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Abstract:

To promote the exploitation and use of the project results Quasimodo has invested in activities for communication, dissemination, and use of project results. Different activities have been organized in this respect. This deliverable reports about activities for dissemination and use of Quasimodo results. These include Quasimodo specific activities such as the Quasimodo workshop, Quasimodo sessions at conferences, demonstrators, and the Quasimodo book, and more general activities such as conferences, symposia, (summer) schools, local and international workshops, and courses in which Quasimodo has been involved and where Quasimodo results have been used, related projects, programmes, and networks where partners from the Quasimodo consortium have been involved and where cross-fertilization has taken place, spin-off activities, and exploitation of Quasimodo results by the industrial partners.

Keyword list: Quasimodo, dissemination, use of results, exploitation.

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Abbreviations

AAU	Aalborg University, DK
CFV	Centre Fédéré en Vérification, B
CHESS	Chess, NL
CNRS	National Center for Scientific Research, FR
ESI	Embedded Systems Institute, NL
ESI/RU	Radboud University Nijmegen, NL
ESI/UT	University of Twente, NL
Hydac	Hydac Electronic GmbH, D
RWTH	RWTH Aachen University, D
SU	Saarland University, D
TERMA	Terma A/S, Space Division, DK

1 Introduction

The Quasimodo project developed methods, techniques, and tools for handling quantitative properties in model-driven development of real-time embedded systems. To promote the exploitation and use of the project results Quasimodo also invested in activities for communication, dissemination, and use of project results. Different activities have been organized in this respect. Some specific Quasimodo activities were organized such as the Quasimodo website, a Quasimodo workshop, special Quasimodo sessions at conferences, Quasimodo demonstrators, and the Quasimodo book. Furthermore, the consortium members were involved in the organization of various symposia, conferences, (summer) schools, and workshops where results and topics related to the project were presented for a wider scientific and industrial audience. Publication of Quasimodo results in the relevant international journals and conferences, both scientific and professional, was another way of dissemination. Moreover, the members of the consortium gave key note and invited presentations, tutorials, summer school lectures, and industrial presentations. Quasimodo has actively promoted interaction and cross-fertilization with related projects and networks, in particular with those in which Quasimodo partners participate. The academic partners use the Quasimodo results in their regular academic courses, the research institutes use these results in courses and training programmes for industry in the area of embedded system engineering, and the industrial partners in the Quasimodo project make efforts to exploit the project results directly in their daily business.

This deliverable provides the final report on activities for dissemination and use of Quasimodo results. The next section describes the specific Quasimodo activities. Section 3 contains conferences, symposia, (summer) schools, local and international workshops, and courses in which Quasimodo was involved and where Quasimodo results were presented. Section 4 mentions related projects, programmes, and networks where partners of the Quasimodo consortium are involved and cross-fertilization took place. The last section reports on potential use of the Quasimodo results by the industrial partners in their respective organizations. This deliverable does not contain a list of regular publications; these can be found in the Quasimodo bibliography system [2] on the Quasimodo website [1].

2 Quasimodo Specific Activities

A couple of specific activities were organized by Quasimodo:

1. Quasimodo has created a website [1] with all information regarding the project, its organization, results, publications, events, related projects, and activities.
2. A Quasimodo workshop was organized during the FM week, November 6, 2009, in Eindhoven (NL), with participants from academia, industry, and Quasimodo itself. A keynote was given by Prof. Rance Cleaveland (University of Maryland), and the workshop was concluded with an industrial panel with members from Reactive Systems, Philips, OCE, and ESI/ASML.

Since the number of participants at this first workshop was a little disappointing, Quasimodo decided, after consultation of the reviewers, to organize no more special workshops. Instead, Quasimodo sessions were organized at a number of conferences; see below.

3. Quasimodo has organized a half-day tutorial session on *Quantitative System Validation in Model Driven Design*, at the Embedded Systems Week in Phoenix (AZ, USA), on October 24 2010. The tutorial covered model-checking and scheduling (Kim Larsen), controller synthesis (Jean Francois Raskin), probabilistic analysis (Holger Hermanns), and model-based testing (Jan Tretmans).
4. A special Quasimodo session was organized at FMCO (Formal Methods for Objects and Components), in Graz (A) on December 1 2010. It included *Quantitative System Properties in Model-driven Design of Embedded Systems* (Brian Nielsen, AAU), *Testing Real-Time Systems under Uncertainty* (Brian Nielsen), and *Model Checking and Simulation for Stochastic Timed Systems* (Arnd Hartmanns, SU).

5. At ETAPS 2011 in Saarbrücken, a special session was organized within the Rocks symposium, on Saturday March 26, 2011, with presentations about *Time for Real Statistical Model Checking* (Kim Larsen) and *Multi-core Update on LTSmin* (Jaco van de Pol).
6. A final dissemination event "From Model-Driven Development to System Engineering Science" will be organized as a joint DANES/Quasimodo/ITEK Mini-conference, on June 15, 2011, in Copenhagen, Denmark. The Quasimodo track will include "Analysis of the Chess Wireless Sensor Network" by Frits Vaandrager (ESI/RU), "The Neopost Case", by Mariëlle Stoelinga (ESI/UT), and "Controller Synthesis in the Hydac Case", by Kim. G. Larsen (AAU).
7. Quasimodo developed a couple of demonstrators:
 - a. The first Quasimodo demonstrator was shown during the Quasimodo Workshop on November 5, 2009. The demonstrator is based on the CHESSE Wireless Sensor Network (WSN) case. It shows that the outer nodes of a number of nodes that are physically placed in a linear configuration can lose synchronization. This illustrates the issue that was found with model-checking the gMAC protocol layer of the WSN with Uppaal, and thus it shows that Uppaal is effective in detecting such synchronization errors.
The demonstrator consists of
 - 10 WSN nodes (the CHESSE Myrianted Development Kit for Wireless Sensor Networks [4]) in a linear configuration with LEDs indicating synchronization;
 - the Uppaal model of the gMAC synchronization protocol;
 - the Uppaal counter-example showing that the nodes can lose synchronization
 - presentation slides explaining the issue;
 - a two-page description of the experiment;
 - a picture of the first demonstration at the Quasimodo Workshop.
 - b. A second demonstrator, which was presented, amongst others, in the Quasimodo Tutorial at the Embedded Systems Week, shows model-based conformance testing of the WSN protocol. Using the model-based testing tools Uppaal-Tron, JTorX, and TorXakis, together with various constructed models and a specifically developed test environment, long and elaborate tests of CHESSE' gMAC protocol software layer are shown. An additional tool visualizes the behaviour so that detailed analysis of the gMAC protocol behaviour can be performed.

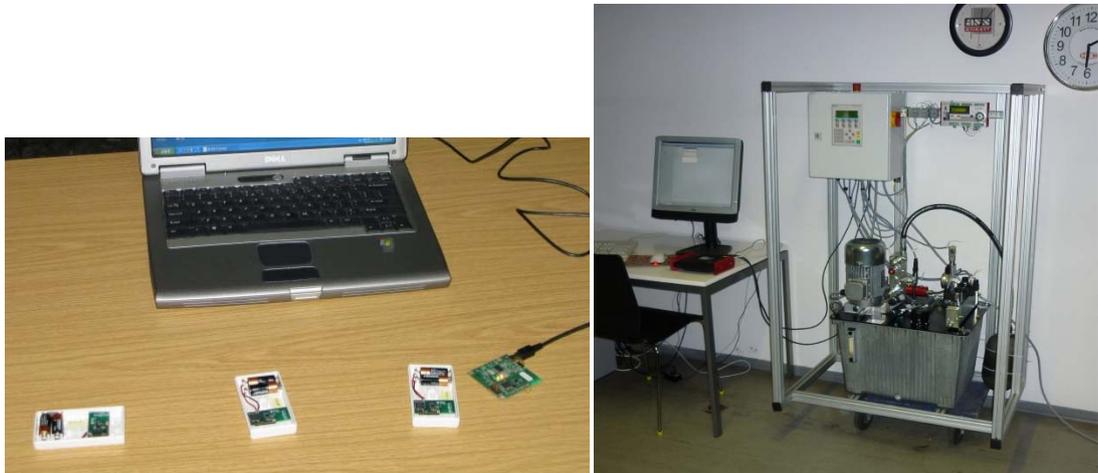


Figure 1 Two demonstrators. Left Part of ChessWSN. Right Hydac Hydraulic Machine

- c. We have developed a software demonstrator for showing how real-time model-based testing can be done; it includes the Uppaal-TRON model, adaptor, and Java implementation (with source) of a temperature controller and alarm monitor. It is described in the MBT chapter of the Industrial Handbook; it is to be made available for download at the accompanying website.
- d. We have developed a software demonstrator showing the procedure of automated controller synthesis using Uppaal-Tiga and Simulink. The controller objective is to maintain a safe

- temperature range in two tanks of liquid sharing a single heating device. Based on a suitable discretized timed game model, Uppaal-Tiga is used to generate a control strategy. This strategy is via a script imported as an S-function into Simulink. Its behaviour can then be simulated and studied in a continuous environment. It is to be made available for download at the website accompanying the handbook.
- e. The Hydac demonstrator consists of a mini-hydraulic (still quite heavy!) system with its controller for evaluating and demonstrating the effect of different control strategies for the hydraulic pump.
8. A book on *Quantitative Analysis of Embedded Systems*, presenting the Quasimodo results for a non-scientific audience, such as engineers working in the area of embedded systems, is under preparation, and will be published by Springer. The book contains 15 chapters covering the different Quasimodo topics with each an introductory tutorial chapter and a case study chapter.
 9. The Quasimodo Project is presented and advertised by a short summary description in the ICT 2010 Special Issue (no 14 September 2010) of the Parliament Magazine's Research Review. Also a dedicated presentation of Quasimodo results appeared in Ercim News No. 75 (the European Research Consortium for Informatics and Mathematics: Special theme on Safety-Critical Software).

3 Dissemination

Quasimodo has been involved in the organization of many conferences, local and international workshops, (summer) schools, events, and courses related to Quasimodo work:

1. AAU: DaNES Simulink/Labview Course, April 7-10, 2008, Sønderborg, Denmark (25 participants).
2. AAU: DaNES Tools Days, April 23-24, 2008, Aalborg, Denmark (30 participants).
3. AAU: DaNES Mini Projects, May 22-23, 2008, DTU, Denmark.
4. AAU: Testnet Conference, October 30, 2008, Aalborg, Denmark.
5. AAU: Opening of the VKR Center of Excellence, MT-LAB, November 19-20, 2008, DTU, Denmark.
6. AAU: DaNES Mini Projects, March 12-13, 2009, Sønderborg, Denmark with participation of CHES.
7. AAU: MT-LAB Advisory Board Meeting, DTU, Denmark, September 15, 2009.
8. AAU, CNRS, CFV: GASICS: 1st workshop at CAV'09, Grenoble (F), June 28, 2009 (www.lsv.ens-cachan.fr/Events/gasics09); 2nd workshop at CONCUR'10, Paris, September 3, 2010 (www.lsv.ens-cachan.fr/Events/gasics10); 3rd workshop at CONCUR'11, Aachen (D), September 10, 2011 (www.lsv.ens-cachan.fr/Events/gasics11), (Nicolas Markey (CNRS), Kim Larsen (AAU), JF Raskin (CFV)).
9. AAU, RWTH: QUANTLOG - workshop on quantitative logics, Satellite event of ICALP'09, Rhodes, Greece, July 11, 2009 (quantlog09.web.auth.gr) Organized by Kim G Larsen and Joost-Pieter Katoen and with contribution from several Quasimodo members (Patricia Bouyer-Dicitre, Nicolas Markey, Jean-Francois Raskin).
10. AAU: VVPS - Workshop on Verification and Validation of Planning and Scheduling Systems, co-located with ICAPS 2009, Rhodes, Greece, September 20, 2009 (www.vvps09.imag.fr/index.php)
11. AAU: "The Energy Aware House" Exhibition at BrightGreen, Forum, Copenhagen, December 12-13, 2009.
12. AAU, RWTH: PhD School on Quantitative Model Checking, Copenhagen, Denmark, March 2-5, 2010 (<http://qmc.cs.aau.dk>).
13. AAU/ESI/RWTH: Session on "Quantitative Verification in Practice", at the 4th Int. Symp. ISOLA 2010, Crete, October 2010.
14. AAU, CNRS: Dagstuhl seminar "Quantitative Models: Expressiveness and Analysis", Schloss Dagstuhl (D), January 18-22, 2010.
15. AAU: External Masters Course on "Model-Driven Development" especially Uppaal verification and MBT, based on selected chapters from the Quasimodo Handbook, Spring 2011
16. CNRS: Summer school MOVEP 2008 (see <http://www.univ-orleans.fr/evenements/movep2008/>) about specifying, modeling, and verifying parallel and concurrent processes for control of real-time applications, reactive, and critical systems (Franck Cassez (CNRS), François Laroussinie (CNRS): steering committee, and Patricia Bouyer (CNRS), Ed Brinksma (ESI), Kim Larsen (AAU), and Jean-Francois Raskin (CFV): program committee. Nicolas Markey (CNRS): tutorial on timed systems).

17. CNRS: CONCUR'10 - 21st Int. Conf. on Concurrency Theory, Paris, August 2010.
18. CNRS: TIME'10 - 17th Int. Symposium on Temporal Representation and Reasoning Paris, September 2010.
19. CFV: Co-organization of the GAMES summer school, Bertinoro (I), May 31-June 6 (<http://www.games.rwth-aachen.de/Activities/bertinoro.html>).
20. RWTH: YR-CONCUR 2009 Workshop, Bologna (I), September 5, 2009.
21. RWTH: Co-organization of the COMPASS Workshop (post-ETAPS workshop), York (UK), March 29, 2009.
22. RWTH: Co-organization of MOVEP Summer school, Aachen (D), June 28-July 2, 2010,
23. RWTH: Organization of the Aachen Concurrency and Dependability Week, consisting of:
 - CONCUR 2011 - 22nd Int. Conf. on Concurrency Theory, September 2011, Aachen (D).
 - QEST - 8th Int. Conf. on Quantitative Evaluation of Systems, September 2011, Aachen (D).
 - TGC - 6th Int. Symp. on Trustworthy Global Computing. September 2011, Aachen (D).
 - 9 workshops.
 - 6 tutorials.
24. SU: A summer School "Fun with Automata" dedicated to 3rd year Bachelor students, September 2008. SU, CNRS, CFV, AAU: Springschool "Automatic Verification and Analysis of Complex Systems" with invited lectures by Jean-Francois Raskin, Kim G. Larsen, Patricia Boyer, Holger Hermanns; Oldenburg, March 15-19, 2010.
25. SU: Co-Organizer of Dagstuhl Seminar "Verification over discrete-continuous boundaries", Dagstuhl, Germany, July 4-9, 2010 (Holger Hermanns).
26. SU: Co-Organizer of Dagstuhl Seminar "Multi-Core Memory Models and Concurrency Theory", Dagstuhl, Germany, January 3-7, 2011 (Holger Hermanns).
27. SU: Organization of ETAPS 2011, Saarbrücken, Germany, March 26 – April 3, 2011 (Holger Hermanns). SU has organized the the 14th European Joint Conferences on Theory and Practice of Software (ETAPS 2011) on the premises of the Saarbrücken campus in spring 2011. This is the primary European forum for academic and industrial researchers working on topics relating to Software Science. The event was composed of five international conferences: TACAS, FOSSACS, FASE, ESOP, and CC, plus 17 satellite workshops. ETAPS featured a special session devoted to QUASIMODO as part of the ROCKS workshop. About 550 scientists and industrial participants took part in this event in total.
28. SU: Programme Committee Co-chair for QEST 2012, London, UK, September 2012 (Holger Hermanns).
29. ESI/UT, CHESS: Dutch IPA Spring Days on Integrated Formal Methods, May 2008.
30. ESI/UT: Dutch Model Checking Day, April 2, 2009, University of Twente (NL), (<http://fmt.cs.utwente.nl/dmcd2009>).
31. ESI/UT: CeDICT Day on Dependable ICT Systems, April 24, 2009, Utrecht, the Netherlands (<http://nirict.3tu.nl/meetings-nirict/24-04-09CeDICT>).
32. ESI/UT: Dutch Dependability Day, May 12, 2009, University of Twente (NL), with 40 int. participants (<http://fmt.cs.utwente.nl/ddd2009>).
33. ESI/UT: Four co-located conferences ICGT/SPIN/PDMC/HiBi, Enschede (NL), September 27-29, 2010, with: 5th Int. Conf. on Graph Transformation (ICGT 2010), 17th Int. SPIN Workshop on Model Checking of Software (SPIN 2010), 9th Int. Workshop on Parallel and Distributed Methods in Verification (PDMC 2010), and the High Performance Computational Systems Biology Workshop (HiBi 2010).
34. ESI/UT: Symposium "Model-Based Testing: From Theory to Practice, and Back Again", May 13, 2011, University of Twente (NL), organized by Arend Rensink and Machiel van der Bijl (ESI/UT) and presentations, amongst others, by Ed Brinksma (ESI/UT), Machiel van der Bijl(ESI/UT) and Jan Tretmans (ESI), with 30 participants from academia and industry.
35. ESI/UT: "Transformation Tool Contest 2010" at TOOLS 2010, July 1-2, 2010, Malaga, Spain.
36. ESI/RU: FORMATS'09 - 7th Int. Conf. on Formal Modeling and Analysis of Timed Systems, Budapest, September 13-16, 2009, chaired by Frits Vaandrager (RU; together with Joël Ouaknine, Oxford). The conference, which was supported financially by Quasimodo, was successful and was attended by more than 80 participants. Three papers in the proceedings acknowledge support by Quasimodo, and all (academic) Quasimodo partners were present.
37. ESI/RU: Course on Model Checking with UPPAAL for Dutch high-school students. Several times during 2008-2010 Fits Vaandrager (RU) has given an extensive master-class on model checking at various high schools in the Netherlands. Course material has been developed, including assignments and a 20 page Uppaal manual (in Dutch). A module of 12 lessons on model checking

- with Uppaal has been developed for a teaching method "Informatica Actief", which is being used at 90 high schools throughout the Netherlands.
38. ESI/UT: Course on Automata Theory for Dutch high school students (Mariëlle Stoelinga).
 39. ESI/UT/RU: Basic Course IPA (Dutch Institute for Programming research and Algorithmics) for PhD students on Formal Methods, August 23-27, 2008.
 40. ESI/RU, ESI: DWFTT 2009: 3rd Dutch Workshop on Formal Testing Techniques, Nijmegen (NL), April 23, 2009.
 41. ESI, ESI/UT: Involved in the organization of "De Nederlandse Testdag" (The Dutch Testing Day), Nov. 27, 2008, Nov. 4, 2009, and Nov. 4, 2010.
 42. ESI: The annual ESI Symposium, presenting all ESI projects including Quasimodo for an industrial and academic audience (>200 persons), Dec. 4, 2008, Dec. 8, 2009, and Dec. 2, 2010.
 43. ESI: Co-organization of Bits&Chips Embedded Systems, an annual conference with mainly industrial attendance (>500 persons), Oct. 9, 2008, Nov. 12, 2009, and Nov. 11, 2010.
 44. ESI: Co-organization of INCOSE 2008 (18th Annual Int. Symposium of the Int. Council on Systems Engineering), June 15-19, 2008.
 45. ESI: The 2nd Int. Joint Workshop on Embedded Software and System Engineering Design Challenges, Daegu, Korea, May 19-23, 2008.
 46. ESI: Embedded Systems track on the Artemisia/ITEA Symposium, Oct. 22, 2008.
 47. ESI: DATE session on MBSE (Model Based Software Engineering), 2009.
 48. ESI: Involvement in FM 2009 (Int. Conference of Formal Methods), Nov. 2-6, 2009.
 49. CHESS: Coordinating the bi-annual Industry Day through our participation in the board of the Formal Techniques Industry Association (ForTIA), a subgroup of Formal Methods Europe, at FM2008 in Turku (Fin), May 28, 2008 (see <http://www.fm2008.abo.fi>), and at FM2009, Eindhoven (NL), November 5, 2009.
 50. CHESS: Organization of an internal workshop on modelling and analysis of the two case studies using the Quasimodo tools and techniques.
 51. CHESS: Chess offers several BSc, MSc and PhD student research projects to work on case-study related projects in the company. Currently we facilitate students from Free University of Amsterdam, University of Twente, and the Radboud University Nijmegen.
 52. CHESS: regular participation in industry fairs and outreach meetings where we are in the position to present the Quasimodo results and the products based on those results.
 53. Hydac: A couple of internal seminars and workshops have been organized to disseminate the Quasimodo results to software engineers.

The Quasimodo results have been presented at conferences, symposiums, and (summer) schools. (This list only contains presentations, lectures, keynotes, etc. at special occasions. Presentations related to regular scientific conference-, symposium-, or workshop-publications are not included. These can be found in the Quasimodo bibliography system [2] on the Quasimodo website [1]).

1. AAU: Invited talk at Workshop of CDC, Tallin, Estonia, January 21-22, 2008 (Kim Larsen).
2. AAU: Invited talk at SSV08, Sidney, Australia, Feb 25-27, 2008 (Kim Larsen).
3. AAU: Invited lecture at WODES 2008, Göteborg, Sweden, May 28-30, 2008 (Kim Larsen).
4. AAU: Invited lecture at Pan-European conference on Systematic Testing, Berlin June 4-5, 2008 (Kim Larsen, Brian Nielsen).
5. AAU: Invited lectures at Marktorberdorff summer school, August 5-17, 2008 (Kim Larsen).
6. AAU, ESI: Lectures at the ARTIST2 summer school in Europe, Grenoble, France, September 8-12, 2008 (Kim Larsen, Ed Brinksma).
7. AAU: Keynote on "Timing and Performance Analysis: Static Analysis versus Model Checking" at the Honoris Causa ceremony for Professor Dr. Reinhard Wilhelm from RWTH Aachen (D), October 24, 2008. (Kim Larsen).
8. AAU: Invited Talk on "Probabilistic Modal Transition Systems". COMBEST meeting on Interfaces, Rennes (F), March 3-4, 2009. (Kim Larsen)
9. AAU: Keynote on "Verification and Controller Synthesis of Real-Time Systems". 3rd Int. Conf. on Fundamentals of Software Engineering, FSEN09, April 15-17, Kish Island, Iran. (Kim Larsen)
10. AAU: Invited Talk on "Verification and Performance Analysis of Real-Time and Embedded Systems" at Joint China/Denmark Symposium on ICT, April 21-23, 2009, Odd Fellow Palæ, Copenhagen. (Kim Larsen)
11. AAU: Invited Talk on "Quantitative and Compositional Model Checking" at 7th Int. Andrei Ershov Memorial Conference, June 15-19, 2009, Novosibirsk, Russia. (Kim Larsen)

12. AAU: Invited Tutorial on "Real-Time Systems Validation and Synthesis" at Software Engineering Summer School, July 15-22, SEI East China Normal University, Shanghai, China. (Kim Larsen)
13. AAU: Invited Tutorial on "Real-Time Systems Validation and Synthesis" at ARTIST Summer School in China, July 19-24, 2009, Tsinghua University, Beijing, China. (Kim Larsen)
14. AAU: Keynote on "Verification and Performance Analysis of Embedded Systems" at TASE, 3rd IEEE Int. Symp. on Theoretical Aspects of Software Engineering, July 29 - 31, 2009, Tianjin, China. (Kim Larsen)
15. AAU: Invited Tutorial on "Validation, Performance Analysis and Synthesis of Embedded Systems" at ARTIST Summer School in Europe, September 7-11, 2009, Autrans (F). (Kim Larsen)
16. AAU: Invited talk on "On Determinism in Modal Transition Systems" at Symposium for Mogens Nielsen's 60th birthday, October 3-4, 2009, Aarhus, Denmark (Kim Larsen with Nikola Benes, Jan Kretinsky and Jiri Srba).
17. AAU: Invited talk on "Playing Games with Timed Interfaces" at Workshop on Foundations and Applications of Component-Based Design, Grenoble, France, October 11. (Kim Larsen and Axel Legay).
18. AAU: Invited talk on "Optimal and Real Time Scheduling using Model Checking Technology" at OR Day, Aarhus, Denmark, November 4, 2009. (Jacob Illum and Kim Larsen)
19. AAU: Invited talk on "Model-based GUI testing using UPPAAL at Novo Nordisk" at FMWeek Industry Day, Eindhoven, The Netherlands, November 5, 2009. (Jacob Illum and Ulrik Hjorth).
20. AAU: Invited talk on "Real-Time Interfaces" at FMCO, Eindhoven, The Netherlands, November 6, 2009. (Kim Larsen)
21. AAU: Invited talk on "Quantitative Modal Logics for Specification and Verification" at Methods for Modalities, Copenhagen, Denmark, November 13, 2009. (Kim Larsen)
22. AAU: Invited talk on "Priced Timed Automata: Theory and Tools" at FSTTCS, Kanpur, India, December 15-17, 2009. (Kim Larsen)
23. AAU: Invited lectures on "Validation, Performance Analysis and Synthesis of Embedded Systems" at CoSBI Centre, Trento, Italy, February 15-19, 2010. (Kim Larsen)
24. AAU: Invited lecture on "Validation, Performance Analysis and Synthesis of Embedded Systems" at AVACS Summerschool, Oldenburgh, Germany, March 15-19, 2010. (Kim Larsen)
25. AAU: Invited talk at the British Colloquium for Theoretical Computer Science, Edinburgh, Scotland, April 6-9, 2010. (Kim Larsen)
26. AAU: Invited tutorial at Weighted Automata: Theory and Applications, Leipzig, Germany, May 3-7, 2010. (Kim Larsen)
27. AAU: Keynote at ACSD, Braga, Portugal, June 21-25, 2010. (Kim Larsen)
28. AAU: Invited lectures on "Model-based Verification and Analysis for Real-Time Systems" at NATO Summerschool, Marktoberdorf, August 3-15, 2010 (Kim Larsen).
29. AAU: UPPAAL TRON and Simulink: Co-simulation and Testing. Presentation at 9th MT-Lab workshop, Aalborg University, August 24, 2010 (Marius Mikucionis)
30. AAU: Invited talk at 4th workshop on Reachability Problems, Brno, Czech Republic, August 27-29, 2010. (Kim Larsen).
31. AAU: Complex Systems Design and Management, Paris, Cité Universitaire, France, October 27-29, 2010 (Kim Larsen).
32. AAU: Invited-talk on "Model-based testing" Oct. 27 2010 at General Assembly and mini-conference of the Danish Software Testing Board (Danish ISTQB board)
33. AAU: Application of Model-Checking Technology to Controller Synthesis. FMCO (Formal Methods for Objects and Components), in Graz (A) on December 1 2010 (Alexandre David)
34. AAU: Embedded World Conference, Development Tools Sessions, Nürnberg, March 3, 2011 (Kim Larsen with Jens Alsted).
35. AAU: ROCKS, Rigorous Dependability Analysis using Model Checking Techniques for Stochastic Systems, Workshop, March 26, Saarbrücken, 2011 (Kim Larsen).
36. AAU: iWIGP, International Workshop on Interaction, Games and Protocols, Saarbrücken, Germany, March 27, 2011 (Kim Larsen)..
37. AAU: RED, Rigorous Embedded Systems, Salzburg, Austria, April 10, 2011 (Kim Larsen).
38. AAU: Microsoft Software Summit (invited panelist), Paris, France, April 14, 2011 (Kim Larsen).
39. AAU: PDMC, 10th International Workshop on Parallel and Distributed Methods in Verification, July 14, 2011, Cliff Lodge, Snowbird, Utah (Kim Larsen).
40. AAU: ARTIST Summer School in China, IOS/ISCAS, Beijing, August 8-12, 2011 (Kim Larsen).
41. AAU: ARTIST Summer School, Aix-les-Bains, France, September 4-9, 2011 (Kim Larsen).
42. AAU: Marktoberdorf Summer School, 2012 (Kim Larsen).

43. CFV: Invited talk at TACAS 2010, Cyprus, March 2010 (Jean-François Raskin).
44. CFV: Lecturer at Summer School "Games", Bertinoro (I), May 31-June 6, (Jean-François Raskin).
45. CFV: Invited talk at the General Meeting of the Authomatha project, Liège, 2009 (Jean-François Raskin).
46. CFV: Invited Talk "Safriless Procedures for Timed Specifications", at FORMATS'10 - 8th Int. Conf. on Formal Modeling and Analysis of Timed Systems, Vienna, Austria, September 2010 (Jean-Francois Raskin).
47. CFV: Lecture "An Introduction to Well-structured Transition Systems", at AVACS School 2010, Oldenburg, Germany, March 2010 (Jean-Francois Raskin).
48. CFV: Lecture "An Introduction to Hybrid Automata", at QMC School 2010, Copenhagen, Denmark, March 2010 (Jean-Francois Raskin).
49. CFV: Invited Presentation "Antichain Algorithms for Finite Automata", at TACAS 2010 - Tools and Algorithms for the Construction and Analysis of Systems, Paphos, Cyprus, March 2010 (Jean-Francois Raskin).
50. CFV: Keynote "Safriless Procedures for Timed Specifications", at FAC 2011 - Formalisation des Activités Concurrentes, Toulouse, April 6-7, 2011 (Jean-Francois Raskin).
51. CFV: Keynote "Antichain-based QBF Solving", at RP 2011 - 5th Workshop on Reachability Problems, Genova (I), September 28-30 2011 (Jean-Francois Raskin).
52. CFV: Keynote "Antichain algorithms for Model-Checking", at the Dutch Model-Checking Day, Delft (NL), June 17, 2011 (Jean-Francois Raskin).
53. CFV: Keynote "Games of imperfect information and robustness", at Workshop on Robustness in Embedded Systems Design, Västerås Sweden, June 15, 2011 (Jean-Francois Raskin).
54. CNRS: Invited talk on "Weighted Automata" at DLT'09 (Benedikt Bollig and Paul Gastin).
55. CNRS: Invited lectures on "Quantitative analysis of timed automata and timed games" at MSR'09 (Patricia Bouyer-Decitre).
56. CNRS: Invited lectures on "Quantitative analysis of timed automata and timed games" at QUANTLOG'09 (Patricia Bouyer-Decitre).
57. CNRS: Invited lectures on "Quantitative analysis of timed automata and timed games" at ACTS'09 (Patricia Bouyer-Decitre).
58. CNRS: Invited lectures on "Quantitative analysis of timed automata and timed games" at the ARTISTdesign school QMC'10 (Patricia Bouyer-Decitre and Nicolas Markey).
59. CNRS: Tutorial on "Quantitative Logics and Weighted Automata", WATA 2010 - Weighted Automata: Theory and Applications, Leipzig (D), May 3-7, 2010 (Paul Gastin).
60. CNRS: Surveu lecture on "Energy management in timed systems" at WATA 2010 - Weighted Automata: Theory and Applications, Leipzig (D), May 3-7, 2010 (Patricia Bouyer-Decitre).
61. CNRS: Lecture on "From timed automata to complex systems - Stochastic timed games" at the AVACS Spring school 2010, Oldenburg, Germany, March 15-19, 2010 (Patricia Bouyer-Decitre).
62. CNRS: Invited talk on "Robustness in timed systems", at SIES 2011 - 6th IEEE Int. Symp. on Industrial Embedded Systems, Västerås, Sweden, June 15-17, 2011 (Nicolas Markey).
63. RWTH: Lectures on Probabilistic Model Checking, at the Nanjing University (June 12-14, 2008) and at the Tshinghua University in Beijing (June 28-July 2, 2008).
64. RWTH: Keynote at the Nordic Workshop on Programming Theory (NWPT), Copenhagen (DK), October 14-16, 2009 (Joost-Pieter Katoen).
65. RWTH: Keynote at the Formal Methods Week soiree (FMWeek), Eindhoven (NL), November 5, 2009 (Joost-Pieter Katoen).
66. RWTH: Invited Talk at Formal Methods for Components and Objects (FMCO), Eindhoven (NL), November 5, 2009 (Joost-Pieter Katoen).
67. RWTH: Keynote at the IMCPS - Int. Symp. on Interdisciplinary Modelling of Cyber-Physical Systems, Manchester, UK, May 2011 (Joost-Pieter Katoen).
68. RWTH: Lectures on "Quantitative Model Checking" at IMCPS - Interdisciplinary Modelling of Cyber-Physical Systems, Manchester, UK, May 2011 (Joost-Pieter Katoen).
69. RWTH: Keynote at FSEN - 4th Conf. on "Fundamentals of Software Engineering, Tehran, Iran, April 2011 (Joost-Pieter Katoen).
70. RWTH: Keynote RP - 5th Int. Workshop on Reachability Problems, Genova, Italy, September 2011 (Joost-Pieter Katoen).
71. RWTH: Invited talk at HAS - ETAPS 2011 Workshop on Hybrid Autonomous Systems, Saarbrücken, Germany, March 2011 (Joost-Pieter Katoen).
72. RWTH: Invited lectures on "Markov Chain Model Checking" at the 18th Summer school on Computer Science (RIO), Rio Cuarto, Argentina, February 2011 (Joost-Pieter Katoen).

73. RWTH: Invited lectures on "Model Checking Continuous-Time Markov Chains" at the Summer school on Model Checking, Beijing, China, October 2010 (Joost-Pieter Katoen).
74. RWTH: Invited lectures on "Model Checking Continuous-Time Markov Chains" at the Summer school MOVEP - Modeling and Verification of Parallel Processes, Aachen, Germany, June 2010 (Joost-Pieter Katoen).
75. RWTH: Invited talk at the Microsoft Workshop on Formal Methods for Predictable Embedded Systems, Aachen, Germany, April 2010 (Joost-Pieter Katoen).
76. RWTH: Keynote at ICE - Interaction and Concurrency Experience, Amsterdam, The Netherlands, 2010 (Joost-Pieter Katoen).
77. RWTH: Invited tutorial at VMCAI - 11th Conf. on Verification, Model Checking and Abstract Interpretation, Madrid, Spain, January 2010 (Joost-Pieter Katoen).
78. RWTH: Invited talk at MLQA – the FLOC Workshop on Modeling, Languages and Analysis of Quantitative Systems, Edinburgh, Scotland, July 2010 (Joost-Pieter Katoen).
79. SU: Lecture series on "Quantitative model checking" at RIO 2009 Summerschool, Rio Cuarto, Argentina, February 16-20, 2009 (Holger Hermanns).
80. SU: Invited speaker at MLQA 2009, York, March 27, 2009 (Holger Hermanns).
81. SU: Lecture on "Probabilistic model checking" in Lucca (I), May 13, 2009 (Holger Hermanns).
82. SU: Lecture series on "Quantitative model checking" in Florence (I), May 14-15, 2009 (Holger Hermanns).
83. SU: Keynote at QFM 2009, Eindhoven (NL), November 3, 2009 (Holger Hermanns).
84. SU: Invited speaker at FMES 2009, Eindhoven (NL), November 5, 2009 (Holger Hermanns).
85. SU: Lectures on "Quantitative model checking" at NATO Summerschool, Marktoberdorf, August 3-15, 2010 (Holger Hermanns).
86. SU: Invited speaker at CONCUR 2010, Paris, August 31-September 3, 2010 (Holger Hermanns).
87. SU: Invited lecture series on "Quantitative model checking" at NATO Summerschool, Marktoberdorf, August 3-15, 2010 (Holger Hermanns).
88. SU: Invited speaker at SEFM 2011, Montevideo, November 14-18, 2011 (Holger Hermanns).
89. SU: Invited speaker at TACAS 2012, Tallinn, Estonia, March 24 – April 1, 2012 (Holger Hermanns).
90. ESI/RU: Invited talk on "Learning I/O automata" at the Dutch Model Checking Day 2010, University of Eindhoven, July 2010 (Frits Vaandrager).
91. ESI/RU: Invited series of 8 lectures on "Theory and Application of Timed Automata Model Checking" at the University of Pisa, May 2011 (Frits Vaandrager).
92. ESI/UT: Keynote SAVCBS: 9th Workshop on Specification And Verification of Component-Based Systems, Amsterdam, August 24, 2009 (Mariëlle Stoelinga).
93. ESI/UT: Keynote at iWIGP 2011: Int. Workshop on Interactions, Games and Protocols, Saarbrücken, March 27 2011 (Mariëlle Stoelinga).
94. ESI/UT: Lectures at NATO Summerschool, Marktoberdorf, August 3-15, 2010 (Ed Brinksma).
95. ESI/UT: Tutorial on "LTsmin" at ECAPS, Freiburg, June 12, 2011 (Jaco van de Pol).
96. ESI/UT: Invited Talk at PDMC 2011, Int. Workshop on Parallel and Distributed Methods in verification, July 2011 (Jaco vd Pol).
97. ESI/UT: Lecture at Dutch IPA Lentedagen on Bioinformatics: "Modeling biological pathway dynamics with Timed Automata", April 14, 2011 (Stefano Schivo).
98. ESI/UT: Invited Talk at the Computing Laboratory, University of Oxford: "Symbolic reductions of probabilistic models using linear process equations", Oxford, September 2010 (Mark Timmer).
99. ESI/UT: Industrial presentation "Model-Based Testing of a Wireless Sensor Network Node" at "De Nederlandse Testdag", Leiden (NL), November 4, 2010 (Axel Belinfante).
100. ESI: Lectures at the Artist2 Summer School in China, Shanghai, July 12-18, 2008 (Ed Brinksma).
101. ESI: Lectures on "Software Testing" and "Model-Based Testing" at EJCP (Ecole Jeunes Chercheurs en Programmation), Rennes, May 29-June 6, 2008, June 3-12, 2009, and May 19-28, 2010 (Jan Tretmans; <http://ejcp2010.inria.fr>).
102. ESI: Lectures on "Model-Based Testing" at the TAROT Summer School, Bath (UK), June 22-27, 2008 (Jan Tretmans), Madrid, July 6-10, 2009 (Julien Schmaltz), and Graz, June 21-25, 2010 (Jan Tretmans).
103. ESI: Invited speaker at MBT 2010 - Int. Workshop on Model-Based Testing, Paphos, Cyprus, March 21, 2010 (Jan Tretmans).
104. ESI: Invited presentation "An Introduction to Model-Based Testing" at "De Nederlandse Testdag", Leiden (NL), November 4, 2010 (Jan Tretmans).

105. ESI: Invited lecturer at SFM-11: CONNECT - 11th Int. School on Formal Methods for the Design of Computer, Communication and Software Systems: Connectors for Eternal Networked Software Systems. University Residential Center of Bertinoro, Italy, June 13-18 2011 (Jan Tretmans).
106. ESI: Industrial presentation "Van Model naar Test - Modelgebaseerd Testen voor een Draadloze Sensornetwerk Node" at Bits & Chips 2010 Embedded Systemen, Eindhoven (NL), November 11, 2010, <http://www.embedded-systemen.nl> (Jan Tretmans).
107. ESI: Several industrial seminars and presentations about "Model-Based Testing": Chess, Thales, OCE, TestNet (Dutch Professional Organization of Software Testers), NSpyre (Jan Tretmans).
108. CHESS: Invited talk "Are Formal Methods the Right Tool for Developing Real-time Distributed Embedded Systems?" at the Microsoft Workshop on Formal Methods for Predictable Embedded Systems, Aachen, Germany, April 13-14, 2010 (Marcel Verhoef).
109. CHESS: Industrial presentation "Large scalable wireless sensor networks; sense or nonsense?" at Bits & Chips 2010 Embedded Systemen, Eindhoven (NL), November 11, 2010 (Frits van de Wateren).

Apart from scientific and technical articles in journals and on conferences (see the Quasimodo bibliography system [2] on the Quasimodo website [1]), Quasimodo has published professional articles and books:

1. AAU: The regular CISS magazine (in Danish) is published 1-2 times a year and distributed in more than 3.000 copies. The targeted audience is future industrial collaborators and political decision makers.
2. ESI/RU: A short introduction on model checking (in Dutch) was completed that is used in courses for high school students [2].
3. RWTH: A monograph on "Principles of Model Checking" was published by Christel Baier and Joost-Pieter Katoen (MIT Press), which covers quite some material on quantitative verification.
4. SU, RWTH, ESI: A review article on "Performance Evaluation and Model Checking Join Forces" in 'Communications of the ACM', September 2010 (Boudewijn Haverkort - ESI, Holger Hermanns - SU, Joost-Pieter Katoen - RWTH, together with Christel Baier, TU Dresden).
5. AAU, CNRS: A survey article on "Quantitative analysis of real-time systems using priced timed automata", to appear in 'Communications of the ACM' (P. Bouyer - CNRS, U. Fahrenberg - AAU, K. Larsen - AAU, N. Markey - CNRS).
6. AAU, CNRS: A book chapter "Verification of real-time systems", to appear in the "handbook of model-checking".

Some of the Quasimodo results are exploited via spin-off activities:

1. AAU: Currently the UPPAAL classic tool as of January 2007 is marketed by the Swedish registered company UP4AAL.
2. AAU: Together with UP4AAL, AAU exploits the UPPAAL branch CORA for testing medical devices at the company Novo Nordisk.
3. AAU: The activities on testing are exploited by the company TK Validate in a product V+ for testing web-services and graphical interfaces.
4. ESI/UT: An STW (Dutch Technology Foundation) valorization grant proposal was granted to Axini (www.axini.com), a start-up spin-off from the University of Twente, on model-based testing.
5. ESI participates in the spin-off stimulation program of the Eindhoven University of Technology, through which all ESI PhD students are offered a course on entrepreneurship.

The results of Quasimodo are used in regular courses and teaching by the Quasimodo participants:

1. AAU: The CS curriculum offers various courses where the tools exploited and developed within Quasimodo (UPPAAL and its various branches) play a central role:
 - o TOV (Test and Verification) aimed at last semester CS students;
 - o Embedded Systems Validation (PhD course);
 - o MTV (Model-Driven Test and Verification) aimed at third year EE students.
2. RWTH: A seminar on "Quantitative Verification" was organized, and Quasimodo results will be incorporated in the optional master course "Advanced Model Checking".
3. RWTH: Quasimodo results have been incorporated in the courses on "Model Checking", and "Testing Theory of Reactive Systems".

4. RWTH: A new course on "Modeling and Verification of Probabilistic Systems" has been set up in the summer semester of 2011, extensively using Quasimodo results.
5. SU: Master level courses on "Modelling and Analysis of Embedded Systems".
6. SU: The CHES WSN protocol and the MyriaNed nodes have been explored and applied in various master level projects. Among them, two demonstrators of verification technology for wireless safety-critical hard real-time technology stand out: a wireless bike brake, and a wireless fortune wheel. The former has led to a publication by our students on IEEE WoWMoM – The IEEE Int. Symposium on a World of Wireless Mobile and Multimedia Networks.
7. SU, ESI: Two-weeks course on "Model-Based Testing" at SU given by ESI (Julien Schmaltz), March 2009.
8. CFV/ULB: An advanced course on "Verification".
9. CNRS: Researchers from CNRS are involved in the Parisian Master of Research in Computer Science; see <http://mpri.master.univ-paris7.fr/english/index.html>. Teachers from CNRS are involved in the lectures on "Foundations of Verification for Timed and Concurrent Systems" and "Verification of timed and hybrid systems".
10. ESI/RU: Several experiments with the application of model checking are conducted in courses, for instance, in a first year course on operating systems; see <http://www.cs.ru.nl/ita/publications/papers/fvaan/MCinEdu>.
11. ESI/RU: Master level courses on "Analysis of Embedded Systems" and "Testing Techniques" directly benefit from Quasimodo results. The CHES Wireless Sensor Network case is used in "Analysis of Embedded Systems", and the model-based testing tool JTorX developed at UT is used in "Testing Techniques".
12. ESI/UT: Within the Embedded Systems track of the Computer Science curriculum a course has been started on "Design of Embedded Systems (MDDP)" where Quasimodo results are used.
13. ESI/UT: A Master Level course on Verification Engineering is given, where students carry out realistic case studies in verification, amongst others based on Quasimodo case studies (Jaco vd Pol).
14. ESI/UT: Theory developed in Quasimodo, and the model-based testing tool JTorX are used in the Master's course "Testing Techniques" (theory and lab exercises).
15. ESI: Lectures at Eindhoven University of Technology presented Quasimodo results.
16. ESI: A post-academic, industry-oriented Competence Development Program is organized, leading to a Master's in Embedded Systems Engineering, in which parts of the Quasimodo results are used.

PhD. students which have been involved in, or influenced by Quasimodo:

1. Nicolas Maquet, "New Algorithms and Data Structures for the Emptiness Problem of Alternating Automata", Université Libre de Bruxelles, 2011.
2. Marijn Jongerden, "Model-Based Energy Analysis of Battery Powered Systems", University of Twente, 2010.
3. Daniel Klink, "Three-Valued Abstraction of Stochastic Systems", RWTH Aachen, 2010.
4. Martin Neuhäusser, "Model Checking Nondeterministic and Randomly Timed Systems", RWTH Aachen and University of Twente, 2010, With Distinction.
5. Tingting Han, "Diagnosis, Synthesis, and Analysis of Stochastic Systems", RWTH Aachen and University of Twente, 2009, With Distinction, Recipient of the Overijssel PhD. Award 2009.
6. Machiel van der Bijl, "On Changing Models in Model-Based Testing", University of Twente, 2011.
7. Reza Pulungan, "Reduction of Acyclic Phase-Type Representations", Universität des Saarlandes, Saarbruecken, Germany, 2009.
8. Lijun Zhang, "Decision Algorithms for Probabilistic Simulations", Universität des Saarlandes, 2008.
9. Bjoern Wachter, "Refined Probabilistic Abstraction", Universität des Saarlandes, 2010.
10. Jasper Berendsen, "Abstraction, Prices and Probability in Model Checking Timed Automata", Radboud University Nijmegen, 2010.
11. Theses in preparation at CNRS: Romain Brenguier (Equilibria in timed games; planned 2012), Ocan Sankur (Robustness and implementability of timed systems; planned 2013).
12. Theses in preparation at SU: Pepijn Crouzen, Ernst Moritz Hahn, Christian Eisentraut, David Spieler Hernan Baro Graf, Luis Maria Ferrer Fioriti, Hassan Hatefiardakani.
13. Theses in preparation at ESI/RU: Lars Frantzen (Symbolic model-based testing; planned 2012), Georgeta Igna, Faranak Heidarian, Fides Aarts.
14. These in preparation at ESI/UT: Wouter Kuijper, Piotr Kordi, Mark Timmer, Minh Tri Ngo (Probabilistic models for security; planned 2013).

4 Relations to Other Projects and Cross-Fertilization

The Quasimodo partners have participated, and still participate in several other projects, programmes, and networks, which are related in content to Quasimodo. These involve both research projects and application-oriented industrial projects. These projects served as knowledge providers as well as knowledge consumers for Quasimodo. In particular, the industrial projects have provided valuable platforms, on the one hand for the exploitation of Quasimodo results, and on the other for hand feedback and reality check of Quasimodo techniques and tools. In addition, Quasimodo partners have submitted 3 new project proposals based on Quasimodo in the last EU-FP7 Call.

Research Projects:

1. AAU: Danish research project MoDES.
2. AAU: The newly formed VKR Center of Excellence MT-LAB (<http://www.mtlab.dk/>) being a collaboration between DTU, ITU and Aalborg University with a focus on combining static analysis and model checking aiming at verification and analysis of complex interacting software systems.
3. AAU, ESI: ARTIST Design. European NoE on Embedded Systems, where Aalborg coordinates the activities on Modeling and Validation. Several partners of Quasimodo are involved as either core or affiliated partners.
4. RWTH: There is a strong cross-fertilization with the research training group Algosyn (Algorithmic Synthesis for Reactive Systems), and with the cluster of excellence UMIC.
5. RWTH, SU, ESI/RU, ESI/UT: There is extensive cross-fertilization with the Dutch/German bilateral research project ROCKS.
6. SU: DFG-funded Sonderforschungsbereich SFB-TR 14-AVACS. The work on quantitative model checking is developed in close collaboration with AVACS, where it is applied in the analysis of self stabilising systems.
7. ESI/UT: UT is project leader of the European project EC-MOAN on the modelling and analysis of molecular mechanisms in the E-coli bacteria, where hybrid techniques are used, so cross fertilization with Quasimodo takes place.
8. ESI/UT: LIST (Laboratory for Integration of Small Tools), where the integration of tools is studied, some of which will be developed in Quasimodo.
9. ESI/RU: There is strong cross-fertilization with the theory-oriented projects FRAAI and ARTS funded by NWO (Dutch National Science Foundation).
10. ESI/UT/RU: There has been extensive exchange of ideas with projects Atomyste (Atom Splitting in Embedded Systems testing, Dutch Technology Foundation STW PROGRESS project TES.5417), and STRESS (Systematic Testing of Realtime Embedded Software Systems, Dutch Science Foundation NWO).
11. CNRS: The French projects (ANR):
 - DOTS - Distributed Open and Timed Systems; see <http://www.lsv.ens-cachan.fr/anr-dots/?l=en>, about the design and verification of complex systems. In DOTS, researchers from LSV cooperate with LaBRI, IRISA, IRCCyN, and LAMSADE.
 - ImPro - Implementability and Robustness (2010-2013). It involves researchers from LSV (Cachan), LIAFA (Paris), LIP6 (Paris), IRCCyN (Nantes), INRIA (Rennes) and LIF (Marseille).
12. CNRS, CFV, AAU, RWTH: participation in the GASICS project, an Eurocores project of the ESF on the study of game theoretic formalizations of interactive computational systems and algorithms for their analysis and synthesis. In this project, CNRS, CFV, AAU, RWTH collaborate with researchers from Warwick, Aachen, and Paris.
13. CFV: There have been several cross fertilization activities with the Belgian Federal Project MOVES - Fundamental Issues in Modelling, Verification and Evolution of Software (<http://moves.vub.ac.be/>)
14. AAU, ESI: EU Artemis, EU FP7 NoE Artist2, and STREP Multiform.
15. ESI: EU FP7 Genesys.
16. CHESS: Chess is participating in the EU FP7 project "Design Support and Tooling for Embedded Control Software": DESTECs. This project investigates and develops methods and open tools that support the collaborative design of dependable real-time embedded control systems using a model-based approach. This means that engineers can perform design evaluation and analysis using co-simulation of models expressed in different tools that reflect in a natural way the relevant aspects of

the design but which can be analyzed consistently and rapidly together. This requires advances in continuous time modeling, formal discrete event modeling of controllers and architectures, fault modeling and tolerance, and open tools frameworks. Bringing these together in methods and tools has the potential to substantially improve the cost-effectiveness of model-based design. DESTECS was awarded in the fourth call of the FP7 ICT call and has started on January 1, 2010 and will run for three years. The tools and techniques developed in Quasimodo are complementary to those researched in DESTECS, hence a lot of synergy is obtained from combining these techniques into the DESTECS approach.

Industrial Projects:

17. AAU: Collaborations with a number of companies within DaNES (Danish Network for embedded Systems) on topics quite affine with those of Quasimodo including model-driven and component-based design; see www.danes.aau.dk.
18. AAU: The Innovation Network INFINIT (<http://www.infinet.dk>) aims at dissemination and collaboration with Danish industry within three strategic areas: pervasive systems, future internet, and embedded systems.
19. AAU: Interaction and integration of the UPPAAL tool suite with Simulink is considered.
20. RWTH: In the ESA Project COMPASS (CORrectness, Modeling, and Performance of Aerospace Systems) Quasimodo results are exploited. Other parties involved in this project are Thales Alenia Space, and Fondazione Bruno Kessler.
21. SU: Quasimodo theory and tools are being applied in the design of asynchronous system architectures developed by Bull, CEA-Leti, and ST Microelectronics as part of the French Pôle de Compétitivité Mondial project Minalogic-Multival.
22. ESI/UT: A collaborative project with NEM Hengelo to explore the use of timed automata for controller design.
23. ESI/UT: Application of the model-based testing tool JTorX for the testing of the XBus application at Neopost, Texas, April-July 2009.
24. ESI/RU, ESI: A couple of collaborative industrial research projects aiming at the application of model checking, of which currently the most important and promising one is a collaboration with OCE in the context of the ESI Octopus project. In this project UPPAAL is applied in the design of the data path of adaptive copiers and printers. Uppaal is now fully integrated in the Octopus Design-Space Exploration (DSE) toolset that aims to leverage existing modeling, analysis, and DSE tools to support model-driven DSE for embedded systems; see <http://www.mbsd.cs.ru.nl/publications/papers/fvaan/odse>.
25. ESI: Several Dutch industrial-academic collaborative projects are executed by ESI, in an "industry-as-laboratory" setting, in which there are several opportunities for transfer of Quasimodo results and obtaining feedback: Boderc, Tangram, Ideals, Trader, Darwin, Falcon, Condor, Poseidon, Octopus, and Alwen; see www.esi.nl/projects for an overview of ESI projects and their descriptions. Currently, Quasimodo methods and tools are actually used in the projects Falcon and Octopus.
26. ESI: In collaboration with the Wings project, an ESI cooperation with ASML, a case study was elaborated for timed and stochastic model checking of a Rapid I/O Packet-Switch in the ASML wafer scanner. The POOSL model developed in Wings was translated to Uppaal and model-checked using results from Quasimodo.
27. ESI, ESI/RU: Commissioned by the Dutch Ministry of Internal Affairs and in cooperation with the Radboud University, Quasimodo results in model-based testing and the test tool TorXakis were applied to testing the new Dutch electronic passport's smart card for compliance with international standards.
28. ESI/RU: In the project FATs Domino, a project in the context of the Dutch *kenniswerkersregeling* together with OCE in Venlo (NL), with the goal of performing model-based testing of OCE's scanner/printer controller software, Quasimodo techniques and tools (JTorX, TorXakis) were used.
29. ESI: Exchange of knowledge and experience took place in the project MODEST, a Dutch *kenniswerkersregeling* project, in which ESI and OCE collaborated on integration and testing of printers.
30. ESI: Interaction is fostered with the Special Interest Group (SIG) on Integration & Testing (I&T) of complex high-tech systems, which is organized by ESI, and in which companies like Philips, ASML, OCE, FEI, Thales, and Panalytical participate.
31. CHESS: Chess is involved, both directly and indirectly through FHI DevLab, in five significant Dutch based joint academic / industry research programmes where there are opportunities to use the

results achieved in Quasimodo. They are: Viewcorrect (will conclude in 2008), Alwen (ambient living with embedded networks; see also above), Storm (sensor technology on radio modules), Pleister (package label electronics including sensing talkative enhanced radio) and NanoWireless (nanowires on wireless sensor modules). The last four projects have started in 2008 and will continue for several years. CHESSE plays an active role in disseminating results into these projects and towards the associated partners and network.

5 Application in Own Products or Processes

1. Hydac: It is intended that the Quasimodo work will be applied in the further development of the Quasimodo case study – the ACC controller-, and in the development of safety transducers.
2. Hydac: We have started to implement our case study in a concrete product. During our test in a real environment and during the model-based testing in Quasimodo we were able to detect some problems. Currently we are working on analyzing these problems and developing a new strategy to encounter them.
3. Hydac: During the Quasimodo project we have built models and used them to validate our case study with test cases automatically generated from these models. On the basis of these experiences we intend to use model-driven software engineering for some upcoming projects and in particular we plan to use automatically generated test cases to validate our products.
4. CHESSE: The work of the academic partners on the two case studies proposed by CHESSE had direct impact on real products that are currently under development in our company. Our primary focus is on the design and analysis of a novel wireless sensor network protocol based on epidemic style communication. Current state-of-practice design, analysis and verification & validation techniques are not sufficiently expressive and powerful to guarantee correct implementation. This is extremely important since we target implementations in silicon to achieve low-cost and high volume implementations. Hence “first time right” is a necessity. We therefore need Quasimodo tools and techniques to address and attack these issues.
Our secondary focus is on the design of complex motion control applications whereby modeling and analysis of operating mode changes is complex in relation to safety requirements imposed on those systems. As a case study we used the self-balancing scooter (people mover) as the challenge. This will not necessarily become a CHESSE product, but the modeling and analysis strategy and the tools proposed by Quasimodo will help us to develop systems of similar scope and complexity. The long-term objective of Chess is to embed the Quasimodo tools into our in-company design flow for the development of mission critical embedded systems. Furthermore, we plan to enlarge the application scope of these tools from the two case studies to our high performance computing (image processing) and machine-2-machine business lines whenever possible.
5. CHESSE, ESI: ESI personnel has worked for two weeks at the Chess premises to seek concrete opportunities for Quasimodo related spin-off opportunities. A Chess internal lecture was provided by ESI on model-based testing, which has lead to two opportunities: firstly the implementation of a conformance testbed for the Chess' Wireless Sensor Network technology, and secondly, the model-based testing of complex web-based applications at the Chess iBusiness group.
6. TERMA: Terma has been involved in three areas:
 - schedulability analysis,
 - model based development and test
 - model based test generation

With respect to schedulability analysis, present practice is based on response time analysis. It is a static analysis, which results in a conservative estimation.

In Quasimodo, schedulability analysis based on timed automata, is being developed. The analysis has been applied to the attitude and orbit controls software for the Herschel and Planck missions, and results compared with the response time analysis. The new analysis was not able to properly model some aspects (the modelling of sporadic tasks is presently too simplistic, i.e., the result could be too optimistic), but the approach is promising. When the deficiencies have been corrected, Terma will seriously consider applying the analysis based on timed automata.

Model based development and test has followed two tracks:

- UML modeling of user requirements from the ASIM project:
During the construction of a UML model, based on verbal requirements, a number of issues to be more detailed/specific were identified.
The construction of a logical model, based on requirements, will be applied in upcoming projects, and is in line with the European Space Agency approach.
- Timed Automata modeling of interface requirements between two instruments on ASIM:
The corresponding test was executed on the model.
Use of timed automata models of complex functional requirements will be considered in future projects.

Model based test generation applies to a subset of Herschel/Planck requirements concerning the management of critical tele-commands. The objective is to generate a test specification (test scripts), that shall be applied on the software executable. This is in line with the approach recommended by the European Space Agency.

The activity is ongoing, and Terma will evaluate the feasibility when it has been concluded.

Bibliography

- [1] <http://www.quasimodo.aau.dk>
- [2] <http://www.quasimodo.aau.dk/aigaion/aigaion2root/index.php/login/index>
- [3] <http://www.ita.cs.ru.nl/publications/papers/fvaan/watismodelchecking.pdf>
- [4] <http://www.chess.nl>