

ANALYSIS AND DESIGN OF ADVANCED MULTISERVICE
NETWORKS SUPPORTING MOBILITY, MULTIMEDIA,
AND INTERNETWORKING

Analysis and Design of Advanced Multiservice Networks Supporting Mobility, Multimedia, and Internetworking

COST Action 279 Final Report

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Preface

This book constitutes the Final Report of COST Action 279, *Analysis and Design of Advanced Multiservice Networks supporting Multimedia, Mobility, and Interworking*, a guided tour of the state-of-the-art work on diverse aspects of modern telecommunications networks design developed within this Action during the four years of its operation, started on July 1, 2001, and ended on June 30, 2005.

As stated in its founding charter, its Memorandum of Understanding, the work area of COST 279 is the analysis, design, and control aspects of present-day networks—quite a wide scope. Behind the unifying façade put on by the Internet Protocol (IP) network layer, today's networks hide a mess of heterogeneity: heterogeneity at the level of applications, both concerning the traffic they produce and the network Quality of Service (QoS) they require, and heterogeneity at the level of network component subsystems, in particular an increasingly important mobile/wireless access segment. A common ground for the treatment of this disparate set of topics was given by the strong methodological component contained in the approach followed in COST 279, with importance placed on the development and application, whenever possible, of analytical techniques and models for the mathematical understanding of the systems under study. The results expected from the Action ranged thus from mathematical models and algorithms as entities of own interest to the understanding of system behavior via their application. Explicit value was also given to contributions to progress in basic issues, such as queueing theory and estimation and identification in stochastic models, in recognition of their status as key elements for the understanding of the behavior of networks and for their design.

During its period of operation, COST 279 was a crucible for a very fruitful interaction among a sizeable group of European researchers exhibiting a remarkable diversity across a number of dimensions: with origins from both telecom operators and universities, with backgrounds in mathematics, computer science, and engineering, and with experiences ranging from basic re-

search to applied engineering. The competences available in this group thus matched quite well the diversity accommodated within the scope of the Action.

The current book summarizes the work contained in the internal technical documents, officially designated *Temporary Documents*, presented in the meetings held during the lifetime of COST 279. The work in some of those TDs has since been published in the peer-reviewed literature, but the work in some others, especially the more recent ones, has not. In the text of the following chapters, references are made to the open literature publications, whenever possible. When only the internal TDs are available, a reader looking for further details is asked to have the kindness of contacting directly the authors for the materials of his interest. The list of author contacts and TDs produced, together with their abstracts, is available at the Action web site, at <http://www.lx.it.pt/cost279/>.

Given its origin and purpose, the present publication is not a textbook. It is rather an annotated bibliography on a body of state-of-the-art work done on a related set of topics on network design, and it has an intrinsic value as such. However, a reader wanting to get an overall picture of the state-of-the-art in a specific sub-area within the scope of COST 279 can most likely do so by systematically exploring the numerous references given in the text.

The book starts with a short *Introduction* to the COST Research Framework and to COST Action 279 itself. The rest of the book, containing the technical material proper, has a hybrid organization. The first technical chapter is on *IP-Based Networks*, and deals essentially with issues relevant to end-to-end QoS. The following two chapters are of a horizontal nature, the first on *Queueing Models*, and the second on *Traffic Measurement, Characterization, and Modeling*. The last three chapters are technology-specific, and cover *Wireless Networks*, *Optical Networks*, and *Peer-to-Peer Services*. The book contains, as Appendices, an extensive *Bibliography*, the *List of Temporary Documents*, and the details on the *COST 279 Management Committee* and the *COST 279 Participating Institutions*.

Because of the hybrid structure of the book, the study of specific topics may fit naturally into more than one chapter, particularly so when both a basic, methodological part, and a system study part are involved. In such cases, the option made was to include references to the work in both chapters, with appropriate cross-references. In this way, chapters are, as much as possible, self-contained.

This book would not have been possible without the contribution of an enthusiastic and hard-working team of people. First and foremost, there are all the members of COST 279, the people who did the technical work reported, and who are indeed the reason for its existence. A large debt is next owed

to Michael Menth, from the University of Würzburg, Germany, who single-handedly coordinated the organization of the *COST 279 Mid-Term Report*, upon which this book is based, together with the fine team of technical chapter editors and contributing members listed at the beginning of each chapter. The overall operation of COST 279 had the wise guidance of its Management Committee and the support of the COST Program Technical Committee for Telecommunications and Information Science and Technology and the COST TIST Secretariat.

In the course of the year 2003 we had the sad news of the passing away of Prof. Olga Casals, MC member from Spain. COST 279 remains indebted to both her technical contributions and personal enthusiasm.

Even though COST 279 ended at its normal four-year term, the ensemble of its members possesses high enough cohesion and momentum to allow itself to materialize in the future, given appropriate conditions, into a similar initiative. We remain in anticipation of its outcome.

June 2005

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Contents

Preface	v
Introduction	1
1 IP-Based Networks	5
1.1 Introduction	5
1.2 Service Models for QoS IP Networks	7
1.2.1 Network Services with Strict QoS	8
1.2.2 Network Services with Relative QoS	9
1.2.3 Network Services for End-to-End QoS	10
1.2.4 Implicit Service Differentiation	11
1.3 Admission Control in IP Networks	12
1.3.1 Admission Control for Streaming Traffic	13
1.3.2 Admission Control for Elastic Traffic	16
1.4 Network Admission Control and Resilience	19
1.4.1 Introduction to NAC Methods	19
1.4.2 Performance of NAC Methods	20
1.4.3 Capacity Renegotiation	21
1.4.4 Performance of NAC Methods with Resilience	24
1.4.5 Comparison between NAC and Overprovisioning	26
1.4.6 Inter-Domain Admission Control	28
1.5 Capacity Dimensioning	29
1.5.1 Insensitive Bandwidth Sharing	30
1.5.2 Access Network Links	31
1.5.3 Backbone Links	32
1.5.4 Streaming and Elastic Traffic Integration	34
1.6 TCP and Packet Level Performance	37
1.6.1 TCP Enhancements	38
1.6.2 Active Queue Management	40
1.6.3 Quality of Voice Traffic	40

1.7	Scheduling Mechanisms	41
1.7.1	Resource Allocation	41
1.7.2	Priority Packet Scheduling	42
1.7.3	Scheduling and Network Behavior	43
1.8	Routing Optimization and Load Balancing	44
1.8.1	Introduction	44
1.8.2	Traffic Engineering Based on IP Routing	45
1.8.3	Traffic Engineering and Resilience Based on MPLS	47
1.9	Multicast Communication	49
1.9.1	Protocols and Mechanisms	49
1.9.2	Performance and Traffic Properties	51
1.10	Graph Models for Interconnection Networks	52
2	Queueing Models	55
2.1	Introduction	55
2.2	Discrete-Time Queueing Models	56
2.2.1	Queues with Static Priority Scheduling	56
2.2.2	Queues with Dynamic Priority Scheduling	58
2.2.3	Queues with Place Reservation	59
2.2.4	Multiserver Queues	61
2.2.5	Queues with Server Vacations	61
2.2.6	Queues in ARQ Systems	62
2.2.7	Queues with Bursty Traffic	63
2.3	Fluid Flow Models	64
2.3.1	Algorithmic Approach	64
2.3.2	Large-Scale Finite Fluid Queues	64
2.3.3	Voice and Multi-Fractal Data Traffic	65
2.3.4	Superposition of General ON-OFF Sources	65
2.3.5	Feedback Fluid Queues	66
2.3.6	Fair Queueing Systems	67
2.3.7	Bottleneck Identification and Classification	68
2.4	Gaussian Storages	68
2.4.1	Most Probable Path Technique	69
2.4.2	Delay Quantiles	72
2.5	Processor Sharing Models	72
2.5.1	Sojourn Times for PS Models with Multiple Servers and Priority Queueing	73
2.5.2	Throughput Measures for PS Models	74
2.5.3	PS Models with State Dependent Blocking Probability and Capacity	75

2.6	Multilevel Processor Sharing Models	75
2.7	Other Continuous-Time Queueing Models	76
2.7.1	Instantaneous and Averaged Queue Length in an M/M/1/K Queue	77
2.7.2	M/D/1/K Vacation Queue	77
2.7.3	BMAP/G/1 Queue with Feedback	78
2.7.4	Two-Class Non-Preemptive Priority Queue	79
2.8	Queueing Networks	80
2.8.1	End-to-End Delay Characteristics	80
2.8.2	Evolution of Traffic Characteristics	80
2.9	Models for Optical Buffers and Networks	81
2.9.1	Burstification Queues	81
2.9.2	Optical Cross-Connects	82
2.9.3	Fiber Delay Line Buffers	83
3	Traffic Measurement, Characterization, and Modeling	85
3.1	Introduction	85
3.2	Traffic Measurement Techniques	86
3.2.1	Measurements Principles	87
3.2.2	Traffic Trace Collection	88
3.3	Traffic Characterization	92
3.3.1	Multicast Traffic	93
3.3.2	Optical Burst Switching Traffic	95
3.3.3	TCP Traffic	95
3.3.4	Modem Pool Traffic	96
3.3.5	GPRS Traffic	96
3.3.6	WLAN Traffic	97
3.3.7	Peer-to-Peer Traffic	97
3.4	Traffic Modeling	99
3.4.1	PDF Estimation	99
3.4.2	Poisson- and Markov-Type Models	100
3.4.3	Time-Discrete Models	102
3.4.4	Flow-Level Models	103
3.4.5	Fluid Models	105
3.4.6	Fractal-Type Models	107
3.4.7	Mobility Models	108
3.5	Interpretation and Application	108
3.5.1	An Interpretation Framework	108
3.5.2	Traffic Matrix Inference	109
3.5.3	Estimation and Classification	110

3.5.4	Traffic Prediction	112
3.5.5	Traffic Control	113
4	Wireless Networks	115
4.1	Introduction	115
4.2	GSM Networks	118
4.2.1	Traffic Measurements and Modeling	118
4.2.2	Resource Management	119
4.3	UMTS Networks	121
4.3.1	Admission Control for WCDMA Systems	122
4.3.2	Soft Handover	125
4.3.3	Handling of Packet Data Traffic in UMTS Networks	127
4.3.4	UMTS Network Planning	131
4.4	Wireless LANs	132
4.4.1	Analytical Models	133
4.4.2	Measurements	134
4.4.3	Methods for Improving Traffic Handling	136
4.4.4	Handover Issues	137
4.5	Satellite Communication	142
4.6	Bluetooth Technology	143
4.7	Mobility Issues	144
4.7.1	Mobility Models	144
4.7.2	Location Management	146
4.7.3	Reliability Aspects of Mobile IP	146
4.8	Data Transmission over Wireless Links	147
5	Optical Networks	149
5.1	Introduction	149
5.2	Optical Circuit Switching	151
5.2.1	Subnetwork Partitioning and Section Restoration in Translucent Optical Networks	155
5.2.2	Placement of Wavelength Converting Nodes in Optical Networks with Sparse Conversion	155
5.2.3	Logical Topology Design in Optical Mesh Networks	156
5.3	Optical Burst/ Packet Switching	157
5.3.1	Analysis of Optical Burst Assembly	159
5.3.2	Analysis of Loss Probability for Bufferless Optical Burst/ Packet Switching Nodes	162
5.3.3	Analysis of Loss Probability for Optical Burst/ Packet Switching Nodes with Fiber Delay Lines	165

6 Peer-to-Peer Services	167
6.1 Introduction	167
6.2 The P2P Concept	168
6.3 P2P Traffic Characterization	170
6.3.1 Gnutella Traffic	170
6.3.2 eDonkey Traffic	171
6.4 Performance of P2P Mechanisms	173
6.4.1 P2P-Based Resource Mediation	173
6.4.2 Influencing P2P User Data Traffic	174
6.4.3 A P2P Epidemic Algorithm for Content Distribution .	175
List of Abbreviations	179
Bibliography	189
List of Temporary Documents	227
COST 279 Management Committee	245
COST 279 Participating Institutions	249