

# Preface

This book is by no means a treatise on all aspects of Intelligent Transportation Systems (ITSs). Rather, it attempts to present a unified perspective on ITS, encompassing a few advanced technologies which we came in touch with during part of our research activity in the last years. In particular, one of the peculiarities of this book is the presentation of possible solutions at various communication layers, encompassing both computer science-oriented (high layers) and telecommunication-oriented (low layers) perspectives. Along the way, we describe, in a coherent fashion, a number of interwoven innovative technologies. The approach is thus inherently cross-layer, in the sense that we cover different wireless communication protocols, but we also take into account application-level services. The intended audience is academic and industrial professionals, with good technical skills in information and communication technologies. To ease reading, we have limited as much as possible the mathematical details, which are mostly reported in the appendices of the book.

The contents of the book flow from a preliminary regulatory overview to more technical issues. The synopsis can be summarized as follows. The *first chapter* presents ITS principles and a brief standardization history, comparing European and US visions. Emerging worldwide ITS architectures are also illustrated, together with the most relevant envisioned ITS applications. The *second chapter* goes more deeply into the analysis of the communication paradigms and technologies that enable ITSs. Key challenges in vehicular networks are discussed, taking into account Vehicle-to-X (V2X) communications. A survey of the literature on centralized client/server and decentralized Peer-to-Peer (P2P) vehicular networks is proposed. This chapter terminates with the presentation of the most important enabling communication technologies for future ITSs, namely: cellular networks, WiFi, IEEE 802.11p, WAVE and ETSI ITS. The *third chapter* is fully devoted to wireless communications for Vehicular Ad hoc NETWORKs (VANETs). We first investigate probabilistic broadcast protocols with silencing, a recursive analytical performance evaluation framework and simulations. Then, we analyze the performance of VANETs as distributed wireless sensor networks. The *fourth chapter* presents X-NETAD, a hierarchical architecture for “cross-network” ITS

communications. Experimental results are illustrated and discussed. The *fifth chapter* focuses on application-level distributed algorithms for ITS. In particular, the Distributed Geographic Table (DGT) P2P overlay scheme is presented, and its performance is evaluated, relying on both analytical and simulation results. The DGT for Vehicular Networks (D4V) architecture, supporting a number of ITS applications, is finally presented.

We remark that the specific protocols and architectures considered in this book are “representative,” as opposed to “optimal.” In other words, we set to write this book mainly to provide the reader with our (limited) view on the subject. Our hope is that this book will be interpreted as a starting point and a useful comparative reference. Some of the tools used in the book (for example, the simulator DEUS) are open-source and available to the interested reader.

It is our pleasure to thank all the collaborators and students who were with us during the years of research which have led to this book, collaborating with our two groups at the Department of Information Engineering of the University of Parma: the Wireless Ad hoc and Sensor Networks (WASN) Lab and the Distributed Systems Group (DSG). We cannot thank them one by one, but their contributions were instrumental to get here. Finally, we express our sincere gratitude to Springer for giving us the opportunity to complete this project. In particular, we are indebted to Dr. Cristoph Bauman, who believed in this project from the very beginning, and to Mrs. Janet Sterritt-Brunner, our production project coordinator, who was very kind and (above all) very patient.

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