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Extending UMM with Speech Acts

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Abstract. The United Nations Center for Trade Facilitation and Electronic Business (UN/CEFACT) provides UN/CEFACT Modeling Methodology (UMM) for technology and protocol independent business process and business information modeling for e-Commerce Systems development.

In e-Commerce, systems design is based on two fundamental types of models, business models and process models. A business model is concerned with value exchanges among business partners, while a process model focuses on operational and procedural aspects of business communication. Thus, a business model defines the *what* in an e-Commerce System, while a process model defines the *how*. This means that the e-Commerce Systems development workflow consists of two main phases. First, a business requirement capture phase focusing on value exchanges, and secondly, a phase focused on operational and procedural realization of those requirements. Among the meta-models defined in UMM, Business Requirements Views (BRV) can be associated by designers for the business model development while Business Transaction Views (BTV) and Business Service Views (BSV) can be associated for business process models.

However it has been realized that still there is a gap between UMM's business models and process models as much explanation cannot be found on how one can move from coarse-grained views at initial phases to more fine-grained views at later stages.

This work is addressed to bridge the gap between UMM's coarse-grained views at initial phases and fine-grained views at later stages of e-Commerce Systems development. For this purpose we are adopting well-established Speech Act theory for modeling business communication and also we are proposing a unified framework based on Speech Acts. This unified framework gives much clearer interpretations for UMM's modeling concepts, facilitates business modeling and process modeling and provides smoother integration between those models.

1. Introduction

Electronic Commerce (e-Commerce) is the buying and selling of goods and services electronically by consumers or by companies via computerized transactions. Replacing manual and paper based business processes with electronic alternatives and by using information flow effectively in new and dynamic ways, e-Commerce has speeded up ordering, production, delivering, payment for goods and services at a lower cost. Among the various standardization activities around today in e-Commerce, United Nations Center for Trade Facilitation and Electronic Business (UN/CEFACT) is leading with large participation from industry and academia (UMM, 2001).

When building e-Commerce systems, two types of models are fundamental: business models and process models. A business model describes what are the economic resources that trading partners are exchanging when they are engaging in businesses. For this business-modeling phase UN/CEFACT has provided Business Requirement View (BRV) meta-models that can be associated.

The business model can be contrasted to a process model, which aims at describing the operational and procedural aspects of a process and specifies the control flow of the activities carried out in a process. A process model specifies what are the business-activities performed in what order by different partners playing different authorized roles. For this purpose, UN/CEFACT proposes Business Transaction View (BTV) and Business Service View (BSV) meta-models.

The purpose of this paper is to analyze the content of UN/CEFACT's business and process models and to propose a framework to integrate them. In this work, we argue that it is possible to move from a business model to a process model and we suggest methodological guidelines and modeling techniques that assist a designer in the task. A starting point of the method proposed is that much of the procedural aspects of a process model concern on communication among actors. This communication is carried out in order to establish commitments among the actors to perform exchanges of values. The commitments are created by speech acts, and the control flow in a process is determined by the interleaving of these speech acts with each other and with the value exchanging activities.

We use UMM's metamodels as conceptual and notational framework for our approach, more specifically BRV for process models and BTV for business models. The theoretical foundations of our approach are based on the Speech Acts theory and Resource-Event-Agent (REA) (REA papers, 1982-to date).

2. Related Research

The approach proposed in this paper is based on the Speech Acts theory (Austin, 1962) and the Resource-Event-Agent (REA) ontology (Geerts, 1999). The application of Speech Acts theory to information systems design focuses on communication aspects when analyzing and developing a system. A speech act is defined as an action changing the universe of discourse when a speaker utters it and a recipient grasps it. It may be oral as well as written, or even expressed via some other communication form such as sign language. Searle has developed speech act theory (Searle, 1975) by

introducing a taxonomy of five different kinds of speech acts: assertive, directive, commissive, expressive, and declarative, also called illocutionary points.

An *assertive* is a speech act, the purpose of which is to convey information about some state of affairs of the world from one agent, the speaker, to another, the hearer. For example, the utterance “The father of speech act theory was Austin”. A *commissive* is a speech act, the purpose of which is to commit the speaker to carry out some action or to bring about some state of affairs. An example is the utterance “I will complete and submit the paper to ICSLS ’04”. A *directive* is a speech act, where the speaker requests the hearer to carry out some action or to bring about some state of affairs, e.g. “You shall complete and submit the paper to ICSLS ’04”. A *declarative* is a speech act, where the speaker brings about some state of affairs by the mere performance of a speech act. An example is the establishment of accepted papers, e.g. “I hereby announce Paper No. 23 as the best paper”. Finally, an *expressive* is a speech act, the purpose of which is to express the speaker’s attitude to some state of affairs, e.g. “I like the ideas presented in this paper”.

In addition to its illocutionary point, a speech act also has a propositional content. For instance, the speech acts “I hereby pronounce you husband and wife” and “You are hereby divorced”, which are both declaratives, have different propositional contents. Furthermore, speech acts with different illocutionary points may have one and the same propositional content, which is the case with the examples for directive and commissive given above. A speech act is often viewed as consisting of two parts, its propositional content and its illocutionary force. The illocutionary force is the illocutionary point together with the manner (for example ordering, asking, begging) in which the speech act is performed and the context in which it occurs.

Some well-known and recent application of Speech Acts theory to systems development are Action Workflow (Medina, 1992), Business Action Theory (BAT) (Goldkuhl, 1996), Dynamic Essential Modeling of Organizations (DEMO) (Dietz, 2001) and Process Patterns Perspective (P³) (Jayaweera, 2003). The second building stone of our approach, the Resource-Event-Agent (REA) framework, (Geerts, 1999), has been designed for representing and reasoning about economic phenomena, more specifically about economic exchanges.

The REA framework is based on three main components: Economic Agents, Economic Resources, and Economic Events, see [Fig. 1]. An Economic Agent is a person or organization that is capable of controlling Economic Resources and interacting with other Economic Agents. An Economic Resource is something, e.g. goods or money that is viewed as being valuable by Economic Agents. An Economic Event is the transfer of control of an Economic Resource from one Economic Agent to another one.

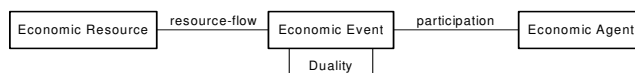


Fig. 1 Resources-Events-Agents (REA) (Geerts, 1999)

A central component in REA is the *Duality* existing between two Economic Events, i.e. one agent transfers some resource to another agent and receives in return another resource from that agent. This *Duality* of resource transfer is essential in commerce.

3. UMM Business and Process Models – BRV and BTV

The scope of UN/CEFACT Modeling Methodology (UMM) is to provide a procedure for specifying business processes involving information exchange in a technology-neutral and implementation independent manner. In UMM, a number of meta-models are defined to support an incremental model development and to provide different levels of specification granularity.

- A business meta-model, called the *Business Operations Map (BOM)* partitions business processes into business areas and business categories.
- A requirements meta-model, called the *Business Requirements View (BRV)* specifies business processes and business collaborations.
- An analysis meta-model, called the *Business Transaction View (BTV)* captures the semantics of business information entities and their flow of exchange between business partners as they perform business activities.
- A design meta-model, called the *Business Service View (BSV)* models the network components services and agents and their message (information) exchange.

The two meta-models relevant for our work are BRV and BTV (see [Fig. 2]) and we describe them briefly in the following sub sections.

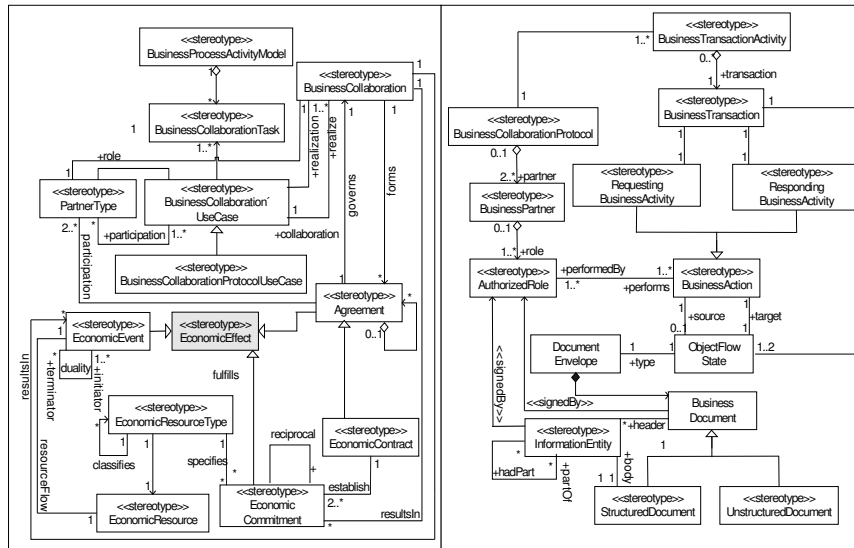


Fig. 2 UMM Business Requirement and Business Transaction Views

3.1. Business Requirements View

The Resource-Event-Agent (REA) (REA papers, 1982-to date) framework has been used as the basis for Business Requirement View (BRV) of the UN/CEFACT Modeling Methodology (UMM) (UMM, 2001). BRV models EconomicEvents, the

Resources transferred through the EconomicEvents, and the Agents, here called Partners between whom the Economic Events are performed. An EconomicEvent is the transfer of control of a Resource from one Partner to another. Each EconomicEvent has a counterpart, i.e. the EconomicEvent that is performed in return and realizing an exchange. For instance the counter part of a goods transfer economic event could be a payment, i.e. a transfer of money economic event. This connection between two economic events is modeled through the relationship *duality*. Furthermore, an EconomicEvent fulfils an Economic Commitment. An EconomicCommitment can be seen as the result of a commissive speech act and is intended to model an obligation for the performance of an Economic Event. The *duality* between EconomicEvents is inherited into the Economic Commitments, where it is represented by the relationship *reciprocal*.

In order to represent collections of related commitments, the concept of Economic Contract is used. A Contract is an aggregation of two or more reciprocal Economic Commitments. An example of a Contract is a purchase order composed of one or more order lines, each one representing a corresponding EconomicCommitment in the contract. The product type specified in each line is the Resource Type that is the subject for the EconomicCommitment. EconomicContracts are often made within the boundaries of different Agreements. An Agreement is an arrangement between two Partners that specifies the conditions under which they will trade.

3.2. Business Transaction View

The Business Transaction View (BTV) specifies the flow of business information between business roles as they perform business activities. A BusinessTransaction is a unit of work through which information and signals are exchanged (in agreed format, sequence and time interval) between two business partners. These information exchange chunks, called BusinessActions, are either Requesting Business Activities or Responding Business Activities (depending on whether they are performed by a Partner Role who is requesting a business service or whether they are the response to such a request). A transaction completes when all the interactions within it succeed otherwise it is rolled back. Furthermore, the flow between different Business Transactions can be choreographed through BusinessCollaborationProtocols. Business Collaboration Protocols should be used in cases where transaction rollback is inappropriate. For example, a buying partner requests a purchase order from a selling partner and the selling partner accepts the order but he does it only partially. Accepting the order completes the transaction (i.e., the transaction can no longer be rolled back). However, the behavior following after the partial acceptance, i.e. the delivery of the accepted parts differs from the behavior of accepting an order in its whole, which would imply the delivery of all products specified in the order.

4. Basic Concepts and Pragmatics

A starting point for understanding the relationships between business models and process models is the observation that a person can carry out several different actions by performing one single physical act. An everyday example could be a person who lifts her hand at an auction and thereby both promise to dispatch the item on which

her bid was place and promise to pay for the item – one physical act (lifting hand), which can be viewed as “carrying” two other actions (promise to dispatch and promise to pay). Relationships like these are particularly common for communicative actions, which are carried out by means of physical actions. One way to look at the role of communicative actions and their relationships to other actions is to view human actions as taking place in three different worlds:

- * ***The physical world.*** This is the world in which people carry out physical actions as they utter sounds, wave their hands, send electronic messages, etc.
- * ***The communicative world.*** People express their intentions and feelings in this world. They tell other people what they know, and they try to influence the behavior of others by communicating with them. People perform such communicative actions by performing actions in the physical world.
- * ***The social/institutional world.*** In this world the social and institutional relationships among people come into existence. For example, people become married or they acquire possession of property. People change social and institutional relationships by performing actions in the communicative world.

Using this division, business models can be seen as describing the social/institutional world, in particular economic relationships and actions like ownership and resource transfers. Process models, on the other hand, describe the communicative world, in particular how people establish and fulfill obligations.

In terms of the three worlds introduced above, UMM explicitly addresses only the physical and the social/institutional worlds. The physical world is modeled through classes like `BusinessTransaction` and `BusinessAction`, while the social/institutional world is modeled through `EconomicCommitment`, `EconomicEvent`, and other classes. The details of the communicative world, however, are not explicitly modeled. This state of affairs causes two main problems. First, the relationship between the physical and the social/institutional worlds is very coarsely modeled; essentially the UMM only states that a completed collaboration may influence objects in the social/institutional world, but it does not tell how the components of a collaboration affect the social/institutional objects. Secondly, there is no structured or systematic way of specifying how events in the physical world influence the social/institutional world. These problems can be overcome by introducing the communicative world as an additional layer in the UMM, thereby creating a bridge between the physical and social/institutional worlds.

4.1. Extended BRV

As a preparation to modeling the communicative world, a minor modification to UMM BRV is made, see [Fig. 3]. A class `EconomicEffect` is introduced as a superclass of `EconomicCommitment`, `Agreement`, and `EconomicEvent`.

The power type (Martin, 1994) of `EconomicEffect`, called `EconomicEffectType`, is also added for the purpose of differentiating between the modeling of concrete, tangible objects in a world, and the abstract characteristic categories of these objects.

These modifications will allow for a more concise representation of the effects (as well as the characteristics of the effects) of communicative actions. In addition to these changes, the classes `BusinessActionEnactment` and `BusinessTransactionEnactment` are added. These represent the actual execution of a business action or business transaction, respectively.

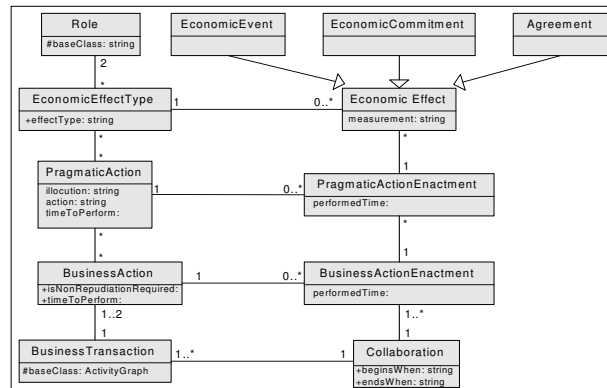


Fig. 3 Extended Business Requirement View

4.2. Pragmatic Actions

The basic notions introduced for modeling the communicative world are those of a pragmatic action and its execution, i.e. `PragmaticAction` and `PragmaticActionEnactment`, see [Fig. 3]. A *pragmatic action* is a speech act as introduced in Section 2. It consists of three parts, denoted as a triple:

<<Illocution, Action, EffectType>>

Intuitively, these components of a pragmatic action mean the following:

- EffectType specifies an `EconomicEffectType`, i.e. it tells what kind of object the pragmatic action may affect
- Action is the type of action to be applied – create, change, or cancel
- Illocution specifies the illocutionary force of the pragmatic action, i.e. it tells what intention the actor has to the Action on the EffectType

Formally, Intention and Action are defined through enumeration:

Action = {create, change, cancel, none}

Illocution = {propose, accept, reject, declare, query, reply, assert}

The meanings of the illocutions are as follows:

propose – someone proposes to create, change, or cancel an object

accept – someone accepts a previous proposal

reject – someone rejects a previous proposal

declare – someone unilaterally create, change, or cancel an object

query – someone asks for information

reply – someone replies to a previous query

assert – someone makes a statement about one or several objects

For ‘query’, ‘reply’, and ‘assert’, there is no relevant Action involved, so only the “dummy” ‘none’ can be used.

The class PragmaticActionEnactment is used to represent the actual executions of pragmatic actions. A PragmaticActionEnactment specifies a PragmaticAction as well as an EconomicEffect, i.e. the agreement, commitment, or economic event to be affected. Some examples of PragmaticActions are:

“Query status of a sales order” would be modeled as <<query, none, salesOrder>>

“Request purchase order” would be modeled as <<propose, create, purchaseOrder>>, where ‘salesOrder’ and ‘purchaseOrder’ are EconomicEffectTypes.

4.3. Integrated view of process and business models

The glue between the physical world and the communicative world is made up by the associations between the BusinessAction and PragmaticAction, classes and BusinessActionEnactment and PragmaticActionEnactment classes. These associations express that a business action can carry one or more pragmatic actions, i.e. by performing a business action, an actor simultaneously performs one or several pragmatic actions. Often, only one pragmatic action is performed, but in some cases several can be performed, e.g. when creating a commitment and its contract at the same time.

The global integrated view of BRV and BTV is shown graphically in [Fig. 4]. The original BTV-parts are grouped within a checked area boundary, BRV-parts are grouped within a dashed area and the new parts introduced in this section are depicted in the white area.

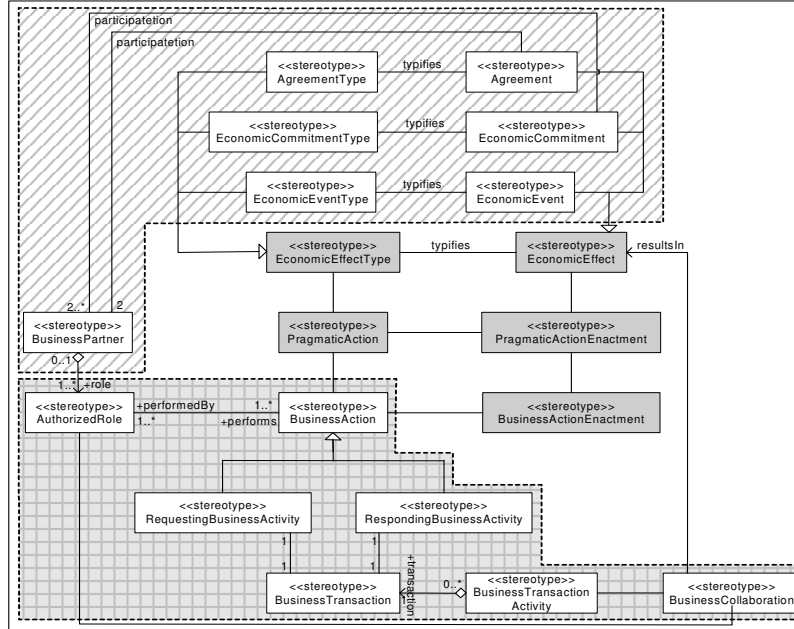


Fig. 4 Integrated Global view

5. Business Transaction Patterns

UN/CEFACT has defined a number of Business Transaction Patterns as part of UMM with the intention of providing an established semantics of frequently occurring business interactions. However business semantics of those business transactions have defined very loosely using natural language. By applying proposed framework these Business Transaction Patterns can be analyzed, understood their business semantics and thereby get much clearer interpretations. A detailed discussion on application of the framework in UMM Business Transaction Patterns can be found in (Bergholtz, 2003).

In this section we introduce few Business Transaction Patterns and how they can be aggregated into Business Collaboration Patterns in process models. Here we have used UML activity diagrams (UML, 2001) with minor extension by labeling transitioning arrows from one activity to another with relevant pragmatic actions causing the transition.

5.1. Query/Response Business Transaction Pattern

The query/response design pattern specifies a query for information that a responding partner already has e.g. against fixed data set that resides in a database. The response comprises zero or more results each of which meets the constraining criterion in the query (UMM, 2001). This transaction consists of requesting business activity with `<<query, none, aBusinessObject>>` pragmatic action and responding business activity with `<<reply, none, aBusinessObject>>` pragmatic action. See left part of [Fig. 5].

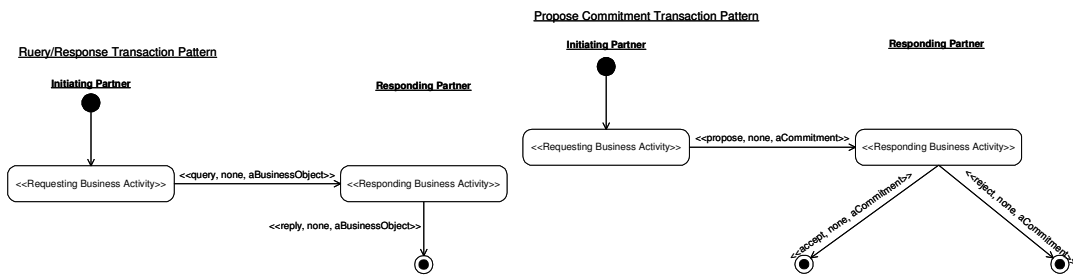


Fig. 5 Query/Response and Propose Commitment Transaction Patterns

5.2. Propose Commitment Transaction Pattern

This design pattern is best used to model the *'propose and acceptance'* business transaction process that doesn't result in a residual obligation between both parties to fulfill the terms of the contract. The pattern specifies an originating business activity sending a business document to a responding business activity that may return a business signal or business document as the last responding message without any intention of getting into legally bound. This is equal to Commercial Transaction Pattern in UMM (UMM, 2001) but with `isLegallyBinding` business parameter set off.

But here in our framework, it has been modeled allowing designer to visualize business requirements pragmatic level instead of lower level parameter instantiations as in UMM.

Relevant requesting pragmatic actions is <<propose, none, aCommitment>> and responding pragmatic action is either <<accept, none, aCommitment>> or <<reject, none, aCommitment>>, see right part of [Fig. 5].

5.3. Offer Commitment Transaction Patterns

This design pattern is best used to model the ‘offer and acceptance’ business transaction process that dose result in a residual obligation between both parties to fulfill the terms of the contract. The pattern specifies an originating business activity sending a business document to a responding business activity that may return a business signal or business document as the last responding message with intention of getting into legally bound. This is also equal to Commercial Transaction Pattern in UMM (UMM, 2001). But here in our framework, distinction between “Propose” and “Offer” is visualized at pragmatic level instead of lower level parameter instantiations as in UMM.

Relevant requesting pragmatic actions is <<propose, create, aCommitment>> and responding pragmatic action is either <<accept, create, aCommitment>> or <<reject, create, aCommitment>>, see left part of [Fig. 6].

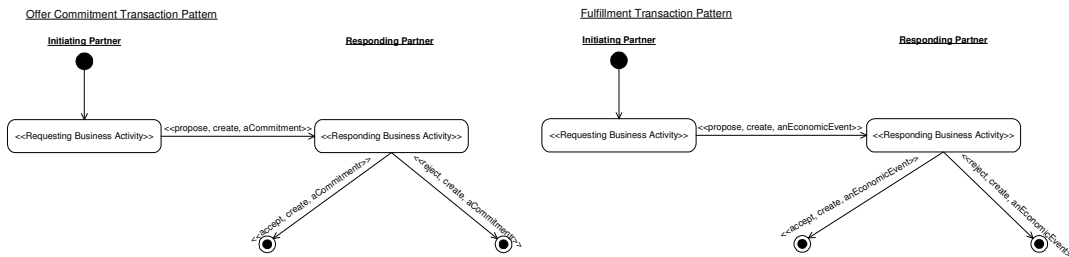


Fig. 6 Offer Commitment and Fulfillment Transaction Patterns

5.4. Fulfillment Transaction Pattern

This is the design pattern that models completion of economic resource transfers. Here initiating partner sends requesting pragmatic action <<propose, create, anEconomicEvent>> to which responding partner can either reply with pragmatic action <<accept, create, anEconomicEvent>> or <<reject, create, anEconomicEvent>>. This is an extension to UMM as it cannot be in UMM’s Business Transaction Patterns, see right part of [Fig. 6].

5.5. Bilateral Cancellation Transaction Pattern

The Bilateral Cancellation Transaction Pattern refers to the bilateral cancellation of an Economic Commitment(s) within an Economic Contract. Relevant pragmatic actions are <<propose, cancel, aCommitment/Contract>> for request and <<accept, cancel, aCommitment/Contract>> or <<reject, cancel, aCommitment/Contract>> for response. See left part of [Fig. 7].

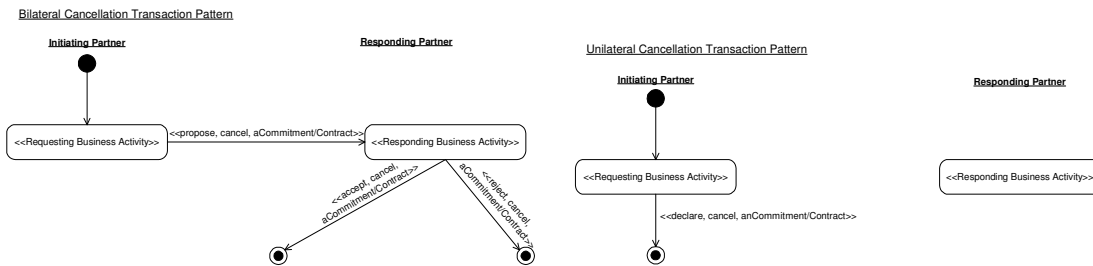


Fig. 7 Bilateral and Unilateral Cancellation Transaction Patterns

5.6. Unilateral Cancellation Transaction Pattern

The Unilateral Cancellation Transaction Pattern refers to the unilateral cancellation of an Economic Commitment(s) within an Economic Contract. See right part of [Fig. 7]. Here initiating partner simply cancels anEconomicCommitment with out waiting for Responding partner. The relevant pragmatic action is <<declare, cancel, aCommitment>>.

6. Business Collaboration Patterns

A *Business Collaboration Pattern* defines the orchestration of activities between partners by defining a set of BusinessTransactions Patterns and/or more basic Collaboration Patterns plus the rules for transitioning from one Transaction/Collaboration to another (BCP2, 2002). The significance of a Business Collaboration Pattern is to serve as a predefined template in that it encodes business rules and business structure according to well-established good practices.

Next we illustrate how Business Transaction Patterns so far introduced can be orchestrated to form more complex business collaborations.

6.1. Commitment Negotiation Collaboration Pattern

With this Business Collaboration Pattern we model all the business communications that two business partners perform prior to formal acceptance of a legally bound

contract. The two Business Transaction Patterns that we use here are Query/Response for communicate about business objects and their attributes and Propose Commitment to negotiate the contract. A propose from an initiating partner can be replied with another propose (propose+switch in left part of [Fig. 8]) reflecting “counter propose” business scenario.

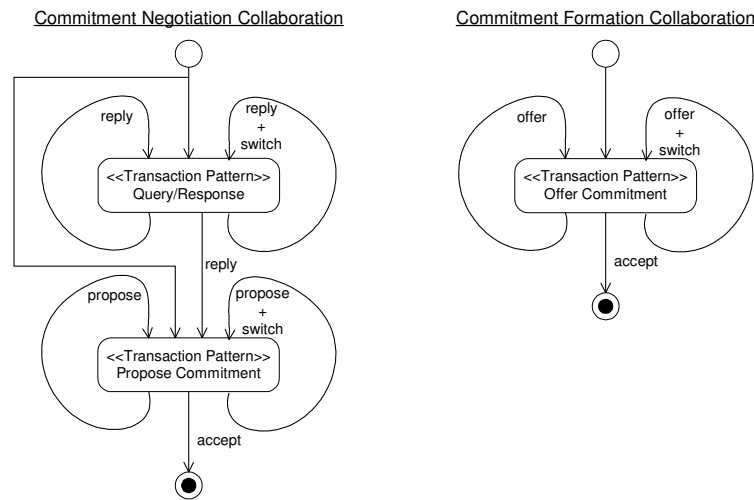


Fig. 8 Commitment Negotiation and Formation Collaboration Patterns

6.2. Commitment Formation Collaboration Pattern

This is the Collaboration Pattern that models Commitment Formation by using only Offer Commitment Transaction Pattern see right part of [Fig. 8]. Similar to the Propose Commitment Transaction Pattern in above, propose+switch reflects “Counter Offer” business scenario. A new proposal followed the original from the same initiating partner may reflects “Biding” in real world.

6.3. Fulfillment Collaboration Pattern

Fulfillment Collaborations is the composition of Fulfillment Transaction Pattern and Unilateral Cancellation Transaction Patterns to complete an Economic Event. Here the initiating partner propose creation of an Economic Event which can be either accept, reject allowing her to fulfill in future or can be canceled the commitment by responding partner to terminate future fulfillment attempts. See left part of [Fig. 9].

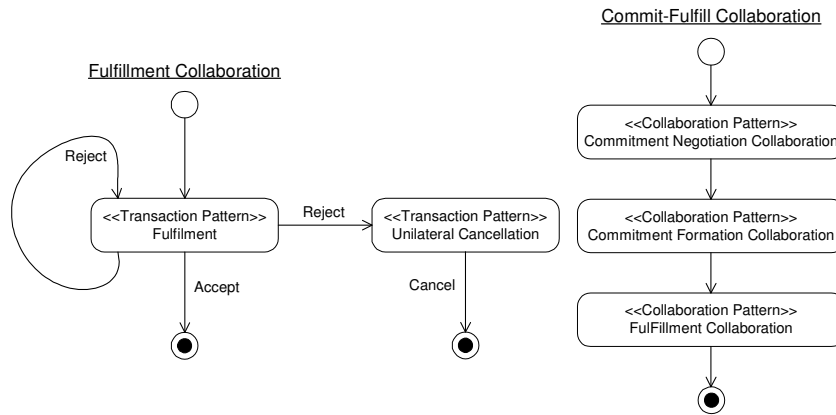


Fig. 9 Fulfillment and Commit-Fulfill Collaboration Patterns

6.4. Commit-Fulfill Collaboration Pattern

Commit-Fulfill Collaboration Pattern is a composition of basic Collaboration Patterns introduced so far. It choreographs Business Negotiation, Commitment Formation and Fulfillment Basic Collaborations Patterns. Choreography of Business Transaction Patterns and Basic Collaboration Patterns has to obey different choreographic and business rules. In (Jayaweera, 2001), (Bergholtz, 2003) and (Bergholtz, 2002) we have introduced such rules that business designers can take into account.

7. Concluding Remarks

The main contribution of this work is a unified framework to facilitate the analysis and integration of business models and process models in e-Commerce. The approach bridges the gap between the declarative aspects of a business model and the procedural aspects of a process model by means of pragmatic actions. The basis for pragmatic actions is Speech Act theory. The work has been carried out and expressed in the context of the UN/CEFACT standard, but the results can easily be adapted to other frameworks.

In addition we present much clearer interpretation to UN/CEFACT's Business Transactions together with few obvious extensions. The Business Transaction Patterns defined according to our framework can be intuitively choreographed when designing Business Collaborations.

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