

Web 2.0

Lecture 2: Cloud Architectures

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Overview

- Introduction
- Cloud Architecture
- Infrastructure as a Service

Terminology

- Cloud computing
- *aaS
- Private, Public, Hybrid Cloud
- Cloud Native
- Microservices
- Serverless

What is a Cloud?

- A different way of thinking
 - *Got your grand mum's savings under your pillow?*
→ *probably not, you better have them in your bank*
 - *Data is your major asset*
 - *you better have them in a "bank" too*
 - *Someone can abuse your data?*
 - *banks bankrupt too, sometimes – it is a risk you take*
 - *there is a market and a competition*
- Outsourcing of application infrastructure
 - *Reliability and availability*
 - *Low costs – pay-per-use*
 - *Elasticity – can dynamically grow with your apps*

What is a Cloud?

- Any app you access over the web?
- A datacenter?
 - *Offers virtualization*
 - *Any company having a datacenter wants to move to*
- Cloud provider should also offer services, such as:
 - *scalability, storage*
 - *Possible to configure programmatically*
 - *integration to enterprise administration processes*
 - *usually REST interface*

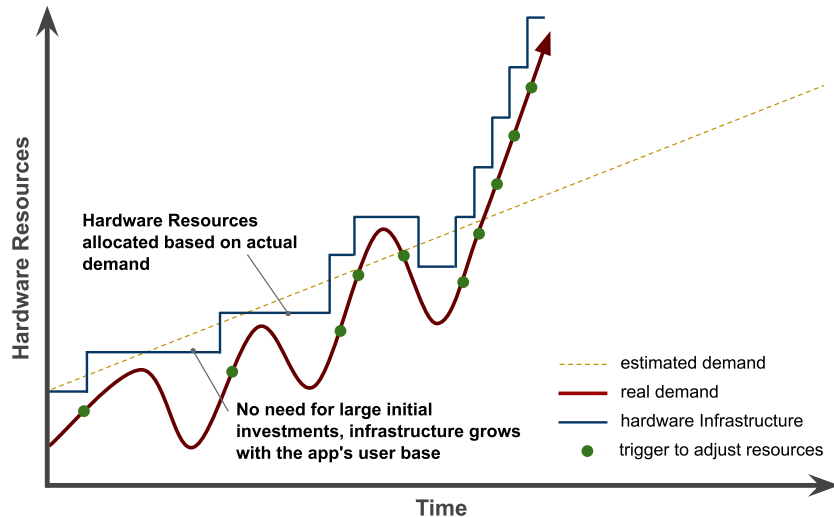
Traditional Solution to Infrastructure

- Traditional hardware model
 - *Up-front hardware investments*
 - *Hardware not optimally utilized*



Good Performance – Cloud Solution

- Cloud Computing model
 - No up-front hardware investments
 - Hardware optimally utilized



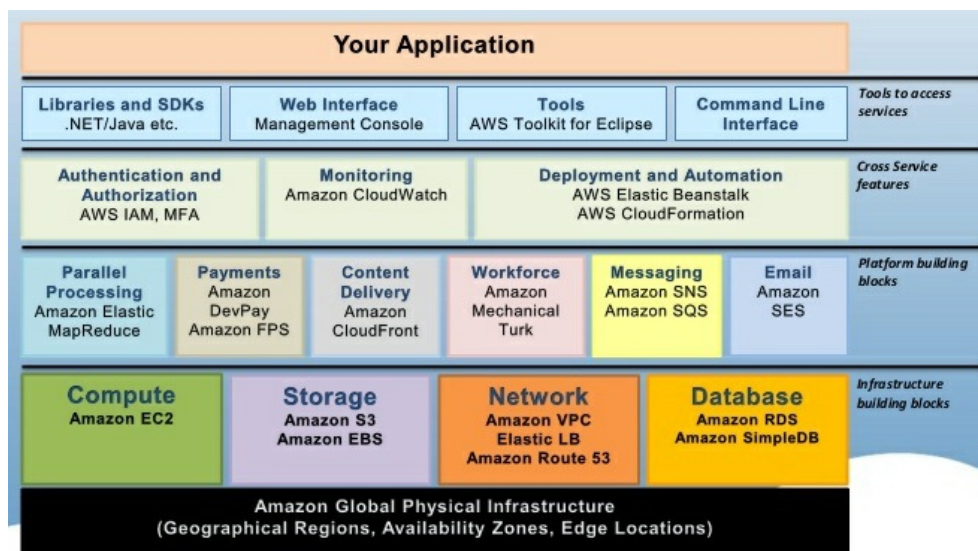
Cloud Computing Concepts

- **Resource Pooling**
 - Resources reused by multiple tenants (multitenancy)
 - Resources: CPU, memory, storage, network
- **On-demand and Self-service**
 - Resources are provisioned as they are requested and when they are required
 - No human interaction, automatic
- **Scalability and Elasticity**
 - Infrastructure may grow and shrink according to needs
 - Automatic or manual
- **Pay-per-use**
 - Consumers only pay for resources when they use them

Cloud Computing Concepts (Cont.)

- Service Models (aka Cloud Layers)
 - *IaaS – Infrastructure as a Service*
 - *PaaS – Platform as a Service, Serverless*
 - *MWaaS, DBaaS, ...*
 - *FaaS*
 - *SaaS – Software as a Service*
- Deployment Models
 - *Public Cloud*
 - *Private Cloud*
 - *Hybrid Cloud*

Cloud Provider Example – Amazon AWS



Overview

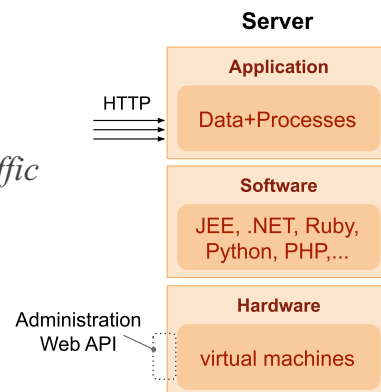
- Introduction
- Cloud Architecture
 - *Service Models*
 - *Multitenancy*
- Infrastructure as a Service

IaaS: Infrastructure as a Service

- Provides basic computing resources and services for application providers
 - *Services for application providers*
 - *A consumer is able to deploy and run arbitrary software*
- Infrastructure implications
 - *Exposing of infrastructure resources through abstraction*
 - *Support for infrastructure resources – compute (hardware/OS/VM), storage, network, etc.*
 - *Supports isolation for multitenant environments*

IaaS: Infrastructure as a Service

- Usage
 - *Predefined machine instances (micro, small, large, extra-large)*
 - *Linux OS, 613 MB of memory, 30 GB of Storage, Load Balancer, etc.*
 - *Pay-per-use – pay for resources you use (time or amount); no up-front costs*
- IaaS Services Examples
 - *Elastic Storage*
 - *Monitoring resources*
 - *Amazon CloudWatch*
 - *Auto Scalling of running instances*
 - *Load Balancing – distributing incoming traffic across multiple instances*
- IaaS providers
 - *Amazon EC2, GoGrid, Rackspace, OpenNebula, Oracle OCI, ...*

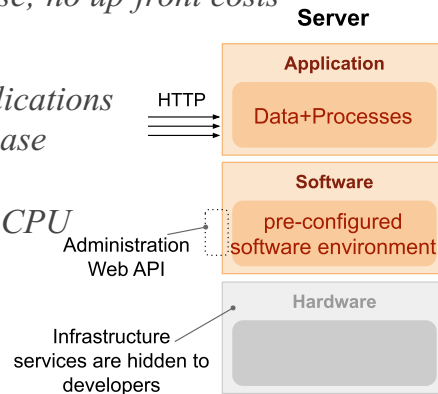


PaaS: Platform as a Service

- Provides scalable platform for applications
 - *Services for application providers*
 - *No costs of buying and managing underlying infrastructure*
 - *hardware and software*
- Infrastructure implications
 - *Scalable platform, deploy on-demand*
 - *Self service interface to deploy applications and services*
 - *Support for monitoring and measuring platform usage*
 - *Model supporting isolation in multi-tenant environments*

PaaS: Platform as a Service

- Usage
 - Choose software platform, e.g., JEE, .NET, Python, etc.
 - Pay-per-use – pay for the resources you use; no up-front costs
- PaaS features
 - Auto Scalling and Load Balancing of applications
 - Persistent Storage - usually NoSQL database
 - Local development environment
 - Backends – for app instances with higher CPU and memory demands
 - Administration APIs for its services
- PaaS providers
 - Google App Engine, Heroku, Windows Azure, etc.



SaaS: Software as a Service

- Software delivery model for applications hosted in the cloud
 - typically software for end-users
 - services accessed using a web browser
 - provides API for programmatic access
- SaaS characteristics
 - Typically build on top of IaaS or PaaS
 - Configurable and customizable modern Web applications
 - Usually basic version for free, need to pay for pro version
 - Global availability - any computer, any device
 - Easy management - automatic and fast updates
 - Pay-per-use – pay for the time you use
- SaaS providers
 - Google Apps, Salesforce, iCloud, Flickr, Picasa, ...

Overview

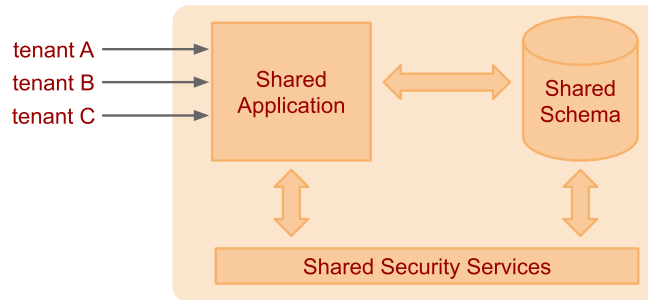
- Introduction
- Cloud Architecture
 - *Service Models*
 - *Multitenancy*
- Infrastructure as a Service

Multitenancy

- Architectural approach where resources are shared between multiple tenants or consumers
- Implications
 - *Centralization of infrastructure in locations with lower costs*
 - *Peak-load capacity increases*
 - *Utilisation and efficiency improvements for systems that are not well utilised*
- Sharing options
 - *Shared Everything*
 - *Shared Infrastructure*
 - *Virtual Machines*
 - *OS "virtualization"*

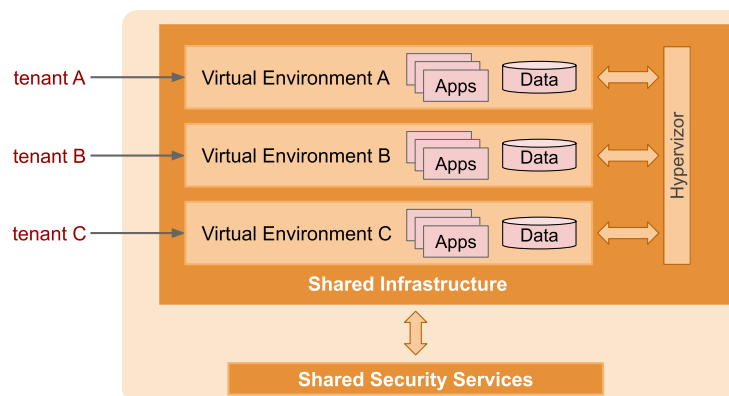
Shared Everything

- Resources are shared between all tenants or consumers
 - *tenant: a service consumer*
- Common for the SaaS model
- The application should provide tenant isolation
- Data for multiple tenants is stored in the same database tables



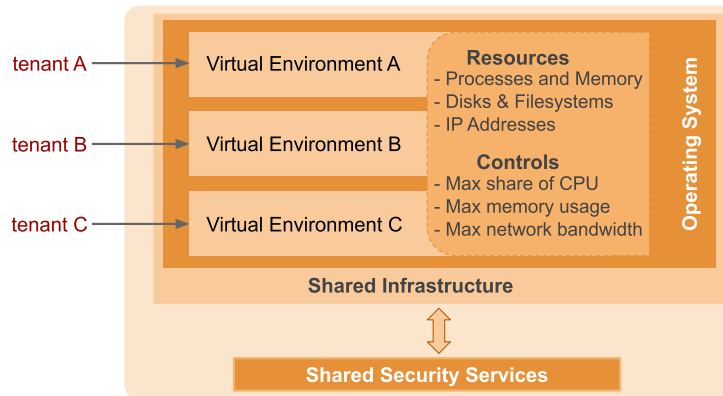
Shared Infrastructure: Virtual Machines

- Infrastructure shared via virtual machines
 - *each tenant has its own virtual environment*
 - *Isolation provided by hypervisor*
 - *hypervisor: virtual machine manager, runs virtual machines*
 - *Resource contention depends on VM capability and configuration*
 - *Adds an additional layer and processes to run and manage*



Shared Infrastructure: OS Virtualization

- Infrastructure shared via OS Virtualization
 - *Each tenant has its own processing zone*
 - *Isolation provided by the operating system*
 - *Resource contention depends on zone configuration*
 - *No VMs to run and manage, no abstraction layer between app & OS*



Overview

- Introduction
- Cloud Architecture
- **Infrastructure as a Service**
 - *Infrastructure as Code*

Terminology (1)

- Region
 - A localized geographical area
 - A cloud provider usually has multiple regions around the world.
- Availability Domain
 - A datacenter in a region; there can be more AD in a region
- Tenancy
 - Isolated partition where a customer creates and organizes cloud resources.
- Instance
 - Compute host running in the cloud
- Bare Metal
 - Physical host that run directly on bare metal servers without hypervisor
- Shape/Class
 - Amount of computing resources allocated to the instance
 - CPUs, Memory, Local Disk, Network Bandwidth, Number of VNICs
- Image
 - A template of a virtual hard drive that defines operating system and other software for an instance.

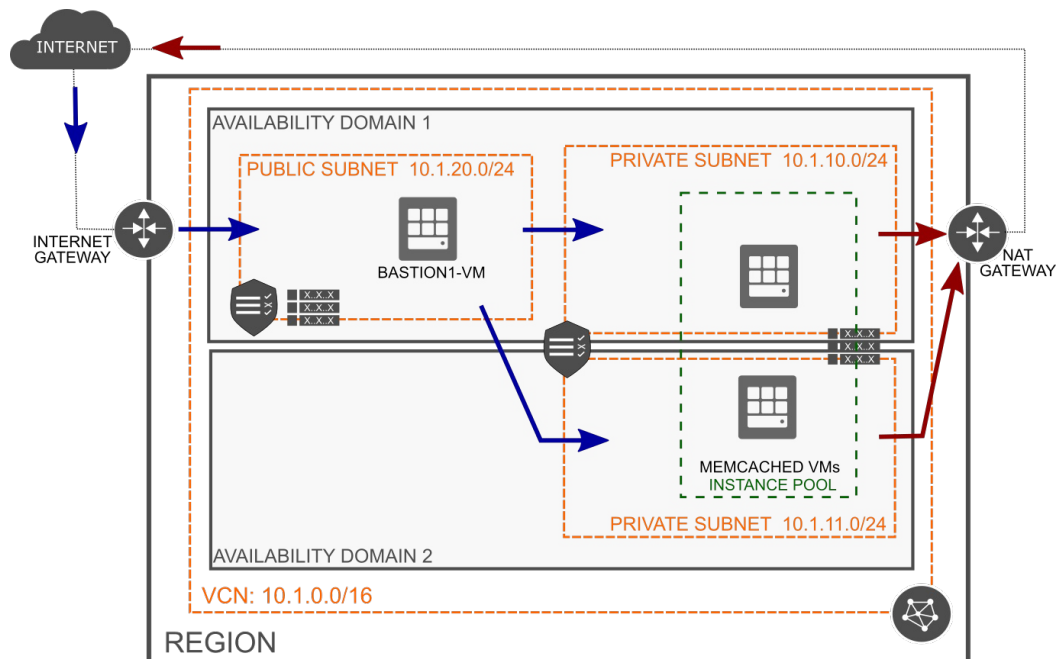
Terminology (2)

- Instance Pool
 - A group of instances
- Virtual Cloud Network (VCN)
 - A virtual network in which instances run
 - It includes: **subnets**, **route tables**, **firewall rules**, **gateways**
- Block Volume
 - A virtual disk providing persistent storage
 - It can be used as a volume attached to the instance
- Object Storage
 - Allows to store and manage data as objects in logical containers (**buckets**)
 - The data can be of any type and are usually of large size
 - The data does not change frequently
 - Examples: data backup, storing unstructured data, sensor-generated data

Access and Usage

- Layers
 - *Cloud Infrastructure* → *REST API* → *CLI, Web Console, other tools*
- Key pair
 - Authentication mechanism using **public** and **private** key
 - *public key is uploaded to an instance, a client uses the private key to authenticate*
 - *Example: ssh using key authentication to access ssh daemon running in Linux*

IaaS Example



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- Introduction
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 - *Infrastructure as Code*

Overview

- Definition
 - *Application envs (in a cloud) managed via definition files*
 - *Version control, team development, scripting, etc.*
- Major Technologies
 - ***Configuration Management Tools***
 - *install and manage software on machines that already exist*
 - *Examples: Ansible, Chef, Puppet*
 - ***Abstraction of cloud infrastructure***
 - *Terraform*

Terraform

- Higher-level abstraction of the datacenter and associated services
- Supports many service providers
 - *Google, Microsoft, Oracle, AWS*
- Steps
 1. *Description of resources in Hashicorp Configuration Language (HCL)*
 - *instances, networks, firewall rules, routing tables, etc.*
 2. *Terraform generates execution plan to reach the desired state*
 3. *Terraform executes the plan to reach the desired state; can generate incremental execution plan*