

CSE 124: OVERVIEW AND INTRODUCTION

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ATTRIBUTION

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WELCOME!



CSE 124: NETWORKED SYSTEMS

- Add networking support to software
 - Between two computers
 - Between computer and datacenter (“The Cloud”)
- Develop software that is:
 - Scalable (handles 100s of M to 1+ billion users)
 - Fault-tolerant (survives failures)
 - Evolvable (how to update services without making them unavailable to end users)

CSE 123 VS. 124

- 123: Networking
 - Theory of how the Internet works
 - Routing protocols, congestion control theory, switching and forwarding
 - “Up to layer 4”
 - “How do I get a byte of data from point A to point B reliably?”
- 124: Networked services
 - How to add networking support to your software
 - Sockets programming, RPC, DNS, protocol design and implementation, replication, scale-out design...
 - “Layer 7”
 - “How can my program access and store data in the cloud? How can I invoke 3rd party network-connected APIs from my app? How can I build a multiplayer video game? ”

MODERN SOFTWARE INCREASINGLY NETWORKED



Endhost / Front-end
(phone, laptop, game console,
electric vehicle, ...)

NETWORKED SERVICES DRIVEN BY DATA

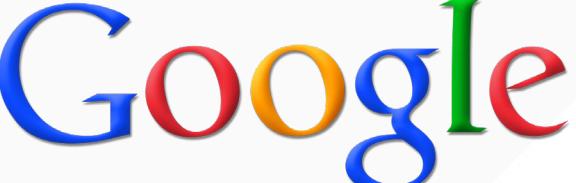
0 1 0 1 0 1 0 0 0 1 1 1
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+  = Product Recommendations

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+  Spotify® = Custom Stations

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+  = Personalized Search

DATA-DRIVEN, PER-USER CUSTOMIZATION + ML

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+ **amazon.com®** = Product Recommendations

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App 3

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App ...

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App 1

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App 2

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App ...



MAJOR THEMES OF THE COURSE

- Programming abstractions for communicating over the Internet through various network protocols
- Naming and indexing to find services and connect clients with servers (or clients with other clients)
- Managing scale; scale-out design
- Replicating and updating “mutable” data over the network
- Replicating and caching “immutable” data over the network (think Netflix, Disney+, Youtube, etc)
- Accessing and managing networked storage
- Managing fault tolerance

HOW CAN YOU WRITE SOFTWARE THAT WORKS DESPITE ADVANCEMENTS IN UNDERLYING TECHNOLOGY?

Paired discussion:

What was the first computer/smartphone/tablet/etc you regularly used?
What is the most recent computer/smartphone/tablet/etc you regularly use?
In terms of how that device connects to the network, how are they different?

2 minutes of discussion then some reporting back!

**THINK ABOUT HOW ONLINE NETWORK SERVICES
HAVE CHANGED OVER THE PAST 20-ish YEARS...**

GOOGLE (1998)

The screenshot shows the original Google homepage from 1998. At the top is the iconic "Google!" logo in its signature multi-colored, slightly shadowed font, with the word "BETA" in smaller capital letters below it. Below the logo is a search bar with the placeholder text "Search the web using Google!". Underneath the search bar are two buttons: "Google Search" and "I'm feeling lucky". The main body of the page is divided into three teal-colored sections. The left section contains links for "Special Searches", "Stanford Search", and "Linux Search". The middle section contains links for "Help!", "About Google!", "Company Info", and "Google! Logos". The right section has a "Get Google! updates monthly:" heading, a text input field for "your e-mail", and two buttons: "Subscribe" and "Archive". At the bottom center of the page is the copyright notice "Copyright ©1998 Google Inc."

Search the web using Google!

Google Search I'm feeling lucky

Special Searches
[Stanford Search](#)
[Linux Search](#)

Help!
[About Google!](#)
[Company Info](#)
[Google! Logos](#)

Get Google! updates monthly:
your e-mail
Subscribe Archive

Copyright ©1998 Google Inc.

NETFLIX (2002)

Try Netflix for **FREE** Today!

Rent all the DVD movies you want.
For 20 bucks a month. No late fees.

World's Largest Selection

FREE & FAST HOME DELIVERY

NO LATE FEES

Free Shipping!

Super Selection!
Create a list online of all the movies you want to see

Free & Fast Home Delivery
The movies you select arrive via first-class mail in 2-4 days.

No Due Dates or Late Fees
Keep each DVD as long as you want. Have up to 3 movies on hand.

Free Shipping!
Return one DVD in its prepaid envelope and get another DVD from your list.

\$19.95 PER MONTH

One Flat Fee!

It's just 20 bucks a month. There are no late fees, no hidden charges, no commitments. If you have any questions, call 1-888-638-3549.

TWITTER (2007)

Find folks to follow! search or [Login / Join Twitter!](#)

A global community of friends and strangers answering one simple question: **What are you doing?** Answer on your phone, IM, or right here on the web!

[explore twitter](#)

Look at what [these people](#) are doing right now...

 **claudiof** @ruimoura: a minha pergunta nao era pa ter a certeza, basta fazeres whols e ves que sim, era mais... "é isto? consolas?" [less than 5 seconds ago](#) from im [in reply to ruimoura](#)

 **mseling** I've started the bad habit of forgetting to eat breakfast and lunch. No wonder i'm always tired. [less than 5 seconds ago](#) from txt

 **cbsiskin** @sharongs It's on its way via email. Not online so can't send a link.. [less than 5 seconds ago](#) from web [in reply to sharongs](#)

 **groovesalad** Mushroom Nation - Helsinki (Pancake Mix) [less than 5 seconds ago](#) from web

 **2525** weer thuis [less than 5 seconds ago](#) from [twitterific](#)

 **erockenjew** Billions of dollars spent on dirty contractors in iraq: <http://tinyurl.com/ywkt3c>, but 35 billion over 5 years for poor children is soci ... [less than 5 seconds ago](#) from [twitterific](#)

 **Becks6735** mein bruder isch jetzt au bei twitter....sein nickname isch Jesusfan!! Bis dennes ihr hennes!! [less than 10 seconds ago](#) from web

 **Levoix** End of my blog : <http://levoix.canalblog.com> [less than 10 seconds ago](#) from web

 **rauski** El diseño gráfico es la peor de las parejas y la mejor de las amantes, así pasa... ¿Porqué siempre nos gustan las cabronas? jajaja [less than 10 seconds ago](#) from web

Please Sign In!

Username or Email

Password

Remember me [Forgot?](#)

[Sign In!](#)

Already using Twitter with your Mobile or IM?
[Activate »](#)

Want an account?
[Join for Free!](#)

It's fast and easy!

Featured!

 [FreeBurma](#)

 [Amie Street](#)

 [WIREDScience](#)

 [New Media Expo](#)

 [New York Times](#)

 [MTV VMAs](#)

 [MacRumors Notify](#)

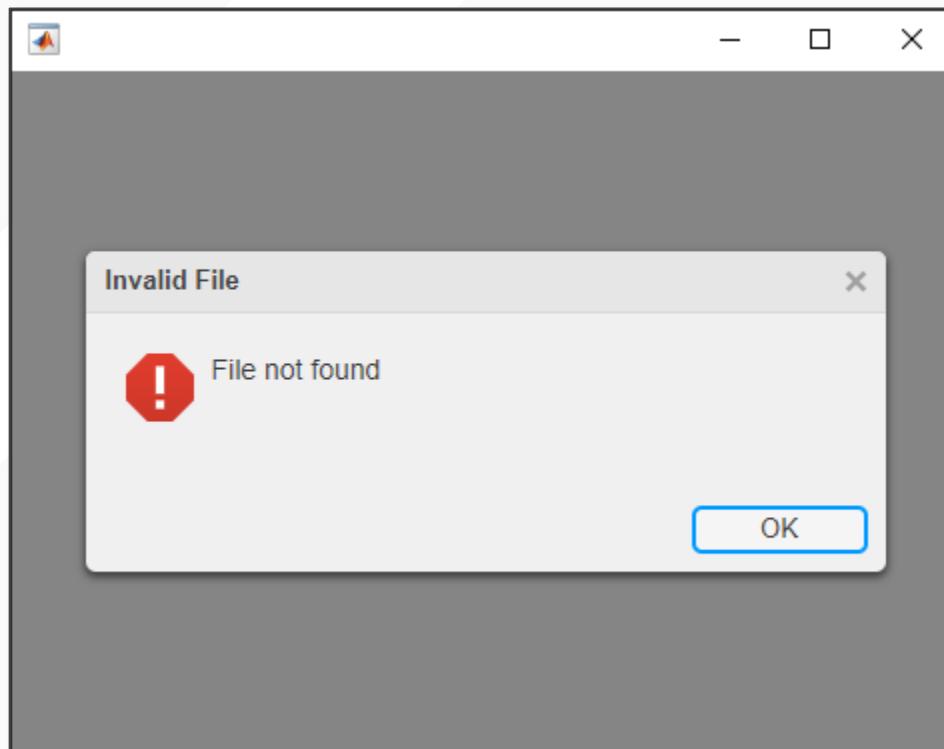
 [Lincoln@APEC2007](#)

 [Chuck Bartowski](#)

 [Alife](#)

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YOUTUBE (2004)



YOUTUBE (2005)

Home | My Videos | My Favorites | My Messages | My Profile

Sign Up | Log In | Help

YouTube

Your Digital Video Repository

Search Videos

[Upload Your Videos](#)

nansheng : azlan : werelband : ny : superbike : japan : sinceretheory
: jozef : party : amazon : board : skate : buckley : shubs : falls : de :
stockshot : cubbyhole : burnout : satellite : coughkeepie : cruise : heritage
: orgel : chin : themed : mill : music : new : live : to : farmer : mtv :
puenbrouck : sicily : fairfield : musical : coffeehouse : bud :
2005 : trip : jk : woordjes : death : xlanz : skill : olle : nature : ads :
dance :

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[Denny's](#)
Added: June 14, 2005 by [jryley](#)
Views: 86 | Comments: 1

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Added: May 3, 2005 by [javed](#)
Views: 82 | Comments: 0

[Father's Day Special](#)
Added: June 19, 2005 by [ATrain](#)
Views: 46 | Comments: 0

[Jingle en Joe](#)
Added: June 21, 2005 by [Lena](#)
Views: 27 | Comments: 0

[River Otter in Central Park Zoo](#)
Added: June 28, 2005 by [TH](#)
Views: 6 | Comments: 0

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FACEBOOK (2004)

The screenshot shows the homepage of Thefacebook.com from 2004. At the top right, there's a blue header bar with the site's name "[thefacebook]" in white, and "login register about" links. A small portrait of a person is visible above the login form. The main content area has a white background. On the left, there's a login form with fields for "Email:" and "Password:", and "register" and "login" buttons. To the right of the form, the text "Welcome to Thefacebook!" is displayed. Below it, a large bold heading says "[Welcome to Thefacebook]". A descriptive paragraph follows: "Thefacebook is an online directory that connects people through social networks at colleges." It then states, "We have opened up Thefacebook for popular consumption at **Harvard University**." A list of features is provided: "You can use Thefacebook to:" followed by a bulleted list: "• Search for people at your school", "• Find out who are in your classes", "• Look up your friends' friends", and "• See a visualization of your social network". Below this, another call to action reads: "To get started, click below to register. If you have already registered, you can log in." At the bottom right, there are two blue "Register" and "Login" buttons. At the very bottom center, there's a footer with links: "about contact faq terms privacy", followed by "a Mark Zuckerberg production" and "Thefacebook © 2004".

SURVEY

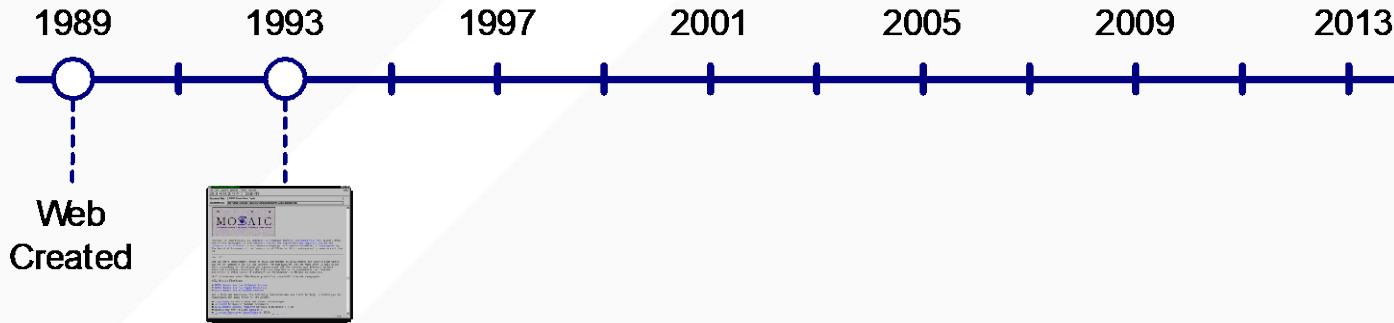
- When was the web protocol created? When was the first graphical web browser released?
 1. 1968 / 1972
 2. 1974 / 1976
 3. 1989 / 1993
 4. 2001 / 2002

THE DEPLOYMENT OF “THE WEB”

RISE OF THE WEB



RISE OF THE WEB

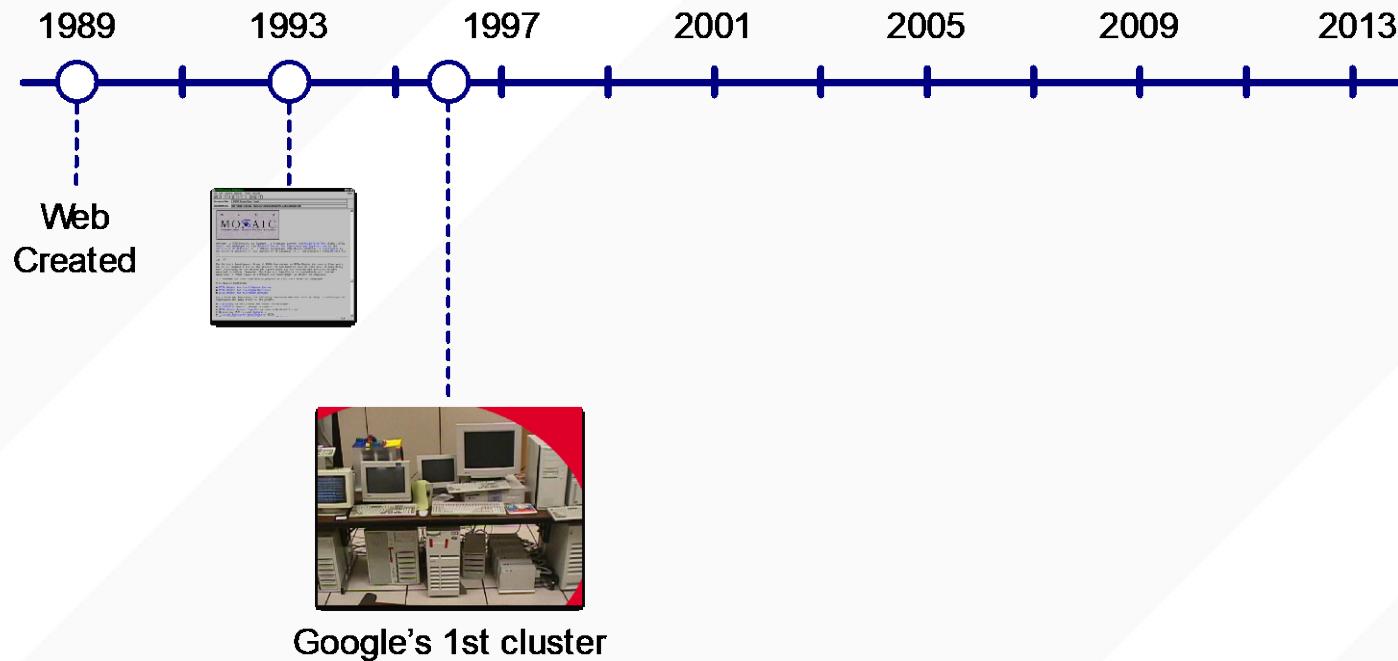


WHERE DO NETWORK SERVICES EXECUTE?

THE FIRST WEB SERVER (NEXT WORKSTATION, 1991)



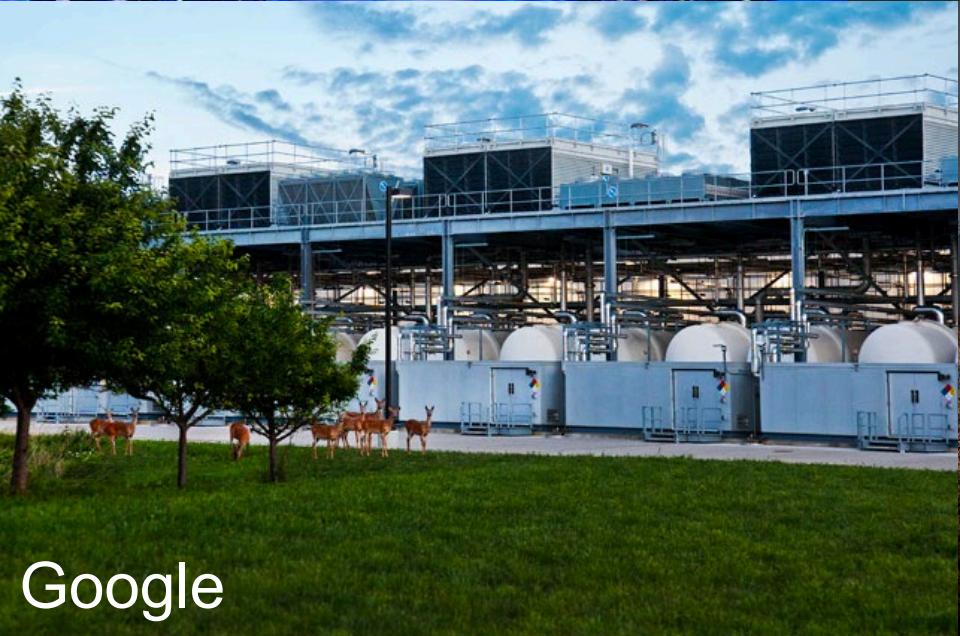
THE RISE OF THE “DATACENTER” (AKA CLOUD COMPUTING)



DATACENTERS: THE HOME OF ALL THIS COMPUTING AND STORAGE



Microsoft



Google



Facebook

Google 2012





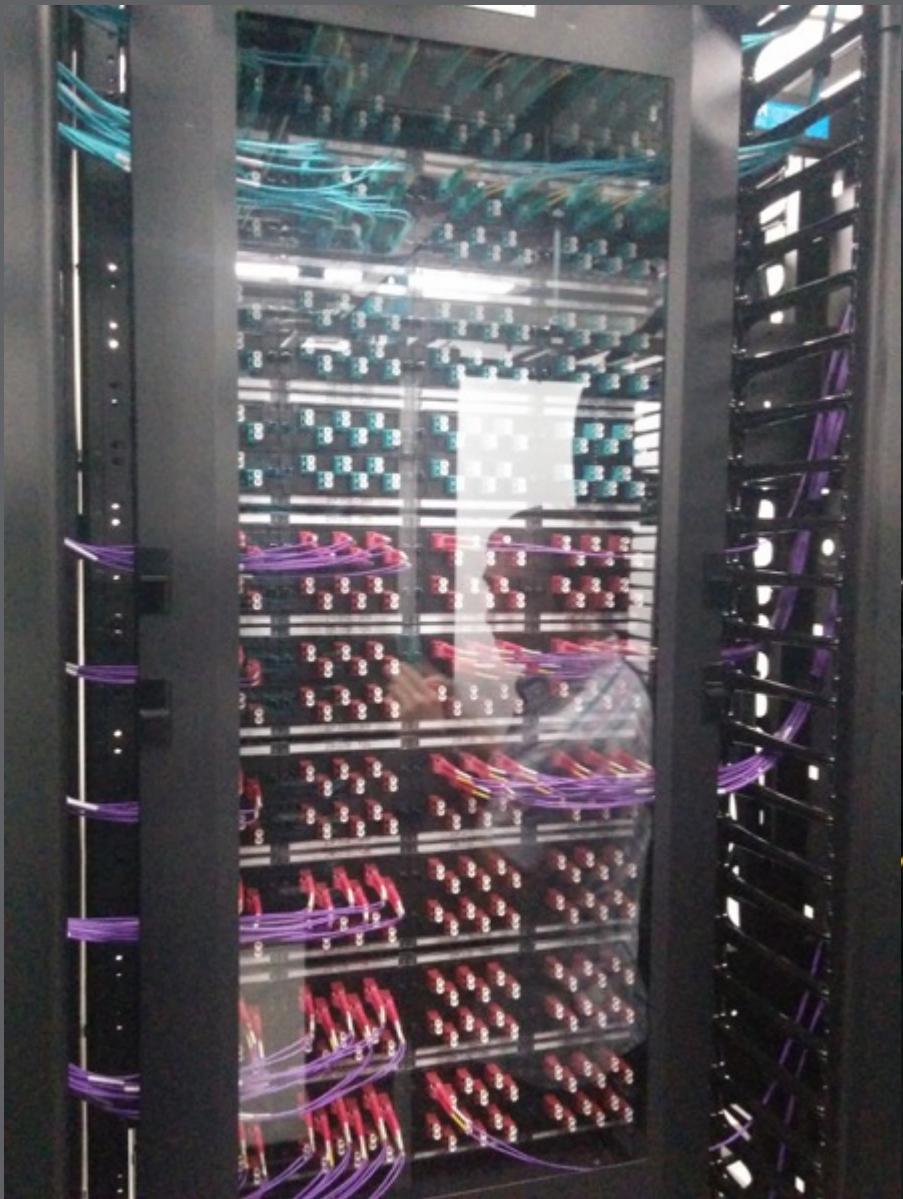
Microsoft

Google

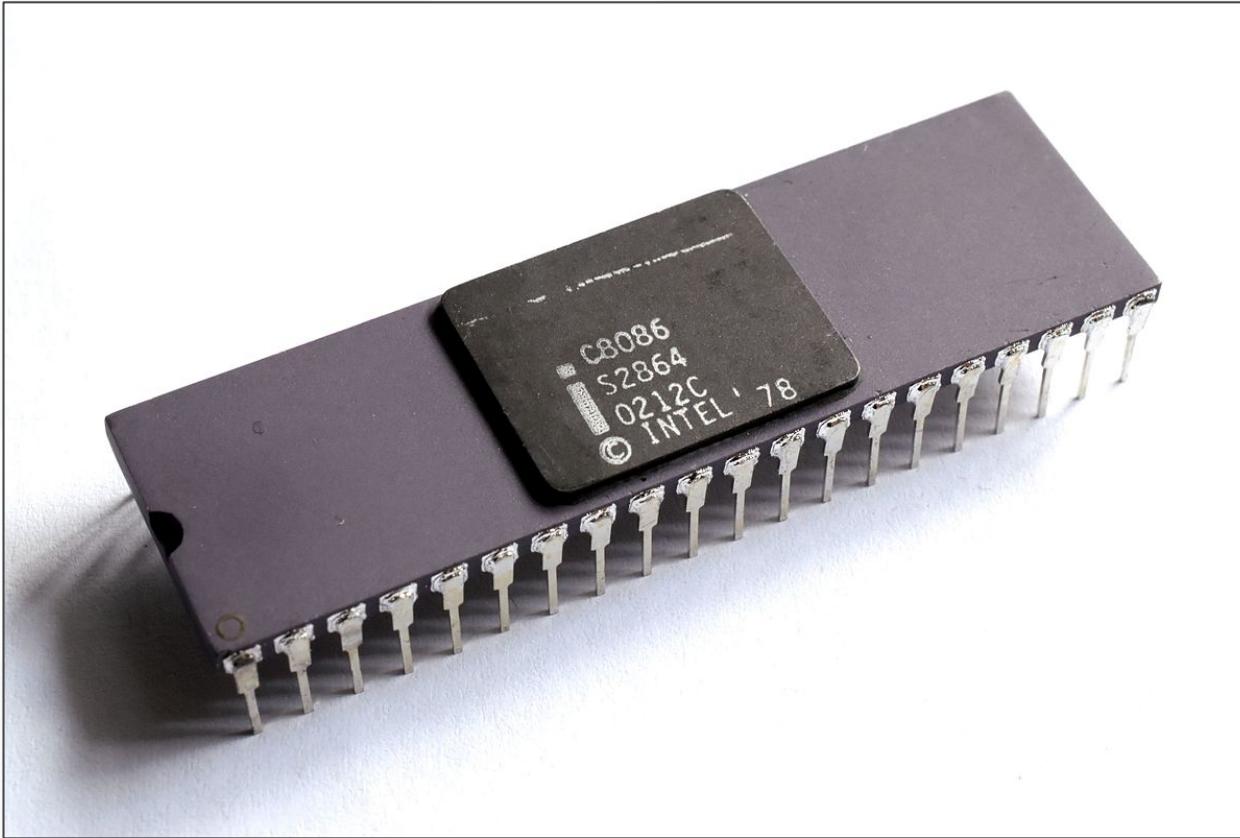




Facebook



HARDWARE HAS EVOLVED AS WELL. STARTING WITH CPUS...



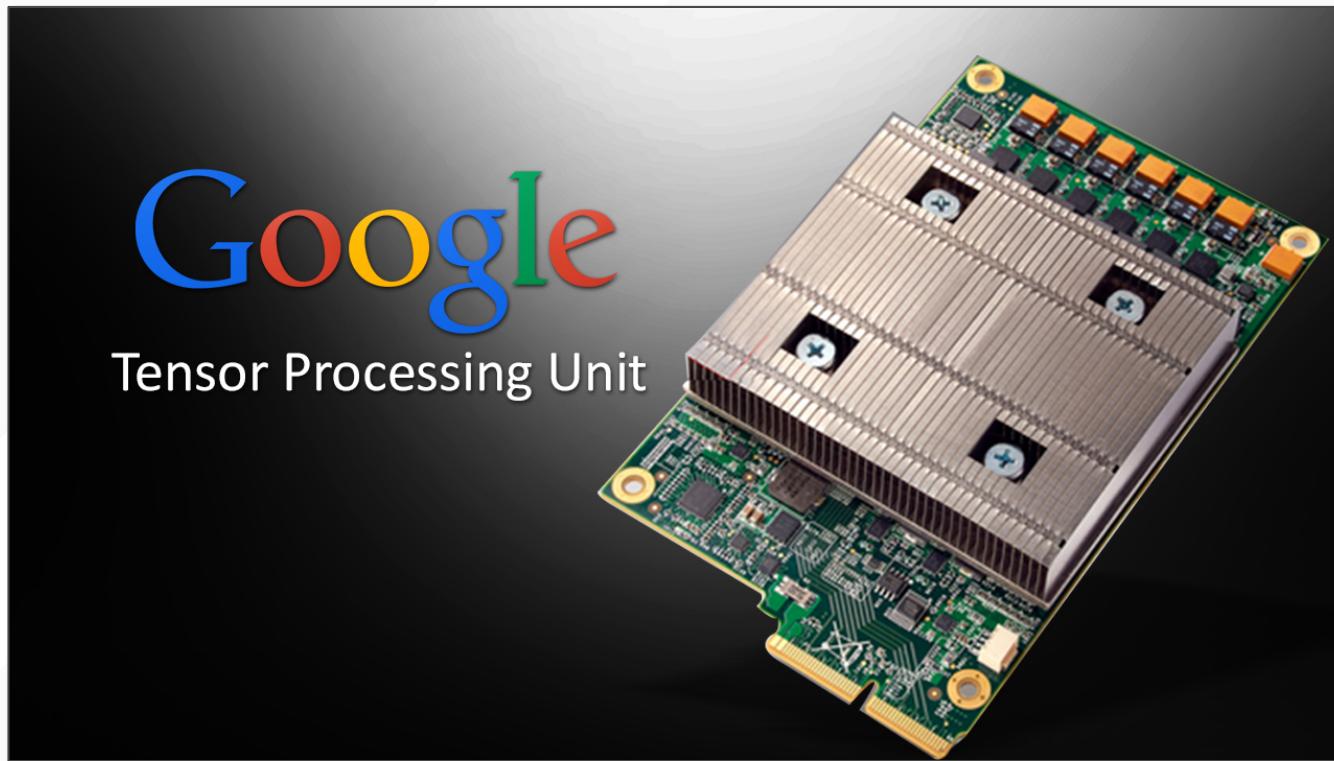
TO GPUS...



TO PROGRAMMABLE FPGAS...



TO CUSTOM DESIGNED CHIPS



CHUSTOM VIDEO TRANSCODING CHIP

ars TECHNICA

BIZ & IT TECH SCIENCE POLICY CARS GAMING & CULTURE STORE

I WONDER IF NETFLIX WANTS TO BUY SOME —

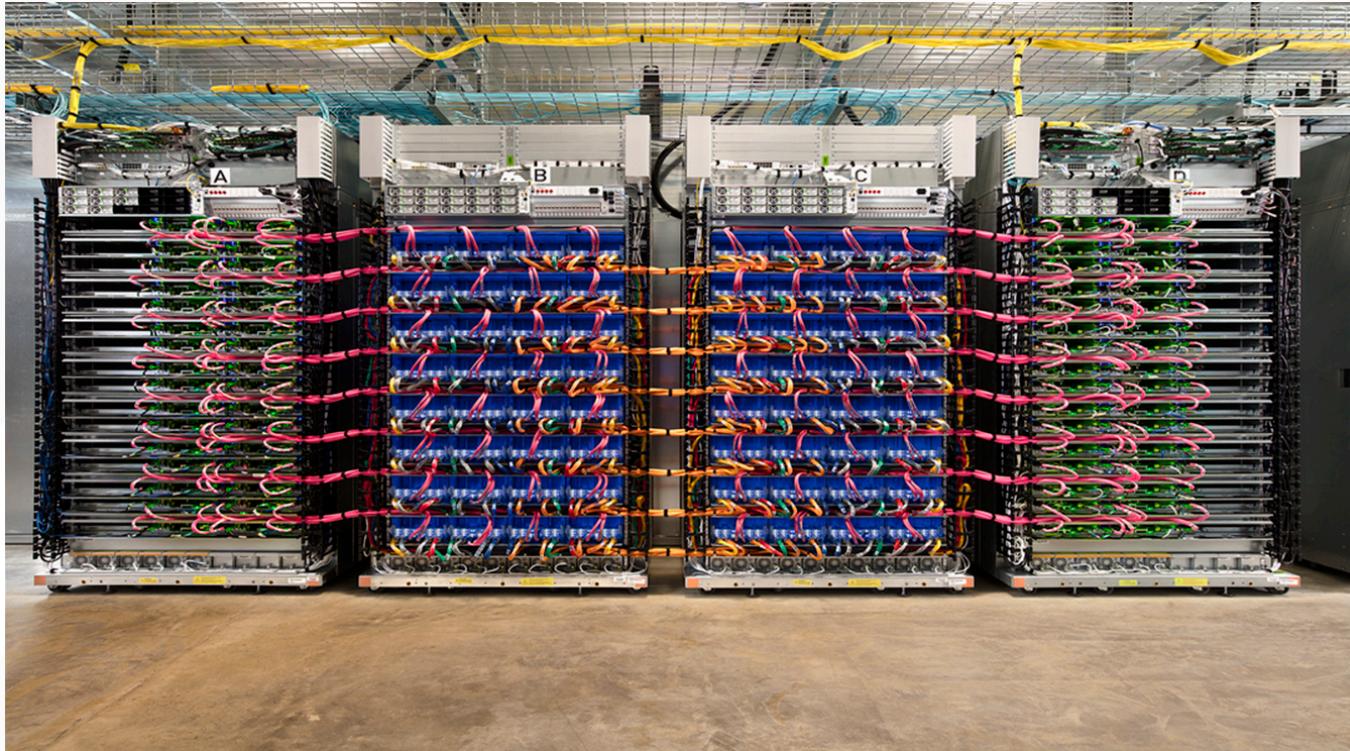
YouTube is now building its own video-transcoding chips

Google throws custom silicon at YouTube's massive video-transcoding workload.

RON AMADEO - 4/22/2021, 11:24 AM

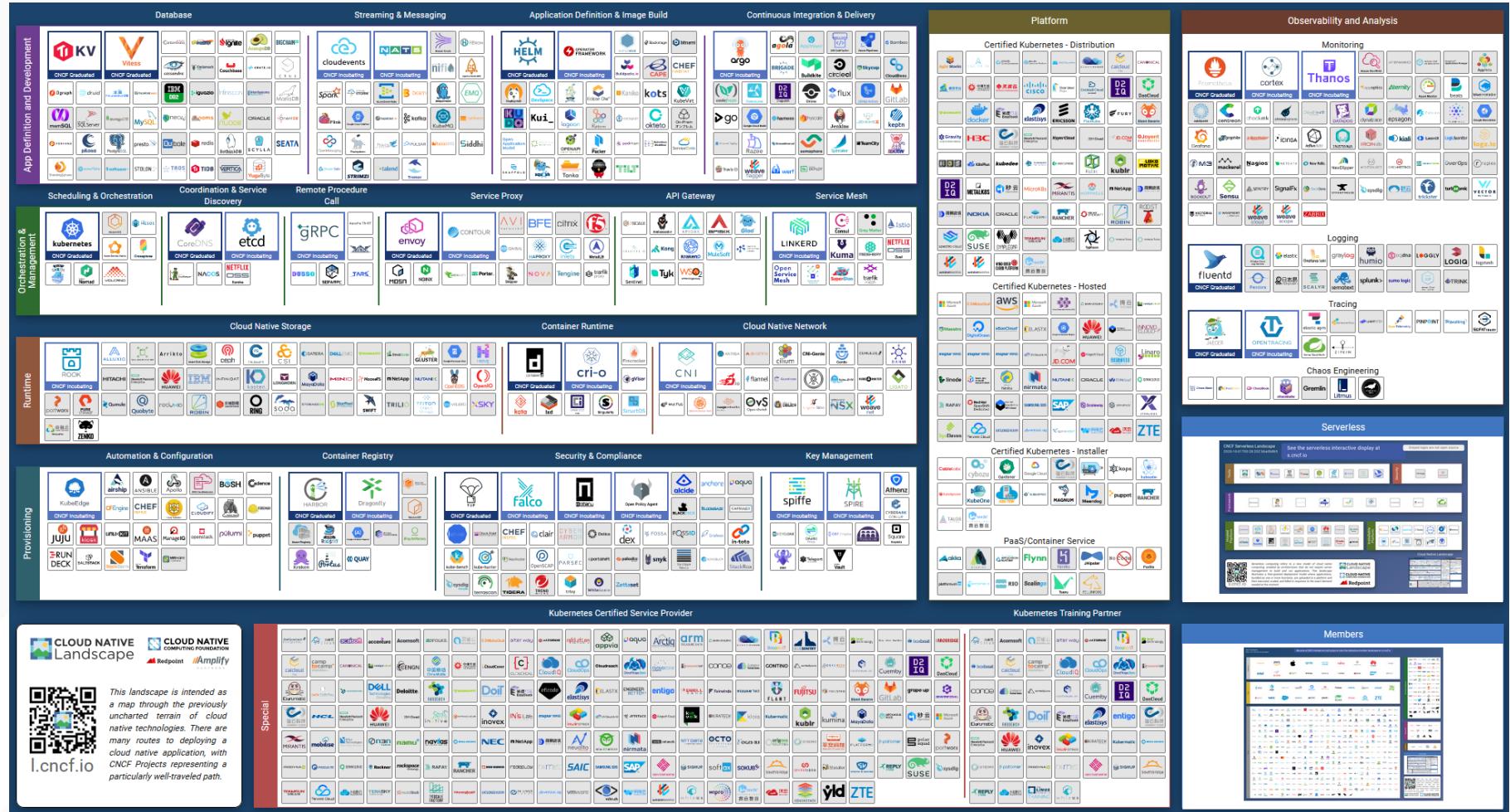


CLUSTERS OF CUSTOM ASICS FOR AI/MACHINE LEARNING



Source: google.com

FULL CLOUD NATIVE LANDSCAPE



CLOUD NATIVE LANDSCAPE IN A 10-WEEK QUARTER



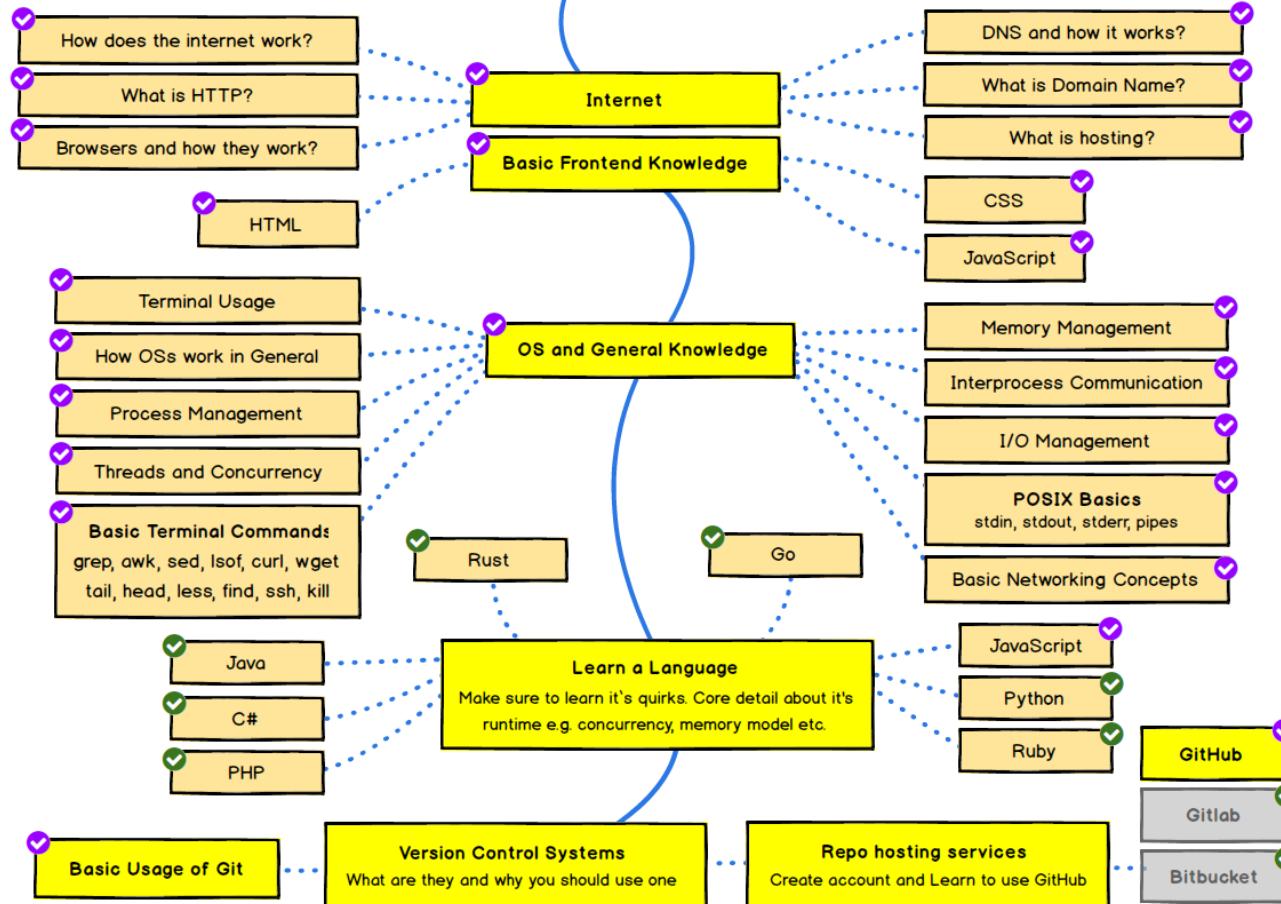
BACKEND DEVELOPMENT ROADMAP

- ✓ Personal Recommendation / Opinion
- ✓ Alternative Option - Pick this or purple
- ✓ Order in roadmap not strict (Learn anytime)
- I wouldn't recommend

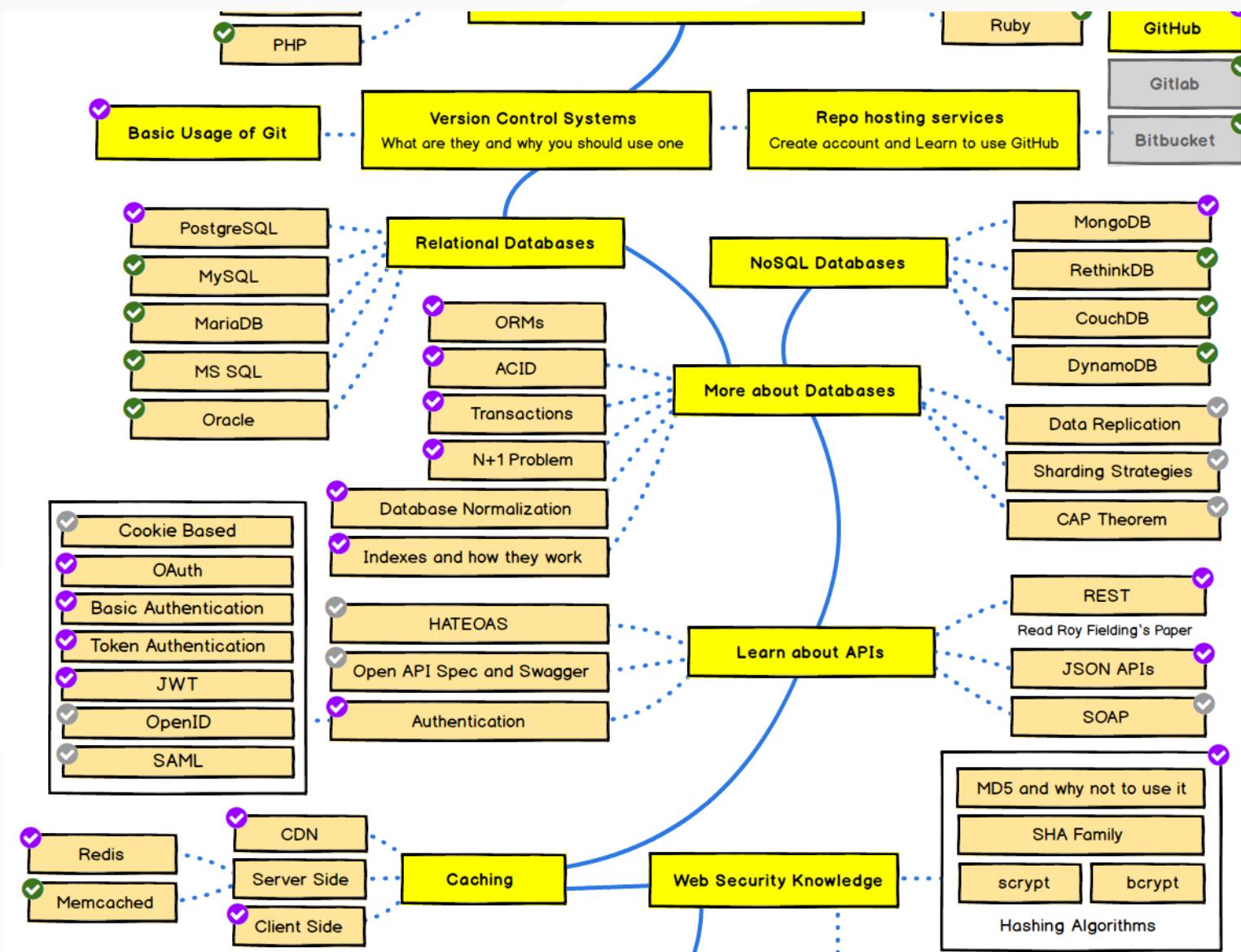
Find the detailed version of this roadmap along with resources and other roadmaps

<http://roadmap.sh>

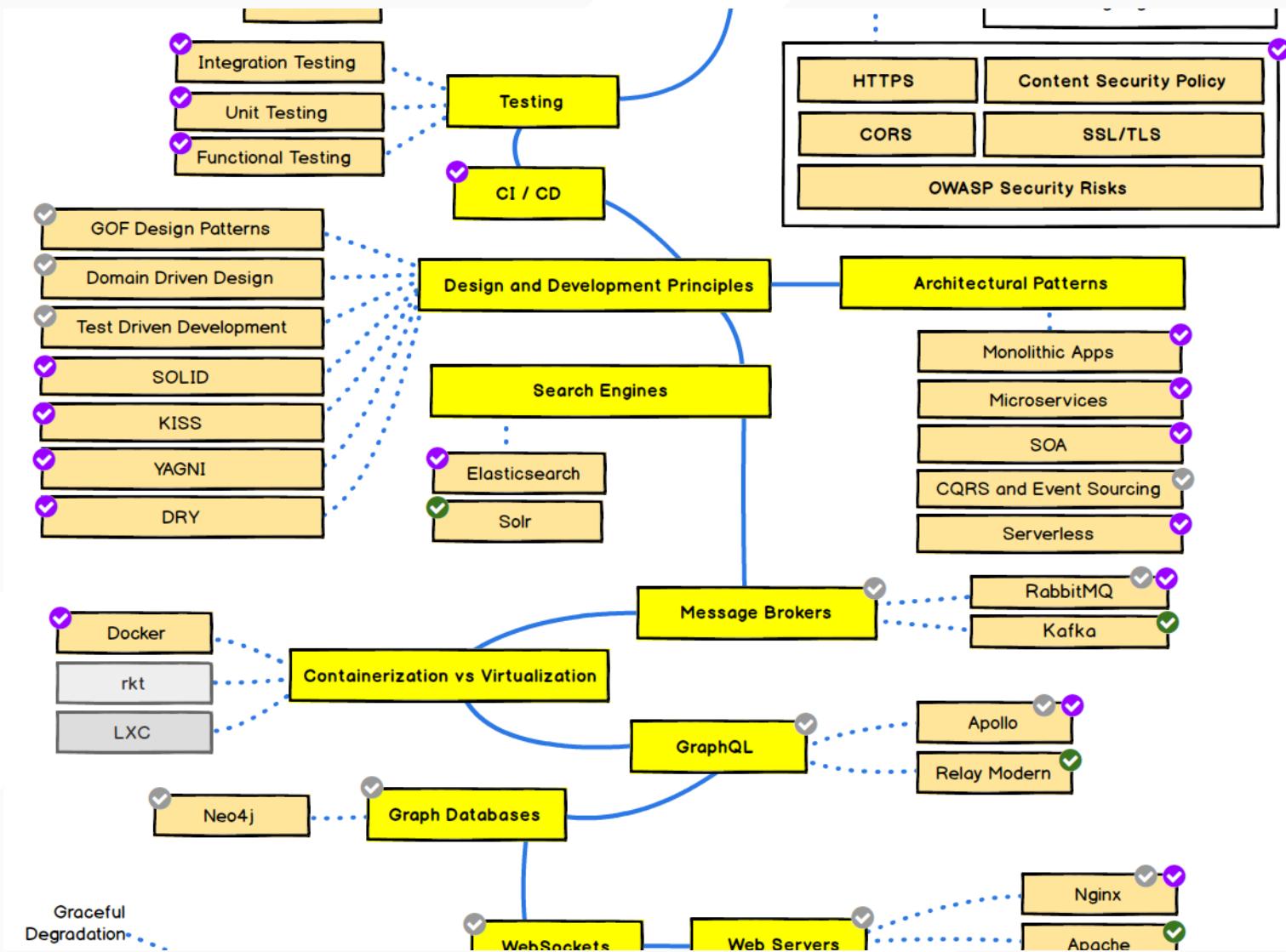
Backend



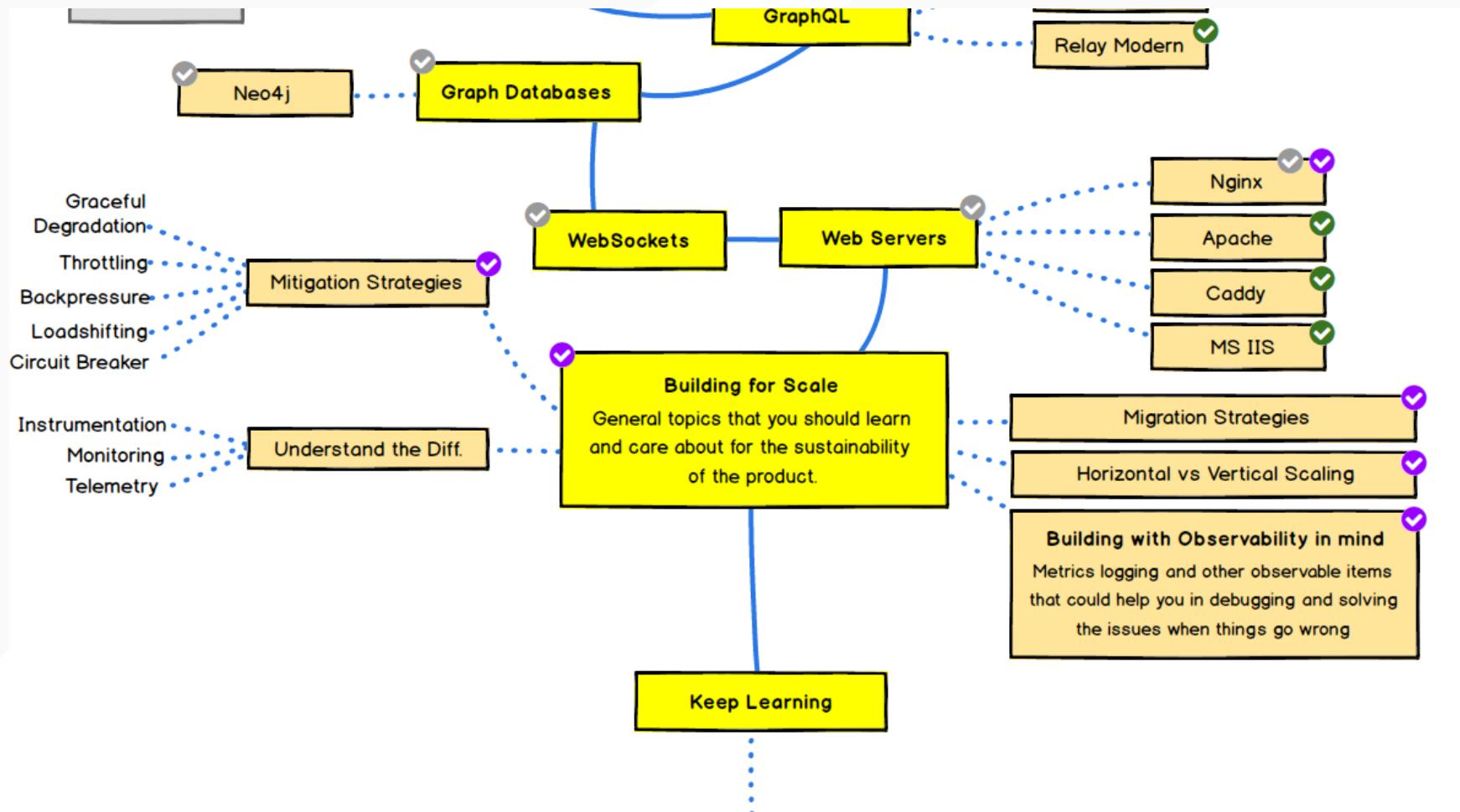
BACKEND DEVELOPMENT ROADMAP



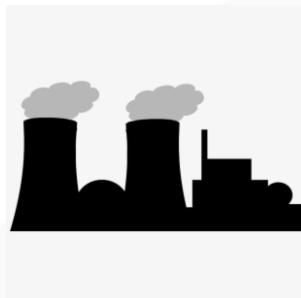
BACKEND DEVELOPMENT ROADMAP



BACKEND DEVELOPMENT ROADMAP



THE ENVIRONMENTAL IMPACT OF CLOUD COMPUTING



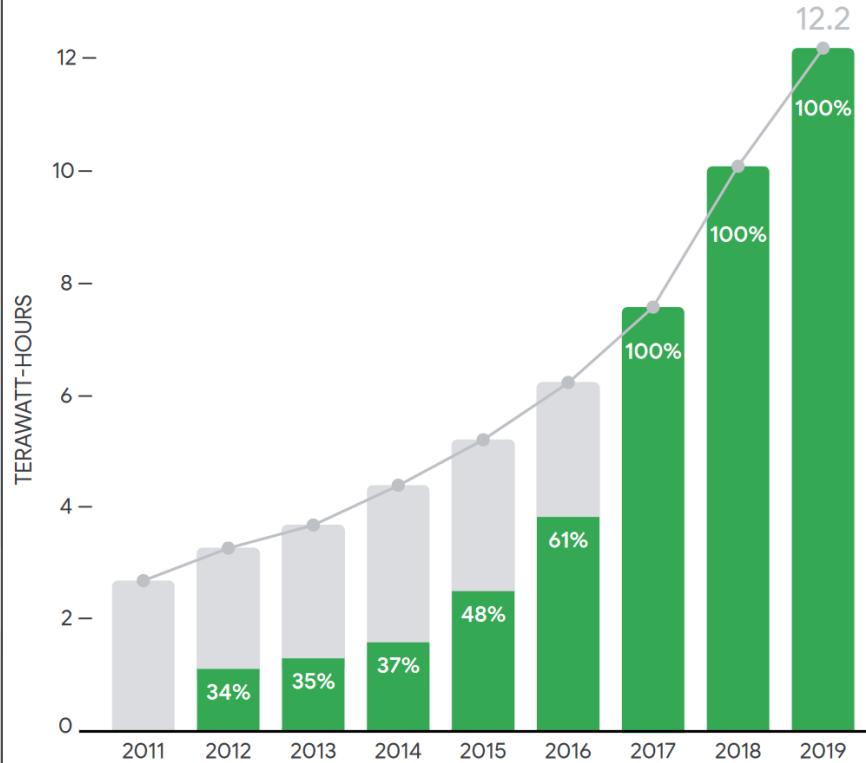
1. LBNL, 2013
2. NRDC report

- Carbon/energy footprint:
 - 1-2% of global energy consumption¹
 - 140 billion kWh (50 power plants)²
 - 100 metric tons of carbon pollution per year²

Google's energy footprint

RENEWABLE ENERGY PURCHASING COMPARED WITH TOTAL ELECTRICITY USE

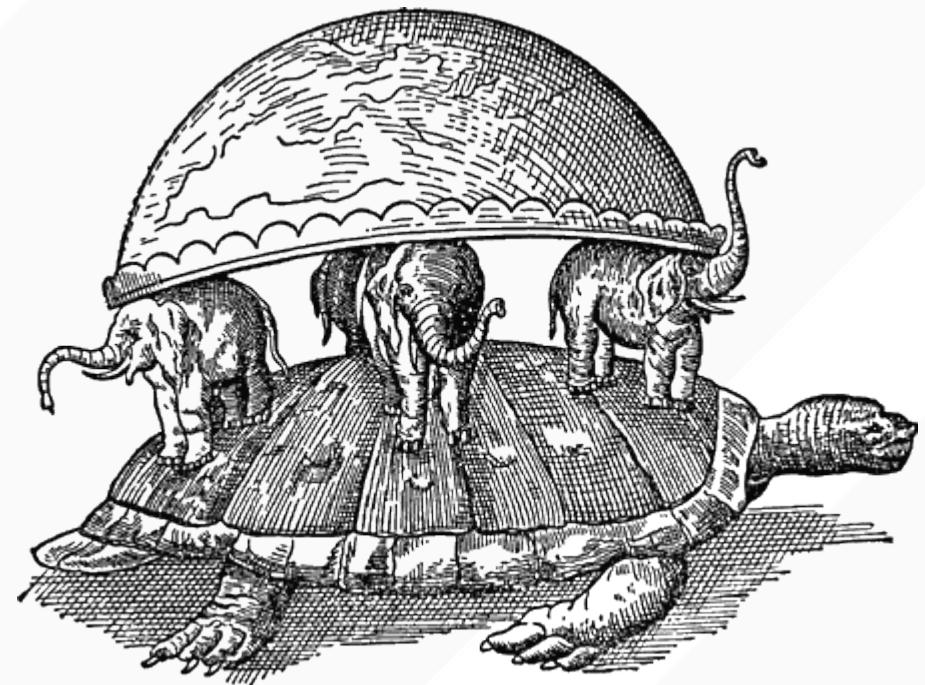
● Total electricity consumption ■ Renewable energy %



SCALING ACROSS TECHNOLOGY IMPROVEMENTS

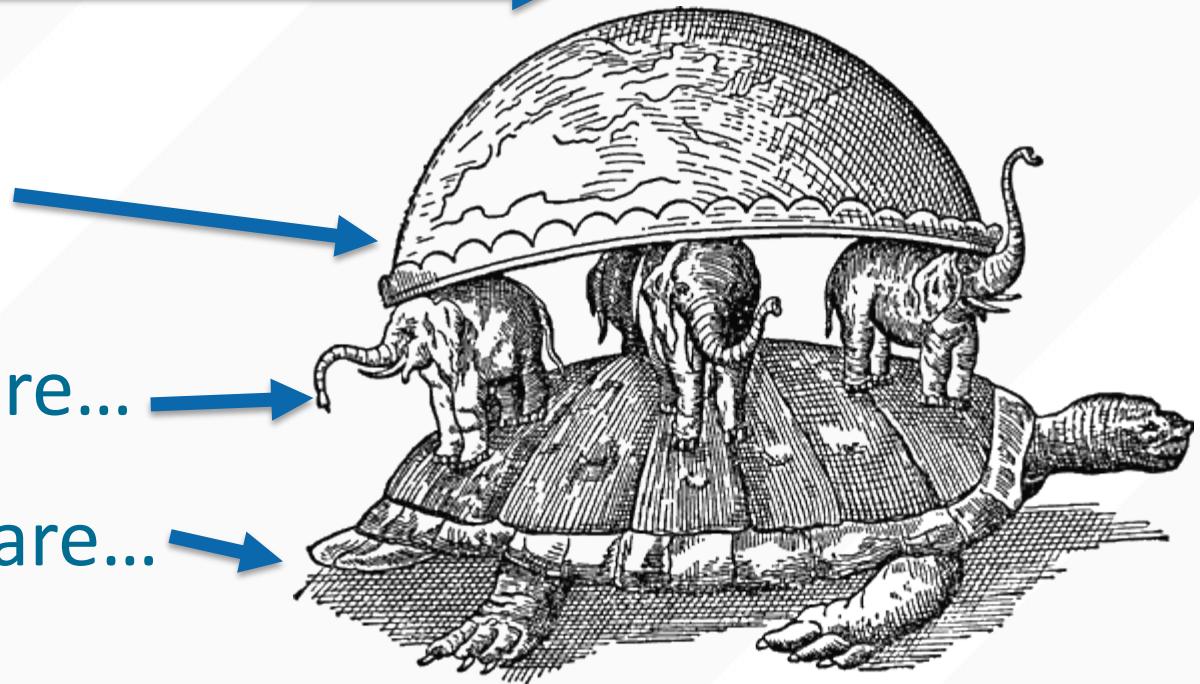
- Network primitives are designed to scale
- Techniques we learn are directly applicable to global-scale services like Google, Facebook, ...
- Your projects will be tested in small scale
 - Yet could scale immensely with minimal to no modifications

HOW TO BUILD SUCH LARGE SYSTEMS?



HOW TO BUILD SUCH LARGE SYSTEMS?

- Systems... →
- Built on top of abstractions... →
- Built on software... →
- Built on hardware... →



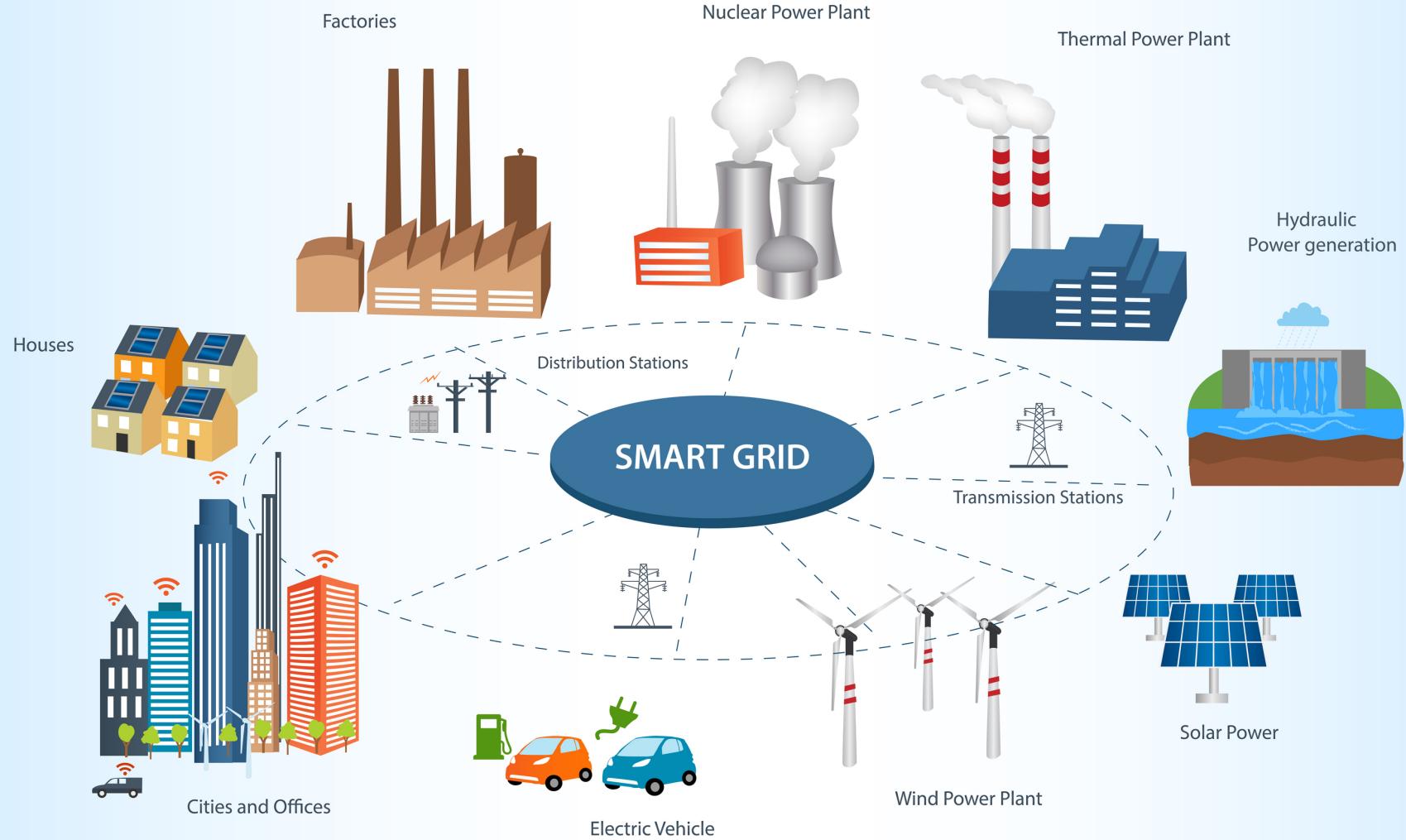
We will cover the software abstractions to enable you to write networked software

**IT'S NOT JUST WEBSITES AND SOCIAL MEDIA
THOUGH!**

SELF-DRIVING CARS AND SMART CITIES



SMART CITIES AND SMART GRIDS



THE CHALLENGE OF NETWORKING

- CS undergraduate curricula includes:
 - Algorithms
 - Programming languages
 - Architecture
 - Data structures
 - Etc...
- How does the network change each of these areas?

RESOURCES

- Website
 - <https://cseweb.ucsd.edu/classes/fa22/cse124-a/>
- Canvas (<https://canvas.ucsd.edu>)
 - Gradebook, links to assignments + deadlines, PDFs of lecture slides, in-class demos and exercises
- Piazza discussion board (linked off Canvas)
- Github (for managing your projects)
- Gradescope (for submitting your projects)
- Two books
- TA discussion section (1x week)

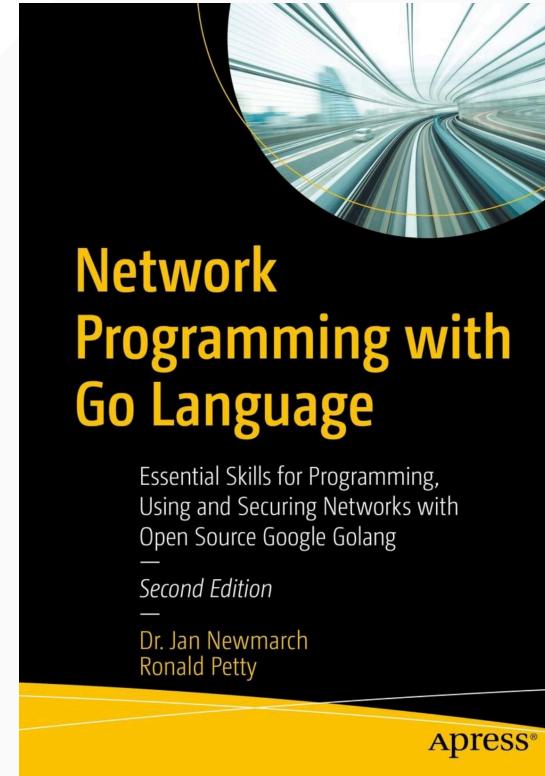
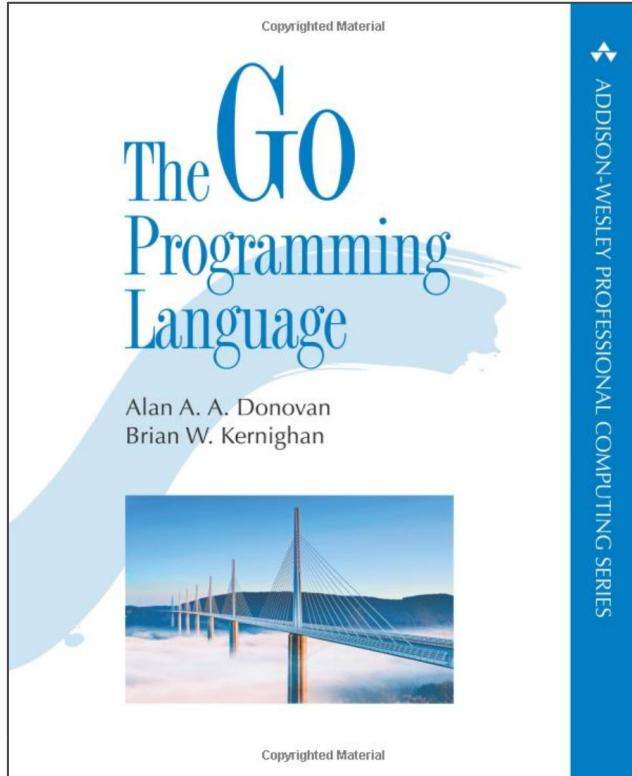
TEACHING ASSISTANTS

- Aditya Barsainya
- Linfang He
- Abhishek Vijeev
- Tianrui Zeng

CLASS MEETINGS

- Mostly putting the material that you read into context
- Live coding demos, activities, some “mini lectures” on algorithms, protocols, etc.
- You are responsible for everything that happens during class
 - Will podcast, but can’t guarantee that system works flawlessly
 - Will be asking for feedback on what works and what doesn’t work a lot during the class

BOOKS



Free if accessed through the
UCSD library

Free if accessed through the
UCSD library

PROGRAMMING SKILLS FOR THIS CLASS

- We'll be using the "Go" language
 - golang.org
 - Designed at Google in 2007
 - Goals: improve programming productivity in an era of multicore, networked machines, and large codebases
 - Kernighan (of 'C' fame) co-created
- Why?
 - Simple, readable, no mem allocation (similar to Python)
 - High-performance networking
 - Concurrency/parallelism
 - Static typing and efficient runtime
 - Industry-quality and deployed at massive scale



CLASS ROADMAP / PROJECTS / GRADING

1. Projects [65%]

1. [5%] Single-node sort (Sept 30, 5pm)
2. [12.5%] Distributed sort w/ sockets (Oct 12, 5pm)
3. [20%] Build your own web server (Oct 31, 5pm)
4. [20%] GRPC-based SurfStore “Dropbox clone” client with non-fault tolerant backend (Nov 21, 5pm)
5. [7.5%] Fault-tolerant SurfStore server (Dec 2, 5pm)
 - These are done individually. 48 hour late policy on the syllabus.

2. Exams [35%]

1. [15%] Midterm (Nov 1 during class time)
2. [20%] Final exam (Dec 6, check registrar for times/locations)

DEFAULT UCSD GRADING SCHEME

Default Grading Scheme

 Select Another Scheme  

Name:	Range:	
A	100 %	to 94.0%
A-	< 94.0 %	to 90.0%
B+	< 90.0 %	to 87.0%
B	< 87.0 %	to 84.0%
B-	< 84.0 %	to 80.0%
C+	< 80.0 %	to 77.0%
C	< 77.0 %	to 74.0%
C-	< 74.0 %	to 70.0%
D+	< 70.0 %	to 67.0%
D	< 67.0 %	to 64.0%
D-	< 64.0 %	to 61.0%
F	< 61.0 %	to 0.0%

[manage grading schemes](#)

Done

DEPLOYMENT PLATFORM: AMAZON CLOUD SERVICES



- Deploy your code on Amazon AWS to datacenters on five continents
 - Mumbai, India; Dublin Ireland; São Paulo Brazil; Seoul, Korea, California

YOUR SERVER IN THE CLOUD

- Every student gets about \$50 in free credit for the Amazon cloud
- Can develop/run your code there
- Can develop on your own computer if you prefer to do that, but make sure it runs correctly on your cloud machine
 - (The autograder runs on x86_64 Linux)

THE COVID-19 PANDEMIC

RETURN TO LEARN

UC San Diego

About ▾ Return to Campus ▾ News & Updates ▾ Info For ▾ Resources ▾ CA COVID Notify Program

CA COVID Notify Program

TOGETHER, WE CAN HELP FIGHT COVID-19.

CA COVID Notify uses the Exposure Notifications System from Google and Apple to alert you when you may have been exposed to COVID-19.

ADD CA COVID NOTIFY

CA COVID NOTIFY

CAMPUS STATUS

UC San Diego continues to monitor the spread of COVID-19, working closely with local, state and national officials. For the latest updates to the campus community, visit the [Current Campus Status page](#) »

Currently, masks are required during class. Check your email for any updates from campus or changes to the rules.

UC San Diego