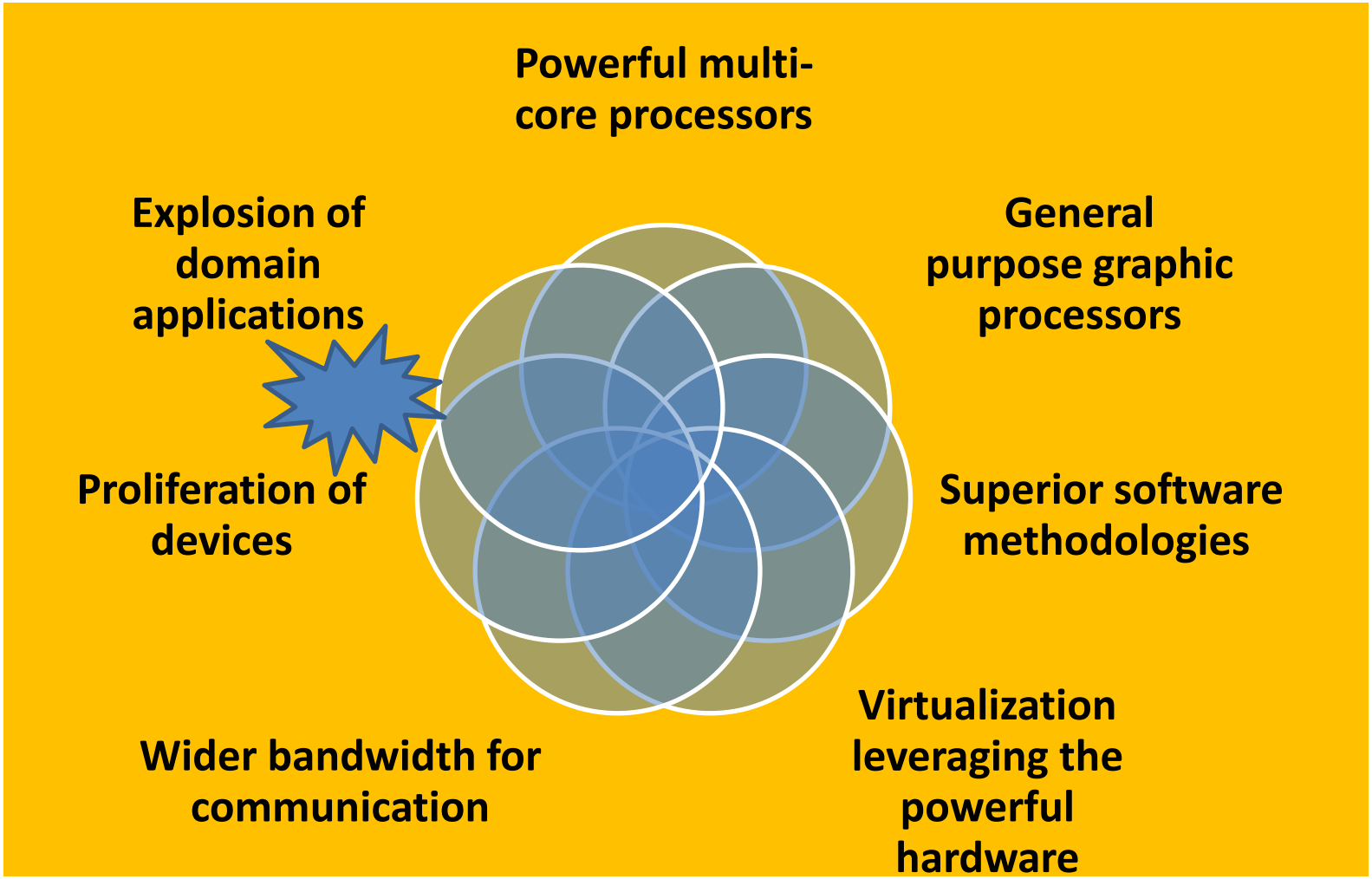
Cloud Computing
A Technical Overview

Chaiyaporn Khemapatapan, Ph.D

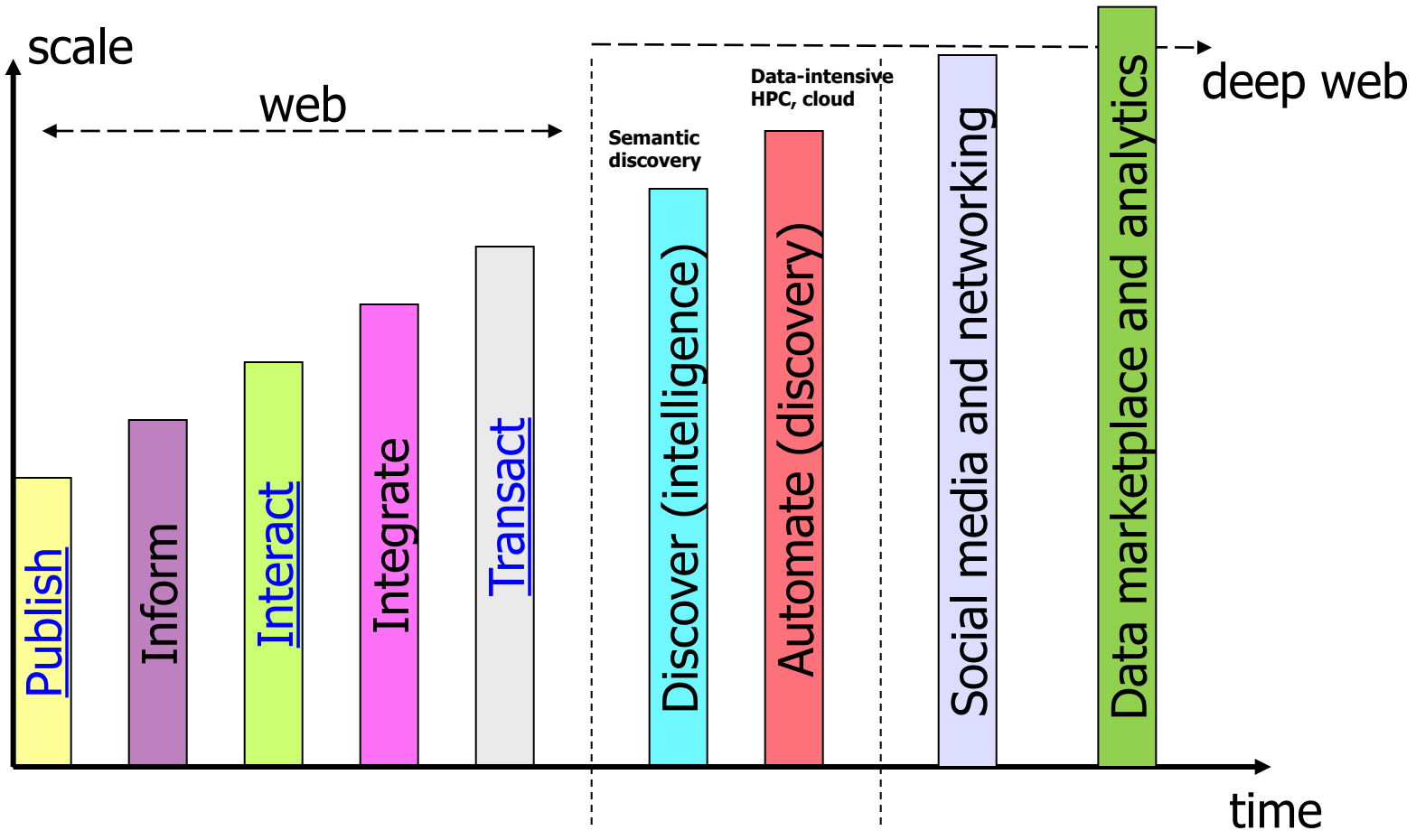
Learning Objectives

- To clearly know what is **Cloud Computing**
- To understand a brief technical concept of **Cloud Computing**
- To aware the importance of **Cloud Computing**
- To learn the architecture of **Cloud Computing**
- To learn how migration does
- To learn On-Premise Cloud Technology
- To know public cloud services

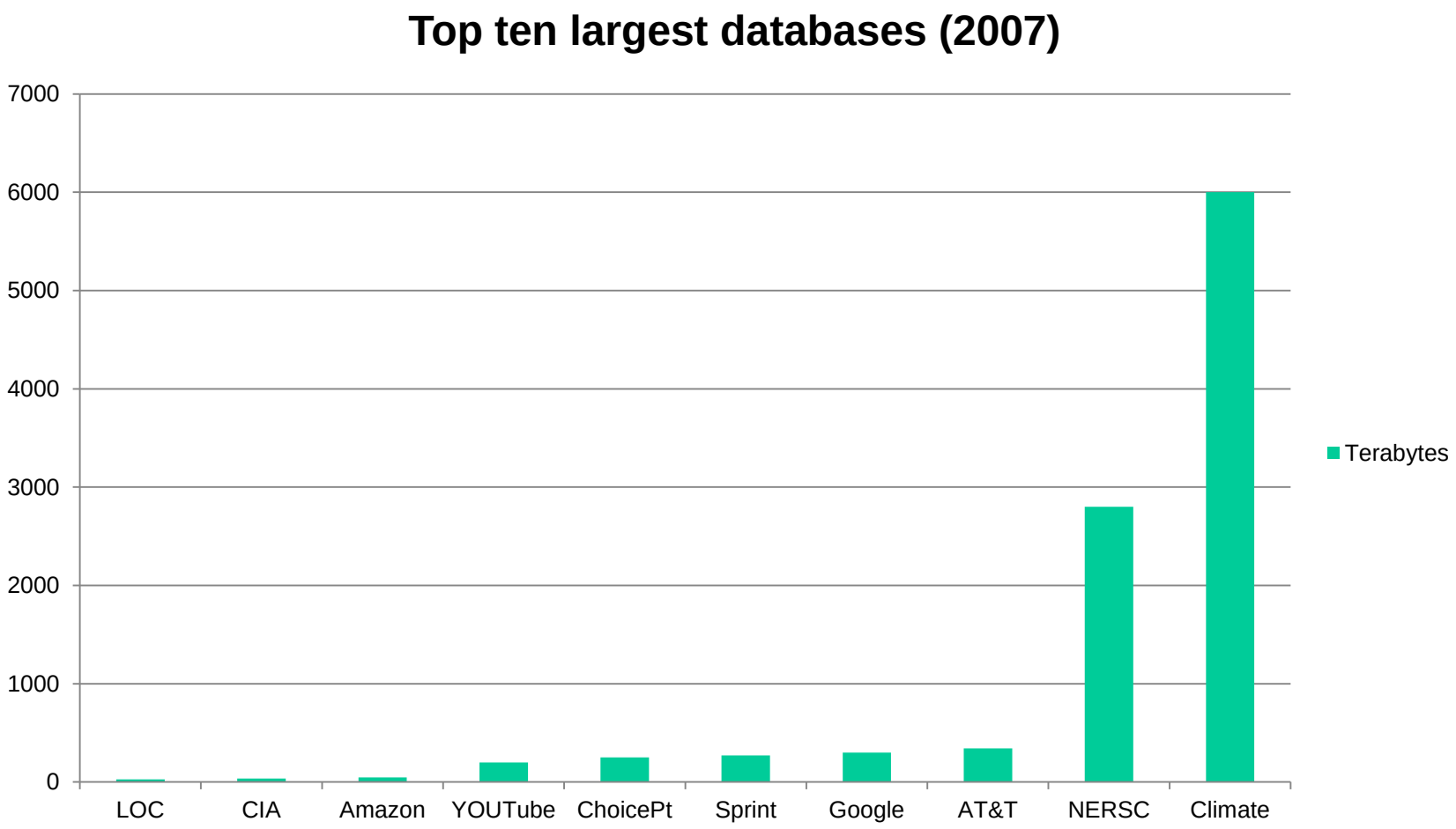
Introduction: A Golden Era in Computing



Evolution of Internet Computing

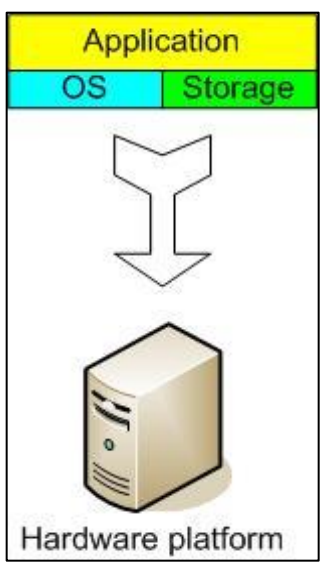


Top Ten Largest Databases



Ref: http://www.focus.com/fyi/operations/10-largest-databases-in-the-world/

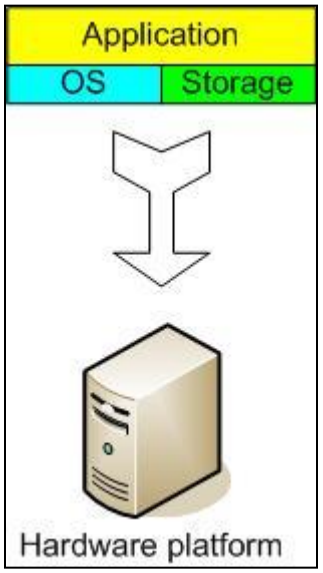
The Traditional Server Concept



Web Server

Windows

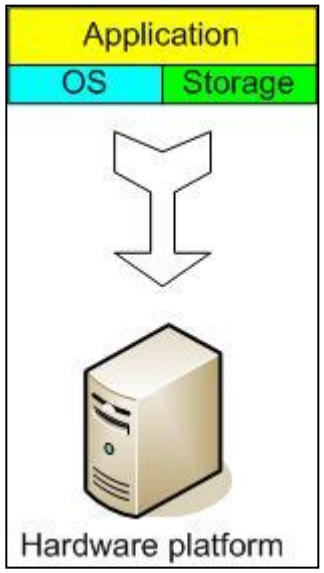
IIS



App Server

Linux

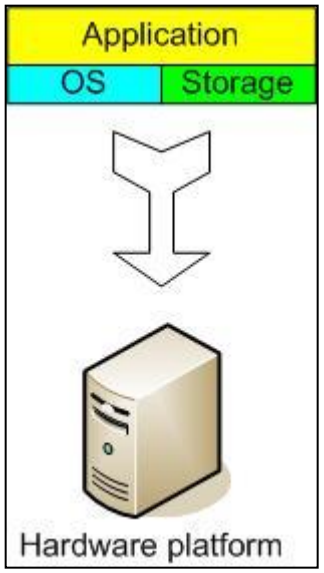
Glassfish



DB Server

Linux

MySQL

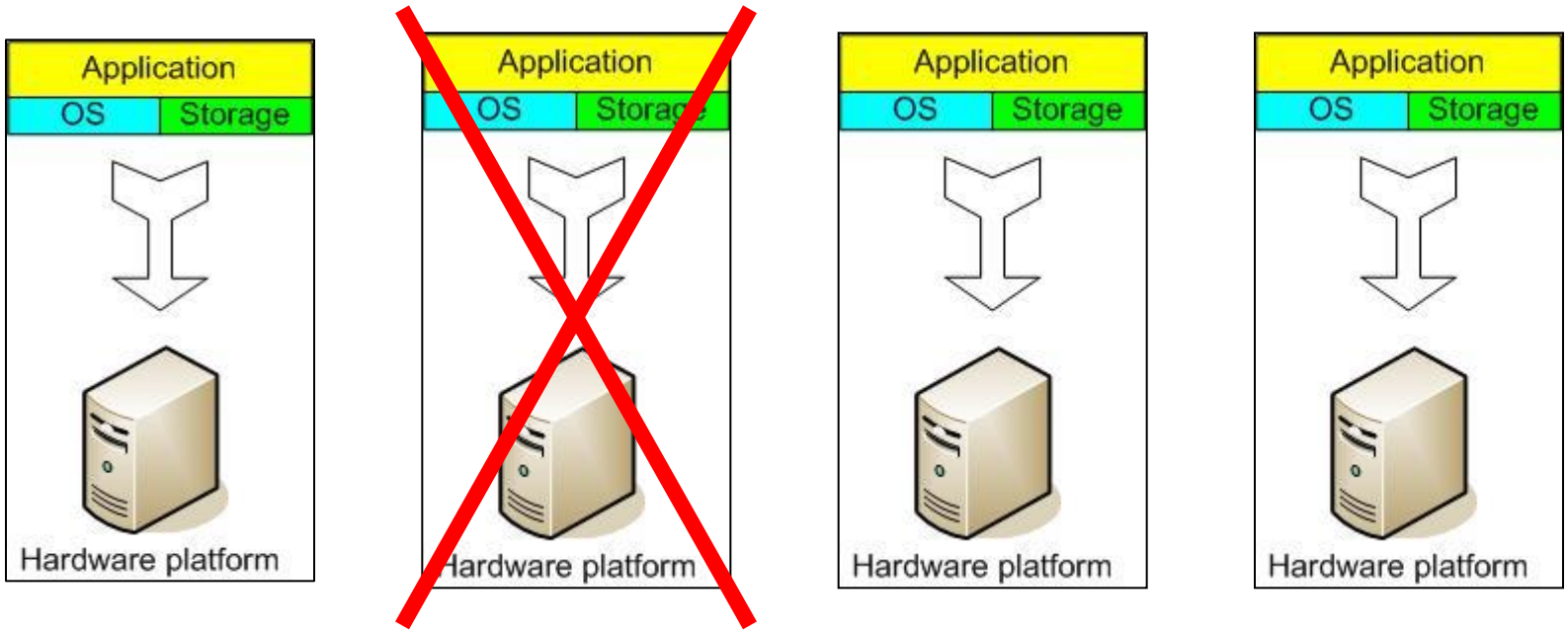


EMail

Windows

Exchange

And if something goes wrong ...



Web Server	App Server	DB Server	EMail
Windows	DOWN!	Linux	Windows
IIS		MySQL	Exchange

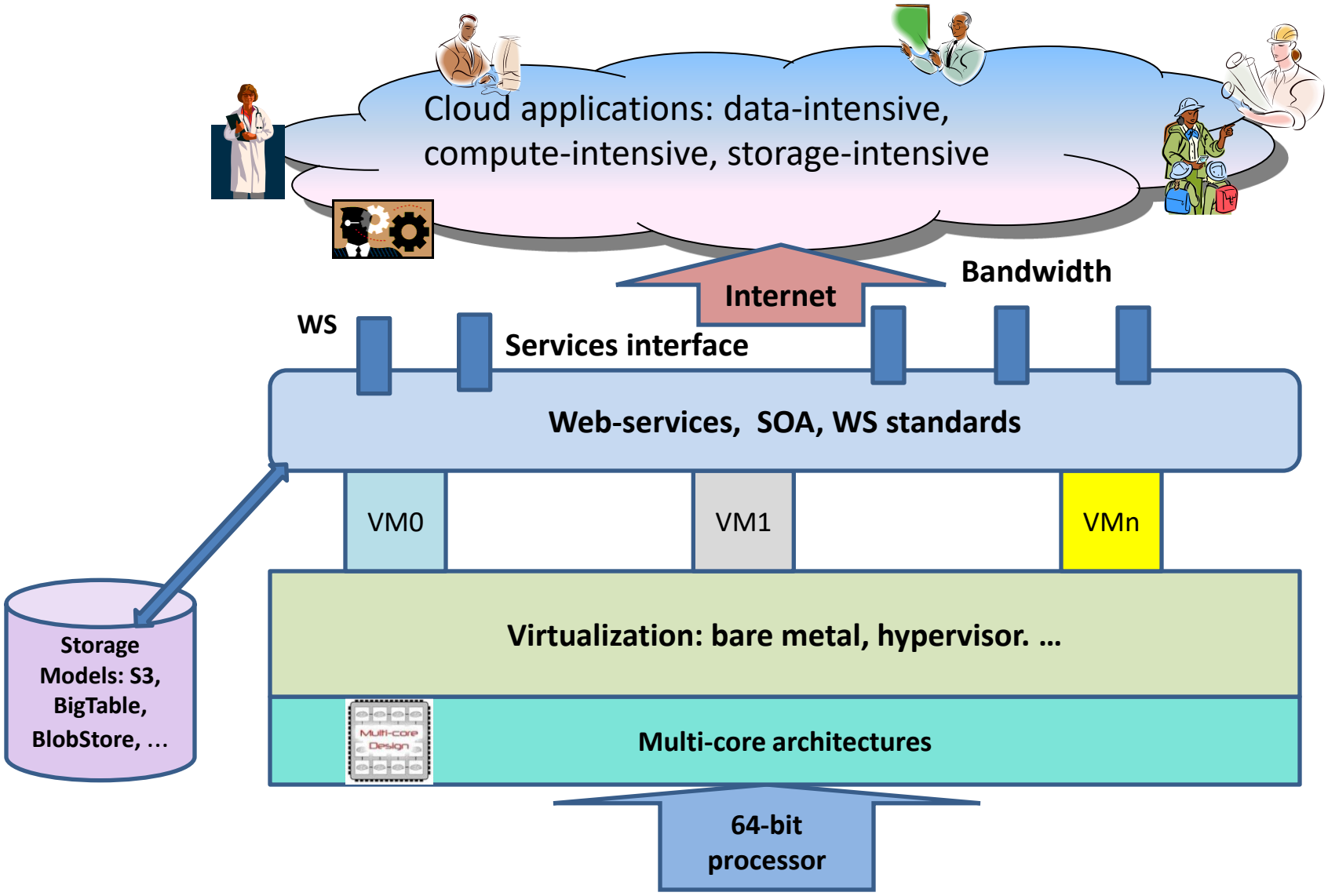
The Traditional Server Concept

- Pros
  - Easy to conceptualize
  - Fairly easy to deploy
  - Easy to backup
  - Virtually any application/service can be run from this type of setup
- Cons
  - Expensive to acquire and maintain hardware
  - Not very scalable
  - Difficult to replicate
  - Redundancy is difficult to implement
  - Vulnerable to hardware outages
  - In many cases, processor is under-utilized

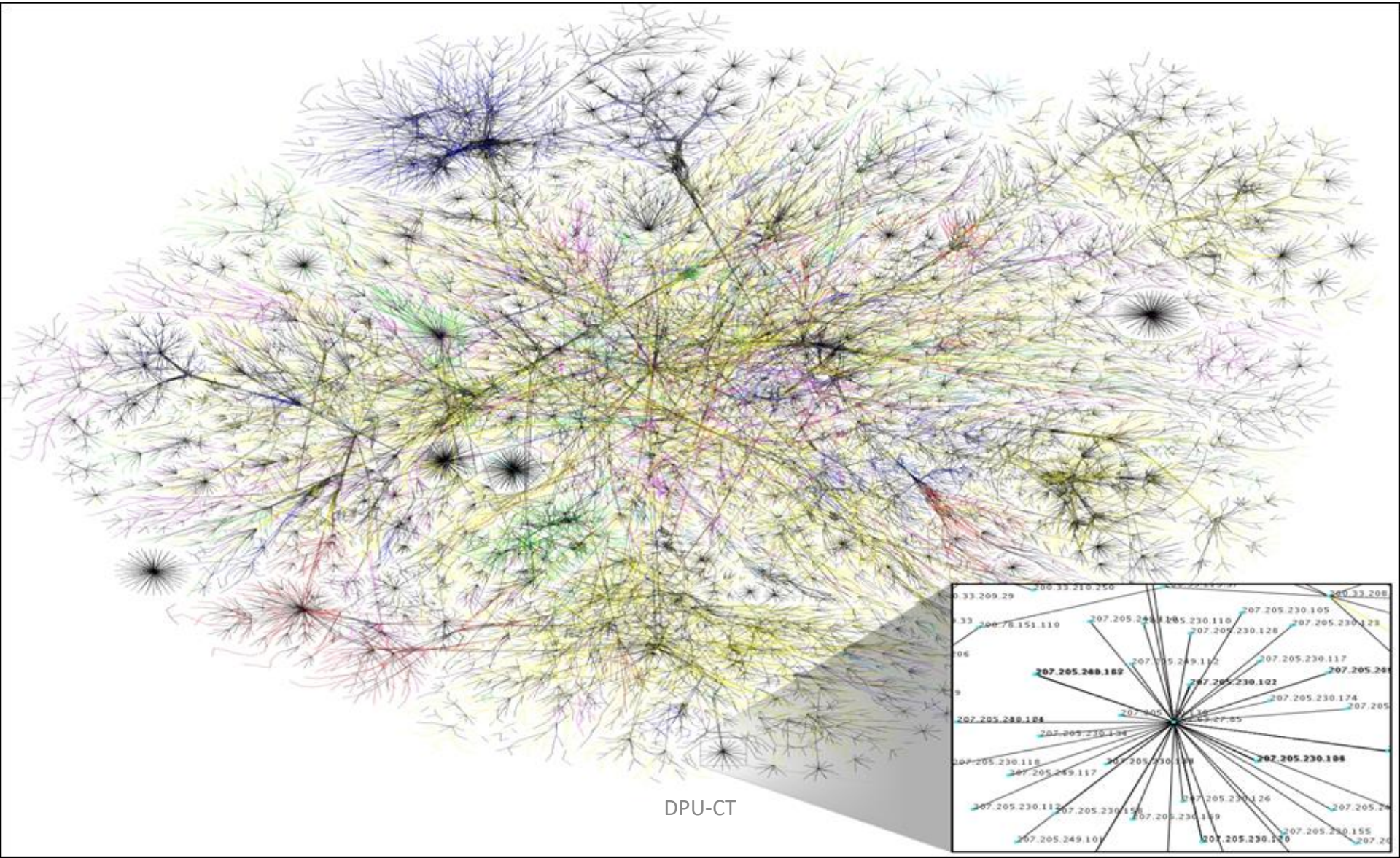
Enter the cloud

- **Cloud computing** is Internet-based computing, whereby shared resources, software and information are provided to computers and other devices on-demand, like the electricity grid.
- The cloud computing is a culmination of numerous attempts at large scale computing with seamless access to virtually limitless resources.
  - on-demand computing, utility computing, ubiquitous computing, autonomic computing, platform computing, edge computing, elastic computing, **grid computing**, …

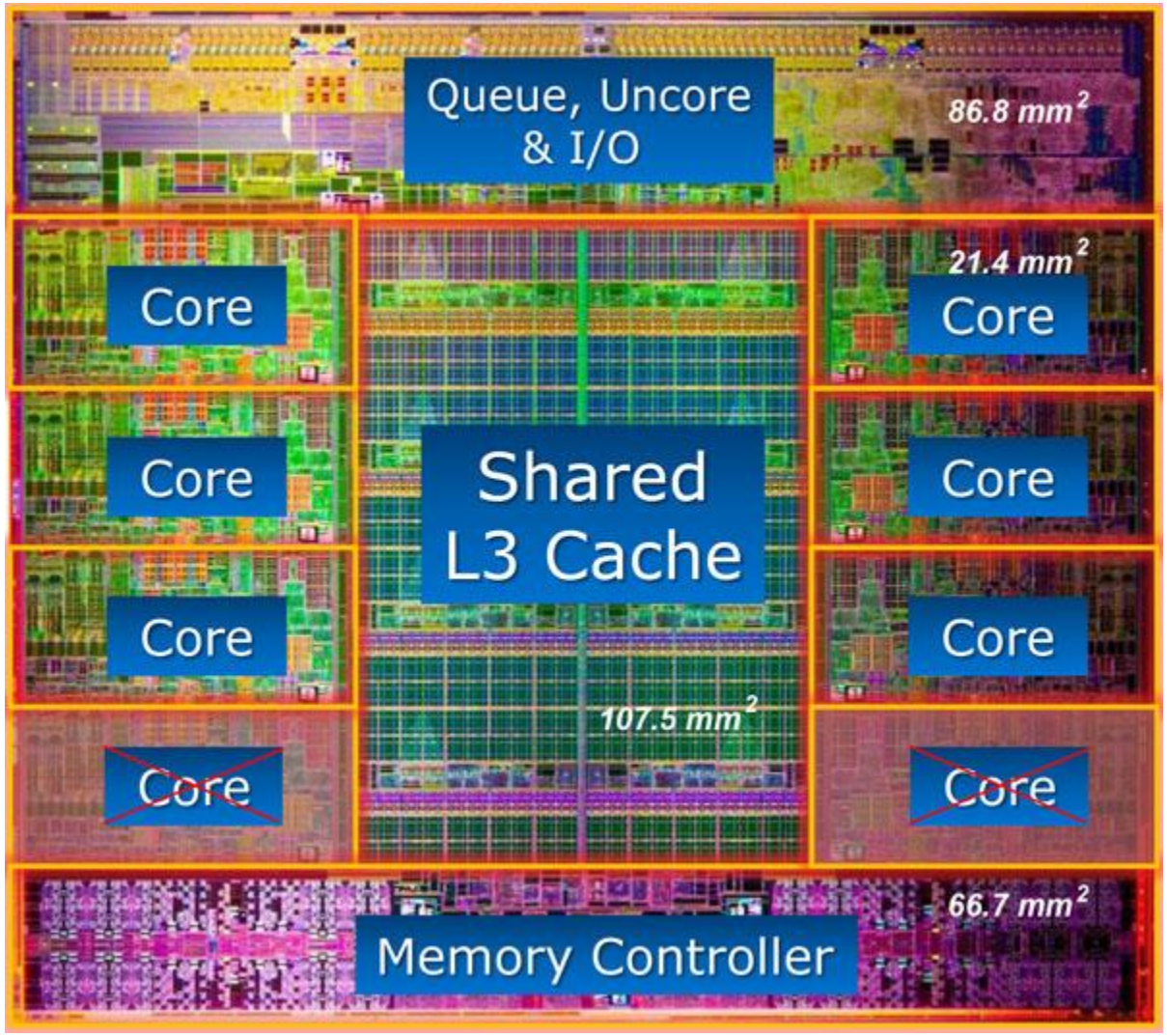
Enabling Technologies



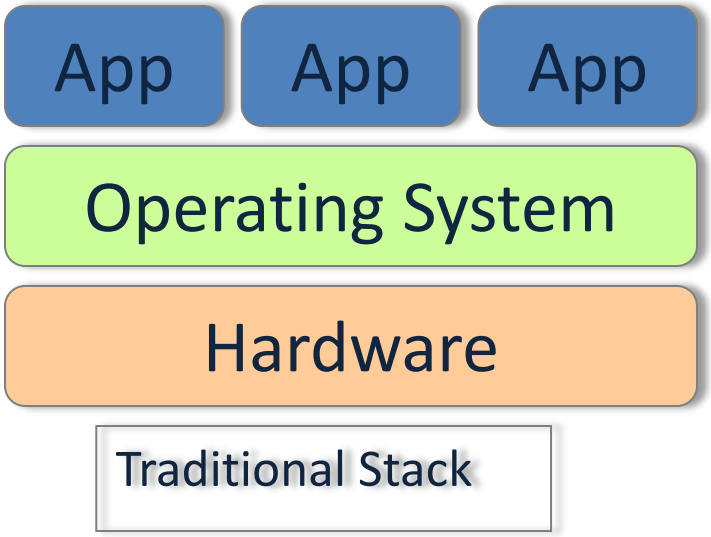
Internet

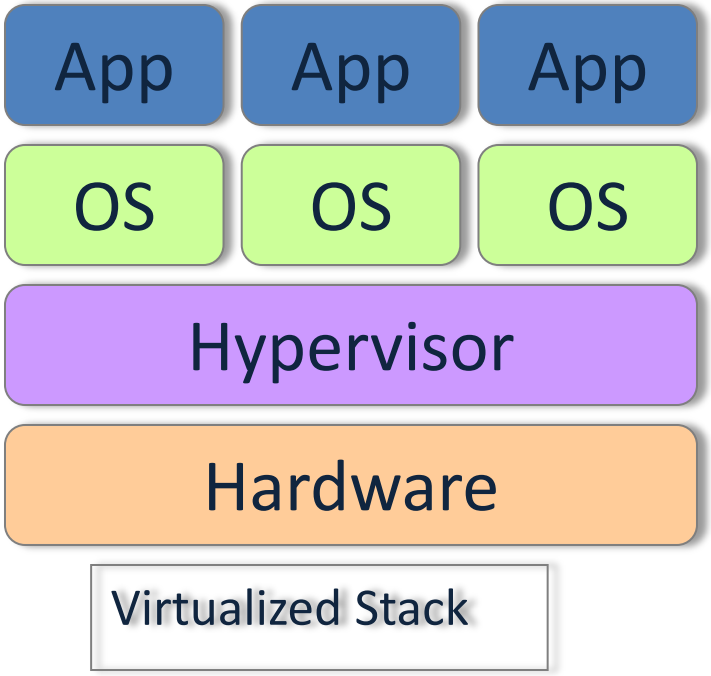


Key Technology: High Performance Computing



Key Technology: Virtualization

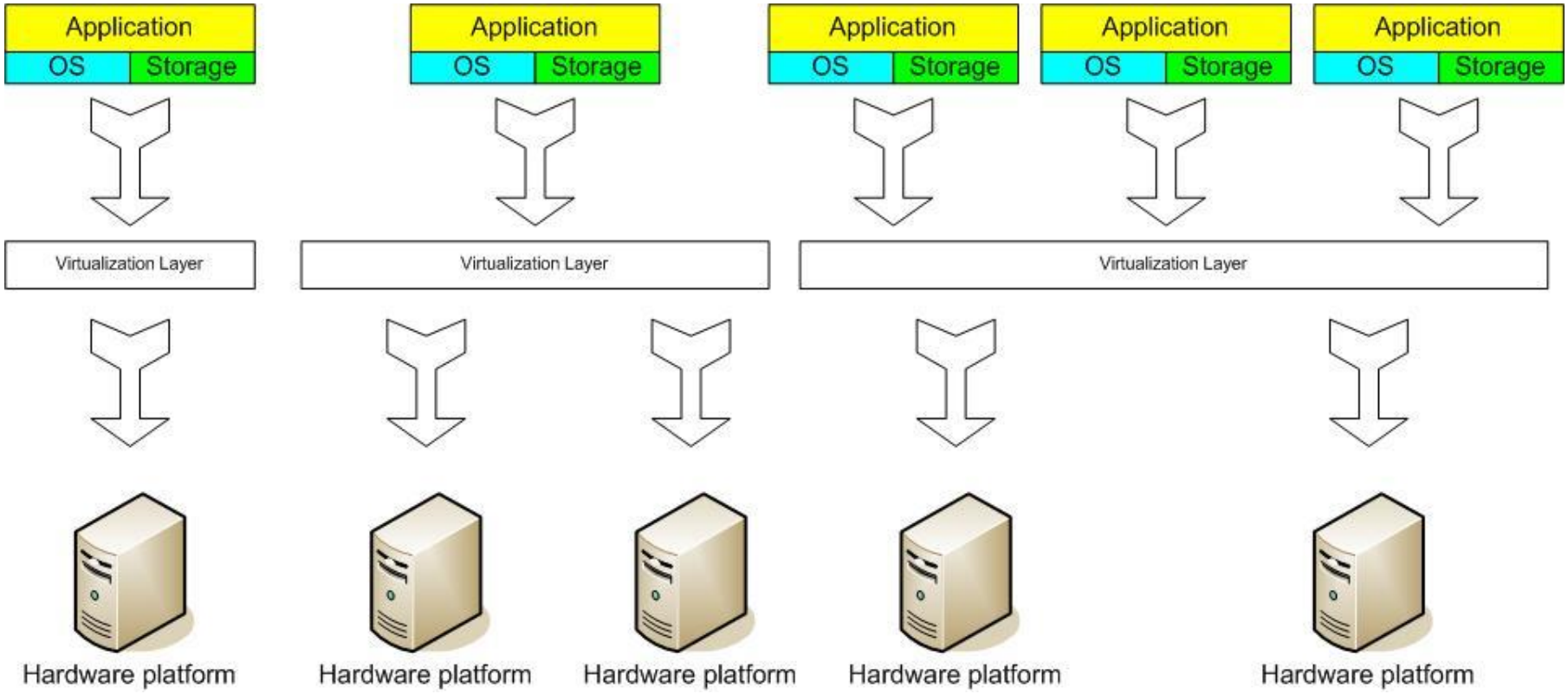




The Virtual Server Concept

- Virtual servers seek to encapsulate the server software away from the hardware
  - This includes the OS, the applications, and the storage for that server.
- Servers end up as mere files stored on a physical box, or in enterprise storage.
- One host typically house many virtual servers (**virtual machines or VMs**).
- A virtual server can be serviced by one or more hosts e.g. storage, services, etc

The Virtual Server Concept



Hypervisor layer between *Guest OS* and hardware

The Virtual Server Concept

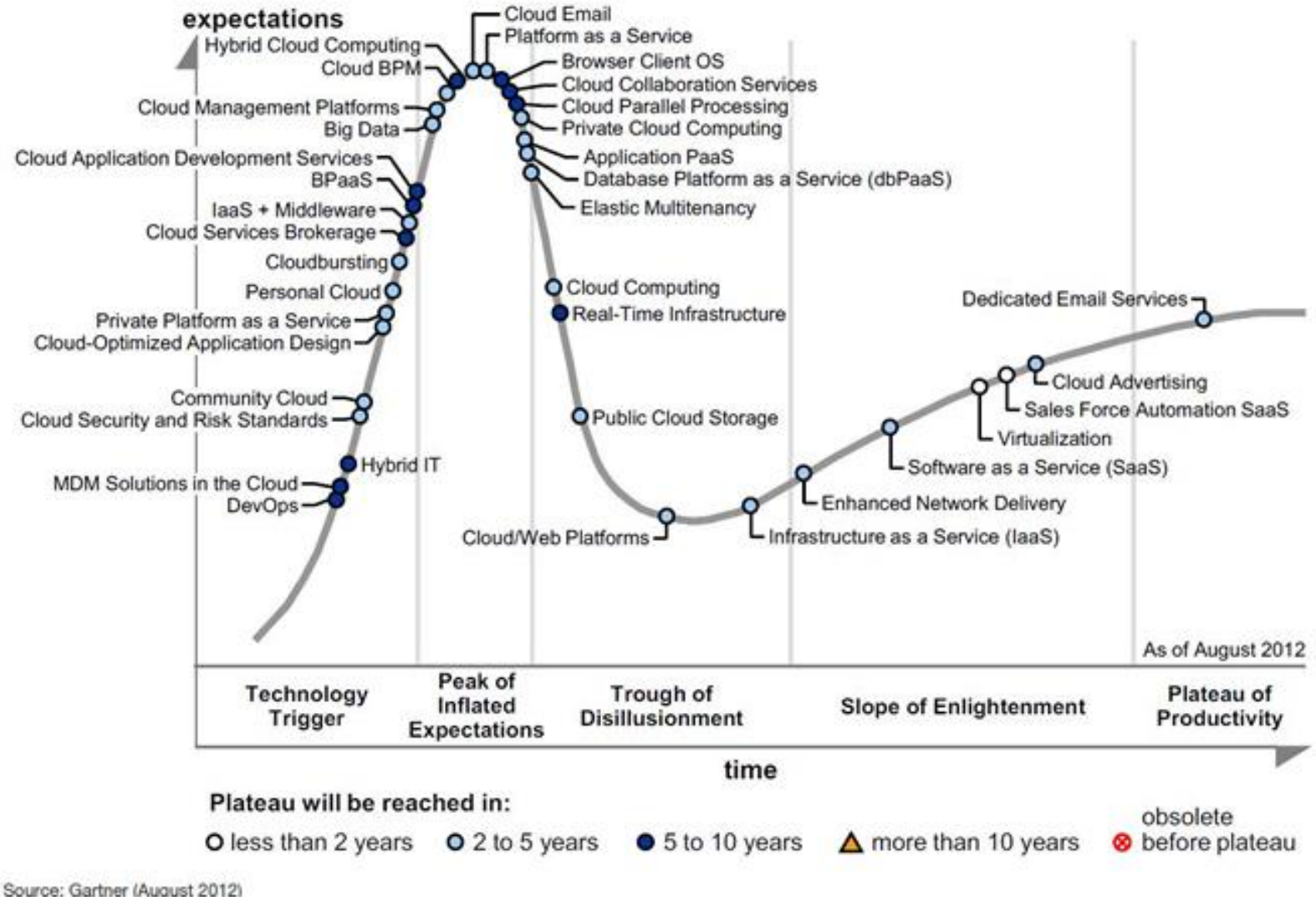
- Pros
  - Resource pooling
  - Highly redundant
  - Highly available
  - Rapidly deploy new servers
  - Easy to deploy
  - Reconfigurable while services are running
  - Optimizes physical resources by doing more with less
- Cons
  - Slightly harder to conceptualize
  - Slightly more costly (must buy hardware, OS, Apps, and now the abstraction layer)

Cloud Computing?

- The cloud is Internet-based computing, whereby shared resources, software, and information are provided to computers and other devices on demand – pay per use.

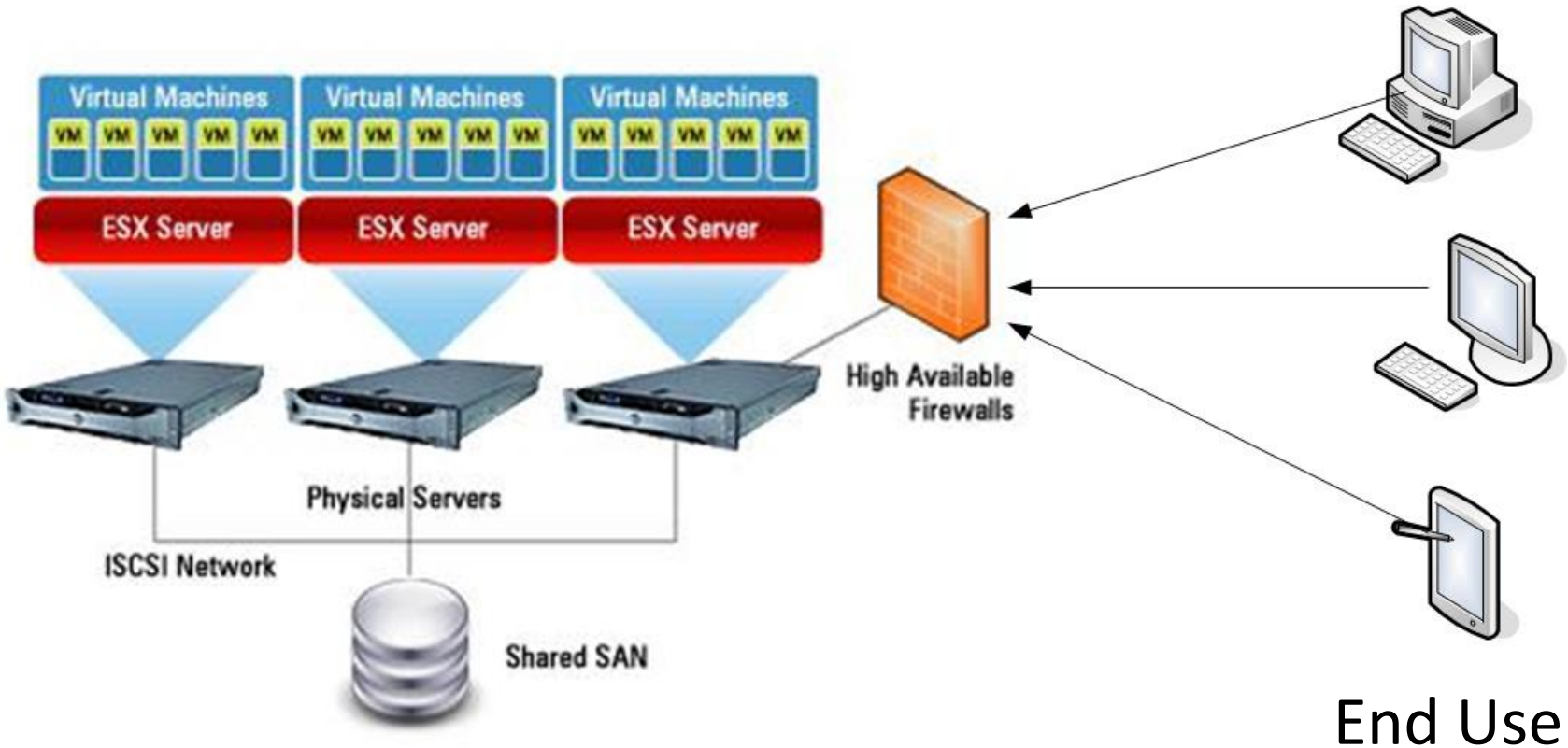
- Cost-effective means of virtualising and making use of resources more effectively
  - Low start-up costs – pay for use helps to kick-start companies
  - Scaling is proportional to demand (revenue) so it's a good business model
- Vast range of Cloud Computing applications
  - Virtual private servers, Web hosting, data servers, fail-over services, etc

Hype Cycle of Cloud Computing 2012



Source: Gartner (August 2012)

Cloud as a User View



Public Vs Private

Public Cloud

- Hosted at a Service Provider Site
- Supports multiple customers
- Often utilizes shared infrastructure
- Supports connectivity over the internet
- Suited for information that is not sensitive
- Can be cheaper than private cloud

Private Cloud

- Hosted at an Enterprise or a Service Provider site
- Supports one customer
- Does not utilize shared infrastructure
- Connectivity over private network/ fiber or the internet
- Suited for information that is needs a high level of security

Public Cloud Taxonomy

Infrastructure Services

Storage
- Amazon S3
- Amazon EBS
- CTERA Portal
- Mosso Cloud Files
- Nirvanix

Compute
- Amazon EC2
- Serve Path GoGrid
- Elastra
- Mosso Cloud Servers
- Joyent Accelerators
- AppNexus
- Flexiscale
- Elastichosts
- Hosting.com CloudNine
- Terramark
- GridLayer
- iTRiCiTY
- LayeredTech

Services Management
- RightScale
- enStratus
- Scalr
- CohesiveFT
- Kaavo
- CloudStatus
- Ylastic
- Dynect
- CloudFoundry
- NewRelic
- Cloud42

Cloud Software

Data
- 10Gen MongoDB
- Oracle Coherence
- Gemstone Gemfire
- Apache CouchDb
- Apache HBase
- Hypertable
- TerraCotta
- Tokyo Cabinet
- Cassandra
- memcached

Compute
- Globus Toolkit
- Xeround
- Beowulf
- Sun Grid Engine
- Hadoop
- OpenCloud
- Gigaspaces
- DataSynapse
- Xeround

Cloud Management
- 3Tera App Logic
- OpenNebula
- Open.ControlTier
- Enomaly Enomalism
- Altor Networks
- VMware vSphere
- OnPathTech
- CohesiveFT VPN Cubed
- Hyperic
- Eucalyptus
- Reductive Lbs Puppet
- OpenQRM
- Appistry

Appliances
- PingIdentity
- Symplified
- rPath
- Vordel

File Storage
- EMC Atmos
- ParaScale
- Zmamda
- CTERA

Platform Services

General Purpose
- Force.com
- Etelos
- LongJump
- AppJet
- Rollbase
- Bungee Labs Connect
- Google App Engine
- Engine Yard
- Caspio
- Qrimp
- MS Azure Services Platform
- Mosso Cloud Sites

Business Intelligence
- Aster DB
- Quantivo
- Cloud9 Analytics
- Blink Logic
- K2 Analytics
- LogiXML
- Oco
- Panorama
- PivotLink
- Sterna
- ColdLight Neuron
- Infobright
- Vertica

Integration
- Amazon SQS
- MuleSource Mule OnDemand
- Boomi
- SnapLogic
- OpSource Connect
- Cast Iron
- Microsoft BizTalk Services
- gnip
- SnapLogic SaaS Solution Packs
- Appian Anywhere
- HubSpan
- Informatica On-Demand

Development & Testing
- Keynote Systems
- Mercury
- SOASTA
- SkyTap
- Aptana
- LoadStorm
- Collabnet
- Dynamsoft

Database
- Google BigTable
- Amazon SimpleDB
- FathomDB
- Microsoft SDS

Software Services

Billing
- Aria Systems
- eVapt
- OpSource
- Redi2
- Zuora

Financials
- Concur
- Xero
- Workday
- Beam4d

Legal
- DirectLaw
- Advologix
- Fios
- Sertifi

Sales
- Xactly
- LucidEra
- StreetSmarts
- Success Metrics

Desktop Productivity
- Zoho
- IBM Lotus Live
- Google Apps
- Desktoptwo
- Parallels
- ClusterSeven

Human Resources
- Taleo
- Workday
- iCIMS

Content Management
- Clickability
- SpringCM
- CrownPoint

Backup & Recovery
- JungleDisk
- Mozy
- Zmanda Cloud Backup
- OpenRSM
- Syncplicity

CRM
- NetSuite
- Parature
- Responsys
- Rightnow
- Salesforce.com
- LiveOps
- MSDynamics
- Oracle On Demand

Document Management
- NetDocuments
- Questys
- DocLanding
- Aconex
- Xythos
- Knowledge TreeLive
- SpringCM

Collaboration
- Box.net
- DropBox

Social Networks
- Ning
- Zembly
- Amitive

OpenCrowd

DPU-CT

Updated as of May 4, 2009









SaaS
Software as a Service

- Email
- CRM
- Collaborative
- ERP

PaaS
Platform as a Service

- Application Development
- Decision Support
- Web
- Streaming

IaaS
Infrastructure as a Service

- Caching
- Legacy
- File
- Networking
- Technical
- Security
- System Mgmt

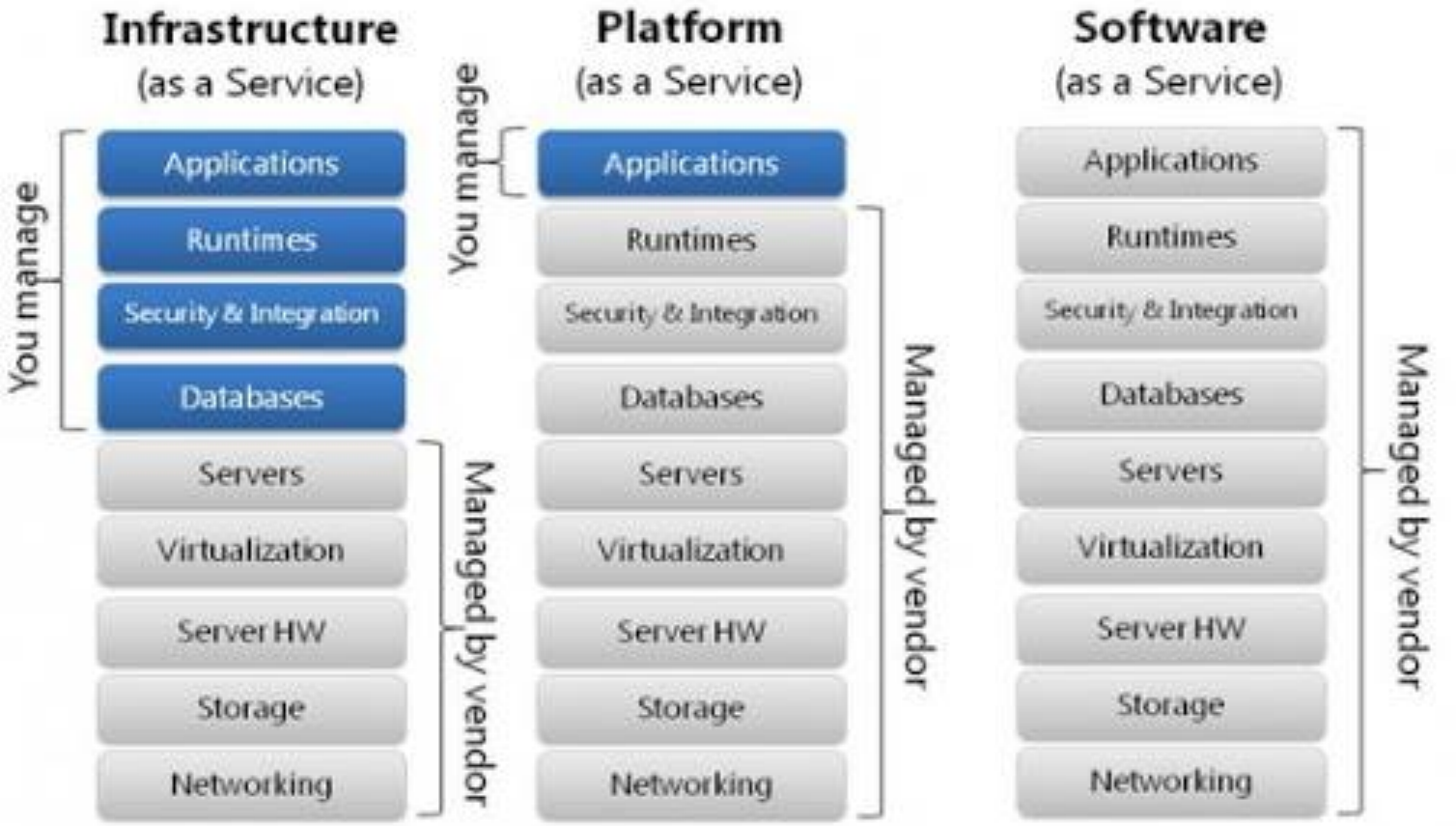
CONSUME

BUILD ON IT

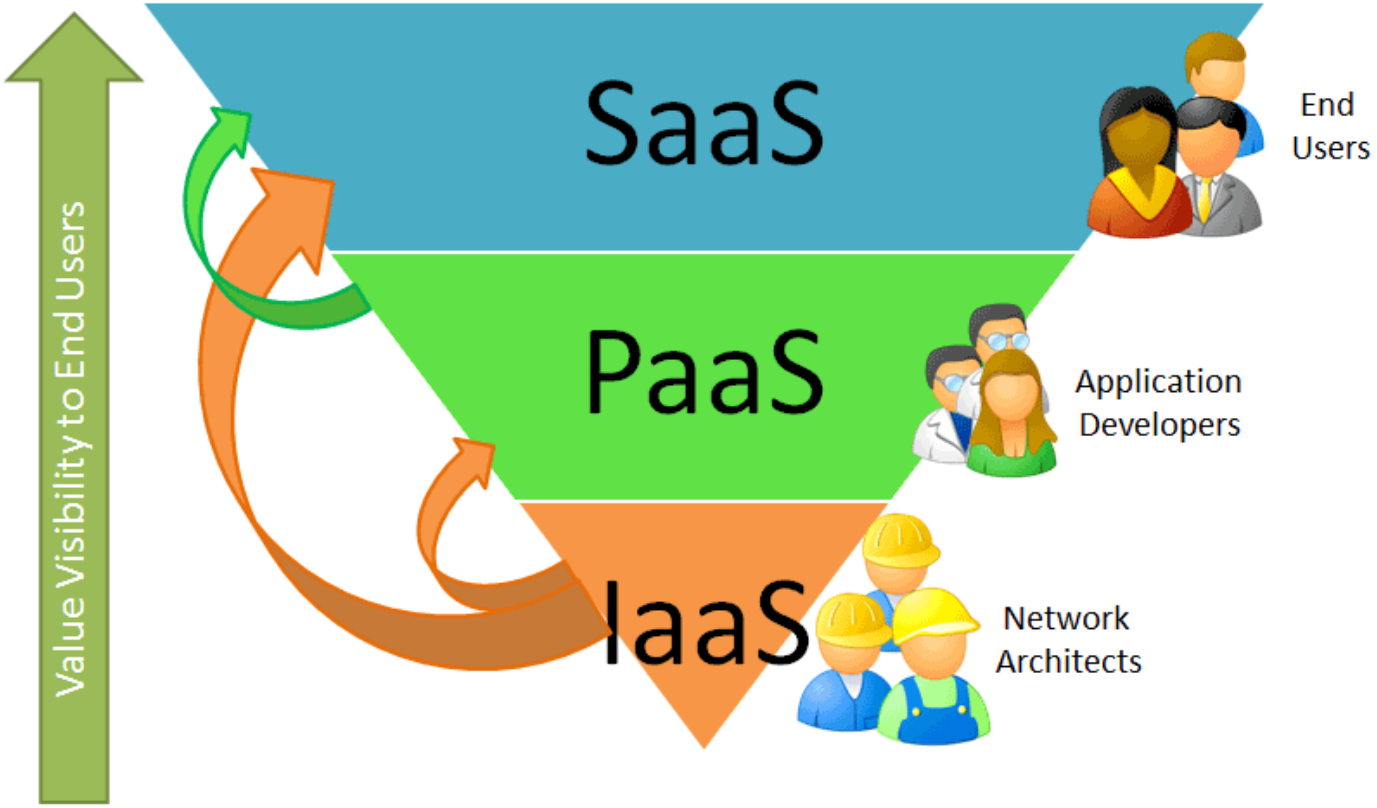
MIGRATE TO IT

Public Cloud Services

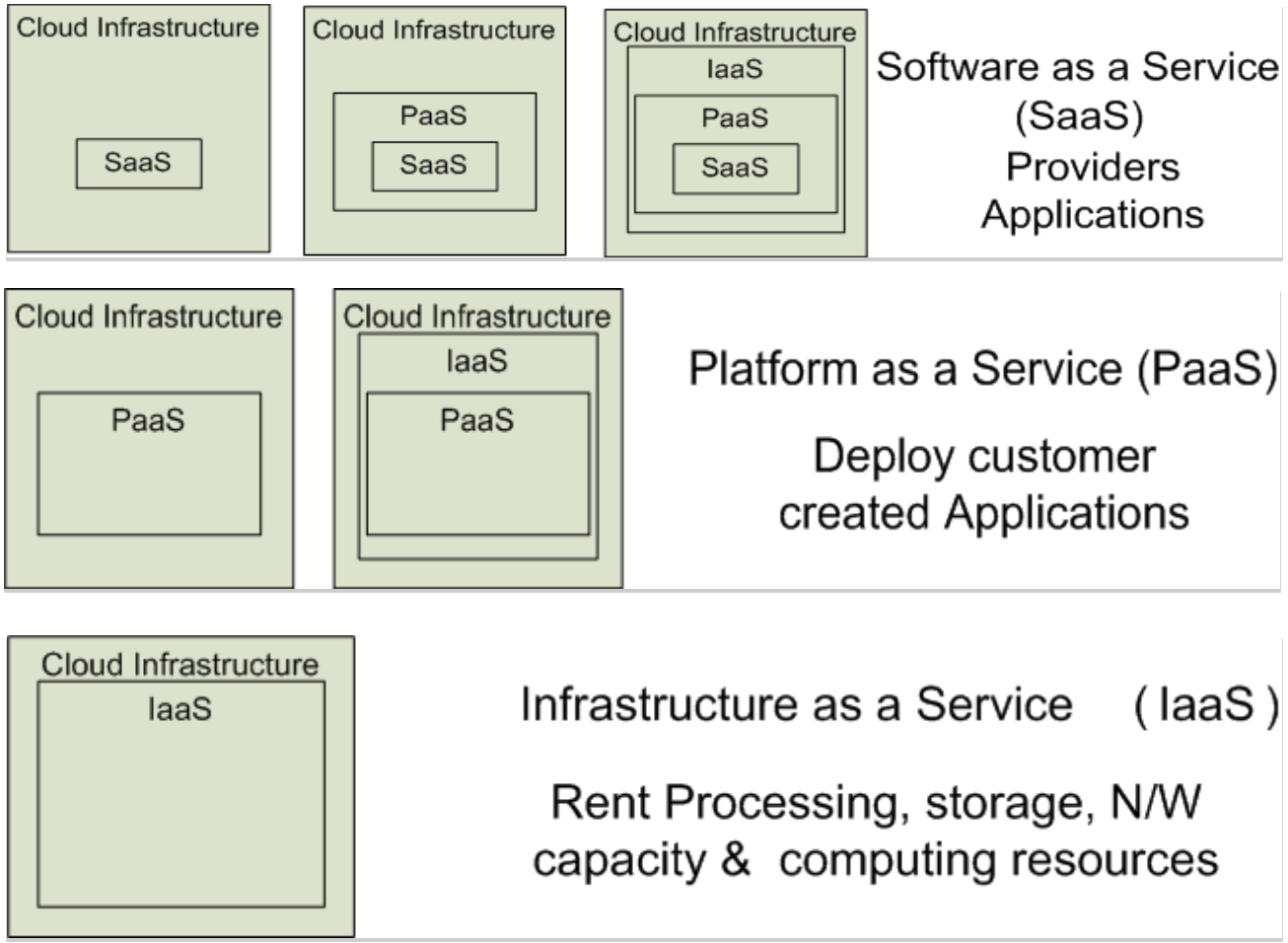
Where we can manage



Value Visibility to End User

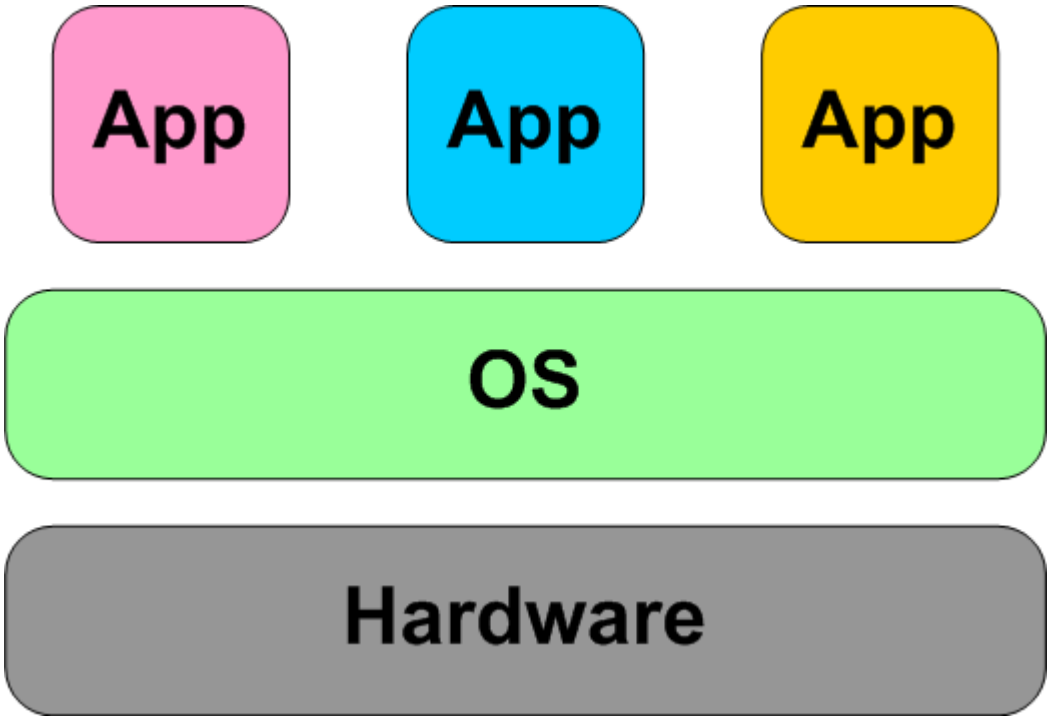


Starting Study

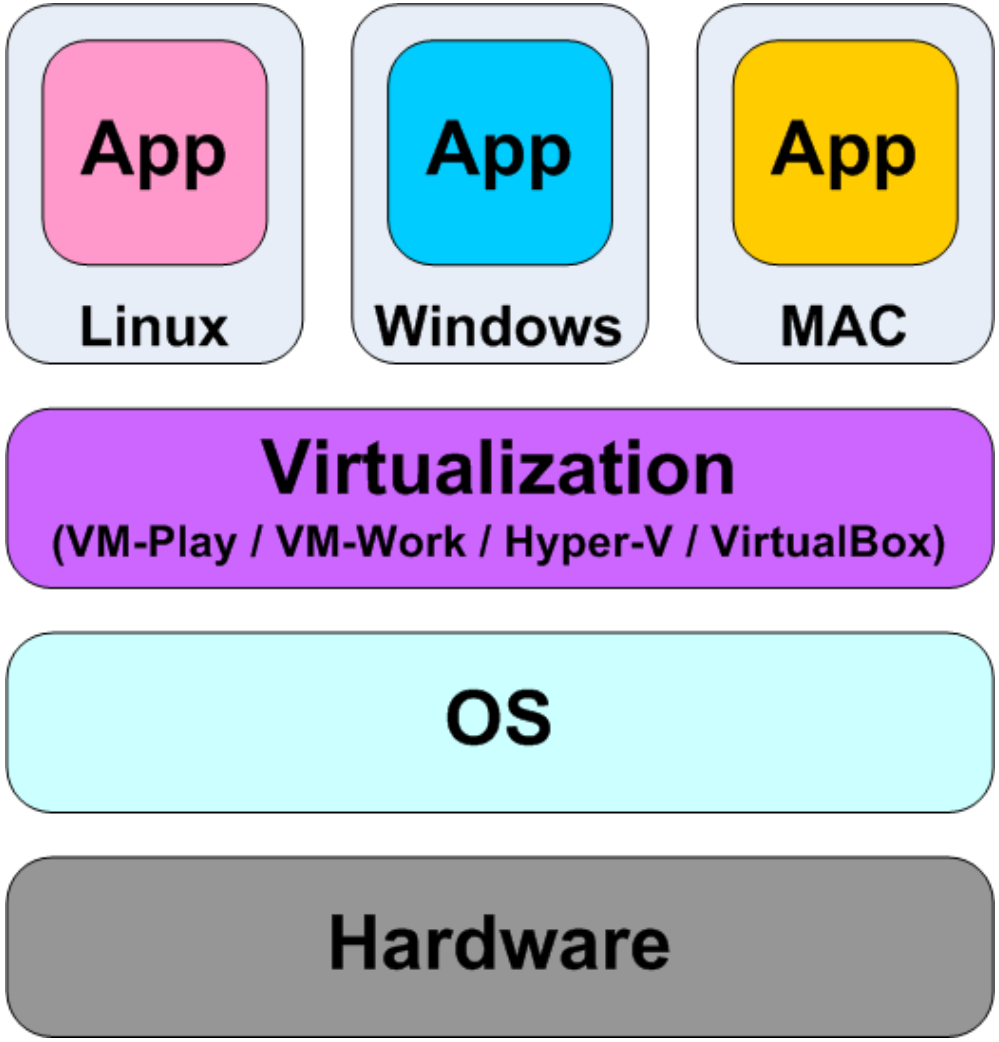


Here we start

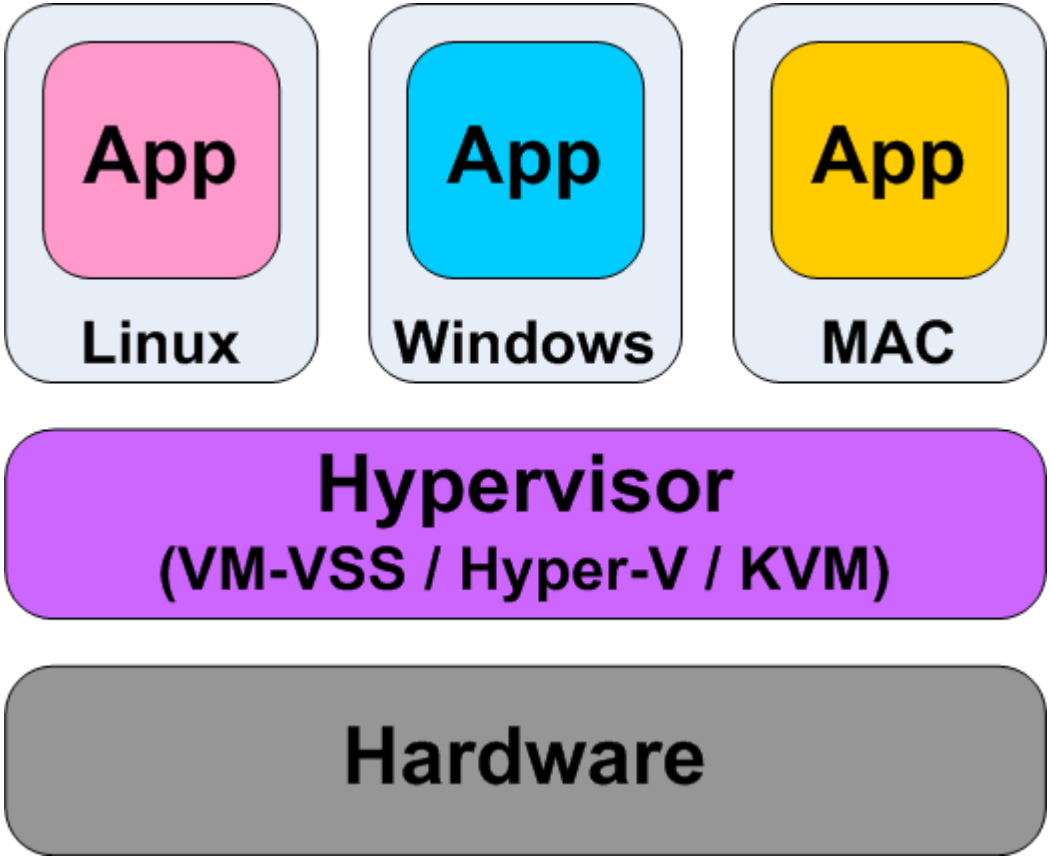
Traditional Computer



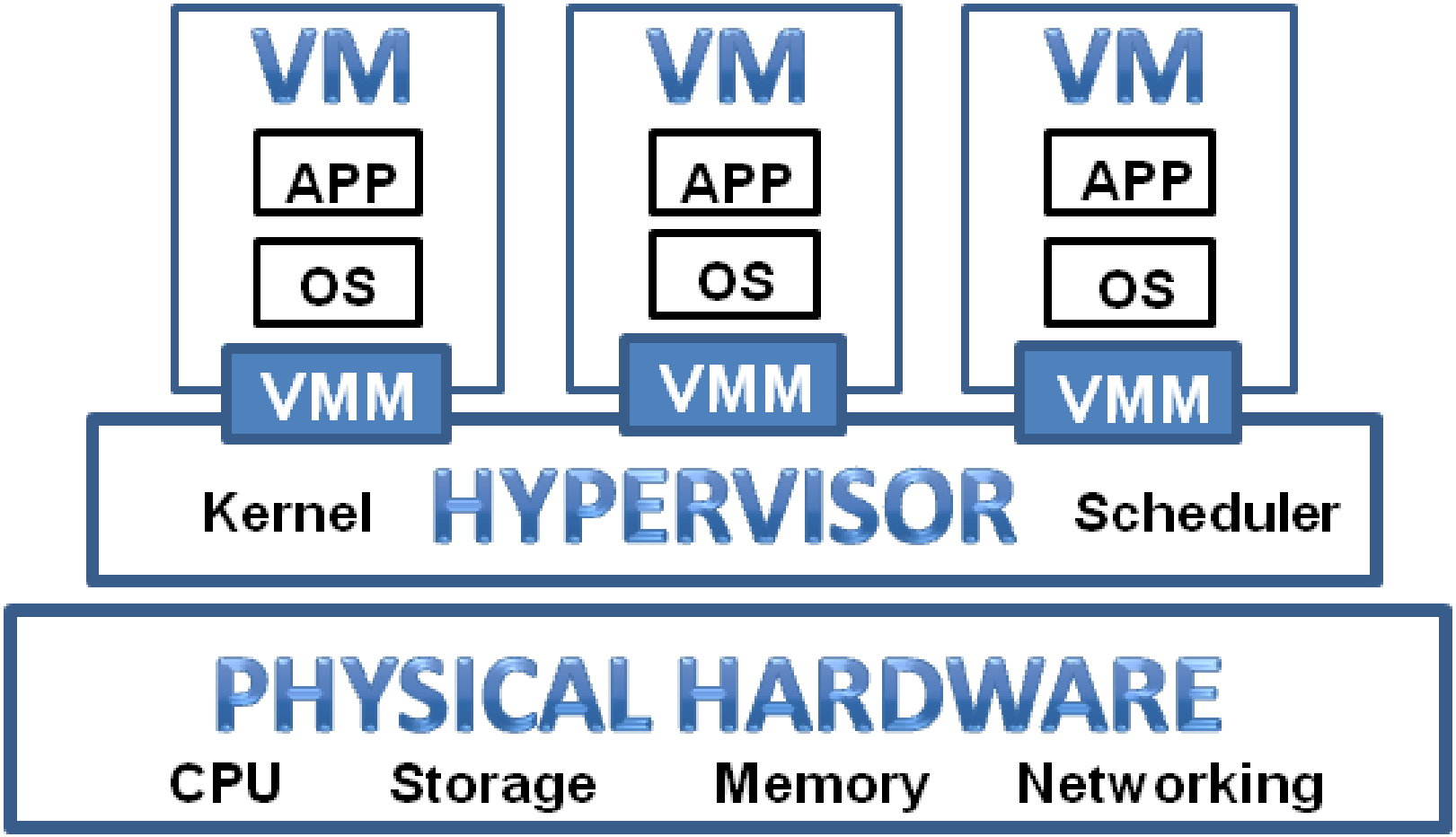
Applying Cloud on PC (Hosted Architecture)



Enterprise Cloud Computing
(Bare-Metal or Hypervisor Architecture)



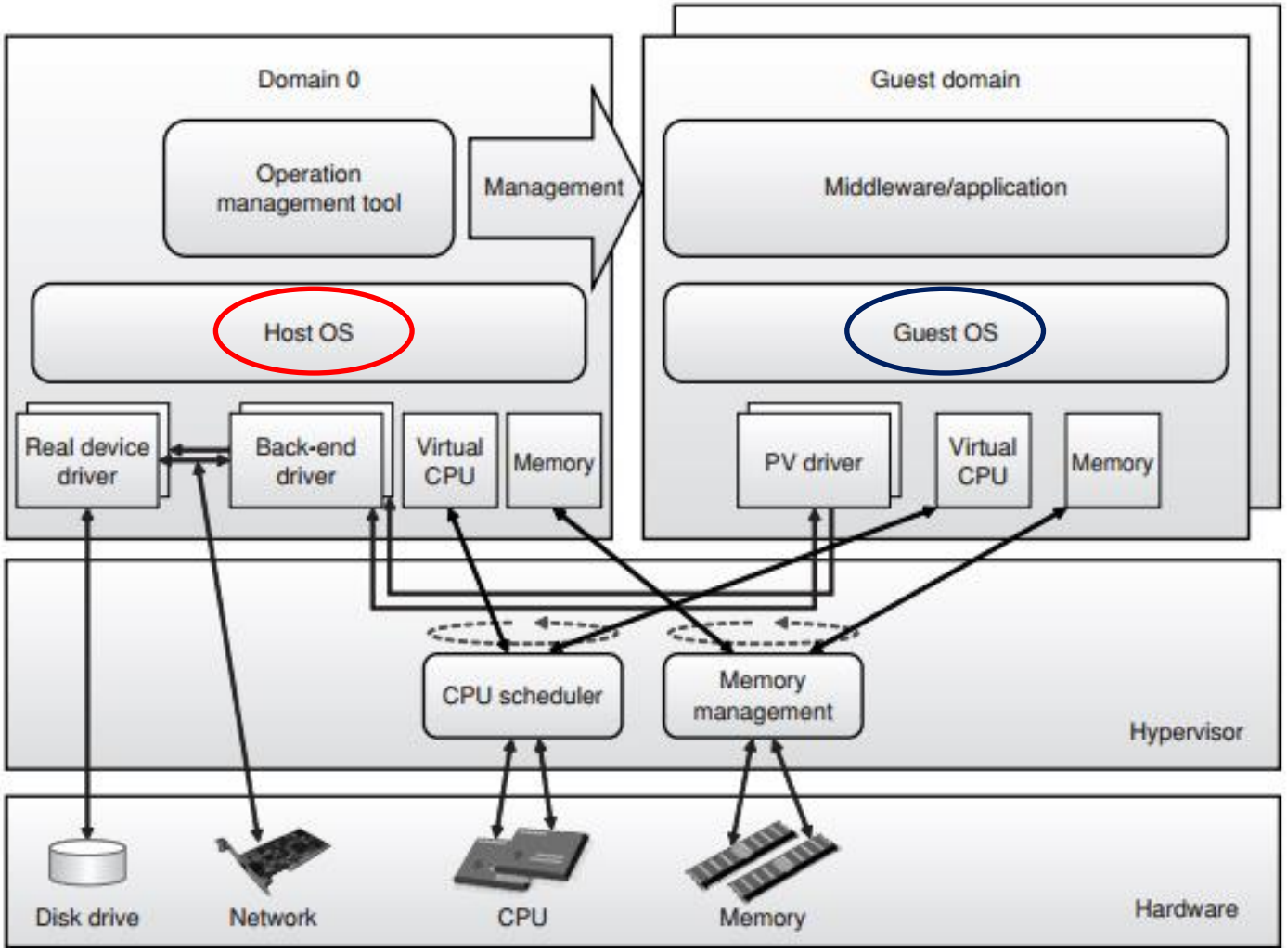
Hypervisor


VM
APP
OS
VMM
VM
APP
OS
VMM
VM
APP
OS
VMM
Kernel
HYPERVISOR
Scheduler
PHYSICAL HARDWARE
CPU
Storage
Memory
Networking

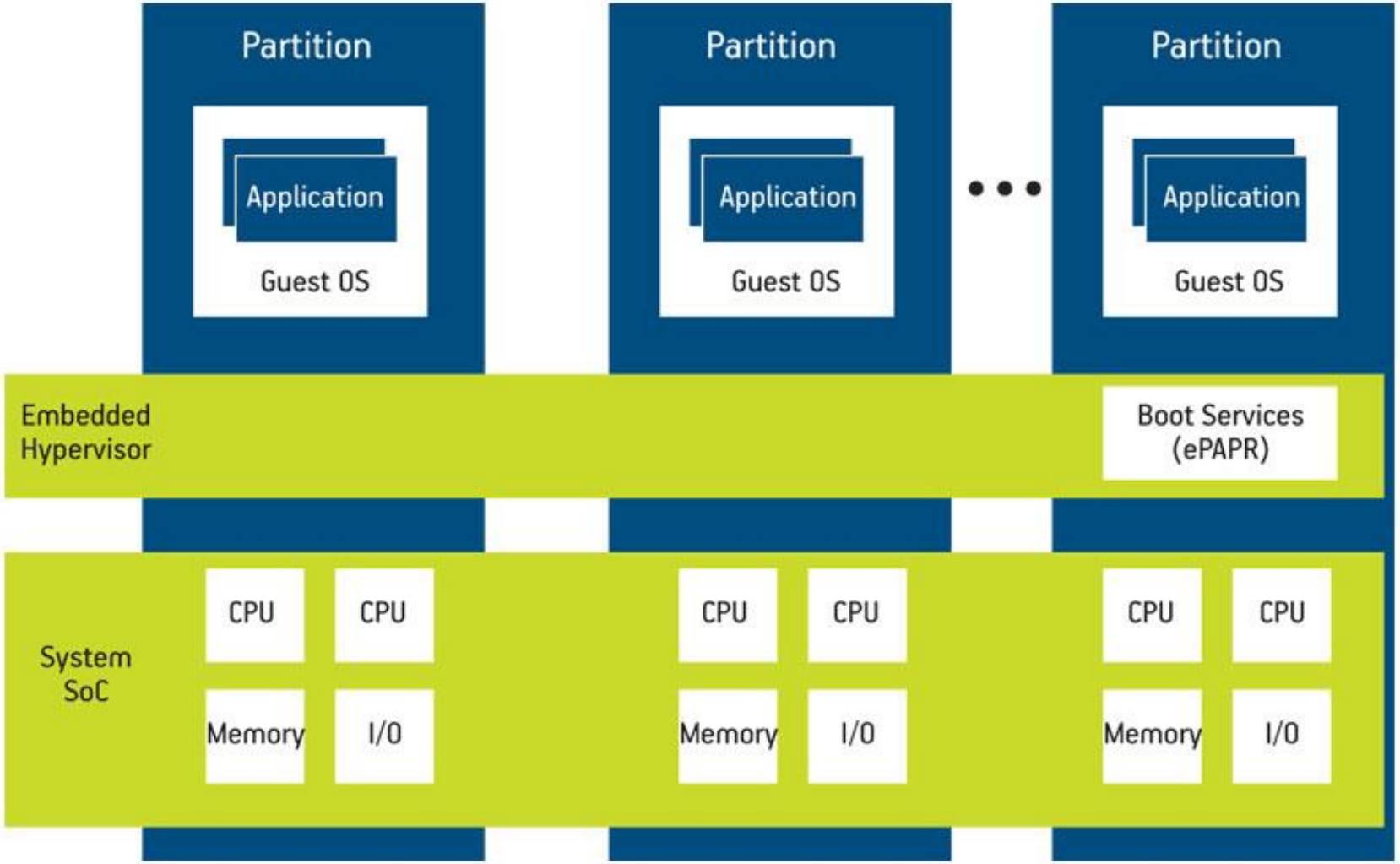
Hypervisors And Hosts

- A **hypervisor** is a piece of computer software, firmware or hardware that creates and runs virtual machines.
- A computer on which a hypervisor is running one or more virtual machines is defined as a **host machine**.
- Each **virtual machine** has a **guest operating systems**, which is managed by the hypervisor.
- Multiple instances of a variety of operating systems may share the virtualized hardware resources.

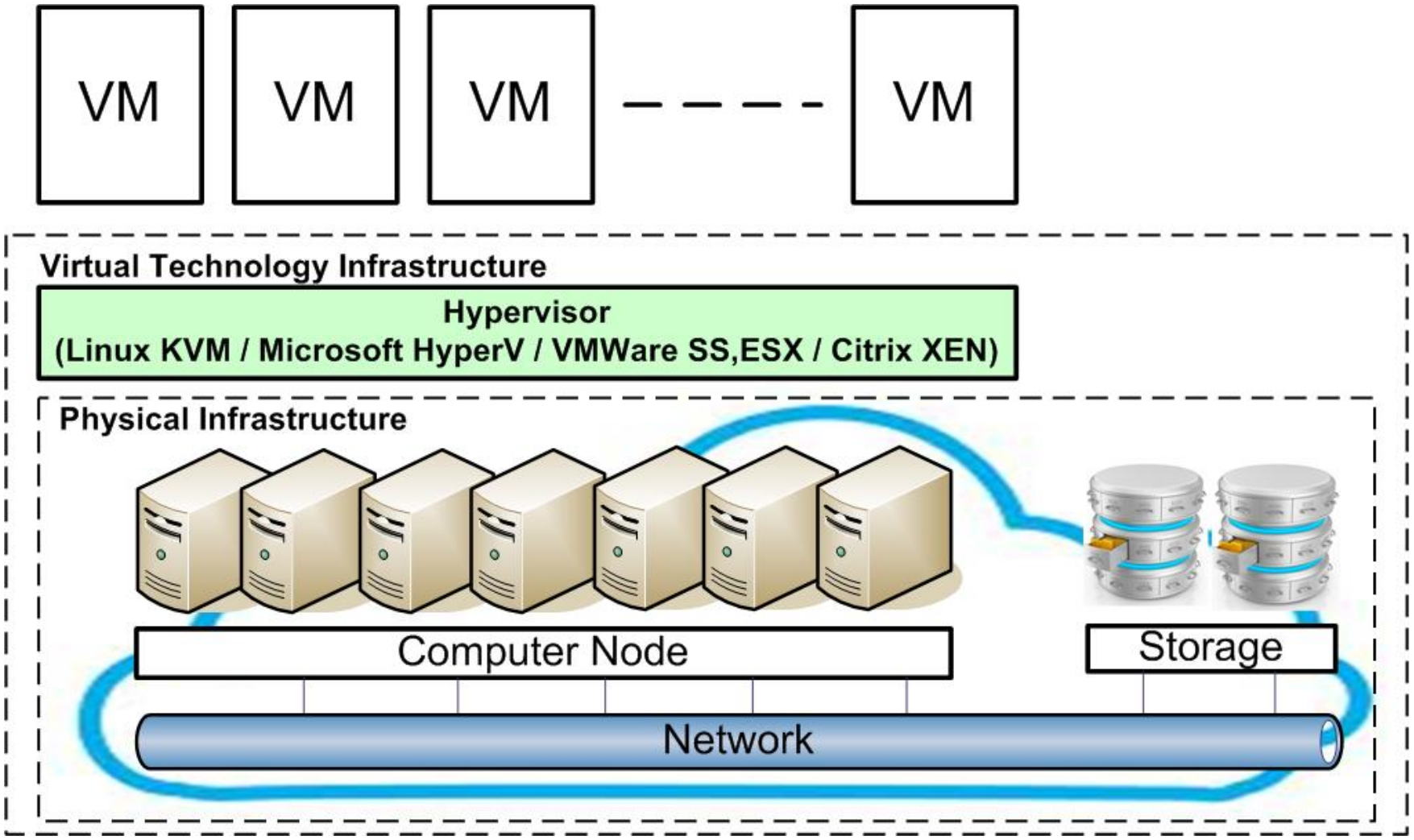
Virtualization / Hypervisor



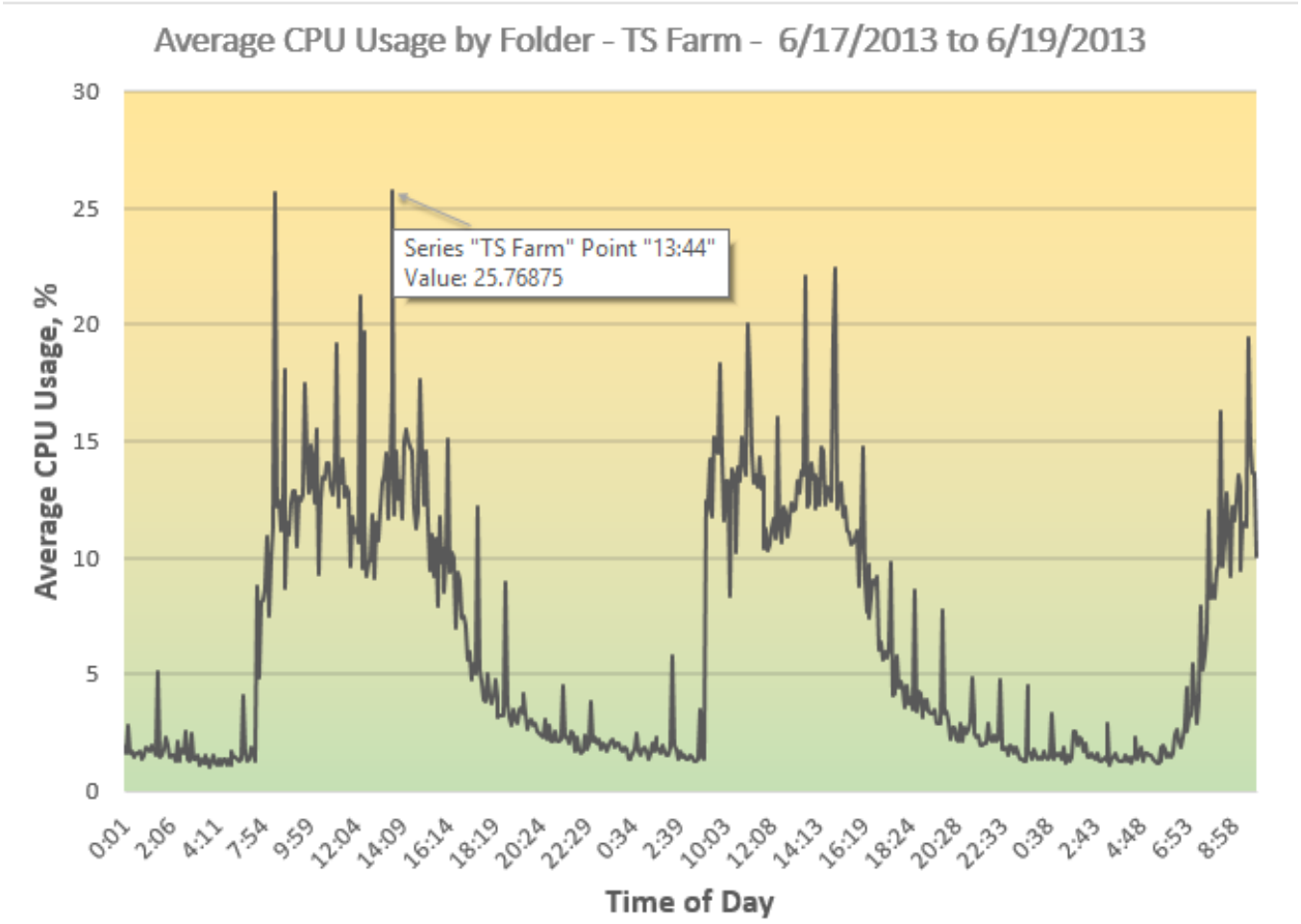
Cloud Architecture



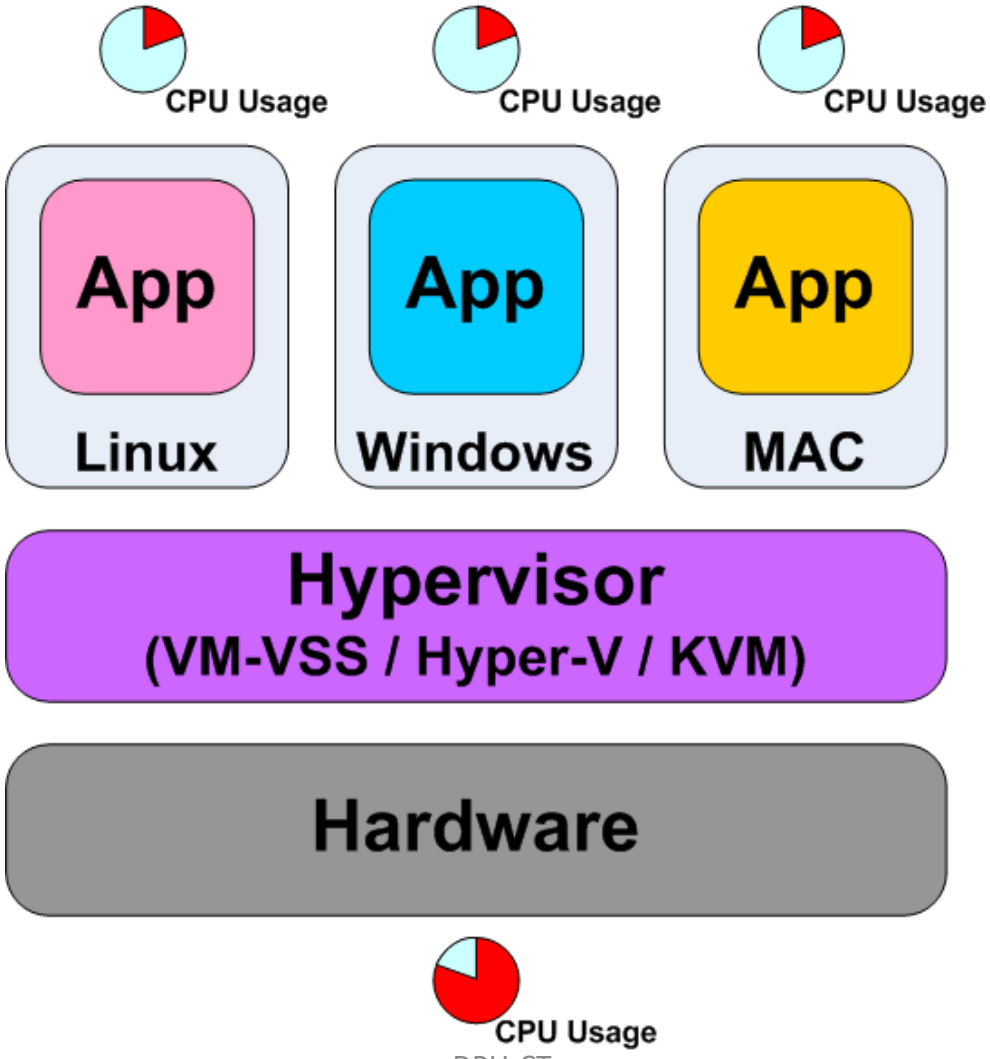
Enterprise Cloud Architecture (On Premise)



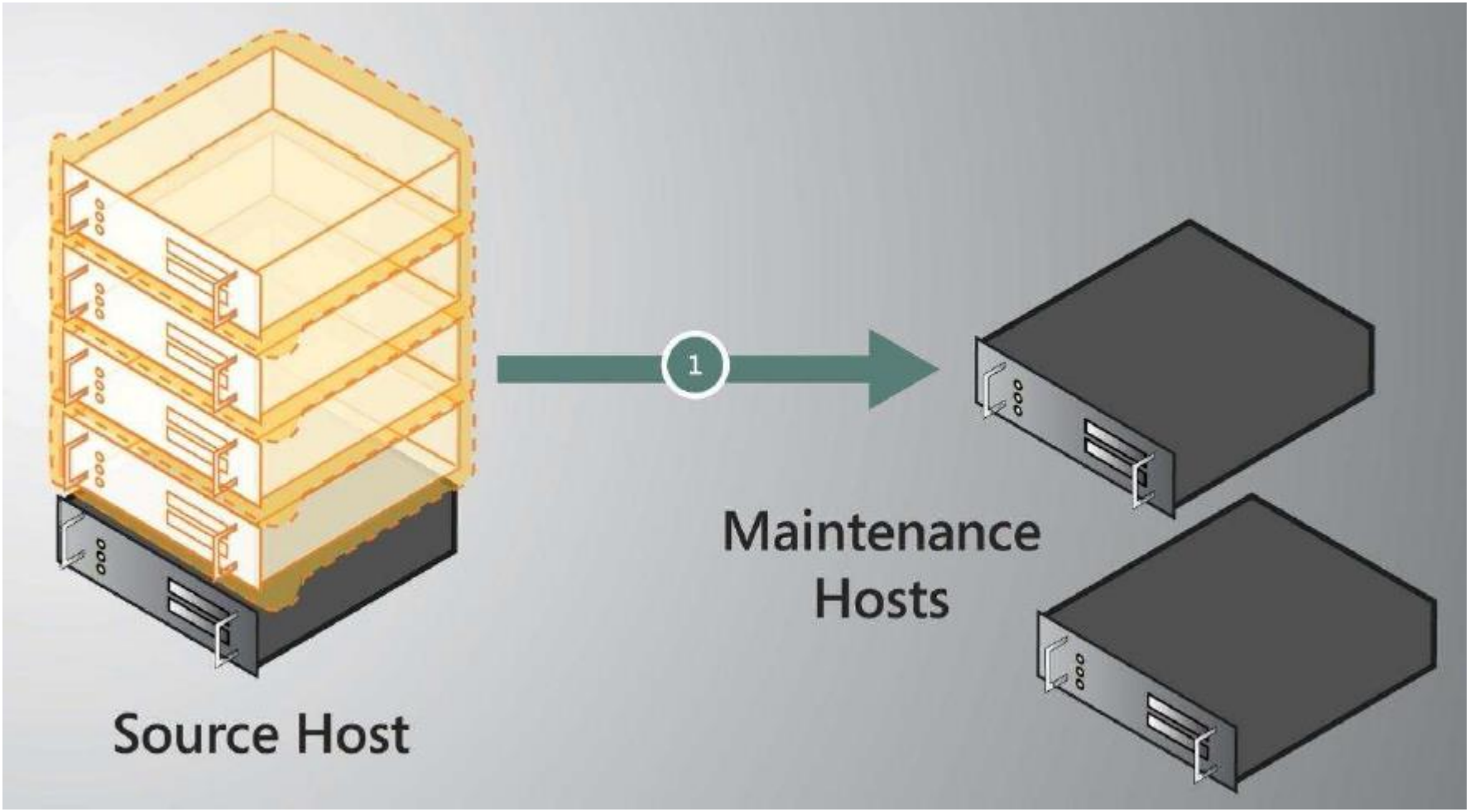
CPU Usage for each Application



Sharing CPU in Cloud Computing



Why migration !!!



VM Migration on Cloud Computing

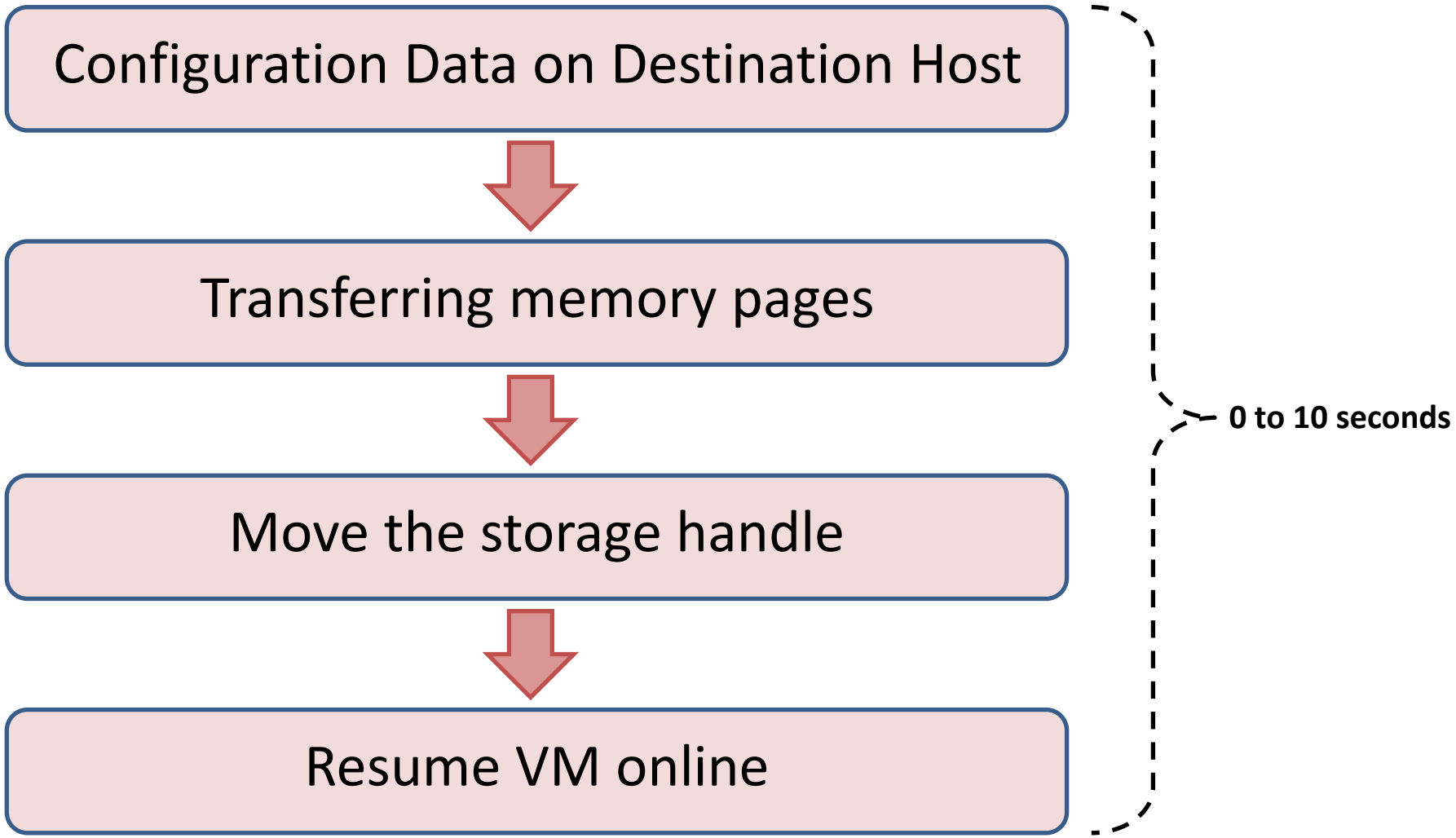
Cold Migration

- Stop VM is needed
- Less complex
- Step
  - Stop VM on a current host
  - Resume VM on a new host
- Take a time to migrate about minutes !!

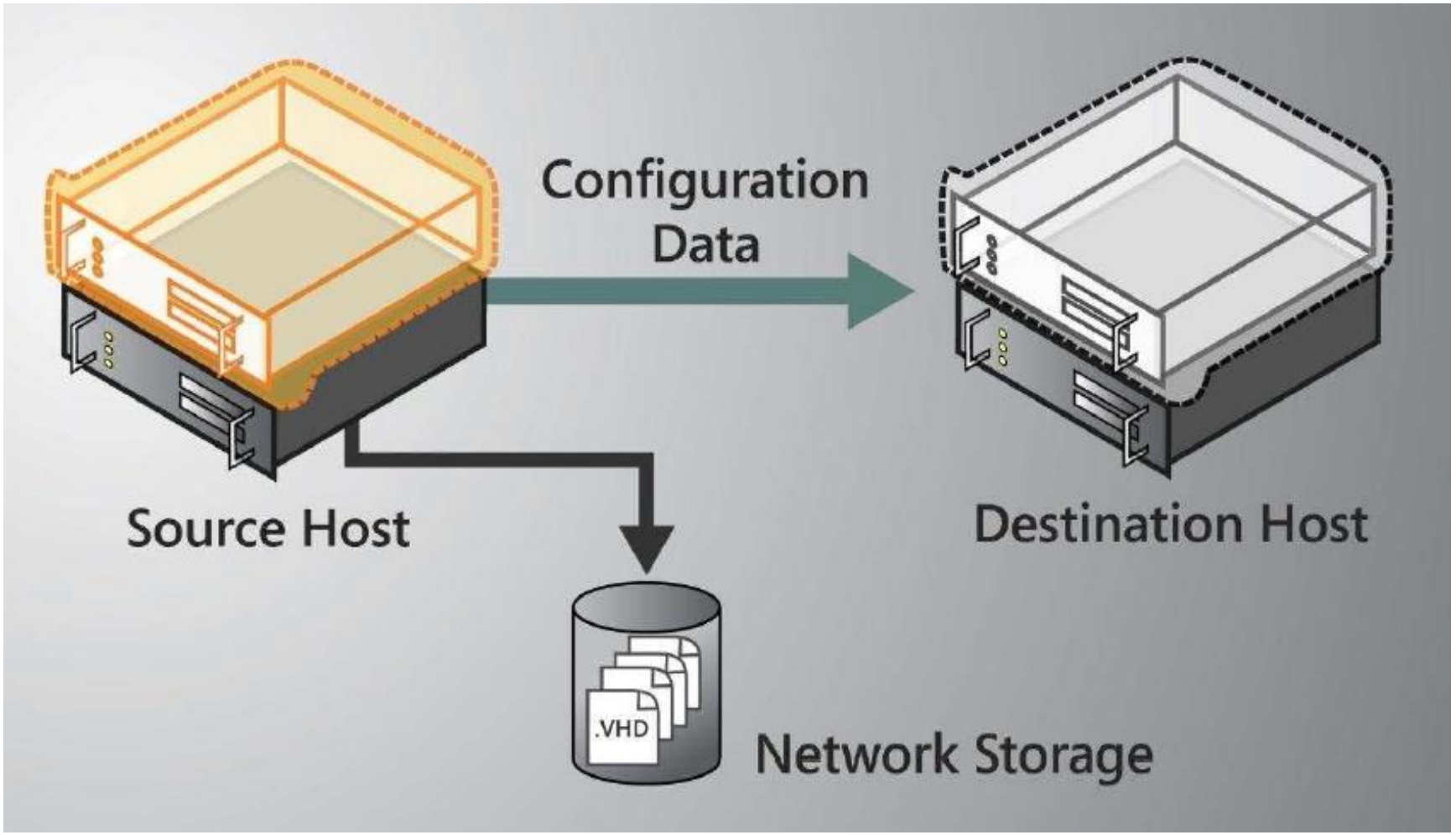
Hot Migration

- VM needs to be non-stop
- Live migration
- More complex
- Step as in next slide
- Take a time in few seconds

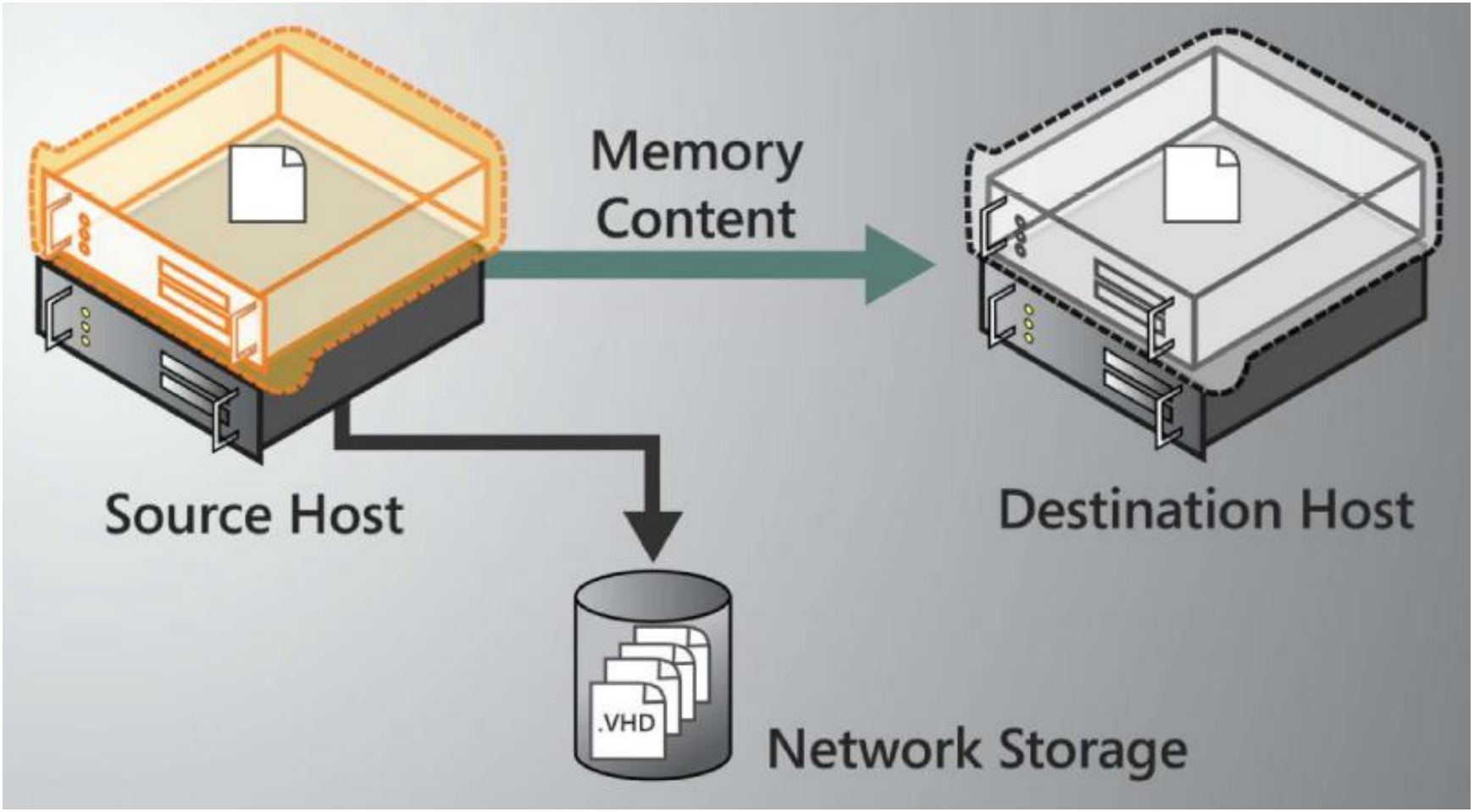
Live Migration Step



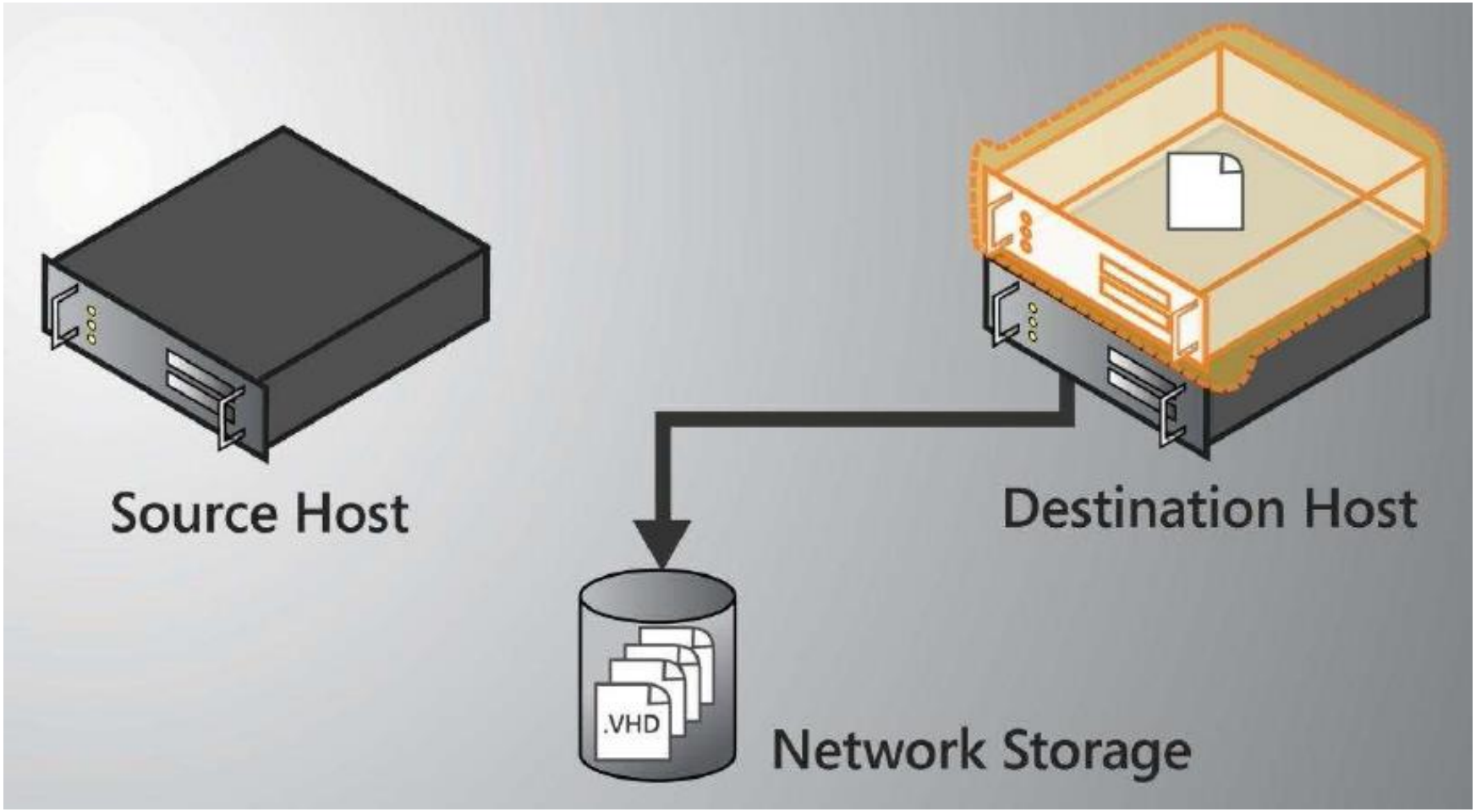
Configuration Data



Transferring memory

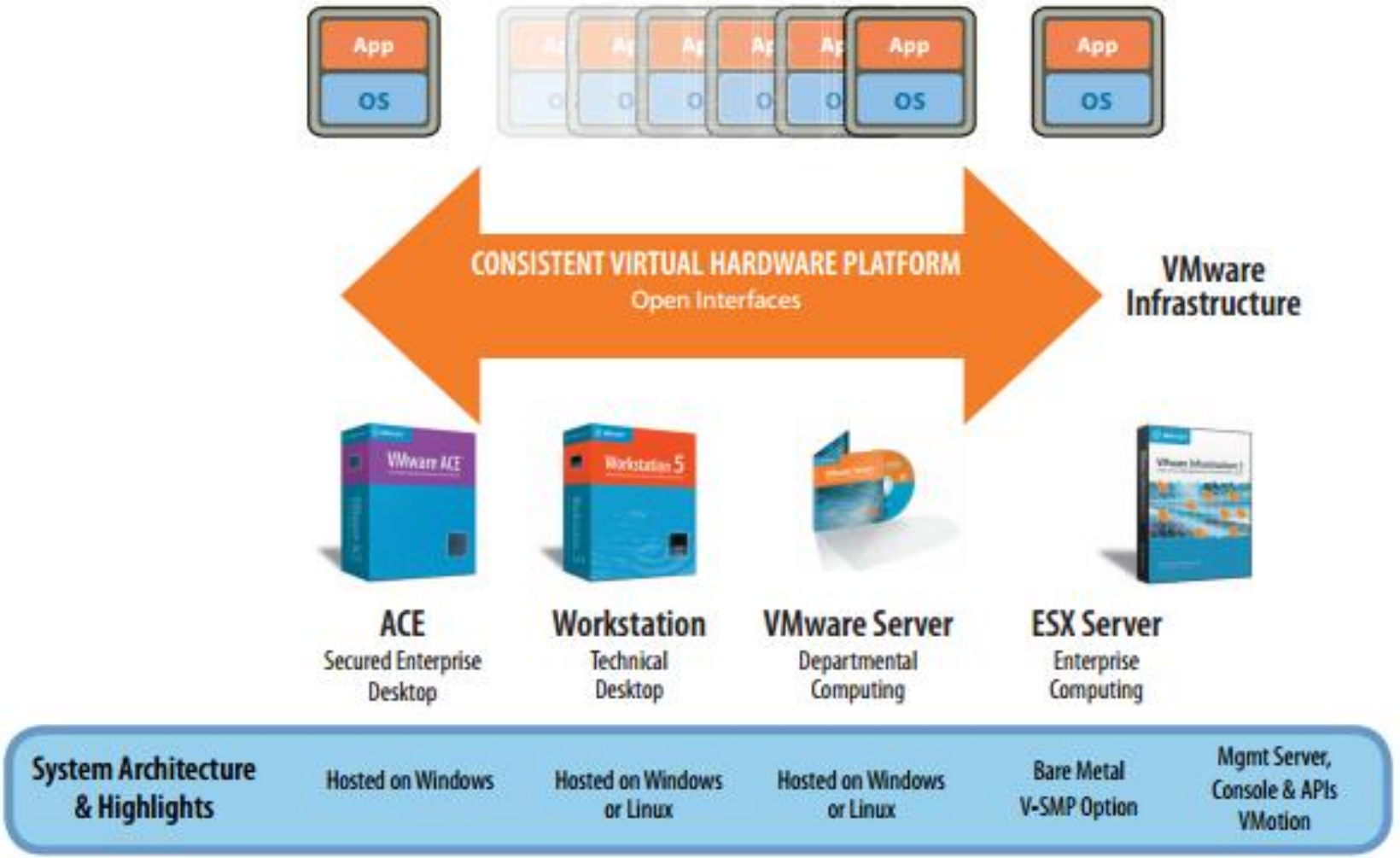


Handle Storage and Resume Online

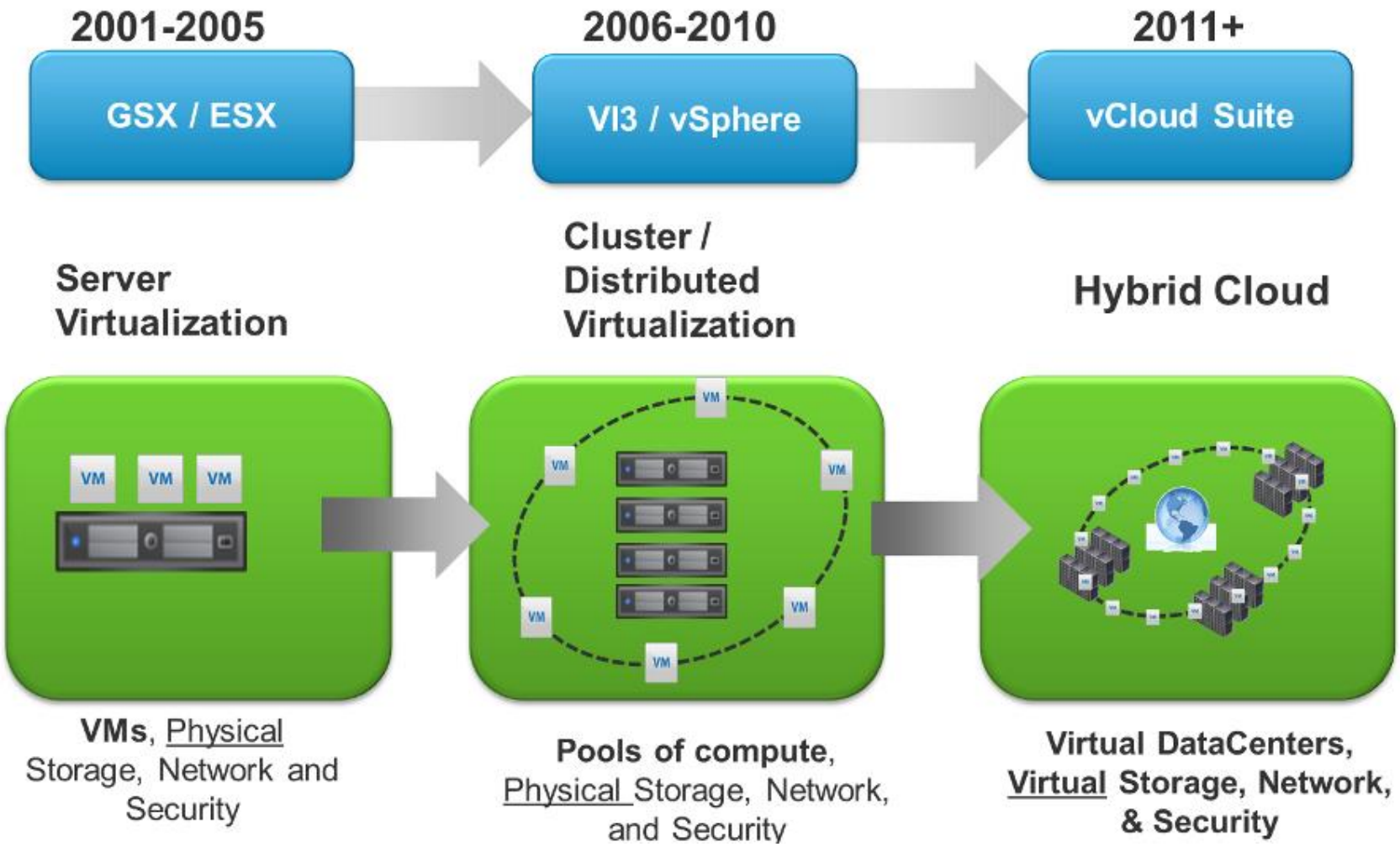


On Premise Battle

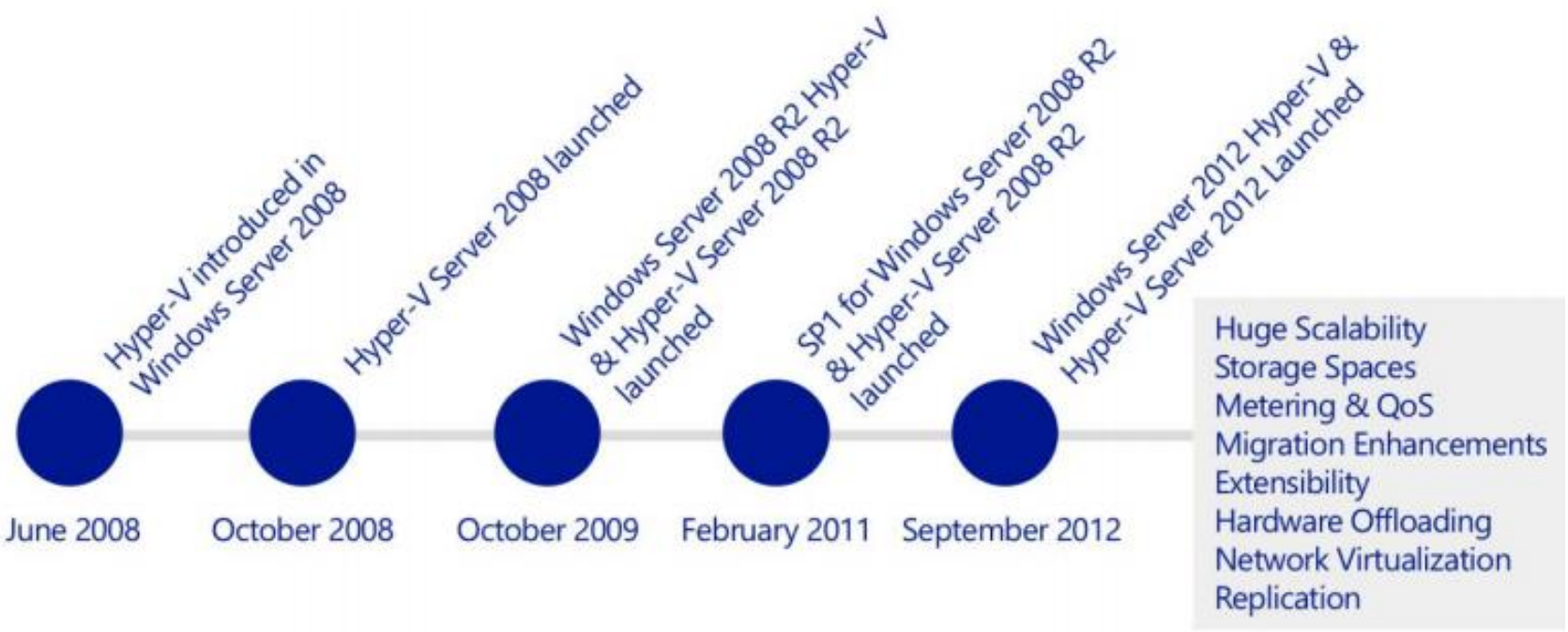
VMWare Cloud Computing Products



VMWare Evolution



Hyper-V Evolution



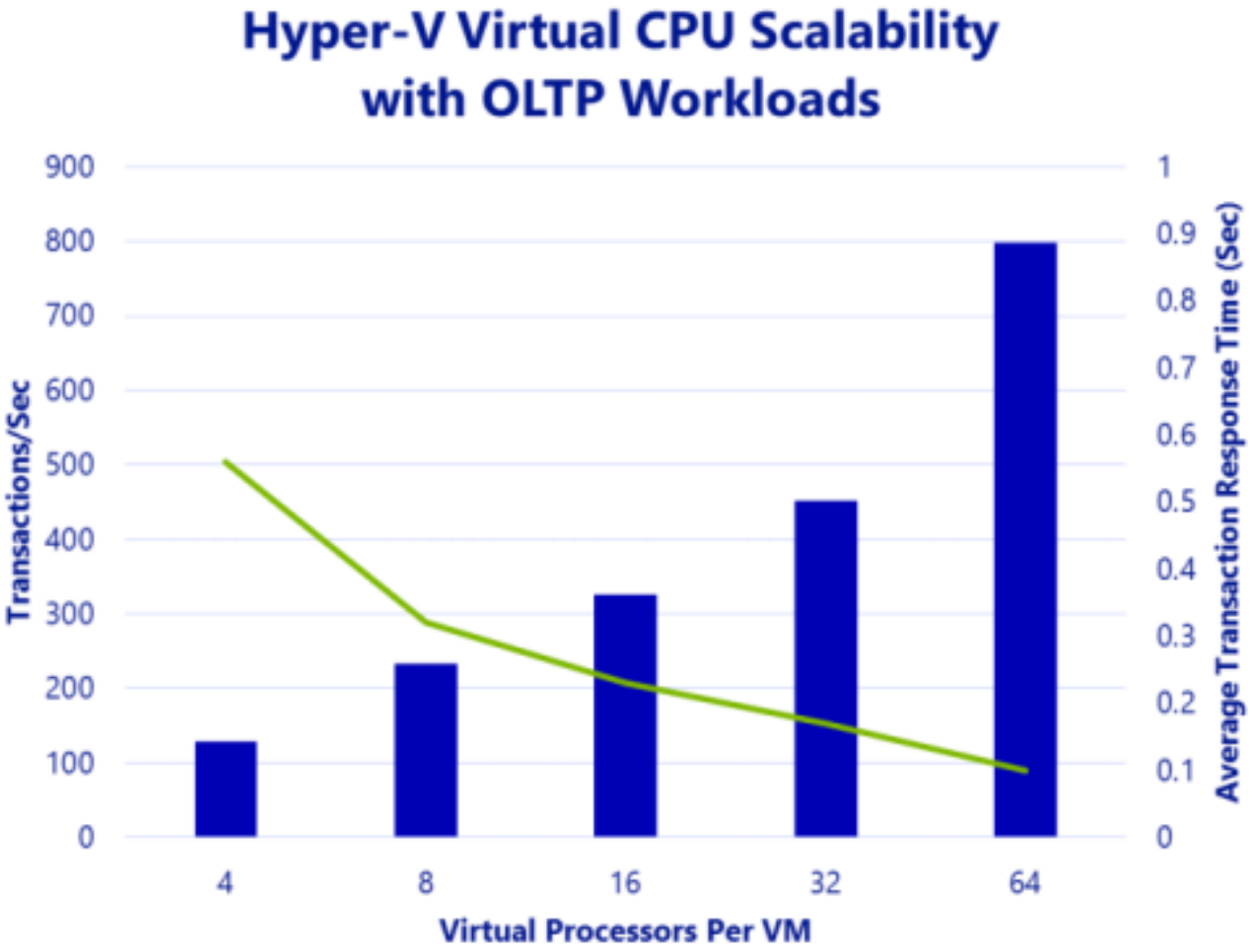
Hyper-V on WS2008R2 & WS2012R2

	Resource	Windows Server 2008 R2 Hyper-V	Windows Server 2012 R2 Hyper-V	Improvement Factor
Host	Logical Processors	64	**320**	**5×**
	Physical Memory	1TB	**4TB**	**4×**
	Virtual CPUs per Host	512	**2,048**	**4×**
VM	Virtual CPUs per VM	4	**64**	**16×**
	Memory per VM	64GB	**1TB**	**16×**
	Active VMs per Host	384	**1,024**	**2.7×**
	Guest NUMA	No	**Yes**	**-**
Cluster	Maximum Nodes	16	**64**	**4×**
	Maximum VMs	1,000	**8,000**	**8×**

NUMA, or Non-Uniform Memory Access, inside a virtual machine.
NUMA refers to a computer architecture in multiprocessor systems, in which the required time for a processor to access memory depends on the memory's location relative to the processor

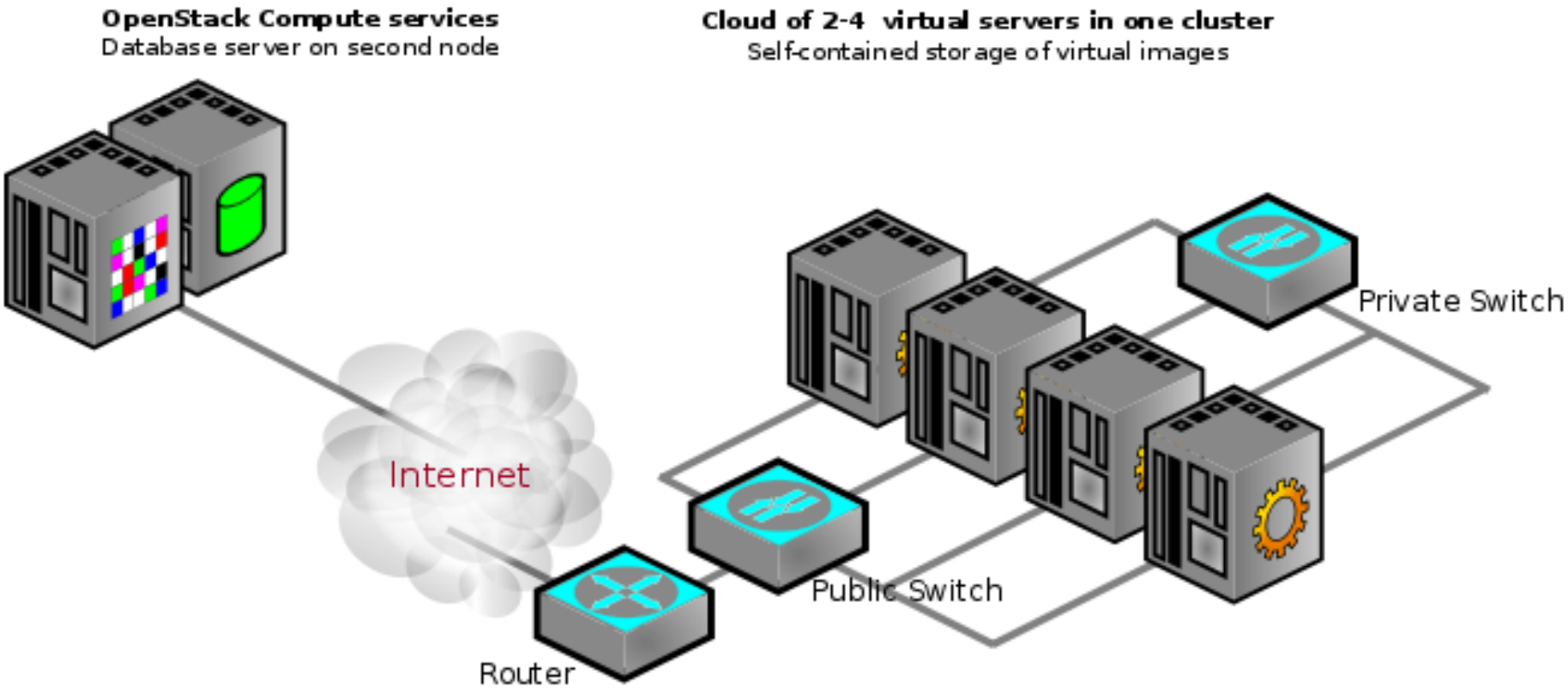
With NUMA, a processor can access local memory (memory attached directly to the processor) faster than it can access remote memory (memory that is local to another processor in the system). Modern operating systems and high-performance applications such as SQL Server have developed optimizations to recognize the system's NUMA topology and consider NUMA when they schedule threads or allocate memory to increase performance.

Hyper-V OLTP Performance



Windows Server 2012, SQL Server 2012, Single VM, 64GB of RAM

OpenStack


OpenStack Compute services
Database server on second node
Cloud of 2-4 virtual servers in one cluster
Self-contained storage of virtual images
Private Switch
Internet
Public Switch
Router

Why and Why not OpenStack

Why

- Open Source
- Free to use
- Good Performance
- Many Software Suits
- Platform for Public Cloud
- Suitable for Data Center
- SUSE Cloud Platform

Why not

- Hard to use
- Hard to support
- Complexity
- Highly Technical
- High cost supporting

	vSphere5			Hyper-V		
Feature	**Standard**	**Enterprise**	**Ent. Plus**	**Standard**	**Enterprise**	**DC**
Max host processors	160	160	160	4	8	64
Max virtual SMP (guest)	8	8	32	4	4	4
Max host RAM (GB)	2048	2048	2048	32	2048	2048
Max RAM per VM	255	255	255	64	64	64
Failover nodes	32	32	32		16	16
Memory overcommit/dynamic mem.	✓	✓	✓	✓	✓	✓
Transparent page sharing	✓	✓	✓			
Live workload migration		✓	✓		✓	✓
Live storage migration		✓	✓			
Max guests per host	512	512	512	384	384	384
Distributed Resource Scheduler		✓	✓			
Distributed switch			✓			
Virtual instance rights (Windows)	0	0	0	1	4	Unlimited
Hypervisor licensing model	per proc	per proc	per proc	per host	per host	per proc

Sources: Configuration Maximums (VMware), Requirements and Limits for Virtual Machines and Hyper-V in Windows Server 2008 R2, Windows Server 2008 R2 Editions Comparison

Hyper-V Vs VSS

	Resource	Windows Server 2012 R2 Hyper-V	VMware vSphere Hypervisor	VMware vSphere 5.5 Enterprise Plus
Host	Logical Processors	**320**	320	320
	Physical Memory	**4TB**	4TB	4TB
	Virtual CPUs per Host	**2,048**	4,096	4,096
VM	Virtual CPUs per VM	**64**	8	64
	Memory per VM	**1TB**	1TB	1TB
	Active VMs per Host	**1,024**	512	512
	Guest NUMA	**Yes**	Yes	Yes
Cluster	Maximum Nodes	**64**	N/A	32
	Maximum VMs	**8,000**	N/A	4,000

Live Migration Comparison

Capability	Windows Server 2012 R2 Hyper-V	VMware vSphere Hypervisor	VMware vSphere 5.5 Enterprise Plus
VM Live Migration	**Yes**	No	Yes
VM Live Migration with Compression	**Yes**	N/A	No
VM Live Migration over SMB/RDMA	**Yes**	N/A	No
1 GbE Simultaneous Live Migrations	**Unlimited**	N/A	4
10 GbE Simultaneous Live Migrations	**Unlimited**	N/A	8
Live Storage Migration	**Yes**	No	Yes
Shared-Nothing Live Migration	**Yes**	No	Yes
Live Migration Upgrades	**Yes**	N/A	Yes
VM Live Cloning	**Yes**	No	Yes
Network Virtualization	**Yes**	No	VXLAN/NSX
Network Virtualization Gateway	**Yes**	No	vCloud Suite
Flexible Linux Guest OS Support	**Yes**	Yes	Yes

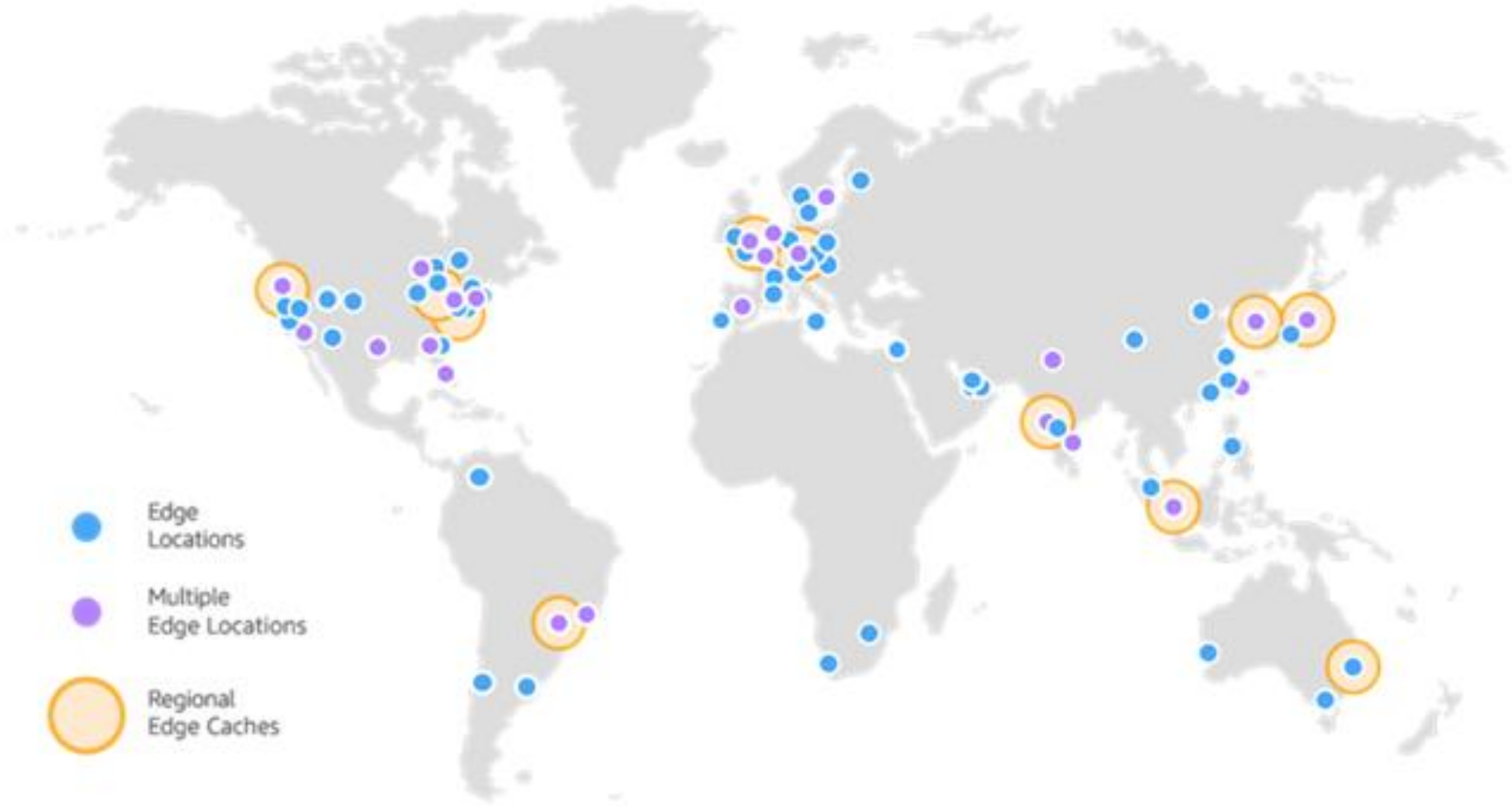
Cluster Features Comparison

Capability	Windows Server 2012 R2 Hyper-V	VMware vSphere Hypervisor	VMware vSphere 5.5 Enterprise Plus
NIC Teaming	**Yes**	Yes	Yes
Integrated High Availability	**Yes**	No	Yes
Nodes per Cluster	**64**	N/A	32
VMs per Cluster	**8,000**	N/A	4,000
Max Guest Cluster Size (iSCSI)	**64 Nodes**	5	5
Max Guest Cluster Size (Fiber)	**64 Nodes**	5	5
Max Guest Cluster Size (File Based)	**64 Nodes**	5	5
Guest Cluster with Shared Virtual Disk	**Yes**	Yes	Yes
Guest Clustering with Live Migration	**Yes**	N/A	No
Guest Clustering with Dynamic Memory	**Yes**	No	No
Guest OS Application Monitoring	**Yes**	N/A	Yes
Cluster-Aware Updating	**Yes**	N/A	Yes
Failover Priority, Affinity & Anti-Affinity	**Yes**	N/A	Yes

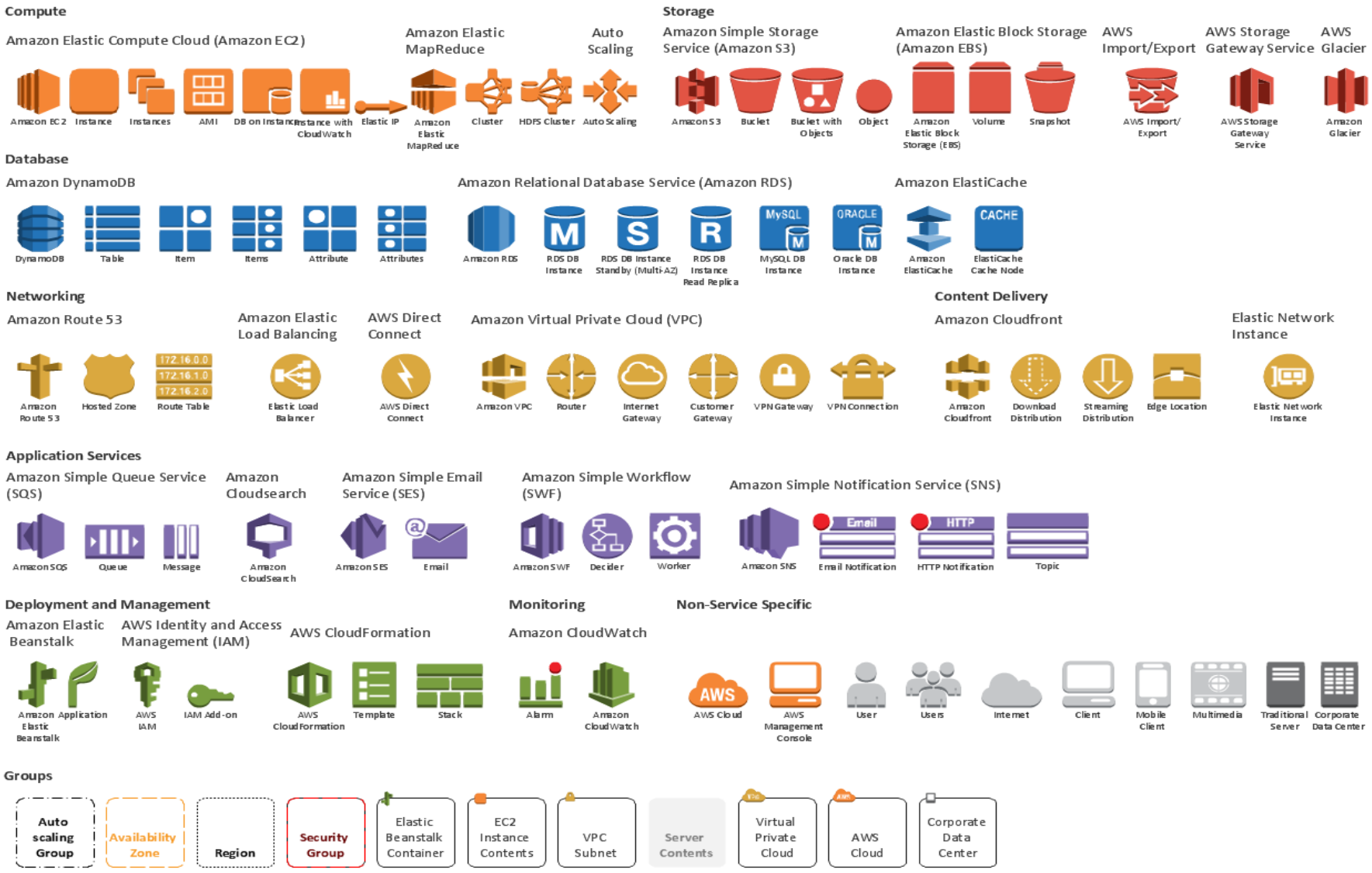
Public Cloud Battle

Public Cloud Players

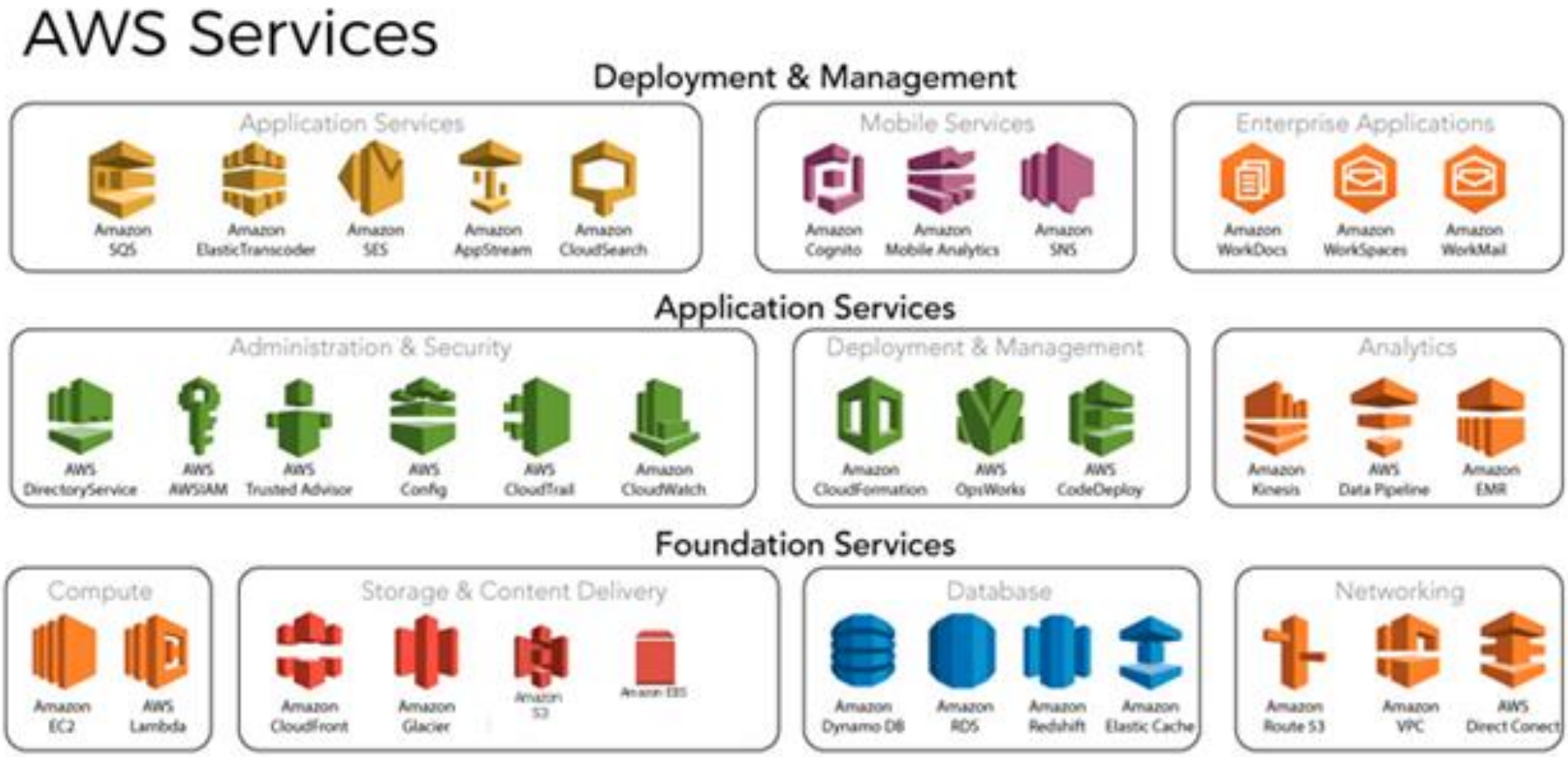
AWS Locations



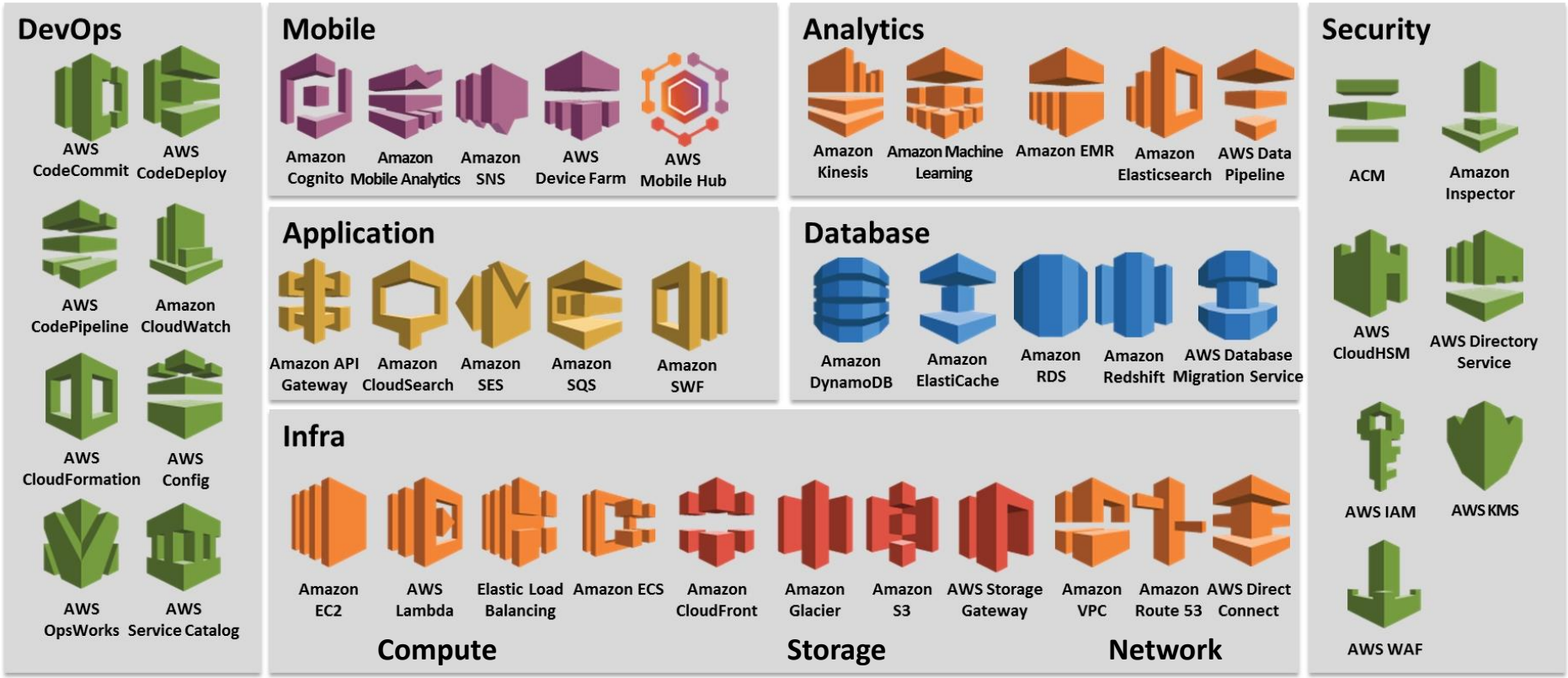
AWS Products/Services



AWS Product Groups
Services Level



AWS Product Groups
Service Groups

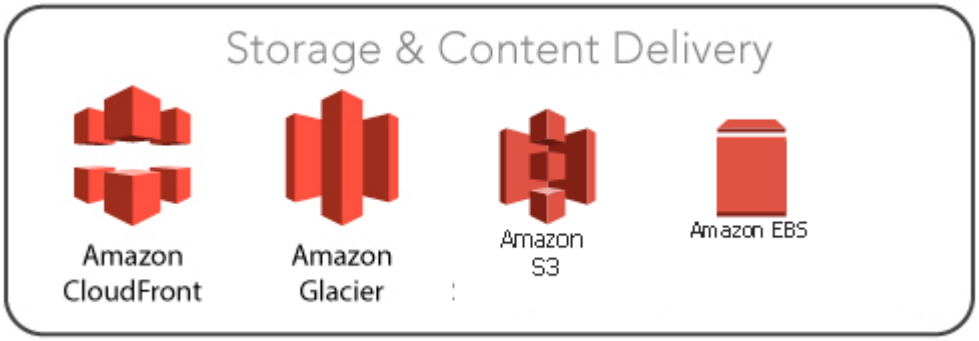


AWS Compute Services

- EC2 or Elastic Compute Cloud – Virtual machine for which user has OS level control.
- AWS Lambda — Run program functions in the cloud.

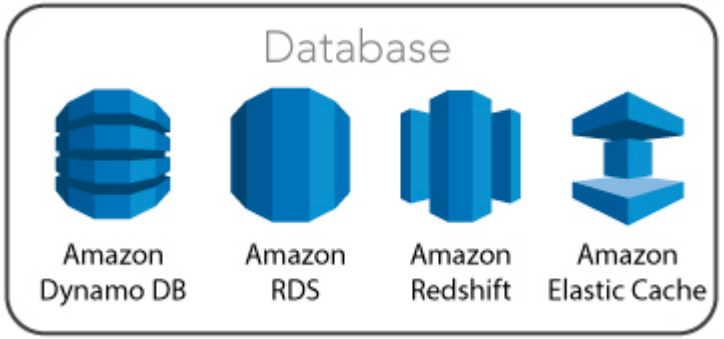
AWS Storage Services

- Amazon Glacier- Low-cost storage service for data archiving and backup.
- Amazon Elastic Block Store (EBS)- Provides block-level storage for Amazon EC2. EBS volumes are network-attached and are free from the life of an instance.
- Amazon S3 – S3 or simple storage service. It provides object storage.
- Cloud Front – It is a CDN or content delivery network to distribute the inert and active web content. For example, .html, .php files to clients



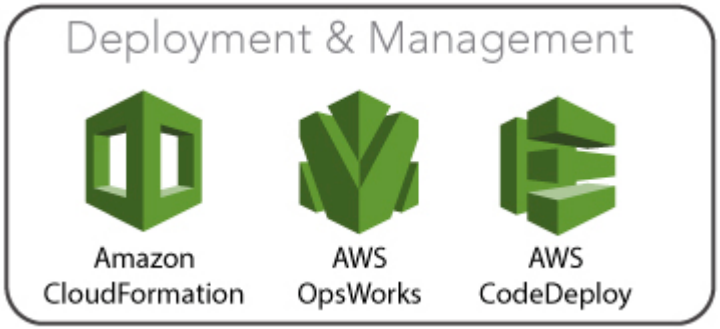
AWS Database Services

- Amazon RDS- Set up, operate, and scale a relational database in the cloud.
- Amazon DynamoDB- Fully managed NoSQL database service.
- Amazon ElastiCache- Deploy, operate, and scale an in-memory cache in the cloud.
- Amazon RedShift - Data warehousing solution to perform OLAP queries.



AWS DevOps

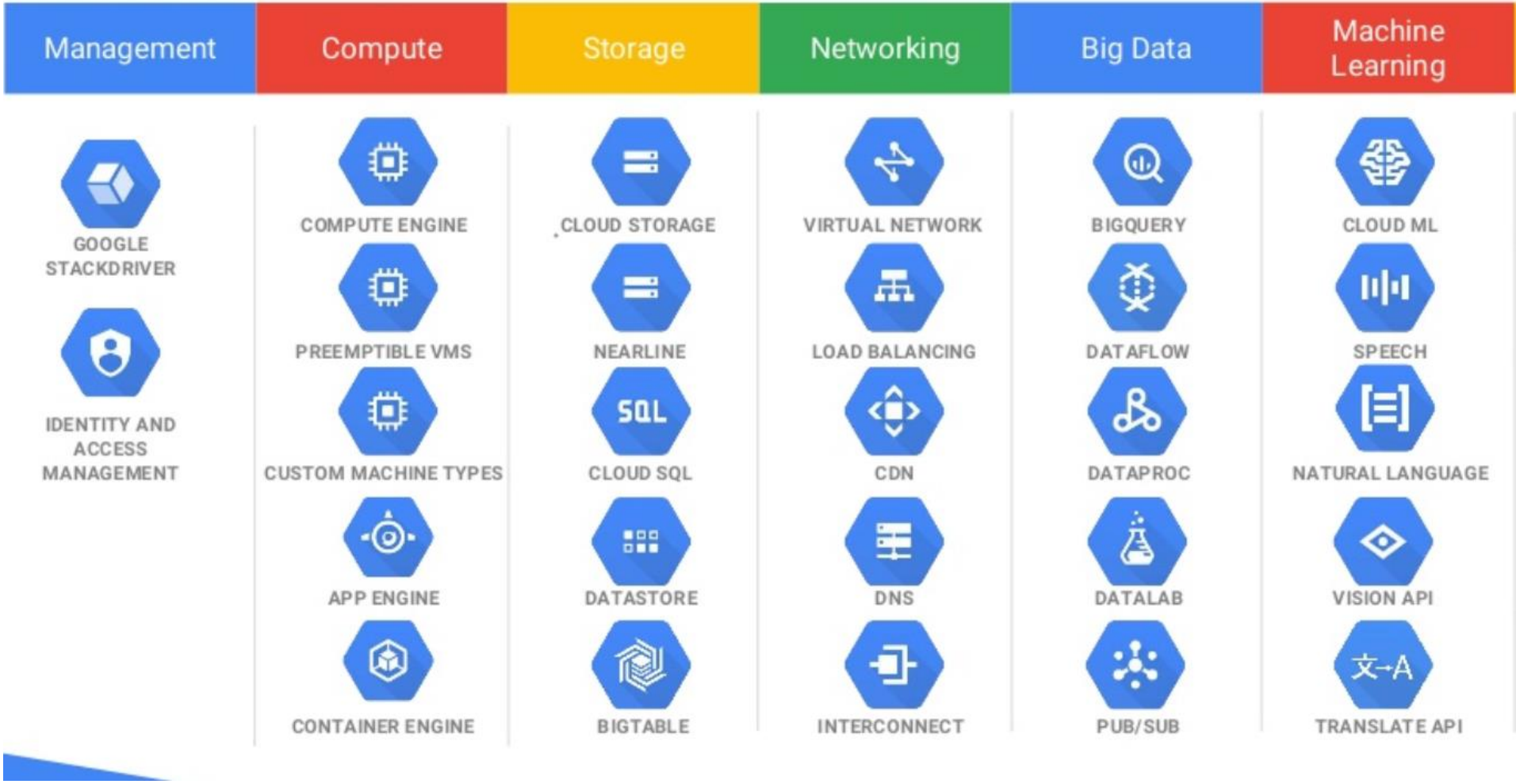
- CloudWatch — Monitor AWS environments like EC2, RDS instances, and CPU utilization. It also triggers alarms depends on various metrics.
- CloudFormation — It turns infrastructure into the cloud. Use templates to get whole production environment in minutes.
- OpsWorks — Automated Chef/Puppet deployments on AWS environment.



AWS Admin and Security

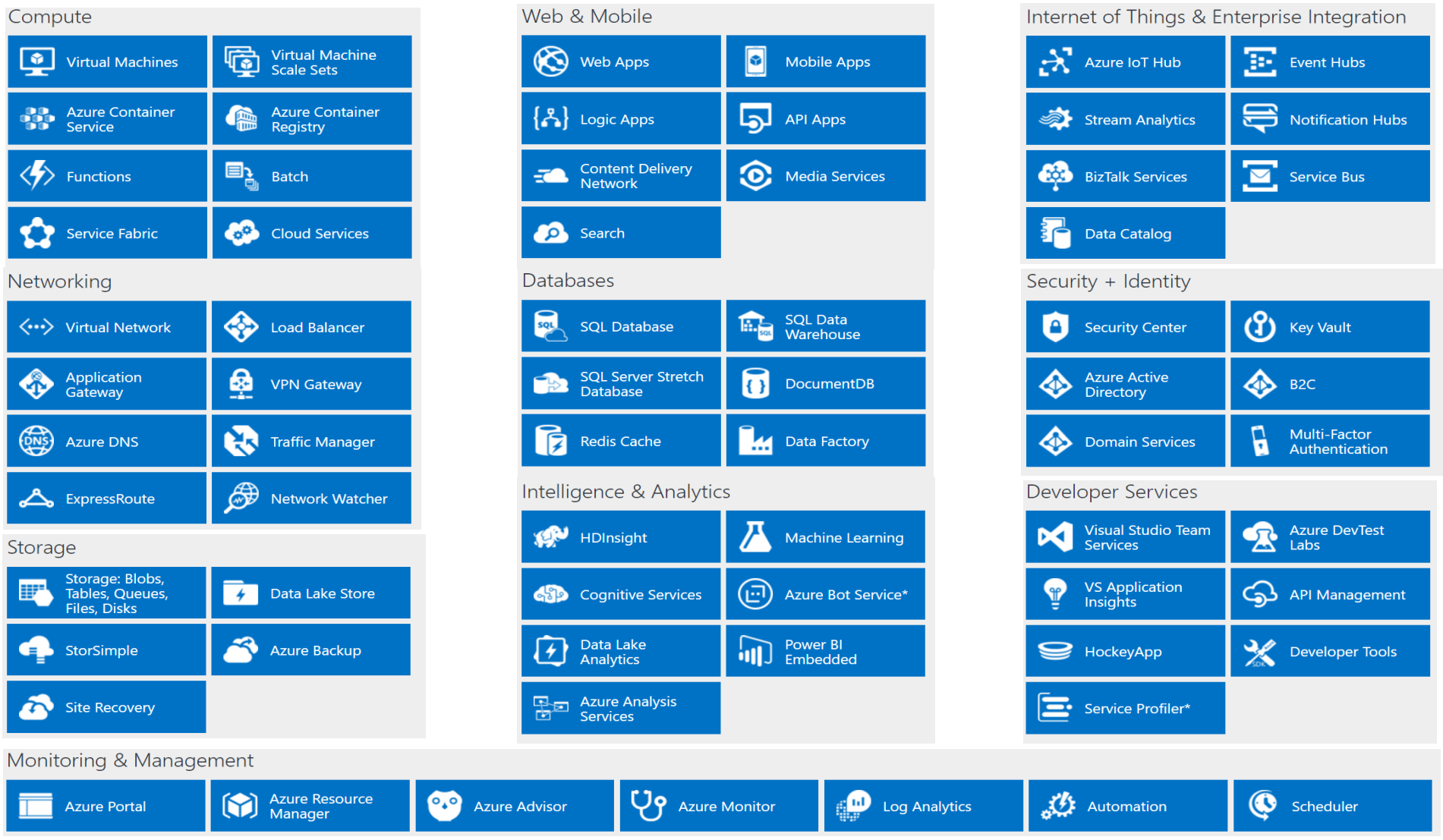
- IAM (Identity and Access Management) — IAM helps to manage users, assign policies, form groups to manage multiple users (Similar to Microsoft Active Directory)
- Certificate Manager — Offers free SSL certificates for your domains that are managed by Route53.
- WAF — Manage protection features for web applications.

GCP Products/Services

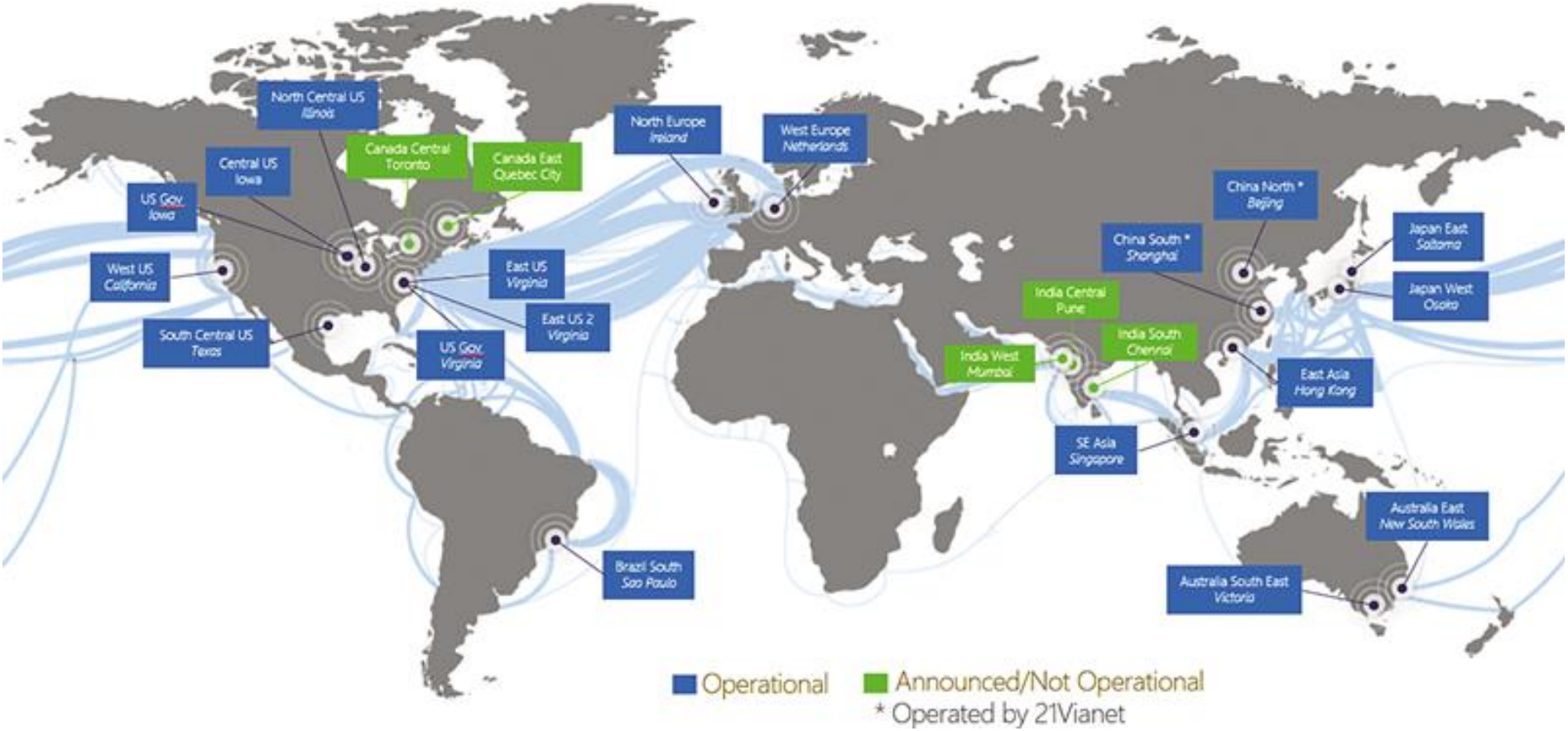


GCP Locations

Azure Products/Services



Azure Locations



Public Cloud Comparison