Chapter 1
Low-power WSN Technology

Generally, a sensor node refers to any device that is capable to sense its environment. Wireless Sensor Network (WSN) as a technology is a collection of sensor devices that co-operate with each other. A WSN may comprise even thousands of autonomic and self-organizing nodes that combine environmental sensing, data processing, and wireless multihop ad-hoc networking. The features of WSNs enable monitoring, object tracking, and control functionality. The potential applications include environmental and condition monitoring, home automation, security and alarm systems, industrial monitoring and control, military reconnaissance and targeting, and interactive games.

Low-power WSNs are characterized by extremely low cost and ultra low energy [9]. This allows the deployment of potentially disposable devices that can have a battery powered lifetime of years or operate on energy gathered from their environment. However, as a trade-off, the low-power WSNs have limited computation, communication, memory, and energy resources.

1.1 WSN and Other Wireless Technologies

Wireless communication technologies are categorized based on their typical coverage and application domains. The link range, data rate, mobility, and power requirements of the technologies are presented in Fig. 1.1. The values are not definite but illustrate the differences between the technologies. In the figure, Radio Frequency (RF) communications is assumed as it is most widely used and does not have inherent limitations such as line-of-sight requirement in infrared.

Wireless Wide Area Network (WWAN) covers a large geographical area and consists of telecommunications networks such as Global System for Mobile Communications (GSM) and satellite communications. In telephone networks, broadband data is supported with packet-switched data services such as General Packet Radio Service (GPRS), 3G, or Universal Mobile Telecommunications System (UMTS).
Mobility requirements are critical, as uninterrupted service is expected even when a user is traveling on high-speed rail (200+ km/h).

Wireless Metropolitan Area Network (WMAN) covers geographic area or region that is smaller than WWAN but larger than Wireless Local Area Network (WLAN). An example of WMANs is IEEE 802.16 (WiMAX) [6]. Both WWAN and WMAN use highly asymmetric devices, as simpler end devices connect to base stations. As such, these networks are intended for single hop uses where the wireless access is used to connect to the Internet or global telephone network. Wireless multihop support is rare and typically limited to base stations.

WLAN spans a relatively small area, such as building or a group of buildings. IEEE 802.11 [3] is the dominant WLAN technology. It was originally targeted to access a wired Local Area Network (LAN) with wireless interface but has been since extended to support mesh networking. IEEE 802.11 is widely utilized for network access in public buildings and enterprises, and sharing Internet in homes.

Wireless Personal Area Network (WPAN) is a short distance network for interconnecting devices centered around an individual person including watches, headsets, mobile phones, audio/video equipment, and laptops. Bluetooth [2] and IEEE 802.15 standard family [4, 5] are the most widely used WPAN technologies. WPANs have varying energy and throughput requirements as the use cases range from low power data exchange with portable devices to high data rate home entertainment and multimedia transfers.

WSN shares most properties with WPANs and may utilize similar technologies. For example, IEEE 802.15.4 low-rate WPAN standard [5] is used as a basis for many WSN communication standards. However, a WSN is designed for multiple users, has usually more devices, and often emphasizes lifetime.

1.2 Characteristics of Low-power WSNs

A WSN consists of nodes that are deployed in the vicinity of an inspected phenomenon [1] as shown in Fig. 1.2. In addition, a network may contain one or more

![Fig. 1.1 Properties of wireless communication technologies.](image_url)