

Computational Science, Engineering and Technology Series: 36

**Techniques for
Parallel, Distributed and Cloud Computing
in Engineering**

Saxe-Coburg Publications on Computational Engineering

Patterns for Parellel Programming on GPUs

Edited by: F. Magoulès

Developments in Parallel, Distributed, Grid and Cloud Computing for Engineering

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

Trends in Parallel, Distributed and Grid Computing for Engineering

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

Parallel, Distributed and Grid Computing for Engineering

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

Substructuring Techniques and Domain Decomposition Methods

Edited by: F. Magoulès

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 Fourth International Conference on Parallel, Distributed, Grid and Cloud Computing for Engineering

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

Proceedings of the Third International Conference on Parallel, Distributed, Grid and Cloud Computing for Engineering

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

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

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

**Techniques for
Parallel, Distributed and Cloud Computing
in Engineering**

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



© Saxe-Coburg Publications, Stirlingshire, Scotland

published 2015 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: 36

ISSN 1759-3158

ISBN 978-1-874672-68-5

British Library Cataloguing in Publication Data

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

Publisher's production and editorial team: Steven Miller, Jane Tabor & Rosemary Brodie

Printed in Great Britain by Bell & Bain Ltd, Glasgow

Contents

Preface	iii
1 High Performance Computer Architectures: Trends, Opportunities and Challenges M.M. Resch	1
2 Smart Manufacturing: Engineering Simulations in the Cloud W. Gentzsch and B. Yenier	9
3 Beyond Navier-Stokes: Advances and Challenges in Modelling Non-Equilibrium Flows D.R. Emerson, R.W. Barber, X. Gu, B. John and J. Meng	33
4 Parallel Implementation of Domain Composition Methods G. Houzeaux, J.C. Cajas, B. Eguzkitza and M. Vázquez	61
5 Review: Parallel Algorithms for Time Domain Decomposition D. Guibert, P. Linel and D. Tromeur-Dervout	93
6 Highly Scalable Domain Decomposition Methods in Engineering Applications V. Vondrak, D. Horak, T. Kozubek and Z. Dostal	119
7 Parallel N-body Particle Mesh Type Methods Based on Domain Decomposition and the Multigrid Method G.A. Gravvanis, P.E. Kyziropoulos, C.K. Filelis-Papadopoulos and C. Efthymiopoulos	133
8 Finite Precision Computation For Linear Fixed Point Methods of Parallel Asynchronous Iterations P. Spiteri	163
9 Asynchronous Optimized Schwarz Methods for Acoustics F. Magoules	197
Author Index	217
Keyword Index	219

Preface

This volume comprises the invited lectures presented at *The Fourth International Conference on Parallel, Distributed, Grid and Cloud Computing for Engineering* (PARENG 2015) held in Dubrovnik, Croatia from 24-27 March 2015. 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.

The contributed papers presented at this conference are published as follows:

- “Proceedings of the Fourth International Conference on Parallel, Distributed, Grid and Cloud Computing for Engineering”, P. Iványi and B.H.V. Topping, (Editors), (Book of Summaries with online delivery of full-text papers), Civil-Comp Press, Stirlingshire, Scotland, 2015.

We would like to thank the members of the Editorial Board of *The Fourth International Conference on Parallel, Distributed, Grid and Cloud Computing for Engineering*: Dr H. Akiba, Japan; Dr N.E. Alaa, Morocco; Mr J.M. Alonso, Spain; Dr D. Andre, France; Dr G. Andreadis, Greece; Dr I. Ari, Turkey; Professor E. Aulisa, USA; Dr L. Badea, Romania; Professor B. Balachandran, USA; Professor J.W. Baugh, USA; Dr R. Baxter, UK; Dr A. Bendali, France; Professor M.L. Bittencourt, Brazil; Professor H. Borouchaki, France; Dr X. Cai, Norway; Dr Y. Cai, China; Dr T. Cakar, Turkey; Professor A.H. Chan, Australia; Dr P.G. Coelho, Portugal; Professor R. Couturier, France; Professor M. Damodaran, India; Professor P. Devloo, Brazil; Dr M. Dolenc, Slovenia; Professor Z. Dostal, Czech Republic; Dr D. Emerson, UK; Professor D. Eyheramendy, France; Dr M. Ganzha, Poland; Professor W. Gentzsch, Germany; Prof K. Giannakoglou, Greece; Dr B. Glut, Poland; Dr S.W. Gong, Singapore; Dr J.M. Gonzalez Vida, Spain; Professor G.A. Gravvanis, Greece; Professor O. Hassan MBE, UK; Professor I. Herrera, Mexico; Dr D. Horak, Czech Republic; Professor G. Houzeaux, Spain; Professor B. Izzuddin, UK; Dr C. Janna, Italy; Professor P.K. Jimack, UK; Professor M.B. Juric, Slovenia; Dr A. Kaceniauskas, Lithuania; Dr G. Karypis, USA; Dr A.I. Khan, Australia; Professor C.W. Kim, Korea; Dr R. Klinc, Slovenia; Dr W.J. Knottenbelt, UK; Dr L. Komzsik, USA; Dr G. Kosec, Slovenia; Professor T. Kozubek, Czech Republic; Professor M. Krafczyk, Germany; Dr J. Kruis, Czech Republic; Dr O. Kurc, Turkey; Dr A. Kuzelewski, Poland; Professor P. Ladevze, France; Professor L. Laemmer, Germany; Dr M. Li, UK; Professor S. Lo, Hong Kong; Dr R.I. Mackie, UK; Professor F. Magouls, France; Dr K. Margaritis, Greece; Dr C. Mateos

Diaz, Argentina; Professor K. Matsuno, Japan; Dr P.D. Michailidis, Greece; Professor V. Migallon, Spain; Dr H.F. Migallon Gomis, Spain; Dr D. Milasinovic, Serbia; Professor K. Morgan, UK; Dr C. Moulinec, UK; Dr N. Muhtaroglu, Turkey; Professor D.T. Nguyen, USA; Professor G.P. Nikishkov, Russia; Professor I.K. Nikolos, Greece; Professor P. Pagliosa, Brazil; Professor J.B. Paiva, Brazil; Prof M. Paprzycki, Poland; Dr E. Patelli, UK; Professor B. Patzak, Czech Republic; Dr G. Peretti Pezzi, Italy; Professor C.D. Perez-Segarra, Spain; Dr R. Putanowicz, Poland; Professor T. Rabczuk, Germany; Dr A. Rama Mohan Rao, India; Dr P. Ramet, France; Professor J. Reese, UK; Professor M.M. Resch, Germany; Professor C. Rey, France; Professor J.R. Roche, France; Dr J.J. Rdenas Garca, Spain; Professor M.L. Romero, Spain; Dr D. Rypl, Czech Republic; Professor L.M. Santos Castro, Portugal; Professor M. Schaefer, Germany; Dr A. Shterenlikht, UK; Professor V. Sonzogni, Argentina; Dr I. Spence, Ireland; Professor P. Spiteri, France; Dr V. Stankovski, Slovenia; Dr D.C. Sternel, Germany; Dr S.i. Sugimoto, Japan; Dr G. Sutmann, Germany; Professor J. Telles, Brazil; Professor V.V. Toropov, UK; Dr R. Trobec, Slovenia; Professor D. Tromeur-Dervout, France; Dr V. Vondrak, Czech Republic; Dr C. Walshaw, UK; Dr L. Wang, USA; Dr T. Yamada, Japan; Professor C.T. Yang, Taiwan; and Dr J. Zeman, Czech Republic.

We are grateful to Dawn Sewell for her administrative support before and during the conference and to Steven Miller, Jane Tabor and Rosemary Brodie.



Professor P. Iványi
Pollack Mihály Faculty of Engineering and
Information Technology
University of Pécs, Hungary



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