

# Wireless Power Transfer Algorithms, Technologies and Applications in Ad Hoc Communication Networks

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Editors

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*To my beloved daughter Nonika*

—Sotiris Nikoletseas

*To my beloved husband Jianchao Wang*

—Yuanyuan Yang

*To my daughter Ariadne*

—Apostolos Georgiadis

# Preface

This book is the first systematic exposition on the emerging domain of wireless power transfer in ad hoc communication networks. It selectively spans a coherent, large spectrum of fundamental aspects of wireless power transfer, such as mobility management in the network, combined wireless power and information transfer, energy flow among network devices, joint activities with wireless power transfer (routing, data gathering and solar energy harvesting), safety provisioning through electromagnetic radiation control, as well as fundamental and novel circuits and technologies enabling the wide application of wireless powering.

Wireless Power Transfer (WPT) has recently evolved as a very active research subject in the field of ad hoc communication networks, as well as a topic of rapid technological progress and emerging practical development and application activities. However, a solid foundational, systemic, and applied background seems still necessary for wireless power transfer to achieve its full potential. The provisioning of relevant abstract models, algorithmic design and analysis methods, networking principles, circuit and system design, and application methodologies is a challenging task.

Several such models, algorithms, circuits, systems, and applications for WPT have already appeared, in relevant journals, conferences, and workshops. This book aims to reinforce the emergence of a critical mass of algorithmic and applied foundations by bringing together, for the first time in a systematic way, high-quality research contributions (in the form of invited book chapters) by leading experts worldwide, relevant to important algorithmic, systematic, and technological WPT applications in ad hoc communication networks.

The content is organized into six thematic parts, covering respective common aspects, issues, and methodologies: Technologies, Communication, Mobility, Energy Flow, Joint Operations, and Electromagnetic Radiation Awareness. Because of the inherent relations of different topics, layers, and problems, many chapters could have been associated with more than one theme, and the themes themselves could have been chosen in a different manner. Still, we hope that the chosen structure will be methodologically useful for the reader. In total, 27 chapters are included, contributed by leading relevant experts worldwide.

We now briefly describe each theme. The first one discusses characteristic key circuits and technologies for wireless power transfer in communication networks and briefly presents several regulations. The second theme presents several applications for achieving efficient communication in wirelessly powered networks and identifies relevant performance trade-offs. The next theme concerns basic efficient solutions for mobility management in WPT networks, both distributed and centralized. Mobile nodes and chargers, effective traversal strategies, cost minimization of mobile elements, and the use of cutting-edge technologies like UAVs are some of the proposed approaches. The fourth theme covers the concept of energy flow, a major challenge in wirelessly powered networks. Different aspects of energy flow are addressed, such as collaborative mobile charging, hierarchy assignment, use of resonant repeaters, and energy balance in populations of mobile peers. Different networking operations that can be combined with WPT are addressed in the fifth theme, such as routing, data gathering, and solar energy harvesting. The book concludes with a recent combination of research between wireless power transfer and electromagnetic radiation awareness. In particular, two algorithmic approaches, which apply radiation control methods to ensure human safety without sacrificing effectiveness, are presented.

We hope that this book will be helpful to its readers and contribute to a solid foundation and deeper understanding of the fascinating and rapidly evolving research area of wireless power transfer. The intended audience includes researchers, engineers, educators, and advanced graduate students interested in the area of wireless power transfer in ad hoc communication networks. In addition to use as a text for advanced university courses and research seminars, the book may also be used as a supplement to academic courses on algorithmic applications, wireless protocols, distributed computing, and networking.

## Acknowledgments

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