

# Evolution of Cloud Computing

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# Agenda

- Evolution of Computing
- Few Sophisticated Systems
- Motivation for Cloud
- Cloud Environment & Providers
- Cloud Services & Case Studies
- Overview of Virtualization
- Docker & Containers
- Microservices & Kubernetes

# My Exposure to Cloud Technologies...

- Teaching Cloud Computing since 10+ years
- Few Publications in the domain of Cloud
- AWS Ambassador
- Consultant to Industry
- Jury for 2018 National Skills Competition
- Community member of AWS, GDG, Alexa etc.



# Daily



Daily Net SALE Six Times as Large as That of Any Penny Lon

EDNESDAY, AUGUST 5, 1914

LONDON

MANCHESTER

# GREAT BRITAIN DECLARES WAR ON GERMANY

The following announcement was issued at the Foreign Office at 12.15 a.m.

## SUMMARY REJECTION OF BRITISH

Britain had sent an ultimatum to Germany which expired at midnight.

This was due to Germany's refusal to leave Belgium neutral and her invasion of that country.

The German Ambassador went to 10 Downing Street at 12.10am to receive his

Historic d







## 4.2 The second variable component

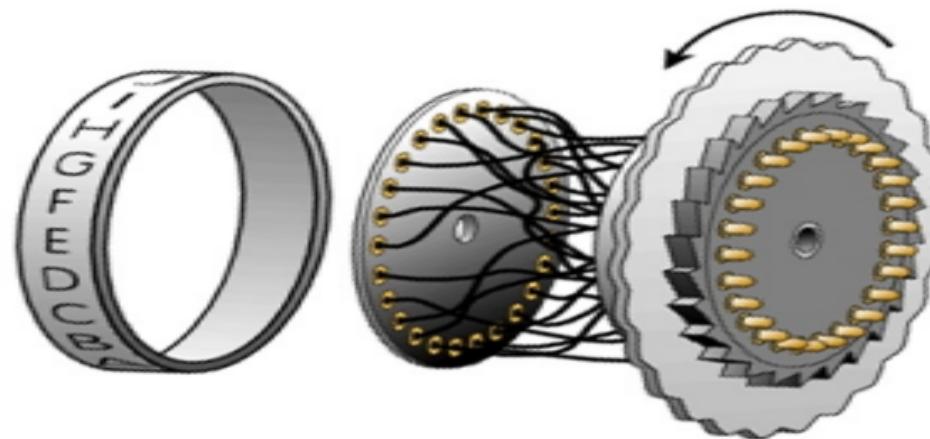


Figure 7: Disassembled Rotor with 26 input and output point on alternating faces<sup>7</sup>

The second variable component was the set three ordered rotors which connects to those 26-input contact points to 26-output contact points positioned on both sides of a disc. So, total number of discs which could have been constructed independently are  $26!$ . Note that:

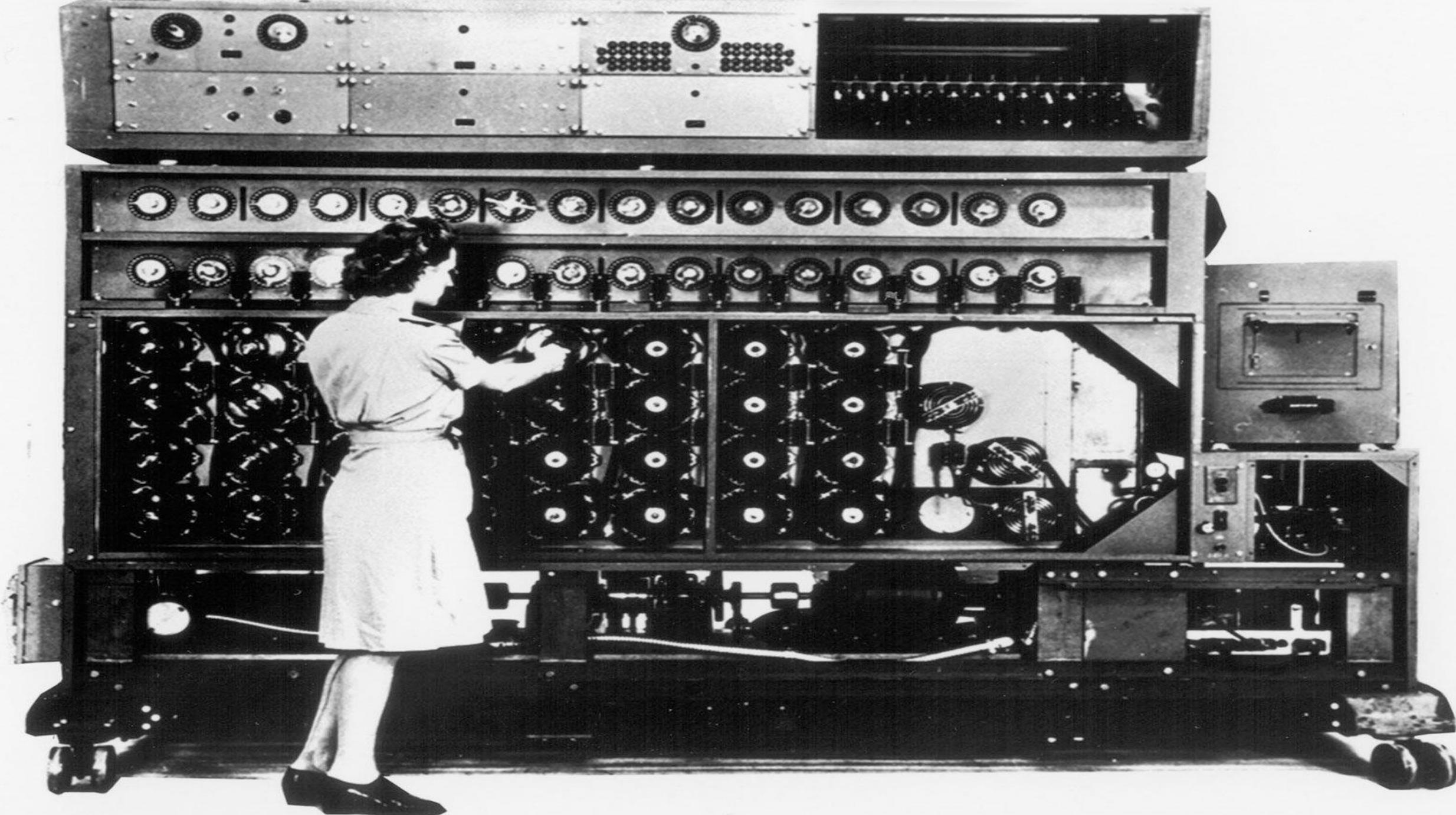
$$26! = 403, 291, 461, 126, 605, 635, 584, 000, 000 \quad (4.5)$$

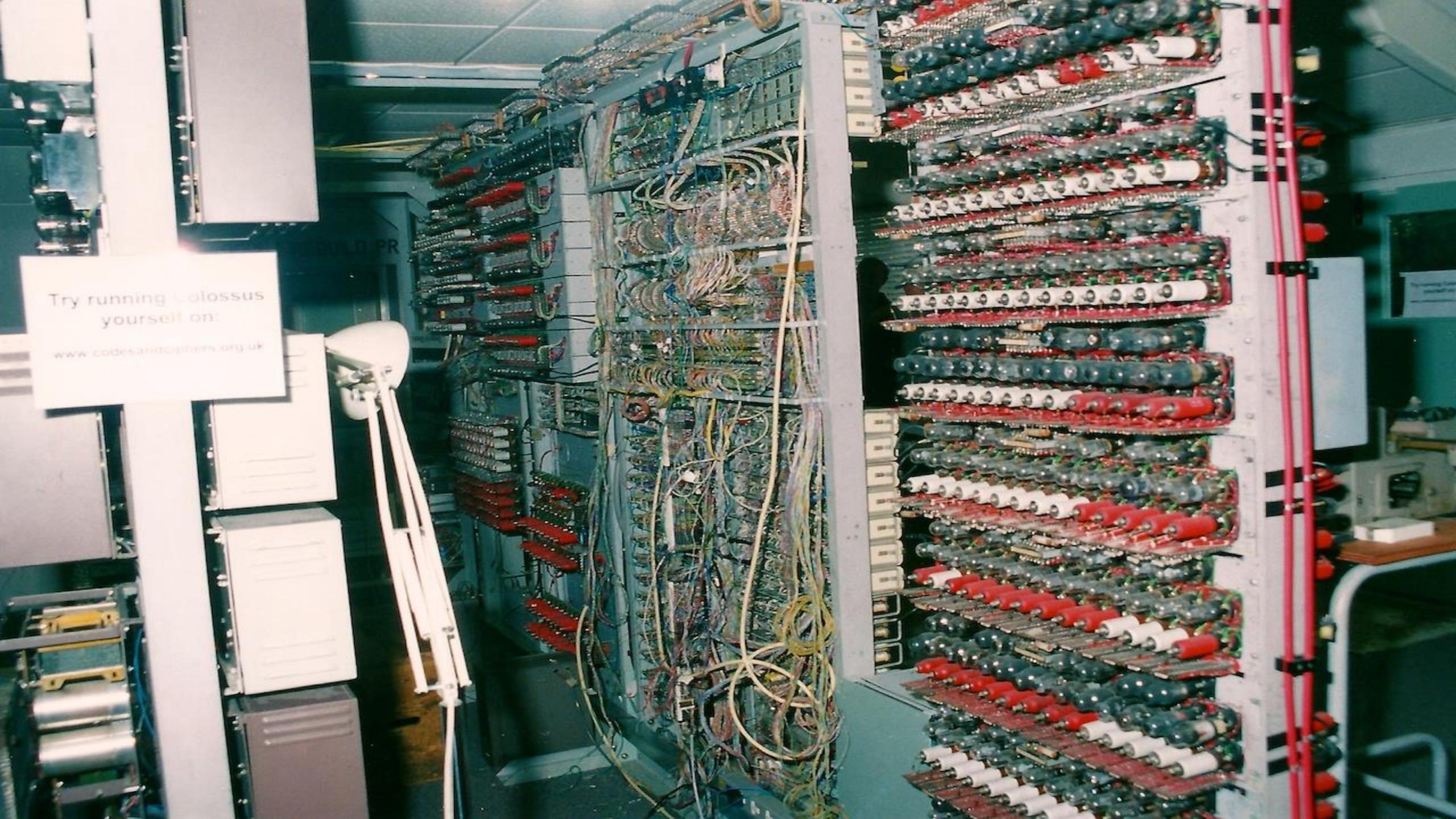
Since the rotor's discs are hardwired. So, such a vast number would have been impossible in practice to construct.

(Also, The Germans never changed the disc wirings during the war. They did, however create several different groups of rotor's disc wirings for special purpose machine.) So to place the leftmost position of rotor, the cryptographers could have select any one of disc from those  $26!$ . Further, for the middle position, it could have been selected from any one of the  $(26! - 1)$  discs and for the rightmost, it could have been selected from any





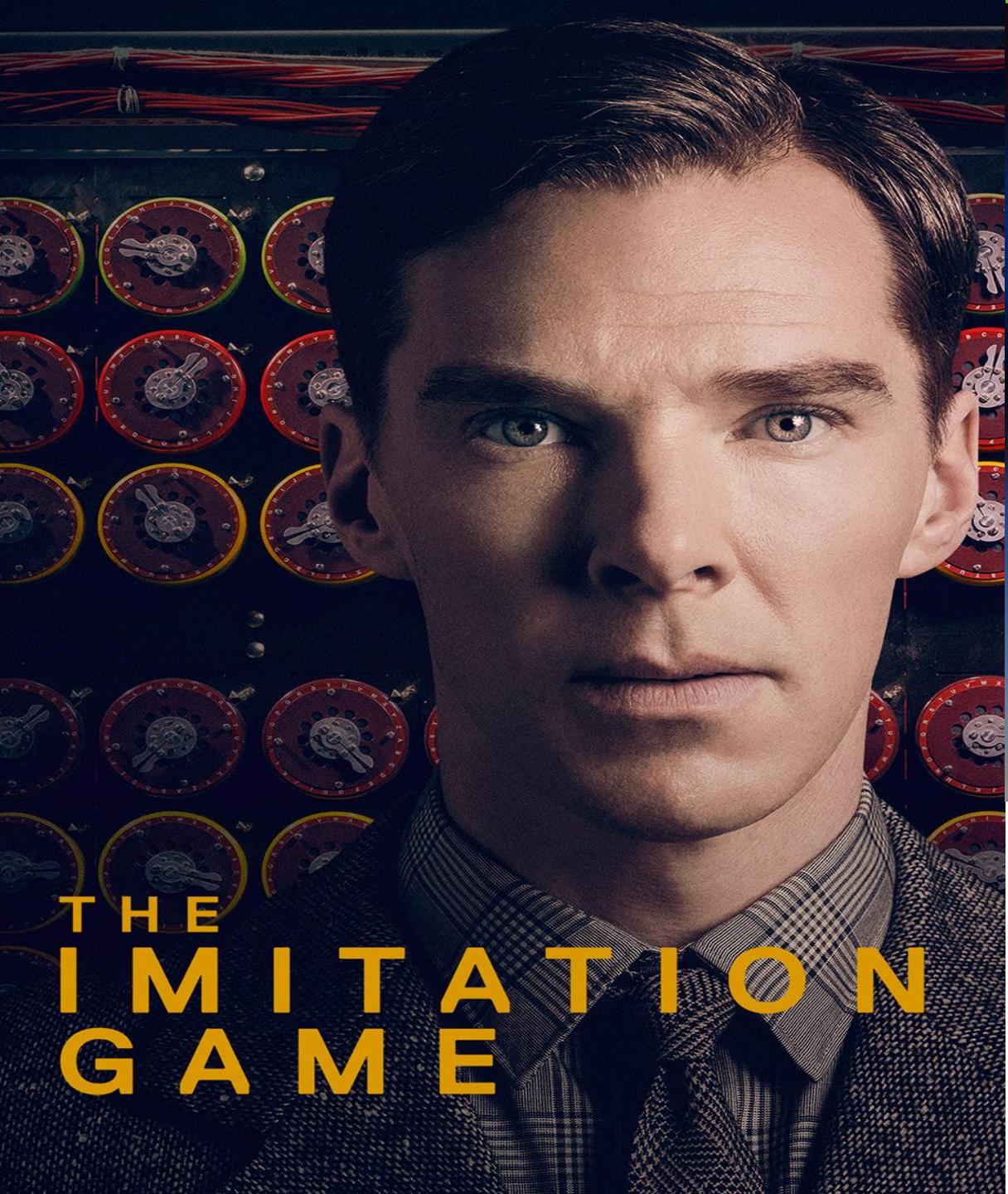




Try running Colossus  
yourself on:

[www.codesandciphers.org.uk](http://www.codesandciphers.org.uk)

BUILD PR



THE  
IMITATION  
GAME



TURING  
AWARD

# 1942 ABC Computer

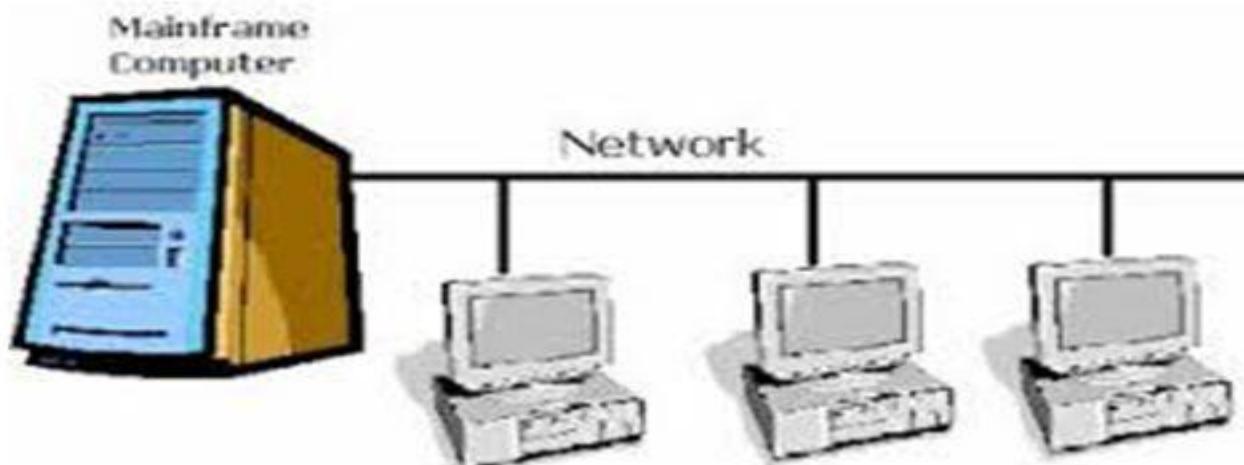
- Inventors: John Atanasoff and Clifford Berry built the first electronic computer. It represented computing, binary system or arithmetic, parallel processing, regenerative memory and computing functions.



# Time Sharing Systems

---

- Processor's time is shared among multiple users
- Multiple users simultaneously access the system through terminals.



# 1981 IBM Personal Computer (IBM 5150)

- Invented by Don Estridge who is also known as “Father of the IBM PC”
- 40k Read Only Memory
- 16k User Memory
- Powered by 8088 microprocessor working in speeds measured in millionths of a second
- Printing
- Size of a portable typewriter



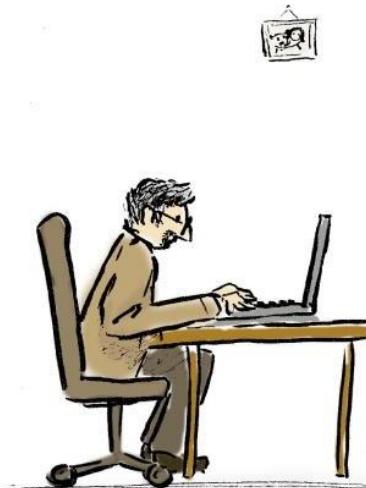
# Everyone needs Cloud ...



1925



1985



2015

# Human Nature - Need for More !



# Technocrat - Need for Speed !



# Motivation for Cloud Computing

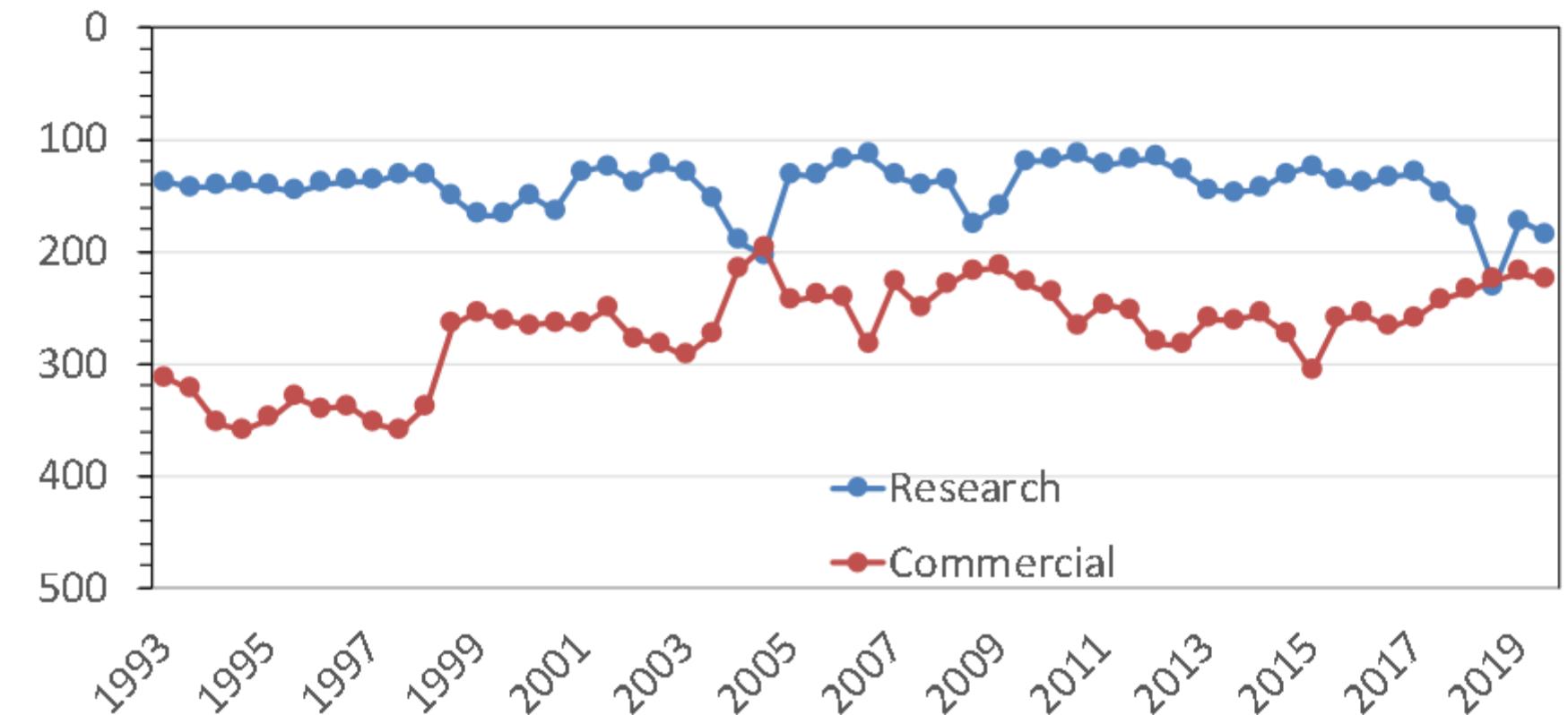
**Innovation**



**Commercialization**



# POSITION OF #100 ON TOP500



# Motivation for Cloud Computing

**Innovation**



**Commercialization**



# Example of High End Computing Requirement

- 10 Years of Gujarat Samachar Articles
- Nearly, 3,00,000 documents
- Approx. 200 words / article
- Total words :  $3,00,000 \times 200 = ???$
- List all articles containing the word “Earthquake”
- Around 10-12 hrs on 4 GB RAM

# Example of High End Computing Requirement

- List all articles containing the words  
“Earthquake” and “Kutch”
- Around 13-14 hrs on 4 GB RAM

# Example of High End Storage Requirement

- Web Corpus – 25 Tera Bytes
- Big Data !!! (Peta Bytes)
- Superfast Networking among Storage Systems

# Motivation for Cloud Computing

**Innovation**



**Commercialization**



# Business Needs Cloud

- Amazon averaged **306 transactions** per second at their peak in 2012.
- That's **26.5M** transactions per day.



# What if Servers Fails



- In August 2013, Amazon was down for **40 minutes**.  
And in that short time-span, they had almost  
**\$5 million** in lost sales

# Amazon Prime Day 2019

- Prime Day started off with **372K** server equivalents and scaled up to **426K** at peak.
- The team added an additional **63 petabytes** of storage ahead of Prime Day; the resulting fleet handled **2.1 trillion requests** per day and transferred **185 petabytes** of data per day.
- On Prime Day, **1,900 database instances** processed **148 billion transactions**, stored 609 terabytes of data, and transferred **306 terabytes** of data.

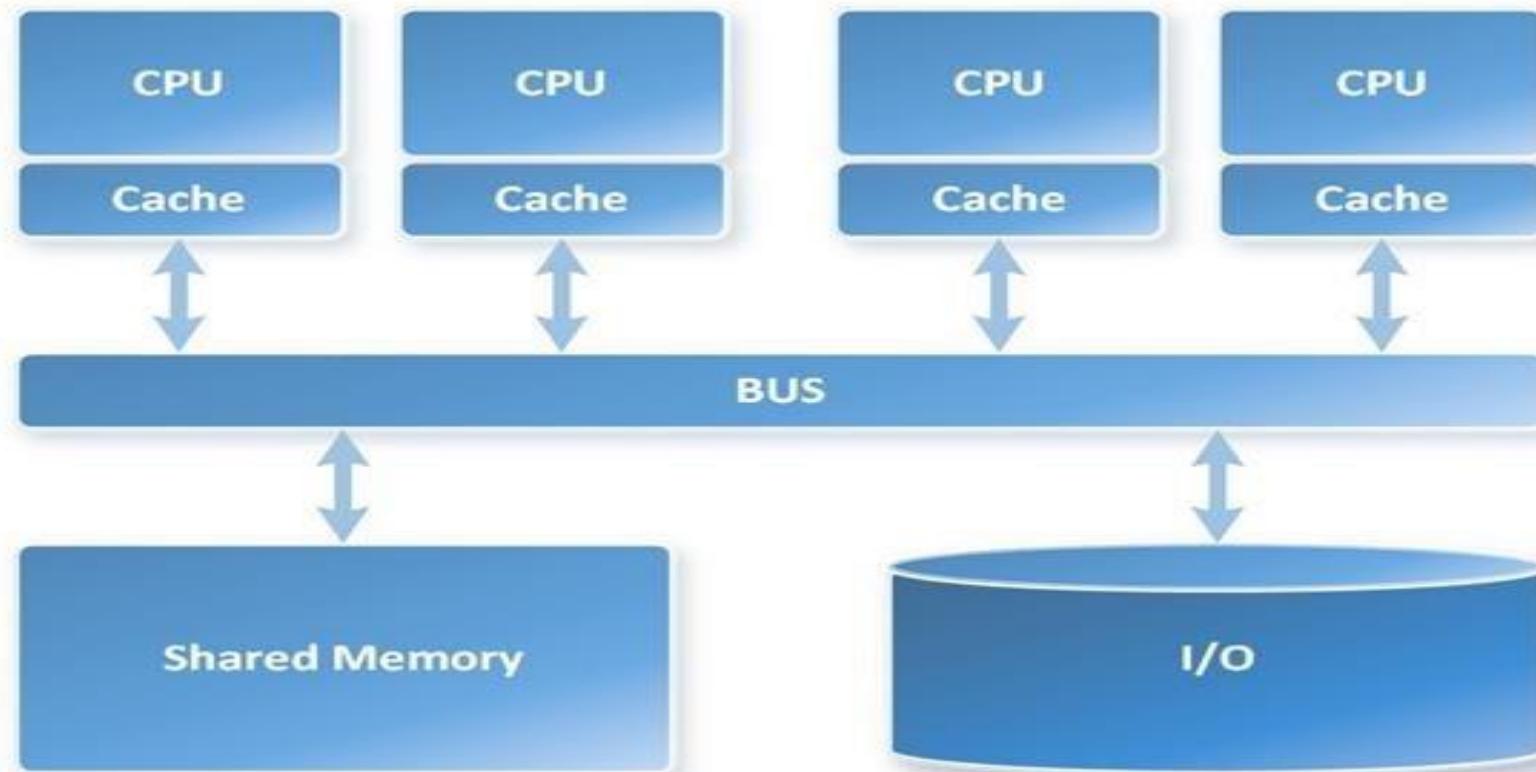
# Cloud Infrastructure on Rent



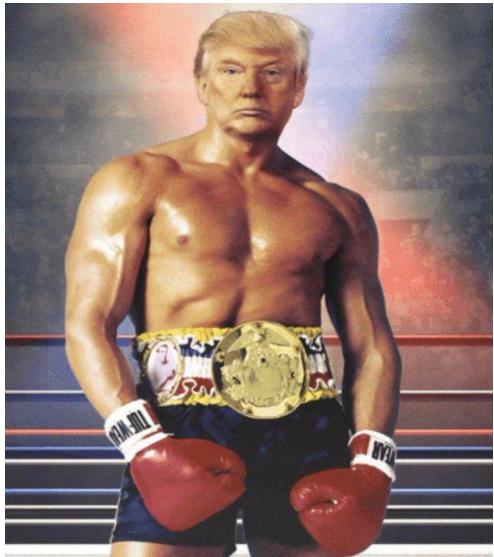
# What is Virtualization ?



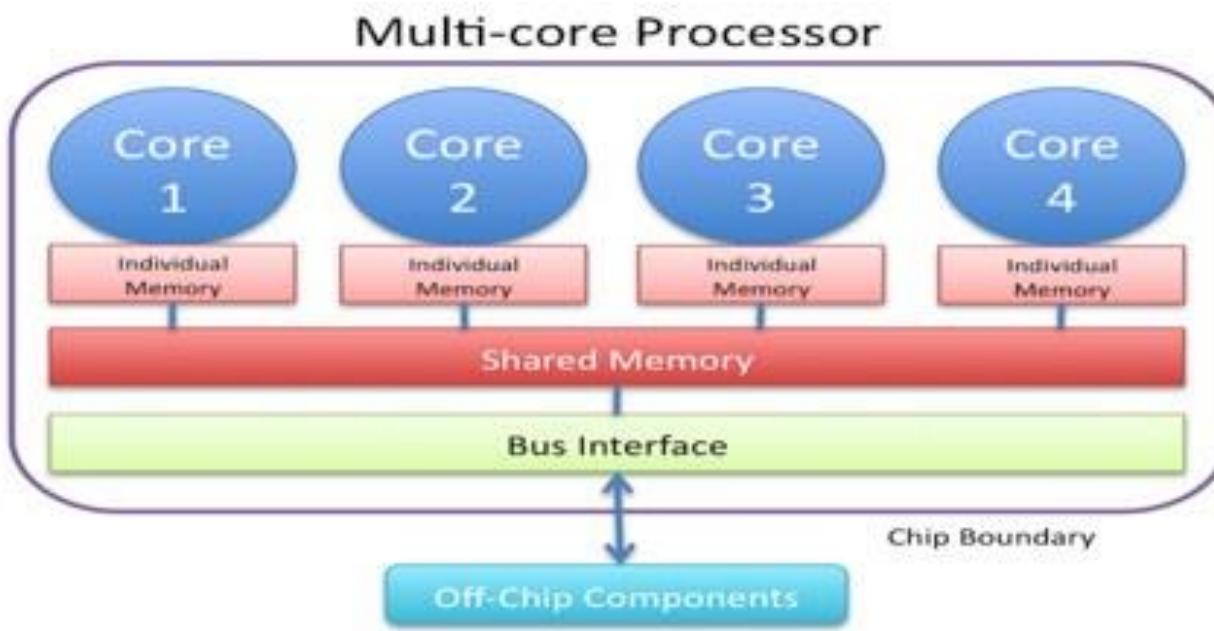
# Array Processors, SMPs, etc.



# Array Processors, SMPs, etc.



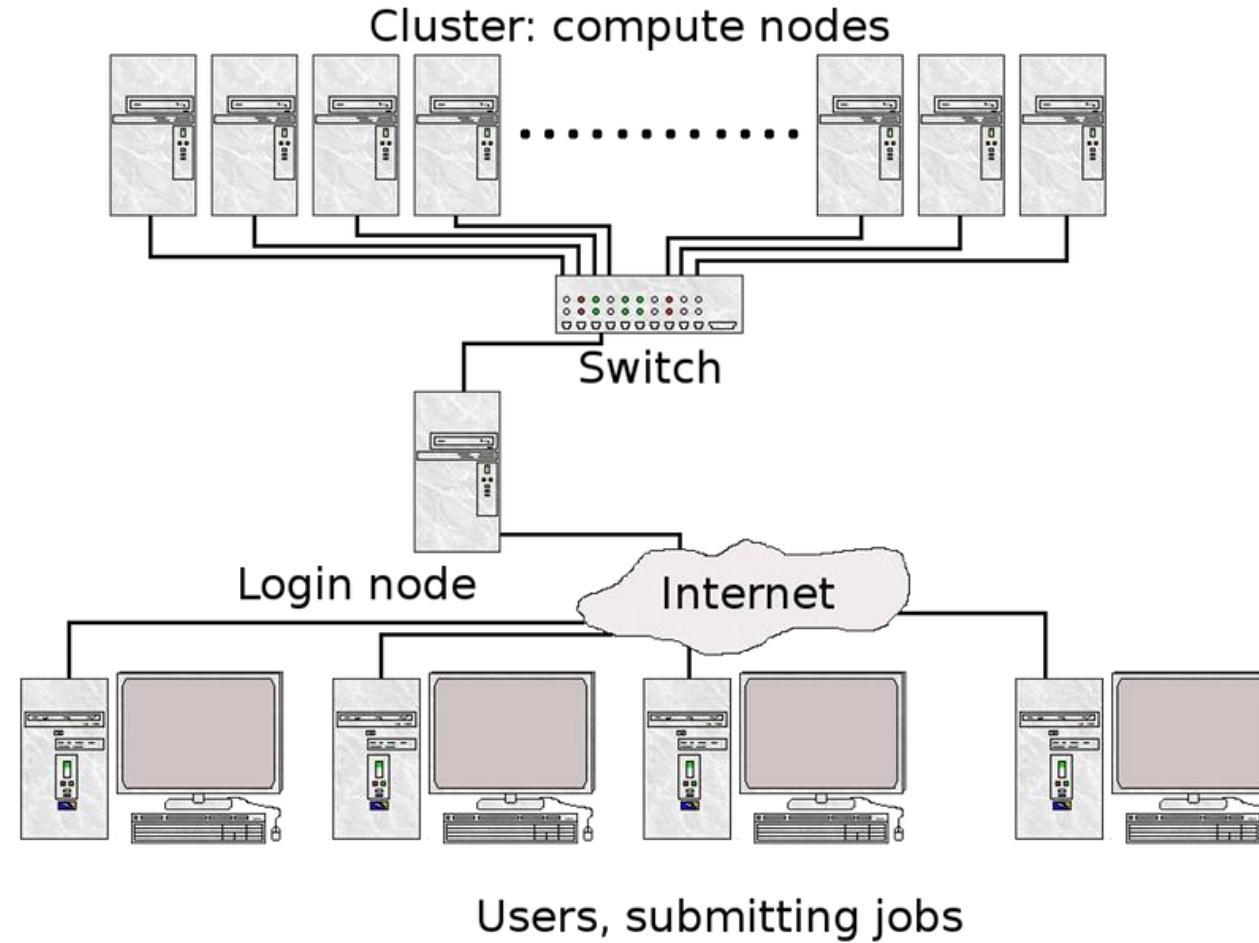
# Multicore Gaming Phones



# Poor Man's Super Computer



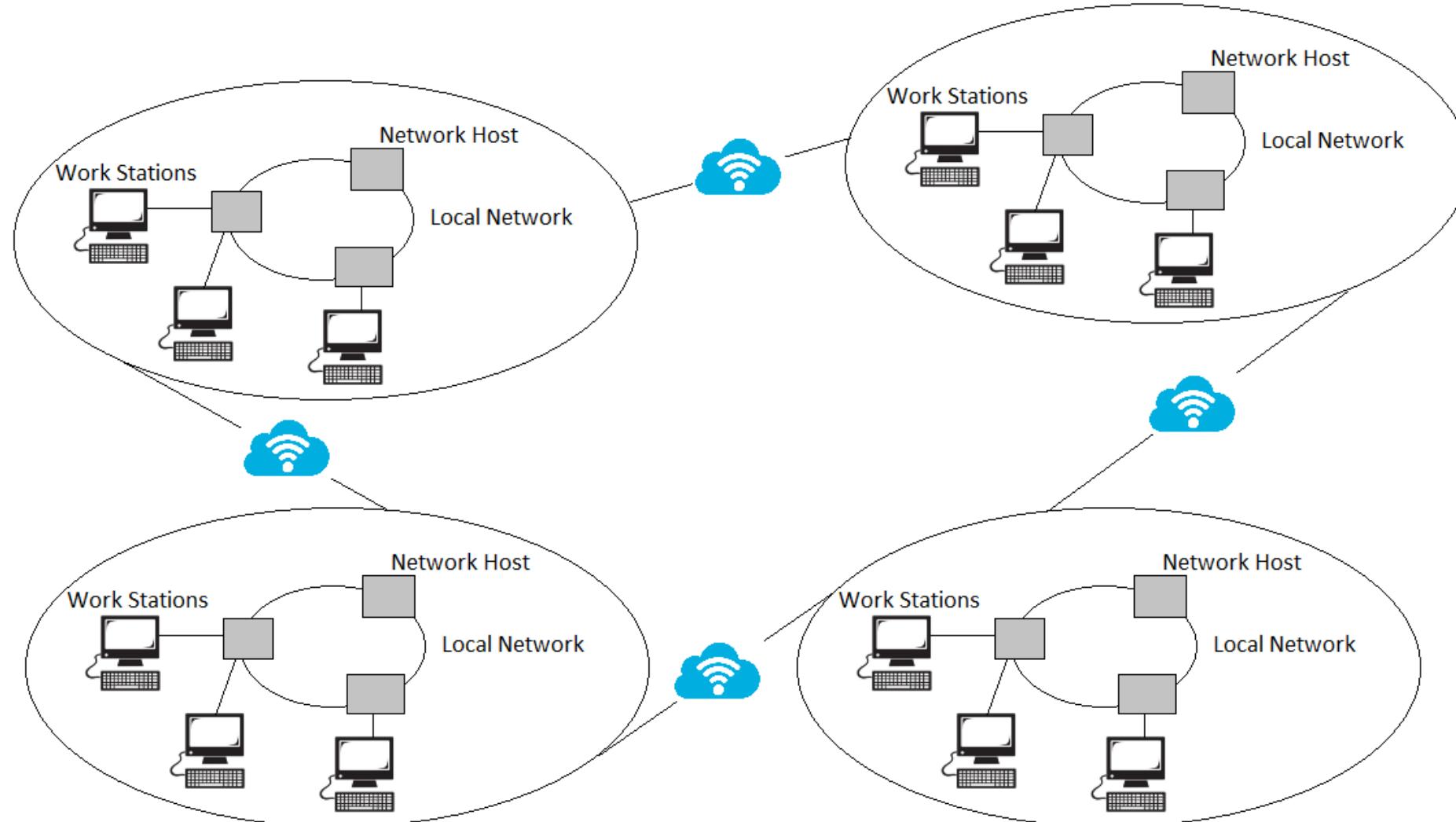
# Poor Man's Super Computer



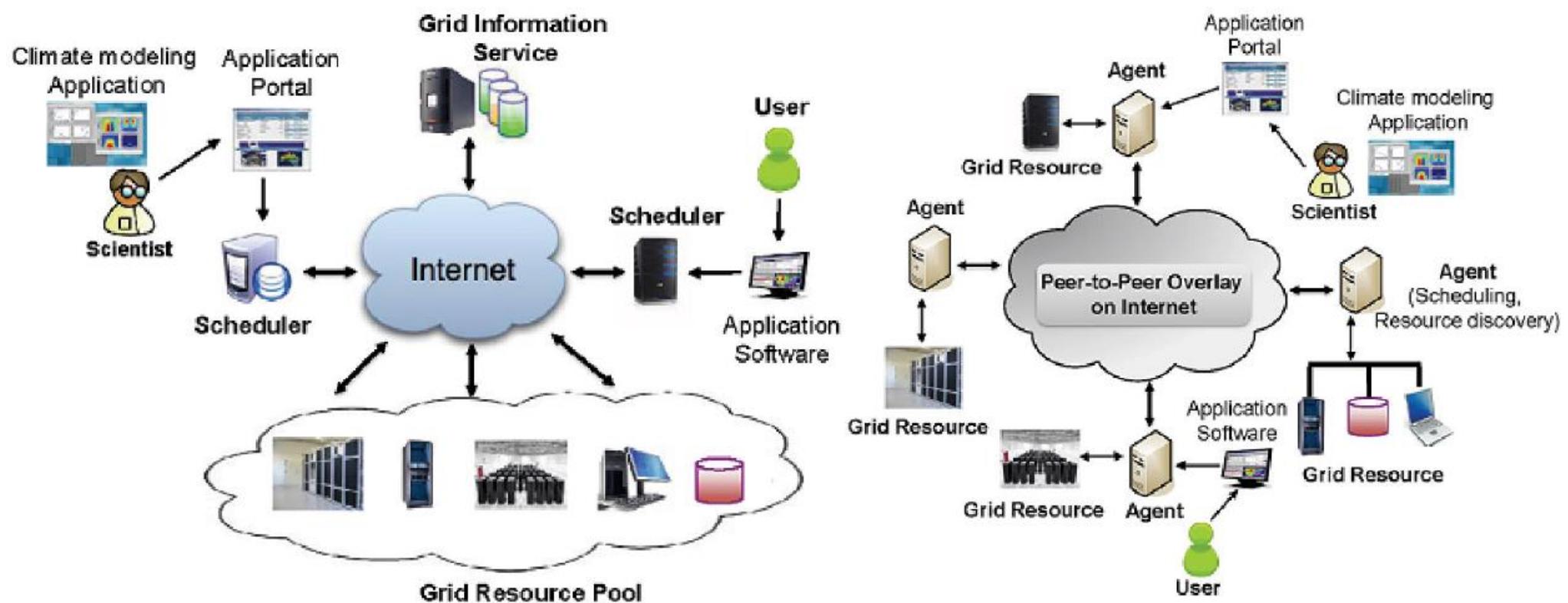
# Super Computer @ Dept. !



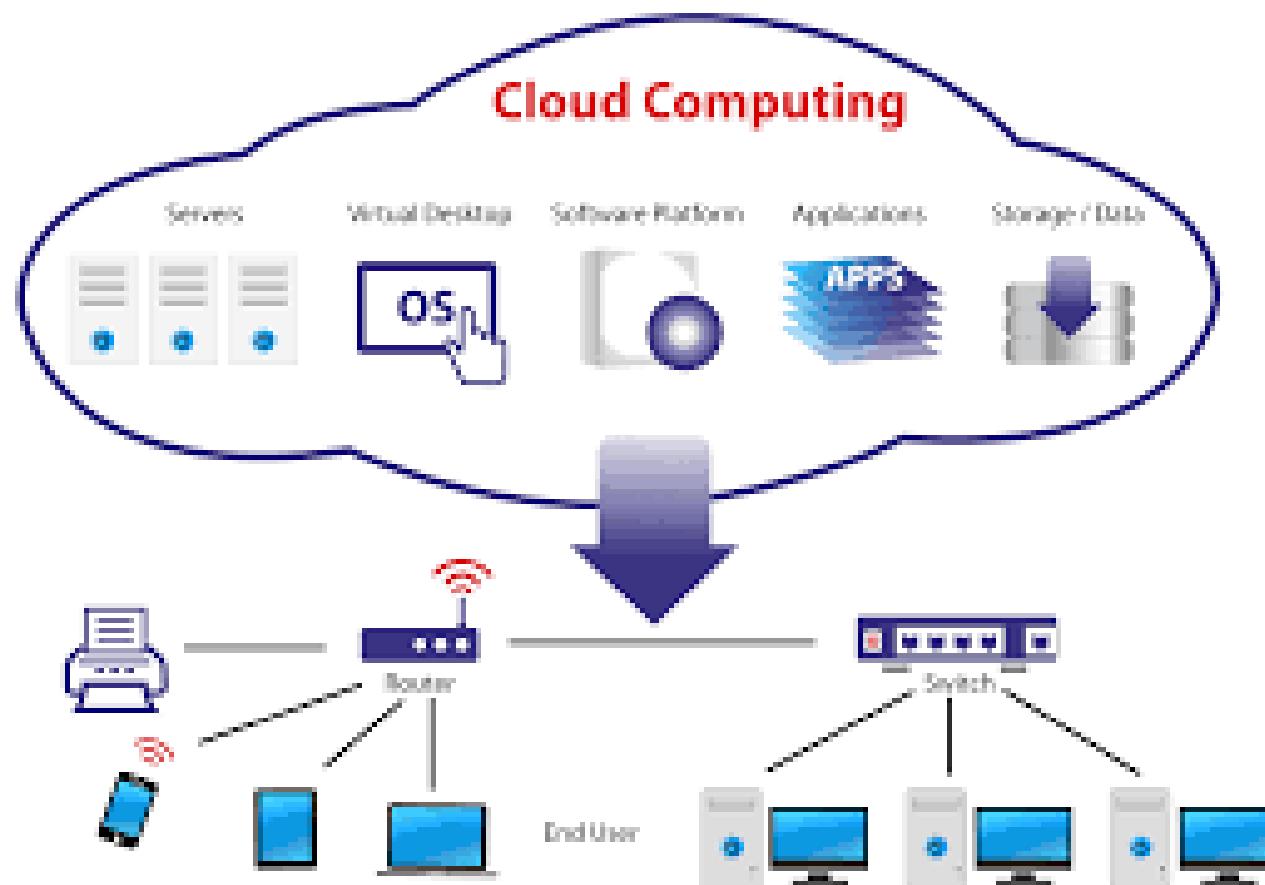
# From Clusters to Grids



# Applications over Grid



# Cloud Computing

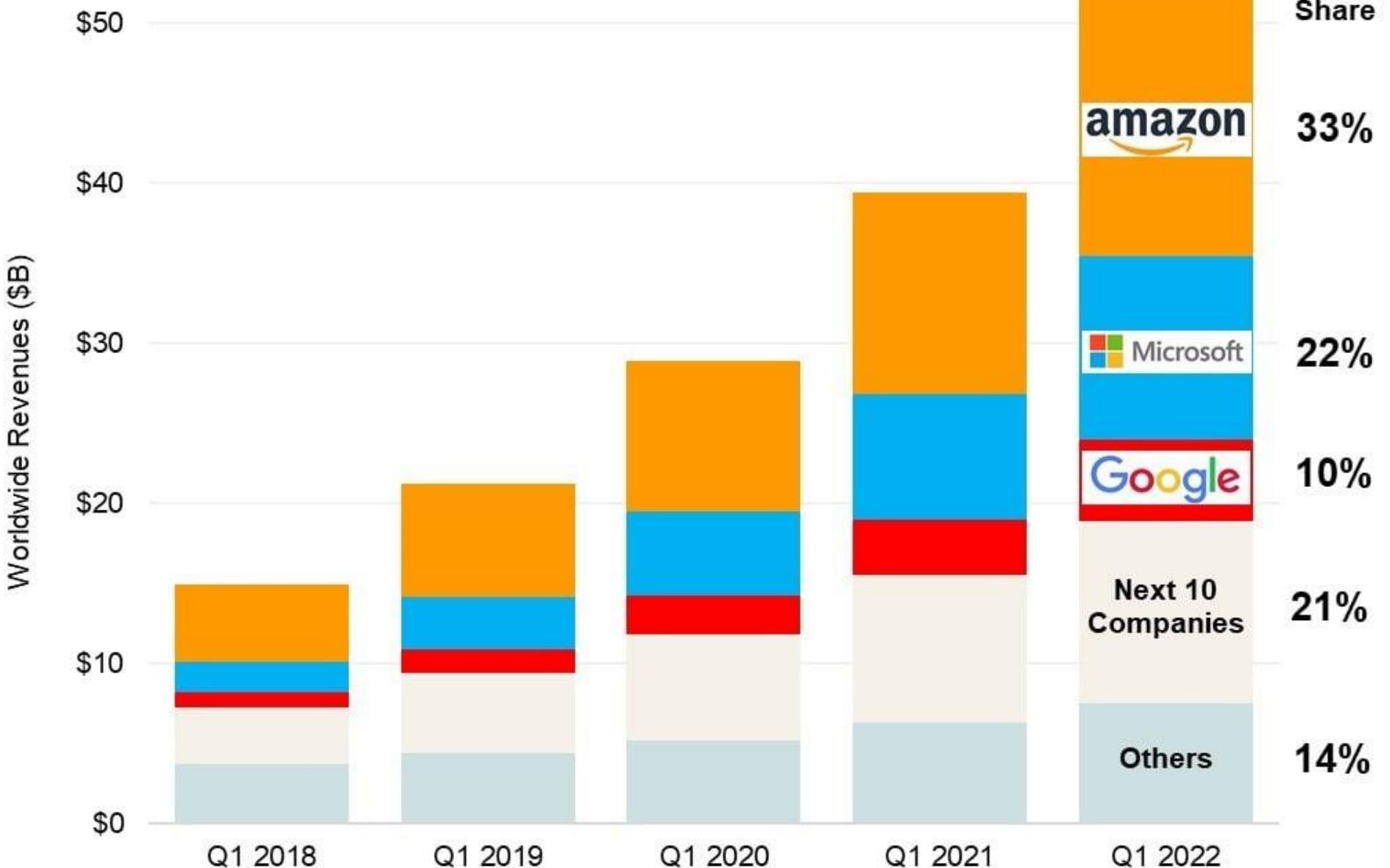


# Top Cloud Providers

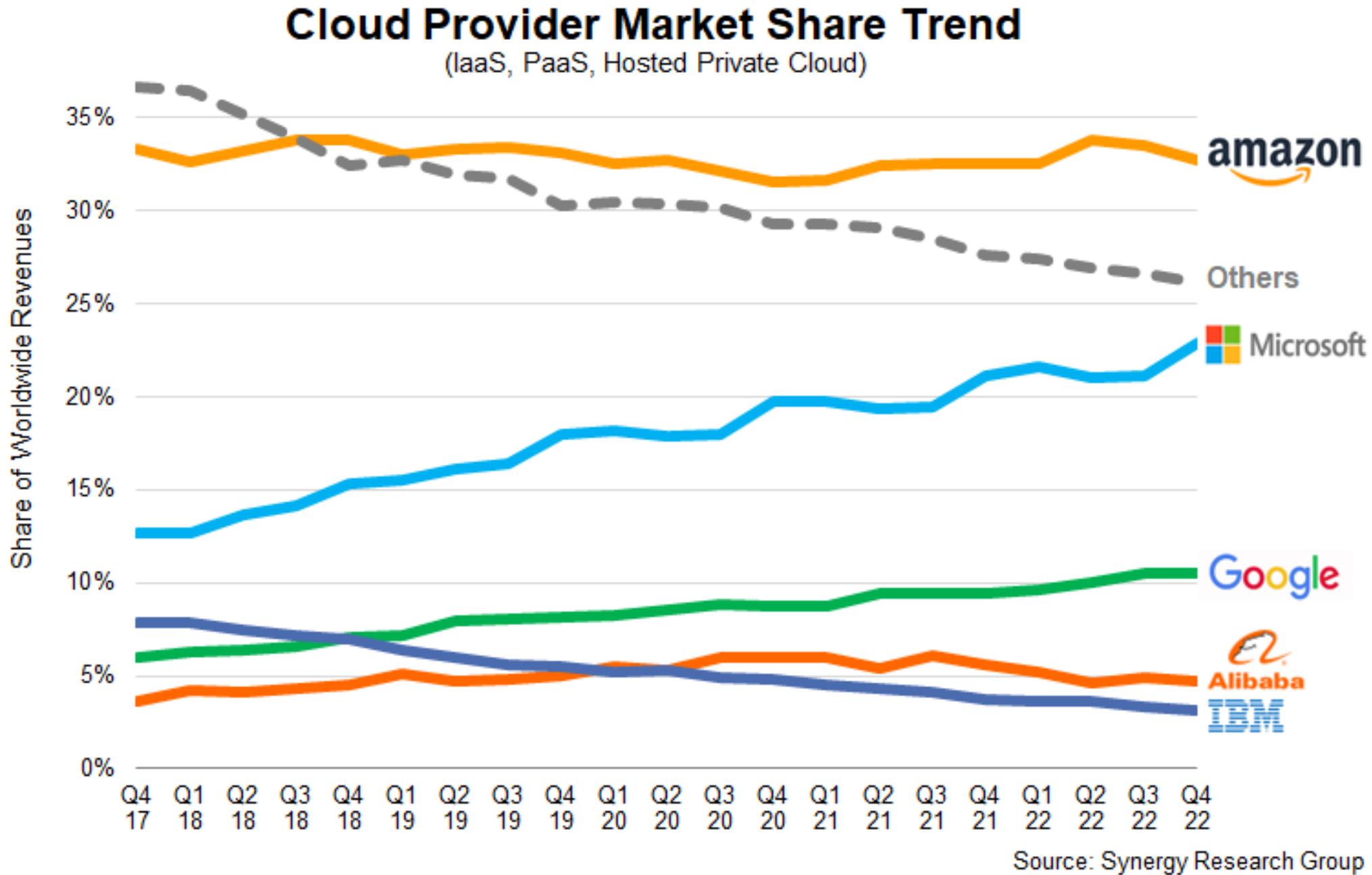


# Cloud Infrastructure Services Market

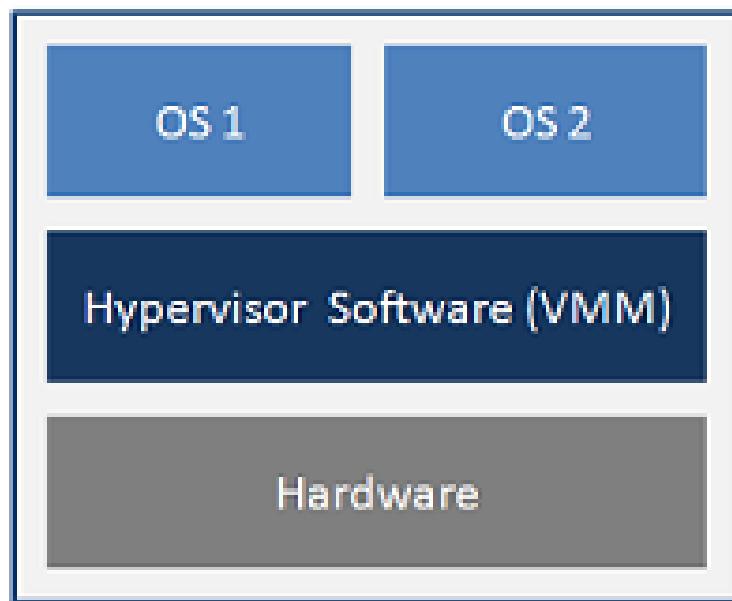
(IaaS, PaaS, Hosted Private Cloud)



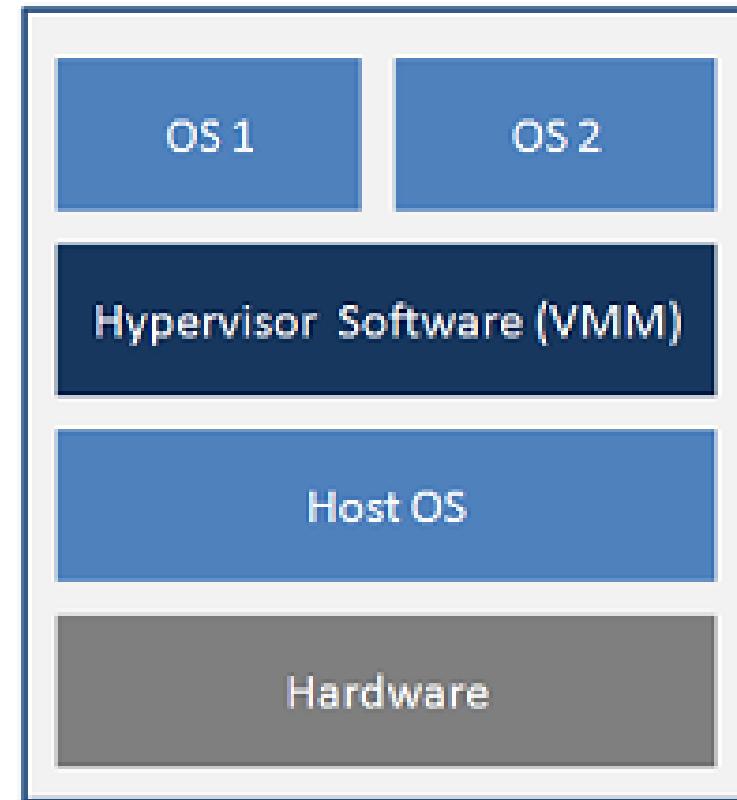
Source: Synergy Research Group



# What is Virtualization ?

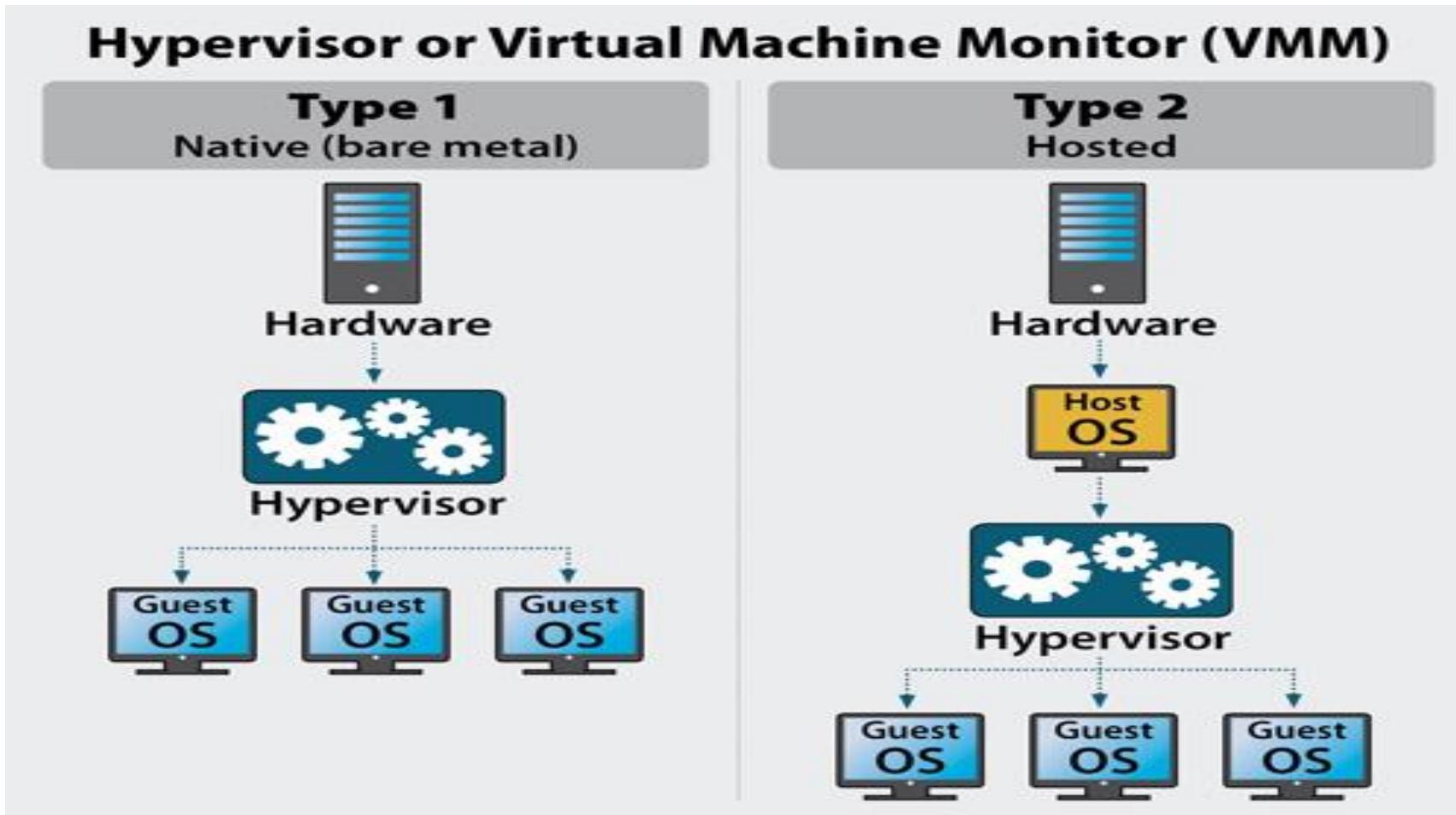


Bare-Metal Architecture



Hosted Architecture

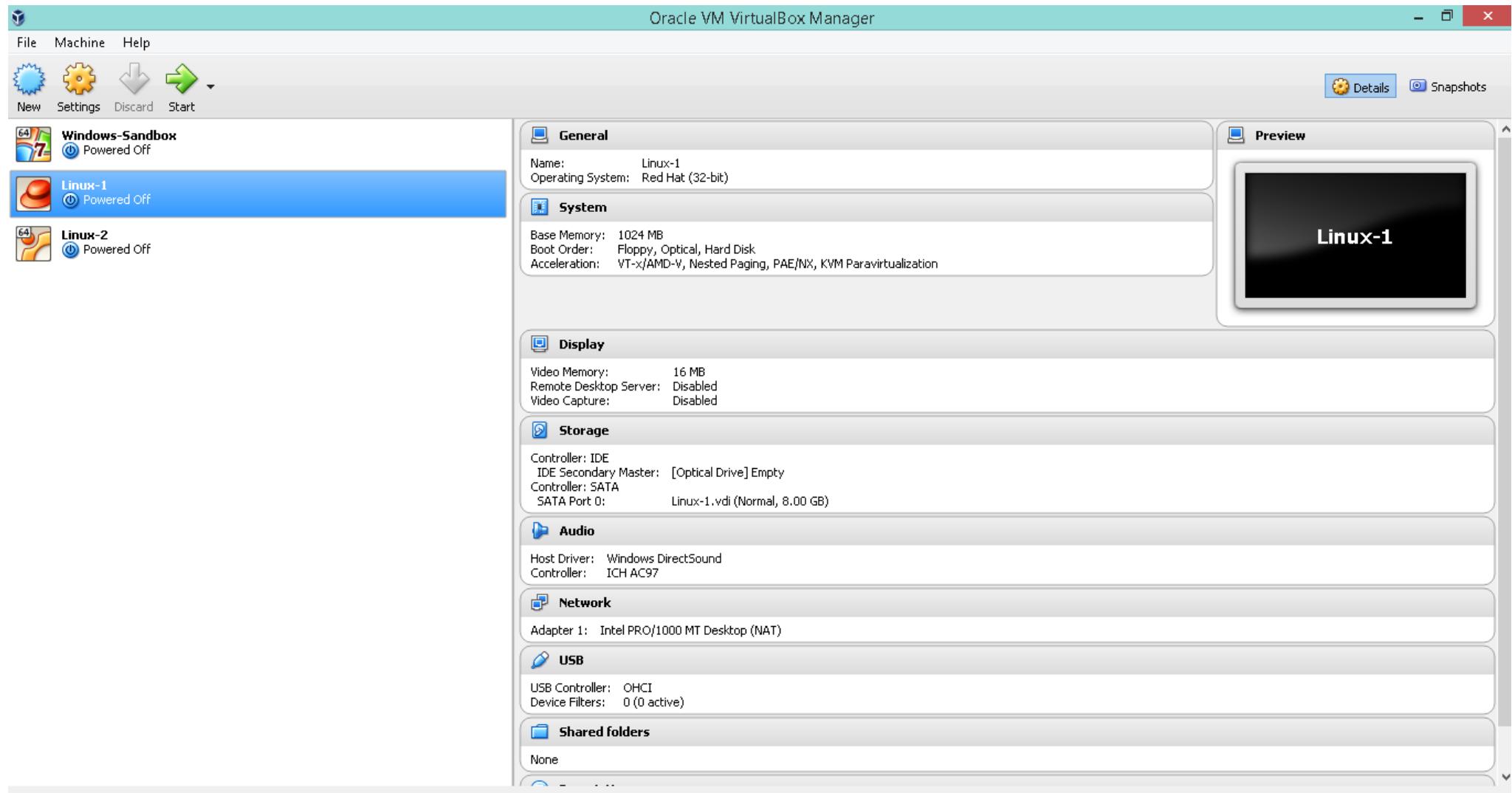
# What is Virtualization ?



# What is Virtualization ?

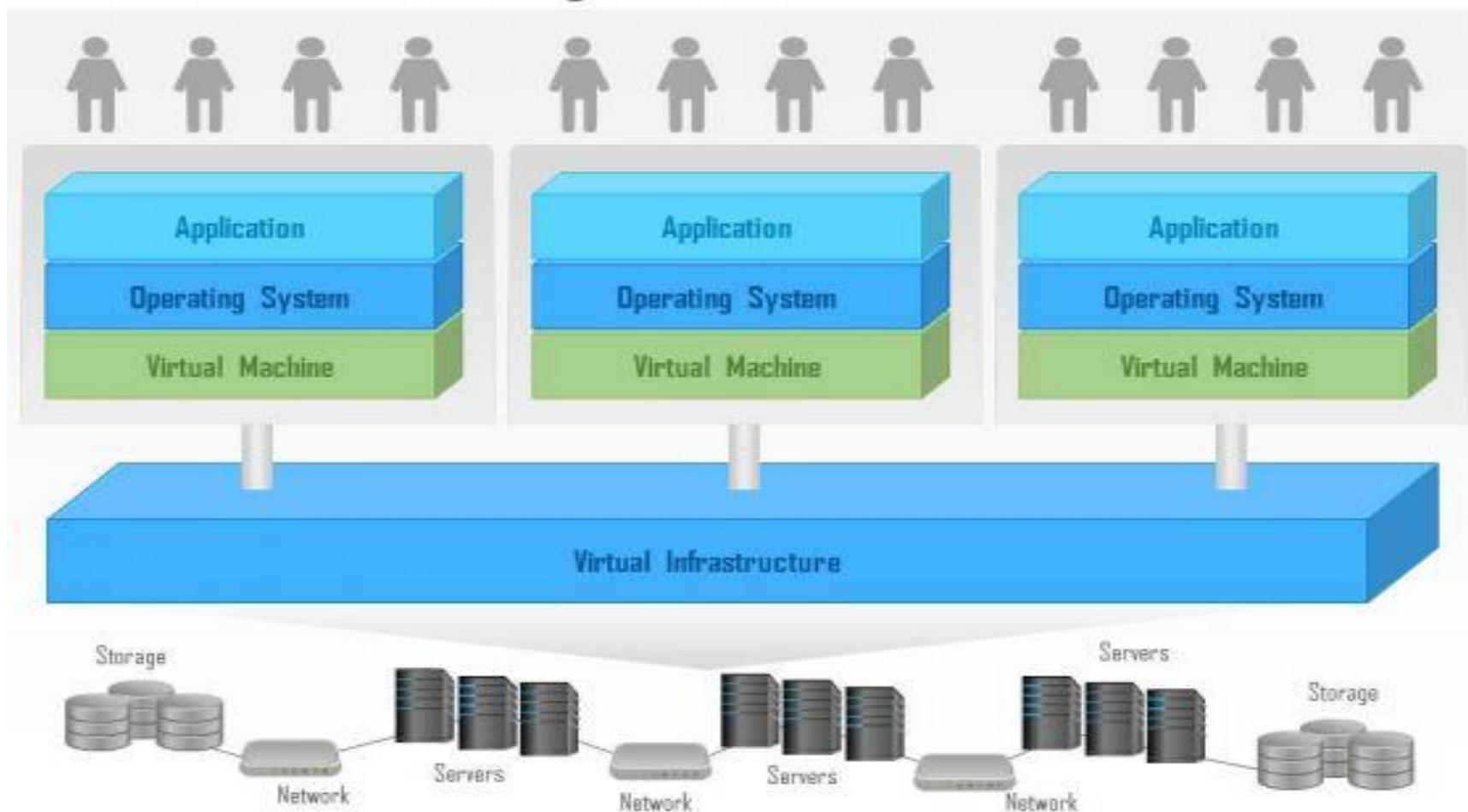
<b>Sl.No</b>	<b>Feature</b>	<b>Type 1</b>	<b>Type 2</b>
1.	<b>Definition</b>	Hypervisors run directly on the system hardware.	Hypervisors run on a host operating system.
2.	<b>Support</b>	Hardware virtualization.	Operating system virtualization.
3.	<b>Examples</b>	VMware ESXi and Citrix XEN Server.	KVM, Virtual Box, VMware Server and Microsoft Virtual PC.
4.	<b>Efficiency, Availability and Security</b>	Comparatively better than Type 2.	Though inferior, it is used mainly on systems where support for a broad range of I/O devices is important.
5.	<b>Performance</b>	Very high. Resources are not being consumed by a bloated parent operating system.	Steep resource-overhead penalties reduce performance.

# What is Virtualization ?



# What is Virtualization ?

End Users connecting to Virtual Infrastructure



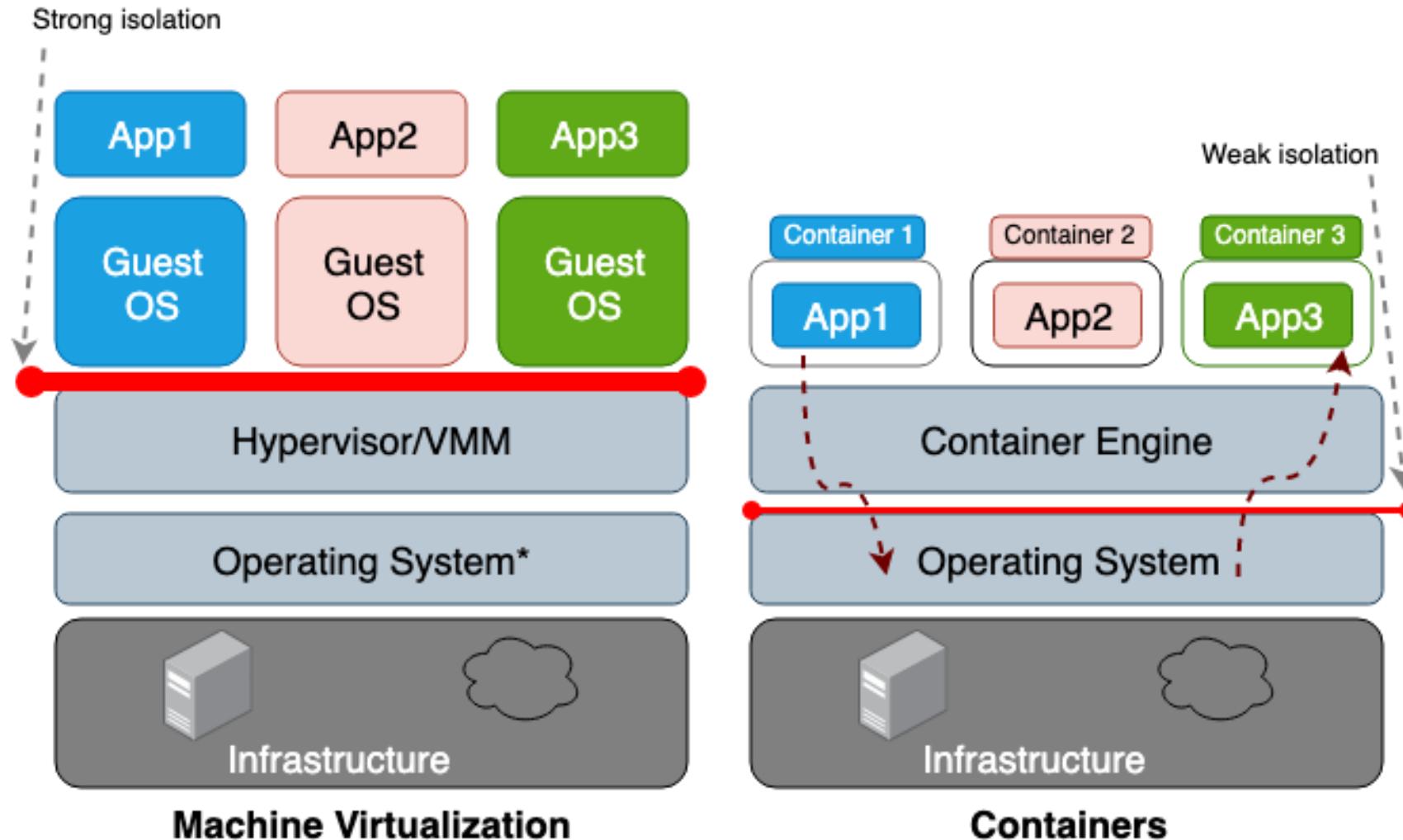
# Containers & Micro Services



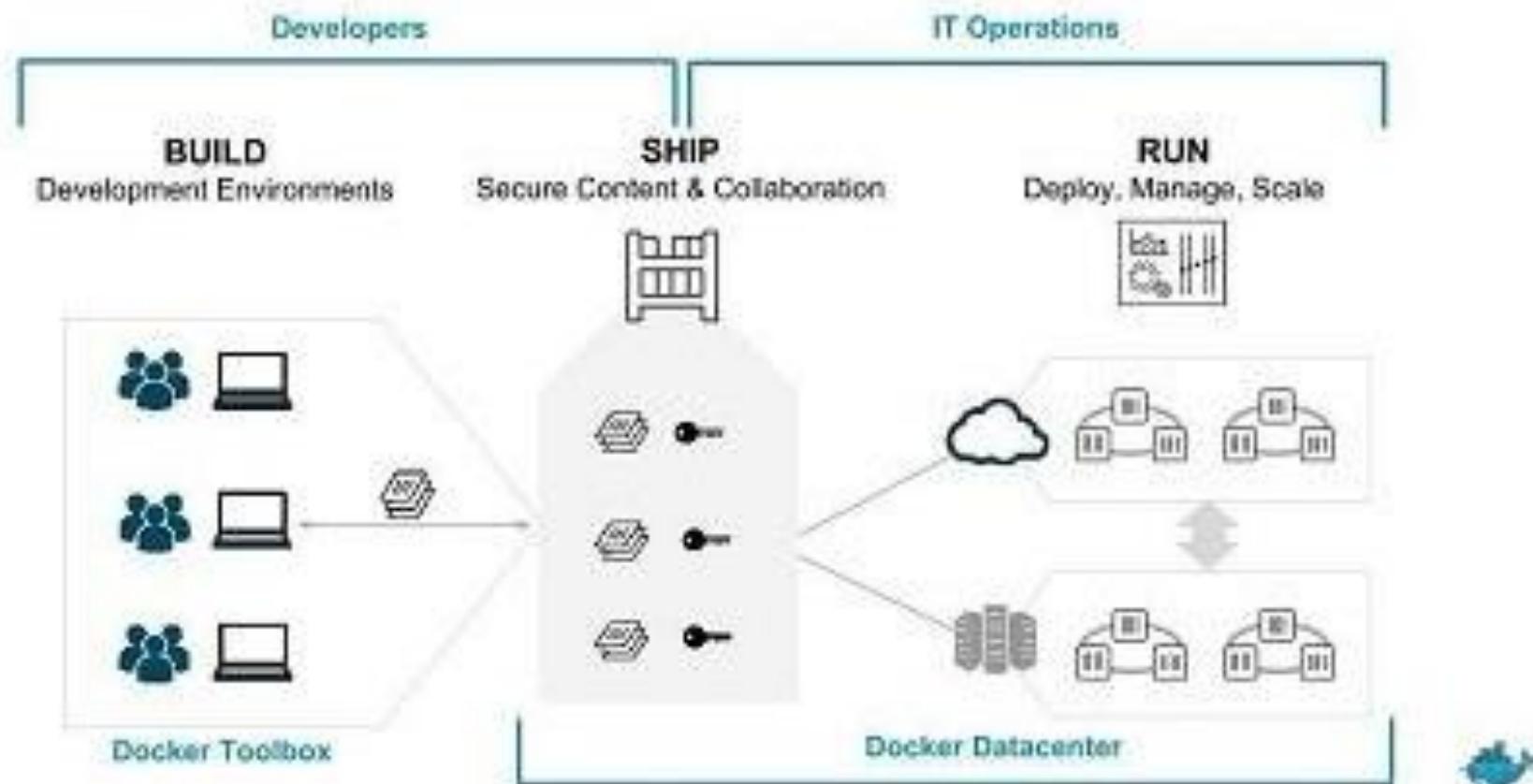
# Docker → Used for Containers



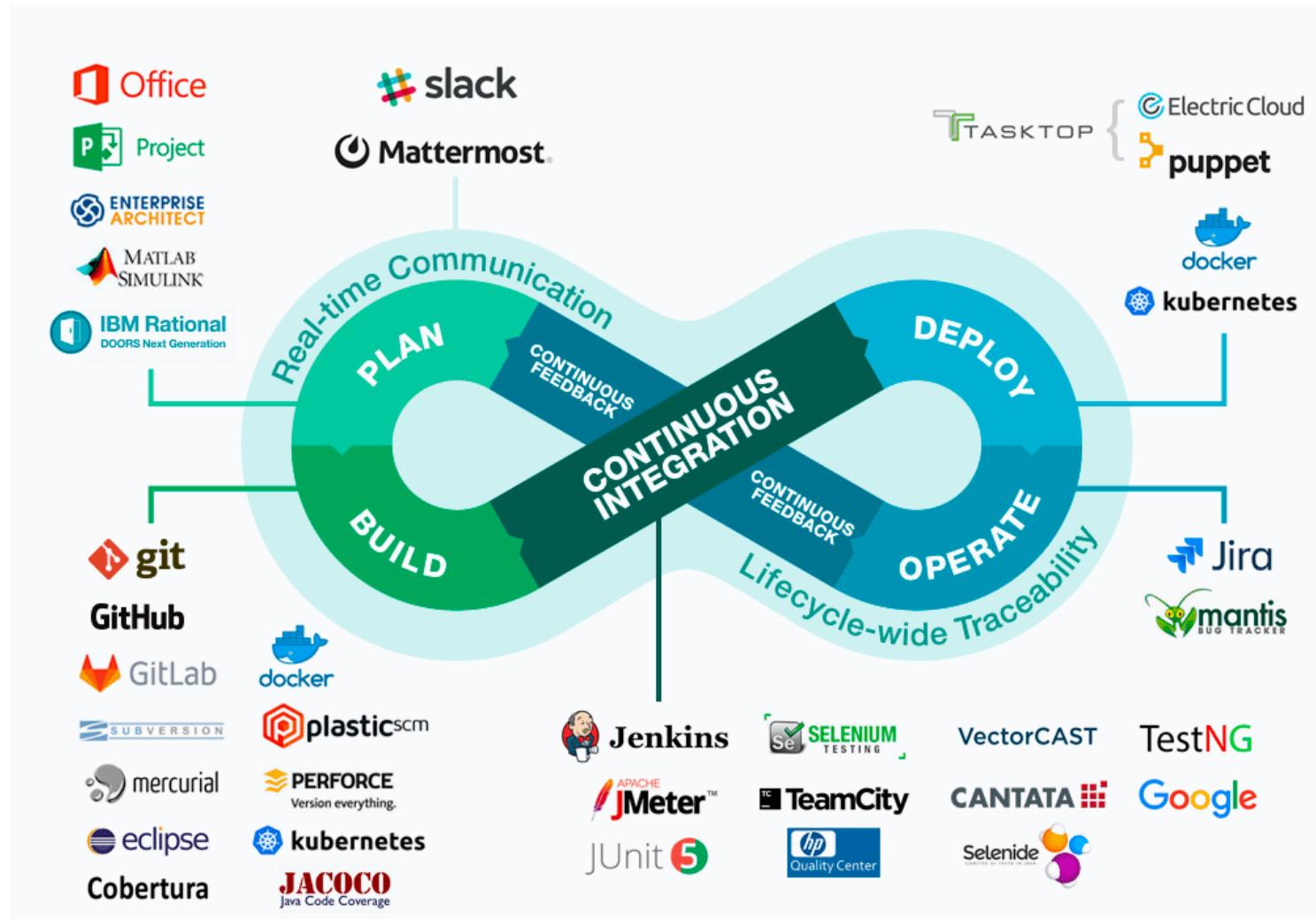
# What are Containers ?



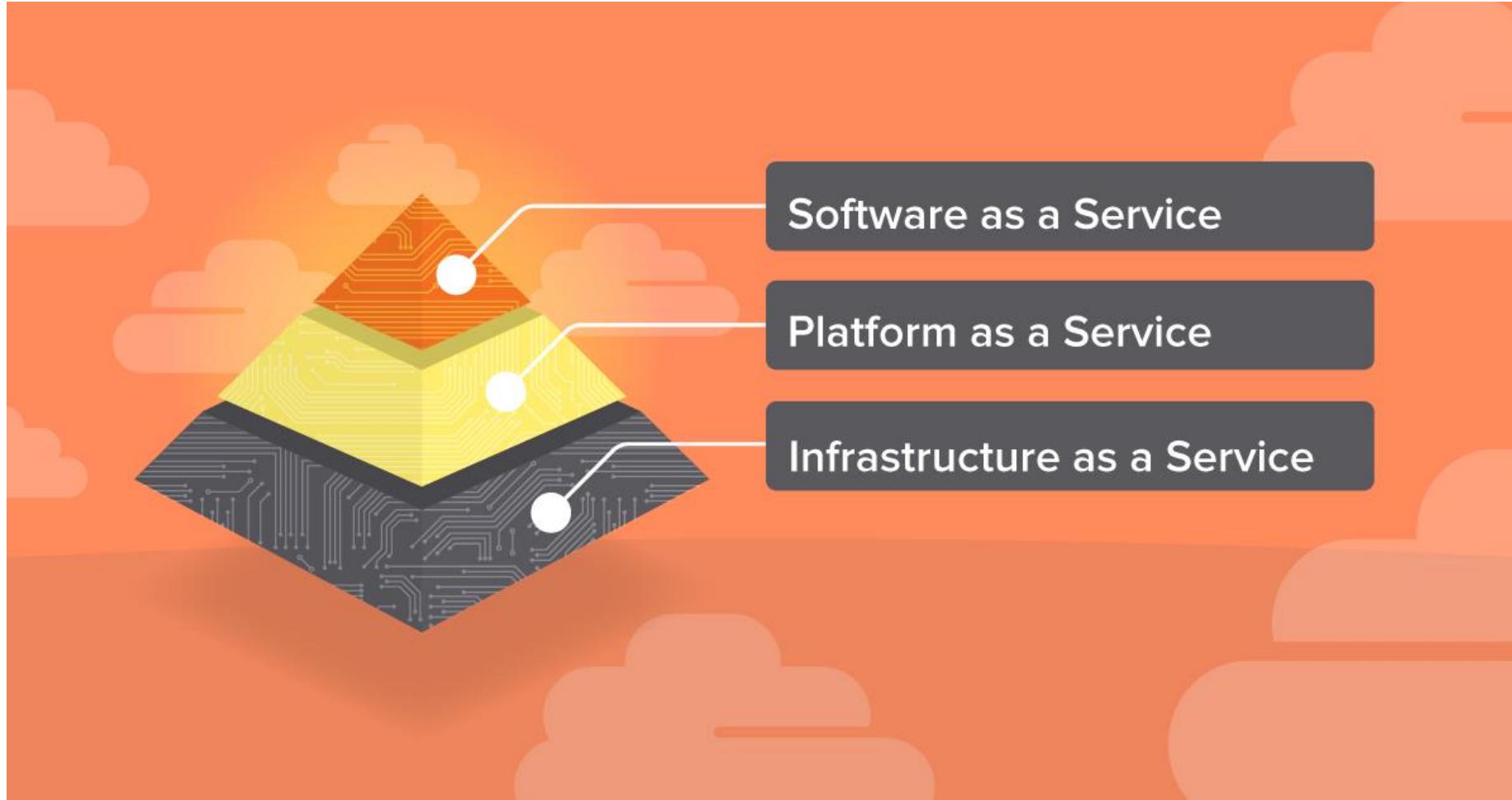
# Deployment with Containers



# Deployment with Containers



# Service Models



# Service Models

SaaS

- Software as a service
- Operating environment largely irrelevant, fully functional applications provided, e.g. CRM, ERP, email

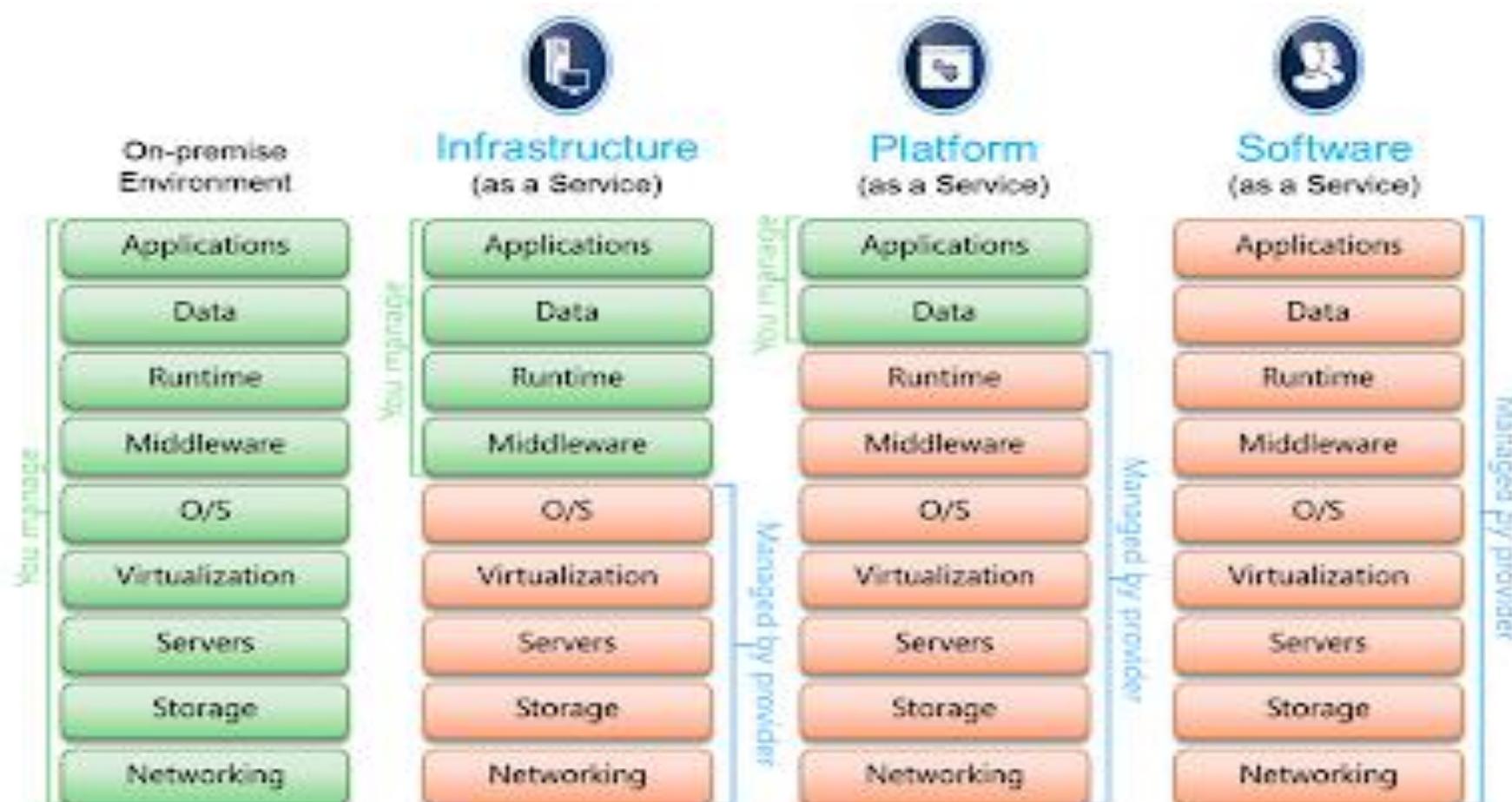
PaaS

- Platform as a service
- Operating environment included, e.g. Windows/.NET, Linux/J2EE, applications of choice deployed

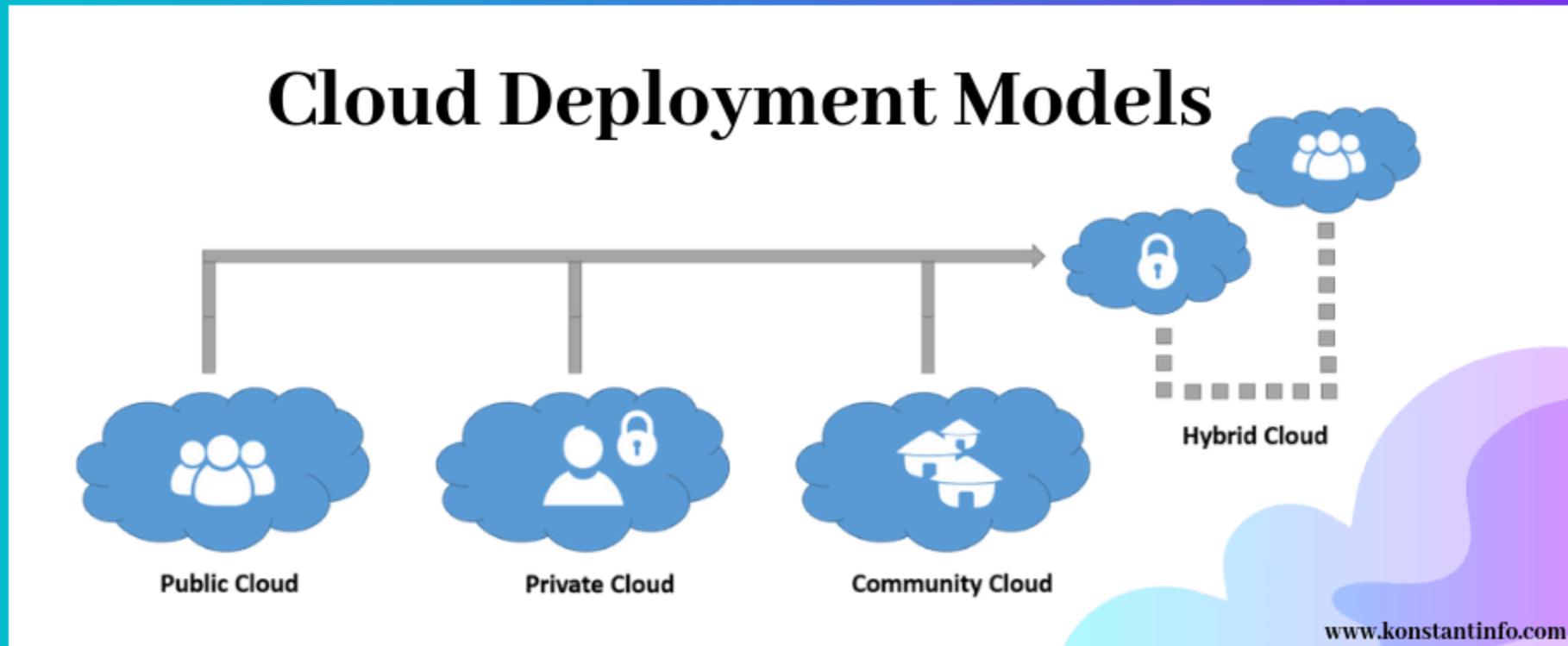
IaaS

- Infrastructure as a service
- Virtual platform on which required operating environment and application are deployed
- Includes storage as a service offerings

# Service Models



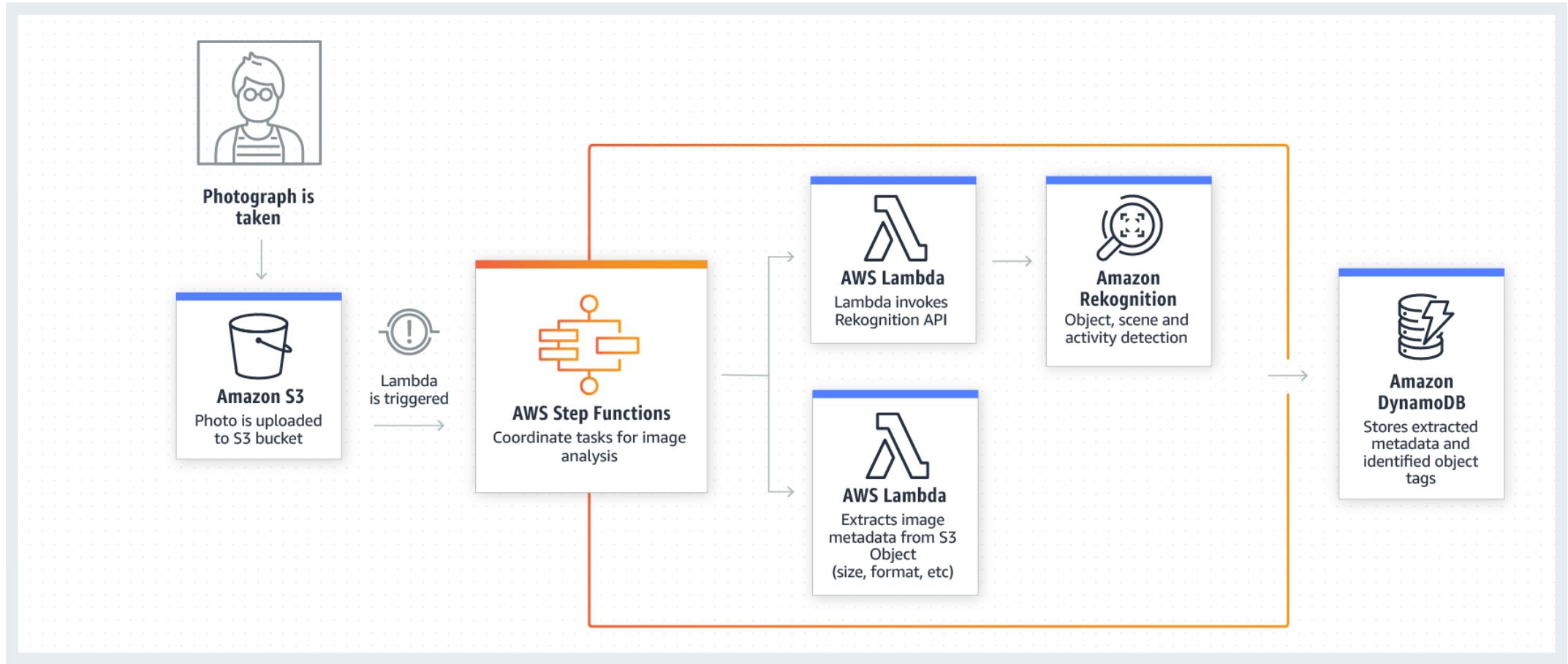
# Cloud Deployment Models



# Defining Cloud Computing (NIST)

Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.

# Development over Cloud



# Periodic Table of Amazon Web Services

by @awsgeek



Analytics  
Application Integration  
AR & VR  
AWS Cost Management  
Blockchain  
Business Applications

Compute  
Customer Engagement  
Database  
Developer Tools  
End User Computing  
Game Tech

Internet of Things  
Machine Learning  
Media Services  
Migration & Transfer  
Mobile  
Management & Governance

Network & Content Delivery  
Robotics  
Satellite  
Storage  
Security, Identity & Compliance



# AWS Console

aws Services Resource Groups ★

vocstartsoft/user174031=hjo... N. Virginia Support

**History**

Console Home

EC2

Compute

- EC2
- Lightsail
- Lambda
- Batch
- Elastic Beanstalk
- Serverless Application Repository
- AWS Outposts
- EC2 Image Builder

Storage

- S3
- EFS
- FSx
- S3 Glacier
- Storage Gateway
- MWS Recklin

Find a service by name or feature (for example, EC2, S3 or VM, storage).

Group A-Z

<b>Blockchain</b>	<b>Analytics</b>	<b>End User Computing</b>
Amazon Managed Blockchain	Athena	WorkSpaces
<b>Satellite</b>	EMR	AppStream 2.0
Ground Station	CloudSearch	WorkDocs
<b>Quantum Technologies</b>	Elasticsearch Service	WorkLink
Amazon Braket	Kinesis	
<b>Management &amp; Governance</b>	QuickSight	
AWS Organizations	Data Pipeline	<b>Internet Of Things</b>
CloudWatch	AWS Data Exchange	IoT Core
AWS Auto Scaling	AWS Glue	FreeRTOS
CloudFormation	AWS Lake Formation	IoT 1-Click
CloudTrail	MSK	IoT Analytics
<b>Security, Identity, &amp; Compliance</b>	IAM	IoT Device Defender
	Resource Access Manager	IoT Device Management
		IoT Events
		IoT Greengrass
		IoT SiteWise
		IoT Things Graph

▲ close

# AWS Console - RDS

The screenshot shows the AWS RDS Dashboard. On the left, a sidebar lists various options: Dashboard, Databases, Query Editor, Performance Insights, Snapshots, Automated backups, Reserved instances, Proxies, Subnet groups, Parameter groups, Option groups, Custom Availability Zones, Events, Event subscriptions, and Recommendations (with 1 notification). The main content area features a large callout for "Amazon Aurora" with a blue info icon. It describes Amazon Aurora as a MySQL- and PostgreSQL-compatible enterprise-class database, mentioning scaling storage capacity, 6-way replication across three availability zones, and 15 low-latency regions. It includes a "Create database" button and a link to "Restore Aurora DB cluster from S3". Below this, a "Resources" section provides a summary of usage in the US East (N. Virginia) region:

You are using the following Amazon RDS resources in the <b>US East (N. Virginia)</b> region (used/quota)	
<b>DB Instances (1/40)</b>	<b>Parameter groups (1)</b>
Allocated storage (0.02 TB/100 TB)	Default (1)
<a href="#">Click here to increase DB instances limit</a>	Custom (0/100)
<b>DB Clusters (0/40)</b>	<b>Option groups (1)</b>
<b>Reserved instances (0/40)</b>	Default (1)
<b>Snapshots (9)</b>	Custom (0/20)
Manual (0/100)	<b>Subnet groups (1/50)</b>
Automated (9)	Supported platforms VPC

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# AWS Academy



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Hardik Joshi ▾

## Welcome

### AWS Academy Forums

Looking for best practices or how-to instructions? Would you like to network with other educators? Check out the AWS Academy Forums. Be sure to join the AWS Academy News Group (under the Groups menu) to get early access to updates and important AWS Academy information.



### Educators

[Manage Educators](#)

Search by Name

[Search](#)

< 1 >

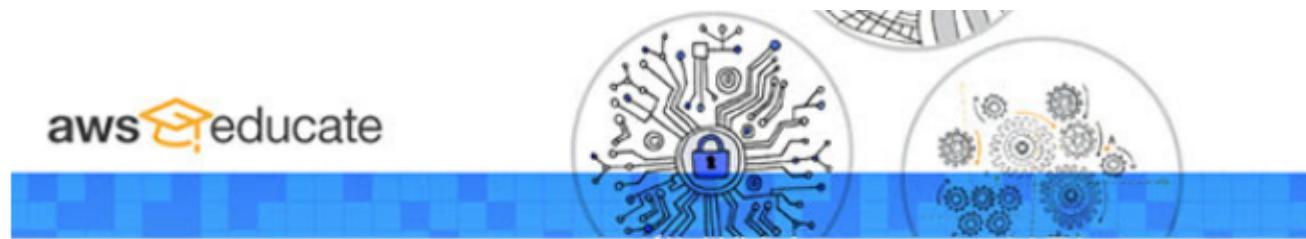
# AWS Events & Certificates



## CERTIFICATE OF ATTENDANCE

THIS CERTIFICATE IS AWARDED TO

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We are delighted to offer you a place in the 2020-2021 AWS Educate Student Ambassador program. We enjoyed learning about your experiences, your passion for AWS Educate, and the impact that you are making on your campus and in your community. You will receive a follow-up email that contains:

- \$150 in AWS Promotional Credit
- A formal AWS Educate Student Ambassador participation certificate

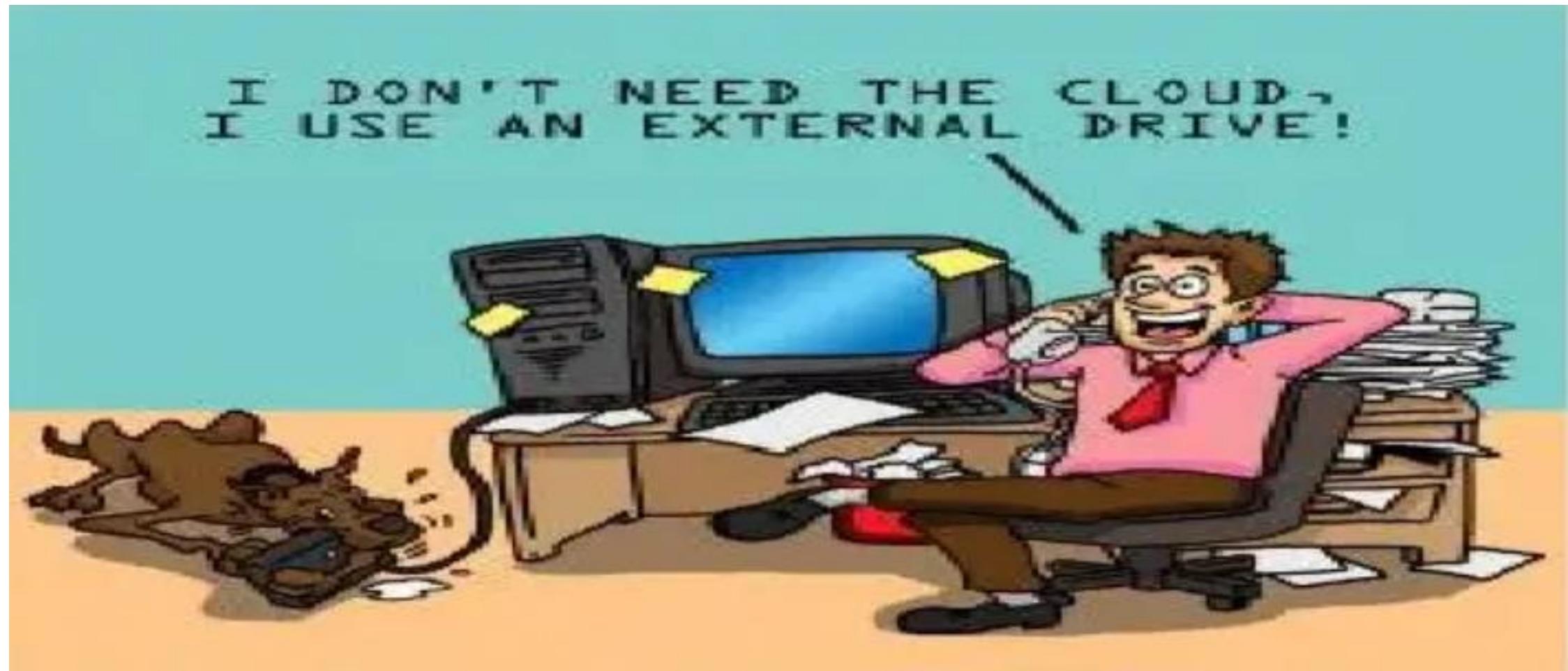
# qwiklabs.com

The screenshot shows the QwikLabs website interface. At the top, there is a navigation bar with a menu icon, the QwikLabs logo, and a search bar. Below the navigation bar, the main content area displays a list of learning paths. On the left, there is a sidebar with icons for Home, Catalog, and My Learning. The main content area shows 629 results sorted by relevance. Two items are visible:

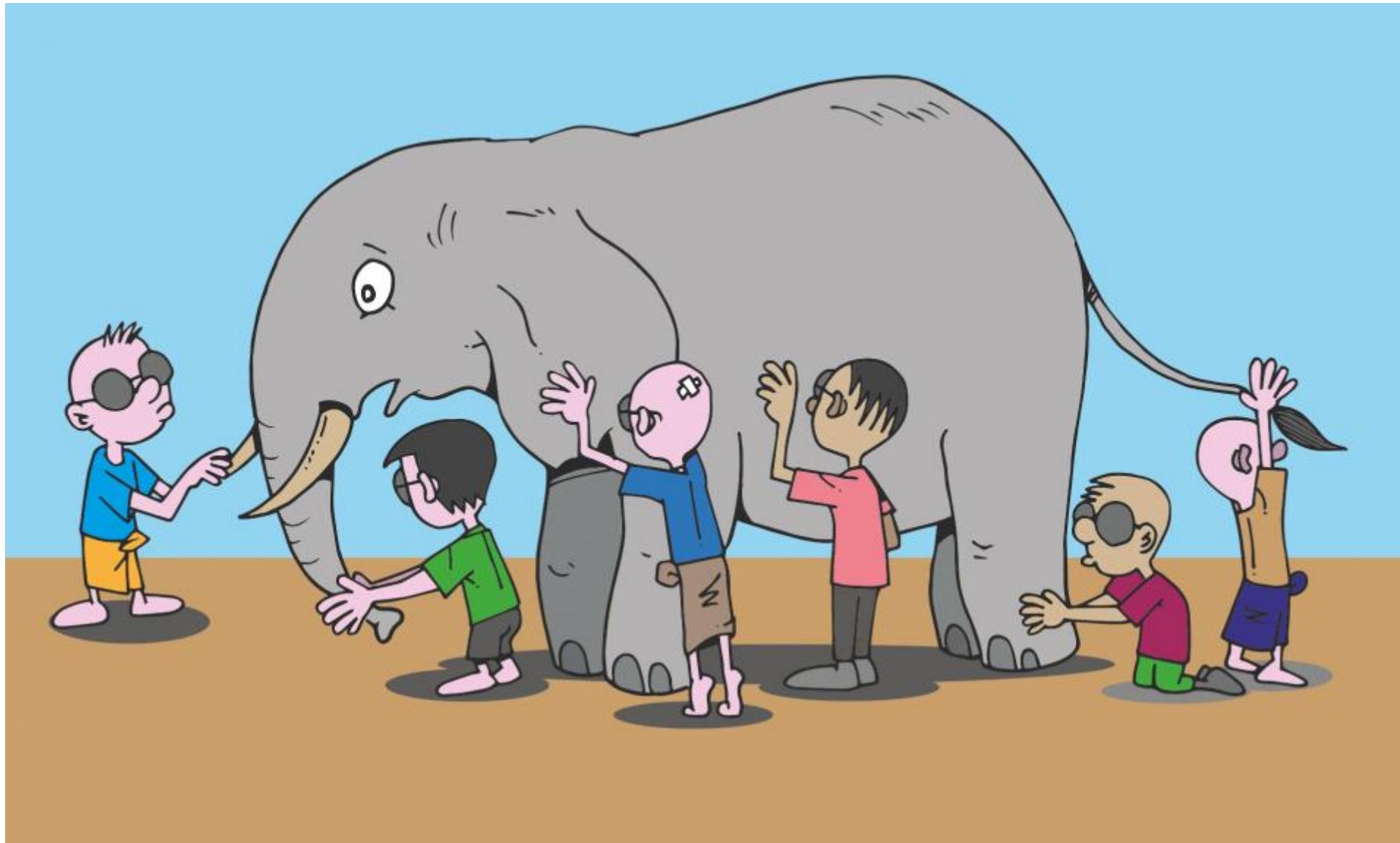
- Google Cloud Essentials**: A QUEST level item. Description: "In this introductory-level Quest, you will get hands-on practice with the Google Cloud's fundamental tools and services. Google Cloud Essentials is the recommended first Quest for the Google Cloud learner - you will come in with little or no prior cloud knowledge, and come out with practical experience that you can apply to your first Google Cloud project. From writing Cloud Shell commands and deploying your first virtual machine, to running applications on Kubernetes Engine or with load balancing, Google Cloud Essentials is a prime introduction to the platform's basic features. [1-minute videos walk you through key concepts for each lab.](#)"
- Baseline: Infrastructure**: A QUEST level item. Description: "If you are a novice cloud developer looking for hands-on practice beyond GCP Essentials, this quest is for you. You will get practical experience through labs that dive into Cloud Storage and other key application services like Stackdriver and Cloud Functions. By taking this quest, you will develop valuable skills that are applicable to any GCP initiative. [1-minute videos walk you through key concepts for these labs.](#)"

On the right side, there is a filter panel titled "Filter" with sections for "Cloud Environment", "Format", "Level", and "Tags".

# Everyone needs Cloud ...



# Perception of Cloud



# Cloud Providers



Alibaba Cloud



Liquid Web



Azure



Google Cloud Platform



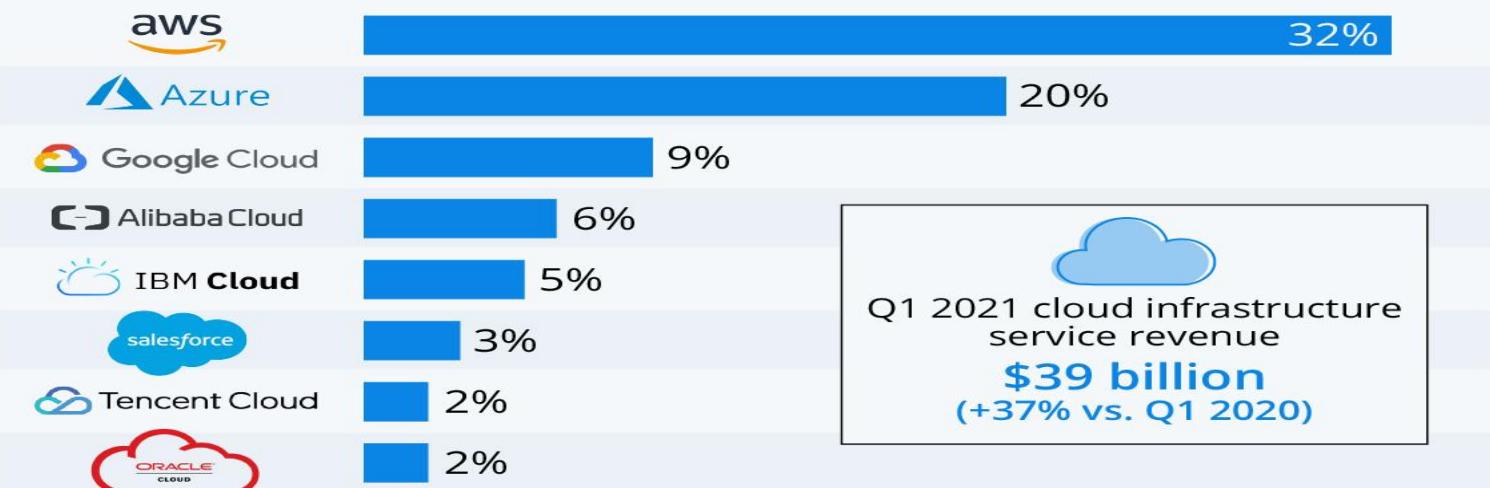
vmware®



# Cloud Market

## Amazon Leads \$150-Billion Cloud Market

Worldwide market share of leading cloud infrastructure service providers in Q1 2021\*



\* includes platform as a service (PaaS) and infrastructure as a service (IaaS) as well as hosted private cloud services

Source: Synergy Research Group



# Cloud Development in India



# Ahmedabad AWS Community – 700+ in 2018 !



# Google Cloud Community of Youngsters !



# Co-WIN Portal

[Home](#)[Administrator](#)[Vaccinator](#)[Verify Certificate](#)[Dashboard](#)[Open API's](#)[Skip To Main Content](#)[A +](#)[A](#)[A -](#)[English ▾](#)

**Co-WIN**  
Winning Over Covid-19

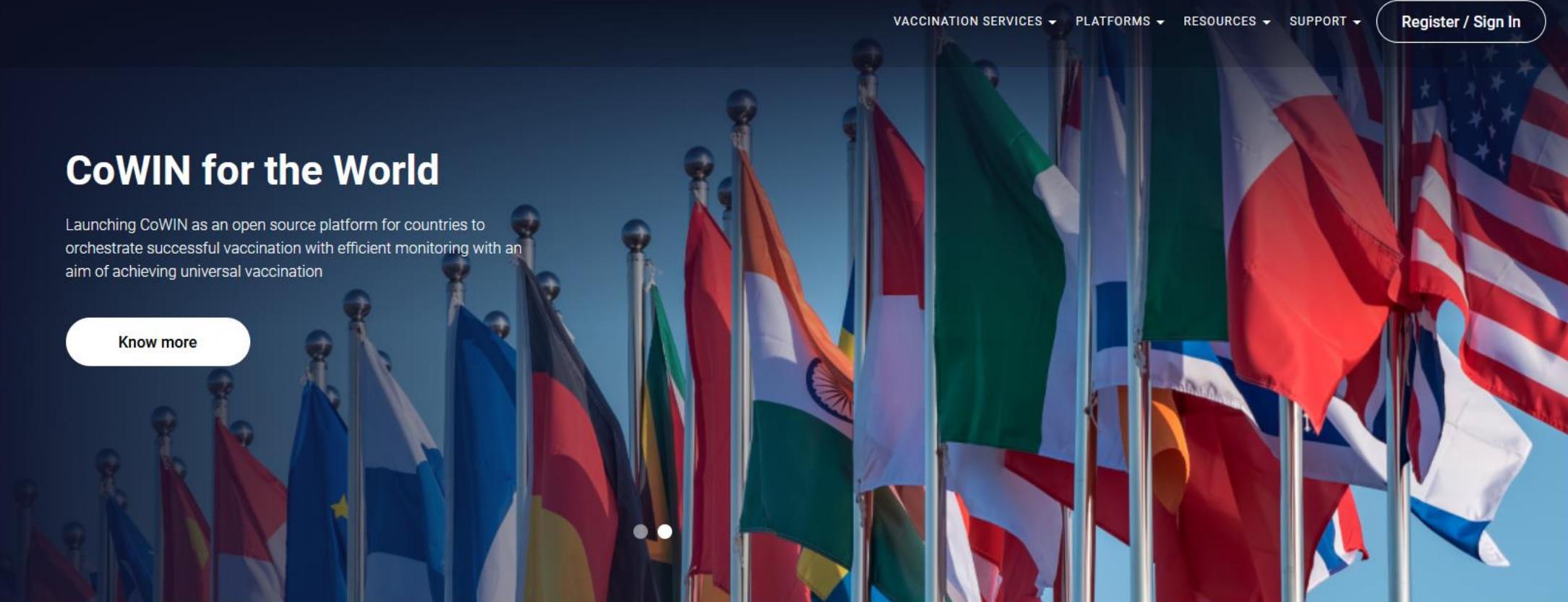
VACCINATION SERVICES ▾ PLATFORMS ▾ RESOURCES ▾ SUPPORT ▾

[Register / Sign In](#)

## CoWIN for the World

Launching CoWIN as an open source platform for countries to orchestrate successful vaccination with efficient monitoring with an aim of achieving universal vaccination

[Know more](#)



[Support for COVID-19](#)

Health Ministry

91-11-23978046 or 1075

Child

1098

Mental Health

08046110007

Senior Citizens

14567

NOW

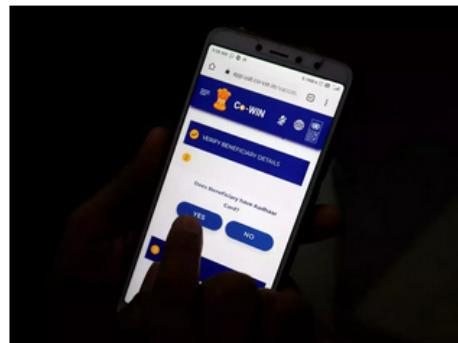
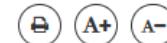
7827170170

# Co-WIN Portal

## Centre assures data security on Co-Win portal, app

The Union Minister of State for Health also informed Lok Sabha that the government has carried out privacy assessments while developing the Co-WIN app.

ETGovernment • February 08, 2021, 17:48 IST



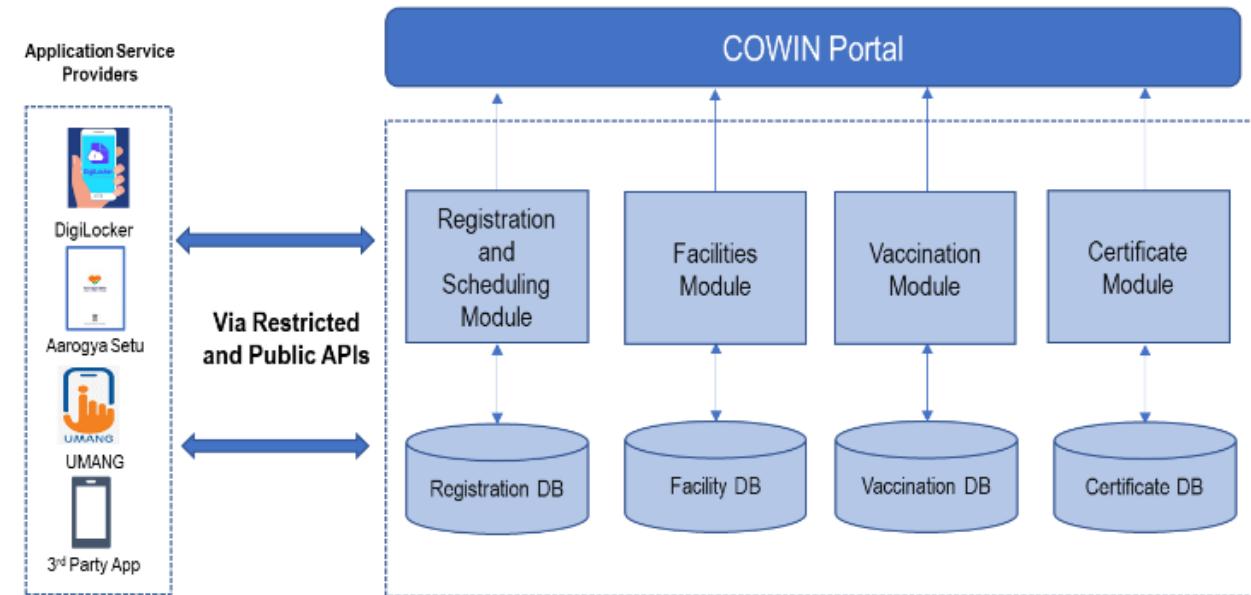
A step further in compliance of data security, the [Union government](#) has assured that the newly developed Co-WIN application and its portal follows all the privacy policy as stated in the [National Digital Health Mission](#) (NDHM).

"The Co-WIN application follows the privacy policy as stated in the National Digital Health Mission (NDHM)," Union Minister

of State for Health Ashwini Choubey said.

The Union Minister of State for Health also informed Lok Sabha that the government has carried out privacy assessments while developing the Co-WIN application. "Yes, privacy impact assessments were carried out for Co-WIN portal. For data safety, data is encrypted using a highly secure key, no unauthorised access to database on AWS server is allowed and restricted access to relational database service (to decrease the risk of malicious activities)," Choubey said on Monday.

### CURRENT TECHNICAL ARCHITECTURE OF COWIN PLATFORM



Source:

<https://www.mohfw.gov.in/pdf/CoWINAPIGuidelinesFinal240521.pdf>

# Myth (Cloud == Hiring of Servers)



# Myth (Cloud == High End Servers)

– THE BEST –  
**Cheap Cloud  
Hosting**



Affordable Uptime  
and Scalability With  
Cloud VPS & Servers

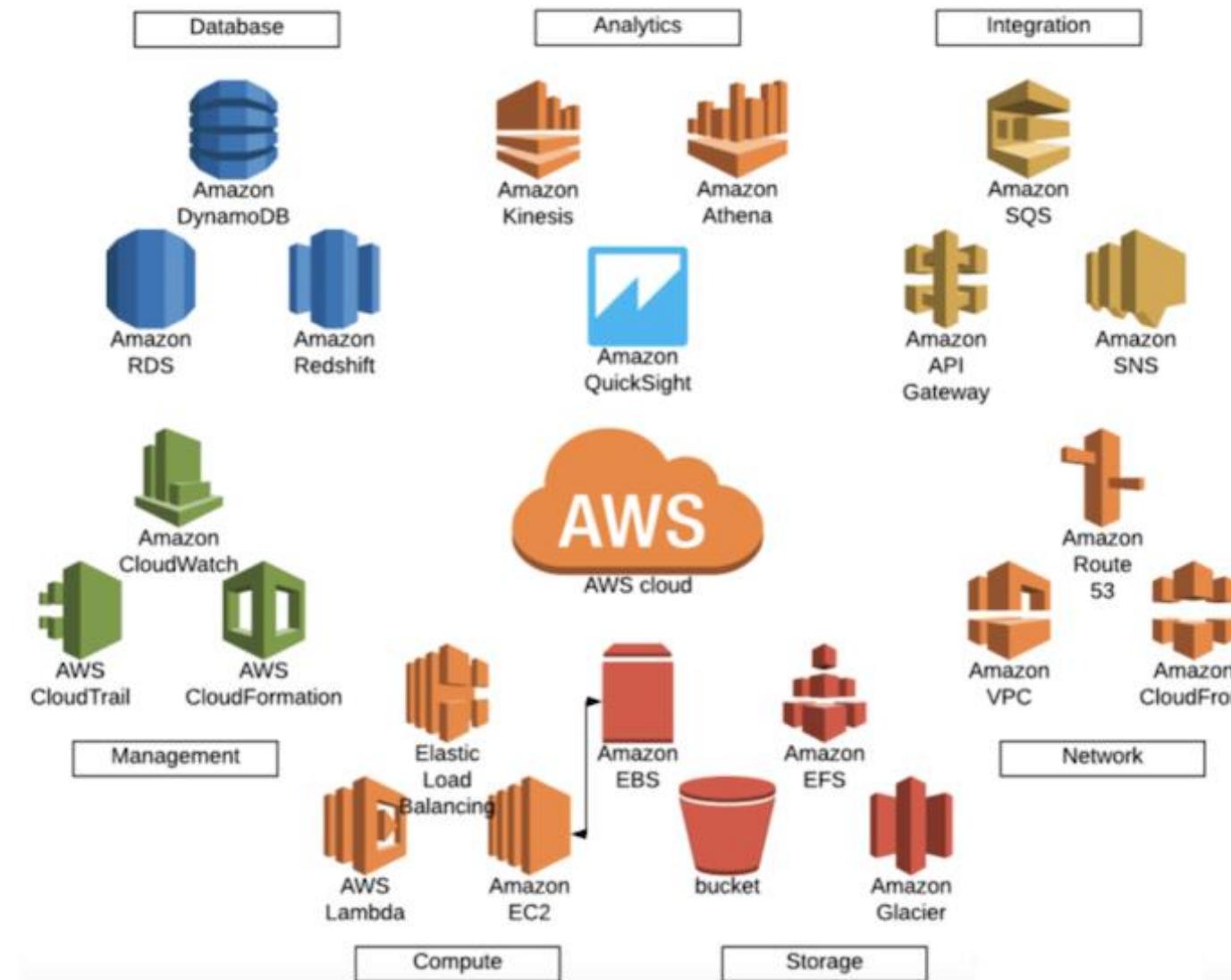


Instance Name	vCPUs	RAM	EBS-Optimized Bandwidth	Network Bandwidth
c5a.large	2	4 GiB	Up to 3.170 Gbps	Up to 10 Gbps
c5a.xlarge	4	8 GiB	Up to 3.170 Gbps	Up to 10 Gbps
c5a.2xlarge	8	16 GiB	Up to 3.170 Gbps	Up to 10 Gbps
c5a.4xlarge	16	32 GiB	Up to 3.170 Gbps	Up to 10 Gbps
c5a.8xlarge	32	64 GiB	3.170 Gbps	10 Gbps
c5a.12xlarge	48	96 GiB	4.750 Gbps	12 Gbps
c5a.16xlarge	64	128 GiB	6.3 Gbps	20 Gbps
c5a.24xlarge	96	192 GiB	9.5 Gbps	20 Gbps

# From Web Services to Cloud Computing

- In 2006, Amazon Web Services (AWS) began offering **IT infrastructure services** to businesses as web services—now commonly known as cloud computing.
- Amazon Web Services offers a broad set of global cloud-based products including compute, storage, databases, analytics, networking, mobile, developer tools, management tools, IoT, security, and enterprise applications: on-demand, available in seconds, with pay-as-you-go pricing.
- Over 200 AWS services are available. (As on August, 2021)

# AWS Services



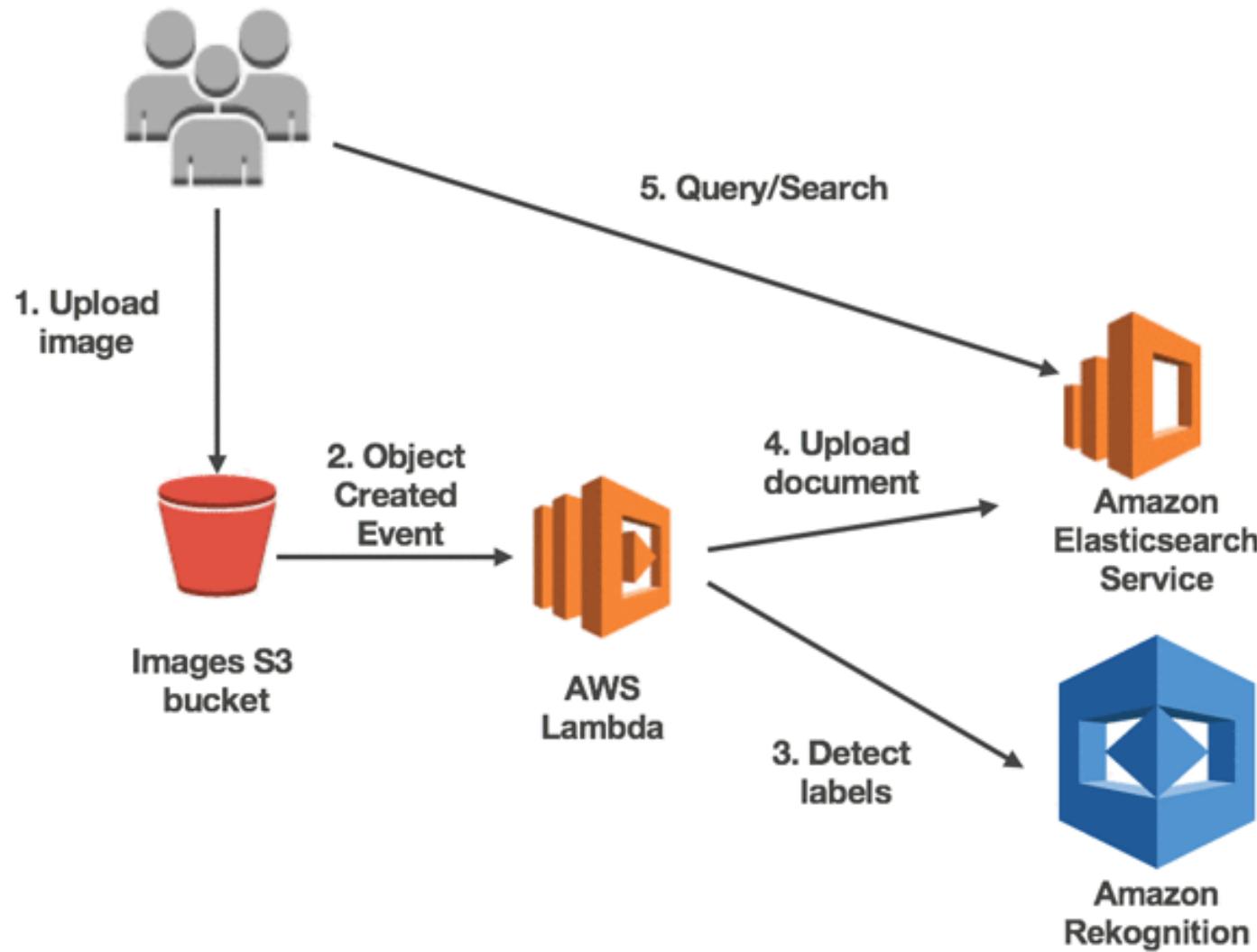
# Comparison of Services

PRODUCT	aws	Microsoft Azure	Google Cloud Platform
Virtual Servers	Instances	VMs	VM Instances
Platform-as-a-Service	Elastic Beanstalk	Cloud Services	App Engine
Serverless Computing	Lambda	Azure Functions	Cloud Functions
Docker Management	ECS	Container Service	Container Engine
Kubernetes Management	EKS	Kubernetes Service	Kubernetes Engine
Object Storage	S3	Block Blob	Cloud Storage
Archive Storage	Glacier	Archive Storage	Coldline
File Storage	EFS	Azure Files	ZFS / Avere
Global Content Delivery	CloudFront	Delivery Network	Cloud CDN
Managed Data Warehouse	Redshift	SQL Warehouse	Big Query

# A Sample Workflow



# Classify Large Number of Images with AWS Rekognition and AWS Batch



# S3 Buckets in AWS

AWS Transfer for SFTP is a fully managed, secure file transfer with storage in Amazon S3. [Learn more »](#)

S3 buckets

Discover  [Discover this service](#)

 Search for buckets All access types

[+ Create bucket](#) Edit public access settings Empty Delete 0 Buckets 0 Regions

You do not have any buckets. Here is how to get started with Amazon S3.

 Create a new bucket

 Upload your data

 Set up your permissions

# S3 Buckets in AWS

Amazon S3 > ui-hosting-example

## ui-hosting-example

Overview Properties Permissions Management Access points

Type a prefix and press Enter to search. Press ESC to clear.

Upload Create folder Download Actions ▾

US East (N. Virginia)

Viewing 1 to 10

Name	Last modified	Size	Storage class
3rdpartylicenses.txt	May 23, 2020 1:42:57 PM GMT-0400	16.3 KB	Standard
favicon.ico	May 23, 2020 1:42:57 PM GMT-0400	948.0 B	Standard
index.html	May 23, 2020 1:42:57 PM GMT-0400	802.0 B	Standard
main-es2015.352647a728d7be11ec39.js	May 23, 2020 1:42:58 PM GMT-0400	217.4 KB	Standard
main-es5.352647a728d7be11ec39.js	May 23, 2020 1:42:57 PM GMT-0400	259.1 KB	Standard
polyfills-es2015.690002c25ea8557bb4b0.js	May 23, 2020 1:42:58 PM GMT-0400	36.1 KB	Standard
polyfills-es5.9e286f6d9247438cbb02.js	May 23, 2020 1:42:59 PM GMT-0400	129.1 KB	Standard
runtime-es2015.1eba213af0b233498d9d.js	May 23, 2020 1:42:59 PM GMT-0400	1.5 KB	Standard

Operations 0 in progress 1 Success 0 Error

# Lambda Function – Personal Kitchen Vs. Unknown Kitchen



**ZOMATO:**  
MORE THAN YOUR FRIENDLY  
FOOD AGGREGATOR

tejimandi

An illustration for Zomato. On the left, a smartphone displays a map with a red and white striped awning over it, representing a food establishment. A delivery person wearing a red helmet and green shirt is riding a red scooter towards the right. A yellow delivery box is strapped to the back of the scooter. The background shows a road with clouds and a checkmark icon. The Zomato logo is prominently displayed at the top right. At the bottom right, the word "tejimandi" is written in a stylized font with a small arrow pointing up next to the letter "t".

# Lambda Function – Serverless Computing

## Configure function

A Lambda function consists of the custom code you want to execute. [Learn more](#) about Lambda functions.

Name\* HelloLambda

Description Lambda Function to capture change events in Dynamo DB

Runtime\* Node.js



## Lambda function code

Provide the code for your function. Use the editor if your code does not require custom libraries (other than the aws-sdk). If you need custom libraries, you can upload your code and libraries as a .ZIP file. [Learn more](#) about deploying Lambda functions.

Code entry type  Edit code inline  Upload a .ZIP file  Upload a .ZIP from Amazon S3

```
1 console.log('Loading function');
2
3 exports.handler = function(event,context){
4
5     event.Records.forEach(function(record){
6         console.log('Event ID: %j',record.eventID);
7         console.log('Event name: %j',record.eventName);
8         console.log('dynamodb record: %j',record.dynamodb);
9     });
10    context.succeed("Successfully processed");
11 };
```

# AWS Rekognition Service

## Object and Scene Detection

Receive automatic image labeling of objects, concepts, and scene detection with a confidence score. (Your images will not be stored.)



Select A Sample Image



Use Your Own Image

Upload

or

Provide an Image URL here:

Go

Next Steps: [Developer Guide >](#)

### ▼ Labels | Confidence

animal	97.9%
dog	97.9%
golden retriever	97.9%
pet	97.9%

### ► Request

### ▼ Response

```
[  
  {  
    "Confidence": 97.97281646728516,  
    "Name": "animal"  
  },  
  {  
    "Confidence": 97.97281646728516,  
    "Name": "dog"  
  },  
  {  
    "Confidence": 97.97281646728516,  
    "Name": "golden_retriever"  
  },  
  {  
    "Confidence": 97.97281646728516,  
    "Name": "pet"  
  }]
```

# AWS Rekognition Service

AWS Services Resource Groups ★

Amazon Rekognition Metrics

Demos Object and scene detection Image moderation

**Facial analysis**

Celebrity recognition Face comparison Text in image

Video Demos Video analysis

Additional Resources Getting started guide Download SDKs Developer resources Pricing

FAQ Forum

## Facial analysis

Get a complete analysis of facial attributes, including confidence scores.



Choose a sample image



Use your own image  
Image must be .jpeg or .png format and no larger than 5MB. Your image isn't stored.

Upload or drag and drop

Use image URL

Go

Done with the demo? [Learn more](#)

▼ Results

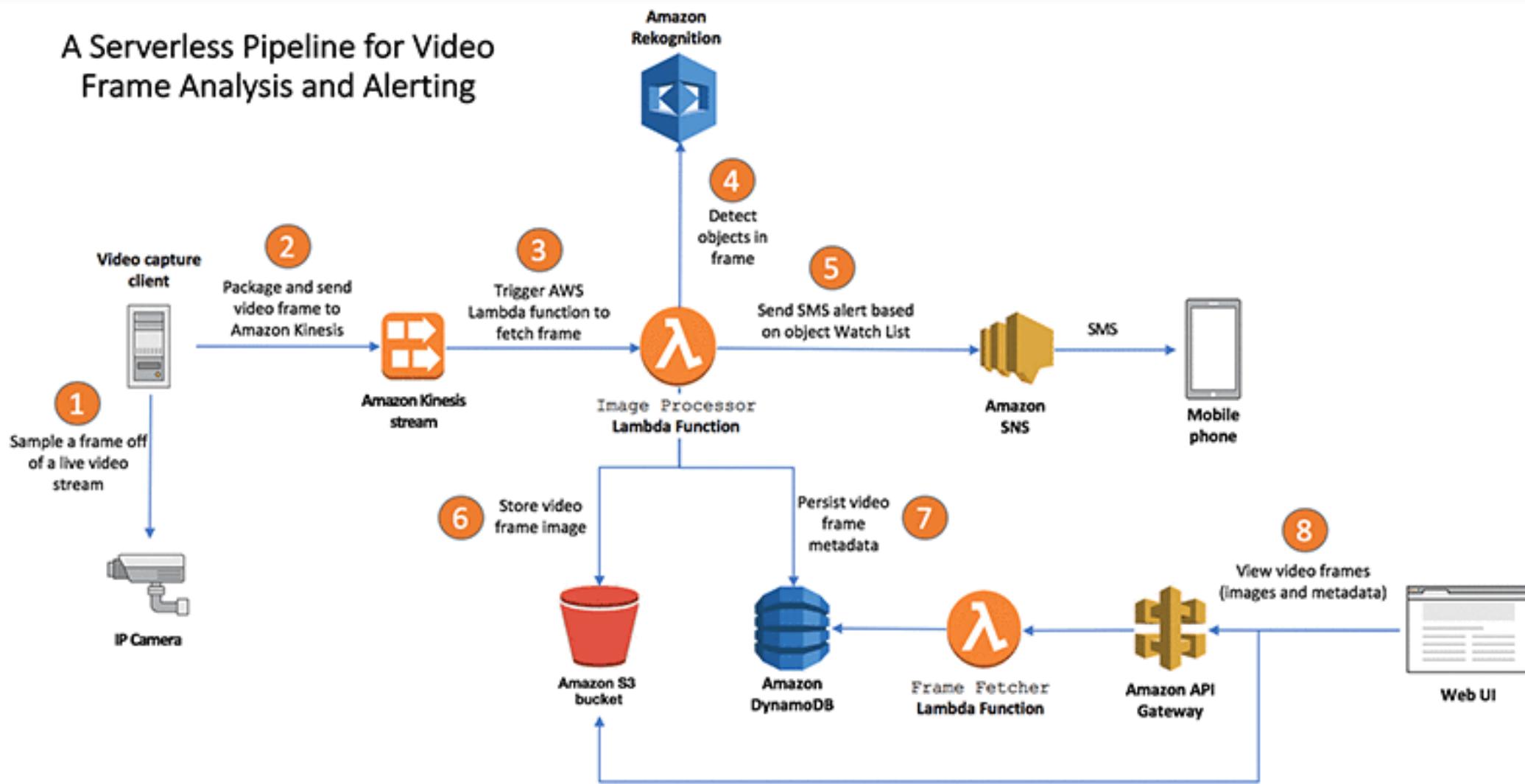
	>
looks like a face	99.9 %
appears to be male	99.8 %
age range	60 - 90 years old
smiling	98.7 %
appears to be happy	99.8 %
not wearing glasses	99.8 %

Show more

► Request

► Response

# Live CCTV Surveillance (Cloud → Big Data)



Thank You