

ARTIST



*ARTIST Network of Excellence*

*International  
Collaboration  
Day*

*October 11<sup>th</sup>,  
2003  
Philadelphia*

**ARTIST Summer School**  
**On**  
**Real-Time Scheduling**

**Giorgio Buttazzo**

University of Pavia

# Aims

- Give an overview of the main scheduling algorithms for supporting the development flexible RT systems.
- Clear the main misconceptions.
- Train future engineers to facilitate the transition of important results from theory to practice.

## Target

- Graduate students
- PhD students
- Computer Engineers

## Requirements

- background on computer science and operating systems.
- no specific knowledge is required to understand the course
- all new concepts are explained and illustrated with concrete examples.

# Structure

5 days – 6 hours per day:

day 1

Scheduling theory

day 2

Fixed Priority Scheduling

day 3

Offline Scheduling

day 4

Real-Time Networks

day 5

QoS Management

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# Day 1: Scheduling theory

Giorgio Buttazzo – Univ. of Pavia

- Basic concepts of real-time computing
- Derivation of timing constraints
- Task models
- Feasibility analysis of specific scheduling algorithms
- Periodic and aperiodic service
- Handling overload conditions

# D2: Fixed Priority Scheduling

Alan Burns – Univ. of York

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- Fixed priority algorithms
- Priority inheritance protocols
- Response Time Analysis
- Extensions to fault-tolerance
- Programming issues
- Advanced reaserch topics

# Day 3: Off-line Scheduling

Gerhard Fohler– Malardalen University

- Table-driven approach to scheduling
- Time-triggered vs. Event-triggered systems
- Handling complex timing constraints
- Off-line schedule construction
- Integrating off-line and on-line approaches

# Day 4: Real-Time Networks

Luis Almeida – Univ. of Aveiro

- Basic concepts on real-time communication networks
- Real-Time message scheduling
- Synchronization issues
- Application service models
- Case studies: standard comm. protocols
- New trends: wirelss nets, sensor nets, ...



# Day 5: QoS Management

Marisol Garcia Valls – Univ. Carols III de Madrid

- Problem of resource management for QoS control in
  - centralized systems
  - distributed systems
- Existing solutions
- Middleware architectures for distributed RT systems
- RMI, RT-Java, and RT-RMI.

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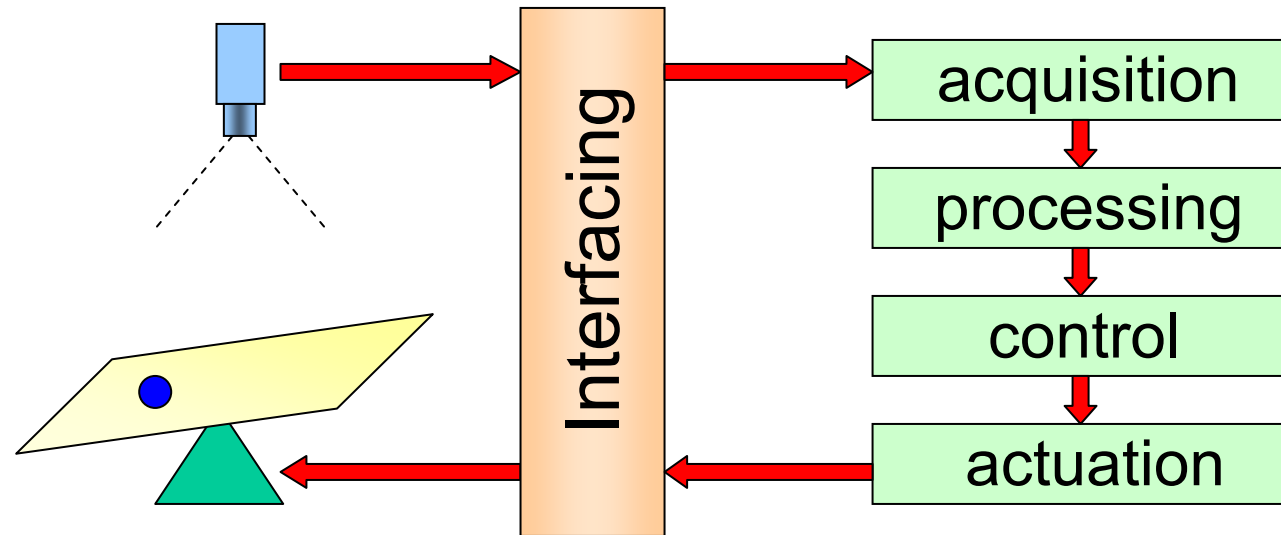
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**What I think we (ARTIST)  
should organize  
to reduce the existing gap**

# Summer school on how to build embedded systems

- Teaching basic theory that is not well established everywhere in Europe
  - RT-systems, distrib. sys., dependability
- Show how to apply theoretical results
- Help in selecting existing:
  - Methodologies
  - Algorithms
  - Tools
  - Hardware components

# Teach concrete examples

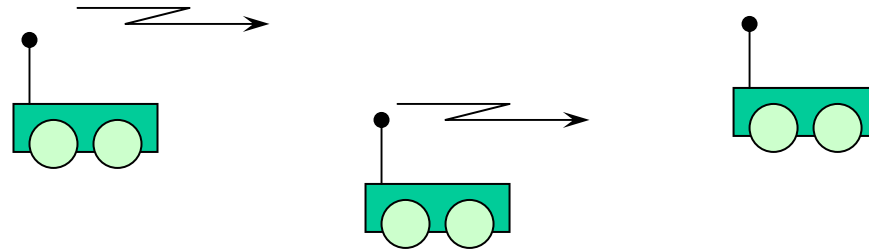


Show how to design the application,  
starting from a given HW and a set  
of requirements

# Many issues can be shown

- Sensor interfacing and acquisition
- Motor interfacing and actuation
- Basic Image processing
- Prediction (e.g., Kalman filtering)
- Use of control techniques
- Software design
- Interfacing with the OS
- Analysis: stability, schedulability
- Verification
- Testing

# Distributed applications



- Which wireless protocols?
- How to handle communication errors
- How to synchronize nodes?
- Centralized or distributed scheduling?
- Local vs. global intelligence

# How can ARTIST help

- Building real systems requires expertise in many different fields
- The ARTIST consortium can use excellence from different teams
- Teams should coordinate and agree on specific case studies
- Prepare a school to show how to go from specification to implementation