

Introduction Cloud Computing part 1/2

winter semester 2020-2021

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Agenda

- What is Cloud Computing
- Drivers of Cloud Computing
- Challenges of Cloud Computing
- Cloud Service Models (IaaS, PaaS, SaaS)
- Hypervisors
- IaaS Offerings
- Containers and Orchestration
- PaaS Providers and Technologies
- Public, Private, Hybrid, On-Premise, Off-Premise Clouds



What is Cloud Computing: Daily Life



NETFLIX



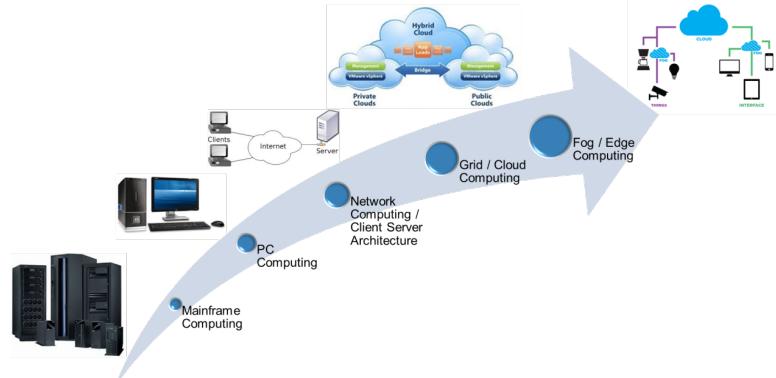
What is Cloud Computing: Definition

- **Cloud computing is the delivery of computing as a service** rather than a product, whereby shared resources, software, and information are provided to computers and other devices as a metered service over a network
- **Cloud computing provides computation**, software, data access, and storage resources without requiring cloud users to know the location and other details of the computing infrastructure
- End-users access cloud-based applications through a web browser or a lightweight desktop or mobile app while the business software and **data are stored on servers at a remote location**
- Cloud application providers strive to give the same or **better service and performance** as if the software programs were installed locally on end-user computers
- **Cloud computing requires special software: architecture, technologies and tools differ from local software development and provisioning**

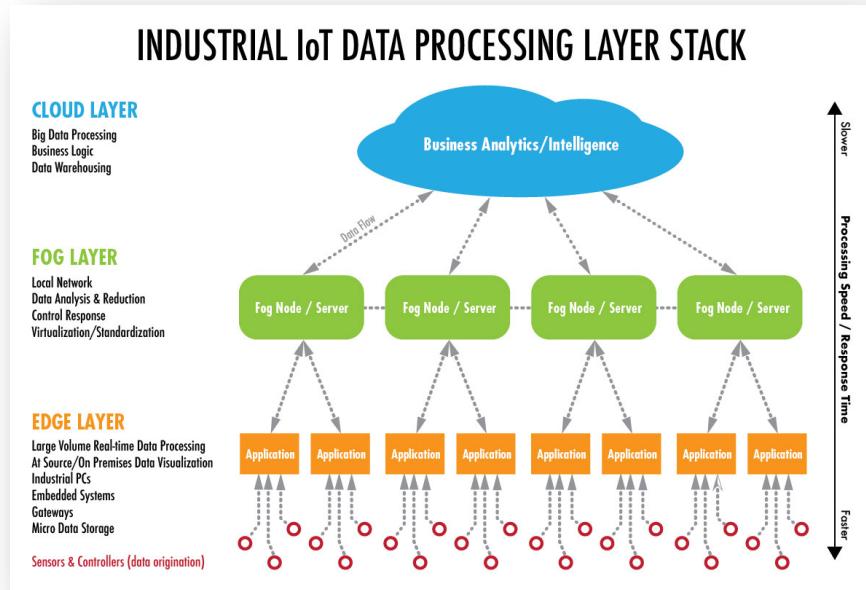
What is Cloud Computing: History

The general idea behind the [Cloud Computing] technology dates back to the 1960s, when John McCarthy (inventor of LISP) wrote that “computation may someday be organized as a public utility.”

[2]

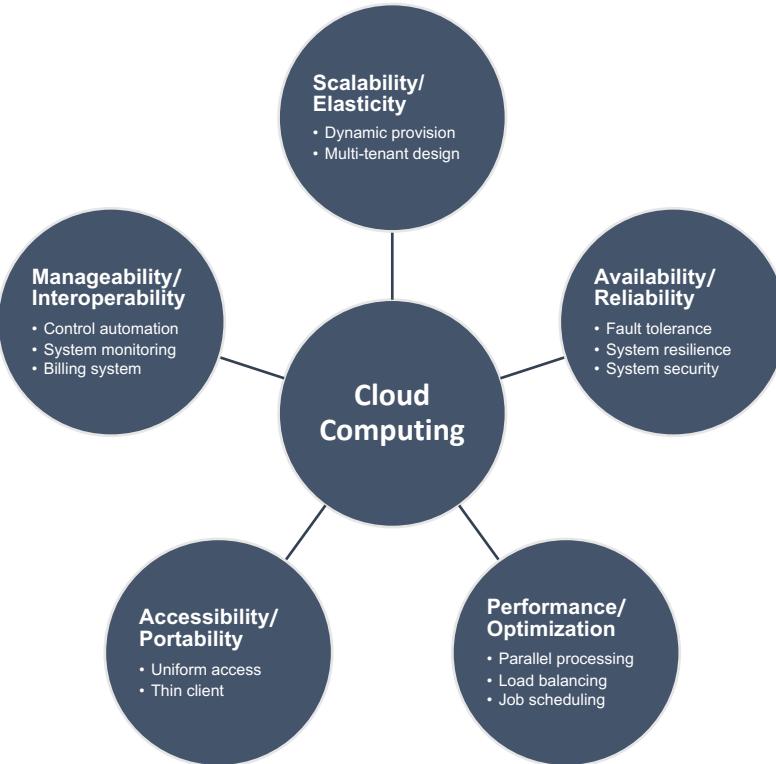


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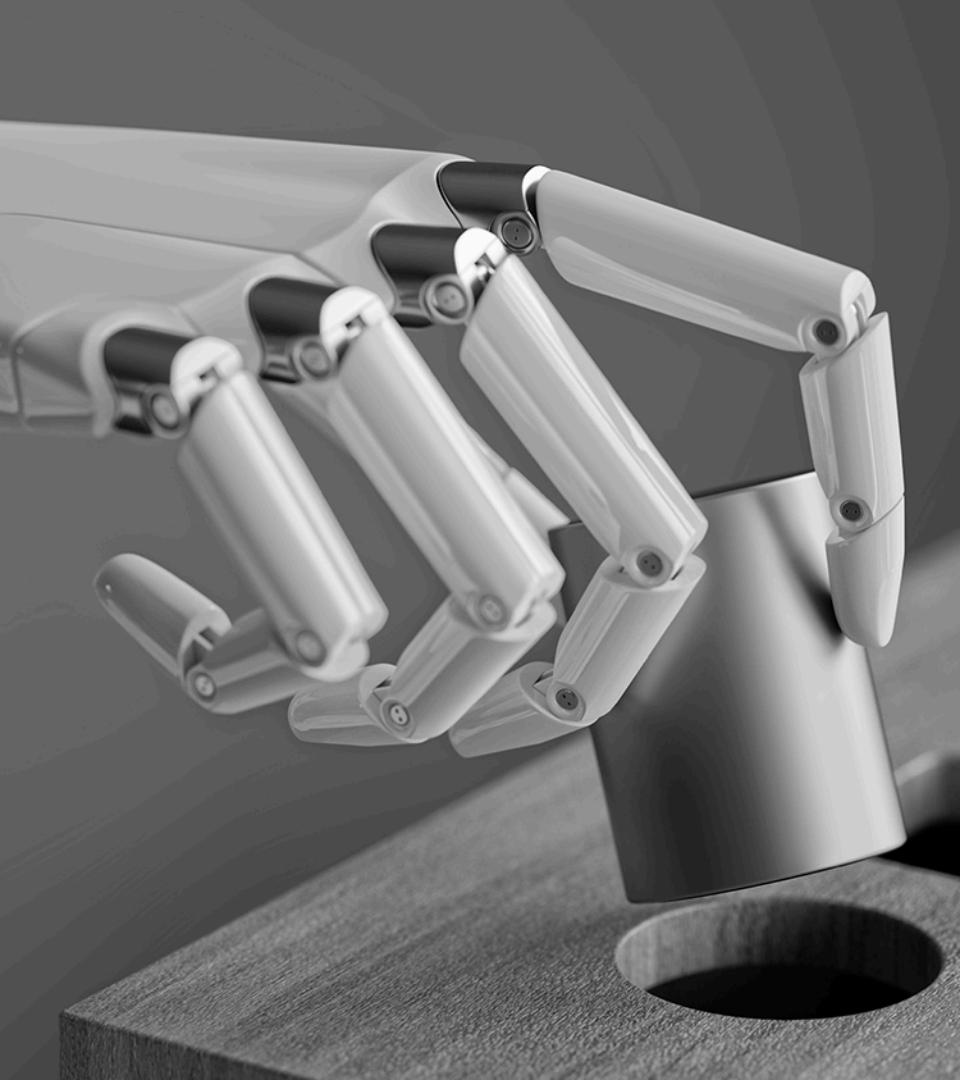
[2]

What is Cloud Computing: Props. & Charact.



What is Cloud Computing: Benefits

- Let's start with the benefits of Cloud Computing for users:
 - **Available always**
 - **Accessible everywhere**
 - **Scalability unlimited**
 - **No down-time**
 - **Low-cost** – flexibility through pay-per-use



Drivers of Cloud Computing: It's All About Business

... and business is moving to cloud

- **Business Growth & Continuity / Disaster Recovery**
 - The cloud provider takes care of the infrastructure
 - The enterprise pays for the service and concentrates on its core business
- **Scalability & Efficiency & Peak Performance**
 - Nothing is worse than the delivery of a great service which is successful – while the infrastructure does not scale
 - This won't happen in the cloud: Performance is available unlimited
- **Cost Reduction**
 - If I have to provide infrastructure for peak performance, my infrastructure will idle most of the time (e.g. except at Christmas sales)
 - In the cloud, we only pay for what we use
- **Agility**
 - Business needs to react quickly (sometimes, a software update is necessary within hours)
 - This is possible in the cloud

Challenges of Cloud Computing

■ Security & Privacy

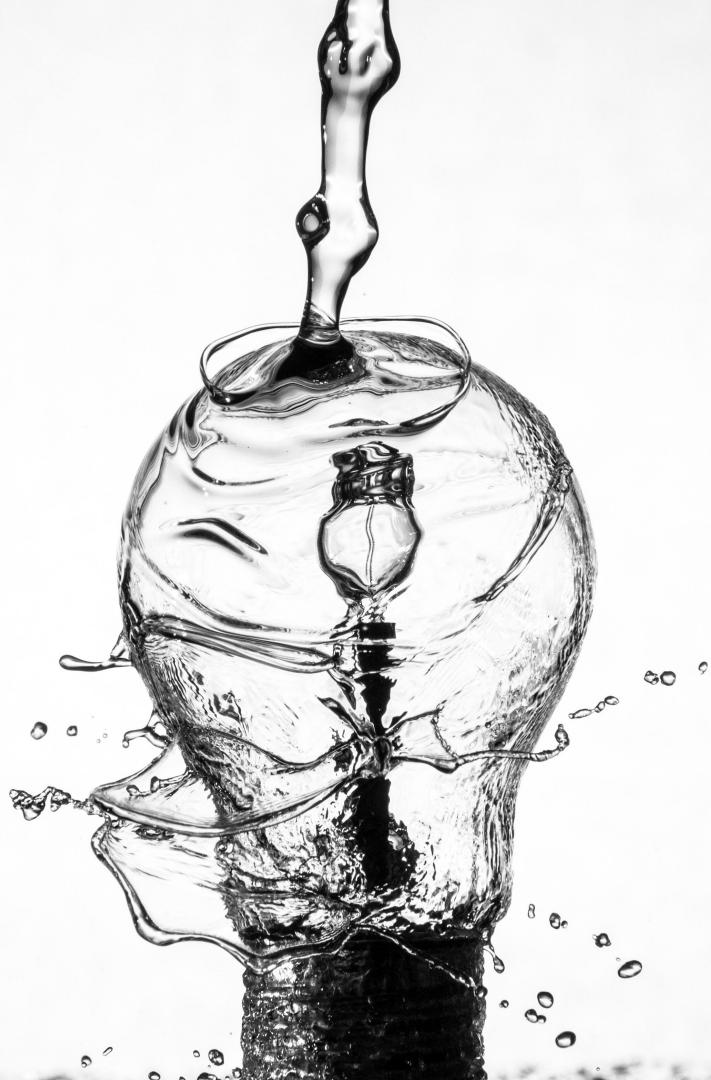
- Who can access the data? Where is it located?
Which laws/regulations has to be considered?
Is data transfer over the internet secure?

■ Integration with Legacy Applications

- How to integrate existing applications with
cloud applications?

■ Service Quality & Downtime

- Which quality standards are implemented by
the cloud provider?
- What is the latency for end-user applications?
- Can transactions be used in the cloud?
- Is the data safe – can hackers access it?



Challenges of Cloud Computing

- **Compliance with Legal Regulations**
 - What regulations exist for this kind of data (e.g. health data)?
 - Is it allowed to store this kind of data somewhere else than in our computing center?
 - Is it allowed, to store this kind of data outside of our country?
- **Employee's Skills**
 - Development of cloud applications differs from development of on-premise non-cloud applications
 - Think of a Cobol programmer coding in node.js in future



More Definitions You Should Have Heard Of

- **Utility Computing** – *Compute(rs) as a Service*
 - Means "**Pay and Use**", with regards to computing power
 - It is not a new concept, but rather has quite a long history
 - *"If computers of the kind I have advocated become the computers of the future, then computing may someday be organized as a public utility just as the telephone system is a public utility..."* (John McCarthy in 1961)
- **Distributed Computing** – *General perspective on components on networked computers*
 - [...] Studies distributed systems
 - **In a distributed system, components located on networked computers communicate and coordinate their actions by passing messages**

More Definitions You Should Have Heard Of

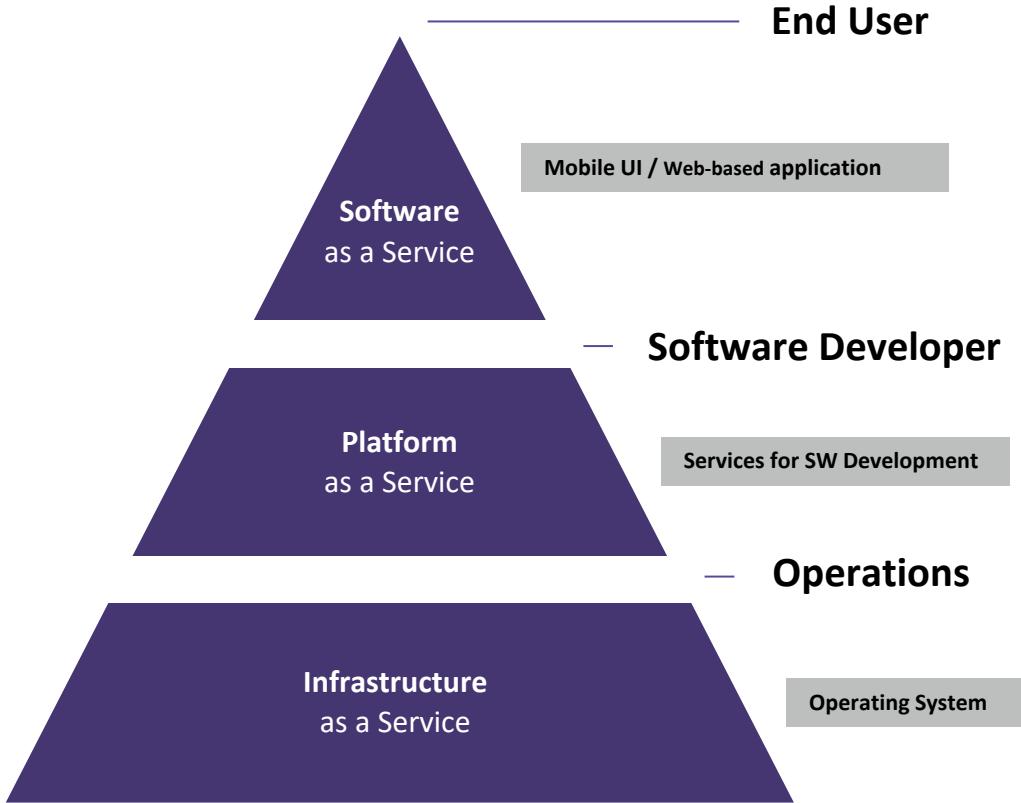
- **Grid Computing** – *Consolidation of compute power for different aspects*
 - Collection of computer resources from multiple locations to reach a common goal
 - A **grid** is a distributed system with non-interactive workloads
 - Differs from conventional high performance computing systems (such as cluster computing) in that grid computers have each node set to perform a different task/application
- **Cluster Computing** – *Aggregation of compute power*
 - A computer cluster consists of a set of connected computers that work together so that they can be viewed as a single system
 - Unlike grid computers, computer clusters have each node set to perform the same task, controlled and scheduled by software
- **Microservices Architecture** – *Developing a single application as a suite of small services*
 - Each service:
 - .. runs its own processes
 - .. can be written in any programming language and is platform agnostic
 - .. is independently deployable and requires a minimum of centralized management

Agenda

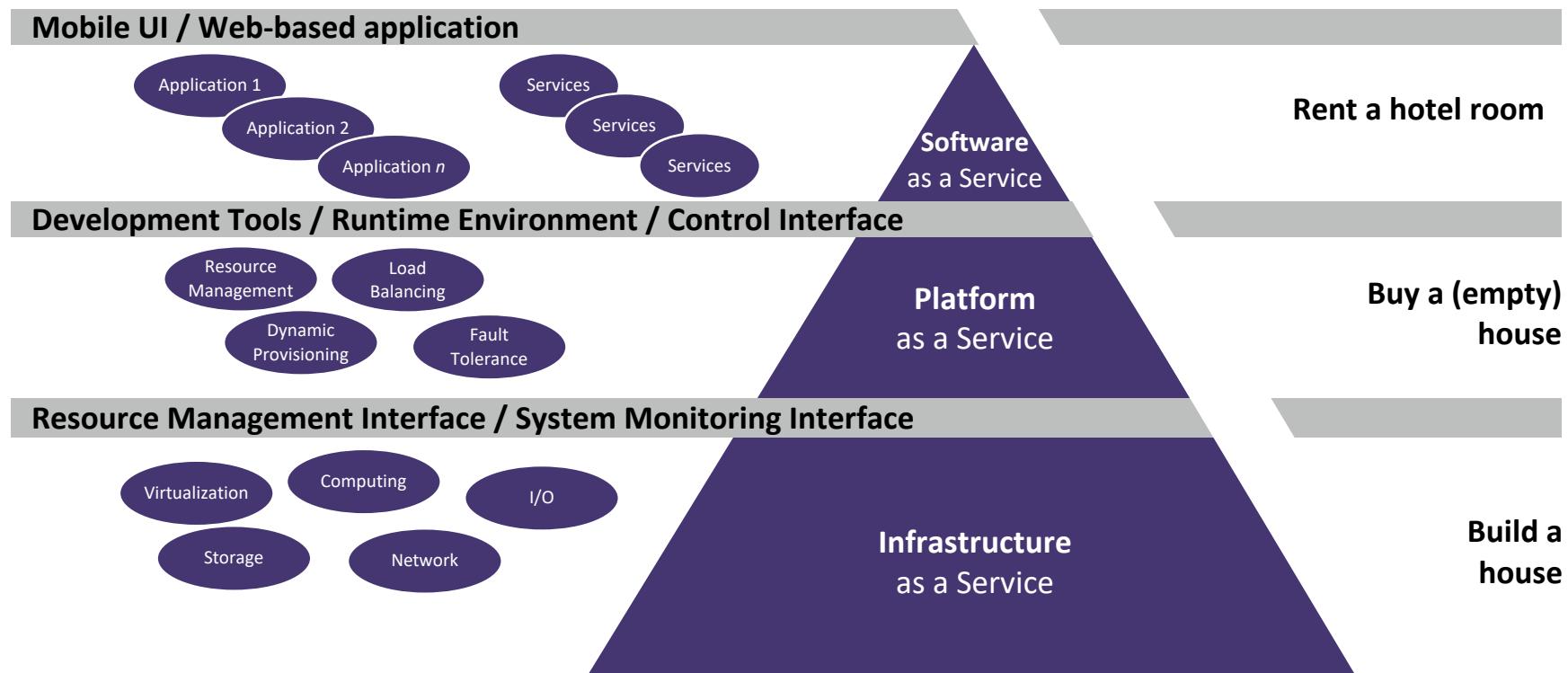
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Cloud Service Models (IaaS, PaaS, SaaS): End User Perspectives



Cloud Service Models (IaaS, PaaS, SaaS): Services



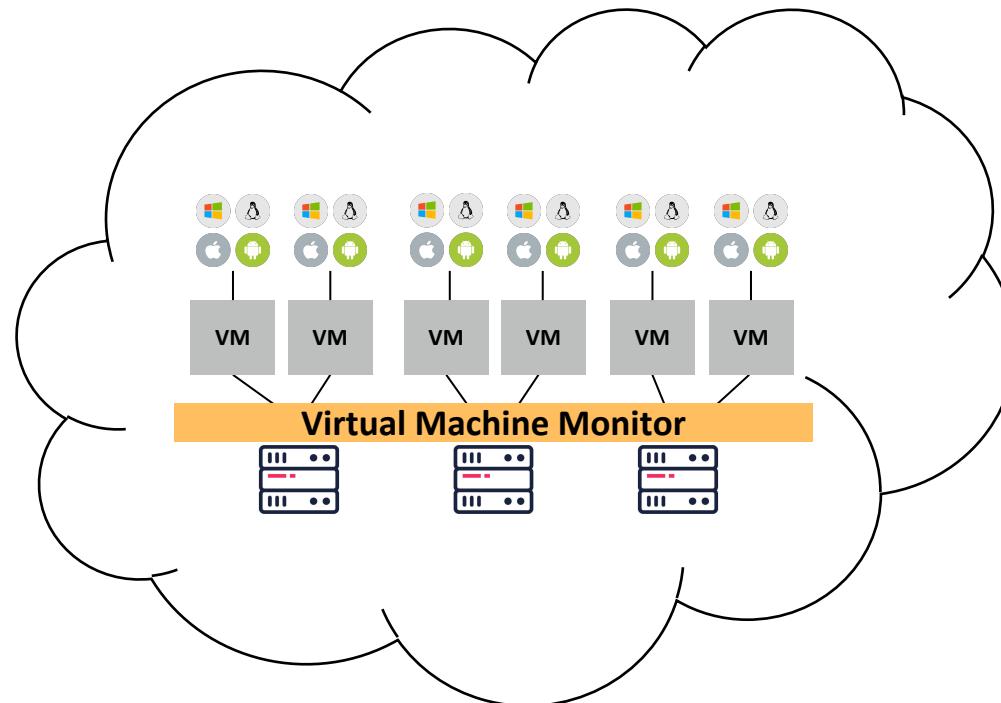
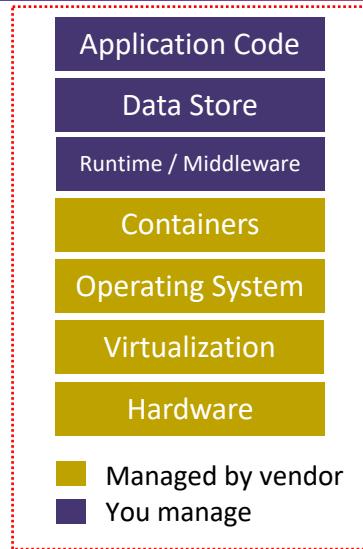
Cloud Service Models (IaaS, CaaS, PaaS, SaaS): Who Manages What?

| Application Code |
|----------------------|----------------------|----------------------|----------------------|----------------------|
| Data Store |
| Runtime / Middleware |
| Containers | Containers | Containers | Containers | Containers |
| Operating System |
| Virtualization | Virtualization | Virtualization | Virtualization | Virtualization |
| Hardware | Hardware | Hardware | Hardware | Hardware |

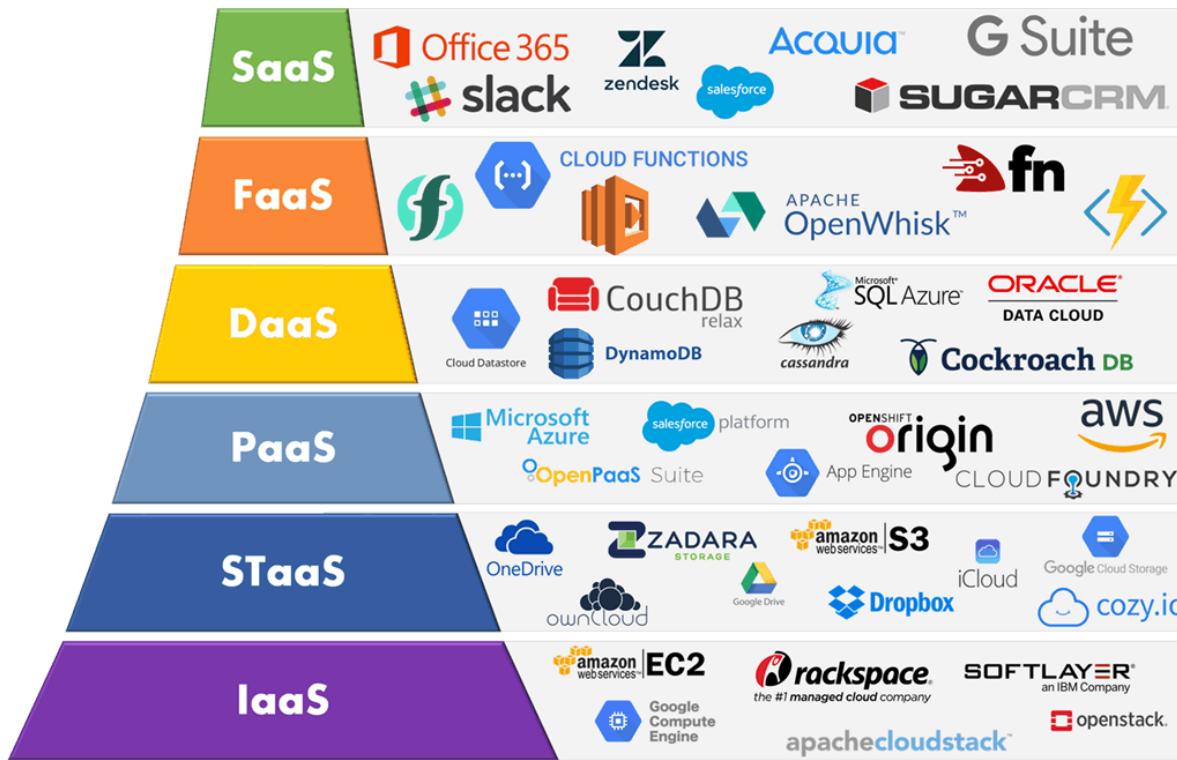
Traditional IT **IaaS** **CaaS** **PaaS** **SaaS**

- Managed by vendor
- You manage

Hypervisors (also known as Virtual Machine Monitor) - Overview

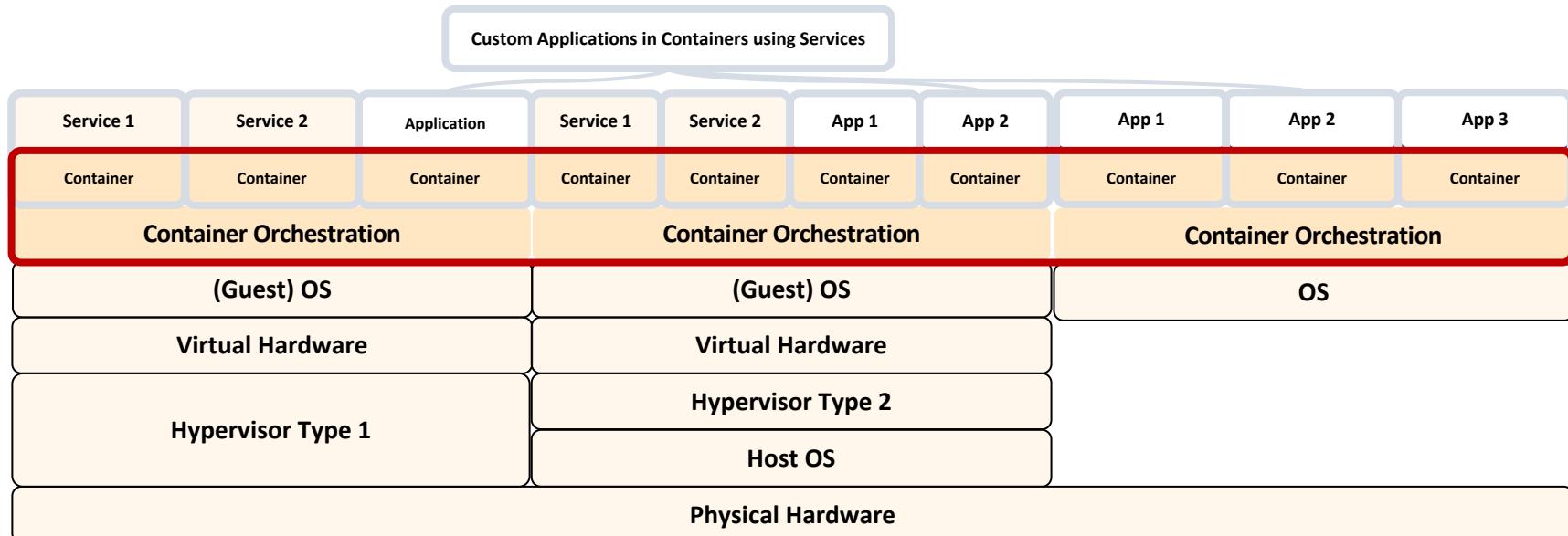


More Cloud Service Models ...



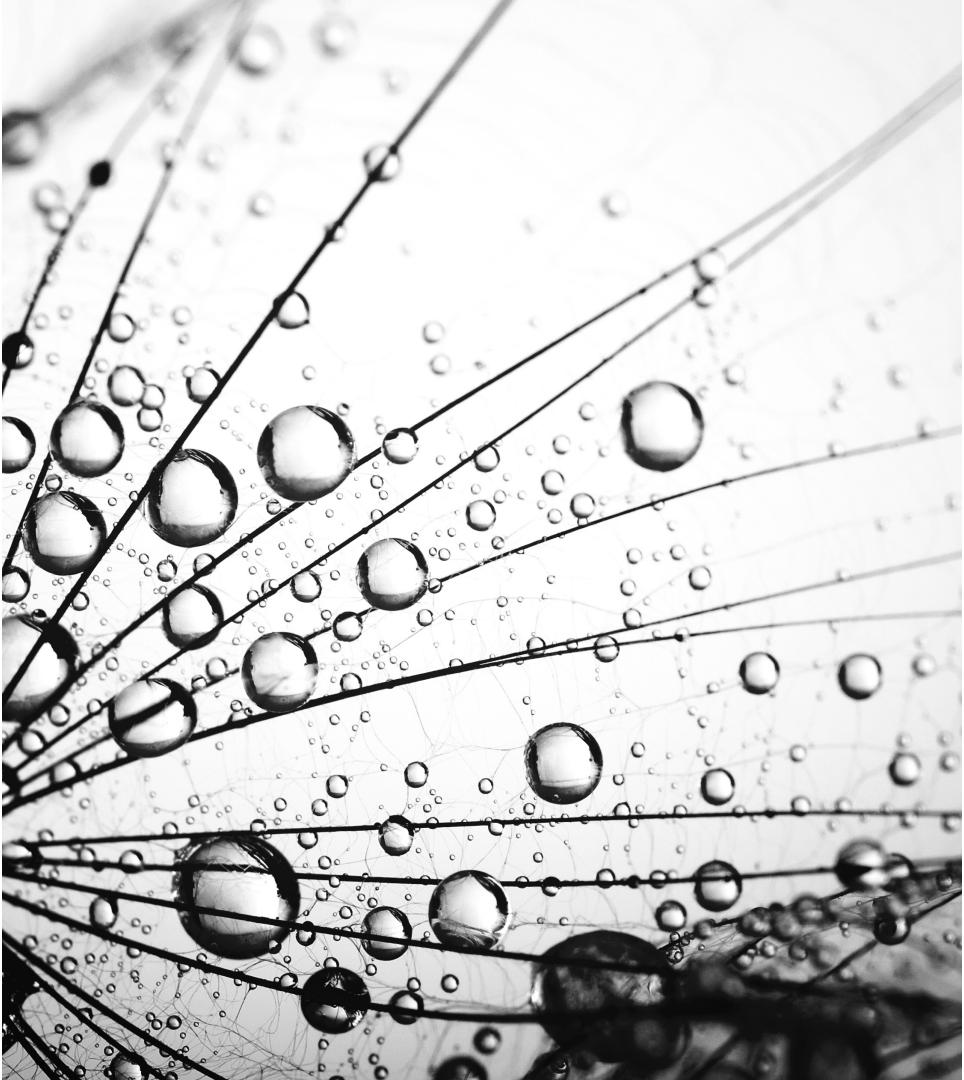
Hypervisors & Containers: Differentiate between them

- **Hypervisors** are virtualizing Hardware and provide an OS on top of that
- **Containers** reuse existing OSs and provide isolated computing



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IaaS Offerings: Introduction

The image displays three screenshots of cloud service provider websites, each featuring a red oval highlighting a specific feature or section:

- Microsoft Azure Screenshot:** Shows a tutorial titled "Create your first Windows virtual machine in the Azure portal". A red oval highlights the first step of the "Step by Step: Creating a Virtual Data Center" guide.
- Amazon EC2 Screenshot:** Shows a "Compute" section with two "10-Minute Tutorial" links: "Launch a Linux Virtual Machine using Amazon EC2" and "Launch a Windows Virtual Machine with Amazon EC2". A red oval highlights the first link.
- Google Cloud Platform Screenshot:** Shows a "Compute Engine" section with a "Quickstart Using a Linux VM" link. A red oval highlights this link.

Microsoft Azure Screenshot Content (Top):

- Header: Microsoft Azure
- Navigation: Why Azure, Solutions, Products, Documentation, Pricing, Partners, Blog, Resources, Support
- Page Title: Create your first Windows virtual machine in the Azure portal
- Text: 3.1.2017 • 3 min to read • Contributors (3)
- Text: This tutorial shows you how easy it is to create a Windows virtual machine (VM) in just a few minutes, by using the Azure portal.
- Text: If you don't have an Azure subscription, create a [free account](#) before you begin.

Microsoft Azure Screenshot Content (Bottom):

- Sidebar: VMware, CLOUD SERVICES, PRODUCTS, SUPPORT, DOWNLOADS, PROFESSIONAL SERVICES, PARTNER PROGRAMS, SOLUTIONS, COMPANY
- Section: Step by Step: Creating a Virtual Data Center
- Text: STEP 1 STEP 2 STEP 3
- Section: Creating a Virtual Data Center
- Table: SOURCE SNAPSHOT (with rows: FORTRESS, KORY, RADE)
- Form: Create Virtual Datacenter (with fields: Available Resources, CPU, MEMORY, STORAGE, PUBLIC IP, DC-VMWAREINC-1000, 30 GHz, 120 GB, 6.0 TB, 3 IPs)
- Text: Use all of these resources. Create Virtual Datacenter

Amazon EC2 Screenshot Content:

- Section: Compute
- Card 1: 10-Minute Tutorial - Launch a Linux Virtual Machine using Amazon EC2
- Card 2: 10-Minute Tutorial - Launch a Windows Virtual Machine with Amazon EC2

Google Cloud Platform Screenshot Content:

- Header: Google Cloud Platform
- Navigation: Why Google, Products, Solutions, Launcher, Pricing, Customers, Documentation, Support, Partners
- Page Title: Quickstart Using a Linux VM
- Text: This page explains how to create a Linux virtual machine instance in Compute Engine using the Google Cloud Platform Console.

Page Footer:

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IaaS Offerings: What They Provide

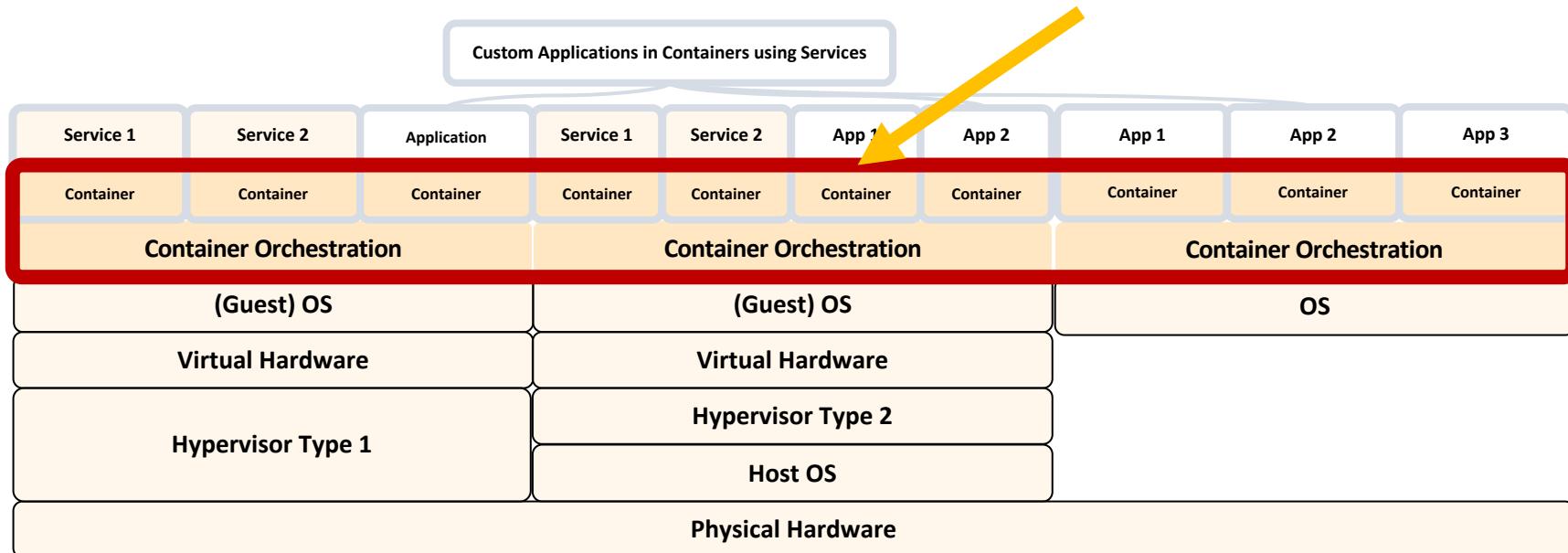
- **IaaS Offerings include**
 - Creation of **Virtual Machines**
 - Creation of **Networks, VPNs, ...**
 - Creation of **Storage**
- What about Databases, Messaging, Artificial Intelligence Services, IoT Connectors, etc.?
 - Those services belong to the PaaS (or even service/function) Layer

In general, you won't say „let's use the IaaS layer of our cloud provider”

Instead, you'll say „let's use ..

- the Linux machines (IaaS) from our cloud provider and
- a MongoDB (PaaS) as a start. We'll use hosted
- Jira (SaaS) to track our tasks.“

Containers and Orchestration: Introduction



Containers and Orchestration: Containers at the heart of PaaS

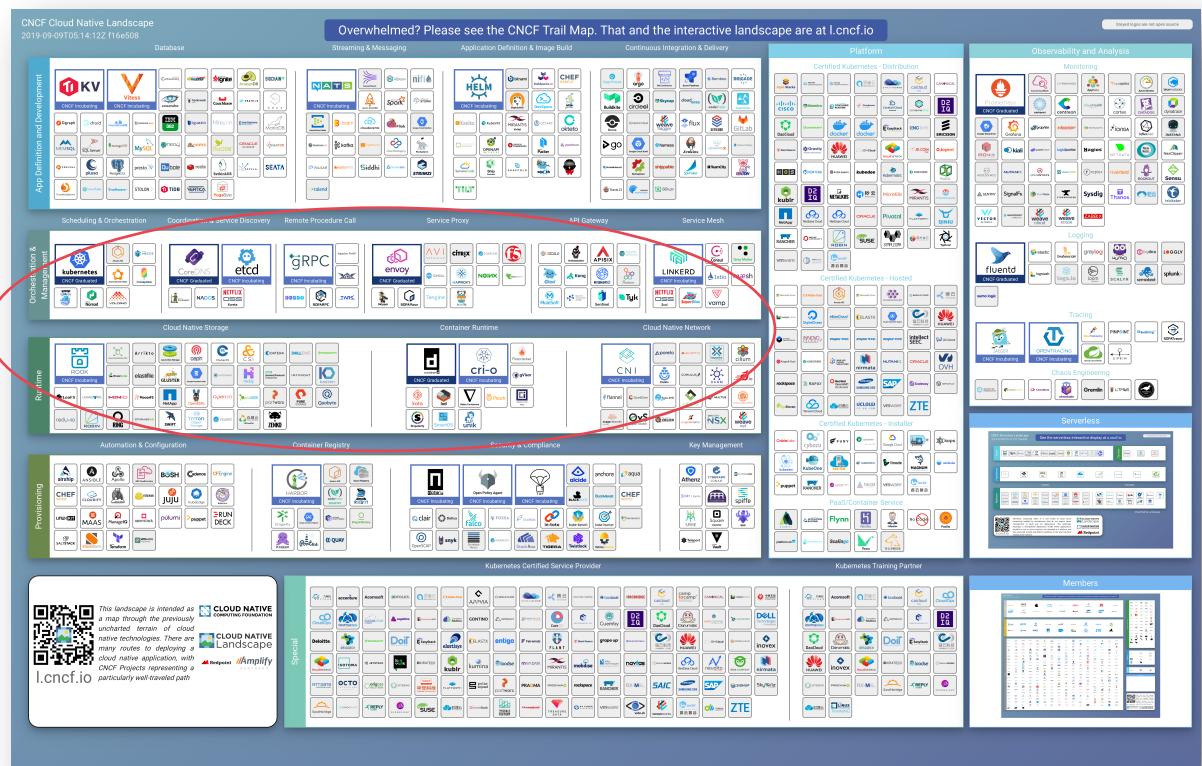
- **Containers and Container Orchestration build the base of PaaS.**
 - Creating containers in seconds or subseconds are required for autoscaling.
 - Containers are a lightweight technique of virtualizing at a operating system level.
 - While **bare metal** machines have to be built and shipped and installed before use ...
 - ... **hypervisors** can create a OS based on an image on an existing bare metal machine.
 - While hypervisors re-create whole operating systems, connected to the underlying hardware...
 - ... **containers** reuse existing OSs configurations and libraries.

	Ships within ...	Manual deployment takes ...	Automated deployment takes ...	Boots in ...
Bare Metal	days	hours	minutes	minutes
Hypervisor	minutes	minutes	seconds	< minute
Container	seconds	minutes	seconds	seconds

(credits to: Jerome Petazzoni from dotCloud)

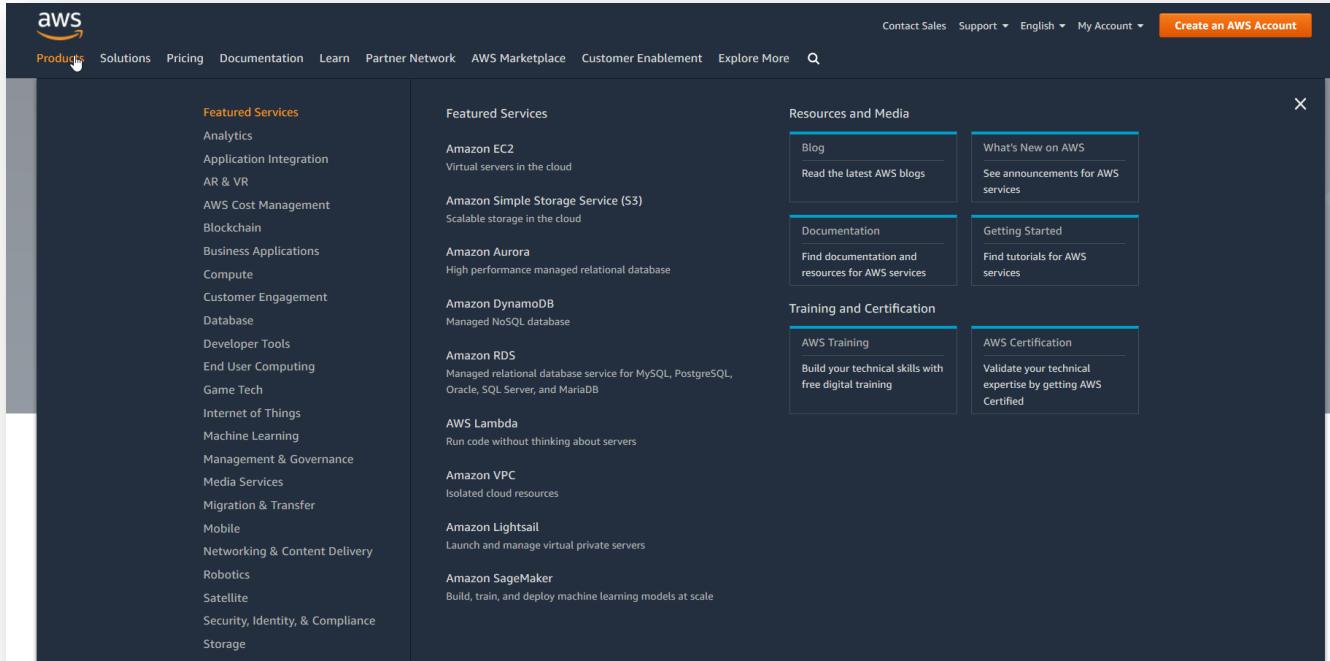
Containers and Orchestration: Between Code and Operating System

- **CNCF Cloud Native Interactive Landscape**
- landscape.cncf.io



PaaS Providers and Technologies: Amazon AWS: Overview

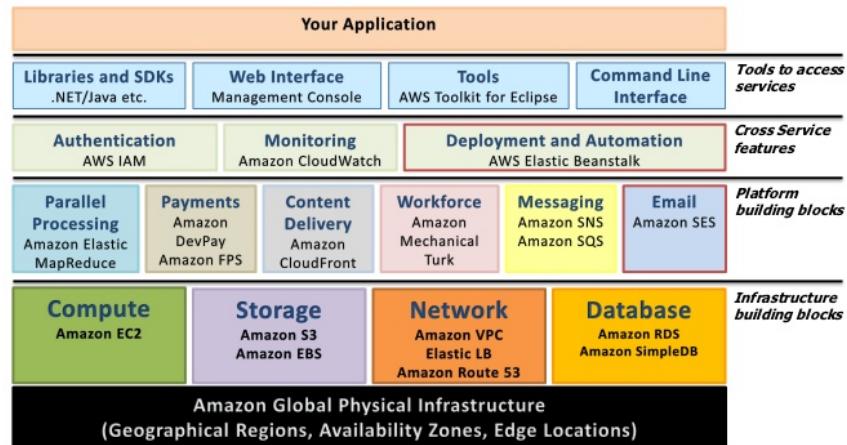
- **Amazon Web Services (AWS):** With its IaaS services, AWS is the leading cloud platform
- **Customers** include: Netflix, Twitch, LinkedIn, Facebook, BBC, Baidu, Adobe, Twitter ...



PaaS Providers and Technologies: Amazon AWS: Layers

- More than **450K physical servers**, can scale up to 300K+ request/sec
- More than **900 billion** objects in the S3 data store
- 8+ Regions and 19+ CloudFront (CDN) locations world wide
- As low as \$.02/hr computing charges (~\$15/month)
- Decent availability (99.95%+)

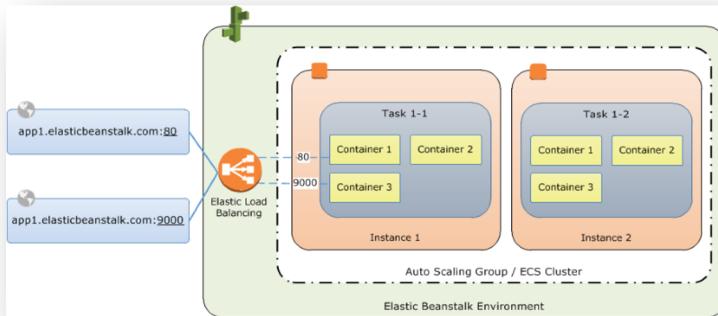
The “Living and Evolving” AWS Cloud



[7]

PaaS Providers and Technologies: Amazon AWS

- **Elastic Beanstalk** runs various programming languages such as Java, .NET, PHP, Node.js, Python, Ruby, Go
 - Bundles are used to deliver applications
 - They contain source artifacts or WAR files
- **Elastic Beanstalk** also supports Docker. Supported configurations:
 - **Single Container Docker:** Runs one Docker image per EC2-Instance
 - **Multicontainer Docker:** Runs multiple Docker images using ECS
 - **ECS:** EC2 Container Service – includes: Autoscaling, Load Balancing, AWS Identity and Access Management, and more



PaaS Providers and Technologies: Google GCP

- **Customers:** Snapchat, Twitter, Ebay, PayPal, Spotify, and others
- **(IaaS) GCE:** Google Compute Engine provides virtual machines (like Amazon EC2)
- **(IaaS) BigQuery:** Compare to Amazon Redshift (columnar database)
- **(PaaS) GAE:** Google App Engine – compare to Amazon Beanstalk



Google Cloud

A screenshot of the Google Cloud homepage. The top navigation bar includes links for Google Cloud, Why Google, Solutions, Products (with a dropdown menu), Pricing, and Getting started. A search bar and language selection are also present. The main content area is divided into sections: "GOOGLE CLOUD PLATFORM" (AI and machine learning, API management, Compute, Data analytics, Databases, Developer Tools), "Hybrid and multi-cloud" (Anthos, GKE On-Prem, Istio on GKE, more), "Internet of Things" (Cloud IoT Core, Edge TPU), "Migration" (Data Transfer, Transfer Appliance, more), "Networking" (DNS, CDN, Virtual Private Cloud, more), "Security" (Security Key Enforcement, Cloud IAM, more), "Storage" (Cloud Storage, Persistent Disk, more). To the right, there's a "MORE CLOUD PRODUCTS" section listing G Suite, Google Maps Platform, Cloud Identity, Chrome Enterprise, and Android Enterprise, each with a brief description and a small icon. At the bottom, a link says "See all products (100+)".

[9]

PaaS Providers and Technologies: Microsoft Azure

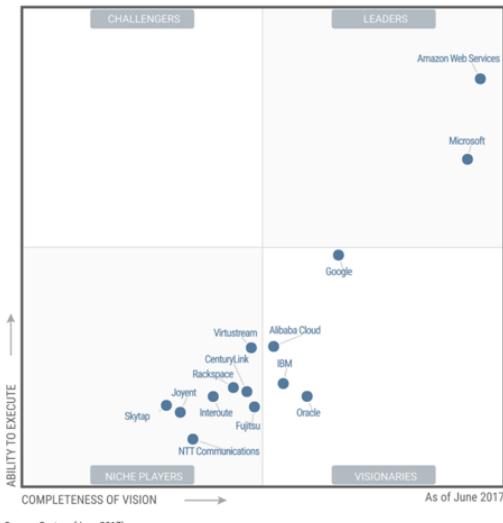
- **Microsoft Azure:** Provides Services across the whole stack
 - **(IaaS) Virtual Machines**, networking and storage; Cloud Services
 - **(PaaS) App Service**
- **Customers:** Pixar, Samsung, Boing, Daimler, BMW, Fujitsu, and others

The screenshot shows the Microsoft Azure homepage. The top navigation bar includes links for Overview, Solutions, Products (which is highlighted with a dropdown menu), Documentation, Pricing, Training, Marketplace, Partners, Support, Blog, and More. A search bar and account links are also present. The main content area features a sidebar with categories such as Featured, Management, AI + Machine Learning, Media, Analytics, Microsoft Azure Stack, Blockchain, Migration, Compute, Mixed Reality, Containers, Mobile, Databases, Networking, Developer Tools, Security, DevOps, Storage, Identity, Web, Integration, Windows Virtual Desktop, Internet of Things, and Cognitive Services. Below this is a search bar and a link to 'See all (100+)'. The main content area displays several 'Featured' services: Virtual Machines, Windows Virtual Desktop, Azure SQL Database, App Service, Azure Cosmos DB, PlayFab, Azure Kubernetes Service (AKS), Azure Functions, Cognitive Services, and Azure Blockchain Service. At the bottom, there are four sections: 'Be future-ready', 'Build on your terms', 'Operate hybrid seamlessly', and 'Trust your cloud', each with a brief description and a 'Learn more >' link.



PaaS Providers and Technologies: Magic Quadrant

- Gartner: Magic Quadrants for Cloud Infrastructure as a Service (Worldwide)



2017



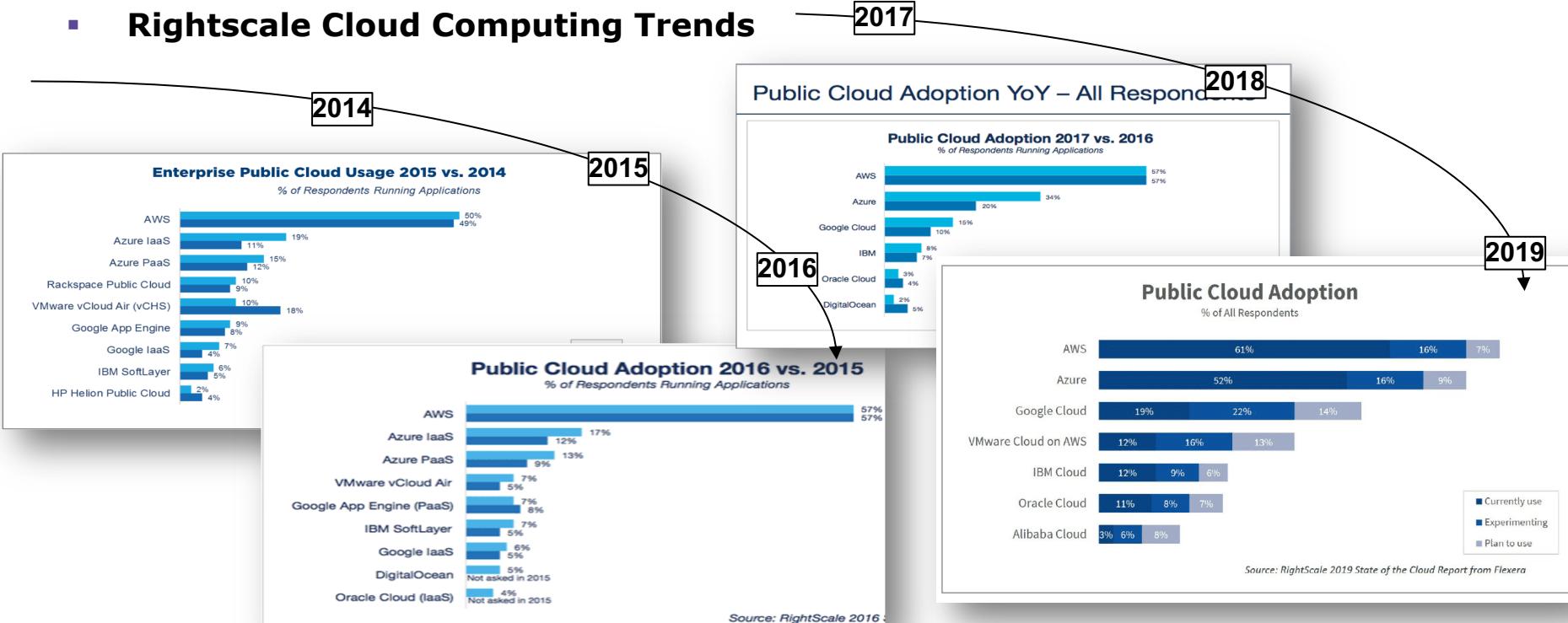
2018



2019

PaaS Providers and Technologies: Cloud Computing Trends

▪ Rightscale Cloud Computing Trends



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Cloud Topologies: Private and Public, on-premise and off-premise

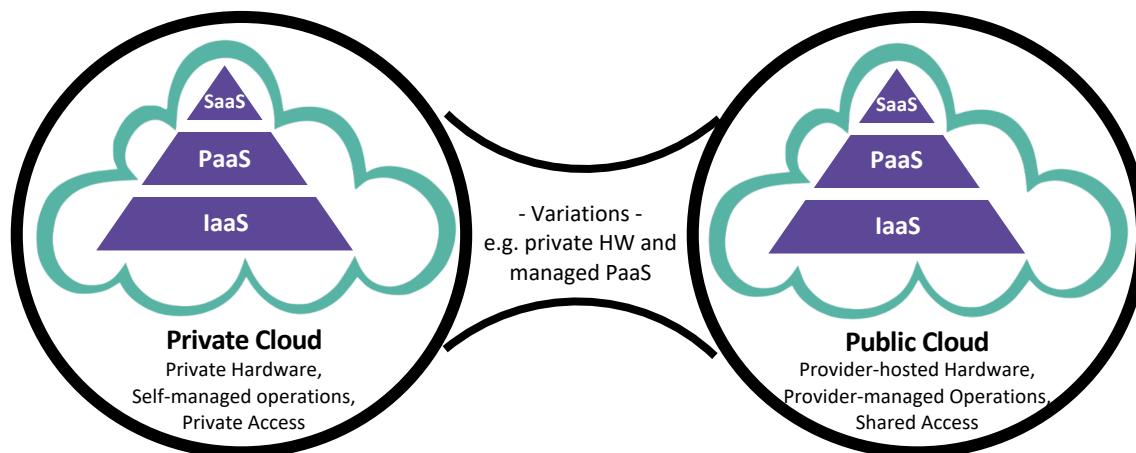
- Private and public, on-premise and off-premise

Provision of Hardware	Own data center (On-Premise)		Hardware in the data center of the cloud provider (Off-Premise)	
Operation of the application platform	Self-managed operation		Provider-managed operation	
Access to the application platform	Private	Public	Private	Public

Cloud Topologies: Techs & Providers

- **Focus on Technology options**

- Kubernetes and Docker
- Pivotal/Open Source Cloud Foundry
- OpenShift
- ...

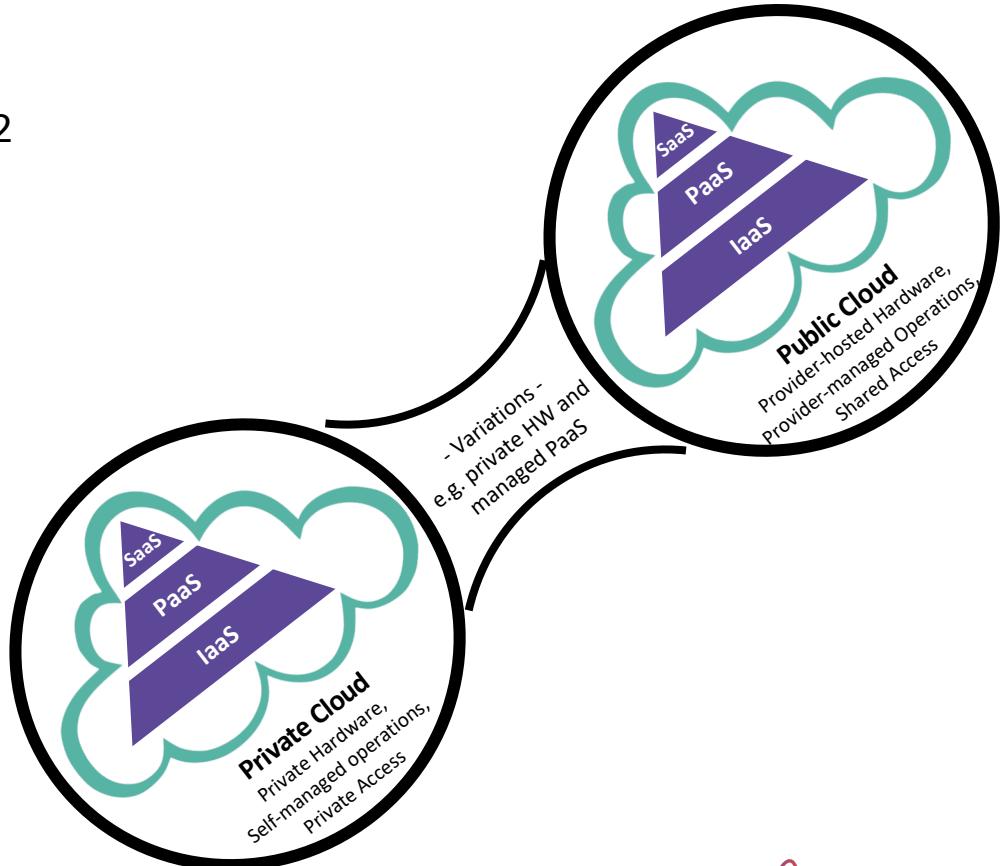


- **Focus on Provider options**

- Amazon AWS
- Microsoft Azure
- Google Cloud
- ...

Cloud Topologies: Hybrid Cloud

- **Hybrid Cloud** is the combination of 2 or more approaches.
- **A typical scenario is:**
 - Private Cloud: Sensitive data on private hardware and private operations
 - Public or dedicated cloud: Mass-operations on provider's hardware, end-user app hosting



WRAP-UP

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Questions?

Introduction Cloud Computing part one



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Sources

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