LAAS Days
Research & Technology

Ambient.Intelligence@laas.fr

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The LAAS Ambient Intelligence initiative

> **Ambient Intelligence:** intelligent cyberphysical systems serving, assisting and interacting with humans

> The Ambient Intelligence (AI) strategic axis of LAAS
- deals with an integrative context bearing significant scientific and technical challenges
- Is based on the excellence of LAAS teams in a number of key domains.

NSF Program (March 2017)

> « The goal of the CPS program is to develop the **core system science** needed to engineer complex cyber-physical systems that people can use or interact with and depend upon.

- expedite and accelerate the realization of cyber-physical systems in a wide range of applications,
- support the development of methods, tools, and hardware and software components based upon cross-cutting principles, along with validation of the principles via prototypes and testbeds. »

Applicative domains

Contextual Physical Environments

> Complex networked systems of machines in close interaction with the physical environment

- **« structured » environment :** instrumented (equipment, network, infrastructure ...), well-known *a priori* information
- **« non-structured » environment :** not instrumented and not controlled, even hostile to the human, and to deployed system

> The human: professional, user, passer-by, victim..

Applicative contexts

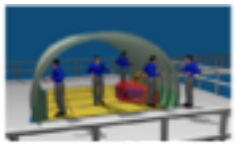
> Networked
- machines, objects, sensors, effectors
- fixed; movable, mobile
- with a full spectrum of autonomy abilities

> in interaction with the environment and with humans over a long-period of time

> providing various physical / immaterial services, assistance, collaboration, sharing decision, task and space

> Robustness, Sustainability, Efficiency, Quality of service, Trust, Extensibility

> Examples:
- Workshop
- Domestic environment
- Public space
- Hospital, elderly care ..



- Strong link with smart cities, vehicles of the future

Farm of the future …

- Interactive networked Robots
- Sensor network
- Smart Objects

LAAS R&T Days

Lunch break : Building skyscrapers

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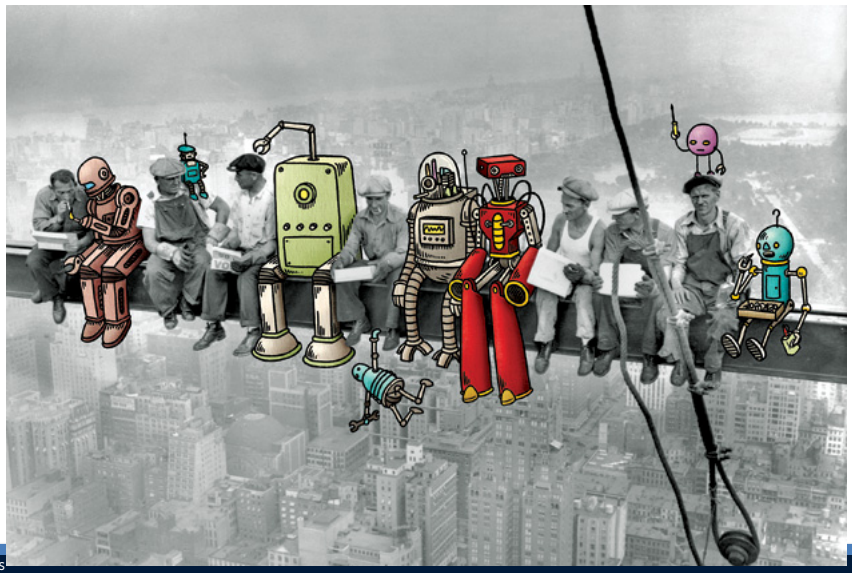
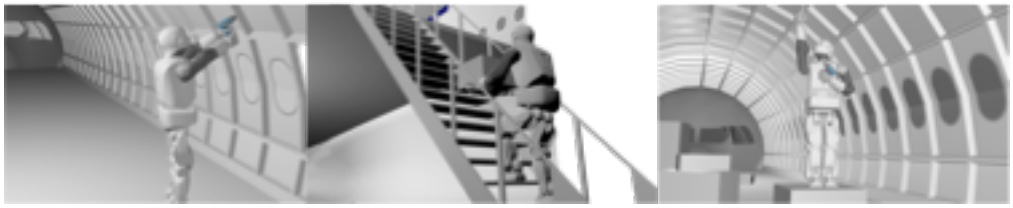


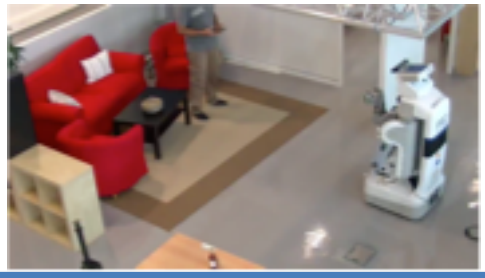
Coworker robot in an instrumented environment



- Humans and robots working independently but in coordination and sharing the same environment
- Robots servicing humans and machines

Human and robots working in the same place: an instrumented workshop

Coworker robot in an instrumented environment



Also

- The Mines
- **Search and rescue :**
  - Intervention after a hazard
  - Cocommittent Deployment of the network and the machine ploiement des machines et du réseau
  - Présence de l'homme (ex: tremblement de terre)

Challenges

The LAAS Ambient Intelligent initiative

A multidiciplinary initiative aiming at developing models, algorithms, tools, components, devices, objects in order to:

- design,
- implement,
- deploy
- and evaluate

intelligent cyberphysical systems serving, assisting and interacting with human.

Challenges

- **Models:**
  - Integration of discrete and continuous systems, physical processe
  - communication, mobility, contingencies
  - Time (reasoning and constraints considerations)
  - Uncertainties at various levels, including those due to human presence and activities
  - The human (from the point of view of the system)
- **Mobility:**
  - Of objects and systems, dynamic nature of the environment,
  - Incremental discovery of agents and services
- **Complexity:**
  - Challenges linked to complexity, distribution, long term action
  - Managing resources and energy

Challenges

- **Design:**
  - Architecture, genericity, System of Systems
  - Adaptation, learning, Learning, simulation, virtualization
- **Decisional Autonomy:**
  - Distributed Optimization, multi-agent, robust & reactive
  - Robust Control (delays, uncertainties, heterogeneity, scaling)
  - Scene analysis and interpretation
  - Planning, Distributed decision processes
  - Interaction protocols, task allocation
- **Assurance**
  - Résilience, adaptation, level of criticity
  - Diagnosis / reconfiguration
  - Verification & validation
- **Interaction with Humans**
  - Privacy
  - Collaboration, Assistance
  - Acceptability
  - « Quality of experience », trust

Challenges linked to Hardware

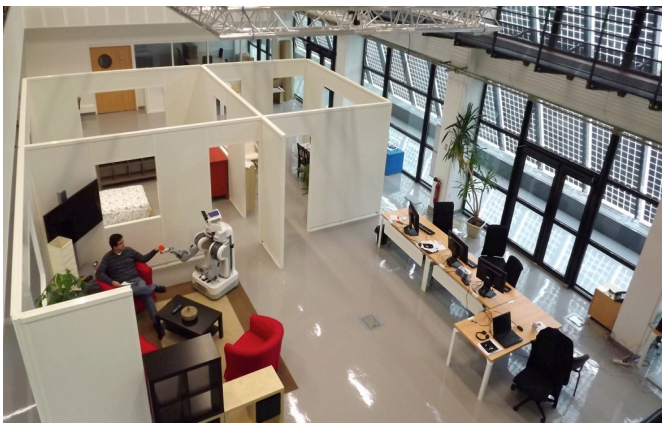
- Hardware / Software Co-design, “cross-layering" (
- Challenges linked to communication needs, agility, energy consumption
- Flexible and Reconfigurable System Architecture
- Degraded but still functional modes (low energy)
- Interoperable devices

Main figures

Participants: 16 teams 2 services > 50 permanent staff

- **DO - Décision et Optimisation**
  - DISCO:
  - MAC
  - ROC:
- **IC - Informatique Critique**
  - ISI
  - TSF
  - VERTICS
- **HOPES - Hyperfréquences et Optique : de l'Electromagnétisme aux Systèmes**
  - MINC
  - PHOTO
  - MOST
  - OSE
- **TIMCS - Technology and Instrumentation for the monitoring of Complex Systems.**
  - S4M
- **RC - Réseaux et Communications**
  - SARA:
- **ROB - Robotique**
  - GEPETTO
  - RAP;
  - RIS
- **GE - Gestion de l'Energie**
  - NEO
- **Services Techniques:**
  - IDEA
  - I2C

The ADREAM lab



Laboratoire, Reconfigurable installation:

Apartment, or workshop, or Terminal, or Mall ….

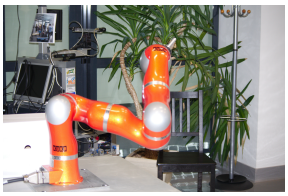
2 PR2 Willow Garage

Pepper (Softbank Rob.)

Motion Capture System

Sensors: RGBD, Caméras, etc..

Equipment



2 Kuka manipulator arms

A (growing) number of UAVs

3 fully equipped oudoors mobile robots

A visitor: the SPENCER robot

Robot in the industrial workshop

Pyrene robot acting on a place fuselage (under study)

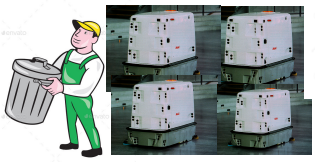
(Gérard Bauzil experimental room)

An instance

A prediction: "20xy – in a mall"

Service: guide and information

semi-autonomous wheelchairs / scooters



A team of human and cleaning robots

assistive or companion robots

Two types of interactions

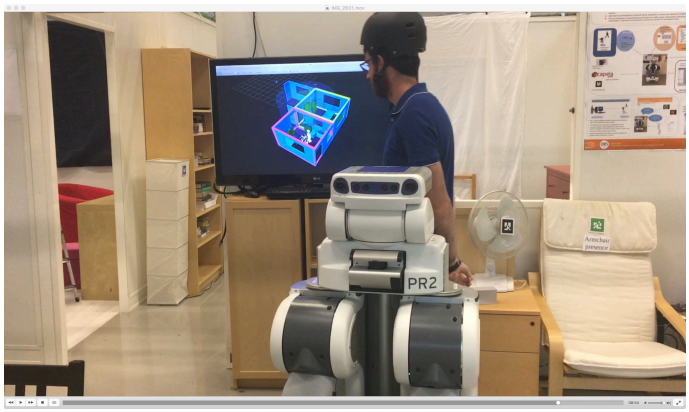
- **Domain and task dependent**: interaction that will be necessary within a team of **robots**, and the **infrastructure**, e.g. perform cooperatively a cleaning task, or a surveillance mission (also true for a human-robot team, a human client for a service)

and also

- **Generic interaction abilities:** when a robot "**encounters**" a **robot** that is dedicated to another activity e.g. efficient avoidance and space sharing, between a cleaning robot and a surveillance robot (also true when a robot encounters a **passer-by,** or to take benefit of general purpose **services provided by the infrastructure**)

Let us start

Toward a cross-fertilization

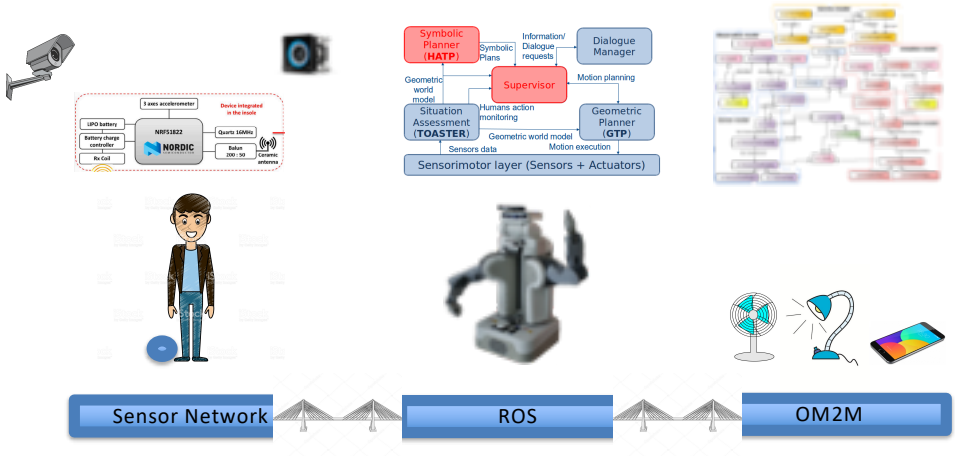


PR2 robot running RIS Software Architecture for Interactive and Cognitive Robots

A set of IoTs modelled and managed using Iot-O Ontology (SARA)

A set of wearable wireless Sensors (S4M)

Toward a cross-fertilization



Toward a cross-fertilization

- Robot has access to new services procided by the IoT and can combine them for its “own”
- Robot provides also complementary services to the IoT system (localization, transfer, accessability to the human, localization of human and interpretation of his activity
- Assistance and joint action with the human (perception, wearable sensors, coordination, decision, ..)

My colleagues

- **Adaptive communication for collaborative interaction in smart environments,** Khalil DRIRA

interoperability and automated adaptation in smart environments and IoT Service platforms.

- **Trust me I am autonomous,** Jérémie GUIOCHET

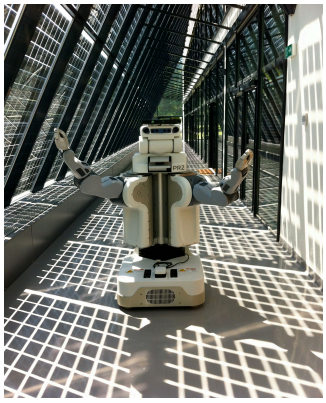
Robotics and autonomous applications are now facing the confidence issue for their deployment.

- **Cross-layering opportunity for designing cyber-physical systems**, Daniela DRAGOMIRESCU

the cross-layering opportunities for designing real-world Cyber- Physical systems.

- **An embedded instrumentation approach for detecting the fragility of complex systems**, Georges SOTO-ROMERO

Distributed instrumentation to construct observables linked to complex systems fragility



Thanks