Towards a Social End-user Composition of Services

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Abstract. Nowadays, end-users' environment is plenty of services that support their life style, and involving them in the process of service creation can allows them to benefit from a cheaper, faster, and better service provisioning. There are tools that face these problems but they consider end-users as isolate individuals. In this paper, we investigate how social networks can be used to improve the authoring and consumption of services by end-users. We propose a social network of service compositions as a valuable mechanism to share knowledge among end-users in order to improve their skills in composing new services. In addition, we analyse the underlying relationships created among service compositions in order to provide end-users with an intuitive way of browsing them.

1. Introduction

Technologies and applications evolve to create new eco-systems of heterogeneous and distributed services that are available for people anytime and anywhere. Nowadays, your environment may be plenty of services that support your life style: services that track your activity through the mobile phone, that allow an efficient use of your home heating and lighting, that allow you to interact with social networks, that provide you with the weather forecast or traffic status in real time, and so on. However, although these services can be used individually, it is their composed usage what has the potential to create new value-added services for end-users. In addition, in a world where end-users play a more and more important role in the development of content, it makes sense to think on the possibility that end-users create new services by the composition of existing ones. By upgrading end-users to *prosumers* (producer+consumer) and involving them in the process of service creation, both service consumers and service providers can benefit from a cheaper, faster, and better service provisioning [1].

We faced this challenge in previous works [2], where we presented an end-user authoring environment and its supporting architecture to allow end-users to create service compositions without requiring knowledge and skills in programming. This environment was focused on mobile devices since they have become into the

universal interface between services and their end-users, and many cases, they are the only platforms that end-users are working with in order to perform their daily tasks. Other works such as [3], [4], [5], or [6] have also focused their efforts on improving this problem.

However, we cannot forget the social aspect that end-users demand on current software solutions. Nowadays, millions of people use Facebook or Twitter to share with other people what is happening in their lives. Messages, images, videos or links are continuously spread through the Internet in order to make people feel that is connected to others. In the same way, social networks allow people to share their relationships: who are their friends and how many they have, who are they relatives, whether or not they have a sentimental relationship, and so on. Even more, they also share relations with things they have or like. We can find applications that allow people to share books[1], products[2], car journeys[3], homes[4], etc. So, considering this scenario, why cannot end-users share also the services they compose with other end-users?

In this paper, we want to investigate how a social network paradigm can be used to improve the authoring and consumption of services by end-users. In particular, the contributions presented in this paper are the following:

- We characterize the main aspects of a social network of service compositions in comparison with typical social networks.
- We take as base our previous work [2] and extend it to support the social aspect.
- We identify the underlying relationships that are defined among services in such a way the resulting social network is navigable. These relationships are used to provide end-user with valuable mechanisms to browse service compositions.

The rest of the paper is organized as follows: Section 2 presents our previous work. Section 3 characterizes a social network of service composition in comparison with typical social networks. Section 4 analyse the underlying relationships created among service compositions. Section 5 presents the related work. Section 6 finish the paper with some conclusions.

2 Previous work

In this section, we present an overview of our previous work [2], which focuses on allowing end-users without knowledge on programming to create and execute compositions of services.

We defined a tool-supported architecture with three main layers (see Figure 1). The **Service Layer** encompasses the services developed by professionals. Services are implemented by using the technology each professional considered convenient (e.g. SOAP or REST).

[1] http://www.goodreads.com/genres/social-media
[2] http://es.wallapop.com/
[3] https://www.blablacar.co.uk/
4 https://www.homeexchange.com/

The **Application layer** provides end-users with *EUCalipTool*, which is an end-user authoring tool for mobile devices. It is supported by a Domain Specific Visual Language (DSVL) designed to help end-users in the definition of service compositions. This language provides end-users with concepts close to their background and skills. EUCalipTool interacts with a Service Registry to access semantic data of services in order to provide end-users with high level representations of them. These representations are based on domain, and hide technical issues to end-users. This aspect allows end-users to compose new services by focusing on the semantics of them, avoiding the interaction with implementation technologies such as REST or SOAP.

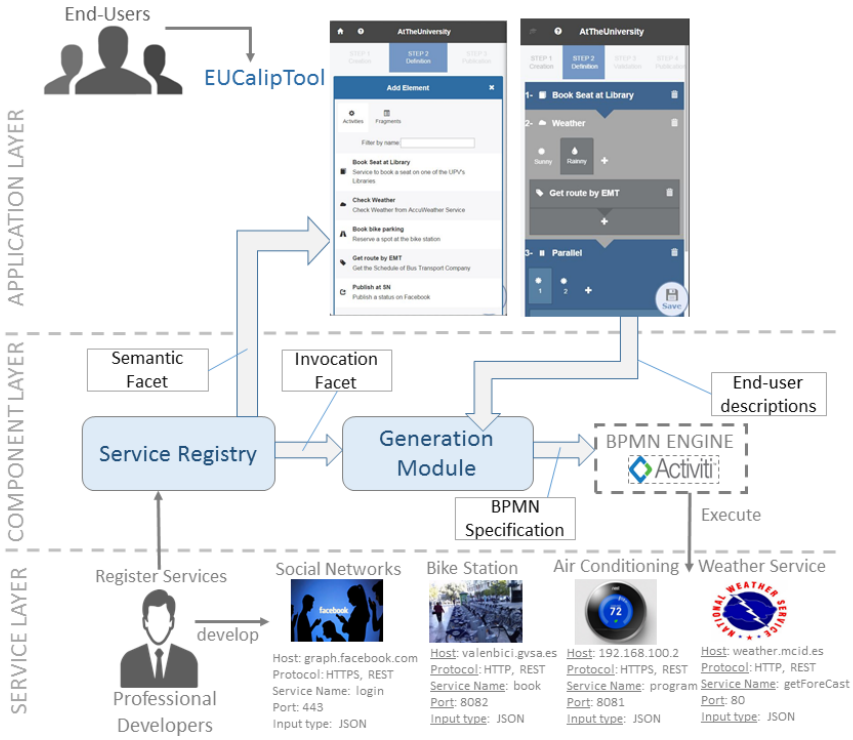

Figure 1. Previous work. Architecture to create and execute compositions of services

The **Component layer** hosts the software artefacts required to connect the above-presented two layers in order to allow end-users the creation and execution of service compositions. On the one hand, a faceted *Service Registry* plays the role of gateway between service implementations and end-users, hiding service technological issues to the latter. By faceted, we mean that service descriptions are logically divided into parts where each part can be stored and retrieved separately without interfering with other parts. The proposed registry maintains two facets of services: (1) *invocation facet*, which includes all the technological aspects required to call a service (e.g.

protocol, url, port, parameters, etc.). This data is used to manage the invocation of a service at runtime, and it is hide to end-users at composition time. And (2) *semantic facet*, which describes the behaviour and goal of each service in such a way end-users can manage it. To make a service available for end-users, developers must register it into the registry by defining both types of data (invocation and semantic). End-users only need to interact with the high level representation provided by the second one.

On the other hand, a *Generation Module* transforms end-user descriptions into BPMN specifications that can be executed by any BPMN engine such as Activi[5]. Once end-users have finished a composition, EUCalipTool submits it to the Generation Module, which connects to the Service Registry in order to obtain the invocation facet of each service of the composition. Then, this data is used together with the end-user description in order to generate an executable BPMN specification.

3 Socializing the composition of services

According to the above presented solution, professional developers register the services they develop into the Service Registry, and end-users can use the EUCalipTool in order to compose them to create new ones. However, these newly created services are only used by their authors. Our current work aims to extend this solution with a social added value that allows end-users to access not only services created by developers but also those composed and shared by other end-users.

Boyd & Ellison [7] state that a social network is characterized by allowing individuals to:

1. Construct a public or semi-public **profile** within a bounded system.
2. Articulate a list of user **connections** that can be viewed and traversed, as well as the list of connections made by others.
3. Share **content** with the list of connections and perform **actions** with the content shared by others.

Although initially defined for social relationships among humans, these three basic characteristics can be adapted in order to consider service compositions.

Profiles. We propose a social network where profiles of end-users[6] and service compositions coexists in such a way they can connect among them. According to [7] user profiles usually includes descriptors such as *name*, *birthday*, *location*, *interests*, and an *about me* section. It is also encouraged the inclusion of a *photo*. In summary, data that can be used to characterize and "know" a user. We adapt this data to create an end-user profile for our purpose. For instance, we think the birthday date is not needed to share service compositions so it is not included. In addition, we think interests of an end-user should be domains of the services compositions they are interested in.

[5] http://www.activiti.org

[6] Hereafter, we use the term "users" to refer to those people that use current social networks, and "end-users" to refer to those people interested in composing services and who constitutes the target of our social network

With regard to composition profiles, we must define analogous data that help end-users to "know" and understand a service composition. By understand we mean that a composition profile must describe it in such a way end-users can figure out their internal behaviour. In a previous work [2], we create a semantic characterization of services from properties that were understandable by end-users. Thus, we based on these properties in order to define a service composition profile. They are the following:

- *Name*: Name of the service
- *Icon*: a graphical representation of the services.
- *Author*: end-user that has created the composition.
- *Type*: Classification of the service into a specific domain (e.g. home care, teaching, e-commerce, and so on). This property should be specified from the concept of some ontology of service types.
- *Purpose*: A high-level description of what constitutes (typical) successful execution of a service
- *Description*: A brief, human readable description of the service, summarizing what the service offers or what capabilities are being requested
- *Location*: Geographic scope of the service, either at the global scale (e.g. e-commerce) or at a regional scale (e.g. university, home). This property is useful to characterize those services that are highly coupled with the physical environment where they are executed (e.g. a services that are available only in a specific smart home, university, or town).
- *Inputs*: values that are required to execute a service. Each input is characterized by a *name* and a *textual description*.
- *Output*: value obtained after the execution of a service. It is defined by a *name* and a *textual description*.
- *Semantic tags*: list of keywords that characterize their internal behaviour of a service. Analogously to the list of interests of a user, which can be considered as a kind of characterization of its behavior, we think that it makes sense to include a list of semantic tags that characterizes the behavior of a service.
- *Device dependencies*: list of physical devices that are needed to execute a service. Note that a service may be intrinsically linked to a specific device (e.g. services that control an air conditioning machine, a smart TV, that need to interact with a mobile device, etc.). This property should be specified from the concepts of some ontology that describe devices.

Connections. A social network such as Facebook connects their users allowing them to create a list of friend users. In a social network of service compositions, we are not only interested on connecting users among them, but also on connecting compositions. In this sense, we propose two types of relationships:

- Between two users that are interested on creating service compositions of a similar domain, which help to create a trustworthiness level among them.
- Between two service compositions that share some characterizing aspect. These connections will be implicitly created from the activity of creating and sharing compositions by end users. This type of connections is inspired by

those proposed by the Social IoT [8]. We discuss this aspect in detail in Section 4.

Content and Actions. Social network users publish content (e.g. multimedia material) and perform actions with the content published by others (e.g. give their opinion, republish it, and so on). In the same way, a social network of service compositions must allow end-users to share compositions and do some actions with the composition shared by others.

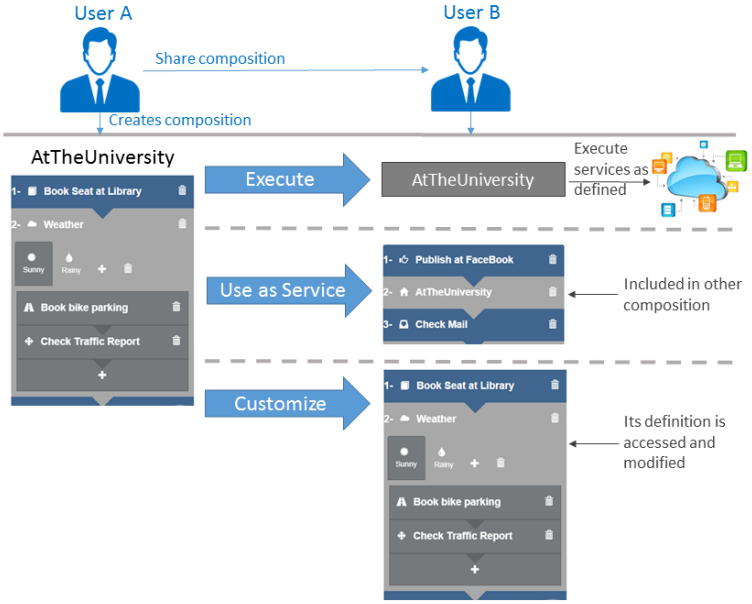

Figure 2. Actions with a shared service composition

An end-user can perform three main actions with a service composition shared by other (see Figure 2): (1) *execute* it as defined; (2) *use* it *as a service* of other composition; and (3) *customize* it to create a new composition. First two actions imply using the composition as a black box, without accessing its internal definition. Third action allows end-users to access and modify the definition of a composition created by others.

3.1 Social EUCalipTool

In this section, we introduce some extensions done to EUCalipTool in order to provide end-users with a social added value.

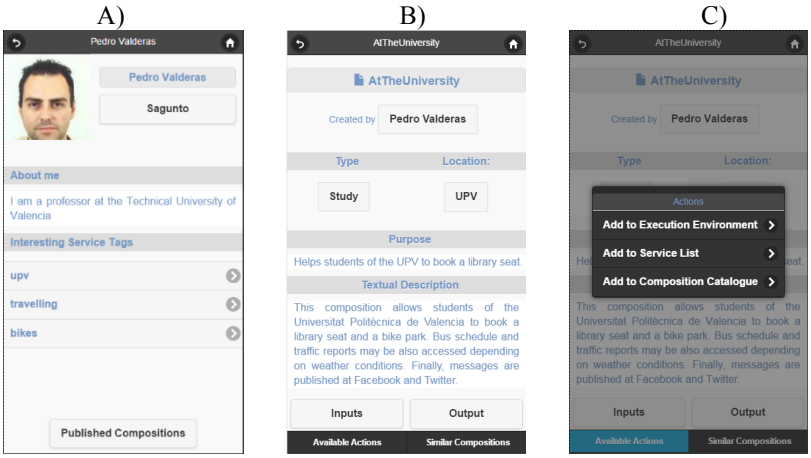

Figure 3. Profiles for the social network of service compositions

Figure 3 presents some examples of the designed interface. For instance, Figures 3A and 3B show the screens designed to support the profiles of end-users and service compositions, respectively. The main goal of these screens is to provide end-users with the data that has been identified for each profile in previous sections. Note how some of this that is implemented as buttons. See for instance the location in both profiles or the author in the service composition profile. This is done to facilitate end-users to browser compositions that share some characterizing aspect (e.g. same location, same author, etc.). Next section discusses this aspect in detail. Figure 3C shows how the list of available actions can be accessed from a composition profile by clicking the button at the left side of screen's footer.

4 Relationships among Service Compositions

One of the goals of the proposed social network is creating an underlying structure of relationships among service compositions. These relationships can constitute a valuable mechanism for end-users in order to browse published service compositions. To achieve this, we are inspired by the emerging area of Social Internet of Things [8], in which they have been analysed the relationships that can be defined among smart objects when they participate together with humans in social networks.

The kinds of relationships we define are those here summarized:

- Author relationship: between service compositions created and published by a same end-user.
- User relationship: between service compositions that are used (to execute, to be used as service, or to be customized) by a same end-user.
- Social relationship: between service compositions whose authors are friends.

- Device relationship: between service composition whose execution depends on a same device.
- Co-location relationship: between service compositions whose execution depends fully or partially on a same physical place.
- Supporting relationships: between service compositions that one is used as service to define the other.
- Parental relationship: between service compositions that one has been taken as base to define the other.
- Co-work relationship: between services compositions that are included as services in the definition of a same composition.
- Semantics relationships: between service compositions that share either some semantic tags or the composition type.

By browsing these relationships end-users can find compositions using notions that are familiar for them (social networks are currently one of the most used mobile apps [9]).

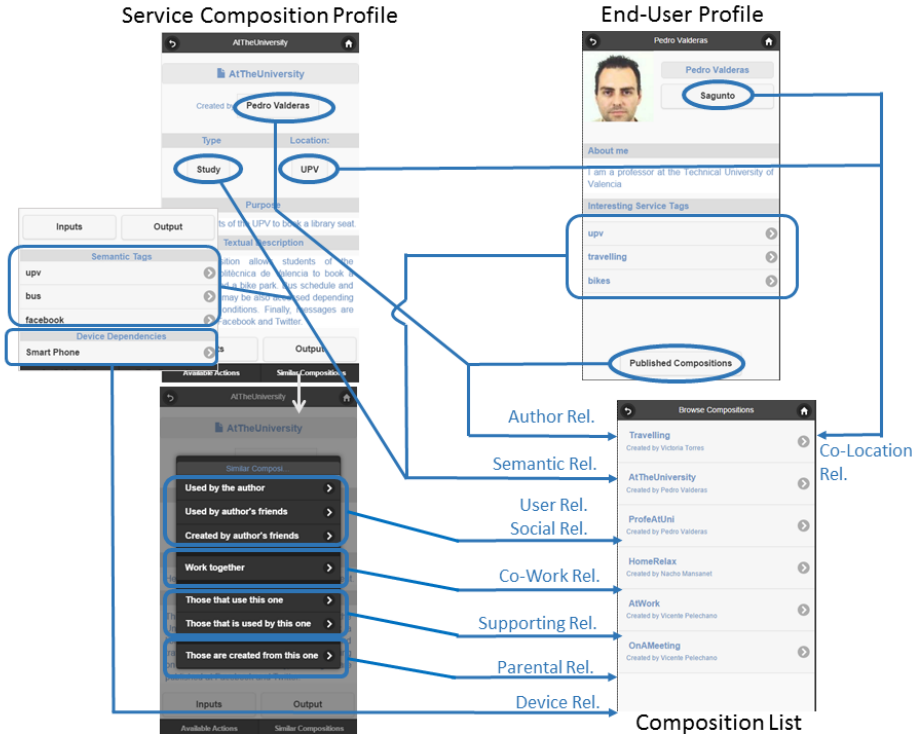

Figure 4. Browsing service composition relationships

Figure 4 illustrates how EUCalipTool's user interface can be used to browse the above introduce relationships in order to find compositions. On the one hand, end-user profiles provide the possibility of navigate three relationships from the included data. The location associated to the end-users allows obtaining all the compositions

associated to the same location. These compositions are related with the co-location relationship. In a similar way, the interesting service tags associated to an end-user allows browsing compositions from the semantic relationship. Finally, the author relationship can also be used to access all the compositions created by the same end-user. On the other hand, the data included in a service composition profile also allows browsing the author, semantic and location relationships. In addition, a menu is accessible in order to navigate the rest of relationships and access other service compositions related with the current one.

5 Related Work

In this work, we have presented a social network to improve the area of mobile end-user development in order to help end-users to create service compositions. As far as we know, there is no works that use social networks as we do.

In the area of mobile end-user development, we can found several works that face the problem of hiding technological issue of services in order to allow end-user to compose them. Works such as [10], [11], [12] or [13] has presented rule-based system to do this. Other such as [3] [4] [14] [15] have presented more sophisticated visual environment to support end-users. However, all of them have focused on individual end-users. None of them have considered the challenge of creating a community of end-users that help them to share knowledge and improve their skills in service compositions.

In the area of Social Internet of Things we can find several works that focus their efforts on the idea of converging social networks with IoT. For instance, [16] analyses the implications of a so-called 'social-technical network'; the concept of Blogject, that is, ''objects that blog'' is presented in [17]; or study the participation of smart objects in current social networks [8]. However, all these works focus on analysing social relationships among smart things. They do not consider the use of social networks as a means to improve end-user composition of services.

6 Conclusions

In this work, we have presented a social network of service compositions as a solution to encourage end-users to become into producers of services and contribute to improve the research of end-user service composition. We have provided end-users with a solution not only to build service compositions in an intuitive way, but also to share the acquired knowledge among them.

We have characterized a social network of service compositions in comparison to a typical social network in such a way participants and allowed behavior are precisely defined. We have presented the extensions done to EUCalipTool that allows us to make this social network become into a reality. In addition, we have analyzed the underlying relationships created among services in order to provide end-users with a valuable mechanism to browse compositions.

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