University of Applied Sciences and Arts Northwestern Switzerland
School of Computer Science

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Cloud Computing
(cloud)

Module 1: Introduction to Foundations of Cloud Computing

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Agenda

1. History of Cloud Computing

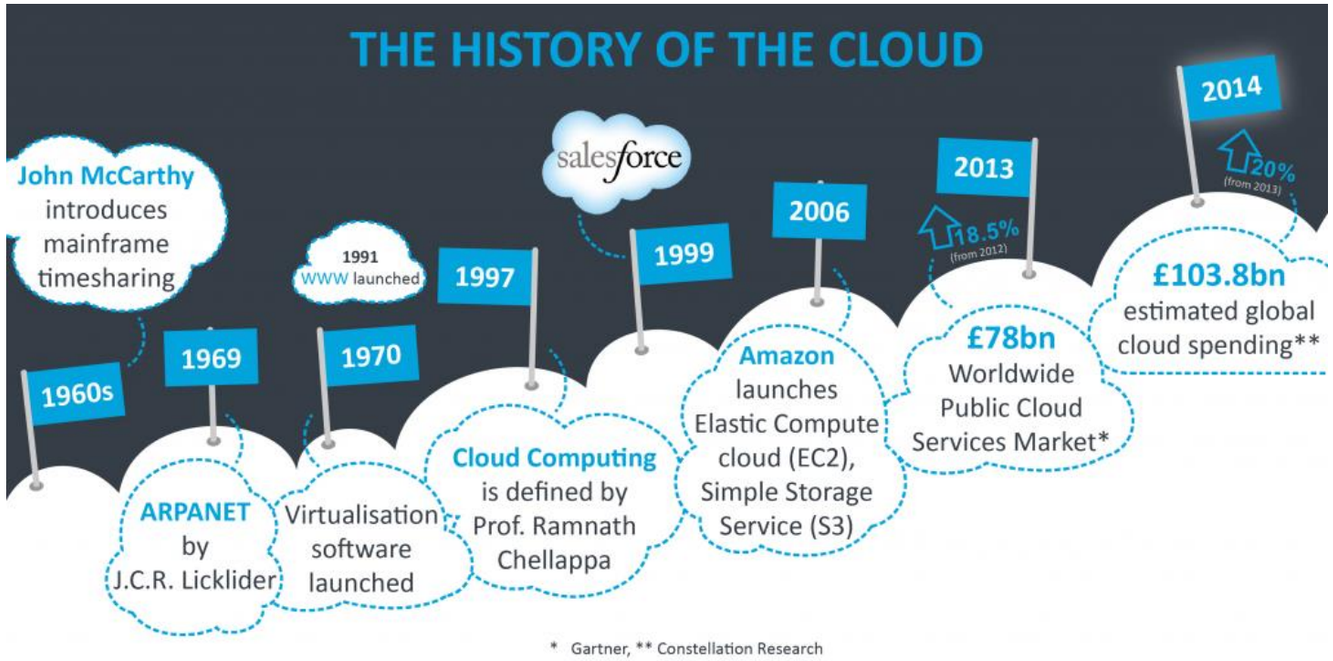
2. NIST Definition and Characteristics
   - Deployment Models
   - Service Models (and Examples)

3. Cloud Infrastructure Building Blocks

Input of this Module

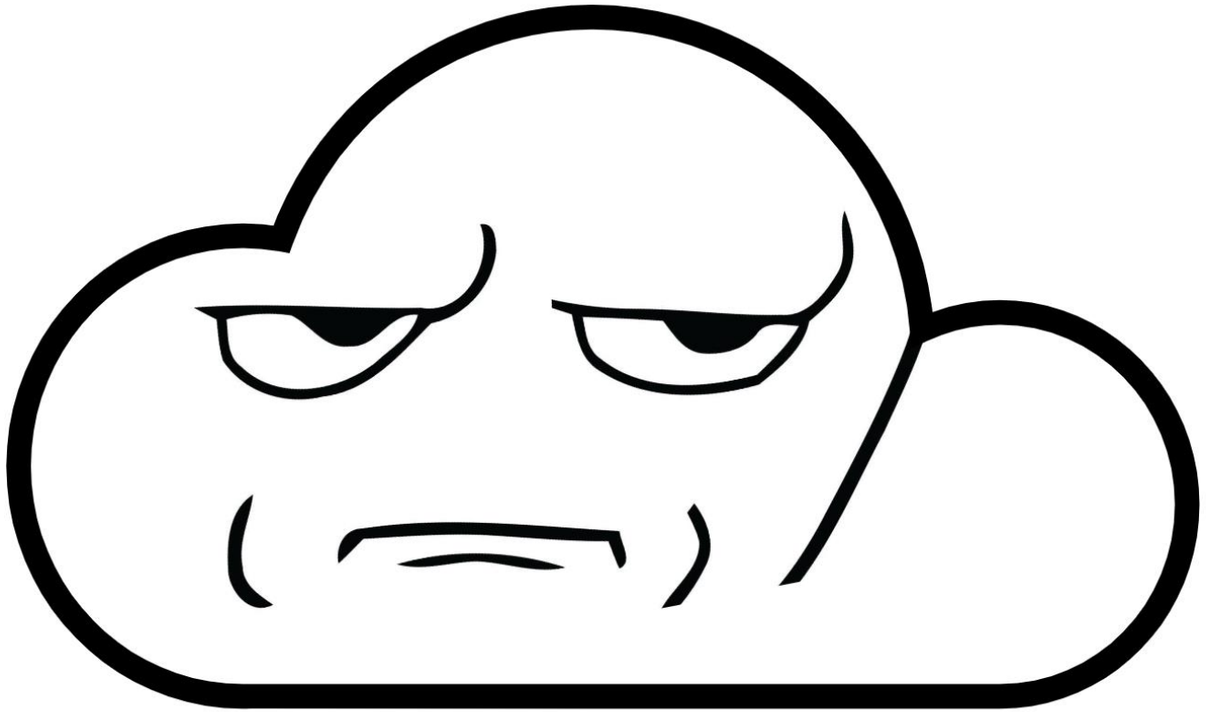
- https://learning.oreilly.com/playlists/43827098-7a87-435e-823e-736586b5694c
  01-introduction
- Several Blogposts

History



Main impact points:

- Mainframe Timesharing
  → Ressource Sharing
- ARPANET
  → Network Access
- Launching Virtualization
  → Pooling Ressources on common infrastructure
- Salesforce offer SaaS-model alike products
  → pay-as-you-go model
- Amazon launching EC2 as product
  → managing of elasticity for customers



There is no Cloud …

… it’s just someone else’s computer.

What is a cloud? - NIST Definition of Cloud Computing

Cloud computing is a model for enabling ubiquitous, 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.

This cloud model is composed of **three service models**, **four deployment models**, and **five essential characteristics**, which are:

- **On-demand self-service**: Resources are provisioned automatically without human interaction.
- **Broad network access**: The cloud must be accessible via network.
- **Resource pooling**: Resources are shared among multiple customers.
- **Rapid elasticity**: Existing resource can be adapted to shrink and to increase dynamically.
- **Measured service**: All usage of the cloud is metered in a transparent matter to enable pay-as-you-go

How can clouds be provided? - Cloud Deployment Models

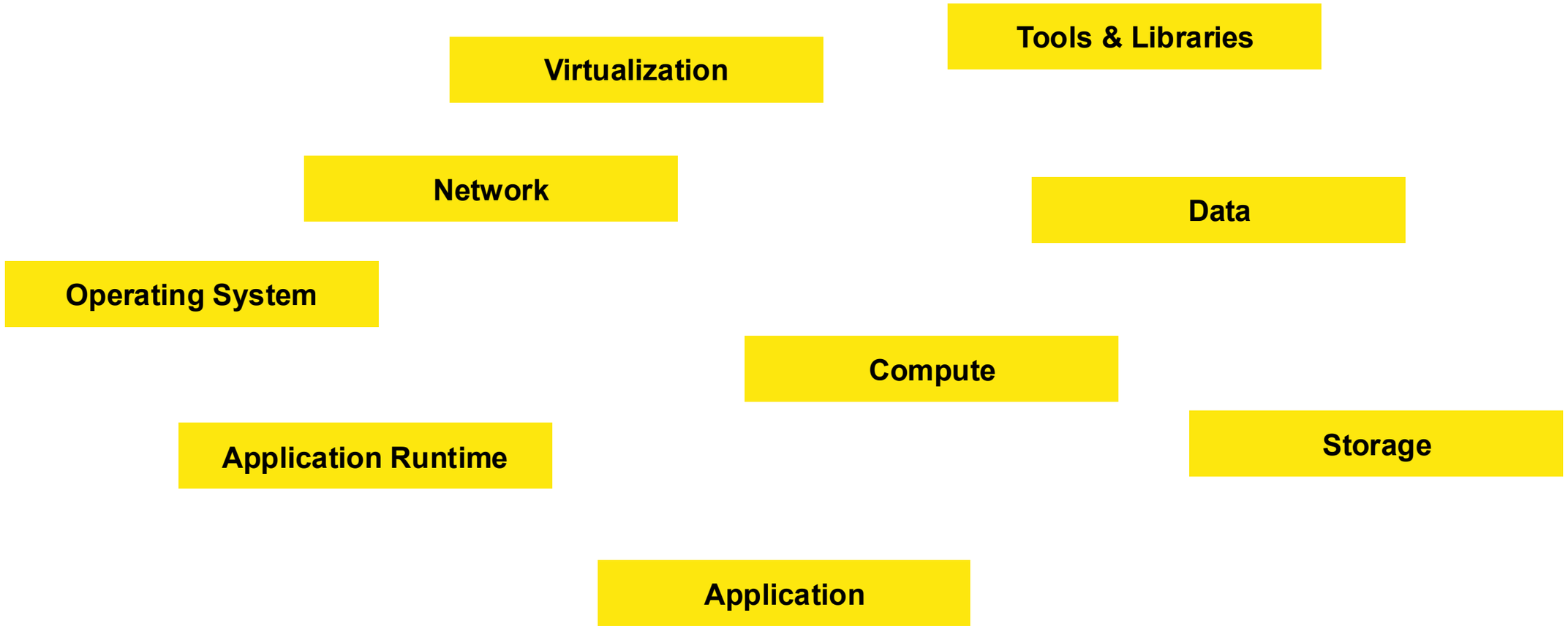
- **Private cloud** for exclusive use by a single organization
  - Within the perimeters of its firewall
  - Third-party may manage the cloud
  - Does not scale as well as Public clouds (often not a real cloud)

- **Public cloud** for the general public
  - Multi-tenant
  - General purpose
  - No full control over the data → Confidential Compute

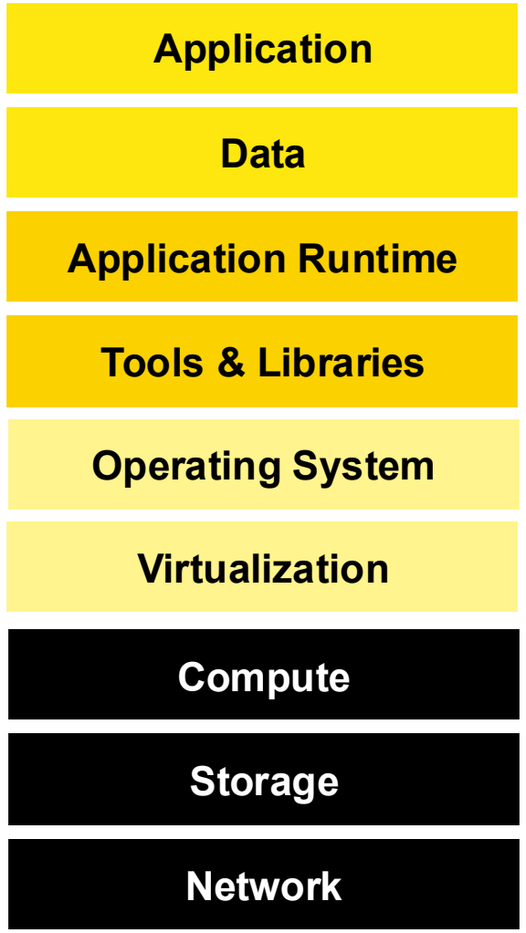
- **Community Cloud** for organizations that have shared concerns (e.g., government, universities)

- **Hybrid Cloud** composition of two or more distinct cloud infrastructures (e.g., private and public)
  - Hardly seen in reality, as companies often stick to one/two public clouds and their on-premise bare metal (which is not a cloud).

Cloud Infrastructure Building Blocks

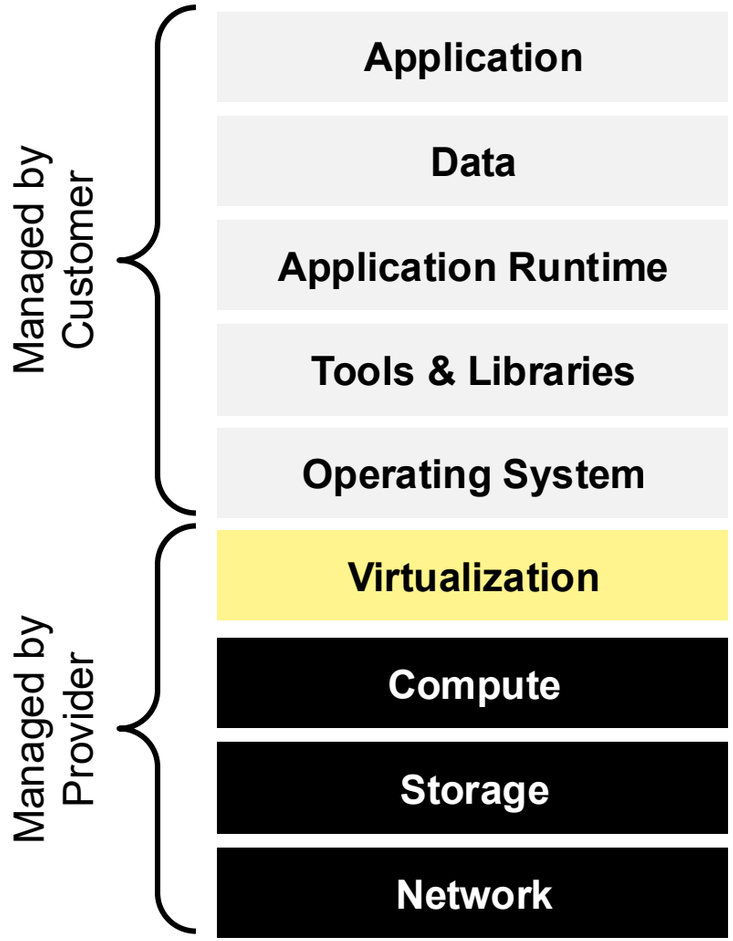


Cloud Infrastructure Building Blocks Organized



Cloud Service Models: Infrastructure as a Service (**IaaS**)

- The consumer can provision **processing**, **storage**, **networks**, and other **computing resources**
- The consumer is able to deploy and run arbitrary software, which can include operating systems and applications
- The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, and deployed applications

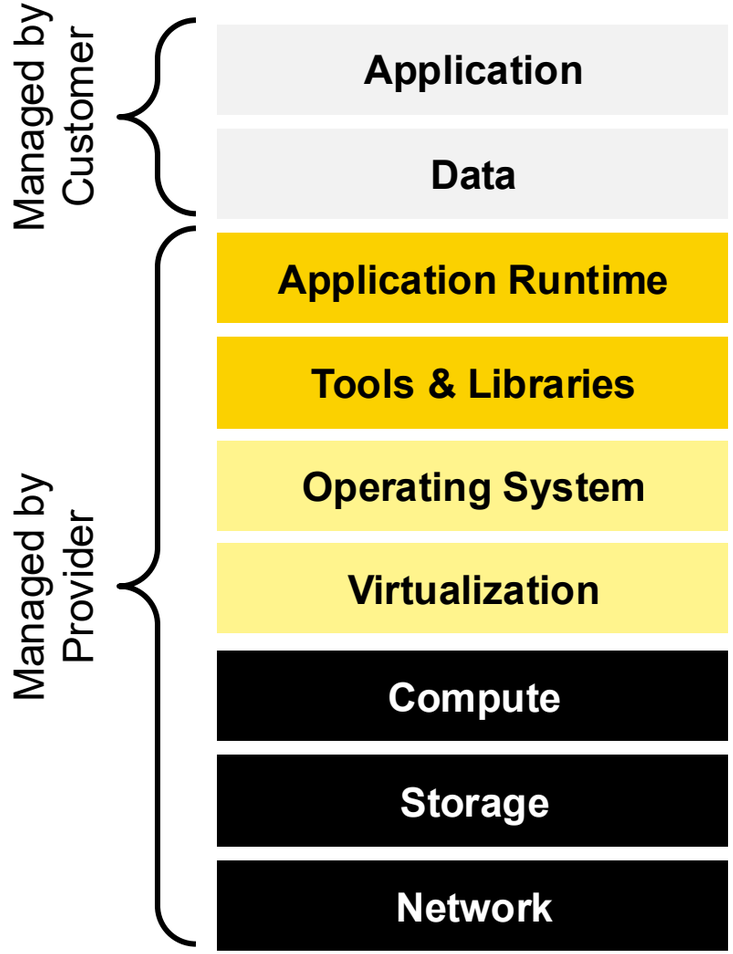


Cloud Service Models: Platform as a Service (**PaaS**)

- The consumer can deploy applications created using programming languages, libraries, services and tools supported by the provider.

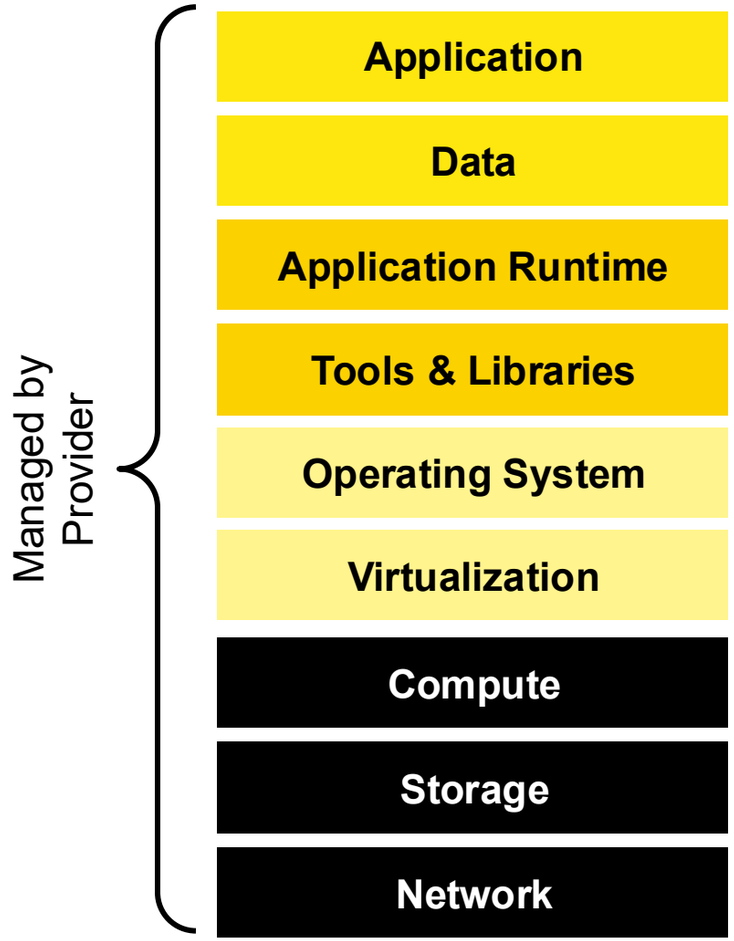
- Offerings:
  - Application design
  - Application development
  - Testing
  - Deployment
  - Hosting
  - Collaboration

- Cloud providers offer a computing platform, typically including an operating system, a programming language execution environment, a database, and a web server

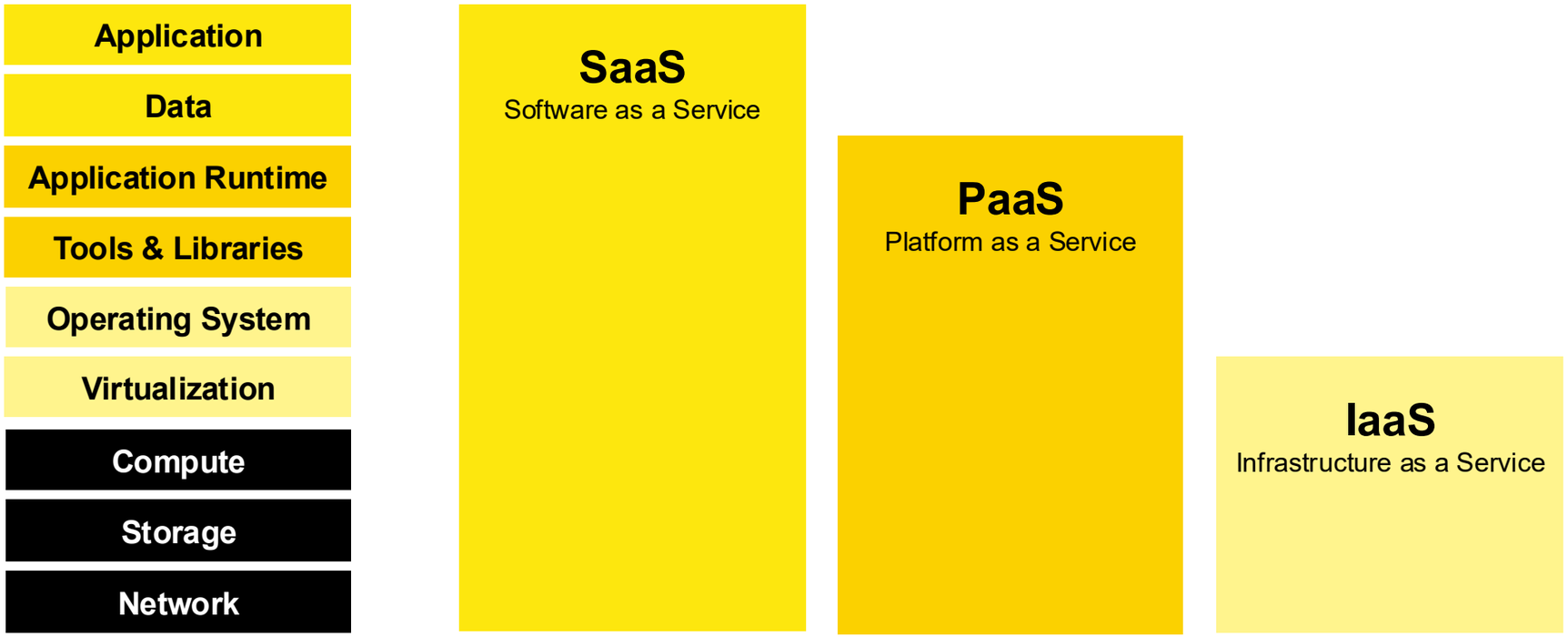


Cloud Service Models: Software as a Service (**SaaS**)

- The cloud service provides **ready-to-use applications**
- The consumer can use the provider applications running on a cloud infrastructure
- Applications are accessible from various client devices
- Applications may run partially or **completely** in the provider environment

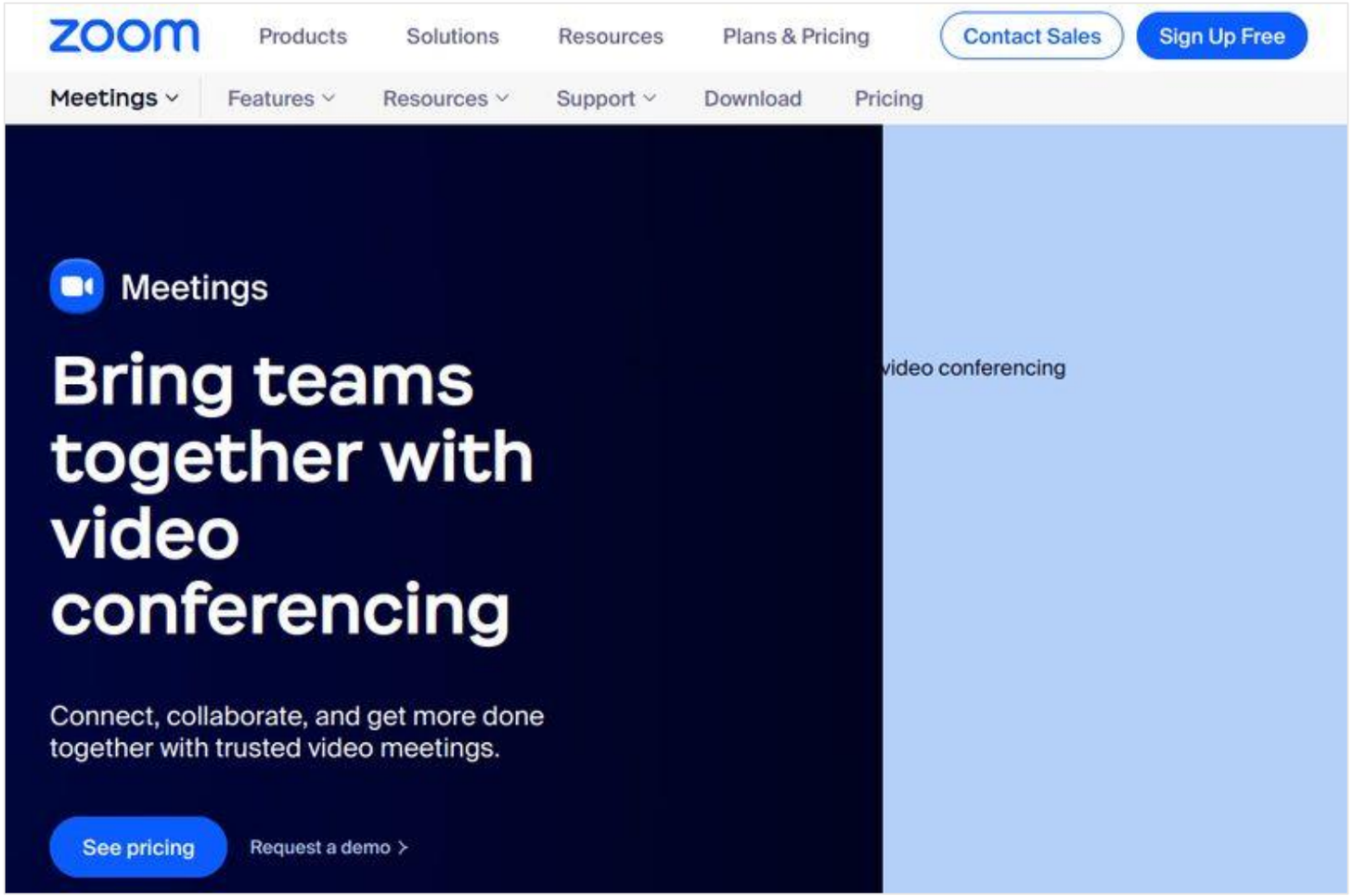


Cloud Service Models



NOTE: *NIST leaves nowadays room for speculation (is Kubernetes a PaaS or not?) and EaaS (Everything as a Service)*

Cloud Service Models: Examples



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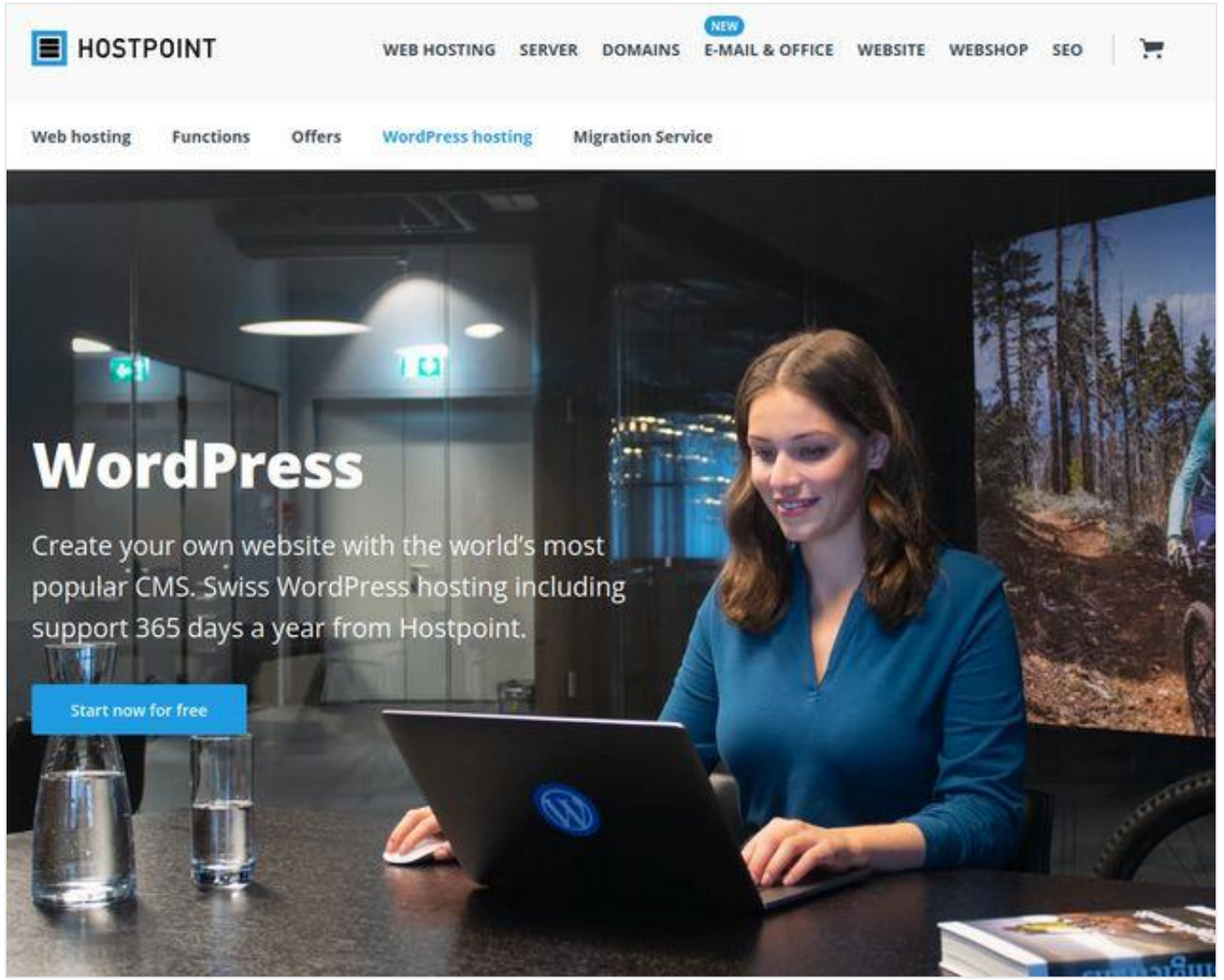

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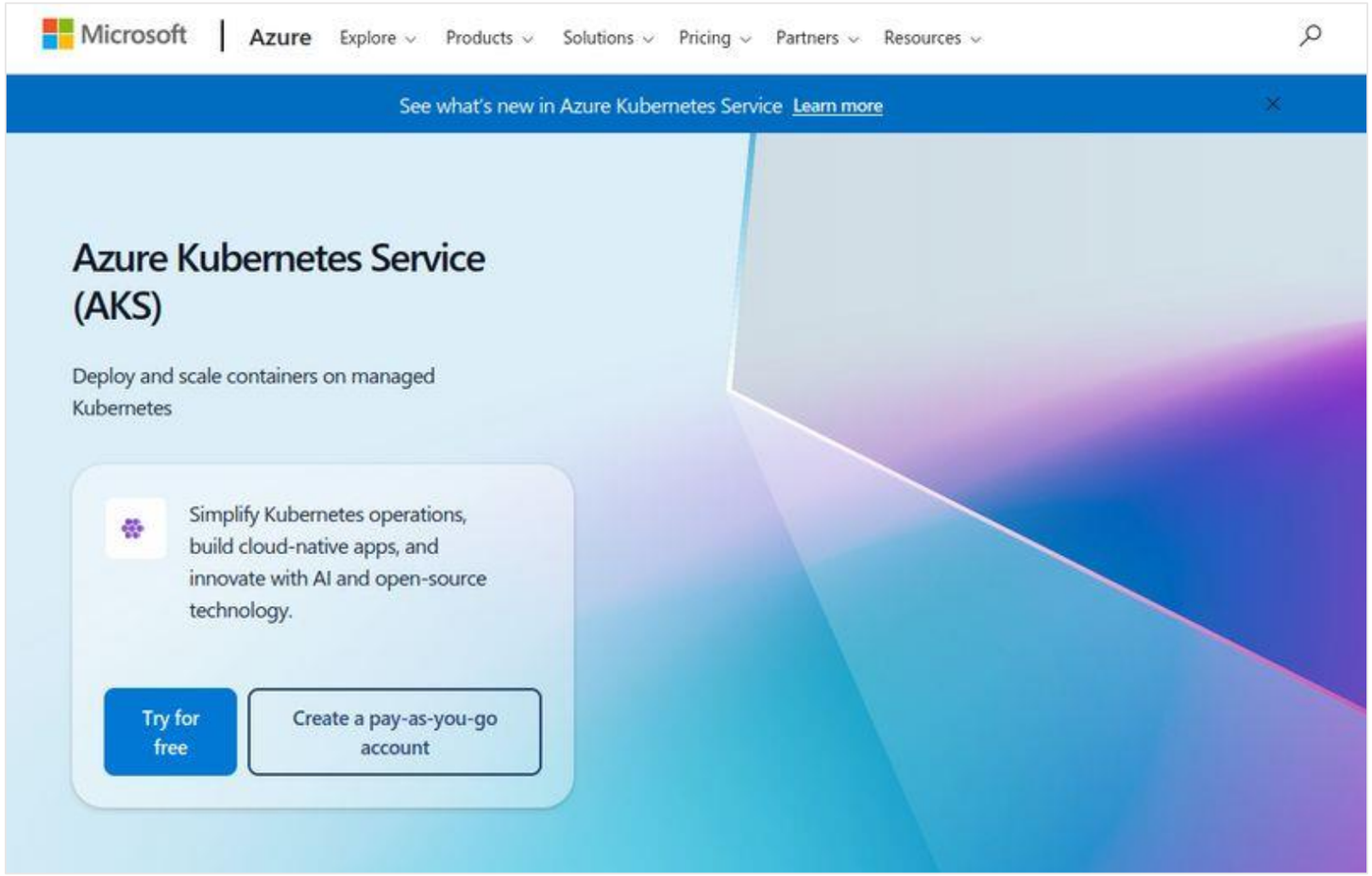

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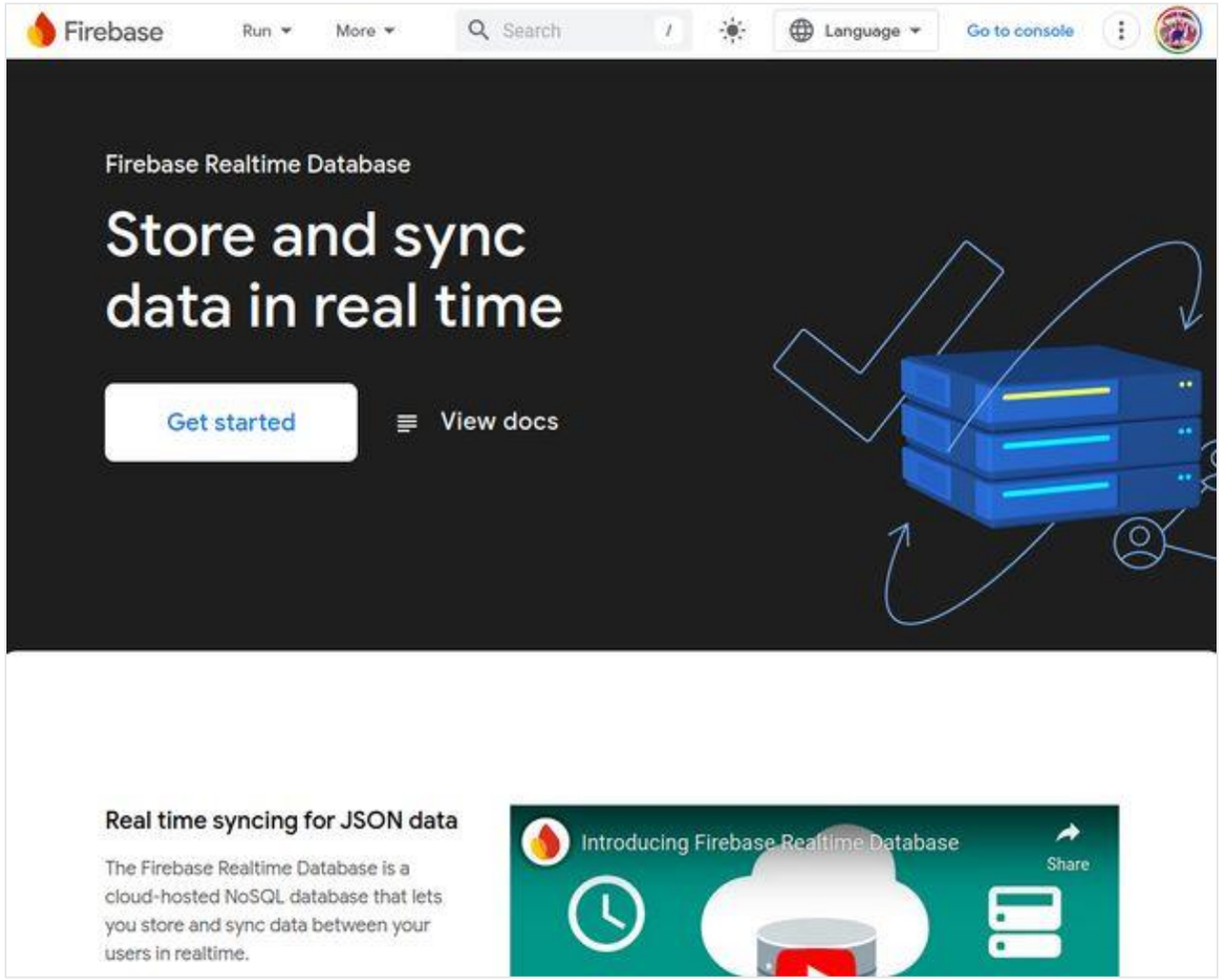

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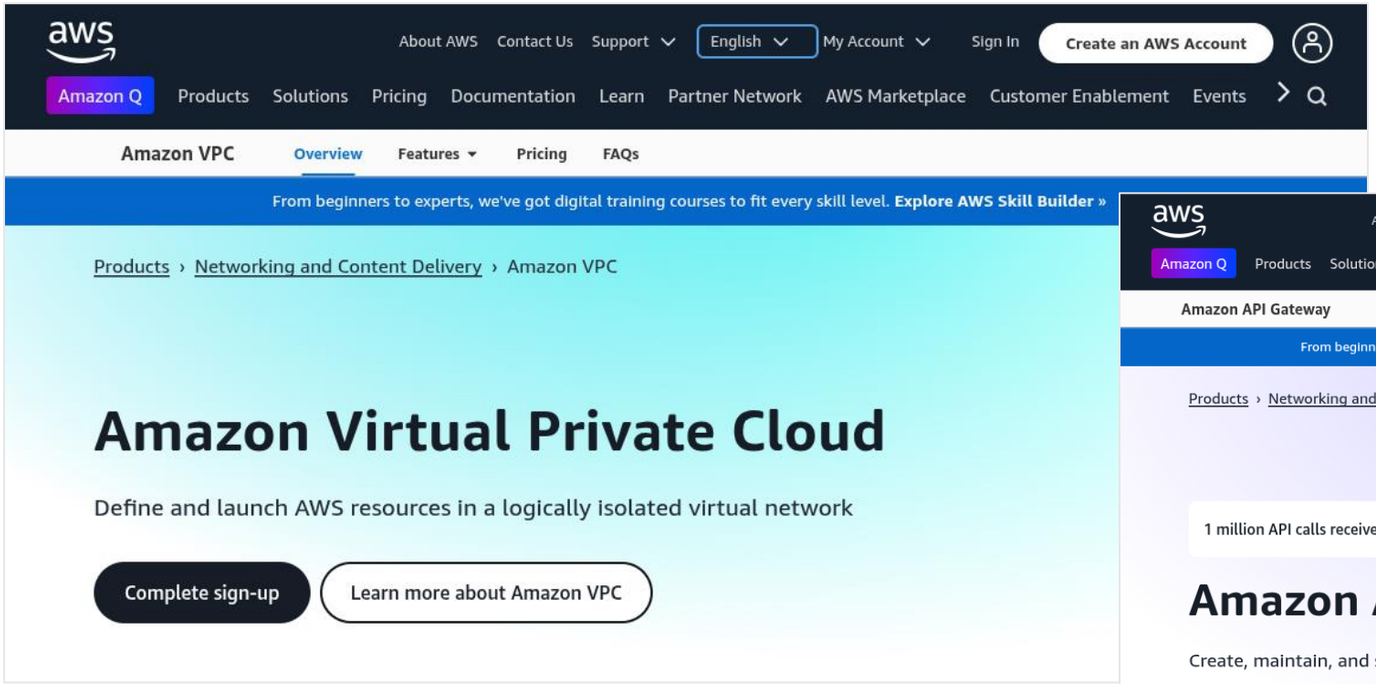
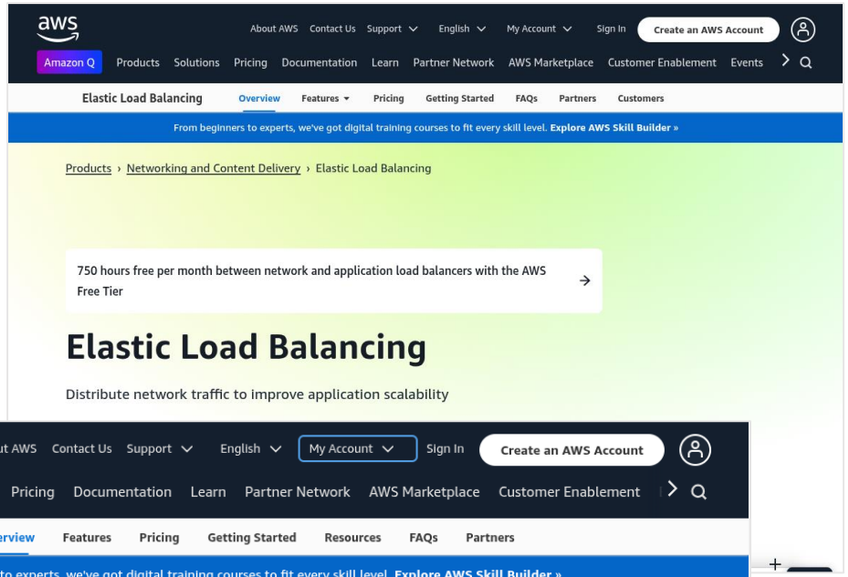
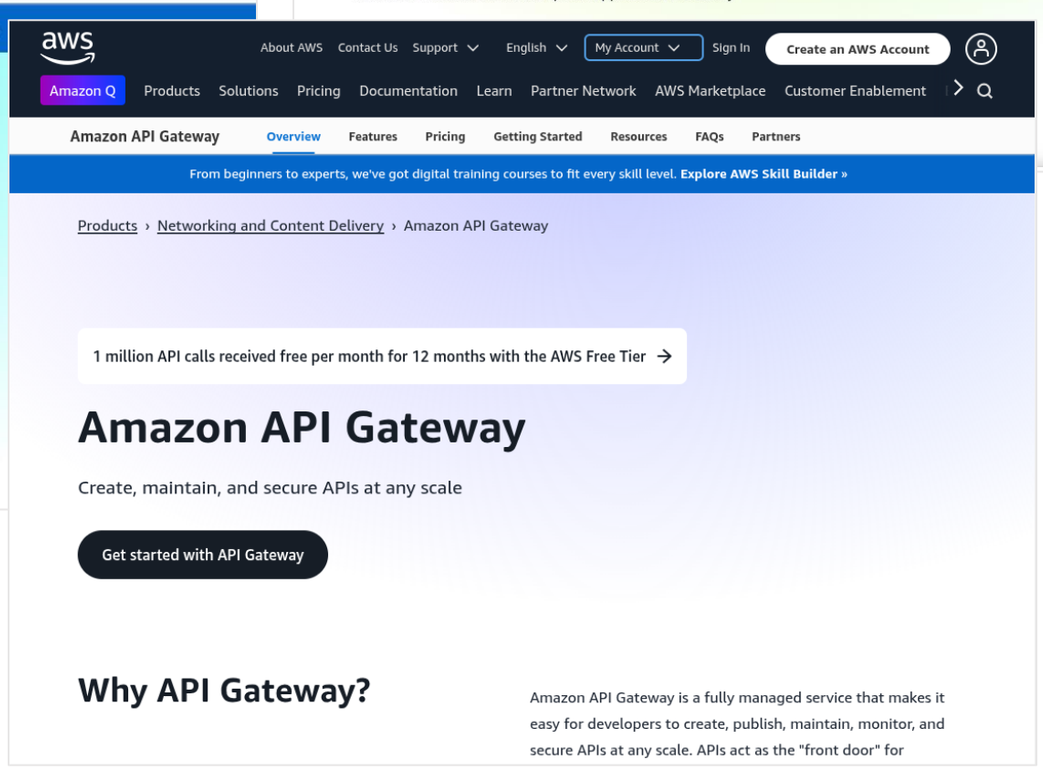


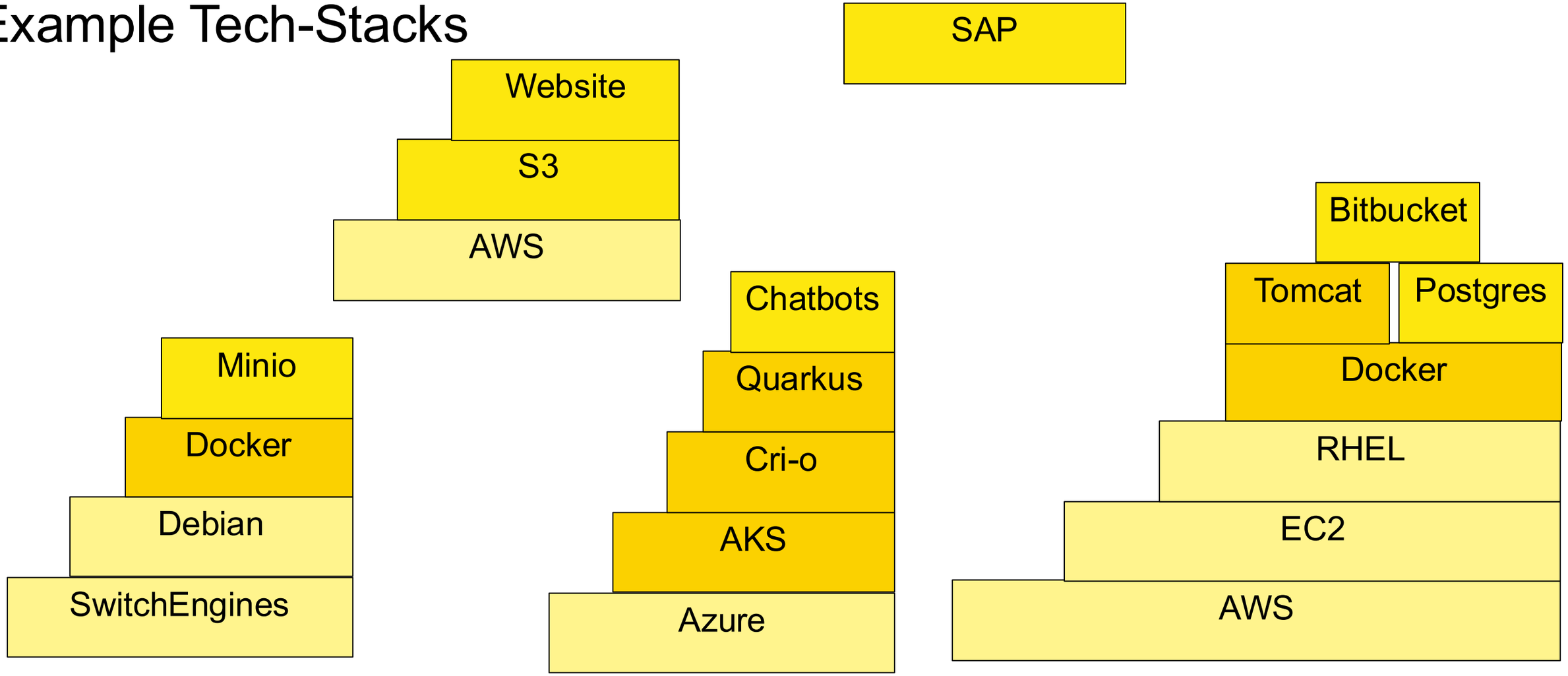


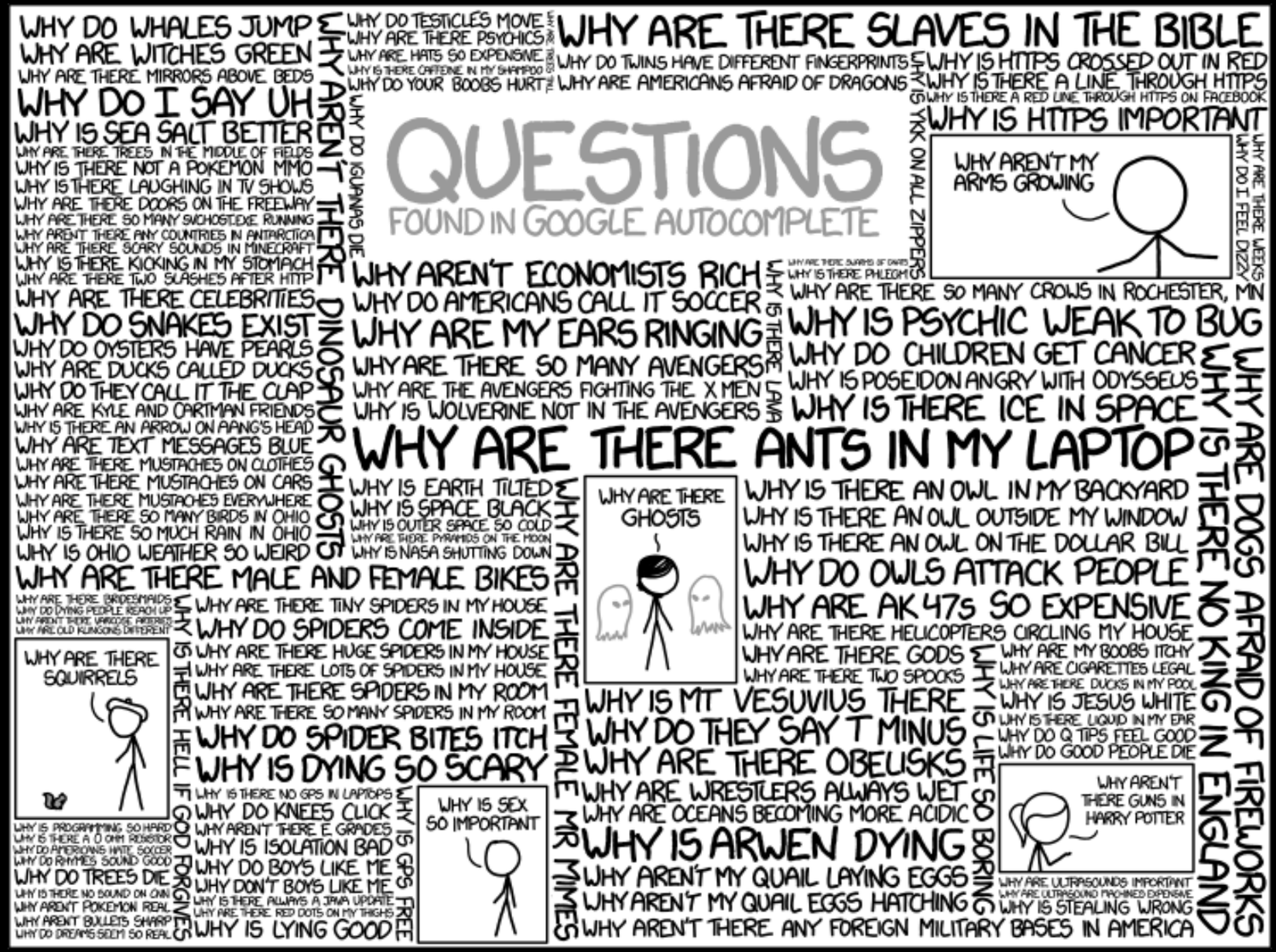


Example Technologies

Cloud	Opensource Products
Network	Cillium, Open vSwitch
Storage	Ceph, Minio
Compute	Proxmox, Openstack
Virtualization	KVM, Hyper-V, quemu
Operating System	Linux
Tools & Libraries (Middleware)	Kubernetes, OCI, Tomcat, Jetty, Mongrel, nginx
Runtime	Java, Python, Javascript, Go
Data	MongoDB, Postgresql, Cassandra
Applications	Up to you ☺

Example Tech-Stacks




QUESTIONS
FOUND IN GOOGLE AUTOCOMPLETE
WHY DO WHALES JUMP
WHY ARE WITCHES GREEN
WHY ARE THERE MIRRORS ABOVE BEDS
WHY DO I SAY UH
WHY IS SEA SALT BETTER
WHY ARE THERE TREES IN THE MIDDLE OF FIELDS
WHY IS THERE NOT A POKEMON MMO
WHY IS THERE LAUGHING IN TV SHOWS
WHY ARE THERE DOORS ON THE FREEWAY
WHY ARE THERE SO MANY SVCHOSTS.EXE RUNNING
WHY AREN'T THERE ANY COUNTRIES IN ANTARCTICA
WHY ARE THERE SCARY SOUNDS IN MINECRAFT
WHY IS THERE KICKING IN MY STOMACH
WHY ARE THERE TWO SLASHES AFTER HTTP
WHY ARE THERE CELEBRITIES
WHY DO SNAKES EXIST
WHY DO OYSTERS HAVE PEARLS
WHY ARE DUCKS CALLED DUCKS
WHY DO THEY CALL IT THE CLAP
WHY ARE KYLE AND CARTMAN FRIENDS
WHY IS THERE AN ARROW ON AANG'S HEAD
WHY ARE TEXT MESSAGES BLUE
WHY ARE THERE MUSTACHES ON CLOTHES
WHY ARE THERE MUSTACHES ON CARS
WHY ARE THERE MUSTACHES EVERYWHERE
WHY ARE THERE SO MANY BIRDS IN OHIO
WHY IS THERE SO MUCH RAIN IN OHIO
WHY IS OHIO WEATHER SO WEIRD
WHY ARE THERE MALE AND FEMALE BIKES
WHY ARE THERE BRIDESMAIDS
WHY DO DYING PEOPLE REARM UP
WHY AREN'T THERE VARICOSE AIRBIKES
WHY ARE OLD KLINGONS DIFFERENT
WHY ARE THERE SQUIRRELS
WHY IS PROGRAMMING SO HARD
WHY IS THERE A 0 OHM RESISTOR
WHY DO AMERICANS HATE SOCCER
WHY DO RHYMES SOUND GOOD
WHY DO TREES DIE
WHY IS THERE NO SOUND ON CNN
WHY AREN'T POKEMON REAL
WHY AREN'T BULLETS SHARP
WHY DO DREAMS SEEM SO REAL
WHY DO IGUANAS DIE
WHY DO TESTICLES MOVE
WHY ARE THERE PSYCHICS
WHY ARE HATS SO EXPENSIVE
WHY IS THERE CAFFEINE IN MY SHAMPOO
WHY DO YOUR BOOBS HURT
WHY ARE THERE SLAVES IN THE BIBLE
WHY DO TWINS HAVE DIFFERENT FINGERPRINTS
WHY ARE AMERICANS AFRAID OF DRAGONS
WHY IS HTTPS CROSSED OUT IN RED
WHY IS THERE A LINE THROUGH HTTPS
WHY IS THERE A RED LINE THROUGH HTTPS ON FACEBOOK
WHY IS YKK ON ALL ZIPPERS
WHY IS HTTPS IMPORTANT
WHY AREN'T MY ARMS GROWING
WHY ARE THERE WEEKS
WHY DO I FEEL DIZZY
WHY AREN'T ECONOMISTS RICH
WHY DO AMERICANS CALL IT SOCCER
WHY ARE MY EARS RINGING
WHY ARE THERE SWARMS OF GNATS
WHY IS THERE PHLEGM
WHY ARE THERE SO MANY CROWS IN ROCHESTER, MN
WHY IS THERE LAVA
WHY ARE THERE SO MANY AVENGERS
WHY ARE THE AVENGERS FIGHTING THE X MEN
WHY IS WOLVERINE NOT IN THE AVENGERS
WHY IS PSYCHIC WEAK TO BUG
WHY DO CHILDREN GET CANCER
WHY IS POSEIDON ANGRY WITH ODYSSEUS
WHY IS THERE ICE IN SPACE
WHY ARE THERE ANTS IN MY LAPTOP
WHY IS EARTH TILTED
WHY IS SPACE BLACK
WHY IS OUTER SPACE SO COLD
WHY ARE THERE PYRAMIDS ON THE MOON
WHY IS NASA SHUTTING DOWN
WHY ARE THERE GHOSTS
WHY IS THERE AN OWL IN MY BACKYARD
WHY IS THERE AN OWL OUTSIDE MY WINDOW
WHY IS THERE AN OWL ON THE DOLLAR BILL
WHY DO OWLS ATTACK PEOPLE
WHY ARE AK 47S SO EXPENSIVE
WHY ARE THERE HELICOPTERS CIRCLING MY HOUSE
WHY ARE THERE GODS
WHY ARE THERE TWO SPOOKS
WHY ARE MY BOOBS ITCHY
WHY ARE CIGARETTES LEGAL
WHY ARE THERE DUCKS IN MY POOL
WHY IS JESUS WHITE
WHY IS THERE LIQUID IN MY EAR
WHY DO Q TIPS FEEL GOOD
WHY DO GOOD PEOPLE DIE
WHY IS MT VESUVIUS THERE
WHY DO THEY SAY T MINUS
WHY ARE THERE OBELISKS
WHY ARE WRESTLERS ALWAYS WET
WHY ARE OCEANS BECOMING MORE ACIDIC
WHY IS ARWEN DYING
WHY AREN'T MY QUAIL LAYING EGGS
WHY AREN'T MY QUAIL EGGS HATCHING
WHY AREN'T THERE ANY FOREIGN MILITARY BASES IN AMERICA
WHY ARE THERE TINY SPIDERS IN MY HOUSE
WHY DO SPIDERS COME INSIDE
WHY ARE THERE HUGE SPIDERS IN MY HOUSE
WHY ARE THERE LOTS OF SPIDERS IN MY HOUSE
WHY ARE THERE SPIDERS IN MY ROOM
WHY ARE THERE SO MANY SPIDERS IN MY ROOM
WHY DO SPIDER BITES ITCH
WHY IS DYING SO SCARY
WHY IS THERE NO GPS IN LAPTOPS
WHY DO KNEES CLICK
WHY AREN'T THERE E GRADES
WHY IS ISOLATION BAD
WHY DO BOYS LIKE ME
WHY DON'T BOYS LIKE ME
WHY IS THERE ALWAYS A JAVA UPDATE
WHY ARE THERE RED DOTS ON MY THIGHS
WHY IS LYING GOOD
WHY IS SEX SO IMPORTANT
WHY ARE DOGS AFRAID OF FIREWORKS
WHY IS THERE NO KING IN ENGLAND
WHY IS LIFE SO BORING
WHY AREN'T THERE GUNS IN HARRY POTTER
WHY ARE ULTRASOUNDS IMPORTANT
WHY ARE ULTRASOUND MACHINES EXPENSIVE
WHY IS STEALING WRONG
WHY IS GPS FREE
WHY ARE THERE FEMALE MR MIMES
WHY ARE THERE DINOSAUR GHOSTS
WHY AREN'T THERE
WHY IS THERE HELL IF GOD FORGIVES

Summarizing Questions

- What is ARPANET?
- You need to migrate windows-instances to your new cloud. What level of service class are you using on the new cloud?
- What types of clouds are existing according to NIST?
- What necessary criterias exists for clouds according to NIST?
- Why are the denoted cloud layers much less dependend on each other than the layers from the OSI model?
- The following tech stack is given: map the elements of the tech stack to the cloud layer model: