CLOUD REQUIREMENT FRAMEWORK: REQUIREMENTS AND EVALUATION CRITERIA TO ADOPT CLOUD SOLUTIONS

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Abstract

Due to the fast growth, Cloud Computing has become a non-transparent market with providers and customers willing to adopt it. Furthermore, many offers only partially meet customers' requirements and it is not clear how exactly Cloud Computing influences the IT. That makes it difficult for customers to plan migration projects and implement sustainable Cloud solutions. There are important factors and considerations for the decision to adopt Cloud Computing. The current studies and research in this field can be summarized to focus around the questions why adoption of Cloud Computing would occur, how much adoption would take place or how it would be adopted. But the adoption requirements covering all three service models (SaaS, PaaS, IaaS) have barely been discussed in literature so far.

A detailed understanding of Cloud requirements enables customers to adopt Cloud solutions efficiently. Therefore this paper aims to contribute a framework addressing the adoption and selection of Cloud services. A Cloud Requirement Framework (CRF) was developed, concentrating on relevant requirements for adopting Cloud services targeting all three service models. To develop this framework we followed a design science approach and conducted a systematic literature review, an extensive market analysis and an evaluation based on expert interviews.

Keywords: Cloud Computing, SaaS, PaaS, IaaS, Framework, Adoption, Requirements

1 Introduction

Recently, Cloud Computing has become a fast growing and non-transparent market with many providers, including heterogeneous service portfolios and models (Hoefer and Karagiannis, 2010; Martens et al., 2011a; Martens et al., 2011b). Through the increased service orientation and the new opportunities to integrate individual services models to create value-added and complex services, flexible value networks have been established (Leimeister et al., 2010). Companies expect to reduce their costs, to gain flexibility and an unlimited resource access (Mueller et al., 2011). Due to the lack of a universal definition and various perceptions of Cloud Computing, including the related benefits and challenges, many companies struggle to make use of the Cloud concept (Nuseibeh, 2011; Leavitt, 2009; Marston et al. 2011). Barriers for the adoption of Cloud Computing are the lack of standards and appropriate selection requirements (Leavitt, 2009; Clemons and Chen, 2011). Furthermore, many offers do not meet - or only partially meet - customers' requirements (Forrester, 2009). The absence of defined Cloud requirements and evaluation criteria makes it difficult for customers to plan migration projects and implement sustainable Cloud solutions. The fact that interoperability between providers hasn't been achieved makes a provider selection often irreversible or requires much effort (Hoefer and Karagiannis, 2010; Repschlaeger and Zarnekow, 2011). This difficulty, known as "provider lock-in", is discussed extensively and is an important topic for practitioners and for several initiatives, e.g. the *Open Grid Forum* (OGF) or the *Distributed Management Task Force* (DMTF) (Cattedu and Hogben, 2009; Armbrust et al., 2009; Ortiz, 2011).

Most researchers such as Briscoe and Marinos (2009) or Vaquero et al. (2009) and institutions like the National Institute of Standards and Technology (NIST) postulate three servcie models or service levels of Cloud Computing: Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS) (Grance and Mell, 2009; Koehler et al., 2010b). Most of the research work, prior to 2011, focused on various technical issues of Cloud Computing (Koehler et al., 2010b). Since 2011, the perceived importance of the business view has grown and Cloud Computing is becoming more than a technological enabler (Iyer and Henderson, 2010). Although, Cloud Computing is examined from several specific business perspectives, for instance, pricing models, resource allocation for IaaS, critical adoption capabilities, a comprehensive framework of requirements for all three service models (layers) remain unexplored.

There are important factors and considerations for the decision to adopt Cloud Computing and the current studies and research in this field can be summarized to focus around the questions why adoption of Cloud Computing would occur, how much adoption would take place or how it would be adopted (Luoma and Nyberg, 2011; Nuseibeh, 2011). But the adoption requirements and evaluation criteria for a service selection covering all three service models have barely been discussed in literature so far.

Given this call for papers and the research gap identified above, our paper aims to contribute a framework addressing the adoption and selection of Cloud services. For that, a Cloud Computing framework concentrating on relevant requirements for adopting Cloud services targeting all three service models will be developed. In this context we focus on the following research questions:

(1) What are the different adoption requirements for each service model (IaaS, PaaS and SaaS)?

(2) How can a Cloud Requirement Framework (CRF) look like, which supports companies to adopt and select Cloud services?

This article is organized as follows. The first section provides an overview of the foundations and related work. Next, the research methodology and prior research is described. We then present a Cloud Requirement Framework (CRF) and give insights into the framework and its scheme. Within section four we develop the structure of the framework based on an extensive market analysis and conducted expert interviews. After discussing the implications, the last section summarizes limitations and promising areas for future research.

2 Background and related work

In the last few years the scientific contributions have started to focus on the business view on Cloud Computing. According to Yang and Tate (2009) only 16% of the literature (nine publications) dealt with business issues of Cloud Computing in 2009. Also Martens et al. (2011a) identified only four scientific publications related to the field of business and management of Cloud Computing in 2010. Based on our literature review in 2011 we could detect over 61 publications focusing on business aspects of Cloud Computing. This growth of publications reflects the enthusiasm on the Cloud Computing paradigm and the increasing importance for practitioners and researchers (Yang and Tate, 2009; Son and Lee, 2011). In addition, Cloud Computing has become more mature and is perceived increasingly from a business perspective rather than only from a technological view (Iyer and Henderson, 2010).

To understand Cloud Computing and to exploit its opportunities, companies have to focus on user-related issues, not technology (Iyer and Henderson, 2010; Koehler et al., 2010a). Thus, the requirements of Cloud adoption are affected by the Cloud strategy, including customer objectives related with a Cloud adoption. Also the provider portfolios with standardized service combinations and the customer operations management, the phase after adoption and implementation of Cloud Computing, are of high relevance for adoption factors. Hence, the existing literature of the business perspective of Cloud Computing relevant for adoption requirements can be distinguished into four main research fields: Cloud strategy, Cloud portfolio, Cloud adoption and Cloud management.

Cloud strategy: The Cloud strategy can be seen as a subset or a part of the IS strategy and should be aligned properly to the IS strategy due to the direct correlation. It subsumes the set of decisions required to create and deploy a network based, information service delivery strategy that results in both, cost savings and organizational agility to achieve competitive advantages (Iyer and Henderson, 2010). Truong (2010) explained how to use Cloud Computing to enhance competitive advantages for small businesses and uses the resource based view of the firm to suggest that individual Cloud offerings provide an un-imitable competitive advantage. Related to this field Shimba (2010) discussed strategies for Cloud Computing adoption in his doctoral thesis. Considering the strategic role of Cloud Computing it reflects a new way in which IT can be used more strategically in business value creation (Son and Lee, 2011). From the perspective of strategic IT use, the value of Cloud Computing enables businesses to enhance dynamic capabilities and to hold its business competence in the market (Teece et al., 1997; Pavlou and El Sawy, 2006).

Cloud portfolio: The design of business models and service portfolios within Cloud Computing for providers is becoming more relevant and includes different hurdles to overcome. Koehler et al. (2010a, 2010b) identified consumer preferences for Cloud service attributes to gain insights on the prerequisites of a successful market introduction of Cloud services. Providers may face the problem of how to price infrastructure services and how this pricing may impact the resource utilization (Anandasivam and Weinhardt, 2010). To help providers decide which jobs should be running or cancelled Pueschel and Neumann (2010) introduced a decision model in order to minimize loss of revenue and key customers during partial resource failures. A decision support policy called Customized Bid-Price Policy is proposed by Anandasivam and Weinhardt (2010). In order to increase customer loyalty Cloud providers have to address their service quality weak spots and identify which factors are crucial for continued Cloud usage (Benlian et al., 2010). To extend the concepts known from the revenue management to the specific case of Cloud Computing Anandasivam and Premm (2009) propose two models, bid price control and a variant of dynamic pricing. Finally, drawing on service quality literature, Benlian et al. (2010) developed a SaaS service quality scale that can be used as a diagnostic tool by SaaS providers and users alike.

Cloud adoption: A study by Nuseibeh (2011) summarized the success factors for a Cloud adoption based on economic theory (Transaction Cost Theory), strategic management theory (Resource Dependency Theory) and Diffusion of Innovation Theory. Especially for firms with purpose to

implement Cloud Computing, it is relevant to identify the factors that affect firms' behavioral intention to adopt Cloud Computing (Son and Lee, 2011). Thus, Son and Lee (2011) focus on establishing a theoretical framework specific to Cloud Computing adoption and conceptualizing factors affecting the adoption and developing measurements. An attempt to capture important influencing factors for the Cloud adoption a maturity model for the quality assessment of Cloud Computing Services is provided by Martens et al. (2011b), where the relationships between Cloud services, SLAs, technical implementation and provider characteristics are described. Associated with Cloud services, Kaisler (2011) examined the service migration in the Cloud Computing environment, by examining security and integration issues associated with service implementation. Benlian et al. (2009) surveyed relevant drivers of SaaS adoption based on an empirical study of different application types and observed the control of IT function and identified benefits related to the outsourcing of the local control, installation and development of software. Adoption factors related to the SaaS model from a government perspective are discussed by Janssen and Joha (2011). Additionally, the adoption of a university was examined by Sarkar and Leslie (2011) who presented a case study of a large Australian university, with a risk-averse IT department, that has begun to engage in Cloud Computing. Luoma and Nyberg (2011) did an exploratory and holistic study on how the adoption of Cloud Computing in China is affected by performance and effort expectancy, social influence and organizational and infrastructural readiness.

Cloud management: The operation of the Cloud infrastructure and the management of actors or services are as important as the implementation process. In this context a continuous controlling and measurement of services are necessary due to significant reconfiguration lead-times and non-trivial dependencies between software and hardware resources (Hedwig et al., 2010). In their work Hedwig et al. (2010) address these factors explicitly and introduce an accurate workload forecasting model, based on Fourier Transformation and stochastic processes. In order to manage the Cloud, companies need methods to avoid being fined for compliance violations, to manage risk factors as well as to manage processes and decision rights (Martens and Teuteberg, 2011). Presenting a reference model that serves to support companies in managing and reducing risk and compliance efforts is presented by Martens and Teuteberg (2011).

3 Research method

The presented Cloud Requirement Framework (CRF) underwent several cycles of development. The research method used in this article is based on the design science paradigm in IS research (Nunamaker et al., 1990; Walls et al., 1992; March and Smith, 1995; March and Storey, 2008). The design science research is a prescription-driven and problem-solving paradigm that seeks to create viable artifacts in the form of a construct, a model, a method, or an instantiation (design artifacts) which provide solutions for management problems (Hevner et al., 2004; Gregor and Jones, 2007; van Aken, 2004). Based on the three-cycle (rigor cycle, design cycle, relevance cycle) view of design science research proposed by Hevner et al. (2004) and Hevner (2007) we structured our research approach and began by conducting a rigor cycle and defining our knowledge base of scientific foundations. Following a rigor cycle we started to build on our existing work and conducted a systematic literature review on Cloud Computing frameworks and adoption requirements. The related work is presented in section 2.

In previous work target dimensions of Cloud Computing were developed, based on an international literature analysis and expert discussions (Wind et al., 2011). In this prior contribution we defined six target dimensions to group and structure the Cloud characteristics. These dimensions help enterprises and other institutions to get better insights of Cloud Computing objectives and support the decision and implementation process, e.g. by classifying appropriate providers. The relevance of the developed target dimensions was evaluated with an additional international survey conducted among 30 IT managers and CIOs (Repschlaeger et al., 2012). In further research we already presented a provider

independent classification model for IaaS and a reference guide to Cloud Computing dimensions (Repschlaeger et al., 2012).

In order to develop the theoretical foundation of our framework we started with a literature review to gather relevant requirements and aspects of existing Cloud frameworks. For this article we followed the approach of a systematic literature review by Webster and Watson (2002) and limited the search approach to the top 16.8% (21 out of 125) of all journals included in the AIS ranking list (Vom Brocke et al., 2009). This list has a wide acceptance among researchers as an international journal meta-ranking. Thus, we started to explore the field from a high quality journal perspective. Subsequently, each journal was searched for special keywords. We focused on keywords like "framework*", "requirement*", "management*", "classification*", "selection*", "portfolio", " criteria", "adoption*" and combined them with "Cloud Computing", "IaaS", "PaaS", "SaaS" and "*as a Service". The applied wildcards assured the identification of related, conjugated terms. To extend the sample we applied a forward (review of reference lists) and backward (author-centric review) search and searched in publisher independent journal data bases like *AIS Electronic Library*, *EBSCO*, *SpringerLink* or *Science Direct*. Doctoral theses that were identified in the course of the search and fit to our research objective were included in the sample as well.

The results of the rigor cycle were used for the initial design cycle. In this research step, we designed a first draft of requirements relevant for the adoption and selection of Cloud services based on existing knowledge. We also constructed a first version of the Cloud Requirement Framework (CRF) and assured that during this phase the results were revised against the requirements until a satisfactory design was achieved. We then conducted three iterations of a relevance cycle to evaluate our framework and gather information about adoption requirements.

In the first iteration we discussed these requirements and the first draft of our framework in two separate workshops with four and three experts (see Table 1). As a result of the workshops we developed a four level hierarchy to illustrate targets, requirements, evaluation criteria and measurable indicators (see Figure 1). The first level (targets) is necessary to capture the intension and objective of the customer regarding the Cloud adoption. The second level (abstract requirement) was defined to limit and aggregate the indicators to a manageable level. The third level (evaluation criteria) was defined to cover aspects ("soft criteria") which cannot be measured and compared easily. The fourth level (key performance indicators, KPI) is defined to realize an assessment and controlling basis, e.g. relevant for a Cloud benchmarking. By means of the experts and the literature review we derived the relevant target dimensions for Cloud Computing and defined two types of scope of the requirements (provider requirement and service requirement).

(Expert from) Company type	Company data	Position within company	Cloud experience
IT service provider	170.000 employees Global IT service offerings 10-15% revenue based on Cloud Computing Innovative solutions in IaaS	Senior Vice President of Cloud Business (W2)	Deep understanding of Cloud Computing (IaaS, PaaS and SaaS)
IT service provider	SME software company 20 employees Development of standardized components for web-based services	CIO (W1), Software architect (W1)	Expert know-how in IaaS and PaaS
IT service provider	Start up company in the field of SaaS 32 employees Developing of digital record and human resources solutions	CEO (W1)	Expert know-how in developing, maintenance and distribution of SaaS.
IT service provider	Start up company offering SaaS solution for newsletter delivery	CEO (W2), CIO (W2)	SaaS and IaaS expertise
Consulting company	International consulting company 500 consultants worldwide Cloud Computing as one consultancy topic	Partner	Current consulting focus; Cloud market appreciation
Customer / Client	Automotive sector ca. 95.000 employees	Divisional director IT	Experience in selecting, implementing and operating IaaS and SaaS
Customer / Client	SME software company 11 employees Development of standardized components for web-based services	Software architect (W2)	Expert knowledge in IaaS and PaaS especially in the implementation

W1 = Participant at workshop 1 W2 = Participant at workshop 2

Table 1. Type of experts interviewed

The second iteration was a market analysis regarding all three service models (SaaS, PaaS, IaaS) where provider and service aspects were gathered and mapped to the prior defined hierarchy. This analysis was based on an extensive internet research where the websites of relevant companies were examined regarding their pricing model, Cloud service offering, company data and customer segment. By means of market studies, business publications on the Cloud market and an extensive internet search we detected over 60 relevant providers for IaaS, 82 relevant providers for PaaS and over 1000 providers for SaaS, mostly located in the US. Due to essential differences on each service level we decided to draw a distinction between requirements specific to one or two service models and requirements valid for all three service models (independent of service model) (Weinhardt et al., 2009).

The third iteration and final evaluation consists of expert interviews to evaluate the developed framework including the structure, the mapped requirements and evaluation criteria. In total nine experts were selected from seven companies, all holding different positions within their companies (see Table 1). Care was taken that those respondents were representing complementary perspectives (provider, customer, integrator, and consultant). The interviews with the experts were structured and conducted referring to Glaeser and Laudel (2010). The final result of our research is the evaluated framework presented in section 4.

4 Cloud Requirement Framework (CRF)

4.1 Structure of the Cloud Requirement Framework

The framework consists of two parts, the Cloud Computing target dimensions and the Cloud requirements (see Figure 1). The target dimensions - such as cost savings or increasing flexibility – represent objectives which the customer pursues and may characterize its IT strategy or especially the related Cloud strategy. These dimensions cover the Cloud Computing in its entirety and are not limited to one service model (SaaS, PaaS, IaaS).

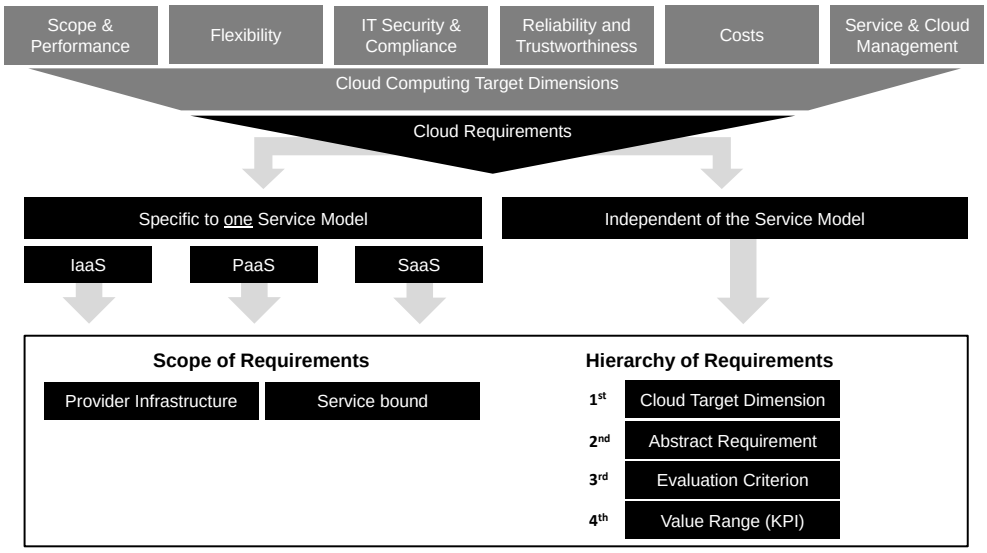

Figure 1. Scheme of the Cloud Requirement Framework (CRF)

The target dimension ”Scope & Performance” cover the functionality and performance of the Cloud service and consists of four abstract requirements: service characteristics, service optimizing, hardware, and performance. The dimension “Flexibility” describes the ability to respond quickly to changing capacity requirements and competition pressure. It is divided into four abstract requirements: interoperability, portability, delivery model, and automatization degree. The target dimension “IT

Security & Compliance" summarizes everything related to protection and safety and is composed of four abstract requirements: datacenter protection, network protection, operations protection and IT compliance. The target dimension "Reliability & Trustworthiness" describes how certain the customer can be that the service from the Cloud has the guaranteed availability. It is divided in three abstract requirements: reliability, trustworthiness and service level agreements. Especially the "IT Security & Compliance" (83%) and "Reliability and Trustworthiness" (53%) dimensions were rated as very important (Repschlaeger et al., 2012). The target dimension "Costs" is characterized through monetary aspects like small capital commitment or low acquisition costs and consists of three abstract requirements: pricing model, payment and service charging. The last target dimension "Service & Cloud Management" includes aspects necessary for the Cloud management and the maintenance of the relationship between customer and provider. IT can be differentiated according to three abstract requirements: provider management, service management and transformation management.

Next, these dimensions can be broken down into Cloud requirements that are comparable. The Cloud requirements are structured in a four level hierarchy. First abstract requirements (second level) are defined and mapped to the target dimensions (top level). On the third level evaluation criteria are described that are comparable but not necessarily measurable. The 4th level finally defines the value range and measurable indicators. The abstract requirements and evaluation criteria of the framework are illustrated in Figure 2. Regarding to our research most of the requirements of the dimensions Costs, Reliability & Trustworthiness, IT Security & Compliance and Service & Cloud Management are independent of the service model. The target dimensions Flexibility and Scope & Performance consist mostly of abstract requirements and evaluation criteria specific to a service model. Furthermore, we divided the scope of the requirements into criteria associated with the provider or related directly to the Cloud service in particular (see Figure 2). Provider requirements describe the characteristics of the underlying infrastructure of a Cloud provider, for instance this can be supplier certifications, IT infrastructure features or data center locations. Service requirements, however, describe the service usage, the prices, the scalability or the number of interfaces.

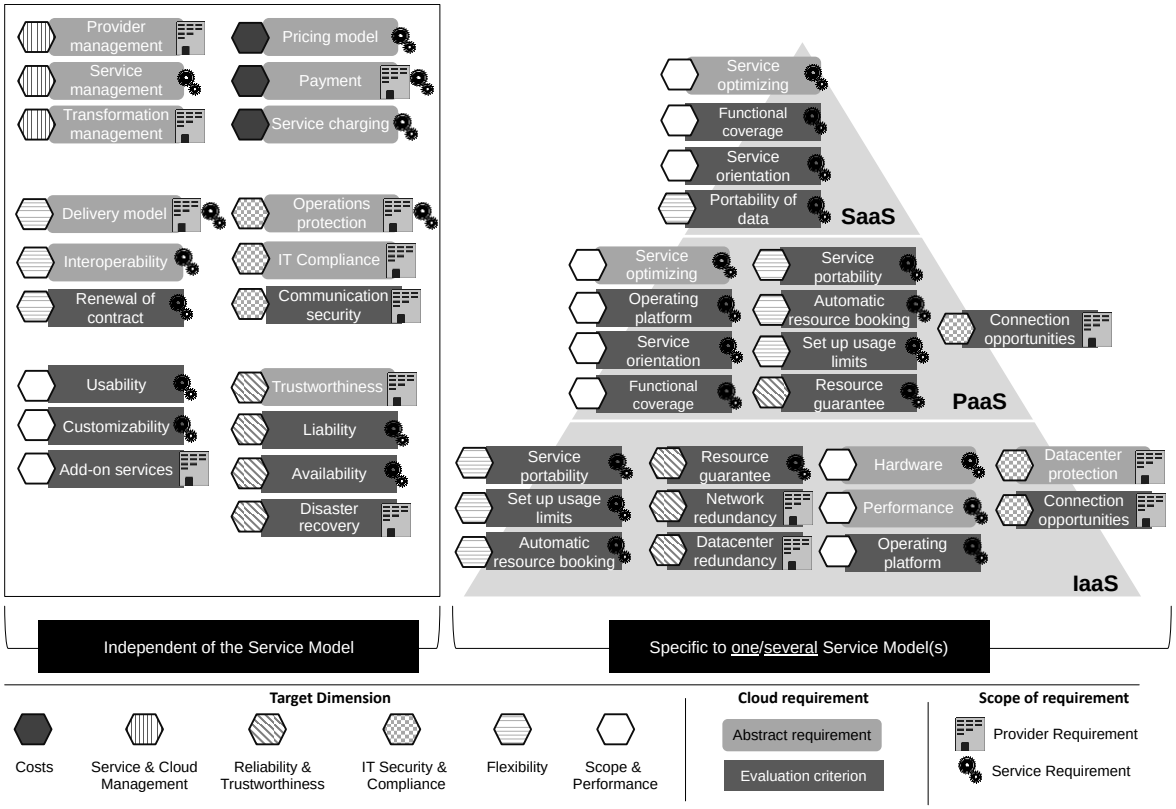

Figure 2: Abstract requirements and evaluation criteria of the Cloud Requirement Framework

In summary, the framework consists of six target dimensions (top level), 21 abstract requirements (second level), 62 evaluation criteria (third level) and a value range (including if possible one KPI) for each evaluation criteria (see appendix for all evaluation criteria). In Figure 2 we focused on illustrating the Cloud requirements regarding their relevance for the three service models IaaS, PaaS and SaaS. For this reason the KPIs and some criteria were not shown and only mentioned in the next sections 4.2 and 4.3.

4.2 Overall requirements of the Cloud Computing framework

The following abstract requirements and evaluation criteria are independent from the specific Cloud service model (SaaS, PaaS, IaaS) and cover all target dimensions.

Service & Cloud management

Provider management contains support and contact information of the provider. This criterion considers all facts regarding support and customer service, e.g. which support is offered and under which conditions. Furthermore it contains information about the internationality, e.g. multilingual support, several offices or local contact options. *Service management* includes all activities necessary to control and manage the obtained Cloud services which are subsumed in this criterion, e.g. monitoring of services and volume control via APIs. *Transformation management* describes consulting and migration support for Cloud implementation projects.

Costs

Payment and pricing models are shaped by monetary considerations regarding the decision to choose Cloud Computing and a particular provider. The payment opportunities include the possible payment method (e.g. credit card or bank transfer), the time of payment (pre-paid or post-paid) and which level of granularity is priced (e.g. 1 MB, 100 MB or 1 GB steps). *Service charging* defines how the service is charged (volume based, time based, account based) and the available booking concept, e.g. pay per use, subscription fee, market based prices (spot pricing).

IT Security & Compliance

IT compliance is separated into provider requirements for privacy (e.g. encryption of data) and compliance (e.g. location of data center). Even standards, identity management and other data privacy requirements are considered. *Communication security* refers to the provided infrastructure and focuses on the communication protection via secure cryptographic protocols (e.g. SSL) and dedicated firewall settings. *Operations protection* includes the access management and role concept related to the used services. Furthermore, it can provide a multi-tenancy and firewall protected infrastructure, including virus protection systems.

Reliability & Trustworthiness

Trustworthiness characterizes the provider, its infrastructure and its business activities, including performance and service transparency (e.g. reports, service description), market experience, the number of customers or the annual revenue. *Disaster recovery* describes activities related to regularly backups, snapshots and data mirroring in other locations. *Availability and liability* include the probability that service commitments and promises can be met by the provider, based on indicators like the service availability, accessibility to several internet service providers and the liability agreements including penalties if the guaranteed service level is not met.

Flexibility

Provisioning and set-up time are subsumed under the associated flexibility advantage of Cloud Computing. Resources, for instance, can be allocated and de-allocated as required. The provisioning time is shorter compared to traditional outsourcing and the set-up time to get in contact with the provider (e.g. register or set up a new account) is shorter as well. *Interoperability and scalability* comprise all features regarding the maximal number of available resources (e.g. user accounts,

instances, functions, services) which can be used simultaneously. Additionally the interoperability describes the integration degree separated into internal communication (between services of the provider) and external communication (between services of different providers). The browser compatibility is important especially on the SaaS level, whereas the development environment (e.g. supported programming languages) is of high relevance on the PaaS level. *Contract flexibility and renewal of contract* both represent the commitment between the customer and the provider (e.g. contract length) and defined contract automatisms (e.g. cancelation period).

Scope & Performance

Usability and customizability refer to the usability and adaptability of the surface of the web portal, the user interacts with. The Usability mainly represents the structure and the ease of use following the self-service concept. Regarding individual preferences predefined templates, editable user views and function settings can be configured by the user. *Add-on services* describe additionally bookable services like storage, database services, communication services (e.g. collaboration, messaging) or security services.

4.3 Specific requirements of the Cloud Computing framework

The following abstract requirements and evaluation criteria are specific to one or maximal two Cloud service models. The specific requirements cover only four dimensions and are not relevant for the dimensions “Service & Cloud Management” and “Costs”.

IT Security & Compliance

Datacenter protection contains the provided security regarding to the data center and is independent from the Cloud services the customer uses. It includes building protection (surveillance by guards or electronic devices), fire safety and physical access control. *Connection opportunities* focus on dedicated connections to realize separate private Cloud areas, e.g. Virtual Private Networks (VPN).

Reliability & Trustworthiness

Network and datacenter redundancy both describe the probability that service commitments and promises can be met by the provider based on the use of redundant internet service providers and locally independent data centers used as backup solutions. In order to achieve a trusted relationship, the provider gives the customer guarantees for necessary resources (resource reservation). These *resource guarantees* are influenced by the internal IT infrastructure, external partners, suppliers and the amount of users.

Flexibility

Service and data portability contain the aspects relevant for the service and data mobility. This includes the provider support related to the data migration, the data backup and the data format. The portability of data is especially of high relevance on the SaaS level and can help to lower the lock–in-effect of the provider. The service portability means the possibility to migrate existing services to another platform (IaaS or PaaS), e.g. proprietary virtual images (AMI) of Amazon are transferable to a Microsoft Azure platform. *Automatic resource booking and usage limits* characterize the capability to control and manage Cloud services without the need of manual interaction. The user is able to configure the settings like maximum budget or latency in advance. These presets will be considered during the operation and automatically be executed by the system, e.g. boot up a virtual instance, installing regularly updates or increase necessary transfer volume.

Scope & Performance

Service optimizing deals with continuous service development, improvement of service functions and maintenance cycles. The *operating platform* relevant for the IaaS and PaaS level describes the operating system and the development environment. Whereas the *performance & hardware* requirements, associated with the IaaS level, contain information about the processor type (32 or 64

bit), the hardware based functionalities (sleep mode), the server type (dedicated or virtual server) and the performance aspects (CPU, RAM or storage). *Functional coverage & scaling* is directly related to the service usage and cover the offered functionalities for PaaS or SaaS.

5 Implications, limitations and future work

In this paper we presented a Cloud Requirement Framework which helps companies to adopt Cloud services and to provide a better assessment foundation. It might provide a first step through a Cloud benchmarking. Our previous research on Cloud target dimensions and selection frameworks was limited to only one Cloud service model (IaaS, PaaS or SaaS). In this article we now have combined the different levels to one Cloud Computing requirement framework and have removed these limitations.

Implications for science and business practice: The presented framework has an impact on most of the research fields of Cloud Computing we described in section two. With its requirements covering all three Cloud service models, this framework can be seen as a contribution to achieve more transparency to the Cloud Computing market. Likewise, companies can orientate and align their approaches to define a Cloud strategy by means of this framework. The provided dimensions can be used to derive an individual Cloud strategy convenient for a Cloud ecosystem. Furthermore, providers can exploit the evaluation criteria to enhance their business portfolios and focus on the right aspects of Cloud services. On the other hand customers will be guided by means of this framework to adopt and implement Cloud solutions, especially for selection and comparing providers or to advance the comprehension of Cloud Computing. The consequence is a shift from a subjective service assessment to a mostly fact-based performance selection where the realization of service requirements is gaining importance. In this context Cloud integrators and aggregators are becoming more relevant to advice customers and to realize a Cloud ecosystem which allows the combination and communication between several Clouds and services of different providers.

A limitation of the presented framework is the lack of prioritization of the Cloud requirements and evaluation criteria. In this article we do not provide an adoption approach how the framework exactly can be used. The customer has to decide individually in which way he wants to use this framework, dependent on its purpose. This can be quite different based on the possible use cases (e.g. provider portfolio design, customer Cloud service selection process, provider benchmarking) of this framework.

In our future research a next step will be the implementation of the framework within a practical case. This may help to gain broad range experience regarding long-term usage and to improve the framework step by step. Furthermore we are planning to conduct several case studies with Cloud customers to evaluate and prioritize the framework and its requirements. The framework will be applied to different IS strategies both at providers' and customers' side to derive associated Cloud strategies and recommendations for the adoption and the portfolio management. Another future research field is the Cloud management. This includes the controlling of the relationship between provider and customer in the Cloud ecosystem and the measurement of respective Cloud services. Until now, only first attempts exist to benchmark Cloud solutions and to capture the efficiency gains and cost savings. Thus, future research will be directed to extend and to evaluate our existing measurable KPIs of the Cloud Requirement Framework and to examine how a feasible Cloud controlling can be realized. Additionally, a few large Cloud projects have been implemented within the last year and will hopefully provide good practices and relevant insights on some of the research fields mentioned in section 2 and offer the possibility to evaluate the framework in a practical case.

References

Anandasivam, A. and Premm, M. (2009), Bid price control and dynamic pricing in clouds. ECIS 2009 Proceedings.

Anandasivam, A. and Weinhardt, C. (2010), Towards an efficient decision policy for cloud service providers. ICIS 2010 Proceedings.
Armbrust, M., Fox, A., Griffith, R., Joseph, A.D., Katz, R.H., Konwinski, A., Lee, G., Patterson, D.A., Rabkin, A., Stoica, I., and Zaharia, M. (2009), Above the clouds: A berkeley view of cloud computing. UC Berkeley Reliable Adaptive Distributed Systems Laboratory.
Benlian, A., Hess, T., and Buxmann, P. (2009), Drivers of SaaS-adoption – An empirical study of Different Application Types. Business & Information Systems Engineering: Vol. 1: Iss. 5, 357-369.
Benlian, A., Koufaris, M., and Hess, T. (2010), The Role of SaaS Service Quality for Continued SaaS Use: Empirical Insights from SaaS Using Firms. ICIS 2010 Proceedings.
Briscoe, G., and A. Marinos. "Digital Ecosystems in the Clouds: Towards Community Cloud Computing." Digital Ecosystems and Technologies Conference. IEEE Press, 2009.
Catteddu, D. and Hogben, G. (2009), Cloud Computing - Benefits, risks and recommendations for information security. European Network and Information Security Agency (ENISA).
Chan, Y.E., Huff, S.L., Copeland, D.G., and Barclay, D.W. (1997), Business Strategic Orientation, Information Systems Strategic Orientation and Strategic Alignment. Information Systems Research (8:2), pp.125-150.
Clemons, E.K. and Chen, Y. (2011), Making the Decision to Contract for Cloud Services: Managing the Risk of an Extreme Form of IT Outsourcing. Proceedings of the 44th Hawaii International Conference on System Sciences.
Forrester (2009), TechRadar For Infrastructure & Operations Professionals: Cloud Computing. Forrester, Q3.
Glaeser, J. and Laudel, G. (2010), Experteninterviews und qualitative Inhaltsanalyse: als Instrumente rekonstruierender Untersuchungen. Vs Verlag; 4. Auflage.
Grance, T., & Mell, P. (2009). The NIST definition of Cloud Computing. National Institute of Standards and Technology (NIST).
Gregor, S. and Jones, D. (2007). The anatomy of a design theory. Journal of the Association of Information Systems, 8 (5), 312-335.
Hedwig, M., Malkowski, S., and Neumann, D. (2010), Towards Autonomic Cost-Aware Allocation of Cloud Resources. ICIS 2010 Proceedings.
Hevner, A.R. (2007). A Three Cycle View of Design Science Research. Scandinavian Journal of IS, 19 (2), 87-92.
Hevner, A.R., March, S.T., Park, J. and Ram, S. (2004). Design Science in Information Systems Research. MIS Quarterly, 28 (1), 75-105.
Hoefer, C.N. and Karagiannis, G. (2010), Taxonomy of cloud computing services. IEEE Globecom 2010 Workshop on Enabling the Future Service-Oriented Internet.
Iyer, B., and Henderson, J.C. (2010), Preparing for the future: Understanding the seven capabilities of Cloud Computing. MIS Quarterly Executive Vol. 9, No. 2.
Janssen, M. and Joha, A. (2011), Challenges for adopting Cloud-Based Software as a Service (SaaS) in the Public Sector. ECIS 2011 Proceedings.
Kaisler, S. (2011), Service Migration in a Cloud Architecture. Proceedings of the 44th Hawaii International Conference on System Sciences.
Koehler, P., Anandasivam, A., and Dan, M.A. (2010a), Cloud Services from a Consumer Perspective. AMCIS 2010 Proceedings.
Koehler, P., Anandasivam, A., Dan, M.A. and Weinhardt, C. (2010b), Customer Heterogeneity and Tariff Biases in Cloud Computing. ICIS 2010 Proceedings.
Leavitt, N. (2009) Is Cloud Computing Really Ready for Prime Time? Computer , vol.42, no.1, pp.15-20.
Leimeister, S., Boehm, M., Riedl, C., and Krcmar, H. (2010), The Business Perspective of Cloud Computing: Actors, Roles and Value Networks. ECIS 2010.
Luoma, E. and Nyberg, T. (2011), Four Scenarios for Adoption of Cloud Computing in China. ECIS 2011 Proceedings.
March, S.T. and Smith, G.F. (1995). Design and natural science research on information technology. Decision Support Systems, 15 (4), 251-266.

March, S.T. and Storey, V.C. (2008). Design Science in the Information Systems Discipline: An Introduction to the Special Issue on Design Science Research. MIS Quarterly, 32 (4), 725-730.
Marston, S.R., Li, Z., Bandyopadhyay, S., Ghalsasi, A. and Zhang, J. (2011), Cloud Computing: The Business Perspective. Proceedings of the 44th Hawaii International Conference on System Sciences – 2011.
Martens, B. and Teuteberg, F. (2011), Risk and Compliance Management for Cloud Computing Services: Designing a Reference Model. AMCIS 2011 Proceedings.
Martens, B., Poeppelbuss, J., and Teuteberg, F. (2011a), Understanding the Cloud Computing Ecosystem: Results from a Quantitative Content Analysis. Wirtschaftinformatik Proceedings 2011.
Martens, B., Teuteberg, F., and Graeuler, M. (2011b), Design and Implementation of a Community Platform for the Evaluation and Selection of Cloud Computing Services: A Market Analysis. ECIS 2011 Proceedings.
Mueller, G., Sonehara, N., Echizen, I. and Wohlgemuth, S. (2011), Sustainable Cloud Computing. Business & Information Systems Engineering (BISE) 5/2011.
Nunamaker, J.F., Chen, M. and Purdin, T.D.M. (1990). Systems Development in Information Systems Research. Journal of Management Information Systems, 7 (30), 89-106.
Nuseibeh, H. (2011), Adoption of Cloud Computing in Organizations. AMCIS 2011 Proceedings.
Ortiz, S. Jr. (2011), The Problem with Cloud-Computing Standardization. Computer, vol. 44, no. 7, pp. 13-16, 2011.
Pavlou, P.A. and El Sawy, O.A. (2006), From IT leveraging competence to competitive advantage in turbulent environments: The case of new product development. Information Systems Research, 17 (3), 198-227.
Pueschel, T. and Neumann, D. (2010), Mitigating the Effects of Partial Resource Failures for Cloud Providers. AMCIS 2010 Proceedings.
Repschlaeger, J. and Zarnekow, R. (2011), Umfrage zur Anbieterauswahl und Markttransparenz in der Cloud. Survey from the technical university Berlin within the IT Operations Day.
Repschlaeger, J., Wind, S., Zarnekow, R. and Turowski, K. (2012), A Reference Guide to Cloud Computing Dimensions: Infrastructure as a Service Classification Framework. Proceedings of the 45th Hawaii International Conference on System Sciences (HICSS). USA, Maui-Hawaii.
Sarkar, P. and Young, L. (2011), Sailing in the Cloud: A Case Study of Perceptions and Changing Roles in an Australian University. ECIS 2011 Proceedings.
Shimba, F. (2010), Cloud Computing: Strategies for Cloud Adoption. Dissertation, Dublin Institute of Technology.
Son, I., and Lee, D. (2011), Assessing A New IT Service Model, Cloud Computing. PACIS 2011 Proceedings.
Teece, D.J., Pisano, G. and Shuen, A. (1997), Dynamic capabilities and strategic management. Strategic Management Journal, 18 (7), 509-533.
Truong, D. (2010), How Cloud computing Enhances Competitive Advantages: A Research Model for Small Businesses. The Business Review, Cambridge, 15(1),59-65.
Van Aken, J.E. (2004). Management Research Based on the Paradigm of the Design Sciences: The Quest for Field-Tested and Grounded Technological Rules. Journal of Management Studies, 41 (2), 219-246.
Vom Brocke, J., Simons, A., Niehaves, B., Riemer, K., Plattfaut, R. and Cleven, A. (2009). Reconstructing the Giant: On the Importance of Rigour in Documenting the Literature Search Process, In Proceedings of the 17th European Conference on Information Systems (ECIS 2009), Verona, Italy.
Vaquero, LM., L. Rodero-Merino, J. Caceres, and M. Lindner. "A Break in the Clouds: Towards a Cloud Definition." ACM SIGCOMM Computer Communication Review 39, no. 1 (2009): 50-55.
Walls, J.G., Widmeyer, G.R. and Sawy, O.A.E. (1992). Building an Infomiarion System Design Theory for Vigilant EIS. Information Systems Research, 3 (1), 36-59.
Webster J. and Watson, R.T. (2002), Analyzing the past to prepare for the future: Writing a literature review. MIS Quarterly, 26(2):13–2.

Weinhardt, C., Anandasivam, A., Blau, B., Borissov, N., Meinl, T., Michalk, W., and Stoesser, J. (2009), Cloud Computing – A Classification, Business Models and Research Directions. Business & Information Systems Engineering: Vol. 1: Iss. 5, 391-399.

Wind, S., Repschlaeger, J., Turowski, K., and Zarnekow, R. (2011), Target Dimensions of Cloud Computing. International Workshop on Clouds for Enterprises (C4E) 2011 held at the 13th IEEE Conference on Commerce and Enterprise Computing.

Yang, H. and Tate, M. (2009), Where are we at with Cloud Computing?: A Descriptive Literature Review. ACIS 2009 Proceedings.

Appendix – Cloud Requirements and Evaluation Criteria

Hirarchy of Requirements			Scope		Service Model		
Target Dimension	Abstract Requirement	Evaluation criteria	Provider	Service	IaaS	PaaS	SaaS
Flexibility							
	Interoperability						
		interfaces			x	x	x
		internal integration degree			x	x	x
		compatibility			x	x	x
		transparency and documentation			x	x	x
	Portability						
		portability of data					x
		Service portability			x	x	
	Delivery Model / Service Dynamics						
		Set-up time			x	x	x
		provisioning time			x	x	x
		scalability			x	x	x
		contract flexibility			x	x	x
	Automatization Degree						
		renewal of contract			x	x	x
		set up usage limits			x	x	
		automatic Resource booking			x	x	
Costs							
	Pricing Model						
		price transparency			x	x	x
		price granularity			x	x	x
		price resiliance			x	x	x
	Payment						
		time of payment			x	x	x
		payment method			x	x	x
	Service Charging						
		volume based costs			x	x	x
		account based costs			x	x	x
		booking concept			x	x	x
		time based costs			x	x	x
Scope & Performance							
	service characeteristics						
		functional coverage				x	x
		usability			x	x	x
		service orientation (service bundles)				x	x
		customizability			x	x	x
		operating platform			x	x	
		add-on services			x	x	x
	service optimzing						
		maintenance/service cycles				x	x
		innovation of Cloud technology			x	x	x
		customer integration			x	x	x
	hardware						
		server type			x		
		processor type			x		
		hardware features			x		
		network access			x		
	performance						
		computing quality			x		
		connection quality			x		
		instance capacity			x		
IT Security & Compliance							
	data center protection						
		building safety (inside)			x		
		building safety (outside)			x		
	network protection						
		connection opportunities			x	x	
		communication security			x	x	x
	operations protection						
		application access			x	x	x
		application protection			x	x	x
	IT compliance						
		data center location			x	x	x
		data protection			x	x	x
Reliability & Trustworthiness							
	Service Level Agreements						
		Availablity			x	x	x
		Liablity			x	x	x
		Resource guarantee			x	x	
	Reliability						
		network redundancy			x		
		data center redundancy			x		
		disaster recovery management			x	x	x
	Trustworthiness						
		provider profile			x	x	x
		Reporting			x	x	x
		Auditing			x	x	x
Service & Cloud Management							
	provider management						
		support			x	x	x
		contact			x	x	x
		internationality			x	x	x
	service management						
		monitoring			x	x	x
		operation			x	x	x
	transformation management						
		consulting			x	x	x
		migration			x	x	x

Provider criterion Service criterion x Relevant for service model