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Comparison of Energy Consumption in MANET Routing Protocols using Variable Bit Rate Traffic Models by varying Traffic Parameters

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Abstract—*A Mobile Ad hoc Networks (MANET) represents a system of wireless mobile nodes that can freely and dynamically self-organize in to arbitrary and temporary network topologies, allowing people and devices to seamlessly communicate without any pre-existing communication architecture. One of the main issues in MANET routing protocols is development of energy efficient protocols due to limited bandwidth and battery life. There are various such protocols developed and analyzed under Constant Bit Rate (CBR) traffic by many authors. In earlier paper we had discussed about the energy consumption with lesser number of nodes. In the present communication the energy consumption in traffic models VBR (Exponential and Pareto) is measured using routing protocols namely AODV and DSDV. Simulation and computation of energy consumed, received and transmitted energy were done with ns-2 simulator (2.34 version) with parameter variation: number of nodes, pause time, average speed.*

Keywords: *MANET, VBR Model, Exponential traffic, Pareto traffic, AODV, DSDV, NS-2.34.*

1. INTRODUCTION

A mobile ad hoc network (MANET) is a collection of wireless mobile nodes dynamically forming a network Topology without the use of any existing network infrastructure or centralized administration. Such infrastructure less networks are usually needed in battlefields, disaster areas, and meetings, because of their capability of handling node failures and fast topology changes. One important aspect of ad-hoc networks is energy efficiency since only a simple battery provides nodes autonomy. Thus, minimizing energy consumption is a major challenge in these networks.

Jaun Carlos Cano et. al. [1] have developed number of such protocols and analyzed them under Constant Bit Rate (CBR) traffic. J Hoong et. al. [2] have compared two reactive protocols under ON/OFF source traffic. They have selected packet delivery ratio, normalized routing overhead and average delay as the performance parameters. Maashri et. al. [3] have compared the energy consumption of various protocols under CBR traffic. D. Nitnawale et. al. [4] have presented a paper on comparison of various protocols under Pareto traffic. Dubey and Shrivastava [5] have identified the packets responsible for increasing energy consumption with routing protocols using different traffic models. In the present paper, we have compared the energy consumption of two routing protocols (AODV and DSDV) under VBR using Exponential and Pareto traffic. Total energy consumed by each node during transmission and reception process has been evaluated as the function of number of nodes, pause time and average speed.

This paper is organized in five sections. Section 2 gives brief description of studied routing protocols. Section 3 describes simulation environment, traffic models and energy evaluation model. Simulation results are discussed in section 4. Section 5 describes our conclusion and future scope.

2. DESCRIPTION OF MANET ROUTING PROTOCOLS

Description of routing protocols AODV and DSDV in brief are as follows:

2.1. AODV (Ad-hoc On demand Distance Vector)

This is a reactive protocol, which performs Route Discovery using control messages route request (RREQ) and route reply (RREP) whenever a node wishes to send packets to destination. To control network wide broadcasts of RREQs, the source node uses an expanding ring search technique. The forward path sets up an intermediate node in its route table with a lifetime association RREP. When either destination or intermediate node using moves, a route error (RERR) is sent to the affected source node. When source node receives the (RERR), it can reinitiate route if the route is still needed. Neighborhood information is obtained from broadcast Hello packet. As AODV protocol is a flat routing protocol it does not need any central administrative system to handle the routing process. AODV tends to reduce the control traffic messages overhead at the cost of increased latency in finding new routes. The AODV has great advantage in having less overhead over simple protocols which need to keep the entire route from the source host to the destination host in their messages. The RREQ and RREP messages, which are responsible for the route discovery, do not increase significantly the overhead from these control messages. AODV reacts relatively quickly to the topological changes in the network and updating only the hosts that may be affected by the change, using the RRER message. The Hello messages, which are responsible for the route maintenance, are also limited so that they do not create unnecessary overhead in the network. The AODV protocol is a loop free and avoids the counting to infinity problem, which were typical to the classical distance vector routing protocols, by the usage of the sequence numbers. [6].

2.2. DSDV (Destination Sequenced Distance Vector)

The Destination Sequenced Distance Vector is a proactive routing protocol. Which include freedom from loops in routing tables, more dynamic and less convergence time. Every node in the MANET maintains a routing table which contains list of all known destination nodes within the network along with number of hops required to reach to particular node. Each entry is marked with a sequence number assigned by the destination node. The sequence numbers are used to identify stale routes thus avoiding formation of loops. In DSDV[7], each node have a routing table, here each table must contain the destination node address, the minimum number of hops to that destination and the next hop in the direction of that destination. The tables in DSDV also have an entry for sequence numbers for every destination. These sequence numbers form an important part of DSDV as they guarantee that the nodes can distinguish between stale and new routes. Here each node is associated with a sequence number and the value of the sequence number is incremented only by the node the sequence number is associated with. Thus, these increasing sequence numbers here emulate a logical clock. Suppose a node receives two updates from the same source then the receiving node here makes a decision as to which update to incorporate in its routing table based on the sequence number. A higher sequence number denotes a more recent update sent out by the source node. Therefore it can update its routing table with more actual information and hence avoid route loops or false routes.

DSDV determines the topology information and the route information by exchanging these routing tables, which each node maintains. The nodes here exchange routing updates whenever a node detects a change in topology. When a node receives an update packet, it checks the sequence number in the packet. If the information in the packet is older than the receiving node has in its routing tables, then the packet is discarded. Otherwise, information is updated appropriately in the receiving node's routing table. The update packet is then forwarded to all other neighboring nodes (except the one from which the packet came). In addition, the node also sends any new information that resulted from the merging of the information provided by the update packet. The updates sent out in this case, by nodes resulting from a change, can be of two types that is either a full update or a partial update. In case of full updates, the complete routing table is sent out and in case of a partial updates only the changes since last full update are sent out.

3. SIMULATION ENVIRONMENT

The simulation is done with the help of NS-2 simulator version 2.34 [8]. The network contains 10, 30 and 50 nodes randomly distributed in a 500m X 500m area, pause time of 10s, 50s and 100s and average speed of 17.10m/s, 4.72m/s and 2.48m/s as basic scenario.

Parameter	Value
No. of nodes	10, 30, 50
Simulation Time	120s
Pause Time	10s, 50s, 100s
Average Speed	17.10m/s, 4.72m/s, 2.48m/s
Traffic Type	VBR(Exponential, Pareto)
Packet Size	512byte

Table 1: Basic Simulation Scenario

The selected parameters are varied using setdest command .

3.1. Traffic Model

Traffic model used are VBR (Exponential and Pareto), which are generated using cbrgen.tcl [9].

3.1.1. VBR Traffic Model

VBR generates traffic at a non-deterministic rate. It is an ON/OFF traffic.

3.1.2. Exponential Traffic Model

It is an ON/OFF traffic with exponential distribution. It generates traffic during ON period (burst time). Average ON and OFF (idle time) times are 1.5s and 0.5s respectively.

Parameter	Value
Burst Time	1.5s
Idle Time	0.5s

3.1.3. Pareto Traffic Model

It is an ON/OFF traffic with exponential distribution. It also generates traffic during ON period (burst time). Average ON and OFF (idle time) times are 1.5s and 0.5s respectively with a shape of 2.5.

Parameter	Value
Burst Time	1.5s
Idle Time	0.5s
Shape	2.5

Table 2: Parameter for Exponential Traffic

3.2. Energy Evaluation Model

We have used energy model as given in the following table:

Parameter	Value
Network Interface	WirelessPhy
MAC Type	802.11
Channel	WirelessChannel
Propogation	TwoRayGround
Antenna	OmniAntenna
Radio Frequency	281.8mW (≈250m)
Initial Energy	100 Joule
Idle Power	1.0w
Receiving Power	1.1w
Transmission Power	1.65w
Transition Power	0.6w
Sleep Power	0.001w
Transition Time	0.005s

Table 3: Parameter for Energy Model

Energy is converted in joules by multiplying power with time. Total energy consumed by each node is calculated as sum of transmitted and received energy for all control packets.

4. RESULTS

We have made following evaluation with pause time 10s:

Energy consumption percentage due to packet type (routing/ MAC/Expo or Pareto) during transmission and reception with 10 nodes (Figure 1), 30 nodes (Figure 2) and 50 nodes (Figure 3)

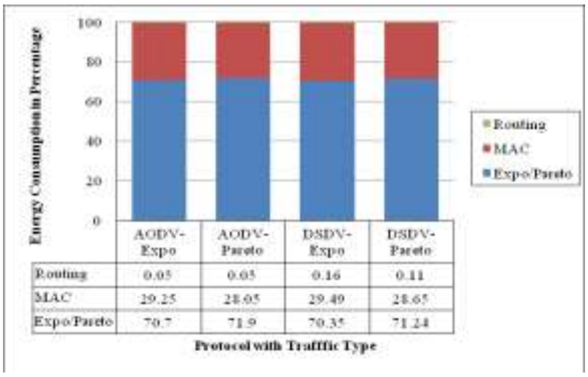

Figure 1: Energy consumption percentage due to packet type during transmission and reception with 10 node

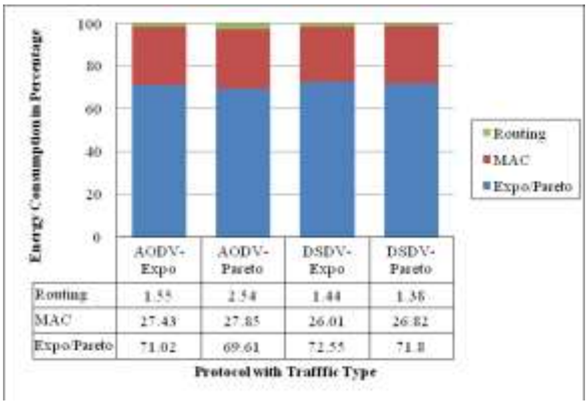

Figure 2: Energy consumption percentage due to packet type during transmission and reception with 30 nodes

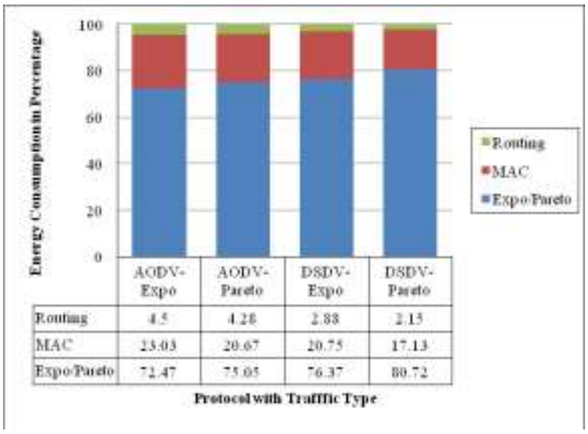

Figure 3: Energy consumption percentage due to packet type during transmission and reception with 50 nodes

Figure 1, 2 and 3 shows the energy consumed due to traffic type Expo or Pareto control packet significantly affects the total energy consumption for AODV and DSDV protocols. The protocol type REQUEST, REPLY and ERROR packets are routing control packets. Request to Send (RTS), Clear to Send (CTS) and Acknowledgment (ACK) are the MAC control packets. Energy consumed by routing control packets is increased with increasing the number of nodes while energy consumed by MAC control packets is decreased with increasing the number of nodes.

Energy consumption percentage of Total transmission and receiving energy due to control packets with 10 nodes (Figure 4), 30 nodes (Figure 5) and 50 nodes (Figure 6).

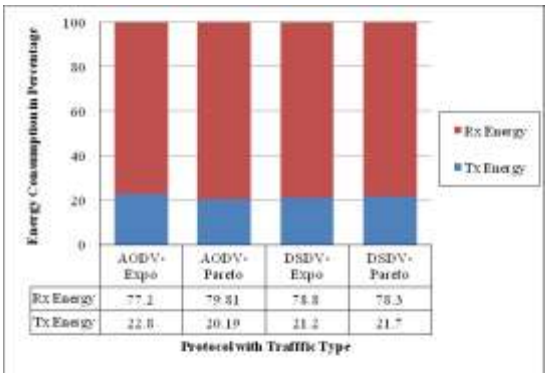

Figure 4: Energy consumption percentage of total transmission and receiving energy with 10 nodes

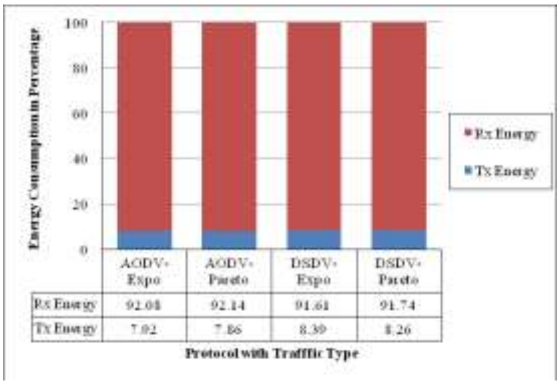

Figure 5: Energy consumption percentage of total transmission and receiving energy with 30 nodes

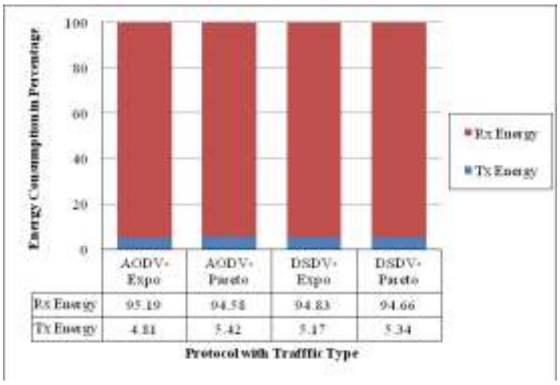

Figure 6: Energy consumption percentage of total transmission and receiving energy with 50 nodes

Figure 4, 5 and 6 shows the total transmission and receiving energy. The energy consumed mainly due to receiving process. When number of nodes is low, the transmitting energy is more with Expo traffic in comparison to Pareto traffic for AODV and DSDV. This is due to burst nature of Exponential traffic. On the contrary, when number of nodes is high, transmission energy is less with Expo Traffic type than Pareto Traffic type.

4.1. Varying Selected Parameters

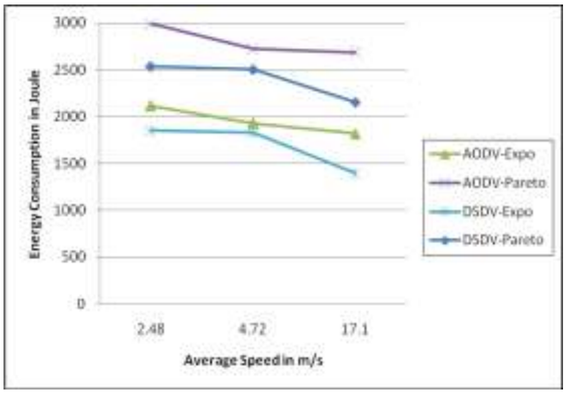

Figure 7: Energy consumption Versus Average Speed with 50 nodes

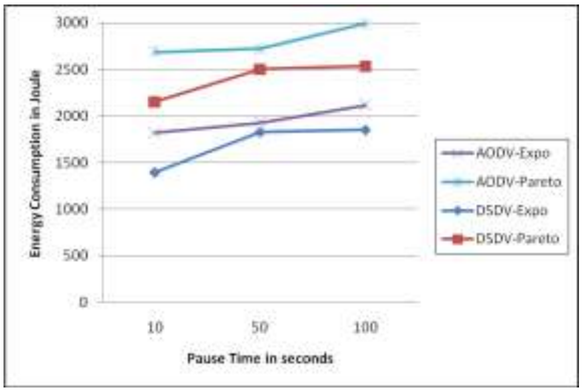

Figure 8: Energy consumption Versus Pause Time with 50 nodes

Figure 7 shows total energy consumed in joule by all 50 nodes involved in transmitting and receiving the control packets with increasing average speed 2.48m/s, 4.72m/s and 17.10m/s. Energy consumption is more with Pareto traffic than Exponential traffic. In both traffic AODV consumes more energy due to more route discovery process than DSDV due to immediate route availability. In Pareto traffic, AODV consumes nearly same amount of energy, while in Exponential traffic energy consumption is decreases with increasing speed. In both Pareto and Exponential traffic, energy consumed with DSDV is decreased with increasing speed.

Figure 8 shows total energy consumed in joule by all 40 nodes involved in transmitting and receiving the control packets with increasing pause time 10s, 50s and 100s. Energy consumption is more with Pareto traffic and less with Exponential traffic with increment in pause time. In Pareto traffic, AODV consumes nearly same amount of energy, while in Exponential traffic energy consumption is increases with increasing pause time. In both Pareto and Exponential traffic, energy consumed with DSDV is increased with increasing pause time.

The speed and pause time defines mobility of nodes, both are inversely proportional to each other. We obtain the results, which verify the same.

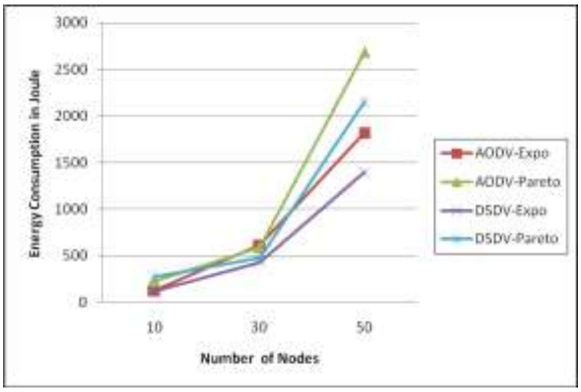

Figure 9: Energy consumption Versus Number of nodes

Figure 9 shows total energy consumed in joule involved in transmitting and receiving the control packets with increasing number of nodes 10, 30 and 50. All traffic models show the increment in energy consumption with increasing number of nodes due to the requirement of more maintenance process. At low number of node all consume nearly same amount of energy. AODV consume more energy compare to DSDV with Pareto and Exponential traffic. The energy consumption in Pareto traffic is more than the Exponential traffic with both the protocols.

5. CONCLUSION AND FUTURE SCOPE

From the above study and obtained simulation results, we observe that AODV consume more energy than DSDV with increasing number of nodes, average speed and pause time with both Pareto and Exponential traffic.

We observed that increasing number of nodes also increases energy consumption due to routing control packets. We can reduce energy consumption by reducing the number of routing control packets to increase the lifetime of network. In future we will try to evaluate and measure performance of other routing protocols under these scenarios and develop an algorithm for reducing the number of routing packets.

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