Lecture 5: Cloud Computing

TIES4560 SOA and Cloud Computing
Autumn 2023

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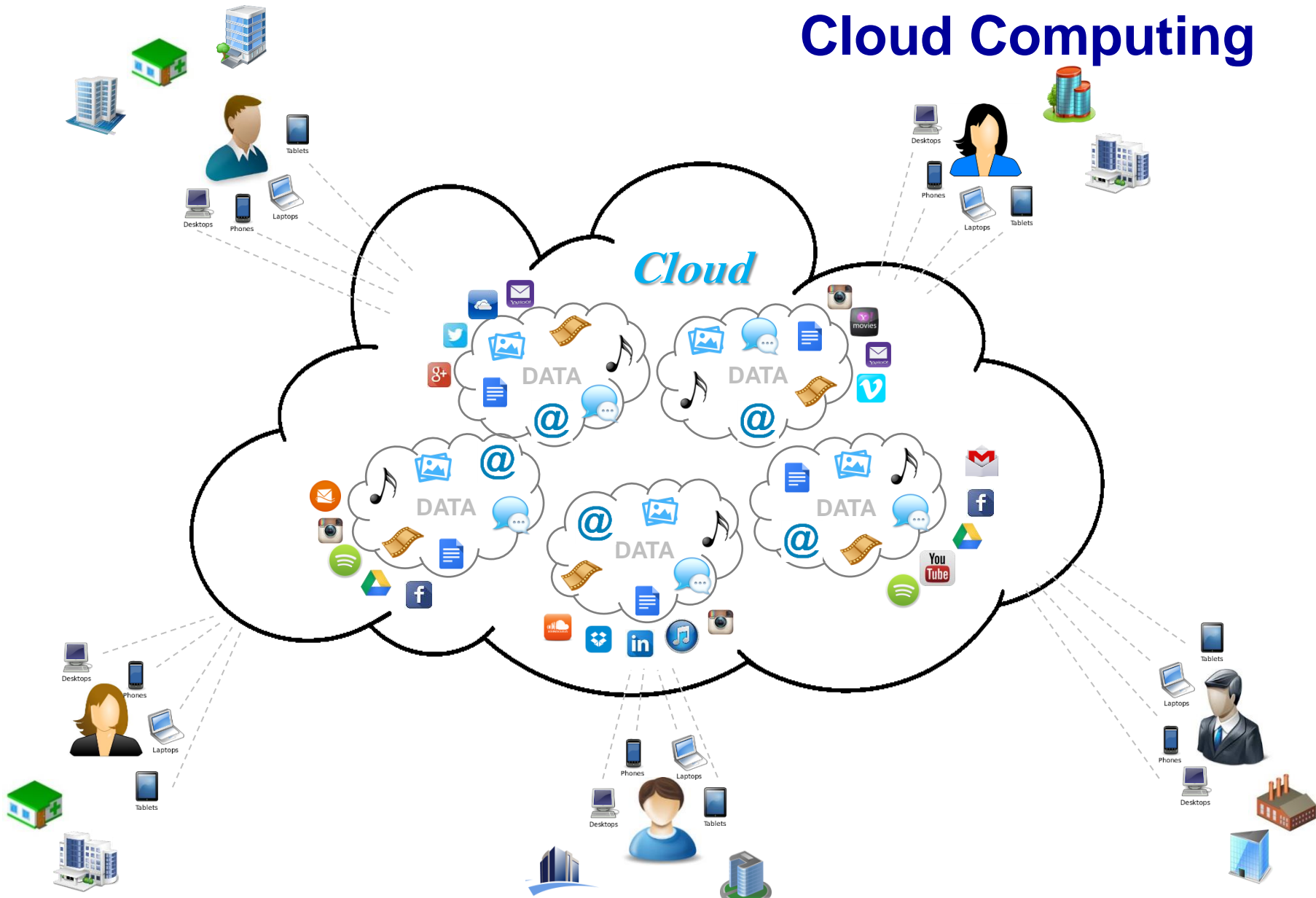# Cloud Computing

Cloud Computing

| FACTORS	ON-PREMISE	CLOUD COMPUTING
DEPLOYMENT	Every resource deployed is within the infrastructure. The enterprise will be responsible for maintaining and handling the related process. The access is limited to the Organization only.	In Public Cloud, resources are deployed at the service providers end and accessed by the public. In Private Cloud, resources are deployed according to the customer's need and can be accessed by them only.
COST	The cost incurred is for the servers, hardware, storage devices, software, power consumption and also space where your architecture is built.	In Cloud Computing you only need to pay for the resources you use. There are no maintenance charge, no upfront charge, and no upkeep costs associated.
SECURITY	Organizations who have sensitive data E.g. Banks must use a certain level of security. The security is taken care by either a third party or by a group of staff using an external tool.	The secure environment is provided by the Cloud Service providers. There is a broad set of policies and technologies provided by the CSPs. These take care of the security of your data.
MAINTENANCE	The user is responsible for maintaining the server hardware and software, the data backups, storage devices, and disaster recovery.	Cloud Computing provides greater flexibility as the user/organization only pay for what they use and can easily scale to meet the demand.
FLEXIBILITY	When you buy/ make changes to your infrastructure, the cost incurred will be by the organization.	You can quickly upgrade your infrastructure to your needs without having to make large investments in costly hardware every time.

https://medium.com/edureka/on-premise-vs-cloud-computing-f9aee3b05f50

Cloud Computing

Cloud Computing

Cloud Computing

Cloud

Cloud Computing

Cloud

IaaS

PaaS

SaaS
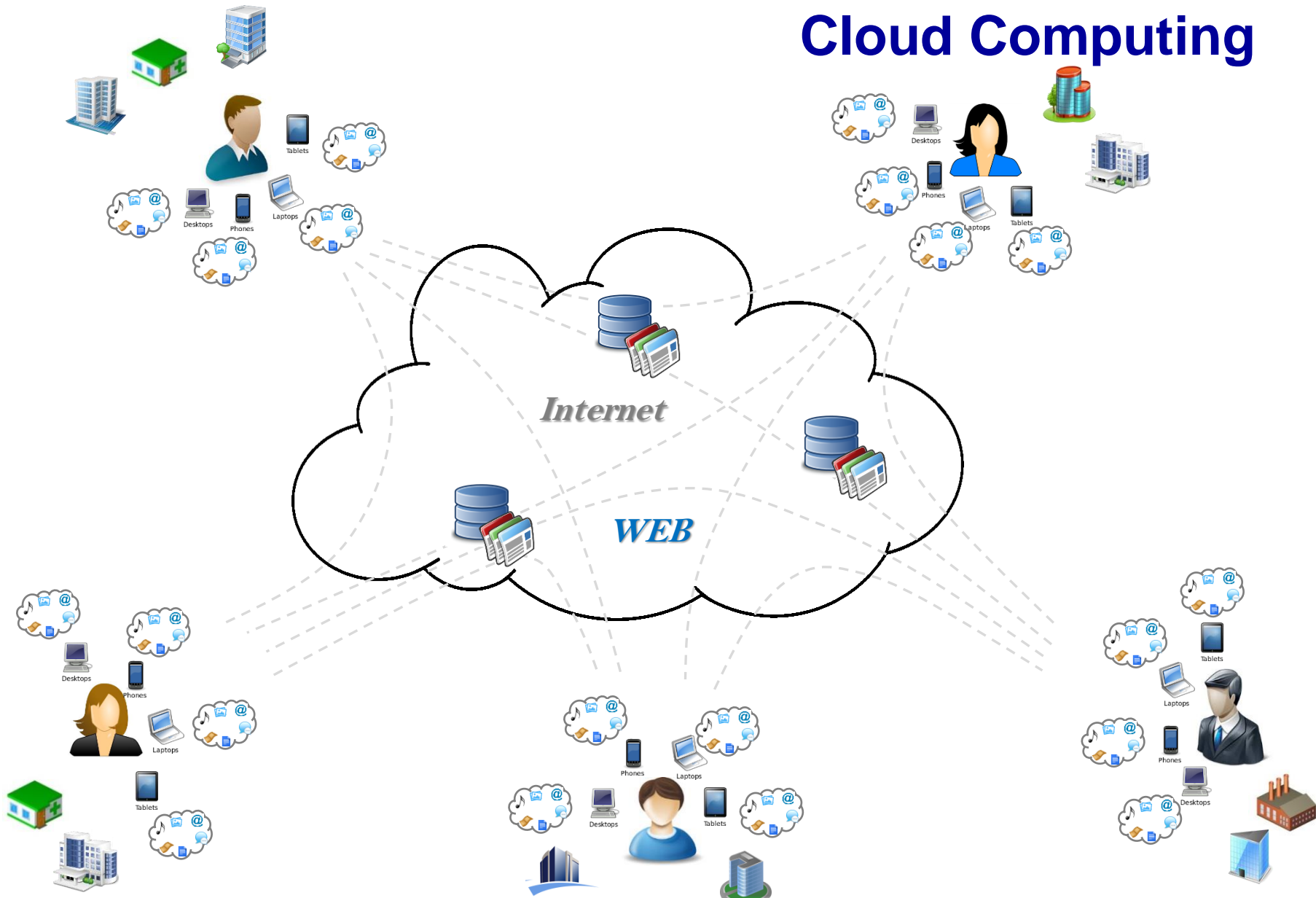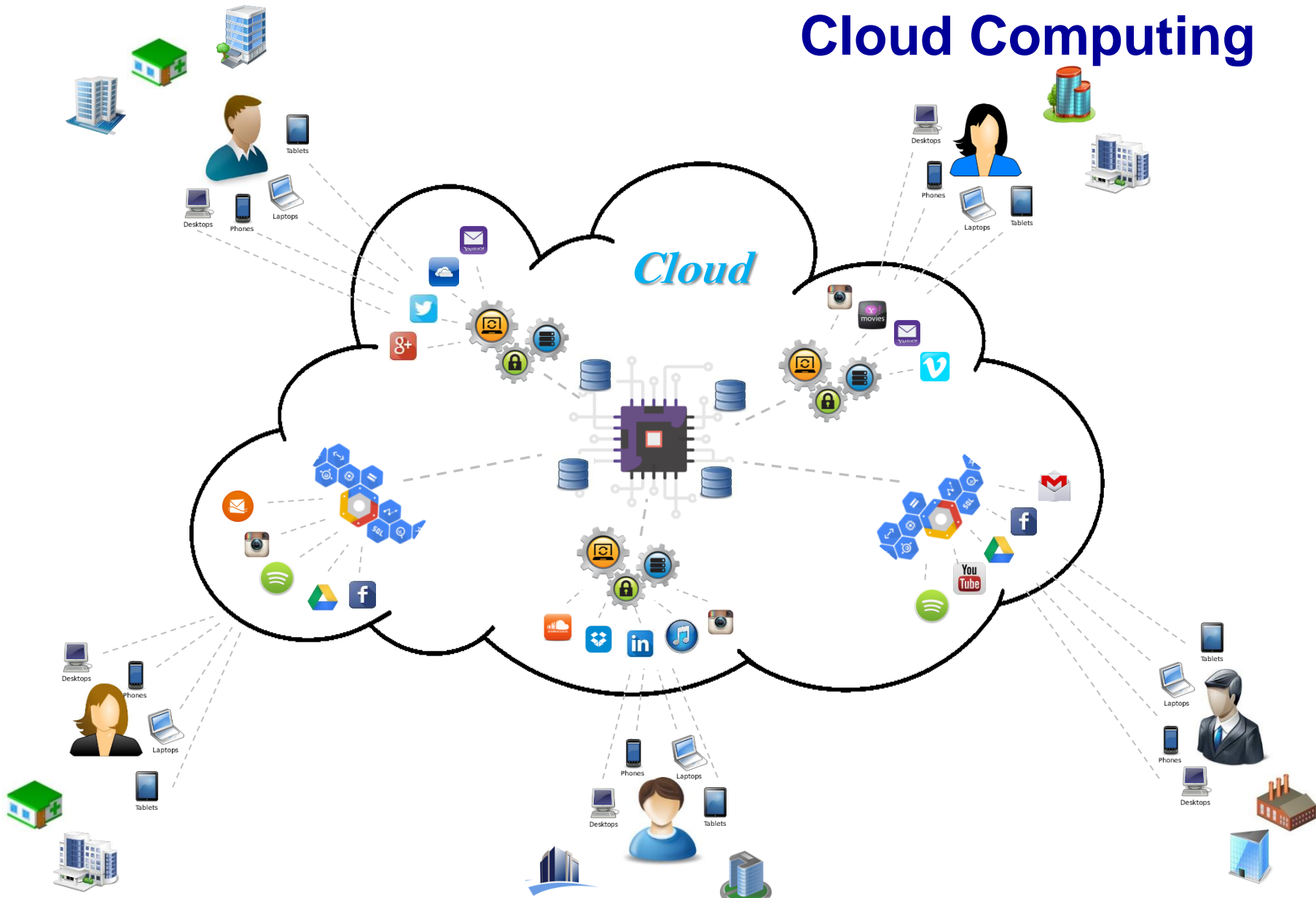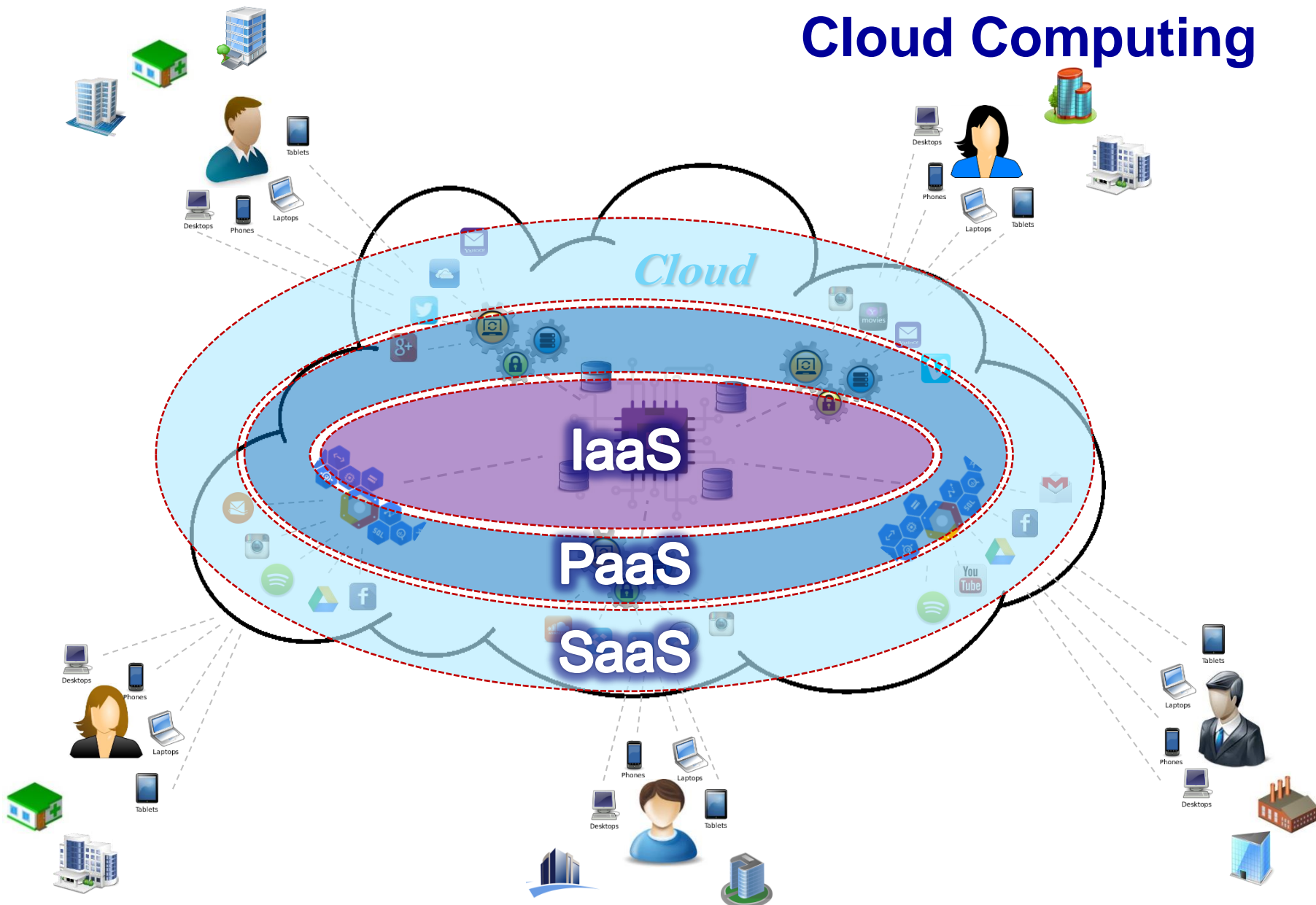
Cloud Computing

Cloud Computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.

Characteristics for a service to be considered "Cloud" are:

o **On-demand self-service**. *The ability for an end user to sign up and receive services without the long delays that have characterized traditional IT*

o **Broad network access**. *Ability to access the service via standard platforms (desktop, laptop, mobile, etc.)*

o **Resource pooling**. *Resources are pooled across multiple customers using virtualization (the ability to increase computing efficiency). Services that can apply for resource pooling: data storage services, processing services and bandwidth provided services.*

o **Rapid elasticity**. *Scalability and fast provisioning a cloud service or application isn't limited to what a particular server can cope with; it can automatically expand or contract its capacity as needed.*

o **Measured Service**. *Billing is metered and delivered as a utility service.*

Cloud Computing

Cloud Computing Stack

- **Software-as-s-Service (SaaS)** *Applications designed for end-users, run on someone else's system, delivered over the web. Applications can be used for a wide range of tasks for both individuals and organizations. (email, content creation tools, communication, entertainment & games, accounting and invoicing, tracking sales, planning, performance monitoring, etc.).*

- **Platform-as-s-Service (PaaS)** *It is a computing platform (a set of tools and services) that allows the creation and deployment of web applications quickly and easily and without the complexity of buying and maintaining the software and infrastructure underneath it (execution runtime, operating systems, database, web service, development tools, etc.). PaaS services can consist of preconfigured features that customers can subscribe to, they can choose to include the features that meet their requirements while discarding those that do not.*

- **Infrastructure-as-s-Service (IaaS)** *Hardware and software that powers it all – virtual server space, network connections, bandwidth, IP addresses and load balancers, storage. Rather than purchasing servers, software, datacenter space or network equipment, clients instead buy those resources as a fully outsourced service on demand. The client is given access to the virtualized components in order to build their own IT platforms.*

Cloud Computing
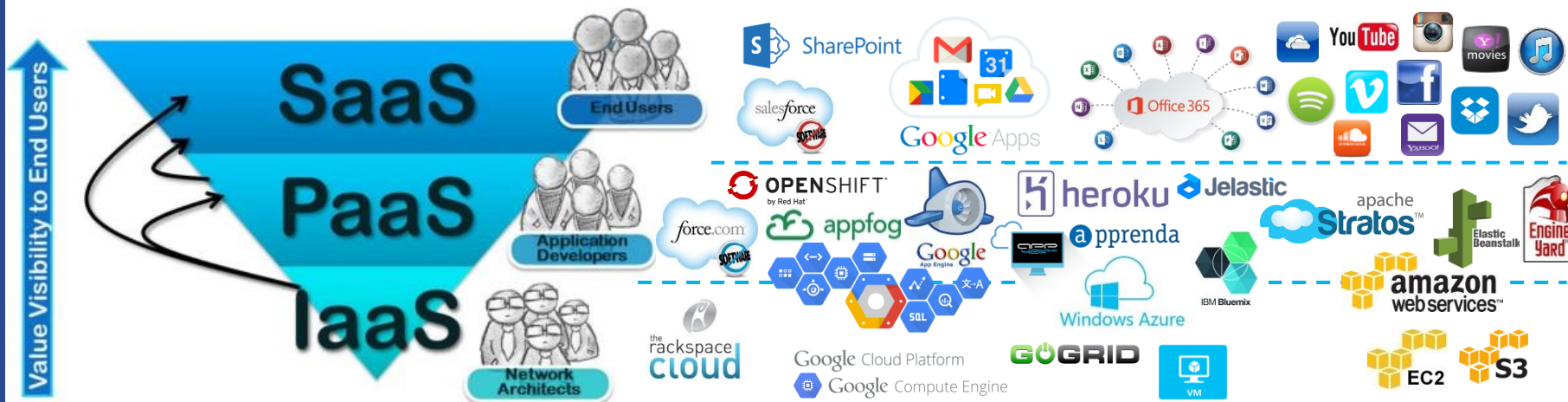
Software-as-s-Service (SaaS)

Characteristics of SaaS :

o Web access to commercial software.

o Software is managed from a central location and accessible from any location.

o Software delivered in a "one to many" model.

o Cross device compatibility. Applications can be accessed via any internet enabled device.

o Users not required to handle software and hardware upgrades and patches.

o Application Programming Interfaces (APIs) allow for integration between different pieces of software.

Applications that organizations usually consider to move to SaaS:

o Applications that have a significant need for web or mobile access. An example would be mobile sales management software

o Software that is only to be used for a short term need. An example would be collaboration software for a specific project

o Software where demand spikes significantly, for example tax or billing software used once a month

Examples where SaaS may not be appropriate:

o Applications where extremely fast processing of real time data is required

o Applications where legislation or other regulation does not permit data being hosted externally

o Applications where an existing on-premise solution fulfills all of the organization's needs

Cloud Computing

Platform-as-s-Service (PaaS)

Characteristics of PaaS :

o *Services to develop, test, deploy, host and maintain applications in the same integrated development environment.*

o *Web based user interface creation tools help to create, modify, test and deploy different UI scenarios.*

o *Flexibility and Adaptability. Customers can have control over the tools that are installed within their platforms and can create a platform that suits their specific requirements. They can 'choose or change' the features they feel are necessary.*

o *Multi-tenant architecture where multiple concurrent users utilize the same development application.*

o *Built in scalability of deployed software including load balancing and failover.*

o *Integration with web services and databases via common standards.*

o *Support for development team collaboration (some PaaS solutions include project planning and communication tools).*

o *Tools to handle billing and subscription management.*

o *Security. Security is provided, including data security and backup and recovery.*

PaaS Makes Sense:

o *In any situation where multiple developers will be working on a development project or where other external parties need to interact with the development process.*

o *Where developers wish to automate testing and deployment services*

PaaS May Not be the Best Option:

o *Where proprietary languages or approaches would impact on the development process*

o *Where a proprietary language would interfere with possibility of later moves to another provider (concerns are raised about vendor lock-in)*

o *Where application performance requires customization of the underlying hardware and software*

Cloud Computing

Infrastructure-as-s-Service (IaaS)

Characteristics of IaaS :

o *Allows for dynamic scaling. Resource is available as and when the client needs it and, therefore, there are no delays in expanding capacity or the wastage of unused capacity.*

o *No investment in hardware. The underlying physical hardware that supports an IaaS service is set up and maintained by the cloud provider, saving the time and cost of doing so on the client side.*

o *Has a variable cost, utility pricing model. The service can be accessed on demand and the client only pays for the resource that they actually use.*

o *Generally includes multiple users on a single piece of hardware.*

o *Physical security of data center locations. Services available through a public cloud, or private clouds hosted externally with the cloud provider, benefit from the physical security afforded to the servers which are hosted within a data center.*

o *No single point of failure. If one server or network switch, for example, were to fail, the broader service would be unaffected due to the remaining multitude of hardware resources and redundancy configurations. For many services if one entire data center were to go offline, never mind one server, the IaaS service could still run successfully.*

IaaS Makes Sense:

o *Where demand is very volatile – any time there are significant spikes and troughs in terms of demand on the infrastructure*

o *For new organizations without the capital to invest in hardware*

o *Where the organization is growing rapidly and scaling hardware would be problematic*

o *Where there is pressure on the organization to limit capital expenditure and to move to operating expenditure*

o *For specific line of business, trial or temporary infrastructural needs*

IaaS May Not be the Best Option:

o *Where regulatory compliance makes the offshoring or outsourcing of data storage and processing difficult*

o *Where the highest levels of performance are required, and on-premise or dedicated hosted infrastructure has the capacity to meet the organization's needs*

Cloud Computing

Separation of Responsibilities
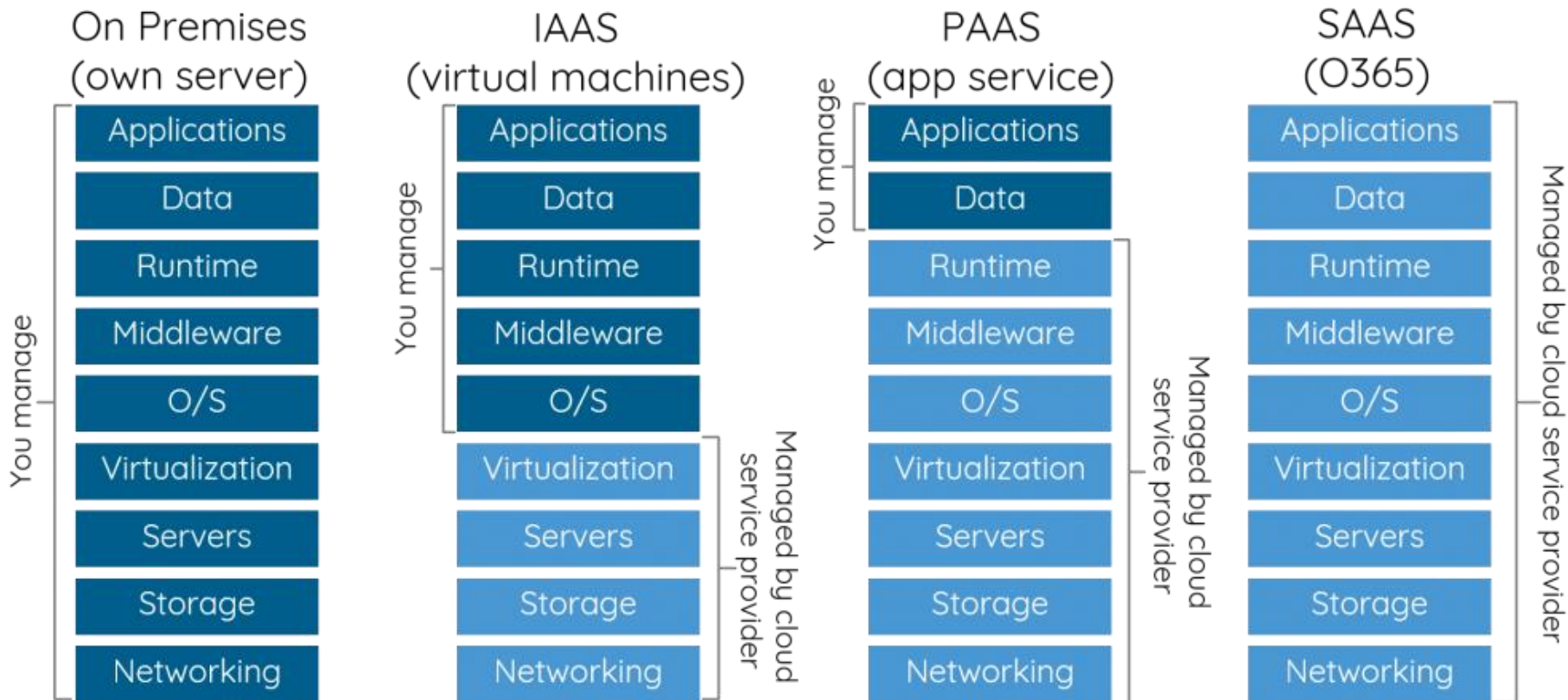
Cloud Computing

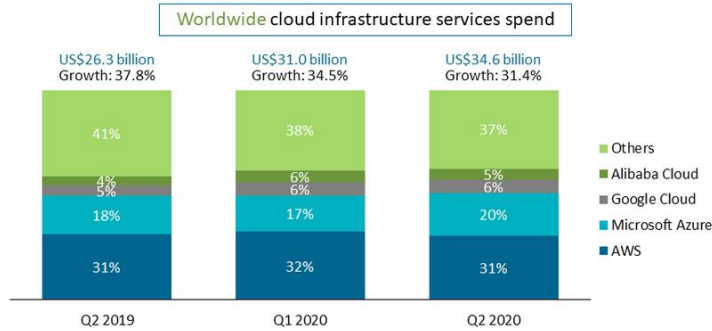*Pros*:

o Lower upfront costs and reduced infrastructure costs.

o Easy to grow your applications.

o Scale up or down at short notice.

o Only pay for what you use.

o Everything managed under service level agreements (SLAs).

o Overall environmental benefit (lower carbon emissions) of many users efficiently sharing large systems

Cons:

o Higher ongoing operating costs. Could systems work out more expensive?

o Greater dependency on service providers. Can you get problems resolved quickly, even with SLAs?

o Risk of being locked into proprietary or vendor-recommended systems? How easily can you migrate to another system or service provider if you need to?

o What happens if your supplier suddenly decides to stop supporting a product or system you've come to depend on?

o Potential privacy and security risks of putting valuable data on someone else's system in an unknown location?

o If lots of people migrate to the cloud, where they're no longer free to develop neat and whizzy new things, what does that imply for the future development of the Internet?

o Dependency on a reliable Internet connection.

Cloud Computing

Cloud computing market share…

Top four providers account for 63% of cloud spend

Worldwide cloud infrastructure services spend

	US$26.3 billion Growth: 37.8%	US$31.0 billion Growth: 34.5%	US$34.6 billion Growth: 31.4%
Others	41%	38%	37%
Alibaba Cloud	4%	6%	5%
Google Cloud	5%	6%	6%
Microsoft Azure	18%	17%	20%
AWS	31%	32%	31%
	Q2 2019	Q1 2020	Q2 2020

Amazon Leads the Race to the Cloud
Worldwide market share of leading cloud infrastructure service providers in Q2 2019*

Provider	Share
amazon	33%
Microsoft	16%
Google	8%
IBM	6%
Alibaba.com	5%
salesforce	3%
ORACLE	2%
Tencent 腾讯	2%

Worldwide cloud infrastructure service revenue in Q2 2019
$23 billion

* includes platform as well as hosted
@StatistaCharts Source: Synergy R...

	Amazon (AWS)			Microsoft (Azure)			Google (GCP)		
	2018	2019	2020e	2018	2019	2020e	2018	2019	2020e
Cloud Rev ($B)	$25.7	$34.9	$46.1	$10.0	$16.3	$23.6	$2.5	$4.3	$6.7
Cloud Rev Growth	47%	36%	32%	82%	62%	45%	135%	70%	55%
*Market Share	67%	63%	60%	26%	29%	31%	7%	8%	9%
CAPEX ($B)	$21.9	$26.5	$30.5	$11.6	$13.9	$14.9	$25.1	$26.8	$32.6
CAPEX growth	11%	21%	15%	43%	20%	7%	91%	7%	22%
Customers	Netflix, GE, Salesforce, Expedia, Adobe, Intuit, Kellogg's, Philips, BP			Walmart, Ford, NBC, Geico, T-Mobile, Daimler			Snap, Home Depot, Colgate, Disney, eBay, Spotify		
Other Key Metrics	69 Availability Zones within 22 geographic regions			Available in 140 countries and 54 geographic regions, with plans for 4 more			61 Availability Zones within 20 regions. Available in 200+ countries & territories.		

*Note: Market share is among "Big 3" (AWS, Azure, GCP)

*Note: Google does not disclose exact Google Cloud revenues or the mix between G Suite and run rate was >$8Bn. For 2Q19, we assume the mix is roughly 50:50 between GCP and G Suite

Country	AWS	Azure	GCP	Others	Total
US	33.10%	20.90%	10.80%	35.20%	100%
UK	32.20%	22.20%	9.80%	35.80%	100%
Germany	31.90%	19.60%	12.30%	36.20%	100%
France	32.10%	20.80%	10.90%	36.20%	100%
Italy	32.70%	21.00%	11.20%	35.10%	100%
Japan	31.90%	21.60%	12.00%	34.50%	100%
India	32.60%	20.80%	11.40%	35.20%	100%
Brazil	30.70%	21.70%	11.30%	36.30%	100%

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Amazon Maintains Lead in the Cloud Market
Worldwide market share of leading cloud infrastructure service providers in Q2 2023*

Provider	Share
aws	32%
Azure	22%
Google Cloud	11%
Alibaba Cloud	4%
IBM Cloud	3%
salesforce	3%
ORACLE	2%
Tencent Cloud	2%

Cloud infrastructure service revenues in Q2 2023
$65B

* Includes platform as a service (PaaS) and infrastructure as a service (IaaS) as well as hosted private cloud services
Source: Synergy Research Group

statista

Report:

- https://www.parkmycloud.com/blog/aws-vs-azure-vs-google-cloud-market-share/
- https://www.parkmycloud.com/blog/alibaba-cloud-market-share/
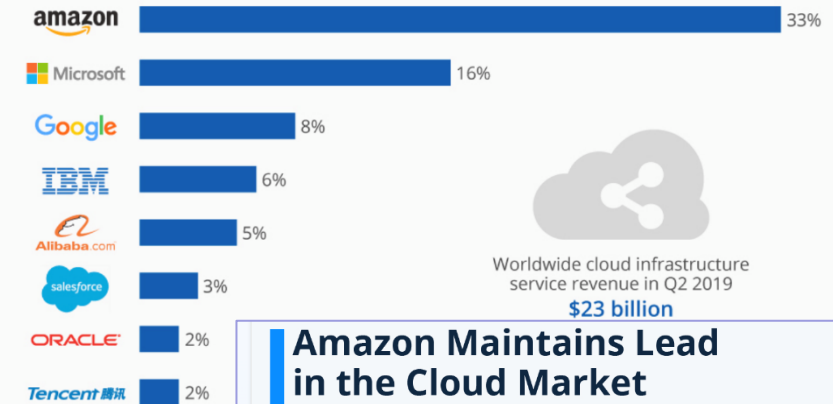- https://www.statista.com/chart/18819/worldwide-market-share-of-leading-cloud-infrastructure-service-providers/
- https://www.zdnet.com/article/the-top-cloud-providers-of-2020-aws-microsoft-azure-google-cloud-hybrid-saas/

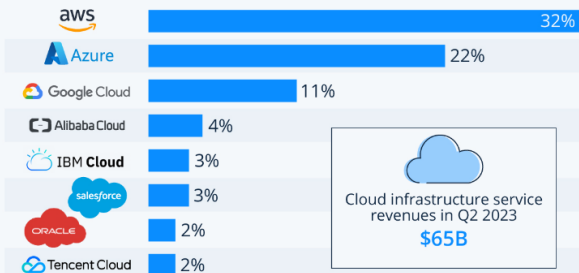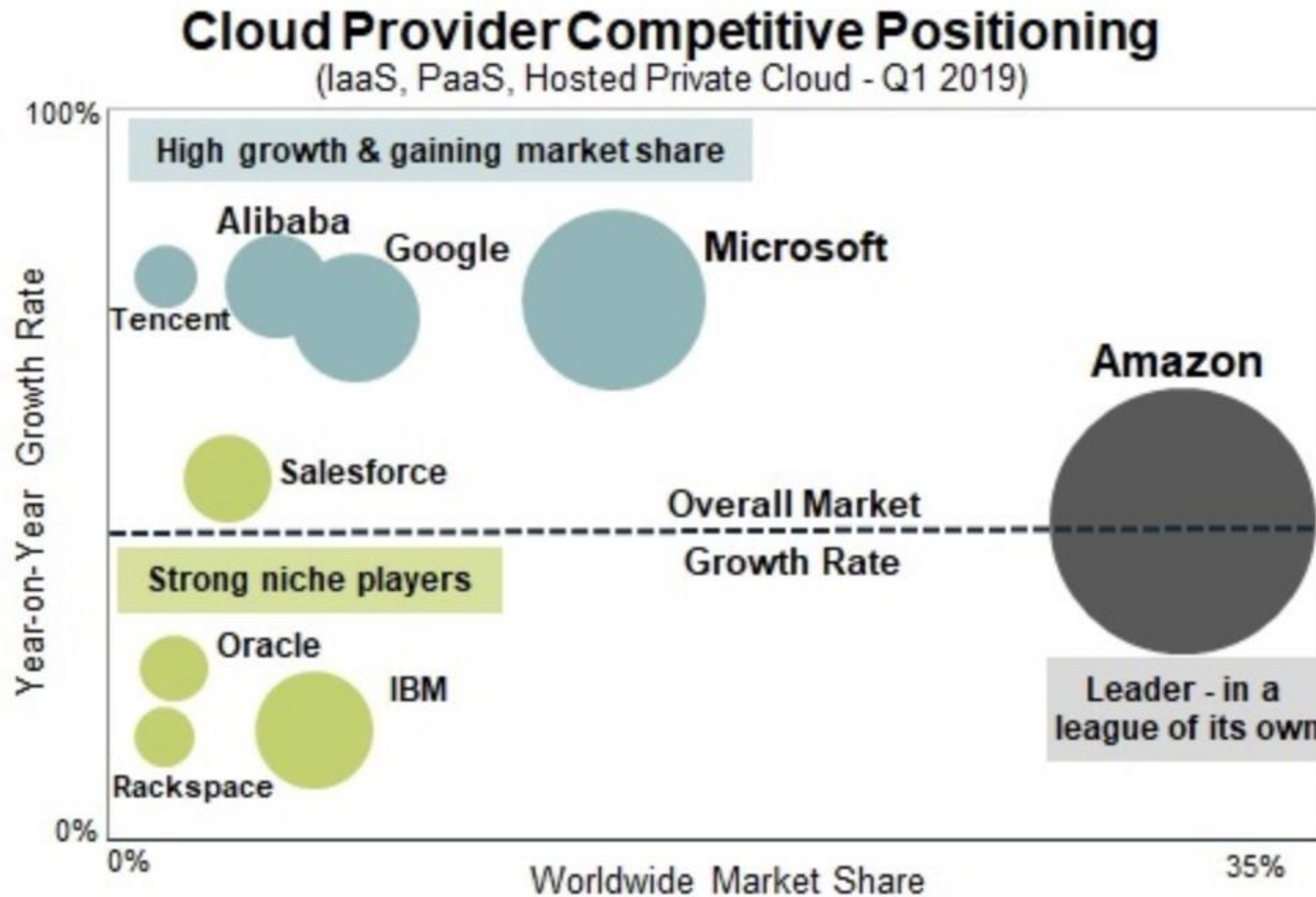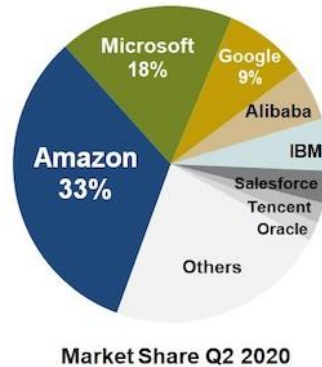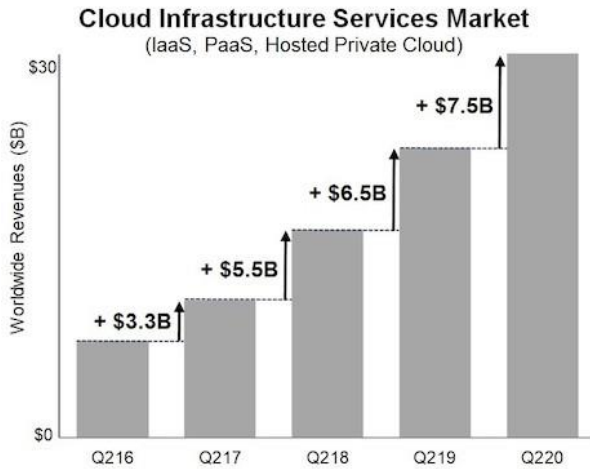# Cloud Computing

Cloud computing market share…

Cloud Provider Competitive Positioning
(IaaS, PaaS, Hosted Private Cloud - Q1 2019)

Report: https://www.parkmycloud.com/blog/alibaba-cloud-market-share/

Cloud Computing

Cloud computing market share…

Cloud Infrastructure Services Market (IaaS, PaaS, Hosted Private Cloud)

Market Share Q2 2020

Source: Synergy Research Group

Cloud Infrastructure Services - Market Share Trend (IaaS, PaaS, Hosted Private Cloud)
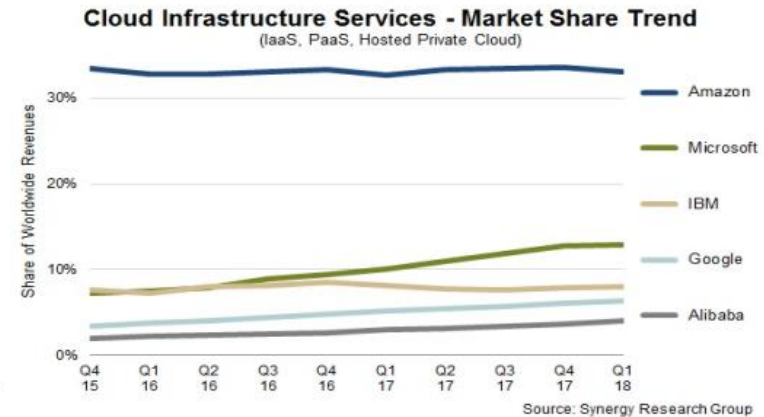
Source: Synergy Research Group

Public Cloud Leadership by Region – Q1 2018

Rank	Worldwide	North America	EMEA Region	APAC Region	Latin America
Leader	AWS	AWS	AWS	AWS	AWS
#2	Microsoft	Microsoft	Microsoft	Alibaba	Microsoft
#3	Google	Google	Google	Microsoft	Google
#4	Alibaba	IBM	IBM	Google	Salesforce
#5	IBM	Salesforce	Salesforce	Tencent	IBM

Source: Synergy Research Group

Local cloud players dominate in China
Top cloud service providers' market share in China

China cloud infrastructure services market Q1 2019: US$2.1 billion
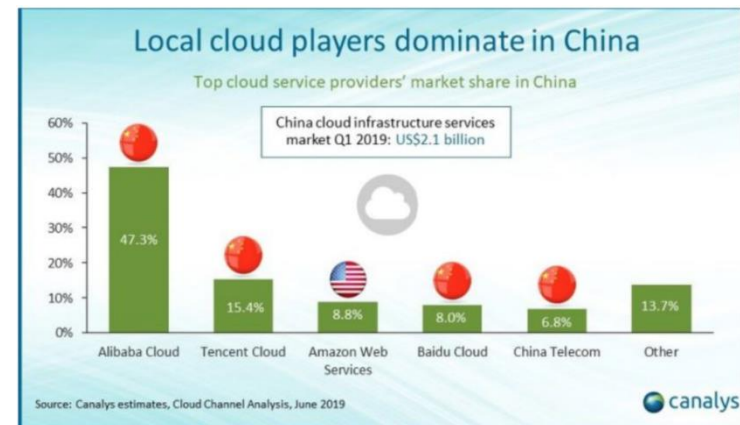
Source: Canalys estimates, Cloud Channel Analysis, June 2019

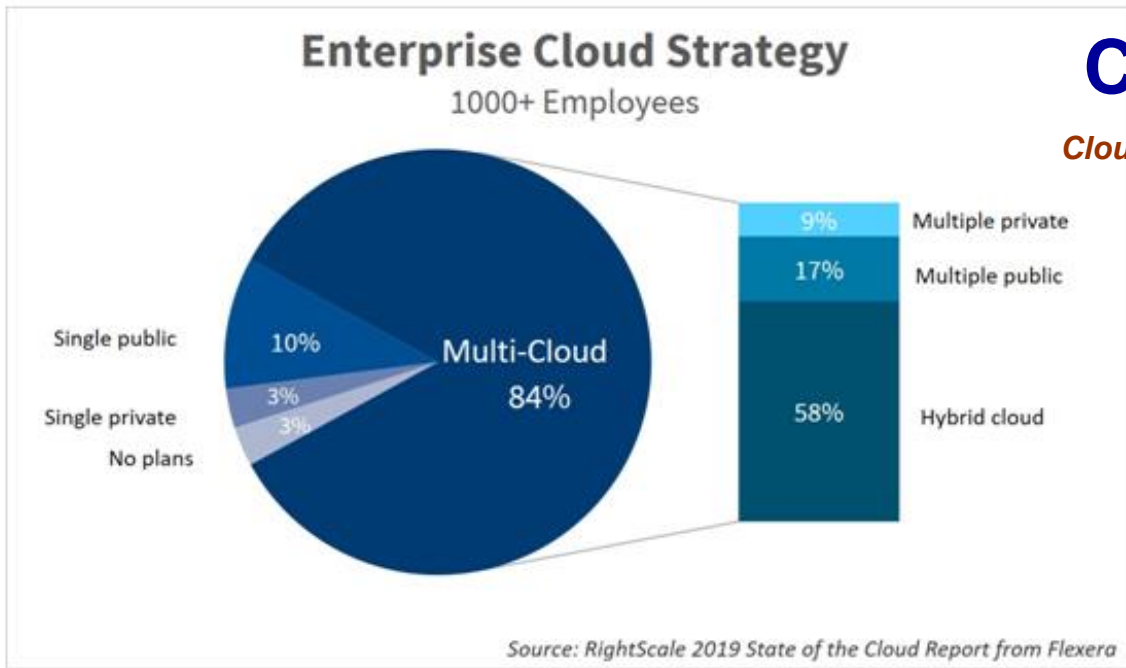*Report:*

- *https://www.channele2e.com/channel-partners/csps/cloud-market-share-2020-amazon-aws-microsoft-azure-google-ibm/*
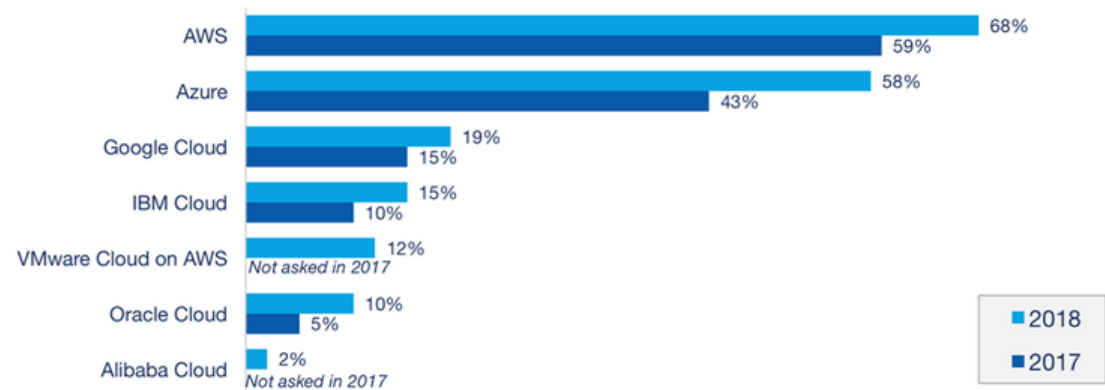- *https://www.parkmycloud.com/blog/alibaba-cloud-market-share/*

Cloud Computing

Cloud computing strategies of enterprises…

Enterprise Cloud Strategy
1000+ Employees

Single public — 10%
Single private — 3%
No plans — 3%

Multi-Cloud 84%

- 9% Multiple private
- 17% Multiple public
- 58% Hybrid cloud

Source: RightScale 2019 State of the Cloud Report from Flexera

Enterprise Public Cloud Adoption 2018 vs. 2017
% of Respondents Running Applications

	2018	2017
AWS	68%	59%
Azure	58%	43%
Google Cloud	19%	15%
IBM Cloud	15%	10%
VMware Cloud on AWS	12%	Not asked in 2017
Oracle Cloud	10%	5%
Alibaba Cloud	2%	Not asked in 2017

Source: RightScale 2018 State of the Cloud Report

Cloud Computing

Predictions for cloud computing revenues…

Cloud Computing 'as a Service' Revenue ($bn)

19% 2016-2021 CAGR
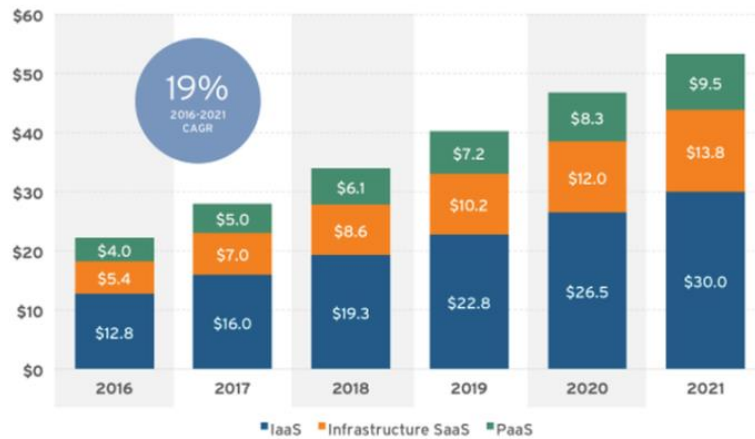
Source: 451 Research's Market Monitor: Cloud Computing, November 2017
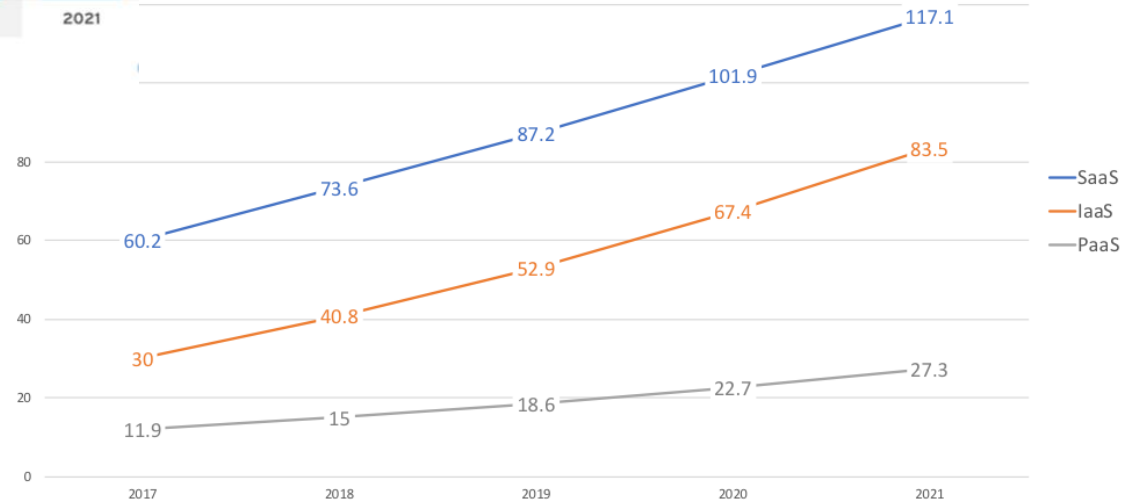

CLOUD MARKET REVENUE IN BILLIONS OF DOLLARS

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

	2017	2018	2019	2020	2021
Cloud Business Process Services (BPaaS)	42.2	46.6	50.3	54.1	58.1
Cloud Application Infrastructure Services (PaaS)	11.9	15.2	18.8	23.0	27.7
Cloud Application Services (SaaS)	58.8	72.2	85.1	98.9	113.1
Cloud Management and Security Services	8.7	10.7	12.5	14.4	16.3
Cloud System Infrastructure Services (IaaS)	23.6	31.0	39.5	49.9	63.0
Total Market	**145.3**	**175.8**	**206.2**	**240.3**	**278.3**

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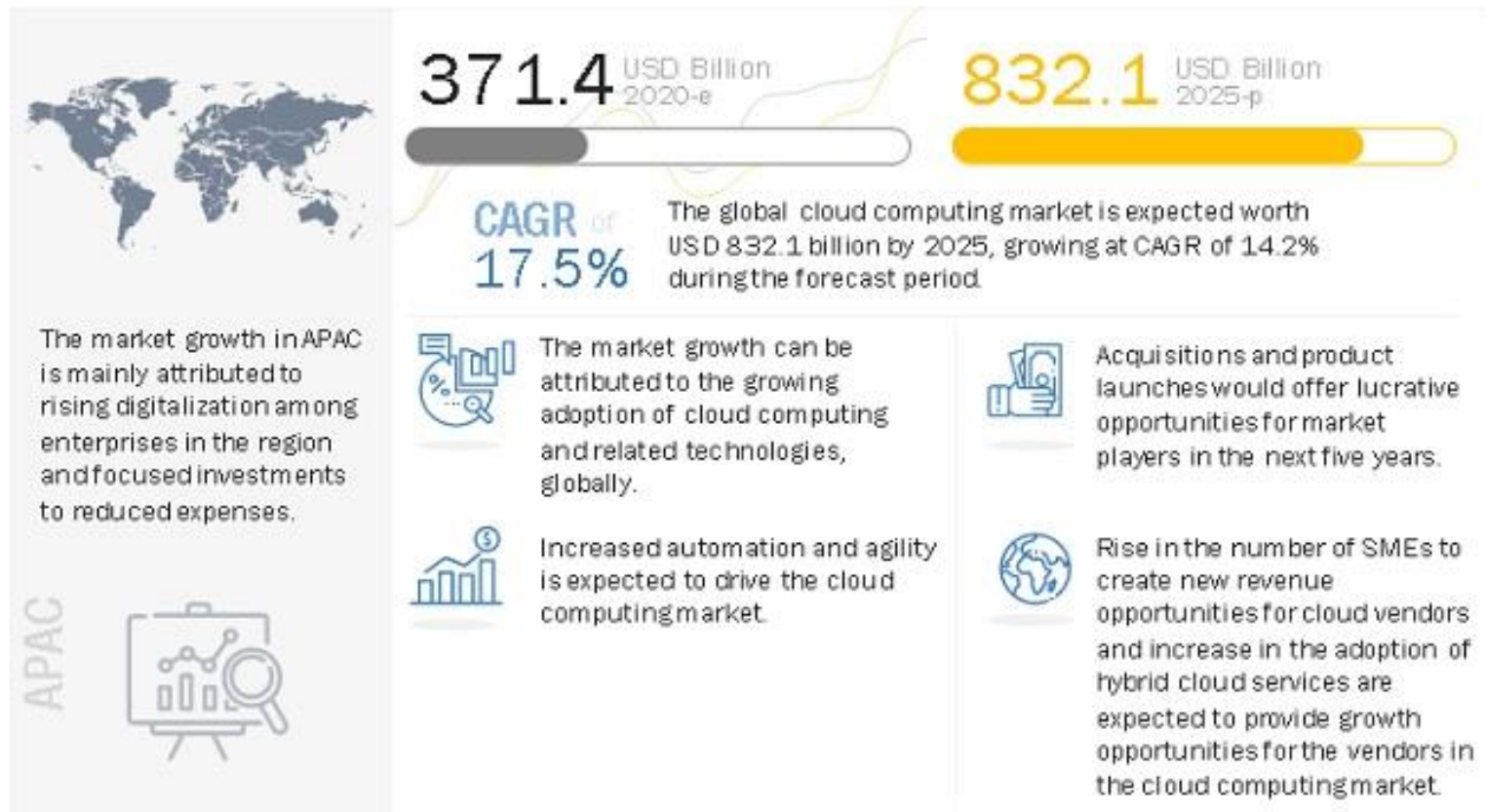Note: Totals may not add up due to rounding.

Source: Gartner (September 2018)

Cloud Computing

Predictions for cloud computing revenues…

Attractive Opportunities in Cloud Computing Market

371.4 USD Billion 2020-e

832.1 USD Billion 2025-p

CAGR of 17.5%

The global cloud computing market is expected worth USD 832.1 billion by 2025, growing at CAGR of 14.2% during the forecast period.

The market growth in APAC is mainly attributed to rising digitalization among enterprises in the region and focused investments to reduced expenses.

APAC

The market growth can be attributed to the growing adoption of cloud computing and related technologies, globally.

Increased automation and agility is expected to drive the cloud computing market.

Acquisitions and product launches would offer lucrative opportunities for market players in the next five years.

Rise in the number of SMEs to create new revenue opportunities for cloud vendors and increase in the adoption of hybrid cloud services are expected to provide growth opportunities for the vendors in the cloud computing market.

Report:

- *https://hostingtribunal.com/blog/cloud-computing-statistics/*
- *https://www.marketsandmarkets.com/Market-Reports/cloud-computing-market-234.html*

Cloud Computing

Cloud Computing Market Ecosystem

SIS/CONSULTANTS/MANAGED SERVICE PROVIDERS
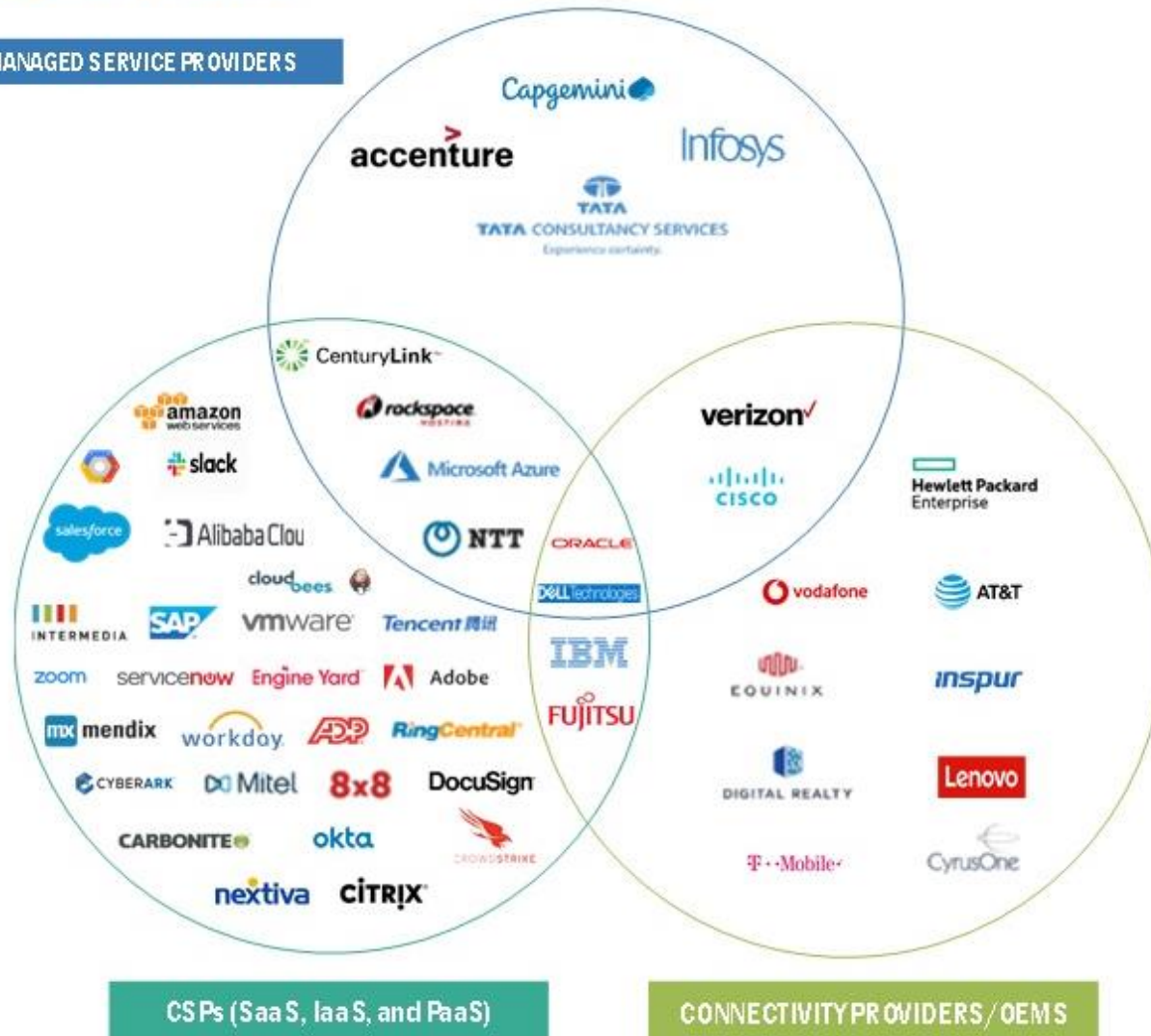
CSPs (SaaS, IaaS, and PaaS)

CONNECTIVITY PROVIDERS/OEMS

Report:

https://www.marketsandmarkets.com/Market-Reports/cloud-computing-market-234.html

Cloud Computing

"Risk executives reported being most concerned about the probability and impact of potential data risks associated with cloud computing"

Risk executives should be especially alert to the following key risk indicators:

- *Rising proportion of data stored in the cloud*
- *Changes in product offerings or contract terms from cloud provider(s)*
- *Growing percentage of non-cloud provider third parties with access to data in the cloud*
- *Unauthorized employee usage of cloud services*

Top Emerging Risks:

Cloud computing. *Either there is unauthorized access to sensitive or restricted information, or the cloud provider is unable to provide access to information as a result of disruption to their own operations*

Cybersecurity disclosure. *The guidelines for disclosing cyberbreaches become more clearly enforced, compelling organizations to release information more quickly than in the past, possibly leading to an increased reputational and financial impact*

General Data Protection Regulation (GDPR). *A specific breach of compliance with GDPR takes place from May 2018 onward, leading to a significant fine to the organization*

AI/robotics skill gaps. *Due to the highly technical and specific skill set required to manipulate artificial intelligence (AI) and robotics, organizations do not have the right capabilities at the right time to effectively capitalize on the opportunities associated with these technological advances*

Global economic slowdown. *A slowdown in global economic growth tied to negative or near-zero percent interest rates will negatively impact organizations' growth*

...

Links:
- *https://hostingtribunal.com/blog/cloud-computing-statistics/*
- *https://www.gartner.com/smarterwithgartner/cloud-computing-tops-list-of-emerging-risks/*
- *https://www.gartner.com/en/newsroom/press-releases/2018-08-15-gartner-says-cloud-computing-remains-top-emerging-business-risk*
- *https://www.gartner.com/ngw/globalassets/en/risk-audit/documents/top-ten-emerging-risks-Q2-2018.pdf*

Cloud Providers

Amazon Web Services (https://aws.amazon.com/)
- *Products & services: https://aws.amazon.com/*
- *Getting started: https://aws.amazon.com/getting-started/*

Windows Azure (https://azure.microsoft.com/en-us/)
- *Products & services: https://azure.microsoft.com/en-us/*
- *Getting started: https://docs.microsoft.com/en-us/azure/*

Google Cloud Platform (https://cloud.google.com/)
- *Products & services: https://cloud.google.com/products/*
- *Getting started: https://cloud.google.com/getting-started/*

IBM Cloud (https://www.ibm.com/cloud/)
- *Products & services: https://cloud.ibm.com/catalog*
- *Getting started: https://cloud.ibm.com/docs*
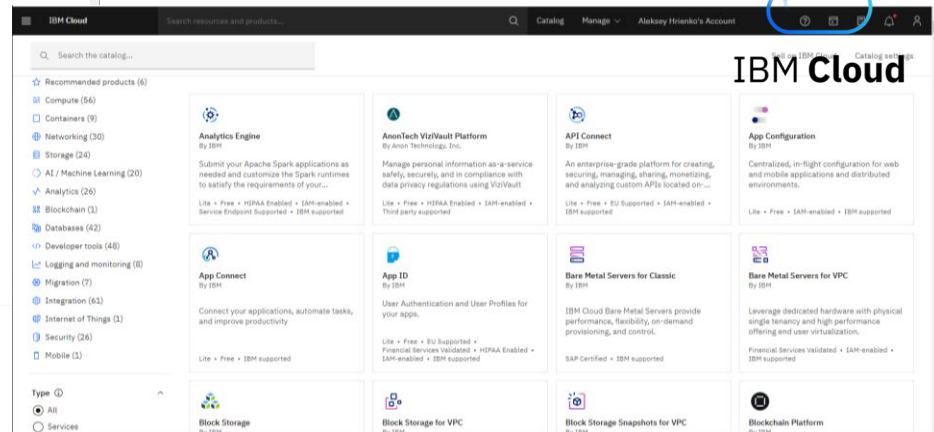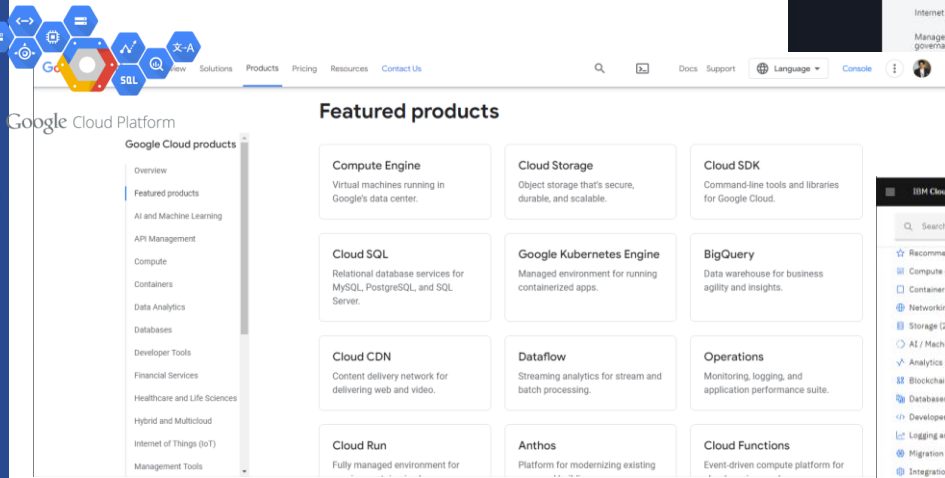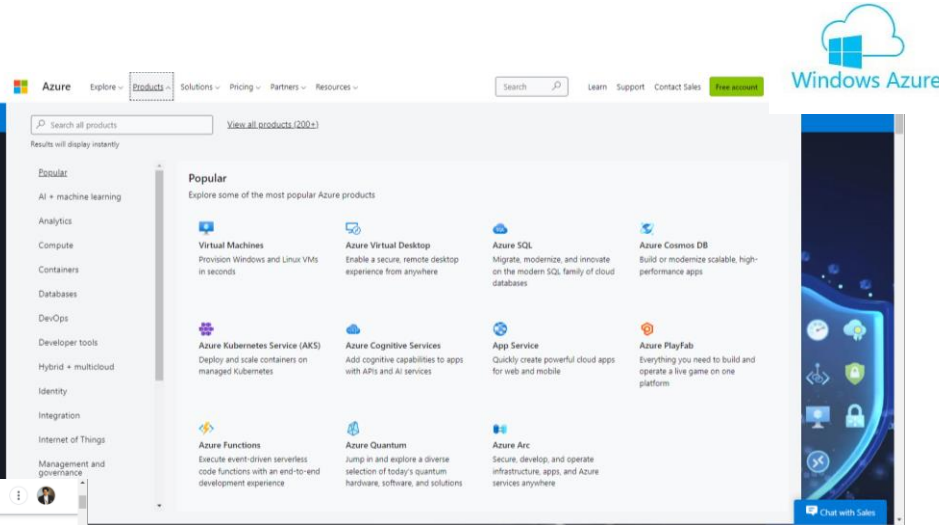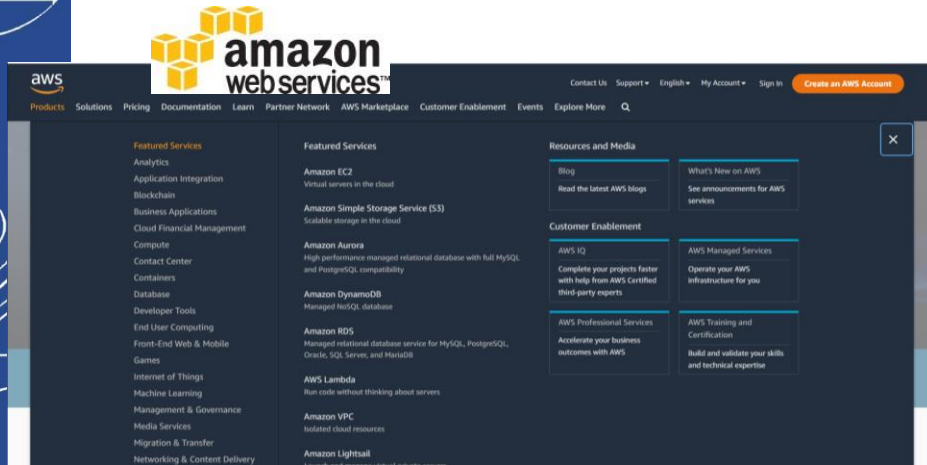
Cloud Services

Heroku Platform

Heroku *is a cloud Platform-as-a-Service (PaaS). It is a cloud-based, scalable server solution that allows you to easily manage the deployment of your applications. It supports variety of programming languages (e.g. Node.js, Ruby, Java, PHP, Python, Go, Scala, Clojure). So, you do not have to worry about infrastructure, just focus on your application. (http://www.heroku.com)*

o *Heroku itself is built entirely on* **AWS cloud servers***.*
o *Heroku uses* **Git** *(a distributed version control system for code management) to manage application deployments. All you'll need to do to deploy your application on Heroku is push your Git repository to their servers.*
o *Eligible students can apply for platform credits through our new* **Heroku for GitHub Students program** *- https://blog.heroku.com/github-student-developer-program.*

Heroku Platform

*To start deploying your Apps to Heroku ,you need to install **Apache Maven** and **Heroku CLI**:*

Apache Maven *is a software project management and comprehension tool. Based on the concept of a project object model (POM), Maven can manage a project's build, reporting and documentation from a central piece of information. (https://maven.apache.org/)*

Installation instruction: https://maven.apache.org/install.html

Heroku Command Line Interface (CLI) *(formerly known at the **Heroku Toolbelt**) is used to manage and scale your applications, to provision add-ons, to view the logs of your application as it runs on Heroku, as well as to help run your application locally.*

Installation instruction: https://devcenter.heroku.com/articles/heroku-cli

Get Started on Heroku with Java...

(https://devcenter.heroku.com/articles/getting-started-with-java)

Heroku Platform
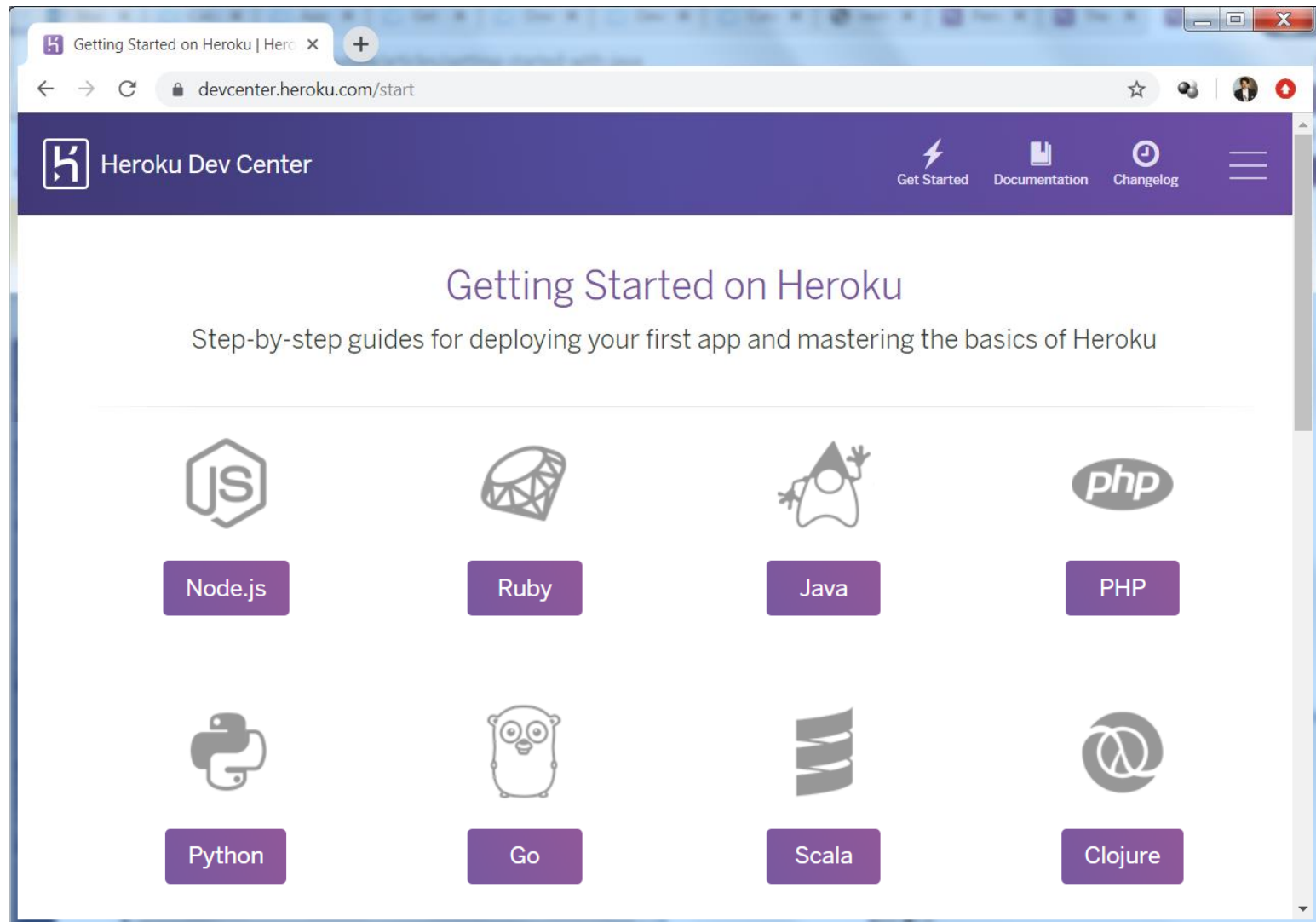
Get Started on Heroku with other languages: https://devcenter.heroku.com/start

Heroku Platform

App deployment to Heroku

There are many ways to deploy your App to Heroku …
(https://devcenter.heroku.com/categories/deployment).

Heroku also provides **supportive articles** *for various deployment options:*

o *Deploying Executable JAR Files (https://devcenter.heroku.com/articles/deploying-executable-jar-files)*

o *Deploying Java Applications with the Heroku Maven Plugin*

  (https://devcenter.heroku.com/articles/deploying-java-applications-with-the-heroku-maven-plugin)

o *Deploying Java Apps on Heroku (https://devcenter.heroku.com/articles/deploying-java)*

o *WAR Deployment (https://devcenter.heroku.com/articles/war-deployment)*

o *Configuring WAR Deployment with the Heroku CLI*

  (https://devcenter.heroku.com/articles/configuring-war-deployment-with-the-heroku-toolbelt)

o *Deploying Tomcat-based Java Web Applications with Webapp Runner*

  (https://devcenter.heroku.com/articles/java-webapp-runner)

o *Create a Java Web Application Using Embedded Tomcat*

o *(https://devcenter.heroku.com/articles/create-a-java-web-application-using-embedded-tomcat)*

o *Deploy a Java Web Application That Launches with Jetty Runner*

  (https://devcenter.heroku.com/articles/deploy-a-java-web-application-that-launches-with-jetty-runner)

o *Etc.*

Heroku Platform

App deployment to Heroku…

Create *a free account in Herohu…*

Use Heroku Command Line Interface to **Login** *to Heroku*

```
heroku login
Enter your Heroku credentials.
Email: adam@example.com
Password: *******
Authentication successful.
```

Since now Heroku belongs to Salesforce, the login will be redirected to the browser based login page…

Create *new app on Heroku*

```
heroku create
Creating warm-eyrie-9006... done
http://warm-eyrie-9006.herokuapp.com/ | https://git.heroku.com/warm-eyrie-9006.git
```

```
heroku create example
Creating example... done
https://example.herokuapp.com/ | https://git.heroku.com/example.git
```

Install *or update the Heroku* **CLI Deploy Plugin** *to deploy your app form CLI*

```
heroku plugins:install heroku-cli-deploy
```

Deploy *app to Heroku:*

```
heroku deploy:jar <path-to-jar-file> --app <app-name>
```
executable .jar file deployment

```
heroku deploy:war <path-to-war-file> --app <app-name>
```
.war file deployment

… use **Logs** *to see an aggregated list of log messages*

```
heroku logs
```

Heroku Platform

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Heroku Platform

Since Heroku uses Java 8 by default, you may specify another Java version by adding a file called "system.properties" (with parameter e.g. java.runtime.version=13) to your application. You may add it while deploying via --includes argument.

Links:
- *https://devcenter.heroku.com/articles/java-support#specifying-a-java-version*

Heroku Platform
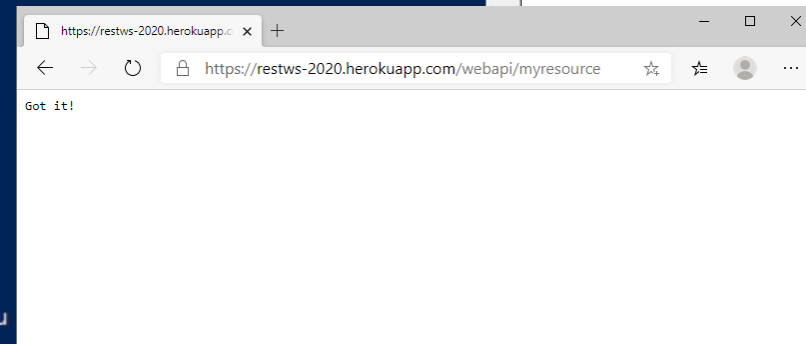
Heroku environment setting HINTs…

❑ *If you have an error e.g. (Error: ENOENT: no such file or directory, open 'U:/_netrc'), you may set HomeDrive environmental variable to the folder where you have Heroku related files (e.g. C:\Users\olkhriye\AppData\Local\heroku)*

❑ *Heroku saves auth related information (including auth token) in '_netrc' file. If you have an error (ERROR: Could not get API key!). You may get access token by running 'heroku auth:token' command and then set provided value for HEROKU_API_KEY environmental variable*

Cloud Deployment

App deployment HINTs…

❑ *You cannot hardcode the port you run the server on. Instead, you need to read the PORT environment variable. In Java, this is can be done as follows*

```
…
Integer port = Integer.valueOf(System.getenv("PORT"));
Server server = new Server(port);
```

❑ *Starting the server on http://localhost... will not work. You have to use http://0.0.0.0... Instead*

```
…
String address = "http://0.0.0.0:"+port+"/";
Endpoint.publish(address, new LibraryWS());
```

❑ *In case you deploy Maven project using Git, you would need to add a file called Procfile and system.properties as described in the Heroku Java tutorial.*

(https://devcenter.heroku.com/articles/procfile)(https://devcenter.heroku.com/articles/java-support)

❑ *Ensure that your Maven project builds proper .WAR file… Run project with option as "Maven Install". If succeed, the WAR file will be generated in "/target" folder of the project. If there are errors related to the incompatible version of the maven-war-plugin, add for example the following dependency and plugin…*

```
…
<plugin>
    <groupId>org.apache.maven.plugins</groupId>
    <artifactId>maven-war-plugin</artifactId>
    <version>3.3.1</version>
    <configuration>
        <failOnMissingWebXml>false</failOnMissingWebXml>
    </configuration>
</plugin>
…
```

```
…
<dependency>
    <groupId>org.apache.maven.plugins</groupId>
    <artifactId>maven-war-plugin</artifactId>
    <version>3.3.1</version>
</dependency>
```

Cloud Computing

Apache JMeter™ *application is open-source software designed to load test functional behavior and measure performance (http://jmeter.apache.org/).*

❑ *It may be used to test performance both on static and dynamic resources:*

　　o *Web Services (SOAP/REST),*

　　o *Web dynamic languages (PHP, Java, ASP.NET, etc.)*

　　o *Java Objects,*

　　o *Data Bases and Queries,*

　　o *FTP Servers*

　　o *Etc.*

❑ *It can be used to simulate a heavy load on a server, group of servers, network or object to test its strength or to analyze overall performance under different load types.*

Try to use it by building a Web Test Plan *(http://jmeter.apache.org/usermanual/build-web-test-plan.html)*

Some useful tips:
https://testingsorttricks.wordpress.com/2015/06/10/what-is-thread-group-in-the-jmeter/
http://jmeter-expert.blogspot.fi/
http://www.javaworld.com/article/2071953/testing-debugging/jmeter-tips.html

IBM Cloud

Access to the platform and services

❑ *Sign up to the platform by creating your personal IBMid. In addition to IBM ID and password, you suppose to specify organization name and space name that will be used in app deployment… (https://cloud.ibm.com/registration/)*

  ○ *no time restrictions with Lite plan services. :*

  ○ *Get access to Infrastructure and Platform services from the catalog (https://cloud.ibm.com/catalog/).*

App Creation and Deployment

❑ *Get started with a new app using Boilerplates.*

❑ *Use the IBM Cloud Command Line Interface (CLI) to deploy and modify applications and service instances. (https://cloud.ibm.com/docs/cli/index.html).*

❑ *Use IBM Eclipse Tools (https://cloud.ibm.com/docs/cloud-foundry?topic=cloud-foundry-starter-eclipse).*

❑ *Use IBM Cloud DevOps Services (https://cloud.ibm.com/devops/getting-started, https://developer.ibm.com/tutorials/cl-deploy-a-hello-world-webpage-to-bluemix-app/).*

❑ *Deploying apps (https://cloud.ibm.com/docs/cloud-foundry-public?topic=cloud-foundry-public-deployingapps , https://cloud.ibm.com/docs/cloud-foundry?topic=cloud-foundry-options_for_pushing).*

```
cf api https://api.ng.bluemix.net                                          login
cf login
```

```
cf push <app-name> -p <path-to-jar-file> --no-route         executable .jar file deployment
```

```
cf push <app-name> -p <path-to-war-file>                         .war file deployment
```

❑ *Deployment via IBM Cloud Kubernetes service (an open-source container orchestration platform that automates the deployment, scaling, and management of containerized applications): https://saturncloud.io/blog/how-to-deploy-a-backend-java-app-to-ibm-cloud-kubernetes*

IBM Cloud documentation: https://cloud.ibm.com/docs/
IBM Developer resources: https://developer.ibm.com/

Cloud deployment

to Google…

- *https://cloud.google.com/eclipse/docs/quickstart*
- *https://cloud.google.com/eclipse/docs/deploy-flex-jar*

to AWS…

- *https://www.edureka.co/blog/deploy-java-web-application-in-aws/*
- *https://mindmajix.com/java-enterprise-application-in-aws-cloud*

to Azure…

- *https://learn.microsoft.com/en-us/azure/developer/java/toolkit-for-eclipse/installation*
- *https://www.linkedin.com/pulse/how-deploy-java-based-web-application-microsoft-azure-shruti-panale/*
- *https://azuredevopslabs.com/labs/vstsextend/tomcat/*

Cloud deployment

Terraform *is Infrastructure as Code (IaC) tool that automatically creates cloud resources defined in the user's /configuration files/*

- *Infrastructure can be created, updated or removed by modifying the code and re-running Terraform*
- *Deployment can and often is automated by running Terraform inside a CI/CD pipeline*

More information: www.terraform.io
https://learn.hashicorp.com/terraform?utm_source=terraform_io

Task 5