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Energy Consumption in Unipath and Multipath MANET Routing Protocols under CBR and VBR Traffic Models

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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. The present communication is an attempt to identify the energy consumption packets in traffic models (CBR and VBR) using unipath routing protocol AODV and multipath routing protocol AOMDV. 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, CBR Traffic, VBR traffic, AODV, AOMDV, NS-2.34.*

1. Introduction

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. 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 identified the energy consumption packet of unipath routing protocol AODV and multipath routing protocol AOMDV under CBR and VBR traffic. Total energy consumed by each node during transmission and reception process has been evaluated as the function of number of nodes, pause time, average speed and number of sources.

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 unipath routing protocols AODV and multipath routing protocol AOMDV in brief are as follows:

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

This is a unipath 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. AOMDV (Ad-hoc On demand Multipath Distance Vector)

The main idea in AOMDV [5] is to compute multiple paths during route discovery. It consists of two components: A route update rule to establish and maintain node and a distributed protocol to find link-disjoint paths. In AOMDV each RREQ, respectively RREP arriving at a node potentially defines an alternate path to the source or destination. Just accepting all such copies will lead to the formation of routing loops. In order to eliminate any possibility of loops, the "*advertised hopcount*" is introduced. The *advertised hopcount* of a node *i* for a destination *d* represents the maximum *hopcount* of the multiple paths for *d* available at *i*. The protocol only accepts alternate routes with *hopcount* lower than the *advertised hopcount*, alternate routes with higher or the same *hopcount* are discarded. The *advertised hopcount* mechanism establishes multiple loop-free paths at every node. These paths still need to be disjoint. When a node *S* floods a RREQ packet in the network, each RREQ arriving at node *I* via a different neighbor of *S*, or *S* itself, defines a node disjoint path from *I* to *S*. In AOMDV this is used at the intermediate nodes. Duplicate copies of a RREQ are not immediately discarded. Each packet is examined to see if it provides a node-disjoint path to the source. For node disjoint paths all RREQs need to arrive via different neighbors of the source. This is verified with the *firsthop* field in the RREQ packet and the *firsthop_list* for the RREQ packets at the node. At the destination a slightly different approach is used, the paths determined there are linkdisjoint, not node-disjoint. In order to do this, the destination replies up to k copies of the RREQ, regardless of the firsthops. The RREQs only need to arrive via unique neighbors.

The core of the AOMDV protocol lies in ensuring that multiple paths discovered are loop-free and disjoint, and in efficiently finding such paths using a flood-based route discovery. AOMDV route update rules, applied locally at each node, play a key role in maintaining loop-freedom.

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, 30s and 50s and average speed of 17.10m/s, 7.4m/s and 4.72m/s as basic scenario.

Table 1: Basic Simulation Scenario

Parameter	Value
No. of nodes	10, 30, 50
No. of Source	6, 17, 26
Simulation Time	120s
Pause Time	10s, 30s, 50s
Average Speed	17.10m/s, 7.4m/s,4.72m/s
Traffic Type	CBR, Exponential, Pareto
Packet Size	512byte

3.1. Traffic Model

Traffic model used are CBR and Exponential, which are generated using cbrgen.tcl [9].

3.1.1. CBR Traffic Model

CBR generates traffic at a deterministic rate. It is not an ON/OFF traffic.

3.1.2. VBR Traffic Model

VBR generates traffic at non deterministic rate.

3.1.2.1 Exponential Traffic Model

It is a VBR 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.

Table 2: Parameter for Exponential Traffic

Parameter	Value
Burst Time	1.5s
Idle Time	0.5s

3.1.2.1 Exponential Traffic Model

It is a VBR traffic with pareto distribution. It 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.

Table 3: Parameter for Pareto Traffic

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

3.2. Energy Evaluation Model

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

Table 4: Parameter for Energy Model

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

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 of 10s:

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

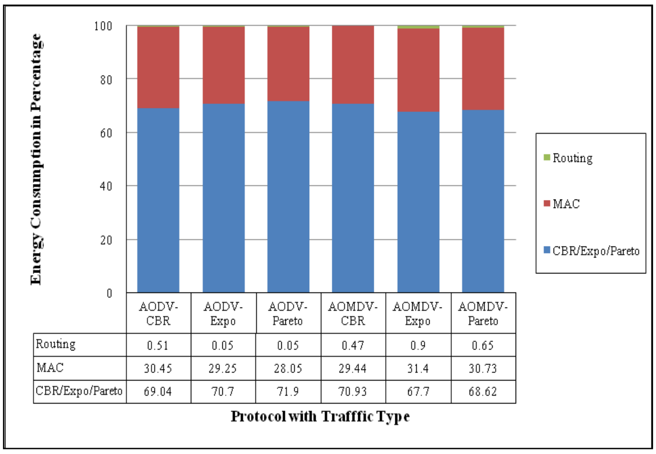

Figure 1: Energy consumption percentage due to packet type during transmission and reception with 10 nodes

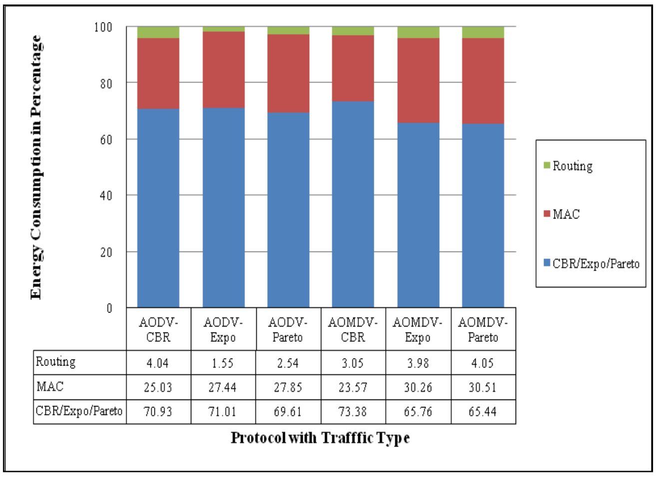

Figure 2: Energy consumption percentage due to packet type during transmission and reception with 30 nodes

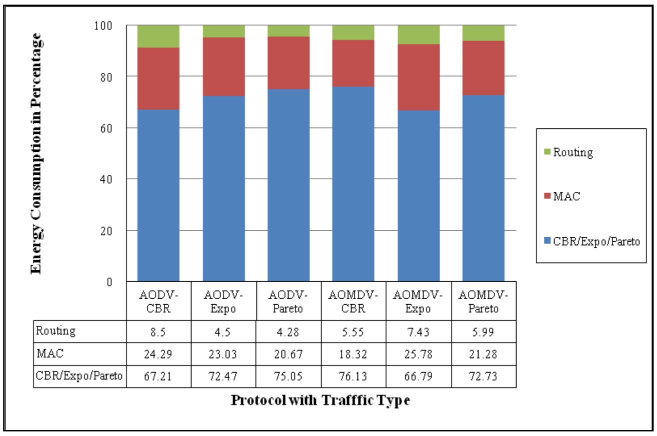

Figure 3: Energy consumption percentage due to packet type during transmission and reception with 50 nodes

Figure 1, 2 and 3 shows the energy consumed due to traffic type CBR or Expo or Pareto control packet significantly affects the total energy consumption for AODV and AOMDV 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.

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

Figure 4: Energy consumption percentage of total transmission and receiving energy due to control packets with 10 nodes

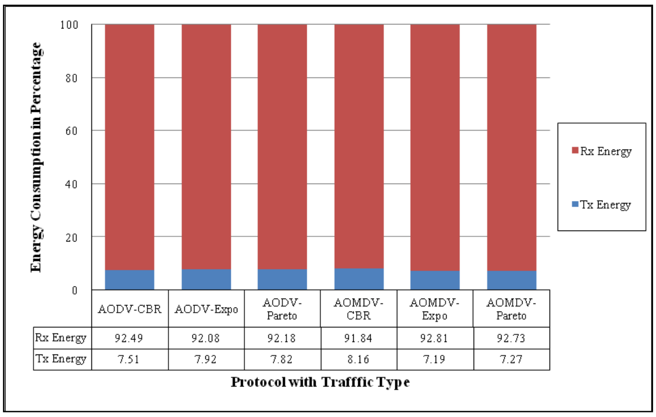

Figure 5: Energy consumption percentage of total transmission and receiving energy due to control packets with 30 nodes

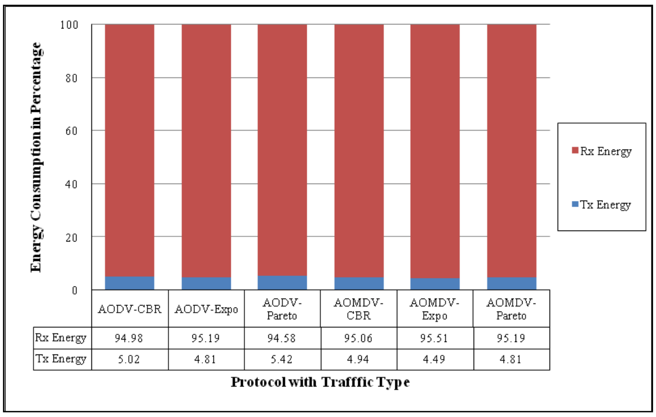

Figure 6: Energy consumption percentage of total transmission and receiving energy due to control packets with 50 nodes

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 VBR traffic models in comparison of CBR traffic for AODV. This is due to burst nature of VBR traffic. When number of nodes is high, transmission energy in AODV with CBR Traffic type is more than Exponential Traffic type but less than Pareto Traffic type, while energy consumed during transmission in AOMDV with CBR Traffic type is more than VBR Traffic types.

4.1. Varying Selected Parameters

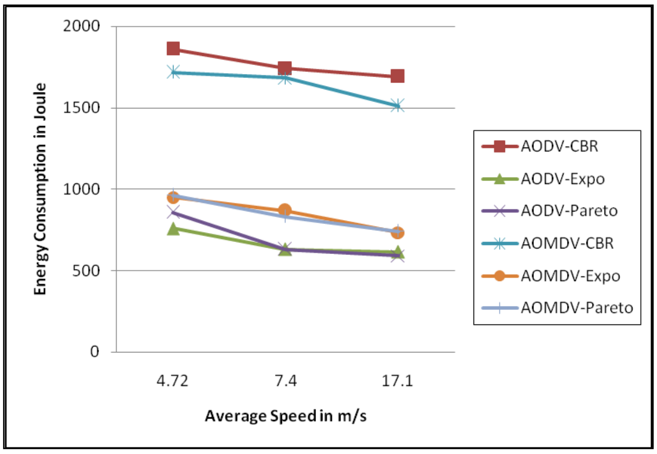

Figure 7: Energy consumption Versus Average Speed

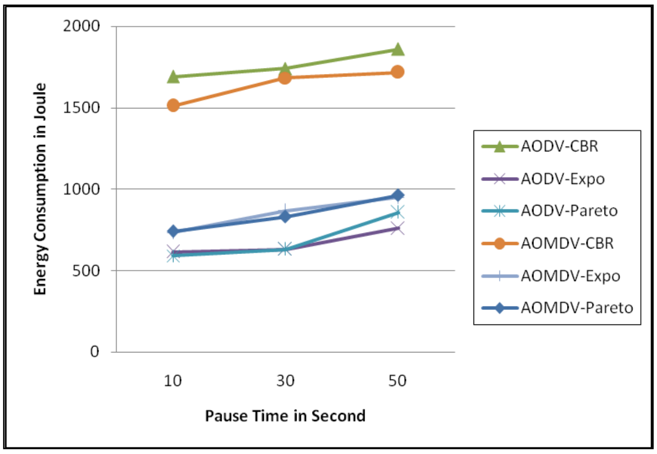

Figure 8: Energy consumption Versus Pause Time

Figure 7 shows total energy consumed in joule by all 30 nodes involved in transmitting and receiving the control packets with increasing average speed 4.72m/s, 7.4m/s and 17.10m/s. Energy consumption is more with CBR traffic than VBR traffic types. In all traffic type AODV consumes more energy due to more route discovery process than AOMDV due to immediate route availability. In both CBR and VBR traffic, energy consumption is decreased with increasing speed.

Figure 8 shows total energy consumed in joule by all 30 nodes involved in transmitting and receiving the control packets with increasing pause time 10s, 30s and 50s. Energy consumption is more with CBR traffic and less with VBR traffic types with increment in 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.

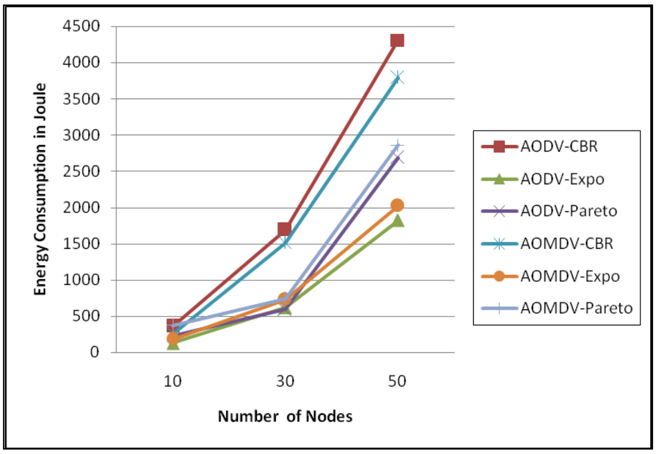

Figure 9: Energy consumption Versus Number of nodes

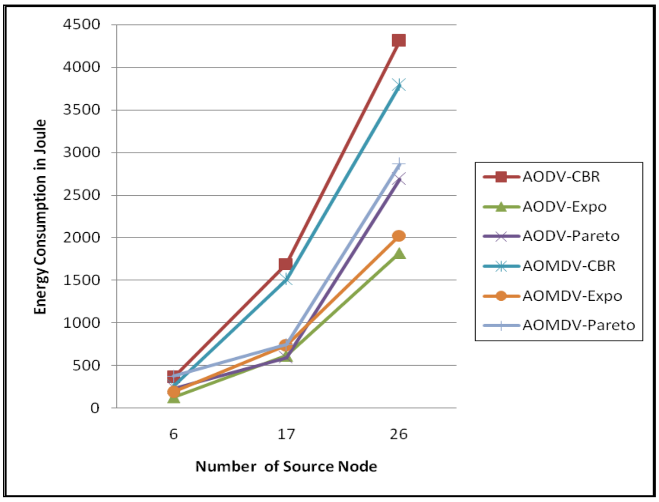

Figure 10: Energy consumption Versus Number of sources

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, while Figure 10 shows total energy consumed in joule involved in transmitting and receiving the control packets with increasing number of sources 6, 17 and 26. Both traffic models show the increment in energy consumption with increasing number of nodes as well as increasing number of sources due to the requirement of more maintenance process. At low number of node and source all consume nearly same amount of energy. AODV consume more energy compare to AOMDV with CBR and VBR traffic types. The energy consumption in CBR traffic is more than the VBR traffic with both the protocols.

5. Conclusion and Future Scope

From the above study and obtained simulation results, we observe that unipath AODV consume more energy than multipath AOMDV with increasing number of nodes, number of sources, average speed and pause time with both CBR and VBR traffic.

We identified 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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