System Administration

LECTURE 2

CLOUD OVERVIEW

slides are adopted from the previous year

Lecture 002: “System Administration: CLOUD OVERVIEW” by Amnir Hadachi
Questions

• Any examples of virtualization? What is virtualized?
  – Virtual Memory
  – JVM, Python, .NET
  – Chroot, sysjail, openvz
  – DOSBox, Wine, pcsx
  – Xen, Hyper-V
  – VDE, OpenVSwitch
  – OpenVPN, GRE, VLAN, Hamachi
  – Lvm2, Qcow, vdi, vmdk
  – Qemu, VirtualBox, VMWare
  – More examples?
LECTURE 2: CLOUD OVERVIEW

OUTLINE

- Cloud computing
- Cloud environment
- Cloud essentials
- Cloud characteristics and properties
- Cloud deployment models
- Cloud as a service
- Service models
LEcTURe 2: CLOUD OVERVIEW
CLOUD COMPUTING

DEFINITION 3.1: Cloud computing provides a model for enabling on-demand network access to a shared pool of computing resources, rapidly and with minimal management efforts.

EXAMPLE 3.1: Example of service that are provided
networks, servers, storage, applications, and services
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WHAT DOES IT TAKE TO MANAGE A CLOUD INFRASTRUCTURE

- Keep running updated maintaining customizing
- Installing required OS creating virtual machines
- Security

INSTALLING AND MAINTAINING NEW APPLICATIONS IS A NIGHTMARE (COMPATIBILITY AND DEPENDENCY ISSUES)

TIME CONSUMING (TRACKING DOWN PROBLEM CAUSED BY SOFTWARE AND OS COMPATIBILITY ISSUES, )

SOMETIMES SOME PHYSICAL WORK IS NEED (UPGRADING HARDWARE PART)
LECTURE 2: CLOUD OVERVIEW
DEFINING CLOUD ENVIRONMENT

- Traditional environment

VM MANAGEMENT TOOL

b) Verify that request is allowed

c) Manually create resource

VM
VM
VM
VM

HYPERVERSORS

COMPUTE/STORAGE/NETWORKING

Admin

User

a) Request resource
LECTURE 2: CLOUD OVERVIEW
DEFINING CLOUD ENVIRONMENT

• Disadvantage of the traditional system
  • Over or under-provisioning
  • Underestimating provisioning
  • Overestimating system utilization \[\rightarrow\] Low utilization

Solution

DYNAMIC PROVISIONING
LECTURE 2: CLOUD OVERVIEW
DEFINING CLOUD ENVIRONMENT

- New environment
  a) Create cloud with predefined resources, users, quotas, and access rights

VM MANAGEMENT TOOL

Admin

b) Request resource

SELF-SERVICE PORTAL

User

Cloud

Cloud

VM

VM

VM

VM

HYPERVERSORS

COMPUTE/STORAGE/NETWORKING
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CLOUD ESSENTIALS

• Cloud platform (or cloud computing) is a utility computing

• All the services provided by the cloud are controlled and monitored by the cloud provider via a pay-per-use business model.

• The ideal cloud computing platform is:
  ▶ Efficient regarding resource management
  ▶ scalable
  ▶ elastic
  ▶ self-managing
  ▶ highly available
  ▶ Accessible
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CLOUD CHARACTERISTICS/PROPERTIES

• What makes a cloud a cloud:
  • Self-service access.
  • Elasticity.
  • Metered use of resources.
  • Pooled Resources
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CLOUDS: DEPLOYMENT MODELS

• Public cloud

**DEFINITION 10.1:**
A public cloud is an open infrastructure to the general public where anyone can access the services provided by the cloud.

• Private cloud

**DEFINITION 10.2:**
A private cloud is provisioned for privilege and exclusive infrastructure for use by a single organization comprising multiple consumers.

• Community cloud

**DEFINITION 10.3:**
A community cloud is similar to private cloud the only difference is in the fact that the exclusive users from the community share the same concerns.

• Hybrid cloud

**DEFINITION 10.4:**
A hybrid cloud is a composition of two or more distinct cloud infrastructure. (e.g. merging between private, public, and community clouds)
LECTURE 2: CLOUD OVERVIEW
CLOUD AS A SERVICE

IaaS
- Infrastructure as a Service
  - File
  - Caching
  - Security
  - Networking

PaaS
- Platform as a Service
  - Web
  - Streaming
  - Decision Support
  - Application Development

SaaS
- Software as a Service
  - Email
  - ERP
  - CRM
  - Collaborative
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CLOUD CORE STACK

APPLICATION
- ANALYTICAL
- TRANSACTIONAL
- INTERACTIVE
- BROWSING

APPLICATION CAPABILITY COMPONENTS
- WEB SERVER
- MSQQL
- APP SERVER
- REPORTING
- ESB
- DATABASE
- CACHE

COMPUTING FRAMEWORKS
- TRANSACTIONAL / DISPATCHING
- ANALYTICAL / SCHEDULING

RESOURCES
- SERVER
- STORAGE
- NETWORK
- Virtualization Resources
- Physical Resources
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CLOUD AS A SERVICE

- hardware & software stack evolution:

Source: Based on the model developed by NIST (2011)

Owned, operated and managed by the organization
Run, operated and managed by the provider
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CLOUD SERVICE LAYERS

- Service stack components
  - People
  - Client Device

- Interconnecting Network
  - Hosted Application Software
  - Infrastructure Software
  - Operating Systems
  - Virtualisation Layer
  - Physical Servers
  - Networking & Firewalling
  - Data Centre Mechanical & Electrical

- Platform-as-a-Service (PaaS)
- Software-as-a-Service (SaaS)

* as a Service

SOURCE: HTTPS://WWW.KATESCOMMENT.COM/JAAS-PaaS-SAAS-DEFINITION/
### LECTURE 2: CLOUD OVERVIEW

**SERVICE MODEL**

<table>
<thead>
<tr>
<th>IaaS</th>
<th>PaaS</th>
<th>SaaS</th>
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<tbody>
<tr>
<td><strong>WHO?</strong></td>
<td><strong>WHAT?</strong></td>
<td><strong>WHY?</strong></td>
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<tr>
<td>System Administrator</td>
<td>OS</td>
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<td>System Manager</td>
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<td>test, development,</td>
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Software As A Service

buy
SaaS
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SOFTWARE AS A SERVICE (SAAS)

• Characteristics:
  
  • On-demand service (No difference between the license fee and the hosting fee.)

• Software delivery model:
  
  • No hardware deployment needed
  
  • Accessible anywhere, anytime
  
  • The application is delivered over a web browser or other thin client.
  
  • The application is configurable, but not customizable.
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SOFTWARE AS A SERVICE (SAAS)

• SaaS Architecture (Maturity Model) / maturity levels:
  • Level I: Ad Hoc/Custom
  • Level II: Configurable
  • Level III: Configurable, Multi-Tenant-Efficient
  • Level IV: Scalable, Configurable, Multi-Tenant-Efficient
LECTURE 2: CLOUD OVERVIEW
SOFTWARE AS A SERVICE (SAAS)

• SaaS Architecture (Maturity Model) / maturity levels:
  • Level I: Ad Hoc/Custom
LECTURE 2: CLOUD OVERVIEW
SOFTWARE AS A SERVICE (SAAS)

- SaaS Architecture (Maturity Model) / maturity levels:
  - Level II: Configurable
LECTURE 2: CLOUD OVERVIEW
SOFTWARE AS A SERVICE (SAAS)

• SaaS Architecture (Maturity Model) / maturity levels:
  
  • Level III: Configurable, Multi-Tenant-Efficient
LECTURE 2: CLOUD OVERVIEW
SOFTWARE AS A SERVICE (SAAS)

- SaaS Architecture (Maturity Model) / maturity levels:
  - Level IV: Scalable, Configurable, Multi-Tenant-Efficient

Tenant 1

Tenant 2

Tenant 3

TENANT LOAD BALANCE

Instance

Instance

Instance
• Metadata Services:
  • providing the ability to the users to create their own primary configurations and customizations of the applications to meet their needs.

• Security services:
  • The nature of SaaS makes security both a paramount concern for customers, and a high priority for application architects.
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SAAS EXAMPLES

SaaS For Enterprises

Microsoft
SAP
Oracle
Yahoo!

SaaS For Consumers

eBay
Google
SAP CRIM ON-DEMAND SOLUTION

CRM
Mailing Labels
Web Site
Email
Marketing
PDF Conversion
Blogs
Payroll
Fax
CRM
Content
Management
Newsletters
Word Processing
Sales Force
Automation
Hosting

SAAS

SAAS SMALL BUSINESS
Platform As A Service
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PLATFORM AS A SERVICE (PaaS)

• Characteristics:

  • PaaS is a computing platform that abstract the infrastructure, OS, and middleware to drive developer productivity.

  • Offers an environment for developers
    • Create and deploy application
    • Different programming languages
    • Different DB
    • Web based console to create application (with dashboard)
LECTURE 2: CLOUD OVERVIEW
PLATFORM AS A SERVICE (PaaS)

- Types of PaaS:
  - Close PaaS: provides a fixed set of services you can use. You cannot install your own services.
  - Open PaaS: provides support for you to develop your own automated service deployments.
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PAAS EXAMPLES
Infrastructure
As A Service
LECTURE 2: CLOUD OVERVIEW
INFRASTRUCTURE AS A SERVICE (IAAS)

- Characteristics:
  - Dynamic provisioning
    - provides virtual machine
    - cannot provide elastic computing by itself (needs PaaS)
  - Multi-tenancy
    - single instance of the software runs on a server and serving multiple clients.
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INFRASTRUCTURE AS A SERVICE (IAAS)

- Two important stacks:
  - Virtualization resources
  - Physical resources Server
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IAAS: VIRTUALIZATION

**DEFINITION 30.1:**
Virtualization is the abstraction of logical resources away from the underlying physical resources.

- Virtualization

![Diagram showing Traditional Stack and Virtualized Stack](image-url)
LECTURE 2: CLOUD OVERVIEW
IAAS: VIRTUALIZATION

DEFINITION 30.1: Virtualization
Virtualization is the abstraction of logical resources away from the underlying physical resources.

• Virtualization

Traditional Stack

Virtualized Stack
LECTURE 2: CLOUD OVERVIEW

IAAS: VIRTUALIZATION

• Types of virtualization:
  • Emulation
    • VM emulate/simulate complete hardware
    • Unmodified guest OS can be run on a different PC
  • Full/native virtualization
    • VM simulates stick minimum hardware to allow run an unmodified guest OS in isolation
LECTURE 2: CLOUD OVERVIEW
IAAS: VIRTUALIZATION

- Types of virtualization:
  - Para-virtualization
    - VM does not simulate the hardware
    - Special API is used by the modified guest OS
    - Hypercalls are trapped by the Hypervisor and serviced
  - OS-level virtualization
    - OS allows to run multiple secure virtual servers
    - Guest OS is the same as host OS (However it appress isolated)
  - Application level virtualization
    - Application is given a copy of its own component and they are shared
**LECTURE 2: CLOUD OVERVIEW**

**IAAS: VIRTUALIZATION**

**DEFINITION 30.1:** Hypervisor

Hypervisor or Virtual Machine Monitor (VMM) is another technology at the heart of system virtualization which is responsible for allocating resources to each virtual machine.

**EXAMPLE 30.1:** Example of Hypervisor

Kernel-based Virtual Machine (KVM) is an open source virtualization platform

- Characteristics: (Provides)
  - Policy-based automation
  - Virtual hard disk
  - Life cycle management
  - Life migration
  - Real time resource allocation
LECTURE 2: CLOUD OVERVIEW
IAAS: VIRTUALIZATION

- Hypervisors:
  - Native/Bare-Metal Hypervisor
    - Runs directly on the hardware
  - Hosted Hypervisor
    - Runs on host operating system
LECTURE 2: CLOUD OVERVIEW
IAAS: VIRTUALIZATION

- Protection rings
  - CPU protection rings
    - Level 0: operating system kernel
    - Level 1 & level 2: operating system services
    - Level 3: Applications run by the user or users.
LECTURE 2: CLOUD OVERVIEW
IAAS: VIRTUALIZATION

- Traditional OS
  - When application invoke a system call
    - CPU will trap to interrupt handler vector in OS.
  - CPU will switch to kernel mode (Ring0) and execute OS instructions.
- When hardware event:
  - Hardware will interrupt CPU execution, and jump to interrupt handler in OS.
LECTURE 2: CLOUD OVERVIEW
IAAS: VIRTUALIZATION

- VMM & Guest OS:
  - System Call
    - CPU will trap to interrupt handler vector of VMM
  - VMM jump back into guest OS.
- Hardware interrupt
  - Hardware make CPU trap to interrupt handler of VMM.
  - VMM jump to corresponding interrupt handler of guest OS.
- Privilege Instruction
  - Running privilege instructions in guest OS will be trapped to VMM for instruction emulation.
  - After emulation, VMM jump back to guest OS.
LECTURE 2: CLOUD OVERVIEW
IAAS EXAMPLES
CONCLUSION

CLOUD

IaaS  SaaS  PaaS

- Clouds provide services at three main levels:
  - Infrastructure as a service
  - Platform as a service
  - Software as a service
- Give a new programming models enabling an easy way for development of large-scale applications.
CONCLUSION

CLOUD

Source: based on the model provided by NIST

BROAD NETWORK ACCESS

RAPID ELASTICITY

MEASURED SERVICE

ON-DEMAND SELF-SERVICE

RESOURCE POOLING

SOFTWARE AS A SERVICE

PLATFORM AS A SERVICE

INFRASTRUCTURE AS A SERVICE

SaaS

PaaS

IaaS

Essential Characteristics

Service Models

Deployment Models

Private

Public

Community

Hybrid

build

buy

deploy

IaaS

SaaS

PaaS