

Preface

The intention of this textbook is to serve as the primary reference in the field of ad hoc and sensor networks for individuals with academic, industry, or military background. It targets not only researchers and engineers, but also those who would like to have a deep yet easy coverage of this growing field, and the current state of research in this area. It comes to fill in the gap of existing literature on ad hoc and sensor networks by providing a comprehensive coverage of the subject matter. This textbook has been written with great care to address the need of those who seek not only detailed knowledge of this important field, but also the breadth. After all, this area is poised to be a key component of future communication networks and likely to have an undaunted impact on our daily lives.

If there is one thing that we have learnt in all these years of research and development on ad hoc and sensor networks is that there is a major interdependence among various layers of the network protocol stack. Contrary to wired or even one-hop wireless (e.g., cellular or mobile) networks, the lack of a fixed infrastructure, the inherent mobility, and the underlying routing mechanism by ad hoc and sensor networks introduce a number of technological challenges that are very hard to be addressed within the boundaries of a single protocol layer. Despite of this clear fact, all existing edited textbooks on ad hoc and sensor networks often focus on a specific aspect of the technology in isolation, fail to provide critical insights on cross-layer interdependencies, and hence leave major questions in the minds of the readers.

Our experience in dealing with students, professionals, and researchers working on ad hoc and sensor networks have revealed the need for a textbook that covers the many interrelated aspects of these networks and which can also clearly pinpoint iterative interactions between different layers. The study of ad hoc and sensor networks is very peculiar and intriguing, and to be able to fully understand this area it is not only enough to understand specific solutions individually, but also their many interdependencies and cross-layer interactions. We are confident that this knowledge will allow readers to firmly grasp this topic, understand its intricacies, and stimulate creativity.

This is in essence the approach we take in this textbook. From the physical up to the application layer, we provide a detailed investigation of ad hoc and sensor networks to date. In addition, wherever applicable, the discussion of these topics is closely followed by their impact on other layers of the network protocol stack. With this explanatory model, we aim to provide the readers with not only the depth in understanding but also the breadth. The ultimate goal is to provide a superior experience that opens up new horizons as one move on from one chapter to another.

The organization of this textbook is based on the authors' long experience in academia and industry, dealing with students and professionals, where we feel that the easiest way to start this journey is through the routing layer. Technologies in this layer are often more easily absorbable so as to create a solid foundation for the follow-up subject areas. Therefore, after an introduction and overview of existing and future wireless communication systems in Chapter 1, we start with detailed technical discussions in Chapter 2 by examining unicast routing protocols and algorithms. To accommodate important new applications and improve the system performance of ad hoc and sensor networks, this is followed by the investigation of mechanisms for broadcasting, multicasting and geocasting in Chapter 3. Once all networking concepts are in place, it is time to move down in the protocol stack. In Chapters 4 and 5 we discuss the enabling technologies that are used at the physical and medium access control (MAC) layers of ad hoc and sensor networks. From IEEE 802.11 to IEEE 802.15, these chapters provide a detailed coverage of existing and forthcoming wireless technologies. Chapter 6 deals with directional antennas, which is a powerful way of increasing the capacity, connectivity, and covertness of ad hoc networks. This is the first textbook that deals with directional antennas from a networking perspective, concentrating on the MAC and routing issues when these types of antennas are in use. Next, we move up the stack to the transport layer and look at the many performance issues of the Transmission Control Protocol (TCP) over ad hoc networks, and discuss ways for improvements. Chapters 8 and 9 are fully dedicated to sensor networks and the unique characteristics and issues they face. As it shall be clear, sensor networks demand special treatment of certain issues which are inherently specific to them as compared to a generic ad hoc network. As both ad hoc and sensor networks are wireless, security becomes a critical component and is extensively discussed in Chapter 10. Finally, Chapter

11 investigates the increasingly important area of *all wireless networks* towards future fourth generation wireless systems and beyond. Among other things, we discuss the integration of heterogeneous wireless networks, such as cellular and wireless local area networks (LANs), with ad hoc and sensor networks, which will form the basis of the universal ubiquitous networking paradigm of the future. To ensure deep understanding of the subject, each chapter is accompanied by numerical questions and topics for simulation projects. Many of the exercises are open-ended and have been taken from open-book examination questions given to graduate students.

The authors are confident that the approach taken in this textbook together with its vast and extensive coverage of topics, will enable the readers to not only understand and position themselves in this hot area of ad hoc and sensor networks, but will also allow them to develop new capabilities, enhance skills, share expertise, consolidate knowledge and encourage further development of the area by identifying key problems, analyzing them and designing new and innovative solutions and applications.

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