A Multi-Agent Based System for Activity Configuration and Personalization in a Pervasive Learning Framework

María Felisa Verdejo
Carlos Celorio

LTCS Group – UNED - Spain

PerEL 2007, NY
Outline

- **Introduction**
  - ENLACE Project
  - Pervasiveness in Learning Processes

- **Educational network infrastructure**
  - Configuration & Adaptation Problem
  - Our Approach

- **Multi-Agent Based Architecture**
  - Description
  - Application Domain Model
  - Agent Organization

- **Conclusions**
ENLACE Project

- Spanish National Research Project
  http://enlace.uned.es

- Explores the design of an innovative educational environment

- Technology seamlessly supporting the flow of learning activities in different contexts and settings
Enlace Project

- Students are engaged both in individual and collaborative activities
  - compiling information
  - analyzing and representing data
  - building models to explain and predict behaviour
  - exchanging and discussing their findings
  - linking their view with real problems
**Pervasiveness in Learning Processes**

- The learning workflow includes activities
  - for a long term period (to be carried out either in sequence, parallel, or overlapping in time)
  - in different scenarios (classroom, home, computer lab, field trips...)

- Ubiquitous context challenging the integration issue through
  - the school curriculum
  - location
  - time
  - social organization levels
  - across devices
  - interoperability
  - connectivity
Pervasiveness in Learning Processes

- Smooth flow throughout the scenarios of activities
- Users can create artefacts that will be reused in other tools, in other devices, or even different students in different contexts.
- Sustain seamless data and tool interoperability, through an educational network infrastructure
  - a variety of mobile devices
  - computer tools
  - connectivity conditions
Outline

● Introduction
  ● ENLACE Project
  ● Pervasiveness in Learning Processes

● Educational network infrastructure
  ● Configuration & Adaptation Problem
  ● Our Approach

● Multi-Agent Based Architecture
  ● Description
  ● Application Domain Model
  ● Agent Organization

● Conclusions
Educational network infrastructure

- The backbone of the technological infrastructure is a Learning Object Repository (LOR)
  - a) a persistence mechanism for tools
  - b) a web interface for accessing artefacts

- Technical conditions of the scenarios can be significantly different

- Configuration & Adaptation
Configuration & Adaptation
Problem

- Previous prototypes: ad-hoc configuration.

- Resources are transferred manually:
  - previous on-going work stored in the LOR that students have to consult or to complete
  - software items for the configuration of the tools
This infrastructure management task is a complex one.

Objective:
- Configuration mechanism for adapting and deploying the resources for a set of planned activities
- Declarative model intelligent enough to adapt the services provided to a particular situation
Our Approach

- A new layer for our educational network architecture
  - configuring the network for a scenario
  - distributing and deploying the needed software resources over different nodes.
  - offer computationally adapted support for a set of learning activities in a particular context
  - model the technological deployment of a scenario design,
  - perform an adapted and personalized configuration of resources

- Based on agents
Outline

- Introduction
  - ENLACE Project
  - Pervasiveness in Learning Processes
- Educational network infrastructure
  - Configuration & Adaptation Problem
  - Our Approach
- Multi-Agent Based Architecture
  - Description
  - Application Domain Model
  - Agent Organization
- Conclusions
Multi-Agent Based Architecture

- Responsible for setting up all the required tools, their data and the learning objects for the user’s activity with the devices.
  - **Installing** and **managing** all necessary software in an automated way on the collection of devices involved in the activity, and
  - **Configuring** and **initializing** the device for the activity as well as personalizing it for a specific student.
Multi-Agent Based Architecture

- Agent based component management system: BOGAR
- This multi-agent platform has been used to develop fully operative distributed industrial applications running on low cost machines.
- Four categories of reusable component models:
  - agent organization models to describe the overall structure of the system
  - agent models
  - resource models to encapsulate computing entities providing services to agents
  - basic computing entities
Multi-Agent Based Architecture Description

Configuration/Personalization Module

Specialist Agents:
- Context Agent
- Resource Mining Agent
- Personalizing Agent

Reactive Agents:
- Resource Agent
- Agent Manager

Internal Resources:
- User profiles
- Learner models

External Resources

LOR

Learning Community Portal

SOFTWARE TOOLS

Devices

PDA

Laptop

Interactive Blackboard

Remote Experimentation Device

Desktop Computer

Configuration/Personalization Module

uses

uses

uses

uses

uses

configure

communicate

use
Multi-Agent Based Architecture Description

**Devices**
- PDA
- Laptop
- Interactive Blackboard
- Remote Experimentation Device
- Desktop Computer

**Configuration/Personalization Module**
- **Specialist Agents:**
  - Context Agent
  - Resource Mining Agent
  - Personalizing Agent
- **Reactive Agents:**
  - Resource Agent
  - Agent Manager

**Application Domain Model**
- Internal Resources:
  - User profiles
  - Learner models

**External Resources**
- Learning Community Portal
- SOFTWARE TOOLS
- LOR

**Internal Resources:**
- User profiles
- Learner models

**External Resources:**
- Learning Community Portal
- SOFTWARE TOOLS
- LOR
Multi-Agent Based Architecture Description

Configuration/Personalization Module

Specialist Agents:
- Context Agent
- Resource Mining Agent
- Personalizing Agent

Reactive Agents:
- Resource Agent
- Agent Manager

Application Domain Model

Internal Resources:
- User profiles
- Learner models

External Resources

SOFTWARE TOOLS

Learning Community Portal

LOR

Devices
- PDA
- Laptop
- Interactive Blackboard
- Remote Experimentation Device
- Desktop Computer

Device Agents

Communicate

Configure

Use

Configure

Uses

Uses

Uses
Multi-Agent Based Architecture Description

Configuration/Personalization Module

Specialist Agents:
- Context Agent
- Resource Agent
- Mining Agent
- Personalizing Agent

Reactive Agents:
- Resource Agent
- Agent Manager

Application Domain Model

Internal Resources:
- User profiles
- Learner models

External Resources

SOFTWARE TOOLS

LOR

Learning Community Portal

Devices

- PDA
- Laptop
- Interactive Blackboard
- Remote Experimentation Device
- Desktop Computer

Device Agents

use

communicate
Multi-Agent Based Architecture Description

**Devices**
- PDA
- Laptop
- Interactive Blackboard
- Remote Experimentation Device
- Desktop Computer

**Configuration/Personalization Module**
- Specialist Agents:
  - Context Agent
  - Resource Mining Agent
  - Personalizing Agent
- Reactive Agents:
  - Resource Agent
  - Agent Manager

**Application Domain Model**

**Internal Resources:**
- User profiles
- Learner models

**External Resources**
- SOFTWARE TOOLS
- LOR
- Learning Community Portal

**Communications**
- Device Agents
- use
- configure
- communicate

**Uses**
- Application Domain Model uses Internal Resources
- Internal Resources uses External Resources
Multi-Agent Based Architecture Description

Configuration/Personalization Module

Specialist Agents:
- Context Agent
- Resource Mining Agent
- Personalizing Agent

Reactive Agents:
- Resource Agent
- Agent Manager

Application Domain Model

Internal Resources:
- User profiles
- Learner models

External Resources

SOFTWARE TOOLS

Learning Community Portal

Devices

- PDA
- Laptop
- Interactive Blackboard
- Remote Experimentation Device
- Desktop Computer

Device Agents

communicate

use

uses

uses

uses

uses

configure
Application domain model

- Represents all the entities understood by the agents
- Holds information about all the elements relevant for a context in terms of:
  - (1) a user in a setting
  - (2) an activity in a learning design
  - (3) the social organization
  - (4) the definition and type of learning objects in a LOR,
  - (5) the definition of the technical support
Agent Organization

- The model in which a group of agents collaborate to achieve system functionality corresponds to an agent organization.
- The components of the agent organization we are designing include:
  - a resource agent and agent manager
  - specialist agents for adaptability and personalization tasks,
  - device agents that are in charge of configuring device’s applications and presenting the information prepared by the specialist agents.
Resource Agent and Agent Manager

- They are responsible for the correct functioning of the system.
- The Agent Manager monitors the state of the agents of the organization and initializes them.
- The Resource Agent is able to access the external resources via web services,
  - the LOR for retrieving learning objects
  - learning community portal for retrieving users, groups, etc.
Specialist agents.

- Specialist agents are implemented as cognitive agents.
- The architectural pattern of a cognitive agent, based on a belief-desire-intention (BDI) processor
- The specialist agents are:
  - Context Agent
  - Resource Mining Agent
  - Personalizing Agent
Specialist agents.

- Specialist agents are implemented as cognitive agents.
- The architectural pattern of a cognitive agent, based on a belief-desire-intention (BDI) processor.
- The specialist agents are:
  - **Context Agent**
  - Resource Mining Agent
  - Personalizing Agent
Specialist agents.

- Specialist agents are implemented as cognitive agents.
- The architectural pattern of a cognitive agent, based on a belief-desire-intention (BDI) processor
- The specialist agents are:
  - Context Agent
  - **Resource Mining Agent**
  - Personalizing Agent

![Diagram of agent architecture](image-url)
Specialist agents.

- Specialist agents are implemented as cognitive agents.
- The architectural pattern of a cognitive agent, based on a belief-desire-intention (BDI) processor
- The specialist agents are:
  - Context Agent
  - Resource Mining Agent
  - Personalizing Agent
Device Agents.

- Platform dependent agent
- Interface Agent for user
- Information about the device’s specific hardware capabilities and available software tools.
- Enable and configure the tools, and then expose them to the user
- Communicates with the other agents using web services
Outline

- Introduction
  - ENLACE Project
  - Pervasiveness in Learning Processes
- Educational network infrastructure
  - Configuration & Adaptation Problem
  - Our Approach
- Multi-Agent Based Architecture
  - Description
  - Application Domain Model
  - Agent Organization
- Conclusions
Conclusion and Future Work

- This approach proposes a system for the personalized deployment of activities in ubiquitous learning scenarios as an agent-based distributed computational environment.
- The AI techniques support the management of current models and configuration profiles in a declarative way, offering full flexibility to evolve in order to capture a broader range of relevant data and goals.

- Particular applications of agents to achieve a specific purpose can be added.
  - i.e. Personal Agents
    - React to spontaneous and not planned events
- Evaluation
A Multi-Agent Based System for Activity Configuration and Personalization in a Pervasive Learning Framework

María Felisa Verdejo
Carlos Celorrio

LTCS Group - UNED

PerEL 2007, NY