ESES: Evolving Software Ecosystems and Services

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***Abstract*—Like our society, software systems are subject to constant change. Innovation cycles in this field are getting shorter and shorter, and user requirements are changing from generation to generation. It is the task of software architects to react to these changes and to ensure that these changes remain silently controllable. A model focused on control of individual software entities and their relations are software ecosystems, borrowing concepts from biological ecosystems but sharing the idea of sustainable management of software systems.**

Keywords-Software Ecosystems, Ecosystems, Software Engineering,

I. INTRODUCTION

Software Ecosystems are a rapidly evolving phenomenon in the field of software engineering and computer science in general. Classical approaches of computer science do not scale well for today's large and complex software-intensive systems. A large part of the complexity arises due to the different requirements of individual (end) users. Aligning with the growing technologies and changing requirements, software systems cannot be considered in isolation and as a monolithic system. In order to tackle these challenges, we need to combine the isolated systems to achieve new, more powerful ecosystems. One of the main challenges is to figure out the balance between the isolated systems on the one side, and the frame of the ecosystem (which considers rules and controlling mechanism) on the other side.

ESES targets approaches along with the research of software ecosystems and services. Developing, maintaining, and continuously evolving of ecosystems and its components requires a deep understanding of the characteristics and the inclusion of the human interaction in different roles, including the emergence of functions, extending classical engineering approaches, adaptive infrastructures, control of semantic diversity, and enhanced human-environment-machine interaction.

A Software Ecosystem can be considered as an overall entity and access for a shared market for software, services, and humans, together with relationships among them. These relationships are frequently underpinned by a common technological platform, or at least at specified communication interfaces and operate through the exchange of information, resources, and artifacts.

Nowadays, we consume and produce data like never before. Companies have started using these data traces to analyze the customer requirements and preferences, for example. Ecosystems were originally referred to as information technology environments. The birth of the web and cloud services has changed that. Now, data is captured and used throughout organizations and IT professionals leading towards data ecosystems. The resulting business faces not only the challenges of proper marketing but also social challenges, e.g., the control by the users over their personal data. Understanding the way information systems grow and change over time and the role of different contributors in these processes is a central problem to current research on software development and digital innovation.

II. KINDS OF ECOSYSTEMS AND SUBMISSIONS

An ecosystem in nature is the relation and the balance between organisms and their environment. The environment influences directly or indirectly the life and the development of the organisms [1]. This concept can be transferred to other domains, such as business ecosystems or software ecosystems. Jacobides, Cennamo and Gawer identified in a literature review three main groups of ecosystems [2]:

- Business ecosystems: centers on a firm and its environment
- Innovation ecosystem: focused on a central innovation and a set of components which support it
- Platform Ecosystems: here, all the actors are organized around a platform.

Missing in this definition was the term *Software Ecosystem*, which is defined as the interaction of a set of actors on top of a common technological platform that results in several software solutions or services [3]. In general, all of these ecosystems focus around one central point, a firm, an innovation, a platform, or a common software. For the accepted submissions of our special track, we used these definitions to cluster the paper in *Business*

Ecosystems, *Innovation Ecosystems*, and *Software Ecosystems*.

A. Business Ecosystems

The first paper is entitled "Development of a Digital Ecosystem using the Example of Amazon" (Mathiszig and Unterluggauer) [4]. The authors analyze the digital ecosystem of Amazon and presented the digital Ecosystem of Amazon in a holistic way. Furthermore, the authors discuss the future of Amazon's digital Ecosystem and predict further investments.

The second Paper "Analysing the Impact of the Implementation of a Blockchain in an Existing Business Model" (Heim) [5] deals with business ecosystems and blockchain technology. Blockchain technology has caught significant attention in the past years and offers great potential. In this paper, the authors present the method of business model stress-testing, which, with certain adjustments, can help to answer the question of the impact of blockchain technology on existing business models.

The third paper "Anonymization of Transactions in Distributed Ledger Technologies" (Werner et. Al) [6] is related to the domain of cryptocurrencies. In the scope of the paper, the authors discuss the role of anonymization in distributed ledger technologies and present a tool for finding the right balance between privacy and law enforcement.

B. Innovation Ecosystems

In terms of innovation Ecosystems, there are three submissions as well. The first paper, "Robot Cognition in Disassembly – Advanced Information Processing for an Adaptive Dismantling Ecosystems" (Poschmann et. al) [7]. The authors propose an agent-based robotic system, which is capable of classifying components in a hierarchical structure for an optimized determination of an ecologically and economically feasible level of disassembly. The overall system is in the frame of the recycling domain and presented by the example of an electric vehicle battery.

In the paper "Towards an Evolving Software Ecosystem in the Mining Industry" Schindler et. al show how an IT Ecosystem is to be implemented in the underground mining domain [8]. Furthermore, they introduce a role and process model, which can support the digital transformation towards mining 4.0, in line with the technical infrastructure.

Strasser et. al present in the paper "A Catalog-based Platform for Integrated Development of Simulation Models" a component simulation-software catalog platform for a cooperatively organized development environment [9]. With their own domain-specific language and a meta-model the authors show a way for the development of future ecosystems.

C. Software Ecosystems

The first paper in this clustering "Towards Improving Software Architecture Degradation Mitigation by Machine Learning" (Herold et. al) shows the role machine learning plays to prevent software architecture degradation [10]. The authors use selected examples to show how machine learning techniques can increase the efficiency of prevention. In addition, the authors highlight a need for future research, including challenges.

The paper "Automated Configuration in Adaptive IoT Software Ecosystems to Reduce Manual Device Integration Effort: Application and Evaluation of a Novel Engineering Method" (Burzlaff et. all) [11] presents a novel integration method that can integrate components automatically in an IoT ecosystem. The authors present a Home automation scenario and therefore, the results of their first evaluation study.

Wilken et. al discuss in "Dynamic Adaptive System Composition Driven By Emergence in an IoT Based Environment: Architecture and Challenges" the challenges in adaptive IoT Ecosystems, such as ´the handling of user requirements, composition mechanisms, and service integration [12]. The authors explain the different challenges and propose their vision of an architecture for an emergent platform.

III. CONCLUSION

The ESES special track includes a wide range of topics related to the area of software ecosystems. It contains a couple of interesting papers which underline the importance of this domain and present interesting results. Furthermore, a couple of papers introducing substantial ideas for future work in this research domain, and open the stage for discussions.

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