Interactions in Service Provisioning Systems for Smart City Mobility Services

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Abstract: In times of smart city and internet of things and services a lot of data is produced. However, there is no benefit in collecting the data without processing it. Smart services are one possibility to enable data access for data processing. Smart services have attracted research along their domain and requirements, benefits for the common as well as possible business models are developed. This work addresses the way how service consumers and service operators conduct business in an open B2B service marketplace. The paper presents and discusses phases of a business relationship in an digital service environment as well as discusses the business actions' sequence. A role-action framework for service provisioning systems is developed. It contributes to a better understanding of service provision systems and demonstrates of what processes it constitutes. It furthermore presents what needs to be done by the systems' participants to offer or consume services.

1 INTRODUCTION AND PROBLEM DESCRIPTION

(Balakrishna, 2012) points out that the Internet is developing towards a fully connected system which connects things, objects and everything else which is worth connecting. He forecasts that such interconnectivity enables smart services to achieve the final goal of revolutionizing the interactions between people and their environment. Smart services process data in an intelligent way to increase economic and social life. Therefore an appropriate infrastructure equipped with sensors is required. However, according to (Monzon, 2015), the infrastructure does not make a city smart at all, but are prerequisite. Balakrishna has identified that it is the combination of well equipped infrastructure and appropriate applications and services which makes a city a smart city. (Nam and Pardo, 2011) add the cooperation of the parties involved to the smart city equation. That applications and services are designed to surpass domain and system boundaries to access data for intelligent processing. In conclusion, if sensor data is not accessible and or not processed intelligently, a city will not become smart. Research has shown that the status quo for services is that i) services are currently available as distributed, isolated and proprietary implementations using different interfaces and protocols to access and process specific data and ii) systems host special domain data but the number of smart services to process that data by surpassing system and domain boundaries is low. A smart city solution provider (who is a service consumer (SC) in the later marketplace context) is currently forced to connect all those service providers' (which is the original service provider (SP) in the later marketplace context) services which deliver the required data or functionality. Each new connected service can have a negative impact on the solution's complexity due to i) new service resources require additional management and interface implementation, ii) more service invocations, iii) protocol adaption if a different protocol is used and iv) comprehensive response aggregation. All this causes a lot of effort and, according to Pfeiffer2014, leads to a complicated network of bilateral agreements and links.

Having introduced the problem of smart service provisioning, the rest of the paper is organized as follow. Section 2 shortly introduces several service provisioning approach currently discussed in academics. Section 3 introduces the developed electronic service marketplace (ESM) and presents an overview of its characteristics. The contribution of this work is presented in Section 4 where the identified interactions among the roles are discussed. An expansion towards

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interconnected marketplaces and the applicability of the elaborated model is presented in Section 5. The paper end with an conclusion in Section 6.

2 APPROACHES FOR SMART SERVICE PROVISIONING

Open Data Platform
One possible approach for smart service provisioning for the mobility domain is presented by Tcholtchev et al. who suggest an Open Data Platform (ODP). This ODP consists of various servers which store all kind of mobility related data. The data is provided by the data owner who are the service providers. The data is synchronized between all servers and an end-customer request is answered by one of them. The proposed ODP is not only Business to Business B2B) but also Business to Customer (B2C) as end users communicate with the ODP directly. The ODP offers information alike a dashboard.

Cloud of Things
A Cloud of Things (CoT) is a similar approach to the ODP and is proposed by (Yonezawa et al., 2015). Their user-centric approach is able to manage and store services along with their data. Due to a development tool everybody is able to develop and share a service. The COP holds all data and therefore the power of what is done with it.

Open Service Platform
The Open Service Platform (OSP) approach suggests to move all responsibility to the OSP. The OSP hosts all services and their data. The OSP does also process the service capabilities and stays in contact with the end user (B2C). Participants give off their complete business and their knowledge to the platform. Similar approaches of an OSP is proposed by (Buchinger et al., 2013; Masuch et al., 2013; Beutel et al., 2014).

What we envision is an environment of equal entities and not one big system that is in the position to overrule its participants and to size the complete power. A system or network of equals is desired which enables them to conduct business. The business should confirm to well defined commercial actions and interactions. Interactions have to follow a defined sequence and the actions conducted have to be mapped to a specific role. Contracts need to be in place to manage the roles responsibilities and the trade services.

3 MARKETPLACE APPROACH FOR SERVICE PROVISIONING

Service Provisioning Marketplace
A service marketplace provides is an environment for service providers and consumer to trade services. A prerequisite for membership is a validation of each participant. The provider offers and the consumer consumers service capabilities. A service provider publishes a service description (e.g. its capabilities and conditions) to the marketplaces but keeps the service and the data himself. This is different to the introduced approaches of Section 2. The marketplace stores data which was processed within its system. It furthermore keeps a digital representation of the business contract which indicates that two participants have established a business relationship.

Service Roaming
Service roaming means service request roaming (also known as routing). A service request triggered by an end-user and received by a service provider is forwarded via a marketplace to all contracted service consumers. That is necessary because the service execution is done by the service provider and thus outside marketplace system boundaries. This ensures that each role keeps its responsibilities and the marketplace acts as a neutral intermediary or broker. This is different from the approaches given in Section 2.

Smart Services in Marketplaces
Services exist in various areas, for example the public and private transport domain, the smart grid, smart home and smart city domain as well as in the autonomous driving and intermodal routing domain. The introduced electronic service marketplace (ESM) is designed as an open marketplace. Open implies that the marketplace welcomes services from various domains. For simplicity reasons the paper focuses on examples taken from electric mobility domain. The ESM is the trading environment which, according to (Alrubaiee, 2012; Strasser et al., 2015; Strasser, 2015) is required to enable multiple distributed service providers and consumers to establish business relationships and trade services. As the ESM on hand is designed as an open marketplace every interested service provider or consumer can obtain membership. The ESM is able to host vertical but also horizontal services, also called utilization services. A marketplace with a broad service landscape is attractive and has positive effects for all its participants.

Service Contracting
As business partners have to sign a contract, anonymity is of no need within the ESM. They show each other their capabilities to offer but more important they present their lack and need. Trust is established to the serious and reliable trading environment - the marketplace. Each contract which is closed via the ESM is a representation of a real paper contract. It is a representative of a legal business relationship. According to (Grieger, 2003), it is feasible that an ESM participant checks all service quotations first and then agrees on a service and its conditions. This is done to get the best offer for the lowest cost. This approach might implies that business relationships are often short-term. Contracts might become canceled as soon as a better service quotation is found. This business partner hopping calls Grieger *spot sourcing*. Our service provisioning ESM is designed to be an environment for participants which are interested in mid-long-term B2B relationships lasting at least a year. Therefore it is assumed that once an ESM participant has found an appropriate service quotation with capabilities that satisfy his requirements, the digital and the paper contract will not be canceled until its expiration date - called *systematic sourcing*.

Service Roaming Example
The ESM's operational concept is explained by following : An end user (ED) of service consumer A (SCA) wants to use a charging station operated by service provider B (SPB). However, SPB does not know the ED. But SPB is registered with the ESM and has a service contract with SCA. SPB forwards ED's charging request to ESM which in turn forwards the request to all of SPB's contracted business partners. SCA recognizes EC and sends an acknowledgment. This acknowledgment shows SPB that ED is known by one of his business partners. Therefore SPB authorizes the charging process and ED can use the charging station. The ESM is designed and implemented on the service oriented architecture (SOA) approach. This ensures system interoperability and simplifies access to distributed capabilities through well defined interfaces. The ESM acts as a man in the middle but in a positive way. This concepts is also called broker (Nüttgens and Iskender, 2008; Elgazzar et al., 2013), Clearing House (Pfeiffer and Bach, 2014) or e-marketplace (Thitimajshima et al., 2015). Despite, (Durante et al., 2000) who consider such an entity to be short-living and specific for each transaction, the elaborated ESM is involved in every single service transaction and long-living. Without the ESM, service roaming among the service trading partners would only be possible through the establishment of bilateral service links. However, this would make the usage of the term *roaming* inappropriate. The ESM simplifies service provisioning and provides a well scalable environment for B2B service trades. It reduces efforts put into the implementation and maintenance of interfaces and protocols.

Resulting Architecture
Benefits of a marketplace that enables the establishment of a collective of service providers and consumers and acts as a broker has been discussed by (Strasser et al., 2015; Strasser and Albayrak, 2015). Their propositions provide service consumers the possibility to reduce the number of data links to their service providers from 1:1 to 1:n. The ESM fosters the idealistic vision of an interconnected ecosystem of smart services. Changes in the service providers' protocols are addressed by the ESM while the communication between ESM and its participants remains, in best case, untouched.

4 BUSINESS PHASES AND INTERACTIONS

Having explained characteristics of which the elaborated ESM is capable of, this section demonstrates what actions have to be done to finally enable the ESM to work as described. The ESM is able to manage business relationships which are necessary to conduct business seriously. To establish a business relationship via the ESM the participants have to consider a special sequence of actions. These actions assure commonplace business patterns and behavior. The approaches shown in Section 2 do not explain how the involved parties in their scenario interact in particular and how they relate to each other. The following grants insight into the internal processes of the ESM regarding a complete service consumption life cycle.

Business Phases and Business Action Theory
(Goldkuhl, 1998) developed the *Business Action Theory* (BAT) model. This conceptual model supports the description of business interactions. It consists of the six generic phases. Each phase hosts various actions that are necessary to conduct business. Because of its extended and fine granularity along with the conceptual approach, the BAT model has been used to assign business phases to business actions performed by ESM participants. All of Goldkuhl's phases are applicable to the ESM. This implies that there is no difference between a digital business relationship established via the ESM and

its counterpart from the real world. Table1 presents a comprehensive overview of actions that have been identified as necessary to consume a service. The fourth phase has been extended with two necessary sub-phases.

Table 1: EMS related actions to BAT.

Phase	Actions by SP, SC, both (B) or ESM
Business prerequisites (I)	SP: Identify ability to offer specific capabilities SC: Identify lack and need for specific capabilities B: Determine ESM with suitable capabilities and service quotations B: Register with ESM M: Validate SP and SC
Exposure and contact search (II)	SP: Create service offer quotation SC: Create service search quotation B: Active / Passive service search B: Assess quotations according to own requirements
Contact establishment & proposal (III)	B: Contact potential business partner B: Negotiate terms and conditions for service consumption
Contractual (IV)	B: Sign paper contract with identified business partner B: Store digital contract within ESM ESM: Validate contract ESM: Establish service request roaming
Contract Cancellation (IV-I)	SC: Cancel contract in case service does not deliver what is promised SP: Cancel contract in case payment is missing or service consumption not valid ESM: Cancel service request roaming ESM: Adjust service data access accordingly
Contract Re-Negotiation (IV-II)	B: Re-negotiate terms and conditions for extended service consumption ESM: Update contract accordingly ESM: Update service request roaming accordingly
Fulfillment (V)	SP: Provide service according to contract and ESM regulations SC: Invoke service according to contract
Completion (VI)	SC: Deliver service functionality or information regarding the expected service effect SP: Pay for service consumption ESM: Roam service requests according to business relationships ESM: Response aggregation and data editing (re-factoring) ESM: Store processed data B: Approach phase IV-I if not satisfied with business partner or service B: Approach phase IV-II if contract should be extended

The rows represent the mapping of business phases to corresponding participant actions. That mapping demonstrate the harmonization and consistency of participant actions with business theorems used in the real world. The possibility to map the actions to acknowledged business phases proves that the approach and its business interactions are serious and reliable. The information presented in Table 1 depicts core functionalities of the elaborated ESM. Compared to the approaches in Section 2 which present high level actions, Table 1 introduces the service consumption life cycle in a very precise level. It provides great insight into its operation and behavior of the elaborated ESM. It is mandatory to emphasize that each of the presented actions can be further subdivided. Furthermore can the roles be divided into several additional roles. The ESM is built on or consist of various roles. Each of these roles have specific sub-actions which they have to perform according to a specific action protocol. Due to this protocol all additional (sub-)roles underlie defined relationships and have itself well specified responsibilities. Table 2 outlines an abstract of identified sub-roles of the EMS which themselves perform certain actions and relate to other sub-roles.

Table 2: EMS sub-roles involved in service life cycle.

EMS sub-role	Intention
Technical Administrator	ESM runs without downtime
Business Administrator	Supports participants
Technical Operator	Develops new ESM capabilities
Broker	Roams requests between B2B partners
Adapter	Ensures data interoperability
Refiner	Increases data quality
Hoster	Provides service hosting
Supporter	Supports participants

Factors of an Electronic Marketplace

(Bakos, 1998) presents three factors an electronic marketplace has to comply with. These factors are *1) matching buyers and seller, 2) facilitation of transactions* and *3) institutional infrastructure*. At first glance, the factors and the business phases have nothing in common. Though, once considered in detail, they have similarities. Bakos combines Goldkuhl's first three phases within the first factor *matching buyers and sellers*. Bakos second factor *facilitation of transactions* includes the last three of Goldkuhl's business phases. The system environment is pointed out in the third factor *institutional infrastructure*. Even though Bakos is not as precise as Goldkuhl

according to business phases, his factors are more precise regarding the complete electronic marketplace paradigm.

Combining Phases, Actions and Factors

The role-action framework for service provisioning systems is presented in Figure 1. It was especially tailored for the ESM and is built on the suggestion of (Strasser, 2015). The framework shows that the participants' actions and their sequence are in alignment with the BAT.

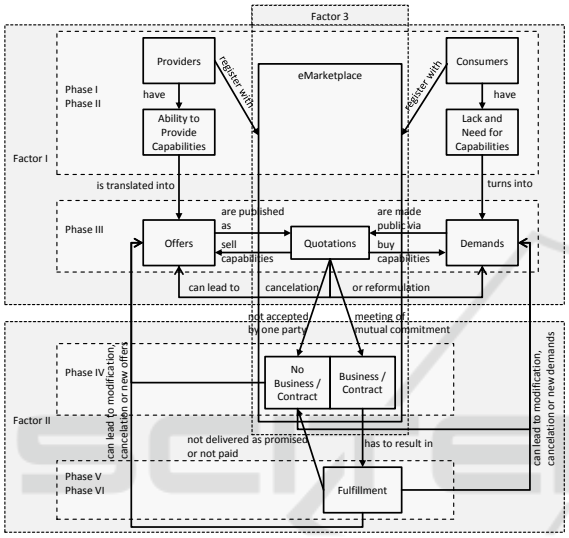

Figure 1: Role-Action framework showing business phases and factors.

During phase I, every potential ESM participant has to identify his capabilities. The identification process will probably unveil that the participant i) can offer certain capabilities to other participants or ii) lacks certain capabilities and therefore has to search for capabilities offered by other participants. Once the participant is aware of his capabilities, it is necessary to identify a source which is capable enough to manage those capabilities. The introduced ESM is such system. A potential participant can obtain the membership in the second phase. However, actions of phase I and II are tightly coupled. Then the participant can either i) create a service offering quotation, ii) create a service provisioning quotation or iii) screen all the offer and provision quotations created by others. It is necessary to distinguish the service quotations between a) public quotations which have been sent to all ESM participants and b) quotations which have been sent to uniquely selected participants. A participant is able to accept exclusively offered and publicly offered service quotations.

In phase III, potential business partners come together and negotiate the terms and conditions of their future business relationship. A contract is signed during phase IV. The paper contract is the legal representation of the partners meeting of minds. The digital contract is required to establish the communication between the partners via the ESM. It possible that one of the business partners' cancels the contract if the outcome phase IV was not satisfying. This is done in the sub-phase IV-I which is a sub-phase of phase IV. A contract might get canceled in case the service does not deliver what was promised in the contract or the service consumption is not paid. The former reason is believed as unlikely when the service provider has described its service offer as precise as possible. Business partners can also re-negotiate if they feel that the terms and conditions are not appropriate. On the other side is it possible to extend the contract duration. The latter two can be done in phase IV-I which is a sub-phase of phase IV. Phase V targets the availability of the service and how the service has to be used by its consumers. Phase VI hosts actions which are related to service delivery and service consumption payment.

5 MARKETPLACE ECOSYSTEM

It is assumed that sooner or later constructs like the EMS will face the same challenges as service providers and consumers - and then they will form alliances with other marketplaces. This will increase their participants' operation area without forcing them into multiple registrations and memberships. This will require adds another management level on top of the current marketplace layer. The communication establishment and the information exchange between marketplaces has to be defined somehow, as it was done for the communication between service trading partners within the ESM. Some requirements might be equal or similar, others different. Approaching the BAT model to define the interactions between marketplaces is recommended. The management of the marketplace network can be realized applying a centralized managed architecture (Strasser and Albayrak, 2015). In this case it is necessary to expand and adjust the actions as the participants will not longer be restricted by the system boundaries of the marketplaces they are registered with. Interconnectivity among marketplaces enables to explore services which have been announced at foreign marketplaces. The establishment of a business relationship across system boundaries provides certain challenges to the marketplaces but also to the ecosystem management.

6 CONCLUSION

The authors have introduced their ESM approach for B2B service provisioning along its operation and functionality. The applied BAT methodology with its resulting role-action model has proven that the business relationships established and managed via the ESM are serious, respectable and comply to commonsense business. The models demonstrate that the ESM relies on clearly defined phases with sequentially arranged actions. The presented actions provide a deep insight into the elaborated ESM capability stack. These capabilities are considered as critical success factors and thus influence the success of the EMS. The work provides an abstraction of the complex relationship between roles, phases and actions in a service marketplace. The abstraction in alignment with real world business phases and supports to understand the underlying principles of service trades. Because of the easy use of the elaborated ESM and its benefits, it is assumed that such a system can accelerate and support the aspiring vision of smart cities and a service provisioning ecosystem.

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