Agent Technologies for Virtual Enterprises
+
SW Demonstrations

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Centralization Vs. Decentralization

In many situations, the centralized and hierarchically organized decision-making, planning, scheduling, manufacturing and business solutions in general are not adequate and fail just because of high problem solving complexity and practical requirements for generality and reconfigurability.

The way out: distributed architectures and solutions, with all the time increasing degree of looseness in their mutual relationships, links and interactions → agents → multi-agent systems
Virtual Enterprise (VE)

- Basic Features of VE (subset of VO)
  - autonomy and independence of members
  - distribution of members
  - core competences of members
  - operating towards the customer as a single company
  - temporality of an existence
  - mission-oriented
  - slight bureaucratic overhead
  - dependency on electronic communication
Agents in Multi-agent Systems

Agents
- autonomous
- goal-oriented
- able to communicate
- able to coordinate and cooperate
- able to share their goals and visions
Agent Community

Efficient coordination and cooperation among autonomous intelligent goal-oriented units (agents) can lead to a quite effective behavior of the community as a whole.

Communication among (not only) the agents is an important enabler of their social behavior.

Specific agent communication language (ACL) with standardized types of protocols and messages usually used.

Dynamic agents’ organizations in order to meet their specific goals

- long-term alliances
- short-term coalitions
  (with or without any coalition leader)
- techniques for planning of their activities
  (team action planning)
Introducing MAS principles into VEs area I.

- Each **company** – an **autonomous unit** (agent)
- Each company **registers with the other** ("yellow pages" and/or "white pages" services)
- Each **company is informed** – at least in the extent needed for participation in the network – **about the capabilities and resources of the others**.
- The **companies** start to **form VBEs** – an **alliance in the MAS terminology** – being step-by-step **ready to create a VO if needed**.
- The processes of the **VE formation** as well as the joint planning and scheduling activities based on **negotiation rules and scenarios** – this is the **coalition formation process** in the **MAS terminology**.
- In parallel, the **VCs of bodies interested** in certain topics (another, "loosely coupled" type of alliances) **can be created**.
**Introducing MAS principles into VEs area II.**

1. The **social knowledge** on the capabilities and trust into the operation of others becomes highly structured and well-organized (the knowledge can be classified into private, semi-private, public). Handling the knowledge according to its classification is a crucial condition for the trust-building.

2. Knowledge sharing, classification of knowledge (public, private and semi-private) – very important in the field, applying specific security principles used in the MAS area can be re-used in the virtual enterprise domain as well.

3. The highly specialized members of VE, like brokers or professional network organizers as a part of VBE, can be represented e.g. by various middle agents, brokers etc in MAS terminology.

4. The VE Support Institutions which observe the activity of the network and which can influence the rules of operation or policies set in the network (like e.g. chambers of commerce, regional authorities, tax office, or new types of “normative institutions”) can be represented by the meta-agents.
(Intelligent) Agent

Different categories of agents
- Individual (mobile) agents
- Information agents (creating MAS)
- Holons

Agent’s architecture
- agent’s body
  - functional part
- agent’s wrapper
  - social knowledge
  - communication module

Types of agents
- reactive
- deliberative (proactive)
  - deductive
  - BDI-based
Agent Platform

- Provide at least basic services and **support for the agents’ life cycle**, act as a medium for communication and goal-oriented collaboration among the agents.

- The **abstract architecture** should be viewed as a basis or a **specification framework** for development of particular architectural specifications.

- The **FIPA Abstract Architecture** defines a high-level organizational model for agent communication and core support for it (www.fipa.org) – neutral with respect to any particular network protocol for message transport or any service implementation.
Meta-agents – Meta-reasoning Process

The meta-reasoning process based on a community model – three mutually interconnected computational processes

- **Monitoring** – process that makes sure that the meta-agent knows the most it can get from monitoring the community of agents, it preserves truthfulness of the community model.

- **Reasoning** – this process manipulates the model of the community so that other true facts (other than monitored) may be deduced. The meta-agent tries extend the model and to maintain its truthfulness.

- **Community revision** – a mechanism for influencing operation of the agents in the community.
MAS techniques not adequately developed for the VE’s needs.

- The **ontology** in the MAS area is not developed enough to provide a direct support to the VE solutions.
- Automatic or semi-automatic algorithms for **coalition formation** processes are still underdeveloped. The centralized approach is acceptable only for VEs with a strong central partner.
- The problems of **coopetition** (mutual cooperation of two units in certain projects and competition in the others) is not solved.
- **Mutual trust** and experience of from cooperation in the past as well as general reputation of each of the partners.
- MAS theories offer well developed formalism for **single deal interaction** (e.g. for auctioning and bargaining)
- The algorithms **evaluating efficiency** of cooperation in a VE are still missing.
- None of the available MAS platforms is **directly applicable** in the field of VEs: they are underdeveloped from the point of view of VEs’
Conclusion

The contemporary MASs provide an excellent motivation for the development of solutions for VE which would be based on similar principles and technologies.

The VE community lacks namely in an efficient IT platform specially developed for that area.

The main problems of developing such a platform seem to be

- the ability to manage exploration of vast volumes of highly distributed knowledge
- interoperability of the communication interfaces which would enable rich communication, which would be technically achievable and accepted by everybody.

A very tight cooperation of both the MAS and VE communities is needed to develop adequate agent-based solutions satisfying the VE requirements
SW Demonstrations
Gerstner Laboratory & CertiCon Heritage
– Production Planning

: ExPlanTech
– Project oriented manufacturing environment
– Integrated with existing software systems in the real environment
– Production feedback and dynamic replanning

: ExtraPlant
– Linking suppliers and collaborators – building virtual enterprise
  – **E2EAgents** – connecting enterprises together
  – EEAagents – access from anywhere anytime (WEB, WAP)
  – Meta-agents for processes optimization and observation

ECOSS 2007
Agent Technology Group
Profiles and Competency Management for SME Clusters

- An agent-based research prototype of a tool for keeping, management and distribution of member profiles and competencies in alliances of SMEs.

Architecture

- A hybrid architecture consisting of peer-to-peer cooperating units (agents) supported by centralized components. Such network enables effective cooperation in a heterogeneous distributed environment where agents ensure maximal independence between alliance members and private knowledge preservation.
- The user interface is provided by thin clients through ordinary web-page browsers.


Collaborative Process Automation Support using Service Level Agreements and Intelligent Dynamic Agents in SME clusters

- PANDA aims to speed up the integration process in the European ERP/CRM industry by providing a powerful framework of e-business services.
- PANDA's components will be developed and integrated in a prototype web-platform to serve ERP/CRM value chain actors.

Solution...

- Form Request-Based Virtual Organizations as flexible clusters reflecting the international ERP/CRM value chain.
- Use innovative sector-specific Service Level Agreements (SLAs), acting as the regulating framework, among value chain members, for VOs operations.
- Utilize a community of Intelligent Agents that will be developed to orchestrate and automate SLAs empowerment and VO operations in a predefined, standardized and automatically generated manner.

ECOLEAD – DSS

Decision Support System for Virtual Organization Management

- The DSS supports VO operational and strategic management. When VO intermediate data are not in line with the contracts. In such case the configuration or/and schedule might have to be adapted – the task of DSS is to provide suggestion of adaptation.

Functionality

- Reconfiguration / Rescheduling: in case the VO does not operate according to its schedule, remedial measures could be applied.
- What-if analysis: simulation of various possible scenarios of alternative futures. It allows verifying various configurations and their robustness, discovering possible bottlenecks and pre-preparing potential adaptations of VO configuration and schedule.


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