

# **Network Services Investment Guide**

**Maximizing ROI in Uncertain Times**

Mark Gaynor



WILEY

Wiley Publishing, Inc.

Publisher: Robert Ipsen  
Editor: Carol A. Long  
Developmental Editor: Adaobi Obi Tulton  
Editorial Manager: Kathryn A. Malm  
Managing Editor: Pamela M. Hanley  
New Media Editor: Brian Snapp  
Text Design & Composition: Wiley Composition Services

This book is printed on acid-free paper. ∞

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Published by Wiley Publishing, Inc., Indianapolis, Indiana

Published simultaneously in Canada

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*Library of Congress Cataloging-in-Publication Data:*

Gaynor, Mark, 1956 –

Network services investment guide: maximizing ROI in uncertain times / Mark Gaynor.

p. cm. — (Wiley Networking Council series)

Includes bibliographical references (p. 285) and index.

ISBN 0-471-21475-2 (paper)

1. Telecommunication systems—Management. 2. Data transmission systems. 3. Integrated services digital networks. I. Title. II. Series.

HE7631 .G26 2002

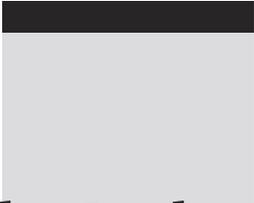
384.3'3—dc21

2002014611

ISBN 0-471-21475-2

Printed in the United States of America

10 9 8 7 6 5 4 3 2 1



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# Foreword

## Networking Council Foreword

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The Networking Council Series was created in 1998 within Wiley's Technology Publishing group to fill an important gap in networking literature. Many current technical books are long on details but short on understanding. They do not give the reader a sense of where, in the universe of practical and theoretical knowledge, the technology might be useful in a particular organization. The Networking Council Series is concerned more with how to think clearly about networking issues than with promoting the virtues of a particular technology—how to relate new information to the rest of what the reader knows and needs, so the reader can develop a customized strategy for vendor and product selection, outsourcing, and design.

In *Network Services Investment Guide: Maximizing ROI in Uncertain Times* by Mark Gaynor, you'll see the hallmarks of Networking Council books—examination of the advantages and disadvantages, strengths and weaknesses of market-ready technology, useful ways to think about options pragmatically, and direct links to business practices and needs. Disclosure of pertinent background issues needed to understand who supports a technology and how it was developed is another goal of all Networking Council books.

The Networking Council Series is aimed at satisfying the need for perspective in an evolving data and telecommunications world filled with hyperbole, speculation, and unearned optimism. In *Network Services Investment Guide*, you'll get clear information from experienced practitioners.

We hope you enjoy the read. Let us know what you think. Feel free to visit the Networking Council Web site at [www.wiley.com/networkingcouncil](http://www.wiley.com/networkingcouncil).

*Scott Bradner*  
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*Vinton Cerf*  
*Senior Vice President, WorldCom*

*Lyman Chapin*  
*Chief Scientist, Founding Trustee of the Internet Society*



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# Introduction

This book analyzes network-based services using a new framework that links market uncertainty to the choice between distributed management structure and centralized management structure. It explores communications technology and suggests how investors, managers, service providers, and consultants can make better decisions about technology. It also highlights how new technologies are adopted and evolve. This book introduces a new way to think about the management structure of network-based services such as email and voice mail.

In Part One, the critical link between market uncertainty and the choice between distributed and centralized management structure is explained, and examples that illustrate the power of this linkage are given. Part One explains why high market uncertainty favors distributed management, while centralized management does better when market uncertainty is low. Part Two contains two case studies of email and voice mail that demonstrate how this theory explains the history of these network services. Part Three applies ideas from Part One to several new technologies: Voice-over-IP (VoIP) wireless network infrastructure and Web applications and services. The chapter explores the predominant theme illustrated in examples from this book: Flexibility in choice between centralized and distributed management creates value for users and service providers. Last, I give advice to different types of readers of this book. For example,

I discuss how a venture capitalist should apply this theory to help decide when to invest in particular technologies.

This book presents an options framework to analyze the decisions about the architecture of network-based services and how these services should be managed, thereby giving managers a strategic advantage in today's uncertain world. The most important concept in this book is how to benefit from uncertainty by leveraging flexibility. Flexibility in uncertain markets creates value because it allows firms to optimize profitability by having a strategy that incorporates new information. Options illustrate the trade-offs between efficiency and flexibility — the greater the uncertainty, the greater the value of flexibility. Managers who know when flexibility has a greater value than efficiency (and other business advantages of centralized management structure) have a strategic advantage in today's uncertain and dynamic IT world.

A novel idea in this book is that choice in management structure is linked to market uncertainty. That is, the higher the market uncertainty, the greater the value of distributed management because it allows more experimentation. When market uncertainty is low, however, this benefit of easy experimentation evaporates, and the efficiencies of centralized management architecture become the dominating factor in this complex decision about management structure. Past approaches have based the choice of optimal management structure on any one of several different methodologies. Possible bases for the choice of management structure include whether it offers business or technical advantages and whether it allows wide latitude in the ability to create and implement new services. Some management structures offer the business advantage of knowing who the users are, as well as what they are doing. This increase in available information is a huge advantage to the network manager. A particular management structure may allow more efficient management, such as central distribution of software or more efficient use of resources. One management structure may have technical advantages over another in terms of how complex a feature is to design and implement. Other management structures promote innovation, but they may do so at the expense of business and technical advantages. Management structures that promote innovation, such as end-2-end structure, allow experimentation by many participants because of the relatively low entry barriers and freedom to try new ideas. Previous research, though, has failed to link market uncertainty to choice of management structure. The case studies in Part Two illustrate this link between market uncertainty and management architecture by explaining previous choices managers and vendors made in the circuit-switched public phone network and the packet-switched Internet.

This book demonstrates that high market uncertainty enhances the value of innovation. In low market uncertainty, the business and technical advantages of a particular management structure are more important than the value of innovation. When market uncertainty is high, management structures that are less efficient and have other business and technical disadvantages, yet allow easy experimentation, are justifiable because of the high value of innovation. On the other hand, if market uncertainty is low, experimentation is of diminished value because it is easy to meet the well-understood needs of the user. This indicates that the value of innovation is less than that of the potential advantages offered by management structures that are more efficient and have other technical advantages. Market uncertainty is linked to the management structure of a network service by showing how it affects the value of innovation relative to the business and technical advantages of a more efficient, but less flexible management structure. This unifies previous approaches into a more general theory, which will lead to choosing the most appropriate management structure for a network service in a given market condition. This general theory explains behavior in today's two most important, yet very different, networks: the Internet and the Public Switched Telephone Network (PSTN).

The telephone network and the Internet are very different: one is intelligent (telephone), and one is not (Internet) [1]. In many countries (including the United States), the telephone network works well in providing voice services to many, at prices most can afford. While the centralized structure of the smart telephone networks is successful, the innovation that has occurred in the "stupid" Internet towers above that within the intelligent telephone network. One reason for the tremendous innovation in the Internet is because of the end-2-end (see Chapter 3) argument that promotes experimentation by end users. Although the telephone and the Internet are fundamentally different, they have many similarities: Both give managers choices about how to manage the services provided over these very different networks. In addition, management can make choices about what to outsource and what to build/manage in-house, as well as how to design any internal systems. Finally, in both systems, market uncertainty affects the value of these choices to an organization's bottom line.

This book advances the end-2-end argument by illustrating what conditions are suited for end-2-end applications. At the outset, the end-2-end ideas focused on the technical advantages of simple networks with complex edges and ends. One reason that end-2-end architecture has great value is that users sometimes come up with better solutions, which may not be the result of greater creativity, but rather the result of more experiments. Furthermore, the value of user innovation depends on the market

uncertainty: High market uncertainty implies tremendous gain when users can experiment, but low market uncertainty suggests that many users are unlikely to devise better services than those offered by a few large, centralized service providers. This book links the value of end-2-end application structure to market uncertainty, thereby helping managers and designers decide how to apply the end-2-end argument to maximize value.

## **Organization of the Book**

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This book is organized into three parts: general theory, case studies, and applying the theory to current technologies. The six chapters in Part One present an intuitive explanation of the theory linking market uncertainty to choice in management structure (this theory is the framework of this book and was developed for my Ph.D. thesis). Part Two contains two case studies that validate this theory. These cases are two of the most successful network-based services: basic/advanced voice services and email. These cases illustrate how market uncertainty was an important factor in determining what management structure users preferred in the past. Part Three applies theories in this book to several upcoming technologies, including Voice over IP (VoIP), wireless network infrastructure (802.11 and cellular), and Web applications and Web-based services. The book ends with the appendix, which presents a formal description of the theory.

### **Part One – General Intuitive Theory**

Part One is an overview of important concepts, including definitions of network-based services and their management structure, the end-2-end argument, market uncertainty, and options. It is geared toward how managers and investors can apply the particular concepts to decisions they must make in today's IT world. Part One should be read by all readers.

### ***Chapter 2 – Network-Based Services***

Chapter 2 discusses network-based services: why these services have market uncertainty and what it means to experiment with network-based services. The framework for understanding different management structures is introduced by discussing the trade-offs between centralized and distributed management architecture and how users shift between different management structures for similar services. It illustrates network-based services in two important networks: the Public Switched Telephone Network (PSTN) and the Internet. It explains how changes in market uncertainty are

a factor in deciding what management architecture will best meet users' needs. In the PSTN's long history, market uncertainty has cycled between high and low. The shorter Internet history has seen decreasing market uncertainty for mature services such as email, but high market uncertainty for new technologies such as VoIP, wireless services, Web applications, and Web services. The strengths of centralized management structure, such as efficiency, stability, and consistency, are contrasted to its weaknesses of being inflexible and hard to experiment with. Distributed management architecture has opposite attributes: It is flexible and easy to experiment with; however, it is not as good at efficiently using its resources and may be a less stable and consistent environment. The main point of this chapter is understanding how similar services can be managed with different management structures (centralized to distributed) and the advantages and disadvantages of each.

### ***Chapter 3 – Internet End-2-End Argument***

This chapter introduces the end-2-end design principle, as well as its history and meaning in today's Internet. Many (including me) believe that the end-2-end argument is one key reason the Internet has seen so much innovation — its basic idea is to keep the network simple, moving as much complexity as possible to the end points of the network. This end-2-end principle applied to applications suggests that the less information the internal network infrastructure knows about any application, the better. End-2-end argues for simple network infrastructure and complicated end devices. One example of an end-2-end protocol is the Transmission Control Protocol (TCP), which is a transport protocol used for the Web. TCP is end-2-end because only the two end points of the TCP connection know a connection exists. The history of the end-2-end argument is traced from its beginning, with ideas from cryptography and transaction processing, to newer applications of end-2-end principles in the modern Internet, such as business transactions where participants need authentication and authorization. The Internet has changed — trust is no longer assumed, which is leading to changes in the Internet's overall architecture. New ideas, such as Network Address Translators (NATs), break the end-2-end model in evil ways, such as breaking the rule of unique global addressing of end points. Other ideas, such as a transaction consisting of several end-2-end interactions (for example, authentication services), make sense in the untrusted world of today. The important concept in this chapter is to understand why the end-2-end argument has created so much value in the Internet and how to keep applying this principle to continue promoting innovation in the future.

### ***Chapter 4 – Management Structure of Network-Based Services***

This chapter provides a more detailed comparison of the attributes of centralized versus distributed management structure. Examples from email, voice, and information services are included. It presents a hierarchical framework that examines the choices management must make. From top-level decisions (such as outsourcing or not) to lower-layer decisions (such as choosing the structure of the network infrastructure when building and managing your own services), this multilevel approach is applied first to email — examining the choices between outsourcing and managing one’s own email service. Next, different options for voice services — such as buying a Private Branch Exchange (PBX) or renting Centrex service from the telephone company — are explained in this hierarchical structure. Last, we look at providing information over the Internet, as well as the different choices management has — from outsourcing, to building a farm of servers, to utilizing a large mainframe to consolidate many information servers. The most important point of this chapter is to understand not only that there are many choices in how to manage network services, but also how these decisions affect the ability of users and others to innovate by experimenting with new services.

### ***Chapter 5 – Intuitive View of Options Theory***

The theory of options explains the value of choice in capital markets. This theory is an accepted tool in modern finance to value financial assets in uncertain markets and build investments to suit many different investors. Options theory illustrates the value of having flexibility, as well as how this value grows as uncertainty increases. This theory has been extended (real options theory) to value nonfinancial assets such as investments in research and development, building IT infrastructure, and valuing modularity when building complex systems. Without dwelling on the complex mathematics explaining the theory behind options and real options, this chapter provides an intuitive look at this important theory. The value of giving users choices in capital markets and how this value increases with greater market uncertainty will be discussed. Options theory illustrates the value of flexibility and thinking in terms of keeping one’s options open. The most important concept in this chapter is to understand how the options framework explains why greater market uncertainty increases the value of having many choices.

## ***Chapter 6 – Market Uncertainty***

In Chapter 6, market uncertainty, as well as how to measure it and its effect on the value of experimentation, is explained in detail. Market uncertainty occurs when vendors, service providers, and even users don't know what will be successful. Historically, market uncertainty for Information Technology has been high, with wrong predictions being the rule. Consider Asynchronous Transfer Mode (ATM) and Integrated Service Digital Network (ISDN): two technologies that were predicted to become winners, but that never became successful. After further defining market uncertainty, this chapter explores different methodologies to gauge its level. These include mythologies used by others, as well as new methods explored in research for my Ph.D. thesis. The chapter ends by linking the level of market uncertainty to the value of experimentation: the greater the market uncertainty, the larger the gain from experimentation. Chapter 6 illustrates how low market uncertainty translates to little value of experimentation because all the experiments are close to average. High market uncertainty, though, spreads out the results of many experiments — some results are terrible, being way below the mean, while other results are fantastic, having values far greater than average. The critical point of this chapter is to understand how to gauge the level of market uncertainty and why it is linked to the value of experimentation (the higher the market uncertainty, the greater the value of experimentation).

## ***Chapter 7 – Theories about How to Manage Network-Based Services***

Part One ends with a short chapter that puts everything together and presents a theory explaining how market uncertainty is an important factor in deciding how to manage network-based services. Chapter 7 first scopes services to which the theory applies and then illustrates the trade-offs between the business and technical advantages of centralized management structure and the flexibility and easy experimentation of distributed management architecture. This chapter weaves together the previous chapters in Part One into an intuitive and easy-to-understand theory. The most important point in this chapter is to understand why market uncertainty is a factor that managers and investors must consider in order to maximize value when choosing the best management structure for the current environment and how flexibility in this management structure creates value in dynamic environments.

## **Part Two – The Case Studies**

Part Two consists of cases studies of two popular network-based services: email and voice. Each case starts with a discussion of the service's history, which illustrates concordance with the theories from Part One. Next, shifts in management structure are shown to occur in coordinating to changes in market uncertainty. These cases illustrate how important market uncertainty is as a force shaping the management architecture that works best. These two cases demonstrate the strength of the theory because it explains the evolution of two very different network services, in two very different types of networks (PSTN compared to the Internet). Each service, in each network, has evolved by giving users choices in how to manage these services.

### ***Chapter 8 – Email***

Email is one of those services that I find hard to believe I ever lived without. It has become a mainstream and ubiquitous way of communication. Email's evolution fits well within the framework based on the theory from Part One: It started out with a distributed management architecture and evolved such that users have choices between email systems with distributed or centralized management structures. At birth, email consisted of one user sending another user a file over a file transfer protocol such as FTP. Today, email service providers, such as Hotmail, that provide email with a centralized management structure have the fastest growth. The current environment allows choice in how to manage your email services, from the most distributed to the most centralized. This case examines the shift of users from distributed to more centralized email architecture in the mid-90s — at the same time that market uncertainty was low by several measures. The evidence argues that market uncertainty is the main factor causing this shift in management structure from a distributed structure, ISP-based email to a more centralized, Web-based email architecture. The important concept in this chapter is that market uncertainty can cause shifts in management structure (as seen in the shift of users to a centralized email structure).

### ***Chapter 9 – Voice Services***

Voice has a long history, but for most of it, market uncertainty was very low because of regulation. Until recently, users had only one choice for voice service or equipment — AT&T was the only option by law. The regulatory environment relaxed starting in 1968 with the *Carterfone Decision*,