# Chapter VI
# Wireless and Mobile Communications

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## ABSTRACT

*This chapter introduces different wireless and mobile communication systems that represent an important technological basis for ubiquitous computing applications. Different communication systems co-exist and vary with respect to many parameters, such as transmission range, data rates, cost, mobility, power consumption, scalability in the number of users, and so forth. The introduction gives a quick chapter overview of prominent communication systems. Next, the necessary minimal knowledge required about wireless transmission and media-sharing technologies is provided. The core of the chapter then provides brief introductions to the classes of wireless networks that are most relevant for ubiquitous computing, in particular wireless wide area networks and wireless distribution, local area, personal area, and sensor networks. A brief description of current convergence efforts follows. Readers should be aware that the wealth of technologies to be considered requires this chapter to remain rather survey-like.*

## INTRODUCTION AND FOUNDATIONS

Figure 1 gives a rough overview of some prominent wireless communication systems focusing on the two parameters gross data rate and relative speed between sender and receiver. Assuming a mobile end-user connected to a stationary transceiver station, the points on the (non proportional) speed axis resemble nonmoving persons, pedestrians, cars downtown, cars outside cities, and cars on a highway, respectively. Note that high-speed trains and airplanes cannot be accommodated by most technologies without specialized equipment.

In the range suitable for higher speeds, we find typical mobile telecommunication systems offering mainly voice service and covering whole countries (see Schiller (2003) for a comparison). The most successful system is GSM (global system for mobile communication) with its successor UMTS (universal mobile communications system) for higher data rates. While GSM can be enhanced for higher data rates with GPRS (general packet radio service) and EDGE (enhanced data rates for global evolution), UMTS with its new enhancements HSDPA (high speed downlink packet access) and HSUPA (high speed uplink packet access) can deliver even higher data rates

of 10 Mbit/s and more per radio cell. Digital broadcast systems, such as DVB (digital video broadcasting), DAB (digital audio broadcasting), and DMB (digital multimedia broadcasting) play a special role as they are (at least *a priori*) conceived as unidirectional broadcast systems. Their key benefits are extreme scalability and suitability for higher speeds. For bidirectional applications, these technologies are often complemented with GSM or UMTS back channels. Systems for higher data rates typically trade off this advantage with sensibility to higher speeds and with lower transmission ranges, requiring antennas to be more close-by i.e. more densely distributed. Prominent examples for this class of systems are WPANs (wireless personal area networks) following the standard IEEE 802.15, such as the Bluetooth and ZigBee substandards, and WLANs (wireless local area networks) following IEEE 802.11. Especially the latter has initiated a revolutionary new way of ubiquitous access to the Internet by forming the basis of thousands of hot-spots world-wide. While offering higher data rates than, for example, GSM or UMTS, WLANs usually apply randomized, optimistic media access control schemes, that is, ways for sharing the available bandwidth among all active users within a hot spot. Such schemes adapt well to the bursty data rates characteristic for Internet use (as opposed to mobile phone use), but usually cannot cope well with accumulated bandwidth demands close to or beyond available bandwidth. WSNs (wireless sensor networks) form a wireless systems class of their own as they focus on energy conservation rather than on high data rates; among others, energy consumption calls for low transmission reach, such that sensor nodes are expected to act as routers for neighboring sensors—a function that consumes energy! The above-mentioned ZigBee standard is considered a basis for WSNs, too. Wireless distribution systems, finally, could replace DSL (digital subscriber line) in residential areas. They follow the IEEE 802.16 standard known as WiMAX (worldwide interoperability for microwave access). The initially lacking mobility support is added under IEEE 802.16e; WiMAX cooperates and competes with IEEE 802.11 at higher data rates.

*Figure 1. Overview of wireless communication technologies relevant for UC*