An Implemented Prototype of Bluetooth-based Multi-Agent System

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Motivation

- Cellular phones are used
  - for traditional communication,
  - recently – help users to satisfy their information needs (information search, data exchange)

- Cellular phones localize their users
- Co-located group of people often have similar interests and (information) needs
- Co-located users equipped with mobile devices can form mobile virtual communities and potentially collaborate and exchange information
An Example
Our objective

Develop applications of multi-agent systems accessible via mobile devices where Bluetooth technology is adopted to reflect users' locality.
What’s new?

- Multi-agent applications to **mobile** devices environments
  - KORE (Bombara, Cali’, Santor, WOA’03) – personal electronic museum guide on mobile device
  - MobiAgent (Vasiu, Mahmoud, ‘04) – agent-based framework, allows users to access various types of services using cellular phones and PDAs

- Few domain specific proposals of **collaborative** environments
  - Context-aware multi-agent system for agenda management (Bucur, Beaune, Boissier, CRR’05)
  - ADOMO (Carabelea, Berger, Ambient Intelligence Workshop at AAMAS’05) – agent-based system, agents running on mobile devices sell space on device’s screen to commercial agents for their advertisements.

- We propose
  - A **general mobile devices environment** where different type of multi-agent applications can be integrated (like ANEMONE)
  - a **collaborative environment** where interacting and collaborative agents act on behalf of their users forming **localized virtual communities**

- Main **features**
  - domain independent (does not depend on the specific services)
  - independent from the multi-agent technology adopted
  - low interaction with the user
ToothAgent

- Main idea: distributed system composed of open virtual communities that evolve and act autonomously on behalf of human communities

- Independent servers with multi-agent platforms on them where agents act on behalf of their users

- Users activate and exchange information with their personal agents using Bluetooth-enabled mobile phones or PDAs (note: there are no agents on mobile devices!)

- Each server proposes specific services related to the location in which it is situated
  - Examples: Buy/sell secondhand books, find a roommate, find a traveling companion, car sharing, etc.

- The system integrates a number of independent multi-agent applications
An Example
Getting Access to Services

1: request for available services
3: show available services
4: request for service(s)
5: configuration file
12: results
6: establish connection
7: request for service(s)
11: results
8: create/update personal agent
9: agents interaction
10: results

SERVICES DB

USER

MOBILE DEVICE

SERVER

PC

Multi-Agent Platform

Personal Agent of Mobile Device, deviceID = x.x.x

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Getting Pending Results

- **A1**: request for p.r. deviceID = x.x.x
- **A2**: list of visited servers
- **A3**: request : deviceID = x.x.x
- **A4, A5**: find results for deviceID = x.x.x
- **A6**: pending results
- **A7**: pending results
- **B1**: list of visited servers
- **B2**: request for p.r.
- **B3**: request : deviceID = x.x.x
- **B4**: find results
- **B5**: pending results
- **B6**: pending results
- **B7**: pending results
Implementation details

- Implemented in Java.
- Bluetooth communication based on Blue Cove, open source implementation of JSR-82 Bluetooth API for Java.
- Multi-agent systems implemented in JADE (Java Agent DEvelopment Framework).
- Tested with Nokia 6260 cellular phones and PC/Server equipped with Tecom Bluetooth adapter.
Accessing the service

1: Bluetooth address
2: Server IP
3: Password
4: Verify agent data
5: If (No agent) Agent data
6: "Registered" or "Not registered"
7: If (Not registered) "Reject" else "Accept"
8: If (No agent & Registered) Request for agent creation
9: Configuration file
10: Request for service
11: "Agent is active"
12: Agents
13: Results
14: Verify presence request
15: "Connected" or no response
16: If (Connected) Bluetooth address
17: Results
18: Results

If (Reject)
Stop connection
Pending Results Retrieval

1: Bluetooth address
2: IPs of visited servers (from #1 to #n)
3: Bluetooth address
4: Bluetooth address
5: “Found” or “Not found”
6: If (Found)
7: Pending results
8: Verify presence request
9: “Connected” or no response
10: If (Connected)
    Pending results

Mobile Device

Server: Comm. Module

Visited Server #k: Comm. Module

Visited Server #k: Database

Mobile Device

PC

Visited Server #k: Comm. Module

Visited Server #k: Database

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Implicit Culture allows (new) members of a community to behave in accordance with the culture of the community (culture support).

An Expert Agent inside each platform supports the culture of the community.

System for Implicit Culture Support (SICS)
Buy/sell books Service

Problem: Personal agent (user) may not have enough knowledge to formulate the request.

For instance: *I want to buy a secondhand book on Java.*
  – Price? (good price)
  – Title of the book? (Title of good book on Java)
The **Expert Agent** provides a set of suggestions related to the Personal Agent request:

- *Thinking in Java* -- the most bought/sold book on java in the community
- 20 € -- the average price for the book *Thinking in Java*
System Demo

QuickTime™ e un decompressore sono necessari per visualizzare quest'immagine.
Conclusion and Future Work

- **ToothAgent**: an implemented prototype of bluetooth-based MAS
  - Supports co-located communities of users
  - Domain and Agent Technology independent
  - Based on the Implicit Culture support framework
  - Able to integrate a number of localized services

- Testing of the system with a number of services located in different areas of Trento
  - University/faculties/departments, museums and other tourist attractions, restaurants, bars, etc.
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