Comparative Analysis of Routing Protocols for MANET Using Packet Level Diagnostic Metrics

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Abstract— **Mobile Ad Hoc Networks (MANETs) are collection of wireless mobile nodes communicating each other hope to hope with internal co-operation and without fixed and central administration. Hope to hope routing of packet is major issue and many protocols are proposed. In this paper we have surveyed and compared performance of most suitable routing protocols like DSR, AODV, AOMDV and DSDV at packet level with different performance metrics. The performance measure by increasing load in terms of increasing number of user from 11 to 200 verses throughput, end to end delay, packet delivery ratio, routing/control overhead and energy consumption. It is found that each protocol has it's owns pros and cons with respect to various performance metrics and no one is superior in all respects.**

***Index Terms*— Mobile Ad Hoc Networks (MANETs), Routing Protocols, Performance Metrics, Throughput, End to End Delay, Energy Consumption, Routing Overhead, Packet Delivery Ratio, Scalability.**

I. INTRODUCTION

The concept of MANETs and its integration with fixed wired networks is most promising technology for packet transmission in future. MANETs promises cost effective and easily deployable solutions for disaster situations and military applications. The nature and characteristics of MANETs makes it different from other networks and makes it advantageous for said applications. MANETs are highly dynamic in nature with no central administration and fixed network components. Packets are delivered from sender to receiver hope by hope. Nodes act as intermediate hopes to transmit data packets between transmitter and receiver. Initial booting of network and node organization to form fully functional network are some initial challenges for MANETs. Apart from this many issues like routing, security, node co-operation, energy consumption and scalability requires heavy attention for fully functional MANETs [9]. Many solutions and algorithms are proposed till date to improve overall performance of MANETs. Recent research shows that improvements are still continuous and possible in various aspects and issues, packet routing is such issue and many routing protocols and techniques are proposed [1] [2]. In following discussion some of the best suited routing protocols explored and their performance analysis is done in subsequent sections.

A. Ad-hoc On Demand Distance Vector (AODV)

The AODV routing protocol is self organizing, reactive routing protocol which includes features like generation of minimum number of broadcast packets by creating routes on demand, uses only symmetric links because the route reply packet follows the reverse path of route request packet, uses hello message to know its neighbours and to ensure symmetric links, dynamic route discovery and route maintenance mechanism. Route maintenance and route discovery is required if the source node moves, it reinitiates the route discovery. If intermediate node moves, it upstream node sends a RREP to the source. The source restarts the route discovery. A route between two nodes is found by sending route request to a small locality and grows gradually until complete route formed [6].

B. Dynamic Source Routing (DSR)

The DSR protocol is reactive type routing protocols which allows dynamic discovery of routes to various nodes in a MANETs. DSR performs routing using two important mechanism wise route discovery and route maintenance. Route discovery mechanism is similar to the one in AODV but in source routing nodes maintain route caches, entries in route caches are updated as nodes learn new routes. Packet send carries complete and ordered list of nodes through which packet will pass. In DSR route maintenance mechanism two types of packets used, route error packet and acknowledgement. If transmission error is generated and send to the original sender of the packet. The node removes the hope which is in error from its route cache when a route error packet is received. ACKs are used to verify the correction of the route links. Nodes use information in ACKs for further transmission of data [5].

C. Ad-hoc On Demand Multipath Distance Vector (AOMDV)

The AOMDV routing protocol is extension of AODV routing protocol. It provides multipath loop free transmission links. Loop free links are assured by providing alternate routes which has less hope counts than advertised. AOMDV can be used to find link disjoints and node disjoints.

The advantages to use AOMDV are that intermediate nodes involve in forming, finding and maintaining the routes but the disadvantage of AOMDV is that control overhead is large due to increased flooding [7].

D. Destination Sequenced Distance Vector (DSDV)

The DSDV protocol is proactive type and learn network topology before sending packet. It is based on Bellman Ford algorithm in which each node maintains a routing tale listing all available destinations, every node knows "where" everybody else is, each node advertises its position and routes are broadcasted from receiver. Each broadcast has destination address, originator, no of hopes and sequence number of broadcast. The route with the most recent sequence is used to transmit the data [4].

II. RELATED WORK

There are high efficiency protocols are available for variety of applications in wired networks. But for MANETs there is no efficient solution available for packet level routing. Many papers presented for comparative analysis of available routing protocols and suggested that most suitable protocols are DSR, AODV and DSDV [1] [2] [3].

III. PERFORMANCE METRICS

Performance and reliability of MANETs can be evaluated by different performance metrics. Performance metrics can be categorized as thread-task level metrics. Diagnostic packet level metrics and scenario metrics [8]. Thread-task level metrics includes average power expanded and task completion time. Diagnostic packet level metrics evaluate MANETs packet level behavior and include throughput, end to end delay, link utilization and packet loss. Network environment can be assessed by scenario metrics such as rate of change of nodes and topology, varying nodes, size of network, density of nodes and varying load and traffic patterns [8].

In this document MANETs AODV, AOMDV, DSR and DSDV routing protocols are evaluated using diagnostics packet level metrics and varying number of nodes.

A. Throughput

It is average successful rate of packet transmission. It is measure of average of number of packets successfully delivered to the destination per unit time. A global counter is set to monitor and count the successful delivery of packets at receiver. Throughput can be calculated as successfully received packets divided by total simulation time.

B. End to End Delay (ms)

It is average time taken by packet to reach correct destination. When packet is generated at sender a timer is set to measure the time taken to reach the destination. End to End delay can be computed by simulation time at reception minus simulation time at generation.

C. Packet Delivery Ratio

It gives number of packets lost. It counts packets discarded after predetermined transmission attempts and packets lost due to looping. It also counts factors like buffer overflow, outdated routing information, path breaks and variable link quality. A global counter is set to increment as network node successfully receives data packet. Similarly another global counter is set to increment as a network node generates a data packet. The packet delivery ratio can be calculated as successfully received packets divided by total transmitted packets.

D. Routing/Control Overhead

It is measure of extra information required to manage and maintain the network functionality and data transmissions. A global counter is set to count the number of control and management packet generated at any stage during simulation time. Then routing/control overhead can be calculated by dividing number of data packets successfully delivered from number of control and management packets generated.

E. Energy Consumption (Joule)

Energy consumption is variance in residual with respect to mobility of nodes. Energy consumption increases as overhead and control packets increases. Energy consumed by each node is calculated in joule. Energy consumed by nodes when they transmit, receive a packet and in idle state.

IV. SIMULATION ENVIRONMENT

The set of parameters and variables used for simulations is listed in TABLE I. The parameters are applied throughout simulation process. The simulator an OS used are NS2.35 and Fedora-12. Different performance metrics discussed earlier are simulated in single phase using loop method. The graphs are drawn using MATLAB 7.0 software.

TABLE I
SIMULATION PARAMETERS

Parameter	Value/Type
Number of Nodes	11 to 200
Total Simulation Time	100 second
Packet Length	50
Network Area	500x500
Antenna Type	Omni Directional
Radio Propagation Model	Two Ray Ground
Interface Queue Type (DSR)	CMU Pri Queue
Interface Queue Type (DSR)	Drop Tail

V. SIMULATION RESULTS AND SUMMERY

In this document various packet level metrics are used with increasing number of node to evaluate the performance and efficiency of different routing protocols. The summery of mean value of each metrics are shown in TABLE II. Mean value of metrics is equal to total value divided number of nodes.

The simulated results for various performance metrics shown from fig. 1 to fig. 5.

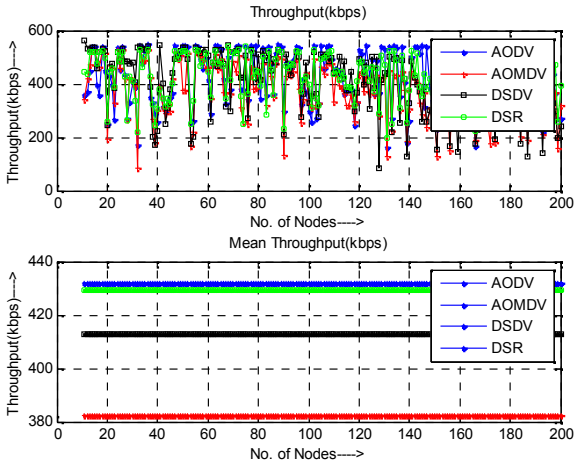

Fig. 1. Throughput V/S Increasing no. of Nodes

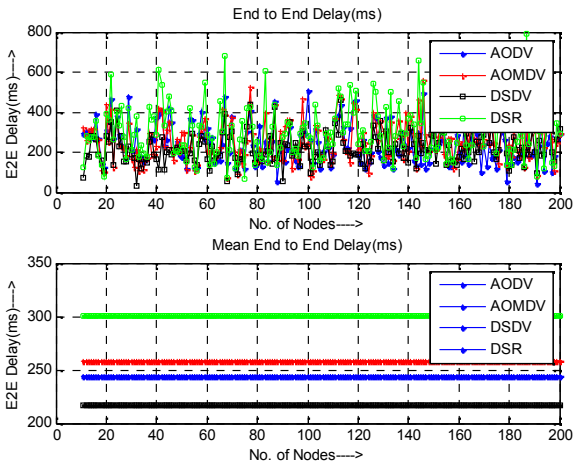

Fig. 2. End to End Delay (ms) V/S Increasing no. of Nodes

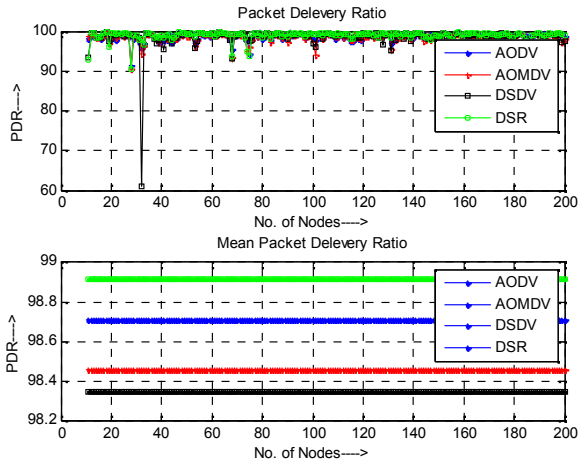

Fig. 3. Packet Delivery Ratio V/S Increasing no. of Nodes

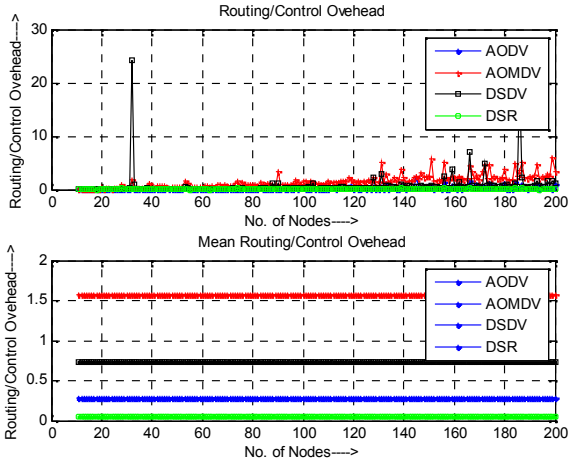

Fig. 4. Routing/Control Overhead V/S Increasing no. of Nodes

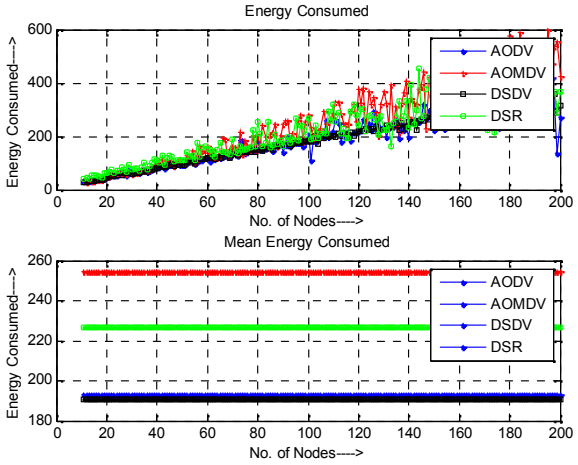

Fig. 5. Energy Consumption V/S Increasing no. of Nodes

TABLE II
RESULT SUMMERY

Performance Metrics	**AODV**	**AOMDV**	**DSDV**	**DSR**
Throughput (kbps)	***431.77***	382.3595	412.976	429.26
E2E Delay(ms)	244.21	258.5474	***216.473***	300.35
PDF(%)	98.712	98.4624	98.3472	***98.912***
Routing/Control Overhead	0.2807	1.5682	0.7279	***0.0576***
Energy Consumed	193.07	254.6531	***190.698***	226.49

The values in TABLE II are mean values of simulated results. The values which are shown in bold and italic format shows the best obtained values amongst protocols under the study for given performance metrics.

VI. OBSERVATIONS AND RESULTS ANALYSIS

Looking towards simulation results in the form of graphs and table following points are observed for respective performance metrics.

A. Throughput V/S Increasing no. of Nodes

AODV routing protocol performs better compared to others. DSR performs as equal as AODV. It is found that as node increases beyond 100 the throughput performance decreases half to the mean value. It is observed that as number of nodes increases throughput is unstable and decreases considerably. Due to dynamic nature of MANET there are measurable fluctuations and spikes are observed. Overall the average throughput is below 50%.

B. End to End Delay (ms) V/S Increasing no. of Nodes

It is observed that all four routing protocols under study performing stably for end to end delay throughout simulation time. DSDV performs considerably well compared to others.

C. Packet Delivery Ratio V/S Increasing no. of Nodes

Nearly all routing protocols performing well throughout simulation time and overall performance is stable. DSR performs better compared to other three routing protocols with efficiency of nearly 99%.

D. Routing/Control Overhead V/S Increasing no. of Nodes

Graphical demonstration of simulation results shows that DSR performs stably for this metrics throughout simulation time and control overhead increases as number of nodes increases for all other routing protocols. DSR outperforms all other routing protocols as it has very less routing overhead.

E. Energy Consumption V/S Increasing no. of Nodes

It is observed that energy consumption linearly increases with increasing nodes. Energy consumption for all routing protocols increases rapidly beyond 100 numbers of nodes. DSDV is the only routing protocol gives steady and linear energy consumption as number of nodes increases throughout simulation time.

VII. CONCLUSION

From result analysis it is found that no routing protocol is superior to others in all respect. This is because the nature of MANAT, it is not stable due to varying mobility of nodes and frequent changes in network topology. DSDV and DSR are most promising solutions for routing in MANTETs. From further observation of values obtained in TABLE II it is concluded that DSDV is most suitable candidate for routing in MANETs. In future improved DSDV with little modification to address its lacking feature may become only routing solution for MANET.

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