Chapter 2
Deployment Strategies for Wireless Sensor Networks

Ruay-Shiung Chang
National Dong Hwa University, Taiwan

Shuo-Hung Wang
National Dong Hwa University, Taiwan

ABSTRACT

In this chapter, we study the deployment problem in wireless sensor networks. The deployment affects the efficiency and the effectiveness of sensor networks. We discuss different types of deployment strategies including deterministic or random deployment, and centralized or distributed deployment. We also review the measures of deployment while considering the connectivity and coverage in detail. The best coverage and the worst coverage are also discussed. An important issue is the energy efficiency in wireless sensor networks. We classify the power conservation issue into 3 types of sensor networks. They are duty-cycle dependent, role dependent, and topology dependent methods. Finally, future trends in sensor deployment are proposed.

INTRODUCTION

Applications of wireless sensor networks (WSNs) exist in many scenarios such as battlefield surveillance, reconnaissance of opposing forces and terrain, forest fire detection, drug administration in hospitals, and so on (Akyildiz, Su, Sankarasubramaniam, & Cayirci 2002). We can generally classify those applications into target tracking and area monitoring. In the target tracking scenarios, we concern if we can trace the moving object accurately. The number of sensors and the position of sensors affect the performance of tracking. In the area monitoring scenarios, we need to have enough sensors to avoid blind angle. It seems that a denser infrastructure cause a more effective WSNs. However, if not deployed well, a denser network will lead to a larger number of packet collisions and traffic congestions. The cost of larger sensors is another reason to devise good deploying strategy. Some factors to explain the importance of deployment strategy in WSNs are discussed below:
Deployment Strategies for Wireless Sensor Networks

- **Limited Energy:** A well-known characteristic is that wireless sensor nodes have limited energy and have difficulty in recharging. According to the energy consumption model (Heinzelman, Chandrakasan, & Balakrishnan 2002), the longer the transmitting range is, the more energy the WSNs consume. For energy saving, proper distance among sensors is important for WSNs. Transmitting by multiple hops path is usually better than by directly (Heinzelman et al., 2002). The topology of WSNs affects the network lifetime considerably.

- **Transmission Jobs:** To prolong the lifetime of WSNs, we usually regularly schedule sleep intervals for sensors. Usually, multiple sensors sensing similar data will need to aggregate them to the source. Transmission jobs will cost a lot, if the WSNs don't have uniform sensing coverage.

- **Unprotected Area:** The monitoring area is not usually protected, especially for military applications. To prevent being invaded, deployment information is a good option to key management schema for WSNs (Wenliang, Jing, Han, & Shigang, 2004), that is, deployment strategy affects the key schema.

How to deploy a lot of sensor nodes into an area of interest is an important issue for wireless sensor networks. Usually, it affects whether the network operations are energy-efficient, robust, and reliable. Different deployment methods result in distinct routing methods. Varying routing methods consume sensor energy at a varied rate. That is, the deployment will affect the energy depletion and the lifetime of WSNs. Furthermore, various deployments lead to different sensor network topologies. Sensor connectivity will also vary. The connectivity of sensor nodes affects the robustness of WSNs. Consequently, how to deploy the sensor nodes efficiently and effectively affects if the WSNs work smoothly and as desired.

Since a deployment strategy is important for WSNs, how do we evaluate the strategy? Coverage (Gage, 1992) and energy-efficiency are two major concerns for deployment. Owing to the characteristic of WSNs with nodes easy to be damaged, using only a node to monitor a fixed area is unreliable. Usually, even a small area needs to be covered by several sensors. So, we can consider coverage the base of executing fault tolerance in WSNs. So, how do we deploy sensors in an interested area with finite nodes to achieve a better coverage? Because the sensing range and the communicate range of a sensor are not the same, coverage does not equal connectivity. To make WSNs work smoothly, we should consider connectivity while discussing coverage. We explain the coverage problem and related issues in the section of the coverage problem. We also study how to evaluate the coverage of an area. The benchmarks include the best and the worst case coverage. They help sensors to be deployed with better coverage. Another important issue about WSNs is its lifetime. If sensors were deployed unbalanced, nodes in sparse area will deplete energy soon due to more frequent data flow and more distant transmission range. Therefore, suitable arrangement of sensors will make WSNs more durable. Other strategies such as duty cycle based and role based are also used to help energy-efficiency. These methods are all mentioned in this chapter.

The rest of the chapter is organized as follows. We discuss the classification of deployment strategy first. Then, we present a survey for the coverage problem. Next we show the energy-efficiency issue. The last section is the conclusions and future trends.

**CLASSIFICATION OF DEPLOYMENT STRATEGY**

In this section, we will first classify the deployment strategies. A simple taxonomy is shown in Figure 1. One branch is deployment with all
Related Content

Towards Sensing-Enabled RFID Security and Privacy
www.igi-global.com/chapter/towards-sensing-enabled-rfid-security/68740?camid=4v1a

Wireless Video Sensor Networks: Advances in Distributed Video Coding
www.igi-global.com/chapter/wireless-video-sensor-networks/59752?camid=4v1a

Sink Mobility in Wireless Sensor Networks: From Theory to Practice
www.igi-global.com/chapter/sink-mobility-wireless-sensor-networks/41124?camid=4v1a

The Auto-ID Trajectory
www.igi-global.com/chapter/auto-trajectory/23822?camid=4v1a