

E-Government Based on Cloud Computing and Service-Oriented Architecture

Abdulelah Awadh Al-Rashedi

Abstract—The rapid development of Information Communication Technology (ICT) governments, organizations and businesses are in search of solutions to improve their services and integrate their IT infrastructures. Recent technological tendency such as Service Oriented Architectures (SOA) and cloud computing are supporting these efforts. Thus, our research focuses to build architecture model using SOA and deployment the services via private cloud computing with cooperated e-government environment.

Index Terms—E-government, cloud computing, software as a service, service-oriented architecture.

I. INTRODUCTION

E-governance (electronic governance) is using Information and Communication Technologies (ICTs) at diverse levels of the government and the public sector and beyond. E-governance is the application of information & communication technologies to convert the efficiency, effectiveness, transparency and responsibility of informational & transactional exchanges within government. E-governance aims to deliver more interactive services to citizens and private sectors. This scenario is resembled to like e-commerce, m-commerce through ICT and e-Governance. Therefore e-government has been identified as one of the top priorities for governments across the world [1], [2]. At a global level, cloud architectures can benefit government to reduce duplicate efforts and increase effective utilization of resources. This paper takes e-governance of Saudi Arabia as a case study and we try to suggest an amendment in the existing model to overcome challenging and improve its features and effectiveness. Section I of this paper presents introduction. In Section II we present the e-government, in Section III we present in the interoperability, in Section IV we describe cloud computing, in Section V we briefly discusses the existing e-governance model of SA, Section VI we present SOA and our research and in Section VII we present the related work.

II. APPLICATION IN THE E-GOVERNANCE

The three main target groups that can be distinguished in e-governance concepts are government, citizens and businesses groups. The Government is the primary provider of all these applications, giving its citizens, employees, state owned enterprises and others, access to such applications.

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Some common e-governance applications that can be moved to cloud. They are summarized in visual form in Fig. 1.

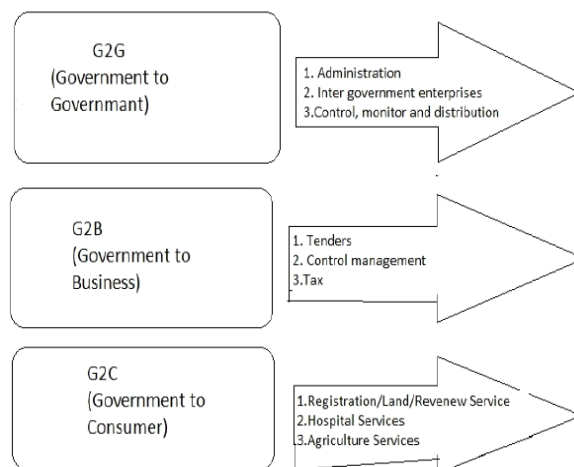


Fig. 1. Types of e-governance [3].

A. Government-to-Government

It is the online non-commercial interaction between Government organizations, departments, and authorities and other Government organizations, departments, and authorities [3].

B. Government-to-Business

G2B is the online non-commercial interaction between local and central government and the commercial business sector, rather than private individuals (G2C), with the purpose of providing businesses information and advice on e-business_best-practices'. Tenders (e-tenders), tax.

C. Government-to-Customer

In G2C, customer (citizen) relationship management, the business (government) can provide the needed products and services accomplish the needs from customer (citizen) [3].

III. INTEROPERABILITY

At a certain stage of e-government evolution, the problem of interoperability arises and becomes the most important. It arises under two conditions. First, e-government achieved such level of development that integrated inter-unit services are required. Second, systems providing e-services in different administrative units are incompatible. Then interoperability becomes one of main obstacles of further e-government development. This problem of interoperability is solved at the IT systems design phase by using Service Oriented Architecture (SOA). Service Oriented Architecture provides a framework for an infrastructure to facilitate the

interactions and communications between services [4]. SOAs are more of a paradigm [5], or a style of design [6] that concludes to architecture. In other words, SOA is a way of thinking about building software than a software development technique [7]. As SOA is being adopted by the government, collections of services as well as specific services will be available for use. Therefore, we propose the cloud computer to deployment these services to become centrally location. We see the details in Section VI.

IV. E-GOVERNANCE IN SAUDI ARABIA

The Saudi Arabian Ministry of Communications and Information Technology (MCIT) established the e-government Program Yesser in 2005 in conjunction with the Ministry of Finance and the Communication and Information Technology Commission (CITC) with the objectives of raising the public sector's productivity and efficiency by providing better and more easy-to-use services for individual and business customers [8]. This National e-government program, acts as an enabler and facilitator for transforming the public sector into an information society. A wide variety of government e-services are currently provided to different types of customers including citizens and residents, labor and employment departments, business organizations and visitors. The technical architecture of Yesser is given in Fig. 2.

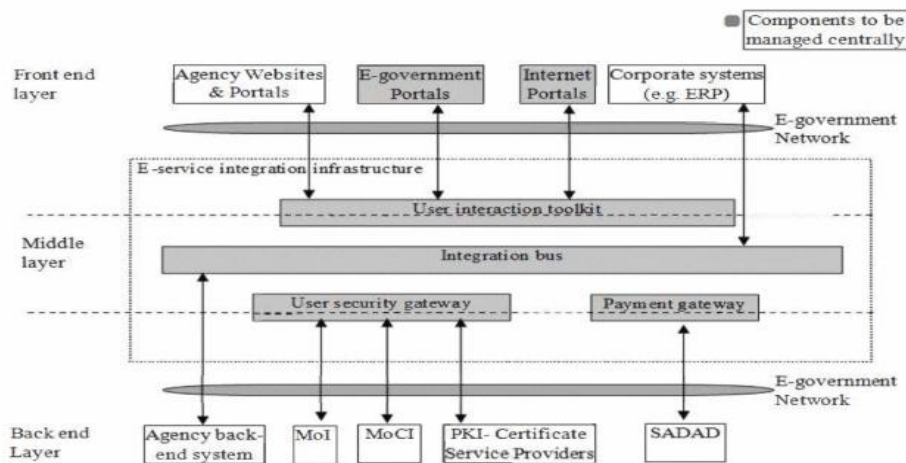


Fig. 2. Technical architecture of e-government Project Yesser.

V. CLOUD COMPUTING

Cloud Computing is a new model for hosting resources and provisioning of services to the consumers. It provides a convenient, on-demand access to a centralized shared pool of computing resources that can be deployed by a minimal management overhead and with a great efficiency. The term "Cloud Computing" sprang from the common practice of depicting the Internet in pictorial diagrams as a cloud. Cloud Computing providers depend on the Internet as the intermediary communications medium leveraged to deliver their IT resources to their consumers on a pay-as-you-go basis. By using cloud computing consumers can be access resources directly through the internet, from anywhere by using any internet devices, and

We can categorize this existing e-government architecture in three layers.

- 1) The front end layer which contains all the user interfaces such as agency web sites and portals, e-government portals, etc., and these portals are the major point of access into the services offered by the Saudi government [8].
- 2) The middle layer contains user interaction toolkits, integration bus and different gateways. A user interaction toolkit establishes mass communication between users with different e-government services. The integration bus is the e-government enabling infrastructure. In its first phase, it will provide integration platform and access to shared government services, like shared data, security, payment services, and notification engine. Later phases of the integration bus will provide integration platform and access to shared government services, like shared data, security, payment services, and notification engine. Later phases of the integration bus will provide advance services, like service orchestration, registry and e-forms integration. The gateways in this layer are responsible for IP security and encryption, firewall security, routing and address management [8].
- 3) The back end layer contains the government agencies IT and network infrastructures which may consist of servers, clustered systems, midrange systems, and mainframes that provide data services to users [8].

at any time without any technical or physical concerns [9]. NIST (National Institute of Standards and Technology) defines, Cloud Computing is on-demand access to a shared pool of computing resources. It is an all-inclusive solution in which all computing resources (hardware, software, networking, storage, and so on) are provided rapidly to the consumers [10].

A. The Need of Society

The characteristics of cloud computing includes: *virtual, scalable, reliable, efficient, and flexible*. Relatively to inexpensive mobile devices and its modern networks, as a fact, computation is increasingly. All Computers that the cloud represents need to scale to this need very quickly. Immediate and automated leasing is a favorite scheduling strategy, since cloud computing is an on-demand

computing paradigm. Most of the strategies is both being an automated scheduling and considering the maximum usage of resources. To achieve an optimal or suboptimal allocation for immediate cloud services, the cloud environment with security is the best option [11]. Moreover, it is characterized by:

- A distributed system where applications are stored in a cloud of decentralized servers that can be reached through an Internet connection and a Web browser.
- A strong extensibility at the applications, platforms and infrastructures levels.
- The resources offered by the cloud can be dynamically assigned according to the need.
- A strong tolerance when one or several resources breakdown.
- A business models where customers pay according to the resources used.

Cloud computing is cheaper than other computing models; zero maintenance cost is involved since the service provider is responsible for the availability of services and clients are free from maintenance and management problems of the resource machines, so organizations do not need to pay for and look after their internal IT solutions [9]. The National Institute of Standards and Technology (NIST) defines cloud computing through five essential characteristics, three cloud service models, and four cloud deployment models. They are summarized in visual form in Fig. 3.

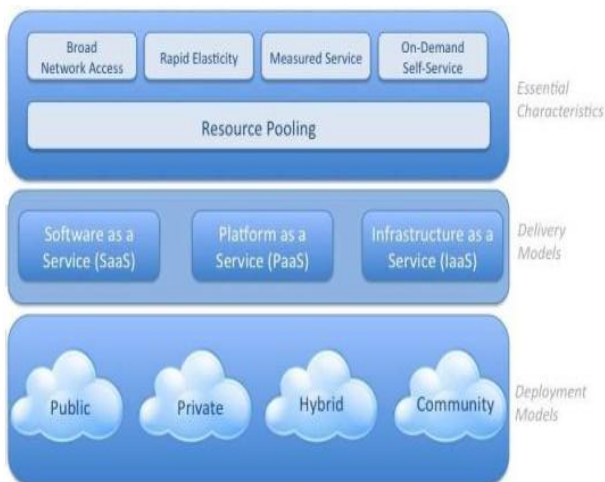


Fig. 3. NIST visual model of cloud computing definition.

B. Cloud Computing Basic Concept

The cloud computing is considered as the 5th generation of architecture in the IT world. It follows-up the following architectures in the chronological order of their appearance: Mainframes (1970), Client-server (1980), Web (1990), SOA (2000) and Cloud (2010). In the literature, there are several definitions of the cloud computing that are more or less vague. However, the definition given by the NIST - National Institute of Standards and Technology [12] is an authoritative one. The view of the NIST is that the cloud computing has three service models, four deployment models and five essential characteristics as shown in Fig. 1 [13].

Three widely referenced service models have evolved [14]:

- **Software-as-a-Service (SaaS):** Only hosted applications are provisioned. By using this model you can reduce the cost of hardware and the software development, maintenance and operations.
- **Platform-as-a-Service (PaaS):** In this model, the customer can develop his application on the provider-supported platform. By using this model you can reduce the cost and full management complexity. The customer can manage his required software components of the platform. The development environment is determined by the cloud provider. The cloud customer has control over applications and application environment settings of the platform.
- **Infrastructure-as-a-Service (IaaS):** The Provider hosts the consumer's virtual machines and provides networks and storage. By using this module the customer avoids purchasing and managing the hardware and software infrastructure components, and is provided with all resources virtualized through a service interface.

In addition to these service models, four deployments have been added:

- **Public cloud:** The cloud infrastructure is made available to the general public or a large industry group and is owned by an organization selling cloud services.
- **Private cloud:** The cloud infrastructure is accessible for an organization only. It may be managed by the organization itself or a third party and can be internal or external.
- **Community cloud:** A private cloud that is shared by several customers with similar security concerns and the same data and applications sensitivity.
- **Hybrid cloud:** It merges more than one Cloud Computing model into a single, hybrid model; using a public cloud for hosting sites that must be published publically and containing uncritical data, and using a private cloud for all the other sensitive data or services. This scenario is good for economic and business requirements.

In addition to the NIST definition, we can find other service models such as:

- **Hardware as a Service (HaaS):** contrarily to the SaaS and PaaS that provide applications and services to the customers, HaaS offers only the hardware.
- **Database as a Service (DaaS):** the aim of a DaaS is to offer a database and the services allowing its management to avoid the complexity and running cost of a database if hosted in the own network of a company or organization.

Monitoring, addressing security and privacy issues remain in the purview of the organization, just as other important issues, such as performance, availability, and recovery [15].

C. Issues and Challenges

Although the benefits that Cloud Computing offers, there are numerous issues and challenges for organizations embracing this new paradigm. A list number of major challenges with respect to the following:

- Data management and governance.
- Service management and governance.

- Product and process control and monitoring.
- Infrastructure and system reliability and availability
- Information and visualization security.
- Concerns over security with respect to knowledge, information and data residing on an external service device.
- Concerns over services' and resources' availability and business continuity.
- Concerns over data transmission across anticipated broadband speeds.

Other shortcomings include no native security attributes, inadequate or no security provisioning by providers, lack of understanding of Cloud legal issues, and the failure to recognize potential liability from either legal issues or because of lack of security. Issues with respect to "control" are also real concerns [10].

D. Cloud Service Provider CSP Experiment

During these last years, the new cloud computing paradigm has been generalized in the IT world. Actually, the idea of cloud computing is not new as John McCarthy suggested its first enunciation in 1960: "computation may someday be organized as a public utility". This paradigm has been used by Amazon since 2002, where it started to resell its storage and treatment capacities as they were higher than its needs. Nowadays, we can distinguish two main kinds of actors: those coming from the Web as Amazon, Salesforce.com, Google and those coming from the IT as IBM, Microsoft, Sun, HP and Oracle. These actors offer several layers in the cloud to allow the development and online publishing of applications (e.g. the Force.com development platform of Salesforce.com or the Gmail application of Google). Actually, we can find taxonomy of the existing services offered in the context of the cloud computing [15].

Because cloud service providers (CSPs) are separate administrative entities, moving to the commercial public cloud deprives users of direct control over the systems that manage their data and applications. Even if CSPs' infrastructure and management capabilities are much more powerful and reliable than those of personal computing devices because users don't have access to the cloud's internal operational details, CSPs might also voluntarily examine users' data for various reasons without detection. Additionally, owing to hardware virtualization, multiple users can now share the same physical infrastructure, which runs their distinct application instances simultaneously [16].

VI. SERVICE ORIENTED ARCHITECTURE SOA

The concept of SOA came about as a way of defining software architectures in a more sophisticated manner by paying greater attention to the exchanges amongst large software components. In addition, the method of service orientation places an emphasis on reusability by separating the interface of a function from its internal implementation. This form of separation makes service orientation an appropriate method for both heterogeneous and distributed architectures [17]. Therefore, it provides well defined interfaces for client applications and separates the interfaces from their implementations and we can set of

principles and policies to consume the service. It facilitates interaction and communication among services and efficient use of heterogeneous, geographically distributed resources. Web Services are required to implement SOA. The web services architecture has three roles: a provider, a requestor, and a registry. The provider creates the web service and makes it available to clients who want to use it. A requestor is a client application that consumes the web service. The service registry provides a way for the provider and the requestor of a web service to interact. Using WSDL and UDDI, SOAP protocols the communication is accomplished [18].

A. Web Services

At the current state of system integration, Web services technology is a general way for implementing SOA. Web services [19] are a recent set of technology specifications that leverage existing proven open standards such as XML, URL, and HTTP to provide a new system-to-system communication standard. Based on this communication model, additional higher-level Web services standards have also been defined to address transactions, security, business processes, and so forth: the higher-order functions that are required to get systems, applications, and processes (rather than objects and components) talking to each other. Web services learn from the way the Web revolutionized how people talk to systems: new customers, new business models, extensions of opportunity, new transparency and improved collaboration between employees and employers, and in some cases reductions in infrastructure costs and complexity. The key to these successes was a universal server-to-client model that is consistent with a highly distributed environment, based on simple open standards and industry support [20]. Web services promises to do the same thing for the way systems talk to systems: integrating one business directly with another so that the process doesn't have to wait for people to provide the glue, get your own business talking to itself or your partners to provide integrated IT systems, and again the potential for dramatic reductions in infrastructure costs and complexity. Once again, the key is a universal program-to-program communication model based on simple open standards and industry support. Web Services are composed of the following components: service provider, service consumer, service broker. The service consumers look for a required service, and the service provider offers the application service. The service broker is an intermediate agent helping the customer to find a service. This mechanism is realized with SOAP (Simple Object Access Protocol) [21], WSDL (Web Service Description Language) [22], and UDDI (Universal Description Discovery Integration) [23]. SOAP is a message exchange protocol, which is based on the XML and HTTP protocols. The use of XML in SOAP provides platform independency of the data format. Similarly, the HTTP provides data transfer capability through the Internet layer. In similar fashion, WSDL explains the service. Its format also follows the XML protocol which is combined with the SOAP. Particularly, it describes where the service is located, how the service behaves, what the required data type and service parameters are. Likewise, UDDI is provided in an XML format. UDDI plays the role of a directory because it

contains all the deployed services by the service provider. So service customer looks up the UDDI and finds the required service descriptions and the WSDL [22].

B. Motivation of Our Work and the Proposed Model

IT Services were usually critical to the implementation of e-government services. The increase in end user numbers either citizen or private sectors, demand for new technologies and complexities of systems has often caused IT services costs to grow faster than other costs. As a result, IT services of centralized e-government systems in future may become high cost or inflexible service.

In Saudi Arabia, IT spending reached SR 27 billion in 2010 and is expected to grow by 10.2% year-on-ear in 2011. Strong growth rates will be maintained over the next few years, with IT spending set to expand at a compound annual growth rate (CAGR) of 11.4% through 2015. This rapid growth, fuelled mostly by increased spending on hardware and IT services, will take IT spending to SR 46.3 billion in 2015 [8].

The key financial factors of these services are categorized as follow:

- Hardware: CPUs, Storage, peripherals, WAN, LAN, Workstations, laptops, PDAs, etc and also Hardware maintenance contracts.
- Software: Operating Systems, Database Management Systems, Application Servers, Web Servers, Mail Servers, Packaged Applications, Monitoring Applications, Security Applications, etc. including Software support contracts and recurrent license cost.

The proposed private cloud architecture can be as shown in Fig. 4. Public sectors may differ in infrastructure, platforms and systems among them. Integration and maintenance for these system is rising, the end-user demands are increasing. In addition to all previous factors, there are increased demands for enabling interoperability between within the government domain. Service-orientation architecture is no need to reengineer the existing system but it allows existing system to be along with new capabilities in order to build a library of services that can then be used as the basis for many different solutions. So, the web services can be developed as loosely coupled using to multiple programming languages, whatever protocol, or any platform. This facilitates the provider of business applications as a service accessible to anybody, anytime, at any place, and using any platform. In our proposal are using a cloud computing to deliver platform as service in order to public sectors deployment their services over cloud computing. The benefit our proposal:

- No need to purchase hardware, software and licence.
- Public sectors can easy to access and deployment their services.
- Easy to consume the services.
- Government can set the policy and workflow to consume the services
- Reduce the cost.
- Easy to monitor, management and maintenance IT infrastructure.
- Supporting loosely coupled concept.

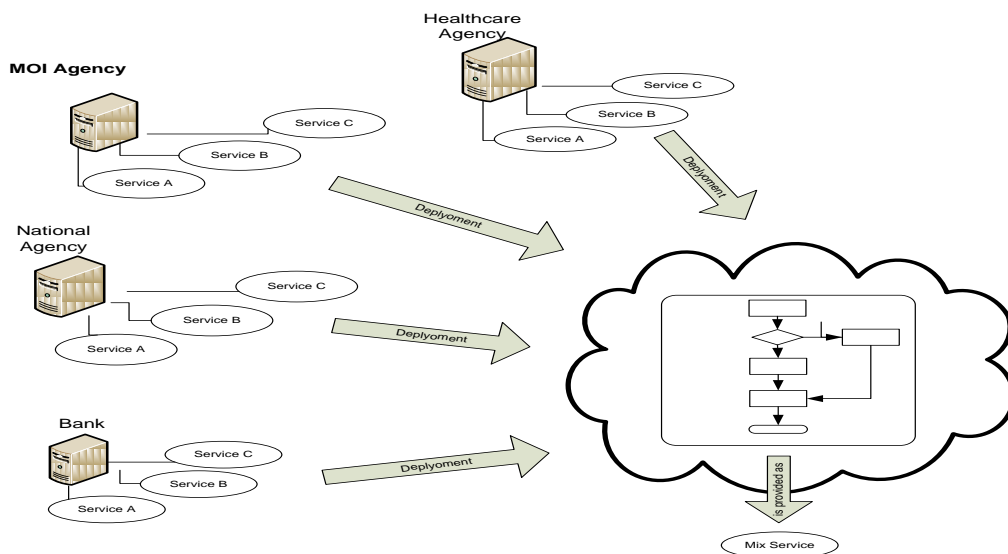


Fig. 4. SOA in public sector: a mix service composed of services provided by both governmental and business units.

VII. RELATED WORK

In this paper [24] the current scenario every enterprise wants to implement Cloud Computing to fulfill their computing needs. These changes naturally should reflect the way government functions in terms of the organization of the government, its relationship with its citizens, institutions and businesses and cooperation with other governments. The critical problem (Rastogi 2010) discussed for the developing countries is the necessary infrastructure to implement the E-services. In another paper

he (Rastogi 2010) also discusses how to overcome the E-governance problems faced by the developing countries. Application of Cloud computing for the better E-governance in Developing countries In this paper we propose a model based framework to implement cloud computing.

In this paper [25] the writer discussed these theoretical architectures CCOA and SOCCA. Both of these architectures propose an ideal architecture that hopes to make cloud computing better. CCOA, as talked about implemented architecture, but the paper does not have enough information or detail in the case study to say that

this is service oriented architecture. In the end the architecture proposed could be service oriented architecture, but there is not enough evidence in the case study to say they succeeded. SOCCA is a promising idea and could possibly be made into service oriented architecture. The concept of a cloud computing architecture that has all the best properties would be an amazing feat, but is still far away and needs more effort invested into it before a service oriented architecture can become a realization. These two architectures could be a good place to start.

In this paper [26], architecture of e-government based on SOA is presented. Through a middleware technology GSB based on ESB and Web Services, service management methods and service interaction function in a distributed heterogeneous environment are provided for SOA-based e-government system. This architecture includes three parts: to encapsulate the specific e-government legacy application into services; to allow all kinds of e-government applications; to intercommunicate and interoperate seamlessly; to adapt and shield the heterogeneity of e-government applications to provide a wealth of service access for outside world. The architecture addresses the complex of the integration and interaction and heterogeneous systems in e-government system, and may expand into other areas such as e-commerce, e-healthcare areas.

VIII. CONCLUSIONS

As follows came from this paper, due to the advances of Internet development and deployment, e-government solutions should be based on cloud computing and service-oriented architecture. These two approaches combined together have significant technical, organizational, social and economical advantages. The national government must have a whole view of electronic government. This view must be optimized from the global point of view to ensure interoperability at the level of the whole state. Interoperability is required to enable dynamically creating multiple services covering the whole customers' processes. Cloud computing has also sociological impact. It allows innovative IT solutions to be rapidly available to all public offices, departments and agencies regardless of their locations or level of technical competencies.

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