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SELECTION OF MULTI-CLOUD STORAGE USING COST BASED APPROACH

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***Abstract* - Companies are often challenged to increase the functionality of IT while minimizing capital expenditures. Cloud providers operated on proprietary closed architectures that make migration a headache. In this paper we present a Cost based approach for selecting Multi-Cloud Storage. We found that our model fits the practical requirements and supports decision making in Cloud Computing. In this work we observed that, from customer's point of view relying upon a solo service provider for his outsourced data is not very promising, so we propose a Cost Based Approach model in cloud computing which holds an economical distribution of data among the available service providers in the market to provide customers with data availability.**

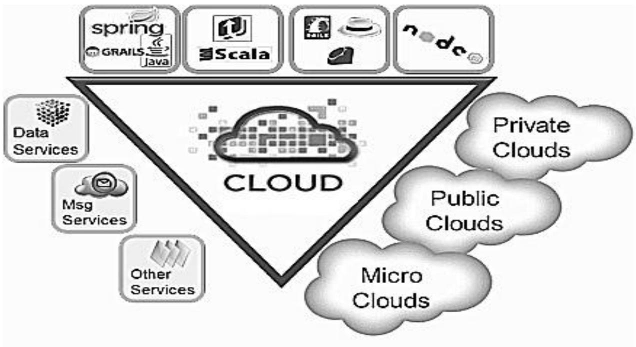
Keywords* - *Cloud Computing, Storage, Cost-Based Approach, Cloud Service Provider, Customer.

I. INTRODUCTION

Cloud computing isn't just potentially delivering savings and flexibility for existing organizations. It is also laying the groundwork for a new generation of business start-ups, a new survey finds. Multi-cloud strategy is the concomitant use of two or more cloud services to minimize the risk of widespread data loss or downtime due to a localized component failure in a cloud computing environment. Such a failure can occur in hardware, software, or infrastructure. A multi-cloud strategy can also improve overall enterprise performance by avoiding "vendor lock-in" and using different infrastructures to meet the needs of diverse partners and customers.

As customer bases and device types grow increasingly diverse (yet at the same time increasingly specialized), organizations face a complex array of challenges in their quest to satisfy the demands of all end users. In particular, the speed with which a given Website loads has a huge impact on customer satisfaction. Recent research has revealed that the average user expects a Webpage to load just as fast on a mobile device as it would on their home computer (two seconds or less). Because faster page loading results in more frequent and longer visits to a given Website, page loading time can indirectly affect rankings in search engines. A multi-cloud strategy can help an organization to minimize page loading times for all types of content.

A multi-cloud approach can offer not only the hardware, software and infrastructure redundancy necessary to optimize fault tolerance, but it can also steer traffic from different customer bases or partners through the fastest possible parts of the network. Some clouds are better suited than others for a particular task. For example, a certain cloud might handle large numbers of requests per unit time requiring small data transfers on the average, but a different cloud might perform better for smaller numbers of requests per unit time involving large data transfers on the average. Some organizations use a public cloud to make resources available to consumers over the Internet and a private cloud to provide hosted services to a limited number of people behind a firewall. A third type of cloud, called a micro cloud, may also be used to manage miscellaneous internal and external services.



It is an unfortunate fact of life that things fail. Vehicles, utensils, appliances, even buildings eventually break down in one way or another and something in them stops working. With IT it's no different. Everyone who has worked in IT for any period of time has experienced some issue related to failures, from hardware - faulty disks, broken PCs, power surges - to software failure - buggy software, application crashes and unhandled exceptions. If anything, the failure of hardware and software seems to be accepted as the norm, rather than the exception, by end-users. Just think about how routine it seems to reboot a laptop, or even a server, if something isn't working properly.

With cloud computing, it's no different: even if your cloud provider offers a 100% uptime guarantee for all the services you rely on, these services will eventually fail. You need to be prepared for when they do. While part of being prepared means having redundancy built into your cloud-based application, many times this redundancy is limited to running redundant copies of your application on separate data centres of the same cloud provider. While this is recommended - it is, after all, one of the reasons why all the large providers have multiple data centres in separate geographical locations - another possible strategy is adopting multiple cloud providers.

In this paper we present a formal mathematical model for the calculation of the Total Cost of Ownership (TCO) for Selecting Multi Cloud storage. The TCO is one of the most important cost-oriented approach that is widely spread in both research and practice [22]. The main focus of our model lies in the identification and calculation of cost factors. More precisely, the model strongly supports start-up companies that do not operate an internal IT infrastructure. The calculation results serve as decision support by evaluating Cloud Computing Services and providers on a cost basis. We based our model on the analysis of real Cloud Computing Services from our Cloud Computing research database (www.CloudServiceMarket.info). Furthermore we conducted a systematic literature review with which we identified important cost types and factors. The TCO model is prototypically implemented on a website for further evaluation steps and is accessible for the general public. The software tool is able to analyze the cost structure of Cloud Computing Services and thus supports decision makers in validating Cloud Computing Services from a cost perspective. The presented multi-method approach extends the TCO theory and applies deductive and inductive methods to develop a theoretically and practically based model

While traditional accounting approaches primarily aim at identifying the lowest possible costs, the benefits of the TCO approach lie in the improvement of customer-supplier communication and the analysis of the whole lifecycle of the IT artifact [7]. Furthermore, the TCO approach makes it possible to analyze the costs or individual cost components of an IT artifact by means of a predefined scheme. It virtually constitutes a mathematical representation of the "real world". However, it is not the purpose of TCO models (or of any model) to provide a 1:1 image of reality, but to deliver a simplified, abstract view [10]. Hence, instead of including all relevant costs into the TCO analysis, the complexity of reality can be reduced by working on the basis of assumptions and by including only a limited number of carefully selected cost factors. In spite of this limitation to selected cost factors the TCO model should be able to provide reliable decision support [6]. For a rigorous development of the Cost based model we applied the following common requirements to T models [3,6,8,7]:

***Transparency*:** We provide an in-depth description of the model and the applied criteria.

***Applicability*:** The prototypical implemented software tool allows for an easy application of the TCO model with reasonable effort.

***Variability*:** The Cost based model is standardized to a large extent, but central aspects are variable, so that desired changes or extensions of the model are possible.

***Comparability*:** The analysis results of the model are comparable to each other since we provide a predefined framework and transparency of the calculation scheme.

***Decision Support*:** Since calculated costs are structured according to cost types and factors, the model provides a sufficient basis for a comprehensive analysis. Decision-making processes are supported since the model provides significant information.

***Status-Quo*:** The formal model is based on current business practices (expert interview) and the state of the art of Cloud Computing (systematic literature review).

II. THORETICAL BACKGROUND

Catastrophic or widespread failures of cloud-based systems are not mere hypothetical events. On August 7, 2011, Amazon experienced an outage at its cloud computing hub located in Dublin, Ireland, apparently caused by an electrical transformer malfunction. On February 29, 2012, Microsoft's Azure cloud management system experienced an outage that adversely affected users in parts of the United States and Europe for several hours. In either case, a multi-cloud strategy might have prevented the failures from causing significant service disruption.

To build this paper on a solid base, we applied the method of a concept-centric systematic literature review [24]. As a first step we define the review scope and concentrate on TCO and cost accounting in Cloud Computing. Key words for the search belong to the realm of Cloud Computing and include terms like “total cost”, account*, combined with “cloud computing” and “as a Service”. The applied wildcard assures the identification of related, conjugated terms. Next we applied these key words to scientific databases like EBSCO, Science Direct, SpringerLink and AISeL to receive scientific, peer-reviewed papers.

To enlarge the number of papers we used forward (review of reference lists) and backward search (author-centric review). Strebel and Stage [22] developed an economic decision model that compares costs for the internal IT infrastructure (server and storage expenses) and the external provisioning by means of Cloud Computing Services (fees for CPU hour, time contingent, storage, internet service provider costs and inbound and outbound data transfer costs). They present a formal cost model, an optimization model and a regression model that focus on the hybrid usage of internal and external infrastructure sources. Simulation runs are conducted with data from a case study. Their first finding is that Cloud Computing is more cost-effective the more business applications and processes are ready to source via a Cloud Computing Service. In contrast they find that the cost-effectiveness decreases with the number of virtualized applications, since internal servers can be used more effectively. However, they conclude that the application of Cloud Computing Services is beneficial for high storage requirements.

A cost-benefit analysis is applied by Kondo et al. [14] that focuses on IaaS. They compare Cloud Computing Services to volunteer computing applications like SETI@home and XtremLab. The benefit analysis concentrates on the system performance. Their overall finding is that in the long run volunteer computing is economically more beneficial but requires high start-up investments. For short and high performance tasks it is recommendable to apply a commercial Cloud Computing Service. Also, they just concentrate on particular cost factors (salaries, electricity, network, hardware, data storage and queries) in their approach.

While Strebel and Stage [22] as well as Kondo et al. [14] applied the company perspective on TCO in Cloud Computing Li et al. [16] focus on the provider perspective. They developed a software tool to calculate setting-up and maintenance costs for a Cloud (costs of hardware, software, power, cooling, staff and real-estate). Instead of focusing on physical hardware they concentrate on maximum virtual machines that can be deployed within a datacenter to react more flexible on customer demands. Moreover they emphasize the importance of fixed costs that providers need to bear during the whole lifecycle.

The results of the systematic literature review indicate that the topic of TCO in Cloud Computing has not been discussed extensively. For instance, several authors in this field argue that a rigorous and comprehensive TCO approach for Cloud Computing is important, since it can significantly lower the TCOs and corresponding risk factors [4]. However, they do not provide further information on how to develop such a model or tool. Furthermore, results from the field of Grid Computing that shares several features with the Cloud Computing paradigm focus on resource providers, omit storage costs and are scenario-specific (not generally applicable) [22]. To the best of our knowledge, we are the first one who develop a comprehensive TCO model that applies for IaaS, PaaS and SaaS, focuses on the particular features of these service models and include a wide range of cost types and factors.

III. PREREQUISTIES FOR THE MODEL CONSTRUCTION

The cost structure and identification of cost types have been initially created on the basis of real Cloud Computing Services and the identified literature. Finally the results of the expert interview approved and extended our model. The identification approach follows a typical decision-making process starting with a strategic decision to source a Cloud Computing Service and ending with the back sourcing or discarding of a Cloud Computing Service [13]. Next we shows an overview of the different identified cost types, representing the single phases of the decision-making process, and corresponding cost factors, which are unique by item or cost type [9].

Selection of Cloud Computing Services and Cloud Types [9,1,16,3] (str): Strategic decision on sourcing a Cloud Computing Service: as-is analysis of the IT infrastructure and business applications, analysis of performance indicators, application of decision tools; choice of Cloud Computing Service type (IaaS, PaaS, SaaS or combinations); choice of Cloud type (Public, Private or Hybrid Cloud); definition of service requirements (as e. g hardware configuration for IaaS, programming language support for PaaS and functionalities for SaaS).

Evaluation and Selection of Service Provider [14,9,1,3,5] (eva): Search process for providers offering the desired service based on the previously defined requirements. Service evaluation and analysis: evaluation of the functionalities of Cloud Computing Services; identification of the best alternative.

Evaluation of the provider and SLA analysis: determining the provider‘s reputation, analysis of the SLAs (quality of service) and of the security requirements (e. g. data recovery)

Service Charge [9,1,16,3] (char): Pricing schemes vary depending on the service type and the provider. The service charge can be calculated on the basis of the pricing schemes

Implementation, Configuration, Integration and Migration [5,1,9] (imp): Implementation and configuration of the service, including, for example, access authorizations (creating groups and users including their specific rights).

Integration into or merging with other systems and business processes. This includes the option of merging two Clouds into a hybrid Cloud. Migration of the system (porting of data)

Support [5,7,1,16] (sup): Phone, email and ticket support and/or support via chat (instant messaging)

Initial and permanent training [5,8,7,1,14] (train): Internal (by own employees) or external training (by third-party providers): User training and administrative training

Maintenance and Modification [14,16,22,7] (maint): Modifying the service to guarantee operability Testing the service operability; configuration of settings; tariff changes. Monitoring and Reporting: Performance and Cost management. Service Level Management: testing whether the provider fulfills contractual obligations (aspects of service quality, as e. g. availability)

System Failure [9,5](fail): Lost working time, Contract penalty for non-delivery of services ,Loss of reputation

Back sourcing or Discarding [9,16,22]bs):

Porting of data from the Cloud Reestablishment.

To construct a realistic and Cloud Computing specific model we conducted several analyses of Cloud Computing Service pricing schemes and distinguish between the IaaS, PaaS and SaaS service models. The selection of services for our analysis is based on our Cloud Computing Service data base which is publicly available on www.CloudServiceMarket.info and currently includes about 170 Cloud Computing Services. Additionally, we consulted several literature sources which list providers [15,20,21] and describes important cost factors [14,11,22]. For the construction of the model we identified and analyzed 15 services that appropriately describe the Cloud Computing market. The purpose of this analysis is to include a wide range of different pricing schemes which enables us to posit a general statement of pricing in Cloud Computing.

A closer look at the different types of Clouds shows that for the usage of services from a *Public Cloud* the service provider delivers the necessary resources [2]. The costs incurred depend on the particular pricing scheme. Their customers do not have any insight into the underlying IT infrastructure and have restrictive administrative rights. Hence, in case the hardware requirements are not sufficiently specified, the user needs to contact the provider’s technical support before closing a contract. On the opposite and not in the focus of this study, a Cloud Computing Service can be defined to be delivered via a *Private Cloud* if the user and the provider of the service belong to the same organization or if a third party provides the service exclusively [2]. The former (same organization) is only the case if the service is implemented into an existing IT infrastructure, i. e. if an existing infrastructure – in a rented or a company-internal data center – is transformed to a Cloud Computing Service delivery environment. The costs incurred in the course of this process include the license costs of the implemented software as well as the costs of the underlying IT infrastructure that the user must provide for. The latter case (third-party provider) resembles the Public Cloud variety of IaaS in the sense that the user procures the resources from an IaaS provider. However, the provider does not administrate the data in a Public Cloud, but in an exclusive Private Cloud. Lastly, h*ybrid solutions* can be described as an aggregation of Public and/or Private Cloud varieties [2]. The total cost of a Hybrid Cloud equals the total or at least proportionate costs incurred by each individual solution that is associated to it. Also, the monetary expenses of aggregating the individual solutions need to be considered (provided the applied software enables the creation of a Hybrid Cloud).

IV. MATHEMATICAL APPORACH FOR COST BASED MODEL

By adopting a multi-cloud strategy, that is, by running your cloud-based deployments on multiple cloud providers, redundancy is taken to a whole new level. By selecting data centres from different providers to host our cloud servers, we can effectively eliminate the risk associated with the business continuity of the infrastructure provider, as well as risks related to electricity suppliers, networking providers and other "data centre" issues, since each cloud provider will usually operate separately.

A multi-cloud strategy also reduces other risks associated with having a single provider: let's say someone discovers vulnerability on the virtualization platform that your current infrastructure provider uses. If you are deploying on multiple clouds, you can simply shut down the servers on the vulnerable provider with little or no impact to your operations. The same mentality applies if suddenly your provider decides to increase its prices, or even change its terms of service: shut down your servers, and move your business to someone else. For a while, during the early years of cloud computing (which was no more than 3-4 years ago), adopting a multi-cloud strategy was hard. Cloud providers operated on proprietary closed architectures that made migration a headache: you'd need to effectively download whatever data you had, rebuild your virtual machine from scratch on another provider, and then upload everything back again. Today, however, these barriers to change are dropping fast.

Motivated by the need to enable the interoperability of existing corporate data centres with their own public infrastructure, cloud providers are facilitating the upload and download of entire virtual machines, so that copying your VMs from one provider to another is easier than ever. There are data migration solutions that allow you to move data from one service provider to another with ease. There are even cloud-based service providers, such as Cloudability, that make it easier for you to manage multiple cloud providers at the same time.

To fulfill the requirement of *transparency* of a TCO model, we start with a description of the general model design. This means that we firstly assign cost factors To fulfill the requirement of *transparency* of a TCO model, we start with a description of the general model design. This means that we firstly assign cost factors that influence the cost types and then present the general underlying formula design that is applied for each cost type. The assignment of the cost factors **f** to the identified cost types **t** is represented in as Cost types and factors below:

Strategic Decision, Selection of Cloud Computing Services and Cloud Types (str): Expenditure of time (eot), consulting services (cons), information for decision-making (inf)

Evaluation and Selection of Service Provider (eva): Expenditure of time (eot), consulting services (cons), information for decision-making (inf)

Service Charge *IaaS* (charIaaS): Computing power (cp), storage capacity (sto), inbound data transfer (inb), outbound data transfer (outb), provider internal data transfer (intdt), number of queries (que), domain (dom), SSL certificate (ssl), licence (lic), basic service charge (bsc)

Service Charge *PaaS* (charPaaS): User-dependent basic charges (use), storage capacity [for the developer team] (sto), inbound data transfer (inb), outbound data transfer (outb), provider internal data transfer (intdt), extra user data storage capacity (udats), extra user document storage capacity (udocs), queries to the Application Programming Interface (api), sent emails (email), database (db), secured logins (seclog), connections with other providers' applications (con)

Service Charge *SaaS* (charSaaS): Access to the service system (acc), user (use).

Implementation, Configuration, Integration and Migration (imp): Expenditure of time (eot), porting process (port)

Support (sup): Expenditure of time (eot), support costs (sc),problem solving (ps)
Initial and permanent training (train): Preparation time of internal employees (prept), participating time of internal employees (part), instruction material (mat), external consulting services (cons)
Maintenance and Modification (maint): Expenditure of time (eot)
System Failure (fail): Loss per period (loss)
Backsourcing or Discarding (bs): expenditure of time (eot), porting process (port)
Selection of Cloud Computing Services and Cloud Types: The costs of strategic decisions and the selection of suitable Cloud Computing Services are made dependent on the expenditure of time (eot) necessary for decision making (expressed in monetary terms). The expenses for information on which the decision may be based (inf), as e. g. scientific literature or market studies, as well as costs of external consulting services (cons). The total costs of the expenditure of time result from the total expenditure of time of all involved employees. It is determined by multiplying the employee's hourly salary $P^{str}_{eot,m}$ by the expenditure of time $a^{str}_{eot,m}$ and add up for all involved employees m: $C^{str}_{eot} = \Sigma\, P^{str}_{eot,m} * a^{str}_{eot,m}$ .Costs for decision-making incur in periods i < 1. Furthermore, the total cost of purchased information materials (inf) can be described as the sum total of the prices of all purchased materials. Lastly, the costs of consulting services C^{str}_{cons} are summarized into a total. The cost factors of cost type str are finally add up:
$C^{str} = C^{str}_{eot} + C^{str}_{cons} + C^{str}_{inf}$
Evaluation and Selection of Service Provider (eva): The costs induced by the process of evaluating and selecting service providers depend on the amount of time that employees invest in this process (eot) and on the costs of external consultants that support this process (cons). The calculations for C^{eva}_{eot} and C^{eva}_{cons} are analogously conducted to C^{str}_{eot} and C^{str}_{cons}.
Service Cost for IaaS (charIaaS): For IaaS the service charge depends on the cost factors **C** that are presented above. The period-specific costs for used computing power are calculated by multiplying the number of used processing units $a^{serIaaS}_{cp,i}$ per period i by the price of one computing unit $p^{serIaaS}_{cp,i}$ within period i. The price varies according to the specific characteristics of the system, as e. g. RAM, the number of computing units, storage capacity (in GB), the used operating system (Linux or Windows) and the platform (32-bit or 64-bit). The total costs of this cost factor result from the addition of all induced costs during all periods n
$C^{charIaaS}_{cp} = \sum_{i=1}^{n} a^{charIaaS}_{cp,i} * p^{charIaaS}_{cp,i}$.

This calculation scheme is also applied for storage capacity costs (sto), inbound (inb), outbound (outb) and internal data transfer (intdt) to other web services by the same provider and query costs (que). The total costs of a domain (dom), an SSL certificate (ssl), software license (lic) and basic service charges (bsc) are determined by multiplying the number of used periods n by the respective price p^{t}_{f} of the cost factor f of the respective cost type t $C^{charIaaS}_{dom}$=n*$P^{charIaaS}_{cp}$
Service Cost for PaaS (charPaaS): Again, we applied the cost factors listed above for charPaaS. Firstly, service prices are regularly user-dependent basic charges and incur in period i.
However, these costs frequently cannot exceed a maximum value $C^{charPaaS}_{MAXuse}$ per period i: $C^{charPaaS}_{use} = \sum_{i=1}^{n} C^{charPaaS}_{use,i} = a^{charPaaS}_{use,i} * p^{charPaaS}_{use,i}$ with $C^{charPaaS}_{use,i} <= C^{charPaaS}_{MAXuse}$ .Storage capacity for the hole developer team is determined by $C^{charPaaS}_{sto,i}$ and calculated in the same way as for IaaS: $C^{charPaaS}_{sto,i} = a^{charPaaS}_{sto,i} * p^{charPaaS}_{sto,i}$
The formula for the calculation of the overall costs of the cost factor computing power is the same for PaaS and IaaS. Furthermore, some providers charge a fee for sent emails whose amount depends on the number of messages . The costs for databases (db), secured logins (seclog) and connections (con) to other providers' applications can be calculated by multiplying the number of occurrences of each cost factor f during period i by the respective price p.
*Service Cost for SaaS (charSaaS)***:** Service charges for SaaS are often determined on the basis of an access price per period $P^{serSaaS}_{acc,t}$ .Additionally they may also be dependent on the number of users $a^{serSaaS}_{acc,t}$ If this is not the case, this factor takes a value of 1 in our approach. The total costs of the period-dependent cost factor acc equals the sum total of all costs caused by this factor during all periods n: $C^{charSaaS}_{acc} = \sum_{i=1}^{n} a^{charSaaS}_{use,i} * p^{charSaaS}_{acc,i}$.

Finally, the overall costs of the service charge for SaaS equal the sum of the total costs of all individual cost factors f.

Implementation, Configuration, Integration and Migration (imp): The total costs of this cost type are dependent on the expenditure of time (eot) to fulfill the required tasks as e. g. implementation, configuration, integration and migration of services and data. An important cost factor in this category is the need of data porting from the customer to the provider (port). As mentioned, the providers charge their customers for inbound data transfer.

The costs of the *initial* transfer of data to the Cloud for the purpose of system migration belong to this cost type. They are calculated by multiplying the data volume per unit (i. e. gigabyte) by the price of one unit. Some providers offer hard disk shipping services to input the customer's data. However, this approach does not focus on data volume but rather on the number of hard drives and data loading time. The cost factor "porting" is not made dependent on temporal price shifts because it is assumed that the data porting process can be completed within one period t: $C_{port}^{imp} = a_{port}^{imp} * p_{port}^{imp}$

Support (sup): The cost type „Support" depends on the costs of support services via telephone, email, ticket systems or chat. It is assumed that the customer has access to the internet for reasons other than technical support (cf. assumption 1). Therefore this type of costs depends on the expenditure of time (eot) required for interactions with support personnel, as well as on occurred costs. However, some providers charge users on the basis of the time needed for problem solving and support.

Initial and Permanent Training (train): The total costs of the cost type „initial and permanent training" can be subdivided into internal training (staff members as coaches) and external training (third party coaches from outside the company). There can be several internal and external trainings. The costs of an internal training depend on the amount of preparation time invested by one or more employees (prept), the amount of time invested by participating employees (part) and the costs of instruction material (mat).

Maintenance and Modification (maint): This cost type depends on the expenditure of time (eot) for the general maintenance and for modifications made to the service implementation The cost factor "tariff switch" is included here as well.

System Failure (fail): The consequences of a system failure strongly depend on the interdependencies of services and business processes and their relevance to the business goals. Hence, the total costs of a system failure need to be stated for each company individually. Possible cost factors are, for example, loss of productive working time, contract penalties for delays or damage to the company's reputation which is hard to evaluate.

Backsourcing or Discarding of the System (bs): The backsourcing of the system involves costs for the porting of data from the Cloud (port), as well as a certain expenditure of time (eot).

Case Study

From a cloud provider's perspective, the elastic resource pool (through either virtualization or multi-tenancy) has made the cost analysis a lot more complicated than regular data centers, which often calculates their cost based on consumptions of static computing. Moreover, an instantiated virtual machine has become the unit of cost analysis rather than the underlying physical server. A sound charging model needs to incorporate all the above as well as VM associated items such as software licenses, virtual network usage, node and hypervisor management overhead, and so on.

For SaaS cloud providers, the cost of developing multitenancy within their offering can be very substantial. These include: re-design and re-development of the software that was originally used for single-tenancy, cost of providing new features that allow for intensive customization, performance and security enhancement for concurrent user access, and dealing with complexities induced by the above changes. Consequently, SaaS providers need to weigh up the trade-off between the provision of multi-tenancy and the cost-savings yielded by multi-tenancy such as reduced overhead through amortization, reduced number of on-site software licenses, etc. Therefore, a strategic and viable charging model for SaaS provider is crucial for the profitability and sustainability of SaaS cloud providers.

To illustrate the application of the presented model, we introduce an example that deals with the provisioning of a public IaaS Cloud Computing Service. A start-up company that develops web platforms and services decides to source infrastructure services like computing, power and storage capacity from a Cloud Computing Provider.

The advantages for the customer lie in the flexible cost accounting of Multi Cloud Computing Services. For instance, in periods with low market demand for his services he can scale down the required systems.

In this case study the chosen Cloud Computing Provider (Amazon Web Services) has been identified in previews periods and the decision-maker wants to calculate the TCO of this particular provider. The strategic decision required 16 hours of work (average wages per hour for decision-maker and IT personnel: $112) plus costs for information material amounting to $140. Consulting services are to be omitted since costs should be kept down. Since the business processes are strongly dependent on the provider's performance the availability of the service is very important and was set to 99.99%. For the identification of a suitable provider he assumes 20 hours. Since the company is quite young the planning period just covers 12 month. Two month during this year are assumed to require a highlevel of computing power. Thus the provider charges 10 times a regular rate for two windows instances of $0.14 per hour and twice $0.48 per hour for peaks.

In the first year 1 TB of storage capacity is required that costs $0.14 per GB. The data transfer will be 200GB per month ($0.12, charged by the second GB of data transfer). Since the company did not realize a Cloud Computing project yet, implementation efforts are quite high and estimated to 50 hours. Costs for inbound data transfer are not charged by the provider. Since support information for the provider's services are available in many internet forums the company subscribes to the lowest level of support that cost $50 per month. Costs for trainings are not accounted, for the new infrastructure will not change the business processes. The maintenance and modification efforts are estimated to be 2 hour per month. For the assessment of the system failure we assume a loss of $50 per month.

V.CONCLUSION

In this paper, we proposed a cost based model for selecting multi-cloud storage ,which seeks to provide each customer with a better cloud data storage decision, taking into consideration the user budget as well as providing him with the best quality of service offered by available cloud service providers. By dividing and distributing customer's data, our model has shown its ability of providing a customer with a secured storage under his affordable budget.In this paper we argue that the analysis of relevant cost types and factors of Cloud Computing Services is an important pillar of decision-making in Cloud Computing management. The IT artifact is presented in the form of a mathematical model and implemented on a website that is open for the general public. The Cost based model has been evaluated by means of an expert interview, the result of the analysis of real Cloud Computing Services, a case study as well as scientific taxonomies and ontologies. During our research process we found that the evaluation and selection process of Cloud Computing Services is frequently conducted ad-hoc and lacks systematic methods to approach this topic. The presented method rises the awareness of indirect as well as hidden costs in Cloud Computing. Nevertheless, the TCO approach should be regarded as one part of a comprehensive IT cost management and as an additional method to evaluate a Cloud Computing Service. Every mathematical approach has some limitations that need to be considered for its practical application.

First, we made some restrictive assumptions that support us in taking a particular focus on Cloud Computing Services. Thus, we hide cost types that focus for instance on an existing internal IT infrastructure and their cost factors (cf. assumption 1 and 2). If a company plans to implement a private Cloud these additional cost types are necessary for a complete evaluation. Since our approach focuses strongly on the evaluation of Cloud Computing Services that are frequently provided externally, we feel that these assumptions simplify the cost evaluation approach and its applicability. Furthermore, we do not consider quality or functional aspects of Cloud Computing Services within our method. We support the migration to multi-clouds due to its ability to decrease security risks that affect the cloud computing user.

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