International Journal of Recent Research and Review, Vol. VII, Issue 4, December 2014
ISSN 2277 – 8322

Performance Differentials Analysis of Aodv and DSR Routing Protocols of Adhoc Network

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Abstract -The main focus of this paper is to discuss and evaluate the relative performance of On-demand routing protocols of Ad hoc networks that are Ad hoc On demand Distance Vector and Dynamic Source Routing by increasing the network size and varying the pause time with respect to the performance metrics such as throughput and packet delivery fraction in different scenarios as small and large networks. The main method for evaluating the performance of Ad hoc networks is simulation. The simulation is done by using Network Simulator 2. On the basis of results and analysis derived from simulation work done, a suitable routing protocol can be chosen for a specified network applications and services among various wireless devices.

Keywords - Ad hoc network, Simulation, AODV, DSR, Throughput, Packet delivery fraction.

I. INTRODUCTION

The frequently use of wireless devices like smart phones, Global Positioning System devices, laptops, Personal Digital Assistances, and other electronic devices have become more cheaper and essential nowadays. Among various wireless devices the demand for communication and networking has been increased for different applications and services. Also, user mobility has increased the demand for wireless networks. A wireless network is a type of computer network that enables two or more devices to communicate using standard network protocols without network cabling. It can be classified into two forms: Infrastructure-based wireless network/ wireless network with access point and Ad hoc network/peer-to-peer wireless network.

A) Infrastructure-based Wireless Network

These types of networks use access points (base station, router, PC running software or servers) for providing connectivity to the devices of the network for the wireless communications. Examples: Mobile phone networks and wireless LANs.

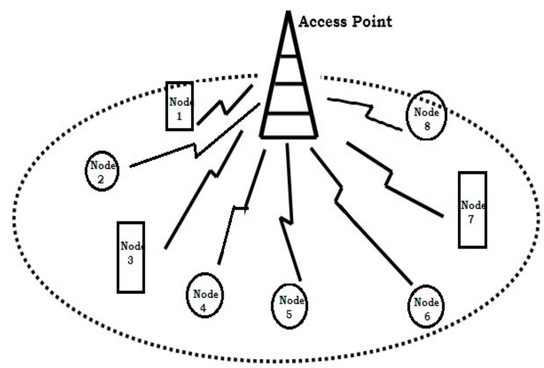

Fig. 1. Infrastructure-based Wireless Network

B) Ad hoc Network

It is a peer-to-peer wireless network between devices that do not have an access point in between them. Each device with a wireless interface can communicate directly (hop-by-hop) with the other devices. They are dynamic and self-organizing networks (no existing infrastructure or pre-configuration). Each device participates in routing by forwarding data for other devices. The determination of which devices forward data is made dynamically based on the network connectivity. These networks can use flooding routing method (technique commonly used for path discovery and information propagation) for forwarding the data. Although devices need to be in range with each other in order to communicate.

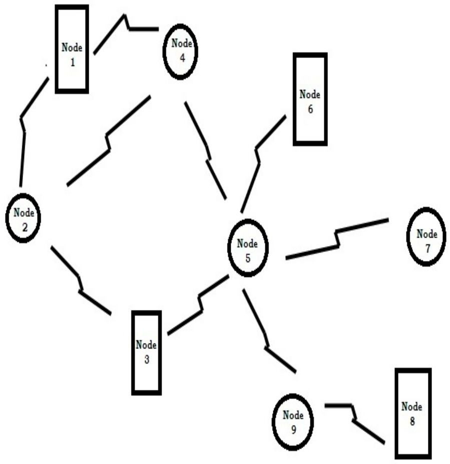

Fig.2. Ad hoc Network

C) Characteristics of Ad hoc Networks

- Operating without a central administrator
- Instant deployment
- Node mobility [1]: Nodes are free to move arbitrarily; thus, the network topology may change randomly and rapidly at unpredictable times.
- Multi-hop routing: involves sending data through multiple stops instead of one long pathway.

D) Types of Ad hoc Networks

- Mobile Ad hoc Network (MANET) [2] is a network of wireless mobile devices (handset, PDAs, notebooks) formed dynamically, self-organizing and without any central administration. Figure 3 shows a MANET network consisting of nodes and their transmission ranges. As shown Nodes 2, 3 & 4 are neighbors of Node 1 whereas Nodes 5 & 6 are not. So, data transmission to Nodes 5 & 6 will have to be relayed by Node 4.

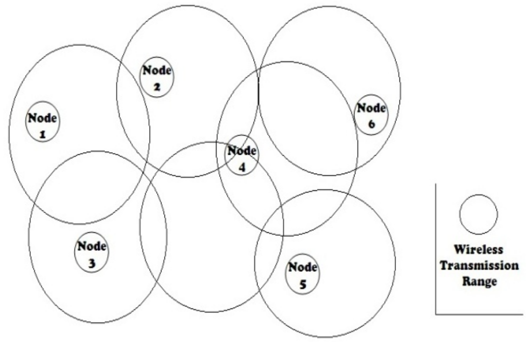

Fig. 3. MANET Nodes and their transmission ranges

- Wireless Sensor Network (WSN) is a special kind of Ad hoc networks; consist of devices equipped with sensing, processing and communication capability. These networks are used to monitor remote locations or the places where signals are not proper.

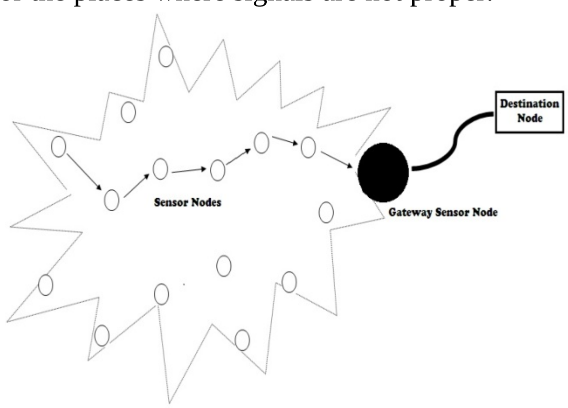

Fig. 4. Wireless Sensor Network Architecture

E) Network Simulator

It is software (or hardware) that approximates the behavior of the network without an actual network being present; the network is typically modelled with devices, channel, traffic etc. and the performance of the network is analyzed.

F) Network Simulator 2 (NS2)

It is open source & free software which is an object-oriented, discrete event driven network simulator that uses C++ and OTcl programming languages [3]. C++ is used to implement the detailed protocol and OTcl is used for users to control the simulation scenario and schedule the events. As shown in figure 5 NS is basically an object-oriented Tcl script interpreter with network simulation object libraries. Its architecture is composed of five parts: Event scheduler, Network components, Tclcl, OTcl library and Tcl 8.0 script language.

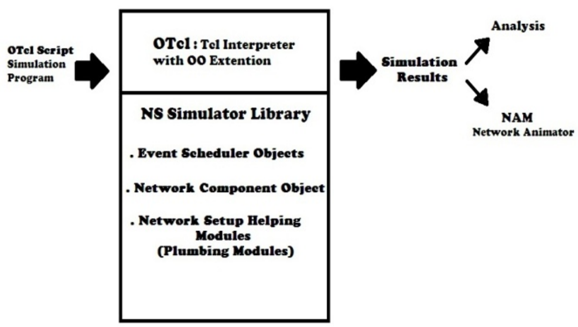

Fig. 5. Simplified User's View of NS2

G) Software Tools used with NS2

- NAM:

  NAM [4] presents a visual version of the network topology created. It can be executed directly from a Tcl script. It is a Tcl/Tk based animation tool and used to visualize simulations and real world packet trace data. It produces a NAM trace file which contains topology information like nodes, links and packet trace information. It controls comprise play, pause, speed controller etc. It provides a drag and drop interface for creating topologies and presents information such as throughput, number packets on each link.

- XGraph:

  It is used to analyze trace files which are produced from a simulation. It is an X-Windows application that includes the interactive plotting & graphing and animation & derivatives. To use it in NS2 the executable can be called within a Tcl Script. This will then load a graph displaying the information visually of the trace file produced from the simulation.

II. LITERATURE SURVEY

To start any thesis selecting a base paper is a very important phase. After going through many research papers I found one recent effort is closely related to our work named as "Performance Measurement of Some Mobile Ad hoc Network Routing Protocols", and selected it as my reference paper for making further enhancements in the work covered in this base paper [5]. Differences in our current research work and the preferred base paper can be compared with the reference of below table I:

Table I
Differences in Current Research Paper and Reference Paper

Disparity	**Base Paper**	**Current Research Work**
Studied and analyzed Protocols	AODV, FSR, LAR	AODV and DSR
Simulation Tool Used	GloMoSim	NS2
Performance Metrics	Routing Messages Overhead, Throughput and End to End Delay	Throughput and Packet Delivery Fraction

Other papers which have provided more insight of the study in the field of network protocols have been summarized below helping to gain more knowledge and understanding of the subject. These papers play a vital role in overall view of the topic and providing a modular design to our research work:

In [6], OPNET Simulator is used for evaluation of AODV and DSR Routing Protocols. The author concluded that in mobile nodes networks AODV is a good choice in all the three scenarios of small, large and very large network for minimal delay and higher throughput.

In an evaluation of two routing protocols of MANET namely AODV and TORA using NS2 simulator to determine which one is efficient through performance metrics which are delay and delivery rate, it was concluded that DSR outperforms AODV in less stressful situations. AODV, however, outperforms DSR in more stressful situations [7].

III. PROBLEM DEFINITION

Our proposed research work will make available explanation and simulation analysis of on-demand routing protocols AODV and DSR for Ad hoc networks and also provide a categorization of these protocols according to the routing approach i.e. table driven, on demand. It will also present a assessment of these protocols under variation in pause time and scalability in the network by increasing its size and simultaneously measured performances under the performance metrics throughput and packet delivery fraction to determine which protocol works best in the required network application. This will do through the Network Simulator 2 (NS2) simulation tool.

IV. ROUTING PROTOCOLS IN AD HOC NETWORK

An Ad hoc routing protocol is a convention that manages how nodes decide which way to route packets between network devices. Ad hoc network routing protocols can be broadly classified into two main categories:

- Table-driven (proactive) routing protocol

  These protocols maintain current lists of destinations and their routes by periodically distributing routing information throughout the network to keep routing table uniformity.

- On-demand (reactive) routing protocol

  These protocols determine routes only when needed. Whenever a node wants to send packets to its destination, it initiates a route discovery process to determine the route by flooding the network with route request packets. After route establishment, route maintenance process is maintained until either the destination becomes inaccessible from the source or route is no longer desired.

Other categories of Ad hoc network routing protocols are:

- Hybrid routing protocol

  These protocols combine the rewards of proactive and reactive routing. The routing process is firstly established with some proactively prospected routes and then serves the demand from additionally activated nodes through reactive flooding.

- Hierarchical routing protocols

  In this protocol the option of proactive and reactive routing depends on the hierarchic level in which a node resides.

Here we discuss and evaluate the relative performance of on-demand routing protocols AODV and DSR.

A) Ad hoc On-demand Distance Vector (AODV) Protocol

It is an On-demand routing protocol which means routes are determined only when needed [8-9]. The route discovery from source to destination is supported by request and reply cycles. The intermediate nodes shop the route information in the route table along the route. In AODV, Control messages used for the route discovery and dead routes are as follows:

- HELLO
- Route Request (RREQ)
- Route Reply (RREP)
- Route Error (RERR)

Hello messages are used to detect and monitor links to neighbors. Each active node periodically broadcasts a Hello message that all its neighbors receive. If a node fails to receive several Hello messages from a neighbor, a dead link is detected.

When a source wants to transmit data to a destination, it broadcasts a RREQ message. At each intermediate node, when a RREQ message is received a route to the source is created. If the receiving node has not received this RREQ before, is not the destination and does not have a current route to the destination, it rebroadcasts the RREQ. The parameters of the route request message are source address, request ID, source sequence number, destination address, destination sequence number, hop count. A RREQ is identified by the pair source address and request ID, each time when the source node sends a new RREQ the request ID is incremented. A node that has no route entry for the destination, it rebroadcasts the RREQ with incremented hop count parameter. A RREP message is generated and sent back to source if a node has route with sequence number greater than or equal to that of RREQ.

If the receiving node is the destination or has a current route to the destination, it generates a RREP. The RREP is unicast in a hop-by-hop fashion to the source. As the RREP propagates, each intermediate node creates a route to the destination. When the source receives the RREP, it records the route to the destination and can begin sending data. If multiple RREPs are received by the source, the route with the shortest hop count is chosen. The parameters of the route reply message: source address, destination address, destination sequence number, hop count, life time.

As data flows from the source to the destination, each node along the route updates the timers. If a route is not used for some period of time, a node cannot be sure whether the route is still valid; thus, the node removes the route from its routing table.

If data is flowing and a link break is detected, a RERR is sent to the source in a hop-by-hop fashion. As the RERR propagates towards the source, each intermediate node invalidates routes to any inaccessible destinations. When the source receives the RERR, it invalidates the route and reinitiates route discovery if necessary.

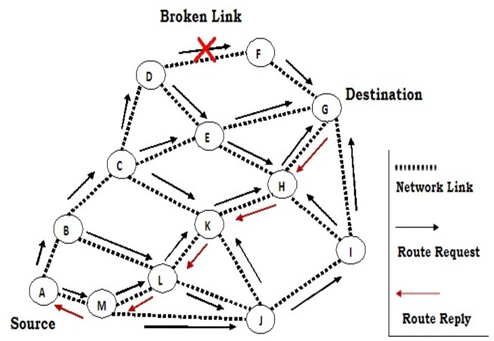

Fig. 6. Message Exchanges of the AODV Protocol (Route Discovery)

B) Dynamic Source Routing (DSR) Protocol

It is an On-demand routing protocol [10]. It is composed of the two mechanisms for routing:

- Route Discovery
- Route Maintenance

When a source wants to transmit data to a destination for which it does not already know the route, it uses a route discovery process to determine a route by flooding the network with RREQ packets. Each node receiving an RREQ rebroadcasts it, unless it is the destination or it has a route to the destination in its route cache. Such a node replies to the RREQ with a RREP packet that is routed back to the source. RREQ and RREP packets are source routed. The RREQ builds up the path traversed across the network. The RREP routes itself back to the source by traversing this path backward. The route carried back by the RREP packet is cached at the source for upcoming use.

If a link on a source route is broken, the source is notified using a RERR packet. The source removes route using this link from its cache. A new route discovery process must be initiated by the source if this route is still needed. Also, forwarding nodes cache the source route in a packet it forwards for future use.

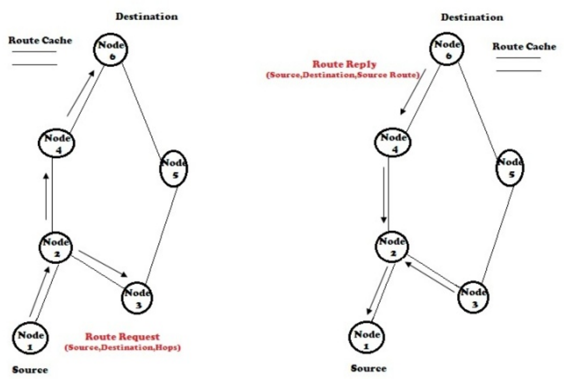

Fig. 7. Message Exchanges of the DSR Protocol (Route Discovery)

C) Comparisons between AODV and DSR

Comparisons between AODV and DSR [11] are shown in table II.

Table II

Property	**AODV Protocol**	**DSR Protocol**
Type of routing	Table-driven routing	Source routing
Beacon (Hello Messages) Less	No	Yes
Loop freedom maintenance	Sequence number	Source route
Amount of routing information	Lesser	Greater
Reply to requests	Replies only once to the request arriving first and ignores the rest	Replies to all requests reaching a destination from a single request cycle
Routing overhead	Higher (AODV has more RERRs than DSR)	Lower (DSR has more RREPs than AODV)
Effect of mobility	They trigger new route discoveries in AODV, since it has at most one route per destination in its routing table.	Route discovery is delayed in DSR until all cached routes fail. With high mobility, the chances of the caches becoming stale are quite high in DSR.

V. PERFORMANCE METRICS

We are using following performance metrics for our research work:

Throughput:

It is usually defined as the number of data packets successfully delivered to their final destination per unit of time. A network requires high throughput. It can be represented mathematically by the following equation:

$$\text{Throughput (bits/sec)} = \text{No. of Successfully Transmitted Packets} / \text{Total Simulation Time}$$

Packet Delivery Fraction:

It is the ratio of the number of delivered data packet to the destination. A network requires high packet delivery fraction. It can be represented mathematically by the following equation:

$$\text{Packet Delivery Fraction} = \sum \text{Number of Packet Received} / \sum \text{Number of Packet Sent}$$

VI. SIMULATION ENVIRONMENT

AODV and DSR are evaluated in different pause times while the number of nodes are six (small network) and twenty (large network) respectively as two different scenarios taken for experimental comparisons.

A) Small Network

Simulation Parameters

The network designed consists of basic network entities with the simulation parameters:

- Simulation Time: 10 seconds
- Packet Size: 512 bytes

- Simulation Area (m x m): 800 x 800
- Traffic Type: Constant Bit Rate
- Type of Nodes: Mobile
- Channel Type: Wireless
- Mobility Model: Random Way Point
- Number of Nodes: 06

Result & Analysis

1) Throughput

Fig. 8 shows the throughput (bits per seconds) vs. pause time (seconds) for the AODV and DSR routing protocols. It is clear that AODV has a good performance compared with DSR. If we exemplify the below graph we can see at 4.000 pause time the value of throughput for AODV is 28 and for DSR it is 6. Similarly, if the values are seen at 8.000 pause time then the value for AODV is 66 and for DSR are 11.

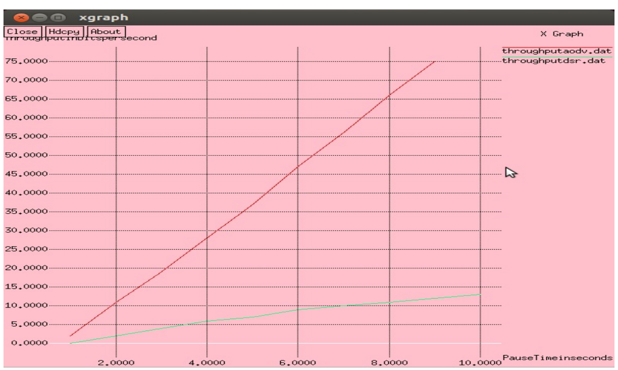

Fig. 8. Throughput of AODV and DSR for Six Nodes

2) Packet Delivery Fraction

Fig. 9 shows the packet delivery fraction vs. pause time (seconds) for the AODV and DSR. It is clear that DSR has a better delivery fraction than AODV. We can see at 4.000 pause time in seconds the value of packet delivery fraction for AODV is 2.3000 and for DSR it is 3.0000.

Fig. 9. Packet Delivery Fraction of AODV and DSR for Six Nodes

B) Large Network

Simulation Parameters

- Simulation time: 20 seconds
- Packet size: 512 bytes
- Simulation Area (m x m): 750 x 750
- Traffic Type: Constant Bit Rate
- Type of Nodes: Mobile
- Channel type: Wireless
- Mobility Model: Random Way Point
- Number of Nodes: 20

Results & Analysis

1) Throughput

Fig. 10, shows the throughput vs. pause time for the AODV and DSR. It is understandable that AODV protocol has a good performance compared with DSR protocol.

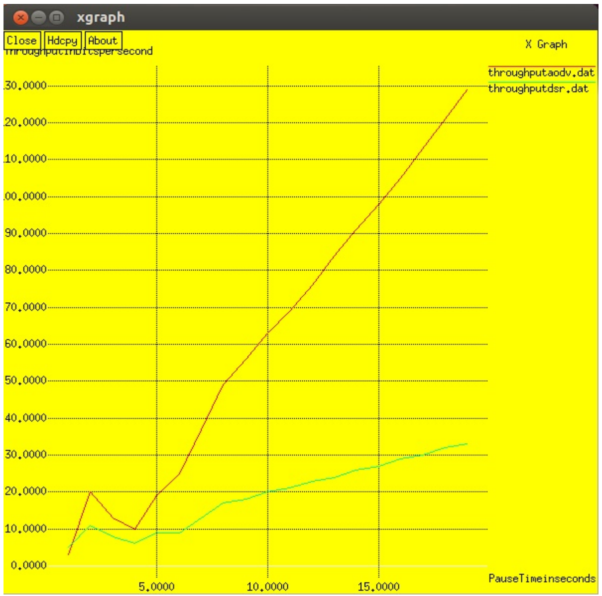

Fig. 10. Throughput of AODV and DSR for Twenty Nodes

2) Packet Delivery Fraction

Fig. 11 shows the Packet Delivery Fraction vs. pause time (in seconds) for the AODV and DSR routing protocols. It is clear that AODV has a better delivery fraction than DSR.

Fig.11. Packet Delivery Fraction of AODV and DSR for Twenty Nodes

VII. CONCLUSION & FUTURE SCOPE

The performance of AODV and DSR were measured; the results indicate that the performance of AODV is superior to DSR.

It is also observed that the performance of AODV is better especially when the number of nodes in the network is higher with respect to throughput and packet delivery fraction as compared to DSR.

For small network, the performance of AODV with respect to packet delivery fraction degenerated due to the fact that a lot of control packets are generated.

It is also observed that DSR is even better than AODV protocol in packet delivery fraction but lower than AODV in throughput for the small networks. The reason for the performance to get drop at six nodes is due to varying source and destination nodes and placement barrier in network topology.

The future research works that can improve the consistency of our observed work may include the following:

- Performance comparison with other routing protocol in different classes could be done.
- Simulations could be carried out using other performance metrics such as end-to-end delay, delay in jitter etc. and different scenarios such as network size, node speed to expand performance analysis of the ad hoc routing protocols.
- Routing protocols can be studied on different types of data traffic such as real time audio/video data transmissions for comprehensive performance evaluation.
- An enhanced simulator also can be developed that could simulate the flawless interface of mobile nodes between two or more heterogeneous ad-hoc networks.

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