Software Radio: A Modern Approach to Radio Engineering

Jeffrey H. Reed
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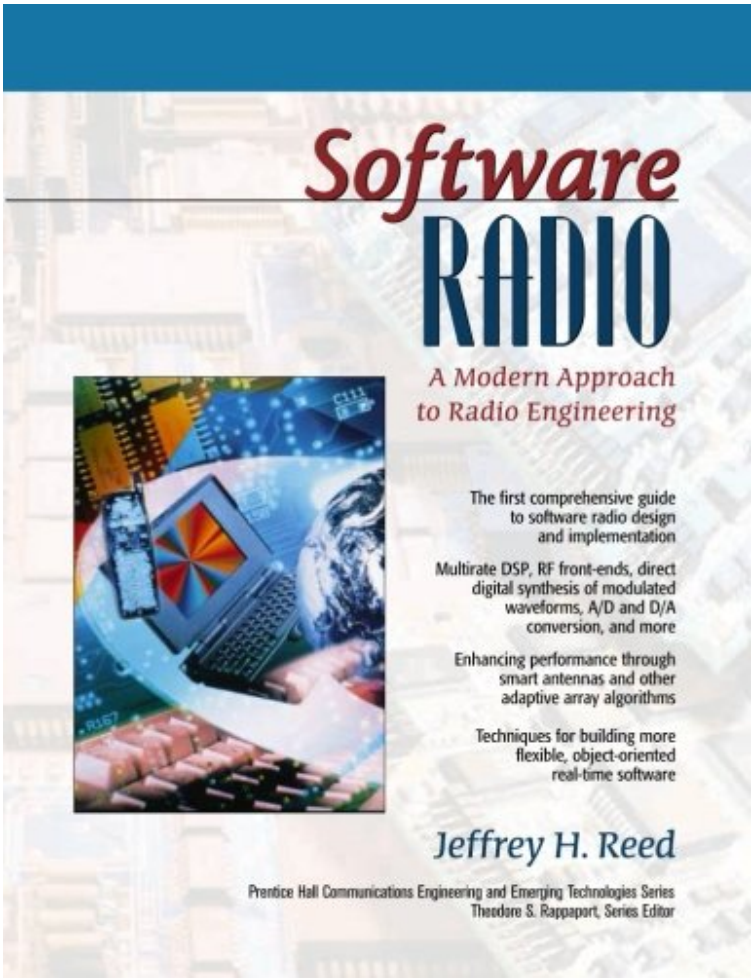

#914720 in Books 2002-05-30 2002-05-20Ingredients: Example IngredientsOriginal language:EnglishPDF # 1 9.10 x 1.40 x 7.00l, 2.04 #File Name: 0130811580592 pages | File size: 60.Mb

Jeffrey H. Reed : Software Radio: A Modern Approach to Radio Engineering before purchasing it in order to gage whether or not it would be worth my time, and all praised Software Radio: A Modern Approach to Radio Engineering:

1 of 1 people found the following review helpful. Graduate Student ReviewBy ASMy motivation for purchasing this text was for a graduate level course on Software Defined Review in Electrical Engineering. The text was somewhat useful with relatively clear illustrations, formulas, and text. The text was somewhat useful with clear illustrations and formulas but lacked the clarity desired to grasp a full understanding of the material from simply reading the book. As such, the text was primarily used as a reference source when lecture material failed to provided enough depth or coverage of a particular subject area. In summary, I would recommend purchasing this book if required but I would look for another text if you are simply trying to get a better understanding of the subject.0 of 0 people found the following review helpful. Very good bookBy John DonovanI usually expect any book coming out of a university to be

highly theoretical and math-centric, but this book is neither. It's a clear exposition of software radio concepts and issues, with a great deal of attention paid to signal generation and processing. Unlike another reviewer, I was happy to see 70 pages devoted to smart antennas, since any multi-protocol transceiver operating in the GHz range is going to need them. The exposition is clear, well developed and well written. More editing would have helped, but overall highly recommended.12 of 13 people found the following review helpful. Good book with many errors!By TechieThis book is a one-stop source for everything you need to know about Software Radio. So, this is an excellent text-book for a 1-semester course on software radio. Some of the concepts such as analog-to-digital conversion are discussed in detail, although the relevance of a 70 page chapter on smart antennas in a Software Radio book still eludes me. A good introduction to RF implementation issues is provided. There isn't too much Math in this book, which is both good and bad. My only complaint is that there are lot of errors, both conceptual and typographical, in this book and many of these errors are not addressed in the webpage maintained by the author. Otherwise, it is a very good book.

Software-based approaches enable engineers to build wireless system radios that are easier to manufacture, more flexible, and more cost-effective. Software Radio: A Modern Approach to Radio Engineering systematically reviews the techniques, challenges, and tradeoffs of DSP software radio design. Coverage includes constructing RF front-ends; using digital processing to overcome RF design problems; direct digital synthesis of modulated waveforms; A/D and D/A conversions; smart antennas; object-oriented software design; and choosing among DSP microprocessors, FPGAs, and ASICs. This is an excellent book for all RF and signal processing engineers building advanced wireless systems.

From the Back CoverThe definitive engineer's guide to designing and building software-based radios. The first systematic guide to software radio design and implementation Multirate DSP, RF front-ends, direct digital synthesis of modulated waveforms, A/D and D/A conversion, and more Enhancing performance through smart antennas and other adaptive array algorithms Techniques for building more flexible, extensible software Radios, once implemented purely in hardware, are increasingly built using programmable digital signal processing (DSP) devices that enhance device flexibility, simplify manufacture, and reduce costs. However, many engineers are unfamiliar with the latest techniques for building software radios for wireless systems and devices. This book fills the gap, introduces the key concepts of software radio design, and covers every issue and technique engineers must understand to successfully utilize DSP in their radio systems and subsystems. Coverage includes: Central role of multirate DSP in software radio design Constructing RF front-ends: utilizing digital processing to overcome key problems in RF design Direct digital synthesis of modulated waveforms A/D and D/A converters and conversion processes: key tradeoffs among resolution, sample rate, and dynamic range Enhancing performance through smart antennas and other adaptive array algorithms Practical techniques for choosing among DSP microprocessors, FPGAs, and ASICs A systematic, object-oriented approach to creating flexible software The book concludes with case studies drawn from the advanced work of the SDR Forum, the leading consortium of companies, universities, and research organizations promoting software radio development. Communications Engineering Emerging Technologies SeriesTheodore S. Rappaport, Series EditorAbout the AuthorJEFFREY H. REED, Director of the Mobile and Portable Radio Research Group (MPRG) and Associate Professor of Electrical Engineering at Virginia Tech, specializes in spread spectrum, position location, DSP, interference rejection, modem design, smart antennas, and software radios. Dr. Reed is co-editor of five textbooks. Excerpt. Reprinted by permission. All rights reserved. Preface Software radios represent a major change in the design paradigm for radios in which a large portion of the functionality is implemented through programmable signal processing devices, giving the radio the ability to change its operating parameters to accommodate new features and capabilities. A software radio approach reduces the content of radio frequency (RF) and other analog components of traditional radios and emphasizes digital signal processing to enhance overall receiver flexibility. This change in the design paradigm for new radios has occurred so rapidly that it has left a significant void in the educational material available to train new radio engineers. Traditional radio engineering textbooks emphasize analog component-level design with little mention of the increasingly important role of digital signal processing in performing the central functions of the radio transceiver. Individual references covering the key analog and digital subsystems tend to be insufficient in that they fail to provide a full understanding of the interaction between these subsystems. I became acutely aware of this void when conducting research into the development of novel high-performance radios for the Defense Advanced Research Projects Agency (DARPA). While constructing radio prototypes, I found there was no comprehensive resource to which I could point my students for information on how to build DSP-based radios. This experience, combined with similar frustrations voiced by my colleagues from both academia and industry, has led me to write this book on modern radio design principles. My goal in developing this book was to provide this necessary understanding of the interaction of key subsystems. Software radios are emerging in commercial and military infrastructure. This growth is motivated by the numerous advantages of software radios. Ease of designTraditional radio design requires years of experience and great care on the part of the designer to understand how the various system components work in conjunction with one another. The time required to develop a marketable product is a key

consideration in modern engineering design, and software radio implementations reduce the design cycles for new products, freeing the engineer from much of the iteration associated with analog hardware design. It is possible to design many different radio products using a common RF front-end with the desired frequency and bandwidth in conjunction with different signal processing software. Ease of manufactureNo two analog components have precisely identical performance, necessitating rigorous quality control and testing of radios during the manufacturing process. However, given the same input, two digital processors running the same software will produce identical outputs. Thus, the move to digital hardware reduces the costs associated with manufacturing and testing the radios. Multimode operationThe explosive growth of wireless has led to a proliferation of transmission standards, and in many cases, it is desirable that a radio operates according to more than one standard. For example, wireless carriers throughout the U.S. are deploying systems that make use of the GSM (Global System for Mobile Communications) standard in some markets and the IS-95 Code Division Multiple Access (CDMA) standard in other markets. Furthermore, the advent of third-generation wireless has introduced a number of standards within that framework. Traditionally, multimode operation has required multiple complete sets of hardware, increasing the size and cost of the radio. However, a software radio can change modes by simply loading appropriate software into the memory. Use of advanced signal processing techniquesThe availability of high speed signal processing on board the radio allows implementation of new receiver structures and signal processing techniques. Techniques such as adaptive antennas, interference rejection, and strong encryption, previously deemed too complex, are now finding their way into commercial systems as the performance of digital signal processors continues to increase. The impact will be enhanced range and quality of service to the consumer while reducing overall infrastructure cost for the service provider. Fewer discrete componentsA single high-speed digital processor may be able to implement many traditional radio functions such as synchronization, demodulation, error detection, and decryption of data, reducing the number of required components and decreasing the size and cost of a radio. Flexibility to incorporate additional functionalitySoftware radios may be modified in the field to correct unforeseen problems or upgrade the radio. For example, it may even be possible to transmit software upgrades to the radio, such as a new vocoder to handsets, to improve overall system performance. Another important improved functionality is the capability of self-diagnosis of the radio and network operations, which means improved reliability with less human intervention. Given these clear advantages and the increasing processing power available in commercial digital signal processing devices, I anticipate that radio engineers that software radios will become the standard approach for radio design. The challenge in creating the software radio is the broad scope of knowledge necessary, including digital signal processing algorithms, RF circuits, software methodologies, and digital circuits. The approach in this text is to provide an understanding of key areas in radio design for the digital signal processing engineer. For example, a digital signal processing engineer must know the ramifications of the choices in RF parameters and the resulting limitations to be able to understand the appropriate subsequent signal processing to account for these limitations. This book reviews critical and interdependent radio subsystems from the perspective of the DSP engineer. Chapter 1 provides a basic introduction to software radio concepts, discusses the benefits of software radios, and sets the stage for discussing software radio design. Digital signal processing engineers tend to know very little about RF engineering and, likewise, RF engineers tend to know very little about digital signal processing. However, to take full advantage of the software radio approach, these subsystems cannot be treated separately. Chapter 2 provides the digital signal processing engineer with fundamentals in constructing RF front-ends and describes processing that can be performed in the digital domain to overcome problem areas in RF design. Multirate digital signal processing uses different sample rates, and this is the topic of Chapter 3. This approach to signal processing is particularly important in software radios where bandwidths and sample rates are high initially and must be reduced for efficient subsequent processing. Multirate digital signal processing is commonly used to channelize the operating band into distinct communication channels. Multirate digital signal processing is also the foundation for modern synchronization techniques. Much of the flexibility of a software radio comes from being able to create arbitrary modulation types directly within the digital domain. In many cases, the direct digital synthesis methods used to generate these signals are more than just digitized realizations of analog techniques and afford the designer greater freedom in design signal waveforms. Chapter 4 surveys the topic of direct digital synthesis of modulated waveforms. Analog to digital converters and digital to analog converters, along with the power amplifier, are the most critical components in software radio design. The demands on these components can be very high. A rigorous understanding of the conversion process and the trade-offs between the resolution, sample rate, and dynamic range of the resulting system are the focus of Chapter 5. An important benefit of software radios is the ability to incorporate sophisticated algorithms, such as smart antennas, into the radio to enhance performance. Chapter 6 reviews the wide variety of adaptive array algorithms and hardware implementation issues. The basics of digital signal processing microprocessors, Field Programmable Gate Arrays (FPGAs), and Application Specific Integrated Circuits (ASICs) and how one would choose one these alternatives for constructing a software radio are discussed in Chapter 7. A systematic design approach to creating software is essential to enable expandability of the radio capability. Furthermore, as new applications are created to run over the software radio, the radio itself must become transparent to the new applications. Chapter 8 examines object-oriented programming approaches, including JAVA

and Common Object Request Broker Architecture (CORBA) for creating software radios. Chapter 9 examines some examples of software radios that have been built. The Software-Defined Radio (SDR) Forum, a consortium of companies, universities, and research organizations, has defined guidelines and standards for the creation of software radios. A description of this standardized software radio is provided in this chapter. If this book is being used for a course, there is much flexibility in selecting chapters to create a customized course. For the one semester class, I recommend covering Chapters 1-3, Sections 4.1-4.8, 5.1-5.4, 6.1-6.6, 7.1-7.3, and Chapters 8-9. For a class on the quarter system, I recommend Chapters 1, 2, and 5, Sections 6.1-6.5, Chapter 8, and Sections 9.1-9.3. Although there is much latitude in mixing and matching sections to customize the course to the instructor's objectives, I do recommend that Chapters 8 and 9 be covered together as a single unit. Students who have an electrical engineering background in basic circuit analysis (typically junior-level), computer architecture (junior- or senior-level), and communications (senior-level) have a sufficient background for all chapters in this book. URLs included in the text and in citations were correct when the book was written. However, due to the dynamic nature of the World Wide Web, URLs may no longer be active. Periodic updates, information for instructors, and errata to the book can be found at http://www.mprg.org/publications/Reed/SWRbook.shtml. Additional information about software radios can be found at http://www.softradios.com