What Is a Wireless Sensor Network?

Publish Date: Aug 24, 2016

Overview

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.

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Figure 1. WSN Components, Gateway, and Distributed Nodes

1. Potential Applications

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
- Asset tracking

Learn how researchers are using wireless measurements to monitor carbon transfer in rain forests by reading the case study, “Researchers Use NI LabVIEW and CompactRIO to Perform Environmental Monitoring in the Costa Rican Rain Forest.” (http://sine.ni.com/cs/app/doc/p/id/cs-11143)

2. WSN System Architecture

Figure 2. WSN System Architecture Combines Wired and Wireless

Wireless technology offers several advantages for those who can build wired and wireless systems and take advantage of the best technology for the application. To do this, you need a flexible software architecture like the NI LabVIEW graphical system design platform. LabVIEW offers the flexibility needed to connect a wide range of wired and wireless devices (see Figure 2).

3. 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 3).

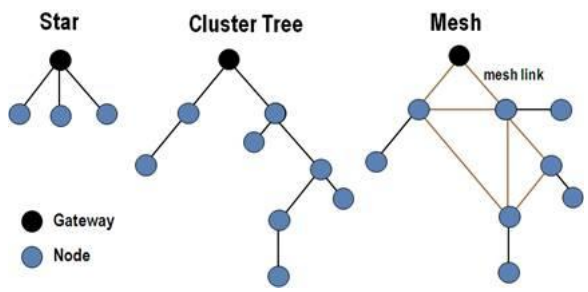

Figure 3. Common WSN Network Topologies

4. Components of a WSN Node

A WSN node contains several technical components. These include the radio, battery, microcontroller, analog circuit, and sensor interface. 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, Wi-Fi 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.

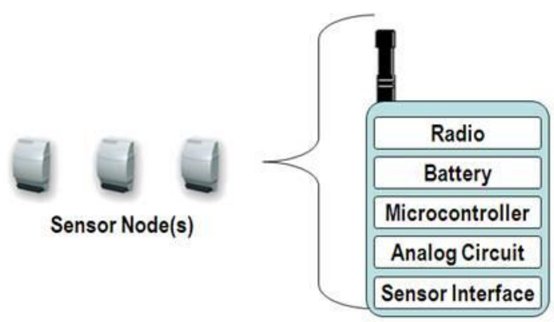

Figure 4. WSN Sensor Node Components

5. Delivering LabVIEW Connectivity for WSN Systems

LabVIEW as a platform offers a broad range of connectivity options including LabVIEW drivers for WSN. These drivers are available for WSN systems from Crossbow, Accsense, and Accutech (http://zone.ni.com/devzone/cda/tut/p/id/5435), and drivers are currently being developed for Banner, MeshNetics, and Techkor WSN systems.

6. Related Links

Download LabVIEW Drivers for Wireless Sensor Networks for Free (http://zone.ni.com/devzone/cda/tut/p/id/5435)