

Preface

Since the 1980s, commercial cellular networks have evolved over several generations, from providing simple voice telephony service to supporting a wide range of other applications (such as text messaging, web browsing, streaming media, social networking, video calling, and machine-to-machine communication) that are accessed through a variety of devices (such as smart phones, laptops, tablet devices, and wireless sensors). These developments have fueled a demand for higher spectral efficiency so that the limited spectral resources allocated for cellular networks can be utilized more effectively.

In parallel, starting in the mid-1990s [1], multiple-input multiple-output (MIMO) wireless communication has emerged as one of the most fertile areas of research in information and communication theory. The fundamental results of this research show that MIMO techniques have enormous potential to improve the spectral efficiency of wireless links and systems. These techniques have already attracted considerable attention in the cellular world, where simple MIMO techniques are already appearing in commercial products and standards, and more sophisticated ones are actively being pursued.

Goals of the book

In this book, we hope to connect these two worlds of MIMO communication theory and cellular network design with the goal of understanding how multiple antennas can best be used to improve the physical-layer performance of a cellular system. We attempt to strike a balance between fundamental theoretical results, practical techniques and core insights regarding the performance limits of multiple antennas in multiuser networks. Unlike books that focus on the theoretical performance of abstract MIMO channels, this one emphasizes the practical performance of realistic MIMO systems.

We present in the first part of the book a systematic description of MIMO capacity and capacity-achieving techniques for different classes of multiple-antenna channels. The second part of the book describes a framework for MIMO system design that accounts for the essential physical-layer features of practical cellular networks. By applying the information-theoretic capacity results to this framework, we present a unified set of system simulation studies that highlight relative performance gains of different MIMO techniques and provides insights into how best to utilize multiple antennas in cellular networks under various conditions. Characterizations of the system-level performance are provided with sufficient generality that the underlying concepts can be applied to a wide range of wireless systems, including those based on cellular standards such as LTE, LTE-Advanced, WiMAX, and WiMAX2.

Intended audience

The book is intended for graduate students, researchers, and practicing engineers interested in the physical-layer design of contemporary wireless systems. The material is presented assuming the reader is comfortable with linear algebra, probability theory, random processes, and basic digital communication theory. Familiarity with wireless communication and information theory is helpful but not required.

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