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Investigation of Adhoc Topology AODV for Wireless Sensor Networks for Varying Terrain Areas for Different Speed (node speed)

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***Abstract*—Wireless Sensor Networks are the latest trends in the market due to the demand for communication and networking among these wireless network devices have been increased for different applications [1].**

The routing protocols are used in the Wireless Sensor Networks for efficient communication of data between sensor nodes. The designs of routing protocols in Wireless Sensor Networks are very concern because of they are influenced by many challenging factors. These factors must be overcome before efficient communication can be achieved in Wireless Sensor Networks [2].

The purpose of this experimental study is to measure the ability of the routing protocol to react to the network topology change while continuing to successfully deliver data packets to their destinations [3]. To measure this ability, different scenarios are generated by varying the maximum speed in the network that also over different terrain areas.

The main focus of this paper is to discuss and evaluate the performance of different network parameters on different topologies based on varying the maximum node speed and keeping the constant pause time in different terrain areas which is small (1000 m. x 1000 m.), large (2000 m. x 1000 m.) and very large (2000 m. x 2000 m.) using AODV routing protocol and monitoring of critical conditions with the help of important parameters like Packet delivery Fraction, Average End- to- End Delay, Average Throughput, NRL and Packet loss.

***Keywords*— Wireless Sensor Network, Packet Delivery Fraction, Normalized Routing Load, Average End-to-End Delay, and Network Simulator.**

I. INTRODUCTION

A Wireless Sensor Networks consists of a network that is made of hundreds or thousands of sensor nodes which are deployed in an unstructured environment with the sensing capabilities, computation and wireless communication (i.e. collecting and disseminating environment data) [4].

Routing protocols is very important for performance evaluation perspective in Wireless sensor networks. There are many factors must be overcome before efficient communication can be achieved in WSNs. Node deployment is application dependent and affects the performance of the routing protocol in WSNs. Sensors can perform their computations and transmission of information in a wireless environment by using their limited supply of energy [5].

AODV is a routing protocol used for data transmission between sensor nodes. AODV finds the routes only when it requires. This routing protocol allows message passing across the sensor nodes. It sends HELLO message to track neighbour node [6]. It uses sequence number generated by each node to check accuracy of updated information of route.

To evaluate this practical work different scenarios are generated by varying the maximum speed (node speed) with keeping the constant pause time (node mobility).

In this paper we describe in Section I Introduction Section II Routing Protocol Section III Simulation Tool Section IV Simulation parameters Section V Related Work Section VI Simulation Setup Section VII Results and Analysis and section VIII Conclusion.

II. ROUTING PROTOCOL

AODV routing protocol is efficient and simple routing protocol for wireless sensor networks or adhoc network. It has no needs for any existing network structure or administration. AODV uses traditional routing tables for one entry per destination while DSR uses multiple route cache entries for each destination. When a node wants to send packets to another node which is not its neighbour, it sends a route request message (RREQ). Route request message consist several data keys as the source, the destination, sequence number etc [7].

The sequence number allows nodes to compare updated information by other nodes. Each node consists all sequence number generate by other nodes exists in network route. The higher sequence number signifies more updated route and which one has more accurate information.

AODV maintain time base status to avoid error message. When a node receives route error message (RERR), it checks all the routes that contains bad nodes and routing table of node. The route error message allows the node to maintain routes and warn to each node when error occurred in network route [8].

III. SIMULATION TOOL

To work on the WSNs routing protocol and to evaluate performance of routing protocol metrics, ns-2 is often used. This is one of most popular simulator for the researchers [9]. ns-2 simulator is used for analysing of different protocols used for wired or wireless networks and its necessity is well known in the field of research [10].

Ns-2 uses TCL (Tool Command Language) to write front-end of the program. It uses C++ as back-en of the program. When a TCL program is compiled a trace file and nam file is created. These files indicate movement patter of the nodes and it keeps the number of hops between two nodes, connection type and number of packets sent etc. at each instance [11].The connection pattern file (CBR file) specifies the connection pattern, topology and packet type. These files are also used to create the trace file and nam file which are further used to simulate the network [12].

IV. SIMULATION PARAMETERS

(I) Packet Delivery Fraction (PDF): Packet Delivery Fraction = (number of data packets delivered to the destination nodes) / (number of data packets produced by source nodes) [13].

(II) End-to-End Delay: The term End-to-End delay refers to the time taken by a packet to be transmitted across a network from source node to destination node which includes retransmission delays at the MAC, transfer and propagation times and all possible delays at route discovery and route maintenance [14]. The queuing time can be caused by the network congestion or unavailability of valid routes [15].

(III) Throughput: The term throughput refers the number of packet arriving at the sink per ms. Throughput is also refers to the amount of data transfer from source mode to destination in a specified amount of time [16].

(IV) Normalized Routing Load [%] (NRL): It is the number of routing packet required to be send per data packet delivered.

NRL = (Number of Routing Packet) / (Number of Packet Received)

(V) Packet Loss [%]: It is the number of dropped packet to the total packets.

Packet Loss [%] = (dropped Packets/ (total packets)) *100)

V. RESEARCH WORK

There are many research papers on routing protocols in wireless sensor network and all are used for evaluating performance of different parameters in different scenario. Researchers specify the difference between routing protocols and its performance for different parameters and which one is best for the case of Wireless Sensor Network.

In this paper we selected to investigated AODV protocol for different performance parameters for different Terrain areas like small (1000 m. x 1000 m.), large (2000 m. x 1000 m.) and very large (2000 m. x 2000 m.) based on varying maximum speed with keeping constant pause time.. Analysis were done using ns-2 simulator on these three cases of terrain areas in order to derive an estimation of the performance parameters.

VI. SIMULATION SETUP

In this paper, we investigated AODV protocol with a scenario where a total of 100 nodes are used with the maximum connection number 10; CBR connection; transfer rate is taken as 4 packets per second i.e. the send rate of 0.25 and the speed is varied starting from 10 m/s, 20 m/s, 30 m/s, 40 m/s, 50 m/s, and 60 m/s (i.e. in the steps of 10 m/s) implemented respectively in a 1000 m. x 1000 m., 2000 m. x 1000 m. and 2000 m. x 2000 m. terrain areas keeping the pause time constant as 0 m/s . The simulation time was taken as 100 seconds. The details of general simulation parameter used are depicted in Table 1.

TABLE I

SIMULATION PARAMETER VALUES

S. No.	Parameters	Values
1	Transmitter range	250m
2	Bandwidth	2 Mbps
3	Simulation time	100 sec
4	Number of nodes	100
5	Max Speed	10
6	Pause time	0 m/s
7	Speed	10 m/s, 20 m/s, 30 m/s, 40 m/s, 50 m/s, and 60 m/s
8	Terrain Area	1000 m. x 1000 m., 2000 m. x 1000 m., 2000 m. x 2000 m.
9	Traffic type	Constant Bit Rate
10	Packet size	512 bytes data
11	MAC type	IEEE 802.11b
12	Antenna type	Omni-Antenna
13	Radio propagation method	Two Ray Ground

VII. RESULT AND ANALYSIS

The investigations were performed on Parameters using AODV routing protocol such as Packet Delivery Fraction [%] (PDF), Average End-to-End Delay [in ms], Average Throughput [in kbps], Normalized Routing Load [%] (NRL) and Packet Loss [%]. The experimental data are shown in Tables 2 to 6 respectively and their respective performance being shown in Figure 1 to 5 respectively by Varying Speed the and keeping the Pause Time Constant = 0.

(A). When nodes = 100, speed = 0-60 m/s, pause time = 0, routing protocol = AODV, and evaluating PDF table 2

TABLE II

EVALUATING PDF BY VARYING SPEED USING AODV ROUTING PROTOCOL

Speed → **Topology ↓**	**10**	**20**	**30**	**40**	**50**	**60**
1000 m. x 1000 m.	96.67	96.17	95.75	94.48	91.35	90.79
2000 m. x 1000 m.	94.53	95.19	80.65	85.21	88.13	85.47
2000 m. x 2000 m.	81.67	74.28	72.85	77.27	74.68	69.47

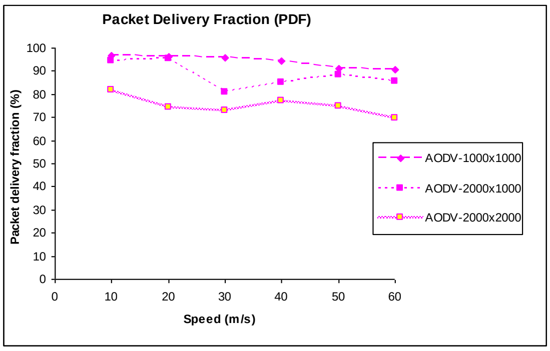

Fig. 1 Speed versus PDF when terrain areas are 1000 m. x 1000 m., 2000 m. x 1000 m., 2000 m. x 2000 m. by varying speed using AODV routing protocol

Using AODV with 100 nodes, constant pause time of 0 s, varying speed (0-60 m/s in intervals of 10 m/s) for 1000 m. x 1000 m., 2000 m. x 1000 m. and 2000 m. x 2000 m. terrain areas, we examine that PDF is maximum for simple topologies (1000 m. x 1000 m.) and decreases for higher topologies (2000 m. x 1000 m. and 2000 m. x 2000 m.). The PDF in general decreases as the speed increases irrespective of terrain area for all topologies like DSR. However, irrespective of area, AODV has more PDF than DSR that increase with increase in speed.

Packet Delivery Fraction α 1/Terrain Areas

(B). When nodes = 100, speed = 0-60 m/s, pause time = 0, routing protocol = AODV, and evaluating average end-to-end delay [in ms]

TABLE III

EVALUATING AVERAGE END-TO-END DELAY [IN MS] BY VARYING SPEED USING AODV ROUTING PROTOCOL

Speed → **Topology ↓**	**10**	**20**	**30**	**40**	**50**	**60**
1000 m. x 1000 m.	81.01	61.22	109.37	197.85	103.29	113.2
2000 m. x 1000 m.	75.66	84.92	480.9	220.81	98.405	155.42
2000 m. x 2000 m.	669.98	632.01	603.57	633.34	403.26	568.26

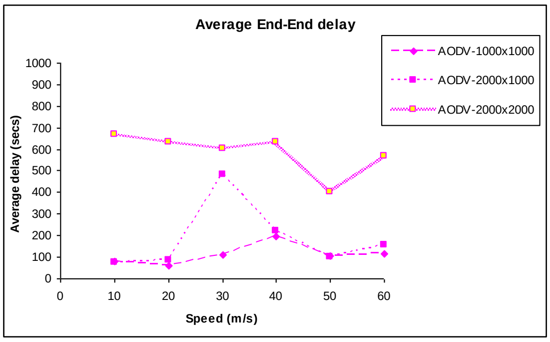

Fig. 2 Speed versus Average End-to-End Delay [in ms] when terrain areas are 1000 m. x 1000 m., 2000 m. x 1000 m., 2000 m. x 2000 m. by varying speed using AODV routing protocol

Like DSR, AODV with 100 nodes, constant pause time of 0 s, varying speed (0-60 m/s in intervals of 10 m/s) for different terrain areas, we examine that Average End-to-End Delay [in ms] for small terrain areas is nearly constant (1000 m. x 1000 m.) and increases with larger terrain areas (2000 m. x 1000 m. and 2000 m. x 2000 m). In general, the Average End-to-End Delay increases for larger terrain areas.

Average End- to-End Delay α Terrain Areas

(C). When nodes = 100, speed = 0-60 m/s, pause time = 0, routing protocol = AODV, and evaluating average throughput [in kbps]

TABLE IV

EVALUATING AVERAGE THROUGHPUT BY VARYING SPEED USING AODV ROUTING PROTOCOL

Speed → **Topology ↓**	**10**	**20**	**30**	**40**	**50**	**60**
1000 m. x 1000 m.	90.411	89.638	88.998	87.821	86.193	85.82
2000 m. x 1000 m.	88.663	89.902	76.236	80.176	83.020	80.60
2000 m. x 2000 m.	75.862	69.837	68.227	72.481	69.343	64.89

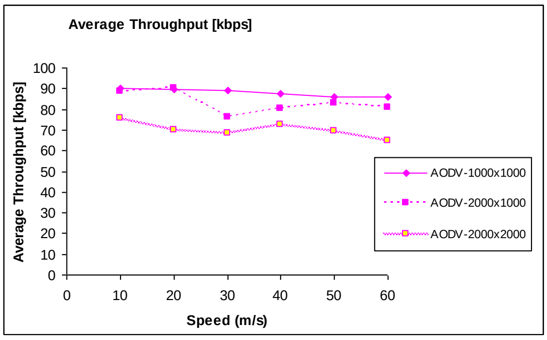

Fig. 3 Speed versus Average Throughput when terrain areas are 1000 m. x 1000 m., 2000 m. x 1000 m., 2000 m. x 2000 m. by varying speed using AODV routing protocol

Using AODV with 100 nodes, constant pause time of 0 s, varying speed (0-60 m/s in intervals of 10 m/s) for 1000 m. x 1000 m., 2000 m. x 1000 m. and 2000 m. x 2000 m. terrain areas, we examine that Average Throughput is maximum for simple topologies (1000 m. x 1000 m.) and decreases for higher topologies (2000 m. x 1000 m. and 2000 m. x 2000 m.). The Average Throughput in general decreases as the speed increases irrespective of terrain area for all topologies. It is better for AODV than DSR for any terrain area.

Average Throughput α 1/Terrain Areas

(D). When nodes = 100, speed = 0-60 m/s, pause time = 0, routing protocol = AODV, and evaluating normalized routing load [%].

TABLE V

EVALUATING NRL BY VARYING SPEED USING AODV ROUTING PROTOCOL

Speed → Topology ↓	**10**	**20**	**30**	**40**	**50**	**60**
1000 m. x 1000 m.	3.13	4.15	5.23	7.27	7.27	7.58
2000 m. x 1000 m.	4.14	4.75	13.11	10.8	8.14	12.77
2000 m. x 2000 m.	6.59	10.1	17.17	14.38	15.64	20.37

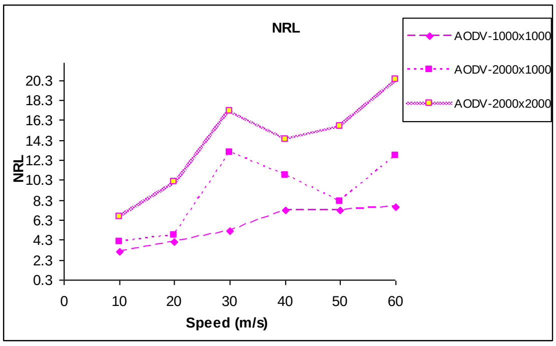

Fig. 4 Speed versus NRL when terrain areas are 1000 m. x 1000 m., 2000 m. x 1000 m., 2000 m. x 2000 m. by varying speed using AODV routing protocol

Using AODV with 100 nodes, constant pause time of 0 s, varying speed (0-60 m/s in intervals of 10 m/s) for 1000 m. x 1000 m., 2000 m. x 1000 m. and 2000 m. x 2000 m. terrain areas, we examine that NRL is minimum for simple topologies (1000 m. x 1000 m.) and increases for higher topologies (2000 m. x 1000 m. and 2000 m. x 2000 m.). The NRL in general increases as the speed increases irrespective of terrain area for all topologies. NRL for AODV is lesser than DSR.

NRL α Terrain Areas

(E). When nodes = 100, speed = 0-60 m/s, pause time = 0, routing protocol = AODV, and evaluating parameters – packet loss [%]

TABLE VI

EVALUATING PACKET LOSS BY VARYING SPEED USING AODV ROUTING PROTOCOL

Speed → Topology ↓	**10**	**20**	**30**	**40**	**50**	**60**
1000 m. x 1000 m.	3.24	3.83	4.294	5.603	8.4412	8.88789
2000 m. x 1000 m.	5.468	4.638	19.24	13.43	11.987	14.304
2000 m. x 2000 m.	18.22	24.15	26.627	22.47	24.874	30.55

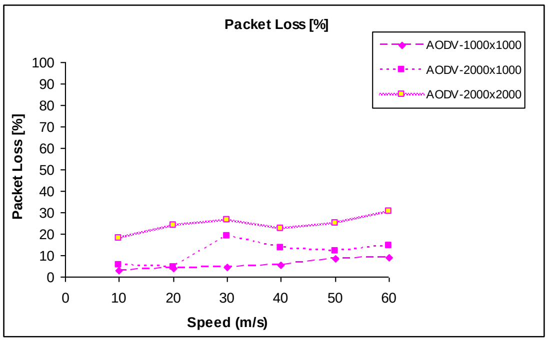

Fig. 5 Speed versus Packet Loss when terrain areas are 1000 m. x 1000 m., 2000 m. x 1000 m., 2000 m. x 2000 m. by varying speed using AODV routing protocol

Using AODV with 100 nodes, constant pause time of 0 s, varying speed (0-60 m/s in intervals of 10 m/s) for 1000 m. x 1000 m., 2000 m. x 1000 m. and 2000 m. x 2000 m. terrain areas, we examine that Packet Loss is minimum for simple topologies (1000 m. x 1000 m.) and increases for higher topologies (2000 m. x 1000 m. and 2000 m. x 2000 m.). The Packet Loss in general increases as the speed increases irrespective of terrain area for all topologies. Packet Loss is more in DSR than AODV

Packet Loss α Terrain Areas

VIII. CONCLUSION

The results of our simulations are analysed and discussed in this section. The results are analysed and discussed in different terrain areas having networks of 100 sensor nodes on varying maximum speed (0-60m/s in intervals of 10 m/s) for evaluating performance of different parameters like Packet delivery Fraction, End- to- End Delay, Average Throughput, NRL and Packet loss in small, large and very large terrain areas.

Our study provides an optimal result which is fully based on simulation and analysis. Every case explains evaluation of parameter with the help of table and generated graph. Each case represents special issue for metric and Terrain areas which is small (1000 m. x 1000 m.), large (2000 m. x 1000 m.) and very large (2000 m. x 2000 m.). According to the analysis value we drive a formula for each case that fully satisfies the values and relationship between parameters and terrain. The overall results says that when we implement sensor nodes in small terrain areas give better performance rather than Large and very large terrain areas.

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