Cloud Computing in E-Government across Europe
A Comparison

Bernd Zwattendorfer[1], Klaus Stranacher[1], Arne Tauber[1], and Peter Reichstädter[2]

[1] E-Government Innovation Center (EGIZ), Graz University of Technology, Graz, Austria
{bernd.zwattendorfer,klaus.stranacher,arne.tauber}@egiz.gv.at
[2] E-Government / ICT Strategy at Austrian Federal Chancellery, Vienna, Austria
peter.reichstaedter@bka.gv.at

Abstract. Cloud computing has many advantages which also governments and public authorities can benefit from. Therefore, a couple of European countries have already adopted cloud computing in the public sector or are planning to do so. In this paper, we evaluate eight European countries on their use of cloud computing in e-Government and compare them. As a result, the dominant cloud computing deployment model in those countries is a so-called G-Cloud (Governmental Cloud), a private or community cloud especially designed for national governmental use. In addition, no favored cloud service model has emerged, hence all standard cloud service models (Infrastructure, Platform, and Software as a Service) are adopted by most countries. Finally, half of the evaluated countries have anchored cloud computing in one of their national ICT strategies.

Keywords: Cloud Computing, e-Government, Europe, Public Sector, G-Cloud.

1 Introduction

Cloud computing is currently one of the dominating topics in the IT sector. In general, cloud computing enables the provisioning of IT services such as computing power or data storage just on demand. Additionally, only those resources which have been effectively consumed are charged by a cloud service provider. The NIST[1] defines cloud computing the following:

"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." [1]

In other words, IT resources such as computational power or data storage are shared across multiple customers and are easily accessible through a network by different devices (e.g. PC, mobile phone, etc.). Furthermore, the resources are provided dynamically, highly elastic, and customers can easily access them just on demand. Finally,

---

[1] National Institute of Standards and Technology

consumed resources are measured by the provider and only effectively consumed resources are charged.

Cloud computing has many advantages such as cost savings, scalability, or high availability, which make cloud computing interesting for many sectors. In particular, due to limited budgets of many governments, cloud computing and its advantages are also interesting for the public sector. Moreover, Khan et al. [2] concluded that - by adopting cloud computing - governments and public authorities can rather focus on their core business, which is serving the citizenry, instead of thinking on IT resource allocation and IT maintenance tasks.

The importance of cloud computing and its benefits for the public sector has already been noticed by several European bodies. For instance, the European Network and Information Security Agency (ENISA) put cloud computing on their current and emerging research trends in 2010 [3]. Moreover, the European Commission explicitly refers to cloud computing in their Digital Agenda for 2020 [4]. In more detail, the European Commission aims on an EU-wide strategy on cloud computing for governments to strengthen the European internal market.

Not only European bodies, but also several European countries jumped on the cloud computing bandwagon or are planning to do so. Hence, they also want to take advantage of cloud computing benefits. In this paper, we compare the adoption of cloud computing within the public sector in eight European countries. For instance, we evaluate which cloud computing deployment models or service models are planned to be used or are already in use for e-Government applications. The evaluation of these countries is based on a thorough literature review and web research, thereby examining various existing articles and studies.

As a result, the dominant cloud computing deployment model in those countries is a so-called G-Cloud (Governmental Cloud), a private or community cloud especially designed for national governmental use. In addition, there is no favored cloud service model, hence all standard service models (Infrastructure, Platform, and Software as a Service) are adopted by most countries.

The remainder of the paper is structured as follows. In Section 2 different cloud computing models are briefly introduced. In Section 3 we discuss the importance of cloud computing in the e-Government sector. Furthermore, we oppose advantages with issues and challenges. In Section 4 we give details on cloud computing adoption in the public sector in eight selected European countries. The adoption of cloud computing in the public sector across those countries is compared in Section 5. Finally, we draw conclusions.

2   Cloud Computing Models

Cloud computing can be differentiated into different types of models. Mell and Grance [1] separate between model types which focus on technical and service aspects, and model types which consider organizational and deployment aspects. In the following sub-sections we briefly introduce different types of service and deployment models according to [1].

2.1   Cloud Computing Service Models

Cloud computing service models are differentiated based on the type of service provided by cloud providers. Usually, three different service models are distinguished.

- *Infrastructure as a Service (IaaS)*
  In this model cloud providers offer basic IT infrastructure such as computing power, virtual machines, or data storage as a service. Customers are usually allowed to install arbitrary operating systems or software of their choice, but do not get access to the underlying hardware.
- *Platform as a Service (PaaS)*
  Applying this model, cloud providers offer specific interfaces and platforms where customers can develop and deploy their own cloud applications to. Here, the cloud provider manages the underlying operating system too.
- *Software as a Service (SaaS)*
  In this case complete software solutions such as e-mail, calendar, or collaboration services are offered by the cloud service provider as a service. Customers can access the software via a simple web browser and do not need local installations on their PC.

2.2   Cloud Computing Deployment Models

Cloud computing can also be separated based on the chosen deployment approach. Usually, four types of deployment models are differentiated.

- *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, or community cloud) is called hybrid cloud.

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 [5]. 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 programme [6].

The cost savings potential of cloud computing in the governmental sector is enormous. Alford [7] estimates a saving potential between 50 to 67% by moving governmental applications into private or public clouds. Harms and Yamartino [8] 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.

3.1   Advantages

Besides cost benefits, cloud computing has several further advantages for public services. Bhisikar [9] 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:

- Scalability
- Pay-as-you-go pricing model
- Easy implementation
- Low maintenance
- Availability

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 period.

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.

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.

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.

Finally, 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. Hindering issues might be, for instance, security or privacy concerns when processing or transferring sensitive data into the cloud [10, 11]. We briefly list some requirements, which must be fulfilled when taking advantage of cloud computing in the public sector. Of course, whether those requirements can be simply fulfilled or not heavily depends on the cloud computing deployment or service model applied. According to Deussen et al. [12], Reichstädter [13], Wyld [5], and Repschlager et al. [14] the main issues and challenges for adopting cloud computing in the public sector are:

- Security
- Data protection and compliance
- Interoperability and data portability
- Identity and access management
- Auditing

Providing a high level of security for public sector cloud computing is essential. Security requirements must be fulfilled on several layers. This means, for instance, that network, application, or data security must be assured by the cloud.

Data protection 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.

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.

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.

Auditing becomes essential e.g. in situations where compliance to specific regulations or policies must be verified. Cloud providers currently do not offer detailed auditing possibilities, hence further research in this field might be required.

Summarizing, e-Government applications and services in the cloud have to fulfill stronger and stricter requirements as needed e.g. for simple informational cloud services. A more comprehensive list on requirements of e-Government applications in the cloud can be found in [15].

3.3   E-Government Applications in the Cloud

Cloud computing has many facets and characteristics. Basically, cloud computing can be applied either in service or deployment models. While sensitive data is processed in most e-Government applications, the selection of the cloud model to be applied for e-Government applications in the cloud requires a thorough and systematic analysis. In fact, none of the existing cloud deployment and service models needs to be bared out for e-Government adoption from the beginning. However, some models might be easier applicable for e-Government than others. ENISA [16] or Zwattendorfer and Tauber [17] provide an overview of strengths and weaknesses of individual deployment models for e-Government adoption.

The decision on which cloud computing deployment model can be adopted for e-Government is difficult. According to [16] the private and community cloud model is recommended for the public sector as it allows more control with respect to security, privacy, or compliance with legal regulations. However, the public cloud model should not be neglected for e-Government adoption because of their low costs [17]. Non-sensitive data processing e-Government applications can be easily mitigated into a public cloud. Hybrid clouds are a mix of different clouds. Hybrid clouds could be also used for e-Government but usually require data separation as sensitive data should not be stored in public clouds.

Regarding the adoption of services models (IaaS, PaaS, or SaaS) for e-Government applications, generally all models are feasible. The IaaS model could be, for instance, used for archiving e-Government data or making backups. Additionally, it is conceivable to place open government data applications into an IaaS cloud. The PaaS model might be applicable for the development of customized public sector applications in the cloud. Such customized public sector services may include national or regional specific services, such as tax or electronic delivery services, or just simple services for filing applications to be processed in the public authorities' back-office. Finally, the SaaS model could be used for collaboration suites, workflow management systems for electronic documents, informational services for business or citizens, or any other "X as a Service"-based model such as "Identity as a Service" [18].

Summarizing, cloud computing offers a couple of benefits to public services and their e-Government solutions. According to [5] and [9], the main benefit is that governments can focus on their core business, which is serving the citizenry, instead of spending high efforts on server or IT management. Nevertheless, before moving public services to the cloud an extensive analysis is required whether the same level of security and data protection can be achieved as for traditional and existing e-Government services.

4   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 [5]. In the next sub-sections we give some details on governmental cloud computing adoption within eight European countries, which currently also have a well-established and successful e-Government infrastructure in place.

4.1   Austria

Austria or Austrian cities have not adopted cloud computing in their public services yet. However, the Platform Digital Austria of the Federal Chancellery has published a position paper for the use of cloud computing in the public sector in 2012 [13]. This position paper especially covers legal, organizational, economic, and technical aspects, as well as opportunities and risks of cloud computing for public sector use. According to this paper, Austrian e-Government applications might be deployed in a private, community, or public cloud in the future. Moreover, they see all service levels applicable. IaaS could be used for archiving or backup purposes. By relying on PaaS, a particular platform supporting an easy applicable framework for developing e-Government cloud services is imaginable. On software level, future cloud services might include specific collaboration suites for public authorities or more security related services such as Identity as a Service [18].

4.2   Denmark

The Local Government Denmark started discussions on using cloud computing in the public sector already in early 2009 [19]. Moreover, according to KPMG [20] Denmark is one of the leading countries regarding the adoption of cloud computing in the public sector. For instance, in 2011 a Danish municipality planned to use Google Apps Services such as calendar or e-mail in their school systems [21]. In addition, a Danish procurement organization of a Danish municipality moved procurement services into the cloud in 2011 [22]. Although Denmark still struggles with security and privacy issues [20], the Danish Data Protection Agency e.g. judged the cloud service of Microsoft - Office 365[2] - to be compliant with the EU and Danish legislations [23]. In addition, cloud.dk offers public cloud services fully compliant with the Danish data legislation.

4.3   Finland

According to [24], Finland currently has no common strategy on cloud computing in the governmental sector. The government has only started an explanatory research for

---

[2] http://www.office365.com

centralizing ICT services where cloud computing could play a major role. Particularly, the aim of such centralized ICT infrastructure is bundling maintenance and support tasks as well as monitoring and helpdesk services. Referring to [24], no statistics exist which public authorities eventually use cloud computing services already. However, the Finish Government particularly emphasizes cloud computing in its report "Productive and Innovative Finland – Digital agenda for the years 2011-2020" [25].

4.4   France

France is currently one of those countries, which favor the development and installation of a nation-wide cloud for governments, a so-called G-Cloud (Governmental Cloud). France started its development of the G-Cloud named "Andromeda" in 2011. This G-Cloud, which is - in this particular case - a IaaS platform for governments, is currently set up and implemented by the two companies Orange[3] and Thales[4] [26]. The main aim for developing an own G-Cloud in France are data protection and legislative issues. A cloud especially developed for France can guarantee full compliance with national law in terms of data protection and security. Such compliance may not be achieved by e.g. adopting US-based services. Furthermore, Accenture is currently building up some kind of G-Cloud for the French Directorate of Legal and Administrative Information (DILA). This cloud shall offer French citizens fast and performing access to French public services [27].

4.5   Germany

Cloud computing is one of the main pillars of the ICT strategy of the German Federal Government [28]. This strategy has been published by the Federal Ministry of Economics and Technology in 2010 and aims on the digital future in Germany until 2015. Focusing on cloud computing, the objective is to facilitate and foster the development and installation of cloud computing services. In particular, both small- and medium-sized enterprises and the public sector should take advantage of cloud computing as fast as possible. The challenges (e.g. data security, quality assurance, easy integration, open standard, etc.), which need to be addressed for adopting cloud computing in Germany, are targeted in the so-called Cloud Computing Action Programme [29]. These challenges particularly arise when adapting existing IT concepts to the specific requirements of cloud computing.

4.6   Ireland

Ireland anchored cloud computing in their national governmental strategy. This strategy of the Irish government with the name "Technology Actions to Support the Smart Economy" was introduced by the Ministry of Energy and Communications and the Ministry of State in 2009 [30]. In more detail, Ireland sees cloud computing as one of

---

[3] http://www.orange.fr
[4] http://www.thalesgroup.com

the key drivers for economic growth in Ireland. They estimate high reductions in server and energy costs by expecting high value job generation at the same time [31]. Therefore, they released a separate "Cloud Computing Strategy" paper in 2012 [31]. They plan several governmental services based on cloud computing offered to their citizens, aiming on increased productivity by decreasing public expenditures at once [31]. Finally, the Irish government provided some kind of guidance for businesses when adopting cloud computing. This guidance entitled "SWiFT 10: Adopting the Cloud – Decision Support for Cloud Computing" consists of a set of standards which shall help businesses to lower obstacles when moving services into the cloud [31].

4.7   Spain

Pérez San-José et al. [34] did a thorough analysis on cloud computing in the Spanish public sector. This study concludes that there is still limited adoption of cloud computing in the public sector in Spain. Reasons are information integrity, privacy, and legal concerns. The central government is not the driving force behind cloud computing adoption but moreover local governments are. Local governments have a limited financial capacity in contrast to the central government and here cloud computing can tremendously help in saving costs. However, a lot of governments have adopted cloud computing already since more than three years. The favored deployment model in Spain is the private cloud (app. 58%), followed by the public cloud (app. 31%) and the hybrid cloud (app. 17%). The private cloud is favored because of higher control in terms of security and privacy. The community cloud model is generally seldom in Spain because it targets a fusion of specific sector applications (e.g. health), which seems to be undesired. [34]

4.8   United Kingdom

In 2011 the UK government published an ICT strategy, which also covers the topic on cloud computing [35]. This strategy particularly involves the implementation and installation of a G-Cloud in the UK. The main objectives of this G-Cloud are reducing ICT costs for governments, optimizing the use of data center infrastructure, and increasing public sector agility [35]. In fact, the installation of this G-Cloud is an iterative process. The first step, the realization of the so-called CloudStore[5], has been achieved in 2012. This CloudStore offers infrastructure, software, platform, and specialist services which can be bought online.

5   Comparison of Cloud Computing in the Public Sector across Europe

In this section we evaluate the adoption of governmental cloud computing within the eight European countries. We further also illustrate how governments benefit from

---

[5]   http://gcloud.civilservice.gov.uk/cloudstore/

cloud computing by placing sample cloud services as example. Furthermore, we discuss how challenges are being met or can be met in future.

5.1   Comparison across European Countries

In this sub-section, we compare whether cloud computing has been anchored in a national governmental strategy or not. Moreover, we elaborate whether cloud computing has been adopted more on national, regional, or municipality level. We further list, which cloud computing deployment models (public, private, community, or hybrid cloud) or service models (IaaS, PaaS, SaaS) are applied in the public sector. However, we do not distinguish whether those models are already in place or it is just planned by the individual country to adopt them. Finally, we list a sample on which government-related services were or are planned to be moved into the cloud.

Our comparison is based on a thorough literature review and web research, involving the countries Austria, Denmark, Finland, France, Germany, Ireland, Spain, and the UK. Table 1 shows the comparison of governmental cloud computing between these countries.

As can be seen, 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.

Most countries plan the adoption of cloud computing in the public sector on national level. The reason for this is probably that security and privacy issues can be easier faced. In particular, Austria, France, Spain, and the UK are planning or are already developing a so-called G-Cloud (Governmental Cloud), a nation-wide private or community cloud. For Finland and Germany no further information was available to compare them against the other countries.

The most frequent planned and developed cloud computing deployment models amongst the evaluated countries are the private and the community cloud. This is because many of those countries tend to implement a national G-Cloud. The use of public clouds is also common across those countries. However, public clouds are and will be only applied if certain security and privacy requirements can be met or even be neglected.

When comparing cloud computing service models, 50% of the evaluated countries rely on the most common service models: Infrastructure as a Service (Iaas), Platform as a Service (PaaS), and Software as a Service (SaaS). France will set up a G-Cloud and focuses on IaaS. However, public authorities, which will take advantage of the offerings of this G-Cloud, will still be able to provide cloud computing services on

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	Public Cloud Private Cloud Community Cloud	IaaS PaS SaaS	Backup/Archiving Cloud Framework for e-Government applications Collaboration Suites Identity as a Service
Denmark	No	Planned Executional	Municipality	Public Cloud Private Cloud Community Cloud	SaaS	E-Mail Procurement
Finland	No	Planned				
France	Yes	Development	National	Community Cloud	IaaS	
Germany	Yes	Planned				
Ireland	Yes	Planned	National	Public Cloud Private Cloud Community Cloud	IaaS PaaS SaaS	Open Data Public Information Repositories Collaboration Suites E-Mail
Spain	No	Planned Executional	National Regional City	Public Cloud Private Cloud Community Cloud Hybrid Cloud	IaaS PaaS SaaS	E-Government Services Open Government Citizen participation E-Mail Storage/Backup Office and Collaboration
UK	Yes	Development Executional	National	Private Cloud Community Cloud	IaaS PaaS SaaS	E-Mail Office Customer Relationship Management

other levels, i.e. PaaS or SaaS. For Denmark, information could only be found on the application of SaaS services.

Finally, in Table 1 we compared which services might be or are already moved to the cloud. The list is not exhaustive, so we named only the most important services. Applying IaaS, many countries think about cost-effective backup and archiving solutions. Additionally, IaaS can also play a major role for open data initiatives. For PaaS, the evaluated countries tend to offer some kind of cloud framework for e-Government solutions. This framework can be further taken as a basis for local governments or cities, where individual e-Government applications could be developed to. Finally, the

most frequent SaaS services to be moved to the cloud are e-mail services. In addition, many countries think about the use of collaboration services or office suites in the cloud.

5.2   Benefits and Challenges

Cloud computing brings up many benefits for the public sector. However, several challenges must be coped with at the same time. In the following we briefly describe how individual countries can and could benefit from cloud computing and how challenges were or are going to be met by placing specific examples. We thereby refer to the benefits and challenges generally described in Section 3.

Benefits

Denmark, for instance, profited from cloud computing *scalability* during the "World Climate Conference" in 2009, where IT services where consumed from a community cloud. The reason for choosing a cloud approach was that high load peaks were expected before and during the conference [25].

The UK is going to set up a G-Cloud, which will also provide a marketplace for offering public sector applications to be shared and re-used. Those applications shall be offered based on a *pay-as-you-go pricing model* [31].

The government of Catalonia, a federal state in Spain, benefited from an *easy implementation* of cloud computing services by transferring their e-mail system (10.500 users) to the cloud in 2010. As they moved to Microsoft, their local Microsoft exchange system was easily upgraded by the system hosted in the Microsoft cloud.

The Calpe Municipal Council in Spain replaced the desktop PCs of its civil servants with virtual desktop terminals. The main objectives were cost savings and *low maintenance* [34].

All public authorities moving IT services into the cloud benefit from *high availability*. For instance, Amazon EC2[6] or Microsoft Azure[7] promise about 99.95% availability in their service level agreements (SLAs) supporting 24/7 uptime of governmental services.

Challenges

Security is still one of the biggest challenges in cloud computing, hence this challenge is not particularly relating to governmental cloud computing only. Currently, many countries rely on private and community clouds as they provide more control on the set up and infrastructure used for securing and protecting data [17]. An appropriate level of security is usually guaranteed by the cloud provider via SLAs or certification (e.g. ISO27001). Germany, for instance, published a whitepaper on security recommendations for cloud computing providers, which includes minimum information security requirements to be fulfilled for public sector cloud computing [37].

---

[6] http://aws.amazon.com/ec2/
[7] http://www.windowsazure.com/en-us/support/legal/sla/

To be compliant with *data protection* regulations, countries (e.g. France or the UK) favor the deployment of G-Clouds, which geographically store sensitive data only in the respective country [34]. Public cloud models are generally avoided by the individual countries due to the lack of data protection if sensitive data needs to be processed.

To avoid *interoperability* or *data portability* issues, many countries rely upon open source components and the implementation of open standards within their G-Cloud. For the UK Government CIO, this is also one main strand to build up the UK G-Cloud [31].

E-Government applications usually require more *secure and reliable authentication and identification mechanisms*. Cloud providers already start supporting such mechanism for their cloud services. For instance, the Austrian cloud provider Fabasoft[8] offers secure authentication supporting the national eID of Austria, Germany, and Switzerland. Such a support can act as key enabler for further migrations of e-Government services into the cloud.

Auditing is still an issue, which cannot be easily fulfilled by public cloud providers. However, relying on private or community clouds within the individual countries helps in overcoming this challenge.

Summarizing, according to [16] national governments of all EU countries should prepare national strategies for cloud computing in the public sector. Such strategies should particularly focus on security and resilience of cloud computing in their national economies over the next years. Moreover, they see a national strategy essential to avoid incompatible approaches and hence guarantee interoperable platforms and data formats.

6   Conclusions

High scalability and enormous cost savings potential are advantages of cloud computing also the public sector can benefit from. Many European countries have already adopted cloud computing in some public sector areas and others are still planning to do so. In this paper, we evaluated eight European countries on their cloud computing adoption in e-Government. Most of those evaluated countries are still in an early development phase for applying cloud computing services in the public sector. However, the use of cloud computing is anchored in some national strategy in half of the evaluated countries. The dominant cloud deployment model is the so-called G-Cloud, which constitutes a special private or community cloud for governmental services in the respective country. G-Clouds offer better compliance possibilities with national regulations and legislations than public clouds. However, a couple of countries still stick to public clouds for low risk and non-sensitive services. For public sector adoption, all cloud computing service models (IaaS, PaaS, and SaaS) are applicable. There also exist a couple of services which may be moved into the cloud by public authorities. Examples are backup/archiving services, open data applications, e-Government platforms, or collaboration and office suites for back-office procedures.

---

[8]   http://www.fabasoft.com

While European countries already take advantage of cloud computing on national level, several initiatives also try to foster and facilitate cloud computing adoption on pan-European level. For instance, the EuroCloud[9] project constitutes an exchange platform for knowledge sharing and common interests on cloud computing across Europe. Currently, 27 countries participate in this project. Finally, the European Commission is currently setting up a co-funded €10 million project called "European Cloud Partnership"[10] within the 7th Framework Programme (FP7). The aim of this project is the development of a common framework for public sector cloud computing across Europe, especially focusing on electronic procurement requirements.

References

1. Mell, P., Grance, T.: The NIST definition of cloud computing. NIST (2010)
2. Khan, F., Zhang, B., Khan, S., Chen, S.: Technological leap frogging e-government through cloud computing. In: 4th IEEE International Conference on Broadband Network and Multimedia Technology, pp. 201–206 (2011)
3. ENISA. Priorities for Research on Current and Emerging Network Trends (2010)
4. European Commission. A Digital Agenda for Europe (2010)
5. Wyld, D.C.: Moving to the Cloud: An Introduction to Cloud Computing in Government (2009), http://www.businessofgovernment.org/sites/default/files/CloudComputingReport.pdf
6. Austrian Ministry of Finance. Verwaltungskosten senken für Bürger/innen und Unternehmen (2011)
7. Alford, T.: The Economics of cloud computing. Booz Allen Hamilton (2009)
8. Harms, R., Yamartino, M.: The Economics of the Cloud for the EU Public Sector (2010), http://www.microsoft.eu/portals/0/document/eu_public_sector_cloud_economics_a4.pdf
9. Bhisikar, A.: G-Cloud: New Paradigm Shift for Online Public Services. International Journal of Computer Applications 22(8), 24–29 (2011)
10. Zissis, D., Lekkas, D.: Addressing cloud computing security issues. Future Generation Computer Systems 28(3), 583–592 (2012)
11. Armbrust, M., Fox, A., Griffith, R., Joseph, A., Katz, R., Konwinski, A., Lee, G., Patterson, D., Rabkin, A., Stoica, I., Zaharia, M.: A view of cloud computing. Commun. ACM 53(4), 50–58 (2010)
12. Deussen, P., Strick, L., Peters, J.: Cloud-Computing für die öffentliche Verwaltung (2010), http://isprat.net/fileadmin/downloads/pdfs/cloud_studie.pdf
13. Reichstädter, P.: Cloud Computing - Positionspapier, pp. 1–42 (2011)
14. Repschlaeger, J., Wind, S., Zarnekow, R., Turowski, K.: A Reference Guide to Cloud Computing Dimensions: Infrastructure as a Service Classification Framework. In: 45th Hawaii International Conference on System Science, HICSS, pp. 2178–2188 (2012)
15. Zwattendorfer, B., Zefferer, T., Tauber, A.: Requirements for E-Government Applications in the Public Cloud (2013) (under review)
16. ENISA. Security & Resilience in Governmental Clouds (2011)

---

9   http://www.eurocloud.org/
10 https://ec.europa.eu/digital-agenda/en/european-cloud-partnership

17. Zwattendorfer, B., Tauber, A.: The Public Cloud for E-Government. In: IADIS International Conference Collaborative Technologies (2012b)
18. Roessler, T.: E-Government und Cloud-Computing (2010),
    https://demo.egiz.gv.at/plain/content/download/678/3913/
    file/E-Government%20und%20Cloud-Computing.pdf
19. EUPractice.eu. (2009), http://www.epractice.eu/en/news/292790
20. KPMG. Exploring the Cloud: A Global Study of Governments' Adoption of Cloud (2012),
    http://images.forbes.com/forbesinsights/StudyPDFs/exploring-
    cloud.pdf
21. Datatilsynet. Processing of sensitive personal data in a cloud solution (2011),
    http://www.datatilsynet.dk/english/processing-of-sensitive-
    personal-data-in-a-cloud-solution/
22. OurBusinessNews.com.   (2011), http://www.ourbusinessnews.com/tdc-
    gets-danish-cloud-computing-framework-deal/
23. E-Commerce Law Week. Issue 719 (2012),
    http://www.lexology.com/library/detail.aspx?g=2419f3a4-186e-
    4c45-9d16-dfbbb4d2cf94
24. Ylätupa, T.: Cloud Computing in the ICT of Finnish Public Administration (2011),
    https://publications.theseus.fi/bitstream/handle/10024/
    34651/Ylatupa_Tuomas.pdf?sequence=1
25. Frelle-Petersen, L., Valli, T., Sigurðardóttir, G., De Brisis, K., Enzell, M.: Nordic Public Sector Cloud Computing – a discussion paper (2012),
    http://www.norden.org/en/publications/publikationer/
    2011-566/at_download/publicationfile
26. Auffray, C.: Cloud Andromeda: Orange and Thales welcome and are ready to start. ZDNet (2012), http://www.zdnet.fr/actualites/cloud-andromede-orange-
    et-thales-se-felicitent-et-se-disent-prets-a-demarrer-
    39770969.htm
27. Zacks Equity Research. Accenture to Build French G-Cloud (2012),
    http://www.zacks.com/stock/news/67978/
    Accenture+to+Build+French+G-Cloud
28. Federal Ministry of Economics and Technology (BMWi). ICT Strategy of the German Federal Government: Digital Germany 2015 (2010a)
29. Federal Ministry of Economics and Technology (BMWi). Action Programme Cloud Computing (2010b)
30. Irish Government. Technology Actions to Support the Smart Economy (2009)
31. Robinson, N.: Computing in the public sector: rapid international stocktaking (2010)
32. Howlin, B.: Cloud Computing Strategy 2012 (2012), http://per.gov.ie/wp-
    content/uploads/Cloud-Computing-Strategy.pdf
33. Bruton, R.: New standards to provide guidance to business on adopting cloud computing, Department of Jobs, Enterprise, and Innovation (DJEI) (2012),
    http://www.djei.ie/press/2012/20120521.htm
34. Pérez San-José, P., de la Fuente Rodríguez, S., García Pérez, L., Gutiérrez Borge, C., Álvarez Alonso, E.: Study on cloud computing in the Spanish public sector, p. 178 (2012)
35. UK Cabinet Office. Government ICT Strategy (2011),
    http://www.cabinetoffice.gov.uk/content/
    government-ict-strategy
36. European Parliament (Directorate General for Internal Policies – Policy Departement A: Economic and scientific policy). Cloud Computing – Study (2012)
37. Federal Office for Information Security. Security Recommendations for Cloud Computing Providers. White Paper (2010)