Bernd Zwattendorfer, Arne Tauber - "The Public Cloud for E-Government" - IADIS International Conferences Web Based Communities and Social Media and Collaborative Technologies, 2012, pp. 129-136

THE PUBLIC CLOUD FOR E-GOVERNMENT

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ABSTRACT

Cloud computing is all over the news today. Its flexible business model and the possibility of consuming IT resources such as computing power or data storage just on demand promises a lot of benefits and advantages. These advantages also the public sector and governments can benefit from. Hence, cloud computing is already on the top agendas of governmental policy and decision makers. Additionally, various countries have already adapted their IT strategies to support cloud computing for their governmental and public services. However, within the public sector the private cloud model currently constitutes the dominant deployed approach. Although this model offers high control it does not take full advantage of the economic benefits of cloud computing. Therefore, based on an evaluation of different cloud models and a comparison of different national cloud computing strategies we argue and show that public clouds are worth more than a peek for e-Government because of their tremendous cost savings potential.

KEYWORDS

Cloud Computing, e-Government, Public Services, Public Cloud

1. INTRODUCTION

The term cloud computing can be read very often in the news and hence can increasingly be found on various agendas of decision makers. Cloud computing promises a lot of advantages such as high scalability and cost reductions due to a "pay as you go" business model. In general, cloud computing allows the provision of IT resources such as computing power or data storage just on demand. Only those resources which effectively are used will be charged.

There does not exist an "official" definition of the term "cloud computing". However, the definition of the National Institute of Standards and Technology (NIST) has been emerged being the de-facto standard: *"Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction."* (Mell & Grance, 2010)

This definition mainly reflects the main features of cloud computing. Besides scalability and the flexible business model, Mell and Grance (2010) specify the following features as essential characteristics of cloud computing:

- On-demand Self Service
- Broad Network Access
- Resource Pooling
- Rapid Elasticity
- Measured Services

Basically, those five characteristics summarize the main capabilities of cloud computing. IT resources such as computational power or data capacity can be provided to costumers automatically and on-demand without any additional human interaction. Those services are provided over a network irrespective of the client used for consumption (e.g. personal computer, mobile phone, etc.). Furthermore, the resources are provided dynamically, highly elastic, and they can be consumed location independent. The consumed resources are measured by the provider and charged to the customer guaranteeing an appropriate level of transparency.

The cost savings potential of cloud computing is enormous. For instance, the analysis of Alford (2009) implies that over a 13-years lifecycle the implementation costs for cloud computing would be more than 60%

lower than setting up a traditional data center. Weimann (2011) even mathematically proofs the inevitability of cloud computing for enterprises and organizations in the future. Additionally, the market potential of cloud computing is enormous. For 2010 the market volume was calculated to be 71 billion US Dollars. Furthermore, analysts predict a yearly growth rate of 26% for the upcoming years (Deloitte, 2009).

This huge cost savings and its market potential makes cloud computing also interesting and important for the public sector, as cost reductions for IT can be and are required to be achieved also in this area. In general, cloud computing can help governments or public authorities to provide reliable and innovative services for their citizens and businesses without any resource constraints. Instead of focusing on IT resource allocation, they can concentrate on their core business, namely serving the citizenry (Khan et al., 2011). The importance of this topic has also been emphasized by European bodies, such as ENISA[1] or the European Commission. For instance, ENISA has cloud computing among their current and emerging research trends (ENISA, 2010). Moreover, the European Commission explicitly refers to cloud computing in its Digital Agenda for 2020 (European Commission, 2010), that has been derived from the Ministerial Declaration of Malmö in 2009 (European Commission, 2009) to strengthen the European Digital Market. Within the Digital Agenda, the Commission states the aim on the development of an *"an EU-wide strategy on cloud computing notably for government and science"* (European Commission, 2010). This further means that cloud computing already is and still will be on the top agendas of governmental and public administrations' policy and decision makers in future. Due to that, those policy makers need to explore how cloud computing can be adopted in the public sector and which cloud model can be applied. Because of legal compliance and data protection regulations in e-Government, policy and decision makers mostly stick to private clouds in this area where high control is granted. However, the aim of this paper is to show and argue that public clouds are worth more than a peek for e-Government because of their tremendous economic benefits compared to private clouds.

Various countries within and outside Europe have already developed or are currently developing strategies for cloud computing adoption in the governmental sector. Moreover, some countries have already moved IT services into the cloud. We give an introduction to country specific strategies and governmental cloud adoptions in section 4. In section 2, we explain different cloud computing models and in section 3 we evaluate their features for usage within e-Government. Most countries and studies recommend the use of private clouds for governments. However, based on the evaluation we argue that – if certain requirements can be met - the use of public clouds should be preferred as they support the main advantages of cloud computing best (flexibility and cost savings).

2. CLOUD COMPUTING ARCHITECTURES AND MODELS

According to Baun et al. (2011), cloud computing can be differentiated into different types of models. Mell and Grance (2010) of NIST distinguish between models, which relate more to technical and service aspects, and models, which focus on operation of clouds and its organizational aspects. In the following sub-sections we briefly introduce these different types of cloud models to illustrate which type and kind of models could be applied in the governmental and public sector.

2.1 Service Models

In this architectural model, cloud computing is explained using a tier architecture. In most cases a three tier architecture is used. However, we extend this three level architecture with a fourth layer to indicate that cloud computing can support even more services.

- *Infrastructure as a Service (Iaas)*
  In this service model, cloud service providers offer their customers fundamental IT resources such as computing power or data storage on demand. Customers are allowed to install their own operating systems and software components but direct access to the infrastructure is denied. *Amazon EC2*[2] is a typical supplier of this service model

[1] European Network and Information Security Agency (ENISA)
[2] http://aws.amazon.com/ec2/

- *Platform as a Service (PaaS)*
  In this layer, cloud service provider offer special interfaces to access the cloud infrastructure. Customers can develop their own applications based on these interfaces. An example for this model the *App Engine*[3] provided by Google.
- *Software as a Service (SaaS)*
  A complete software solution in the cloud is offered by the cloud service provider in this case. E-mail or calendar services to be consumed are classical examples. Google for instance provides such services (*Google Apps*[4]).
- *Everything as a Service (XaaS)*
  IaaS, PaaS and SaaS usually build the main service layers for cloud computing. However, a lot of other services can be offered in the cloud, such as Security or Identity as a Services (BSI, 2011). We indicate such offerings by extending the three tier model with a fourth layer, where "everything" could be offered as a service.

2.2 Deployment Models

Applying this model, cloud computing is reflected by distinguishing how cloud services are deployed and operated. In most cases, cloud computing is differentiated into the operation of a private cloud, community cloud, public cloud and hybrid cloud.

- *Private Cloud*
  A private cloud is only deployed and operated for a single organization.
- *Community Cloud*
  A community cloud is deployed and operated for a couple of organizations that share common interests.
- *Public Cloud*
  A public cloud is deployed and operated for the general public and can be used by everyone.
- *Hybrid Cloud*
  A combination or interconnection of different cloud models (e.g. between public, private and community clouds) is called hybrid cloud.

3. EVALUATION OF CLOUD COMPUTING MODELS

All the previously defined cloud models have their advantages and disadvantages. In fact, all models could be used for governmental applications and public services taking several limitations into account for each model. In this section, we evaluate all four cloud computing deployed models on their applicability for the use in e-Government. This evaluation will serve as basis for our argumentation in section 5, that public clouds should also be considered for e-Government applications and services.

We limit our evaluation to deployment models only as all service models are applicable, depending on the governmental use case. Our evaluation is based on a SWOT[5] analysis carried out by ENISA (ENISA, 2011). The following Table 1 compares strengths and weaknesses of all cloud deployment models for their e-Government adoption.

Table 1 - Evaluation of Cloud Models

Public Clouds		**Community Clouds**	
Strengths	**Weaknesses**	**Strengths**	**Weaknesses**
• High availability • Reliability • High elasticity	• Compliance with legal regulations • Isolation issues due to multi-tenancy	• Lower costs than private cloud • Elasticity	• Competition between consumers • Specific point to attack

[3] https://appengine.google.com/
[4] http://www.google.com/enterprise/apps/business/index.html
[5] Strengths-Weaknesses-Opportunities-Threats (SWOT)

• Facilitated patch management • Distribution for failure safety • Low costs	• Less detailed logging capabilities • Proprietary interfaces	• Compliance with legal regulations	• Consensus between involved parties required • No accurate prediction on required resources • Who is the legal entity in case of liability
Private Clouds		**Hybrid Clouds**	
Strengths	**Weaknesses**	**Strengths**	**Weaknesses**
• Strong control • Detailed logging/auditing • Compliance with legal regulations	• Higher costs • Specific point to attack • Lack of elasticity	• Flexibility • Stronger control	• Complexity • Compatibility issues due to different interfaces • Classification of data (sensitive data should not be stored in public cloud)

4. THE USE OF CLOUD COMPUTING FOR PUBLIC SERVICES

In general, cloud computing offers and provides a lot of benefits. The main advantages are high flexibility and huge cost savings due to the on-demand provision of services and its charging model. Besides this, cloud computing offers a wide range of additional advantages. Public authorities or governments should also benefit from these advantages by adopting cloud computing. Benefits for public services are for example having not the necessity of setting up an own IT infrastructure and hence also decreasing investment and administrative expenditures. Bhisikar (2011) lists further benefits of cloud computing for governments:

- Increased flexibility
- Access anywhere
- Elastic scalability and pay-as-you-go
- Easy to implement
- Service quality
- Availability of software updates
- Sharing documents and group collaboration
- Data Recovery
- Distributed Data Centers

Those benefits are the reason why countries and governments have already strategies for the adoption of cloud computing or why countries already use cloud computing for public services. The following sub-sections briefly explain national strategies and cloud adoptions of various countries. These explanations will show that most countries stick to the highly controlled and less economical private cloud model for their governmental applications.

4.1 Europe

4.1.1 Austria

Austria has published a position paper (Plattform Digitales Österreich, 2011) for the use of cloud computing services within the government and public authorities. They emphasize the advantages of cost savings. However, cost savings must be opposed to governance, security and data protection. Due to that issues and challenges, the authors think that for governments private and community clouds could satisfy the requirements and needs best. However, they do not exclude the use of other cloud models for public services but they struggle if e.g. data protection requirements could be met by public clouds.

4.1.2 Denmark

In 2009 Denmark has started a discussion round on how cloud services could be used in the public sector. The idea was to foster the modernization of public administrations and to decrease costs of IT services (EPractice.eu, 2009). At the beginning of 2011 Denmark moved services of the Danish procurement authority into the cloud of a telecom provider (OurBusinessNews.com, 2009).

4.1.3 Ireland

According to Robinson (2010), cloud computing has been identified as a key driver for economic renewal by the Irish government. The technological action plan of Ireland includes cloud computing as one of the main drivers. The corresponding document "Technology Actions to Support the Smart Economy" was published in 2009 (Irish Government, 2009). For instance, this strategic paper states that Ireland has a lot of expertise in the field of cloud computing because IBM and Microsoft host appropriate data centers close to Dublin. Based on that expertise, Ireland expects 10.000 high value jobs in this area over the next 5-10 years.

4.1.4 United Kingdom

The Digital Britain Final Report (Department for Business Innovation & Skills, 2009) is one of the central reports for future plans of British authorities. This report foresees the installation of a so-called G-Cloud (Governmental Cloud) as strategic priority. A G-Cloud constitutes a separate cloud computing network for British authorities. Principally, a G-Cloud involves more or less a special private or community cloud which covers all general service layers (IaaS, PaaS, and SaaS). Concerning SaaS, an own e-Government application store should be established (Cloudbook, 2012).

4.2 America

4.2.1 Canada

In 2009 the CTO at Public Works Government Services Canada published the document "Cloud Computing and the Canadian Environment" (Danek, 2009) dealing with Canada's cloud adoption strategy and balancing cloud benefits (e.g. reduction of operating costs and improved maintainability) with cloud risks (e.g. privacy and personal data protection). Based on that, the Canadian government was offering a community cloud for certain services (pay, pension, etc.) in 2010. The idea was to use IaaS for virtual storage, PaaS for commoditized hosting of cloud applications and SaaS for virtual office provision and internal collaboration (Robinson, 2010).

4.2.2 USA

Currently, the USA is one of the leading countries in cloud computing adoption. Several services, especially e-mail services, have already been moved to the cloud. For instance, the cities Los Angeles, Washington, and Carlsbad shifted the e-mail services of their employees to the cloud (West, 2010). Another popular example for US governmental cloud services is Apps.gov[6], where cloud solutions are offered by the US General Service Administration (GSA) for public sector customers.

In general, the US government forecasts in its "Federal Cloud Computing Strategy" enormous cost savings potential (Kundra, 2011). Therefore, 40% of the existing data centers should be closed and substituted by modern cloud computing technologies. The general aim of the US cloud computing strategy is taking advantage of cloud computing and drive forth its adoption in the public sector.

4.3 Australia

The Australian government published a strategic paper on cloud computing in 2011 (Australian Government, 2011). The main policy of this paper is that "*agencies may choose cloud-based services where they demonstrate value for money and adequate security*" (Australian Government, 2011). Basically, the hosting of cloud computing services should decrease the need of separate data centers for Australian agencies. Some agencies have already piloted cloud computing applications (eTax, Electronic Lodgement System, etc.). However, the cloud computing strategic paper foresees more mature cloud adoptions based on a risk-managed approach. From 2011 onwards low risk services should be deployed in a public cloud, medium risk services in outsourced private clouds and high risk services in community clouds for government. (Australian Government, 2011)

[6] https://www.apps.gov/

4.4 Asia

4.4.1 China

China does not follow a particular and nation-wide cloud computing strategy. Only some cities such as Dongying or Wuxi have started some cloud computing initiatives. These initiatives do not especially aim on e-Government adoption. They furthermore should help less financially strong start-ups to set up their businesses and thereby strengthen the economic growth of China. (Wyld, 2010)

4.4.2 Japan

In contrast to China, Japan has already started a big governmental cloud initiative. Within this initiative, a private cloud hosting all Japanese public services should be developed. The cloud is named "Kasumigaseki" and is part of the governmental Digital Japan Creation Project. The aim of this cloud is to decrease development and operational costs for services and to increase performance of applications. Deployment of this cloud should happen step-by-step and should be completed in 2015. (Ng, 2009)

4.4.3 Thailand

Besides Japan, also Thailand has ambitions to build and set up a private cloud for public services. By the help of this private cloud, small- and medium-sized public authorities with limited budget should get facilitated access to e-Government. The cloud should be deployed and operated by Thailand's Government Information Technology Service (GITS). (Hicks, 2009)

4.4.4 Singapore

At the end of 2011 Singapore started an auction for the development and set-up of a private cloud. Like for the UK (see section 4.1.4), this cloud should form a G-Cloud and model the governmental infrastructure to take advantage of all cloud computing benefits. In addition, this cloud should offer central public services of Singapore. Nevertheless, during the development security and public services requirements must be taken into account. (Guo, 2011)

5. THE PUBLIC CLOUD FOR E-GOVERNMENT

All cloud computing deployment models described and evaluated in the sections 2 and 3 have their advantages and disadvantages. The desired model to be applied strongly depends on the intended use case and its derived requirements. Although the enormous cost savings potential and high resource capacity argue for a highly adoption of public clouds, requirements such as control possibilities or legal compliance constrain for the use of private or community clouds. Especially in e-Government, criteria such as security or data protection play a stronger role than cost savings.

Various studies have already investigated the use of cloud computing for public services. Most studies recommend the use of private and community clouds for public authorities. For instance, due to the heterogeneity of national laws and regulations also ENISA recommends these two models for e-Government. More concretely, they state that *"in terms of architecture, for sensitive applications private and community clouds appear to be the solution that currently best fits the needs of public administrations since they offer the highest level of governance, control and visibility […]"* (ENISA, 2011). Additionally, all current cloud computing adoptions in various countries target more the private cloud than the public cloud (see section 4).

However, although current studies recommend the use of private and community clouds for governments and most countries even rely on these models, the use of public clouds should not be excluded for more sophisticated public and governmental services as long as certain requirements (e.g. legal compliance, data protection, security, etc.) can be fulfilled. The reason for this statement is simple because public clouds offer the best advantages of cloud computing (low costs, high availability, less maintenance, etc.). Especially, the possibility of cost reductions for IT infrastructure and services must be emphasized.

According to Harms and Yamartino (2010), IT infrastructure costs take the main share of IT expenditures, namely 53%. In addition, 36% apply to maintenance of existing services and 11% to the development of new applications. For these areas, cloud computing can effectively help to decrease IT expenses. Concerning IT

infrastructure, IT costs can be decreased by shifting parts or the complete infrastructure to a public cloud provider. Furthermore, such a move also transfers maintenance burdens such as installing software patches to the cloud provider. Additionally, applications need not to be expensively developed but can simply be consumed from the cloud.

Overall, the study of Harms and Yamartino (2010) sees public clouds always more economical than private clouds, irrespective of the organization size or the number of required servers or computing power. Figure 1 illustrates this cost effectiveness of public clouds (Total cost of ownership per server compared to the number of servers).

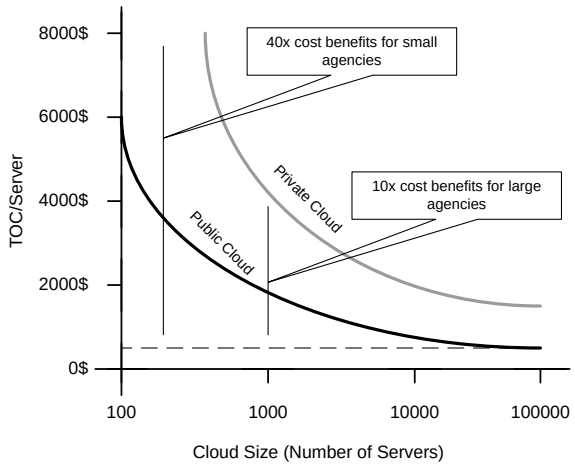

Figure 1 - Economic benefits of public clouds compared to private clouds (aligned to Harms and Yamartino (2010))

The highest cost saving potential is given if organizations just require a couple of hundreds server only. The cost benefit is given under a factor of 40 if a public cloud is preferred over a private cloud. Increasing the number of required servers the cost benefit shrinks down to a factor of 10. Nevertheless, according to this figure public clouds will be always more beneficial than private clouds. What this figure does not illustrate are investment costs for setting up a private cloud. Since there are no investment costs for using a public cloud, the economic benefits of public clouds compared to private clouds may be even higher.

This economic advantage and flexibility of public clouds is especially interesting for public authorities and municipalities. Referring to Figure 1, smaller municipalities do not require an own data center with more than hundred servers. Since in this area of the chart the cost savings potential is the highest, municipalities can save a lot of money by transferring IT infrastructure or applications into the public cloud. They can further focus on forcing e-Government activities instead of maintaining and setting up their own data center.

6. CONCLUSIONS

Cloud computing currently dominates the IT landscape. The reasons are the main advantages it offers: High availability of IT resources, flexibility, and huge cost savings potential due to an on demand pricing and charging model. These advantages make cloud computing also very interesting to be adopted in the public sector and e-Government. Bhisikar (2011) lists further advantages of cloud computing for governments (see also section 4).

Many countries have already recognized the benefits of cloud computing for governmental applications and thus have already installed their own cloud systems or have transferred applications into the cloud. Furthermore, a high number of countries included cloud computing into their national IT strategies for future adoption. Most countries rely on private or community clouds for their public services only. However, in section 5 we showed that public clouds have the highest economic benefits and thus should be also considered for e-Government if certain requirements can be met. This cloud computing model seems to be very interesting for public authorities or municipalities due to its flexibility and huge cost savings potential.

Although cloud computing has huge potential for governmental adoption, issues and challenges of governmental cloud computing still remain. Further research and investigations are required in the field of data security, open standards and interoperability, and legal issues (Wyld, 2010). Especially countries should harmonize their laws regarding security and privacy to accelerate cloud computing adoption in the governmental sector (Robinson, 2010). Meeting of existing cloud computing challenges can have a significant impact on the economic growth as e.g. in the EU a few hundred thousands of new small- and medium-sized enterprises can be created (Etro, 2009). In general, Harms and Yamartino (2010) see a long-term shift to the cloud as organizations can concentrate on innovation than on burdensome administrative IT processes.

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