

# PROGRESS REPORT

Reference period from 1 April 2003 to 30 September 2003

**KUN, all**

April 2004

## AMETIST DELIVERABLE 0.1.3

Project acronym: AMETIST

Project full title: Advanced Methods for Timed Systems

Project no.: IST-2001-35304

Project Co-ordinator: Frits Vaandrager

Project Start Date: 1 April 02

Duration: 36 months

Project home page: <http://ametist.cs.utwente.nl/>

### Consortium

<i>No</i>	<i>Name</i>	<i>Short name</i>	<i>Country</i>
1	Katholieke Universiteit Nijmegen	KUN	NL
2	Robert Bosch GmbH	Bosch	D
3	Cybernetix Recherche	CYR	F
4	Axxom Software AG	Axxom	D
5	Terma A/S	Terma	DK
6	Aalborg University	AAU	DK
7	Universität Dortmund	Uni DO	D
8	VERIMAG	VERIMAG	F
9	Weizmann Institute of Science	WIS	IL
10	Laboratoire d'Informatique Fondamentale de Marseille	LIF	F
11	University of Twente	UT	NL

## **Contents**

<b>1 Industrial Objectives and Strategic Aspects</b>	<b>3</b>
<b>2 Status, Achievements, Delays, Milestones</b>	<b>3</b>
<b>3 Recommendations by the Experts</b>	<b>4</b>
<b>4 Key Events During Reporting Period</b>	<b>6</b>
<b>5 List of Deliverables</b>	<b>7</b>
<b>6 Scientific and Technical Performance</b>	<b>8</b>
<b>7 Exploitation and Dissemination</b>	<b>8</b>
<b>8 Management, Co-ordination, Resources</b>	<b>9</b>

## 1 Industrial Objectives and Strategic Aspects

AMETIST intends to contribute to solutions for the growing industrial need to design reliable and efficient time dependent systems. In particular, it intends to provide theory and tools for error-detection, control and optimisation of real-time distributed systems. Its approach will be based on translating state-of-the-art academic research into methods and tools that can be a basis for an industrial design practice of such systems.

In addition to its technological contributions, AMETIST invests actively in knowledge transfer to the European industry of computer-aided timing analysis and design. Moreover, it is expected that the academic dissemination of the AMETIST research results will influence and advance the field of timed systems research, and (indirectly) contribute to the education of future generations of system engineers.

Whereas timed automata and the tools for their analysis are widely accepted in academia and are being used at hundreds of universities and research laboratories all around the world, they have yet to find their way into industry. The aim of AMETIST is to advance and mature the related models, tools, and methods to allow this situation to change.

The need for automatic tools that allow reasoning about time is evident. Beyond manufacturing, telecommunication and hardware, it is of essential importance for the growing market of embedded systems (from car electronics to home automation). However, there are several obstacles that seem to hinder the use of timed automata technology in industry at this time:

- Scalability: Currently, tools based on timed automata do not allow to handle big examples. There are industrial scale examples that have been treated with these tools but only after tedious manual simplification involving a lot of work in each case.
- Convenience: Current timed automata tools are stand-alone programs and their input formalisms lack important features for convenient specification in an industrial setting.
- Accessibility: To make optimal use of the currently available tools requires quite some sophistication on the user's part, which makes them practically inaccessible even to well-trained engineers.

AMETIST aims at the (at least partial) elimination of these obstacles. The project moves towards this goal along several tracks. One is the treatment of real-life case studies from some candidate application domains to see if, indeed, the proposed models, tools and methodology are suited for them. Indeed much of the project's resources are being spent on case studies. A second direction, and this has probably been the main thrust of AMETIST thus far, aims to improve the situation regarding scalability, by introducing better algorithms and data-structures to model and manipulate large systems, in particular in the area of real-time controller synthesis, planning and scheduling. Moreover, the project aims at tool interaction to allow the interfacing of different tools, which can help to improve usability/convenience. The third track, which will become more dominant as the project evolves, aims at synthesizing the accumulated results in order to assess the applicability of the project's vision and modify it according to feedback from the field.

## 2 Status, Achievements, Delays, Milestones

During the first two and a half months of the reporting period much effort was invested in producing the project deliverables for Year 1, and the preparations for the first review meeting in Brussels on June 19. All deliverables (except the last progress report D0.1.2 that was handed over during the review) were sent in on time in paper or electronic versions. Originally, the first review was planned to take place as part of the project meeting in Cassis on May 5-7, but as the European Commission experienced some delay in selecting the external experts, scheduling constraints of forced a change of plan.

Based on the review meeting, an overall quite positive Technical Evaluation Report was prepared by the experts Bo Wahlberg, Rajeev Alur and Claude Le Pape (final version 08/09/03). This report and the recommendations contained in it were discussed extensively during the PCC meeting in Aalborg, Denmark, on September 18, 2003 (see Section 3).

At the beginning of the reporting period, Bosch decided to stop the further development of the Car Periphery System, which was being proposed as a case study for AMETIST. The PCC decided that also within AMETIST the work on the CPS case study will be finished after the papers in progress on this case have been completed. Bosch expects to be able to come up with a new case study (power management, reliability modelling / safety of an airbag system?) before the end of year 2.

During the last three and a half month of the reporting period there were no specific milestones, and work has proceeded according to plan.

### 3 Recommendations by the Experts

In this section, we discuss the recommendations from the Technical Evaluation Report.

#### Recommendation 1

*Increase efforts to identify the end-user community and reach out to them by, for example, setting up an end-user panel. Dissemination targeted at industry is crucial to the success of the overall goals (Addendum to D<sub>4</sub>).*

Already in the technical the creation of an end-user-panel was announced but this activity got delayed amidst all the other activities of the project during the first year. The PCC fully agrees with the experts about the importance of outreach to the end-user community, and meanwhile an end-user panel has been set up (see Section 7 below).

#### Recommendation 2

*Among the many exciting research directions listed, prioritise them based on the initial experiences from the case studies (Recommendation for D0.1.3).*

Clearly, success on the Axxom case study is central to the success of the AMETIST project as a whole. Whereas during the first year we successfully tackled the (relatively simple) initial version of the case study as provided by Axxom, the project is still far from solving the type of problems Axxom tackles routinely.

Hence, amongst the many possible research questions, the questions whose solution may advance our ability to make progress on the Axxom case study have highest priority. Phrased at a more general level, we would like to obtain by the end of the project a clear view of what timed automata verification technology has to offer to the operation research area: Where can it do well? How can it help to improve existing tools? Where can it be competitive?

Concretely, we give high priority to developing new versions of our timed automata tools that are more geared towards scheduling than the current versions (by adding cost functions, guided search, heuristics,..).

Developing new theory/methods/tools to support scheduling under uncertainty is also high on our priority list, also because our industrial partners expressed strong interest in this.

#### Recommendation 3

*To evaluate the advance in the tools for analysis, to identify quantitative criteria, and to measure the progress in terms of those criteria. A most important criterion is scalability to larger problems (Recommendation for D0.1.4).*

The PCC was somewhat surprised by this recommendation, since many of the papers produced by the project extensively discuss the (impressive) quantitative progress in terms of performance (memory, CPU time,..) that we have achieved. The AAU team has set up a webpage with various benchmarks from the verification literature (see [www.uppaal.com](http://www.uppaal.com)) and performance figures for the various releases of the Uppaal tool are recorded for these benchmarks. In our papers we also tackle benchmark problems from the OR community (such as the airplane landing problem) and present quantitative information about performance. Scalability to larger problems is always a driving force in our research. During the second year of AMETIST, we have the ambition to tackle significantly larger instances of the Axxom case study.

In response to Recommendation 3, the project will gather and collect information about quantitative improvements of tools and give an overview of this in D2.5.a.

#### **Recommendation 4**

*Each of the four industrial partners have proposed an independent case study, corresponding to a specific application of the methodology provided. The consortium should work through in greater detail qualitative assessment of their progress in R&D and their risk in terms of industrial use (Recommendation for D0.1.4).*

The PCC adopts this suggestion.

#### **Recommendation 5**

*To plan the exploitation routes, the consortium is strongly advised to establish and sign a consortium agreement that discusses and clarifies among the partners the Intellectual Property Rights (IPRs) issues.*

The possibility of establishing a consortium agreement was discussed at the start of the project, but none of the partners saw the need for this. Following the recommendation by the experts, the issue was discussed again by the PCC, but again the unanimous view was that – as the AMETIST research is of a precompetitive nature – there are no IPRs issues that need to be clarified via a consortium agreement. All partners agree that IP is completely free to the outside world and industrial exploitation is not limited to any entity inside/outside the consortium.

#### **Recommendation 6**

*The consortium should inform the Commission of its participation in future conferences, events and any publications prior to its submission or acceptance (obviously only if costs are going to be charged to the project).*

The PCC had difficulties to see the rationale of this recommendation. Researchers typically do not want to make public to which meetings they submit (they always find it embarrassing if the paper gets rejected). Also, at the time of submission of a paper it is typically not clear which author will attend the venue in case of acceptance (too far ahead to plan) and consequently it is also unclear whether support from AMETIST is needed. The PCC was not convinced of the benefit of the additional administrative burden incurred by the new procedure.

Following discussion with the project officer, it was decided that

- If any publication is made based on the activities of AMETIST, the support of the Commission will (of course) be referenced.
- If partners in addition ask for re-funding of travel expenses outside the EU (mainly for over-sea travels) and for dissemination activities, the Commission will be informed in advance. For this it suffices that the project coordinator sends his permission acknowledgement in copy (CC) to the project officer, who then can object where appropriate.

## 4 Key Events During Reporting Period

During the reporting period two regular project meetings as well as the first review meeting took place:

- On May 5-7, 2003, a project meeting was held in Cassis, France, organised by LIF. Altogether 29 persons attended this meeting.
- On June 19 the first review meeting took place in Brussels.
- On September 18-19, a project meeting was held in Aalborg, Denmark, organised by AAU. This meeting was attended by 25 persons.

The agendas and (most of) the slides for the above meetings are available on-line at <http://ametist.cs.utwente.nl/INTERNAL/MEETINGS/Meetings.htm>.

Oded Maler and used AMETIST funds for travelling to Carnegie-Melon university at Pittsburgh during the summer. In addition, many other mutual research visits, and visits to conferences in order to present AMETIST papers were supported by the project.

## 5 List of Deliverables

No	Description	Due Date	Delivery	Status	Resp Partner
<b>4.4</b>	AMETIST Website	May 02	May 02	accepted	UT, all
<b>0.1.1</b>	Project Rep. - Progress & Evaluation	Oct 02	Nov 02	accepted	KUN, all
<b>3.1.1</b>	Case Study 1: Prel. Description	Oct 02	May 02	accepted	LIF, CYR
<b>3.2.1</b>	Case Study 2: Prel. Description	Oct 02	Apr 02	accepted	AAU, Terma
<b>3.3.1</b>	Case Study 3: Prel. Description	Oct 02	Sep 02	accepted	Uni DO, Bosch
<b>3.4.1</b>	Case Study 4: Prel. Description	Oct 02	Oct 02	accepted	Uni DO, Axxom
<b>4</b>	Dissemination and Use Plan	Oct 02	Oct 02	accepted with qualifications	VERIMAG, all
<b>4.1.1</b>	AMETIST Workshop	Oct 02	Apr 02	accepted	VERIMAG
<b>0.1.2</b>	Project Rep. - Progress & Evaluation	Apr 03	Jun 03	accepted	KUN, all
<b>0.2.1</b>	Framework Report (v1)	Apr 03	Jun 03	accepted	VERIMAG, all
<b>0.3.1</b>	Financial Review	Apr 03	Jun 03	accepted	KUN, all
<b>1.5</b>	Modeling: Controller Synthesis	Apr 03	Apr 03	accepted	VERIMAG
<b>2.3.a</b>	A & T: State Space Representations	Apr 03	Jun 03	accepted	LIF
<b>3.1.2</b>	Case Study 1: Model	Apr 03	Jun 03	accepted	LIF, CYR
<b>3.2.2</b>	Case Study 2: Model	Apr 03	May 03	accepted	AAU, Terma
<b>3.3.2</b>	Case Study 3: Model	Apr 03	Jun 03	accepted	Uni DO, Bosch
<b>3.4.2</b>	Case Study 4: Model	Apr 03	Jun 03	accepted	Uni DO, Axxom
<b>3.5.1</b>	Misc. Case Studies: First Year Report	Apr 03	May 03	accepted	UT, all CRs
0.1.3	Project Rep. - Progress & Evaluation	Oct 03	Apr 04	draft	KUN, all
0.1.4	Mid Term Assessment Report	Apr 04	-	-	KUN, all
0.2.2	Framework Report (v2)	Apr 04	-	-	VERIMAG, all
0.3.2	Financial Review	Apr 04	-	-	KUN, all
1.2	Modelling: Model Composition	Apr 04	-	-	KUN
1.3	Modelling: Quantitative Modelling	Apr 04	-	-	UT
1.4	Modelling: Scheduling and Planning	Apr 04	-	-	Uni DO
2.1.1	A & T: Abstraction and Compositionality	Apr 04	-	-	KUN
2.2.1	A & T: Control Synthesis Algorithms	Apr 04	-	-	VERIMAG
2.3.b	A & T: State Space Representations (v2)	Apr 04	-	-	LIF
2.4.a	A & T: Stochastic Analysis (v1)	Apr 04	-	-	UT
2.5.a	A & T: Tool Interaction (v1)	Apr 04	-	-	AAU
3.1.3	Case Study 1: Optimisation	Apr 04	-	-	LIF, CYR
3.2.3	Case Study 2: Optimisation	Apr 04	-	-	AAU, Terma
3.3.3	Case Study 3: Optimisation	Apr 04	-	-	Uni DO, Bosch
3.4.3	Case Study 4: Optimisation	Apr 04	-	-	Uni DO, Axxom
3.5.2	Misc. Case Studies: Second Year Report	Apr 04	-	-	UT, all CRs
0.1.5	Project Rep. - Progress & Evaluation	Oct 04	-	-	KUN, all
0.1.6	Final Project Rep. - Progress & Evaluation	Apr 05	-	-	KUN, all
0.2.3	Framework Report (final)	Apr 05	-	-	VERIMAG, all
0.3.3	Financial Review	Apr 05	-	-	KUN, all
1.1	Modelling: Model Classification	Apr 05	-	-	VERIMAG
2.1.2	A & T: Structure Exploitation	Apr 05	-	-	KUN
2.2.2	A & T: Scheduling and Planning Algorithms	Apr 05	-	-	VERIMAG
2.3.c	A & T: State Space Representations (v3)	Apr 05	-	-	LIF
2.4.b	A & T: Stochastic Analysis (v2)	Apr 05	-	-	UT
2.5.b	A & T: Tool Interaction (v2)	Apr 05	-	-	AAU
3.1.4	Case Study 1: Final Report	Apr 05	-	-	LIF, CYR
3.2.4	Case Study 2: Final Report	Apr 05	-	-	AAU, Terma
3.3.4	Case Study 3: Final Report	Apr 05	-	-	Uni DO, Bosch
3.4.4	Case Study 4: Final Report	Apr 05	-	-	Uni DO, Axxom
3.5.3	Misc. Case Studies: Final Report	Apr 05	-	-	UT, all CRs
4.1.2	AMETIST Conference	Apr 05	-	-	VERIMAG

## 6 Scientific and Technical Performance

During the reporting period the scientific and technical work in the project proceeded as planned. A detailed description of the work done will be presented in Deliverable 0.1.4.

## 7 Exploitation and Dissemination

The AMETIST exploitation plan is described in Section 8.2 of the Technical Annex. No changes were made to this plan during the reporting period. The plan lists three main instruments for industrial exploitation:

1. Direct interaction with industrial partners.
2. Integrating framework and tool interaction.
3. End user panel.

During the first year of the project we mainly concentrated on the first item. The academic partners in AMETIST were really committed to demonstrate the usefulness of their automata based methodology on the four industrial case studies and were quite successful in achieving this. We certainly obtained increased awareness and understanding of the potential of the AMETIST technology for the industrial partners.

Some progress was made towards an integrated framework and tool interaction, but these issues will become more prominent in the second half of the project.

After the summer, an end-user-panel has been composed. The AMETIST project views the end-user-panel as an important means for interaction with the industry at large. The panel serves both as a dissemination channel for the project results and as a provider of feed-back on the development of the project. Panel members participate in discussions on future directions within the project and are kept informed about the developments as well as the technological perspective of the work.

The panel consists of representatives of companies that have expressed an interest in AMETIST and have committed to participate in the yearly panel meetings. In principle, this panel is an open forum and it is intended to attract more participants in the course of the project. Currently, eight companies and research labs participate in our panel:

- ASML (Rick van Lierop and Barend van de Nieuwelaar), Veldhoven, [www.asml.com](http://www.asml.com)
- Philips Research (Lex Heerink), Eindhoven, [www.philips.com](http://www.philips.com)
- National Aerospace Laboratory NLR (Ernst Kessler), Amsterdam, [www.nlr.nl](http://www.nlr.nl)
- Thales Naval (Ronald Lutje Spelberg), Hengelo, [www.thales-naval.nl](http://www.thales-naval.nl)
- BMW AG (Heinz Treseler), Muenchen, [www.bmw.com](http://www.bmw.com)
- Kern Delta Systems (Mr Eberhard), Aachen, [www.delta-systems.de](http://www.delta-systems.de)
- Degussa AG (Markus Schulz), Hanau, [www.degussa.com](http://www.degussa.com)
- Carmen Consulting (Niklas Kohl), Copenhagen, [www.carmenconsulting.com](http://www.carmenconsulting.com)

The AMETIST project was one of the main initiators and sponsors of the First International Workshop on Formal Modeling and Analysis of Timed Systems (FORMATS 2003) held as satellite event of CONCUR 2003 in Marseille, France, September 6-7, 2003. FORMATS and CONCUR were hosted by the *Université de Provence* and the *Laboratoire d'Informatique Fondamentale de Marseille (LIF)*.



FORMATS is a new workshop aimed to be a major annual event dedicated to the study of Timed Systems, uniting three independently started workshop series related to the topic: MTCS (held as satellite event of CONCUR'00-02), RT-TOOLS (held as satellite event of CONCUR'01 and FLoC'02) and TPTS (at ETAPS'02), with a total in 2002 of around 100 individual participants.

The AMETIST consortium plans to establish this workshop as a major vehicle for advancing a unified timing technology. To increase visibility, the proceedings will be published in the Lecture Notes in Computer Science series of Springer-Verlag.

Of the 36 papers submitted to the first FORMATS workshop, 19 were selected for presentation and publication. In addition to these contributions, invited talks were given by Evgeny Asarin (VERIMAG, France), Paul Pettersen (University of Uppsala, Sweden) and Reinhard Wilhelm (University of Saarbrücken, Germany).

In addition to this workshop, dissemination will be pursued through other channels including submissions to existing conferences (CAV, TACAS, EMSOFT) and collaboration with other related European and American project and initiatives such as ARTIST, CC, OMEGA, MOBIES and CHESS. During the reporting period, a formal collaboration was set up between AMETIST and the EU-IST project Hybride focusing on the compositional specification and analysis of real-time stochastic systems.

## 8 Management, Co-ordination, Resources

There are no deviations from the plan for any of the partners or any of the workpackages during the reporting period. A detailed overview of activities/issues, effort consumption, etc will be presented in Deliverable 0.1.4.