

Preface

Why this book was written

Our modern way of life is critically dependent on wireless and mobile networking technology which enables citizens to communicate with each other and access all types of information and services from anywhere anytime. To meet the growing demand and diversified requirements of new applications and services, wireless networking technology has advanced at a rapid pace in recent years introducing many new features and concepts. These developments range from adding new features to previous versions of the technology to developing completely new paradigms for wireless networking. While it is important for the next generation students to gain a good understanding of these latest developments, it is rare to find a text that covers them in a compact form. This book fills this gap by covering not only the latest developments in Bluetooth, WiFi, and Cellular networks, but also the emerging wireless networking paradigms including Internet of Things (IoT) networking with LoRa, Artificial Intelligence (AI) assisted wireless networking, wireless sensing with WiFi and millimeter wave radars, and aerial networking with drones. Presenting the fundamental wireless concepts in a less mathematically intensive manner is another key feature of this book, which makes it accessible to readers from a wide range of backgrounds.

Who can benefit from this book

This book would be an ideal text for a one semester course on Wireless and Mobile Networking suitable for both undergraduate students in their 3rd or 4th year and postgraduate students from a range of disciplines including Computer Science, Information Technology, Information Systems, Mechatronics, and Electrical Engineering. Instructors using the book as a text for classroom teaching can obtain from the author power point slide decks as well as additional multiple-choice questions for each chapter. Professionals working in the industry as well as hobbyists can use the book to keep themselves abreast of the latest developments in popular and emerging wireless networking technologies.

Organization of the book

The book is organized into six parts including the first one that introduces the book. Part II is a review of the fundamentals of wireless communications that are critical to understand the wireless technologies covered in the rest of the book. These fundamental wireless concepts are explained without resorting to intensive mathematics, which makes them accessible to readers from a wide range of background. Chapter 2 covers the basic theories of **coding and modulation**, which is the fundamental technique to map digital information to the underlying signal so that a receiver can retrieve the information from the signal using appropriate decoder and demodulator, while Chapter 3 explains the fundamentals of **wireless signal propagation**.

Part III covers **WiFi**, which is one of the most widely used wireless networking technology today, especially for indoor and local area applications. WiFi has been primarily used as a networking technology for enterprise and residential domains, as well as connecting personal mobile devices, such as mobile phones, tablets, laptops, etc. to the Internet in homes, cafes, airports, and university campuses. These mainstream WiFi predominantly used the ISM bands 2.4GHz and 5GHz, with the new versions aiming to use the 6GHz band. In addition to these mainstream WiFi, IEEE has also released several 802.11 amendments that target some niche

applications. These niche WiFi standards operate outside the mainstream bands, both at the very low end of the spectrum, i.e., below 1GHz, as well as at the very high end, i.e., 60GHz. For example, 802.11af is targeting the exploitation of 700MHz spectrum recently vacated by TV stations due to their digitization, 802.11ah using 900MHz to connect emerging Internet of Things operating at low power, and 802.11ad/ay at 60GHz to support multi-gigabit applications at short range. To systematically cover these developments, this part breaks the treatment of WiFi into three chapters. Chapter 4 covers the **basics of WiFi** that are common to all WiFi versions. Chapter 5 covers the **mainstream WiFi**, while Chapter 6 focuses on **niche WiFi**.

Part IV is dedicated to **cellular networks**, which are designed to provide wide area coverage to both static and mobile users. Cellular network is the oldest communications network technology, which has now gone through several generations of evolution with the fifth generation currently being deployed. Chapter 7 covers the fundamental concepts of cellular networks with a brief examination of the advancements brought forth by each generation up to the fourth. While the previous four generations mainly sought to improve the data rate and capacity of the cellular systems, 5G is designed to improve several other aspects of communications and connectivity beyond the data rates. Chapter 8 discusses the new applications promised by 5G and some of the key networking technologies behind them.

Part V is devoted to **Internet of Things (IoT)**, which is an emerging networking paradigm to connect all types of objects to the Internet, making it possible to digitize every phenomenon and processes of interest. Chapter 9 introduces **IoT** discussing the business opportunities and the recently standardized wireless networking technologies to support the need of IoT. Chapter 10 explains **Bluetooth**, the oldest and the most pervasive technology to connect a wide range of devices and ‘things’ around us. This chapter covers its history, markets, and applications, followed by the core technologies behind the three generations of Bluetooth including versions 5.0 and 5.3. Pervasive IoT deployments demand low-power wide area networking (LPWAN) solutions that can connect hundreds of thousands of sensors and ‘things’ over a large area with minimal infrastructure cost. While Bluetooth is certainly low-powered, it works only for short ranges. Cellular networks are designed for wide area coverage, but they consume too much power which requires large batteries and frequent battery recharging for the end nodes. Consequently, there is a significant momentum in standardizing new networking solutions for LPWAN. New developments are emerging from both cellular and WiFi standard bodies, i.e., from the 3GPP and IEEE/WiFi-alliance, respectively, to fill this gap, but there is a third momentum that is proving very successful. It is called LoRa Alliance (LoRa stands for *long range*), which is an industry alliance committed to accelerate the development and deployment of LPWAN networks. Chapter 11 examines the details of the **LoRa** technology.

Part VI covers some of the latest developments in wireless and mobile networking. As wireless networks get more and more complex to deal with the ever-growing demand for capacity and quality of service, artificial intelligent (AI) is being explored as a potential aid to wireless networking in the future. Chapter 12 examines what, why, and how questions for **AI in wireless**. While wireless has revolutionized mobile data communications, it also plays a major role as a sensing technology. Recently, scientists are discovering techniques to monitor human activities and even vital signs, such as heart and breathing rates, simply by analyzing the wireless signals reflected by the human body. These advancements have created the potential for wireless to penetrate the growing mobile and IoT sensing market. Chapter 13 explains the working principles of the popular wireless sensing tools and techniques targeted at the IoT market. Finally, miniaturization of electronics has created an opportunity to fit wireless communications equipment into the payload of various aerial platforms such as drones and

aerostats. Aerial wireless networks can be deployed quickly and cost-effectively to provide coverage in remote areas where terrestrial infrastructure is difficult to build, in disaster zones with damaged cellular towers, and even in urban areas to absorb sudden peaks in data traffic. The final chapter of the book, Chapter 14, examines options, characteristics, and design considerations for such **aerial wireless networks**.

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