Evaluation of Energy Efficient Data Delivery in Mobile Ad-hoc network

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Abstract

MANET (Mobile Ad hoc Network) is self organizing and self configuration and self controlled network without the need of any base station AP (Access Point). Mobility of nodes in MANET causes ever changing topologies. As one of constraints in MANET is limited battery resources, it is important to know energy efficiency of routing protocols to limit the power consumption, prolong the battery life and to improve the robustness of the system. This paper focuses on energy consumption analysis on MANET with the comparative study on routing protocols like DSR and AODV. The evaluation is performed by using NS-2.

Key words: *Mobile Ad-hoc Network, AODV, DSR, NS2*

1. Introduction

Wireless network [13] becomes increasingly popular in nowadays. There are two kinds of networks. They are Infrastructure networks and Infrastructure less networks. The former is fix, wired backbone. Mobile nodes communicate directly with access points. It is suitable for locations where access points can be placed such as Cellular networks [14]. The later network is a network without any base stations "infrastructure-less" or multi-hop. A collection of two or more devices equipped with wireless communications and networking capability. It can support anytime and anywhere computing. Ad-hoc networks are a new feature of wireless communication for mobile hosts. In MANET [12], each node acts as a router or a host and the topology of network may also change rapidly. So this type of network has no fixed infrastructure. A MANET is a type of ad hoc network that can change locations and configure itself on the fly. Such a network may operate in a standalone fashion, or may be connected to the larger Internet .Energy conservation is also an important issue in MANET [10] [6] because mobile nodes are often battery powered and cannot function without enough power level. As devices are being designed to be smaller (cell phones, PDAs, digital cameras), communication energy cost becomes a more significant portion of the total power consumed. In situations such as emergency rescue, military actions, and scientific field missions, energy conservation in MANET [3] plays an even more important role which is critical to the success of the tasks performed by the network. Therefore, energy conservation should be considered carefully when designing or evaluating ad hoc routing protocols. Figure 1 shows the architecture of MANET.

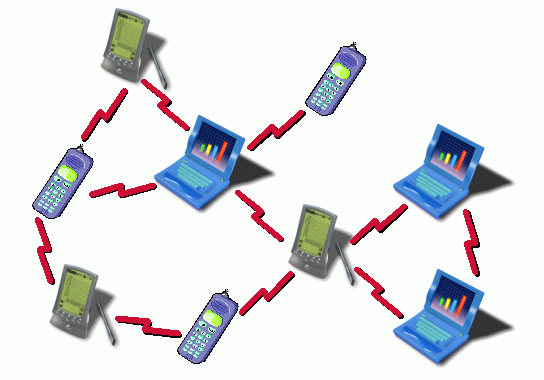

Figure 1: Mobile Ad-hoc Network Architecture

The paper is organized as follow. Section.2 describes features and challenges of MANET. The reactive routing protocols, DSR (Dynamic Source Routing) and AODV (Ad-hoc On Demand Distance Vector) are described in Section 3. Section.3 describes MANET challenges. Section.4 describes the experimental setup using Ns2 and analyze the ECSDD (Energy Consumption per Successful Data Delivery). Section.5 concludes the paper.

2. Features and Challenges of MANET

2.1 Features of MANET

The features of MANET are as follows:

Distributed operation: There is no centralized control network to send and receive

packets. Mobile nodes can do self-control and management of routs to reach destinations.

Multi hop routing: Packets are transmitted to destination in both routing algorithms single hop and multi hop. Multi hop is more complex than single hop not only in structure but also in configuration. Unlike simple wireless network, MANET needs to hop multipath to reach destination.

Light-weight terminals*:* MANET nodes are mobile devices with less CPU processing capability, small memory size, and low battery power. Such devices need optimized algorithms and mechanisms that implement the computing and communicating functions.

2.2 Challenges of MANET

Some of the challenges of MANET are:

Packet loss: MANET gets higher packet loss due to ever changing network, due to the presence of hidden terminals and presence of interference. Frequent paths break occurs because of node mobility.

Battery constraints: One of the major constraints in MANET [9] is exhausted battery power consumption. Devices in MANET need to maintain mobility, size and weight of devices in order to save battery power.

Route changes: Network topology in MANET is ever changing due to movement of nodes. Paths break in every time. This situation leads to change routes.

Potentially frequent network partitions: Randomly movement of nodes in MANET [5] in mobile ad hoc network lead to partitions of network. Intermediate nodes are the major nodes to partitioning of MANET.

Limited wireless transmission range: Radio band is limited in wireless network and data rates it can transfer is much lesser than wired network.

3. Reactive Routing Protocols

This section we briefly review the studied routing protocols.

3.1 AODV

AODV [1] provides route discovery when need to send packets or in MANET. It is called on-demand routing. If the source node doesn't have routing information in its table when source needs to send destination, route discovery process is started to find the routes from source to destination.

3.1.1 Rout Discovery

Rout discovery process is performed in nodes, which may be source node, intermediate node and destination node. Source Node initiates RREQ route request messages. RREQ contains source node IP address and current sequence number of Source, Destination IP address, last known sequence number of destination and broadcast ID. It sets a timer to wait for reply. Intermediate nodes check the unique identifier (Source IP address & broadcast ID)of the RREQ. If it has already seen from it, discards the packet .If not, set up a *reverse route* for the source node, associated with a lifetime and broadcast the RREQ to its neighbors. Node responds to the RREQ (not necessary destination node) must have an unexpired entry for destination and reply a RREP back to the source, using the node from which it received the RREQ as the next hop.

3.1.2 Rout Maintenance

Suppose some routes are not used, they are expired their lifetimes and need to remove these routes. But if routes are needed to be used, the lifetime period of them are needed to be updated so those routes are not expired. When a source node wants to send data to some destination, first it searches the routing table. If it finds route that can reach to destination, it will use that routes. Otherwise, it must start a route discovery to find a route. It is also needed to send Route Error (RERR) message that used to notify the other nodes about some failures in other nodes or links.

3.1.3 Advantages of AODV

Route discovery is started when no active routes in tables and routes maintained as necessary. Guarantee loop free through the use of sequence number. Currently only use the symmetric links. Nodes maintain only next-hop routing information.

3.1.4 Disadvantages of AODV

Periodic beaconing leads to unnecessary BW consumption. Multiple RREPs in response to a single RREQ can lead to heavy control overhead. Intermediate nodes have stale entries.

3.2 DSR

Dynamic Source Routing (DSR) [2] is a reactive routing protocol. It has equality of treating routing algorithm in all nodes on network as it as flat structure. In DSR routing, the source node needs to append the complete routing path to each data packet header before transmitting to other nodes. Additionally, each node uses a caching technique to maintain the route information that they have traversed before. Routing construction in DSR also has two major phases; the route discovery and the route maintenance.

3.2.1 Rout Discovery

When a source node wants to send a data, it broadcasts the RREQ packet to its neighbor nodes. When an intermediate node on the route to the destination receives the RREQ packet, it appends its address to the route record in RREQ and re-broadcast the RREQ. When the destination node receives the first RREQ packet, it starts a timer and collects RREQ packets from its neighbors until quantum q time expires. The destination node finds the two (primary +Backup) best routes from the collected paths within the quantum q time. The destination node D sends RREP packet to the source node S by reversing (RREQ) packets which includes the two routes (Primary +Backup) for further communication.

3.2.2 Rout Maintenance

In the Route maintenance, DSR provides three successive steps: link layer acknowledgment, passive acknowledgment and network layer acknowledgment. When a route is broken and one node detects the failure, it sends a Route Error packet to the original sender.

3.2.3 Advantages of DSR

DSR has the advantages of being able to use asymmetric links and generating no additional routing overhead if the network topology remains unchanged. Moreover, it is easily implemented and supports multipath routing. The main disadvantage of DSR lies in the use of source routing. More specifically, the size of RREQ packets can increase as they propagate through the network. Moreover, if the route is sufficiently long, the routing information embodied in a packet can become large in relation to data carried by the packet. These issues compromise the scalability of DSR.

3.2.4 Disadvantages of DSR

It is not scalable because packet header size grows linearly with route length due to source routing. Flood of route requests may potentially reach all nodes in the network. It causes too much overhead. Care must be taken to avoid collisions between route requests propagated by neighboring nodes insertion of random delays before forwarding RREQ Reply storm problem can caused because of Increased contention if too many route replies come back due to nodes replying using their local cache. It has stale cache problem as an intermediate node may send Route Reply using a stale cached route, thus polluting other caches. This problem can be eased if some mechanism to purge (potentially) invalid cached routes is incorporated.

4. Experimental Setup

In this paper, AODV and DSR protocols analyze the performance metrics in term of the following parameters.

Table 1: Simulation Parameters

Parameter	Value
Protocols	AODV, DSR
Traffic Source	Constant Bit Rate (CBR)
Simulation Time	100 s
Packet Size	512 bytes
Area	500 x 500 m^2
Number of Nodes	25,50, 75, 100 nodes
Mobility model	Random way point model
Radio Propagation Model	Two way ground
Initial Energy	7.0J
Transmit Power	0.6W
Receive Power	0.3W

There are many performance metrics which are used for analysis of various protocols. In this paper, Energy Consumption per Successful Data Delivery, ECSDD use as the performance metric for evaluation of energy consumption.

4.1 ECSDD (Energy Consumption per Successful Data Delivery):

It is the ratio of total energy consumption to the number of data packets successfully delivered to the destination. Lower the ECSDD values indicate that node uses less energy for data communication. This helps in extending the lifetime of node and thus overall network lifetime.

$$\text{ECSDD} = \sum_{n=0}^{n-1} \frac{\text{EnergyConsumed}}{\text{DataPacketNumber}} \qquad (1)$$

4.2 Energy Consumption Analysis Model

Simulation is implemented using random way-point mobility model. Pattern and traffic was generated using constant bit rate. Overall Consumption Energy is calculated by using Energy Model [4]. Each mobile node has initial energy value. Node consumes energy for transmitting and receiving packets. Based on simple equation,

$$Energy = Power \times time \qquad (2)$$

The evaluation of energy consumption with ECSDD with varying nodes analysis is show in fig 4.1.

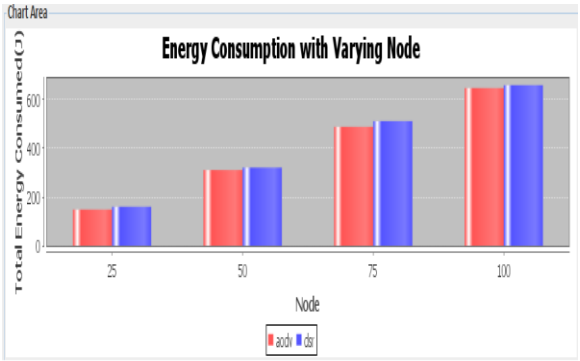

Figure 4.1 Energy Consumption with Varying Node

Figure 4.1shows the performance graphs for AODV and DSR with varying node number. Both protocols AODV and DSR energy consumption increases in increasing number of nodes. In dense node number, AODV‘s energy consumption lesser from 8 (%) to 24% than DSR. AODV consumes more energy than DSR because of routing tables. But in increasing node numbers, DSR consumes more energy than AODV. DSR has many hop counts to get destination in dense node number. DSR has greater energy consumption in dense network because it sends routing packets than AODV and stale route.

Figure 4.2, 4.3 and 4.4 show the performance graphs for AODV and DSR varying packet sending rate. In lower node numbers, DSR protocol has nearly the same energy consumption with AODV. But in larger node number AODV has lesser energy consumption than DSR in both lower and higher packet sending rate. And in higher packet sending rate, energy performance is nearly the same values because of nodes can only send packets that they are available to send whatever packet sending rate is increasing.

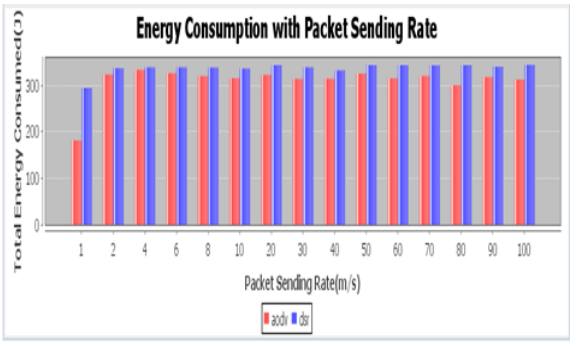

Figure 4.2 Energy Consumption with Packet Sending Rate For 50node

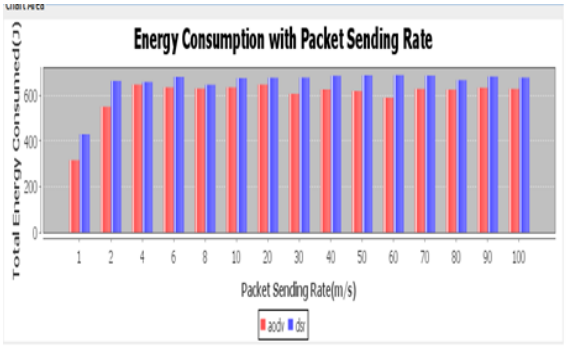

Figure 4.3 Energy Consumption with Packet Sending Rate For 100node

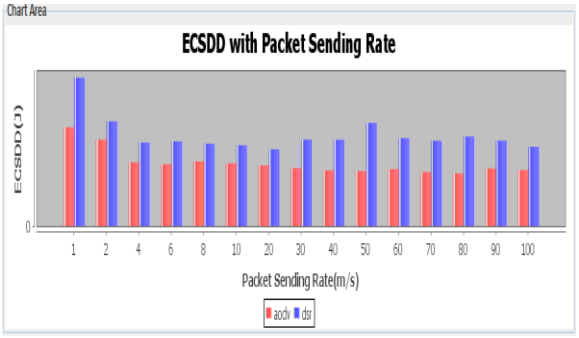

Figure 4.4 ECSDD with Packet Sending Rate For 50node

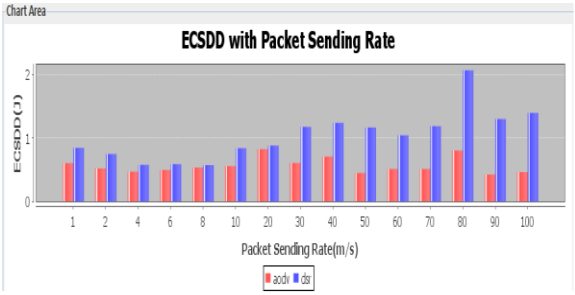

Figure 4.5 ECSDD with Packet Sending Rate For 100node

5. Conclusion

This paper is an attempt to evaluation performance of two commonly used mobile ad hoc routing protocols namely AODV and DSR. Performance evaluation is performed in NS-2 simulator. The evaluation was ECSDD and packet sending rate. According to the results AODV gives better performance in wide range of simulation conditions for MANET but DSR can only give good energy consumption performance in low dense node, mobility, high packet sending rate.

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