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Ontological Representation and Governance of Business Semantics in Compliant Service Networks*

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Abstract. The Internet would enable new ways for service innovation and trading, as well as for analysing the resulting value networks, with an unprecedented level of scale and dynamics. Yet most related economic activities remain of a largely brittle and manual nature. Service-oriented business implementation focus on operational aspects at the cost of value creation aspects such as quality and regulatory compliance. Indeed they enforce how to carry out a certain business in a prefixed non-adaptive manner rather than capturing the semantics of a business domain in a way that would enable service systems to adapt their role in changing value propositions. In this paper we set requirements for SDL-compliant business service semantics, and propose a method for their ontological representation and governance. We demonstrate an implementation of our approach in the context of service-oriented Information Governance.

1 Introduction

Given their essentially intangible nature, it is commonly believed that the Internet would enable new ways for creating, bundling and trading *services* as well as for analysing the resulting *value networks* on a world-wide scale with an unprecedented level of efficiency and dynamics [28]. Yet most economic activities related to online service trading, remain of a largely brittle and manual nature. Despite the initial assumption that software-based services[5] would be a core enabling technology supporting a highly efficient service-based economy at a global scale, we are still to witness a significant adoption of this technology on the Internet as a means to support service trading. Yet, from a computational perspective, a

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[5] as in service-oriented architecture (SOA)

large number of enterprise systems rely on a large set of functional components encapsulated as Web services in order to support their activities or interact with third parties for data and/or functionality exchange and reuse [25]. Indeed electronic businesses implementations enforce *how* to carry out a certain business in a prefixed non-adaptive manner rather than an explicit understanding of the business (service) domain (read: *business (service) semantics*) in a way that could enable a service system to adapt its role in changing value propositions.

Service-orientation is a promising paradigm to decompose inward-oriented organisational processes into outward-oriented business service components. SOA does not constitute business service components; they are about functional decomposition which is very distinct from business service decomposition. Thus the underlying conception of a service is not merely static: it is largely limited to request and response elements of software artefacts, which are disjunct from *value creation aspects* such as strategy, proposition, roles, resourcing, pricing, quality and regulatory compliance. This lack of ontological analysis of service as a first-class concept is also witnessed in business modeling. Only recently a commonly agreed service conception emerged from a *service-dominant* marketing paradigm. SDL promotes a shift from goods to service as first-class citizen in economic exchange was required to understand and develop new ways of value creation in networked enterprises [22]. The immediate ontological consequence of this was to regard a service as a *perdurant* (value co-creation activity) rather than an *endurant* (value object). This has lead to the design of SDL-compliant upper-level models (e.g., [11, 26]) that could play an important role in automated business service (de)composition.

The importance of services has triggered the idea to use more structured approaches to design and implement software-based services. For example, the ISE (Inter-enterprise Service Engineering) [4] methodology and workbench was one of the first attempts to devise a service engineering procedure for designing business services. While the approach was orthogonal to the domain for which services were engineered, ISE can benefit from agreed business semantics that can support meaningful decision making taking on the aformentioned value co-creation aspects of services.

In this paper, after an overview of service perspectives in Sect. 2, we set (in Sect. 3) ontological and (in Sect. 4) governance requirements for SDL-compliant business service semantics. Domain ontologies for the purpose of service automation must convey these business semantics in order to specifically account for the quality and compliance of functionality and data exchanged across the network. Obviously, this makes only sense if these ontologies are governed effectively, i.e. they are managed by an optimal configuration of roles among peers in the networked enterprise. The adoption of an upper-ontology can also guarantee that the services developed follow an SDL paradigm. In Sect. 5, we set the background for our approach. In Sect. 6, we propose a method for the ontological representation and governance of business service semantics, and an implementation in the context of service-oriented Information Governance implemented using Collibra's Business Semantics Glossary. We conclude with a discussion and future work in Sect. 7.

2 Service Science, Engineering, and Business Modelling

Maglio et al. [17] define Service Science as *"the study of the application of the resources controlled by one [service] system for the benefit of another [service] system in the context of an economic exchange"*. This study came along with a shift in marketing from goods-dominant to service-dominant logic (SDL) [32] where *service* becomes this new unit of economic exchange. Hence, a *service* is conceived as a (value-providing or -integrating) action. This stands in strong contrast to goods-dominant logic in which a service is considered to be an object [11]. This paradigm shift was required to understand and develop new ways of value creation in networked enterprises [22].

We distinguish at least two areas of service study important for our purpose. They have been developing largely independently from each other, resulting in divergent service conceptions.

1. The *business perspective* – aims to – adopts SDL to understand why enterprises should innovate and trade services by considering value creation aspects. Yet most modelling approaches take the perspective from one company (e.g., [19, 23]). As a consequence, they assume a *closed world*[6] and their business service semantics, i.e., shared understanding of value aspects, remains tacit [27]; hence useless outside the organization. Also, these approaches classify a service as a *static* resource (i.e., endurant) rather than as an *occurrence* of actions (perdurant) in which resources are acted upon (e.g., [12, 33]). Only recently SDL-compliant service meta-models have been proposed (e.g., [11, 26]) that may lead to sound ontological foundations.
2. The *IT perspective* adopts service-oriented modelling as a paradigm for functional decomposition and engineering of distributed systems. Prominent service description meta-models (i.a., WSMO and WSDL) conceive service as a static function, and fail to convey any value creation aspect. Web service engineering aims at the interoperability of communication protocols (e.g., SOAP, REST) and data formats between heterogeneous "service parks" (see [9]; and Sycara in [31]). Process languages (BPMN, BPEL, etc.) are adopted for choreography, control flows, events, and temporal dependencies to define valid sequences of service invocations. It may be the case that some business decision logic is cryptically embedded within some complex control flow logic. In the worse case, the business logic is largely hidden within expert components or deferred to some manual decision steps.

In the networked Internet era, the ability to reactively (rather than proactively) and automatically (rather than manually) engage in service value chains

[6] A closed-world assumption is the logical presumption that what is not currently known to be true is false.

is a key competitive advantage. Yet it requires the ability to automate business decision making in a way such that computers do not only know a brittle prefixed operational procedure to carry out business but rather have embedded business semantics that shall enable them in adapting enterprises operational activities to maximise the business performance. The governance of business semantics and its embedding in ontologies that support the aformentioned value creation aspects of service networks entails many requirements that we cannot cover completely in this paper. Therefore, we focus on quality and compliance aspects of value interactions. This results in ontological requirements (ORs) (in Sect. 3) and governance requirements (GRs) (in Sect. 4).

3 Ontological Requirements

To overcome the issue of semantic alignment, peers usually create an ontology that is represented using a knowledge representation grammar (textually using SBVR or OWL , or visual using UML). The more aligned the ontology with the peer's individual perspectives, the easier it becomes to synchronize between business expectations and Web service solutions [5]. OWL-S[7] (in 2004) and WSMO[8] (in 2005) were first attempts to standardise operational semantics for a service, but the ontologies do not capture business semantics necessary to evaluate quality and compliance aspects of its constituting (action and content) commitments (Battle in [18]; [24, 11]). Hence, our requirements constrain the foundation (OR1-2) as well as representation (OR3-4) of viable ontologies.

Computational ontologies for our purpose must convey domain-specific business service semantics in terms of upper-level categories and relations describing the nature and structure of service-dominant logic. Therefore semantic alignment concerns requirements at the upper-level and domain-level, with resp. two types of validity. First, we require an upper-level foundation that accounts for service-dominant logic.

Ontological Requirement 1. An SDL-compliant upper-level ontology accounts for an externally valid alignment of service conceptions such as action, service system, resource, and service.

By posing *external* validity, we require that an upper-level ontology should serve either as a foundation for the development of domain ontologies or as a common ground for aligning heterogenous domain ontologies. The latter requires domain ontologies to specialize upper-level concepts from SDL for a specific domain of value creation:

Ontological Requirement 2. A domain-dependent specialisation of an SDL-valid upper ontology accounts for a descriptively valid alignment of business service semantics about value creation aspects in a specific domain.

[7] http://www.w3.org/Submission/OWL-S/
[8] http://www.w3.org/Submission/WSMO/

By posing *descriptive* validity we require the domain terminology and rules to be a substantial description of the business service domain as perceived and *agreed* by a community. See [1] for more on ontological validity.

The intention of such a domain-dependent specialization is to provide a *service description*, i.e., a description of value-creation aspects, actions on these aspects, and peer roles entitled to realize these actions in a compliant way. In that respect, our conception lies close to the one proposed by Ferrario and Guarino [11]. They state that *service commitment* needs to be distinguished from service *content*, i.e., the kind of action(s) the trustee commits to; and service *process*, i.e. how the service commitment is implemented. A trustee makes a service commitment to produce a certain content, i.e. set of actions. It is a temporal static event; a speech act documented in a contract among peers [11]. This corresponds largely to the business service semantics. A service content – while also defining the types of actions and roles, rather than merely pre-and postconditions – may well be close to the operational semantics; the latter which definitely corresponds to the service process. As a result, in order for a service description to make sense for both business and ICT, service commitment speech act (hence business service semantics) are to be aligned with the service process (hence operational semantics) through domain-dependent specialisations that define service content. This ways we could possibly abandon the use of prefixed process-based languages and embrace instead declarative rules that capture *what* value aspects restrict our decision making, rather than *how* to actually honour these restrictions.

The Unified Service Description Language (USDL), and especially Linked-USDL, is a good example of such domain-specialization. The latter uses semantic Web principles to construct an ontology to describe services by establishing explicit links to other existing ontologies emerging from Linked Data initiatives. While the model was initially constructed to describe services, in [3], we conducted a study which revealed that it could also be used to model internal parts of service systems and service networks by adding rich, multi-level relationships. Representing this alignment between service commitment and content/process implies two additional requirements for the ontology representation grammar.

Ontological Requirement 3. The ontology representation grammar must account for tracking of circumstances (e.g., state, event, process) that determine the relevance of value creation aspects across the service lifecycle.

Indeed, real-world entities, like services, are dynamic by nature [11]. Their possession of (i.e., *transient*) properties is not always persistent throughout their lifecycle; hence may change in function of different types of circumstances, including the form of the entities themselves. For example, it is possible that a service description is considered as possessing the property price only after having it passed all quality assurance tests during its production and it has been committed to by a provider.

In an open-world assumption, functionality and users are not completely accounted for a priori. Hence, a sufficient level of implementation independence is required from the ontology representation grammar and method. Ontologies that adopt these approaches will also have more potential for large-scale adaption by a wide variety of software-based service technologies; hence contribute to a generative service Web [34]. This all entails a dual utility for our ontologies.

Ontological Requirement 4. The adopted KR grammar and method allows to build a computational ontology that has a dual utility [1]:

- in an IT/IS context, it serves as computer specification to build diverse semantic applications (such as web services);
- in a business context, it serves as a theoretical model referring to real-world objects aligning the strategic goals, values, and processes among (human) stakeholders.

The open-world assumption and dual utility puts additional constraints on new ways of governance as we will see next.

4 Governance Requirements

The need for ontologies that convey business service semantics to assess aspects of business services such as *regulatory compliance* and *quality* has been hypothesised [29]. Only recently, it has become pertinent in the aftermath of the global financial crisis. Internationally agreed regulations such as *Sarbanes-Oxley* in the US, and *Basel* in the EU, enforce strict corporate governance policies that have primordial impact on the roles and responsibilities among peers in information management. Yet the issue has been more than often taken lightly as we witness from at best very poor information governance practice of many networked industries ranging from financial services to pharmaceuticals (see Gartner, Forrester and IBM).

In order for business semantics to be useful in the assessment of regulatory compliance of services, they have to be defined and validated by relevant and trusted people (usually called data stewards) from very different business functions (ranging from IT to business; with legal and compliance departments in particular). The industry's attempt to categorize this GR is labelled as Information Governance[9] . Gartner defines IG as: *"the specification of decision rights and an accountability framework to encourage desirable behavior in the valuation, creation, storage, use, archival and deletion of information. It includes the processes [actions], roles [actors], standards and metrics [actands] that ensure the effective and efficient use of information in enabling an organization to achieve its goals."* From this definition, we infer our first governance requirement:

Governance Requirement 1. In order to account for compliance and quality, an SDL-compliant upper ontology should additionally define governance concepts such as actors, roles and competencies.

[9] see an overview of IG business drivers in MDM Institute's survey: http://www.the-mdm-institute.com (last accessed on 23/09/2012).

Most scientific papers propose deterministic role patterns and decision domains with a predefined terminology, and are too much inspired by traditional Data Quality Management and IT governance [15]. Yet, although best practices for so-called data stewardship are emerging, we deem it necessary that governance models need to be flexible at run-time. E.g., in earlier work we analyzed individual contributions to an ontology. This behavioral analysis allowed us to identify user profiles that could lead to a more effective the assignment of roles in the governance model [7].

Governance Requirement 2. The configuration of roles and responsibilities among peers in governance of service descriptions must be dynamic.

5 Background in Ontology Representation

fact-oriented ontological analysis In order to accommodate for OR4, we adopt a *fact-oriented* approach for the following reasons. Its natural-language grounding closely relates to speech acts, and therefore it is easier for domain experts themselves to play a contributing role resulting in ontologies that clearly and accurately convey realistic business semantics. Furthermore, its attribute-free approach, as opposed to frame-based techniques (such as UML or ER), promotes *semantic stability* under change [14]. Fact-oriented methods include NIAM/ORM [14].The key of conceptual analysis is to identify relevant object types, and the roles they play, so we can understand the facts of the business domain by minimizing the occurrence of lexical ambiguities.

Fact-orientation was repurposed for ontological analysis in the DOGMA project [20] and further extended with community-driven ontology evolution support in DOGMA-MESS. Later, *Business Semantics Management* (BSM) [5] refined this method by identifying ontology evolution processes and linking them to community evolution processes (such as found in Nonaka's knowledge conversion model SECI [21]). BSM is now commercially exploited via Collibra's Data Governance Center product[10]. Fact-orientation is currently also part of OMG's Meta-Object Facility for platform-independent modeling of business rules with modal logic capabilities using the SBVR[11] standard.

Ontological analysis seeks further domain abstraction from fact types that represent different perspectives on the same business concepts. Perspective divergence and convergence are principal mechanisms in BSM to reconcile perspectives that are taken by different people and are based on different glossaries, conceptual hierarchies, and code systems. The result is an ontology that represents a higher level of abstraction for common domain concepts that can be applied for *semantic interoperability* [5]. BSM is currently limited to one specific type, i.e., *knowledge-intensive communities* that have explicitly set *semantic interoperability requirements* (ibid.). In this respect, we cannot claim that we

[10] http://www.collibra.com
[11] http://www.omg.org/spec/SBVR/1.0/

account for decentralized governance yet. Summarising, BSM has to be repurposed for compliance goals of service networks, and its community model has to be dynamic.

Important activities in BSM are context-driven lexical disambiguation of terms for concepts and their linking in upper-level conceptual hierarchies [6] and other types of relationships. Other important considerations in formal ontological analysis are *essence* and *rigidity* [13]. An entity's property is essential if it necessarily holds throughout its lifecycle. A property is rigid if it is essential to all its instances. This leads to the more advanced notions of *identity* and *unity*. In this paper, we will touch upon these notions when exploiting SBVR's modal logic capabilities to impose the possibility or necessity of certain facts about service systems.

ontology of dynamic entities In order to accommodate for OR3, we adopt previous work [16] on a conceptual apparatus of an ontology that is designed to handle the conceptualisation of dynamic entities and the notion of a transient property. We illustrated the design of a *property possession algebra* for conceptualizing the behaviour of transient properties across the lifecycle of corresponding entities. In other words, we can define for every fact type (that actually expresses a predicate for an entity), a possession formula. For example, a dispossession formula may use an SBVR "impossibility" statement[12] :

– **It is impossible that a** PROPOSAL *defines* **a** WORK PLAN **if the** PROPOSAL *has* **not** *been submitted* **or the** PROPOSAL *has* **not** *been accepted*.

The fact that the PROPOSAL has not been submitted or accepted is a CIRCUMSTANCE that excludes the validity of a PROPOSAL playing the role of defining a WORK PLAN.

6 A Proposal for Business Service Semantics

Based on our requirements analysis and background, wee propose a framework for the ontological representation and governance of business service semantics in compliant service networks. We adapt the BSM [5] method and illustrate with SBVR.

6.1 SDL-Compliant Upper-Level Model

To meet OR1, our upper-level model comprises key SDL concepts ACTION, RESOURCE, SERVICE SYSTEM and SERVICE. To meet GR1 and GR2, we extend this upper-level model with IG concepts such as ACTOR and COMPETENCE. Further,

[12] We are using caps for NOUNS (SBVR NOUN CONCEPTS), showing *relationships* (SBVR *verb concepts* or fact types) using italics, and using bold face for **keywords** such as **if**.

we provide an extension point to model CIRCUMSTANCES that allows for temporal causal reasoning about resource possession formula. We follow a fact-oriented analysis approach by which we abstract elementary fact types based on service science literature.

Action We first introduce a general notion of ACTION adopted from the Formal Framework for Information System Concepts (FRISCO) [10]. We replace a FRISCO action's theme/patients called *actands* with the SDL-compliant concept of (operant and operand) RESOURCE.

– ACTION *part of* COMPOSITE ACTION/ COMPOSITE ACTION *has part* ACTION
– ACTION *acted upon by* OPERANT RESOURCE / OPERANT RESOURCE *acts in* ACTION
– ACTION *acts on* OPERAND RESOURCE / OPERAND RESOURCE *acted upon in* ACTION

To illustrate modal logic capacities of SBVR, we require an ACTION to act on at least one OPERAND RESOURCE; hence necessitating a certain fact:

– **It is necessary that an** ACTION *acts on* **at least one** OPERAND RESOURCE

Circumstance We could also link an ACTION to a triggering external CIRCUMSTANCE, that could be either a STATE, EVENT, or PROCESS. Distinguishing between event types is important in the context of temporal causal reasoning as shown by [30].

– ACTION *guarded by* CIRCUMSTANCE / CIRCUMSTANCE *guards* ACTION

This makes our definition similar to the *artefact-centric* approach to service interoperation (ACSI) originally proposed by IBM and currently further developed (with us) in the likewise called EC-funded project[13].

Resource We distinguish between two types of RESOURCE that, in ACTIONS, play the role of either theme/patient (OPERAND) or agent (OPERANT). Note, in the rest of this paper we only verbalize one reading direction for fact types:

– OPERANT RESOURCE *is a* RESOURCE
– OPERAND RESOURCE *is a* RESOURCE

Next, we define *service systems* as specialisations of *operant resources*. We discuss specialisations of operand resources in the treatment of applications in next subsection.

[13] http://www.acsi-project.eu

Service System Maglio [17] defines a SERVICE SYSTEM as an open system that is capable of improving the state of another system through sharing or applying its own RESOURCES; and improving its own state by acquiring external RESOURCES. Its pivotal role also highlights the importance of working systems for realizing value creation proposed by Alter [2]. We contribute to the latter when introducing the notion of COMPETENCE that will be important for compliance of service-related ACTIONS. Accordingly, a SERVICE SYSTEM is an OPERANT RESOURCE and can be either a (working) INDIVIDUAL or ORGANIZATION, the latter being a composite of INDIVIDUALS [26].

- SERVICE SYSTEM *is a* OPERANT RESOURCE;
- SERVICE SYSTEM *controls* RESOURCE;
- INDIVIDUAL *is a* SERVICE SYSTEM (e.g., "John Doe");
- ORGANISATION *is a* SERVICE SYSTEM (e.g., "IG Council");
- ORGANISATION *owns* SERVICE SYSTEM.

The above definition requires that SERVICE SYSTEMS see value in having interactions with each other, which brings us to the definition of a SERVICE.

Service A SERVICE is a value co-creating COMPOSITE ACTION constituted by a number of INTERACTION EVENTS in which OPERANT RESOURCES of one SERVICE SYSTEM act upon OPERAND RESOURCES for the benefit of another SERVICE SYSTEM. When delivered, a SERVICE is an EVENT (perdurant in DOLCE), and therefore bound to time and space. We adopt the SDL-compliant *Resource-Service-System* model, recently introduced by Poels (ibid.) and is inspired by the well-known Resource-Event-Agent (REA) model [19]. To indicate the flow of value, Poels distinguishes between service *provider* and a service *integrator* roles. The economic notion of reciprocity entails a duality in the conception of SERVICE, resulting in a reflexive "requiting" service in which the integrator and provider swap their roles. Moreover, economic agent in REA is replaced by the SDL concept *Service System*. We devise the following fact types to state a *Service* as a special type of *Composite Action*.

- SERVICE *is a* COMPOSITE ACTION;
- SERVICE *is requited by* SERVICE;
- SERVICE *provided by* SERVICE SYSTEM;
- SERVICE *is integrated by* SERVICE SYSTEM.

Note, in order to reason about value creation, we have to further distinguish between value-creating interactions and non-value-creating interactions. E.g., Poels [26] applied ISPAR conditions in this context. This would open a window to adopt the benefits from speech act theory as well.

Actor In order to account for our GR1-2, we must introduce additional concepts that have not been considered before in this context. Until now, the semantics of the role of a RESOURCE in a SERVICE was limited to the –economic

– label of provider or integrator. However, for a compliant orchestration every ACTION a SERVICE constitutes, we want to know the detailed ACTOR roles and responsibilities, as well as the required COMPETENCIES. To this end, an OPERANT RESOURCE acting in a SERVICE plays the role of a designated ACTOR role that comes along with a permission to perform certain ACTIONS. We adopt an SVBR-featured deontic rule to define a permission.

– ACTOR *is a* OPERANT RESOURCE;
– **It is permitted that** ACTOR *acts in* ACTION.

We can adopt the widely-used RACI roles to define specific responsibility assignment and devise four relationships accordingly:

– ACTOR *responsible for* ACTION; ACTOR *accountable for* ACTION;
– ACTOR *is consulted about* ACTION ; ACTOR *informed of* ACTION.

These relationships may imply certain combinations of the earlier introduced permissions. We could further exclude combinations of role and actor can play in the context of a specific action using the following SBVR syntax.

– **No** ACTOR *is responsible for* **and** *is consulted about* **the same** ACTION.

Or we could state implications of roles for the sake of inferencing:

– **It is always true that an** ACTOR *is informed of* ACTION **if the** ACTOR *is responsible for* that ACTION.

Competency A COMPETENCY is modeled as a special type of OPERAND RESOURCE controlled by an INDIVIDUAL. The HR-XML consortium proposed to model a REUSABLE COMPETENCY DEFINITION (RCD) as: *"a specific, identifiable, definable, and measurable knowledge, skill, ability and/or other deployment-related characteristic (e.g. attitude, behavior, physical ability) which a human resource may possess and which is necessary for, or material to, the performance of an activity within a specific business context"*[14]. Hence, we devise following concept types:

– COMPETENCY *is a* OPERAND RESOURCE
– ATTITUDE ; KNOWLEDGE ; SKILL ; LEARNING OBJECTIVE *is a* COMPETENCY

There are many open RCD repositories that could be adopted for this purposes. E.g., HR-BA-XML (official German extension of Human Resource XML), SOC (Standard Occupational Classification System), BKZ (Occupation Code) which is a German version of SOC, NAICS (North American Industry Classification System); and finally, WZ2003 (Classification of Industry Sector) which is the German classification for economic activities.

[14] http://ns.hr-xml.org/

6.2 Application of the Ontology

We demonstrate the the modeling of business semantics in the context of service-oriented Information Governance. We have implemented these applications in Collibra's Business Semantics Glossary product.

Modelling Service System Perspectives SBVR and BSM acknowledges the existence of multiple perspectives on how to represent concepts (by means of *vocabularies*), and includes the modelling of a governance model to reconcile these perspectives (insofar practically necessary) in order to come to an ontology that is agreed and shared (by means of communities and speech communities) [5].

- A *semantic community* (itself an ORGANISATION) groups ORGANISATIONS and controls a shared body of business service semantics. Domain concepts are identified by a URI.
- A *speech community* is a subset of ORGANISATIONS from a semantic community that control a set of vocabulary RESOURCES to refer to this body of shared meanings.
- A *vocabulary* is a meaningful grouping of lexical RESOURCES (e.g., noun types, fact types and rules primarily drawn from a single natural language or jargon) to represent conceptions within a body of shared semantics.

The participation of INDIVIDUALS in the governance of the vocabulary controlled by their ORGANISATION is contrained by specific governance services. The latter are defined – as domain specialisations of our upper-level mode – by assigning ACTOR roles to INDIVIDUALS for certain ACTIONS on these LEXICAL RESOURCES.

Dynamic Actor Type Management Types of ACTOR can be dynamically defined as a noun concept with a gloss in a designated ACTOR VOCABULARY. For example, consider:

- BUSINESS STEWARD *is a* ACTOR

where the term is mapped on the following gloss articulating the term for this role: "expert in a certain business unit or line of business". Responsibility can be assigned to ACTOR type definitions as follows:

- **It is permitted that** BUSINESS STEWARD *acts in* ADDNOUNCONCEPT;

where ADDNOUNCONCEPT *is a* ACTION; one of the many that can be performed on vocabulary RESOURCES.

Assigning Individuals to Actor Types Based on their COMPETENCY, INDIVIDUALS are assigned to an ACTOR type; permitting or obligating them to play a role in a certain ACTION. The following screenshot shows an assignment of a role is done for the business semantics management of a service called "Data Governance Council" in a a financial service company.

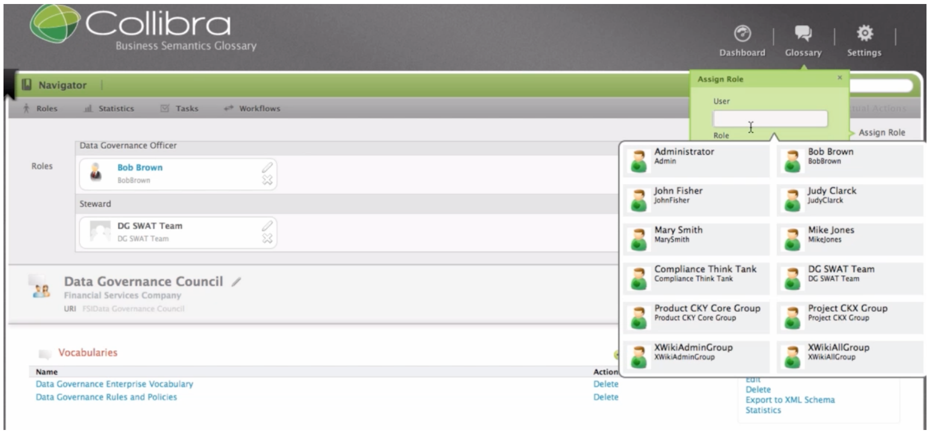

Fig. 1. Assigning Individual "Bob Brown" to play Actor in a specific Vocabulary for a "DG Council" service. This implies a number of permittable Actions on the vocabulary's constituents.

7 Discussion and Conclusion

We proposed a method for ontological representation and governance of business service semantics. Currently, no commercial tool, aside from the prototype in Collibra's Business Semantics Glossary used to demonstrate the feasibility of our solution, exists. Hence, we find our effort in this work as paving the road towards the development of improved service-integration tools that are better equipped to facilitate inter-silos communication. The next step is to investigate the automatic configuration of roles and responsibilities along peers in modelling quality and compliance of their services by, i.a., matching competency and reputation profiles, based on earlier work [7].

We will validate our approach in the Flanders research Information Space (FRIS) case study [16]. FRIS is a knowledge-intensive community of interest for two main reasons. First, it exhibits participatory characteristics that are typical to open networks. The actors are inter-dependent yet highly autonomous, heterogeneous, and distributed; including research institutes, funding agencies, patent offices and industrial adopters. The FRIS community has a minimum level of governance. The Flemish Public Administration has limited means to enforce information quality and compliance requirements on its FRIS peers; hence a high level of trust is assumed. Yet they inter-dependency on value creation is a main incentive. Secondly, the FRIS information space[15] itself is a true product of open value cocreation. FRIS publishes information about innovation-related entities such as researchers, projects, proposals, publications, and patents that is provided and consumed by all actors. FRIS will also benefit from external (Open

[15] The FRIS portal currently consists of 22636 projects, 3596 publications, 1981 organizations and 17096 researchers: http://researchportal.be/

Data) sources as we demonstrated earlier in [8]. This will make the discussion of quality and compliance even more complicated.

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