Cloud Computing – Outsourcing 2.0 or a new Business Model for IT Provisioning?

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1 Introduction

The term cloud computing is sometimes used to refer to a new paradigm – some authors even speak of a new technology – that flexibly offers IT resources and services over the Internet. Gartner market research sees cloud computing as a so-called “emerging technology”[2] on its way to the hype. When looking at the number of searches for the word pair “cloud computing” undertaken with the Google search engine one can get an imagination of the high interest on the topic. Even terms like “outsourcing”, “Software-as-a-Service (SaaS)” or “grid computing” have already been overtaken[3].

Cloud computing can be seen as an innovation in different ways. From a technological perspective it is an advancement of computing, which’s history can be traced back to the construction of the calculating machine in the early 17th century[4]. This development continued with the invention of the analytical engine (1837), the logical engine (1885) and the tabulating machine (1890)[5]. The actual history of modern computing began with the invention of the first computers (Z3 in 1941 and ENIAC in 1945)[6]. Since then advancements emerged at a good pace. The sixties and seventies were the ages of mainframe computing. Central computing resources were harnessed through terminals that provided just the input and output devices to interact with the computer. With the development of the first microprocessor (1969) hobbyists began to construct the first home computers, before mail-order kits such as the Altair 8800 were sold in 1975. Other computer manufacturers like Apple, Atari or Commodore entered the market for computer home users, before IBM introduced its personal computer (PC) in 1981[7]. Since then the development paced up, the diffusion of PCs increased significantly and an increasing miniaturization lead to the development of laptop computers and mobile devices.

Another important technology, which paved the way for cloud computing was the development of the ARPAnet (1969), a fail-proof communications network which became today’s Internet[8]. Soon, services like e-mail or the world wide web, a hypertext based information management system, gained popularity. Technologies like Java, Ajax, WebServices and many more supported the development of rich, interactive websites. Eventually whole applications could be deployed over the Internet, which was around the year 2000 referred to as Software-as-a-Service[9]. In analogy to the provision of software via the web, computing resources could also be accessed via the Internet. Especially for scientific purposes grid computing got established in the early 1990ies[10]. When looking at this brief history of computing, one can easily see the different streams from local calculating machines, to central mainframes, via personal computers and handheld devices to the new quasi centralization trend that can be seen in cloud computing.

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2 Cf. *Fenn* et al. (2008).

3 Cf. *Google* (2009).

4 Cf. *Freytag-Löringhoff/Seck* (2002).

5 Cf. *Babbage* (1864) and *Burack* (1949).

6 Cf. *Goldstine/Goldstine* (1946), *Rojas* (1997).

7 Cf. *Freiberger/Swaine* (2000), p. 325 et seqq.

8 Cf. *Freiberger/Swaine* (2000), p. 206 et seqq.

9 Cf. *Bennett* et al. (2000) and *Finch* (2006).

10 Cf. *Foster/Kesselman* (2003).

F. Keuper et al. (Eds.), *Application Management*, DOI 10.1007/978-3-8349-6492-2_2,

Yet a different point of view is to look at cloud computing from an IT provisioning perspective. In this sense 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.

Our contribution shall focus on the IT provisioning perspective of cloud computing. It will start with a literature review on current definitions of cloud computing and a conceptual framework of different service layers. It will further examine the evolution from outsourcing to cloud computing as a new IT deployment paradigm. Hereby it highlights the effects on the outsourcing value chain, summarizes market actors and their roles within a new cloud computing value network, and finally discusses potential business models for IT service providers.

2 The Cloud Computing Concept: Definition of a new Phenomenon

Due to the current fashion, the term cloud computing is often used for advertising purposes in order to revamp existing offerings with a new wrap. Larry Ellison's (CEO of Oracle) statement at the Analysts' Conference in September 2007 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 with all of these announcements. The computer industry is the only industry that is more fashion-driven than women's fashion"*[11]. In the following chapter we try to clarify the term to provide a common understanding.

2.1 State of the Art

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*"[12]. 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*"[13]. When speaking about levels of abstraction, the authors refer to their proposed cloud computing ontology which will be described in Chapter 2.3 of this contribution.

11 FOWLER/WORTHEN (2009), p. 2.

12 YOUSEFF et al. (2008), p. 1.

13 YOUSEFF et al. (2008), p. 1.

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*"[14]. 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[15].

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.[16] In an attempt to provide a generally accepted definition, Vaquero et al. have derived similarities, based on Geelan's collection of expert opinions.[17] 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*"[18].

The majority of definitions however originate from cloud computing service providers, consulting firms and market research companies. The market research company IDC for example defines cloud computing very general as "*an emerging IT development, deployment and delivery model, enabling real-time delivery of products, services and solutions over the Internet*"[19]. In that sense, cloud computing is the technical basis for cloud services, offering consumer and business solutions that are consumed in real-time over the Internet. The technological foundation of cloud computing includes infrastructure, system software, application development and deployment software, system and application management software as well as IP-based network services. IDC also mentions usage-bound pricing as a core characteristic[20]. Another example of a market research company's declaration is Gartner's definition of cloud computing as "*a style of computing where massively scalable IT-enabled capabilities are delivered 'as a service' to external customers using Internet technologies*"[21].

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14 *ARMBRUST* et al. (2009), p. 4.

15 *ARMBRUST* et al. (2009), p. 4.

16 Cf. *BUYYA* et al. (2008), p. 2.

17 Cf. *GEELAN* (2009).

18 *VAQUERO* et al. (2009), p. 51.

19 *GENS* (2008).

20 Cf. *GENS* (2008).

21 *PLUMMER* et al. (2008), p. 3.

Autor[22]	**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

[22] [1] *ARMBRUST* et al. (2009) [2] *BREITER/BEHRENDT* (2008) [3] *BRISCOE/MARINOS* (2009) [4] *BUYYA* et al. (2008) [5] *FOSTER,* et al. (2008) [6] *PLUMMER* et al. (2008) [7] *GROSSMAN/GU* (2009) [8] *GRUMAN/KNORR* (2008) [9] *GENS* (2008) [10] *KIM* (2009) [11] *MCFREDRIES* (2008) [12] *NURMI* et al. (2008) [13] *VAQUERO,* et al. (2009) [14] *VYKOUKAL* et al. (2009) [15] *WANG* et al. (2008)[16] *WEISS* (2007) [17] *YOUSEFF* et al. (2008).

2.2 A 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 search. 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[23] 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. These two aspects might be driving forces, through which cloud computing could change the IT-Service Business. Thus, we define c*loud computing as 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 The Layers of Cloud Computing

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. Although, many of the concepts don't 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[24]. 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[25]. In an attempt to obtain a comprehensive understanding of cloud computing and its relevant components, Youseff, Butrico and Da Silva were among the first who suggested a unified ontology of cloud computing[26]. According to their layered model (see Figure 1), cloud computing systems fall into one of the following five layers: applications, software environments, software infrastructure, software kernel, and hardware. Each layer represents a level of abstraction, hiding the user from all underlying components and thus providing

23 Cf. *ARMBRUST* et al. (2009).

24 Cf. *KONTIO* (2009), *REEVES* et al. (2009) and *SUN MICROSYSTEMS* (2009).

25 Cf. *WANG* et al. (2008).

26 Cf. *YOUSEFF* et al. (2008).

simplified access to the resources or functionality. In the following section we are going to describe each layer of Youseff's Butrico's and Da Silva's model.

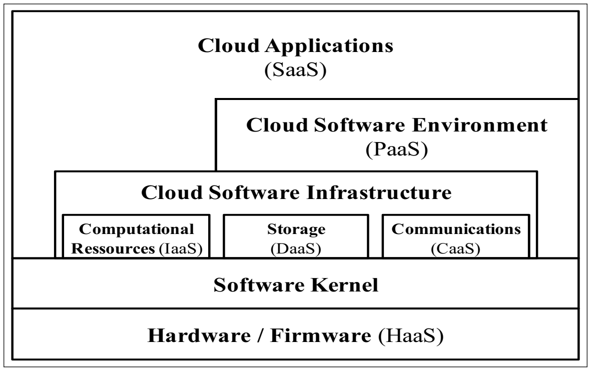

Figure 1: The layers of cloud computing27

2.3.1 Cloud Application Layer

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, normally also referred to as *Software-as-a-Service*, appears to be attractive for many users. Reasons for this are the reduction of software and system maintenance costs, the shift of computational work from local systems into the cloud, or a reduction of upfront investments into hardware and software licenses. Also the service provider has advantages over traditional software licensing models. The effort for software upgrades is reduced, since patches and features can be deployed centrally in shorter cycles. Depending on the pricing model a continuous revenue stream can be obtained. However, security and availability are issues that still need to be addressed. Also the migration of user data is a task that should not be underestimated.

Examples for applications in this layer are numerous, but the most prominent might be Salesforce's Customer Relationships Management (CRM) system[28] or Google's Apps, which include word-processing, spreadsheet and calendaring[29].

2.3.2 Cloud Software Environment Layer

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

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27 In imitation of *YOUSEFF* et al. (2008), p. 4.

28 Cf. http://www.salesforce.com.

29 Cf. http://apps.google.com.

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*.

A known example of a cloud software platform is Google's App Engine[30], which provides developers a phyton runtime environment and specified APIs to develop applications for Google's cloud environment. Another example is Salesforce's Apexchange platform[31] that allows developers to extend the Salesforce CRM solution or even develop entire new applications that runs on their cloud environment.

As we will highlight in Chapter 4.1 one can also look at the cloud platform from a value network or business model perspective. In that sense, the cloud platform can act as a market place for applications.

2.3.3 Cloud Software Infrastructure Layer

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 cannot give strong performance guarantees which result in unsatisfactory service level agreements (SLA). These weak SLAs propagate upwards in the cloud stack, possibly leading to availability problems of cloud applications. The most prominent examples of IaaS are Amazon's Elastic Compute Cloud[32] and Enomalism's Elastic Computing Infrastructure[33]. There are also some academic open source projects like Eucalyptus[34] and Nimbus[35].

In analogy to computational resources data storage within the cloud computing model is offered as *Storage-as-a-Service*. This 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.

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30 Cf. http://code.google.com/intl/de-DE/appengine.

31 Cf. http://sites.force.com/appexchange/home.

32 Cf. http://aws.amazon.com/ec2.

33 Cf. http://www.enomalism.com.

34 Cf. http://www.eucalyptus.com.

35 Cf. http://workspace.globus.org.

Examples of Storage-as-a-Service are Amazon's Elastic Block Storage (EBS)[36] or its Simple Storage Service (S3)[37] and Rackspace's Cloud Files.[38] In addition, to simple storage space, data can be offered as service as well. Amazon for example offers the human genome or the US census as public data sets to use for other services or analytics[39].

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. So far this service is only a research interest rather than in commercial use. However, Microsoft's Connected Service Framework (CSF)[40] can be counted into this class of services.

As Figure 1 shows, cloud applications must not necessarily be developed upon a cloud software platform, but can also run directly on the cloud software infrastructure layer or even the software kernel, thus bypassing the aforementioned layers. Although this approach might offer some performance advantages, it is directly dependent on lower level components and does not make use of development aids such as the automatic scaling provided by the cloud software platform.

2.3.4 Software Kernel Layer

The software kernel layer represents the software management environment for the physical servers in the datacenters. These software kernels are usually implemented as operation system kernel, hypervisor, virtual machine monitor or clustering middleware. Typically, this layer is also the level where grid computing applications are deployed. Globus[41] is an example of a successful grid middleware. At this layer, cloud computing can benefit from the research already undertaken in the grid computing research community.

2.3.5 Hardware / Firmware Layer

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 a as-a-service context also referred to as *Hardware-as-a-Service (HaaS)*. One example of this is IBM's Managed Hosting Service[42].

With regard to the layered model of Youseff, Butrico and Da Silva 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, rather than a disruptive technological innovation. In our opinion cloud computing is rather an innovation in the delivery model of IT services, as we have highlighted it in our definition

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36 Cf. http://aws.amazon.com/ebs.

37 Cf. http://aws.amazon.com/s3.

38 Cf. http://www.rackspacecloud.com/cloud_hosting_products/files.

39 Cf. http://aws.amazon.com/publicdatasets/.

40 Cf. http://msdn.microsoft.com/en-us/library/bb931207.aspx.

41 Cf. http://www.globus.org.

42 Cf. http://www-935.ibm.com/services/de/index.wss/offering/ebhs/a1007253.

(see Chapter 2.2). Therefore we are showing the evolution of cloud computing in the context of IT provisioning in the following chapter.

3 Differences between Cloud Computing and the Traditional Provision of IT

The provision of IT resources in enterprises is closely linked with the general consideration whether information and communication technology should be kept inside the firm or whether it should be sourced from external providers – a question that has been established as a prominent research topic in business administration research for quite a while under the term “make or buy” decision or vertical design[43]. In recent years, the option to outsource IT services to an external service provider has grown in importance due to a variety of positive aspects associated with the outsourcing decision, such as, e.g., cost, quality, flexibility, and competitive 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[44].

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

3.1 The Evolution from Outsourcing to Cloud Computing

Although outsourcing has been an established topic for decades and one of the essential research issues is, the focus of the research has shifted over time. At the beginning of the outsourcing phenomenon the focus laid 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 of outsourcing decisions* was investigated. The central motives for outsourcing decisions are still mainly economical benefits, in particularly 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[45].

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[46]. Within short time this has led to the consideration of what benefits and what performance advantages can be gained through an external

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[43] Cf. *BEHME* (1995) and *DILLMANN* (1996).

[44] Cf. *MATIASKE/MELLEWIGT* (2002).

[45] Cf. *BONGARD* (1994) and *GROVER* et al. (1994).

[46] Cf. *LACITY/HIRSCHHEIM* (1993).

sourcing of IT services. It was investigated, which *efficiency gains* could be obtained through outsourcing, compared to the internal operation of IT[47]. 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 become an established management practice and further, the design parameters of a successful outsourcing project have gained particular interest. So far the focus has mainly been on the *design of the contract* between the outsourcing partners[48]. Only recently, the awareness has been increased that the contract alone 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 during the outsourcing relationship[49]. 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[50]. Figure 1 summarizes the evolution of the outsourcing concept.

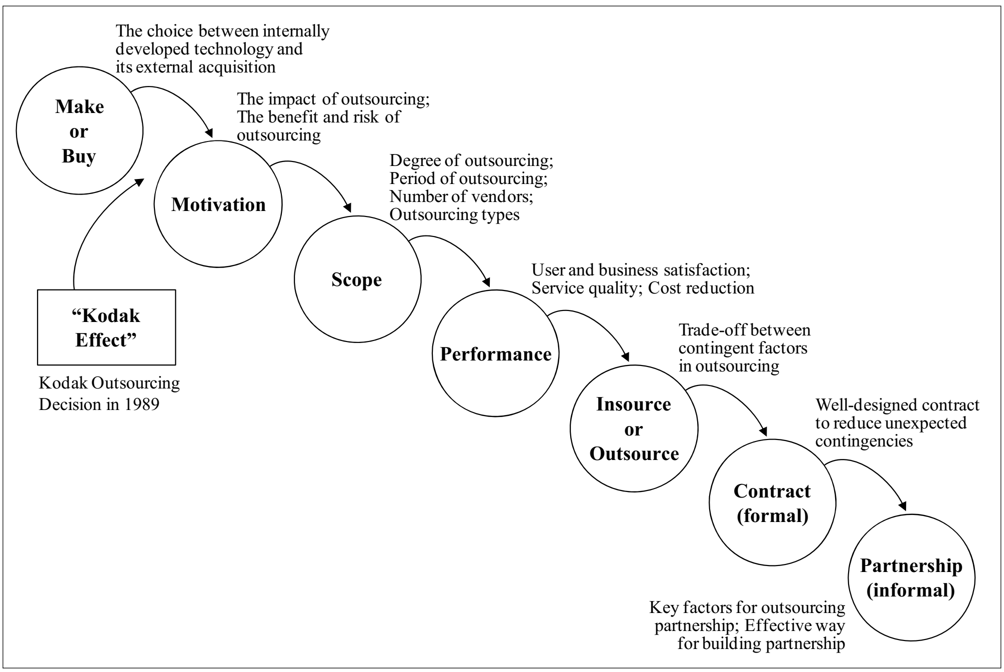

Figure 2: The evolution of external IT provisioning51

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

47 Cf. *LOH/VENKATRAMAN* (1995).
48 Cf. *SAUNDERS* et al. (1997).
49 Cf. *HÄBERL* et al. (2005).
50 Cf. *GOLES/CHIN* (2005) and *LEIMEISTER* et al. (2008).
51 In accordance with *LEE* et al. (2003).

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[52]. Out of these challenged 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 (see Figure 2) 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.

3.2 A Comparison of Outsourcing and Cloud Computing Value Chains

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.[53] A value chain does not only contain different companies but also different business units inside one organization that jointly produce a product or service. The manufacturing process is seldom strictly linear and, thus, is often not seen as a value chain but rather as a value network. It is a network of relationships that generates economical value and other advantages through complex dynamical exchanges between companies.[54] 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.[55]

3.2.1 Traditional IT Service Outsourcing Value Chain

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 (see Figure 2). 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

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52 Cf. *LEIMEISTER* et al. (2008).

53 Cf. *PORTER* (1985).

54 Cf. *ALLEE* (2002).

55 Cf. *TAPSCOTT* et al. (2000).

resources of a hosting provider. Here, the myriad possibilities of combination may lead to complex outsourcing relationships.

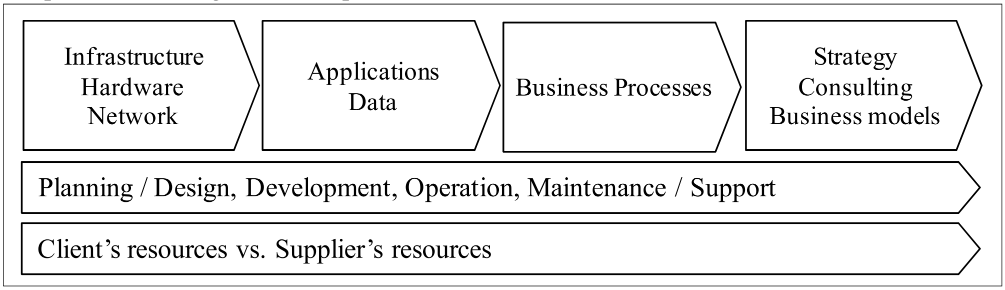

Figure 3: A traditional IT service outsourcing value chain

3.2.2 Cloud Computing Value Chain

A general trend from products to services can be observed[56]. This trend is not only restricted to the IT world, but becomes evident also in many other industries. In the transport industry, for example, the service offering is mobility, instead of solely cars. 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 (see Chapter 2.3.3). 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 (see Chapter 2.3.1). 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 (see Chapter 2.3.2). 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 and can be supported and accessed via a unified user interface. The as-a-service concept of cloud computing allows to develop new complex service-oriented applications that consist of a mixture of on-premise and off-premise services as well as pure cloud applications. Examples, how different business models utilize the new concept provided with cloud computing are given in Chapter 4.

From the layers of the cloud computing services model, described in Chapter 2.3, we can derive three major actors within the value network: the service provider, the platform provider and the infrastructure provider. The infrastructure provider supplies the value network with all the computing and storage services needed to run applications within the cloud. The platform provider offers an environment within which cloud applications can be

56 Cf. JACOB/ULAGA (2008).

deployed. He also acts as some kind of catalogue or market within which applications are offered to the customer through one simple portal. The service provider develops applications that are offered and deployed on the cloud computing platform. As we especially want to highlight the aspect of service composition, we have added the aggregator role to the simplified cloud computing value network depicted in Figure 4. The aggregator is a specialized form of the service provider, offering new services or solutions by combining pre-existing services.

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 can of course act in more than one role. Salesforce for example is a platform provider (AppExchange) and application provider (CRM) at the same time[57]. 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.

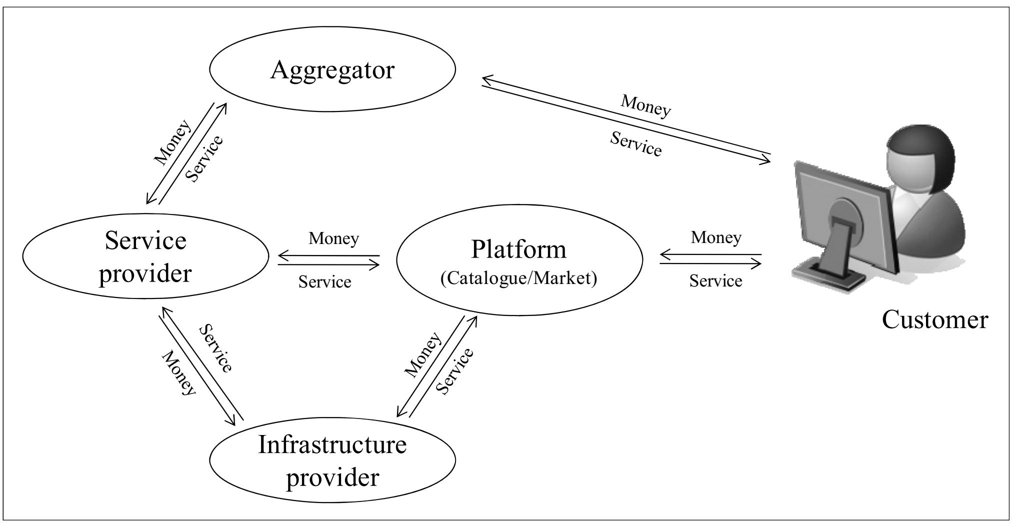

Figure 4: A simplified value network of cloud computing[58]

3.2.3 Comparison

Through an increased service orientation and a continuing technical standardization, the classical value chain has broken up. The model of "single-provider, one-stop provision of

57 Cf. http://www.salesforce.com.

58 A more elaborate, generic value network of cloud computing is presented and discussed in *BÖHM* et al. (2010).

outsourcing" is replaced by a network of different service providers, offering a wide range of services and products on different levels.

The main characteristics of cloud computing, from a users perspective, compared to traditional IT outsourcing is the flexible deployment of virtual and asset-free resources and services. This model allows the implementation of flexible, pay-per-use business models. Comparing cloud computing with classical outsourcing shows how the value chain has broken up and how fine-grained services can be offered. This allows service providers, to provide existing customers a new flexibility, and to access entirely new customer groups with new services and business models. In addition, the cloud computing model allows modifying existing services without large investments, extending them and offering them with new business models. JungleDisk[59] for example uses the hardware-related infrastructure services of Amazon to offer user-friendly storage services for end-users.

4 Cloud Computing Business Models

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 and business models that can be found in cloud computing. The following sections discuss these new roles in cloud computing and the business models that offer opportunities for those new market players.

4.1 Actors and Roles 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).[60]

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 (see Chapter 3.2.2). Based on the analysis of providers of cloud computing services 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*[61], *RIEDL ET AL.*[62] or *HAUPT*[63].

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59 Cf. http://www.jungledisk.com.

60 Cf. *YOUSEFF* et al. (2008).

61 Cf. *BARROS/DUMAS* (2006).

62 Cf. *RIEDL* et al. (2009b).

63 Cf. *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 access hardware and infrastructure of the infrastructure providers. For example, *TAPSCOTT* et al. call this role "content provider"[64] and *HAUPT* "manufacturer"[65].

Infrastructure providers provide the technical backbone. They offer the necessary, scalable hardware for the services[66] upon which the service providers offer their services. Infrastructure providers are sometimes also called IT vendors.

Aggregate services providers (aggregators) combine 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"[67], *HAUPT* calls that an "assembler"[68]. 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*[69] or "service mediator" by *BARROS* and *DUMAS*[70]. 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* 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[71].

4.2 The Platform Business Model

The platform provider is the fundamental player in the cloud computing environment. It provides the central platform and market place where all other actors come together, trade their services, and interact with each other. The platform provides a central registry of

64 Cf. *TAPSCOTT* et al. (2000).
65 Cf. *HAUPT* (2003).
66 Cf. *TAPSCOTT* et al. (2000).
67 Cf. *BARROS/DUMAS* (2006).
68 Cf. *HAUPT* (2003).
69 Cf. *MUYLLE/BASU* (2008).
70 Cf. *BARROS/DUMAS* (2006).
71 Cf. *CURRIE* (2000).

services offered on the platform.[72] Service providers can then register their services with the central service registry which can be browsed by customers to discover the services they need. Thus, the platform provider brings service providers and service consumers closer together. There are several options how the platform provider can generate revenue from the services provided through the platform. Most common, as in the examples of Salesforce, the Apple Store, or Amazon, is a fee or subscription based system: either for the provider to register the service, the service consumer to access the registry, or both.

As the example of Salesforce later on shows, it is also common for the platform provider to offer its own services on the platform as well. These are often basic delivery functions necessary for third-party providers to create marketable services such as billing and payment services.[73] These platform services allow others to easily create tradable services from their "raw" services. It is also quite common for the platform provider to offer infrastructure services as well. In such a way, they hope to expand the range and portfolio of their platform by offering rather simple ways through which service providers can offer their services.

The aim of the platform business model is to increase value and revenue through attracting as many other providers and customers to interact through their platform and thus achieving network effects.[74] They generate value through their brokering activities of bringing supply and demand closer together as well as through their value added services that allow others to create service offering easily. The following paragraphs illustrate the platform business model using Salesforce as an example.

Based in the United States, Salesforce[75] is a supplier of applications for the customer relationship management (CRM) and the automation of the sales organization. However, these applications are not sold as software for on-premise operation, but as a service via Salesforce's cloud computing platform. In a monthly subscription companies provide their sales staff with flexible access to Salesforce applications without having to purchase new additional hardware resources or software licenses. This allows companies to respond flexibly to constantly changing business requirements, increasing or reducing their user-basis. Companies are not required to commit to any up-front investments and expensive implementation projects.

Next to offering its own CRM and sales organization automation applications, Salesforce opened its platform for third party service providers. Thus, other service providers are able to offer specialized extensions and entirely new applications that are seamlessly integrated into Salesforce's applications. For example, the service provider *Print SF*[76] offers an application that allows users to create, print and mail letters and other postal items. Thus a value network between customers, Salesforce and various third-party providers is established (see Figure 5).

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72 Cf. *RIEDL* et al. (2009a).

73 Cf. *BARROS/DUMAS* (2006).

74 Cf. *ECONOMIDES* (1996).

75 Cf. http://www.salesforce.com.

76 Cf. http://www.printsf.com.

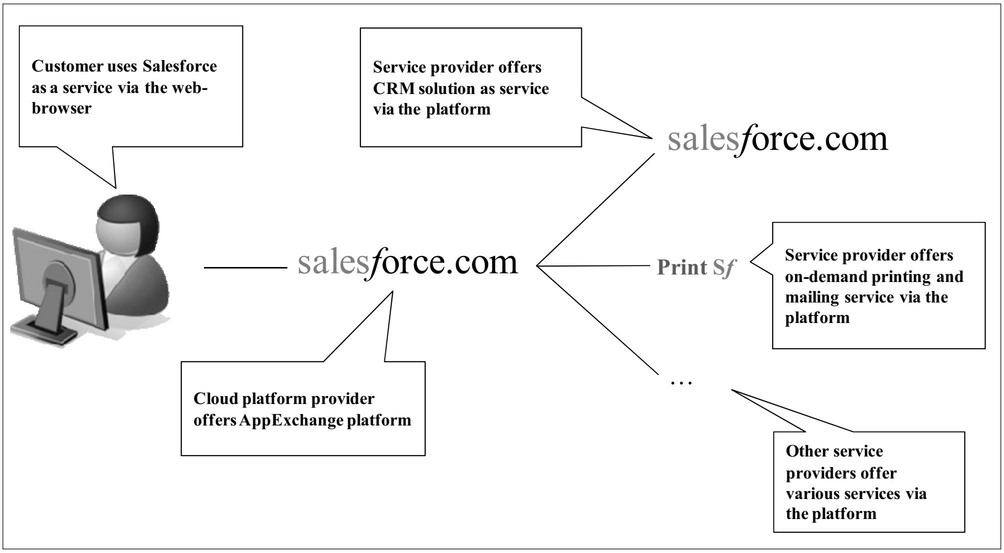

Figure 5: Example of the Salesforce value network

4.3 The Aggregator Business Model

Aggregation and composition are used to describe services that contain other services as sub-services.[77] In the business domain, an aggregation would comprise multiple services and provide access to them in a single location. Aggregation and composition are core characteristics of the value networks and ecosystems that evolve around cloud computing. Service aggregations are quite ubiquitous and can be found in business-to-business as well as business-to-consumer markets for products, services and information.[78] In a similar definition, service aggregators are defined as entities that "group services provided by other providers into a distinct value-added service and can themselves act as providers"[79]. Thus, service aggregators have a dual role. On the one hand, they offer the aggregated services and thus act as a service provider who can enforce their own policies for the aggregated service. On the other hand, they rely on external services offered by other parties within the ecosystem. Hereby, they act as a service consumer.[80]

Similar to a digital retailer, aggregators choose suitable services that are offered by various service providers, make decisions about different market segments, determine prices, and control the transaction. Due to market volume and market power, aggregators can decrease their transaction costs and thus generate value. Aggregators can, for example, be found in the area of logistics where they allow their customers to outsource complete business processes.

77 Cf. *O'Sullivan* et al. (2002).

78 Cf. *Tapscott* et al. (2000).

79 *Papazoglou/van den Heuvel* (2007).

80 Cf. *Riedl* et al. (2009b).

In the aggregator business model, an entity acts as an intermediary between service consumers and providers. Through the aggregator role certain services are combined based on the aggregators detailed domain knowledge which adds additional value to the resulting aggregate service. The main goal is to offer services that provide a solution to a customer-specific need. Thus, aggregators re-brand, re-purpose and re-factor services for a specific or anticipated customer demand. The value proposition includes selection, organization, matching, price, convenience, and fulfillment.[81] One might assume and further investigate when analyzing the value chain of cloud computing, that a fair amount of the value is captured by the service aggregator – compared to other cloud roles.

Related to the integration of data, a specialization of the aggregator role is the data integrator. The data integrator operates under a similar business model as the aggregator, but its focus lies more on the integration and provision of data rather than on the integration of service components. Data integrators would, for example, act as entities that "can transparently collect and analyze information from multiple web data sources"[82]. This process requires in particular resolving the semantic or contextual differences in the information. Based on post-aggregation analysis where the integrated data is combined with the integrator's domain, knowledge value-added information is synthesized.

5 Conclusion and Perspectives

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 and that will be addressed below.

5.1 Contribution to Research

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 of understanding the substantial elements of the cloud computing concept, i.e., the characteristics of service, hardware, software, scalability and Internet/network. Also pay-per-use billing models and virtualization belong to the core elements of the new cloud concept.

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81 Cf. *TAPSCOTT* et al. (2000).

82 *MADNICK/SIEGEL* (2002).

In addition, the article could contribute to a systematic description of major actors (such as, e. g., customer, service provider, infrastructure provider, aggregator, platform, consulting and data integrators) entering the cloud computing market. Such a description can provide a first step towards systematically investigating the value network of cloud actors and can also shed light on analyzing where the value of cloud services is captured.

5.2 Contribution to Practice

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.

5.2.1 Perspectives for Customers

Cloud computing is closely related to the general question of whether IT resources should be provided internally or externally and in both cases *how* they should best be delivered. Holding their own IT resources, such as, e. g., a datacenter does often not make sense for many customers and is too much effort, especially for small or startup companies. In Armbrust's words, this "would be as startling for a new software startup to build its own datacenter as it would for a hardware startup to build its own fabrication line"[83]. Here, externally sourcing IT resources in a cloud computing model provides new opportunities for a flexible, usage-dependent sourcing of IT resources. Besides start-up companies, also established organizations can take advantage of the elasticity of cloud computing regularly. Similar to the underlying idea of selective sourcing or on-demand outsourcing models, cloud computing can provide flexibility and efficiency in terms of cost variabilization (monetary flexibility) and also in terms of availability of IT resources (IT flexibility).

Moreover, the flexibility associated with cloud computing can also be used in settings where clients keep their IT in-house. So-called private clouds allow clients to efficiently manage their IT resources and balance peak loads and idle time in an optimal way. These opportunities should be considered in future decisions. However, the potential gains in flexibility and efficiency come along with some risks, for example, in the field of data security that needs to be taken into account. Breaking up the traditional outsourcing value chain uncovers a variety of new configurations and different actors which may result in the development of complex value networks that need to be identified and managed accordingly.

5.2.2 Perspectives for Service Providers

For service providers new opportunities arise from both a technical as well as from a business view. From a technical view, the construction of very large data centers using commodity computing, storage, and networking resources facilitated the opportunity of selling those resources on a pay-per-use basis below the costs of many medium-sized datacenters, while at the same time serving a large group of customers. From a business view, the challenges and opportunities are even more interesting. Here, service providers benefit from breaking up the outsourcing value chain to position themselves in the market and to offer new services. As the

83 *ARMBRUST* et al. (2009).

market for cloud computing services has not yet a clear shape we now observe a phase of experimentation where new and viable business models are explored. Especially in the field of service aggregation and integration new opportunities for service providers emerge. Even without large investments in infrastructure reliable and powerful services can be offered that use the infrastructure of established providers such as Amazon or Google. This has implications for innovation aspects such as time-to-market and offering of service prototypes. In addition, there are new businesses fields in the area of accompanying services such as data integration and consulting that will evolve in the next years.

5.3 Outlook and Further Research

In a broad understanding, cloud computing can be regarded as an evolution in the development of outsourcing models, i.e., the provision of IT resources. The business challenges of the user and the specific customer requirements for cost reduction, flexibility, and innovation are met in a more granular and mature way. At the same time, cloud computing as a new technological concept asks the same basic question as outsourcing does: *How are IT resources provided for the customer?* Consequently, the same problems, challenges, and issues are raised that have already been posed in the various stages of the development of outsourcing (see Figure 1). In analogy to the evolution in outsourcing, cloud computing is in the initial phase where asking for the participation ("if or if not"), for the motivation ("why cloud computing", "cui bono?") and for the subject ("what should be done externally") is relevant.

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.

A second promising research stream focuses on the business challenges associated with the rise of the new computing paradigm. New players – formerly active in other core markets – entered the cloud computing market and are now in competition with established IT (service) providers. As one major consequence, the traditional value chain breaks up and develops a complex value network with a myriad of established and new players on different layers in the cloud computing stack. It has to be investigated what the newly evolving value network looks like and where the value of cloud computing is captured in the long-run. Within the context of evolving value networks, the implications of cloud computing on service level agreements and the relationship between the actors will become a further research topic. Since future software solutions might be composed of several modular cloud services the complexity increases and possibly inhibits serious impacts on service level agreements and liability issues.

References

ALLEE, V. (2002): The future of knowledge: Increasing prosperity through value networks, Burlington 2002.

ARMBRUST, M. et al. (2009): Above the Clouds: A Berkeley View of Cloud Computing, Berkeley 2009.

BABBAGE, C. (1864): Passages from the life of a philosopher, London, 1864.

BARROS, A. P./DUMAS, M. (2006): The Rise of Web Service Ecosystems, in: IT Professional, 2006, Vol. 8, No. 5, pp. 31–37.

BEHME, W. (1995): Outsourcing, in: Das Wirtschaftsstudium, 1995, Vol. 24, No. 12, p. 1005.

BENNETT, K. et al. (2000): Service-based software: the future for flexible software, Seventh Asia-Pacific Software Engineering Conference (APSEC), Singapore 2000, pp. 214–221.

BÖHM, M./KOLEVA, G./LEIMEISTER, S./RIEDL, C./KRCMAR, H. (2010): Towards a Generic Value Network for Cloud Computing, in: *ALTMANN, J./RANA, O. F.* (Ed.) 7th International Workshop on the Economics and Business of Grids, Clouds, Systems, and Services (GECON), Heidelberg, pp. 129–140.

BONGARD, S. (1994): Outsourcing-Entscheidungen in der Informationsverarbeitung. Entwicklung eines computergestützten Portfolio-Instrumentariums: Unternehmensführung & Controlling, Wiesbaden 1994.

BREITER, G./BEHRENDT, M. (2008): Cloud Computing Concepts, in: Informatik Spektrum, 2008 Vol. 31, No. 6, pp. 624–628.

BRISCOE, G./MARINOS, A. (2009): Digital Ecosystems in the Clouds: Towards Community Cloud Computing, in: Arxiv preprint arXiv:0903.0694, 2009.

BURACK, B. (1949): An Electrical Logic Machine, in: Science, 1949 Vol. 109, No. 2842, pp. 610–611.

BUYYA, R./YEO, C. S./VENUGOPAL, S. (2008): Market-oriented cloud computing: Vision, hype, and reality for delivering it services as computing utilities, International Conference on High Performance Computing and Communications 2008.

CURRIE, W. (2000): The supply-side of IT outsourcing: the trend towards mergers, acquisitions and joint ventures, in: International journal of physical distribution and logistics management, 2000 Vol. 30, No. 3/4, pp. 238–254.

DILLMANN, L. (1996): Outsourcing in der Produktentwicklung. Eine transaktionskosten-theoretische Betrachtung der zunehmenden Fremdvergabe pharmazeutischer Produkt-entwicklungsaufgaben in der BRD, Dissertation, Frankfurt 1996.

ECONOMIDES, N. (1996): The economics of networks, in: International journal of industrial organization, 1996 Vol. 14, No. 6, pp. 673–699.

FENN, J. et al. (2008): Hype Cycle for Emerging Technologies, 2008, Research Report, Gartner, Stamford 2008.

FINCH, C. (2006): The Benefits of the Software-as-a-Service Model, in: Computerworld Management, online: http://www.computerworld.com/s/article/107276/The_Benefits_of_the_Software_as_a_Service_Model, last update: 2006-01-02, date visited: 2009-07-03.

FOSTER, I./KESSELMAN, C. (2003): The grid: blueprint for a new computing infrastructure, 2nd edition, Amsterdam 2003.

FOSTER, I./ZHAO, Y./RAICU, I./LU, S. (2008): Cloud Computing and Grid Computing 360-Degree Compared, Grid Computing Environments Workshop (GCE), Austin 2008, pp. 1–10.

FOWLER, G. A./WORTHEN, B. (2009): The Internet Industry Is on a Cloud - Whatever That May Mean, in: The Wall Street Journal, online: http://online.wsj.com/article/SB123802623665542725.html, last update: 2009-03-26, date visited: 2009-04-09.

FREIBERGER, P./SWAINE, M. (2000): Fire in the valley: the making of the personal computer, 2nd edition, New York 2000.

FREYTAG-LÖRINGHOFF, B. V./SECK, F. (2002): Wilhelm Schickards Tübinger Rechenmaschine von 1623, 5th edition, Tübingen 2002.

GEELAN, J. (2009): Twenty-One Experts Define Cloud Computing, in: Virtualization Journal, online: http://virtualization.sys-con.com/node/6123752009, date visited: 2009-04-09.

GENS, F. (2008): Defining “Cloud Services” and “Cloud Computing”, in: IDC eXchange, online: http://blogs.idc.com/ie/?p=1902008, date visited: 2009-04-08.

GOLDSTINE, H. H./GOLDSTINE, A. (1946): The electronic numerical integrator and computer (ENIAC), in: Mathematical Tables and Other Aids to Computation, 1946, pp. 97–110.

GOLES, T./CHIN, W. W. (2005): Information systems outsourcing relationship factors: detailed conceptualization and initial evidence, in: SIGMIS Database, 2005 Vol. 36, No. 4, pp. 47–67.

GOOGLE (2009): Insights for Search, online: http://www.google.com/insights/search/2009, date visited: 2009-04-08.

GROSSMAN, R. L./GU, Y. (2009): On the Varieties of Clouds for Data Intensive Computing, in: IEEE Computer Society Bulletin of the Technical Committee on Data Engineering, 2009 Vol. 32, No. 1, pp. 44–51.

GROVER, V./CHEON, M. J./TENG, J. T. C. (1994): A Descriptive Study on the Outsourcing of Information Systems Functions, in: Information & Management, 1994 Vol. 27, No. 1, pp. 33–44.

GRUMAN, G./KNORR, E. (2008): What cloud computing really means, in: Infoworld, online: http://www.infoworld.com/print/340312008, date visited: 2009-04-08.

HÄBERLE, O./JAHNER, S./KRCMAR, H. (2005): Beyond the On Demand Hype: A Conceptual Framework for Flexibility in Outsourcing, European Academy of Management Annual Conference (EURAM), Germany, May 4th – 7th 2005, TUM Business School Munich 2005.

HAUPT, S. (2003): Digitale Wertschöpfungsnetzwerke und kooperative Strategien in der deutschen Lackindustrie, Dissertation, St. Gallen 2003.

JACOB, F./ULAGA, W. (2008): The transition from product to service in business markets: An agenda for academic inquiry, in: Industrial Marketing Management, 2008 Vol. 37, No. 3, pp. 247–253.

KIM, W. (2009): Cloud Computing: Today and Tomorrow, in: Journal OF Object Technology, 2009 Vol. 8, No. 1, pp. 65–72.

KONTIO, M. (2009): Architectural manifesto: An introduction to the possibilities (and risks) of cloud computing, online: http://www.ibm.com/developerworks/library/ar-archman10/, date visited: 2009-07-30.

LACITY, M. C./HIRSCHHEIM, R. A. (1993): Information Systems Outsourcing – Myths, Metaphors and Realities, Chichester, New York 1993.

LEE, J.-N. et al. (2003): IT Outsourcing Evolution – Past, Present and Future, in: Communications of the ACM, 2003 Vol. 46, No. 5, pp. 84–89.

LEIMEISTER, S./BÖHMANN, T./KRCMAR, H. (2008): IS Outsourcing Governance in Innovation-Focused Relationships: An Empirical Investigation, 16th European Conference on Information Systems, Galway, Ireland 2008.

LOH, L./VENKATRAMAN, N. (1995): An empirical study of information technology outsourcing: Benefits, risk and performance implications, Sixteenth International Conference on Information Systems, Amsterdam 1995, pp. 277–288.

MADNICK, S./SIEGEL, M. (2002): Seizing the opportunity: Exploiting web aggregation, in: MIS Quarterly Executiue, 2002 Vol. 1, No. 1, pp. 35–46.

MATIASKE, W./MELLEWIGT, T. (2002): Motive, Erfolge und Risiken des Outsourcings – Befunde und Defizite der empirischen Outsourcing-Forschung. (With English sum-mary), in: Zeitschrift für Betriebswirtschaft, 2002, pp. 641–659.

MCFREDRIES, P. (2008): Technically speaking: The cloud is the computer, in: Spectrum IEEE, 2008 Vol. 45, No. 8, p. 20.

MUYLLE, S./BASU, A. (2008): Online support for business processes by electronic intermediaries, in: Decision Support Systems, 2008 Vol. 45, No. 4, pp. 845–857.

NURMI, D. et al. (2008): The Eucalyptus Open-source Cloud-computing System, Cloud Computing and Its Applications, Chicago 2008.

O'SULLIVAN, J./EDMOND, D./TER HOFSTEDE, A. (2002): What's in a Service?, in: Distributed and Parallel Databases, 2002 Vol. 12, No. 2, pp. 117–133.

PAPAZOGLOU, M./VAN DEN HEUVEL, W. (2007): Service oriented architectures: approaches, technologies and research issues, in: The VLDB Journal The International Journal on Very Large Data Bases, 2007 Vol. 16, No. 3, pp. 389–415.

PLUMMER, D. C. et al. (2008): Cloud computing: Defining and describing an emerging phenomenon, Research Report, Gartner, Stamford 2008, pp. 1–9.

PORTER, M. E. (1985): Competitive Advantage: Creating and Sustaining Superior Performance, New York 1985.

REEVES, D. et al. (2009): Cloud Computing: Transforming IT Midvale 2009.

RIEDL, C. et al. (2009a): A Framework for Analysing Service Ecosystem Capabilities to Innovate, Proceedings of 17th European Conference on Information Systems (ECIS'09) 2009.

RIEDL, C. et al. (2009b): Quality management in service ecosystems, in: Information Systems and e-Business Management, 2009 Vol. 7, No. 2, pp. 199–221.

ROJAS, R. (1997): Konrad Zuse's legacy: the architecture of the Z1 and Z3, in: IEEE Annals of the History of Computing, 1997 Vol. 19, No. 2, pp. 5–16.

SAUNDERS, C./GEBELT, M./HU, Q. (1997): Achieving Success in Information Systems Outsourcing, in: California Management Review, 1997 Vol. 39, No. 2, pp. 63–79.

SUN MICROSYSTEMS (2009): Take your Business to a Higher Level 2009.

TAPSCOTT, D./TICOLL, D./LOWY, A. (2000): Digital capital: harnessing the power of business Webs, Boston 2000.

VAQUERO, L. M. et al. (2009): A break in the clouds: towards a cloud definition, in: ACM SIGCOMM Computer Communication Review, 2009 Vol. 39, No. 1, pp. 50–55.

VYKOUKAL, J./WOLF, M./BECK, R. (2009): Service-Grids in der Industrie – On-Demand-Bereitstellung und Nutzung von Grid-basierten Services in Unternehmen, in: WIRTSCHAFTSINFORMATIK, 2009 Vol. 51, No. 2, pp. 206–214.

WANG, W. et al. (2008): Scientific Cloud Computing: Early Definition and Experience, High Performance Computing and Communications, 2008. HPCC '08. 10th IEEE International Conference on 2008.

WEISS, A. (2007): Computing in the clouds, in: netWorker, 2007 Vol. 11, No. 4, pp. 16–25.

YOUSEFF, L./BUTRICO, M./DA SILVA, D. (2008): Toward a Unified Ontology of Cloud Computing, Grid Computing Environments Workshop 2008, pp. 1–10.