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Research Paper on centralized clustering approach for wireless sensor networks using Leach-C(Ed) Protocol

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Abstract: Wireless Sensor Networks consists of hundreds and thousands of micro sensor nodes that monitor a remote environment by data aggregation from individual nodes and transmitting this data to the base station for further processing and inference. The energy of the battery operated nodes is the most vulnerable resource of the WSN, which is depleted at a high rate when information is transmitted, because transmission energy is dependent on the distance of transmission. In a clustering approach, the Cluster Head node loses a significant amount of energy during transmission to base station. So the selection of Cluster Head is very critical. An effective selection protocol should choose Cluster Heads based on the geographical location of node and its remaining energy.

In this paper a centralized protocol for Cluster Head selection in WSN is discussed, which is run at the base station, thus reducing the nodes' energy consumption and in-creasing their life-time. The primary idea is implemented using a fuzzy-logic based selection of Cluster Head from among the nodes of network, which is concluded depending on two parameters, the current energy of the node and the distance of the node from the base station. The protocol is named LEACH-C(ED)-Centralized LEACH based on Energy and Distance, and is run periodically at the base station where a new set of cluster heads are selected at every round, thus distributing the energy load in the network and increasing the network lifetime. The simulation results show that the proposed approach is more effective than the existing LEACH-Centralized protocol.

KEYWORDS: Wireless sensor networks, Cluster Head, micro sensors, network lifetime, LEACH, LEACH-C.

I. INTRODUCTION

Wireless Sensor Networks (WSNs) are networks that comprise of sensors that are distributed in an ad hoc fashion over a defined geographical area, aimed at sensing some predefined information from the surrounding, processing them and transmitting them to the sink station. The sensors work with one another to capture some physical event. The data assembled is then transformed to get important outcomes. Remote sensor systems comprise of protocols and algorithms with self-arranging capabilities. WSNs can be widely divided into two types-Unstructured WSN and Structured WSN. While Unstructured WSN have a large collection of nodes, put up in an ad-hoc fashion; Structured WSN have few, scarcely distributed nodes with pre-planned deployment. The Unstructured WSNs are di cult to maintain, but it is relatively easy to maintain Structured WSNs.

The Sensor Node:

Wireless Sensor Networks mainly consists of nodes known as sensors. Sensors are devices with low energy as they operate on battery, having limited memory and processing ability and are designed to survive extreme environmental conditions. These are mostly due to their small size. They are also featured with self-organizing and self-healing power. Three basic parts of a SENSOR NODE can be seen as:

- A sensing subsystem that is used for data capturing from the real world.
- A subsystem for processing that is used for local data processing and storage.
- A subsystem consisting of wireless communication to be used to for data receiving and transmission.

Figure 1: Uses of Wireless Sensor Network

Applications of Wireless Sensor networks: The applications of WSN can be categorized in 3 parts:

a) Object Monitoring

b) Area Monitoring

c) Space and objects Monitoring

Protocols of WSNs: The different layers of communication use various protocols to accomplish their aims. Some of the protocols of the three layers are mentioned below.

1) Transport Layer Protocols:

Sensor Transmission and Control Protocol (STCP)-It is a non-special, adaptable and solid protocol, in which larger part of the functions are executed at the Base Station. STCP errors controlled variable unwavering quality, blockage discovery and shirking, and backings different requisitions in the same system [1]. Cost-Oriented Reliable Transport Protocol (PORT)-To acquire unwavering quality and minimize vitality utilization, a dynamic rate-control and congestion-avoidance transport plan called PORT is utilized as a part of WSN's Transport Layer. PORT minimizes vitality utilization with two plans. To begin with is focused around the sink's provision-based enhancement approach that bolsters back the ideal reporting rates. Second is a generally ideal directing plan as per the reaction of downstream correspondence condition [2]. Congestion Detection and Avoidance (CODA)-CODA comprises of three mechanisms to combat with degree of congestion during event impulses: (i) receiver-based congestion detection; (ii) open-loop hop-by-hop backpressure; and (iii) closed-loop multi-source regulation [3]. Delay Sensitive Transport (DST) - The principle aim of DST protocol is to conveniently and dependably transport occasion characteristics from the sensor led to the sink with least vitality utilization. The convention at the same time addresses blockage control and opportune occasion transport unwavering quality targets in WSNs [4].
Pump Slowly, Fetch Quickly (PSFQ)-An easy, expandable, and reliable trans-port protocol that is modifiable to meet the requirements of emerging depend-able data applications in sensor networks, PSFQ is designed to send data from a source node by sending data at a slower velocity ("pump slowly"), but permit-ting nodes that encounter data loss to regain any missing data from their local immediate neighbors aggressively ("fetch quickly")[5].
Event-to-Sink Reliable Transport (ESRT)- It is a solution for transport developed to accomplish dependable event detection in WSN with least energy expenditure. It contains a congestion control module that does the dual purpose of accomplishing dependability and preserving energy. The algorithms primarily work on the sink, with minimum requirement of resource constrained sensor nodes [6].

2) Network Layer Protocols:

The protocols like Geographic Routing Algorithm (GERA), is evaluated in terms of end to end delay and routing load management done by the protocol [7]. Anchor Location Service (ALS) protocol is based on grid that supplies sink position data in an extensible and optimal fashion and therefore bears location-based routing in large-scale wireless sensor networks. Secure Routing-All the luster based protocols like LEACH, LEACH-C, LEACH-E, LEACH-A, Multi-hop Routing, etc. are secured routing protocols Their efficiency is being constantly improved by researchers. Secure Cell Relay (SCR)- is a routing protocol, immune to various types of attacks on sensor networks, including selective forwarding, sinkhole, wormhole, Sybil, hello coding attacks, etc. SCR is also an optimal energy utilization routing protocol with a ordable security overhead [9].

3) Data-link Layer Protocols:

Z-MAC [10]-This protocol aggregates the strengths of TDMA and CSMA. CC-MAC [11] (Spatial Collaboration based Collaborative MAC)-CC-MAC protocol has two parts: Event MAC (E-MAC) and Network MAC (N-MAC). E-MAC strains out the relation in sensor records while N-MAC gives priority the trans-mission of route-through packets.
Low Power Distributed MAC-This design is mostly for multi-hop WSNs. A set of low power MAC design principles are proposed in the work [12], and a new umber-low power MAC is developed to be broadcast in nature to support extensible, survivable and adaptability requirement of WSNs.

Clustering based Protocols for WSNs:

Grouping calculations for WSNs could be isolated as Centralized cluster calculations and distributed grouping calculations. Distributed clustering systems are again isolated into four sub segments relying upon the sort of cluster, necessity for clusters and parameters utilized for CH determination. The four sub-sections are - Identity based grouping, Iterative, Neighborhood information based and Probabilistic individually [13]. Probabilistic systems for framing clusters in Wireless sensor systems rely on attributed likelihood values for sensor hubs. Low-Energy Adaptive Clustering Hierarchy convention proposed in [14] is such a protocol, giving o set of vitality utilization by arbitrary turn of group heads then ensuring equivalent burden adjusting in one-bounce sensor systems. LEACH-C is focused around transmission of position subtle elements and vitality levels of every sensor hub to base station (BS) and sensor hubs with vitality level above decided beforehand edge are chosen for getting to be cluster heads by the base station (BS) itself [14].

II. LEACH (LOW-ENERGY ADAPTIVE CLUSTERING HIERARCHY) PROTOCOL

LEACH is application specific protocol architecture [15, 16]. It is designed to supports application that are based on micro sensor networks, used for monitoring remote physical environment. Each node's data are often redundant and co-related in such networks, while the end user does not desire the repetitive elaborate data. Thus the nodes are featured with data aggregation and compression techniques, utilized to aggregate multiple correlating signals of data into tinier sized sets of data that maintain the effectiveness of data (i.e., the content of information) of the original signals [17]. The correlation is the most in between signals from sensor nodes that are positioned near each other.

LEACH works with the principle that all the nodes arranges itself into smaller clusters on a local scale and a single sensor node pretends to be the CH. All the other non-CH nodes need to communicate their information to the CH. The CH accepts information from entire cluster, that is the other nodes, it performs data collection, and then sends the information to the sink, the Base Station. Hence, becoming a cluster head (CH) is lot more energy consuming than a non-CH node. When the CH exhausts it energy and it cannot operate any longer, then it affects whole of the network as all the nodes that are belonging to that cluster don't have any means to communicate. Thus the energy overhead in acting as a CH is uniformly divided between all the sensor nodes. LEACH operates by dividing the functioning into rounds. The round in LEACH initiates with a set-up phase. This is accompanied by a steady-state, in which information is transmitted from sensor nodes to Cluster Head and then to the Base Station by the Cluster Head [14].

LEACH has a few drawbacks as mentioned:

- The time duration of setup-phase cannot be determined. The collisions cause too much delay, therefore the sensing service is interrupted. This may cause LEACH to be unstable during the setup phase.
- LEACH Protocol cannot be applied to networks that are used in a gigantic field area, as it utilizes one hop routing in which each sensor node transmits information immediately to the CH, that in turn transfers to the BS.
- The CH nodes in a LEACH round use up a big volume of energy if the locations are far from the BS.
- Leach cannot give assure that CH will be distributed uniformly.
- Leach makes use of dynamic clustering, thus resulting in added overhead such as the CH change, Ch advertising, etc. which increases the energy expense.

III. DESIGN CHALLENGES & PURPOSES METHOD

Heterogeneous Nodes: The sensor devices deployed in area maybe of various types and they need to collaborate with each other.

Distributed Algorithms: The algorithms should be of distributed type as they are executed on different nodes.

Low Bandwidth Communication: The data should be transferred with least possible bandwidth, between sensor nodes.

OBJECTIVE:

- To develop an effective selection protocol that chooses Cluster Heads based on the geographical location of node and its remaining energy.
- The algorithm is a centralized protocol for Cluster Head selection in WSN, which is run at the base station, thus reducing the nodes' energy consumption and increasing their life-time.
- Improvement on centralized LEACH based on Energy and Distance, which is run periodically at the base station where a new set of cluster heads are selected at every round, thus efficiently distributing the energy load in the network.

PROPOSED METHOD:

Clustering approaches that are presently being uses make use of 2 methods: selection of a CH with more left over energy and rotation of CH periodically so that the energy consumption among nodes is distributed and thus the lifetime of network is extended.

The work done is the output of three observations. Firstly the energy expense of a node is dependent on the distance to which the node transmits its energy, because when the distance of transmission is greater than a factor d0 then the energy consumption grows by D4, the details of which is in the Radio Energy Dissipation model. The second observation is that LEACH-C is more energy efficient than LEACH [18], primarily because LEACH does not generate uniformly distributed clusters in every round and does not consider the nodes' energy and distance from BS. The third observation is that LEACH uses dynamic clustering which results in extra overhead such transmission of advertisement and receiving join requests that reduces the energy consumption gain; whereas this overhead is curbed in LEACH-C in which the Cluster Head selection process is run at Base Station, which is assumed to have infinite energy as compared to nodes' energy. Thus any WSN process run at the BS does not generate energy overhead to the network nodes, except the minimal node information that is communicated to BS by node.

SYSTEM ASSUMPTIONS:

We consider WSN implementations in where sensor nodes are put up in a random order so that the environment is monitored continuously. The data accumulated by sensor nodes is transmitted to a BS situated in exterior of the chosen area. Every sensor node can function either in sensing mode to check the surrounding and send it to the allotted CH or in Cluster Head mode to collect data, squeeze it and send it to the BS. The additional presumptions are as follows:

- The sensor nodes and BS are immobile.
- All the nodes possess the equal energy initially.
- All nodes are given unique identifier.
- The distance among nodes is calculated depending on the received strength of signal.
- All nodes have ability to compute their respective distance from base-station, based on GPS or other location detection scheme.
- All nodes are part of event driven WSN model.

PROPOSED ALGORITHM:

Input:

N: the wireless sensor network
nn: the total number of nodes in N
k: the expected number of clusters for each round a : a node in N
T: a randomly selected value for becoming a CH candidate
chance(a): the chance of the node to be CH, calculated based on current Energy and distance from BS probability(a): true for the node which has chance(a) value above threshold bucket(a): the node a is a member for random selection of CH candidate(a): a is a candidate for cluster head

Output:

cluster(a): the CH of the node, which is a node from among nn nodes
Function:
Broadcast (data, range of distance);
send (data, receiver);
fuzzy logic (current Energy, distance);
ndMinDist(nodesX1[], nodesY1[], nwSize1, nodesX2[], nodesY2[], nwSize2,
node Index, cluster Index) ;
/* FOR EVERY CLUSTERING ROUND*/
/* SET-UP Phase */
/* AT NODE*/

```
1       Send (data[currentEnergy, distance], BS);
        /* AT BASE-STATION    */
2       foreach node nn do
3       chance(a) <   fuzzylogic(currentEnergy, distance);
4       probability(a) <- false;
5       if (chance(a) > T ) then
6       probability(a): true;
7       count++;
8       bucket(a);
9       else
10      probability(a):false;
11      end
12      end
13      candidate(a) = random(bucket);      /* k unique nodes are selected
        randomly from "count" number of nodes in "bucket[]", as
        candidate for CH */
14      cost = ndMinDist(nodesX1[], nodesY1[], k, nodesX2[], nodesY2[], nn, nodeIndex, clusterIndex);
15      minCost = cost;
16      itr = count*count;
17      while itr do
18      candidate(a) = random(bucket);   /* k unique nodes are selected randomly from "count" number of nodes in
"bucket[]", as candidate for CH */
19      cost = ndMinDist(nodesX1[], nodesY1[], k, nodesX2[], nodesY2[], nn, chIndex, clusterIndex);

20      if (cost < minCost) then
21      minCost = cost;
22      cluster(a) = clusterIndex(a);
23      end
24      itr   ;
25      end
        Broadcast (cluster[], N);
```

IV. SIMULATION AND RESULTS

The proposed clustering algorithm LEACH-C(ED), is compared with the basic Centralized Cluster-Head se-lection algorithm LEACH-C. The simulation results prove that the approach selected in the work reveals better performances.

This simulation was deployed using the MATLAB 2013a software. There are 100 nodes. They are spread in a random order in a 100 x 100 area. The values that are used in the first order radio model are shown in Figure 2 given below.

Type	Parameter	Value
Network topology	Number of nodes	100
	Expected number of clusters	5
	Network coverage	(0, 0) (100, 100) m
Radio Model	Startup energy	2 J
	E_{elec}^{Tx} / E_{elec}^{Rx}	50 nJ/bit
	ϵ_{fs}	10 pJ/bit/m^2
	ϵ_{mp}	0.0013 pJ/bit/m^4
Application	Packet header size	25 bytes
	Data packet size	500 bytes

Figure 2: Configuration Parameters used

Given a fixed Base Station and a 100 nodes fixed topology of Sensor nodes, the number of nodes alive during the time of simulation is compared for LEACH-C and LEACH-C(ED) in the following Fig. 3 and Fig.4.

Fig.3 also shows similar characteristics of LEACH-C(ED)in comparison to LEACH-C in Fig.1.3, when BS is at (100,175).

In Fig.4, at any point of time during the simulation, the number of nodes alive for LEACH-C(ED) network is more than that of LEACH-C network. It can also be observed that the network for LEACH-C(ED) and LEACH-C die at almost same time.

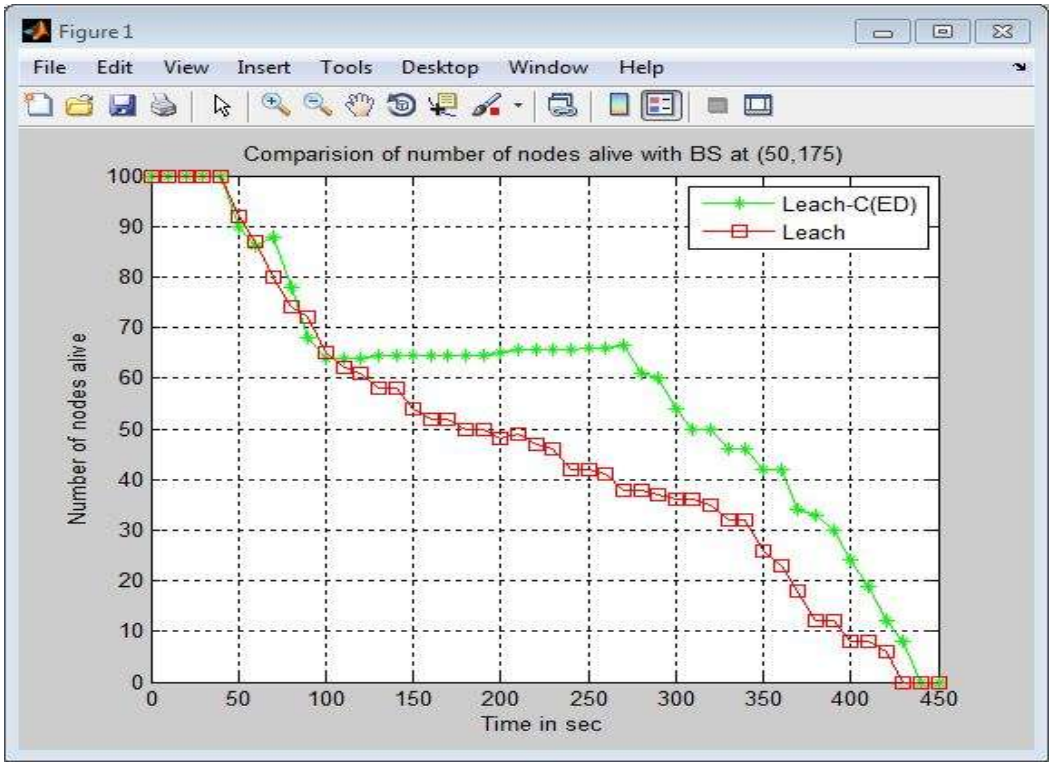

Figure 3: Nodes alive when BS is at (50, 175)

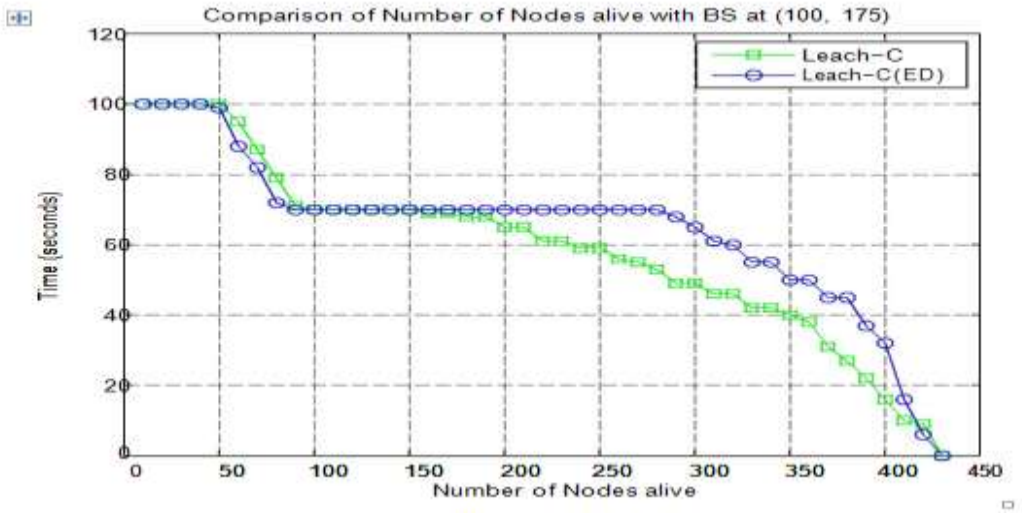

Figure 4: Nodes alive when BS is at (100, 175)

V. CONCLUSION AND FUTURE WORKS

This work, named LEACH-C(ED) proposes a centralized approach for Cluster Head selection based on fuzzy rules for energy and distance. The main aim of the proposed algorithm is to extend the lifespan of the Wireless Sensor Network by dividing and spreading the load and to improve the NP hard annealing algorithm, to reduce the execution time at the base-station. At any point of time, the overall number of nodes not dead in the WSN of LEACH-C(ED) is greater than number of nodes not dead in LEACH-C, for a fixed Base Station. The Half Life of Network under LEACH-C(ED) is much better than LEACH-C. For a network of 100 nodes with Base Station at (50,175), LEACH-C(ED)'s efficiency is 42.72 % better than LEACH-C, when HNA is compared. It is also observed the while the HNA status of LEACH-C(ED) is much better than LEACH-C, the total energy consumption of both the networks is equivalent. The comparison of HNA Status of LEACH-C(ED) with LEACH-C shows that LEACH-C(ED) performs better than LEACH-C for various Base Station locations taken into consideration. Thus the simulation outputs present that the proposed LEACH-C(ED) is more efficient than the centralized algorithm LEACH-C.

REFERENCES

[1]. Y.G. Iyer, S. Gandham, and S. Venkatesan. Stcp: a generic transport layer protocol for wireless sensor networks. In Computer Communications and Networks, 2005. ICCCN 2005. Proceedings. 14th International Conference on, pages 449{454, Oct 2005.

[2]. Yangfan Zhou, M.R. Lyu, Jiangchuan Liu, and Hui Wang. Port: a price-oriented reliable transport protocol for wireless sensor networks. In Software Reliability Engineering, 2005. ISSRE 2005. 16th IEEE International Symposium on, pages 10 pp.{126, Nov 2005.

[3]. Chieh yih Wan and Shane B. Eisenman. Coda: Congestion detection and avoidance in sensor networks. pages 266{279. ACM Press, 2003.

[4]. V.C. Gungor and O.B. Akan. Dst: delay sensitive transport in wireless sensor networks. In Computer Networks, 2006 International Symposium on, pages 116{122, 2006.

[5]. Chieh yih Wan, Andrew T. Campbell, and Lakshman Krishnamurthy. Pump slowly, fetch quickly (psfq): a reliable transport protocol for sensor networks. In IEEE Journal on Selected Areas in Communications, pages 862{872, 2005.

[6]. O.B. Akan and I.F. Akyildiz. Event-to-sink reliable transport in wireless sensor networks. Networking, IEEE/ACM Transactions on, 13(5):1003{1016, Oct 2005.

[7]. R. A. Santos, A. Edwards, O. Alvarez, A. Gonzalez, and A. Verduzco. A geographic routing algorithm for wireless sensor networks. In Electronics, Robotics and Automotive Mechanics Conference, 2006, volume 1, pages 64{69, Sept 2006.

[8]. Rui Zhang, Hang Zhao, and Miguel A. Labrador. The anchor location service (als) protocol for large-scale wireless sensor networks. In Proceedings of the First International Conference on Integrated Internet Ad Hoc and Sensor Networks, InterSense '06, New York, NY, USA, 2006. ACM.

[9]. Xiaojiang Du and Fengjing Lin. Secure cell relay routing protocol for sensor networks. In Performance, Computing, and Communications Conference, 2005. IPCCC 2005. 24th IEEE International, pages 477{482, April 2005.

[10]. Chunlong Guo, Lizhi Charlie Zhong, and J.M. Rabaey. Low power distributed mac for ad hoc sensor radio networks. In Global Telecommunications Conference, 2001. GLOBECOM '01. IEEE, volume 5, pages 2944{2948 vol.5, 2001.

[11]. V. Geetha, P.V. Kallapur, and Sushma Tellajeera. Clustering in wireless sensor networks:

[12]. Performance comparison of fLEACHg and; leach-c protocols using fNS2g. Procedia Technology, 4(0):163 { 170, 2012. 2nd International Conference on Computer, Communication, Control and Information Technology(C3IT-2012) on February 25 - 26, 2012.

[13]. W.B. Heinzelman, A.P. Chandrakasan, and H. Balakrishnan. An application-speci c protocol architecture for wireless microsensor networks. Wireless Communications, IEEE Transactions on, 1(4):660{670, Oct 2002.

[14]. Wu Xinhua and Wang Sheng. Performance comparison of leach and leach-c protocols by ns2. In Distributed Computing and Applications to Business Engineering and Science (DCABES), 2010 Ninth International Symposium on, pages 254{258, Aug 2010.

[15]. Shangwei Duan and Xiaobu Yuan. Exploring hierarchy architecture for wireless sensor networks management. In Wireless and Optical Communications Networks, 2006 IFIP International Conference on, pages 6 pp.{6, 2006.

[16]. I.F. Akyildiz, Weilian Su, Y. Sankarasubramaniam, and E. Cayirci. A survey on sensor networks. Communications Magazine, IEEE, 40(8):102{114, Aug 2002.

[17]. Di Tian and Nicolas D. Georganas. A coverage-preserving node scheduling scheme for large wireless sensor networks. In Proceedings of the 1st ACM International Workshop on Wireless Sensor Networks and Applications, WSNA '02, pages 32{41, New York, NY, USA, 2002. ACM.

[18]. Chee-Yee Chong and S.P. Kumar. Sensor networks: evolution, opportunities, and challenges. Proceedings of the IEEE, 91(8):1247{1256, Aug 2003.

[19]. Wenli Chen, N. Jain, and S. Singh. Anmp: ad hoc network management protocol. Selected Areas in Communications, IEEE Journal on, 17(8):1506{1531, Aug 1999.

[20]. W.B. Heinzelman, A.P. Chandrakasan, and H. Balakrishnan. An application-speci c protocol architecture for wireless microsensor networks. Wireless Communications, IEEE Transactions on, 1(4):660{670, Oct 2002.

[21]. W.R. Heinzelman, A. Chandrakasan, and H. Balakrishnan. Energy-e cient communication protocol for wireless microsensor networks. In System Sciences, 2000. Proceedings of the 33rd Annual Hawaii International Conference on, pages 10 pp. vol.2{, Jan 2000.