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Comparison between Hierarchical Based Routing Schemes for Wireless Sensor Network

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Abstract: *A Wireless Sensor Network is a collection of sensor nodes that have some properties like low cost, low power, limited network lifetime etc. These sensor nodes are deployed to the region of interest (Area monitoring, Air pollution monitoring, Forest fire detection, Water quality monitoring etc.) for gathering data. An important issue in wireless sensor networks is developing an energy-efficient routing protocol to increase the network lifetime of the network. Routing protocols can be divided on many basis either it is network structure or protocol operation. On the basis of network structure routing protocols can be further divided into three parts (Flat, Clustering-based, location-aware) In this paper, we simulates the static clustering based routing schemes EEPSC (Energy Efficient Protocol with Static Clusteing) and EEEPSC (Extended Energy Efficient Protocol with Static Clustering). Our experimental results show that EEEPSC increases the network lifetime of a wirless sensor network.*

Keywords: *Clustering methods, energy efficiency, routing protocol, wireless sensor networks.*

I. INTRODUCTION

A Wireless sensor Network is a collection of sensor nodes that are connected by wireless medium. Every sensor node equipped with data processing and communication capabilities. These networks can be used for home security, area monitoring, air pollution monitoring and earthquake warning. A wireless sensor networks have infinite scopes but they are limited to node battery lifetime. The network can be working while the battery power is adequate. In the related literature, there are many routing schemes in wireless sensor network. On the basis of network structure, the routing protocols can be divided into flat-based routing, hierarchical-based routing, location -based routing. In flat routing, every node has same work (sensing and sending the data to the sink). When every node has the same role, the network lifetime is less and this is the drawback of flat routing. In hierarchical routing, nodes have different role, less energy nodes sense the environment and high energy node send the data to the sink, so there is hierarchy maintained between high energy nodes and low energy nodes. In location-based routing, sensor nodes' positions are exploited to route data in the network.

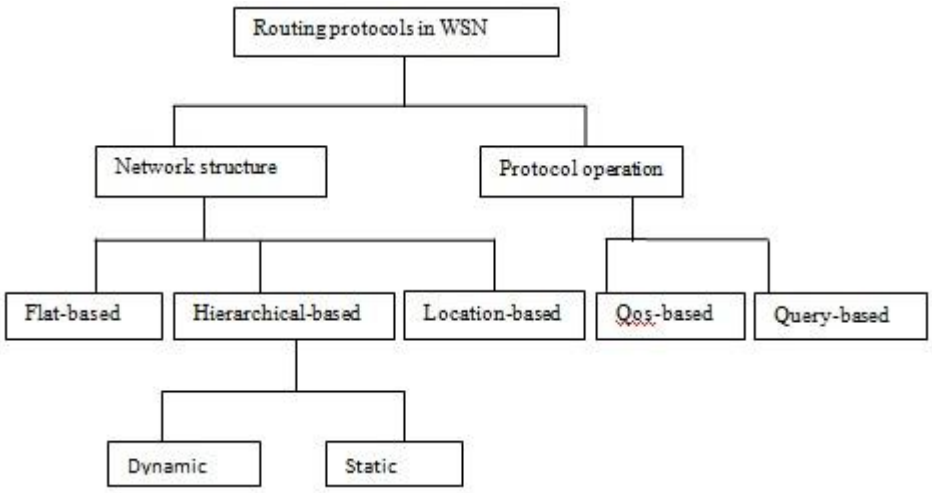

Figure 1: Classification of routing protocols

Hierarchical- based routing: In a hierarchical architecture, higher energy nodes can be used to process and send the information and lower energy nodes used to sense the environment. So there is a hierarchy of low and high energy nodes. The creation of clusters and assigning special tasks to cluster heads can affect the scalability, lifetime, and energy efficiency. Hierarchical routing is two-layer routing where one layer is used to select cluster heads and the other for routing. This can be further divided into two parts dynamic hierarchical based routing scheme and static hierarchical based routing scheme. In dynamic, clusters are formed dynamically whereas in static once the clusters are formed remains same throughout the network lifetime.

In this paper, we focus on the static hierarchical based routing protocols. EEPSC (Energy Efficient Protocol with Static Clustering) and EEEPSC (Extended Energy Efficient Protocol with Static Clustering) are the static hierarchical based routing protocols.

II. RELATED WORK

Energy Efficient Protocol with Static Clustering (EEPSC) is a static clustering based routing algorithm. EEPSC divided the network into static clusters, temporary-cluster-heads are used to distribute the energy load among high energy sensor nodes; thus extends the network lifetime and there is no overhead to select the clusters dynamically [2]. The operation of EEPSC is divided into rounds, where each round contains set-up phase, responsible node selection phase and steady state phase. Setup phase and responsible node selection phase are the cluster formation phase and steady state phase is responsible for sending the data to the base station.

2.1 Setup phase: In this phase, base station broadcasts k-1 different messages with different transmission powers, where k is the desired number of clusters. By broadcasting the k=1 message all the sensor nodes which 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 by transmitting a join-request.

2.2 Responsible node Selection phase: After the clusters are established, network starts its temporary-cluster head and cluster head selection phase begin. In every round, nodes send its energy level to the temporary cluster head in its time slot. Temporary- cluster head choose the sensor node with utmost energy level as cluster head.

2.3 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. 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.

Extended Energy Efficient Protocol with Static Clustering is (EEEPSC) devised to reduce the inter cluster communication cost of EEPSC. it has also the same steps like EEPSC but there is a new term distance(between the cluster heads and the nodes) is calculated and the less distance node with high residual energy is choose as the cluster head.

2.4 Setup phase: In this phase, the base station broadcasts (k-1) messages one-by-one with different transmission powers, where k is the desired number of clusters.

2.5 Responsible Node Selection Phase: In this phase, cluster-heads (CHs) for the current round and the temporary-cluster-heads (TCHs) for the next round are selected in each cluster. At the beginning of every round, nodes in each cluster send 2-tuple data (***Eresiduali j , dmean ij***) to the *TCHi*. Now *TCHi* declares the node with the highest value of (***Eresidual/ dmean***) as cluster head (*CHi*) for the current round. Node with the second highest value of(***Eresidual/dmean***) is selected as *TCHi* for next round. The newly declared *CHi* broadcasts a round-start packet including responsible nodes' id (*CHi* and *TCHi*) towards the nodes of its cluster indicating the beginning of a round [3].

2.6 Steady state phase: In this phase, similar to EEPSC, nodes send their sensed data to corresponding CH during their pre-allocated fixed time slots indicating the fact that the time required for sending a frame depends upon the number of nodes in the cluster.

III. SIMULATION RESULTS

To validate the performance of EEPSC and EEEPSC, we simulate EEPSC and EEEPSC and utilize a network with 100 nodes randomly deployed between (x=0, y=0) and (x=100, y=100) and base station at (50,175). The bandwidth of channel is set to 1 Mb/s, each data message is 500 bytes long, and the packet header for each type of packet is 25 bytes long. The initial power of all nodes is considered to be 2J and duration of each round is 20s. The number of clusters for above assumptions is optimized for $1 < k < 6$. So for the rest of the experiment, we set $k=4$.

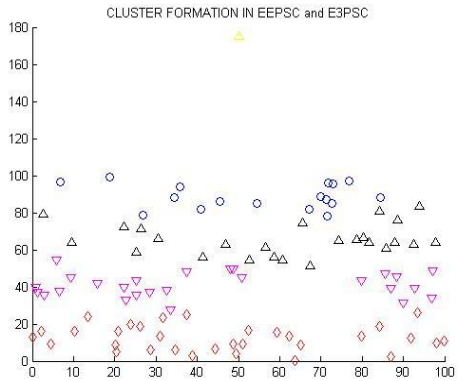

Figure 2: Cluster formation of eepsc and e3psc

This is the cluster formation (setup phase) in both eepsc and e3psc. The base stations send the messages of different transmission powers and the nodes corresponding power send the join request message to the base station.

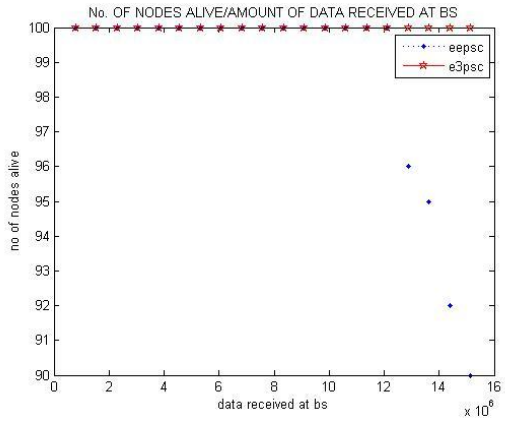

Figure 3: Number of nodes alive after sending the data to BS

The graph shows the number of nodes are alive after sending the data to base station.

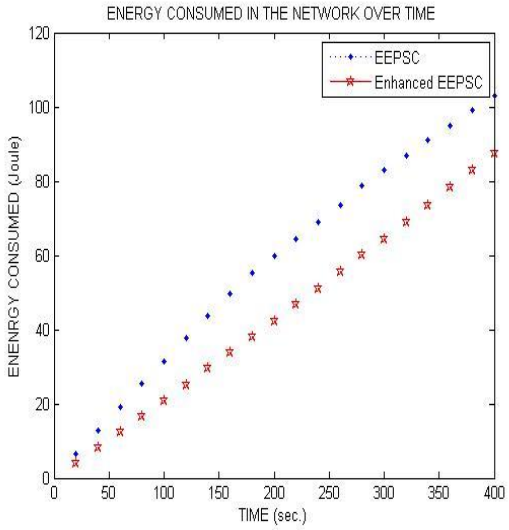

Figure 4: Energy consumption of algorithms (eepsc and e3psc)

The graph shows that the e3psc saves the significant amount of energy. So the e3psc is efficient routing scheme than eepsc.

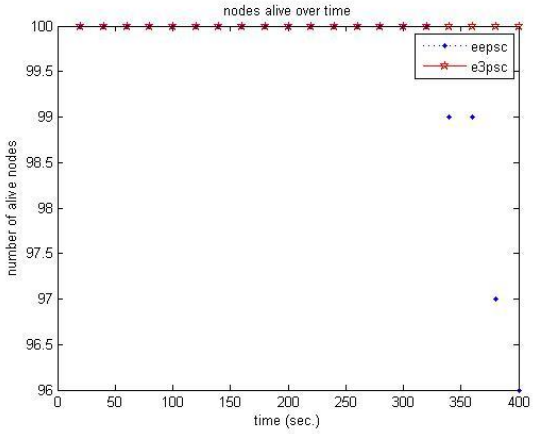

Figure 5: number of nodes alive over time.
The figure shows that the nodes alive are more in EEEPSC than EEPSC.

IV. PARAMETERS AND ENVIRONMENT

To evaluate the performance of both schemes, MATLAB is used as a simulation tool. We consider the sensor nodes are deployed randomly across a plain area. Each node has the equal amount of energy at the beginning of the simulation. Following are the parameters and its values that are used in simulation environment.

TABLE 1: PARAMETERS AND VALUES

Parameter	EEPSC	EEEPSC
Network	100mx100m	100mx100 m
Base station position	50,175	50,175
Number of deployed nodes	100	100
Energy consumed by transceiver circuitry(Eelec)	50 nj/bit	50 nj/bit
Energy consumed by free space model (Efs)	10 pj/bit/m2	10 pj/bit/m2

The performance of the scheme is evaluated considering network lifetime as a parameter which is defined as the time until the last node dies in the network. Network lifetime is measured using two different yard-sticks: Number of nodes alive in the network— more number of nodes alive implies network lifetime lasts longer. Number of messages received at BS—More Number of messages received at BS implies more number of nodes is alive in the network leading to longer network lifetime.

V. CONCLUSION

In this paper the routing schmes (EEPSC, E3PSC) are simulated. The E3PSC is an modifying scheme over EEPSC. It has the advantage, increase the network lifetime and the number of nodes are more in EEEPSC than EEPSC. Our experiment is the comparative study of routing schemes.

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