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Energy Efficient Protocol with Static Clustering (EEPSC) Comparing with Low Energy Adaptive Clustering Hierarchy (LEACH) Protocol

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Abstract
A wireless sensor network with a large number of tiny sensor nodes can be used as an effective tool for gathering data in various situations. One of the major issues in wireless sensor networks is developing an energy-efficient routing protocol which has a significant impact on the overall lifetime of the sensor network. In this paper, we propose a novel hierarchical with static clustering routing protocol called Energy-Efficient Protocol with Static Clustering (EEPSC). EEPSC, partitions the network into static clusters, eliminates the overhead of dynamic clustering and utilizes temporary-cluster-heads to distribute the energy load among high power sensor nodes; thus extends network lifetime. We have conducted simulation-based evaluations to compare the performance of EEPSC against Low-Energy Adaptive Clustering Hierarchy (LEACH). Our experiment results show that EEPSC outperforms LEACH in terms of network lifetime and power consumption minimization.
Keywords: Clustering methods, energy efficiency, routing protocol, wireless sensor networks

I. INTRODUCTION:-

Wireless sensor network is a collection of sensor nodes interconnected by wireless communication channels. Each sensor node is a small device that can collect data from its surrounding area, carry out simple computations, and communicate with other sensors or with the base station (BS). Such networks have been realized due to recent advances in micro electromechanical systems and are expected to be widely used for applications such as environment monitoring, home security, and earthquake warning. Despite the infinite scopes of wireless sensor networks, they are limited by the node battery lifetime. Once they are deployed, the network can keep operating while the battery power is adequate. This is critical point to be considered as it is almost impossible to replace the node battery once deployed over an inaccessible area. Such constraints combined with a typical deployment of large number of sensor nodes, have posed many challenges to the design and management of

Sensor networks and necessitate energy-awareness at all layers of networking protocol stack In this paper we assume a sensor network model, similar to those used in, with the following properties:

- All sensor nodes are immobile and homogeneous with a limited stored energy.
- The nodes are equipped with power control capabilities to vary their transmitted power.
- None of the nodes know their location in the network.
- Each node senses the environment at a fixed rate and always has data to send to the base station.
- Base station is fixed and not located between sensor nodes.

In this paper, we propose EEPSC (Energy-Efficient Protocol with Static Clustering), a hierarchical static clustering based protocol, which eliminates the overhead of dynamic clustering and engages high power sensor nodes for power consuming tasks and as a result prolongs the network lifetime. In each cluster, EEPSC chooses the sensor node with maximum energy as the cluster-head (CH); thus, not only there is always one CH for each cluster, but also the overhead of dynamic clustering is removed. EEPSC is a modified version of the Low-Energy Adaptive Clustering Hierarchy (LEACH) protocol presented in LEACH uses the paradigm of data fusion to reduce the amount of data transmitted between sensor nodes and the base station. Data fusion combines one or more data packets from different sensors in a cluster to produce a single packet. It selects a small number of CHs by a random scheme which collects and fuses data from sensor nodes and transmits the result to the base station. LEACH uses randomization to rotate the CHs and achieves a factor of 8 improvement compared to the direct approach before the first node dies The main difference between EEPSC and LEACH are described below:

- EEPSC benefits a new idea of using temporary-CHs and utilizes a new setup and responsible node selection phase.
- EEPSC utilizes static clustering scheme, therefore eliminates the overhead of dynamic clustering.

The rest of the paper is organized as follows. Section II describes the proposed method.

2. EEPSC PROTOCOL ARCHITECTURE

EEPSC is a self-organizing, static clustering method that forms clusters only once during the network action. The operation of EEPSC is broken up into rounds, where each round consists set-up phase, responsible node selection phase and steady-state phase.

In the following sub-sections we discuss each of these phases in details.

A. Setup Phase

According to the static clustering scheme which is used in EEPSC, cluster formation is performed only once at the beginning of network operation. For this aim, base station broadcasts k-1 different messages with different transmission powers, which k is the desired number of clusters (specified a priori). By broadcasting the k=1 message all the sensor nodes which hear this message (are in the radio range of this message) set their cluster ID to k and inform the base station that they are member of the cluster k via transmitting a join request message (Join-REQ) back to the base station. Similarly, by broadcasting the k=k-1 message, all the sensor nodes which are not joined to any clusters yet and hear this message set their cluster ID to k-1 and inform base station with a Join-REQ message. Later, all sensor nodes which are not joined to any clusters set their cluster ID to k and inform base station.

Fig. 1 shows how the network area is divided into k=4 clusters with broadcasting k-1=3 different messages from base station. Fig. 1 Network area is divided into 4 clusters with broadcasting 3 different messages from base station. These messages are small messages containing node's Ids and a header that distinguishes them as announcement messages. Like LEACH, in order to reduce the probability of collision among joint-REQ messages during the setup phase, CSMA (Carrier Sense Multiple Access) is utilized as the MAC layer protocol

Afterward, the base station selects randomly one temporary-CH for each cluster and advertises these rules to the whole network. In addition, base station (based on the number of each cluster) sets up a TDMA (time-division multiple-access) schedule and transmits this schedule to the nodes in each cluster. Once the TDMA schedule is known by all nodes in the cluster, the set-up phase is complete and the next phase can begin.

B. Responsible Node Selection Phase

After the clusters are established, network starts its normal operation and responsible nodes (temporary-CH and CH) selection phase begins. At the beginning of each round, every node sends its energy level to the temporary-CH in it's time slot. Afterward, temporary-CH choose the sensor node with utmost energy level as CH for current round to collect the data of sensor nodes of that cluster, perform local data aggregation, and communicate with the base station; and the node with lowest energy level as temporary-CH for next round and sends a round-start packet including the new responsible sensor IDs for the current round. This packet also indicates the beginning of round to other sensor nodes. Since every sensor node has a pre-specified time slot, changing the CHs has no effect on the schedule of the cluster operation.

C. Steady-State Phase

The steady-state phase is broken into frames where nodes send their data to the CH during pre-allocated time slots. These data contain node ID and the measure of sensed parameter. We show in the next section that the total energy expended in the system is greater using multi-hop routing than direct transmission to the base station; thus, we use direct transmission approach among CH and base station. The duration of each slot in which a node transmits data is constant, so the time to send a frame of data depends on the number of nodes in the cluster. To reduce energy dissipation, the radio of each non-cluster head node is turned off until its allocated transmission time, but the CHs must be awake to receive all the data from nodes in the cluster.

3.The assumptions for the working scenarios are shown as following:

1. All sensors rarely move.
2. All sensors are homogeneous and energy restricted.
3. Energy consumption is variable for different types of sensors.
4. The base station is fixed with energy supply, and located outside the wireless sensor network.
5. Network stability is highly requested.
6. Once certain percent of the sensors fail, the full wireless sensor network fails.

In such scenarios, wireless sensor network must lower down energy consumption of each sensor, distribute energy consumption equally throughout the sensors and keep high stability of the whole network. The running stages of LESCS can be divided into three phases, centralist network clustering calculation phase, cluster formation phase, and intra-cluster scheduling phase. The centralist network clustering calculation phase and the cluster formation phase, only run one time during the network initialization. Once the network cluster is formed, the wireless sensor network enters the third phase, a loop procedure, until the entire network fails. Figure 1. Network data transmission

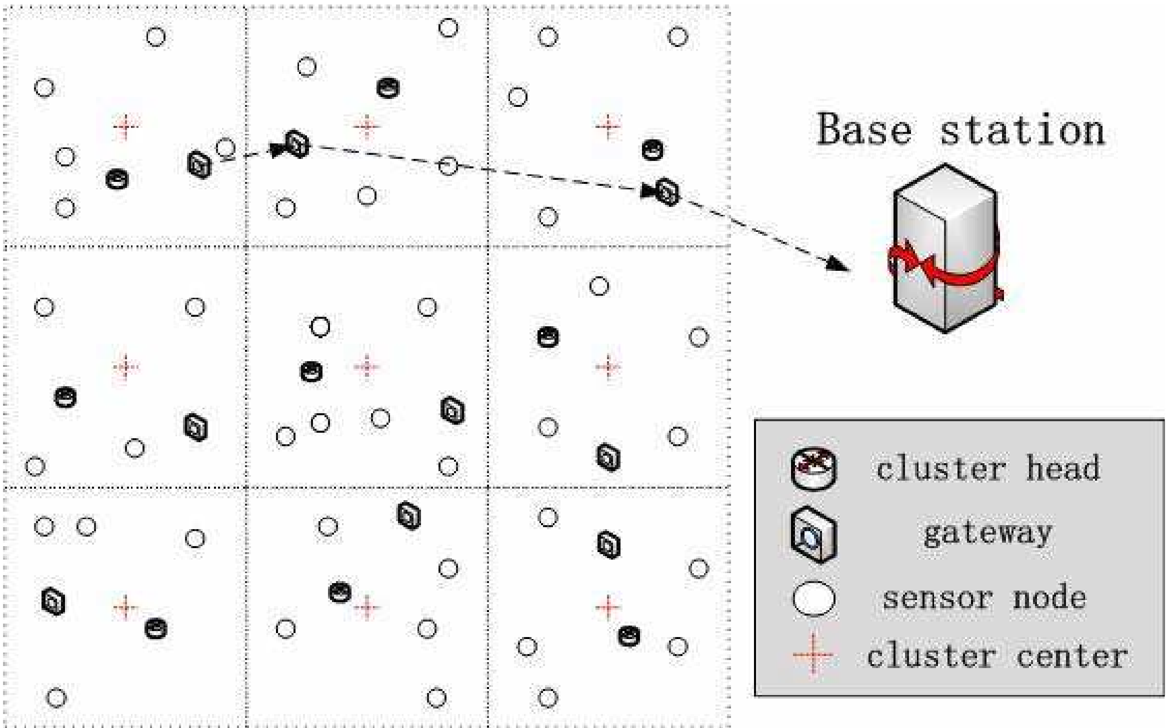
First phase is centralist network clustering calculation.Because the data information is always attached with position information [5, 6], it is easy to employ a base station that locates outside to calculate the optimal network topology, which means how to divide the entire network to several clusters. Also, the base station selects cluster head for each cluster. The cluster and their heads are decided only once and never changed. Then, the base station broadcasts the results to the whole network. An example of clustering calculation results is given as Figure 1. In the example, the network is divided to 9 clusters.

Second phase is cluster formation phase. Based on the broadcast message from the base station, each sensor selects to join the cluster whose center is the nearest from itself.

The cluster head answers for recording the position and energy information of all sensors in the cluster. Then, cluster head will assign a sequence number, from 0 to k-1 (k means

the amount of sensors in the cluster), to each sensor in the cluster. The sequence number is used for later scheduling. The cluster head also records the available energy

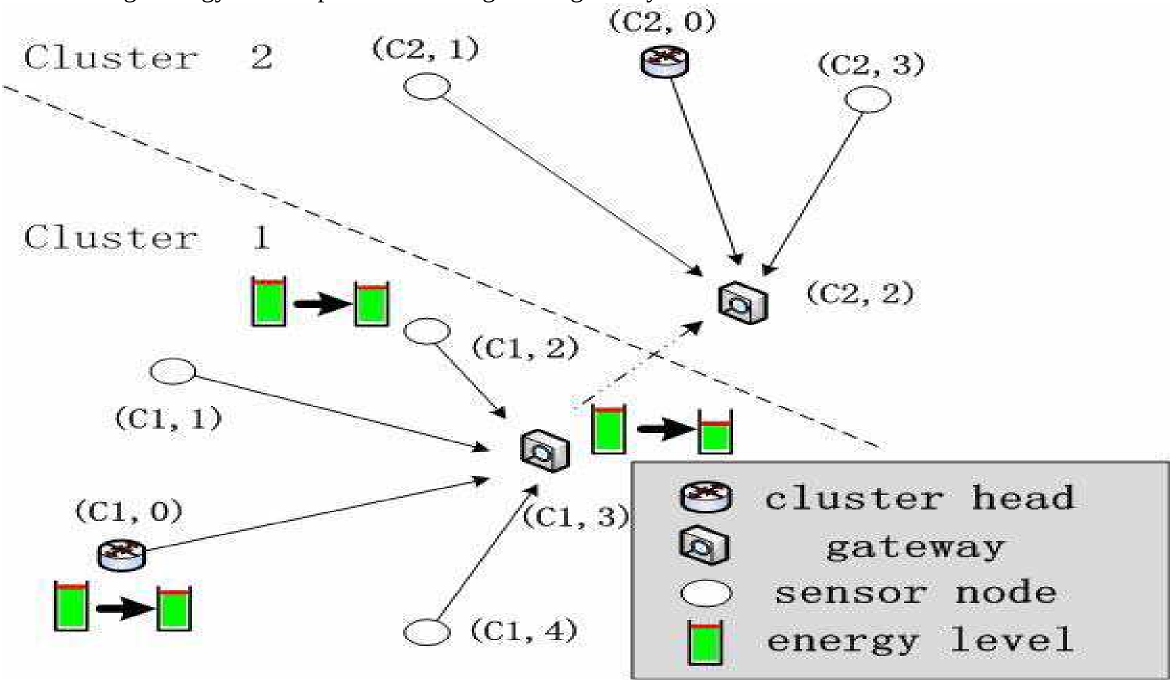
information of each sensor. Before the description of the third phase, it must be made clear how the static clustering protocols work. Figure 1 also illustrates an example of how to transmit data from source sensor to the base station in LESCS. The sensors in the upper-left corner cluster of Figure 1 transmit the data to their gateway. The gateway fuses the data and transmits the data to the gateway of the adjacent cluster [7, 8, 9, 10, 11]. Through such multi hops, the fused data can be finally transmitted to the base station.During the multi hops, the gateways take charge of collecting data, fusing data and transmitting data. Obviously, gateways consume energy much faster than other sensors. If a sensor is always serving as gateway, it will fail much earlier than others. Such phenomenon is called hotspot problem, which inherently exists in the static clustering protocols. To solve this, LESCS carries out the third phase to assign gateway dynamically.The third phase is a loop procedure. Each loop is a fixed time span, named time step or round, same as that concept of LEACH. In each round, cluster head assigns the most energy remained sensor as the gateway.



4.For example

Figure 2 shows the gateway assignment and data transmission between two adjacent clusters, in some round. The sensor of (C1, 3), serves as the gateway of cluster

All data from sensors in cluster 1, will be transmitted to (C1, 3). Then, (C1, 3) will fuse the data and transmit the data to the gateway of cluster 2, (C2, 2). Observing the energy level shown in Figure 2, the sensor For example, Figure 2 shows the gateway assignment and data transmission between two adjacent clusters, in some round. The sensor of (C1, 3), serves as the gateway of cluster 1. All data from sensors in cluster 1, will be transmitted to (C1, 3). Then, (C1, 3) will fuse the data and transmit the data to the gateway of cluster 2, (C2, 2). Observing the energy level shown in Figure 2, the sensor For example, Figure 2 shows the gateway assignment and data transmission between two adjacent clusters, in some round. The sensor of (C1, 3), serves as the gateway of cluster 1. All data from sensors in cluster 1, will be transmitted to (C1, 3). Then, (C1, 3) will fuse the data and transmit the data to the gateway of cluster 2, (C2, 2). Observing the energy level shown in Figure 2, the sensor (C1, 3) consumes energy faster than cluster head (C1, 0) and other sensors in the cluster, for example, the sensor of (C1,2). If no adaptation was performed, it's obvious that (C1, 3) would fail faster than other sensors. Figure 3 shows the situation after a round. Now, (C1, 2) is assigned to serve as the gateway of cluster 1. Serving as the gateway, (C1, 2) also consume more energy than other sensors of cluster 1. However, the available energy of (C1, 2) is almost equal to that of (C1, 3). Through assigning the gateway dynamically, the energy consumption of each sensor can be balanced.Such scheduling can distribute the large energy consumption for serving as gateway, to all sensors. It can solve the hotspot problem and lengthen the lifetime of the entire wireless sensor network. The detailed procedure of the gateway assignment is following: First step, the cluster head predicts the available energy of each sensor in the cluster. Then, the cluster head selects the most energy remained sensor as the gateway, following the prediction. After that, cluster head broadcasts the selection to all sensors in the cluster. If any sensor has more available energy than the selected sensor, the cluster head will correct the selection and the new one is assigned as the gateway. Otherwise, the predicted most available energy sensor will be assigned as the gateway. It's also possible that the cluster head itself is assigned as gateway sometimes, because, the additional energy consumption for serving as a cluster head can be marginally ignored, comparing it with the large energy consumption for serving as the gateway.



5.Energy Analysis and Simulation

To analyze the energy consumption, assumptions are made about the radio characteristics, including energy consumption in the transmit and receive modes. In our research, a simple model is assumed that the radio dissipates

Eelec = 50 nJ/bit to run the transmitter or receiver circuitry and ƒÃamp = 100 pJ/bit/m2 for the transmit amplifier [4]. Thus, it is calculated that, to transmit a k-bit message over a distance d, the energy consumption ET is

Et= Eelec x K+e amp X K d^2 ....(1)

and to receive the message, the energy consumption ER is

Er= Eelec x K ....(2)

It fs also assumed that there are three types of sensors with different data send-out rates of 1000 bit/round, 2000 bit/round and 3000 bit/round, named type 1, type 2 and type 3 respectively. According to equation (1) and (2), it is calculated that, E1, E2 and E3, energy consumptions for the three types in each round while not serving as gateway, are

E1 = 50ƒÊJ +100nJ x d^2...(3)

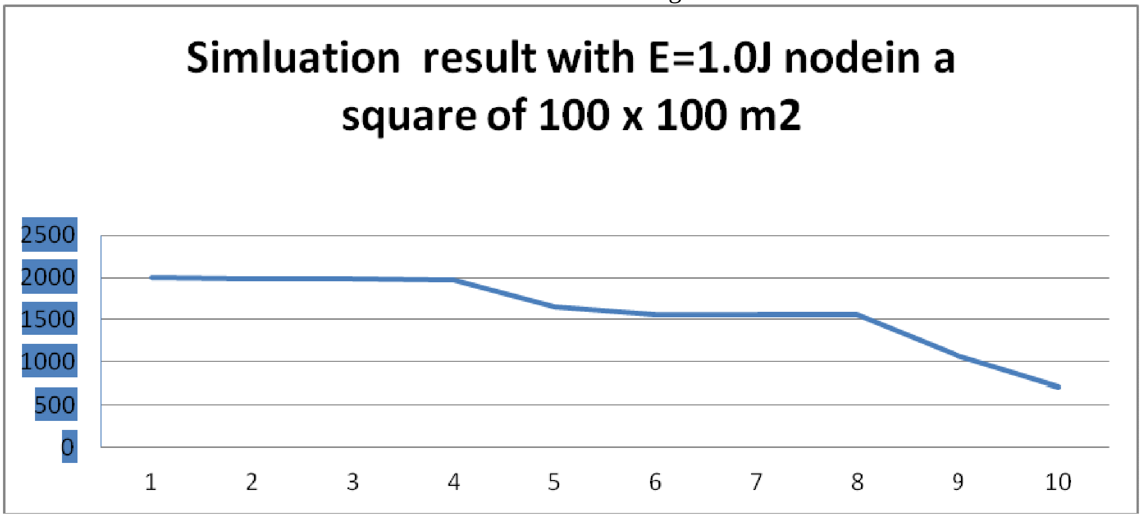
E2 =100ƒÊJ + 200nJ x d^2..(4)

E3 =150ƒÊJ + 300nJ xd^2...(5)

And E gateway, energy consumption while serving as gateway, is

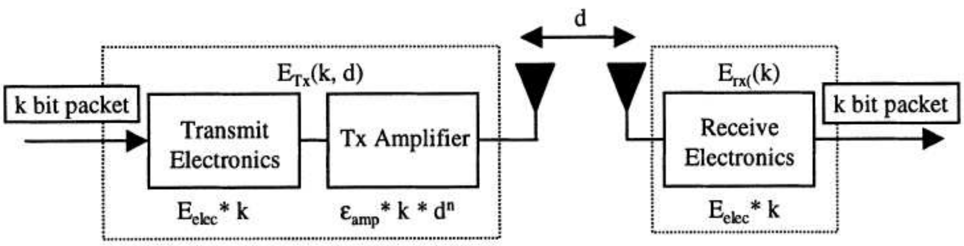
$$E_{gateway} = m_1 \times 50nJ + m_2 \times 100\,pJ \times D^2$$

In the equations, d is the distance between sensors and gateway inside cluster, D is the distance between gateways in different clusters, m1 is the total data rate inside each cluster and m2 is the total data rate after data fusion and
transmitted to the base station through multi-hop.A 100 sensors network is randomly generated for the simulation. The locations of 100 sensors are randomly generated in a square of 100 ~100m2, with 50 type 1 sensors (1000 bit/round), 30 type 2 sensors (2000 bit/round) and 20 type 3 sensors (3000 bit/round). Each sensor has the initial energy of 1.0 J.Two evaluation parameters are taken into account. The first one is the round when the initial failure of sensor occurs .The second one is the average lifetime of sensors.

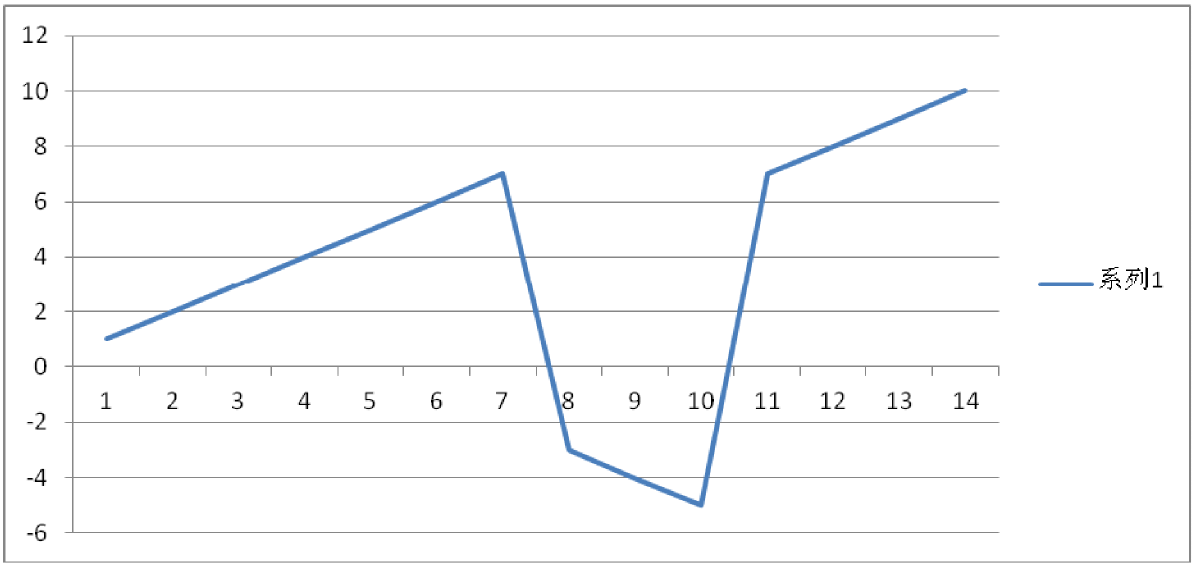


The simulation result for LESCS and LEACH, with 1.0J/node in a square of 100×100 m2. X-axis is the round of the simulation and y-axis is the number of the sensors that keep active. Observing Figure 4, it's found that LESCS performs better than LEACH, not only on the initial failure of sensor, but also on the average lifetime of sensors. The initial failure of sensor occurs much later than LEACH, and the final failure of sensor occurs almost the same round as LEACH. LESCS keeps the entire network working normally longer
than LEACH.

6. Energy and Simulation of Leach;-



If 100 nodes of the LEACH are dissipates per round as the number of cluster varies between 1 to 100 is the most energy efficient method when there are between 3 and 5 cluster in the 100-node network as predicted by by the analysis.



Number of cluster Vs average energy dissipation per round (J)

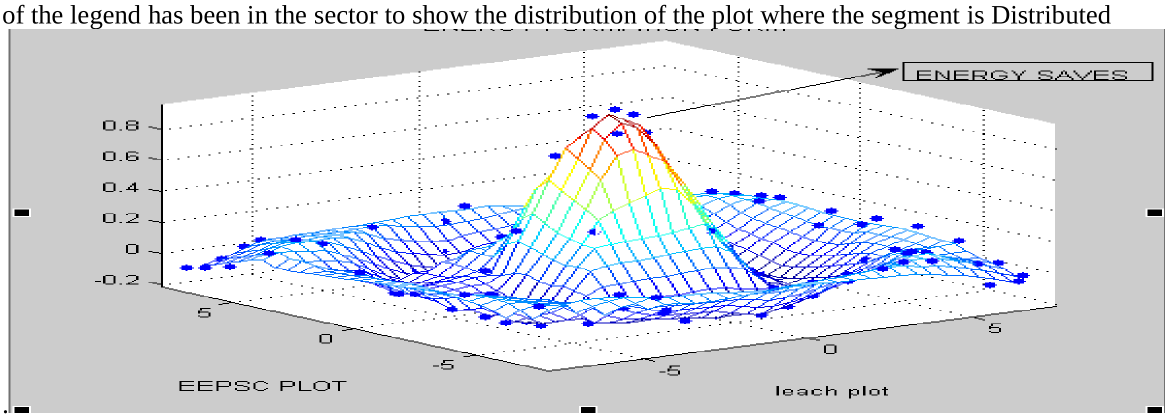
Fig. shows that LEACH is not as efficient as EEPSC

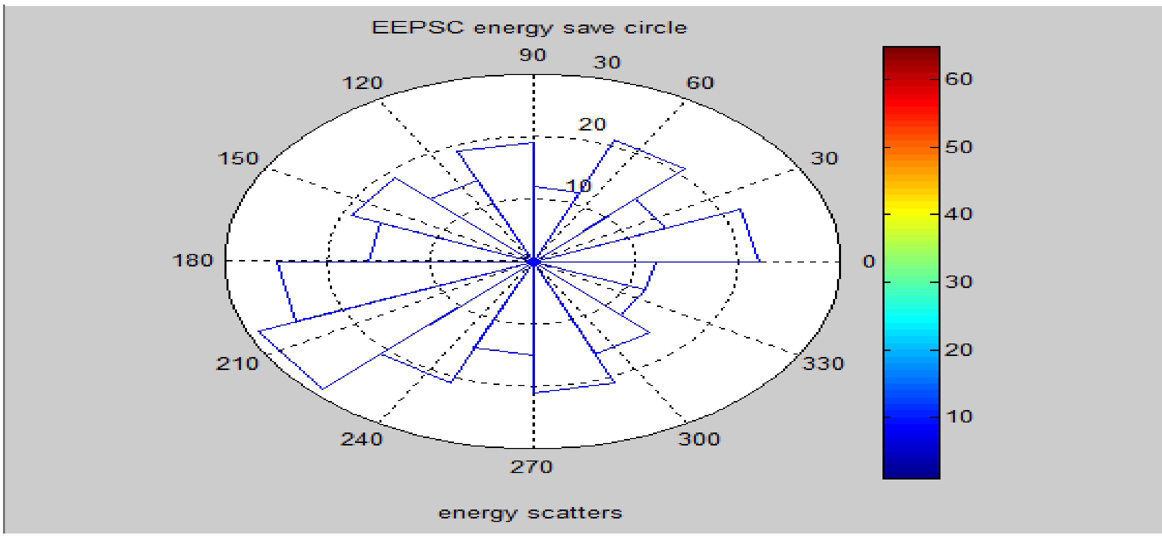
(LEACH-C delivers about 40% more data per unit energy than LEACH). This is because the BS has global knowledge of the location and energy of all the nodes in the network, so it can produce better clusters that require less energy for data transmission.

In addition, the BS formation algorithm ensures that there are clusters during each round of operation. As there are only 100 nodes in the simulation, even though the expected number of clusters per round is in LEACH, each round does not always have five clusters.

Energy distribution:- EEPCA shows the energy distribution across the boundary of the base station where the three vector coincidence occurs at the level of the distribution rounds.Inthe the distribution chamber has been consider to convert the medium into energy transformation across the cluster.These energy system shows the formation of the cluster from the equation (1). This distribution curve shows the leading legend in the energy shows is the eeca forms the symbol in the corner formation of the energy level simulation.

The energy distribution is seen from the plot chamber that EECA forwars in the surface plot level that the energy conservation is greater in the base station of the secure transformation of the consumption.The queue formation of the legend has been in the sector to show the distribution of the plot where the segment is Distributed





7.Expiereimental analysis plot

In these experiments, each node begins with only 2 J of energy and an unlimited amount of data to send to the BS. Each node uses the probabilities in (3) to determine its cluster head status at the beginning of each round, and each round lasts for 20 s.6 We tracked the rate at which the data packets are transfered to the BS and the amount of energy required to get the data to the BS. When the nodes use up their limited energy during the course of the simulation, they can no longer transmit or receive data. For these simulations, energy is consumed whenever a node transmits or receives data or performs data aggregation. Using
spread-spectrum increases the number of bits transmitted, thereby increasing the amount of energy dissipated in the electronics of the radio. We do not assume any static energy
dissipation nor do we assume energy is consumed during carrier-sense operations; hence, the results here do not account for the potential energy benefits of using TDMA in LEACH
compared with CSMA in MTE.

8. Conclusion

When designing protocol architectures for wireless microsensor networks, it is important to consider the function of the application, the need for ease of deployment, and the
severe energy constraints of the nodes. These features led us to design LEACH, a protocol architecture where computation is performed locally to reduce the amount of transmitted
data, network configuration and operation is done using local control, and media access control (MAC) and routing protocols enable low-energy networking. Results from our experiments show that EECA provides the high performance needed under
the tight constraints of the wireless channel.

REFERENCES

[1] P. Agarwal and C. Procopiuc, "Exact and approximation algorithms for clustering," in *Proc. 9th Annu. ACM-SIAM Symp. Discrete Algorithms*, Baltimore, MD, Jan. 1999, pp. 658–667.

[2] J. Agre and L. Clare, "An integrated architecture for cooperative sensing networks," *IEEE Computer*, vol. 33, pp. 106–108, May 2000.

[3] D. Baker, A. Ephremides, and J. Flynn, "The design and simulation of a mobile radio network with distributed control," *IEEE J. Select. Areas Commun.*, vol. SAC–2, pp. 226–237, Jan. 1984.

[4] A. Chandrakasan, R. Amirtharajah, S.-H. Cho, J. Goodman, G. Konduri, J. Kulik, W. Rabiner, and A. Wang, "Design considerations for
distributed microsensor systems," in *Proc. IEEE Custom Integrated CircuitsConf. (CICC)*, San Diego, CA, May 1999, pp. 279–286.

[5] L. Clare, G. Pottie, and J. Agre, "Self-organizing distributed sensor networks," in *Proc. SPIE Conf. Unattended Ground Sensor Technologies and Applications*, vol. 3713, Orlando, FL, Apr. 1999, pp. 229–237.

[6] M. Dong, K. Yung, and W. Kaiser, "Low power signal processing architectures for network microsensors," in *Proc. Int. Symp. Low Power Electronics and Design*, Monterey, CA, Aug. 1997, pp. 173–177.

[7] D. Estrin, R. Govindan, J. Heidemann, and S. Kumar, "Next century challenges: Scalable coordination in sensor networks," in *Proc. 5th*

Annual ACM Int. Confe. Mobile Computing Networking (MobiCom), Seattle, WA, Aug. 1999, pp. 263–270.
[8] M. Ettus, "System capacity, latency, and power consumption in multihop- routed SS-CDMA wireless networks," in *Proc. Radio and Wireless Conf. (RAWCON)*, Colorado Springs, CO, Aug. 1998, pp. 55–58.
[9] D. Hall, *Mathematical Techniques in Multisensor Data Fusion*. Boston, MA: Artech House, 1992.
[10] W. Heinzelman, "Application-specific protocol architectures for wireless networks," Ph.D. dissertstion, Mass. Inst. Technol., Cambridge, 2000.
[11] W. Heinzelman, A. Chandrakasan, and H. Balakrishnan, "Energy-efficient routing protocols for wireless microsensor networks," in *Proc.33rd Hawaii Int. Conf. System Sciences (HICSS)*, Maui, HI, Jan. 2000.
[12] L. Hu, "Distributed code assignments for CDMA packet radio networks," *IEEE/ACM Trans. Networking*, vol. 1, pp. 668–677, Dec. 1993.
[13] C. Intanagonwiwat, R. Govindan, and D. Estrin, "Directed diffusion: A scalable and robust communication paradigm for sensor networks," in *Proc. Fourth Annu. ACM Int. Conf. Mobile Computing and Networking (MobiCom)*, Boston, MA, Aug. 2000, pp. 56–67.
[14] T. Kwon and M. Gerla, "Clutering with power control," in *Proc. MILCOM*, vol. 2, Atlantic City, NJ, Nov. 1999.
[15] C. Lin and M. Gerla, "Adaptive clustering for mobile wireless networks," *IEEE J. Select. Areas Commun.*, vol. 15, pp. 1265–1275, Sept.1997.
[16] T. Murata and H. Ishibuchi, "Performance evaluation of genetic algorithms for flowshop scheduling problems," *Proc. 1st IEEE Conf. Evolutionary Computation*, vol. 2, pp. 812–817, June 1994.
[17] UCB/LBNL/VINT Network Simulator – ns (2000). [Online]. Available: http://www.isi.edu/vint/ nsnam/
[18] K. Pahlavan and A. Levesque, *Wireless Information Networks*. New York: Wiley, 1995.
[19] S. Park and M. Srivastava, "Power aware routing in sensor networks using dynamic source routing," *ACM MONET Special Issue on Energy Conserving Protocols in Wireless Networks*, 1999