

Preface

Wireless Sensor Networks (WSNs) have become an increasingly active field of research in recent years. The very idea of making many small objects with limited capabilities (the sensors) collaborate to create a very versatile and powerful system (a WSN) has stimulated the intellectual and scientific “fantasies” of many researchers. In fact, WSNs can be studied from several perspectives. Moreover, besides their scientific appeal, they hold the promise of playing a key role in future communication and networking systems, such as machine-to-machine communication systems and the Internet of Things.

IEEE 802.15.4 is a Physical (PHY)/Medium Access Control (MAC) air interface commonly considered as a de facto standard for WSNs. While IEEE released the current version of the standard years ago and many books cover issues related to the use of IEEE 802.15.4 for WSNs, there is still a lack in the understanding of the true performance achievable in large WSNs using IEEE 802.15.4 when distributed processing techniques are applied to estimate the values taken by physical instances.

During spring 2009, after years of research performed on the topic of WSNs, Chiara Buratti and Marco Martalò received their Ph.D. degrees from the University of Bologna (under the supervision of Prof. Roberto Verdone) and the University of Parma (under the supervision of Prof. Gianluigi Ferrari), respectively. While research was carried out separately and the two Ph.D. theses were prepared independently, it was immediately clear that the two works were addressing the two faces of the same coin. Therefore, it was decided to put together the contents of the two theses to give birth to a coherent text providing the deepest possible knowledge of how the IEEE 802.15.4 MAC layer can be accurately modeled and of the limits of distributed processing, inherently connected to the MAC behavior, in WSNs. This book is the outcome of that will. However, it is even more.

This book is indeed composed of four parts. After a short introductory chapter on the fundamentals of WSNs, the second and third parts represent the core of Marco’s and Chiara’s theses, respectively, after proper alignment was found. More precisely, the second part ([Chaps. 2 and 3](#)) is dedicated to distributed processing in

WSNs, whereas the third part is dedicated to MAC and connectivity of WSNs. The fourth part is completely new, as it reports on the outcomes of the effort to integrate the models proposed and validated in the two Theses, to create a novel cross-layer framework for IEEE 802.15.4 system design.

It is our view that the book, in its final form, can assist a WSN designer, whose aim is the estimation of physical instances, in understanding all mechanisms lying behind IEEE 802.15.4 MAC and the application of distributed processing techniques. The book provides many performance charts and all means to generate a complete evaluation tool which is able to compute the performance, in terms of reliability, latency, energy efficiency, of an IEEE 802.15.4-based WSNs for environmental monitoring applications.

We would like to thank Dr. Cristoph Bauman, our Springer Engineering Editor, for immediately supporting our idea and allowing us to finalize this project. We are also indebted to several collaborators, whose help was instrumental. In particular: C. Buratti and R. Verdone would like to thank those scientists whose activities have had an impact on the content of this book: John Orriss, from the University of Manchester, and Flavio Fabbri from the University of Bologna; M. Martalò and G. Ferrari would like to thank Dr. Roberto Pagliari, Dr. Paolo Medagliani, and Marco Sarti for their contributions (while at the University of Parma) to Part II of the book. Authors would also like to thank Flavia Martelli for reading the draft of this book.

Bologna and Parma, September 2010

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Sensor Networks with IEEE 802.15.4 Systems
Distributed Processing, MAC, and Connectivity
Buratti, C.; Martalo', M.; Verdone, R.; Ferrari, G.
2011, XVIII, 250 p., Hardcover
ISBN: 978-3-642-17489-6