On the Impact of Software Ecosystems in Requirements Communication and Management

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Abstract. The treatment of economic and social issues in Software Engineering was pointed out as a challenge for the next years. Companies and organizations have directly (or not) opened up their software platforms and assets to others, including partners and third-party developers around the world, generating software ecosystems (SECOs). This changes the traditional software industry because it requires mature research in software requirements and architecture in an environment where business models and socio-technical networks can impact the management of the platforms' needs and demands overtime. However, one strong inhibitor is the complexity in defining and modeling SECOs elements to improve their comprehension and analysis and their impacts on requirements engineering. So, this paper introduces an approach to support SECO definition and modeling based on the SECOs domain. The goal consists in dealing with the stakeholders' value proposition and realization in SECOs, as well as treating nontechnical issues in components and social repositories.

Keywords: Software Ecosystems, Conceptual Modeling, Domain, Sociotechnical Networks, Requirements Management, Repositories, Reuse.

1 Introduction

Software Engineering (SE) field has directly supported software industry through methods, techniques and tools to develop interconnected and large-scale software systems in a rapid speed of deployment and evolution [5]. According to Boehm [4], the main goal of SE is to create products, services and processes to earn value to society considering its different facets and perspectives. Software industry exists since it produces value realized by its stakeholders [3]. So, the way their interests and expectations are communicated is critical for the manner they are heard and effectively influence future solutions to meet their needs [6]. In parallel, in the software vendor's point of view, large-scale software development process is complicated, expensive, slow, and unpredictable [9]. This remaining challenge motivates research and practice communities to understand the economic and social issues in SE [18]. In this context, some explanations can be highlighted:

- software development process requires to carefully think about the platforms which will support it as well as the networks among its artifacts and stakeholders (socio-technical networks), i.e., connectivity and dependency among products and organizations, for example, suppliers, distributors, third-parties, developers, consultants and other organizations and clients that affect (and are affected by) this scenario [2];
- innovations no longer arise from an organization, i.e., they result from a synergy of different agents of software industry called co-innovation, in such a way organizations collaboratively join and focus on supporting new products to satisfy clients' needs and requirements and to incorporate new innovation cycles [19].

As stated by Bosch [5], software engineers should have abilities to abstract the complexity of a system as a whole, which is composed by software, hardware and peopleware joint around a common environment (i.e., platform). Additionally, the traditional perspective of SE has been deconstructed in order to consider the birth, development, maturation, and "death" or transformation of platforms, where collaboration and interoperability among actors and artifacts are crucial [16]. It means that the development of software products and systems generally requires collaboration of many individuals, groups, and organizations that form an ecosystem of interdependent artifacts and stakeholders [21]. The underlying structures were discussed in SE research as software ecosystems (SECOs) in the early 2000s [8]. Some of the biggest software organizations are heading SECOs development such as Amazon, Microsoft, Nokia, SAP, Google, and Apple. For this reason, SECO is reaching a status of research topic basically conceived from the movements of software industry and its related services [12]. However, the first researches about SECOs were done by Business Schools in the 90s, as discussed by Bosch [5] and Santos & Werner [15].

Based on previous studies from literature, in this research we define SECOs as *sociotechnical networks*[1] for developing software products and services, that are composed by technical, transactional and social components that relate to each other in order to engineer and manage one or more platforms, generating value and innovation in software industry. Some examples are Eclipse SECO, Microsoft SECO, and iPhone SECO [8]. SECOs studies in SE field were initially motivated by the software product line approach aiming at allowing external developers to contribute to hitherto closed platforms through a global software industry [5][13]. SECOs community has discussed the research directions at literature and industrial cases that reinforce important SECO perspectives, such as requirements, architecture, mobile platforms, global SE, social and sociotechnical networks, modeling, business considerations, organizational-based management, and multidisciplinary studies [2].

Since software vendors resort to virtual integration through alliances to create and keep networks of influence and interoperability in SECOs worldwide [15], different requirements communication and management networks are produced and should be

[1] *Socio-technical* networks are graphs of nodes (actors and artifacts) and edges (their dependencies). In turn, *sociotechnical* networks extend them to contemplate a multidisciplinary view, including other elements to analyze SECOs facts and artifacts based on the actor-network theory [7].

maintained [9]. According to Fricker [6], it means that large-scale organizations need to consider the interplay of a considerable number of stakeholders for defining requirements of their commercial and technical products and platforms. For Paech *et al.* [9], different specifications are used to negotiate and document agreements that match stakeholders' propositions and realizations, e.g., marketing requirements specifications to define the product related offering by product management; use case specifications to align product management and users; technical specifications to align development and product managements; and system specification to align team leaders and development management.

Based on this discussion, requirements communication and management in SECOs is a challenge, especially in the distributed software development scenario [17]. Fricker [6] points out (i) *tactics and methodology problems* as responsible for difficulties in understanding the matching between requirements and solutions, and (ii) *strategic problems* as responsible for mismatching between interests and expectations that is critical to prepare an organization and its markets to accept new software products, systems, services, and SECO platforms. Moreover, a transition from conventional structures and relationships in industry to a SECO will likely have impacts on business and technical specification and design choices [15]. Thus, the communication and management of needs and requirements can be affected by SECOs definition and modeling since they depend on strategic goals, intentions and relationships of each actor in a network of both actors and artifacts [2].

2 Objectives of the Research

The novelty and complexity of SECO research in SE produce many issues especially related to a vague and diverse concept of SECOs and to the lack of results and contributions from empirical studies [8]. So, it is important to provide a conceptual and technological support for defining and modeling SECOs, as well as the impacts on requirements communication and management. In order to contribute in this direction, the current research aims at exploring the concept of domain for SECOs to develop an approach to improve the comprehension of SECOs in a globalized software development environment, named *ReuseSEEM* (**Reuse**-based **S**oftware **E**cosystems **E**ngineering and **M**anagement). The concept of domain is inspired in that one used in Software Reuse [20].

The focus of the research is to consider business and social elements to understand both the internal view of a SECO (i.e., organizational) and the external view (i.e., software supply network and related ecosystems). In this case, business and social elements should enrich the definition and modeling of SECOs, such as pricing, marketing, negotiation, and evaluation, from the business side [12][14][15], and interaction, utility, reputation, promotion, contribution, and recommendation, from the social side [11][16][19]. On the other hand, an application of *ReuseSEEM* consists in mapping the knowledge of networks of actors and artifacts to SECOs' needs and requirements. Thus, platform, products and services' requirements can be communicated and managed in a SECO environment, which is usually distributed, interactive and dynamic.

3 Scientific Contributions

Four steps were established for the *ReuseSEEM* approach, as shown in Fig. 1: (1) *definition*: create and validate a body of knowledge for the SECOs domain through a conceptual model enriched with variability (e.g., actors with different roles in distinct SECOs); (2) *modeling*: map the conceptual modeling to sociotechnical and software supply networks in order to visualize and browse through the SECOs; (3) *analysis*: select a SECO (or part of it) from a stakeholder's point of view in order to analyze its different perspectives and levels based on business and social elements, e.g., identify needs and requirements for a SECO platform, or suggest new niches or SECOs of interest for a specific organization; and (4) *maintenance*: provide a research strategy to support empirical studies aiming at generating and feeding a historical data and experience reports repository since there are many research and practice targets to be analyzed in SECOs from the SE field. The link between the modeling and analysis of SECOs is created through a repository of SECO components (e.g., registered SECOs, actors, platforms, artifacts, previous software supply networks etc.) and a social network site (e.g., actors and artifacts exposed to the global software industry).

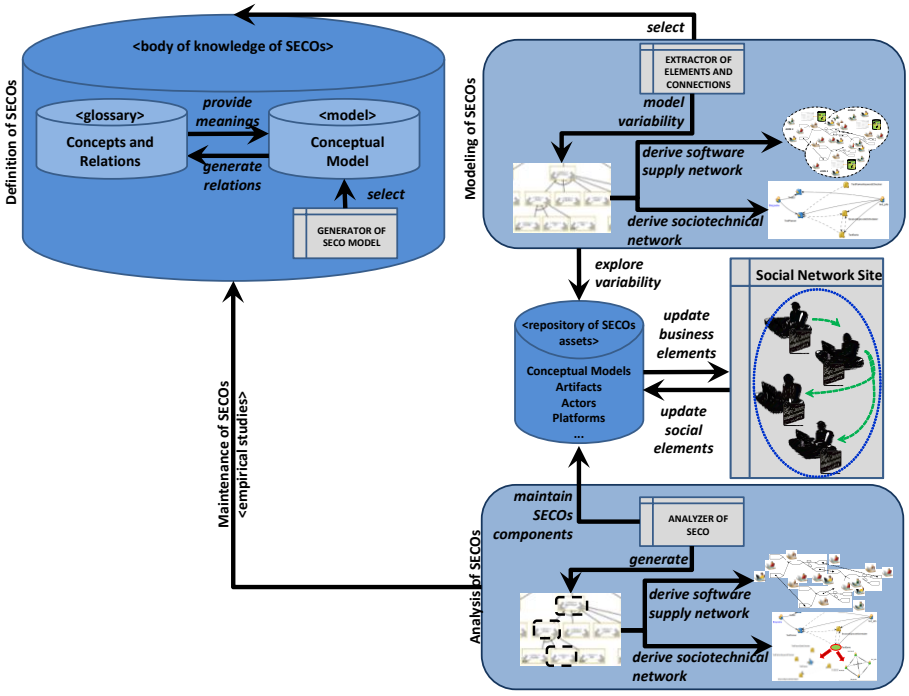

Fig. 1. *ReuseSEEM* approach.

The first two steps are the initial focus of this research, i.e., definition and modeling of SECOs. As mentioned in Section 2, the main contribution of this research consists in improving the comprehension of SECOs from the SE point of view. As such, *ReuseSEEM* tries to use the SECOs metaphor to understand the economic- and social-based SE view as well as to better identify, visualize and

manage opportunities, requirements, market niches, clients' needs and systems evolutions. So, modeling of requirements, goals and domains can be treated by *step 3* through the development of a tool to support requirements communication and management based on a community participation to suggest and solve client's needs in an extended social network site. Finally, as empirical contributions, we intend to plan and execute at least two studies to verify *ReuseSEEM*: (1) a *survey with experts* in SECOs in order to evaluate the conceptual model; and (2) a *case study* in order to evaluate the definition, modeling and analysis of a SECO (in this case, using the mentioned tool focused on requirements communication and management).

4 Conclusions

Since SE community is dealing with both technical issues and other kinds of concerns in its evolution as a research field, SECOs emerge as a topic to investigate the different and integrated perspectives of the global and dynamic software industry, i.e., technical [10][13], transactional [15] and social [16]. Despite the efforts performed by researchers and practitioners, the SECO domain is still vague and divergent [2][8]. At the same time, its comprehension is becoming very important to the SE point of view because SECOs metaphor allows understanding its activities, such as requirements communication and management [6][11]. This research intends to contribute in defining and modeling the SECOs domain as well as use this knowledge to analyze cases of SECOs in the SE point of view [17]. Apart from applying requirements engineering (RE) concepts (i.e., requirements, goals and domains) to develop the first two steps of *ReuseSEEM*, this approach can contribute to RE research as an instrument for identifying, visualizing and managing opportunities, requirements, market niches, clients' needs and systems evolutions in the context of SECOs (*step 3*).

5 Ongoing and Future Work

Nowadays, we are working in three tracks: (1) developing *step 1* of *ReuseSEEM*, i.e., mapping the SECO domain and creating a conceptual model through a map of concepts (e.g., actors, artifacts, relationships, roles and responsibilities) [11] in order to execute an empirical evaluation with experts in SECOs; (2) developing an application for *step 3* of *ReuseSEEM* in *architecture*, i.e., defining a technology recommender to support a SECO governance approach for enabling an information technology (IT) architecture based on software asset management [1]; and (3) developing another application for *step 3* of *ReuseSEEM* in *RE*, i.e., mapping sociotechnical networks through the extension of social network sites to communicate and manage needs and requirements in SECOs [19]. Although *steps 1* and *2* are not finished, tracks (2) and (3) can be independently built and initially evaluated based on the common sense on SECO concepts and models identified and studied by the Software Reuse Lab at COPPE/UFRJ since 2009.

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