

THE BUSINESS PERSPECTIVE OF CLOUD COMPUTING: ACTORS, ROLES, AND VALUE NETWORKS

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Abstract

With the rise of a ubiquitous provision of computing resources over the past years, cloud computing has been established as a prominent research topic. Many researchers, however, focus exclusively on the technical aspects of cloud computing, thereby neglecting the business opportunities and potentials cloud computing can offer. Enabled through this technology, new market players and business value networks arise and break up the traditional value chain of service provision. The focus of this paper lies on the business aspects of cloud computing. Besides elaborating on a comprehensive definition of cloud computing its main contribution is a conceptual compilation of cloud actors and their roles within a new cloud computing value network and a conceptual development of a generic value network of different actors in cloud computing. Extending the prevailing technical perspective of cloud computing, this paper shifts the focus from an exclusive technological perspective to a broader understanding of business opportunities and business value.

Keywords: Cloud computing, software as a service, value network, modelling, business model, e³ value methodology

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1 INTRODUCTION: THE RISE OF A NEW PHENOMENON

With the rise of a ubiquitous provision of computing resources over the past years, cloud computing has been established as a prominent research topic. Some authors even refer to cloud computing as a new paradigm and emerging technology that flexibly offers IT resources and services over the Internet (Fenn et al. 2008).

Cloud computing can be seen as an innovation in different ways. From a technological perspective it is an advancement of computing history that evolved from large tabulating machines and mainframe architectures that centrally offered calculating resources via distributed and decentralized client-server architectures to personal computers, and eventually to ubiquitous, small personal (handheld) devices (Freiberger and Swaine 2000).

While much research is dedicated to the technical aspects of cloud computing, many authors neglect the IT provisioning, i.e., the business perspective of cloud computing. In this regard cloud computing has the potential to revolutionize the mode of computing resource and application deployment, breaking up traditional value chains and making room for new business models. Many providers like Amazon, Google, IBM, Microsoft, Salesforce, or Sun positioned themselves as platform and infrastructure providers in the cloud computing market. Beside them there emerge more and more providers, who build their own applications or consulting services upon infrastructure services offered by other market players.

In addition to hardly considering the business potential of the new technology of cloud computing, the concept remains somewhat unclear and vague to many. With this contribution we aim to provide an understanding of the business aspects of cloud computing, thereby conceptually focusing on different actors in the value network that provide new computing resources. Starting with a literature review on current definitions of cloud computing we will summarize the core characteristics and suggest a comprehensive definition. We will further examine the evolution from outsourcing to cloud computing as a new IT deployment paradigm. Hereby the paper highlights the effects on the outsourcing value chain, summarizes market actors and their roles within a new cloud computing value network, and finally develops a generic value network of different actors in the cloud computing arena.

2 DEFINITION AND BUILDING BLOCKS OF CLOUD COMPUTING

Due to the current fashion, the term cloud computing is often used for advertising purposes to revamp existing offerings with a new wrap. Larry Ellison's (CEO of Oracle) statement at 2007s Analysts' Conference provides a felicitous example: *"We've redefined cloud computing to include everything that we already do. I can't think of anything that isn't cloud computing [...]. The computer industry is the only industry that is more fashion-driven than women's fashion"* (Fowler and Worthen 2009).

2.1 Related work

To date there are few scientific contributions which strive to develop an accurate definition of the cloud computing phenomenon. Youseff et al. were among the first who tried to provide a comprehensive understanding of cloud computing and all its relevant components. They regard cloud computing as a *"collection of many old and few new concepts in several research fields like Service-Oriented Architectures (SOA), distributed and grid computing as well as Virtualization"* (Youseff et al. 2008). According to Youseff et al. *"cloud computing can be considered a new computing paradigm that allows users to temporary utilize computing infrastructure over the network, supplied as a service by the cloud-provider at possibly one or more levels of abstraction"* (Youseff et al. 2008). When

speaking about levels of abstraction, the authors refer to their proposed cloud computing ontology which will be described in the subsequent sections.

According to Armbrust et al. “*Cloud Computing refers to both the applications delivered as services over the Internet and the hardware and systems software in the datacenters that provide those services. The services themselves have long been referred to as Software as a Service (SaaS). The datacenter hardware and software is what we will call a Cloud. When a Cloud is made available in a pay-as-you-go manner to the general public, we call it a Public Cloud; the service being sold is Utility Computing. We use the term Private Cloud to refer to internal datacenters of a business or other organization, not made available to the general public. Thus, Cloud Computing is the sum of SaaS and Utility Computing, but does not include Private Clouds*” (Armbrust et al. 2009). In this way the authors as well understand cloud computing as a collective term, covering preexisting computing concepts such as SaaS and utility computing. Armbrust et al. especially perceive the following aspects as new: (1) the illusion of infinite computing capacity available on demand, (2) the elimination of up-front commitment to resources on the side of the cloud user, and (3) the usage-bound pricing for computing resources on a short-term basis (Armbrust et al. 2009).

Being grid computing scholars, Buyya et al. postulate a more technical focused approach, regarding cloud computing as a kind of parallel and distributed system, consisting of a collection of virtualized computers. This system provides resources dynamically, whereas Service Level Agreements (SLA) are negotiated between the service provider and the customer (Buyya et al. 2008).

In an attempt to provide a generally accepted definition, Vaquero et al. have derived similarities, based on Geelan’s collection of expert opinions (Geelan 2009). They claim that “clouds are a large pool of easily usable and accessible virtualized resources (such as hardware, development platforms and/or services). These resources can be dynamically reconfigured to adjust to a variable load (scale), allowing also for an optimum resource utilization. This pool of resources is typically exploited by a pay-per-use model in which guarantees are offered by the Infrastructure Provider by means of customized SLAs” (Vaquero et al. 2009). The majority of definitions however originate from cloud computing service providers, consulting firms and market research companies such as IDC (Gens 2008) or Gartner (Plummer et al. 2008).

| Author | Service | Hardware | Software | Data | (Development) Platform | Pay-Per-Use | off-premise (public) | Scalability | No Upfront Commitment | Virtualization | SLA | Deterministic Performance | Internet/network | Automation |
|----------------------|---------|----------|----------|------|------------------------|-------------|----------------------|-------------|-----------------------|----------------|-----|---------------------------|------------------|------------|
| Armbrust et al. [1] | x | x | x | | | x | x | x | x | | | | x | |
| Breiter/Behrendt [2] | x | x | | | | x | | x | | x | | | | x |
| Briscoe/Marinos [3] | x | x | x | | | | | x | | x | | | x | |
| Buyya [4] | | x | | | | | | x | | x | x | | | |
| Foster et al. [5] | x | x | x | | x | | | x | | x | | | x | |
| Gartner [6] | x | x | x | | | | | x | | | | | x | |
| Grossman/Gu [7] | x | x | | x | | | | x | | | | | x | |
| Gruman/Knorr [8] | x | x | x | | x | | | | | | | | x | |
| IDC [9] | x | x | | | | x | | x | | | | | x | |
| Kim [10] | x | x | x | x | | x | | x | x | | | | x | |
| McFredries [11] | x | x | x | x | | | | | | x | | | | |

| | | | | | | | | | | | | | | |
|----------------------|-----------|-----------|-----------|----------|----------|----------|----------|-----------|----------|----------|----------|----------|----------|----------|
| Nurmi et al. [12] | x | x | x | | | | | x | | | | x | | |
| Vaquero et al. [13] | x | x | | | x | x | | x | | x | x | | | |
| Vykoukal et al. [14] | x | x | | | | x | | x | | | | | x | |
| Wang et al. [15] | x | x | x | x | | | | | | | | | | |
| Weiss [16] | x | x | x | | | | | x | | | | | | |
| Youseff et al. [17] | x | x | | | x | x | | x | | x | x | | | |
| Nominations | 16 | 17 | 10 | 4 | 4 | 7 | 1 | 14 | 2 | 7 | 3 | 1 | 9 | 1 |

Table 1. A comparison of various cloud computing definitions

2.2 Definition of cloud computing

Table 1 summarizes key characteristics of cloud computing as they are understood by the respective authors. The list of definitions was compiled in May 2009 based on database queries and web searches. It is restricted to scientific contributions and statements of selected market research companies. The largest consent among the authors is spanning around the features service, hardware, software, scalability and internet/network. Furthermore, usage-bound payment models and virtualization are frequently mentioned as well. The latter, however, is considered a fundamental prerequisite (Armbrust et al. 2009) and is thus not explicitly mentioned by many authors.

Based on our literature review and our perception of cloud computing, we provide a definition that regards the concept holistically, from both the application and infrastructure perspective. Hereby we focus on the deployment of computing resources and applications, rather than on a technical description. Furthermore our definition stresses the ability of service-composition, allowing service providers to create new services by aggregating existing services, enabling customized solutions and varying distribution models. In our understanding, cloud computing is *an IT deployment model, based on virtualization, where resources, in terms of infrastructure, applications and data are deployed via the internet as a distributed service by one or several service providers. These services are scalable on demand and can be priced on a pay-per-use basis.*

2.3 Layers of cloud computing

The idea behind cloud computing is based on a set of many pre-existing and well researched concepts such as distributed and grid computing, virtualization or Software-as-a-Service (SaaS). Although, many of the concepts do not appear to be new, the real innovation of cloud computing lies in the way it provides computing services to the customer. Various business models have evolved in recent times to provide services on different levels of abstraction. These services include providing software applications, programming platforms, data storage or computing infrastructure.

Classifying cloud computing services along different layers is common practice in the industry (Kontio 2009, Reeves et al. 2009, Sun Microsystems 2009). Wang et al. for example describe three complementary services, Hardware-as-a-Service (HaaS), Software-as-a-Service (SaaS) and Data-as-a-Service (DaaS). These services together form Platform-as-a-Service (PaaS), which is offered as cloud computing (Wang et al. 2008). In an attempt to obtain a comprehensive understanding of cloud computing and its relevant components, Youseff et al. (2008) were among the first who suggested a unified ontology of cloud computing. According to their layered model (see Figure 1), cloud computing systems fall into one of the following five layers: applications, software environment, software infrastructure, software kernel, and hardware. Each layer represents a level of abstraction, hiding the user from all underlying components and thus providing simplified access to the resources or functionality, which we will shortly describe in the following.

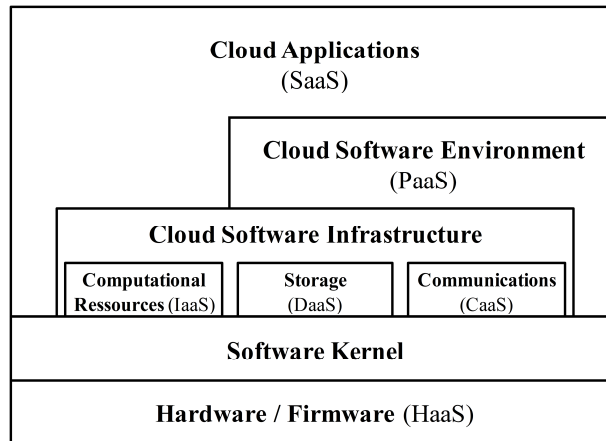


Figure 1. The layers of cloud computing (Youseff et al. 2008)

When it comes to user interaction, the *cloud application layer* is the most visible layer to the end customer. It is usually accessed through web-portals and thus builds the front-end, the user interacts with when using cloud services. A Service in the application layer may consist of a mesh of various other cloud services, but appears as a single service to the end-customer. This model of software provision is also referred to as *Software-as-a-Service (SaaS)*.

The *cloud software environment layer* (also called software platform layer) provides a programming-language environment for developers of cloud applications. The software environment also offers a set of well-defined application programming interfaces (API) to utilize cloud services and interact with other cloud applications. Thus developers benefit from features like automatic scaling and load balancing, authentication services, communication services or graphical user interface (GUI) components. However, as long as there is no common standard for cloud application development, lock-in effects arise, making the developer dependent on the proprietary software environment of the cloud platform provider. This service, provided in the software environment layer is also referred to as *Platform-as-a-Service (PaaS)*.

The *cloud software infrastructure layer* provides resources to other higher-level layers, which are utilized by cloud applications and cloud software platforms. The services offered in this layer are commonly differentiated into computational resources, data storage, and communication. Computational resources in this context are usually referred to as *Infrastructure-as-a-Service (IaaS)*. Virtual Machines are the common form of providing computational resources to users, which they can fully administrate and configure to fit their specific needs. Virtualization technologies can be seen as the enabling technology for IaaS, allowing data center providers to adjust resources on demand, thus utilizing their hardware more efficiently. The downside of the medal is the lack of a strict performance allocation on shared hardware resources. Due to this, infrastructure providers can't give strong performance guarantees which results in unsatisfactory service level agreements (SLA).

In analogy to computational resources data storage within the cloud computing model is offered as *Data-Storage-as-a-Service (DaaS)*. DaaS allows users to obtain demand-flexible storage on remote disks which they can access from everywhere. Like for other storage systems, trade-offs must be made between the partly conflicting requirements: high availability, reliability, performance, replication and data consistency, which in turn are manifested in the service providers SLAs. A fairly new idea is *Communication-as-a-Service (CaaS)*, which shall provide quality of service ensured communication capabilities such as network security, dedicated bandwidth or network monitoring. Audio and video conferencing is just one example of cloud applications that would benefit from CaaS.

The *software kernel layer* represents the software management environment for the physical servers in the datacenters. These software kernels are usually implemented as OS kernel, hypervisor, virtual

machine monitor or clustering middleware. Typically this layer is also the level where grid computing applications are deployed.

At the bottom end of the layered model of cloud computing is the *actual physical hardware*, which forms the backbone of any cloud computing service offering. Hardware can also be subleased from datacenter providers to, normally, large enterprises. This is typically offered in traditional outsourcing plans, but in an as-a-service context also referred to as *Hardware-as-a-Service (HaaS)*.

With regard to the layered model of Youseff et al. (2008), described above, cloud computing can be perceived as a collection of pre-existing technologies and components. Therefore we see cloud computing as an evolutionary development and re-conceptualization of the delivery model, rather than a disruptive technological innovation.

3 THE CHANGING IS DELIVERY MODEL: COMPARISON OF CLOUD COMPUTING AND OUTSOURCING

The provision of IT resources in enterprises is closely linked with the general consideration whether information and communication technology should be kept in the enterprise or be sourced from external providers – a question that is established in business administration research as “make or buy” decision or vertical design (Behme 1995, Dillmann 1996). In recent years, the option to outsource IT services to an external service provider has grown in importance, because of cost, quality, flexibility and competency advantages. Outsourcing has become one of the most important organizational concepts in recent decades, especially in the light of the rapid development of information technology (Matiaske and Mellewig 2002).

To understand the evolution of cloud computing, a short summary of the history of outsourcing research is helpful. This might also help to rank and evaluate cloud computing in the context of IT service provisioning, from traditional IT provisioning models towards new concepts of IT service provision such as cloud computing provisioning models.

3.1 Traditional provision of computing resources – IS outsourcing

Although outsourcing has been an established topic since decades and the core of the concept is still around the lasting question of IT provisioning, the focus of the issue has quite shifted over time. At the beginning of the outsourcing phenomenon the focus has been on the *decision between an internal or external provision of IT services* and the *subject of outsourcing* (infrastructure, applications and processes). Later, the strategic outsourcing decision of Kodak in 1989 led to a more differentiated approach, addressing the topic of *vertical design*. As a first step the motivation behind the *pro or contra outsourcing decisions* has been investigated. The central motives for outsourcing decisions are still mainly economical benefits, in particular flexibility of costs and cost savings, technological advantages, innovation, strategic aims, and business-oriented advantages, such as an increasing service quality or an increasing flexibility of the business.

Following the discussion about outsourcing motives and potential benefits and risks the question of the appropriate *scope of outsourcing* became an issue that led to the distinction between selective and total outsourcing. Within short time this has led to the discussion of which benefits and which performance advantages can be gained through an external sourcing of IT services. The question remained which *efficiency gains* could be obtained through outsourcing, compared to the internal operation of IT. These questions often remained unanswered and the efficiency of outsourcing was very difficult to prove which resulted in a backward movement towards *insourcing or backsourcing*. Despite criticism the organizational concept of outsourcing has been established and today the design parameters of a successful outsourcing project are of interest. So far the focus has mainly been the *design of the contract* between the outsourcing partners. Only recently, the awareness has developed that the contract on its own is not able to completely cover and specify the complexity of an outsourcing

project. This is especially true, because the subject-matter of the contract, “information technology”, is a very volatile, fast changing asset and therefore requires flexibility in the outsourcing relationship. Since that, new approaches to the “relationship management”, i.e., the maintenance of a good outsourcing relationship, are now seen as the key factor to a successful outsourcing project.

3.2 Evolution from outsourcing to cloud computing

The relation between cloud computing and outsourcing is best illustrated by taking current challenges of outsourcing into account: On the one hand, customers expect a cost-effective, efficient and flexible delivery of IT services from their service providers, at a maximum of monetary flexibility (i.e., pay-per-use models). At the same time, more and more customers demand innovations or the identification of a customer-specific innovation potential from their service providers (Leimeister et al. 2008). Out of these challenges and constraints posed by clients, the new phenomenon of cloud computing has emerged. Cloud computing aims to provide the technical basis to meet customer’s flexibility demands on a business level. Interestingly, new cloud computing offers to meet these business demands were first addressed by providers that have not been part of the traditional outsourcing market so far. New infrastructure providers, such as Amazon or Google, that were previously active in other markets, developed new business models to market their former by-products (e.g., large storage and computing capacity) as new products. With this move, they entered the traditional outsourcing value chain and stepped into competition with established outsourcing service providers. These new service providers offer innovative ways of IT provisioning through pay-per-use payment models and help customers to satisfy their needs for efficiency, cost reduction and flexibility. In the past the physical resources in traditional outsourcing models have been kept either by the customer or the provider. On the contrary, cloud computing heralds the paradigm of an asset-free provision of technological capacities.

4 THE BUSINESS PERSPECTIVE IN CLOUD COMPUTING

4.1 Evolution of the outsourcing value chain towards a cloud computing value network

According to Porter (1980), a value chain is described as those primary and support activities within and around an organization that together design, produce, deliver and support a product or service. The primary process directly adds value to and transforms inputs into goods or services while the support processes are those activities necessary to support or enable the primary operations. A value chain describes the interactions between different business partners to jointly develop and manufacture a product or service. Here, the manufacturing process is decomposed into its strategically relevant activities, thus determining how competitive advantages can be achieved. Competitive advantages are achieved by fulfilling the strategically important activities cheaper or better than the competition (Porter 1985). A value chain does not only contain different companies but also different business units *inside one* organization that jointly create a product. Porter (1985) argues that a firm’s value chain links to the value chain of suppliers and buyers of products and services that result in a large stream of activities called the value system). Thereby, the value of the product is enhanced with each step along the linear production process. However, the manufacturing process is seldom strictly linear. Also, it has been found that the value chain analysis is more applicable for the analysis of manufacturing and production firms rather than services (see Stabell and Fjeldstad, 1998). With regard to services, there is rather a (value) network of relationships that generates economical value and other advantages through complex dynamical exchanges between companies (Allee 2002). Especially with regard to new internet services, value networks are often understood as a network of suppliers, distributors, suppliers of commercial services and customers that are linked via the internet and other electronic media to create values for their end customers (Tapscott et al. 2000).

In traditional IT service outsourcing the value chain is usually divided into the areas infrastructure, applications and business processes, which can be complemented by strategy and consulting activities.

In each of these four value chain steps the whole cycle of IT-services, often referred to as “plan, build, run”, must be supported and implemented. Thus, single aspects of individual value chain steps may be outsourced, such as the development of applications. Purchasing and operating IT hardware as well as hosting can be further divided into services that are done by the customer himself and such that use resources of a hosting provider. Here, the myriad possibilities of combination may lead to complex outsourcing relationships.

In cloud computing the traditional value chain that can be applied for outsourcing becomes even more complex and breaks up into a myriad of different combination of actors and their interactions to depict rather a network than a sequential chain. Part of this new complexity can be found in a general trend from products to services (Jacob and Ulaga 2008). The trend does not only lead to more outsourcing, but also from the classical hardware-based outsourcing of data centers to computing as a service. A similar trend can be found in the software business, which leads away from delivering software products off the shelf towards offering software as a service. Cloud computing links these two areas of a stronger service-oriented hardware outsourcing to the “as-a-service” concept for software. Here, cloud computing shows two big facets: infrastructure-based services are now offered dynamically to the needs of customers, often referred to as utility computing, where the customer is charged according to its actual usage.

Secondly, new cloud computing platforms emerged, to integrate both hardware and software as-a-service offerings. These platforms allow creating new, single as well as composed applications and services that support complex processes and interlink multiple data sources. From a technical point of view these platforms provide programming and runtime environments to deploy cloud computing applications. Looking at these platforms from a value chain perspective, they can be perceived as some kind of market place, where various cloud computing resources from different levels (infrastructure, platform services and applications) are integrated and offered to the customer. By composing different services, complex business processes can be supported and accessed via a unified user interface.

4.2 Actors and roles in the cloud computing value network

Through the increased service orientation and the opportunities of offering services on general cloud computing platforms provided by other providers as well as the new opportunities to integrate individual component services to create value-added, complex services gave rise to a set of new roles that can be found in cloud computing.

Cloud computing services are often classified by the type of service being offered. For example, Youseff et al. distinguish between five levels with corresponding services in their ontology: applications (SaaS), cloud software environment (PaaS), cloud software infrastructure (IaaS, DaaS, CaaS), software core and finally the hardware (HaaS). In contrast to this layer model, that is quite common in the IT domain, the outsourcing market can also be seen from a more business-oriented perspective, namely from a value chain or value network perspective. Based on the analysis of providers of cloud computing services and based on the layers of the cloud computing services model we could identify the following actors in the cloud market:

The *customer* buys services through various distribution channels, for example, directly from the service provider or through a platform provider. Corresponding roles are found, for example, in Barros and Dumas (2006), Riedl et al. (2009) or Haupt (2003).

Service providers, also labeled IT vendors, develop and operate services that offer value to the customer and an aggregate services provider respectively. They develop applications that are offered and deployed on the cloud computing platform and access hardware and infrastructure of the infrastructure providers. For example, Tapscott et al. call this role “content provider” (Tapscott et al. 2000) and Haupt “manufacturer” (Haupt 2003).

Infrastructure providers supply the value network with all the computing and storage services needed to run applications within the cloud and provide the technical backbone. They offer the necessary, scalable hardware for the services (Tapscott et al. 2000) upon which the service providers offer their services. Infrastructure providers are sometimes also called IT vendors.

Aggregate services providers (aggregators) might be regarded as a specialized form of the service provider, offering new services or solutions by combining pre-existing services or parts of services to form new services and offer them to customers. Therefore, they are both a customer (from the perspective of the service provider) and a service provider (from the perspective of the customer). Barros and Dumas call that role “service broker” (Barros and Dumas 2006), Haupt calls that an “assembler” (Haupt 2003). Aggregators that focus on the integration of data rather than services are called *data integrators*. They ensure that already existing data is prepared and is usable by different cloud services and can be regarded as a sub-role of aggregators with a straightforward focus on technical data integration. A similar concept is called “system integrator” or “business process integrator” by Muylle and Basu (2008) or “service mediator” by Barros and Dumas (2006). With these terms these authors refer, in general, to aggregators that focus more on the technical aspects necessary for data and system integration while (service) aggregators in a broad sense also include the business aspects of merging services to offer new service bundles.

The *platform provider* offers an environment within which cloud applications can be deployed. He acts as a kind of catalog in which different service providers offer services. Often the services are based on the same development platform but also completely open, platform-independent development directories are possible. The platform provider offers the technical basis for the marketplace where the services are offered.

Last, the *consulting* for the customers serves as a support for the selection and implementation of relevant services to create value for their business model (Currie 2000).

5 CONCEPTUALIZING A VALUE NETWORK OF CLOUD COMPUTING

5.1 The e³-value method for modeling a generic value network

The actors described in the sections above are characterized by numerous interrelations that build up a complex network of exchanges, interactions, and value flows. Besides the elaboration of different roles, one of the main contributions of this paper is to depict the interrelations between the actors and roles to show the new value network of cloud computing. In order to depict these interrelations the e³-value methodology provides suitable modeling concepts for showing which parties exchange things of economic value with whom, and expect what in return. These concepts are based on recent economics and business science literature on e-business combined with formal ontology of systems theory (Gordijn 2002). This methodology has two main characteristics. First, it is a methodology, which recognizes the importance of economic value. Consequently, e³-value analyses the creation, exchange and consumption of economically valuable objects in a multi-actor network. Second, e³-value is founded on principles of multi-viewpoint requirements engineering and semi-formal conceptual modeling.

It involves several components such as actors, value objects (actors exchange value objects, which are services, products, money, or even consumer experiences), value ports (an actor uses a value port to show to its environment that it wants to provide or request value objects. The concept of port enables us to abstract away from the internal business processes, and to focus only on how external actors and other components of the e-business model can be ‘plugged in’), value offerings (A value offering models what an actor offers to or requests from his/her environment), value interfaces (Actors have one or more value interfaces, grouping individual value offerings. A value interfaces shows the value

object an actor is willing to exchange in return for another value object via its ports), value exchange, market segment, and composite actors to model actors and their interrelations (Gordijn 2002).

5.2 The value network of cloud computing

With the understanding of the roles and actors elaborated in section 4.2 and the methodology to depict their interrelations and value flows described in section 5.1, we can now model a comprehensive value network of cloud computing. Within this value network value is created by providing services that are valuable for other participants of the network. Infrastructure services for example are essential for all other actors within the value network, who consume this service to provide their service offering. All the actors within the value network exchange services for money, add value for other actors through service refinement and eventually provide services that fulfill the customers' needs. As it can be observed in practice, one company of course also act in more than one role. Salesforce for example is platform provider (AppExchange) and application provider (CRM) at the same time. It can also host its own infrastructure or partly source it from third party infrastructure providers. Various service providers can offer their applications on the Salesforce platform which customers can utilize in conjunction with or separately of Salesforce's CRM solution. Aggregators might combine different services to easily provide a customized solution for the customer.

It is important to notice that the value network depicted in Figure 2 does not entail all possible interrelations between the actors. We conceptually modeled only the most common or most likely value paths between the specific actors. Also in this stage of the research, we cannot weigh the importance of certain "value streams" or analyze how the value is shared among the actors.

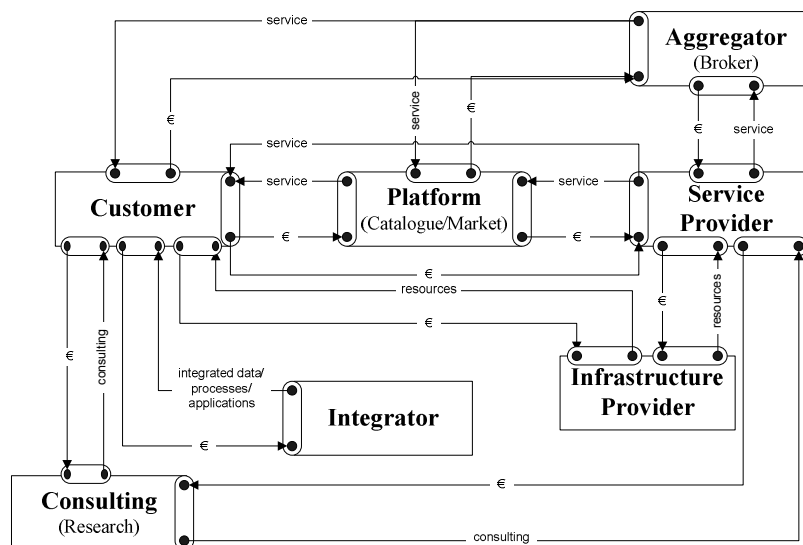


Figure 2. A generic value network of cloud computing

6 CONCLUSION AND OUTLOOK ON FURTHER RESEARCH

Considering the historic development of providing IT resources, cloud computing has been established as the most recent and most flexible delivery model of supplying information technology. It can be seen as the consequent evolution of the traditional on-premise computing spanning outsourcing stages from total to the selective, and from the multi-vendor outsourcing to an asset-free delivery. While from a technical perspective, cloud computing seems to pose manageable challenges, it rather incorporates a number of challenges on a business level, both from an operational as well as from a strategic point of view. As laid out above, cloud computing in its current stage also holds a number of contributions for both theory and practice that this article could reveal.

6.1 Contributions to research and practice

The field of cloud computing research is only just emerging. Existing research focuses particularly on the technical aspects of the provision of a cloud, particularly in the area of grid computing and virtualization. Business models and value chains have been studied only to a limited degree. In this respect, this article takes a first step by systematically bringing together the various definitions of cloud computing and combining them under one coherent definition. As a major result, this article could elaborate on the building blocks and substantial elements of the cloud computing concept, i.e., the characteristics of service, hardware, software, scalability and Internet/network. In addition, the article could contribute to a systematic description of major actors entering the cloud computing market and model their interactions by conceptually developing a value network of cloud actors.

The development of outsourcing and cloud computing towards a more flexible delivery model laid out in this paper has a strong impact not only from an academic point of view, but also particularly on practical business issues. Thereby, both the client and provider perspective of cloud computing and outsourcing services have to be taken into consideration.

6.2 Outlook and further research

While cloud computing might be regarded as the consequent development of the established organizational concept of outsourcing on the basis of a new technological concept, it states an even more holistic claim. Extending many aspects of IT outsourcing, cloud computing shifts the focus from an exclusive technological perspective to a broader understanding of business needs. It addresses the most prevailing business needs of flexibility, availability, and reliability, as well as economies of scale and skill and lays out how the technological concept of cloud computing can meet (both in an aligning and enabling claim) these business challenges.

However, these considerations are only just beginning and focus primarily on the causes and manifestations of cloud computing. From an academic perspective, future research should focus on two major topics in this context: First of all, many practitioners label cloud computing as a disruptive innovation. Although uncovering a number of new features, one has to investigate further whether cloud computing can live up to these expectations and deserves the label disruptive technology. By drawing analogies from other business models and technologies that were successful or not successful in the past, one can evaluate the sustainability of the new cloud computing paradigm.

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References

- Allee, V. (2002). The future of knowledge: Increasing prosperity through value networks. Butterworth-Heinemann.
- Armbrust, M., A. Fox, R. Griffith, A. D. Joseph, R. Katz, A. Konwinski, G. Lee, D. Patterson, A. Rabkin, I. Stoica and M. Zaharia (2009). Above the Clouds: A Berkeley View of Cloud Computing. EECS Department, University of California, Berkeley.
- Barros, A. P. and M. Dumas (2006). The Rise of Web Service Ecosystems. *IT Professional*, 8 (5), 31-37.
- Behme, W. (1995). Outsourcing. *WISU - Wirtschaftsstudium*, 24 (12).

- Buyya, R., C. S. Yeo and S. Venugopal (2008). Market-oriented cloud computing: Vision, hype, and reality for delivering it services as computing utilities. International Conference on High Performance Computing and Communications IEEE Computer Society,
- Currie, W. (2000). The supply-side of IT outsourcing: the trend towards mergers, acquisitions and joint ventures. *Int. journal of physical distribution and logistics management*, 30 (3/4), 238-254.
- Dillmann, L. (1996). Outsourcing in der Produktentwicklung. Eine transaktionskostentheoretische Betrachtung der zunehmenden Fremdvergabe pharmazeutischer Produktentwicklungsaufgaben in der BRD. Dissertation, Universität Gießen, Frankfurt.
- Fenn, J., N. Drakos, W. Andrews, R. E. Knox, et al. (2008). Hype Cycle for Emerging Technologies, 2008. Research (Ed, Gartner) Gartner.
- Finch, C. (2006). The Benefits of the Software-as-a-Service Model. *Computerworld Management*.
- Fowler, G. A. and B. Worthen (2009). The Internet Industry Is on a Cloud - Whatever That May Mean. *The Wall Street Journal*.
- Freiberger, P. and M. Swaine (2000). *Fire in the valley : the making of the personal computer*. McGraw-Hill, New York.
- Geelan, J. (2009). Twenty-One Experts Define Cloud Computing. *Virtualization Journal SYS-CON Media*.
- Gens, F. (2008). Defining "Cloud Services" and "Cloud Computing". IDC eXchangeIDC.
- Gordijn, J. (2002). E³-value in a Nutshell. *Vrije Universiteit, Amsterdam*, p. 1-12.
- Haupt, S. (2003). *Digitale Wertschöpfungsnetzwerke und kooperative Strategien in der deutschen Lackindustrie*. Dissertation, Universität St. Gallen, St. Gallen.
- Jacob, F. and W. Ulaga (2008). The transition from product to service in business markets: An agenda for academic inquiry. *Industrial Marketing Management*, 37 (3), 247-253.
- Kontio, M. (2009). *Architectural manifesto: An introduction to the possibilities (and risks) of cloud computing*. Technical library, Vol. 2009 IBM.
- Leimeister, S., T. Böhm and H. Krcmar (2008). IS Outsourcing Governance in Innovation-Focused Relationships: An Empirical Investigation. 16th European Conference on Information Systems (Eds, Golden, W., Acton, T., Conboy, K., van der Heijden, H. and Tuunainen, V. K.), Galway, Ireland.
- Matiaske, W. and T. Mellewigt (2002). Motive, Erfolge und Risiken des Outsourcings - Befunde und Defizite der empirischen Outsourcing-Forschung. (With English summary.). *Zeitschrift für Betriebswirtschaft*, 72 (6), 641-59.
- Muyllé, S. and A. Basu (2008). Online support for business processes by electronic intermediaries. *Decision Support Systems*, 45 (4), 845-857.
- Plummer, D. C., T. J. Bittman, T. Austin, D. W. Cearley and D. M. Smith (2008). Cloud computing: Defining and describing an emerging phenomenon. *Research*(Ed, Gartner), p. 1-9.
- Porter, M. E. (1985). *Competitive Advantage: Creating and Sustaining Superior Performance*. The Free Press, New York.
- Reeves, D., D. Blum, R. Watson, G. Creese, B. Blakley, C. Haddad, C. Howard, A. T. Manes, D. Passmore and J. Lewis (2009). *Cloud Computing: Transforming IT* Burton Group, Midvale.
- Riedl, C., T. Böhm, M. Rosemann and H. Krcmar (2009). Quality management in service ecosystems. *Information Systems and e-Business Management*, 7 (2), 199-221.
- Sun Microsystems (2009). *Take your Business to a Higher Level*. Sun Microsystems.
- Tapscott, D., D. Ticoll and A. Lowy (2000). *Digital capital: harnessing the power of business Webs*. Ubiquity, 1 (13).
- Vaquero, L. M., L. Roderó-Merino, J. Cáceres and M. Lindner (2009). A break in the clouds: towards a cloud definition. *ACM SIGCOMM Computer Communication Review*, 39 (1), 50-55.
- Wang, W., T. Tao, M. Kunze, A. C. Castellanos, D. Kramer and W. Karl (2008). Scientific Cloud Computing: Early Definition and Experience. *High Performance Computing and Communications*, 2008. HPCC '08. 10th IEEE International Conference on p. 825-830,
- Youseff, L., M. Butrico and D. Da Silva (2008). *Toward a Unified Ontology of Cloud Computing*. Grid Computing Environments Workshop, p. 1-10.