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Introduction Cloud Computing part 1/2

winter semester 2020-2021

Matthias Haeussler

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

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.*"

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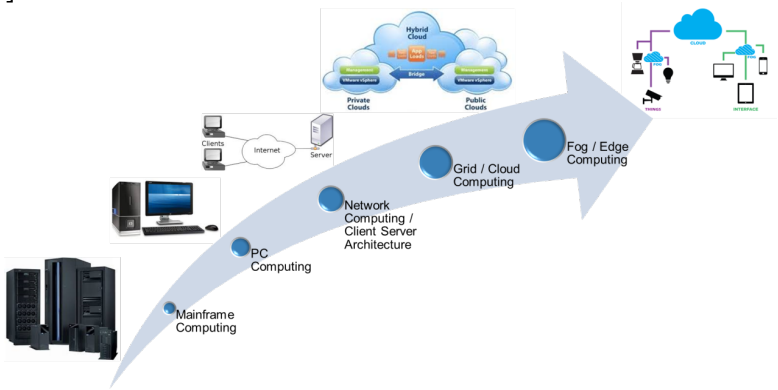

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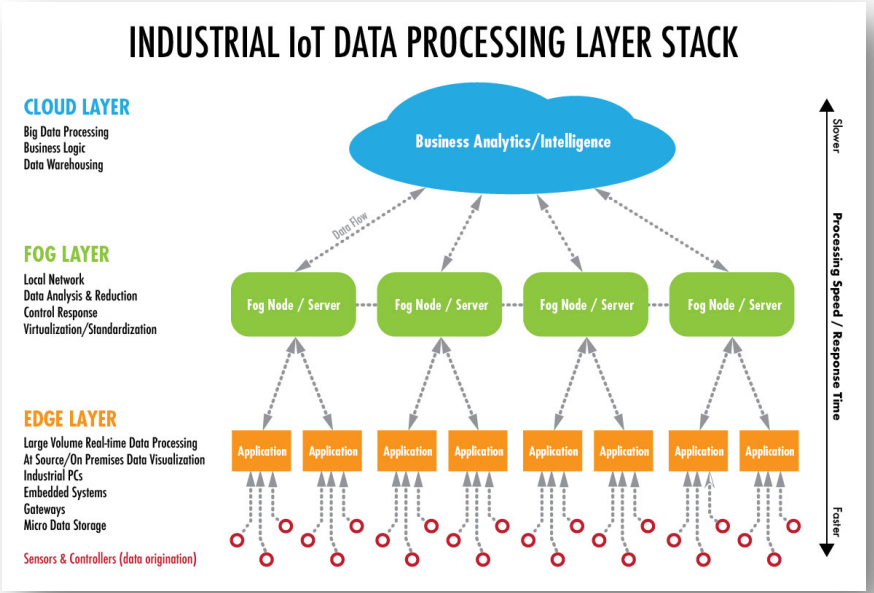

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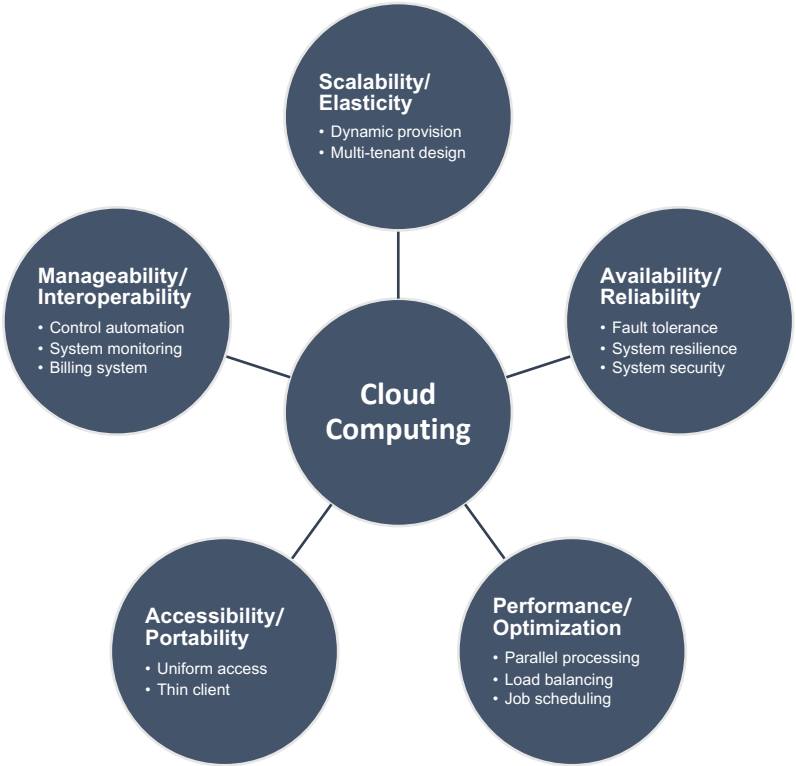
What is Cloud Computing: Props. & Charact.



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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

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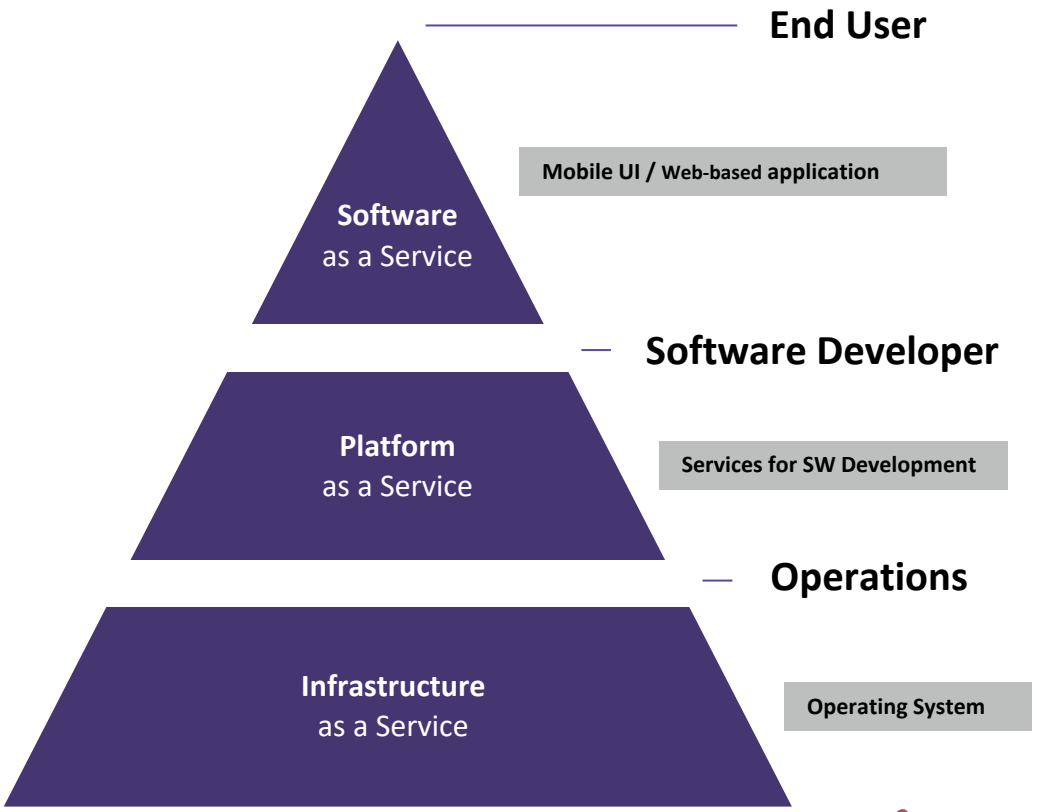
Cloud Service Models (IaaS, PaaS, SaaS): End User Perspectives



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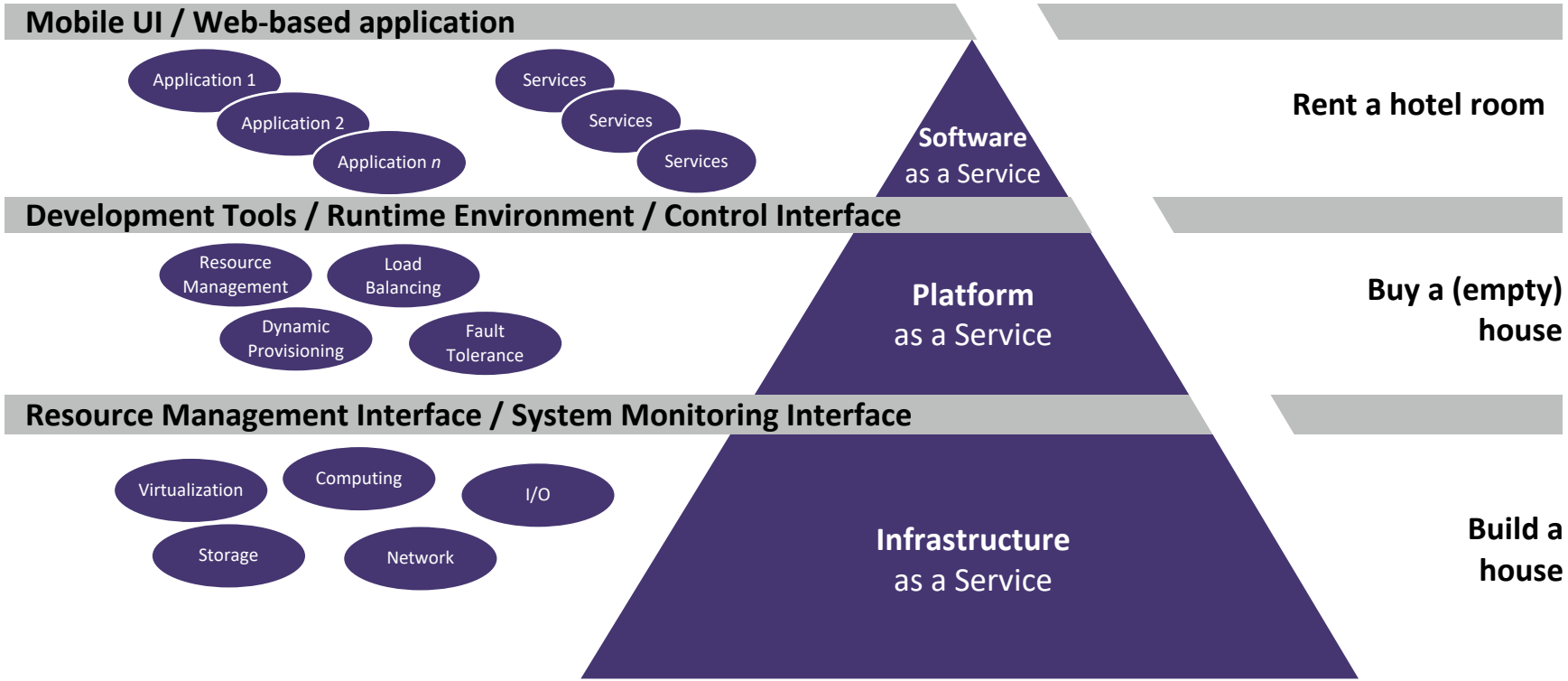
Cloud Service Models (IaaS, PaaS, SaaS): Services



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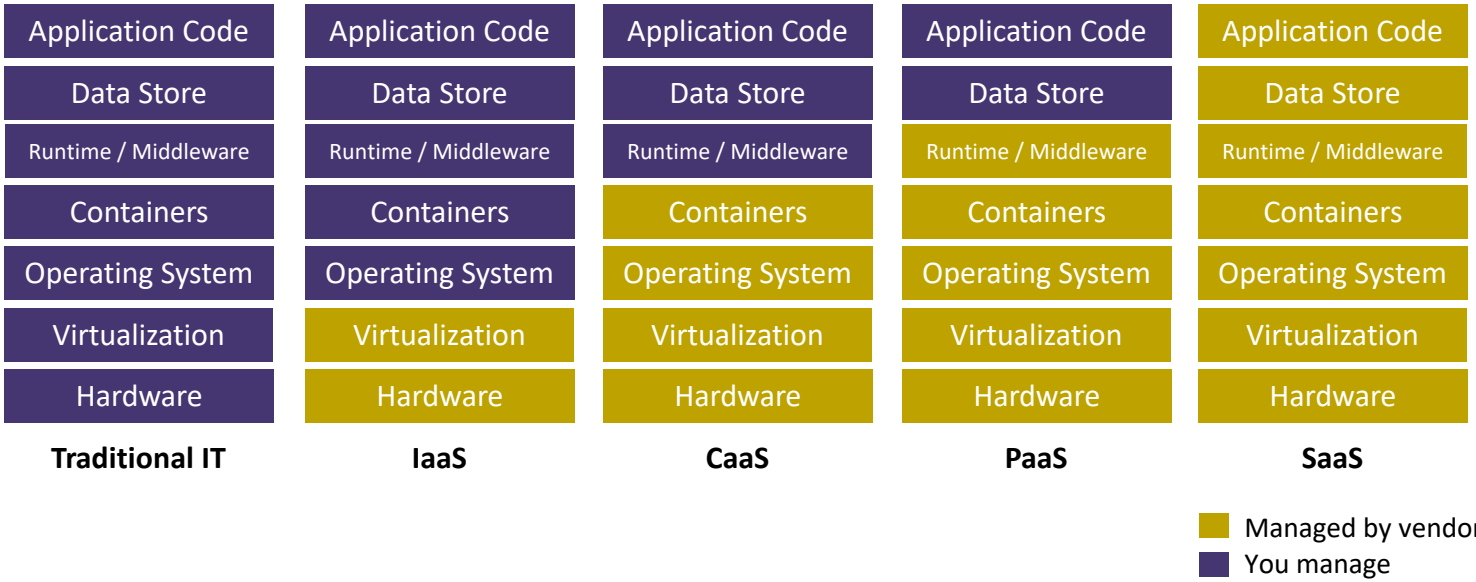
Cloud Service Models (IaaS, CaaS, PaaS, SaaS): Who Manages What?



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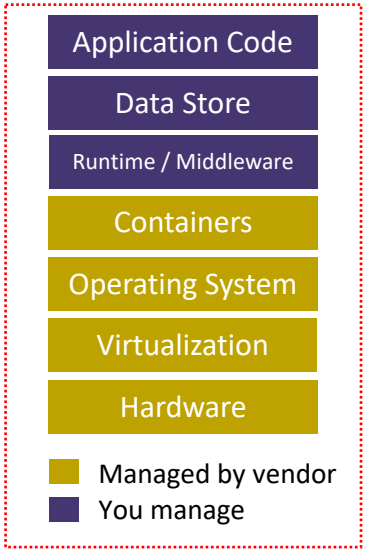
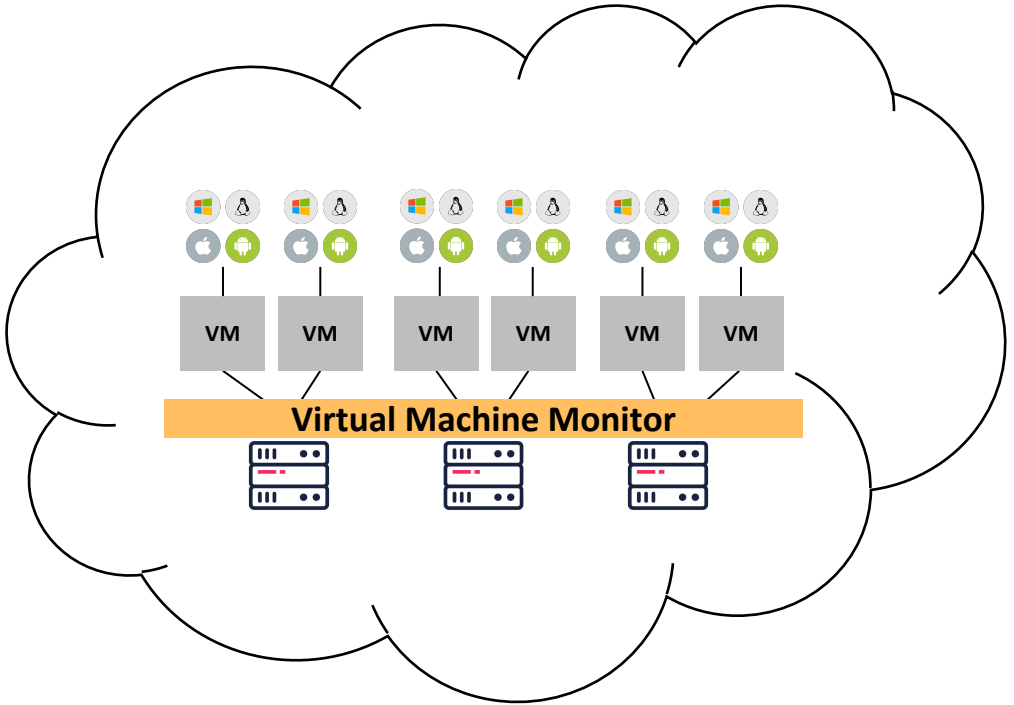
Hypervisors (also known as Virtual Machine Monitor) – Overview





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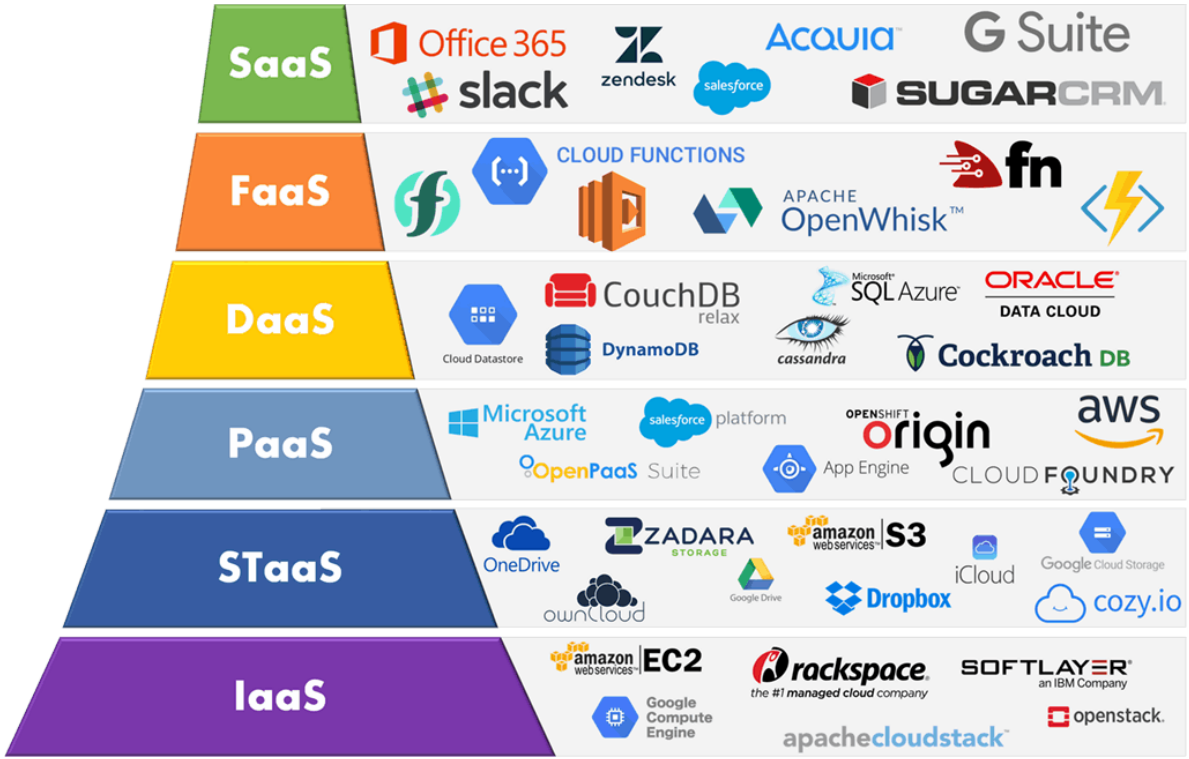
More Cloud Service Models …



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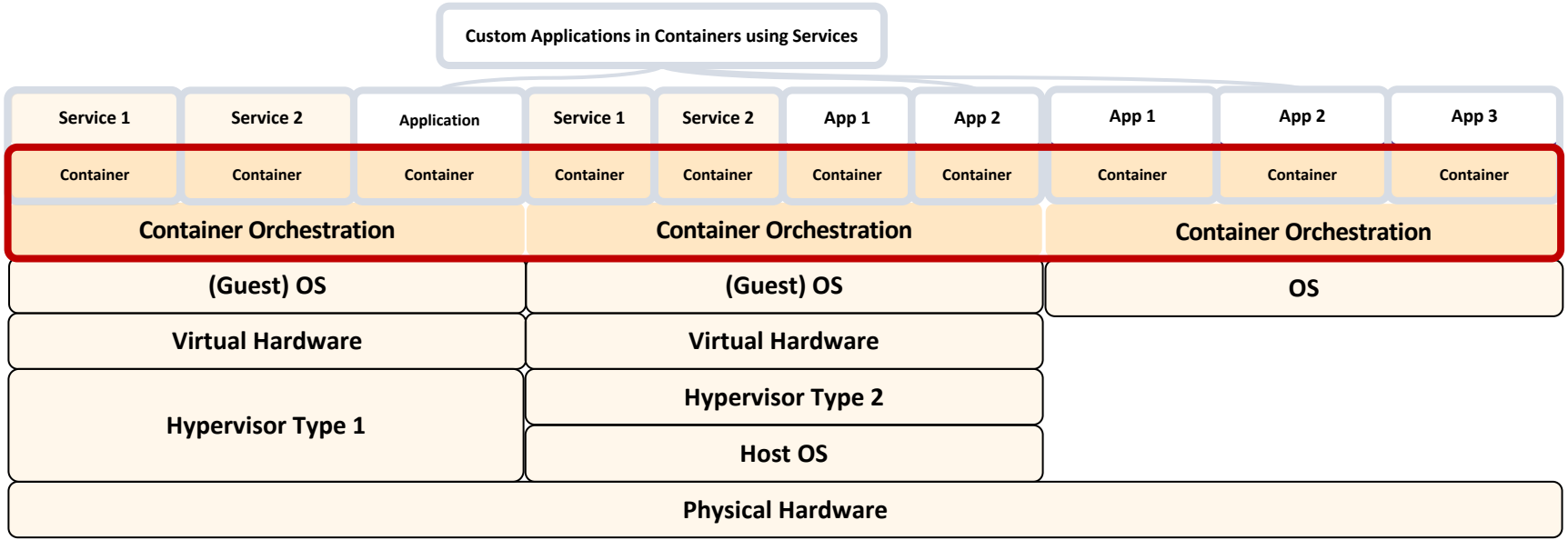
Hypervisors & Containers: Differentiate between them

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



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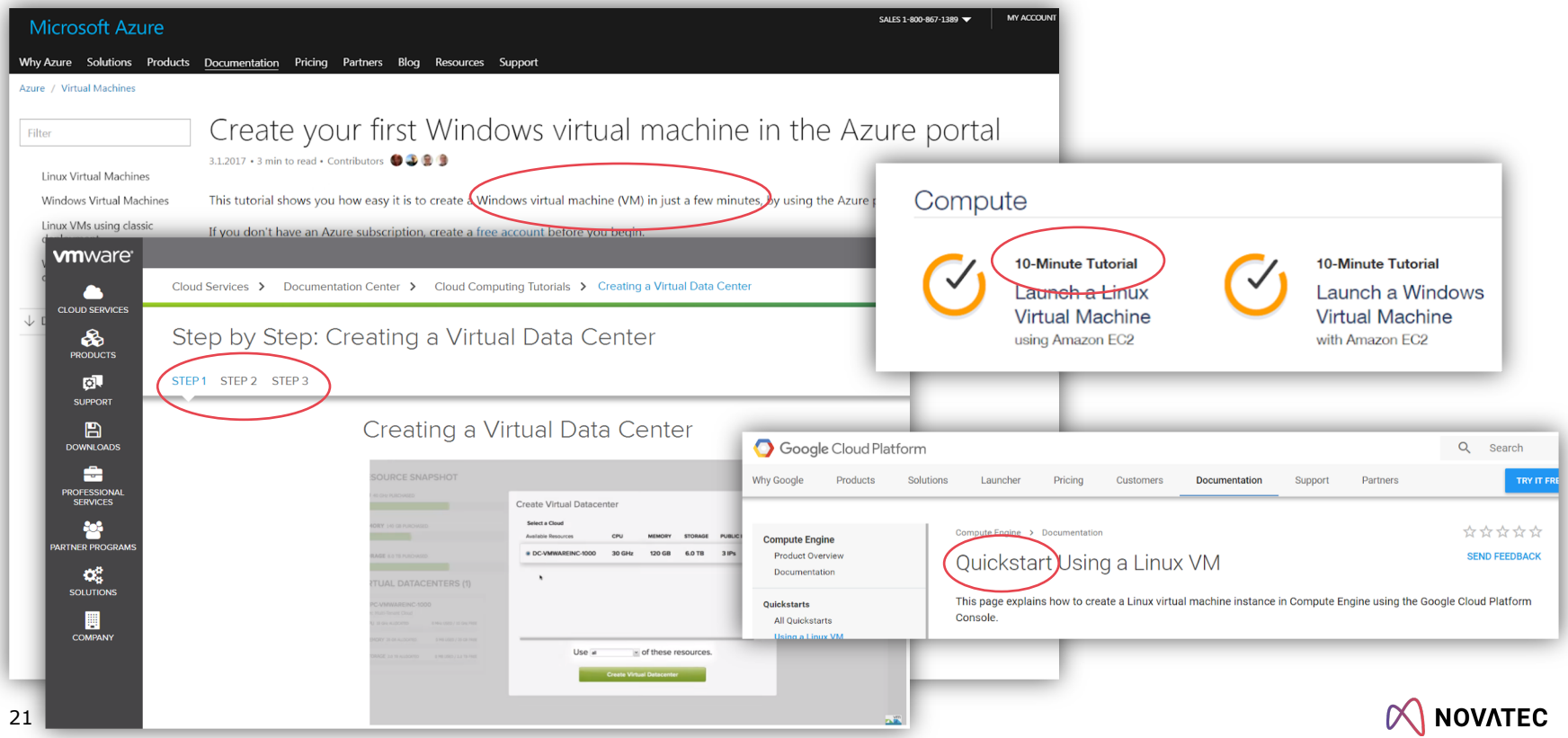
IaaS Offerings: Introduction



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IaaS Offerings: What They Provide

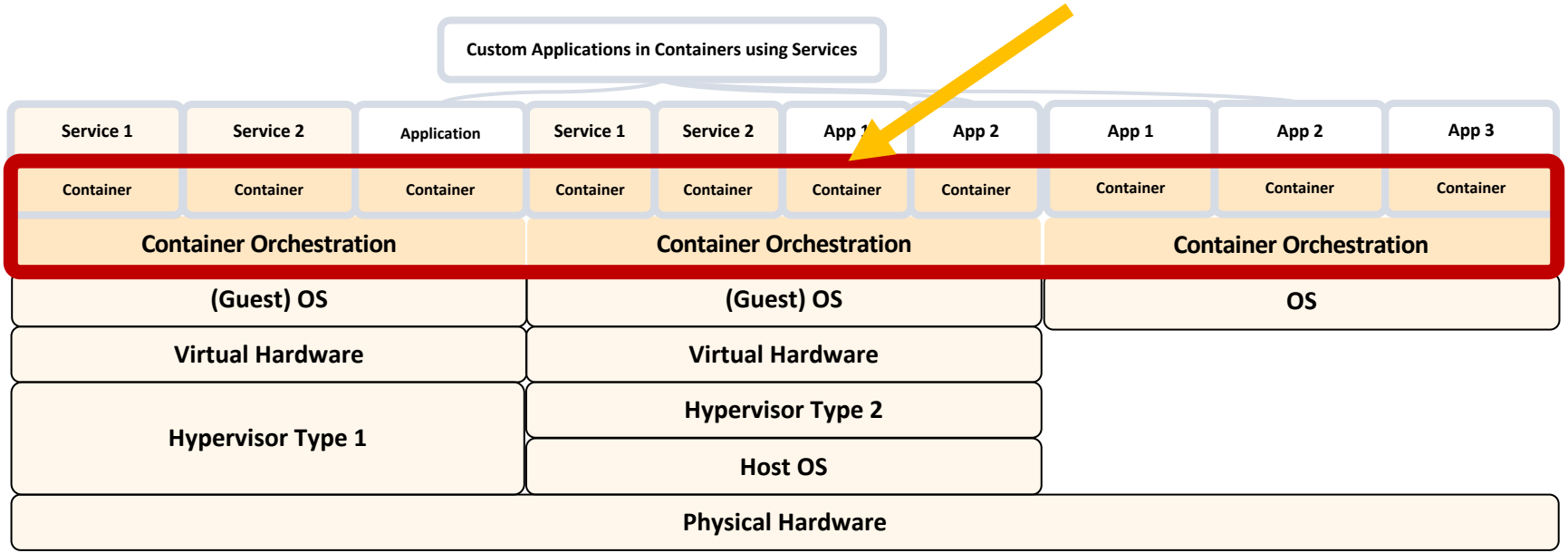
- **IaaS Offerings include**
  - Creation of **Virtual Machines**
  - Creation of **Networks**, **VPNs**, ...
  - Creation of **Storage**
- What about Databases, Messaging, Artificial Intelligence Services, IoT Connectors, etc.?
  - Those services belong to the PaaS (or even service/function) Layer

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



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Containers and Orchestration: Containers at the heart of PaaS

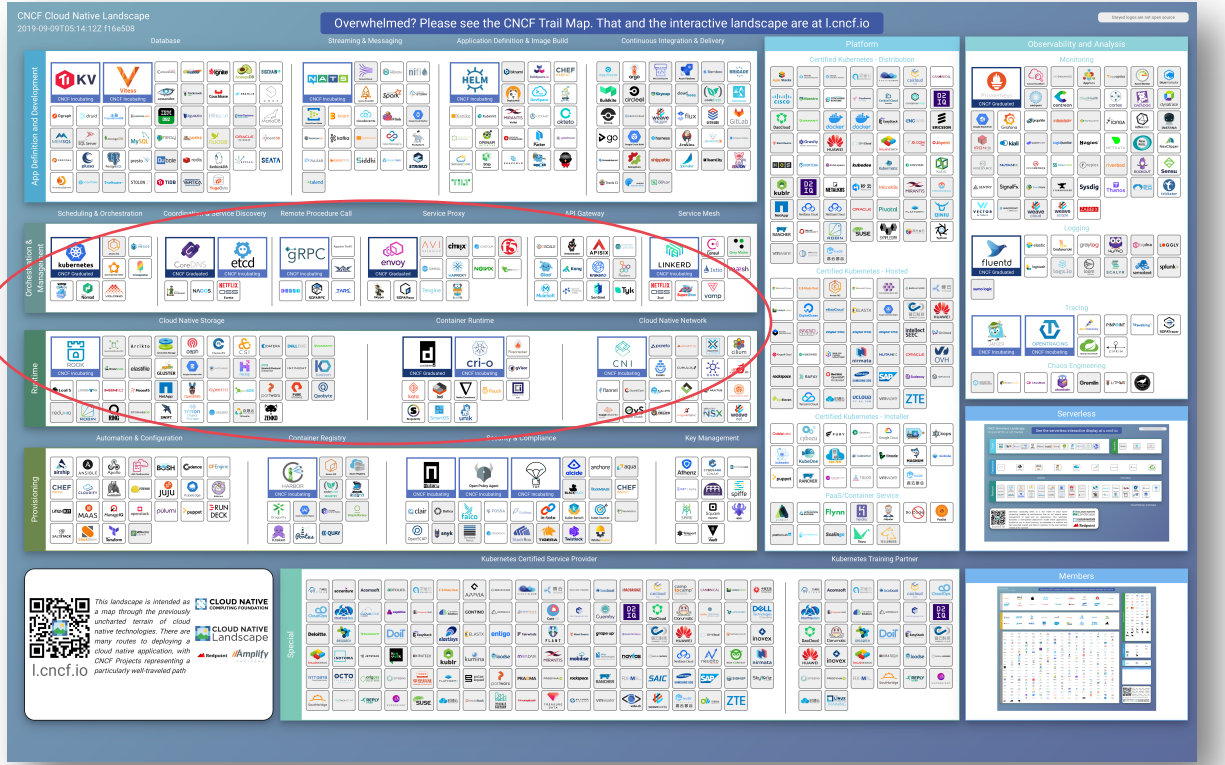
- **Containers and Container Orchestration build the base of PaaS**.
  - Creating containers in seconds or subseconds are required for autoscaling.
  - Containers are a lightweight technique of virtualizing at a operating system level.
  - While **bare metal** machines have to be built and shipped and 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)
see https://aucouranton.com/2014/06/13/linux-containers-parallels-lxc-openvz-docker-and-more/

Containers and Orchestration: Between Code and Operating System

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



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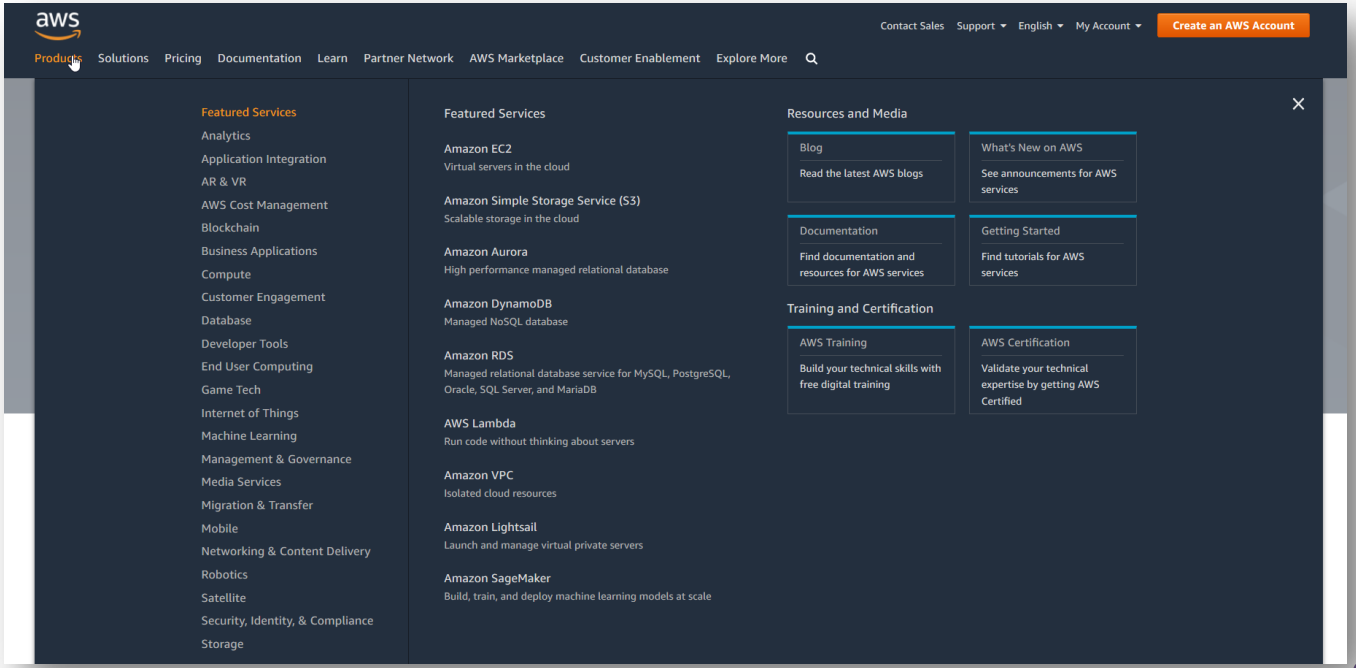
PaaS Providers and Technologies: Amazon AWS: Overview

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



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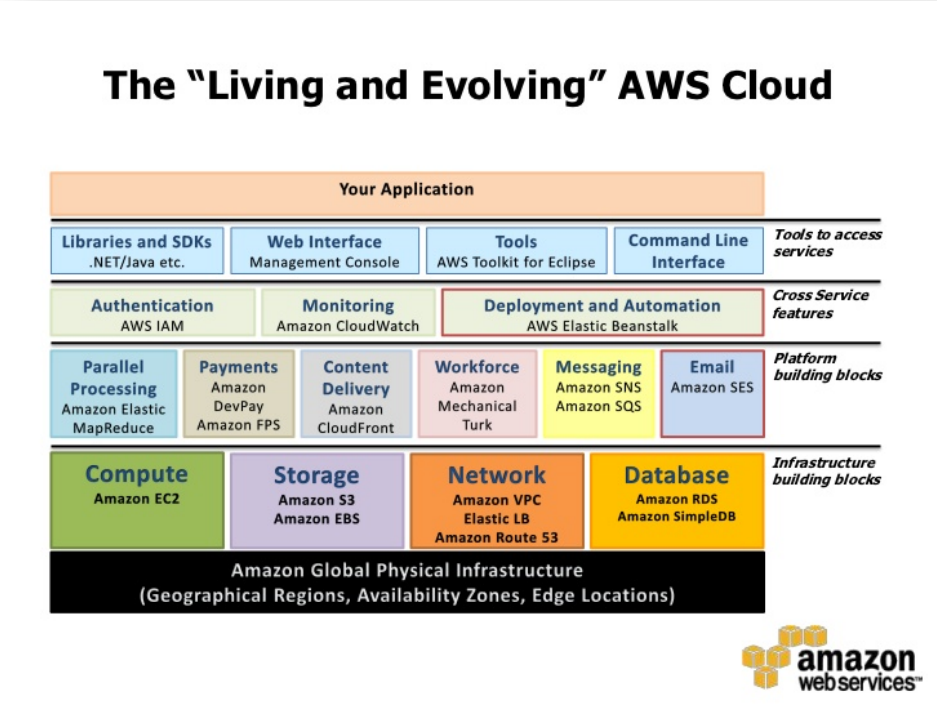
PaaS Providers and Technologies: Amazon AWS: Layers

- 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%+)



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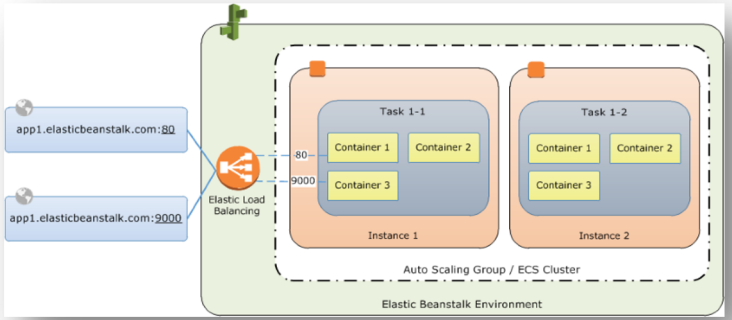
PaaS Providers and Technologies: Amazon AWS

- **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



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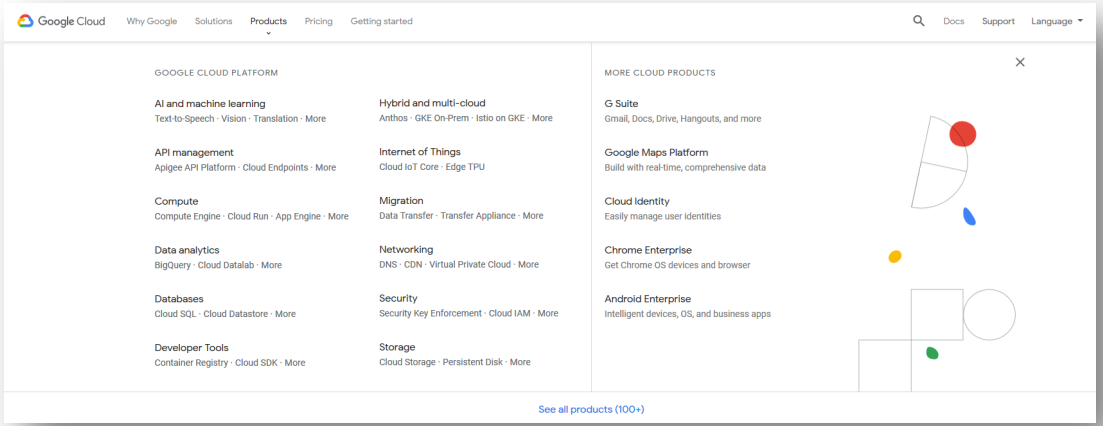
PaaS Providers and Technologies: Google GCP

- **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



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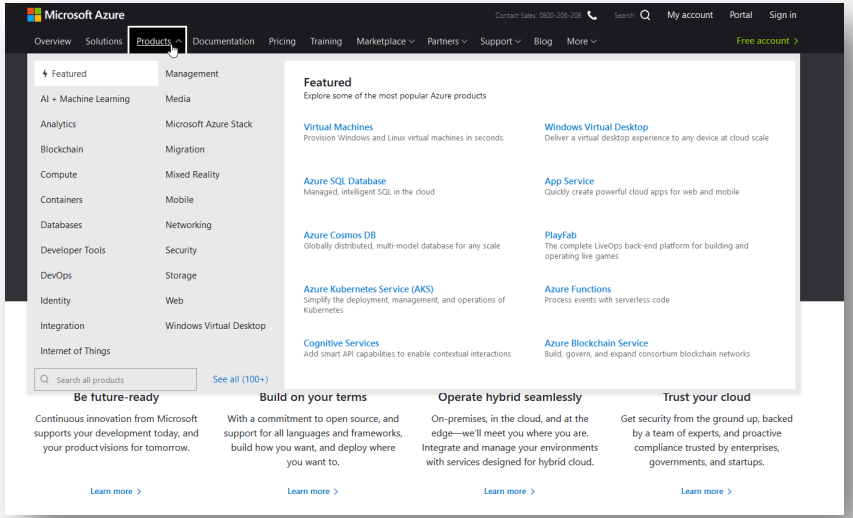
PaaS Providers and Technologies: Microsoft Azure

- **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



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PaaS Providers and Technologies: Magic Quadrant

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

2017

2018

2019

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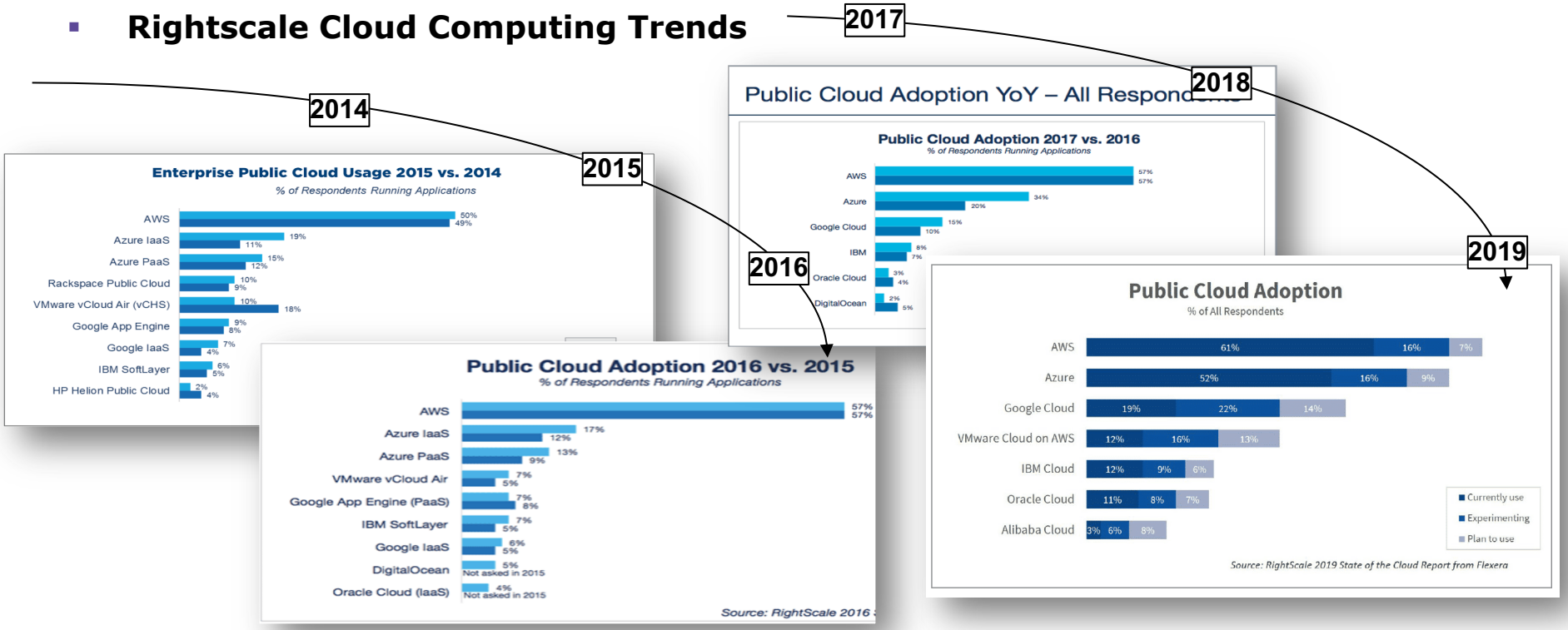
PaaS Providers and Technologies: Cloud Computing Trends

- **Rightscale Cloud Computing Trends**



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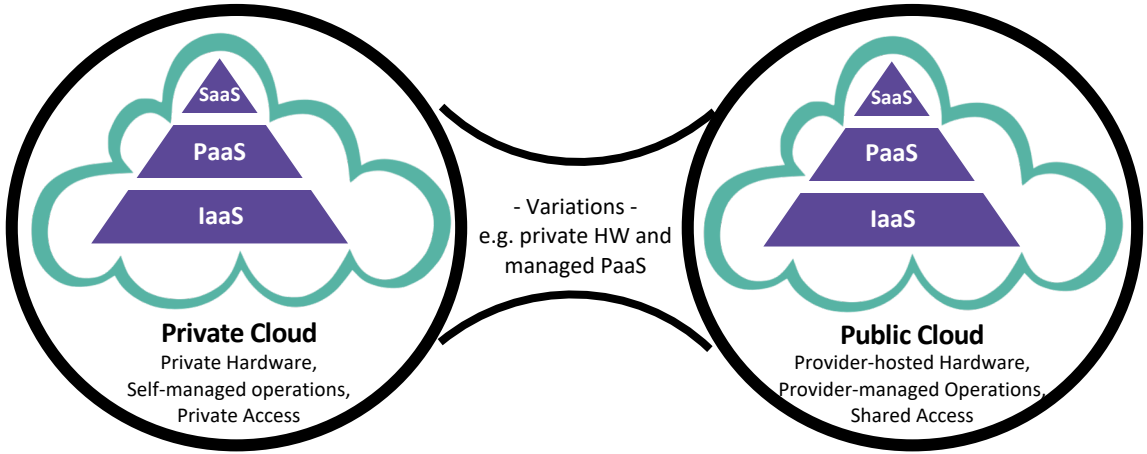
Cloud Topologies: Private and Public, on-premise and off-premise

- 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		Self-managed operation		Provider-managed operation	
Access to the application platform	Private	Public	Private	Public	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
  - …



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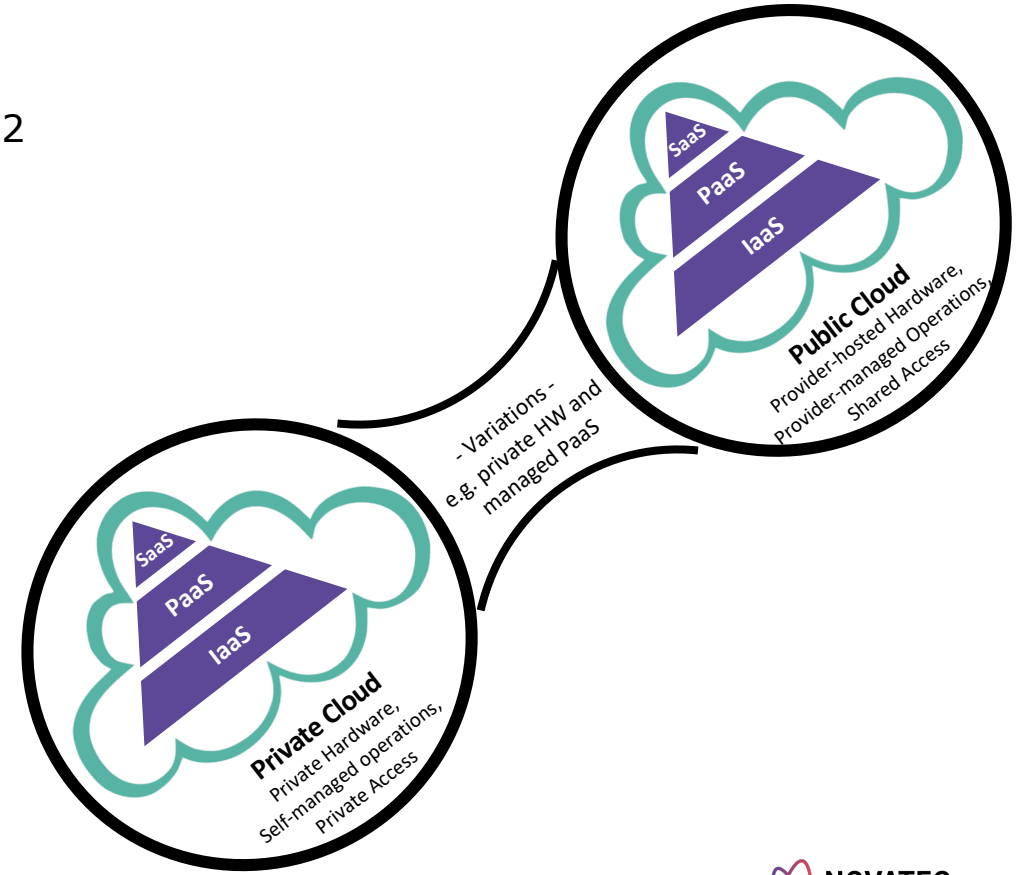
Cloud Topologies: Hybrid Cloud

- **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



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WRAP-UP

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Questions?

Introduction Cloud Computing part one

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