

# Agent-Oriented Business Modeling

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## 1. INTRODUCTION

Cross-organizational business processes are common in today's economy. Of necessity, enterprises conduct their business in cooperation to create products and services for the marketplace. Thus business processes inherently involve autonomous partners with heterogeneous software designs and implementations. Based on the abstractions they use, existing cross-organizational modeling approaches can be broadly classified as high-level and low-level. The high-level approaches such as e<sup>3</sup>value are too high-level, and cannot be easily operationalized. The low-level approaches such as BPMN and WS-CDL employ control and data flows, which lead to highly rigid processes, and lack business semantics.

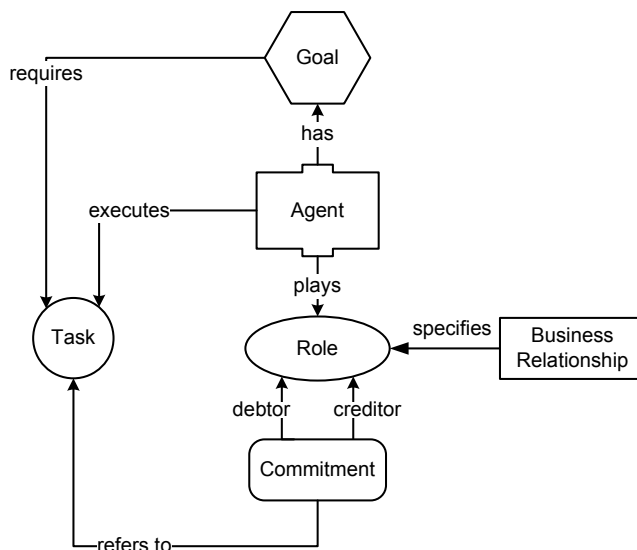
We propose a novel high-level business model based on agent-oriented abstractions of agent, role, goal, and commitment. In contrast to existing approaches, our model gives primacy to the contractual relationships among the business partners. In our approach, a set of reusable patterns model recurring business scenarios. A step-by-step methodology guides a modeler in developing a business model starting from an informal description of a cross-organizational scenario. We develop an approach employing NuSMV, an existing model checker, to verify an operationalization specified as UML sequence diagrams with respect to a business model. A developer study found that our approach yields improved model quality compared to RosettaNet, a traditional approach widely used in the industry.

## 2. BUSINESS METAMODEL

Figure 1 shows our business metamodel [2]. An *agent* is a computational representation of a business partner. An agent has goals, and executes business tasks. For each business relationship in which an agent participates, it enacts one or more roles. A *role* is an abstraction over agent. Each role specifies the commitments expected of the agents who play that role along with the tasks they must execute to function in that role. A *goal* is a state of the world that an agent desires to be brought about. An agent achieves a goal by executing appropriate tasks or negotiating with other agents to have them execute appropriate tasks. A *task* is a business activity viewed from the perspective of an agent. A *commitment* is an element of a contractual business rela-

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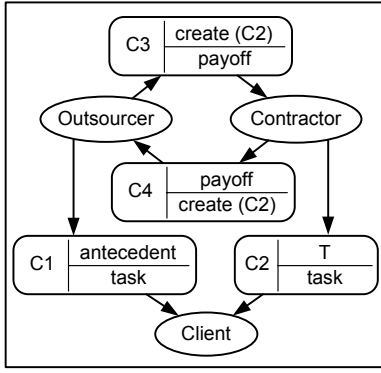
**Figure 1: A commitment-based business metamodel.**

tionship. A commitment  $C(\text{DEBTOR}, \text{CREDITOR}, \text{antecedent}, \text{consequent})$  denotes that the DEBTOR commits to the CREDITOR to bring about the consequent if the antecedent begins to hold [1]. A *business relationship* is a set of interrelated commitments among two or more roles that describe how they carry out the given business process.

## 3. BUSINESS PATTERNS

A pattern is a recipe for modeling recurring business scenarios. We develop a key set of patterns such as commercial transaction, outsourcing, and service contract, which could seed a potential business model pattern library.

Figure 2 shows the outsourcing pattern. An outsourcer delegates a task to a contractor, typically because the outsourcer lacks the necessary capabilities or expects some other benefit, such as reduced costs or a lower risk of failure. As an example, consider a customer who signs up for cable television service. The cable operator commits to the customer for installation. Instead of staffing its entire service area directly, the cable operator outsources the installation task to its local partners in various regions. The outsourcer has a commitment  $C_1$  towards its client to execute a task. The outsourcer and the contractor negotiate, and agree that the contractor will create the commitment  $C_2$  to execute the

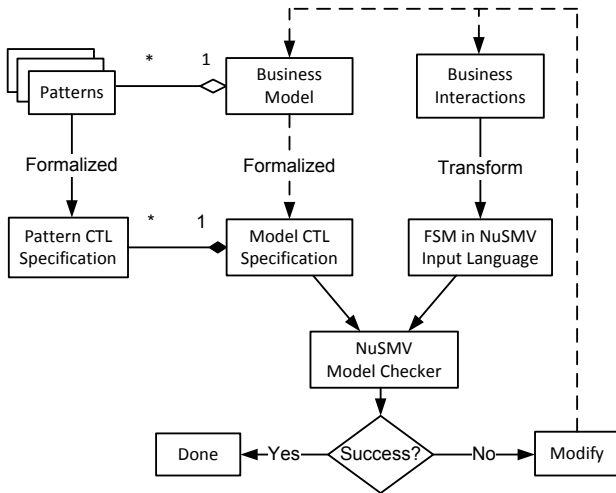


- $C_1$   $C(\text{OUTSOURCER}, \text{CLIENT}, \text{antecedent}, \text{task})$   
 $C_2$   $C(\text{CONTRACTOR}, \text{CLIENT}, \top, \text{task})$   
 $C_3$   $C(\text{OUTSOURCER}, \text{CONTRACTOR}, \text{create}(C_2), \text{payoff})$   
 $C_4$   $C(\text{CONTRACTOR}, \text{OUTSOURCER}, \text{payoff}, \text{create}(C_2))$

**Figure 2: Outsourcing**

task if the outsourcer pays. Conversely, the outsourcer commits to paying the contractor if the contractor creates  $C_2$ . Note that the antecedent of this commitment is true ( $\top$ ), which means that it is unconditional. We say that the commitment  $C_2$  covers the commitment  $C_1$ . Eventually when the contractor creates  $C_2$  the original commitment becomes pending.

## 4. VERIFICATION



**Figure 3: Our approach in conceptual terms.**

Figure 3 shows the main components of our verification approach [3]. We map a business model to a temporal logic specification regarding the progression of the states of the relevant commitments. A business model is an aggregation of several business patterns. We map each pattern to a set of CTL specifications, and can compose CTL specifications for a business model based on the specifications for the patterns that the model aggregates. UML 2.0 sequence diagrams capture operational interactions, which we map to FSMs specified in the NuSMV input language.

## 5. METHODOLOGY AND DEVELOPER STUDY

We introduce a step-by-step methodology for developing cross-organizational business models [4]. Our methodology begins from an informally described real-life cross-organizational scenario, and produces formal business and operational models. Table 1 summarizes our methodology steps.

**Table 1: Methodology steps.**

Description	Input	Output
1. Extract subscenarios	Given scenario	Subscenarios
2. Identify roles from each subscenario	Subscenario	Roles
3. Identify business tasks from each subscenario	Subscenario	Tasks
4. Introduce a pattern for each subscenario	Pattern, subscenario, roles, tasks	Business model
5. Introduce MSCs for each pattern	Pattern MSCs, subscenario, roles, tasks	Operational model

We report on the results of a developer study that compared our methodology with a methodology recommended by the RosettaNet Consortium. We found that our methodology yields improved model quality, a greater focus on the more important aspects of modeling, and a general reduction in total time despite more comprehensive models.

## 6. CONCLUSIONS

The main contributions of our work are a novel business metamodel, a set of modeling patterns, an approach for verifying sequence diagrams with respect to a business model, a methodology that starts from an informal scenario and creates a formal business model, and a developer study that shows improved quality. Future work will incorporate goal modeling in the methodology, and will consider adding normative relationships such as authorizations and prohibitions in our metamodel.

## 7. REFERENCES

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