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Packet delay and energy consumption are important considerations in wireless and sensor networks as these metrics directly affect the quality of

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service of the application and the resource consumption of the network; especially, for a rapidly growing class of real-time applications that impose strict restrictions on packet delays.

Dynamic rate control is a novel technique for adapting the transmission rate of wireless devices,

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almost in real-time, to opportunistically exploit time-varying channel conditions as well as changing traffic patterns. Since power consumption is not a linear function of the rate and varies significantly with the channel conditions, adapting the rate has significant benefits in minimizing

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energy consumption. These benefits have prompted significant research in developing algorithms for achieving optimal rate adaptation while satisfying quality of service requirements. In this book, we provide a comprehensive study of dynamic rate control for energy minimization under packet

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delay constraints. We present several formulations and approaches adopted in the literature ranging from discrete-time formulations and dynamic programming based solutions to continuous-time approaches utilizing ideas from network calculus and stochastic optimal control theory. The

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goal of this book is to expose the reader to the important problem of wireless data transmission with delay constraints and to the rich set of tools developed in recent years to address it. Table of Contents: Introduction / Transmission Rate Adaptation under Deadline Constraints / Average Delay

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Constraints

This revised textbook motivates and illustrates the techniques of applied probability by applications in electrical engineering and computer science (EECS). The author presents information processing and communication systems that use

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algorithms based on probabilistic models and techniques, including web searches, digital links, speech recognition, GPS, route planning, recommendation systems, classification, and estimation. He then explains how these applications work and, along the way, provides the

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readers with the understanding of the key concepts and methods of applied probability. Python labs enable the readers to experiment and consolidate their understanding. The book includes homework, solutions, and Jupyter notebooks. This edition includes new topics such as Boosting, Multi-armed

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bandits, statistical tests, social networks, queuing networks, and neural networks. For ancillaries related to this book, including examples of Python demos and also Python labs used in Berkeley, please email Mary James at mary.james@springer.com. This is an open access book.

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The last decade has seen an unprecedented growth in the demand for wireless services. These services are fueled by applications that often require not only high data rates, but also very low latency to function as desired. However, as wireless networks grow and support

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increasingly large numbers of users, these control algorithms must also incur only low complexity in order to be implemented in practice. Therefore, there is a pressing need to develop wireless control algorithms that can achieve both high throughput and low delay, but with low-complexity

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operations. While these three performance metrics, i.e., throughput, delay, and complexity, are widely acknowledged as being among the most important for modern wireless networks, existing approaches often have had to sacrifice a subset of them in order to optimize the others, leading

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to wireless resource allocation algorithms that either suffer poor performance or are difficult to implement. In contrast, the recent results presented in this book demonstrate that, by cleverly taking advantage of multiple physical or virtual channels, one can develop new

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low-complexity algorithms that attain both provably high throughput and provably low delay. The book covers both the intra-cell and network-wide settings. In each case, after the pitfalls of existing approaches are examined, new systematic methodologies are provided to develop algorithms that

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perform provably well in all three dimensions.

Tackles the many issues surrounding one of the most important assets in any company: its network. Modern networks need to be fast and effective to meet the ever-increasing need to for more information and faster

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communication. This text offers a clear and concise presentation of the key issues for those involved in the purchase, management, planning and implementation of communication networks. It provides the broad technical understanding required to ask the right questions, set viable

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plans and avoid expensive investment and deployment mistakes. * Explains effective and practical design techniques for communication networks * Advises how to avoid the common pitfalls associated with setting up and running a network * Focuses on the techniques for

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planning and assembling network technology * Presents numerous real examples This is essential reading for network designers and will be recommended reading for students in computer science, electrical and electronic engineering and telecommunications courses. Norris

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and Pretty tackle the many issues surrounding the design of one of the most important communication infrastructures in a company. The enterprise network needs to be fast and effective to meet an ever increasing demand for more information and communication. It

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provides broad technical understanding to aid those involved in the purchase, management, planning and implementation of enterprise networks. Effective and practical design techniques are explained in detail and are illustrated with real examples. It also discusses the

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associated pitfalls which often occur to show the reader what not to do when setting up a network.

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Performance Modeling, Stochastic

Networks, and Statistical Multiplexing

Network Games

A Concise Introduction, Second

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Edition

Performance Modeling of
Communication Networks with Markov
Chains

***Algorithmic discrete
mathematics plays a key
role in the development***

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***of information and
communication
technologies, and
methods that arise in
computer science,
mathematics and
operations research - in***

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***particular in algorithms,
computational
complexity, distributed
computing and
optimization - are vital to
modern services such as
mobile telephony, online***

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banking and VoIP. This book examines communication networking from a mathematical viewpoint. The contributing authors took part in the European

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COST action 293 - a four-year program of multidisciplinary research on this subject. In this book they offer introductory overviews and state-of-the-art

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***assessments of current
and future research in the
fields of broadband,
optical, wireless and ad
hoc networks. Particular
topics of interest are
design, optimization,***

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robustness and energy consumption. The book will be of interest to graduate students, researchers and practitioners in the areas of networking, theoretical

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***computer science,
operations research,
distributed computing
and mathematics.***

***How do cell phones
change society? How do
children use computers?***

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How can we manage relationships via text messages? The internet, television, email and other new forms of information technology are changing at a rapid

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pace with potentially profound but also subtle influences on social life. This book offers a succinct introduction to both the experience and implications of these

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information and communication technologies (ICTs) in everyday life. Drawing on a wide variety of studies from different countries, the author considers the

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***potential, or feared,
social consequences of
ICTs. Throughout, he
analyzes what factors are
shaping the debates
surrounding information
and communication***

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technologies. The outcome is a cutting-edge book that offers a fresh approach to understanding ICTs and everyday life.

This book is an

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***introduction to Markov
chain modeling with
applications to
communication networks.
It begins with a general
introduction to
performance modeling in***

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Chapter 1 where we introduce different performance models. We then introduce basic ideas of Markov chain modeling: Markov property, discrete time

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***Markov chain (DTMC)
and continuous time
Markov chain (CTMC).
We also discuss how to
find the steady state
distributions from these
Markov chains and how***

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they can be used to compute the system performance metric. The solution methodologies include a balance equation technique, limiting probability

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technique, and the uniformization. We try to minimize the theoretical aspects of the Markov chain so that the book is easily accessible to readers without deep

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mathematical

***backgrounds. We then
introduce how to develop
a Markov chain model
with simple applications:
a forwarding system, a
cellular system blocking,***

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slotted ALOHA, Wi-Fi model, and multichannel based LAN model. The examples cover CTMC, DTMC, birth-death process and non birth-death process. We then

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introduce more difficult examples in Chapter 4, which are related to wireless LAN networks: the Bianchi model and Multi-Channel MAC model with fixed

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duration. These models are more advanced than those introduced in Chapter 3 because they require more advanced concepts such as renewal-reward theorem and the

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queueing network model.

We introduce these

concepts in the appendix

as needed so that readers

can follow them without

difficulty. We hope that

this textbook will be

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***helpful to students,
researchers, and network
practitioners who want to
understand and use
mathematical modeling
techniques. Table of
Contents: Performance***

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Modeling / Markov Chain

Modeling / Developing

Markov Chain

Performance Models /

Advanced Markov Chain

Models

This monograph presents

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***a concise mathematical
approach for modeling
and analyzing the
performance of
communication networks
with the aim of
introducing an***

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appropriate mathematical framework for modeling and analysis as well as understanding the phenomenon of statistical multiplexing. The models, techniques, and results

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***presented form the core
of traffic engineering
methods used to design,
control and allocate
resources in
communication
networks. The novelty of***

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***the monograph is the
fresh approach and
insights provided by a
sample-path methodology
for queueing models that
highlights the important
ideas of Palm***

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distributions associated with traffic models and their role in computing performance measures. The monograph also covers stochastic network theory including

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Markovian networks.

Recent results on network utility optimization and connections to stochastic insensitivity are discussed. Also presented are ideas of large buffer,

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and many sources asymptotics that play an important role in understanding statistical multiplexing. In particular, the important concept of effective

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***bandwidths as mappings
from queueing level
phenomena to loss
network models is clearly
presented along with a
detailed discussion of
accurate approximations***

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for large networks.

Overlapping Coalition

Formation Games in

Wireless Communication

Networks

A New Metric for

Information Freshness

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Sustainable Wireless

Networks

Communication

Networks, 2nd Edition

***Concise Encyclopedia of
Latin American Literature***

First Published in 2001. Routledge is an

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imprint of Taylor & Francis, an informa company.

This book results from many years of teaching an upper division course on communication networks in the EECS department at the University of California, Berkeley. It is motivated by the perceived need for an easily accessible textbook that

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puts emphasis on the core concepts behind current and next generation networks.

After an overview of how today's Internet works and a discussion of the main principles behind its architecture, we discuss the key ideas behind Ethernet, WiFi networks, routing, internetworking, and TCP. To make the book as self-

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contained as possible, brief discussions of probability and Markov chain concepts are included in the appendices. This is followed by a brief discussion of mathematical models that provide insight into the operations of network protocols. Next, the main ideas behind the new generation of wireless networks based on

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LTE, and the notion of QoS are presented. A concise discussion of the physical layer technologies underlying various networks is also included. Finally, a sampling of topics is presented that may have significant influence on the future evolution of networks, including overlay networks like content delivery and peer-to-

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peer networks, sensor networks, distributed algorithms, Byzantine agreement, source compression, SDN and NFV, and Internet of Things.

Nowadays, the Internet plays a vital role in our lives. It is currently one of the most effective media that is shifting to reach into all areas in today's society. While we

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move into the next decade, the future of many emerging technologies (IoT, cloud solutions, automation and AI, big data, 5G and mobile technologies, smart cities, etc.) is highly dependent on Internet connectivity and broadband communications. The demand for mobile and faster Internet connectivity is on the

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rise as the voice, video, and data continue to converge to speed up business operations and to improve every aspect of human life. As a result, the broadband communication networks that connect everything on the Internet are now considered a complete ecosystem routing all Internet traffic and delivering Internet

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data faster and more flexibly than ever before. This book gives an insight into the latest research and practical aspects of the broadband communication networks in support of many emerging paradigms/applications of global Internet from the traditional architecture to the incorporation of smart applications. This

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book includes a preface and introduction by the editors, followed by 20 chapters written by leading international researchers, arranged in three parts. This book is recommended for researchers and professionals in the field and may be used as a reference book on broadband communication networks as well as on

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practical uses of wired/wireless broadband communications. It is also a concise guide for students and readers interested in studying Internet connectivity, mobile/optical broadband networks and concepts/applications of telecommunications engineering.

This text presents a modern theory of

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analysis, control, and optimization for dynamic networks. Mathematical techniques of Lyapunov drift and Lyapunov optimization are developed and shown to enable constrained optimization of time averages in general stochastic systems. The focus is on communication and queueing systems, including wireless

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networks with time-varying channels, mobility, and randomly arriving traffic. A simple drift-plus-penalty framework is used to optimize time averages such as throughput, throughput-utility, power, and distortion. Explicit performance-delay tradeoffs are provided to illustrate the cost of approaching optimality. This theory is

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also applicable to problems in operations research and economics, where energy-efficient and profit-maximizing decisions must be made without knowing the future.

Topics in the text include the following: -
Queue stability theory - Backpressure, max-weight, and virtual queue methods -
Primal-dual methods for non-convex

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stochastic utility maximization - Universal scheduling theory for arbitrary sample paths - Approximate and randomized scheduling theory - Optimization of renewal systems and Markov decision systems Detailed examples and numerous problem set questions are provided to reinforce the main concepts. Table of

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Contents: Introduction / Introduction to
Queues / Dynamic Scheduling Example /
Optimizing Time Averages / Optimizing
Functions of Time Averages /
Approximate Scheduling / Optimization of
Renewal Systems / Conclusions
Backscattering and RF Sensing for Future
Wireless Communication

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Concepts, Computation, and Optimization

Designing the Total Area Network

Advances in Multi-Channel Resource

Allocation

Information and Communication

Technologies in Everyday Life

This book provides a quick

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reference and insights into modeling and optimization of software-defined networks (SDNs). It covers various algorithms and approaches that have been developed for optimizations related to the control plane, the

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considerable research related to data plane optimization, and topics that have significant potential for research and advances to the state-of-the-art in SDN. Over the past ten years, network programmability has transitioned from research

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concepts to more mainstream technology through the advent of technologies amenable to programmability such as service chaining, virtual network functions, and programmability of the data plane. However, the rapid

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development in SDN technologies has been the key driver behind its evolution. The logically centralized abstraction of network states enabled by SDN facilitates programmability and use of sophisticated optimization and

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control algorithms for enhancing network performance, policy management, and security. Furthermore, the centralized aggregation of network telemetry facilitates use of data-driven machine learning-based

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methods. To fully unleash the power of this new SDN paradigm, though, various architectural design, deployment, and operations questions need to be addressed. Associated with these are various modeling, resource allocation, and

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optimization opportunities. The book covers these opportunities and associated challenges, which represent a "call to arms" for the SDN community to develop new modeling and optimization methods that will complement or improve on

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the current norms.

The concept of physical-layer network coding (PNC) was proposed in 2006 for application in wireless networks. Since then it has developed into a subfield of communications and networking

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with a wide following. This book is a primer on PNC. It is the outcome of a set of lecture notes for a course for beginning graduate students at The Chinese University of Hong Kong. The target audience is expected to have some prior

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background knowledge in communication theory and wireless communications, but not working knowledge at the research level. Indeed, a goal of this book/course is to allow the reader to gain a deeper appreciation of the various

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nuances of wireless communications and networking by focusing on problems arising from the study of PNC. Specifically, we introduce the tools and techniques needed to solve problems in PNC, and many of these tools and

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techniques are drawn from the more general disciplines of signal processing, communications, and networking: PNC is used as a pivot to learn about the fundamentals of signal processing techniques and wireless communications in

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general. We feel that such a problem-centric approach will give the reader a more in-depth understanding of these disciplines and allow him/her to see first-hand how the techniques of these disciplines can be applied to solve

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real research problems. As a primer, this book does not cover many advanced materials related to PNC. PNC is an active research field and many new results will no doubt be forthcoming in the near future. We believe that this book

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will provide a good contextual framework for the interpretation of these advanced results should the reader decide to probe further into the field of PNC.

This book concerns peer-to-peer applications and mechanisms

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operating on the Internet, particularly those that are not fully automated and involve significant human interaction. So, the realm of interest is the intersection of distributed systems and online social networking. Generally,

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Simple models are described to clarify the ideas. Beginning with short overviews of caching, graph theory and game theory, we cover the basic ideas of structured and unstructured search. We then describe a simple framework for

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reputations and for iterated referrals and consensus. This framework is applied to a problem of sybil identity management. The fundamental result for iterated Byzantine consensus for a relatively important issue is also

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given. Finally, a straight-forward epidemic model is used to describe the propagation of malware on-line and for BitTorrent-style file-sharing. This short book can be used as a preliminary orientation to this subject matter. References are

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given for the interested student to papers with good survey and tutorial content and to those with more advanced treatments of specific topics. For an instructor, this book is suitable for a one-semester seminar course.

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Alternatively, it could be the framework for a semester's worth of lectures where the instructor would supplement each chapter with additional lectures on related or more advanced subject matter. A basic background is required in the

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areas of computer networking, probability theory, stochastic processes, and queueing. Table of Contents: Networking overview / Graphs / Games / Search in structured networks / Search in unstructured networks /

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Transactions, reputations, and
referrals / False Referrals / Peer-to-
peer file sharing / Consensus in
dynamical belief systems /
Byzantine consensus / Epidemics
Communication networks: Network
Services, Protocol layering ...

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Recent Advances and Lessons from
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Sharing Network Resources

Diffusion Source Localization in
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Performance Modeling, Loss
Networks, and Statistical

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Multiplexing

An Introduction to Models of

Online Peer-to-Peer Social

Networking

In this book, we consider the problem of achieving the maximum throughput and utility in a class of networks with resource

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sharing constraints. This is a classical problem of great importance. In the context of wireless networks, we first propose a fully distributed scheduling algorithm that achieves the maximum throughput. Inspired by CSMA (Carrier Sense Multiple Access), which is widely deployed in today's wireless networks, our

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algorithm is simple, asynchronous, and easy to implement. Second, using a novel maximal-entropy technique, we combine the CSMA scheduling algorithm with congestion control to approach the maximum utility. Also, we further show that CSMA scheduling is a modular MAC-layer algorithm that can work with other

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protocols in the transport layer and network layer. Third, for wireless networks where packet collisions are unavoidable, we establish a general analytical model and extend the above algorithms to that case. Stochastic Processing Networks (SPNs) model manufacturing, communication, and

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service systems. In manufacturing networks, for example, tasks require parts and resources to produce other parts. SPNs are more general than queueing networks and pose novel challenges to throughput-optimum scheduling. We proposes a "deficit maximum weight" (DMW) algorithm to achieve throughput

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optimality and maximize the net utility of the production in SPNs. Table of Contents: Introduction / Overview / Scheduling in Wireless Networks / Utility Maximization in Wireless Networks / Distributed CSMA Scheduling with Collisions / Stochastic Processing networks

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Backscattering and RF Sensing for Future Wireless Communication Discover what lies ahead in wireless communication networks with this insightful and forward thinking book written by experts in the field Backscattering and RF Sensing for Future Wireless Communication delivers a concise and insightful picture of emerging

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and future trends in increasing the efficiency and performance of wireless communication networks. The book shows how the immense challenge of frequency saturation could be met via the deployment of intelligent planar electromagnetic structures. It provides an in-depth coverage of the fundamental

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physics behind these structures and assesses the enhancement of the performance of a communication network in challenging environments, like densely populated urban centers. The distinguished editors have included resources from a variety of leading voices in the field who discuss topics such as the

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engineering of metasurfaces at a large scale, the electromagnetic analysis of planar metasurfaces, and low-cost and reliable backscatter communication. All of the included works focus on the facilitation of the development of intelligent systems designed to enhance communication network performance.

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Readers will also benefit from the inclusion of: A thorough introduction to the evolution of wireless communication networks over the last thirty years, including the imminent saturation of the frequency spectrum An exploration of state-of-the-art techniques that next-generation wireless networks will likely

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incorporate, including software-controlled frameworks involving artificial intelligence An examination of the scattering of electromagnetic waves by metasurfaces, including how wave propagation differs from traditional bulk materials A treatment of the evolution of artificial intelligence in wireless

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communications Perfect for researchers in wireless communications, electromagnetics, and urban planning, Backscattering and RF Sensing for Future Wireless Communication will also earn a place in the libraries of government policy makers, technologists, and telecom industry stakeholders who wish to get a

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head start on understanding the technologies that will enable tomorrow's wireless communications.

The congestion control mechanism has been responsible for maintaining stability as the Internet scaled up by many orders of magnitude in size, speed, traffic volume, coverage, and complexity over the last

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three decades. In this book, we develop a coherent theory of congestion control from the ground up to help understand and design these algorithms. We model network traffic as fluids that flow from sources to destinations and model congestion control algorithms as feedback dynamical systems. We show that the

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model is well defined. We characterize its equilibrium points and prove their stability. We will use several real protocols for illustration but the emphasis will be on various mathematical techniques for algorithm analysis. Specifically we are interested in four questions: 1. How are congestion control

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algorithms modelled? 2. Are the models well defined? 3. How are the equilibrium points of a congestion control model characterized? 4. How are the stability of these equilibrium points analyzed? For each topic, we first present analytical tools, from convex optimization, to control and dynamical systems, Lyapunov and

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Nyquist stability theorems, and to projection and contraction theorems. We then apply these basic tools to congestion control algorithms and rigorously prove their equilibrium and stability properties. A notable feature of this book is the careful treatment of projected dynamics that introduces discontinuity in our

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differential equations. Even though our development is carried out in the context of congestion control, the set of system theoretic tools employed and the process of understanding a physical system, building mathematical models, and analyzing these models for insights have a much wider applicability than to

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congestion control.

Annotation After an overview of how today's Internet works and a discussion of the main principles behind its architecture, this text discusses the key ideas behind Ethernet, WiFi networks, routing, internetworking and TCP.

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Broadcasting and Optical Communication
Technology

Age of Information

A Concise Introduction and Research
Guide

Recent Advances

This monograph presents

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a concise mathematical
approach for modeling
and analyzing the
performance of
communication networks
with the aim of
understanding the

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phenomenon of
statistical
multiplexing. The
novelty of the monograph
is the fresh approach
and insights provided by
a sample-path

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methodology for queueing models that highlights the important ideas of Palm distributions associated with traffic models and their role in performance measures.

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Also presented are recent ideas of large buffer, and many sources asymptotics that play an important role in understanding statistical

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multiplexing. In particular, the important concept of effective bandwidths as mappings from queueing level phenomena to loss network models is

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clearly presented along
with a detailed
presentation of loss
network models and
accurate approximations
for large networks.

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Introduction to Traffic
Models and Analysis /
Queues and Performance
Analysis / Loss Models
for Networks /
Statistical Multiplexing
With the fast pace of

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developments in quantum technologies, it is more than ever necessary to make the new generation of students in science and engineering familiar with the key ideas

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behind such disruptive systems. This book intends to fill such a gap between experts and non-experts in the field by providing the reader with the basic tools

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needed to understand the latest developments in quantum communications and its future directions. This is not only to expand the audience knowledge but

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also to attract new talents to this flourishing field. To that end, the book as a whole does not delve into much detail and most often suffices to

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provide some insight into the problem in hand. The primary users of the book will then be students in science and engineering in their final year of

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undergraduate studies or
early years of their
post-graduate
programmes.

This book will provide a
comprehensive technical
guide covering

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fundamentals, recent advances and open issues in wireless communications and networks to the readers. The objective of the book is to serve as a

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valuable reference for
students, educators,
scientists, faculty
members, researchers,
engineers and research
strategists in these
rapidly evolving fields

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and to encourage them to actively explore these broad, exciting and rapidly evolving research areas.

This comprehensive handbook serves as a

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professional reference
as well as a
practitioner's guide to
today's most complete
and concise view of
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offers in-depth coverage of theory, technology, and practice as they relate to established technologies and recent advancements. It explores practical

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solutions to a wide range of nanoscale networking and communications issues.

Individual chapters, authored by leading experts in the field,

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address the immediate and long-term challenges in the authors' respective areas of expertise. Key Features Identifies the main differences between

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nanonetworks and
classical wireless
networks and explains
how to leverage those to
develop new
communication techniques
for nanonetworks

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Presents the different alternatives for network communication among nanomachines, whether these are nanomaterial-based devices or genetically modified

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cells Provides a
framework that will
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An Introduction to

Quantum Communication

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A Primer on Physical-

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Layer Network Coding

Diffusion processes in large networks have been used to model many real-world phenomena, including how rumors spread on the Internet, epidemics among human beings, emotional contagion through social networks, and even gene regulatory

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processes. Fundamental estimation principles and efficient algorithms for locating diffusion sources can answer a wide range of important questions, such as identifying the source of a widely spread rumor on online social networks. This book provides an overview of recent

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progress on source localization in large networks, focusing on theoretical principles and fundamental limits. The book covers both discrete-time diffusion models and continuous-time diffusion models. For discrete-time diffusion models, the book focuses on the

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Jordan infection center; for continuous-time diffusion models, it focuses on the rumor center. Most theoretical results on source localization are based on these two types of estimators or their variants. This book also includes algorithms that leverage partial-time

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information for source localization and a brief discussion of interesting unresolved problems in this area.

Networks naturally appear in many high-impact domains, ranging from social network analysis to disease dissemination studies to infrastructure system design. Within

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network studies, network connectivity plays an important role in a myriad of applications. The diversity of application areas has spurred numerous connectivity measures, each designed for some specific tasks. Depending on the complexity of connectivity measures,

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the computational cost of calculating the connectivity score can vary significantly. Moreover, the complexity of the connectivity would predominantly affect the hardness of connectivity optimization, which is a fundamental problem for network connectivity studies. This book

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presents a thorough study in network connectivity, including its concepts, computation, and optimization.

Specifically, a unified connectivity measure model will be introduced to unveil the commonality among existing connectivity measures. For the connectivity computation aspect,

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the authors introduce the connectivity tracking problems and present several effective connectivity inference frameworks under different network settings. Taking the connectivity optimization perspective, the book analyzes the problem theoretically and introduces

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an approximation framework to effectively optimize the network connectivity. Lastly, the book discusses the new research frontiers and directions to explore for network connectivity studies. This book is an accessible introduction to the study of connectivity in complex networks.

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It is essential reading for advanced undergraduates, Ph.D. students, as well as researchers and practitioners who are interested in graph mining, data mining, and machine learning. Today's wireless communications and networking practices are tightly coupled with economic

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considerations, to the extent that it is almost impossible to make a sound technology choice without understanding the corresponding economic implications. This book aims at providing a foundational introduction on how microeconomics, and pricing theory in particular, can

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help us to understand and build better wireless networks. The book can be used as lecture notes for a course in the field of network economics, or a reference book for wireless engineers and applied economists to understand how pricing mechanisms influence the

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fast growing modern wireless industry. This book first covers the basics of wireless communication technologies and microeconomics, before going in-depth about several pricing models and their wireless applications. The pricing models include social optimal pricing,

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monopoly pricing, price differentiation, oligopoly pricing, and network externalities, supported by introductory discussions of convex optimization and game theory. The wireless applications include wireless video streaming, service provider competitions, cellular usage-

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based pricing, network partial price differentiation, wireless spectrum leasing, distributed power control, and cellular technology upgrade.

More information related to the book (including references, slides, and videos) can be found at ncel.ie.cuhk.edu.hk/content/wireless-network-

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pricing.

Information usually has the highest value when it is fresh. For example, real-time knowledge about the location, orientation, and speed of motor vehicles is imperative in autonomous driving, and the access to timely information about stock

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prices and interest rate movements is essential for developing trading strategies on the stock market. The Age of Information (AoI) concept, together with its recent extensions, provides a means of quantifying the freshness of information and an opportunity to improve the

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performance of real-time systems and networks. Recent research advances on AoI suggest that many well-known design principles of traditional data networks (for, e.g., providing high throughput and low delay) need to be re-examined for enhancing information freshness in

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rapidly emerging real-time applications. This book provides a suite of analytical tools and insightful results on the generation of information-update packets at the source nodes and the design of network protocols forwarding the packets to their destinations. The

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book also points out interesting connections between AoI concept and information theory, signal processing, and control theory, which are worthy of future investigation.

Wireless Communications and
Networks

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Throughput, Delay, and Complexity

Broadband Communications

Networks

Multi-Armed Bandits

A Concise Introduction

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Electrical Engineering Handbook stands as the definitive reference to the multidisciplinary field of electrical engineering. Our knowledge continues to

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grow, and so does the Handbook. For the third edition, it has been expanded into a set of six books carefully focused on a specialized area or field of study.

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represents a concise yet
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key concepts, models,
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networks, Broadcasting
and Optical

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explores communications,
information theory, and
devices, covering all
the basic information

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needed for a thorough understanding of these areas. It also examines the emerging areas of adaptive estimation and optical communication, including lightwave

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technology, long-distance fiber optic communications, and photonic networks.

Articles include defining terms, references, and sources

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of further information.
Encompassing the work of
the world's foremost
experts in their
respective specialties,
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presents the latest developments, the broadest scope of coverage, and new material on mobile communications. It offers fast, convenient

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access to specialists in
need of detailed
reference on the job.
This brief introduces
overlapping coalition
formation games (OCF
games), a novel

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mathematical framework
from cooperative game
theory that can be used
to model, design and
analyze cooperative
scenarios in future
wireless communication

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networks. The concepts of OCF games are explained, and several algorithmic aspects are studied. In addition, several major application scenarios

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are discussed. These applications are drawn from a variety of fields that include radio resource allocation in dense wireless networks, cooperative spectrum

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sensing for cognitive radio networks, and resource management for crowd sourcing. For each application, the use of OCF games is discussed in detail in order to

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show how this framework
can be used to solve
relevant wireless
networking problems.
Overlapping Coalition
Formation Games in
Wireless Communication

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Networks provides
researchers, students
and practitioners with a
concise overview of
existing works in this
emerging area, exploring
the relevant fundamental

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theories, key
techniques, and
significant
applications.

This brief focuses on
network planning and
resource allocation by

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jointly considering cost and energy sustainability in wireless networks with sustainable energy. The characteristics of green energy and investigating

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existing energy-efficient green approaches for wireless networks with sustainable energy is covered in the first part of this brief. The

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book then addresses the random availability and capacity of the energy supply. The authors explore how to maximize the energy sustainability of the

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network and minimize the failure probability that the mesh access points (APs) could deplete their energy and put the network out of service due to the unreliable

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energy supply. This brief also studies network resource management issues in green wireless networks to minimize cost. It jointly considers the

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relay node (RN)

placement and sub-

carrier allocation (RNP-

SA) issues in wireless

networks with

sustainable energy, and

then formulates the

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problem into a mixed integer non-linear programming problem. Concise and informative, this brief is a useful resource for professionals or

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researchers studying wireless networks, communication networks, and energy efficiency. Advanced-level students interested in energy technology or

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communications

engineering will also

find the material

valuable.

Multi-armed bandit

problems pertain to

optimal sequential

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decision making and learning in unknown environments. Since the first bandit problem posed by Thompson in 1933 for the application of clinical trials,

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bandit problems have enjoyed lasting attention from multiple research communities and have found a wide range of applications across diverse domains. This

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book covers classic results and recent development on both Bayesian and frequentist bandit problems. We start in Chapter 1 with a brief overview on the

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history of bandit
problems, contrasting
the two schools—Bayesian
and frequentist—of
approaches and
highlighting
foundational results and

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key applications.

Chapters 2 and 4 cover, respectively, the canonical Bayesian and frequentist bandit models. In Chapters 3 and 5, we discuss major

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variants of the canonical bandit models that lead to new directions, bring in new techniques, and broaden the applications of this classical problem. In

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Chapter 6, we present several representative application examples in communication networks and social-economic systems, aiming to illuminate the

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connections between the Bayesian and the frequentist formulations of bandit problems and how structural results pertaining to one may be leveraged to obtain

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solutions under the
other.

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Theory and Applications

to Online Learning in

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Analytical Methods for

Network Congestion

Control

Intranets, VPN'S and

Enterprise Networks

Explained

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Traditional network optimization focuses on a single control objective in a network populated by obedient users and limited dispersion of information. However, most of today's networks are large-scale with lack of access to centralized information, consist of users with diverse requirements, and are subject to dynamic changes. These factors

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naturally motivate a new distributed control paradigm, where the network infrastructure is kept simple and the network control functions are delegated to individual agents which make their decisions independently ("selfishly"). The interaction of multiple independent decision-makers necessitates the use of game theory, including economic

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notions related to markets and incentives.

This monograph studies game theoretic models of resource allocation among selfish agents in networks. The first part of the monograph introduces fundamental game theoretic topics. Emphasis is given to the analysis of dynamics in game theoretic situations, which is crucial for design and

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control of networked systems. The second part of the monograph applies the game theoretic tools for the analysis of resource allocation in communication networks. We set up a general model of routing in wireline networks, emphasizing the congestion problems caused by delay and packet loss. In particular, we develop a systematic

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approach to characterizing the inefficiencies of network equilibria, and highlight the effect of autonomous service providers on network performance. We then turn to examining distributed power control in wireless networks. We show that the resulting Nash equilibria can be efficient if the degree of freedom given to end-users is

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properly designed. Table of Contents: Static Games and Solution Concepts / Game Theory Dynamics / Wireline Network Games / Wireless Network Games / Future Perspectives

This monograph presents a concise mathematical approach for modeling and analyzing the performance of

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communication networks with the aim of introducing an appropriate mathematical framework for modeling and analysis as well as understanding the phenomenon of statistical multiplexing. The models, techniques, and results presented form the core of traffic engineering methods used to design, control and allocate resources in

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communication networks. The novelty of the monograph is the fresh approach and insights provided by a sample-path methodology for queueing models that highlights the important ideas of Palm distributions associated with traffic models and their role in computing performance measures. The monograph also covers

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stochastic network theory including Markovian networks. Recent results on network utility optimization and connections to stochastic insensitivity are discussed. Also presented are ideas of large buffer, and many sources asymptotics that play an important role in understanding statistical multiplexing. In particular, the

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important concept of effective bandwidths as mappings from queueing level phenomena to loss network models is clearly presented along with a detailed discussion of accurate approximations for large networks. Table of Contents:

Introduction to Traffic Models and Analysis / Queues and Performance Analysis / Loss

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toward a global village—we are in
information era where practically nothing

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can be done without the power of computers in most industries. A solid knowledge about fundamentals of computing has become indispensable in everyday life. This book has been prepared for you to uncover several confusing concepts that pose a big challenge to computer learners and users. I am coming

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from both educational and professional background with great experience to better alienate the hinges that serve as obstacles to high-tech solutions to everyone. It is the togetherness of a great practical experience, educational and teaching skills, technical know-how, and continuous customer value-added service and research that has always

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been the source of creation of this book and three other computer science books. The feedbacks so far received from few professors in information technology in Dallas, Texas, area strongly suggests the use of these books as a great fundamental and companion material for computer science students. In Ghana, the Education Service

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and Curriculum Research and Development Department (CRDD) has approved the Concise ICT Fundamentals textbook as the recommended supplementary material for the teaching and learning of ICT in senior high schools, technical schools, and colleges of education and for general usage. The organization of the core material in this

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book both provides support training unconditionally to everyone who wants to be computer literate and also extends its learning curve to high quality ICT systems engineering to individuals or companies already operational in the high-tech industry. This book provides a solid foundation for information technology.

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Or, How Shall We Communicate in the
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Nanoscale Networking and
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**Resource Allocation lies at the
heart of network control. In the**

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**early days of the Internet the
scarcest resource was bandwidth,
but as the network has evolved to
become an essential utility in the
lives of billions, the nature of the
resource allocation problem has
changed. This book attempts to**

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describe the facets of resource allocation that are most relevant to modern networks. It is targeted at graduate students and researchers who have an introductory background in networking and who desire to

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internalize core concepts before designing new protocols and applications. We start from the fundamental question: what problem does network resource allocation solve? This leads us, in Chapter 1, to examine what it

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means to satisfy a set of user applications that have different requirements of the network, and to problems in Social Choice Theory. We find that while capturing these preferences in terms of utility is clean and

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rigorous, there are significant limitations to this choice. Chapter 2 focuses on sharing divisible resources such as links and spectrum. Both of these resources are somewhat atypical -- a link is most accurately modeled as a

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queue in our context, but this leads to the analytical intractability of queueing theory, and spectrum allocation methods involve dealing with interference, a poorly understood phenomenon. Chapters 3 and 4 are

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introductions to two allocation workhorses: auctions and matching. In these chapters we allow the users to game the system (i.e., to be strategic), but don't allow them to collude. In Chapter 5, we relax this restriction and

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focus on collaboration. Finally, in Chapter 6, we discuss the theoretical yet fundamental issue of stability. Here, our contribution is mostly on making a mathematically abstruse subdiscipline more accessible

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**without losing too much
generality.**

**Studies in Broadband, Optical,
Wireless and Ad Hoc Networks
Performance Modeling,
Stochastic Networks, and
Statistical Multiplexing, Second**

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Network Connectivity

Energy-Efficient Scheduling

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