

VIRTUALIZATION

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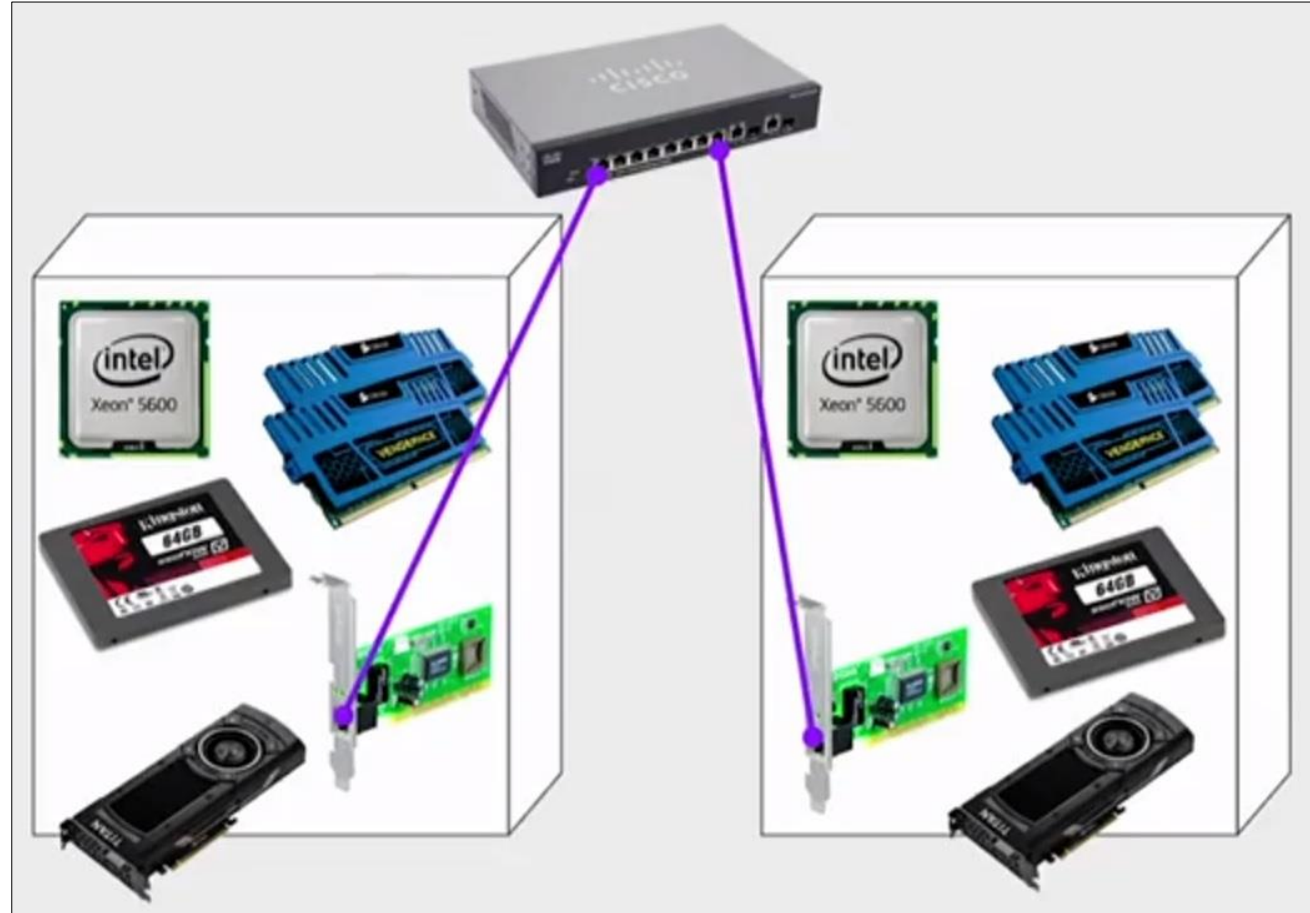
- Virtualization
- OS-based virtualization
- Infrastructure as a Service (IaaS) providers

The whole economics of cloud requires
you to **share**.

ABSTRACTION

- Introduce an abstract model of what a generic computing resource should look like
- The physical computer resource then provides this abstract model to many users

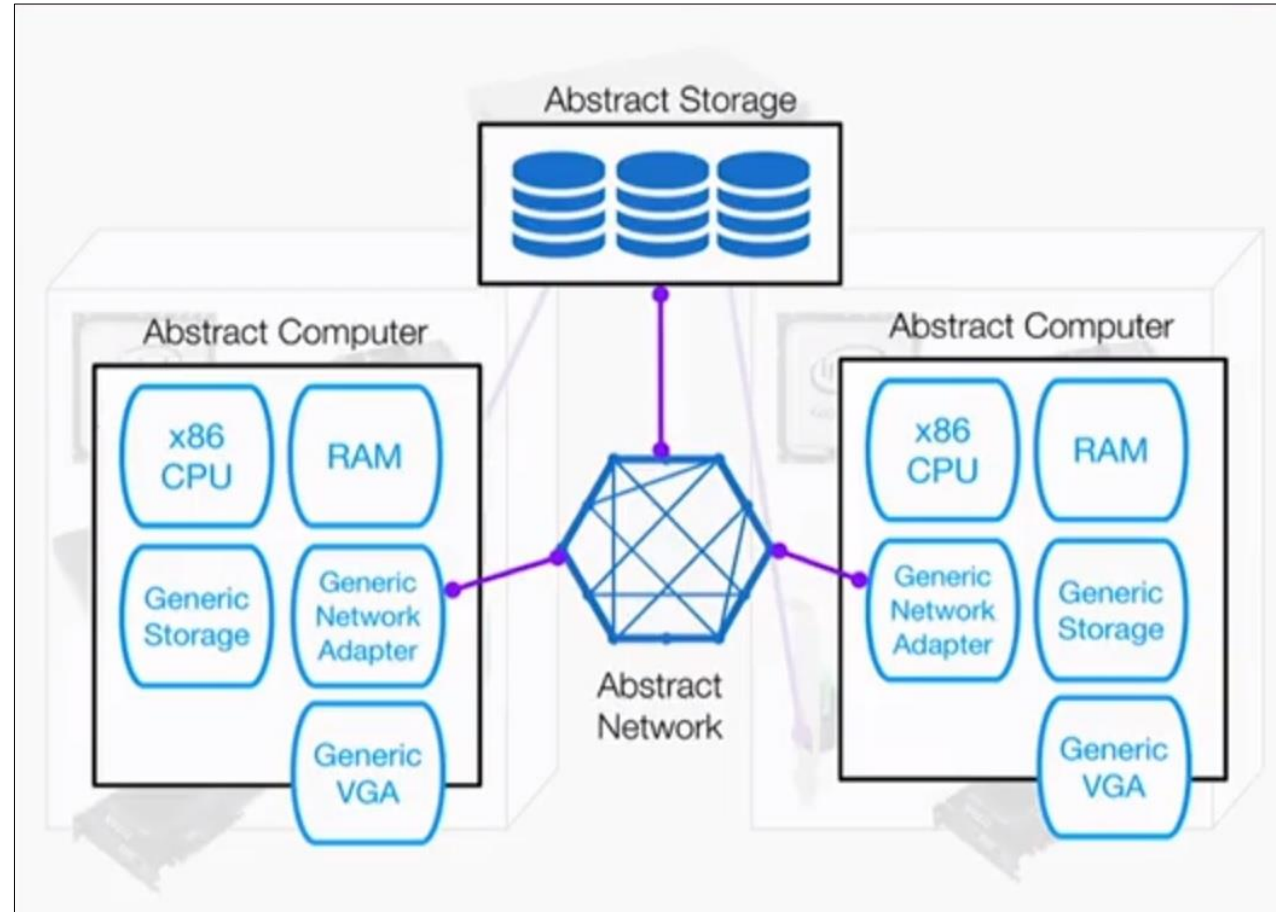
LAYERS OF ABSTRACTION



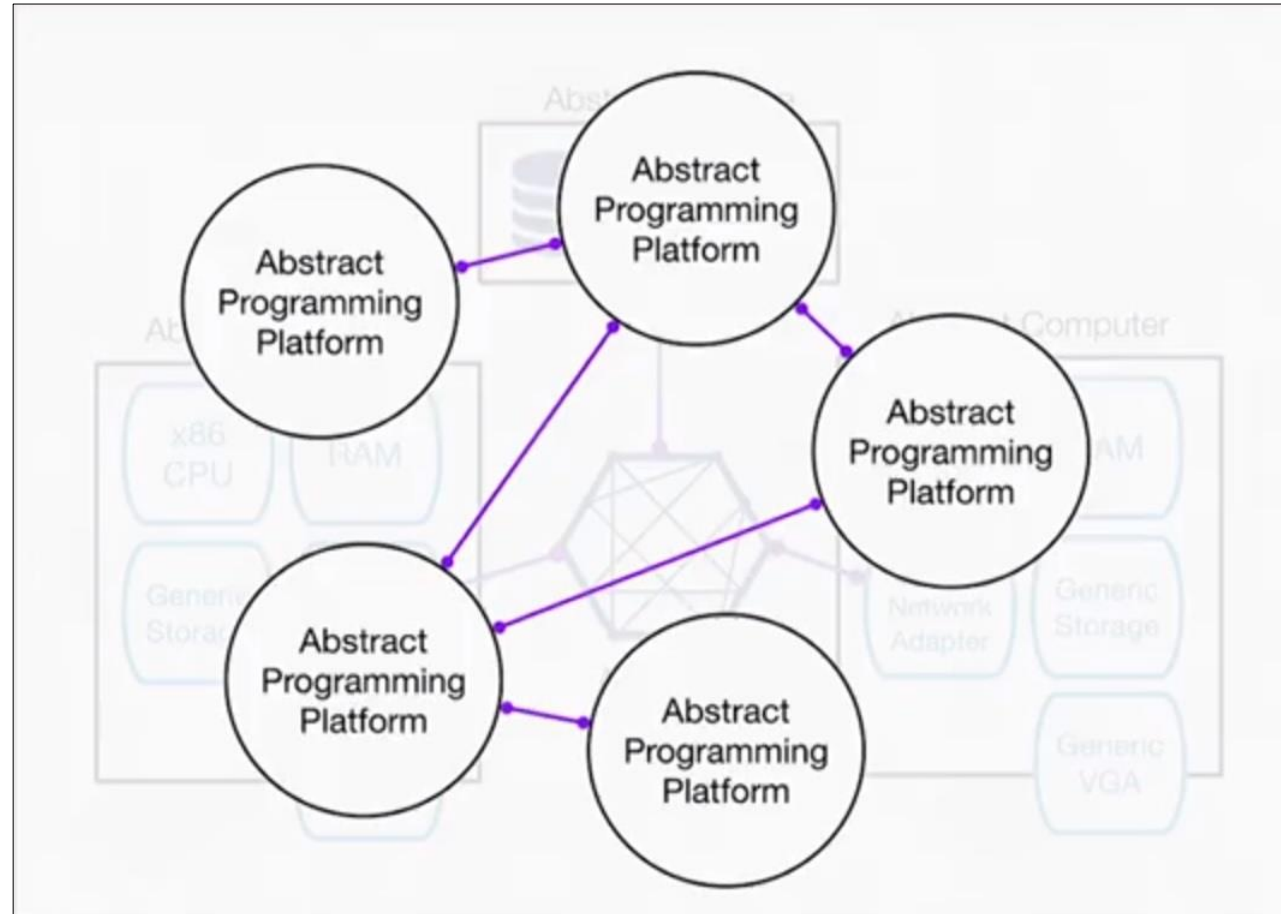
VIRTUALIZATION

Virtualization is the mechanism to create the dependencies and to map those dependencies onto the real hardware and provide the layer of abstraction we want.

LAYERS OF ABSTRACTION (2)



LAYERS OF ABSTRACTION (3)



VIRTUALIZATION: FOUNDATION OF CLOUD COMPUTING

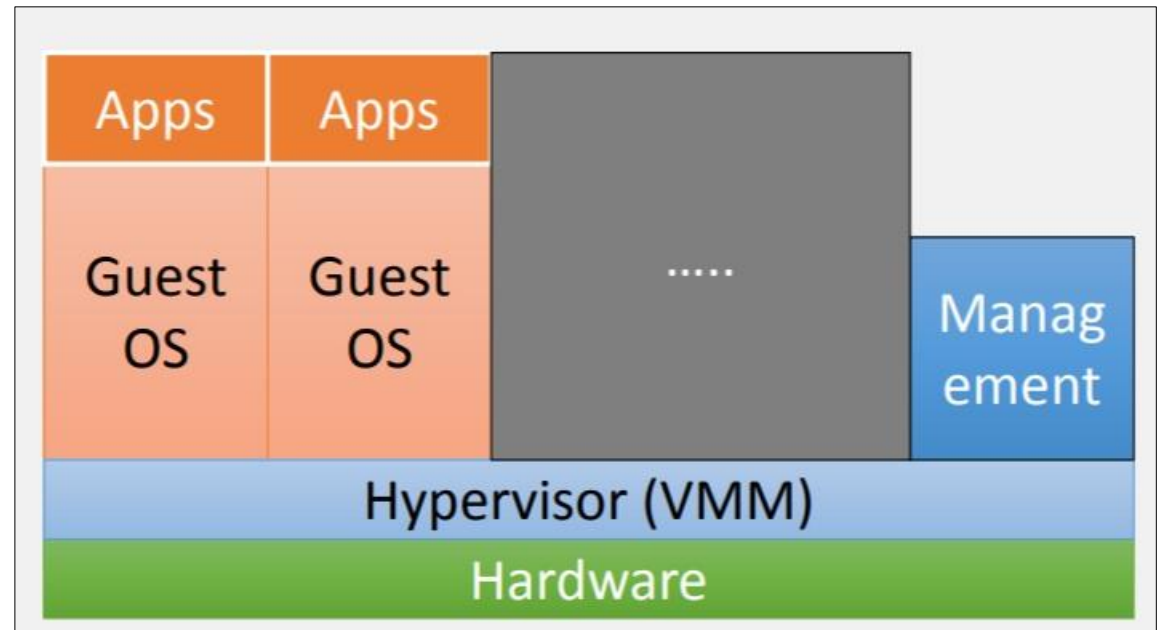
- **It doesn't create dependencies between the physical resources and the client's application**
- Clouds are based on virtualization
- Clients can construct services from lots of resources

TYPES OF VIRTUALIZATION

- Native, full
- Hardware assisted
- Para-virtualization
- OS level
 - Containers
 - Jails
 - Chroot
 - Zones
 - Open-VZ -> Virtuozzo

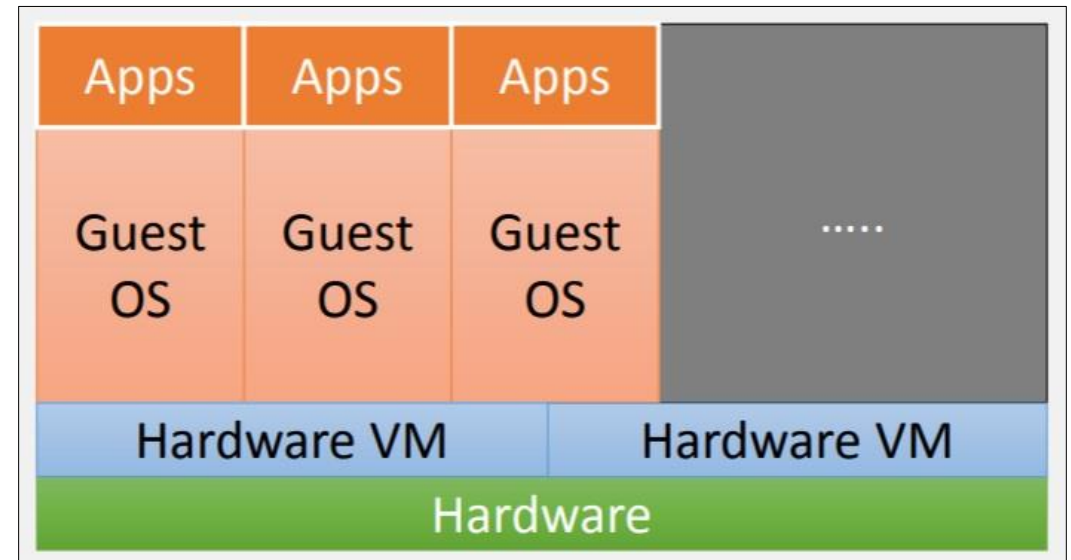
NATIVE AND FULL VIRTUALIZATION

- The virtual machine simulates enough hardware to allow an unmodified “guest” OS to be run in isolation
- Examples:
 - VirtualBox
 - Virtual PC
 - Vmware
 - QEMU



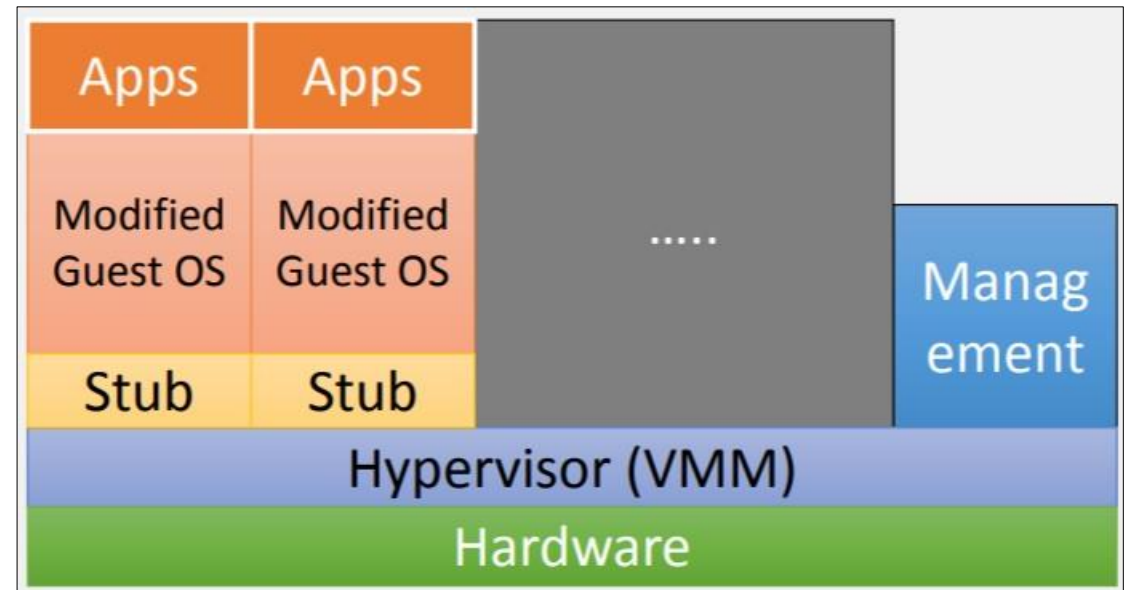
HARDWARE ENABLED VIRTUALIZATION

- The virtual machine has its own hardware and allows a guest OS to be run in isolation
- Intel VT (IVT)
- AMD virtualization
- Examples:
 - Vmware Fusion
 - Parallels Desktop for Mac
 - Parallels Workstation



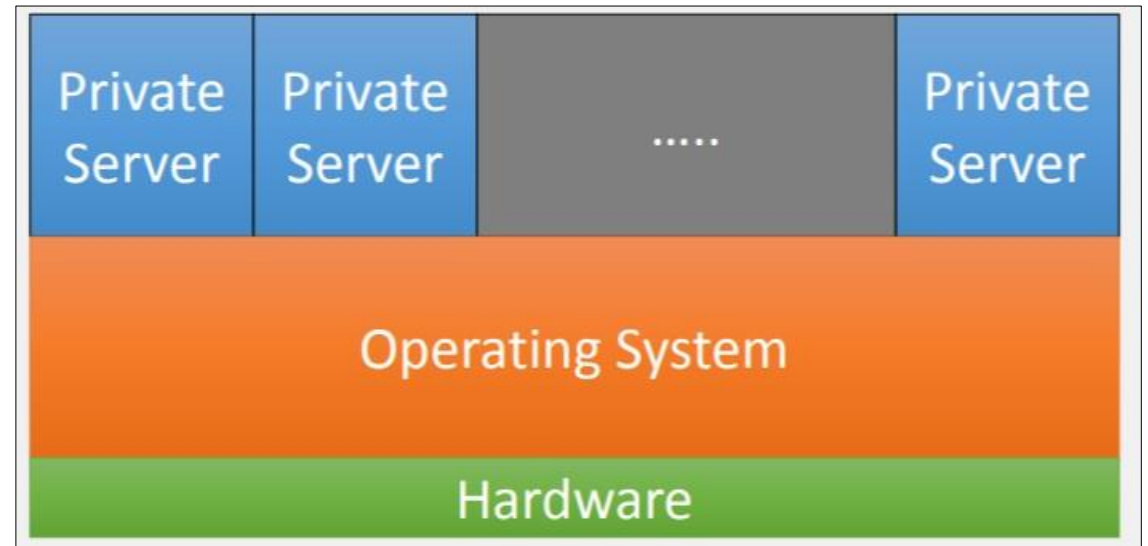
PARAVIRTUALIZATION

- The virtual machine does not necessarily simulate hardware, but instead (or in addition) offers a special API that can be used by modifying the “guest” OS
- Examples:
 - XEN



OPERATING SYSTEM-LEVEL VIRTUALIZATION

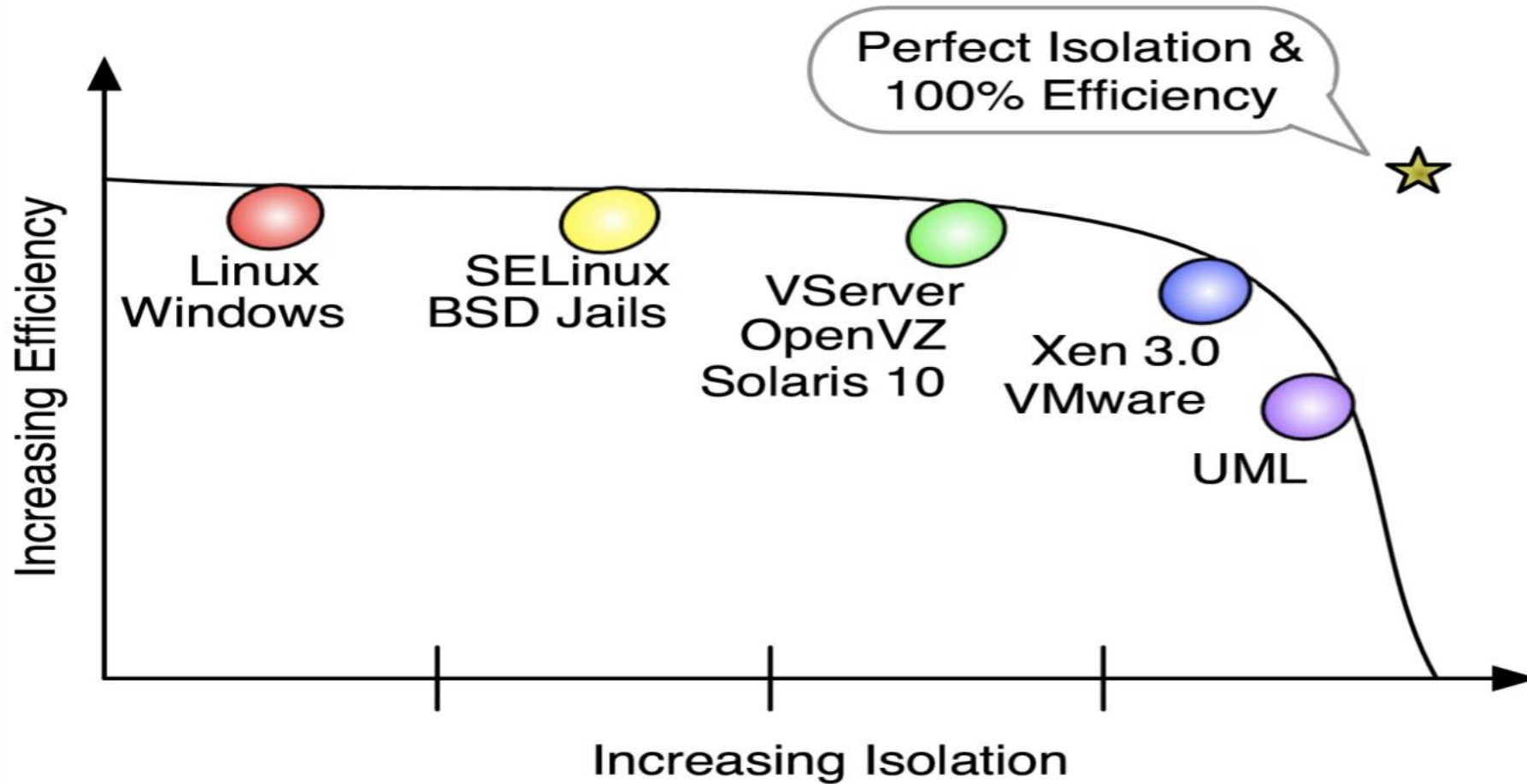
- Virtualizing a physical server at the operating system level, enabling multiple isolated and secure virtualized servers to run on a single physical server
- Examples:
 - Linux-Vserver
 - Solaris Containers
 - FreeBSD Jails
 - Chroot
 - CGroups



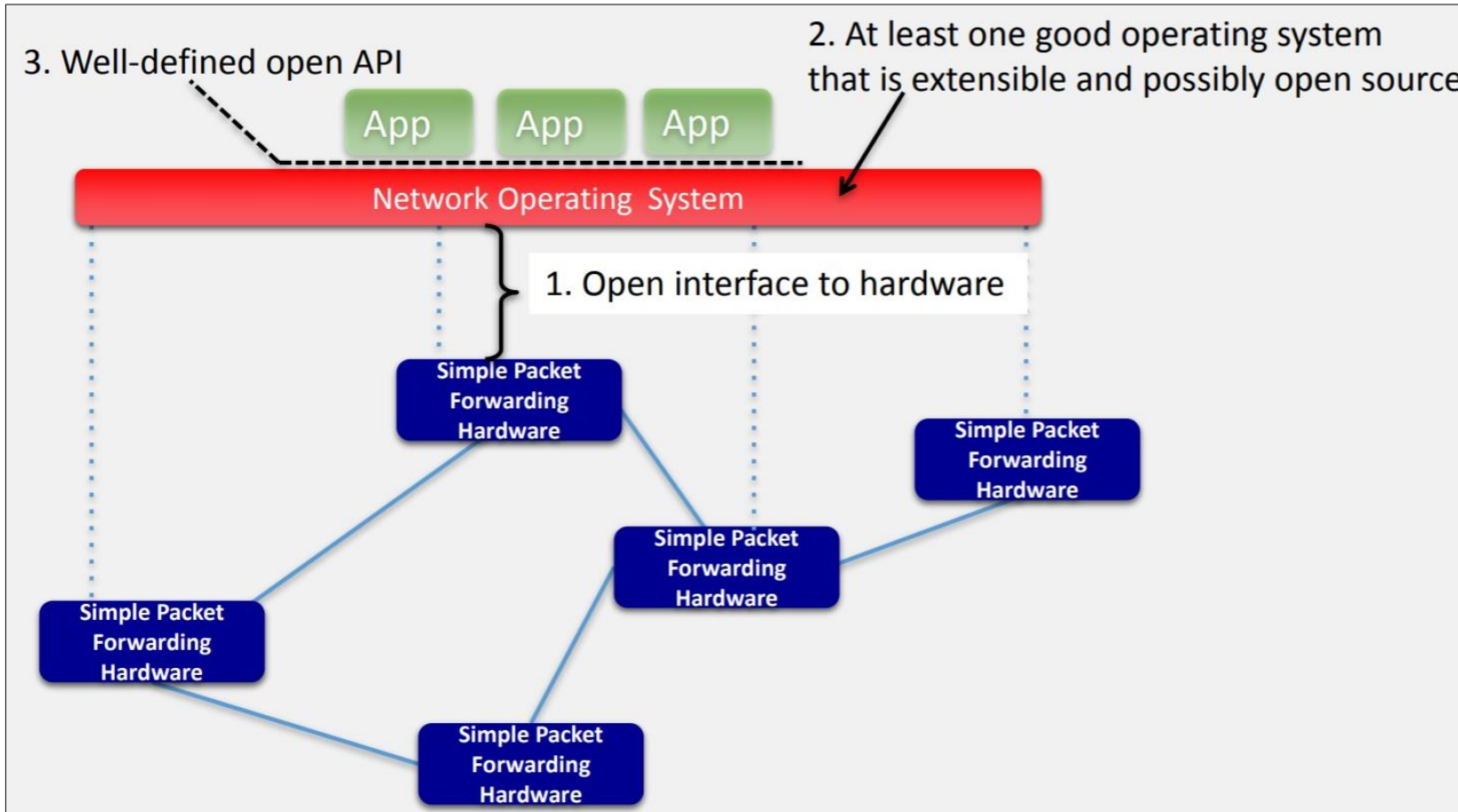
OPERATING SYSTEM-LEVEL VIRTUALIZATION (2)

- Hypervisor (VM)
 - One real HW, many virtual HWs, many OSs
 - High versatility – can run different OSs
 - Lower density, performance, scalability
 - Are mitigated by new hardware features (such as VT-D)
- Containers (CT)
 - One real HW (no virtual HW), one kernel, many user space instances
 - Higher density, natural page sharing
 - Dynamic resource allocation
 - Native performance: (almost) no overhead

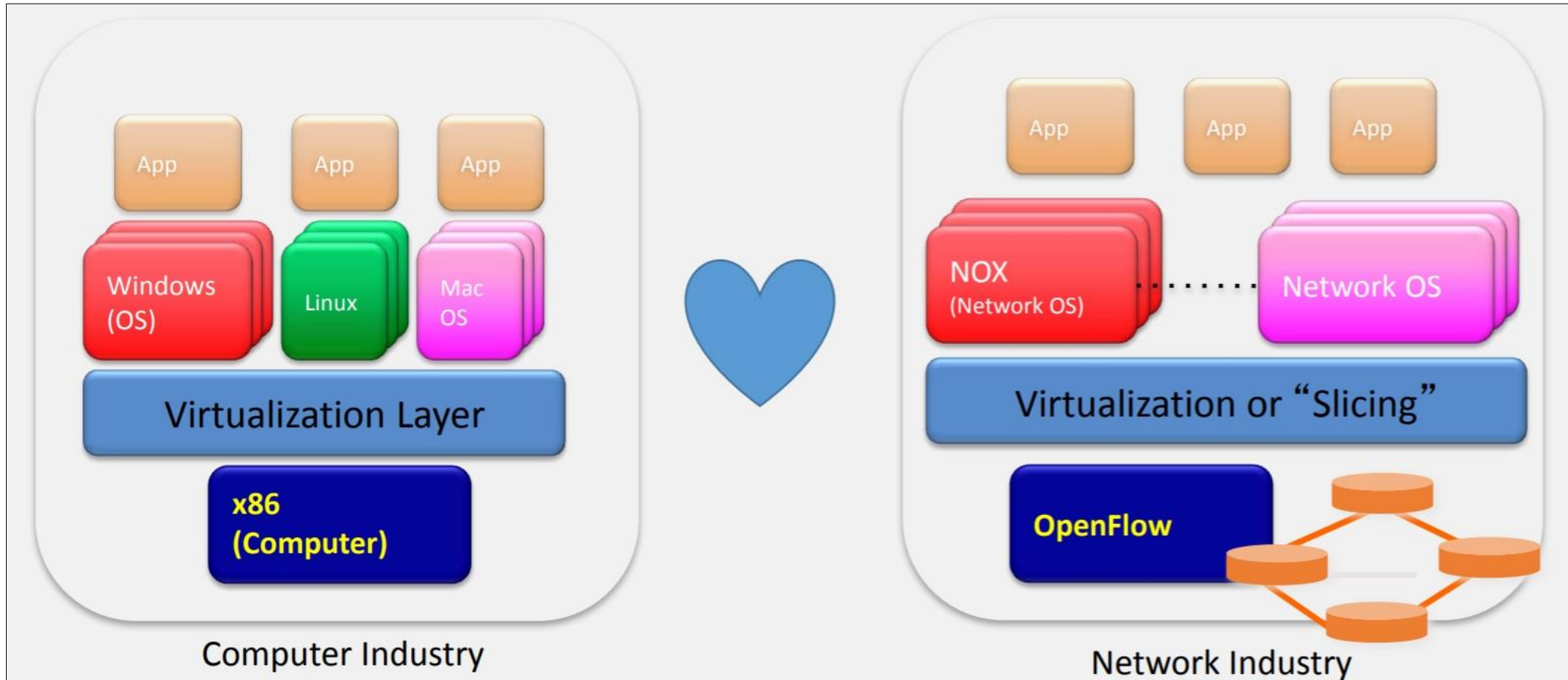
THE TRADE-OFF



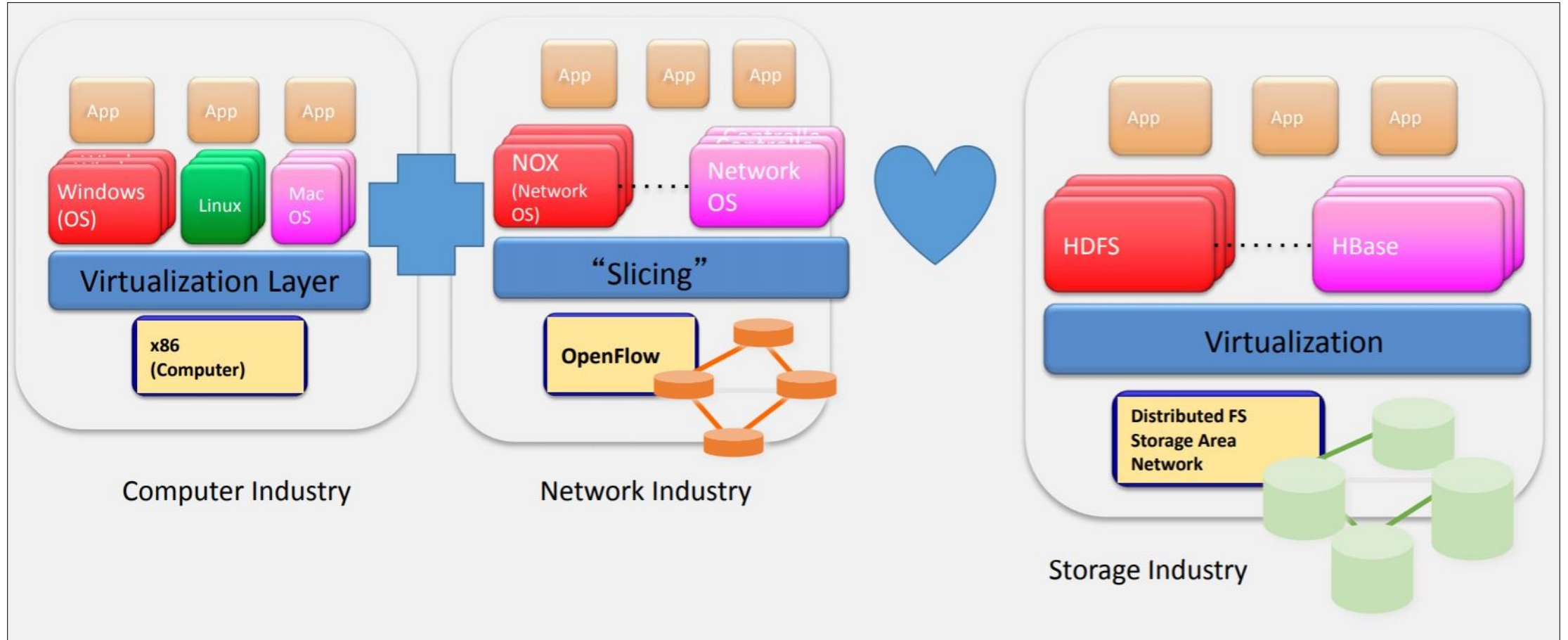
THE “SOFTWARE-DEFINED NETWORK”



VIRTUALIZED OS + VIRTUALIZED NETWORK



THEN ADD VIRTUALIZED STORAGE



AMAZON WEB SERVICES

- AWS provides a collection of services for building cloud applications
- Services for:
 - **Storage:** S3, EBS
 - **Computation:** Elastic Cloud Computing (EC2), scaling/loading balancer, Elastic MapReduce, Elastic Beanstalk
 - **Database:** RDS, DynamoDB, ElastiCache
 - **Coordination:** Simple Notification Service, Simple Workflow Framework
- All services are paid depending on use

AMAZON WEB SERVICES (2)



Amazon EC2

Resizable compute capacity in the Cloud.



Amazon DynamoDB

Fast and flexible NoSQL database with seamless scalability.



AWS Lambda

Compute service that runs your code in response to events and automatically manages the compute resources



Amazon S3

Highly scalable, reliable, and low-latency data storage infrastructure.

AMAZON WEB SERVICES (3)

- US East (North Virginia)
- US West (Oregon)
- US West (North California)
- EU (Frankfurt)
- EU (Ireland)
- Asia Pacific (Singapore)
- Asia Pacific (Tokyo)
- Asia Pacific (Sydney)
- South America (Sao Paulo)

6 TYPES OF INSTANCES

- Micro instances (free tier)
- General purpose
- Memory optimized
- Storage optimized
- Compute optimized
- GPU optimized

AMAZON VERSUS COMPETITION

- Wall Street estimates of AWS revenue are typically in the \$4 billion to \$5 billion range for 2014, representing a doubling of revenue over a two-year period despite continuous decreases in prices
- 10x capacity of its nearest 145 competitors combined

AMAZON TECHNOLOGY

- Xen Hypervisor – proprietary
- Micro instances are oversubscribed
- Storage and local-area networks are shared
- Billed by hour
- Operating systems are chosen by the client
- Can use 3rd party consoles to control your stuff – Vmware, Microsoft

STORAGE

- Transient, instance-specific storage
- Persistent, instance-independent Elastic Block Store (EBS) storage (encryption options)
- Object-based Simple Storage Service (S3)
- Data restricted to region

NETWORKING

- Virtual Private Cloud
- Private routing between VPCs
- VPN tunnels can connect your enterprise to Amazon

SERVICES OFFERED BY AMAZON

Amazon Web Services

Compute

- EC2**
Virtual Servers in the Cloud
- Lambda**
Run Code in Response to Events
- EC2 Container Service**
Run and Manage Docker Containers

Storage & Content Delivery

- S3**
Scalable Storage in the Cloud
- Elastic File System** PREVIEW
Fully Managed File System for EC2
- Storage Gateway**
Integrates On-Premises IT Environments with Cloud Storage
- Glacier**
Archive Storage in the Cloud
- CloudFront**
Global Content Delivery Network

Database

- RDS**
MySQL, Postgres, Oracle, SQL Server, and Amazon Aurora
- DynamoDB**
Predictable and Scalable NoSQL Data Store
- ElastiCache**
In-Memory Cache
- Redshift**
Managed Petabyte-Scale Data Warehouse Service

Networking

- VPC**
Isolated Cloud Resources
- Direct Connect**
Dedicated Network Connection to AWS
- Route 53**
Scalable DNS and Domain Name Registration

Administration & Security

- Directory Service**
Managed Directories in the Cloud
- Identity & Access Management**
Access Control and Key Management
- Trusted Advisor**
AWS Cloud Optimization Expert
- CloudTrail**
User Activity and Change Tracking
- Config**
Resource Configurations and Inventory
- CloudWatch**
Resource and Application Monitoring

Deployment & Management

- Elastic Beanstalk**
AWS Application Container
- OpsWorks**
DevOps Application Management Service
- CloudFormation**
Templated AWS Resource Creation
- CodeDeploy**
Automated Deployments

Analytics

- EMR**
Managed Hadoop Framework
- Kinesis**
Real-time Processing of Streaming Big Data
- Data Pipeline**
Orchestration for Data-Driven Workflows
- Machine Learning**
Build Smart Applications Quickly and Easily

Application Services

- SQS**
Message Queue Service
- SWF**
Workflow Service for Coordinating Application Components
- AppStream**
Low Latency Application Streaming
- Elastic Transcoder**
Easy-to-use Scalable Media Transcoding
- SES**
Email Sending Service
- CloudSearch**
Managed Search Service

Mobile Services

- Cognito**
User Identity and App Data Synchronization
- Mobile Analytics**
Understand App Usage Data at Scale
- SNS**
Push Notification Service

Enterprise Applications

- WorkSpaces**
Desktops in the Cloud
- WorkDocs**
Secure Enterprise Storage and Sharing Service
- WorkMail** PREVIEW
Secure Email and Calendaring Service

Resource Groups

A resource group is a collection of resources that share one or more tags. Create a group for each project, application, or environment in your account.

[Create a Group](#)[Tag Editor](#)

Additional Resources

Getting Started
See our documentation to get started and learn more about how to use our services.

AWS Console Mobile App
View your resources on the go with our AWS Console mobile app, available from [Amazon Appstore](#), [Google Play](#), or [iTunes](#).

AWS Marketplace
Find and buy software, launch with 1-Click and pay by the hour.

AWS re:Invent - Register Now
Join us for keynote announcements, technical sessions, bootcamps and more.

Service Health

 All services operating normally.

Updated: Jul 06 2015 14:41:00 GMT-0500

[Service Health Dashboard](#)

AMAZON RESOURCES

The screenshot displays the Amazon EC2 Dashboard interface. On the left is a navigation sidebar with categories like EC2 Dashboard, INSTANCES, IMAGES, ELASTIC BLOCK STORE, NETWORK & SECURITY, and AUTO SCALING. The main content area is divided into several sections: 'Resources' showing counts for Running Instances, Elastic IPs, Snapshots, Key Pairs, Load Balancers, Volumes, Placement Groups, and Security Groups; 'Create Instance' with a 'Launch Instance' button; 'Service Health' showing the status of the US West (Oregon) region and its availability zones; 'Scheduled Events' showing no events; 'Account Attributes' showing supported platforms and default VPC; and 'AWS Marketplace' listing various software trial products.

EC2 Dashboard

- Events
- Tags
- Reports
- Limits
- INSTANCES
 - Instances
 - Spot Requests
 - Reserved Instances
- IMAGES
 - AMIs
 - Bundle Tasks
- ELASTIC BLOCK STORE
 - Volumes
 - Snapshots
- NETWORK & SECURITY
 - Security Groups
 - Elastic IPs
 - Placement Groups
 - Load Balancers
 - Key Pairs
 - Network Interfaces
- AUTO SCALING
 - Launch Configurations
 - Auto Scaling Groups

Resources

You are using the following Amazon EC2 resources in the US West (Oregon) region:

0 Running Instances	0 Elastic IPs
0 Volumes	0 Snapshots
0 Key Pairs	0 Load Balancers
0 Placement Groups	1 Security Groups

[Automate application deployments to EC2 with CodeDeploy.](#) [Hide](#)

Create Instance

To start using Amazon EC2 you will want to launch a virtual server, known as an Amazon EC2 instance.

[Launch Instance](#)

Note: Your instances will launch in the US West (Oregon) region

Service Health

Service Status:

- US West (Oregon): This service is operating normally

Availability Zone Status:

- us-west-2a: Availability zone is operating normally
- us-west-2b: Availability zone is operating normally
- us-west-2c: Availability zone is operating normally

[Service Health Dashboard](#)

Scheduled Events

US West (Oregon):

No events

Account Attributes

Supported Platforms

VPC

Default VPC

vpc-31e67a54

Additional Information

- [Getting Started Guide](#)
- [Documentation](#)
- [All EC2 Resources](#)
- [Forums](#)
- [Pricing](#)
- [Contact Us](#)

AWS Marketplace

Find **free software trial** products in the AWS Marketplace from the [EC2 Launch Wizard](#). Or try these popular AMIs:

[Brocade 5400 Virtual Router/Firewall/VPN](#)

Provided by Brocade

Rating ★★★★★

Pay by the hour for software and AWS usage

[View all Networking](#)

[Alert Logic Threat Manager for AWS](#)

Provided by Alert Logic, Inc.

Rating ★★★★★

Pay by the hour for software and AWS usage

[View all Security Software](#)

[TIBCO Spotfire Analytics Platform \(Hourly\)](#)

Provided by TIBCO Software, Inc.

Rating ★★★★★

Pay by the hour for software and AWS usage

BUILDING A SYSTEM

1. Choose AMI

2. Choose Instance Type

3. Configure Instance

4. Add Storage

5. Tag Instance

6. Configure Security Group

7. Review

Cancel and Exit

Step 1: Choose an Amazon Machine Image (AMI)

An AMI is a template that contains the software configuration (operating system, application server, and applications) required to launch your instance. You can select an AMI provided by AWS, our user community, or the AWS Marketplace; or you can select one of your own AMIs.


Quick Start

My AMIs

AWS Marketplace

Community AMIs


☐ Free tier only ⓘ

 **Amazon Linux**
Free tier eligible

Amazon Linux AMI 2015.03 (HVM), SSD Volume Type - ami-e7527ed7
The Amazon Linux AMI is an EBS-backed, AWS-supported image. The default image includes AWS command line tools, Python, Ruby, Perl, and Java. The repositories include Docker, PHP, MySQL, PostgreSQL, and other packages.
Root device type: ebs Virtualization type: hvm

Select


64-bit

 **Red Hat**
Free tier eligible

Red Hat Enterprise Linux 7.1 (HVM), SSD Volume Type - ami-4dbf9e7d
Red Hat Enterprise Linux version 7.1 (HVM), EBS General Purpose (SSD) Volume Type
Root device type: ebs Virtualization type: hvm

Select


64-bit

 **SUSE Linux**
Free tier eligible

SUSE Linux Enterprise Server 12 (HVM), SSD Volume Type - ami-d7450be7
SUSE Linux Enterprise Server 12 (HVM), EBS General Purpose (SSD) Volume Type. Public Cloud, Advanced Systems Management, Web and Scripting, and Legacy modules enabled.
Root device type: ebs Virtualization type: hvm

Select


64-bit

 **Ubuntu**
Free tier eligible

Ubuntu Server 14.04 LTS (HVM), SSD Volume Type - ami-5189a661
Ubuntu Server 14.04 LTS (HVM), EBS General Purpose (SSD) Volume Type. Support available from Canonical (<http://www.ubuntu.com/cloud/services>).
Root device type: ebs Virtualization type: hvm

Select

64-bit

 **Windows**

Microsoft Windows Server 2012 R2 Base - ami-67c7ff57
Microsoft Windows 2012 R2 Standard edition with 64-bit architecture. [English]
Root device type: ebs Virtualization type: hvm

Select

64-bit

Are you launching a database instance? Try Amazon RDS.

Hide

BUILDING A SYSTEM (2)

1. Choose AMI2. Choose Instance Type3. Configure Instance4. Add Storage5. Tag Instance6. Configure Security Group7. Review

Step 2: Choose an Instance Type

Amazon EC2 provides a wide selection of instance types optimized to fit different use cases. Instances are virtual servers that can run applications. They have varying combinations of CPU, memory, storage, and networking capacity, and give you the flexibility to choose the appropriate mix of resources for your applications. [Learn more](#) about instance types and how they can meet your computing needs.

Filter by:

All instance typesCurrent generationShow/Hide Columns

Currently selected: t2.micro (Variable ECUs, 1 vCPUs, 2.5 GHz, Intel Xeon Family, 1 GiB memory, EBS only)

	Family	Type	vCPUs	Memory (GiB)	Instance Storage (GB)	EBS-Optimized Available	Network Performance
<input checked="" type="checkbox"/>	General purpose	t2.micro Free tier eligible	1	1	EBS only	-	Low to Moderate
<input type="checkbox"/>	General purpose	t2.small	1	2	EBS only	-	Low to Moderate
<input type="checkbox"/>	General purpose	t2.medium	2	4	EBS only	-	Low to Moderate
<input type="checkbox"/>	General purpose	t2.large	2	8	EBS only	-	Low to Moderate
<input type="checkbox"/>	General purpose	m4.large	2	8	EBS only	Yes	Moderate
<input type="checkbox"/>	General purpose	m4.xlarge	4	16	EBS only	Yes	High
<input type="checkbox"/>	General purpose	m4.2xlarge	8	32	EBS only	Yes	High
<input type="checkbox"/>	General purpose	m4.4xlarge	16	64	EBS only	Yes	High
<input type="checkbox"/>	General purpose	m4.10xlarge	40	160	EBS only	Yes	10 Gigabit
<input type="checkbox"/>	General purpose	m3.medium	1	3.75	1 x 4 (SSD)	-	Moderate

Cancel

Previous

Review and Launch

Next: Configure Instance Details

MICROSOFT

- Cloud first, mobile first
- Virtualization provided by Hyper-V
- Microsoft Azure is IaaS and PaaS
- Office 365 and Office for iPad
- SharePoint
- Yammer (social and collaboration)
- Exchange (primary competitor to Gmail)
- Dynamics CRM

MICROSOFT AZURE

- It was launched by Microsoft in 2010
- Provides both PaaS and IaaS services
- It is like a hybrid cloud provider

USES OF AZURE

- Can be used for anything since it provides IaaS services that can host virtual machines
- However, its PaaS services have been known to host web sites that may receive a lot of traffic
- Good for .NET developers

AZURE CLOUD

- Microsoft developed their own operating system called Windows Azure that is used for their datacenter cluster
- Uses Hyper-V, a Windows server Hypervisor that can run virtual machines

MICROSOFT AZURE (2)

- Windows Azure is the OS for the data center
 - Model: treat the data center as a machine
 - Handles resource management, provisioning, and monitoring
 - Manages application lifecycle
 - Allows developers to concentrate on business logic
- Provides shared pool of compute, disk and network
 - Virtualized storage, compute and network
 - Illusion of boundless resources
- Provides common building blocks for distributed applications

MODELING CLOUD APPLICATIONS

- A cloud application is typically made up of different components:
 - Front end: e.g. load-balanced stateless web servers
 - Middle worker tier: e.g. order processing, encoding
 - Backend storage: e.g. SQL tables or files
 - Multiple instances of each for scalability and availability

THE MICROSOFT AZURE SERVICE MODEL

- A Microsoft Azure application is called a 'service':
 - Definition information
 - Configuration information
 - At least one 'role'
- Roles are like DLLs in the service 'process'
 - Collection of code with an entry point that runs in its own virtual machine
- There are currently three role types:
 - Web role: e.g. ASP.NET in MS Azure supplied OS
 - Worker role: e.g. arbitrary code in MS Azure supplied OS
 - VM role: uploaded VHD with customer supplied OS

ROLE CONTENTS

- Definition:
 - Role name
 - Role type
 - VM size (e.g. small, medium, etc.)
 - Network endpoints
- Code:
 - Web/Worker role: hosted DLL and other executables
 - VM Role: VHD
- Configuration:
 - Number of instances
 - Number of update and fault domains

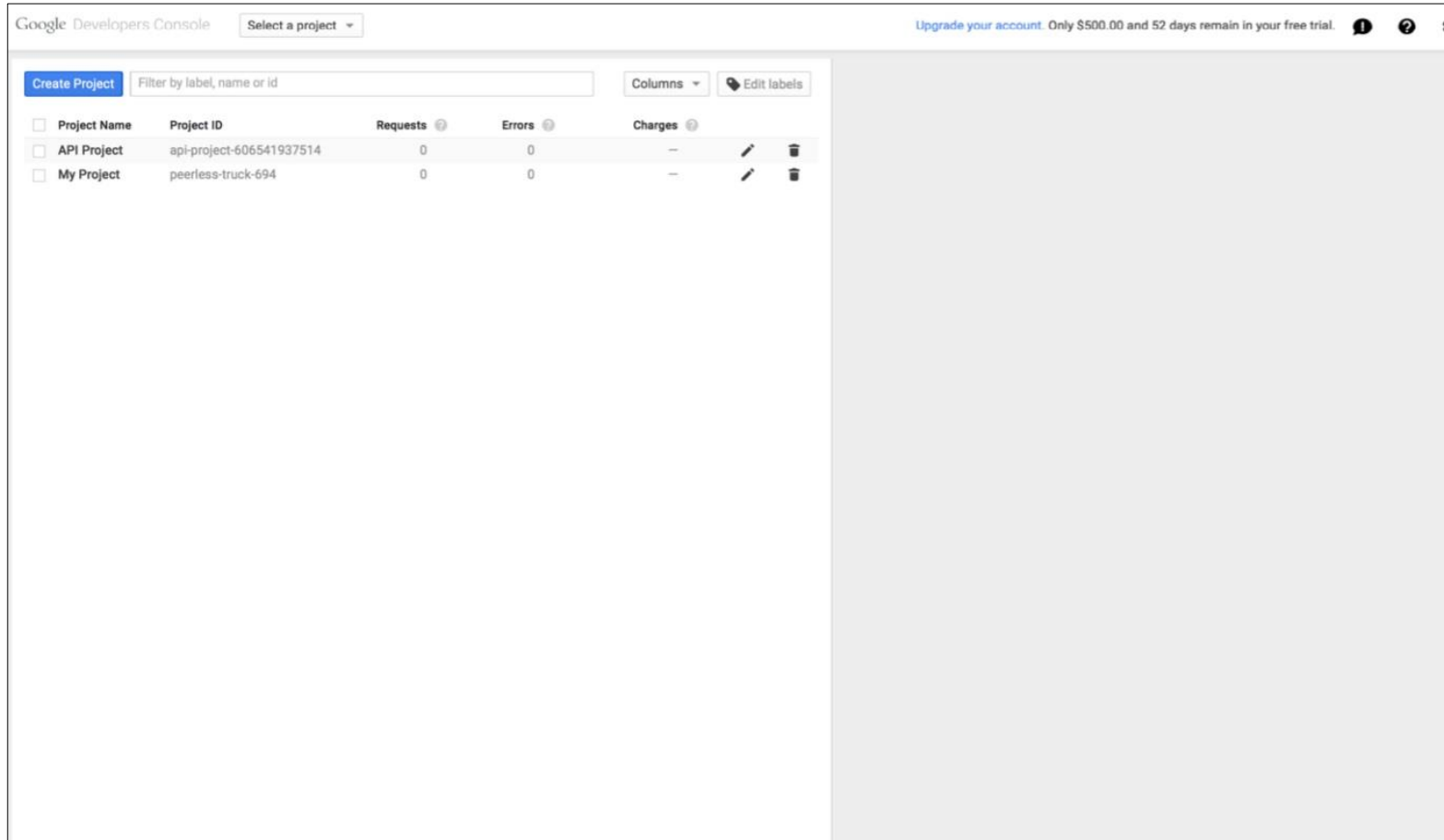
GOOGLE

- Leads online advertising
- Small and mid-size businesses
- Does not change to meet customer needs
- Does rapidly innovate
- Values data, including real-time data
- Champions cloud, web-scale infrastructure
- We're not like you and you should want to be more like us





PLATFORM AS A SERVICE

- Google App Engine: Python, Java, PHP, Go
- Shared hardware
- Cloud storage (object store)
- NoSQL cloud data store
- MySQL-based relational Cloud SQL
- Apache Hadoop
- Cloud Pub/Sub
- Cloud endpoints
- Business analytics - baPaaS

GOOGLE CLOUD PROJECT



The screenshot displays the Google Developers Console interface. At the top, there's a header with the Google logo, 'Developers Console', a 'Select a project' dropdown, and a trial status message: 'Upgrade your account. Only \$500.00 and 52 days remain in your free trial.' Below the header, there's a 'Create Project' button and a search bar labeled 'Filter by label, name or id'. To the right of the search bar are 'Columns' and 'Edit labels' options. The main content area features a table with the following data:

<input type="checkbox"/>	Project Name	Project ID	Requests	Errors	Charges	
<input type="checkbox"/>	API Project	api-project-606541937514	0	0	—	 
<input type="checkbox"/>	My Project	peerless-truck-694	0	0	—	 

GOOGLE CLOUD OVERVIEW

Google Developers Console

My Project

Upgrade your account. Only \$500.00 and 52 days remain in your free trial.

Overview

Permissions

APIs & auth

Monitoring

Source Code

Deploy & Manage

Compute

App Engine

Compute Engine

VM instances

Instance groups

Instance templates

Disks

Snapshots

Images

Networks

Network load balancing

HTTP load balancing

Metadata

Zones

Operations

Quotas

Settings

Container Engine

Networking

Storage

Big Data

New instance New instance group Reset Start Stop Delete

VM instances

CPU utilization

1 hour 6h 12h 1 day 2d 4d 7d 14d 30d

CPU

...

<input type="checkbox"/>	Name ^	Zone	Disk	Network	In use by	External IP	Connect
<input type="checkbox"/>	instance-1	us-central1-f	instance-1	default		130.211.126.70	SSH

Activities (Idle)

Create VM instance "instance-1" and its boot disk "instance-1"

Initializing Compute Engine for project My Project

THAT'S ALL FOR TODAY