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?

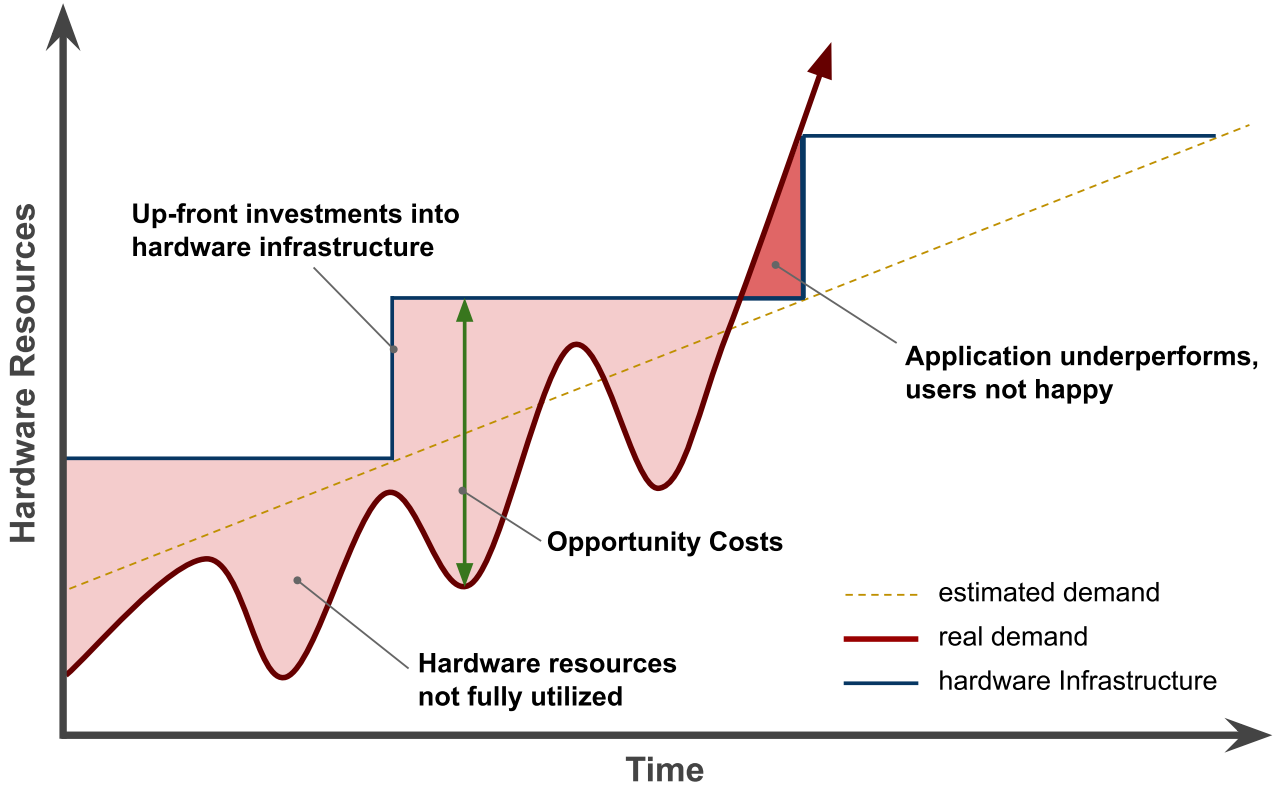
- A different way of thinking
  - *Got your grand mum's savings under your pillow?*
    → probably not, you better have them in your bank
  - *Data is your major asset*
  - *you better have them in a "bank" too*
  - *Someone can abuse your data?*
  - *banks bankrupt too, sometimes – it is a risk you 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*

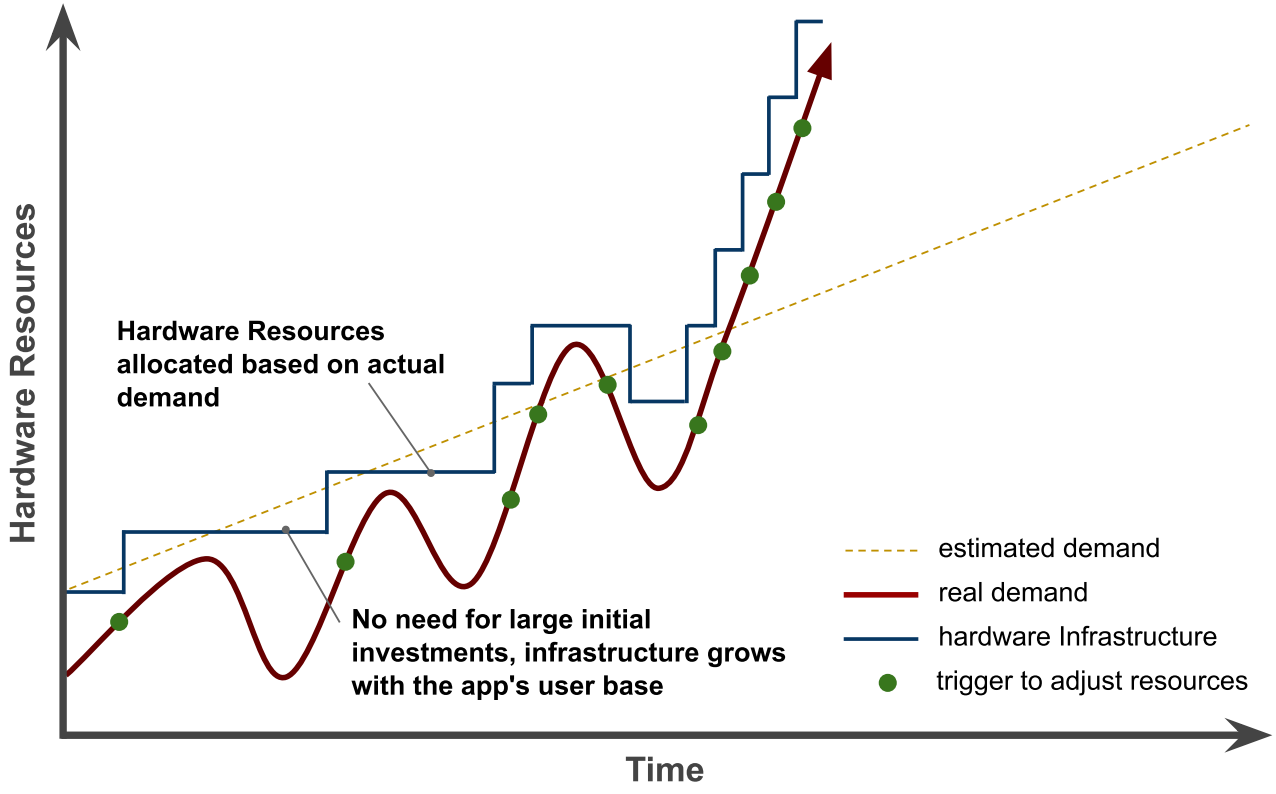
Traditional Solution to Infrastructure

- 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*



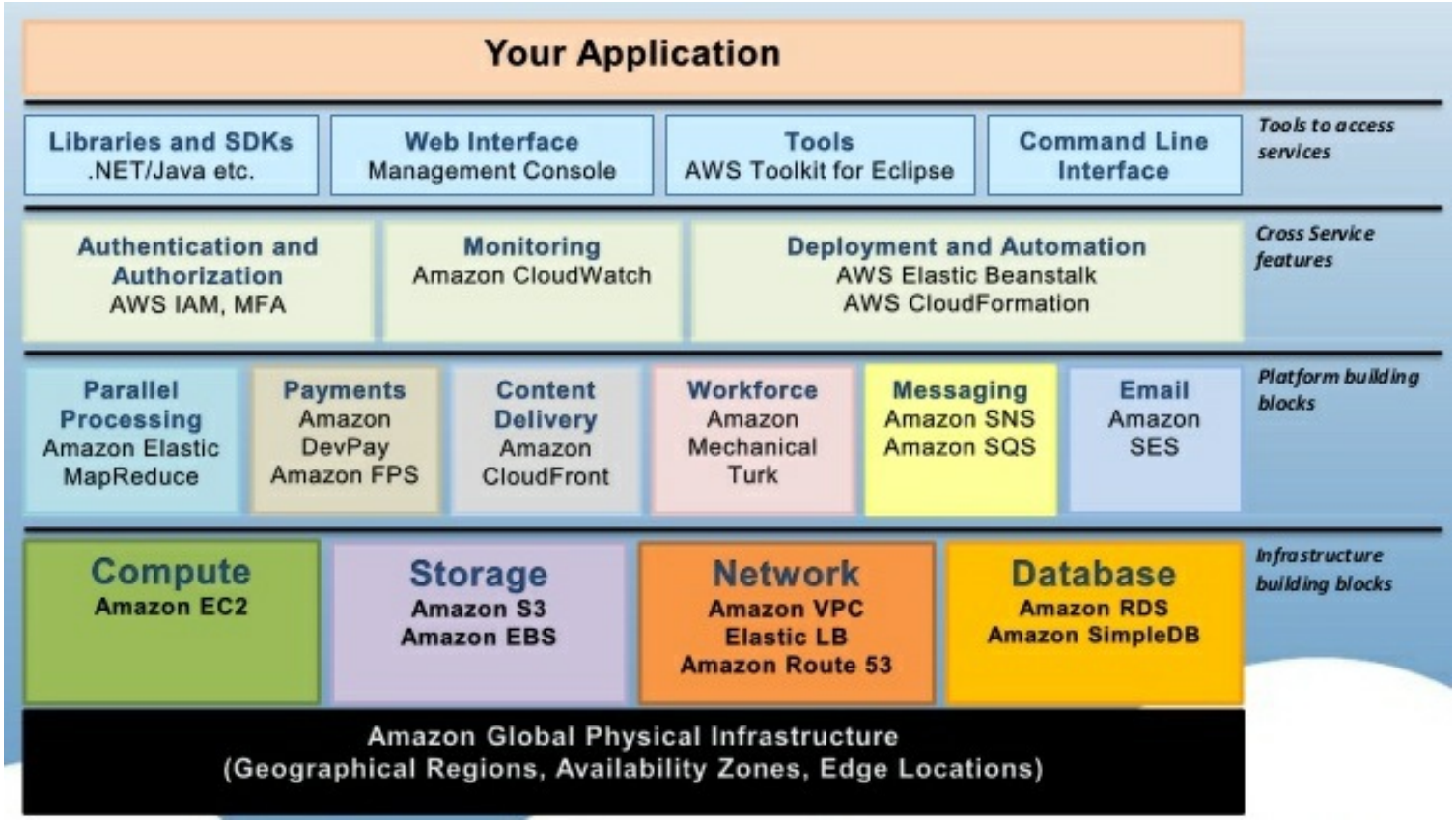
Cloud Computing Concepts

- **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

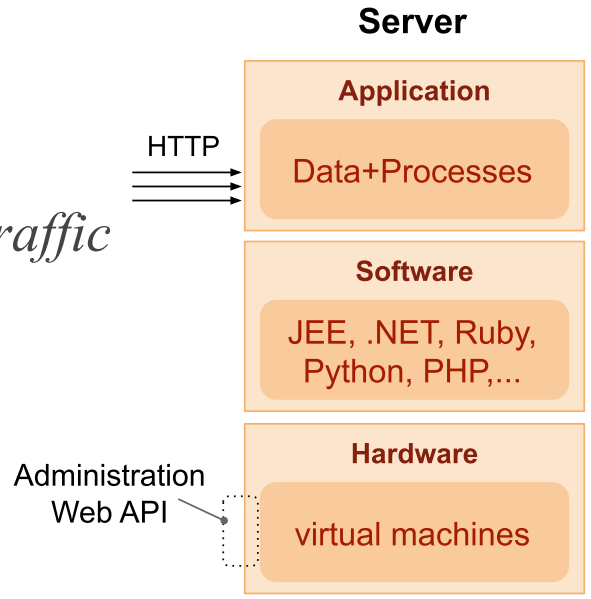
- Introduction
- Cloud Architecture
  - *Service Models*
  - *Multitenancy*
- Infrastructure as a Service

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, ...*

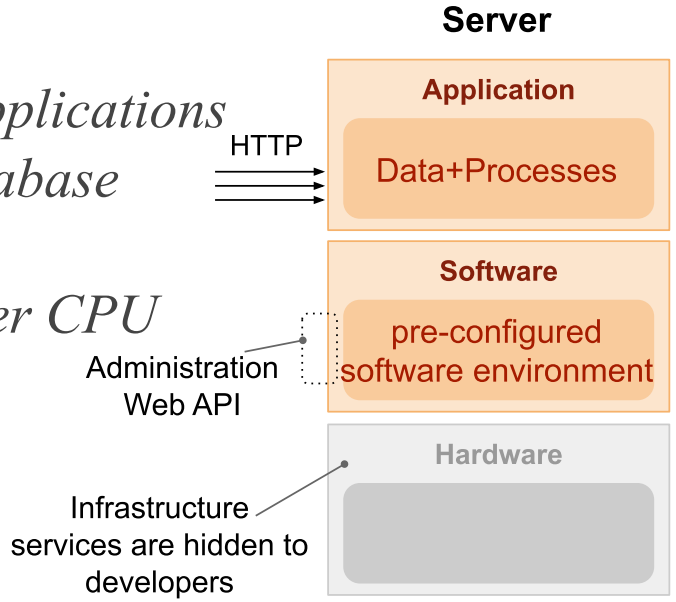


PaaS: Platform as a Service

- 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

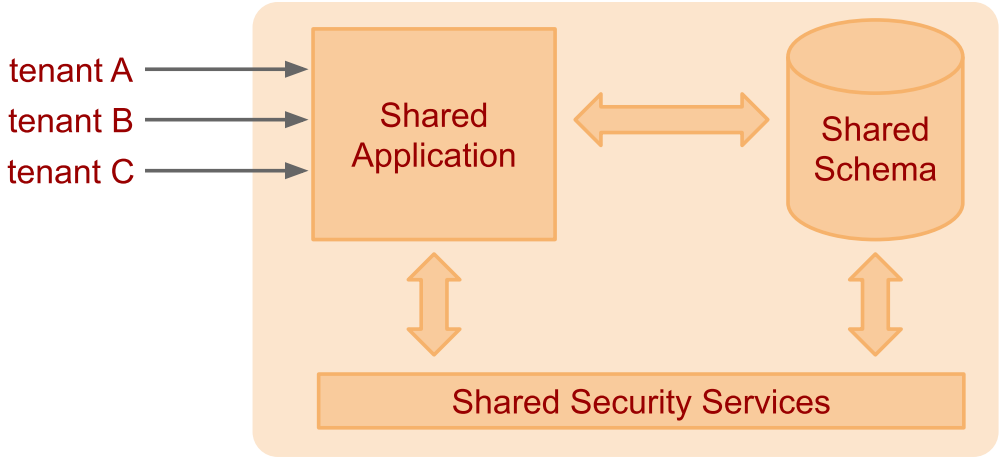
- Introduction
- Cloud Architecture
  - *Service Models*
  - *Multitenancy*
- Infrastructure as a Service

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"*

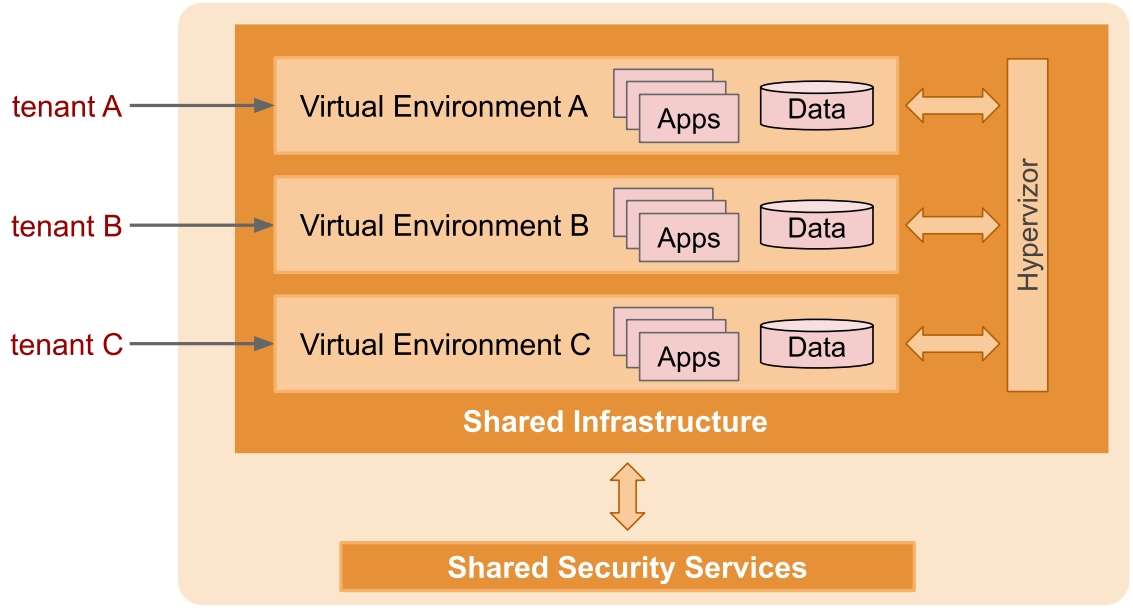
Shared Everything

- 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



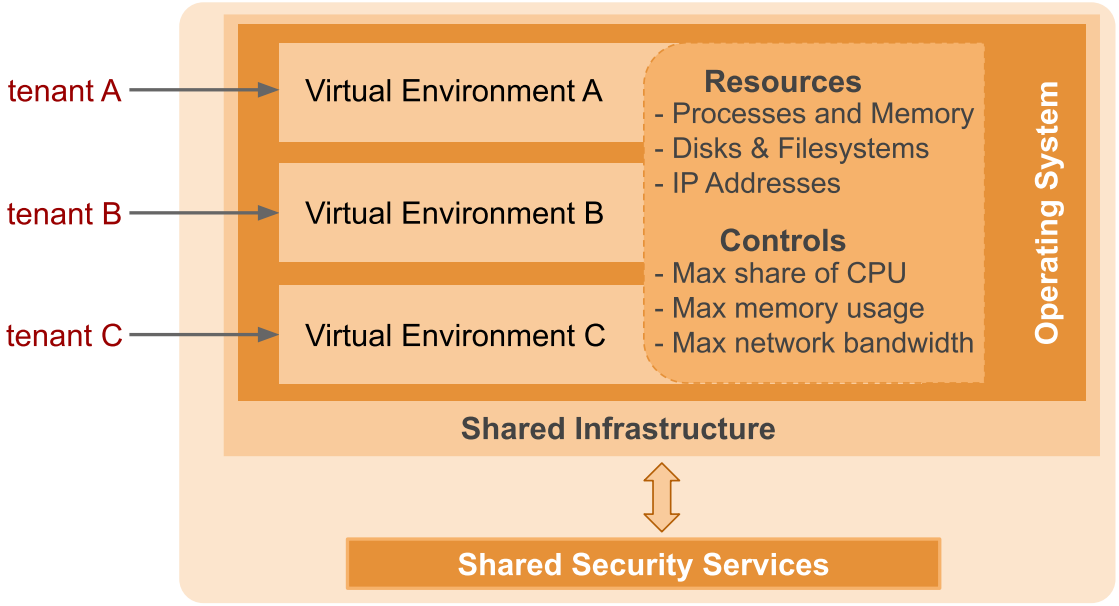
Shared Infrastructure: Virtual Machines

- 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.*

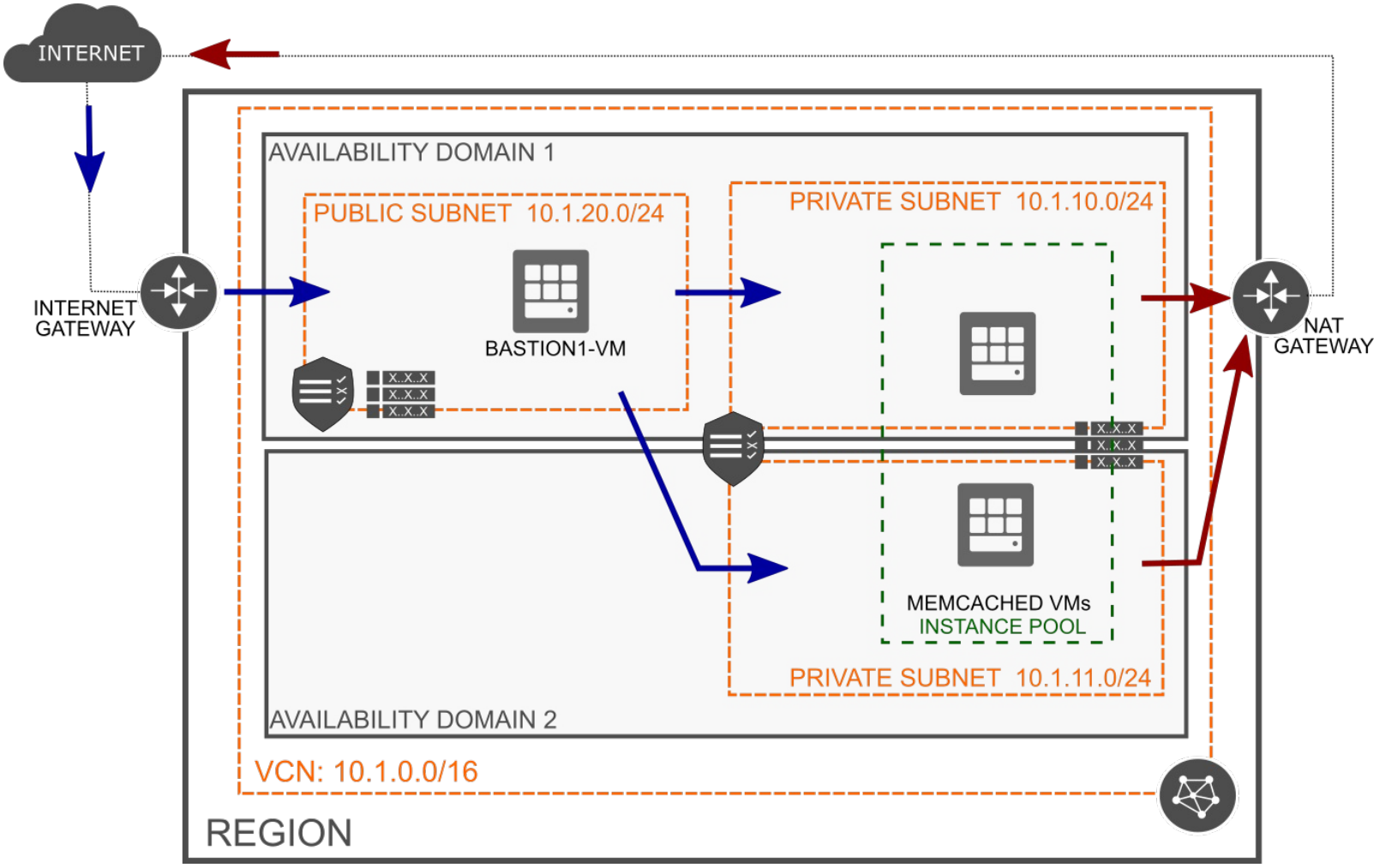
Terminology (2)

- 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 deamon running in Linux*

IaaS Example



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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*