

# Pervasive Learning Environments



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# Agenda

- Part I: Literature survey on PLEs
- Part II: Technologies for PLEs
- Part III: Cases – SciMyst, TekMyst and other \*Mysts.
- Future directions

# PART I

## Literature Survey on Pervasive Learning Environments

# Background

- *Pervasive computing*: Wireless, embedded, networked computing devices all around us. Various sensors provide context-awareness.
- *Pervasive learning*: (m-)learning enhanced with intelligent environment and context-awareness. It is an immersive experience which mediates between the learner's mental (e.g. needs, preferences), physical (e.g. objects, other learners) and virtual (e.g. content accessible with mobile devices, artefacts) contexts (Syvänen *et al.*, 2005).

# Background (cont'd)

- *Pervasive learning environment (PLE)*: is a collection of mobile users, mobile services, mobile devices, contexts and policies (Syukur and Loke, 2007) through which learners can become totally immersed in the learning process.
- Lack of research on:
  - What kinds of PLEs have been developed?
  - How were these PLEs built?
  - What sensor technologies have been used?
  - What learning models have been suggested?
  - What roles do mobile devices have in PLEs?

# Background (cont'd)

- Goal of this literature survey: to build a solid ground for further research on how different learning models can be efficiently utilised in pervasive learning environments and what are the critical features of such an environment.

# Methodology - Questions

- Research questions:
  1. What are the currently existing context-aware pervasive learning environments and how are they built?
  2. What learning models, if any, have been established to support pervasive learning experiences in these environments?
  3. What is the role of mobile devices in existing pervasive learning environments?
- These questions were divided further into more detailed ones.

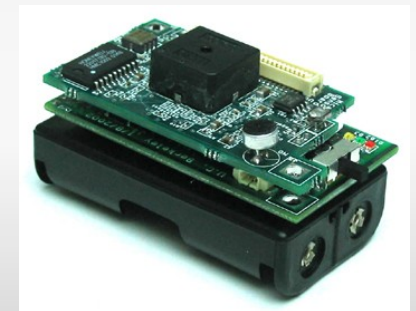
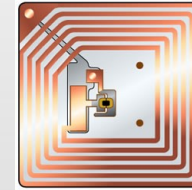
# Methodology – Data

- A set of rules according to which data were collected in two phases.
- Result: 15 pervasive learning environments qualified.
- Collected data were evaluated with the detailed research questions.
- Data collection and evaluation took place in November-December 2007.



# Observation 1 – Sensors

- 60% of the systems utilized RFID.
- 26.7% had a notion on GPS usage.
- Of those which used sensors, 46.7% utilised more than one sensor type.
- Other mentioned sensors: light, moisture, wired triggers, water flow sensors, piezoelectric "object usage" sensors, force, temperature, humidity, infrared distance sensors, motion and touch sensors, cameras, 3D accelerometers and microphones.



# Observation 2 – Learning models

- Only 46.7% discussed learning models and most of these works did not explicitly suggest their suitability.
- However, we managed to extract **8 different learning models** that could be used in pervasive learning environments.
  - **Problem: no validation!**

# Observation 2 – Learning models

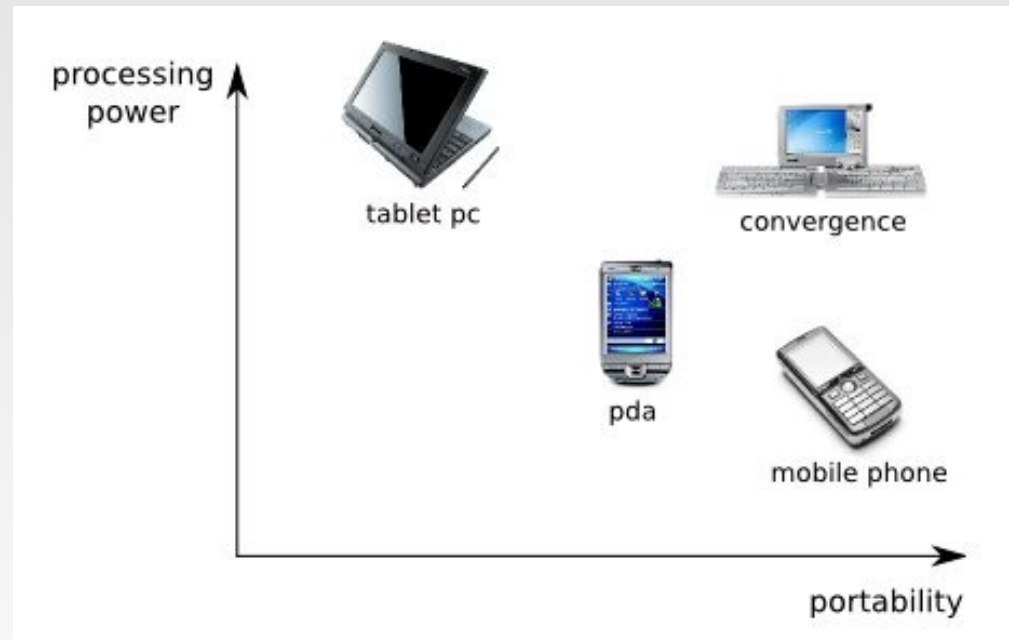
	<i>Learning model</i>	<i>Example</i>
1	Group-based learning	A group of learners manipulate objects on an RFID-enhanced interactive sensor board for museums (Kusunoki <i>et al.</i> , 2002). When an object is placed on the sensor board, a projected image on the board shows more information about the object. The board is able to recognise multiple objects simultaneously.
2	Individual learning	Children use mobile phone's camera and 2D barcodes to gather information of animals both within indoor and outdoor environments (Mitchell and Race, 2005). The children perform the activities independently and communication between the learners is not supported by the system.
3	Microlearning	Learners are continually given small chunks of knowledge of a foreign language through responsive household objects (Beaudin <i>et al.</i> , 2007). When a learner interacts with an object, vocabulary related to the object is played back as sound.
4	Authentic learning	JAMIOLAS is a PLE which allows learners to study Japanese mimicry and onomatopoeic expressions through authentic situations (Ogata <i>et al.</i> , 2006). For example, when a learner goes out and it rains, the system tells the learner an onomatopoeia for raining. The authors explicitly refer to this learning activity as authentic learning.

# Observation 2 – Learning models

	<i>Learning model</i>	<i>Example</i>
5	Learning by playing	PLE constructed by Lampe and Hinske (2007) consists of a set of sensor-enhanced toys and a mobile device. Toy characters respond to children's actions by, for example, telling a historical story or singing a song. This system is a good example of how a pervasive learning environment can be used in a playful manner to educate children.
6	On-demand learning	In LORAMS system, mobile videos and RFID-tagged objects are used to record and share learning experiences (Ogata et al., 2007). There are two types of user role in the system: movie provider and movie consumer. In the latter role, users retrieve movies from the system according to the context, so the learning material is acquired in an on-demand basis.
7	Hands-on / Minds-on learning	LORAMS system supports also hands-on learning as learners can record a video of a hands-on activity, e.g. assembly of a computer hardware, which is then shared to other learners, who can easily imitate recorded activities.
8	Problem-based learning	Derntl and Hummel (2005) describe a pervasive learning environment for a university laboratory in which learners are provided with a set of problem-based learning activities to perform. The objects in the lab are equipped with RFID tags so they can be used as part of the learning process.

# Observation 3 – Architecture and usage of mobile devices

- Most PLEs are based on client-server architecture.
  - 2 environments allowed ad-hoc peer-to-peer communication
- All but one utilised a mobile device as a learning tool.
  - PDA was the most popular of all device types.



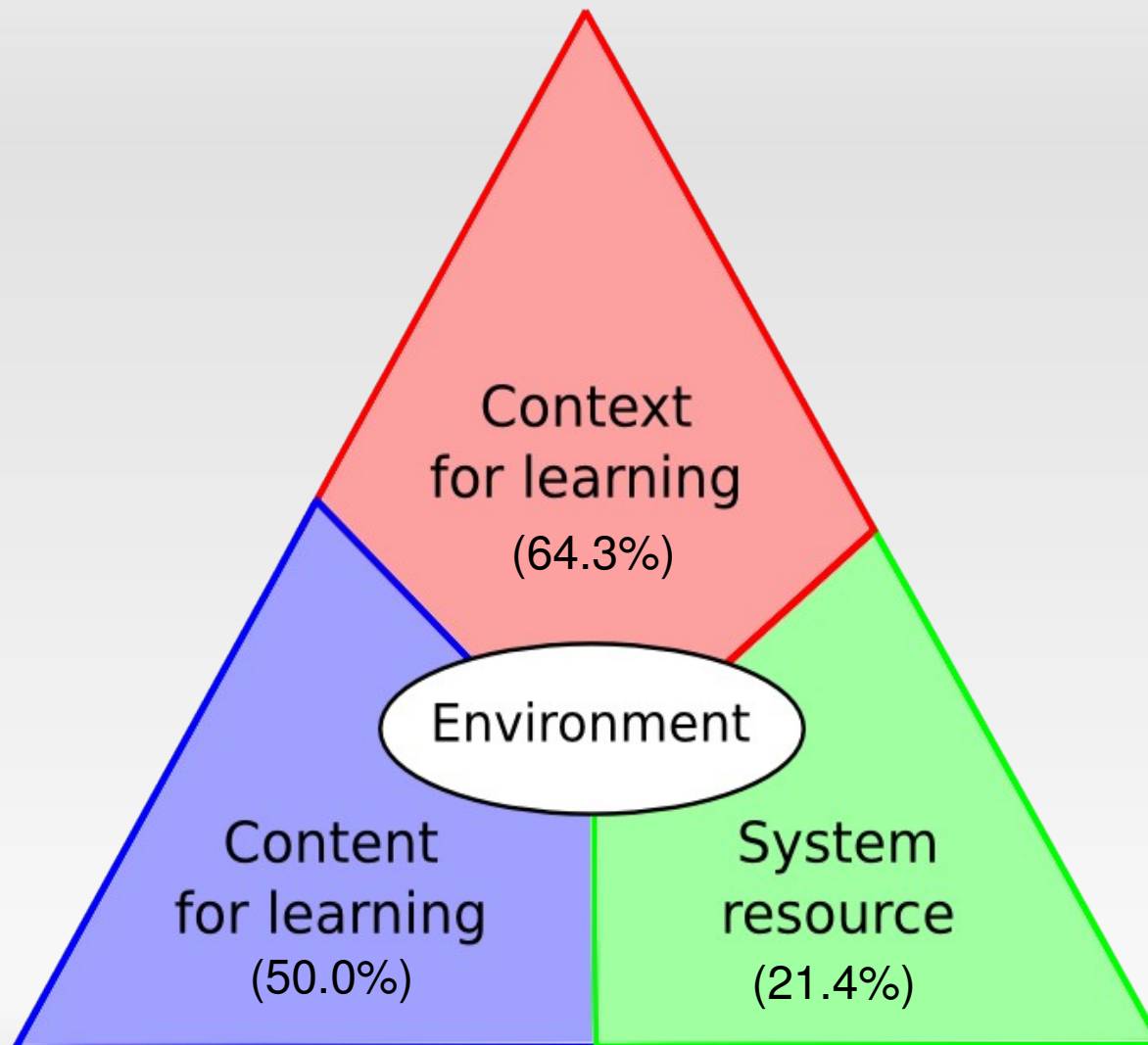
# Observation 3 – Roles of mobile devices

<i>Role of a mobile device</i>	<i>f</i>	<i>Description</i>
Data collection tool	5	Users collect data from the environment by using information capturing features of the device such as camera (still and video images) and/or microphone. Captured data can be processed further by the system or stored as a trace of learning activities, for example.
Content representation tool	13	In this role, mobile devices are used to view context-sensitive content provided by the system. The format of the content represented on mobile devices in the reviewed systems was text, image, audio or video.
Communication tool	4	In some of the systems mobile devices were utilised to establish communication among users of the system.
Navigation tool	2	Mobile devices were used for navigation through GPS or RFID; with the help of the device a user is able to know his/her own location or a location of a specific object within the environment.
Notice receiving tool	2	In two PLEs, different types of announcements and notices were delivered to users' mobile devices, such as reminders and announcements submitted by the teacher.

# Observation 4 - Communication

- Two aspects of multi-user PLE:
  - 1) Support for multiple simultaneous users (80%)
  - 2) Communication (physical or virtual) among users was mediated by the PLE (40%)
- Virtual communication tools: forum, chat, sms, IM and content sharing.
- No voice or video based communication.

# Observation 5 – Roles of the physical environment





# Overview of the Literature Survey

- 1) RFID (Radio Frequency IDentification) is the most prevalent sensor technology used in pervasive learning environments.
- 2) There are several learning models that are suitable for different learning activities in pervasive learning environments, but none of them was validated properly.
- 3) The vast majority of the systems are based on a client-server architecture and most of them utilize mobile devices in various ways; content representation tool was the most common role for mobile devices.
- 4) The majority of the pervasive learning environments support multiple simultaneous users, but only a small number support communication among the users.
- 5) Roles for the physical environment in pervasive learning systems are: context for learning, content for learning, and system resource.

# PART II

## Technologies for PLEs

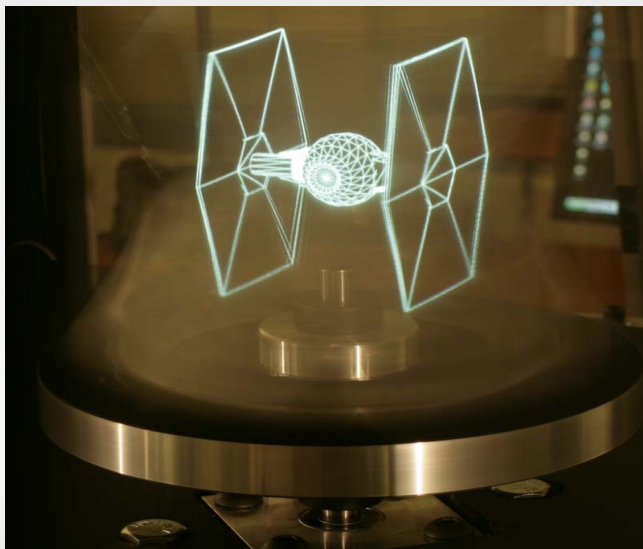
# Technology for PLEs – Future displays



Fog Screen



3D displays

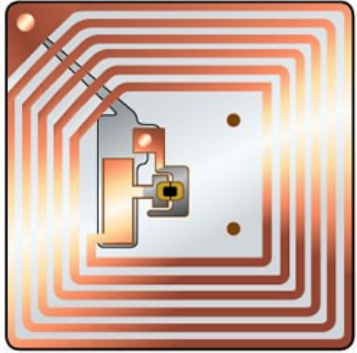


Holographic displays



Miniature projectors

# Technology – Sensors and tags



RFID/NFC



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Barcodes



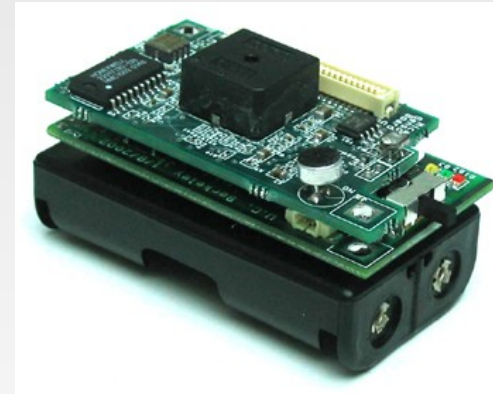
Accelerometer, tilt and optical sensors



Pressure sensors  
(Z-tiles)

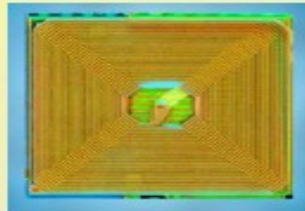
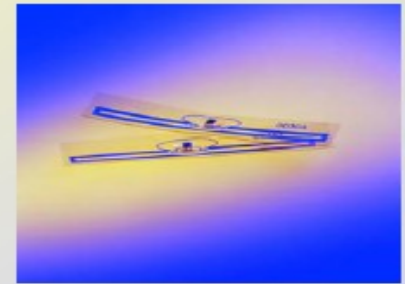


Positioning (GPS)



Environmental sensors  
(e.g. thermal, sound, humidity)

# Technology - RFID



Passive



135KHz

13.56MHz

433.92 MHz

UHF(862-928MHz)

2.45GHz

ISO 18000 part 2

part 3

part 6 (GTAG)

part 4

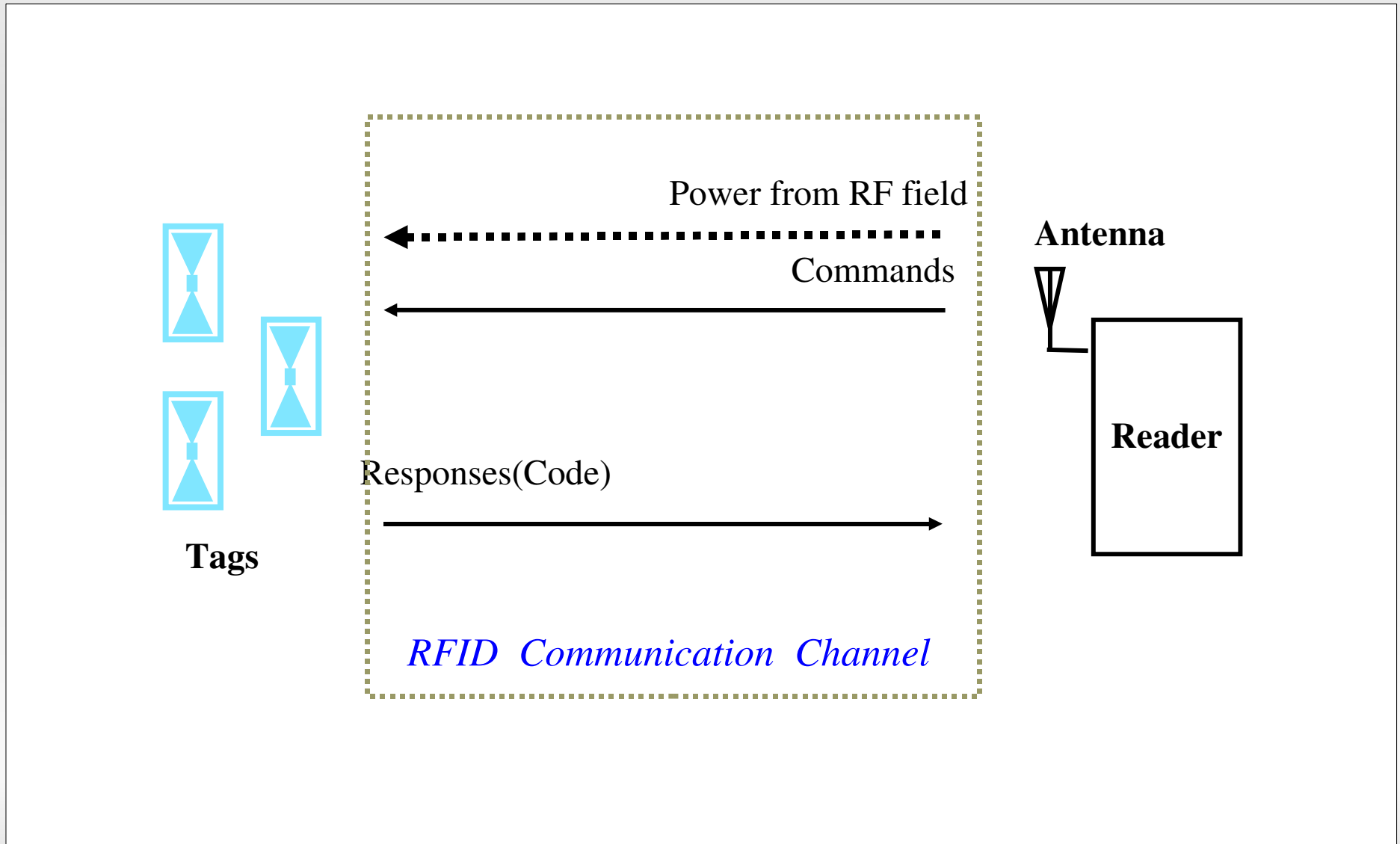
Inductive

Electromagnetic



Active

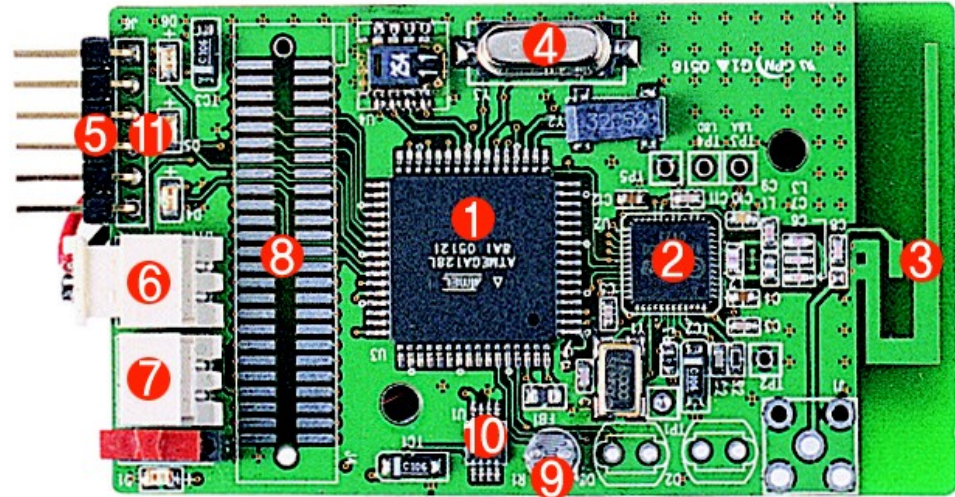
# RFID Communication Model



# Wireless Sensor Networks

- Networked, low cost and low power sensor nodes.

- 1. CPU - ATmega128L
  - 2. RF Chip - CC2420
  - 3. Antenna
  - 4. Clock
  - 5. Serial port
  - 6. Battery power input
  - 7. External power input
  - 8. Extension connector
  - 9. Luminance sensor
  - 10. Temperature sensor
  - 11. LED (red, yellow, green)
- + infrared and humidity sensors



ZigBeX mote (Hanback Electronics)

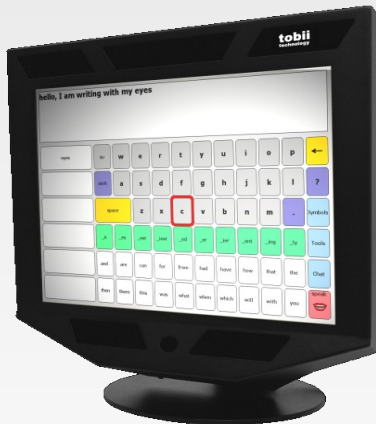
# Technology – Input and authentication



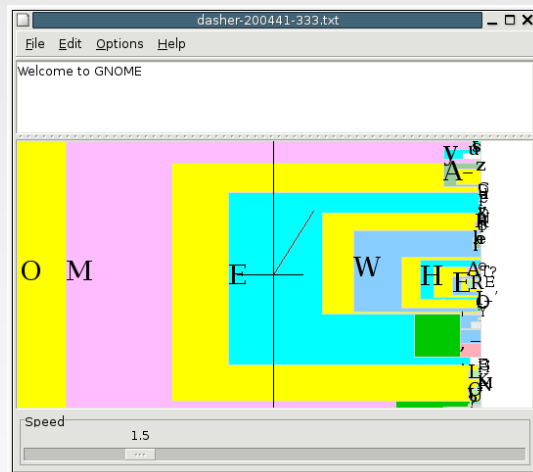
Speech/voice recognition



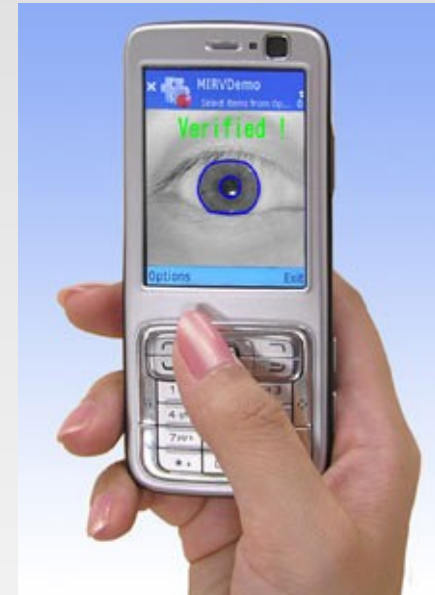
Haptic user interfaces



Eye tracking



Alternative text input



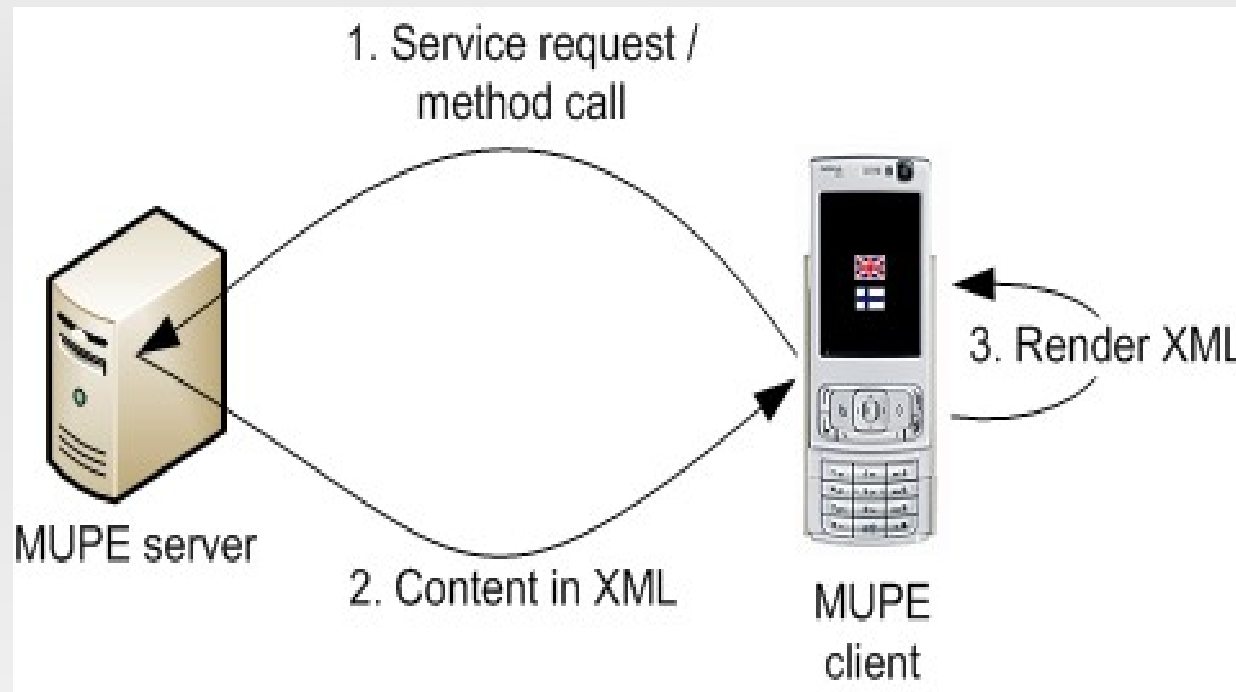
Biometrics (fingerprints, iris scanner, voice, face recognition)



# Technology – MUPE platform

- Multi-User Publishing Environment from Nokia
- Open source, Java-based client-server approach for multi-user mobile applications.
- J2SE for server-side functionality, XML for client.
- Easy access to phone's features: camera, sound video, BlueTooth, location (GPS).
- Works in theory on all J2ME enabled phones, but:
  - Applications tend to be memory hungry.
  - Features like GPS are not in all phones.
- Plugin API: e.g. 2D barcode, NFC plugin

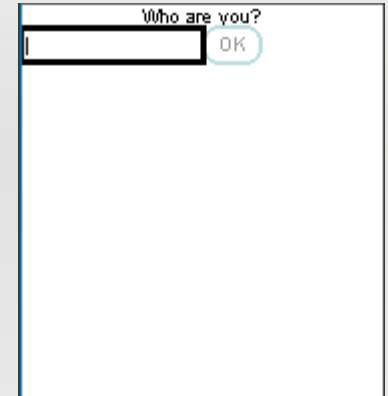
# Technology – MUPE – How it works?



# Technology – MUPE Hello World

Hello world – client code (pushed from the server):

```
<canvas>
  <string id='hello' text='Who are you?' halign='center' width='100%' />
  <prompt id='name' anchor='top_left/bottom_left/hello' />
  <button text='OK' anchor='center_left/center_right/name'>
  <on_select>
    <send>!#this#!::clientMyMethod {$(name.text)}</send>
  </on_select>
</button>
<allowuserinput />
</canvas>
```



Hello world – server code:

```
public String clientMyMethod(User caller, String name) throws MupeException {
  String greeting = "Hello, "+name+"!";
  return "<settext id='hello' text='"+greeting+"' />";
}
```



- Development tools: Eclipse+MUPE plugin, Sun Wireless Toolkit, MUPE libraries.

# PART III

Cases: SciMyst, TekMyst and  
Other \*Mysts

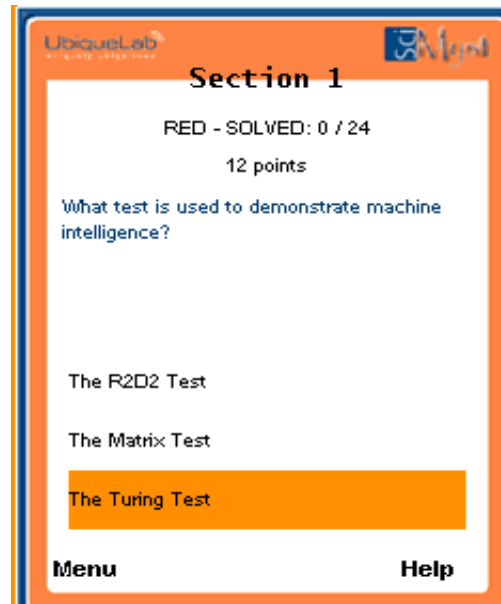
# SciMyst

- A multilingual pervasive mobile adventure game with multiplayer characteristics.
- Presented at the SciFest 2007 & 2008 in Joensuu
- Aim: engage and motivate visitors of the festival to explore the environment in a novel way.
- Players use their mobile devices to adventure through a real world game environment by solving intriguing problems (enigmas) related to the surrounding objects and phenomena.
- Different types of enigmas: from *multiple choice* enigmas to more activating *find-an-object* enigmas.
- Suitable for players of all ages.

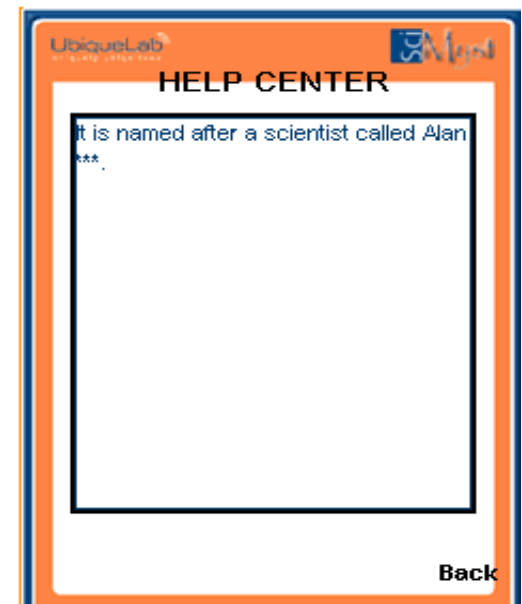
# SciMyst (2)

- Help feature has been implemented in multiplayer mode
  - Social interaction among players and NPCs
- Game arena is divided into sectors.
  - Moving from one sector to another done by *smart tags* (barcodes, RFID)
- Game has three modes:
  - Basic – no time limitation, reduction of points from wrong answers.
  - Battle – countdown counter and penalty points for wrong answers. To be played after the basic mode, as the *final battle*.
  - Record impressions: player takes photos and adds comments. These *impressions* are then shown on the website.
- Common goal of all players: beat the ever-growing ignorance!
- Real-time [website](#) integration

# SciMyst (3)



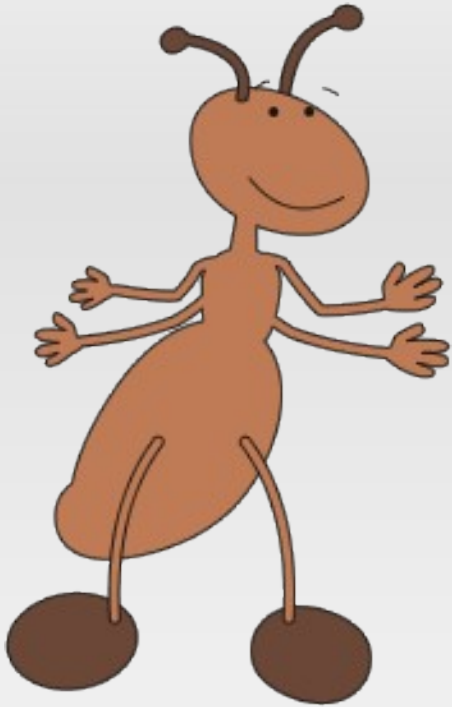
a)



b)

- a) multiple choice enigma
- b) context help for the enigma

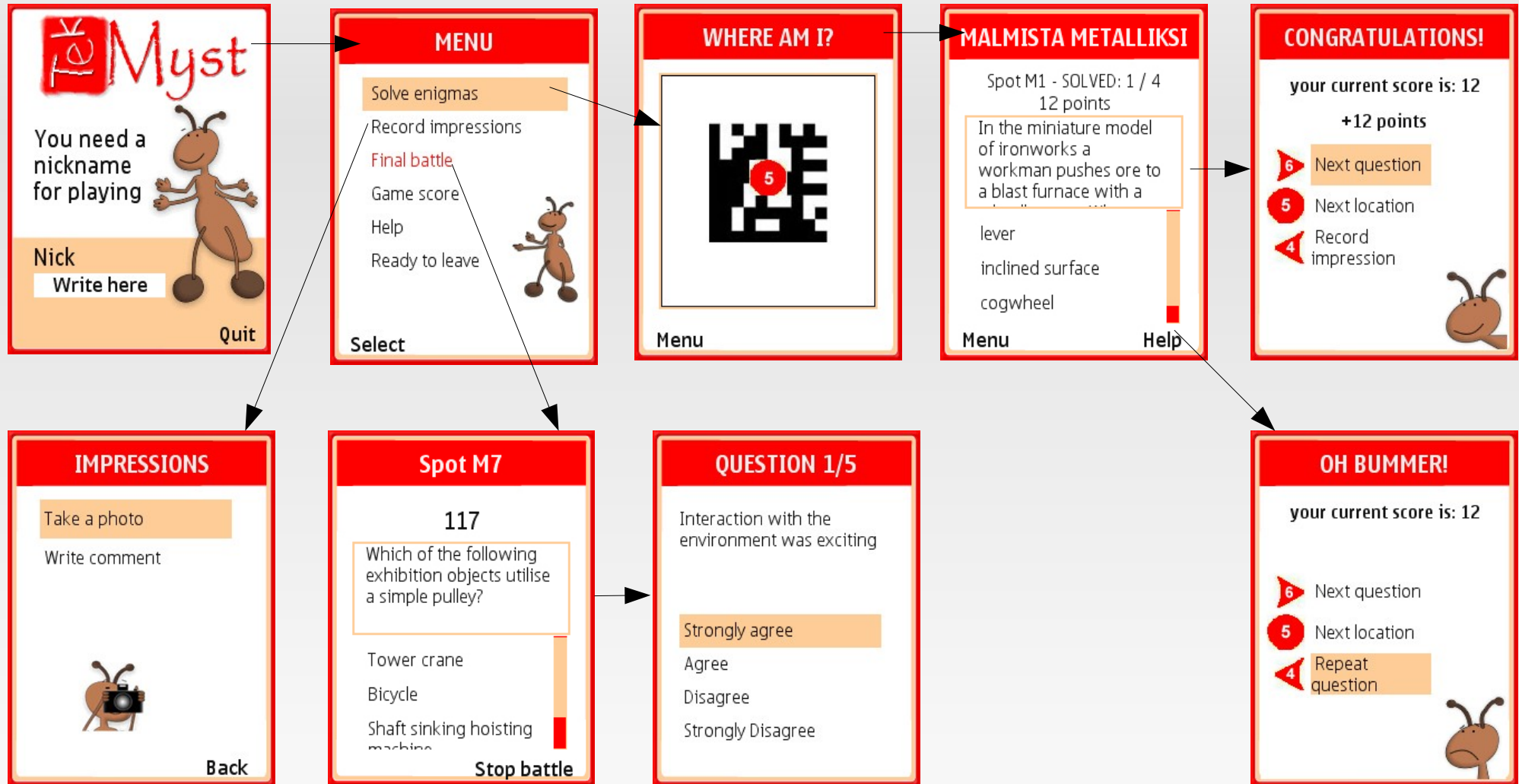
# TekMyst



- Enhanced version of SciMyst for the Museum of Technology in Helsinki.
- Aim: an alternative way to gain knowledge at the museum (and help the ants).
- Fascinating story about ants and sharing knowledge.
- Was tested from 25<sup>th</sup> to 31<sup>st</sup> August 2008.
- [website](#)



# TekMyst (2)



# Upcoming Mysts - LieksaMyst

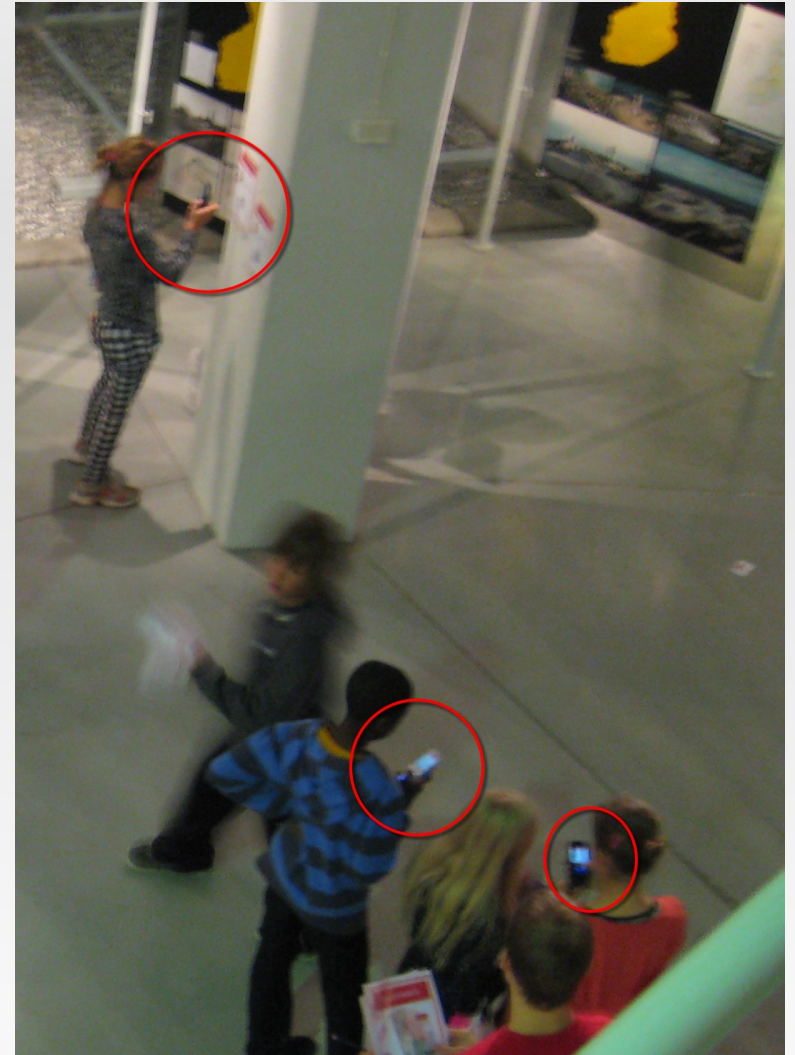
- *LieksaMyst* (working title) for Museum of Pielinen in Lieksa, Finland
  - 2<sup>nd</sup> largest outdoor museum in Finland
  - Over 100,000 objects and over 70 buildings and structures.
- A role-playing approach to immerse learner into a "time travel" experience.
- Participatory design workshops ran during Summer 2008.
- First tests in November 2008.

# Upcoming Mysts - MathMyst

- *MathMyst* is a context-aware math training application for African context (and why not elsewhere!)
- Idea: learn contextual mathematics through everyday problem solving practices.
- Takes into account learner's cultural and educational background, skills, learning style, speed and personal preferences.
- Research *with* people rather than *on* them.
- Still a concept.

# Future

- Developing process of the Myst PLE platform continues(SciMyst, TekMyst,...).
  - For schools, fairs, museums, amusement parks, art houses, companies...
- Investigation on how discovered learning models can be efficiently applied in PLEs in various environments.
- Goal: make learning ubiquitous and fun.



TekMyst @ the Museum of Technology  
in Helsinki, August 2008

Thank you!

Questions?