IJCSC International Journal of Computer Science & Communication Vol. 1, No. 1, January-June 2010, pp. 67-71

Performance Evaluation of Energy Consumption of Reactive Protocols under Self- Similar Traffic

Dhiraj Nitnaware[1] & Ajay Verma[2]

[1]Department of Electronics & Telecommunication Engg., IET, DAVV, Indore (M.P), India

[2]Department of Electronics & Instrumentation Engg., IET, DAVV, Indore (M.P), India

Email: [1]dnitnaware.iet@rediffmail.com, [2]ajayrt@rediffmail.com

ABSTRACT

MANET (Mobile Adhoc Network) is an infrastructureless multi-hop wireless network where development of energy efficient protocols is of current research interests because of limitation of bandwidth and battery life. Many authors have developed number of such protocols and analyzed them under Constant Bit Rate (CBR) traffic [1]. In the present communication we have presented the energy consumption of existing reactive routing protocols namely DSR and AODV under Self-Similar traffic (Pareto and Exponential) in comparison with CBR. Simulation and computation of energy consumption was done with ns-2 simulator (2.31 Version) with following parameter variation: (i) Mobility pattern (ii) Traffic pattern (iii) Area Shape (iv) Sending Rate and (v) number of nodes. Result and conclusion compares the behavior of two protocols in terms of energy consumption under self-similar traffic.

Keywords: MANET, Reactive Routing Protocols, Pareto Traffic with Shape 2.5, ns-2 Simulator.

1. INTRODUCTION

Development of energy efficient routing algorithm plays important role in MANET because each node in the network has limited battery life and bandwidth as the applications of MANET are: (i) in decision making in the field during military operation, (ii) conferencing during disaster relief, (iii) rescue operations and many more.

J Hoong et. al. [2] have compared two reactive protocols namely AODV and DSR under ON/OFF source traffic. They have selected packet delivery ratio, normalized routing overhead and average end to end delay as the performance parameters. A. A. Maashri et. al. [3] have compared the energy consumption of various protocols under CBR traffic. The authors of the present paper have already presented a paper on comparison of various protocols under Pareto traffic [4] and [5]. In the present analysis, we have compared the energy consumption of two reactive protocols (AODV and DSR) under Pareto and Exponential traffic. Total energy consumed by each node during transmission and reception process has been evaluated as the function of pause time, speed, number of nodes, number of sources, sending rate and area shape.

The paper is organized as follows. Sections 2 briefly describe two reactive routing protocols. Section 3 gives the details of simulation and energy model. Simulation results are shown in section 4. Sections 5 describe our conclusion and future scope.

2. MANET ROUTING PROTOCOLS

Here we discuss the two reactive protocols DSR and AODV in brief.

2.1. Dynamic Source Routing Protocol

The Dynamic Source Routing (DSR) protocol [6] [7] finds route to destination when required. Each node in the network maintains a cache. The cache contains the route to reach the other nodes in the network. If sender wants to send data to some destination then the path is used if available in cache. If not then the source node initiate the route discovery process in which the source node flood *RREQ* (route request) packet to its neighbors. After receiving this packet, the node forwards it to their neighbors and so on. When the request reaches the destination, the destination responds by sending *RREP* (route reply) packet. The path followed by *RouteReply* packet is used to send back the data packets.

2.2. Adhoc on Demand Distance Vector Protocol

The Ad hoc On demand Distance Vector (AODV) protocol [8] uses *Hello* beacon for connectivity among the nodes. AODV uses routing table to avoid loop and to distinguish between stale and fresh route. The routing table contains the sequence number and next hop information. If source has data to send, it floods the *RREQ* packet. The destination then send *RREP* packet in response to the request. If the link breaks then the intermediate node send *RERR* (route error) message to the source node about the broken link. AODV protocol uses the route discovery process like in DSR and routing table like DSDV [9].

3. SIMULATION ENVIRONMENT

The simulation is done with the help of NS-2 simulator version 2.31 [8]. The network contains 50 nodes randomly distributed in a 750m X 500m area, with 30 numbers of connections with pause time of 10s and speed of 5m/s as the basic scenario. Initial energy is 100 Joules, Power consumed during transmission and reception is taken as 1.65 W and 1.1 W respectively. The selected parameters are varied using setdest command.

3.1. Traffic Model

Traffic model used in the simulation are CBR, Exponential and Pareto which are generated using cbreng.tcl [11]:

3.1.1. CBR Traffic Model

CBR generates traffic at a deterministic rate. Packet size was set to 512 bytes at a constant rate of 32kbps.

3.1.2. Exponential Traffic Model

It is an ON/OFF traffic with exponential distribution. Traffic generation rate is 32kbps during ON period. Average ON and OFF time are 1.5s and 0.5s respectively.

3.1.3. Pareto Traffic Model

It is also an ON/OFF traffic with Pareto distribution. Traffic is generated at 32kbps during ON period. Average ON and OFF time are 1.5s and 0.5s respectively with a shape parameter of 2.5.

3.2. Energy Evaluation Model

Table 2
Traffic Model's Parameters

Parameter	*CBR Value*	*Exponential Value*	*Pareto Value*
Data Packet Size	512 bytes	512 bytes	512 bytes
Sending Rate	32 kbps	32 kbps	32 kbps
Burst Time	NA	1.5 s	1.5 s
Idle Time	NA	0.5 s	0.5 s
Shape	NA	NA	2.5
Simulation Time	120 s	120 s	120 s

NA- Not Applicable

We have taken the energy model as given by Marzoni and Cano [1]. The selected parameters behave as 2400 MHz WaveLan of IEEE 802.11. The Radio Frequency (RF) value is set at 281.8 mW which is equivalent to a radio range of 250 m. The traffic model parameters for CBR, Exponential and Pareto traffic are shown in Table 2. Energy is converted in joules by multiplying power with time. The following equations are used to convert energy in joules:

Transmitted Energy: *Tx Energy = (Tx Power* Packet Size)/2×10⁶* (1)

Receiving Energy: *Rx Energy = (Rx Power*PacketSize)/2×10⁶* (2)

Total energy consumed by each node during transmission and reception is calculated by the following equation:

Total Energy Consumed = Initial energy – Energy left at each node (3)

4. RESULTS

We have evaluated:

1. Energy consumed (%) due to packet type (routing/ MAC/ CBR or EXPO or Pareto) during transmission and reception (Figure 1).
2. Energy consumed (%) during transmission and reception of control packets (Figure 2).
3. Energy consumed due to packet type (routing/ MAC) during transmission and reception of control packets (Figure 3).

4.1. Due to the Basic Scenario

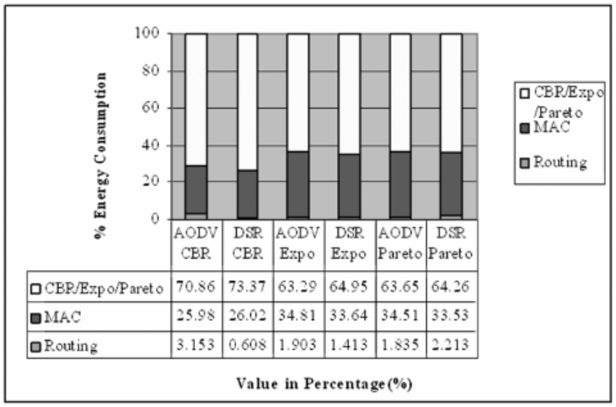

Fig 1: Energy Consumption (%) Due to Control Receiving Packets Type.

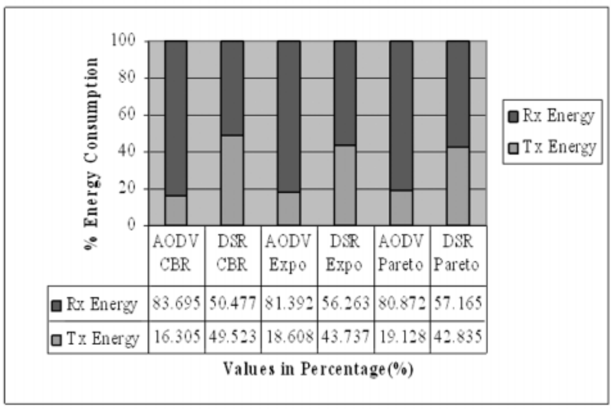

Fig 2: Energy Consumption (%) in Transmitting and Control Packets.

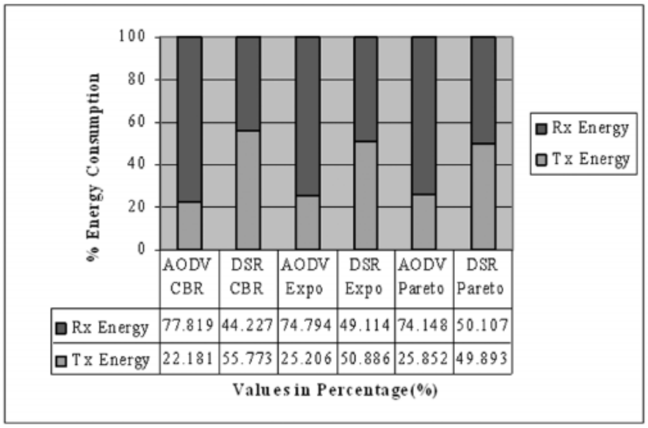

Fig 3: Total Energy Consumption (%) in Transmitting and Receiving at MAC Level

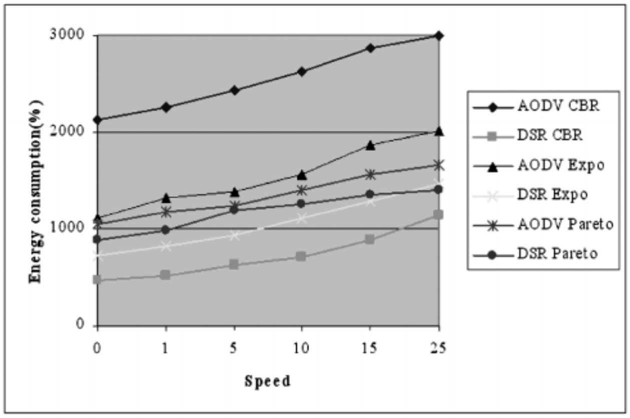

Fig 5: Energy consumption Versus Speed

Figure 1 show the energy consumed due to packet type. We observed that energy consumed due to MAC control packets significantly affects the total energy consumption for both the protocols. Figure 2 gives the energy consumption (%) in transmitting and receiving control packets. RREQ, RREP, RERR and DELETE are the routing control packets while Request to Send (RTS), Clear to Send (CTS) and Acknowledgement (ACK) are the MAC control packets. The result shows that the energy consumed mainly due to receiving process for both DSR and AODV irrespective of the traffic model. And figure 3 demonstrate the total energy (%) at MAC level during transmitting and receiving. Again the energy consumption is mainly due to receiving process. The transmitting energy is more with Pareto traffic and Exponential traffic as compared with CBR traffic for both AODV and DSR. This is due to the bursty nature of Pareto and Exponential traffic.

4.2. Varying Selected Parameters

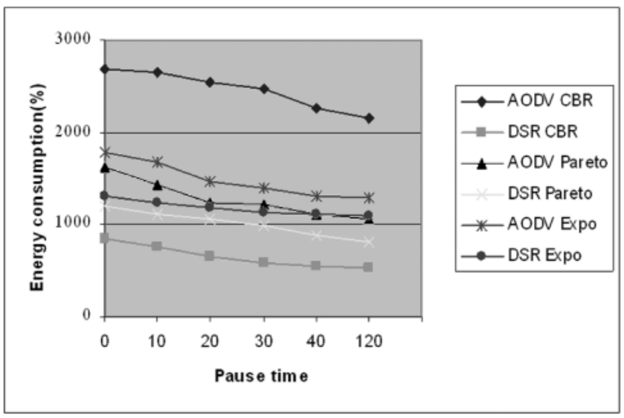

Fig 4: Energy Consumption Versus Pause Time

Figure 4 shows the total energy consumed (Joules) by all the nodes involved in transmitting and receiving the control packets by varying pause Time. DSR consumed less energy than AODV due to control packet as route cache in DSR stores multiply path therefore needed less route discovery process as compared to AODV which result in less overhead.

Figure 5 shows the total energy consumed (Joules) by all the nodes when the speed is varied as 0m/s, 1m/s, 5m/s, 10m/s, 15m/s and 25m/s. Pause time and speed defines the mobility of nodes where high pause time is equivalent to low speed and vice-a-versa; we get the same result that DSR outperformed AODV.

Figure 6 shows the total energy consumed (Joules) by all the nodes while varying the number of connection by 10, 20, 30, 40, 50 and 60. The routing packet is increased with increase in the number of sources so energy consumption of both AODV and DSR increases with number of sources. DSR performed better AODV due to route cache.

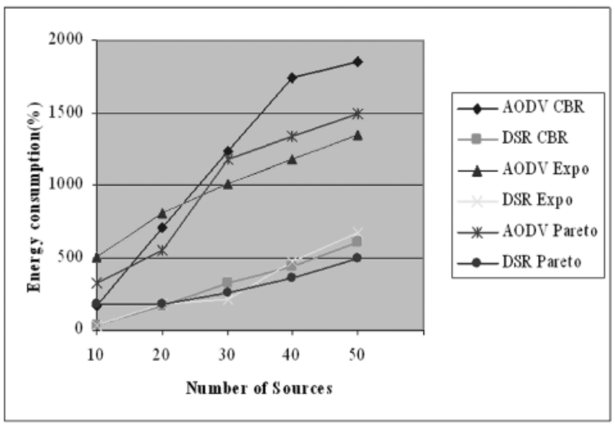

Fig 6(a): Energy Consumption Versus No. of Sources

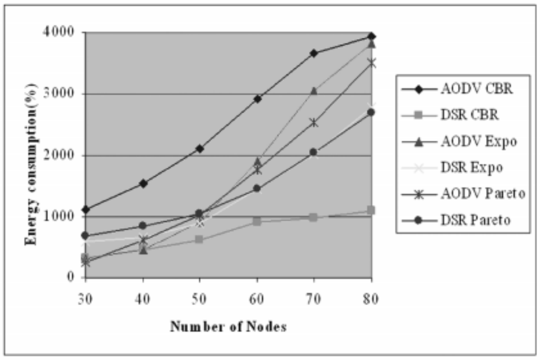

Fig 7: Energy consumption Versus No. of Node

Figure 7 gives the total energy consumed (Joules) as a function of number of nodes when varying the number of nodes between 30, 40, 50, 60, 70 and 80. Both On demand protocols show the increment in energy consumption with the increase in nodes due to increase in the maintenance process. Again DSR performed better than AODV for more number of nodes while AODV performed better at low nodes.

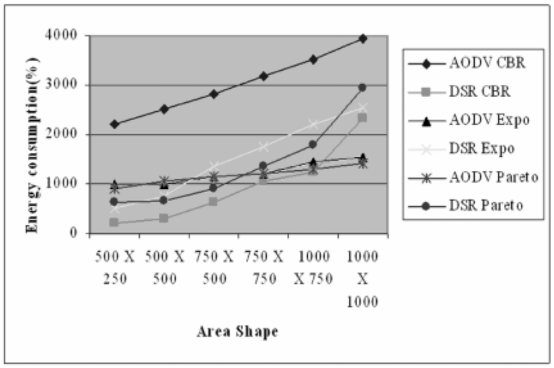

Fig 8(a): Energy consumption Versus Grid Area

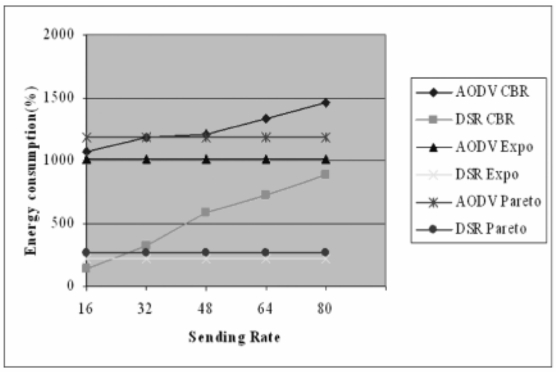

Fig 9: Energy consumption Versus Sending Rate

Figure 8 shows the total energy consumed (Joules) versus the grid area. The selected grid areas were: 500m x 250m, 500m x 500m, 750m x 500m, 750m x 750m, 1000m x 750m and 1000m x 1000m. The result shows that DSR outperformed AODV up to 750m x 750m. After this area AODV outperformed DSR because the routing table in AODV helps the nodes to learn about new routes that result in less route discovery and maintenance process.

Figure 9 shows the total energy consumed when the sending rate is varied by 16, 32, 48, 64, 80, and 96 packets/s. Again DSR outperformed AODV.

5. CONCLUSION AND FUTURE SCOPE

From the above simulation results we observe that DSR outperformed AODV in terms of (i) pause time, (ii) speed, (iii) large number of nodes, (iv) number of sources, (v) medium range of area and (vi) sending rate for all CBR, Exponential or Pareto traffic models. While AODV performed better than DSR in terms of (i) less number of nodes and (ii) large area shape. This is due to routing table which helps to learn about new route. The conclusion is presented in table 3:

Table 3
Energy Comparison Table for AODV and DSR for all Traffic Sources (CBR/Exponential/Pareto)

	AODV		*DSR*		
Low	*High*	*Low*	*High*		
Pause Time	More	More	Less	Less	Total Energy Consumption due to Control Packets
Speed	More	More	Less	Less	
No. of Nodes	Less	More	More	Less	
No. of Source	More	More	Less	Less	
Area Shape	Less	More	More	Less	
Sending Rate	More	More	Less	Less	

We observed that the energy consumption is increased mainly due to the increase in the routing packet overhead like RREQ and RREP packets. If we reduced this overhead by reducing the number of control packets, we can reduce the energy consumption and increase the lifetime of the network. In future we want to develop an algorithm that reduce these routing packets and increase the network life time.

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