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Study of all Routing Protocols of Wireless Sensor Network

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ABSTRACT

Wireless Sensor Network (WSN) consists of many small sensor nodes. A sensor node is a battery operated small device capable of computation and communication. These nodes are capable of sensing events within their coverage area. The main objective of WSN is to sense destructive events from its environment and send that information to the sink node, so that it can take the corrective actions. As the sensor nodes are deployed in remote location, it is very difficult to recharge the batteries. Thus, energy efficiency is the main challenge in WSN. The paper gives a brief study about different energy efficient routing protocols, so that the problem areas can be identified and solved.

Key words: Wireless Sensor Network, computation and communication, routing network,

INTRODUCTION

A Wireless Sensor Network (WSN) contains hundreds or thousands of these sensor nodes. These sensors have the ability to communicate either among each other or directly to an external base-station (BS). A greater number of sensors allows for sensing over larger geographical regions with greater accuracy. Basically, each sensor node comprises sensing, processing, transmission, mobilizer, position finding system, and power units (some of these components are optional like the mobilizer). The same figure shows the communication architecture of a WSN.

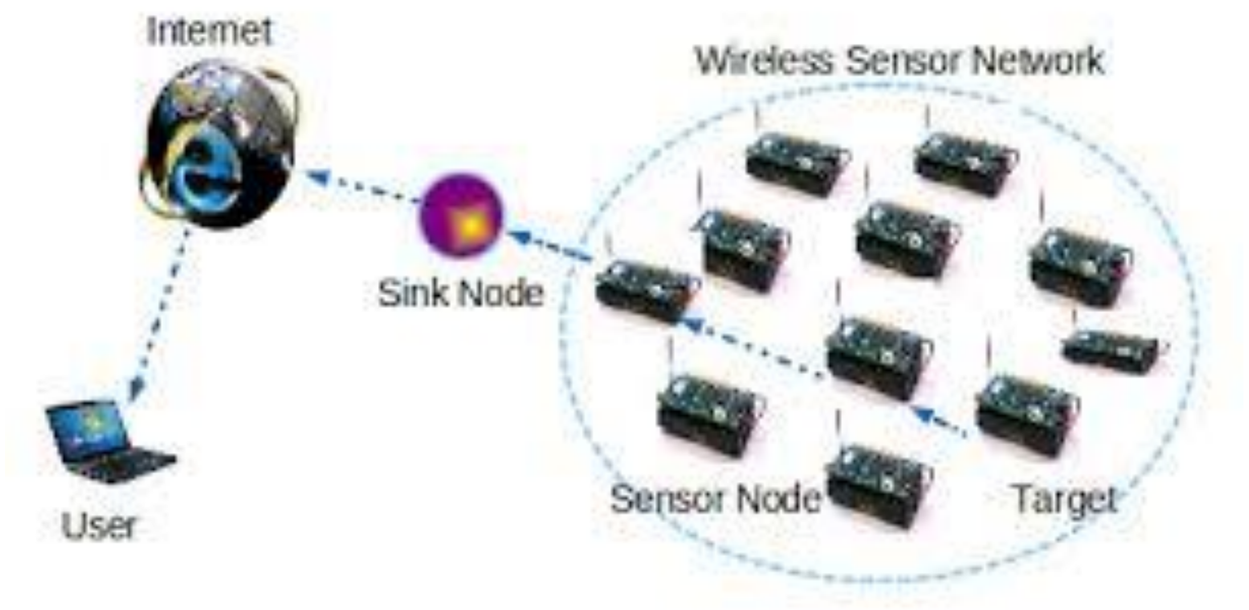

Figure 1.1 A Wireless Sensor network

Sensor nodes are usually scattered in a sensor field, which is an area where the sensor nodes are deployed. Sensor nodes coordinate among themselves to produce high-quality information about the physical environment. Each sensor node bases its decisions on its mission, the information it currently has, and its knowledge of its computing, communication, and energy resources. Each of these scattered sensor nodes has the capability to collect and route data either to other sensors or back to an external base station(s) A base-station may be a fixed node or a mobile node capable of connecting the sensor network to an existing communications infrastructure or to the Internet where a user can have access to the reported data.

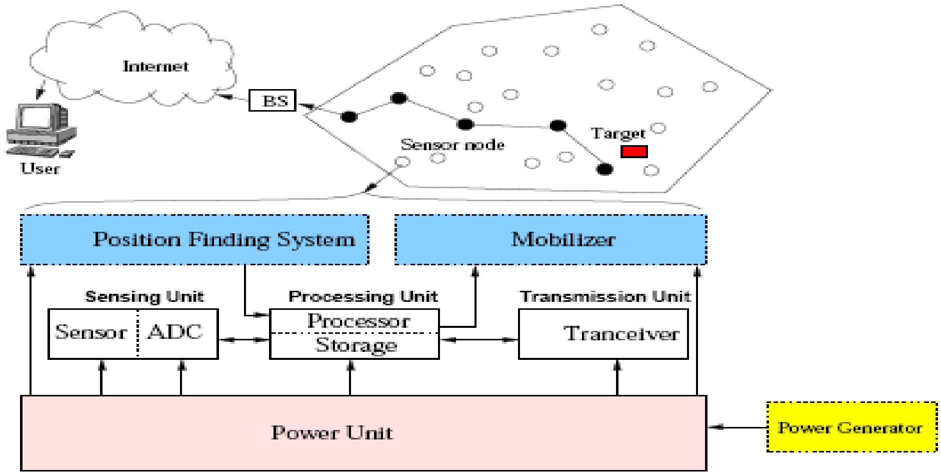

Figure1.2 Sensor node architecture

Components Of A Sensor Node:

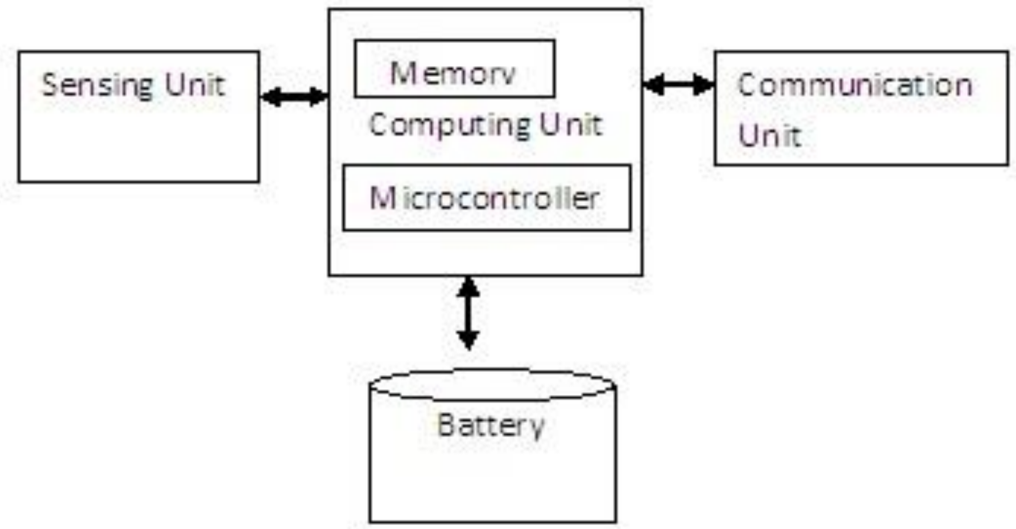

Figure 1.3 Sensor node

Every sensor node is equipped with a transducer, microcomputer, transceiver and power source.

- The transducer generates electrical signals based on sensed physical effects and phenomena.
- The microcomputer processes and stores the sensor output.
- The transceiver, which can be hard-wired or wireless, receives commands from a central computer and transmits data to that computer. Transceiver hence acts as Communication unit.
- The power for each sensor node is derived from the electric utility or from a battery.

SOME EMINENT APPLICATIONS OF WIRELESS SENSOR NETWORKS:

Area Monitoring: Area monitoring is a common application of WSNs. In area monitoring, the WSN is deployed over a region where some phenomenon is to be monitored. A military example is the use of sensors detect enemy intrusion; a civilian example is the geo-fencing of gas or oil pipelines.

Environmental/Earth monitoring: The term Environmental Sensor Networks has evolved to cover many applications of WSNs to earth science research. This includes sensing volcanoes oceans glaciers forests etc. Some of the major areas are listed below.

Air Quality Monitoring: The degree of pollution in the air has to be measured frequently in order to safeguard people and the environment from any kind of damages due to air pollution. In dangerous surroundings, real time monitoring of harmful gases is a concerning process because the weather can change with severe consequences in an immediate manner. Fortunately, wireless sensor networks have been launched to produce specific solutions for people.

Interior Monitoring: Observing the gas levels at vulnerable areas needs the usage of high-end, sophisticated equipment, capable to satisfy industrial regulations. Wireless internal monitoring solutions facilitate keep tabs on large areas as well as ensure the precise gas concentration degree.

Exterior Monitoring: External air quality monitoring needs the use of precise wireless sensors, rain & wind resistant solutions as well as energy reaping methods to assure extensive liberty to machine that will likely have tough access.

Air Pollution Monitoring: Wireless sensor networks have been deployed in several cities (Stockholm, London and Brisbane) to monitor the concentration of dangerous gases for citizens. These can take advantage of the ad-hoc wireless links rather than wired installations, which also make them more mobile for testing readings in different areas. There are various architectures that can be used for such applications as well as different kinds of data analysis and data mining that can be conducted.

Forest Fire Detection: A network of Sensor Nodes can be installed in a forest to detect when a fire has started. The nodes can be equipped with sensors to measure temperature, humidity and gases which are produced by fire in the trees or vegetation. The early detection is crucial for a successful action of the firefighters; thanks to Wireless Sensor Networks, the fire brigade will be able to know when a fire is started and how it is spreading.

Landslide Detection: A landslide detection system makes use of a wireless sensor network to detect the slight movements of soil and changes in various parameters that may occur before or during a landslide. Through the data gathered it may be possible to know the occurrence of landslides long before it actually happens.

Water Quality Monitoring: Water quality monitoring involves analyzing water properties in dams, rivers, lakes & oceans, as well as underground water reserves. The use of many wireless distributed sensors enables the creation of a more accurate map of the water status, and allows the permanent deployment of monitoring stations in locations of difficult access, without the need of manual data retrieval.

Natural disaster prevention Wireless sensor networks can effectively act to prevent the consequences of natural disasters, like floods. Wireless nodes have successfully been deployed in rivers where changes of the water levels have to be monitored in real time.

Machine Health Monitoring: Wireless sensor networks have been developed for machinery condition-based maintenance (CBM) as they offer significant cost savings and enable new functionalities. In wired systems, the installation of enough sensors is often limited by the cost of wiring. Previously inaccessible locations, rotating machinery, hazardous or restricted areas, and mobile assets can now be reached with wireless sensors.

Data Logging: Wireless sensor networks are also used for the collection of data for monitoring of environmental information; this can be as simple as the monitoring of the temperature in a fridge to the level of water in overflow tanks in nuclear power plants. The statistical information can then be used to show how systems have been working. The advantage of WSNs over conventional loggers is the "live" data feed that is possible.

Industrial Sense and Control Applications: In recent research a vast number of wireless sensor network communication protocols have been developed. While previous research was primarily focused on power awareness, more recent research have begun to consider a wider range of aspects, such as wireless link reliability real-time capabilities or quality-of-service. These new aspects are considered as an enabler for future applications in industrial and related wireless sense and control applications, and partially replacing or enhancing conventional wire-based networks by WSN techniques.

Water/Waste Water Monitoring: Monitoring the quality and level of water includes many activities such as checking the quality of underground or surface water and ensuring a country's water infrastructure for the benefit of both human and animal. The area of water quality monitoring utilizes wireless sensor networks and many manufacturers have launched fresh and advanced applications for the purpose.

- **Observation of water quality:** The whole process includes examining water properties in rivers, dams, oceans, lakes and also in underground water resources. Wireless distributed sensors let users to make a precise map of the water condition as well as making permanent distribution of observing stations in areas of difficult access with no manual data recovery.
- **Water distribution network management:** Manufacturers of water distribution network sensors concentrate on observing the water management structures such as valve and pipes and also making remote access to water meter readings.
- **Preventing natural disaster:** The consequences of natural perils like floods can be effectively prevented with wireless sensor networks. Wireless nodes are distributed in rivers so that changes of the water level can be effectively monitored.

Agriculture: Using wireless sensor networks within the agricultural industry is increasingly common; using a wireless network frees the farmer from the maintenance of wiring in a difficult environment. Gravity feed water systems can be monitored using pressure transmitters to monitor water tank levels, pumps can be controlled using wireless I/O devices and water use can be measured and wirelessly transmitted back to a central control center for billing. Irrigation automation enables more efficient water use and reduces waste.

- **Accurate agriculture:** Wireless sensor networks let users to make precise monitoring of the crop at the time of its growth. Hence, farmers can immediately know the state of the item at all its stages which will ease the decision process regarding the time of harvest.
- **Irrigation management:** When real time data is delivered, farmers are able to achieve intelligent irrigation. Data regarding the fields such as temperature level and soil moisture are delivered to farmers through wireless sensor networks. When each plant is joined with a personal irrigation system, farmers can pour the precise amount of water each plant needs and hence, reduce the cost and improve the quality of the end product. The networks can be employed to manage various actuators in the systems using no wired infrastructure.

Greenhouses

Wireless sensor networks are also used to control the temperature and humidity levels inside commercial greenhouses. When the temperature and humidity drops below specific levels, the greenhouse manager must be notified via e-mail or cell phone text message, or host systems can trigger misting systems, open vents, turn on fans, or control a wide variety of system responses.

Recent research in wireless sensor networks in agriculture industry give emphasis on its use in greenhouses, particularly for big exploitations with definite crops. Such microclimatic ambiances need to preserve accurate weather status at all times. Moreover, using multiple distributed sensors will better control the above process, in open surface as well as in the soil.

CHARACTERISTICS OF WIRELESS SENSOR NETWORKS:

The main characteristics of a WSN include:

- Power consumption constrains for nodes using batteries or energy harvesting
- Ability to cope with node failures
- Mobility of nodes
- Communication failures
- Heterogeneity of nodes
- Scalability to large scale of deployment

- Ability to withstand harsh environmental conditions
- Ease of use

Sensor nodes can be imagined as small computers, extremely basic in terms of their interfaces and their components.

They usually consist of a processing unit with limited computational power and limited memory, sensors or MEMS (including specific conditioning circuitry), a communication device (usually radio transceivers or alternatively optical), and a power source usually in the form of a battery.

Other possible inclusions are energy harvesting modules, secondary ASICs, and possibly secondary communication devices (e.g. RS-232 or USB).

The base stations are one or more components of the WSN with much more computational, energy and communication resources. They act as a gateway between sensor nodes and the end user as they typically forward data from the WSN on to a server. Other special components in routing based networks are routers, designed to compute, calculate and distribute the routing tables.

UNIQUE FEATURES OF WIRELESS SENSOR NETWORKS:

It should be noted that sensor networks do share some commonalities with general ad hoc networks.

Thus, protocol design for sensor networks must account for the properties of ad hoc networks, including the following:

- Lifetime constraints imposed by the limited energy supplies of the nodes in the network.
- Unreliable communication due to the wireless medium
- Need for self-configuration, requiring little or no human intervention.
- However, several unique features exist in wireless sensor networks that do not exist in general ad hoc networks. These features present new challenges and require modification of designs for traditional ad hoc networks.

These are the following:

- While traditional ad hoc networks consist of network sizes on the order of 10s, sensor networks are expected to scale to sizes of 1000s.
- Sensor nodes are typically immobile, meaning that the mechanisms used in traditional ad hoc network protocols to deal with mobility may be unnecessary and overweight.
- Since nodes may be deployed in harsh environmental conditions, unexpected node failure may be common.
- Sensor nodes may be much smaller than nodes in traditional ad hoc networks (e.g., PDAs, laptop computers), with smaller batteries leading to shorter lifetimes, less computational power, and less memory.
- Additional services, such as location information, may be required in wireless sensor networks.
- While nodes in traditional ad hoc networks compete for resources such as bandwidth, nodes in a sensor network can be expected to behave more cooperatively, since they are trying to accomplish a similar universal goal, typically related to maintaining an application-level quality of service (QoS), or fidelity.
- Communication is typically data-centric rather than address-centric, meaning that routed data may be aggregated/compressed/prioritized/dropped depending on the description of the data.
- Communication in sensor networks typically takes place in the form of very short packets, meaning that the relative overhead imposed at the different network layers becomes much more important.
- Sensor networks often have a many-to-one traffic pattern, which leads to a "hot spot" problem.

Incorporating these unique features of sensor networks into protocol design is important in order to efficiently utilize the limited resources of the network. At the same time, to keep the protocols as light-weight as possible, many designs focus on particular subsets of these criteria for different types of applications. This has led to quite a number of different protocols from the data-link layer up to the transport layer, each with the goal of allowing the network to operate autonomously for as long as possible while maintaining data channels and network processing to provide the application's required quality of service.

ROUTING CHALLENGES AND DESIGN ISSUES IN WSNS

Despite the innumerable applications of WSNs, these networks have several restrictions, e.g., limited energy supply, limited computing power, and limited bandwidth of the wireless links connecting sensor nodes. One of the main design goals of WSNs is to carry out data communication while trying to prolong the lifetime of the network and prevent connectivity degradation by employing aggressive energy management techniques. The design of routing protocols in WSNs is influenced by many challenging factors. These factors must be overcome before efficient communication can be achieved in WSNs. Some of the routing challenges and design issues that affect routing process in WSNs will be discussed further.

CONCLUSION

Energy efficiency is the main research area in wireless sensor network. As sensor nodes have limited power sources, saving and recharging of power in batteries is a very important aspect. Energy saving provides a potential solution to this problem. Though developments in recent technologies have helped to decrease the power consumption, the lifespan of a wireless sensor network depends on the type of events that are to be dealt with. Other major limitations include decreased computation speed, high cost and limited bandwidth that must be shared among all nodes in the network. Different energy efficient techniques can be used according to different environmental conditions and requisite parameters. In this paper, a comparison of various such techniques has been presented, which would help one to know about the existing routing protocols and choose the optimum resources to deal with them. These protocols can be put under the respective category depending on their advantages and limitations, and utilized efficiently.

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