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Comparison and Performance Analysis of Dynamic and Static Clustering Based Routing Scheme in Wireless Sensor Network

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Abstract- Wireless Sensor Networks have created new opportunities across the spectrum of human efforts including engineering design, forest fire tracking, and battlefield surveillance**.** Wireless Sensor Network is a group of sensor nodes that comprised of sensing, computing, and communication elements that gives an administrator the ability to observe and react to events and phenomena in a specified environment. Basically, sensor network have mainly two types of applications: monitoring and tracking. In monitoring, air pollution monitoring, traffic monitoring etc and in tracking, animal tracking in habitat consisted. When the sensor nodes are deployed to develop a wireless sensor network there must be routing of data to communicate with other nodes and conserve the battery power and increase the network lifetime. On the basis of network structure, Routing protocols are divided into three parts: flat, hierarchical and location aware. Hierarchical clustering based routing scheme can be further divided into parts: Dynamic and static. In Dynamic Clustering based routing scheme the cluster formed dynamically across the network lifetime and in static, once the clucster is formed it remain same throughout network lifetime. In this paper, the performance of Dynamic and static routing scheme is checked on the basis of various node distribution schemes like Random node distribution, Poisson distribution and Uniform distribution.

Keywords: Wireless Sensor Networks, Dynamic and Static Clustering Based Routing Scheme, Network-lifetime, Node distribution.

INTRODUCTION

A Wireless Sensor Networks is a specialized wireless network made up of a large number of sensors and at least one base station. The foremost difference between the WSN and the traditional wireless networks is that sensors are extremely sensitive to energy consumption. Energy saving is the crucial issue in designing the wireless sensor networks [1]. Since the radio transmission and reception consumes a lot of energy, one of the important issues in wireless sensor network is the inherent limited battery power within network sensor nodes. In order to maximize the lifetime of sensor nodes, it is preferable to distribute the energy dissipated throughout the wireless sensor network. So it is essential to design effective and energy aware protocols in order to enhance the network lifetime. A WSN can have network structure based or protocol operation based routing protocol .In this paper, a review on Dynamic and Static Clustering based Routing protocols which are the part of network structure protocol is carried out. Energy consumption and network life time has been considered as the major issues wireless sensor network (WSN) requires an enormous breadth of knowledge from an enormous variety of disciplines, so its study becomes challenging [1]. A wireless sensor network basically consists of small devices called sensor nodes having the capability of sensing the environment around them, computation the task, and performing wireless communications. Sensor networks may also consist of different type of sensors such as seismic, low sampling rate magnetic, thermal, visual, and infrared, radar and acoustic, which monitor a wide variety of ambient conditions that includes [2] habitat monitoring, temperature fluctuation, air pollution control, traffic control. In wireless sensor network, each node is connected to one or more sensors, because it is built of nodes from a few to several hundreds or even thousand **.**That sensor network node having several parts: a radio transceiver with an internal antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery. An important feature in wireless sensor networks is the battery lifetime of the node. Energy efficiency is a main challenge in wireless sensor networks and energy use is dominated by the energy required. In wireless sensor networks the size and cost of the sensor nodes may vary from micro to macro and from one to few hundred dollars respectively. Battery power decides whether the sensor nodes sense for long time or for short time even the battery cannot be recharged or replaced.

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Routing is a process of determining a path between source and destination upon request of data transmission. In WSNs the network layer is mostly used to implement the routing of the incoming data. There are many types of routing protocols on the basis of different parameters. On the basis of network structure the routing protocols are divided into three parts: Flat based, Hierarchical based, Location aware Routing. In Flat routing all the nodes have the same roles i.e. sensing the environment and sending the data to the sink or base station. So it has very low network lifetime and increases the data redundancy. But in Hierarchical routing, the low energy nodes sense the environment and high energy nodes used to send the data to the base station. So there is a hierarchy between low and high energy nodes. Location based routing can be used in networks where sensor nodes are able to determine their position using a variety of localization systems and algorithms. There are many routing challenges like fault tolerance, quality of service, Transmission Media and connectivity issues. But this paper focuses on the routing protocols and their performance.

II. ROUTING PROTOCOLS

In general, Routing in WSNs can be dividing into Flat-based Routing, hierarchical-based routing, and location-based routing depending on the network structure. In flat-based routing, all the nodes are typically assigned equal roles. In hierarchical-based routing nodes have different roles like low energy nodes sense the environment and high energy nodes used to transmit it. The figure(1) depicts the taxonomy of the routing protocols:

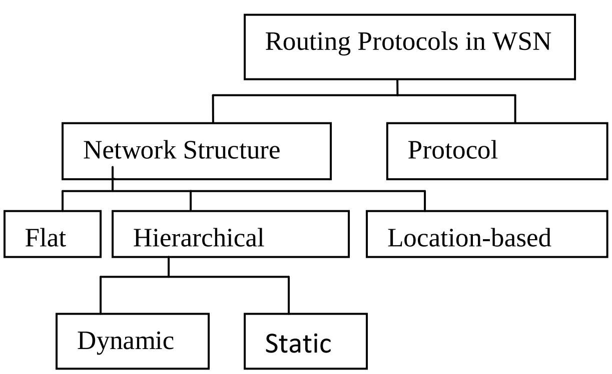

Figure-1 Taxonomy of Routing Protocol

Hierarchical Routing: In hierarchical routing, higher energy nodes can be used to process and send the information, while low-energy nodes can be used to perform the sensing in the targeted area. The creation of cluster can help to achieve scalability, network lifetime, and energy efficiency. Hierarchical routing is two layer routing where one layer is used to select cluster heads and the other for routing. It can be further divided into two parts Dynamic and Static. In Dynamic, cluster are changed with the rounds but in Static, once the clusters are created remain same throughout network lifetime. Following is the explanation of some dynamic and static Hierarchical Routing.

LEACH: It is Dynamic Hierarchical Routing for sensor network, called Low Energy Adaptive Clustering Hierarchy (LEACH). A routing protocol is considered adaptive if certain system parameters can be controlled in order to adapt to current network conditions and available energy levels. LEACH randomly selects a few sensor nodes as cluster heads (CHs) and rotates this role to evenly distribute the energy load among the sensors in the network. In LEACH, the CH nodes compress data arriving from nodes that belong to the respective cluster, and send an aggregated packet to the BS in order to reduce the amount of information that must be transmitted to the BS. LEACH uses a TDMA/code-division multiple access (CDMA) MAC to reduce inter-cluster and intra-cluster collisions. However, data collection is centralized and performed periodically. Therefore, this protocol is most appropriate when there is a need for constant monitoring by the sensor network. A user may not need all the data immediately. Hence, periodic data transmissions are unnecessary, and may drain the limited energy of the sensor nodes. After a given interval of time, randomized rotation of the role of CH is conducted so that uniform energy dissipation in the sensor network is obtained. The operation of LEACH is separated into two phases, the setup phase and the steady state phase. In the setup phase, the clusters are organized and CHs are selected. In the steady state phase, the actual data transfer to the BS takes place. The duration of the steady state phase is longer than the duration of the setup phase in order to minimize overhead. During the setup phase, a predetermined fraction of nodes, *p*, elect themselves as CHs as follows. A sensor node chooses a random number, r , between 0 and 1. If this random number is less than a Threshold value,T(n), the node becomes a CH for the current round. The threshold value is calculated based on an equation that incorporates the desired percentage to become a CH, the current round, and the set of nodes that have not been selected as a CH in the last (1/p) rounds denoted as G. it is given by

$$T(n) = (p/(1-p(mod(1/p)))) \text{ if } n \in G$$

where *G* is the set of nodes that are involved in the CH election. All elected CHs broadcast an advertisement

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message to the rest of the nodes in the network that they are the new CHs. All the non-CH nodes, after receiving this advertisement, decide on the cluster to which they want to belong. This decision is based on the signal strength of the advertisement. The non-CH nodes inform the appropriate CHs that they will be a member of the cluster. After receiving all the messages from the nodes that would like to be included in the cluster and based on the number of nodes in the cluster, the CH node creates a TDMA schedule and assigns each node a time slot when it can transmit. This schedule is broadcast to all the nodes in the cluster. During the steady state phase, the sensor nodes can begin sensing and transmitting data to the CHs. The CH node, after receiving all the data, aggregates it before sending it to the BS. After a certain time, which is determined a priori, the network goes back into the setup phase again and enters another round of selecting new CHs. Each cluster communicates using different CDMA codes to reduce interference from nodes belonging to other clusters.

Limitation: It is not applicable to networks deployed in large regions. It also assumes that nodes always have data\ to send, and nodes located close to each other have correlated data. It is not obvious how the number of predetermined CHs (*p*) is going to be uniformly distributed through the network.

III. SIMULATION RESULTS OF LEACH

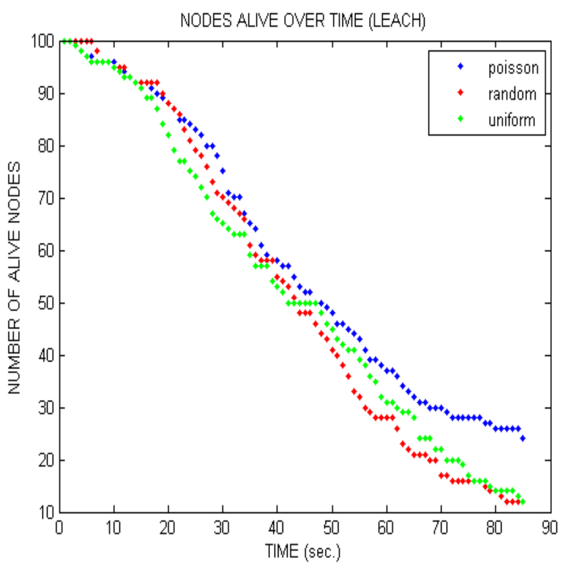

Figure 2: Performance of LEACH on various node deployment strategies

The simulation result shows that the nodes over poisson random distribution are alive for maximum network lifetime. Network lifetime of Nodes deployed on uniform random number distribution has less than network lifetime of nodes deployed on poisson distribution. At last, the nodes deployed on random distribution have least network lifetime because it has minimum number of alive node. The poisson distribution is a discrete probability distribution that expresses the probability of a given number of events occurring in a fixed interval of time and/or space if these events occur with a known average rate and independently of the time since the last event. The poisson distribution can also be used for the number of events in other specified intervals such as distance, area or volume. The uniform random number block generates uniformly distributed random numbers over a specified interval.

IV. ENHANCED ENERGY EFFICIENT PROTOCL WITH STATIC CLUSTERING

Enhanced Energy-Efficient Protocol with Static Clustering (E3PSC) which is basically a modification of an existing routing scheme, Energy-Efficient Protocol with Static Clustering (EEPSC). In EEEPSC, cluster-head selection is performed by taking into account both the spatial distribution of sensors nodes in network and their residual energy with an objective to reduce the intra-cluster communication overhead among the nodes making the scheme more energy-efficient base station computes the mean positions of node-distribution (Pmeani) of every cluster where ***i*** is cluster id which help in reducing the inter-cluster communication.

V. SIMULATION RESULTS OF E3PSC

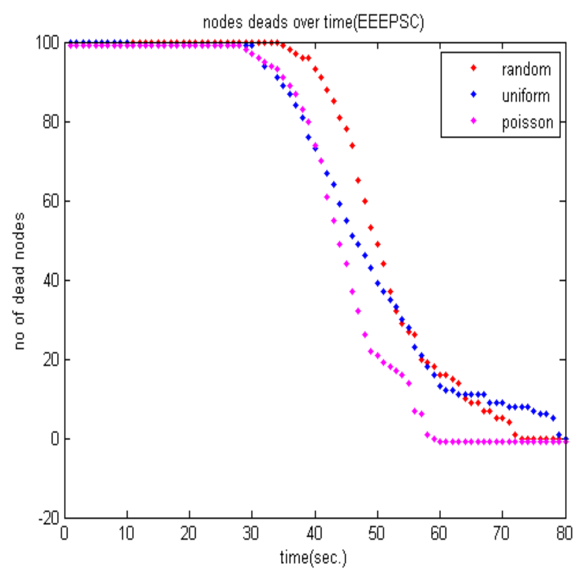

Figure 3: Performance of E3PSC on various node deployment strategies.

The simulation result shows that EEEPSC has good result on Uniform random distribution. As the graph depict, the

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last node under uniform distribution dead on 80 second, and nodes on random distribution are dead on 72 second, and the nodes under poisson distribution dead on 62 second. So the nodes deployed on uniform distribution have the largest network lifetime.

VI. ENERGY EFFICIENT PROTOCOL WITH STATIC CLUSTERING

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. The operation of EEPSC is broken up into rounds, where each round consists set-up phase, responsible node selection phase and steady-state phase.

Setup phase: 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. 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.

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 its 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.

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 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.

Advantage:

- 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.

VII.SIMULATION RESULT

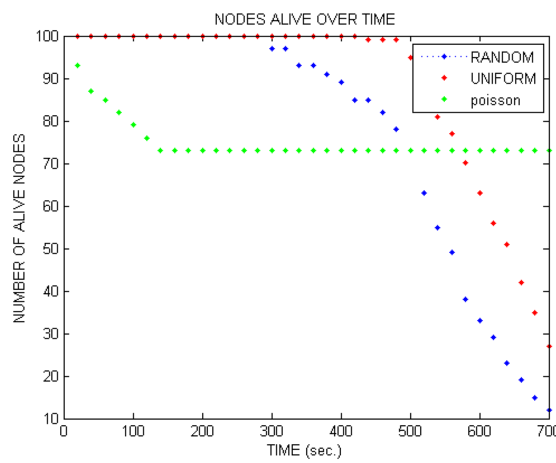

Figure 4: Performance of EEPSC on various node deployment strategies

The simulation result shows the performance or nodes under various node deployment strategies. The nodes under poisson distribution has best network lifetime because 72 nodes are alive after 80 second. The uniform distribution has also good performance as the simulation result shows, 20 nodes alive under uniform distribution. And nodes under random distribution has minimum network lifetime.

VIII. CONCLUSION

Routing in sensor networks is a new area of research, with a limited but rapidly growing set of research results. In this article we present a comprehensive survey of Dynamic and static Clustering based routing techniques in wireless sensor networks that have been presented in the literature. They have the common objective of trying to extend the lifetime of the sensor network while not compromising data delivery.

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Overall, the routing techniques are classified based on the network structure into three categories: flat, hierarchical, and location-based routing protocols. Furthermore, these protocols are classified into multipath-based, query-based, negotiation-based, and QoS-based routing techniques depending on protocol operation. Our simulation result shows that the network lifetime of nodes is depend on the Routing technique as well as on node deployment strategies. Although many of these routing techniques look promising, there are still many challenges that need to be solved in sensor networks. Our paper is the performance comparison of Dynamic Clustering based routing scheme - LEACH and Static Clustering based routing scheme- EEPSC and EEEPSC.

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