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Dissemination of Information in Communication Networks

Broadcasting, Gossiping, Leader Election, and Fault-Tolerance

With 73 Figures

Springer

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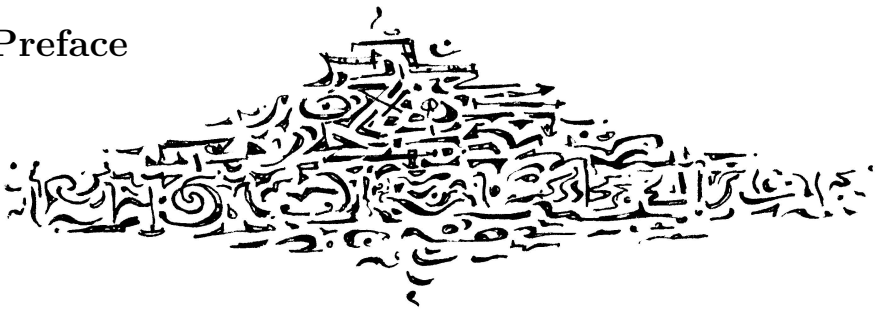
To our dear friend
and coauthor Peter Ružička,
in memoriam.

It is necessary to live in such a way
that death might seem
to be the greatest injustice done to us.
What is really important
is to give life a real sense:
to identify oneself with the yearnings of people,
to be responsible for the way things are
and to be present in all the struggles
which shape our existence.

Emmanuel Robles

Preface



Due to the development of hardware technologies (such as VLSI) in the early 1980s, the interest in parallel and distributive computing has been rapidly growing and in the late 1980s the study of parallel algorithms and architectures became one of the main topics in computer science. To bring the topic to educators and students, several books on parallel computing were written. The involved textbook "Introduction to Parallel Algorithms and Architectures" by F. Thomson Leighton in 1992 was one of the milestones in the development of parallel architectures and parallel algorithms. But in the last decade or so the main interest in parallel and distributive computing moved from the design of parallel algorithms and expensive parallel computers to the new distributive reality – the world of interconnected computers that cooperate (often asynchronously) in order to solve different tasks. **Communication** became one of the most frequently used terms of computer science because of the following reasons:

(i) Considering the high performance of current computers, the communication is often more time consuming than the computing time of processors. As a result, the capacity of communication channels is the bottleneck in the execution of many distributive algorithms.

(ii) Many tasks in the Internet are pure communication tasks. We do not want to compute anything, we only want to execute some information exchange or to extract some information as soon as possible and as cheaply as possible. Also, we do not have a central database involving all basic knowledge. Instead, we have a distributed memory where the basic knowledge is distributed among the local memories of a large number of different computers.

The growing importance of solving pure communication tasks in the interconnected world is the main motivation for writing this book. The main goals of this material are:

(i) to provide a monograph that surveys the main methods, results and research problems related to the design and analysis of communication algorithms (strategies) under different technological constraints; and
(ii) to provide an introductory textbook in the field of information dissemination in interconnection networks with a special emphasis on broadcast, information collection, gossip, leader election, and related tasks.

Our work is divided into two parts. This first textbook is devoted to the classical, direct communication between connected pairs of nodes of a communication network and to the related communication tasks such as broadcasting, gossiping, and leader election. The forthcoming part focuses on the fast communication via fixed paths between senders and receivers, which is based on new technologies such as optical networks, ATM networks, and wireless networks (for instance, mobile phones and radio networks).

This book aims to be a textbook accessible for students as well as a monograph that surveys the research on communication, presents the border between the known and the unknown, and can so be of interest to researchers and professionals, too.

We would like to thank Manuel Wahle for the successful embedding of our manuscripts into a common style, and for his technical help concerning the typical problems that occur when several people try to write something together. We are indebted to Ingrid Zámečniková for her original illustrations. The (as always) excellent cooperation with Alfred Hofmann, Ingeborg Mayer, and Ronan Nugent from Springer is gratefully acknowledged.

This textbook is devoted to our dear friend and coauthor Peter Ružička, who died during the work on this project. Slovakian computer science lost in him one of its greatest personalities, one of those who wrote the computer science history in Czechoslovakia. Peter was an excellent researcher, and a beloved teacher, who was able to inspire his students for the study and the investigation of the topic of his interest in a fascinating way. But, first of all, he was a man, and to express what we mean and feel by this, it is impossible to find anything better than the following words of Antoine de Saint-Exupéry:

Only he who carries inside a greater personality
than himself deserves to be called a man.

All quotations forthcoming in this textbook remember Peter and present his views and his way of living as we were able to understand them.

Juraj Hromkovič, Ralf Klasing,
December 2004 Andrzej Pelc, Walter Unger

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