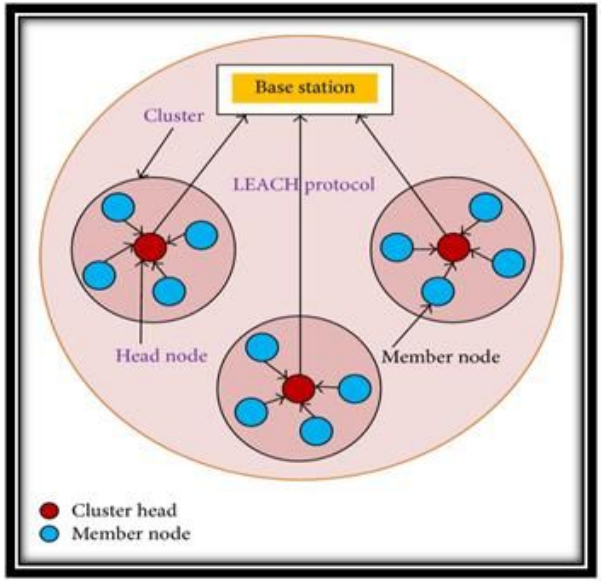
PEGASIS : Power Efficient Gathering in Sensor Information Systems

- PEGASIS aims to address the overhead caused by the cluster formation in L.E.A.C.H by constructing chains of nodes instead of clusters.
- The chain construction is performed according to a greedy algorithm, where nodes select their closest neighbors as next hops in the chain. It is assumed that the nodes have a global knowledge of the network and the chain construction starts from the nodes that are farthest from the sink.
- As a result of chain operation, instead of maintaining cluster formation and membership, each node only keeps track of its previous and next neighbor in the chain



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Ref: Comparative Study of PEGASIS Protocols in Wireless Sensor Network Hetal Rana M.E.I.T(pursuing) Thakur College Of Engineering And Technology University of Mumbai

PEGASIS IN DETAIL

The main idea in PEGASIS protocol is for node to receive from and transmit to close neighbors and take turns for being the leader for transmission of data to BS. This approach distributes the energy load evenly among the sensor nodes. The nodes randomly placed in the field, organize themselves in the form of chain using greedy algorithm. Alternatively, BS computes this chain and broadcasts it to all the nodes.

Fig 5: shows node 0 and node 1 connecting to node 3, node 3 connecting to node 1 and node 1 connecting to node 2. When a node dies, the chain is constructed in the same manner to bypass the dead node.

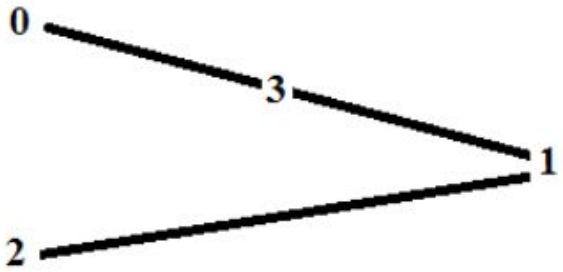

Fig 5: Chain formation

For data gathering, each node receives the data from one neighbor, fuses its own data and transmits it to the next node in the chain. In a given round, a simple token passing approach is initiated by the leader to start the data transmission from the ends of the chain. Here the cost is very less because the size of the token is very small.

The fig 6: shows node C2 as the leader. It passes the token to C0. C0 sends its data to C1. C1 fuses its own data with C0's data and sends it to leader C2. C2 then transmits the token to C4. C4 sends its data to C3. C3 fuses its data with C4's data and then transmits it to leader C2.

C2 waits to receive data from both the neighbors and then it fuses its data to neighbor's data. The leader then transmits only one message to the BS.

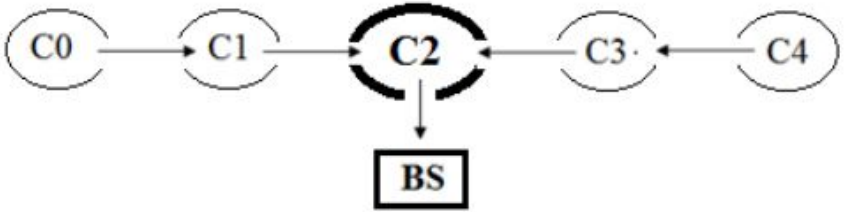

Fig 6: Token Passing

Thus in PEGASIS, each node receives and transmits one packet in each round and be the leader at least once in n rounds (n are no of nodes).

PEGASIS improves on LEACH by saving energy at following stages.

First, in the local gathering, the distance that most of the nodes transmits is much less as compares to CH in LEACH. Second, the leader receives at most only two messages from the neighbors which is not in the case of LEACH (in the network of 100 nodes, it receives 20 messages if there are 20 nodes per cluster). Finally, one node transmits the message to the BS in each round of communication.

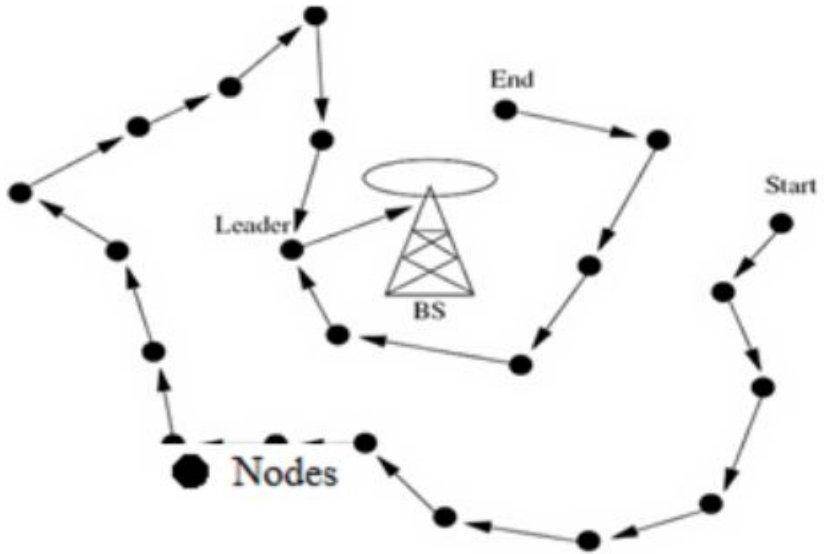

Fig 7: Illustration of PEGASIS Protocol

- **EXAMPLE 7.3**
- An example of chain communication is shown in Figure 7.9.
- The chain leader in this example is node 2. Node 2 first passes the token to node 0 to initiate communication.
- Node 0 transmits its data to node 1, which aggregates these data with its own to create a packet of the same length.
- This packet is transmitted to node 2. Once node 2 receives the packet from node 1, it passes the token to the other end of the chain, i.e., node 6. Information from nodes 6, 5, 4, and 3 is also aggregated and sent to node 2 in the same fashion.
- Upon receiving the aggregated information in the chain, node 2 uses a single hop communication to transmit the data to the sink.

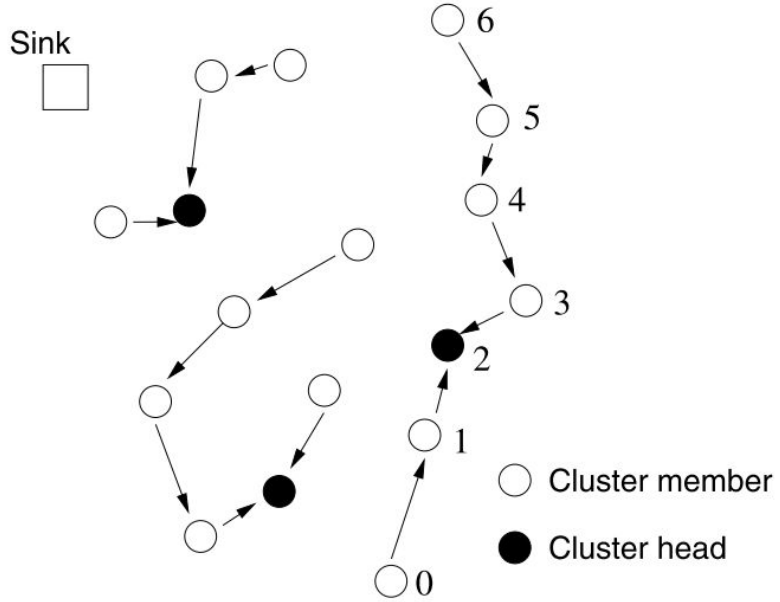

Figure 7.9 Chain structure of PEGASIS.

PERFORMANCE

- PEGASIS provides performance enhancement of 100–300% over LEACH in energy consumption.
- This improvement is due to the limited overhead in chain communication compared to cluster formation.
- However, PEGASIS results in significant delays since the data have to be sequentially transmitted in the chain and the chain leader waits until all the messages are received before communicating with the sink.
- Moreover, PEGASIS requires all the information in the chain to be aggregated into a single packet, which may cause inaccuracy in the information sent to the sink.
- Dragonfly Algorithm for Enhancing PEGASIS Protocols in Wireless Sensor Networks
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Types of PEGASIS protocols

Energy Efficient PEGASIS Based (EEPB)is an enhanced PEGASIS algorithm [7] in WSN. As in PEGASIS greedy algorithm is used to form the data chain, it can result in communication distance between two sensors being too long. Thus the sensors consume more energy in transmitting the data and die early. In the chaining process, a node will consider the average distance of which the chain is formed. This distance is known as thresh distance. If the distance from the closest node to the upstream node is longer than thresh distance, the closest node is the "far node". If the closest node joins the chain, it will become "long chain". EB-PEGASIS avoids this phenomena using distance threshold. It not only saves energy on threshold, but also balances the energy consumption of all sensor nodes.

The**PEGASIS-ANT**[8] protocol uses ANT colony algorithm rather than greedy algorithm to construct the data chain. This helps to achieve global optimization. It forms the chain that makes the path more even-distributed and reduces the transmission distance. It also balances the energy consumption between the nodes. In each round of transmission, on the basis of current energy of each node the leader is selected that directly communicates with the BS. This algorithm has prolonged network lifetime.

H-PEGASIS [3] is an extended version of PEGASIS protocol.It was introduced with the objective of decreasing the delay of transmission packets to the BS. It proposes a solution to data gathering problems by considering energy X delay metrics. In order to reduce delay, simultaneous data messages are transmitted. To avoid collisions, signal coding is implemented e.g CDMA to avoid signal interference, only spatially separated nodes are allowed transmit data at the same time. With CDMA capable nodes, the chain forms the tree like hierarchy and each selected node transmit the data to the node of upper hierarchy. This ensures parallel data transmission and reduces the delay significantly.

PEGASIS with double Cluster Head(PDCH)[9] balances load of every node and increase network lifetime. Generally PEGASIS protocol uses one CH that communicates with the BS. Here instead of one double CH are used in a single chain and is given a hierarchical structure so that long chaining is avoided. PDCH outperforms PEGASIS by eliminating dynamic cluster formation, reducing the distance between nodes, reducing the number of messages sent to and from other nodes and using only one transmission to BS per round. As the energy load is distributed among the nodes, the network lifetime increases and so does the quality of network.

Improved Energy Efficient PEGASIS Based (IEEPB)[10] protocol, overcomes the deficiencies of EEPB. When EEPB builds a chain, the threshold adopted is uncertain and complex to determine. This results in the formation of "long chain". Also, when EEPB selects the leader, it ignores the node energy and the distance between the BS and node that optimizes the selection of leader. Based on this, IEEPB compares the distance between two nodes twice and finds the shortest path to link two adjacent nodes. The chain construction is simplified such that formation of "long chain" is avoided. Also while selecting the leader, IEEPB considers the node's energy, distance between the BS and the node, normalizes these twofactors and assigns different weight co-efficient to them. Finally the node with the minimum weight becomes the leader.IEEPB has higher energy efficiency and hence longer network lifetime.

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