Performance Analysis of DSR, AODV Routing Protocols based on Wormhole Attack in Mobile Ad-hoc Network

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ABSTRACT
Mobile ad-hoc network are able work without any existing infrastructure. MANET is a self configure network connected by wireless links. Mobile ad-hoc network uses temporary network which is able to work without any centralize administration or stand alone infrastructure. In mobile ad-hoc network each device move in any direction without any restriction so it changes it links to often with other devices present in same network. Mobility of mobile device anywhere in the network without any centralize administration makes it difficult to manage routing. In mobile ad-hoc network each device need to forward traffic that is not related to its own use and therefore each device work as a router. In this paper we have compared the performance of two On-Demand MANET routing protocol AODV and DSR by using random waypoint mobility model and changing the node density with varying number of source node. DSR and AODV both protocol uses On-Demand route discovery concept but internal mechanism which they use to find the route is significantly different for both protocol. We have analyzed the performance of protocols for low and high node density (50 and 100 nodes) on a 750m*750m area with varying source node and random waypoint mobility model. Simulation with random waypoint mobility model has been carried out by using Qualnet 5.0.2 Simulator. The metrics used for performance evaluation are packet Delivery fraction, Average End-to-End Delay, Average Jitter, and number of packet dropped for buffer overflow.

Keywords
MANET, AODV, DSR, IMPORTANT, TCP, CBR, Random waypoint Mobility Model

1. INTRODUCTION
Mobile networks can be classified into infrastructure networks and mobile ad hoc networks (MANET) according to their dependence on fixed infrastructures [2]. In infrastructure based mobile network wired access point is used and within the transmission range of access point all mobile device are free to move in any direction. In mobile ad-doc network each device is free to move any direction so the routes use to reach from one device to another change frequently. In mobile ad-hoc networks each device need to forward traffic that is not related to its own. Routing paths in MANETs potentially contain multiple hops, and every node in MANET has the responsibility to act as a router [4]. There are various mobility models such as random way point, reference point group mobility model (RPGM), Manhattan mobility model, freeway mobility model, Gauss Markov mobility model etc that have been proposed for evaluation [6, 13]. Several parameters such as mode mobility, traffic load and node density and pause time has been used to evaluate performance of MANET routing protocols. . Biradar, S. R. et al.[11] have analyzed the AODV and DSR protocol using Group Mobility Model and CBR traffic sources. Biradar, S. R. et. al.[11] investigated that DSR performs better in high mobility and average delay is better in case of AODV for increased number of groups. Also Rathy, R.K. et. al[8] investigated AODV and DSR routing protocols under Random Way Point Mobility Model with TCP and CBR traffic sources. They concluded that AODV outperforms DSR in high load and/or high mobility situations.

The paper is organized as follows. In the section 2 we give brief description of Random waypoint Mobility Model. In section 3, we have given the brief introduction of AODV and DSR routing protocol. Section 4 describes the simulation setup and results obtained on the execution of simulation. Finally in section 5 we draw the conclusion of simulation scenarios.

2. RANDOM WAYPOINT MOBILITY MODEL
MANET's protocol performance frequently observes and studied by simulation and their performance depends heavily on the mobility model that governs the movement of the nodes [5]. Random way point is a mobility model that use random based mobility to manage mobility of mobile devices in a wireless communication system. This mobile model describes various property of mobility like movement patter of the mobile users and their location velocity and acceleration change over time. Mainly this type of mobility model is use for simulation when network protocol performance is evaluated. The Random waypoint model, first proposed by Johnson and Maltz[17], soon became a "benchmark" mobility model[20] to evaluate the Mobile ad hoc network (MANET) routing protocols, because of its simplicity and wide availability.

3. DESCRIPTION OF ROUTING PROTOCOLS

3.1 Ad-Hoc on Demand Distance Vector
The Ad-hoc On-demand Distance Vector routing protocol [1,3,12] enables multi hop routing between the participating mobile nodes wishing to establish and maintain an ad-hoc network. AODV is a reactive protocol based upon the distance vector algorithm. ADOV uses many type of message in order to find route from one mobile device to another mobile device.

Route discovery process starts when a source node needs to send a packet to destination node but it does not have a valid route to destination node. AODV initiate a path discovery process to locate the other node. Source node broadcast route request (RREQ) packet to all it neighbors. Then their entire neighbors forward this request to their neighbors and so on. This process is continuing until either the destination node is found or a intermediate node with "fresh enough" route to destination is located. Sequence number is use by AODV to ensure all route are loop-free and contain most recent route information. In AODV to avoid looping each node maintains it own sequence number as well as a broadcast ID. The broadcast ID is incremented for every RREQ the node initiates, and together with the node's IP address, uniquely identifies an RREQ. Along with its own sequence number and the broadcast ID, the source node includes in the RREQ the most recent sequence number it has for the destination. Intermediate nodes can reply to the RREQ only if they have a route to the destination whose corresponding destination sequence number is greater than or equal to that contained in the RREQ. AODV uses periodic local broadcast hello message. Hello message help a node to inform its neighbor that it active and working. However, the use of hello messages is not required for Nodes listen for retransmissions of data packets to ensure that the next hop is still within reach. If such a retransmission is not heard, the node may use any one of a number of techniques, including the reception of hello messages. Hello messages may list the other nodes from which a mobile has heard, thereby yielding a greater knowledge of network connectivity.

3.2 Dynamic Source Routing (DSR)

This is an on-demand routing protocol based on source routing concept. In DSR mobile nodes stores source routes in it caches for which mobile device are aware. When new routes are learned by nodes entries of cache is updated for these new routes. Working of this protocol can be divided in two parts. (a) Route discovery,(b) Route maintenance. When a mobile node need to send any packet it first consults with its route cache that whether it already have a route for destination. It an unexpired route is present it send the packet using this route. But if node does not have such route it initiates broadcasting of route request packet. This route request message contains the address of the destination, along with the source node's address and a unique identification number. Each node that receive that packet check it cache to know whether a route for this destination exists or not. If route does not exists it adds it own information to the packet and send it to outgoing link. To limit the number of route requests propagated on the outgoing links of a node, a mobile only forwards the route request if the request has not yet been seen by the mobile and if the mobile's address has not already appeared in the route record. A reply packet is generated when request packet either reach to destination node or it reach to a intermediate node who have unexpired route for destination in its cache. By the time the packet reaches either the destination or such an intermediate node, it contains a route record yielding the sequence of hops taken.

4. SIMULATION SETUP

We have used Network Simulator Qualnet 5.0.2 in our evaluation. The evaluation consists two scenarios. In first Scenario we have place 50 nodes uniformly distributed in area of 750m x 750m. In Second Scenario 100 node have been place in an area of 750m x 750m. For this study, we have used random waypoint mobility model for the node movement with 30 sec pause time and 0-20 m/sec speed. The parameters used for carrying out simulation are summarized in the table 1.

Table 1: Simulation Parameters

Parameters	Value
Routing Protocols	AODV, DSR
MAC Layer	802.11
Packet Size	512 bytes
Terrain Size	750m * 750m
Nodes	50,100
Mobility Model	Random waypoint
Data Traffic Type	CBR
No. of Source	5,10,15,20,25,30
Simulation Time	200 sec.
Maximum Speed	0-20 m/sec (30 sec pause time)
CBR Traffic Rate	8 packet/sec
Maximum buffer size for packets	10 packets

4.1 PERFORMANCE METRICS

We have used the following metrics for evaluating the performance of two on-demand reactive routing protocols (AODV & DSR):

4.1.1 Packet delivery ratio:

It is the ratio of data packets delivered to the destination to those generated by the sources. It is calculated by dividing the number of packet received by destination through the number packet originated from source.

$$PDF = (Pr/Ps)*100$$

Where Pr is total Packet received & Ps is the total Packet sent.

4.1.2 Average End-to-End Delay (second)

This includes all possible delay caused by buffering during route discovery latency, queuing at the interface queue, retransmission delay at the MAC, propagation and transfer time. It is defined as the time taken for a data packet to be transmitted across an MANET from source to destination.

$$D = (Tr - Ts)$$

Where Tr is receive Time and Ts is sent Time

4.1.3 Average jitter

Jitter is used as a measure of the variability over time of the packet latency across a network. A network with constant latency has no variation (or jitter). Packet jitter is expressed as an average of the deviation from the network mean latency. Jitter is cause by network congestion, timing drift, or route changes. At the sending side, packets are sent in a continuous stream with the packets spaced evenly apart. Due to network congestion, improper queuing, or configuration errors, this steady stream can become lumpy, or the delay between each packet can vary instead of remaining constant.

4.1.4 Number of packet dropped for buffer overflow

This parameter measure Total number of packets dropped at network layer because of buffer overflow. Normally with the increase of network traffic data packet dropped will increase significantly.

4.1.4.1 Packet delivery ratio:

In case of low traffic (5 to 15 source nodes) with low node density (50 nodes) AODV protocols delivers almost all originated data packets (around 90-100%) But the packet delivery fraction starts degrading gradually when there is increase in number of sources node. DSR perform less efficiently then AODV when number of source nodes are low(5 to 15 source nodes) with low node density (50 nodes) But when network load increases packet delivery ratio of DSR degraded faster as compare to AODV (fig 1). For high node density (100 node) and low traffic (5 to 15 source nodes) AOVD perform better then DSR but once traffic is increase ADOV performance decrease drastically (we can see in case of 20 source nodes) and DSR start performing better then AODV (fig 1).

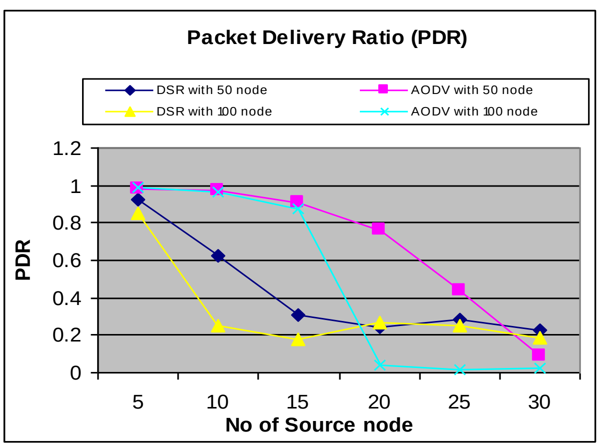

Fig 1: Packet Delivery Fraction vs. Number of source nodes

4.1.4.2 Average Jitter:

Fig 2 show that average jitter is always high for both the scenario (50 and 100 node) for DSR protocol because DSR uses more than one route to transfer data packets from source node to destination node. These different routes causes variation in delay to delivering the data packet from source node to destination node due to this average jitter increase significantly in case of DSR . In case of AODV it uses only one route to deliver data packet until this route fails in that situation it starts new route discovery process for destination node. Using one route for delivering data packets from source node to destination node causes less variation in delay which will with lead to less jitter. For both the protocol jitter average jitter increases when number of source node increases.

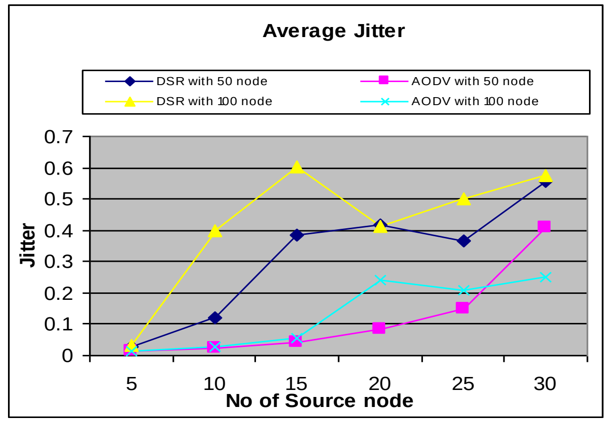

Fig 2: Average jitter vs. Number of Source Nodes

4.1.4.3 Average End to End delay:

Fig 3. Show that average end to end delay is low (below 10 second) in case of AODV protocol for both high node Density (100 node) and low node Density (50 nodes). AODV user only one route that is shortest path for delivery data from source node to destination node due to this reason average end to end delay for AODV is low as compare to DSR. DSR use more than one route to transfer data packet from source node to destination node which causes more delay as it is not always using shortest path for delivering all data packet from source node to destination node.

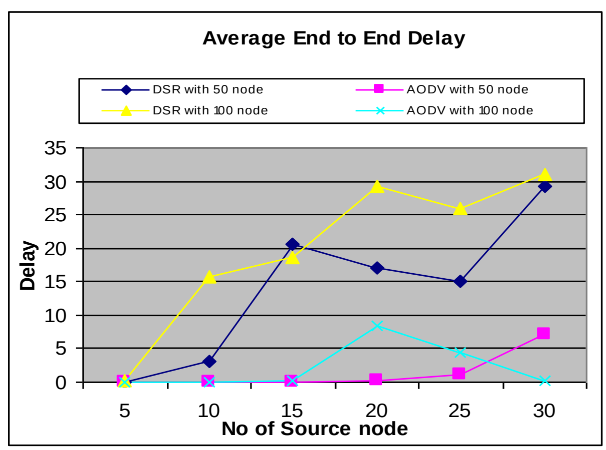

Fig 3: Average End to End-Delay vs Number of souce nodes

4.1.4.4 Number of Data packets Dropped for Buffer over flow:

Data packet Dropped at the network layer due to buffer over flow in low traffic (5 to 15 source nodes) for both the protocols

DSR and AODV is less (fig 4). But when number of source nodes increases then data packet dropped rate for the AODV protocol increase rapidly as compare to DSR protocol because

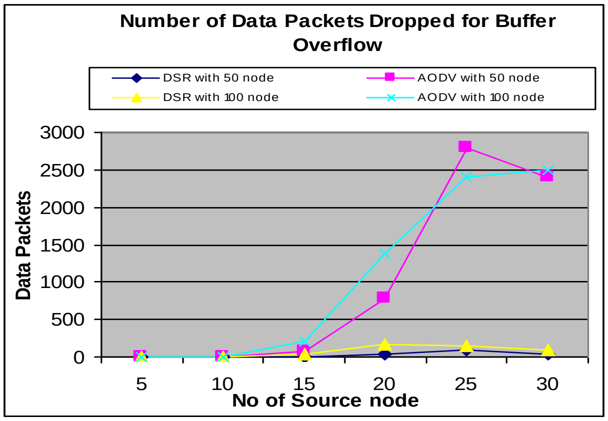

Figure 4: Number of Data packets Dropped for Buffer over flow vs. Number of source nodes

AODV use only one route to transfer data for source node to destination node so when congestion increase there is frequent drop of data packets from each intermediate node involve in the route. In case of AODV Some time it may possible that one node is involve in more than one route as intermediate node in that case data packet drop in this particular node increases significantly due to this reason data packet drop for buffer over flow is always high in AODV when traffic load increases .DSR use more than one route for transferring data so data packet drop rate for DSR is low.

5. CONCLUSION

From the fig. 1 to 4, we obtain some conclusion that in Random waypoint mobility model with CBR traffic sources, AODV perform better than DSR when node density is low. In case of high node density AODV performance is still better in low Traffic load. But in case of high node density and high traffic load DSR perform better than AODV. AODV always give low jitter irrespective of traffic load and node density also AODV is gives better performance then DSR for Average End to End delay. Average End to end delay for DSR increases rapidly when traffic load increases and it is not affected by the node density. In this paper, only two routing protocol are used and their performance have been analyzed under random. This paper can be enhanced by analyzing the other MANET routing protocols under different mobility model and different type of traffic load.

6. REFERENCES

[1] S. Das, C. E. Perkins, E. Royer, "Ad Hoc On Demand Distance Vector (AODV) Routing", IETF Draft, June 2002

[2] C-K Toh "Ad Hoc Mobile Wireless Networks Protocols and Systems", First Edition, Prentice Hall Inc, USA, 2002

[3] C.E. Perkins and E.M.Royer, "Ad-Hoc On Demand Distance Vector Routing", Proceedings of the 2nd IEEE Workshop on Mobile Computing Systems and Applications, New Orleans, LA, USA, pages 90-100, February 1999.

[4] Elizabeth M. Royer and Chai-Keong Toh, "A Review of Current Routing Protocols for Ad Hoc Mobile Wireless Networks", IEEE Personal Communications, pages 46-55, April 1999.

[5] Fan Bai, Ahmed Helmy "A Framework to systematically analyze the Impact of Mobility on Performance of Routing Protocols for Adhoc Networks", IEEE INFOCOM 2003

[6] Tracy Camp, Jeff Boleng, Vanessa Davies "A Survey of Mobility Models for Ad Hoc Network Research", Wireless Communication & Mobile Computing (WCMC): vol. 2, no. 5, pp. 483-502, 2002

[7] D. Johnson, Dave Maltz, Y Hu, Jorjeta Jetcheva, "The Dynamic Source Routing Protocol for Mobile Ad Hoc Networks", Internet Draft, February 2002

[8] Suresh Kumar, R.K. Rathy and Diwakar Pandey, "Traffic Pattern Based Performance Comparison of Two Reactive Routing Protocols for Ad-hoc Networks using NS2", 2nd IEEE International Conference on Computer Science and Information Technology, 2009.

[9] D. Johnson, Y. Hu, and D. Maltz, "The Dynamic Source Routing Protocol (DSR) for Mobile", RFC 4728, Feb 2007

[10] S.Corson and J.Macker, "Routing Protocol Performance Issues and Evaluation considerations", RFC2501, IETF Network Working Group, January 1999.

[11] S. R. Biradar, Hiren H D Sharma, Kalpana Shrama and Subir Kumar Sarkar, "Performance Comparison of Reactive Routing Protocols of MANETs using Group Mobility Model", IEEE International Conference on Signal Processing Systems, pages 192-195 2009.

[12] C. Perkins, E. Belding-Royer, S. Das, quet, "Ad hoc On-Demand Distance Vector (AODV) Routing", RFC 3561, July 2003

[13] N.Aschenbruck,E.Gerhands-Padilla ,P.Martini,"A Survey on mobility models for Performance analysis in Tactical Mobile networks," Journal of Telecommunication and Information Technology,Vol.2 pp.54-61,2008

[14] X. Hong, M. Gerla, G. Pei, and C.-C. Chiang, "A group mobility model for ad hoc wireless networks," in *ACM/IEEE MSWiM*, August 1999.

[15] Bai, Fan; Helmy, Ahmed (2006). A Survey of Mobility Models in Wireless Adhoc Networks. (Chapter 1 in Wireless Ad-Hoc Networks. Kluwer Academic. 2006.