Service Composition in Open Agent Societies

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Agentcities

● Agentcities is a worldwide initiative
  - Realise the commercial and research potential of agent-based applications
  - Construct a worldwide, open network of platforms hosting agent-based services
  - Enable the dynamic, intelligent and autonomous composition of services to achieve user and business goals, thereby creating compound services to address user changing needs

● The Agentcities network is designed to be
  - A distributed testbed for experimenting with agent technology and composable services
  - A common resource for developers wishing to collaborate with each other and link up their agent systems and services
  - A benchmark environment to validate and test compliance to relevant technology standards and provide input to the standards themselves
  - A focus for discussion of next generation information networks as well as the development of services, technologies and methodologies
Agentcities Partners

- Motorola
- Adetti
- AEGIS
- BT Exact
- Broadcom Eirean
- Communication Technologies
- DFKI
- EPFL
- Fujitsu
- Imperial College
- Agentscape
- Queen Mary College
- UPC
- University of Parma
- TILab
Agentcities Network

- Backbone of 14 agent platforms
- 160 connected platforms
- 80 active platforms
- Etorogenous network
  - Zeus, FIPA-OS, Comtec, AAP, Agentworks, Opal
  - 2/3 of them are based on JADE, LEAP and BlueJADE
Network Architecture

- Network services offered by the central node
  - Agent Platform Directory
  - Agent Directory
  - Service Directory
- Each one is accessible over the Internet
  - Standard FIPA interfaces – access for agents, through HTTP or IIOP channels
  - Web interfaces – access for humans
- A polling agent uses a data source of registered entities (platforms, agents or services) and regularly polls the instances found
Network Architecture
Service Composition

- Main aim of the Agentcities project
  - Intelligent composition of services to create new compound services and fulfill the user’s goals
- FIPA agents
  - Autonomous
  - Reactive
  - Communicative
  - Goal oriented
- Event Organizer demonstration scenario
Event Organizer (UniPR) Agent-based web-application

- The EO allows a conference chair to organize an event
  - Book all needed venues and services
  - Then sell the tickets for the new event
- Web interface
  - The user lists a set of needed services
  - Fixes desired constraints on each individual service
  - Among different services
- Agent-based application
  - The user’s global goal is split into sub-goals, assigned to skilled solver agents
  - Solver agents return a list of services that fulfill local constraints
  - The organizer finds a solution that fulfills cross constraints
Event Organizer
Integration with other services

- The Event Organizer directly interacts with a Trade House to search for venues and negotiate selected services.
- Other agent-based applications, as the Venue Finder and the SME Access, are responsible to offer goods on the Trade House and to negotiate them on behalf of their users.
- A Banking Service takes care of managing the banking accounts of the involved partners, securing all requests against tampering and eavesdropping.
- An Auction House is used to create auctions and sell the tickets of the new event.
Event Organizer Demonstration Scenario
Event Organizer Matchmaking

- The Event Organizer uses the marketplace infrastructure (Trade House) to search for suitable venues
- Matched locally against cross-service constraints
- If found, a proper solution is proposed to the user as a list of services that allow the arrangement of the event
- The task of selecting services that validate all the constraints is distributed between
  - The Trade House, which checks the constraints regarding individual services
  - And the Event Organizer, which instead checks the constraints that link the features of two different services
Event Organizer Negotiation

- The selected services are then negotiated on the Trade House with their providers
  - The negotiation process involves the servant agents, representing the buyer and the seller, hosted on the TH
  - If successful, the negotiation ends suggesting a point of balance between the contrasting interests of the buyer and the seller
  - It can take into account multiple attributes of the traded good, for example the price and the period of booking
- A list of contracts is proposed to the user for final acceptance
- Finally, after the new event has been successfully organized and all contacts have been accepted and signed, some tickets can be sold on an Auction House

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Trade House (UPC)

- Advertisement, discovery and negotiation of products
  - Ontology independence
    - Dynamically-loaded, user-defined ontologies, both in the advertising and in the trading
    - Able to offer its services for any kind of product
    - The user-defined ontologies are published in the Agentcities Ontology Service
  - Constraint-based search (matchmaking process)
  - Federation
    - Each instance of the Trade House can be federated in a P2P fashion either with other instances of the Trade House or with instances of the Auction House
  - Multi-attribute negotiation
    - The trading engine can adjust the properties of a product to maximize the satisfaction of both the seller and the buyer
    - Intersection of the interest ranges of both parties, weighted with their preferences
    - A range and a preference are required for each negotiated attribute
  - Servant agents
    - User agents can customize a servant agent by defining their own negotiation strategies and their own interests
Auction House (DFKI)

- Typical auction-style trading activities
  - Concurrent auctions
    - Users of the Auction House may concurrently create, participate in, and bid on multiple auctions of different type including English, Dutch, and Vikrey auctions.
  - Bidding strategies
    - The Auction House provides different parameterized bidding strategies
  - History functions
    - Users, both auctioneers and bidders, are allowed to inspect their past or current activities on auctions, making the auction house even more convenient to use.
  - Constraint-based search
    - Any user that is registered at an Auction House may search for items that are currently traded in the Auction House as commodities
    - Users may search for a given type of commodity, either locally or globally
  - Ontology independence
    - Users may upload individual ontologies for describing their items to be auctioned
    - Published on the Ontology Server
Ontology Service (BT)

- Repository for ontologies defined by the services and applications deployed on the Agentcities network
  - Ontology language
    - DAML+OIL
    - Jena library (HP Labs) is used as a base to maintain ontology repository
  - Import statements
    - Ontologies are centrally maintained and are linked to each other through ontology imports statements
    - In order to maintain the consistency of the existing knowledge base, an assertion or a retraction that violent the consistency is disallowed by the system
  - Role-based access control
    - Each ontology is associated with an access group managed by its owner
  - Interface
    - A FIPA agent is associated with the Ontology server to communicate with other agents through FIPA ACL Language
    - Interactive web access through JSP pages
SME Access (BT)

- SME Access is an agent generation and hosting service for businesses, designed to allow them to deploy a presence on the Agentcities network
  - Web interface (JSP pages)
  - Agent server (Zeus toolkit)
- Supported actions
  - Agent creation
    - The application allows businesses to create agents according to templates
    - Currently, there are templates for restaurants, hotels and cinemas
  - Agent deployment
    - Agents can be deployed to the hosting platform, where they will run and make themselves available for communication with other agents
    - Their status can be queried from the web interface, and their details changed
  - Advertisement
    - Directory facilitators
    - Trade House
Venue Finder (QM)

- **Two levels**
  - It allows to create instances of individual venues they would like to publish and sell
  - It allows venue procuring services to access the system for querying, negotiating and booking of venues
- **Main features**
  - Heterogenous venues
  - Advertisement on the Trade House
  - Integrated payment
  - Match-making routines
Banking Service (EPFL)

- A set of services that a virtual agent-based banking institution offers to the agents accessing the Agentcities marketplace
  - The payment service includes the set of operations and mechanisms allowing the transfer of money between distinct accounts
    - Either under the control of the same bank
    - Or under the control of different banks
  - The account management service groups the set of actions and operations needed to manage bank accounts
    - Open a bank account
    - Dynamically verify the information about an account
    - Close an existing bank account
  - Authorization and authentication of user agents
    - Integration with the Agentcities Security Service
Security Service (QM)

- Security mechanisms have been developed to protect the access to the Banking Service
- Both the electronic payment and the account management services of the Banking Service are supported by the distributed security service
- Security requirements
  - Message confidentiality
  - Message integrity
  - Agent authentication
- The system provides two key functionalities
  - A Certificate Authority (CA) service
    - To provide credential management services
    - Published on an agent server hosted on the Agentcities network
  - A plug-in for agent security management
    - Installed on clients and the Banking Service to provide the necessary security support
    - Plug-in for agent systems to communicate securely
    - End-to-end confidentiality, mutual authentication, data integrity
Conclusions and future works

- FIPA agents proved to be a feasible solution to achieve the dynamic and intelligent composition of basic services to fulfill user’s goals
- The proposed scenario can be easily adapted to different domains
  - The Event Organizer back-end and the Trade House are domain and ontology agnostic
  - They can be used to search for and negotiate any kind of product and service
  - Custom JSP forms are needed to define constraints about new products
  - The SME Access can be upgraded adding more agent templates to advertise different products on the marketplace
  - New ad-hoc service providers can interact directly with the Trade House