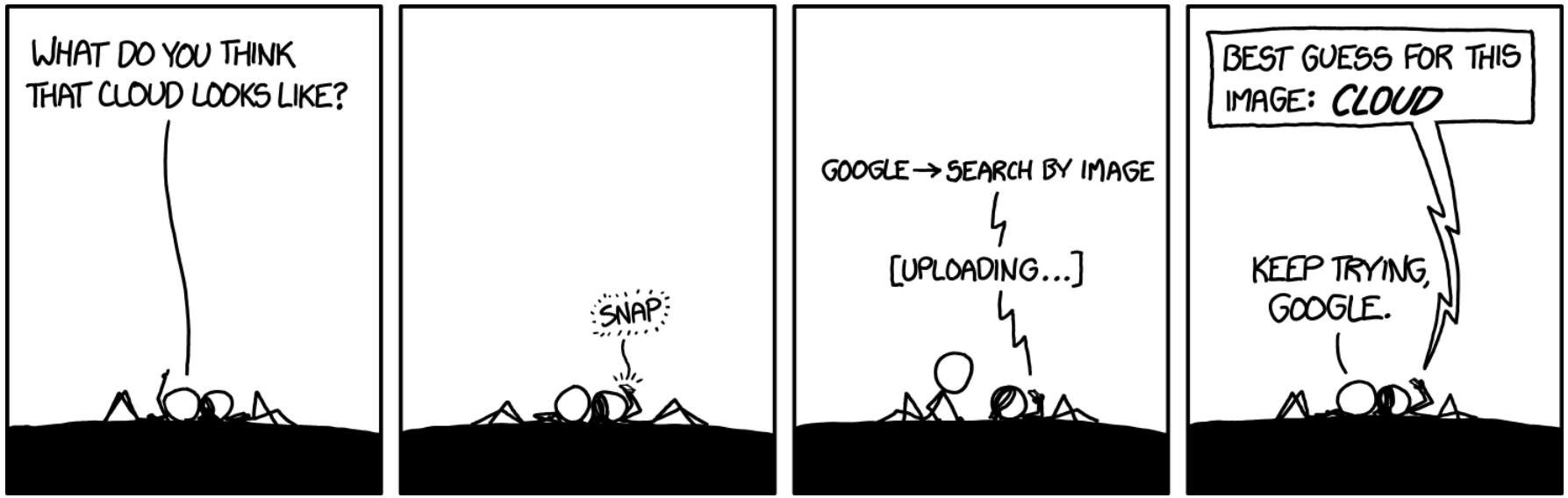
BIG DATA AND CLOUD PLATFORMS

Cloud computing



https://xkcd.com/1444/

Why going cloud?

Cloud computing (National Institute of Standards and Technology)

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

- On-demand self-service (consume services when you want)
- Broad network access (consume services from anywhere)
- Resource pooling (infrastructure, virtual platforms, and applications)
- Rapid elasticity (enable horizontal scalability)
- Measured service (pay for the service you consume as you consume)

Digital transformation involves the **cloud** to create/change business flows

- Often involves changing the company culture to adapt to this new way of doing business
- One of the end goal is to meet ever-changing business and market demand

Why going cloud?

Goal: adjusts capacity to have predictable performance at the lowest cost

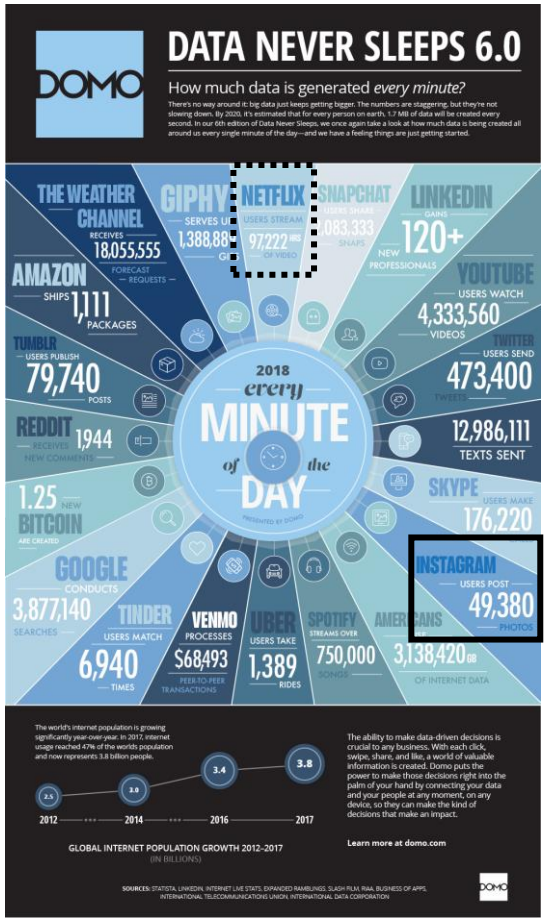
Scalability that is not possible on premises

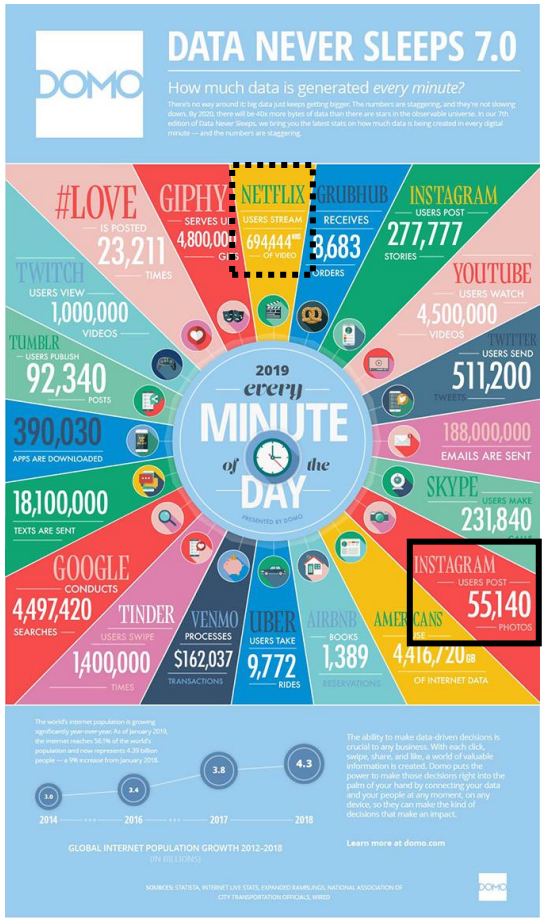
- Scale from one to thousands of servers

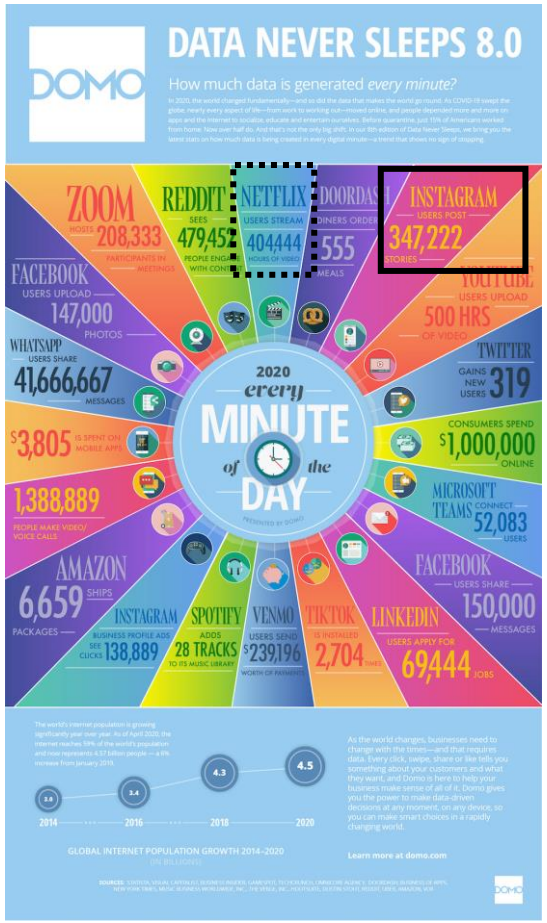
Elasticity

- Automatically scale resources in response to run-time conditions
- Adapt to changes in workload by turning on/off resources to match the necessary capacity
- Core justification for the cloud adoption

Why going cloud?







https://www.domo.com/learn/data-never-sleeps-8

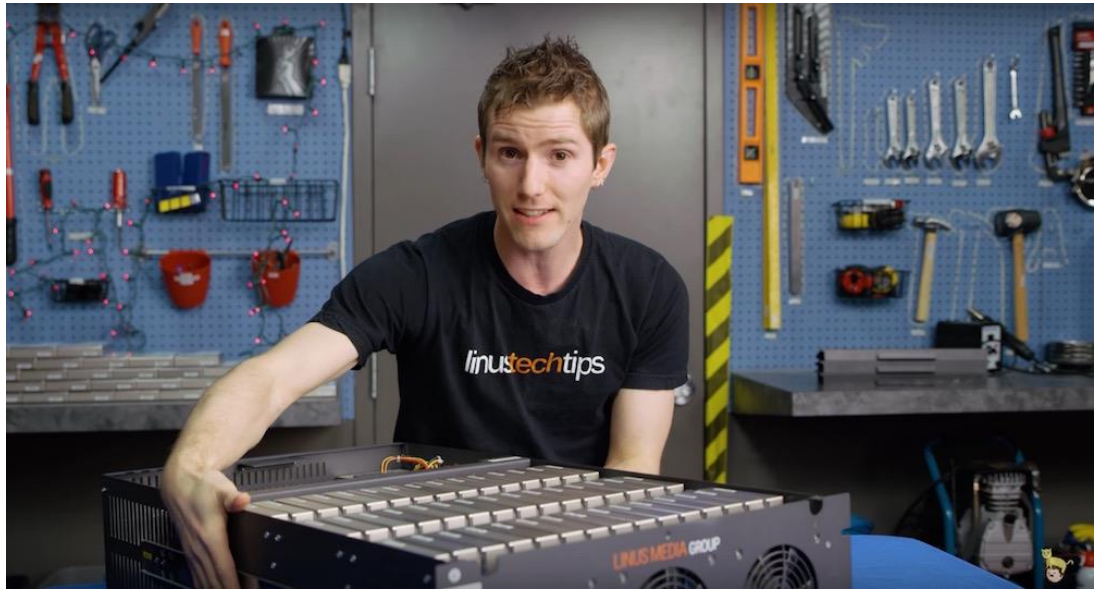
Why going cloud?

Hardware scalability

- No longer think about rack space, switches, and power supplies, etc.

Grow storage from GBs to PBs

- 1PB: one hundred 10TB Enterprise Capacity 3.5 HDD hard drives



https://blog.seagate.com/business/linus-tech-tips-want-petabyte-system/

Why going cloud?

Resource pooling

- Enable cost-sharing, a resource to serve different consumers
- Resources are dynamically reassigned according to demands
- Based on virtualization, running multiple virtual instances on top of a physical computer system
- Economy of scale for physical resources

Reliability

- Built to handle failures
- Fault-tolerant or highly available

Why going cloud?

Worldwide **deployment**

- Deploy applications as close to customers as possible
  - E.g., to reduce network latency
- Improve data locality
- Compliant to privacy regulations (e.g., GDPR)

Measured **quality of service**

- Services leverage a quantitative qualitative metering capability making pay-as-you-go (or pay-per-use) billing and validation of the service quality available

Why going cloud?

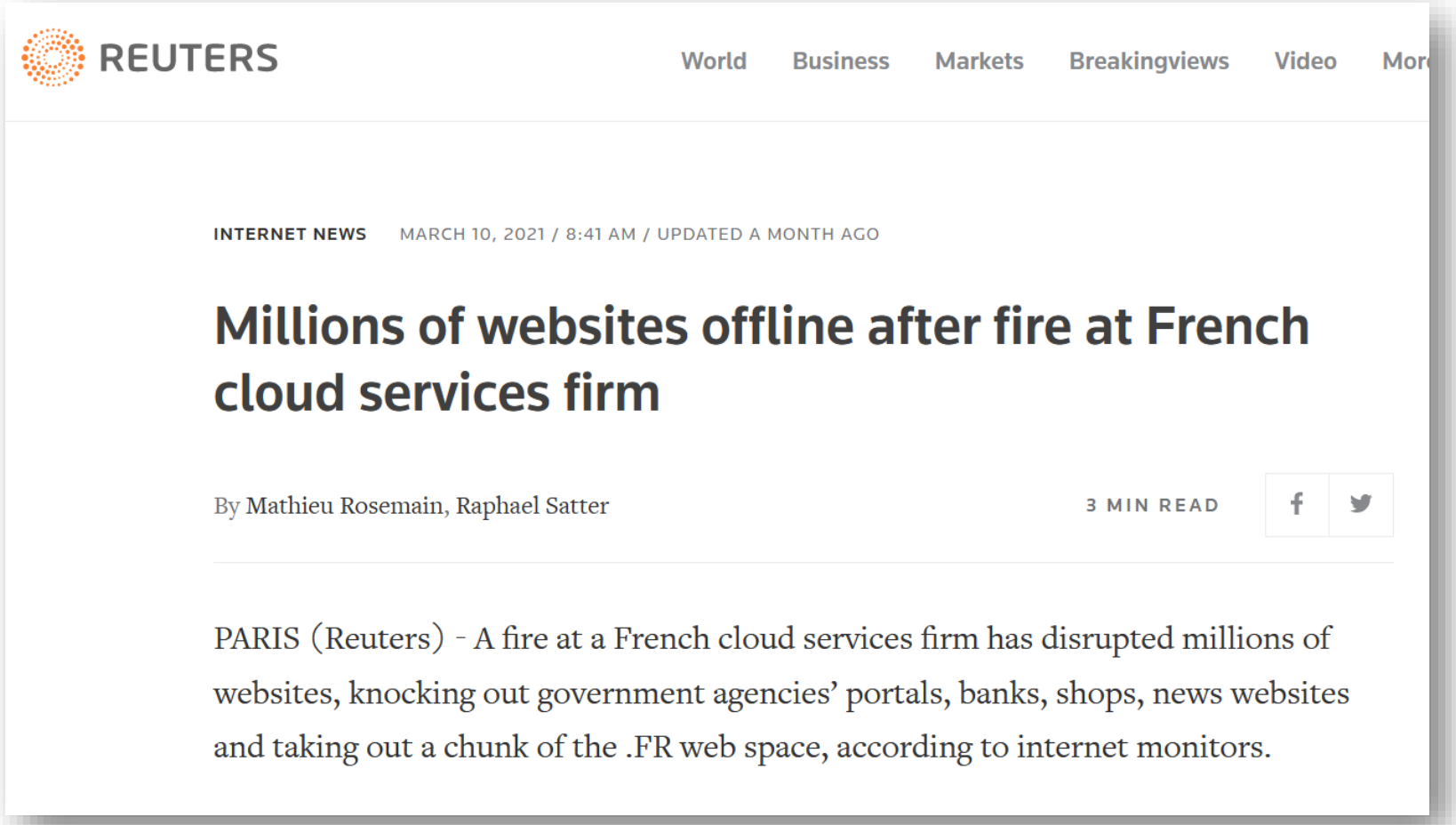
Service **integration**

- Do not reinvent the wheel, eliminate repetitive tasks
  - Use services that solve common problems (e.g., load balancing, queuing)
- Abstract and automatically adapt the architecture to requirements
  - E.g., create (test) environments on demand

Integration and abstraction are drivers of change

- From databases to data platforms
- From on-premises to serverless architectures
- From custom to standardized data pipelines

Is cloud a silver bullet?



REUTERS

World Business Markets Breakingviews Video Mor

INTERNET NEWS MARCH 10, 2021 / 8:41 AM / UPDATED A MONTH AGO

Millions of websites offline after fire at French cloud services firm

By Mathieu Rosemain, Raphael Satter 3 MIN READ

PARIS (Reuters) - A fire at a French cloud services firm has disrupted millions of websites, knocking out government agencies' portals, banks, shops, news websites and taking out a chunk of the .FR web space, according to internet monitors.

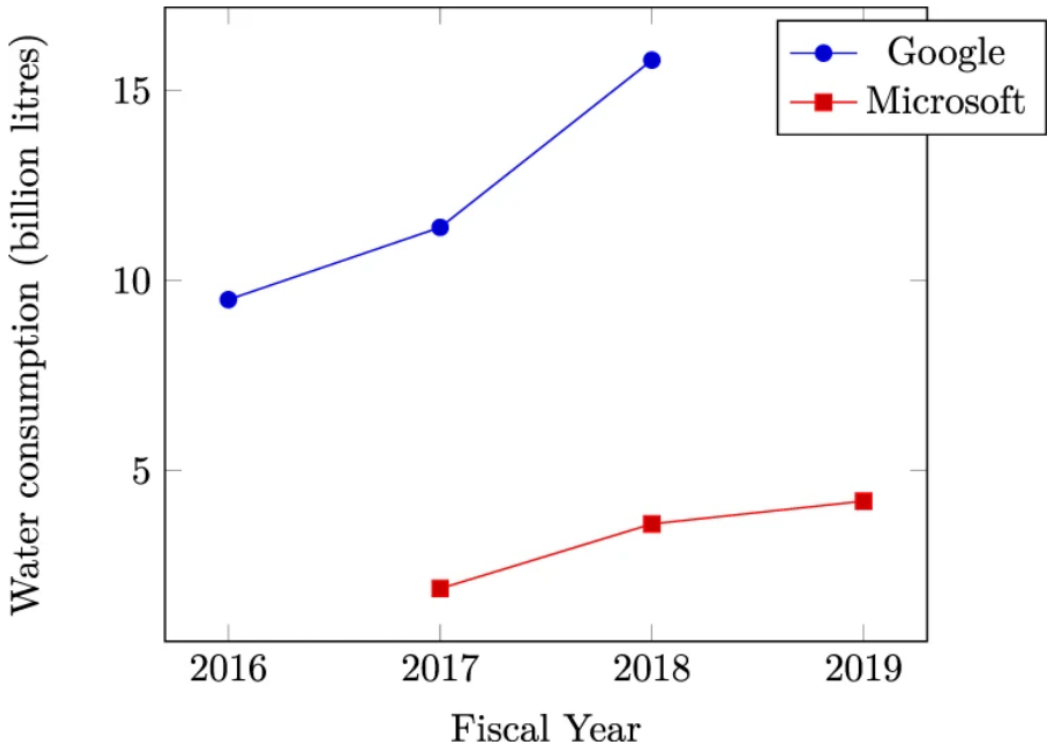
https://www.reuters.com/article/us-france-ovh-fire-idUSKBN2B20NU

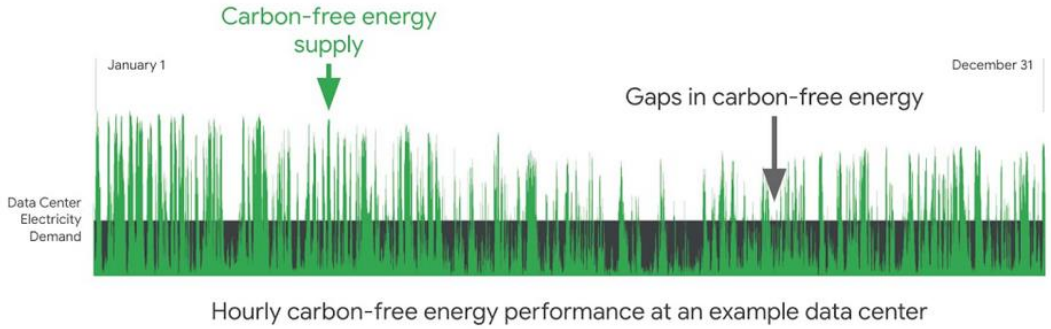
Is cloud a silver bullet?

Cloud computing is the outsourcing of a company's hardware and software architecture

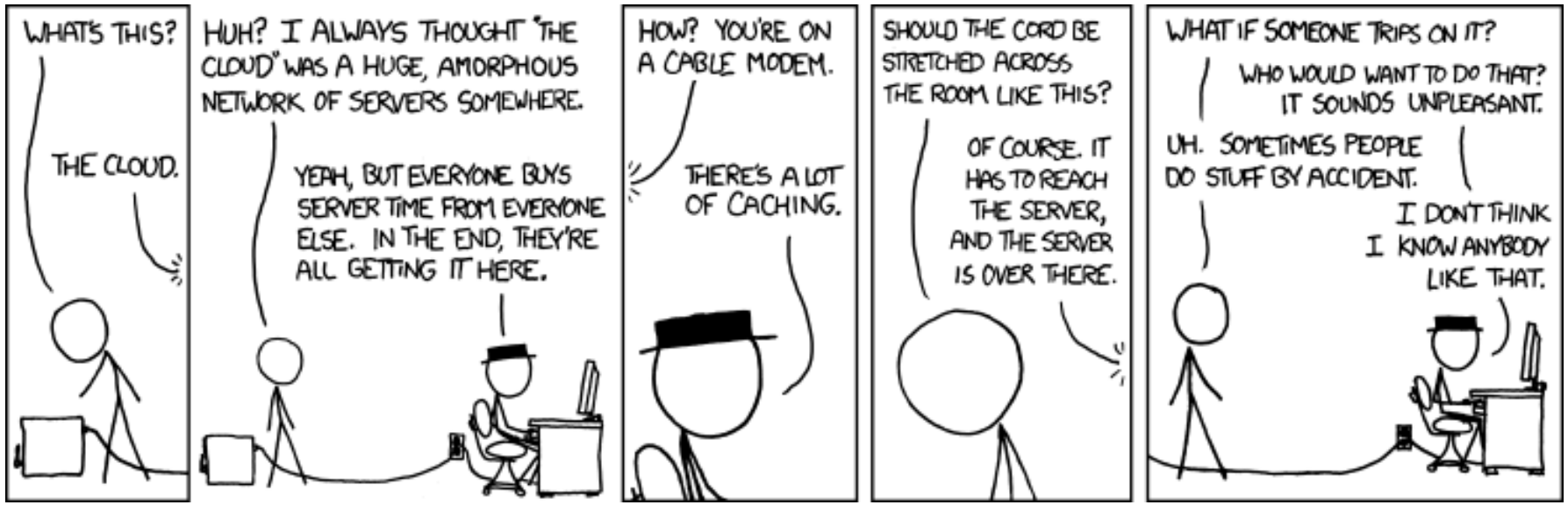
- Which are the risks and issues?

Is cloud a silver bullet?





Left: Mytton, David. "Data centre water consumption." *npj Clean Water* 4.1 (2021): 1-6.
Right: https://cloud.google.com/blog/topics/inside-google-cloud/announcing-round-the-clock-clean-energy-for-cloud (accessed 2022-08-01)

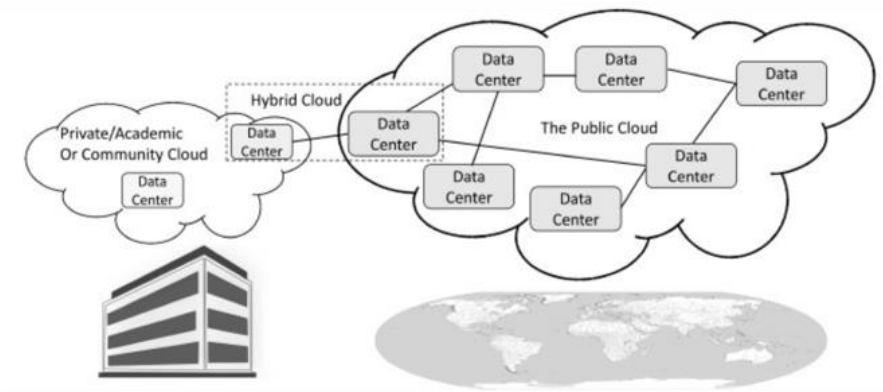


https://xkcd.com/908/

Cloud computing: types of cloud

There are different types of cloud

- **Public**: accessible to anyone willing to pay (e.g., Microsoft, AWS, Google)
- **Private**: accessible by individuals within an institution
  - In public cloud, any resources that you are not using can be used by other
  - Users share the costs
  - Cost-sharing disappears in private clouds
- **Hybrid**: a mix of the previous



Cloud computing: types of cloud

Cloud services are hosted in separate geographic areas

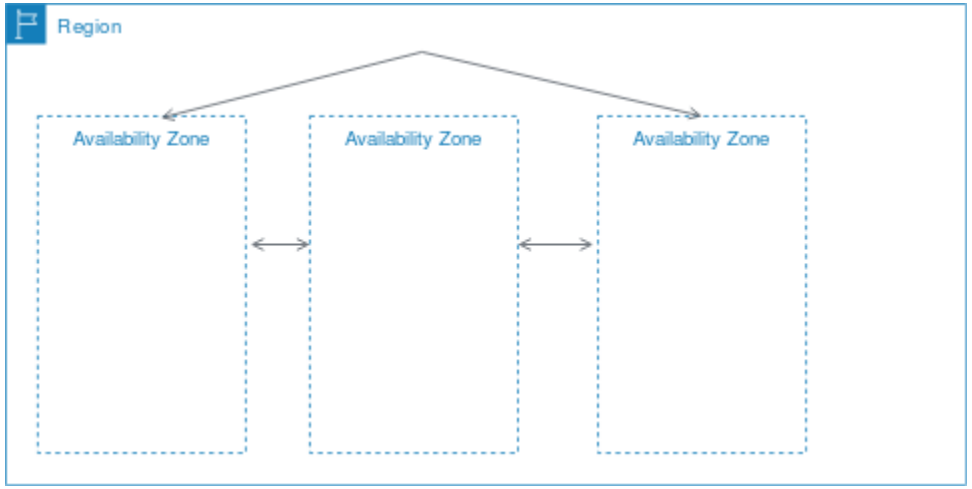
- Locations are composed of **regions** and **availability zones**

Region (e.g., us-east-1)

- Is an independent geographical area that groups data centers
- Has availability zones

Availability zones in a region

- A data center
- Connected through low-latency links
- Resources are usually replicated across zones but not regions



https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/using-regions-availability-zones.html

Cloud computing: principal vendors

Figure 1. Magic Quadrant for Cloud Infrastructure and Platform Services

https://www.gartner.com/en/research/methodologies/magic-quadrants-research

Gartner Magic Quadrant

- Understanding the technology providers to consider for an investment
- **Leaders** execute well and are well positioned for tomorrow
- **Visionaries** understand where the market is going but do not yet execute well
- **Niche Players** focus successfully on a small segment, or are unfocused and do not out-innovate or outperform others
- **Challengers** execute well but do not demonstrate an understanding of market direction
- Focusing on leaders isn't always the best
  - A niche player may support needs better than a market leader. It depends on how the provider aligns with business goals

Cloud computing: deployment models

On a cloud architecture, you can rely on serverless or managed services

Serverless

- Standalone independent services built for a specific purpose and integrated by cloud service provider
- No visibility into the machines
  - There are still servers in serverless, but they are abstracted away
  - No server management, do not have to manage any servers or scale them
  - E.g., when you run a query on BigQuery you do not know how many machines were used
- Pay for what your application uses, usually per request or per usage

(Fully) Managed

- Visibility and control of machines
  - You can choose the number of machines that are being used to run your application
- Do not have to set up any machines, the management and backup are taken care for you
- Pay for machine runtime, however long you run the machines and resources that your application uses

https://cloud.google.com/blog/topics/developers-practitioners/serverless-vs-fully-managed-whats-difference (accessed 2020-08-01)

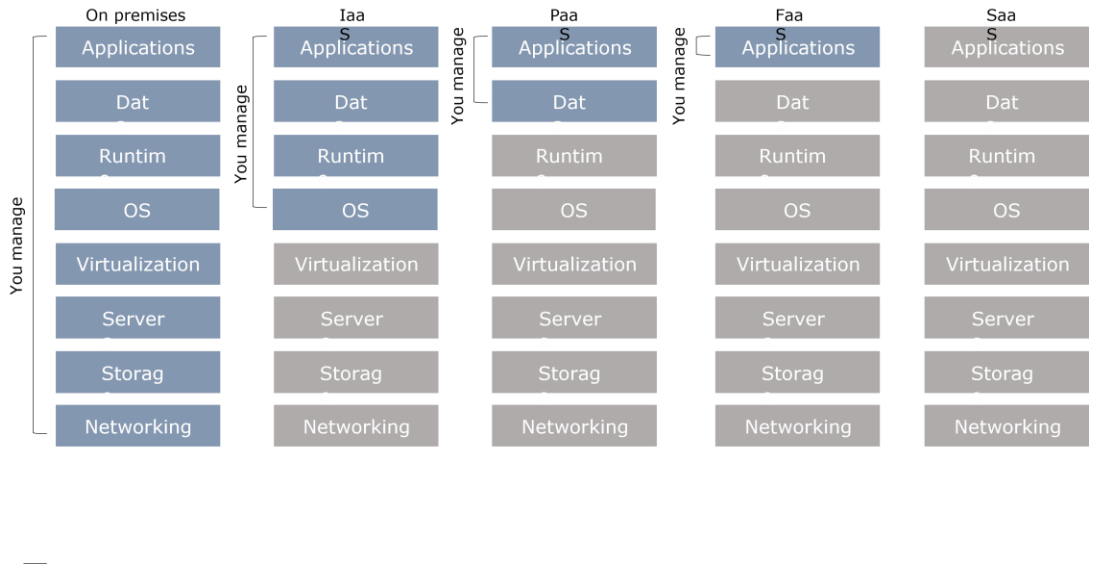
Cloud computing: deployment models

Understanding architectures is paramount to successful systems

- Good architectures help to scale
- Poor architectures cause issues that necessitate a costly rewrite

XaaS (anything as a service)

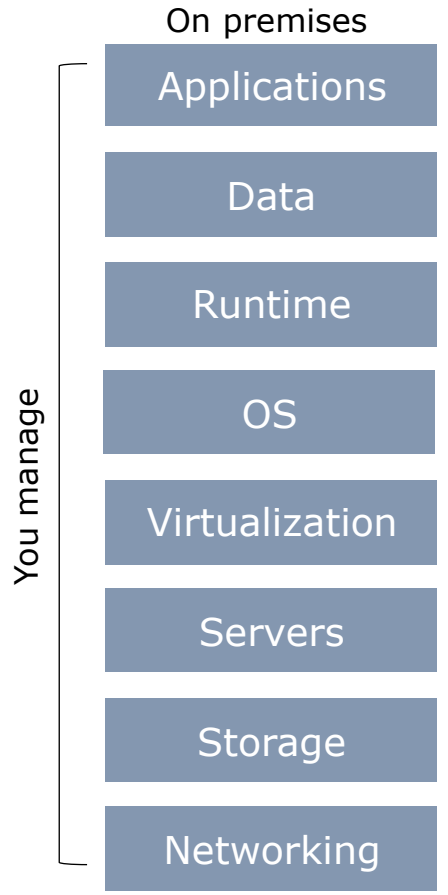
- A collective term that refers to the delivery of anything as a service
- It encompasses the products, tools and technologies that vendors deliver to users



Cloud computing: deployment models

On-premises

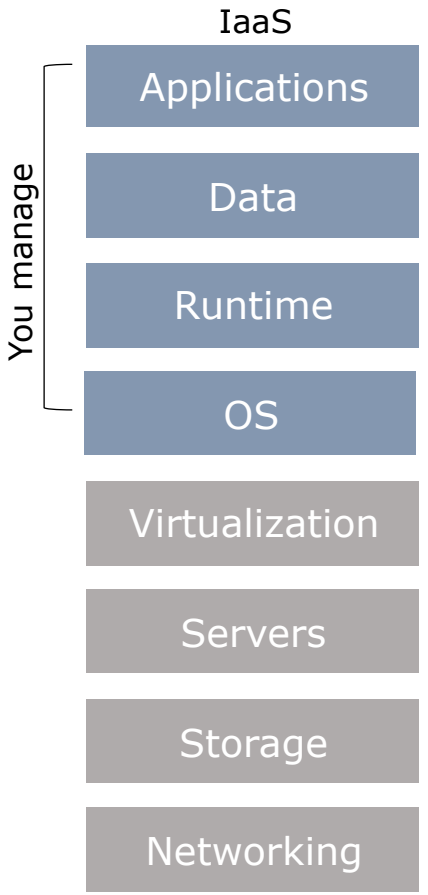
- Provisioning servers is time-consuming
  - A non-trivial environment is hard to set up
- Require dedicated operations people
- Often a distraction from strategic tasks



Cloud computing: deployment models

Infrastructure as a service (IaaS)

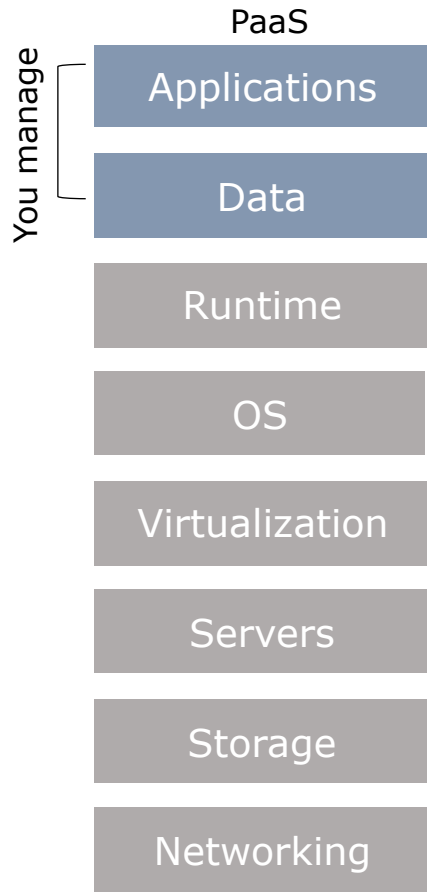
- A computing infrastructure provisioned and managed over the internet (e.g., AWS EC2)
- Avoid expense/complexity of buying/managing physical servers/data-centers
- IaaS overcomes issues on-premises
- Possibly requires to manage many environments



Cloud computing: deployment models

Platform as a Service (PaaS)

- A development and deployment environment in the cloud (e.g., AWS Elastic Beanstalk)
- Support complete application life-cycle: building, testing, deploying, etc.
- Avoid expense/complexity of managing licenses and application infrastructure



Cloud computing: deployment models

PaaS and **containers** are potential solutions to inconsistent infrastructures

PaaS provides a platform for users to run their software

- Developers write software targeting features/capabilities of the platform

Containerization isolates an application with its own environment

- Lightweight alternative to full virtualization
- Containers are isolated but need to be deployed to (public/private) server
- Excellent solution when dependencies are in play
- Housekeeping challenges and complexities

Cloud computing: deployment models

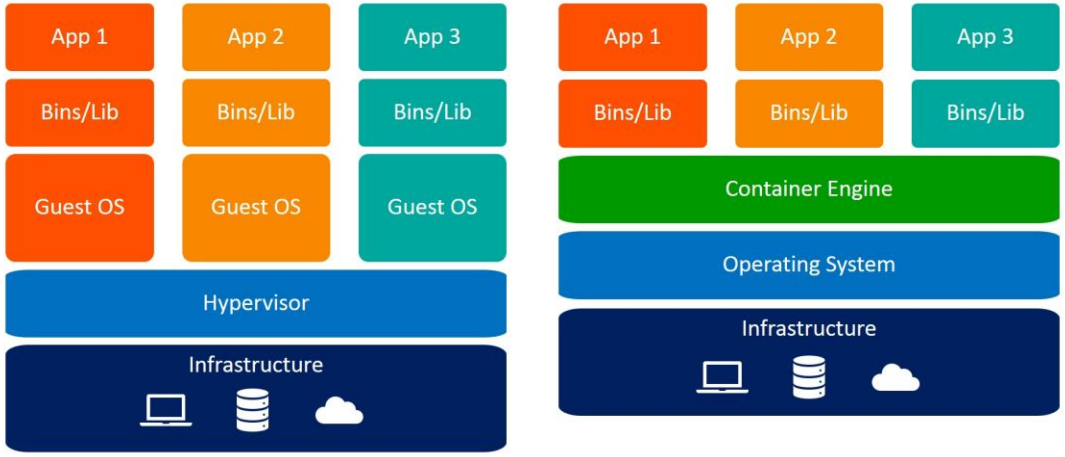
Containers and virtual machines are packaged computing environments

Containers

- On top of physical server and its host OS
- Share the host OS kernel
- Shared components are read-only
- “Light”, take seconds to start

Virtual machines

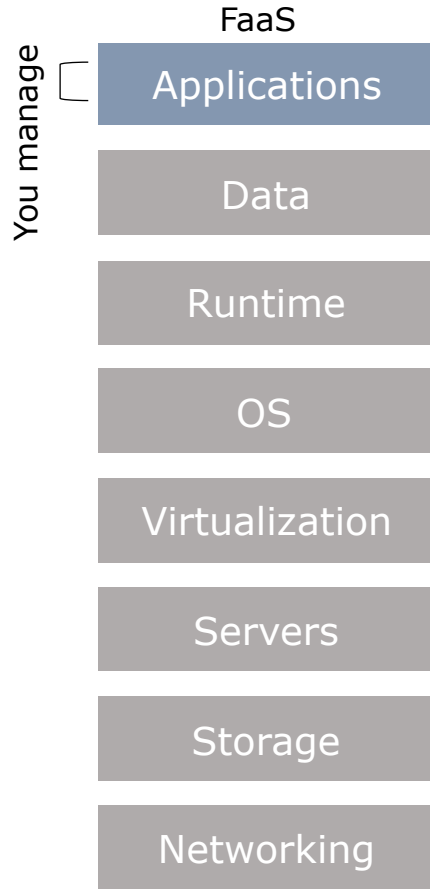
- Emulate a hardware/software system
- On top of a hypervisor (VM monitor)



Cloud computing: deployment models

Function as a Service (FaaS)

- A coding environment, cloud provider provisions platform to run the code (e.g., AWS Lambda)
- Infrastructure provisioning and management are invisible to the developer



Cloud computing: deployment models

Principles of FaaS architectures

- FaaS is based on a serverless approach, use a compute service to execute code on demand
- Every function could be considered as a standalone service
- Write single-purpose stateless functions

Functions react to events

- Design push-based, event-driven pipelines
- Create thicker, more powerful front ends
- Embrace third-party services (e.g., security)

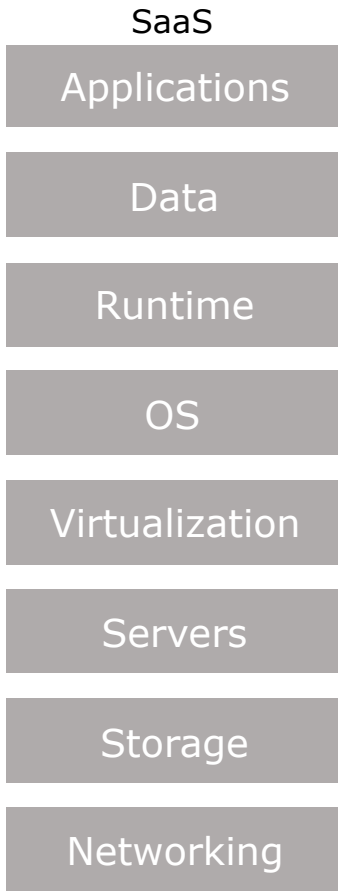
FaaS is not a silver bullet

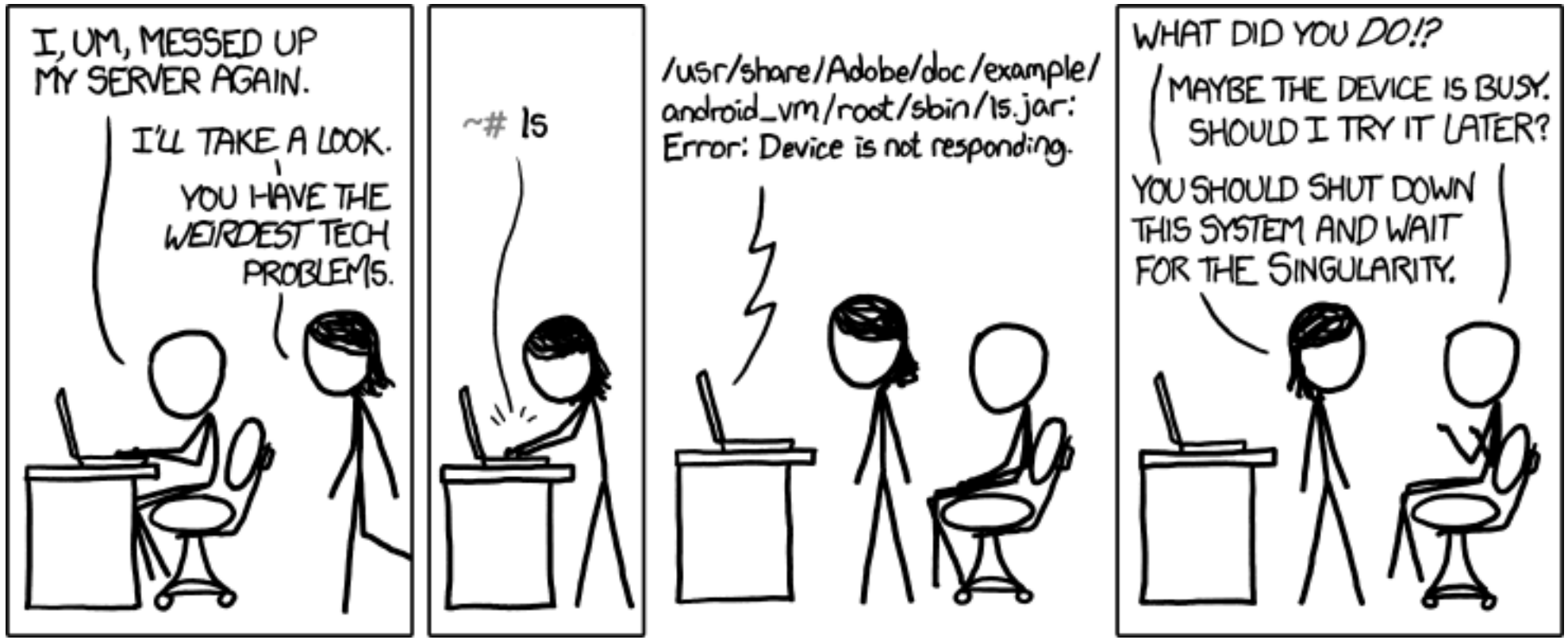
- Not appropriate for latency-sensitive applications
- Strict specific service-level agreements
- Migration costs
- Vendor lock-in can be an issue

Cloud computing: deployment models

Software as a service (SaaS)

- An application environment
- Access cloud-based apps over the Internet (e.g., email, Microsoft Office 365)





https://xkcd.com/1084/