



3,586 Data Science and Cloud Solutions for Start-ups

Prof. Johannes Binswanger & Dominique Paul



Today: building & sharing has never been easier

- Today: barrier have virtually disappeared
 - Code examples for 90% of your application are online
 - Global availability & instant deployment at zero cost*
- Spinning up a server is cheap and fast
 - Ave. boot time for GCP server: ≈42 seconds
 - Hourly cost for running a server: \$0.04 per hour
→ no approval process required
 - Most providers offer a free tier of servers
- This isn't only relevant for big businesses:
you as a small creator can share your ideas
with everyone in the world, without having to
consider financial costs

THE NEW YORKER

ANNALS OF TECHNOLOGY

D.I.Y. ARTIFICIAL INTELLIGENCE COMES TO A JAPANESE FAMILY FARM

By Amos Zeeberg August 10, 2017

A photograph showing three people standing in front of a large, multi-chambered greenhouse. On the left is a young man in a light blue long-sleeved shirt and grey pants. In the center is an older man wearing a grey t-shirt, blue pants, and a baseball cap, with a blue towel draped over his shoulder. On the right is a woman wearing a pink polo shirt, blue and white checkered pants, and a wide-brimmed tan hat. They are standing on a dirt ground with some agricultural equipment visible in the background.

Makoto Koike has built a cucumber classifier for his parents' farm using code snippets from the internet and the cloud

Today: building & sharing has never been easier

URL: www.youtube.com/watch?v=4HCE1P-m1l8&feature=emb_title



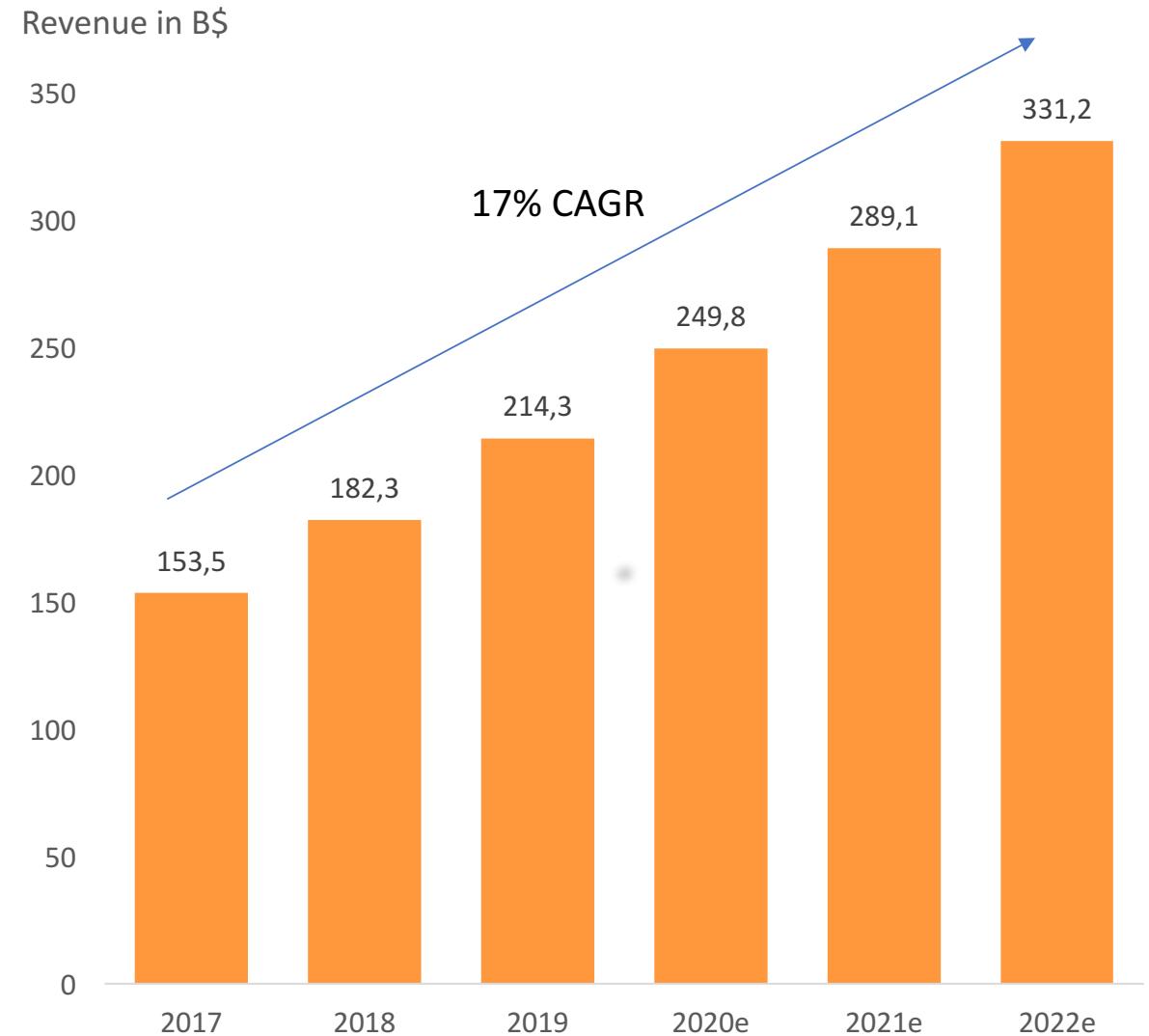
You don't have to create the next Facebook or Twitter.

You don't have to aspire to make something big.

If you think you have a cool idea, no matter how small,
you can create it and share it with anybody in the
world.

Global cloud
revenue is growing
at a rapid speed...

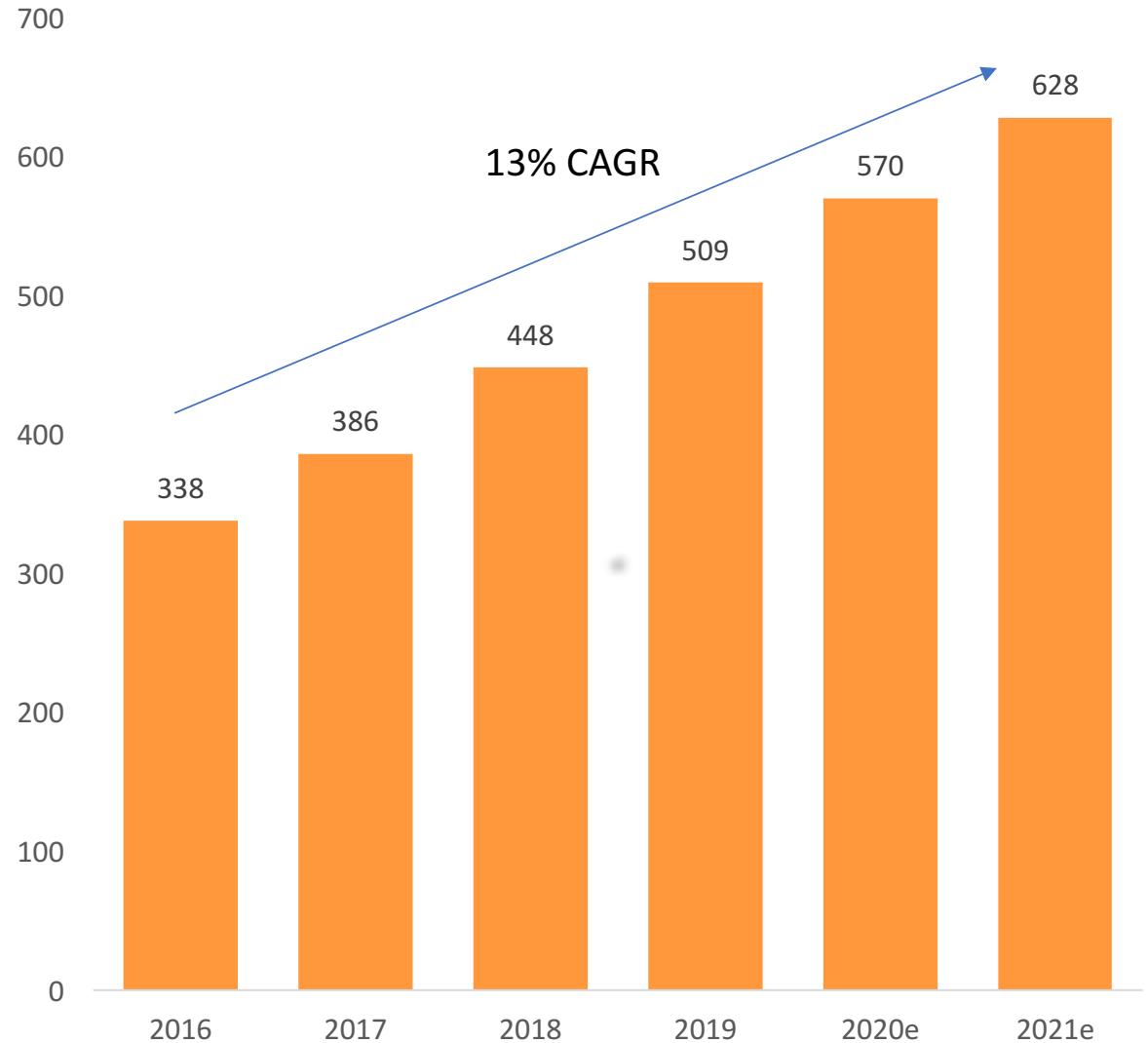
Global cloud Revenue



Source: Gartner 2019

...and providers
are heavily
investing in new
infrastructure.

of hyperscale data centers



Source: Cisco Global Cloud Index, 2016-2021

But at the same time we see issues with cloud services on a weekly basis

CNN BUSINESS Markets Tech Media Success Perspectives Videos Edition ▾

China's data centers emit as much carbon as 21 million cars

By Julie Zaugg, CNN Business Updated 0739 GMT (1539 HKT) September 10, 2019

Aerial view of Tencent's biggest data center in Yunnan province, on March 13, 2018.

TECHSPOT TOP STORIES LOGIN f Twitter

Data centers are using two percent of the world's energy

Demand is only going to grow By Greg Synek on November 20, 2018, 9:20 AM

Aerial view of Tencent's biggest data center in Yunnan province, on March 13, 2018.

TC Loading... Disrupt SF 2019 Startups Apps Gadgets Videos Audio Extra Crunch Newsletters Events Advertise — Crunchbase More Search Apple Enterprise Transportation Facebook privacy

Indian state government leaks thousands of Aadhaar numbers

Another security lapse involving India's national identity system

FINANCIAL TIMES US COMPANIES TECH MARKETS GRAPHICS OPINION WORK & CAREERS LIFE & ARTS HOW TO SPEND IT MAKE SENSE OF A DISRUPTED WORLD Explore

Equifax: credit due Premium Ex-Trump adviser Gary Cohn joins blockchain start-up Equifax hit with UK fine over data hack

Equifax Inc + Add to myFT

Equifax to pay almost \$800m in US settlement over data breach

FTC says credit reporting agency 'failed to take basic steps' to prevent hack that hit 147m people

Course structure

Sess. #	Content	Topic of the Session(s)	Date
1	Fundamentals of cloud computing	<ul style="list-style-type: none">• Understand what the cloud is and what <i>you</i> can do with it• Understanding the most important concepts and terminology	14. Sept.
2-6	Building a web app with Python	<ul style="list-style-type: none">• Python Basics (fast-paced)• Building web-apps with Flask• Helping yourself: finding what you need efficiently online• Basics of SQL	21. Sept. - 19. Oct.
7-9	Building a modern data application in the cloud	<ul style="list-style-type: none">• Deploying your app to the cloud• Integrating cloud products into your python app	02. Nov. - 04. Nov.
10	Final project presentations	<ul style="list-style-type: none">• Project Presentations	07. Dec.

About us: Prof. Johannes Binswanger

- Professor for Business Economics and Public Policy, School of Economics of Political Science
- Originally started working with data science in different research areas
- Responsible for the HSG Data Science Fundamentals (DSF) program
- Has designed and teaches several machine learning and AI courses at the executive level (MBA and EMBA) – some in collaboration with Microsoft

About us: Dominique Paul

- Studied in SG until 2018, former student of Prof. Binswanger in the precursor to the data science fundamentals course.
- Wrote bachelor's thesis on deep learning and computer vision with TensorFlow
- Kept learning about programming/statistics post-university via books, papers, courses from other universities shared online and work.
- Created production forecast algorithm for On Running during internship. Worked one year for a venture capital fund in Berlin where I built the data infrastructure for the investment team.
- 2019 - Now: Data Science Analyst at Lakestar where I split my time between programming, talking to ML founders, and quantum computing research
- 2020 - Now: Master in Statistics at ETH Zurich

Live expert sessions in this course



How to think about data as a young company

Stephan Schulze CTO, Project A Ventures



Working with data as a founder

Humberto Ayres Pereira CEO and Founder at DashDash



Growing and managing large data teams

Stephen Nundy CTO & Partner at Lakestar, Former Technology MD at Goldman Sachs

What you will learn

Step 1:

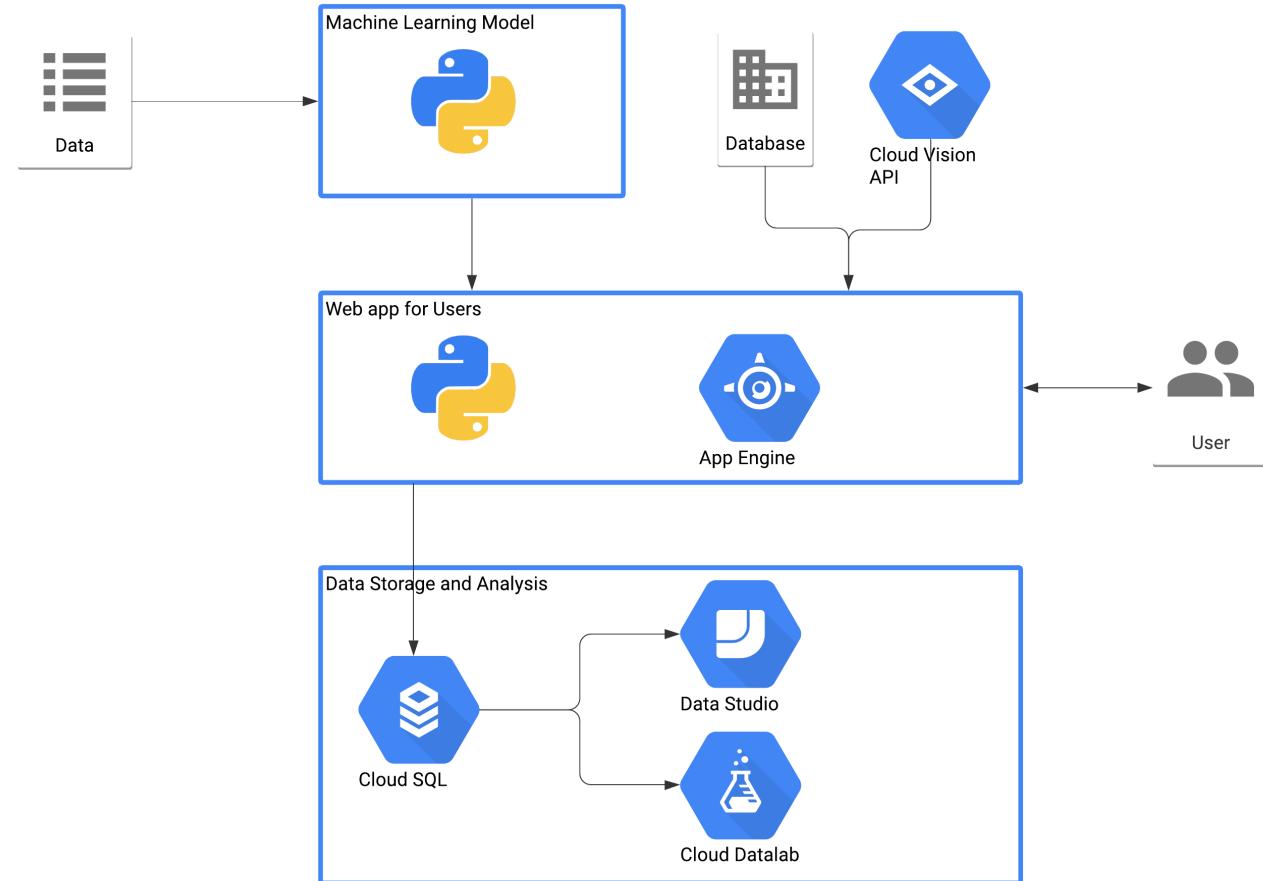
Basics of Python,
Using APIs,
Building a small machine learning
model

Step 2:

Building a web app with flask,
Collecting user data with forms,
Basics of SQL

Step 3:

Hosting your app on the cloud ,
Visualising your data with Datastudio,
Adding ML Capabilities without Coding



Examination & grading

50% Problem sets solved at home

- Focus on programming. The questions will help you prepare you for the contents of sessions 3-5 and your own project
- Five assignments, best four will count towards grade
- Problems are not hard, but will make you learn each building block

50% Group projects

- Focus on creative usage of the cloud and learning how to share your own app with other people
- You will learn essential tools of the cloud in the course but will learn how to use additional ones on your own

Assignments details

- There will be weekly Assignments from week 2 to 6
- All assignments (not the questions) are weighted equally. Your best four out of five assignments are counted towards the final grade.
- Assignments are a practice of what we cover in each lesson as well as stretch exercises. Deadlines are the next day of class at 8 AM.
- You are expected to solve the assignments using the internet

Course project details

- In groups of 2-4 you will create your own application for a purpose of your choice using GCP products
- Using online tutorials and code snippets is ok. You must comment them as such in your submission. Grading will not only be based on code written by yourself, but also your capability to use other people's code to build a project
- Tips:
 - Talk early to your classmates about groups and ideas
 - Design your application in different levels of complexity, so that you have a working application early
 - Use Qwiklabs to learn how to use cloud products not covered in class
 - Build an application that you think is cool or useful. Be creative!

Course tools

- We will be using GCP throughout the course:
 - Best cloud platform for data*
 - Many [free tier services](#)
 - Free \$300 credit per person
= no costs
- Qwiklabs:
 - Online learning platform providing a temporary GCP sandbox environment
 - Learn about products not covered in this course or explore tools after the course
 - Sign up for free credits [here](#)
- Google also offers free Coursera courses and discounts on certifications for students



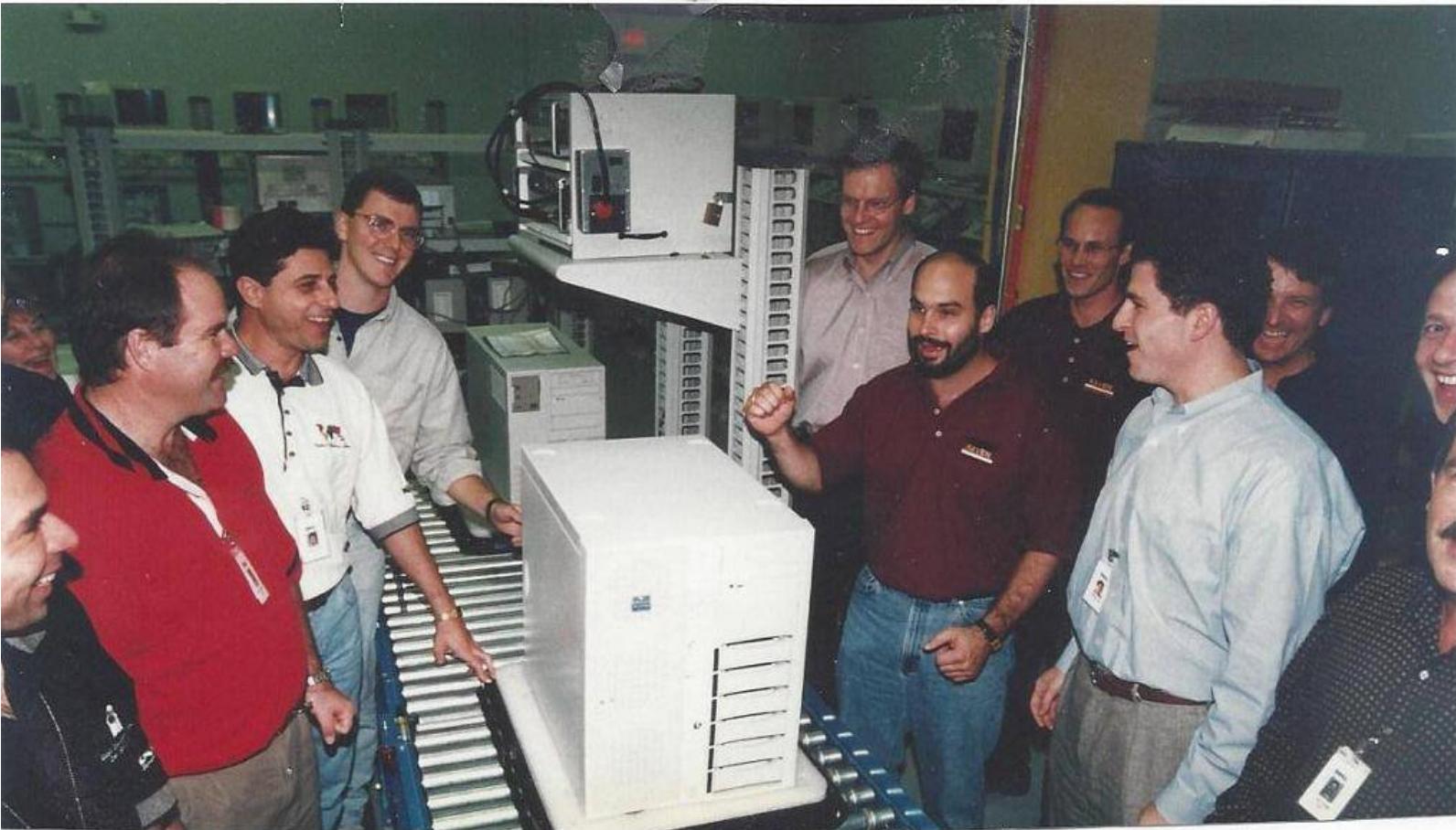
Google Cloud





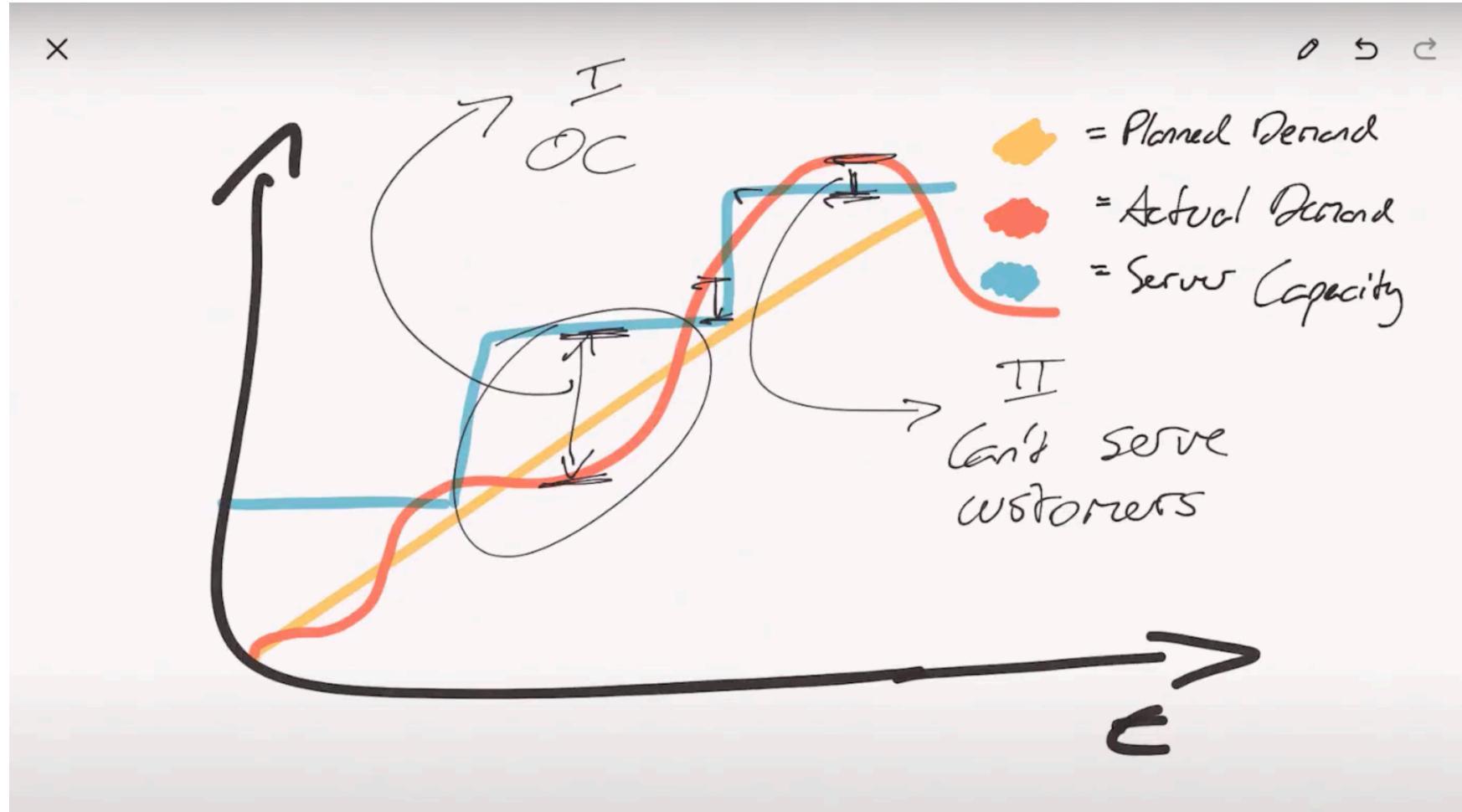
- 01 Introduction
- 02 What makes the cloud interesting?
- 03 The cloud market
- 04 Setting up a server on GCP
- 05 Core functions and architectures
- 06 Cloud delivery and deployment models
- 07 Databases, Lakes and Warehouses
- 08 A word on security
- 09 Data roles and teams
- 10 Development environment setup

Setting up servers used to be a lengthy and manual task



The Dell PowerEdge, the best-selling server in the world

Traditional hardware leads to inefficiencies



Dotcom bubble

- <https://youtu.be/EsvpNB2Lv3U?t=26>

Many businesses without a sound business model were valued at millions

The screenshot shows the homepage of Pets.com. At the top, the logo 'pets.com' with the tagline 'because pets can't drive' is displayed. A navigation bar below it includes links for 'home', 'dogs', 'cats', 'fish', 'birds', 'ferrets', 'reptiles', and 'small pets'. On the left, there's a 'find' search bar and a sidebar with 'today's features' like 'Portrait of a Poodle', 'A Very Kitty Christmas', 'Hanukkah at My House', 'Animal Instincts', and 'Bunny Speak'. The main content area features a large banner with the text 'Celebrate our Anniversary With 10% off Everything!' and illustrations of a dog and a cat. Below this, sections for 'Try this for dogs' (Nutro MAX Mini Chunk) and 'Or this for cats' (Pets.com Cat Gift Basket) are shown, each with a price comparison between regular and sale prices. The bottom of the page has links for 'pets law' (Landlord Liability), 'pets vet' (Dr. Bobbie on Family), and 'pets.commitment'. On the right, there are links for 'shopping cart', 'my account', 'gift center', 'community', 'resources', 'Pet of the Day' (with a black cat image), and 'associates program'. A small watermark 'FROM INTERNET ARCHIVE/URVERACK MACHINE' is visible on the right side.

But the bubble burst



And companies were forced to rethink efficiencies



JULY 25, 1994 \$2.95

Finance

Bubble bursts Iron laws of the market bring a sharp dose of reality to the virtual business world

The year dot.com turned into dot.bomb

Jane Hartman
and Larry Elliott

First it was tulips, then it was tulips again. Now the dot.coms have been added to that dubious hall of fame — the roll call of speculative bubbles that have punctuated the history of financial markets. Yesterday yet another high-profile internet business — Lycos.com — announced it had run into difficulties.

The mania for technology stocks is back to all-time highs, with a number of companies like them, to buy shares

without a care, soaring, as missing

days go by all cylinders, some clutching

young entrepreneurs, a small army of chemists in brokerage houses and in

the media peddling the line that the

reign of buoyness had been restored.

Yet what it did not have was the

kind of solid rules of accountancy

that the historians will be writing the

script of the dot-com bubble that's

likely to be the same as that painted after the madness ended in 17th century

Holland, London or New York Street

in 1929. It wasn't different this time.

In case did the Cassandra syndrome

that it would all end in tears, that there

were simply too many companies churning

too little income, and that for the

same reason, the price of a company

to be justified every person on earth

would have to be surfing the net 24

hours a day with a smiley glease

clamped to each eye.

The last laws of markets have come re-

asserted themselves. The retching up

Rise and fall

S&P Composite Index



of interest rates by the Federal Reserve has not helped, leading to weaker consumer demand and higher business costs. But there were also structural factors at play. Over the million firms, share prices are linked to profit with a fairly stable relationship between share prices and earnings per-share earnings ratio. If the price-to-earnings ratio is much higher than normal, then a fall in share price — either due to a fall in the company's cash flow or to a fall in its share price — eventually justify its share price by making higher profits or its share price will move down to match with a lower

Most dot.coms were invested in sectors where profits — assuming there were any — were destined to be

America Online, the world's biggest internet service provider, and Time Warner, one of biggest traditional media companies, among the early victims of the "new paradigm."

The mania appeared to mask the coming of age of online upstarts as AOL had all the glitz and all the potential, but Time Warner was making all the money. When the bubble burst, the iron laws of the stock market were rather than the start of an avalanche of losses.

However, a recent market-making 40% in April, the Nasdaq composite index of technology companies rallied even higher in the last three months of 2000. On March 10, the index reached a record high of 4,000. In the closing weeks of the year, it is trading at least half that level. With the bubbly-happy and investor confidence in tatters, the index has recorded its worst ever annual performance in its 12-year history. The year-long loss of a 35% decline was exceeded during the oil crash of 1973.

This year's bear market began in April, when the Nasdaq suffered one of its worst one-day falls in stock market history. Within 25 trading days, \$2.4 billion (\$200 million) had been wiped from the technology-driven stock market.

The arrival of the dot-coms made and has in the mid-1990s fuelled enthusiasm. Microsoft has halved its value since the beginning of the year with about \$14 billion cut from its market capitalisation. Bill Gates, the company's founder, is still the world's richest man in spite of losing about \$40 billion as a result of his company's misfortunes. Others to have lost several billion dol-



American professor Robert Shiller predicted the strong Internet bubble

ing. After years out of the spotlight, Shiller is author uncomforable with some aspects of his role as a prophet. "I felt flattered," he says of the attention, "but I was worried about what many people were concerned about their own plain-sounding fortunes. It seems as though all choices, whether economic or medical, are meant to be measured."

The Nasdaq has declined by about 40% since Shiller's book was launched. Yet, still he is anxious about the future direction of the market. "I think we're at the bottom of the current market," he said, adding that in a trading 12-month book, the S&P 500 index will end 2001 at a pre-earnings multiple of 22 times, almost twice the current average.

The rate of company closures is still accelerating, according to a report published by the Internet, an online organisation. In the first 11 months of the year, 1,100 internet companies folded with about 8,000 job losses.

In spite of signs that the stock market might be close to an end, most analysts believe the internet will make a lasting impact on business and the economy.

Andy Grove, chairman of Intel, recently predicted last year: "There won't be another Internet bubble for a few years. All companies will be forced to compete, or they will die."

This is almost certainly true. The Wall Street crash of 1929 did not mean the end of profits or prevent the spread of the market. But a word of warning. In real terms, the S&P composite index did not regain its level of September 1999 until December 1999.

Amazon Web Services launches in 2006

The screenshot shows the Amazon Web Services homepage. At the top, there's a navigation bar with links like "Your Store", "Make Money", "See All 34 Product Categories", "Your Account", "Cart", "Your Lists", "Help", and a shopping cart icon. Below the navigation is a secondary menu with links to "Program Overview", "Marketplace", "Associates", "Advantage", "Web Services" (which is highlighted), "Paid Placements", and "On-Demand Publishing". A search bar is present, along with buttons for "Find Gifts" and "AOL Web Search".

Welcome to Amazon Web Services

Amazon Web Services provides developers with direct access to Amazon's robust technology platform. Build on Amazon's suite of web services to enable and enhance your applications. We innovate for you, so that you can innovate for your customers. Browse developer innovations in our [Solutions Catalog](#) to see the possibilities!

What's New?

Give Us Your Feedback - Developer Resources (August 09 2006)
Where can we improve to help you build on Amazon Web Services? Your feedback is very important to us as we release services that you use to run your businesses. Please take 5 minutes to complete the brief survey in Newsletter #17. By completing the survey, you will be entered into a drawing for one of 250 \$5 Amazon.com gift certificates. (NO PURCHASE NECESSARY. Ends August 31, 2006. See the [official rules](#) for details.)

Announcing Alexa Site Thumbnail (July 26, 2006)
The Alexa Site Thumbnail web service provides developers with programmatic access to thumbnail images for the home pages of web sites. It offers access to Alexa's large and growing collection of images, gathered from its comprehensive web crawl. This web service enables developers to enhance web sites, search results, web directories, blog entries, and other web real estate with Alexa thumbnails images. Including web site thumbnail improves user experience by allowing end users to preview sites before clicking on the thumbnail's associated link.

Amazon Simple Storage Service (Amazon S3) - Continuing Successes (July 11, 2006)
La Nacion, Microsoft, and SmugMug represent the breadth of companies choosing to use the web scale storage offered by Amazon S3. Global enterprises like Microsoft are using Amazon S3 to dramatically reduce their storage costs without compromising scale or reliability. On the opposite end of the spectrum, small businesses that depend on storage, such as SmugMug, are using Amazon S3's benefits of scale and cost-efficiency that were previously only available to large companies. Amazon continues to use Amazon S3 for its own business as well, recently launching new digital initiatives that store and retrieve large data files using Amazon S3. Click on "News Releases" at <http://www.amazon.com/pr> to read the press release.

Amazon Simple Queue Service (Amazon SQS) Now Generally Available (July 11, 2006)
Amazon Simple Queue Service (Amazon SQS) offers a reliable, highly scalable hosted queue for

Your Web Services Account

Sign-up Today!

Reasons to Sign-up for AWS:

- Access several Amazon Web Services for FREE.
- Receive FREE newsletters about AWS.
- Join an innovative developer community
- Learn to build new solutions and applications to make money.

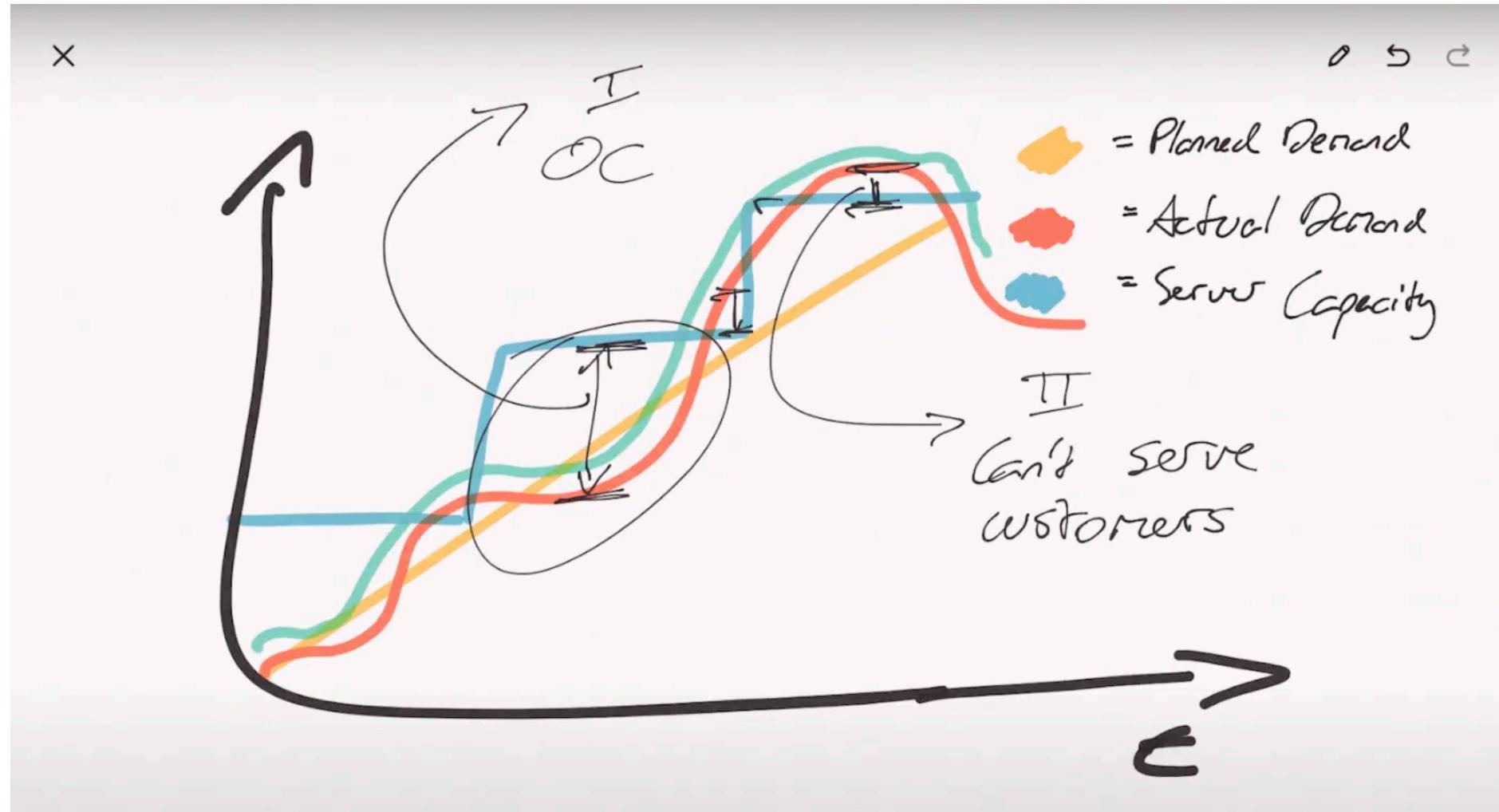
[Click here to Sign-Up.](#)

Customer Spotlight

MediaSilo

In need of storage for its customers' memory-hungry video files, MediaSilo turned to the Amazon Simple Storage

With cloud computing capacity equals demand



Amazon pioneered the market, others followed suit



2006

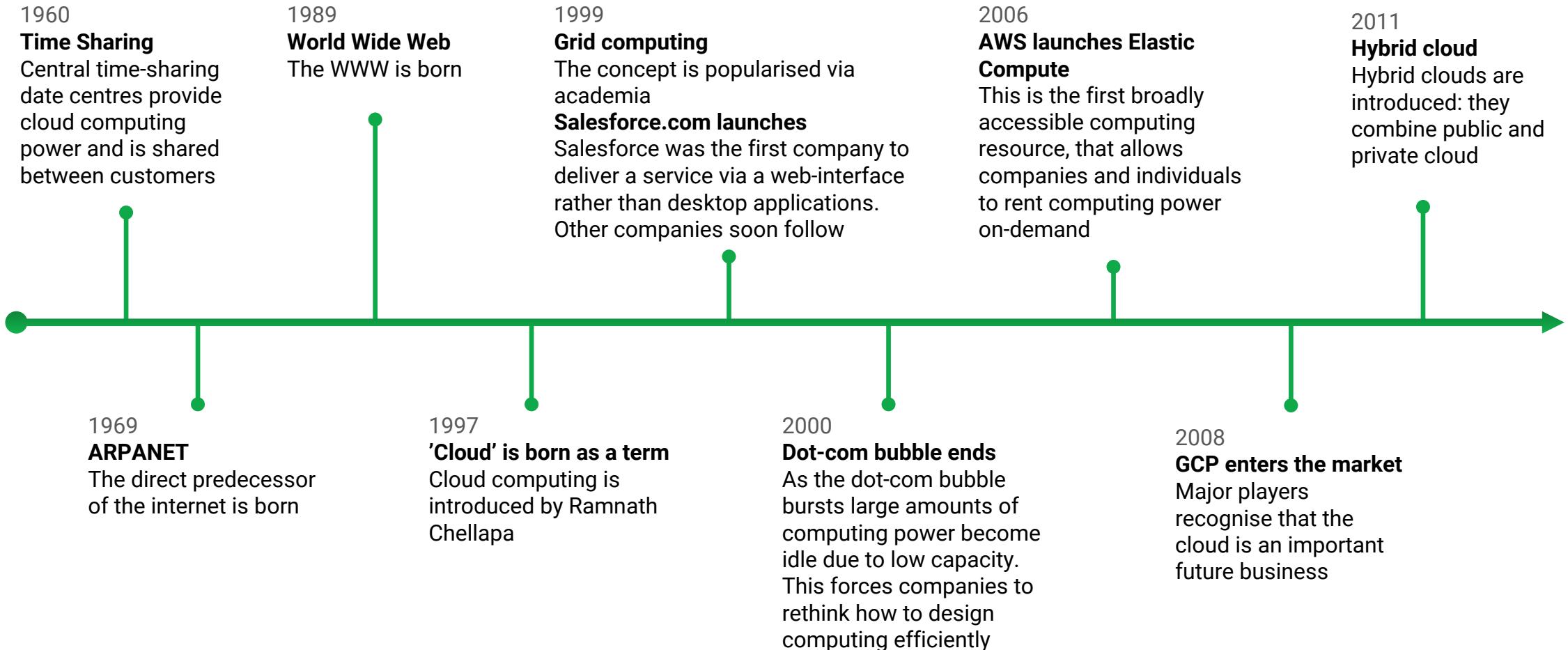


2008

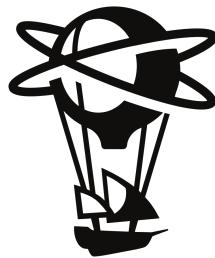


2010

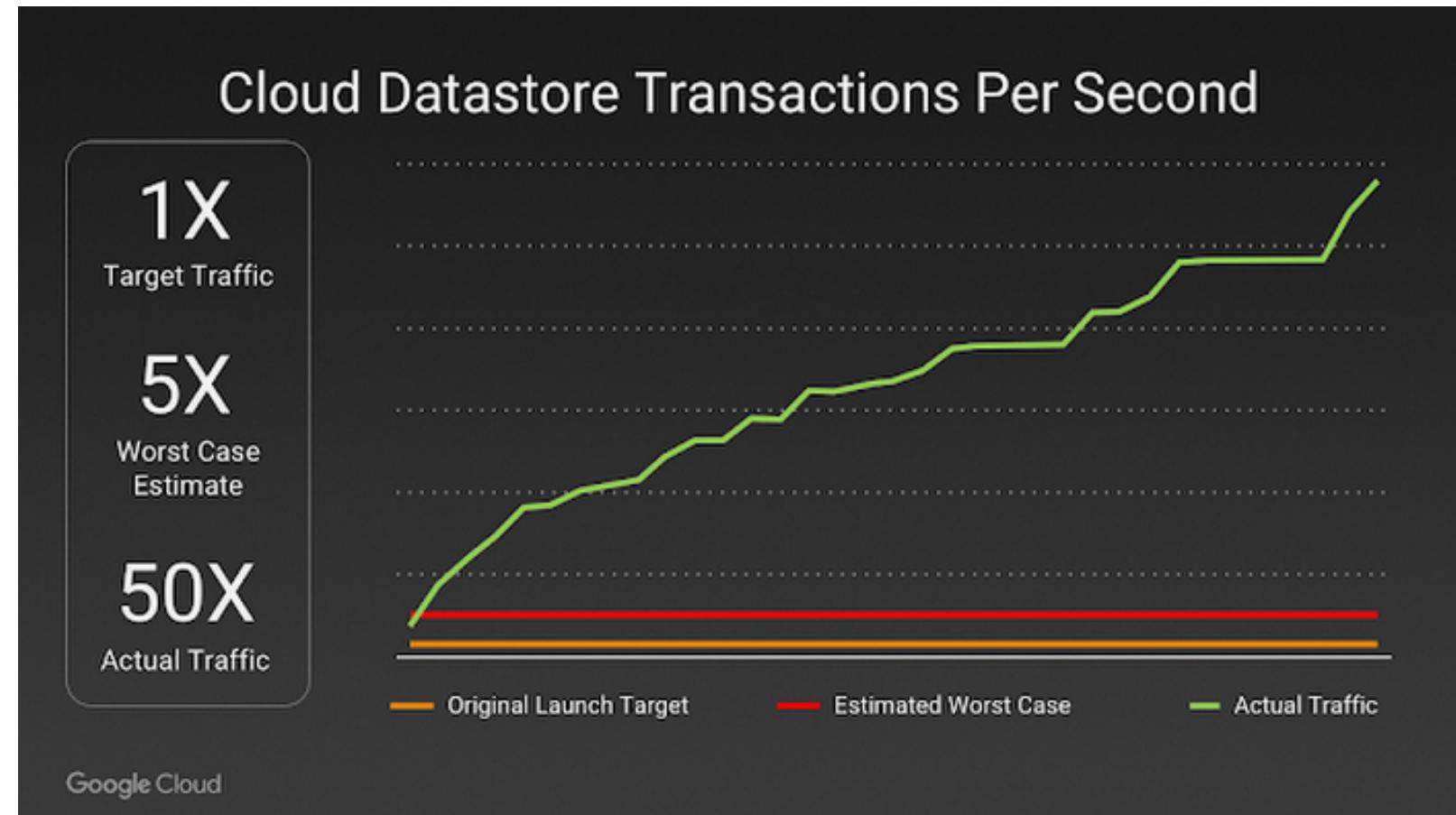
Timeline of the cloud



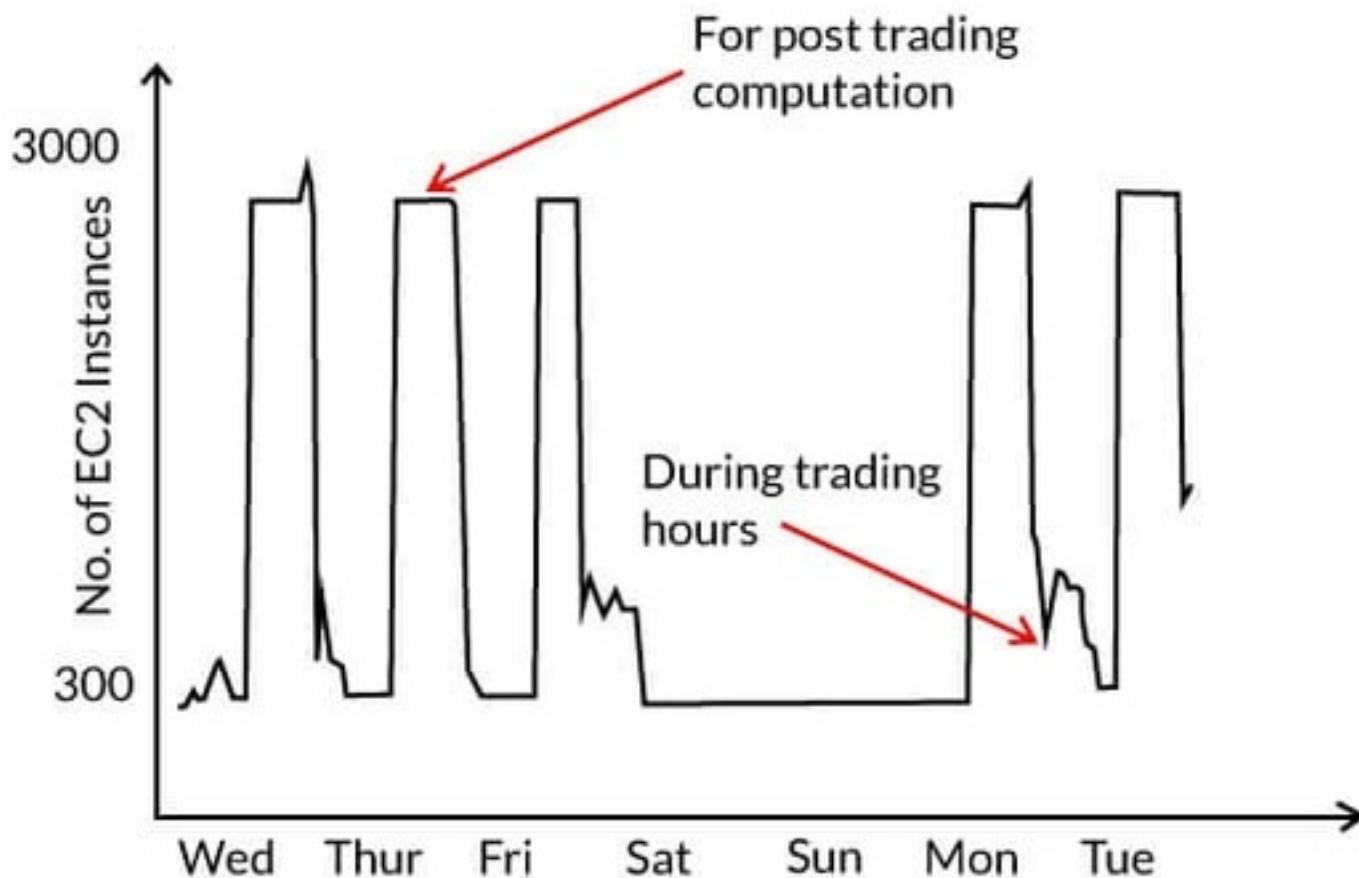
Unpredictable growth: The example of Niantic (Pokémon Go)



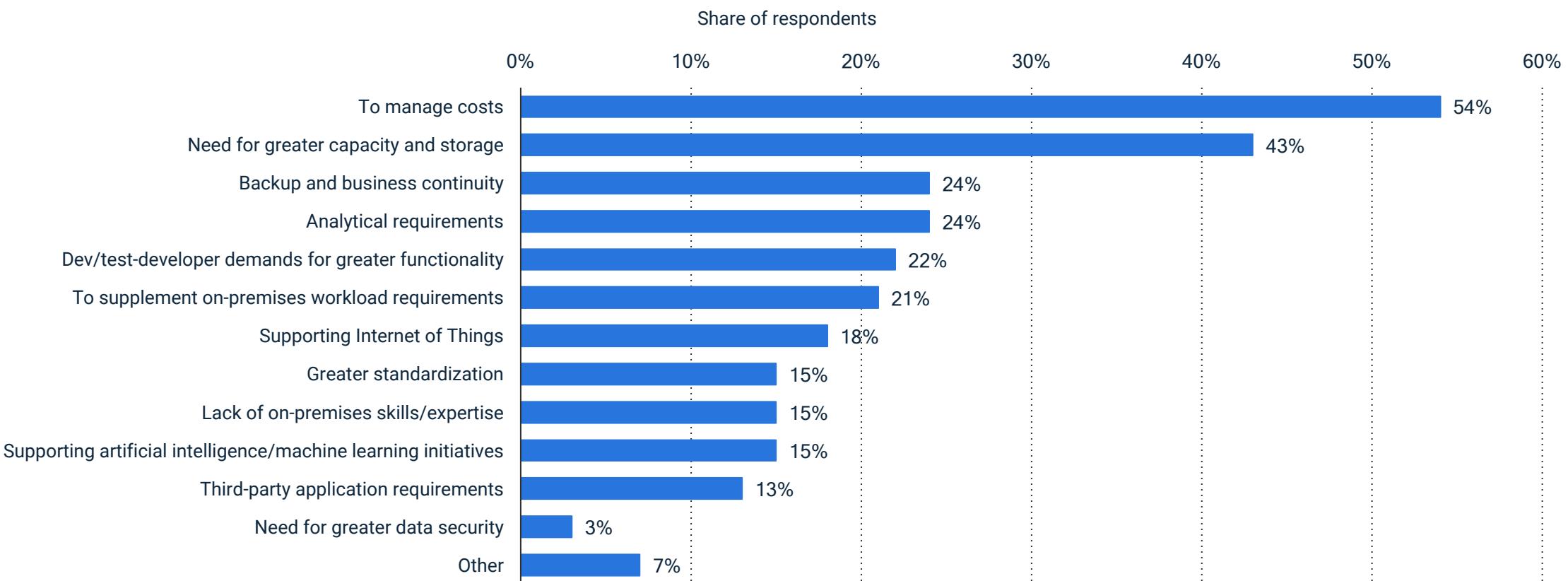
NIANTIC



Elastic compute for high amplitudes – Hedge Fund Example



What's driving adoption?



Note: Worldwide; 2018; 202 Respondents; data managers and professionals members of the independent oracle users groups (IOUG)

Source(s): Quest Oracle Community

Cloud adoption drivers

01

Capacity Planning

- Determining and fulfilling future demands of an organisation's IT resources, products and services
- Capacity: the maximum amount of work a resource is capable of delivering
- Planning for capacity can be challenging because it requires estimating usage load fluctuations.
- Both under- and over-provisioning of resources have different risks

02

Cost Reduction

- Two costs need to be accounted for: cost of acquiring new infrastructure and the cost of ongoing ownership
- Direct alignment of IT costs and performance of business is difficult
- Growth of IT resources is generally associated with the expected *maximum* usage requirement.
- Maintaining own servers means that infrastructure will mostly be under-utilised

03

Organisational Agility

- The responsiveness of an organisation to change, e.g. scaling IT resources beyond the previously planned scope
- Changing priorities of business (e.g. speed v. reliability) may require *different* types of resources
- Willingness to start and terminate new and risky projects
- Speed of fixing to security risks: e.g. newly discovered weakness of external software

Characteristics of the cloud

01 On-demand usage

Consumers can access cloud-based IT resources without having to go through any approval process or interaction with a human making the products on-demand and self-service.

Without any approval process, starting new instances can also be automated via scripts running on other IT resources, thus removing human action on both sides

02 Multitenancy and resource pooling

Multiple cloud users can use resources the same but are still isolated during usage

This isolation is achieved through a technology called ‘virtualisation’ which we will discuss in greater detail later

This has been a major driving technology for the cloud as it allows cloud providers to pool large scale resources and dynamically assign fractions of computing power or storage to different users based on demand

03 Ubiquitous access

Products running on the cloud can be made globally available and from every device.

Consumers generally restrict access for specific resources though

Source: National Institute of Standards and Technology (NIST) definition of cloud computing

Characteristics of the cloud

04 Elasticity

The automated ability of a cloud to scale resources up and down as demand intensifies

It is a core reason for companies to use the cloud as it reduces investment requirements and makes cost proportional. Expenses for IT resources grow and fall together with demand for your service

Scale matters: Providers with vast amounts of IT resources can offer the greatest range of elasticity

05 Measured usage

Users are charged only for the resources actually used and for the timeframe of their usage, often measured by the minute or second

Measurement is not only relevant for billing. It enables collection of more detailed statistics for reporting and the monitoring of resources:

Users can e.g. set-up notifications when servers break down or are running at a very high capacity

06 (Resiliency)

Cloud infrastructure expects individual elements to break from time to time. It is thus often has redundant versions of a resource in different regions. If one of them fails the other can take over or, in the case of storage, the data is not lost

Source: National Institute of Standards and Technology (NIST) definition of cloud computing

Data centres contain ginormous amount of computing power, storage and wires...

Computers...



...are packed into drawer slides...



...stacked on 'racks'...

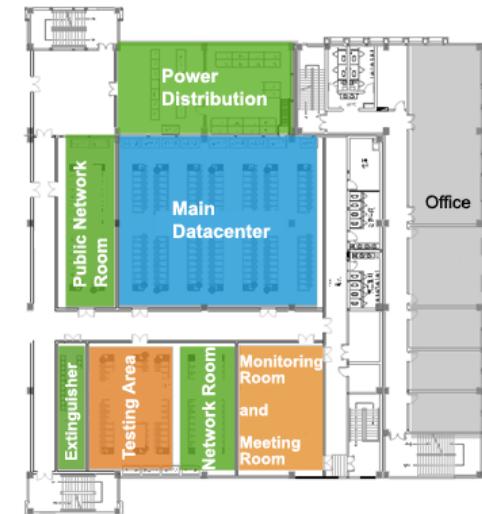
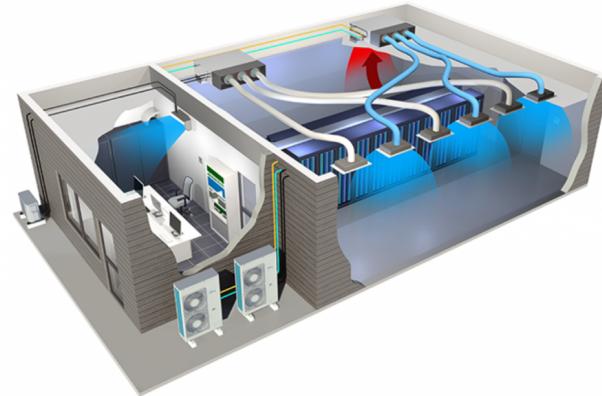


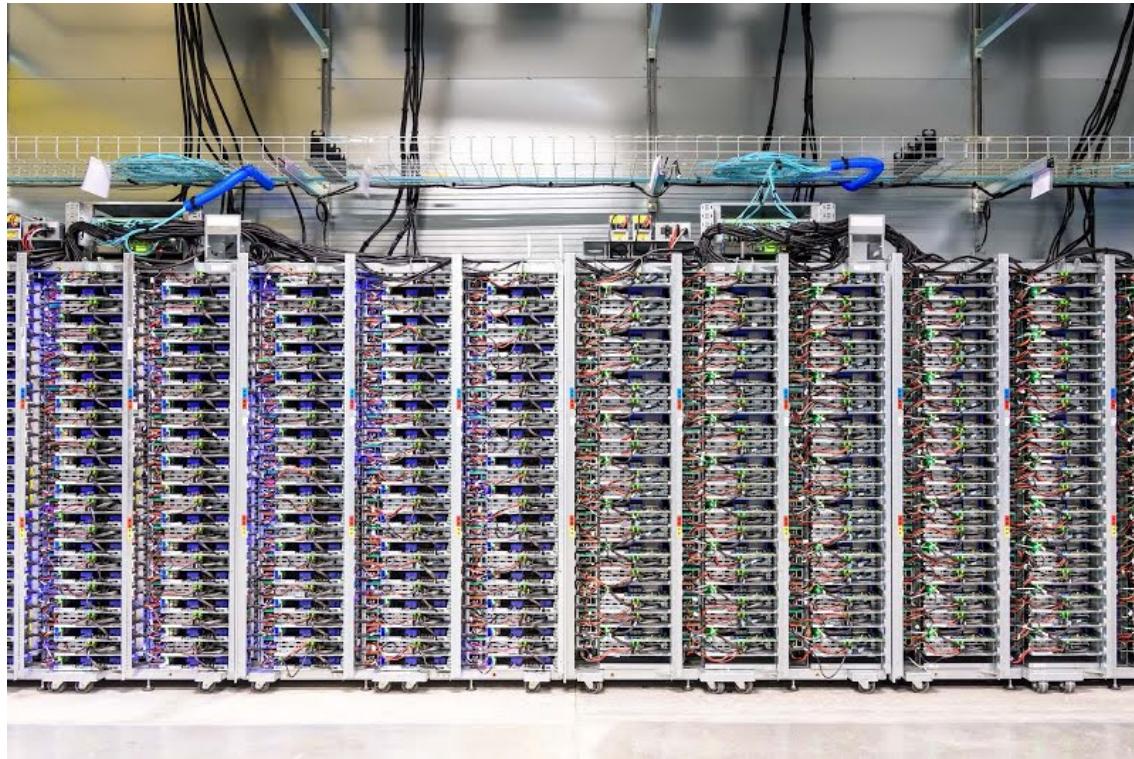
...and stored in datacentres



...which are locked up at high security...

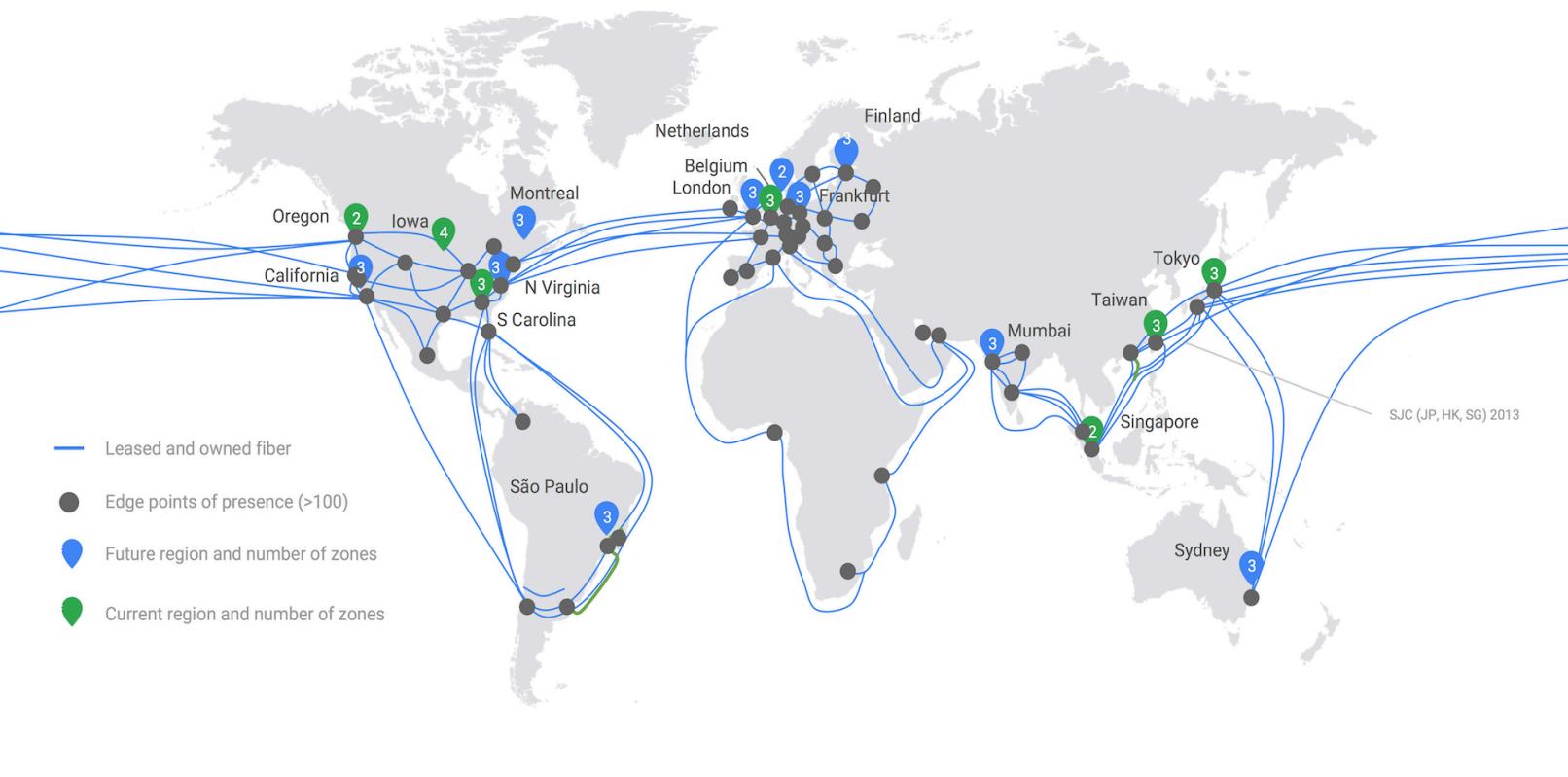
- Human security: Entrants to datacentres need to be whitelisted, pass iris scans, pass through middle rooms and sometimes even have to pass background checks.
- Physical security: Walls are multiple dozen centimetres thick, servers are supplied hooked onto multiple power sources, including emergency generators, and interiors are equipped with humidity controls and movement sensors.
- Four tiers of data centre infrastructure redundancy and their uptime:
 - Tier 1: Basic data centre (>99.671%)
 - Tier 2: Redundant components data centre (>99.741%)
 - Tier 3: Concurrently maintainable data centre (>99.982%)
 - Tier 4: Fault-tolerant datacentre (>99.995%)







But running a cloud is very expensive...



\$1 Billion

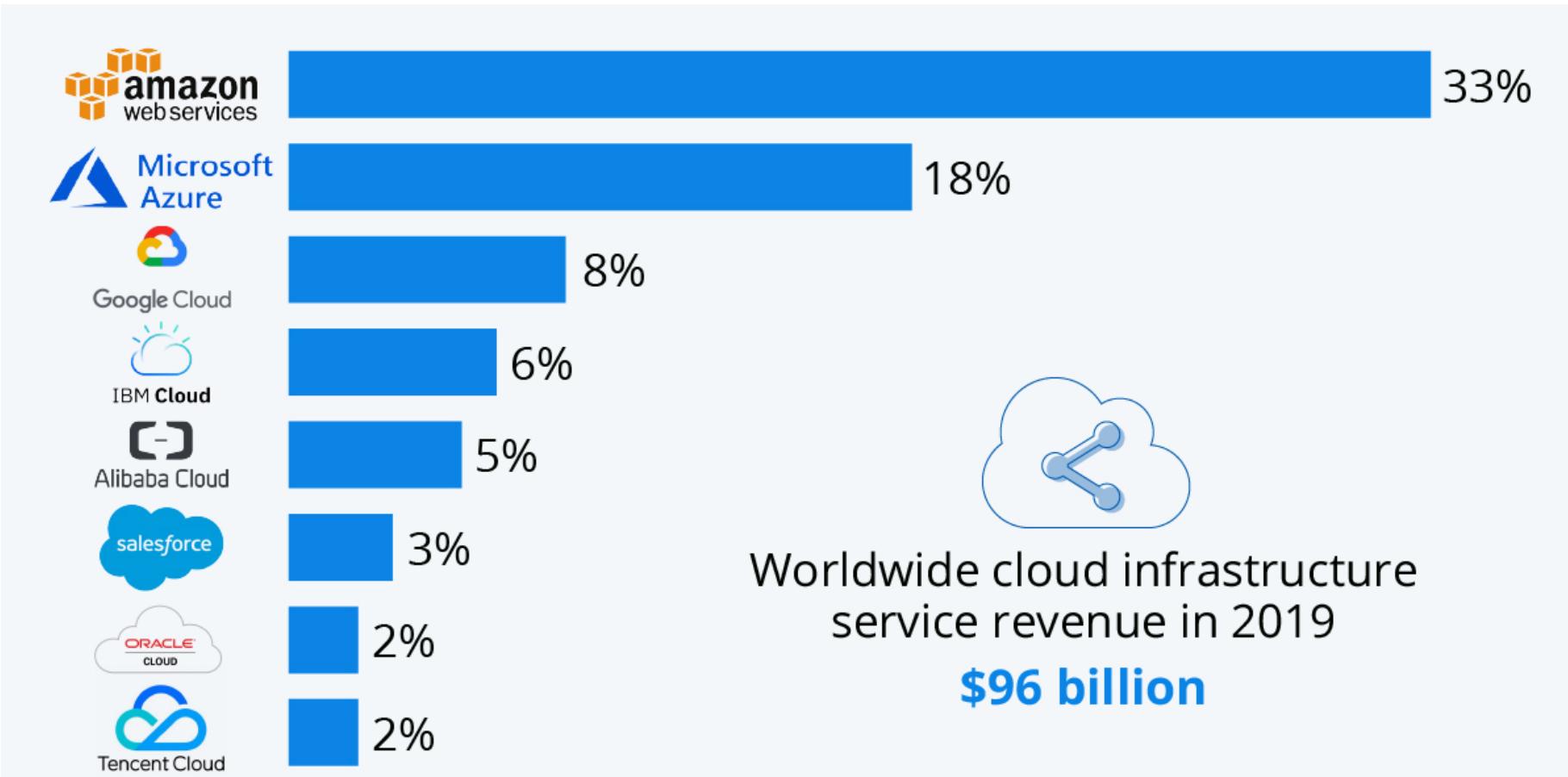
Typical construction cost of a hyperscale data centre

6% - 10%

Of construction costs as annual operating cost

Sources: Datacenterfrontier, CTEC US Chamber of Commerce

...which is why the \$100 billion market is dominated by large corporations



Source: Synergy Research Group

Three players dominate the market



Amazon Web Services

- First provider in 2006 and largest service provider by revenue with 33% market share
- Offers many private cloud services that help large corporate customers migrate more easily. It boasts large players as customers such as Netflix, Apple, Spotify, Dropbox
- Deepest and widest offering of products and biggest network of datacentres
- Large scope of products and at times complicated pricing structure make it difficult for individuals/organisations new to the cloud



Microsoft Azure

- Fast follower in 2010, also offer a broad range of services. Market share: 18% and growing very fast at 64% YoY in 2019
- Biggest advantage: strong ties and trust of enterprise customers with Microsoft through office products
- Good hybrid cloud offerings which allows customers to keep some of their applications on-premises while still taking advantage of some cloud features. Also, Microsoft's cloud integrates well with Microsoft Office products



Google Cloud Platform

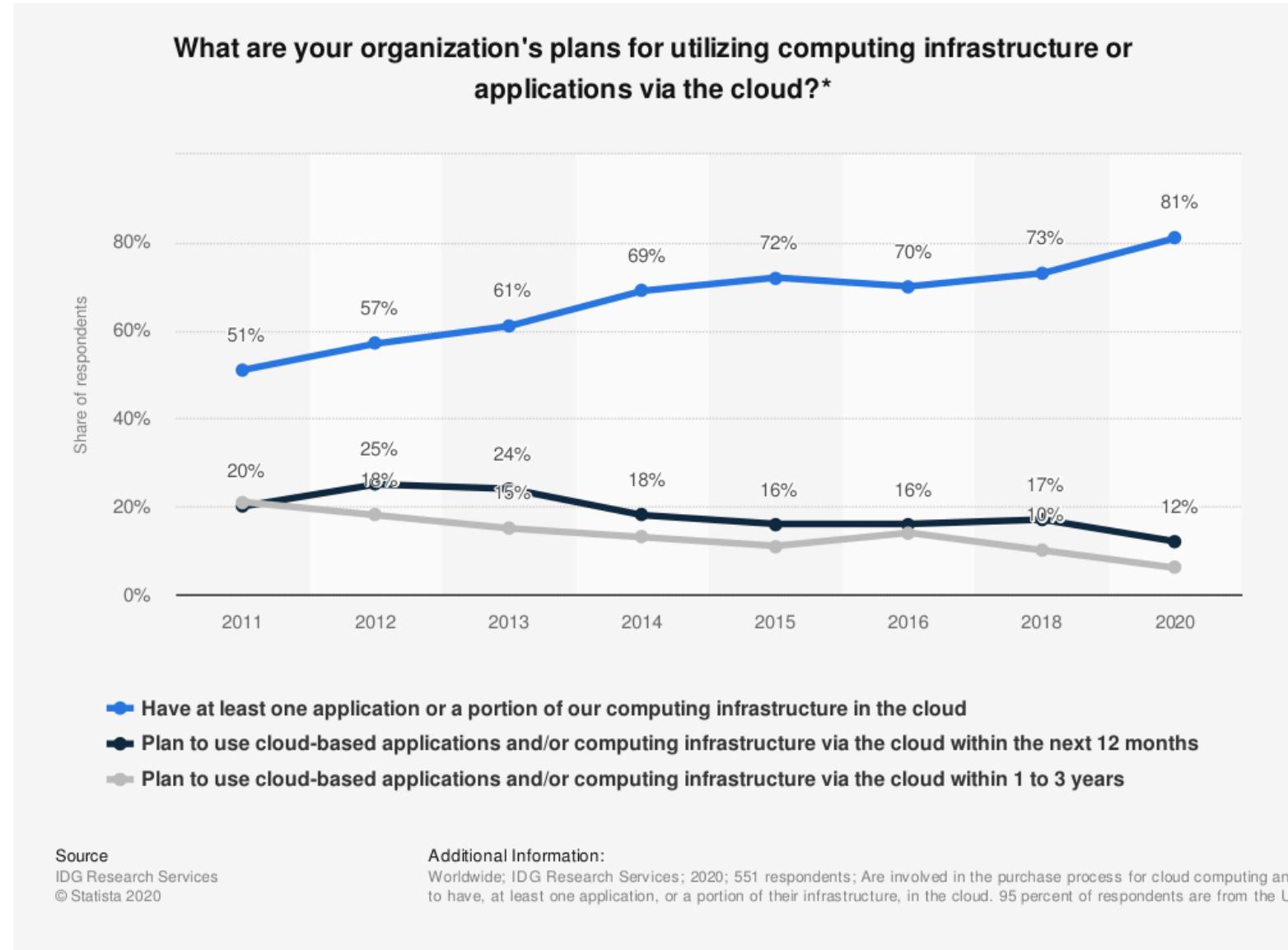
- Perceived as late-mover and still lagging behind in terms of market-share with 8% but growing as the fastest
- Biggest advantage is their own experience working with large amounts of data. The products they sell apparently are the same they use in-house. AI, machine learning and data tools are the primary selling point
- Outperforms other providers in the SMB sector, especially with start-ups, but does not always trusted by large enterprises

Most mature player, biggest product suite

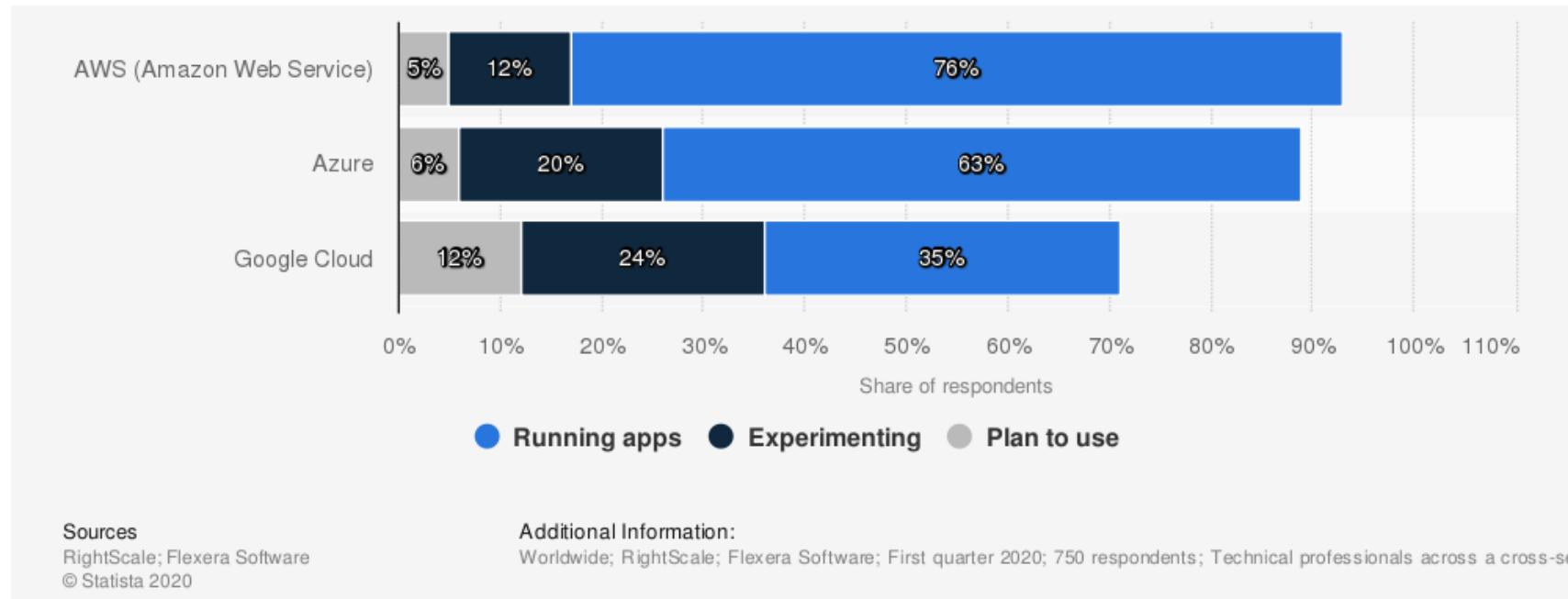
Favourite choice for enterprise customers

Strong in data & AI, fast developing platform

Four in five companies are using the cloud



Current and planned usage of public cloud services





- 01 Introduction
- 02 What makes the cloud interesting?
- 03 The cloud market
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GCP Console and starting a server

GCP Console

Google Cloud Platform HSG-SIAW Search products and resources CUSTOMISE

DASHBOARD ACTIVITY

How Google Cloud is helping during COVID-19 [Learn more](#) DISMISS

Project info

Project name: HSG-SIAW
Project ID: hsg-siaiw
Project number: 44200956813

[ADD PEOPLE TO THIS PROJECT](#)

[Go to project settings](#)

Resources

Cloud Functions: 3 functions

Trace

No trace data from the last 7 days

[Get started with Stackdriver Trace](#)

API APIs

Requests (requests/sec)

No data is available for the selected time frame.

[Go to APIs overview](#)

Google Cloud Platform status

All services normal

[Go to Cloud status dashboard](#)

Billing

Estimated charges: CHF 0.00
For the billing period 1–17 May 2020

[View detailed charges](#)

Error Reporting

No sign of any errors. Have you set up Error Reporting?

[Learn how to set up Error Reporting](#)

News

How SAP on Google Cloud is helping Multipharma manage change

Starting a Server with GCP

Google Cloud Platform HSG-SIAW Search products and resources

Create an instance

To create a VM instance, select one of the options:

- New VM instance** Create a single VM instance from scratch
- New VM instance from template** Create a single VM instance from an existing template
- New VM instance from machine image** Create a single VM instance from an existing machine image
- Marketplace** Deploy a ready-to-go solution onto a VM instance

Name Name is permanent **\$24.67 monthly estimate**
That's about \$0.034 hourly
Pay for what you use: No upfront costs and per second billing

Labels (Optional) **+ Add label**

Region Region is permanent **Zone** Zone is permanent

Machine configuration

Machine family General-purpose Memory-optimised Compute-optimised
Machine types for common workloads, optimised for cost and flexibility

Series Powered by Intel Skylake CPU platform or one of its predecessors

Machine type

	vCPU	Memory
	1	3.75 GB

Container Deploy a container image to this VM instance. [Learn more](#)

Boot disk

AWS Console

AWS Management Console

AWS services

Find Services
You can enter names, keywords or acronyms.

Example: Relational Database Service, database, RDS

▼ Recently visited services

 VPC  Elastic Kubernetes Service  IAM

 Billing  EC2

► All services

Build a solution
Get started with simple wizards and automated workflows.

Launch a virtual machine
With EC2
2-3 minutes

Build a web app
With Elastic Beanstalk
6 minutes

Build using virtual servers
With Lightsail
1-2 minutes

https://eu-central-1.console.aws.amazon.com/console/home?nc2=h_ct®ion=eu-central-1&src=header-signin#

Stay connected to your AWS resources on-the-go

 Download the AWS Console Mobile App to your iOS or Android mobile device. [Learn more](#)

Explore AWS

AWS DeepRacer F1 ProAm
Test your machine learning skills against F1's finest in Circuit de Barcelona-Catalunya
[Learn more](#)

S3 Intelligent-Tiering
Optimize costs automatically with Amazon S3.
[Get started](#)

Run Containers Not Servers
Build, Deploy, and Operate Containerized Applications with AWS Fargate. [Learn More](#)

All AWS Products

The screenshot shows the AWS Management Console with the following interface elements:

- Top Bar:** AWS logo, Services dropdown, Resource Groups dropdown, Notifications icon, User dominique-paul, Region Frankfurt, Support dropdown.
- Left Sidebar:** History section with links to Console Home, VPC, Billing, Elastic Kubernetes Service, EC2, and IAM.
- Search Bar:** "Find a service by name or feature (for example, EC2, S3 or VM, storage)."
- Sort Options:** Group (selected) and A-Z.
- Service Categories:**
 - Compute:** EC2, Lightsail, Lambda, Batch, Elastic Beanstalk, Serverless Application Repository, AWS Outposts, EC2 Image Builder.
 - Storage:** S3, EFS, FSx, S3 Glacier, Storage Gateway, AWS Backup.
 - Database:** RDS, DynamoDB, ElastiCache, Neptune, Amazon Redshift, Amazon QLDB, Amazon DocumentDB.
 - Blockchain:** Amazon Managed Blockchain.
 - Satellite:** Ground Station.
 - Quantum Technologies:** Amazon Braket.
- Analytics:** Athena, EMR, CloudSearch, Elasticsearch Service, Kinesis, QuickSight, Data Pipeline, AWS Data Exchange, AWS Glue, AWS Lake Formation, MSK.
- End User Computing:** WorkSpaces, AppStream 2.0, WorkDocs, WorkLink.
- Internet Of Things:** IoT Core, FreeRTOS, IoT 1-Click, IoT Analytics, IoT Device Defender, IoT Device Management, IoT Events, IoT Greengrass, IoT SiteWise, IoT Things Graph.
- Management & Governance:** AWS Organizations, CloudWatch, AWS Auto Scaling, CloudFormation, CloudTrail, Config, OpsWorks.
- Security, Identity, & Compliance:** IAM, Resource Access Manager, Cognito, Secrets Manager, GuardDuty, Inspector, Amazon Macie, AWS Single Sign-On, Certificate Manager, Key Management Service, CloudHSM, Directory Service.
- Game Development:** Amazon GameLift.
- Containers:** Elastic Container Registry, Elastic Container Service, Elastic Kubernetes Service.

At the bottom, there is a note: "covering AWS products and services. Learn more" with a link icon.

Starting a Server with AWS

The screenshot shows the AWS Step Functions interface for launching a new server. The top navigation bar includes the AWS logo, Services dropdown, Resource Groups dropdown, a bell icon for notifications, user dominique-paul, location Frankfurt, and Support dropdown.

The main steps are listed at the top: 1. Choose AMI (highlighted in orange), 2. Choose Instance Type, 3. Configure Instance, 4. Add Storage, 5. Add Tags, 6. Configure Security Group, and 7. Review.

Step 1: Choose an Amazon Machine Image (AMI)

An AMI is a template that contains the software configuration (operating system, application server, and applications) required to launch your instance. You can select an AMI provided by AWS, our user community, or the AWS Marketplace; or you can select one of your own AMIs.

A search bar at the top allows you to "Search for an AMI by entering a search term e.g. 'Windows'" and a "Search by Systems Manager parameter" option.

Quick Start sidebar:

- My AMIs
- AWS Marketplace
- Community AMIs
- Free tier only (i)

The main content area displays a list of available AMIs:

Image	Name	Description	Root device type	Virtualization type	ENAv Enabled	Select	Architecture
Amazon Linux	Amazon Linux 2 AMI (HVM), SSD Volume Type - ami-076431be05aaaf8080 (64-bit x86) / ami-00b295cf57f3deb6 (64-bit Arm)	Amazon Linux 2 comes with five years support. It provides Linux kernel 4.14 tuned for optimal performance on Amazon EC2, systemd 219, GCC 7.3, Glibc 2.26, Binutils 2.29.1, and the latest software packages through extras.	ebs	hvm	Yes	Select	<input checked="" type="radio"/> 64-bit (x86) <input type="radio"/> 64-bit (Arm)
Amazon Linux	Amazon Linux AMI 2018.03.0 (HVM), SSD Volume Type - ami-03ab4e8f1d88ce614	The Amazon Linux AMI is an EBS-backed, AWS-supported image. The default image includes AWS command line tools, Python, Ruby, Perl, and Java. The repositories include Docker, PHP, MySQL, PostgreSQL, and other packages.	ebs	hvm	Yes	Select	64-bit (x86)
Red Hat	Red Hat Enterprise Linux 8 (HVM), SSD Volume Type - ami-07dfba995513840b5 (64-bit x86) / ami-0f0b94d1e9498fca7 (64-bit Arm)	Red Hat Enterprise Linux version 8 (HVM), EBS General Purpose (SSD) Volume Type	ebs	hvm	Yes	Select	<input checked="" type="radio"/> 64-bit (x86) <input type="radio"/> 64-bit (Arm)
SUSE Linux	SUSE Linux Enterprise Server 15 SP1 (HVM), SSD Volume Type - ami-0d63f0d5c7bc514dd (64-bit x86) / ami-0595766533df6c128 (64-bit Arm)	SUSE Linux Enterprise Server 15 Service Pack 1 (HVM), EBS General Purpose (SSD) Volume Type. Public Cloud, Advanced Systems Management, Web and Scripting, and Legacy modules enabled.	ebs	hvm	Yes	Select	<input checked="" type="radio"/> 64-bit (x86) <input type="radio"/> 64-bit (Arm)
Ubuntu	Ubuntu Server 18.04 LTS (HVM), SSD Volume Type - ami-0e342d72b12109f91 (64-bit x86) / ami-04e80dcb9504b6979 (64-bit Arm)	Ubuntu Server 18.04 LTS (HVM), EBS General Purpose (SSD) Volume Type. Includes the latest version of the Ubuntu Server, including the desktop environment, the command-line interface, and various system management tools.	ebs	hvm	Yes	Select	64-bit (x86)

Azure Console

Microsoft Azure ⌂ ☰ 🔍 📁 🔔 ? 😊 Dominique.Paul@unisg... UNIVERSITÄT ST.GALLEN

Azure services

 Create a resource  Resource groups  Virtual machines  App Services  Storage accounts  SQL databases  Azure Database for PostgreSQL...  Azure Cosmos DB  Kubernetes services  More services

Navigate

 Subscriptions  Resource groups  All resources  Dashboard

Tools

 Microsoft Learn [Learn Azure with free online training from Microsoft](#)  Azure Monitor [Monitor your apps and infrastructure](#)  Security Center [Secure your apps and infrastructure](#)  Cost Management [Analyze and optimize your cloud spend for free](#)

Useful links

[Technical Documentation](#) [Azure Services](#) [Recent Azure Updates](#) [Azure mobile app](#)

[Azure Migration Tools](#) [Find an Azure expert](#) [Quickstart Center](#)

 Download on the App Store  GET IT ON Google Play

Starting a Server with Azure

The screenshot shows the 'Create a virtual machine' wizard in the Microsoft Azure portal, specifically the 'Basics' tab. The top navigation bar includes the Microsoft Azure logo, a search bar, and user account information for Dominique.Paul@unisg... UNIVERSITÄT ST.GALLEN.

The breadcrumb navigation shows: Home > New > Create a virtual machine.

The main title is 'Create a virtual machine' with a close button (X).

The 'Basics' tab is selected, with other tabs available: Disks, Networking, Management, Advanced, Tags, and Review + create.

A descriptive text block states: 'Create a virtual machine that runs Linux or Windows. Select an image from Azure marketplace or use your own customized image. Complete the Basics tab then Review + create to provision a virtual machine with default parameters or review each tab for full customization.' It includes a 'Learn more' link.

Project details

Select the subscription to manage deployed resources and costs. Use resource groups like folders to organize and manage all your resources.

Subscription: Azure-Abonnement 1

Resource group: (dropdown menu) with 'Create new' option.

Instance details

Virtual machine name: (input field)

Region: (Europe) Switzerland North

Availability options: No infrastructure redundancy required

Image: Ubuntu Server 18.04 LTS (dropdown menu) with 'Browse all public and private images' link.

Azure Spot instance: No (radio button selected)

Size: Standard D2s v3 (2 vcpus, 8 GiB memory (103,45 CHF/month)) with 'Change size' link.

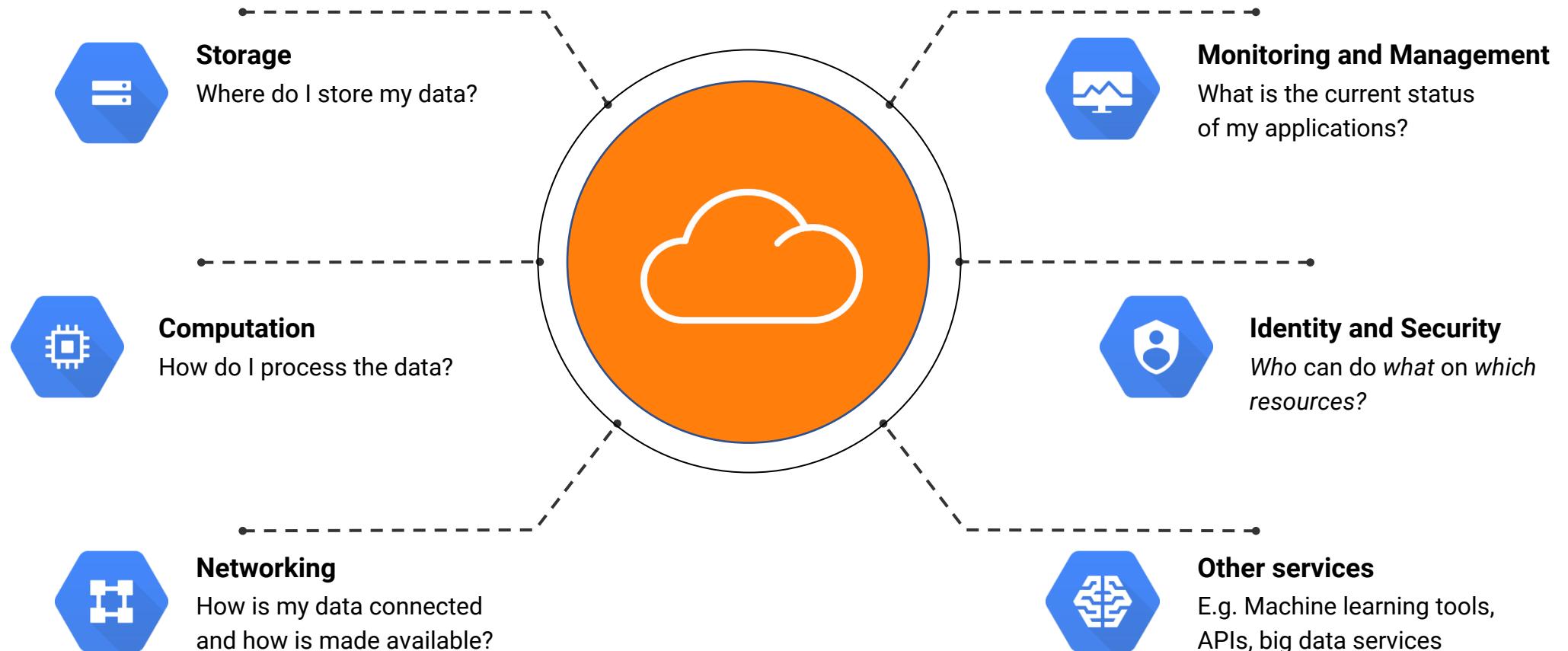
At the bottom are buttons for 'Review + create' (highlighted in blue), '< Previous', and 'Next : Disks >'.



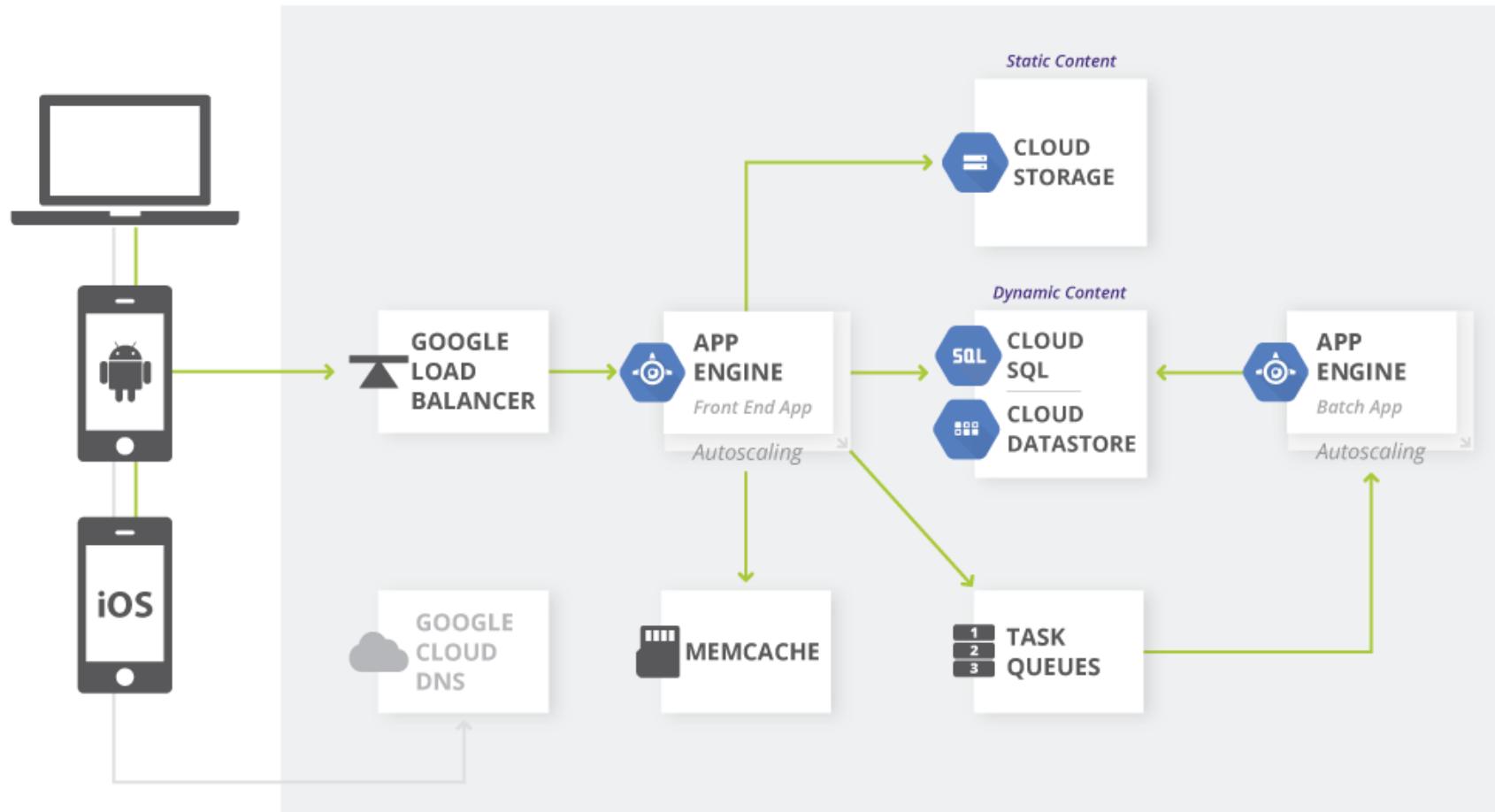
- 01 Introduction
- 02 What makes the cloud interesting?
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Lets take a step back on how setting up a service works

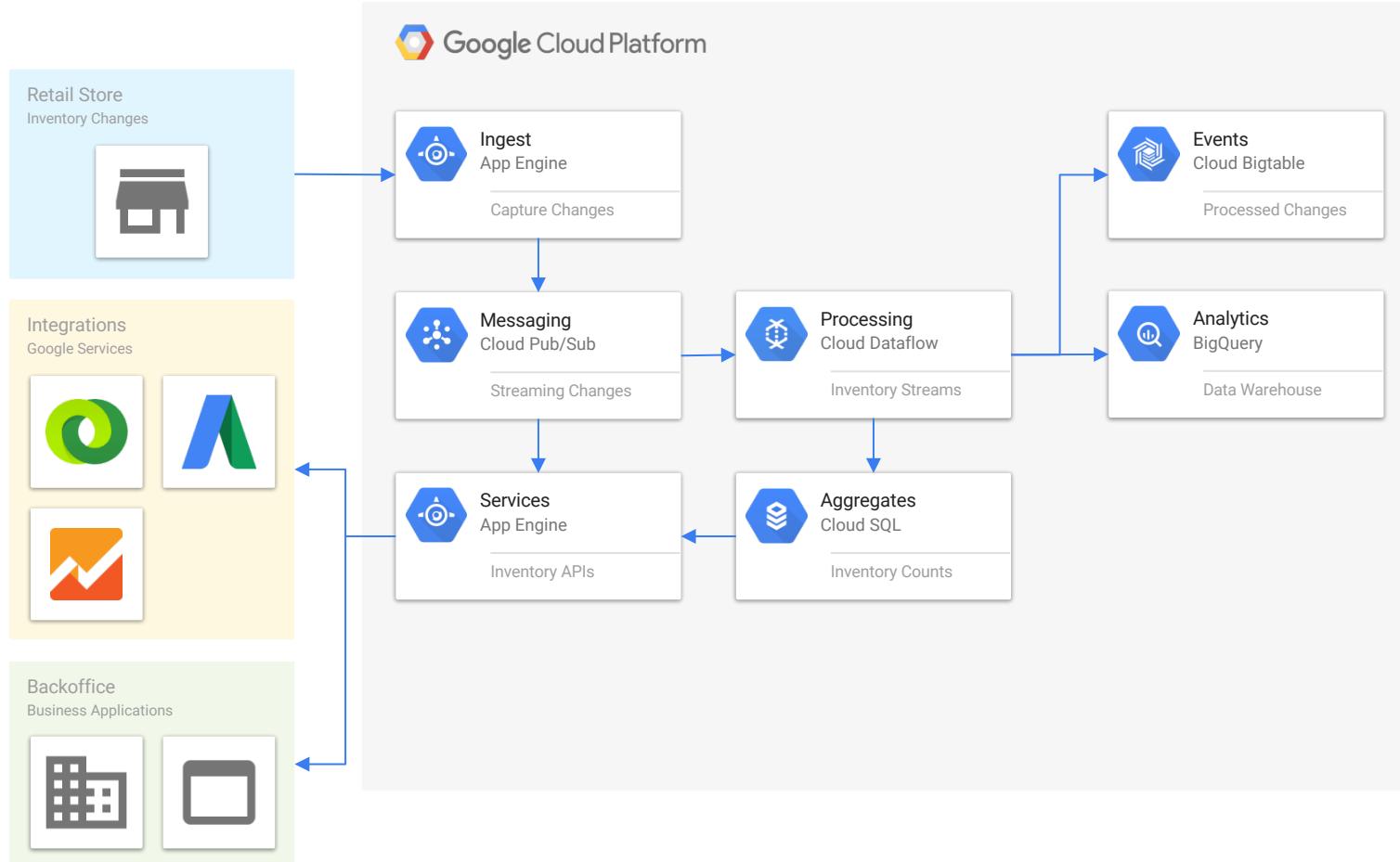
Core functions of the cloud



Basic e-commerce architecture



Architecture of a games company



You can discover more
architectures at:
gcp.solutions



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Cloud delivery models

Building from
the bottom up



Out-of-the-box
functionality

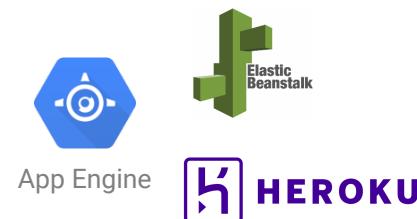
Infrastructure as a Service (IaaS)

- Custom IT environment with non-configured resources that are freshly initialised
- User has to take care of running programs and services himself. High level of control and responsibility



Platform as a Service (PaaS)

- "ready-to-use" environment typically comprised of already deployed resources
- Limited degree of customisability but at the same time less effort required to get a program up and running



Software as a Service (SaaS)

- Typically used to make software program readily able to a broad audience via an user-interface
- User can directly use the service for desired use but has very limited control over administrative functionality



Readiness to use comes at the cost of control and flexibility

On Premise	IaaS	PaaS	SaaS
Applications	Applications	Applications	Applications
Data	Data	Data	Data
Runtime	Runtime	Runtime	Runtime
Middleware	Middleware	Middleware	Middleware
O/S	O/S	O/S	O/S
Virtualization	Virtualization	Virtualization	Virtualization
Servers	Servers	Servers	Servers
Storage	Storage	Storage	Storage
Networking	Networking	Networking	Networking

 You Manage  Other Manages

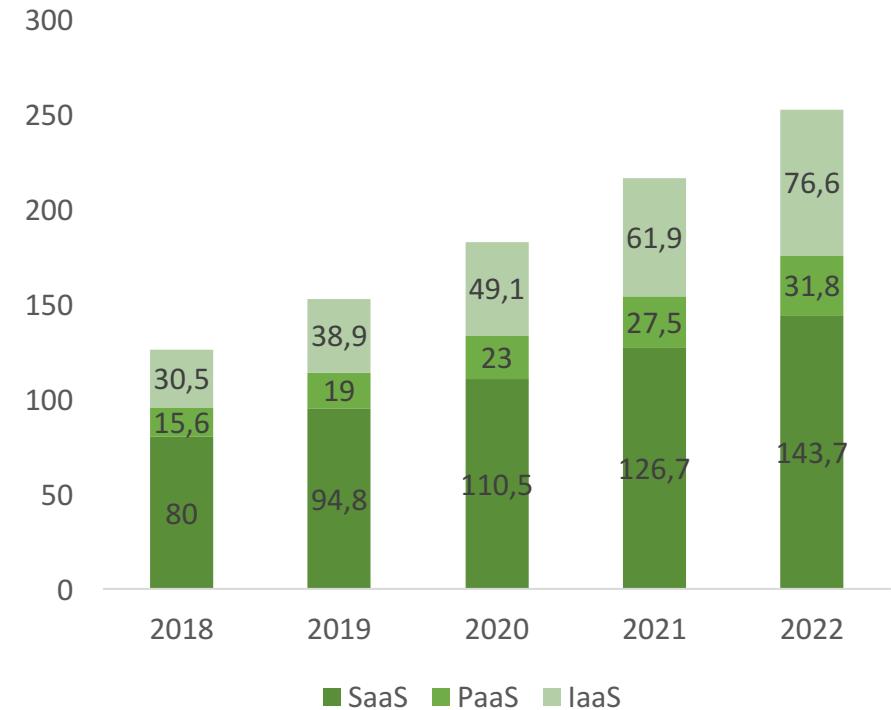
Cloud delivery models

Formal definition: A cloud delivery model is a specific pre-packaged combination of IT resources offered by a cloud provider

IaaS helps build the **infrastructure** of a cloud-based technology. PaaS helps developers build **custom apps** via an API that can be delivered over the cloud. And SaaS is **cloud-based software** companies can sell and use.

No model is generally better than the other. The best choice depends on the purpose of an application

Worldwide Public Cloud Service Revenue Forecast (\$B)



Source: Gartner, April 2019

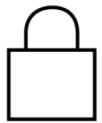
Cloud deployment models



Public Cloud

Publicly accessible cloud environment owned by a third-party cloud provider. The cloud provider is responsible for the creation and on-going maintenance of the resources. This is the type we will be discussing in class.

Examples: GCP, AWS, Microsoft Azure



Private Cloud

Owned by a single organisation and serves to centralise access to IT resources by different parts, locations or departments of the organisation.

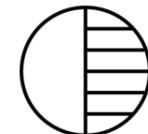
Examples: VMware, Hewlett-Packard Enterprise



Community Cloud

Similar to the public cloud except that access is limited to a specific community of cloud consumers. The community cloud may be jointly owned by the community members or a third party.

Examples: Government cloud used by multiple departments

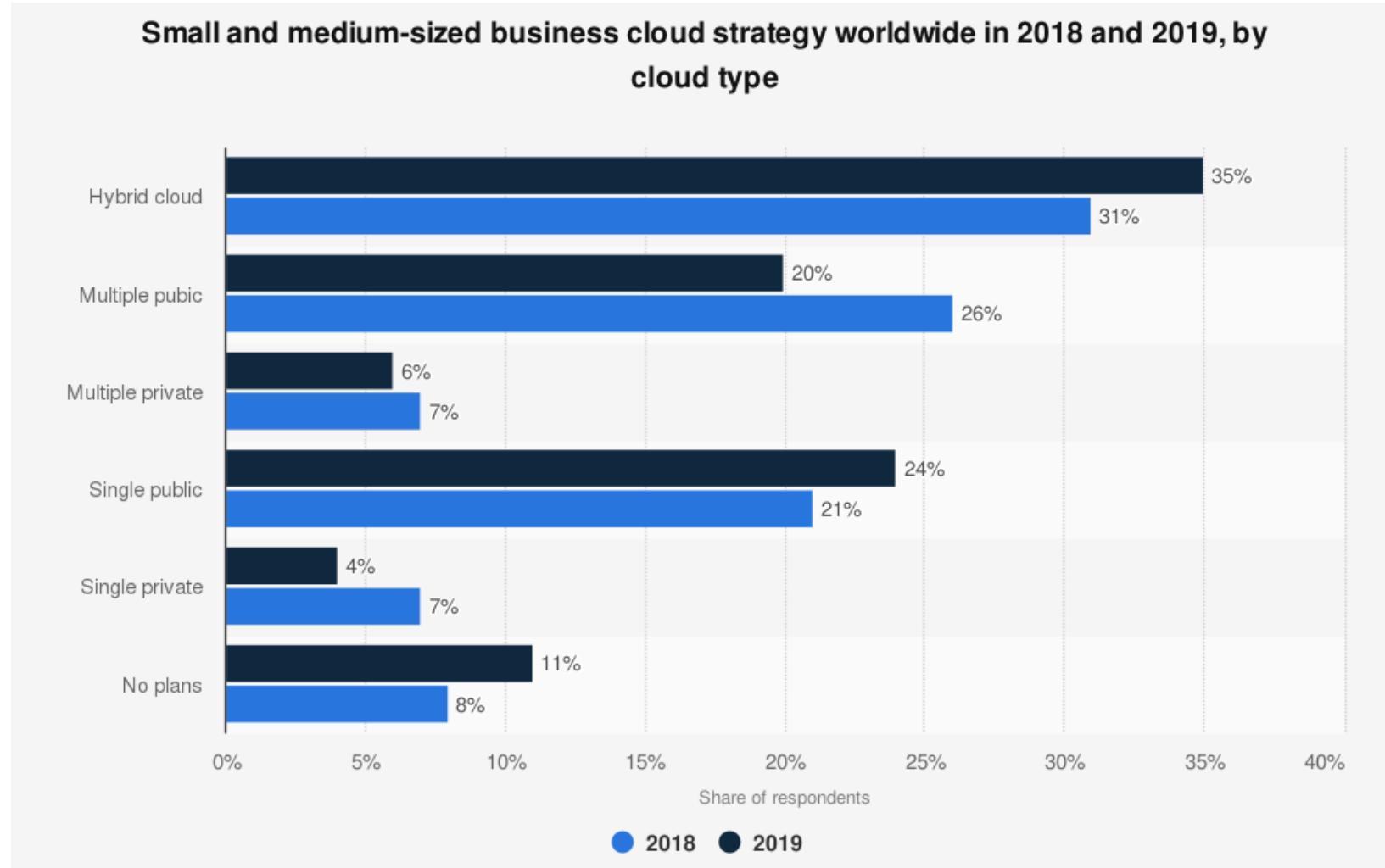


Hybrid Cloud

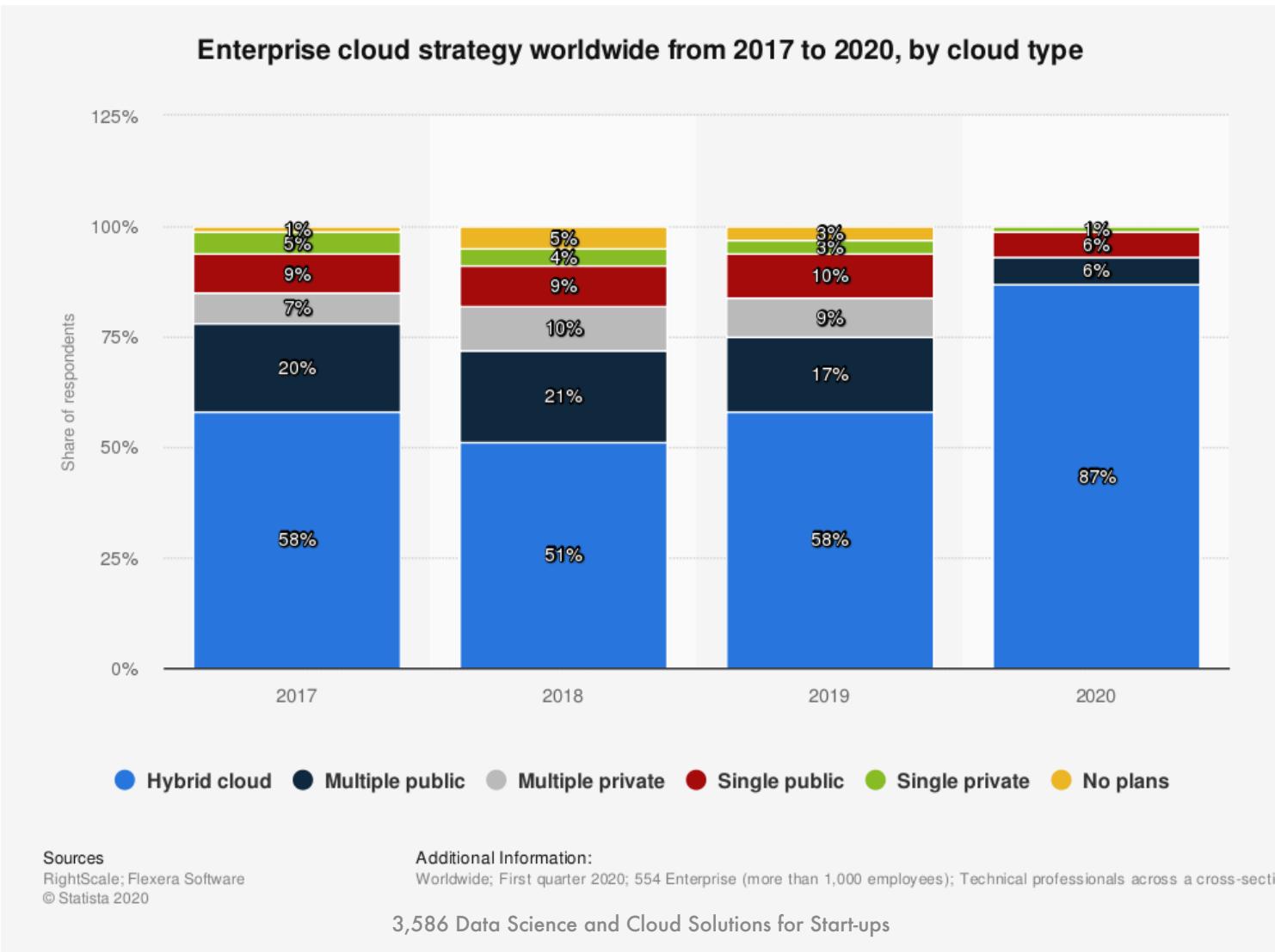
A cloud environment comprised of two or more different cloud deployment models. These architectures can be complicated to create but are growing in popularity as some organisations acknowledge the benefits of the public clouds but at the same time don't trust them with all their data

Examples: Domino's pizza, Marriott Hotels

Most companies aren't 100% cloud yet



The Trend is going towards hybrid cloud





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What kinds of data do companies work with?

Data Sources

- Sales
- Customer data
- Warehouse Stock
- Financial planning
- Research and Development
- App-data
- Application logs
- Internal files and documents
- Reports
- CRM

Data Types

- Text only
- PDFs
- Images
- Videos
- Application code
- Spreadsheets
- Custom application formats

Data in a company is a patchwork of many different sources and formats that often grows historically

How is data used?

Operations

- Stock in individual stores // salesforce
- Stock sales // Salesforce
- Migros Cumulus Customer data // SQL database

Dashboard: How are sales doing this week?

Marketing

- Planned campaigns // Facebook ad manager)
- Advertising metrics // Google Analytics
- Image and video collection // Microsoft OneDrive
- Marketing plan // Excel sheets

App to advertise discounts on over-supplied products

Finance

- Sales targets // Google Sheets
- Financial Models // Excel
- Bank loan contracts // PDFs
- Payroll data // Replicon
- Annual Shareholder report // PDF

Model impact of supply chain disruptions on financial model



Database



Data Lake



Data Warehouse

A quick overview



Database

Logically grouped data, e.g. for a specific application



Data Lake

General agglomeration of all kinds of data – structured and unstructured – and not necessarily with a defined use case



Data Warehouse

Cleaned and filtered data for clear cut use cases.
Best case scenario, but not easy to achieve

Three examples



Database

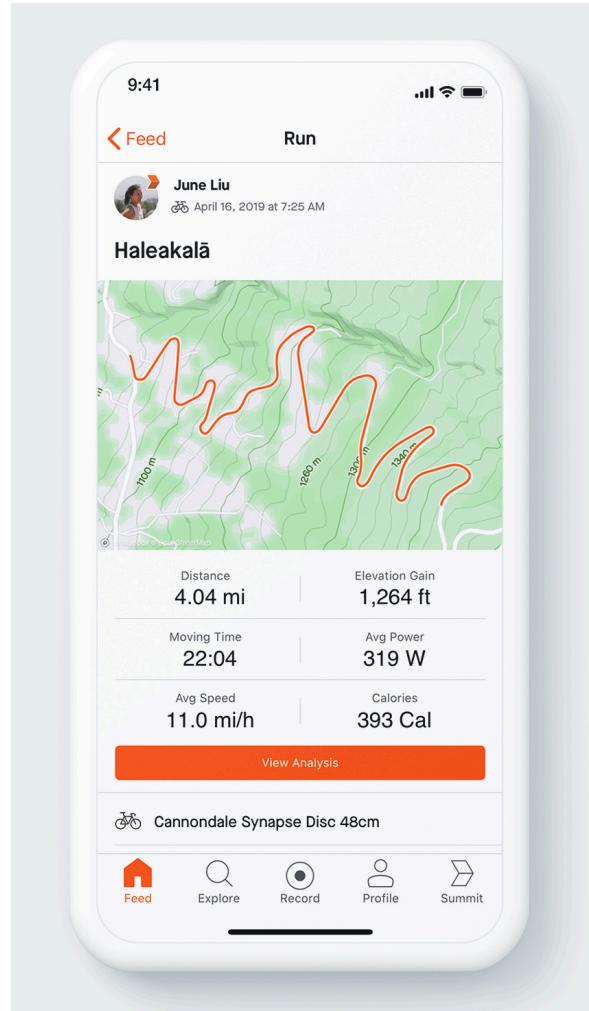
Processed data with app-specific
structure

Application specific and critical data

Data from single or few sources (e.g.
online shop of a cheese producer)

Optimised for quick reading and saving
of data

Used by applications and product
managers



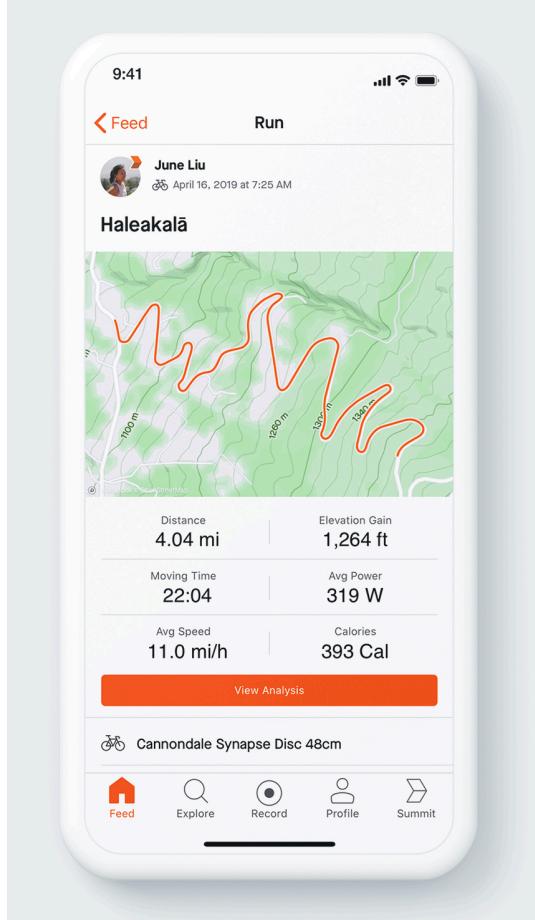
- Single application
- Clear-cut purpose
- Multiple data tables (e.g. users, activities)
- All data relating to specific domain
- Main access to data will be by app itself or product managers

Manageable amounts and diversity of data to keep in single database

One database can contain many tables or objects

user_table	user_id	first_name	last_name	birthdate	email	is_premium_user	...	profile_image_as_bytes	
	11234	John	Doe	30.01.1994	John.doe@gmail.com	TRUE		b'\x01\x02\x03\x04...'	
	57723	Jenny	McGuire	04.05.1981	jguire@outlook.ch	False		b'\x09\x22\x13\x55...'	
activity_table	activity_id	user_id	Activity_date	activity_type	distance_activity	duration	...	gps_start_lat	gps_start_lon
	45678987	11234	20.05.2020	cycle	77.9	4:13		52.533921	13.4152953
	76543456	11234	17.05.2020	run	11.2	1:21		51.283315	51.285522
user_metrics	:								
	user_id	activity_date	activity_time	activity_type	object_id	...	preceded_my_push		
	11234	28.04.2020	175902	viewed_user_profile	654294				

Strava



- Single application
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Database

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Optimised for quick reading and saving of data

Used by applications and product managers

Data Lake

Unstructured data with different formats and sizes

General storage space for data that might be useful soon or some day

Data from many different sources (production plant, marketing department, R&D images)

Optimised for high accessibility and cheap long-term storage

Used by data scientists and special analyses

On Running



The screenshot shows the On Running website homepage. At the top, there is a navigation bar with links for Men, Women, Technology, Stories, and Athletes. Below the navigation is a banner with the text "Free standard shipping and 30 day home try on". The main visual is a photograph of a person's legs and feet wearing dark green running shoes, set against a background of colorful, flowing fabric and fallen leaves. Below the banner, the text "HOME > MEN" is visible. A "Sort by" dropdown menu is located on the right side of the page. The main content area features two shoe models: the "Cloudswift" (black) and the "Cloud 70 | 30" (yellow/green). Each shoe has a "NEW COLOR" badge. The "Cloudswift" is described as "The urban running shoe with ultimate cushioning". The "Cloud 70 | 30" is described as "The latest seasonal addition to the Cloud family. Never Not On performance in statement colorways." Below each shoe, there is a price (CHF 220.00 and CHF 190.00 respectively), a color swatch, and a "Filter" link. On the left side of the page, there is a sidebar with links for Men, All Products, Filter, and Color.

- Young and dynamic company
- Different data sources (marketing, finance, warehouses, orders, design)
- Strategy exists, but many plans and product roadmap bound to change
- Data needs to be stored and made accessible, but use cases not 100% clear

Data should be available for testing but structures aren't clearly defined and resources limited

Data Lake means all data at one place, but not that its tidy

Database

Processed data with app-specific structure

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Cleaned and filtered data for specific use cases

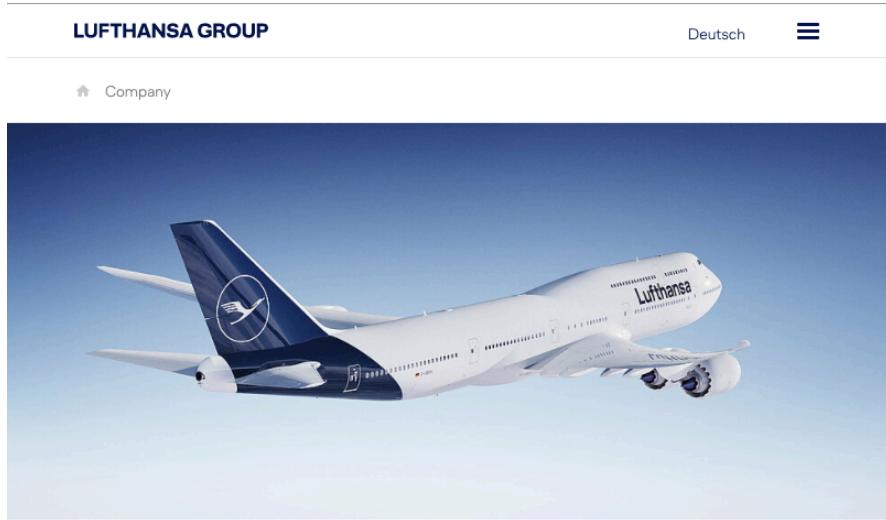
Curated data and descriptive metrics representing ground truth

Data from many sources but is filtered (customer orders, financial reporting, stock availability)

Optimised for Business intelligence and easy usage, even for non-technical users

Used by sales personnel, managers or business analysts

Lufthansa



COMPANY PORTRAIT

The Lufthansa Group is an aviation group with operations worldwide. With 138,353 employees, the Lufthansa Group generated revenue of EUR 36,424m in the financial year 2019. The Lufthansa Group is composed of the segments Network Airlines, Eurowings and Aviation Services. Aviation Services comprises the segments Logistics, MRO, Catering and Additional Businesses and Group Functions. The latter also include Lufthansa AirPlus, Lufthansa Aviation Training and the IT companies. All segments occupy a leading position in their respective markets.

[Company portrait](#)

- Global company with many departments and business units
- Lots of data (flights, bookings, staffing, stocks, procurement)
- Important queries and metrics are clearly defined
- Data must be reliable, up to date and accessible to non-technical users (check-in counter, logistics team, HR)

A structured Data Warehouse creates value and resources for maintenance are available

Overview

Database

Processed data with app-specific structure

Application specific and critical data

Data from single or few sources (e.g. online shop of a cheese producer)

Optimised for quick reading and saving of data

Used by applications and product managers

Data Lake

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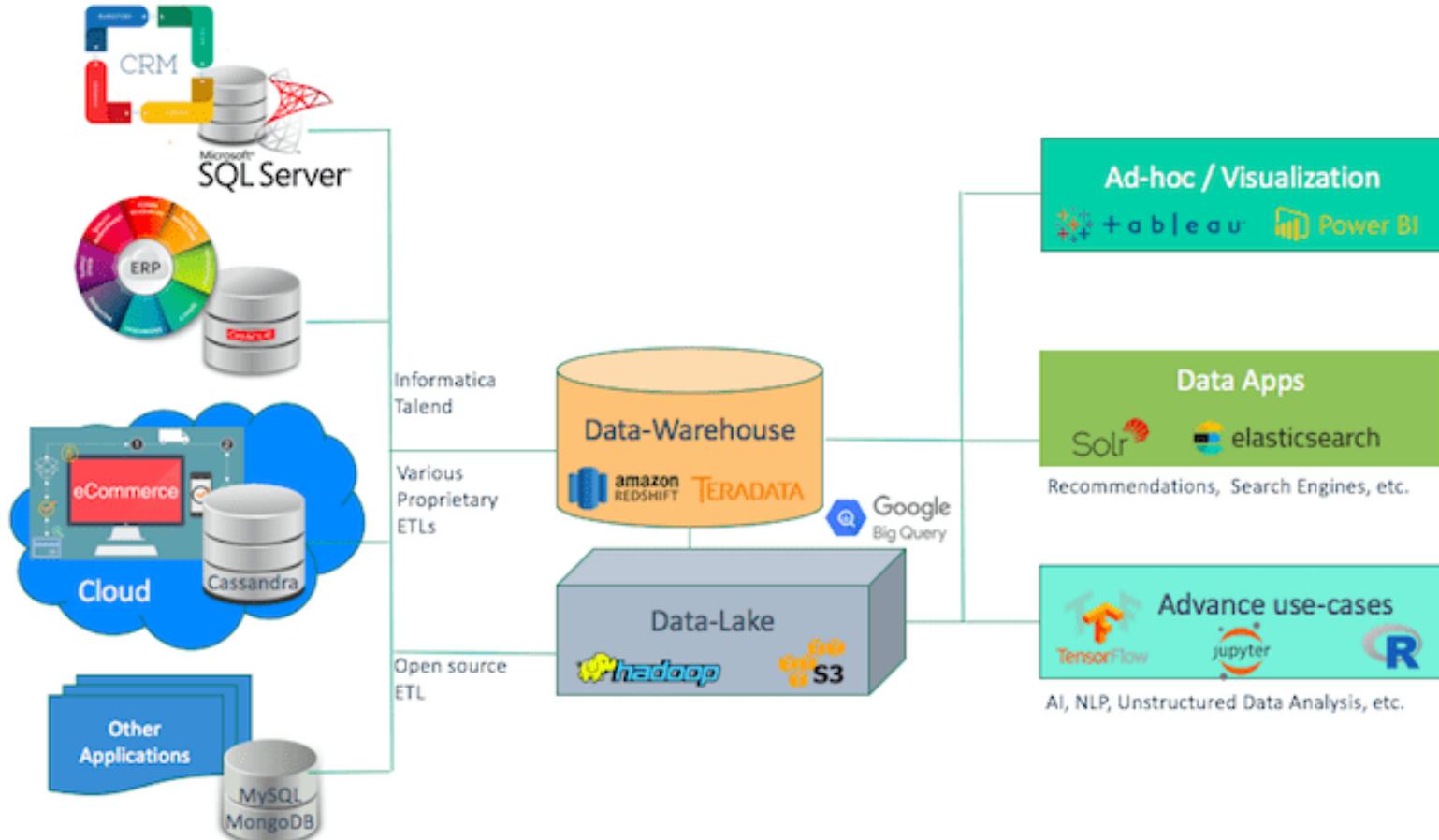
Optimised for Business intelligence and easy usage, even for non-technical users

Used by sales personnel, managers or business analysts

Some general take-aways

- Companies have many different types of data, often in different locations which grow historically
- Planning where your data is coming from and what you want to use it for in the future can save you a lot of time
- Most companies will use a mix out of databases, data lakes and data warehouses. There is no right or wrong, it generally rather depends on how serious a company about handling its data
- Cleaner data is always better, but often there is a trade-off with costs such as time and money expenses

In real life, the most realistic set-up is a mix of all three



Questions to consider

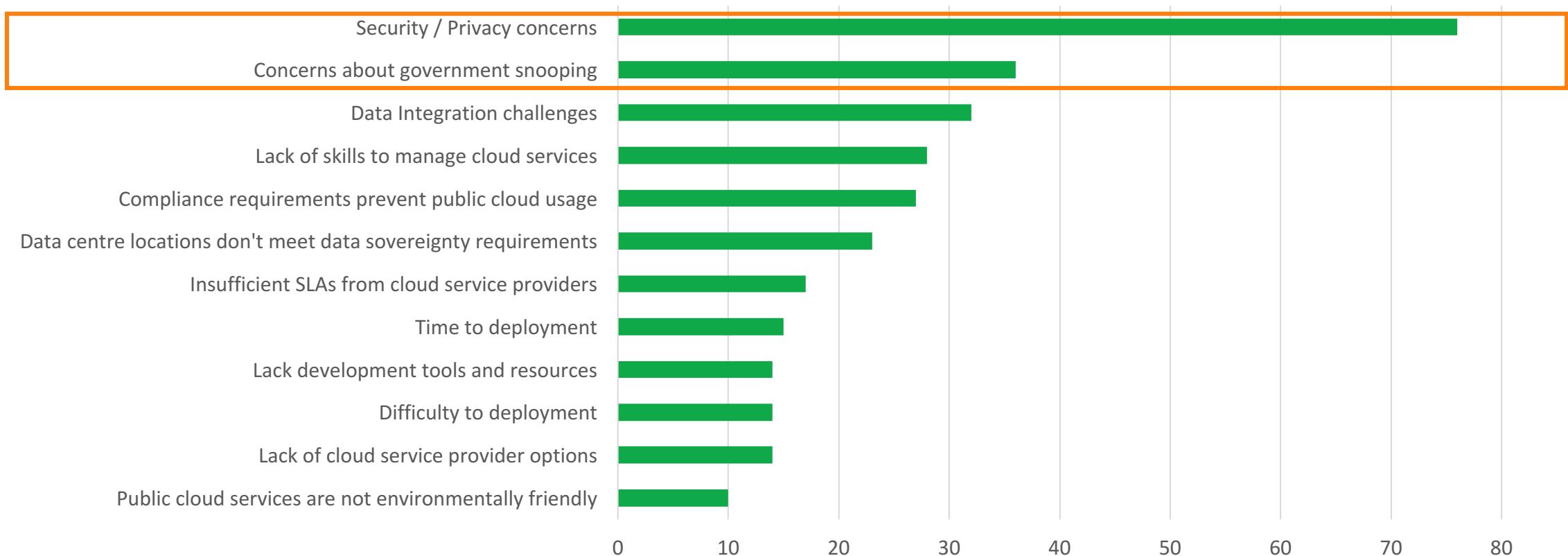
1. What do I want to achieve?
2. Who will be using it?
3. Do I need consistent results?
4. Size: will you be managing a few CSVs or millions of rows?
5. Am I building a proper business intelligence and reporting system on top of this?



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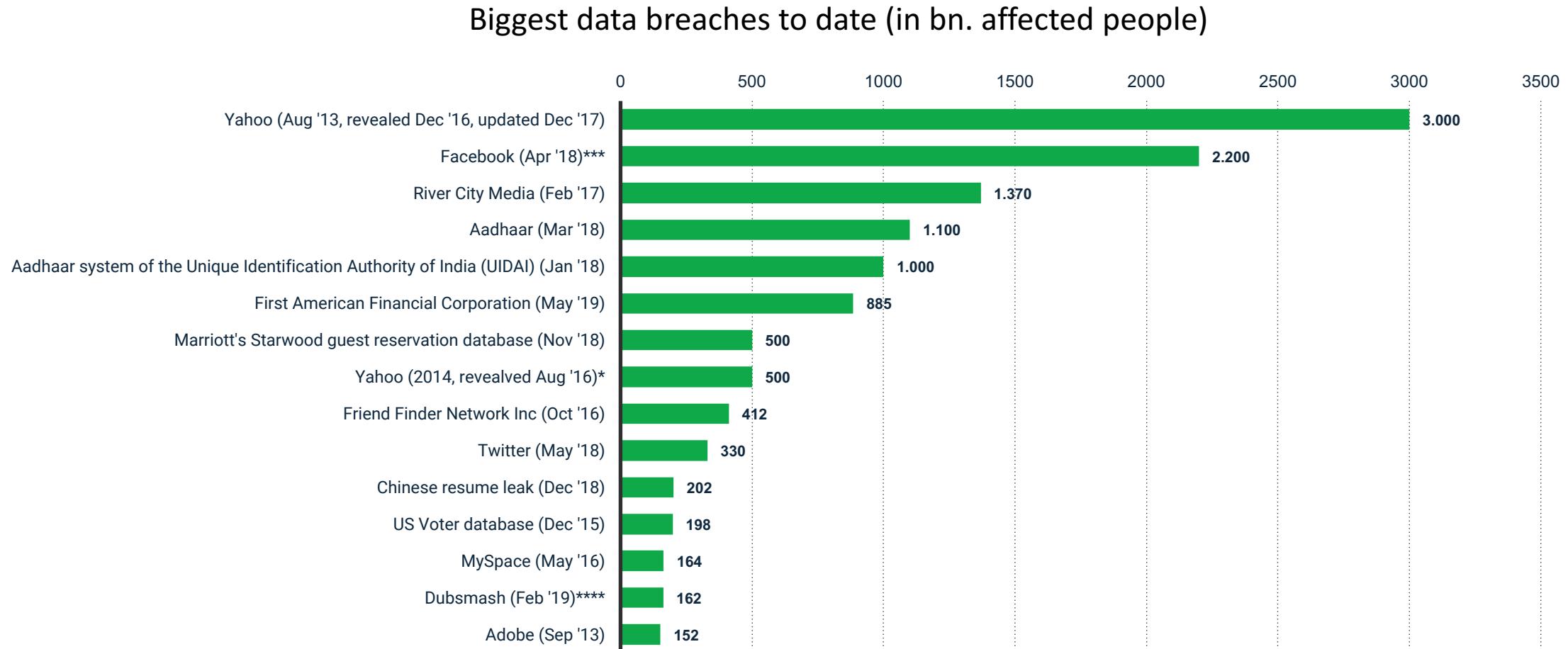
Most companies are still worried about security...

People mentioning factor as inhibitor to cloud adoption



Source: Gartner, Feb. 2015; n=122

...while data breaches are growing in size and frequency



Source: Statista, counting all incidents up to May 2019

What happens when data was 'stolen'?

- When security breaches make headlines its often about 'hackers' in other countries, in reality, however, its often caused by internal mistakes
- Severity of a breach depends on the type of data, not the 'amount'. Social security numbers or medical data is much more dramatic than birthdays and names
- Data breaches are not just an ethical concern, but also a financial and brand risk for companies
- Top three industries under attack: healthcare, financial services and manufacturing
- Examples of human data breaches:
cybersecurity-insiders.com/top-5-cloud-security-related-data-breaches

The New York Times

Equifax to Pay at Least \$650 Million in Largest-Ever Data Breach Settlement



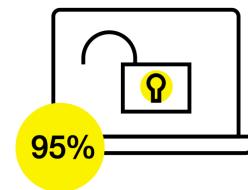
The Equifax offices in Atlanta. One of America's three largest credit bureaus, the company has files on hundreds of millions of people worldwide that contain extensive details about their financial accounts and transactions. Kevin D. Liles for The New York Times

Most common security issues

1. Weak and stolen credentials
2. Application vulnerabilities
3. Malware
4. Malicious Insiders
5. Insider error

60%

Of all attacks are carried out by insiders



Gartner predicts that, through 2020, **95% of cloud security failures** will be the customer's fault.



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Data Analyst / BI Analyst



Responsibilities:

- Create and maintain the logic and processes to support trustworthy and efficient consumption of business data
- Uncover areas of opportunity for the business and translate these into recommendations for other departments. Create a narrative around the data as a whole
- Analyse data in a prepared source (e.g. a database or SQL) and generate business specific insights from it. E.g. product line A has been unsuccessful in the months x and y

Typical skills:

- Basic programming in a data related language (e.g. R or Python) and basic statistics
- Understanding of data processes: you have to understand what the more technical people are working on or understand what might be the root of a problem in the data when you find it
- Domain knowledge of the business
- Strong communication skills: Often an analyst will have to present or explain his/her results to someone who was far less experience. Content must thus be explained in a simple manner and the “so whats” have to be made clear

Data Scientist



Responsibilities:

- Design experiments, test hypotheses and build models to conduct analyses and uncover ‘hidden’ patterns.
- Trying to automate the question-answer of: “what will happen in the future based on our knowledge of the past”
- Process ‘dirty’ data into cleaner formats (Extract Transform Load: ETL)
- Model and frame business scenarios that will have an impact on the operative business, make recommendations on how discovered data patterns can translate into a business advantage

Typical skills:

- Advanced programming skills data languages (e.g. R or Python) and advanced statistics
- Data understanding in the organisation: knows how data is collected and how to gather/access new data
- Understanding of business processes and workflows

Data Engineer



Responsibilities:

- Builds the data infrastructure of a company at a raw level: where is the data coming from, how is it collected, how does it have to be transformed so that it makes sense. Ensures that the data made available is clean, reliable and prepped for whatever it might be used for
- Transforms small models that a data science builds into a large scale application that is capable to work at scale and is fault tolerant
- Builds a data warehouse or data lake. Efficiency is key here: an engineer is not just responsible about making sure *that* processes work, but also that they work very fast to make sure that speed is not a bottleneck.

Typical skills:

- Programming skills in data and database related languages (e.g. Python, R, SQL) but especially on server or engineering related languages (e.g. Go, Node.js), possibly also big data languages like Hadoop, Spark
- Understanding of the different data tools and what their pros and cons are (e.g. trade-offs between different database types). Understanding of system level architecture: what is required to scale up or down and how systems interact
- Because more knowledge is required on an architecture and system level, less is required in terms of stats or communication



- 01 Introduction
- 02 What makes the cloud interesting?
- 03 The cloud market
- 04 Setting up a server on GCP
- 05 Core functions and architectures
- 06 Cloud delivery and deployment models
- 07 Databases, Lakes and Warehouses
- 08 A word on security
- 09 Data roles and teams
- 10 Development environment setup

Four things to do

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3,586 Data Science and Cloud Solutions for Start-ups

Prof. Johannes Binswanger & Dominique Paul

