# The Unit of Account in Financial Reporting and AIS
## An ontological approach

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## 1 Introduction.

This paper partially extends work originally presented in 20th IEEE International Enterprise Distributed Object Computing Conference, EDOC 2016 [1].

In Accounting Information Systems (AIS) "transactional [economic exchange] data is collected and stored into meaningful information from which business decisions are made" [2]. The data of economic phenomena [material[1] for an enterprise] is captured, classified and estimated, recognized and measured, and periodically disclosed and presented. AIS is a sub-system that contributes to the wider system of Financial Reporting. The Statements of Financial Reporting of an Enterprise are a related set; each articulates with the others, and all are derived from the same underlying data.

Although the field of the AIS has a long tradition, scholars in [3] conclude the absence of a widely-adopted conceptualization.

The Accounting and Financial Reporting (FR) and thus AIS domain may be characterized as a three-level hierarchy of models:

1) Conceptual Framework for Financial Reporting,
2) International and National Accounting Standards and Interpretations,
3) Enterprise Policies.

The Financial Reporting and these models are undergoing a substantial change with the introduction of a new Conceptual Framework for Financial Reporting - CF [7] and several new International Financial Reporting Standards – IFRS e.g. [8-10], by the International Accounting Standards Board (IASB)[2]. Some of the problems that remain are the vagueness, inconsistency, concept definition by exampling and ambiguity of the verbal form of the CF and IFRS standards [22], as well as the limited coverage of the economic exchange lifecycle and insufficient integration of concepts of individual standards. To overcome these issues ontology technologies are researched for engineering Financial Reporting and AIS domain reference ontologies e.g. in [5, 6, 22, 24]; as well as by the authors [1] using the SABiO [18] methodology.

SABiO recognizes the importance of the reuse of ontological resources: existing domain ontologies, core ontologies, foundational ontologies, and ontology patterns (OP) in the development of domain ontologies and advocates for the use of an ontolog-

[1] *Materiality* is a legal concept

[2] There are more than 80 International Accounting Standards and Interpretations, extensively used in 120 countries worldwide. These standards include specific (industry) exchange types, such as Sale, Lease, Insurance, Transactions with Inventories, Financial Instruments and other Economic Resources. Similar standardization activities are performed by Federal Accounting Standards Board in U.S. and other countries.

ically well-founded language during ontology capture. Per [19], Foundational ontologies span across many fields and model the very basic and general 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, we further discuss the concept of the Economic relator of the EXP - Economic exchange ontology for AIS introduced in [1] that is grounded in Unified Foundational Ontology (UFO) [12] and the core ontology of Services UFO-S [11], by applying the FOPs of UFO by analogy and DROPs of UFO-S by extension. 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.

We subscribe to Ijiri's view [4] that the activities of an enterprise as an economic agent comprise planning and fulfillment of a coordinated chain of economic exchanges. These exchanges affect economic resources and claims against an enterprise (called negative economic resources in [4]). Economic exchange is a commitment based and recurrence aimed action of economic agent, transferring its resources motivated by receiving new resources of a greater [possibly indirect] benefit for the agent. Commitment base and possibly separated in time transfer and receipt events imply a lifecycle of exchange. The lifecycle [the effects and types of the exchange events] is captured in Units of Account. Notice that this exchange interpretation is rather overarching and include activities which inclusion may be disputed. So, not only resources, but also claims against the Enterprise may be transferred and received; transfer and receipt actions are exchanges themselves, due to the lapse of time between transfer and receipt. For a uniform treatment of all changes in the resource set of an enterprise, we following [4] also consider a degenerate [non-reciprocal] exchange, where a transfer has occurred without a receipt or vice versa. Within Enterprise the conversion processes, such as production [4] and even their maintenance and storing may also regarded as kinds of exchange. From a financial period standpoint, we may regard economic activities as exchange between the Enterprise and the Society/Environment. Such generalization approach to economic activities together with generalization of commitments and claims against the Enterprise in a form of the Unit of Account, comprise our base for finding comprehensive patterns and taxonomies, facilitating reuse. The concepts and patterns of the economic exchange lifecycle, participating agents and economic resources, their qualities and dispositions, are the entities of an AIS and our research.

There are differences and interdependencies between the Financial Reporting (FR) and AIS models. The labyrinth of rules that exists today as patterns of Financial Reporting must be primarily understandable, while for AIS the reuse and discrete modeling goals are important in searching for overarching, cohesive principles, that eventually will save development and reporting costs. Another point is that AIS patterns exist, and often facilitate [3] accounting change, but are not standardized and explicated.

The FR is primarily concerned with reporting some established elements of Financial Statements, such as Line items, Subtotals, Totals and Notes of aggregated data of Units of Account. AIS task is to facilitate the capturing and processing of data for reporting, that include prompting, validating and enhancing [inferring] starting at transaction level, classifying and storing information to Units of Account, and securing valid and reasoning transition process between the phases of Units of Account. This, and

especially the specification of the transition process may require a more detailed classification and characteristics, as well as full lifecycle, upper ontologies grounded coverage of Units of Account. Not surprisingly, such additions may produce a feedback for standard setting or concepts in place when standard setters introduce new elements, such as digital currencies, as well as unifying concepts and taxonomy allowing the simplification by eliminating or subordinating accounting differences, such as between fulfillment and settlement, or asset and business. Isomorphism between FR and AIS, though, should be retained.

IFRS Standards and CF are lengthy [sometimes for decades] publicly discussed before acceptation. Surprisingly small number of respondents come from the IT community, that could unify and make concepts more easy and widely implemented in software. Agile and profound AIS implementation of current IFRS are substantial factors of IFRS deployment. By Conceptual Modeling of the new CF and IFRS, using ontological approach, we attempt to interpret the Financial Reporting concepts through ontological categories and patterns and suggest a conceptualization methodology and a wider set of concepts for Conceptual Framework analogue for AIS to facilitate reuse and discrete modeling.

The main contribution of this paper is the discussion of a concept for reciprocal and complex Unit of Account that may further extend the proposed EXP ontology, concluding that Unit of Account should be modeled as an economic relator and introducing top level relationships specializing and classifying social relator.

## 2 Standard setting and ontology engineering methods.

The proposed use of UFO grounded ontology engineering methods for Financial Reporting conceptualization for building ontology-driven AIS is shown in Figure 1.

<table>
<tr><td>Row</td><td rowspan="2">Accounting standartization</td><td colspan="5">Accounting standardization (DP, ED, Final, Implementation) Artifacts and Languages:</td></tr>
<tr><td>1</td><td>Basis for conclusions</td><td>Accounting Standard text, XBRL Taxonomy</td><td>Implementation and Transition guidance, Decision trees</td><td>Illustrative examples, Post-Implementation review</td><td>Natural Languages, Journal Entry Types, XBRL</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">Accounting standartization layers↓:</td><td colspan="5">Ontology engineering</td></tr>
<tr><td>Ontology stack</td><td>Ontology Patterns (OPs)</td><td>OP Application Languages (OPLs)</td><td>Verification, Validation, Instantiatons, Antipatterns</td><td>Ontology engineering Languages and Tools</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">Social norms and regulations</td><td>Unified Foundational Ontology (UFO)</td><td>Foundational OPs (FOPs)</td><td>SABiO Methodology</td><td rowspan="2">Concept relationship validation - Stereotype compliance, multiplicities, ontological restrictions, Examples, Antipattern collection</td><td rowspan="3">OntoUML, [Temporal] OCL, Menthor editor, Alloy Analyzer</td></tr>
<tr><td>UFO Services Core Ontology (UFO-S)</td><td>Domain related OPs (DROPs), Subontologies</td><td>UFO-S OPL, E OPL</td></tr>
<tr><td rowspan="2">4</td><td>IASB Conceptual Framework</td><td rowspan="2">AIS Core Ontology (FRISCO)</td><td>Domain related OPs (DROPs), Subontologies ↓</td><td rowspan="2">AIS Ontology Pattern Language - AIS-OPL</td><td rowspan="3">Instantiation and Simulation visualization, Model verbalization, Test cases</td></tr>
<tr><td rowspan="2">IFRS Standards and Best Practices</td><td>Common DROPs of IFRS, ERPs ↑</td></tr>
<tr><td>5</td><td>AIS IFRS nn Domain Ontology</td><td>IFRS nn DROPs</td><td rowspan="2">AIS IFRS nn OPL</td><td rowspan="5">OntoUML, [Temporal] OCL, Alloy Analyzer, Menthor editor, DSL, XBRL Taxonomy, Code generators</td></tr>
<tr><td rowspan="5">6</td><td>Complient Enterprise Accounting policies</td><td>AIS Enterprise Policy Specifications</td><td>AIS Policy DROPs</td></tr>
<tr><td>Exchange offerings</td><td rowspan="4">AIS Exonomic Exchange Specifications</td><td colspan="3" rowspan="4">AIS Modules, Reports, Entry screens, BP scenarios, DB schema</td></tr>
<tr><td>Exchange agreements</td></tr>
<tr><td>Delivery obligations</td></tr>
<tr><td>Delivery</td></tr>
</table>

**Fig. 1.** Similarities in FR standard setting and ontology engineering

**The first row** lists the main components that are produced together with an accounting standard or framework and in the last column - the Languages and Tools used. A standard with the basis for conclusions, implementation and transition guidance and examples is described in natural language, often with the (Transaction) Journal Entry examples. Sometimes, the texts are contradictory or incomplete for the application, that leads to postponed implementations and numerous additions. For a Standard, an addition to XBRL Financial Reporting elements taxonomy is provided[3]. XBRL filings are structured using a taxonomy which defines the accounts on the financial statements with accounting concepts and identifies the relationship between accounts and footnote disclosures. While XBRL FR Taxonomy offers significant means for unification and communication, its semantics are relatively weak and unstructured within the element of the hierarchy that should be referred to as taxonomies that describe the structure of a document, not ontologies that describe the content.

**The second row**, in dark blue, lists the main and corresponding (by column) components of an ontology engineering. An ontology stack or even network of related ontologies and its sub-ontologies have a basis for conclusions (Meta-ontological choices). An ontology and an IFRS could be regarded as a set of patterns, with pattern implementation and application guidance/language (OPL). At present, there is no UFO related tools for ontology transitions known to the authors. UFO tools provide Concept relationship validation - stereotype compliance, multiplicities, ontological restrictions. Formal verification and validation through instantiation, model verbalization and anti-pattern detection provides feedback for ontology engineering and improvement. Illustrative examples of IFRS and public response is a limited method of validation through instantiation. Ontology engineering Languages and Tools provide graphical and formal means of development. Besides verification and validation (at least DBMS schema) code generation for AIS is possible.

**The third row** lists corresponding components of the foundation and core ontologies used - UFO and UFO-S. The main Foundational Ontology Patterns (FOPs) used are listed in the next Section. For Ontology pattern application languages - OPLs, see [20]. OntoUML is an ontologically well-founded conceptual modeling profile of UML, realized through Menthor graphical editor [17]. To cover domain constraints that cannot be represented using the OntoUML language's diagrammatic notation, the editor supports specification of OCL and temporal OCL formal constraints. The instantiation within Menthor editor is provided using Alloy Analyzer. In Financial Reporting, there is a principle of economic substance over legal form, nevertheless, we may generally position Social and Legal norms as foundational layer for Accounting and Financial Reporting.

**The fourth row** lists components for the Core AIS ontology (eg, EXP) for IASB Conceptual Framework [7]. The Domain Related Ontology Patterns (DROPs) of the EXP, besides CF concepts, include concepts and DROPs common for other IFRS Standards and existing AIS within ERP Systems. The taxonomies used for AIS and IFRS may be different, the AIS taxonomies are particularly motivated by inheritance of relationships and operations from higher level entities. The OPL for EXP is not yet published. The instantiation for EXP examples in addition to Alloy format, will be provided in a special Journal Entry like format that is more familiar and concise for the domain specialists.

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[3] http://www.ifrs.org/XBRL/Pages/XBRL.aspx

**The fifth row** lists EXP components for particular IFRS Standards, that are planned for a future work.

**The sixth row** list components for engineering policy and exchange phases in particular enterprise.

## 3 The main FOPs used from UFO and UFO-S

UFO Foundation Ontology Patterns(FOPs) used:

- **Endurant FOP**, that includes:
  - Objects specialized in Agents, Non-agentive Objects and Situations;
  - Modes specialized in Intrinsic Modes and Relators.

  The extension of the Endurant type due to a change in intrinsic properties is a Phase. It is a partition along the time dimension.
- **Relator FOP**. that are existentially dependent on two or more Endurants. When mediated by a Relator, an Endurant plays a Role in a certain context.
- **Agent FOP** represents an Object that can bear Intentional Modes, such as Beliefs, Desires, and Intentions. Every Intentional Mode has an associated Proposition, which is called the propositional content of the Mode. The propositional content of an Intentional Mode can be satisfied by Situations in reality.
- **Disposition FOP** represents Intrinsic Modes that are only manifested in particular Situations, but that can also fail to be manifested. When manifested, they are manifested through an occurrence of Events.
- **Intention FOP** - the propositional content of an Intention is termed a Goal. Actions are intentional Events with the specific purpose of satisfying a Goal. An Action achieves a Goal if the Action brings about a Situation in the world which satisfies that Goal.
- **Rolemixin FOP**, used for roles of different [Economic agent] kinds.
- **Social relator FOP** is a relator, depicted in lower part of Fig. 2, composed of one or more pairs of social commitments and social claims among agents - A and B in this Figure [11].
- **Structural model for events pattern** [25] is used here in combination with Social relator, employed for modeling Economic resources and claims against the enterprise.

As with all relators, social relators are founded by events [25], see upper part of Fig.2. The pattern extends the treatment of reified events that was proposed in [13]. As events, creation events begin and end at certain time points. The creation moment of a relator is derived from the termination time point of its creation event (e.g. initial recognition of an economic resource).

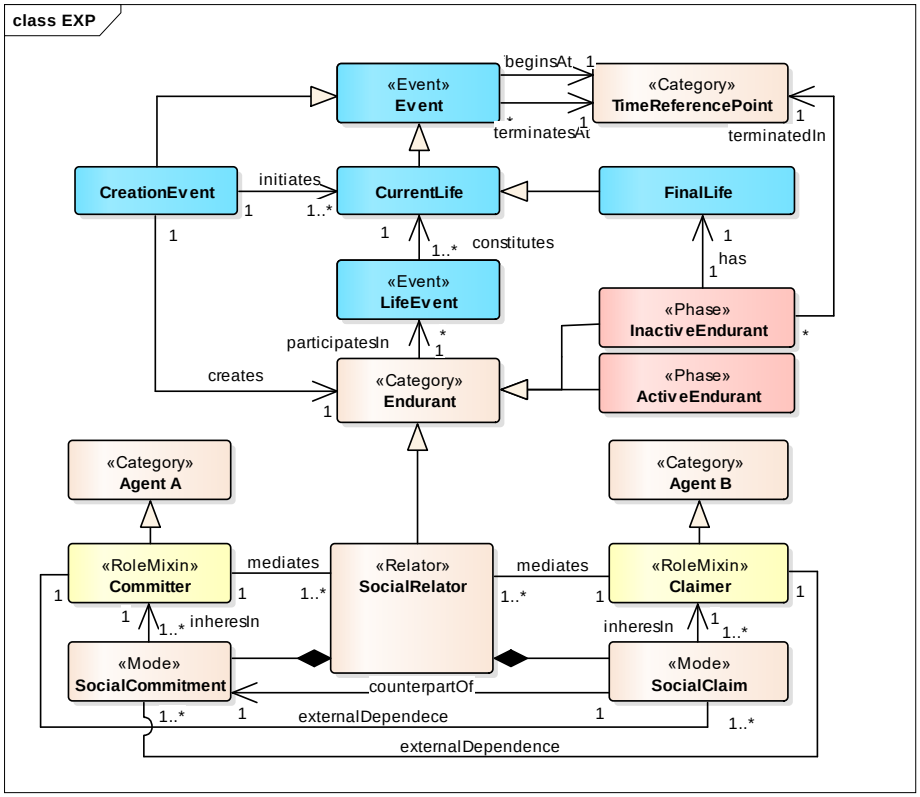


**Fig. 2.** An OntoUML diagram of Social relator, adapted from [11] and the Modeling Pattern for Representing Events in Structural Business Models from [25].

Relators have a causally active phase (e.g., an agreement, an acquired property, an incurred debt) during which the qualities and dispositions of this relator are manifested through several *life events* (e.g., a fulfillment of a promise, a depreciation of a property, a revaluation of a foreign currency debt) that accumulate to constitute, at each point, a different process that represents the *current life of the relator*.

Relators also have a causally inactive phase (e.g., an expired agreement, a sold property, a settled debt). In this latter phase, the properties of that relator can no longer be manifested and, its qualities are immutable regarding their values and we can refer to the *final life of the relator* as the total accumulation of all *events in the life of the relator*. OntoUML give us a clear methodological support for deciding for which types in a Model of endurants we should specify a behavioral Model of changes [25].

UFO-S [11] is a core ontology on services, which is grounded on the UFO. It includes the lifecycle of an exchange as service system [23]. 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.

## 4 Economic relator pattern. A Reciprocal and Complex Unit of Account.

### 4.1 Enterprise (E) E. Commitments and E. Claims as Economic relators

Ijiri [4] 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 [claim to receive] or a decrease of economic resources [commitment to transfer]" and suggests extending economic resource control recognition criteria to agreements, forecasts, and budgets. The existing accounting, though, on the face of Financial Statements recognizes only such commitments, that have enforceability of legal or constructive obligation [7], ["no matter how likely" the other might be].

Part of the economic commitments are accounted [to our opinion, not systemically] and *disclosed* (but not recognized) in the Notes to the Financial Statements. The disclosure rules are difficult to understand [22] and their scope is not complete. The FR community is having a constant debate about recognition versus disclosure and the tendency is increase recognition [10] and improve disclosure. While there is a difference in reliability between commitments and obligations, it doesn't make the former insignificant for the decision making and "the ability to obtain access to necessary materials or rights, and employees"[26]. The CF has substantial texts about recognition and derecognition, but lacks concepts and descriptions for disclosure. This aspect is criticized by FR community, from the FR oriented view.

From AIS and ontological approach view commitments are regarded "first-class citizens", e.g. in [6, 11, 15]. We would like to note that:

- commitments are speech acts about economic resources;
- commitments are precursors and typify most of the economic events and thus are dispositions for recognition;
- many commitments must be disclosed in FR;
- commitments may be used to produce other commitments;
- some commitments may be valued and transferred;
- commitments may be used as a base for reclassification and revaluation.

We will further call the enforceable economic commitments and claims - *Recognized* resources and claims against the E [representing Rights and Obligations], but the other economic commitments - *Intentional* resources [15].

An UFO-S precursor paper [23] provides more specific commitment definition: "A Service Commitment is an agent's explicit and enduring commitment to guarantee the execution of some type of core actions, on the occurrence of a certain triggering event, in the interest of another agent and upon prior agreement, according to a certain specification (Service description) which constrains the way Service actions will be performed." In addition to the latter definition, the former one understands the core actions as transfers/receipts of economic resources. By *Economic commitment* we assume that specified actions will be performed at specified timing, by and to specified agents or channel [of committer and claimer principals[4]] in specified roles, for specified purpose, for specified rights/obligations, for specified underlying object or its

[4] An agent of a principal is a party that is primarily engaged to act on behalf of, and for the benefit of the principal. If an Enterprise holds an Economic Resource (ER) as an agent, the Economic Benefits arising from the ER flow to the principal instead of the agent. Consequently, the E does not control [own] the ER

function, measured by quantity or identified, and monetary exchange-valued. *Economic commitment* together with its counterpart – *Economic claim* constitutes *Economic relator* that is a specialization of a Social Relator.
*E.commitment (aka C.claim)* will be an economic relator committed by an Enterprise (E), *E.claim (aka C.commitment*) – committed by a Counterparty (C).
As mentioned in [23] "Quality evaluations are not made solely on the outcome of a service; they also involve evaluations of the process of service delivery". For modeling the FR and AIS we need to depict not only Economic relators (Real and Personal Accounts), but also Events that create or change them (Nominal Accounts).

Economic relators as well as Social relators may form (complex) Group relator structures [such as bundles of Commitments either for different underlying objects or for the same object] among the same or different agents. Examples of a group of relators are: an obligation to provide lease of an owned property, if the property is bought by the Enterprise it obtains the ownership rights and possibly a lease obligation; a house ownership with lifelong tenant rights; a house ownership with a mortgage.

Another complex is a Reciprocal relator pair of converse relators among the same agents, where their roles are reversed, e.g., Agreement, or even a Business[5].

The fulfillment of the commitments change the relators. The net value is called balance or equity.

We distinguish property relators(in rem) and contract relators(in personam). Property relators are characterized by three features [21]: in rem, right to exclude and running with assets.

Large part of the economic relators is mediated by Society. Institutions and institutional arrangements coordinate and enforce the rights and obligations, substantially decreasing the transaction costs and risks.

## 4.2 Economic resources as economic relators

The recent Conceptual Framework [7] defines an *Economic resource* as a [valued] right [bundle of rights] that has the potential to produce benefits, an enterprise controls an economic resource [has an asset[6]] if it has the present rights and ability to direct the use of the economic resource and obtain the benefits that flow from it. The enterprise also has obligations – claims against its assets - liabilities to its creditors and equity claims to its owners. In EXP, these rights and obligations are modeled as *Economic relators* – specializations of Social relators regarded in previous section.

Economic resource rights generally rest on a foundation of legal rights [7] of Contract and Property Laws. For example, in American property law, a property right is described as a collection of legal relations between parties with respect to things [21]. Applying this approach, economic resources as rights and the claims against the enter-

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and it does not have an Asset, nor does it have a Liability because it has no Obligation to transfer any ER that it will or does control [7].

[5] To be considered a Business, an economic complex must include, at a minimum, an input and a substantive process that together contribute to the ability to create outputs [26].

[6] The important kind of assets are Goods/Services (e.g., employee Services) that are received and immediately consumed are understood as Momentarily Rights to obtain Economic Benefits until they are consumed [7].

prise in EXP are modeled as reified relationships between the enterprise and a counterparty (including society) with respect to an underlying object (of goods, services or rights). The rights specification is regarded as a bundle of permitted actions:

- actions with the rights themselves, e.g. a right to sell a "right to receive", a right to transfer a contract to another party; power to transfer rights
- 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 categories of agents for a party (or parties) for an economic relator are *Economic agents* defined as trusted, trustful and capable of committing, receiving, having and transferring control over economic relators – a specific person or an enterprise, a group of people or enterprises, or society at large. Economic actions are performed by agents playing a certain role in an institutional context. In CF, the Economic 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)" [7].

The enterprise (E) is the focal party for our model and a counterparty (C) - the other party performed by another economic agent that mediates in an economic relator. The E is separate from all the parties associated with the E, and is a going concern. Specialized roles of the parties are distinguished for different types of economic relators.

The E in the role of having control (E.claim) over the assets, covers the roles of E.creditor, E.holder and E.owner. The role of E mediating E.liability will be called E.debtor with the corresponding role of C.creditor and vice versa. The role of an E.equity holder will be called C.holder. Thus, the economic relators recognized by the enterprise are: universal claims against the society (Property), claims against C.debtors (Receivables), claims from C.creditors (Liabilities) and claims from C.holders (Owners' equity). The state and changes of these economic relators are presented as elements in Statements of Financial Reporting in an aggregated form [per the XBRL] from data classified in Units of Account (UOA) [7].

### 4.3 Unifying commitments and resources: The Unit of Account

Each of an [legally etc. enforceable] E's Rights is a separate Asset. However, for accounting purposes, related Rights are often treated as a single Asset, namely the UOA. The CF [7] describes the *Unit of account* as the group of rights, the group of obligations or the group of rights and obligations, to which recognition and measurement requirements are applied. We will enlarge that definition and use it also for Economic relators in general and commitments disposing obligations and claims disposing rights, adding *Recognized*, *Group* and *Reciprocal* [*Unit of account*] when needed. We assume that an Economic exchange (as Reciprocity) is a Reciprocal Economic Relator that progresses through different phases during its lifetime.

The proposed UOA pattern includes OCL constraints, including those prescribing the permissible phase transitions, and the OntoUML diagram, essence of which is depicted in Fig.3.

For OntoUML based conceptual modeling we use extended approach of event reification [13], where the effect of an event is a set of structural events, that is, a set of

changes in the population of entity and relationship types defined in the structural schema. We define a particular operation in each domain event type, whose purpose is to specify the effect by using the operation *Effect()* written in OCL.

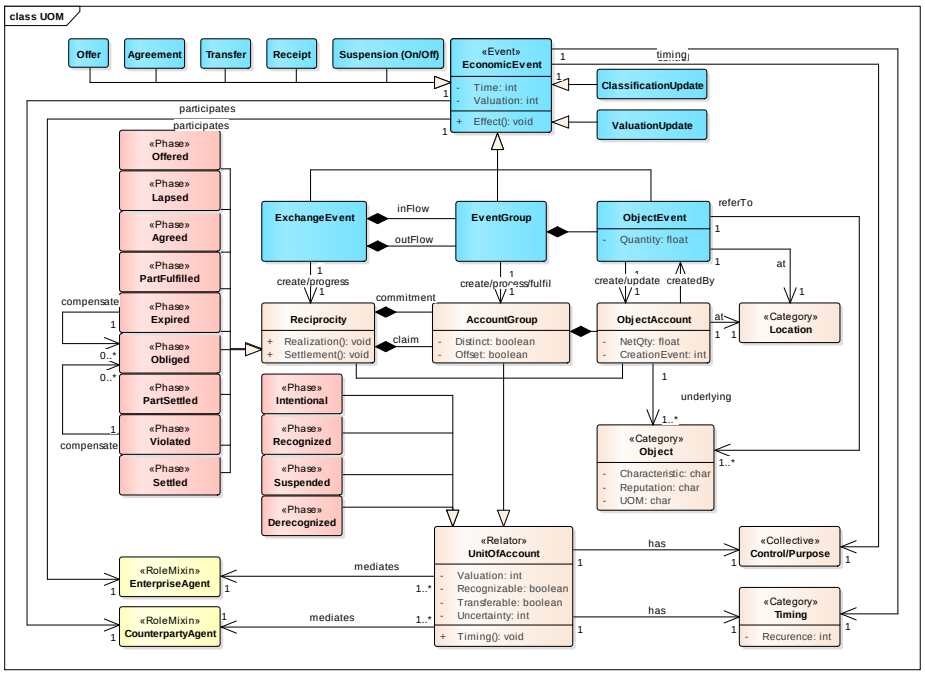


**Fig. 3.** Unit of Account pattern UML diagram with corresponding Economic Events.

**The relationships of the Economic relator (UOA) are:**

- **Participation** of two Economic agents – The E and a C in the opposite roles of Committer or Claimer and the agents of their Principal. See UFO-S Axioms SO1-SO3 [11]. Both, the roles (statuses) regimenting actions, and underlying types (identities) of the agents are important. The C.role is an *attitude* [15] – i.e. the roles, commitments and claims are regarded from the focal perspective of the E.[7] Valuation and Classification may depend on Counterparty's characteristics.
- **Control -** Bundle of Rights/Obligations [external positioning]
- **Purpose -** The intention, capability and level of deploying the rights and general functions of Economic Resource in E's activities with potential to obtain Economic Benefits [internal positioning]

[7] Specifying Underlying Object, Internal and External Participants and Action Types as in [5, 6] is not sufficient to depict an economic relator, as noticed eg in [24], besides that the Economic Relator is an Endurant and not a set of Events.

The resource within enterprise must be properly positioned – ie to have a role in the complex, that is reflected by classification. type of the committed/controlled/consumed resource: eg, “Fuel”, “Merchandise”, “Assets pledged as collateral for which transferee has right by contract or custom to sell or repledge collateral”, “Assets held for distribution to owners”; Represent legal and natural disposition and restriction of future events, such as major classes of inventory or accounting methods: “Investments accounted for using equity method”. From UFO standpoint [27] it is “an externally dependent universal (either a role or role mixin) that may be instantiated by objects of a particular allowed type ... in a defined context” of contribution to the production of outputs by applying of process of conversion, trade, financing.
The resource may have different valuation depending on the purpose.

- **Timing** - the timing of the transfer of Economic Resources required to fulfil the commitment, such as:
  - condition or triggering event, including covenants based on the Financial Statements of the E;
  - on fixed or determinable dates;
  - on demand;
  - at the end of the process; or
  - at liquidation.

  Timing also, characterizes priority of the commitment fulfilment relative to other commitments (e.g. senior, junior or most subordinate).
  The timing of transferring resources may be *Over time* or *Point in time* [9] and [Contractually based] *Current or Noncurrent* [8], that are common classifications for most of the Standards.
  The AIS Core Ontology should include general patterns of timing common to Financial Reporting that will be specialized by Standards;
  The [28] provides an exhaustive classification of normative positions based on the timing. They include Punctual, Persistent, Achievement, Maintenance, Perduring and non-Perduring positions which are included in our ontology, but will not be further described here, These .
  Timing influence valuation, particularly fulfilling Achievement may be less costly than Punctual Obligation.

- **(Underlying) Object** [7] or its Function (Characteristic) measured in units (UOM), an object type or an identifiable object [10], rights for which are required to be transferred to fulfil the commitment or are owned (e.g. cash, goods (including intellectual rights), momentarily (including services), owners’ equity), such as a pallet of bricks or human resources. Characteristics specify role - function in potential actions and underlying natural features. Objects and their rights may be publicly registered. Objects may be, commoditized and their market prices publicized and definitely influence valuation.
- Additional identification of the portion of the Economic Resource by the **Event ID** affecting the Resource and its Valuation. The time of this event may be used to determine the **Age** of the resource, that is often required to be disclosed.
- Additional identification of the portion of the Object type by **Location** [including “in transit”], that is often required to be disclosed;

- **Quantity** of Economic Resources required to be transferred or are owned (e.g. currency units, commodity units, formulas or rates of change, or a share of the net Assets of the E);
- The exchange **Valuation** ascribed to the relator, a method, eg, "at fair value" and a monetary measurement by E initially in agreement with C. For Reciprocal UOA the initial net value in normal cases is zero. The valuation may change directly [by ValueUpdate Event] during the UOA lifetime due to market prices, impairment etc. In this context, we regard Value as a monetary expression of a claim, for [part of] economic resources [to be] transferred/received (claims/commitments increased/decreased). Notice also that the exchange value is different from the carrying value used for valuing the internal relators (Expenses) with Enterprise owners. For public resources the Valuation is zero.

**Phases of Reciprocal UOAs** are listed in their progression order in Fig. 4, and further explained below. The phases primarily are the consequence of events separated in time and thus characteristic of any reciprocity with some unbalanced claim i.e phases/classifications are praxiological before being economic.

| Phase | Event | Fulfills (Conforms to) | Examples in Financial Reporting |
|---|---|---|---|
| Offered | Offer | Policy | Notes [8] |
| Lapsed | Timing | Offering | Notes [8] |
| Agreed | Agreement | Offering | Notes [8] |
| PartFulfilled | Transfer | Agreement Promise | Contract Assets [9] |
| | Receipt | Agreement Consideration | Contract Liabilities [9] |
| Expired | Timing | Agreement | Overdue Promises, Considerations |
| Obliged | Realization | Agreement | Payables, Receivables [8] |
| PartSettled | Transfer | Payable | Depreciation Assets [10] |
| | Receipt | Receivable | Depreciation Liabilities [10] |
| Violated | Timing | Obligation | Overdue Payables, Receivables [8] |
| Settled | Settlement | Obligation | Notes |

**Fig. 4.** The [top level] phases of the Reciprocal UOAs

- **Offered** (an Offering) is formed by Offer event as a meta-commitment by E or C, to exchange and conforms to the Policy. It may become **Lapsed** if not Agreed or Expired; disclosing Lapsed or Agreed Offerings of specific type would provide information about stewardship of the management of an E, what constitutes one of the two goals of FR;
- **Agreed** (An Executory Contract[8]) is formed by Agreement (Negotiation) event between E and C, as mutual commitment to exchange. A Contract should *conform to*

[8] The CF [7] describes an executory contract as a contract that is equally unperformed: neither party has fulfilled any of its obligations [commitments], or both parties have fulfilled their obligations partially and to an equal extent. A right to exchange rights. The underlying claims and commitments are not separable for fulfillment actions, but may be independently revaluated and reclassified or updated by mutual agreement.

(fulfil) what was previously established in the corresponding offering - Axiom SN01 of UFO-S [11];

- **Partially fulfilled** by Economic Relator Transfer or Receipt [Accomplishment] event from/to E to/from C, conforms to Contract, exemplified by accounts of Contract assets and liabilities;
- **Expired** to fulfill the Commitment or Claim within the specified timing; Similarly, as for Violated we may want to see in FR the information about contracts unfulfilled at deadline;
- **Obliged** (Enforceable Obligations/Rights) phase is formed by Wholly fulfilling Commitments/Claims of the Contract that triggers the Realization () operation[9] (Achievement Event) of the Reciprocity class. While it may be regarded as identity change, we following, eg, [6, 16] remain in the Reciprocity context. This phase is exemplified by accounts "Payables for purchase of energy", "Receivables from rental of properties". Obligations may raise also without listed preceding phases (e.g. statutory or raised from some Court decision);
- **Partially settled** Obligation by Transfer/Receipt event, conforms to Obligation, but is [rarely] used in cases when the partial settlement may not offset obligation;
- **Violated** – failed to settle the Obligation at deadline;
  A compensation is a set of obligations in force after a violation of an obligation. The compensations are obligations themselves they can be violated, and they can be compensable as well, thus we need a recursive notion of compensated obligation; Compensations can be used for two purposes: to specify alternative, less ideal outcomes [eg collateral, compensation of value, possibility of return]; to capture sanctions and penalties.
- **Settled** is formed by Transfer/Receipt events conforming to the Obligation, or wholly settling, that triggers the Settlement operation of the Reciprocity class in cases when the partial settlement may not offset obligation.

## 5 Discussion and Conclusions

Financial Reporting standard setting, implementation and corresponding AIS development at present is mostly informal and long process and as exemplified by other domains, may be improved by using ontological conceptual modeling approaches. That in turn may improve AIS models. An analogy between FR standard setting and AIS ontology engineering processes is proposed.

AIS patterns may be different from Financial Reporting because of the different goals, and more general patterns, grounded in upper ontologies.

The generalized Complex Exchange pattern and Complex Unit of Account pattern, that unifies commitments and resources, may have significant reuse potential and be extended to intentional (disclosable) concepts and plans as well as recognizable income and capital transactions, production, taxation, period activities and business acquisitions.

An additional research should be done from the standpoint of Managerial Accounting, to find out if the Complex Exchange Pattern may be used or generalized for Conversion, using methods similar to Holonic Manufacturing.

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[9] Depending from Policy and Legislation

While the concept number compared to CF may increase, it makes sense at least for AIS Core Ontology to:

- Ground Financial Reporting Information Systems Core Ontology (FRISCO) in Foundational and Upper Ontologies;
- Ground Economic positioning in Commitments and Claims as opposed to their specializations in Assets and Liabilities [elements]
- Ground on the [fundamental] most important concepts of Economic Agent, Business, Exchange, Quantity, Value, Money, their positioning and behavior.
- Use EXP (exchange event) and UOA (reciprocal relator) are two core patterns of FRISCO
- Extract common concepts from IFRSs intersection and AIS (ERPs) realizations;
- Generally, regard UOA as Economic Reciprocity of Claims and Commitments and develop higher level operations with UOA than debits and credits.

Particularly suggested is:

- Introduction of Quantity concept in CF, that is common for all IFRS Standards.
- Introduction of [top level] Phases of Reciprocal Units of Account.
- Inclusion of Phase transition rules.
- Inclusion of Reciprocity types as a foundation of Nominal accounts.
- Introduction of Journal Entry type notation for specifying Reciprocity.
- Simplify Standards by eliminating accounting differences between transactions involving assets and transactions involving businesses
- Eliminate the need to distinguish between a joint venture and other types of investees
- Generalize transactions with the Counterparty before introducing those with the Customers, etc.

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