# Eucalyptus Cloud to Remotely Provision e-Governance Applications

**Cloud computing can be defined as on-demand, scalable and elastic web services on public or private fabric consisting any of grid, cluster, virtual machines and physical machines. Ensuring high reliability, scalability, high availability of citizen centric e-Governance services is very important. Cloud computing makes it possible to accomplish this task cost effectively.**

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THE open source Infrastructure as a Service (IaaS) cloud based on Operating System virtualization (Xen, KVM, VMWare, HyperV) allows leasing computing as a utility.

IaaS Cloud allocation is
- Set of Virtual Machines
- Set of storage resources
- Private network to minimize security vulnerabilities
- Application Virtualization

**IaaS Benefits:**
- Share under-utilized software, net work, storage resources
- Efficient Server provisioning
- Effective Data Persistence

## CURRENT STATUS OF PROTOTYPE

The Govt. of India, Department of Information Technology, has initiated National e- Governance Plan (NeGP) for the execution of e-governance projects in the country, both at Central and State levels. It has identified "Mission Mode" Projects at both the levels. The NeGP proposes citizen service delivery up to the village level through common service delivery outlets and ensure efficiency, transparency & reliability of such services at affordable costs to realize the basic needs of the common man. The citizen services to be delivered could be based on the Service Oriented Architecture paradigm (as against the present web enabled services). These services expect adequate networking and computing resources for effective and efficient service delivery.

National Informatics Centre (NIC) of the Department of Information Technology is providing network backbone and e-Governance support to Central Government, State Governments, UT Administrations, Districts and other Government bodies. It offers a wide range of ICT services including Nationwide Communication Network for decentralized planning, improvement in Government services and wider transparency of national and local Governments. SAN (Storage Area Network) Data Centers and SWANs (State Wide Area Network) have been established in all 35 states/UTs through NIC as a part of NICNET.

Presently SAN and SWANs are individually connected and are independently operating without any resource sharing or even without any replica or mirroring storage elsewhere. By connecting all these Data Centers (SAN) into a cloud, all the computational resources such as the CPUs, disk storage systems, specialized software systems, etc., can be provisioned to all the users connecting to the cloud, including sophisticated users needing advanced capabilities like remote application hosting space, data storage on cloud, persistent transaction states, and distributed data mining.

Also, NIC is having various applications which are running under different platforms and operating without any resource sharing. These applications often need to interact with each other and may also need additional resources temporarily, for a small duration of time. There are many critical mission mode applica-

tions where the services of computer are continuously required for any kind of citizen services. Under these circumstances, breakdown of any machine or operating system or database server or application server brings the services to the citizens to a standstill. Hence, it is required to plan a business continuity model for such applications. Using the enabling technologies enumerated below, the applications can be deployed as web services in the container to make them interoperable and solution for business continuity plan (BCP) and disaster management and recovery (DR) can be provided.

### HIGH PERFORMANCE ARCHITECTURE FOR A TYPICAL e-GOVERNANCE SERVICE

To ensure high reliability, availability and business continuity following empirical architecture is suggested for e-Governance applications.

The architecture has been devised based on the experience gained in launching several e-Governance applications by NIC. The architecture comprises following layers.

- Governance Content Management Layer
- Application Frameworks Layer
- Service Mediation Layer
- Process Service Layer
- Interface Integration Layer
- Client Layer
- Management and Monitoring Layer

### ENABLING TECHNOLOGIES

Given below are the cloud technology platform, grid and grid based cloud platform, data mining platform over grid and cloud.

### Introduction to Eucalyptus

Elastic Utility Computing Architecture for Linking Your Programs To Useful Systems (EUCALYPTUS) -- is an open-source software infrastructure for implementing Elastic/Utility/Cloud computing using computing clusters and/or workstation farms. Eucalyptus is a distributed computing system

implemented using commonly available Linux tools and basic Web-service technologies. Eucalyptus implements private/hybrid cloud. A Eucalyptus cloud setup consists of five types of components. The cloud controller (CLC) and "Walrus" are top-level components, with one of each in a cloud installation. The cloud controller is a Java program that offers EC2- compatible SOAP and "Query" interfaces, as well as a Web interface to the outside world. In addition to handling incoming requests, the cloud controller performs high- level resource scheduling and system accounting. Walrus, also written in Java, implements bucket-based storage, which is available outside and inside a cloud through S3-compatible SOAP and REST interfaces.

Top-level components can aggregate resources from multiple clusters (i.e., collections of nodes sharing a LAN segment, possibly residing behind a firewall). Each cluster needs a cluster controller (CC) for cluster-level scheduling and network control and a "storage controller" (SC) for EBS-style block-based storage. The two cluster-level components would typically be deployed on the head-node of a cluster (in fact, this is required if the cluster is behind a firewall). Finally, every node with a hypervisor will need a node controller (NC) for controlling the hypervisor. CC and NC are written in C and deployed as Web services inside Apache; the SC is written in Java. Communication among these components takes place over SOAP with WS- security.

Euca2ools are command-line tools for interacting with Web services that export a REST/Query-based API compatible with Amazon EC2 and S3 services. The tools were inspired by command-line tools distributed by Amazon (api-tools and ami-tools) and largely accept the same options and environment variables. Euca2ools use cryptographic credentials for authentication. Two types of credentials are issued by EC2- and S3-compatible services: x509 certificates and keys. Euca2ools are used to learn about

installed images, start VM instances using those images, describe the running instances, and terminate them. Eucalyptus versions 1.5 and higher include a highly configurable VM networking subsystem that can be adapted to a variety of network environments. There are four high level networking "modes", each with its own set of configuration parameters, features, benefits and in some cases restrictions placed on local network setup.

### Features of Eucalyptus 1.6.1 include:

- Deployment on multiple clusters Deployment of components (Cloud controller, Walrus, Storage Controller, Cluster Controller) on different machines
- Enhanced maintenance support: components are now "crash consistent," maintaining state across process restart or machine crash
- Enhanced concurrency management: cloud requests are serviced asynchronously with minimal locking using eventual consistency for scale.
- Networking improvements, including multi-cluster support
- Building and installation improvements

### ISSUES

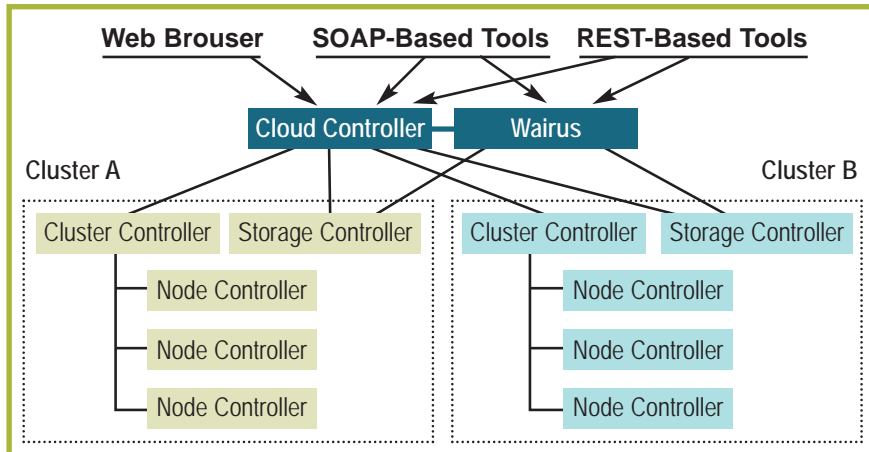Some of the business-cases include:

### Remote provisioning of Virtual Servers for application development and hosting :

The virtualization technologies in Eucalyptus, Nimbus allow efficient resource usage of the servers by decoupling an operating system and the services and applications supported by that system from a specific physical hardware platform. Given specifications, suitable virtual machine can be created and maintained at the national and state data centers where required hardware, network exist. These virtual machines are remotely accessible by the users from interior areas of the states without the need to

have the same facilities as those in state capitals. The provisioned virtual machines can then be used for application development and prototyping, hosting production environments consisting of operating systems, application servers, database servers, middleware systems.



**Eucalyptus Architecture**

**Cloud Storage :**
Eucalyptus distributed file system Walrus allows use-cases as diverse as effective backup of data securely, snapshots of virtual machine states for persistence, seamless addition of load balancers and application servers through snapshots, elastic IPs, VLANs and Security Groups.

**Application Virtualization in Cloud :**
From a value-add standpoint, application virtualization is more than cost effective hardware use and remote software hosting. Given a enterprise service registry, cloud layer abstracts enterprise infrastructure to dynamically provision network, storage, applications according to user specifications. Cloud layer of architecture interfaces with other application layers through web services, thus enabling on-demand scalability, availability, interoperability of applications.

## RECOMMENDATIONS
- To ensure interoperability and inte-

grate processes, create web service wrappers for existing application software. Develop new applications within the framework of SOA (Service Oriented Architecture) with the above mentioned layered architecture.
- Setup IaaS cloud at national, state data centers. The resulting virtual machines can then be provisioned to remote locations like villages, talukas and even districts without incurring additional costs on infrastructure.
- The virtual machines can be further utilized for application hosting, data and server migration over the cloud.
- The Cloud can also be used for BCP (Business Continuity Planning), DR (Disaster Recovery), BPM (Business Process Modeling), Risk Management, Performance Management, Change Management etc.
- Specialized e-Governance applications involving data persistence across transactions and distributed data mining systems can be further explored.
- Requirement based analysis of SOA Governance, On-Demand BPM and BPEL in IaaS cloud.

## PLAN OF ACTION
The follow up Plan of action is proposed for implementation:

- Web Services have to be developed wrapped around existing (legacy) e-governance applications. For new applications SOA can be adopted.
- Web Service Repositories can be developed at Central, State and District level.
- Simultaneously Eucalyptus may be installed in each data centre (on a cluster of at least two Servers) to create virtual machines (locally or remotely) clusters.
- Virtual Platforms (such as PostgreSQL) can be installed on all Virtual Machines as desired and made available as services.
- Web Service Repositories can be hosted on Virtual Machines using Virtual Platforms in the data center. Such artifacts shall have pre-configured application servers, database servers etc.

Thus, we will have all the three components of a cloud infrastructure:
- IaaS
- PaaS, and
- SaaS  (Web Services)

## POC
The implementation of the above plan has been initiated in various States in the country.  Initially at Hyderabad Data Centre of NIC Eucalyptus Cloud as IaaS is created and certain applications (in open source platform) have been hosted as IaaS model.  At Pune Data Centre of NIC Eucalyptus Cloud as IaaS has been created and e-Procurement application is proposed to be hosted and managed from NIC, Chennai.  Similarly Eucalyptus Cloud as IaaS is being created at NIC, Bhopal Data Centre, NIC Trivandrum Data Centre and NIC, Haryana Data Centre, Chandigarh.  In other remote locations as NIC Sikkim Data Centre Gangtok, NIC Tripura Data Centre Agartala and NIC Assam Data Centre, Guwahati, the initial steps are being taken towards the installation of Eucalyptus Cloud and hosting applications in SaaS model.