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Simulation and Analysis of Routing Protocols in MANETS for Different Network Sizes

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Abstract: Efficient deployment of MANET (Mobile Ad hoc Networks) requires high engineering research to overcome many challenges. Routing in MANET is one of the challenging tasks due to its dynamic topology and lack of centralized infrastructure. The communication in ad hoc network is uncertain because established route could be broken anytime. In recent years, several routing protocols have been proposed for mobile ad hoc networks and prominent among them are DSDV, DSR and AODV. This paper is a comparative study of these routing protocols under different network size showing the simulation results using NS2. We have chosen four performance criteria i.e. average energy consumed, end to end delay, and throughput and packet delivery fraction to compare these protocols.

Keywords: MANET, routing protocols, DSR, DSDV, AODV

I. INTRODUCTION

With recent performance advancements in computer and wireless communications technologies, advanced mobile wireless computing is expected to see increasingly widespread use and application. Mobile Ad-hoc network is a self organizing network of mobile devices which communicate with each other without the help of centralized infrastructure [Figure 1]. Ad-hoc networks came into existence in early 1970s with the development of ALOHANet and PRNET (PACKET RADIO NETWORK). Since then Ad-hoc Networks have undergone through many advancements and crucial researches. Each mobile node in the MANET behaves as packet source, router and packet sink.

This paper is a comparative study of the most famous routing protocols in MANETs using various performance criteria i.e. average energy consumed, end to end delay, and throughput and packet delivery fraction. The most popular simulation tool NS2 is used for this study. This paper compares DSDV, AODV and DSR under different network size. The performance is estimated by increasing the size of network from 20 to 80 nodes.

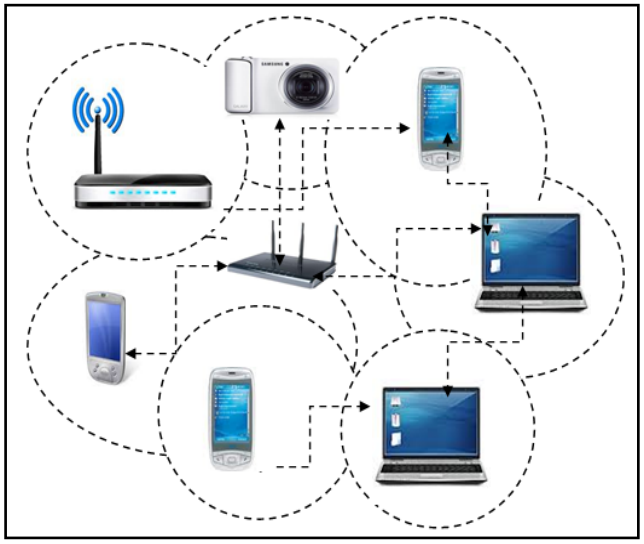

Figure 1. MANET Example

II. MANET PROPERTIES

The following properties make MANETs different from other networks [1]:

A. Highly Dynamic Topology

The nodes in a MANET can leave or join at any point of time. Moreover the nodes are free to move thus causing breakage of links and formation of new links.

B. Lack of infrastructure:

MANET is a self organizing network. It lacks centralized infrastructure or administration. Each node itself behaves as router and forwards the traffic ahead.

C. Power constraint:

MANET mainly consists of miniature devices with limiting battery power. There is no source of power backup in this type of ad-hoc network.

D. Bandwidth constraint:

MANET nodes work on limited bandwidth. They mainly communicate only to their neighbors to conserve bandwidth.

E. Device diversity:

A Mobile ad-hoc network can include various types of miniature devices which differ in their hardware, operating system, interface etc. MANET nodes can use different protocols such as Bluetooth, IrDA, ZigBee, 802.11.

F. Limited Computing power:

MANET nodes can perform limited computation such as data caching, sensing, aggregation etc.

III. ROUTING IN MANETS

Routing is the process of finding a path from a source to some arbitrary destination on the network. A routing protocol is needed whenever a packet needs to be transmitted to a destination via number of nodes. Numerous routing protocols have been proposed for such kind of ad hoc networks. These protocols find a route for packet delivery and deliver the packet to the correct destination. The main two reasons for

route breakages are: movement of a node in the route from its neighbor's signal range and any node in the route may run out of battery. The studies on various aspects of routing protocols have been an active area of research for many years. Many protocols have been suggested keeping applications and type in view.

MANET routing protocols [2] fall into three general categories: Proactive routing protocols, Reactive routing protocols and Hybrid routing protocols.

A. Proactive Routing protocols:

Proactive routing protocols are also called table driven routing protocols because each node maintains a dynamic routing table. This type of routing protocols is derived from Bellman-Ford algorithm [3]. It is efficient if the network is static and routes are often used. The updates are shared periodically between the nodes. Each node than recalculates the shortest path on the basic of minimum hop count. Thus each node contains a complete picture of the network topology. Various proactive routing protocols are DSDV, FSR, and WRP etc.

B. Reactive Routing protocols:

Reactive routing protocols first listen to the communication request. It is also called as on-demand routing as route discovery is initiated only when there is a demand of communication between any two nodes. This paradigm is more efficient and prevents routing overhead up to a certain limit. The examples are DSR, AODV and TORA.

C. Hybrid Routing protocol:

A Hybrid protocol combines the advantages of proactive and reactive routing protocols. It uses reactive protocol for reducing routing overhead and proactive protocols to reduce latency. It presents a trade-off between latency and overhead. The Zone Routing Protocol (ZRP) [4] is the most popular hybrid routing protocol. ZRP takes advantage of this fact and divides the entire network into overlapping zones of variable size. It uses proactive protocols for finding zone neighbors (instantly sending *hello* messages) as well as reactive protocols for routing purposes between different zones [5]

IV. MOST POPULAR ROUTING PROTOCOLS

The three most popular routing protocols in MANETS are described below. These protocols are further analyzed and compared in this paper.

A. DSDV: (Destination Sequenced Distance Vector Routing):

It is a proactive routing protocol that works on Bellman-Ford algorithm. Every mobile station maintains a routing table that lists all available destinations, the number of hops to reach the destination and the sequence number assigned by the destination node. The stations periodically transmit their routing tables to their immediate neighbors. The sequence number is used to distinguish stale routes from new ones and thus avoid the formation of loops. DSDV [6] performs well under low node mobility.

B. DSR (Dynamic Source Routing):

It is a reactive protocol. DSR [7] is based on source routing. So instead of hop by hop routing, the source knows the exact route a packet has to travel. The packet header includes the complete path to the destination. Each intermediate node may maintain a cache which is used in the case of link failure. The two major phases of the protocol are: route discovery and route maintenance. In the route discovery phase the sender broadcasts a RREQ (route request) packet containing the source and destination ID and a unique request ID. Each intermediate node appends its ID in the RREQ packet header until it reaches the destination. The destination generates RREP (Route Reply) Packet and unicasts it to the reverse path. In route maintenance if the link between any two nodes fails, the intermediate node generates RERR (Route ERROR) packet and transmits it to the sender. Each intermediate node deletes its cache entry on receiving the RERR packet and a new route discovery phase starts.

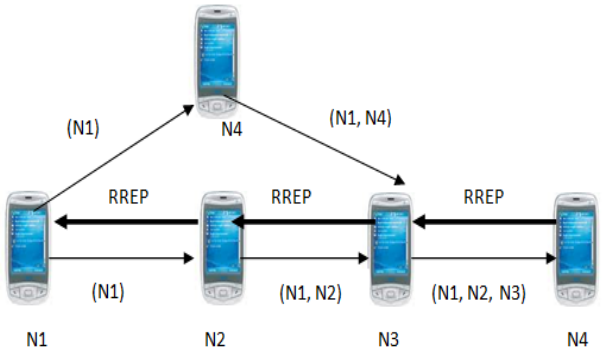

Figure 2. DSR Route Discovery

C. AODV (Ad-Hoc On-Demand Distance Vector Routing):

AODV [8] algorithm is descendant of DSDV. It is a reactive algorithm and works on on-demand paradigm thus reducing the number of routing updates and overall broadcast overhead as compared to DSDV. In the Route discovery phase as a RREQ traverses the network, the intermediate nodes store information about the source, the destination, and the mobile node from which they received the RREQ. The later information is used to set up the reverse path back to the source. It works on hop by hop paradigm so there is no fixed path as in DSR. In case of the link failure, a Route Error (RERR) is sent to the affected source nodes as in DSR which reinitiates the route discovery phase. The main advantage of this protocol is that routes are established on demand and destination sequence numbers are used to find the latest route to the destination.

V. PERFORMNACE MATRICES

In this paper four performance matrices are considered to compare the above three routing protocols which are as follows:

A. Average energy consumed:

The initial node energy is taken 50 J. Average energy consumed is calculated by dividing the total energy consumed by number of nodes.

B. End to End Delay:

It is defined as the time taken by the packet to reach from source to destination.

C. Throughput:

This is the parameter related to the channel capacity. It is defined as the maximum possible delivery of the messages

over the channel per unit time. It is usually measured in kilo bits per second [kbps].

D. Packet Delivery Fraction:

It is given as the ratio of total packets generated by source to that of total packets received by destination.

VI. SIMULATION SCENARIO

Simulation is carried out using NS2 (Network simulator 2) ver-2.35 which is considered as the best tool for simulating wired and wireless systems. NS2 [9] consists of two key languages: C++ and Object-oriented Tool Command Language (OTcl). While the C++ defines the internal mechanism (i.e., a backend) of the simulation objects, the OTcl sets up simulation by assembling and configuring the objects as well as scheduling discrete events (i.e., a frontend). Various simulation parameters are given below in Table1:

Table I. Simulation Parameters

Sr. No.	Simulation Parameters	Value
1.	Routing protocols	DSDV, DSR, AODV
2.	Network topology	500x400 in meters
3.	Number of nodes	20,30,40,50,60,80
4.	Simulation duration	75sec
5.	Node Pause time	0.1 sec
6	Initial Node energy	50 Joules
7.	Packet size	512bytes
8.	Traffic Agent	CBR(FTP)
9.	Queue type	Drop Tail
10.	Antenna Type	Omni Antenna
11.	Propagation Model	Two ray ground
12.	MAC	802.11
13.	Traffic Source	TCP

VII. RESULTS AND ANALYSIS

A. Average Energy Consumed:

As the results shows, energy consumption in case of AODV is more than that of DSR and DSDV [Figure 3]. With increase in network size the average energy consumption decreases due to decrease in neighbor distance in DSR. DSDV does not shows this pattern as there is zigzag effect of increasing the number of nodes over DSDV. In AODV, average energy becomes stable after 50 and above number of node.

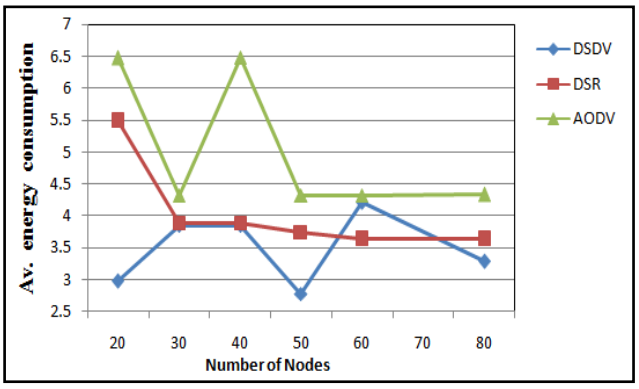

Figure 3. Av. Energy consumed vs. Number of nodes

B. End to End Delay:

The simulation results show that DSDV has the highest end to end delay among the three protocols. DSR shows a regular pattern i.e. delay decreases with increase in network size. In AODV, delay increases abruptly at 40 numbers of node but after that it increases slowly with increasing the number of nodes [Figure 4].

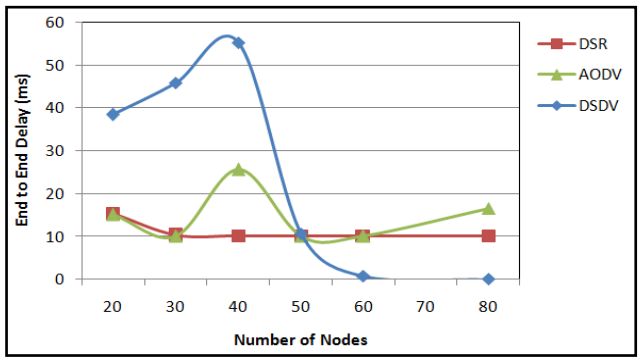

Figure 4. End to end delay Vs. Number of nodes

C. Throughput:

The results [Fig 5] indicate that DSR and AODV perform similar in terms of throughput in given scenario. There is no remarkable effect of number of nodes over throughput in AODV and DSR. But in DSDV, when the network size is increased, throughput first decreases, then increases and then becomes constant. It is also inferred here that DSDV offers higher throughput in TCP traffic than DSR and AODV.

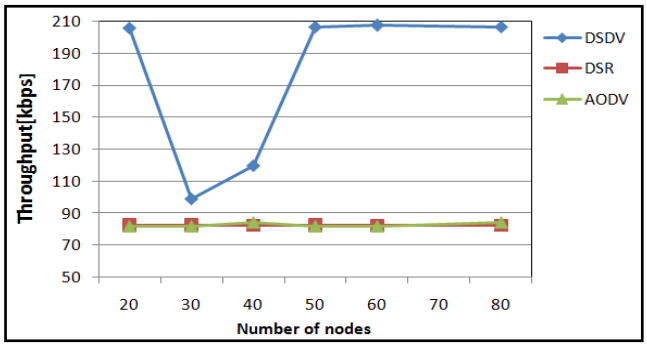

Figure 5. Throughput vs. Number of nodes

D. Packet Delivery Fraction:

AODV outperforms in terms of PDF in TCP traffic [Figure 6]. DSR shows a similar pattern but it gives less PDF than AODV. In DSDV, PDF decreases with increasing number of nodes. Thus, DSDV is not suitable of large network.

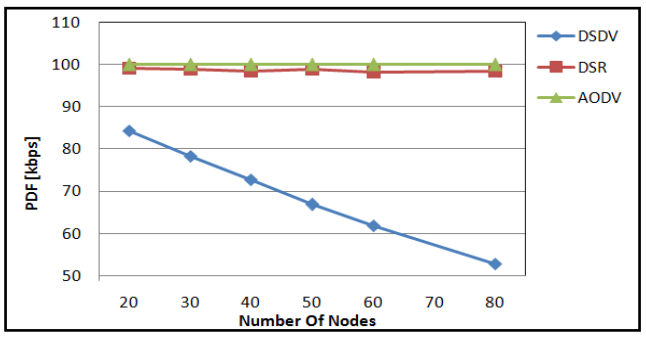

Figure 6. PDF vs. Number of Nodes

VIII. CONCLUSIONS

Here simulation of three most famous MANET routing protocols i.e. DSDV, DSR, AODV is performed using NS2

under different network sizes. The results show that DSDV being a proactive protocol underperforms than DSR and AODV in many cases. DSR is the basic and most famous proactive protocol and is showing good results maintaining a trade-off between various performance parameters. AODV is a competitor of DSR but it consumes more energy and has high delay.

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