Migrating From Current E-Governance Computing Architecture to Cloud based Architecture

(A case study based approach)

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ABSTRACT

E-Governance is one of the important Information and Communication Technology (ICT) enabled administrative mechanism to affect deliverables to all its stakeholders. It is expected to provide reliable services to all, anywhere, anytime, 24 by 7, with acceptable levels of performance. There are various e-governance projects which have been successfully implemented in different part of India. Citizens have actually started adopting such services in full swing. It has been noticed that some of the e-governance projects have not been able to meet up the growing expectations of the stakeholders pertaining to the constraints like performance, availability, data management, concurrency, security and efficiency. Choice of appropriate IT infrastructure plays a vital role in fulfilling the goals of various e-governance projects. Looking at the current usage pattern of such project there is lot of scope of integration of newer technologies for reinventing the traditional system.

Cloud computing is a new genre of computing which has a potential to build and deploy applications and services via internet targeting the needs large sets of geographically dispersed users by delivering integrated functionality across the masses and the Web. Adoption of cloud based architecture will help in embedding techniques like virtualization of critical resources for instant service deployment and optimizing resource utilization.

This paper provide a case study based approach to anticipate cloud based implementation in the existing infrastructure to cope up with the issues like fault tolerance, high availability, high volume query processing request, central data centre management, data security etc. It reveals the analysis of Kalyan Dombivli Municipal Corporation (KDMC) e-governance project with its IT architecture. At last the paper proposes a cloud based implementation model for dealing with the above mentioned issues along with its advantages.

General Terms

Cloud Computing

Keywords

E-Governance;Cloud computing;Virtualization;

1. INTRODUCTION

E-governance has wide variety of applications. Considering the nature and scale of e-governance initiatives planned and implemented under various plans and policies, the governments typically do not presently have enough committed supporting infrastructure to manage the e-Governance projects [1]. As per the technological development the cost of storage and power consumed by hardware has decreased to some level. But there is opportunity to leapfrog from current level of computational cost effectiveness to much more competitive computational facilities. Cloud computing offers reduced software licensing fee, reduced hardware platform cost and also offers extreme scalability and maintainability.

Looking at the recent case studies of certain state government projects, it has been found that the computing architecture of these projects are not design to withstand the traffic generated by the incoming requests to the servers. As a result the data centers are sometimes failing to meet our needs and the traditional approaches cannot provide a solution to this problem.There is a need for building capacity for efficient operation of all the functional modules including data maintenance, replication, accuracy of data, internetworking of operational nodes, hardware and software installation, maintenance etc. To cope up with this challenge a new solution is needed to allow maximum efficiency and utilization of resources and the same time to be economically viable.

Cloud infrastructure can greatly support government departments maintaining and managing e-services for e-governance.Cloud Computing would involve extending the use by current data centers of some of the tools and technologies to manage resources better. The strategy for E-governance would involve building a Private Cloud with public interfaces that can scale and provide the required agility and flexibility.

This paper highlights the requirement of e-governance project implementation based on the case study of Kalyan Dombivli Municipal Corporation (KDMC) e-governance project. It also address the issues associated with the implementation of KDMC found from findings of an IT audit report. It further list the benefits provided by cloud based architecture along with a new proposed architecture for the same.

2. E-GOVERNANCE COMPUTING MODEL

2.1 E-Governance Architecture

E-governance architecture is generally based on 3 layers of implementation. The lower layer corresponds to the backend systems like storage unit, database servers, underlying

hardware used for building the backbone for the system. The second layers calls for the middleware which help in interfacing with the upper layer. This layer consists of the gateways and protocols used to cooperate, collaborate and integrate information across functional modules. NSDG (National e-Governance Services Delivery Gateway) is a standard based messaging middleware for e-Governance services. The upper layer provides the means for accessing various services provided by the functional modules. It covers various front end system, portals, customer facilitation centres through which the stakeholders get access to various G2C,G2B and G2E services.
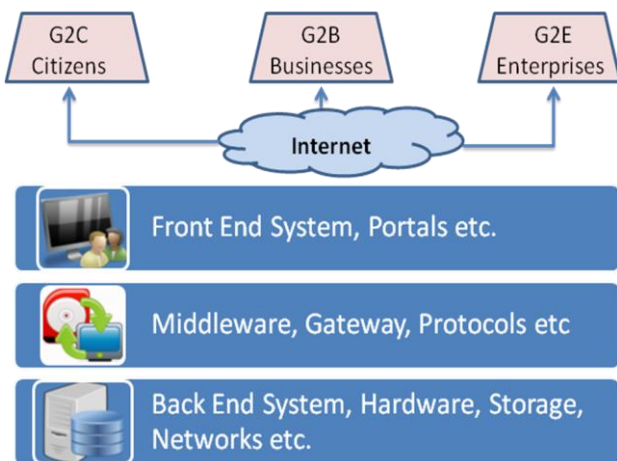

Fig 1. Basic E-Governance Computing 3 tier Architecture

2.2 Challenges in E-Governance Operations

Various challenges pose by the e-governance implementation model which needs to be addressed are as follows:

Availability: As per the rising demands of stakeholders, availability of services via internet has become a critical factor. Due to huge traffic sometimes the server becomes unavailable.

Elasticity: There is a need for adding more resources to a single computation unit by vertical and horizontal scale up techniques as per the growing demand and usage.

Heterogeneity: The e-governance model provides multiple services and applications which can utilize strengths of different platforms and different tiers. The infrastructure should provide the choice of platform .

Modifiability: Ease in modification facilitates replacing the code at any tier without affecting other tiers as modifiability is important architectural driver in this case.

Interoperability: E-Governance is about multiple services offered by different departments. This calls out for interoperability between different interconnects, so that they can run simultaneously without any incompetency.

Security: One of the important requirements of such implementation is security as the confidential details of the citizen and the businesses are transacted on this platform. Apart from data security, physical security of the confidential

data for preventing unauthorized physical access is also required.

Scalability: Traditional infrastructure needs to be upgraded frequently to meet new challenges. E-Governance should offer flexibility and easiness to scale up the applications as and when required.

Robustness: The system should able to perform under fault situation and heavy load. Data replication by means of backup server in case of system failure or disaster is necessary for recovery. There is a need for proper load balancing and load sharing techniques to support multiple users under different load scenarios.

Maintainability and software licensing: Maintaining the system is again a costly affair. The complete cost of maintaining the software module and for licensing of the application and software in traditional model is bear by the agencies offering the services. There is a need for a infrastructure which can reduce the maintenance and support cost.

Performance: Delay in the execution of the services under heavy load circumstances is a common problem which prevails in such implementation. Data centers are not able to withstand the traffic generated by multiple queries results in performance degradation.

Usability : It has been found that even after the implementation of complete project some of the modules are not at all used by the stakeholders due to lack of awareness and trust in the system. This factor impedes the projects to achieve its predetermined objective.

3. CLOUD COMPUTING MODEL

Gartner defines cloud computing as a style of computing where massively scalable IT-related functions and information are provided as a service across the Internet, potentially to multiple external customers, where the consumers of the services need only care about what the service does for them, not how it is implemented.

Cloud computing is a model for enabling 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 [2]. In cloud computing, resource-intensive computing is offloaded to the cloud to leverage the cost advantages of massive data centers.
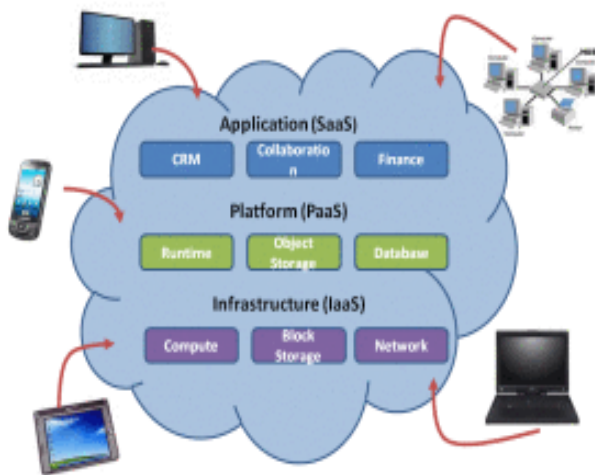
Fig 2.Cloud Computing Architecture [3]

Some of the benefits offered by cloud computing are:

- On demand resource utilization
- Scalable technology
- Pay as per use
- Reduced licensing cost
- Scale up and down in capacity and functionalities
- Provide ubiquitous services

Cloud Computing services are organized in a layered architecture:

A. **Software as a Service (SaaS)** provides software products and service value nets to be consumed as a utility. This type of cloud service offers a complete application functionality that ranges from productivity applications (e.g., office-type) to programs such as those for Customer Relationship Management (CRM) etc.

B. **Platform as a Service (PaaS)** combines infrastructure, operating systems, database support, runtime and application software and offers it as a utility.

C. **Infrastructure as a Service (IaaS)** implements an abstract view towards the hardware and allows running virtual instances of mini data centers. Products offered via this mode include the remote delivery (through the Internet) of a full computer infrastructure (e.g., virtual computers, virtual servers, storage devices, etc.).

4. CLOUD BASED E-GOVERNANCE APPROACH

E-governance needs in conjunction with cloud computing will focus on the benefits which have never been realized in distributed computing. Cloud provides an excellent platform to host government services. The biggest benefit of the cloud is that it helps consolidate all data centers and optimize resource utilization, reducing support and maintenance costs by more than half, without compromising on performance, availability and reliability of applications.

Registration of property, railway reservation, electricity and water billing, solid waste management, examinations results, birth death certificates, educational admissions, land records,

taxation, domicile certificate and driving license are some of the e -governance projects which have been initiated in the recent past. Some of these are useful to citizens but their impact is low in terms of transparency, ease of use, availability, information dissemination and integration.

For such cases cloud computing provides a centralized and stable platform that can be shared, reused and can support multiple heterogeneous departments. The current e-Governance practices can be enhanced by an effective deployment of cloud computing environment that can be characterized by high asset utilization, a continuum demand for resources, universal systems, and platforms, environments which are easier to manage, and on-time procurement may lead less time. These efficiencies positively impact any Government's ability to serve the public and masses [4].It also provides a solid foundation for application virtualization for the introduction of widespread provision of services to various stakeholders. Virtualization provides abstraction of a physical host machine. Virtual machines (VMs) monitor intercepts and emulate instructions from the users and allow management of available resources. Some of the advantages of virtualization are:

- Easier to create new machines, backup machines, etc.
- Emulate more machines than are physically available
- Timeshare lightly loaded systems on one host,
- Easy debugging
- Easy migration of virtual machines

E-governance application requires 24 by 7 infrastructure availability, minimizing downtime. For making the application highly available, the part of development activity can make use of caching for storing the frequently used functional modules .These cached data can be easily managed using cloud infrastructure by means of virtualization.

5. CASE STUDY OF KDMC E-GOVERNANCE PROJECT

5.1 Project Description

Under this project 12 application modules were developed for computerizations of various functions such as water billing, property tax, birth and death registration, accounts, city engineering, working of the Commissioner's office etc. All these modules had a common user interface i.e. KDNET, facilitated through the Citizen Facilitation Centre (CFC) in Headquarters and in the Ward offices [5]. There are total 6 CFCs, one in Head office and other 5 in different wards offices of KDMC. All of them connected online with the central server and offer over 65 corporation services across the counter.CFC has become single touch point for all the citizens to interact with KDMC.

All these services are hosted by means of a central server. A disaster recovery database server is also in place for backup and recovery. All department of KDMC are integrated by a WAN with five ward offices connected using fiber optics while one office has been connected using radio frequency link. Services are also deployed using internet through lease line.

The complete architecture ensures transparency in service execution, faster processing ,IT infrastructure at KDMC is depicted by means for the figure given below:
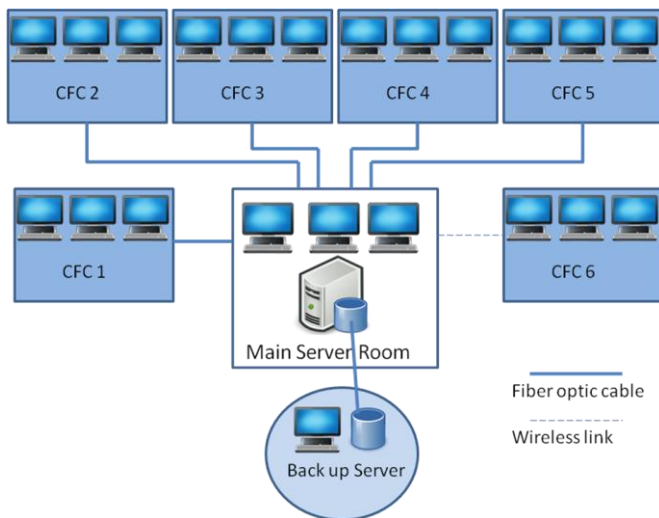
Fig 3.IT Infrastructure Model at KDMC [6]

The project aimed to provide efficient and on time delivery of services to the citizens with less redundancy. It also has committed security and privacy to the citizen by means of firewall.

As per the finding of IT audit report of KDMC, still lot of incidences of fraudulent transaction and manipulation of data have been noticed [7]. It has been found that database system was not configured to record any modifications of data through the backend. Lot of problem has been faced in tracking the history of transaction, system failure, erroneous transaction, changes in data etc. Some of the modules are not able to generate the bills on time. No mechanism was in place to monitor the network uptime (network connectivity and power backup) in CFCs in ward offices to ensure continuous service delivery. Since services are not integrated citizens have to face problems arising out of data inconsistency. Since it works on the centralized system of computing lot of load has been put over the single server. Data pertaining to all the 12 modules resides in the same database, which increases the pressure on the database during heavy traffic.

5.2 Proposed Solution

Looking towards all the problems face by the current system, a new model of computing can be introduced with the help of cloud to streamline the current system. As per the research initiative taken at IIT, Hyderabad, with the use of cloud data center operations would become centralized and offers greater benefits in terms of the resource usage, department wise [8]. Multiple datacenters can be made available for distributing the load of the single server and can be deployed using clouds. Datacenter operations aim to provide uninterrupted and available service to the applications even if one of the data center fails. All these data centers can be made available by means of virtualization [9].

Under IaaS, It can provide option for hiring storage capacity from the cloud vendors. Cloud servers usually have a routine backup schedule so, if a server crashes, your data can be brought back up online with little or no loss. Clouds usually have hardware redundancy built-in so, if a hard drive dies, it can usually be immediately replaces with no data loss. Under

PaaS, cloud provides a platform that hides the complexity and details of the underlying infrastructure from users and applications by providing very simple graphical interface to the client, typically provided using virtualization.Under SaaS ,it provide scalable, configurable & multi-tenant-efficient model. Multiple users can get access to the system at once by interacting with different instances of the server provided by the cloud.

Apart from this, the accessibility of this project is limited by only 6 CFCs. Citizen has to interact with one of the CFC operator for accessing the available services. The web options are available but are inefficient because of extra load incurred on a single server.

6. PROPOSED CLOUD BASED ARCHITECTURE FOR KDMC

A cloud computing model could be built which will be highly flexible, modular and can integrate with the other system as well. The proposed model claims to solve the above mentioned problems there by supporting wed based user in efficient manner using the cloud components.

 In the below mentioned architecture, cloud vendor would manage the storage of the complete project. Cloud vendors will be responsible for maintaining the security of the data in the form of threat and facility management, personnel physical access control and micro computer physical security control. Cloud provides with the method of these all types of security. The bottom layer Infrastructure as a service virtualizes the hardware/network and the storage aspects of the datacenter. Government can put their applications on the cloud and use the servers within the cloud to do processing and data manipulations etc.
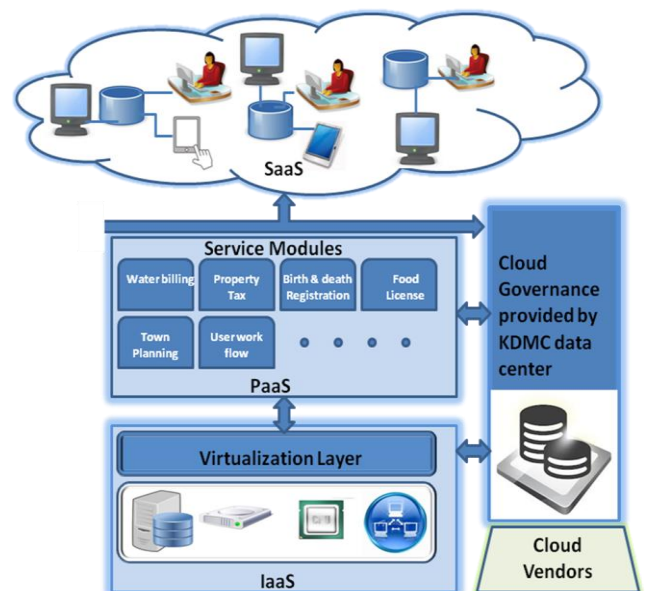

Fig 4. Cloud based e-governance model for KDMC

The middle layer provides with the virtualization of the supporting run-time environment used for making different application modules [10]. Depending on the need of the application module under consideration different computing platform will be made available by relinquishing developer

bothering about the underlying architecture. The entire module will be integrated together and will be synchronized to avoid data in consistency problems. Software as a service will offer on demand applications with availability and performance guarantee across the application and network. It supports deployment of applications in data centers close to the end user for low latency.

7. ADVANTAGES OF THE PROPOSED CLOUD BASED MODEL

Here are some of the advantages of using the proposed cloud based computing model:

A. **Scalability:** Databases for such government application tends to store large amount of data over the years. It should be scalable enough to accommodate the changes over the time. Such applications need to be upgraded frequently to meet the challenges. Cloud provides means of extending the capabilities there by adding new application module without disturbing the existing ones. Could database could be scaled vertically to higher configuration of memory, c vertically to higher configuration of memory, processing power or horizontally by adding more resources.

B. **Providing Proper Auditing And Check:** The most prevalent problem seen in KDMC project was modification of the data from the back end. It leads to fraud and manipulation of data .Cloud provides with a means to trace such modification happening to the data pertaining to application modules. Corruption in such application modules can be controlled by making the provider of the service accountable. Cloud vendors will be responsible for keeping audit nag log check to the databases. It can help in building defence mechanism to enhance the security, thereby making applications reliable and available.

C. **Agility:** As recorded by the audit findings, the execution time for the KDMC client request was much higher. There were delays in generation of the bills pertaining to certain module. Cloud ensures agility in processing the request using application module. Time for processing the request will be reduced from several weeks to one week or from a week to an hour, depending on the nature of the request and the task to be performed.

D. **Disaster Recovery:** Natural disaster could cause e-governance module not only loose data but also make service unavailable. As we have seen in KDMC project a disaster recovery server is located geographically apart with complete backup and recovery. But if that replicated server becomes the part of cloud then it will be fully maintained by the cloud vendors. Cloud virtualization allows backups and restoring. It offers seamless application migration compared to traditional data centre.

E. **Offers Better Management:** Information regarding data centre usage, peak loads, consumption, network downtime is some factors which are need to be monitored for better utilization of resources. Cloud manages all this information for efficient utilization of the modules with respect to their availability. It help in avoiding inconvenience happening to the stakeholders and helps in building good customer relationship management model.

F. **Cost effectiveness:** It save the cost of software licensing and support. Virtual servers are made available to the clients on demand which save the cost of licensing each server individually. All this expenses are beared by the cloud vendors only. By using the Cloud infrastructure on "pay as used and on demand", government can save in capital and operational investment.

G. **Easy Migration** To New Technologies: Moving to a different version of the software is again a big challenge as per the technological development, which is solved using cloud architecture.

H. **Increased Data Reliability:** Unlike desktop computing, in which if a hard disk crashes and destroy all your valuable data, a computer crashing in the cloud should not affect the storage of your data. It also provide with replicated servers to withstand such loss. Cloud computing is a data-safe computing platform and offers virtually limitless storage.

I. **Better Accessibility:** Data can be accessed easily from variety of end points like desktop, tablets, mobile user, and customer facilitation centers. Web based services can be easily integrated through cloud and provide anytime anywhere service model to the stakeholders.

8. CONCLUSION

Cloud based computing architecture helps enabling e-governing services faster and cheaper. It ensures easy availability, reliability and scalability. The model presented in this paper provides a solid foundation for the introduction of wider spread provision of services to various stakeholders. The model presented in this paper claims efficient government practices. Migrating from the traditional e-governance architecture to new cloud based architecture open up a new avenues of services which can be incorporated in the existing model in future.

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