From conceptual framework toward revenue recognition

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Abstract
The International Accounting Standards Board Conceptual Framework (CF), which is used in 168 jurisdictions, serves as the foundation for developing accounting and financial reporting standards. In this paper, we regard improvements in our CF Ontology concerning *Unit of Account* and *Control* concepts. Further, we provide an ontological analysis of IFRS 15 standard "Revenue from Contracts with the Customers". We present a draft ontology model of this standard in OntoUML developed by specializing CF Ontology.

Keywords
UFO, OntoUML, COFRIS, Revenue Recognition, Unit of Account, Control

1. Introduction

The International Accounting Standards Board (IASB) Conceptual Framework (CF) [1] which is used in 168 jurisdictions and together with its country and industry counterparts serves as the foundation for developing accounting and financial reporting standards [3]. Despite CF's fundamental nature and history, new and updated definitions and interpretations emerge and are discussed regularly (cf. IASB 2018, US GAAP Framework [2] 2021, 2022, and 2023). For formal presentation, understanding, convergence, and development of the ontologies of the standards through specialization, the IASB Conceptual Framework core Ontology (CF Ontology) was proposed in [10]. CF Ontology is grounded in Unified Foundational Ontology (UFO) [4] and Core Ontology for Financial Reporting IS (COFRIS) [9]. In alignment with the Design Science Research (DSR) methodology [19], the subsequent phase in the evolution of the core CF Ontology involves its practical application in the creation and refinement of the International Financial Reporting Standards (IFRS) ontologies, as well as in the formulation of a systematic methodology for their development.

In this work-in-progress paper, we regard some improvements and motivation behind the modeling of the CF Framework elements aimed towards understandability and development of ontologies of standards. We include the UFO/OntoUML stereotype descriptions, CF element definitions, the main part of the CF model, and the improvements in Section 2, making the paper to some extent self-contained. In Section 3 we regard IFRS 15 standard "Revenue from Contracts with the Customers" (further Customer Contracts) [11]. We present a draft ontology model of this standard developed by specializing CF Ontology. Section 4 concludes and outlines further validation work.

2. Background

Unified Foundational Ontology (UFO) is an axiomatic domain-independent formal Theory. UFO is divided into three layered compliance sets: UFO-A, an ontology of concrete endurants – of substantials and aspects [4], UFO-B, an ontology of events [12], and UFO-C, an ontology of intentional and social entities [6].

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OntoUML is a language whose meta-model has been designed to comply with the ontological distinctions and axiomatization put forth by UFO [5]. OntoUML diagrams (e.g., Figure 1) represent types. The stereotypes of concepts and relations (in addition to those of UML) used are described in Table 1. In UFO-C, agents and (non-agentive) objects specialize substantials [6]. Objects can be physical and social (e.g., economic resources, money). Agents can be physical (e.g., a person) or institutional (e.g., an enterprise) and have intentional aspects that can be mental or social.

Mental aspects include intentions, beliefs (that can be justified by situations), and desires (which express the will of an agent toward a situation). The notion of intention refers to a situation that the agent commits to bring about by pursuing goals and executing actions. A closed intention specializes commitment to pursue a goal in a specific way, i.e., constrained by a particular type of action type termed a plan [6] or a schedule.

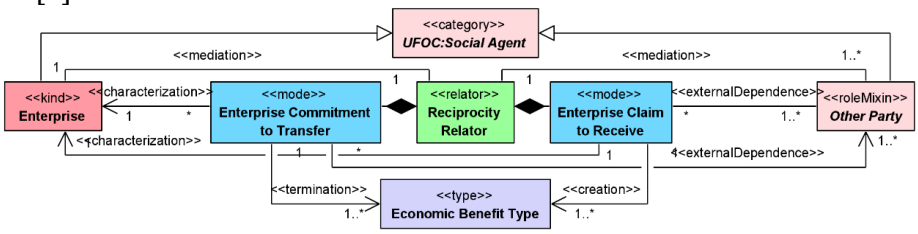

Figure 1: OntoUML diagram of economic Reciprocity Relator. Adapted from [13]. Enterprise view. In all diagrams, types are represented in purple, objects in pink, modes in blue, events in yellow, and relators in green.

Social commitments and claims (aka expectations) specialize social aspects [6]. A social commitment is the commitment of an agent A towards another agent B. As an externally dependent mode, a social commitment is a characterization of the A, has externalDependence on the B, and causes the creation of an internal commitment in the A [6]. Also, correlative to this internal commitment, a (comparative) social claim of the B towards the A is created.

Social commitments and claims always form a pair that refers to unique propositional content. A social relator, mediated by agents, is an example of a relator composed of correlative commitments/claims. Actions are intentional events, i.e., events that are performed by agents to satisfy their goals. Actions are manifestations of agent modes and action types are specified in commitment schedules or by committed resource types [6].

Reciprocity relators [13, 9] combine commitments (or correlative claims) of each of the two agents, e.g., the enterprise and the other market participant(s), as in contracts. The services ontology UFO-S [13] regards reciprocity relator as an agreement to exchange service actions. Specific reciprocity relators also can mediate different roles of an enterprise in a production process. In different cases, other parties can be represented by second-order types or sets of prospects.

Table 1.
OntoUML Stereotypes of entities and primitive relations used [5]

Stereotype	Description	Example from this paper[2]
«type»	High-order type whose instances are themselves types.	Service Type, Resource Type
«instantiation»	Relation between an entity type and its higher order type	Asset → Asset Type
«category»	Necessary properties that are shared by entities of multiple kinds.	Non-Agentive Object
«kind»	Type of objects that exist according to a particular conceptualization of the given domain. These fundamental types describe what the objects in that domain essentially are.	Enterprise, Person
«subkind»	Subdivision of a kind.	Bank, Contract
«collective»	Any group of entities that are considered together as a single unit	Unit of Account of Rights and Obligations
«phase»	Anti-rigid sortal type that captures a cluster of change conditions in intrinsic properties	Contract Asset, Receivable
«phaseMixin»	Anti-rigid non-sortal type that captures a cluster of change conditions in intrinsic properties, for instances of multiple kinds	Going Concern phase of Market Participant

[2] We use the same stereotypes for relations between endurant types and modes as for relations between endurant types and event types.

«role»	Relationally dependent universal, capturing relational properties shared by instances of a given kind	Asset, Liability, Equity Claim, Principal
«roleMixin»	Role for types that represent properties shared by entities of multiple kinds	Other Party, Hired Provider
«quality»	Aspect that can be directly associated with structured value spaces.	Transaction Price
«mode»	Aspect that cannot be directly associated with structured value spaces.	Right to Receive,
«characterization»	Relation between a bearer type and its «quality» or «mode».	Enterprise ← Right to Receive,
«externalDependence»	Identifies an endurant type on which the mode depends	Other Party ← Right to Receive
«relator»	Truth-maker of relational propositions. Relations (classes of n-tuples) can be completely derived from relators.	Reciprocity Relator, Contract
«mediation»	Relation between a «relator» and the entities it connects	Enterprise–Contract–Customer
«event» and relations:	Class whose instances are events.	Transaction, Transfer
«historicalRole»	Role played by sortal objects in an event.	Resource Transferred
«historicalRoleMixin»	Role played by non-sortal objects in an event.	Service Provider
«participation»	Relation between an endurant type and the event type.	Enterprise ← Transfer
«bringsAbout»	Relation between a situation type and the event type.	Contract Asset ← Realization
«creation»	Relation between an endurant type and the event type [or mode] of creation of the endurants.	Asset Increase ← Receipt, (aka recognition)
«termination»	Relation between an endurant type and the event type [or mode] of making the endurant nature "historical".	Asset Decrease ← Transfer, (aka derecognition)
«manifestation»	Relation between a mode and event type in which the mode is manifested and [partially] terminated	Right to Receive → Receipt, (aka fulfillment, realization)

Core Ontology for Financial Reporting IS (COFRIS) [9] adds economic resource flow and affected resource stock concepts to the commitments/obligations and their (incremental) fulfillment [9]. Furthermore, economic resources are considered as a set of institutional rights (including rights to receive services) that have the potential to produce economic benefits.

An Economic Exchange is defined as a transaction whereby two economic agents (A and B) conclude and execute contracted reciprocal performance obligations to transfer economic resources and to provide services, affecting both parties' resources and activities, with the goal of producing economic benefits for either party [9].

Transactions are regarded primarily as institutional actions of Resource Transfer of rights (and assumption of Claims) that may involve the simultaneous or postponed manifestation of service provision, including object custody, delivery, transformation, or production. While the labor of the employee or the service of the provider is an important characteristic of an economic event, the ultimate provider of a service is the enterprise or the other party.

The resource flow affects transactor operations, or economic resources (and claims) held and controlled by parties, termed assets (and liabilities), valued by their holders or the market [1]. The market is a network of market participants – enterprises and persons serving to facilitate exchanges and economic resource-related rights and obligations.

For instance, in a basic sales contract, an enterprise employs designated quantities of grain assets *and* a hired workforce labor to transfer and deliver these resources to the other party. In return, the enterprise's cash assets are affected by the receipt of cash, but the accompanying bank's services are expensed for the benefit of operations.

Ontology of conceptual frameworks for financial reporting (CF Ontology**)** [10] is building upon the foundation laid by COFRIS, but CF Ontology takes a broader perspective by encompassing not only economic exchanges, but also events, roles, and phases of resources and claims additionally required for the framework. About 60 concepts in total and terminology have been refined to align closely with those used in established frameworks. We have tried to minimize the introduction of new concepts beyond those found in existing frameworks. However, it is assumed that for most concepts, corresponding high-order types and correlative counterparts of concepts exist. The UFO foundational concepts are denoted in camelCase, such as roleMixin but CF Ontology concepts are starting in uppercase – Economic Resource. In this paper, the adjective Economic refers to the monetary value of most of the regarded concepts.

The purpose of the IASB Conceptual Framework [and CF Ontology**]** is to: (a) assist the IASB to develop International Financial Reporting Standards (IFRS) [and IFRS Ontologies] that are based on consistent concepts; (b) assist preparers to develop consistent accounting policies [and Policy Ontologies]; and (c) assist all parties to understand and interpret the Standards [1]. The CF Ontology is depicted in Figure 2 and described together with the short reviews of CF chapters.

The Objective of Financial Reporting. Per [1:1], The objective is to provide financial information about the reporting entity [aka Enterprise] that is useful to existing and potential investors and creditors in making decisions relating to providing resources to the entity. Financial reports provide information about (a) the nature and amounts of the entity's Economic Resources and Claims against the entity; (b) the effects of Transactions and other events that change an entity's Economic Resources and (Claims)[3]; (c) the efficiency and effectiveness with which the entity's management discharged their stewardship [and custody] responsibilities.

The Qualitative Characteristics of Useful Financial Information. "If financial information is to be useful, it must be Relevant and Faithfully Represent what it purports to represent. The usefulness of financial information is enhanced if it is Comparable, Verifiable, Timely, and Understandable" [1:2.4]. These are qualities of transactions and other events and of affected economic resources and claims. However, the Framework's "Qualitative Characteristics are not so much a description of the properties of accounting information but, rather, of useful information in general" [20].

Reporting Entity and Financial Statements. Per [1:3], "Financial statements provide information about transactions and other events viewed from the perspective of the reporting entity as a whole, not from the perspective of any particular group of the entity's existing or potential investors or creditors. Financial statements are normally prepared on the assumption that the reporting entity is [in a phase of] a Going Concern and will continue in operation for the foreseeable future. A reporting entity is an entity [institutional agent] that is required, or chooses, to prepare financial statements, it can be a single entity or a portion of an entity or can comprise more than one entity". We assume that an Enterprise is a Market Participant in some Environment and Holds economic resources and claims that are affected by economic Transactions and other events with enterprise participation.

The Elements of Financial Statements. For modeling the elements of financial statements based on rights and obligations - Economic Resources and Claims, namely Assets, Liabilities, Equity Claims, Income, and Expenses, as well as Contracts, and Units of Account, we use the Reciprocity Relator concept briefly considered in Figure 1. In Figure 2 it is introduced comprising economic Commitments to Outflow and Expectations to Inflow. Expectations are used instead of UFO-C: claims to avoid terminological overlap.

An Economic Resource [a subkind of a reciprocity relator] is a right that has the potential to produce economic benefits" [1:4.4], including:

(a) rights that correspond to an [contractual, legal, or constructive] obligation of another party [Rights to Inflow against Other Party] [1:4.6]. An Other Party is [a Market Participant] a person or another entity, a group of people or other entities, or society at large [1:4.29].

(b) rights that do not correspond to an obligation of another party [1:4.6]. These rights are property rights over a Non-Agentive object. Legal property rights are rights to receive economic resources in exchange for rights over economic resources transferred. To fulfill a commitment embedded in property rights, the enterprise must sacrifice benefits to produce transferred resources, and the new benefits are produced from received resources. For example, the entity has a property right to sell the inventory (to terminate assets and create transferred resources) and to retain any sale proceeds (to terminate received resources and create assets).

Commitment to Outflow mode specifies the types for:

- creation of transferred Resources (termination of received Claims) to be Conveyed and their manifestation via Services provided,
- the resulting outflow of economic benefits specified by the Sacrifice Belief mode comprising:
- termination of Assets (creation of Liabilities) and bringsAbout related Expenses.

[3] We use (Claim) in parentheses or simply Claim to denote claim *against* the enterprise.

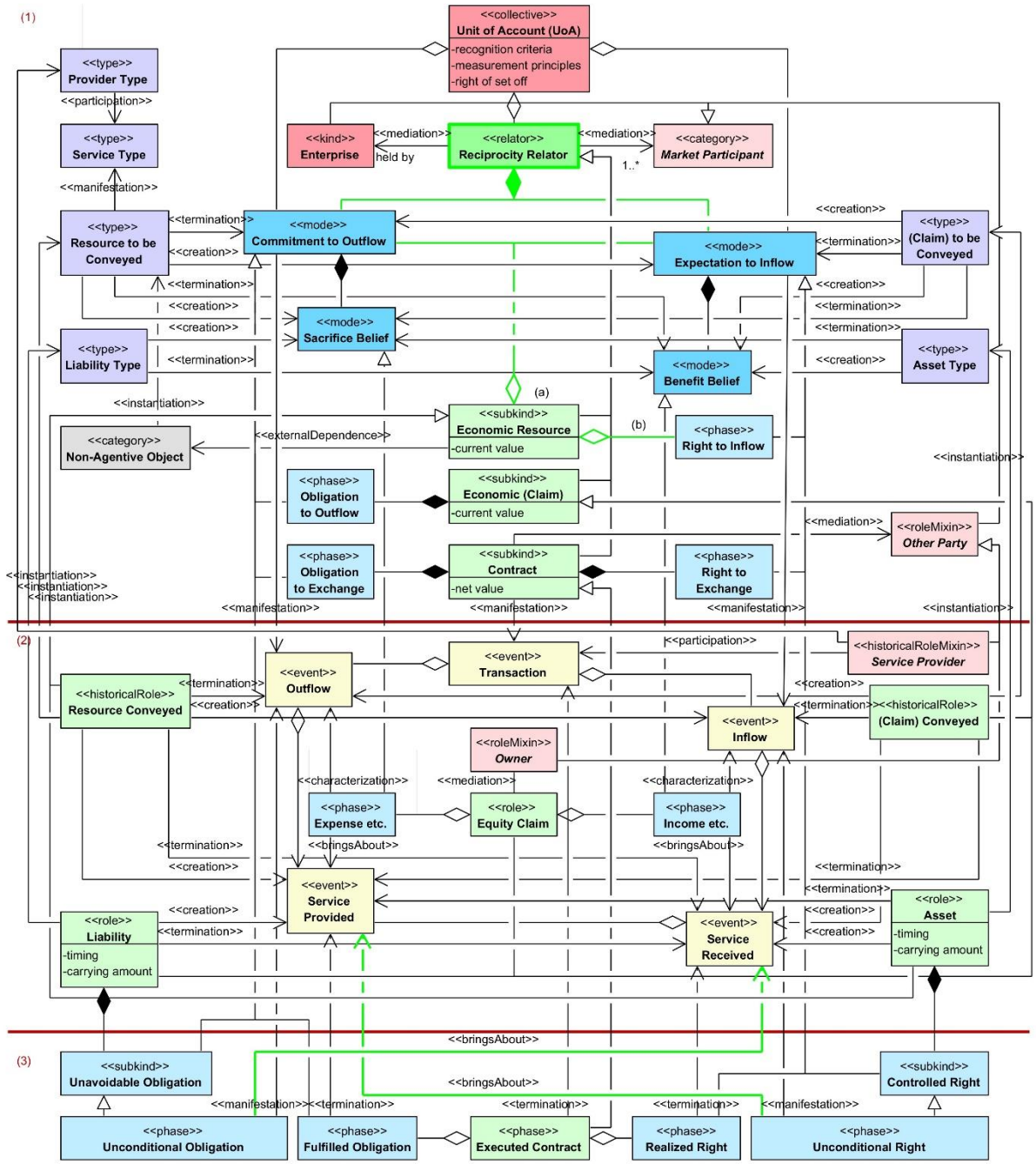

Figure 2: CF Ontology. OntoUML diagram. Enterprise View. Sections: (1) specification of the UoA; (2) execution of the UoA; (3) lifecycle phases of UoA and its modes. Outflow comprises the Transfer of Resources or Receipt of Claims. Inflow comprises Receipt of Resources or Transfer of Claims. Conveyed Resources (Claims) mean Received or Transferred Resources (Claims).

Expectation to Inflow mode specifies types for:

- termination of received Resources (creation of transferred Claims) to be Conveyed and their manifestation via Services received,
- the resulting inflow of economic benefits specified by the Benefit Belief mode comprising:
- creation of Assets (termination of Liabilities) and bringsAbout related Income, or
- consumption by Services provided.

An Asset is a present economic resource controlled [is in the Controlled Right phase] by the entity as a result of past events [1:4.3]. Per [1:4.20] "An entity Controls an economic resource if it has the present ability to direct the use of the economic resource (and to prevent others from directing) and obtain the Economic Benefits that may flow from it (and prevent others from obtaining). An entity has the present ability to direct the use of an economic resource if it has the right to deploy that economic resource in its activities, or to allow another party to deploy the economic resource in that other party's activities." In [14] the control of an asset is also defined as the ability of an enterprise.

Asset is the role of an economic resource in an enterprise. Ability (and capability) is an intrinsic characteristic of an agent [17], tied to the agent's skills, knowledge, competencies, or powers. Abilities are generally not transferable because they are inherently linked to the agent's modes or qualities. Certain aspects of capability, like procedural knowledge or licenses, can be transferred to another agent under specific conditions. Such aspects are separate economic resources rather than capability itself. In addition, capability refers to the disposition to achieve certain outcomes and is more often associated with a role or type of agent rather than an individual enterprise.

An Economic (Claim) against Other Party, as a subkind of reciprocity relator, comprises an Obligation to Outflow mode specializing Expectation to Outflow as a result that economic benefits have been obtained [1:4.43].

A Liability is a present obligation of the entity to transfer an economic resource as a result of past events. An obligation is a duty or responsibility that an entity has no practical ability to avoid [1:4.26]. Liability is the role of a present economic claim against an enterprise whereby the Obligation to Outflow propels into the Unavoidable Obligation phase.

While rights and obligations of the counterparties are correlative, assets and liabilities are not: "A requirement for one party to recognize a liability and measure it at a specified amount does not imply that the other party (or parties) must recognize an asset or measure it at the same amount" [1:4.30]. It proves the statements of COFRIS [9] that the economic exchange cannot be conceptualized by actions alone as argued in [18], and that the accounting cannot be built by independent view [7] alone.

Equity [quality] is the residual interest in the assets of the entity after deducting all its liabilities [1:4.63]. Equity Claim is the role of an Economic Claim of an Owner who specializes Other Party. Equity claim is subject to creation due to Owner Contributions or Income[4] related to the creation of assets (termination of liabilities) or Services Received. Equity is subject to termination due to Owner Distributions or Expenses[5] related to the termination of Assets (creation of Liabilities) or Services Provided. Income and expenses characterize the period, nature, role, and historical value of the flow of resources and claims, and are phases of economic benefits and sacrifices. Given the specialization of relationships within the enterprise - assets, liabilities, and equity claims specialize resources and claims as roles.

The Unit of Account (UoA) is the Right or the group of rights, the Obligation or the group of obligations, or the group of rights and obligations, to which Recognition Criteria and Measurement Concepts are [or will be] applied [1:4.48]. How rights and obligations are grouped, categorized, recognized, and measured into particular UoA is a matter of particular standards. We regard the Unit of Account (in the Unrecognized or Recognized phase) as a collective of Reciprocity Relators.

Per [11] a Contract is an agreement between two or more parties [a subkind of Reciprocity Relator] comprising enforceable Obligations to Exchange and Rights to Exchange. An Executory Contract [1:4.54] is a phase of a Contract or a portion of a contract, that is equally unperformed—neither party has fulfilled any of its obligations, or both parties have partially fulfilled their obligations to an equal extent. An executory contract establishes a combined right and obligation whereby right and obligation are interdependent and cannot be separated.

Criteria for Recognition, Guidance on Derecognition. Recognition is the process of capturing for inclusion in the statement of financial position or the statement(s) of financial

[4] Income - increases in assets, or decreases in liabilities, that result in increases in equity. [1:4.68]

[5] Expenses - Decreases in assets, or increases in liabilities, that result in decreases in equity. [1:4.69]

performance an item that meets the definition of one of the elements of financial statements. The amount at which an asset, a liability, or equity is recognized in the statement of financial position is referred to as its 'Carrying Amount'. If it is uncertain whether an asset or liability exists, or the probability of an inflow or outflow of economic benefits is low, the asset or liability is not recognized. Derecognition is the removal of all or part of a recognized asset or liability from an entity's statement of financial position.

In CF Ontology the specified or actual recognition (derecognition) is depicted as the creation (resp. termination) primitive relation between an event and the element or item. Now we will describe the actual recognition and derecognition during the manifestation of Contracts, Rights, and Obligations (see the (2) and (3) sections of Figure 2).

Commitment to Outflow manifestation via Outflow event progresses its termination into the Fulfilled Obligation phase, providing:

- creation and termination of transferred Resources (termination and creation of received Claims) Conveyed and Resource manifestation via Service Provided events,
- resulting in the termination of Assets (creation of Liabilities) and bringsAbout related Expenses.
- Per [1:4.58] Obligation to Exchange fulfillment causes the termination of the Contract into the Executed phase and
- bringsAbout the reciprocal Right to Exchange into the Unconditional phase that constitutes an Asset.

Expectation to Inflow manifestation via Inflow event progresses its termination into the Realized Right phase, providing:

- creation and termination of received Resources (termination and creation of transferred Claims) Conveyed and Resource manifestation via Service Received events,
- resulting in the creation of Assets (termination of Liabilities) and bringsAbout related Income or
- consumption by Service Provided events. In the latter case, in contrast to [1], or [2], no rights for economic benefits or assets are formed.
- Per [1:4.58] Expectation to Inflow realization causes termination of the Contract into the Executed phase and bringsAbout
- the reciprocal Commitment to Outflow into the Unconditional phase that constitutes a Liability.

The participants of the Outflow and receipt events – resources and claims processed, play the historicalRoles and have Historical Cost valuation (conceptually a separate event is required to establish Current Value). The service provider plays the historicalRoleMixin.

Measurement. Per [1:6.1] elements recognized are quantified in monetary terms. This requires the application of a measurement basis—historical or current cost, fair value, value in use, or fulfillment value—of an item being measured. Conceptually, an item bears all these values, while a particular one is selected for presentation following the principles of IFRS.

According to [1:6] the Historical Cost of an asset when it is acquired or created [at creation] is the value of the costs incurred [at the termination of Resources Conveyed] in acquiring or creating the asset, comprising the Consideration paid to acquire or create the asset plus transaction costs [of creation of Resources Conveyed]. The consumption or sale of the asset gives rise to an Expense measured at the historical cost of the asset consumed or sold. The expense arising from the sale of an asset is recognized at the same time as the Consideration for that sale is recognized as Income.

The Historical Cost of a liability when it is incurred or taken on [at creation] is the value of the Consideration received to incur or take on the liability minus transaction costs. The fulfillment of the liability gives rise to Income measured at the value of the consideration received for the part fulfilled. The historical cost is updated over time to depict the impairment of an asset or if a liability becomes onerous.

Per [1:6.12] Fair Value is the price that would be received to sell [a Resource of] an asset or paid to transfer [a Claim of] a liability, in an orderly transaction between Market Participants at the measurement date. According to [1:6.17] Value in Use is the present value of the economic benefits

that an entity expects to derive from the use of an asset and its ultimate disposal. Fulfillment value is the present value of the economic resources, that an entity expects to be obliged to transfer as it fulfills a liability. Per [6.21] The Current Cost of an asset is the cost of an equivalent asset at the measurement date, comprising the Consideration that would be paid at the measurement date plus the transaction costs that would be incurred at that date. The Current Cost of a liability is the Consideration that would be received for an equivalent liability at the measurement date minus the transaction costs that would be incurred at that date.

Presentation and Disclosure. Classification of elements based on shared characteristics for presentation and disclosure include the Economic Nature of the item, its Role (or Function) in the entity's Activities, and how it is measured.

3. IFRS 15 Ontology: Revenue from contracts with customers.

We will now regard how IFRS Standard 15 Revenue from the contracts with customers [11] ontology can be engineered from the CF Ontology and its OntoUML diagram depicted in Figure 2, through specialization depicted in Figure 3. We will introduce the additional concepts of IFRS 15 in Figure 3 as specializations and parts of the framework concepts, i.e., subkinds, roles, and phases. We will continue with the primitive relation approach used in CF Ontology.

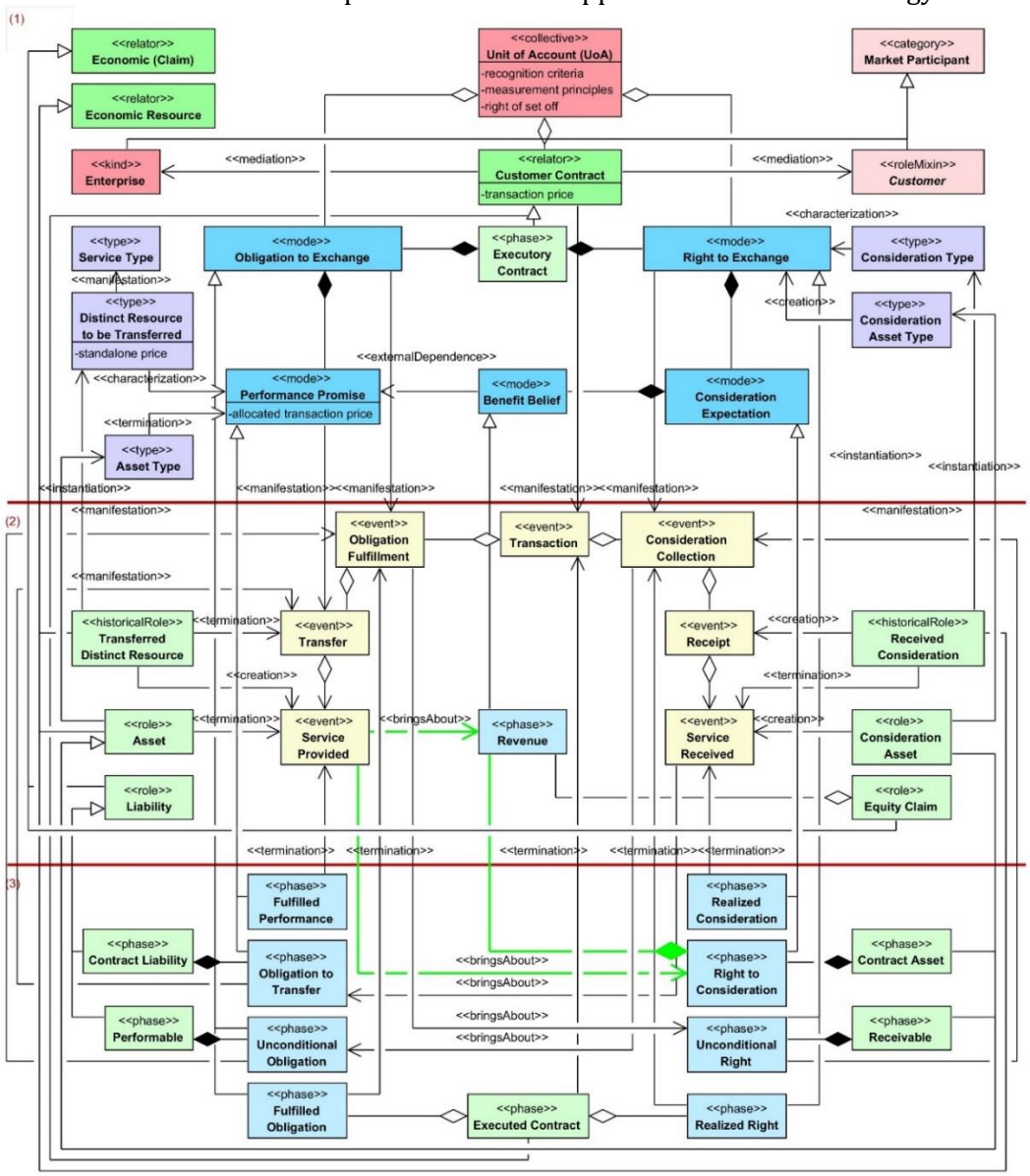

Figure 3: IFRS 15 Ontology. OntoUML diagram. Enterprise view.

As for any standard, we will try to answer the following competence questions for a particular standard concerning Units of Account, their recognition, and measurement: (1) What are the Units of Account and their modes and qualities specified; (2) What are transactions and other events affecting those UoAs; and (3) What are phases of the lifecycles of UoAs and their modes? The answers are depicted in sections of Figure 3.

IFRS 15 guides how an enterprise should recognize revenue arising from a contract with a customer in five steps.

Identify the Customer Contract. Customer Contract specializes Contract. The Enterprise and the Customer[6] (specializes Other Party) are two distinct Market Participants. The main Unit of Account of IFRS 15 is a contractual relationship between these two agents, characterized by mutual Rights and Obligations to Exchange. The enterprise has the obligation to transfer goods or services to the customer, while the customer has the obligation to provide consideration (usually monetary) to the enterprise, estimated at the Transaction Price. This contractual relationship represents the core principle of IFRS 15: recognize revenue to depict the transfer of promised goods or services to the customer in an amount that reflects the consideration to which the entity expects to be entitled in exchange for those goods or services. Rights to Exchange comprise Expected Considerations specifying Consideration, Consideration Service, and Asset Types.

Identify Performance Promises. Performance Promise[7] (aka Obligation in [11]) to Transfer Distinct Economic Resource of a specified type depicts their creation and manifestation via termination of Assets. A good or service promised is Distinct if both of the following criteria are met: (a) the customer can benefit from the good or service either on its own or together with other resources that are readily available to the customer; and (b) the entity's promise to transfer the good or service to the customer is separately identifiable from other promises in the contract.

Problem 1. Regarding Distinct goods and services, case (a) of the definition is only possible to model if market or contract-accepted specifications followed by the other party exist, because the (readily available) resources and abilities of the other parties are out of the scope of the framework and thus standards.

In contrast, case (b) is in line with COFRIS, regarding transfers as production processes, cf. [11:29] "The nature of the promise, within the context of the contract, is to transfer each of those goods or services individually or, instead, to transfer a combined item or items [Resources transferred] to which the promised goods or services are inputs [Resources created]."

Determine the Transaction Price. The Transaction Price – the quality of the Customer Contract - is the amount of Consideration to which the entity expects to be entitled in exchange for the promised goods or services in the contract. It can be fixed and specified in the contract, but also variable and dependent on different factors such as significant financing component, noncash consideration, and consideration payable to a customer. These factors will not be considered further in this paper.

Allocate the Transaction Price to the Performance Promises in the Contract. The allocation of the transaction price to the performance promises is done based on the Standalone Selling Prices[8] of the economic resources specified in the performance promise. The Allocated Transaction Price is a quality of Performance Promise.

Recognize Revenue. Per [11]: "An entity shall recognize Revenue[9] when (or as) the entity satisfies a performance obligation by transferring a promised good or service (ie an asset) to a customer. An asset is transferred when (or as) the customer obtains control of that asset." In terms of Figure 3, the Transfer event by the termination of Assets provides the creation,

[6] A party that has contracted with an entity to obtain goods or services that are an output of the entity's ordinary activities in exchange for consideration.

[7] A promise in a contract with a customer to transfer to the customer either: (a) a good or service (or a bundle of goods or services) that is distinct; or (b) a series of distinct goods or services that are substantially the same and that have the same pattern of transfer to the customer.

[8] The price at which an entity would sell a promised good or service separately to a customer.

[9] Income arising in the course of an entity's ordinary activities.

manifestation, and termination of a Distinct Economic Resource that bringsAbout Revenue via progressing reciprocal Benefit Belief.

Problem 2. According to [11] "an asset is transferred when (or as) the customer obtains Control of that asset". In the previous section, we argued that the transfer of control generally is not possible. The concept of transfer of control was also criticized in US GAAP CF [2]. Knowing the abilities of a customer and thus the state of control is out of the scope of the framework and thus standards. We find the only reliable criteria are those of transferring a property title, physical possession, or satisfying the requirements of the contract.

Problem 3. Based on the preceding analysis, it is deduced that the transferability attribute does not pertain to an asset directly, but rather to an economic resource.

Description of the transaction part of Figure 3. Manifestation of the Contract, Obligation and Right to Exchange comprises manifestations of Performance Promises and Consideration Expectations. Manifestation of a particular Performance Promise by Transfer causes its termination into the Fulfilled Promise phase and bringsAbout the reciprocal Benefit Belief and Expectation to Consideration into the Revenue phase and Right to Consideration phase that constitutes a Contract Asset[10].

Manifestation of the Obligation to Exchange by Obligation Fulfillment causes its termination into the Fulfilled Obligation and bringsabout the reciprocal (if any) Right to Exchange into the Unconditional Right to payment phase and progresses Contract Asset into the Receivable[11] phase.

Manifestation of a particular Right to Exchange by Receipt causes its termination into the Realized Consideration phase and bringsabout the reciprocal Performance Promise (if any) into the conditional Obligation to Transfer phase that constitutes a Contract Liability[12].

Manifestation of the overall Right to Exchange by Consideration Collection causes its termination into the Realized Right phase and bringsabout the reciprocal (if any) Obligation to Exchange into the Unconditional Obligation phase and progresses Contract Liability into the Performable (aka Payable) phase. Per [11], contract assets and contract liabilities arising from the same contract are presented net as either a single net contract asset or single net contract liability for presentation purposes (i.e., the contract oscillates), but that does not contradict their separate conceptual existence.

4. Conclusion and future work

Engineering Ontologies for a network of Financial Reporting Standards are investigated using the specialization of OntoUML diagrams of CF Ontology. Notable overlaps are found whereby standards duplicate framework concepts. In addition, several standards use common additional concepts or common standards such as related parties or multicurrency that may be candidates for inclusion in the CF Ontology. The full set of the concepts included in the framework and their precise conceptualization is important because usage of these concepts in the standards. That was the reason for our review of the Control and Unit of Account concepts of the CF.

A special, more elaborate transaction pattern and tools should be introduced to facilitate specialization and improve understandability. Possibly a value cycle or shared ledger model should be used as suggested in [10]. In [10], a set of specific stereotypes was suggested; however, it was found that their integration into the existing OntoUML plug-in poses considerable challenges. For additional specification, the Petri nets and Decision Tables should be regarded in combination with the OntoUML.

A methodology for developing IFRS ontologies should be established. Currently, in addition to the IASB due process of standard-setting, it consists of answering the competence questions about Units of Account in three OntoUML diagram sections, by ontological analysis of the standard's texts, the basis of conclusions, post-implementation reviews, and academic literature.

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[10] An entity's right to consideration in exchange for goods or services that the entity has transferred to a customer when that right is conditioned on something other than the passage of time (e.g., the entity's performance) [11].

[11] A right to consideration that is unconditional [11].

[12] An entity's obligation to transfer goods or services to a customer for which the entity has received consideration (or the amount is due) from the customer [11].

Further steps should include validation and explanation of the IFRS ontologies using many existing illustrative and generated examples.

The feature of generating examples based on ontology or its parts is very much needed in the IFRS domain. This feature was part of the OntoUML predecessors but unfortunately has not progressed. A possible way of generating examples is by using GPT-4. GPT-4 shows a rather high degree of "understanding" of UFO, CF, and IFRS 15. Another way of validating the ontologies and testing the examples is by developing software based on proposed ontologies like in [8, 16].

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