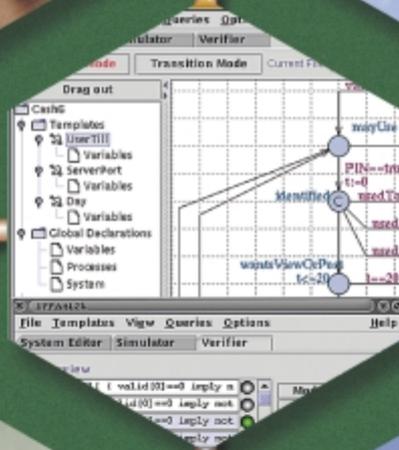
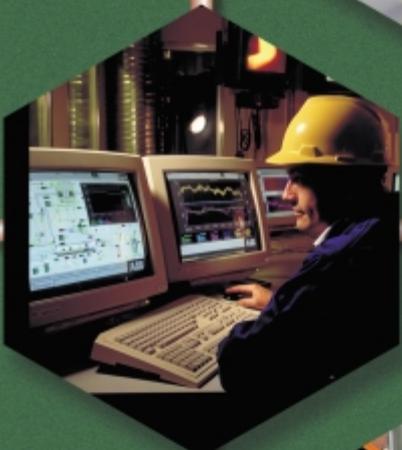


# Take advantage of ARTES



**ARTES**  
A network for Real-Time research and  
graduate Education in Sweden

# Real-time systems

## An enabling technology with numerous applications

Real-time systems are computer systems that sense their environment and directly influence it through actions.

Real-time systems must not only choose appropriate actions, but also choose them at appropriate times. Most real-time systems are embedded in products. For instance, an autonomous vehicle will have an embedded computer-based control system that has to respond in time to avoid collisions. Real-time computing is not about building “fast” systems; it is about building systems that are predictably “fast enough” to interact with their environments in well specified ways.

Real-time systems are embedded in a multitude of applications and products, in areas such as multimedia, telecommunications, robotics, process control, flexible manufacturing, avionics, vehicular systems, air-traffic control, nuclear power plants, medical equipment and defence applications. In fact, the vast majority of processors used are in embedded systems.



Courtesy of Husqvarna AB

## Competencies vital to Swedish industry

Real-time computing plays a key role in many sectors of Swedish industry. For example, the automotive manufacturers can only stay competitive if they incorporate state-of-the-art real-time systems into their vehicles.

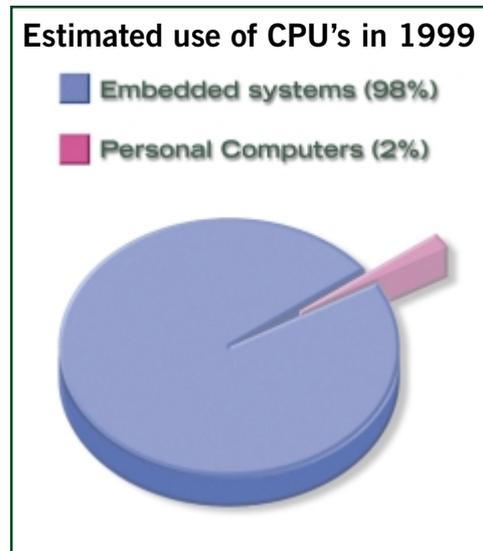
In the future, distributed real-time control systems will replace and enhance many of the conventional control systems in cars, making them safer and more efficient.

In order to fully utilise distributed real-time systems, a number of significant research challenges must be addressed, e.g. precise real-time response (to the microsecond), fault tolerance under strict timing requirements, serviceability and testability, all under competitive price pressure.

## A multidisciplinary research area

Developing real-time systems demands knowledge of and contacts with a number of research disciplines, including automatic control, computer science, computer engineering and electrical engineering.

ARTES' mission is to facilitate the transition of real-time technology between academy and Swedish industry and to stimulate graduate education, thereby helping industry solve the critical problem of finding qualified personnel.



Reference: Jim Turley, Microprocessor Report



*“ARTES offers an enhancement of research and education targeting computer systems integrated in products and industrial processes.*

*ARTES network for research and industry will lead to a stronger Swedish competence in technical development of great importance for our manufacturing industry.”*

Ingvar Carlsson,  
Chairman, Swedish Foundation for Strategic Research



# This is ARTES

## Our twofold vision:

To transfer knowledge and competence to Swedish industry that will allow it to first utilise the latest achievements in real-time systems design

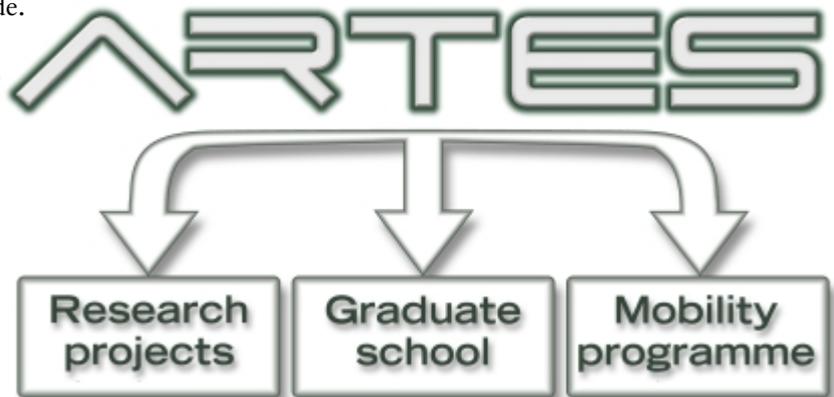
To reduce lead times for designing and modifying real-time systems by an order of magnitude by the year 2005

## A strategic research initiative

ARTES is a Swedish national research initiative in real-time systems, supported by the Swedish Foundation for Strategic Research (SSF), which funds the programme with MSEK 88. ARTES was formed in 1997, following an initiative from The Swedish National Real-Time Association (SNART). ARTES is organised as a research programme at Uppsala University and forms a national network of academic and industrial groups, with the ambition to strengthen the real-time systems competence nation-wide.

The main focus of ARTES is on graduate education and co-operation between industry and academia.

The ARTES programme consists of three interrelated and mutually supportive sub-programmes.



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*“We live in real-time. Most future products will have their main functionality in the form of built-in electronic systems. The demands for interaction with other products and with human users mean that all these systems must be designed for real-time performance.”*

Bernt Ericson,  
Vice President, Research and Innovations, Ericsson

# Research projects

[www.artes.uu.se/project](http://www.artes.uu.se/project)

Co-operation between academia and industry is a vital ingredient in all ARTES projects. Equally important is to provide relevant research problems and environments for graduate students.

A typical project considers several research areas, but is focused on one application area. Preferably, the project should apply research results to real industrial problems, or develop results conforming to industrial requirements.

Currently there are more than twenty ARTES projects in a wide variety of areas. Here are just a few examples:

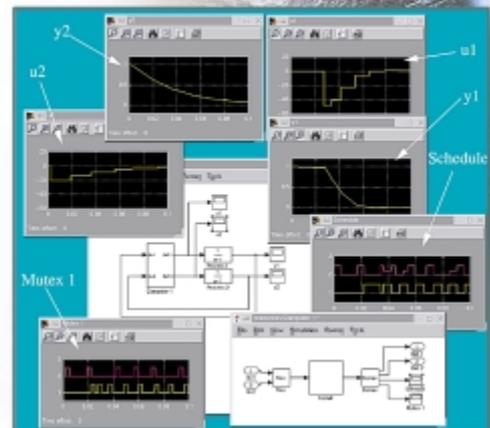
## Integrated control and scheduling

Most real-time systems are control systems. This project, conducted at Lund Institute of Technology, focuses on combining control theory and scheduling theory to achieve higher CPU utilisation and better control performance.

The theoretical results will be implemented in tools that can be used in industrial applications. One such tool is a simulator that makes it possible to study the signals for control and measurement, as well as the schedule and the allocation of shared resources in the computer system.

The industrial partners in the project include Sigma Exallon Systems and DDA Consulting.

Project leaders: Karl-Erik Årzén and Klas Nilsson,  
Lund Institute of Technology

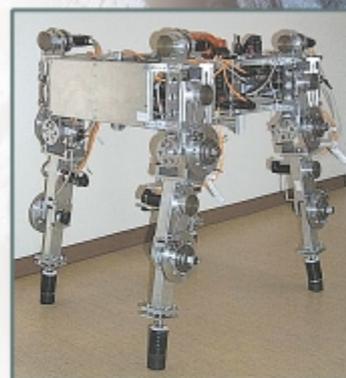


## System architecture for mechatronics systems

The MARCH (Mechatronics ARCHitecture) project explores design methodologies and develops a system architecture framework suitable for mechatronics systems controlled by an embedded distributed computer system. SAAB Automobile AB is one of the industrial partners.

As an example of an application, the project develops a system architecture for walking robots, with a case study being conducted at the Centre for Autonomous Systems at the Royal Institute of Technology (KTH) in Stockholm. The objective is to provide a robust and agile locomotion platform suitable for difficult terrain.

Project leaders: Martin Törngren and Jan Wikander, KTH



## A tool environment for the development of embedded systems

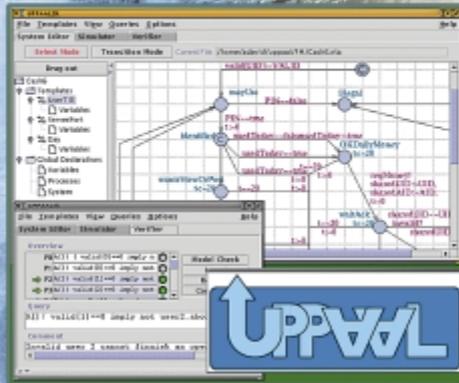
UPPAAL is a tool box for graphic modelling, debugging, validation and verification of real-time embedded systems, developed jointly by Uppsala University and Aalborg University in Denmark. It has been successfully applied all over the world in research, education and industrial case studies.

The vision of the research group is to extend UPPAAL into a coherent tool environment supporting each step of the system development process from requirements specification to testing.

Two Ph.D. projects are funded by ARTES.

Volvo Technological Development Corporation and Mecel AB are the industrial partners.

Project leader: Wang Yi, Uppsala University and Mälardalen University



## Hardware - software co-design of real-time systems

Modern real-time systems are built from carefully optimized hardware and software components. As the complexity of such systems increases new design techniques that can address the concurrent development of hardware and software components (hardware/software co-design) are required.

The aim of this project, conducted at the Embedded Systems Laboratory at Linköping University, is to develop a real-time design environment consisting of a set of integrated design methods and tools that allow designers to quickly explore the design space and to produce optimized implementations. One of the application areas is automotive electronics, with Volvo Technological Development Corporation as industrial partner.

Project leaders: Zebo Peng and Petru Eles, Linköping University



## Making VR appear real with multiprocessors

Virtual reality (VR) technology is opening up several new applications. Design alternatives (e.g. in car design) can quickly be prototyped and evaluated, risky training sessions (e.g. in surgical training) can be avoided, and new forms of education are made possible. Realistic VR demands high computing capacity, however.

At Chalmers University of Technology in Göteborg, algorithms central to VR are boosted using off-the-shelf multiprocessors. Despite their high computing power, a key challenge is to make applications exploit better the inherent parallelism. Parallelisation techniques for animated ray tracing are under investigation. The work is carried out in collaboration with ABB Digital Plant Technologies AB.

Project leader: Per Stenström, Chalmers



The VR project is a part of PAMP, a sub-programme within ARTES. PAMP (Performance-demanding Applications on MultiProcessors) develops design methods, tools and generic building blocks to reduce the time-to-market of industrial high-performance real-time applications using multiprocessor technology.



# Industry seminars

If your company is actively developing real-time systems we suggest that you let ARTES visit you for a mutual exchange of experiences.

A real-time seminar is typically a half-day to a full-day meeting aimed at establishing contact and exchanging ideas between real-time scientists and practitioners.

You can choose to invite one or more specific ARTES projects.

Researchers working with these projects will then come and talk about their research and the latest developments in the real-time area. Your own researchers/engineers can outline their current work and any problems that the academic researchers can help them solve, or that might be suitable for inclusion in current or future ARTES projects.

This is an opportunity not only to get access to some of the latest research achievements, but also to influence the future direction of research, making it even more certain that your company will benefit from ARTES.

Information about the ARTES researchers and projects is available at

[www.artes.uu.se/project](http://www.artes.uu.se/project)

Please feel free to contact us for further information and to discuss the time for and contents of your ARTES seminar.

## The ARTES network

The following companies and universities are currently involved in ARTES research projects.

ABB Automation Products AB	Ericsson Radio Systems AB	
ABB Digital Plant Technologies AB	Ericsson Utvecklings AB	Chalmers University of Technology
Arcticus Systems AB	HMS Fieldbus Systems AB	Mecel AB
Axis Communications AB	Northern Real Time Applications	University of Skövde
Carlstedt Research & Technology AB	KTHNOC/SUNET	University of Karlskrona/Ronneby
Combitech Systems AB	Prover Technology AB	Innovation Team AB
Datex-Ohmeda AB	SAAB Automobile AB	Royal Institute of Technology
DDA Consulting	Saab Ericsson Space AB	Halmstad University
TietoEnator Teknik Mälardalen AB	Scania	Sigma Exallon Systems AB
Enea Data AB		Linköping University
Enea OSE Systems AB	Siemens-Elema AB	Lund University
Ericsson Microwave Systems AB	Volvo Construction Equipment Components AB	Mälardalen University
Ericsson Software Technology AB	Volvo Technological Development Corporation	Swedish Institute of Computer Science
		Uppsala University

# ARTES is a valuable partner

## Research projects

- Join this co-operation between industry and academic research and help develop the real-time areas of interest to your company.

## Graduate school

- Attend the ARTES summer school to get in touch.
- Increase your competence by attending an ARTES course.

## Mobility programme

- Invite a Ph.D. student to your company or swap personnel with an academic research institution for a period.

## Industry seminars

- Invite academic researchers to exchange ideas and to discuss how you can co-operate in real-time systems development.

## The ARTES Network

- Consider recruiting excellent personnel to highly qualified positions.
- Stay informed by adding your e-mail address to our list of interested persons.



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*“Real-time systems are of strategic importance to Swedish industry, and Sweden is a leading nation in real-time research. Join the ARTES network, and you get access to top researchers and their latest findings!”*

Hans Hansson, Programme Director

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