ON UNDERSTANDING OF SERVICE ECOSYSTEMS BASED ON BUILDING A CONCEPTUAL SPACE

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Abstract
Service ecosystems are socio-technical complex systems that enable service-based interactions between actors. We are still in the early stages of understanding the spontaneous creation and dynamic evolution with a huge velocity of such a complex structures that have a recognized innovative leading role in the global economy. Even if there are different types of ecosystems they include common elements that need to studied. This article provides a conceptual space for a better understanding of the main modeling elements to be considered when an ecosystem structure or an ecosystem evolution are analyzed. The aim of this research work is to codify in UML diagrams the knowledge about service ecosystems in order to facilitate communication and decision making in this domain.
Keywords:service ecosystem; model; knowledge; innovation; service system; governance.

1. INTRODUCTION

Since 2006 when a research manifesto toward a foundation of service science published new technology developments have been introduced and evolved in the service sector (Chesbrough & Spohrer, 2006). Service ecosystems including digital service ecosystems or software ecosystems are recognized among the complex systems with the leading role in the global economy. B2B collaboration is transformed due to new standardization organizations, business process modeling techniques that deconstruct a business into constituent parts, and Service Oriented Architecture framework that formalize business processes. ICT technologies support high velocity of knowledge codification, transmission, reuse and recombination that make it possible a knowledge-based multi-dimensional development of modern businesses.

Service ecosystems are based on services and services exchange involves various transformations on knowledge during interactions between various actors, providers or recipients of services. The nature of knowledge involved in a service exchanged depends on the interactions that could be episodic in case of consumer services or long-time relationships in case of enterprises. Knowledge can be codified in an explicit form or tacit and there is a knowledge creation cycle that can be taken in consideration in business management (Nonaka et al. 1996). Codified knowledge refers to knowledge that is represented in formal languages, thus it enables communication. Tacit knowledge is difficult to transfer between people, groups or organizations. Tacit knowledge complicates the services exchange and limits the ability of each party to fully comprehend the needs and abilities of the others. Today services exchanges involve many complex combinations of both codified and tacit knowledge. One of the challenges is how to combine the huge volume of information with the need to acquire tacit knowledge to create ecosystems. Knowledge partition, integration, coordination of the recombination and reuse have to be efficient processes.

Participants in networked service-centered business models increase their values and create service ecosystems. Networking realizes benefits from synergy and complementary of relations between participants. A service ecosystem is considered a socio-technical complex system that enables service-based cooperation between entities. Competition between ecosystem participants can also occur there. Simultaneous cooperation and competition between entities looks like a paradox that is addressed in the literature with a new term called "coopetition" (Nalebuff & Brandenburger, 1997).

Modeling ecosystems has many challenges. The main one is to explain better this spontaneous socio-technical phenomena, to define key aspects from a general perspective and to establish a consistent and coherent conceptual space for study.

Service ecosystem modeling is an important activity because the model captures the abstraction from a specific viewpoint and this must be an effective representation. The results of a modeling process are descriptions in various forms and notations that can be used for service management, optimization and analytics. Using various modeling techniques brings benefits for communicating, theorizing, and anticipating developments on service ecosystems, giving rigorous solutions to be applied for creating certain relationships between participants, to support decision makers in taking action to adjust their strategies and partnerships in ecosystems.

The shift towards a new development paradigm, where enterprises are centered on services, focuses on creation of value. The economic exchange is characterized by service-for-service exchange, meaning that competences, such as knowledge and skills, are used in exchange for the benefit of the parties involved in the relationship. There is also the recognition that value is collaboratively co-created. Value creation process is considered mutual and reciprocal, being interactive and taking place in the context of an unique set of multiple exchange relationships.

We are still in the early stages of understanding the spontaneous creation and dynamic evolution with a huge velocity of such a complex structures that have a recognized leading role in the global economy. Even if there are different types of ecosystems they include common elements that need to be studied. Service science is a new emerging discipline and research in this domain contributes to better ways to describe, model and communicate services. Thus it requires new forms to capture, conceptualize and formalize service systems so that they can be studied, analyzed and improved. Value creation can be better understood by developing models of service ecosystems by using existent modeling approaches to achieve a required quality based on specific constraints such as strategic moves of participants or reciprocity (Pant & Yu, 2017).

This article provides a conceptual space for a better understanding of the main modeling elements to be considered when an ecosystem structure or an ecosystem evolution are analyzed. The aim of this research work is to codify in UML diagrams the knowledge about service ecosystems in order to facilitate communication and decision making in this domain. It begins with the identification of the main background of this domain anchored in service science and addresses concepts that facilitate analysis and design of service ecosystem models including structure and service evolution elements. It compares several definitions of ecosystems and related terms used to communicate service innovation strategies and co-creation of value. The last part of the paper focuses on conceptual space elements and relations established between these modeling elements. These concepts are represented in Unified Modeling Language (UML) diagrams similar to software systems development. Modeling elements provided by UML is can be used to represent the conceptual space defined for service ecosystem.

2. BACKGROUND

Research on service ecosystems has been described from different perspectives and several become mature contributions in this domain. Scientific literature provides numerous and valuable insights in the service ecosystems. Various studies discuss about particular types of ecosystems including business ecosystems, digital service ecosystem (Abeywickrama & Ovaska, 2017), software ecosystems, open data ecosystems (Immonen et al., 2014) (Immonen et al., 2017), platform ecosystem (Pant & Yu, 2017) (Dobrica & Pietraru, 2017). In a bi-dimensional analysis defined by dynamism vs. dependency of ecosystems participants, a business ecosystem has the highest dynamism, and a software ecosystem has the highest dependency of the ecosystem participants. In a business ecosystem process have been identified flows of knowledge, materials, customer experiences and employee experiences. Business ecosystems include platform-based ecosystems that are build by platform leaders like Google, startup ecosystems that are community of stakeholders with resources organized around the process of entrepreneurial opportunity discovery and scale-up, and mobility ecosystems with connected cars, ride-sharing and driverless transportation. In business ecosystems there is a significant interrelationship of innovation, corporate strategy and public policy (Sako, 2018).

This section provides an overview of these perspectives and defines the main concepts and specific elements for modeling service ecosystems from a reductionist perspective of service science. Definitions of concepts such as service, service system and service ecosystem have also been discussed in (Dobrica, 2018).

Service is the main concept that needs a clear definition considering our modeling perspective in the service engineering and management. Generally, definitions of a service recognize that co-creation of value is the fundamental feature of a service and it must be essentially introduced. The lifecycle of a service has several phases including value proposition, value creation, performance and innovation. Learning from market needs, developing output resources capable of realizing the needs, performing and improving for sustainability are the main operations. The theory of Service-Dominant Logic (SDL) defines a service as a „previously agreed exchange of competences and knowledge between a provider and a customer in order to provide value to both parties" (Vargo & Akaka, 2009).

In order to do modeling of services in a systemic approach a new definition has been introduced being considered a foundation for service science: „Service is an activity initiated and mediated by two or more actors through which value is co-created for these actors." (Badinelli, 2016). This definition replaces provider and customer with a more general term actor, which is more appropriate for the complex structures and interactions that need to be modeled. Various actors and complex networks of interactions may be included in a service ecosystem structure.

A second concept that needs to be defined and explained is a service system. This is a collection of resources, stakeholders, processes and other service assets that, combined, enable value co-creation between producer and consumer (Cardoso et al., 2014). In 2008 a service system was defined as "value co-creation configurations of people, technology, value propositions connecting internal and external service systems and shared information." Interaction is a key feature of a system and implies dynamic processes that transform, create, or destroy system components. There are differences between a traditional system and a service system. A traditional system has a boundary between itself and an "outside world", but a service system is an open system because co-creation of value for people involves multi-dimensional interactions of participants with their environments.

The concept ecosystem has come into common use of the research community in the recent years. It identifies service systems with numerous actors and interactions that take part with independent initiatives and motivations in the execution of a service. A service ecosystem is a spontaneously sensing and responding spatial and temporal structure of largely loosely coupled, value-proposing social and economic actors interacting through institutions, technology, and language to (1) co-produce service offerings, (2) engage in mutual service provision, and (3) co-create value (Vargo & Lusch, 2010). This definition needs some clarifications. a) "Spontaneously sensing and responding." - Actors cooperate or compete with other actors and use their senses to determine how and when to respond or act. With the current evolution of information technology the sensing and responding is more and more spontaneous. b) "Spatial and temporal structure." - Actors and resources are distributed over geographic space and temporal dimensions. c) "Largely loosely coupled."- Actors connect to others both within and outside organizations mostly via primarily soft contracts (not. hard contracts). d) "Value proposing actors." - Actors cannot create value for other actors, but they can make offers that have potential value and this occurs via value propositions. e) "Use of language, institutions and technology." - To interface successfully, actors need a common language. They rely upon these and other social institutions (e.g., monetary systems, laws, etc.) to regulate interfacing and exchange. Technologies, and especially innovation, drive system evolution and performance. f) "Co-produce service offerings. "- Actors invite other actors to assist in the production of service offerings. g) "Engaging in mutual service provision." - Actors do not get a free ride but must help other actors, via service exchange, either directly or indirectly (e.g., monetarily or generalized reciprocity). h) "Co-creating value." - Actors, in the integration of service offerings with other resources (including other service offerings), create value which is unique to their situation and context.

A recent study on business ecosystems introduces three meta-characteristics that distinguish this concept [12]. These are sustainability, self-governance and evolution.

- Sustainability means that the ecosystem can meet the needs of the present, without compromising the ability to satisfy the needs for the future.
- Self-governance implies the ecosystem is not dependent on an outside force, nor is controlled by a single dominant actor within the ecosystem. Also it implies that activities are governed by a shared set of formal rules and informal norms and allow for emergence of competing rules or standards that challenge established ones.
- Evolution is the ability to evolve over time through competition and experimentation. Experimentation includes research and development leading to invention or business model innovation.

3. MAIN ELEMENTS OF A CONCEPTUAL SPACE FOR SERVICE ECOSYSTEMS

The science of service is relatively new, as the understanding of service as co-creation of value has only recently been formalized. A service model is an abstraction of a service system that highlights its structure, its elements, and the relations between elements, hiding its complex nature from who does not need to know it. (Cardoso et al., 2014)

It is recognized that a set of standard forms from which to build models within a domain of interest brings benefits such as a methodology for model building is provided together with the standard forms, all modelers communicate their design (Badinelli, 2016).

Model elements give a conceptual space for describing service systems. Existent modeling languages can be considered to represent the conceptual space elements. UML diagrams have been used in software engineering in various development stages from requirements engineering to architecture representation and detailed design to create software system models. In the same way UML class diagrams provide a structural view from a static

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viewpoint. UML classes and relations between them including generalization, association, aggregation, composition, dependency or realization will be considered for the conceptual space representation.

Service systems can be modeled as a network of nested systems. At the atomic level the structure modeling a service is based on a conceptual space that includes modeling elements such as actor, will, value, agent, role, resource, access, activity, usage and yield, authorization.

An actor is a human that could be a person or an institution of persons with certain categorical values which in a given context motivate and guide the behavior of the actor in service engagement. A model must identify any person or organization who is engaged. Actors define and measure value, which is considered unique to each person based on personal standards. An innovator actor is distinctive for a business ecosystem.

A will is an actor internal initiative to act guided by ethics and morality. The context of a decision includes personal history, personality, emotional state and determine the actor’s course of actions. Actors have categorical values such as principles, prejudices, standards or political views that guide an actor’s will. An actor may inherit these values from institutions to which the actor belongs.

An agent is a computer application, which behaves according to an actor’s will. Agents are decision analysts and automated. Their main features include resource integrators and decision makers. An actor can determine the structure of value that is associated with the outcome of a decision and the agent do the framing, modeling and solution of a decision.

Intelligent computerized agents, such as knowledge-intensive business systems or knowledge-based intelligent systems, have the main function in modeling a decision on behalf of an actor. An actor can be an agent having the knowledge, intelligence and desire to make decisions. Non-human agents are ubiquitous in our lives in the form of applications. Smart phones provide a lot of agents to their users for the purpose of engaging or disengaging service opportunities from voice, video or text communication, vehicle routing, scheduling appointments, making reservations, purchasing tickets, forecasting weather, playing games. Smart devices have revolutionized the service-based economy.

Role. Agents play roles for an actor in a context. Thus agents execute essential functions such as data collection, data analysis, information display, decision analysis, decision recommendation or optimization, communication, proposing, evaluating, offering, storing, retrieving, accessing etc.

Resource. Resources are consumed, transformed, and created through a service. They vary in their nature and it can be discussed about capacity resources, data resources, information resources, knowledge resources, material. Resources can be tangible or intangible. Value is derived from resources and is an intangible outcome of a service. Resources have properties and the relevant ones are determined by their usage in a context.

Access. Agents identify, invoke, and commit resources to a service system. Access rights to resources can take many forms. Access rights are relationships between agent roles and resources.

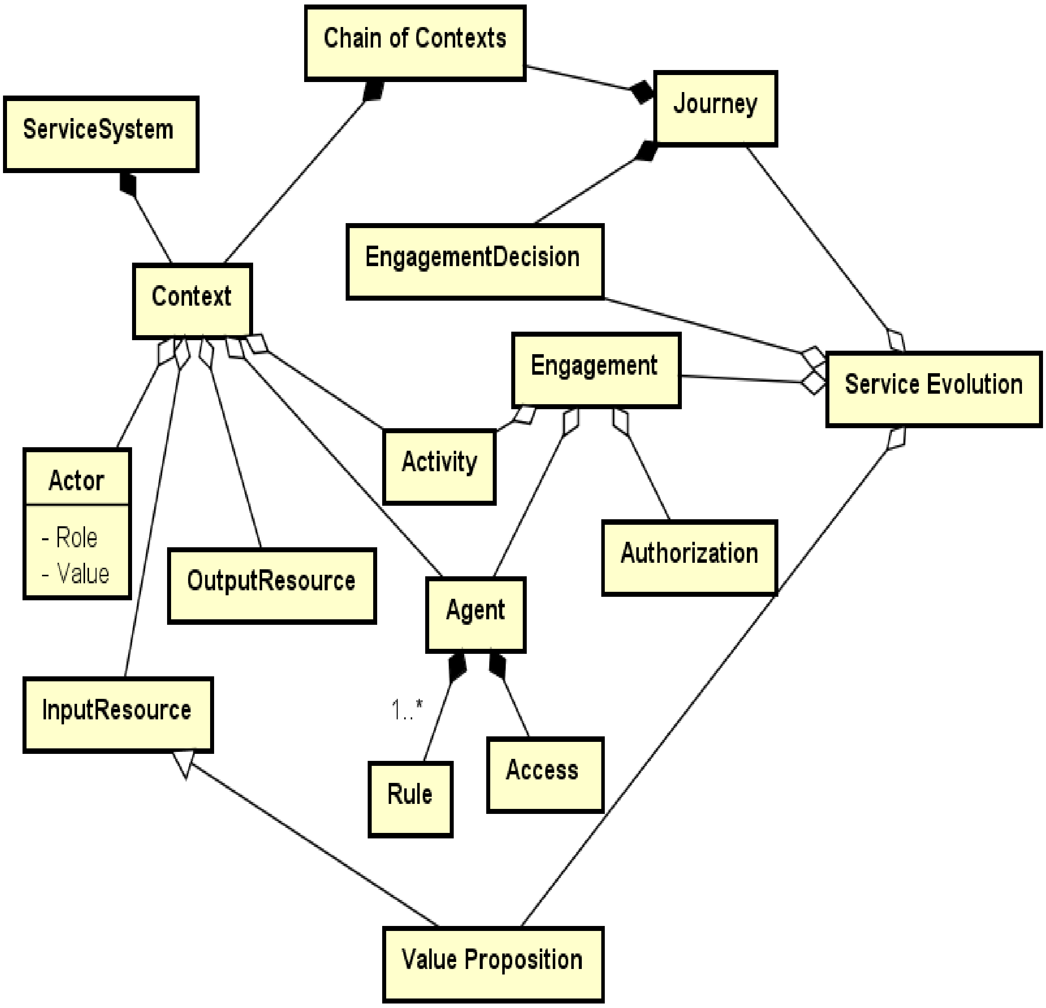

FIGURE 1 - CONCEPTUAL SPACE OF A SERVICE SYSTEM.

Value is a multidimensional property of each actor. A value is dynamic, different dimensions of a value may increase or decrease over time. Value creation is a process that converts resources into value. Value destruction is also considered together with risks to be considered by actors. Key aspects of value are value-in-exchange, value-in-use, and value-in-context (Vargo & Lusch, 2010).

An activity transforms input resources into output resources and value. A transformation needs time to perform. Service activities drive the utilization and production of resources. A common set of rules for all service activities must be defined. An activity is a general-purpose building block for modeling evolution of complex services. Large service systems are built by networking as many activities as required. Complexity is managed by decomposing a service system into activities at an appropriate level of detail. Each activity is parameterized by

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the usage rates of input resources, the yield rates of output resources and the activity time. Decisions and other actions that involve information resources can be modeled as activities. Authors of an important research study (Maglio & Spohrer, 2008) discuss about four basic activities: interact, serve, propose, and realize. Also activity element can do decision making, proposing, offering, receiving, information gathering, communicating, questioning, responding, producing, reviewing, messaging, or any other similar actions in the evolution of a service.

Activities can be de-composed in sub-activities or can be grouped in classes of activities. An activity that converts resource inputs into resource outputs can be modeled at different levels of detail. Therefore, the activity modeling element can be used hierarchically so that activities can occur within other activities. Even a simple activity of submitting an application can be broken down into numerous steps with associated information resources so that the overall activity is seen to contain a network of component activities. However, even in a large network of activities, each activity has the same fundamental function of converting input resources into output resources. A class of activities that can be invoked for a particular context is a contextual archetype (Hastings & Saperstein, 2014).

Usage and Yield are model elements defined to structure a service system model.

A service system evolution model includes modeling elements such as engagement, engagement decision, context, journey and value proposition. Context is an aggregated object built by specifying the relationships among structural model elements. A generic context includes actors, agents, service activity which is engaged, input resources and output resources of an activity.

A chain of contexts with engagement decisions mediating selections of service processing defines a journey. Value proposition is a key input resource that may engage a service and is a tool of a service provider to manipulate the recipient's journey through those service activities that the provider feels obligated to execute.

Service ecosystem has specific modeling elements that are added to service system elements introduced above. In ecosystems agents are elements that must follow certain rules for their roles in contexts. Rules for agent behavior are numerous and are very important to explaining the performance of a service system.

Governance is a specific modeling element in a service ecosystem. Governance defines the entire collection of rules, regulations, policies, and conventions that constrain and enable service activities through social, governmental, and corporate institutions (Yu, 2001). The mechanisms of governance can be formal and informal, explicit and implicit. Governance can be implemented with various set of codes. It includes a) the corporate policies that direct and limit the efforts of marketing personnel in providing customer service; b) the cultural norms that influence individuals in their interactions with online services; c) the sanitation laws that ensure the safety of hospitality services or d) the protocols for requesting information in support of a service activity. Service activities have to be controlled to remain within the limits of socio-governmental conventions, policies, and laws.

Good governance mechanisms include transparency levels in buyer-supplier rating system, a more collaborative relation government-private sector, and super-regulators that are non-government organizations approved by government .

Modeling the rules that describe the resource transformations of service activities often incorporate governance requirements. Resource usage must be feasible. A modeler must be aware of the constraints on resource usage by service activities for each context as various governance modes can impose binding constraints on the usage. To a modeler, governance is a set of rules to be incorporated in service activity transition laws. Although some rules can be global or institutional in scope, a modeler have to represent context-dependent governance rules bringing the modeling of the rules to the level of system elements.

Categorical values is a term used to identify the dimensions of the ethical or prejudicial values that motivate or constrain agent decision making. For the modeler, categorical values may be difficult to observe and measure. Parameters of governance and categorical values can be made very specific and measurable, but in some cases these are imprecise.

Governance and a set of categorical values define an institution. Institutions can be classified along these two dimensions. Each institution has its own governance, but the control by a governance can vary from rigorous to flexible. Each institution has categorical values that can range from precise to fuzzy.

- Institutions that are highly flexible in governance and very imprecise in categorical values contain service systems that require evolvability in order to be effective. Such institutions may be highly inefficient.
- Institutions that are rigid in governance and precise in categorical values can be very efficient as long as the mission is relevant. If environmental conditions change, however, the effectiveness of such an institution can diminish rapidly.

Institutions promulgate ethics. Governance and categorical values can become codified formally or informally into a code of ethics. As the ethics of an institution become more explicit, they serve to delineate and bind the elements of an institution.

The service system modeler can make effective use of the construct of an institution to identify the boundary-setting parameters of actors who are participants in the system.

Actors who seek a service can usually choose among institutions and, during a service journey, they can switch from one institution to another. For example, a mobile software developer can easily switch from one provider to another (Android or Apple) effectively leaving one institution and joining another, as each provider imposes its own governance (Dobrica & Pietraru, 2017). The engagement decision at each context of a service allows an agent to switch from one service system to another, allowing for multiple possible journeys. Institution switching can incur costs through governance constraints and requirements. Each service system then strives to retain the commitment of actors by ensuring that the perceived value achievement and the value potential of continued engagement is competitively high and sufficient to override the costs of switching.

A service system modeler is, therefore, entrust with modeling the entire ecosystem of service institutions in the same domain of interest in order to compete.

A service system with its composition of actors, agents, resources, and their interactions through activities and institutions is a complex system. Thus there is a modeling challenge because they have no boundary, being open. Also this boundary is constantly changing.

Evolving hierarchies of service systems can be modeled as ecosystems. An ecosystem consists of a nesting of infrastructures, institutions, service systems, and contexts. In Fig. 2 a conceptual space of a Service Ecosystem is presented in an UML diagram.

There are several macroscopic measures of service systems that derive directly from the model of service contexts and the effects of agent decision making in guiding the service journey. In service systems, such as knowledge-based information systems, the service journey reflects learning and adaptation by agents. As agents receive feedback from each activity engagement, they decide if and how they will reengage the service system. These decisions are made with imprecise understanding of the nature of ensuing contexts and uncertainty about the resources that will be made available to those activities.

Dissonance, consonance, and resonance are modeling concepts for stages in learning and adaptation. These establish a sequence of contexts in a service journey that is designed in an order of activity engagements that co-create a learning experience with the service agent.

- The first stage is dissonance and this is most likely to instigate a rejection of a service proposition.
- Consonance is the second stage of the service journey which is marked by the service consumers and service providers achieving a common understanding of the service proposition.
- Resonance is the third and final stage of a successful service journey which is marked by co-creation of value. When resonance is achieved, not only have all agents achieved a common understanding of the service activity but also the expected outcomes of the activity will produce value for all actors. In this stage, the service system is viable.

Design and development of the value proposition co-evolves with the understanding of agents throughout a service journey. Service modelers should, therefore, consider scenarios when a service is appropriate or beneficial to all parties.

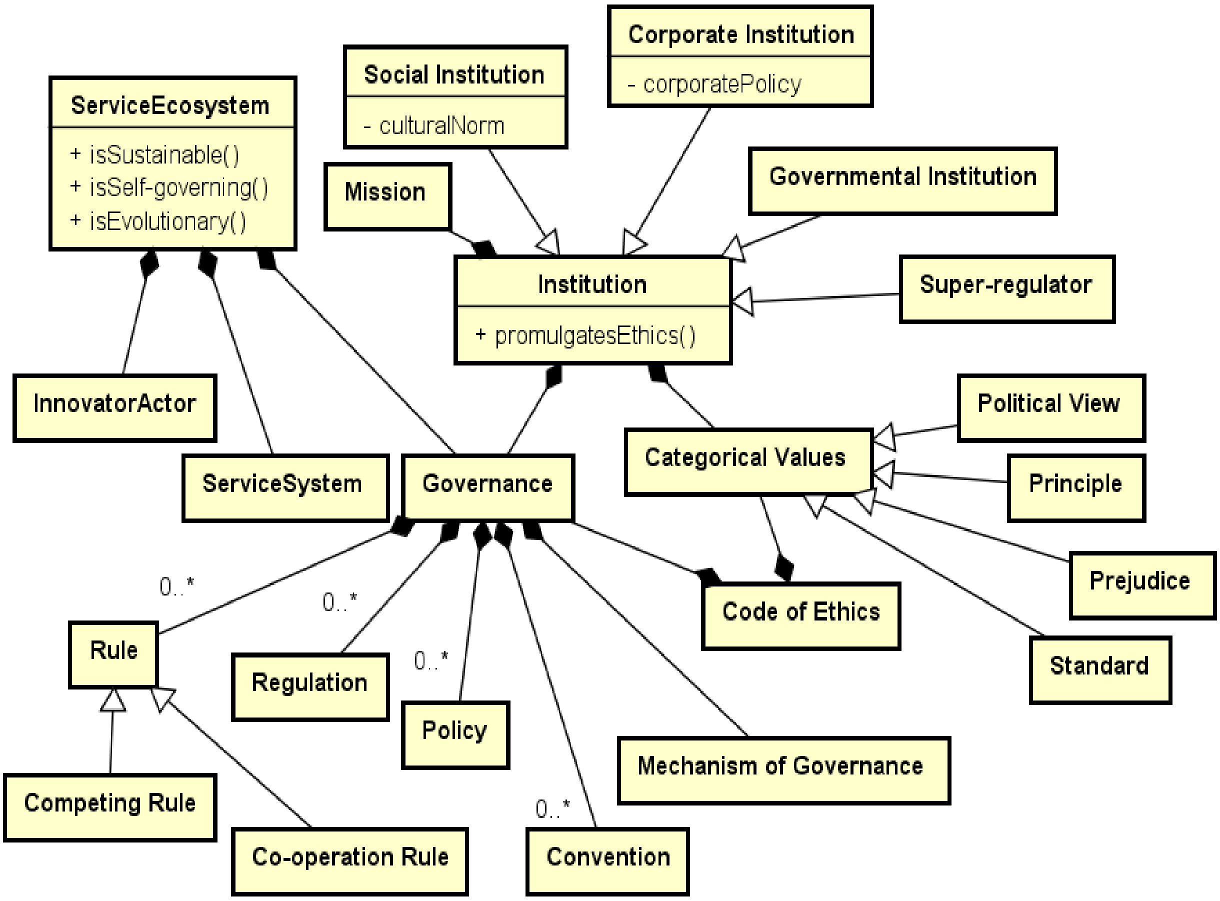

Figure 2 - Conceptual space of a Service Ecosystem (UML representation).

Conventional models of enterprises divide functions into a hierarchy of strategic, tactical, operational, and technical levels that are integrated through a chain of command and feedback communications. Models represent systems from these different perspectives and reflect different decision-making levels in an enterprise. In co-creative ecosystems decision making is distributed both horizontally and vertically. Furthermore, structures of authority and governance are less distinct than in traditional views of business organizations.

4. CONCLUSIONS

In order to participate in a business ecosystem, an actor need to have an understanding of service development and interactions with other ecosystem participants. Common elements and relations between them have been analyzed and represented in graphical representations using a general modeling language UML frequently used

ISSN: 2067 – 2462
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in software engineering. The main contribution of this work is in the line with research community towards knowledge codification for a better comprehension of this spontaneous socio-technical complex system.

There are many challenges that need future attention regarding service ecosystems. An important one is related to methodologies that support actors which are interested in participating in a cooperative service development process with business ecosystem. A study of existent approaches business-oriented and technical-oriented together with case studies are included in the future work.

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