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A Novel Chain Based Wireless Data Sensor Network (ECBSN) Technique

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***Abstract*– Wireless Sensor Networks (WSNs) have received tremendous attention in recent years because of the development of sensor devices, as well as wireless communication technologies. WSNs make it easier to monitor and control physical environments from remote locations and present many significant advantages over wired sensor networks for a variety of civilian and military applications .A WSN is usually randomly deployed in inaccessible terrains, disaster areas, or polluted environments, where battery replacement or recharge is difficult or even impossible to be performed. For this reason, network lifetime is of crucial importance to a WSN. To prolong network lifetime, efficient utilization of energy is considered with highest priority. In this paper, we propose a energy efficient chain based network, (ECBSN) which ensures maximum utilization of network energy. Later, a comparison of ECBSN with PEGASIS has been done and found out that energy consumption can be decreased up to 15-20% and reliability of a network can be considerably enhanced using this method.**

***Index Terms*– Computer Network Reliability, Cost, Energy Conservation, Lifetime Estimation and Wireless Sensor Network**

I. INTRODUCTION

A typical WSN contains a large number of sensor nodes, which send collected data via radio transmitter to a sink Figure. 1 shows architecture of communications in a WSN. The decrease in both the size and the cost due to the development of MEMS has led to smart disposable micro sensors, which can be networked through wireless connections to the Internet. Sensor nodes are capable of organizing themselves, and collect information about the phenomenon and route data via neighboring sensors to the sink. The gateway in Fig. 1 could be a fixed or mobile node with an ability of connecting sensor networks to the outer existing communication infrastructure, such as Internet, cellular and satellite networks.

The unique features of the WSNs pose challenging requirements to the design of the underlying algorithms and protocols. Several ongoing research projects in academia as well as in industry aim at designing protocols that satisfy these requirements for sensor networks [4], [5], [6].

Some of the important challenges are presented as:

• *Sensor nodes are limited in energy, computational capacities and memory:* Sensor nodes are small-scale devices with volumes approaching a cubic millimeter in the near future. The batteries with finite energy supply must be optimally used for both processing and communication tasks. The communication task tends to dominate over the processing task in terms of energy consumption. Thus, in order to make optimal use of energy, the amount of communication task should be minimized as much as possible. In practical real-life applications, the wireless sensor nodes are usually deployed in hostile or unreachable terrains, they cannot be easily retrieved for the purpose of replacing or recharging the batteries, therefore the lifetime of the network is usually limited. There must be some kind of compromise between the communication and processing tasks in order to balance the duration of the WSN lifetime and the *energy density* of the storage element.

• *Sensor nodes in the WSN are ad hoc deployed and distributed for processing and sensing:* The sensor nodes must be able to configure themselves to form connections to set up the network to meet the application requirement. In case of any changes in the operating conditions or environmental stress on the sensor nodes that causes them to fail leading to connectivity changes, this requires reconfiguration of the network and re-computation of routing paths.

Another point to take note is that using a WSN, many more data can be collected as compared to just one sensor. Even deploying a sensor with great line of sight, it could still have obstructions. Thus, distributed sensing provides robustness to environmental obstacles. Hence, multi hop communication in WSNs is expected to consume less power than the traditional single hop broadcast communication because the transmission power levels can be kept low. Additionally, multi hop communication can also effectively overcome some of the signal propagation effects experienced in long-distance wireless communication.

• *Network and communication topology of a WSN changes frequently:* When the sensor nodes are deployed, the position of sensor nodes is not predetermined. This means that the sensor nodes must be able to configure themselves after deployment. They must possess some means to identify their location either globally or with respect to some locally determined position. Once the network is set up, it is required that the WSN be adaptable to the changing connectivity (for e.g., due to addition of more nodes, failure of nodes, etc.) as well as the changing environmental conditions. Here, we propose a parallel chain formation method that aims to provide

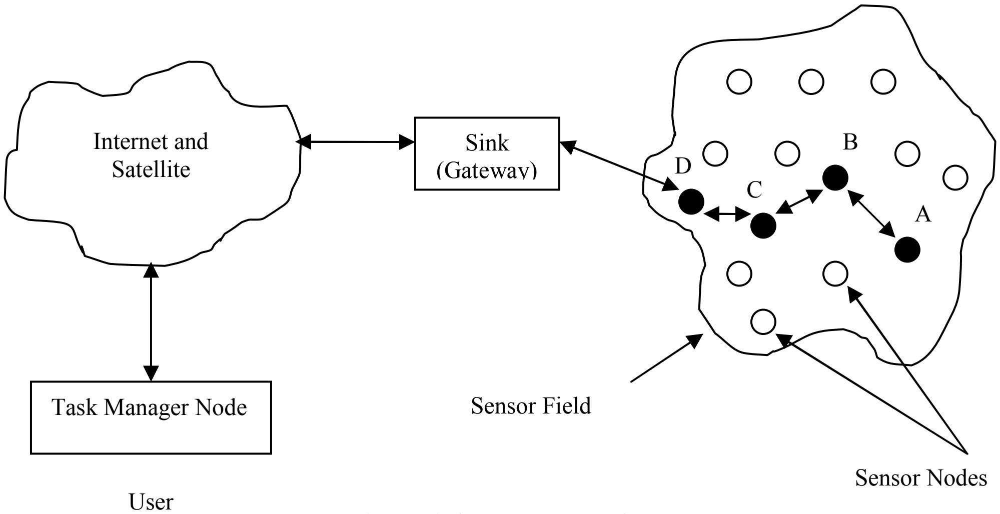

Fig. 1. Wireless Sensor Network

efficient, more stable and long lasting paths from source to destination. This method forms one higher level chain and number of lower level chains. In this a MAC layer concept for energy conservation has been used .Nodes form chains based on certain criteria and all nodes in the lower level chain send data to lower level leader and all lower level leader than send information to higher level leader .The higher level leader is the node that transmit the information to the base station. Due to multiple chain structure, these protocols require less time and energy as compared to other chain based protocols.

II. RELATED WORK

A number of routing protocols have been proposed which try to maximize the lifetime of sensor network of constrained resources. We review some of the most relevant designs [7]-[9]. In LEACH [7], sensor nodes are organized into clusters with one node in each cluster working as cluster-head. The cluster-head receives data from all other sensors in the cluster, aggregates the data, and then transmits the aggregated data to the BS. LEACH rotates the cluster-head in order to evenly distribute the energy consumption. The operation of LEACH is organized into rounds. Each round begins with a set-up phase followed by a steady-state phase. During the set-up phase, each node decides whether it becomes a cluster-head or not according to a predefined criterion. After that, the rest sensor nodes decide the cluster-head they will belong to for that round.

PEACH [8] an improved LEACH work by selecting a proxy node which can assume the role of the current cluster-head of weak power during one round of communication. It is based on the consensus of healthy nodes for the detection and manipulation of failure of any cluster-head. It allows considerable improvement in the network lifetime by reducing the overhead of re-clustering.

PEGASIS [9] forms a chain covering all nodes in the network using a greedy algorithm so that each node communicates with only the neighboring nodes. In each round of communication, a randomly selected node in the chain takes turn to transmit the aggregated information to the BS to save the energy. Also, the elimination of cluster set-up phase allows considerable energy saving. However, the communication delay can be large due to long single chain. When the network size is relatively large, the delay might be intolerable. Also, as the nodes in the chain cannot be relocated, the inter-node distance gets larger as the network size grows, which causes increased energy consumption.

Considerable amount of research has been done on chain based protocols and numbers of schemes have been devised. Like [10] diamond shaped pegasis is proposed which increase reliability of data packets for securing data transmission .In [11] concentric clustering scheme which consider the location of the base station to enhance its performance and to prolong the life time of the network. In this clusters are formed by dividing the sensor field in the form of concentric circles, considering base station outside the wireless sensor network.

CRBCC [12] gives a good compromise between energy consumption and delay. Chains are formed based on simulated annealing (SA) algorithm. Clusters are formed based on y co-ordinate and chain leaders are formed on x co-ordinates.

A new routing and data gathering approach [13] in which clusters are formed and cluster head is selected using LEACH approach and then in clusters, chains are formed using shortest path first. Clusters and chain construction occurs only once and the cluster head rotates locally inside the clusters without re clustering.

III. RADIO MODEL

In our proposal we consider the following network model assumptions:

- The BS is located far from the sensor network and fixed.
- All nodes are homogeneous and energy constrained.
- Data is collected periodically from the network.
- Radio channel is symmetric so that the energy required to transmit a message from node *i* to node ***j*** is the same as energy required to transmit a message from node ***j*** to node i for a given signal to noise ratio.

For the sake of uniformity ECBSN uses the same radio model as used in LEACH and PEGASIS. The energy consumed in transmitter amplifier for transmission is $\in amp$ =100pJ/bit/m2 for a decent signal to noise ratio (SNR). In addition energies required in running transmitter and receiver electronics are equal and given by $Eelec = ETX - elec = ERX - elec$ =50nJ/bit. Thus for free space model, the total transmission cost for a k-bit message to transmit to a distance d is given by the Eq. 1.

$$E_{TX}(k,d) = E_{TX-elec}(k) + E_{TX-amp}(k,d)$$
$$E_{TX}(k,d) = Eelec * k + \in amp * k * d^2 \quad (1)$$

The energy consumption in the receiver is given by Eq. 2.

$$E_{RX}(k) = E_{RX-elec}(k)$$
$$E_{RX}(k) = Eelec * k \quad (2)$$

Moreover, the energy cost for data aggregation is considered as 5nJ/bit/message. The radio speed is considered as 1Mbps. It is further assumed that information processing time in a node is 5 – 10 milliseconds [9].

IV. PROPOSED PLAN

The protocol operates in two phases: Chain construction phase and data transmission phase. In chain formation phase chains of different levels are formed and in data transmission phase information is transmitted along with the designated paths.

We assume that a position from a base station to every node is known, based on the received radio signal strength. A node selection procedure (discussed below) is executed to find all the active nodes that take part in the chain formation process.

- *Node selection procedure*

A source node S broadcast a route request message at a distance of one hop (TTL=1) containing threshold energy value th.

At neighbor node n

If En>Eth, an Active Reply is generated containing route length.

Else if En < Eth

No reply is sent

Where, En is the energy level of the node, Eth is a pre-defined threshold,

At the source node S

All received REPLY messages are scanned. The neighbor with shortest active route is selected for forwarding the data.

Table 1: Chain Table

CID	Chain Number	SID

Table 2: Node Table

Source Address	Threshold (energy)	TTL	Destination Address	CID	Energy

- *Chain formation procedure:*

For a N Node network , if each chain contain M nodes .The number of chains formed are N/M.A node in a chain selects the nearest node that has not been yet selected based on the criteria discussed above. This way chain formation continues until all the active nodes are grouped into chains. After fixing the chain the next target is to find out the leader node in a chain. This protocol will choose leader based on the remaining energy levels. Once the leaders are selected, a higher level leader node is selected among the leader nodes whose distance from the base station is minimum. It is the responsibility of the higher level node to pass aggregated data onto the base station as shown in Fig. 3, after receiving these data; the neighbor node aggregates them with their own data and transmits these data to its neighbor node. Since in this, we have selected only those nodes that have their energy level greater than threshold. The chain formation process will take place again only, when 20% of the nodes die away. As the result the leader formation will also be delayed. The benefits of using a slight larger duration between leader selections rather than selecting leaders in every round are: 1) less communication overhead, 2) reduction in time in selection of leaders.

In this we have considered two table Node table and chain table as shown in Table 1 and Table 2. A node table will keep account of all the current nodes status in terms of its unique ID, current energy level, time to live and destination node address. A chain table will keep account of the number of chains formed, CID and its source ID.

- *Data transmission phase:*

After the formation of the chain and selection of leader, the data transmission phase starts. We assume that sensors always have data to send to the base station so data is aggregated at each level before transmission .The same token passing mechanism will be followed as in PEGASIS. In figure 2, node c2 is the leader, and it will pass the token along the chain to node co. Node co will pass its data towards node c2. After node c2 receives data from node cl, it will pass the token to node c4, and node c4 will pass its data towards node c2.

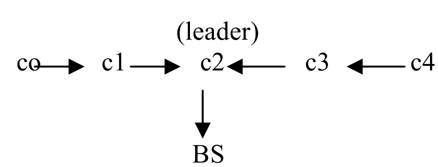

Fig. 2. Data transmission phase

V. IMPLEMENTATION

In simulation, we have considered a random network of 100 nodes placed in an area of 100 meters X 100 meters. Initially all the nodes have same amount of initial energy. A node will act as a base station considering two criteria of distance and energy. A simulation is performed on mat lab 7.0 considering first radio model .To evaluate the performance of the proposed scheme, we have compared ECBSN with the PEGASIS .Only

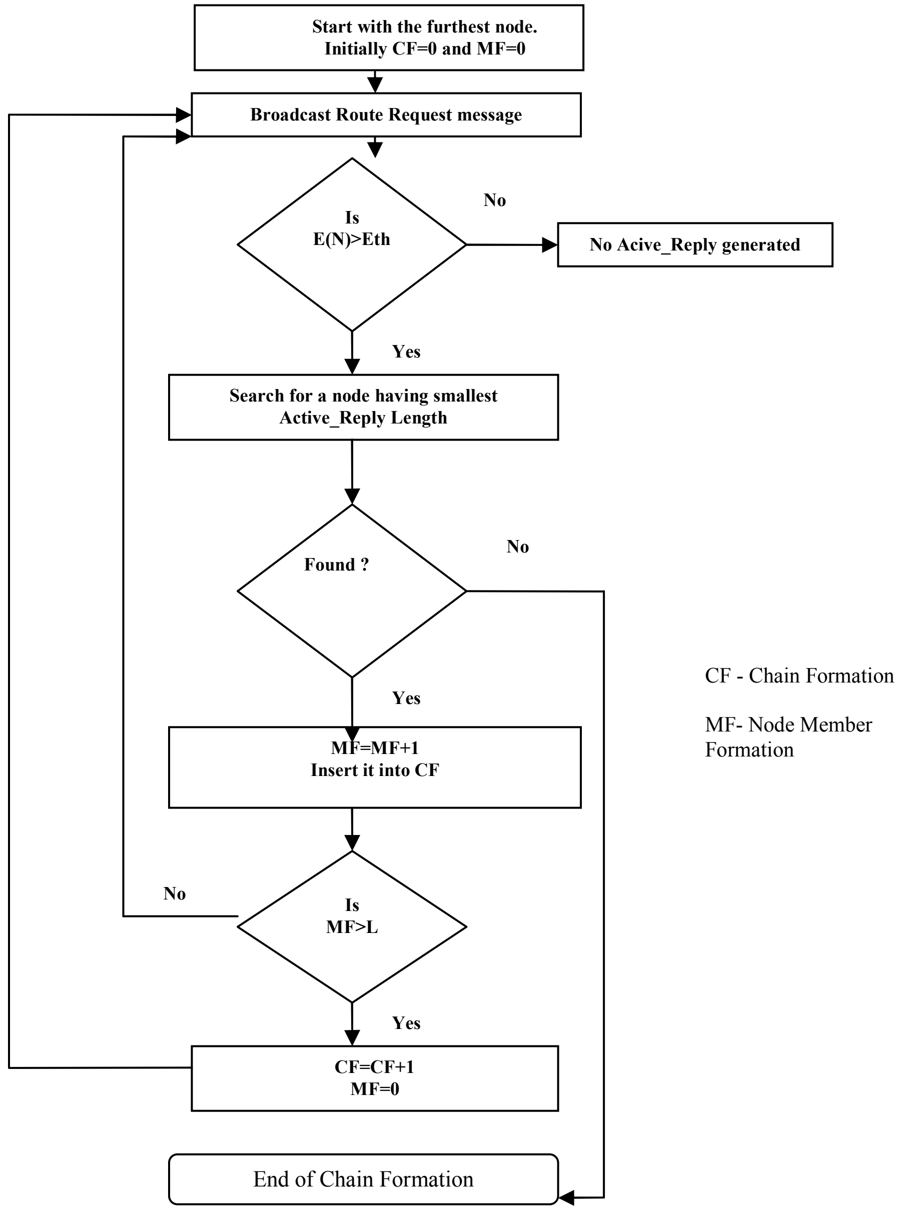

Figure 3: Chain formation Algorithm

two parameters are considered: 1) total energy consumed and 2) number of alive nodes. We have found out that in subsequent rounds the number of alive nodes is more in case of ECBSN then in PEGASIS. Also, the energy consumption of ECBSN is less as compare to PEGASIS As shown in Fig. 5, Long chain formation occurs in PEGASIS, which incurs delay. Fig. 4 results in lesser delay and energy consumption as short chain forms in parallel. Also, the comparative result can prove this fact that proposed technique results in lesser consumption and increases reliability.

VI. CONCLUSION

In this paper we have proposed a protocol for information collection based on some energy level criteria. The parallel formation of chains with length L (L=N/M) reduce latency. To consider only those nodes who have certain energy levels and among them the selection of leader nodes, help further as an improvement over chain based protocols like PEGASIS .This process even reduces energy consumption as selection of leaders only take place after optimal number of rounds when 20% of nodes die away ..Considering all these factors, the protocol shows a remarkable improvement over existing protocols. In future work we can further extend this to multiple layer hierarchical chain based protocol. This can be enhanced further by including issues of MAC layer like active/sleep cycle.

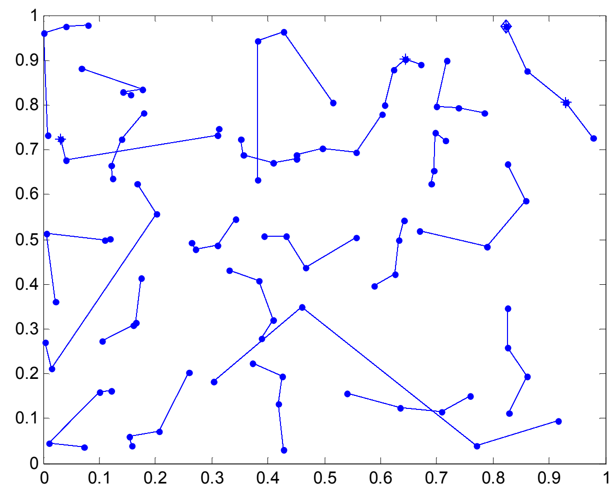

Fig. 4. ECBSN chain formations

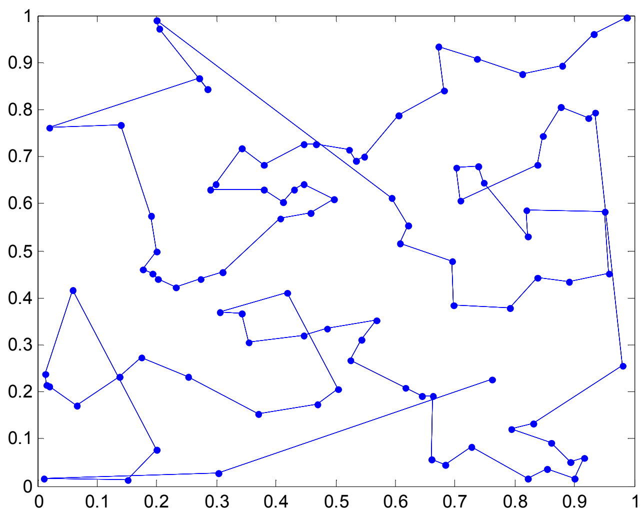

Fig. 5. PEGASIS chain formation

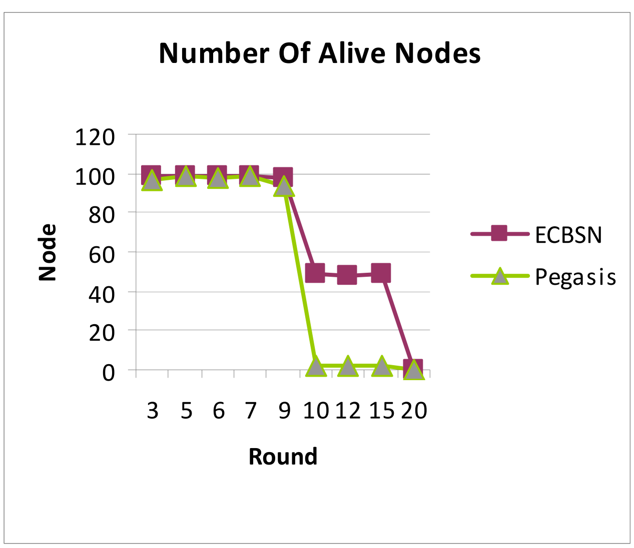

Fig. 6. Number of alive nodes

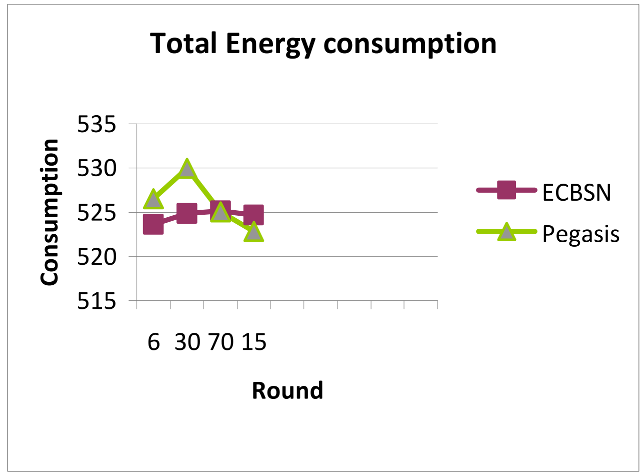

Fig. 7. Total energy consumption

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