AD HOC MOBILE WIRELESS NETWORKS: PRINCIPLES, PROTOCOLS, AND APPLICATIONS

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Mobile wireless ad hoc networks (MANETs) are a rapidly evolving telecommunications technology. Their popularity is connected with their easy deployment and fast configuration. These features make them ideal for average users, Internet service providers, and reacting to emergency situations in which normal communication is impossible. They can be used with success in disaster areas (earthquake, flood, hurricane), military training grounds, schools; at conferences, hotels, airports, houses, and so on. This kind of network is the best alternative for developing countries, and everywhere communications infrastructure does not exist. Ad hoc networks clearly differ from the traditional cable infrastructure. However, in comparison with wired networks, ad hoc networks offer much smaller bandwidth; hence, their design requires much more attention. What is more, constantly changing and unpredictable channel conditions, hidden and exposed node problems, varying network load, changeable device performance, different transmission and sensing ranges, and mobility of ad hoc networks make it an even more difficult task.

This book is targeted at a variety of readers with different levels of wireless network knowledge. The presented material is in its majority focused on different layer protocols for ad hoc networks. It covers practical applications review and cross-layer design aspects as well as quality of service (QoS), energy, and mobility issues. The book consists of 10 chapters, and begins with a short introduction to wireless and ad hoc networks. This chapter describes wireless network fundamentals covering Bluetooth, IrDA, HomeRF, IEEE 802.11 (WiFi), and IEEE 802.16 (WiMAX) standards. Moreover, it introduces the Mobile IP concept. The main technical and research challenges of ad hoc networks are also considered in the first chapter.

Chapter 2 overviews medium access control (MAC) layer protocols. The need for new MAC protocols is presented at the beginning, and then classification of MAC protocols is discussed. A number of well-known MAC protocols for MANETs (MACA, MACA-BI, DCF of IEEE 802.11, GAMA-PS, Multichannel CSMA, DBTMA, HRMA, MMAC, DCA-PC, PAMAS, DPSM, PCM, PCMA) are briefly described. Several issues like collision resolution, power conservation, multiple channels, and directional antennas usage are covered.

Chapter 3 focuses on routing protocols. Design issues of routing protocols for ad hoc networks are highlighted. Classification of routing protocols is also discussed. Several proactive, reactive, and hybrid routing protocols are presented in detail. This allows the reader to understand different characteristics of each routing protocol as well as to find its relationship with others.

Multicast ad hoc routing protocols are the topic of Chapter 4. These allow the creation and maintenance of a multicast tree or mesh to assume quick reactions to network topology changes and minimization of packet loss. The classification of multicast routing protocols based on topology, initialization of the multicast session, the topology maintenance mechanism, and zone routing are showed. The most important multicast protocols, including multicasting with QoS guarantees, and energy-efficient and application-dependent protocols, are characterized in this chapter.

Chapter 5 is devoted to transport protocols. It is shown that the Transmission Control Protocol (TCP) in most of its versions is inappropriate for wireless networks because of high bit error rates, hidden and exposed stations, path asymmetry, multihop communications, and mobility problems. TCP performance and route failures over MANETs are studied. A number of recently proposed transport layer end-to-end approaches to improve TCP's performance are explained and compared at the end.

In Chapter 6 QoS issues and challenges are addressed. Each OSI/ISO layer is briefly analyzed in terms of the QoS at the beginning; then a classification of QoS solutions is presented. The authors point out some factors that increase the complexity of QoS support in the MANET environment. Furthermore, the selected QoS-capable MAC

(Continued from page 12) and network layer protocols are explored. The Flexible QoS Model for MANETs (FQMM) and INSIGNIA framework description finishes this chapter.

Chapter 7 presents energy management systems for ad hoc wireless networks. How to manage energy efficiently assuming limited power sources in MANET nodes is discussed. The IEEE 802.11 power-saving mode is overviewed here. This chapter also deals with different energy-efficient routing protocols, transmission power management schemes, and control.

Chapter 8 investigates the mobility models for multihop networks. Specifically, it shows how the performance results of an ad hoc network protocol drastically change as a result of changing the simulated mobility model. This chapter contains results that come from the authors' own research. The random waypoint mobility, reference point group, Gauss-Markov, and Manhattan models were used in evaluation of the routing protocol's performance.

Chapter 9 emphasizes the cross-layer design issues. After reading this chapter, it seems that cross-layer design can be a suitable approach for standalone wireless ad hoc networks and dedicated for use with only a single application; thus, we do not have to worry about interoperability issues. The authors suggest that aggressive use of cross-layer design is not a reasonable idea. As an example, the design of transmit power control protocol for wireless networks is analyzed.

The last chapter (Chapter 10) addresses applications and recent developments in ad hoc networking. The most typical applications are presented. The challenges, with special attention on security, are exemplified.

In summary, the book is a considerable source of information about MANET protocols and principles. It contains a lot of information, mostly gathered from international conferences, RFCs, and journal papers. Extensive bibliography sections for deeper reading are attached to the end of all chapters. Each chapter contains a short introduction in which the motivation can be found. In addition, at the end of each chapter final conclusions are given that summarize the presented knowledge. Some illustrations help understand important topics. Unfortunately, the reader can find some overlap in material among different chapters; then again, this makes it possible to read each chapter independently. The book should be attractive to students and graduate students as well as lecturers and network engineers.