INTRODUCTION TO WIRELESS SENSOR NETWORKS

1.0 INTRODUCTION

A wireless sensor network (WSN) is a wireless network consisting of spatially distributed autonomous devices using sensors to monitor physical or environmental conditions. A WSN system incorporates a gateway that provides wireless connectivity back to the wired world and distributed nodes (see Figure 1). The wireless protocol you select depends on your application requirements. Some of the available standards include 2.4 GHz radios based on either IEEE 802.15.4 or IEEE 802.11 (Wi-Fi) standards or proprietary radios, which are usually 900 MHz.

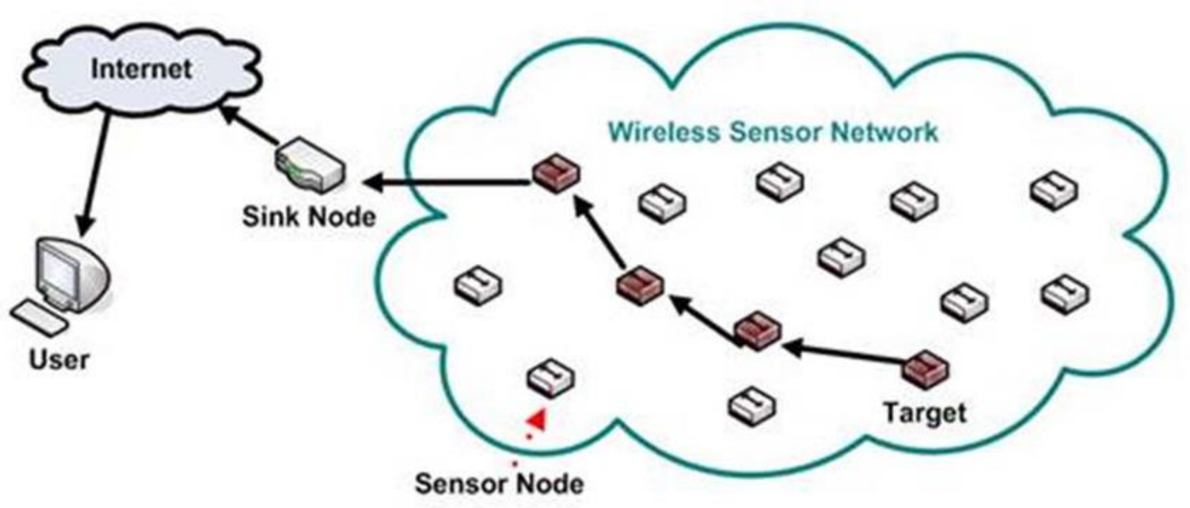

Figure 1. General Wireless Sensor Model

2.0 INFRASTRUCTURE NETWORKS

In an infrastructure-based network the network is managed by a dedicated set of nodes which are connected to a power supply and have a fixed/wired network connection.

3.0 ADHOC NETWORKS

In an ad-hoc network, there are no special controller nodes. Nodes can join and leave the system dynamically, and access to resources (like medium access) needs to be shared among the nodes using distributed protocols.

4.0 WSN NETWORK TOPOLOGIES

WSN nodes are typically organized in one of three types of network topologies. In a star topology, each node connects directly to a gateway. In a cluster tree network, each node connects to a node higher in the tree and then to the gateway, and data is routed from the lowest node on the tree to the gateway. Finally, to offer increased reliability, mesh networks feature nodes that can connect to multiple nodes in the system and pass data through the most reliable path available. This mesh link is often referred to as a router (see Figure 2).

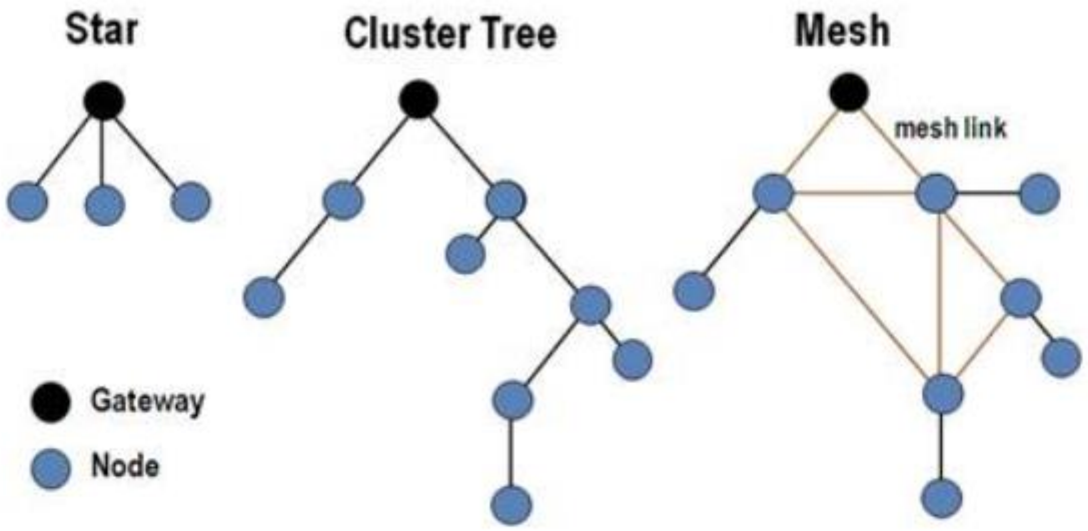

Figure 2. WSN Topologies

5.0 SENSOR NODE

A sensor node, also known as a mote (chiefly in North America), is a node in a sensor network that is capable of performing some processing, gathering sensory information and communicating with other connected nodes in the network. The main components of a sensor node are a microcontroller, transceiver, external memory, power source and one or more sensors.

5.1 Components of A WSN Node

A WSN node contains several technical components. These include the radio, battery, microcontroller, analogue circuit, and sensor interface as shown in Figure 3.

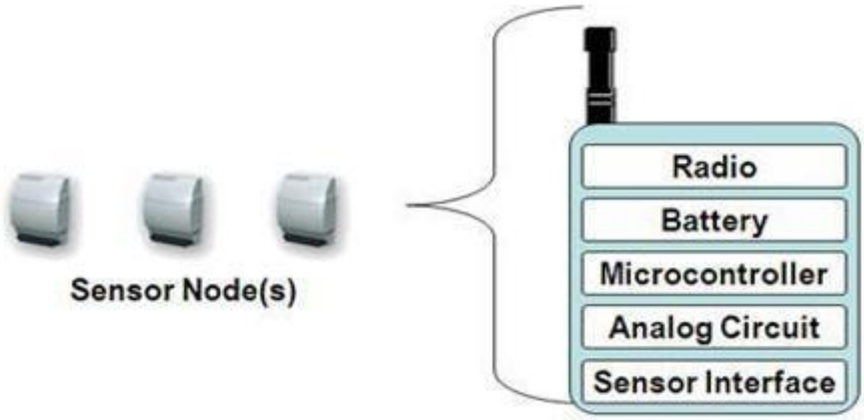

Figure 3. Components of a Wireless Sensor Node

When using WSN radio technology, you must make important trade-offs. In battery-powered systems, higher radio data rates and more frequent radio use consume more power. Often three years of battery life is a requirement, so many of the WSN systems today are based on ZigBee due to its low-power consumption. Because battery life and power management technology are constantly evolving and because of the available IEEE 802.11 bandwidth, WiFi is an interesting technology.

The second technology consideration for WSN systems is the battery. In addition to long life requirements, you must consider the size and weight of batteries as well as international standards for shipping batteries and battery availability. The low cost and wide availability of carbon zinc and alkaline batteries make them a common choice.

To extend battery life, a WSN node periodically wakes up and transmits data by powering on the radio and then powering it back off to conserve energy. WSN radio technology must efficiently transmit a signal and allow the system to go back to sleep with minimal power use. This means the processor involved must also be able to wake, power up, and return to sleep mode efficiently. Microprocessor trends for WSNs include reducing power consumption while maintaining or increasing processor speed. Much like your radio choice, the power consumption and processing speed trade-off is a key concern when selecting a processor for WSNs. This makes the x86 architecture a difficult option for battery-powered devices.

6.0 LIFETIME OF A WIRELESS SENSOR NETWORK

Lifetime of a wireless sensor network is generally defined as the time during which the network is operational. In other words the lifetime of network is defined as the operational time of the network during which it is able to perform the dedicated task(s). One of the most important issues in Wireless Sensor Networks (WSNs) is severe energy restrictions. Since the performance of Sensor Networks is strongly dependant to the network lifetime, researchers seek a way to use node energy supply effectively thereby increasing network lifetime. Consequently, it is crucial to use routing algorithms which result in decreased energy consumption and better bandwidth utilization. Two strategies which can be used to extend the lifetime of a wireless sensor network are as follows.

Strategy 1 - Aggregate traffic: When a node receives a message from a neighbour node which should be forwarded towards the sink, it will wait some time to see if it receives more messages from other neighbouring nodes. If several messages have been received the relaying node can bundle those messages together in order to reduce the cost of transmission. In case of duplicated information, some messages can be suppressed, and in some cases the data itself can be aggregated in the relaying node. The main drawback of this strategy is an increased delay from the time the message was first sent until it is received by the sink node.

Strategy 2 -Duty cyclic: The sensor network nodes go to sleep and only wake up with a certain period. This drastically reduces the energy consumption for each node. The drawback with this strategy is that it can result in a longer delay of detecting and sensing the environment. It also requires more complicated communication protocols since they must account for the fact that nodes are asleep most of the time.

7.0 APPLICATIONS OF WIRELESS SENSOR NETWORKS

Engineers have created WSN applications for areas including health care, utilities, and remote monitoring. In health care, wireless devices make less invasive patient monitoring and health care possible. For utilities such as the electricity grid, streetlights, and water municipals, wireless sensors offer a lower-cost method for collecting system health data to reduce energy usage and better manage resources. Remote monitoring covers a wide range of applications where wireless systems can complement wired systems by reducing wiring costs and allowing new types of measurement applications. Remote monitoring applications include: Environmental monitoring of air, water, and soil; Structural monitoring for buildings and bridges; Industrial machine monitoring; Process monitoring; and Asset tracking.