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Arie M.C.A. Koster · Xavier Muñoz
Editors

Graphs and Algorithms in Communication Networks

Studies in Broadband, Optical, Wireless
and Ad Hoc Networks

 Springer

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ISSN 1862-4499

ISBN 978-3-642-02249-4

e-ISBN 978-3-642-02250-0

DOI 10.1007/978-3-642-02250-0

Springer Heidelberg Dordrecht London New York

Library of Congress Control Number: 2009940112

Mathematics Subject Classification (1998): F.2, G.2, G.4, I.6, C.2, G.1.6

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Cover design: KuenkelLopka GmbH

Printed on acid-free paper

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COST is supported by the EU RTD Framework programme

Preface

Communication networks are a vital and crucial element of today's world. Mobile devices, the Internet, and all new applications and services provided by these media have changed dramatically the way both individual lives and society as a whole are organized. All these services depend on fast and reliable data connections, whether wired or wireless. To meet such requirements, information and communication technology is challenged again and again to provide faster protocols, wireless interfaces with higher bandwidth capacity, innovative mechanisms to handle failures, and so on.

For many of those challenges a variety of mathematical disciplines contribute in a supportive role, either in providing insights, evidence, or algorithms or as decision support tools. In particular, the broad area of algorithmic discrete mathematics plays a crucial role in the design and operation of communication networks. However, the discipline is fragmented between scientific disciplines such as pure mathematics, theoretical computer science, distributed computing, and operations research. Furthermore, researchers from communication engineering utilize discrete mathematical techniques and develop their own extensions.

With the aim to bring together the above-mentioned disciplines and draw synergy effects from it, the COST action 293 – Graphs and Algorithms in Communication Networks – was launched in October 2004 for a period of four years. Scientists from the above disciplines have been gathering on a regular basis to learn from each other and to work jointly on emerging applications to the benefit of the information and communication technology society. Also workshops and training schools have been organized to disseminate recent advances in all subject areas. An active exchange programme (short-term scientific missions in COST terminology) between the research groups has resulted in a high number of joint publications.

To document on the one hand the multidisciplinary research carried out within COST 293 and on the other hand to encourage further collaborations between the disciplines, this book presents a number of studies in broadband, optical, wireless, and ad hoc networks where the techniques of algorithmic discrete mathematics have provided highly recognized contributions.

The way the studies are presented, this book is particularly suited for Ph.D. students, postdoctoral researchers in mathematics, computer science, operations research, and network engineering as well as industrial researchers who would like to investigate state-of-the-art mathematical alternatives to resolve the technological challenges of tomorrow. An introductory chapter should ease access to the material for researchers not familiar with the mathematical terminology used by the chapters' authors.

As chair and vice-chair of COST 293, it has been a pleasure for us to prepare this book. We would like to thank all authors and reviewers for the contributions. Without their voluntary help it would have been impossible to publish this book. We also are grateful to COST for supporting our action in general and the dissemination of this book in particular .

Coventry/Barcelona,
March 2009

Arie M.C.A. Koster
Xavier Muñoz

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Acronyms

3-MECA	Maximum Efficiency Channel Assignment with Three Channels, Hyperbolic Formulation
3-MECA _E	Maximum Efficiency Channel Assignment with Three Channels, Linear Formulation
3-MOCA	Minimum Overlap Channel Assignment with three channels
3-MT-MO	Integration of MTAL and 3-MOCA
3-MT-ME	Integration of MTAL and 3-MECA
ABC	Adaptive Broadcast Consumption
ACK	Acknowledgement Frame
ADM	Add/Drop Multiplexer
AODV	Ad Hoc On Demand Distance Vector
AOLS	All-Optical Label Switching
AP	Access Point
API	Average Path Interference
APX	Approximable
AR	Alternative Routing
AS	Autonomous System
ATM	Asynchronous Transfer Mode
B&C	Branch-and-Cut
BEB	Binary Exponential Backoff
BIP	Broadcast Incremental Power
BL	Basic Localization
BLP	Burst Loss Probability
BSS	Basic Service Set
CBWFQ	Class-Based Weighted Fair Queueing
CDMA	Code Division Multiple Access
CFS	Cost Function Smoothing
CMAx	Capacity-Competitive Algorithm
CMI	Cost Minimization in Multi-interface Networks
CoS	Class of Service
CR-LDP	Constraint-Based Routing Label Distribution Protocol

CRP	Contention Resolution Protocol
CS	Circuit Switching
CSMA	Carrier Sense Multiple Access
CSMA/CA	Carrier Sense Multiple Access with Collision Avoidance
CSMA/CD	Carrier Sense Multiple Access with Collision Detection
CSPF	Constraint Shortest Path First
CTS	Clear to Send
CWDM	Coarse Wavelength Division Multiplexing
DAG	Directed Acyclic Graph
DCF	Distributed Coordination Function
DiffServ	Differentiated Services
DIFS	Distributed Inter-frame Space
DPP	Dedicated Path Protection
DS	Distribution System
DWDM	Dense Wavelength Division Multiplexing
D-LSP	Distributed LSP
ECMP	Equal Cost Multi-path
ECS	Effective Computing System
ELS	Ethernet VLAN-Label Switching
ESS	Extended Service Set
EXC	Electrical Cross-connect
FAP	Frequency Assignment Problem
FDM	Frequency Division Multiplexed
FDMA	Frequency Division Multiple Access
FDPP	Failure Dependant Path Protection
FEC	Forwarding Equivalence Class
FIFO	First-In First-Out
FIP	Finite Improvement Path
FPQ	Fair Packet Queueing
FSC	Fiber Switching Capable
GbE	Gigabit Ethernet
Gbit/s	Gigabit per Second
GHz	Gigahertz
GMM	Generalized Multicast Multi-path
GMPLS	Generalized MPLS
GNPP	General Network Planning Problem
GSM	General System for Mobile Communication
IBM	Induced Bipartite Matching
IBSS	Independent Basic Service Set
IETF	Internet Engineering Task Force
IGP	Interior Gateway Protocol
ILP	Integer Linear Programming
IMBM	Iterative Maximum-Branch Minimization
IP	Internet Protocol
IPv4	Internet Protocol Version 4

IS-IS	Intermediate System to Intermediate System
ISP	Inverse Shortest Path Problem
ITU	International Telecommunication Union
JET	Just-Enough-Time
JIT	Just-In-Time
LDP	Label Distribution Protocol
LER	Label Edge Router
L2SC	Layer 2 Switching Capable
LIB	Label Information Base
LISE	Low Interference Spanner Establisher
LL	(Overall) Link Loss
LL-NRL	Link Loss model with Non-Reduced Load
LP	Linear program
LSP	Label Switched Path
LSR	Label Switched Router
LTE	Light Termination Equipment
MAC	Medium Access Control
MANET	Mobile Ad Hoc Network
Mbit/s	Megabit per second
MCNFP	Multi-commodity Network Flow Problem
MEBR	Minimum Energy Broadcast Routing
MECA	Maximum Efficiency Channel Assignment, hyperbolic formulation
MERLIN	Mergin Link group
MILP	Mixed-Integer Linear Program
MIP	Mixed-Integer Program
MIR	Mixed-Integer Rounding
MIRA	Minimum Interference Routing Algorithm
MLTE	Multilayer Traffic Engineering
MLU	Maximum Link Utilization
MOCA	Minimum Overlap Channel Assignment
MOP	Multi-Objective Problem
MPLS	Multi-protocol Label Switching
MPLS-TE	Multi-protocol Label Switching Traffic Engineering
MR	Multi-path Routing
MST	Minimum Spanning Tree
MSTP	Minimum Spanning Tree Protocol
MT	Mobile Terminal
MTBF	Mean Time Between Failures
MTTR	Mean Time To Repair
MT-MO	Integration of MTAL and MOCA
NHLFE	Next Hop Label Forwarding Entry
NL	(Overall) Network Loss
NL-RL	Network Loss model with Reduced Load
NL-NRL	Network Loss model with Non-Reduced Load
NP	Non-deterministic Polynomial

NRL	Non-Reduced Load
NSF	National Science Foundation
OBS	Optical Burst Switching
OFDM	Orthogonal Frequency Division Multiplexing
OSPF	Open Shortest Path First protocol
OTIS	Optical Transpose Interconnection System
OTN	Optical Transport Network
oVPN	Open Virtual Private Network
OXC	Optical Cross-Connect
P2P	Peer-to-peer
PCF	Point Coordination Function
PIRA	Path-Interfering Routing Algorithm
PSC	Packet Switching Capable
PTAS	Polynomial Time Approximation Scheme
QoS	Quality of Service
RCFS	Randomized Cost Function Smoothing
RFC	Request for Comment
RIT	Reservation with Just-In-Time
RL	Reduced Load
RSVP	Resource Reservation Protocol
RSVP-TE	Resource Reservation Protocol for Traffic Engineering
RTS	Request to Send
SAT	Satisfiability problem
SCFQ	Self-Clocked Fair Queueing
SCSP	Shortcut Span Protection
SDH	Synchronous Digital Hierarchy
SFQ	Start-time Fair Queueing
SIFS	Short Inter-Frame Space
SLP	Shared Link Protection
SONET	Synchronous Optical Network
SPP	Shared Path Protection
SPR	Shortest Path Routing
SPT	Shortest Path Tree
SRG	Shared Risk Group
SSP	Shared Segment Protection
STEP	Shortest Path Traffic Engineering Problem
STM	Synchronous Transport Module
TAG	Tell-And-Go
TAW	Tell-And-Wait
TCP	Transmission Control Protocol
TDM	Time Division Multiplexing
TDMA	Time Division Multiple Access
TE	Traffic Engineering
ToA	Time of Arrival
TP	Test Point

TSC	TDM Switching Capable
UDG	Unit Disk Graph
UMTS	Universal Mobile Telecommunications System
VLAN	Virtual Local Area Network
VPN	Virtual Private Network
VP λ N	Virtual Private Wavelength Network
VON	Virtual Overlay Network
WBSC	WaveBand Switching Capable
WDM	Wavelength Division Multiplexing
WFQ	Weighted Fair Queueing
WGP	Wireless Gathering Problem
WLAN	Wireless Local Access Network
W λ SC	Wavelength Switching Capable
XTC	X Topology Control