VIRTUALIZATION

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CONTENTS

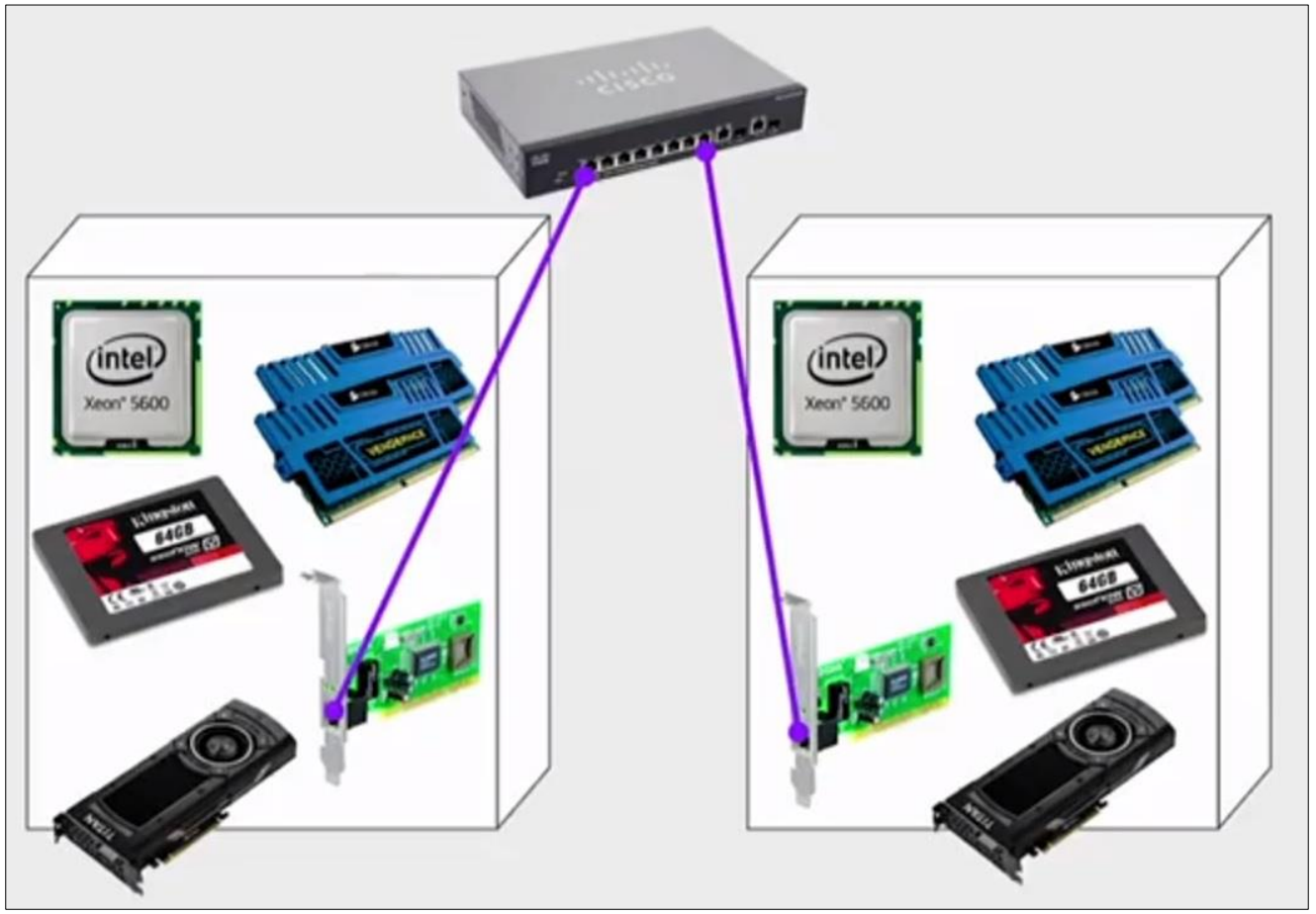
- Virtualization
- OS-based virtualization
- Infrastructure as a Service (IaaS) providers

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

ABSTRACTION

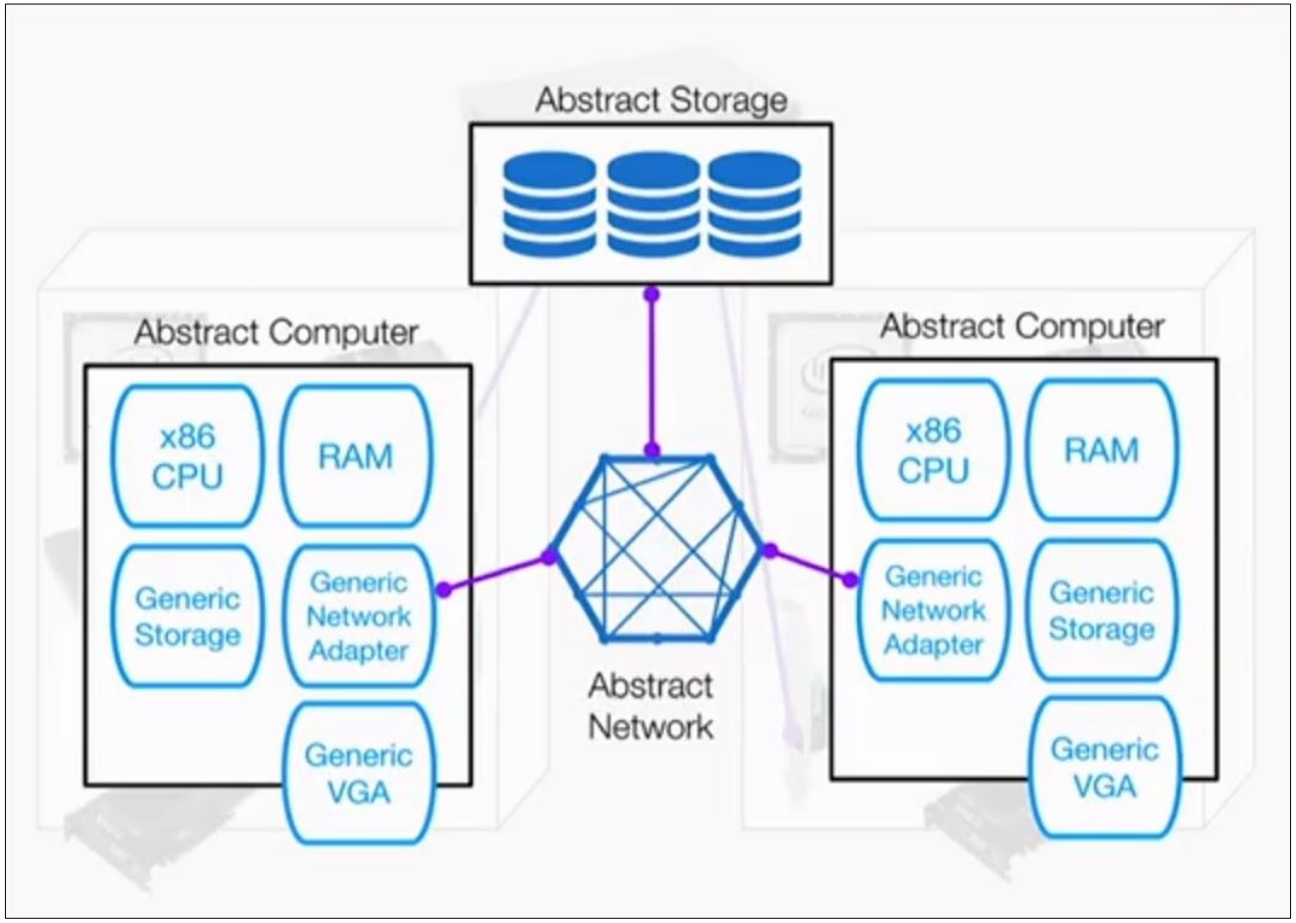
- Introduce an abstract model of what a generic computing resource should look like
- The physical computer resource then provides this abstract model to many users

LAYERS OF ABSTRACTION

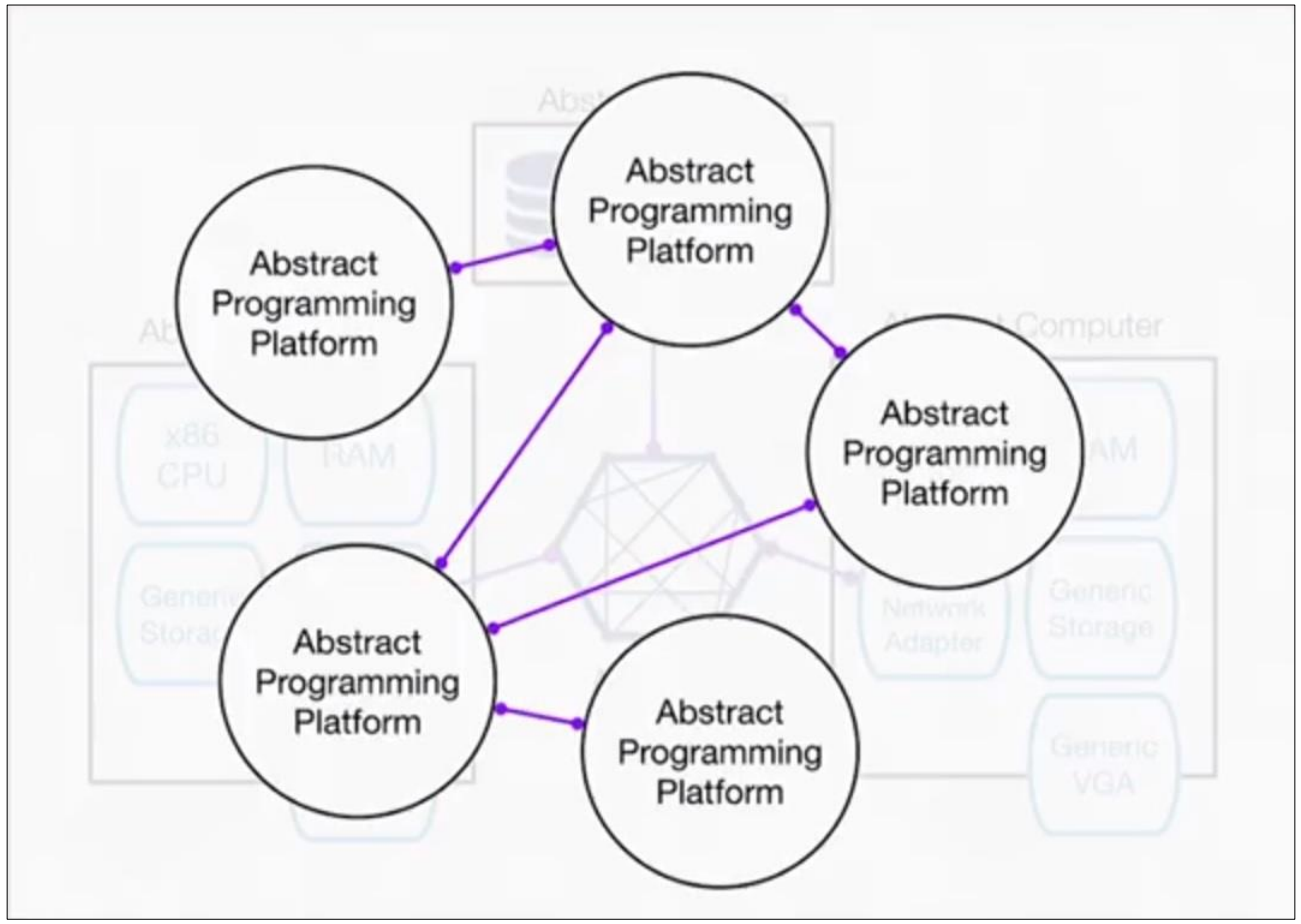


Virtualization is the mechanism to create the dependencies and to map those dependencies onto the real hardware and provide the layer of abstraction we want.

LAYERS OF ABSTRACTION (2)



LAYERS OF ABSTRACTION (3)



VIRTUALIZATION: FOUNDATION OF CLOUD COMPUTING

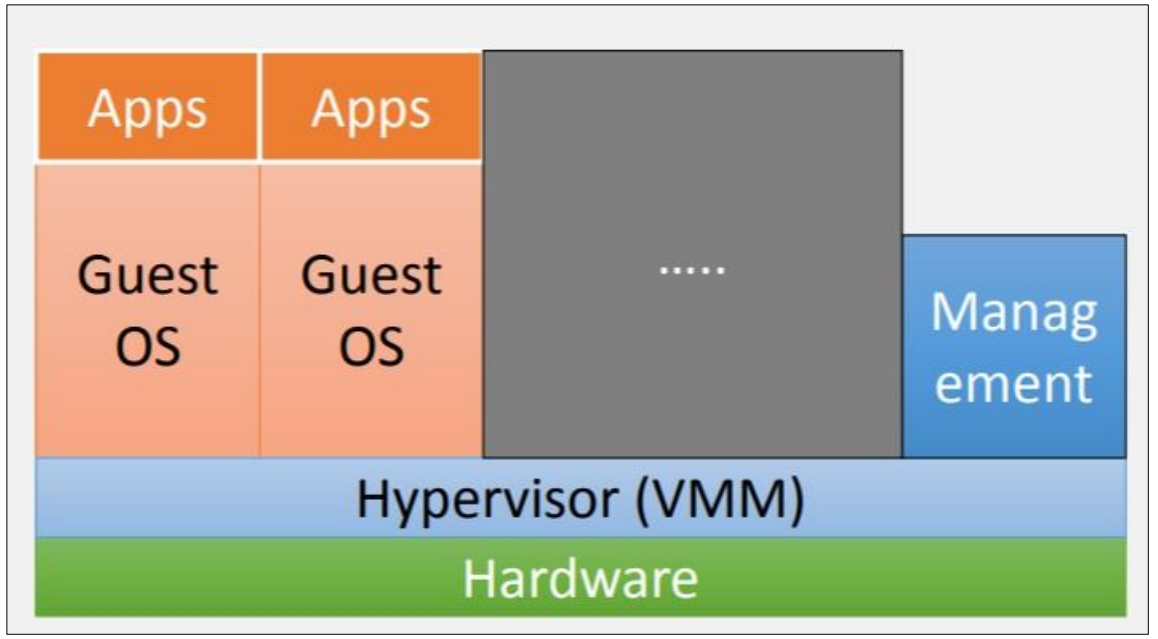
- **It doesn’t create dependencies between the physical resources and the client’s application**
- Clouds are based on virtualization
- Clients can construct services from lots of resources

TYPES OF VIRTUALIZATION

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

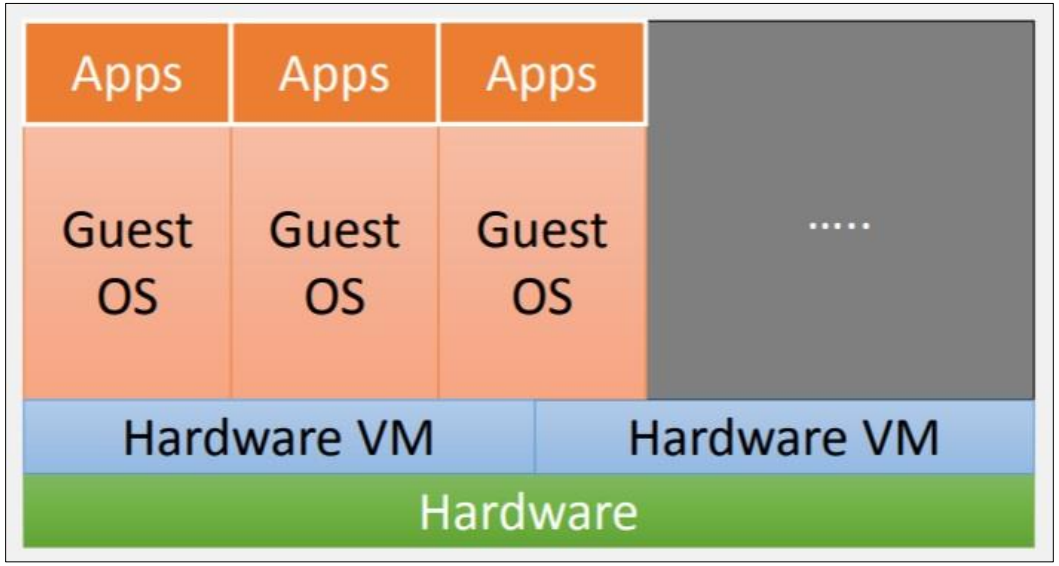
NATIVE AND FULL VIRTUALIZATION

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



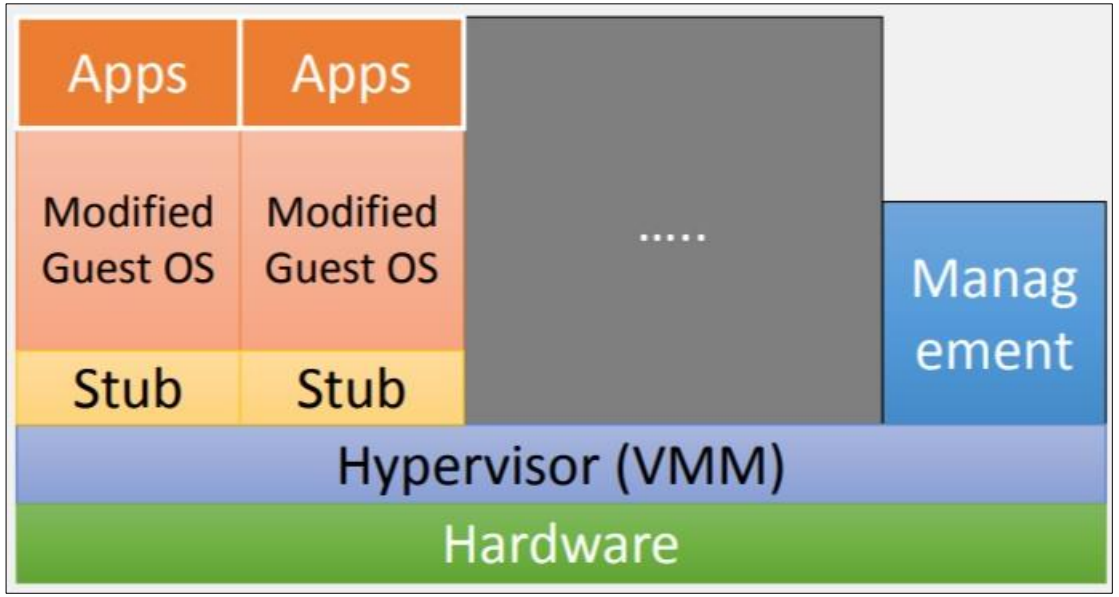
HARDWARE ENABLED VIRTUALIZATION

- 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



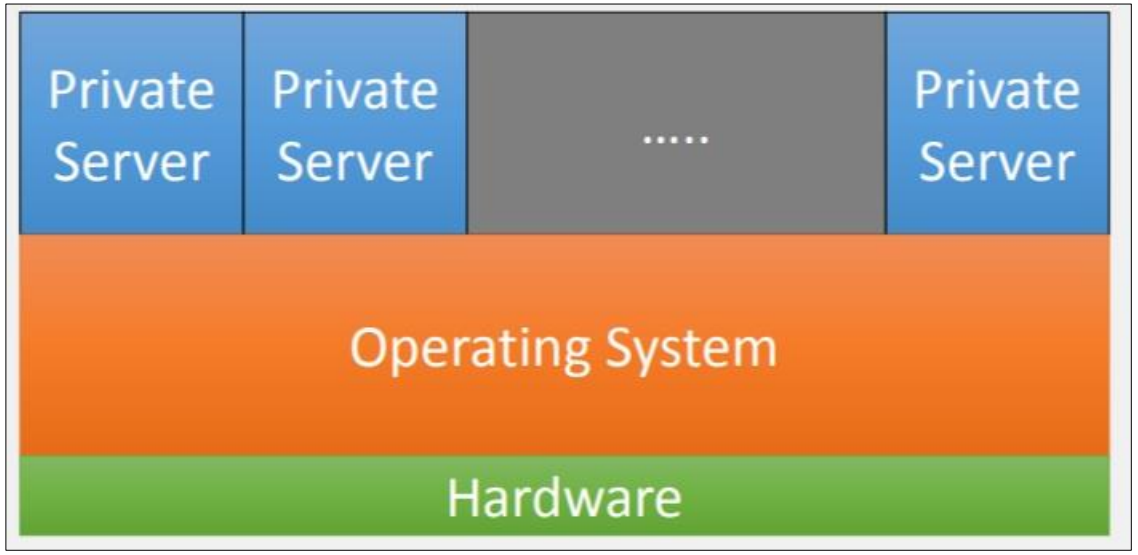
PARAVIRTUALIZATION

- 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

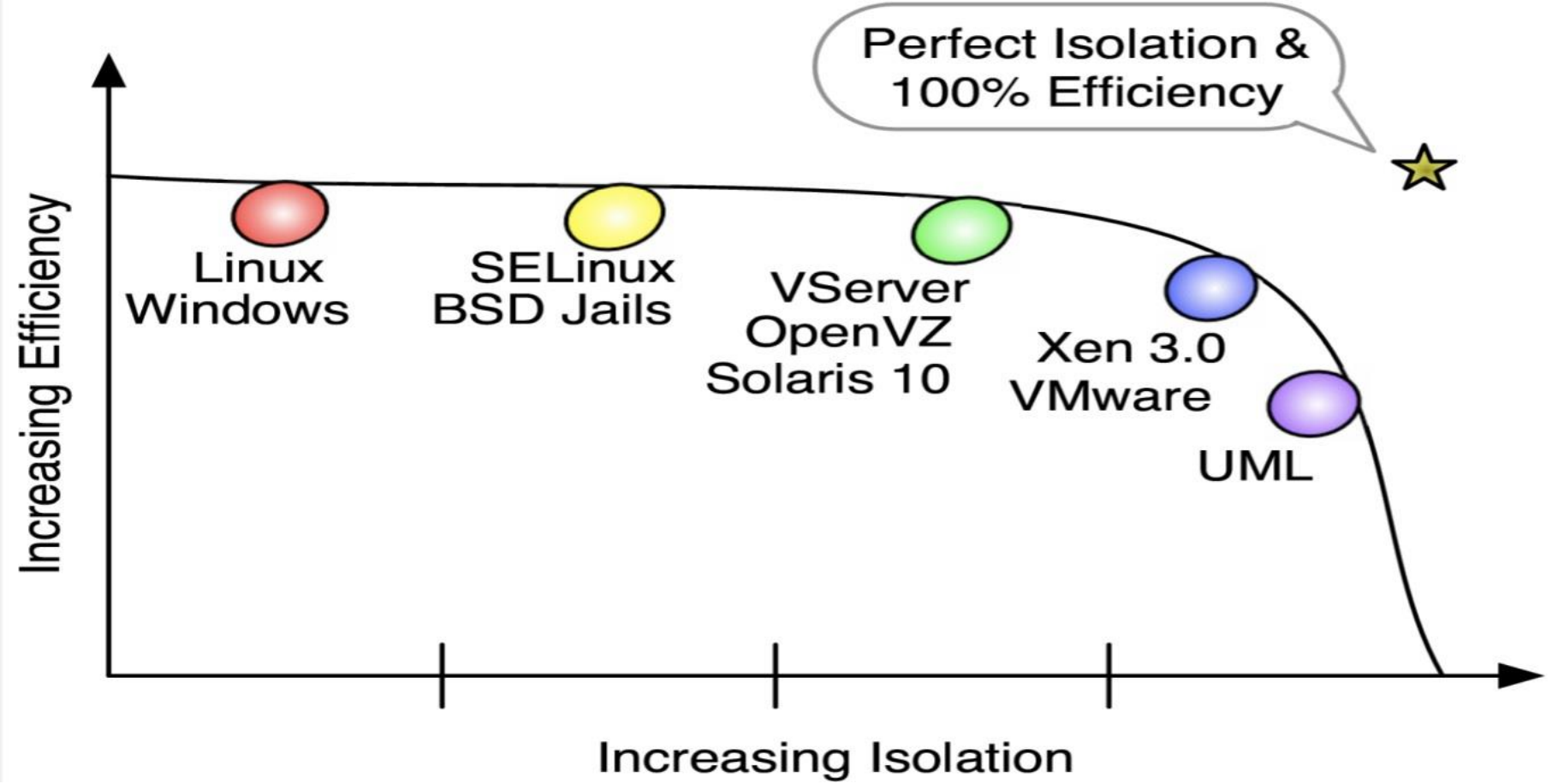
- Virtualizing a physical server at the operating system level, enabling multiple isolated and secure virtualized servers to run on a single physical server
- Examples:
  - Linux-Vserver
  - Solaris Containers
  - FreeBSD Jails
  - Chroot
  - CGroups



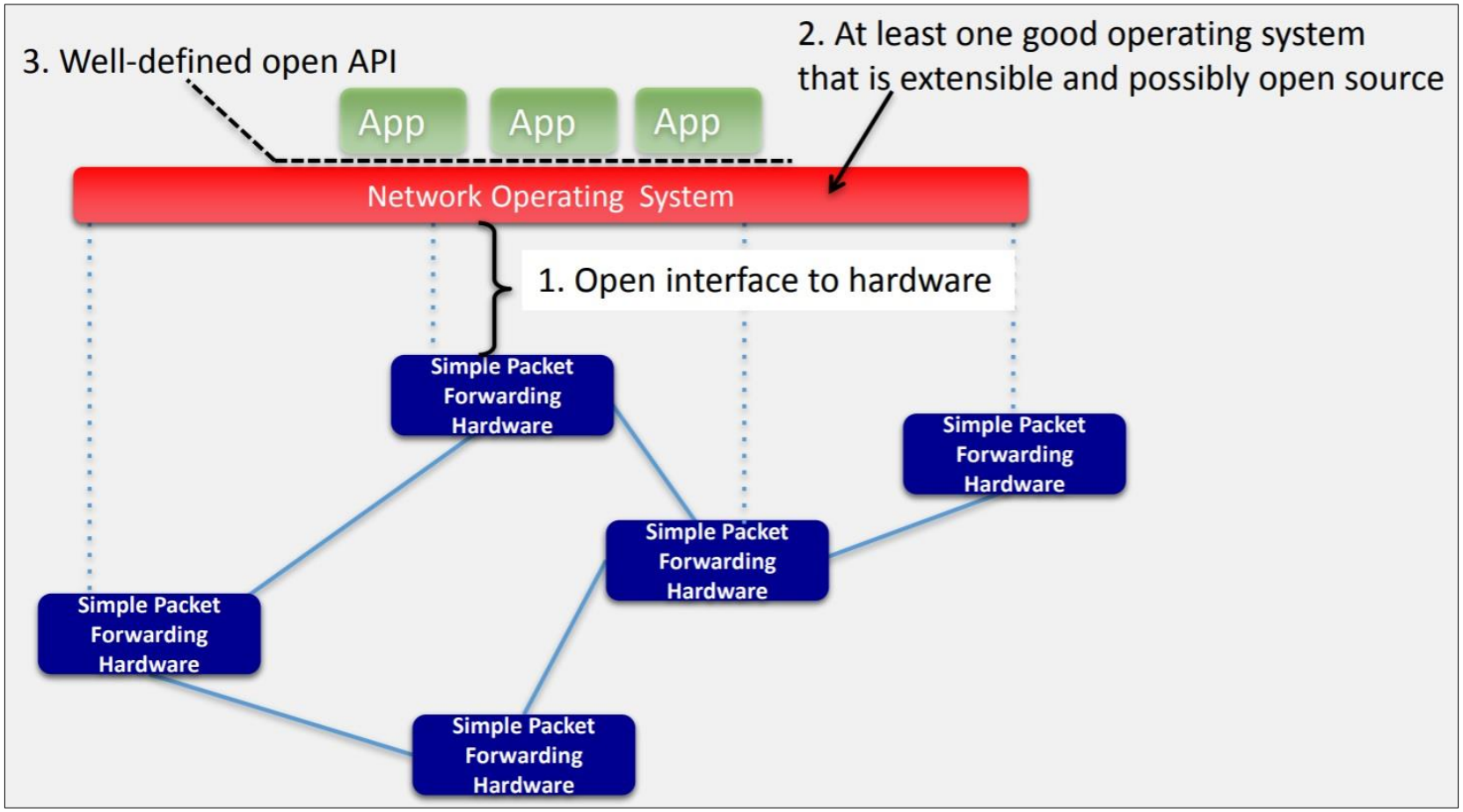
OPERATING SYSTEM-LEVEL VIRTUALIZATION (2)

- 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

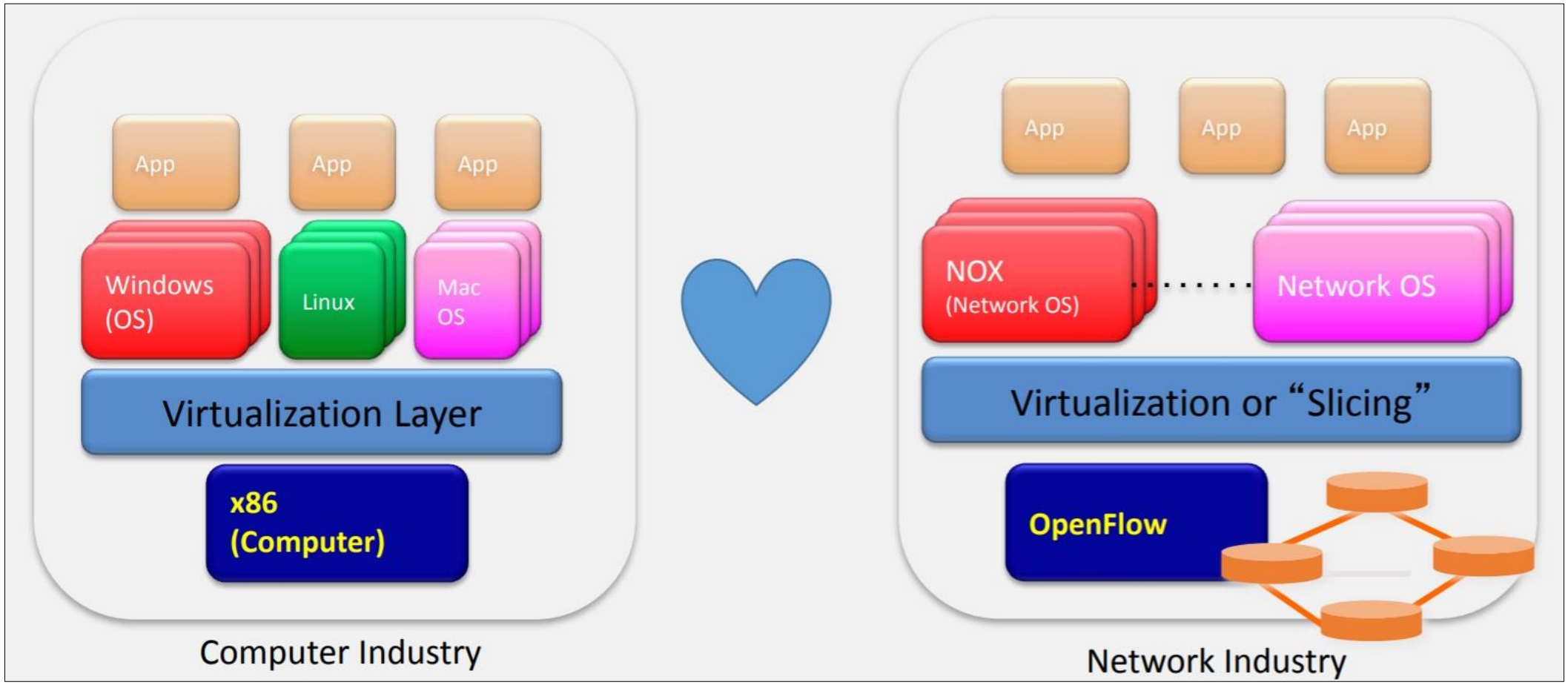
THE TRADE-OFF



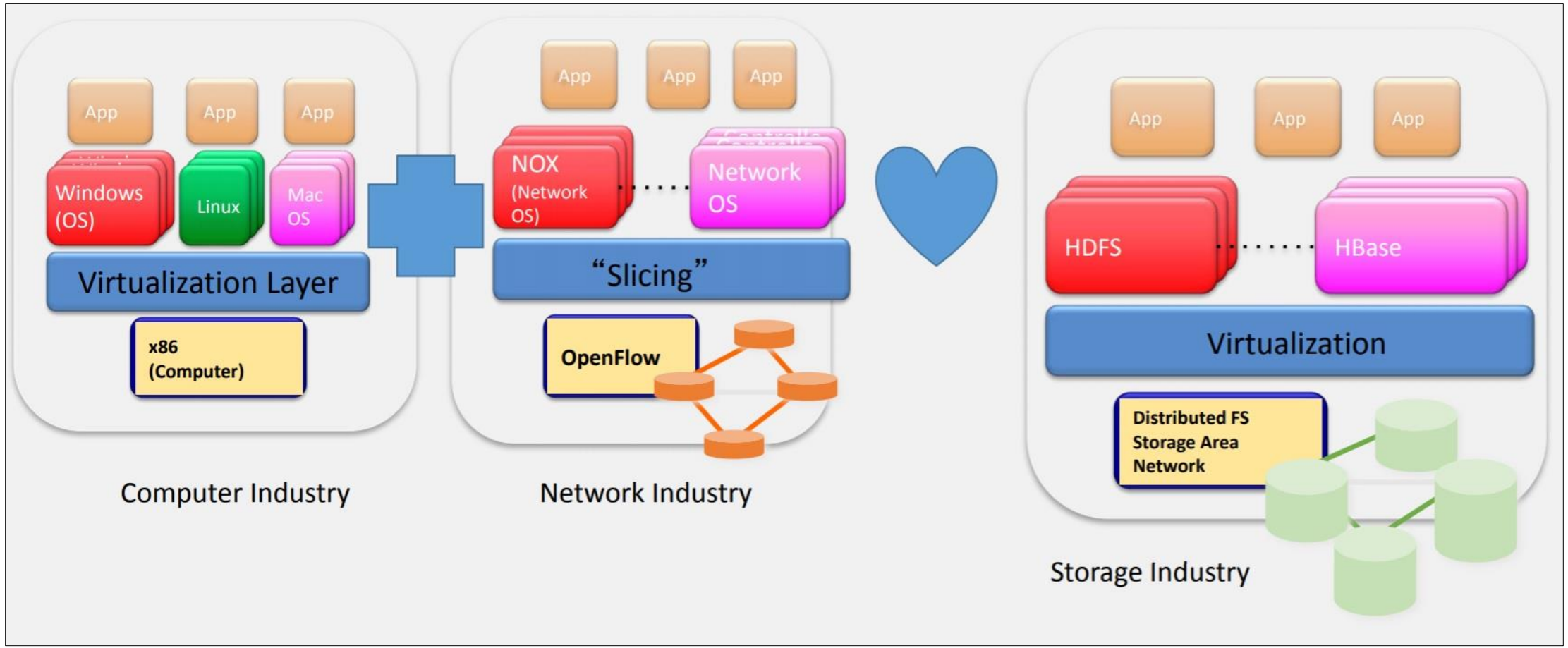
THE “SOFTWARE-DEFINED NETWORK”



VIRTUALIZED OS + VIRTUALIZED NETWORK



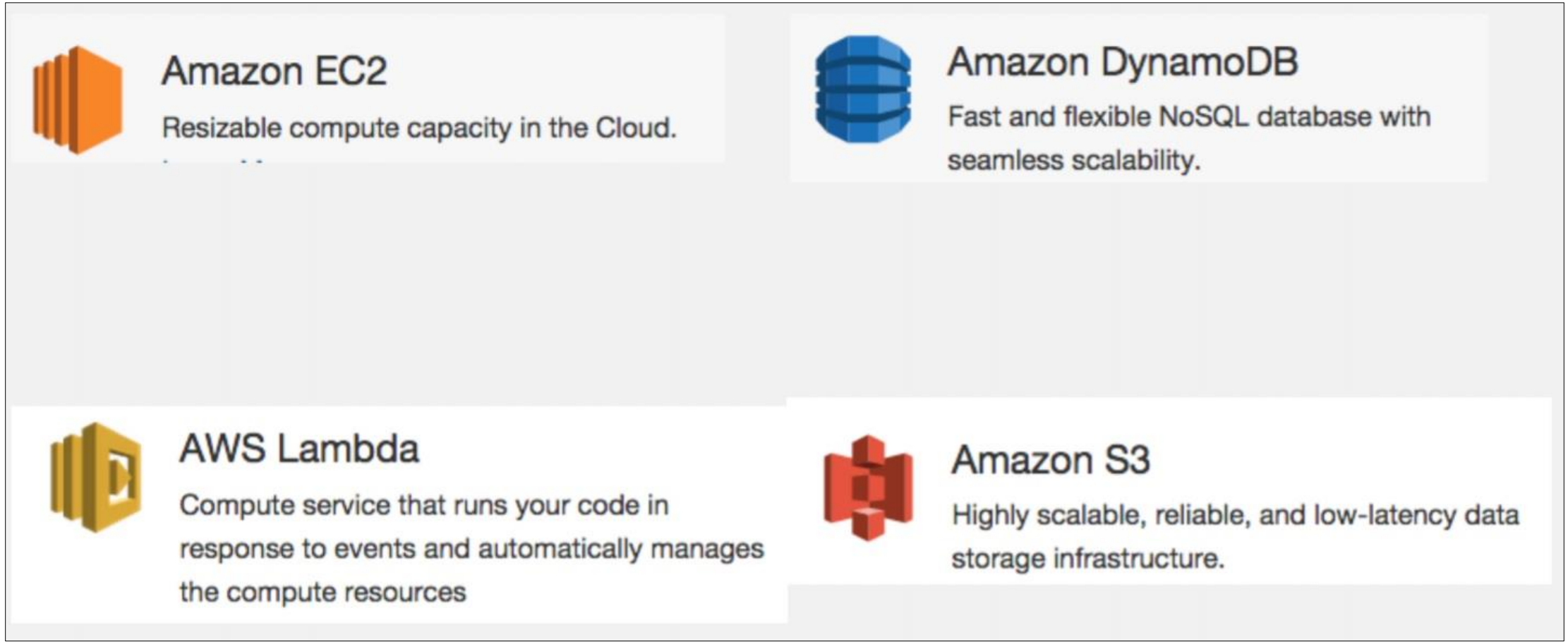
THEN ADD VIRTUALIZED STORAGE



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 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 Paolo)

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

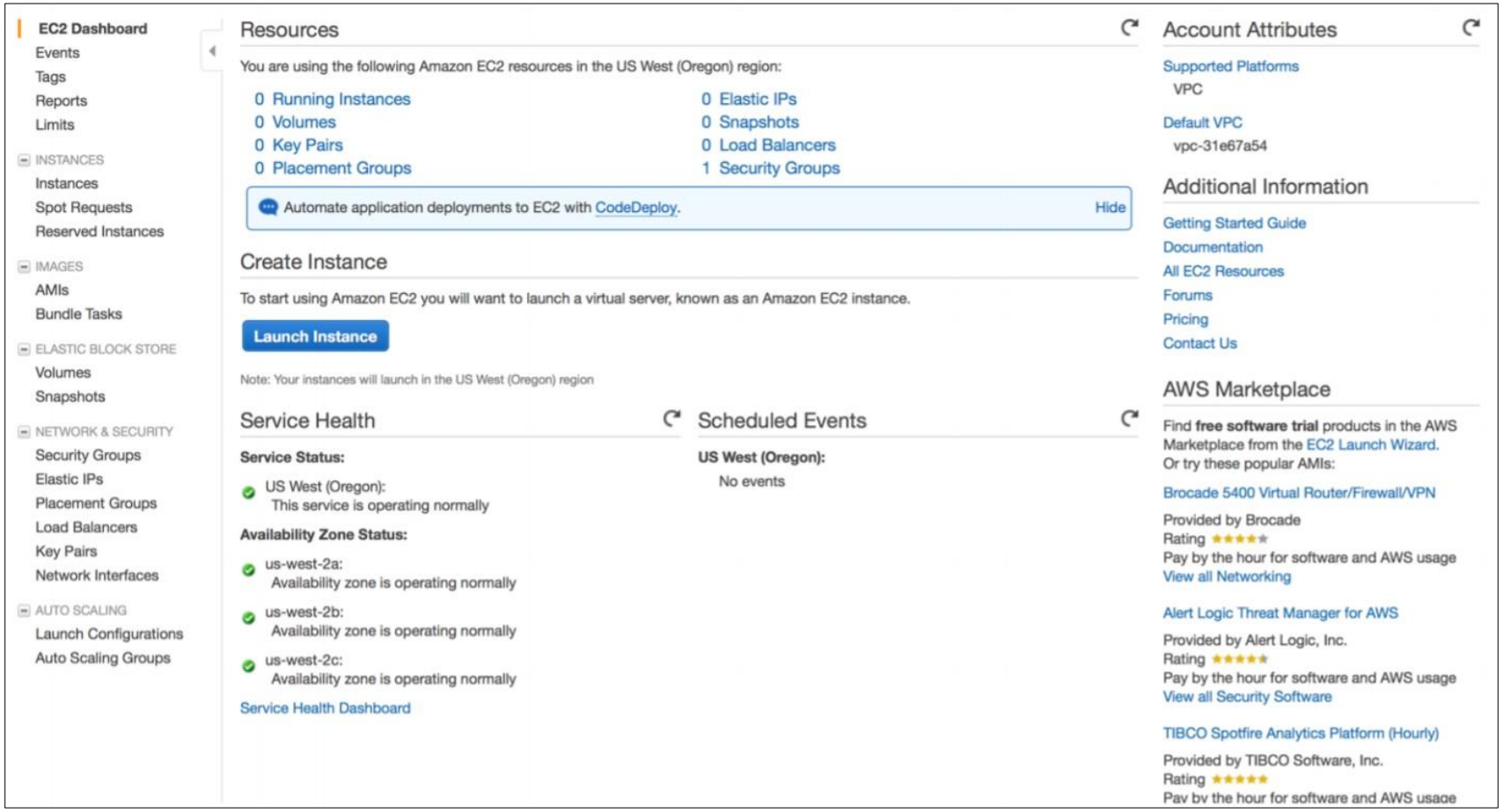
- Transient, instance-specific storage
- Persistent, instance-independent Elastic Block Store (EBS) storage (encryption options)
- Object-based Simple Storage Service (S3)
- Data restricted to region

NETWORKING

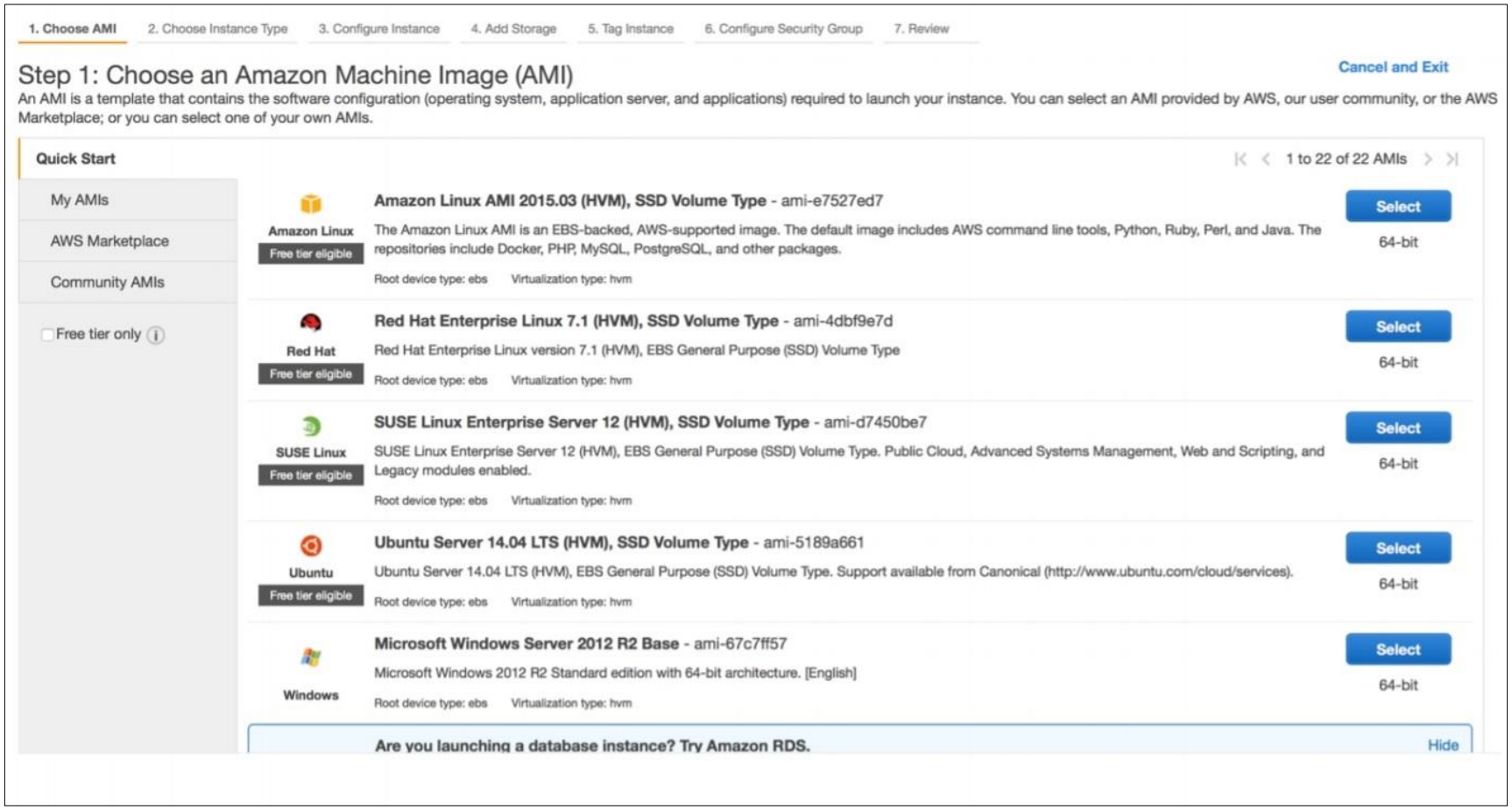
- Virtual Private Cloud
- Private routing between VPCs
- VPN tunnels can connect your enterprise to Amazon

SERVICES OFFERED BY AMAZON

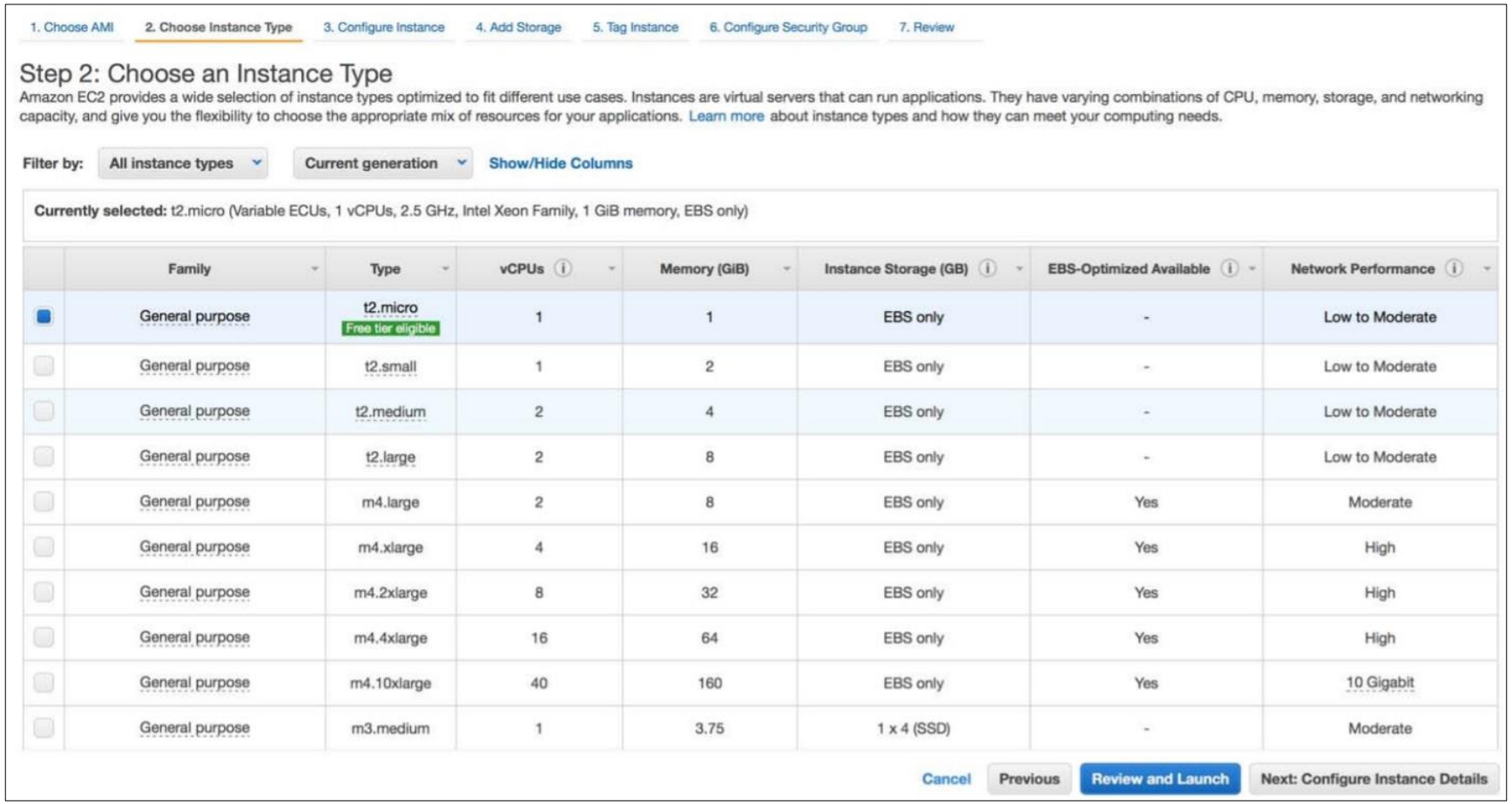
AMAZON RESOURCES



BUILDING A SYSTEM



BUILDING A SYSTEM (2)



1. Choose AMI | 2. Choose Instance Type | 3. Configure Instance | 4. Add Storage | 5. Tag Instance | 6. Configure Security Group | 7. 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 types | Current generation | Show/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
☑	General purpose	t2.micro (Free tier eligible)	1	1	EBS only	-	Low to Moderate
☐	General purpose	t2.small	1	2	EBS only	-	Low to Moderate
☐	General purpose	t2.medium	2	4	EBS only	-	Low to Moderate
☐	General purpose	t2.large	2	8	EBS only	-	Low to Moderate
☐	General purpose	m4.large	2	8	EBS only	Yes	Moderate
☐	General purpose	m4.xlarge	4	16	EBS only	Yes	High
☐	General purpose	m4.2xlarge	8	32	EBS only	Yes	High
☐	General purpose	m4.4xlarge	16	64	EBS only	Yes	High
☐	General purpose	m4.10xlarge	40	160	EBS only	Yes	10 Gigabit
☐	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

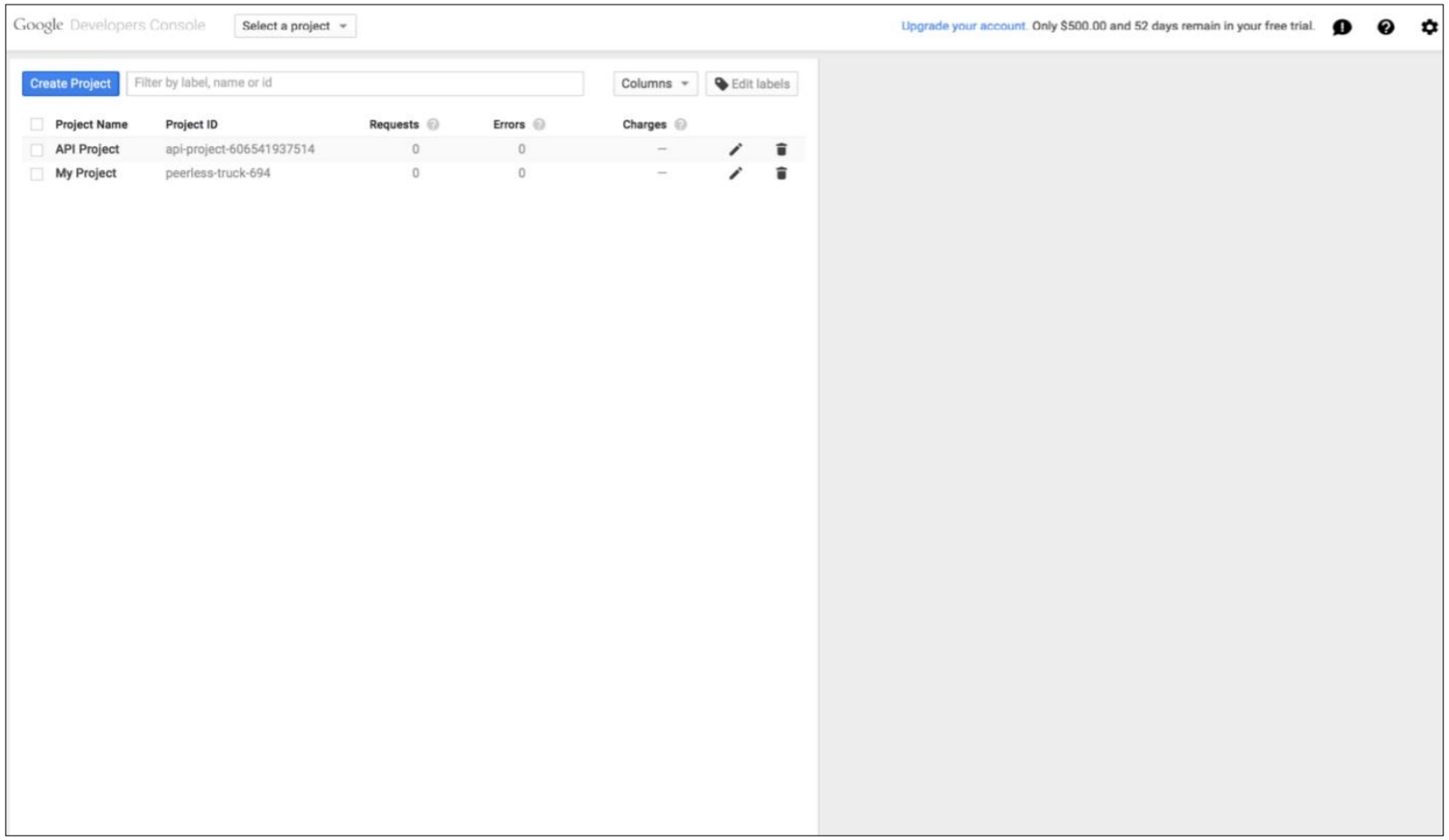
GOOGLE

- 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



GOOGLE CLOUD OVERVIEW