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**

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∴ 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**

- 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.

- 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 it classification is a crucial condition **for the trust-building**.
- **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.
- 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**.
- 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**.

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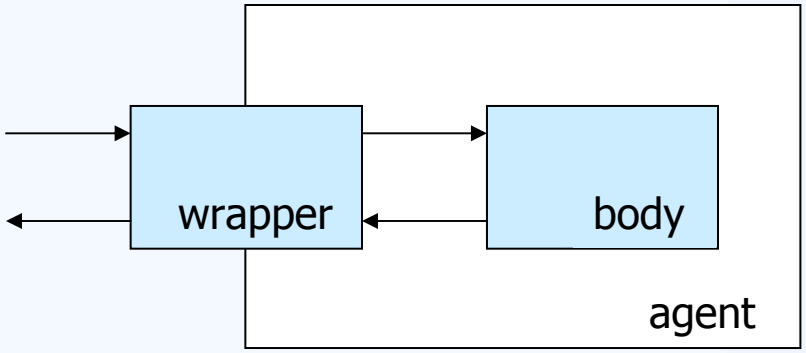
- **Different categories of agents**
  - Individual (mobile) agents
  - **Information agents** (creating MAS)
  - Holons
- **Agent's architecture**
  - **agent's body**
    - functional part
  - **agent's wrapper**
    - social knowledge
    - communication module
- **Types of agents**
  - reactive
  - 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

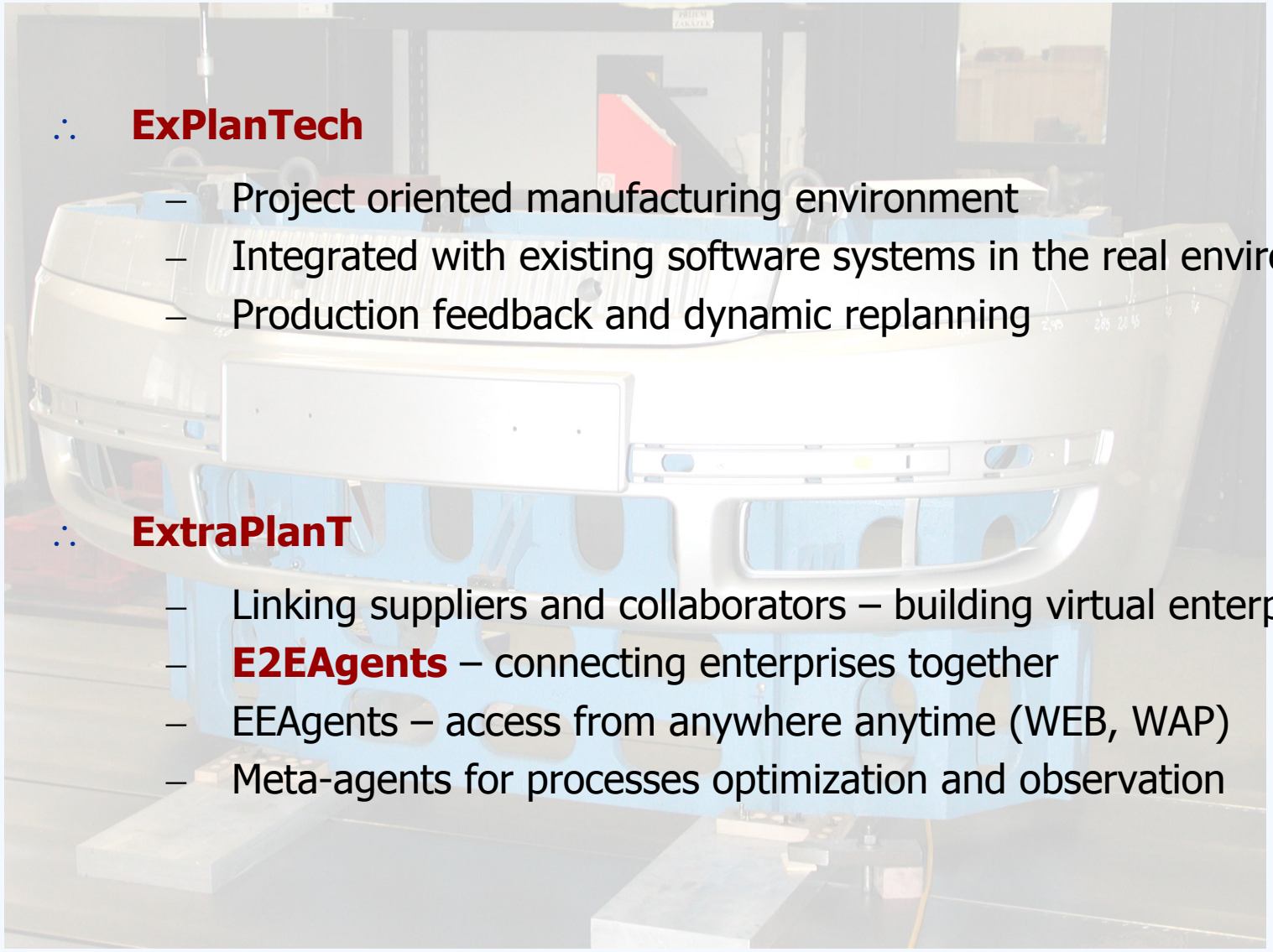
- ∴ The **ontology** in the MAS area is not developed enough to provide a direct support to the VE solutions.
- ∴ Automatic or semi-automatic algorithms for **coalition formation** processes are still underdeveloped. The centralized approach is acceptable only for VEs with a strong central partner.
- ∴ 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
- EEAgents – access from anywhere anytime (WEB, WAP)
- Meta-agents for processes optimization and observation

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.

Jiri Hodik, Petr Becvar, Jiri Vokrinek, Jiri Biba, Eduard Semsch: e-Cat - VBE Members Profiling and Competency Management Tool. In *Intelligent Production Machines and Systems 2nd I*PROMS Virtual International Conference, 3-14 July 2006*. Elsevier, 2006.

Jiri Hodik, Jiri Vokrinek, Jiri Biba, Petr Becvar: Competencies and Profiles Management for Virtual Organizations Creation. In *Multi-Agent Systems and Applications V (CEEMAS 2007)*. LNCS 4696. Springer, 2007.

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.

Jiri Vokrinek, Jiri Biba, Jiri Hodik, Jaromir Vybihal, Michal Pechoucek: Competitive Contract Net Protocol. In *SOFSEM 2007: Theory and Practice of Computer Science*. Berlin: Springer, 2007.

Decision Support System for Virtual Organization Management

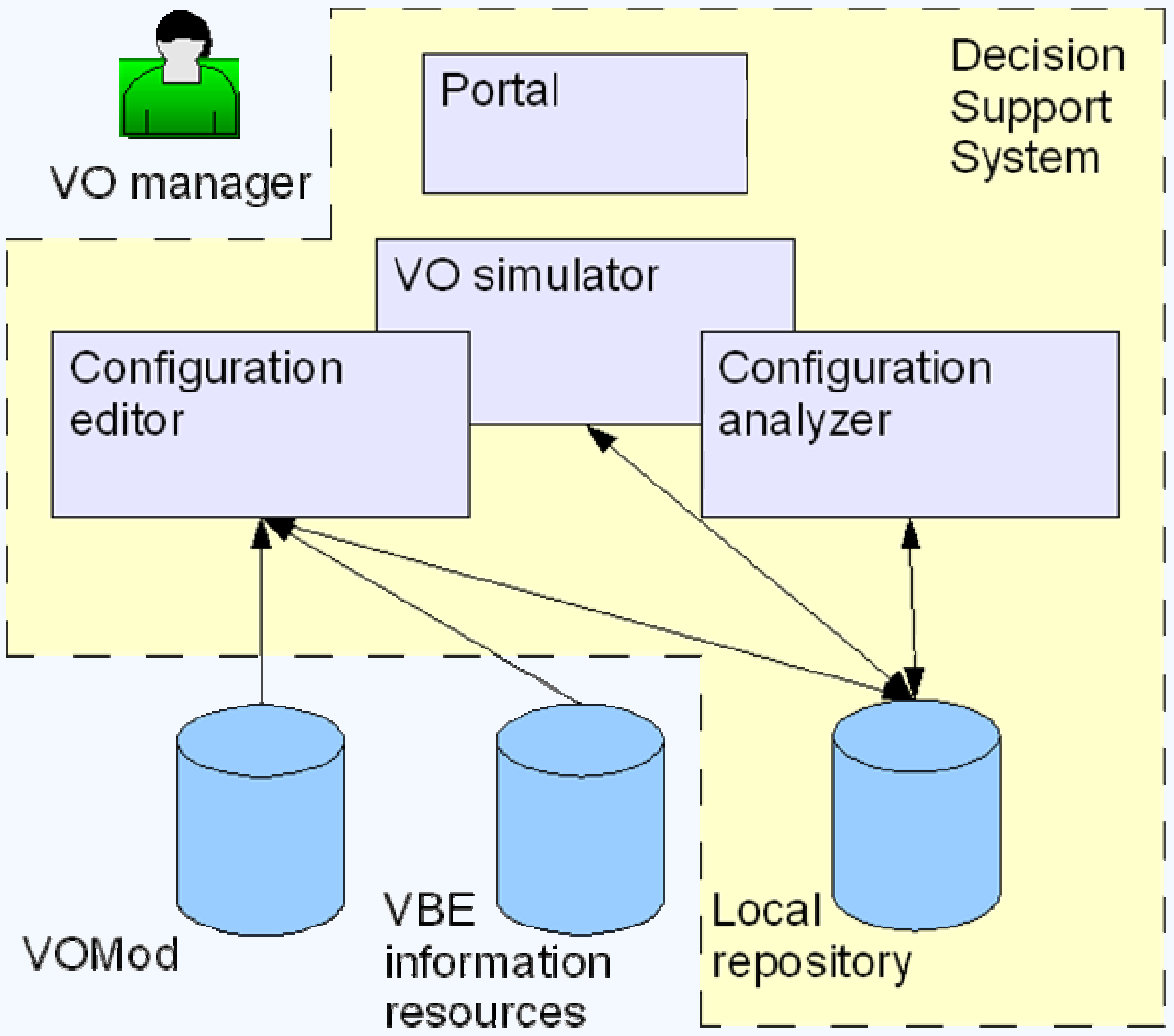
- The DSS supports VO operational and strategic management. When VO intermediate data are not in line with the contracts. In such case the configuration or/and schedule might have to be adapted – the task of DSS is to provide suggestion of adaptation.

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.

- **Jiri Hodik, Jiri Vokrinek, Radek Hofman, Eduard Semsch: Decision support system for virtual organization management. In *Innovative Production Machines and Systems Third I*PROMS Virtual International Conference, 2-13 July, 2007*. Whittles Publishing, 2006. (in print)**
- **Jiri Hodik, Wico Mulder, Lorenzo Pondrelli, Ingo Westphal, Radek Hofman: ICT Services Supporting Virtual Organization Management. In *Innovative Production Machines and Systems Third I*PROMS Virtual International Conference, 2-13 July, 2007*. Whittles Publishing, 2006. (in print)**

ECOLEAD – DSS


VO manager
Portal
Decision
Support
System
VO simulator
Configuration
editor
Configuration
analyzer
VOMod
VBE
information
resources
Local
repository

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