CLIMA 2016 - proceedings of the 12th REHVA World Congress

volume 6

Heiselberg, Per Kvols

Publication date:
2016

Document Version
Publisher's PDF, also known as Version of record

Revisiting Business Models within Cloud Market

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Abstract

ASCETiC supports software developers to optimise energy efficiency from designing, developing, deploying, and running software in a cloud. In particular, it offers a cloud stack that relates software design and energy use, depending on the deployment conditions and the correct operation of the service by means of an adaptive environment. In this context, we focus on the existing business models within the cloud market, and investigate how they could be evolved taking into account energy efficiency considerations. The three main actors identified, basically SaaS, PaaS and IaaS providers, as those that can adopt ASCETiC results, and which can extend their current business models based on these premises. Based on this, we propose and implement a methodology for validating business models according to different considerations in order to determine which the most promising ones within the cloud market are.

Keywords - energy efficiency; cloud computing; business models

1. Introduction

Adapting Service lifeCycle towards EfficienT Clouds (ASCETiC) [1] is an EU-FP7 project focused on providing novel methods and tools to support software developers aiming to optimise energy efficiency from designing, developing, deploying, and running software in cloud. At the same time, quality of service, experience and perception is taken into account, so energy efficiency will complement them and boost cloud efficiency at several dimensions. The primary aim of ASCETiC solution, called *ASCETiC Toolbox* [2], is to relate software design and energy use, depending on the deployment conditions and the correct operation of the service by means of an adaptive environment. ASCETiC considers the three different layers of a Cloud stack. *SaaS* layer facilitates the modelling, design and construction of cloud applications. *PaaS* layer provides middleware functionality for a cloud application and facilitates the energy-aware deployment and operation of the application as a whole. *IaaS* layer considers the admission, allocation and management of virtual resources. A conceptual view of ASCETiC architecture is depicted in Figure 1. More technical information is provided in [3].

SaaS, PaaS and IaaS providers are those that can adopt the ASCETiC Toolbox, and the main actors in the its value chain. These actors may cooperate with each other for the provision of the service or purchase the services of the other layers. Thus, depending on the relation of an organization to the roles of the value chain, we may result in the stand-alone business models (i.e., Infrastructure, Platform and Software). Under these models, the organizations can have only one role, and consequently the way of gaining revenues is based on this role. However, other organizations may exist combining two or more roles in the way of doing business. For example, Microsoft plays both the Infrastructure and the Platform roles when it provides VMs with Microsoft Azure. Thus, multiple combined business models may exist (e.g., IaaS- PaaS). Apart from potential coalitions between the involved stakeholders, we consider incentive issues regarding information exposure among the different cloud layers. As a next step, we propose and implement a methodology for validating business models according to different considerations in order to determine which the most promising ones within the cloud market are.

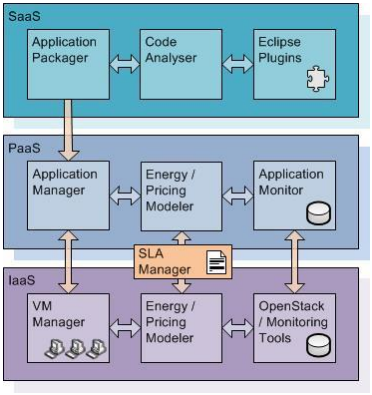

Fig. 1 A conceptual view of the three-layer ASCETiC architecture

The paper is organized as follows: Chapter 2 depicts the ASCETiC value chain and analyses the roles of the different actors involved. In Chapter 3, we identify the potential business models under the ASCETiC approach, depending on the relation of an organization to the roles of the value chain and highlight incentive issues regarding information exchange among the involved stakeholders. Chapter 4 proposes a methodology and validates the potential business models arising under ASCETiC approach.

2. Value-chain for cloud services

Figure 3 depicts the ASCETiC value chain, by using the traditional chain for cloud computing services as a starting point for our analysis.

Hardware Providers: Such stakeholder is an indirect part of the ASCETiC value chain, since the demand for energy efficiency will motivate them to adapt their offerings based on the needs of the market.

Virtualization vendors: The overhead generated by virtualization results in increased energy consumption. The Toolbox provides several benefits to them, assuming that they combine their offerings with cloud.

Energy meter providers: Energy meter providers are an optional actor, as energy meters are one of the mechanisms used for the necessary energy monitoring. ASCETiC has investigated other mechanisms in order to gather energy monitoring data by using new capabilities offered by hardware providers in new equipment and mechanisms to reduce the number of meters needed. In addition, in order to reduce the amount of necessary meters in a infrastructure, and therefore associated costs, hardware servers' profiling and simulation can be used.

Energy providers: Since the Toolbox focuses on decreasing energy consumption; this could affect the revenues of energy providers. On the other hand, monitoring consumption may provide useful input to provide customized offering to the needs of each client. By using the Toolbox, energy provider could be enabled to include in their portfolio enhanced management, as well as an optimal energy consumption certificate.

IaaS providers: IaaS layer clearly demonstrates the difference between traditional IT approach and the cloud-based infrastructure service, since the user has the capability to access and use processing, storage, networks and other fundamental computing resources. IaaS providers allow consumers to tailor their requirements, which may however affect a wide range of parameters, including for example the energy usage. The Toolbox could be an important asset for the IaaS providers to monitor the cost-related parameters and apply appropriate pricing schemes, as well as a competitive advantage to make the difference with their competitors.

PaaS providers: In PaaS service model providers deliver a cloud-hosted virtual development environment along with the necessary solution stack, allowing customers to develop, run and manage applications without the complexity of building, configuring and maintaining the infrastructure typically associated with application development and launching. Using the Toolbox, PaaS providers will be enabled to access the mechanisms required to offer an energy-optimized service to their customers, and minimize their own performance costs. Additionally, the Toolbox enables the bidirectional communication among the IaaS and SaaS layers.

SaaS providers: Since the ASCETiC framework provides an energy-aware software designing tool, as well as a programming model; it could be useful also for the SaaS providers. In particular, SaaS providers will be enabled to identify the parts of an application that consume more energy at a given time, as well as to adapt it dynamically, based on their needs. Apart

from optimizing the energy consumption of a given application, the SaaS providers will be enabled to develop and port applications to the cloud.

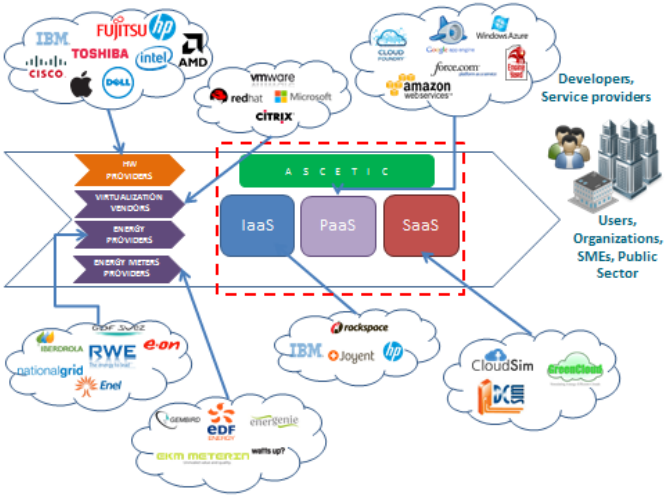

Fig. 2 ASCETiC value chain

3. Arising Business Models

Depending on how identified actors interact in the market, and taking into account the adoption path proposed by ASCETiC, the Toolbox can be adopted in different ways, going from individual providers (IaaS, PaaS and SaaS) to a combination of them. ASCETiC Toolbox adoption for Cloud providers propagates from bottom to top of the Cloud stack. PaaS features rely on the IaaS layer capabilities and metrics, while SaaS tools require PaaS layer tools adoption. ASCETiC Toolbox builds on top of state-of-the-art tools. Based on energy monitoring metrics (gathered by means of any of the available mechanisms) together with the ASCETiC IaaS layer tools, a IaaS Cloud provider can become an ASCETiC-enabled IaaS provider. Building on top of IaaS tools, providers can move upper in the Cloud stack by adopting increasingly PaaS and SaaS tools. Within this context, different business scenarios have been identified to cover the adopters' needs and a set of business models is provided for each of them. After ASCETiC adoption, traditional business models are converted into ASCETiC enabled ones to include energy considerations. Below, we identify potential stand-alone, as well as combinatory BMs, and discuss incentive issues regarding information exchange among the different layers of a cloud stack.

a. Stand-alone Business Models

Three business models (BMs) can be found, the ASCETiC IaaS, the ASCETiC PaaS and the ASCETiC SaaS, as depicted in Figure 3.

IaaS BM: It can be considered as the basic one, since the IaaS providers are those that are primarily affected by the energy consumption of their machines and they also pay the bill. It is based on the needs of the IaaS cloud providers or cluster and server providers. The providers adopt and use the ASCETiC Cloud Stack in order to be able to measure the energy consumed by the deployed VMs, optimize the consumption and reduce related costs. The cost reduction and the optimization of the operation of the machines will differentiate the provider and will incentivize customers using these services.

PaaS BM: It is applicable to providers offering services under the PaaS level. The providers may adopt the Toolbox to provide to their customers of SaaS level the energy monitoring offered by the IaaS providers. The incentive of the providers of this level for using the Toolbox is not very clear since they are not paying the electricity bill. However, adopting ASCETiC will enable them to provide specialized services to their customers as monitoring energy and adjusting their software to the energy changes as well.

SaaS BM: It is applicable to providers that offer services from SaaS level. After adopting the Toolbox, SaaS providers can decrease energy consumption offering to their customers "green" software or providing developers the means to produce energy efficient software.

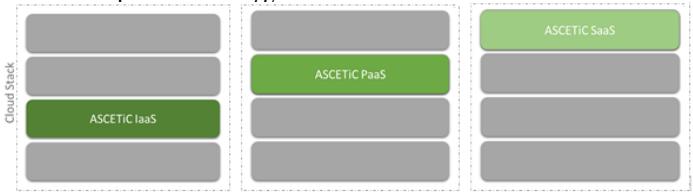

Fig. 3 ASCETiC stand-alone business models

b. Combinatory Business Models

In real life, providers usually combine several roles. For example, it is natural for an IaaS provider to also become a PaaS provider or even to offer SaaS services too. In this section, we analyze the combinatory BMs that results from the merging of the above stand-alone ASCETiC enabled BMs. Figure 4 summarizes the identified combinatory business models.

Energy Provider–IaaS: Since energy becomes really important for IaaS providers, they soon understood that providing their own energy to their infrastructure and managing the way of its production, it would save them a huge proportion of costs. Large companies have adopted this model (or even the combination with PaaS too, as presented below), such as Google. The companies under this BM possess the infrastructure to produce their own, usually green, energy and they take seriously into account alternative ways of cooling their machines. An ASCETiC-enabled IaaS provider producing its own energy, could boost its savings even more. The information is flowing between these two, in any other case, entities freely and they can adapt their energy production based on the information coming from the Toolbox.

Energy Provider–IaaS–PaaS: This BM combines the above BM with the functionality of the PaaS stand-alone BM that described before.

Energy Provider–IaaS–PaaS–SaaS: This BM combines the above BM with the functionality of the SaaS stand-alone BM that described before.

IaaS–PaaS: Its basis, the one that is not ASCETiC enabled, is one of the most common BMs, since it has been adopted by many large companies and medium ones that are Infrastructure providers offering also services that usually belong to the Platform level. This BM is so popular that makes it difficult for most people to distinguish a stand-alone PaaS provider.

IaaS–PaaS–SaaS: This BM has been adopted by many large companies that are Infrastructure providers but also offer software as a service. Note here that another BM may exist, the PaaS-SaaS BM, where the value proposition is similar but the IaaS services are provided by a key partner.

Fig. 4 ASCETiC combinatory business models

c. Information Exposure Incentives

An interesting arising issue is the collaboration among different providers, as well as the level of information exposure among the cloud layers. Such coalitions could result in gaining mutual benefits. For example, assuming that an IaaS provider using the Toolbox is aware of the predicted energy consumption of a given task potentially has incentives to collaborate with an additional IaaS provider to handle and minimize his upcoming costs. Apart from collaboration among stakeholders of the *same* group, cooperation between *different* groups may also provide benefits for both (e.g., an IaaS provider and an energy provider). Business agreement between players could differ in terms of information exchange. Such agreements do not necessarily mean that both players will reveal all the available information. For example, there could be information asymmetry between the IaaS and PaaS layers, if the IaaS provision and the PaaS provision roles are played by different stakeholders. In this case, it may be assumed that one party to an interaction has relevant information, whereas the others do not. Such information could

be related to *energy prices*, *price variations*, *special price offerings*, *prediction of energy consumptions* among the different cloud stack layers, etc.

4. Business Models Validation

Once the different BMs have been identified, it is necessary to investigate their viability to identify which are the most promising ones to succeed in the current market context. In ASCETiC, this has been done in two ways: one from the *purely research point of view* and another one *interacting with different stakeholders out of the project*. In the first case, a questionnaire has been distributed among project partners to collect their thoughts about the potential of ASCETiC applied to the different scenarios previously identified, opposite to traditional scenarios where energy aspects do not play a relevant role. The second case has been implemented through a wide set of business questionnaires where different XaaS providers have been interviewed to identify their real needs and expectations, and validate our proposed models. A thoroughly analysis of traditional models where produced prior to the elaboration of the different questionnaires to identify the gaps that can be covered by ASCETiC BMs. Results of conducted business interviews and online survey were combined and approximate values were extracted in order to measure each of the validation criteria used below.

a. Validation criteria

Our evaluation framework evaluates, validates and compares the BMs with each other as well as with the current BMs. A set of criteria of the basic evaluation model are categorized into two dimensions; the *impact* on the *customers* and the *market* and the *ease of implementation*, which describes how likely is for a provider to adopt this BM. We have added a few more criteria that belong to the wide category of alignment of the BM to the market trends. These criteria have resulted through the analysis of the business questionnaires and the interviews to key stakeholders. The range of the values assigned to the criteria is between 0 (lowest) and 5 (highest). Table 1 depicts the criteria and their definition. All the values of the criteria construct a unique one that identifies each BM to ease the comparison between them.

	Criterion	**Value**
		[0 - 1] lower, [1 - 2] low, [2 - 3] medium, [3 - 4] high, [4 - 5] higher
IMPACT	*Revenue potential*	Value the revenue potential.
	Customer acceptance	Value the need of customers for the product.
	Differentiation	Value the novelty on the market.
	Impact on critical mass	Value the number of partners and customers participating.
	Visibility	Value the potential to raise attention without explicit marketing campaigns.

EASE OF IMPLEMENTATION	*Investment costs*	Value the investment costs.	
	Time required	Value the time required until first service is sold.	
	Risks	Value the objective technical feasibility with today's knowledge.	
	Transparency	Value how detailed is the info provided to the customers	
	Value creation	Partners	Importance of value generated from the partners (current and future).
		Value proposition	Value the robustness of your proposition.
		Customer	Value the size of your target market (potential customers)
ALIGNMENT WITH NEW TRENDS	*Aligned with Governmental Policies*	Value how aligned the model is with the governmental policies regarding energy	
	Aligned with demand response model	Value how aligned the model is with possible demand and response model	
	Aligned with pricing schemes based on energy consumption	Value how aligned the model is with possible pricing schemes based on energy consumption	
	Aligned with multiple consumption patterns	Value the ability of the provider to use different consumption patterns	
Savings		Value the savings on costs based on energy	

Table 1. Validation criteria

b. Validation Business Scenarios

After analysing the previous work, three different models have been appointed as the most promising ones: *IaaS stand-alone BM*, the *combination between IaaS and PaaS BMs*, and the one that covers the adoption of the whole Toolbox (*combination of IaaS, PaaS and SaaS BMs*).

IaaS BM: Traditional IaaS BM has been depicted as the most common one nowadays in the market, as it is adopted by several IT companies to offer services to their customers. Thus, its impact on the market is huge, and it has a high revenue potential as it also has a high impact on critical mass due to the large customer base. On the other hand, the ASCETiC BM has a big factor of differentiation, allowing IaaS providers savings by metering the energy consumed at VM level, controlling costs, introducing new pricing schemes based on energy consumption and offering more transparency to customers on the procedures. Results are synthetized in Figure 5.

IaaS and PaaS BM: This traditional BM is even more common than the stand-alone IaaS one. Thus, it is expected that this model has a high impact, since its revenue potential, acceptance, impact on critical mass and visibility are also high. The value creation from the ASCETiC proposition for this model is high, as concluded from the available information, as it has been

identified as a more robust model that really faces market trends and it is more transparent and differentiated than the traditional one. Based on the results of the conducted studies, *differentiation* has been identified as the key factor for adopting this model (Figure 6).

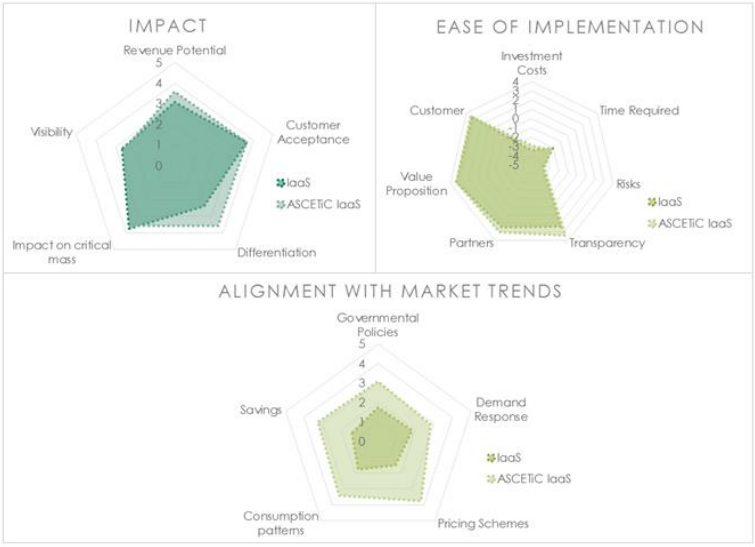

Fig. 5 Validation of IaaS and ASCETiC IaaS business models

Fig. 6 Validation of IaaS-PaaS and ASCETiC IaaS-PaaS business models

IaaS, PaaS and SaaS BM: This BM represents the whole validation of a cloud stack, as it covers all its layers. However, it can become easily obsolete as the traditional model is not following the current market trends, not taking energy into account as the model proposed by ASCETiC is doing. From the new proposed model perspective, IaaS and PaaS providers interact as one single entity what means total revelation of information between the different layers, becoming more transparent. *Transparency*, *differentiation* and *revenue potential* have been identified as decisive factors for adopting this new model (Figure 7).

Fig. 7 Validation of IaaS-PaaS-SaaS and ASCETiC IaaS-PaaS-SaaS business models

5. Discussion

The provided information represents not only a theoretical work, as the presented BMs are being validated through three different use cases, that represents the combination of data-intensive applications with compute intensive applications, so to understand differences and complementarities among them.

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