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A Business Model for a South African Government Public Cloud Platform

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Abstract: Advances in Information Technology have brought about cloud computing, an evolutionary computing practice that facilitates the provisioning of computing services as a utility. Cloud computing has brought about change in the economics and sustainability of Information and Communication Technology (ICT) enabled service provision. In South Africa, major aspects of public cloud computing or cloud in general have not yet been developed and realised and in some cases not even researched, hence the struggle to reach the full promises of public cloud computing locally.

Whilst a lot of development and progress worldwide has already been made in the public cloud space, there still remains a wide range of concerns that still need to be addressed in order for it to reach its full potential, more specifically in the South African context.

A study identifying fundamental services needed by the community and possibilities for and potential impacts of delivering public services in line with the concept of a cloud of public services is conducted. This paper designs a cloud business model that suits South Africa's perspective. The idea is to model a government public cloud which does not interfere with the secured business functions of the government but find a suitable mechanism to extend government services to the citizens.

In adopting this vision, the government must ensure that the cloud service still provides an acceptable level of security risk mitigation and allows government organizations to demonstrate their procedures of meeting legal and statutory obligations as far as information is concerned.

Keywords: Cloud Computing, Business Model, Public Cloud, , ICT

1. Introduction

Although utility computing appeared earlier and is in principle applicable in grid computing, only recently have business models and pricing become accepted and implemented in a cloud computing context. Cloud computing can be provisioned using an organizational servers, or it can be rented from a cloud provider, taking all the capital risk of owning the infrastructure.

Cloud computing is reshaping the economics of IT [2]. Businesses and consumers now can access massive amounts of computing power. Cloud computing is a way to access and use ICT services in a flexible and agile fashion, buying only the services needed when they are needed ensuring that it is done well once and then re-used later. In achieving this, there are challenges that evolve in procurement, transition and operational arrangements. In adopting this vision, the government should ensure that the cloud service still provides an

acceptable level of security risk mitigation and also allows government departments to demonstrate the procedure they are using to meeting their legal and statutory obligations as far as information is concerned.

In the private model, a company or organisation owns the technologies and defines consumers who can use the service. This leads to greater control but not always greater security; and maybe not to lower costs because the technologies still need to be operated and maintained internally. Certainly, these technologies can be customised, managed, and monitored by trusted employees, and this leads to greater confidence in what happens to the data and applications delivered.

Business model choices define the architecture of the business. It is therefore crucial to embrace agile methods during the design process. In business agility, IT can be used as a competitive tool through rapid deployment, parallel batch processing, use of compute-intensive business analytics and mobile interactive applications that respond in real time to user requirements. The greatest value will be gained by government changing the way customers buy and operate their ICT. Some of the basic concepts that are crucial to understand and form significant part of this paper are listed and discussed in details below.

1.1. Utility computing

Utility computing is essentially outsourced computing resources offered in a metered or pay-as-you-go scheme. In one model of virtualisation [19], the customer selects or controls the software for virtual server instances obtained from one or more utility service providers. The customer may in turn use their private slices of leased resources to run software that provides a service to a dynamic community of clients.

1.2. The cloud architecture

Cloud architecture, the systems architecture of the software systems involved in the delivery of cloud computing, typically involves multiple cloud components communicating with each other over application programming interfaces (APIs), usually web services [22]. The two most significant components of cloud computing architecture are known as the front end and the back end. The front end is the part seen by the client including the applications used to access the cloud via a user interface such as a web browser. The back end of cloud computing architecture is the 'cloud' itself, comprising various computers, servers and data storage devices. Cloud architectures are designs of software applications that use Internet-accessible on-demand services [20]. Applications built on cloud architectures are such that the underlying computing infrastructure is used only when it is needed, for example, to process a user request, draw the necessary resources on-demand (like computer servers and storage), perform a specific job, then relinquish the unneeded resources and often dispose them after the job is done. While in operation, the application scales up and down elastically based on resource needs. Cloud architectures address key difficulties surrounding large-scale data processing. In traditional data processing the following difficulties can be faced:

- To get many machines as an application needs.
- To get the machines when one needs them.
- To distribute and coordinate a large-scale job on different machines, run processes on them and provision another machine to recover if one machine fails.
- To auto scale up and down based on dynamic workloads.
- To get rid of all those machines when the job is done.

Cloud architectures solve such difficulties [20].

2. Motivation of the Study

The objective of this study is to design a business model for the SA public cloud. This cloud will serve as an enabler for hosting education application for the 26 schools located at Cofimvaba district. The end product form this project will be a cloud demonstrator, which can then be extended to national government depending on its reception. The intention of this work is to extend the possibilities of providing government services to South African citizens. No interference with the government private cloud is intended; hence permission boundaries should be made between the critical systems running government core business functions (government private cloud) and services offered to the public through a cloud of public services.

This study focus is on education since national and provincial government have prioritized education as a key focus area for major improvements with the extension of broadband technology to reach schools throughout the country and one of key government infrastructure investments. The education project already launched in the Eastern Cape Province is used as a proof of concept to demonstrate the feasibility of using a cloud concept for providing government services. ICT4RED is a project managed by the CSIR education team. The stakeholders involved in ICT4RED besides CSIR-Meraka includes the Department of Science and Technology (DST), Department of Basic Education, Department of Rural Development, and Eastern Cape Department of Education. It involves the rolling out of tablets to learners and teachers in 26 schools in the Cofimvaba district of the Western Cape province of South Africa. Cofimvaba is a rural area; therefore Internet connectivity is a problem. Only one school is connected through satellite bandwidth. The rest of the schools will be connected through wireless mesh network since satellite bandwidth is costly.

3. Cloud Based Business Model

This section forms the basis of our cloud business model, a review of principles underlying the business perspective of cloud computing are elaborated. There are several definitions of cloud computing. Possibly, the definition that is most widely accepted is the one that the National Institute of Standards and Technology developed, currently, at version 15 [1]. From the perspective of economy, a semantically equal mnemonic cloud can utilise the customer-centric cloud service model proposed at [2] that can help in bringing the economic advantages to the surface. A cloud service has the Business Model and Value Chain. The concept of business model is highly relevant in the context of cloud computing. According to Iyer and Henderson (2010), cloud computing is an evolution of the dominant business model for delivering IT-based solutions [3]. Similarly, Zhu, et al. (2009) argued that cloud computing distinguishes itself from previous computing paradigms by its emerging business model, which creates remarkable commercial value in inventive developments. The concept of the business model is still relatively poorly understood and there is much confusion in the terminology [4, 5, and 23]. Some authors use the business model to simply refer to the way a company does business, whereas other authors emphasise the conceptual model aspect. Nevertheless, previous research agrees on the business models' position as a conceptual and theoretical layer between business strategy and business processes [5]. According to [7] business logic triangle model, the business model represents the architectural level between planning and implementation (Figure 1).

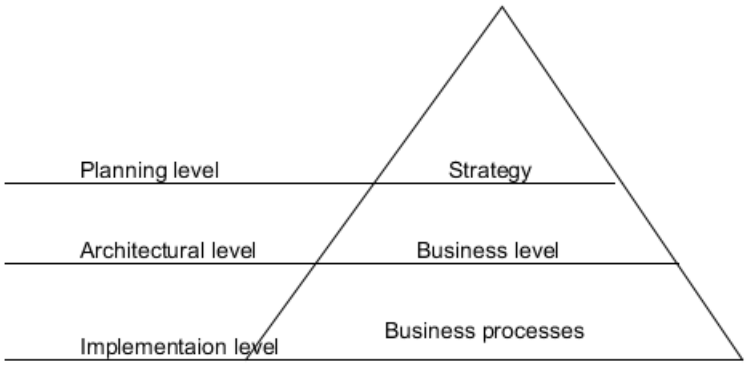

Figure 1: Business logic triangle (Osterwalder & Pigneur, 2009)

In [5], the business model is defined as ways to create value for customers: "The concept of the business model in the literature on information systems and business refers to ways of creating value for customers, and to the way in which a business turns market opportunities into profit through sets of actors, activities and collaboration". While [7] define a business model as a tool for expressing business logic and describing customer value: "A business model is a conceptual tool containing a set of objects, concepts and their relationships with the objective to express the business logic of a specific firm. Therefore we must consider which concepts and relationships allow a simplified description and representation of what value is provided to customers, how this is done and with which financial consequences."

The authors propose a single reference model based on the similarities of a wide range of business model conceptualisations. The model comprises nine "building blocks" categorised to four elements (Figure 2). The element of financial aspects is composed of cost structure and revenue model building blocks, and together they determine the business model's profit/loss-making logic.

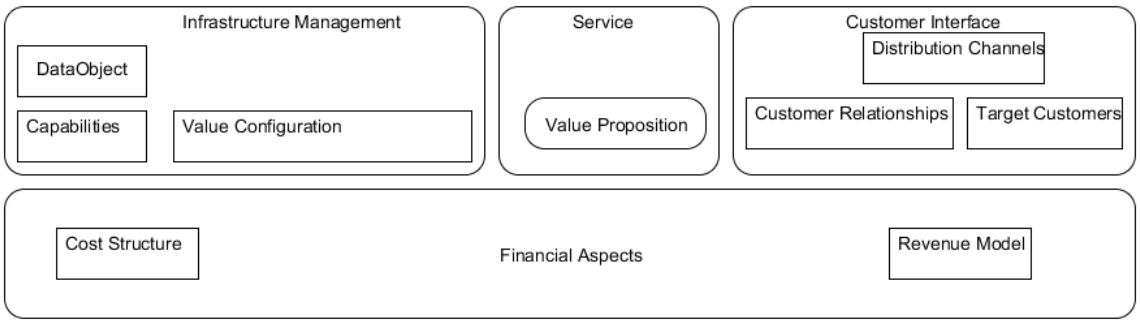

Figure 2: The business model ontology (Osterwalder, 2004)

[8] discuss the role of the business model in capturing value from an innovation. Since cloud computing is generally regarded as some type of innovation, the business model could serve as a tool for capturing economic value from this new technology. The authors define a business model as a mediating construct between technology and economic value (Figure 3). The business model mediates technical inputs such as feasibility and performance to economic outputs such as value, price or profit.

Other authors argue that the function of the business model is to justify the financial capital needed to realise the model and to define a path to scale up the business.

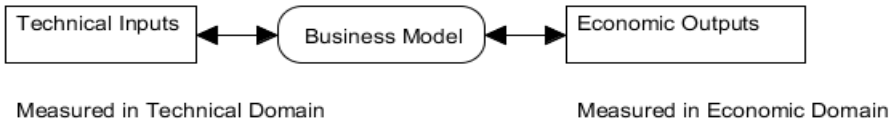

Figure 3: The business model as a mediating structure (Chesbrough & Rosenbloom, 2002)

[6] connects the business model concept to cloud computing by proposing a cloud business model framework (Figure 3-7). The framework suggests that different business models could be derived from the different cloud service models as shown in Figure 4.

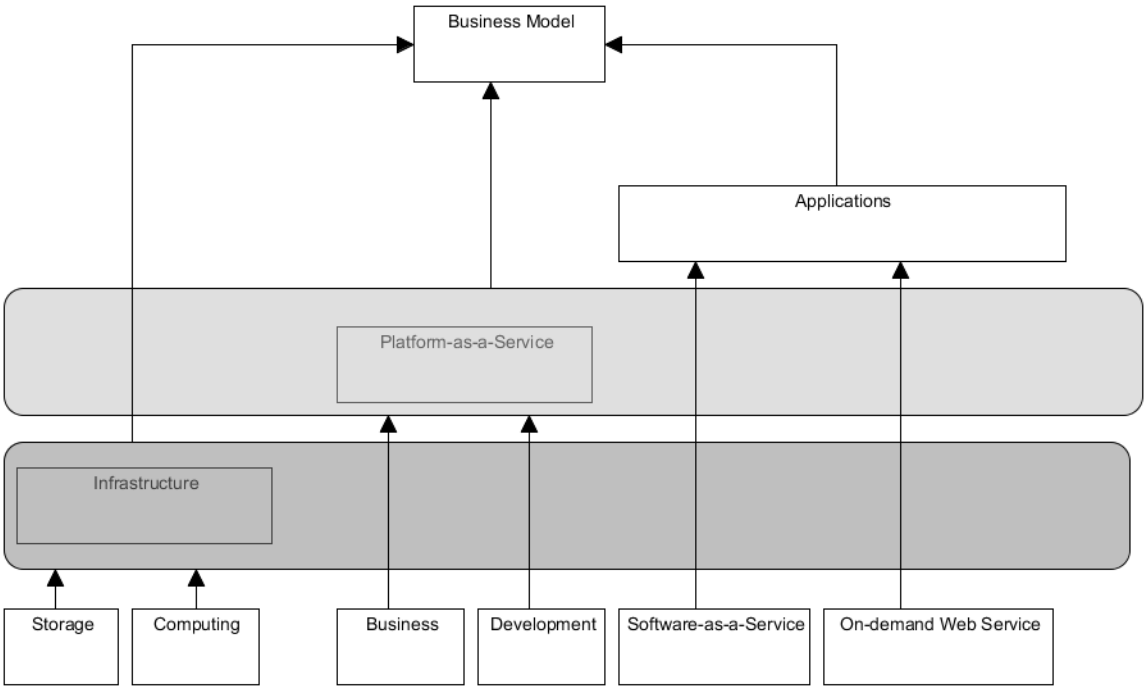

Figure 4: Cloud business model framework (Weinhardt et al., 2009)

[9] also argue that each of cloud service should be based on a certain business model. However, Leimeister et al. (2010) argue that because of the dynamic and highly evolving nature of the cloud services market, business models must also be dynamic. They argue that conventional static models do not reflect the real world and lack substantial elements of changing market environments. They therefore suggest that business models are continuously adjusted to the current hype cycle phase, technology changes, regulations and market developments, which helps service providers to create stable businesses. Some authors [e.g. 10 & 11] compare the business model in the cloud computing context with the role of service providers. [9] discuss cloud computing value network and identify five primary actor roles among customers:

- Consultant: works as a support for the selection and implementation of relevant services to create value for a customer's business model.
- Service providers: develop and operate services that are offered and deployed on the cloud computing platform and access hardware and infrastructure through service providers. In return, this offer value to the customer and service providers respectively.
- Aggregate service providers (aggregators): might be regarded as a specialised form of the service provider, offering new services or solutions by combining pre-existing services or parts of services to form new services which they offer to customers.

- Data integrators: focus more on the technical aspects necessary for data and system integration.
- Service aggregators: also include the business aspects of merging services to offer new service bundles.
- Platform provider: offers an environment within which cloud applications can be deployed. Acts as a kind of catalogue in which different service providers offer services.
- Infrastructure providers: supply the value network with all computing and storage services required to run applications within the cloud and provide the technical support.

Figure 5 illustrates a cloud computing value chain based on the work of Jaekel and Luhn, (2009), Leimeister et al. (2010) and Zhang et al. (2010).

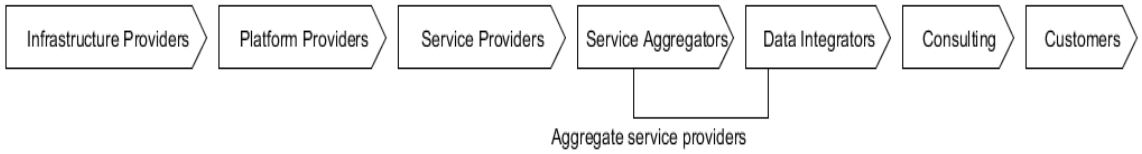

Figure 5: Cloud computing value chain

The real-life cloud computing value network may be far more complex. [3] analysed the cloud services industry ecosystem and identified strategic relationships, technical alliances, reseller relationships, original equipment manufacturer (OEM) or independent software vendor (ISV) arrangements, and consortium memberships between different companies.

The cloud computing literature discusses some of the pricing mechanisms found in a cloud-pricing model. [2, 6, 14 and 15] discuss the pay-per-use mechanism, which is widely hyped to be one of the key changes that cloud computing brings to the IT services business. With the pay-per-use mechanism, capacity units such as number of transactions, gigabytes of storage or memory or units per time such as gigabytes of memory per hour are associated with resources and assigned fixed price values, and the customer pays according to the metered usage of resources. Pay-per-use pricing is typically used with IaaS and PaaS services and its benefit is that it allows customisation to specific application needs. [18] notes that quantification of resources and measurement of dynamic usage may be a challenging task with cloud services. [17] discusses various advanced ways to implement the pay-per-use pricing mechanism.

4. Data analysis and methods

The research methodology applied in this paper is future-oriented, exploratory, and qualitative action research method [24] utilizing for example the scenario technique [34] [39] and business modelling technique [36][32] in data collection. The research is based on Cofimvaba education case study. The selected case for the research enables a deep examination of the cloud business model transformation in a real life setting. Action research methodology is suitable for seeking in-depth understanding of the mechanisms of change [35][37]. It has also been argued that action research is a valuable method in research dealing with dynamic and turbulent environments [38] and that the method enables researchers to get close to business reality and fosters the development of deep understanding of complexities [24]. The applied research methodology can also be regarded as procession as it concerns time-dependent and path-dependent dynamism of complex systems of organizational processes [33].

In practice the research followed the action research process consisting of a spiral of planning, acting, observing and reflecting [24]. The first phase was to define the value

proposition of the project. A definition of cloud computing in relation to our action plan and the identification of an example to use in demonstrating our cloud was concluded in this phase. The identification of the cloud business model transformation related challenges within the case study were observed. All this was made possible by organizing an internal workshop that included all stakeholders (i.e. Meraka, DST and SAP) of the collaboration. Conclusions of the workshop were documented for research purposes and the materials developed during the workshop provided base data for the analysis. The second action research step contained putting the plan into action. This phase consisted of designing the architecture for the SA Public cloud. The third step was to deploy the cloud platform in order to form a full, integrated picture of the situation. This is work in progress, with an integration of hardware, applications and tablets to access the cloud still outstanding.
The last phase of the process is to develop a roll-out business model that will ensure sustainability as well as to reflect and learn from the actions. This paper is an necessary part of the learning process, presenting the theoretical approach and conceptualisations developed and shared by the researchers, describing the methodological choices of the research, and incorporating the data and the findings of the research into a conclusive discussion on the topic of the paper.

5. The Case Study

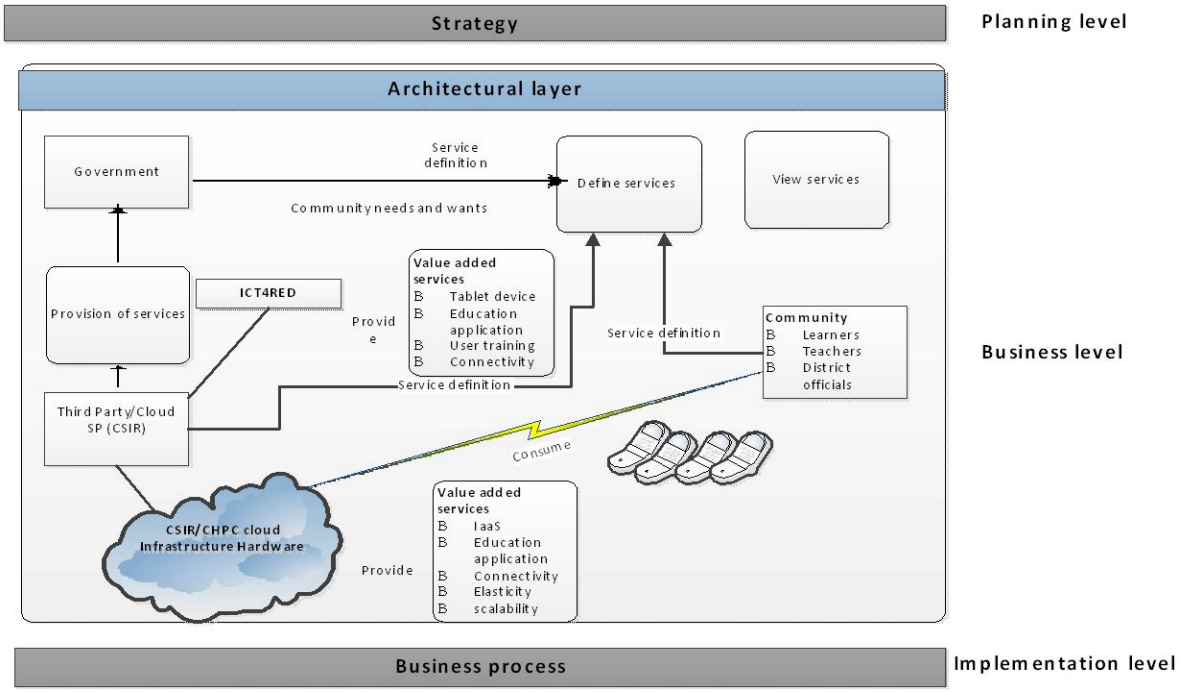

Figure 6: SA Public cloud business model

The proposed business model of the SA Public cloud is shown in Figure 6. There are three layers in this model: planning level, business level, and implementation level. The business strategy layer focuses on positioning the organisation in the market so that the organisation has an advantage over the competitors. The aim is to position the organisation in the market so as to maximise long-term profitability and meet the interests of the stakeholders. In this level strategic planning is achieved, this is the principal responsibilities of upper-level management.

The architectural layer is where the core business activities are realised. In this layer cloud is used as an enabler for delivering education content to learners, teachers and district officials. Government department of education work in collaboration with CSIR (Cloud service provider) and the education community (learners, teachers and government

officials) in defining services that the community need ,this is done by analysing the rquirements of the Nciba education community. Once the the requirements specification proceess is complete, applications are developed. The CSIR comes in as a cloud service provider since CHPC has the capability of providing this service through their high perfomance computing servers and reliable Internet connectivity. Therefore the education applications will be hosted on the CSIR cloud. The CSIR will use Cloudstack platform to deploy the cloud.

CloudStack is open source cloud computing software for creating, managing and deploying infrastructure cloud services. It uses existing hypervisors such as KVM, vSphere and XenServer/XCP for virtualisation. In addition to its own API, CloudStack also supports the Amazon Web Services API. CloudStack has the following implementation designs:

- It is composed of two parts: the management server that contains the business logic and the ServerResource that contains the translation layer to talk to the hardware·
- ServerResource can be deployed within the management server or remotely in an agent container. Therefore a ServerResource cannot access the management database
- ServerResource is a peer to the management server ·
- An agent container is written to deploy ServerResources and handle protocol issues such as communicating through the firewall, serialising and deserialising, security, etc.
- JSON is the API glue between management server and ServerResource. Therefore a server resource does not have to be written in Java.

Finally the business processes level is an illustration of the selection, design, integration and composition of IT services in the form of workflows that fulfil the needs of the outlined business services. SA Public cloud will be implemented at this level.

6. Business Benefits of the cloud business model

Cloud computing benefits for e-governance are clear but one cannot deny the challenges that government cloud can create. Cloud computing for e-governance can:

- Reduce IT labour costs
- Improve capital by significantly reducing license costs
- Provides much needed scalability.
- Cloud architecture is built on service-oriented architecture (SOA) principles, therefore services are reusable
- Cloud computing offers unlimited supply of central processing unit (CPU) capacity, storage and bandwidth
- Application designers are free to focus on features and usability and not hardware aspects.
- While e-governance applications face data outburst, cloud computing can scale better.
- Cloud-computing-supported e-governance can provide efficient management and disaster recovery.
- The cloud helps to increase the number of resources dynamically to maintain quality of service intact even at the times of high load, which generally happens in e-governance.
- With cloud, e-governance applications can manage the policies well by providing security and adoptability.
- Various e-governance applications can be integrated easily.

Many of these benefits facilitate innovation in the same way they concern everbody eg individuals, SMEs, large firms, govrnmnents , NGOs. Progress made in lowering costs while effectively enabling flexibility and scalability (market responsiveness) significantly

enhances an enterprise's ability to reduce time to market for new products and services (agility).

7. Conclusions

The goal of this research was to design a South African government cloud business model customised for the education case. In this study, a cloud business model was designed that is meant to give disadvantaged Cofimvaba community ICT infrastructure without having to own the infrastructure. The schools that will be using the cloud are not expected to pay for utilising the services; instead all costs for using the cloud will be covered by the provider. The foundation of the proposed model is laid by providing relevant literature review on business models' concept. The end product of this work is a demonstrator of the SA public cloud. The education cloud will be used to demonstrate the practicality of cloud applications. It is anticipated that the government cloud will be extended to the national level.

References

[1] Mell, P., Grance, T (2011). The NIST definition of cloud computing: Recommendations of the National Institute of Standards and Technology. National Institute of Standards and Technology, Information Technology Laboratory, 145(6), 1-7. Retrieved from http://csrc.nist.gov/publications/nistpubs/800-145/SP800-145.pdf.

[2] Cai, H., Zhang, K., Wang, M., Li, J., Sun, L., Mao, X. (2009). Customer-centric cloud service model and a case study on commerce as a service. Proceedings of IEEE International Conference on Cloud Computing, 57-64.

[3] Iyer, B., Henderson, J. C. (2010). Preparing for the future: Understanding the seven capabilities of cloud computing. MIS Quarterly Executive, 9(2), 117-131.

[4] Osterwalder, A., Pigneur, Y. (2009). Business model generation. Modderman Drukwerk Amsterdam: Self-published.

[5] Rajala, R., Westerlund, M. (2007). Business models – A new perspective on firms' assets and capabilities – Observations from the Finnish software industry. Entrepreneurship and Innovation 8(2), 115-125.

[6] Weinhardt, C., Anandasivam, A., Blau, B., Stober, J. (2009). Business models in the service world. IEEE Computer Society, 1(2), 28-33. Retrieved from http://www.im.uni-karlsruhe.de/Upload/Publications/2f5d87da-1af5-4d44-b422-9b7e5802b5a5.pdf.

[7] Osterwalder, A. (2004). The business model ontology – A proposition in a design science approach. Unpublished doctoral thesis, University of Lausanne, Switzerland.

[8] Chesbrough, H., Rosenbloom, R. S. (2002). The role of the business model in capturing value from innovation: Evidence from Xerox Corporation's technology spin-off companies. Industrial and Corporate Change. 11(3), 529-555.

[9] Leimeister, S., Riedl, C., Böhm, M., Krcmar, H. (2010). The business perspective of cloud computing: Actors, roles, and value networks. Proceedings of the 18th European Conference on Information Systems, ECIS 2010. Retrieved from http://aisel.aisnet.org/ecis2010/56/.

[10] Altmann, J., Ion, M., Mohammed, A. A. B. (2007). Taxonomy of grid business models. Lecture Notes in Computer Science 4685. Proceedings of the 4th International Conference on Grid Economics and Business Models, 29-43. Retrieved from Springer-Verlag.

[11] Zhang, Q., Lu, C., Boutaba, R. (2010). Cloud computing: State-of-the-art and research challenges. Journal of Internet Services and Applications, 1(1), 7-18.

[12] Zhu, J., Fang, X., Guo, Z., Niu, M.H., Cao, F., Yue, S., Liu, Q.Y. (2009). IBM cloud computing powering a smarter planet. Lecture Notes in Computer Science, 5931, 621-625.

[13] Yeo, C. S., Venugopal, S., Chu, X., Buyya, R. (2009). Automatic metered pricing for a utility computing service. Future Generation Computer Systems,Workshop on Business-Driven IT Management, 39-44.

[14] Youseff, L., Butrico, M., Da Silva, D. (2008). Toward a unified ontology of cloud computing. Proceedings of 2008 IEEE Grid Computing Environments Workshop, 1-10.

[15] Amazon Web Services. (2011). Amazon virtual private cloud. Retrieved 30 April 2011 from http://aws.amazon.com/vpc/.

[16] Denne, M. (2007). Pricing utility computing services. International Journal of Web Services Research, 4(2), 114-127.

[17] Ouyang, J., Sahai, A., Pruyne, J. (2007). A mechanism of specifying and determining pricing in utility computing environments. Proceedings of the 2nd IEEE/IFIP International Workshop on Business-Driven Management, BDIM 2007, Munich, Germany, 39-44.
[18] Lim, H.C., Babu, S., Chase, J.S., Parekh, S.S., Automated control in cloud computing: challenges and opportunities, ACDC'09, June 2009, Barcelona, Spain.
[19] Varia, J., Cloud architectures, Amazon Web Services
[20] Sotomayor, B. Montero, R. Llorente, I. Foster I. "Capacity Leasing in Cloud Using OpenNebula Engine" [online], http://www.cca08.org/papers/Paper20-Sotomayor.pdf (accessed on 10 November 2011).
[21] Cloud computing, http://en.wikipedia.org/wiki/Cloud_computing
[22] Jaatmaa, J. (2010). Financial aspects of cloud computing business models. Aalto University, Helsinki, Finland, Department of Business Technology, School of Economics. Retrieved from http://www.intertic.org/Policy%20Papers/Jaatmaa.pdf.
[23] Carson, D., Gilmore, A., Perry, C., and Gronhaug, K., (2001). Action Research and Action Learning. Qualitative Marketing Research. London: SAGE Publications, Ltd
[24] Van de Ven, A.H. & Poole, M. S. (2005). Alternative approaches for studying organizational change. Organization studies, 26(9), 1377-1404.
[25] Osterwalder, A. & Pigneur, Y. (2010). Business Model Generation. John Wiley & Sons, New Jersey.
[26] Van de Ven, A.H. & Poole, M. S. (2005). Alternative approaches for studying organizational
[27] change. Organization studies, 26(9), 1377-1404.
[28] Van Der Hejden, K. (2007). Scenarios – The art of strategic conversation. (2nd ed.). England: John Wiley & Sons.
[29] Gummesson, E. (2000). Qualitative methods in Management Research. Thousand Oaks, CA, USA: Sage Publications Inc.
[30] Ballon, P. (2007). Business modelling revisited: the configuration of control and value. Info, 9(5), 6-19.
[31] Ballantyne, D. (2004). Action research reviewed: a market-oriented approach. European Journal of Marketing, 38(3/4), 321–337.
[32] Bishop, P., Hines, A. & Collins, T. (2007). The current state of scenario development: an overview of techniques. Foresight, 9(1), 5-25.