Assignment: Please summarize the methods to improve the energy efficiency, from the view of node architecture design.

Answer:

A wireless sensor network consists of sensor nodes deployed over a geographical area for monitoring physical phenomena like temperature, humidity, vibrations, seismic events, and so on.

Typically, a sensor node is a tiny device that includes three basic components: a sensing subsystem for data acquisition from the physical surrounding environment, a processing subsystem for local data processing and storage, and a wireless communication subsystem for data transmission. In addition, a power source supplies the energy needed by the device to perform the programmed task. This power source often consists of a battery with a limited energy budget. In addition, it could be impossible or inconvenient to recharge the battery, because nodes may be deployed in a hostile or unpractical environment. On the other hand, the sensor network should have a lifetime long enough to fulfill the application requirements. In many cases a lifetime in the order of several months, or even years, may be required.

In some cases, it is possible to scavenge energy from the external environment(e.g., by using solar cells as power source). However, external power supply sources often exhibit a non-continuous behavior so that an energy buffer (a battery) is needed as well. In any case, energy is a very critical resource and must be used very sparingly. Therefore, energy conservation is a key issue in the design of systems based on wireless sensor networks.

Sensor network architecture:

The sensor network model consisting of one sink node (or base station) and a (large) number of sensor nodes deployed over a large geographic area (sensing field). Data are transferred from sensor nodes to the sink through a multi-hop communication paradigm. We will consider first the case in which both the sink and the sensor nodes are static (static sensor network).

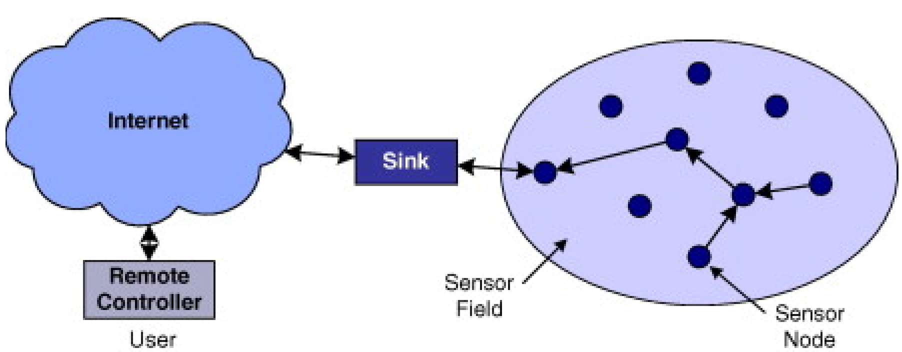

Fig: Sensor network architecture

Experimental measurements have shown that generally data transmission is very expensive in terms of energy consumption, while data processing consumes significantly less The energy cost of transmitting a single bit of information is approximately the same as that needed for processing a thousand operations in a typical sensor node. The energy consumption of the sensing subsystem depends on the specific sensor type. In many cases it is negligible with respect to the energy consumed by the processing and, above all, the communication subsystems. In other cases, the energy expenditure for data sensing may be comparable to, or even greater than, the energy needed for data transmission. In general, energy-saving techniques focus on two subsystems: the networking subsystem (i.e., energy management is taken into account in the operations of each single node, as well as in the design of networking protocols), and the sensing subsystem (i.e., techniques are used to reduce the amount or frequency of energy-expensive samples).

General approaches to energy conservation

The architecture of a typical wireless sensor node, as usually assumed in the literature. It consists of four main components: (i) a *sensing subsystem* including one or more sensors (with associated analog-to-digital converters) for data acquisition; (ii) a *processing subsystem* including a micro-controller and memory for local data processing; (iii) a *radio subsystem* for wireless data communication; and (iv) a *power supply unit*. Depending on the specific application, sensor nodes may also include additional components such as a *location finding system* to determine their position, a *mobilizer* to change their location or configuration (e.g., antenna's orientation), and so on.

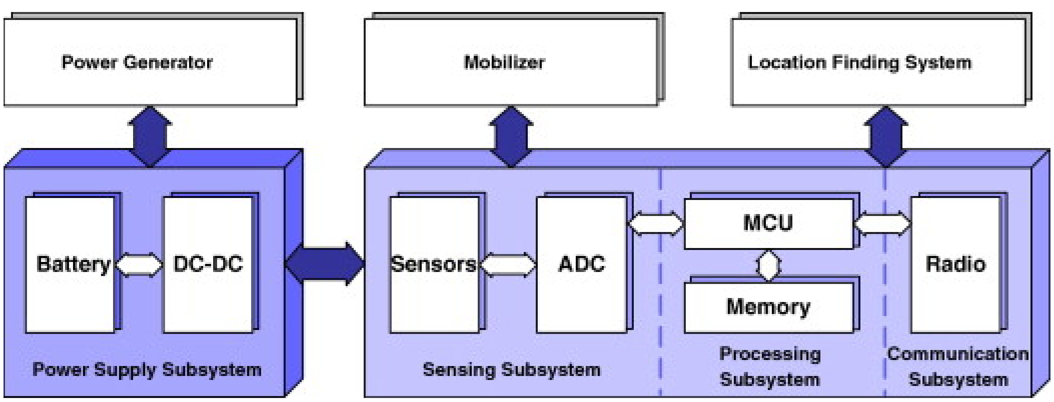

Fig: Architecture of a typical wireless sensor node

1) The radio energy consumption is of the same order of magnitude in the reception, transmission, and idle states, while the power consumption drops of at least one order of magnitude in the sleep state. Therefore, the radio should be put to sleep (or turned off) whenever possible.

2)Depending on the specific application, the sensing subsystem might be another significant source of energy consumption, so its power consumption has to be reduced as well.

Based on the above architecture and power breakdown, several approaches have to be exploited, even simultaneously, to reduce power consumption in wireless sensor networks. At a very general level, we identify three main enabling techniques, namely, *duty cycling*, *data-driven approaches*, and *mobility*.

Duty cycling is mainly focused on the networking subsystem. The most effective energy-conserving operation is putting the radio transceiver in the (low-power) sleep mode whenever communication is not required. Ideally, the radio should be switched off as soon as there is no more data to send/receive, and should be resumed as soon as a new data packet becomes ready. In this way nodes alternate between active and sleep periods depending on network activity. This behavior is usually referred to as duty cycling, and duty cycle is defined as the fraction of time nodes are active during their lifetime. As sensor nodes perform a cooperative task, they need to coordinate their sleep/wakeup times. A sleep/wakeup scheduling algorithm thus accompanies any duty cycling scheme. It is typically a distributed algorithm based on which sensor nodes decide when to transition from active to sleep, and back. It allows neighboring nodes to be active at the same time, thus making packet exchange feasible even when nodes operate with a low duty cycle (i.e., they sleep for most of the time).

Duty-cycling schemes are typically oblivious to data that are sampled by sensor nodes. Hence, data-driven approaches can be used to improve the energy efficiency even more

Assignment: Briefly describe what the results are caused from multi path propagation?

Answer:

Multi-path propagation is simply a radio signal taking 2 different paths from the transmitter to the receiver. This occurs when one path is direct (can be indirect) and a 2nd path of the signal that usually bounces off an object and is reflected to the receiver with the 2 signals arriving usually out of phase, can be 180 degrees out of phase.

The results are one signal will oppose or cancel to some degree the direct signal reducing it in level making it more difficult to receive.

Also in mobile or moving transmitters and/or receivers the paths will be changing with the results of the 2 paths changing in strength and phase at the receiver resulting in a “flutter” sound as detected in the receiver. Depending on the rate of change or velocity of the moving gear and the frequency of operation will affect the rate of flutter.

If the transmitter and receiver are stationary, then moving one of the other slightly can improve and reduce the phase differences of the 2 signals. Can even increase the signal by moving to a point where the 2 signals are in phase.

Result caused by multipath propagation:

One of the ways which is particularly obvious when driving in a car and listening to an FM radio. At certain points the signal will become distorted and appear to break up. This arises from the fact that the signal is frequency modulated and at any given time, the frequency of the received signal provides the instantaneous voltage for the audio output. If multipath propagation occurs, then two or more signals will appear at the receiver. One is the direct or line of sight signal, and another is a reflected signal. As these will arrive at different times because of the different path lengths, they will have different frequencies, caused by the fact that the two signals have been transmitted by the transmitter at slightly different times. Accordingly when the two signals are received together, distortion can arise if they have similar signal strength levels.