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THIRD EDITION
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Dedication

For Jean and Ruth, Ron and Pam, Seana and Riley. This is also for Shelby, whose artistic skill I endeavor to replicate in my writings.
Foreword

Jim McCabe’s third edition of *Network Analysis, Architecture, and Design* defines a disciplined approach to network architecture and design. Jim’s approach addresses the critical elements required to successfully design and deploy networks in an increasingly complex environment. There is constant pressure to deploy new features and services while increasing the quality of existing services and network security. In addition, market forces are pressing network operators to closely manage investment in new infrastructure and decrease operations and maintenance costs. In the three years since Jim released the second edition the landscape has fundamentally changed. It is no longer possible to overbuild the network and hope to “grow” into it. Converged services, Voice over IP, and emerging IPv6 deployments are forcing network architects to return to the fundamentals of engineering best practices.

Jim’s focus on requirements analysis, design traceability, and design metrics is right on target. Jim has developed a mature, repeatable methodology, that when followed properly, produces well-engineered and scalable networks. This is not a book on the theory of network architecture and design, it is a practical guide based on Jim’s wealth of experience. The concepts have been proven in the successful deployment of numerous networks.

The timing of this edition could not be better. We are at the start of a major transition, deploying the next generation of networks. Jim provides the guidance to successfully architect and deploy them.

John McManus, US Department of Commerce
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Preface

*Network Analysis, Architecture, and Design, Third Edition* is about making intelligent, informed network engineering decisions. This includes processes to develop and validate requirements for your project, and applying them in making architecture and design decisions. These processes have been adopted by corporations, universities, and government agencies around the world.

Although this book focuses on networking, the decision-making processes can be applied to any IT engineering project, from developing a national network to a small enterprise LAN, from an overall network upgrade to focusing on particular capabilities such as VPNs, QoS, or MPLS. For example, the processes in this book have recently been applied to projects to develop an external security perimeter (as part of a defense-in-depth strategy) and an IPv6 addressing architecture.

During the ten years that span the publications of the first and second editions of *Network Analysis, Architecture, and Design*, several concepts in this book have entered the mainstream of network engineering. Traffic flow analysis, and the coupling of requirements to traffic flows, is increasingly important in providing security and performance across the network. Developing and validating requirements to formally prepare for the network design are essential to ensure accuracy and consistency within the design.

*Network Analysis, Architecture, and Design, Third Edition* provides an updated design section that includes how to evaluate and select vendors, vendor products, and service providers, as well as diagramming the design. The analysis sections have also been updated to couple requirements to the architecture and design, including requirements validation and traceability.

Approach

*Network Analysis, Architecture, and Design, Third Edition* will help you to understand and define your network architecture and design. It examines the entire system, from users and their applications, to the devices and networks that support them.
Preface

This book is designed to be applied to undergraduate and graduate programs in network engineering, architecture, and design, as well as for professional study for IT engineers and management (including CTOs and CIOs). It is structured to follow the logical progression of analyzing, developing, and validating requirements, which form the basis for making decisions regarding the network architecture, which in turn forms the basis for making network design decisions. When I teach network analysis, architecture, and design at universities, corporations, or conferences, I find that students readily adapt the material in this book as part of their engineering process.

In this book, I provide you with step-by-step procedures for doing network analysis, architecture, and design. I have refined this process through years of architecting and designing large-scale networks for government agencies, universities, and corporations, and have incorporated the ideas and experiences of expert designers throughout the book. Like an open standard for a technology or protocol, the procedures in this book are the result of several contributions, and offer you the cumulative experience of many network architects and designers.

I tackle some of the hard problems in network analysis, architecture, and design, and address real architecture and design challenges, including how to:

- Gather, derive, define, and validate real requirements for your network
- Determine how and where addressing and routing, security, network management, and performance are implemented in the network, and how they interact with each other
- Evaluate and select vendors, vendor products, and service providers for your project
- Developing traceability between requirements, architecture decisions, and design decisions
- Determine where to apply routing protocols (RIP/RIPv2, OSPF, BGP-4, MPLS), as well as classful and classless IP addressing mechanisms
- Determine where to apply performance mechanisms, including quality of service, service-level agreements, and policies in your network

In addressing challenges such as these, I provide guidelines, examples, and general principles to help you in making the tough decisions. You may find some or all of them to be useful, and I encourage you to modify them to fit your architecture and design needs.
For those using this book in a class or for self-study, there are a number of exercises at the end of each chapter. In addition, the Web page for this book at the publisher's Web site (www.mkp.com) contains additional material useful in your progress through the book, as well as a password-protected solutions manual to the exercises available to instructors.

Roadmap

The first four chapters are based on the systems approach, requirements analysis, and flow analysis from the first edition. They have been updated to include changes and improvements in network analysis since the release of the second edition. Chapter 1 introduces network analysis, including the systems approach, and provides definitions and concepts that will be used throughout the book. Chapters 2 and 3 focus on the concepts and process of determining requirements for your network, and Chapter 4 discusses how traffic flow analysis can be used to couple performance requirements to various traffic flows.

Chapters 5 through 9 cover the network architecture process. Chapter 5 provides an introduction to network architecture, developing internal and external relationships within and between major functions (addressing and routing, security, network management, and performance) in the network. Chapters 6 through 9 detail each of these major functions, developing component and reference architectures that describe their internal and external relationships.

Chapter 10 discusses the design process. This takes the results of the previous chapters and applies them toward making design decisions, including how to evaluate and select vendors, vendor products, and service providers, and diagramming the design.

For appropriate chapters, I have provided a list of recommended reading that will be useful to you in understanding the concepts of that chapter. Since this book introduces a fair number of new concepts, I also provide an extensive glossary of acronyms and terms that are used throughout the book.

Acknowledgments

First of all, many thanks to Pat Dunnington (NASA) and John McManus (Department of Commerce) for giving me the opportunity to refine the latest design
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concepts during my time at NASA. I would also like to thank Havi Hoffman for use of her photo “Teaching Space to Curve” as the front cover of this book.

Also, thanks to Tony Arviola and Bessie Whitaker of NASA for their help in adopting the concepts of this book and applying them to several engineering projects across NASA.

The material presented in this book is based on a compilation of my own professional experiences and those of other members of the networking community. As always, I am solely responsible for any errors in this book. The analysis, architecture, and design processes are continually evolving, and any feedback from you on how to improve these processes is most welcome. Questions, comments, and suggestions can be sent to me at doowah_1@yahoo.com or through Morgan Kaufmann Publishing.

The people at Morgan Kaufmann Publishing have been a wonderful influence on the development of this edition. Many thanks to Dr. David Clark (Series Editor), Rick Adams (Senior Acquisitions Editor), Rachel Roumeliotis (Associate Editor), and Kathryn Liston (Project Manager).

The chapters on requirements and flow analyses are based on early work on data flow analysis done while I was at the Numerical Aerodynamic Simulation (NAS) facility at NASA Ames Research Center in Mountain View, CA. I owe much thanks to Bruce Blaylock, who had the foresight to encourage this work, as well as the tenacity to help me through the process.