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Autonomic and Trusted Computing

Third International Conference, ATC 2006
Wuhan, China, September 2006
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Preface

Welcome to the proceedings of the Third International Conference on Autonomic and Trusted Computing (ATC 2006) which was held in Wuhan and Three Gorges, China, September 3-6, 2006.

Computing systems including hardware, software, communication and networks are growing with ever increasing scale and heterogeneity, and becoming overly complex. The complexity is getting more critical along with ubiquitous permeation of embedded devices and other pervasive systems. To cope with the growing and ubiquitous complexity, autonomic computing focuses on self-manageable computing and communication systems that perform self-awareness, self-configuration, self-optimization, self-healing, self-protection and other self-ware operations to the maximum extent possible without human intervention or guidance.

Any autonomic system must be trustworthy to avoid the risk of losing control and to retain confidence that the system will not fail. Trust and/or distrust relationships in the Internet and pervasive infrastructure-based global computing exist universally in the course of dynamic interaction and cooperation of various users, systems and services. Trusted computing targets computing and communication systems as well as services that are available, predictable, traceable, controllable, assessable, sustainable, dependable, persist-able, security/privacy protect-able, etc. A series of grand challenges exist to achieve practical self-manageable autonomic systems with truly trustworthy services.

The ATC 2006 conference provided a forum for engineers and scientists in academia, industry, and government to address the most innovative research and development including technical challenges and social, legal, political, and economic issues, and to present and discuss their ideas, results, work in progress and experience on all aspects of autonomic and trusted computing and communications. ATC 2006 as a conference came from the First International Workshop on Trusted and Autonomic Ubiquitous and Embedded Systems (TAUES 2005) held in Japan, December, 2005, and the International Workshop on Trusted and Autonomic Computing Systems (TACS 2006) held in Austria, April, 2006.

There was a very large number of paper submissions (208), representing 18 countries and regions, not only from Asia and the Pacific, but also from Europe, and North and South America. All submissions were reviewed by at least three Program or Technical Committee members or external reviewers. It was extremely difficult to select the presentations for the conference because there were so many excellent and interesting submissions. In order to allocate as many papers as possible and keep the high quality of the conference, we finally decided to accept 57 papers for presentations, reflecting a 27% acceptance rate. We believe that all of these papers and topics not only provided novel ideas, new results, work in progress and state-of-the-art techniques in this field, but also

stimulated the future research activities in the area of autonomic and trusted computing and communications.

The exciting program for this conference was the result of the hard and excellent work of many others, such as Program Vice-Chairs, external reviewers, Program and Technical Committee members, and Publication Chairs under a very tight schedule. We are also grateful to the members of the Local Organizing Committee for supporting us in handling so many organizational tasks, and to the keynote speakers for accepting to come to the conference with enthusiasm. Last but not least, we hope you enjoy the conference program, and the beautiful attractions of Three Gorges, China.

Laurence T. Yang, Hai Jin, Jianhua Ma
Theo Ungerer, David Ogle
Manish Parashar, Kouichi Sakurai
ATC 2006 Steering, General and Program Chairs

Organization

ATC 2006 was organized and sponsored by Huazhong University of Science & Technology (HUST), co-sponsored by the National Science Foundation of China, 863, ChinaGrid, and International Federation for Information Processing (IFIP). It was held in cooperation with the IEEE Computer Society and *Lecture Notes in Computer Science* (LNCS) of Springer.

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Table of Contents

Keynote Speech

Track 1: Autonomic/Organic Computing and Communications

Track 2: Trust Models and Trustworthy Systems/Services

Track 3: Cryptography, Security and Privacy

Track 4: Reliability, Fault Tolerance and Dependable Systems

Emergence in Organic Computing Systems: Discussion of a Controversial Concept

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Abstract. Philosophy of mind has investigated the emergent behavior of complex systems for more than a century. However, terms such as "weak" or "strong" emergence are hardly applicable to intelligent technical systems. Organic Computing has the goal to utilize concepts such as emergence and self-organization to build complex technical systems. At first glance this seems to be a contradiction, but: These systems must be reliable and trustworthy! In order to measure, to control, and even to design emergence, a new notion or definition of emergence is needed. This article first describes the definition of emergence as used in philosophy of mind because this definition is often misunderstood or misinterpreted. Then, some very recent approaches for definitions of emergence in more or less technical contexts are discussed from the viewpoint of Organic Computing. The article concludes with some new thoughts that may help to come to a unifying notion of emergence in intelligent technical systems.

1 Introduction

Organic Computing (OC) has emerged recently as a challenging vision for future information processing systems, based on the insight that we will soon be surrounded by systems with massive numbers of processing elements, sensors, and actuators, many of which will be autonomous. Due to the complexity of these systems it will be infeasible to monitor and control them entirely from external observations; instead they must monitor, control, and adapt themselves. To do so, these systems must be aware of themselves and their environment, communicate, and organize themselves in order to perform the actions and services required. The presence of networks of intelligent systems in our environment opens up fascinating application areas but, at the same time, bears the problem of their controllability. Hence, we have to construct these systems – which we increasingly depend on – as robust, safe, flexible, and trustworthy as possible. In particular, a strong orientation towards human needs as opposed to a pure implementation of the technologically possible seems absolutely central. In order to achieve these goals, our intelligent technical systems must act more independently, flexibly, and autonomously. That is, they must exhibit life-like (organic) properties. Hence, an *Organic Computing System* is a technical system, which adapts dynamically to the current

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conditions of its environment. It will be self-organizing, self-configuring, self-healing, self-protecting, self-explaining, and context-aware. OC goes beyond Autonomic Computing by studying the mechanisms of self-organized emergence in technical systems and finding methods to control and direct it.

The vision of OC and its fundamental concepts arose independently in different research areas such as Neuroscience, Molecular Biology, and Computer Engineering. Self-organizing systems have been studied for quite some time by mathematicians, sociologists, physicists, economists, and computer scientists, but so far almost exclusively based on strongly simplified artificial models. Central aspects of OC systems are inspired by an analysis of information processing in biological systems. Within short time, OC became a major research activity in Germany and worldwide [1][1].

A key issue of OC is the technical utilization of *emergence* and *self-organization* as observed in natural systems. Emergent and self-organizing behavior has been observed in nature, demonstrated in a variety of computer-simulated systems in artificial life research, and also utilized in highly complex technical systems (such as the Internet) where it sometimes has led to unexpected global functionality.

In philosophy of mind, the *emergent* behavior of more or less complex systems has been investigated for more than a hundred years. Today, it turns out that phenomena that are interesting in OC or related fields such as autonomic or proactive computing and phenomena that are interesting in philosophy of mind require very different terms and definitions. For example, a question studied in philosophy of mind is: Why and how does *experience* arise? In organic computing we are interested in self-organization, for instance: How can new and *unexpected behavior* of a team of robots be characterized, measured, and / or controlled?

Certainly, if we want to control emergence, we have to answer some other questions first (cf. [2]), for example:

1. What are the underlying principles of emergence?
2. How can we define emergence within the contect of OC?
3. How can we model emergence?
4. What are pre-conditions for emergence to occur?
5. How can we measure emergence?
6. What are the limits of emergence?

In this article, we begin to answer these questions; the focus will be on various definitions of emergence. Initially, we will take a look at various historical, philosophical definitions or notions of emergence and discuss whether they could be useful for us (Section 2). Then, some very recent definitions of emergence that could be appropriate for OC are analysed in Section 3. We have selected publications (authored by STEPHAN, DE WOLF and HOLVOET, FROMM, ABBOTT, and MNIF and MÜLLER-SCHLOER, the first author of this article) that have a close relationship to intelligent technical systems. They all appeared in 2005 or 2006. We assess all these suggestions and alternatives from the viewpoint of OC and set out some new thoughts that may help to come to a unifying notion of emergence in the field of Organic Computing (Section 4).

[1] The URLs of the OC Websites are `http://www.organic-computing.de/SPP` and `http://www.organic-computing.org`.