

Martin Gogolla
Cris Kobryn (Eds.)

LNCS 2185

«UML» 2001 – The Unified Modeling Language

Modeling Languages, Concepts, and Tools

4th International Conference
Toronto, Canada, October 2001
Proceedings



Springer

TP31-53
U52
2001
Martin Gogolla Cris Kobryn (Ed.)

«UML» 2001 – The Unified Modeling Language

Modeling Languages, Concepts, and Tools

4th International Conference

Toronto, Canada, October 1-5, 2001

Proceedings



Springer

Series Editors

Gerhard Goos, Karlsruhe University, Germany
Juris Hartmanis, Cornell University, NY, USA
Jan van Leeuwen, Utrecht University, The Netherlands

Volume Editors

Martin Gogolla
University of Bremen, Department of Mathematics and Computer Science
Database Systems Group
P.O. Box 33 04 40, 28334 Bremen, Germany
E-mail: gogolla@informatik.uni-bremen.de

Cris Kobryn
Telelogic Technologies
P.O. Box 23 20, Fallbrook, CA 92088, USA
E-mail: cris.kobryn@telelogic.com

Cataloging-in-Publication Data applied for

Die Deutsche Bibliothek - CIP-Einheitsaufnahme

The unified modeling language : modeling languages, concepts, and tools ;
4th international conference ; proceedings / "UML" 2001, Toronto, Canada,
October 1- 5, 2001. Martin Gogolla ; Cris Kobryn (ed.). - Berlin ;
Heidelberg ; New York ; Barcelona ; Hong Kong ; London ; Milan ; Paris ;
Tokyo : Springer, 2001
(Lecture notes in computer science ; Vol. 2185)
ISBN 3-540-42667-1

CR Subject Classification (1998): D.2, D.3, K.6

ISSN 0302-9743

ISBN 3-540-42667-1 Springer-Verlag Berlin Heidelberg New York

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, re-use of illustrations, recitation, broadcasting, reproduction on microfilms or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the German Copyright Law of September 9, 1965, in its current version, and permission for use must always be obtained from Springer-Verlag. Violations are liable for prosecution under the German Copyright Law.

Springer-Verlag Berlin Heidelberg New York
a member of BertelsmannSpringer Science+Business Media GmbH

<http://www.springer.de>

© Springer-Verlag Berlin Heidelberg 2001
Printed in Germany

Typesetting: Camera-ready by author, data conversion by PTP- Berlin, Stefan Sossna
Printed on acid-free paper SPIN 10840541 06/3142 5 4 3 2 1 0

Lecture Notes in Computer Science

2185

Edited by G. Goos, J. Hartmanis and J. van Leeuwen

Springer

Berlin

Heidelberg

New York

Barcelona

Hong Kong

London

Milan

Paris

Tokyo

Preface

In the four years since the Object Management Group adopted the Unified Modeling Language (UML) in 1997, it has become widely accepted throughout the software industry and successfully applied to diverse domains. During this time it has become the de facto standard for specifying software blueprints, which continue to increase in value as we evolve from analysis and design models to multi-view architectures. Indeed, it is becoming difficult to find a software project with more than ten developers who don't use UML in some way to specify part of their architecture.

Despite its rapid and widespread acceptance, however, the UML 1.x series of revisions has not been without its problems. Some of the major issues commonly cited include: excessive size, gratuitous complexity, limited customizability, non-standard implementations, and lack of support for diagram interchange. Such substantive problems can only be addressed by major revisions to UML. Fortunately, the Object Management Group realizes this and has issued four Requests for Proposals for UML 2.0.

UML 2.0 represents both a wonderful opportunity and a serious responsibility for the UML community. It is an opportunity to resolve the serious shortcomings listed above; it is also a responsibility to ensure that the second version of the language does not suffer from "second system syndrome." This conference, whose objective is to bring together researchers and practitioners to share their visions for the future of UML, is an ideal place to explore how we can exploit the opportunity and share the responsibility for UML 2.0. Now in its fourth year, the «UML» conference series remains the premier forum for presenting and discussing innovative ideas that will make UML easier to learn, apply, and implement.

In total 122 abstracts and 102 papers were submitted to this year's conference, of which 32 were selected by the program committee for presentation. As in 2000, this year's conference included a two-day tutorial and workshop session, in which nine tutorials and five workshops were scheduled. The primary purpose of these sessions was to provide a more informal forum for discussing state-of-the-art research in UML. Topics included: Agile modeling, teaching UML, concurrency, rigorous development methods, OCL, software architecture, concurrent, distributed, and real-time applications, tools, requirements, time-critical systems, meta-modeling, quality assurance, effective diagrammatic languages and executable UML. A short description of the workshops and tutorials can be found in these proceedings and details at the conference web site: <http://www.cs.toronto.edu/uml2001/>.

We would like to express our deepest appreciation to the authors of submitted papers, tutorials, workshops, and panels, and the program committee members

and the additional referees. Jaelson Castro together with Manuel Kolp did an excellent job of managing all matters of the conference organization. Heinrich Hußmann chaired the workshop and tutorial submissions. We would also like to thank Werner Damm, John Mylopoulos and James Rumbaugh for agreeing to present invited talks at the conference. Mark Richters and Oliver Radfelder at the University of Bremen are thanked for their contribution to setting up the conference web site and in organizing and handling the electronic submission process. The ConfMan program (<http://confman.unik.no/~confman/ConfMan/>) was used to gather and organize submitted papers and reviews, and Mark Richters extended it to deal with an online preference selection process for the PC members. Ralf Kollmann at the University of Bremen organized the preparation of the final version of the conference proceedings. We would also like to thank the «UML» steering committee for their advice, Jean-Michel Bruel and Robert France for maintaining the mailing list, and last year's program chair, Andy Evans, for lots of helpful emails and hints.

July 2001

Martin Gogolla
Cris Kobryn

Organization

Executive Committee

General Chair:	Cris Kobryn (Telelogic Technologies, USA)
Conference Chair:	Jaelson Castro (Universidade Federal de Pernambuco, Brazil)
Program Chair:	Martin Gogolla (Universität Bremen, Germany)
Tutorial/Workshop Chair:	Heinrich Hußmann (Technische Universität Dresden, Germany)

Organizing Team

Publicity Chair (Europe):	Jean-Michel Bruel (University of Pau, France)
Publicity Chair (Americas):	Robert France (Colorado State University, USA)
Program Organization:	Ralf Kollmann (Universität Bremen, Germany) Oliver Radfelder (Universität Bremen, Germany)
Local Organization:	Mark Richters (Universität Bremen, Germany) Manuel Kolp (University of Toronto, Canada)

Program Committee

Colin Atkinson (DE)	Heinrich Hußmann (DE)
Jean Bezivin (FR)	Jean-Marc Jezequel (FR)
Marco Boger (DE)	Stuart Kent (UK)
Grady Booch (US)	Haim Kilov (US)
Jean-Michel Bruel (FR)	Steve Mellor (US)
David Bustard (UK)	Richard Mitchell (UK)
Betty Cheng (US)	Ana Maria Dinis Moreira (PT)
Derek Coleman (US)	Pierre-Alain Muller (FR)
Steve Cook (UK)	Gunnar Övergaard (SE)
Desmond D'Souza (US)	James Rumbaugh (US)
John Daniels (UK)	Bernhard Rumpe (DE)
Bruce Douglas (US)	Andy Schürr (DE)
Gregor Engels (DE)	Bran Selic (CA)
Andy Evans (UK)	Keng Siau (US)
Robert France (US)	Perdita Stevens (UK)
Brian Henderson-Sellers (AU)	Alfred Strohmeier (CH)
Pavel Hruby (DK)	Jos Warmer (NL)
Peter Hruschka (DE)	Alan Wills (UK)

Additional Referees

João Araújo	Francois Pennaneach
Toby Baier	Noël Plouzeau
Julian Bradfield	Mohamed Kandé
Benoit Baudry	Anneke Kleppe
Didier Buchs	Thomas Kühne
Olivier Burgard	Jochen Küster
Benoit Caillaud	Juliana Kuester-Filipe
R. G. Clark	Frank-Ulrich Kumichel
Birgit Demuth	Stefan Sauer
Massimo Felici	Ansgar Schleicher
Frederic Fondement	Lothar Schmitz
Falk Fünfstück	João Costa Seco
Sudipto Ghosh	Shane Sendall
Nabil Hameurlain	Zixing Shen
J.H. Hausmann	Gerson Sunyè
Reiko Heckel	Anne Thomas
Annik Lacayrelle	Yuhong Tian
Katharina Mehner	Yves Le Traon
Manfred Muench	Guido Wimmel
Thierry Nodenot	

Sponsors



IEEE Computer Society
<http://www.computer.org>



IEEE-CS Technical Committee
on Complexity in Computing (TCCX)
<http://www.elet.polimi.it/tccx/>

Corporate Donors



Telelogic Technologies
<http://www.telelogic.com>



Rational Software Corporation
<http://www.rational.com>

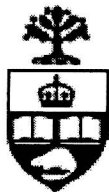
Academic Supporters



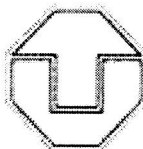
Universidade Federal Pernambuco
<http://www.ufpe.br>



Universität Bremen
<http://www.uni-bremen.de>



University of Toronto
<http://www.toronto.edu>



Technische Universität Dresden
<http://www.uni-dresden.de>

Lecture Notes in Computer Science

For information about Vols. 1–2112
please contact your bookseller or Springer-Verlag

- Vol. 2113: H.C. Mayr, J. Lazansky, G. Quirchmayr, P. Vogel (Eds.), Database and Expert Systems Applications. Proceedings, 2001. XIX, 991 pages. 2001.
- Vol. 2114: Y. Kambayashi, W. Winiwarter, M. Arikawa (Eds.), Data Warehousing and Knowledge Discovery. Proceedings, 2001. XIV, 361 pages. 2001.
- Vol. 2115: K. Bauknecht, S.K. Madria, G. Pernul (Eds.), Electronic Commerce and Web Technologies. Proceedings, 2001. XI, 347 pages. 2001.
- Vol. 2116: V. Akman, P. Bouquet, R. Thomason, R.A. Young (Eds.), Modeling and Using Context. Proceedings, 2001. XII, 472 pages. 2001. (Subseries LNAI).
- Vol. 2117: M. Beynon, C.L. Nehaniv, K. Dautenhahn (Eds.), Cognitive Technology: Instruments of Mind. Proceedings, 2001. XV, 522 pages. 2001. (Subseries LNAI).
- Vol. 2118: X.S. Wang, G. Yu, H. Lu (Eds.), Advances in Web-Age Information Management. Proceedings, 2001. XV, 418 pages. 2001.
- Vol. 2119: V. Varadharajan, Y. Mu (Eds.), Information Security and Privacy. Proceedings, 2001. XI, 522 pages. 2001.
- Vol. 2120: H.S. Delugach, G. Stumme (Eds.), Conceptual Structures: Broadening the Base. Proceedings, 2001. X, 377 pages. 2001. (Subseries LNAI).
- Vol. 2121: C.S. Jensen, M. Schneider, B. Seeger, V.J. Tsotras (Eds.), Advances in Spatial and Temporal Databases. Proceedings, 2001. XI, 543 pages. 2001.
- Vol. 2123: P. Perner (Ed.), Machine Learning and Data Mining in Pattern Recognition. Proceedings, 2001. XI, 363 pages. 2001. (Subseries LNAI).
- Vol. 2124: W. Skarbek (Ed.), Computer Analysis of Images and Patterns. Proceedings, 2001. XV, 743 pages. 2001.
- Vol. 2125: F. Dehne, J.-R. Sack, R. Tamassia (Eds.), Algorithms and Data Structures. Proceedings, 2001. XII, 484 pages. 2001.
- Vol. 2126: P. Cousot (Ed.), Static Analysis. Proceedings, 2001. XI, 439 pages. 2001.
- Vol. 2127: V. Malyshekin (Ed.), Parallel Computing Technologies. Proceedings, 2001. XII, 516 pages. 2001.
- Vol. 2129: M. Goemans, K. Jansen, J.D.P. Rolim, L. Trevisan (Eds.), Approximation, Randomization, and Combinatorial Optimization. Proceedings, 2001. IX, 297 pages. 2001.
- Vol. 2130: G. Dorffner, H. Bischof, K. Hornik (Eds.), Artificial Neural Networks – ICANN 2001. Proceedings, 2001. XXII, 1259 pages. 2001.
- Vol. 2131: Y. Cotronis, J. Dongarra (Eds.), Recent Advances in Parallel Virtual Machine and Message Passing Interface. Proceedings, 2001. XV, 438 pages. 2001.
- Vol. 2132: S.-T. Yuan, M. Yokoo (Eds.), Intelligent Agents. Specification, Modeling, and Application. Proceedings, 2001. X, 237 pages. 2001. (Subseries LNAI).
- Vol. 2133: B. Christianson, B. Crispo, J.A. Malcolm, M. Roe (Eds.), Security Protocols. Proceedings, 2001. VIII, 257 pages. 2001.
- Vol. 2134: M. Figueiredo, J. Zerubia, A.K. Jain (Eds.), Energy Minimization Methods in Computer Vision and Pattern Recognition. Proceedings, 2001. X, 652 pages. 2001.
- Vol. 2136: J. Sgall, A. Pultr, P. Kolman (Eds.), Mathematical Foundations of Computer Science 2001. Proceedings, 2001. XII, 716 pages. 2001.
- Vol. 2138: R. Freivalds (Ed.), Fundamentals of Computation Theory. Proceedings, 2001. XIII, 542 pages. 2001.
- Vol. 2139: J. Kilian (Ed.), Advances in Cryptology – CRYPTO 2001. Proceedings, 2001. XI, 599 pages. 2001.
- Vol. 2140: I. Attali, T. Jensen (Eds.), Java on Smart Cards: Programming and Security. Proceedings, 2001. VIII, 255 pages. 2001.
- Vol. 2141: G.S. Brodal, D. Frigioni, A. Marchetti-Spaccamela (Eds.), Algorithm Engineering. Proceedings, 2001. X, 199 pages. 2001.
- Vol. 2142: L. Fribourg (Ed.), Computer Science Logic. Proceedings, 2001. XII, 615 pages. 2001.
- Vol. 2143: S. Benferhat, P. Besnard (Eds.), Symbolic and Quantitative Approaches to Reasoning with Uncertainty. Proceedings, 2001. XIV, 818 pages. 2001. (Subseries LNAI).
- Vol. 2144: T. Margaria, T. Melham (Eds.), Correct Hardware Design and Verification Methods. Proceedings, 2001. XII, 482 pages. 2001.
- Vol. 2146: J.H. Silverman (Eds.), Cryptography and Lattices. Proceedings, 2001. VII, 219 pages. 2001.
- Vol. 2147: G. Brebner, R. Woods (Eds.), Field-Programmable Logic and Applications. Proceedings, 2001. XV, 665 pages. 2001.
- Vol. 2149: O. Gascuel, B.M.E. Moret (Eds.), Algorithms in Bioinformatics. Proceedings, 2001. X, 307 pages. 2001.
- Vol. 2150: R. Sakellariou, J. Keane, J. Gurd, L. Freeman (Eds.), Euro-Par 2001 Parallel Processing. Proceedings, 2001. XXX, 943 pages. 2001.
- Vol. 2151: A. Caplinskas, J. Eder (Eds.), Advances in Databases and Information Systems. Proceedings, 2001. XIII, 381 pages. 2001.
- Vol. 2152: R.J. Boulton, P.B. Jackson (Eds.), Theorem Proving in Higher Order Logics. Proceedings, 2001. X, 395 pages. 2001.
- Vol. 2153: A.L. Buchsbaum, J. Snoeyink (Eds.), Algorithm Engineering and Experimentation. Proceedings, 2001. VIII, 231 pages. 2001.

- Vol. 2154: K.G. Larsen, M. Nielsen (Eds.), *CONCUR 2001 – Concurrency Theory. Proceedings, 2001. XI, 583 pages. 2001.*
- Vol. 2156: M.I. Smirnov, J. Crowcroft, J. Roberts, F. Boavida (Eds.), *Quality of Future Internet Services. Proceedings, 2001. XI, 333 pages. 2001.*
- Vol. 2157: C. Rouveirol, M. Sebag (Eds.), *Inductive Logic Programming. Proceedings, 2001. X, 261 pages. 2001. (Subseries LNAI).*
- Vol. 2158: D. Shepherd, J. Finney, L. Mathy, N. Race (Eds.), *Interactive Distributed Multimedia Systems. Proceedings, 2001. XIII, 258 pages. 2001.*
- Vol. 2159: J. Kelemen, P. Sosik (Eds.), *Advances in Artificial Life. Proceedings, 2001. XIX, 724 pages. 2001. (Subseries LNAI).*
- Vol. 2161: F. Meyer auf der Heide (Ed.), *Algorithms – ESA 2001. Proceedings, 2001. XII, 538 pages. 2001.*
- Vol. 2162: Ç. K. Koç, D. Naccache, C. Paar (Eds.), *Cryptographic Hardware and Embedded Systems – CHES 2001. Proceedings, 2001. XIV, 411 pages. 2001.*
- Vol. 2163: P. Constantopoulos, I.T. Sølvberg (Eds.), *Research and Advanced Technology for Digital Libraries. Proceedings, 2001. XII, 462 pages. 2001.*
- Vol. 2164: S. Pierre, R. Gliitho (Eds.), *Mobile Agents for Telecommunication Applications. Proceedings, 2001. XI, 292 pages. 2001.*
- Vol. 2165: L. de Alfaro, S. Gilmore (Eds.), *Process Algebra and Probabilistic Methods. Proceedings, 2001. XII, 217 pages. 2001.*
- Vol. 2166: V. Matoušek, P. Mautner, R. Mouček, K. Taušer (Eds.), *Text, Speech and Dialogue. Proceedings, 2001. XIII, 452 pages. 2001. (Subseries LNAI).*
- Vol. 2167: L. De Raedt, P. Flach (Eds.), *Machine Learning: ECML 2001. Proceedings, 2001. XVII, 618 pages. 2001. (Subseries LNAI).*
- Vol. 2168: L. De Raedt, A. Siebes (Eds.), *Principles of Data Mining and Knowledge Discovery. Proceedings, 2001. XVII, 510 pages. 2001. (Subseries LNAI).*
- Vol. 2170: S. Palazzo (Ed.), *Evolutionary Trends of the Internet. Proceedings, 2001. XIII, 722 pages. 2001.*
- Vol. 2172: C. Batini, F. Giunchiglia, P. Giorgini, M. Mecella (Eds.), *Cooperative Information Systems. Proceedings, 2001. XI, 450 pages. 2001.*
- Vol. 2173: T. Eiter, W. Faber, M. Truszczynski (Eds.), *Logic Programming and Nonmonotonic Reasoning. Proceedings, 2001. XI, 444 pages. 2001. (Subseries LNAI).*
- Vol. 2174: F. Baader, G. Brewka, T. Eiter (Eds.), *KI 2001: Advances in Artificial Intelligence. Proceedings, 2001. XIII, 471 pages. 2001. (Subseries LNAI).*
- Vol. 2175: F. Esposito (Ed.), *AI*IA 2001: Advances in Artificial Intelligence. Proceedings, 2001. XII, 396 pages. 2001. (Subseries LNAI).*
- Vol. 2176: K.-D. Althoff, R.L. Feldmann, W. Müller (Eds.), *Advances in Learning Software Organizations. Proceedings, 2001. XI, 241 pages. 2001.*
- Vol. 2177: G. Butler, S. Jarzabek (Eds.), *Generative and Component-Based Software Engineering. Proceedings, 2001. X, 203 pages. 2001.*
- Vol. 2180: J. Welch (Ed.), *Distributed Computing. Proceedings, 2001. X, 343 pages. 2001.*
- Vol. 2181: C. Y. Westort (Ed.), *Digital Earth Moving. Proceedings, 2001. XII, 117 pages. 2001.*
- Vol. 2182: M. Klusch, F. Zambonelli (Eds.), *Cooperative Information Agents V. Proceedings, 2001. XII, 288 pages. 2001. (Subseries LNAI).*
- Vol. 2184: M. Tucci (Ed.), *Multimedia Databases and Image Communication. Proceedings, 2001. X, 225 pages. 2001.*
- Vol. 2185: M. Gogolla, C. Kobryn (Eds.), *«UML» 2001 – The Unified Modeling Language. Proceedings, 2001. XIV, 510 pages. 2001.*
- Vol. 2186: J. Bosch (Ed.), *Generative and Component-Based Software Engineering. Proceedings, 2001. VIII, 177 pages. 2001.*
- Vol. 2187: U. Voges (Ed.), *Computer Safety, Reliability and Security. Proceedings, 2001. XVI, 261 pages. 2001.*
- Vol. 2188: F. Bomarius, S. Komi-Sirviö (Eds.), *Product Focused Software Process Improvement. Proceedings, 2001. XI, 382 pages. 2001.*
- Vol. 2189: F. Hoffmann, D.J. Hand, N. Adams, D. Fisher, G. Guimaraes (Eds.), *Advances in Intelligent Data Analysis. Proceedings, 2001. XII, 384 pages. 2001.*
- Vol. 2190: A. de Antonio, R. Aylett, D. Ballin (Eds.), *Intelligent Virtual Agents. Proceedings, 2001. VIII, 245 pages. 2001. (Subseries LNAI).*
- Vol. 2191: B. Radig, S. Florczyk (Eds.), *Pattern Recognition. Proceedings, 2001. XVI, 452 pages. 2001.*
- Vol. 2192: A. Yonezawa, S. Matsuoka (Eds.), *Metalevel Architectures and Separation of Crosscutting Concerns. Proceedings, 2001. XI, 283 pages. 2001.*
- Vol. 2193: F. Casati, D. Georgakopoulos, M.-C. Shan (Eds.), *Technologies for E-Services. Proceedings, 2001. X, 213 pages. 2001.*
- Vol. 2194: A.K. Datta, T. Herman (Eds.), *Self-Stabilizing Systems. Proceedings, 2001. VII, 229 pages. 2001.*
- Vol. 2196: W. Taha (Ed.), *Semantics, Applications, and Implementation of Program Generation. Proceedings, 2001. X, 219 pages. 2001.*
- Vol. 2197: O. Balet, G. Subsol, P. Torguet (Eds.), *Virtual Storytelling. Proceedings, 2001. XI, 213 pages. 2001.*
- Vol. 2200: G.I. Davida, Y. Frankel (Eds.), *Information Security. Proceedings, 2001. XIII, 554 pages. 2001.*
- Vol. 2201: G.D. Abowd, B. Brumitt, S. Shafer (Eds.), *Ubicomp 2001: Ubiquitous Computing. Proceedings, 2001. XIII, 372 pages. 2001.*
- Vol. 2202: A. Restivo, S. Ronchi Della Rocca, L. Roversi (Eds.), *Theoretical Computer Science. Proceedings, 2001. XI, 440 pages. 2001.*
- Vol. 2205: D.R. Montello (Ed.), *Spatial Information Theory. Proceedings, 2001. XIV, 503 pages. 2001.*
- Vol. 2207: I.W. Marshall, S. Nettles, N. Wakamiya (Eds.), *Active Networks. Proceedings, 2001. IX, 165 pages. 2001.*
- Vol. 2209: W. Jonker (Ed.), *Databases in Telecommunications II. Proceedings, 2001. VII, 179 pages. 2001.*
- Vol. 2211: T.A. Henzinger, C.M. Kirsch (Eds.), *Embedded Software. Proceedings, 2001. IX, 504 pages. 2001.*

Table of Contents

Invited Talk

The Preacher at Arrakeen	1
<i>Jim Rumbaugh</i>	

Metamodeling

An Action Semantics for MML	2
<i>José M. Álvarez, Tony Clark, Andy Evans, Paul Sammut</i>	
The Essence of Multilevel Metamodeling	19
<i>Colin Atkinson, Thomas Kühne</i>	
Mapping between Levels in the Metamodel Architecture	34
<i>José M. Álvarez, Andy Evans, Paul Sammut</i>	

Activity Diagrams

An Execution Algorithm for UML Activity Graphs	47
<i>Rik Eshuis, Roel Wieringa</i>	
Timing Analysis of UML Activity Diagrams	62
<i>Li Xuandong, Cui Meng, Pei Yu, Zhao Jianhua, Zheng Guoliang</i>	
UML Activity Diagrams as a Workflow Specification Language	76
<i>Marlon Dumas, Arthur H.M. ter Hofstede</i>	

OCL

On Querying UML Data Models with OCL	91
<i>D.H. Akehurst, B. Bordbar</i>	
OCL as a Specification Language for Business Rules in Database Applications	104
<i>Birgit Demuth, Heinrich Hussmann, Sten Loecher</i>	

A Formal Semantics for OCL 1.4..... 118
María Victoria Cengarle, Alexander Knapp

Architecture and Patterns

Refactoring UML Models 134
Gerson Sunyé, Damien Pollet, Yves Le Traon, Jean-Marc Jézéquel

UML Support for Designing Software Systems as a Composition
of Design Patterns 149
Sherif M. Yacoub, Hany H. Ammar

Integrating the ConcernBASE Approach with SADL 166
*Valentin Crettaz, Mohamed Mancona Kandé, Shane Sendall,
Alfred Strohmeier*

Analysis and Testing

The Message Paradigm in Object-Oriented Analysis 182
Frank Devos, Eric Steegmans

A UML-Based Approach to System Testing 194
Lionel Briand, Yvan Labiche

Performance and Databases

UML Modelling and Performance Analysis of Mobile Software
Architectures 209
Vincenzo Grassi, Raffaella Mirandola

Extending UML for Object-Relational Database Design 225
E. Marcos, B. Vela, J.M. Cavero

Invited Talk

Understanding UML – Pains and Rewards 240
Werner Damm

Graph Transformations

A Formal Semantics of UML State Machines Based on Structured Graph Transformation	241
--	-----

Sabine Kuske

A Visualization of OCL Using Collaborations	257
---	-----

*Paolo Bottoni, Manuel Koch, Francesco Parisi-Presicce,
Gabriele Taentzer*

Rule-Based Specification of Behavioral Consistency Based on the UML Meta-model	272
---	-----

Gregor Engels, Reiko Heckel, Jochen Malte Küster

Real-Time and Embedded Systems

A New UML Profile for Real-Time System Formal Design and Validation .	287
---	-----

L. Aprville, P. de Saqui-Sannes, C. Lohr, P. Sénac, J.-P. Courtiat

Representing Embedded System Sequence Diagrams as a Formal Language	302
--	-----

Elizabeth Latronico, Philip Koopman

Scenario-Based Monitoring and Testing of Real-Time UML Models	317
---	-----

Marc Lettrari, Jochen Klose

Associations and Ontology

Semantics of the Minimum Multiplicity in Ternary Associations in UML ..	329
---	-----

Gonzalo Génova, Juan Llorens, Paloma Martínez

Extending UML to Support Ontology Engineering for the Semantic Web ..	342
---	-----

*Kenneth Baclawski, Mieczyslaw K. Kokar, Paul A. Kogut, Lewis Hart,
Jeffrey Smith, William S. Holmes, Jerzy Letkowski,
Michael L. Aronson*

On Associations in the Unified Modelling Language	361
---	-----

Perdita Stevens

Statecharts

iState: A Statechart Translator	376
<i>Emil Sekerinski, Rafik Zurob</i>	
Specifying Concurrent System Behavior and Timing Constraints Using OCL and UML	391
<i>Shane Sendall, Alfred Strohmeier</i>	
Formalization of UML-Statecharts	406
<i>Michael von der Beeck</i>	

Invited Talk

UML for Agent-Oriented Software Development: The Tropos Proposal	422
<i>John Mylopoulos, Manuel Kolp, Jaelson Castro</i>	

Components

A UML Meta-model for Contract Aware Components	442
<i>Torben Weis, Christian Becker, Kurt Geihs, Noël Plouzeau</i>	
A Specification Model for Interface Suites	457
<i>E.E. Roubtsova, L.C.M. van Gool, R. Kuiper, H.B.M. Jonkers</i>	

Use Cases

Against Use Case Interleaving	472
<i>Pierre Metz, John O'Brien, Wolfgang Weber</i>	
Estimating Software Development Effort Based on Use Cases - Experiences from Industry	487
<i>Bente Anda, Hege Dreiem, Dag I.K. Sjøberg, Magne Jørgensen</i>	

Workshops and Tutorials

Workshops and Tutorials at the UML 2001 Conference	503
<i>Heinrich Hussmann</i>	
Author Index	509