PERFORMANCE ANALYSIS OF ADHOC ROUTING PROTOCOLS USING RANDOM WAYPOINT MOBILITY MODEL IN WIRELESS SENSOR NETWORKS

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Abstract:
This paper investigates and undertakes simulation based study of adhoc routing protocols in wireless sensor networks. In this paper we have compared the performance of two 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 use 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 varying network load and mobility. 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.

Key words:

AODV, DSR, CBR, Random waypoint, Mobility Model, Sensor Network, Adhoc Routing, Scenario Study, Simulation.

1. Introduction

Wireless Sensor Networks (WSN) is a special class of ad hoc wireless network that are used to provide a wireless communication infrastructure that allows us to instrument, observe and respond to phenomena in the natural environment and in our physical and cyber infrastructure. Even though sensor networks are a superset of ad hoc routing protocols, the routing protocols proposed for ad hoc routing protocols cannot be used as it is for sensor networks because of various reasons as given in [1, 2]. But Surprisingly we found out that there is lack of simulation based study or research work [7] as to show why ad hoc routing protocols cannot be used in a sensor network environment. The main contribution of this paper is that we have carried out a simulation based study of ad hoc routing protocols to understand their behavior when used in a sensor network environment.

This paper is organized as follows. In the second section 2 we discus the random Waypoint Mobility Model. In section 3, we give brief introduction of AODV and DSR [8] routing protocol and in section 4 deals the simulation setup and results obtained on the execution of simulation. Finally we draw the conclusion in section 5.

2. Random Waypoint Mobility Model :

Random waypoint model is a random based monility model used in mobility management schemes for monile communication systems. This designed to describe the movement pattern of monile user which include how their location, mobility and accelaration change over time. The random waypoint model, first proposed by Johnson and Maltz [11], soon became a “benchmark” mobility model to envaluate the because of its simplicity and wide availability.

3. Description of Routing Protocol

3.1 *Ad-Hoc on Demand Distance Vector (AODV)*

We give brief description of routing protocols and the simulator, which we have considered for studying the behavior of ad hoc routing protocols in WSN [10]. Adhoc On Demand Distance Vector (AODV) Routing Protocol: AODV routing protocol uses on demand approach for finding routes. In AODV the source node and the intermediate nodes store the next hop information corresponding to each flow for data packet transmission. To find a route to the destination, the source node floods the network with RouteRequest packets. The RouteRequest packets create temporary route entries for the reverse path through every node it passes in the network. When it reaches the destination a RouteReply is sent back through the same path the RouteRequest was transmitted. For route maintenance, every routing table entry maintains a route expiry time which indicates the time until which the route is valid. Each time that route is used to forward a data packet; its expiry time is updated to be the current time plus Active Route Timeout. A routing table entry is invalidated if it is not used within such expiry time. AODV [7] uses an active neighbor node list for each routing entry to keep track of the neighbors that are using the entry to route data packets. These nodes are notified with routeerror packets when the link to the next hop node is broken. Each such neighbor node, in turn, forwards the routeerror to its own list of active neighbors, thus invalidating all the routes using the broken link. The main advantage of this protocol is that routes are established on demand and destination sequence numbers are used to find the latest route to the destination. The disadvantage of this protocol is that the intermediate nodes can lead to inconsistent routes if the source sequence number is very old and the intermediate nodes have a higher, but not the latest destination sequence number [3].

3.2 *Dynamic Source Routing (DSR)*

Dynamic source routing protocol (DSR) [4]: DSR is an on-demand routing protocol. The major difference between DSR and the other on demand routing protocols is that, it is beacon less and hence does not require periodic hello packets. Consider a source node that does not have a route to the destination. When it has a data packet to be sent to that destination, then it initiates a RouteRequest packet. This RouteRequest is flooded throughout the network. Each node upon receiving a RouteRequest broadcasts the packet to its neighbors if it has not forwarded already or if the node is not the destination node. Each RouteRequest carries a sequence number generated by the source node and the path it as traversed. A node, upon receiving a RouteRequest packet, checks the sequence number on the packet before forwarding it. The packet is forwarded only if it is not a duplicate Route Request packet. The sequence number on the packet is used to prevent loop formations and to avoid multiple transmissions of the same RouteRequest by an intermediate node, which receives it through multiple paths. Thus, all the nodes except the destination node, forwards a RouteRequest packet during the route construction phase. A destination node upon receiving the RouteRequest packet, replies to the source node through the reverse path the RouteRequest packet had traversed. Several optimization techniques have been incorporated into the basic DSR protocol to improve the performance of the protocol like caching the routes at intermediate nodes. The route cache is populated with the routes that can be extracted to forward the data packet. This cache information is used by the intermediate nodes to reply to the source when they receive a RouteRequest packet and if they have a route to the corresponding destination.

4. Simulation Setup

We have used Network Simulator Qualnet 5.0.2 in our evaluation. In this scenario we have placed 50 and 100 nodes randomly distributed in area of 1500m x 1500m. 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	*1500m * 1500m*
Nodes	*50, 100*
Mobility Model	*Random waypoint*
Data Traffic Type	*CBR*
No. of Source	*5,7,9,11,13,15*
Simulation Time	*200 sec.*
Maximum Speed	*0-20 m/sec (30 sec pause time)*
CBR Traffic Rate	*8 packet/sec*

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.

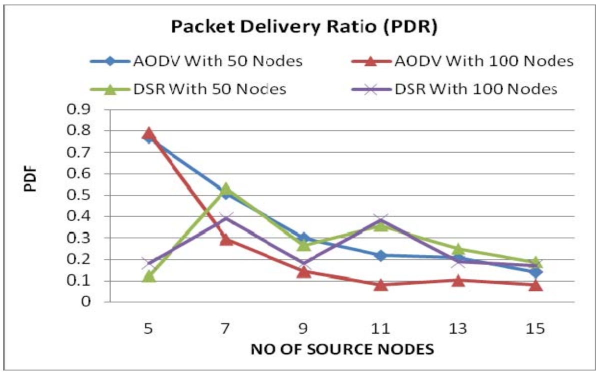

Figure 1: Packet Delivery Fraction vs Number of source nodes

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).

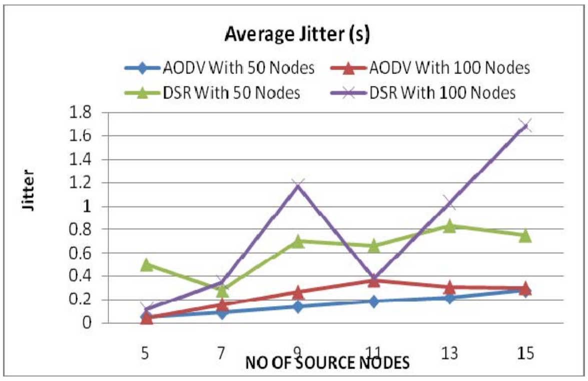

Figure 2: Average jitter vs. Number of Source Nodes

Average Jitter:
Figure 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.

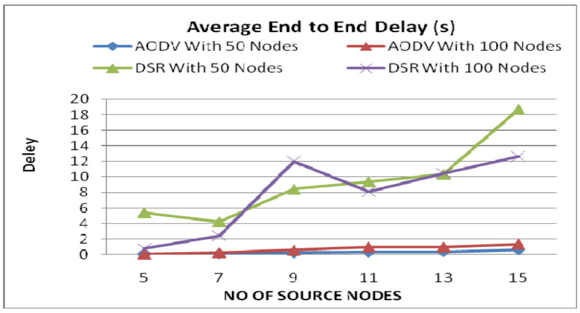

Figure 3: Average End to End-Delay vs Number of souce nodes

Average End to End delay:
Figure 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 then 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.

5. Conclusion

From the figure 1 to 3, 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 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 waypoint mobility model. Also we list the various problems we had to face while simulating the routin protocols in a sensor network paradigm. Our future work includes designing an energy efficient routing protocol for Wireless Sensor Networks. With all these research challenges we firmly believe that we have a very exciting time ahead of us in the area of Wireless Sensor Networks.

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