# Foreword

This book presents a comprehensive reference of state-of-the-art efforts and early results in the area of autonomic networking and communication. The essence of autonomic networking, and thus autonomic communication, is to enable the autonomic component, device or system to govern the set of services and resources delivered at any given time while protecting context-sensitive business goals. An additional challenge is to provide self-governance in the face of changing user needs, environmental conditions, and business objectives. In other words, an autonomic network understands relevant contextual data and changes to those data, and adapts the services and resources it provides in accordance with business-driven policies that protect user and business interests.

Autonomic computing is often described as self-CHOP (self-configuration, -healing, -optimisation, and -protection). Autonomic networking instead focuses on self-knowledge, which is the foundation to build self-governance. Note that self-CHOP functionality is still provided, but the emphasis of autonomic networking is on the foundation to realise self-CHOP, not in the different self-* technologies and benefits.

Given this foundation, the next challenge is how to apply autonomic networking principles in the network on an application-specific basis. Since networks continue to grow increasingly larger and more complex, they become harder to manage efficiently and reliably. The goal is not to eliminate human personnel, but rather to automate the currently numerous manually-intensive tasks that are so error-prone in today's networks. We advocate a formal systems approach in which autonomic devices, components and systems are able to detect, diagnose and repair faults, as well as adapt their configuration and optimise their performance in the face of changing user needs and environmental conditions. Both of these must be done while protecting and healing themselves in the face of natural problems and malicious attacks. Building adaptive and autonomous control directly into the corresponding network elements enables a shift of focus from the technology used by the network elements to the provisioning of next generation converged services.

This special issue explores different ways in which autonomic principles and techniques can be applied to existing and future networks. In particular, this book is divided into three main parts, each of them represented by three papers discussing a particular aspect from industrial as well as academic perspectives.

The first part focuses on architectures and modelling strategies. It starts with a discussion on current standardisation efforts for defining a technological neutral, architectural framework for autonomic systems and networks. This first paper also defines a set of critical system services that Autonomic Networks require and emphasises (along with the other two papers in this section) that a new framework based on standards must be developed to build a new generation of infrastructures (networks and systems) with inherent autonomic capabilities. The second

paper examines how a telecommunication company utilises autonomic principles to manage its infrastructure. In particular, this paper focuses on defining semantic information as the basis for knowledge. It defines the need to focus on legacy equipment and services, not just new "clean slate" devices, and advocates the use of software agent technologies. The final paper in this section describes a European effort to model distribution and behaviour of and for (autonomic) network management. While a P2P paradigm was used, this approach is suitable for many different topologies. Its key contribution is the use of a metamodel dedicated to modelling the needs of network management.

Part two of this book is dedicated to middleware and service infrastructure as facilitators of autonomic communications. This part starts introducing a connectivity management system based on a resilient and adaptive communication middleware. A key feature of this approach is its potential for sustained connectivity in the event of path disruptions. The second paper of this part combines the concept of a knowledge plane with real-time demands of the military sector to regulate resources. This paper defines a variant of the Knowledge Plane that uses situatedness as a new management paradigm for gathering, computing and exchanging knowledge and control over a large network. This is followed by a profound discussion on how the management of service access can benefit from autonomic principles, with special focus on next generation networks. This paper concentrates on enabling adaptive connectivity management of nomadic end hosts across heterogeneous access networks using loosely-coupled distributed management functions and control methods.

Part three focuses on how current networks can be equipped with autonomic functionality and thus be migrated to autonomic networks. We start this part by analysing the difference between traditional network management and autonomic network management and learn how the latter enables cross-layer optimisation. This paper emphasises the use of simple and dependable elements that can self-organise to produce more sophisticated behaviours. The second paper shows how a multi-agent system helps to manage a combined MPLS DiffServ-TE Domain. An architecture is described that defines a novel LSP creation strategy that reduces the number of LSPs and hence, the number of signalling operations in the network. Finally, this part concludes with a very interesting approach that applies game theory to autonomically manage the available spectrum in wireless networks in order to improve spectrum efficiency and maximise network revenue. Two different games (revenue-sharing and price) model the spectrum sharing and spectrum trading behaviours between inter-operator radio access networks, leading to a novel bargaining based dynamic spectrum sharing approach that simplifies reaching agreements.

We would like to thank all people who helped us providing this book for you. First of all, all the authors who submitted papers and who made their current research available for this book. Second, our colleagues from Birkhäuser, who gave us the chance of publishing our view on Autonomic Communications. Last not

least a special thanks to Roberto Ghizzioli from Whitestein Technologies, who worked very hard over the last summer and constantly pushed us to our limits.

We hope you enjoy and learn from this book as much as we have!

*Monique Calisti, Sven van der Meer, John Strassner*
Zürich - Waterford - Schaumburg
November 2007

http://www.springer.com/978-3-7643-8568-2

Advanced Autonomic Networking and Communication
Calisti, M.; Strassner, J.C. (Eds.)
2008, IX, 190 p., Softcover
ISBN: 978-3-7643-8568-2
A product of Birkhäuser Basel