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Preface

This year marks the fourth year of the International Working Conference on Active Networks; this volume contains the papers accepted for full presentation at the conference. These proceedings are proof that Active Networks is a vibrant field with truly international participation, with research done not only in the context of formal programs (such as FAIN and DARPA Active Nets), but also in a number of independent research programs.

We received significantly more submissions than could possibly be accommodated during the two days of sessions, and combined with the desire for high standards this has resulted in a very selective program. The distinguished program committee did an outstanding job of reviewing the papers, with detailed comments and suggestions to the authors, each paper receiving from 4 to 6 reviews. Of the 53 papers submitted, 9 were accepted unconditionally. An additional set of papers were conditionally accepted, with program committee members working with the authors to insure that review concerns were addressed, while shepherding towards final publication; 11 of these papers are included in the proceedings. An additional set of poster presentations were given for worthy submissions that could not be accommodated within these limitations, as well as position papers and work in progress.

The best paper award went to Nadia Shalaby, Yitzchak Gottlieb, and Mike Wawrzoniak for "Snow on Silk: A NodeOS in the Linux Kernel," which begins these proceedings and the papers in the node operating systems session. These proceedings also contain active networking papers on: service deployment, discovery, and composition; monitoring and management; mobile wireless; system architecture; and peer-to-peer and group communication. In keeping with the "working" nature of the conference, significant time was reserved for discussion, and panels on active mobile networking, peer-to-peer, and the future prospects for active network research and deployment.

We would like to thank the technical program committee members for their hard work in reviewing and shepherding papers. We would like to thank Bernhard Plattner, Placi Flury, and Lukas Ruf for their considerable time and support in conference organization, and for providing the infrastructure at the Swiss Federal Institute of Technology (ETH), Zürich that made the work of the program committee considerably easier. And of course it is the work of the authors that is the core of these proceedings, and the attendees' participation that makes for an outstanding working conference. We hope you enjoy the fruits of their labor.

September 2002

James Sterbenz
Osamu Takada
Christian Tschudin

Introduction

It is my great pleasure to introduce to you the proceedings of the 4th Annual International Working Conference on Active Networks, which took place in December 2002 at ETH Zürich, Switzerland. The end of 2002 has a special meaning for researchers in the area of active and programmable networks. It marks the closing of the DARPA Active Networks program, which provided important resources to researchers exploring this new approach to computer networking. This program, together with notable independent research in many other countries, generated a basic understanding of the architecture and functionality of active networks and produced a terminology which has been adopted by most individuals working in this field – terms like *NodeOS*, *Execution Environment*, or *Capsule* now have a well-known meaning. Furthermore, many potential applications of active networks have been studied, simulated, implemented, and demonstrated all over the world.

However, it is too early to declare victory. Active network technology still has not found widespread acceptance among manufacturers or network operators. The technology, in its "natural" shape, is disruptive, since introducing it would require that much of the current Internet would have to be changed. History teaches us that introducing a disruptive technology (prominent examples of such technologies are the personal computer and the Internet) takes a long time, if it replaces a well-established and well-working technology. Therefore, the active networks research community needs to consciously address the issues that may hinder a more widespread adoption of active networking. First, we have to make a better case and show that active network technology dominates competing technologies in real-life large-scale situations; this calls for a testbed which will not only be used for demonstrations, but also for production in our daily business. Second, we need to address the issue of how to introduce active network technology into our current IT environment, which today is largely dominated by the Internet – i.e., we need to take away some of the disruptiveness associated with active networks. Third, active networks research needs to look at and perhaps merge with related research areas; the "merger" with the area of programmable networks is imminent, but perhaps we also need to follow the road towards a software engineering discipline for active networks, which already has been paved by the research groups looking at domain-specific programming languages. Other interesting research areas are peer-to-peer networks and ad hoc networks, where nodes take on the roles of both end-systems and routers, and therefore may use active network technology to provide better and more suitable services to their users. Fourth, we need to be aware of basic technologies that may serve as drivers, such as network processors and programmable and reconfigurable hardware. Finally, we need to actively address the issue of technology transfer, i.e., to make active network technology accessible to manufacturers and operators.

IWAN 2002, coming at the end of the first phase of active network research, also marks the beginning of the second (and decisive) phase in our field. You will find some of the issues mentioned above addressed in the papers of this volume, but not all of them. Thus, there's still much to be done. Let's do it!

September 2002 Bernhard Plattner

Organization

IWAN 2002 was organized by the Computer Engineering and Networks Laboratory, Swiss Federal Institute of Technology (ETH), Zürich. We would like to acknowledge the support of our sponsors, the Swiss Federal Institute of Technology, Zürich, IFIP (International Federation for Information Processing), Hitachi, Japan, and Fraunhofer FOKUS (Research Institute for Open Communication Systems), and we thank them for their contributions. Their support demonstrates the international interest in the benefits of active networking. The IWAN international committee would also like to express their gratitude to the Swiss Federal Office for Education and Science for their generous support.

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