Investigation of Different Adhoc Routing Topologies DSR, AODV and DSDV using IEEE 802.11 for WSNs using ns-2 for Varying Terrain Areas for Different Speed (Node Speed)

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Abstract- Themicro-electro-mechanical systems (MEMS) based Wireless Sensor Network (WSN) are the next big thing in communications. A comparison of various Adhoc Routing Protocols viz. Dynamic Source Routing (DSR), Adhoc On-Demand Distance Vector Routing (AODV) and Destination-Sequenced Distance-Vector (DSDV)using IEEE 802.11 standards using Network Simulator 2 (ns-2) for WSNs is made. The parameters of a particular routing are affected by the choice of size, node mobility, etc. which has been extensively studied. This paper discuss and evaluate the performance of different network parameters like Packet Delivery Fraction (PDF), Average End-to-End Delay, Average Throughput, Normalized Routing Load **(**NRL) and Packet loss on different routing protocols by 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.) and monitoring critical conditions with the help of these parameters. The actual Network designer can make use of such analysis before design of an actual WSNs system.

Keywords- Adhoc Routing, AODV, Average End-to-End Delay, Average Throughput, DSDV, DSR, IEEE 802.11, Maximum Node Speed, MEMS, Network Design, NRL, ns-2, Packet Loss, Pause Time, PDF, WSN

I. INTRODUCTION

Recent advancement in micro-electro-mechanical systems (MEMS) led to Wireless Sensor Network (WSN) which are wireless network with numerous spatially distributed tiny immobile autonomous devices or sensors with sensing, computation, and wireless communications capabilities envisioned to be deployed in the physical environment to monitor a wide variety of real-world phenomena [1].

The routing protocols designs used in the WSNs is of huge concern for efficient communication of data between sensor nodes. Sensors can perform their computations and transmission of information in a wireless environment by using their limited supply of energy [2, 14].

The Dynamic source routing protocol is an efficient reactive and simple routing protocol specifically used for multi-hop wireless adhoc networks of mobile nodes and wireless sensor networks. It has no need for any existing network infrastructure or administration. Dynamic source routing allows the network to be completely self- organizing and configuring. Dynamic source routing uses source routing to send packet which means the complete hop sequence to the destination is well known by the source. DSR protocol uses two mechanisms for sending packet from source to destination which are “Route Discovery” and “Route maintenance” which works together to allow nodes to discover and maintain routes [3, 4]. 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. It uses sequence number generated by each node to check accuracy of updated information of route. [2]. Destination-Sequenced Distance-Vector (DSDV) Routing Algorithm is based on idea of the classical Bellman-Ford routing algorithm designed for adhoc networks with improvements [5].

The experimental study is to measure the ability of the the above protocol to react to the network topology change while continuing to successfully deliver data packets to their destinations. To measure this, different scenarios were generated by varying the maximum speed of nodes (node speed) with keeping the constant pause time (node mobility) in the network that over different terrain areas [2, 3,4].

In this paper we describe in Simulation Tools, Simulation parameters, Related Work, Simulation Setup, Results and Analysis and Conclusion.

II. TOOLS AND METHODOLOGY

To work on the WSNs routing protocol and to evaluate performance of routing protocol metrics, Network simulator 2 (ns-2) was used[6]. This is most popular simulator for the researchers [9]. even though newer tools like ns3 are used nowadays because of the simplicity in programming in simple English like Tool Command Language (TCL)to write front-end of the program [7]. It uses C++ as back end of the program. When TCL is compiled a trace file .tr and nam file is created. These files indicate movement pattern of the nodes and it keeps the number of hops between two nodes, connection type and number of packets sent etc. at each instance [8].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 [9].

III. PERFORMANCE 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) [10, 11].

(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 [10, 12]. The queuing time can be caused by the network congestion or unavailability of valid routes [10].

(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 [10, 13].

(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) [10].

IV. SIMULATION SETUP

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. In this work, a total of 54 simulations were carried out as shown in Figure I below (i.e. 3 Protocols x 3 terrain areas x 6 speeds).

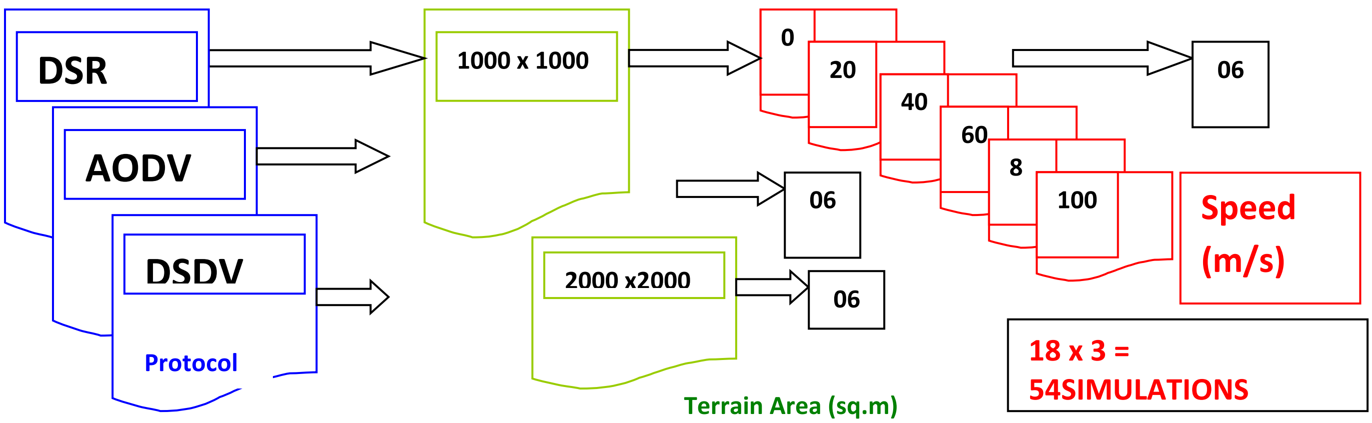

Fig.1: 54 Simulations i.e. 3 Protocols x 3 terrain areas x 6 speeds.

In this paper, an attempt was made to investigate all the three routing protocols under the same simulation environment wherein, the same movement models were used, for different terrain topologies, the pause time of the nodes was set to 0 m/s and the speed was varied as 0 – 60 m/s in intervals of 10 m/s. 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, implemented respectively on a terrain area of 1000 m. x 1000 m., 2000 m. x 1000 m. and 2000 m. x 2000 m. The simulation time was taken as 100 seconds. The details of general simulation parameter used are depicted in Table I .

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

V. RESULT AND ANALYSIS

The investigations were performed on different routing protocol on different parameters. The choice for large and medium terrain area WSNs and the experimental summary of results are depicted in Table II and their respective relative performanceof the three routing protocols being shown in Figure II to VIrespectively by Varying Speed the and keeping the Pause Time Constant = 0.

TABLE II
VARYING THE SPEED AND KEEPING THE PAUSE TIME CONSTANT = 0

Parameters ↓	Protocol DSR	AODV	DSDV	Choice for medium and large terrain area WSNs: Terrain Area	Choice
Packet Delivery Fraction	α 1/Terrain Areas α 1/ Speed	α 1/Terrain Areas α 1/ Speed	α 1/Terrain Areas α 1/ Speed	Medium and Large	PDF $_{AODV}$> PDF $_{DSR}$> PDF $_{DSDV}$
Average End- to- End Delay	α Terrain Areas	α Terrain Areas	α 1/Terrain Areas	Medium and Large	Av E2E Delay $_{DSDV}$< Av E2E Delay $_{AODV}$ < Av E2E Delay $_{DSR}$
Average Throughput [kbps]	α 1/Terrain Areas α 1/ Speed	α 1/Terrain Areas α 1/ Speed	α 1/Terrain Areas α 1/ Speed	Medium	AvgThroughput$_{AODV}$>AvgThroughput$_{DSR}$>AvgThroughput$_{DSDV}$
				Large	AvgThroughput$_{DSR}$>AvgThroughput$_{AODV}$>AvgThroughput$_{DSDV}$
NRL	α Terrain Areas α Speed	α Terrain Areas α Speed	α Terrain Areas α Speed	Medium and Large	NRL $_{AODV}$< NRL $_{DSR}$< NRL $_{DSDV}$
Packet Loss [%]	α Terrain Areas α Speed	α Terrain Areas α Speed	α Terrain Areas α Speed	Medium and Large	PacketLoss[%] $_{AODV}$<PacketLoss[%] $_{DSR}$<PacketLoss[%] $_{DSDV}$

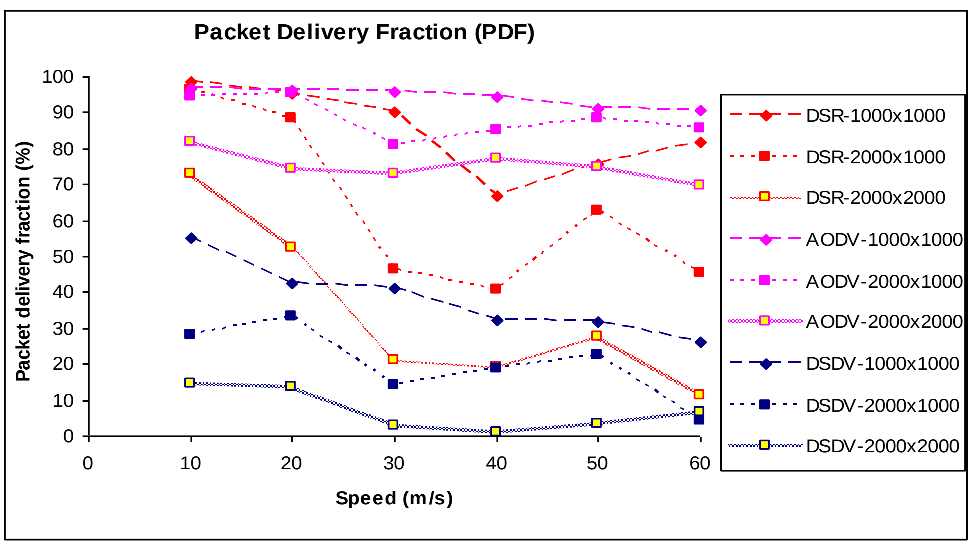

Fig.2: Speed vs PDF for terrain area 1000 m. x 1000 m., 2000 m. x 1000 m. and 2000 m. x 2000 m.

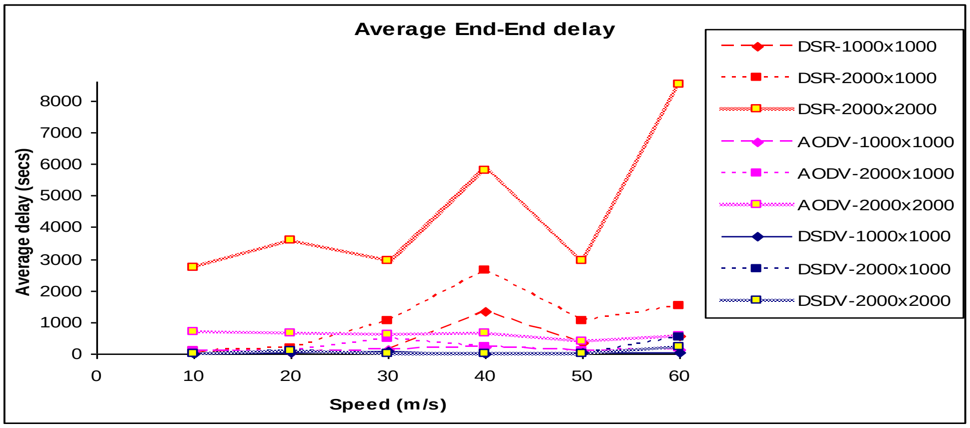

Fig.3: Speed vs Average End-to-End Delay [in ms]for terrain area 1000 m. x 1000 m., 2000 m. x 1000 m. and 2000 m. x 2000 m.

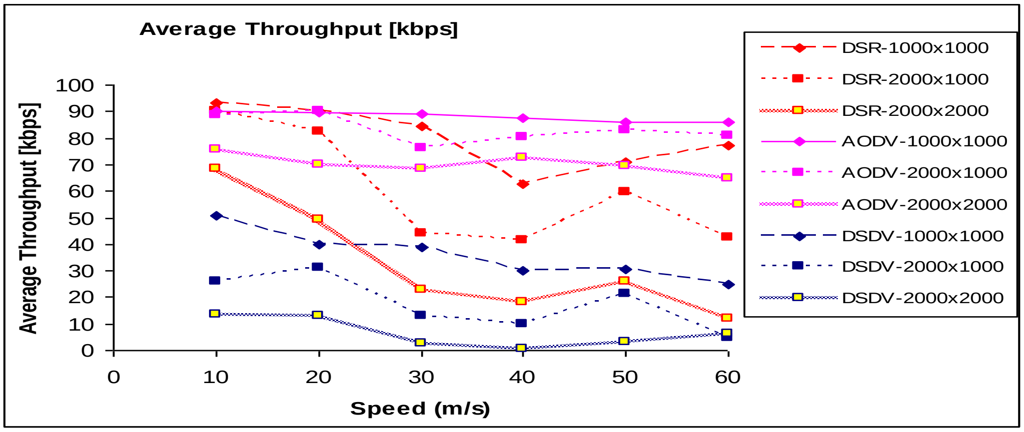

Fig.4: Speed vs Average Throughput for terrain area 1000 m. x 1000 m., 2000 m. x 1000 m. and 2000 m. x 2000 m.

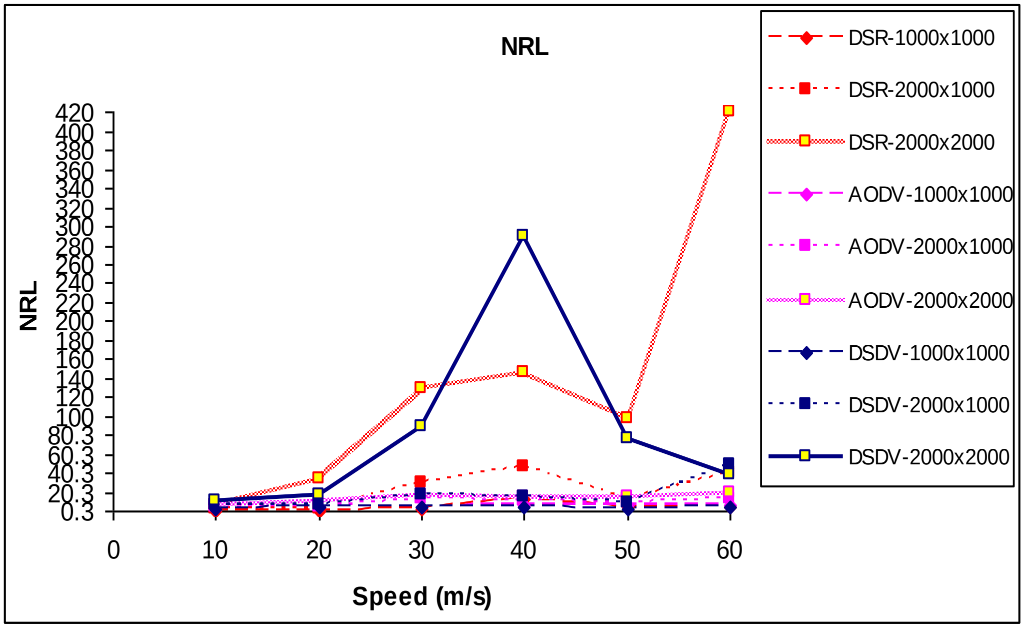

Fig.5: Speed vs NRL for terrain area 1000 m. x 1000 m., 2000 m. x 1000 m. and 2000 m. x 2000 m.

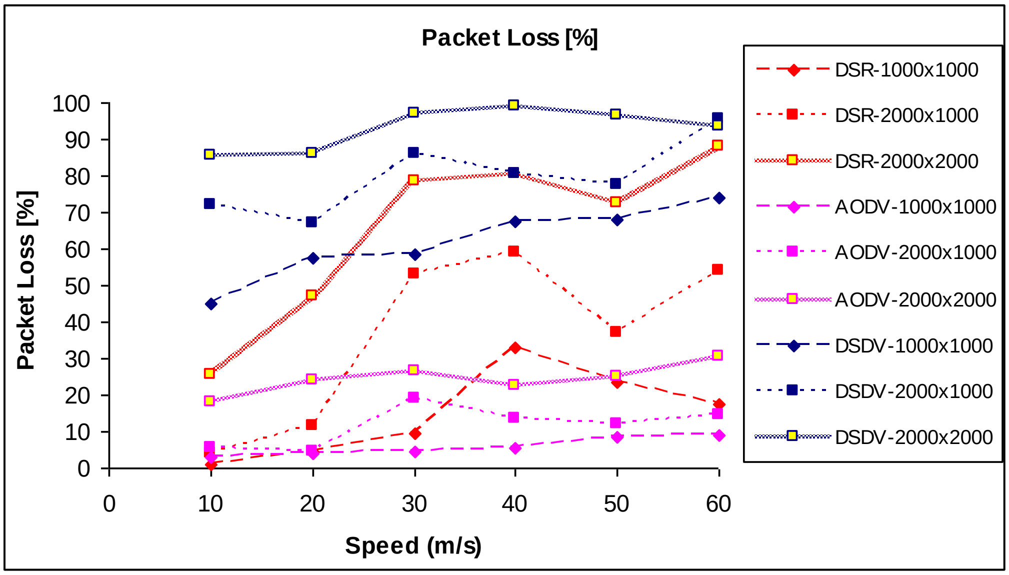

Fig.6: Speed vs Packet Loss for terrain area 1000 m. x 1000 m., 2000 m. x 1000 m. and 2000 m. x 2000 m.

VI. CONCLUSION

1 Packet Delivery Fraction [%] (PDF):In all three routing protocols, the PDF decreases with increase in terrain areas. The PDF for DSR, AODV and DSDV decreases as one increases the speed. The PDF is least for DSDV compared to DSR and AODV.

2 Average End-to-End Delay [in ms]:Unlike DSR and AODV, in DSDV Average End-to-End Delay [in ms] decreases with larger terrain areas. The on demand protocols AODV and DSR gave higher delays then DSDV. In all three simulations the Average Throughput decreases with increase in terrain areas.

3 Average Throughput: The Average Throughput for DSR, AODV and DSDV decreases as one increases the speed. The on demand protocols DSR and AODV gave better Average Throughput than DSDV.

4 Normalized Routing Load [%] (NRL): NRL increases with increase in terrain areas as well as increases in speed. The on demand protocols DSR and AODV are preferred choices as NRL is lesser than DSDV.

5 Packet Loss [%] Comparison: The Packet Loss increases with increase in terrain areas. The Packet Loss in general increases as the speed increases. The on demand protocols DSR and AODV are preferred choices as Packet Loss is lesser than DSDV.

All protocols deliver a greater percentage of the originated data packets when there is little node mobility (i.e., at large pause time), converging to 100% delivery when there is no node motion.Researchers specify the difference between routing protocols and its performance for different parameters and then the Network designer chose the best for the case of an actual practically deployable WSN.

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VIII. REFERENCES

[1]. V. K. Sharma and Ravindra Prakash Gupta, "Design Issues: Duty Cycle Control in Wireless Sensor Networks" International Journal of Computer Science and Communication (IJCSC), ISSN: 0973-7391, Vol (2), No.(1), Jan.– Jun. 2011, pp – 59-61.

[2]. Vijay Mohan Shrimal, Ravindra Prakash Gupta, Virendra Kumar Sharma, "Investigation of Adhoc Topology AODV for Wireless Sensor Networks for Varying Terrain Areas for Different Speed (node speed) " International Journal of Advanced Research in Computer Science and Software Engineering (IJARCSSE), ISSN: 2277 128X, Vol (2), No. (1), Jan. 2012.

[3]. Vijay Mohan Shrimal, Ravindra Prakash Gupta, Virendra Kumar Sharma, "Investigation of Different Parameters of Dynamic Source Routing for Wireless Sensor Networks for varying terrain areas and different speed (node speed)" International Journal of Advanced Research in Computer Science (IJARCS), ISSN: 0976-5697 (Online), Vol (2), No (6), Nov-Dec 2011, pp 309-314.

[4]. Ravindra Prakash Gupta, Dr. Virendra Kumar Sharma, Vijay Mohan Shrimal "Investigation of Different Parameters of Dynamic Source Routing with varied Terrain Areas and Pause Time for Wireless Sensor Network", International Journal of Modern Engineering Research (IJMER) – ISSN: 2249-6645, pp 626-631.

[5]. C.E. Perkins & P. Bhagwat, "Highly Dynamic Destination Sequence-Vector Routing (DSDV) for Mobile Computers", Computer Communication Review, vol. 24, no.4, 1994, pp. 234-244

[6]. Kevin Fall, Kannan Varadhan and Editors,"TheVINT Project", UC Berkeley, LBL, USC/ISI, and Xerox PARC, The ns Manual.

[7]. Pramod Sharma, Ravindra Gupta, Satyendra Sharma "A Comparative Study of NS-2 and NS-3", International Journal for Scientific Research and Development (IJSRD) – ISSN: 2321-0613 (Online), Vol (2), No (3), May 2014, pp 429-431.

[8]. VatsalyaKunchakarra," Simulation Study of Routing Protocols in Wireless Sensor Networks", Osmania University, 2003 December, 2005.

[9]. Sukumar Panda, Rahul Mohapatra," Implementation and Comparison of Mobility Models in Ns-2", National Institute of Technology, Rourkela 2009.

[10]. Pramod Sharma, Ravindra Gupta, Satyendra Sharma "CP-30 Quality of Services (QoS) Parameters and Challenges in Wireless Sensor Networks" 8th Biyani International Conference on "Amplification of Futuristic Technology by an Integrated Approach of Computing, Engineering and System Science" held on 22 September, 2013, ISBN 978-93-83343-01-0 organised by Biyani International Institute of Engineering and Technology for Girls, Jaipur, Rajastan, India, pp 264-69

[11]. Siti Rahayu, Abdul Aziz, Nor Adora Endut, ShapinaAbdullahandMiorNorazmanMiorDaud,"Performance Evaluation of AODV, DSR and Dymo Routing Protocol In Manet" Conference on Scientific &Social Research, CSSR 08'09, 14-15 March 2009.

[12]. Asar Ali, Zeeshan Akbar," Evaluation of AODV and DSR Routing Protocols of Wireless Sensor Networks for Monitoring Applications", Master's Degree Thesis, Karlskrona October 2009.

[13]. Ian F. Akyildizy Mehmet C. Vurany O¨ zgu¨ r B. AkanzWeilianSu," Wireless Sensor Networks: A Survey Revisited", Computer Networks Journal (Elsevier Science).

[14]. Poonam Tyagi, Ravinder Prakash Gupta, Rakesh Kumar Gill, "Comparative Analysis of Cluster Based Routing Protocols used in Heterogeneous Wireless Sensor Network", International Journal of Soft Computing and Engineering (IJSCE) – ISSN: 2231-2307 (Online), Vol (1) , No (5), Nov. 2011, pp 362-366.

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