Perspectives for Moving Business Processes into the Cloud

Rainer Schmidt

Aalen University
Anton-Huber-Str. 27
73430 Aalen, Germany
Rainer.Schmidt@htw-aalen.de

Abstract. Moving business processes into the cloud means that the business processes are no longer supported on premise but using a set of cloud services. Cloud services allow to highly reduce upfront investments, change to a "pay-as-you-grow" model and to flexibly react to changes in demand. However, to leverage the benefits of cloud services it is necessary to appropriately integrate the definition of cloud services into business process models. Therefore, three perspectives for defining cloud services are introduced. The functional perspective describes clouds services as the exchange of sub-services between service provider and consumer. The non-functional perspective describes cross-cutting, quality oriented properties of the cloud services. Meta-services as third perspective are used to capture functionality beyond the standard operation of a service, e.g. in the case of service failure.

1 Introduction

Cloud computing is a business transformation based on a number of technical innovations such as virtualization[1], web services [2] and software as a service (SaaS) [3]. There are a number of definitions for cloud computing [4], [5], [6]. However, there is a growing consensus, that the advances of cloud computing can be more easily defined from an economical perspective [7].

Cloud computing may provide public, private or hybrid clouds. Public clouds offer easy to integrate and easy to use cloud services over the internet. In this way, cloud computing transforms the Internet from a source of information to a source of services. By using cloud services enterprises can avoid large upfront investments. E.g. a start-up enterprise is able to minimize its investments because it can start with a low-volume cloud-service consumption and scale up on a pay-for-use only basis. Furthermore, cloud services are elastic. You can increase or decrease their usage according to market requirements without the need to create an infrastructure capable to fulfil the maximum demand. Due to scaling effects, cloud services can be much cheaper than on premise services. Cloud services are designed for internet use; therefore the effort to integrate new cloud services is low. Thus new business processes and thus business models can be implemented quickly and easily and a high agility is achieved.

Up to now, business processes use cloud services in the same way as on premise services. However, there are important differences between on premise services and

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cloud services requiring the adaptation of business management concepts. Foremost, business processes in the cloud imply an important change in organization. Internal business processes depend upon hierarchic coordination. At the end of the day all participants have a common executive manager being capable to give orders. A business process in the cloud however, does not have such a common manager and thus there is not a hierarchical coordination but a market-based coordination. Disputes have to be solved by negotiations between peers. This implies that contracts have to be agreed upon between the participants of the business process. To do so, it is important to exactly define the business processes and especially the cloud services used. Therefore, this paper will introduce new perspectives for defining cloud services. These new perspectives are the formal foundation for the management of business processes in the cloud.

The paper starts with the presentation of a scenario. A definition of standard perspectives in business processes follows. Then the support of business processes by cloud services is described, and the changes, when moving a business process into the cloud, are analysed. Three new perspectives are introduced: the functional, non-functional and meta-service perspective. Related work is discussed in the following section. Finally a summary and a summary on further work are given.

2 Perspectives for Business Processes

Perspectives represent independently evolving parts of reality. Perspectives are disjoint sets of modelling elements used for process definition. Named aspects, perspectives have been introduced in the workflow [8] and software engineering domain [9]. An approach to unify the usage of the terms in both domains has been done in [10]. There are four core perspectives needed in every process: as shown in the scenario depicted in Figure 1.

It shows a (simplified) business process using the BPMN [11] notation. The business process starts with a request from the customer. He then searches for a book. Assumed he has found a book he enters the delivery address and pays.

The *hierarchical perspective* describes how the service process is composed of sub-processes and activities. In the example of Figure 1, the hierarchical perspective is used to represent the fact, that the business process contains the tasks “Select book“, “Enter delivery address“ and “Pay“.

The *behavioral perspective* defines, when and under which preconditions tasks are performed. The behavioral perspective is often identified with the control flow. The behavioral perspective consists of sequence, gateway elements, etc... Referring to the example above, the behavioral perspective defines, that the process is started by a message of the customer. Upon this message, first the task “Select book“ is performed, than “Enter delivery address“ and final “Pay“.

Furthermore, there is a flow of information between activities. In the *informational perspective* the information that is exchanged between activities is defined. In the example, an data object “Order” is moved from “Select book“ to “Enter delivery address“ and a data object “Completed Order” is moved from “Enter delivery address“ to “Pay“.

The *resource perspective* complements the hierarchical perspective by describing how the activities specified in the behavioral perspective are executed using one or several resources and whether they are operant (active) or operand (passive) resources. Thus it describes the implementation. Resources may be people, organization, information or technology. The resource perspective specifies not only the resource itself, but also the procedure needed to obtain and return the resource, for example from the customer. In the example above, the tasks "Select book", "Enter delivery address" and "Pay" are assigned to the departments Marketing, Logistics and Accounting.

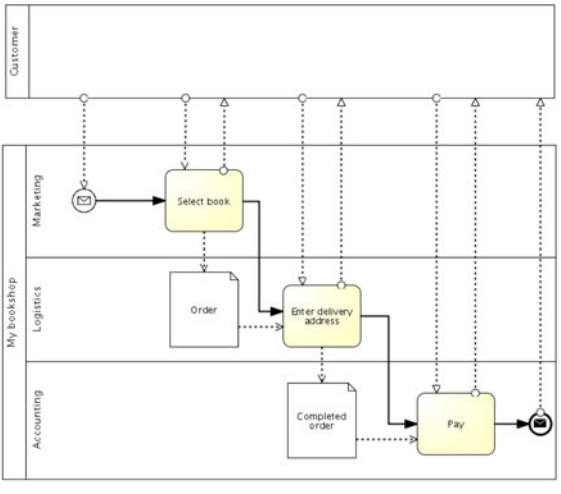

Fig. 1. Perspectives

3 Cloud Services for Business Process Support

The term cloud service includes services already known from SOA but also embraces human based services, infrastructure service etc. Services such as software as a service [3] cannot be described as a software interface alone, how it can be done with web services. The support of business processes by cloud services is done on 4 layers as shown in Figure 2. Often higher services are provided by combining low level services. The business process may be encapsulated as business service.

Business services are services which directly support business processes [12]. They are the interface between the business oriented view of the business process and the more technological view of IT services. They are necessary to aggregate the service properties of underlying services in a way that allows evaluating their appropriateness for business process support. Business services can be either software-based, human-based or a mixture of both. An example is call-centre service provided by a service provider.

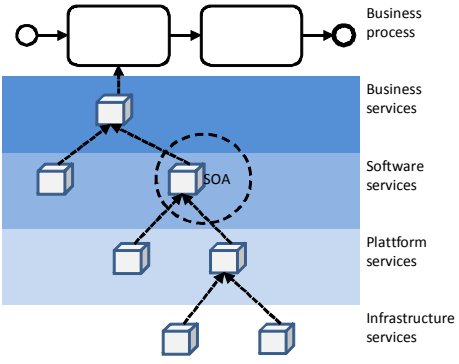

Fig. 2. Layers Cloud Services

Software services exist as two types. There are human-oriented applications which are provided as Software as a Service. And there are application services which are part of so-called Service-Oriented-Architectures [13] that are a popular paradigm for creating enterprise software [14]. A service in the context of SOA is a special kind of interface for an encapsulated unit of software [13].

Platform Services provide support of the development of applications. They provide services for the execution of applications, middleware stacks, web servers etc.

Infrastructure services are more hardware flavoured services which are provided using computers. They may have a human addressee but contain many infrastructure services such as providing computing power, storage etc. They are an important topic in management and practice collections such as ITILV3 [15] or standards such as ISO/IEC 20000 [16] having gained a high popularity.

4 Moving Business Processes into the Cloud

In the good old "new economy" world, the implementation of the business process introduced above would have required large investments in hard- and software. Especially you had to cope with the dilemma, either to buy a very powerful infrastructure to be capable to serve also rare peaks in demand, or to reduce your investments and accept times of bad service due to long response times. Because you do not exactly know how demand will develop you have to endanger your company either by making too huge investments or frustrating customers due to bad service.

Using cloud computing this dilemma can be avoided: You can create your e-shop nearly without upfront hard- and software investments by using cloud-services. Because the e-shop is hosted by a cloud computing provider you can easily enhance your capacities if your business grows. You only pay the performance you actually need ("pay-as-you-grow") and thus avoid either too big or too small investments.

It can be easily seen that using cloud services implies that the business process hitherto confined to the e-shop now includes a number of service providers. However, these service providers do not belong to the same legal entity but are independent, as shown by using choreography instead of orchestration in accordance with the BPMN notation (see Figure 3). The catalogue with the books is now maintained by a

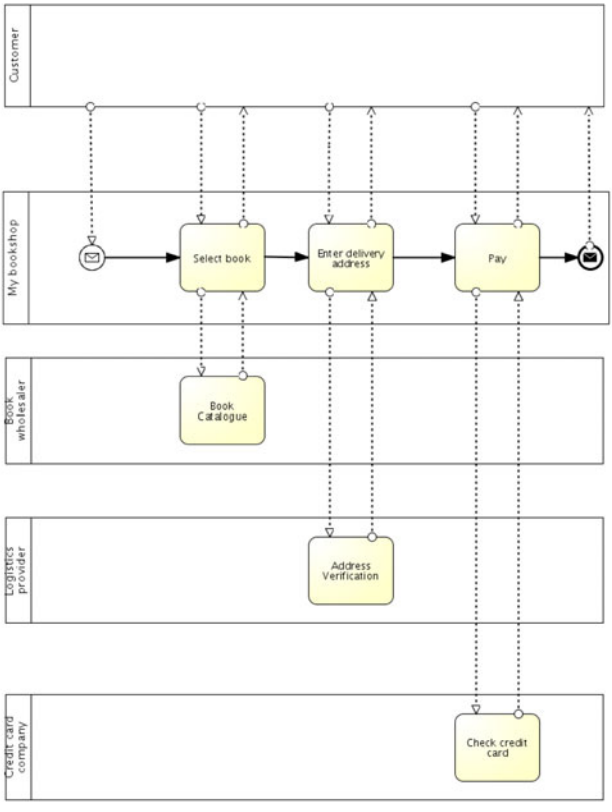

Fig. 3. E-Shop Business Process in the Cloud

wholesaler for books. After the customer has found a book, he enters his address. This address is verified by the logistics provider. Also an expected delivery date is calculated by the logistics provider. Finally the customer enters his credit card number that is checked by the credit card company and to perform the payment.

Due to the distribution of cloud services to different legal and organisational entities it is necessary to describe in more detail, rigorously and explicitly the clouds services used during service execution. Within an enterprise the informal description of a service may be enough to allow an appropriate cooperation of service provider. This is supported by the assumptions that both use the same terminology and thus have a common understanding. However, when service provider and consumer originate from different organizations, such an implicit and mutual understanding of service provider and consumer cannot be assumed. Therefore additional perspectives have to be added to existing business process models. They allow centralizing the information necessary to use cloud services and avoid redundancies. Furthermore, the use of additional perspectives allows improving the separation of concerns by separating hitherto cross-cutting concerns.

5 Perspectives for Defining Cloud Services

To completely define a cloud service it is necessary to not only define the functional properties of the service itself, but also its non-functional properties. Both perspectives are orthogonal, the same service can be provided with different service levels. E.g. the same help desk service can be available from 8 to 8 or around the clock.

However there is still a gap, because these two perspectives consider the operational level only. Therefore a further perspective is required, the meta-service perspective. It contains service acting upon the service not-only in case of failure but also to adapt it to changing requirements etc.

Only the combination of all three perspectives (see Figure 4) allows describing a service completely and evaluating the value of a service. If you define a service but not its availability, you never can rely on the service. If you furthermore define the availability of the service but no means to enforce the agreed upon level of availability, the value of the service is nil.

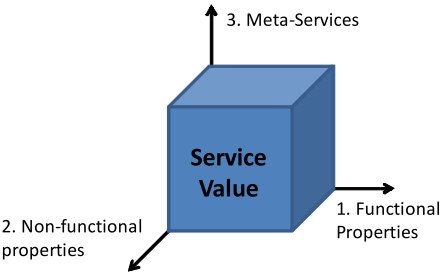

Fig. 4. Perspectives for defining cloud services

5.1 The Functional Perspective

To define the functional properties of cloud services it is necessary to look at the definition of service. There is a long history of service definitions; often the IHIP criteria are used [17]. They define a service by being intangible, heterogeneous, inseparable and perishable. However this definition has been questioned increasingly [18] because there are services not fulfilling the IHIP-criteria. E.g. many mass-produced or industrialized services are highly homogeneous. Furthermore, the IHIP-criteria are also questioned on a formal level, because they define service by the absences of features but not by the presence of features.

Due to the increasing criticism of the IHIP criteria, alternative service definitions have been created such as the one of SD-Logic. Following Service-dominant logic a "service is defined as the application of specialized competences (knowledge and skills) for the benefit of another entity, rather than the production of units of output" [19]. The benefit for the customer should be in the center of interest not the output of production.

Furthermore, there is a shift in understanding from service as an unidirectional activity to a bidirectional one [20]. The provisioning of services is rarely an unidirectional activity of the service provider. In most cases a service is rendered with the help of the

service consumer. That means, also the service consumer has to provide resources etc. to make the provisioning of the service possible. Such an active service consumer is also called prosumer [21]. E.g. given, if the e-book-store wants to use the credit card payment service of the credit company, it has to provide information to the credit card company to enable it to provide the service. If the e-book-store fails to deliver the data appropriately, the credit card is freed from the obligation to check the credit card data. The credit card company may also use subordinated services such as a check of the credit rating of the client.

To reflect this bidirectional character of service provisioning, both the service provider and the service prosumer should be abstracted as a so-called service-system. Maglio et al. [22] define a service system "as an open system capable of improving the state of another system through sharing or applying its resources and capable of improving its own state by acquiring external resources". A service system is defined [23] "as a value co-production configuration of people, technology, other internal and external service systems, and shared information (such as language, processes, metrics, prices, policies, and laws)". The resources shared, applied or acquired by service systems may be divided into four basic classes, namely people, organizations, information and technology [24]. Based on these resources, the service system provide one to many sub-services, by integrating and coordinating resources [25] and co-creates the service desired with other service systems. Thus, there is no service provider producing services in isolation, but service is always the common effort of two or more service systems [26].

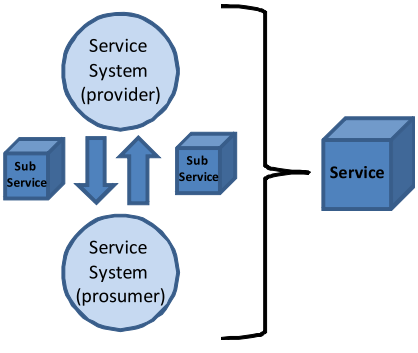

Fig. 5. Functional Perspective of Cloud Services

Based on these fundamental considerations, the functional perspective of cloud services should be represented as a coordinated exchange of sub-services between two service systems representing service provider and consumer. It has to include both the contributed services of the service provider and the service consumer. The sub-services to be exchanged create a system of mutual obligations.

5.2 The Non-functional Perspective

The non-functional perspective describes the non-functional properties of cloud services such as quality, availability etc. Non-functional properties have been identified

as important issue in information systems design (see e.g. [27], [28]). They cannot be assigned to a single entity within a service, they are determined by the service as a whole. Non-functional properties represent cross-cutting issues. They are an important topic for services as shown by the research of O'Sullivan [29]. Following O'Sullivan's point of view, non-functional properties are constraints associated to service functionality. In [29] nine different aspects of non-functional properties are identified: availability, price, payment, discounts and penalties, rights, quality, security and trust.

Availability defines the time and/or location when or where a service can be requested and received by a customer. The prices of a service may depend upon amount of contributed sub-services by the service prosumer. The modalities of payment are agreed upon in the beginning of a service relationship. There may be discounts depending on terms of payment, attributes of the service prosumer or violations of the agreed upon level of service. Also penalties for the failure to fulfill obligation may be part of the non-functional properties. Furthermore quality attributes of the service may be defined. Finally also security and trust are important non-functional properties especially in the context of cloud services. The cloud service provider may receive important information which has to be protected. Furthermore he may use sub-service-providers which have to be included into a sphere of trust.

5.3 The Meta-service Perspective

The meta-service perspective defines services acting upon services. Meta-services are used to capture functionality beyond the standard operation of a service, e.g. in the case of service failure. There are two types of meta-services. First, there are meta-services changing the status of the service. E.g. a service is put into production and changes its status from defined to deployed. In general, a service may have the status undefined, defined, deployed and retired (see Figure 6). When being deployed, a service instance may be instantiated and flagged. Based on these stati, the following meta-services can be defined. The **define**-meta-service creates the necessary definitions of a service. By **deploying**, a service changes from the status defined into deployed. In practice, this is associated with the assignment of resources according to service level agreements. Finally a service may be moved in the status retired by the **retire**-meta-service. When being in status deployed, a service may be **instantiated** that means instances of the service are created. If there is any abnormality, the service instance may be **tagged**. E.g. the instance may be **tagged** if it not performing properly. If the operation of the service instance is back to normal, it is untagged.

The second type of meta-services is those creating or modifying meta-data of a service. Such a meta-service is the **evaluate** meta-service. It is used to collect data about the degree of fulfilment of functional- and non-functional properties defined in order to fulfil requirements. Using the **modify-**meta-service, a service is adopted to changed requirements, either functional or non-functional.

The set of meta-services available to the service consumer may be determined by the business model. E.g a service provider concentrating on standardized, industrialized services may only offer the instantiate and tag meta-services.

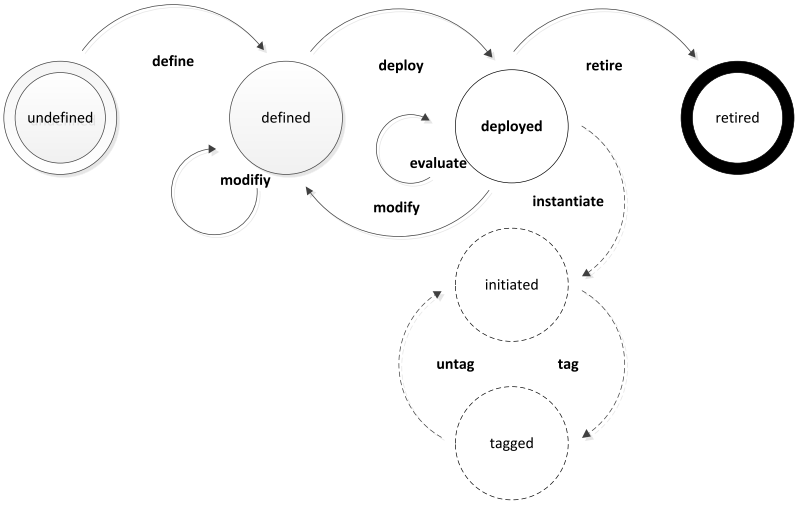

Fig. 6. Service stati and meta-services

6 Example

Now the perspectives shall be used to specify a cloud service for credit payment. The functional perspective of the card payment consists of two interacting sub-services. First, the services prosumer provides the credit-card number and the amount to be paid. Then the credit card company verifies the credit card number and confirms the payment if everything is ok. The non-functional perspective may define that the credit card payment service may be available 24 hours 365 days a year. Furthermore, there may be specified, that there is a maximum interruption of service of 15 minutes in length. The total length of service interruptions may not exceed 4 hours a year. In the meta-service perspective, there may be specified, that there have to be **instantiate-** and **tag-**meta-services. The instantiate meta-service starts the payment process. The tag meta-service is used to indicate service failures.

7 Related Work

There are only cursory approaches for representing services with business process models such as ARIS [30] or BPMN [11]. ARIS allows to model services provided, but neither SLAs nor meta-services. In BPMN 2.0 there are tasks to represent software services. However, there are neither SLAs nor meta-services.

There are a number of approaches using the term meta-service; however, there is no common understanding of meta-services. In [31] the term meta-services is used for the monitoring, optimizing and adjusting of resource services in a grid environment. Meta-services as a kind of intermediary are found in in [32]. Here they “map an existing grid workflow to a service by overriding attributes of the grid workflow”. The term meta-service discovery in [33] or more exactly meta-(service-discovery), thus

meta refers to discovery of services but not to services. In [34] a similar meta-(service-discovery) approach is described.

Meta-services processing meta-data are proposed in [35] those managing meta-data in [36]. Meta-services as a kind of abstract service identifying "a set of services which have similar function" are described in [37]. Thus they are not services acting upon other services. A single service for the composition of e-services is classified as a meta-service in [38]. However, no further meta-services or even a complete framework is identified. The same applies for meta-services in [39], too. Meta-services are used as synonym for certain non-functional properties of services in [40]. Also in [41] QoS provisioning and maintenance are identified as meta-services.

In frameworks like Cobit [42] and ITIL[43] a number of procedures and processes are defined in order to manage services. However, these procedures are neither identified nor managed as meta-service. Instead, an asymmetric handling is introduced, with services as "first-order-objects" and procedures and processes as "second-order-objects"

Service management approaches such as ITIL are organized in an on-premise services provisioning approach. That means ITIL is organized in a way influenced by the idea that all services are provided on premise and not in a outsourced manner. ITIL does not differentiate services whether they are in contact with the customer but only according to their positioning in the service lifecycle. There is no distinction between services interfacing with the customer and those which do not.

Another deficit of approaches such as ITIL or ISO 20000 is that they handle internal and external partners equally. However, external partners are independent legal entities and all interactions with them have to be documented in a very extensive way to be prepared for later juridical disputes. Therefore, processes interacting with external partners have to be designed in another way than processes interacting with internal partners. They have to bear in mind the possibility of a later legal dispute and thus document all interactions.

8 Summary and Outlook

Cloud computing is an increasingly important way to support business processes. However it is necessary to augment business processes by cloud management perspectives to successfully put them into the cloud. Cloud services are externally provided; therefore the required functional and non-functional properties have to be clearly defined. The interfaces between the cloud services and the business processes have to be described in an unambiguous way. This is necessary, because outsourced business processes are in a separate legal entity and therefore a contract has to be agreed upon. Furthermore it is necessary to define meta-services handling the status transition of the services and modifications of the service and its meta-data. The combination of functional, non-functional and meta-service perspective describes a service completely and allows evaluating the value of a service. Especially the meta-services allow describing a service during not only in normal operation, but also in non-standard situations such as service failure.

The identification of perspectives for managing cloud services is the foundation for a number of future areas of research: The meta-services for interfacing between service provider and consumer are only one class of meta-services. There are other classes which may be of importance for the internal management of service systems.

One class of such meta-services are "mirror" meta-services which complement the external meta-services in order to provide services. E.g. the ticket meta-process is mirrored by a process responsible for investigating the deeper causes of service level violations. Contrary to the ticket meta-process its goal is not to re-establish service provisioning as quick as possible but to rigorously identify the root causes of the events. Another class of meta-services are composition and resource-oriented meta-services. They allow to combine existing services or to use resources to provide them. Furthermore, the formal specification of services can be improved.

Because meta-services are likewise services, there are also assigned functional properties, non-functional properties and meta-services. An example for such meta-meta-services is the possibility to complain about the delayed processing of a complaint. Many helpdesks have defined response times and offer escalation mechanisms if tickets are not handled adequately. Of course it is possible to escalate even a level further if this complaint about the complaint handling is not handled properly. Thus, a recursive structure of meta-services is created. Another area of work is the integration of the perspectives into business process modelling methods such as BPMN [11].

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