Preface

A new computing and networking paradigm is currently on the spot as one of the priority research areas, and its research activities are booming recently: autonomic computing and networking (ACN), which are inspired by the human autonomic nervous system. ACN are characterized by their self-* facets such as self-organization, self- configuration, self-healing, self-optimization, self-protection, and so on, whose context-awareness used to dynamically control computing and networking functions.

The overarching goal of ACN is to realize computing and networking systems, which can manage themselves without direct human interventions. Meeting this grand challenge of ACN requires a rigorous approach to ACN and the notion of self-*. To this end, taking advantage of formal methods, in this book, we establish formal and practical aspects of ACN through specifying, refining, programming, and verifying ACN and their self-*. All of these are to achieve foundations and practice of ACN.

From the above characteristics, novel approaches of specification, refinement, programming, and verification are arising in formal methods for ACN. Therefore, new methodologies, programming models, tools, and techniques are imperative to deal with the impact of ACN and their self-* mentioned above on emerging computing and networking systems.

This book is preferred to be a reference material for readers who already have a basic understanding of ACN and are now ready to know how to specify, develop, and verify ACN using rigorous approaches. Hence, the book includes both theoretical contributions and reports on applications. For keeping a reasonable trade-off between theoretical and practical issues, a careful selection of the chapters was completed, on the one hand, to cover a broad spectrum of formal and practical aspects, and on the other hand, to achieve as much as possible a self-contained book.

Formal and practical aspects will be presented in a straightforward fashion by discussing the necessary components in detail and briefly touching on the more advanced components. Therefore, specification, development, and verification demonstrating how to use the formal methods for ACN will be described by sound judgments and reasonable justifications.

This book, with chapters contributed by prominent researchers from academia and industry, will serve as a technical guide and reference material for researchers, scientists, professionals, and students in computer science and computer engineering as well as developers and practitioners in computing and networking systems design by providing them with state-of-the-art research findings and future opportunities and trends. These contributions include formal approaches and applications in ACN. In particular, the book covers existing and emerging research issues in the formal methods for ACN.

The book has 13 chapters organized into two sections. The first section contains six chapters addressing formal and practical aspects of autonomic computing. The second section consists of seven chapters presenting formal and practical aspects of autonomic networking.

SECTION 1: FORMAL AND PRACTICAL ASPECTS OF AUTONOMIC COMPUTING

This section includes Chapters 1-6 and covers various topics on formal and practical aspects of autonomic computing.

Chapter 1, by R. Calinescu et al., discusses ways in which rigorous mathematical techniques, termed formal methods, can be employed to improve the predictability and dependability of autonomic computing. Model checking, formal specification, and quantitative verification are presented in the contexts of conflict detection in autonomic computing policies, and of implementation of goal and utility-function policies in autonomic IT systems, respectively.

Chapter 2, by E. Vassev, presents ASSL (Autonomic System Specification Language), an initiative for self-management of complex systems whereby the problem of formal specification, validation, and code generation of autonomic systems is approached within a framework. Being a formal method dedicated to autonomic computing, ASSL helps developers with problem formation, system design, system analysis and evaluation, and system implementation. As part of the framework's proof-of-concept strategy, ASSL has been used to make a variety of existing and prospective systems autonomic.

Chapter 3, by A. Manzalini et al., presents the main concepts of an autonomic communications toolkit designed and developed in the EU project CASCADAS for creating and supervising service networking ecosystems, structured as ensembles of distributed and cooperating autonomic components. Moreover, it describes several use-cases developed for its validation and demonstration and reports the experimental results to assess the toolkit performances.

Chapter 4, by C. Anagnostopoulos et al., discusses the application of particle swarm intelligence in autonomic computing and networking. Basic concepts and definitions of particle swarm intelligence are mapped to autonomic computing, and contextual information exploration (detection, discovery, and exploitation) is investigated in autonomous dynamic environments.

Chapter 5, by H. S. Venkatarama et al., discusses simulation environments to implement approaches to automate the tuning of MaxClients parameter of Apache web server using fuzzy controllers. These are illustrations of the self-optimizing characteristic of an autonomic computing system.

Chapter 6, by L. Ferariu et al., discusses the features of genetic programming based identification approaches. In the context of complex identification problems, genetic programming brings some important benefits which basically refer to its inherent capacity of self-organizing the models, without restrictive working hypothesis.

SECTION 2: FORMAL AND PRACTICAL ASPECTS OF AUTONOMIC NETWORKING

This section consists of Chapters 7–13, with a focus on formal and practical aspects of autonomic networking and communications.

Chapter 7, by P.C. Vinh, is a reference material for readers who already have a basic understanding of the mobile environments (MEs) for their applications and are now ready to know how to specify and verify formally aspect-oriented self-configuring P2P networking (ASPN) in MEs using categorical language, assured that their computing needs are handled correctly and efficiently. ASPN in MEs is presented in a straightforward fashion by discussing in detail the necessary components and briefly

touching on the more advanced components. Several explanatory notes and examples are represented throughout the chapter as a moderation of the formal descriptions. Significant properties of ASPN in MEs, which emerge from the specification, create the firm criteria for verification.

Chapter 8, by S. Hallé et al., discusses self-configuration from a mathematical logic point of view. In contrast with imperative means of generating configurations, characterized by scripts and templates, the use of declarative languages such as propositional or first-order logic is argued. In that setting, device configurations become models of particular logical formulae, which can be generated using constraint solvers without any rigid scripting or user intervention.

Chapter 9, by C.S. Sahin et al., presents a topology control mechanism based on genetic algorithms (GAs) within a mobile ad hoc network (MANET). Formal and practical aspects of convergence properties of the force-based genetic algorithm, called FGA, are discussed. Within this framework, FGA is used as a decentralized topology control mechanism among active running software agents to achieve a uniform spread of autonomous mobile nodes over an unknown geographical terrain. FGA can be treated as a dynamical system in order to provide formalism to study its convergence trajectory in the space of possible populations.

Chapter 10, by V. Vlassov et al., introduces Niche, a general-purpose distributed component management system used to develop, deploy, and execute self-managing distributed applications. Niche consists of both a component-based programming model as well as a distributed runtime environment. It is especially designed for complex distributed applications that run and manage themselves in dynamic and volatile environments.

Chapter 11, by G. Rétvári et al., presents a practical guideline for building truly autonomic systems. This idea is demonstrated by an example of building advanced self-adaptive routing mechanisms on top of Open Shortest Path First (OSPF) routing protocol.

Chapter 12, by J. Antoniou, addresses enhanced Session Management (SM) for multiparty communications, i.e. how to set up and modify a multi-party session that may respond to context changes and adapt to satisfy the users of a service group. By using the users' situation information, i.e. environment and network context, the chapter illustrates ways to provide more accurate sessions for mobile communities.

Chapter 13, by U. Mir, provides an overview of using multiagent systems over cognitive radio networks for dynamic spectrum sharing. In this work, avoiding unnecessary spectrum wastage problem requires performing the sharing and allocation functions opportunistically. In accordance to developing spectrum sharing solutions where the cognitive radio nodes can work collectively, a comprehensive study of utilizing multiagent systems over cognitive radio networks is discussed.

This book has the following remarkable features:

- Provides a comprehensive reference on formal and practical aspects of ACN.
- Presents state-of-the-art formal and practical aspects of ACN.
- Formally specifies, develops and verifies ACN.
- Includes illustrative figures facilitating easy reading.
- Discusses emerging trends and open research problems in the formal methods for ACN.

Being an Editor devoted to this book, I am advised by an Editorial Advisory Board (EAB) that currently consists of Dr. Costin Badica (University of Craiova, Romania), Dr. Radu Calinescu (Aston University, UK), Prof. Chin-Chen Chang (Feng Chia University, Taiwan), Prof. Mieso Denko (University of Guelph, Canada), Prof. Petre Dini (Cisco Systems, USA / Concordia University, Canada), Prof.

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The book serves as a comprehensive and essential reference on ACN and is intended as a textbook for senior undergraduate and graduate-level courses. It can also be used as a supplementary textbook for undergraduate courses. The book is a useful resource for the students and researchers to learn ACN. In addition, it will be valuable to professionals from both the academia and industry and generally serves instant appeal to the people who would like to contribute to ACN technologies.

We highly welcome and greatly appreciate your feedback and hope you enjoy reading the book.

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