Cloud Computing Services/Providers

Prof. Lenuța Alboaie
lalboaie@gmail.com

July 2024

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    - Amazon
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    - OpenStack
  - Other Cloud services providers (Rackspace, GoGrid, SymetriQ, AT&T, Heroku, Aptana, EngineYard , Salesforce.com, NetSuite, Intacct, Appistry,….)

Cloud Computing | Services

XaaS - Anything as a Service

Storage as a Service

Database as a Service

Function as a Service

Integration as a Service

Communication as a Service

Analytics as a Service

Application as a Service

Governance as a Service

Monitoring as a Service

HPC as a Service

Information as a Service

Identity as a Service

Backup as a Service

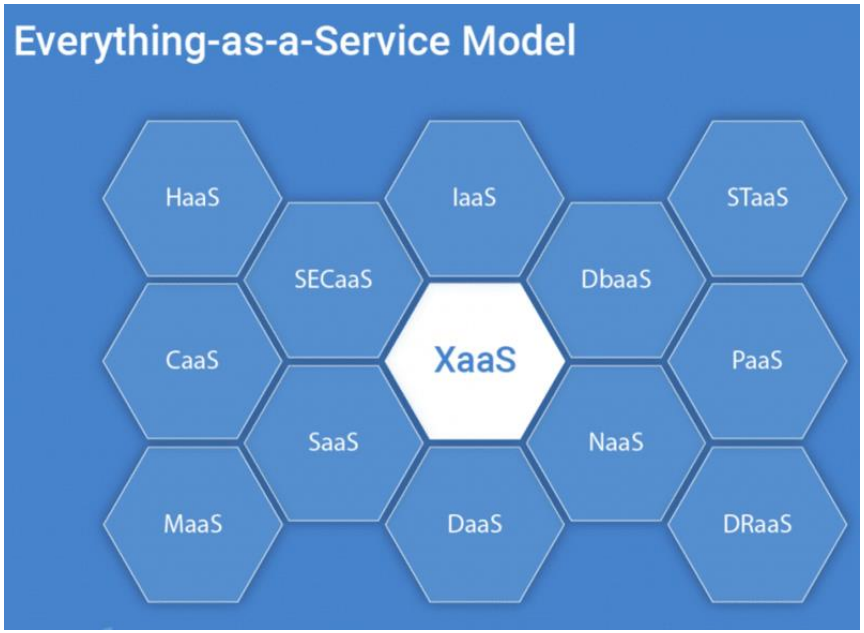
Security as a Service

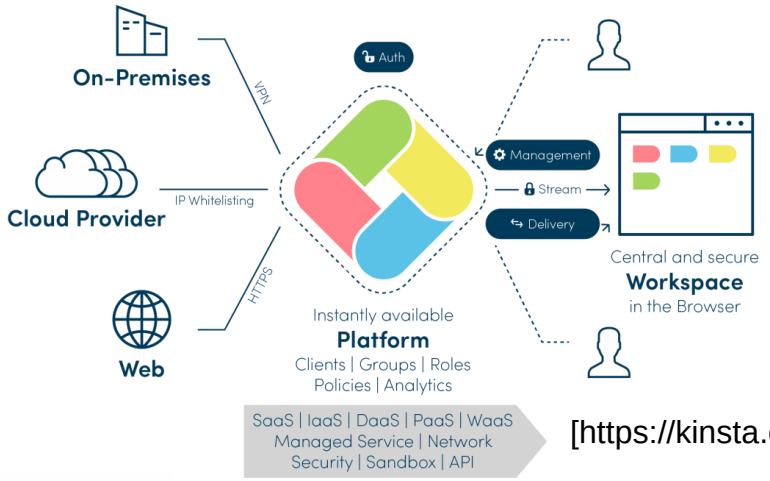
AI as a Service

Machine Learning as a Service

Edge Computing as a Service

...





[https://kinsta.com/blog/xaas/]

Cloud Computing

Storage as a Service (STaaS)

On-Demand Storage: Managed by a service provider, delivered via the internet.

Scalable Solutions: Adjusts to data size needs, pay for what you use.

High Availability: Built-in redundancy for consistent data access.

Durability: Data is protected against loss or corruption.

Backup and Recovery: Options available for data protection and disaster recovery.

Cost-Effective: No upfront hardware costs, with a pay-as-you-go pricing model.

Global Accessibility: Access your data from anywhere with an internet connection

Cloud Computing

Storage as a Service (STaaS)

Providers:

Google Docs: Cloud-based document creation, storage, and collaboration platform.

Web Email Providers (Gmail, Yahoo! Mail): Services offering email storage and management.

Photo Sharing Services : Platforms for storing and sharing digital photos.

YouTube: Video sharing service providing video storage and streaming.

Web Hosting Providers (GoDaddy): Companies offering website hosting and data storage services.

Social Networking Sites (Facebook, Linkedin): Platforms for social interaction also store user-generated content.

Cloud Storage Services (…): Offer storage space for various types of digital data, including media and documents.

….

Cloud Computing

Communication as a Service (CaaS) is a cloud-based delivery model that offers a range of communication solutions, such as:

Voice over Internet Protocol (VoIP): Services like RingCentral or 8x8 provide internet-based voice calling.

Video Conferencing: Tools such as Zoom and Cisco Webex facilitate virtual meetings.

Instant Messaging and Chat: Platforms like Slack and Microsoft Teams enable real-time text communication.

Email Services: Solutions from providers like Mailchimp offer mass email communication capabilities.

Key advantages of CaaS include its on-demand nature, scalability to match business size, and the elimination of maintenance costs associated with traditional communication systems.

Cloud Computing

Identity as a Service (IDaaS): emphasizes the transition from traditional identity management systems to cloud-based and decentralized identity services

Digital Identity Management: Assigns a unique digital identity to users.

User Authentication & Permissions: Determines user access rights within applications.

In-House vs. Cloud: Traditional apps might use Active Directory, whereas cloud services require specific cloud identities.

Proprietary IDs **Examples**:

- Amazon Cloud Services: Amazon-defined identity.
- Google's App Engine: Requires a Google account.
- Microsoft's Cloud Applications: Uses Windows Live ID.

OpenID Connect (peste OAuth 2.0):

- Allows logging in across multiple services with one identity.
- Supports various authentication methods (e.g., smart cards, biometrics).
- Adopted by major organizations like Google, IBM, Microsoft,…

Cloud Computing | Example

Identity as a Service (IDaaS) @ WORK : **Authentication and Authorization**

Ex. Imagine **Application A** – a web application that wants to authenticate users and access their files stored in Google Drive without asking users to enter their passwords directly. These resources were previously stored by users through other applications or services.

0. Register Application A with Google

- Create a Google Developer Account and access Google Cloud Console
- Create a project in Google Cloud Console
- Configure the OAuth consent screen
- Create OAuth 2.0 credentials
  - Navigate to "Credentials"
  - Click on "Create Credentials" and select "OAuth 2.0 Client IDs"
  - Choose the application type "Web application"
  - Enter a name for the credentials and add the redirect URI (e.g., https://applicationa.com/callback)
- Obtain client_id and client_secret:
  - After configuring the application, Google will generate and display client_id and client_secret

Cloud Computing | Example

Identity as a Service (IDaaS) @ WORK : **Authentication and Authorization**

Ex. Imagine **Application A** – a web application that wants to authenticate users and access their files stored in Google Drive without asking users to enter their passwords directly. These resources were previously stored by users through other applications or services.

1. **Initiating Authentication and Authorization:** Application A redirects the user to Google for authentication and authorization using the client_id obtained during registration.
2. **User Authentication (OpenID Connect):** The user is redirected to Google's authentication page. The user enters their credentials (username and password) to authenticate with Google

3. Google Returns an Authorization Code

After the user successfully authenticates, Google redirects the user back to **Application A** with an authorization code.

4. Obtain Tokens

Application A uses the USER_AUTHORIZATION_CODE obtained in step 3, along with the client_id and client_secret, to make a POST request to Google to obtain the tokens (ID Token and Access Token).

Redirect URL:

```
https://accounts.google.com/o/oauth2/v2/auth?
  response_type=code&
  client_id=APP_A_CLIENT_ID&
  redirect_uri=https://applicationa.com/callback& &
  scope=openid email profile&
  state=UNIQUE_STATE_VALUE
```

Redirection to Application A:

```
https://applicationa.com/callback?
  code=USER_AUTHORIZATION_CODE&
  state=UNIQUE_STATE_VALUE
```

Token Request:

```
POST /oauth2/v4/token HTTP/2
Host: oauth2.googleapis.com
Content-Type: application/x-www-form-urlencoded

code=authorization_code&
client_id=YOUR_CLIENT_ID&
client_secret=YOUR_CLIENT_SECRET&
redirect_uri=https://applicationa.com/callback&
grant_type=authorization_code
```

Cloud Computing | Example

Identity as a Service (IDaaS) @ WORK : **Authentication and Authorization**

5. Token Issuance (OpenID Connect and OAuth 2.0)

Google responds with an ID Token and an Access Token.

json

Token Response:

```
{
  "id_token": "eyJhbGciOiJSUzI1NiIsImtpZCI6...",
  "access_token": "ya29.a0AfH6SMA...",
  "expires_in": 3600,
  "token_type": "Bearer",
  "scope": "openid email profile"
}
```

6. **Using the Tokens**

ID Token: Validated and used to verify the user's identity.

Access Token: Used to make API requests and access the user's resources.

Ex: Accessing Protected Resources (OAuth 2.0)

Application A uses the **Access Token** to access the user's resources stored in Google Drive. For example, to access the user's files in Google Drive, the application makes an API request

API Request to Google Drive using Access Token

```
GET /drive/v3/files HTTP/2
Host: www.googleapis.com
Authorization: Bearer ya29.a0AfH6SMA...
```

The Google API validates the **Access Token** and, if valid, allows access to the requested resources.

=> **Using OpenID Connect and OAuth 2.0, Application A can authenticate users and access their cloud-stored resources without asking for their passwords, ensuring enhanced security and a better user experience**

Cloud Computing

Monitoring as a Service (MaaS) are important in maintaining optimal operation and security within modern IT environments

Real-Time Insights: Track performance, health, and security of IT infrastructure.

Proactive Issue Resolution: Identify and address issues before they escalate.

Enhanced System Reliability: Ensure systems are running optimally.

Data-Driven Decision Making: Leverage analytics for informed decisions.

Scalable & Cloud-Based: Easily adjust to business growth.

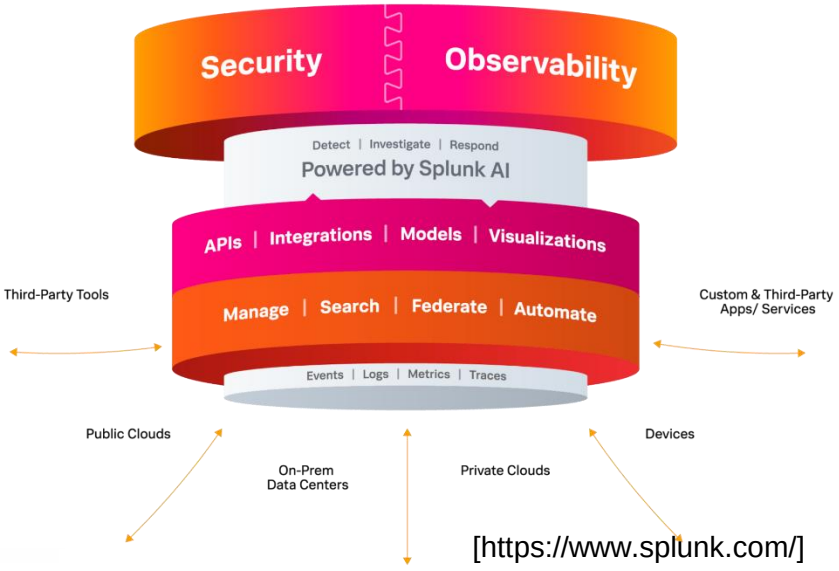
Comprehensive Monitoring: Integrates with existing systems for a holistic view.

Examples:

New Relic: Offers application performance monitoring.

Datadog: Provides monitoring for cloud-scale applications.

Splunk: Specializes in analyzing big data for monitoring.



[https://www.splunk.com/]

Cloud Computing

Management/Governance-as-a-Service (MaaS & GaaS) - achieving efficient, compliant, and risk-managed IT operations

Centralized Control: Streamline management of IT resources and policies.

Regulatory Compliance: Ensure adherence to industry standards and laws.

Risk Management: Identify and mitigate potential risks in real-time.

Resource Optimization: Efficiently allocate and use IT resources.

Strategic Decision Support: Provide data for informed strategic planning.

Examples:

AWS Management & Governance: Tools for cloud resource management.

Microsoft Azure Governance: Framework for cloud governance and compliance.

Cloud Computing

Backup-as-a-Service (BaaS) - for ensuring data security and business continuity

Cloud-Based Data Protection: Securely back up data to cloud environments.

Automated & Scheduled Backups: Ensure data is regularly backed up without manual intervention.

Scalability: Adjust storage needs as organizational data grows.

Disaster Recovery: Quick data restoration capabilities in case of data loss events.

Reduced Infrastructure Costs: Eliminate the need for on-premises backup hardware.

Examples:

Carbonite: Offers cloud and hybrid backup solutions for businesses.

Acronis Cloud Backup: Provides comprehensive protection for any environment.

Cloud Computing

Security as a Service (SecaaS) - are crucial for maintaining robust security postures in cloud-based and hybrid IT environments

Comprehensive Security: Offers a suite of security services through the cloud.

Threat Prevention: Protects against viruses, malware, and cyber attacks.

Data Protection: Ensures data integrity and confidentiality.

Regulatory Compliance: Helps meet various compliance standards.

Examples:

McAfee Cloud Security: Provides cloud-centric security solutions.

Symantec Cloud Security: Offers a range of cloud and internet security services.

Cloud Computing

High-Performance Computing as a Service (HPCaaS) - facilitates cutting-edge computing for industries and research requiring intensive computational power, like genomic sequencing, climate modeling, and financial risk analysis

On-Demand Supercomputing: Access to high-performance computing resources without significant capital investment.

Scalable Compute Power: Cater to complex computational tasks with scalable resources.

Advanced Simulations & Analytics: Enables intricate data analysis and modeling for research and development.

Speed to Insight: Accelerate the time from research to results.

Cost-Efficiency: Only pay for the HPC resources used, optimizing budget expenditure.

Examples:

AWS Batch: Allows developers, scientists, and engineers to easily and efficiently run hundreds of thousands of batch computing jobs on AWS.

Microsoft Azure HPC: Offers high-performance computing services combining batch processing and HPC tools.

Cloud Computing

Question: Are you moving to a city and looking for accommodation solutions?

- Do you build a from scratch?

- Do you buy a house?

- Do you plan to live in a hotel?

Cloud Computing

Question: Do you want to set up an IT departement?

- **Choose IaaS (Infrastructure as a Service) – Previous course**

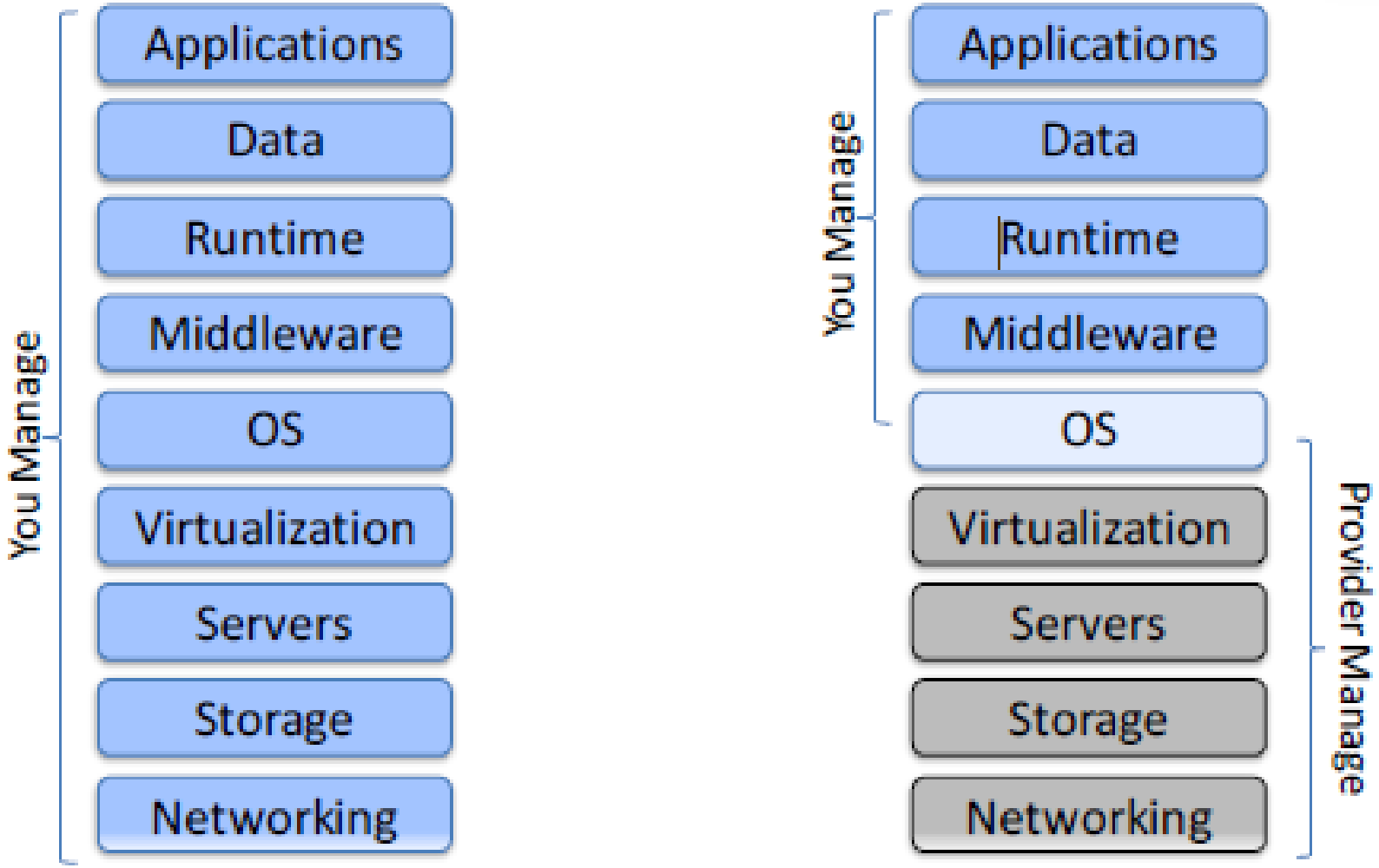
  - Renting virtualized infrastructure and building an IT system that you may fully control

- **Choose PaaS (Platform as a Service)**
  - Develop the IT system on an existent cloud platform, without concern over low level resources management

- **Choose SaaS (Software as a Service)**
  - Make use of pre-existent IT systems, provided by a cloud provider, without knowledge of technical details

Cloud Computing

Traditional Model (*on-premise*) versus IaaS



Cloud Computing

Users may:

• Need a development or testing environment for their developed applications or services

•Need to employ an automated mechanism for job assignment and management

•Need an access control and authentication mechanism

•Need large amounts of resources (as per requirements)

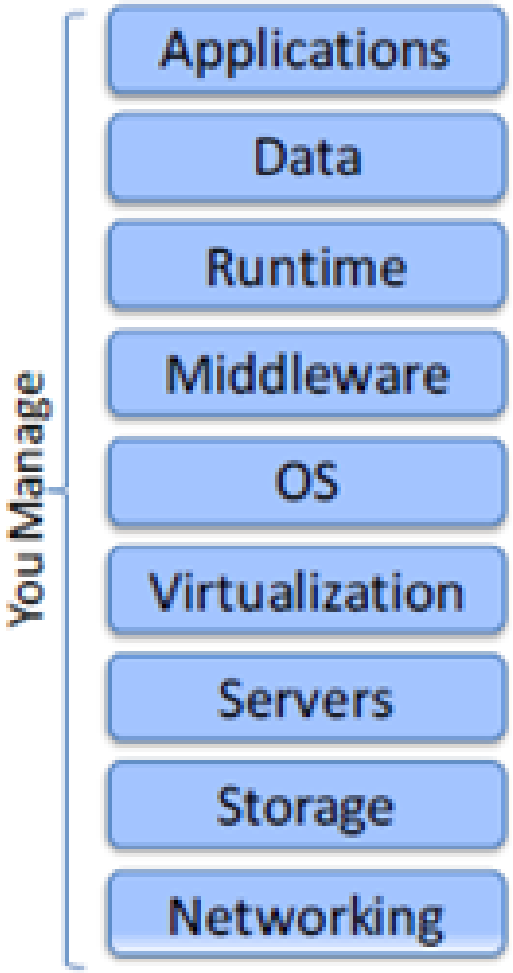
•….

=>

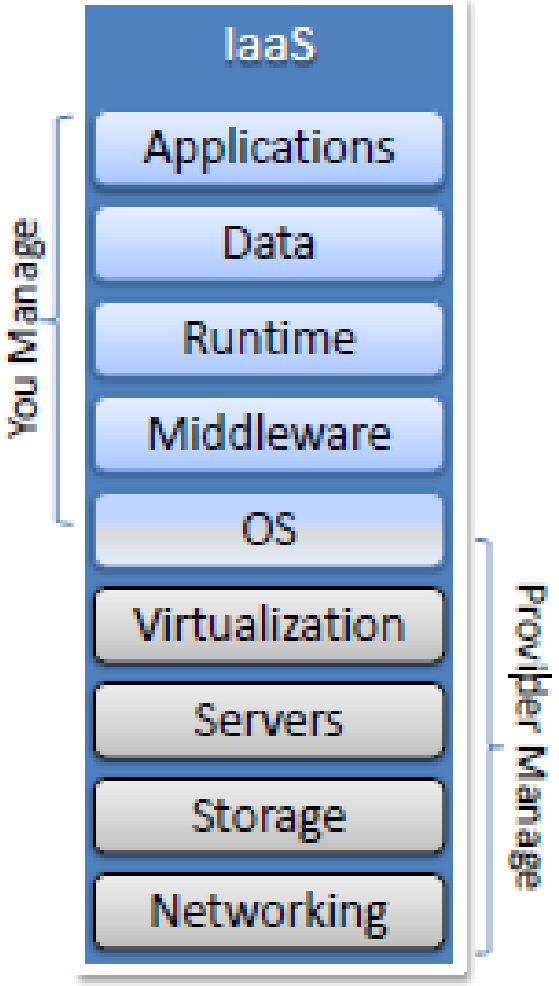
- **PaaS** provides properties to comply with customer requirements
- PaaS guarantees the quality of used resources, services, and applications

Cloud Computing

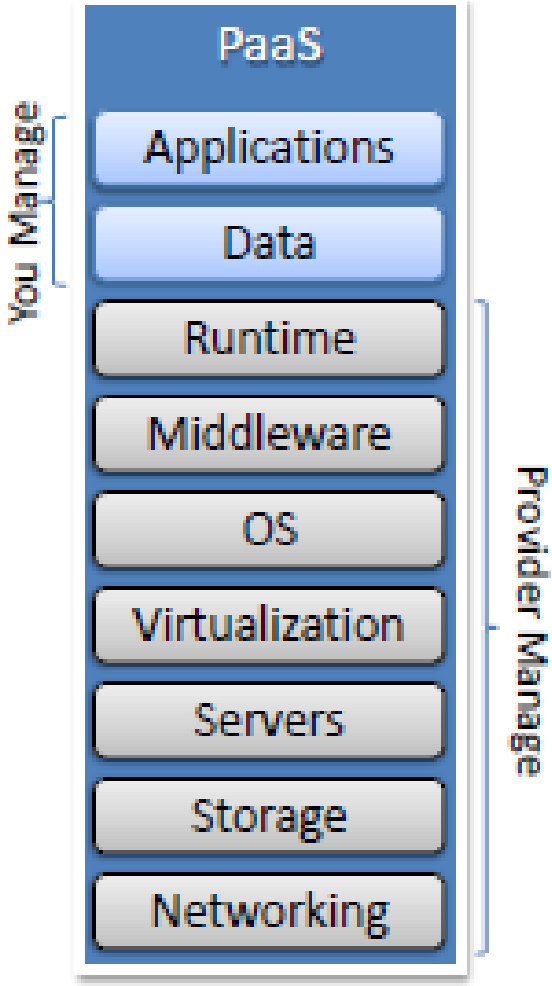
Traditional Model /On-premise



IaaS



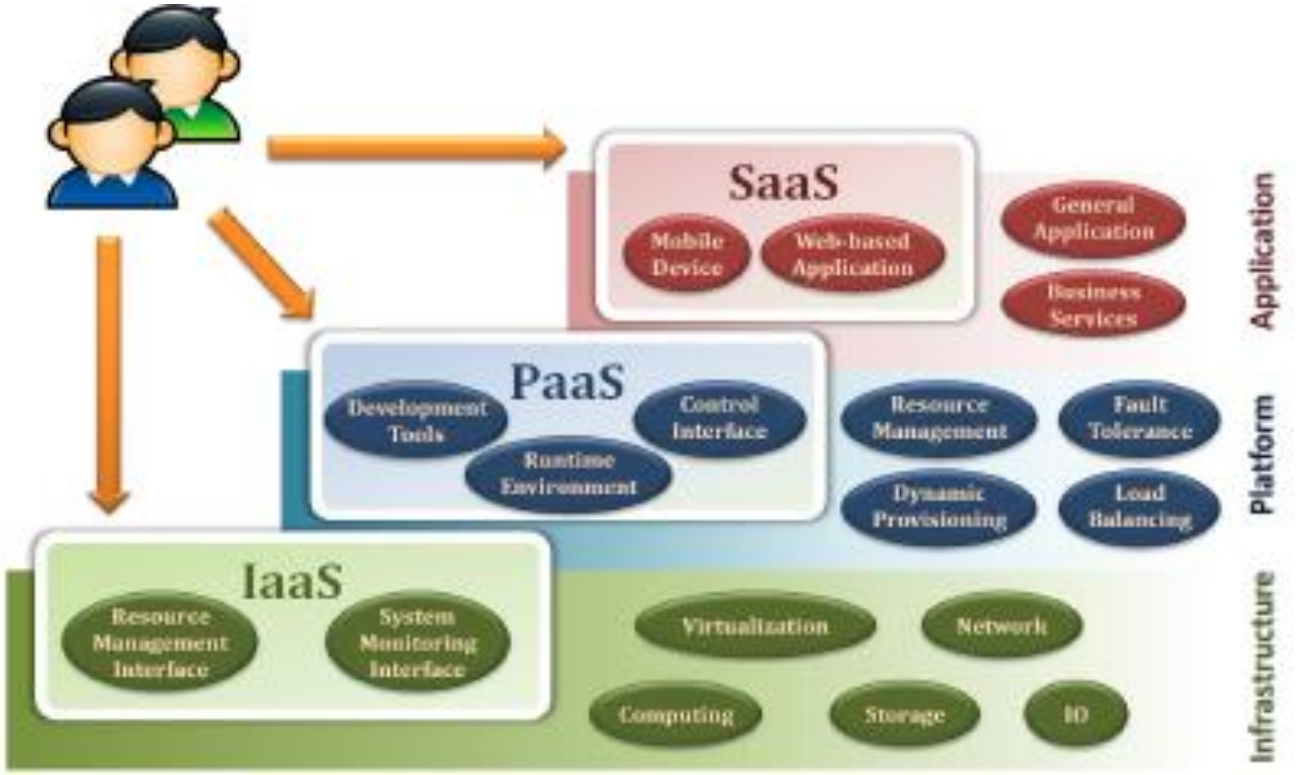
PaaS



PaaS

PaaS (Platform as a Service)

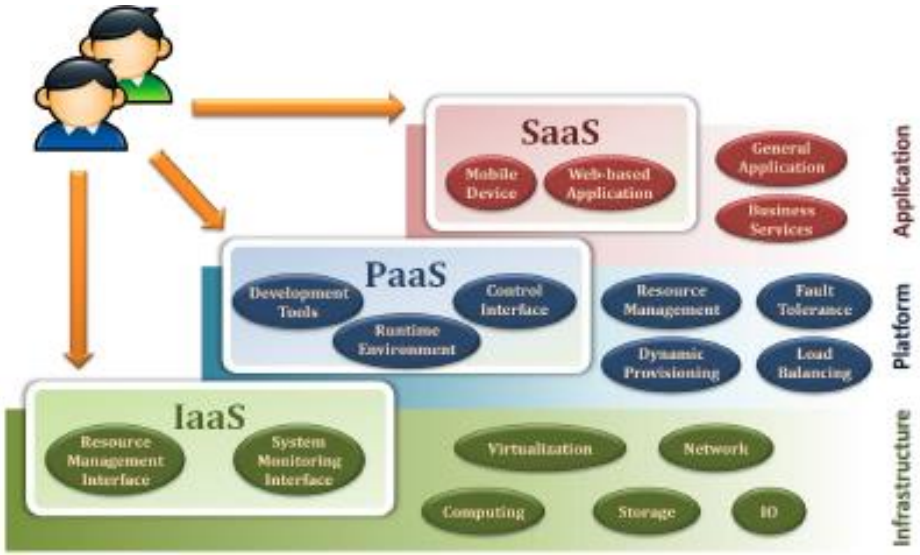
• It is a computing platform enabling the abstractization of infrastructure, OS and middleware, providing support for increasing developers' productivity

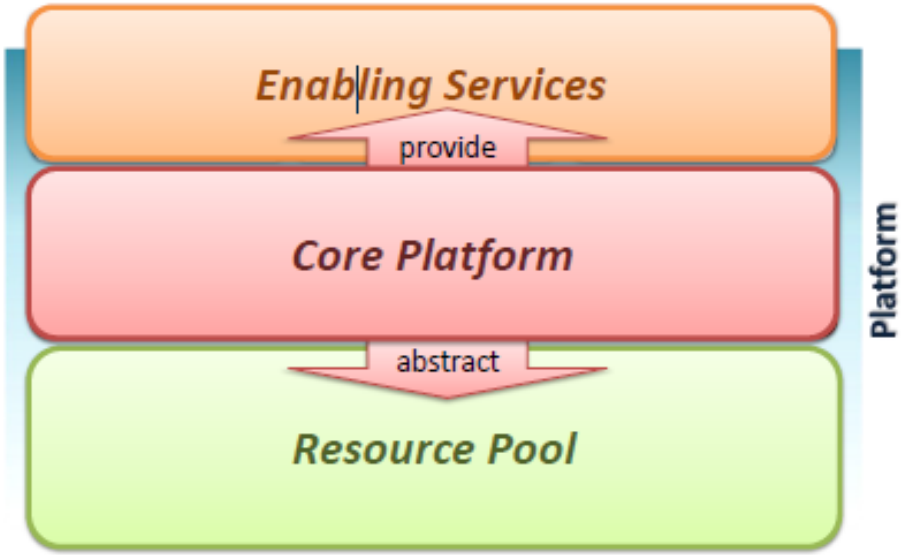


PaaS

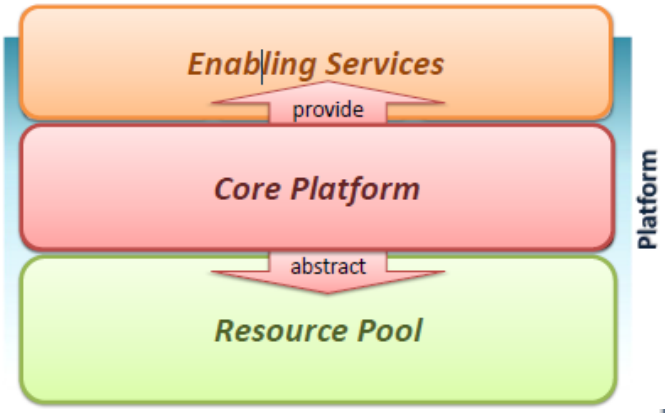
PaaS (Platform as a Service)

- Provides the platform as a service
  - Development of applications using languages and tools provided by the PaaS provider
  - Running applications on cloud infrastructure





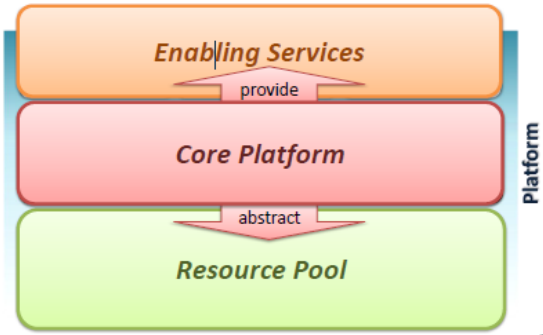
PaaS| Structure



- ***Resource Pool - abstracted***
  - Provides the ability to abstract and control the resources
  - Users may automatically allocate and deallocate resources on demand
  - Reduces the complexity of resource management in the cloud infrastructure
  - The cloud providers determine

  "smalles unit of resource"
    - 1GB for storage or 1MB memory or 1GHz CPU ….
  - Users are not usually aware if the used resources are dedicated or shared

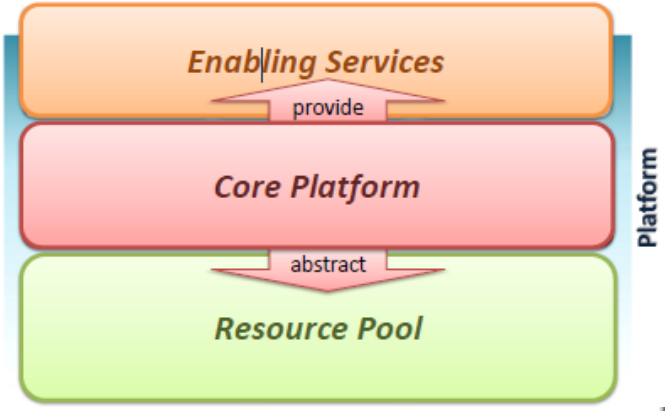
PaaS| Structure



- ***Core Platform***
  - Provides a safe environment for running applications and services
  - Provides core functionalities of a PaaS environment

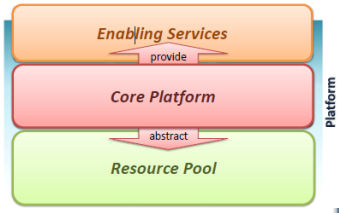
    => downsizes the responsibilities concerning the running environment (configuration, management, ...)
  - Acts as a bridge between the user and the hardware level
  - The environment is *automatically controlled*, therefore the developers may focus on provided services
    - *Dynamic provisioning*
      - On demand
    - *Load balancing*
      - Load balancing
    - *Fault tolerance*
      - Operates even in case of errors
    - *System monitoring*
      - System monitoring and assessment of used resources

PaaS| Structure



- ***Enabling Services***
  - It is the level of maximal interest for developers
  - Provides interfaces and services required in the development process
    - *Programming IDE*
      - Integrates all functionalities supported by the running environment
      - Provides tools for developers (debugger, testing environment,…)
    - *System Control Interfaces*
      - Assured decision making according to certain principles or requirements
      - Describes the installation flow and resources configuration

PaaS major offerings



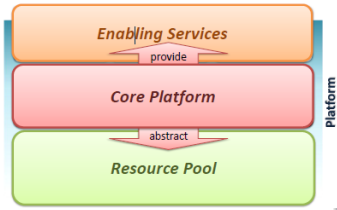
- **iPaaS – integration Platform as a Service**
  - can be used for cloud-to-cloud, cloud-to-on-premise, or even on-premise-to-on-premise integration including legacy applications
  - Without proper integration tools on the long term, this would raise serious issues by creating connections liable to break by software upgrades, or possibly by additional integrations (Master Course – MOM, ESB,…)

iPaaS

Figure 1: Magic Quadrant for Data Integration Tools

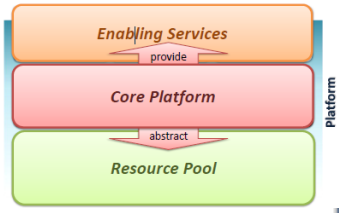
Source: Gartner (August 2022)

PaaS major offerings



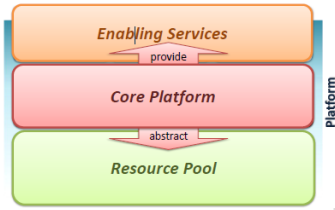
- aPaaS – application Platform as a Service
  - **Instance aPaaS**
    - layer lies at the bottom of aPaaS stack, closer to IaaS Layer
    - Instance aPaaS solution providers take responsibility for managing development and deployment components, including on-demand instance creation, Web application and database servers, monitoring and process management, databases et.al.
    - Instance aPaaS tenants are experienced software developers and systems programmers who get direct command line access to the operating system but have to take care of all the details of actually deploying the code

PaaS major offerings



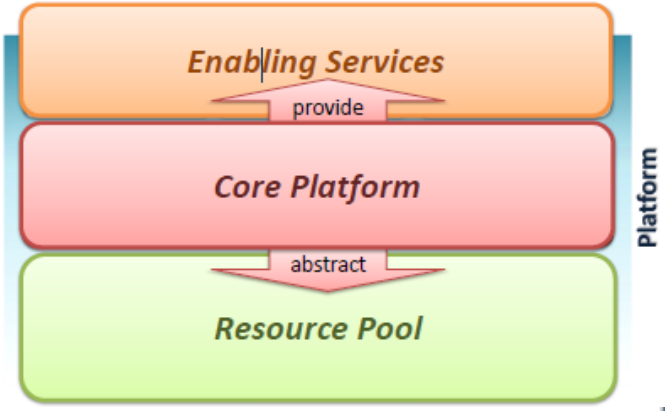
- aPaaS – application Platform as a Service
  - **Framework aPaaS**
    - developers deploy code conforming to framework conventions and let the platform worry about deploying code
    - Framework aPaaS presents a platform stack chosen by the provider and it is often tightly coupled to its infrastructure
      - E.g. Google App Engine abstracts Java and Python application server instances using the Servlet request model and common gateway interface (CGI)
      - Salesforce.com's Heroku is another example of framework aPaaS
    - framework aPaaS may provide additional features such as monitoring, community features for the operation phase with integration with other elements of the framework => advantages with additional features without any configuration problem

PaaS major offerings



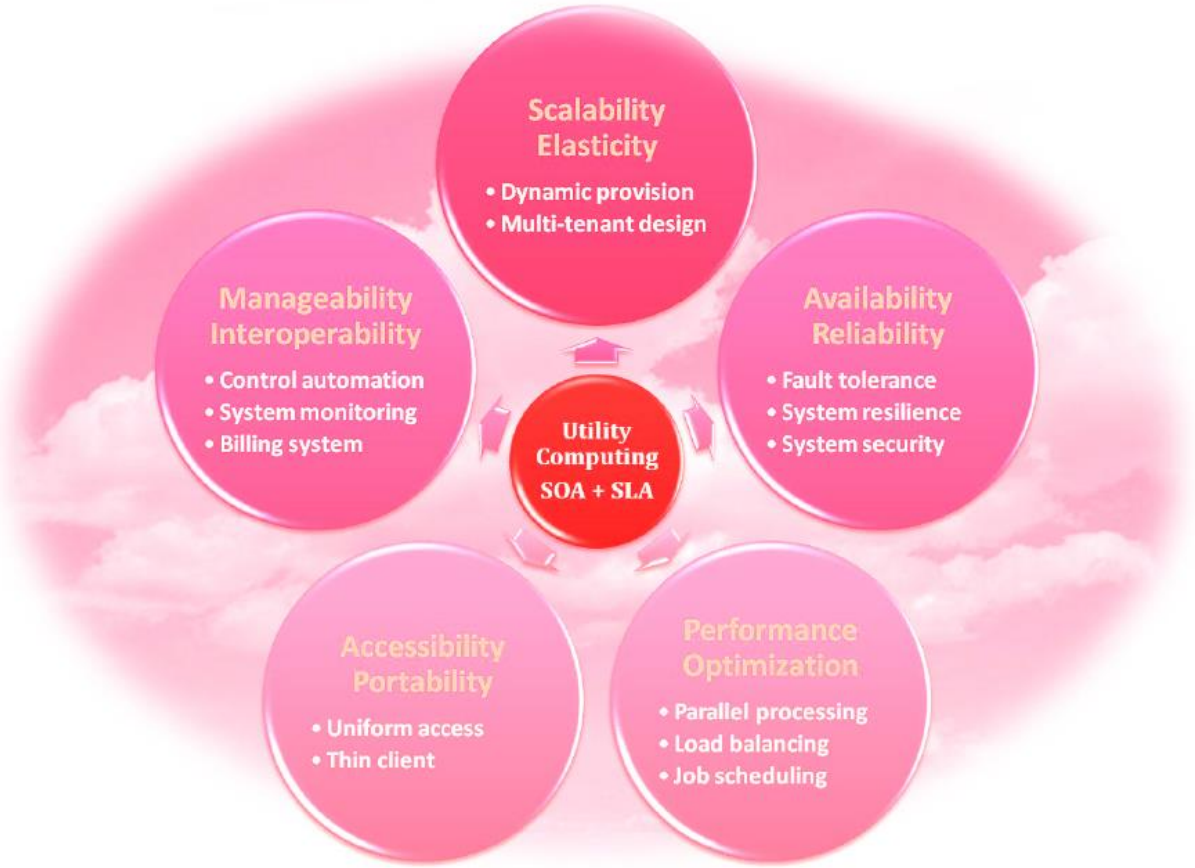
- aPaaS – application Platform as a Service
  - **Metadata aPaaS**
    - metadata aPaaS offers visual tools to customize data models, application logic, workflow, and user interfaces
    - enables users (including nondevelopers) to customize applications according to their own business needs.
    - metadata aPaaS is a metadata-driven application development environment that targets novice coders with a cloud computing application development framework for building standalone and / or integrated applications
    - Examples: Force.com, ImonaCloud.com, Mendix.com, OrangeScape.com

PaaS



PaaS – proprieties and characteristics

- *Scalability*
- *Availability*
- *Manageabilit*
- *Performance*
- *Accessibility*



Cloud Computing

Properties:

- ***Scalability***
  - PaaS provides dynamically allocated resources
  - PaaS provide abstractization of cloud infrastructure and dynamic management

- ***Availability***
  - PaaS provides fault tolerance and the system does not fail
  - PaaS also provides *resilience* by replicating applications and services
    - Automated Backup and recovery in case of natural disasters
    - When a resource fails, PaaS will engage the reserve resource
    - When an application error occurs, PaaS will migrate services to another replicated instance

There is no error

Cloud Computing

Proprieties:

•*Manageability*

- PaaS provides automated mechanisms for resource usage control
- PaaS provides monitoring services that support management and job assessment
- Users pay for use (bandwidth, CPU, storage space, data migration)

• Performance

- PaaS assures unused resources

allocation to jobs and load balancing

Cloud Computing

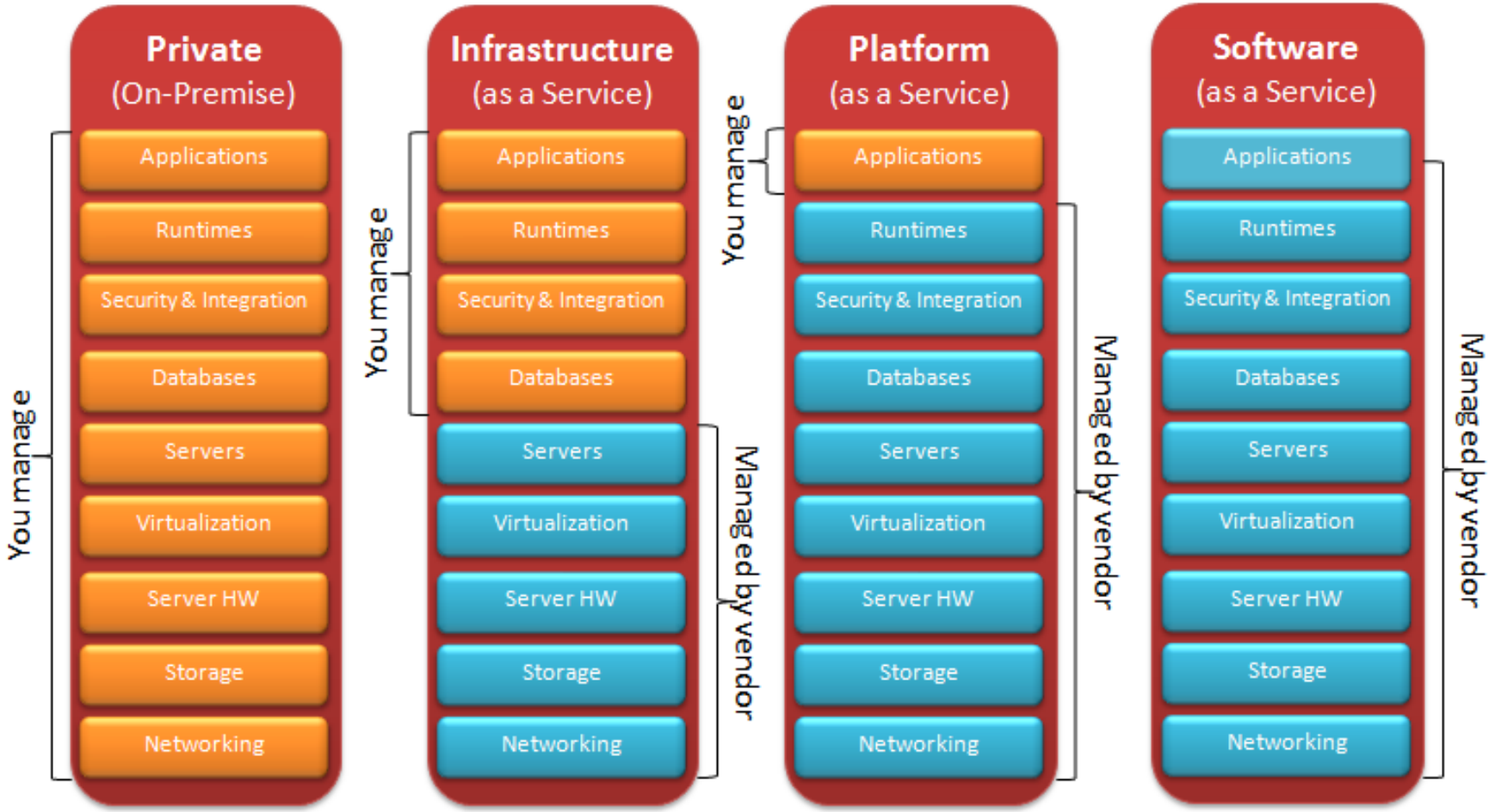
Proprieties:

- *Security*
  - PaaS provides authentication and authorization services to differenciate access rights

- *Accessibility*
  - Developers may design and test applications via web browsers or various *thin clients*

=> " *PaaS is a magic box …*"

Cloud Services Providers (IaaS and/or PaaS and/or SaaS)



[Microsoft]

Magic Quadrant

Figure 1. Magic Quadrant for Cloud Infrastructure as a Service, Worldwide

Source: Gartner (August 2016)

Gartner's Magic Quadrant for Cloud Infrastructure as a Service, Worldwide June 2017

Gartner's Magic Quadrant for Cloud Infrastructure as a Service, Worldwide April 2018

Figure 1. Magic Quadrant for Cloud Infrastructure as a Service, Worldwide

Source: Gartner (May 2018)

Gartner's Magic Quadrant for Cloud Infrastructure and Platform Services, 2022

AWS's " *vibrant and thriving ecosystem* ", Azure's " *solution-oriented and hybrid multicloud approach* ", Google Cloud's "*sovereign controls and progress in talking to businesses* ".

Magic Quadrant

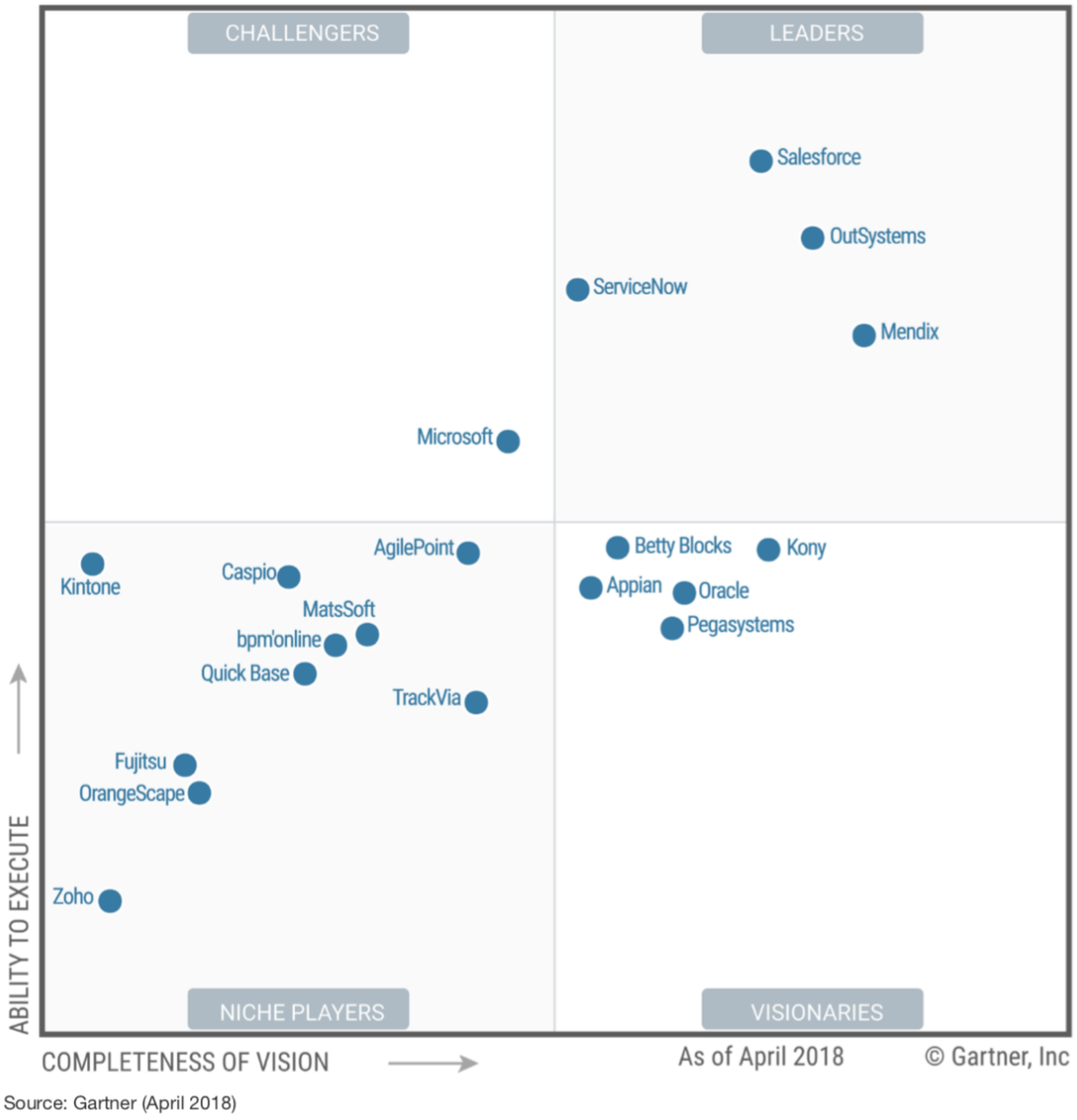
Figure 1. Magic Quadrant for Enterprise Application Platform as a Service, Worldwide

Source: Gartner (March 2016)

Figure 1. Magic Quadrant for Enterprise High-Productivity Application Platform as a Service

Source: Gartner (April 2017)

Cloud Computing



Source: Gartner (April 2018)

Cloud Computing

CRM Software & Cloud Computing Solutions - Salesforce EMEA
https://www.salesforce.com/eu/
CRM software solutions and enterprise cloud computing from Salesforce, the leader in customer relationship management (CRM) and PaaS. Free 30 day trial.

Salesforce.com - Force.com
Salesforce.com – stand out through a successful enterprise SaaS appplication (CRM)
Force.com – PaaS, hosted in the Salesforce infrastructure, where the developers are using the Apex programming language

There is integration between Google and Salesforce.com, a.s. an application developed in GAE may access the data store in Salesforce

Mendix
Cloud computing company

mendix.com

Mendix is a low-code software platform developed by the company of the same name. Low-code application development makes it possible to build web and mobile applications reducing the need to code with traditional procedural computer programming. Wikipedia

Headquarters: Boston, Massachusetts, United States

Founded: 2005

Number of employees: Approximately 300 (2017)

OutSystems

Products [edit]

The OutSystems Platform is a high-productivity platform as a service (PaaS) intended for developing and delivering enterprise web and mobile applications, which run in the cloud, on-premises or in hybrid environments. The current version is 10, for both the paid and unpaid versions - developers are permitted personal cloud environments to use the platform without charge.

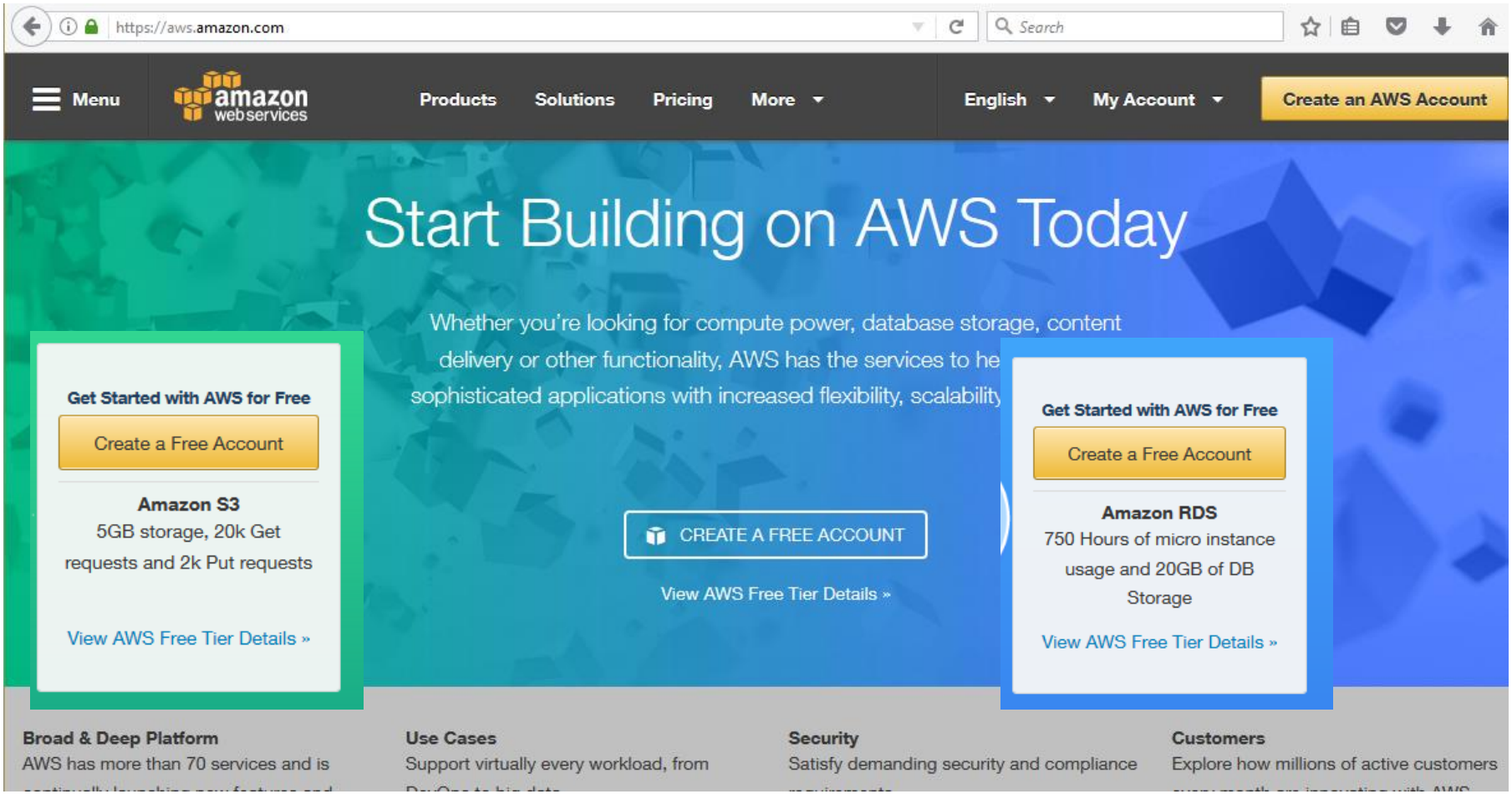
Company history [edit]

- In October 2017, OutSystems was named a leader in The Forrester Wave: Low-Code Development Platforms For AD&D Pros, Q4 2017 [1]
- In August 2017, OutSystems won the CODiE award for Best Mobile Development Solution [2]
- In June 2017, OutSystems was named a leader in the Gartner Magic Quadrant for Mobile App Development Platforms [3]

Cloud Computing

Amazon

http://aws.amazon.com/



Cloud Computing

Amazon

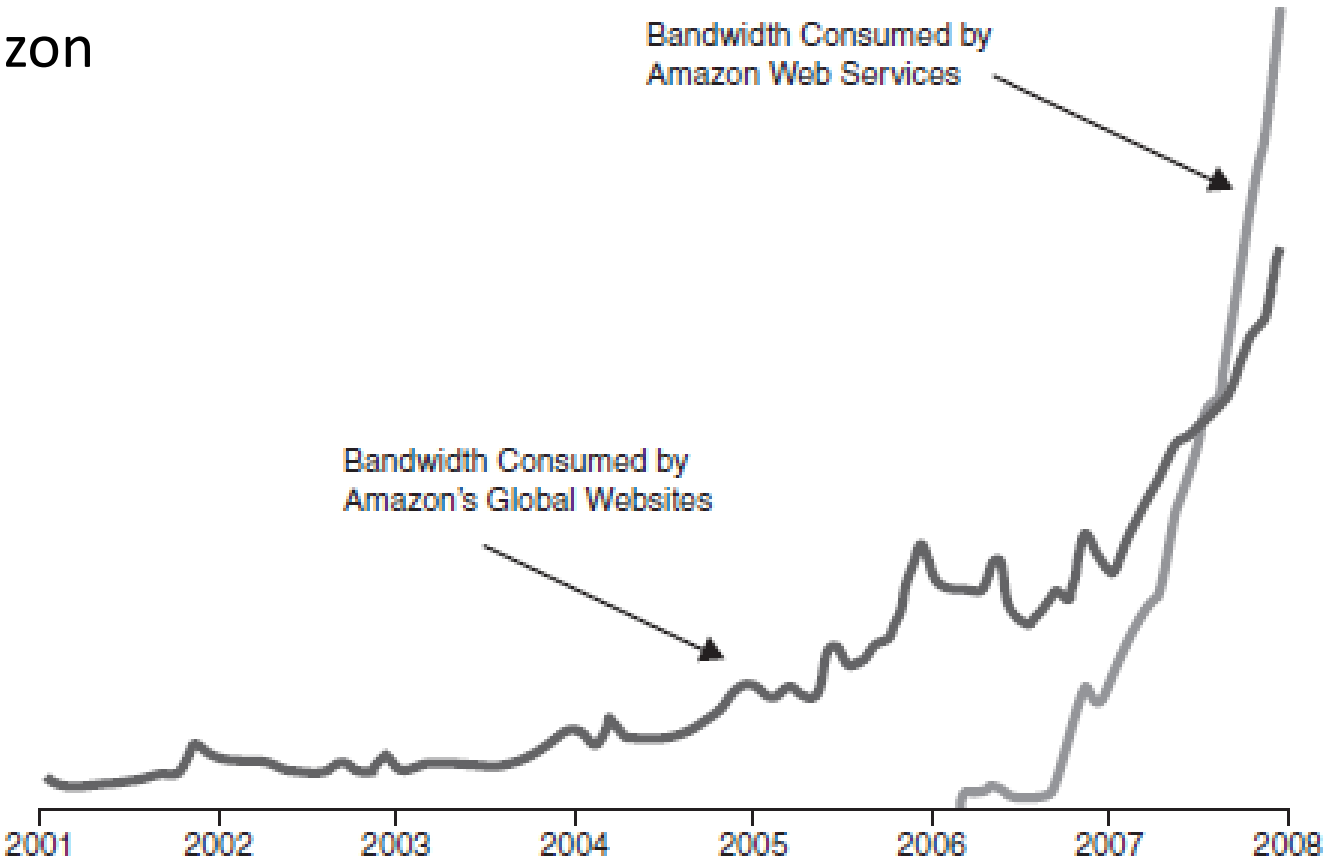


Figure 1.1 Amazon originally deployed a large IT infrastructure to support its global e-commerce platform. In less than 18 months after making the platform available as a cloud service to external users, its usage, as measured by amount of bandwidth consumed, outstripped bandwidth used internally.

The company claimed to have over 500,000 users by the end of 2008

[The Cloud at Your Service,
Jothy Rosenberg ,
Arthur Mateos,]

Cloud Computing

Amazon EC2: IaaS

- Provides support for automated scaling and error handling (these are programed via an API) versus PaaS that supports automated and invisible scaling
- Enables use of any programming language, and provides total control over IaaS
- A common initial configuration for EC2: *LAMP stack (->TW☺)*

L	Linux	Operating system
A	Apache	Web server
M	MySQL	Relational database
P	PHP	Server side of website

- Example of creating an AMI:

http://aws.amazon.com/getting-started/

http://aws.amazon.com/articles/938?_encoding=UTF8&jiveRedirect=1

https://www.youtube.com/watch?v=r4YIdn2eTm4

https://www.youtube.com/watch?v=a9__D53WsUs

Cloud Computing

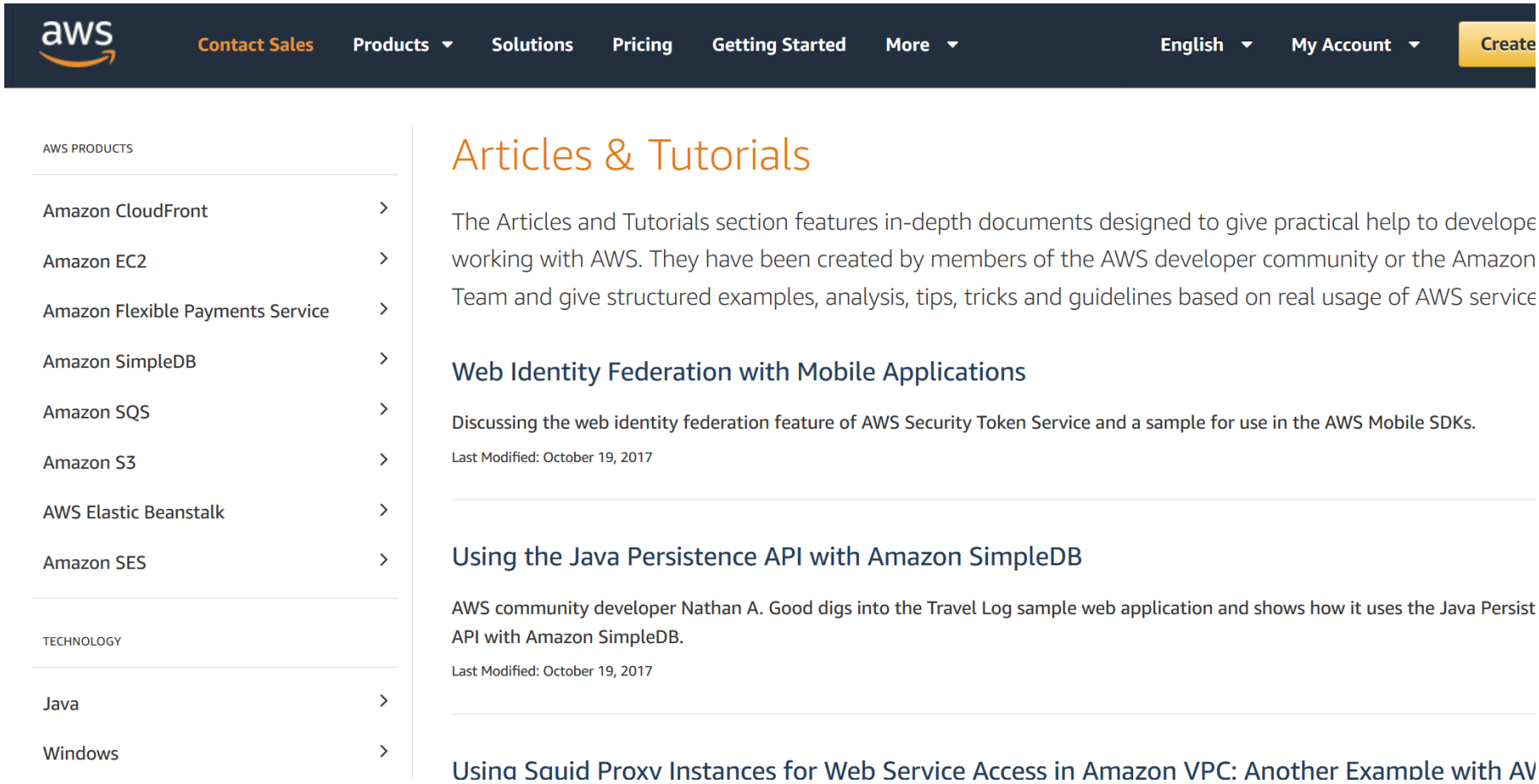
Amazon EC2: IaaS

- Linux Amazon Machine Images use one of two types of virtualization: paravirtual (PV) or hardware virtual machine (HVM)
  - HVM - virtualization type provides the ability to run an operating system directly on top of a virtual machine without any modification, as if it were run on the bare-metal hardware. The Amazon EC2 host system, emulates some or all of the underlying hardware that is presented to the guest
  - PV - Paravirtual guests can run on host hardware that does not have explicit support for virtualization. Historically, PV guests had better performance than HVM guests in many cases, but because of enhancements in HVM virtualization and the availability of PV drivers for HVM things are getting change (https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/UserProvidedKernels.html)
    - (see Virtualisation Course☺)

[https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/virtualization_types.html]

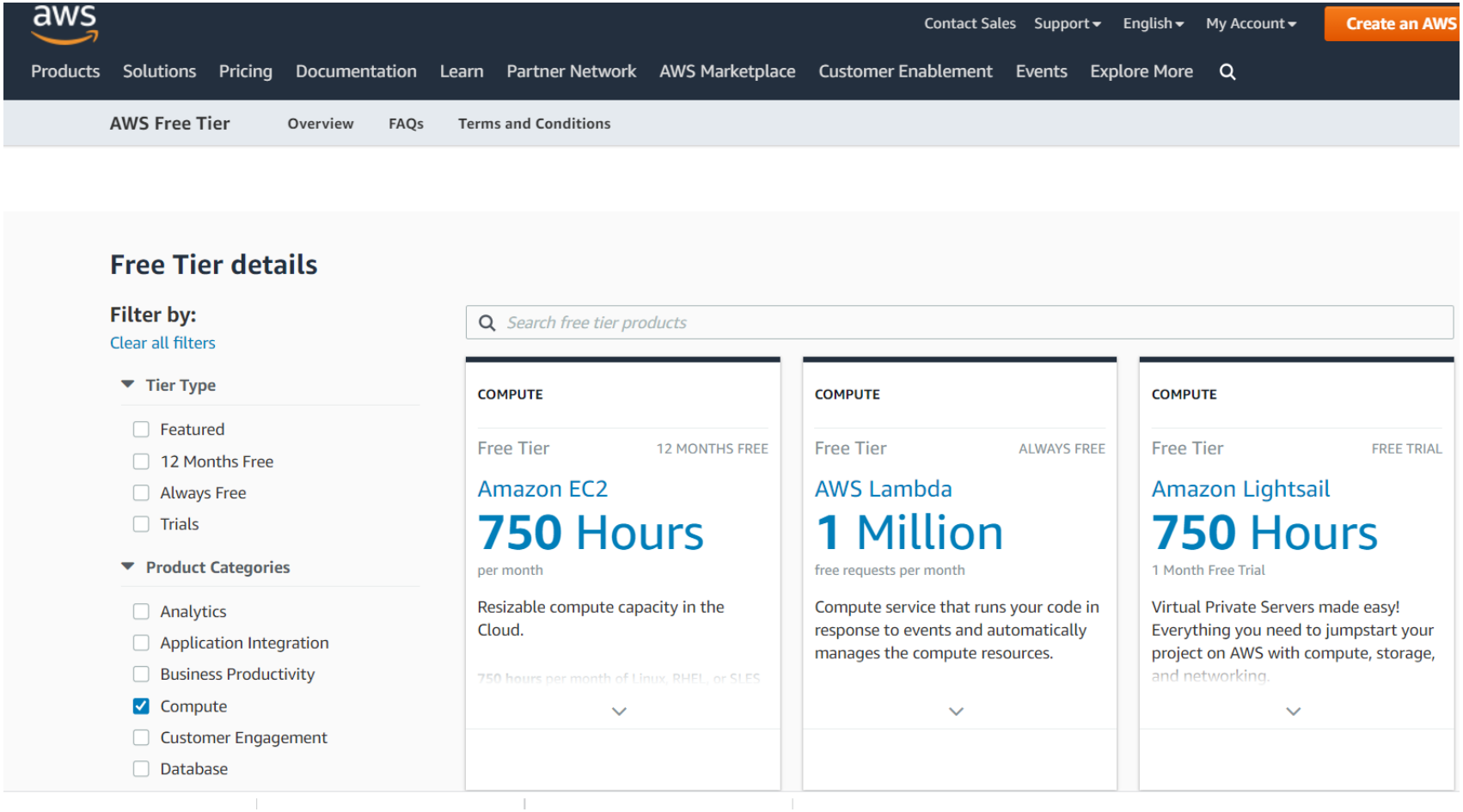
Cloud Computing

Amazon – http://aws.amazon.com/



Cloud Computing

Amazon – http://aws.amazon.com/

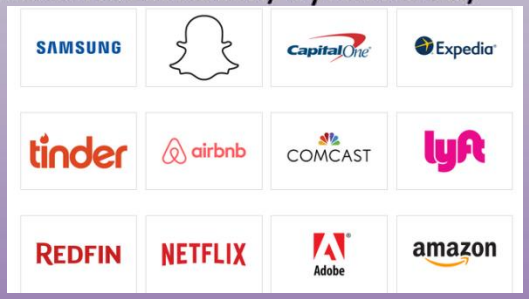


[https://aws.amazon.com/free/?sc_icampaign=acq_aws_takeover-1st-visit-free-tier&sc_ichannel=ha&sc_icontent=awssm-evergreen-1st-visit&sc_iplace=hero&trk=ha_awssm-evergreen-1st-visit&all-free-tier.sort-by=item.additionalFields.SortRank&all-free-tier.sort-order=asc&awsf.Free%20Tier%20Types=*all&awsf.Free%20Tier%20Categories=categories%23compute]

Cloud Computing

Amazon – https://www.youtube.com/watch?v=JIbIYCM48to/

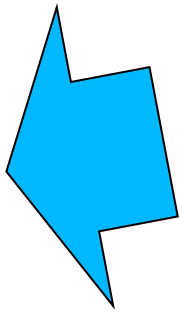
Cloud Computing

Serviciu	Descriere
Simple Storage Service (S3)	-Folosit pentru stocare si regasire de date printr-un API -Este integrat cu EC2: AMI-urile sunt stocate in S3, si datele transferate de la S3 la EC2 nu implica costuri aditionale
DynamoDB http://aws.amazon.com/dynamodb/ 	-serviciu de BD NoSQL cu performante mari privind scalabilitatea si performanta accesului, performantele fiind predictibile • Se folosesc solid state disks (SSDs) pentru raspunsuri rapide si nu exista limite pentru dimensiunea unei tabele • Datele si cererile sunt impartite la servere mutiple
SimpleDB http://aws.amazon.com/simpledb/	-BD NoSQL -limitari ale dimensiunii la 10 GB + limitari la numarul de cereri (~25 de scrieri/secunda) - Scalarea implica management manual (e.g. repartitionarea tabelelor) daca storage-ul depaseste 10GB

Cloud Computing

Amazon – https://aws.amazon.com/simpledb/details/

Machine Utilization Example



Amazon SimpleDB measures the machine utilization of each request and charges based on the amount of machine capacity used to complete the particular request (SELECT, GET, PUT, etc.), normalized to the hourly capacity of a circa 2007 1.7 GHz Xeon processor. Machine utilization is driven by the amount of data (# of attributes, length of attributes) processed by each request. A GET operation that retrieves 256 attributes will use more resources than a GET that retrieves only 1 attribute. A multi-predicate SELECT that examines 100,000 attributes will cost more than a single predicate query that examines 250.

In the response message for each request, Amazon SimpleDB returns a field called Box Usage. Box Usage is the measure of machine resources consumed by each request. It does not include bandwidth or storage. Box usage is reported as the portion of a machine hour used to complete a particular request. For the US East (Northern Virginia) Region and US West (Oregon) Region, the cost of an individual request is Box Usage (expressed in hours) * $0.14 per Amazon SimpleDB Machine Hour. The cost of all your requests is the sum of Box Usage (expressed in hours) * $0.14.

For example, if over the course of a month, the sum of the Box Usage for your requests uses the equivalent of one 1.7 GHz Xeon processor for 9 hours, your charge will be:

9 hours * $0.14 per Amazon SimpleDB Machine Hour = $1.26.

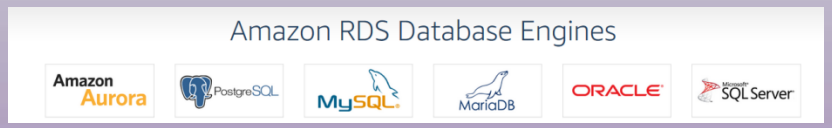
If your query domains are located in the EU (Ireland) Region, Asia Pacific (Tokyo), Asia Pacific (Singapore) Region, Asia Pacific (Sydney) Region, or US West (Northern California) Region, Amazon SimpleDB Machine Hours are priced at $.154 per Machine hour. If your query domains are located in the South America (Sao Paulo) Region, Amazon SimpleDB Machine Hours are priced at $0.19 per Machine Hour. All cost calculations should be adjusted to reflect pricing in the relevant region.

Intended Usage and Restrictions

Your use of this service is subject to the Amazon Web Services Customer Agreement.

Cloud Computing

Amazon – http://aws.amazon.com/

Serviciu	Descriere
Amazon EBS (**Elastic Block Store**) https://aws.amazon.com/ebs/	- Se recomanda a fi folosit ca storage primar pentru un sistem de fisiere sau pentru aplicatii care necesita accesarea de date neformatate (multe citiri /scrieri random) – e.g *Big Data analytics engines* (e.g. Hadoop/HDFS ecosystem)
Amazon Redshift	-Serviciu warehouse ce permite *petabyte-scale data* => utilizarea de instrumente proprii de *business inteligence a*supra datelor proprii - Costuri: minim $0.25/pe ora -> $1,000 per terabyte per an; http://aws.amazon.com/redshift/
Amazon RDS (**Relational Database Service**) 	- Ofera acces la engine-uri SQL cum ar fi: MySQL, Oracle, Microsoft SQL Server, PostgreSQL - Ofera suport pentru scalabilitate *"AWS Free Tier includes **750hrs of Micro DB Instance** each month for one year, **20GB of Storage**, and **20GB for Backups** with Amazon Relational Database Service (RDS)."*

Cloud Computing

Amazon – http://aws.amazon.com/

Serviciu	Descriere
Amazon Cloud Watch	*Amazon CloudWatch to collect and track metrics, collect and monitor log files, set alarms, and automatically react to changes in your AWS resources* *AWS Free Tier includes 10 Metrics, 10 Alarms, and 1,000,000 API requests with Amazon Cloudwatch.*
AWS IAM (Identity and Access Management)	- Permite accesul securizat a utilizatorilor asupra serviciilor si resurselor
CloudFront CDN	-serviciu distribuit pentru livrarea continutului la viteze foarte mari (concurent pentru Akamai) + filtrarea traficului -modelul pay-as-you-go
Simple Queque Service (SQS)	- Sistem de management al mesajelor trimise intre computere => ajuta la crearea de workflow-uri automate intr-un sistem distribuit

Obs. ! Community Contributed Software…

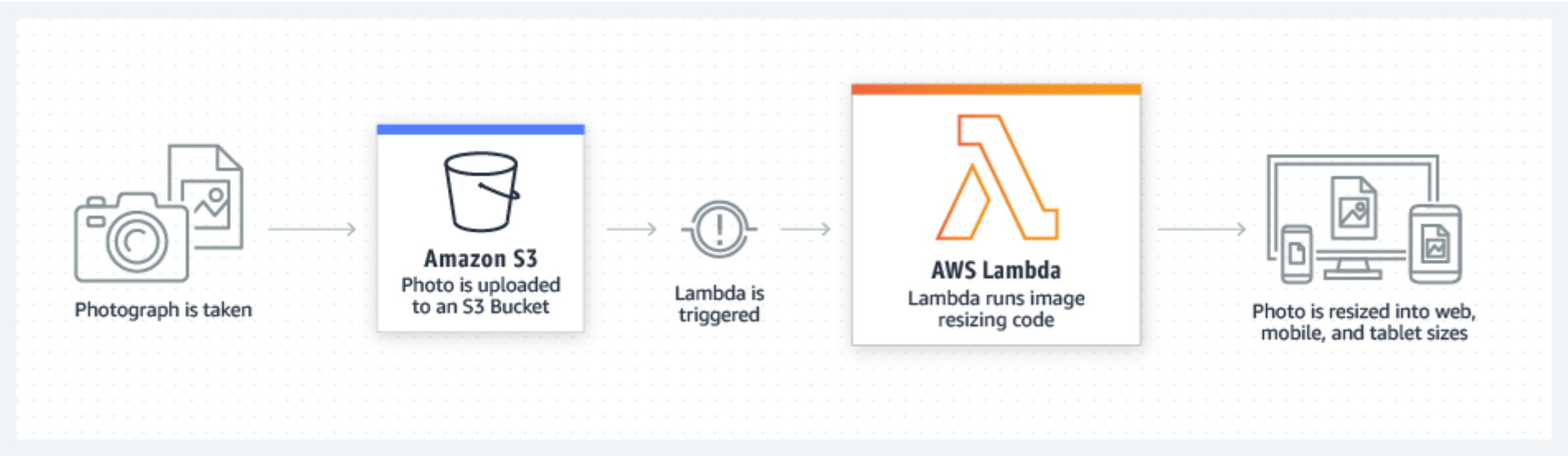
Cloud Computing

1 million requests free

per month with the AWS Free Tier

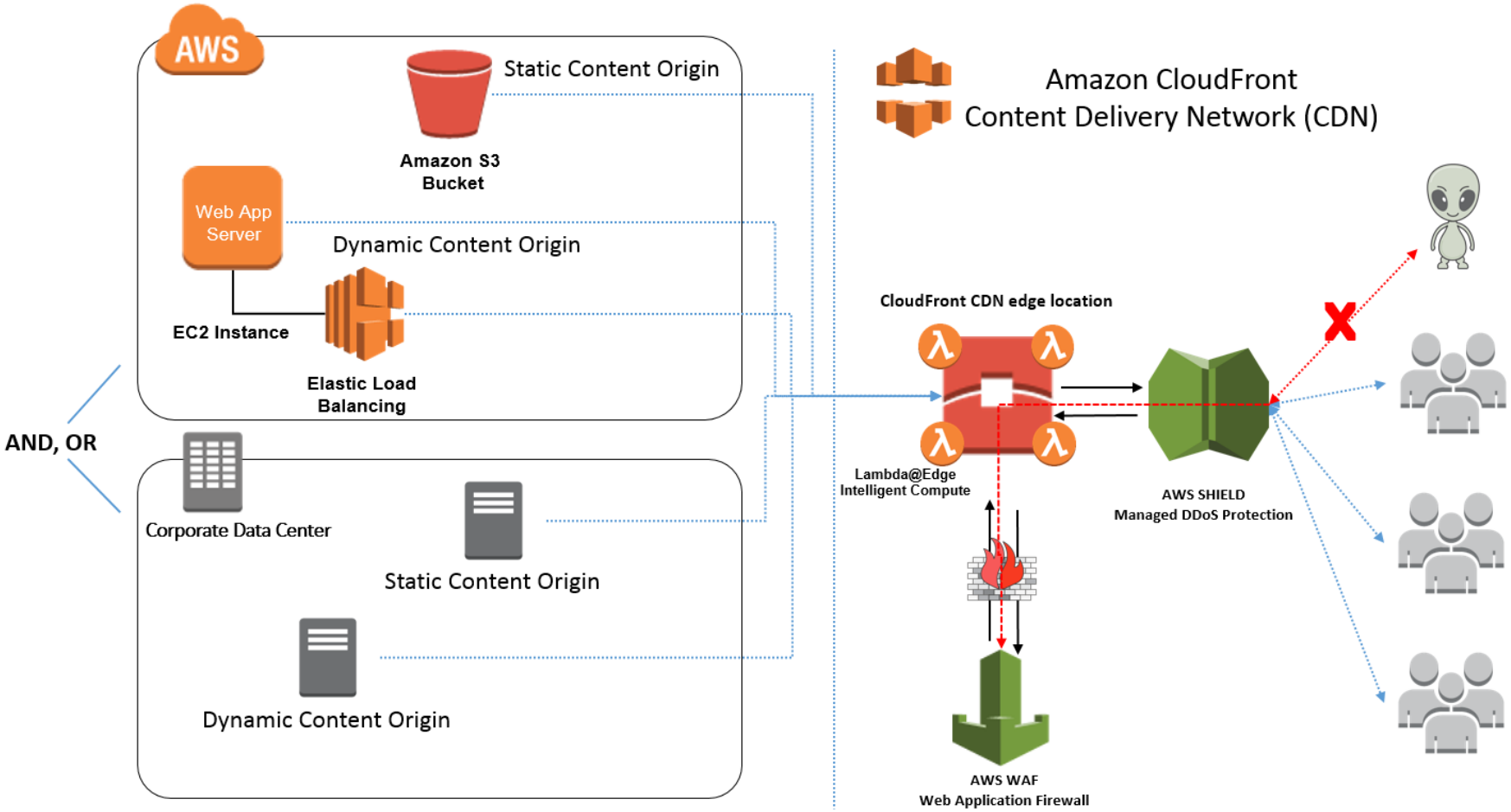
AWS Lambda - https://aws.amazon.com/lambda/

- "Run code without thinking about servers or clusters"
- "AWS Lambda is a serverless, event-driven compute service that lets you run code for virtually any type of application or backend service without provisioning or managing servers. You can trigger Lambda from over 200 AWS services and software as a service (SaaS) applications, and only pay for what you use."

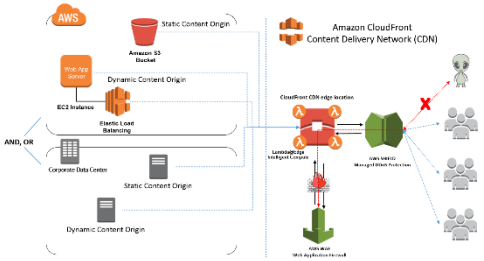


Cloud Computing

Amazon CloudFront CDN



Cloud Computing



Amazon CloudFront CDN

CloudFront with Lambda@Edge

•*"Lambda@Edge is an extension of AWS Lambda, a compute service that lets you execute functions that customize the content that CloudFront delivers. You can author functions in one region and execute them in AWS locations globally that are closer to the viewer ..."*

- *CloudFront can return different objects to viewers based on the device they're using by checking the User-Agent header, which includes information about the devices*
- *A Lambda function can also make network calls to external resources to confirm user credentials, or fetch additional content to customize a response*
- *Or you could check cookies for other criteria. For example, on a retail website that sells clothing, if you use cookies to indicate which color a user chose for a jacket, a Lambda function can change the request so that CloudFront returns the image of a jacket in the selected color.*

[https://docs.aws.amazon.com/AmazonCloudFront/latest/DeveloperGuide/lambda-at-the-edge.html]

PRODUCTS & SERVICES

- Amazon EC2 Spot Instances
- Product Details
- Pricing
- Getting Started
- Spot Bid Advisor
- FAQs
- Testimonials

RELATED LINKS

- Amazon EC2
- Amazon EC2 Purchasing Options
- AWS Documentation - Spot Instances

Get Started with AWS for Free

Create Free Account

Amazon EC2 Spot Instances

Amazon EC2 Spot instances allow you to bid on spare Amazon EC2 computing capacity. Since Spot instances are often available at a discount compared to On-Demand pricing, you can significantly reduce the cost of running your applications, grow your application's compute capacity and throughput for the same budget, and enable new types of cloud computing applications.

Launch an Amazon EC2 Instance for Free

Try Amazon EC2 for Free

AWS Free Tier includes 750 hours of Linux and Windows t2.micro instances each month for one year. To stay within the Free Tier, use only EC2 Micro instances.

View AWS Free Tier Details »

Introduction to Amazon EC2 Spot Instances

https://aws.amazon.com/ec2/spot/

https://www.youtube.com/watch?v=H24h3DoOZtE

Cloud Computing

The Amazon Cloud is recommended if:

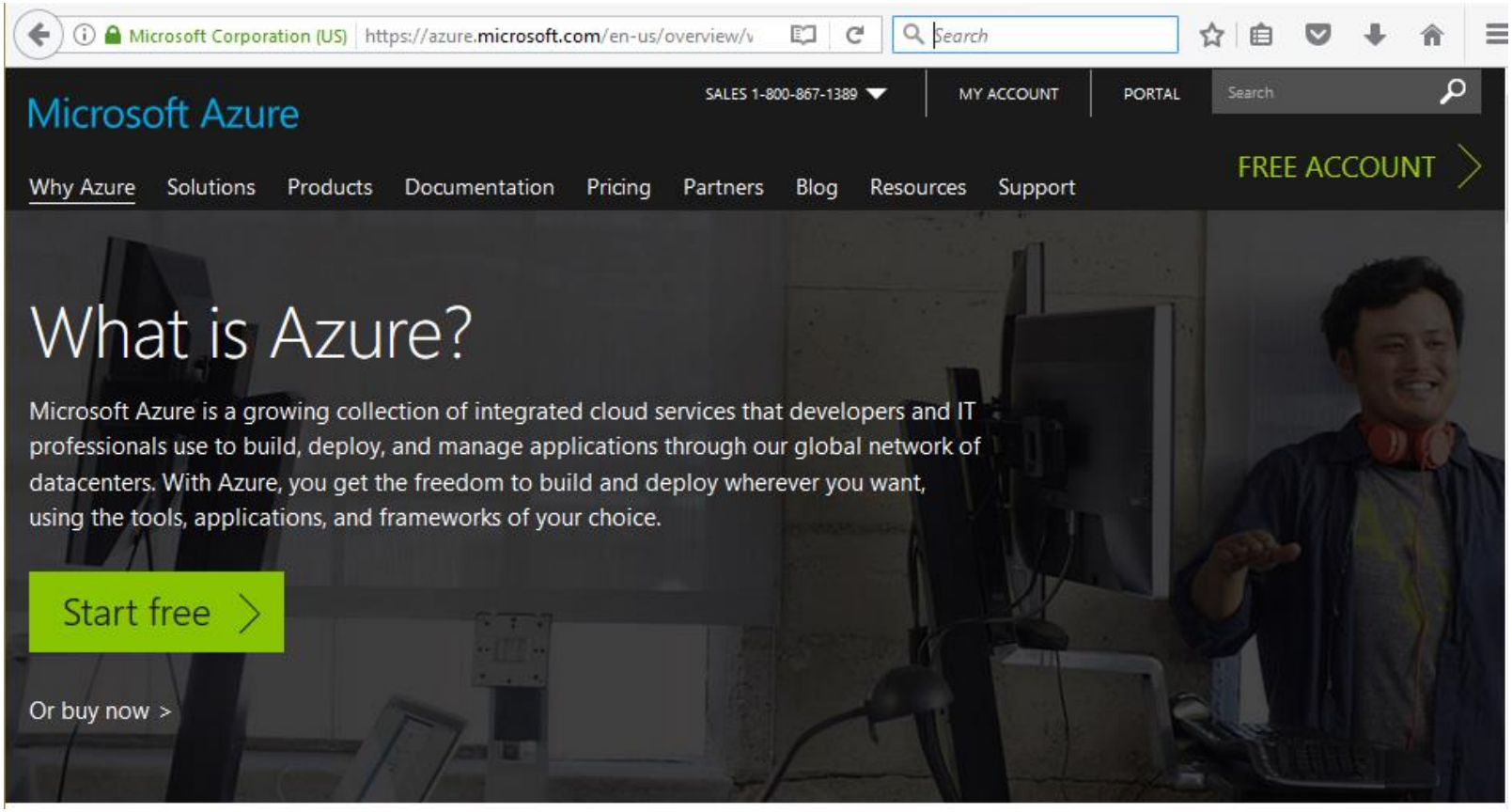
- Using a open-source software from a different provider is considered
- An existent code is available
- The web application transfer on one's own machine is further considered (cca. ~*zero lock-in*)
- Migrating code to a different language
- Total control is required
- Stress/ load tests are required (e.g. *(000) instances)

[https://www.youtube.com/user/AmazonWebServices/videos]

Cloud Computing

Windows Azure

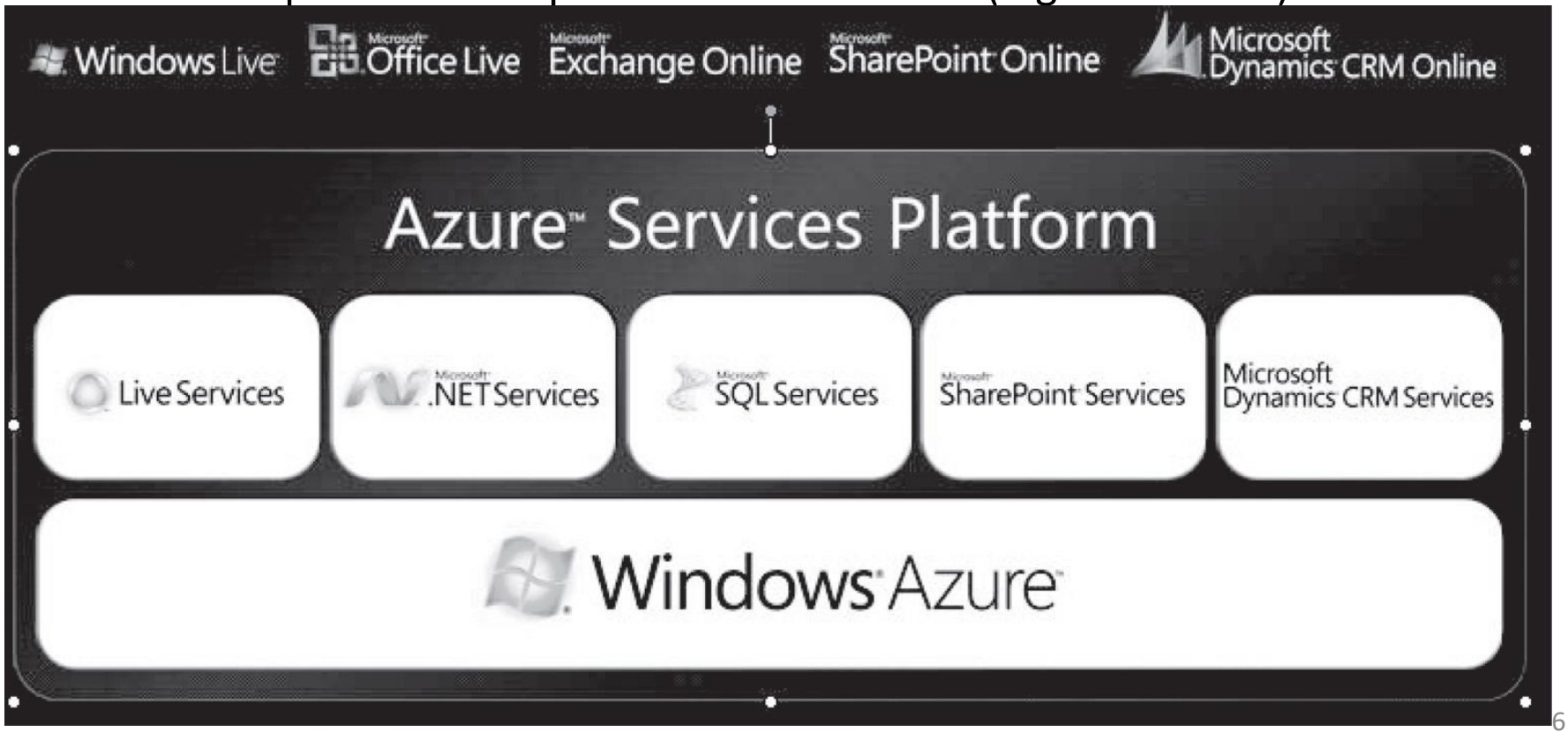
https://www.windowsazure.com/



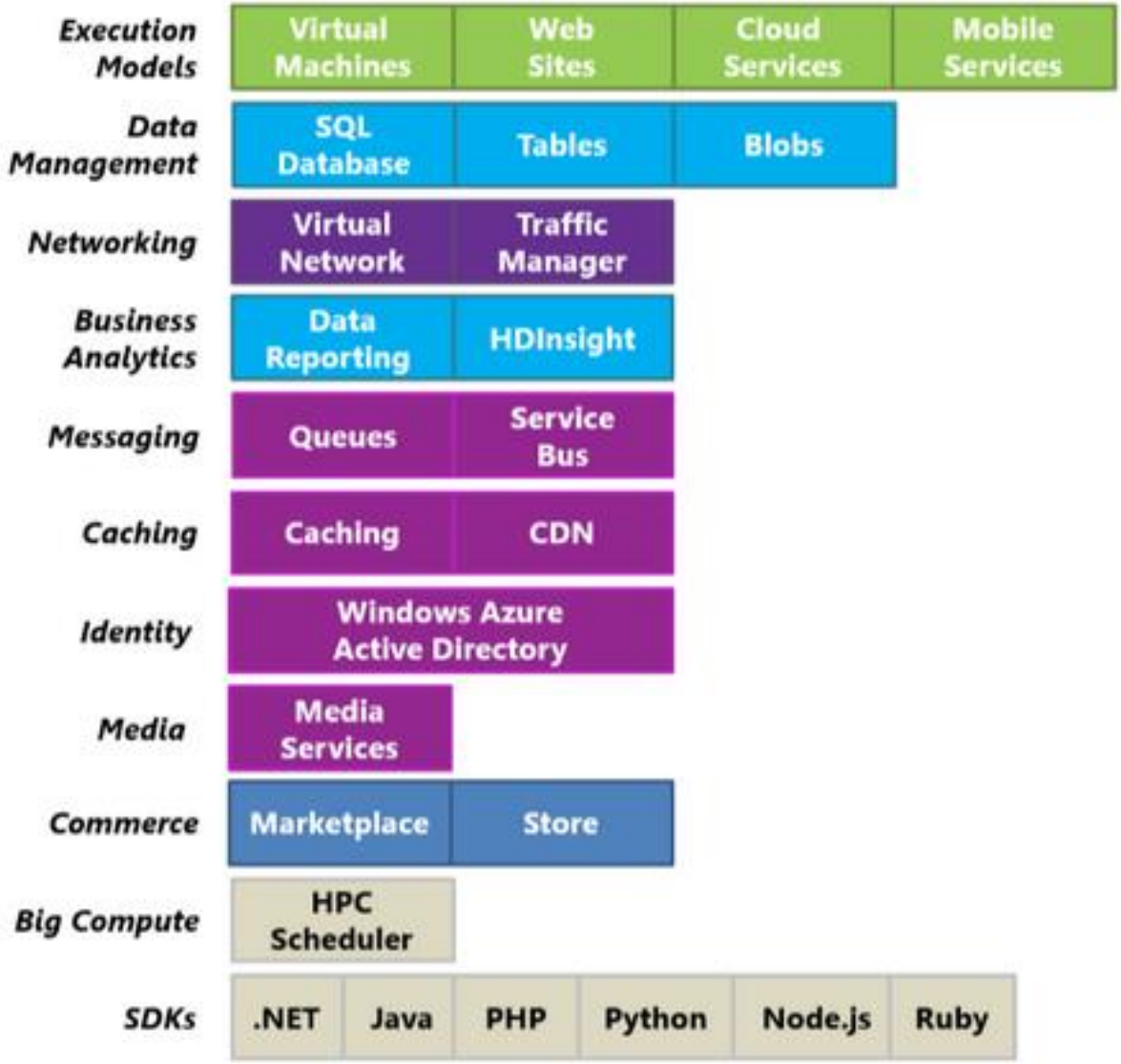
Cloud Computing

Windows Azure

- Provides IaaS services similar to Amazon, but also provides numerous PaaS services
- Multiple end-user Microsoft applications were modified to run in cloud; ; Note: The platform also provides SaaS services (e.g. Office 365)



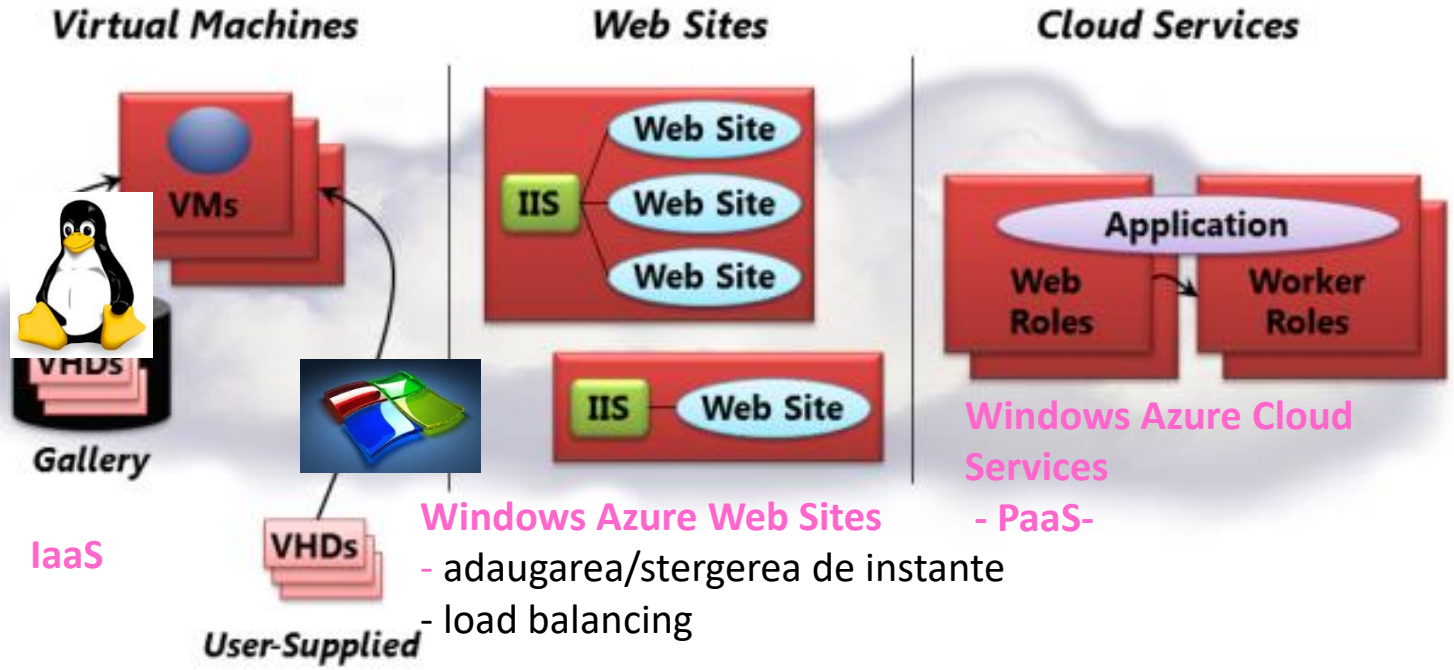
Cloud Computing



[http://www.windowsazure.com/en-us/develop/net/fundamentals/intro-to-windows-azure/]

Windows Azure

Modele de executie



Windows Azure Mobile Services

- Support for cloud data storage, authentication *push notifications*
- Libraries for Android, iOS, HTML/javaScript. Windows Phone, Windows Store

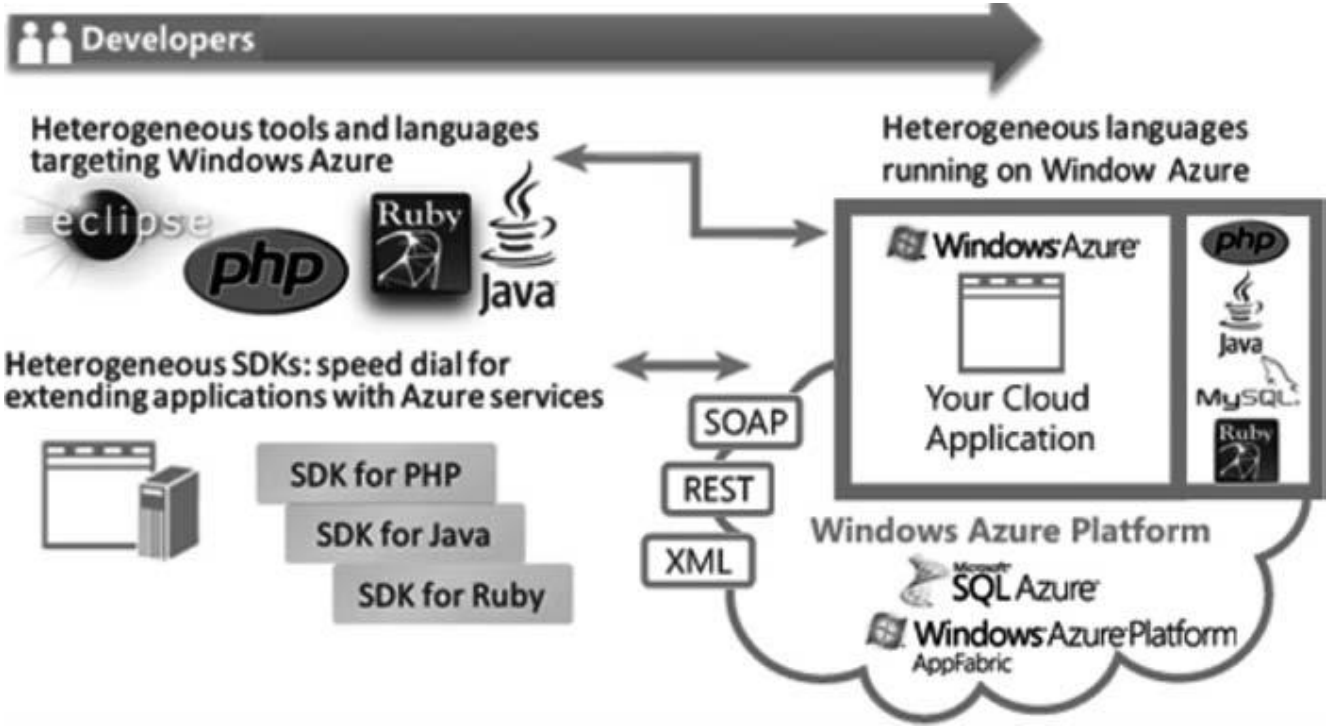
[http://www.windowsazure.com/en-us/develop/net/fundamentals/intro-to-windows-azure/]

Cloud Computing

Windows Azure

Note. Numerous applications were/ are developed for a LAMP platform

Azure provides Windows Azure SDK for node.js, php, java, ruby,… => tools heterogeneity



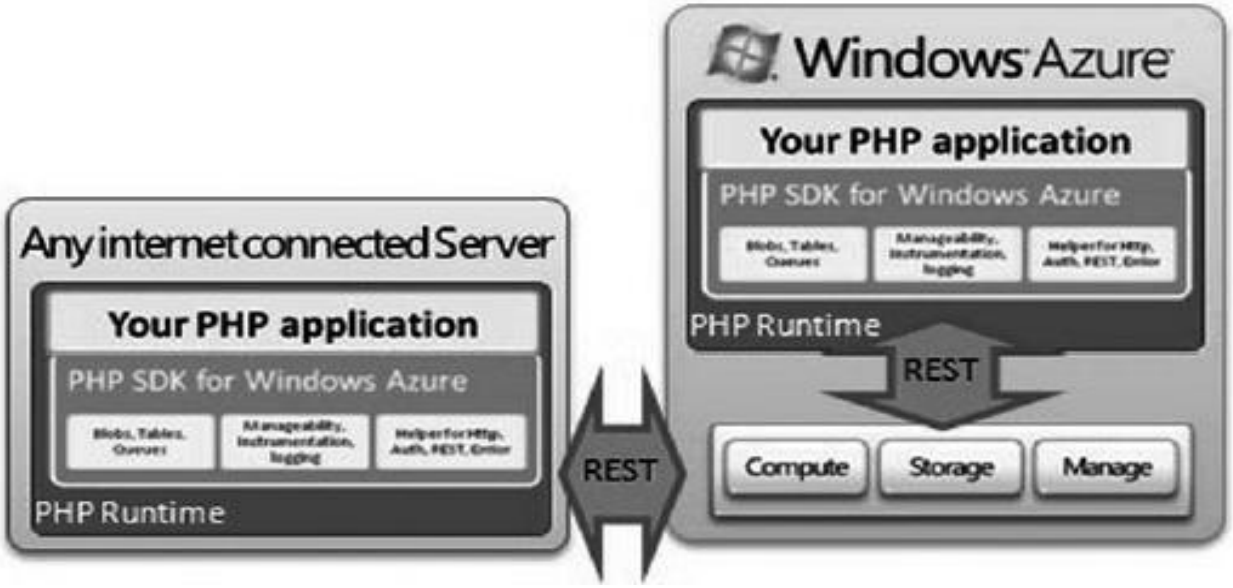
[Implementing and Developing Cloud Computing Applications, David E.Y. Sarna]

Cloud Computing

Windows Azure

Any Internet connected server may access Windows Azure

An application built using Windows Azure SDK (php,…) may access Windows Azure services regardless of the hosting location: Azure platform or an *on-premise* Web server



[Implementing and Developing Cloud Computing Applications, David E.Y. Sarna]

Cloud Computing

Windows Azure – recommended examples:

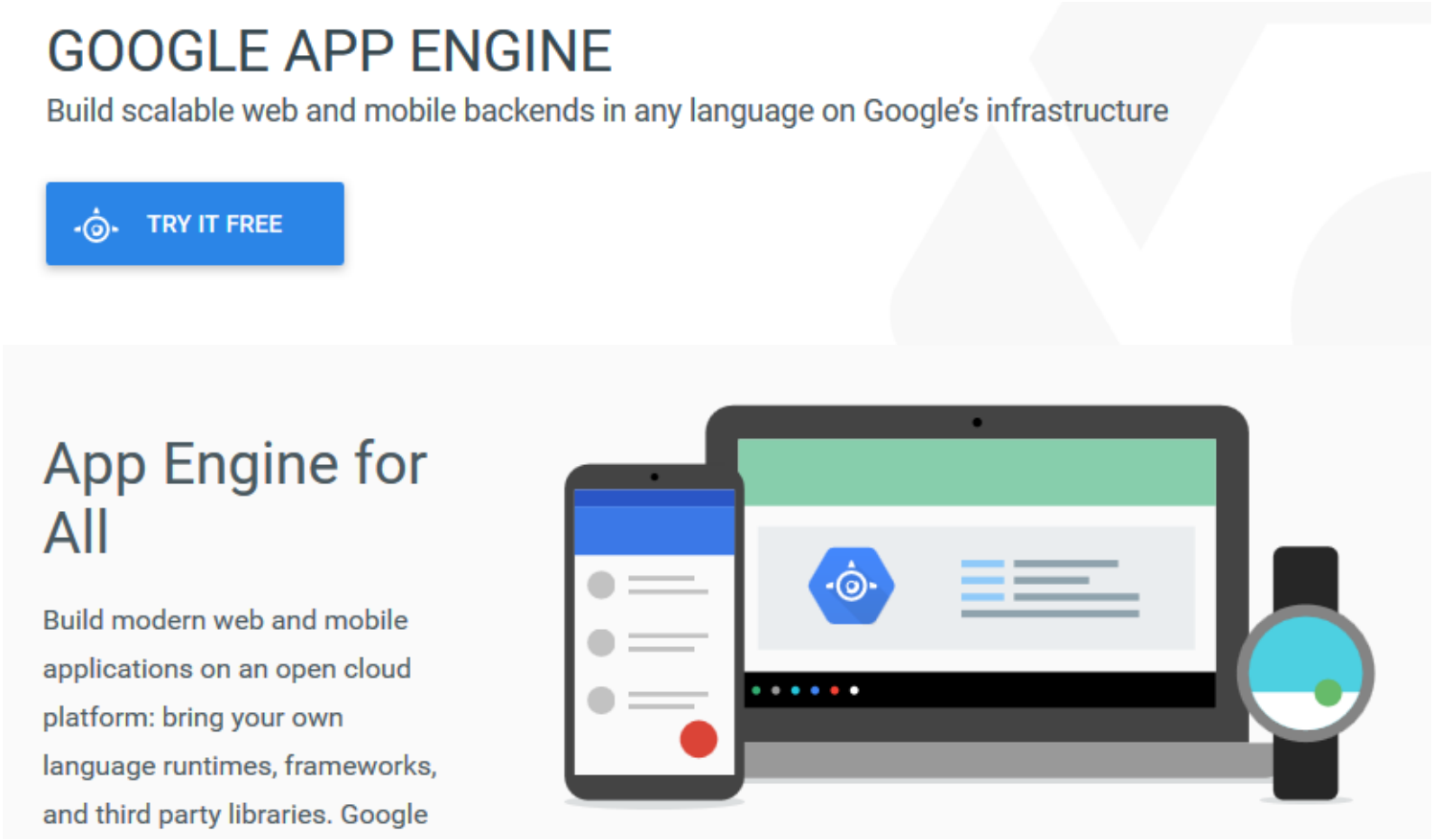
- You are using .Net and SQL Server (parts of Microsoft stack)
- The programming teams are developing applications using Visual Studio
- Combining desktop and cloud development is required
  - The applications may be locally developed and then integrated in cloud; Note. It is recommended that the UI and the logic of data extraction are rewritten to accommodate low-speed Internet connections ;
- There is no issue concerning the "lock-in" to Microsoft

- Note. Elements in the Windows Azure core are based on the well known Sql Server, IIS, .Net framework, that may be provided in a cloud platform by a different company

Cloud Computing

Google Cloud Platform

https://cloud.google.com/docs/



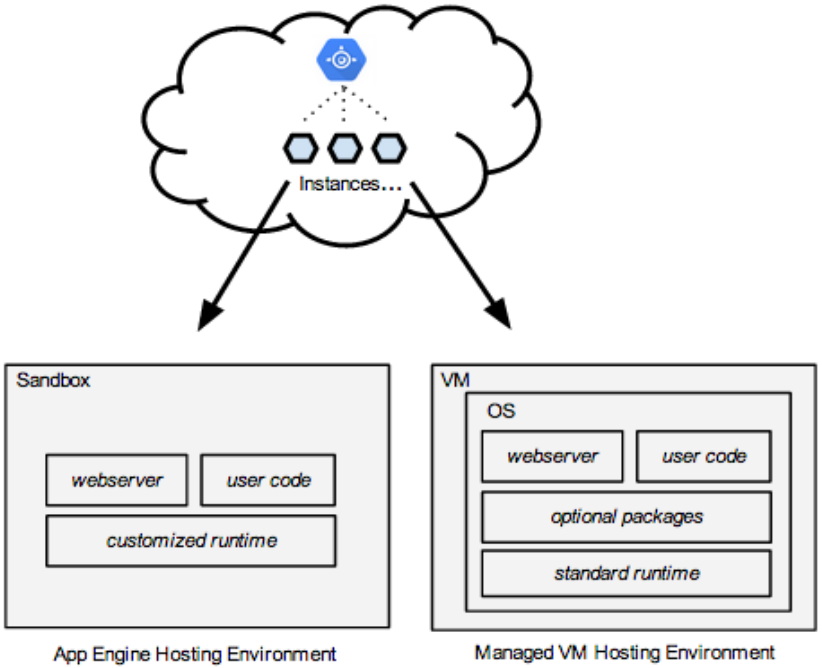
Cloud Computing

Google Cloud Platform

- Provides elements such as virtualization and elasticity visible in IaaS, and also in PaaS – where these are usually almost invisible ; at this level there is *automatic elasticity*
- Google Cloud Platform provides a multitude of services (see future course) such as:
  - *AppEngine - Sandbox* – the applications are running in a safe environment, isolated from the harware level, the operating system and the server physical location
    - This limitation enables the distribution of web requests to various web servers (their allocation/ deallocation) depending in demand increment/ downsize
  - Google Compute Engine (ex. *ManagedVM)*– *"*delivers virtual machines running in Google's innovative data centers and worldwide fiber network.*"*
- An application may comprise modules running in different hosting environments e.g it is possible to use the *sandbox* for frontend and *managed VM* for processing

Cloud Computing

Google App Engine: PaaS



Feature	App Engine sandbox	Managed VM
Instance startup time	Milliseconds	Minutes
Maximum Request Timeout	60 seconds	24 hours
Background threads	Yes, with restrictions	Yes
Background processes	No	Yes
SSH debugging	No	Yes

Cloud Computing

Google App Engine: PaaS

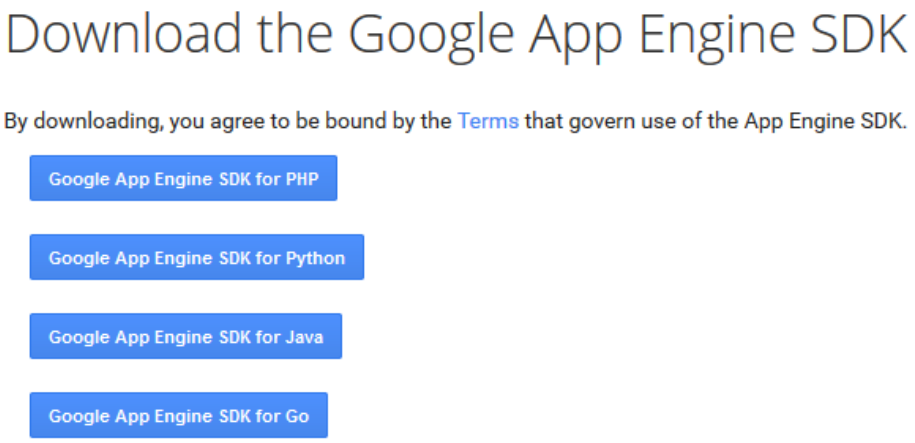
Standard environment

Python | Java | PHP | Go

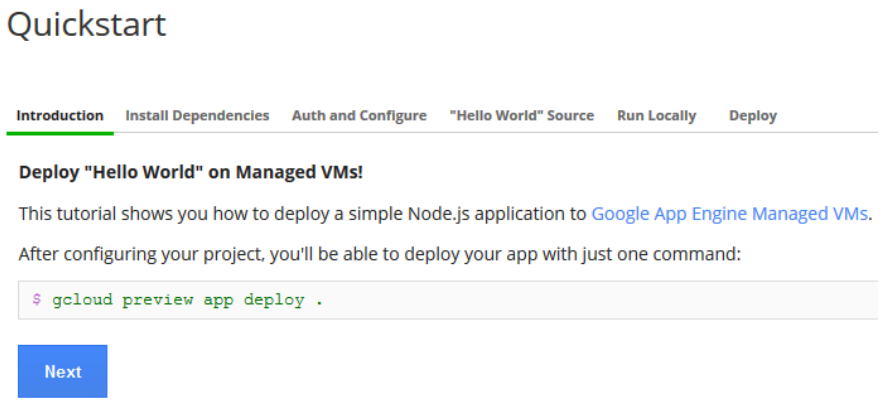
Flexible environment

Python | Java | Node | Go

Ruby | PHP | .NET | Custom Runtimes



-https://cloud.google.com/solutions/nodejs/



Cloud Computing

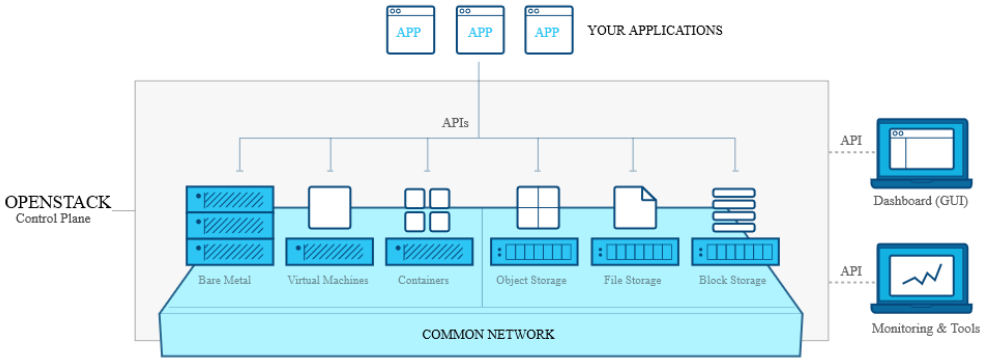
Google App Engine PaaS - *Sandbox* environment – is recommended if:

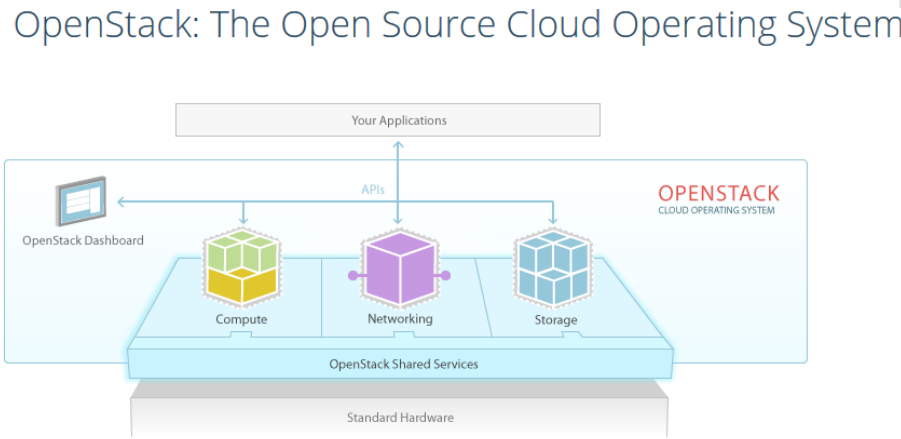
- There is no pre-existent code
- *Mushup* or query-answer applications are developed
- The expedient launch on the market is the foremost aspect
- Software installation is not required
- The "*lock-in*" to Google aspect is not an issue…

Cloud Computing

Open Stack - http://docs.openstack.org

- IaaS provider



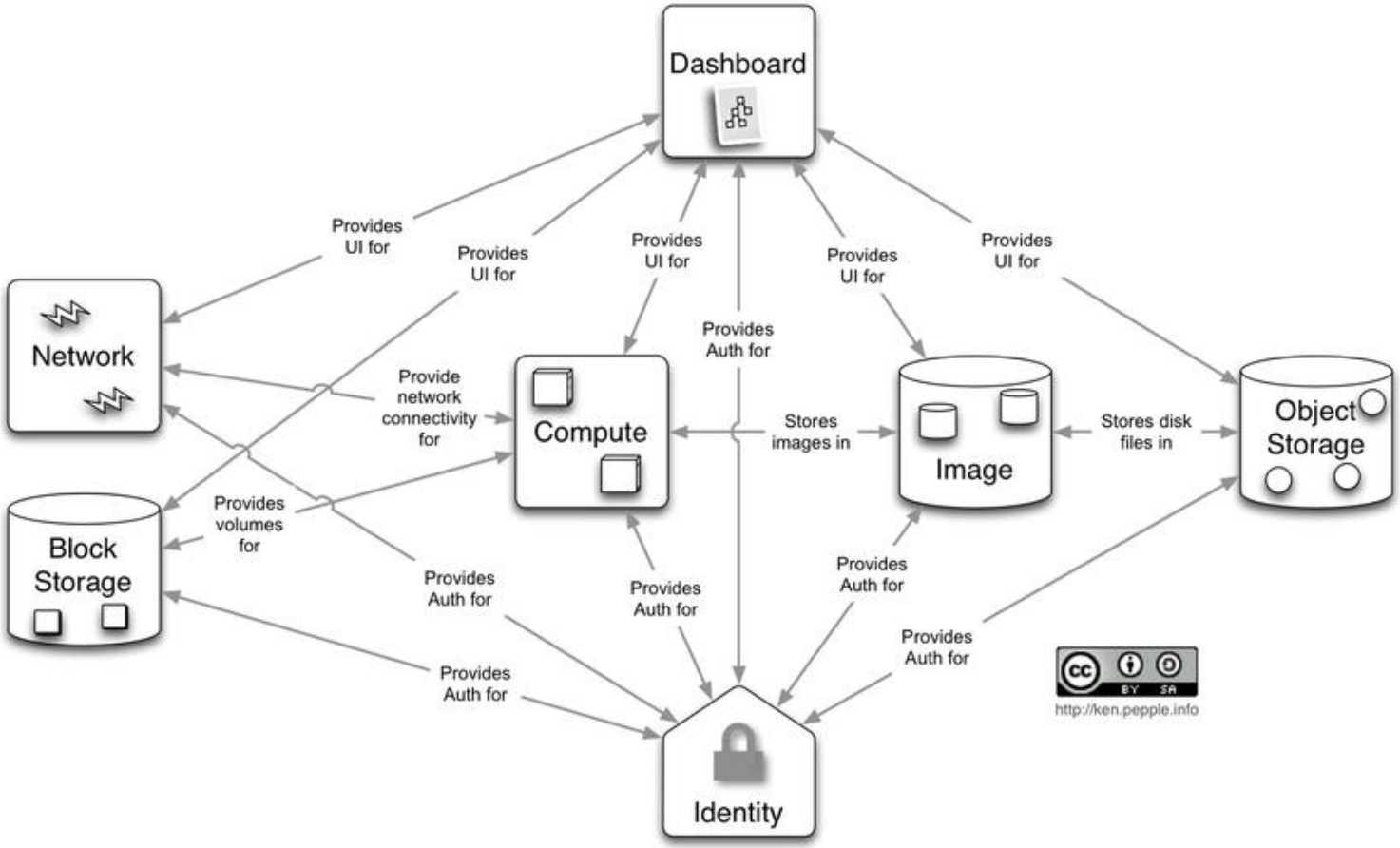


"OpenStack is a cloud operating system that controls large pools of compute, storage, and networking resources throughout a datacenter, all managed through a dashboard that gives administrators control while empowering their users to provision resources through a web interface." (http://www.openstack.org)

Cloud Computing

Open Stack

- http://docs.openstack.org
- IaaS provider



[http://docs.openstack.org/trunk/openstack-compute/admin/content/conceptual-architecture.html]

Cloud Computing

Open Stack

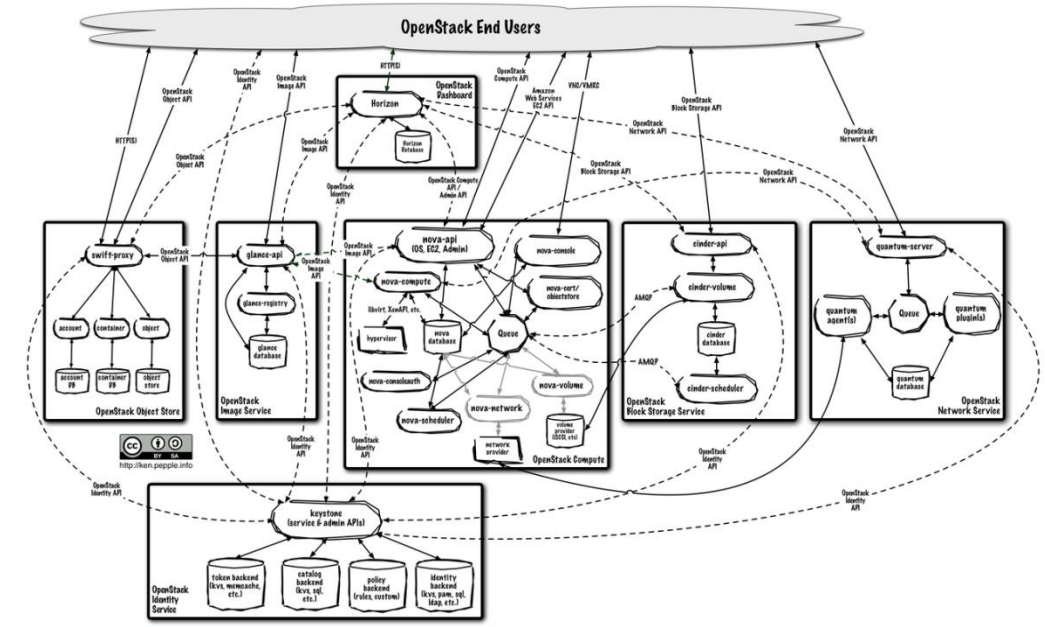
- Dashboard ("Horizon") – front-end for OpenStack services
- Compute ("Nova") – stores and recovers virtual disks ("images") and associated metadata in Image
  - Rackspace and HP are providing enterprise services based on Nova
  - It is used as infrastructure core in Mercado Libre (over 6000 virtual servers) or NASA (the original source)
- Network ("Quantum") – provides virtual network for Compute
- Block Storage ("Cinder") provides persistent storage mechanism for Compute
- Image ("Glance") – enables virtual disks images storage in Object Store
- Object Store ("Swift") – enables file storage and recovery
- Identity ("Keystone") – assures the authentication of all services

[http://docs.openstack.org/trunk/openstack-compute/admin/content/conceptual-architecture.html]

Cloud Computing

Open Stack - architecture

- The final users may interact through an web interface (Horizon) or an API
- All services are autheticated through Keystone
- Individual services interact through public APIs (except only certain administrative commands)



[http://docs.openstack.org/trunk/openstack-compute/admin/content/conceptual-architecture.html]

Open Stack - Projects

Web frontend (1 Results)

HORIZON	Dashboard

Workload provisioning (3 Results)

SAHARA	Big Data Processing Framework Provisioning
MAGNUM	Container Orchestration Engine Provisioning
TROVE	Database as a Service

Compute (3 Results)

IRONIC	Bare Metal Provisioning Service
NOVA	Compute Service
ZUN	Containers Service

Networking (3 Results)

DESIGNATE	DNS Service
OCTAVIA	Load Balancer
NEUTRON	Networking

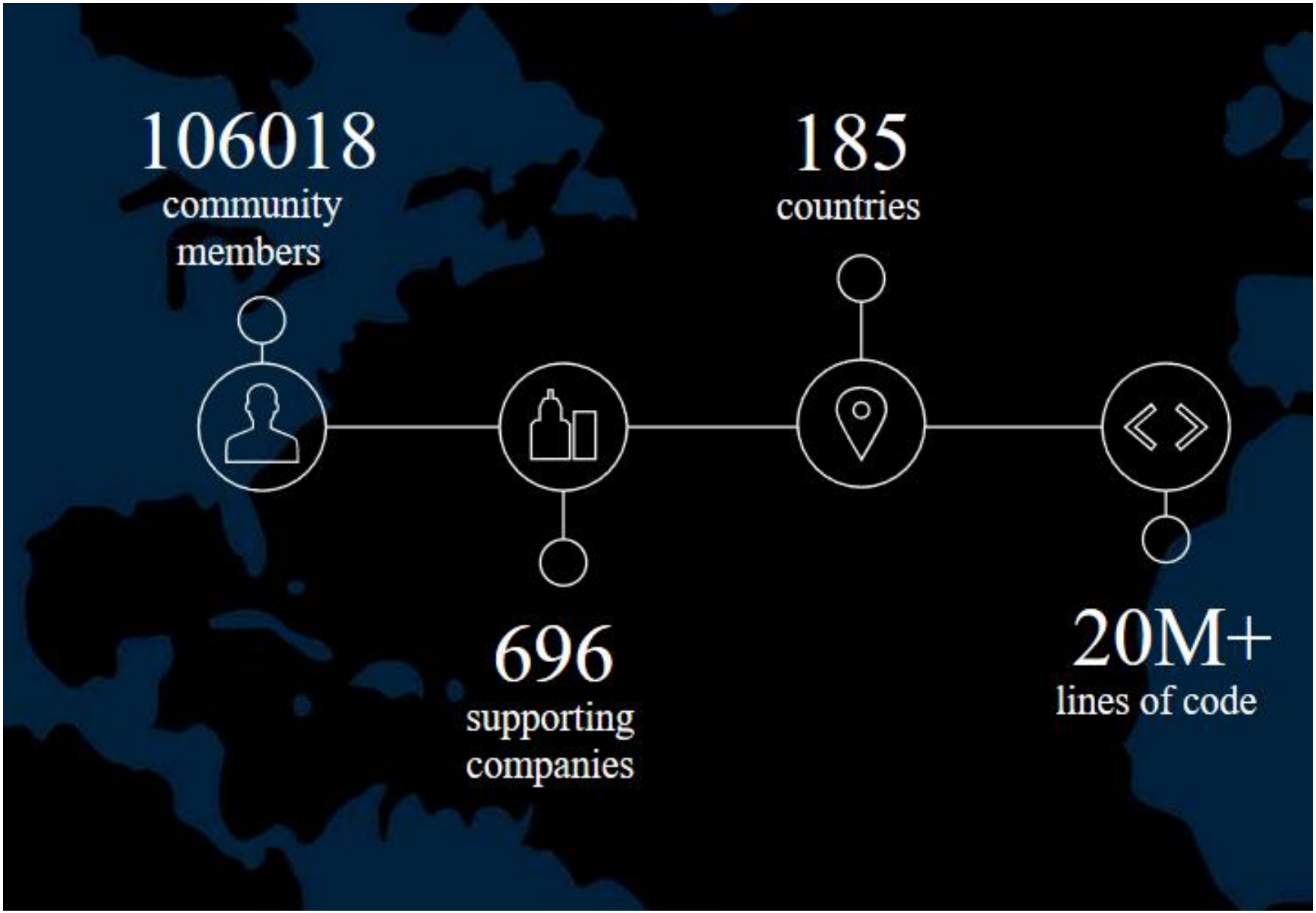
Application lifecycle (3 Results)

MURANO	Application Catalog
FREEZER	Backup, Restore, and Disaster Recovery
SOLUM	Software Development Lifecycle Automation

Orchestration (5 Results)

AODH	Alarming Service
SENLIN	Clustering service
ZAQAR	Messaging Service
HEAT	Orchestration
MISTRAL	Workflow service

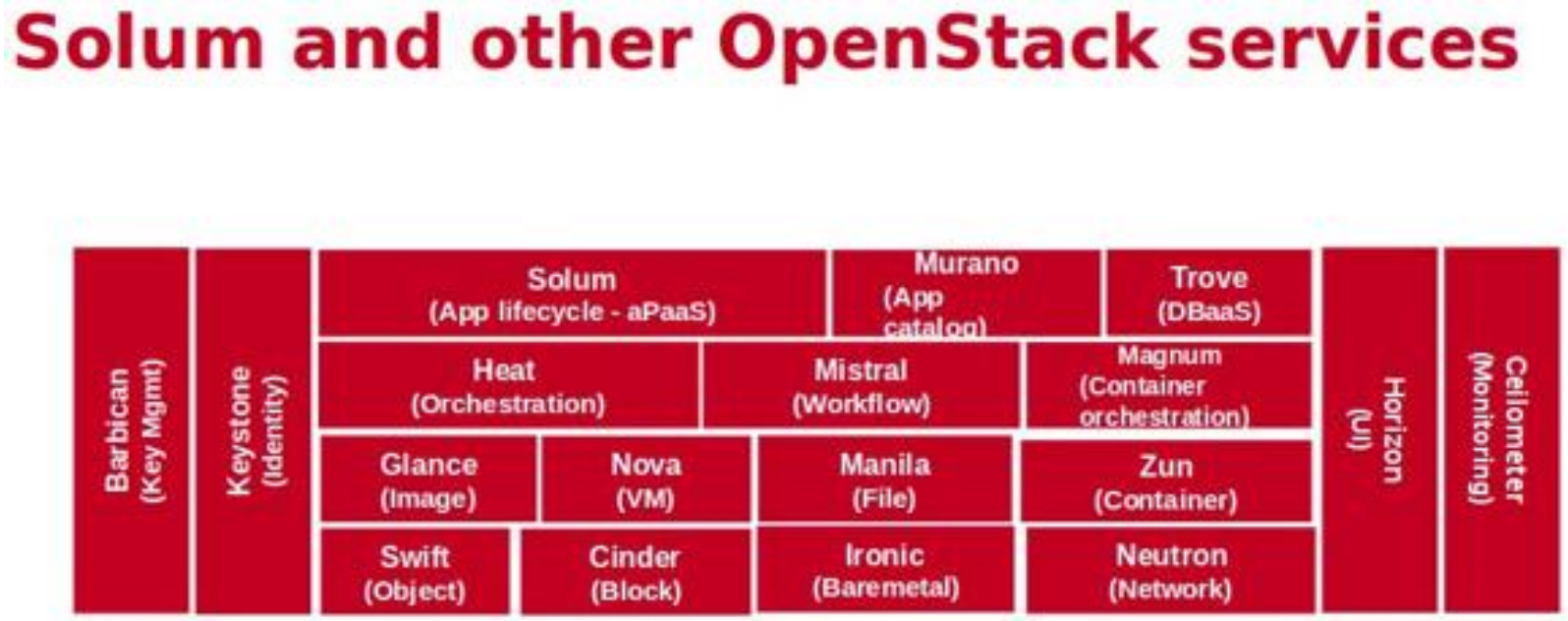
Cloud Computing



Cloud Computing

Open Stack -> aPaaS

- Solum - https://wiki.openstack.org/wiki/Solum
- Solum is natively designed for OpenStack clouds and leverages several other OpenStack projects, including Heat, Keystone, Nova, Trove, and more.

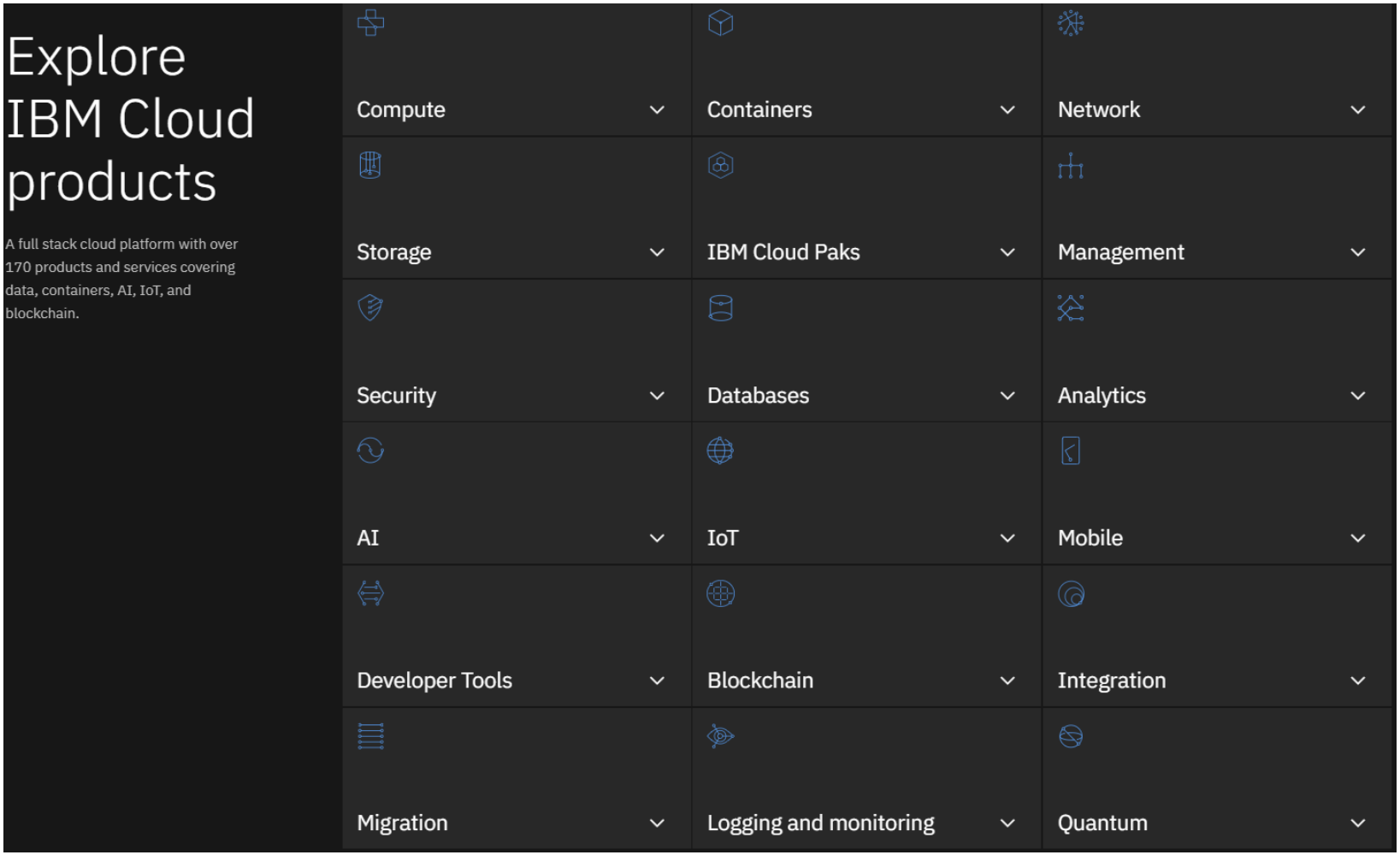


[https://www.openstack.org/videos/vancouver-2015/openstack-docker-and-cloud-foundry-how-does-the-leading-open-source-triumvirate-come-together https://www.openstack.org/summit/portland-2013/session-videos/presentation/cloud-foundry-your-paas-on-openstack]

Cloud Computing

IBM Cloud

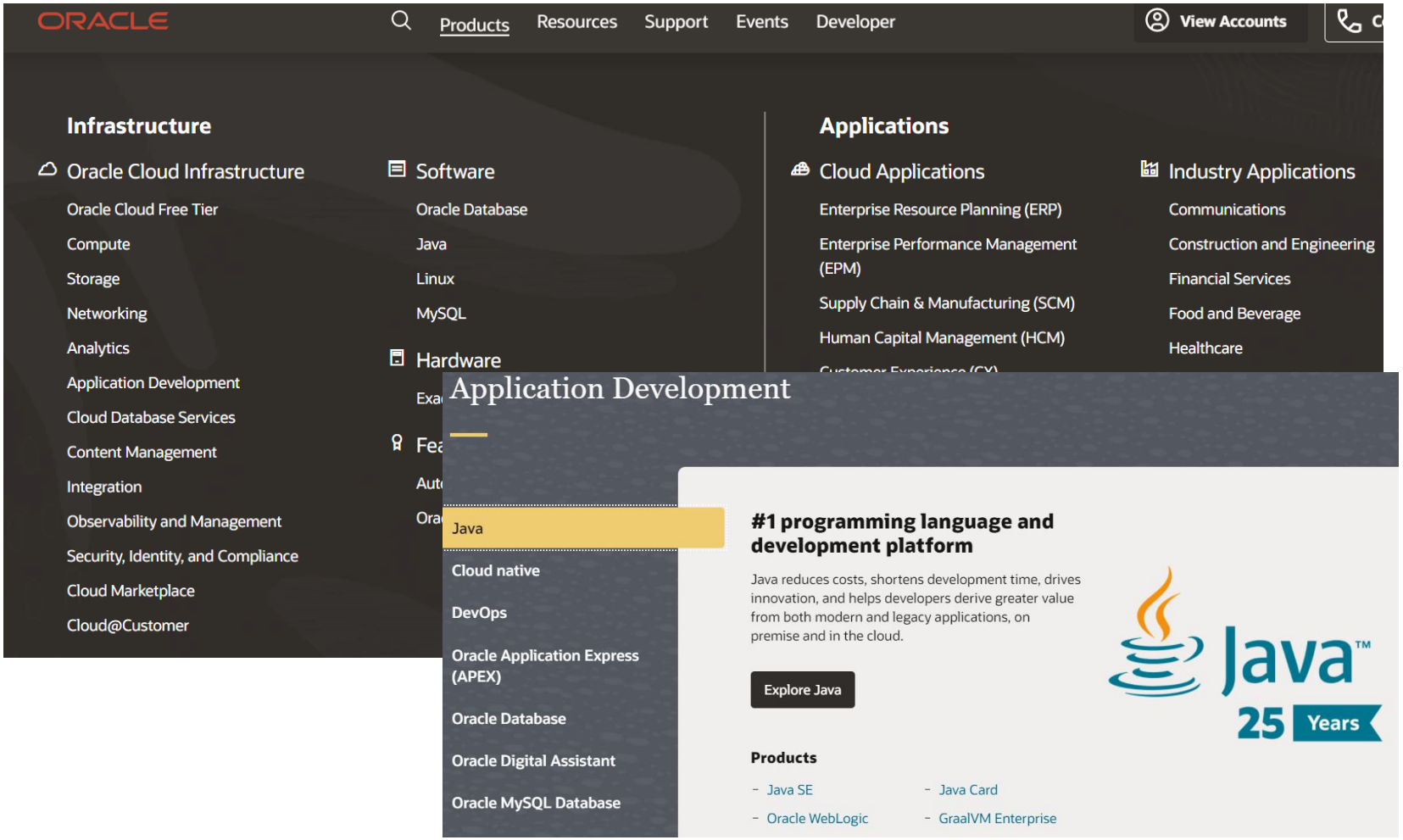
- https://www.ibm.com/cloud



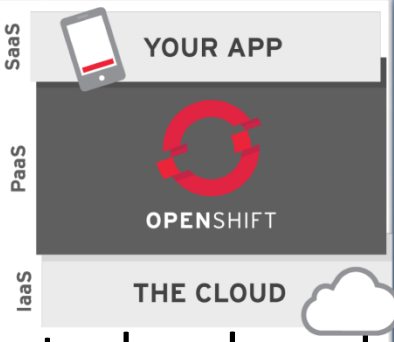
Cloud Computing

Oracle Cloud

- https://www.oracle.com/cloud/



Cloud Computing

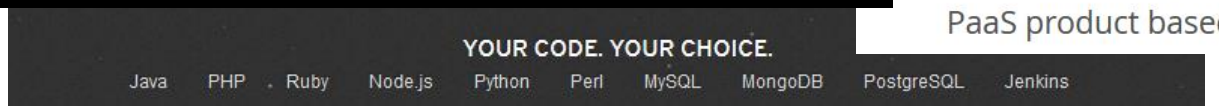


Open Shift - https://www.redhat.com/en/technologies/cloud-computing/openshift

- PaaS provider
- OpenShift is a family of containerization software products developed by Red Hat

Red Hat OpenShift

Red Hat® OpenShift® is an enterprise-ready Kubernetes container platform built for an open hybrid cloud strategy. It provides a consistent application platform to manage hybrid cloud, multicloud, and edge deployments.



MOST INNOVATIVE CLOUD SERVICE HONOURABLE MENTION: RED HAT & T-SYSTEMS

Red Hat together with T-Systems got an honorable mention and a trophy at the Global Telecoms Awards last night for being highly commended by the judges in the 'cloud innovation' category, for AppAgile, T-System's successful PaaS product based on OpenShift Container Platform.

Cloud Computing

Open Shift

- https://www.openshift.com
- https://www.youtube.com/watch?v=KTN_QBuDplo

- https://www.jenkins.io/

Cloud Computing

Cloud services providers:

Figure 1. Magic Quadrant for Public Cloud Infrastructure Managed Service Providers, Worldwide

Source: Gartner (March 2017)

Cloud Computing

Cloud services providers:

Figure 1. Magic Quadrant for Public Cloud Infrastructure Professional and Managed Services

Source: Gartner (May 2020)

Cloud Computing

Cloud services providers:

Figure 1: Magic Quadrant for Public Cloud IT Transformation Services

Source: Gartner (July 2022)

Cloud Computing

PaaS providers

- https://www.engineyard.com/

Key Features:	Dedicated instances with no multi-tenancy at the virtual machine level. More control over your virtual machine instances than other PaaS providers. Integration with both public and private Git repositories.
Limitations:	Supported languages are limited to Ruby, JRuby, REE, Rubiniu, Node.js, and PHP.
Pricing:	Based on a "pay as you go" model with standard and premium support options. Prices range from $0.05/hour per instance to $2.19/hour per instance, depending on your configuration.

Heroku

- **Supports** Ruby, Python, Java, Scala, Node.js
- **Dynos =** Abstract running environment = Virtualized containers running processes in isolated environments

[http://www.tomsitpro.com/articles/paas-providers,1-1517.html]

Key Fetures:	One of the early Pass providers, Heroku is ideal for quick deployments and fits a wide range of distributed applications.
Limitations:	Cost of addons vary and estimating costs can be challenging as the number of addons increase and loads vary across application components.
Pricing:	Based on the number and size of dynos deployed ($0.05/hour - $0.10/hour), the size of the Postgres database and addons used.
Bonus:	Starter databases with up to 10,000 rows are free.

Cloud Computing

PaaS providers

Appian

- BPM services provider (business process management)
- Friendly support for application development through a broad tools palette
- The developed solutions are not portable

MIOsoft

STRENGTHS

- MIOsoft's strategic investment in big data management, data integration, business analytics and machine learning distinguishes it from most aPaaS competitors. Its platform can accommodate petabytes of data, and it supports parallel and hybrid transactional/analytical processing (HTAP).
- Flexible deployment options enable customers to choose between public, virtual private and managed private cloud services, as well as on-premises software. Cloud services can be deployed in MIOsoft data centers or on AWS and other IaaS platforms.

CAUTIONS

- MIOsoft's focus on NoSQL/Hadoop analytical data models makes its platform less suitable for simple transactional applications using a basic relational data model. The platform is not suitable for migrating existing enterprise applications to the cloud.
- MIOsoft has minimal brand recognition, which reflects its limited marketing ability.

Cloud Computing

PaaS providers

Cybozu(kintone)

Gartner

2017 Magic Quadrant High Productivity aPaaS

STRENGTHS

- Kintone has more than 3,000 companies as subscribed clients and in excess of 100,000 end users globally, and this number is rapidly increasing.
- Kintone offers citizen developers a high-productivity graphical drag-and-drop application development capability, the ability to incorporate Microsoft Excel spreadsheets into forms with prefilled data, and more than 50 prebuilt applications to download and customize.
- Cybozu has more than 150 official system integrator partners for kintone, and a very active developer network. It holds more than 50 developer events a year.
- Cybozu is expanding the kintone ecosystem by exploiting new scenarios — such as Internet of Things (IoT) control and machine-learning-based real-time prediction — by integrating AWS IoT, AWS Lambda and Amazon API Gateway technologies.

CAUTIONS

- Kintone does not support any high-control capability. Nor does it support on-premises deployment, although applications are customizable with JavaScript/REST APIs.
- Kintone users surveyed by Gartner consider its functionality to be relatively weak around service-oriented architecture (SOA), integration capabilities and product technical support.
- Cybozu has traditionally had little presence and few customers outside Japan, although it does have partners in Hong Kong, Taiwan, Thailand, Singapore and Vietnam, and opened a regional kintone office in the U.S. during 2014.
- Small or midsize businesses, rather than large enterprises, are the main buyers of kintone — in line with its focus on citizen developers.

[https://www.gartner.com/doc/reprints?id=1-2C8JHBP&ct=150325&st=sb]

Cloud Computing

PaaS providers

Caspio

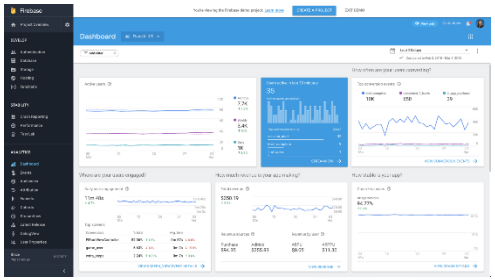
- It is not entirely a PaaS ; it is used for database creation, providing forums and report generation
- Uses AWS

Key Features:	Easy to use graphical user interface and wizard driven development environment lower the barriers to entry in application development in the cloud.
Limitations:	Caspio is not a true PaaS; application integration with existing software could become complex and it is best suited for small businesses with limited development resources.
Pricing:	Monthly subscription plan with unlimited users, apps, and storage is $249/month plus $30GB data transfer over 1GB/month. A custom plan, which starts at $19/month, is also available.
Bonus:	Free 14-day trial is available to new users.

Cloud Computing

mBaaS

- Mobile Backend as a Service or MBaaS is an architecture that performs backend development automation and handles the cloud infrastructure
- is as a cloud-hosted infrastructure to let mobile and web apps access backend storage, APIs, and social networks efficiently
- An MBaaS enables companies to focus on frontend development while the server maintenance responsibilities lie with a third party



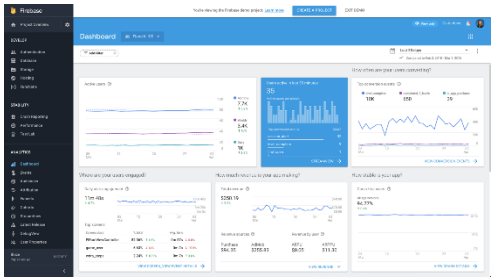
PaaS		MBaaS	
You Manage	Client-Side Code	You Manage	Client-Side Code
You Manage	Backend Side Business Logic	You Manage	Backend Side Business Logic
You Manage	Backend Side Push-Notifications Email Notifications Social Login Database	Provider Manages	Backend Side Push-Notifications Email Notifications Social Login Database
Provider Manages	Runtime	Provider Manages	Runtime
Provider Manages	Midddleware	Provider Manages	Midddleware
Provider Manages	Operating System	Provider Manages	Operating System
Provider Manages	Virtualization	Provider Manages	Virtualization
Provider Manages	Servers	Provider Manages	Servers
Provider Manages	Storage	Provider Manages	Storage
Provider Manages	Networking	Provider Manages	Networking

https://www.mobindustry.net/blog/top-9-mobile-backend-as-a-service-mbaas-platforms/

Cloud Computing

mBaaS providers

- **Back4app**
- **Firebase**
- **Parse**
- **AWS Amplify**
- **GAMESparks (Amazon)**
- **BackendLess**
- **CloudKit(Apple)**



PaaS	MBaaS
• A PaaS or **Platform as a Service** can be used for developing, testing and running both mobile and web applications.	• An MBaaS or **Mobile Backend as a Service** is a model utilized for the development, testing and running of only mobile applications.
• A PaaS will minimize the costs related to buying, configuring and performing maintenance on infrastructure.	• The main purpose of using an MBaas is to help developers perform easier and faster management of backend services.
• PaaS has mechanisms like automated deployment, content distribution networks, and load balancers.	• MBaaS has mechanisms like database management, various backend features, and serverless environment.
• PaaS cannot provide features like frontend code, database management, and business logic.	• MBaaS or any BaaS is not capable of providing server-level access, or the same levels of flexibility offered by a PaaS
• PaaS is responsible for the management of application runtime and execution.	• MBaaS is responsible for the management of application runtime and execution.
• Developers using a PaaS model have to build the client/application.	• Developers using an MBaaS model have to build the client/application and utilize a mobile backend as the service.

2023 - https://www.mobindustry.net/blog/top-9-mobile-backend-as-a-service-mbaas-platforms/

Cloud Computing

Other Cloud Services Providers

IaaS providers

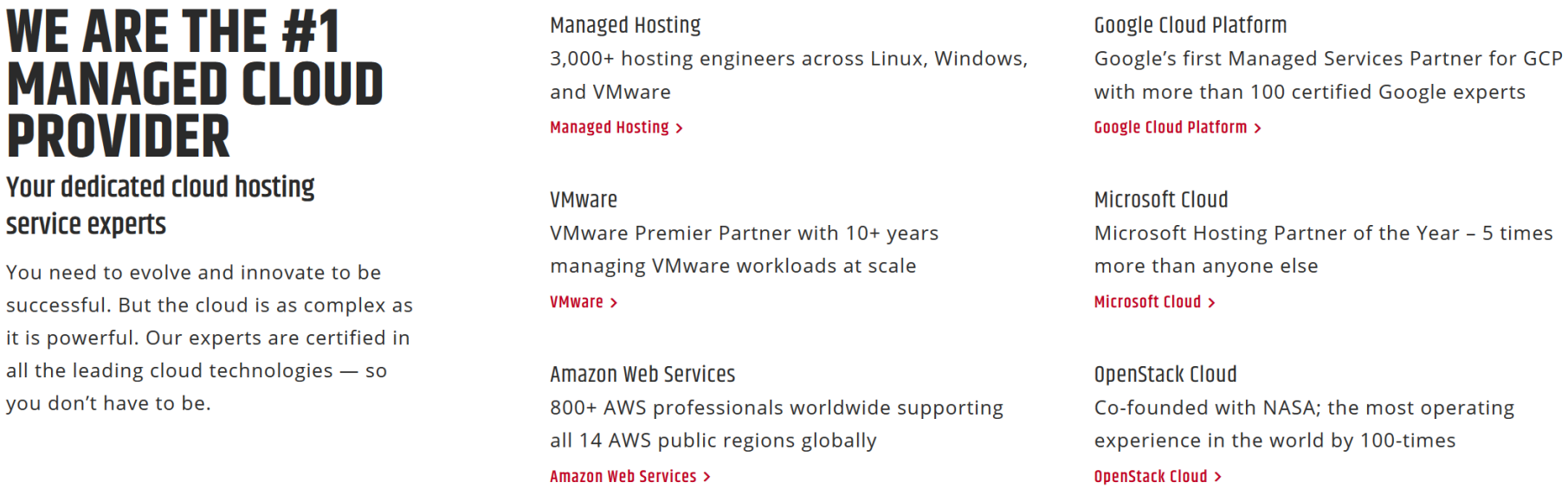
- **Joyent**
  - Partnership with Dell
  - Provides free hosting services for Facebook developers
  - Provides public cloud services challenging Amazon EC2, as well as private clous in partnership with Dell
  - www.joyent.com
- **Elastic Hosts**
  - The first cloud service providing virtual servers based on Linux KVM (Linux Kernel-based Virtual Machine), also running its own servers farm (10 data centers - United Kingdom (two sites), Netherlands, United States (four sites), Canada, Hong Kong and Australia)
  - www.elastichosts.com

Cloud Computing

Other IaaS, PaaS, SaaS providers

IaaS providers

- **Rackspace**
  - Provides Rackspace Cloud
  - https://www.rackspace.com/cloud



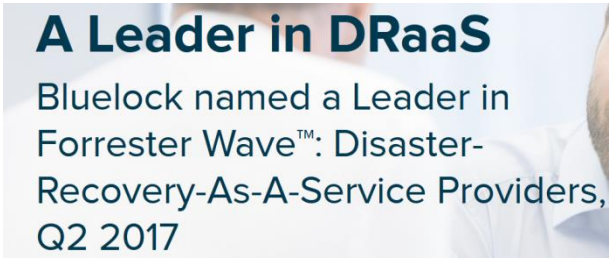
Cloud Computing

Other cloud providers:

IaaS providers

- **GoGrid**
  - Provides a large variety of cloud servers suporting Windows si Linux
  - Has the best SLA: 24/7 – 100%
- **SymetriQ**
  - Building a virtual image is performed by a simple drag-and-drop
  - www.symetriq.com
- **Bluelock –** provides IaaS si and trusted services, initially based on VMware
  - Multiple data centers integration solutions

Deprecate

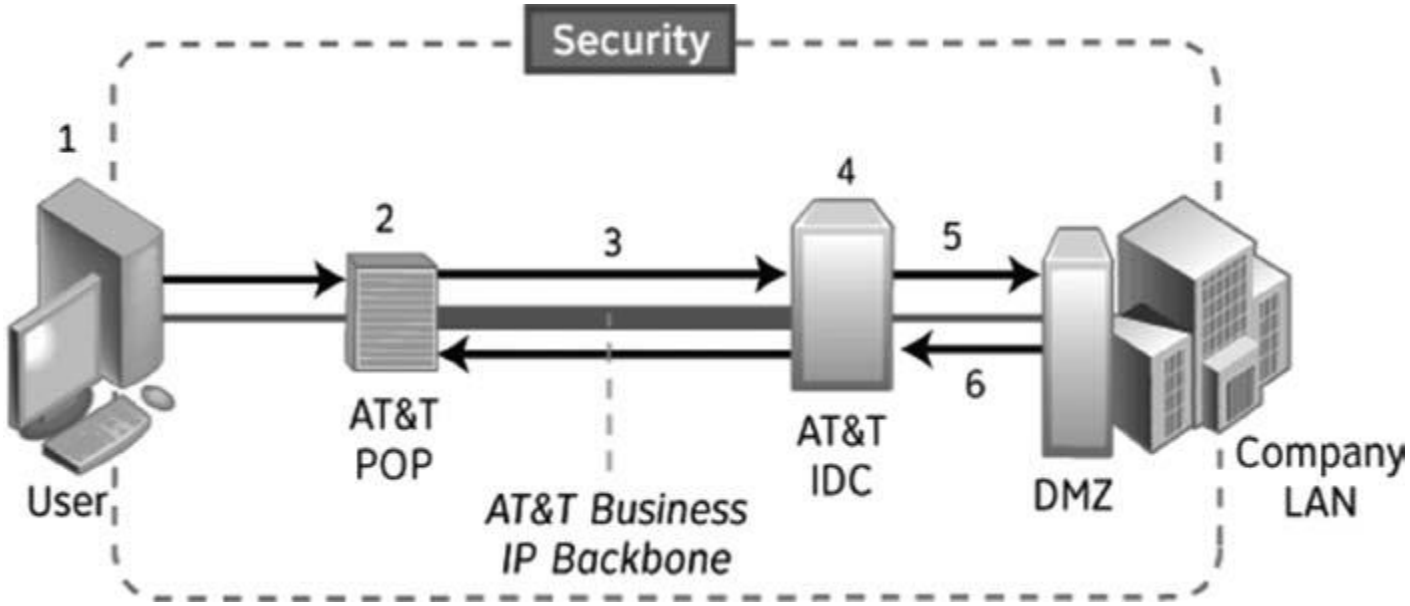


Cloud Computing

Other cloud providers:

PaaS providers

- **AT&T**
  - Also has IaaS services provider characteristics through coallocation



[Implementing and Developing Cloud Computing Applications, David E.Y. Sarna]

Cloud Computing

Other cloud providers:

SaaS providers

- **NetSuite**
  - Leader in providing business CRM, ERP , e-commerce software
  - www.netsuite.com/portal/home.shtml
- **Intacct**
  - Applications for financial management
  - Assures interoperability with other business apllications: Salesforces CRM, Avalara, Avectra

Specialized Cloud providers

- **Appistry**
  - Provides Cloud infrastructure for military organizations, and also ISV (Independent Software Vendor)
  - Clients: US Government, Sprint, FedEx
  - www.appistry.com

Cloud Computing

Private Clouds: DaaS (Datacenter as a Service)

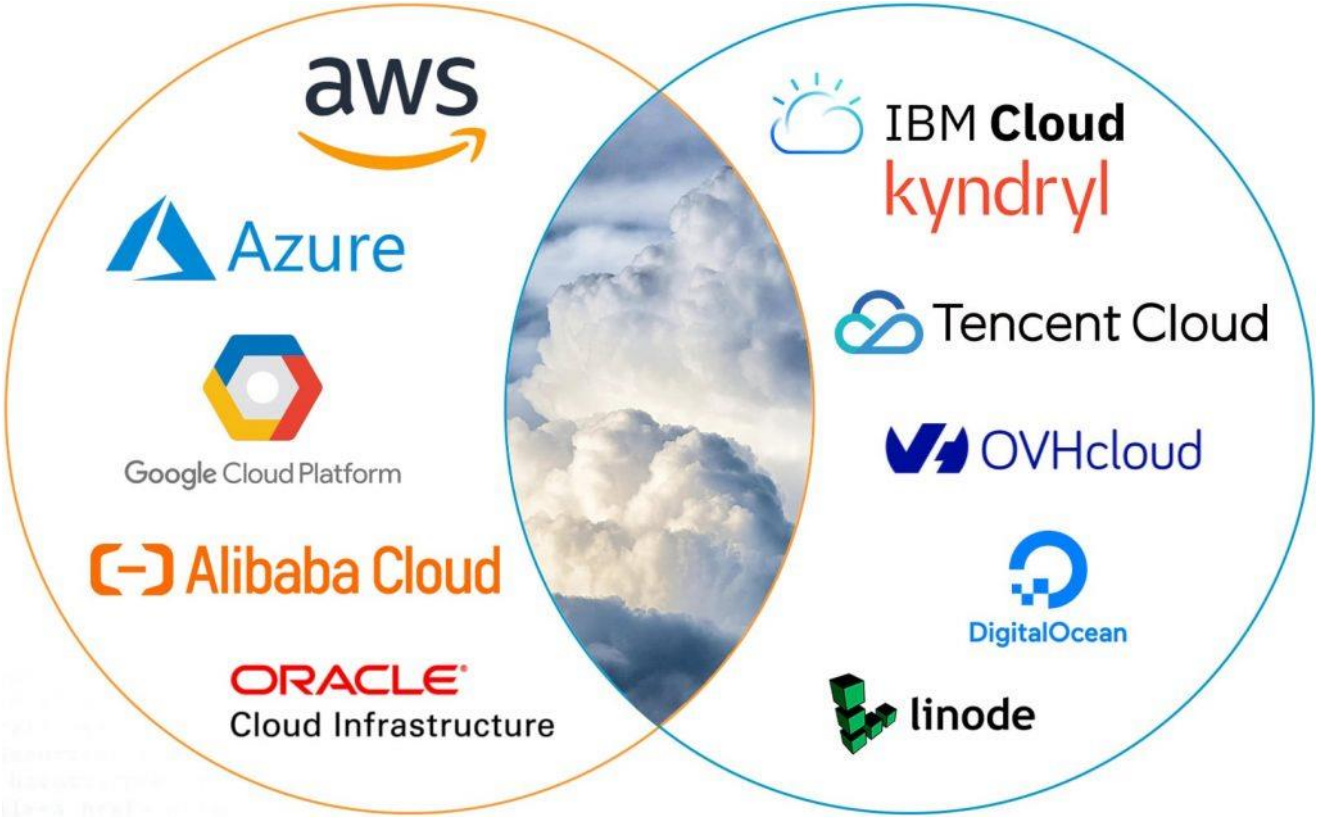
- Considerations
  - Private cloud are small
  - *Legacy application* – it is difficult to migrate to a cloud specific architecture
  - *On-premises* – does not necessarily imply higher security
  - *Do what you do best* ☺
  - (Future Course)

Cloud Computing

The Best Cloud Services in 2017 [conform http://cloud-services-review.toptenreviews.com/]

Cloud Computing

The Best Cloud Services in 2023 [conform https://dgtlinfra.com/top-10-cloud-service-providers-2022/]



Cloud Computing

The Best Cloud Services in 2023 [conform https://dgtlinfra.com/top-10-cloud-service-providers-2022/]

#	Cloud Service Provider	Regions	Availability Zones
1	Amazon Web Services (AWS)	26	84
2	Microsoft Azure	60	116
3	Google Cloud Platform (GCP)	34	103
4	Alibaba Cloud	27	84
5	Oracle Cloud	38	46
6	IBM Cloud (Kyndryl)	11	29
7	Tencent Cloud	21	65
8	OVHcloud	13	33
9	DigitalOcean	8	14
10	Linode (Akamai)	11	11

Cloud Computing

The Best Cloud Services in 2023 [conform https://dgtlinfra.com/top-10-cloud-service-providers-2022/]

Amazon Web Services (AWS), the cloud computing service of Amazon.com, is the largest cloud service provider globally. From its data centers, the business provides over 200 fully featured services including computing, storage, and database.

AWS currently has 26 regions and 84 availability zones in operation. These regions and availability zones are located throughout the United States, AWS GovCloud (US), Americas, Europe, Asia Pacific, as well as in the Middle East & Africa.

Cloud Computing

The Best Cloud Storage Services in 2019 [conform http://cloud-services-review.toptenreviews.com/]

Reviews

Below are all our reviews for cloud storage, online backup services and related categories. Our coverage includes reviews of the best business online backup, Mac online backup, online data backup, online storage and cloud services.

CrashPlan for Small Business Review

Storage Guardian Review

IDrive Review

Zoolz Review

Carbonite Review

Acronis Backup Review

Egnyte Review

Backblaze Review

BackupAssist Review

Amazon Cloud Drive Review

Barracuda Review

Mozy Review

OneDrive for Business - Cloud Storage and Online Backup Services Review

R1Soft Review

Cloud Computing

The Best Cloud Storage Services in 2021 [conform https://www.techradar.com/news/the-best-cloud-storage]

1. IDrive is the best cloud storage provider

IDrive, the cloud storage veteran, delivers tons of storage online for an incredibly small outlay. **5TB for $3.48** for the first year is unmatched till now and so is the support for unlimited devices and the extensive file versioning system available.

2. pCloud provides a lifetime cloud storage subscription

The Swiss-based company is more expensive than the competition but the one-off payment means that you won't have to worry about renewal fees that can be very horrendously expensive. $350 for 10 years is less than **$3 per month.**

3. Microsoft OneDrive cloud storage

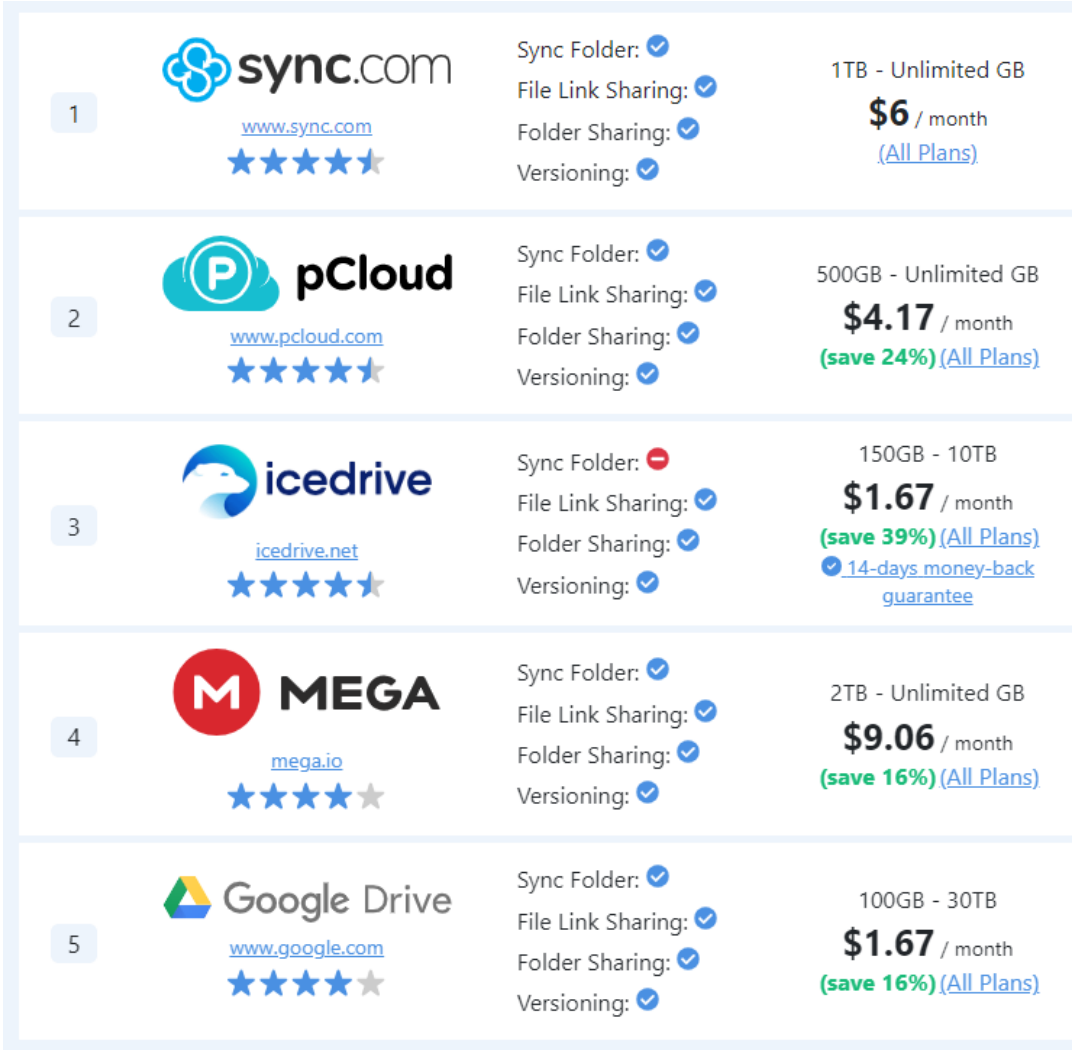
Best for those who are invested with Microsoft Office

SPECIFICATIONS **Free tier:** 5GB **Storage capacity:** 6TB

Number of devices: 30

Cloud Computing

The Best Cloud Storage Services in 2023 [conform https://www.cloudwards.net/best-cloud-storage/]



Cloud Computing

Table 1. Worldwide Public Cloud Service Revenue Forecast (Billions of U.S. Dollars)

	2018	2019	2020	2021	2022
Cloud Business Process Services (BPaaS)	45.8	49.3	53.1	57.0	61.1
Cloud Application Infrastructure Services (PaaS)	15.6	19.0	23.0	27.5	31.8
Cloud Application Services (SaaS)	80.0	94.8	110.5	126.7	143.7
Cloud Management and Security Services	10.5	12.2	14.1	16.0	17.9
Cloud System Infrastructure Services (IaaS)	30.5	38.9	49.1	61.9	76.6
Total Market	**182.4**	**214.3**	**249.8**	**289.1**	**331.2**

BPaaS = business process as a service; IaaS = infrastructure as a service; PaaS = platform as a service; SaaS = software as a service
Note: Totals may not add up due to rounding.

Source: Gartner (April 2019)

Cloud Computing

	2021	2022	2023
Cloud Business Process Services (BPaaS)	54,952	60,127	65,145
Cloud Application Infrastructure Services (PaaS)	89,910	110,677	136,408
Cloud Application Services (SaaS)	146,326	167,107	195,208
Cloud Management and Security Services	28,489	34,143	41,675
Cloud System Infrastructure Services (IaaS)	90,894	115,740	150,254
Desktop-as-a-Service (DaaS)	2,059	2,539	3,104
Total Market	**412,632**	**490,333**	**591,794**

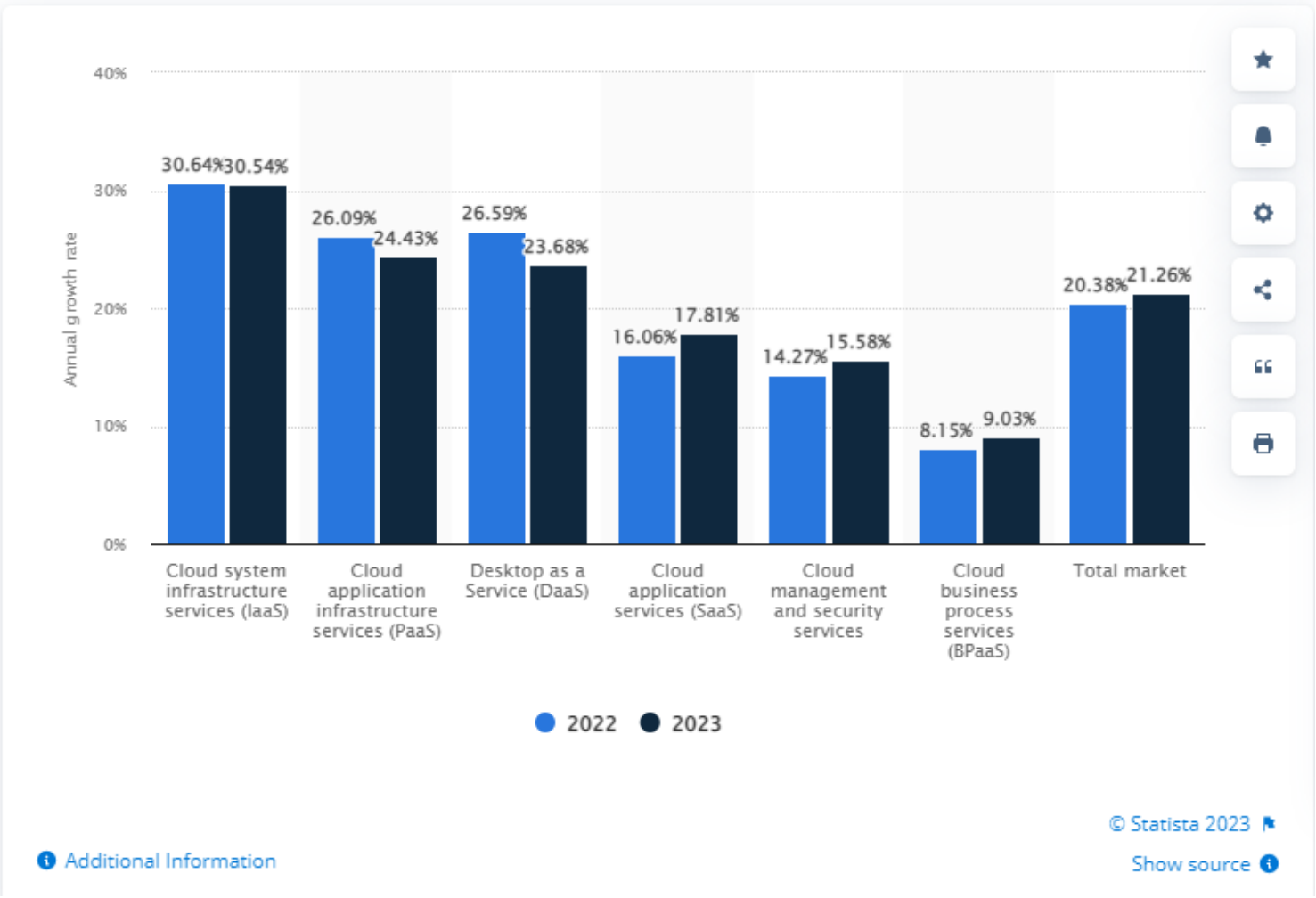
BPaaS = business process as a service; IaaS = infrastructure as a service; PaaS = platform as a service; SaaS = software as a service

Note: Totals may not add up due to rounding.

Source: Gartner (October 2022)

Cloud Computing

Public cloud services annual growth rate worldwide in 2022 and 2023 [conform https://www.statista.com/statistics/258718/market-growth-forecast-of-public-it-cloud-services-worldwide/



Cloud Computing

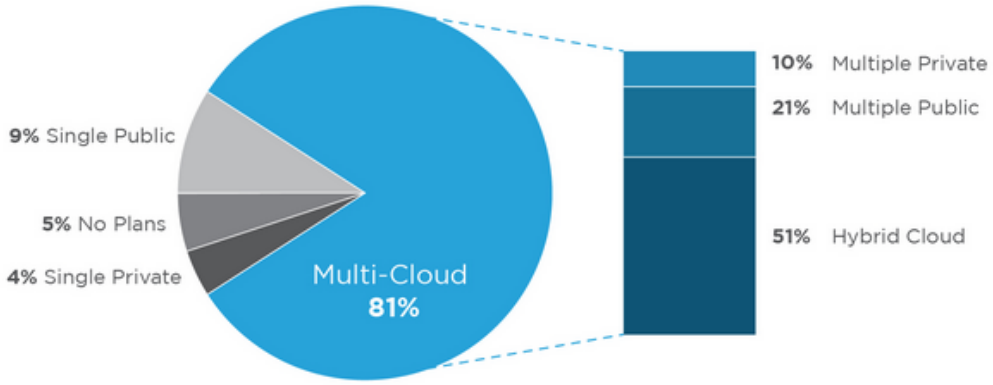
RIGHT SCALE FROM FLEXERA

GET FULL REPORT

Enterprises Choose Multi-Cloud

Respondents with 1,000+ Employees

81% of enterprises have a multi-cloud strategy



Source: RightScale 2018 State of the Cloud Report

Cloud Computing

Predictions…vision…☺

- Escalated investment in cloud security and resilience
  - Secure Access Service Edge (SASE)
- Multi-cloud is an increasingly popular strategy
- The AI and ML-powered cloud
- Low-code and no-code cloud services
- Innovation and consolidation in cloud gaming
- Deploying to the Edge
- Rise of Serverless Computing
- Blockchain
- Quantum Computing
- …

Abstract

- Vocabulary
- PaaS – proprieties and characteristics
- Cloud Services Providers (IaaS and/or PaaS and/or SaaS)
  - Amazon
  - Microsoft
  - Google
  - OpenStack
  - Other cloud services providers (Joyent, Rackspace, GoGrid, Elastic Hosts, SymetriQ, AT&T, Heroku, Aptana, EngineYard , Salesforce.com, NetSuite, Intacct, Appistry,…)

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- https://www.windowsazure.com/en-us/community/education/program/overview/
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- https://www2.deloitte.com/us/en/insights/industry/public-sector/future-of-quantum-technology-public-sector.html
- https://www.analyticsinsight.net/top-10-cloud-computing-trends-and-predictions-to-follow-in-2023/

Cloud Computing Services/Providers

Questions?

July 2024