IST-004527 ARTIST2
Network of Excellence
on Embedded Systems Design

Periodic Activity Report for Year 3

Executive Summary

Joseph Sifakis – Artist2 Scientific Coordinator
Bruno Bouyssounouse – Artist2 Technical Coordinator

Artist2 Consortium

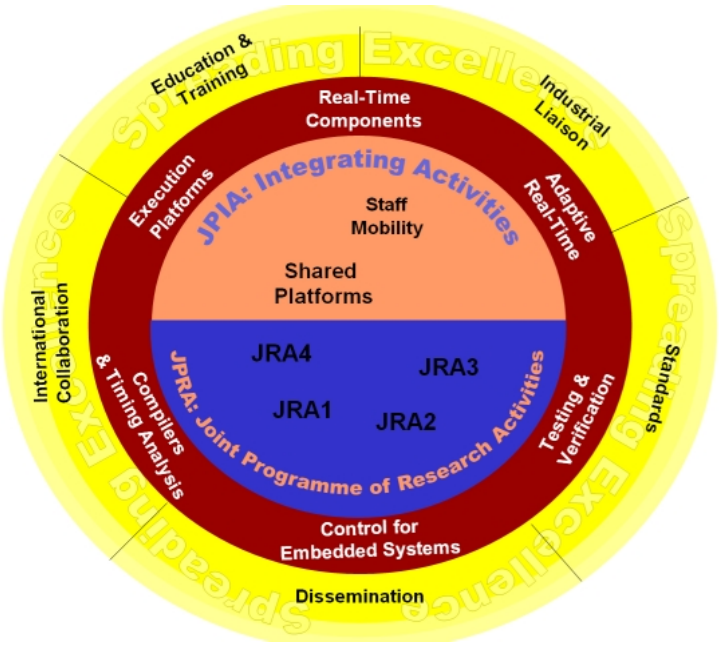
1. Project Objectives

These objectives have remained in place since the start of the Artist2 NoE.

The strategic objective of the ARTIST2 Network of Excellence is to strengthen European research in Embedded Systems Design, and promote the emergence of this new multi-disciplinary area. We gather together the best European teams from the composing disciplines, and will work to forge a scientific community. Integration will be achieved around a Joint Programme of Activities, aiming to create critical mass from the selected European teams.

The ARTIST2 Network of Excellence on Embedded Systems Design implements an international and interdisciplinary fusion of effort to create a unique European virtual centre of excellence on Embedded Systems Design. This interdisciplinary effort in research is mandatory to establish Embedded Systems Design as a discipline, combining competencies from electrical engineering, computer science, applied mathematics, and control theory. The ambition is to compete on the same level as equivalent centres in the USA (Berkeley, Stanford, MIT, Carnegie Mellon), for both the production and transfer of knowledge and competencies, and for the impact on industrial innovation.

ARTIST2 has a double core, consisting of leading-edge research in embedded systems design issues (described later in this document) in the Joint Programme of Research Activities (JPRA), and complementary activities around shared platforms and staff mobility in the Joint Programme of Integration Activities (JPIA).



Building the embedded systems design scientific community is an ambitious programme. To succeed, ARTIST2 builds on the achievements and experience from the ARTIST1 FP5 Accompanying Measure on Advanced Real-Time Systems. ARTIST1 provided the opportunity to test the concept of a two-level integration (within and between clusters) – four clusters in ARTIST2 originated as “actions” in ARTIST1. Building the ARTIST2 consortium and associated structure is the culmination of discussions and ambitions elaborated within ARTIST1.

ARTIST2 addresses the full range of challenges related to Embedded Systems Design, covering all aspects, ranging from theory through to applications.

2. Contact Details and Contractors Involved

2.1 Core Partners

For a complete description including web links, see:
http://www.artist-embedded.org/artist/-Core-Partners-.html

Scientific Coordinator:	Technical Coordinator:
Joseph Sifakis	Bruno Bouyssounouse
Tel: +33 4 56 52 03 51	Tel: +33 4 56 52 03 68
Joseph.Sifakis@imag.fr	Bruno.Bouyssounouse@imag.fr
Mailing address: Verimag Laboratory - Centre Equation - 2, ave de Vignate - 38610 Gières - France	

Partic N°	Participant name	Country
1	Caisse des Dépots et Consignations	France
2	UJF / Verimag	France
3	RWTH Aachen	Germany
4	BRICS – Aalborg University	Denmark
5	AbsInt GmbH	Germany
6	University of Aveiro	Portugal
7	Universidad de Cantabria	Spain
8	Commissariat à l'Énergie Atomique – Laboratoire LIST	France
9	CFV, Université de Liège	Belgium
10	Czech Technical University	Czech Rep.
11	Dortmund University	Germany
12	Technical University of Denmark	Denmark
13	Swiss Federal Institute of Technology – Zurich	Switzerland
14	France Telecom R&D	France
15	Institut National de Recherche en Informatique et Automatique	France
16	Royal Institute of Technology (KTH)	Sweden
17	Linköping University	Sweden
18	CNRS / Laboratoire LSV	France
19	Lund University (Sweden)	Sweden
20	University of Mälardalen	Sweden

Partic N°	Participant name	Country
21	Kuratorium OFFIS e. V.	Germany
22	PARADES	Italy
24	Universidad Politecnica de Madrid	Spain
25	Saarland University	Germany
27	TU of Eindhoven	Netherlands
28	TU of Vienna	Austria
29	TU Braunschweig	Germany
30	University of Twente	Netherlands
31	University of Bologna	Italy
32	Uppsala University	Sweden
33	Universidad Polytecnica de Valencia	Spain
34	University of York	UK
35	Polytechnic Institute of Porto	Portugal
36	EPFL	Switzerland
37	Scuola Sant'Anna – Pisa	Italy
38	Ace	Netherlands
39	Tidorum	Finland
40	TU Kaiserslautern	Germany
41	TU Berlin	Germany

The following partners have withdrawn from the NoE:

- Partner 23 – University of Pavia (Italy)
- Partner 26 – ST Microelectronics, Central R&D (France)

2.2 Affiliated Partners

Affiliated partners play a very strong role in the Spreading Excellence from the core partners to the research and industrial communities at large.

Affiliated partners generally play an active role in the research activities, either participating directly in research, or transferring the results directly to industry.

Each of the JPRA and JPIA activities' deliverables provides the list of the corresponding affiliated partners and roles.

Affiliated Industrial Partners

The complete set of Affiliated Industrial partners, including web links, is available online, here: http://www.artist-embedded.org/artist/-Affiliated-Industrial-Partners-.html

Christer Norström Göran Arinder	ABB	Peter Mårtensson	NOKIA Connecting People
David Lesens	EADS Astrium Space (EADS)	Dirk Ziegenbein	BOSCH Robert Bosch AG
Thomas Thurner Matthias Grochtmann	DaimlerChrysler	Sven Holme Sørensen	SIEMENS
Dr Joachim Stroop	dSPACE	Roberto Zafalon	ST
Alain Ourghanlian	EDF Electricité de France	Dr. Kai Richter	SYMTA VISION
Jan Lindblad	ENEA	Thomas Hune	TERMA
Johan Eker	ERICSSON	Dominique Potier, Philippe Kajfasz	THALES

Philippe Baufreton

Vladimir Havlena

Dr. Michael Winokur

Dr. Matthias Gries

Intel Gmbh

Peter Mårtensson

Maquet Critical Care

Fabian Wolf

Magnus Hellring

Magnus Hellring

Jakob Axelsson

Affiliated SME Partners

Alan Moore

Dr. Monica Donno

Joachim Stroop

Jan Lindblad

Bernard Dion

Paolo Gai

Carl von Platen

António Garrido

Fernando Santos

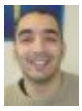
Affiliated Academic Partners

Prof. Ahmed Bouajjani
LIAFA - Université Paris 7 & CNRS UMR 7089
Tel: +33 (0) 1 4427 7819


Dr. Frédéric Boulanger
Ecole supérieure d'électricité (Supélec), Computer Science Department
Component-Based Design of Heterogeneous Systems
Tel: +33 1 69 85 14 84


Prof. Lubos Brim
Masaryk University Brno
Tel: +420 549 493 647

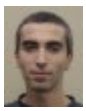

Prof. Dr. Dr. h.c. Manfred Broy
TU München
Tel: +49 89 289-17304


Ass. Prof. Salvatore Carta
Università degli Studi di Cagliari
Tel: +39 070-675-8780


Dr. Francky Catthoor
IMEC
Tel: +32 16 281202


Prof. Lucia Lo Bello
University of Catania
Tel: +39 095 7382386


Prof. Dr. Miroslaw Malek
Humboldt University Berlin
Tel: +49 30 2093 3027


Dr. Pau Martí Colom
Universitat Politècnica de Catalunya
Tel: +34 93 401 1679

Dr. Fabio Martinelli
Istituto di Informatica e Telematica
National Research Council C.N.R.
Tel: +39.050.315.3425


Dr. Marius Minea
Timisoara - Institute e-Austria Timisoara
Tel: +40-256-403284


Associate Prof. Laurent Pautet
ENST
Tel: +33 1-45-81-73-22

Prof. Geert Deconinck

Katholieke Universiteit Leuven

Tel: +32 16 32.11.26

Prof. Giovanni DeMicheli

EPFL Lausanne

Tel: (+41 21) 693-0911

Prof. Ivo De Lotto

Università degli studi di Pavia
Team leader

Tel: +39 0382 98 53 57

Prof. Dr. Ed Deprettere

Leiden University

Tel: +31 (0)71 5275776

Prof. Luca Fanucci

University of Pisa

Prof. Dr. Marisol Garcia-Valls

Universidad Carlos III de Madrid

Tel: +34 91-624-8783

Julián Proenza

University of the Balearic Islands

Tel: (+34) 971 17 29 92

Dr. Isabelle Puaut

IRISA

Tel: +33 02 99 84 73 10

Michael Rusinowitch

INRIA
Formal methods on embedded systems – in particular on verification of security properties.

Tel: +33 03 83 59 30 20

Prof. Pablo Pedro Sanchez

Universidad de Cantabria
Design and Implementation of Embedded H/S Systems

Tel: +34 942 201548

Dr. Markus Schordan

TU Vienna

Prof. Donatella Sciuto

Politecnico di Milano

Tel: +39-02-2399 3662

 Prof. José Maria Giron-Sierra

University Complutense of Madrid

Tel: +34913944387

 Prof. Axel Jantsch

Royal Institute of Technology (KTH)

Tel: +46 8 790 4124; +46 70 713 7428

 Prof. Christoph Kirsch

University of Salzburg

Tel: +43 (0) 662 8044-6328

 Prof. Stefan Kowalewski

RWTH Aachen

Tel: +49 241 80 21150

 Prof. Andreas Krall

TU Vienna

 Prof. Luciano Lavagno

Politecnico di Torino

Tel: +39-011-5644150

 Prof. Johan Lilius

Åbo Akademi University

 Ass. Prof. Dimitrios Soudris

Democritus University of Thrace

Tel: +30 25410 79557

 Prof. Neeraj Suri

TU Darmstadt

Tel: +49 6151 16 3513

 Prof. Dr.-Ing. Jürgen Teich

University of Erlangen-Nuremberg
Design Methodology for Embedded Systems

Tel: +49 9131 85 25150

 Dr. ir. Jan Tretmans

University of Nijmegen

Tel: +31 24 365 2069

 Prof. Pierre Verbaeten

Katholieke Universiteit Leuven

Tel: +32 (0)16 32 75 66

 Prof. Eugenio Villar

Universidad de Cantabria
Design and Implementation of Embedded H/S Systems

Tel: +34 942 201398

Tel: +358-40-544 0741	

Affiliated International Collaboration Partners

Prof. Tarek Abdelzaher

University of Illinos at Urbana-Champaign
Technical expert

Tel: +1 217 265-6793

Prof. Zhou Chaochen

Chinese Academy of Sciences

Prof. Giovanni De Micheli

EPF Lausanne

Tel: +41 21 693-0911

Assoc. Prof. Stephen A. Edwards

Columbia University

Tel: +1 212 939 7019

Prof. Sharon Hu

University of Notre Dame - Indiana USA
Design for Low Power

Tel: +1 574 631-6015

Shankar Sastry

Berkeley University

Tel: +1 (510) 643-2200

Prof. Heinz Schmidt

Monash University (Australia)

Tel: +61 3 9905-2479

Prof. Lui Sha

University of Illinos at Urbana-Champaign
Technical expert.

Tel: +1 244-1887

Assoc. Prof. Mircea R. Stan

University of Virginia
Power and thermal modeling at the device, circuit and system level.
Self-consistent power modeling by taking into account thermal effects.
Temperature-aware circuit design.
Automotive computing applications.
Participates in the activity on Design for Low Power.

Tel: +1 434 924 3503

Prof. Mathai Joseph

Tata Research Development & Design Centre (TRDDC)

Prof. Edward A. Lee

UC Berkeley

Tel: +1-510-642-0253

Prof. Xiaojian Liu

Zhiming Liu

UNU-IIST Macau
Co-organiser of the Artist2 / UNU-IIST School in China - 2007

Tel: +853 712930

Prof. Kang Shin

University of Michigan

Tel: +1 (734) 763-0391

Prof. John Stankovic

University of Virginia

Tel: +1 (434) 982-2275

Prof. Janos Sztipanovits

Vanderbilt University USA

Tel: +1 615-343-7572

Prof. P.S. Thiagarajan

National University of Singapore

Tel: (65) 6516 7998

3. Vision and Assessment of the Work Performed

Artist2 finances durable integration between teams and not the concrete elements of the JPA which most often belong to other projects. These specific technical objectives may or may not be attained (this is the essence of research as opposed to development), but we feel that the main product of Artist2 is the emergence of a lasting European research community, that has a significantly enhanced capacity for preparing Europe's future.

The research is completed by work on the JPIA Platforms, which aim to transform research results in tangible tools and components.

We believe that the topics chosen provide a good coverage of the area, for embedded software and systems.

The ARTIST2 NoE is a complex construction assembled from world-leading communities, teams, and individuals. This is certainly an asset, but also a source of complexity in management. Each team has two essential characteristics: world-class excellence and strong interaction with top industrial players. Artist2 partners play a leading role in the different communities in embedded systems design, and they advance the state of the art in each of these.

Over the course of Years 1-3, Artist2 has been extremely active in submitting new proposals

It is difficult to abstract out a global synthesis of the overall technical achievements. This is due to the diversity and the low granularity of the actions to be covered (meetings, publications, attendance at workshops, visits, platforms).

The following is a certainly non-exhaustive assessment of the work in the Joint Programme of Activities' 4 main branches.

3.1 Joint Programme of Research Activities (JPRA)

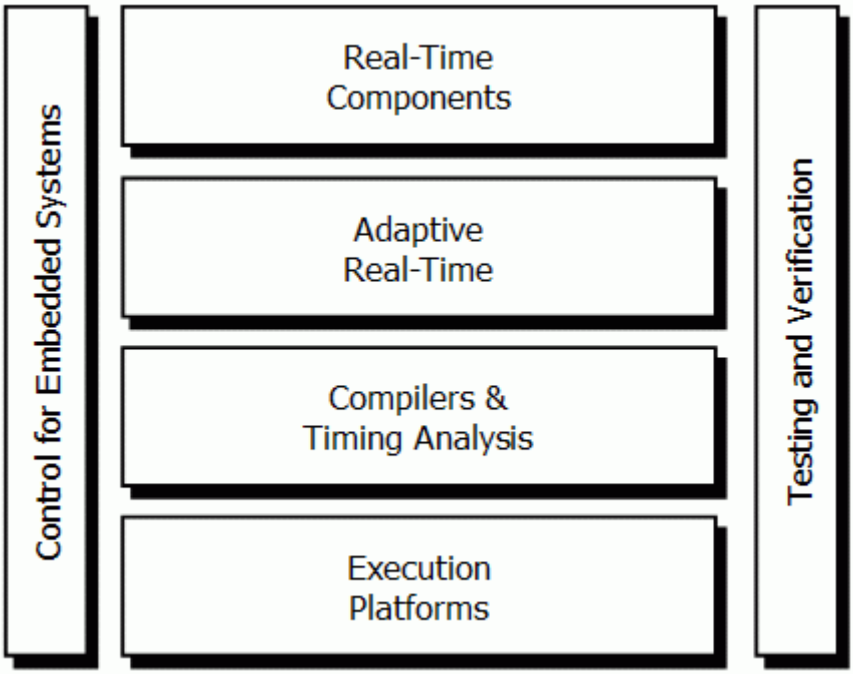
3.1.1 Structure of the Research Effort

The JPRA is composed of intra and inter-cluster research activities on cutting-edge topics in embedded systems design. While the main bulk of financing for these activities is taken up by outside programmes (Integrated Projects, National Programmes, Industrial Contracts, etc), the Artist2 NoE finances the extra burden due derived from integrating these into a single coherent research programme.

Thus, the essential ingredient within Artist2 is the JPRA, which motivates the participating research teams far more than the actual financing, which is tiny in comparison with the overall research aims. It is completed by the Joint Programme of Integrating Activities (JPIA), and the Joint Programme of Activities for Spreading Excellence (JPASE), and overseen by the Joint Programme of Management Activities (JPMA).

The structure of the research activities reflects the following decomposition of the embedded systems design flow.

This design flow is composed of the following cooperating activities, starting with component-based modelling and leading to implementation. These activities must be well coordinated, and supported by tools and methods to ensure satisfactory levels of productivity and quality. Accordingly, we have structured the area of embedded systems design into the following topics.



Real-Time Components: The development of a general framework for component-based engineering of complex heterogeneous embedded systems is a grand challenge which spans many research problems. A key characteristic of component-based embedded systems is heterogeneity of component models. This heterogeneity concerns different execution models (synchronous, asynchronous, vs. timed), communication models (synchronous vs. asynchronous), as well as different scheduling paradigms. Technology must be provided to allow designing heterogeneous embedded systems from diverse types of components, and allow predicting and optimizing functional and non-functional properties of the designed systems.

Adaptive Real-time: This is a more recent approach to embedded systems design, where temporal constraints can be relaxed, which allows optimized use of resources. This includes applications – where managing the Quality of Service (QoS) is essential, such as telecommunication systems, multi-media, and wide-area networked applications. In this relatively new area, there is a recognized lack of design theory and tools.

Compilers and Timing Analysis: Once the application software has been developed, using the above, the system must be implemented on a given target platform. Compilation tools and their associated technologies play a fundamental role for automating this process. For the implementation of embedded systems, we need tools capable of combining platform independent software and a description of the target platform, to generate an executable code having the desired properties related to use of such resources as memory, power, energy, network bandwidth, and computation time). Resource-aware compilation requires the use of Timing Analysis tools to estimate the execution times of embedded software on a given platform.

Execution Platforms: This topic is strongly linked to the compilation and implementation of embedded systems. For a given application, it is important to have the technology, methods and tools to make rational choices about the platform and the design used, before proceeding to final implementation. Research in Execution Platforms targets the development of the theoretical and practical tools for modelling the dynamic behaviour of application software for a given platform. This is a new area of research, which will allow greater flexibility in designing optimal embedded systems.

Testing and Verification: This is transversal topic, which interacts with all the other topics in embedded systems design. It aims to ensure that the different design steps meet given properties, as well as the overall correctness of the implementation. This is a very active research topic, with results at different levels of the design process. The current challenge is in achieving on overall approach for testing and verification, focussing on two important aspects.

First is the Verification and Testing of real-time properties, to ensure that hard real-time constraints or quality of service constraints are met. Second is for Verification of Security Properties, where identification of gaps in security is desired.

Control for Embedded Systems: Embedded systems are deployed in the real world, and are often reactive to it. This interaction with the environment is intrinsic to the service provided. A large proportion of embedded systems can be considered to be controllers. On the other hand, most automated control applications will be implemented as embedded components. Thus, it is essential that work on joining control theory and embedded systems be included in the ARTIST2 NoE.

3.1.2 *Overview of the Year3 Research Results*

An overview of each intra-cluster ("Cluster Integration") and inter-cluster ("NoE Integration") research activities is provided.

3.1.2.1 Real Time Components

Following the decisions at the review in November 2006, the activities of the clusters was changed: the two activities *Forums with specific industrial sectors* and *Seeding new research directions* were replaced by the activity *Component-Based Design of Heterogeneous Systems.* This restructuring was very beneficial in that it better emphasized on continuous longer-term research lines in the cluster, and the view that workshops and seminars are a means to support them.

We have seen a strong degree of integration on Component-based Design, between teams at INRIA, OFFIS, PARADES and VERIMAG, through the active participation of the SPEEDS IP project, and subsequently the COMBEST STREP project.

A further sign of integration is the work for the development of the MARTE standard, that takes into account results from teams in the cluster.

The cluster has organised two successful workshops, in collaboration with the Testing and Verification and the Control clusters. The first one took place at DATE 2007 and the second at CAV 2007.

The cluster has produced joint publications on significant research results, in particular regarding fundamental problems in Component-based Design (work by EPFL, Verimag, as well as INRIA, PARADES, VERIMAG).

3.1.2.2 Adaptive Real Time

During this third year of work, all the partners actively contributed to the progress of the research activities planned by the cluster. Affiliated partners also gave a substantial contribution by attending meetings, workshops, by participating in joint publications and by exchanging human resources.

A tangible sign of progressing integration is the emergence of new projects focusing on Adaptive Real Time, in collaboration with other clusters.

The ART cluster has contributed to creating the necessary critical mass to set up the FRESCOR EU project that started in June 2006 and coordinated by University of Cantabria. Many of the ART partners involved in the activity on flexible scheduling are also partners of the project. This is an excellent situation in which the FRESCOR project can benefit from the ARTIST2 NoE expertise, and the network can benefit from being able to influence the project, and from being able to exploit its results.

Other two consortia were formed thanks to the ARTIST2 network, which made two project proposals that are still in phase of preparation, PREDATOR (coordintated by University of Saarlandes) and QUAEST (coordintated by Philips Research), both involving several members of the network.

A new activity on real-time languages (led by Universtity of York) was started and a series of workshops and meetings were organized. This is proving a successful way of coordinating a broad base of research on different languages taking place at a number of institutions.

The work on networks has reached significant results, regarding evolution of the Flexible Time Triggered (FTT) framework, as well as the design, analysis and implementation of protocols, mechanisms and paradignms for wireless sensor networks (WSN).

3.1.2.3 Compilers and Timing Analysis

The work on defining the ARTIST Interchange Representation (AIR), despite some delays, federates all the teams that work on Timing Analysis.

Dortmund's cooperation with AbsInt and the Universities of Bologna and Linköping exceeds expectations. The cooperation with the IMEC meets expectations. Future opportunities include a commercialization of some of the results, for example through the technology transfer center ICD, located at Dortmund and headed by Peter Marwedel.

The organization of the SCOPES 2007 Workshop on Software and Compilers for Embedded Systems by Dortmund University supported by Artist2 led to the publication of 12 papers of very high quality.

The collaboration between Dortmund University and IMEC vzw has produced tangible results, on the definition of a common roadmap on research for MPSoC memory management.

The work revolving around the CoSy platform, mainly involving partners ACE, Aachen, and Berlin can be regarded very successful. The cooperation has led to various student exchanges, joint master theses, papers, public demonstrations and SW prototypes.

3.1.2.4 Execution Platforms

There has been substantial progress in integrating different research directions and view points. Indicators that show this clearly are (a) the joint participation in summer schools, workshops and tutorials and (b) the number and quality of joint publications, and (c) the integration of tools.

The cluster report provides an impressive and detailed list of interactions, between the cluster partners, and the associated results.

This cluster plays a pivotal role for overall integration within the NoE. In particular, it participates in 2 main STREP projects: COMBEST (with the Real Time Components cluster), and PREDATOR (with the Timing Analysis and Compilers cluster).

3.1.2.5 Control for Embedded Systems

The integration within the cluster has continued to progress nicely also during this year. The amount of joint research and publications continues to be high, although not as high as during last year.

The excellence building within the cluster has also progressed according to plans. The main examples are our graduate schools, the international workshop, and the different presentation at ARTIST2 events given by members of the cluster. The PhD student mobility between the partners in still low. A major reason for this is that by now the different partners know each others work so well that it is no longer necessary to meet physically in order to continue the collaboration.

3.1.2.6 Testing and Verification

Each research activity within the cluster has successfully pursued the research goals. As last year the cluster integration activities within *Quantitative Testing and Verification* and *Verification of Security Properties* have been particularly active. This is most clearly demonstrated by the (very) extensive lists of publications at leading scientific conferences and journals, thus demonstrating true excellence within the area.

Work on Quantitative Testing and Verification has been excellent. It also provides the theoretical foundation for the development of methods and tools implemented in the *Testing*

and Verification Platform. Within this activity the objectives related to the individual tools, their advancement and dissemination has been fully accomplished.

The objective of designing a joint infrastructure for a European Verification Grid has not been pursued during this third year: the main people involved in setting up the Verification Grid are currently occupied by building up the infrastructure for general high performance computing on grids with natural science applications in mind.

3.1.2.7 Inter-cluster Integration

The planned NoE Integration activities have led to the following results:

- **QoS Aware Components**: Collaboration between the members of this activity has helped to enrich the views and approaches of the topics, in particular through meetings in the context of the OMG. A PhD student of UPM visited THALES for three months, in order to perform the modelling and analysis of the safety properties of the ATM architecture. Resources for collaboration have been obtained through new projects, such as e-MAGERIT (UPM and UC3M) or Inflexion (THALES and CEA-LIST).

  The Artist2 partners have played a central role in the organisation of three international workshops on QoS-Aware components, and the MARTE standard.

- **Resource-aware Design**: There have been several strong interactions between the participants. These are also attested by many joint publications.

  The activities of Bologna have required interaction with Aachen and Dortmund. Interaction with Aachen was required on the use of the LISATek tools both for behavioural description and for RTL generation of the VLIW processors. Students from Bologna and Aachen met at the DATE conference and discussed technical issues.

  Bologna and Dortmund have discussed compiler architecture and the two-step compilation approach (source-to-source parallelization followed by code generation). based on previous experience in Dortmund, they agreed to using a similar approach for memory-aware compilation.

  ETH Zurich has given a PhD course at DTU on formal methods for embedded systems, especially for resource-aware design. In addition, there was much interaction during the workshops organized and co-organized by ETH Zurich.

- **Adaptive Real-time, HRT and Control**: There have been numerous collaborations between the partners in the activity and with several affiliated partners.

  Joint research has been carried out to integrate feedback control schemes into the Shark operating system (used as a shared platform) and to investigate the effects of different scheduling policies on delays and jitter in control loops. There has been close collaboration to investigate research issues that can have a significant impact on the embedded community.

  The teams were also quite active in disseminating the results through workshops, scientific publications and summer schools, such as the “First European Laboratory on Real-Time and Control for Embedded Systems”, in Pisa, June 10-14 2006.

- **Quantitative Testing and Verification**: There have been intense exchanges between the partners, including visits of researchers, Post-Docs, and PhD students. This has led to many joint publications, and contributions to schools and workshops through invited presentations. In particular, the activity has played a leading role in setting up the ARTIST2 Winter School MOTIVES in Trento, February 2007.

In addition to the NoE Integration activities planned in the JPA (above), we can mention the following:

- Spontaneous collaboration between clusters on **Real-Time Components** has led several interactions and to several workshops (e.g.: Leiden Workshop, Y4 workshop on the Foundations and Applications of Component-based Design (http://www.artist-embedded.org/artist/-Foundations-and-Applications-of-.html)
- The University of Saarland (**Timing Analysis**) has started cooperation about Design for Predictability – new theme in the area - with partners in the **Execution Platforms** cluster, ETHZ, Bologna, and Dortmund.
- The University of Bologna and teams outside Artist2 such as TU Karlsruhe, U Edinburgh, and TU Dresden have adopted the proposed **compiler platform**. Links to other communities (e.g. compiler researchers in the HiPEAC NoE) have been strengthened.

3.2 Joint Programme of Integration Activities (JPIA)

3.2.1 Structure of the Integration Effort

The Joint Programme of Integrating Activities contains the technical but non-research activities that participate in the overall effort. As with the JPRA, the main financing for these technical activities is derived from other sources, and is small in comparison with the overall objectives.

The JPIA is composed of Platform Activities (roughly one for each cluster), and Mobility actions between partners – both core and affiliated partners.

Integration between research teams work to achieve critical mass in 2 important dimensions:

- Strong integration within selected topics by assembling the best European teams, to advance the state of the art in the topic.
- Integration between topics to achieve the multi-disciplinary excellence and skills required for the development of future embedded technologies.

The ARTIST2 platforms integrate the results of long-term efforts, and are meant to be durable, evolving with the state of the art. The partners are committed to durability, and have invested significant resources into their development. The construction of ARTIST2 has provided the opportunity to assemble existing pieces into a rationally-structured set of platforms, covering the area of embedded systems design.

Some of the ARTIST2 platforms have international visibility, and the ambition is for these to serve as world-wide references in their respective topics.

Both types of integration are achieved through Joint Programme of Integration Activities (JPIA) activities involving:

- Sharing Research Platforms, Tools, and Facilities
  State of the art research platforms, composed of competencies, resources, and tools targeting specific technical and scientific objectives around a chosen topic. These are made available to the R&D community for experimentation, demonstration, evaluation, and teaching.
- Staff Mobility and Exchanges
  Staff mobility actions continue to play an important part of integration between Artist2 partner teams. (see the “Spreading Excellence” deliverable).

This is an essential activity for integration within the NoE, including mobility of students and/or researchers, between core teams, or between core teams and affiliated teams.

Our assessment of Artist2 progress on integration over Year 3 is very positive.

3.2.2 Integration through Mobility

Mobility actions are reported on the Artist2 intranet:
http://www.artist-embedded.org/artist/-Reporting-on-Mobility-.html

3.2.3 Progress on the Platforms

The following are the main highlights from the different clusters over the course of Year 3. Naturally, the represent only a part of the total effort deployed.

3.2.3.1 Real Time Components

The problems tackled in the third year can be classified in the previously defined structure, i.e., 3 platforms dealing with specific application domains. In addition, we have initiated new collaborations. Overall achievements are in 5 topics:

1. Modelling languages and semantic frameworks and their implementations.
   The work includes both studies of semantic frameworks, and their implementation in tools for MARTE, Executable UML profiles, HRC, BIP, and Metropolis.
2. Platforms for analysis of safety critical embedded systems.
   This includes development of analysis tools, within the framework of projects OpenEmbedd, SPEEDS, and ASSERT, as well as generation of analysable models between tools.
3. Platform for the analysis of performance critical systems.
   This includes the generation of timed models from UML specifications and their performance analsysis by commercially-available tools, as well as performance evaluation of sensor networks.
4. Platform for the certification of smart-card applications.
   This supports a validation methodology that is compliant with the Common Criteria (CC) standard.
5. We have also developed validation methods and tools which are not included in the Testing and Verification platform. These are very tool-specific, and cannot be used in other contexts.

Within this topic, there is an appreciable volume of high-quality results, but there remains some dispersion, due to to the wide variety of languages and models.

3.2.3.2 Adaptive Real Time

The platform activity on Adaptive Real Time has:

- Performed extensive testing to identify algorithms and tools to support adaptive RT systems. This work has been mainly performed for specific applications developed under Shark, such as Ball balancing, Inverted pendulum, Mobile Robots, Overload management techniques, Feedback Scheduling, Cibermouse client, Video processing. Furthermore, several partners have provided teaching on using the Shark kernel.

- Participated in the evolution of RTOS standards, by introducing advanced scheduling methods for enhancing the predictability of real-time systems and handle their increased complexity. In particular, it has provided advanced features in OSEK compliant kernels.

3.2.3.3 CTA: Timing Analysis

The work deals with:

- Development of common representation formats for the various analysis tools available, such as the ARTIST Interchange Representation (AIR), ALF for Computation Semantics Representation, and SWEET. In addition, the teams have made progress on the integration of tools by using these formats.
- New analysis techniques such as the Transformation of Flow Information during Compilation, and the Generation of Common Flow Description Attributes
- Organising the WCET Challenge 2006 (Mälardalen, USaar, AbsInt, Tidorum, National University of Singapore, TU Vienna together with Christian-Albrechts University Kiel, DaimlerChrysler Research Ulm, University Duisburg-Essen, and University Stuttgart). The purpose of this Challenge was to study, compare and discuss the properties of different WCET tools and approaches, to define common metrics, and to enhance the existing WCET benchmarks.
- Applications, such as the evaluation of SWEET and aiT at Volvo CE, and WCET Analysis and Certification of Automatically Generated Code (Mälardalen, CC-Systems AB and Tidorum)

3.2.3.4 CTA: Compilers

Work has been carried out in two directions:

- Taking execution times into account in the compilation process. This includes work on Transformation of Flow Facts within Optimizations of a WCET-aware Compiler, Compile-Time Decided Instruction Cache Locking Using Worst-Case Execution Paths, Evaluating the Influence of Procedure Cloning on WCET Prediction.
- Optimization, retargeting, and verification techniques for Compilers. This includes work on SIMD & Conditional Execution Support in CoSy, Optimization and Verification in Compilers, Optimized Dynamic Memory Allocation, Automatic Source-Code Annotation.
- An External Program Representation for Tool Interoperability.

3.2.3.5 Execution Platforms

The aim is to provide a scalable and realistic modelling platform which is abstract enough to provide complete system representations and some form of functional models even for billion-transistor future systems, while at the same time providing the needed flexibility for modelling a number of different embodiments (e.g. multi-processors, homogeneous and heterogeneous, reconfigurable, etc.).

The focus for year 3 was to extend the simulation-based modeling to address issues of dynamically reconfigurable architectures, distributed embedded systems, and lab-on-a-chip, and to consolidate the the integration between the simulation models of Bolgna and DTU. For

the formal-based modeling the focus was on model integration, using timed automata models, and to extend current models to address and encompas more hardware issues.

These objectives have been achieved. Here is non-exhaustive list of the results described in detail in the platform deliverable: NoC Emulation Framework, Modeling and formal timing analysis of Multiprocessor Systems On Chip, Sensitivity Analysis and System Robustness Optimization for Complex Embedded Systems, Fault-Tolerent Process Graph Model , MOVES (Modeling and Verification of Embedded Systems), Modeling and Verification of Hardware Components, Simulation Platform for Dynamical Reconfigurable Systems, MT-ADRES (Multithreading on Coarse-Grained Reconfigurable Architecture), MPA Model Integration.

3.2.3.6 Control for Embedded Systems

Work has been carried out in the following directions:

- Development of individual tools/platforms developed by cluster partners. This includes the TrueTime simulation toolbox, and its improvement in a number of directions. TrueTime has been widely distributed and used (there are between 1,000 – 1,500 users over the course of a year, and version 1.5 has been downloaded 963 times since its release in January 2007). TrueTime has been used in the RUNES Integrated Project, in a large demonstrator involving wireless networks and autonomous mobile robots used as mobile network routers.
  Furthermore, the TORSCHE Scheduling Toolbox for Matlab has been extended, with new scheduling algorithms, and integrated with TrueTime.
- Development of an integrated environment for embedded control systems. This environment is compatible with Matlab/Simulink and compliant with HIS and AUTOSAR.
- Model-based embedded systems engineering.
  In connection to the ATESST project (www.atesst.org), KTH has been investigating model transformations between UML, Simulink and safety analysis tools: UML-Simulink, Continuous-time modelling in SysML/UML2, UML-Safety modelling and analysis. In addition, interviews and studies of industrial practices in model-based development have been carried out, especially for automotive embedded systems. This work has also been extended through workshops in conferences such as DATE and CAV.

3.2.3.7 Testing and Verification

Work has been carried out in three directions:

- Development of existing and new tools
  - IRISA has improved the STG tool (test generation for models with control and data) and it is now freely distributed.
  - UPPSALA has developed a prototype tool (named CATS) for compositional timing and performance analysis using timed automata and the real time calculus developed at EPFL.
  - AALBORG has continued its work on improving *UPPAAL* (www.uppaal.com) and its variants *UPPAAL Tron* (online testing) and *UPPAAL Tiga* (analysis and synthesis of winning strategies for timed games).
  - VERIMAG has implemented new techniques for deadlock detection in DeadlockFinder - a prototype tool that generates from BIP models sufficient conditions for deadlockfreedom.

- BRNO has put a major effort into the development of tools to support parallel verification of complex embedded systems. The DiVinE tool has been made publically available and extended by a Promela front-end for SPIN compatible distributed model checking.

- Evaluation and dessimination of tools
  A number of industrial case studies have been carried out by OFFIS, Twente, Aalborg and Uppsala. Apart from being documented via scientific papers, they are also collected and dessiminated through the open repository for Artist2 Test and Verification Case Studies (https://bugsy.grid.aau.dk/artist2).

- Investigations wrt. High-performance tool server
  Aalborg is currently installing a large (600 node) PC cluster which will be made available via NoduGrid (www.nordugrid.org). It will mainly be dedicated to scientific computing, but experiments with high-performance model checking (also parallel and distributed model checking) will be possible to a certain extent.

3.3 Joint Programme of Activities for Spreading Excellence *(JPASE)*

The achievements and results from the Joint Programme of Activities for Spreading Excellence (JPASE) is contained in a separate deliverable, entitled: "Spreading Excellence".

Our actions for Spreading Excellence are at 2 levels:

1. *Targeted towards affiliated partners*
   Affiliated partners are not core members in the consortium, but receive support for travelling to Artist2 meetings, and actively contribute to the implementation of the Joint Programme of Activities (JPA). These affiliated partners include industrial, SME, academic, and international affiliates.
2. *Targeted towards the scientific and technical community in the large*
   This is achieved mainly bottom-up through the organisation of scientific events, publications, distribution of tools and components, industrial partnerships (not funded by Artist2), education; and through the Artist2 web pages.

Regarding Scientific events, we distinguish between International Collaboration, Schools, Artist Workshops, keynotes/tutorials, Industrial Liaison, Publications.

3.3.1 International Collaboration

Here, we focus on the workshops and schools organized outside the EU, globally by the NoE.

Further International Collaboration is carried out within the clusters, as reported in the cluster–level activity reports.

First European-SouthAmerican School for Embedded Systems

August 20-24, 2007 Buenos Aires, Argentina
The purpose of the school is to foster the well-established and dynamic research cooperation in the field of embedded systems between groups in Europe and South America, by allowing South-American students (specially graduate), to meet European researchers.

Artist2 / UNU-IIST School in China - 2007

August 1-10 2007 Suzhou (near Shanghai),
ARTIST2 organized, in collaboration with UNU-IIST, the 2nd edition of a school on embedded systems design.

Artist2 - Foundations and Applications of Component-based Design

October 26th, 2006 Seoul, South Korea
The workshop gathered researchers from computer science and electrical engineering to discuss recent results on component-based design with emphasis on design frameworks for real-time systems encompassing heterogeneous composition and models of computation. Especially frameworks for handling non-functional and resource constraints, design under conflicting dependability criteria, trade-offs between average performance and predictability.

WESE'06 - Embedded Systems Education

October 26th, 2006 Seoul, Korea
This second workshop on the subject aims to bring researchers, educators, and industrial representatives together to assess needs and share design, research, and experiences in embedded systems education.

3.3.2 Organisation of Schools

In Year 3, Artist2 has directly organized and funded the schools and courses.

First European-SouthAmerican School for Embedded Systems
Artist2 / UNU-IIST School in China - 2007
See details in the International Collaboration section, above.

ARTIST2 PhD Course on: Automated Formal Methods for Embedded Systems
June 4-12, 2007 DTU - Lyngby, Denmark
Embedded systems engage into an ongoing, hardly foreseeable, interaction with their asynchronously evolving environment. This fact contributes to the intrinsic complexity of their design and validation.
http://www.artist-embedded.org/artist/ARTIST2-PhD-Course-on-Automated.html

ARTIST2 Graduate Course on Embedded Control Systems
May 7-11, 2007 Lund, Sweden
The objective of the course is to provide an overview of the main principles and technologies for supporting the development of embedded control systems.
http://www.artist-embedded.org/artist/Course-Report.html

Real-Time Microcontroller Systems: OSEK Standard and experiments on µcontroller devices
March 26-28, 2007 RETIS Laboratory, Scuola Superiore Sant'Anna, Pisa, Italy
Training course on Real-Time Systems for Microcontrollers: OSEK Standard and experiments on microcontroller devices *Organised in conjunction with Evidence Srl.*
http://www.artist-embedded.org/artist/Course-Programme.html

ARTIST2 - MOTIVES 2007
February 19-23, 2007 Trento, Italy

ARTIST2 Winter School 2007 offers foundational tutorials and lectures on exciting emerging technologies and industrial applications - given by leading scientific and industrial experts.
http://www.artist-embedded.org/artist/Overview,577.html

ARTIST2 Winter School - MOTIVES 2007
February 19-23, 2007 Trento, Italy

MOdelling, TestIng, and Verification for Embedded Systems.
ARTIST2 Winter School 2007 offers foundational tutorials and lectures on exciting emerging technologies and industrial applications - given by leading scientific and industrial experts.
http://www.artist-embedded.org/artist/Overview,577.html

3.3.3 Organisation of Workshops

In Year 3, Artist2 has directly organized and funded the following workshops.

FCC 2007 3rd Workshop on Formal and Computational Cryptography
July 4-5, 2007 Venice, Italy

ARTIST WS: Tool Platforms for ES Modelling, Analysis and Validation
July 1-2, 2007 Berlin, Germany (satellite event of CAV 2007)

2nd Int'l ARTIST Workshop on Control for Embedded Systems
May 31st - June 1st 2007 U. of Illinois, Urbana-Champaign (USA)

Towards a Systematic Approach to Embedded System Design
April 20th, 2007 Acropolis Nice, France

ARTIST2 Workshop on Basic Concepts in Mobile Embedded Systems
December 4-5, 2006 Vienna - Austria

ARTIST2 Workshop on Timing Analysis in the Industrial Development Process
November 17th, 2006 Paphos, Cyprus

MoCC - Models of Computation and Communication
November 16-17, 2006 Zurich, Switzerland

Artist2 - Foundations and Applications of Component-based Design
October 26th, 2006 Seoul, South Korea

WESE'06 - Embedded Systems Education
October 26th, 2006 Seoul, Korea

ATVA China 2006
October 23-26, 2006 Beijing, China

ATVA China 2006
October 23-26, 2006 Beijing, China

In addition, Artist2 has also partially organized and funded 15 other workshops (see the deliverable on Spreading Excellence for details).

3.3.4 Keynotes, Tutorials provided to the Embedded Systems Community

Over the course of Year 3, the Artist2 consortium has provided at least 175 keynotes, workshops, and tutorials to the embedded systems community.

Details including web links are available in the deliverable on Spreading Excellence.

3.3.5 Industrial Liaison

Artist2 has a wide array of affiliated industrial and SME partners, as described above. Most of these partners have participated in some way in the Artist2 technical meetings and the overall effort. There is strong, high-level industry participation through the various Spreading Excellence events organised by Artist2. Our active involvement in the European Technology Platform ARTEMIS also has a significant and long-term impact.

In addition, each Artist2 partner has an outstanding track record for interaction with industry. Globally, the Artist2 consortium has a very strong impact on European R&D in embedded systems, through participation in the three main Integrated Projects: DECOS, ASSERT, and RUNES. This impact is visible via the achievements in these Integrated Projects, related to time-triggered architectures and modelling and validation at the architectural level.

We believe that the strong involvement of four main Artist2 partners in the SPEEDS Integrated Project has a very positive impact on progress in the state of the art, in component-based embedded systems engineering.

A more detailed description of industrial liaison activities is provided below.

3.3.5.1 ARTEMIS ETP

Three Artist2 members are on the steering board for the ARTEMIS European Technology Platform. In this capacity, they participate in working groups for defining the overall European long term strategy in the area.

Several RTC Cluster partners, including INRIA, OFFIS, PARADES, VERIMAG; and TU Vienna, are actively involved in ARTEMIS, an initiative to form a European technology platform on embedded systems supporting the needs for various industrial and academic embedded application domains, such as the automotive, avionics, but also the real-time requirements of consumer electronics. The interaction with ARTEMIS is expected to influence the work within ARTIST2 positively towards establishing a well-defined conceptual fundament that is useful for academia and industry. Several partners (CEA, INRIA, OFFIS) are involved in EICOSE, the recently establised European Institute for COmplex and Safety Critical Embedded Systems Engineering. EICOSE has been selected as the ARTEMIS Innovation Cluster on Transportation. VERIMAG and FT R&D contribute within French MINALOGIC cluster to promote the creation of a center of excellence in ARTEMIS encompassing "Nomadic environments" and "Private space" application contexts of the ARTEMIS SRA chart. Contacts have been taken with Nokia and ElectroBit from the Finlandais Symetra Consortium

3.3.5.2 Deep Industrial Liaison through New Projects

A strong visible sign of deep and lasting interaction with inudtry is the trigerring and implementation of a several new projects, involving key members of the Artist2 research community and key industrial partners.

The following have been submitted and approved for funding in the recent FP7-ICT-2007-1 call.

- ACTORS (216586)
  Adaptivity and Control of Resources in Embedded Systems
  Duration: 36 months
  Activity: ICT-1-3.3 – Embedded systems design
  Consortium:
  - Scuola Superiore Sant'Anna (Italy)
  - Technische Universität Kaiserslautern (Germany)
  - Evidence Srl (Italy)
  - Ecole Polytechnique Fédérale de Lausanne (Switzerland)
  - Lunds Universitaet (Sweden)

- ALL-TIMES (215068)
  Integrating European Timing Analysis Technology
  Duration: 24 months
  Activity: ICT-1-3.3 – Embedded systems design
  Consortium:
  - Maelardalen University (Schweden)
  - AbsInt Angewandte Informatik GmbH (Germany)
  - Technische Universität Wien (Austria)
  - Symtavision GmbH (Germany)

- COMBEST (215543)
  COMponent-Based Embedded Systems design Techniques
  Duration: 36 months
  Activity: ICT-1-3.3 – Embedded systems design
  Consortium:
  - UJF Filiale (France)
  - Université Joseph Fourier Grenoble I (France)
  - Technische Universität Carolo – Wilhelmina zu Braunschweig (Germany)
  - EADS Deutschland GmbH (Germany)
  - Ecole Polytechnique Fédérale de Lausanne (Switzerland)
  - Swiss Federal Institut of Technology (Switzerland)
  - Institut National de Recherche en Informatique et en Automatique (France)
  - ISRAEL AEROSPACE INDUSTRIES LTD. (Israel)
  - Offis e.V. (Germany)
  - PARADES GEIE (Italy)

- PREDATOR (216008)
  Design for Predictability and Efficiency
  Duration: 36 months
  Activity: ICT-1-3.3 – Embedded systems design
  Consortium:
    - Universität des Saarlandes (Germany)
    - Swiss Federal Institute of Technology Zurich (Switzerland)
    - Universität Dortmund (Germany)
    - Università di Bologna (Italy)
    - Scuola Superiore Sant'Anna (Italy)
    - Absint Angewandte Informatik GmbH (Germany)
    - Airbus France (France)
    - Robert Bosch GmbH (Germany)

- Quasimodo (214755)
  Quantitative System Properties in Model-Driven Design of Embedded Systems
  Duration: 36 months
  Activity: ICT-1-3.3 – Embedded systems design
  Consortium:
    - Aalborg University (Denmark)
    - Centre National de la Recherche Scientifique (France)
    - RWTH Aachen University (Germany)
    - Universität des Saarlandes (Germany)
    - Université Libre de Bruxelles (Belgium)

3.3.5.3 Industrial Liaison within the clusters

In the section on "Industrial Sectors", within the cluster-level activity reports, detailed descriptions of collaborations between Artist2 teams and industrial partners are provided.

3.3.6 Publications

The Artist2 community has been very active in publishing in scientific journals and conferences, as attested by the list of publications provided in this document. Clearly, this represents a huge amount of work. Publication of research is a bottom-up process, which may seem chaotic – but this is intrinsic to research.

Over the course of Year 3, the Artist2 consortium has published at least 185 joint papers, involving at least two distinct Artist2 core or affiliated partners. References for these are provided in the deliverable on Spreading Excellence.

Two essential joint publications provided over the course of year 3 were:

- VERIMAG and EPFL jointly produced a position paper [HS06], which summarizes some current trends in embedded systems design and point out some of their characteristics, such as the chasm between analytical and computational models, and the gap between safety-critical and best-effort engineering practices. The work calls for a coherent scientific foundation for embedded systems design, and discusses a few key demands on such a foundation: the need for encompassing several manifestations

of heterogeneity, and the need for constructivity in design. This paper argues that the development of a satisfactory Embedded Systems Design Science provides a timely challenge and opportunity for reinvigorating computer science.

- PARADES [SV07] wrote a state-of-the-art and beyond paper in system-level design that overviews present approaches to the design of complex SOCs as well as distributed systems and embedded software. The paper underlines the opean areas and the academic and industrial trends to fill the gaps.

3.4 Managing the Network of Excellence (JPMA)

Joint Programme of Management Activities

We believe that the current two-tiered Management structure - dividing the management amongst cluster leaders and the Strategic Mangement Board composed of both cluster leaders and a limited number of other selected prominent core partners – is the right one for managing such a large research entity. It provides the right combination of flexibility and accountability, while leaving room for innovation and evolution.

Within the consortium, we have refined the reporting procedures, and strengthened the monitoring.

4. End Results

At the end of the NoE, we expect to achieve a more integrated community, in which the fragmentation by topics and communities will fade. This will be implemented through the disappearance of the currently existing clusters. This will take time, to create convergence of interests, and allow the emergence of recognized leaders.

In Year3, two important steps forward have been reached, for achieving strong, long-term integration between the partners:

- A visible sign of integration is the funding of five STREP projects, led by Artist2 core partners and covering the main scientific achievements posed by our community. It is worth noting that each project involves teams from several clusters.
- Setting up the ARTEMISIA industrial association, and in particular its Public Research Organizations chamber (Chamber B). This provides a basis for sustained integration of the community, as well as for continuous interaction with other types of players, such as SMEs and corporate industry.

A complete list of the detailed expected end results is provided in the Project Timetable / Milestones available in the overall Periodic Activity Report.

IST-004527 ARTIST2
Network of Excellence
on Embedded Systems Design

Periodic Activity Report for Year 3

Joseph Sifakis – Artist2 Scientific Coordinator
Bruno Bouyssounouse – Artist2 Technical Coordinator

Artist2 Consortium

Table of Contents

1. Overview

1.1 Project Objectives and Major Achievements

A detailed description of objectives, and particularly the main aims for integration, is provided for each cluster in the sections labelled « State of Integration in Europe ».

1.1.1 Historical Perspective

Before setting up the Artist2 NoE, a subset of the current consortium implemented an FP5 Accompanying Measure, whose objectives were to:

- Coordinate the R&D effort in the area of Advanced Real-time Systems
- Improve awareness of academics and industry in the area
- Define innovative and relevant work directions

This was achieved through work along 3 axes:

- Roadmaps for selected actions: (Hard Real Time, Component-based Design, Adaptive Real Time, Execution Platforms)
- International Collaboration
- Education

Information about these results is publicly available:

http://www.artist-embedded.org/Roadmaps/

1.1.2 Current Relation to the State of the Art

The NoE's current relation to the State of the Art is provided in the deliverables for this review:

- This document:
  sections "Description of the Area", for each Artist2 cluster.
- Each of the sections called "Brief Description of the State of the Art", provided within each of the 24 activity deliverables.

1.2 Workpackage progress of the period

Given the size of this NoE, and the structuring by clusters, this information is provided in detail in sections 3-10 of this document.

1.3 Deliverables for the Reporting Period

The due date for all the Year1 deliverables was August 31st, 2005.
The delivery dates are provided per deliverable below.

WP0 JPMA: Joint Programme of Management Activities

CDC	D1-Mgt-Y3	Year 3 Project Management Report	
UJF/VERIMAG	D2-Mgt-Y3	Year3 Project Activity Report	
		Executive Overview	
	chapter 1	Overview	
	chapter 2	Real Time Components	RTC
	chapter 3	Adaptive Real Time	ART
	chapter 4	Compilers&Timing Analysis	Compilers&TA
	chapter 5	ExecPlatforms	Execution Platforms
	chapter 6	Control for ES	Control
	chapter 7	Testing&Verification	Test&Verif

WP1 JPIA: Joint Programme of Integration Activities

UJF/ VERIMAG	D4-RTC-Y3	Component Modelling and Verification (Platform)	RTC
Scuola Sant'Ana	D7-ART-Y3	A common infrastructure for adaptive Real-time Systems (Platform)	ART
Saarland	D12-CTA-Y3	Timing - Analysis (Platform)	Compilers&TA
Aachen	D13-CTA-Y3	Compilers (Platform)	Compilers&TA
DTU	D14-EP-Y3	System modelling infrastructure (Platform)	ExecPlatf
KTH	D18-Control-Y3	Design Tools for Embedded Control (Platform)	Control
Aalborg	D22-TV-Y3	Testing and Verification Platform for Embedded Systems (Platform)	Test&Verif

WP2 JPASE: Spreading Excellence

UJF/ VERIMAG	D3-Mgt-Y3	Report on Spreading Excellence	Global

WP3 JPRA : NoE Integration - Research Activities

UP Madrid	D8-ART-Y3	QoS aware Components (NoE Integration)	ART
Dortmund	D15-EP-Y3	Resource-aware Design (NoE Integration)	ExecPlatf
Lund	D19-Control-Y3	Adaptive Real-time, HRT and Control (NoE Integration)	Control
Twente	D23-TV-Y3	Quantitative Testing and Verification (NoE Integration)	Test&Verif

Please note that workpackages WP5-WP10 concern only Cluster integration (not NoE Integration), and do not include the Platforms (which are in WP1).
Workpackage 4 (Modelling and Components) was halted at the end of Year 1

WP5 JPRA: Real-Time Components

CEA	D5-RTC-Y3	Development of UML for Real-time Embedded Systems (Cluster Integration)	RTC
Uppsala	D6-RTC-Y3	Component-based Design of Heterogeneous Systems (Cluster Integration)	RTC

WP6 JPRA: Adaptive Real-time

Kaiserslautern	D9-ART-Y3	Flexible Resource Management (Cluster Integration)	ART
York	D10-ART-Y3	Real-Time Languages (Cluster Integration)	ART
Porto	D11-ART-Y3	Dynamic and Pervasive Networking (Cluster Integration)	ART

Please note that the only activity in WP7 was merged into the the Timing Analysis Platform at the end of Year2.

WP8 JPRA: Execution Platforms

TUBS	D16-EP-Y3	Communication-centric systems (Cluster Integration)	ExecPlatf
Linkoping	D17-EP-Y3	Design for low power (Cluster Integration)	ExecPlatf

WP9 JPRA: Control for Embedded Systems

Lund	D20-Control-Y3	Control in real-time computing (Cluster Integration)	Control
UPVLC	D21-Control-Y3	Real-time techniques in control system implementations (Cluster Integration)	Control

WP10 JPRA: Testing and Verification

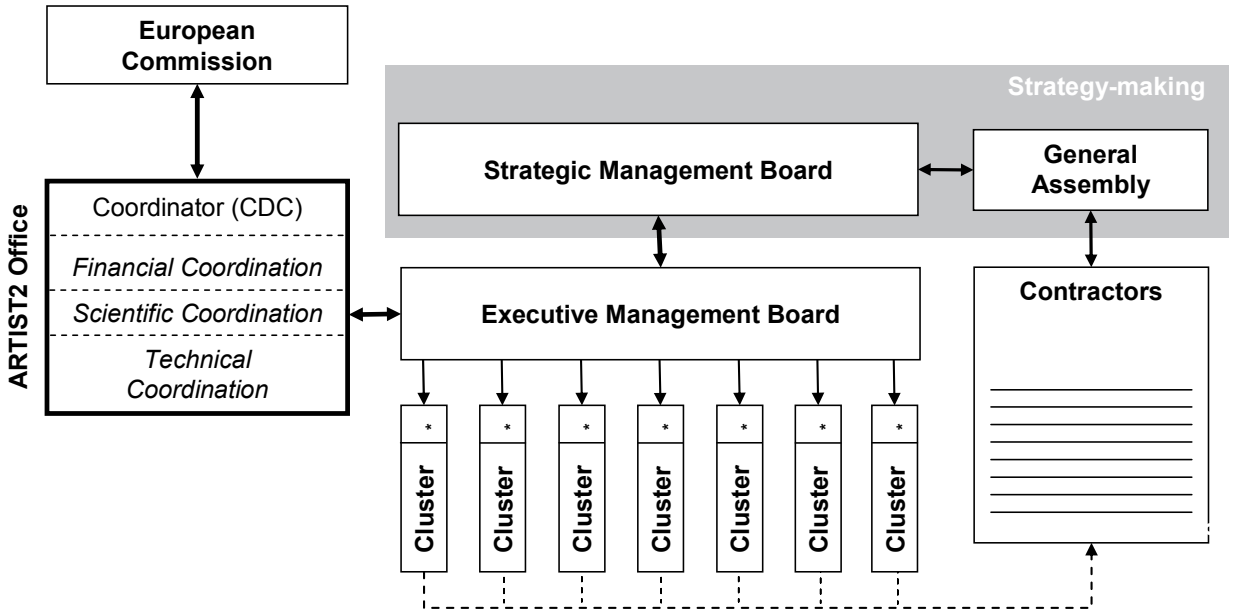
Twente	D24-TV-Y3	Verification of Security Properties (Cluster Integration)	Test& Verif

1.4 Consortium Management

1.4.1 Governance Structure

Scientific Coordinator:	Technical Coordinator:
Joseph Sifakis	Bruno Bouyssounouse
Tel: +33 4 56 52 03 51	Tel: +33 4 56 52 03 68
Joseph.Sifakis@imag.fr	Bruno.Bouyssounouse@imag.fr
Mailing address: Verimag Laboratory - Centre Equation - 2, ave de Vignate - 38610 Gières - France	

The methodology adopted for achieving the JPA objectives follows the same lines as for managing a laboratory. The activities, their objectives, their technical description, the partners involved, their roles, and the resources available have been clearly defined in the initial Description of Work, and updated in the deliverables. This will be monitored and guided by a tight and rigorous management, as defined in the diagram below:



The main governance bodies are:

The **General Assembly** is composed of one representative per core partner. It is convened at the beginning of the project and meets once per year. It is chaired by the Scientific Manager.

The **Strategic Management Board** is initially composed of the NoE cluster leaders, and a representative of the Coordinator – who attends, with no voting rights. It is chaired by the Scientific Manager, assisted by the Technical Manager. It meets at least once per year – close to the General Assembly meeting. Its members are elected by the General Assembly every two years, according to modalities to be determined in the Consortium Agreement.

The **Cluster Leaders** (who compose the Executive Management Board) are responsible for the overall coordination of the activities led by their cluster. A cluster functions as a virtual

team – with a degree of autonomy for defining its internal meetings and day to day management.

1.4.2 Partners Involved

This is provided in the publishable Executive Summary, in the first part of this document.

1.4.3 Contractors

There are no changes to the consortium at the end of Year 3.

1.4.4 Project Timetable

The JPA is organized into activities. The activities should not be considered as tasks of a workprogramme, with begin/end and synchronisation dependencies. Of course, the detailed description of an activity could be decomposed into sub-tasks and intermediate milestones, but this would imply a granularity that is too fine for research activities.

The inter-dependencies between activities are complex and rich, and will evolve dynamically. The work plan and major milestones for the activities are provided in cluster description, and repeated in the 18 month workplan.

1.4.5 Other Issues

None

1.4.6 Plan for using and disseminating the knowledge

The main instruments for using and disseminating knowledge are:

- Workshops and Schools organised.
  The list is quite impressive, and is provided in the deliverable on “Spreading Excellence”.
- Artist2 Web Portal.
  Here also, the quantity of information made available to the greater embedded systems community is quite impressive, and continusouly growing. This is possible through the efforts of the entire consortium, who now have direct access for updating the contents.
- Course Materials.
  There is a growing body of course materials made available via the Artist2 web portal.
- Publications.
  The Artist2 consortium is very prolific in publishing research articles, surveys, textbooks, roadmaps, and position papers.

1.5 Metrics

1.5.1 Excellence Indicators

Indicator	number	*Method used*
Number of publications (journals, proceedings, etc) by ARTIST Partners in Embedded System Design over Year3	610	*from partners, (web form)*
Number of course books published by ARTIST Partners in the area over Year3	28	*from partners, (web form)*
Number of public conferences, seminars and workshop in the area by ARTIST Partners over Year3	216	*From JPASE deliverable, section 5*
Number of white papers published in the area by ARTIST Partners over Year3	33	*from partners, (web form)*

1.5.2 Integration indicators

Indicator	number	*Method used*
Number of EC-funded projects in embedded systems, involving two or more ARTIST2 partners over Year 3	32	*from partners, (web form)*
[IST] ACTORS (2008-2011), [ST] WASP (08-11), [FP6] HYCON NoE, [FP6] PREDATOR, [FP6] RIMACS, [FP7] COMBEST (2007-2010), [FP7] Speeds (2006/2009), [FP6] BETSY (2004-2007), [FP6] WASP (2006-2010), [FP6]FRESCOR (May 2006 May 2009), [FP7] MNENEE (2007-2010), [GAMES Research training network](2002-2006), [IST] ASSERT (2004-2007), [IST] MORE (2006-2009), [ITEA]ES_PASS (07-9), [ITEA2] TECOM (07/010), [NABIIT] MoDES (2006-2009), [VTU] D-ARTEMIS (2007-2009), ALL-TIMES 2008-2009, EU FP7 CONET (2008/2011), EU MORE 6/2006-5/2009, EU RUNES Sep 2004 - Aug 2007, FP6 HiPEAC (2004-2008), FP6 SHAPES (2006-2009), FRESCOR (2007-2010), [IST-FP7] Genesys FP7 18 months, [IST] ATESST, 04/01/2006 => 03/31/2008, KKS WCET 2006-2008, Quasimodo, SPEEDS, Verisoft (03-10), VINNOVA FISS2 May 2007 - Dec 2009		
Number of other source funded projects in embedded system design, implying two or more ARTIST2 partners over year 3	18	*from partners, (web form)*
[CH] FIRE, [CH] MICS, [CH] PerformanceEvaluation, [ESA] Prototype Execution Time Analyzer for SPARC (Sept 2006/Feb 2007), [HTF] DaNES (2007-2010), [NABIIT] MoDES (2006-2009), [Spain PN] THREAD (2005-2008), [Spanish Government]THREAD (05/08), [Spanish project]THREAD (Jan 2005, Dec 2008) [Swedish Foundation for Strategic Research] SAVE(2003-2008), [US DARPA and Industry]: GSRC, [US NSF] CHESS, [VTU] D-ARTEMIS (2007-2009), ALL-TIMES 2008-2009, KKS WCET 2006-2008, SuReal (German BMBF, 2006-2008), Verisoft (03-10), VINNOVA FISS2 May 2007 - Dec 2009		
Number of PhD visiting other partners in the network over year 3	69	*from partners, (web form)*

Number of joint PhDs over year 3	33	*from partners, (web form)*
Number of visits between teams over year 3	115	*from partners, (web form)*
Lengths of visits between teams over year 3	1-2 days; 1-2 weeks; or 2-4 months	*from partners, (web form)*
Number of public conferences, special sessions and workshop organised by ARTIST2 over year 3	31	*from website*
Number of jointly published papers from two or more partners from ARTIST2 over year 3	176	*From JPASE deliverable section 11*
Number of seminars and meetings attended by ARTIST partners from different clusters	*This is impossible to measure.*	
Number of research platforms or facilities shared for research	6	*JPIA*

1.5.3 Indicators about Spreading Excellence

Indicator	**number**	***Method used***
Summer Schools organised and funded by ARTIST2	6	*from website*

First European-SouthAmerican School for Embedded Systems
organised and funded by Artist
August 21-24, 2007 Universidad Argentina de la Empresa (UADE), Buenos Aires - Argentina

Artist2 / UNU-IIST School in China - 2007
organised and funded by Artist
August 1-10, 2007 Suzhou (near Shanghai), China

ARTIST2 PhD Course on: Automated Formal Methods for Embedded Systems
organised and funded by Artist
June 4-12, 2007 DTU - Lyngby, Denmark

ARTIST2 Graduate Course on Embedded Control Systems
organised and funded by Artist
May 7-11, 2007 Lund, Sweden

Real-Time Microcontroller Systems: OSEK Standard and experiments on µcontroller devices
organised and funded by Artist
March 26-28, 2007 RETIS Laboratory, Scuola Superiore Sant'Anna, Pisa, Italy

ARTIST2 - MOTIVES 2007
organised and funded by Artist
February 19-23, 2007 Trento, Italy

Other Summer Schools with Artist2 funding or participation	5	*from website*
Quantitative Aspects of Embedded Systems *organised with Artist partners* March 4-9, 2007 Schloss Dagstuhl, Wadern, Germany CASTNESS'07 Workshop and School *sponsored by Artistorganised with Artist partners* January 15-17, 2007 Rome, Italy ADSD 2006: Advanced Digital Systems Design *sponsored by Artist* September 25-29, 2006 Lausanne, Switzerland FOSAD 2006: 6th International School on Foundations of Security Analysis and Design *sponsored by Artist* September 10-16, 2006 Bertinoro, Italy MDD4DRES *organised with Artist partners* September 4-8, 2006		
Adoption of the recommended curricula in major European Schools	*This is impossible to measure.*	
Education: International seminars / training sessions organised specifically on Education WESE'06 - Embedded Systems Education *organised and funded by Artist* October 26th, 2006	1	
Other international seminars / training sessions organised:	82	*from JPASE deliverable, section 5*
JPIA / Platforms : Number of uses for the platforms	*This is impossible to measure.*	
Number of papers published in top international journals and conferences	*Very large. This is very difficult to measure with any meaningful degree of accuracy.*	
Number of hits on the ARTIST2 web portal	2663540	*from JPASE deliverable, section 6*
International collaboration : nb of projects defined at the events	*This is impossible to measure.*	
Number of external links referring to ARTIST2 web portal *Obtained from google, by searching for:* `link:www.artist-embedded.org`	142	

1.5.4 Indicators on the financial independence from EC funding and from other sources

Indicator	**number**	***Method used***
Number of affiliated industrial partners	22	*from website*
Number of spinoff companies created	12	*from partners, (web form)*
Percentage of the ARTIST2 funding, respective to the partners'overall operating budget	*This is absolutely impossible to measure any meaningful way.*	
Number of affiliated partners willing to pay for membership in ARTIST2 *This would depend on the cost of membership, and the benefits they would get. Part of the benefits is the "seal of approval" involved in otaining EC funding.*		
Overall revenue from memebership dues from affiliated partners. *See previous question.*		

1.5.5 Indicators for Integrating the Gender Dimension

Indicator	**number**
Number of women currently active in the NoE	4
Number of women initially active in the NoE	1
Promotion of women in the area	No statistics