used in the evaluation of proposed protocol. Finally, in section 8 we present simulation results and we discuss the performance of MA-AODV and AODV in a high mobility environment.

2. PROBLEM STATEMENT

Mobile nodes in MANETs are free to move at any time without any restrictions towards any direction and at any speed; consequently, nodes may join or leave the network at any time [4]. Thus the main challenge in the design of MANET is how to make mobile nodes self-efficient in routing and forwarding data packets? In addition, the dynamic behavior of the network and the lack of predefined infrastructure have direct impact on the overall network performances. The high mobility of nodes may cause frequent changes in network topology, leading to unreliable routes and frequent link failure [5]. The dynamic feature of MANETs has lead to the development of various routing protocols. The purpose of each protocol is to solve related issues to a specific network conditions. In case of high dynamic network, reactive routing has better behavior than proactive routing because route discovery is initiated only if a node has data to send; in contrast, proactive routing performs routing table update all the time. The AODV routing has demonstrated good performance in high dynamic network compared to other reactive protocols [6]. However, during data forwarding of an active communication, the AODV reinitiates the route request process, from source node toward destination node, each time a link failure is detected. This leads to an extra routing overhead and bandwidth consumption. Considering the advantages and the limitations of AODV in high dynamic network, we have tried to answer the following questions:

- ✓ Is it efficient to develop a new routing approach based on AODV?
- ✓ Can we improve the overall network performance under high mobility of nodes?
- ✓ How do we adapt AODV routing working process (RREQ, RREP and RERR) [7], to meet expected performances?

Later in this paper, we propose a new adaptive AODV based on new metric called degree of mobility variation (DMV). This approach succeeded in enhancing routing performance due to selecting the most stable route and repairing locally broken links.

3. RELATED WORK

Mobility of nodes in MANETs has substantial negative impact on network performances. Therefore, researchers in MANET field have dedicated significant effort to improve the efficiency of routing protocols. Consequently various routing protocols have been proposed for MANETs, which use different approaches in path setting and link recovery process due to link failure that occurs when a node moves away from the existing networks.

Literature review and the efficiency study of well known routing protocols in MANETs in high mobility environment have lead to the flowing conclusion:

- Flat routing have better performance than hierarchical routing in high mobility

- Proactive flat routing protocols do not scale very well because of their periodic updating procedure. This procedure consumes big amount of scarce bandwidth. Even if some optimizations have been made. For instance OLSR which is good in low mobility context

- Reactive routing protocols outperform proactive routing due to their simple route discovery and maintenance procedure. These protocols might experience more latency during route establishment when there is no previous communication between the source and the destination or route recovery due to links breakage. In this category, AODV shown better performance compared to all other reactive protocols due to low overhead, low bandwidth consumption and local links failure management.

In this context, various optimization schemes based on AODV have been proposed to overcome the rapid change in network topology. In the perspective to develop new variants of AODV that deal with node mobility, authors followed two main approaches. The first one consists of selecting a stable route based on some metrics such as node energy and signal strength than traditional hop-count used by AODV. The second approach attempts to find multiple paths to the destination during route discovery process.

3.1 Stable Path Approach

In [8], Xu Bingkun and Li Yanping proposed novel link stability and energy aware routing with tradeoff strategy in mobile ad hoc networks (NLSEA-AODV) as an improvement of AODV. This uses link stability and node energy metrics to select stable routes during route request process and predicts link failure in route maintenance. The Protocol improves packet delivery ratio and reduces routing overhead but the average latency is quite higher than AODV. The energy efficient Ad hoc on demand Distance Victor EE-AODV routing protocol was proposed by Singh Reena and Gupta Shilpa in [9]. This routing algorithm enhanced RREQ and RREP process to save nodes energy. It considers a threshold energy level as minimum energy required to select a node to participate in active path. When node energy reaches the threshold level, it would not be considered for data delivery unless alternative paths are unavailable. In addition, Prasad Sanjeev and Bhatia Karamjit in [10] integrated new routing metric into AODV messages to select stable path and avoid route failure. The protocol named route stability AODV (RSAODV) uses node stability value in RREQ packet. Intermediate node compares received NSV to its own value, update it and forward to the next hop. The process is repeated until reaching the destination. Then, a RREP packet is generated in response to the RREQ packet with the largest route stability value to the source node. H. Dandotiya et al. proposed in [11], a routing protocol based on signal strength. It's entitled intelligent Ad hoc On demand Distance Victor (IAODV). It employs a new route selection mechanism that works in two phases; in the step IAODV measures signal strength between nodes and compare with received signal strength indication (RSSI) threshold value. If the measured value, is greater than threshold value then it is accepted for further processing otherwise it is discarded. If IAODV could not find any route between source and destination then the second step is invoked to setup the route on the basis of minimum hop count.

3.2 Multipath Approach

A Link Reliable Multipath Routing was proposed by P. Periyasamy and E. Karthikeyan in [2]. They modified the existing Ad hoc on-demand multipath distance vector (AOMDV) into Link Reliable Multipath Routing (LRMR) protocol for finding multiple link reliable shortest paths between any pair of source and destination node based on two metrics: Path-Link Quality Estimator (P-LQE) and Path Length. Moreover, T. Huang et al introduced in [3] AODV-based backup routing scheme (AODV-BBS), in which each node maintains two hop neighborhood information for finding alternative routes, but the maintenance of multiple alternative paths is difficult, costly, and time consuming, which in turn reduces data delivery performances of the network. Likewise, in [4] M.Zarei et al. presented the Modified Reverse Ad-hoc on Demand Distance Vector (MRAODV) routing protocol. It floods the RREP packets to the entire network in order to find the source. This helps to reduce the probability of RREP packet loss and to avoid the source node repeatedly reinitiate the route discovery process due to node mobility. This scheme introduces extra overhead packet in the network, which impacts processing time and end-to-end throughput.

In conclusion, authors have proposed different approaches to enhance the performance of AODV. Multipath approach is efficient in terms of latency but generate a huge amount of routing overhead in case of high mobility. Thus, this approach is performs better in low mobility environment. The stable path approach seems to be useful in high mobility context. However, related routing does not succeed to improve more than two performance metrics.

4. SYSTEM MODEL

Consider the MANET as a graph G (V, C), where V= {N1, N2….Nn} represents the mobile nodes and C represents the direct link between nodes, C Є (V × V). These nodes V are distributed

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in a square area of HW, where H and W represent the Height and Width of the network [15].

Each node in the network connects directly with others which are placed within the radio range (R), where R represents the communication range of node N Є V and C = {i, j Є N}. The direct connection (i, j) Є C denotes that the node Nj is located within the R of node Ni.

Node j is an active neighboring node of i, if it satisfies the two conditions in the given equation, that means nodes i and j should belong to V as well as C.

$$\mathbf{NH_{i\to j} = (i,j) \in V \wedge (i,j) \in C} \quad (1)$$

Where $NH_{i\to j}$ represents that the node j is a neighboring node of i.

In AODV, the source node S floods the Route Request (RREQ) packet, and discovers a route to the destination D. The destination node D replies the node S via SRO, which represents the shortest routes (SRO Є {S-N1-N2-.... Ni-1}. The nodes of Nn Є V move on the basis of the random waypoint mobility model (RWP), and it may break the link [Nn- Nn+1]. Intermediate nodes Nn and Nn+1 belong to the C as well as to the shortest route SRO.

$$\mathbf{([N_n - N_{n+1}] \in C) \wedge ([N_n - N_{n+1}] \in SRO)} \quad (2)$$

Every node stays for a Pause Time (PT) and moves to another location with a speed of S_{min} to S_{max}, as per the mobility model [5]. The node N_n sends Route Error (RERR) packet to the node S, which rebroadcast the RREQ packets towards the destination D. This degrades the routing performance of AODV under highly mobile environment. To solve this issue, the Mobility Adaptive-AODV (MA-AODV) introduces the Degree of Mobility time Variation (DMV) in the route discovery process and applies a local route repair concept during the data routing process. In MA-AODV, the value of mobility time of a neighboring node i (MT_i) is extracted. Moreover, the source node appends the current DMV_c as zero. A node j that receives the RREQ packet changes the label of DMVc to the previous DMV (DMV_p) and subtracts the value of MT_i from MT_j

$$\mathbf{DMV_c = DMV_p + (\pm MT_j - MT_i)} \quad (3)$$

This process is continued until the RREQ reaches the destination. When the node D receives the RREQ packets from more than one routing paths, it selects a path with high DMV/hop count. High DMV denotes that the subsequent intermediate nodes in a path, SRO do not move at a time, due to high variation of MT between them. It avoids the subsequent link failures in the routing path at a time. The local route repair scheme can solve the link failure in an SRO, but there is no possibility to solve the link failure occurred in the more than one subsequent links. Thus, the time variation between the subsequent intermediate nodes in a path avoids the subsequent link failures at a time and utilizes the advantages of local route repair under high mobility environment without incurring the route discovery process.

5. PROPOSED APPROACH

To improve the efficiency of communication in MANET we propose a novel mobility adaptive routing approach, which aim to reduce the side effect of mobility. This selects routing path with a high degree of mobility time variation and performs local route repair using common neighbor linkup to mitigate the impact of a link failure on communication.

Our proposal is based on DMV metric, which is calculated according to formula (3). Instead of using the classical method of flooding during RREQ process we integrate the new DMV metric into RREQ packet and during route discovery we evaluated the DMV value in each node and then propagate it hop by hop until reaching the destination node. At node destination we select the most stable route, which correspond to the path with a high value of DMV/Hop cout.

In case a link failure occur, we try repairing the route locally without engaging the whole route discovery process

5.1 Route Discovery Using Degree of Mobility time Variation

The proposed MA-AODV is composed of two phases such as route discovery based on DMV factor, and data forwarding. The core of the MA-AODV mechanism lies in ensuring that the routing paths discovered are stable, and it does not face subsequent link breakage on a route at a time. The MA-AODV route selection rules are applied locally at each node in repairing the link failure locally, rather than re-initiating the route discovery process.

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5.1.1 Path determination

Besides achieving high stable routing paths, MA-AODV seeks to include the degree of mobility time variation in the neighbor list. In distributed distance vector routing algorithms, a node builds routing paths to a destination incrementally on the basis of communication links obtained from the neighbors towards the destination. So, as illustrated in figure 1, finding a stable communication link at a node can be seen as a two-step process:

1. Every node extracts the mobility time of a neighboring node and appends it in a neighbor list;
2. Constructing a stable route using a degree of mobility time variation.

The mobility time is a parameter used in the random waypoint mobility model. The random waypoint mobility model sets the pause time initially, but the initial movement of each node varies from 0 to pause time, i.e., all the nodes do not move at a time initially. Every node moves after expiring the pause time. Note, that these steps are trivial; the destination node, which receives the RREQ packets simply needs to ensure that the path has high DMV value.

5.1.2 Neighbor table

The MA-AODV neighbor table, shown in table 1, has new fields for the mobility time and DMV factor. The mobility time of a node represents the moving time of a node to another location initially. For instance, consider a network with two nodes, and assign the pause time as 5 seconds. Both the nodes do not move at 0 th second.

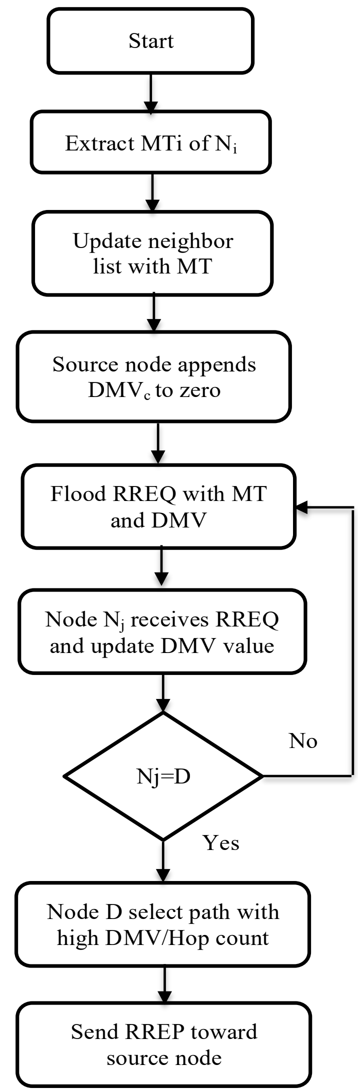

Figure 1: Path determination process

Table 1: Neighbor Table of MA-AODV

Node Identity	Neighbor Node Identity	MA-AODV specific Fields	
		Mobility Time	DMV

The node 1 starts to move at 0 sec, and the node 2 moves at 2 sec. By following the random waypoint model, the node 1 enables the next movement at 5 sec, and the node 2 starts the next movement at 7 sec. It is continued until the simulation time is ending. In case, the pause time is 0, all the nodes do not pause in the network, and the MT value is also 0.

The initial time of movement MT does not exceed the value of pause time since a node should move to another location after expiring the pause time. However, the initial movement of a node lies between 1 to pause time, and this varies the value of mobility time of a node.

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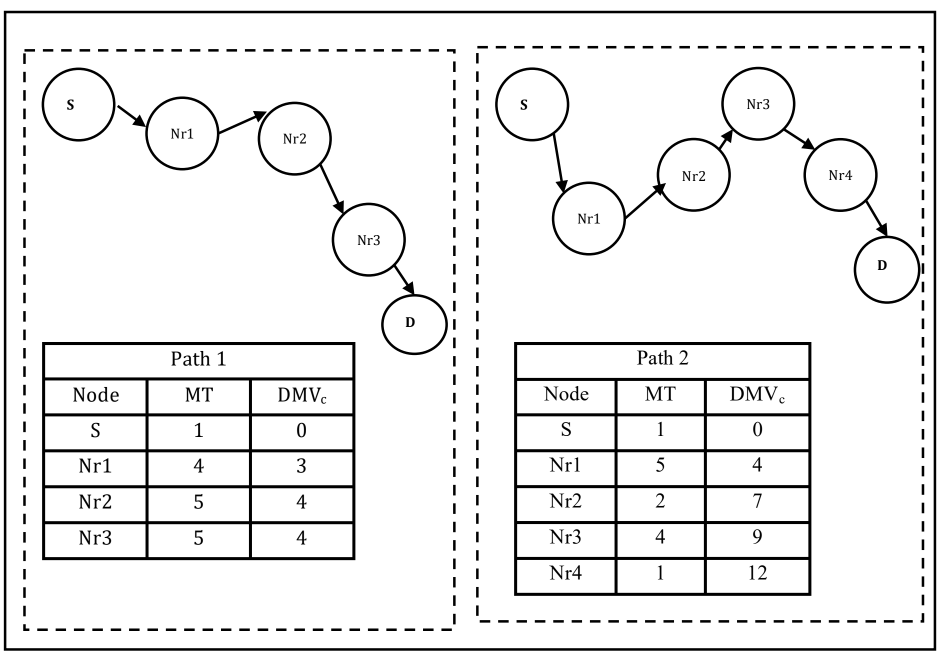
The local route repair concept is possible when there is a single link failure. However, the failure of subsequent links in a path has to establish the route discovery process. To avoid this, the proposed MA-AODV exploits the mobility time of a node to construct the stable route. When subsequent nodes on a route have a high difference in mobility time, the link failures do not happen in subsequent links. So the MA-AODV enables the source node to attach the degree of mobility time variation with a neighboring node in RREQ packet. The RREQ of MA-AODV contains the following fields:

- Source address
- Source sequence number
- Broadcast ID
- Destination address
- Destination sequence number
- Hop count
- MT
- DMV

On receiving the RREQ packet, each node identifies the DMVc and continues the RREQ flooding until the destination node D is reached. The hop count limitation is applied. That means the destination assigns the hop count limit, which is more than the shortest hop count between the source and destination. Only when a destination receives the RREQ, which has the hop count within the assigned hop count limit, the value of DMVc/hop count is measured. Finally, the destination node selects a stable route with a considerable hop count and replies the sender node through Route Reply (RREP) packet. The RREP of MA-AODV contains the following fields:

- Source address
- Destination address
- Destination sequence number
- DMVc/Hop count

In figure 2 we illustrate two different routing paths to the destination node D. The first path is the shortest one. However, the total DMVc value is small. The intermediate nodes in the first path from Nr1 to Nr3 have closer mobility time, and these links fail at a time. It affects the local route repair scheme significantly. However, in the second path, the total DMVc value is 12. The communication links break at the different time and do not affect the efficiency of the local route repair scheme. The DMV_c value is divided by the hop count (DMV_c/HC) and the path with the highest DMV_c/HC value is selected as routing path. Thus, the second path enhances the routing performance. It is the central concept of an MA-AODV routing protocol in MANETs.



Path 1		
Node	MT	DMV_c
S	1	0
Nr1	4	3
Nr2	5	4
Nr3	5	4

Path 2		
Node	MT	DMV_c
S	1	0
Nr1	5	4
Nr2	2	7
Nr3	4	9
Nr4	1	12

Figure 2: Example path selection in MA-AODV

5.1.3 Data forwarding

The proposed work enables the sender node to start the communication to offer data packet forwarding at a node having a stable path to a destination. The proposed MA-AODV uses a path, only if it has high DMVc/HC value.

5.2 Local Route Repair Scheme

The node mobility is one of the critical factors in MANETs, and the unpredictable node mobility introduces some limitations if not handled well. In MA-AODV, the path maintenance process includes the following process to avoid the packet loss due to node mobility and route rediscovery process in AODV protocol, such as local route repair scheme.

Most of the conventional work predicts the link breakage, by frequently sending the hello packets. In contrast, the proposed MA-AODV protocol exploits the MT of the previous hop to detect the link failure. In the following we illustrate local route repair operations:

1. Every node sends the hello packet to the neighbor list.
2. It determines the common neighbors with next hop.
3. A node that detects the link failure selects its neighbors from the received common neighbor list of the previous hop.
4. Routing decision will be done depending on the availability or not of a common neighbor:
   i. Availability of one or more common neighbor:
      a. If only one common neighbor is available, the previous hop considers the selected neighbor ID as next hop.
      b. Otherwise, a common neighbor with a high value of DMV_c/HC is selected as the next hop.
      c. The previous hop sends the modified routing table to the selected neighbor. The modified routing table includes, <dest addr, sequence number, MT, and DMV_c>
   ii. Unavailability of common neighbor:

   The previous hop sends a RERR packet to the node S for re-initiating the route discovery process.

This reduces the mobility impact on the MA-AODV routing protocol. Moreover, the stable route selection avoids the subsequent link breakage at a time, and so the advantage of the local route repair scheme is fully utilized.

6. IMPLEMENTATION DETAILS

To test the effectiveness of our solution, simulations were implemented by using network simulator (NS2) platform. We used C++ to develop the first four modules of MA-AODV as described in section 6.1. Then MA-AODV package was compiled and integrated into NS2. The fifth module related to performance evaluation was developed in Tool Command Language (TCL).

6.1 Modules Description

The purpose of this section is to present the description of different modules of the proposed MA-AODV routing protocol.

6.1.1 Module 1 route discovery phase - RREQ Flooding with Degree of Mobility time Variation.

Input: source and destination.
Output: Flooding of RREQ with Degree of Mobility time Variation.
The source node initiates the RREQ flooding towards the destination. The RREQ includes the field Mobility time and degree of mobility time variation. When a node receives the RREQ, the value of DMVc is generated. The RREQ flooding is continued until the destination is received.

6.1.2 Module 2: Route Discovery Phase - Stable Path Selection.

Input: Received RREQs at Destination.
Output: RREP with High DMV_c/HC to Source node.
The destination receives one or more than one RREQ packets from the source nodes. The destination node divides the value of DMV_c by HC and selects a path with a high value of DMV_c/HC. The destination replies the source node through the selected path.

6.1.3 Module 3: Data Forwarding Phase - Link Failure Detection.

Input: Data Transmission via the stable routing path.
Output: Detecting Link Failure using MT value.
The source node receives the RREP packet from the destination. After receiving the RREP, the source node initiates the data forwarding. During data

transmission, the link failure is detected using the MT value.

6.1.4 Module 4: Local Route Repair Scheme

Input: Link Failure.
Output: Common Neighbor Based Routing Decision.
If a node identifies the movement of a neighboring node, it sends the hello packet to the neighbor list. The moving node determines the common neighbors with the next hop and its previous hop. It selects its neighbors from the received common neighbor list. The data transmission is continued using a new route.

6.1.5 Module 5: Performance Evaluation

Input: MA-AODV and AODV
Output: Performance Results
The performance is evaluated using NS2. By varying the node pause time (varied from 0 to 12sec) and speed (varied from 6 to 30 m/s), the scenarios are created. The performance metrics are measured for MA-AODV and AODV, and the metrics are Packet delivery Ratio, Throughput, overhead and communication delay.

6.2 Simulation Parameters

In order to evaluate the performances of MA-AODV in high mobility environment, we created simulation scenario based on the parameters listed in table 2.

We simulated the MA-AODV and AODV routing protocols using various value of speed and pause time in order to create high mobility environment.

7. PERFORMANCE METRICS

By varying the node pause time and speed, the performance of MA-AODV is measured and compared with the AODV routing scheme. The performance metrics are as follows:

Packet Delivery Ratio (PDR): The ratio of the data packets delivered to the destinations to those generated by the CBR sources. It is the fraction of packets sent by the application that are received by the receivers.

$$\boldsymbol{PDR} = \left(\frac{\sum \boldsymbol{Dp}}{\sum \boldsymbol{Sp}}\right) * \mathbf{100} \qquad (4)$$

Where Dp and Sp represent respectively packets delivered and packets sent.

Table 2: Simulation Parameters

Parameter	Values
Simulator	NS2
Number of Nodes	100
Area	600m X 600m
Communication Range	100m
Maximum Speed	30 m/s
Minimum Speed	6 m/s
Pause Time	0s to 12s
Interface Type	Phy/WirelessPhy
MAC Type	IEEE 802.11
Queue Type	Drop Tail/Priority Queue
Queue Length	50 packets
Antenna Type	Omni Antenna
Propagation Type	Two Ray Ground
Routing Protocol	MA-AODV and AODV
Transport Agent	UDP
Application Agent	Constant Bit Rate (CBR)
Simulation Time	100s

Throughput (Bw): Throughput is the measure of how fast we can actually send packets through network. The number of packets delivered to the receiver provides the throughput of the network. The throughput is defined as the total amount of data a receiver actually receives from the sender divided by the time it takes for receiver to get the last packet.

$$\boldsymbol{Bw} = \frac{\sum \boldsymbol{Rp} * \boldsymbol{Ps}}{\triangle \boldsymbol{t}} \qquad (5)$$

Rp: Received packets,
Ps: Packet size
$\triangle$ t: Transmission time

Routing Overhead (Ro): The number of routing packets transmitted per data packet delivered at the destination. Each hop-wise transmission of a routing packet is counted as one transmission. The routing overhead describes how many routing packets for route discovery and route maintenance need to be sent in order to propagate the data packets.

$$Ro = \frac{\sum Rp}{\sum Sp} \quad (6)$$

Rp represents routing packet

End-to-End Delay (D): End-to-End delay indicates the total time taken by each packet to reach the destination. Average End-to-End delay of data packets includes all possible delays caused by buffering during route discovery, queuing delay at the interface, retransmission delays at the MAC propagation and transfer times.

$$D = \frac{\sum_{i=1}^{N} \triangle\ t[i]}{N} \quad (7)$$

$\triangle$ t[i]: Transmission time of packet [i]
N: Number of received packets

8. SIMULATION RESULTS AND DISCUSSION

The purpose of this section is to evaluate the performance of proposed routing protocol MA-AODV versus AODV under high mobility level. According to RWP mobility model, increasing the speed or decreasing pause time of nodes could generate high mobility.

8.1 Impact of speed variation

In this section we illustrate the performance of MA-AODV and AODV by increasing the speed of nodes.

Packet Delivery Ratio, shown in figure 3, is decreased in both protocols while increasing frequently changes topology. However, PDR in proposed MA-AODV protocol is better than AODV due to the DMV based path selection and local route scheme.

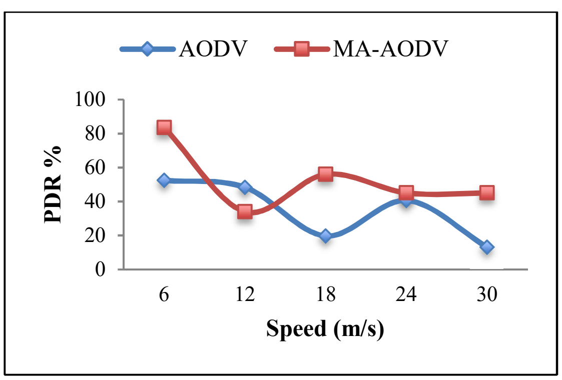


Figure 3: PDR vs. speed

In figure 4, the delay is increased in MA-AODV compared to AODV routing protocol due to the stable path selection in route discovery process.

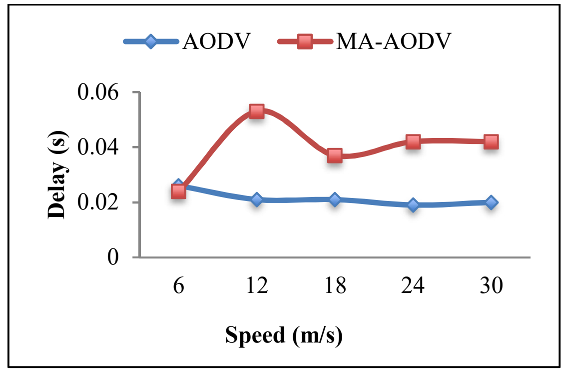


Figure 4: Delay vs. speed

Figure 5 shows that in most cases MA-AODV routing overhead is better than AODV due to the stable path selection in route discovery process. But in high mobility MANET environment proposed MA-AODV protocol is better than AODV.

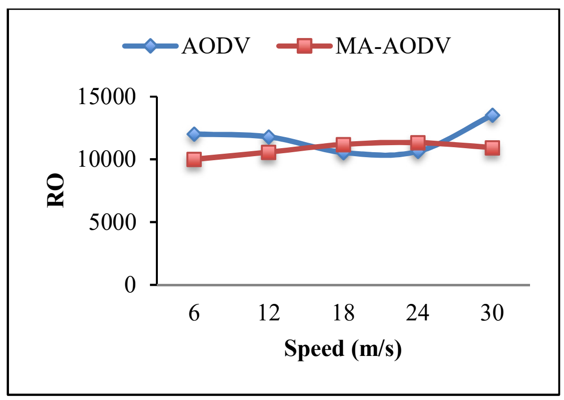


Figure 5: Overhead vs. speed

The throughput of MA-AODV, illustrated in figure 6, is better than AODV due to the stable path selection in route discovery process. In high mobility environment proposed MA-AODV protocol demonstrates significant performance in terms of throughput than AODV.

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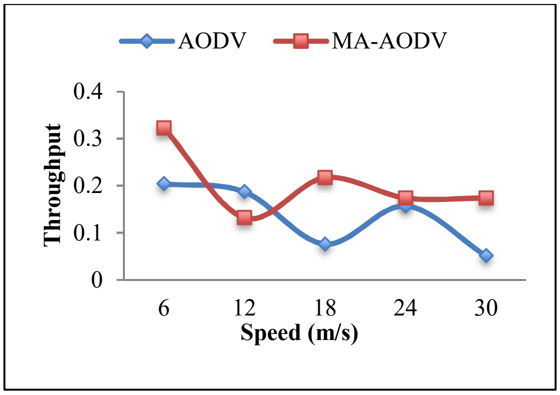

Figure 6: Throughput vs. speed

8.2 Impact of pause time variation

In this section we illustrate the performance of MA-AODV and AODV by increasing the speed of nodes.

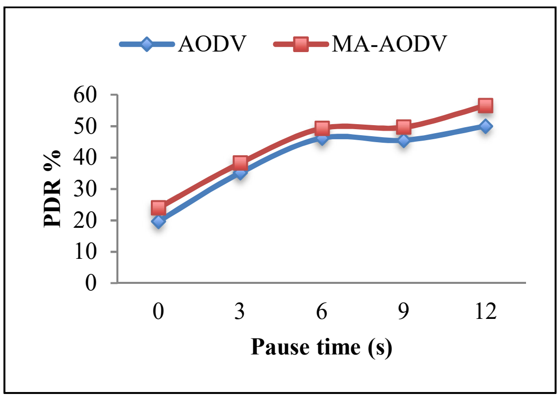

Figure 7: PDR vs. pause time

Figure 7 shows that Packet Delivery Ratio is increased in both protocols while increasing node pause time interval. PDR in proposed MA-AODV protocol is better than AODV due to the DMV based path selection and local route scheme.

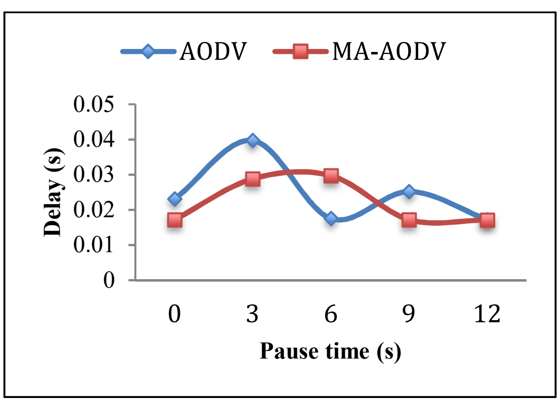

Figure 8: Delay vs. pause time

Due to the stable path selection in route discovery process, delay is increased in MA-AODV compared to AODV routing protocols, as shown in figure 8.

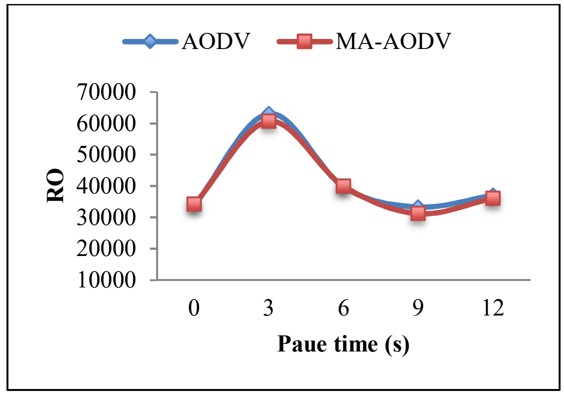

Figure 9: Overhead vs. pause time

In figure 9, MA-AODV overhead is better than AODV due to the stable path selection in route discovery process.

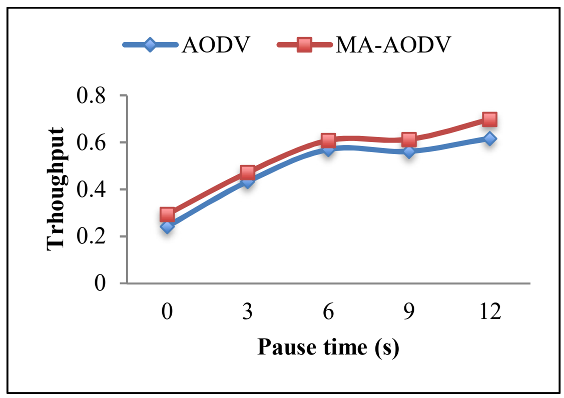

Figure 10: Throughput vs. pause time

Figure 10 shows that the throughput of MA-AODV is better than AODV. This is due to the stable path selection in route discovery process.

8.3 Discussion

In general, the proposed MA-AODV outperforms AODV routing protocol in high mobility context. Simulation analysis demonstrates that PDR, throughput and routing overhead are better in case of MA-AODV that AODV. In comparison to previous proposals discussed in related work section, the MA-AODV achieves better performances in three metrics. For instance, PDR value of MA-AODV measured around speed 30m/s and pause time around 6 is far better compared with AODV PDR. The same conclusion is made for throughput and routing overhead. In contrast end-to-end delay is a little higher than

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AODV because MA-AODV select stable route based on DMV calculation. This introduces extra-processing time. But it still conforms to the average latency required by almost MANET application except some real time applications.

9. CONCLUSION

Mobility of nodes in MANETs has substantial undesirable effect on network performances. This influence is essentially revealed by the increase of network overhead and traffic control messages. On the other hand, latency, path throughput and packet delivery ratio experience significant decrease at the point where the applications might not work properly. Literature review shows that there is no single routing protocol that is efficient under several network condition. Various schemes have been proposed to handle mobility issues but al of them succeeded in improving some metric and impacted others. In this context, we proposed a novel mobility adaptive routing protocol MA-AODV to improve the overall performance metrics. This protocol uses two new routing metrics. The new routing metrics called mobility time (MT) and degree of mobility time variation (DMV) are integrated into the neighbor table, route request packet RREQ and route reply packet RREP of traditional AODV in order to select the most stable route and avoid subsequent link failure. The stable path has the higher DMV/Hop count value. During data forwarding process link failure is predicted and local repair scheme is used for a quit path recovery. The proposed MA-AODV achieves significant improvements compared to AODV performance. Simulation results show that MA-AODV outperforms AODV in term of PDR, Throughput and Routing overhead when the speed is increased to 30 m/s and pause time decreased to 6s that represent high mobility environment. Although, the end to end delay of MA-AODV is slightly higher than AODV due to the calculation of DMV. It remains conform to the average delay required by various type of traffic. In the near future work, will are going to evaluate the suitability of MA-AODV for real time applications, which involve the transport of high volume of audio-video data streams.

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