

**Computational Science, Engineering and Technology Series: 27**

**Trends in  
Parallel, Distributed,  
Grid and Cloud Computing  
for Engineering**

## **Saxe-Coburg Publications on Computational Engineering**

### **Developments and Applications in Engineering Computational Technology**

*Edited by: B.H.V. Topping, J.M. Adam, F.J. Pallarés, R. Bru and M.L. Romero*

### **Developments and Applications in Computational Structures Technology**

*Edited by: B.H.V. Topping, J.M. Adam, F.J. Pallarés, R. Bru and M.L. Romero*

### **Substructuring Techniques and Domain Decomposition Methods**

*Edited by: F. Magoulès*

### **Soft Computing in Civil and Structural Engineering**

*Edited by: B.H.V. Topping and Y. Tsompanakis*

### **Trends in Civil and Structural Engineering Computing**

*Edited by: B.H.V. Topping, L.F. Costa Neves and R.C. Barros*

### **Parallel, Distributed and Grid Computing for Engineering**

*Edited by: B.H.V. Topping and P. Iványi*

### **Computational Methods for Acoustics Problems**

*Edited by: F. Magoulès*

### **Mesh Partitioning Techniques and Domain Decomposition Methods**

*Edited by: F. Magoulès*

### **Object Oriented Methods and Finite Element Analysis**

*R.I. Mackie*

### **Programming Distributed Finite Element Analysis**

*R.I. Mackie*

### **Computer Aided Design of Cable-Membrane Structures**

*B.H.V. Topping and P. Iványi*

### **Domain Decomposition Methods for Distributed Computing**

*J. Kruis*

## **Civil-Comp Press publications on Computational Engineering**

### **Proceedings of the Seventh International Conference on Engineering Computational Technology**

*Edited by: B.H.V. Topping, J.M. Adam, F.J. Pallarés, R. Bru and M.L. Romero*

### **Proceedings of the Tenth International Conference on Computational Structures Technology**

*Edited by: B.H.V. Topping, J.M. Adam, F.J. Pallarés, R. Bru and M.L. Romero*

### **Proceedings of the First International Conference on Parallel, Distributed and Grid Computing for Engineering**

*Edited by: B.H.V. Topping and P. Iványi*

**Trends in  
Parallel, Distributed,  
Grid and Cloud Computing  
for Engineering**

*Edited by*  
**P. Iványi and B.H.V. Topping**



© Saxe-Coburg Publications, Stirlingshire, Scotland

published 2011 by  
**Saxe-Coburg Publications**  
Dun Eaglais  
Station Brae, Kippen  
Stirlingshire, FK8 3DY, UK

*Saxe-Coburg Publications is an imprint of Civil-Comp Ltd*

Computational Science, Engineering and Technology Series: 27  
ISSN 1759-3158  
ISBN 978-1-874672-53-1

**British Library Cataloguing in Publication Data**

A catalogue record for this book is available from the British Library

Front cover image: A snapshot of an Eulerian turbulent velocity field from the direct numerical simulation of the Navier–Stokes equation. Image courtesy of Federico Toschi, National Research Council (CNR), Italy and Technische Universiteit Eindhoven, Netherlands. Results achieved in the DEISA “Heavy Particles in Turbulent Flows” project. For more information, see Chapter 2 by W. Gentsch and H. Lederer.

Back cover image: Hurricane storm surge: simulated high water mark for hurricane Katrina (dark red: +6.0m). For more information, see Chapter 9 by S. Aliabadi, E. Yilmaz, M. Akbar, S. Palle, B. Soni and R. Patel.

Printed in Great Britain by Bell & Bain Ltd, Glasgow

# Contents

|   |            |
|---|------------|
| <b>Preface</b>  | <b>iii</b> |
| 1 State of the Art Distributed Parallel Computational Techniques in Industrial Finite Element Analysis<br>L. Komzsik  | 1          |
| 2 DEISA: A Distributed European HPC Ecosystem for Engineers and Scientists<br>W. Gentsch and H. Lederer   | 21         |
| 3 The Virtual Prairie Project<br>M. Garbey, M. Smaoui, W. Rinsurongkawong and C. Mony   | 49         |
| 4 Network Services for High Performance Distributed Computing and Data Management<br>W.E. Johnston, C. Guok, J. Metzger and B. Tierne                               | 83         |
| 5 Performance Models of Zoned Disk Arrays<br>W.J. Knottenbelt, A.S. Lebrecht and N.J. Dingle  | 105        |
| 6 Advanced Object-Oriented Paradigms for Parallel Computational Mechanics<br>D. Eyheramendy, R. Saad and F. Oudin-Dardun  | 135        |
| 7 The Scalable GPGPU-based Hybrid Computing System and its Applications<br>B.N. Chetverushkin   | 159        |
| 8 High Performance Computer Simulation for Engineering: A Review<br>M.M. Resch  | 177        |
| 9 Scalable Hybrid Algorithms for Large-Scale Parallel Computational Fluid Dynamics Applications<br>S. Aliabadi, E. Yilmaz, M. Akbar, S. Palle, B. Soni and R. Patel | 187        |
| 10 Modeling of Multiphase and Multifield Flow Problems<br>E. Monaco, T. Kersten and G. Brenner  | 221        |

|    |   |            |
|----|---|------------|
| 11 | High Performance Strategies for Large Scale Complex Structural Analysis<br>J.Y. Cognard and P. Verpeaux   | 243        |
| 12 | Massive Parallelization for Industrial CFD Based Analysis and Design<br>S. Peigin and B. Epstein  | 269        |
| 13 | Parallel Approximate Inverse Preconditioning using the Finite Difference Method: The General Purpose Graphics Processing Unit Approach<br>G.A. Gravvanis, C.K. Filelis-Papadopoulos and K.M. Giannoutakis | 291        |
| 14 | Grid Technology for Collaborative Computing in Engineering<br>H.M. Chen and Y.C. Lin  | 321        |
| 15 | Ontology for Contract Negotiations in an Agent-based Grid Resource Management System<br>M. Drozdowicz, K. Wasielewska, M. Ganzha, M. Paprzycki, N. Attaoui, I. Lirkov, R. Olejnik, D. Petcu and C. Badica | 335        |
| 16 | Negotiations in an Agent-based Grid Resource Brokering System<br>K. Wasielewska, M. Ganzha, M. Paprzycki, M. Drozdowicz, D. Petcu, C. Badica, N. Attaoui, I. Lirkov and R. Olejnik                        | 355        |
|    | <b>Author Index</b>   | <b>375</b> |
|    | <b>Keyword Index</b>  | <b>377</b> |

# Preface

This volume comprises the invited lectures presented at The Second International Conference on Parallel, Distributed, Grid and Cloud Computing for Engineering (PARENG 2011) held in Ajaccio, Corsica, France, 12-15 April 2011. We are grateful to the authors and co-authors of the Invited Lectures included in this volume. Their contribution both to these conferences and this book is greatly appreciated.

Other papers presented at this conference are published as follows:

- *The Invited Review Lectures are published in:*  
Computational Technology Reviews, Volume 3, Saxe-Coburg Publications, Stirlingshire, Scotland, 2011.
- *The Contributed Papers are published in:*  
Proceedings of the Second International Conference on Parallel, Distributed, Grid and Cloud Computing for Engineering, P. Iványi and B.H.V. Topping, (Editors), (Book of Summaries with a CD-ROM of full-text papers), Civil-Comp Press, Stirlingshire, Scotland, 2011.

We would like to thank the members of the Editorial Board of The Second International Conference on Parallel, Distributed, Grid and Cloud Computing for Engineering: Prof. H. Adeli, USA; Prof. R.K. Agarwal, USA; Prof. H.U. Akay, Turkey; Dr H. Akiba, Japan; Dr N.E. Alaa, Morocco; Dr A. Al-Dubai, UK; Prof. S. Aliabadi, USA; Dr O. Allix, France; Mr J.M. Alonso, Spain; Dr T. Alrutz, Germany; Prof. E. Aulisa, USA; Dr L. Badea, Romania; Prof. J.W. Baugh, USA; Prof. M.L. Bittencourt, Brazil; Prof. P.-A. Boucard, France; Prof. P. Bouvry, Luxembourg; Prof. G. Brenner, Germany; Dr J. Brozovsky, Czech Republic; Dr X. Cai, Norway; Prof. A.H.C. Chan, UK; Dr H-M. Chen, Taiwan; Prof. B.N. Chetverushkin, Russia; Dr F. Cirak, UK; Dr B. Codenotti, Italy; Dr P.G. Coelho, Portugal; Prof. J.Y. Cognard, France; Dr T.N. Croft, UK; Prof. M. Damodaran, India; Prof. P.R.B. Devloo, Brazil; Dr C. Di Napoli, Italy; Dr M. Dolenc, Slovenia; Dr D. Emerson, UK; Dr J. Erhel, France; Dr D. Eyheramendy, France; Dr V. Galiano, Spain; Dr M. Ganzha, Poland; Prof. J.D. García, Spain; Prof. W. Gentzsch, Germany; Dr C. Gil Montoya, Spain; Prof. L. Giraud, France; Dr B. Glut, Poland; Dr J M Gonzalez Vida, Spain; Dr G.A. Gravvanis, Greece; Prof. A.A. Groenwold, South Africa; Prof. O. Hassan, UK; Dr D. Henty, UK; Dr D. Horak, Czech Republic; Dr F. Hulsemann, France; Prof. I.R. Ionescu, France; Prof. B.

Jeremic, USA; Prof. P.K. Jimack, UK; Mr W.E. Johnston, USA; Dr A. Kaceniauskas, Lithuania; Prof. P. Kacsuk, Hungary; Prof. Hiroshi Kanayama, Japan; Dr A.I. Khan, Australia; Prof. S.U. Khan, USA; Prof. C.-W. Kim, Korea; Dr W.J. Knottenbelt, UK; Dr L. Komzsik, USA; Prof. M. Krafczyk, Germany; Dr J. Kruis, Czech Republic; Dr O. Kurc, Turkey; Prof. P. Ladeveze, France; Prof. L. Laemmer, Germany; Prof. F.C.M. Lau, Hong Kong; Dr M. Leps, Czech Republic; Prof. S.H. Lo, Hong Kong; Dr R.I. Mackie, UK; Prof. J. Magiera, Poland; Prof. F. Magoules, France; Dr K.G. Margaritis, Greece; Prof. A.L. Marquez, Spain; Dr C. Mateos Diaz, Argentina; Prof. K. Matsuno, Japan; Prof. A. Meyer, Germany; Dr P.D. Michailidis, Greece; Prof. V. Migallón, Spain; Dr H.F. Migallon Gomis, Spain; Dr G.F. Moita, Brazil; Prof. D.T. Nguyen, USA; Prof. G.P. Nikishkov, Japan; Prof. P.A. Pagliosa, Brazil; Prof. J.B. Paiva, Brazil; Dr M. Paprzycki, Poland; Dr B. Patzak, Czech Republic; Prof. S. Peigin, Israel; Prof. J. Penades, Spain; Dr R. Putanowicz, Poland; Prof. A. Rama Mohan Rao, India; Prof. J.M. Reese, UK; Prof. M.M. Resch, Germany; Prof. C. Rey, France; Prof. J.R. Roche, France; Prof. Dr S. Roller, Germany; Prof. M.L. Romero, Spain; Prof. D. Roose, Belgium; Dr D. Rypl, Czech Republic; Prof. M. Sarkis, USA; Prof. M. Schaefer, Germany; Prof. V.E. Sonzogni, Argentina; Prof. P. Spiteri, France; Dr D.C. Sternel, Germany; Dr S-I. Sugimoto, Japan; Dr G. Sutmann, Germany; Dr A. Suzuki, Czech Republic; Prof. D.B. Szyld, USA; Prof. J.C.F. Telles, Brazil; Prof. D. Tromeur-Dervout, France; Prof. B. Vinter, Denmark; Dr V. Vondrak, Czech Republic; Dr C. Walshaw, UK; Dr L. Wang, USA; Prof. G Wellein, Germany; Dr T. Yamada, Japan; and Prof. C.T. Yang, China.

We are grateful to Jelle Muylle (Saxe-Coburg Publications) for his help in coordinating the publication of this book.



UNIVERSITY OF PÉCS

Dr P. Iványi  
University of Pécs, Hungary



UNIVERSITY OF PÉCS

**HERIOT  
WATT**  
UNIVERSITY

Professor B.H.V. Topping  
University of Pécs, Hungary  
& Heriot-Watt University, Edinburgh, UK