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QMIPS

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Quantitative
Modeling
In
Parallel
Systems

The list of QMIPS Papers

R W0.T0.8.v1

September 28, 1995

Distribution Level: All Partners

Approved by: F. Baccelli

Abstract This document lists the contents of all documents delivered during the QMIPS project: deliverables, workshop proceedings and other documents

The QMIPS Project: The QMIPS project is a collaborative research project supported by the CEC as ESPRIT-BRA project no 7269. It is being carried out by the following organisations: CWI (Amsterdam), EHEI (University of Paris V), Imperial College (London), INRIA (Sophia-Antipolis), University of Erlangen, University of Newcastle, University of Torino and University of Zaragoza.

1 Deliverables

1.1 Deliverable D1

Title State-of-the-art on model classification (proceedings of the workshop on "Formalisms")

Workpackage/Task WP1 T0

Participants All partners involved

Responsible UER

Contents

Proposal of INR for the Classification of Performance Evaluation Models of Parallel and Distributed Systems, F. Baccelli, A. Jean-Marie and Z. Liu

The Timed (Coloured) Petri-Net Formalism: position paper, QMIPS groups in UTO+ZAR

(Coloured) GSPN Models of the UTO1 Example, R. Gaeta

SWN Models of the UTO2 Example, C. Anglano and G. Chiola

Stochastic Well Formed Model of the UTO3 Example, M. Ribaudo

Multiprocessor and Distributed System Design: The Integration of Functional Specification and Performance Analysis Using Stochastic Process Algebras, N. Gotz, U. Herzog and M. Rettelbach

Process Algebra for Discrete Event Simulation, P.G. Harrison and B. Strulo

Temporal Logic in a Stochastic Environment, B. Strulo, P.G. Harrison and D. Gabbay,

A Survey on Solution Methods for Task Graph Models, F. Baccelli, A. Jean-Marie and Z. Liu,

A QMIPS Significant Example: Multiprocessor Performance with Task Graph Models, E. Gelenbe

Stochastic Graph Models for Performance Evaluation of Parallel Programs and the Evaluation Tool PEPP, F. Hartleb

Using Stochastic Recursive Equations as a Tool for Modeling and Performance Evaluation of Parallel Processing Systems, F. Baccelli, A. Jean-Marie and Z. Liu

Application and Evaluation of the Spectral Expansion Solution Method, I. Mitrani and R. Chakka

Optimization of Static Traffic Allocation Policies, M.B. Combe and O.J. Boxma

Load Balancing Pragmatics, E. Gelenbe and F. Pekergin

1.2 Deliverable D2a

Title Interleaving semantics for timed process algebras: motivation and semantics models

Workpackage/Task WP1 T1

Participants IMP, IER

Responsible UER

Contents

Multiprocessor and Distributed System Design: The Integration of Functional Specification and Performance Analysis Using Stochastic Process Algebras, N. Gotz, U. Herzog and M. Rettelbach, UER

Process Algebra for Discrete Event Simulation, P.G. Harrison and B. Strulo, IMP

Temporal Logic in a Stochastic Environment, B. Strulo, P.G. Harrison and D. Gabbay, IMP

1.3 Deliverable D2b

Title Integral specification of functional properties and performace evaluation by timed process algebra

Workpackage/Task WP1 T1

Participants IMP, UER

Responsible UER

Contents

D2b-1 "Stochastic Process Algebras – Constructive Specification Techniques Integrating Functional, Performance and Dependability Aspects", N. Götz, H. Hermanns, U. Herzog, V. Mertsiotakis and M. Rettelbach

D2b-2 "A Stochastic Process Algebra Based Modelling Tool", H. Hermanns and V. Mertsiotakis

D2b-3 "Exploiting Quasi-reversible Structures in Markovian Process Algebra Models", P. Harrison and J. Hillston

D2b-4 " Formal Characterisation of Immediate Actions in SPA with Nondeterministic Branching", H. Hermanns, M. Rettelbach and T. Weiß

D2b-5 " Probabilistic Branching in Markovian Process Algebras", M. Rettelbach

1.4 Deliverable D3

Title Timed and stochastic temporal logic models

Workpackage/Task WP1 T1

Participants IMP, UER

Responsible IMP

Contents

D3-1 "Temporal Logic in a Stochastic Environment" B. Strulo, D. Gabbay and P.G. Harrison

D3-2 "Performance Prediction of Behavioural Descriptions with Temporal Logics" Holger Hermanns

1.5 Deliverable D4

Title Characteristic equations for the different modelling techniques

Workpackage/Task WP1 T2

Participants INR, UER, UTO+Z

Responsible UTO+Z

Contents

Immediate Transitions in Parametric Stochastic Petri Nets, G. Chiola, S. Donatelli and G. Franceschinnis

Structural, Temporal and Stochastic Properties of Unbounded Free-Choice Petri Nets, F. Baccelli, S. Foss and B. Gaujal

Characteristic Equations for Markovian TIPP, H. Herrmanns and M. Rettelbach

Understanding Stochastic Process Algebras via their Stochastic Petri Nets Semantics, M. Ribaudo

1.6 Deliverable D5

Analysis of 2-dimensional Markov chains and random walks WP2 T1 CWI, UNE CWI

Contents

D5-1 On a Class of Two-Dimensional Nearest Neighbouring Random Walks, J.W. Cohen

D5-2 The Compensation Approach Applied to a 2×2 Switch, O.J. Boxma and G.J. van Houtum

D5-3 Heterogeneous Multiprocessor Systems with Breakdowns: Performance and Optimal Repair Strategies, Ram Chakka and Isi Mitrani

D5-4 Spectral Expansion Solution for a Class of Markov Models: Application and Comparison with the Matrix-Geometric Method, Isi Mitrani and Ram Chakka

D5-5 Routing in the Presence of Breakdowns, Isi Mitrani and Paul E. Wright

1.7 Deliverable D6

Title State-of-the-art in the theory and applications of queueing networks with negative and positive customers

Workpackage/Task WP2 T1

Participants EHE, IMP

Responsible EHE

Contents

D6-1 G-Networks with multiple class of negative and positive customers, J.M. Fourneau, E. Gelenbe and R. Suros

D6-2 Response Time Distributions in Tandem G-Networks, P.G. Harrison and E. Pitel

D6-3 The $M/G/1$ Queue with Negative Customers, P. G. Harrison and E. Pitel

1.8 Deliverable D7

Title A solver of queueing networks with negative and positive customers

Workpackage/Task WP2 T1

Participants EHE

Responsible EHE

Contents

D7-1 "A solver tool for G-networks" Chabridon, Labed, Hernandez and Gelenbe

1.9 Deliverable D8

Title Parallel evaluation of large-scale models

Workpackage/Task WP2 T1

Participants INR, UNE, UTO+Z

Responsible UNE

Contents

D8-1 "Parallel and Distributed Simulation of Free Choice Petri Nets", by François Baccelli, Nathalie Furmento and Bruno Gaujal.

D8-2 "An asymptotic analysis of closed queueing networks with branching populations", N. Bayer, E.G. Coffman, Jr. and Y. Kogan,

1.10 Deliverable D9

Title Approximation techniques based on fixed-point approximations

Workpackage/Task WP2 T1

Participants EHE, IMP, UNE

Responsible UNE

Contents

D9-1 Modelling and Evaluation of Cache Coherence Protocols in Multiprocessor Systems, E. Ametistova and I. Mitrani

D9-2 A Uniform-Memory Access Model of a Distributed Coherent Cache System, A.J. Field, P.G. Harrison and N. Lehovetsky

1.11 Deliverable D10

Title Performance of interconnection networks for parallel systems

Workpackage/Task WP2 T1

Participants IMP

Responsible IMP

Contents

D10-1 An approximate analysis of asynchronous, packet-switched, buffered Banyan networks with blocking, P.G. Harrison, A. de C. Pinto, IMP

D10-2 Response time distributions in packet-switched banyan networks, P.G. Harrison and A. de C. Pinto, IMP

D10-3 A Uniform-memory Access Model of a Distributed Coherent Cache System, A.J. Field, P.G. Harrison and N. Lehovetski, IMP

D10-4 Transmission times in buffered full crossbar communication networks with cyclic arbitration, A.J. Field and P.G. Harrison, IMP

D10-5 On the determination of the stationary distribution of a symmetric clocked buffered switch, J.W. Cohen, CWI

1.12 Deliverable D11

Title Distribution of transmission times in queueing networks

Workpackage/Task WP2 T1

Participants CWI, IMP

Responsible IMP

Contents

D11-01 Tandem queues with deterministic service times, O.J. Boxma and J.A.C. Resing, CWI

D11-02 On the analysis of the symmetrical shortest queue, J.W. Cohen, CWI

D11-03 Waiting time distribution in a class of wireless multi-channel local area networks, S. Coury and P.G. Harrison IMP

D11-04 Transmission times in buffered full crossbar communication networks with cyclic arbitration, A.J. Field and P.G. Harrison IMP

D11-05 Response time distributions in packet-switched banyan networks, P.G. Harrison and A. de C. Pinto, IMP

D11-06 On the power series algorithm, G.M. Koole, CWI

D11-07 Sojourn times in single-server queues with negative customers, P.G. Harrison and E. Pitel, IMP

D11-08 Response time distributions in tandem G-networks, P.G. Harrison and E. Pitel, IMP

D11-09 Response times in two-headed queues, P.G. Harrison and A.J. Field, IMP

D11-10 Response times in two random queues, P.G. Harrison and A.J. Field, IMP

D11-11 Queueing-theoretic solution methods for models of parallel and distributed systems, O.J. Boxma, G.M. Koole and Z. Liu, CWI+INR

D11-12 Response time distributions in queueing network models, P.G. Harrison. IMP

1.13 Deliverable D12

Title Bounds for networks

Workpackage/Task WP2 T1-T2

Participants INR, UTO+Z

Responsible INR

Contents

D12-1 Structural Techniques and Performance Bounds for Stochastic Petri Net Models, J. Campos and M. Silva, ZAR

Approximation Techniques for Stochastic Macroplace/Macrotransition Nets, H. Jungnitz, A. Desrochers and M. Silva

Comparison Properties of Stochastic Decision Free Petri Nets, F. Baccelli and Z. Liu

D12-2 Operational Analysis of Timed Petri Nets and Application to the Computation of Performance Bounds, G. Chiola, C. Anglano, J. Campos, J.M. Colom and M. Silva

D12-3 Computing bounds for the performance indices of quasi-lumpable Stochastic Well-Formed Nets, G. Franceschinis and R. R. Muntz

D12-4 Analytical Computation of Lyapunov Exponents in Stochastic Event Graphs, Alain Jean-Marie

D12-5 On the Saturation Rule for the Stability of Queues/ On the Stability of Jackson Queueing Networks, F. Baccelli and S. Foss

1.14 Deliverable D13

Title Markovian analysis of symmetric CGSPNs

Workpackage/Task WP2 T2

Participants UTO+Z

Responsible UTO+Z

Contents

Markovian analysis of symmetric CGSPNs: Symmetry Exploitation in Stochastic Well-Formed Colored Nets, G. Chiola, G. Franceschinis, R. Gaeta and M. Ribaudo

1.15 Deliverable D14

Title Approximation techniques in stochastic Petri nets

Workpackage/Task WP2 T2

Participants INR, UTO+Z

Responsible INR

Contents

D14-1 Approximation Techniques for Stochastic Macroplace/Macrotransition Nets, H. Jungnitz, A. Desrochers and M. Silva

D14-2 A Survey on Solution Methods for Task Graph Models, F. Baccelli, A. Jean-Marie and Z. Liu

D14-3 Approximate Throughput Computation of Stochastic Marked Graphs, J. Campos, J.M. Colom, H. Jungnitz, and M. Silva

D14-4 Approximate Performance Analysis on Petri Net Based Models of Manufacturing Systems, M. Tilgner and M. Silva

1.16 Deliverable D16a

Title Distributed and parallel simulation of networks

Workpackage/Task WP2 T3

Participants INR, UNE, UTO+Z

Responsible INR

Contents

D16a-1 Distributed Simulation of Timed Petri Nets, G. Chiola and A. Ferscha

Parallel simulation of Stochastic Petri Nets Using Recursive Equations, F. Baccelli and M. Canales

D16a-2 Marking Optimization and Parallelism of Marked Graphs, Miguel Canales and Bruno Gaujal

1.17 Deliverable D16b

Title Distributed and parallel simulation of networks

Workpackage/Task WP2 T3

Participants INR, UNE, UTO+Z

Responsible INR

Contents

D16b-1 "Parallel and Distributed Simulation of Free Choice Petri Nets", by François Baccelli, Nathalie Furmento and Bruno Gaujal.

D16b-2 "Some Algebraic Considerations for Efficient Computations in Timed Petri Nets", by Bruno Gaujal.

D16b-3 "Minimal Representation of Uniform Recurrence Equations", by Bruno Gaujal, Alain Jean-Marie and Jean Mairesse.

1.18 Deliverable D17

Title Task graph parametrisation

Workpackage/Task WP3 T1

Participants EHE, IMP

Responsible EHE

Contents

D17-1 Characterization, Approximate Analysis and Simulation of Task Graph Models Representing the Dependable Execution of Parallel and Distributed Programs, Erol Gelenbe and Sophie Chabridon, EHE

1.19 Deliverable D18

Title State-of-the-art and advances in load balancing

Workpackage/Task WP3 T2

Participants CWI, EHE, INR

Responsible CWI

Contents

D18-1 "Routing among different nodes where servers break down without losing jobs" N. Thomas and I. Mitrani

D18-2 "Optimization of Static Traffic Allocation Policies" M.B. Combe and O.J. Boxma

D18-3 "Static optimization of queueing systems", O.J. Boxma

D18-4 "Failure detection algorithms for a reliable execution of parallel programs", S. Chabridon and E. Gelenbe,

D18-5 "Approximate Solution Methods for Open Queueing Networks with Breakdowns and Repairs", R. Chakka and I. Mitrani

1.20 Deliverable D19

Title Communication in parallel and distributed systems

Workpackage/Task WP3 T2-T3

Participants CWI, INR

Responsible INR

Contents

D19-1 "Communications in Multiprocessor Machines: A Survey", Alain Jean-Marie, Philippe Mussi and Michel Syska

D19-2 "Polling systems", O.J. Boxma

D19-3 "Polling models with threshold switching", O.J. Boxma, G.M. Koole, I. Mitrani

D19-4 "A polling model with threshold switching", D.G. Down, O.J. Boxma

D19-5 "Polling models with and without switchover times", S.C. Borst and O. Boxma

D19-6 "The use of service limits for efficient operation of multi-station single-medium communication systems", S.C. Borst, O. Boxma and H. Levy

1.21 Deliverable D20

Title Scheduling issues

Workpackage/Task WP3 T2

Participants All Partners

Responsible IMP

Contents

Scheduling of Parallel Programs in Single-Bus Multiprocessor Systems, L. Finta and Z. Liu

Regular Sequences and Applications in Cyclic Scheduling, B. Gaujal

Assigning a Single Server to Inhomogeneous Queues with Switching Costs, G. Koole

Optimal Probabilistic Allocation of Customer Types to Servers, S.C. Borst

A Simulator for Task Assignment and Load Balancing in Presence of Failures, M. Hernánadez and J. Aguilar

Strategies for Load Balancing in the Distributed Computation of Associative Operations, B. Gaujal, A. Jean-Marie and S. Mazeau

Dependable Distributed Computing, S. Chabridon and E. Gelenbe

Incremental Dynamic Load Balancing in Distributed Systems, E. Gelenbe and R. Kushwaha

Routing Among Different Nodes Where Servers Break Down Without Losing Jobs, N. Thomas and I. Mitrani

Cache Coherency in an SCI Ring, A.J. Field, P.G. Harrison and N. Lehovetski

The $M/G/1$ Queue with Negative Customers, P.G. Harrison and E. Pitel

1.22 Deliverable D22

Title Performance engineering for parallel computation

Workpackage/Task WP3 T3

Participants All Partners

Responsible UNE

Contents

D22-1 "Requirements for a Modeling and Performance Evaluation Software Environment", G. Chiola, G. Balbo and A. Jean-Marie.

1.23 Deliverable D23

Title The Extra Deliverable

Workpackage/Task WP2 T1-2-3

Participants CWI, EHE, UER, UNE, ZAR

Responsible All Partners

Contents

2 Workshops

2.1 Proceedings of the Sophia-Antipolis Workshop

Location Sophia-Antipolis

Date 11-13 November 1992

Topic State-of-the-Art on Stochastic Petri Nets

Organizer INRIA

Availability INRIA publication, Centre de documentation, INRIA, BP 93, 2004 Route des Lucioles, F-06902 Sophia-Antipolis.

Contents

Chapter 1: Program of the Workshop

Chapter 2: Formalisms

- Petri Nets and Queueing Networks. Similarities and Differences, by G. Chiola.
- Recursive Equations for Stochastic Event Graphs, by F. Baccelli.
- Timed Petri Nets, by M. Ajmone Marsan, G.Balbo A. Bobbio, G. Chiola, G. Conte, and A. Cumani.

Chapter 3: Computational Aspects

- Structural Techniques and Performance Bounds for Stochastic Petri Nets Models, J. Campos, M. Silva.
- Approximation Techniques for Stochastic Macroplace/Macrotransition Nets, Hauke Jungnitz, Alan Desrochers and Manuel Silva.
- Comparison Properties of Stochastic Decision Free Petri Nets, by F. Baccelli and Z. Liu.
- Superposed Stochastic Automata: a Class of Stochastic Petri Nets with Parallel Solution and Distributed State Space, by S. Donatelli.
- On Efficient Markov Modelling by M. Siegle.

Chapter 4: Software Tools

- Distributed Simulation of Timed Petri Nets, by G. Chiola and A. Ferscha.
- Parallel Simulation of Stochastic Petri Nets Using Recursive Equations, by F. Baccelli and M. Canales.

2.2 Proceedings of the Erlangen Workshop

Location Erlangen/Pommersfelden

Date 17-19 March 1993

Topic Formalisms: Principles and State-of-the-Art

Organizer University of Erlangen

Availability Arbeitsberichte des Instituts für Mathematische Maschinen und Datenferarbeitung (IMMD), Friedrich Alexander Universität Erlangen-Nürnberg. N. Götz, U. Herzog and M. Rettelbach (eds.). Band **26**, Nummer 14, September 1994.

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Preamble

2.3 Proceedings of the Torino Workshop

Location Torino

Date 25-26 September 1993

Topic Solution Methods

Organizer University of Torino and CWI

Availability "Performance Evaluation of Parallel and Distributed Systems: Solution Methods", parts 1 and 2. CWI Tracts #105 and #106, O.J. Boxma and G.M. Koole (eds.), 1994.

Contents

Survey papers

Queueing models

Petri net models

The (Max,+) algebra

- Analytical computation of Lyapunov exponents in stochastic event graphs, *A. Jean-Marie*
- A graphical representation for matrices in the (Max,+) algebra, *J. Mairesse*

2.4 Proceedings of the London Workshop

Location Imperial College, London

Date 14-15 Avril 1994

Topic Performance of Parallel Computer Systems

Organizer Department of Computing, Imperial College

Availability "Proceedings of the 4th QMIPS Workshop on the Performance of Parallel Computer Systems", P.G. Harrison and A.C. de Pinto (eds.), Research Report DoC 94/18, Department of Computing, Imperial College, October 1994.

Contents

Chapter 1: Optimization and Scheduling

- Scheduling of Parallel Programs in Single-Bus Multiprocessor Systems, L. Finta and Z. Liu.
- Regular Sequences and Applications in Cyclic Scheduling, B. Gaujal.
- Assigning a Single Server to Inhomogeneous Queues with Switching Costs, G. Koole.
- Optimal Probabilistic Allocation of Customer Types to Servers, S.C. Borst.

Chapter 2: Load Balancing

- A Simulator for Task Assignment and Load Balancing in Presence of Failures, M. Hernánadez and J. Aguilar.
- Strategies for Load Balancing in the Distributed Computation of Associative Operations, B. Gaujal, A. Jean-Marie and S. Mazeau.
- Dependable Distributed Computing, S. Chabridon and E. Gelenbe.
- Incremental Dynamic Load Balancing in Distributed Systems, E. Gelenbe and R. Kushwaha.

Chapter 3: Work in Progress

- Routing Among Different Nodes Where Servers Break Down Without Losing Jobs, N. Thomas and I. Mitrani.
- Cache Coherency in an SCI Ring, A.J. Field, P.G. Harrison and N. Lehovetski.
- The $M/G/1$ Queue with Negative Customers, P.G. Harrison and E. Pitel.

3 Other Documents

3.1 Management Documents

Progress Reports

R W0.T0.1 Periodic Progress Report #1 (October 92-April 93)

R W0.T0.2 Periodic Progress Report #2 (October 92-October 93)

R W0.T0.3 Periodic Progress Report #3 (October 93-April 94)

R W0.T0.4 Periodic Progress Report #4 (October 93-October 94)

R W0.T0.5 Periodic Progress Report #5 (October 94-April 95)

R W0.T0.6 Periodic Progress Report #6 (October 94-October 95)

R W0.T0.7 QMIPS Final Report

Synthetic Documents

R W0.T0.8 The list of QMIPS papers

R W0.T0.9 The list of QMIPS references

3.2 The Qmips Book

Title: Quantitative Models In Parallel Systems

Editors: F. Baccelli, A. Jean-Marie and I. Mitrani

Availability: Springer Verlag, Basic Research Series, October 1995.

Contents

Introduction

Part 1: Formalisms

- Stochastic process algebras: constructive specification techniques integrating functional, performance ans dependability aspects, *N. Götz, H. Hermanns, U. Herzog, V. Mertsiotakis and M. Rettelbach.*
- Stochastic timed process algebra for discrete event simulation, *P.G. Harrison and B. Strulo.*
- GSPN and SPA compared in practice: Modelling a distributed mail system, *S. Donatelli, H. Hermanns, J. Hillston and M. Ribaudo.*
- Functional and performance analysis of cooperating sequential processes, *J. Campos, J.M. Colom, M. Silva and E. Teruel.*

Part 2: Solution Methods

- Analysis of the QMIPS example through linear (max,+) systems, *F. Baccelli, B. Gaujal, A. Jean-Marie and J. Mairesse.*
- Stochastic process algebras and the spectral expansion method, *I. Mitrani, A. Ost and M. Rettelbach.*
- G-networks: a survey of results, applications and solutions, *S. Chabridon, E. Gelenbe, M. Hernandez and A. Labed.*
- A two-queue polling model with a threshold service policy, *O.J. Boxma, G.M. Koole and I. Mitrani.*
- Analysis of the shortest 2-server queueing model, *J.W. Cohen.*
- The M/G/1 G-queue and an iterative solution for a Fredholm integral equation, *P.G. Harrison and E. Pitel.*
- Operational analysis of timed PN and application to the computation of performance bounds, *G. Chiola, C. Anglano, J. Campos, J.M. Colom and M. Silva.*
- A general iterative technique for approximate throughput computation of stochastic marked graphs, *J. Campos, J.M. Colom, H. Hungnitz and M. Silva.*

Part 3: Applications

- Optimal probabilistic allocation of customer types to servers, *S.C. Borst.*
- Task Graph Scheduling, *Z. Liu.*
- Dependability of distributed programs: algorithms and performance, *S. Chabridon and E. Gelenbe.*
- A fixed-point model of a distributed memory consistency protocol, *A.J. Field and P.G. Harrison.*
- Load balancing among unreliable parallel nodes, *N. Thomas and I. Mitrani.*
- Modelling symmetric computer architectures by SWNs, *G. Chiola, G. Franceschinis and R. Gaeta.*
- Arrival theorems for product-form stochastic petri nets, *G. Balbo, S. C. Bruell and M. Sereno.*

4 Extra-Deliverable Reports

R W2.T2.1 Mean Value Analysis of Stochastic Petri Nets, M. Sereno and G. Balbo.

R W2.T2.2 Computational Algorithms for Product Form Solution Stochastic Petri Nets, M. Sereno and G. Balbo.

R W3.T2.1 Incremental Dynamic Load Balancing in Distributed Systems, E. Gelenbe and R. Kushwaha.

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