Towards a Generic Value Network for Cloud Computing

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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. In contrast to many other research works, this paper does not focus on technical aspects of cloud computing but rather takes a business perspective. By taking this perspective we examine the ecosystem that has developed around cloud computing. Here, new market players emerged, breaking up the traditional value chain of IT service provision. In this paper we describe the roles of different market actors and develop a generic value network of cloud computing, using the e³-value method. Based on interviews with domain experts we were able to draw first estimates regarding possible future value streams within the ecosystem. Extending the prevailing technical perspective of cloud computing, this paper shifts the focus to a broader understanding of business opportunities and business value. Researchers can apply the developed generic value network as an analytical framework to guide their research, while practitioners might apply it to position themselves in the cloud computing market and identify possible business opportunities.

Keywords. Cloud Computing, Market Actors, Value Network, Value Chain

1 Introduction

With the rise of a ubiquitous provision of computing resources over the past years, cloud computing has been established as a prominent research topic. It can be seen as an innovation in different ways. From a technological perspective it is an evolution of computing that evolved from large tabulating machines and mainframe architectures, centrally offering calculating resources to personal computers for decentralized computation, and eventually to ubiquitous, small personal (handheld) devices [1].

While much research is dedicated to the technical aspects of cloud computing, many authors neglect the business perspective of IT provisioning. From this perspective 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.com, or Sun position themselves as platform and infrastructure

providers in the cloud computing market. Alongside, there emerge other providers, who build their own applications or consulting services upon the services offered by the before mentioned. This eventually leads to a whole new ecosystem of service providers in the cloud computing market.

So far, only little research has been conducted around value creation, value chains and value networks in cloud computing. Some studies have been conducted in the context of grid computing. Stanoevska-Slabeva et al. [2] describe different grid stakeholders and have developed a generic value chain and a corresponding value network for grid computing based on an analysis of industry case studies. Another work by Altmann et al. [3] developed a taxonomy and description of stakeholders and their roles in grid computing. Lee and Leem [4] have studied the value chain for a ubiquitous computing environment. A value chain reference model explicitly developed for cloud computing was presented by Mohammed et al. [5], based on Porter's value chain theory [6]. Their work, so far, appears to be the most comprehensive value chain reference model for cloud computing. They distinguish between primary (core) services, business oriented support services and cloud oriented support services. Primary services include hardware, grid middleware, software and data & content services. Business oriented support services include resellers, composers, financial services and market places, while cloud oriented support services are comprised of technology operators, grid financial management services, solution and consultant services as well as customized services.

However, Mohammed et al.'s [5]work is settled on a comparatively micro-economic level, describing service scenarios, including costs and profits as well as serving as a check-list for building cloud services. We could not identify any detailed work around the cloud computing ecosystem, which takes a comparatively macro-economic perspective on cloud computing. Our objective is to describe this emerging ecosystem with its market actors and their value exchange relationship. To achieve this, our research was guided by the following two questions:

a) *What generic market actors can be identified in the cloud computing market?*

b) *How does the ecosystem of market actors and value exchanges look like?*

2 Cloud Computing Definition

Until today no common definition of cloud computing has emerged. Youseff et al. were among the first who tried to provide a comprehensive understanding of cloud computing and all its relevant components. According to them "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" [7]. By levels of abstraction, the authors distinguish between cloud applications (Software as a Service, SaaS), cloud software environment (Platform as a Service, PaaS) and software infrastructure (Infrastructure as a Service, IaaS) based on a software kernel and hardware. Despite different definitions (an overview can be found in [8]), there is some consent, which can be summarized as the dynamic, on demand provision of services via a network

which are priced according usage. 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"[8]. This definition was derived on the basis of a review of scientific definitions, taking a holistic view of cloud computing from applications to infrastructure, stressing the ability of service composition. Thus it supports our business oriented perspective and our observation of a growing ecosystem of different market actors around cloud computing.

3 Value Systems Concepts

3.1 Value Chain

The value chain is a model that describes a series of value-adding activities connecting a company's supply side (raw materials, inbound logistics, and production processes) with its demand side (outbound logistics, marketing, and sales). By analyzing these activities, managers are able to redesign their internal and external processes to improve efficiency and effectiveness and to identify their core competencies [9]. As such it is often used to analyze a firm and its major competitors by identifying differences in performance (benchmark) [10].

The most established value chain approach was presented by Porter, who distinguishes between primary activities (inbound logistics, operations, outbound logistics, marketing & sales, services) and support activities (firm infrastructure, human resource management, technology development, procurement), also adding a value margin [6]. To account for the collaboration between companies, Porter created an extended value chain, termed *value system*. It represents an interconnected system of value chains. A value system includes the value chains of a firm's supplier (and their suppliers all the way back), the firm itself, the firms distribution channels, the firms customers and so forth to the end customer (consumer). Linkages connect value activities inside a company but also create interdependencies between the members of the value system [6]. A company can create competitive advantage by optimizing or coordinating these links to the outside [11].

3.2 Value Network

The value network focuses on value co-creation by a combination of actors within a network. A value network is a "set of relatively autonomous units that can be managed independently, but operate together in a framework of common principles and service level agreements (SLAs)" [10]. Within such a network, value for the consumer is created at the network level, where each actor contributes incremental value to the overall offering [12]. Instead of providing the maximum value to the customer, which is always at risk of being unprofitable, actors concentrate on their core competencies and the competence complementarity of the network [13, 14].

Biem and Caswell have examined and compared several definitions of the value network. Their derived definition puts a special emphasis on the increase of inter-firm relationships. A ”value network is a model of inter-organizational exchange as an attempt to address the increasing intricateness of inter-firm relationships, pushed by a more and more connected economy” [15].

3.3 Critical Comparison

Sturgeon [9] analyzed the key differences of value chains and value networks. Both approaches have many things in common but a fundamental distinction can be made. While the value chain “maps the vertical sequence of events leading to the delivery, consumption, and maintenance of a particular good or service, the value network maps both the vertical and horizontal linkages between economic actors, i.e., recognizing that various value chains often share common economic actors and are dynamic in that they are reused and reconfigured on an ongoing basis” [9].

Another differentiation can be seen by the order activities are carried out. The value chain is a linear approach, which perfectly represents a manufacturing process in traditional industries, following a sequential logic. The value network on the other hand is a model, where functions and activities are performed simultaneously rather than sequentially [10, 17]. It can better display alliances and cooperation relationships. Firm relationships have increased in complexity. Firms can no longer be simply classified as customers, suppliers or competitors. Often they have two or more of these dimensions simultaneously [15, 17].

Yet another aspect is the dematerialization and digitization of products and the trend towards service delivery. According to Peppard and Rylander [10] every business today competes in two worlds: a physical world of resources that can be seen and touched and a virtual world made of information. The latter has given rise to the world of electronic commerce, a new way of value creation. Processes in creating value are not the same in both. The value chain treats information as a supporting element in the value-adding process, but it can also be a source of value in itself. Therefore, the value chain is better suited to present the physical value creation while the value network is more suitable for the virtual world. The latter is particularly evident in sectors such as banking, insurance, telecommunications, news, entertainment, music, advertising, and of course cloud computing.

As this discussion highlights, value networks appear to suit better for modeling the interdependencies between different actors observed in the cloud computing market.

4 Methodology

By analyzing literature on market actors in the areas of living systems theory [18], network organizations [19, 20], (electronic) business webs [21-25], IT outsourcing [26], grid computing [2, 3], and value networks in traditional industries [27, 28] we could identify 105 generic roles. After clustering these roles based on their descriptions provided by the authors we reflected them with the observed cloud computing market. Therefore we have built a dataset of 2628 cloud computing

services based on convenient sampling. The services from the dataset were then assigned to actor clusters and it has been checked, whether some services could not be assigned to any service. At the end of this process we ended up with a set of 8 generic roles described in section 5.1.

We developed our conceptual generic value network, based on the roles described in section 5.1 and modeled it with the e³-value method by Gordijn and Akkermans [29]. This value network, explained in section 5.2, was then evaluated through ten interviews with domain experts. The interviews, lasting between 45 and 90 minutes, were conducted between October and December 2009, following a semi-structured interview guideline. The interviewees were selected based on their expertise in the cloud computing area, demonstrated by their active participation in BITKOM's[1] cloud computing task force. To improve reliability, the interviews were tape-recorded and transcribed. The semi-structured interviews covered the experience of the interview partner with cloud computing, different roles and their relationship amongst each other as observed by the interviewee, and the presentation and validation of our proposed value network. The interviewees were also asked for their estimation of the value creation and flow within the value network based on three distinct scenarios.

5 A Generic Value Network of Cloud Computing

5.1 Generic Roles and Market Actors

Due to an increasing trend towards service orientation, opportunities to offer services on cloud computing platforms, and the possibilities to integrate individual component services to create value-added, complex services gave rise to a set of new roles in cloud computing and the resulting service ecosystems [30, 31].

Cloud computing services are typically classified by the type of service being offered. With reference to Youseff et al.'s cloud computing ontology [7], cloud services are often differentiated by application (SaaS), platform (PaaS) and infrastructure (IaaS) level. In contrast to this layer model, which is quite common in the IT domain, cloud services can also be classified in a more business-oriented manner, by market actors that offer a certain class of services. Since market actors represent companies that might offer different services on different levels, such as Salesforce.com, we abstract from this construct and speak of roles. In our understanding a role is a set of similar services offered by market players to similar customers. This abstraction helps us to indicate that a certain company (market player) can offer different services, acting in different roles. The generic roles described below were derived by clustering roles identified in the literature discussed above and a proceeding reflection in practice.

[1] BITKOM is the federal association for Information Technology, Telecommunications and New Media in Germany (www.bitkom.org)

Application Provider
The application provider offers applications for its customers. In contrast to the traditional software model the applications are hosted and operated by the application provider in an own or outsourced datacenter and are accessible for customers via the internet. The application provider has to ensure a smooth operation of the applications. This includes monitoring, asset/resource management and failure/problem management. Monitoring means that the service provider is aware of the state of his system at any time. Asset/resource management aims to maximize datacenter utilization by, for example, load balancing [32]. Failure/Problem management refers to both, instant fixes of problems such as bugs as well as to long term software maintenance to avoid problems in advance. Also new features and further application improvements are provided and installed [33]. Yet another important aspect is the security of the software. Unwanted attempts of accessing or manipulating the software have to be detected and stopped (intrusion detection) [34].

(Technical) Platform Provider
We distinguish between two kinds of platform providers. One is the more technically oriented platform provider described here; the other is a market platform, described below. (Technical) platform providers offer an environment to develop, run and test applications. From a technical perspective an operating environment, application programming interfaces (APIs), programming languages etc. are provided. Furthermore, team collaboration services may be offered [35]. Developers are shielded from technical, infrastructure related details. Programs are executed over datacenters, not concerning the developers with matters of resource allocation. This however comes at the cost of some trade-offs and development constraints, possibly leading to a different application design. For instance, depending on the platform, key-value stores have to be used instead of relational databases [36].

Market Platform
The market platform represents a marketplace where various cloud computing services of different roles are offered. The main objective of the market platform is to bring customers and service providers together. The former can search for suitable cloud computing services while the latter can advertise its services. In addition to offering a platform for marketing and searching services, the market platform might also offer additional services to both service providers and customers, such as SLA contracting or billing.

Infrastructure Provider
The infrastructure provider offers virtual hardware, network connections including firewalls and virtual storage to its customers. The customer has full responsibility for the received machine instances and controls them. Once a machine reaches its performance limits, another machine has to be instantiated manually to scale the application [36]. As cloud computing matures, more and more infrastructure providers offer potentially different SLAs to their customers, regarding for example availability and performance [37]. Disaster recovery for both, infrastructure and data is an important aspect of the infrastructure provider's work. [33].

Consultant
To introduce a cloud computing project in a company consultants are often asked for their expertise. Consultants can provide fundamental knowledge about cloud computing offerings as well as the customer company‘s business processes and requirements to identify and introduce suitable cloud services. Additional services might be a cost benefit evaluation to decide whether cloud computing is profitable or not, security consulting or billing. Consulting services are not limited to users of cloud services, but may also target service providers to solve technical problems, evaluate the service offering or analyze customers.

Aggregator
With cloud computing a large number of small and modular services arose, creating the opportunity to aggregate these services into value-added, complex solutions for certain needs. This aggregation of services is accomplished by aggregators. According to the market analyst Gartner three different types of aggregators may arise within the cloud computing context: The first one combines existing services, created by different providers into a new service. The aggregator has to ensure that the different services work together neatly and that no losses occur via data movement between the systems. The second type of aggregator is comparable to a value added reseller. He adds value on top of a given service to ensure some specific capability. These might be add-ons or new services. The last type may categorize and compare cloud services from different providers, based on certain selection criteria. The end user can specify its criteria and get the best fitting solution for its needs [38]. The latter type might also fit into our generic role of the market platform.

Integrator
Once a company decides to integrate a cloud computing solution, the system integrator faces two main tasks. The first is to convert preexisting on-premise data in order to migrate it into the cloud or prepare it for certain applications. The second task is to integrate a cloud computing solution into the existing IT landscape, developing interfaces to other on-premise applications. This also includes system and integration tests to ensure a seamless cooperation of different systems as well as the training of users. Beyond the integration project, the integrator might also offer additional training or customer support, by setting up a help desk for example [39]. There might be some similarities between the aggregator and the integrator role in terms of aggregating different modular services into a more complex solution. The main difference between these two roles is that the integrator creates a customer individual solution, whereas the aggregator develops a more standardized solution that is offered to a larger group of users with similar needs.

Consumer
The consumer is the final customer who receives services for business or private use. He does not create value within the cloud computing ecosystem, nor does he offer cloud computing services to someone else. The consumer is the starting point of service request and the ending point of service delivery. All value adding activities are eventually paid by the consumer.

5.2 A Generic Value Network

Based on our understanding of the different roles emergent in the cloud computing ecosystem, we are able to develop a generic value network, using the e³-value method to model it. Figure 1 depicts the different roles, their interrelationships and value exchanges. Within this value network value is created by providing services that are valuable for other participants of the network. Products or in our case services are exchanged in return of either money, which is the typical case, or other benefits that the service provider values. Value is created by producing elementary services (infrastructure) and refining them throughout the value network. In this way value is added with each step along a path in the value network until the *Consumer* receives the service that fulfils his needs.

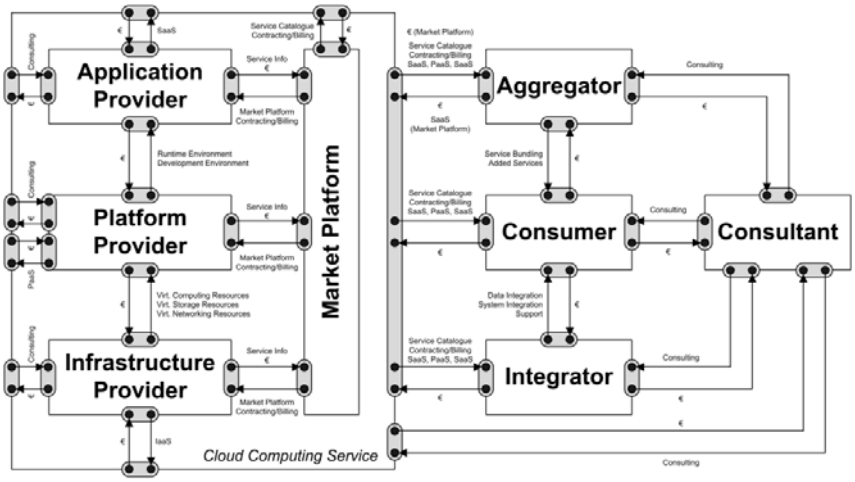

Fig. 1. A generic Value Network of Cloud Computing

The composite actor *Cloud Computing Service* represents the service as perceived by the *Consumer* who does not necessarily care how it is implemented and what other services are utilized in order to provide the requested service. Therefore the composite actor is comprised of the roles *Infrastructure Provider*, *Platform Provider*, *Application Provider* and *Market Platform*. Roles within this composite actor may offer objects jointly with other roles, but they may also offer objects on their own.

Consumers, *Aggregators* and *Integrators* may request any kind of services (SaaS, PaaS, IaaS) directly from one or more service providers or via a *Market Platform*. In Figure 1 this is represented by the value ports at the edge of the composite actor. For higher level services *Application* and *Platform Providers* can request services from other service providers. This is represented by the links among the service providers.

Both *Aggregators* and *Integrators* receive any number and kind of services (SaaS, PaaS, IaaS) from the composite actor to offer their value-added service to the *Consumer*. The *Consultant* is the only role that does not offer cloud computing services itself, but advises each of the other roles regarding cloud computing issues.

Empirical Findings on the Value Network
The interviews conducted throughout this research, all confirmed our identified roles and their relationships within the value network. The interviews also indicated two emerging roles, *Data Providers* and *Monitors*. A data provider would generate data and information to provide it for other actors within this network. A similar role called content provider is mentioned by Altmann et al. [3]. The monitoring role provides permanent control of data privacy and security. Thereby, it controls the end-to-end connection, beginning with the first provider reaching to the consumer.

Exemplary Illustration
As described above and observed in practice, one company can act in more than one role. Salesforce.com is a typical example for a company that acts in different roles. On the one hand, and that is how they started, they offer a customer relationship management (CRM) solution[2] as SaaS, making them an *Application Provider*. With their Force.com[3] platform on the other hand they also offer a development and runtime environment to developers, taking on the role of a *Platform Provider*. Developers can either be *Application Providers* if they sell their applications to others, or *Consumers*, in case they just operate the application for own purposes. These third party cloud computing services developed and deployed on the Force.com platform can be offered on Salesforce.com's AppExchange[4] marketplace. Thus it also acts as *Market Platform*. From an external point of view Salesforce.com is no *Infrastructure Provider*, because it does not offer IaaS externally. To run its own and third-party applications on their platform it can either operate its own hardware or use the services of one or more *Infrastructure Providers*. To complete the example, *Aggregators* might take two or more cloud computing services, not all necessarily running on the Force.com platform, to build an aggregate solution that is useful for a certain group of *Consumers* or other service providers. *Integrators* on the other hand might introduce Salesforce.com's CRM solution into a production company, develop a customized solution on the Force.com platform on behalf of the *Consumer* and integrate all together with the on-premise SAP software. The *Consultant* could have prepared the way for the *Integrator* by, for example, advising the *Consumer* about the benefits of a cloud solution at an earlier stage of the introduction project.

6 Value Creation and Value Flow

Besides the validation of the conceptual generic value network, our empirical research also aimed at providing some first estimates on value creation and value flow within the network. Many interviewees compared the cloud computing market with the cell phone market. There are only a few big providers and many brokers, who buy network capacity and resell it under their label. Transferred to cloud computing, this

[2] http://www.salesforce.com/de/crm/
[3] http://www.salesforce.com/de/platform/
[4] http://sites.force.com/appexchange/

could give a rise to the aggregator role, bundling existing solutions and reselling them with added value.

Two rivaling opinions arose. One group thought that especially the application provider and the integrator will generate most of the monetary value, since they need a deep understanding of the consumers' business model and their processes to offer solutions. Furthermore, they would profit from direct contact to the consumer, which can lead to follow-up projects. More than half of the interviewees argued that infrastructure and platform services will become a commodity. Thus they will only be profitable for high volume low margin businesses.

The second cluster of interviewees assigned the largest share of value creation to the infrastructure and platform providers. They argue that in many sectors such as the financial sector, applications are not very complex, but need large hardware resources.

7 Conclusion

As our discussion has shown, we believe that the value chain concept is too restricted to describe the cloud computing ecosystem with all its interrelationships between different market actors. Thus we postulate the application of a value network instead. We have described eight generic roles currently being observable in the cloud computing market and developed a generic value network to further analyze the emergent ecosystem.

Although, we could gain some first insights on value creation and value flow within the cloud computing ecosystem from our exploratory interviews, no valid estimations can be made yet. Therefore future research needs to investigate this in more depth on a broader empirical basis. Our proposed generic cloud computing value chain can serve as an empirically validated conceptual analytical framework to guide this research. Future research could also investigate the emerging data provider and monitor roles, reflecting them in practice to extend the generic value network.

From a practitioner's point of view, our proposed value network can be applied to strategically position a company or service offering in the cloud computing market and to identify possible business opportunities. Therefore it is not necessarily important to know, which generic role might take the largest share within the ecosystem, but to develop a unique value proposition based on core competencies.

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