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Coimbatore-35

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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

19ECE402- WIRELESS ADHOC AND SENSOR NETWORKS

IV ECE / VII SEMESTER

UNIT 4 WIRELESS SENSOR NETWORKS

Topic 2- Wireless Sensor Network Architecture

Sensor Network Architecture

- The two basic kinds of sensor network architecture

    – Layered Architecture

    – Clustered Architecture
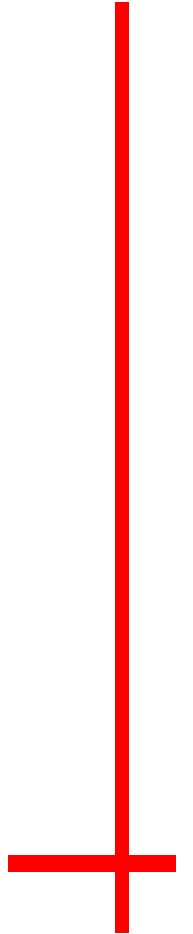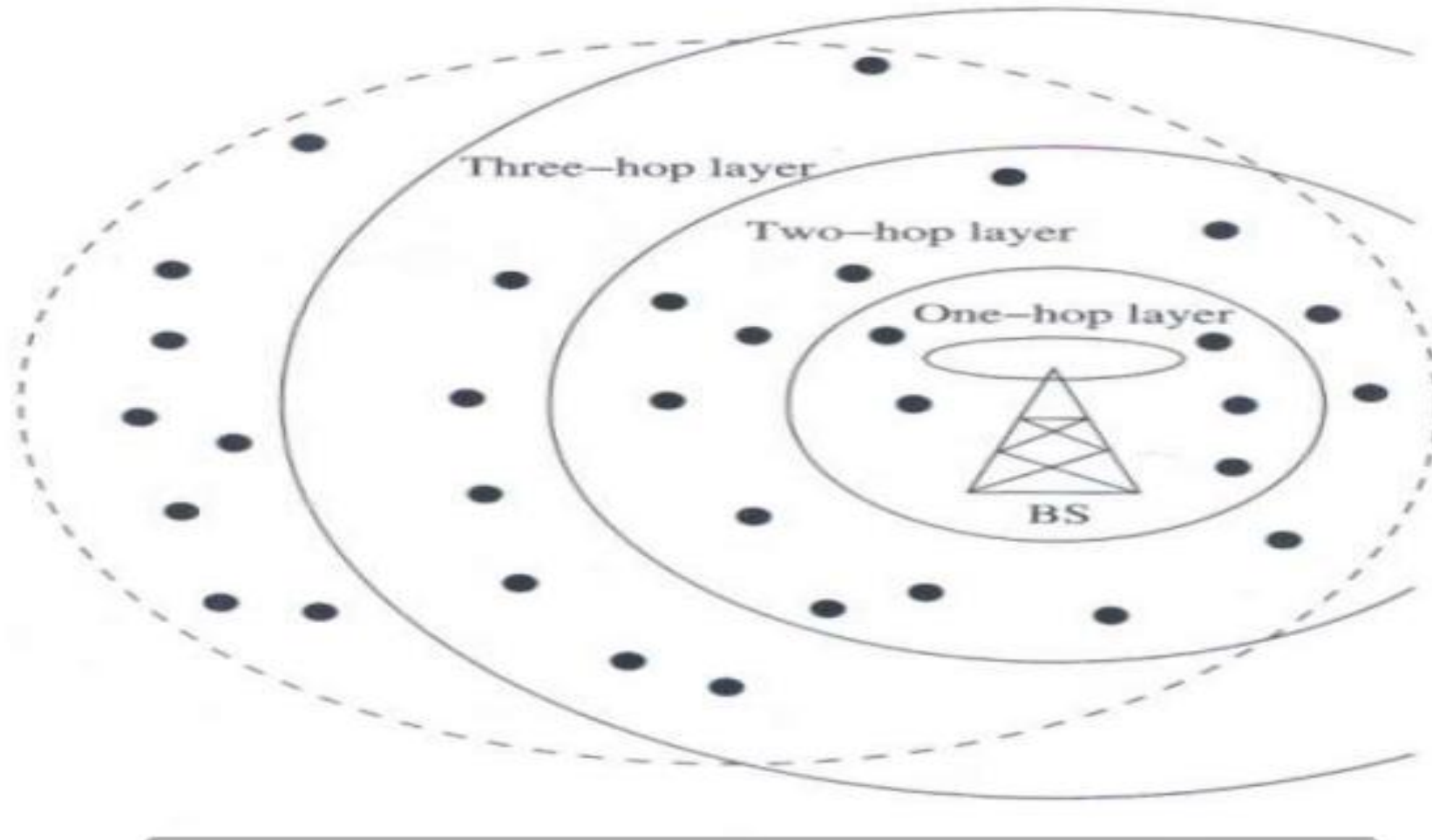
2.1.Layered Architecture

- A layered architecture has a single powerful base station, and the layers of sensor nodes around it correspond to the nodes that have the same hop-count to the BS.

- In the in-building scenario, the BS acts an access point to a wired network, and small nodes form a wireless backbone to provide wireless connectivity.

- The advantage of a layered architecture is that each node is involved only in short-distance, low-power transmissions to nodes of the neighboring layers.

2.1.Layered Architecture

Figure : Layered architecture

Unified Network Protocol Framework (UNPF)

- UNPF is a set of protocols for complete implementation of a layered architecture for sensor networks

- UNPF integrates three operations in its protocol structure:
    - Network initialization and maintenance
    - MAC protocol
    - Routing protocol

Network initialization and maintenance

- The BS broadcasts its ID using a known CDMA code on the common control channel.

- All node which hear this broadcast then record the BS ID. They send a beacon signal with their own IDs at their low default power levels.

- Those nodes which the BS can hear form layer one

- BS broadcasts a control packet with all layer one node IDs. All nodes send a beacon signal again.

- The layer one nodes record the IDs which they hear (form layer two) and inform the BS of the layer two nodes IDs.

- Periodic beaconing updates neighbor information and change the layer structure if nodes die out or move out of range.

MAC protocol

- During the data transmission phase, the distributed TDMA receiver oriented channel (DTROC) assignment MAC protocol is used.

- Two steps of DTROC :

  - Channel allocation : Each node is assigned a reception channel by the BS, and channel reuse is such that collisions are avoided.

  - Channel scheduling : The node schedules transmission slots for all its neighbors and broadcasts the schedule. This enables collision-free transmission and saves energy, as nodes can turn off when they are not involved on a send/receive operation.

Routing protocol

- Downlink from the BS is by direct broadcast on the control channel. Uplink from the sensor nodes to BS is by multi-hop data forwarding.

- The node to which a packet is to be forwarded is selected considering the remaining energy of the nodes. This achieves a higher network lifetime.

Clustered Architecture

- A clustered architecture organizes the sensor nodes into clusters, each governed by a cluster-head. The nodes in each cluster are involved in message exchanges with their cluster-heads, and these heads send message to a BS.

- Clustered architecture is useful for sensor networks because of its

inherent suitability for data fusion. The data gathered by all member of the cluster can be fused at the cluster-head, and only the resulting information needs to be communicated to the BS.

- The cluster formation and election of cluster-heads must be an

autonomous, distributed process.

Clustered architecture
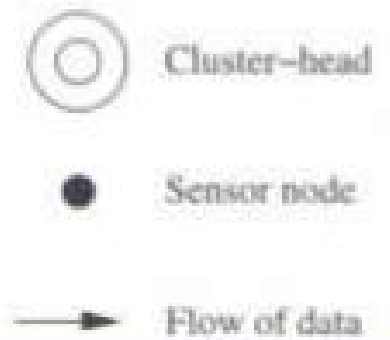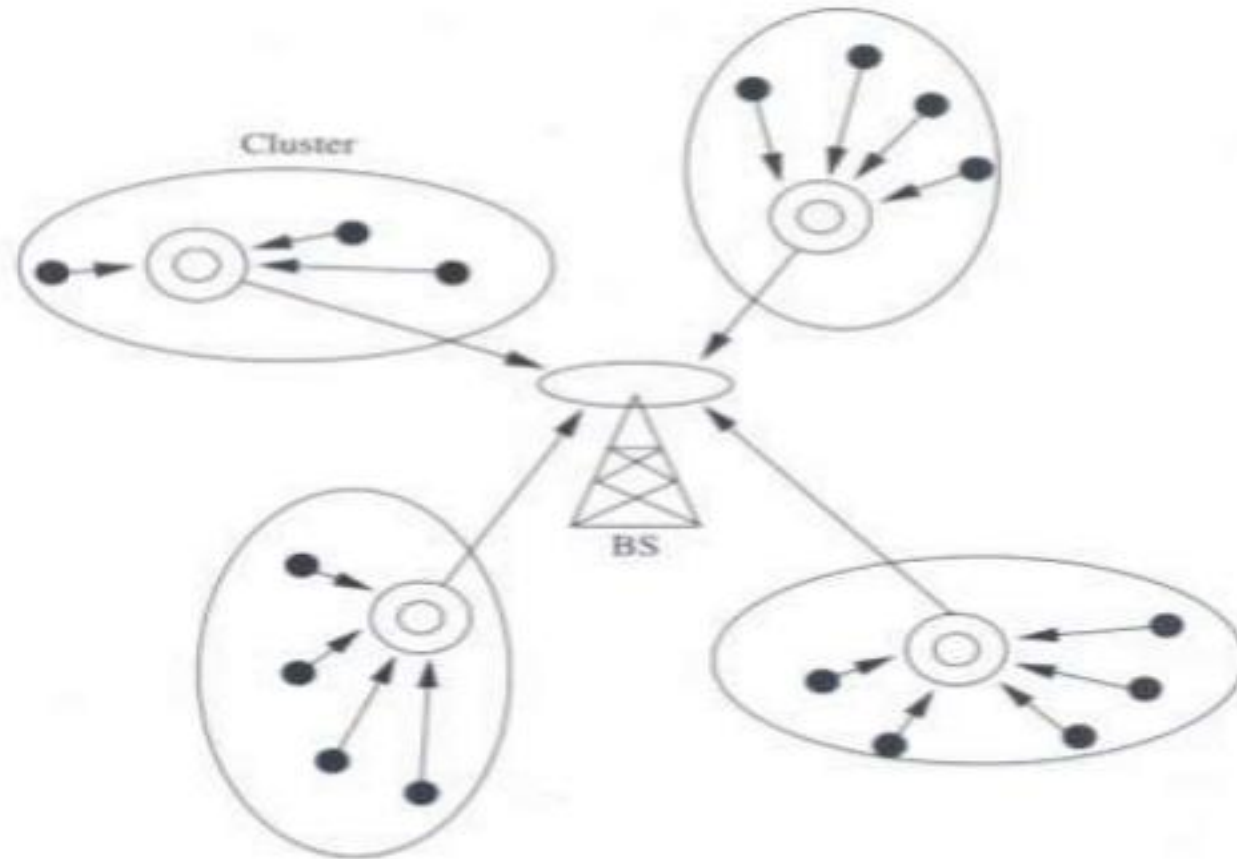
LEACH is a clustering-based protocol that minimizes energy dissipation in sensor networks. The operation of LEACH is spilt into two phases : setup and steady.

- Setup phase : each sensor node chooses a random number between 0 and 1. If this is lower than the threshold for node n, T(n), the sensor node becomes a cluster-head. The threshold T(n) is calculated as

$$T(n) = \begin{cases} \frac{P}{1-P[r \times mod(1/P)]} & \text{if } n \in G \\ 0 & \text{otherwise} \end{cases}$$

- P : t
- r : the current round
- G : the set of nodes that has not been cluster-heads in the past 1/P rounds

After selection, the cluster-heads advertise their selection to all nodes. All nodes choose their nearest cluster-head by signal strength (RSSI). The cluster-heads then assign a TDMA schedule for their cluster members.

– Steady phase : data transmission takes place based on the TDMA schedule, and the cluster-heads perform data aggregation/fusion.

After a certain period of time in the steady phase, cluster-heads are selected again through the setup phase.

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