Energy-Aware Performance Metric for AODV and DSDV Routing Protocols in Mobile Ad-Hoc Networks

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Abstract

In Mobile Ad-Hoc Networks (MANETs), mobile devices are equipped with power (energy). In order to utilize this energy equipped devices efficiently for transmission of data packets, many energy aware routing strategies are followed. As a key note to these routing strategies, the energy aware performance metrics are analyzed on two routing protocols like Ad-Hoc On Demand Distance Vector Protocol (AODV) and Destination Sequenced Distance Vector Routing Protocol (DSDV). The comparison results prove that AODV protocol can be adopted for any routing strategy, in order to increase the performance of the network lifetime in comparison with DSDV.

Keywords: *Mobile Ad-Hoc Network, MANET Routing Protocols, AODV, DSDV.*

1. Introduction

Mobile Ad-Hoc networks (MANETS) are self-configured and infrastructure less network with more number of mobile devices connected via a w ireless links. Energy conservation in ad-hoc networks is very important due to the limited energy availability in each wireless node [7]. Since the communication between two wireless nodes consumes more energy, it is important to minimize the cost of energy required for communication by exercising an energy aware routing strategy. Such routing procedures/policies potentially increase the lifetime of the network. In this paper, the energy metrics of AODV and DSDV are compared by simulating with increasing the density of nodes.

2. MANET Routing Protocols

Routing protocols is a standard that controls how nodes decide to route the packets between the source and the destination node. Each node learns about nodes nearby and how to reach them. The routing protocols find a route for packet transmission and will transfer the packet from source to destination. The routing protocols are mainly classified in two ways.1.Table Driven protocols or proactive protocols 2.On-Demand protocols or reactive protocols. Table-driven routing protocols are trying to maintain consistent, routing information from each node to every other node in the network [2]. Each node is maintaining one or more tables that containing routing information about every other node in the network. Examples for table driven protocols are: Destination Sequenced Distance Vector Routing Protocol (DSDV), Wireless Routing Protocol (WRP), and Cluster Switch Gateway Routing (CGSR) [2]. The On-Demand protocols will establish the route between the nodes that they want to communicate. When a source node requires a r oute to destination node, it initiates a route discovery process in the network. This process is completed once a r oute is found or all possible route permutations have been examined [2]. The route remains valid until the route is no longer needed. Examples of On-Demand routing Protocols are Relative Distance Microdiversity Routing (RDMR), Temporally Ordered Routing Algorithm (TORA), Dynamic Source Routing (DSR), Ad-Hoc On Demand Distance Vector Protocol (AODV) [2].

2.1 DSDV

DSDV is a proactive routing protocol based on the classical distributed Bellman-Ford routing algorithm [2]. In DSDV[4] messages are shared between the mobile nodes (i.e., nodes are in the same transmission range).The nodes will continuously evaluate the routes to all reachable nodes and attempt to maintain consistent up-to date information. The routing table updates will sent periodically throughout the network thus the table will maintain its consistency but this will generate a lot of traffic in the network. Each node will maintain a routing table in which all of the possible destinations within the network and the number of hops to each destination are recorded [3]. Each entry in the routing table is marked with a sequence number that is assigned by the destination node; the sequence numbering system will avoid the formation of loops.

2.2 AODV

The Ad-Hoc On-Demand Distance Vector routing protocol is a r eactive routing protocol. AODV protocol is a combination of Dynamic Source Routing (DSR) and DSDV protocol [5]. It is a distance vector routing protocol and is capable of both unicast and multicast routing [8]. It will maintain the routes only between the nodes which need to communicate. The routing information will be maintained as routing tables in each node. A routing table entry expires if it has not been used or reactivated for pre-specified expiration time. When a source node wants to send the packet to a destination node then the entries in the routing table will check whether there is a current route to the destination node or not, if there is a route then the packets will transmit to destination node in that path [2]. If don't have any valid route, then the route discovery process will be initiated. For route discovery AODV is using Routing Request (RREQ), Routing Reply (RREP) Packets [1]. The RREQ packet containing the source node IP address, source node current sequence number, the destination node sequence number and broadcast ID [1][8]. The advantage of AODV is that it creates no extra traffic for communication along the existing link but requires more time to establish a connection. It is simple and doesn't require much memory or calculation.

3. Simulation Model

A discrete event Network Simulator NS2 2.34 was used for the simulation purpose [6].

Parameters considered for the simulation:

Channel type	: **WirelessChannel**
Radio-propagation Model	: **TwoRayGround**
Antenna type	: **OmniAntenna**
Interface queue type	: **Drop Tail /PriQueue**
Maximum packet in Queue	: **50**
Network interface type	: **Phy/WirelessPhy**
MAC type	: **802_11**
Topographical Area	: **800 x 800 Sq.m**
TxPower	: **4.00W**
RxPower	: **3.00W**
IdlePower	: **1.0W**
Transition Power	: **0.01W**
Transition Time	: **0.003s**
Sleep Power	: **0.004W**
Total simulation Time	: **110 ms**
Initial energy of a Node	: **200.0 Joules**
Routing protocols	: **AODV/ DSDV**
Traffic Model	: **FTP**
Packet Size	: **1060 Bytes**
Number of mobile nodes	: **5, 15,25,35,45,55,65,75, 85, 95**
Mobility Speed	: **10 m/s**

3.1 Metrics Analyzed for simulation

This is the number of data packets that are sending from source to destination during the transmission. In this study the total number of data packets sent by the source within the simulation time is calculated.

Consumed Energy

The number of nodes in the network versus the total consumed energy is considered as a metric.

Remaining Energy

The remaining energy available in each node after the transmission.

Packet Delivery Fraction [PDF]
This is the ratio of the data packets delivered to the destination to those generated by the traffic source.
Routing Overhead
Routing overhead is the number of routing packets transmitted per data packet delivered to the destination.
Normalized Routing Load [NRL]
This will be the ratio between the number of routing packets and the number of received packets. The Normalized Routing load must be low.
Throughput is the average rate of successful message delivery over the communication channel.

The following tables show the analysis parameters of AODV and DSDV protocols.

Table 1: Energy Conservation Analysis Parameters of AODV

No. of Nodes	***Sent packets***	***Received packets***	***Remaining Energy***	***Consumed Energy***
5	3050	3028	225.39186	774.60815
15	1335	1315	312.1986	2687.8013
25	3568	3552	1780.2018	3219.7983
35	2026	2006	1688.3478	5311.6523
45	3656	3647	724.77563	8275.225
55	3212	3212	2559.7375	8440.263
65	4346	4332	2956.675	10043.325
75	1312	1220	1096.602	13903.398
85	1941	1920	1025.5564	15974.443
95	4345	4333	4316.955	14683.045

Table 2: Energy Conservation Analysis Parameters of AODV

No. of Nodes	***PDF***	***NRL***	***Routing Load***	***Throughput***
5	99.2786	0.004293	13	682.56
15	98.5018	0.786311	1034	143.29
25	99.5515	0.007319	26	679.37
35	99.0128	0.055333	111	307.76
45	99.8085	0.134557	491	545.77
55	100.0	0.035180	113	471.97
65	99.6778	0.015235	66	681.75
75	92.9878	4.726229	5766	121.13
85	98.9180	0.441666	848	261.62
95	99.7238	0.022155	96	682.59

Table 3: Energy Conservation Analysis Parameters of DSDV

No. of Nodes	***Sent packets***	***Received packets***	***Remaining Energy***	***Consumed Energy***
5	2092	2080	156.12029	843.8797
15	460	447	1041.9852	1958.0148
25	3474	3458	2967.76086	4703.2393
35	1981	1945	1118.2605	5881.7393
45	2269	22488	820.5607	8179.4395
55	3443	3409	538.13	10461.87
65	4109	4096	109.43597	12890.564
75	143	122	5822.0615	9177.938
85	443	425	5284.9946	11715.006
95	4023	4009	127.533585	18872.467

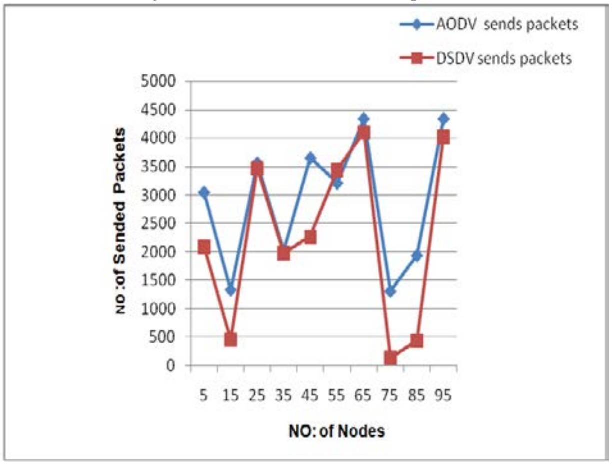
Table 4: Energy Conservation Analysis Parameters of DSDV

No. of Nodes	***PDF***	***NRL***	***Routing Load***	***Throughput***
5	99.42639	0.0302884	63	682.56
15	97.17391	0.6263982	280	332.04
25	99.53944	0.1477732	511	658.00
35	98.18274	0.3881748	755	224.12
45	99.07448	0.4577402	1209	205.30
55	99.01249	0.4068642	1387	532.77
65	99.68362	0.4082031	1672	636.90
75	85.31468	16.540983	2018	318.14
85	95.93679	5.449412	2316	316.33
95	99.652	0.6390621	2562	620.84

4. Performance and Results

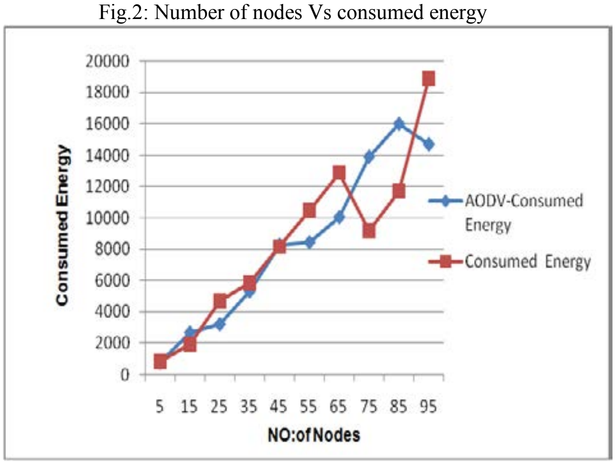
The following graphical analysis shows the performance results of AODV and DSDV protocols.

Fig.1: Number of nodes Vs sent packets



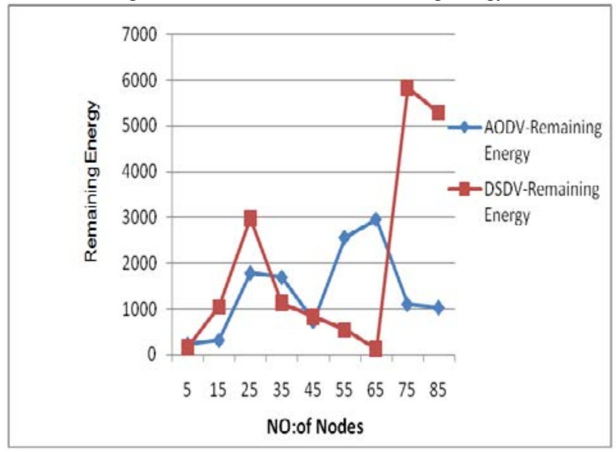
See fig.1,AODV protocol can send more number of packets compared to DSDV protocol. AODV protocol will increase the network lifetime, but in-between the performance goes down because more number of packets are dropped due to link failure.

Fig.2: Number of nodes Vs consumed energy



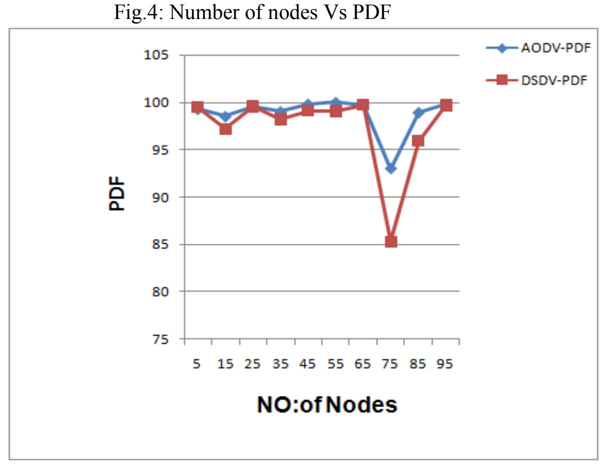
See fig.2, when comparing to DSDV protocol, ADOV consumes less energy for data transmission. DSDV needs more amount of energy for data transmission.

Fig.3: Number of nodes Vs Remaining energy



See fig.3, when compared to AODV protocol DSDV consumes more amount of energy needed for data transmission so the remaining energy will be high in DSDV.

Fig.4: Number of nodes Vs PDF



See fig.4, AODV produces more PDF when comparing to DSDV protocol because AODV can send and receive more number of packets.

Fig.5: Number of nodes Vs NRL

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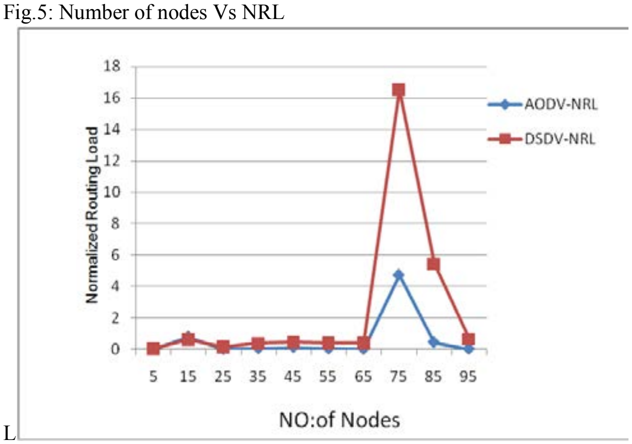
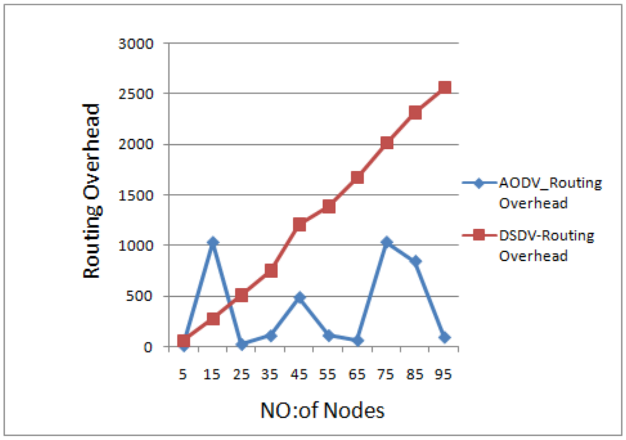


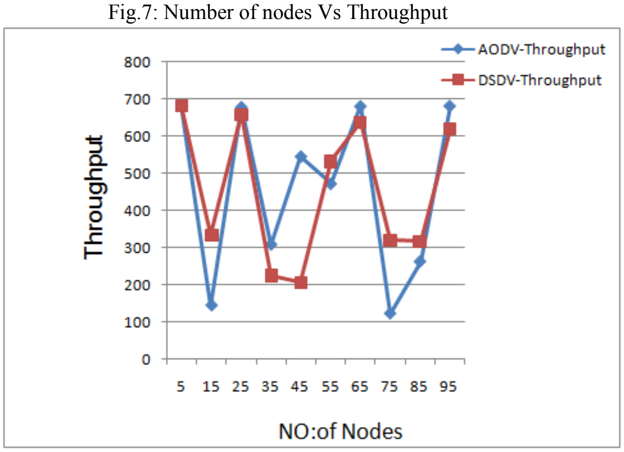
See fig.5, shows that DSDV is producing more amount of traffic when comparing to AODV so the Normalized Routing Load will be high in DSDV protocol.

Fig.6: Number of nodes Vs Routing Load



See fig.6, DSDV producing more number of routing packets when the number of nodes increases, compared to DSDV protocol, AODV is not producing that number of routing overhead.

Fig.7: Number of nodes Vs Throughput



See fig.7, AODV is providing high throughput when compared to DSDV protocol. The average rate of successful message delivery is high for AODV protocol.

Conclusion

The various energy-aware parameters are analyzed in NS2 2.34 for AODV and DSDV protocol by increasing the density of nodes. It is concluded that, AODV performs well in Packet Delivery Fraction (PDF) but in some situations due to link breakage the PDF is low. AODV can send more number of packets compared to DSDV by increasing the number of nodes. Based on energy consumption DSDV performs low in state compared with AODV, Since AODV requires less energy for transmission of packets. As the remaining energy of nodes are calculated in AODV. It is advantages not to use the nodes with minimum remaining energy in order to avoid stale nodes in the network.

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