INTRODUCTION TO **CLOUD COMPUTING 1/2**

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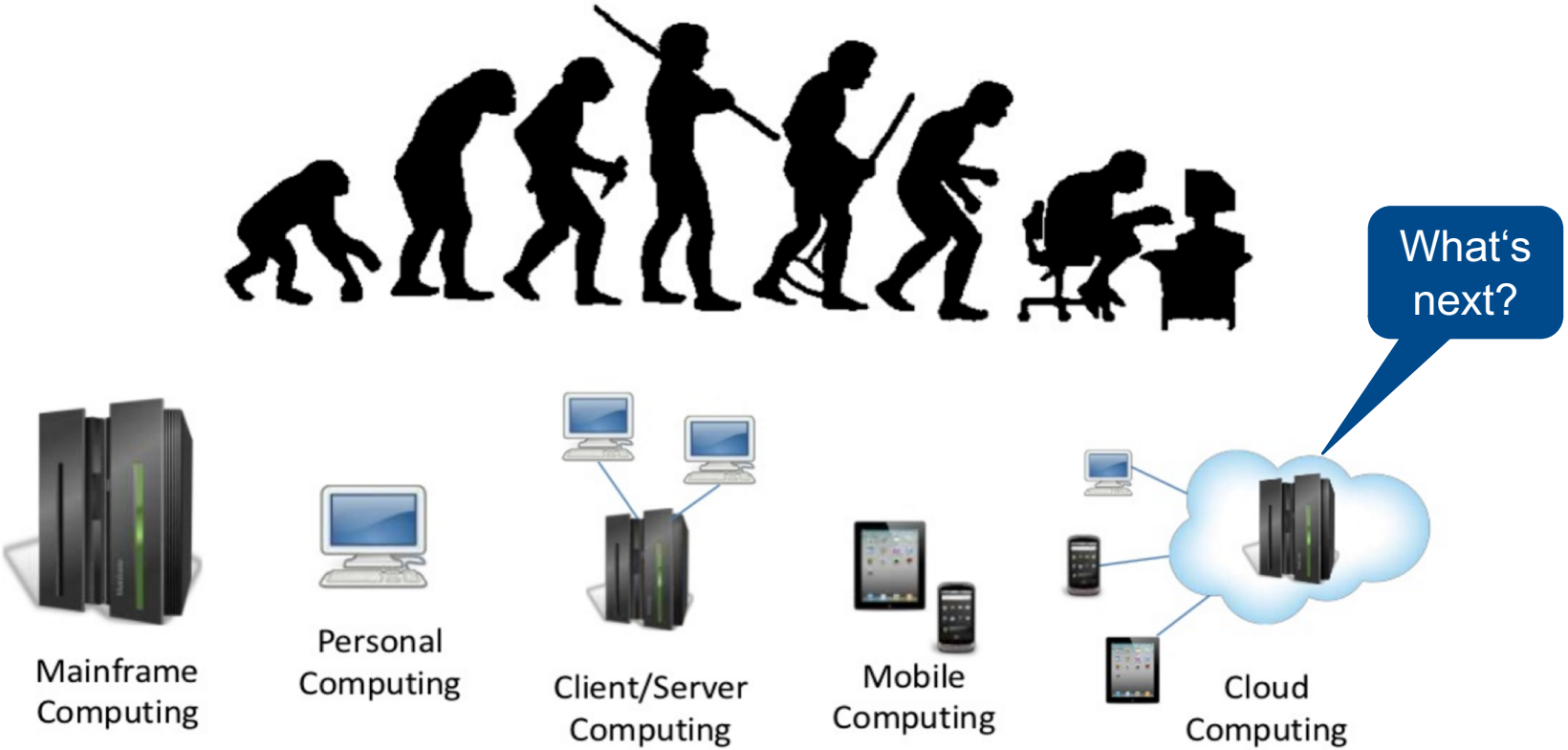
NOVATEC

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:** Pivotal **CF**, Redhat **OpenShift**, Salesforce **Heroku**, Amazon **AWS**, Google **GCP**, Microsoft **Azure**
- **Public, Private, Hybrid, On-Premise, Off-Premise Clouds**

What is Cloud Computing: Your Daily Life

What is Cloud Computing: Computing Paradigm Evolution



(https://www.slideshare.net/ottomora/cloud-computing-101-11931761)

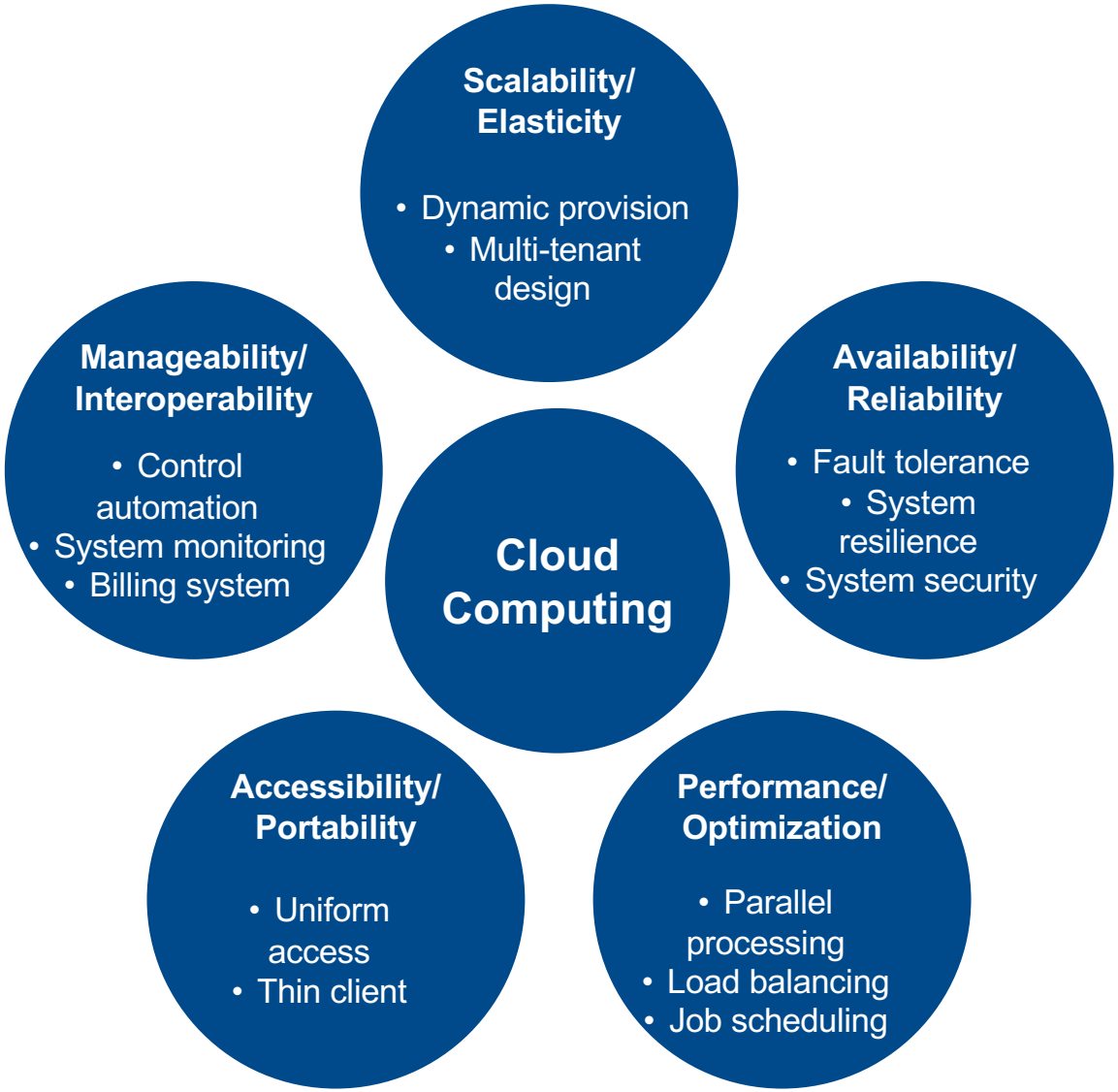
What is Cloud Computing: Benefits

- **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*

- **... and continue with the benefits for businesses**
  - don't have to care about physical machines, especially in peak times
  - can provide new functionality immediately to customers
  - can easily connect to other services through APIs
  - ...

- **... and not to forget some trade-offs**
  - my data may be somewhere located
  - can‘t control some pieces of the software anymore

What is Cloud Computing: Properties and Characteristics



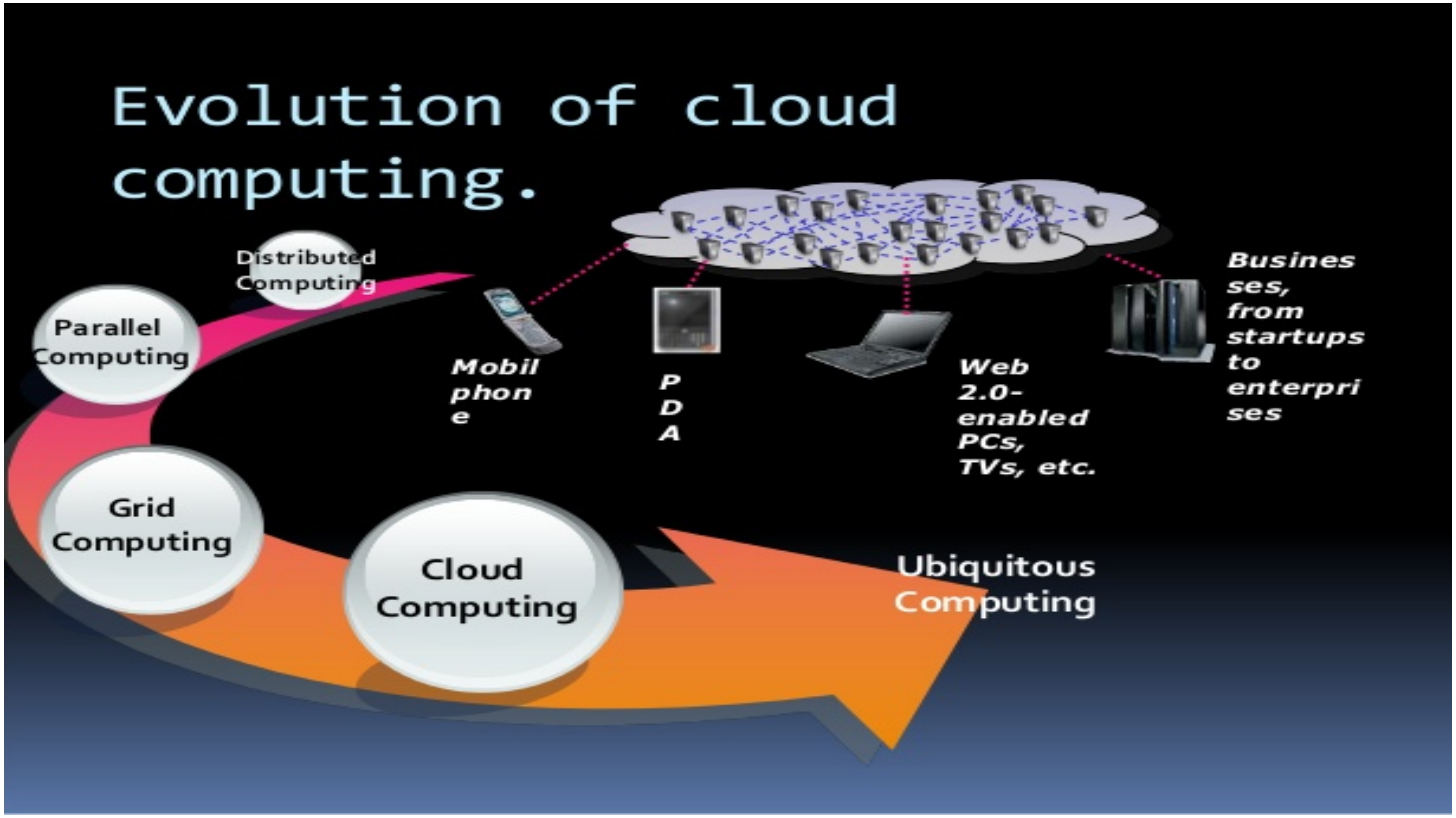
What is Cloud Computing: Definition

- **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
- At the foundation of cloud computing is the broader concept of **infrastructure convergence and shared services**
- **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.*"

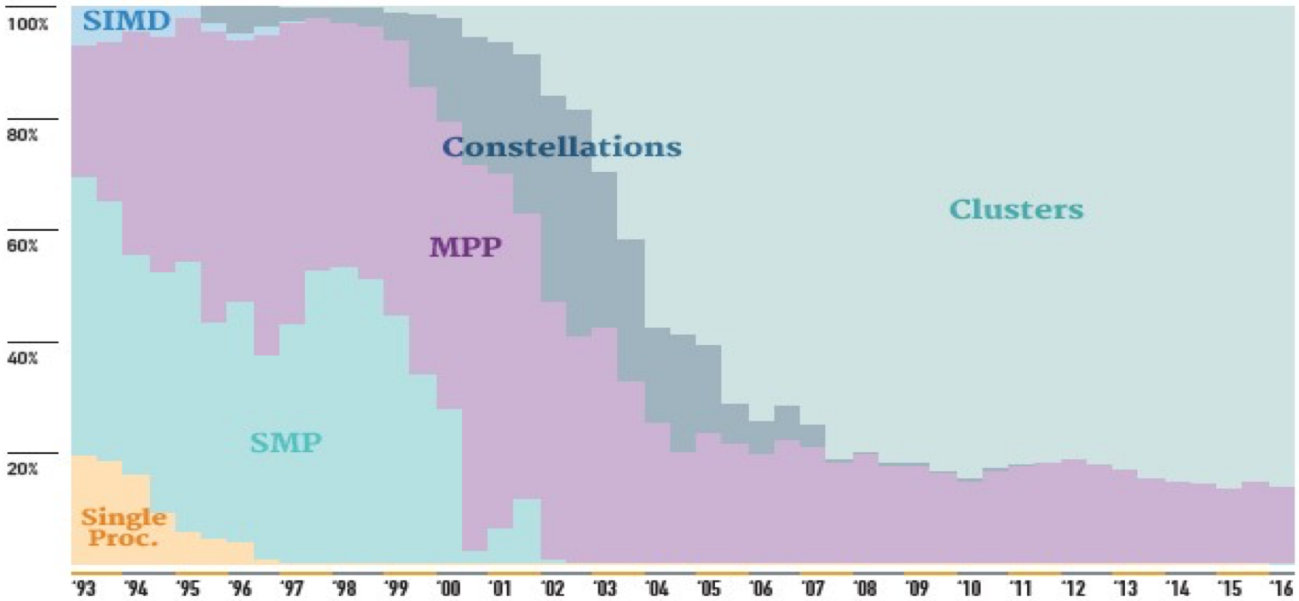
(https://cloudtweaks.com/2011/02/a-history-of-cloud-computing/)



(https://www.slideshare.net/beeniew/history-and-evolution-of-cloud-computing-safaricom-cloud)

What is Cloud Computing: Evolution of Computing Capacity

- **SMP: Symmetric Multi Processing** (multi-processor, shared memory)
- **MPP: Massively Parallel Processing** (multi-processor, dedicated memory)
- **Constellations:** Clusters in which the number of processors in a multi-processor compute node (typically an n-way Symmetric Multi-Processing or SMP node) exceeds the number of compute nodes.
- **Clusters:** Parallel computer systems assembled from commercially available systems/servers and networking devices, with each compute or I/O node a complete system capable of standalone operation.



(https://www.nextplatform.com/2016/06/20/china-topples-united-states-top-supercomputer-user/)

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

(http://www.grammarch.org/)

Challenges of Cloud Computing (1/2)

- **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?

(http://www.grammarch.org/)

Challenges of Cloud Computing (2/2)

- **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

(https://ivanblatter.com/040-ueberforderung)

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**

(definitions taken partly from Wikipedia)

More Definitions You Should Have Heard Of

(definitions taken partly from Wikipedia)

- **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

(definitions taken partly from Wikipedia)

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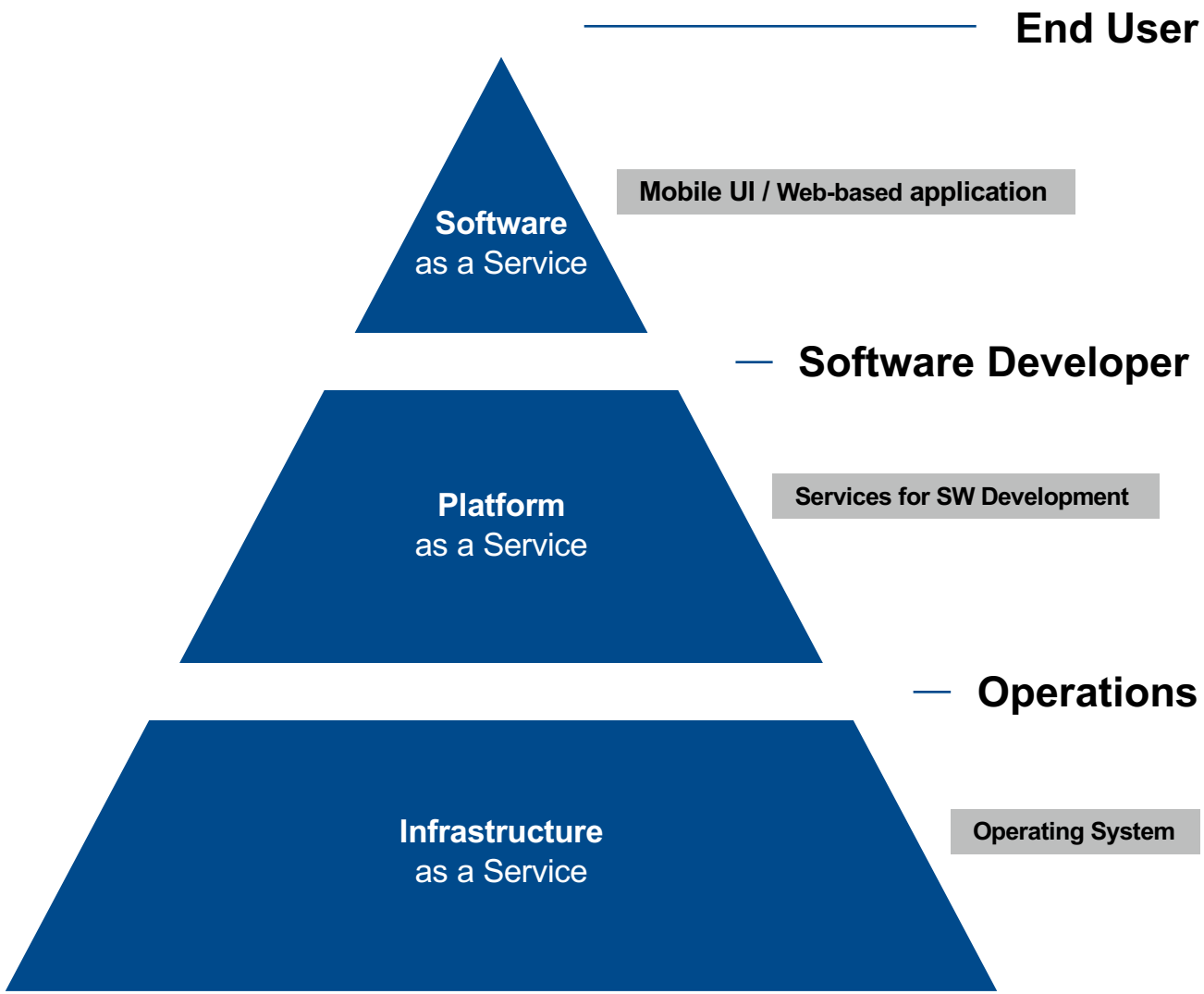
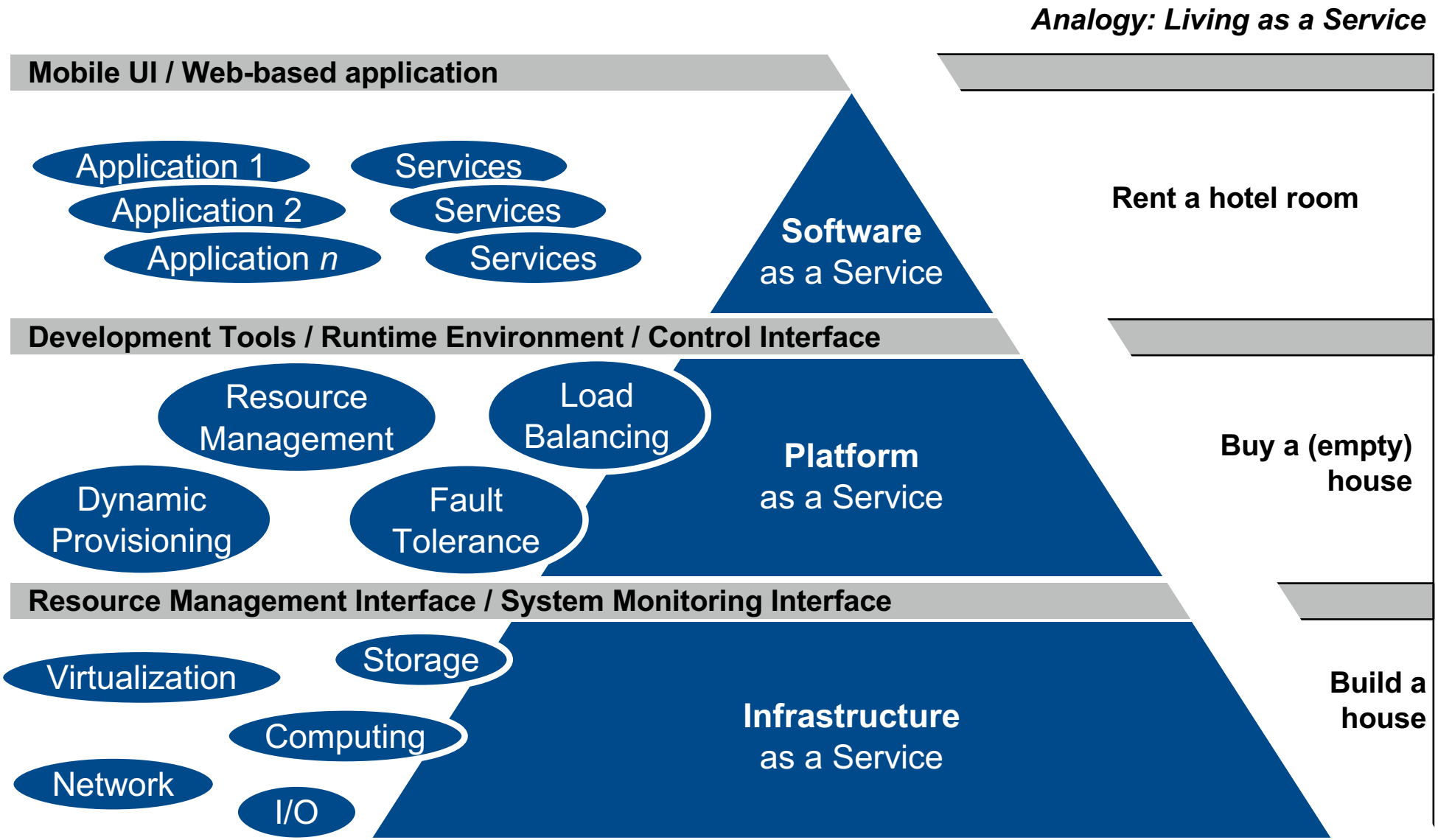
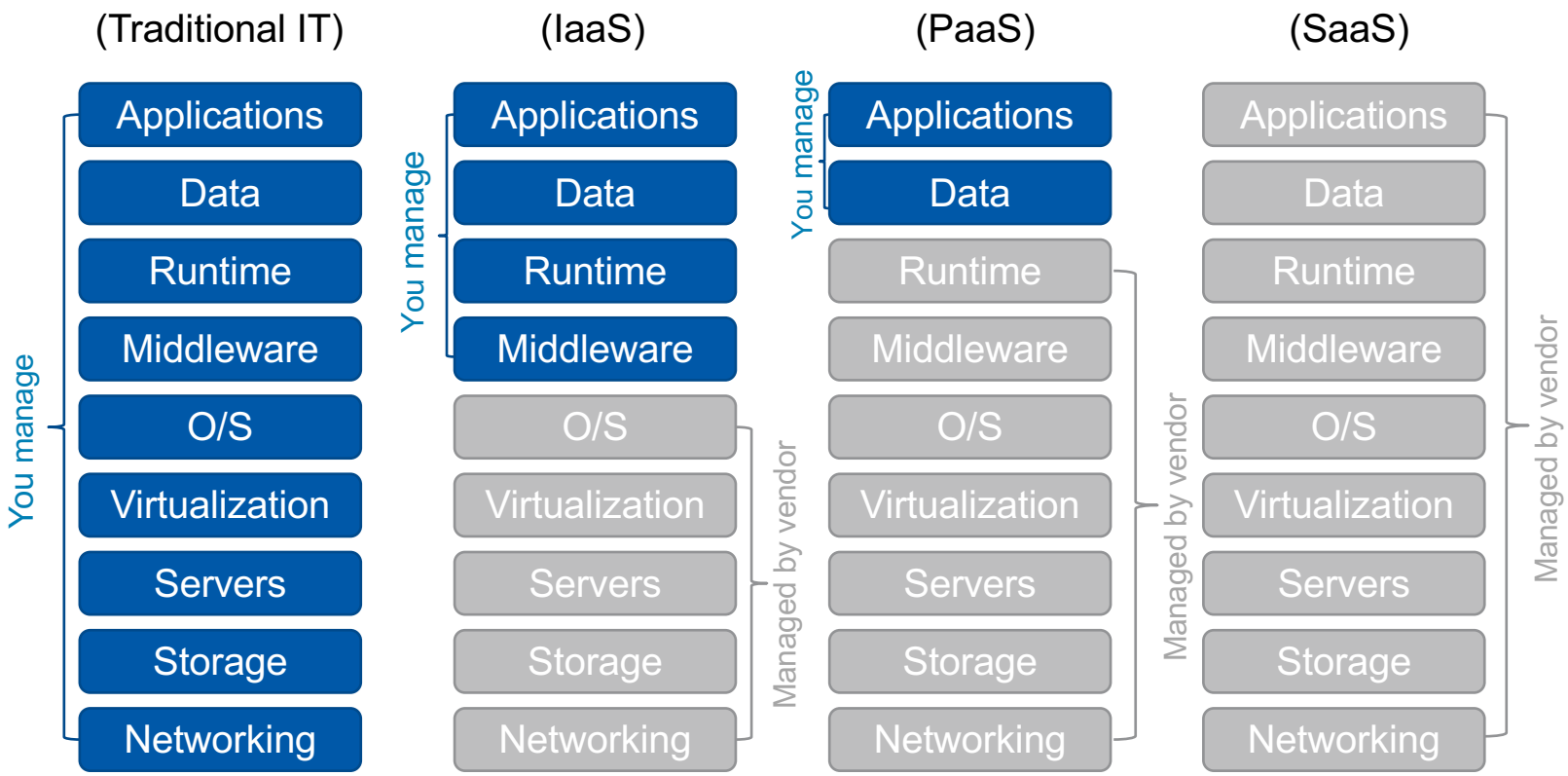
Cloud Service Models (IaaS, PaaS, SaaS): End User Perspectives



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

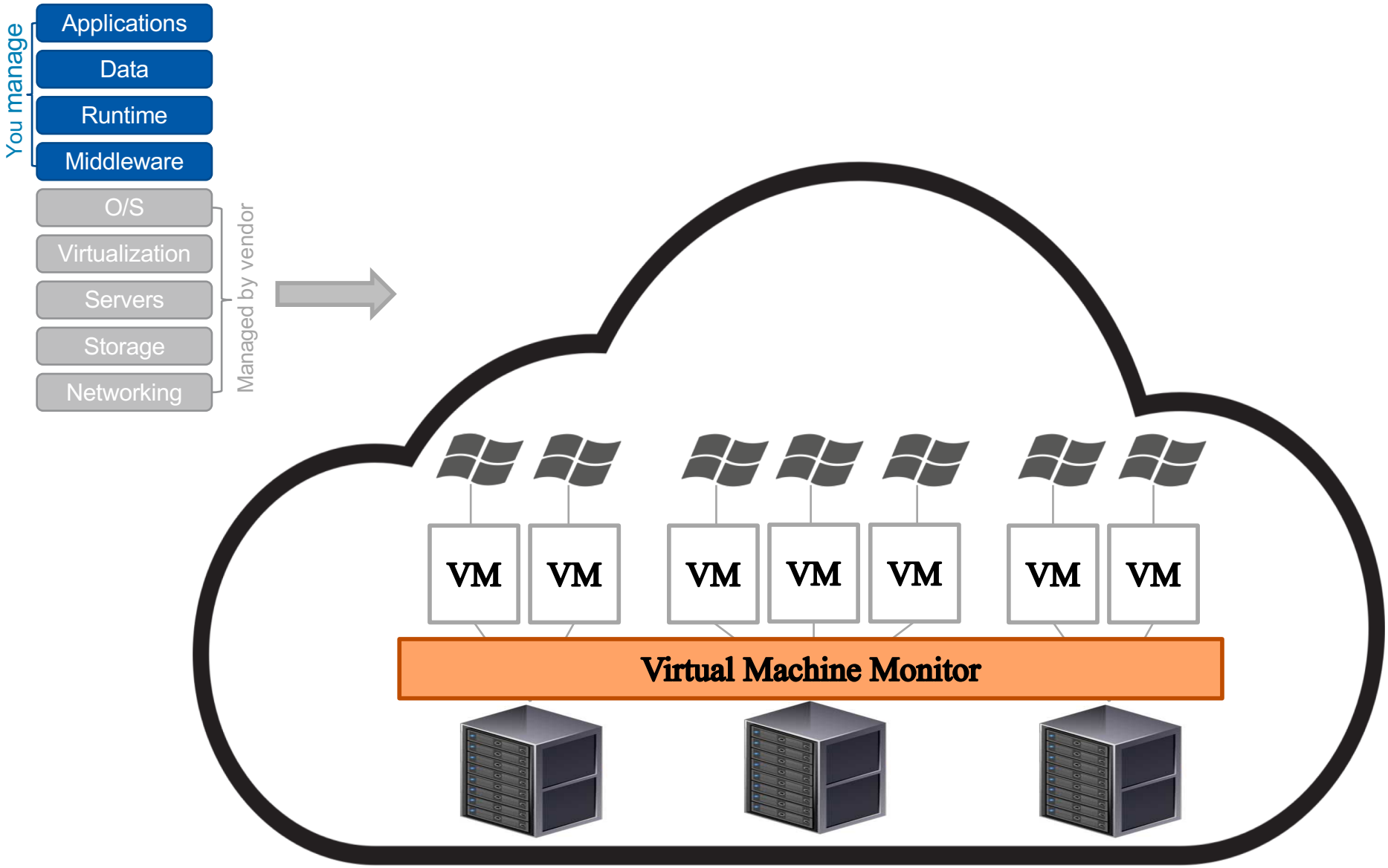


Cloud Service Models (IaaS, PaaS, SaaS): Who Manages What?



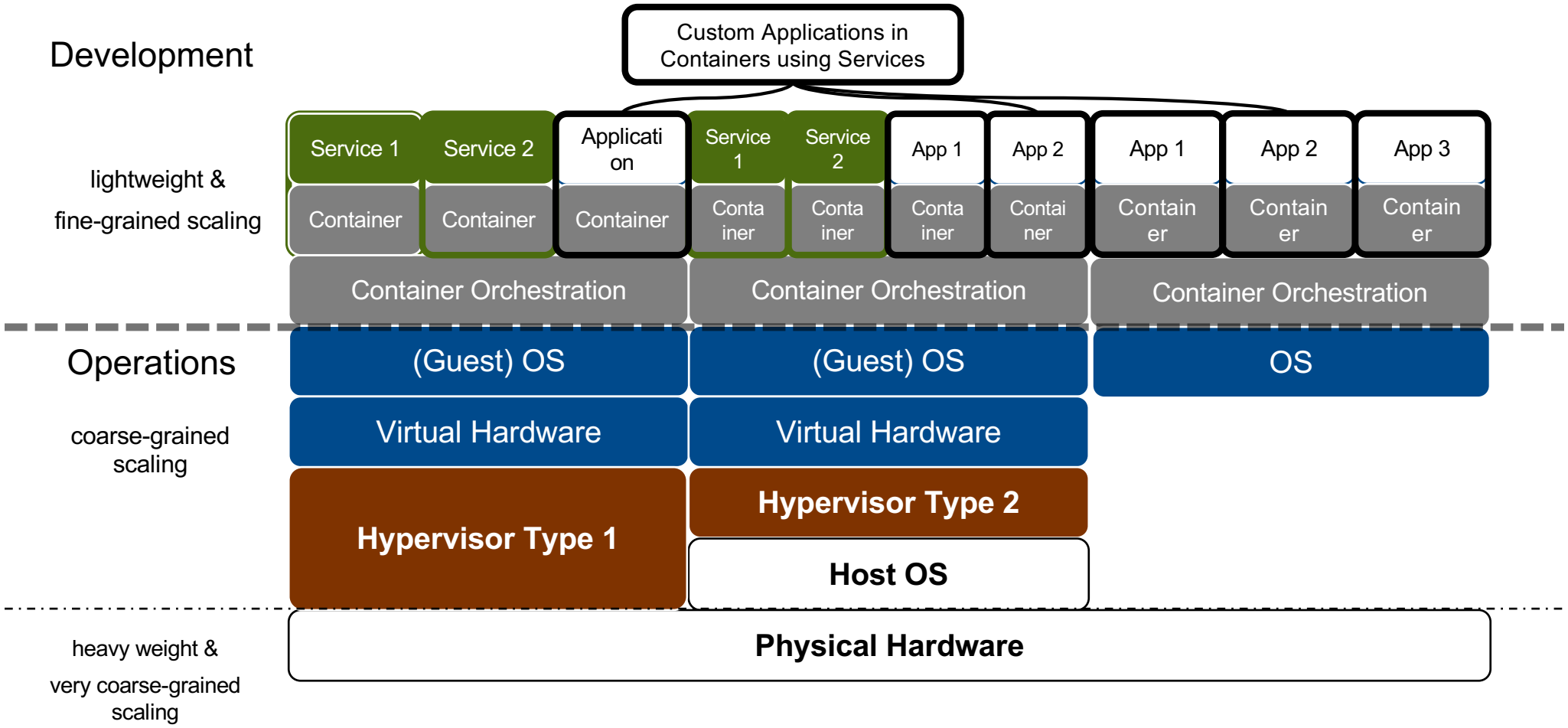
(http://www.slideshare.net/soumow/windows-azure-platform-4321694)

Hypervisors – Overview



Hypervisors & Containers: Differentiate between Container and Hypervisor

- **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

Microsoft Azure

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Linux VMs using classic deployment

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Create your first Windows virtual machine in the Azure portal

3.1.2017 • 3 min to read • Contributors

This tutorial shows you how easy it is t create a Windows virtual machine (VM) in just a few minutes, y using the Azure portal.

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Step by Step: Creating a Virtual Data Center

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Quickstart Using a Linux VM

SEND FEEDBACK

This page explains how to create a Linux virtual machine instance in Compute Engine using the Google Cloud Platform Console.

Compute

amazon web services

10-Minute Tutorial

Launch a Linux Virtual Machine using Amazon EC2

10-Minute Tutorial

Launch a Windows Virtual Machine with Amazon EC2

IaaS Offerings: What They Provide

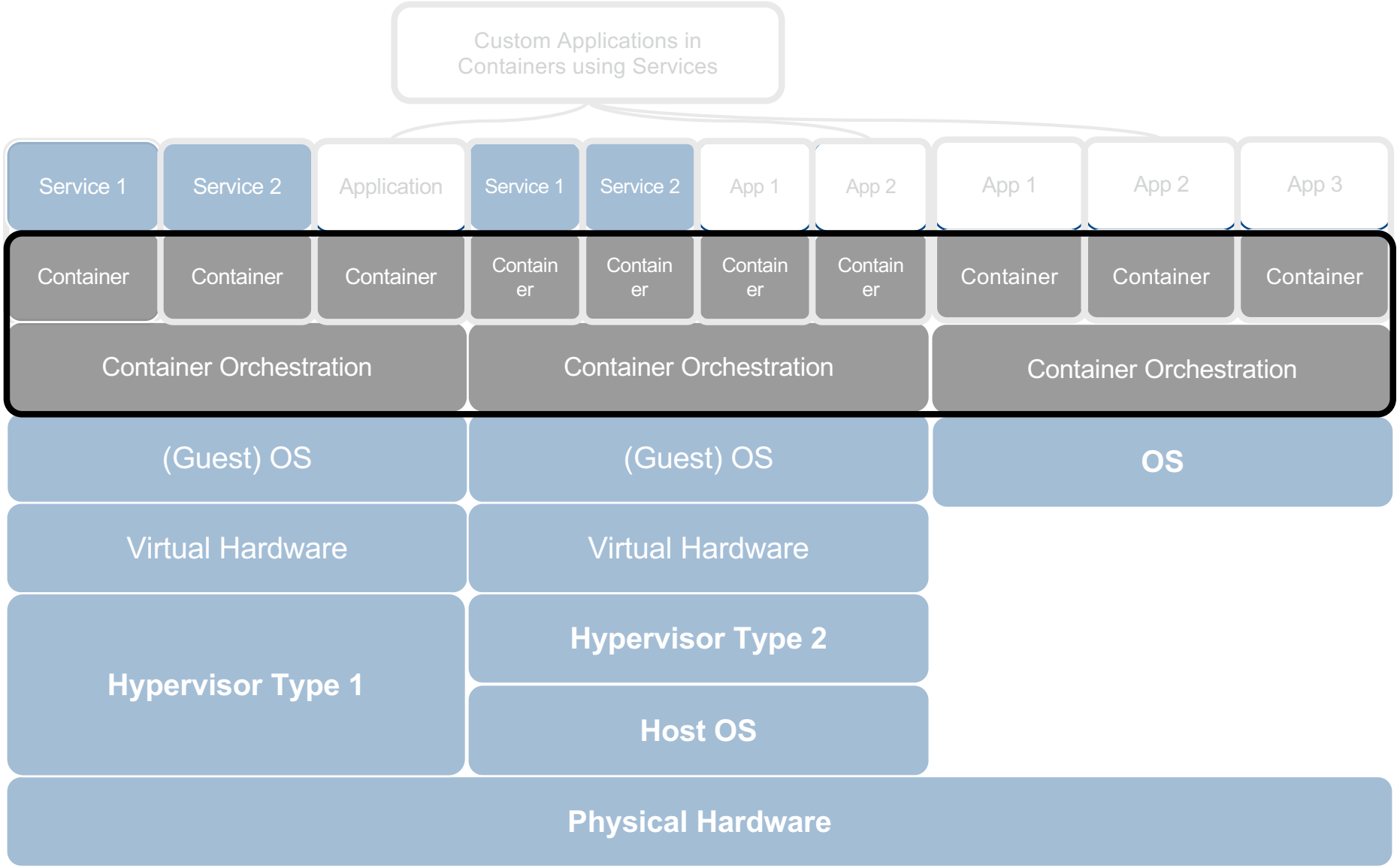
- **IaaS Offerings include**
  - Creation of Virtual Machines
  - Creation of Networks, VPNs, ...
  - Creation of Storage

- **What about Databases, Messaging, Artificial Intelligence Services, IoT Connectors, etc.?**
  - Those services belong to the PaaS 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



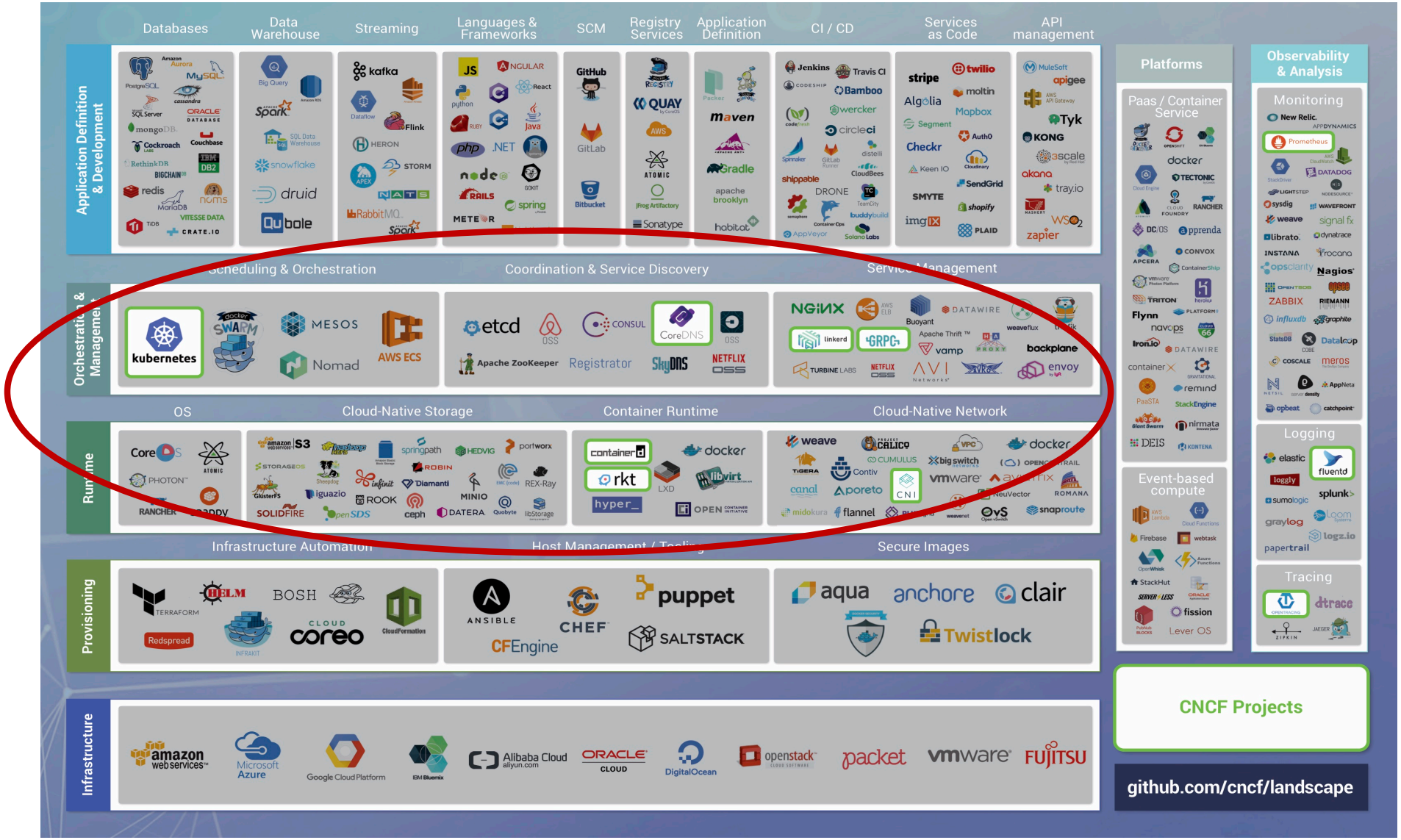
Containers and Orchestration: Containers at the heart of PaaS

- **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)
see https://aucouranton.com/2014/06/13/linux-containers-parallels-lxc-openvz-docker-and-more/

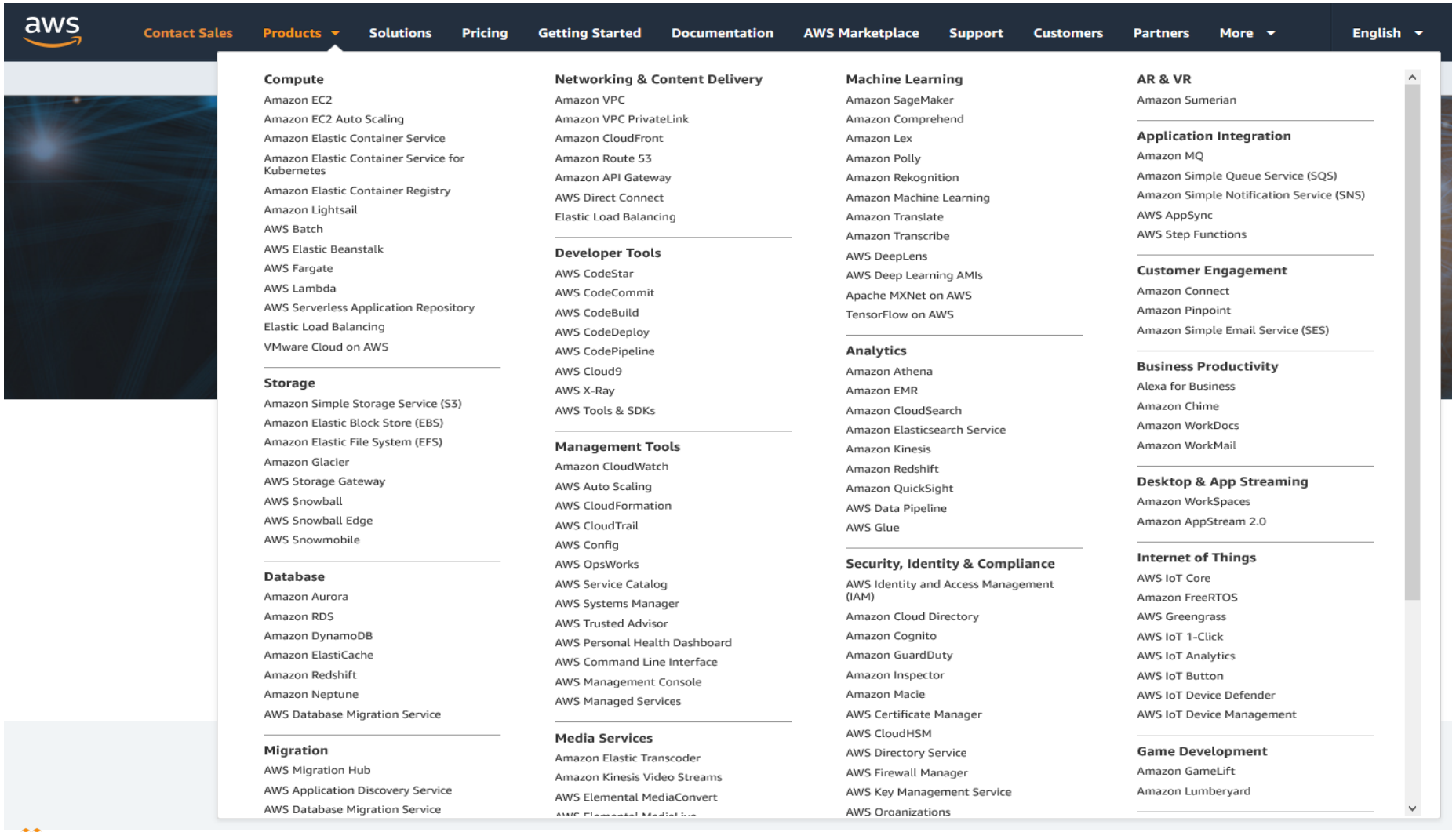
Containers and Orchestration: Between Code and Operating System



(CNCF Landscape)

PaaS Providers and Technologies: Amazon AWS (1/3): Overview

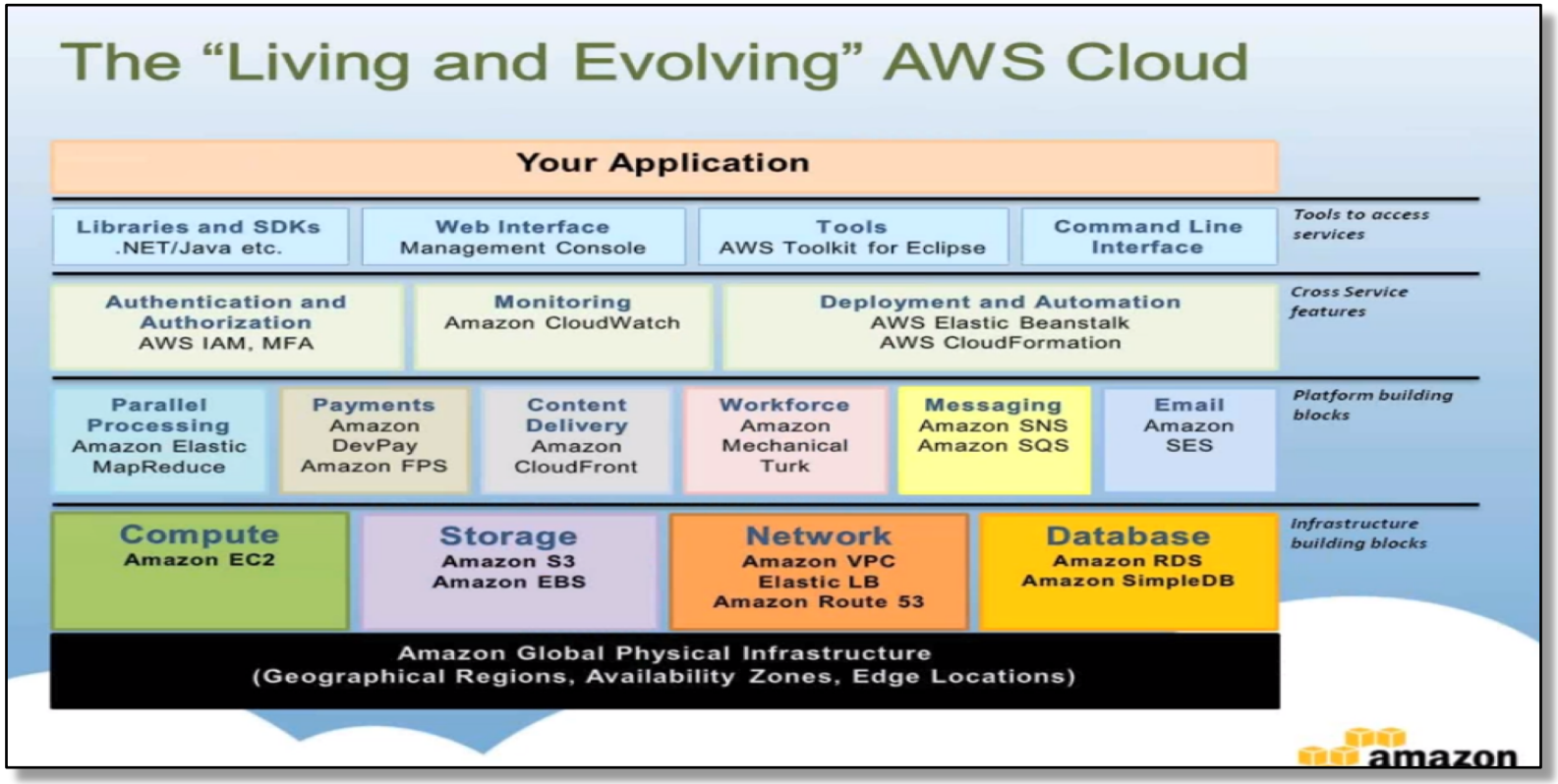
- **Amazon Web Services (AWS):** With its IaaS services, AWS is the leading cloud platform
- **Customers** include: Hess, Siemens, Comcast, Expedia, Dow Jones, Vodafone, Novartis, …



(aws.amazon.com)

PaaS Providers and Technologies: Amazon AWS (2/3): Layers

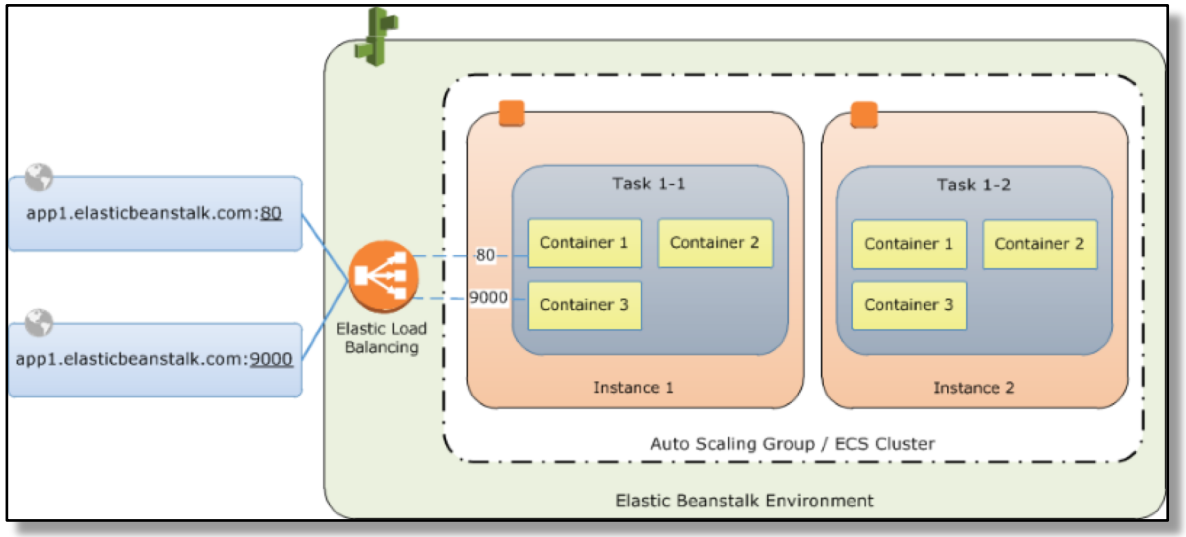
- More than **450K physical servers**, can scale up to 300K+ request/sec
- More than **900 billion** objects in the S3 data store
- 8+ Regions and 19+ CloudFront (CDN) locations world wide
- As low as $.02/hr computing charges (~$15/month)
- Decent availability (99.95%+)



(http://www.amazon.com)

PaaS Providers and Technologies: Amazon AWS (3/3)

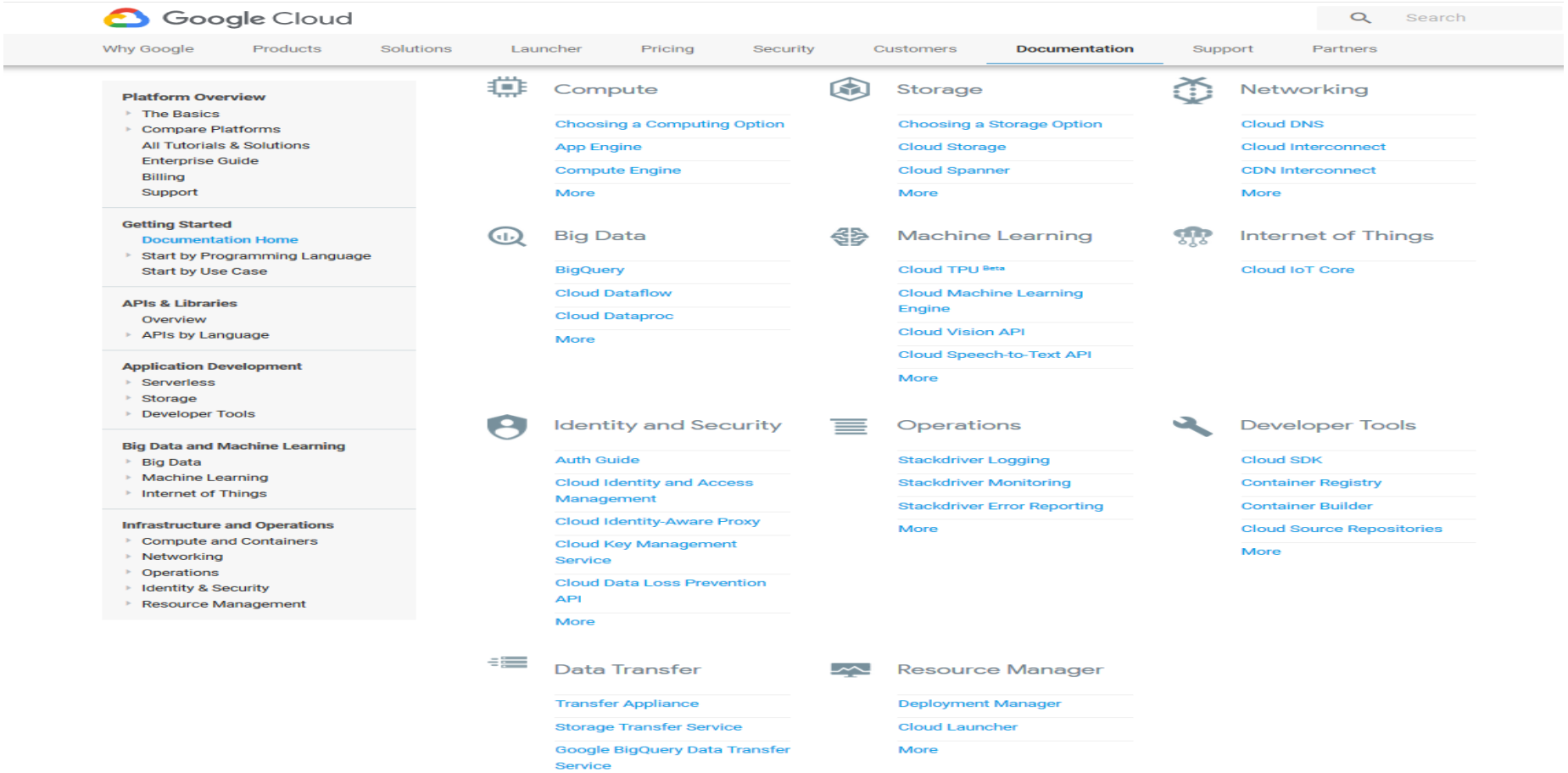
- **Elastic Beanstalk** runs various programming languages such as Java, .NET, PHP, Node.js, Python, Ruby, Go
  - Bundles are used to deliver applications
  - They contain source artifacts or WAR files
- **Elastic Beanstalk** also supports Docker. Supported configurations:
  - **Single Container Docker:** Runs one (1) 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



(http://www.amazon.com)

PaaS Providers and Technologies: Google GCP

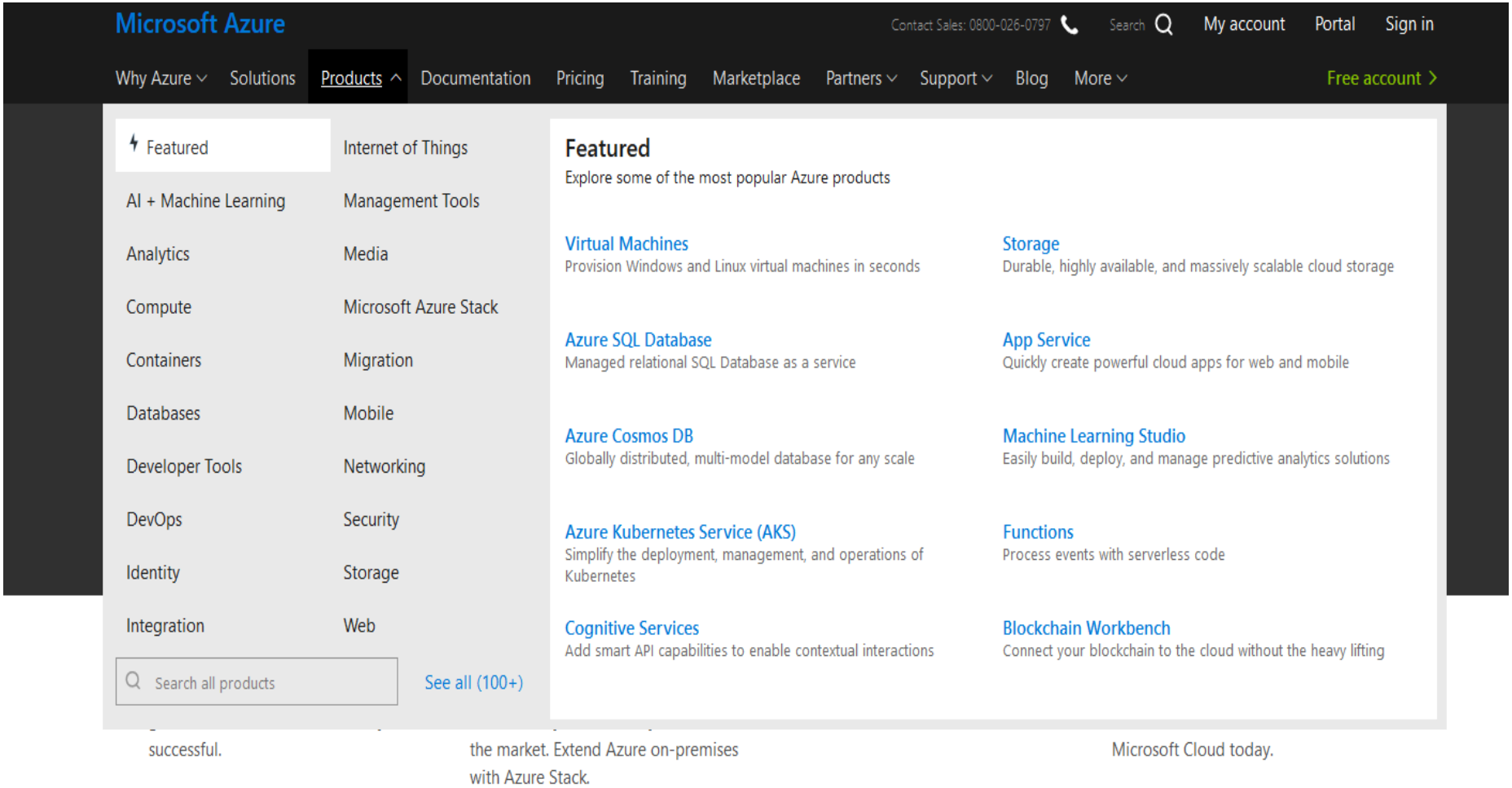
- **Customers:** Evernote, Spotify, and others
- **(IaaS) GCE:** Google Compute Engine provides virtual machines (like Amazon EC2)
- **(Iaas) BigQuery:** Compare to Amazon Redshift (columnar database)
- **(PaaS) GAE:** Google App Engine – compare to Amazon Beanstalk



(https://www.google.com)

PaaS Providers and Technologies: Microsoft Azure (1/3)

- **Microsoft Azure:** Provides Services across the whole stack
  - **(IaaS) Virtual Machines**, networking and storage; Cloud Services
  - **(PaaS) App Service**



(azure.microsoft.com)

PaaS Providers and Technologies: Microsoft Azure (2/3)

- **Microsoft Azure:** Shown as second leader in Gartner's Magic Quadrant

Magic Quadrants for Cloud Infrastructure as a Service (Worldwide)

2017

Source: Gartner (June 2017)

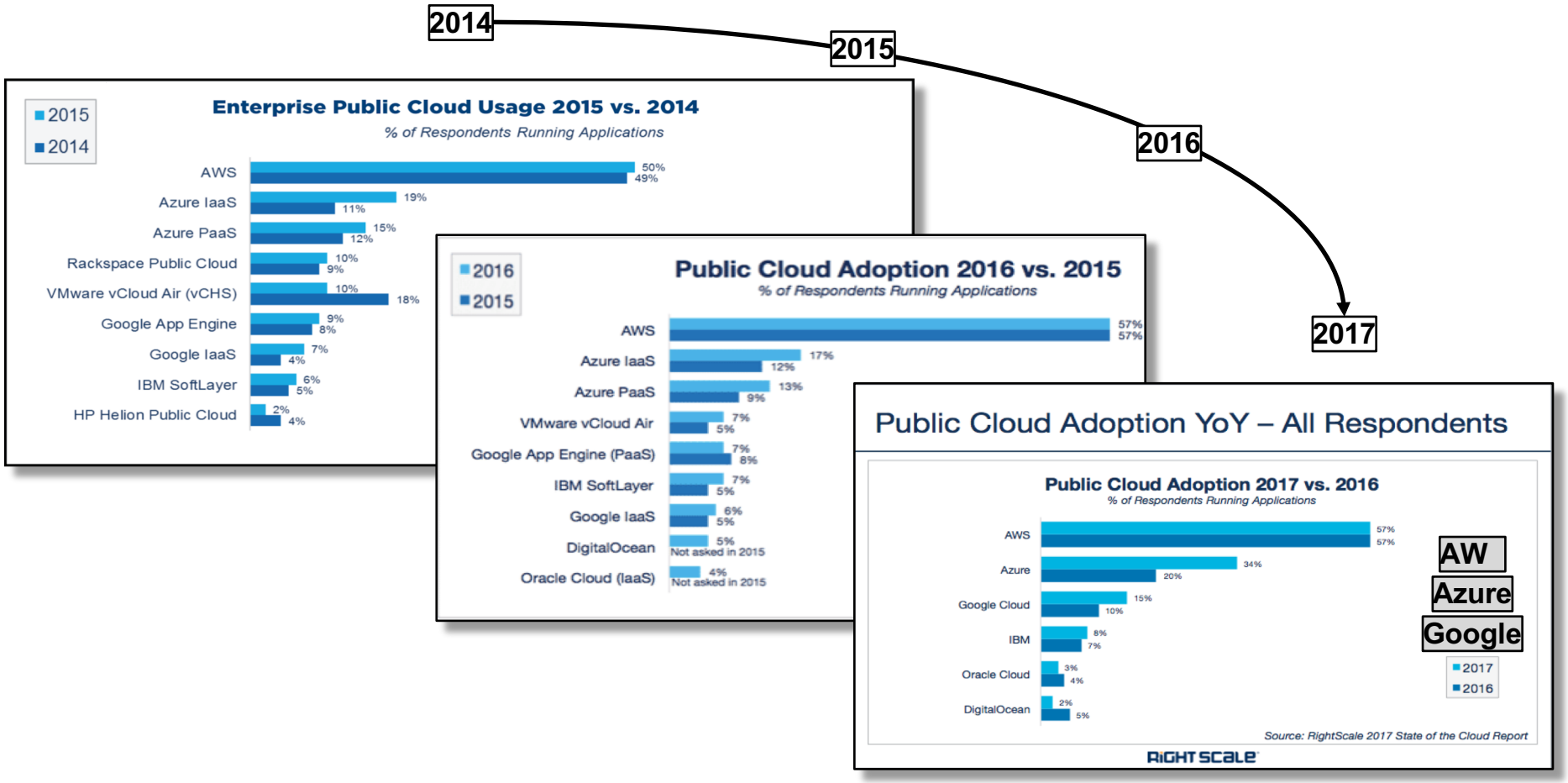
2018

Source: Gartner (May 2018)

(http://www.gartner.com)

PaaS Providers and Technologies: Microsoft Azure (3/3)

- **Microsoft Azure:** Gained traction in the last years
  - Also supports Linux technologies now



(http://www.rightscale.com)

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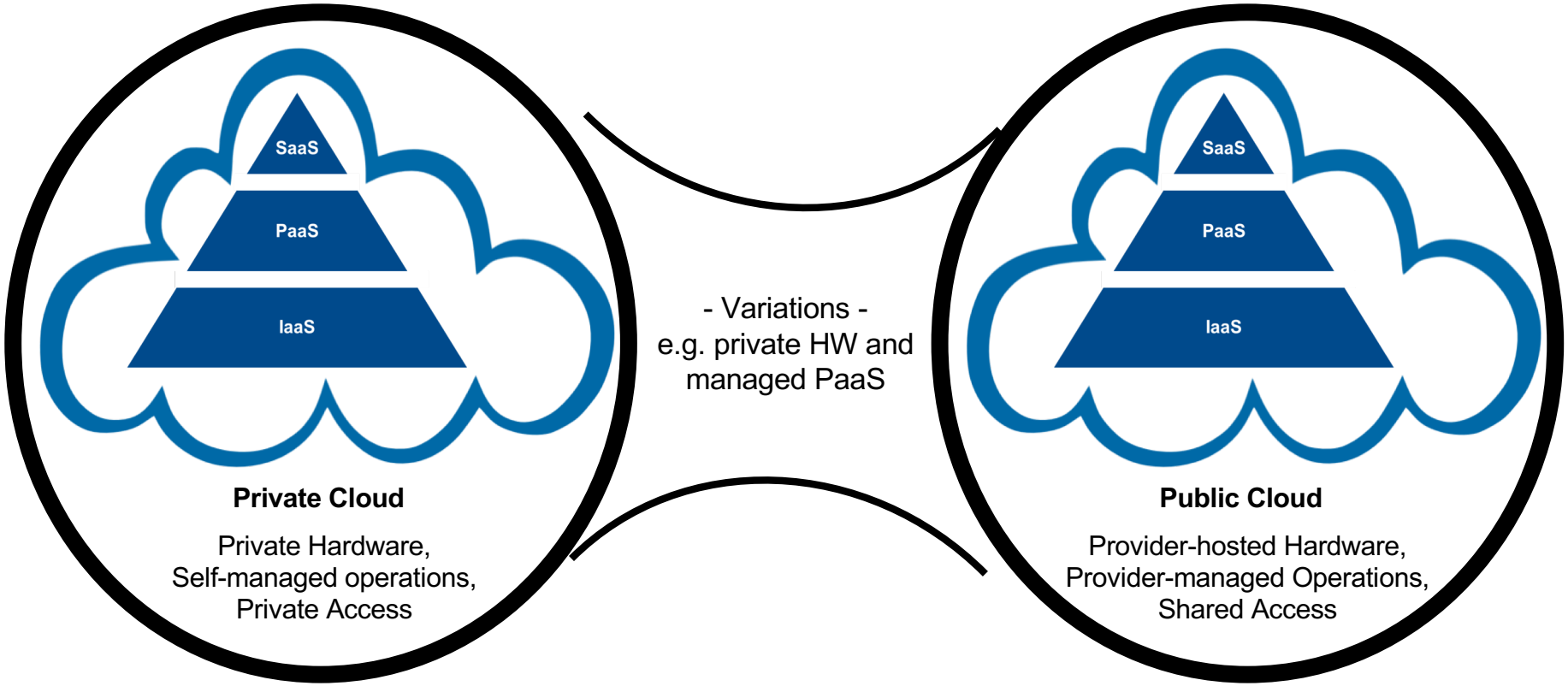
Cloud Topologies: Matrix

Name	IaaS Hardware	IaaS Operations	PaaS Operations	Comment
Private	Private	Private	Private	
	Private	Private	Provider	E.g. with PCF/OpenShift; Focus on support
	Private	Provider	Private	unusual
Private	Private	Provider	Provider	
Private with off-premise HW	Dedicated	Private	Private	
	Dedicated	Private	Provider	
	Dedicated	Provider	Private	
Private with Dedicated HW	Dedicated	Provider	Provider	
off-premise	Public	Private	Private	
Public Self-Managed	Public	Private	Provider	unusual
Public IaaS	Public	Provider	Private	
Public	Public	Provider	Provider	Blog (4)

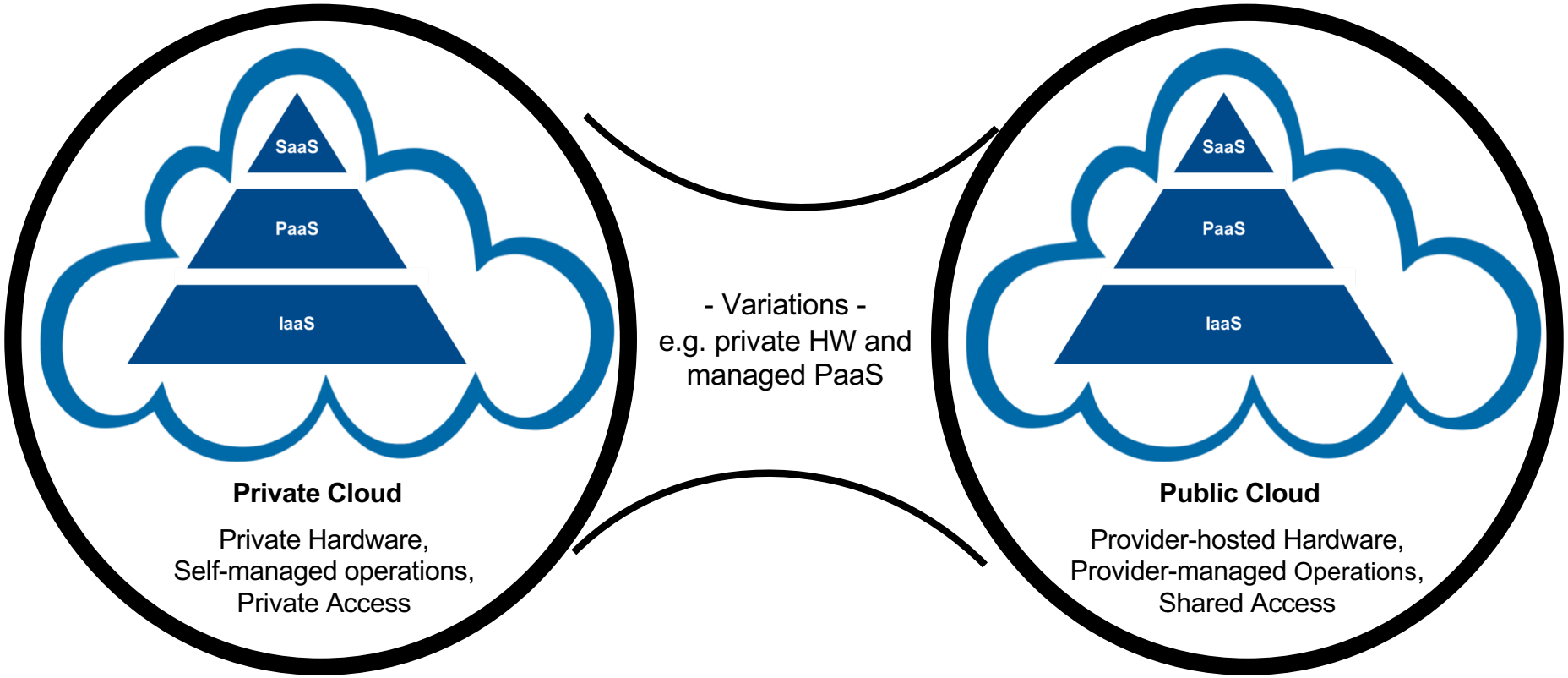
Cloud Topologies: Private and Public, on-premise and off-premise

on-premise	off-premise
privacy	cost savings
individualism	reliability
high performancy / specialized hardware	unlimited capacity



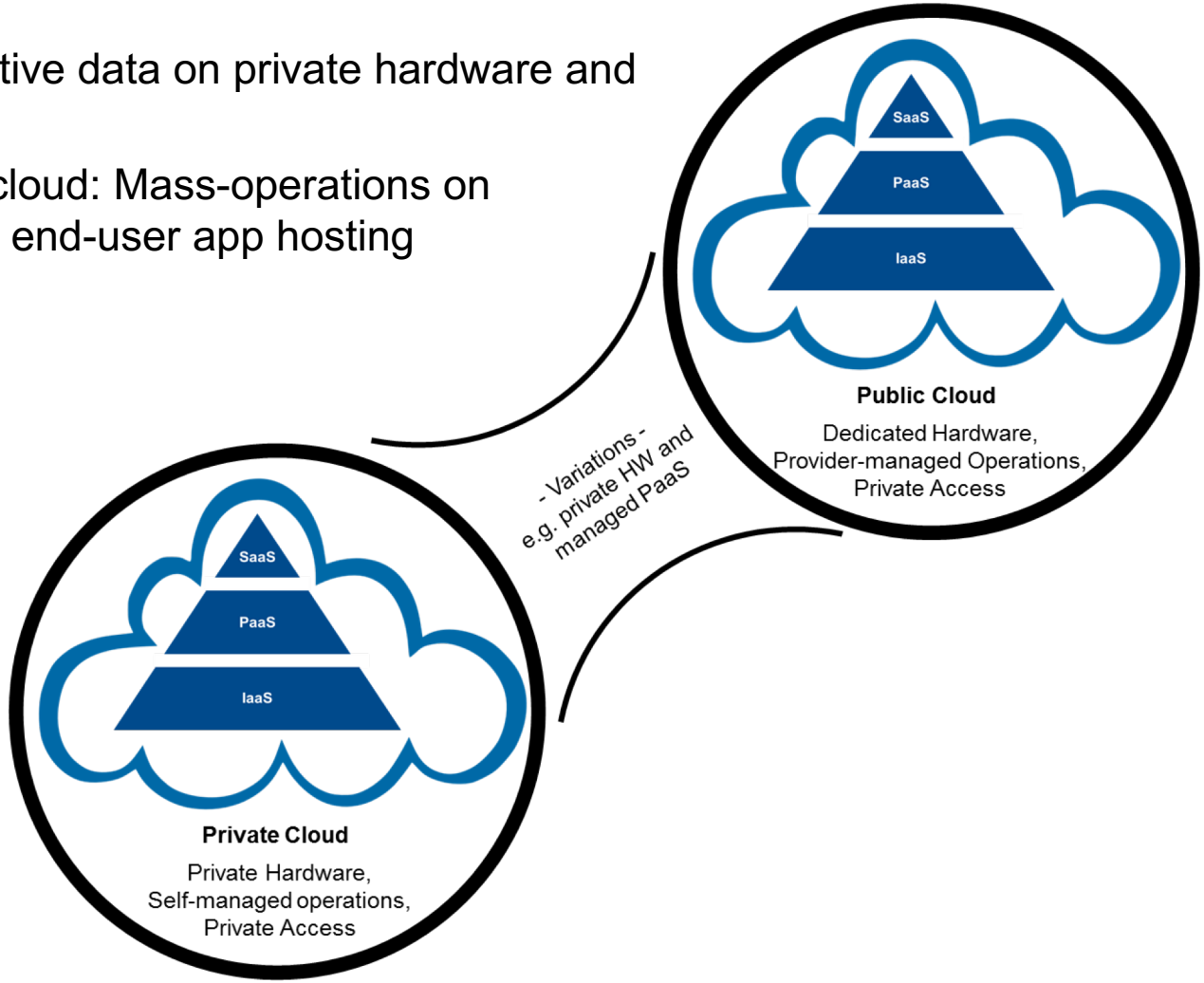
Cloud Topologies: Private and Public, on-premise and off-premise – Techs & Providers

- **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



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- HW and Ops from provider
- Money, money, flexibility
- Security, Integration
- IaaS, PaaS, SaaS
- Hardware Virtualization
- VMWare, AWS, Google, Azure
- Docker, LXC, Kubernetes
- CF, OpenShift, Heroku, *AMG*
- Privacy vs Costs

Questions?