The Commoditization of IT Services with Cloud Computing

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Abstract - *The commoditization of IT services has reached a new quality with the growing use of cloud services. Based on overarching standards as REST, these services can be accessed on-demand via internet and billed depending on the actual usage at a defined service level. However, compared to other commodities as electricity, cloud services still lack a number of general standards regarding quality and pricing as well as technical definitions to implement these standards. The goal of this paper is to describe and evaluate the current level of commoditization in the cloud industry, leading to recommendations for a continuous success of cloud services.*

Keywords: cloud computing; commoditization; services; SLA; pricing; standards

1 Introduction

Cloud Computing is one of the most discussed IT topics in recent history. Despite concerns about security and availability, analysts expect annual growth rates of almost 22% with a global market volume increasing from 40.7 billion US$ in 2011 to 241 billion US$ in 2020 [1]. One of the drivers behind this development is the standardization of IT services, often described as commoditization in order to emphasize the similarity to other standardized products as gold, electricity or wheat.

Commodities lack qualitative differentiation across an often global market, i.e. that to the customer it doesn´t matter or is unknown who is producing the good. Commodities are often categorized into agricultural products as soybeans or coffee, mining raw materials as copper or silver and energy commodities as oil, electricity and gas. In recent years, products based on intellectual capital also have become commoditized, forming a fourth group containing for example generic pharmaceuticals and even complex technical products as silicon chips.

Main reason for the commoditization is the loss of differentiation of goods or services across a supply base, mostly due to the diffusion of intellectual capital necessary to acquire or produce it efficiently. This spreading of knowledge is often driven by overarching organizations within an industry, defining a set of standards for product quality and terms of delivery to achieve simplified trading of goods. Consequently, these goods formerly carrying premium margins become commodities due to standardization. This leads to a growing competition and importance of price regarding the sourcing of these products.

With the arrival of cloud computing and the concomitant trend to outsource non-core competencies in many industries, the commoditization of IT services has become more important. Especially if services providers fail to deliver the stipulated services as Amazon´s Web Service did in April 2011, it has become vital to possess backup options that are based on similar technologies and standards to allow for on-demand access.

Cloud services have five essential characteristics: on-demand self-service, access via broadband network, resource pooling by providers, rapid elasticity and the capability to measure a service with regards to usage and quality [2]. In order to use cloud services efficiently and reach the aspired improvement of the cost-benefit ratio, cloud providers and users need to agree on transparent standards to allow for on-demand pricing and allocation of resources.

The main areas of standardization of any commodity are the product or service quality, the terms of delivery and the form of contracting including pricing mechanisms. This paper will give a comprehensive overview of current standards already in use in the context of cloud computing with focus on pricing mechanisms. Also, an outlook on what still needs to be achieved to make cloud services a true commodity will be given.

2 Standardizing model of delivery

Delivering IT services via networks has a much longer history than any efforts to describe service levels or prices for the usage of a service. Therefore, standards defining the means of transportation and delivery of IT services are a lot more sophisticated and resilient than quality and price related standards. Namely, the OSI reference model developed for communication networks in the early 1980s has set a structure and standards that still persist. The TCP/IP stack is the dominant transportation model for cloud services. It sets the basis for the transporting of messages between applications (e.g. with FTP, HTTP or SMTP protocols) and the web service stack defining protocols to wrap messages in XML (SOAP), access services (REST), describe services (WSDL) and publish services in a catalogue (UDDI).

It can be said that the delivery of cloud services is a rather mature area of IT. Of course, gradual improvements will always occur, but the right choice of which protocol to use in a certain context or the flexibility to access a service with many protocols seems to have a lot higher effect on the results and success of a cloud service.

3 Standardizing quality

The quality of IT services needs to be described with hard, measurable parameters as well as soft parameters that depend on user perception. Traditionally, hard parameters have been defined, monitored and analyzed since the early days of computing. Availability, response times and utilization are understood by IT experts across the globe. Unfortunately, the definition and measurement of these parameters is not standardized and vary greatly from company to company.

Currently, most cloud users rely on quality parameters defined (and often also monitored) by service providers or define and stipulate SLAs to pledge providers to deliver the desired quality. This is rather simple for parameters as availability, but these SLA are arguable due to unclear measurement or remain a result of individual negotiations. A standard SLA for a specific service across industries describing technical details as well as mode and place of measurement has not been defined as of today. For soft parameters describing the user experience, the situation is even worse. The ease of use, problem handling and user helpdesks based on resilient quality measurements is rarely defined in any service contract.

For cloud services, however, the comparison of the final service quality of competing services is of great importance. This requires a flexible SLA specification and monitoring framework to replace the individual SLAs often described in natural language as part of a service contract. In the past, different XML-based languages to define quality parameters like Web Service Level Agreement [3] or WS-Agreement, standards to describe quality concepts like ITU-T E-800 [4] and ontologies to allow QoS definitions like DAML-QoS have been proposed. They all might be valuable tools to develop and describe machine-readable quality standards, but they don´t suggest any concrete SLA definitions or service parameters for a specific service.

While the requirements towards QoS concepts and SLA definitions are often described in detail, e.g. by [5], the IT industry has so far failed to develop overarching quality standards as SOAP or REST representing communication standards. Organizations and communities like IEEE and the National Institute of Standards and Technology (NIST) are already trying to develop standards based on existing technologies. However, these activities are hardly coordinated and focus mainly on interoperability and portability. It will take some years to come until everyone in IT will have the same understanding of “gold level” for a specific service includes.

4 Standardizing pricing mechanisms

Today, Infrastructure- and Platform-as-a-service (as provided for example by Amazon´s Elastic Cloud or Microsoft Azure) is mostly billed depending on the time a processor is used or the volume of input, output or amount of storage used. Software-as-a-Service (SaaS) is usually offered based on fixed time frames, e.g. per month, year or even just a one-time fee for ongoing usage. These pricing models are simple and transparent, but they are not supported by any formal standard to describe pricing parameters. Usually, the current price is displayed on the respective web page or service catalogue, and at the moment of ordering, a time meter is starting. The final bill is the product of time and the price displayed initially. No standard or ontology to describe whether a service is offered at a fixed price, is available for auctions or another pricing mechanism currently exists. The whole topic seems to be “undiscovered” from a standardization point of view, therefore the underlying pricing models are now analyzed in more detail.

4.1 Overview of Pricing Models

Since the times of traditional bartering in natural economies, many pricing and resource allocation mechanisms have been invented to find the “right price” for a good. The introduction of money allowed people to buy goods independently of what the trade partner was offering. This lead to four common pricing models still prevalent: posted prices and auctions which are very common in commodity markets and tendering as well as bargaining that are rather used for customized products.

4.1.1 Posted Prices

Posted prices are either flat or based on the usage of a certain good. They are defined by the vendor, often depending on production costs, maximal profitability or prices of substitute products. Usage-based fees can relate to the time a certain good was used or the amount of the good that was consumed. In some pricing models, flat and usage-based fees are combined where the flat fee is a means to limit the entry to a market and cover fixed expenses.

Vendors of goods with posted prices often use price differentiation according to certain conditions, e.g. the age of the buyer, the time of the year (or day), the region or the number of buyers, to skim the consumer surplus [6]. Also, they allow consumers to influence the price by choosing product bundles, using volume discounts or buying a certain quality or service level of the good (QoS) which is also called Paris Metro pricing.

4.1.2 Auctions

Auctions were invented due to information asymmetries and the vendors desire to further skim the consumer surplus. They help to determine the customers willingness to pay without the vendor risking to set prices too low or too high. Because of the many different types of goods and markets auctions are applied for, a large number of auction types were invented. The most popular type is an English auction often used for auction of works of art. One seller is offering one specific good to many bidders. The starting price is at the low end, mostly a reserve price is fixed, bidders can bid repeatedly and are overbidding each other until no one is willing to pay more. The winner is paying the whole amount of his last bid.

Other important auction types are the Dutch auction with a high starting price which is constantly lowered until a bidder is willing to pay the price, the First-price-sealed-bid auction where bidders are only submitting one hidden bid and the highest wins, and the Vickry auction which is similar to the English auction except that the winning bidder is paying the price of the second highest bid. The stock market represents a double auction where multiple sellers and bidders are constantly "bidding" to buy or sell multiple, identical goods. Further auction types as Calcutta, American, Walrasian, Smart Market [7], Reverse and Progressive Second Price Auction [8] will be described later on according to their usability in cloud computing.

4.2 Tendering and bargaining

Tendering is a customer-driven process mostly used for rather complex, non-standard products. Public institutions and large companies are obliged to tender large infrastructure projects to fulfill legal requirements. Generally, a consumer describes his demand, e.g. for a machine or a building to be constructed, very detailed and publishes it via respective channels. Potential vendors get the chance to pose clarifying questions and make their offer in the end. Since offers are rarely identical (due to the complexity of the product), the customer needs to decide which is most suitable with regards to time, quality and price.

A hybrid between tendering and auctions is the reverse auction. The customer publishes his demand and takes the role of an auctioneer whereas the bidders are underbidding each other in order to get the contract. Since this model does not include a large time frame to ask questions and concretize the demand, it is not used for complex products.

Bargaining is the oldest form of price fixing. It is applied in almost all settings but auctions, mostly if no price or pricing mechanisms are defined, if a customer does not want to pay a posted price or if a price already agreed on needs to be adapted due to a new, unexpected situation.

4.3 Application of pricing models in IT and other industries

Cloud services have been around for quite some time already; Amazon´s Elastic Cloud and Salesforce´ CRM software are just two prominent examples. This chapter will give an overview of pricing models already used in this field. In addition, pricing models that are used for other network based products and further industries are described to lay the foundation for the following outlook on future pricing models in the field of cloud computing.

4.3.1 Pricing in Cloud Computing

Pricing models in cloud computing generally fulfill three conditions: 1) the QoS is clearly defined, therefore quality for a specific service is not changing over time and does only influence cost calculation of the vendor, not the pricing model itself; 2) the price is based on the actual usage of the service; 3) price discrimination can only be achieved with the help of different QoS levels, via pricing depending on time or amount of usage and indirectly via market entry barriers.

The most common pricing schemes in cloud computing today are by far posted prices as shown in Table II. While Platform- and Infrastructure-as-a-Service offerings are generally charged by the hour, all software offered as "cloud software" is billed via a monthly or even annual flat fee. Although that is a lot more flexible than buying software licenses for unlimited usage, true usage-based pricing should be based on shorter periods, e. charging one-time usage to look at or print a file.

The only price discrimination besides different levels of service quality could be found based on region (e.g. cheapest Salesforce.com license at identical QoS in Japan almost 80% more expensive than in the US), volume (e.g. discounts at Amazon´s Elastic Computing Cloud (E2C) for renting an instance for one or three years and getting lower hourly rates in return), or time of usage (e.g. Windows Azure charges inbound data transfer only in peak times from April 2011 on).

The currently most innovative pricing model is used for the spot instances of Amazon´s E2C. Customers can name a maximum hourly fee they are willing to pay, and depending on the current workload of the infrastructure, the hourly fee is increased or decreased by Amazon every 30 minutes to reach an optimum of utilization. Therefore, consumers that don´t want to buy reserved instances for a year (and are flexible with regards to time) can lower their costs compared to on-demand instances that are more than 100% more expensive. Although the price is publicly posted, scientifically speaking this model is a recurring auction on many identical goods with a hidden reserve price (which is constantly changing), hidden bidding and all successful bidders paying the amount of their bid.

This pricing mechanism for Amazon´s E2C is strikingly similar to the pricing method that [9] proposed almost 15 years ago for network based products with guaranteed QoS in a monopoly. Based on an estimation of the probable user demand, they suggest to define the monopoly price (E2C reserved instances) and set up a spot market for remaining capacities (E2C spot instances) while still offering the option to order guaranteed capacities on demand (E2C on-demand instances). This does not only give an impression of Amazon´s current self-conception as a monopolist, it also gives a good foresight of how certain cloud offerings may be priced in the future.

One fact however attracts attention: all offerings only address spot markets with their pricing schemes, i.e. the contract between provider and consumer is put in force at the time the usage is starting and the price at that specific moment. They don´t allow consumers to reserve usage volumes for a later point in time.

4.3.2 Pricing in Other Industries

The four main models to price products – posted prices, auctions, tendering and bargaining – have been adopted and modified in manifold ways in mature, non-IT industries. Compared to network based products, customers in other industries are not facing the problem of congestion. They are not competing for an infinitely divisible, abstract good, i.e. bandwidth, but for real and often non-divisible products carrying different valuations of each consumer. Therefore, consumer goods can be offered at guaranteed QoS and allow for posted prices (e.g. groceries), bargaining (e.g. to lower a posted price) and auctions. The costly pricing mechanism of tendering is used rather for capital-intensive goods as large machines, infrastructure or buildings.

The pricing mechanisms of bargaining and tendering are straightforward and have experienced limited innovations over time. Bargaining is still wide-spread in developing countries and itself often a much valued part of a transaction. In most other cases, it is a means of adapting posted prices for commodity products in case the customer has a lower valuation. However, the rapid growth of the internet has made bargaining also very popular online by using reverse pricing (e.g. on priceline.com). It describes process where a customer releases a bid for a certain product on an internet platform, giving different competing vendors the option to accept or refuse. While the customer has the chance to get a good deal, vendors can optimize the utilization of their resources without risking that the (hidden) reserve price is jeopardizing the posted prices in other sales channels.

Tendering is also a pricing mechanism mostly found offline. Usually applied for very capital-intensive goods, it is a time-consuming way of specifying the final product by detailing the initial tender. Thus, it allows the tenderer to offer a price based on realistic estimations of costs to be expected and gives the client a chance to receive comparable offers. The reversed auction mechanism explained above (e.g. used by my-hammer.com) is an online tendering mechanism. It has become popular for simple customized products due to the immense acceleration of communication speed.

Posted prices are very common for consumer goods. While the internet has become a very important channel to interact with customers and sell products, it has also given vendors the opportunity to significantly refine their pricing mechanisms. Collecting customer data has become so cheap that vendors can easily compare and correlate customer profiles to estimate their willingness to pay for certain products. This allows for very detailed price discrimination and almost personal prices (e.g. based on age, job or even address) which are posted only to the respective individual.

But customers also have to chance to profit from the internet by forming virtual buying syndicates (e.g. on letsbuyit.com). It enables many individuals to aggregate their demands on an internet platform and therefore use volume discounts.

Especially tour operators have been very creative using the internet to optimize pricing mechanisms. They try to maximize profitability by bundling products or discriminating prices via time and quality. Bundling reduces comparability to competing offers and helps to maximize utilization by offering not-so-popular products with popular ones. They use dynamic pricing to increase or decrease posted online prices depending on remaining capacity and oversubscription of available capacities knowing that a certain percentage of guests will cancel or not show up. Even offering goods at a posted price without exactly defining the product is increasingly used, e.g. by airlines selling tickets to “a destination at the beach” or “a European capital”, telling the customer only when and where the flight begins.

Auctions are undoubtedly the area with most innovations in recent times, even leading to the formation of auction theory as independent field of research. Traditional auction mechanisms are English auctions used by auction houses for works of art, Dutch auctions to sell many identical products (e.g. flowers) and double auctions applied on stock markets.

The internet has also made auctions a widely used instrument of pricing for consumer goods. They are often auctioneered with Second-Price Sealed-Bid auctions which have proven to be efficient and giving bidders incentives to bid at their true valuation for the auctioned good [10]. Ebay.com for example is joining characteristics of the English (multiple bids possible per bidder) and the Vickrey auction (second highest bid is final price plus a small increment). In a business context, reversed auctions have become a viable instrument of procurement with the rise of eCommerce, e.g. for basic chemicals and other commodities.

All pricing mechanisms are not only applied on spot markets, but also for future demand. Options to buy (call option) or sell

(put option) a certain good at a specific price are even traded on stock markets, thus combining posted prices with auctions.

5 Outlook

5.1 Required standards for cloud services

Cloud services will only be as successful as many people believe today if overarching standards are defined. Communication standards for the interaction of providers, users and among services have a solid basis with the TCP/IP, the web service stack defining XML-based standards as SOAP, WSDL or UDDI and further protocols as REST. Standards describing quality and pricing information on the other hand are either not existent or lacking overarching application.

To define service quality, one of the existing WS languages describing technical elements of quality needs to be agreed on and enhanced to fulfill all requirements. Also, a single framework incorporating all necessary parameters that influence service quality needs to be defined. In addition to response time or mere computing power, this may also include soft facts as usability. It will also be of great importance to define these parameters with customer-oriented view. A user is not interested in the clock rate of certain CPU, all that matters are the FLOPs that a certain service can offer in a specific context.

A number of standards to describe quality concepts like ITU-T E-800, XML-based languages to define quality parameters like WSLA and ontologies to allow QoS definitions like DAML-QoS have been proposed by different vendors and organizations. However, they can only be the basis for a comprehensive catalogue of quality parameters. For cloud services to be comparable, overarching service classes and optional functionalities need to be defined by an overarching initiative. This will result in a service construction kit similar to car configurators with generally accepted standards.

The most promising initiative so far is the “Standards Acceleration to Jumpstart the Adoption of Cloud Computing” project by the NIST. Started in 2010 and designated by the US Federal CIO Vivek Kundra, it´s goal is “to drive the formation of high-quality cloud computing standards” [11] in order to. Although this venture is focusing on portability, security and interoperability at first, standards to describe service quality and actual suggestions for overarching SLAs are likely to be developed soon. For the time being, vendors will try to push their technical configurations and sets of standards into the market, leading to lock-in effects for almost any cloud service.

Concerning prices, the standardization has not even started yet. So far, no protocols or any kind of standard within existing protocols exist to describe which pricing mechanism a service is supporting, if upper and lower price boundaries exist and which types of contracts are supported. This is still an area that requires a lot of research. The next chapter describes on more detail which pricing mechanisms are likely to be used in a world of cloud commodities.

5.2 Future pricing of cloud services

As for any product, the future cloud pricing mechanisms depend strongly on the ratio of vendors and buyers for a specific cloud service and the availability and costs of alternative solutions. If a vendor has a monopoly for his service, he can dictate the resource allocation and choose between posted prices (e.g. as Amazon Web Services today), auctions or bargaining with every individual customer.

However, monopolies will be rare or not persist for long. Especially for IT infrastructure, overarching technical and performance standards are already evolving, making services comparable and eventually leading to converging markets with interchangeable products. This even holds true for the SaaS market which is a lot more diversified compared to Infrastructure- (IaaS) and Platform-as-a-Service (PaaS) due to the manifold application areas and specific requests by end users. While computing services could be made comparable via a virtual measurement unit (e.g. input/output performance or million instructions per second), software is much more dependent on functionality and usability.

Thus, the SaaS market is in fact composed of many small SaaS markets with rather few competitors who are able to shoulder the large initial investments to develop software. Nonetheless, SaaS delivered as true cloud services via networks is as dependent on and limited by the underlying IT infrastructure as any cloud service and calls for differentiated service levels and pricing models. Due to a growing standardization of process landscapes and thus the supporting software, e.g. based on ITIL or eTOM, the software market is also experiencing decreasing fragmentation and is more and more comparable to IaaS and PaaS markets.

Therefore, the level of standardization of a certain service category will be an important driver of the corresponding pricing mechanism in all three categories of cloud services. While ERP systems or stock trading platforms will be subject to customization and an opportunity to gain competitive advantage for some time to come, other services as hosting or communication will be highly standardized. At the same time, customized products will less likely become true cloud services while services with strong positive network effects will be typical cloud commodities.

From a vendors´ perspective, Paris Metro Pricing based on different service levels will be the method of choice to maximize utilization of hardware and revenues while still offering transparent pricing. Customers will define which available services fulfill their required quality levels and leverage pricing and quality to choose the adequate service.

For services with high degree of standardization, usage-sensitive fees based on very short time intervals (e.g. one-time access or per hour) or small volumes (e.g. storage per day per MB) are thinkable since the costs for searching and putting a service into operation are marginal. Vendors can flexibly adjust posted prices according to the current utilization of their resources or auction remaining capacities via double auctions similar to stock markets.

Consequently, customers relying on spot prices of services will try to manage the risk of price volatilities by requesting predicted service volumes for future points in time. As other non-storable goods, cloud services might have much higher volumes in future contracts than in spot contracts someday [12]. Similar to electricity markets, this may even lead to a "cloud stock exchange" with derivatives like options. Also, companies operating their own IT infrastructure might offer unused capacities in times of low utilization via this platform just like private households are offering electricity. In forward markets, pricing via bargaining and tendering could also be applied as long as the expected contract volumes justify higher costs for the customization of products and an extensive pricing process.

Providers working with posted prices will continue to discriminate prices not only based on quality levels or utilization (i.e. time), but also use volume discounts, blur pricing transparency by bundling unpopular products with popular ones or sell capacities to virtual 3rd party cloud providers. Also, for less standardized services that don´t generate enough supply and demand to justify double auctions, business-to-business internet platforms with Vickrey or reverse auctions might help vendors to further optimize utilization.

6 Summary

The commoditization of cloud services today is still in its beginning, applying only few methods of defining comparable service levels or assigning prices to resources based on their valuation. The markets are fragmented and standards to compare performance of similar services are rare, leading to monopolistic structures and therefore pricing mechanisms dominated by the vendors.

However, it seems clear that the market will mature in the next years as companies are continuously outsourcing commoditized IT services which are not supporting their core competencies. As large power plants transformed the electricity industry a century ago, the world of IT will be transformed by huge data centers currently built by providers like Amazon or Google. The underlying economies of scale lead to cost reductions [13], and more and more IT departments will decide to use cloud services once new investments into infrastructure are required.

Vendors as well as governments have understood that a comprehensive set of standards will be the basis for a continuing success of cloud computing. Most efforts currently focus on interoperability, portability and security. This will be followed by standards to describe service quality, allowing cloud users to compare different offerings more easily.

The pricing mechanism used for each type of cloud service depends on the market structure and possible alternatives. Markets of capital-intensive services as software or services addressing a limited clientele will be rather vendor-driven which prefer long-term contracts. Products that can be highly standardized with regards to service quality will become more and more comparable, bringing forward typical pricing mechanisms of commodities as stock and forward markets.

End users however prefer simple pricing schemes and don´t want price meters constantly showing their usage-based costs increasing [14]. Thus, IT departments will have to manage the identification and purchase of various cloud services while translating the diverse, complex and usage-based pricing mechanisms into transparent and user-friendly internal pricing.

Depending on regulatory efforts of developed countries, the "cloud industry" will experience a certain degree of liberalization to avoid large IT companies becoming too powerful. This may lead to a rise of virtual cloud service providers operating platforms to sell and buy remaining capacities with different posted price and auction models, comparable to virtual mobile network operators (MVNOs) in the telecom industry.

Automation of pricing and allocation of resources will go alongside with this development, requiring providers and consumers of IT services to agree on overarching standards to define service levels, underlying service catalogues and price-related information, e.g. with XML. The current research of the authors of this paper is focusing on these standards, platforms, requirements of customers and providers as well as procedural and organizational implications. Results are to be expected within the next year.

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