ANNUAL REVIEW

OF SCALABLE COMPUTING

SERIES ON SCALABLE COMPUTING

Editor-in-Chief: Yuen Chung Kwong (*National University of Singapore*)

ANNUAL REVIEW OF SCALABLE COMPUTING

Published:

- Vol. 1: ISBN 981-02-4119-4
- Vol. 2: ISBN 981-02-4413-4
- Vol. 3: ISBN 981-02-4579-3
- Vol. 4: ISBN 981-02-4951-9
- Vol. 5: ISBN 981-238-369-7

SERIES ON SCALABLE COMPUTING – VOL 6

ANNUAL REVIEW OF SCALABLE COMPUTING

Editor

Yuen Chung Kwong

National University of Singapore

World Scientific

NEW JERSEY • LONDON • SINGAPORE • BEIJING • SHANGHAI • HONG KONG • TAIPEI • CHENNAI

Published by

World Scientific Publishing Co. Pte. Ltd.

5 Toh Tuck Link, Singapore 596224

USA office: Suite 202, 1060 Main Street, River Edge, NJ 07661

UK office: 57 Shelton Street, Covent Garden, London WC2H 9HE

British Library Cataloguing-in-Publication Data

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

ANNUAL REVIEW OF SCALABLE COMPUTING

Series on Scalable Computing — Vol. 6

Copyright © 2004 by World Scientific Publishing Co. Pte. Ltd.

All rights reserved. This book, or parts thereof, may not be reproduced in any form or by any means, electronic or mechanical, including photocopying, recording or any information storage and retrieval system now known or to be invented, without written permission from the Publisher.

For photocopying of material in this volume, please pay a copying fee through the Copyright Clearance Center, Inc., 222 Rosewood Drive, Danvers, MA 01923, USA. In this case permission to photocopy is not required from the publisher.

ISBN 981-238-902-4 (pbk)

Printed in Singapore.

EDITORIAL BOARD

Editor-in-Chief

Chung-Kwong Yuen
National University of Singapore

Coeditor-in-Chief

Kai Hwang
*Dept of Computer Engineering
University of Southern California
University Park Campus
Los Angeles, California 90089, USA*

Editors

Amnon Barak
*Dept of Computer Science
Hebrew University of Jerusalem
91905 Jerusalem, Israel*

Willy Zwaenepoel
*Faculty of Computer & Communication Sciences
ETH Lausanne, CH-1015
Switzerland*

Jack Dennis
*Laboratory for Computer Science
MIT, Cambridge, MA 02139-4307, USA*

Proposals to provide articles for forthcoming issues of Annual Review of Scalable Computing should be sent to:

C K Yuen
School of Computing
National University of Singapore
Kent Ridge, Singapore 119260
email: yuenck@comp.nus.edu.sg

For the Year 2005 volume, draft versions should be sent by August 2004; final electronic versions (in prescribed LaTeX format) by December 2004.

This page is intentionally left blank

Preface

The year 2003 marks the start of recovery for the high-tech world from the gloom of the past three years, but in Asia we suffered additional setbacks due to tension and war in the Middle East at the start of 2003, followed by the outbreak of SARS shortly after. As we speak, the avian flu crisis, similar to yet independent of SARS, may just be unfolding, with what potential damage we do not yet know. While it might not strike as hard as SARS, things remain rather uncertain around us.

While the supply of material has not markedly increased for the current volume of the Annual Review, we can surely take comfort in seeing that the four articles published have come from authors in Europe and North America. It shows that the Annual Review continues to fulfill its role of providing a regular platform for extended discussions of significant developments in the domain of Scalable Computing to an international research and development community.

Chung-Kwong Yuen
National University of Singapore
January 2004

This page is intentionally left blank

Contents

1	An OMIS-based Approach to Monitoring Distributed Java Applications	1
1.1	Introduction	1
1.2	Related Work	2
1.3	Building of a Monitoring system	3
1.4	A Way from OMIS to J-OMIS	4
1.5	Architecture of Java-Oriented Monitoring System	5
1.6	The J-OCM as Middleware	8
1.6.1	Interface Definition	9
1.6.2	Stub and Skeleton	10
1.6.3	Object Manager and Registration/Naming Service	12
1.6.4	Transport Layer	13
1.7	Event Handling in the J-OCM	14
1.7.1	Java-Oriented Techniques for Event-Based Monitoring	14
1.7.2	The OMIS Event Model	14
1.7.3	Event Processing	16
1.7.4	Event-Based Interaction in Low-Level Components	18
1.8	Monitoring RMI Calls	19
1.8.1	Existing Techniques of RMI Monitoring	19
1.8.2	An Approach to Monitoring RMI calls	22
1.8.3	Architecture of J-OCM/RMI	24
1.9	Conclusions	27
1.10	Bibliography	27
2	Scalable and Self - Optimizing Data Grids	30
2.1	Motivation and Overview	30
		ix

2.2	P2P Systems as Components for Scalable Grids	31
2.3	A Scalable Data Grid with P2P Components	33
2.4	Availability Component	34
2.4.1	Basic Equations and Model Parameters	35
2.4.2	Analytical Model	36
2.4.3	Applying the Model	40
2.5	Synchronization Component	42
2.6	Self-Management Components	46
2.7	Putting it All Together	49
2.8	Related Work	50
2.9	Conclusion	52
2.10	Bibliography	52
3	The Immediate Dependency Relation	61
3.1	Introduction	62
3.1.1	Background	62
3.2	Related Work	63
3.2.1	Partial Causal Ordering	64
3.2.2	Complete Causal Ordering	64
3.3	The Immediate Dependency Relation	68
3.3.1	Immediate Dependency Relation in Broadcast Environment	68
3.3.2	Analysis of the IDR principle	70
3.3.3	Dependency Relation in Multi-Group Environment	71
3.4	The Minimal Broadcast Causal Protocol (MBCP)	73
3.4.1	Description of Structures Used in the Protocol	73
3.4.2	Scenario Example	76
3.5	Conclusion	77
3.6	Bibliography	77
4	Highly Scalable Parallel Matrix Computing with Optical Buses	80
4.1	Introduction	80
4.2	Preliminaries	86
4.2.1	A Computing Model with Optical Buses	86
4.2.2	Scalability of Parallel Computations	88
4.3	Limitations of Static Networks	90
4.4	Basic Matrix Operations	91
4.5	Matrix Multiplication	92
4.5.1	Bilinear Algorithms	92

4.5.2	Implementation Details	94
4.5.3	High Scalability	98
4.6	Matrix Chain Product and Matrix Powers	99
4.6.1	Matrix Chain Product	100
4.6.2	Matrix Powers	103
4.7	Other Matrix Computations	107
4.7.1	Inversion of Lower and Upper Triangular Matrices	107
4.7.2	Characteristic Polynomials, Determinants, and Ranks	110
4.7.3	Inversion of Arbitrary Matrices	112
4.7.4	Linear Systems of Equations and Krylov Matrix	113
4.7.5	LU- and QR-Factorizations	114
4.8	Summary	117
4.9	Bibliography	117