Performance Analysis of Mobile Adhoc Routing Protocols

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Abstract: MobileAd-Hoc Network (MANET) is a wireless network without infrastructure. They are connected via wireless channels and can use multiple hops to exchange data. Routing protocols are needed for communication in such Ad hoc networks, where it targets for efficient and timely delivery of message. Self-configurability and easy deployment feature of the MANET resulted in numerous applications. Efficient routing protocols will make MANETs reliable. In this paper, an attempt has been made to compare three well know protocols AODV, DSR and DSDV by using three performance metrics Packet loss, Receive throughput and Sending throughput. NS-2 software is used to design, simulate and to do performance analysis of these protocols.

Keywords: MANET, NS-2, AODV, DSDV, DSR

1. Introduction

The rise of smart phones means that more and more people are going online from a mobile device. Wireless communications between mobile users is becoming more popular than ever before. Technological advances lead to lower prices and high speed data transmission, which are major reasons why mobile computing continues to enjoy rapid growth.

There are two distinct approaches for enabling wireless communication [2, 9]. One approach is to let the existing cellular network infrastructure to handle data and voice transmission. Handoff is the major problem in cellular network. Problem occurs when it tries to handover a connection from one base station to another base station without packet loss or transmission delay. And, cellular networks are limited to places where there exists such a cellular network infrastructure.

The second approach is to form an Ad hoc network among all users wanting to communicate with each other. This means all users participating in Ad hoc network must be willing to forward packets to ensure packet delivery from source to destination. This form of networking is limited in range by the individual nodes transmission range and is typically smaller compared to range of cellular system. This does not mean that cellular approach is better than Ad hoc network technique. Ad hoc network has many advantages as compared to traditional cellular system. These advantages include:

- On demand setup
- Fault tolerance
- Unconstrained connectivity

Table 1 gives the major differences between cellular and ad hoc networks.

Table 1: Cellular VS Ad Hoc wheless Networks	
Cellular	Ad Hoc Wireless networks
Infrastructure networks	Infrastructure less networks
Fixed, percolated cell sites and	Base station is not required,
base station	deployment of network takes less
	time
Backbone network topology is	Network topologies is highly
static	dynamic and it utilizes multihop
Relatively caring environment	environment is hostile in nature and
and stable connectivity	irregular connectivity
Detailed planning before base	Ad hoc network automatically
station can be installed	forms and adapts to changes
High setup costs	Cost-effective
Large setup time	Less setup time

Table 1: Cellular vs Ad Hoc Wireless Networks

Routing protocols plays a key role to determine performance and quality of service of adhoc network. This paper aims to provide a comparison of AODV, DSDV and DSR which are three popular routing protocols. The rest of paper is organized as follows: section 2 gives an overview of routing protocols and discusses AODV, DSDV and DSR in brief; section 3 discuss mobility model; simulation parameters, simulation result and performance analysis are discussed in section 4; section 5 concludes the analysis and finally, section 6 discuss about future scope of the work.

2. MANET Routing Protocols

Routing protocols of a Mobile adhoc network can be categorized as:

- 1. Topology based Routing Protocol
- 2. Position based Routing Protocol

One of the most popular methods to distinguish mobile ad hoc network routing protocols is based on how routing information is acquired and maintained by mobile nodes. Mobile ad hoc network routing protocols can be further classified as:

- Proactive routing
- Reactive routing

• Hybrid routing

A proactive routing protocol is also called a "table-driven" routing protocol. Nodes of a mobile ad hoc network in proactive routing protocol continuously evaluate routes to all reachable nodes and keep updated routing information which is consistent in nature. This is fast as a source node can get a routing path immediately when it needs.

In proactive routing protocols, all nodes need to maintain a consistent view of the network topology. In an event of a change in topology, respective changes must be circulated throughout the network to intimate the change. Table driven routing protocols generally proposed for mobile ad hoc networks have inherited properties from algorithms used in wired networks.

2.1 Destination Sequenced Distance Vector Protocol

The Destination Sequenced Distance Vector Protocol (DSDV) [6] is a topology based proactive, distance vector protocol which is based on the Bellmann-Ford algorithm. It uses the hop count as metric in route selection. Every node has a single entry in the routing table. A sequence number is associated with each route or path to the destination to prevent routing loops. The DSDV update messages have three fields namely Destination Address, the new Sequence Number and the number of hops required to reach the destination. Routing updates are exchanged even if the network is idle which uses up battery and network bandwidth. That's why it is not suggested for networks which are highly dynamic in nature.

2.2 Dynamic Source Routing Protocol

The Dynamic Source Routing Protocol (DSR) [7] is a topology based reactive or on demand routing protocol. In this protocol a node can find out dynamically a source route to any destination in the network over many hops. Discovered root is loop free due to the fact that a fully ordered list of the nodes through which the packet must pass is included in every packet header. Route Discovery and Route Maintenance are mainly two mechanism of DSR protocol. DSR employs these two to discover and maintain source routes to any destinations in the network. It uses no periodic routing message, thus reduces bandwidth overhead and conserved battery power and also large routing updates. MAC layer helps to identify any link failure.

2.3 Ad Hoc on Demand Distance Vector Protocol

The topology based Ad hoc on demand distance vector routing protocol (AODV) [4, 5] joins mechanisms of DSR and DSDV. The periodic beacons, hop-by-hop routing and sequence numbers (guarantee of loop-freedom) of DSDV and the pure on-demand mechanism of Route Discovery and Route Maintenance from DSR are combined. It is loop-free, self-starting, and scales to large numbers of mobile nodes.

3. Mobility Models

To evaluate the performance of a protocol for an Ad Hoc network, it is necessary to test the protocol under realistic conditions, especially including the movement of the mobile nodes. We chose Random Waypoint Mobility model which is define below.

3.1 Random Waypoint Mobility Model

A mobile node begins the simulation by waiting a specified pause-time. After this time it selects a random destination in the area and a random speed distributed uniformly between 0 m/s and maximum speed (Vmax). When mobile node reaches to its destination, it waits again for pause-time seconds before choosing a new way point and speed.

The mobile nodes are initially distributed over the simulation area. This distribution is not representative to the final distribution caused by node movements. To ensure a random initial configuration for each simulation, it is essential to discard a certain simulation time and to start registering simulation results after that time.

The Random Waypoint Mobility Model is very widely used in simulation studies of MANET [8, 12]. As described the performance measures in mobile Ad hoc networks are affected by the mobility model which one used. Nodal speed is one of the most important parameters in mobile Ad hoc. We would like to adjust the average speed to be stabilized around a certain value and not to change over time. Further, we look to compare the performance of the mobile ad hoc routing protocols under different nodal speeds. For the Random Waypoint Mobility Model a common expectation is that the average is about half of the maximum. Reason for the same is that the speeds in a Random Waypoint Model are chosen uniformly between 0 m/s and maximum speed (V_{max}). In the Random Waypoint Mobility Model a node selects its destination and its speed. The node keeps moving at that speed until it reaches its destination. If it selects a distant destination and a low speed around 0 m/s then it travels for quite a long time with that low speed. If it selects a speed near V_{max} the time traveling with this high speed will be short. After a certain time the node has traveled much more time at low speed than at high speed. The average speed will approach 0 m/s. The suggestion to prevent this problem is choosing, e.g. 1 m/s instead of 0 m/s as minimum speed (V_{min}). This helps in stabilizing average speed after a certain time at a value below $\frac{1}{2} V_{max}$.

4. Simulation Analysis and Performance Result

A typical simulation with network simulator is shown in figure1 below [1, 3, 10, 11]. Basically it consists of generating following input files to ns-2:

- 1) A scenario file that describes the movement pattern of nodes.
- 2) A communication file that describes the traffic in the network.

These files can be generated manually or by generating completely randomized movement and communication pattern with script. These files are then used for simulation in ns-2. Two trace files are generated as output. Parameters

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that are going to be traced during simulation must be selected before the simulation. The trace file then can be scanned and analyzed for various parameters that we want to measure.



Figure 1: Simulation analysisusing NS-2

We have studied the performance analysis of AODV, DSDV and DSR for different number of nodes -10, 20, 40 and 100.

4.1 Performance Parameters

Sending Throughput: - Throughput in this simulation is defined as the total number of bits generated per second throughout the network. It is denoted by bps (generated bits per second). It signifies the capacity of the network to utilize available bandwidth.

Received Throughput: - It is defined as the total number of bits received per unit of time. It signifies the useful utilization of available bandwidth.

Packet Loss: - It signifies the reliability of the network. We calculate it as:-

Packet Loss = Total Packets sent – Total Packets Received

Simulation Time: - The time for which simulations will be run that is time between the starting of simulation and when it ends.

Network size: - It determines the number of nodes and size of area that nodes are moving within. Network size basically determines the connectivity. Less number nodes in the same area mean fewer nodes to communicate to, but also smaller probability of collision.

Number of nodes: - This is constant during the simulation. We used 10, 20, 40 and 100 nodes for simulations.

Environment Size: - It determines the size of the environment. We have used a size of 500X400.

4.2 Simulation Environment

Initially we have chosen the simulation of 10 nodes in 500X400 square meter area, in other words we have chosen two dimensional area (2D) rectangles. The position of each mobile node is represented in 2D grid; the X-axis value is chosen from the range of (0,500) and Y-axis value is chosen from the range of (0,400). In random waypoint model, a mobile node is assigned a destination. The mobile node then moves to the destination at given speed. Once the destination is reached, the mobile node stops for a given pause time. The mobile node then chooses another random destination for mobile node's next movement. We have used CBR sources that started at different times because we want to get a general view of how routing protocol behaves, rather than TCP sources which use flow control and retransmission feature. We have assumed bidirectional links during our simulations i.e. links work well in both directions. Because bidirectional links are necessary if 802.11 acknowledgements are supposed to be used. Traffic load is taken very low. The traffic consists of 8 connections. The source destination pairs are chosen at random. Table 2 summarizes our parameters.

Table 2:Simulation Parameters	
Parameter	Value
Number of nodes	10, 20, 40 and 100
Simulation time	200 sec
Node speed	10 m/s
Pause Time	0 sec
Environment Size	500x400
Packet size	512 bytes
Traffic Type	Constant Bit Rate
Packet Rate	4 packet/sec

Here three MANET routing protocols are taken AODV [3, 4], DSR [5], DSDV [7, 9]. The relationship between simulation time and throughput is calculated, and comparison of throughput is performed between these protocols.

4.3 Simulation Result



Figure 2: Received Throughput (bps) for 10 nodes



Figure 3: Received Throughput (bps) for 20 nodes





Figure 4:Received Throughput(bps) for 40 nodes





Figure 6: Throughput (Packets Generated per second) for 10 nodes



Figure 7:Throughput (Packets Generated per second) for 20 nodes



Figure 8: Throughput (Packets Generated per second) for 40 nodes



Figure 9: Throughput (Packets generated per second) for 100 nodes



Figure 10: Packet Loss vs Number of nodes



Figure 11: Received Throughput vs Number of nodes

Packets Generated



Figure 12: Sending Throughput vs Number of nodes

5. Conclusion

In this paper the analysis of adhoc routing protocol is done in the above mentioned mobility and traffic pattern on different number of nodes and simulation duration. AODV and DSR show much better Received Throughput than DSDV for entire duration of simulation window. DSR performance matches with AODV when number of nodes is less but AODV shows clearly better performance when number of nodes are 100.

DSDV Sending throughput performance fluctuates for lesser number of nodes but as number of nodes is increased upto 40, DSDV performance improves and matches with those of AODV and DSR.

DSR and AODV packet loss performance is much better than DSDV. DSR gives slightly better performance when number of nodes is less but as it reaches to 100, AODV wins in this performance metric as well. Overall, we conclude that AODV shows better performance than DSR and DSDV.

6. Future Scope of the Work

Our analysis is limited to three commonly used protocols in adhoc network which falls under category of topology based proactive and reactive protocols. Further study can be done on topology based hybrid routing protocols like ZRP. One can also do the performance analysis of position based routing protocols like DREAM or LAR.

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