Lecture Notes in Computer Science 852
Edited by G. Goos, J. Hartmanis and J. van Leeuwen

Klaus Echtle Dieter Hammer
David Powell (Eds.)

Dependable Computing – EDCC-1

First European Dependable Computing Conference
Berlin, Germany, October 4-6, 1994
Proceedings

Springer-Verlag
Berlin Heidelberg New York
London Paris Tokyo
Hong Kong Barcelona
Budapest

Series Editors

Gerhard Goos
Universität Karlsruhe
Postfach 69 80, Vincenz-Priessnitz-Straße 1, D-76131 Karlsruhe, Germany

Juris Hartmanis
Department of Computer Science, Cornell University
4130 Upson Hall, Ithaka, NY 14853, USA

Jan van Leeuwen
Department of Computer Science, Utrecht University
Padualaan 14, 3584 CH Utrecht, The Netherlands

Volume Editors

Klaus Echtle
Fachbereich Informatik
Universität Dortmund, Lehrstuhl IV
D-44221 Dortmund, Germany

Dieter Hammer
Humboldt-Universität zu Berlin
Fachbereich Informatik
D-10119 Berlin, Germany

David Powell
LAAS-CNRS
7 avenue du Colonel Roche, F-31077 Toulouse, France

CR Subject Classification (1991): B.1.3, B.2.3, B.3.4, B.4.5, C.3-4, D.2.4, D.2.8, D.4.5, E.4, J.7

ISBN 3-540-58426-9 Springer-Verlag Berlin Heidelberg New York

CIP data applied for

Printed in Germany

Typesetting: Camera-ready by author
SPIN: 10478938 45/3140-543210 - Printed on acid-free paper

Foreword

The "First European Dependable Computing Conference" is both the start of a new European forum for dependable computing and the continuation of two former conference series – the "International Conference on Fault Tolerant Computing Systems" held in the Federal Republic of Germany until 1991 and the "International Conference on Fault-Tolerant Systems and Diagnostics" held in the countries of Eastern Europe until 1990.

Hardware and software reliability, safety and security, fault detection and tolerance, verification and validation are challenges newly arising for every computing system generation where high dependability requirements must be met in a practical and efficient way. Theoretical and experimental research form the scientific background to enable safety-critical applications.

The new series "European Dependable Computing Conference", EDCC will become a meeting point and enforce the exchange of ideas, models, designs and results from all over the world in a place where considerable contributions have been made. European industry spans the scope from highly available transaction processing applications to safety-critical areas such as railway signalling and aircraft control.

The work on dependability improvement is supported by interest groups in various European countries. They agreed to set up EDCC as their new common platform. The unification of their previous activities also reflects the political opening, which offers promising prospects to the scientific community. We wish all the best to the free cooperation among researchers and developers. It will certainly ease and promote their efforts.

The East West unification character of this conference is underlined by selecting Berlin as the location of the very first event, and by the composition of the program committee, the external referees, the session chairs – and the two co-chairs of EDCC-1 as well.

The conference would not be possible without the substantial contributions of many persons. First of all we express our thanks to the program committee, which performed excellent work under the chair of David Powell. By the willing help of the external referees an outstanding selection of papers was achieved. Our thanks is also directed to Erik Maehle who mainly contributed to EDCC's publicity and made it a well-known event.

The conference organisation was supported by the German interest group "Fault-Tolerant Computing Systems" and its chairman Ernst Schmitter, by LAAS-CNRS in Toulouse, and staff at University of Dortmund, Humboldt University of Berlin,

University of Paderborn, and Technical University of Cottbus. All their help is gratefully acknowledged.

We also express our thanks to Springer-Verlag for publishing the conference proceedings in the well-known series "Lecture Notes in Computer Science", and the Informationstechnische Gesellschaft ITG for arranging this conference.

We hope that EDCC-1 will be a successful start of the new conference series and that the participants will find its technical contribution interesting. We also hope that everyone enjoys the stay in Berlin.

July 1994

Klaus Echtle, Dieter Hammer

Co-Chairs

Preface

Europe has been evolving quickly as we approach the end of the second millennium. In the 1980s, the advent of the European Community funding of technical research and development was a key factor in the creation of an international Western European Scientific Community, in particular in the field of computer science, thanks to the ESPRIT program. Now, in the 1990s, Europe is on the move again on a wider scale and our Community can grow further. This first European Dependable Computing Conference unites and expands two earlier series of conferences that were held in our formerly divided continent. It seems most fitting that Berlin should host this first united European conference and it has been my very great honour to chair its program committee.

Since this is the first conference of its sort, a major concern was to set high standards regarding both international representation on the program committee and the rigour of the paper selection process. A 30-strong committee was set up with representatives from 16 different European countries. Furthermore, to encourage submissions from outside Europe, two international liaison chairs kindly agreed to assist us. The committee was also ably assisted by 228 external referees from 23 different countries.

Overall, 106 papers were submitted from 29 countries. For each paper, 3 committee members were asked to nominate 1 committee member referee and 2 external referees. With this data, each paper was finally allocated 2 committee member referees and 3 external referees. Assigning referees in this way gave very positive results since the rate of return of completed reviews was extremely good. Overall, 530 manuscripts and review forms were sent out and 472 completed reviews were returned (89%). Most papers (91.5%) received 4 or more reviews and all papers were reviewed by at least 3 referees.

The program committee met on April 11-13, 1994 at LAAS-CNRS, Toulouse, to select those papers that were judged to be of a sufficiently high standard to be presented at the conference and to be included in the proceedings. Of the 106 papers submitted, 24 met the committee's stringent requirements and were thus accepted outright. Another 10 papers were accepted on the condition that the authors carry out the modifications requested by the referees. These papers were re-checked before final acceptance. In all, 34 papers out of 106 were finally accepted, with authors from 13 different countries.

The selected papers cover many different areas of dependable computing, including fault avoidance and fault tolerance techniques, in both hardware and software, for dealing with a wide class of faults: physical faults, design faults, intrusions,... There

are also many interesting papers that deal with fault removal and fault forecasting aspects for validating dependable systems through testing and evaluation.

The technical program at the conference has been purposely organized in a single track so that attendees will have the opportunity to apprehend the basic concepts of dependability that are applicable over a wide range of viewpoints. Maybe the resulting cross-fertilization of ideas will provide inspiration for future research? I hope so.

I also hope that this first EDCC has laid firm foundations for a regular series of high-standard conferences that will periodically provide a respected European venue for researchers worldwide to present and discuss their results.

July 1994

David Powell

Program Chair

Organization Committee

Co-Chairs

Klaus Echtle
University of Dortmund
Germany

Dieter Hammer
WIP Berlin
Germany

Program Chair

David Powell
LAAS-CNRS, Toulouse
France

Publicity Chair

Erik Maehle
University of Paderborn
Germany

Finance Chair

Volker Schanz
ITG-VDE, Frankfurt
Germany

International Liaison Chairs

North America:
Jacob Abraham
University of Texas, Austin
USA

Asia:
Yoshiro Tohma
Tokyo Denki University
Japan

Program Committee

A. Avizienis (Lithuania)
D. Avresky (Bulgaria)
O. Babaoglu (Italy)
A. Costes (France)
P. J. Courtois (Belgium)
M. Dal Cin (Germany)
Y. Deswarte (France)
W. Görke (Germany)
B. Helvik (Norway)
J. Hlavicka (Czech Republic)
A. Hlawiczka (Poland)
H. Kirrmann (Switzerland)
H. Kopetz (Austria)
C. Landrault (France)
J. C. Laprie (France)
J. McDermid (United Kindgom)
J. Nordahl (Denmark)
A. Pfitzmann (Germany)
J. J. Quisquater (Belgium)
B. Randell (United Kindgom)
E. Schmitter (Germany)
J. Silva (Portugal)
L. Simoncini (Italy)
B. Straube (Germany)
J. Sziray (Hungary)
J. Torin (Sweden)
R. Ubar (Estonia)
P. Veríssimo (Portugal)
J. Vytopil (Netherlands)

External Referees

E. J. Aas
L. Alvisi
T. Anderson
R. Anderson
J. Arlat
P. Azéma
L. F. Bacellar
K. Badzmirowksi
F. Balbach
G. Balbo
A. Balivada
M. Banâtre
P. Banerjee
H. Beilner
F. Belli
T. Bemmerl
C. Bernardeschi
Y. Bertrand
J. Biskup
J. P. Blanquart
A. Bobbio
A. Bode
A. Boehm
A. Bondavalli
L. Breveglieri
E. Brinksma
J. Bruck
H. H. Brüggemann
S. Budkowski
A. Burns
L. Cacciari
A. Canning
J. Carrasco
S. Chabridon
A. Ciuffoletti
A. Clematis
J. Coenen
R. Cooper
D. Crestani
F. Cuppens
R. Cuyvers
B. d'Ausbourg
A. Dahbura
G. Dahll
J. Devooght
F. Di Giandomenico
B. Dimke
A. Domenici
L. Donatiello
V. Dràbek
H. Dücker
C. Dufaza
W. Dulz
H. Edler
G. Eizenberg
R. Ernst
B. Eschermann
A. Fantechi
G. Färber
B. Ferruccio
S. Fischer-Hübner
G. Fohler
D. Forslund
P. Frankl
K. Fuchs
E. Fuchs
R. Gantenbein
W. Geisselhardt
J. Gentina
J. Gerardin
R. Gerlich
P. Girard
M. Girault
J. Goldberg
K. Goseva-Popstojanova
M. Gössel
E. Gramatová
F. Grandoni
K. Großpietsch
G. Grünsteidl
H. Guillermain
K.M. Hansen
L. Heerink
K. D. Heidtmann
S. Hellebrand
M. Hildebrand
M. Hiltunen
W. Hohl
J. Hooman
G. Horvàth
K. A. Iyoudou
J. Jacob
J. Jacobson
E. Jonsson
G. Juanole
M. Kaâniche
Y. Kakuda
Z. Kalbarczyk
A. Kalendarev
G. Kanawati
K. Kanoun
H. Kantz
A. Kaposi
J. Karlsson
J. P. Kelly
P. Keresztes
K. Kim
Y. S. Kim
Y. Koga
M. Kotocovà
C. Koza

A. Krasniewski
H. Krawczyk
U. Krieger
T. Krol
H. Krumm
M. Labarrère
X. Lai
J. Lala
G. Leber
P. Lee
R. Lepold
R. Leveugle
B. Littlewood
D. Logothetis
T. Lovric
T. Lunt
C. Macnish
H. Madeira
E. Maehle
P. Maestrini
V. Mainkar
N. Malvache
R. Marie
R. Maxion
C. Meadows
S. Metge
J. F. Meyer
F. Meyer
S. Miller
M. Millinqe
I. Mitrani
M. Morganti
C. Morin
G. Muller
R. Needham
R. Negrini
J. Nehmer
M. Nicolaïdis
H. Niederreitter
O. Novàk
J. O'Connell
C. O'Halloran
P. Olivo
A. Pataricza
S. Perl
B. Pfitzmann
A. Pluhàcek
P. Poechmueller
I. Pomeranz
D. K. Pradhan
S. Pravossoudovitch
P. Puschner
A. P. Ravn
M. Raynal
J. Richier
A. Robinson
L. Rodrigues
A. Romanovsky
R. A. Rueppel
J. Rushby
J. Rutkowski
H. Rzehak
F. Saglietti
J. Santucci
K. Sapiecha
G. Saucier
A. Schedl
H. Schepers
A. Schiper
R. Schlatterbeck
R. Schlichting
W. G. Schneeweiß
W. Seidel
E. Selényi
N. S. Sendrier
B. Sericola
E. Shokri
D. P. Siewiorek
J. Sifakis
L. M. Silva
A. Skavhaug
P. Slaba
J. Sosnowski
N. Speirs
T. Stälhane
F. Stanischewski
F. Stassen
A. Steininger
A. Stopp
L. Strigini
M. Svéda
A. Szegi
S. Tao
P. Thévenod
K. Tilly
J. Toetenel
S. Tritsolev
K. Trivedi
G. Tsudik
P. D. V. van der Stok
M. Vanneschi
H. Vanthiena
H. Veit
H. T. Vierhaus
C. Viho
U. Voges
A. Vrchoticky
H. Waeselynck
M. Waidner
A. Wellings
H. Wunderlich
J. Xu
V. Yodaiken
L. T. Young
H. Zhu
C. Ziegler
J. Zwiers

Table of Contents