A Grid-Based Multi-Agent System for Realizing Adaptive Service Organizations

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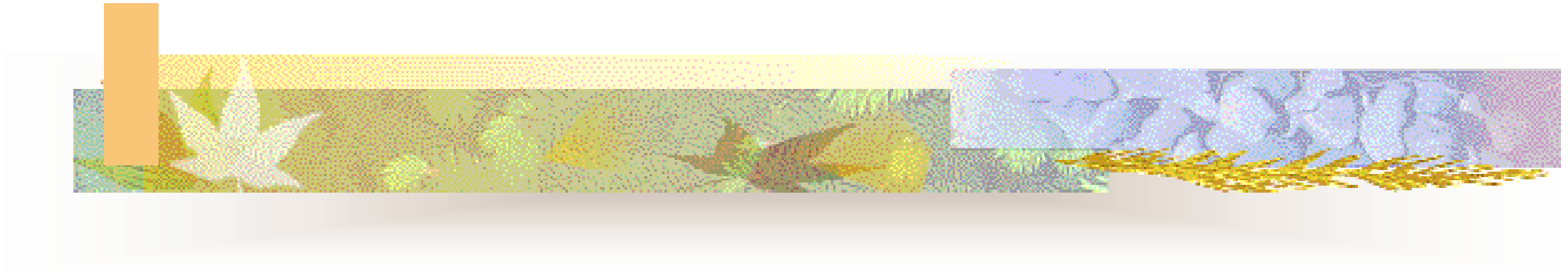

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The Agenda

- Introducing Virtual Organizations
- Research Goals
- Previous Work
- Virtual Organization Enablers
- Research Hypothesis
- Research Objectives
- Research Methodology
- Research Deliverables
- Research Action Plan
- References

Introducing Virtual Organizations

Virtual Organizations (VOs)

- A counterbalance to traditional organizational forms
- Develop through a network of physically dispersed entities (people, organizational units and network nodes)
- Participate in a coordinated value-adding process
- Dynamically establish connections among single nodes in a problem-oriented manner
- Task-oriented assignments determine the structure of a virtual enterprise at any point in time

Reasons for Creating VOs

- An increasing need for flexibility in order to obtain necessary core competences in collaboration with external partners
- More efficient resource sharing among partners

VO Characteristics

- Boundary crossing
- Tendency to complement core competencies or,
- Tendency to ease pooling of available resources
- Requires knowledge sharing
- Geographical dispersion
- Participants list changes
- Participants are equal
- Facilitate electronic communication

Dynamic VOs

- Involve the rapid teaming of business partners
- SMEs in pursuit of specific business objectives
- On demand dynamic linking of business partners as per customer requirements

Trends in Supporting VOs

- Layered-based (transactional) Approach
  - Inter-organization cooperation is based on transaction-oriented interactions
- Agent-based framework
  - agents represent enterprises and their interactions realize inter-enterprise cooperation
  - The requirement of a common ontology to support communication
- Service-federation/service-market framework
  - enterprises to be able to plug and unplug their services to/from directories through some standard interface

The Vision

"In 2015 most enterprises will be part of some sustainable collaborative networks that will act as breeding environments for the formation of dynamic virtual organizations in response to fast changing market opportunities and conditions"

Hamideh Afsarmanesh and Luis M. Camarinha-Matos, "A vision for VOs in Europe" in VOmap Newsletter Number 1, Editor Martin Ollus Editor, January 2003.

Mechanisms To Reach This Vision

- Formulate well founded collaboration models
- Formulate management systems for reproducing replicable environments for a variety of sectors
- Provide generic and invisible infrastructure and re-utilizable service toolbox based on interoperability standards
- Extensive use of pervasive computing
- VO management principles adapted to emerging behavior in complex networks
- Active innovation and new value systems management in networks
- Support of social responsibility based on a suitable ethical code
- Comprehensive (international) legal frameworks for VOs

Hamideh Afsarmanesh and Luis M. Camarinha-Matos, "A vision for VOs in Europe" in VOmap Newsletter Number 1, Editor Martin Ollus Editor, January 2003.

Research Goals

To Enable Dynamic Construction of Virtual Adaptive Organizations by Means of Supporting Formation, Execution and Deformation of Virtual Organizations

Previous Work

Study work in related research areas

- Cross Organizational Workflow
- Service Composition

Cross Organizational Workflow

Previous work is characterized by one or more of the following features:

- Use an editor to define the business process in terms of a workflow of tasks or use a planner
- No assumption of cross-organizational workflow
- Resources are explicitly identified with facilitation of dynamic discovery features
- Explicit selection of computational resources as the middleware is unable to select the best resource give the criteria of load, network traffic and host capabilities

Service Composition

Previous work is characterized by:

- Agent based system where rational middle-agents forming a team where they share a mental state,

OR

- Semantic web techniques are used to compose a service
  - Compose a service using business process model fragments, or
  - Compose a service through the use of planning techniques, or
  - Use ontology to define service semantics that would help a service composition module to define a service

Virtual Organization Enablers

- Business Models
- Service-Oriented Architectures
- The Semantic Web
- Multi-agent Systems
- Grid Computing

Business Models

- Provides understanding of how company business mission and company objectives to be realized
- Depicts organization inter and intra process maps
- Represent the focal point around which business is conducted or around which business operations are improved
- Refers to the architecture of products, services and the information flows
- business model could convey business rules

Service-Oriented Architectures

- Aim to provide dynamic configuration capabilities to a set of semantically interrelated industry specific business partners
- Leverage and recombine business partner capabilities to provide greater value to themselves and the ecosystem in which they exist

The Semantic Web

- An extension of WWW in which the meaning of information is clear and explicitly linked to the information itself
- Better enabling computers and people to work in cooperation.
- Permits greater data reuse by making it available for purposes not planned or conceived by the data provider.
- Encourages information to be surfaced in the form of machine-processable data
- Deals to a large extent with interoperability

Multi-agent Systems

- A virtual organization is an alliance made of distributed, heterogeneous and autonomous components
- Managing virtual organizations requires coordination and distributed problem solving
- The requirement of effective execution and monitoring activities of alliance members
- Alliance formation, partner abilities, partner selection and the assignment of roles and responsibilities, negotiation and market characteristics

Grid Computing

- To enable *"resource sharing and coordinated problem solving in dynamic, multi-institutional VOs"*

  Foster, I. and Kesselman, C. (eds.). The Grid: Blueprint for a New Computing Infrastructure (2nd Edition). Morgan Kaufmann, 2004.

- Provide an infrastructure for federated resource sharing across trust domains.
- Allow coordination and cooperation between virtual team members

Research Hypothesis

- To achieve interoperability, it is required that every entity within a collective to associate cross-domain semantics with the services it provides and with its business processes
- SOA is a prerequisite for adaptive (dynamic) VO
- Grid computing is the ideal platform for deploying a VO
- Given a business model of a particular service VO, a system of rational agents could cooperate to define services and processes composed out of member entities services and processes

Research Objectives

- Support VO formation:
  - Recognize the potential for creating a virtual organization
  - Support negotiation process aiming to select a business model
  - Recruit a team of (virtual) organizations with the objective of creating a virtual organization
- Support VO execution:
  - Negotiate roles and responsibilities of each member organization
  - Develop VO business processes in accordance to business model
  - Monitor VO performance
  - Adapt business processes to changes in the VO business model
- Support VO deformation

Research Deliverables

- An Author-ware to Define VO business models along with associated actors, activities, roles and capabilities
- An ontology defining semantics for business models, business processes and business services
- A Grid-based Multi-agent system with the following features
  - Use ontologies and negotiation to cooperatively define required VO organizational business processes based on developed VO business model based
  - Use ontologies and negotiation to cooperatively execute VO organizational business processes in order to deliver composite services
  - Use ontologies and negotiation to cooperatively adapt to changing business conditions

Research Methodology

- Study previous and current research in areas of grid computing, semantic Web, service oriented computing, service composition, business process modeling, and the use of autonomous agents
- Study the domain of dynamic virtual organizations and associated business models
- Define dynamic virtual enterprise reference architecture including a definition of business meta-model, business process meta-model, workflow meta-model
- Define multi-agent system architecture
- Develop author-ware
- Develop multi-agent system
- Develop a proof of concept

Research Action Plan

- Study previous and current research in related fields
- Define virtual enterprise reference architecture
- Define multi-agent system architecture
- Define Grid architecture
- Develop author-ware
- Develop multi-agent system
- Develop a proof of concept

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Questions

Thank You