Qos Based Performance Enhancement of Routing Protocols in MANET Environment

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ABSTRACT

A mobile ad-hoc network is an assortment of wireless mobile hosts, which establishes a momentary network without any assist of centralized administrator. The characteristics of an ad-hoc network can be explored on the base of routing protocols. The dynamic topology is the vital characteristic in which nodes frequently change their position. In the ad-hoc networks, there are mobile nodes such as personal digital assistance (PDA), smart phone and laptops; they have limited operational resources like battery power and bandwidth. Thus the control traffic is to be minimized, which is the main responsibility of routing protocols by selecting the shortest path and controlling the traffic. In this study work we focus on performance issues of routing protocols Ad Hoc On-Demand Distance Vector (AODV), Dynamic Source Routing (DSR), and Destination-Sequenced Distance vector (DSDV) in mobility and standalone ad-hoc networks. For this purpose we first study and explain these protocols and then we use the Network Simulator – 2.35 (NS2) tool and analyze the performance metrics Packet Delivery ratio, End to End delay, and Throughput.

Keywords: MANET, Performance Evaluation, Routing Protocols, Ad-hoc Network, Routing Challenges, Performance Metrics and Mobility.

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I.   INTRODUCTION:

A form of wireless network where each node communicates with other node using multi-hop links without stationary infrastructure is called Ad-hoc network. According to [1], an Ad hoc network is crew of wireless mobile nodes that creates a network without any. assist of centralized administrator. It uses multi-hope point-to-point (P2P) routing as an alternative of stationary network communication to offer network connectivity [2]. In such circumstances, due to partial range of mobile host in wireless transmission, each node needs to join up other node in order to communicate with each other and to reach to the destination if located far away. This communication involves the mechanism of finding paths from one end node to other through which data can be transferred.

Routing in ad-hoc networks has been a challenging task ever since the wireless networks came into existence. The major reason for this is the nature of ad-hoc networks where network

topologies cannot be static [3]. The non-static nature of Ad-hoc networks raises various performance challenges for routing protocols.

II.   AIMS AND OBJECTIVES

The aim of this work is to assess the relative performance of routing protocols for the considered mobile ad-hoc network and to identify their performance challenges. The outcome for this study is in the form of quantitative results of efficiency of the routing protocols with reference to performance metrics. These results can be used as baseline for selecting routing protocols in a variety of situations.

The objectives are:

- To conduct a detailed literature survey to review the current state of art of routing protocols used in Ad-hoc networks.

- To explore different classifications of routing protocols in Ad-hoc networks and their mobility features. Furthermore, to identify the performance challenges for routing protocols in such networks.

- To study the mobility features in Ad-hoc networks. For this purpose, network scenarios having mobile nodes are designed. The performance of routing protocols in mobile nodes network is evaluated to identify the impact on node mobility.

- To evaluate the routing protocols with reference to their performances in fixed nodes network. In this evaluation, static network nodes are selected while designing network scenario. The performance statistics of each routing protocols for set of performance metrics are collected.

- Comparison regarding performance of different routing protocols for a set of performance metrics in fixed nodes networks. A table is maintained showing the results of this comparison. This helps to identify which routing protocol performs best in static nodes network.

- To design different network scenarios using NS2 simulator for implementation of different routing protocols. These scenarios will mainly be different based on network nodes i.e., mobile and static nodes. Secondly, the number of communicating nodes, application classes and selection of routing protocol differentiate these scenarios from each other.

- Comparison regarding performance of different routing protocols for the same set of performance metrics in mobile nodes network. For this purpose tabulated results are shown. This comparison helps to see which routing protocol performs best in mobile nodes network.

- Comparison of overall results of different routing protocols in both mobile and fixed nodes network for the same set of performance metrics.

- In order to evaluate the performance of routing protocols, a cross comparison is performed based on collected statistic, which will be shown in a table. The collected statistics present the protocol performance with respect to nodes type, i.e., static or mobile. This helps to assess the best routing protocols for different network scenarios.

III.   WIRELESS NETWORK TYPES

The system that receives and transmits data over the air is referred to as wireless network. It has two main types, one is infrastructure network and the other is infrastructure-less or ad-hoc network.

INFRASTRUCTURE NETWORKS:-A network with a fixed physical layout is called an infrastructure network. A central device is responsible for connecting all communicating devices through wireless or wired link. This central device is referred to as Access Point (AP), which is responsible for the management of network operations such as network security implementation, IP configuration. If a device is using wireless technique for connecting to AP, it can connect to any AP, which is in its wireless range depending on the security authorization from AP.

In the WiFi or cellular networks, which are infrastructure-based wireless networks, the wireless link has one-hop or multiple –hop up to the base station and the remaining routing is done with wired infrastructure. The bandwidth, topology, switching and routing resources of infrastructure networks are provisioned to ensure best result to the expected traffic [16].

AD-HOC NETWORK:-A network is installed without fixed physical layouts, which are generally deployed in emergencies, or battlefield communication on temporary basis. When there is not an infrastructure network available or it is cost effective and devices need to connect for communication, multiple nodes are connected wirelessly. In these devices one or more devices act like nodes as well as routers [16].

Such a network is very easy to deploy and flexible, because devices are not bound to any agreement to stay connected. It can be categorized in following two types

- Static Ad-hoc Networks (SANET)
- Mobile Ad-hoc Networks (MANET)

IV.   PROBLEM STATEMENT

MANET routing protocols are based on different design philosophies and proposed to meet certain requirements.Providing a convenient routing protocol for MANETs is a challenge because

of its dynamic environment. Therefore, the suitability of each routing protocol depends on many parameters such as, network size, node mobility, and traffic load together with the limited resources in MANETs (e.g., bandwidth and energy) make the selection of an optimum routing protocol into a complicated task. The frequent topology changes and variable propagation conditions make a routing table obsolete very quickly, which results in enormous control overhead for route discovery and route maintenance. In some scenarios, route maintenance may consume so much in the way of resources that no bandwidth remains for the transmission of data packets. Even worse, the short lifetime of routing information means that a portion of the information may no longer be useful and thus the bandwidth used to distribute the routing update information could be wasted.

V.   ROUTING PROTOCOLS IN MANETS

The function of ad hoc routing protocol is to control the node decisions when routing packets between devices in MANET. When a node joins or tries to join the network, it does not know about the network topology. By announcing its presence or by listening from the neighbor nodes it discovers the topology. In a network route discovery process depends on the routing protocol implementation.

For wireless ad hoc networks, several routing protocols have been designed and all these protocols are classified under two major fields of protocols called reactive or proactive. An ad hoc routing protocol with combination of these two is called a hybrid protocol [18].
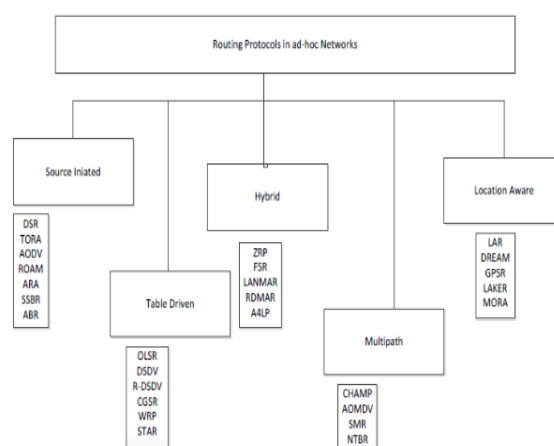
Figure 1: Ad-hoc Routing Protocols' Categories [16]

DESTINATION SEQUENCED DISTANCE-VECTOR ROUTING PROTOCOL:-DSDV is a table-driven routing scheme for an ad hoc mobile network based on the Bellman-Ford algorithm. It was developed by C. Perkins and P. Bhagwat in 1994 [2]. The main contribution of this algorithm was to solve the routing loop problem. In DSDV each node maintains a route to every other node in the network and thus routing table is formed. Each entry in the routing table contains sequence numbers which are even if a link is present; else, an odd number is used. The number is generated by the destination, and the emitter needs to send out the next update with this number [5]. This number is used to distinguish stale routes from new ones and thus avoids the formation of loops. The routing table updates can be sent in two ways: a "full dump" or an incremental update. A full dump sends the full routing table to the neighbours and could span many packets whereas in an incremental update only those entries from the routing table are sent that have a metric change since the last update and it must fit in a packet. When the network is relatively stable, incremental updates are sent to avoid extra traffic and full dump are relatively infrequent. In a fast-changing network, incremental packets can grow big so full dumps will be more frequent. DSDV was one of the early algorithms available. It is quite suitable for creating ad hoc networks with small number of nodes. DSDV requires a regular update of its routing tables, which uses up battery power and a small amount of bandwidth even when the network is idle. Whenever the topology of the network changes, a new sequence number is necessary before the network reconverges; thus, DSDV is not suitable for highly dynamic networks.

AD HOC ON-DEMAND DISTANCE VECTOR (AODV):- In ad-hoc network AODV is a loop free protocol. It has the characteristic of self-starting in the mobile node environment. Route Maintenance and Route Discovery are its important mechanisms [6]. If a link gets failed, a notification is sent to the affected nodes and therefore, this invalidates the routes via failed link. It requires less memory overhead and establishes unicast routes between source and destination therefore the network utilization is minimal. AODV has low overhead and its on-demand nature does not burden the network. Routing traffic is minimal because routes are built on network demand. There is no need to keep information of those routes that are not being used by the network. When two nodes want to make a connection, the multi hop routes are built between mobile nodes by AODV. AODV uses destination sequence number (DSN) in order to avoid from counting to infinity. This feature distinguishes it from other algorithms. Sequence number based optimal routes are also selected by AODV [22].

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DYNAMIC SOURCE ROUTING:-The DSR, simple and efficient routing protocol is designed for multi-hop wireless ad-hoc networks. Using DSR, there is no need for administration or existing network infrastructure and the network is completely self-configuration and self-organizing. It is not table driven like AODV but it has on-demand characteristics and based on source routing [23]. The source routing is a technique in which the source of the packet determines the complete sequence of nodes through which to forward the data packets. The source routing has the advantage that there is no need to maintain the routing information by the intermediate hops. Due to routing decision of source it is different from link-state routing and table-driven routing [23].

The DSR protocol has route discovery and route maintenance mechanisms that work together in the ad-hoc network [7].

VI.   SOLUTION DOMAIN AND ALGORITHM

DSR is on demand routing algorithm and its main feature is to control infinite looping problem by using unique sequence numbers for every packet. Functioning of DSR is in the following algorithm.

1. Initialize Network

2. Procedure link search for all possible destinations

3. Procedure periodic messages broadcast PM(TR)

4. PM(TR) ← DEST_ADD,NXT_HOP

5. At node n PM(TR) process

6. if

7. PM(TR) new == PM(TR) old

8. SEQ_NUMold←SEQ_NUMnew // replace sequence number

9. Elseif

10. PM(TR) ≠ MP(TR)old

11. RT ← PM(TR)new

12. Flush all PM(TRnew

13. Elseif

14. PM(TR)new== Null

15. // Link Fail

16. Flush all TRIGGEREDM SG

17. RT ←updateTRIGGERED_MSG

18. // Link Established

19. BUFFER← DATA_PKT till LINK_SETTLING_TIME

20. Flush all DATA_PKT

21. // Continue Periodic Messages

22. End Procedures

VII.   SIMULATION AND RESULT

We use the Network Simulator 2.35 in order to simulate the routing protocols involves in our study. The figure2 shows the setup of one simulation environment of 50 nodes, which are static and the pause time of 100 sec. The details of simulation parameters are given in table.

Table: Performance Parameters

S NO.	PARAMETERS	VALUES
1	No of nodes	30(Intial Phase), 40(Second Phase), 50(Final Phase)
2	Routing Protocols	AODV, DSDV, DSR
3	Performance Metrics	Packet Delivery Ratio, Throughput, End-to-End Delay
4	Simulation Area	2000m*2000m
5	Packet Size	Random
7	Pause time	100 Seconds

In initial phase, we use 30 nodes in our scenario and simulate using mobility of the nodes for the performance metrics packet delivery ratio, end to end delay and throughput of routing protocols AODV, DSR and DSDV.

In the second phase, we use 40 nodes in our scenario and simulate using static nodes for the performance metrics packet delivery ratio, end to end delay and throughput of AODV, DSR and DSDV the routing protocols.
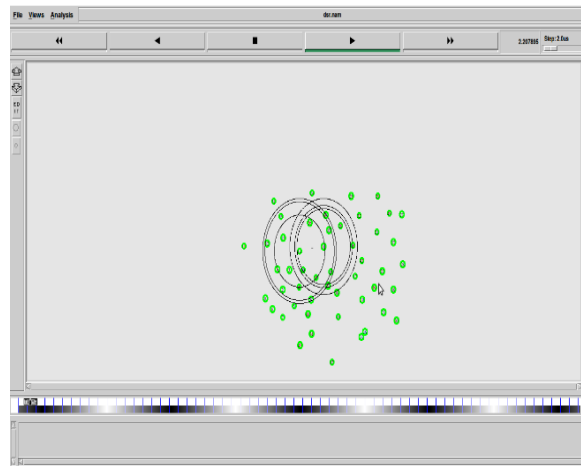
In the final phase, we use 50 nodes in our scenario and simulate using static nodes for the performance metrics packet delivery ratio, end to end delay and throughput of AODV, DSR and DSDV the routing protocols.

Figure 2: Simulation Setup

Packet Delivery Ratio:-It is the ratio of actual packet delivered to total packets sent i.e. performance is measured on the major basis of parameters like PDF (packet delivery function). PDF is defined as the total number of packets sending dividing by the total number of packets receiving by TCP sources.
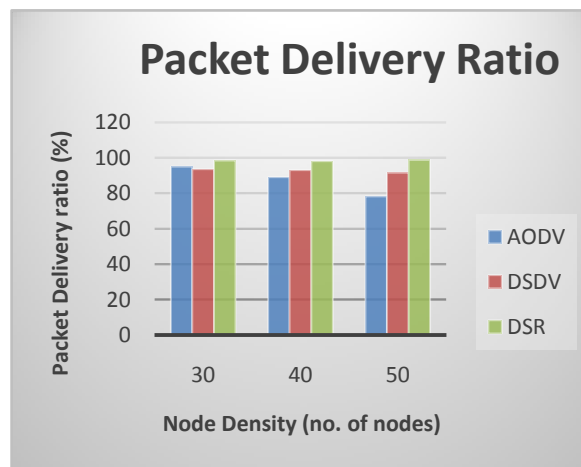

Figure3: Packet Delivery Ratio

End-to-End Delay:- The average time taken by the packets to pass through the network is called end-to-end delay. This is the time when a sender generates the packet and it is received by the application layer of destination, it is represented in seconds. This is the whole time that includes all delay of network such as transmission time, buffer queues, MAC control exchanges and delay produced by routing activities.
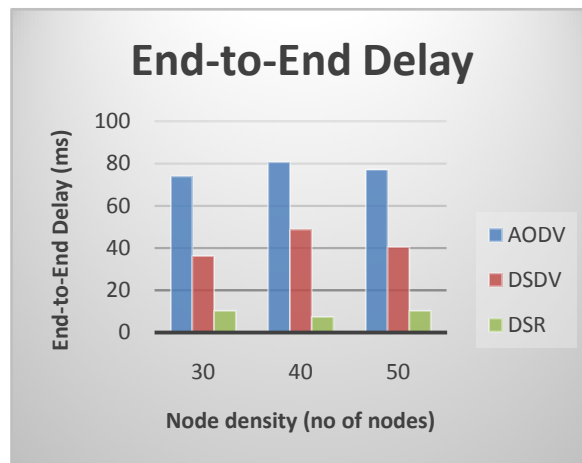
Figure 4: End-to-End Delay

Throghput:- Throughput is the ratio of total amounts of data that reaches the receiver from the source to the time taken by the receiver to receive the last packet. It is represented in packets per second or bits per second. In the MANET unreliable communication, limited energy, limited bandwidth and frequent topology change affect throughput. A network requires high throughput and can be represented mathematically by the following equation.
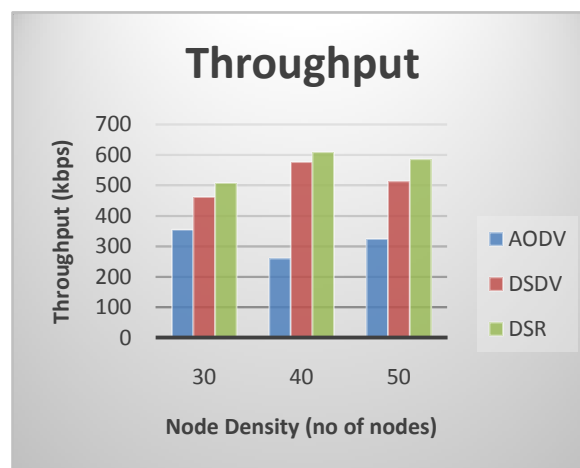

Figure5: Throughput

Residual Energy: - The residual energy for the network is shown in figure 4.4, which refers as the Residual Energy is the total amount of energy Consumed by the Nodes during the completion of Communication or simulation. If a node is having 100% energy initially and having 70% energy after the simulation than the energy consumption by that node is 30%. The unit of it will be in Joules. The X-Axis represents the no of nodes and Y-Axis indicates the residual energy in joule.
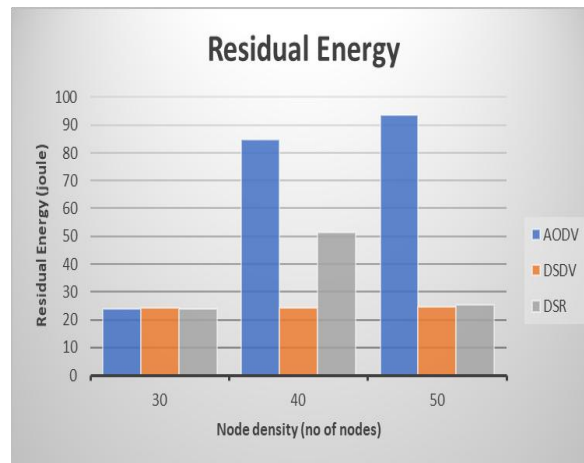
Figure 6: Residual Energy

VIII.   CONCLUSION & FUTURE WORK

The overall performance of DSR in terms of network load is best as compared to AODV and DSDV. When the network size is increased it does not affect the performance of DSR in static ad-hoc networks which means that DSR outperforms AODV and DSDV. DSR is a source routing and has the characteristics of on-demand routing. The end-to-end delay of DSR has less as compared to AODV and DSDV when the traffic load is high, which means that its performance is best in static ad-hoc network. The increase in network size does not affect the performance of DSSR in static ad-hoc networks. The reason is that DSR is reactive routing protocol, which means that there are no routing tables with each node, and the packets are directly broadcasted by all nodes. In the case of throughput DSR attains high rate in static ad-hoc networks. When the network size is increase is does not affect the performance of DSR, which means that DSR outperform the AODV and DSDV. DSR is reliable in terms of large-scale environment. The reason for high throughput of DSR in comparison with other protocols is that, for DSR routing path are easily available due to the characteristic of reactive routing protocols.

As future work in addition to end-to-end delay we intend to study the delay jitter parameter, and investigate its impact on congestion control when the network is highly loaded. Efficiency of mobile ad-hoc networks in terms of delay jitter would result in decreased power consumption; therefore, network life would be prolonged.

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