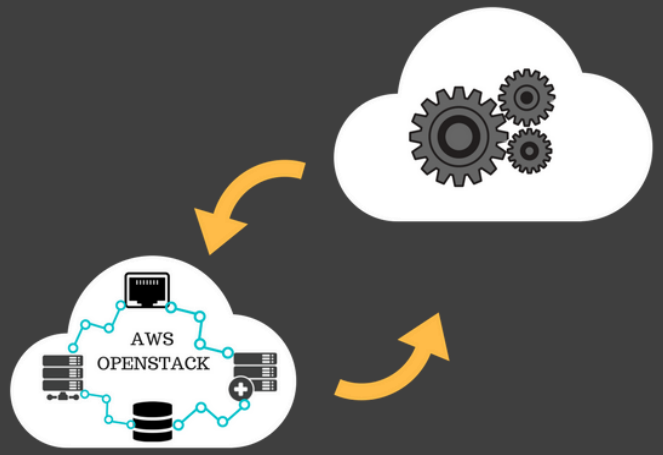
Course and Labs



AWS Design and Automation

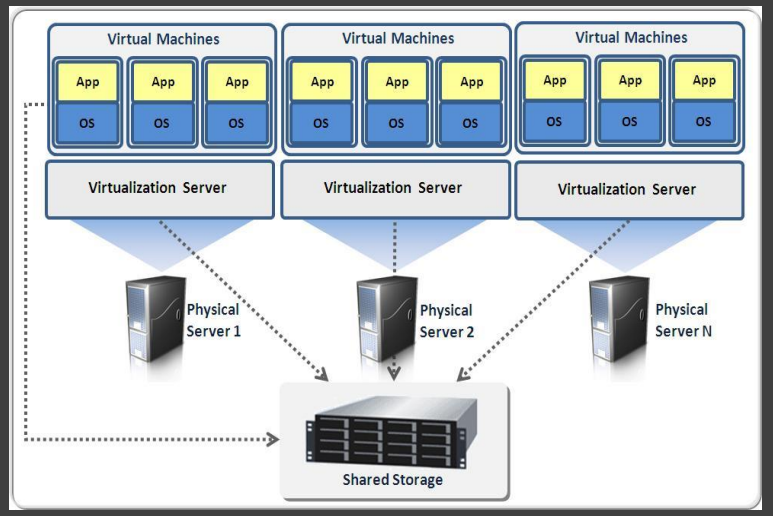
Module 1: Cloud Compute Basics

Mohanraj Shanmugam

Topic 2: Cloud Computing Infrastructure

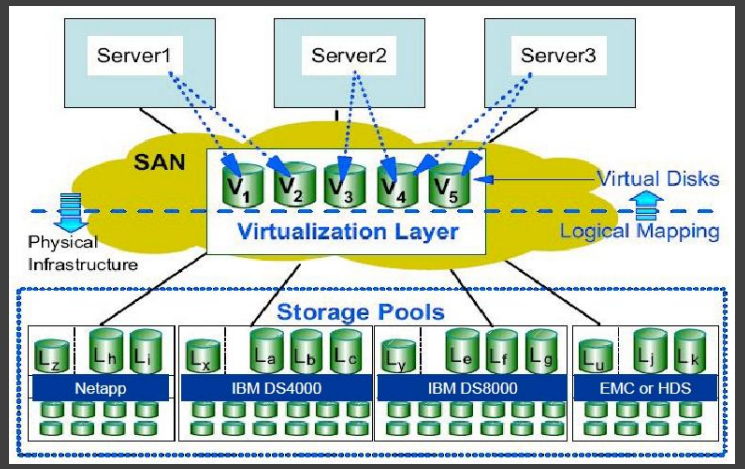
Virtualization

Course and Labs

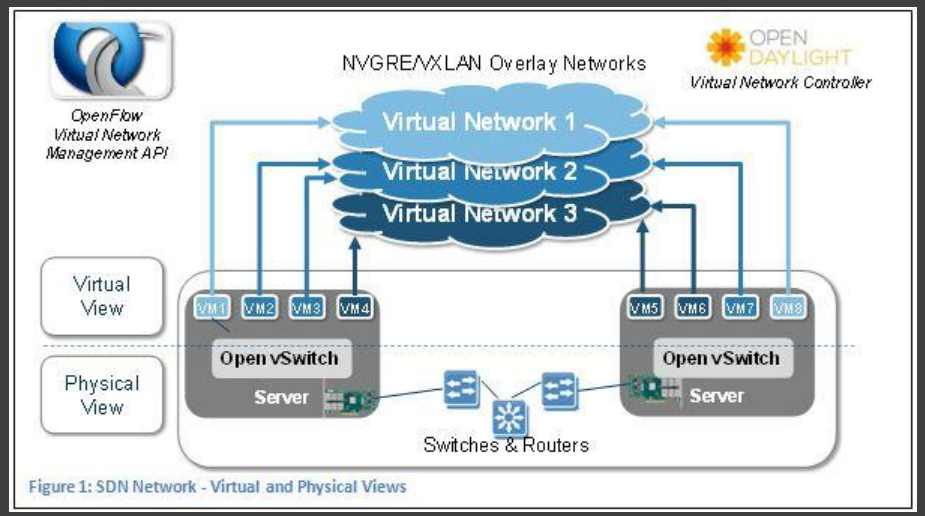


Server Virtualization

- Virtualization is the creation of a virtual (rather than actual) version of something, such as an operating system, a server, a storage device or network resources.

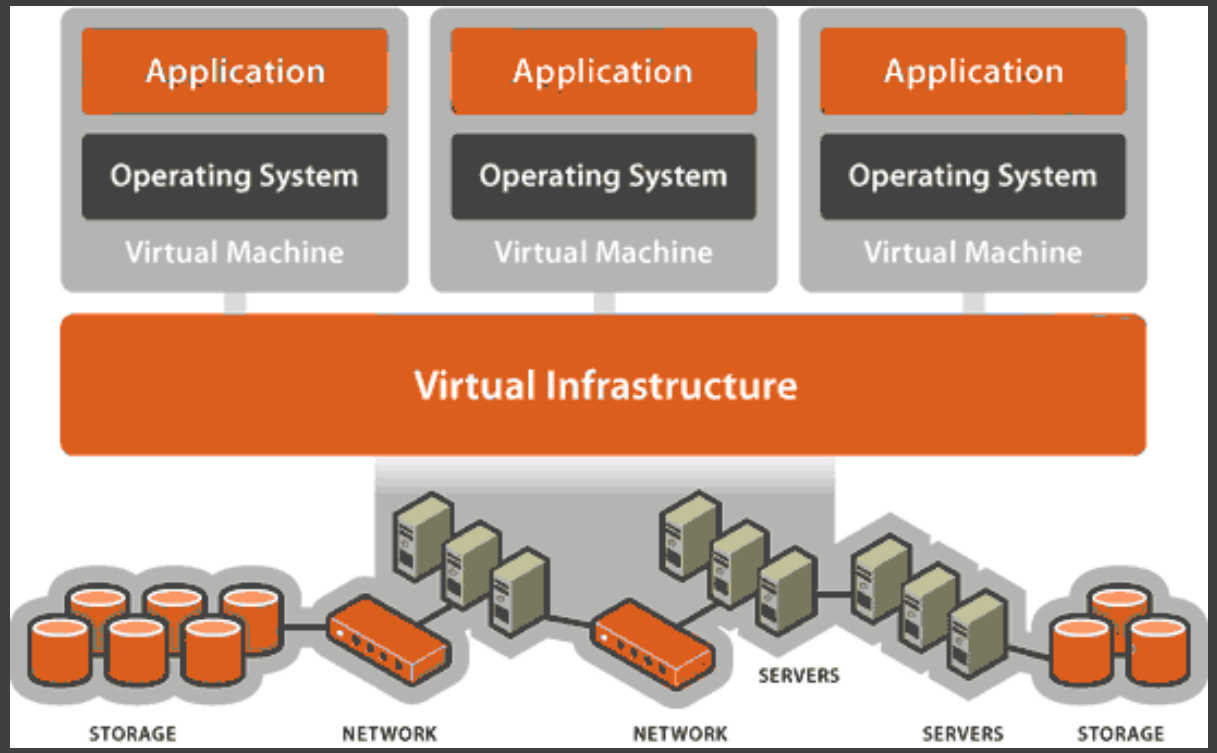


Storage Virtualization



Network Virtualization

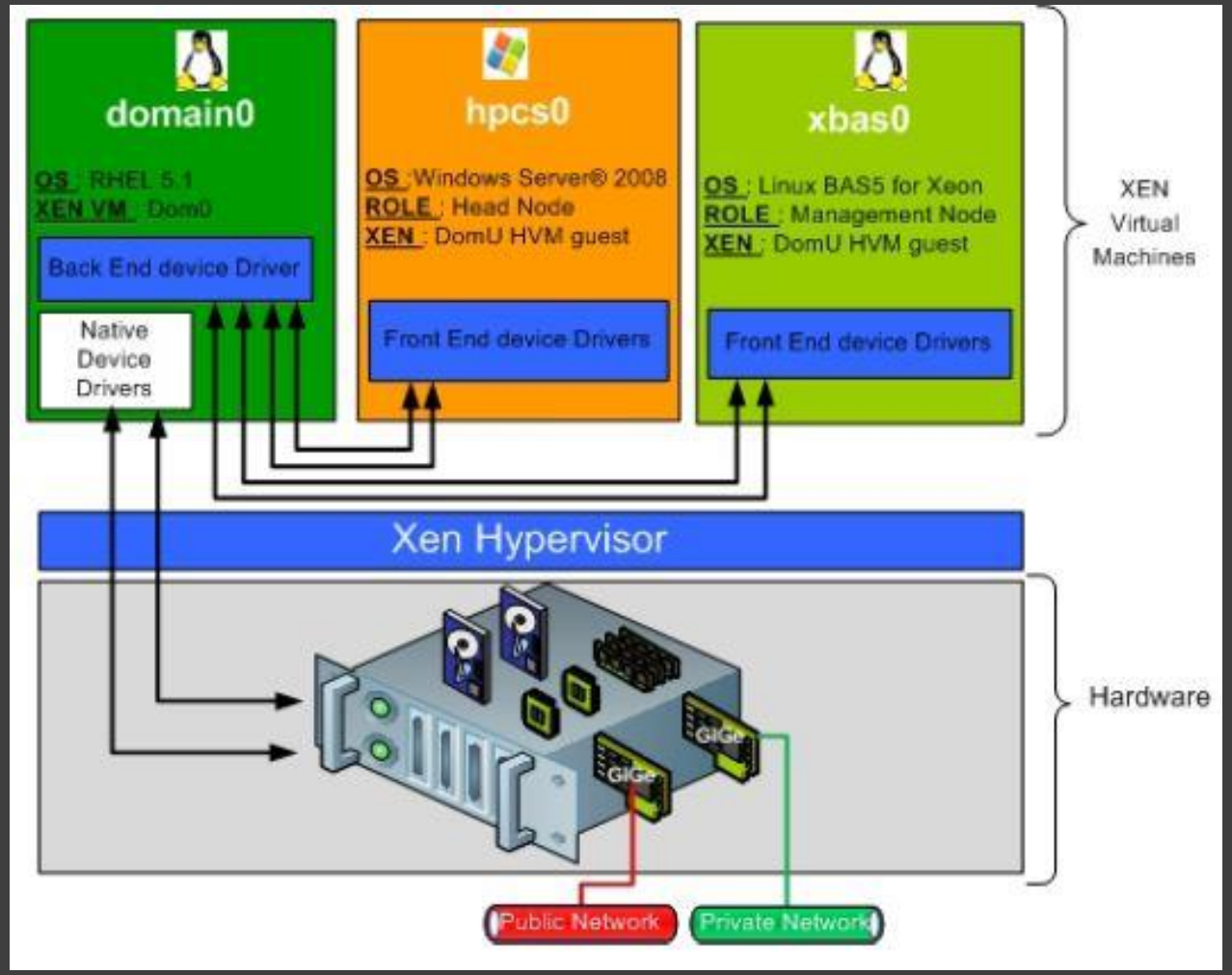
Virtualization



- Virtualization is the creation of a virtual (rather than actual) version of something, such as an operating system, a server, a storage device or network resources.
- Infrastructure Virtualization consist of:
  - Server Virtualization
  - Operating System Virtualization
  - Storage Virtualization
  - Network Virtualization

Server Virtualization

Server Virtualization



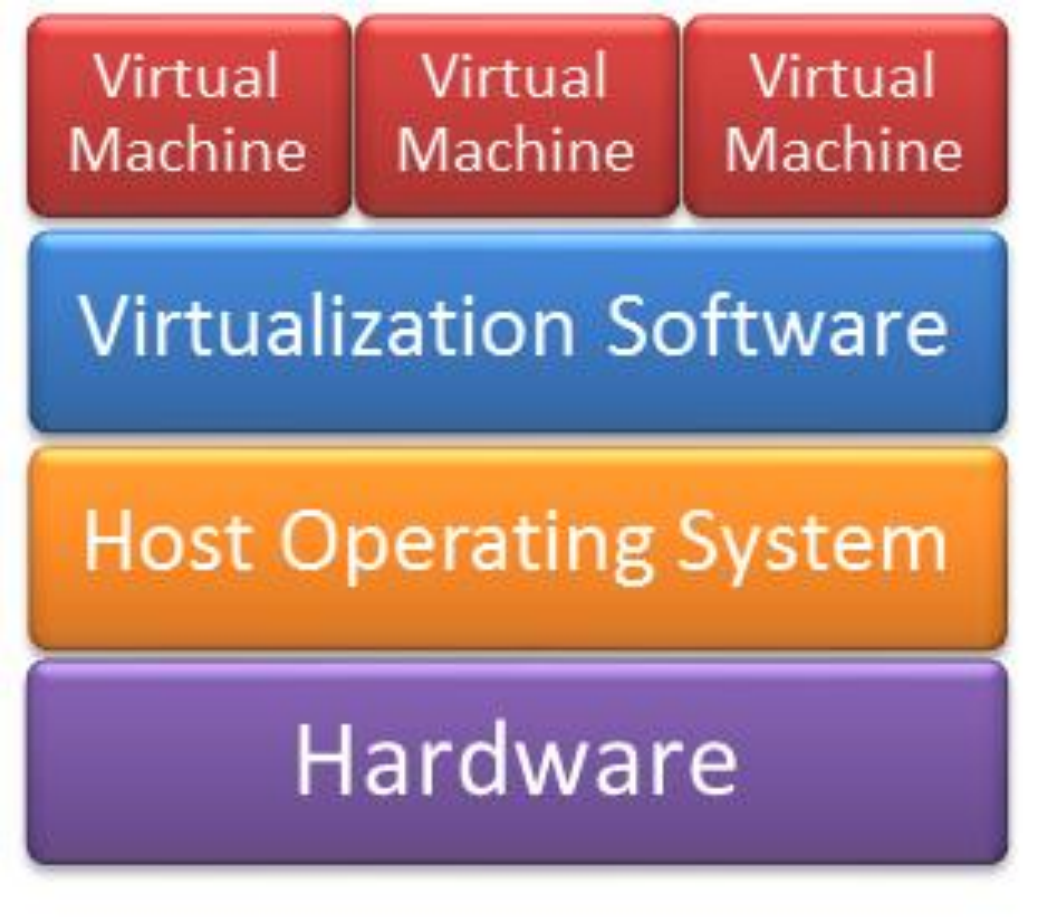
- Server virtualization is creating a Virtual Environment of Server resources like processors, Memory, Motherboard, Disks, and IO devices and operating systems masking from users.
- The virtual environments are called
  - Virtual Machines
  - Guests
  - Instances
  - Containers
  - Emulations
- The OS on which virtual environment running are called
  - Hosts
  - Hypervisor
  - Virtual Machine Monitor
  - Emulators
- Virtualization administrator uses Virtualization Management Console (VMC) to manage virtual machines.

Types of Server Virtualization

Course and Labs

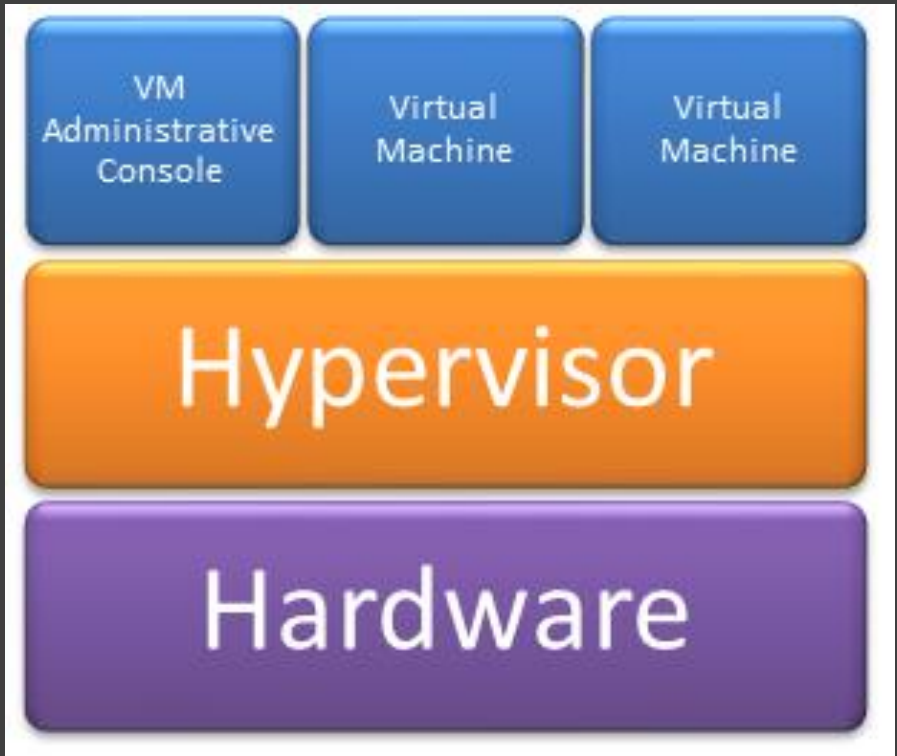
- There are different types of Server Virtualization:
  - *Guest OS/Virtual Machine Model*
  - *Hypervisor Model*
    - *Para Virtualization Model*
    - *Full Virtualization Model*
  - *Hardware Assisted Virtualization Model*
  - *Kernel Base Virtualization Model*

Guest OS/Virtual Machine Model



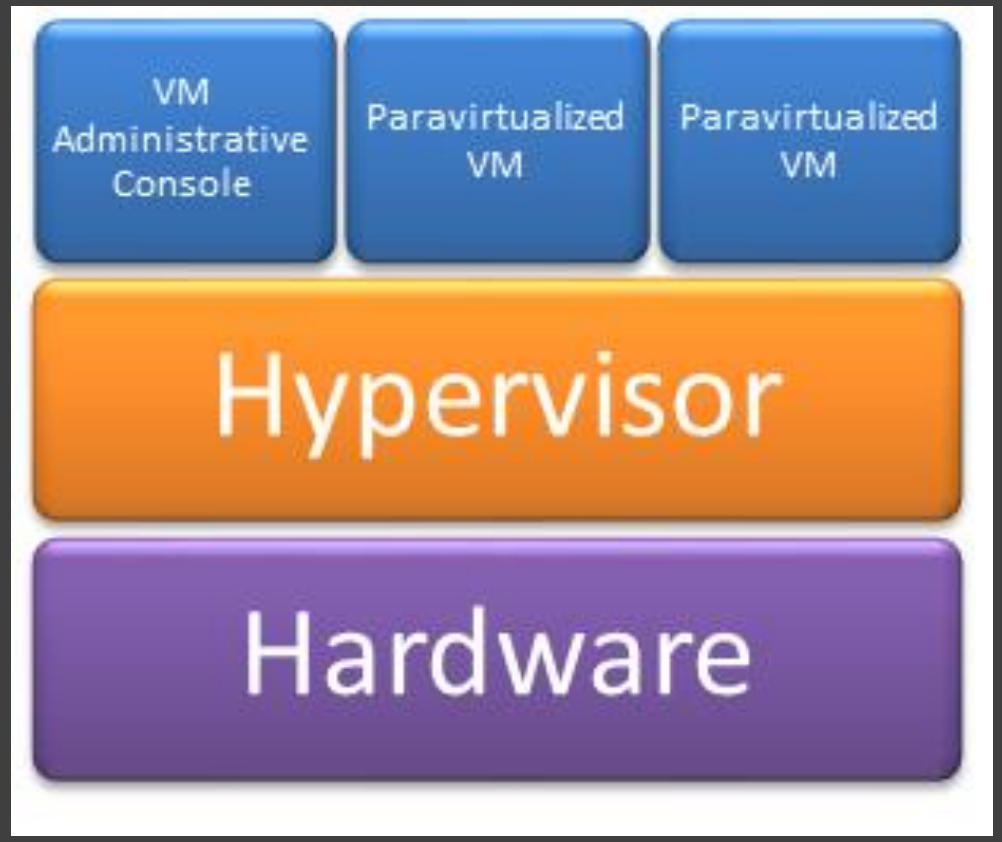
- **Guest OS/Virtual Machine Model**:
  - In this virtualization model each Virtual Machine (VM) runs as a separate instance of operating system within the virtualization software.
  - Virtualization software itself runs in another operating system which is installed on the hardware.
  - The operating system on which the virtualization application runs is often referred to as the "Host Operating System (OS)" because it provides the execution environment for the virtualization application.
  - This virtualization technique does not require any modification in the "guest OS".
- Examples
  - Parallels Workstation (Mac)
  - VMWare Workstation (VMWare)
  - VMWare GSX Server (VMWare)
  - Oracle Virtual Box (VMWare)
- Use Cases:
  - Labs
  - Proof of Concept
  - Development Environment

Hypervisor based Virtualization



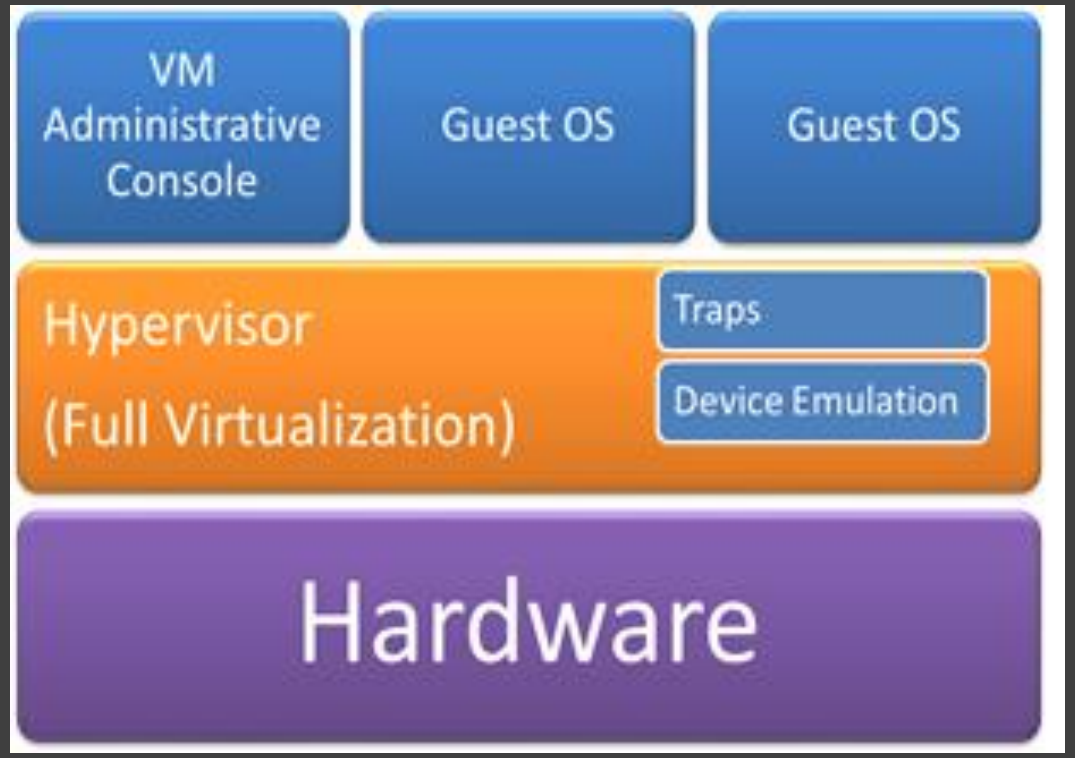
- In Hypervisor based virtualization a thin software layer called virtual machine monitor (VMM) or hypervisor runs on the top of machine's hardware and provides the necessary Virtual drivers and software for virtual devices in the virtual machines.
- It also handles queuing, dispatching and returning the results of hardware requests made by virtual machines.
- Virtual machine console also runs on the top of the hypervisor, whose main purpose is the administration and management of virtual machines.
- Two types of Hypervisor based Virtualization
  - Para Virtualization
  - Full Virtualization

Para Virtualization



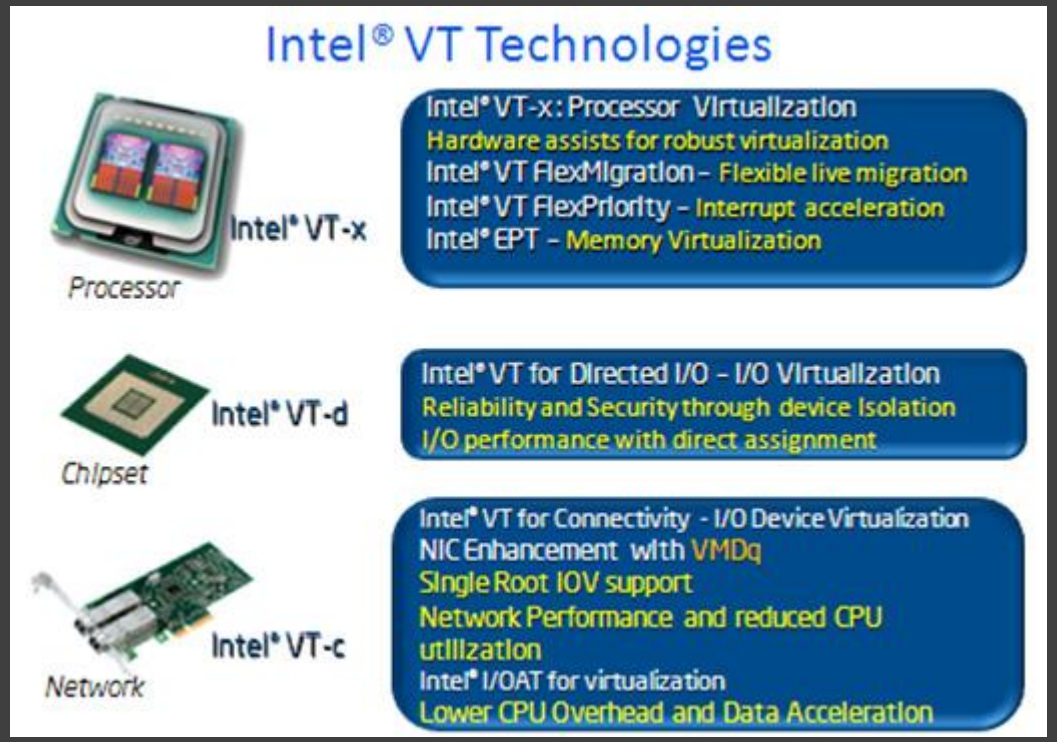
- Para virtualization is also based on hypervisor virtualization model.
- It requires that guest operating system should be recompiled or modified before installation inside the virtual machine to eliminate much of the trapping-and-emulation overhead associated with software implemented virtualization.
- Due to modification in guest operating system it gives performance enhancement over other techniques because the modified guest OS communicates directly with the hypervisor, and eliminates overheads occurred due *emulation process.*
- Examples
  - Xen
  - Hyper-V
- Use Cases:
  - Production Deployments
  - Availability of PV enabled Operation System
  - Direct Access to Hardware is required for Performance
  - Where Availability of Para Virtualization drivers for direct access hardware's

Full Virtualization



- Full virtualization is very similar to paravirtualization model. It contains functionality to emulate the underlying hardware when necessary.
- Full virtualization causes the hypervisor to “trap” the machine operations the OS uses to read or modify the system’s status or perform input/output (I/O) operations.
- After it has trapped them, the hypervisor emulates these operations in software and returns status codes consistent with what the real hardware would deliver.
- That’s why unmodified operating system can run on the top of hypervisor.
- Examples
  - VMWare ESX
- Use Cases:
  - Production Deployments
  - All OS Environment supported by Hypervisor

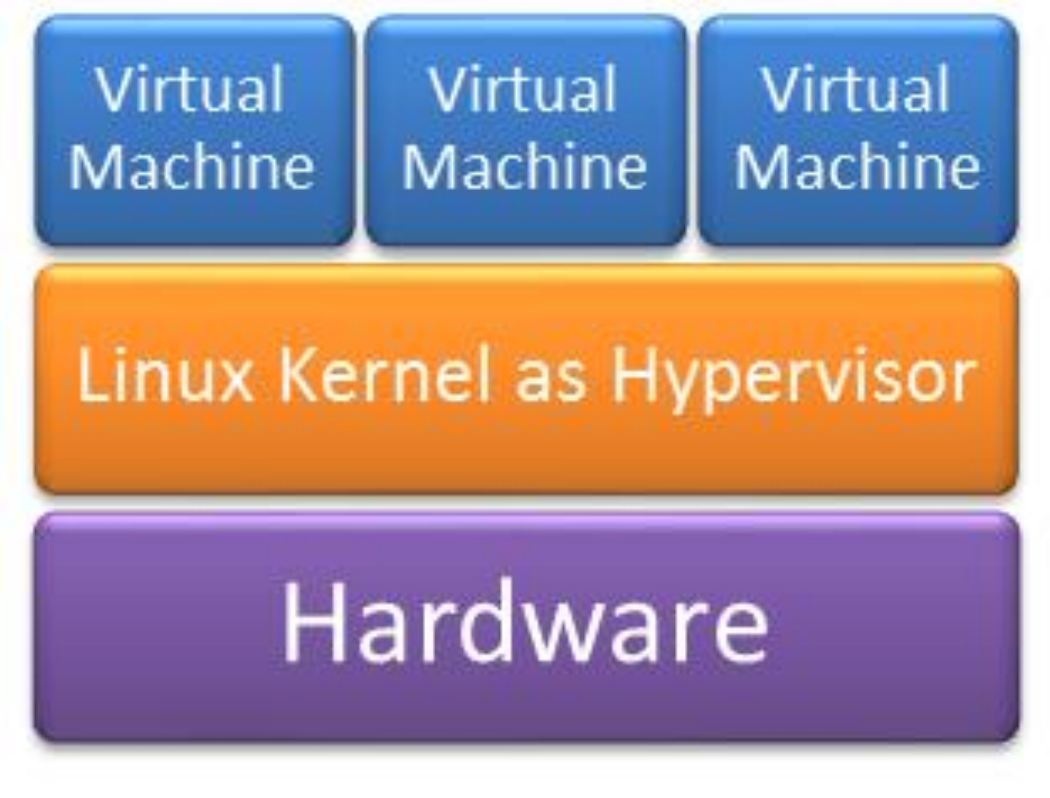
Hardware Assisted Virtualization



- Hardware Assisted Virtualization uses a hypervisor technique but it is only available on systems that support hardware virtualization.
- It relies on hardware extensions to the x86 system architecture to eliminate much of the hypervisor overhead associated with trapping and emulating I/O operations and status instructions executed within a guest OS.
- Hypervisors – based systems such as Xen and VMWare ESX Server, and kernel – level virtualization technologies such as KVM, can take advantage of the hardware support for virtualization that is provided on the latest generation of Intel (Intel VT, aka Vanderpool) and AMD (AMD – V, aka Pacifica) processors.

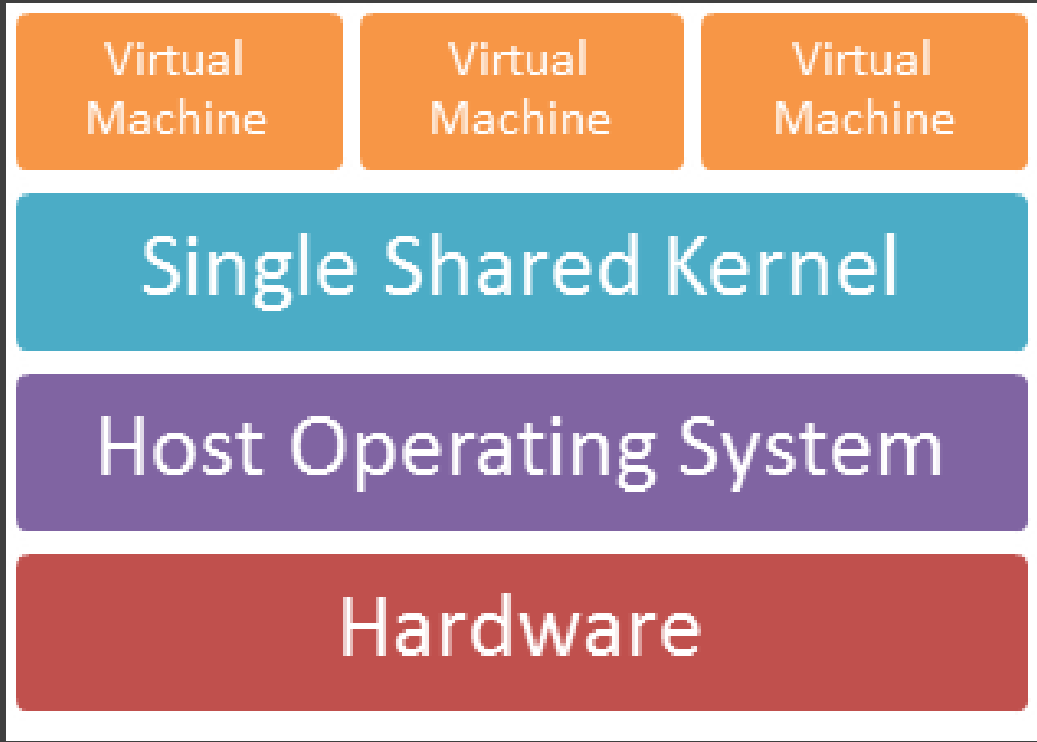
- Use Cases:
  - Production Deployments
  - Availability of Hard Assisted devices
  - All OS Environment supported by Hypervisor

Kernel Level Virtualization



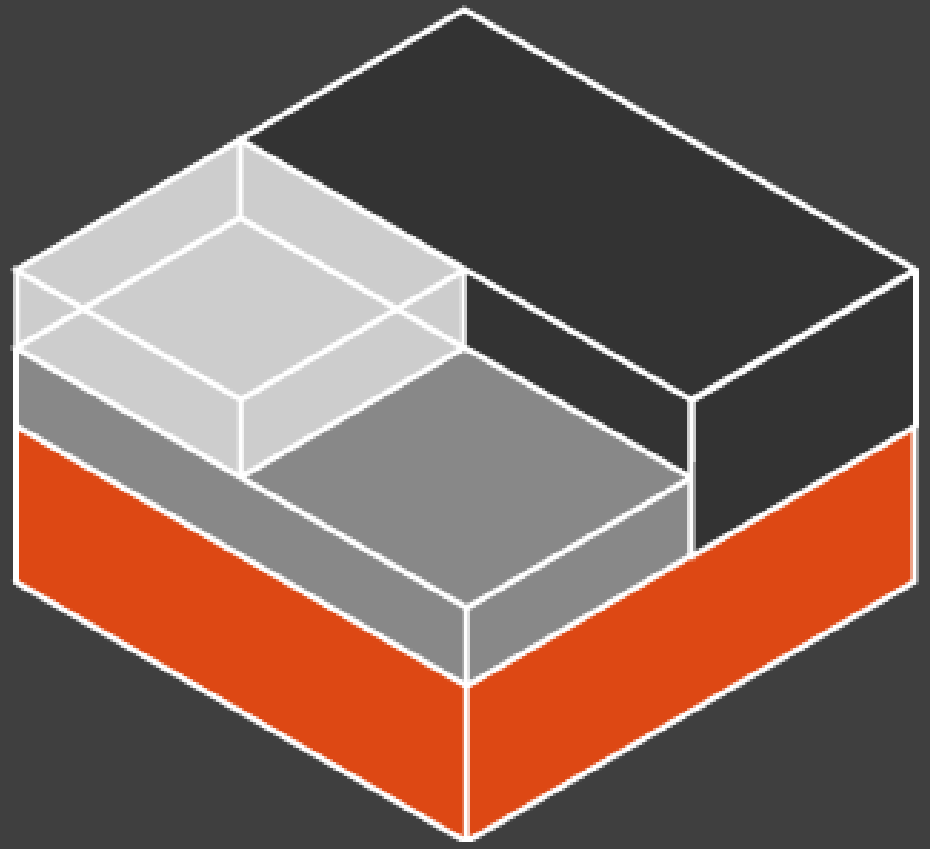
- This type of virtualization does not require a hypervisor, but instead runs a separate version of the Linux kernel and an associated virtual machine as a user – space process on the physical host.
- KVM uses a device driver in the host's kernel for communication between the main Linux kernel and the virtual machines.
- It requires processor support for virtualization (Intel VT or AMD – v) and uses a slightly modified QEMU process as the display and execution container for its virtual machines.
- Examples
  - Kernel Virtual Machine (KVM), which was introduced in the 2.6.20 mainline Linux kernel. It is a kernel based full virtualization
- Use Cases:
  - Production Deployments
  - Availability of Kernel based Virtualized Kernel
  - All OS Environment supported by Hypervisor

Operating System- Level Virtualization



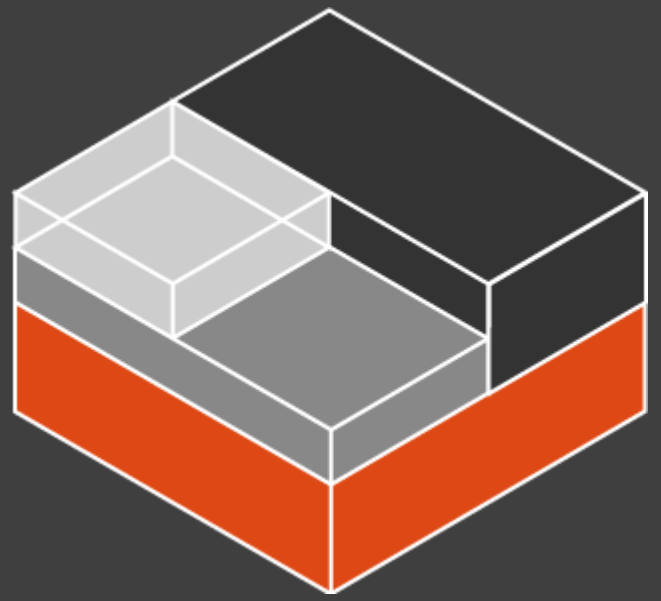
- Operating system – level virtualization describes various implementations of running multiple but logically distinct system environments on a single instance of an operating system kernel.
- . It is also called shared kernel approach because all the virtual instances shared a common kernel of host operating system.
- It is based on the change root **“chroot”** concept that is available on all modern UNIX like systems.
- The chroot mechanism as used by system – level virtualization is an extension of this concept, enabling the system to start virtual servers with their own sets of processes that execute relative to their own filesystem root directories.
- If all of your virtual servers must share a single copy of an operating system kernel, this is system – level virtualization. If different virtual servers can be running different operating systems, including different versions of a single operating system.
- Examples
  - Linux Containers
  - Oracle Solaris Containers and Zones
  - FreeBSD Jailed root.
- Use Cases:
  - DevOps Environment
  - Deployment is based on container vs packages

Linux Container



- **LXC** (Linux Containers) is an operating-system-level virtualization method for running multiple isolated Linux systems (containers) on a control host using a single Linux kernel - Wikipedia
- LXC is a userspace interface for the Linux kernel containment features.
  Through a powerful API and simple tools, it lets Linux users easily create
  and manage system or application containers – Linuxcontaier.org
- It is advanced chroot
- It is advanced BSD Jailed root
- It looks like a VM inside the Container
- But it is a process within the Base OS

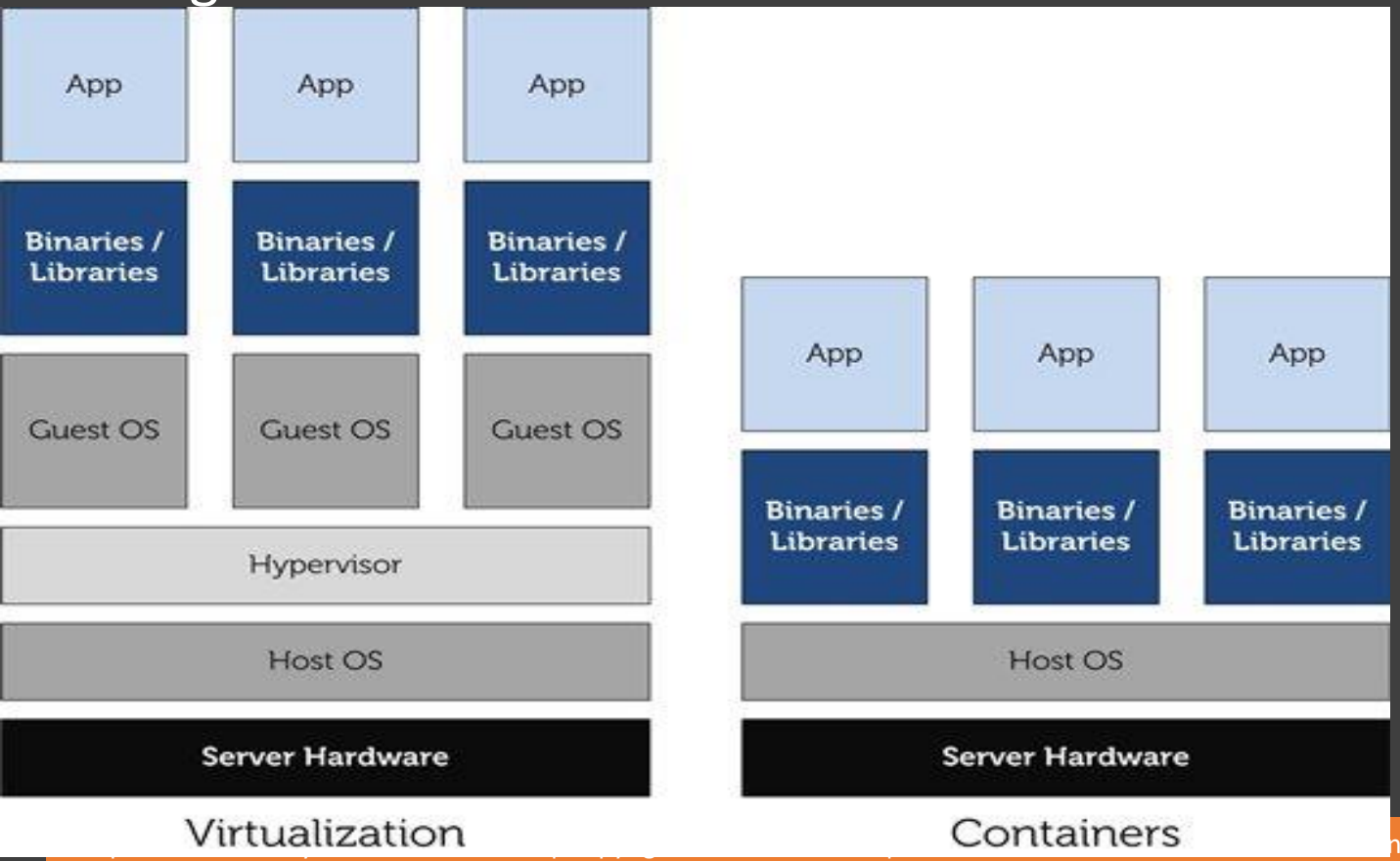
Linux Container



- LXC containers are often considered as something in the middle between a chroot and a full fledged virtual machine.
- The goal of LXC is to create an environment as close as possible to a standard Linux installation but without the need for a separate kernel.
- LXC is free software, most of the code is released under the terms of the GNU LGPLv2.1+ license

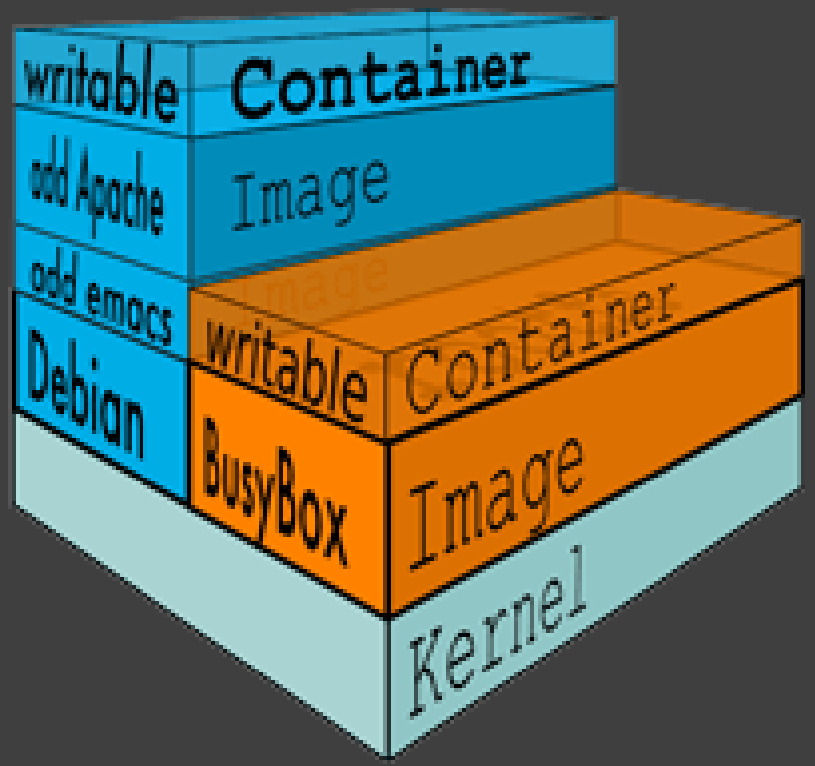
Container Vs Virtual Machine

- LXC containers is “lightweight virtualization”.
- Containers are similar to virtual machines (VMs) because they provide isolated computing environments all running independently on the same host.
- However, containers have very low overhead because you are not installing a separate operating system for the container and you do not need a hypervisor running on the host along with its overhead.



	Virtualization (i.e. kvm, xen)	LXC Containers
Footprint	Requires a hypervisor and a full operating system image.	Does not require a hypervisor or a separate operating system image.
OS supported	Any OS supported by the hypervisor	Most Linux distros, uses same kernel as host
Typical server deployment	10 – 100 VMs	100 - 1000 containers
Boot time	Less than a minute	Seconds
Physical resources use (i.e. memory, CPU)	Each VM has resource reserved for its own use	Shared by all containers

What is Docker?



- Docker allows you to package an application with all of its dependencies into a standardized unit for software development.
- Docker containers wrap up a piece of software in a complete filesystem that contains everything it needs to run:
  - code,
  - runtime,
  - system tools,
  - system libraries –

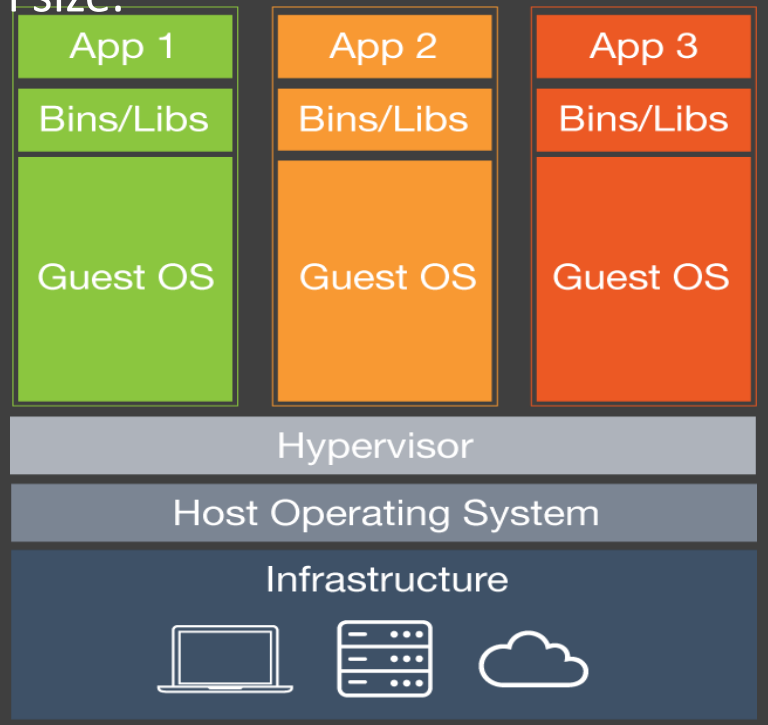
  anything you can install on a server.
- This guarantees that it will always run the same application, regardless of the environment it is running in.

Features of Docker

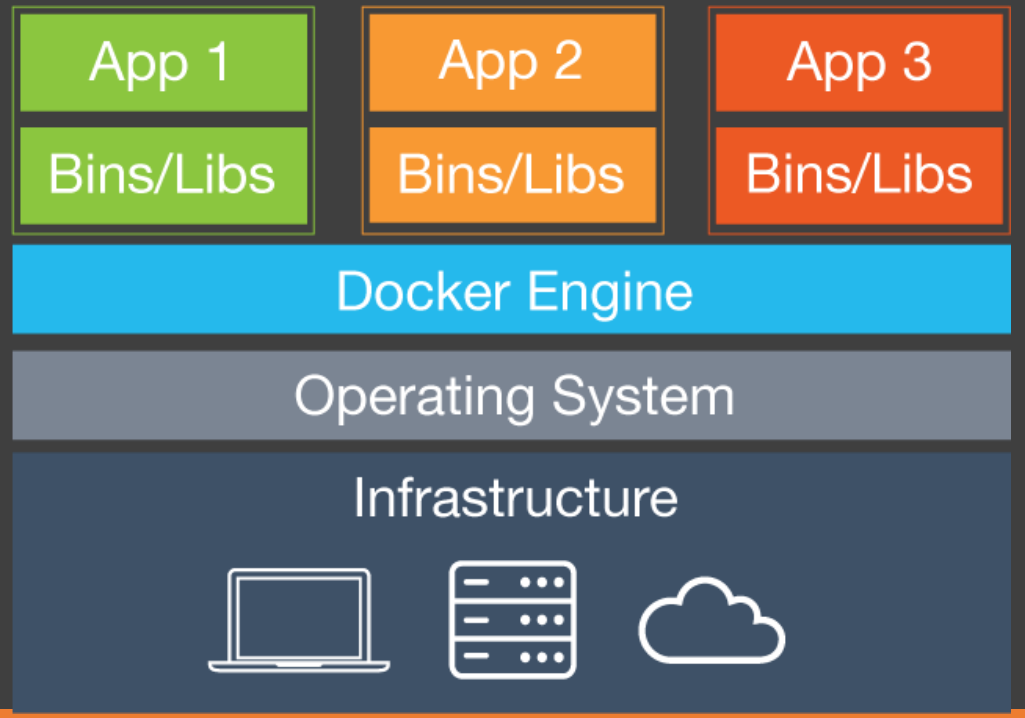
- Lightweight
  - Containers running on a single machine all share the same operating system kernel so they start instantly and make more efficient use of RAM.
  - Images are constructed from layered filesystems so they can share common files, making disk usage and image downloads much more efficient.
- Open
  - Docker containers are based on open standards allowing containers to run on all major Linux distributions and Microsoft operating systems with support for every infrastructure.
- Secure
  - Containers isolate applications from each other and the underlying infrastructure while providing an added layer of protection for the application.

VM Vs Docker

- Virtual Machines
  - Each virtual machine includes the application, the necessary binaries and libraries and an entire guest operating system - all of which may be tens of GBs in size.



- Containers
  - Containers include the application and all of its dependencies, but share the kernel with other containers.
  - They run as an isolated process in userspace on the host operating system.
  - They're also not tied to any specific infrastructure – Docker containers run on any computer, on any infrastructure and in any cloud.



Docker helps to build better Software

- Accelerate Developer Onboarding
  - Stop wasting hours trying to setup developer environments, spin up new instances and make copies of production code to run locally.
  - With Docker, you can easily take copies of your live environment and run on any new endpoint running Docker.
- Empower Developer Creativity
  - The isolation capabilities of Docker containers free developers from the worries of using “approved” language stacks and tooling.
  - Developers can use the best language and tools for their application service without worrying about causing conflict issues.

Docker helps to build better Software

- Eliminate Environment Inconsistencies
  - By packaging up the application with its configs and dependencies together and shipping as a container, the application will always work as designed locally, on another machine, in test or production.
  - No more worries about having to install the same configs into a different environment.

Docker helps to Share Software

- Distribute and share content
  - Store, distribute and manage your Docker images in your Docker Hub with your team.
  - Image updates, changes and history are automatically shared across your organization.
- Simply share your application with others
  - Ship one or many containers to others or downstream service teams without worrying about different environment dependencies creating issues with your application.
  - Other teams can easily link to or test against your app without having to learn or worry about how it works.

Docker helps to Ship Software

- Ship 7X More
  - Docker users on average ship software 7X more after deploying Docker in their environment.
  - More frequent updates provide more value to your customers faster.
- Quickly Scale
  - Docker containers spin up and down in seconds making it easy to scale an application service at any time to satisfy peak customer demand, then just as easily spin down those containers to only use the resources you need when you need it

Docker helps to Ship Software

- Easily Remediate Issues
  - Docker make it easy to identify issues and isolate the problem container, quickly roll back to make the necessary changes then push the updated container into production.
  - The isolation between containers make these changes less disruptive than traditional software models.

Docker is a shipping container system for code

Course and Labs

Multiplicity of Stacks

Static website

User DB

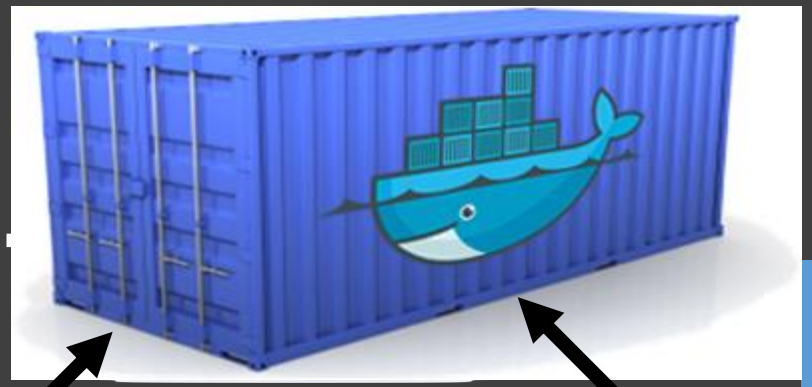
Web frontend

Queue

Analytics DB

Do services and apps interact appropriately?

An engine that enables any payload to be encapsulated as a lightweight, portable, self-sufficient container…



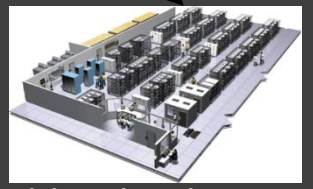
…that can be manipulated using standard operations and run consistently on virtually any hardware platform

Multiplicity of hardware environments

Development VM

QA server

Customer Data Center



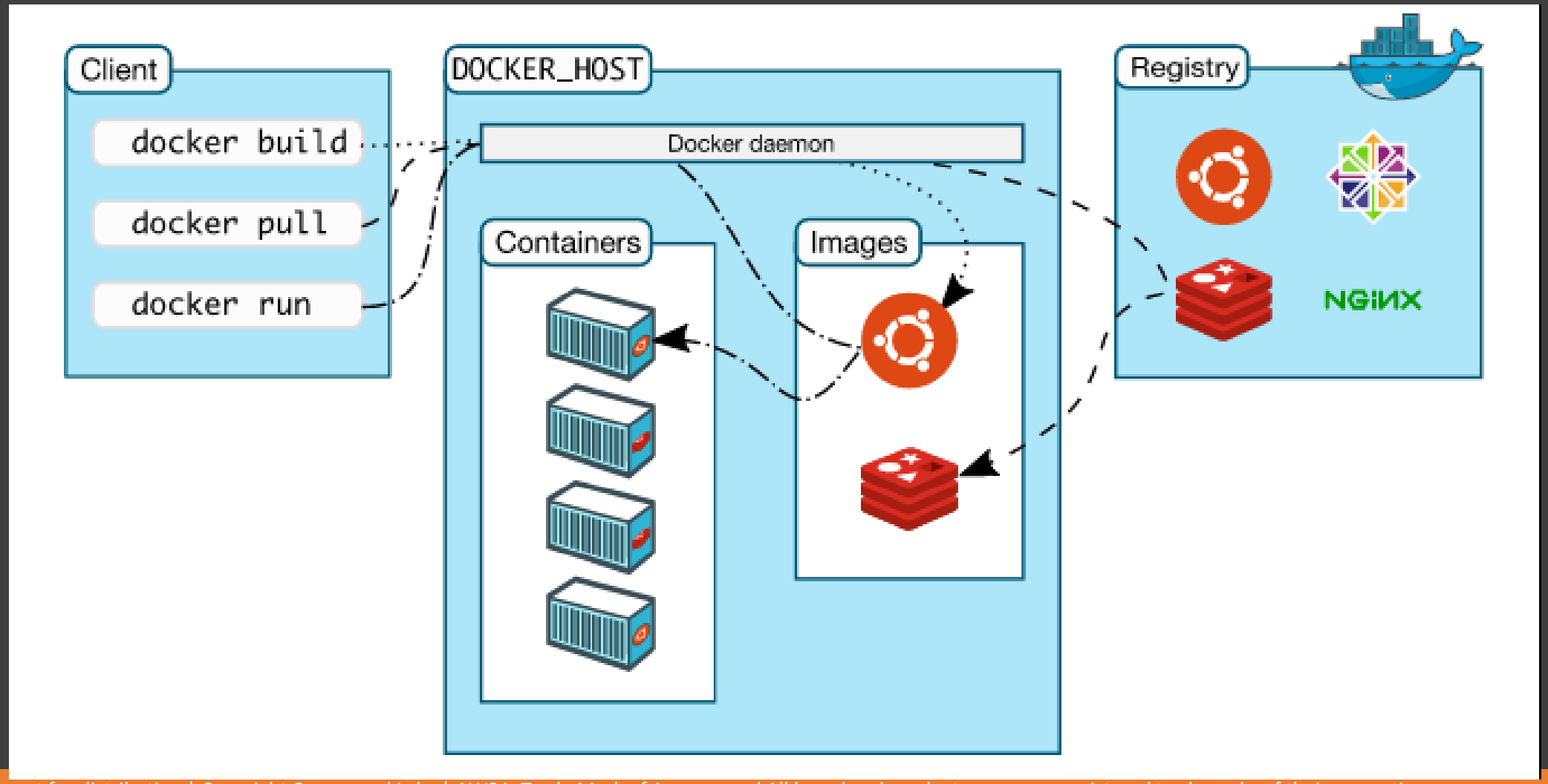
Public Cloud

Production Cluster

Contributor's laptop

Can I migrate smoothly and quickly

Docker Architecture



Cloud Compute Infrastructure

Cloud Compute Infrastructure

Course and Labs

- Cloud Compute Infrastructure consist of Below:
  - Compute
  - Storage
  - Network
  - Datacentres and Regions
  - Shared Services
  - Platforms

Cloud Compute Infrastructure

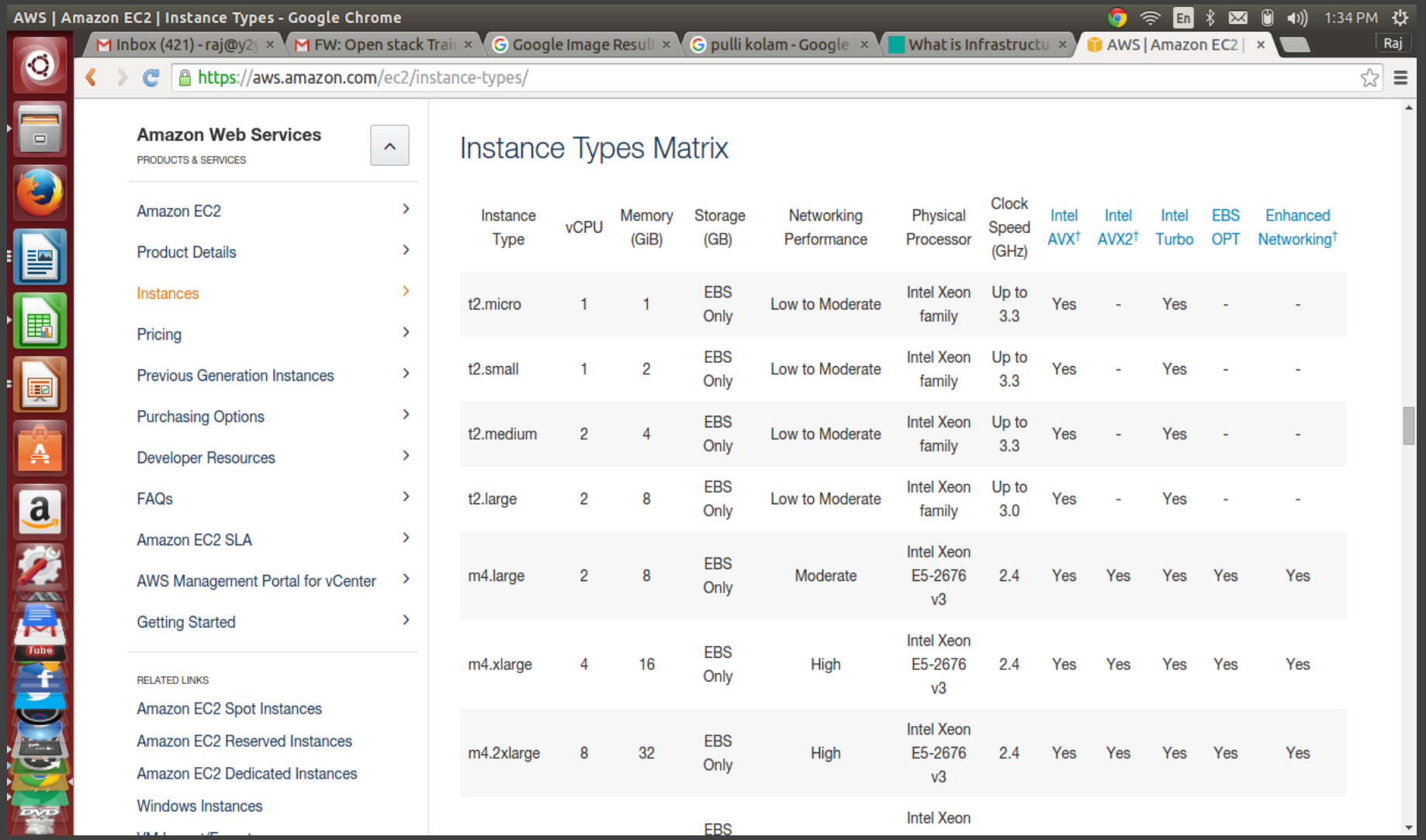
Course and Labs

- Cloud compute infrastructure is a Virtual Machines on the cloud which provides a
  - Virtual Processor (vCPU)
  - Virtual Memory
  - Virtual disk
  - Virtual Network
  - Virtual Operating System
  - Management dashboard or a API to manage the VM
  - Accessable via Internet or Enterprise Network
  - Will connected to Network to other cloud instance within the network domain
  - On which you can deploy your platform or software for the business application

Cloud Compute Infrastructure

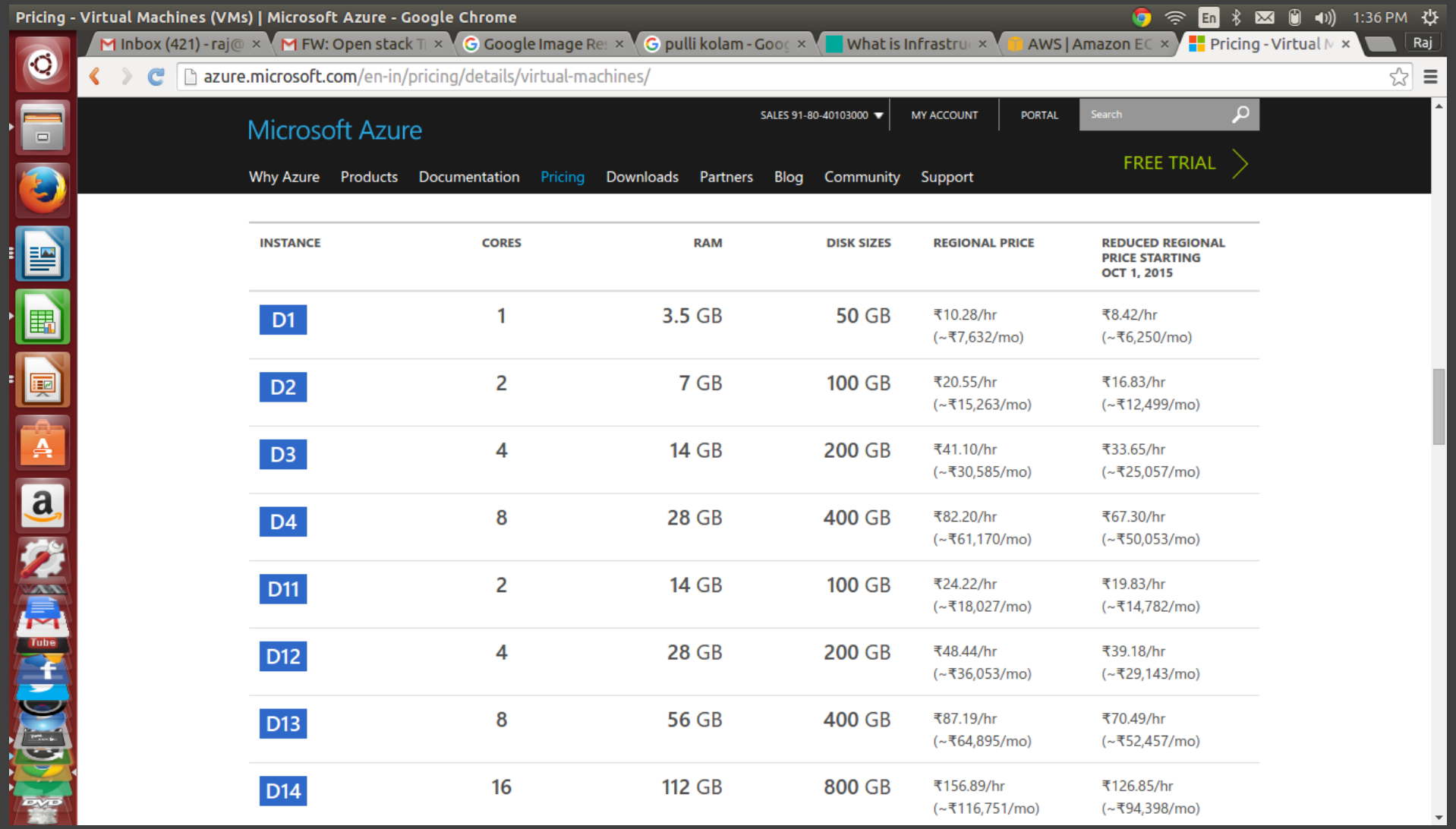
- Characteristics of Cloud Compute Infrastructure
  - Self service
  - Increase or Decrease or stop VM or its resources any time
  - Charged for usage
  - Fully automated provisioning
  - Accessible within the prescribed network boundry

Amazon Compute EC2 Examples



Microsoft Azure VM Examples

Course and Labs



INSTANCE	CORES	RAM	DISK SIZES	REGIONAL PRICE	REDUCED REGIONAL PRICE STARTING OCT 1, 2015
D1	1	3.5 GB	50 GB	₹10.28/hr (~₹7,632/mo)	₹8.42/hr (~₹6,250/mo)
D2	2	7 GB	100 GB	₹20.55/hr (~₹15,263/mo)	₹16.83/hr (~₹12,499/mo)
D3	4	14 GB	200 GB	₹41.10/hr (~₹30,585/mo)	₹33.65/hr (~₹25,057/mo)
D4	8	28 GB	400 GB	₹82.20/hr (~₹61,170/mo)	₹67.30/hr (~₹50,053/mo)
D11	2	14 GB	100 GB	₹24.22/hr (~₹18,027/mo)	₹19.83/hr (~₹14,782/mo)
D12	4	28 GB	200 GB	₹48.44/hr (~₹36,053/mo)	₹39.18/hr (~₹29,143/mo)
D13	8	56 GB	400 GB	₹87.19/hr (~₹64,895/mo)	₹70.49/hr (~₹52,457/mo)
D14	16	112 GB	800 GB	₹156.89/hr (~₹116,751/mo)	₹126.85/hr (~₹94,398/mo)

Virtual Processor (vCPU)

Course and Labs

- A vCPU stands for Virtual Central Processing Unit.
- One or more vCPUs are assigned to every Virtual Machine (VM) within a cloud environment.
- Each vCPU is seen as a single physical CPU core by the VM's operating system.

Virtual Processor (vCPU)

Course and Labs

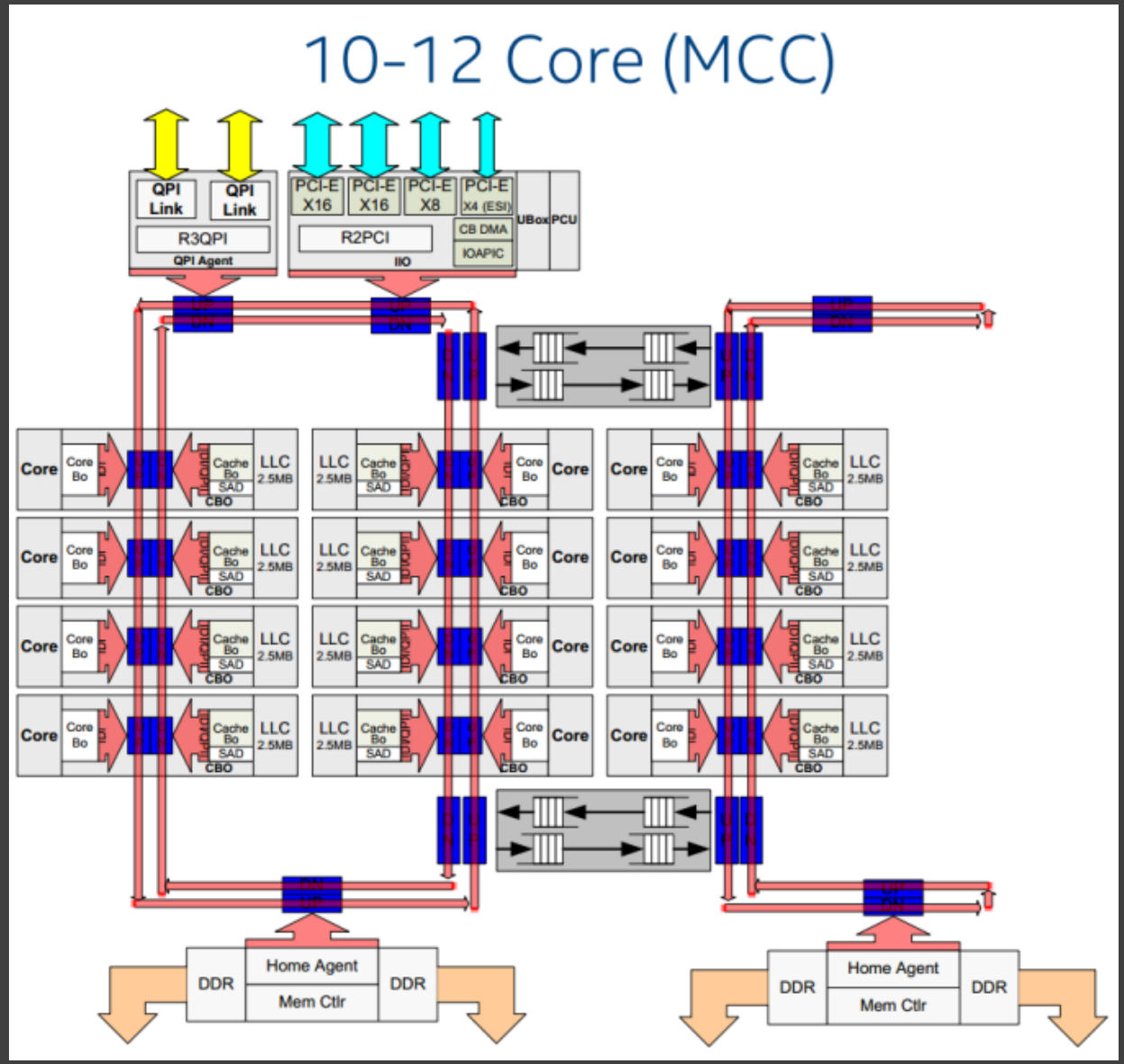
- How much processing of 1vCPU gets when i am in the cloud enviroinment...
- It is a complex answer
  - It depends lets understand how the vCPU is transulated in to Physical CPU

Intel xeon 4 core cpu specs

Course and Labs

Performance	
# of Cores	4
# of Threads	8
Processor Base Frequency	3.2 GHz
Max Turbo Frequency	3.5 GHz
TDP	140 W

Physical CPU Layout



Hyperthreading

Course and Labs

- Hyper-threading Technologies used to improve parallelization of computations performed on x86 microprocessors.
- A Physical core is logically divided in to multiple threads and each thread will view as one Physical core to the operating system and it starts scheduling the to the thread
- Most Xeon processor have 2 threads per core that means each physical core will have 2 threads

Hyperthreading

Course and Labs

- If One thread is waiting for resources other thread will be processed due to which the effecience of the Per core performence goes up.
- An unoffical thumb of rule we follow to size the thread is One thread can give maximum of 60% of the core performence the means using thread we can get up to 120% of core's performece.

Virtual Threading

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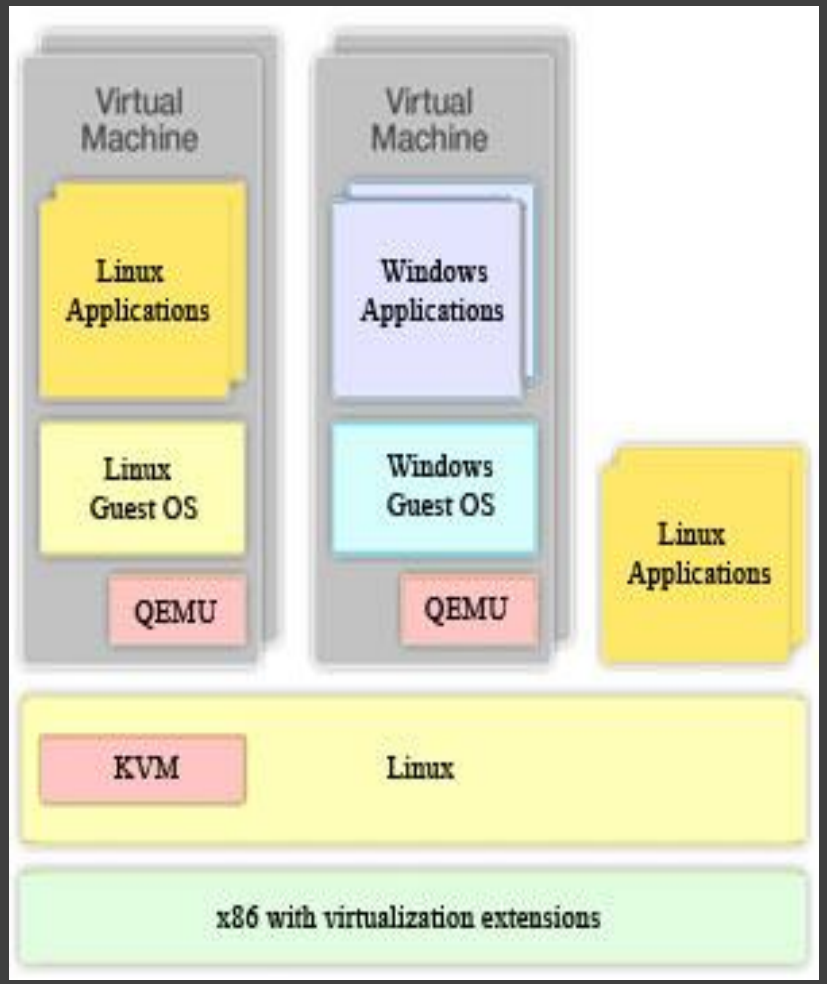
- Each threads will show as vCPU if you enable hyper threading.
- Consider you can get 60% of the core performance in thread allocate number for vCPU required

Virtual Memory



- Virtual machine is allocated with Virtual Memory
- Allocate the memory as per the requirement by the VM
- The Memory can be increased and decreased any time based on the requirement as long you have available physical memory

Virtual Memory

- Virtual Memory can be overallocated based on the Hypervisor support
- Overallocation can acheived through
  - Transparent Page Sharing (TPS)
  - Ballooning
  - Swapping
  - Compression

Virtual Memory

- Virtual can support NUMA based on the Processor and Hypervisor support
- Non-uniform memory access (NUMA) is a computer memory design used in multiprocessing, where the memory access time depends on the memory location relative to the processor.

Virtual disk

- Each VM will have a Block Virtual disk allocated to the VM on which Virtual Operating System exists
- The Virtual disk will point to a File in Storage or the storage itself or a partition or a volume of a storage
- Storage can be of three types
  - Local Storage on the computer
  - SAN (Storage Area Network)
  - NAS (Network Area Storage)

Virtual disk file types

- VMWare - VMDK
- Virutalbox – VDI
- HyperV – VHD
- KVM – Raw image(img), qcow2, LVM
- Parallel - HDD

Virtual Operating System

- Virtual Operating system is the OS running on a Virtual Machine manages the Virtual Resources like vCPU, Virtual Memory and Virtual disks.
- The Virtual Operating system you can run depends on the Hypervisor support.
- Virtual Machine runs on a Hypervisor which in turn converts the VM's OS instructions to the physical device instructions
- Popular Hypervisors are:
  - Vsphere – VMWare
  - KVM – Linux
  - Xen – Linux
  - HyperV - Windows

Virtual Network

- Virtual Network in a VM connected via Virtual NIC
- Virtual NIC is inturn connected to Physical NIC via Bridging or NATing or a physical device pass through
- Bridging or NATing is created by the Virtual Network with in the cloud
- Virtual Network is created by
  - Virtual Switch
  - Virtual Router
  - Virtual Firewall

Virtual Machine Management

- Most common virtual machine management
  - Create resources (vCPU, vMEM, vDISK) for VM
  - Modify Resources for the VM
  - Delete resources for a VM

Cloud Management Dashboard

- Cloud Management Dashboard are the portal or a application through which we will manage the Virtual machine on the VM
- Dashboard used by diffrent cloud
  - AWS – AWS Management Console
  - Openstack – Horizon dashboard
  - VMWare – Vcenter portal
  - HyperV - System center portal or Azure portal

Connectivity to Cloud

- Public Cloud
  - User connect to VM on cloud via Internet
- Private cloud
  - User connected to VM on cloud via corporate network
- Hybrid cloud
  - User connect to VM to the Corporate cloud controller which inturn connect to the VM based on the location of the VM either in corporate network or in the internet or via VPC network.
- VMs are connected via ssh or RDP depends on either it is a Linux or Windows

Cloud Storage

Cloud Storage

- Cloud storage is data storage on cloud which can be consumed as when required which is highly available and accessible over network.
- Cloud Stotage would be highly scalable
- It is charged per GB usage
- Diffrent offering based on the performence

Types of Cloud Storage

- Broadly there are three types of Cloud Storage offering based on usage types
  - Block Storage
  - Network Attached Storage (NAS)
  - Object based Stoarge

Cloud Block Storage

- Cloud Block storage is a type of data storage typically provided by a storage-area network (SAN) storage at a backend.
- SAN Storage creates volumes and provides to Cloud Compute to use it for hosting virtual disks
- Required filesystem to be created in operating system to use this storage
- Generally it is replicated across datacentre
- It is higly available across replicated datacentres

Cloud Block Storage usage

- Cloud Block storage is used in following use cases
  - Hosting Virtual operating system
  - Hosting Application
  - Hosting Application data
  - Hosting Database
  - Hosting Clusters

Disks used for Different performance

- SSD – Solid state disks
  - SSDs use NAND-based flash memory, which retains data without power.
- SSHD
  - SSHD combines NAND flash solid-state drive (SSD) with hard disk drive (HDD) technology, with the intent of adding some of the speed of SSDs to the cost-effective storage capacity of traditional HDDs.
- HDD
  - A hard disk drive (HDD) is a data storage device used for storing and retrieving digital information using one or more rigid ("hard") rapidly rotating disks (platters) coated with magnetic material.

Interfaces used for Different performance

- SAS
  - Serial Attached SCSI
    - SAS-1: 3.0 Gbit/s, introduced in 2005
    - SAS-2: 6.0 Gbit/s, available since February 2009
    - SAS-3: 12.0 Gbit/s, available since March 2013
    - SAS-4: 22.5 Gbit/s, under development and expected in 2017
- SATA
  - Serial ATA
    - SATA revision 1.0 (1.5 Gbit/s, 150 MB/s) released on on January 7, 2003.
    - SATA revision 2.0 (3 Gbit/s, 300 MB/s) released on April 2004
    - SATA revision 3.0 (6 Gbit/s, 600 MB/s) release on August 18, 2008
    - SATA revision 3.1(6 Gbit/s, 600 MB/s) mSata and SSD SATA
    - SATA revision 3.2 (16 Gbit/s, 1969 MB/s) SATA Express

Cloud Block Storage Examples

Amazon EBS Pricing

With Amazon EBS, you only pay for what you use. The pricing for Amazon EBS volumes is listed below.

Region: US East (N. Virginia)

Amazon EBS General Purpose (SSD) volumes

- $0.10 per GB-month of provisioned storage

Amazon EBS Provisioned IOPS (SSD) volumes

- $0.125 per GB-month of provisioned storage
- $0.065 per provisioned IOPS-month

Amazon EBS Magnetic volumes

- $0.05 per GB-month of provisioned storage
- $0.05 per 1 million I/O requests

Amazon EBS Snapshots to Amazon S3

- $0.095 per GB-month of data stored

Cloud Block Storage Examples

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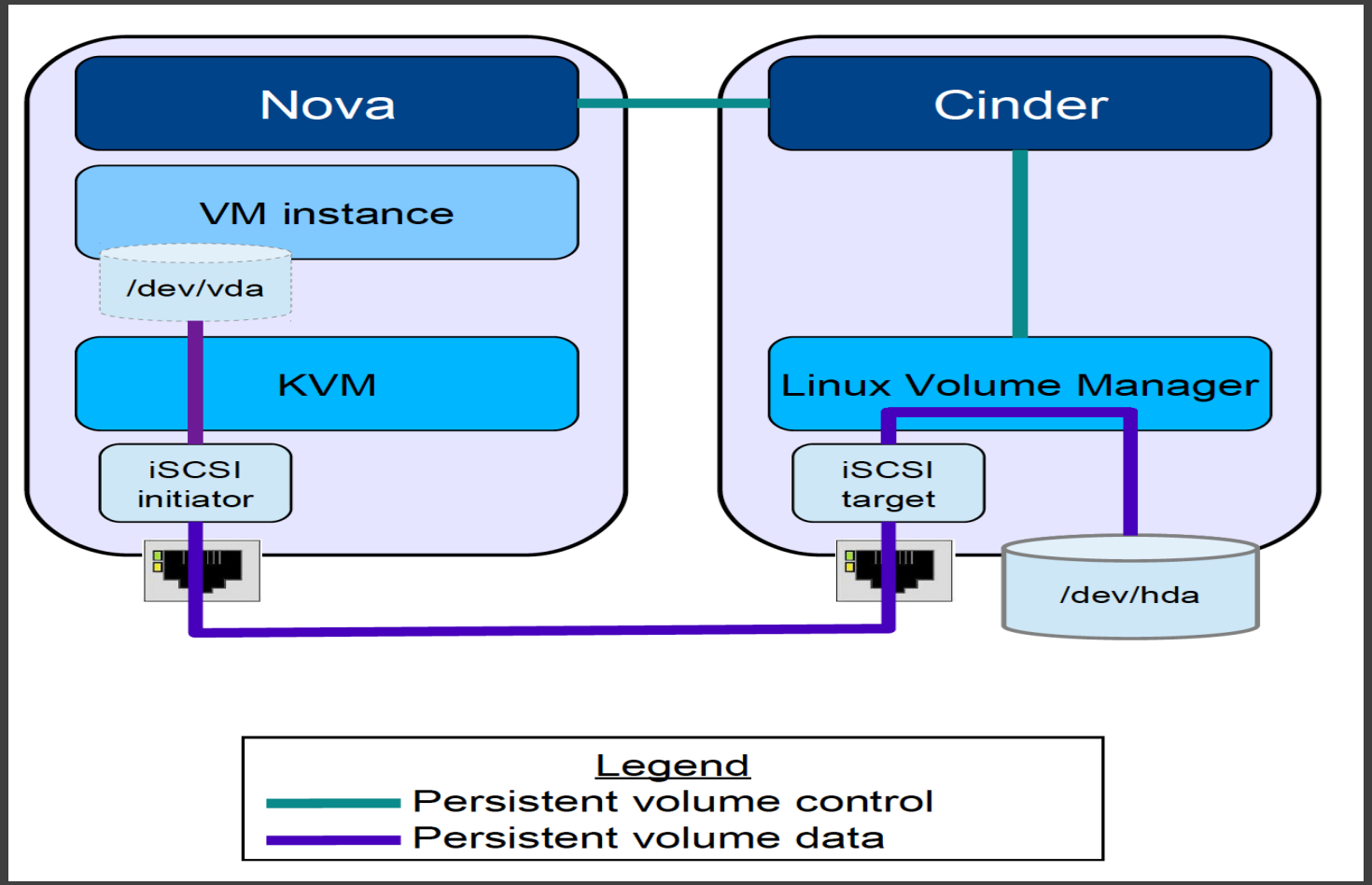
Openstack Cinder block storage



NAS Storage

- Network-attached storage (NAS) is a file-level computer data storage server connected to a computer network providing data access to a heterogeneous group of clients.
- NAS is specialized for serving files either by its hardware, software, or configuration.
- Generally it is served by NFS for unix and CIFS for windows based system
- For NFS we do not need to create filesystem at host level
- We need NAS clients to access the NAS
- Mode of transfer between the host and storage will be file based

NAS use cases

- File storage
- Used by the operating system using clients
- Can be shared to multiple system
- Home directories
- Application files which needs to be shared across hosts

Cloud NAS Storage Examples

Amazon EFS Pricing

With Amazon EFS, you pay only for the amount of file system storage you use in GB. There is no minimum fee and no set-up costs.

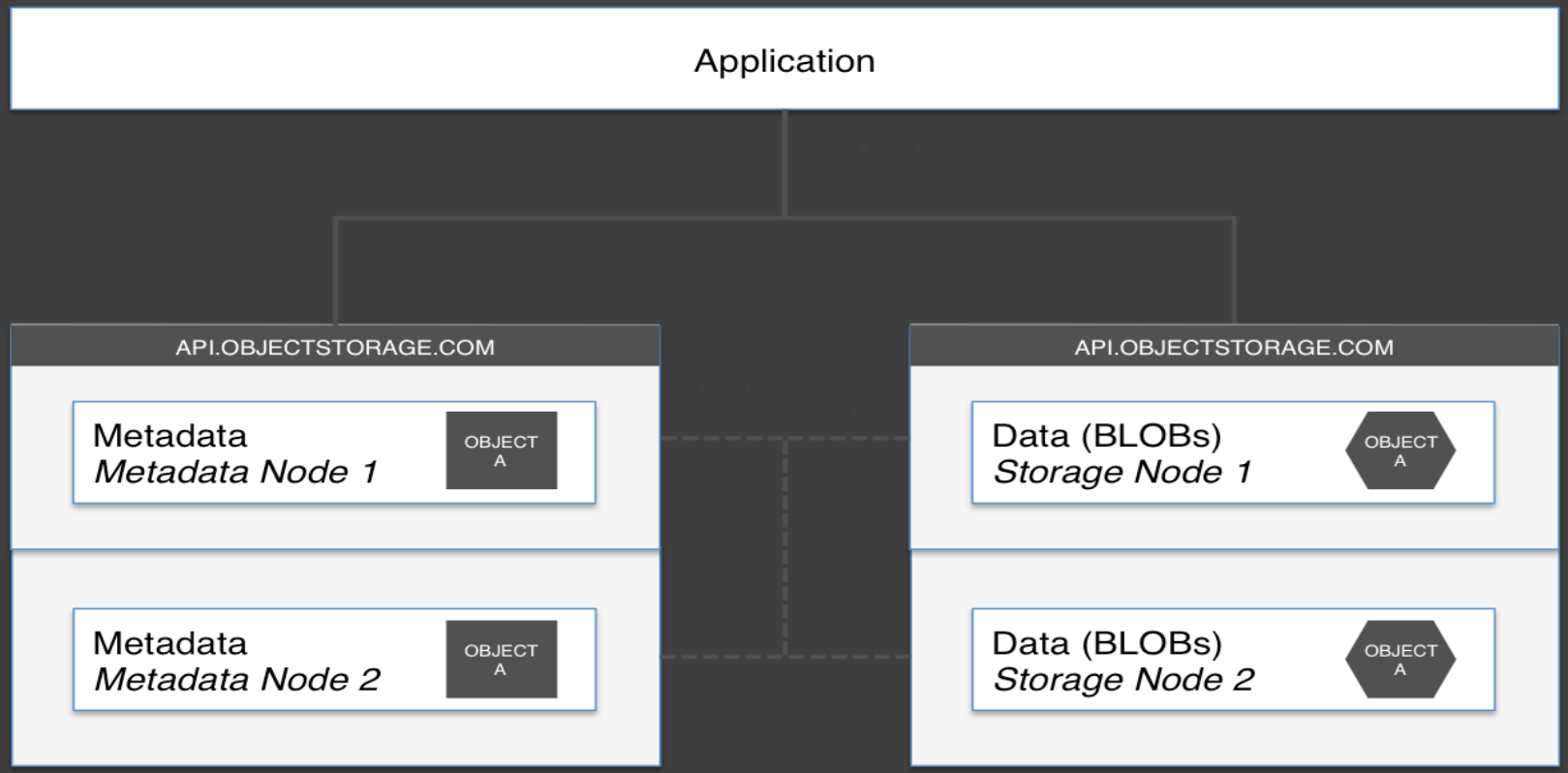
Pricing

- $0.30/GB-month

Object based Storage

- Object Storage is a storage architecture that manages data as objects
- Each object typically includes
  - the data itself,
  - a variable amount of metadata,
  - and a globally unique identifier.
- It uses web API call to access the data in the object storage using its unique identifier
- Usually accessed via client to access all the files for a account
- Usually use a webcall within the application to access the indiviual objects

Object based Storage



Object Storage Examples

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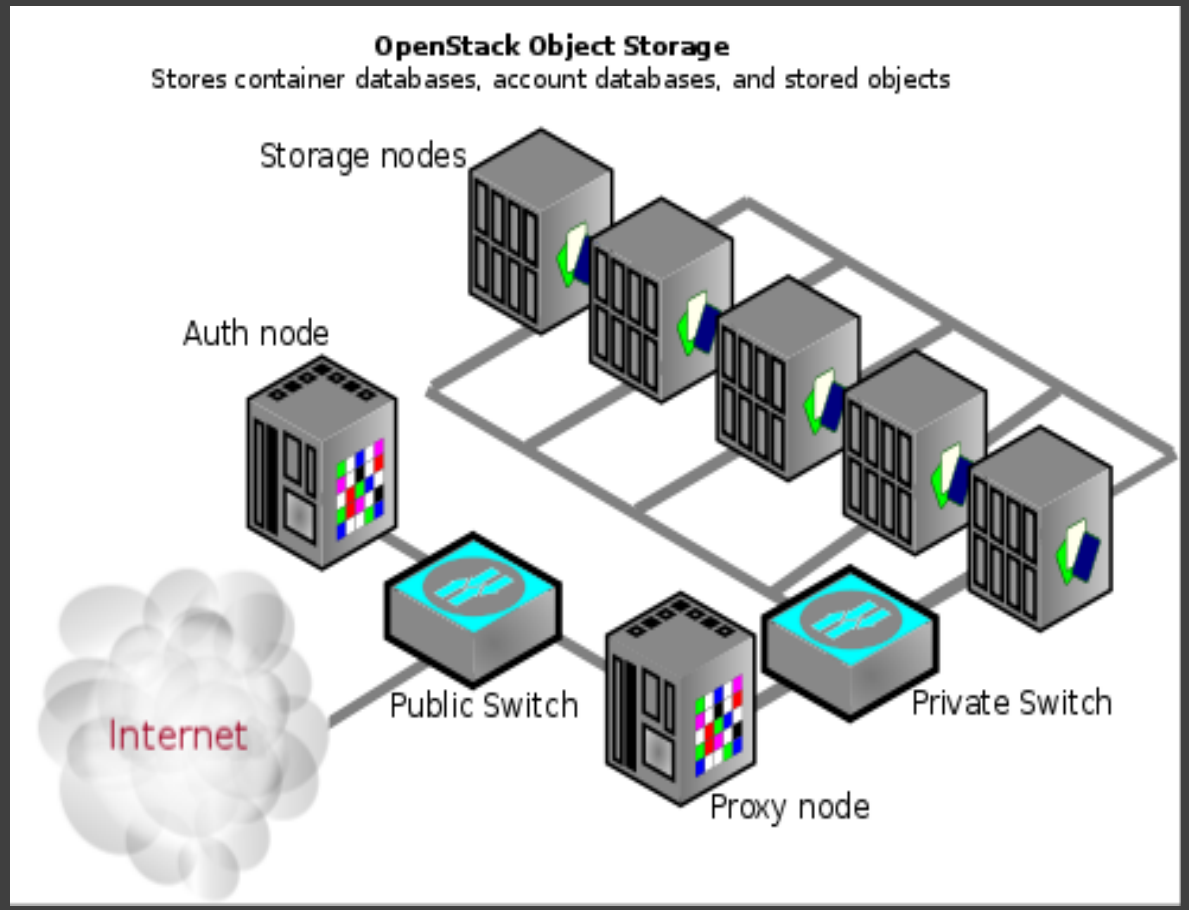
Dropbox

Google Drive

Amazon S3



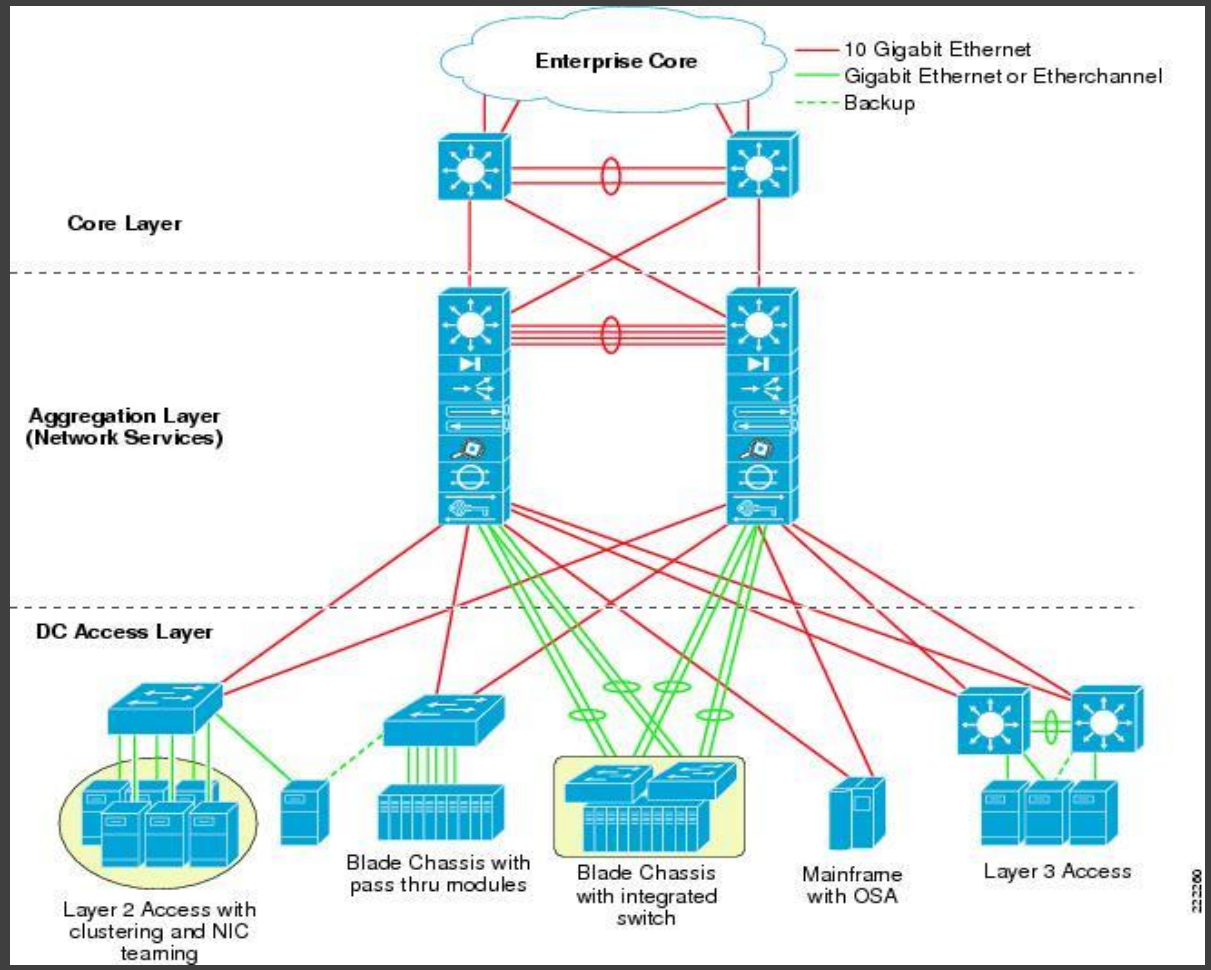
Cloud Networking

- Cloud networking is a new networking paradigm for building and managing secure private networks over the public Internet by utilizing global cloud computing infrastructure.
- In cloud networking, traditional network functions and services including connectivity, security, management and control, are pushed to the cloud and delivered as a service.

Cloud Networking Types

- There are two categories within cloud networking
  - Cloud-Enabled Networking (CEN)
  - Cloud-Based Networking (CBN)
- CEN moves management and certain aspects of control (such as policy definition) into the cloud, but keeps connectivity and packet-mode functions – such as routing, switching and security services – local and often in hardware.
- CBN moves all core networking functions, including addressing and the actual packet path, into the cloud and eliminates the need for any local hardware other than that which provides an internet connection

Typical Datacentre Networking



Leaf and Spine Model Networking

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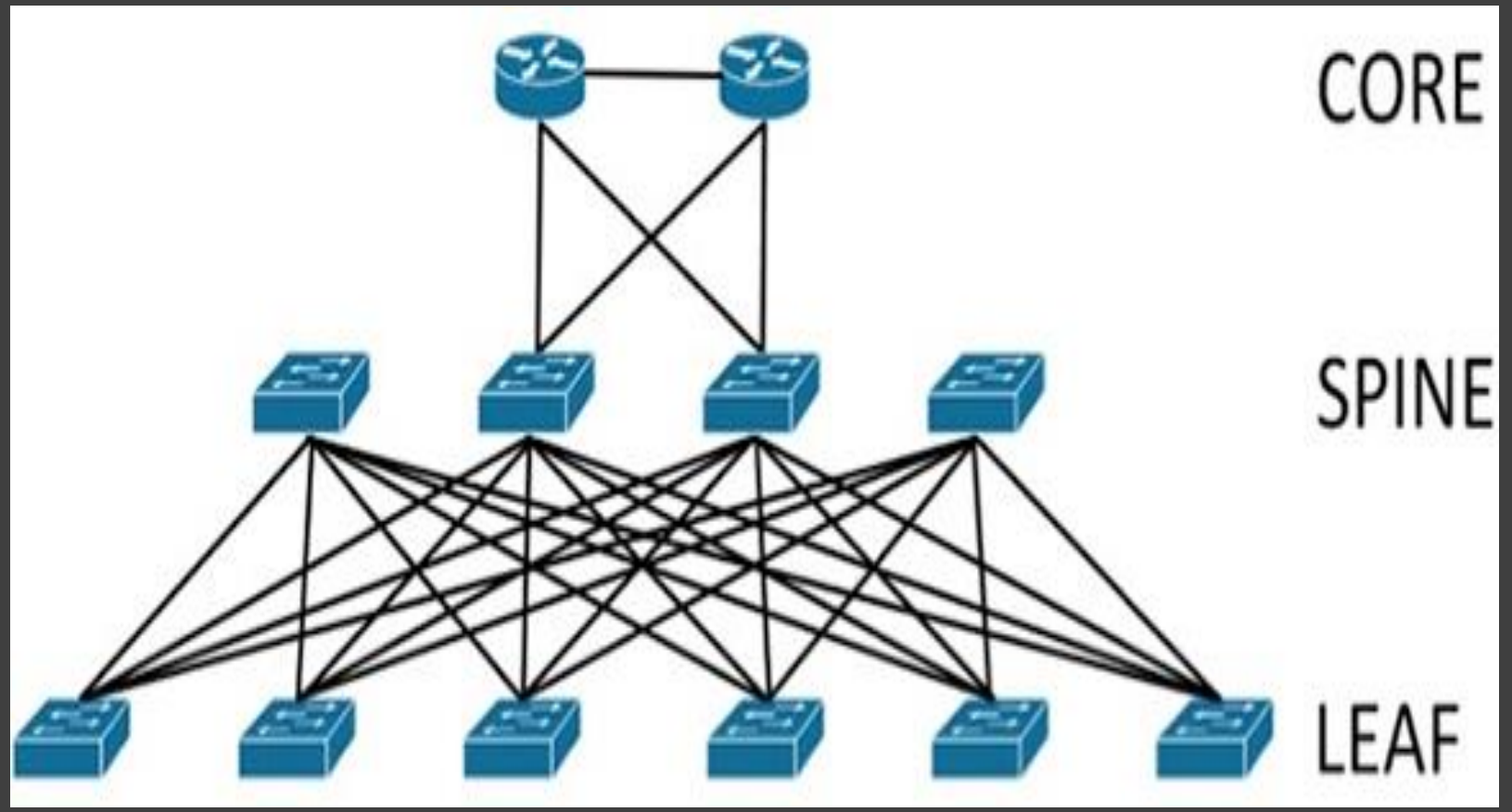

Network Virtualization

- Network virtualization is the process of combining hardware and software network resources and network functionality into a single, software-based administrative entity, a virtual network.
- There are two types of Network Virtualization
  - External virtualization
    - combining many networks or parts of networks into a virtual unit within a datacentre or spanning across multiple datacentre.
  - Internal virtualization
    - Networking virtualization done with in the server

Cloud Networking

- Most of the Cloud services provide both Internal and External network Virtualization
- Internal network virtualization is used to network between cloud compute
- External network provides segmentation of network, Load balancing, Routing, Security to the network, Connectivity (Internet or Virtual private cloud)

Cloud Networking Examples

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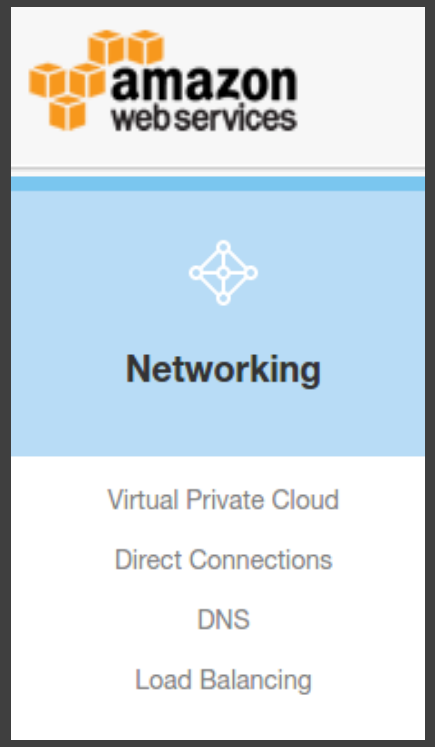
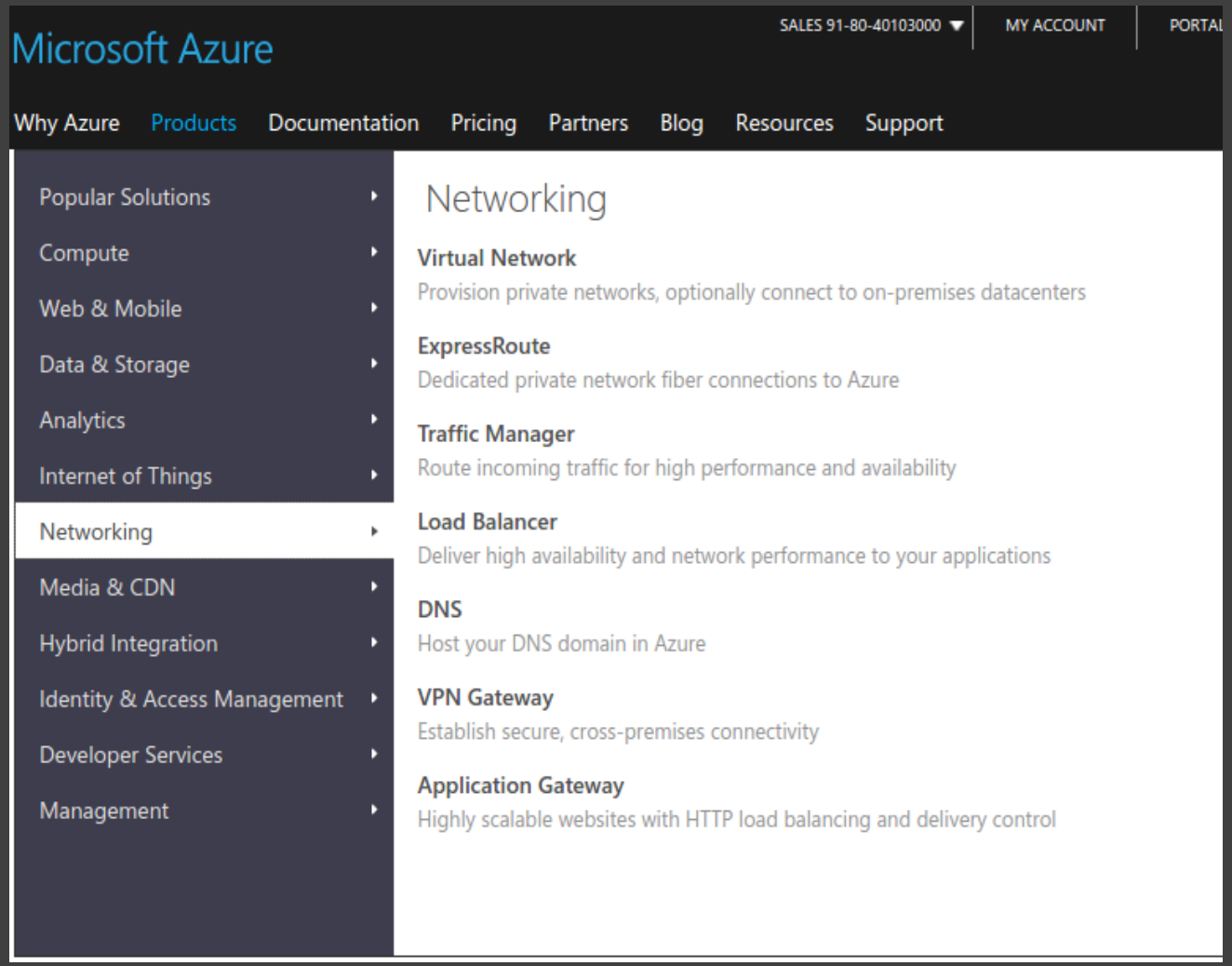




Cloud Management/ Shared Services

Cloud Shared Service

- Cloud Shared service
  - Identity Service
  - Image Service
  - Orchestration service
  - Usage service
  - Database service
  - Other common application services

Identity Service

- Identity service is used to autenticate and authourize the use of a user to the cloud resources
- You create user, groups, roles, permissions in identitiy service to provide right access to the right user for cloud resources
- Identity services are federated across datacentres to manage a single Identity service

Examples of identity service

AWS Identity and Access Management

AWS Identity and Access Management (IAM) enables you to securely control access to AWS services and resources for your users. Using IAM, you can create and manage AWS users and groups, and use permissions to allow and deny their access to AWS resources.

Welcome to Keystone, the OpenStack Identity Service!

Keystone is an OpenStack project that provides Identity, Token, Catalog and Policy services for use specifically by projects in the OpenStack family. It implements OpenStack's Identity API.

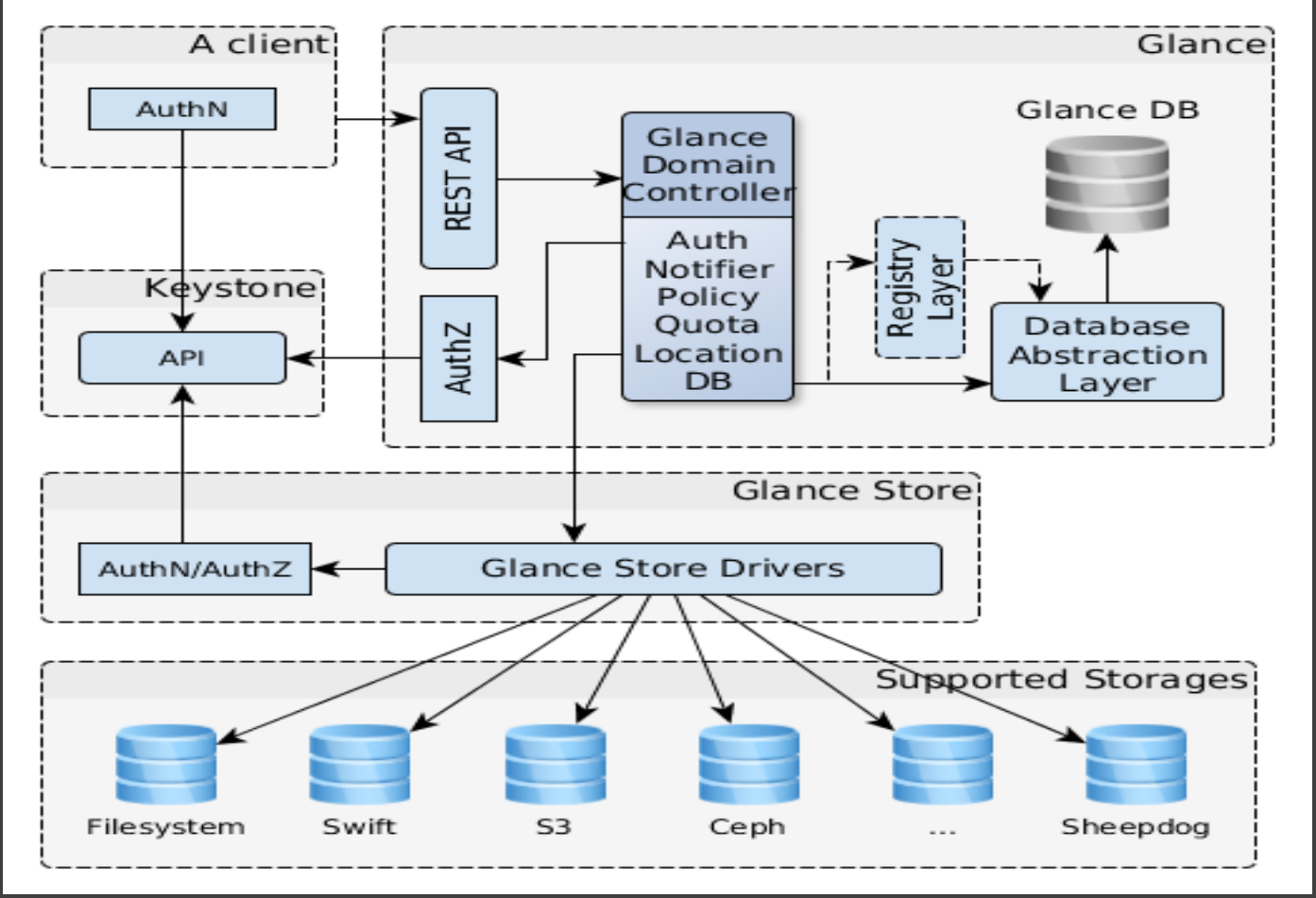
Image Service

- In Cloud Infrastructure the VM's are created from images
- The base images are created by Cloud administrators or providers
- Cloud users can create image out of the Vms which have all the application or databse installed at any time and reuse this image to create VM from them.
- To create any image from a VM we need use a Template process

Image Service

- Image service is to provide image as a service to create cloud compute Vms
- It will provide service to create New image from a VM template or modify the existing image
- Image type depends on the hypervisor type you use in the cloud, Generic image type are:
  - Raw
  - Machine (kernel/ramdisk outside of image, a.k.a. AMI)
  - VHD (Hyper-V)
  - VDI (VirtualBox)
  - qcow2 (Qemu/KVM)
  - VMDK (VMWare)
  - OVF (VMWare, others)

Examples of Image service



Orchestration Service

- Orchestration service helps to describe and automate the deployment of Cloud infrastructure
- It will provide flexible template language that can specify
  - compute,
  - Storage
  - networking configurations
  - detailed post-deployment activity
  - to automate the full provisioning of infrastructure as well as services and applications.

Examples of Orchestration service

AWS CloudFormation

AWS CloudFormation gives developers and systems administrators an easy way to create and manage a collection of related AWS resources, provisioning and updating them in an orderly and predictable fashion.

AWS OpsWorks

AWS OpsWorks is an application management service that makes it easy to deploy and operate applications of all shapes and sizes. You can define the application's architecture and the specification of each component including package installation, software configuration and resources such as storage. Start from templates for common technologies like application servers and databases or build your own to perform any task that can be scripted. AWS OpsWorks includes automation to scale your application based on time or load and dynamic configuration to orchestrate changes as your environment scales.

Examples of Orchestration service

Heat

Heat is the main project in the OpenStack Orchestration program. It implements an orchestration engine to launch multiple composite cloud applications based on templates in the form of text files that can be treated like code. A native Heat template format is evolving, but Heat also endeavours to provide compatibility with the AWS CloudFormation template format, so that many existing CloudFormation templates can be launched on OpenStack. Heat provides both an OpenStack-native ReST API and a CloudFormation-compatible Query API.

Puppet

The Puppet OpenStack Mission: to bring scalable and reliable IT automation to OpenStack cloud deployments.

Puppet OpenStack is open source, openly designed, openly developed by an open community.

Usage Service

- Usage service are used to monitor the individual cloud resources utilization
- Monitoring cloud utilization helps to charge the user for the cloud resources
- It will also collect the performence metrics of the cloud resources
- It will allow cloud operators to view metrics globally or by individual deployed resources

Example of usage service

- Amazon CloudWatch
  - Amazon CloudWatch is a monitoring service for AWS cloud resources and the applications you run on AWS. You can use Amazon CloudWatch to collect and track metrics, collect and monitor log files, and set alarms. Amazon CloudWatch can monitor AWS resources such as Amazon EC2 instances, Amazon DynamoDB tables, and Amazon RDS DB instances, as well as custom metrics generated by your applications and services, and any log files your applications generate.

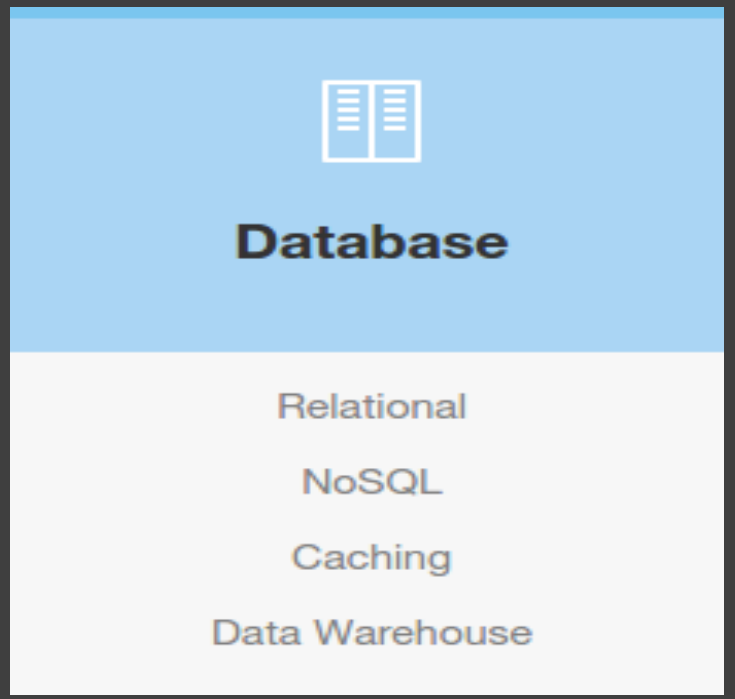
Example of usage service

- Openstack Telemetry service
- Efficiently collects the metering data about the CPU and network costs.
- Collects data by monitoring notifications sent from services or by polling the infrastructure.
- Configures the type of collected data to meet various operating requirements. Accessing and inserting the metering data through the REST API.
- Expands the framework to collect custom usage data by additional plug-ins.
- Produces signed metering messages that cannot be repudiated.

Database service

- Database service allowing users to provision database as a service without worrying about provisiong of database application, high availability and security of database.
- Automated provisioning of database as and when requested by user or a DBA
- Most of cloud support relational and Nosql DB

Examples of Database service



- Amazon RDS
- Trove
  - Trove is Database as a Service for OpenStack. It's designed to run entirely on OpenStack, with the goal of allowing users to quickly and easily utilize the features of a relational or non-relational database without the burden of handling complex administrative tasks.

Other PaaS and Saas

- There are numerous Platform as a Service and Software as a Service offered by cloud providers.
- PaaS and SaaS are achieved to fully automated platform and software deployment and scale as and when required.

Cloud Datacentres/Zones

Cloud Datacentres

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- Cloud Datacentre are place to host Cloud Datacentres
- The datacentre are designed such that all physical components like power cooling and compute infrasture are highly available
- In case of any of the physical infrastructure goes bad it will seamlessely take over by another device untill it is replaced.

Cloud Availability Zones

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- Cloud Availability zones are created to cater the disaster scnerio
- Generally Availabilty zones are build with in multiple cloud datacentres in case of disaster in one datacenter all the services will be failed over to other datacentre

Cloud Regions

- Create Cloud Regions with multiple availability zones.
- Only few services are replicated across availability zone generally a image service, identity service.
- If you need more available of cloud VM you can deploy Vms in multiple availabilty zone and load abalance across availabilty zones
- No Data is replicated across regions. All your data reside with in the Cloud regions

Cloud **User Interface**

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- The Cloud is generally accessed via
  - Dashboard or Management Console
  - Command line Interfaces
  - Using API

Cloud Management Consoles

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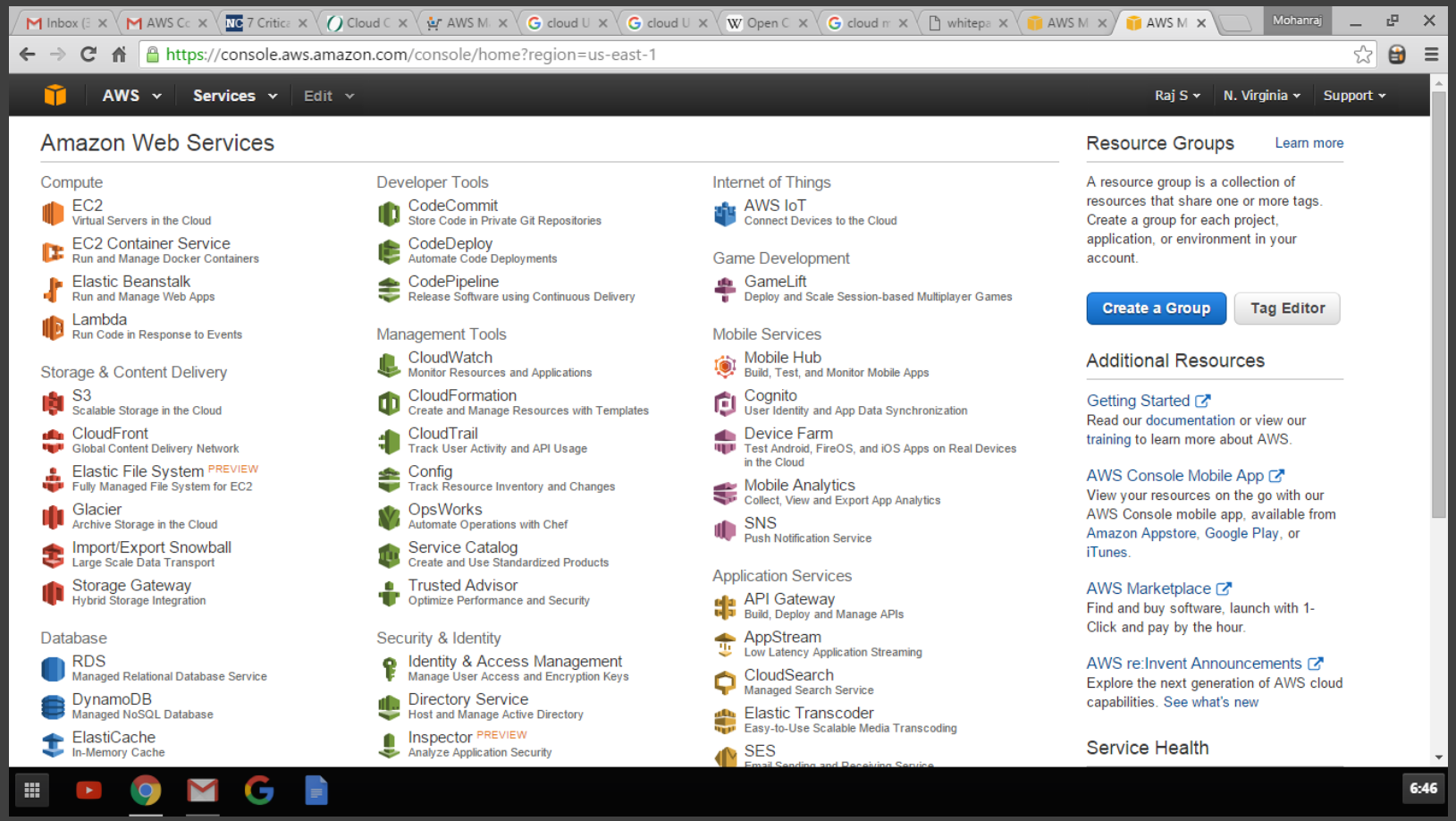
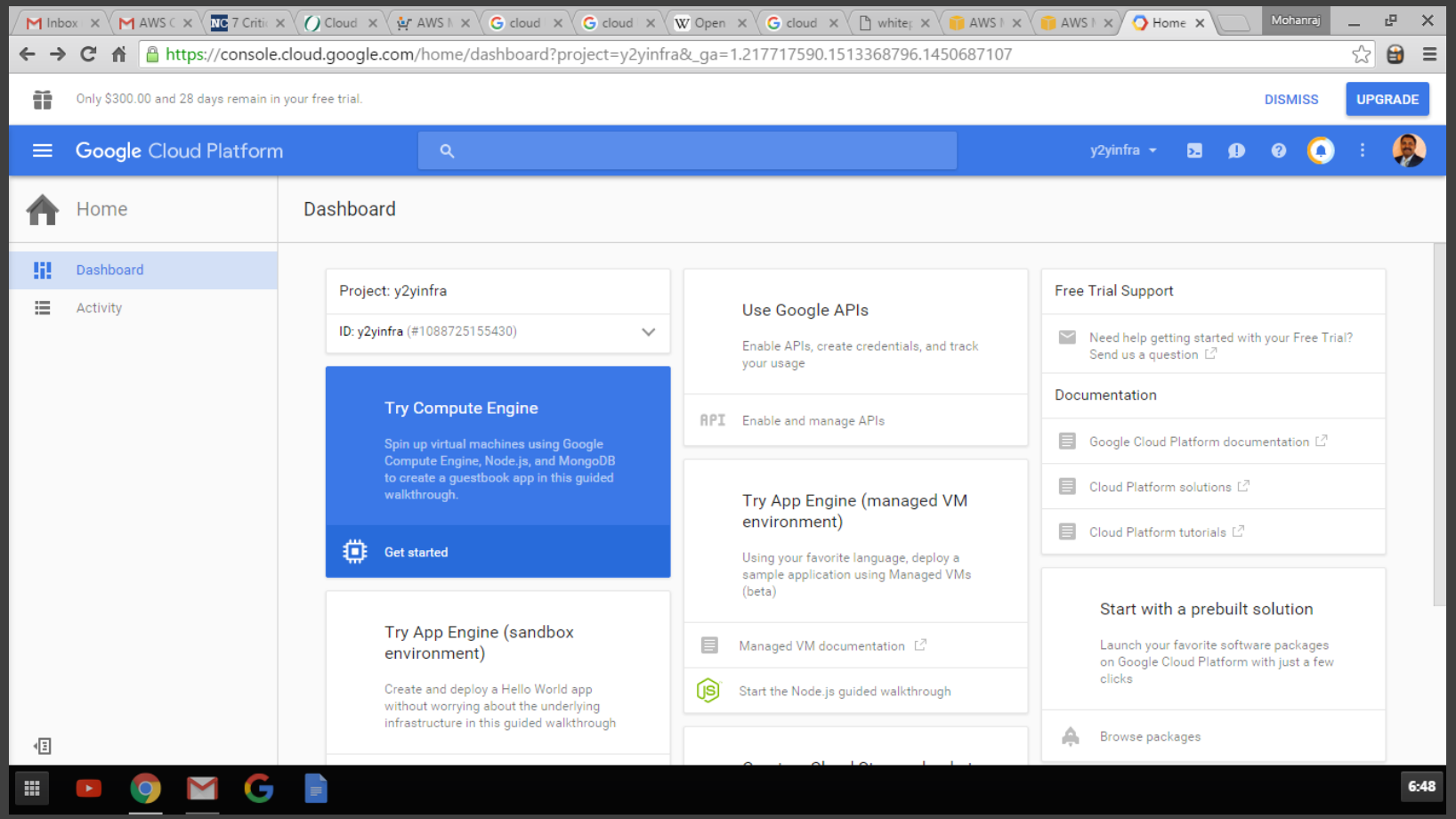


- AWS Console
- Access and manage Amazon Web Services through a simple and intuitive web-based user interface. You can also use the AWS Console mobile app to quickly view resources on the go.

Cloud Management Consoles

Course and Labs



- Google Cloud Platoform console
- https://console.cloud.google.com

Cloud Management Consoles

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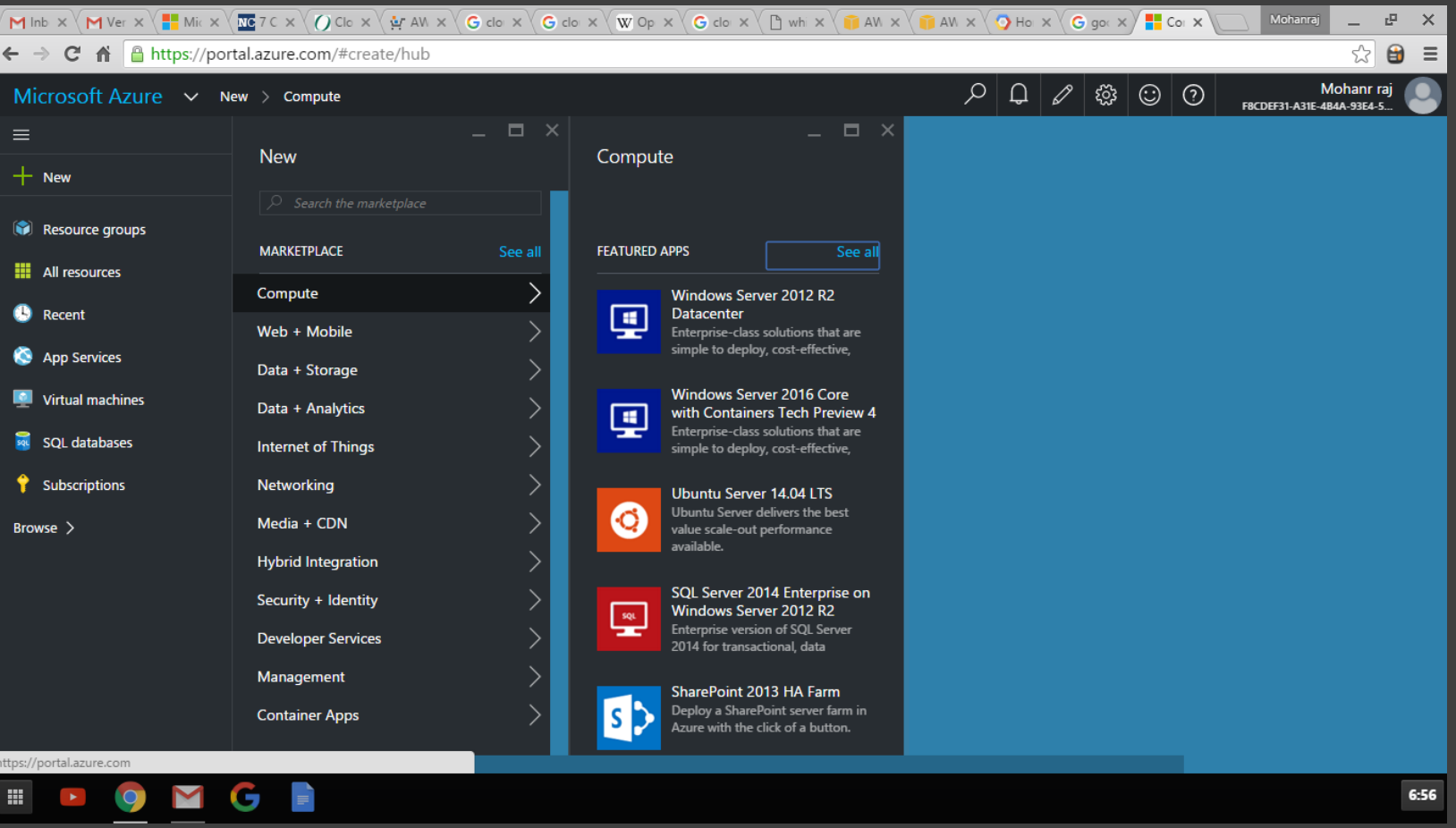

- Microsoft Azure Portal
- https://portal.azure.com

Cloud CLI

- The AWS Command Line Interface (CLI) is a unified tool to manage your AWS services. With just one tool to download and configure, you can control multiple AWS services from the command line and automate them through scripts.
- https://aws.amazon.com/cli/
  - Download Windows, Linux and Mac CLI Tools

Cloud Services API

- Mostly all Cloud Software exposes their services as API (Application Programming Interface)
- The Action of create, Delete and Modify of a service can be performed via an API
- A Sample API call will look like this:
  - https://ec2.amazonaws.com/?Action=AttachVolume &VolumeId=vol-1a2b3c4d &InstanceId=i-1a2b3c4d &Device=/dev/sdh &AUTHPARAMS
- Sample Output will be
  - <AttachVolumeResponse xmlns="http://ec2.amazonaws.com/doc/2015-10-01/"> <requestId>59dbff89-35bd-4eac-99ed-be587EXAMPLE</requestId> <volumeId>vol-1a2b3c4d</volumeId> <instanceId>i-1a2b3c4d</instanceId> <device>/dev/sdh</device> <status>attaching</status> <attachTime>YYYY-MM-DDTHH:MM:SS.000Z</attachTime> </AttachVolumeResponse>

Accessing Cloud VMs

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- Most Cloud Providers provide two types of Virtual Operating System:
  - Windows
  - Linux
- For Linux VMs will give ssh access to access the VMs
- For Windows VMs will give RDP to access the VMs