Cloud Computing for E-Governance

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***Abstract*:- The worldwide revolution in Internet is changing our lives in terms of the way we work, learn and interact. 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. Also, the increasing generalization of technology access by citizen and organizations brings expectations and demands on government. At the same time, governments are also proactive in this domain and are planning new ways of interacting, improving services, optimizing processes and revitalizing democracy by spending amount on IT. It aims to deliver more interactive services to citizens and businesses through E-Governance. For this, cloud computing may lead to significant cost savings. It entails use over the Internet of computing hardware and software infrastructure and applications that are remotely hosted. In this white paper, we describe how this newly emerged paradigm of cloud computing can be helpful for E-Governance.**

Keywords:- E-Governance, Cloud Computing, Cloud Models

INTRODUCTION

This paper describes the role of cloud computing standards and architectures in framing a good E-Governance strategy to realize e-Government. Governments have been slower in realizing the potential benefits of the Information Technology to provide e-services. E-services are delivering cost-effective services, which can drive the growth of the economy and government productivity.

Cloud computing provides a new service consumption and delivery model inspired by Consumer Internet Services. Cloud computing drives down costs and accelerates cost reduction benefit. Cloud is making rapid inroads.

E-Governance with cloud computing offers integration management with automated problem resolution, manages security end to end, and helps budget based on actual usage of data. At a global level, Cloud architectures can benefit government to reduce duplicate efforts and increase effective utilization of resources. This in turn helps the government going green,

Cloud Computing for E-governance can:

- Reduce IT labor cost by 50%
- Improve capital utilization by 75%, significantly reducing license costs
- Provides much needed scalability

reducing pollution and effective waste management. Enterprises and Small and Medium businesses are already reaping the benefits of cloud by using the pay-as-you-use service model, its massive scalability and ready availability.

Since government requires a massive infrastructure it is important for government to use cloud computing on long term basis.

A unified e-government infrastructure, based on cloud and SOA architectures is required, that paves the way for inter-agency information sharing and workflow and is enabling the delivery of seamless services to the public. Cloud architectures allow rapid deployment of turn key test environments with little or no customization.

The white paper elucidates the benefits of cloud in rolling out E-Governance services. It also describes E-Governance general requirements, while delving more into the challenges of E-Governance and listing out the benefits of cloud computing architectures for the same. The paper lists out the cloud computing benefits as applied to rolling out E-Governance applications.

Ensuring legal framework and institutional setups are required to create and promote the ideal environment of e-services. The private sector can undertake the componentized delivery of these applications in a well orchestrated legal framework of

public/private partnership. Independent E-Government initiatives from different departments, threatened to make services level worse due to lack of interagency unity and not because all organizations would proceed at the same pace.

No one should be deluded by the complexity and scale of services and hurdles to overcome to implement such a large scale program for a country of our size and distribution. Proper planning, execution, training and good management could reduce overall costs to a great extent and help in more efficient utilizations of tax payers' money.

Baby steps are already made in providing E-Governance services, and it is time for E-Governance to take an elephant leap.

1. E-GOVERNANCE REQUIR EMENTS

E-Governance is a process of reform in the way governments work, share informatio n, engage citizens and deliver services to external and internal clients for the benefit of both governm nt and the clients that they serve.

Governments have innumerable ap plications that can be automated. Government spe nding on IT would increase the productivity of the go vernment and would help in decision making and policy enforcement etc. Applications in the government fall into the following broad categories:

Figure 1: Types of E-Governance applications

Figure 1 lists the types of the E-Gov ernance applications. All the applications fall under these categories:

- Government to Governme nt (G2G): Various functions of the government interact to fulfill the work. Majority of these ap plications are both vertical and horizontal. Vertical applications target a specific application of th e government and horizontal make it. These applications have a high degree of message passing across departments.
- Government to Enterprise (G2E): Enterprises like Water Board, Electricity are controlled by the governments and should re act quickly to government policies. Policy enforcem ents, security and auditing (for accountability) are the biggest challenges.
- Government to Business (G2B): Government interacts with various business in terms of policy enforcement, collection of taxes, contract management etc. The biggest ar ea that falls under government is Contract Ma nagement.
- Government to Consume r (G2C): Government provides numerous services to their citizens. Different departments offer various services that could scale from a simple re quest resolution to a starting workflow related scenarios.

1.1 E-Governance Other Requirements

- Accountability Law: An accountability framework for E-Governance requires an interactive model of building trust. It provides reassurance to citizens that they can collaborate with government on an equal footing for better governance.
- Law for Privacy: To avoid the misuse of the sensitive information, the law protects the privacy of personal data maintained by federal government. It imposes numerous requirements upon federal agencies to safeguard the confidentiality and integrity of personal data, and puts limits on the use of the data.
- E-process checks and others: Traceability to infrastructure changes.

2. COMPONENTS OF A TYPICAL E-GOVERNANCE APPLICATION

Elements of three tier architecture with an over view of E-Government services is presented below. For E-Governance services three tier architecture is used because it provides following advantages:

- Heterogeneous Systems: Applications can utilize strengths of different platforms and different software components at the different tiers.
- Modifiability: As responsibilities are separated, it becomes easy to replace the code at any tier without affecting other tiers as modifiability is imp architectural driver of the case.
- Scalability to handle many clients: Each client is light weight and all access to the system is through the middle tier. The middle tier can share the database connection across the clients, and if middle tier becomes bottleneck, we can deploy several servers executing the middle tier code; clients can connect to any of these servers.
- Integrated Data Access: In many applications, the data must be accessed from several sources. This can be handled transparently at the middle tier, where we can centrally manage connections to all database system involved.

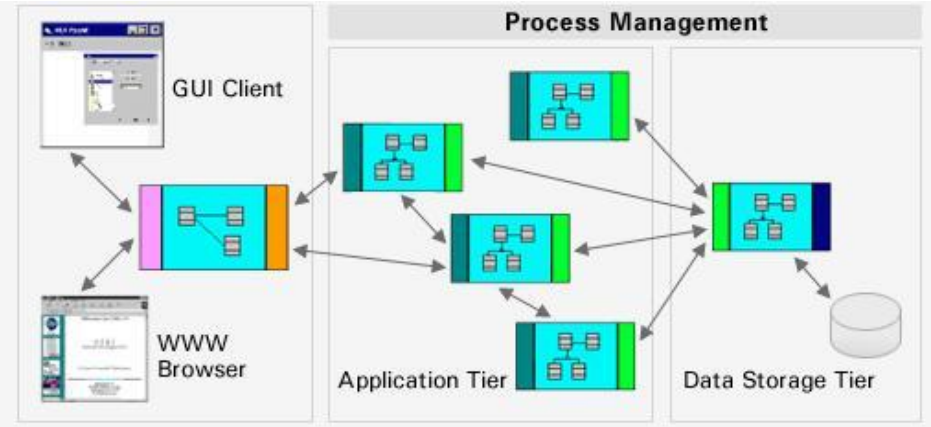

Figure 2: Typical architecture for an E-Governance application

2.1 Challenges with Traditional Infrastructure

- Application Life Cycle Man agement: With traditional infrastructure, we need to ensure secure, cost-effective management of structured data throughout application life, from development and testing to archiving and retirement. For making the application highly available, the replication facility needs to be provided and its part of development activity which could be cumbersome. It may caus e duplication of resources across various governm ent organizations and departments. As the c omplexity and sophistication of the software dev elopment task has grown it needs to use increasing numbers of tools.
- Software licensing and S upport: It is another major concern as for each data center and application the licensing is required but for distributed data centers only one license for the application is sufficient eno ugh.
- Scalability: Traditional infr astructure cannot scale, scalability demands change over time. It has to frequently upgrade to meet these challenges, thereby making some of the hardware and software redundant.
- Accountability: The applications in traditional infrastructure don't have central authority and accountability.
- Modifiability: Traditional infrastructure incurs more costs when modificatio n is required, for example as they are not inherently scalable the provisioning cost and time fo r moving from 100 users to 10000 users could eat up lots of resources.
- Physical security: It involv es the provision of a safe environment for information processing activities with a focus on preventing unauthorized physical access to computing equipment. It includes: (1) threats and f acility requirements, (2) personnel physical acces s control, and (3) microcomputer physical security. It's also difficult to maintain in traditional infrastructure.

3. INTRODUCTION TO CLOUD COMPUTING

The three main tenets of Cloud computing are instance availability of services, pay per u se model and massive scalability. Cloud architecture is b uild with SOA principles and hence is highly flexible and mo dular and can integrate with other systems. It offers t he following layers of abstraction as shown in Figure 3. Each layer offers a service that is virtualized, where they do not have to depend on any physical artifacts.

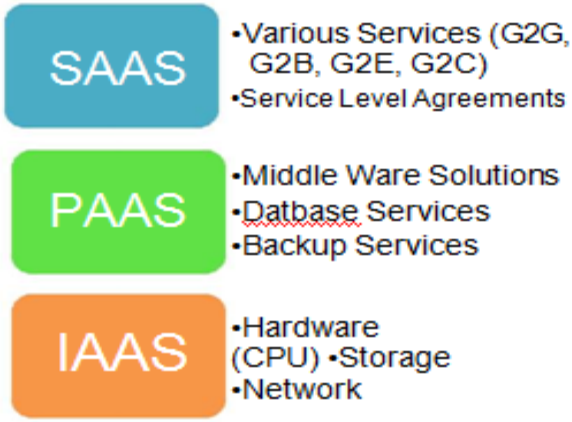

Figure3 : Cloud architecture and services provided

3.1 Infrastructure as a Service (IaaS)

Infrastructure as a service virtualiz es the hardware/network and storage aspects of the datacenter. A Storage Area Network must also b e in place in order to fully realize the benefits of cl oud computing for E-Governance initiatives. Cloud architectures present a common infrastructure for all applications to work which is easy to use and deploy.

Cloud architecture is build on SOA principles

Cloud computing offers unlimited supply of CPU, storage and bandwidth

Application designers are free to focus on features and usability

E-Governance requires a 24x7 infrastructure availability minimizing downtime. E-Governance applications can assume unlimited supply of CPU, storage and bandwidth when operating from cloud. Application designers can focus on features and usability instead of worrying about scalability etc. Still, applications perform better on cloud compared to traditional architecture.

3.2 Platform as a Service (PaaS)

Cloud offers standard platforms in terms of providing different kinds of systems, middleware and integration systems. Some of the standard platforms they provide are:

- OS provisioning
- Queuing Service
- Database Services
- Middleware Services
- Workflow Services

Government departments requiring resources can request and get resources instantly as compared to traditional methods where they have to wait till they purchase, deploy etc. Applications requiring middleware services can be provided instantly.

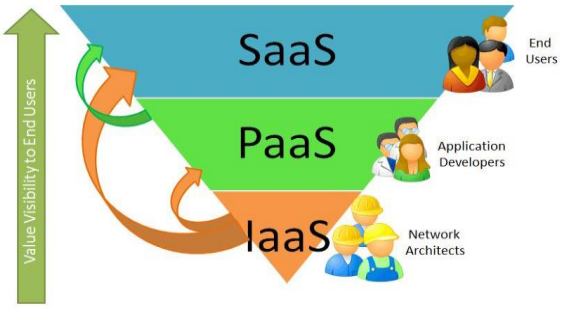

Figure 4: Value visibility to end-user

3.3 Software as a Service (SaaS)

Cloud offers applications as a service. Imagine a case of new district deciding to move to E-Governance solution for some application for their citizens. The district need not purchase applications, hardware and software. They can make a request for a particular service from the cloud provider. Applications instances can then be created for their use. Numerous applications can be provided as standard services, where departments can request and manage. Some of the applications can be:

- Complaint Resolution System
- Employee Management Systems
- Attendance Resolutions Systems
- E-police, E-court
- Municipal Maintenance
- Water Boards, Billing, Payment Systems
- District Management Solutions
- Service Desk

E-Governance applications face data-outburst, cloud computing can scale better.

Cloud computing supported E-Governance can provide efficient management and disaster recovery

Cloud fits in right into the requirements and can offer excellent service in this regard. Instead of each department hosting hardware, software and applications, they can get all the applications for a district instantly to be provisioned and operational. Hence cloud accelerates the implementation of E-Governance services. This one feature can reduce the cost of E-Governance to a great extent.

4. E-GOVERNANCE CHALLENGES AND CLOUD BENEFITS

4.1 Data Scaling

The databases should be scalable, to deal with large data over the years for E-Governance applications. Where relational databases ensure the integrity of data at the lowest level, cloud databases could be scaled and can be used for such type of applications.

Cloud databases available for deployment offer unprecedented level of scaling without compromising on the performance. Cloud databases must be considered if the foremost concern is on-demand, high-end scalability – that is, large scale, distributed scalability, the kind that can't be achieved simply by scaling up.

4.2 Auditing and logging

Traceability to any changes to information content in E-Governance services is required. Corruption in government organizations can be controlled by using Information Technology services, by keeping the providers of the services accountable. Process audits, security audits must be done periodically to ensure the security of the system.

Cloud can help in analyzing huge volumes of data and detecting any fraud. It can help in building and placing defense mechanisms to enhance the security, thereby making the applications reliable and available.

4.3 Rolling out new Instances, Replication and Migration

Traditionally, applications in E-Governance work for department states and municipalities and hence take more time, effort, resources and budget. This happens for all the instances of these applications. Capabilities must exist to replicate these to include another municipality or e-court as part of E-Governance.

Cloud architectures offer excellent features to create an instance of application for rolling out a new municipality. Cloud can reduce the time to deploy new application instances.

4.4 Disaster Recovery

Natural disasters like floods, earthquakes, wars and internal disturbances could cause the E-Governance applications not only loose data, but also make services unavailable.

Multiple installations in geographically separated locations with complete backup and recovery solutions must exist. This could create huge problems. Disaster recovery procedures must be in place and practiced from time to time. Applications and data must be redundant and should be available on a short notice to switch from one data center to center.

Cloud virtualization technologies allow backups and restoring. It offers application migration seamlessly compared to traditional data center.

Cloud helps to increase the number of resources dynamically to maintain quality of service intact even at the times of high load, which generally happens in E-Governance.

4.5 Performance and Scalability

The architecture and technology adopted for the E-Governance initiatives should be scalable and common across delivery channels .It is required to meet growing numbers and demands of citizens. If implemented, the E-Governance portals could become the biggest users and beneficiaries of Information Technology.

With cloud architectures, scalability is inbuilt. Typically, E-Governance applications can be scaled vertically by moving to a more powerful machine that can offer more memory, CPU, storage. A simpler solution is to cluster the applications and scale horizontally by adding resources.

4.6 Reporting and Intelligence (Better governance)

Data center usage (CPU, storage, network etc), peak loads, consumption levels, power usage along with time are some of the factors that needs to be monitored and reported for better utilization of resources. It minimizes costs and plan well. Profiling data enables better visibility into various services provided by the government.

Cloud offers better Business Intelligence infrastructure compared to traditional ones because of its sheer size and capabilities. Cloud computing offers seamless integration with frameworks like MapReduce (Apache Hadoop) that fit well in cloud architectures. Applications can mine huge volumes of real time and historic data to make better decisions to offer better services.

4.7 Policy management

E-Governance applications have to adhere and implement policies of the governments in terms of dealing with citizens. Along with the infrastructure and data center policies has to be enforced for day to day operations.

Cloud architectures help a great deal in implementing policies in data center. Policies with respect to security, application deployment etc can be formalized and enforced in the data center.

With cloud, E-Governance applications can manage the policies well by providing security and adoptability.

Various E-Governance applications can be integrated easily.

4.8 Systems Integration and Legacy Software

Not only the applications that are already deployed and providing services are to be moved to the cloud, but also integrate with applications deployed in the cloud. The power of Information Technology comes in co-relating the data across applications and pass messages across different systems to provide faster services to the end users.

Cloud is built on SOA principles and can offer excellent solutions for integration of various applications. Also, applications can be seamlessly easily moved into cloud.

4.9 Obsolete Technologies and Migration to New Technologies

Technology migration is the biggest challenge. Moving to different versions of software, applying application and security patches is the key to maintaining a secure data center for E-Governance.

Cloud architecture efficiently ena bles these kinds of requirements, by co-existin g and co-locating different versions and releases of th e software at the same time. Once these applications are tested, they can be migrated into production with ease.

4.10 Going green

More emphasis is laid out today in terms of the amount of pollution the data centers can create. The power usage, air-conditioning and electronic waste could create bio-hazard.

This could be one of the reasons for moving to cloud architecture for governance. Instead of duplicating these facilities, with cloud, one can offer centralized infrastructure tha t can be efficiently used to minimize pollution.

Cloud computing helps governm ent to go-green, by centralizing all resources and efficient utilization

5. CLOUD VISION FOR E-GO VERNANCE

The section deals with elements of cloud those are useful for deployments on cloud.

5.1 Internet over Cloud

In summary, 69% of online users are using some form of cloud computing! Overall, 69% of online users have done at least one of six activities listed in box, with 40% of internet users having done at least two of them.

5.2 Distributed Data Cennters

Information systems face many r isks, e.g. viruses, hackers, fire, terrorist attacks. Som e disasters possess mass destructibility, and even intentioned destroy activities after disasters. Distributed data centers provide fault tolerance against such disasters.

These centers facilitate robus communication support, self-supervision capability and real-time visible platform, which will he lp E-Governance application to use and mange.

Sharing security can be provide d through these centers so that critical data of citizens won't be under single authority and also provides security against unlawful activities.

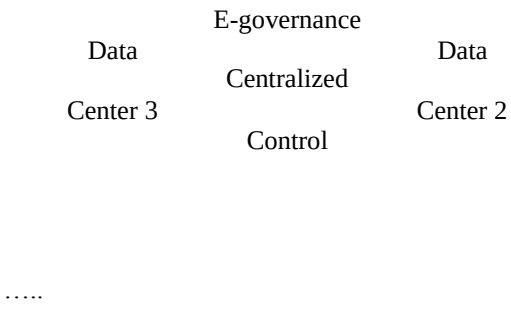

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Figure 5: Distributed Data Centers

5.3 Data Center Operati ons

With cloud, data center operations would become centralized and offers greater benefits in terms of the resource usage, department wise. Datacenter operations aim to provide uninterru pted and available service to the applications even if o ne of the data center fails.

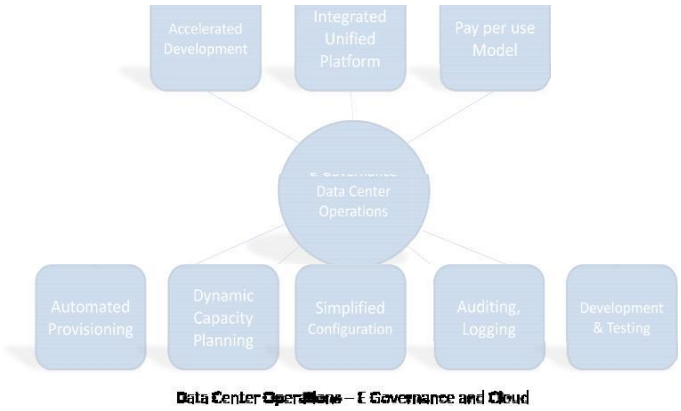

Figure 6: Data Cen ter Operations

As cloud computing can e built on top of cheap commodity hardw are, it helps to increase the economy of scale in data center operations.

As the usage of same resources can be done for the various applicati ons, the resource consumption would be very high.

By monitoring the resou rce consumption, health of resource and data, the definite matrix could be formed w hich helps to make future plans of E-Governance.

6. BENEFITS OF CLOUD ARCH ITECTURE

In a traditional architecture, the services offered are bound to a physical machine. One has to maintain the redun dancy in terms of the physical services. T his model increases the cost of deploym ent and becomes expensive to maintain as number of services increase.

Cloud computing offers:

- On-demand self sufficient s ervices
- Ubiquitous network access
- Location independent resource
- Rapid elasticity

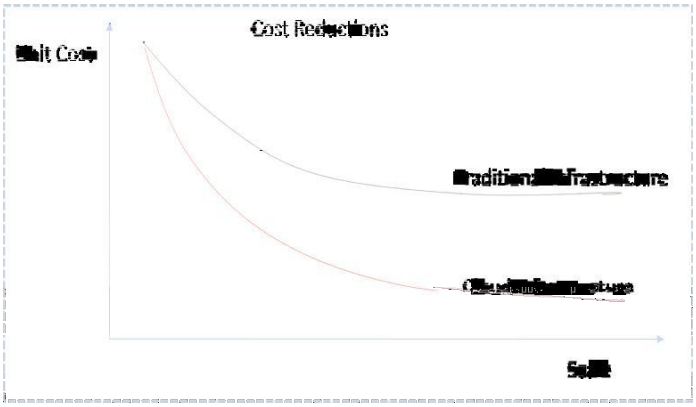

Figure 7: Reducing costs compared to traditional IT

Cloud is making rapid inroads beca use of the following advantages:

- Can reduce IT labor cost by 50% in configuration, operations, management an d monitoring
- Can improve capital utilization by 75%, significantly reducing license costs
- Reduce provisioning cycle times from weeks to minutes
- Can reduce end user IT support costs by up to 40%

In a traditional infrastructure there will be one instance of application per physical server and has an average utilization of 10%. Cloud not only automates the maintenance and manual o perations, but also raises the utilization rate by 50% an d offers full virtualization.

6.1 Cloud Economics

A large portion of cloud architecture savings are associated with labor reductions derived through automation enabled by a service m anagement system. With cloud, the services are vi rtualized, in such a way that the services can be move d from physical server to other based on the poli cies. In addition to

servers, cloud architectures provide access, storage and backup services that can be utilized by the unified E-Governance infrastructure. Infrastructure leverage and centralized management offers good benefits. The major factors that drive cost reduction are shown in Figure 8.

Figure 8: Cloud Economics

6.2 Service Management System

A service management system pro vides the visibility, control and automation needed for efficient cloud delivery in both public and private implementations. Cloud unlocks the following benefits compared to a traditional infrastructure:

- *Simplified user interaction with IT*: Its user friendly self service interface accelerates time to value. The service catalog enables standards which drive consistent service delivery and provides enhanced transparency and accountability.
- *Provisioning enables policies to lower cost:* The automated provisioning a nd de-provisioning speeds service delivery. The provisioning of policies allows release and re use of assets. Its centralized identity and a ccess control policies provides fast and affordable adherence to security compliance.
- *Increase system administrator productivity:* The productivity increase is attributed from its move from management silos to a service management system.
- *Improve service deliver y to the citizens in their constituencies:* P rovides improved informational services to citizens.
- *Automate virtual infrastr ucture for peak performance*: Virtual infrastructu re will accelerate provisioning time by 50 t o 70%. It manages virtual machines from a ce ntral location and monitors the performance of these machines and their hosts. We can have live migration of applications from one virtu al host to the other. It also enables dynamic policy based allocation of IT resources with autom ated load balancing and eliminates the repetitive configuration and maintenance tasks.
- *Reduce costs:* We can red uce costs by consolidating hardware and increasing server utilization. Server utilization can go up from 5-15% up to 80% based on workloads. We can measure the performance and availabili ty of critical virtual server resources, correlate even ts and understand the impact of problems on the E-Governance by saving on power consumptio . And also analyze costs, budget, plan, track, allocate and invoice by department, user and many additional criteria by efficient management of resources & assets.

Service catalog drives standards by standardizing on hardware, software, platforms and storage. During deployment, one can get an environment when needed with an outstanding user experience. The standard services avoid unexpecte d problems as well.

7. SUMMARY AND CONCLUSIONS

Cloud provides a solid foundation for the introduction of widespread provision of services to various stakeholders. Applications designed using the principles of Service Oriented Architecture and deployed in cloud architectures will benefit the government in reducing operating costs and increasing the governance. SOA and cloud architectures when properly applied to developing E-Governance applications have the capability to transform the nation into an Information Society. Service Level Agreements are keys for the government to measure how well the services are being performed and provided by the government. Cloud helps enabling E-Governing services faster and cheaper thereby accelerating the adoption and use of Information Technology for e-services. Cloud architectures allow rapid deployment of turnkey test environments with little or no customization.

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