Role of ICT in e-Governance: Impact of Cloud Computing in Driving New Initiatives

By N Vijaykumar

Cloud computing is increasingly becoming a viable platform to host e-Governance applications

E-Governance aims at providing citizen-centric services and ensuring increased transparency in the service interactions with various government agencies. Governments world over are increasingly aiming to reduce manual touch points, provide more reliable, efficient services and reduce cycle time. e-Governance is all about doing business online and in a secure manner. Coverage, usability and volumes are some of the key success factors for any e-governance initiative and agencies are increasingly leveraging the massive advancements in information and communication technology (ICT) to drive these initiatives and reduce the digital divide.

According to OECD, the term e-government focuses on the use of new ICTs by governments as applied to the full range of government functions [1]. Two major trends are considered as the key drivers for ICT to propel e-governance projects: (a) massive developments in IT industry that has propelled e-governance further, making it more convenient for government bodies to e-enable their operations; and (b) development of skills and knowledge of end users in computers and internet and increasing adoption of ICT in their daily lives. These factors have fuelled the usage of ICT in development of e-governance solutions and platforms. Given this congenial environment toward fast growth with ICT, it is time that the public sector takes full advantage of this massive growth to implement solutions for e-governance.

A technology that has the potential to offer solutions for e-governance is cloud computing. Cloud computing provides service-oriented access to users without compromising on security. This makes cloud an excellent platform to host e-governance services. Currently, there are very little e-governance initiatives that have been hosted on a cloud environment. Even in India, the government is currently evaluating options of rolling out
e-governance services using cloud-based technologies. Considering the vast amount of business processes and services that exist in any governance model, cloud computing is one of the key technology vehicles that could make e-governance projects a reality, take it to the masses and more importantly, sustain them over a period of time.

WHAT IS CLOUD COMPUTING?
Cloud computing is a new business paradigm in a service oriented model, delivering business applications and other IT resources as services over the internet. It is a conglomeration of infrastructure (hardware devices) and application software providing services to consumers on a pay-per-use basis. Cloud computing represents the next generation infrastructure and application hosting service and delivery model. A cloud typically has three key differentiating characteristics: (a) the usage of the resources is on demand and billed at actual consumption, (b) is scalable and can support varying bursts of traffic, and more importantly, (c) can be accessed over the internet. Cloud represents a drastic variation from traditional infrastructure hosting that is done in a datacenter within the customer premises. Table 1 provides the key differences between traditional and cloud model from an ownership and service delivery perspective.

Cloud computing comes in various types. Public, private and hybrid clouds define the manner and location in which the IT infrastructure is being setup and the way resources are being accessed. Another variant of cloud computing service model is based on the services provided. Cloud provides infrastructure as a service (IaaS), platform as a service (PaaS) and software as a service (SaaS). A suitable combinational model for e-governance can be chosen based on the actual requirements.

TRENDS IN CLOUD COMPUTING AS A PLATFORM FOR e-GOVERNANCE
While traditional methods of rolling out e-governance projects is the order of the day, governments world over have started looking at cloud as an alternative platform for hosting e-governance services. Even though there are

<table>
<thead>
<tr>
<th>Traditional Hosting Model</th>
<th>Cloud Computing Model</th>
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<tbody>
<tr>
<td>End user (or the customer) purchases IT assets (hardware, software, licenses, etc.) upfront and ownership of IT assets is with customer</td>
<td>Service provider procures the IT infrastructure and the ownership of the IT assets is with the cloud service provider</td>
</tr>
<tr>
<td>IT infrastructure hosted in a datacenter within the customer premises (or at times, co-hosted in a datacenter service provider)</td>
<td>IT infrastructure hosted in the cloud datacenters in the service provider premises</td>
</tr>
<tr>
<td>Whether used or not, compute resources available full time to users</td>
<td>Compute resources available to users on demand and for specific durations as well</td>
</tr>
<tr>
<td>No need to pay for the usage of the resources</td>
<td>Charged on per-usage basis</td>
</tr>
<tr>
<td>High initial investment and high on-going costs</td>
<td>No or very low initial investment. Reduced operating expenditure</td>
</tr>
<tr>
<td>High overheads like vendor management, server monitoring and management</td>
<td>Low overheads</td>
</tr>
<tr>
<td>Dedicated infrastructure</td>
<td>Shared infrastructure or multi-tenanted</td>
</tr>
</tbody>
</table>

Table 1: Differences between Traditional and Cloud Hosting Model

Source: Infosys Research
not many cloud based e-governance initiatives, there is an uptrend to use cloud to increase the coverage. With rapid developments around new and innovative cloud offerings being provided by technology providers, more and more initiatives are being planned using cloud.

In a document that outlines a Digital Japan Creation Project, dubbed the ICT Hatoyama Plan, Japan’s Ministry of Internal Affairs and Communications revealed plans to build a massive cloud computing infrastructure to support the government’s IT systems. “Government information systems are using innovative technologies such as cloud computing to develop the Kasumigaseki Cloud, in stages, by 2015. The Kasumigaseki Cloud will enable various ministries to collaborate to integrate and consolidate hardware and create platforms for shared functions [2].”

Similarly in India, there are major initiatives that are being planned to tap the potential of cloud. India might soon become the first country in the world to deliver e-governance services to citizens using cloud-based IT services. The government is in a dialogue with the apex software industry body, Nasscom, on how to roll out e-governance services using this emerging technology [3].

One of the biggest e-governance initiatives in India, the Unique Identification Authority of India (UIDAI) aims to provide unique biometric identity cards to the Indian citizens and this project will be one of the first to use cloud computing as a platform. According to UIDAI, the UID application will be architected for the cloud and will sit on an e-governance cloud platform that will be assembled using open architecture and components. This might turn out to be one of the biggest such implementations in the world, considering the scale and reach.

On the other hand, technology service providers are competing to provide cost effective and innovative solutions to host services on cloud. Many providers are partnering with governments to build and operate e-governance platforms on cloud. Vendors like Google, Rackspace and Amazon in US and Europe are providing readymade platforms for hosting such initiatives. Similarly Microsoft, IBM and HP are some key players engaged in developing SaaS-based applications for government initiatives.

**e-GOVERNANCE APPLICATION ARCHITECTURE**

The typical application architecture includes core business logic and business processes, necessary workflows and various application components. More importantly, integration with other sub-systems is a critical element in the e-governance architecture. Figure 1 overleaf indicates a typical e-governance reference architecture.

e-Governance architecture calls for scalability and interoperability given the various interconnects that are deployed. Typically a cloud infrastructure is built with virtualization as a key foundation component at all possible levels like server, storage, application, etc. This feature supports all non-functional requirements of e-governance applications seamlessly.

**CLOUD COMPUTING AND e-GOVERNANCE**

Cloud computing is shared environment, multi-tenant and over-the-internet based service delivery model. Cloud provides an attractive alternative to the common man as well as for organizations to transact and do business online. There are some key characteristics
of cloud that can help to host e-governance applications over internet.

**Accessibility:** The biggest advantage of a cloud environment is its accessibility of environment by consumers. Since it is on the internet, it is always accessible. One just needs a PC and internet connectivity to access the applications. With internet becoming a fast penetrating commodity, a consumer is able access the application anywhere, anytime.

**High Availability:** Since the applications are hosted on internet, they need to be made available 24/7. Cloud is built on a sturdy infrastructure platform that guarantees high availability of IT infrastructure. All key components and sub-systems are clustered and single point of failures eliminated. Clustering is implemented at almost all levels of hardware and even at application and middleware component levels.

**Scalability:** e-Governance is characterized by uncertainty in demand and load. There could be a heavy spurt in demand during particular period(s) of the year and relatively stable and lesser load during other periods. For instance, tax filing is at its peak during certain periods of the year. The platform should support adding resources dynamically to meet this excess demand. Cloud is built on the basic premise that it is elastic and dynamic. Technologies like virtualization, clustering, and load balancing ensure scalability and high availability. Today, technologies are available to add memory and processor to the services on the fly without having to bring down either the hardware or application.

**Service Orientation:** Cloud is built on the concept of service oriented architecture. This facilitates provisioning of compounded or mashed up services spanning the entire

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*Figure 1: Key Elements of an e-Governance Architecture*  
*Source: Infosys Research*
consumer process keeping the end consumer in mind. At times, the model ensures ease of operation for a service receiving citizen and a service providing enterprise. This includes some of the value added services provided by external partners, on top of government services. This promotes both customer centricity and also brings in value added services and service providers to further promote the growth of e-governance.

**Interoperability:** e-Governance is all about multiple agencies and departments providing services to end users. With varying sets of independent applications in respective departments e-governance should make these variations transparent to the consumer. This also means that the IT infrastructure should support multiple sets and versions of applications and technologies to bring in inclusivity. Cloud computing supports interoperability as it is majorly based on virtualization and platform independent services.

**Information Security:** One of the key requirements of an internet based application is security as the confidential details of citizens, businesses, etc., are transacted on this platform. Though it is a multi-tenanted model, cloud provides a tight security such that confidentiality, integrity and availability of the information is not compromised.

With such viable features, cloud computing is highly relevant to host e-governance applications as it guarantees reach, scalability and availability. For governments, it provides a centralized and stable platform that can be shared, re-used and can support multiple departments thereby cutting down on individual platforms and solutions.

**CLOUD MODELS AND APPLICABILITY TO e-GOVERNANCE INITIATIVES**

As a service model, cloud offers various services from its stack. Based on the type of services it provides, cloud offers three layers. These are three abstracted and virtualized layers and provide services independent of each other. e-Governance projects can use any or a combination of these layers to provide services to consumers. Table 2 overleaf reflects the level of abstractions and the applicability of each layer to various initiatives.

These are the service-oriented models that cloud computing has to offer. e-Governance projects can adopt either of these models for implementation. However SaaS model will be a better fit than others.

**BENEFITS OF CLOUD COMPUTING**

Cloud offers a very attractive platform for the governments to host and operate the e-governance applications. Key benefits are -

**Reduced Total Cost of Ownership (TCO)** – Adoption of cloud reduces TCO in the long run. Deploying applications on a cloud platform and especially on a public cloud reduces capital outlays. Even if the government intends to setup a private cloud, there are new business models like public private partnership (PPP) and build, operate and transfer (BOT) that ensure that the outflow from the government exchequer is minimal.

**Minimizes Labor Cost** – As infrastructure is hosted on cloud provider premises that will also manage and maintain the platform, government does not have to spend on management cost and overheads. Certain reports indicate that the IT operations cost can be cut by as much as 50% on cloud enabled e-governance applications [4].
High Availability – Cloud guarantees uptimes in the range of 99%. Being available anywhere and anytime is the unique selling proposition (USP) of e-governance. Cloud infrastructures provide high availability as well as reachability. Of course, the underlying infrastructure has to support these non-functional characteristics.

Apart from these, there are other features like metering, on-demand availability and better disaster recovery abilities that add to the choice of cloud as an e-governance delivery mechanism.

<table>
<thead>
<tr>
<th>Model</th>
<th>Characteristics</th>
<th>Services offered</th>
<th>Applicability to e-Governance</th>
<th>Relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software as a Service (SaaS)</td>
<td>• Software application is offered as a service</td>
<td>• e-Governance services (G2B, G2C, G2G)</td>
<td>• Actual G2X services as offered to end customers, accessible through internet</td>
<td>HIGH</td>
</tr>
<tr>
<td></td>
<td>• Pre-built applications that can be deployed on demand</td>
<td>• Value added services (e.g., payment gateway)</td>
<td>• Easy to deploy and rollout</td>
<td></td>
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<tr>
<td></td>
<td>• Service virtualization</td>
<td></td>
<td>• Similar applications for different departments can be provisioned faster</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>• Reduces TCO as the application is available off the shelf</td>
<td></td>
</tr>
<tr>
<td>Platform as a Service (PaaS)</td>
<td>• Provides required platform to develop and customize applications</td>
<td>• Plain or pre-configured application stack</td>
<td>Pre-configured stack and middleware elements available, facilitating faster application</td>
<td>LOW</td>
</tr>
<tr>
<td></td>
<td>• Exposes service components &amp; APIs</td>
<td>• Workflow and message queue services</td>
<td>development and rollout</td>
<td></td>
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<tr>
<td></td>
<td>• Integration platform</td>
<td>• Application instances (e.g., middleware containers)</td>
<td>Consistency and repeatability—helps re-deploy multiple instances quicker</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Choice of different platforms</td>
<td>• Application clustering</td>
<td>End customer does not have to buy the software licenses</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Reduces maintenance and management overheads</td>
<td></td>
</tr>
<tr>
<td>Infrastructure as a Service (IaaS)</td>
<td>• Provides hardware infrastructure (servers, OS, storage, network) on demand</td>
<td>• Slices of hardware (server, storage instances)</td>
<td>Pre-configured hardware instances that can be provisioned faster</td>
<td>MEDIUM</td>
</tr>
<tr>
<td></td>
<td>• Virtualized environments and hence are highly scalable</td>
<td>• Data backup and restore services</td>
<td>Resource augmentation easier to support burst of demand</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• High availability</td>
<td>• Clustering solutions</td>
<td>Uniformity of the environment configuration thereby ensuring consistency</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Choice of different platforms</td>
<td>• Disaster recovery</td>
<td>End customer does not have to buy hardware and OS licenses thereby reducing the TCO</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Virtualized containers</td>
<td></td>
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</table>

Table 2: SaaS Model is a better Cloud Implementation for e-Governance

Source: Infosys Research

Increases Go-to-Market Times and Speed to Launch – Being hosted in an existing platform that serves as the foundation, rolling out various services is really easy. As e-governance application architecture is modular and supports staggered delivery, underlying infrastructure components that are built on virtualization support such service rollouts. There is no need to buy hardware and software for each service. This helps reduce cost and time.
PUBLIC OR PRIVATE CLOUD?
Which one will be ideal for e-governance services? What are the criteria for choosing the right model? These are some of the typical questions that one confronts during a cloud implementation. While both variants of cloud will support hosting e-governance applications, a private cloud will be more suitable for a government scenario. While public cloud is hosted on a third-party service provider premises, a private cloud setup exclusively for hosting e-governance application(s), will cater to a focused set of requirements and can be used for multiple e-governance projects. Since most government agencies will share a similar set of applications, it is better to set up a private cloud and allow extension of services across various departments and agencies.

Such a private cloud could be set up on-premise or it could also be hosted in a third party provider space. In India, National Informatics Center (a government owned service provider) is the nodal agency to host websites, portals and other infrastructure requirements of all state and central government departments. Private cloud allows more control of infrastructure and application components to the departments and also defines its own strategic control and security policies. Once the bare IT infrastructure is provisioned, additional services can be rolled out at a differential cost and time. Moreover, with advent of open source application components, it is easier to customize the requirements. Public clouds are not non-starters but it happens to be so given the criticality of businesses and sensitivity of data involved. Thus, private clouds are preferred over public clouds.

BENEFITS OF PRIVATE CLOUD FOR e-GOVERNANCE
Private clouds offer the required flexibility and control to government departments for hosting their e-governance solutions. Some of the key benefits of private cloud for governments are -

Security: Levels of security are ensured as cloud infrastructure is hosted within a government department and is behind the firewall.

Shared Platform: Many government departments can share the platform for hosting their applications. This is more so as most of the government agencies use similar applications and a private cloud will provide a common platform to host such shared applications. Moreover, cloud guarantees a uniform environment to host multiple e-governance initiatives.

Reduces Overall Cost: Private cloud does not require individual infrastructure for every department or agency. This helps to save on capital expenditure and reduces the overall cost. Also, it reduces the software license cost for the departments as it is a shared platform.

Compliance with Standards: Since the infrastructure is hosted in-house, the risk associated with a third-party hosting like possible security and data theft issues are largely reduced. Moreover, such cloud can be built as per the standards laid out by the government.

SETTING UP THE CLOUD ENVIRONMENT
Deploying a private cloud is a good starting point for the government departments to support e-governance initiatives. This has two distinct components -

IT Infrastructure: Government departments can consolidate all the IT hardware and create a virtualization wrapper on the infrastructure
that will act as a virtual private cloud. This will create the basic infrastructure platform on which the applications can be hosted. Also, such a pooling helps optimize infrastructure utilization. Technology providers like Microsoft and VMware provide tools to build the infrastructure. Similarly, open source tools like Eucalyptus, Enomaly, etc., help build the underlying cloud infrastructure within the department.

**Applications:** e-Governance initiatives are usually green field as the application has to be developed ground up. In such scenarios, enabling the application for cloud or making it SaaS enabled is much easier than migrating existing applications. For such applications, SOA enabling the architecture will provide the SaaS features. There are numerous technologies like Microsoft Azure and Google App Engine that provide migration tools. There are also open source tools that help migrate applications from legacy platform to a cloud-enabled architecture. However, such tools place restriction on the technology that needs to be used on various application layers. Thus, such tools might be a good fit for green field applications. Existing and running applications that need to be moved to an e-governance platform require undergoing substantial change to the technology stack. Also, if the existing application is running a legacy stack, it is recommended to re-engineer the application. Migrating an existing application is more complicated and time consuming than building a green field SaaS enabled application.

**COMPLIANCE STANDARDS IN CLOUD**

e-Governance is all about transacting on government services involving confidential and sensitive data. The data can involve details about government departments as well as information pertaining to consumers, for e.g., identification number, business details, etc. Also, information security is very critical as there are interactions with external providers in the form of payment gateways and value added services. This becomes much more pronounced and important considering the fact that cloud is a multi-tenanted framework and multiple applications and services are hosted on the same IT platform. Thus, it is highly essential that cloud applications enforce maximum security at all levels. Moreover, every government has its own legal and compliance standards to which any e-governance security or information security process must comply with. This becomes more critical in a cloud environment.

A variety of regulations pertaining to storage and use of information and data, including PCI-DSS, SOX, HIPAA and SAS 70 are being enforced in cloud environment. These regulations require reporting and audit trails. Cloud service providers should enable these controls on both infrastructure and e-governance applications and must be able to prove the compliance on a periodic basis. It is for the service provider to make available these controls for the government to check and ensure data protection.

One key challenge for cloud service providers is the location of data storage. Many governmental regulations expect that sensitive data should be stored within the country’s geographical boundaries and should not be off shored. But given the basic cloud architecture and distributed nature of infrastructure on which cloud is based, it might be difficult to retain the data storage within the same country. Since public cloud providers span their infrastructure across countries and continents for disaster recovery purposes, there is every possibility that data could be replicated to a storage device located in a different geography.
This is one of the key deterrents toward wide acceptance of cloud to host e-government services. There are various initiatives taken by the service providers to ensure data localization. According to a report published in 2008, Gartner reports data storage related risks as one of the key security risks in a cloud environment [5].

SERVICE LEVEL MANAGEMENT OF e-GOVERNANCE SERVICES
Another performance metric that is key to the success of e-governance projects is service levels. In a manual mode of government transaction, service levels are not measured often and this is more because a consumer can obtain status of the transactions across the counter. But in an electronic form, it is imperative that service levels are published upfront to help consumers track the transaction. An example can be a service catalog. But irrespective of the services provided from a cloud or an on-premise environment, service management in an electronic platform is essential for the success of the initiative. It is more so as it is a common expectation to have better service levels in an automated and computerized platform vis-à-vis the manual mode. There are two major dimensions in service level management. One is related to business services where each department commits to certain timelines and service guarantees on the business process flow while the other is related to technology where the technology service provider commits to certain service levels on the environment. Both the perspectives are complementary to each other.

Services Perspective: As the transaction moves from one stage to the other in an automated workflow process, certain actions have to be performed at each step by relevant departments. The entire application and the workflow have to be service oriented to make services more modular. Service orientation entails covering the entire consumer process and enables applications to be used in a more integrated and compounded fashion. With more and more compounded services being rolled out, it is essential that the processing time is defined and measured at each stage-gate. Since speed and transparency are key objectives of e-governance, they have to be monitored and measured. The application has to be built to support such a service level definition.

Technology Perspective: The essence of rolling out e-governance services is to ensure reach and high availability of the service and both these tenets have to be provided by the technology platform. Surely, cloud computing provides both. Reach is ensured as it is hosted on internet. With the basic construct of the infrastructure, availability of the platform is ensured by virtualization technologies. With these underlying technologies, the platform provides an on-demand environment where service levels are key characteristics. For instance, the e-governance service uptime is always expected to be greater than 99% and it can be achieved only if the underlying platforms support the same. Cloud service providers guarantee attractive uptimes that will aid in hosting the services on cloud.

CONCLUSION
E-Governance represents change and represents a progressing economy. Integrating disparate processes and providing a uniform set of services will form the crux of rolling out e-governance initiatives. Apart from simplifying the process and changing the mindset of the people, it is the
technology that will support the success of such programs. Cloud computing is one such vehicle that will help the growth of e-governance and take such initiatives to every nook and corner of the geography. Cloud computing provides a firm base to provide e-services to various stakeholders.

It is worth noting that deployment of e-government solutions in the form of cloud computing enables benefit from economies of scale. Cloud computing also bears a social impact. It enables advanced IT solutions to be rapidly available to all public offices, irrespective of locations or level of technical competencies. Cloud architectures when applied to developing e-governance applications have the potential to transform a nation into an information society.

REFERENCES

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