IGTASC: A Model for Institution-Governed Trusted and Autonomic Service Cooperation (Extended Abstract)

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ABSTRACT
Because of the inherent non-controllability of business services across different management domains, constructing virtual organizations, by creating service cooperation in Internet computing environment, has been confronted with the challenge of so-called "trust" crisis that the success and benefit of cooperation cannot be ensured. Thereby，this paper proposes a model for Institution-Governed Trusted and Autonomic Service Cooperation, called IGTASC, in order to conquer this crisis.

Categories and Subject Descriptors
I.2.11 [ARTIFICIAL INTELLIGENCE]: Distributed Artificial Intelligence – *Multiagent systems, Coherence and coordination, Intelligent agents*

General Terms
Design, Management, Standardization, Performance, Economics, Reliability, Experimentation

Keywords
Service cooperation; Institution-governed; Trusted; Autonomic; Policy-driven; Virtual organization

1. INTRODUCTION
Along with the development of Service-Oriented Computing (SOC), constructing Virtual Organizations (VOs) by creating service cooperation (i.e. service-oriented cooperation) has become the mainstream approach for reforming the development of application software systems in Internet computing environment[1]. While the relationships of service cooperation can be created dynamically, on requirement, and in low cost by composing business services distributed on Internet, the inherent non-controllability of business services across different management domains has brought on the so-called "trust" crisis that the success and benefit of cooperation cannot be ensured, and thereby seriously prevented VOs from being deployed in a large scale.

In order to conquer the crisis, this paper proposes a model for Institution-Governed Trusted and Autonomic Service Cooperation, called IGTASC, which also can eliminate the dilemma that the requirements of "Autonomy" and "Trust" conflict with each other, which has worried the research of autonomic computing and multi-agent systems for a long time.

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IGTASC depends on three technologies to make service cooperation both trusted and autonomic: domain e-institutions (electronic institutions), policy-driven self-management, and community facilitation management. Domain e-institutions formulate sound protocol systems as service cooperation regulations to govern agents' cooperation behaviors in macro level so that it can be trusted that service cooperation created dynamically by agents will achieve required objectives as long as those agents all conform to relevant regulations respectively[2,3]. However, how to ensure that all of individuals (agents) conform to those regulations is confronted with a real challenge because of the inherent non-controllability of agents across different management domains.

The technologies of policy-driven self-management and community facilitation management can just be used to overcome this challenge. The former aims at using management policies to drive agents to make their own micro behaviors comply rationally with relevant regulations[4] while the latter deploys the agents enacting cooperation facilitation-oriented roles formulated in the agent community in order to provide cooperation assistance and to maintain cooperation order (i.e. force the agents in application domains to conform to relevant regulations). Thereby, the macro-level government can be exerted reliably to the agents participating in cooperation.

2. CONSTRUCTING MODEL IGTASC
In order to support effectively the autonomic construction, running, and evolution of VOs, IGTASC proposes a three-level Virtual Society (VS) as the environment where VOs live and work (see Figure 1). VS is defined as a 3-tuple:

VS = (AC, TV, RA)

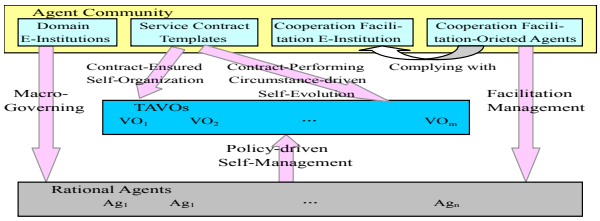

Figure1 Three-level virtual society supported by three technologies constituting model IGTASC

• AC: the Agent Community for VOs and agents to live. As the first level of VS, AC accommodates a variety of e-institutions in order to provide the regulations for constraining the cooperation behaviors of agents and manages and maintains community order depending on the facilitation management mechanism.

• TV: the set of TAVOs (Trusted and Autonomic VOs). As the second level of VS, TV promises community members to freely constitute VOs for achieving the business objectives of VO sponsors by conforming to domain e-institutions.

• RA: the set of rational agents registering in the agent community. As the bottom level of VS, RA accommodates a variety of heterogeneous agents providing and / or consuming business services. By implementing policy-driven self-management, these agents make their own cooperation behaviors conform to the regulations formulated in relevant e-institutions, and thus become trusted and further result in trusted VOs.

In order to achieve the service cooperation-based TAVOs, the model IGTASC is defined as a 3-tuple:

IGTASC = (DEI, PDSM, CFM)

• DEI: the set of domain e-institutions, which is used to formulate protocol systems as the regulations for governing agents' service cooperation behaviors in macro level. For each application domain (say D), E-Institution^D = (S-Structure^D, B-Norm^D, Ontology^D), which means the regulations in D are partitioned into two parts: social structure standards and coupling cooperation behavior norms. The former, as the hard constraints cooperation participants can not violate, aims at formulating B-Service^D (the set of business services provided or consumed), B-O-Role^D (the set of business operation-oriented roles which agents can enact in service cooperation), and DBP^D (the Distributed Business Process for multiple agents to cooperate) in D so that the non-determinability of service providing-requiring processes can be reduced largely. In contrast, the latter is the soft constraints which the business operation-oriented roles and distributed business processes should comply with, including obligations, forbiddances, and rights (promises). Ontology^D defines the application domain concepts referenced by those regulations. Especially, the Ontology^D based templates of service providing-requiring contracts, including structure and semantics, are defined to support dynamical creation of the contracts.

• PDSM: the policy-driven self-management, which models agents as the rational individuals which provide and / or consume business services according to the social structures in domain e-institutions, have their autonomic behaviors accept the macro-government of the outer constraints, and are driven by management policies. Here, the outer constraints include cooperation behavior norms formulated in domain e-institutions and the business instructions (high-level business goals and transaction principles) sent over by agents' owners; and management policies are used as the principles or rules for agents to decide cooperation behaviors according to these outer constraints and cooperation status. It is PDSM that supports effectively the contract-ensured self-organization and contract-performing circumstance-driven self-evolution of VOs.

• CFM: the community facilitation management, which, by formulating a cooperation facilitation e-institution (E-Institution^F) and deploying a team of agents which provide facilitation services on cooperation facilitation-oriented roles in the e-institution, can assist the creation of cooperation relationships and maintain cooperation order through forcing agents to conform to cooperation behavior norms and service contracts dynamically created. Three types of facilitation services are formulated: Information-Archiving (e.g. agent-role-registration, capability-advertisement, contract-notarization, contract-performing-report-receiving), Assisting (e.g. partner-recommendation, reputation-query, role-registration-query), and Regulating (e.g. contract-monitoring, contract-violation-analyzing, contract-violation-arbitration, reputation-updating). Regulating services form the regulating mechanism composed of five phases: indicting (requesting arbitration), analyzing (and verifying), arbitrating, monitoring (by receiving contract-performing reports), and reputation-updating (as sanction means) in order to force agents to conform to behavior norms and service contracts (see Figure 2).

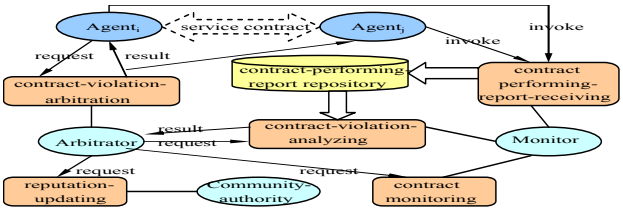

Figure 2 Contract-based regulating mechanism (the dotted arrow indicates that agents i and j cooperate on contract)

3. CONCLUSIONS

Along with solving "trust" crisis, IGTASC can overcome the limitation resulting from non-autonomic service cooperation, therefore makes the autonomy and change-response ability of service cooperation exhibit the advantage of robustness and intelligence. Furthermore, IGTASC also establishes the solid foundation for the institution-governed and contract-ensured hierarchical-cooperation self-organization of VOs and the contract-performing circumstance-driven cooperation self-adaptation and self-evolution of VOs, and thus makes the service cooperation-based VOs possess high performance of self-organization and self-evolution.

In Contrast with the current research work of Institution-Governed cooperation, which is isolated from the mainstream technology of SOC, IGTASC is able to closely integrate with SOC by using business services as the basic constituents, and thereby has a great promise of operationalized realization.

7. ACKNOWLEDGMENTS

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