Spoken and Multimodal Dialogue Systems Research Group

AmI and Multimodal Dialogue Systems: Potential Benefits in Mutual Cooperation

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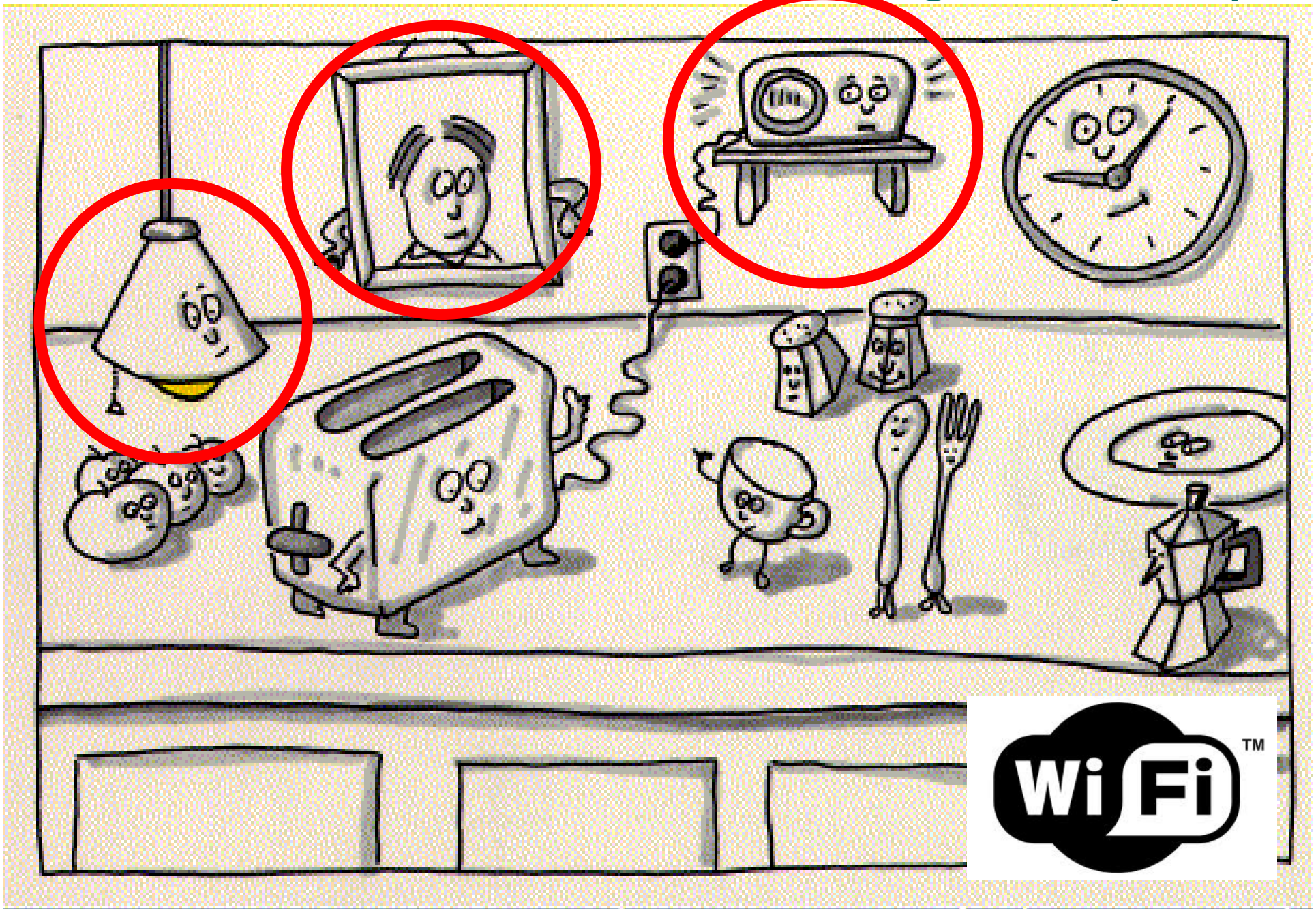
Talk Overview

1. Introduction to Ambient Intelligence (AmI)
2. Implications of AmI for DSs and mutual benefits
3. Current research at the UGR
4. Conclusions

1. Introduction to Ambient Intelligence (AmI)

- **New HCI paradigm**
  - Users are surrounded by intelligent objects, interconnected through fixed or mobile networks
  - Help users carry out daily activities
  - AmI environment is aware of users' presence and adapt to their needs, preferences or habits
  - Sensing devices are seamlessly placed in environment
  - User-environment interaction is **"transparent"** for the user

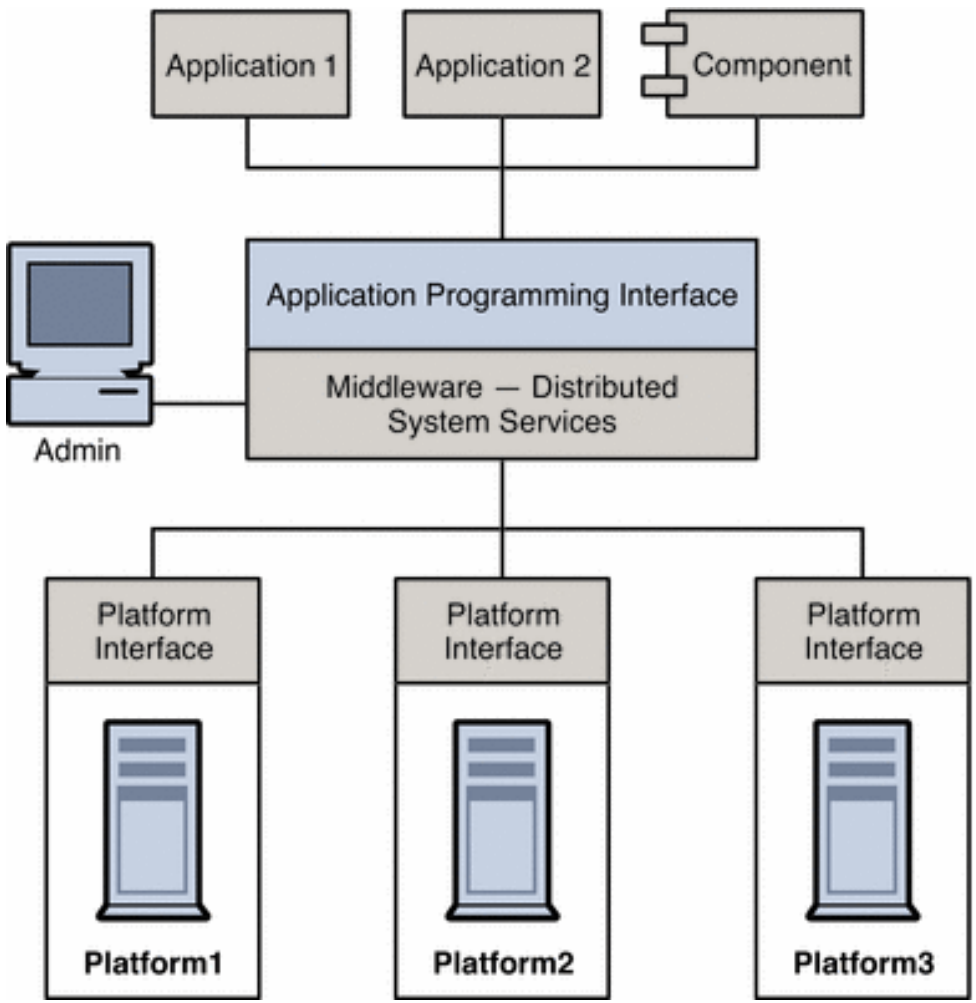
1. Introduction to Ambient Intelligence (Aml)



Middleware

1. Introduction to Ambient Intelligence (AmI)

- **Middleware**
  - Software layer that provides services to enable functioning of distributed applications over heterogeneous platforms



1. Introduction to Ambient Intelligence (AmI)

- **Middleware**
  - Examples
    - OAA (Cheyer and Martin, 2001)
    - WSAMI (Sachetti et al. 2004)
    - SodaPop (Encarnaçao and Kirste, 2005)
    - COCOA (Mokhtar et al. 2006)
    - SAMBA (Berre et al. 2007)
    - MUSDAC (Cardoso et al. 2007)
    - **INMIDIO** (Issarny et al. 2006)
      - **AMIGO project**

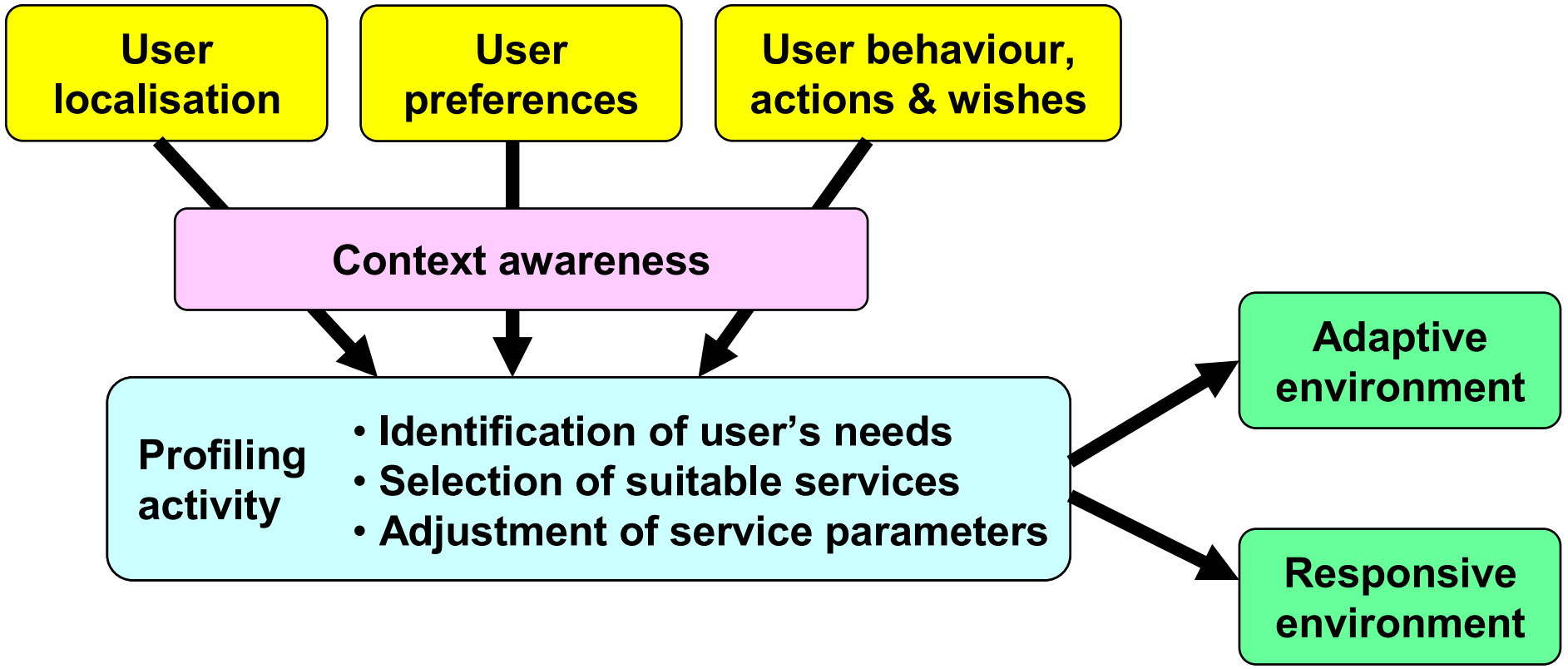
1. Introduction to Ambient Intelligence (AmI)

- **Middleware**
  - Examples
    - **Blackboard** (Montoro et al. 2004)
      - HADA project (UAM, Spain)

User profiles

1. Introduction to Ambient Intelligence (AmI)

- **User profiles**



  - Possible conflicts between shared resources

Learning

1. Introduction to Ambient Intelligence (AmI)

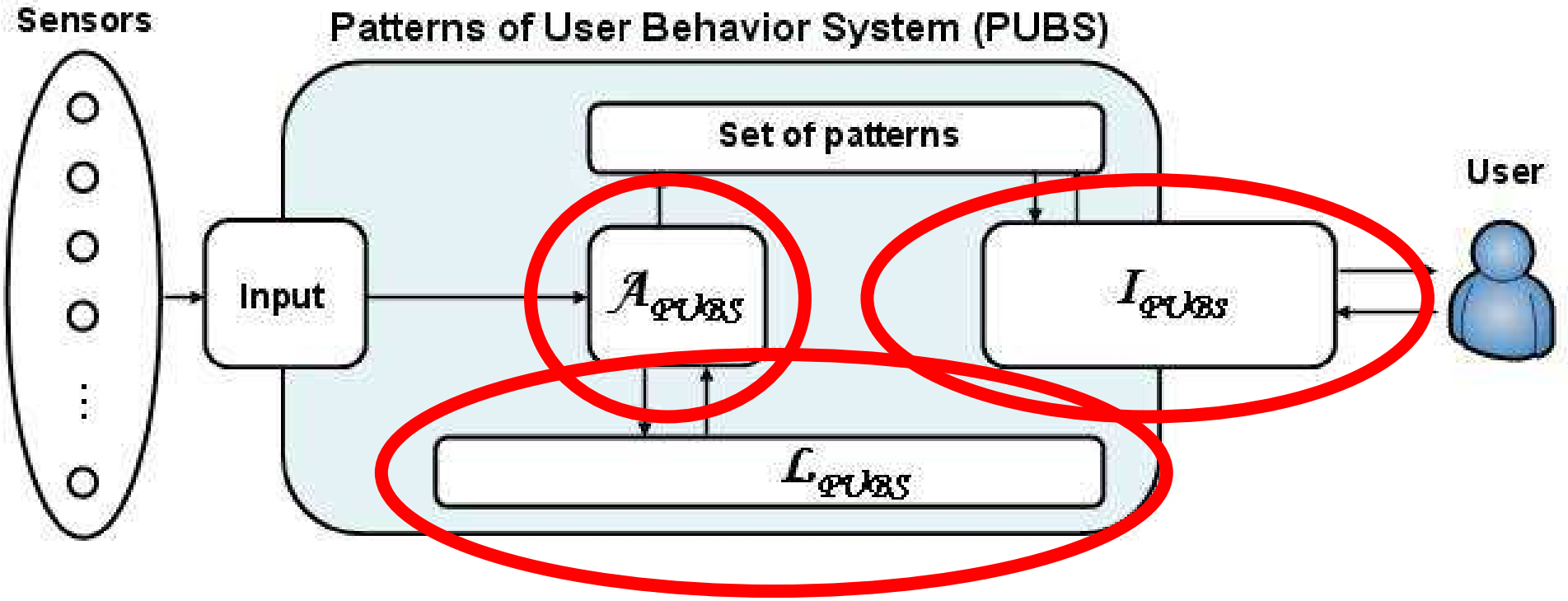
- **Learning**
  - AmI environments should learn patterns of user behaviour in a unobtrusive and transparent way
    - Understand user behaviour
    - Derive new information based on what seems to be a change in behaviour
    - Automation of services and detection of hazardous or abnormal situations

1. Introduction to Ambient Intelligence (AmI)

- **Learning**
  - Implementation
    - ANNs (Mozer et al. 1995; Rivera, 2005)
    - Allen's temporal relations (Jakkula and Cook, 2007)
    - MavHome project
      - Markov models (Cook et al. 2003)
    - iDorm project
      - Fuzzy logic (Cook et al. 2003)
    - MyCampus project
      - Case-based reasoning (Sadeh et al. 2005)
    - SmartOffice project
      - Decision trees (Le Gal et al. 2001)

1. Introduction to Ambient Intelligence (AmI)

- **Learning**
  - PUBS (Patterns of User Behaviour System) (Aztiria et al. 2008)



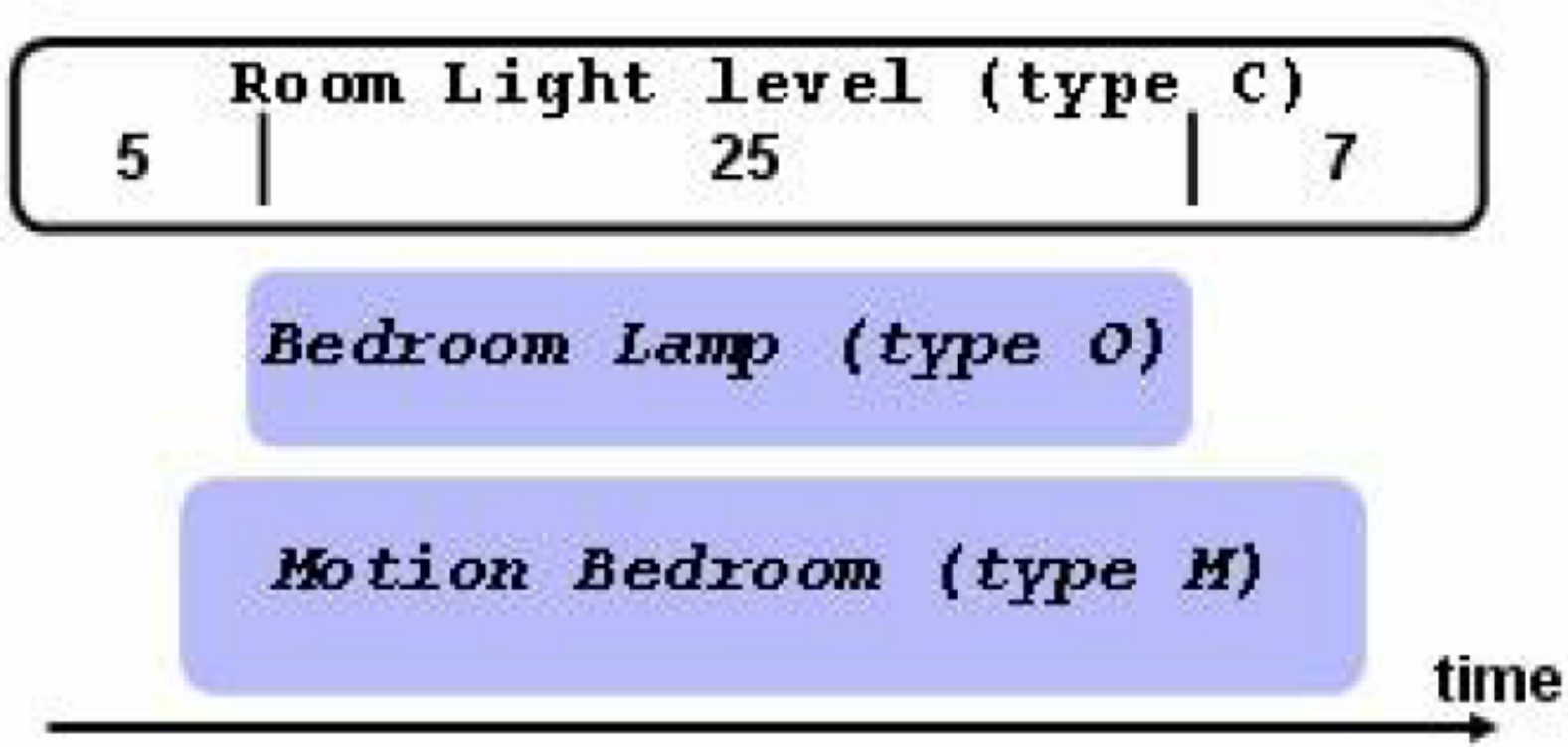
- Learn and refine patterns of user behaviour

1. Introduction to Ambient Intelligence (AmI)

- **Learning**
  - PUBS (Patterns of User Behaviour System) (Aztiria et al. 2008)
    - Types of sensor
      - **Type O**: sensor installed in objects
      - **Type C**: context sensors
      - **Type M**: motion sensors

1. Introduction to Ambient Intelligence (AmI)

- **Learning**
  - PUBS (Patterns of User Behaviour System) (Aztiria et al. 2008)
    - Example of sensors' temporal evolution



1. Introduction to Ambient Intelligence (AmI)

- **Learning**
  - PUBS (Patterns of User Behaviour System) (Aztiria et al. 2008)
    - Sample pattern:

"Motion Bedroom has been turned on and If Room Light Level is lower than 5 Then Bedroom Lamp is turned on 2 seconds after"

Representation in L_{PUBS}:

ON occurs (Motion Bedroom, On, t_0)
IF context (Room Light level (< , 5))
THEN do (On, Bedroom Lamp, t) when $t = t_0 + 2s$

Ethical and privacy issues

1. Introduction to Ambient Intelligence (AmI)

- **Ethical and privacy issues**
  - Users must “trust” AmI systems
    - All automatic decisions made by the systems must be approved by the end users
    - Decisions should be revised at regular intervals

1. Introduction to Ambient Intelligence (AmI)

- **Ethical and privacy issues**
  - User information must be shared over multiple networks
  - Wireless technology
    - Potential problems of unauthorised access to information
    - Careful design of the systems becomes essential

1. Introduction to Ambient Intelligence (AmI)

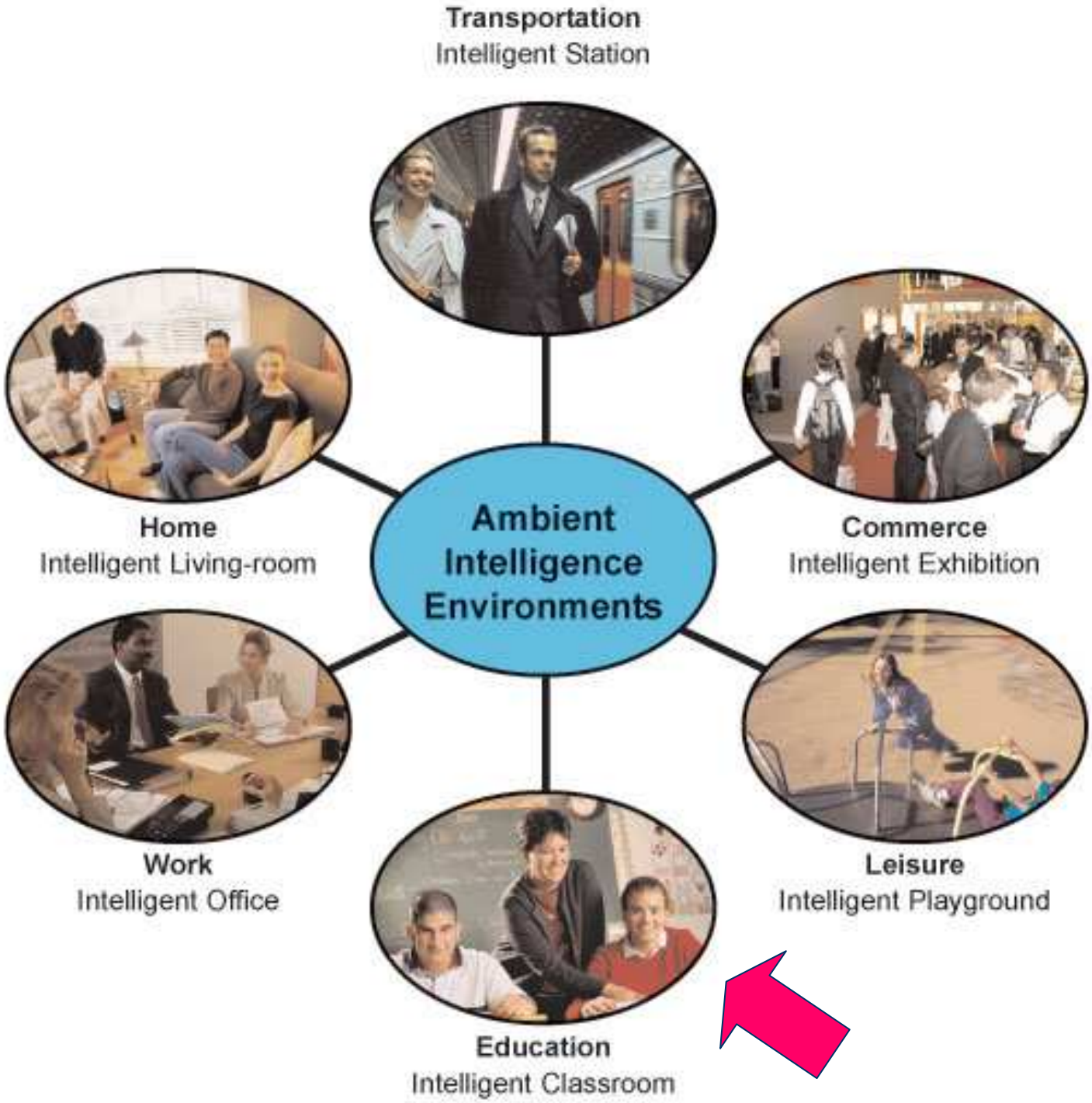
- **Ethical and privacy issues**
  - Will users accept AmI systems?

AmI systems will be accepted if they seem to be of benefit without effort, and with no risk of compromising privacy

Applications

1. Introduction to Ambient Intelligence (AmI)

- **Applications**
  - Education
  - Home
  - Transportation
  - Work
  - Leisure
  - Commerce
  - Etc.


Transportation
Intelligent Station
Home
Intelligent Living-room
Ambient Intelligence Environments
Commerce
Intelligent Exhibition
Work
Intelligent Office
Leisure
Intelligent Playground
Education
Intelligent Classroom

1. Introduction to Ambient Intelligence (AmI)

- **Application to educational environments**
  - Classroom 2000 project (Abowd, 1999)

http://www-static.cc.gatech.edu/fce/eclass/index.html

- Adaptation of educational tools to preferences and needs of students
- Activity of professor is detected and stored in AmI environment

1. Introduction to Ambient Intelligence (AmI)

- **Application to education**
  - Classroom 2000 project (Abowd, 1999)

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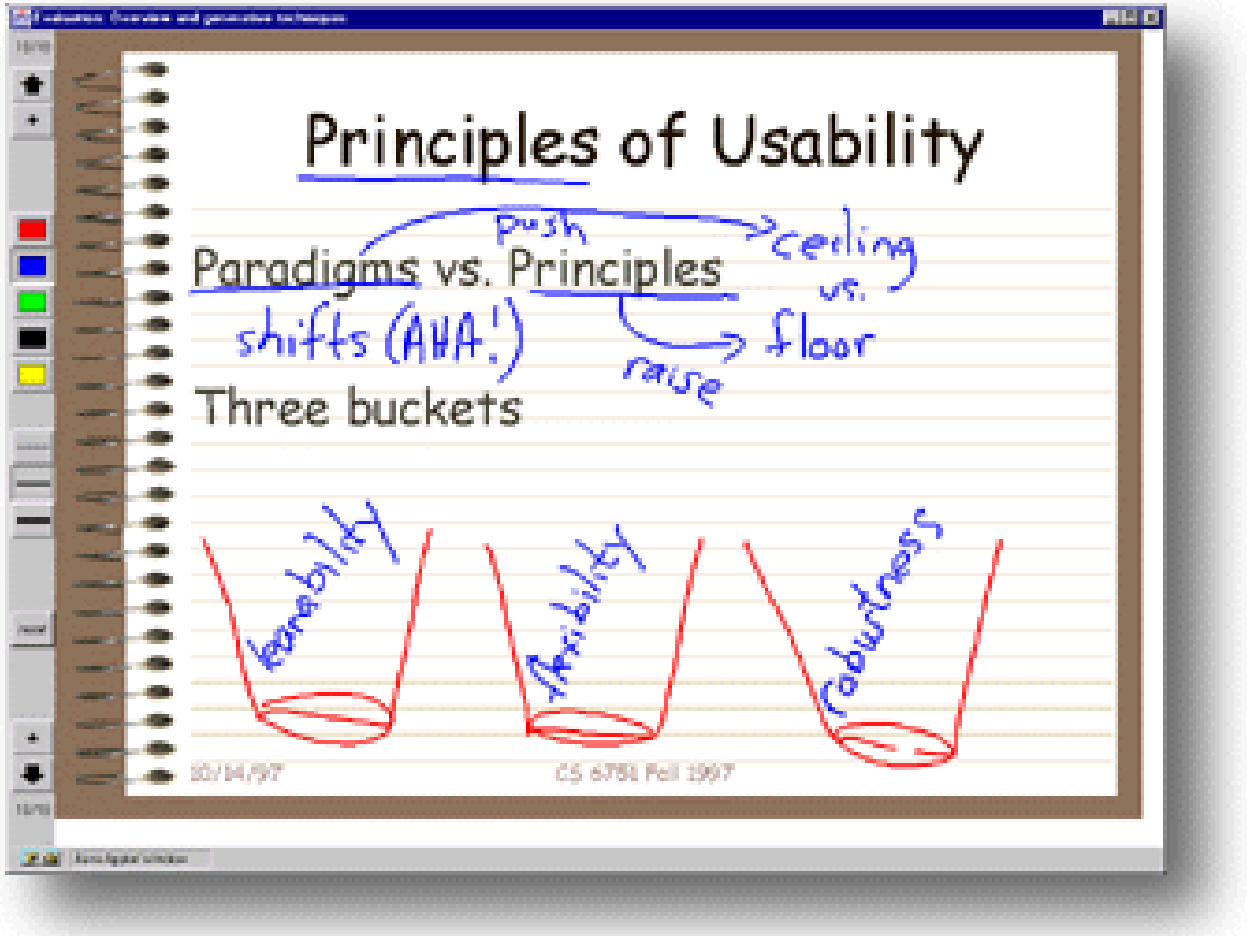
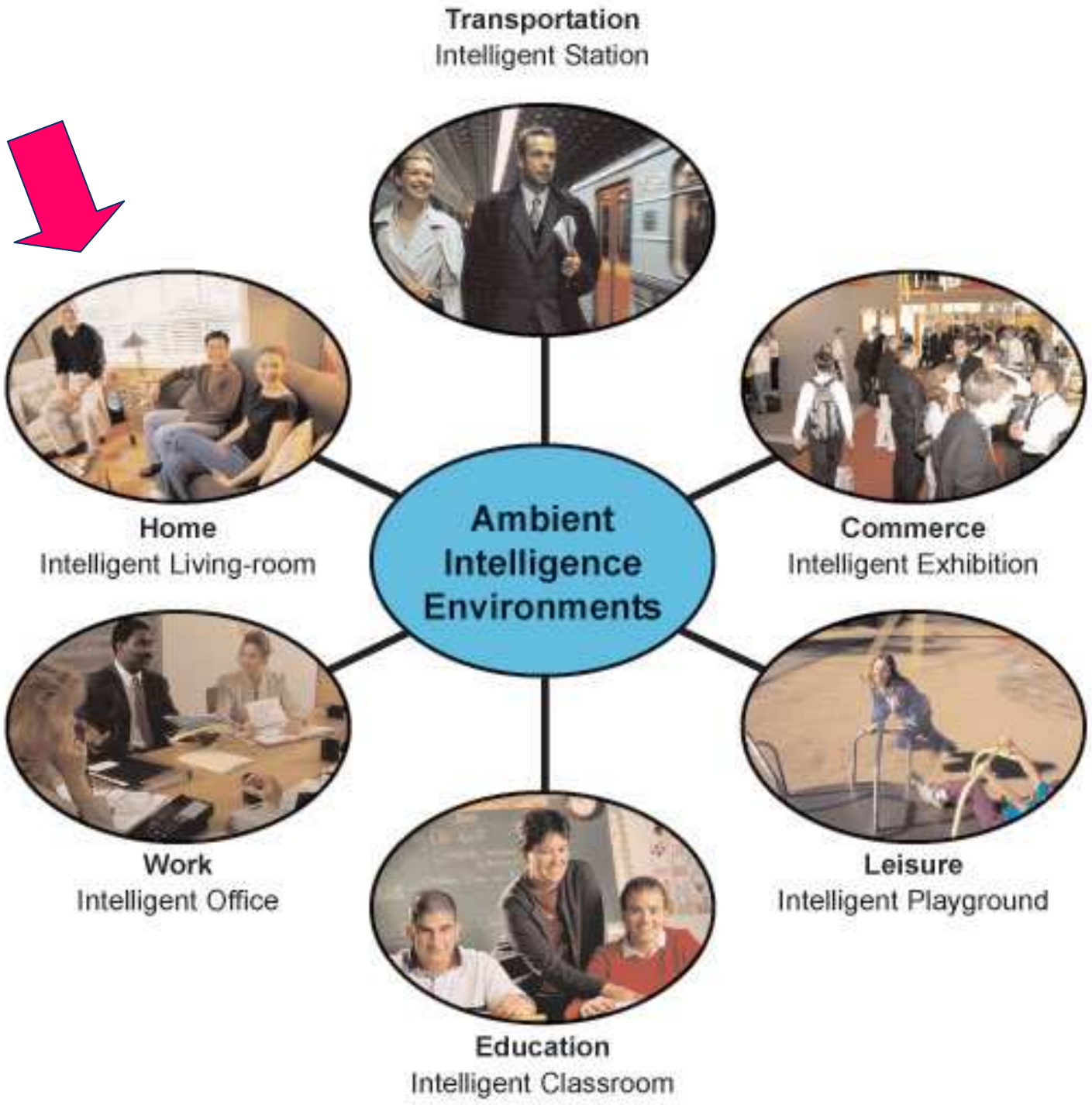
- **Application to education**
  - Classroom 2000 project (Abowd, 1999)




Transportation
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Intelligent Classroom

1. Introduction to Ambient Intelligence (AmI)

- **Application to home**
  - **Living room project** (Vanhala et al. 2005)
    - Adaptation to user preferences

1. Introduction to Ambient Intelligence (AmI)

- **Application to home**
  - **AMIGO project**
    - Ambient Intelligence for the networked home environment
    - Funding institution: European Commission, FP6
    - Goals
      - Develop open, standardized, interoperable middleware and attractive user services
      - Creating prototype applications to improve everyday life, addressing all vital user aspects:
        - Home care and safety
        - Home information and entertainment

1. Introduction to Ambient Intelligence (AmI)

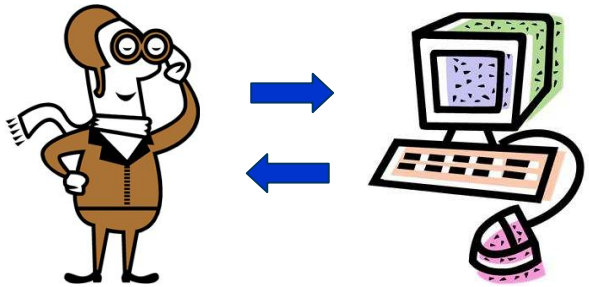
- **Application to home**
  - **AMIGO project**
    - Goals
      - Support interoperability between equipment and services within the networked home environment by using standard technology
      - Making the middleware and basic user services available as open source software together with architectural rules for everyone to use

Talk Overview

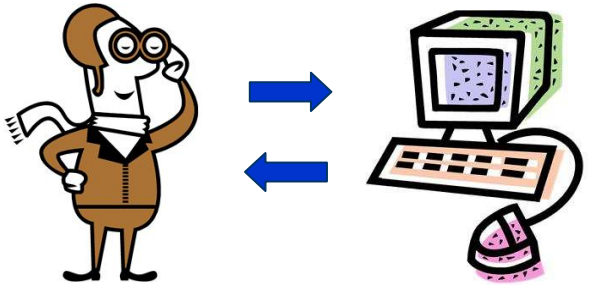
1. Introduction to Ambient Intelligence (AmI)
2. Implications of AmI for DSs and mutual benefits
3. Current research at the UGR
4. Conclusions

2. Implications of AmI for DSs

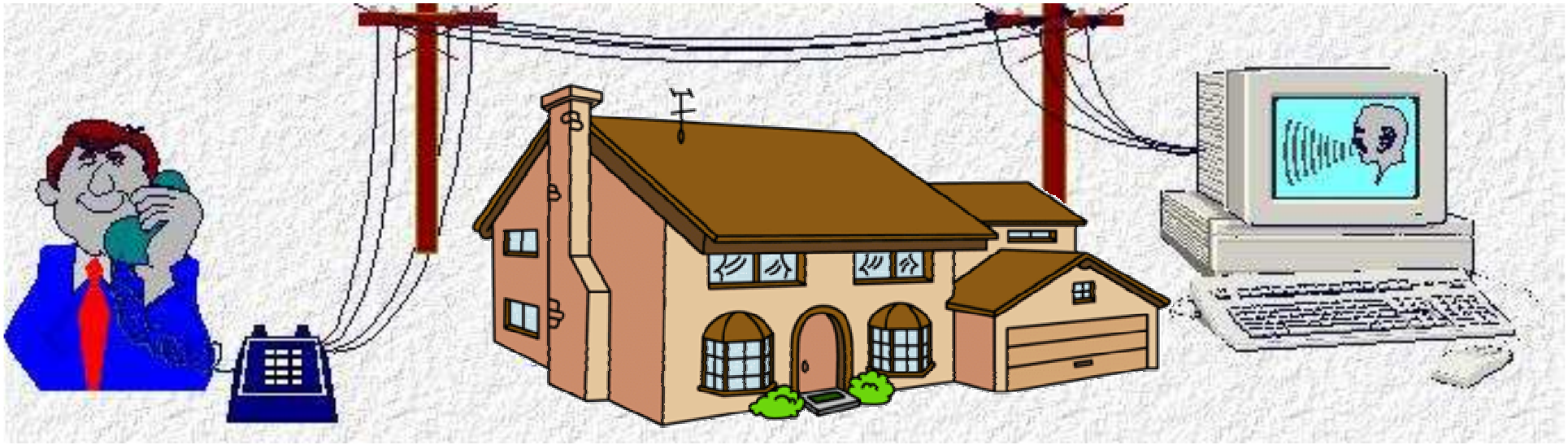
- First generation of DSs
  - Text-based systems
  - Examples
    - Eliza (1969)
    - Parry (1971)



2. Implications of AmI for DSs

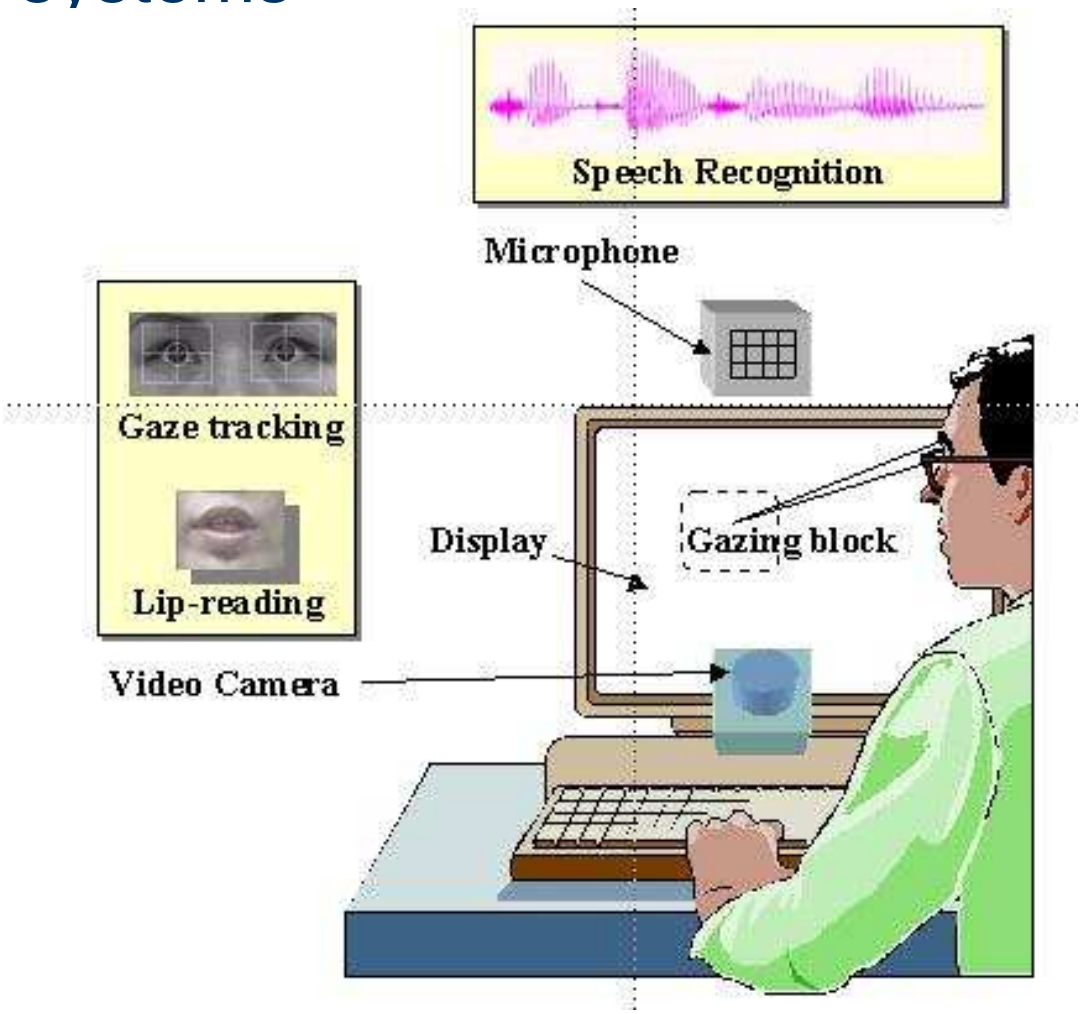


- Second generation of DSs
  - Spoken dialogue systems
  - Examples
    - Tosburg (’94), Voyager (‘95), Dialogos (‘96), Arise (‘97), Jupiter (‘97), Saplen (’97), August (’99), AdApt (2000)



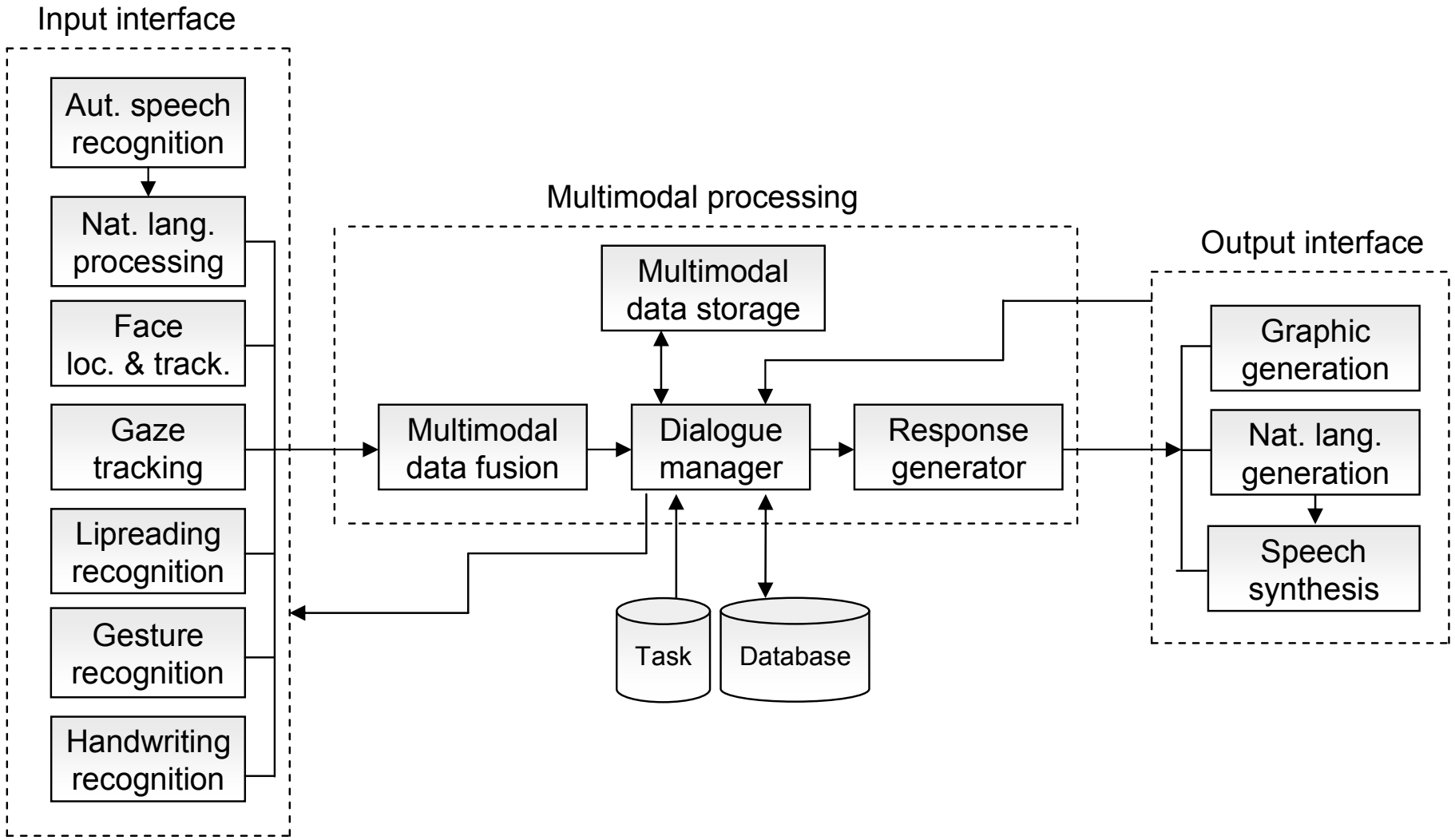
2. Implications of AmI for DSs

- Third generation of DSs
  - Multimodal dialogue systems
  - Examples
    - REA (1999)
    - MATCH (2002)



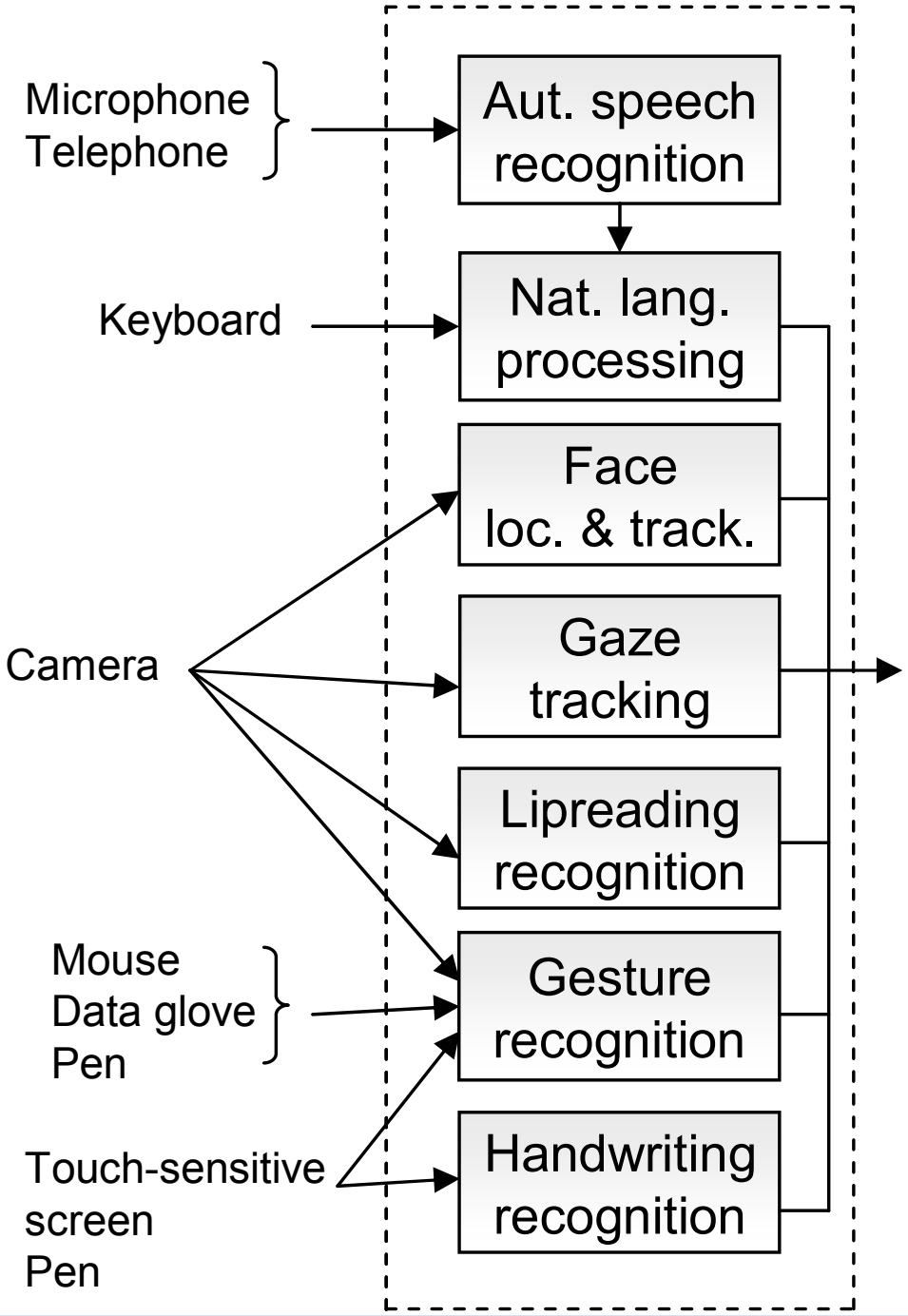
2. Implications of AmI for DSs

- Third generation of DSs
  - Multimodal dialogue systems



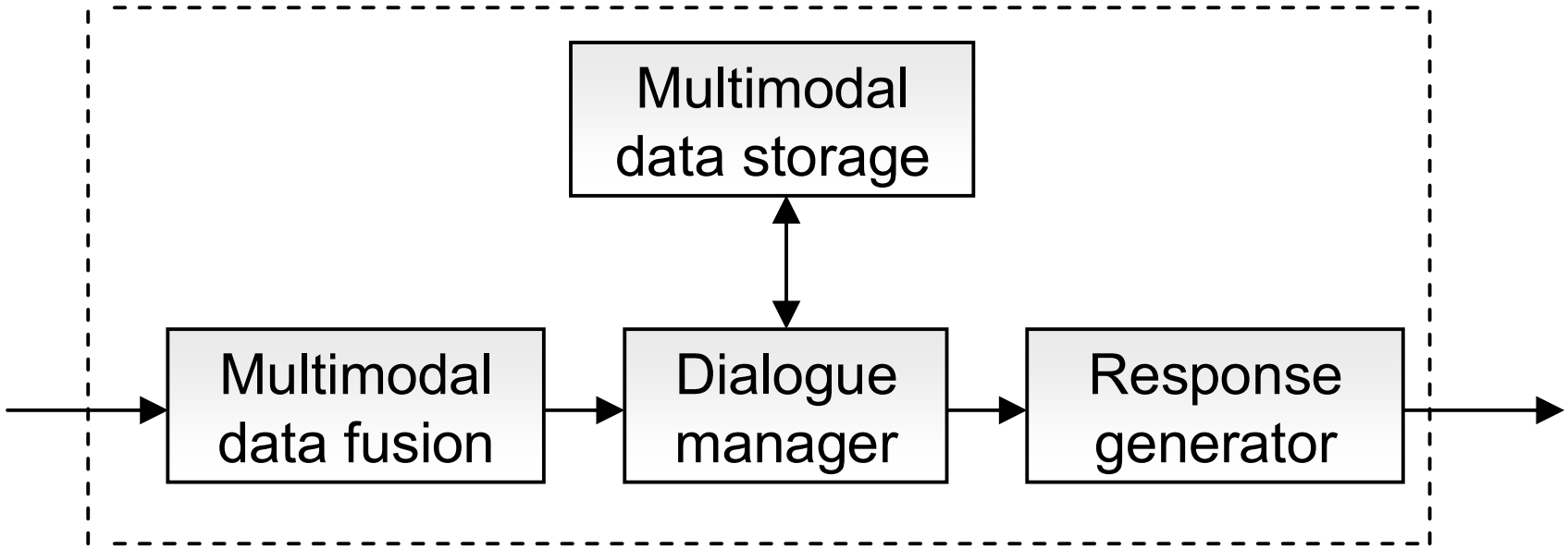
2. Implications of AmI for DSs

- Third generation of DSs
  - Multimodal dialogue systems
    - **Input interface**



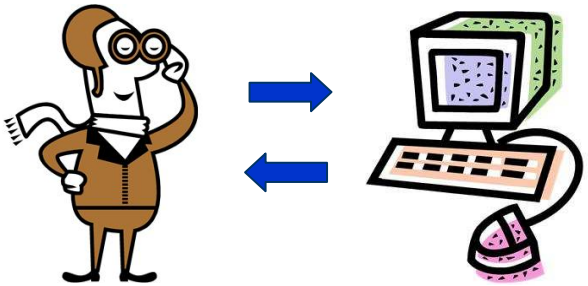
2. Implications of AmI for DSs

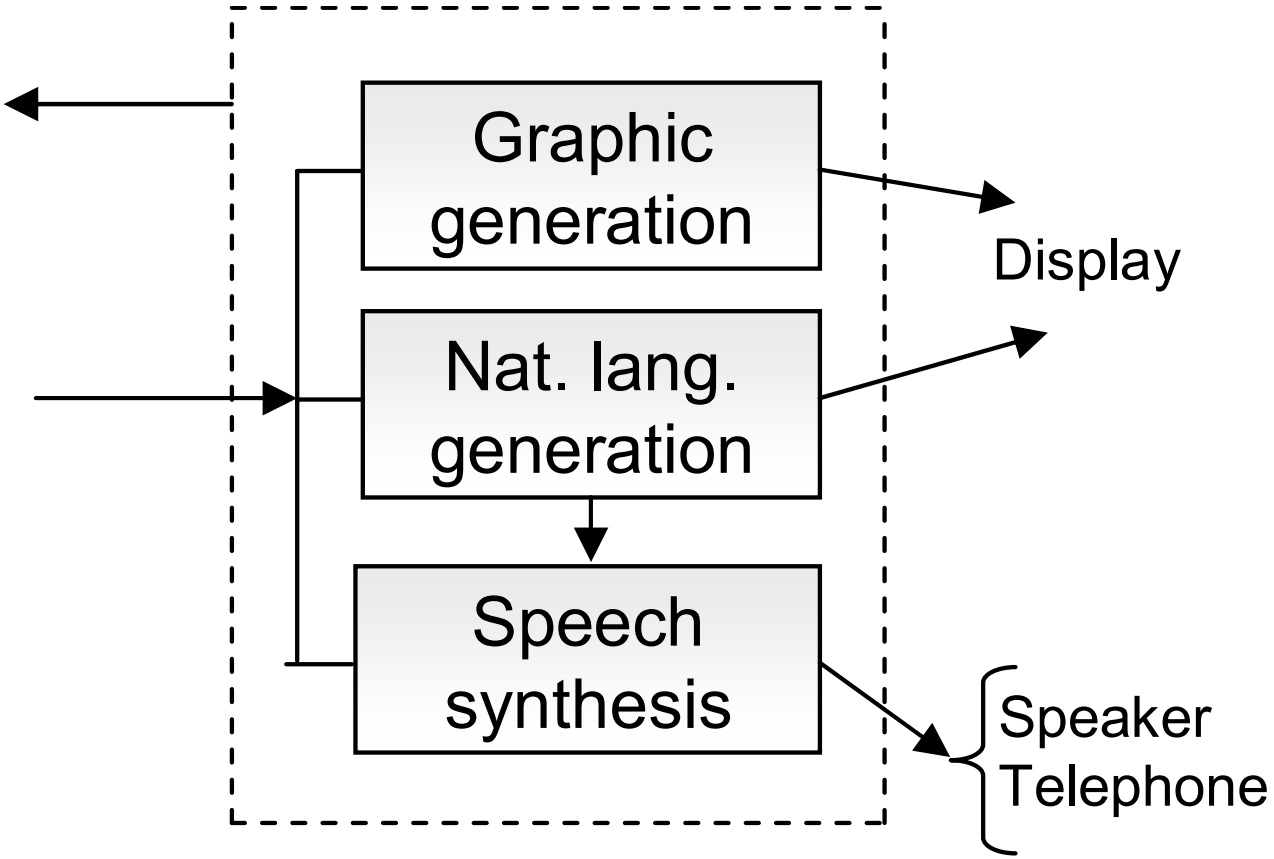
- Fourth generation of DSs
  - Interaction with other entities
    - **Multimodal processing**



2. Implications of AmI for DSs

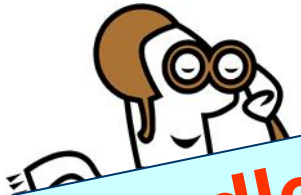
- Third generation of DSs
  - Multimodal dialogue systems
    - **Output interface**

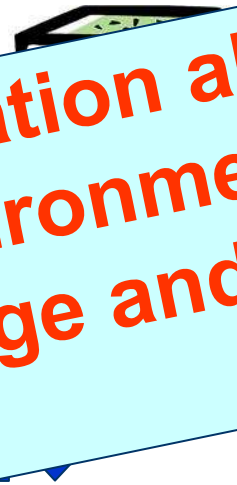




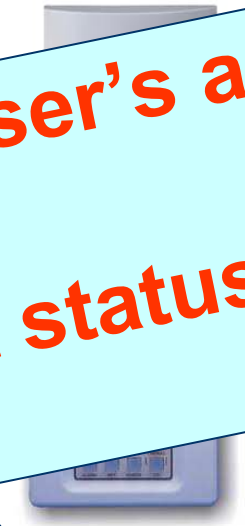
2. Implications of AmI for DSs

- Fourth generation of DSs
  - Context-awareness systems





Presence



Temperature

- Handle information about user's activity within the environment
- Control, change and adapt status of environment

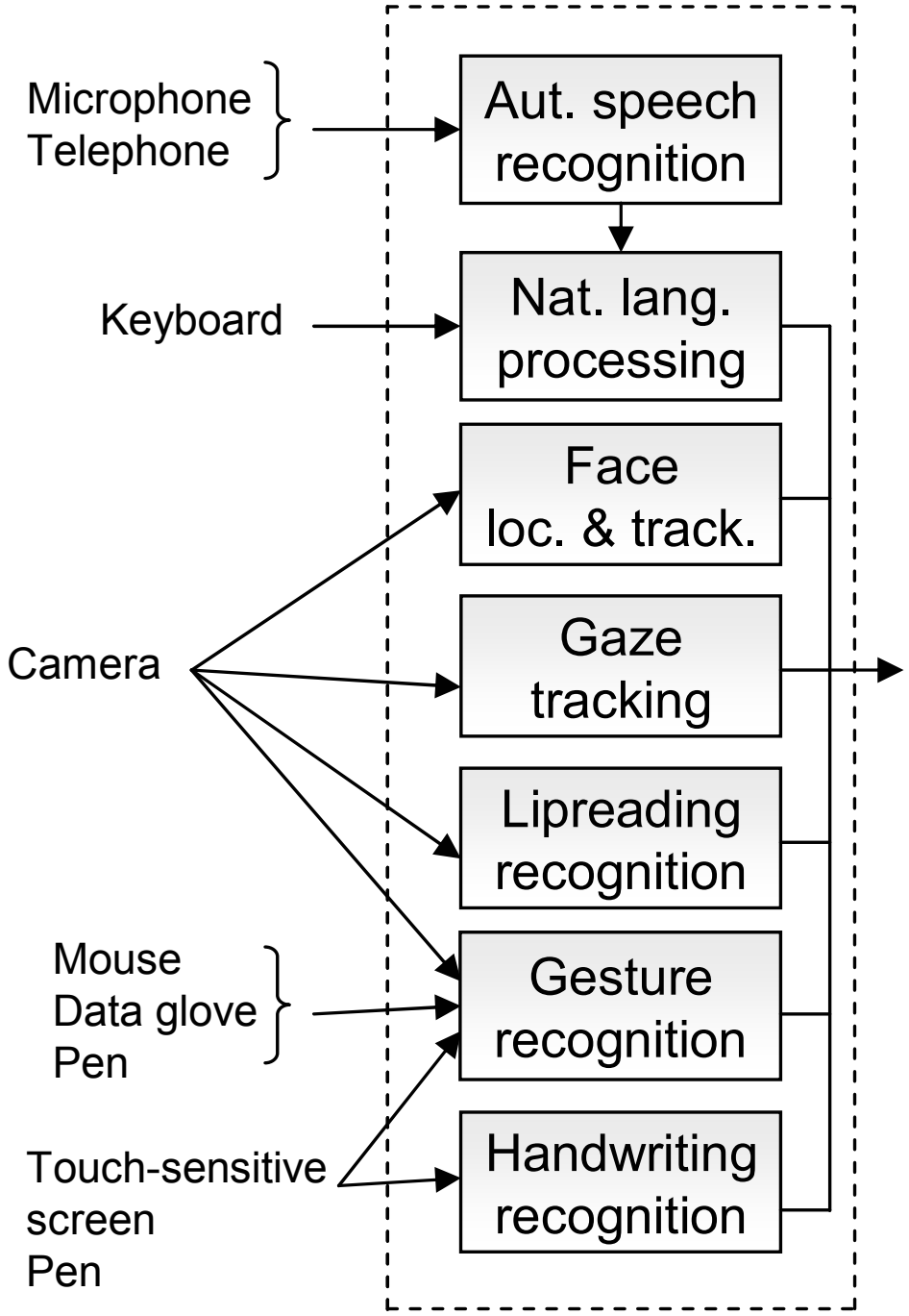
Sensors

Devices

2. Implications of AmI for DSs

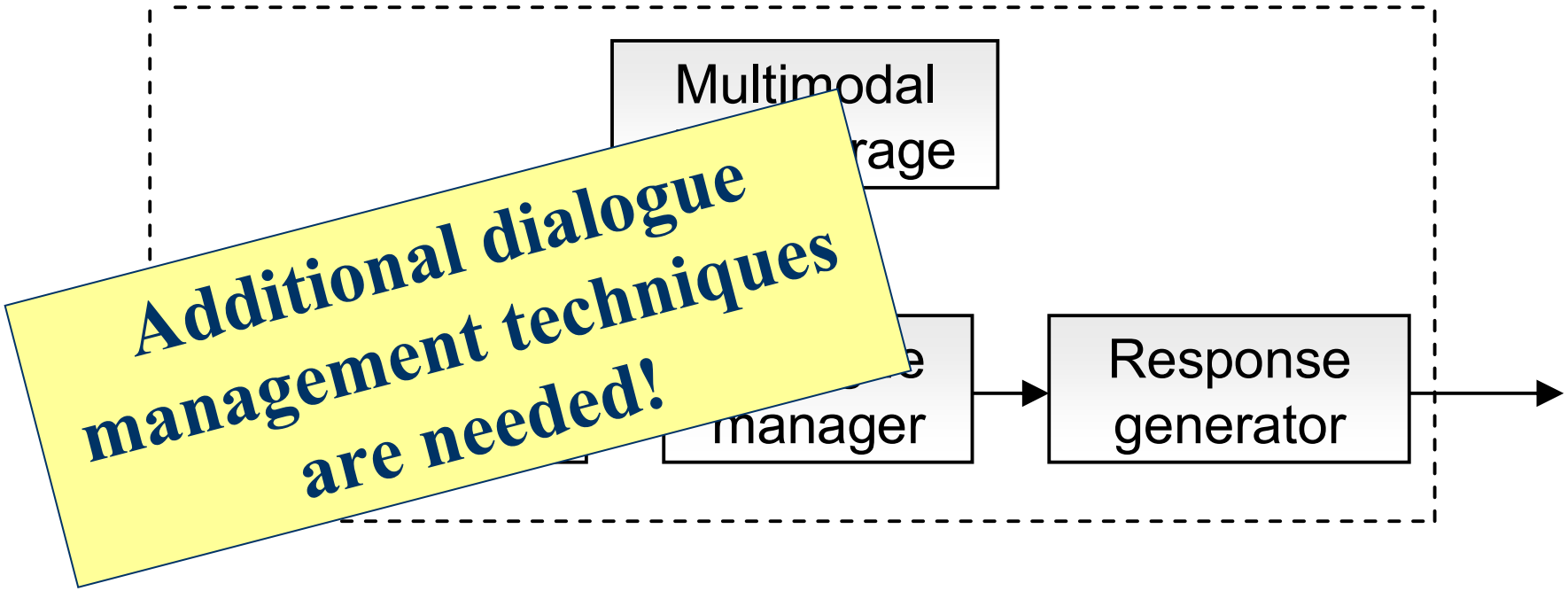
- Fourth generation of DSs
  - Interaction with other entities
    - **Input interface**

Additional processing modules are needed!



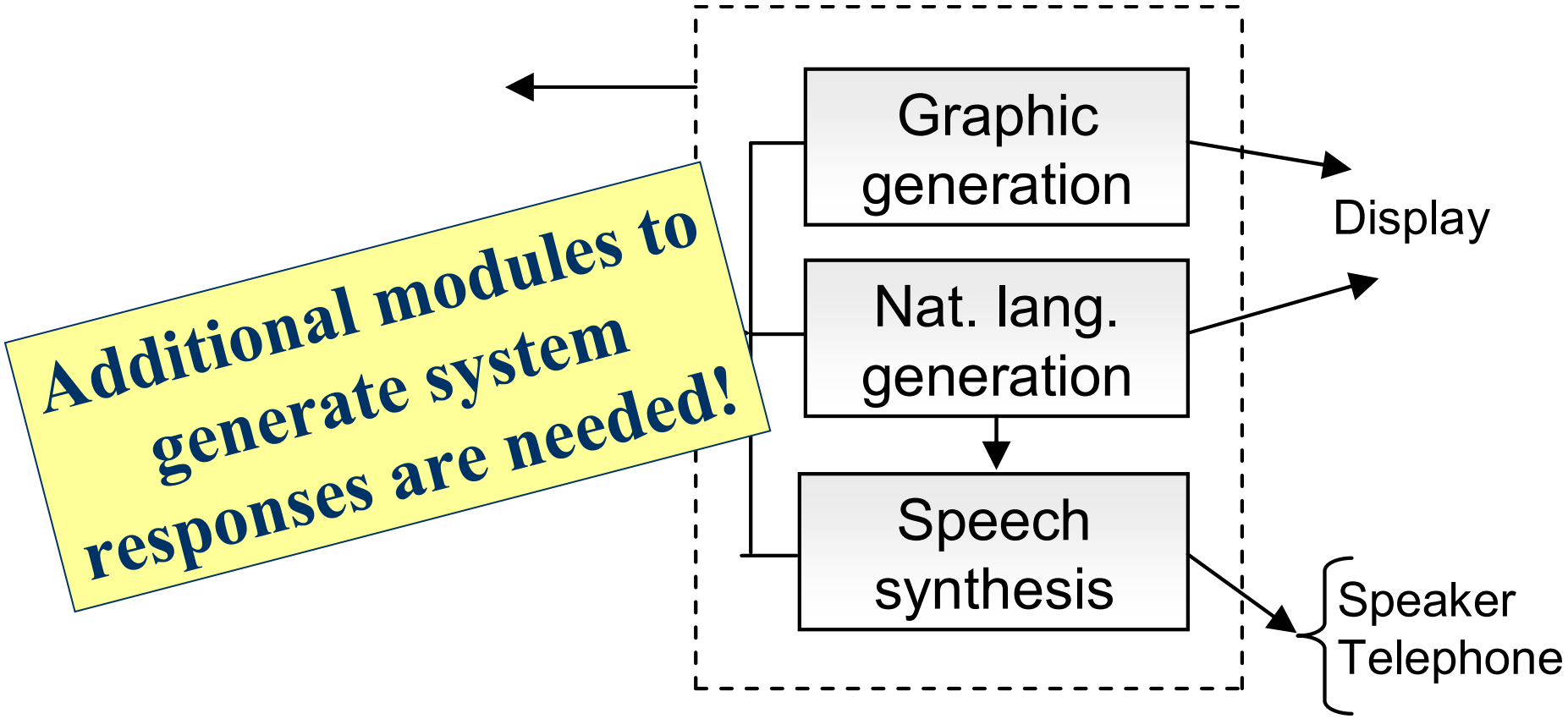
2. Implications of AmI for DSs

- Fourth generation of DSs
  - Interaction with other entities
    - **Multimodal processing**



2. Implications of AmI for DSs

- Fourth generation of DSs
  - Interaction with other entities
    - **Output interface**



2. Implications of AmI for DSs

- Fourth generation of DSs
  - Examples
    - TALK project (2004-2006)
      - SAMMIE system
      - MIMUS system
    - ATRACO project (2007-2013)
      - OwlSpeak dialogue manager
    - HADA project (2008-2011)
      - Mayordomo system

2. … Benefits in mutual cooperation

- Dialogue systems may enable **more natural interaction with the environment**
  - Spoken language is one of the more intuitive human-computer interfaces

2. … Benefits in mutual cooperation

- AmI enables using **context-awareness information to enhance performance of DS**
  - User localisation
  - Status of devices (e.g. home appliances)
  - More efficient dialogues
    - Smaller number of dialogue turns
  - System proactiveness
    - E.g. remainders for students

Talk Overview

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3. Current research at the UGR

HADA project

3. Current research at the UGR

- HADA – Adaptive Hypermedia for Attention to the Diversity in Ambient Intelligence Environments
  - Founding institution: Spanish Ministry for Science and Education
  - Development of new tools and technologies to facilitate universal access to information and services
  - Target users: disable, elderly and non-computer experts
  - Goal: adaptation of developed systems to user needs and preferences

3. Current research at the UGR

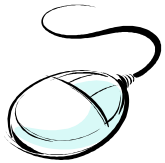
Mayordomo system

3. Current research at the UGR

- **Mayordomo system**
  - Context-awareness dialogue system for an AmI
  - Control of home appliances
  - Users can communicate using their voice or a GUI interface

3. Current research at the UGR

SPEECH INTERFACE



GUI INTERFACE

Home.cfg

ROOMS
APPLIANCES

Light.cfg

ATTRIBUTES
VALUES
(range)

Light.xml
(SRGS Grammar)
ACTIONS

3. Current research at the UGR

- **Mayordomo system**
  - Additional features
    - Any kind of home/appliances
    - Paternal control
    - Different kinds of user (administrator)
    - Install and uninstall of appliances dynamically
    - Log files

3. Current research at the UGR

- **Mayordomo system**
  - **Automatic speech recognition**
    - Windows Vista Speech SAPI 5.3
    - Generic SRGS file
    - Appliance-specific SRGS files

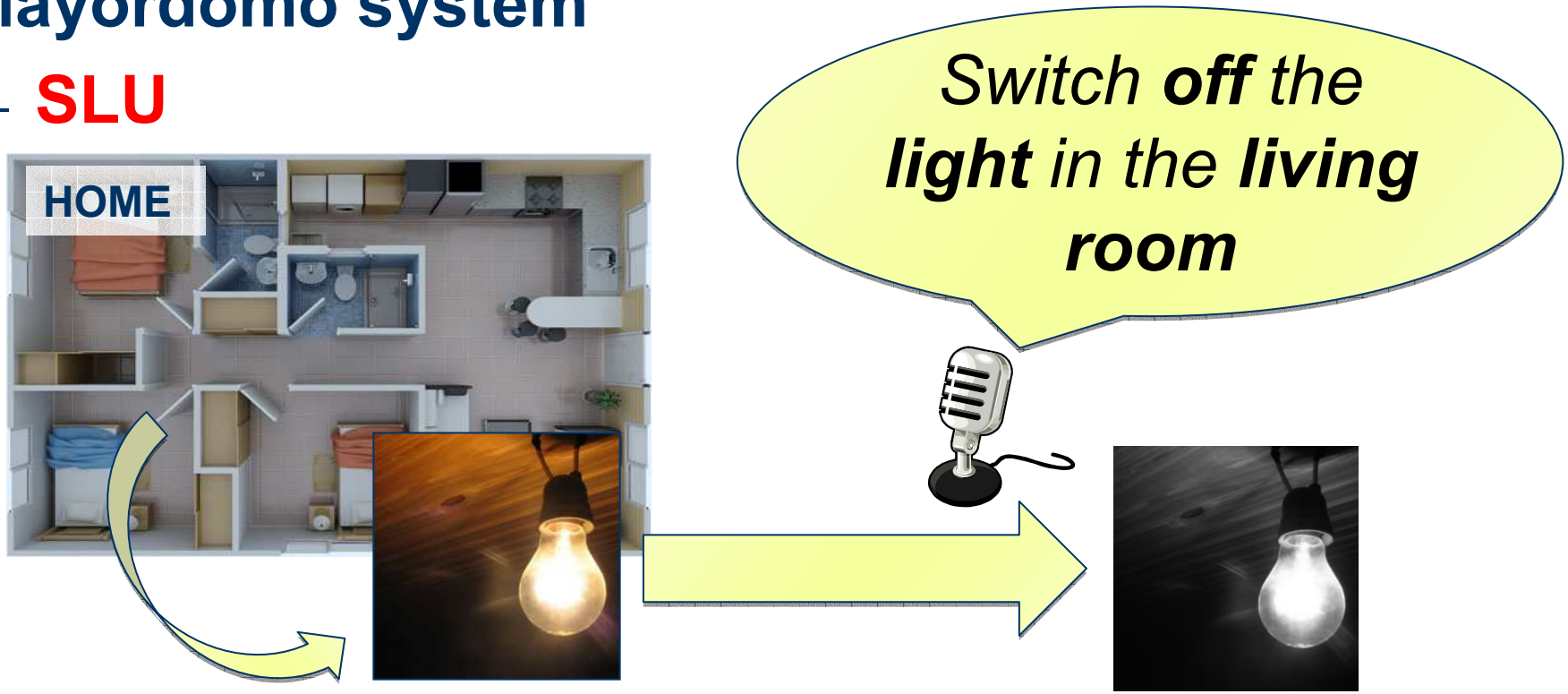
3. Current research at the UGR

- **Mayordomo system**
  - **Spoken language understanding (SLU)**
    - **"ACTION"** frame
      - Search for keywords of specific types in recognised sentence

Room	Place where the appliance is and thus where the **ACTION** is carried out.
Appliance	Device for the **ACTION**.
Attribute	Feature of the appliance affected by the **ACTION**.
Value	Value fore the attribute provided by the **ACTION**.

3. Current research at the UGR

- **Mayordomo system**
  - **SLU**



Room	Living room
Appliance	Light
Attribute	State
Value	**Off**

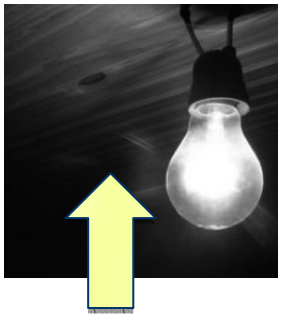
3. Current research at the UGR

- **Mayordomo system**
  - **Dialogue management**

*Switch **off** the **light***

Lack of information

Where?



Room	-
Appliance	Light
Attribute	State
Value	Off

In the living room

Room	Living room
Appliance	Light
Attribute	State
Value	Off

3. Current research at the UGR

- **Mayordomo system**
  - **Sentence generation**
    - Types of sentence
      - Information requested by the user
      - Information about change in appliance status
    - Sentence generation using patterns
      - You have changed to <value> the <attribute> of the <appliance> in the <room>
      - E.g.: *You have changed to on the status of the washing machine in the laundry room*
  - **Speech synthesis**

    TTS engine of Windows Vista

Home

Menu Administrator

switch on the washing machine
living room

OUR HOME

Room: LAUNDRY ROOM

Appliance: WASHING MACHINE

Command

Appliance

Option

- STATE
- TEMPERATURE
- SPIN SPEED
- LOAD
- COLOR
- TEXTILE

Value

- OFF
- ON

Rooms

LIVING ROOM

KITCHEN

LAUNDRY ROOM

BATHROOM

BEDROOM

BEDROOM TWO

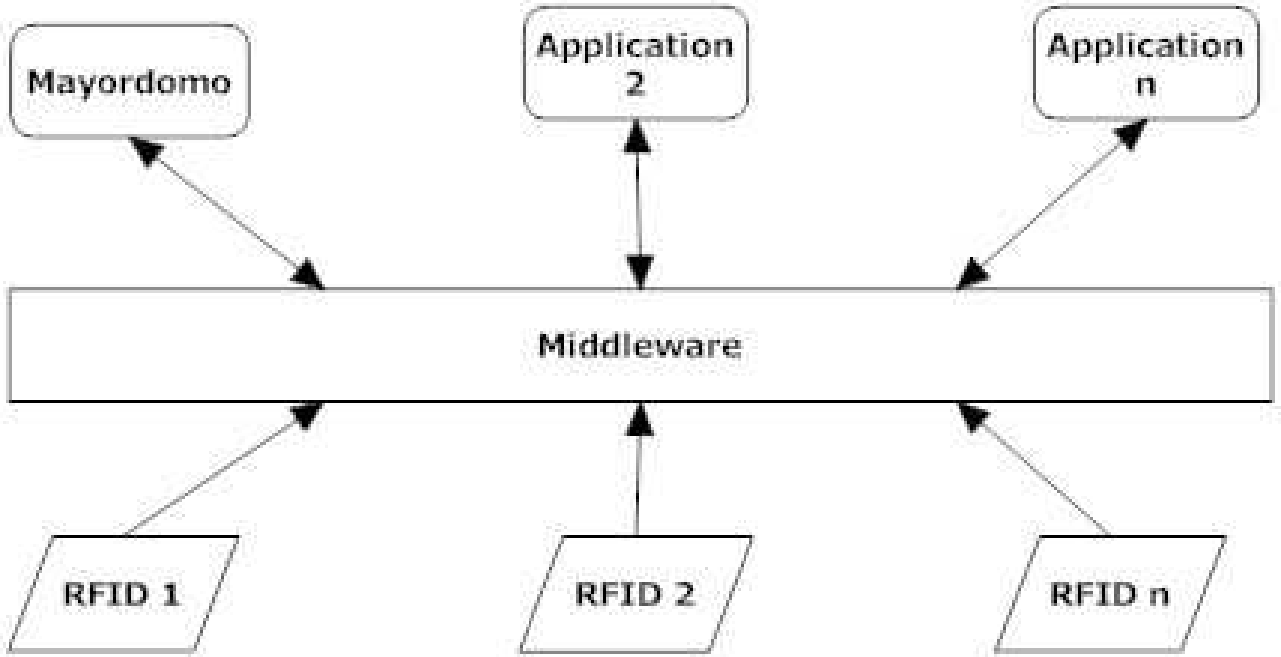
HALL

You have changed to on the state of the washing machine in the laundry room

Nieves 26/06/2009

3. Current research at the UGR

- **Mayordomo system**
  - **Interaction with the Aml environment**
    - RFID **cards** provide information about user localisation
    - RFID **readers** to be installed in different rooms



3. Current research at the UGR

- **Mayordomo system**
  - **Interaction with the environment**

Phidgets

http://www.phidgets.com/

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4. Conclusions

- **AmI**
  - Users are surrounded by “intelligent” objects
  - Environments capable of recognising and responding to presence of different individuals
  - Interaction in these environments allows a number of applications
    - Education
    - Home
    - Transportation
    - Work
    - Leisure
    - Commerce

4. Conclusions

- **AmI**
  - Middleware
    - Software layer that provides services to enable functioning of distributed applications over heterogeneous platforms
  - User profiles
    - Enable environment adaptation to user preferences and needs
  - Learning
    - Enables acquiring patterns of user behaviour
    - Detection of abnormal situations

4. Conclusions

- **AmI**
  - Ethical and privacy issues
    - Wireless technology
      - Potential problems of unauthorised access to information
    - Users must **"trust"** AmI systems
      - AmI systems will be used if they seem to be of benefit without effort and with no risk of compromising privacy

4. Concluions

Challenges for DSs ?

4. Conclusions

- **Challenges for DSs**
  - Concerned with infrastructural aspects
    - Existence of various applications and knowledge sources
    - In some cases, performance in mobile environments with a wide range of devices
      - Seamless and interrupted communication
    - Users may act as composers of AmI environment

4. Conclusions

- **Challenges for DSs**
  - Concerned with dialogue management
    - More diverse interaction
    - Dialogue may be less structured
    - More complex models for understanding user behaviour
    - Adaptability

4. Conclusions

- **Challenges for DSs**
  - Concerned with user expectations and demands
    - Evaluation methods to ensure
      - Usability
      - Acceptability

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