# An Agent Based Inter-organizational Collaboration Framework: OperA+[1]

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## 1 Introduction

Socio-technical systems are complex adaptive entities that are composed of interconnected components whose interactions form processes at multiple levels of abstraction. Modeling and analysis of such systems is difficult because (1) it is impossible to elaborate everything at the same aggregation level, (2) requirements and functionalities are not fixed a priori, (3) components are not designed nor controlled by a common entity, and (4) unspecified changes may occur during runtime. Examples of such systems are inter-organizational projects, supply chains, introduction of new policies and etc.

Agent-based models have been increasingly adopted to describe, analyze and simulate socio-technical systems and explore phenomena concerning complex relations between entities. Nevertheless, current practice of Multi-Agent System design tends to take agents as atomic entities presented at the same level of abstraction. This either leads to an extremely large model that tries to describe everything at the same aggregation level or a vague model without sufficient information to guide or regulate the actors. Another problem of an extremely large model is the lack of controllability when unspecified changes occur. To solve these problems, the idea of compositionality should be considered, which enables to define and integrate processes and knowledge at different levels of abstraction. The higher levels model the systems in terms of coarser-grained components while the lower levels provide increasing details to the components designed and controlled by different entities. This not only enables integrating components of different complexities in one model and providing necessary opacity in inter-organizational systems but also makes it easier for actors to understand their partnerships. Thus, components and groups of components can be easily reused at all levels of design. Moreover, to make sure that the implementation of a system does not deviate from the original goals, there is a need for representing the regulating structures explicitly and independently from the acting components.

In this paper, we present a framework OperA+ which extends the OperA [1] modeling framework with constructs to represent multi-organizational collaboration. The composite structure of the framework provides users with a multi-level modeling environment. The higher level specification captures the commonalities of different organizational collaborations while the lower level specification presents the individualities by empowering each component at the higher level to elaborate its inner structure according to its own circumstance. Components at the same level are modeled separately through lower level specifications, which decreases their mutual influence when one of them changes.

## 2 OperA+

OperA+ describes two dimensions of analysis: the **specification** dimension which describes *what to do* in the inter-organizational collaboration from the designer's perspective, and the **enactment** dimension which describes *who does what* from an implementation's perspective based on the specification dimension. The metamodel of the OperA+ framework in Fig. 1 shows the main concepts and their relationships.

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[1] The full version of this paper has been accepted for publication at the *13th International Workshop on Coordination, Organization, Institutions and Norms in Agent Systems* --- COIN 2011.

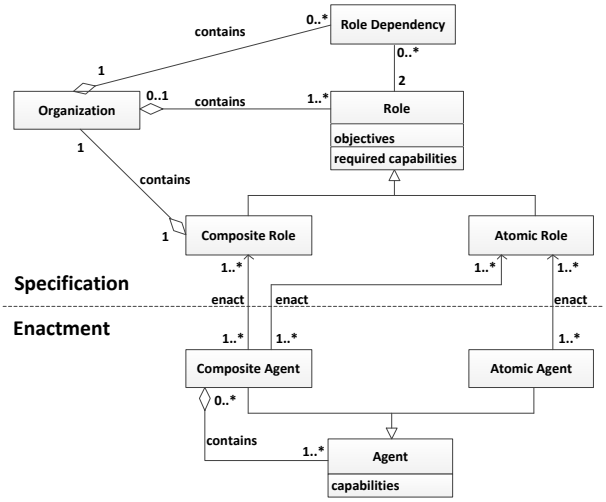


Figure 1: Meta-model of the OperA+ framework

A **specification** starts from a role and continues with a set of organizations at different levels of abstraction. An organization is a social arrangement which pursues collective objectives through a set of connected roles. Roles are typically declarative entities meant to represent a part of the organization's design. In OperA+, we refine roles into two kinds: *atomic role* and *composite role*. Each composite role refers to a unique organization at a lower level in the hierarchy which elaborates the objectives of the composite role into finer-grained roles and gives more constraints or information on how to accomplish the objectives. Atomic roles are not further specified enabling heterogeneous enactment.

In the enactment dimension, roles in a specification are enacted by agents. A specification can have multiple enactments at different times and circumstances. An **enactment** of a specification is a set of agents and their mappings to the roles. Two kinds of agents are defined in OperA+: *atomic agent* and *composite agent*. An atomic agent is an atomic entity whose inner structure is either invisible or unimportant to the other parts of the system. A composite agent is a group of agents who usually cooperate with each other and follow the same set of norms. Each sub-agent in a composite agent can be either atomic or composite.

Different types of agents have different characteristics when they enact different types of roles. An atomic role can be enacted by any type of agents. A composite role can be (i) directly enacted by a composite agent providing that the internal organization of the agent matches that of the composite role, or (ii) indirectly enacted by a set of independent agents each enacting a sub-role.

# 3 Conclusion

This paper proposes the framework OperA+ to model inter-organizational collaborations at different levels of abstraction. Targeting at modeling complex systems where autonomous entities interact with each other to achieve collective goals and those entities again have inner structures in which a set of sub-entities coexist, OperA+ facilitates a composite way of modeling organizational interactions, which not only distributes the complexity of the whole system but also provides a mechanism to show the commonalities and individualities of an inter-organizational collaboration model from different perspectives.

# References

[1] M. V. Dignum. A model for organizational interaction: based on agents, founded in logic. Doctoral Thesis, *DSpace at Utrecht University*, 2004.