Performance Evolution of AODV and DSR Routing Protocols in MANET Using NS2

Sachin Dnyandeo Ubarhande

Research Student, Department of Software Systems
RGPV University, Bhopal, India

Abstract— Mobile ad hoc network (MANET) is an autonomous system of mobile nodes connected by wireless links. Each node operates not only as an end system, but also as a router to forward packets. The nodes are free to move about and organize themselves into a network. These nodes change position frequently. The main classes of routing protocols are Proactive, Reactive and Hybrid. A Reactive (on-demand) routing strategy is a popular routing category for wireless ad hoc routing. It is a relatively new routing philosophy that provides a scalable solution to relatively large network topologies. The design follows the idea that each node tries to reduce routing overhead by sending routing packets whenever a communication is requested. In this work an attempt has been made to compare the performance of two prominent on demand reactive routing rotocols for MANET: - Ad hoc On Demand Distance Vector (AODV), Dynamic Source Routing (DSR) protocols. DSR and AODV is a reactive gateway discovery algorithms where a mobile device of MANET connects by gateway only when it is needed. As per our findings the differences in the protocol mechanics lead to significant performance differentials for both of these protocols. The performance differentials are analyzed using varying metrices. These simulations are carried out using the ns-2 network simulator. The results presented in this work illustrate the importance in carefully evaluating and implementing routing protocols in an ad hoc environment.

Index Terms— Reactive protocols, AODV, DSR, NS2, Performance metrics.

1 INTRODUCTION

Wireless cellular systems have been in use since 1980s. We have seen their evolutions to first, second and third generation's wireless systems. These systems work with the support of a centralized supporting structure such as an access point. The wireless users can be connected with the wireless system by the help of these access points, when they roam from one place to the other. The adaptability of wireless systems is limited by the presence of a fixed supporting coordinate. It means that the technology can not work efficiently in that places where there is no permanent infrastructure. Easy and fast deployment of wireless networks will be expected by the future generation wireless systems. This fast network deployment is not possible with the existing structure of present wireless systems. Recent advancements such as Bluetooth introduced a fresh type of wireless systems which is frequently known as mobile ad-hoc networks. Mobile ad-hoc networks or "short live" networks control in the nonexistence of permanent infrastructure. Mobile ad hoc network offers quick and horizontal network deployment in conditions where it is not possible otherwise. Ad-hoc is a Latin word, which means "for this or for this only."

Mobile ad hoc network is an autonomous system of mobile nodes connected by wireless links; each node operates as an end system and a router for all other nodes in the network. A wireless network is a growing new technology that will allow users to access services and information electronically, irrespective of their geographic position. Wireless networks can be classified in two types: - infrastructure network and infrastructure less (ad hoc) networks. Infrastructure network consists of a network with fixed and wired gateways. A mobile host interacts with a bridge in the network (called base station) within its communication radius. The mobile unit can move geographically while it is communicating. When it goes out of range of one base station, it connects with new base station and starts communicating through it. This is called handoff. In this approach the base stations are fixed. A Mobile ad hoc network is a group of wireless mobile computers (or nodes); in which nodes collaborate by forwarding packets for each other to allow them to communicate outside range of direct wireless transmission. Ad hoc networks require no centralized administration or fixed network infrastructure such as base stations or access points, and can be quickly and inexpensively set up as needed. A MANET is an autonomous group of mobile users that communicate over reasonably slow wireless links. The network topology may vary rapidly and unpredictably over time, because the nodes are mobile. The network is decentralized, where all network activity, including discovering the topology and delivering messages must be executed by the nodes themselves. Hence routing functionality will have to be incorporated into the mobile nodes. MANET is a kind of wireless ad-hoc network and it is a self-configuring network of mobile routers (and

associated hosts) connected by wireless links – the union of which forms an arbitrary topology. The routers, the participating nodes act as router, are free to move randomly and manage themselves arbitrarily; thus, the network's wireless topology may change rapidly and unpredictably. Such a network may operate in a standalone fashion, or may be connected to the larger Internet.
Mobile ad hoc network is a collection of independent mobile nodes that can communicate to each other via radio waves. The mobile nodes can directly communicate to those nodes that are in radio range of each other, whereas others nodes need the help of intermediate nodes to route their packets. These networks are fully distributed, and can work at any place without the aid of any infrastructure. This property makes these networks highly robust.

1.1 Characteristics Of Manet

Mobile ad hoc network nodes are furnished with wireless transmitters and receivers using antennas, which may be highly directional (point-to-point), omnidirectional (broadcast), probably steerable, or some combination there of . At a given point in time, depending on positions of nodes, their transmitter and receiver coverage patterns, communication power levels and co-channel interference levels, a wireless connectivity in the form of a random, multihop graph or "ad hoc" network exists among the nodes. This ad hoc topology may modify with time as the nodes move or adjust their transmission and reception parameters.

The characteristics of these networks are summarized as follows:

- Communication via wireless means.
- Nodes can perform the roles of both hosts and routers.
- Bandwidth-constrained, variable capacity links.
- Energy-constrained Operation.
- Limited Physical Security.
- Dynamic network topology.
- Frequent routing updates.

1.2 Advantages Of Manet

The following are the advantages of MANET:

- They provide access to information and services regardless of geographic position.
- These networks can be set up at any place and time.

1.3 Disadvantates Of Manet

Some of the disadvantages of MANETs are as follows:

- Limited resources and physical security.
- Intrinsic mutual trust vulnerable to attacks.
- Lack of authorization facilities.
- Volatile network topology makes it hard to detect malicious nodes.
- Security protocols for wired networks cannot work for ad hoc networks.

1.4 Application Of Manet

Some of the applications of MANETs are as follows:

- Military or police exercises.
- Disaster relief operations.
- Mine cite operations.
- Urgent Business meetings.

2 Protocols In Ad-hoc Networks

2.1 Ad-Hoc On Demand Distance Vector

AODV is a distance vector type routing. It does not require nodes to maintain routes to destinations that are not actively used. As long as the endpoints of a communication connection have valid routes to each other, AODV does not play a role. The protocol uses different messages to discover and maintain links: Route Requests(RREQs), Route Replies(RREPs), and Route Errors(RERRs). These message types are received via UDP, and normal IP header processing applies. AODV uses a destination sequence number for each route entry. The destination sequence number is created by the destination for any information it sends to request nodes. Using destination sequence numbers ensures loop freedom and allows to know which of several routes is more fresh. Given the choice between two routes 1 to a destination, a requesting node always selects the one with the greatest sequence number. When a node wants to find a route to another one, it broadcasts a RREQ to all the network till either the destination is reached or another node is found with a fresh enough route to the destination (a fresh enough route is a valid route entry for destination whose associated sequence number is at least as great as that contained in the RREQs). Then a RREQ is sent back to the source and the discovered route is made available. Nodes that are part of an active route may offer connectivity information by broadcasting periodically local Hello messages (special RREQ messages) to its immediate neighbors. If Hello messages stop arriving from a neighbor beyond some given time threshold, the connection is assumed to be lost. When a node detects that a route to a neighbor node is not valid it removes the routing entry and send a REER message to neighbors that are active and use the route; this is possible by maintaining active neighbor lists. This procedure is repeated at nodes that receive REER messages. A source that receives an REER can reinitiate a RREQ message. AODV does not allow to handle unidirectional links.Ad hoc On-Demand Distance Vector (AODV) routing is a routing protocol for mobile ad hoc networks and other wireless ad-hoc networks. It is jointly developed in Nokia Research Centre of University of California, Santa Barbara and University of Cincinnati by C. Perkins and S. Das. It is an on-demand and distance-vector routing protocol, meaning that a route is established by AODV from

a destination only on demand. AODV is capable of both unicast and multicast routing . It keeps these routes as long as they are desirable by the sources. Additionally, AODV creates trees which connect multicast group members. The trees are composed of the group members and the nodes needed to connect the members. The sequence numbers are used by AODV to ensure the freshness of routes. It is loop-free, self-starting, and scales to large numbers of mobile nodes AODV defines three types of control messages for route maintenance: RREQ- A route request message is transmitted by a node requiring a route to a node. As an optimization AODV uses an expanding ring technique when flooding these messages. Every RREQ carries a time to live (TTL) value that states for how many hops this message should be forwarded. This value is set to a predefined value at the first transmission and increased at retransmissions. Retransmissions occur if no replies are received. Data packets waiting to be transmitted (i.e. the packets that initiated the (RREQ). Every node maintains two separate counters: a node sequence number and a broadcast_ id. The RREQ contains the following fields.

source address	broadcast ID	source sequence no.	destination address	destination sequence no.	Hop count

2.2 DYNAMIC SOURCE ROUTING

Dynamic Source Routing (DSR) is a routing protocol for wireless mesh networks. It is similar to AODV in that it establishes a route on-demand when a transmitting mobile node requests one. However, it uses source routing instead of relying on the routing table at each intermediate device. Dynamic source routing protocol (DSR) is an on-demand, source routing protocol ,whereby all the routing information is maintained (continually updated) at mobile nodes. DSR allows the network to be completely self-organizing and self-configuring, without the need for any existing network infrastructure or administration. The protocol is composed of the two main mechanisms of "Route Discovery" and "Route Maintenance", which work together to allow nodes to discover and maintain routes to arbitrary destinations in the ad hoc network . An optimum path for a communication between a source node and target node is determined by Route Discovery process. Route Maintenance ensures that the communication path remains optimum and loop-free according the change in network conditions, even if this requires altering the route during a transmission. Route Reply would only be generated if the message has reached the projected destination node (route record which is firstly contained in Route Request would be inserted into the Route Reply). To return the Route Reply, the destination node must have a route to the source node. If the route is in the route cache of target node, the route would be used. Otherwise, the node will reverse the route based on the route record in the Route Reply message header (symmetric links). In the event of fatal transmission, the Route Maintenance Phase is initiated whereby the Route Error packets are generated at a node. The incorrect hop will be detached from the node's route cache; all routes containing the hop are reduced at that point. Again, the Route Discovery Phase is initiated to determine the most viable route. It is beacon-less and hence it does not have need of periodic hello packet (beacon) transmissions, which are used by a node to inform its neighbors of its presence. The fundamental approach of this protocol during the route creation phase is to launch a route by flooding RouteRequest packets in the network. The destination node, on getting a RouteRequest packet, responds by transferring a RouteReply packet back to the source, which carries the route traversed by the RouteRequest packet received.

3 NETWORK SIMULATORS

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 network environment for ad-hoc networks, Wireless channel modules (e.g.802.11), Routing along multiple paths, 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

4 PERFORMANCE METRICS

Some important performance metrics can be evaluated

4.1 Slow Speed Mobile Nodes: We can check the tcp performance of routing protocols, with nodes are moving at very slow speed of 5ms.

4.2 High Speed Mobile Nodes: We can check the tcp performance of routing protocols, with nodes are moving at High speed of 10ms.

4.3 Very High Speed Mobile Nodes: We can check the tcp performance of routing protocols, with nodes are moving at Very High Speed of 30ms.

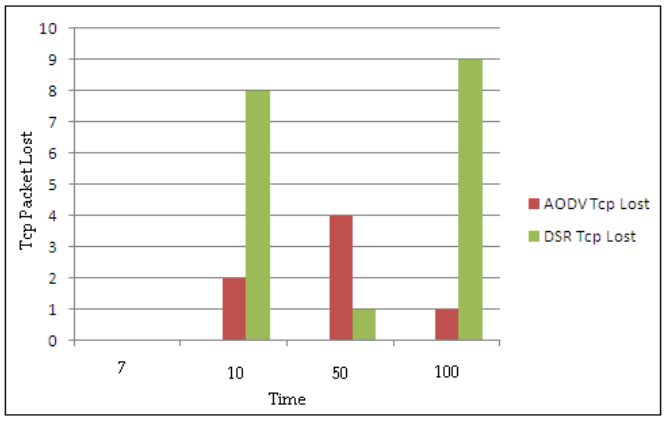
4.4 Small Number of Hops:Hops are nothing but the count of intermediate nodes from source to destination.We can check tcp performance of routing protocols by considering small number of hops that is 4 hops between source and destination.

4.5 Large Number of Hops: Hops are nothing but the count of intermediate nodes from source to destination.We can check tcp performance of routing protocols by considering large number of hops that is 7 hops between source and destination.

5 Results And Discussion

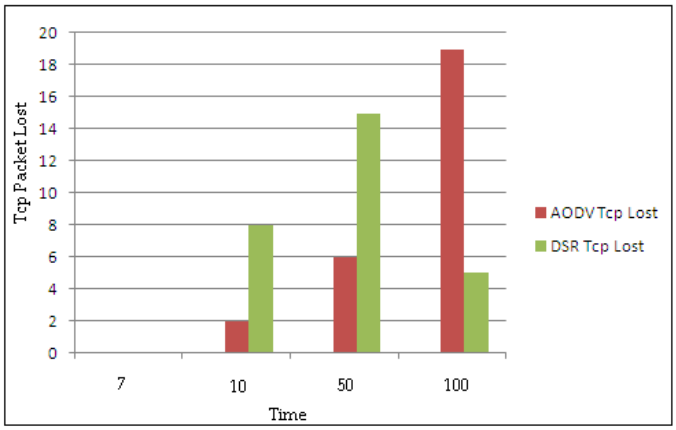
5.1 Slow Speed Mobile Nodes:

Packet sent and received difference in AODV is more than DSR with scenario mobile nodes moving at 5ms.



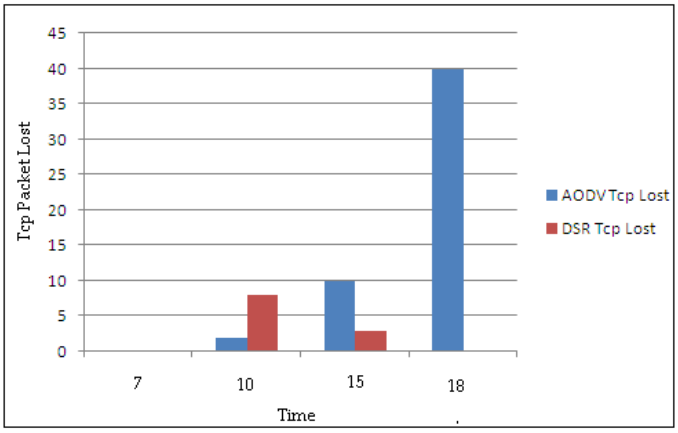
5.2 High Speed Mobile Nodes:

Packet sent and received difference in AODV is more than DSR with scenario mobile nodes moving at 10ms.



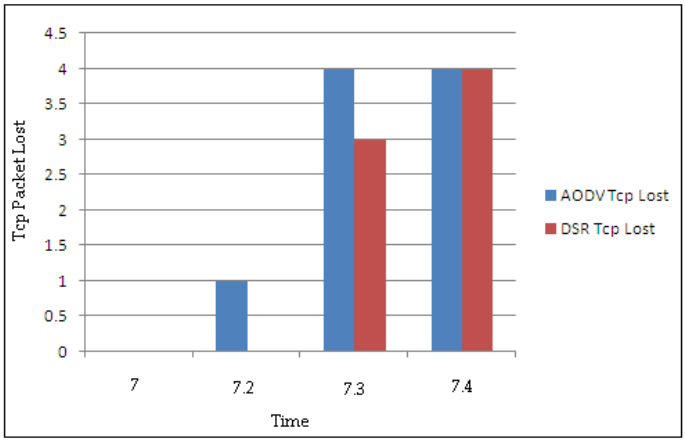
5.3 Very High Speed Mobile Nodes:

Packet sent and received difference in AODV is more than DSR with scenario mobile nodes moving at 15ms.



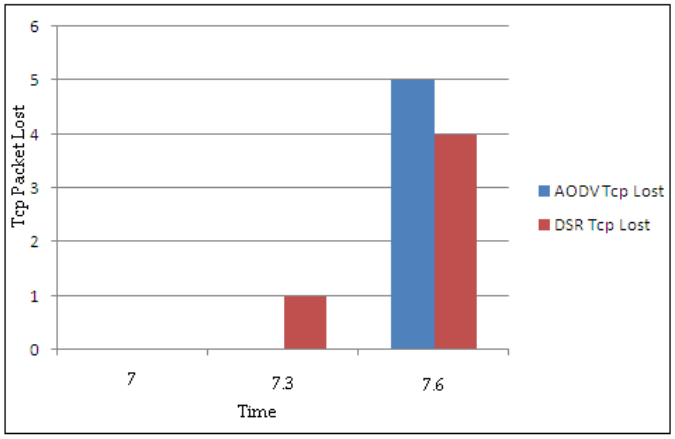
5.4 Small Number of Hops:

Packet sent and received difference in DSR is less than AODV, but total packet sent amount is very high in AODV than DSR. As AODV is sent 2409 tcp packets where as in DSR sent only 20 tcp packets in 150 sec and hence tcp packet lost rate is also less in DSR and which is inefficient than AODV as it is able to sent only few packets during time interval.



5.5 Large Number of Hops:

Packet sent and received difference in DSR is less than AODV ,but total packet sent amount is very high in AODV than DSR. As AODV is sent 1342 tcp packets where as in DSR sent only 18 tcp packets in 150 sec and hence tcp packet lost rate is also less in DSR and which is inefficient than AODV as it is able to sent only few packets during time interval.



6 CONSCLUSION

From above result we conclude that as speed of mobile nodes changes low to high Dynamic Source Routing Protocol deliverd the better performance in terms of less tcp packets dropped than Ad-hoc on Demand Distance Vector Routing Protocol.And by considering hops metric, as increasing number of hops AODV is produced good result than DSR in terms of large tcp packet sending rate.

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