How governments can benefit from Cloud Computing

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Abstract

Across the world, governments are trying to present, in the best possible way, their government services to citizens. Using the new technology is paramount to reduce this interaction through effective and efficient services.
Cloud Computing is a computing concept that is formed from the aggregation and development architecture such as SOA. Its purpose is to provide resources for communication and storage in a secure environment based on the service as quickly as possible, which is virtually implemented, via Internet access.
As the services provided by the e-Government are available via the Internet, so the benefits of Cloud Computing can be used in the implementation of e-Government architecture to provide better service with the least economic cost.
Many countries have attempted to implement the e-Government based on the functionality provided by Cloud Computing, some of these countries have achieved remarkable success, and others have confronted difficult to make it worked.
This article will explore the use of Cloud Computing in e-Government, identify challenges and benefits of this use, and finish with benchmarking countries that have followed this approach.

Keywords: *e-Government, Cloud Computing, Public services, Advantages, Challenges, Benchmarking, European governments, Arabic governments.*

1. Introduction

For the past 10 years, the Internet and web services have experienced rapid and significant increases, which generated through their use in all sectors of activity, a high cost of data storage and consumption energy and complexities of implementation and infrastructure solutions.
To remedy this, large organizations have begun extensive studies to reduce these costs and complexities and they deduced the Cloud Computing.
Today, Cloud Computing, this new technology, has effectively respond to thousands of their hardware and software needs, and it is considered the topic most requested by academics and research centers related to the field of information technology.
The e-Government among the industries that used the Internet and web services, seeks firstly overwhelming user satisfaction, and others from the implementation of an effective system based on Information Technology. To do this, the e-Government adopted to use the concepts of Cloud Computing.

2. Cloud Computing

2.1. Definition

In 2009, the National Institute of Standards and Technology (NIST) [9] published a definition of Cloud Computing as : "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."

This definition was included in the Global Security Mag magazine as "Cloud Computing is a new way of delivering IT resources, not a new technology." Moreover, this concept has been proven in my post in the second edition of the PhD day at the FST University of Settat [1].

2.2. Essential Characteristics:

Cloud Computing is characterized by:

1. On-demand self-service: A consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service's provider.
2. Broad network access: Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, laptops, and personal digital assistants [PDAs]).
3. Resource pooling: The provider is computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. There is a sense of location independence in that the customer generally has no control or knowledge over the exact location of the provided resources but may be able to specify

location at a higher level of abstraction (e.g., country, state, or datacenter). Examples of resources include storage, processing, memory, network bandwidth, and virtual machines.

4. Rapid elasticity: Capabilities can be rapidly and elastically provisioned, in some cases automatically, to quickly scale out and rapidly released to quickly scale in. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be purchased in any quantity at any time.
5. Measured Service. Cloud systems automatically control and optimize resource use by leveraging a metering capability3 at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported, providing transparency for both the provider and consumer of the utilized service.

2.3. Service Models:

NIST [9] also counts three service models:

1. Cloud Software as a Service (SaaS). The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through a thin client interface such as a Web browser (e.g., Web-based email). The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user specific application configuration settings.
2. Cloud Platform as a Service (PaaS). The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly application hosting environment configurations.

   3. Cloud Infrastructure as a Service (IaaS). The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, deployed applications, and possibly limited control of select networking components (e.g., host firewalls).

2.4. Deployment Models

According to organization approaches, there are several deployment models of Cloud Computing services:

1. Private cloud: The cloud infrastructure is operated solely for an organization. It may be managed by the organization or a third party and may exist on premise or off premise.
2. Community cloud. The cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy, and compliance considerations). It may be managed by the organizations or a third party and may exist on premise or off premise.
3. Public cloud: The cloud infrastructure is made available to the public or a large industry group and is owned by an organization selling cloud services.
4. Hybrid cloud. The cloud infrastructure is a composition of two or more clouds (private, community, or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load balancing between clouds).

3. Cloud Computing and e-Government

Cloud computing is penetrating many areas because of its advantages. High scalability, low maintenance efforts, enormous cost savings potential, and several other benefits make cloud computing also interesting in e-Government. Especially, the increasing tightness of governmental budgets can benefit from cloud computing adoption, as the amount of IT expenditures could be decreased [2].

Figure 1: The Benefits of Cloud Computing

Saving costs in the governmental sector is essential. For instance, the aim of decreasing costs for public services was also anchored in the Austrian governmental program [3]. Alford [4] estimates a saving potential between 50 to 67% by moving govern-mental applications into private or public clouds. Harms and Yamartino [5] conclude similarly in their economic analysis of cloud computing for the public sector. Particularly, they argue that public clouds have always-higher cost benefits for public services compared to private clouds, irrespective of the required amount of IT resources or the cloud size. (see Fig. 2).

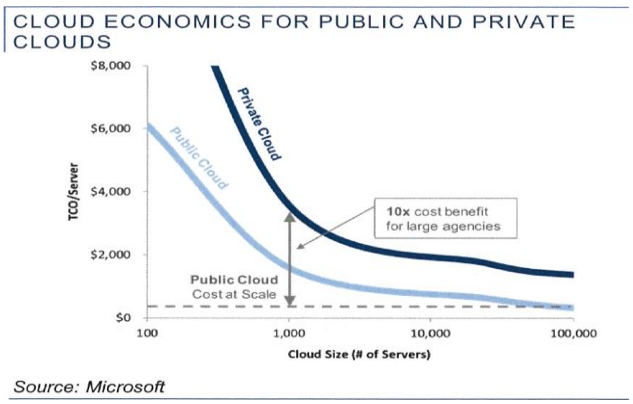

Figure 2: Cloud economics for public and private clouds

3.1. Benefits of Cloud Computing

Besides cost benefits, cloud computing has several further advantages for public services. Bhisikar [6] lists a couple of advantages of cloud computing for the public sector. Based on these findings, we list the most important advantages of cloud computing in the governmental sector:

1. Elasticity: One main advantage of cloud computing for public services is scalability. Depending on the e-Government application, only resources, which are actually required, are consumed. This especially helps to absorb high load peeks of applications (e.g. e-Procurement, tendering, or election days), which may have higher access rates in a limited time.
2. Pricing model Pay-as-you-go: The flexible pricing model of clouds allows for just paying the very amount of IT resources, which effectively have been consumed. This pay-as-you-go pricing model enables public services to save a lot of IT costs.
3. Easy implementation: Cloud applications are easy to implement. Public services do not need to buy hardware or software licenses but just can use the IT infrastructure (IaaS, PaaS, or SaaS) of the cloud service provider. Usually, cloud service providers offer some kind of APIs (application programming interfaces), where individual cloud applications can be developed to.
4. Low maintenance: The use of cloud services also lowers maintenance tasks. Patch or update management can be fully handled by the cloud service provider, hence no manual maintenance tasks, e.g. for updating operating systems or installing security patches, are required.
5. Availability: The use of clouds can increase availability of applications. Applications can be deployed in different cloud data centers, distributed around the world. In case of a breakdown of one data center, the application may still continue running in another cloud data center of the cloud provider.

3.2. Issues and challenges

Although cloud computing offers a lot of advantages to public services, several issues and challenges need to be targeted or to be met when applying cloud computing in the public sector. According to [2] and [7] the main issues and challenges for cloud adoption in the public sector are:

1. Security: Providing a high level of security for public sector cloud computing is essential. Security requirements must be fulfilled on several layers.
2. Data Protection and compliance: defines one of the main issues when talking about cloud computing. In e-Government applications and services usually sensitive data are processed, hence meeting this requirement is indispensable. Particularly, some data protection regulations do not allow the storage of sensitive data in other countries, which is basically not accomplished by most cloud service provider as their data centers are usually spread around the world. Hence, being compliant to such regulations is essential.
3. Data portability and interoperability: Cloud computing has a fast growing and emerging market. Up to now, this mainly led to a heterogeneous landscape on service and interface offerings of cloud service providers. Due to that, the so-called "lock-in" effect can be often recognized. This means that although another cloud service provider offers better pricing conditions than the current one, switching to the other cloud service provider is still uneconomic because the opportunity costs for data and application transfer are too high. To bypass this issue, standardized services and interfaces might help to achieve interoperability between cloud service providers.
4. Identity and access management: E-Government applications usually require more secure and reliable authentication and identification mechanisms. While most traditional e-Government services stick to stronger authentication and identification techniques, current cloud applications still lack in adoption of such techniques. However, e-Government services in the cloud require the same strength of authentication and identification as current e-Government applications do.
5. Auditing: Auditing becomes essential e.g. in situations where compliance to specific regula-tions or policies must be verified. Cloud providers currently do not offer detailed auditing possibilities, hence further research in this field might be required.

4. Benchmarking Cloud Computing in e-Government in Europe

The adoption of Cloud Computing in e-Government is not only a vision, it already became reality. Many countries or cities, especially across Europe, have already adopted cloud computing solutions in the public sector or are planning to do so [2].
According to [8], hereafter a table that gives some details on the government's adoption of Cloud Computing in eight European countries, which also have a well-established infrastructure and successful e-Government:

Table 1: Comparison of Cloud Computing in e-Government across eight European countries

Country	Cloud Computing anchored in a National Strategy	Cloud Adoption	Cloud Adoption Level	Cloud Deployment Models	Cloud Service Models	Cloud e-Government Sample Services
Austria	Yes	Planned	National Regional City	E1; E2; E3;	F1; F2; F3;	Backup/Archiving Cloud Framework for e-Government applications Collaboration Suites Identity as a Service
Denmark	No	Planned Executional	Municipality	E1; E2; E3;	F3;	E-Mail Procurement
Finland	No	Planned				
France	Yes	Development	National	E3;	F1;	
Germany	Yes	Planned				
Ireland	Yes	Planned	National	E1; E2; E3;	F1; F2; F3;	Open Data Public Information Repositories Collaboration Suites E-Mail
Spain	No	Planned Executional	National Regional City	E1; E2; E3; E4;	F1; F2; F3;	E-Government Services Open Government Citizen participation E-Mail Storage/Backup Office and Collaboration
UK	Yes	Development Executional	National	E2; E3;	F1; F2; F3;	E-Mail Office CRM

Index	Meaning
E1	Public Cloud
E2	Private Cloud
E3	Community Cloud
E4	Hybrid Cloud
F1	IaaS
F2	PaaS
F3	SaaS

As can be seen in the "table 1", five of the eight investigated countries have anchored the adoption of cloud computing in the public sector in some kind of national strategy. For the remaining three countries, cloud

computing is individually applied by local governments such as municipalities or cities.

Two of the evaluated countries have already adopted cloud computing and hence are in an executional stage. The other countries are still in the developing or planning phase. All countries, which have manifested cloud computing in some national strategy, are mostly still in the planning phase. However, the UK has already some governmental cloud services running. Nevertheless, the full implementation of their national cloud computing strategy will still take another few years.

5. Benchmarking Cloud Computing in e-Government in Arab countries

As in many other countries, Cloud Computing has been one of the most discussed trends in ICT in the Arab region in recent years. However, Cloud Computing initiatives in Arab countries are still in their infancy, and are usually conducted by local operators. This is the case of Etisalat in the UAE and Mobily in Saudi Arabia. In 2009, IBM developed the Qatar Cloud Computing Initiative, first Cloud platform in the Middle East. It is conducted by three universities, led by Carnegie Mellon University in Qatar. The objectives of this initiative are to advance research previously limited by time, resources and overwhelmed systems, and open Cloud infrastructure to local businesses and industries to support oil and gas exploration. This platform is equipped with a web search engine in Arabic.

6. Conclusions

The study conducted in this paper has shown the importance of using the concepts of Cloud Computing that improve efficiency and reduce costs in the e-Government. In addition, countless other benefits can be exploited such as elasticity, flexibility, cost effectiveness and integration.

We can conclude that even developed countries already have critical obstacles to create an e-Government based on Cloud Computing especially those put forward at the issues and challenges of Cloud Computing.

The outlook document will study the participation of countries with each other on technical and legal issues, as these two points will be key to successful implementation of e-Government based on the cloud as soon as possible.

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