ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Performance Comparison of MANETs Routing Protocols with the Help of Simulation Knowledge

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Abstract:
A Mobile Ad hoc Network (MANET) is a kind of wireless ad-hoc network, and is a self configuring network of mobile routers connected by wireless links. It is a wireless network without infrastructure. Self configurability and easy deployment feature of the MANET resulted in numerous applications in this modern era. Efficient routing protocols will make MANETs reliable. Various research communities are working in field of MANET and trying to adopt the protocols and technology in other applications as well. In this paper, an attempt has been made to compare two well known protocols AODV and DSR by using two performance metrics, End to end delay and Throughput. The comparison has been done by using simulation tool NS2 which is the main simulator, NAM (Network Animator) and excel graph which is used for preparing the graphs from the trace files.

Index Terms— ***MANET, NS-2, AODV, DSR.***

1. Introduction:

Wireless mobile ad-hoc network technology is designed for the establishment of a network anywhere and anytime, characterized by lack of infrastructure, clients in a network free to move and organize themselves in an arbiter fashion.

Communication may have multiple links and heterogeneous radio, can operate in a stand-alone fashion, with self configured & self maintenance. It is a wireless network consist of collection of heterogeneous mobile devises (nodes) which are connected by a dynamically varying network topology without fixed infrastructure and absence of central coordinator or base station where network intelligence placeless inside every node thus nodes in a network act as a router as well as host which means MANETs behave as a peer to peer network. The connectivity between nodes may have a multiple links and heterogeneous radio and can operate in a standalone fashion. Due to characteristics of MANETs well suited a situation where infrastructure is difficult to setup, cost or time effective.

The design, development, performance of MANETs majorly include in routing, QoS, Security, multicasting, service discovery, scalability & Resource management (energy, bandwidth, delay and battery power). The QoS design issue is inherently related with MANET's applications. Qos is the performance level of service which is offered by the network to user in case of QoS routing process it has to provide end to end loop free path with ensure the necessary QoS parameters like bandwidth, delay, jitter, availability and resources has met. Depending up on the application QoS parameter varies.

- Real Time Traffic :- Bandwidth, Delay
- Group Communication :- Battery Life
- Emergency Services :-Network Availability
- Security

Routing, QoS & security is challenging in MANETs compared to infrastructure network due to its

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International Journal & Magazine of Engineering, Technology, Management and Research
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characteristics like dynamic network topology, absence of pre established infrastructure for central administration, mobility of nodes, resource constraint, error prone channels and hidden , expose node problem.

Routing in MANETs is an active research area in recent years; number of routing protocols has been developed. Routing protocols are useful when they offer acceptable communication services like route discovery time, communication throughput, end to end delay, and packet loss.

Energy-Efficient routing is another effective factor for MANETs routing due to its energy Constraint characteristic so as to reducing the energy cost during data communication. Routing protocol aim is to just finding energy consumption during end to end packet travelling is not reliable routing but it also consider reliable links and residual energy of nodes which not only improve QoS but also improve life time of network. Various routing protocols have been proposed which aim to improve reliability, energy efficiency and life time of network.

In any MANET's application secure communication is important; especially in military application security is mandatory. Many security protocols have been proposed which mainly focus on the security issues related to data integrity, confidentiality and other focus on availability.

As MANETs is specifically designed for military application and disaster recovery operations, Just resource reservation to achieve QoS is not enough but also robust against security threats. Hence the proposed research will mainly focus on Improving QoS in MANETs .The research will be carried out using analytical and mathematical modeling along with simulations. The research objective is to improvement of QoS in MANETs.

The design goal of MANETs is to support network anywhere any time, characterized by lack of infrastructure with self configured & self maintenance .It is a wireless network with collection of heterogeneous mobile devices (nodes) which are connected by a dynamically varying network topology without fixed infrastructure and absence of central coordinator or base station where network intelligence placed inside every node, thus nodes in a network act as a router as well as host which means MANETs behave as a peer to peer network. The connectivity between nodes may have a multiple links and heterogeneous radio and can operate in a standalone passion. Due to characteristics of MANETs it is well suited in situations where infrastructure is difficult to setup, cost or time effective.

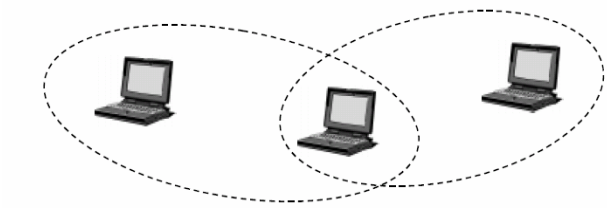

Fig 1.1 Example of a simple ad-hoc network with three participating nodes.

The design, development, performance goal of MANETs majorly include in routing, QoS, Security, multicasting, service discovery, scalability & Resource management (energy, bandwidth, delay and battery power). Where the routing protocol design issue is inherently depends on MANET's applications. The primary purpose of Routing protocols is to find the path between source and destination but in MANETs it should include QoS, resource management & security.

1.1 CHARACTERISTICS OF MANETs

The characteristics of these networks are summarized as follows

a. Communication via wireless means.

b. Nodes can perform the roles of both hosts and routers.

c. Bandwidth-constrained, variable capacity links.

d. Energy-constrained Operation.

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e. Limited Physical Security.
f. Dynamic network topology.
g. Frequent routing updates.

1.2 ADVANTAGES OF MANETS

i. They provide access to information and services regardless of geographic position.
ii. These networks can be set up at any place and time.
iii. With improved algorithm it is becoming more scalable
iv. Cost effective

1.3 DISADVANTAGES OF MANETS

i. Limited resources and physical security.
ii. Intrinsic mutual trust vulnerable to attacks.
iii. Lack of authorization facilities.
iv. Volatile network topology makes it hard to detect malicious nodes.
v. Limited bandwidth and higher error rates.

1.4 APPLICATIONS OF MANETS

i. Military or police exercises.
ii. Disaster relief operations.
iii. Mine site operations.
iv. Urgent Business meetings.

2, LITERATURE SURVEY

2.1 Routing in MANETs

Routing in MANETs is an active research area in recent years; number of routing protocols has been developed. Routing protocols are useful when they offer acceptable communication services like route discovery time, communication throughput, end to end delay, and packet loss.

Qos is the performance level of service which is offered by the network to user, in case of QoS routing process it has to provide end to end loop free path which has to ensure the necessary QoS parameters like bandwidth, delay, jitter, availability and resources has met .Depending up on the application QoS parameter varies. Many different QoS routing protocols have been developed based on different QoS parameters.

Energy-Efficient routing is another effective factor in MANETs routing due to its energy Constraint characteristic so as to reduce the energy cost during data communication. Routing protocol aims is to just finding energy consumption during end to end packet travelling is not reliable routing but it also consider reliable links and residual energy of nodes which not only improve QoS but also improve life time of network. Various routing protocols have been proposed which aim to improve reliability, energy efficiency and life time of network.

In any MANET's application secure communication is important; especially in military application security is mandatory. Many security protocols have been proposed which mainly focus on the security issues related to data integrity, confidentiality and other focus on availability.

Routing, QoS & security is challenging in MANETs compared to infrastructure network due to its characteristics like dynamic network topology, absence of pre established infrastructure for central administration, mobility of nodes, resource constraint, error prone channels and hidden , expose node problem.

Hence a requirement of routing protocol which should address the MANETs challenges. The routing protocol must be fully distributed and adaptive to network dynamics, loop free with route construction and maintenance effort must be minimum in time, energy, power and memory. Finally it must support certain level of QoS parameters with security. In our project we study well known routing protocol AODV & DSDV in terms of path establishment, Throughput, delay, packet loss.

2.2 PROPERTIES OF MANETs ROUTING PROTOCOL

The properties that are desirable in Ad-Hoc Routing protocols are

2.2.1) Distributed operation

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The protocol should be distributed. It should not be dependent on a centralized controlling node. This is the case even for stationary networks. The dissimilarity is that the nodes in an ad-hoc network can enter or leave the network very easily and because of mobility the network can be partitioned.

2.2.2) Loop free

To improve the overall performance, the routing protocol should assurance that the routes supplied are loop free. This avoids any misuse of bandwidth or CPU consumption.

2.2.3) Demand based operation

To minimize the control overhead in the network and thus not misuse the network resources the protocol should be reactive. This means that the protocol should react only when needed and should not periodically broadcast control information.

2.2.4) Unidirectional link support

The radio environment can cause the formation of unidirectional links. Utilization of these links and not only the bi-directional links improves the routing protocol performance.

2.2.5) Security

The radio environment is especially vulnerable to impersonation attacks so to ensure the wanted behaviour of the routing protocol we need some sort of security measures. Authentication and encryption is the way to go and problem here lies within distributing the keys among the nodes in the ad-hoc network.

2.2.6) Power conservation

The nodes in the ad-hoc network can be laptops and thin clients such as PDA‘s that are limited in battery power and therefore uses some standby mode to save the power. It is therefore very important that the routing protocol has support for these sleep modes.

2.2.7) Multiple routes

To reduce the number of reactions to topological changes and congestion multiple routes can be used. If one route becomes invalid, it is possible that another stored route could still be valid and thus saving the routing protocol from initiating another route discovery procedure.

2.2.8) Quality of Service Support

Some sort of Quality of service is necessary to incorporate into the routing protocol. This helps to find what these networks will be used for. It could be for instance real time traffic support.

3. THEORETICAL ANALYSIS

3.1 CLASSIFICATION OF ROUTING PROTOCOLS

The existing routing protocols in MANETs can be classified into three categories. Classification of routing protocols in mobile ad hoc network can be done in many ways, but most of these are done depending on routing strategy and network structure. Fig 3.1 shows the classification along with some examples of existing MANET protocols.

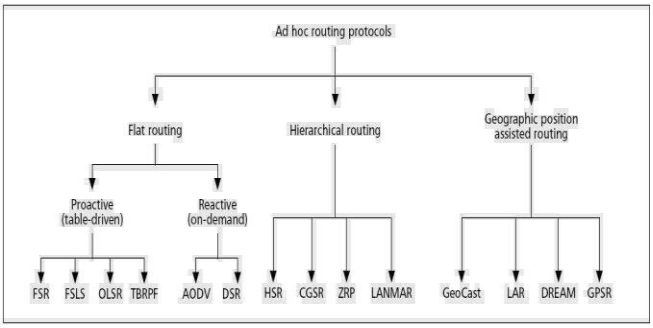

Fig 3.1 Classification of Routing Protocols in Mobile Ad-hoc Networks

The routing protocols can be categorized as flat routing, hierarchical routing and geographic position assisted routing while depending on the network structure.

According to the routing strategy routing protocols can be classified as Table-driven and source initiated.

3.1.1 Flat Routing Protocols

Flat routing protocols are divided mainly into two classes; the first one is proactive routing (table driven) protocols and other is reactive (on-demand) routing protocols. One thing is general for both protocol classes is that every node participating in routing play an equal role. They have further been classified after their design principles; proactive routing is mostly based on LS (link-state) while on-demand routing is based on DV (distance-vector).

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i) Pro-Active / Table Driven routing Protocols

Proactive MANET protocols are also called as table-driven protocols and will actively determine the layout of the network. Through a regular exchange of network topology packets between the nodes of the network, at every single node an absolute picture of the network is maintained.

There is hence minimal delay in determining the route to be taken. This is especially important for time-critical traffic. When the routing information becomes worthless quickly, there are many short-lived routes that are being determined and not used before they turn invalid. Therefore, another drawback resulting from the increased mobility is the amount of traffic overhead generated when evaluating these unnecessary routes. This is especially altered when the network size increases. The portion of the total control traffic that consists of actual practical data is further decreased. Lastly, if the nodes transmit infrequently, most of the routing information is considered redundant.

The nodes, however, continue to expend energy by continually updating these unused entries in their routing tables as mentioned, energy conservation is very important in a MANET system design. Therefore, this excessive expenditure of energy is not desired. Thus, proactive MANET protocols work best in networks that have low node mobility or where the nodes transmit data frequently. Examples of Proactive MANET protocols include

a. Optimized Link State Routing (OLSR)
b. Fish-eye State Routing (FSR)
c. Destination-Sequenced Distance Vector (DSDV)
d. Cluster-head Gateway Switch Routing Protocol (CGSR)

ii) Reactive (On Demand) protocols

Portable nodes- Notebooks, palmtops or even mobile phones usually compose wireless ad-hoc networks. This portability also brings a significant issue of mobility. This is a key issue in ad-hoc networks. The mobility of the nodes causes the topology of the network to change constantly. Keeping track of this topology is not an easy task, and too many resources may be consumed in signaling. Reactive routing protocols were intended for these types of environments.

These are based on the design that there is no point on trying to have an image of the entire network topology, since it will be constantly changing. Instead, whenever a node needs a route to a given target, it initiates a route discovery process on the fly, for discovering out a pathway. Reactive protocols start to set up routes on-demand. The routing protocol will try to establish such a route, whenever any node wants to initiate communication with another node to which it has no route. This kind of protocols is usually based on flooding the network with Route Request (RREQ) and Route reply (RERP) messages by the help of Route request message the route is discovered from source to target node; and as the target node gets a RREQ message it send RERP message for the confirmation that the route has been established. This kind of protocol is usually very effective on single-rate networks. It usually minimizes the number of hops of the selected path.

However, on multi-rate networks, the number of hops is not as important as the throughput that can be obtained on a given path.

The different types of On Demand driven protocols are

a. Ad hoc On Demand Distance Vector (AODV)
b. Dynamic Source routing protocol (DSR)
c. Temporally ordered routing algorithm (TORA)
d. Associativity Based routing (ABR)
e. Signal Stability-Based Adaptive Routing (SSA)
f. Location-Aided Routing Protocol (LAR)

3.2 COMPARISON OF PROACTIVE AND REACTIVE ROUTING PROTOCOLS

The following Table briefly compares the Proactive (Table –Driven) routing protocol with Reactive (On-Demand) routing protocols.

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Table: Comparison of Proactive and Reactive routing protocols

Proactive Protocols	Reactive protocols
Attempt to maintain consistent, up-to-date routing information from each node to every other node in the network	A route is built only when required.
Constant propagation of routing information is information periodically even when topology change does not occur.	No periodic updates. Control information is information periodically unless there is a change in topology
Incurs substantial traffic and power consumption, which is generally scarce in mobile computers	Does not incur substantial traffic and power consumption compared to Table Driven Routing Protocol
First packet latency is less when compared with on-demand protocols	First-packet latency is more when Compared with table driven routing protocol
A route to every other node in ad-hoc Not available network is always available	Not available

3.3 PROBLEM STATEMENT OF EXISTING SYSTEM

EXISTING SYSTEM

S Vanthana et all proposed a "Comparative study of Proactive and Reactive Adhoc Routing protocols Using NS2" with respect to different packet size. They studied the performance of two MANET routing protocols; AODV and DSDV. The different performance metrics were investigated with respect to packets size.

Disadvantages of Existing system

Investigation of Performance metrics with respect to packets size is not suitable for mobile ad hoc Network due to its characteristics like mobility, heterogeneity and Dynamic nature.

4 PROBLEM STATEMENT OF PROPOSED SYSTEM

This project proposes a performance evaluation of AODV and DSDV with respect to following characteristics of MANETs which is not considered in existing work.

1. Hop count
2. Traffic
3. Mobility

PROPOSED SYSTEM

The objective of this work is to evaluate the performance of two routing protocols, namely, Ad hoc Demand Distance vector (AODV) and Destination Sequence distance Vector (DSDV), for wireless adhoc networks environment. This evaluation is to be carried out through exhaustive literature review and simulation.

The general objectives can be outlined as follows

1. Get a general understanding of ad -hoc networks.
2. Literature review of AODV and DSDV.
3. Generate a simulation environment that could be used for further studies.
4. Implement AODV and DSDV routing protocols for wireless ad-hoc networks.
5. Analyze the protocols performance through simulation and verify it on the basis of literature review.
6. Discuss the result of the proposed work.

SIMULATION ENVIRONMENT

SIMULATION MODEL

The objective of this paper is the performance evaluation of two routing protocol for mobile ad hoc networks by using an open-source network simulation tool called NS-2. Two routing protocols DSDV and AODV have been considered for performance evaluation in this work. The simulation environment has been conducted with the LINUX operating system, because NS-2 works with Linux platform only.

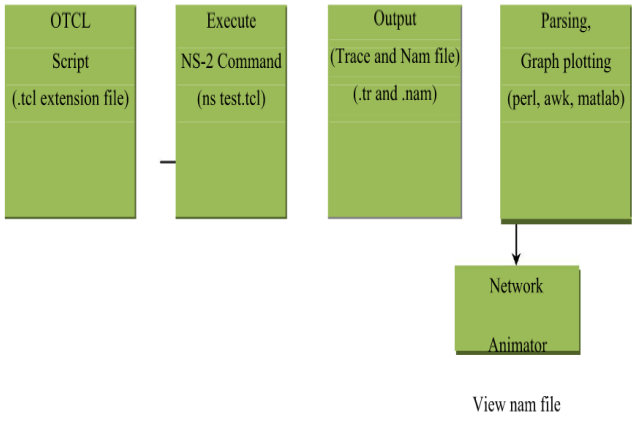

Fig 3.13.1 Simulation Overview

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NETWORK SIMULATORS

According to dictionary, Simulation can be defined as ―reproduction of essential features of something as an aid to study or training. In simulation, we can construct a mathematical model to reproduce the characteristics of a phenomenon, system, or process often using a computer in order to information or solve problems.

Nowadays, there are many network simulators that can simulate the MANET. In this section we will introduce the most commonly used simulators. We will compare their advantages and disadvantages and choose one to as platform to implement reactive/proactive protocol and conduct simulations in this thesis.

Network Simulator-NS2

NS-2 is a discrete event simulator targeted at networking research. It provides substantial support for simulation of TCP, routing and multicast protocols over wired and wireless networks. It consists of two simulation tools. The network simulator (ns) contains all commonly used IP protocols. The network animator (nam) is use to visualize the simulations. NS-2 fully simulates a layered network from the physical radio transmission channel to high-level applications.

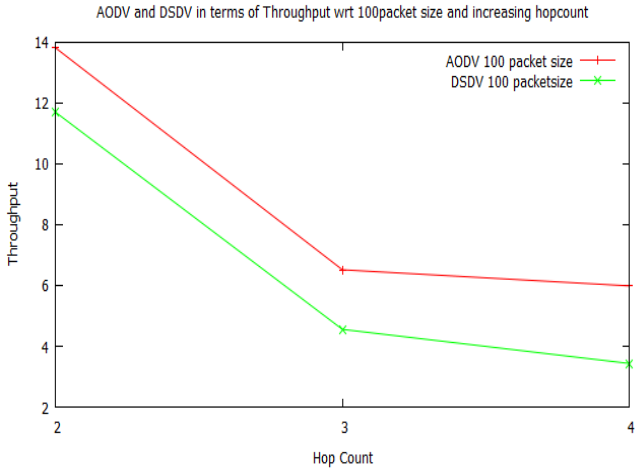
Version 2 is the most recent version of ns (NS-2) . The simulator was originally developed by the University of California at Berkeley and VINT project the simulator was recently extended to provide simulation support for ad hoc network by Carnegie Mellon University (CMU Monarch Project homepage, 1999). The NS-2 simulator has several features that make it suitable for our simulations.

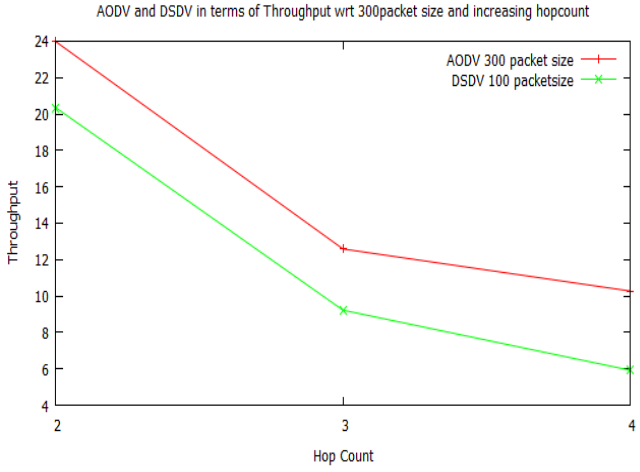
a. A network environment for ad-hoc networks
b. Wireless channel modules (e.g.802.11)
c. Routing along multiple paths
d. Mobile hosts for wireless cellular networks

NS-2 is an object-oriented simulator written in C++ and OTcl. The simulator supports a class hierarchy in C++ and a similar class hierarchy within the OTcl interpreter. There is a one-to-one correspondence between a class in the interpreted hierarchy and one in the compile hierarchy. The reason to use two different programming languages is that OTcl is suitable for the programs and configurations that demand frequent and fast change while C++ is suitable for the programs that have high demand in speed. NS-2 is highly extensible. It not only supports most commonly used IP protocols but also allows the users to extend or implement their own protocols. It also provides powerful trace functionalities, which are very important in our project since various information need to be logged for analysis. The full source code of NS-2 can be downloaded and compiled for multiple platforms such as UNIX, Windows and Cygwin.

EXPERIMENTAL RESULTS

5.1 Throughput Vs Hopcount with different packet size





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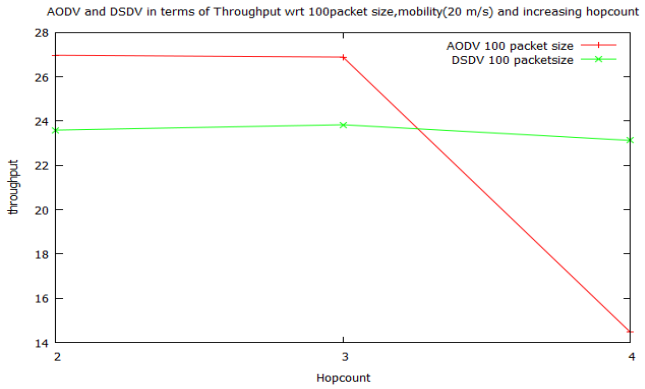
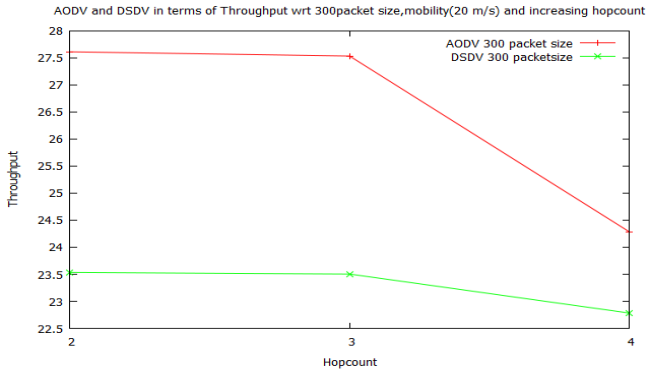
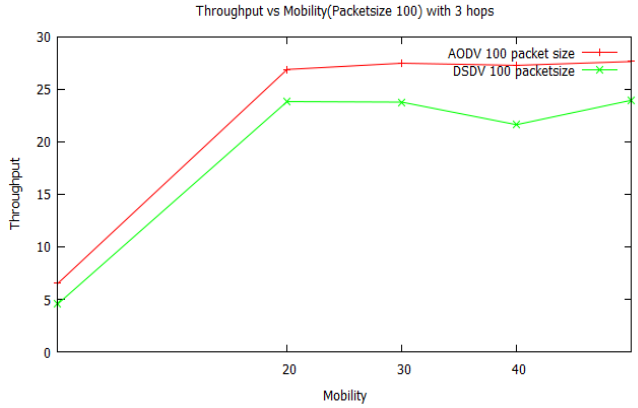
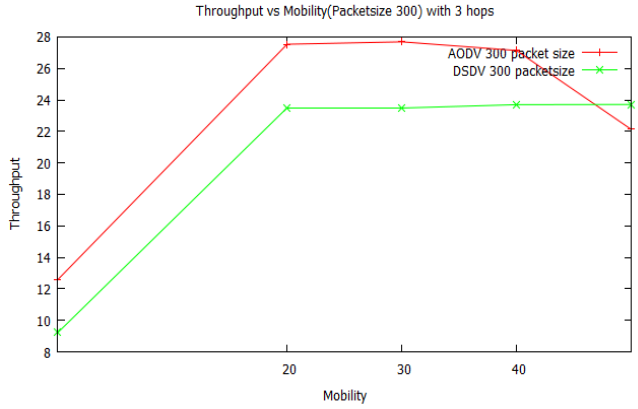
5.2 Throughput Vs Hopcount with 20 Mobility

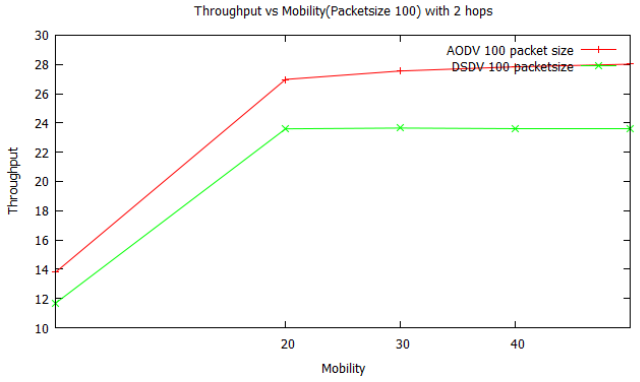


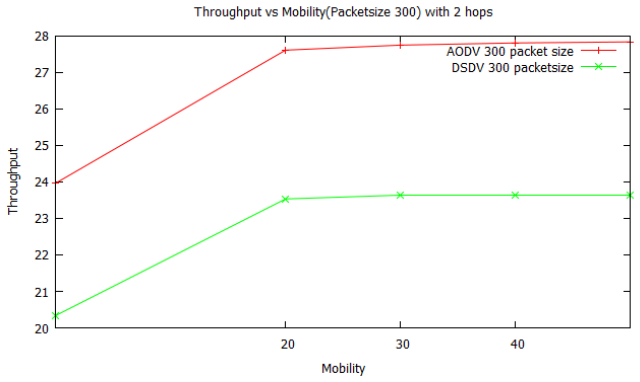




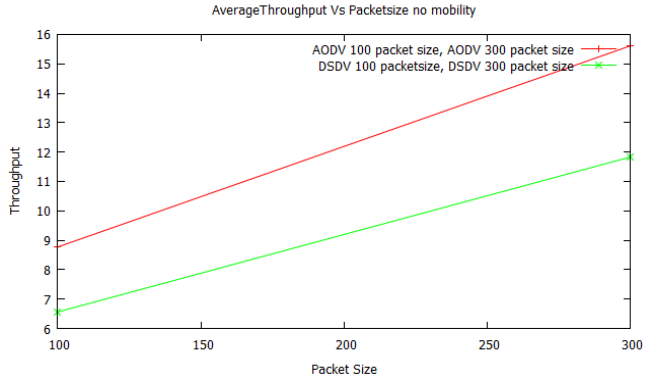


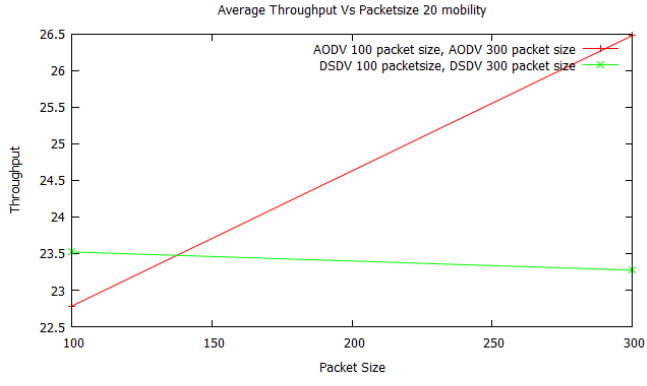
5.3 Throughput Vs Mobility





5.4 Average Throughput Vs Packet size





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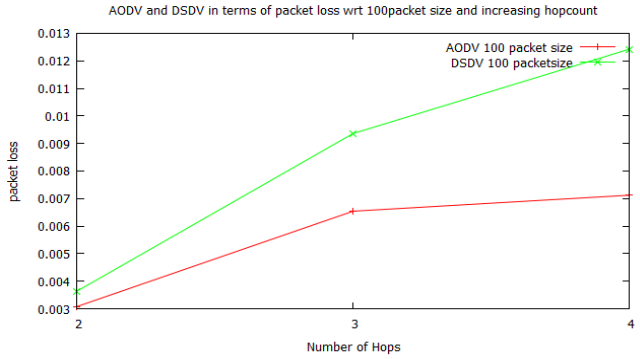
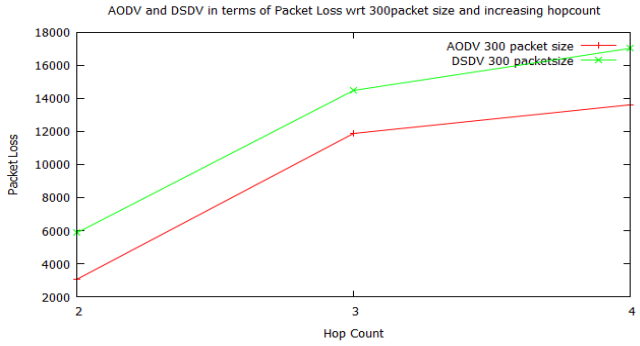
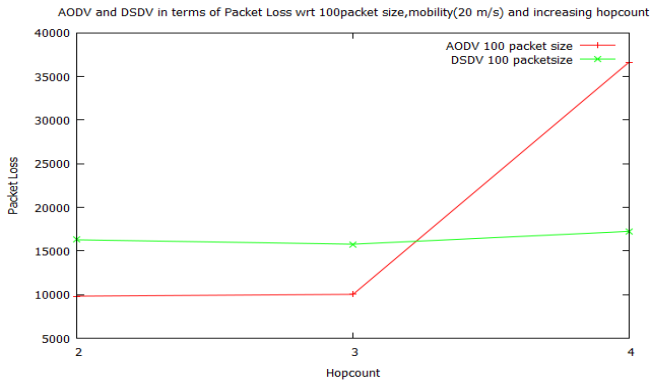
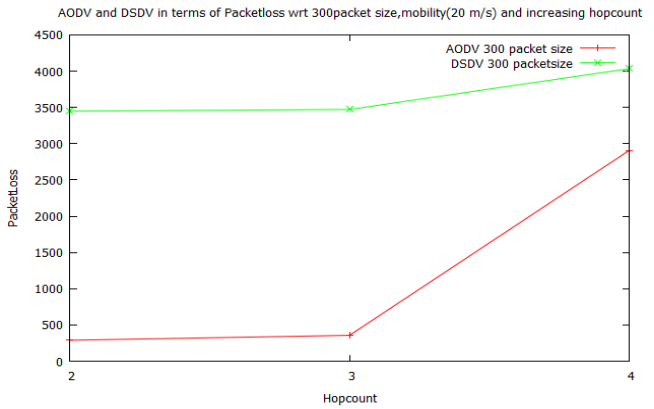
5.5 Packet Loss Vs Hopcount



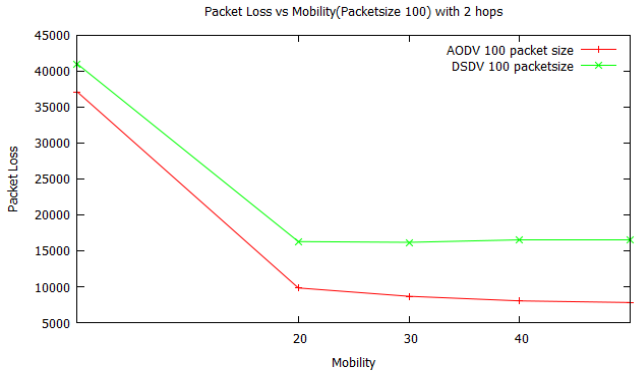


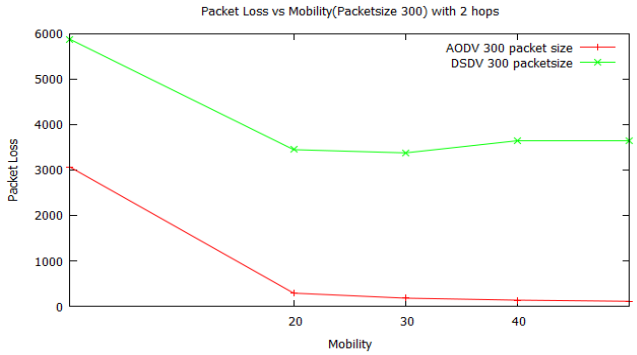
5.6 Packet Loss Vs Hop count with 20 Mobility

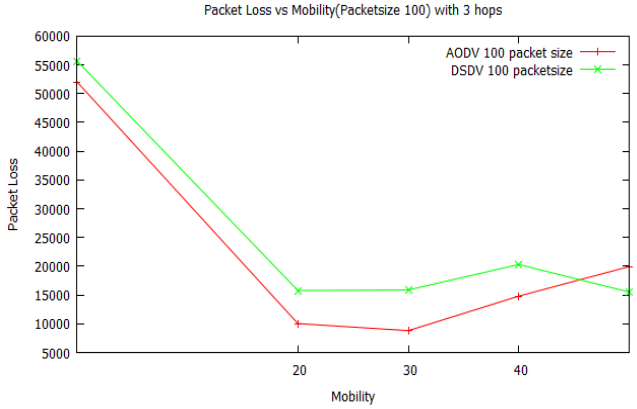


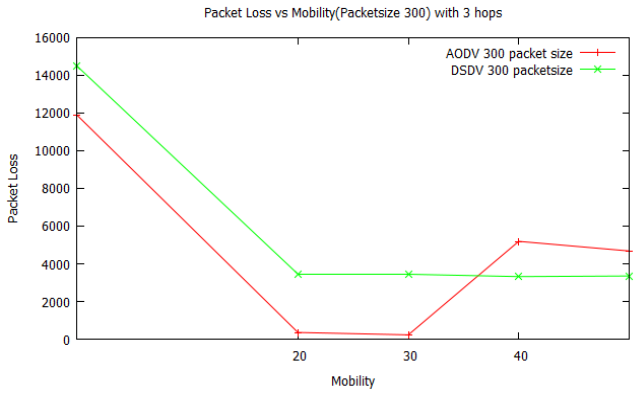


5.7 Packet Loss Vs Mobility









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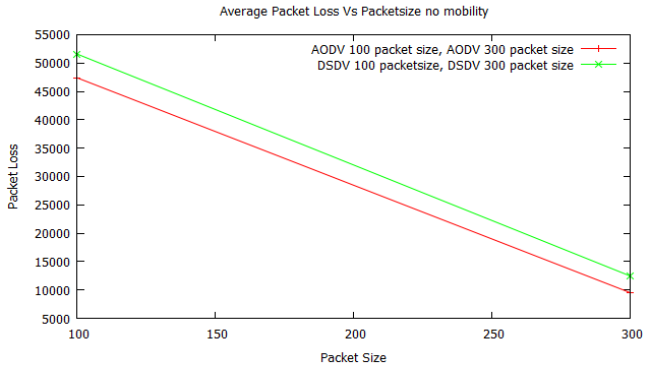
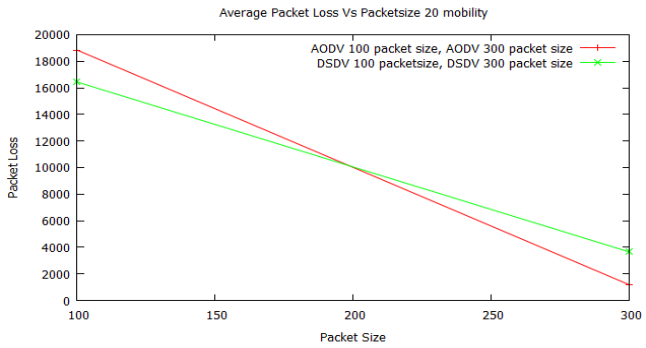
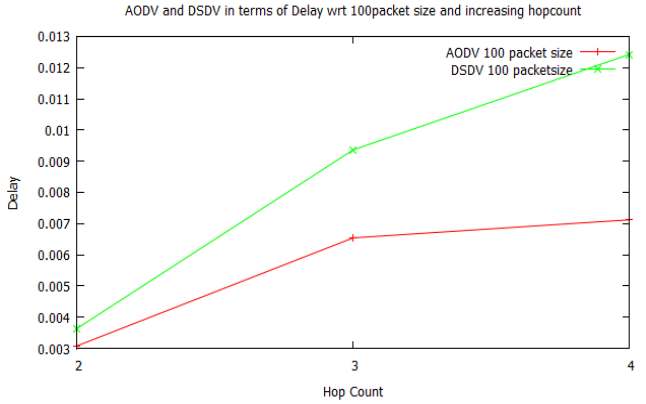
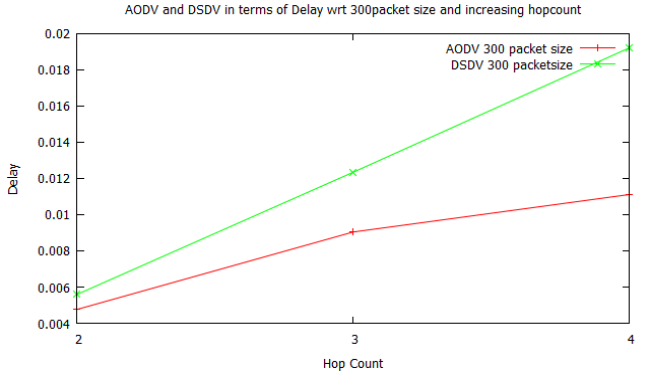
5.8 Average Packet Loss Vs Packet size



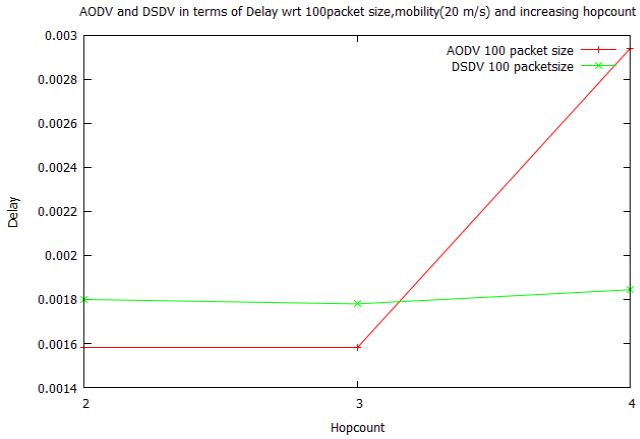


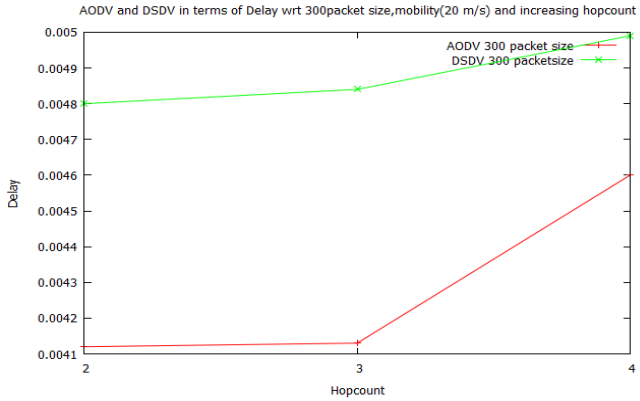
5.9 Delay Vs Hop Count



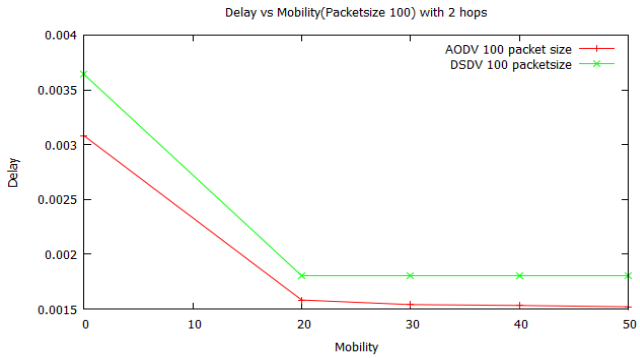


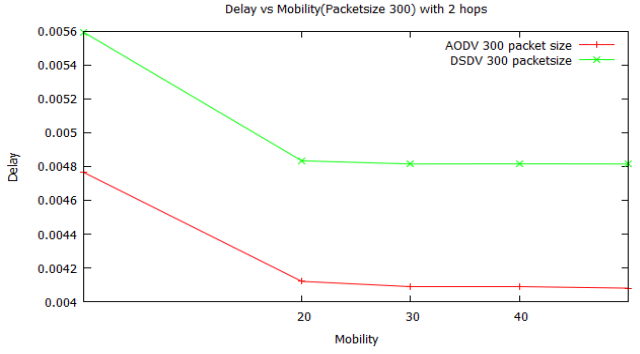
5.10 Delay Vs Hopcount with 20 Mobility





5.11 Delay Vs Mobility





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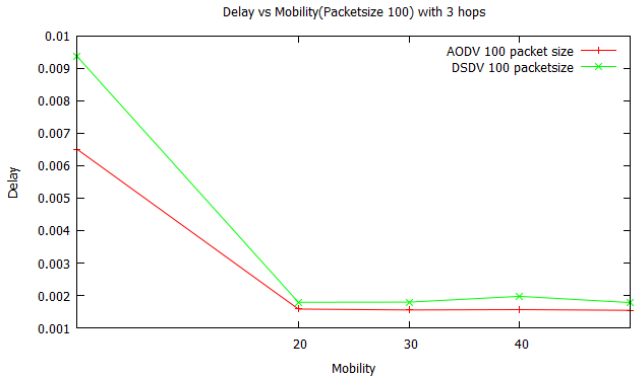
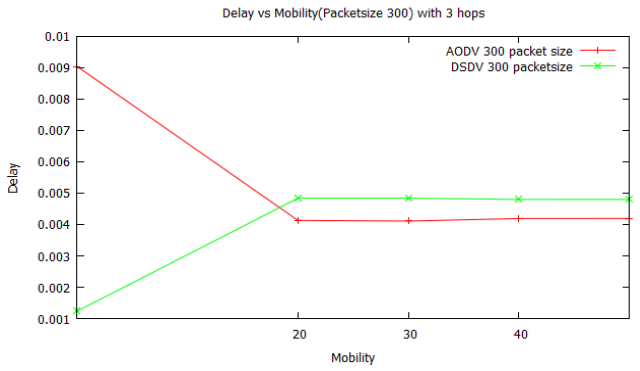
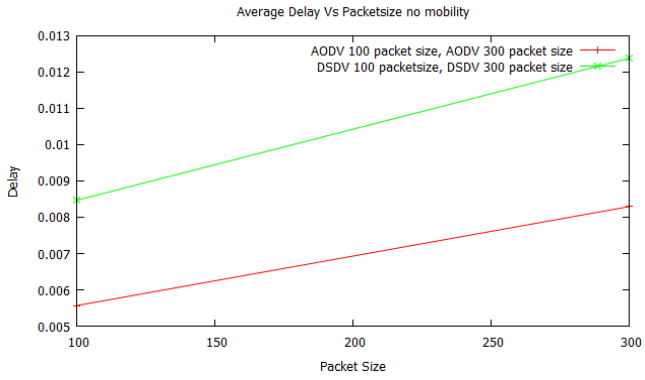
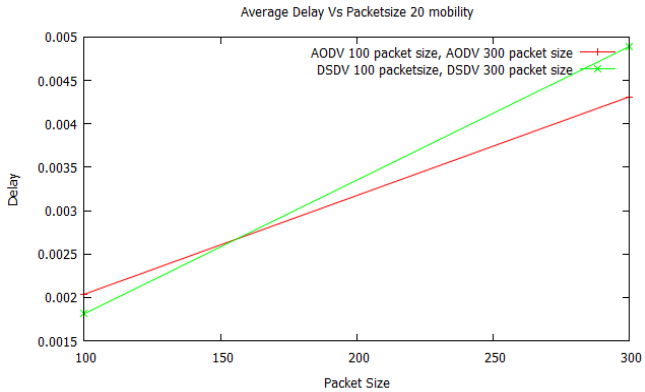




5.12 Average Delay Vs Packet size





CONCLUSION

Routing is the important issue in MANETs. The main aim of our work is to evaluate the performance of AODV and DSDV routing protocol by using different performance metrics namely throughput, end to end delay and packet loss in different traffic conditions. AODV is on demand reactive routing protocol which maintenance a routing table, one route per destination, which uses destination sequence number which avoids loops and gives freshness of route. We have done detailed simulation model to evaluate the performance characteristic of routing protocol. According to our simulation knowledge, AODV is effective for application oriented metrics such as throughput and delay in less stressful situation like smaller number of nodes and smaller load compare to DSDV.

FUTURE SCOPE

In future work, the AODV, DSDV routing protocol results which we got analyzed deeply in order to complete understand of AODV, DSDV routing protocols. To improve the QoS in MANETs there is a large scope to improve AODV and DSDV. Also, the performances of other routing protocols of MANETs are compared with our simulation result.

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