Information Society Technologies

ARTIST2 – Year 1 Review

Grenoble, October 3rd-4th, 2005

Cluster

Adaptive Real-Time

Cluster leader: Giorgio Buttazzo (Univ. of Pavia)

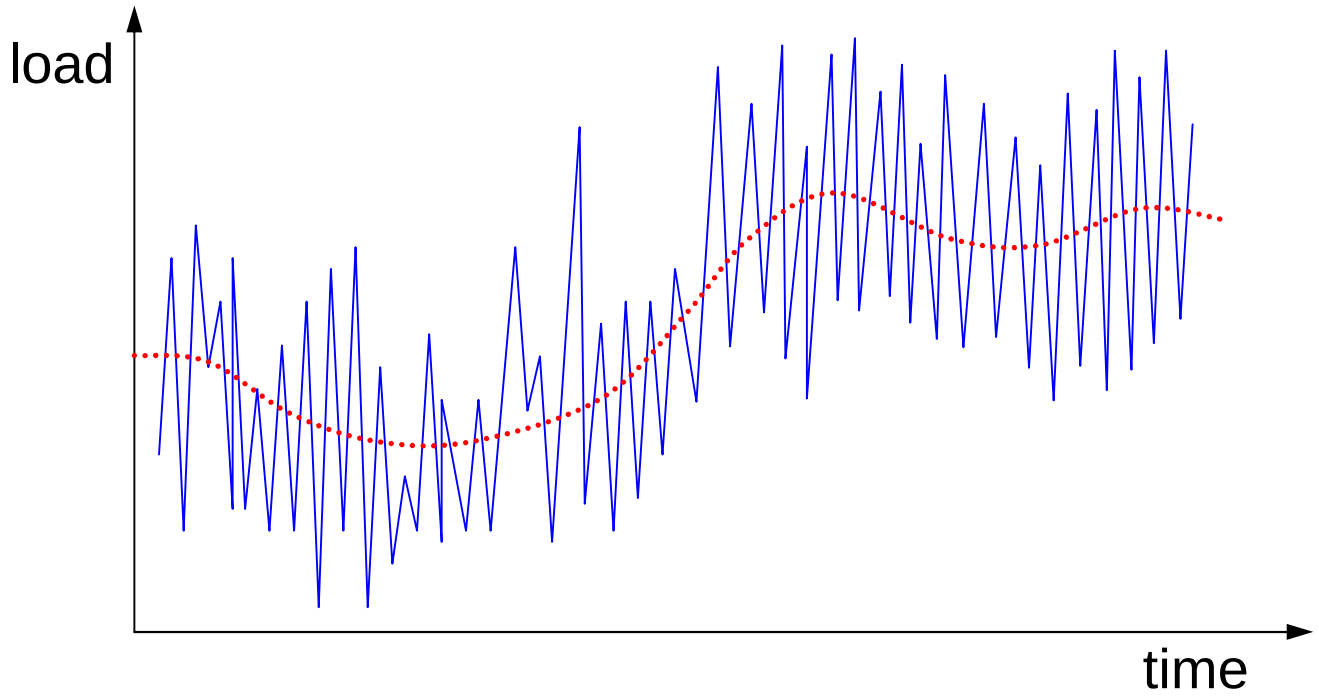
Outline of the Presentation

- **The ART cluster**
  - Goal
  - Partners
- **Cluster integration**
  - Organized events and mobility
  - Participation in other cluster activities
  - Joint publications
- **Industrial Needs and Experience**
  - Applications domains
  - Problems, State of practice
  - Research challenges
- **ART Activities**
  - Achievements in Year 1
  - 18 month perspective

The ART Cluster

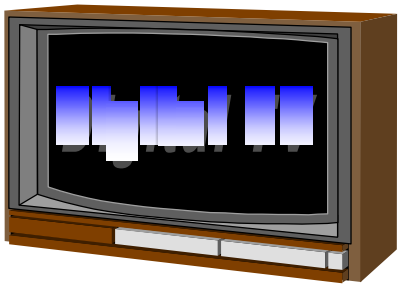
Goal

Investigate novel methodologies to provide predictability and flexibility for systems where resources requirements are inherently unstable and difficult to predict in advance.



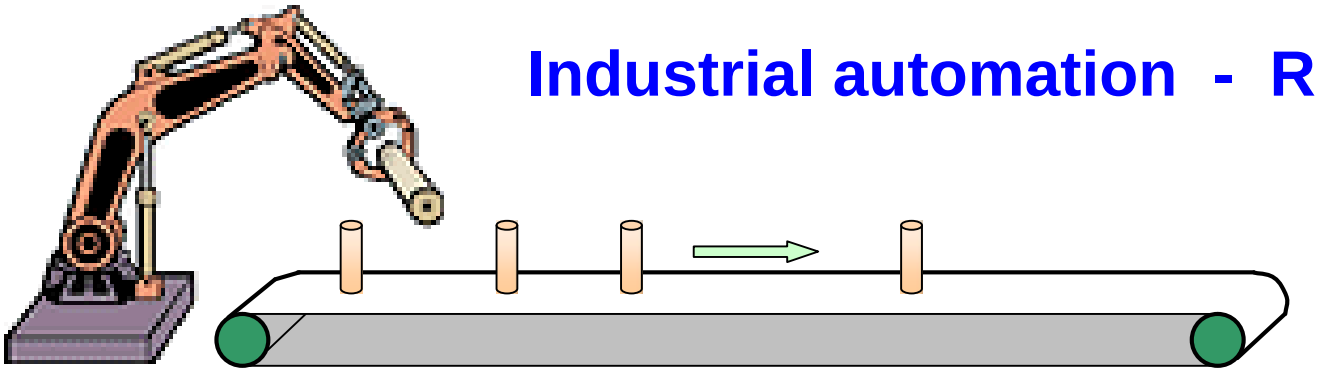
Application domains

Consumer Electronics



Multimedia systems

Telecommunication systems



Industrial automation - Robotics

ART Partners

Cluster Leader

Univ. of Pavia:	RT scheduling and RT kernels

Core Partners

Univ. of Aveiro:	networking, distributed applications
Malardalen Univ.:	video streaming, scheduling
Univ. of Cantabria:	schedulability analysis and OS standards
Univ. of York:	real-time languages
UP Madrid:	QoS and resource management
PI Porto:	heterogeneous networks

Affiliated Partners

SSSA Pisa:	RT scheduling and resource management
Evidence:	kernels and tools for RT systems
UP Catalonia:	control methodologies for RT systems
Univ. of Catania:	distributed systems
UC3 Madrid:	QoS and resource management

Cluster Integration (selected)

Seminars

- ARTIST2 seminar on Adaptive RT Systems with emphasis on RT Control Systems, Barcelona, June 20-23, 2005.
- RT Operating Systems, Univ. of Pavia.

Workshops

- OSPERT Workshop on Operating Systems, at ECRTS 05, Palma, July 5, 2005.
- The First SHARK Workshop, Pisa, Feb. 28 – Mar. 4, 2005.

Cluster Integration (selected)

Intra-cluster collaborations and exchange

- Malardalen Univ. & Univ. of Catania – Distributed systems
- Lund & Univ. of Pavia – RT & Control
- Catalonia & Lund – RT & Control
- Cantabria & Pisa – Schedulability Analysis

Overseas collaborations

- Univ. of Virginia – RT and Control and Sensor Networks
- Univ. of Illinois (UIUC) – RT scheduling and wireless networks
- Univ. of North Carolina @ Chapel Hill – Sched. Analysis

Interaction with other clusters

Real-Time and Control

- Participation in a Graduate Course on Embedded Control Systems, Valencia, April 5-8, 2005.
- Participation in a workshop on Real-Time and Control in Lund, June 13-15, 2005
- Participation in a workshop on Real-Time and Control at ECRTS 05, Palma, July 5, 2005.
- ARTIST2 seminar on Adaptive RT Systems with emphasis on RT Control Systems, Barcelona, June 20-23, 2005.

Participation in cluster meetings

- Modelling and Components
- Compilers and Timing Analysis
- Hard Real-Time Systems

Joint Publications (selected)

Books

- **All**: The Industrial Information Technology Handbook, CRC Press, 2004.
- **All**: The Industrial Communication Technology Handbook, CRC Press, 2005.
- **York-Pavia-USA**: Handbook of Networked and Embedded Control Systems, Birkhauser, Boston, 2005.

Journals

- **Aveiro-Pavia**: IEEE Trans. on Industrial Informatics, 1(3), 2005.
- **Pavia-Lund-York-USA**: Real-Time Systems, 28(2-3), 2004.
- **MDH-Philips**: Int. Jou. On Embedded Systems, 2005.

International Conferences

- **Pavia-Aveiro**: IEEE RTSS, Lisbon, Portugal, 2004.
- **Lund-Pavia**: RTCSA, Gothenburg, Sweden, 2004.
- **Pisa-Pavia**: ECRTS, Palma, Spain, 2005.
- **Pavia-Aveiro**: IEEE ETFA, Catania, Italy, 2005.
- **Pavia-Catalonia-MDH**: ECRTS, Catania, 2004
- **Catania-MDH**: ETFA, Catania, 2005.

Industrial Needs and Experience

Interaction with Industry

Within ARTIST we collaborated with several industries that use RT embedded systems in different application domains:

- **Consumer electronics**

  Philips, Ericsson

- **Telecommunications**

  Ericsson, PTI, Nokia

- **Industrial automation**

  Equipos Nucleares S.A., Desin Instruments S.A., MAPS S.A., SPIN S.A., Centre CIM, Thales

- **Automotive**

  Lear Automotive, Magneti Marelli

Industrial Needs and Experience

Facts

- Embedded systems are getting too complex.
- SW code is constantly increasing. Applications consists of several million lines of code involving large number of concurrent activities.

Goals

Efficiency, robustness, predictability, complexity control, simple user interface.

Achieving these goals with an increased complexity requires new software technologies.

Industrial Needs and Experience

State of practice

- Current real-time embedded systems have very limited capabilities for adaptation.
- They are built on top of commercial components that do not offer the possibility of being reconfigured at runtime.
- At any level, scheduling, resource management, and communication protocols rely on static management strategies that cannot be modified at runtime.
- Some adaptation is done at the application level.

Industrial Needs and Experience

Required features

- Strong focus on application portability, security, power consumption and size
- Support for complexity control:
  - ⇒ Flexible scheduling to adapt to dynamic changes
  - ⇒ QoS management
- Increasing SW dimension requires
  - ⇒ optimized resource usage
  - ⇒ overload management
- Rapid systems evolution requires highly configurable, reusable, and scalable platforms

ART Cluster Activities

JPIA Platforms

- A common infrastructure for adaptive RT systems

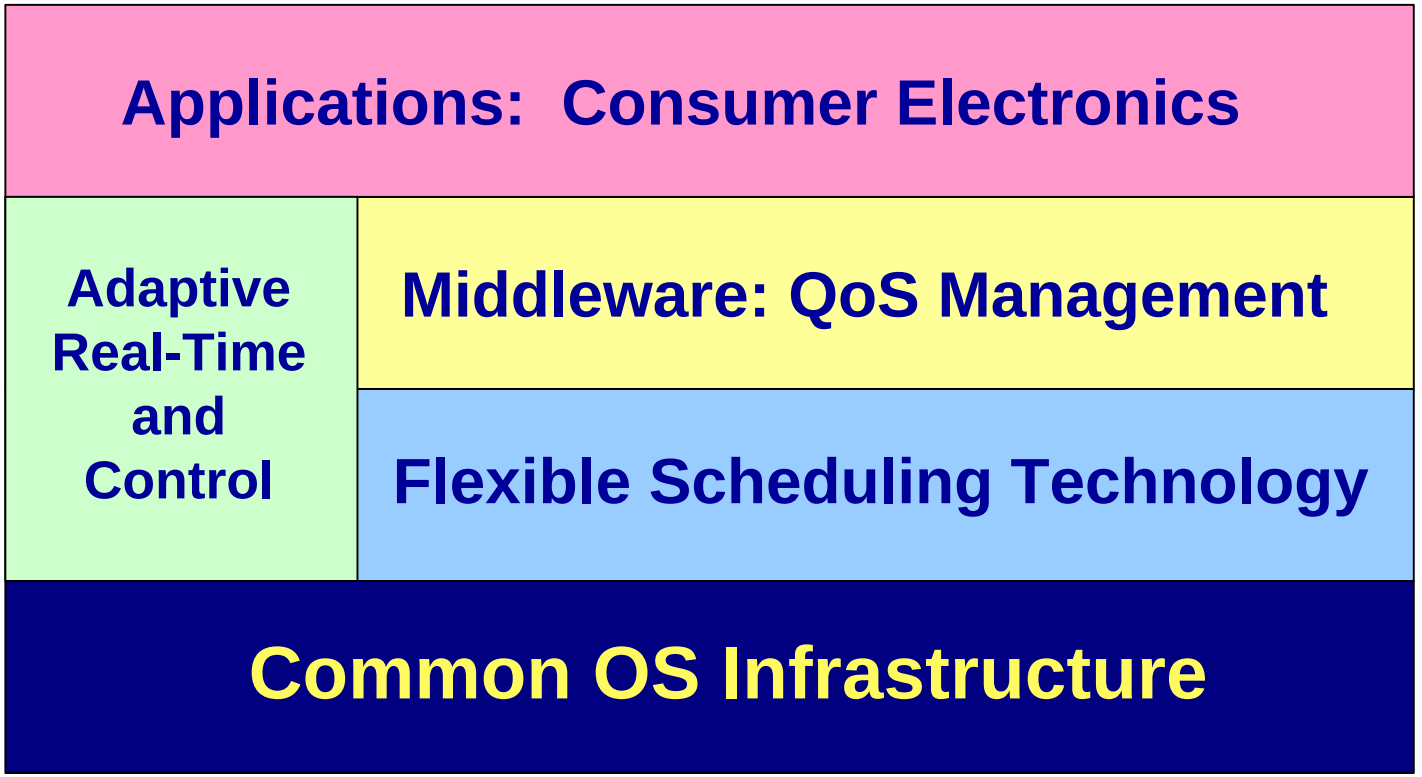
JPRA NoE Integration

- Adaptive real-time, HRT and Control
- QoS Aware Components
- Merging the E-T and T-T paradigms → **Postponed**
- Semantic framework for hard RT design flow → **OUT**
- Timing analysis for adaptive RT systems → **OUT**

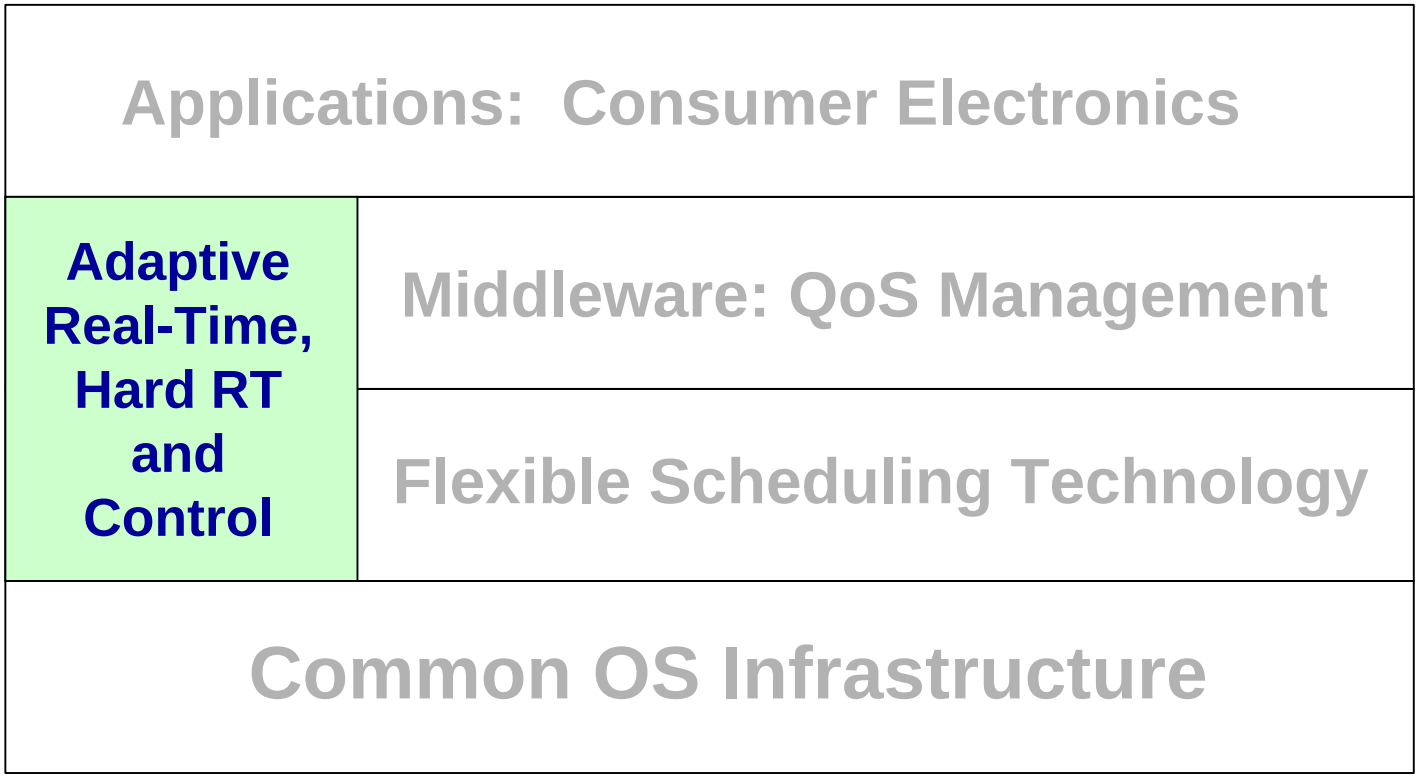
JPRA Cluster Integration

- Flexible Scheduling Technologies
- Adaptive Resource Management for Consumer Electronics
- Real-Time Languages ← **IN**

Overview of the activities of the ART cluster



Overview of the activities of the ART cluster



Activity 3: JPRA NoE Integration

Adaptive Real-Time and Control

Objectives

- **RT for Control**
  - Improve the performance of control systems by integrating feasibility analysis in the design of complex control applications
  - Use flexible scheduling technologies to make control systems more adaptive
- **Control for RT**
  - Use feedback control techniques to make RT embedded systems more reactive to environmental changes
  - Improve system adaptivity by integrating the results of control theory and real-time scheduling

Activity 3: JPRA NoE Integration

Adaptive Real-Time and Control

Approach

1. Organize meetings and workshops for brainstorming
2. Mobility: invite people in Control to work with people in RT, and viceversa
3. Use the common OS platform to implement and experiment new algorithms for control applications

Activity 3: JPRA NoE Integration

Adaptive Real-Time and Control

Achievements in Year 1

- Participation in a Graduate Course on Embedded Control Systems, Valencia, April 5-8, 2005.
- Participation in a workshop on Real-Time and Control in Lund, June 13-15, 2005
- ARTIST2 seminar on Adaptive RT Systems with emphasis on RT Control Systems, Barcelona, June 20-23, 2005.
- Participation in a workshop on Real-Time and Control at ECRTS 05, July 5, 2005.
- Implementation of the elastic scheduling method for rate adaptation into the Shark kernel (Pavia – Lund)
- Developed a design methodology for managing QoC in overloaded systems.

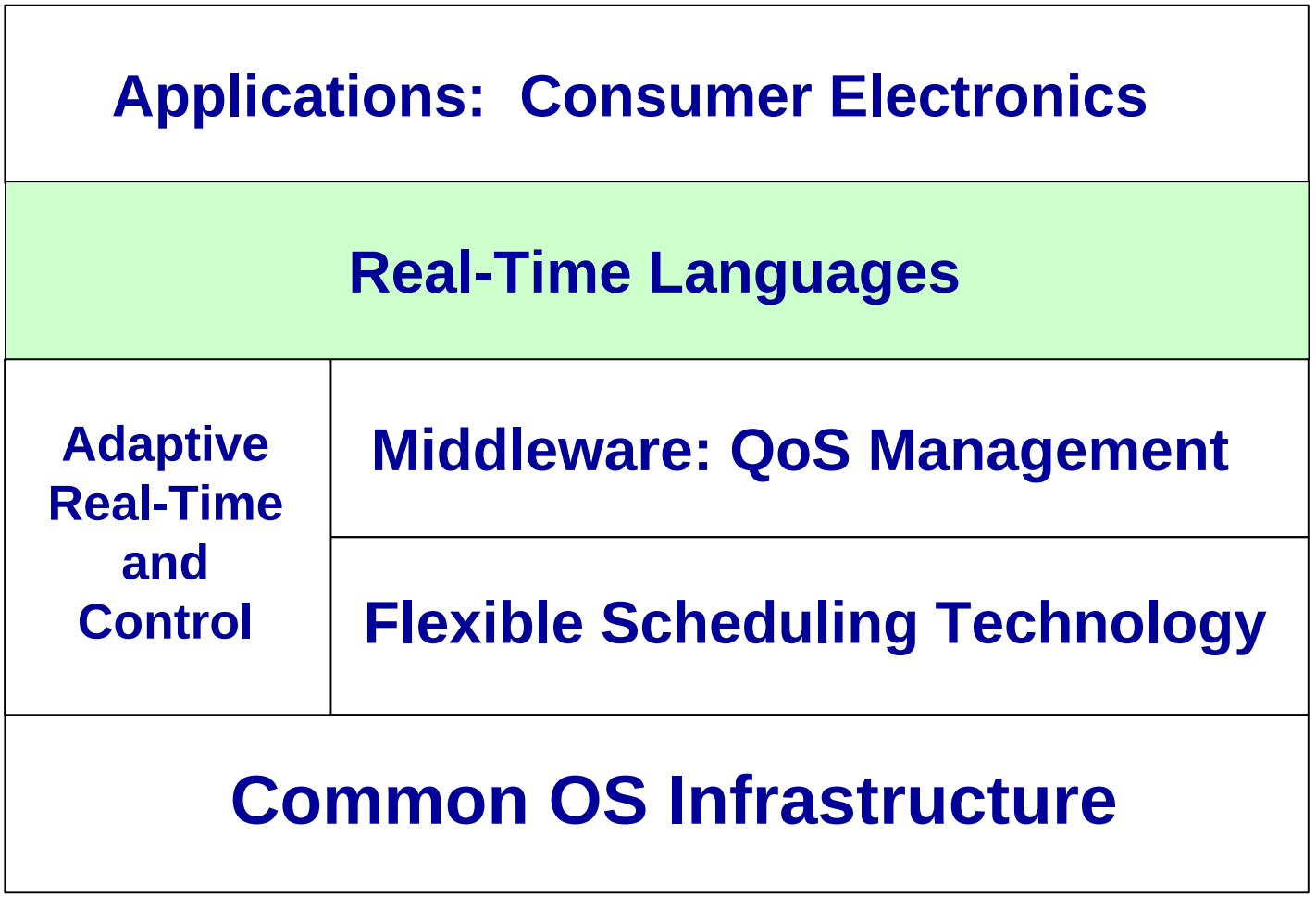
Activity 3: JPRA NoE Integration

Adaptive Real-Time and Control

Plan for the next 18 months

- Evaluate the effect of jitter and delay in RT applications
- Investigate scheduling policies to reduce jitter and delay
- Implement and experiment such policies using Shark and True Time
- Feedback-based scheduling for rate adaptation
- Integration of QoS management with model-based control

New activity



Real-Time Languages

Activity Leader: Alan Burns (Univ. Of York)

Objective

- Supporting RT functionality via language constructs rather than OS calls eases the programmer's task in writing complex applications.

Approach

- Combine the efforts and skills of the leading group to define flexible RT technologies that support multi-language development.
- Initial focus will be on **Ada**, **Java**, and **POSIX** standards.

Expected Results

- Modifications to the standards
- Development of patterns for the use of language abstractions
- Development of guidelines for using RT programming languages