Cloud Service Mediation through Brokerage Service

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1 RESEARCH PROBLEM

The advent of cloud computing has introduced an entirely new way of thinking about IT services and their role within an organization. It is in many ways consistent with the general shift in focus to the outsourcing trend that has become common practice in modern businesses. Outsourcing lets businesses concentrate on their core competencies while simultaneously taking advantage of the core competencies of their service providers – whether in accounting services, manufacturing and any number of other business activities. Cloud computing is the manifestation of this trend applied to the day to day operations traditionally delivered by internal IT departments. As cloud computing services mature, an increasing number of businesses will choose to move their IT applications to the cloud (Cambridge Technology 2011) to take advantage of the benefits it can deliver.

Common IT services like file storage, e-mail, databases, web sites, and many others can be pushed into the cloud – leaving businesses to shift greater focus and effort to delivering their own products and services to their customers. The National Institute of Standards and Technology (Mell and Grance 2011) identifies the following characteristics associated with cloud services:

1. On-demand self-service – a consumer is able to provision computing power, network storage and other capabilities automatically and as needed without interaction of a human.
2. Broad Network Access – all services are provided over the network and are accessible using standard thin and thick clients such as traditional workstations, tablet PC's and even smart phones.
3. Resource Pooling – the service provider's computing resources are pooled together in what is called a multi-tenant model. These resources are dynamically assigned and reassigned to different tenants as needed (according to demand). Examples of such resources include memory, bandwidth, processing power and storage.
4. Rapid Elasticity – the ability to scale up or down on demand and often automatically gives the customer valuable flexibility to meet the needs of the business.
5. Measure Service – the customer pays only for what is used. The consumed re-sources are monitored, controlled and reported upon. This provides transparency to both the customer and the service provider. The IT services are essentially billed to the customer like a traditional utility company.

Having understood the benefits these characteristics could potentially deliver, companies are taking notice and looking to capitalize on this new paradigm of IT services. To find the right service with the right quantity and quality so called cloud service brokers are playing an intermediary role between the providers and customers.

Companies and organizations planning to use cloud services are facing today a huge number of different possible cloud solutions. Because of the sheer number of possibilities it is hard to orient oneself and find the optimal solution and offering. Cloud Brokering companies are offering the provision of an optimal service to its customers. This time consuming process stands in opposite to the cloud paradigms of fast provision and on-demand self-service of a service. Thus, an automated brokerage approach could leverage advantages of cloud computing and increase companies' agility.

If a company would like to examine if it is able to use cloud services, different aspects like process requirements, data security etc., have to be considered. According to (Xin and Datta 2010) no best practices or other manageable methods are yet available to support customers in investigating these aspects.

The analysis of own requirements can be a very time intensive task. But also the selection of an appropriate provider and service are a complex challenge, especially for small and medium enterprises with no or low IT expertise.

This research projects picks up these issues with the goal to simplify the high complexity. Thus the needed effort for an integrated Cloud Service Mediation (from requirements analysis, service

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classification and the appropriate mapping) should be diminished.

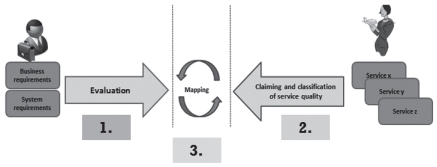
Therefore the thesis statement is defined as follow: There exists a method to mediate cloud services based on user requirements and cloud service quality properties. This method is easy to use for customers and can deliver automatic decision support.

2 OUTLINE OF OBJECTIVES

This research project foresees three main objectives, which can be identified as a part of such an integrated Mediation Broker approach. The main goal is to support SME's using cloud services and to simplify the due diligence process. From a scientific point of view, this means that three main aspects have to be investigated:

- How can customers easily define, collect and describe their business and functional requirements. Thus, a requirements evaluation method has to be developed. Main properties of such a method should be:
  a. Simplicity to understand for business; defining a language which makes Cloud necessities understandable for people with a low technical affinity
  b. Easy to use; in this case the project is intended to find an appropriate form of self-services for the needs assessment and service selection. A high degree of self-explanation of the operation of the system is aimed. The usage of the self-service should be as simple as possible to gain access to the required information.
  c. Machine readable; whereas results are derived from the customer analysis, they will be used for input for the mapping component, this must also be described and understandable for the mapping system
- Cloud services must be identified, described and have to be classified qualitative and quantitative so that a statement of compliance with the claimed customer requirements can be made. Areas for classification criteria could be for example:
  a. Contractual aspects
  b. Operational processes
  c. Properties of Service Level Agreements
  d. Training and Support
  e. Interfaces and Interoperability
- How can data from I and II be automatically mapped to derive an optimal match of cloud service quality and customer requirements.

The following figure should give a short impression on the entire system, beginning at the requirements assessment, to the service classification and finally the mapping of the services to the requirements.



1. Are current requirement engineering methods valid to collect customer's business and functional requirements with regards to a cloud service?
2. Is there an approach to identify, describe and compare qualitative and quantitative Cloud Services so that a statement of compliance with the claimed customer requirements can be made?
3. How can data mapping methods be evaluated and ranked for a given mapping challenge?

Figure 1: Cloud Mediation.

The three main objectives can be summarized as follow:

1. Defining and developing a method to collect customer's business and functional requirements with regards to a cloud service. The method has to be easy to understand and usable for users without IT background.
2. Defining a classification and weighting scheme for cloud services with regards to service quality.
3. Evaluating an appropriate technology for mapping data retrieving from objective 1 and 2. Based on the chosen technology a proper system has to be developed to mediate cloud services easily to the customer.

3 STATE OF THE ART

The functionality and the role of a so-called Cloud Brokers are discussed at international level for some time. According to the National Institute for Standards and Technology (NIST), there exist the following three forms of brokering services in the cloud environment (NIST 2013):

- Service-Intermediation: A cloud broker adds a given service by improving the ability of some specific services for cloud consumers. Such added-values can be a management access, personnel management, performance reporting, enhanced security, etc be the actual service.
- Service Aggregation: A cloud broker combines and integrates multiple services into one or more new services. The broker provides data

integration and ensures the secure data movement between the cloud consumer and multiple cloud providers.

- Arbitrage-Service: Service arbitrage means that a broker can choose from different services from various providers. A cloud broker, for example, can choose a suitable selection (Cloud Service Selection) out of various offerings based on different criteria.

Whereas on the field of intermediation and aggregation (e.g. on the topic of interoperability) already a lot of scientific effort takes place (Sundareswaran et al., 2012) and various solutions are available (Sun et al., 2013; Gartner, 2013), there is only limited knowledge and on a high level of abstraction in the field of arbitration (Kalepu et al., 2003; Mondal et al., 2010; Buyya et al., 2012). At this level first scientific efforts were taken of Buyya et al. (Buyya et al, 2012; Garg et al., 2011). Buyya looks such a broker as a central role for a market-oriented approach of cloud services (Garg et al., 2011).

Silas et al., (Silas et al., 2012) propose a service middleware for efficient service selection. By using the ELECTRE methodology of the selection process is approached as a multi on criteria decision problem. Many criteria, such as response time, service costs, responsiveness, trust, scalability, performance, flexibility thereby influence the selection process. Deng et al. (2011) used for service selection also a multi-criteria decision-making process, which is based on the Fuzzy-AHP (Saaty, 1986) and TOPSIS method.

Furthermore, (Deng-Neng et al., 2011) is using trust as the sole criterion for the selection of service providers. Garg et al., (2012) focus their work on the indexing and classification of the provider, which is required for a service switching. A so called cloud service index with parameters such as service type, price unit, security provider is used. The whole concept is based on the provision of data by the respective provider and thus does not provide independence from the service provider.

The existing activities focus either on the side of the classification of services or the decision support methods for the customer. Grag et al., (2012) and Hussain (2011) also complain about that today's cloud based service evaluation and selection methods and in particular functional requirements. For a successful service selection and service mapping but also the business needs, as well as non-functional requirements such as potential regulators, Performance, Support etc. must be considered and the service characteristics are com-pared.

The field of Business / IT Alignment (BITA) seems to be suitable. BITA aims to align, adapt and integrate business strategy, IT strategy, business infrastructure and IT infrastructure with each other (Henderson et al., 1993; Papp, 2001). In this field there exist various approaches (plugIT, 2012, Wolf et al., 2011) on how BITA has to be applied and used. However, these methods are not suitable for the selection and placement of cloud services, because of the time consuming processes. Such as experiences from the plugIT project (2012) have shown in other areas, the efforts of such frameworks are not practical for the users.

With regards to the mapping mechanism, the complexity of such structures have to imply that corresponding comparison algorithms have to have a high tolerance for structural deviations without harming the semantic content of the compared entities. One way to take this into account are approximate comparison methods based on similarity-based reasoning. Among them there exists a wide range of techniques including Case Based Reasoning techniques such as example-based reasoning, instance-based reasoning, memory-based reasoning, or analogical reasoning (Wolf et al., 2011; Aamodt, 1994).

4 METHODOLOGY

At this stage of the research project, pragmatism is the right stance, because it offers the greatest flexibility within the research project. The disruptive nature of cloud computing and the resulting complexity within the vendor landscape might still hold sur-prises along the way. As research progresses and knowledge for the development of a mediation broker will mature, it is crucial in this research to adapt quickly.

As discussed in the previous chapters extensively, cloud computing evolves at a great pace and the focus in this market changes constantly. As a consequence it is getting more difficult to keep the pace and stay on top of things in the shifting cloud environment. This rapid evolvement in its early stage makes it even harder to develop a robust theory to test and validate (i.e. deductive reasoning), which could withstand the disruptive nature of cloud computing. However, literature is available in this area, which would favour a deductive approach thoroughly. As a pragmatist and while looking be-yond the horizon, it might be meaningful to combine both approaches. In the first stage the inductive approach helps to break down the complexity and explore the transition in the cloud vendor market. Then, in a second stage when the complexity decreased and less debate is excited,

deductive reasoning can complement research with more pro-found theories and results. Finally, the foreseen approach is to collect data first and then develop a theory out of it while keeping in mind that deductive reasoning still will be applied in a later stage.

- Strategy: Design Research, also referred to as Design Science research (Vaishnavi 2007) is particularly suited to Information Science research and is grounded in the types of research questions that are often asked within this field (Vaishnavi, 2007). This research will follow the process steps as described by (Vaishnavi, 2007), which requires looking at the problem of service brokerage in a cloud environment and extracting possible solutions from the existing knowledge.
- Time Horizon: the intended research will follow a cross-sectional approach as it is per-formed at a particular point in time.
- Data Collection: with regard to the Design Science Research phases (Vaishnavi, 2007) the following data collection methods and partners are intended:
    - Awareness of the Problem: in this phase literature review will be conducted and interviews with governmental partners and SME Associations will be held.
    - Suggestion: in the suggestions phase interviews and workshops with different responsible roles within SMEs, Expert Interviews with Consultant e.g. Auditors and Scientific Experts will be held. First artefacts will be developed in cooperation with technical experts
    - Development: developing of prototypes with technical experts from software developing companies and scientific experts.
    - Evaluation and conclusion: for the evaluation different test cases will be prepared and afterwards tested with potential customers from (SMEs and governmental institutions). Results will be discussed with technical and scientific experts.

5 EXPECTED OUTCOME

This PhD project is closely coupled with the CLIMB research project funded by Swiss Commission for Technology and Innovation. The author is also CLIMB's project lead. Goal of this project is to develop and establish kind of a Service mediation broker based on the Star Audit Certification. Thus, the outcome of this PhD project is two folded. On the one hand there will be a practical outcome. It is expected to develop a software, which (i) supports customer to identify their needs regarding cloud services, which (ii) offers to providers the opportunity to classify their services and to compare it with other providers and (iii) which maps these described services with the claimed client requirements and gives a valuable recommendation of appropriate services.

On the other hand it is expected that the project will bring some scientific contributions like:

- A method to collect customer's business and functional requirements with regards to a cloud service. The method has to be easy to understand and usable for users without IT background.
- An evaluation method for benchmarking data mapping methods based on a given mapping challenge.
- A classification and weighting scheme for cloud services with regards to service quality.
- A Cloud Service Description method to collect and compare cloud service properties.

6 STAGE OF THE RESEARCH

6.1 Work in Progress

There are currently several activities in progress.

- With regards to the requirement elicitation part, there an in depth literature review on requirements engineering has been executed to gain insights on current trends and techniques in this field. Furthermore first expert interviews have been made to identify the need and gap for a new requirement evaluation method for cloud services.
- A first identification and analysis on different mapping candidates like AHP, Fuzzy AHP, Graph matching, Ontology, Rule Engine, ELECTRE, TOPSIS, Statistical methods, term-based matching and preference matrix has been done. Currently a list of evaluation criteria are setup to compare and classify these candidates.
- State of the art on cloud brokering approaches. As result a draft categorisation on different cloud brokering approaches and cloud service selection has been made (e.g. service intermediation, service aggregation, service arbitrage (service mediation internal vs external)).

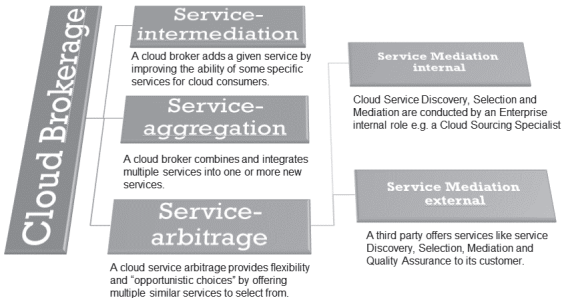


Figure 2: Cloud Brokering Classification.

6.2 Next Steps

After finishing the current work in progress, there are several further activities planned as follows:

1. Two to three requirement analysis approaches will be piloted and tested with a set of potential customers
2. Six mapping candidates will be short listed and analyses more in detail. Four candidates of this six options will be implemented and ranked, based on test data.
3. Conducting a first study on approaches for service classification and descriptions. Developing a method to identify, describe and compare qualitative and quantitative Cloud Services so that a statement of compliance with the claimed customer requirements can be made.

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