UNIVERSIDADE
BEIRA INTERIOR

Public Cloud Platforms

Computação na Cloud
Mestrado em Engenharia Informática

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Credits

- These slides are based on the following:
- Distributed and Cloud Computing: From Parallel Processing to the Internet of Things, Kai Hwang, Jack Dongarra, Geoffrey C. Fox (Authors), Morgan Kaufmann, 1st edition, 2011, ISBN-13: 978-0123858801, 672 pages.
- AWS vs. Azure vs. Google: Cloud Comparison, Cynthia Harvey and Andy Patrizio, Datamation, March 17, 2020, https://www.datamation.com/cloud-computing/aws-vs-azure-vs-google-cloud-comparison.html
- How Much Do the Differences Between Cloud Providers Actually Matter?, Katy Stalcup, Business 2 Community, September 16, 2019, https://www.business2community.com/cloud-computing/how-much-do-the-differences-between-cloud-providers-actually-matter-02240335
- AWS vs Azure vs Google Cloud Market Share 2020: What the Latest Data Shows, Katy Stalcup, ParkMyCloud, Feb 5, 2020, https://www.parkmycloud.com/blog/aws-vs-azure-vs-google-cloud-market-share/

Agenda

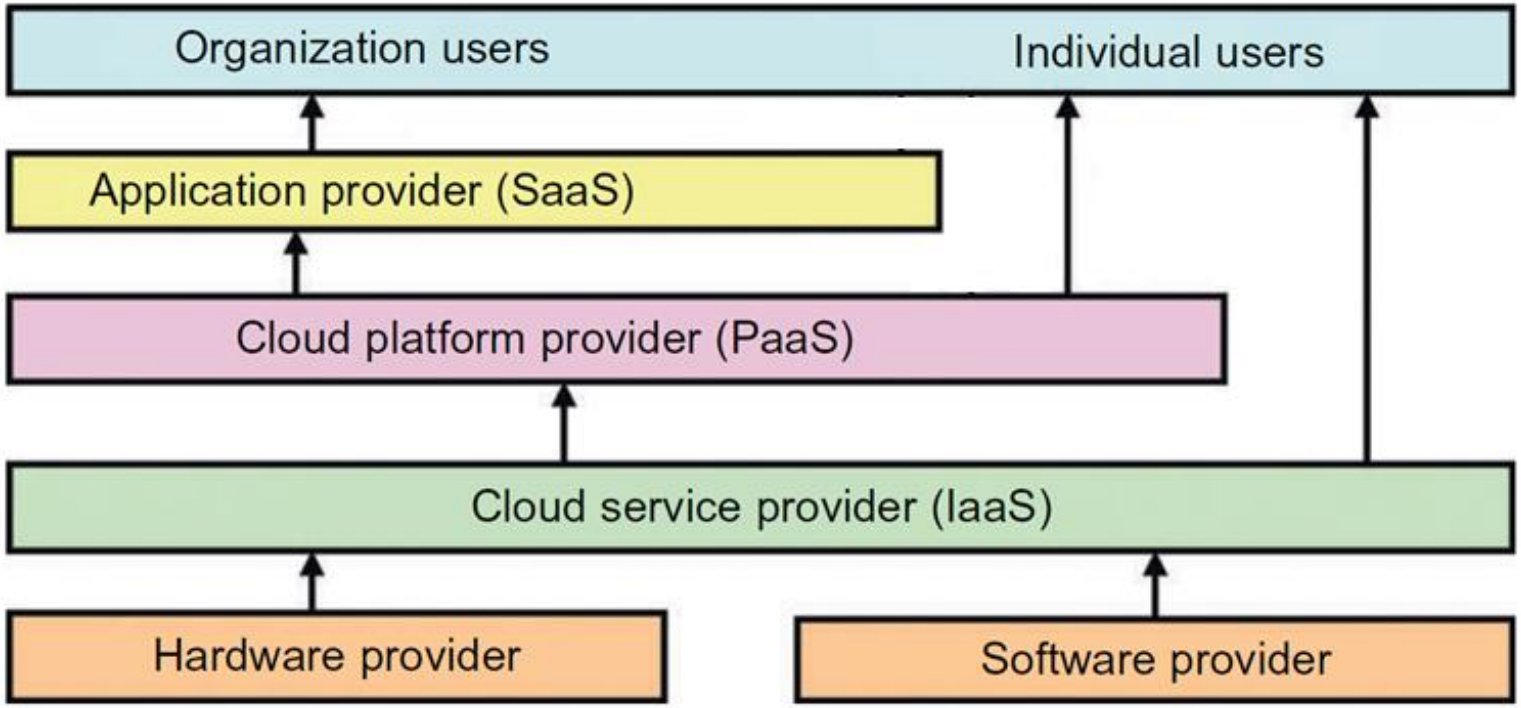
- Public Clouds and Service Offerings
- Google Cloud Platform
- Amazon Web Services (AWS)
- Microsoft Azure
- IBM Cloud
- Salesforce
- Alibaba Cloud

Public Clouds and Service Offerings

- There are five levels of cloud players:
  - At the top level, individual users and organizational users may demand very different cloud services.
  - The application providers at the SaaS level serve both individual users and organizational users.
  - Most business organizations and individual users are serviced by PaaS providers.
  - The infrastructure services (IaaS) provide hardware resources to both PaaS and users.
  - The cloud environment is defined by the platform providers (PaaS), which provides support for both SaaS and users.

Public Clouds and Service Offerings

- Roles of individual and organizational users and their interaction with cloud providers under various cloud service models organized in five levels of cloud players.



Adapted from: Distributed and Cloud Computing: From Parallel Processing to the Internet of Things, Kai Hwang, Jack Dongarra, Geoffrey C. Fox (Authors), Morgan Kaufmann, 1st edition, 2011.

Public Clouds and Service Offerings

- Cloud services rely on new advances in machine virtualization, SOA, grid infrastructure management, and power efficiency.
- Consumers purchase cloud services in the form of IaaS, PaaS, or SaaS. Also, many cloud entrepreneurs are selling value-added utility services to massive numbers of users.
- The cloud industry leverages the growing demand by many enterprises and business users to outsource their computing and storage jobs to professional providers.
- The provider service charges are often much lower than the cost for users to replace their obsolete servers frequently.

Public Clouds and Service Offerings

- Amazon pioneered the IaaS business in supporting e-commerce and cloud applications by millions of customers simultaneously.
- The elasticity in the Amazon cloud comes from the flexibility provided by the hardware and software services.
- Amazon EC2 provides an environment for running virtual machines on demand. S3 provides unlimited online storage space. Both EC2 and S3 are supported in the AWS platform.
- Microsoft offers the Azure platform for cloud applications. It has also supported the .NET service, dynamic CRM, Hotmail, and SQL applications.
- Salesforce.com offers extensive SaaS applications for online CRM applications using its Salesforce platform.

Public Clouds and Service Offerings

- All IaaS, PaaS, and SaaS models allow users to access services over the Internet, relying entirely on the infrastructures of the cloud service providers.
- These models are offered based on various SLAs (Service Level Agreements) between the providers and the users. SLAs are more common in network services as they account for the QoS characteristics of network services.
- For cloud computing services, it is difficult to find a reasonable precedent for negotiating an SLA.
- In a broader sense, the SLAs for cloud computing address service availability, data integrity, privacy, and security protection.

Public Clouds and Service Offerings

- AWS vs. Microsoft Azure vs. Google CP: Relative Position

Source: Magic Quadrant for Cloud Infrastructure as a Service, Worldwide, Raj Bala, Bob Gill, Dennis Smith, David Wright, Gartner, 16 July 2019, https://www.gartner.com/doc/reprints?id=1-2G2O5FC&ct=150519&st=sb&aliId=1154870580

Public Clouds and Service Offerings

- AWS vs. Microsoft Azure vs. Google CP: Overall Pros and Cons

Vendor	Strengths	Weaknesses
AWS	• Dominant market position • Extensive, mature offerings • Support for large organizations • Extensive training • Global reach	• Difficult to use • Cost management • Overwhelming options
Microsoft Azure	• Second largest provider • Integration with MS tools and software • Broad feature set • Hybrid cloud • Support for open source	•Issues with documentation • Incomplete management tooling
Google	• Designed for cloud-native businesses • Commitment to open source and portability • Deep discounts and flexible contracts • DevOps expertise	• Late entrant to IaaS market • Fewer features and services • Historically not as enterprise focused

Source: AWS vs. Azure vs. Google: Cloud Comparison, Cynthia Harvey and Andy Patrizio, Datamation, March 17, 2020, https://www.datamation.com/cloud-computing/aws-vs-azure-vs-google-cloud-comparison.html

Public Clouds and Service Offerings

- AWS vs. Microsoft Azure vs. Google CP: Offer Comparison

	AWS	Azure	GCP
Compute	Amazon EC2	Azure Virtual Machines	Google Compute Engine
File Storage	Amazon S3	Azure Blob Storage	Google Storage
NoSQL	Amazon DynamoDB	Azure DocumentDB	Google Cloud Datastore
Function as a Service	Amazon Lambda	Azure Functions	Google Cloud Functions
Relational Database	Amazon RDS	Azure SQL Database	Google Cloud SQL
Container Scheduler	Amazon EC2 Container Service	Azure Container Service	Google Kubernetes Engine
App Deployment	Amazon Elastic Beanstalk	Azure Cloud Services	Google App Engine
Data Warehouse	Amazon Redshift	Azure SQL Data Warehouse	Google BigQuery

Source: How Much Do the Differences Between Cloud Providers Actually Matter?, Katy Stalcup, Business 2 Community, September 16, 2019, https://www.business2community.com/cloud-computing/how-much-do-the-differences-between-cloud-providers-actually-matter-02240335

Public Clouds and Service Offerings

- AWS vs. Microsoft Azure vs. Google CP: Offer Comparison

	AWS EC2	**Azure VMs**	**Google Compute Engine**
Configuration Options	Many CPU/Memory/GPU combinations	Many CPU/Memory/GPU combinations	Pre-defined & customizable instance types
OS Options	Linux, Windows, custom, or from marketplace	Linux, Windows Server, SQL Server, Oracle, IBM, SAP	Linux and Windows
Bare metal instances available?	Yes	No	No
Auto scaling available?	Yes (auto scaling groups)	Yes (virtual machine scale sets)	Yes (managed instance groups)
Hypervisor	Xen or Nitro	Hyper-V	KVM

Source: How Much Do the Differences Between Cloud Providers Actually Matter?, Katy Stalcup, Business 2 Community, September 16, 2019, https://www.business2community.com/cloud-computing/how-much-do-the-differences-between-cloud-providers-actually-matter-02240335

Public Clouds and Service Offerings

- AWS vs. Microsoft Azure vs. Google CP: Offer Comparison

Resource Type (US-east, linux)	AWS instance	Azure Instance	Google Instance	Hourly Cost (on demand)		
				AWS	Azure	Google
Standard 4 vCPU w SSD	m4ad.xlarge	D4 v3	n1-standard-4	$0.206	$0.192	$0.195
HighMemory 4 vCPU w SSD	r5ad.xlarge	D12 v2	n1-highmem-4	$0.262	$0.371	$0.2696
HighCPU 4 vCPU w SSD	c5d.xlarge	F4	n1-highcp-4	$0.192	$0.199	$0.1626
GPU vCPU no SSD	G3.4xlarge	NC12	-	$1.14	$0.792	-

Source: How Much Do the Differences Between Cloud Providers Actually Matter?, Katy Stalcup, Business 2 Community, September 16, 2019, https://www.business2community.com/cloud-computing/how-much-do-the-differences-between-cloud-providers-actually-matter-02240335

Public Clouds and Service Offerings

- AWS vs. Microsoft Azure vs. Google CP: Market Share

Worldwide cloud infrastructure spending and annual growth
Canalys estimates, Q4 2019

Cloud service provider	Q4 2019 (US$ billion)	Q4 2019 market share	Q4 2018 (US$ billion)	Q4 2018 market share	Annual growth
AWS	9.8	32.4%	7.3	33.4%	33.2%
Microsoft Azure	5.3	17.6%	3.3	14.9%	62.3%
Google Cloud	1.8	6.0%	1.1	4.9%	67.6%
Alibaba Cloud	1.6	5.4%	1.0	4.4%	71.1%
Others	11.6	38.5%	9.3	42.4%	24.4%
Total	**30.2**	**100.0%**	**22.0**	**100.0%**	**37.2%**

canalys

Note: percentages may not add up to 100% due to rounding
Source: Canalys Cloud Channels Analysis, January 2019

Source: AWS vs Azure vs Google Cloud Market Share 2020: What the Latest Data Shows, Katy Stalcup, ParkMyCloud, Feb 5, 2020, https://www.parkmycloud.com/blog/aws-vs-azure-vs-google-cloud-market-share/

Public Clouds and Service Offerings

- Public Cloud Services Comparison: **Amazon Web Services, Microsoft Azure, Google Cloud Platform, IBM Cloud, Oracle Cloud, Alibaba Cloud**
- Side-by-side Category and Service comparison of Public Cloud Services
- Available at: http://comparecloud.in/

Source: Public Cloud Services Comparison, http://comparecloud.in/

Public Clouds and Service Offerings

- Cloud Providers Comparison: **Katamera Performance Cloud, atlantic.net, M5, Zettagrid, CloudSigma, eApps, Microsoft Azure, Amazon Web Services, elastichosts, cloudware, e24cloud.com, Storm, Exoscale, Google Cloud Platform, Acess Alto, HYVE Mission-critical cloud hosting, dimension data**
- The cloud computing providers comparison delivers detailed information about each cloud computing company.
- It breaks down each cloud computing provider offer into 130+ distinct features that might be relevant to your cloud computing provider selection process (such as SLA, security).
- The cloud computing providers comparison gathers everything into a single resource.

Source: Cloud Providers Comparison, https://www.cloudorado.com/cloud_providers_comparison.jsp

Public Clouds and Service Offerings

- Cloud Providers Comparison: **Katamera Performance Cloud, atlantic.net, M5, Zettagrid, CloudSigma, eApps, Microsoft Azure, Amazon Web Services, elastichosts, cloudware, e24cloud.com, Storm, Exoscale, Google Cloud Platform, Acess Alto, HYVE Mission-critical cloud hosting, dimension data**
- Comparison of: Cloud Features & Management, Cloud Servers, Images & Licenses, Transfer, Networking, Security, Locations, Reliability & Failover, Services, Support, Billing, Trial & Specials, Third-Party Tools Support, Provider Information
- Available at: https://www.cloudorado.com/cloud_providers_comparison.jsp

Source: Cloud Providers Comparison, https://www.cloudorado.com/cloud_providers_comparison.jsp

Google Cloud Platform

- Google has the world's largest search engine facilities. The company has extensive experience in massive data processing that has led to new insights into data-center design and novel programming models that scale to incredible sizes.
- The Google platform is based on its search engine expertise with MapReduce. This infrastructure is applicable to many other areas. Google has hundreds of data centers and has installed more than 460,000 servers worldwide.
- For example, 200 Google data centers are used at one time for a number of cloud applications.
- Google's App Engine (GAE) offers a PaaS platform supporting various cloud and web applications.

Google Cloud Platform

- **Google Cloud Infrastructure**
- Google has pioneered cloud development by leveraging the large number of data centers it operates. For example, Google pioneered cloud services in Gmail, Google Docs, and Google Earth, among other applications.
- Notable technology achievements include the Google File System (GFS), MapReduce, BigTable, and Chubby.
- In 2008, Google announced the GAE web application platform which is becoming a common platform for many small cloud service providers. This platform specializes in supporting scalable (elastic) web applications.
- GAE enables users to run their applications on a large number of data centers associated with Google's search engine operations.

Google Cloud Platform

Products of Google Cloud Platform

GOOGLE CLOUD PLATFORM

IA e Machine Learning
Speech-to-Text· Vision· Translation· Mais

Gerenciamento de APIs
Plataforma de APIs da Apigee· Cloud Endpoints· Mais

Compute
Compute Engine· GPUs do Cloud· Mais

Nuvem híbrida e várias nuvens
Anthos· Migrate for Anthos· GKE· Mais

Análise de dados
BigQuery· Looker· Mais

Bancos de dados
Cloud SQL· Cloud Firestore· Mais

Ferramentas para Desenvolvedores
Cloud Build· Cloud Code· SDK do Cloud· Mais

Migração
Transferência de dados· Migração de VMs· Mais

Redes
DNS· CDN· Nuvem privada virtual· Mais

Segurança e identidade
VMs protegidas· Cloud IAM· Mais

Computação sem servidor
Cloud Run· App Engine· Cloud Functions· Mais

Armazenamento
Cloud Storage· Persistent Disk· Mais

MAIS PRODUTOS DO CLOUD

G Suite
Gmail, Documentos, Drive, Hangouts e muito mais

Plataforma Google Maps
Crie com dados abrangentes em tempo real

Cloud Identity
Gerencie com facilidade as identidades dos usuários

Chrome Enterprise
Adquira os dispositivos com Chrome OS e o navegador Chrome

Android Enterprise
Dispositivos inteligentes, SO e apps empresariais

X

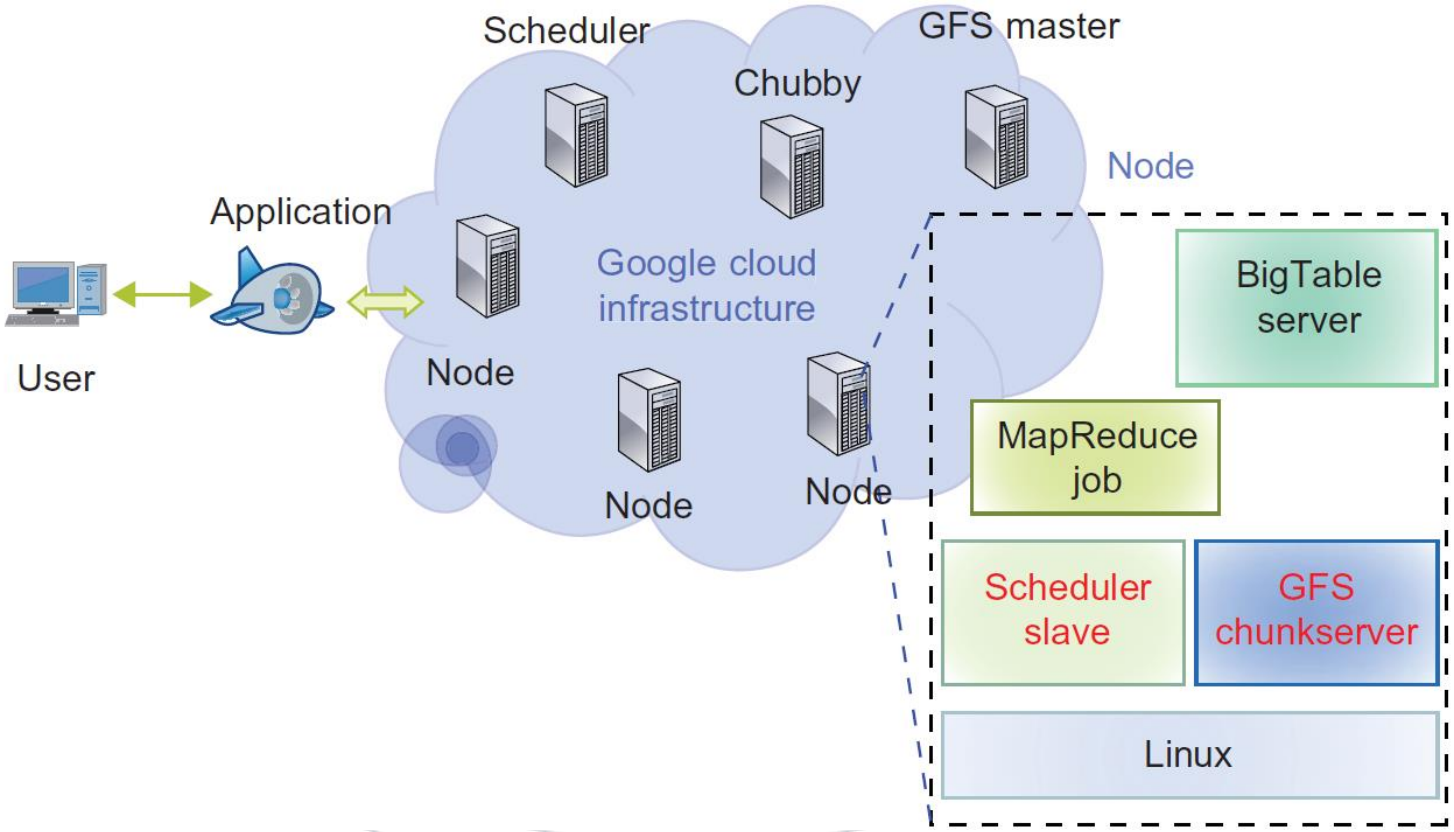
Source: https://cloud.google.com/.

Google Cloud Platform

- **Google cloud platform Architecture**
- Major building blocks of the Google cloud platform:
  - Google File System is used for storing large amounts of data.
  - MapReduce is for use in application program development.
  - Chubby is used for distributed application lock services.
  - BigTable offers a storage service for accessing structured or semistructured data.
- Users can interact with Google applications via the web interface provided by each application.
- Third-party application providers can use GAE to build cloud applications for providing services. The applications all run in data centers under tight management by Google engineers.

Google Cloud Platform

Google cloud platform and major building blocks, the blocks shown are large clusters of low-cost servers.



Source: Distributed and Cloud Computing: From Parallel Processing to the Internet of Things, Kai Hwang, Jack Dongarra, Geoffrey C. Fox (Authors), Morgan Kaufmann, 1st edition, 2011.

Google Cloud Platform

- **Functional Modules of GAE (Google App Engine)**
- GAE is not an infrastructure platform, but rather a serverless application development platform for users.
- The GAE platform comprises the following five major components:
  - The datastore offers object-oriented, distributed, structured data storage services based on BigTable techniques. The datastore secures data management operations.
  - The application runtime environment offers a platform for scalable web programming and execution. It supports several development languages: Java, PHP, Node.js, Python, C#, .Net, Ruby e Go.

Google Cloud Platform

- The software development kit (SDK) is used for local application development. The SDK allows users to execute test runs of local applications and upload application code.
- The administration console is used for easy management of user application development cycles, instead of for physical resource management.
- The GAE web service infrastructure provides special interfaces to guarantee flexible use and management of storage and network resources by GAE.

Google Cloud Platform

- Google offers services to all Gmail account owners. One can register for a GAE account or use the Gmail account name to sign up for the service.
- The service is free within a quota. If you exceed the quota, the page instructs you on how to pay for the service.
- The platform does not provide any IaaS services, unlike Amazon, which offers Iaas and PaaS.
- This model allows the user to deploy user-built applications on top of the cloud infrastructure that are built using the programming languages and software tools supported by the provider (Java, Python).
- Microsoft Azure does this similarly for .NET. The user does not manage the underlying cloud infrastructure.

Google Cloud Platform

- Google Cloud Applications
- Well-known Google applications include the Google Search Engine, Google Docs, Google Earth, and Gmail. These applications can support large numbers of users simultaneously.
- Users can **interact** with Google applications via the web interface provided by each application.
- Third-party application providers can use GAE to build cloud applications for providing services.
- The applications are all run in the Google data centers. Inside each data center, there might be thousands of server nodes to form different clusters. Each cluster can run multipurpose servers.

Google Cloud Platform

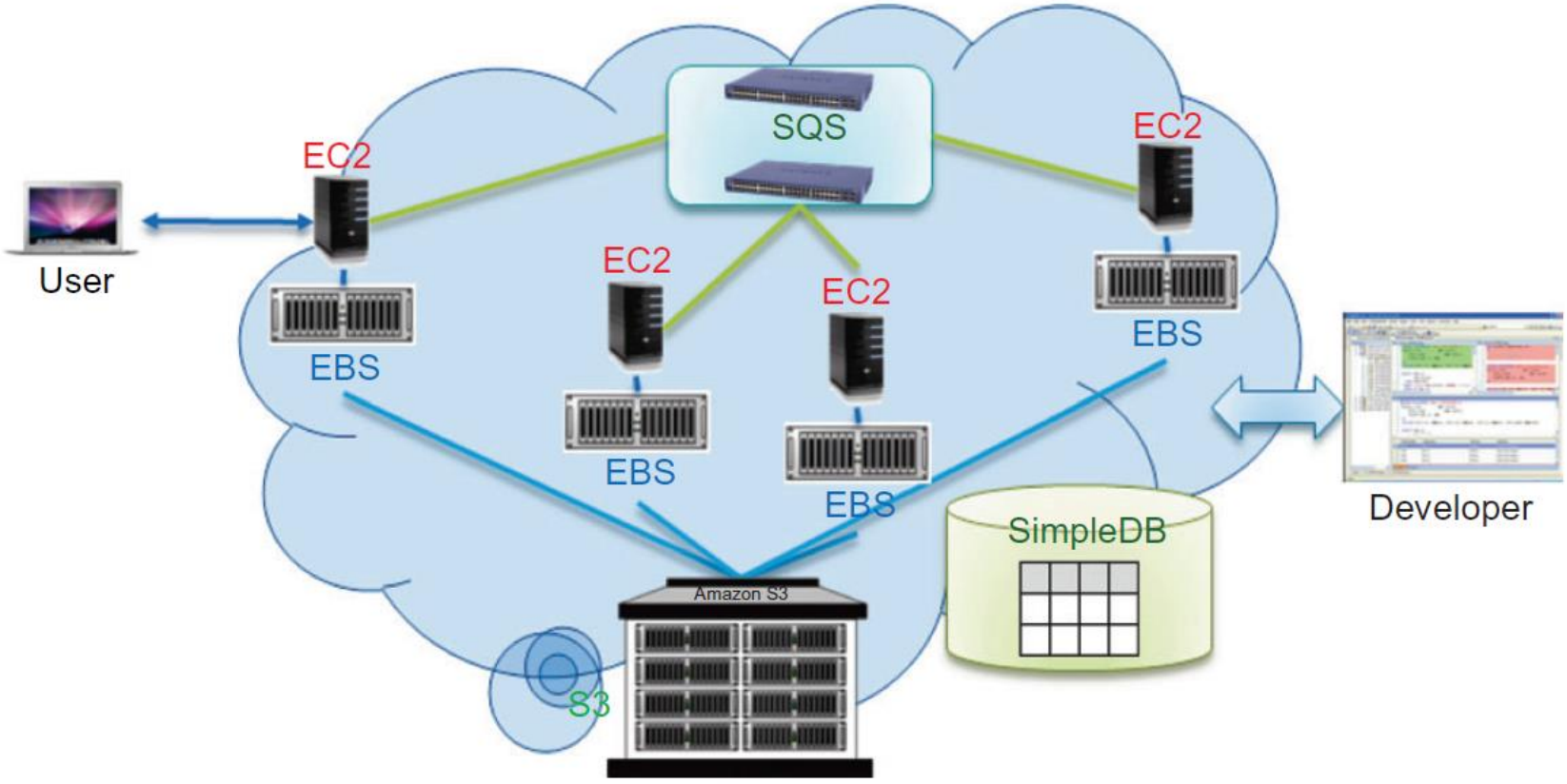
- GAE supports many web applications. One is a storage service to store application-specific data in the Google infrastructure.
- The data can be persistently stored in the backend storage server while still providing the facility for queries, sorting, and even transactions similar to traditional database systems.
- GAE also provides Google-specific services, such as the Gmail account service (which is the login service, i.e, applications can use the Gmail account directly).
- This can eliminate the tedious work of building customized user management components in web applications.
- Thus, web applications built on top of GAE can use the APIs authenticating users and sending e-mail using Google accounts.

Amazon Web Services (AWS)

- Amazon has been a leader in providing public cloud services.
- VMs can be used to **share** computing resources both flexibly and safely.
- EC2 (Elastic Compute Cloud) provides virtualized platforms to host VMs where the cloud application can run.
- S3 (Simple Storage Service, now Cloud Object Storage) provides the object-oriented storage service for users.
- EBS (Elastic Block Service) provides the block storage interface which can be used to support traditional applications.
- SQS (Simple Queue Service) ensures a reliable message service between two processes. The message can be kept reliably even when the receiver processes are not running. Users can access their objects through SOAP with either browsers or other programs.

Amazon Web Services (AWS)

Architecture of the Amazon cloud computing infrastructure



In: Distributed and Cloud Computing: From Parallel Processing to the Internet of Things, Kai Hwang, Jack Dongarra, Geoffrey C. Fox (Authors), Morgan Kaufmann, 1st edition, 2011.

Amazon Web Services (AWS)

- Amazon offers queuing and notification services (SQS and SNS), which are implemented in the AWS cloud.
- Note brokering systems run very efficiently in clouds and offer a striking model for controlling sensors and providing office support of smartphones and tablets.
- Amazon provides a flexible cloud computing platform for developers to build cloud applications. Small and medium-size companies can put their business on the Amazon cloud platform.
- Using the AWS platform, companies can service large numbers of Internet users and make profits through those paid services.

Amazon Web Services (AWS)

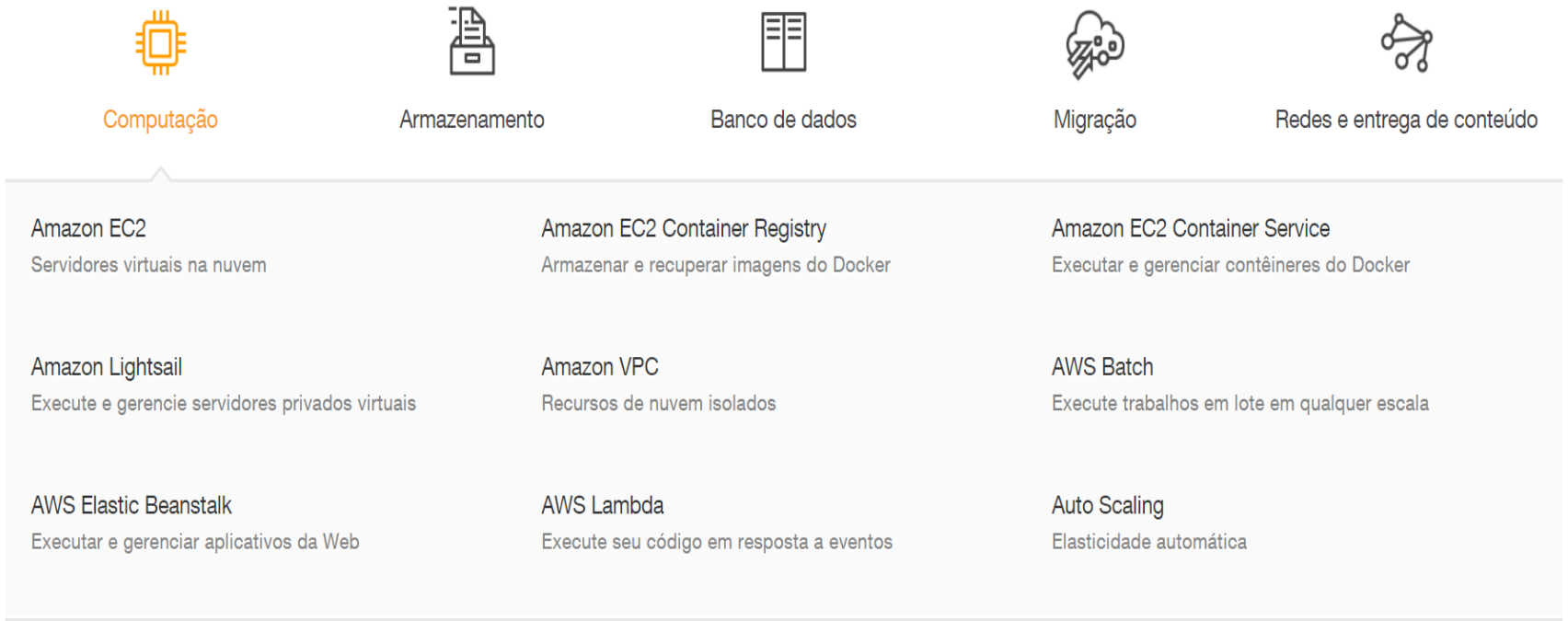
- ELB/EBS (Elastic Load Balancing/Elastic Block Store) automatically distributes incoming application traffic across multiple Amazon EC2 instances and allows user to avoid nonoperating nodes and to equalize load on functioning images.
- Both AWS Auto Scaling and ELB are enabled by CloudWatch which monitors running instances.
- CloudWatch is a web service that provides monitoring for AWS cloud resources, starting with Amazon EC2.
- CloudWatch provides customers with visibility into resource utilization, operational performance, and overall demand patterns, including metrics such as CPU utilization, disk reads and writes, and network traffic.

Amazon Web Services (AWS)

- Service offerings by AWS (https://aws.amazon.com/pt/)
- Tutoriais: https://aws.amazon.com/pt/getting-started/tutorials/

Amazon Web Services (AWS)

- Compute Service offered by AWS (https://aws.amazon.com/pt/)



Amazon Web Services (AWS)

- Amazon (like Azure) offers a Relational Database Service (RDS) with a messaging interface.
- The Elastic MapReduce capability is equivalent to Hadoop running on the basic EC2 offering.
- AWS Import/Export allows one to ship large volumes of data to and from EC2 by shipping physical disks; it is well known that this is often the highest bandwidth connection between geographically distant systems.
- Amazon CloudFront implements a content distribution network.
- Amazon DevPay is a simple-to-use online billing and account management service that makes it easy for businesses to sell applications that are built into or run on top of AWS.

Amazon Web Services (AWS)

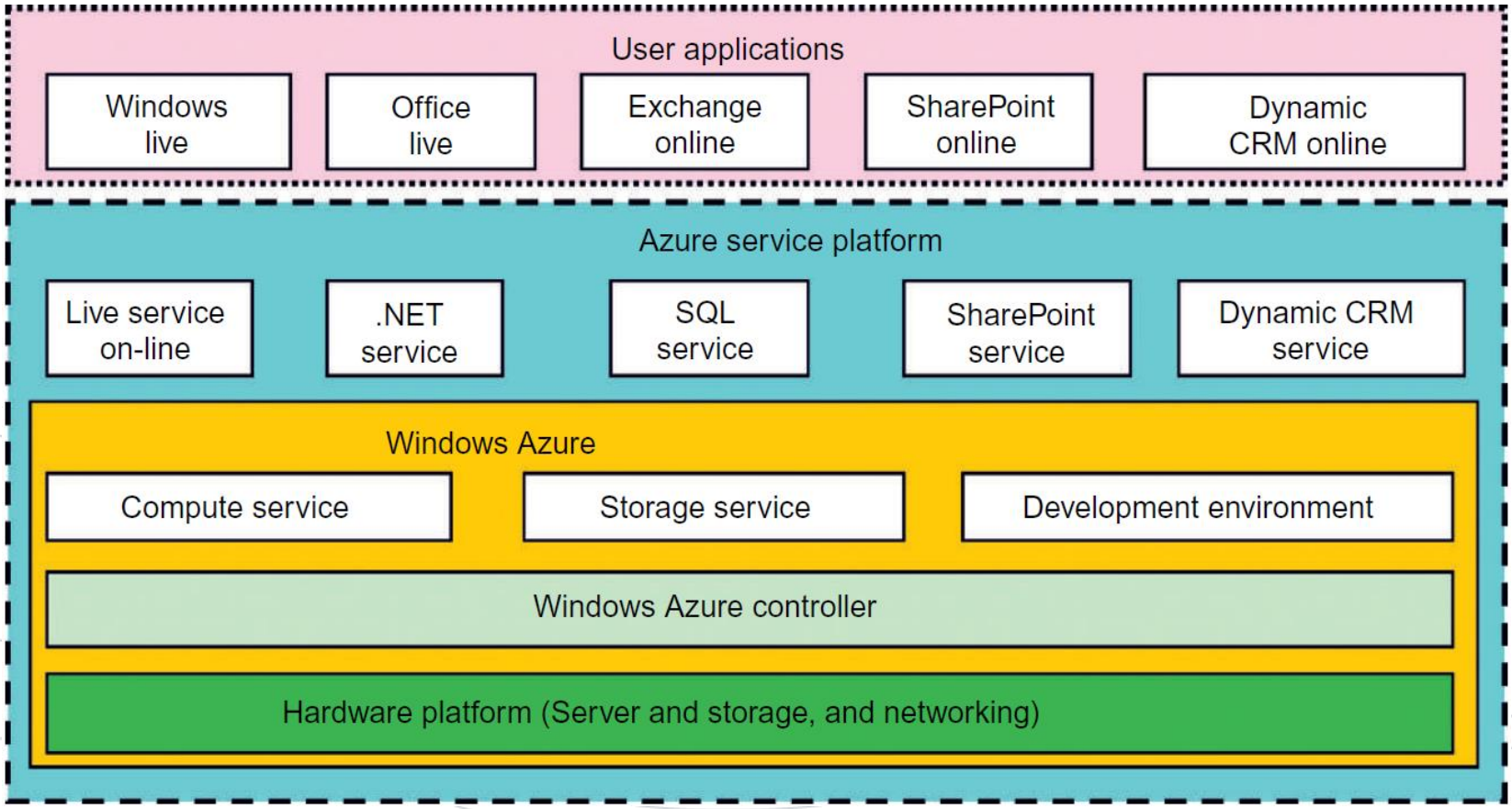
- FPS (Flexible Payments Service) provides developers of commercial systems on AWS with a convenient way to charge Amazon's customers that use such services built on AWS.
- Customers can pay using the same login credentials, shipping address, and payment information they already have on file with Amazon.
- The FWS (Fulfillment Web Service) allows merchants to access Amazon's fulfillment capabilities through a simple web service interface. Merchants can send order information to Amazon to fulfill customer orders on their behalf. In July 2010, Amazon offered MPI clusters and cluster compute instances.
- The AWS cluster compute instances use hardware-assisted virtualization instead of the para-virtualization used by other instance types and requires booting from the EBS. Users are freed to create a new AMI (Amazon Machine Images) as needed.

Microsoft Azure

- In 2008, Microsoft launched Windows Azure platform to meet the challenges in cloud computing. This platform is built over Microsoft data centers.
- The platform is divided into three major components: Windows Azure, Azure service platform, User applications.
- Windows Azure offers a cloud platform built on Windows OS and based on Microsoft virtualization technology.
- Applications are installed on VMs deployed on the data-center servers. Azure manages all servers, storage, and network resources of the data center.
- On top of the infrastructure are the various services for building different cloud applications.

Microsoft Azure

Overall architecture of Microsoft Windows Azure platform.



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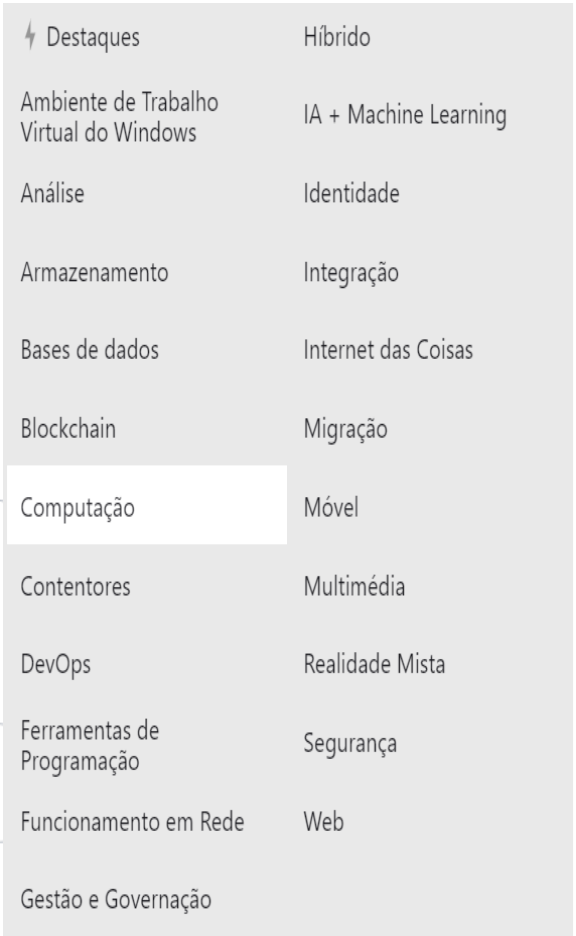
Microsoft Azure

Products of Microsoft Azure



 Source: https://azure.microsoft.com/pt-pt/.

Microsoft Azure

- Cloud-level services provided by the Azure platform are introduced below:
  - Live service Users can visit Microsoft Live applications and apply the data involved across multiple machines concurrently.
  - .NET service This package supports application development on local hosts and execution on cloud machines.
  - SQL Azure This makes it easier for users to visit and use the relational database associated with the SQL server in the cloud.
  - SharePoint service This provides a scalable and manageable platform for users to develop their special business applications in upgraded web services.
  - Dynamic CRM service This provides software developers a business platform in managing CRM applications in financing, marketing, and sales and promotions.

Microsoft Azure

- All these cloud services in Azure can interact with traditional Microsoft software applications, such as Windows Live, Office Live, Exchange online, SharePoint online, and dynamic CRM online.
- The Azure platform applies the standard web communication protocols SOAP (Simple Object Access Protocol) and REST (Representational state transfer).
- The Azure service applications allow users to integrate the cloud application with other platforms or third-party clouds.
- The powerful SDK (Software Development Kit) allows Azure applications to be developed and debugged on the Windows hosts.

IBM Cloud

- On 4 June 2013 IBM announced the acquisition of SoftLayer, to form an IBM Cloud Services Division and in March 4, 2014 IBM acquired Cloudant.
- IBM Bluemix was announced for public beta in February 2014, after having been developed since early 2013.
- IBM announced the general availability of the Bluemix Platform-as-a-Service (PaaS) offering in July 2014.
- By April 2015, Bluemix included a suite of over 100 cloud-based development tools, including social, mobile, security, analytics, database, and IoT (Internet of Things).

Source: Bluemix, https://en.wikipedia.org/wiki/Bluemix

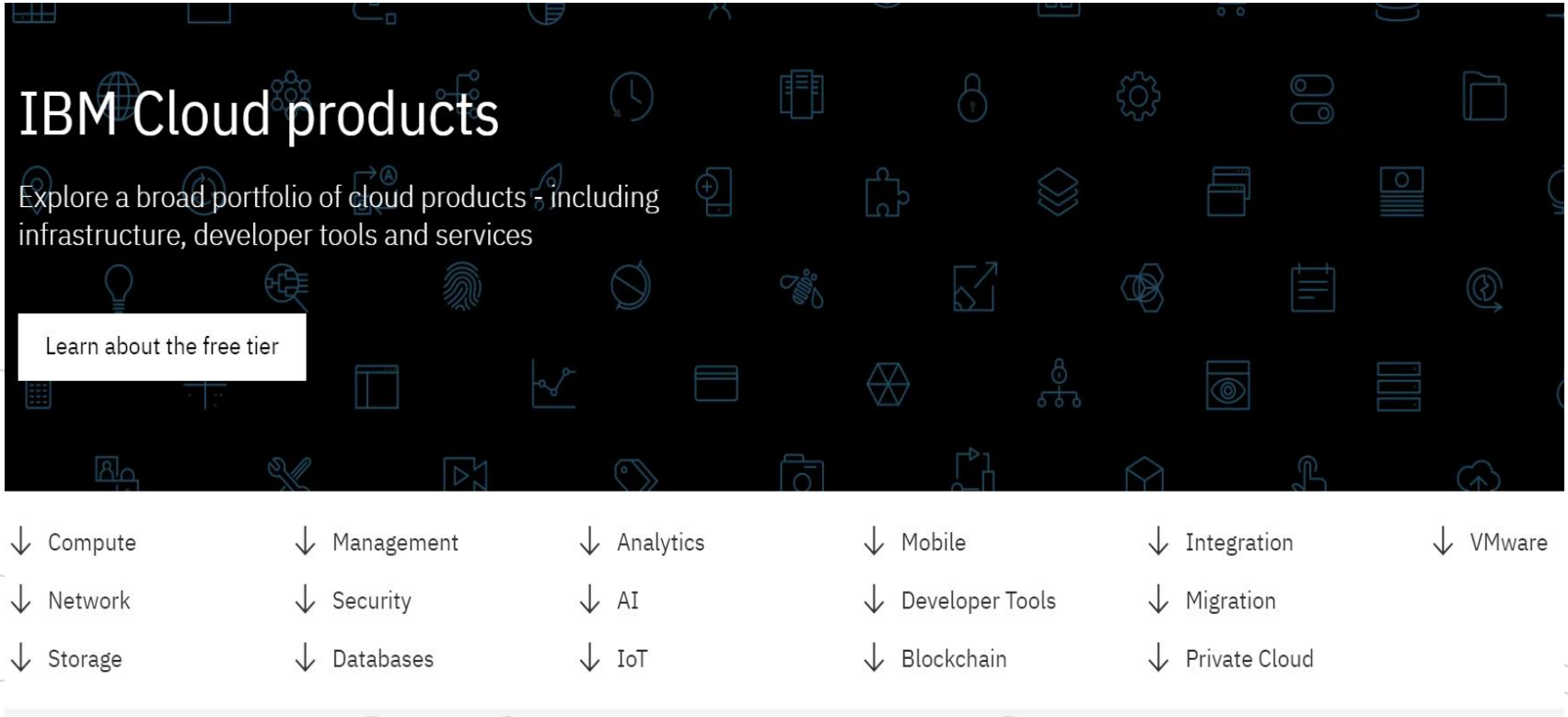
IBM Cloud

- IBM Bluemix supported several programming languages and services as well as integrated DevOps to build, run, deploy and manage applications on the cloud.
- Bluemix was based on Cloud Foundry open technology and runs on SoftLayer infrastructure.
- In October 2017, IBM announced that they would rebrand their cloud as IBM Cloud, merging all components.
- IBM Cloud services includes infrastructure as a service (IaaS), platform as a service (PaaS), software as a service (SaaS).
- IBM Cloud is focused on smarter business.

Source: Bluemix, https://en.wikipedia.org/wiki/Bluemix
Source: IBM Cloud, Documentation, https://cloud.ibm.com/docs

IBM Cloud

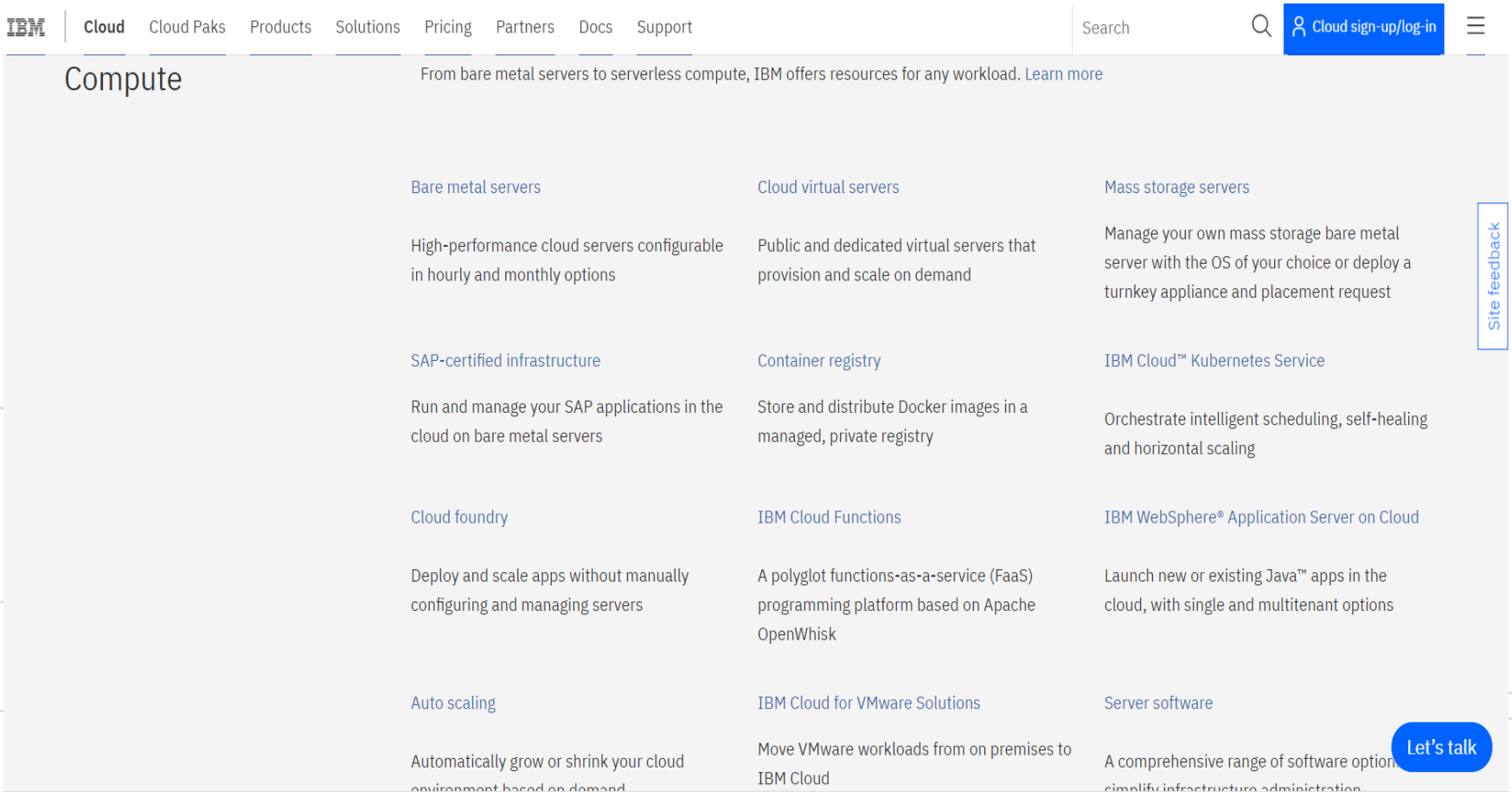
- Type of services available in IBM Cloud



Source: IBM Cloud, https://www.ibm.com/uk-en/cloud/products

IBM Cloud

- Compute services available in IBM Cloud



Source: IBM Cloud, https://www.ibm.com/uk-en/cloud/products

Salesforce

- Salesforce.com, Inc. is an American cloud-based software company headquartered in San Francisco, California.
- The company was founded in 1999 by former Oracle executive Marc Benioff, Parker Harris, Dave Moellenhoff, and Frank Dominguez as a software as a service (SaaS) company.
- Salesforce.com's customer-relationship management (CRM) service comprises several broad categories: Commerce Cloud, Sales Cloud, Service Cloud, Data Cloud (including Jigsaw), Marketing Cloud, Community Cloud, Analytics Cloud, App Cloud, and IoT

Source: Salesforce, https://en.wikipedia.org/wiki/Salesforce
Source: Salesforce, https://www.salesforce.com/eu/?ir=1

Salesforce

- Salesforce is a customer relationship management solution that brings companies and customers together. It's one integrated CRM platform that gives all enterprise departments — including marketing, sales, commerce, and service — a single, shared view of every customer.
- It also sells a complementary suite of enterprise applications focused on customer service, marketing automation, analytics, and application development.
- Salesforce is nowadays the world’s #1 CRM platform.

Source: Salesforce, https://en.wikipedia.org/wiki/Salesforce
Source: Salesforce, https://www.salesforce.com/eu/?ir=1

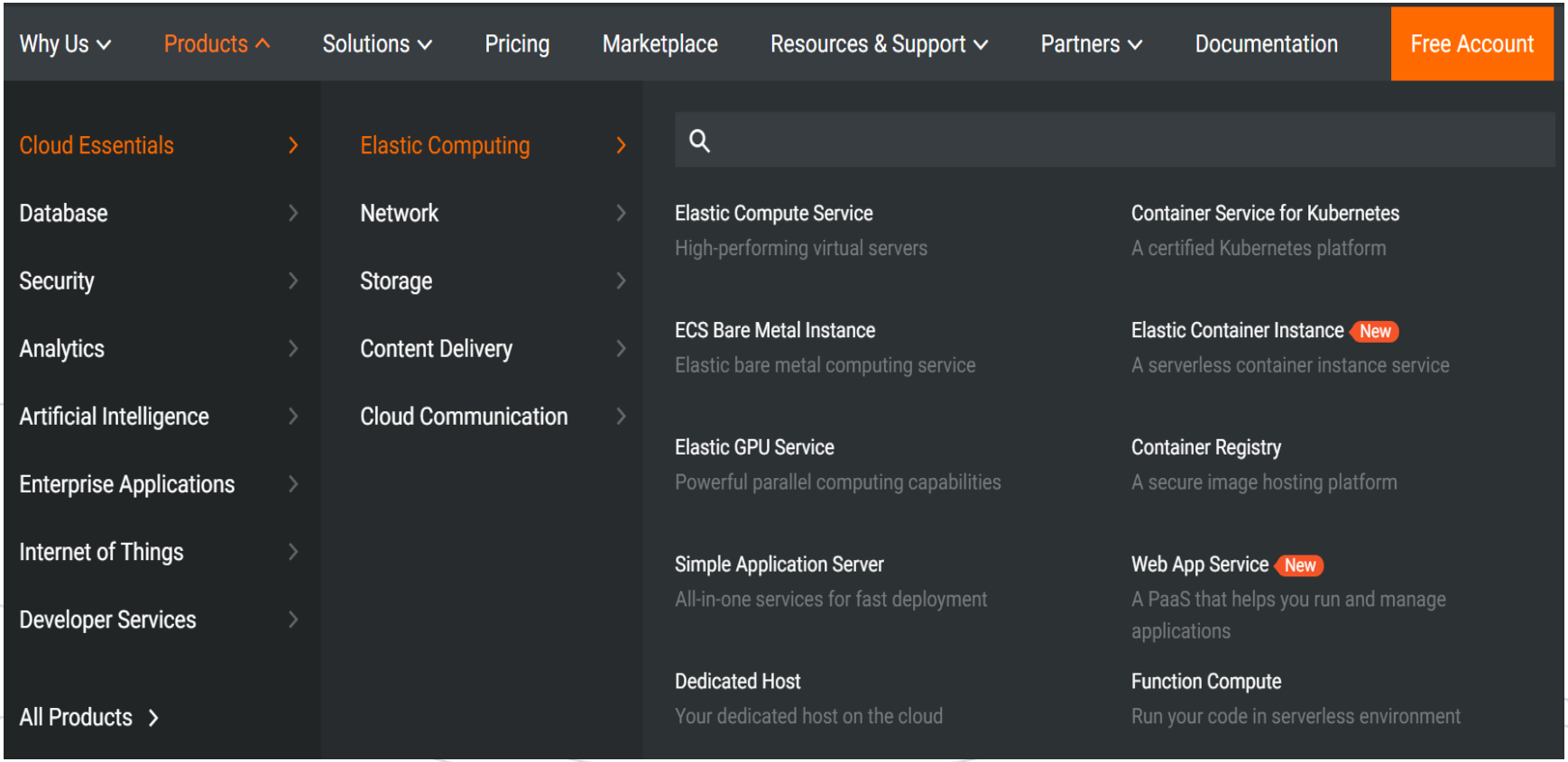
Alibaba Cloud

- Alibaba Cloud, also known as Aliyun, is a Chinese cloud computing company, a subsidiary of Alibaba Group.
- It was founded in September 2009 and R&D centers and operation centers were subsequently opened in Hangzhou, Beijing, and Silicon Valley.
- Alibaba Cloud provides cloud computing services to online businesses and Alibaba's own e-commerce ecosystem.
- As in Aug. 2019, the company made an announcement to rename Alibaba Cloud to Alibaba Cloud Intelligence.

Alibaba Cloud, https://en.wikipedia.org/wiki/Alibaba_Cloud
Alibaba Cloud, https://us.alibabacloud.com/

Alibaba Cloud

- Type of services available in Alibaba Cloud



Source: IBM Cloud, https://www.ibm.com/uk-en/cloud/products