14.1 What are the similarities and differences between ad hoc networks and sensor networks? Explain clearly

Answer:

Ad hoc networks have characteristics of band width-constrained, and energy-constrained operation. Wireless sensor networks also have such characteristics. While ad hoc networks have dynamic topologies, nodes are free to move, the mobility of nodes in a sensor network is very limited. Wireless sensor networks are 'data centric', unlike traditional networks where data is requested from a specific node. A wireless sensor network is a collection of tiny disposable and low power devices. The routing protocols proposed for all the traditional networks are point-to point and so these protocols are not well suited for wireless sensor networks.

14.3 In a sensor network, the energy consumed by different functions by a sensor is as follows:

Mode	Energy Consumed (in nJ/bit)
Sleeping mode	0
Sensing or idle mode	0.5
Aggregation	5
Communication to cluster head	100
Cluster head to BS	1000

Assume the total number of nodes as *P*, the number of cluster heads to be *m*, the number of sensor nodes which send their data to different cluster heads as *n*, and the frame size to be *B* bits.

(a) Find the power consumption, during a frame time period if sensing and communication is done during every frame, assuming the other half of the nodes are sleeping at that time.

(b) Find the power consumption in the idle frame when sensing and communication to the CH is done in every alternate frame. Remember that power is consumed even in the sleeping mode of the cycles, when sensing is not carried out.

(c) Find the total power consumption in different frames if sensing is done every other cycle, while transmission to CH is done every fourth frame.

(d) Repeat part (b) if there are 10 clusters, with each cluster consisting of 8 sensor nodes and aggregation done by CH every 8 frames while CH to base station communication takes place every 16 frames.

Answer:

In a sensor network, the energy consumed by different functions by a sensor, is as follows:

-Sleeping mode is 0:

-Sensing mode is 0:5:

-Aggregation is 5:

-Communication to cluster head is 100:

-Cluster head to BS is 1000:

-Energy consumed is in nJ/bit.

Assume total number of nodes is P.

Assume number of non-cluster nodes is N.

Assume number of cluster heads is M.

Assume size of frame in bits is B.

(a) Sensing and communication is done during every frame, assuming other half nodes are sleeping at that time. Assuming that half of both cluster and non-cluster nodes are active at any time. Therefore, the power consumption during a frame time period is

0:5 *(N +M) * 0:5 + 5 * 0.5 *M + (0.5 * N *100 + 1000 *M) *B

= 0.25 *N + 2.75 *M + 50 * N * B + 1000 *M * B:

(b) Sensing and communication to CH is done in every alternate frame.

Remember that power is consumed even in sleeping mode of the

cycles, when sensing is not carried out. Therefore, the power consumption in the idle frame is 5 *(N +M).

(c) There are 4 types of frames

- Idle frames: 5 *(N +M) or 500 nJ
- Sensing frames: 0.5 *(N +M) or 50 nJ (When the sensing and transmission do not coincide)
- Transmission frames: 100 * N * B (When the sensing and transmission do not coincide)
- Sensing and transmission frames: 0.5*(N +M)+100*(N +M) (When the sensing and transmission do coincide)

(d) There are 4 kinds of sensing frames

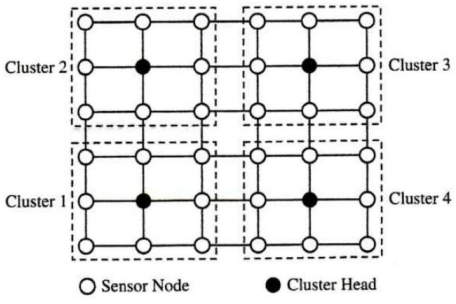
- Sensing frames: 0.5 * (N +M) or 40 nJ (When the sensing, aggregation and transmission do not happen)
- Sensing frames with aggregation: 0.5 *M + 5 *M = 5.5 *M or 27.5 nJ (Only the cluster heads before sending to BS)
- Sensing frames with communication to BS:
  0.5 *M + 1000 *M or 5002:5 nJ
- Sensing frames with aggregation and communication to BS:
  0.5*M + 1000*M + 50*B or 10005 nJ +50* B nJ.

14.8 Using the energy consumption by different functions in a sensor of Problem P14.2 , determine the energy consumption in the following topologies:

(a) How much energy is consumed for transmission to the CH?

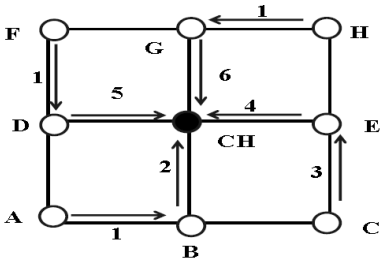
(b) How much energy is consumed to send data to the BS?

(c) What is a good location of the BS? Justify your answer.



Answer:

Each cluster has 8-sensors with each CH. All these 8-sensors need to send data to the CH located at the center as shown in the Figure.



(a)100 * 8 * 4 = 3200(nJ)

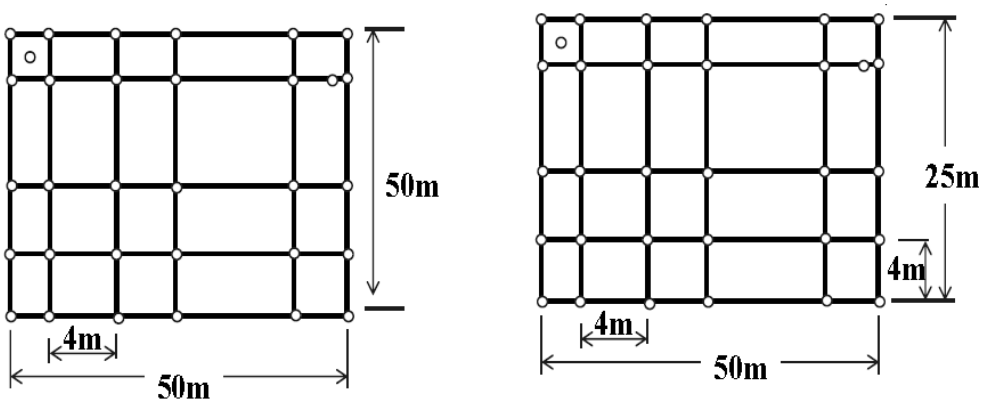
(b)1000 * 4 = 4000(nJ)

(c) It should be placed in the middle of the 4 CHs, so that the distance between the 4 CHs and the BS is as equal as possible.

14.13 A wireless sensor has a transmitter/receiver range of 2 m, and many such sensors need to be installed in a nuclear plant building of size 50 mx50 m with the height of 25 m. Can you think of an efficient arrangement of the sensor arrays assuming sensors can be placed anywhere in the plant? Explain clearly.

Answer:

We arrange the sensors as shown in the following Figure where we would have complete coverage of all of the nuclear plant building sensing all kinds of attributes. The distance between two adjacent sensors is 4 m.



The total sensors we need is:$(\frac{50-2}{4}+1)(\frac{50-2}{4}+1)(\left\lceil\frac{25}{4}\right\rceil+2)$=1521

14.17 Why do you use a "data-centric" approach in a sensor network?

Answer:

Data centric approach is used in sensor networks to save energy with the help of aggregation. In this approach instead of the traditional address centric approach we follow the data centric approach for establishing the routes.