# Using an Ontology Pattern Stack to engineer a Core Ontology of Accounting Information Systems

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**Abstract.** Although the field of Accounting Information Systems (AIS) has a long tradition, there is still a lack of a widely adopted conceptualization. In this paper, The UFO ontology patterns are regarded for application by analogy and extension in the engineering of a core ontology for AIS. The new IASB Conceptual Framework for Financial Reporting is used as a main source of the domain knowledge, and a core ontology for AIS is proposed that includes (offered, agreed, partial, settlement and realization) economic exchange patterns of an enterprise. The economic exchanges affect enterprise economic resources and claims that are represented by economic relator patterns including offerings, agreements, (unconditional, in process and residual) obligations and property rights. The model is an important step towards the development of a Core ontology and Ontology Pattern Language for AIS.

**Keywords.** AIS, UFO, Ontology Patterns, Economic Exchange, Resources

## 1. Introduction

Although the field of the enterprise Accounting Information Systems (AIS) has a long tradition, scholars in [11] conclude the absence of a widely adopted conceptualization.

The (Financial) Accounting for an enterprise and thus AIS domain may be characterized as a hierarchy of models: 1. Conceptual Framework for Financial Reporting, 2. International and National Accounting Standards and Interpretations, 3. Enterprise Policies. At present these models are undergoing a substantial change with the introduction of a new Conceptual Framework for Financial Reporting - *CF* [4] and a number of new International Financial Reporting Standards – *IFRS* [5, 6, 29], by the International Accounting Standards Board (IASB). Some of the problems that still remain are the vagueness, inconsistency and ambiguity of the verbal form of the *CF* and standards [32], as well as the limited coverage of the economic exchange lifecycle. To overcome these issues ontology technologies are researched for building Accounting and AIS domain reference ontologies e.g. in [3, 32]; and by the authors [31] using the SABiO [21] methodology.

SABiO recognizes the importance of the reuse of ontological resources: existing domain ontologies, core ontologies, foundational ontologies, and ontology patterns (OPs) in the development of domain ontologies and advocates for the use of an ontologically well-founded language during ontology capture. According to [23], Foundational ontologies span across many fields and model the very basic and general

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concepts and relations that make up the world, they contain the *Foundational Ontology Patterns(FOPs)*. Domain ontologies, in turn, describe the conceptualization related to a specific domain and contain *Domain Related Ontology Patterns(DROPs)*. Core ontologies are located between foundational and domain ontologies and provide a definition of structural knowledge in a specific field that spans across different application domains in this field.

In this paper, the engineering of a core ontology for AIS called EXP [31] is considered as grounded on Unified Foundational Ontology (UFO) [15] and using the core ontology of Services UFO-S [7], by applying the FOPs of UFO by analogy and DROPs of UFO-S by extension. The domain is elicited from the works of accounting theorists e.g. [1, 9]; the *CF* and common concepts for the most of *IFRS* standards; working as and with the AIS and Audit experts. The DROPs of the EXP ontology are supposed to be used as core patterns for engineering of the IFRS Standards and Policy based sub-ontologies for AIS.

The main contribution of the paper is the proposed FOP and DROP *Pattern stack* for the EXP and the extension of UFO-S concepts and patterns for commitment based economic exchanges and economic resources. The expected benefits are better understanding and more precise concepts for AIS, pattern reuse for modeling IFRS Standards and Policies and aligning with other Enterprise related Ontologies, e.g. [17, 30], and substantial code reuse for AIS Software.

The evaluation of EXP is in progress by testing and verifying the model with the UFO language tools, engineering the sub-ontologies for the *IFRSs* and a large number of cases included with them, as well as analyzing several ERP systems [from Infor, 1C, Oracle] and practical cases, and conduct reviews with domain specialists.

We subscribe to Ijiri's view [1] that the activities of an enterprise comprise planning and fulfillment of a coordinated chain of economic exchanges. These exchanges affect economic resources and claims against the enterprise (negative economic resources). In an economic event of exchange, an economic agent *expenses* its resources, to earn an *income* of resources of a greater benefit for the agent. The concepts and patterns of the economic exchanges, participating agents and economic resources are the entities of an AIS and our research.

Section 2 describes the background of the research, section 3 introduces the overall exchange model, section 4 compares with related work while section 5 concludes with a discussion and future directions.

## 2. Background

### *2.1. Unified Foundational Ontology (UFO)*

In search of the ontological foundations for conceptual modeling - theories, methodologies and engineering tools (including modeling languages, patterns, anti-patterns as well as computational tools) and a functional complex of FOPs and consistent guidelines of their application for our model, we have looked for one that includes event and social concepts as well as provides tools for a modular ontology engineering support. Next in our criteria were the enterprise DROPs and their usage in ontological analysis and improving existing enterprise related standards and ontologies, as well as engineering new ontologies. These additional criteria played a crucial role for the choice in favor of the UFO [8,15] with the ontologically well-founded conceptual modeling

profile of UML termed OntoUML [20] — the language as well as its associated methodological and computational tools of pattern-based model construction, code generation, formal verification and formal validation, model verbalization and anti-pattern detection. In addition, it provides Ontological Pattern Languages (OPLs) that are based on a set of interrelated patterns, plus a process model (a procedure, a script) guiding on how to use and combine them in a specific order, and suggesting patterns for solving some modeling problems. The UFO is divided into three strata dealing with different aspects of reality, namely:

UFO-A covers structural aspects and patterns - Objects, their types, their parts/wholes, the roles they play, their intrinsic/relational particularized properties (modes) and their types. A distinguishing concept in UFO-A is *a Relator* [27], which can be seen as reified relationship of aggregations of particularized properties inhering in related entities, accounting for the way the related entities are involved in the relationship. The FOPs that were selected for our modeling are the Role with disjoint allowed types pattern, needed for Economic agent roles and the Relator-material relation pattern employed for Economic resources.

UFO-B covers dynamic aspects - Events and their parts, Relations between events, Object participation in events, Temporal properties of entities, Causation, Change and the connection between Events and Objects via Dispositions. For our modeling, the Individual Participation FOP of UFO-B was of interest, for Economic exchange and its sub-events.

UFO-C: An Ontology of Intentional and Social Entities, which is constructed on top of UFO-A and UFO-B, and which addresses notions such as Beliefs, Desires, Intentions, Goals, Actions, Commitments and Claims, Social Roles and Social Particularized Relational Complexes (Social Relators), among others. The main FOP that will be used in engineering our ontology is the Social Relator Pattern, see Fig.1.

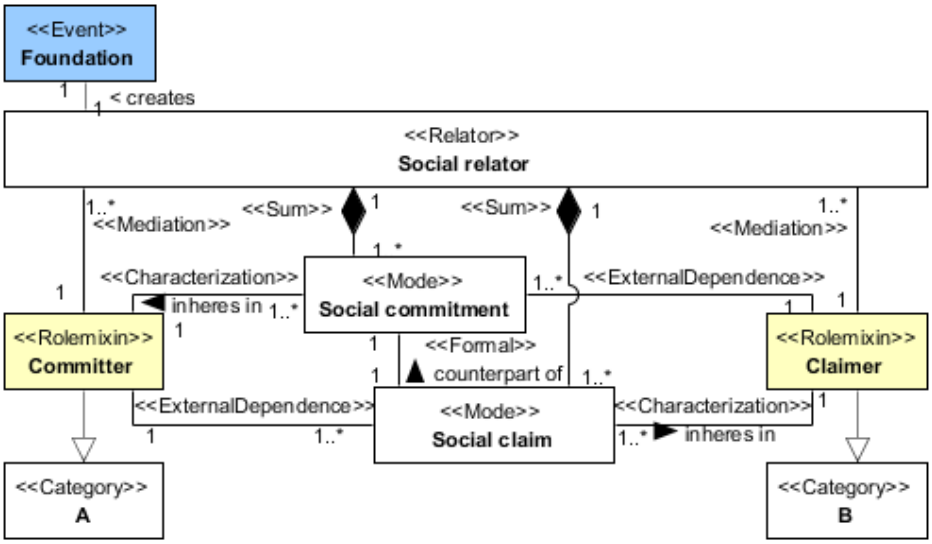


**Figure 1.** An OntoUML diagram of Social relator pattern, adapted from the [10], foundation event added.

*Social relators* are relators composed of one or more pairs of social commitments and social claims [16]. As with all relators, social relators are founded in particular events.

A social commitment is a commitment of an agent A towards another agent B. As an externally dependent mode, a social commitment inheres in A and is externally dependent on B. As a consequence, a social claim of B towards A is created.

DROPs relating to enterprise structure and measurement, that are required for our purposes are organized for reuse by E-OPL and M-OPL [28].

UFO-S [7] is a core ontology on services, which is grounded on the Unified Foundational Ontology. UFO-S characterizes the service phenomena by considering service commitments and claims established between service participants (provider and customer) along the service life-cycle. UFO-S is modularized into three sub-ontologies that account for the basic phases of the service life-cycle: service offer, service negotiation/agreement and service delivery. As a core ontology, UFO-S presents general concepts that span across several applications domains in such a way that its conceptualization can be broadly reused, and as shown further, also for our ontology. UFO-S facilitates the pattern reuse with S-OPL [24]. As an illustration of phenomena conceptualized, we further use a case from [7]: "A restaurant [the enterprise] establishes the meta-commitment of accepting the commitment of serving Caesar Salad in less than 10 minutes after order (a service offer). When a customer sits down, checks the menu and orders a Caesar Salad via the waiter (an event which can be understood as a simplistic service negotiation leading to a service agreement), the restaurant becomes committed towards that customer to serve a Caesar Salad in less than 10 minutes. In that moment, we can say that the meta-commitment was fulfilled." The actual preparing and serving the Caesar Salad and consumption and payment actions by customer comprise the service delivery phase.

In order to cover domain constraints that cannot be represented using the language's diagrammatic notation, the editor supports specification of OCL and temporal OCL formal constraints, the ones from UFO-S patterns are used in EXP.

### *2.2. Economic exchange and the main concepts of the IASB Conceptual Framework*

The current state of the Financial accounting conceptualization is represented by the new *CF* [4] and the IFRS. Neither formal conceptualization nor AIS exists at the moment that conforms to the issued standards and the *CF,* that is set to be finalized in 2016. An AIS maintains, processes and reports information about the enterprise economic resources, claims against the enterprise (at a point of time) and changes in those economic resources and claims caused by economic exchanges (during a time period).

The *CF* [4] defines *an economic resource* as a right that has the potential to produce benefits. The *CF* [4] further postulates that an enterprise *controls* an economic resource if it has the present rights and ability to direct the use of the economic resource and obtain the benefits that flow from it. Economic resources as rights and the claims against enterprise in EXP are modeled as reified relationships between the enterprise and a counterparty or community with respect to a thing (*underlying object*). These rights generally rest on a foundation of legal rights [4] of Contract and Property Laws as e.g., in American property law, a property right is described as a collection of legal relations between parties with respect to things [25]. However, there is also the civil law that treats a property right as a relation between a person and an object. The rights definition may be regarded as the specification of permitted actions:

- actions with the rights themselves, e.g. a right to sell a "right to receive";

- actions with the *underlying object* to be performed for the benefit of the enterprise by itself, e.g. a right to control the use of a leased object; or
- actions that another party has a present obligation to perform for the benefit of the enterprise, e.g. a right to receive a service.

*The party (or parties)* for a particular right or exchange could be an Economic agent – a specific person or an *enterprise*, a group of people or enterprises (*community*), or society at large. *The enterprise (E)* is the focal party for our model and a *counterparty (C)* - the other party that participates in an exchange with the *E*. *The E* is separate and distinct from all the parties associated with the *E*, it is a *going concern*. Specialized roles of the parties are distinguished for different types of exchanges and their phases. Two special roles for the core ontology are counteragents participating in exchanges affecting claims against the enterprise: 1) *Creditors* (*CR*) - in exchanges affecting liabilities of the *E* in the role of *Debtor* and 2) *Owners (O)* - holders of equity claims.

The financial effects of economic exchanges of an *E*, comprising its activities (i.e. "as a result of past events" [4]), are classified into the following kinds of relationships:

- *An asset (A)* is a present economic resource controlled by the *E*.
- *A liability (L)* is a present obligation of the *E* to transfer an economic resource.
- *Equity (OE)* is the residual interest in the *A* of the *E* after deducting all its *L*.
- *Income (I)* is increases in *A* or decreases in *L* that result in increases in *OE*, other than those relating to *contributions (OEC)* from *O*.
- *Expenses (S)* are decreases in *A* or increases in *L* that result in decreases in *OE*, other than those relating to *distributions (OED)* to *O*.

With a general constraint of values for the *E* and for each economic event:

$$A = L + OE + OEC - OED + I - S.$$

To be recognized in AIS, an economic resource or claim must be *measured*. In many cases, measurements must be estimated and are subject to *uncertainty*. Measures are based on *historical cost* or on *current value* measurement method.

Ijiri [1] defines *Economic commitment* as "an agreement to execute an economic event in a well-defined future that will result in either an increase of economic resources or a decrease of economic resources" and suggests extending economic resource control recognition criteria to agreements, forecasts, and budgets. The existing accounting, though, recognizes only such obligations of future events, that are enforceable by law, natural law or are *constructive* [4].

## 3. Complex economic exchange model description

### *3.1. Social relator based Economic relator and Economic exchange pattern*

We have conceived of an Economic exchange as an offering of interaction made by one of two parties, followed by its acceptance by the counterparty resulting in an agreement, that is fulfilled by delivery or by incurring obligations [31].

UFO-S covers the backbone of an economic exchange – the actions in the form of services. Actions comprise any economic exchange, but in addition, the EXP economic

exchange specializes UFO-S by adding delivery process steps, incurring and settling obligations, equity changes, economic resources - their change and measurement. While generally the services are distinguished from goods as activities of non-separable production and consumption, we don't see anything in the model of UFO-S that restricts modeling a goods transfer. In the running example, a meal serving in a restaurant might be separated from its consumption, e.g., by taking the meal home.

Our economic exchange patterns of the enterprise's interactions with a counterparty employs the Social relator pattern with its axioms [7], see Fig 1. If one party has an economic commitment, it follows that another party (or parties) has an economic claim. In *CF*, the social relator is exemplified by the following statement: "If one party has an obligation to transfer an economic resource (a liability), it follows that another party (or parties) has a right to receive that resource (an asset)" [4, para 4.25].

We make the following extensions to the UFO-S model because of our AIS and enterprise-centric orientation: We introduce the *Economic relator and a pattern*, see Fig 2, as a specialization of the Social relator, that has an exchange value ascribed (a monetary measurement) to the involved modes. We distinguish two subtypes of this pattern: 1) *E commitment* is an economic relator where the enterprise plays the role of the committer, and 2) *E claim* is an economic relator where the enterprise plays the role of the claimer. Because the *corresponding* [7] modes of a counterparty are counterparts they will be omitted when depicting the economic relator. The abovementioned relators may be also referred as (Counterparty) *C claim* and *C commitment* respectively. The Economic resources (Assets) of the enterprise defined in *CF* are represented by *E* claim relator, and Counterparty Claims against enterprise (Liabilities, Equity) are represented by *E* Commitment relator. The Economic relators may be conditioned (and thus classified) on some future events, crucial for our model are the following conditions:

- completion or breach of a certain economic process;
- completion of an investment process or liquidation of the enterprise;
- passage of time.

The economic relators refer to a time period and an underlying object or its function (more details in Section 3.4). We ascribe (a measurement) exchange value - V to the economic relator and ▲/▼events for economic relator exchange value increase/decrease. We omit "service" for all the concepts due to different usage of service term in accounting and imply rights and control. In EXP, we use "*E*" qualifier for the Enterprise; we use "*C*" qualifier for the Counterparty; and we use "*O*" qualifier for the Enterprise Owners as prefixes of their roles, modes, and relators that mediate (m) them. Generally, the *E* qualifier will be omitted for the economic relators, but not for the agent roles.

As shown in Fig 2 we introduce an AIS domain-related pattern of Economic exchange that will further be applied for the exchange lifecycle phases and sub-phases of delivery. Fulfilling some [meta-]commitments/claims Economic exchange decreases commitments/claims represented by Economic relators for total value V- and increases other commitments/claims for value V+. There are altogether four combinations for commitment/claim exchange that we group into two cause and effect action kinds. We use *transfer* for enterprise actions towards the benefit of the counterparty and *receive* for counterparty actions towards the benefit of the enterprise. We define:

- *A transfer* is the enterprise's action, governed by the terms and conditions, agreed with and for the benefit of the counterparty, fulfilling a [meta-]

commitment. It exchanges *E* claim decreases (*E* commitment increases) for other *E* claim increases.

- *A receive* is the result of the counterparty's action, governed by the terms and conditions, agreed with and for the benefit of the enterprise, fulfilling a [meta-] claim. It exchanges *E* claim increases (*E* commitment decreases) for other *E* commitment increases.

The increases/decreases named as *expenses* are decreases of commitments to the owners, and those named as *income* are increases of commitments to the owners and are a generalization of the expenses and income defined in the subsection 2.2 where they increase/decrease the equity.

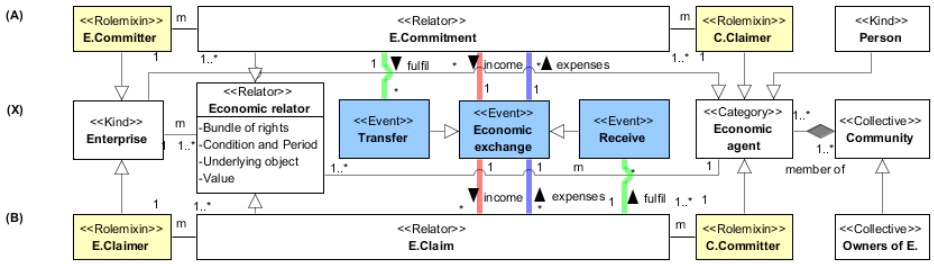


**Figure 2.** Abridged OntoUML diagram: *E* relator with the enterprise in the role of Committer; *E* relator with the enterprise in the role of Claimer; and Economic exchange.

### *3.2. Exchange Offer*.

In an analogy with UFO-S, at the beginning of an exchange relation, there is a promise of the enterprise, a speech act that establishes a pattern of commitments and corresponding counterparty-claims, that is called enterprise offer, and the resulting pattern of *Enterprise offering* relationship. The offer and intention are for the exchange and involves a conditional promise as defended by Bach [22]. As depicted in Fig 3(a) an enterprise offer event results in the establishment of an offering – a pair of economic relators, between the enterprise as *Offering committer* and a *Target community*. An offering relationship is composed of the enterprise offering *E* commitments (promises) with <u>expected</u> enterprise offering *E* claims (considerations) from the offering committer towards the target community, using the economic exchange pattern.

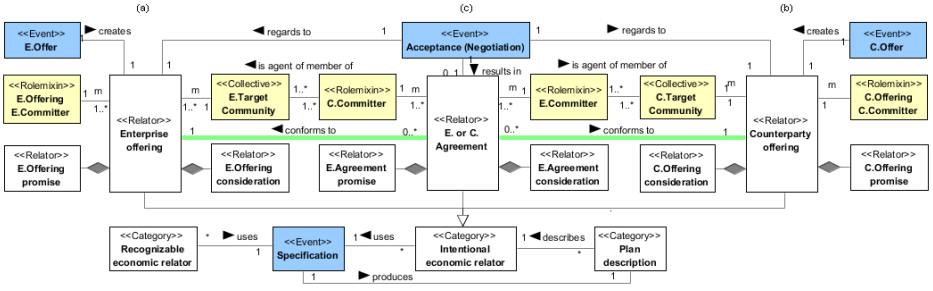


**Figure 3.** Abridged OntoUML diagram of Economic exchange planning phase. (a) Enterprise offering; (b) Counterparty offering; (c) Agreement

The actual content of offering promises and considerations is described in offering descriptions i.e., normative descriptions in UFO; and in EXP contains the Transfer plans, that include the main features of an economic resource control transfer/use (see subsection 3.3). Similarly, for the Receive plans, that are offered for committing by the Counterparty. The enterprise's offering promise is conditional – it is committing if the counterparty will counter-commit. Offering commitments in EXP may be meta-commitments as in [7], or concrete ones.

*Offering-committer* is the role played by agents when these agents commit themselves to a target community by an offer event. In terms of UFO, the roles are Rolemixin, since it can be instantiated by parties of different kinds, e.g., persons and enterprises or their agents. According to [7], *Target community* is a *collective* UFO pattern that refers to the loosely coupled group of agents that constitute the community to which the exchange is being offered.

Since we take an enterprise-centric view, as in accounting, in EXP we must regard the enterprise also as a receiver of the counterparty's offer (which is not necessarily a counteroffer for a previous one), and the enterprise as a member of counterparty's target community. The pattern diagram, in this case, is similar to the provider case and is shown in Fig 3(b).

### *3.3. Exchange Agreement Acceptance (Negotiation).*

According to UFO-S, an offering (either of enterprise or counterparty) is a base for an agreement negotiation event, see the agreement pattern in Fig 3(c), based again on the economic exchange pattern. If the (negotiation) acceptance succeeds, an exchange agreement is established, and the enterprise starts to play the role of the *committer* while the counterparty starts to play the role of *counterparty committer*. Committer roles are accountable for governing the fulfillment of the agreement. Like an offering, an agreement is composed of reciprocal clauses of *E* commitment (*promise*) and *E* claim (*contribution*) pairs. However, in an agreement, these pairs are mutually accepted. An agreement should conform to what was previously established in the corresponding offering. As in the case of an offer, what is agreed between the parties (reciprocal commitments and counter-claims of both *E* and *C*) is described in agreement description. In EXP we additionally to UFO-S distinguish the meta-agreements and concrete agreements.

In our model, in accordance with [14] we introduce *intentional economic relators* – *Agreement promise* and *Agreement consideration* (similarly for Offering and Counterparty offering, but without other party's acceptance). The intentional resources allow specifying the management of offering and agreement producing processes with the specializations of exchange patterns, for details see [14]. We define:

- *A promise* is the enterprise's commitment to transfer, motivated and conditioned by reciprocal consideration (agreed or offered).
- *A consideration* is the enterprise's claim to receive, a counterpart of a counterparty's commitment - a promise to transfer.

*An offering or agreement* is the enterprise's commitment to exchange for offered or agreed claim. The agreement (offering) promises and considerations are fulfilled as interrelated and not separable within clauses of the agreement (offering), they are transformed to separate objects in delivery phase.

An enterprise is established by an agreement called *Articles of association.* In addition to the enterprise name, purpose, etc. it establishes: *O* investment consideration to be fulfilled by *contributions* to the *E* and *E* return on investment promise to the *O* for dividends and residual obligations to be fulfilled by *distributions* to the *O*. The *Articles* may be regarded also as initiating of an overall periodic process that should increase equity and is reflected in by including the expense/income changes in the economic exchange pattern.

The *CF* refers to an agreement as an *executory contract* [4] that is equally unperformed: neither party has fulfilled any of its obligations [promises], or both parties have fulfilled their obligations partially and to an equal extent. Such unperformed agreements are not recognized in Financial reports but are used in several ways for disclosing, measurement, "production" of other intentional and recognized resources and claims, thus need to be included in the AIS concepts.

### *3.4. Exchange Delivery and obligation incurring actions.*

Delivery concerns the execution of actions aimed at fulfilling the commitments established in the agreement [7]. The Delivery process in EXP is a substantial specialization of UFO-S delivery phase pattern, using the EXP economic exchange pattern in four (eight) different ways.

First (see e.g. (1) in Fig.4), because in EXP we assume that the agreement promise fulfillment may be specified and/or executed by two and more partial actions (*Transfer/Receive*), that leads to introducing *in process obligations* (*AIP/LIP*, here and further respectively).

Second, because after completing of the fulfillment process, the *in process obligations* are transformed into the opposite *unconditional obligations* (*Receivable/Transferable*) specified by agreement consideration.

Third, the unconditional obligation settlement may be specified and/or executed by two or more partial actions (*Receive/Transfer*), that again leads to maintaining *in process obligations* (*LIP/AIP*).

Fourth, these *in process obligations* after completing the settlement, finally settle the opposite unconditional obligations (*Transferable/Receivable*).

These processes are depicted in Fig. 4 which constitutes the Complex economic exchange delivery pattern. The exchanges are represented by events in blue color. We should note that concurrently with the *transfer* process, according to the agreement or due to agent's autonomy [18], the *receive* process specified by the same agreement clause may progress. As mentioned earlier, during the delivery phase, equity changes of *contribution (OEC)* and *distribution (OED)*, as the fulfillment of the *Articles of association* agreement, may occur.

Regarding the running example, the agreement may contain the Caesar Salad and the Main course to be served by separate actions, each of which will not be considered separately and thus will incur an AIP, called Contract asset in [5]. Completion of the meal serving will cause Contract asset to convert into a Receivable, which is to be settled by the customer. The customer may pay also before the serving, thus creating LIP – Contract liability.

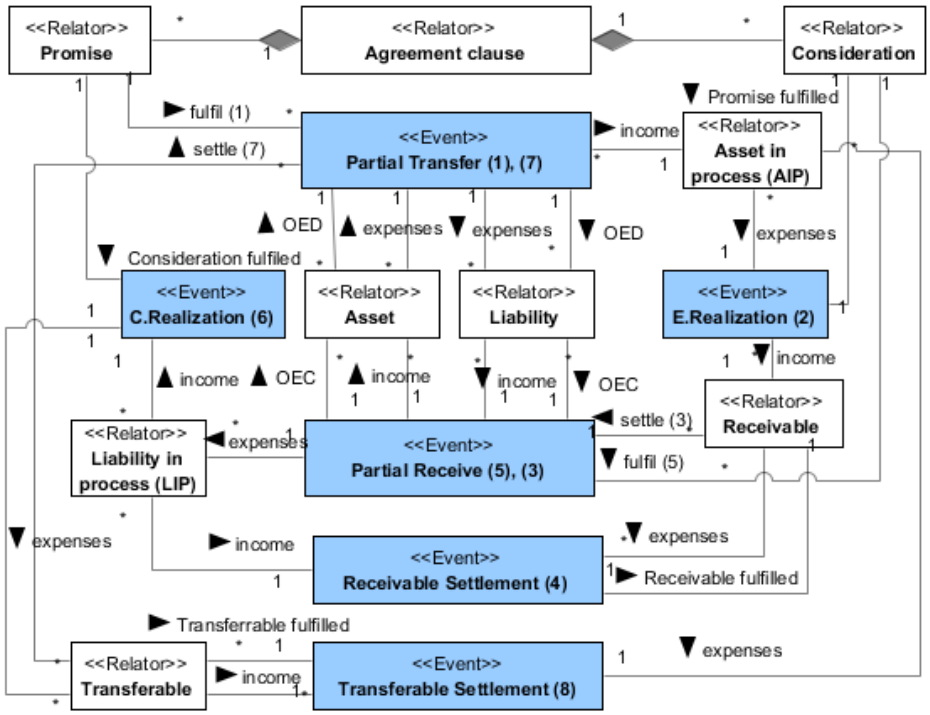


**Figure 4.** A fragment of an OntoUML diagram of the Economic exchange delivery phase. See Fig.5 for the Economic agent roles. Legend: OED – distributions to the Owners of *E*, OEC – contributions from the Owners of *E*.

Each distinct economic resource or action should contain criteria for partition or integration governed by the UFO *mereological decomposition patterns* [8]. The quantity of the economic resource is one of the bases for its partition, see other bases as economic resource associations in Fig 5. Fig 5 shows the proposed taxonomy and structure of economic resources. Obligations are mediated by *debtor* and *creditor* roles. For equity claim, the creditor role is specialized by equity claim *holder* role. Assets, in general, are mediated by the *Controller* role.

Recognizing the universal economic exchange process states and generalizing the patterns in IFRS standard [5] we suggest *in process* concepts for inclusion in [4] and define:

- *An asset in process (AIP)* is the *E*'s right to receive/settle for partially completed transfer, conditioned on the fulfillment of the remaining promise/transferable (realization).
- *A liability in process (LIP)* is the *E*'s obligation to transfer/settle, for partially completed receipt, conditioned on the fulfillment of the remaining consideration/receivable.
- *A transferable (LT)* is a present [unconditional] obligation of the *E* to transfer, conditioned on the passage of time.
- *A receivable (AR)* is a present [unconditional] obligation of the counterparty to transfer, conditioned on the passage of time.

- *A property right (AO)* is a present claim of the *E* against the community for the underlying object.
- *An equity claim of OE* is the *E*'s [residual] obligation to the owners of transferring the assets of the *E* after the settlement of all its liabilities conditioned on the liquidation of the *E*, and the *E*'s promise to transfer dividends.

The general constraint for values now may be extended:

$$AO + AR + AIP = LT + LIP + OE + OEC - OED + I - S.$$

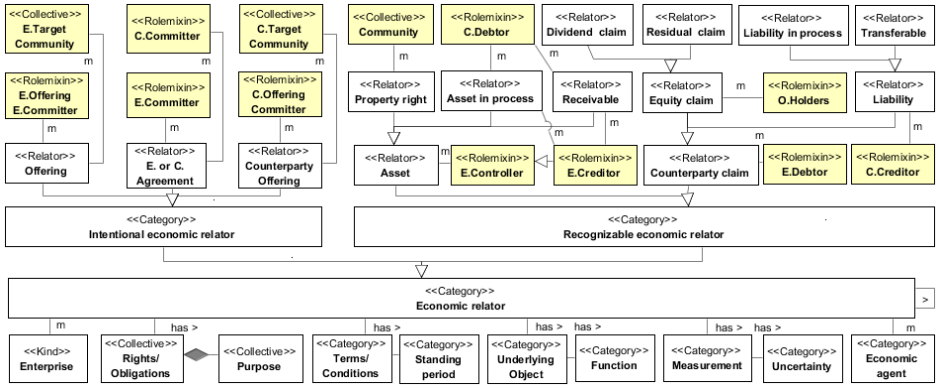


**Figure 5.** Abridged OntoUML diagram of Economic resource relators and the mediating roles.

## 4. Related work

The *Domain Ontology for Financial Reporting* proposed by [32] is similar to our efforts but covers reporting issues of the older *CF*. Concerning the main elements, it doesn't cover the interpretation of income and expenses, in process resources, offerings, and agreements; and phases and processes of economic exchanges. Their work is based on OWL and not specific upper ontology nor pattern stack.

The recent VDML standard [19] provides value and exchange concepts and patterns even beyond the economic, generalizes and explains many other important concepts for value modeling that overlap with our analysis, their planning level though is restricted to Value-Proposal that is roughly similar to the Offering concept. The further details of agreements, commitments and obligations and their fulfillments are not regarded. Their ontology is not grounded in any upper ontology, except for SSM Measurement, and is not directly applicable to accounting.

Fundamental work on the commitment patterns is provided by Singh et al. [18]. While many concepts are directly comparable in the commitment area we differ from Singh in the elaboration of reciprocity and economic resources, economic or accounting view.

As mentioned earlier, REA Ontology and its patterns [2, 3] is often used for teaching in the AIS courses but has not received traction in the Accounting domain. As concluded in [26]: "Amazingly, in the traditional accounting literature, which is the actual home base of the [REA] ontology, the [REA] ontology is mainly neglected." In short, we think

it is due to the prioritization of physical assets transfer ex-post duality, disregarding some social relationships and valuation flows that are created as possibly intermediate results of the economic processes.

There are obvious similarities between our economic exchange and the transaction in DEMO Enterprise Ontology [13] in terms of phases. However, there are also important differences. The economic exchange is always assuming economic reciprocity and, in the end, is concerned about economic resources. The commitment is not only for coordination but also has economic value. The order (agreement) phase in EXP is not generally followed by one execution phase and one result phase, but multiple partial execution – result (delivery) phases with possible reciprocal actions, leading to the final result and reciprocal obligations, facilitating the interaction.

## 5. Conclusions

The UFO and UFO-S ontology patterns were regarded for application by analogy and extension in the engineering of a core ontology for AIS. The new IASB Conceptual Framework for Financial Reporting was used as a main source of the domain knowledge, and an economic exchange pattern for the core ontology for AIS was proposed. Economic exchange pattern was specialized to specify offered, agreed, partial action, settlement and realization economic exchange patterns. The economic resources and claims of the enterprise affected by economic exchanges are represented by patterns of economic relators including offerings, agreements, (unconditional, in process and residual) obligations and property rights. The Conceptual model, engineered using OntoUML, is an important step towards the development of a Core ontology and Ontology Pattern Language for AIS.

The UFO provides a solid concept and pattern base for the researched domain. The UFO-S ontology was extended to cover reciprocity, obligations, delivery process and measurement issues for AIS. The OntoUML language and tool have a potential for creating formalized and conveniently shareable ontologies for our domain. Some drawback was the inability to introduce new stereotypes, that have been created for UFO-B, C and other ontologies, as well as a difficulty to express behavior and interaction in a UML class diagram profile. The pattern extraction capabilities for reuse and some other features were not ready yet for engineering.

Concerning the modeling of the IASB *CF* and the new standards, we suggest to integrate the concepts of intentional economic relators and spread the value assessment and production patterns to planning level; and generalize and prioritize process assets/liabilities. A UFO mereological pattern application is needed for processes, economic resources and particularly for “bundles of rights” which are treated in [4] as “sets” or collectives, while in fact they are functional complexes [8].

One of the features of the OPLs in addition to the choice and other operators may be the instantiation of the view of a particular agent, location or time. Another feature for OPL languages could be the generalizing of sub-ontology patterns into core ontology.

The future directions involve elaborating the AIS ontology formalization, creating EXP-OPL pattern application scripts [24] for developing IFRS sub-ontologies. The S-OPL didn’t play a significant role yet for engineering of EXP because it is also a core

ontology that extends the whole pattern complex of UFO-S, but S-OPL will be the base for the EXP-OPL.

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