• Develop Cloud-based European infrastructure
• Provide a range of open educational resources
• Remote access and sharing of educational and professional software
• Remote and practice-based learning facilities.
What do we share?

• Laboratory experiences

• CAD tools

• Project ideas

• A common infrastructure as “educational cloud” on top of the cloud software/hardware infrastructure

• E-Learning materials for at least 16 courses
  o CAD systems
  o Microelectronics technologies
  o Test & Characterisation
  o Application of integrated circuits and systems
  o Open educational resources to strengthen the virtual mobility
  o Each university will provide remote access to facilities, laboratories in a cloud teaching system
Cloud Systems useful for Teaching

• KVM
  • Linux-based Virtualization

• Cloudstack
  • Open Source software designed to deploy and manage large networks of virtual machines

• Cloudify
  • Open Source cloud orchestration framework
• KVM – the Kernel-based Virtual Machine – is a Linux kernel module that turns Linux into a hypervisor

• Supports multiple architectures: x86 (32- and 64-bit) s390 (mainframes), PowerPC, ia64 (Itanium)

• Tightly integrated into Linux

• In the Virtual Machine is possible to install almost any Operating System
• Useful for setting up Virtual Machines on which Students can remotely access and to do Lab works
  • Using their PCs, so from Standard Classrooms
  • In the Campus Area
  • With controlled accesses from Home (not implemented at Polito)
The Access to the Virtual Machines

- It is possible using FreeNX Server (the free version of OpenNX), and NoMachine (Open Source Client for accessing Remote Machines)

- The students can enter with his/her privileges and work

- The Session can be interrupted and the work can start as stopped opening a new session, also on another PC
Apache CloudStack is an Open Source Infrastructure-as-a-Service (IAAS) platform that manages and orchestrates pools of storage, network, and computer resources to build a public or private IaaS compute cloud.

With CloudStack you can:
- Set up an on-demand elastic cloud computing service
- Allow end-users to provision resources
300+

Large Scale Production Clouds In Deployment

Production sites with over

40,000+

Servers

Enterprise and Education

Service Providers and Telcos

Web 2.0

Spotify

edmunds.com

InMobi

Trader Media Group
CloudStack Architecture

4/29/ 2012
Chiradeep Vittal
Alex Huang
CloudStack Supports Multiple Cloud Strategies

Private Clouds
- On-premise Enterprise Cloud
  - Dedicated resources
  - Security & total control
  - Internal network
  - Managed by Enterprise or 3rd party

Public Clouds
- Hosted Enterprise Cloud
  - Dedicated resources
  - Security
  - SLA bound
  - 3rd party owned and operated

- Multi-tenant Public Cloud
  - Mix of shared and dedicated resources
  - Elastic scaling
  - Pay as you go
  - Public internet, VPN access
CloudStack Provides On-demand Access to Infrastructure Through a Self-Service Portal
Create Custom Virtual Machines via Service Offerings

Select Operating System
- Windows, Linux

Select Compute Offering
- CPU & RAM

Select Disk Offering
- Volume Size

Select Network Offering
- Network & Services

Create VM
Dashboard Provides Overview of Consumed Resources

- Running, Stopped & Total VMs
- Public IPs
- Private networks
- Latest Events
Virtual Machine Management

Users

VM Operations
- Start
- Stop
- Restart
- Destroy

Console Access

VM Status
- CPU Utilized
- Network Read
- Network Writes

Change Service Offering
- 2 CPUs, 1 GB RAM, 20 GB, 20 Mbps
- 4 CPUs, 4 GB RAM, 200 GB, 100 Mbps
Volume & Snapshot Management

- Add / Delete Volumes
- Create Templates from Volumes
- Schedule Snapshots
- View Snapshot History

VM 1

Volume → Template

Now

Hourly  Daily  Weekly  Monthly

...
Network & Network Services

- Create Networks and attach VMs
- Acquire public IP address for NAT & load balancing
- Control traffic to VM using ingress and egress firewall rules
- Set up rules to load balance traffic between VMs
Hypervisor is the basic unit of scale.

Cluster consists of one or more hosts of same hypervisor.

All hosts in cluster have access to shared (primary) storage.

Pod is one or more clusters, usually with L2 switches.

Availability Zone has one or more pods, has access to secondary storage.

One or more zones represent cloud.
CloudStack Cloud can have one or more Availability Zones (AZ).
Management Server Managing Multiple Zones

- Single Management Server can manage multiple zones
- Zones can be geographically distributed but low latency links are expected for better performance
- Single MS node can manage up to 5K hosts.
- Multiple MS nodes can be deployed as cluster for scale or redundancy
Management Server Deployment Architecture

**Single-node Deployment**

- **User API**
- **Admin API**
- **Management Server**
- **MySQL DB**

**Multi-node Deployment**

- **User API**
- **Admin API**
- **Load Balancer**
- **MySQL DB**

- **Infrastructure Resources**

- **MS is stateless. MS can be deployed as physical server or VM**
- **Single MS node can manage up to 10K hosts. Multiple nodes can be deployed for scale or redundancy**
- **Commercial: RHEL 5.4+; FOSS: Ubuntu 10.0.4, Fedora 16**
CloudStack Storage

**Primary Storage**
- Configured at Cluster-level. Close to hosts for better performance
- Stores all disk volumes for VMs in a cluster
- Cluster can have one or more primary storages
- Local disk, iSCSI, FC or NFS

**Secondary Storage**
- Configured at Zone-level
- Stores all Templates, ISOs and Snapshots
- Zone can have one or more secondary storages
- NFS, OpenStack Swift
Core CloudStack Components

- **Hosts**
  - Servers onto which services will be provisioned

- **Primary Storage**
  - VM storage

- **Cluster**
  - A grouping of hosts and their associated storage

- **Pod**
  - Collection of clusters

- **Network**
  - Logical network associated with service offerings

- **Secondary Storage**
  - Template, snapshot and ISO storage

- **Zone**
  - Collection of pods, network offerings and secondary storage

- **Management Server Farm**
  - Responsible for all management and provisioning tasks
Understanding the Role of Storage and Templates

- **Primary Storage**
  - Cluster level storage for VMs
  - Connected directly to hosts
  - NFS, iSCSI, FC and Local

- **Secondary Storage**
  - Zone level storage for template, ISOs and snapshots
  - NFS or OpenStack Swift via CloudStack System VM

- **Templates and ISOs**
  - Imported into CloudStack
  - Can be private or public
1. User Requests Instance
2. Provision Optional Network Services
3. Copy instance template from secondary storage to primary storage on appropriate cluster
4. Create any requested data volumes on primary storage for the cluster
5. Create instance
6. Start instance
Red Hat Enterprise Linux (KVM)

- Integrates with libvirt using Cloud Agent
- Snapshots at host level
- System VM control channel at host level
- Network management is host level
- Only RHEL 6, not RHEV
  - Also supports Ubuntu 10.04
Management Server Interaction with Hypervisors

Management Server

XAPI
- XenServer
  - XS 5.6, 5.6FP1, 5.6 SP2, 6.0
  - Incremental Snapshots
  - VHD
  - NFS, iSCSI, FC & Local disk
  - Storage over-provisioning: NFS

HTTP
- vCenter
  - ESX 4.1, 5.0 (coming)
  - Full Snapshots
  - VMDK
  - NFS, iSCSI, FC & Local disk
  - Storage over-provisioning: NFS, iSCSI

- Agent
  - KVM
    - RHEL 6.0, 6.1, 6.2 (coming)
    - Full Snapshots (not live)
    - QCOW2
    - NFS, iSCSI & FC
    - Storage over-provisioning: NFS

- Agent
  - OVM
    - OVM 2.2
    - No Snapshots
    - RAW
    - NFS & iSCSI
    - No storage over-provisioning
Multi-tenancy & Account Management

- Domain is a unit of isolation that represents a customer org, business unit or a reseller
- Domain can have arbitrary levels of sub-domains
- A Domain can have one or more accounts
- An Account represents one or more users and is the basic unit of isolation
- Admin can limit resources at the Account or Domain levels
Guest Networks with L3 isolation

Public Internet
- Public IP addresses: 65.37.141.11, 65.37.141.24, 65.37.141.36, 65.37.141.80
- Load Balancer
  - Pod 1 L2 Switch
    - Guest 1 VM: address 10.1.0.2
    - Guest 2 VM: address 10.1.0.3
  - Pod 2 L2 Switch
    - Guest 1 VM: address 10.1.0.4
  - Pod 3 L2 Switch
    - Guest 1 VM
    - Guest 2 VM: address 10.1.16.12
    - Guest 2 VM: address 10.1.16.21
    - Guest 1 VM
    - Guest 1 VM
    - Guest 1 VM: address 10.1.16.85

L3 Core Switch

Pod 1 L2 Switch
- 10.1.0.1
Pod 2 L2 Switch
- 10.1.8.1
Network Offerings

- Cloud provider defines the feature set for guest networks
- Toggle features or service levels
  - Security groups on/off
  - Load balancer on/off
  - Load balancer software/hardware
  - VPN, firewall, port forwarding
- User chooses network offering when creating network
- Enables upgrade between network offerings
- Default offerings built-in
  - For classic CloudStack networking
Networking Principles in Apache CloudStack

- **Flexibility**
  - Allow various combinations of technology for L2-L7 network services
  - Allow different providers (vendors) for the same network service in a Cloud POP

- **Pluggability**
  - Plugins allow vendors to drop in vendor-specific configuration and lifecycle management code

- **Service scalability**
  - Scale out using virtual appliances when possible
  - Scale up using hardware appliances if needed
On-Board and Scale

**Level 2: Cloudify**

- Cloudify is an open source cloud orchestration framework

- It is a **Platform as a Service (PaaS)**, a category of cloud computing services that provides a platform allowing customers to develop, run, and manage web applications

- Cloudify allows to:
  - Model applications and services and automate their entire life cycle
  - Deploy on any cloud or data center environment
  - To monitor all aspects of the deployed application
CLOUDIFY POSITIONING IN THE CLOUD STACK

Productivity

PaaS

Heroku

CloudFoundry

GAE

OpenShift

DevOps

(Automation)

IaaS

Public clouds

(AWS, Rackspace,..)

Private clouds

(Vmware, OpenStack..)

Control

High productivity with full control

Enstratus

Puppet

Chef

Rightscale

Cloudify

1. Upload your **recipes**
2. Cloudify creates VMs & installs agents
3. Agents install and manage your app
4. Cloudify automates the scaling
Extensive Platform Support

Leverage any Chef Cookbook

Focus on Big Data applications

Dozens of built in recipes GitHub Recipe Repository

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application {
    name = "petclinic"
    service {
        name = "mongod"
    }
    service {
        name = "mongoConfig"
    }
    service {
        name = "apacheLB"
    }
    service {
        name = "mongos"
        dependsOn = ["mongoConfig", "mongod"]
    }
    service {
        name = "tomcat"
        dependsOn = ["mongos", "apacheLB"]
    }
}
scalingRules ([
  scalingRule {
    serviceStatistics {
      metric "Total Requests Count"
      statistics Statistics maximumThroughput
      movingTimeRangeInSeconds 20
    }
    highThreshold {
      value 1
      instancesIncrease 1
    }
    lowThreshold {
      value 0.2
      instancesDecrease 1
    }
  }
])
Topics to discuss

- LICENSES are not “Cloudable” !!!
- Selection of Cloud Training Tools
  - MOOC
  - Hardware mCloud
  - Software mCloud
  - Lab mCloud
- Selection of Tools and Configurations to be installed in the MECA shared Training Platform
- Selection of Resources by each Partner