Through The Clouds: An Introduction to Cloud Computing

Day 1: Introductions

Instructors: Anurag Khandelwal, Ramla Ijaz, Garrett Sager
TA: Joaquin Soto

Yale

Today’s Agenda

Today’s Agenda

- Introductions
- The ‘What’, ‘How’ and ‘Why’ of the Cloud
- How you will get your hands dirty during this workshop!

Introductions :)

Who am I?

- Anurag Khandelwal (he/him/his)
- Assistant Professor in CS, started Spring 2020 (15.5/18 months wfh)
- **Research:** Distributed Systems & Networks; Algorithm & Data structure design
- **Non-academic interests:**
  - All things sci-fi (proud Trekker and Whovian; that's what got me into CS)
  - Voracious reader and aspiring writer (emphasis *aspiring*)

Call me (in order of preference)

Call me (in order of preference)

Anurag

Call me (in order of preference)

Anurag > Prof. Anurag

Call me (in order of preference)

Anurag > Prof. Anurag > Prof. Khandelwal

(If you must)

Who are your other instructors?

- Ramla Ijaz (she/her/hers)
- 4th year PhD student
- **Research:** Operating Systems and Programming Languages
- **Non-academic interests:**
  - I really like reading in my free time, non-fiction and fiction
  - Trying out recipes of different cuisines :)

Who are your other instructors?

- Garrett Sager (he/him/his)
- 2nd year PhD student
- **Research:** Computational and systems neuroscience
- **Non-academic interests:**
  - Competitive ballroom dancing in college!
  - On ESPN a few times playing football for my high school!

Who are your other instructors?

- **TA:** Joaquin Soto (he/him/his)
- Rising Sophomore at Yale College, intended major in Economics with a certificate in Stats & Data Science
- **Non-academic interests:**
  - IntegrateU, a developing resource hub to and authentically inform and engage Yale students on local community-centered learning and movements.
  - Biking routines, meditation, reading tech news

Your turn now…

- What should we call you?
- What interested you in taking up this workshop?
- What are your non-academic interests?

Let’s keep it interactive…

Let’s keep it interactive…

- This is a ***discussion,*** not a ***lecture!*** :)

Let’s keep it interactive…

- This is a ***discussion,*** not a ***lecture!*** :)
- Much more fun if we brainstorm together!

Let’s keep it interactive…

- This is a ***discussion,*** not a ***lecture!*** :)
- Much more fun if we brainstorm together!
- Let’s aim to keep our videos on, and try to stay unmuted (unless you can’t)

What is the Cloud?

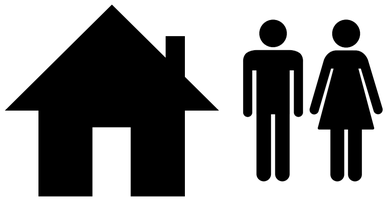
What is the Cloud?

What is the Cloud?

- Lets start with how a “utility service” like power distribution works

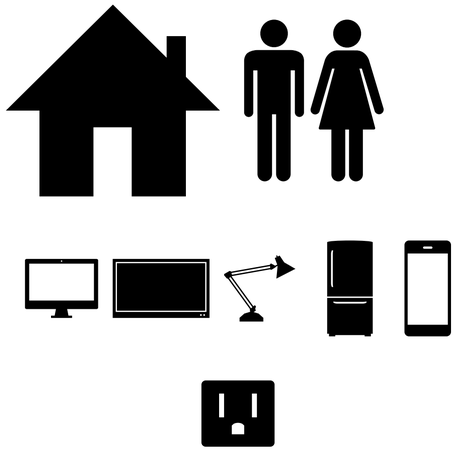
What is the Cloud?

- Lets start with how a “utility service” like power distribution works



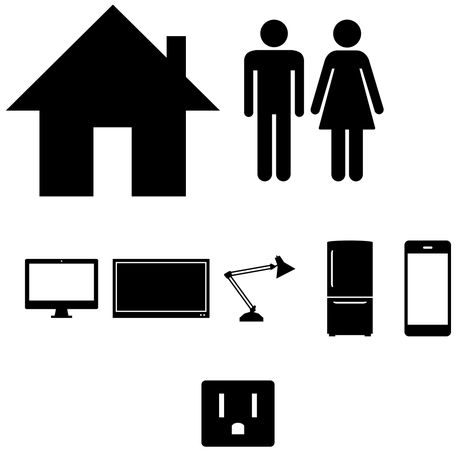
What is the Cloud?

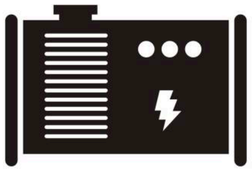
- Lets start with how a “utility service” like power distribution works



What is the Cloud?

- Lets start with how a “utility service” like power distribution works

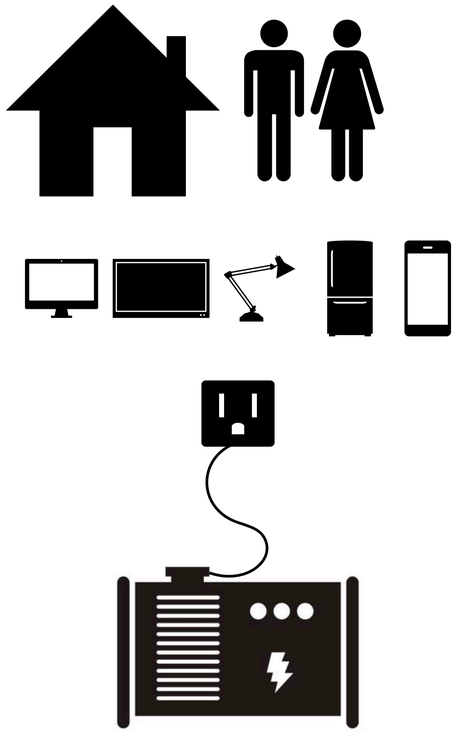




Generator

What is the Cloud?

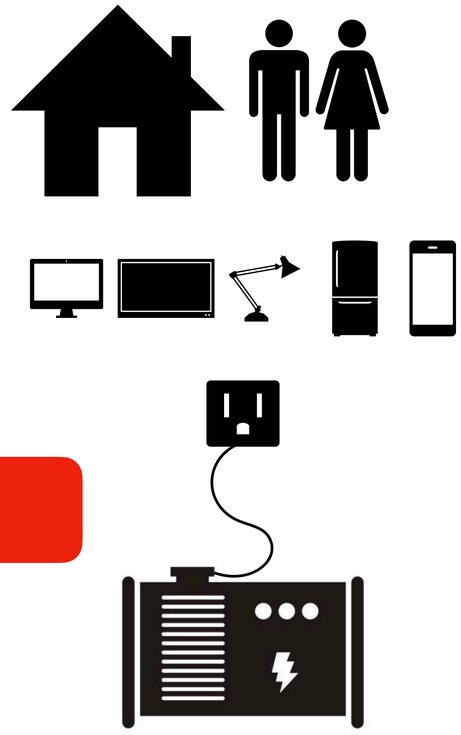
- Lets start with how a “utility service” like power distribution works



Generator

What is the Cloud?

- Lets start with how a “utility service” like power distribution works

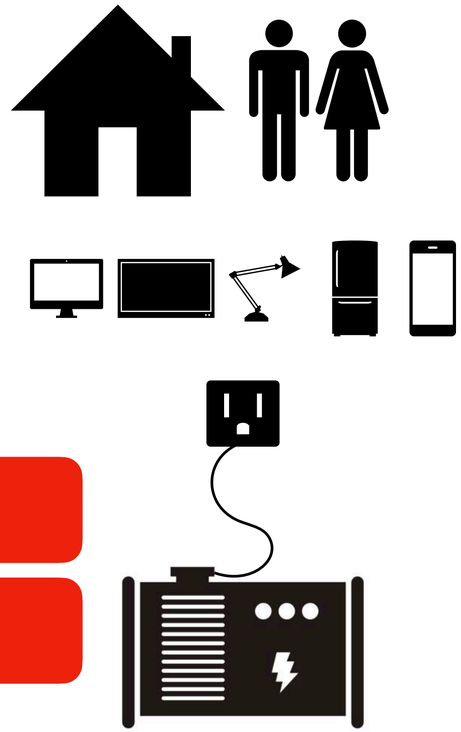


Hard to manage!

Generator

What is the Cloud?

- Lets start with how a “utility service” like power distribution works



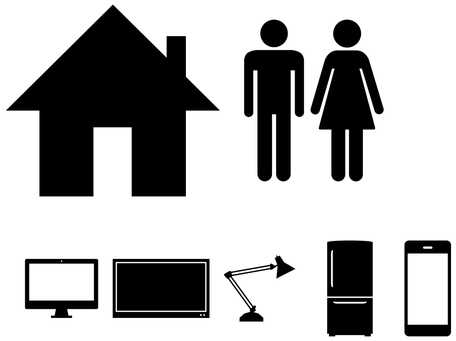
Hard to manage!

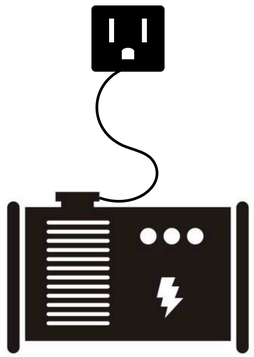
Expensive to maintain!

Generator

What is the Cloud?

- Lets start with how a “utility service” like power distribution works





Generator

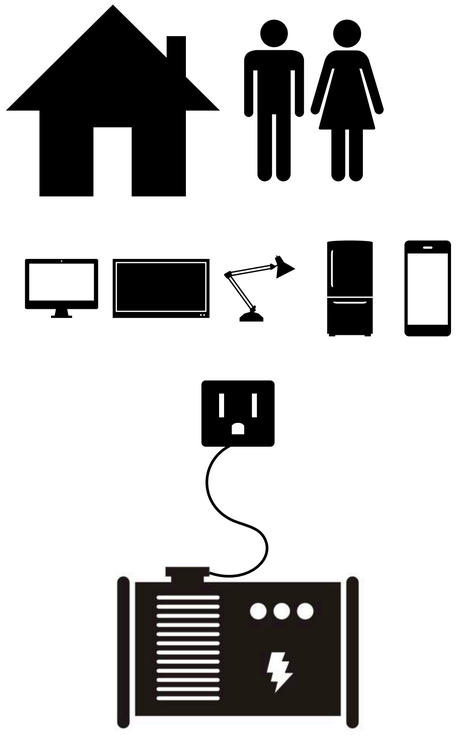
Hard to manage!

Expensive to maintain!

What if I need more power?

What is the Cloud?

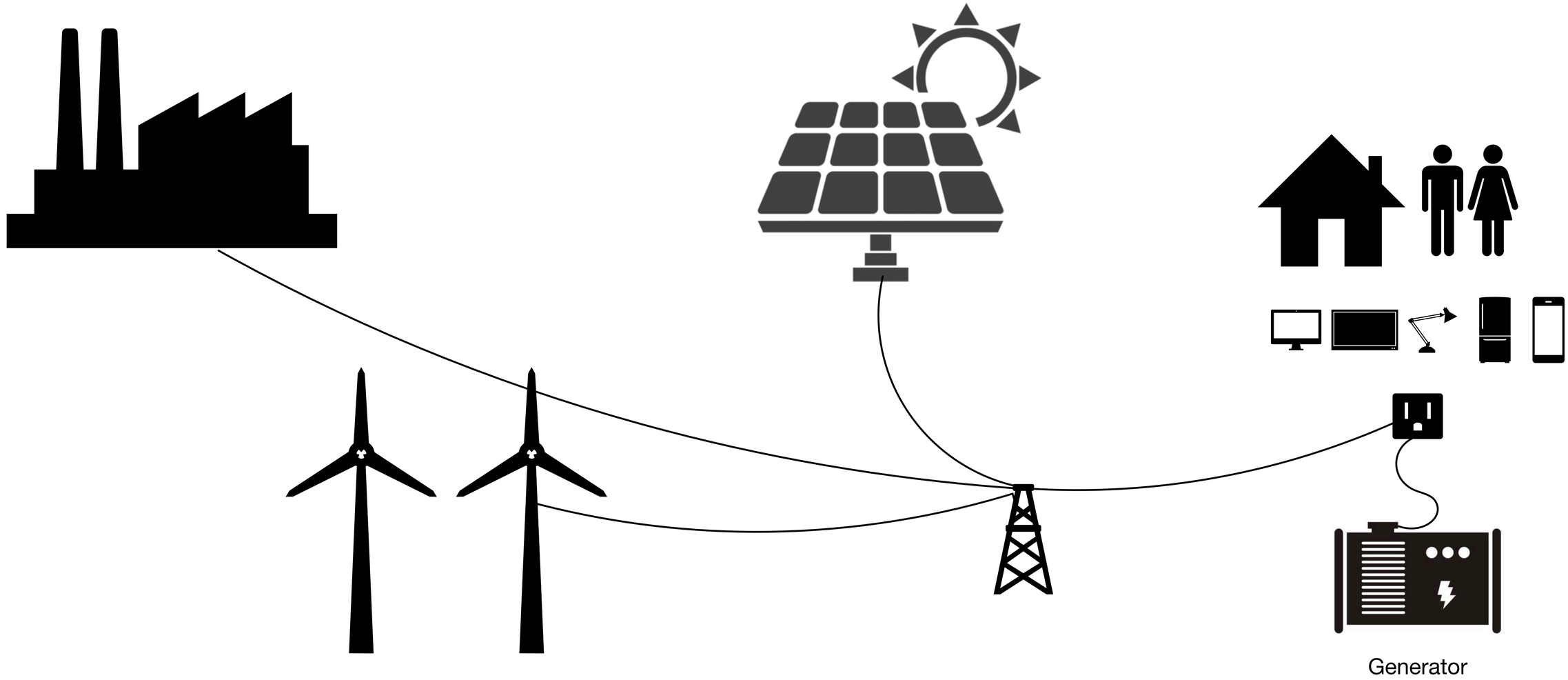
- Lets start with how a “utility service” like power distribution works



Generator

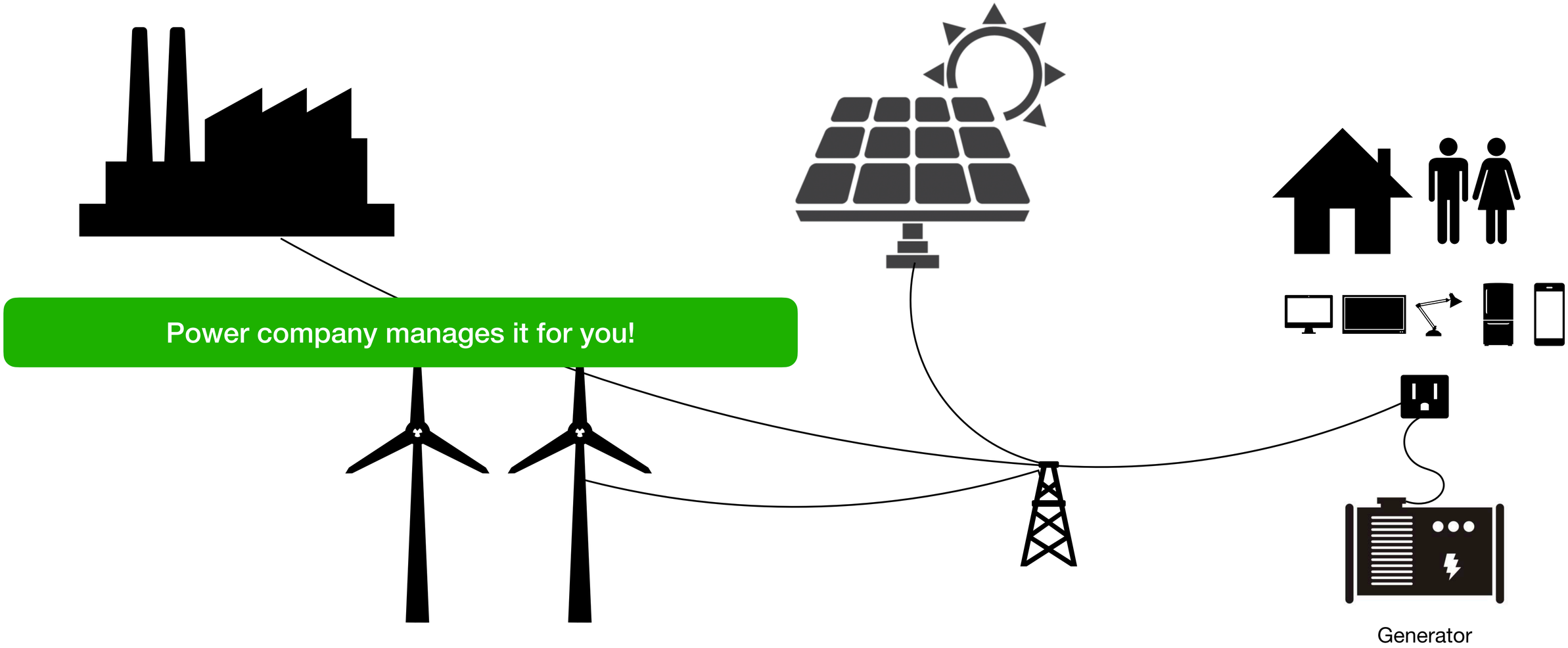
What is the Cloud?

- Lets start with how a “utility service” like power distribution works



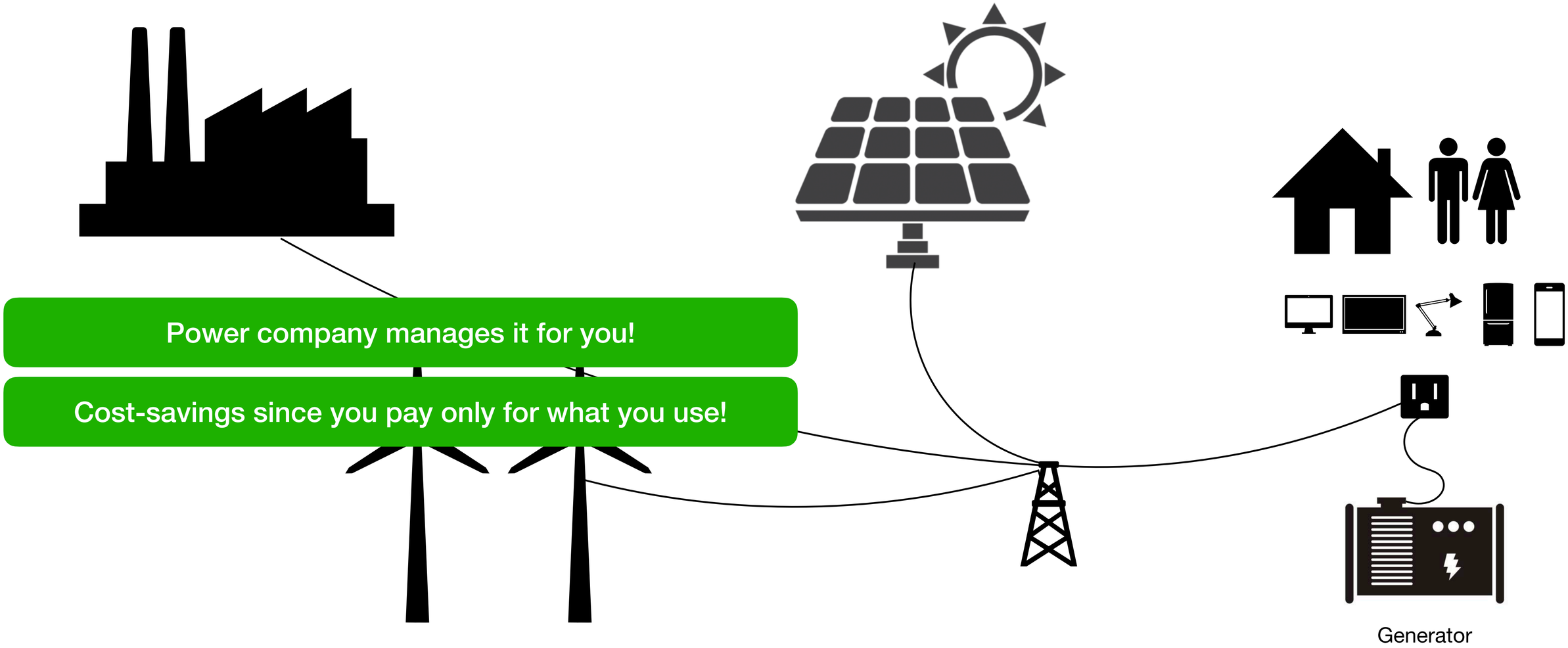
What is the Cloud?

- Lets start with how a “utility service” like power distribution works



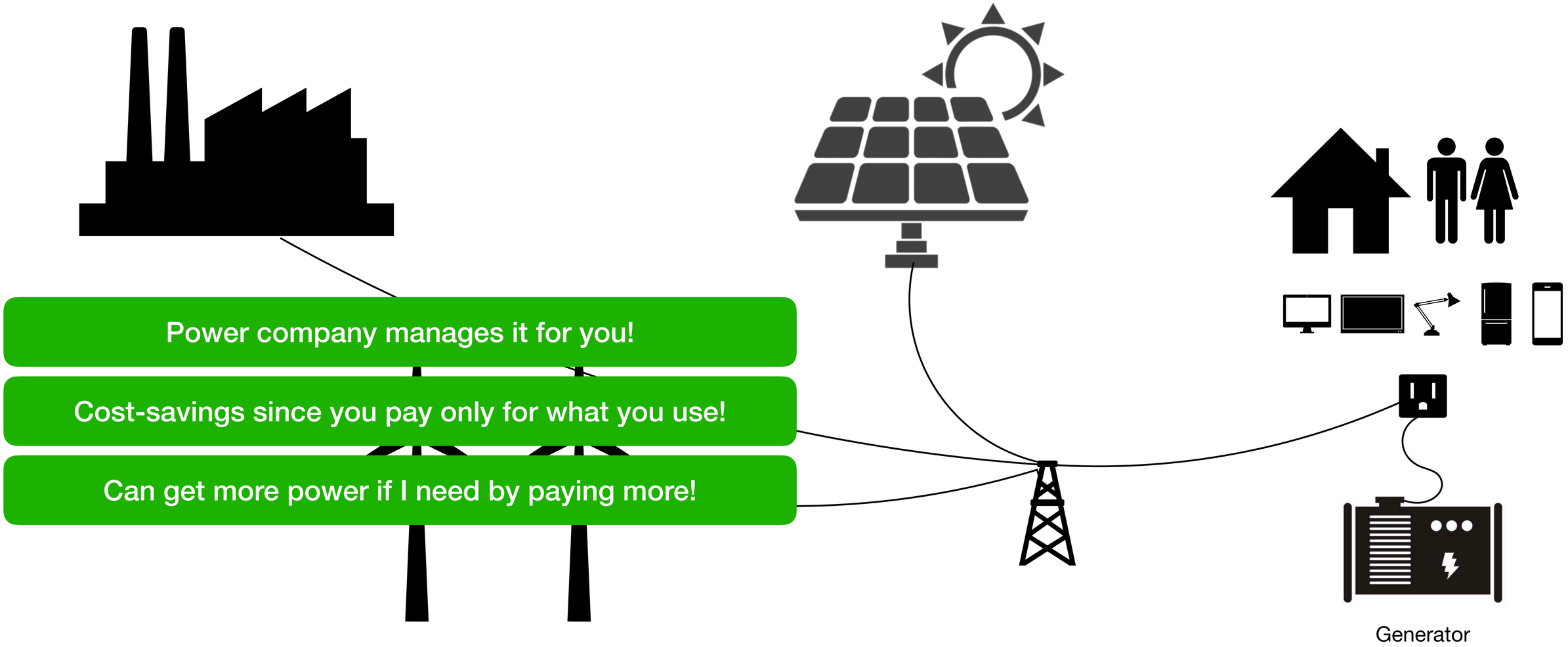
What is the Cloud?

- Lets start with how a “utility service” like power distribution works



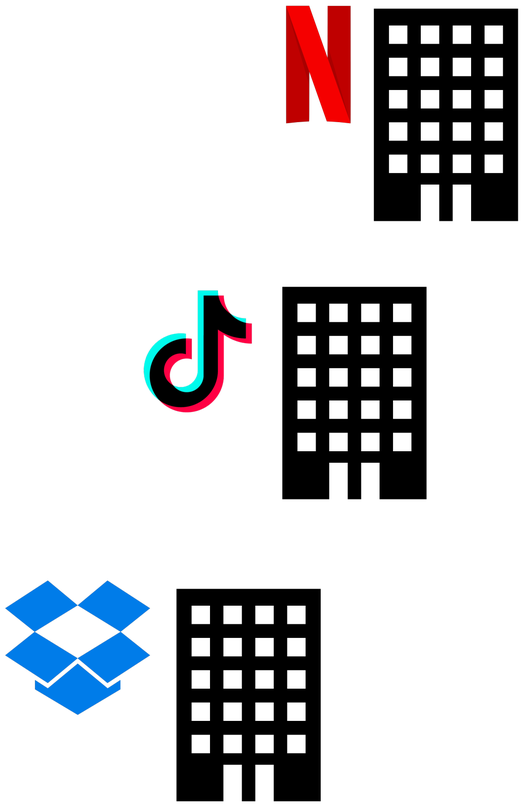
What is the Cloud?

- Lets start with how a “utility service” like power distribution works

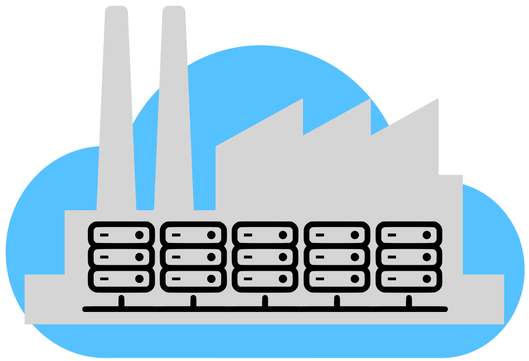


The Cloud is a utility service for computing & storage!

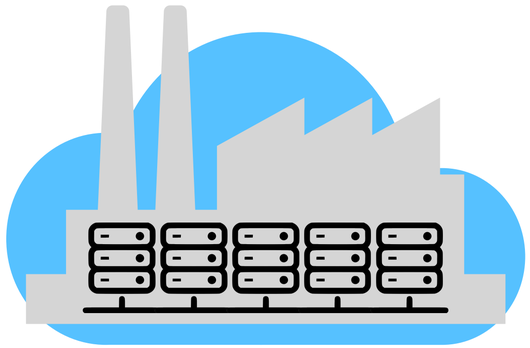
The Cloud is a utility service for computing & storage!



The Cloud is a utility service for computing & storage!

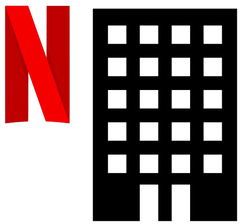


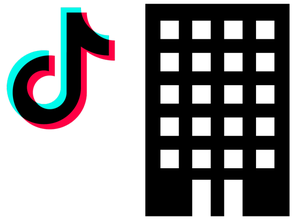
Data center

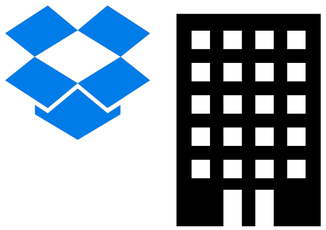


Data center

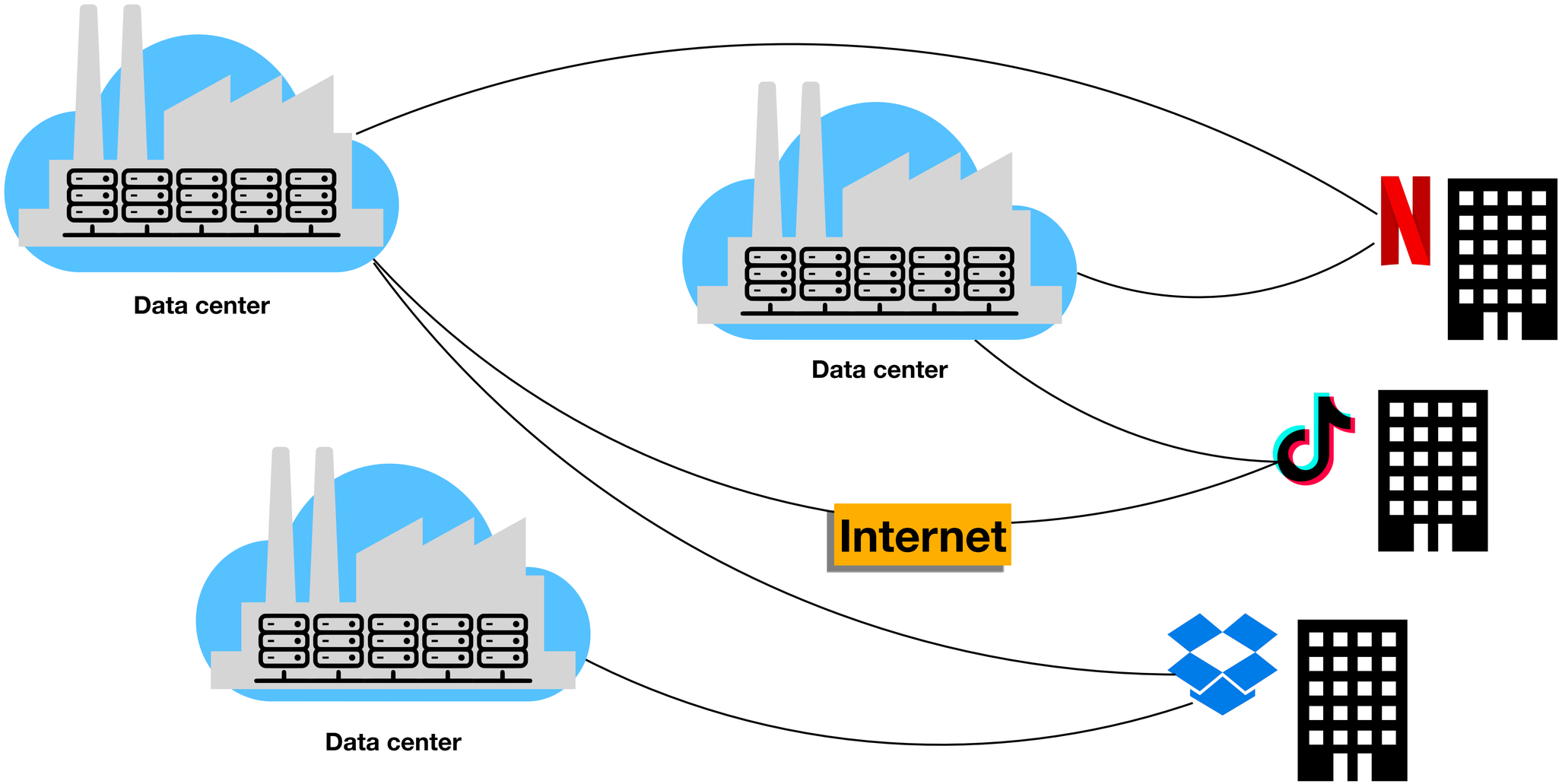
Data center



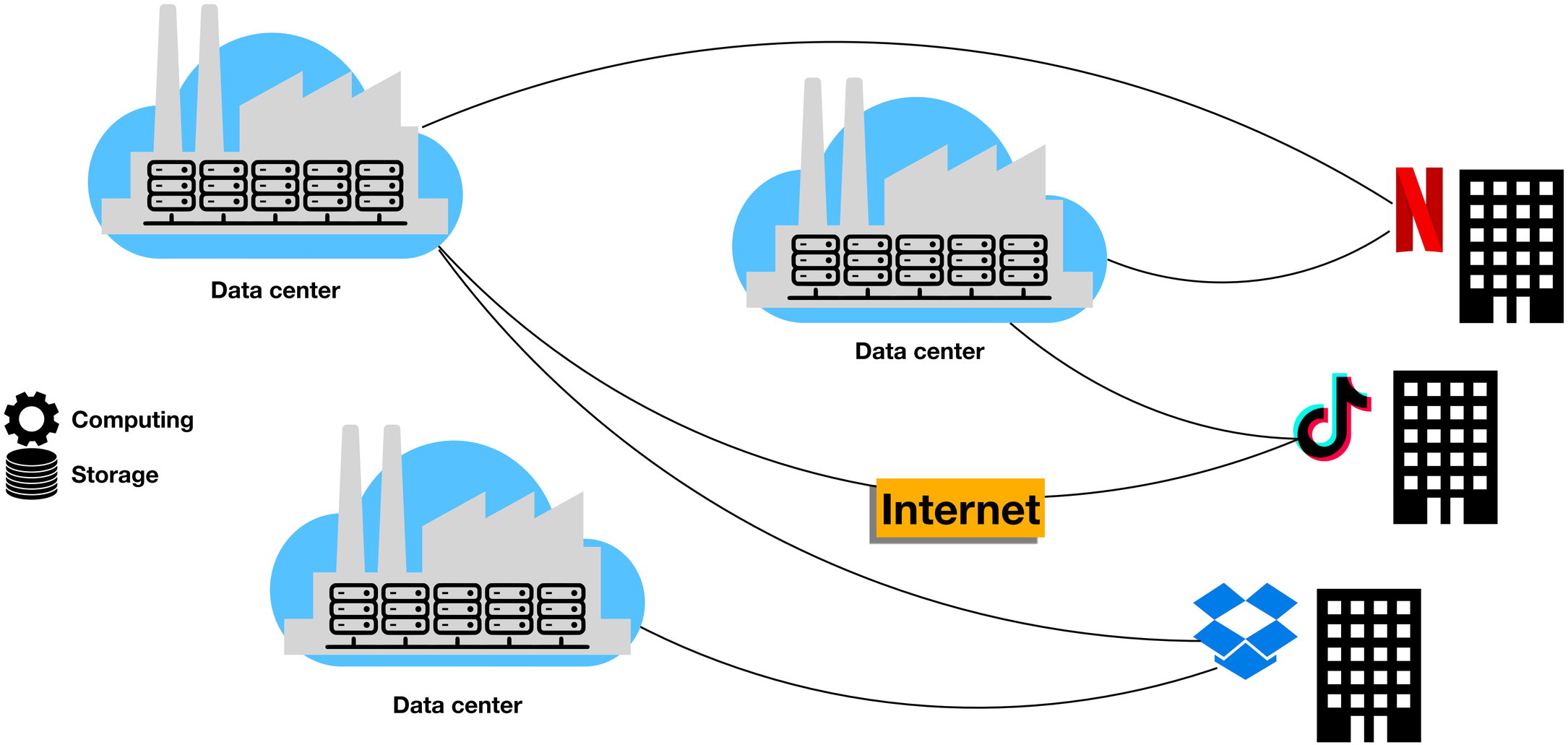




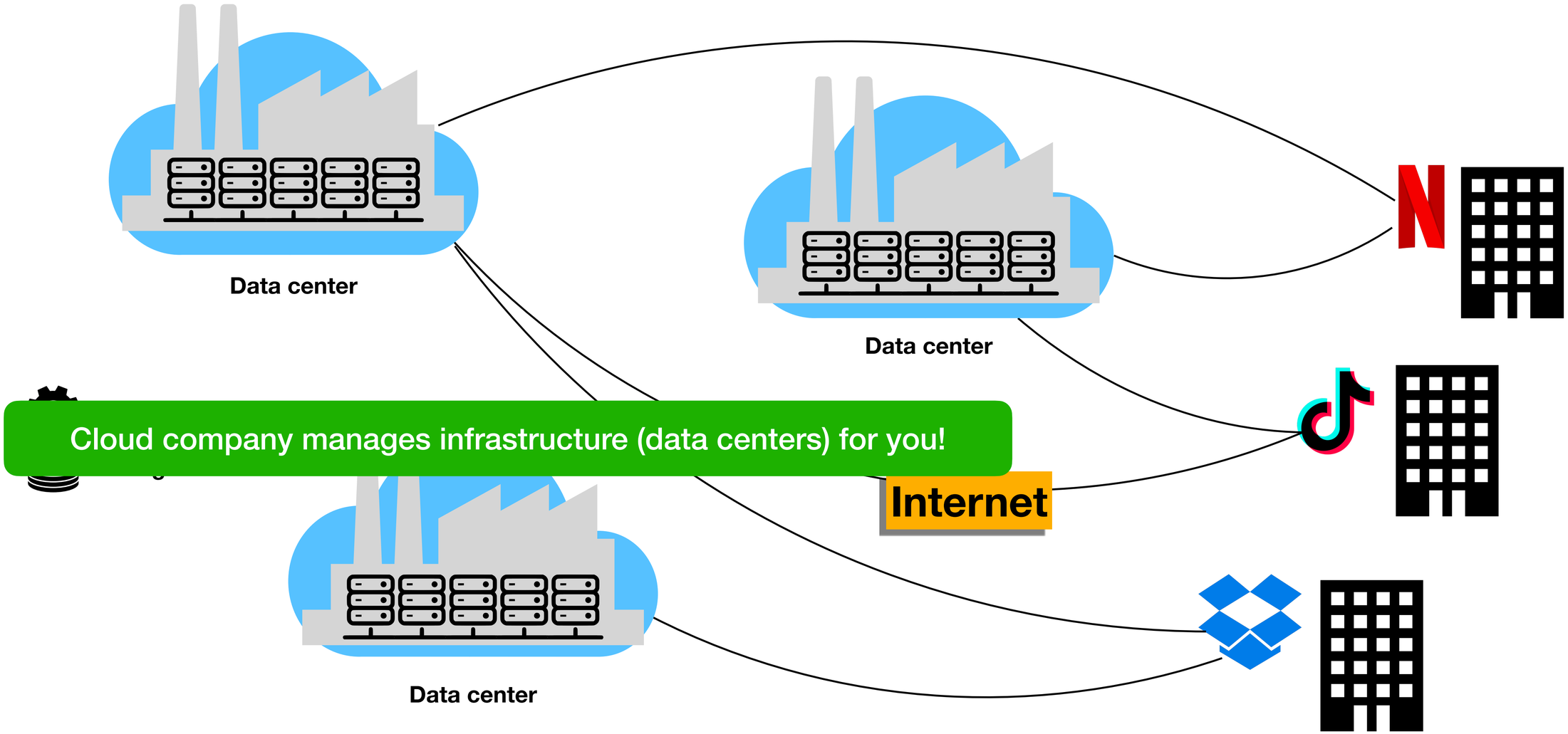
The Cloud is a utility service for computing & storage!



The Cloud is a utility service for computing & storage!

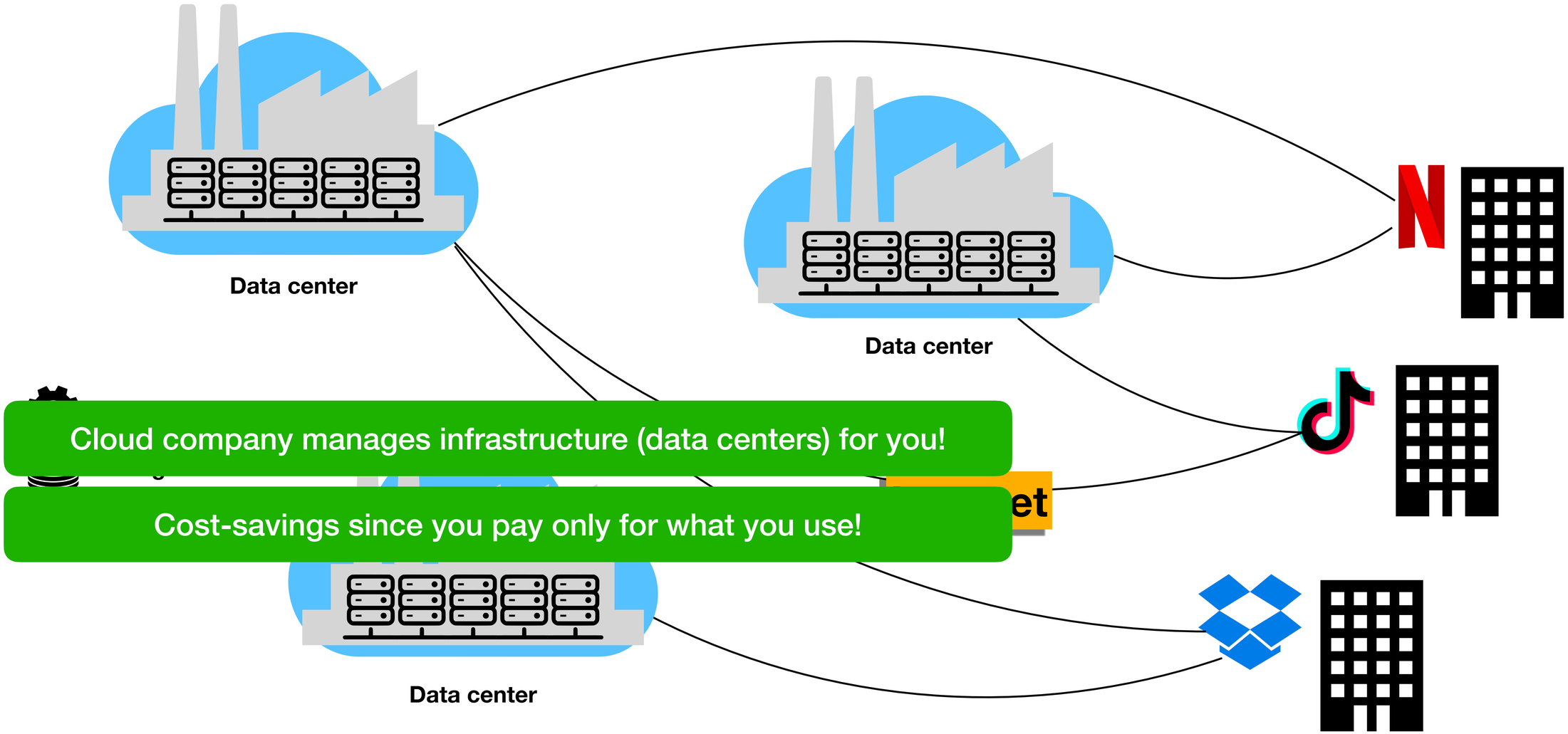


The Cloud is a utility service for computing & storage!



Cloud company manages infrastructure (data centers) for you!

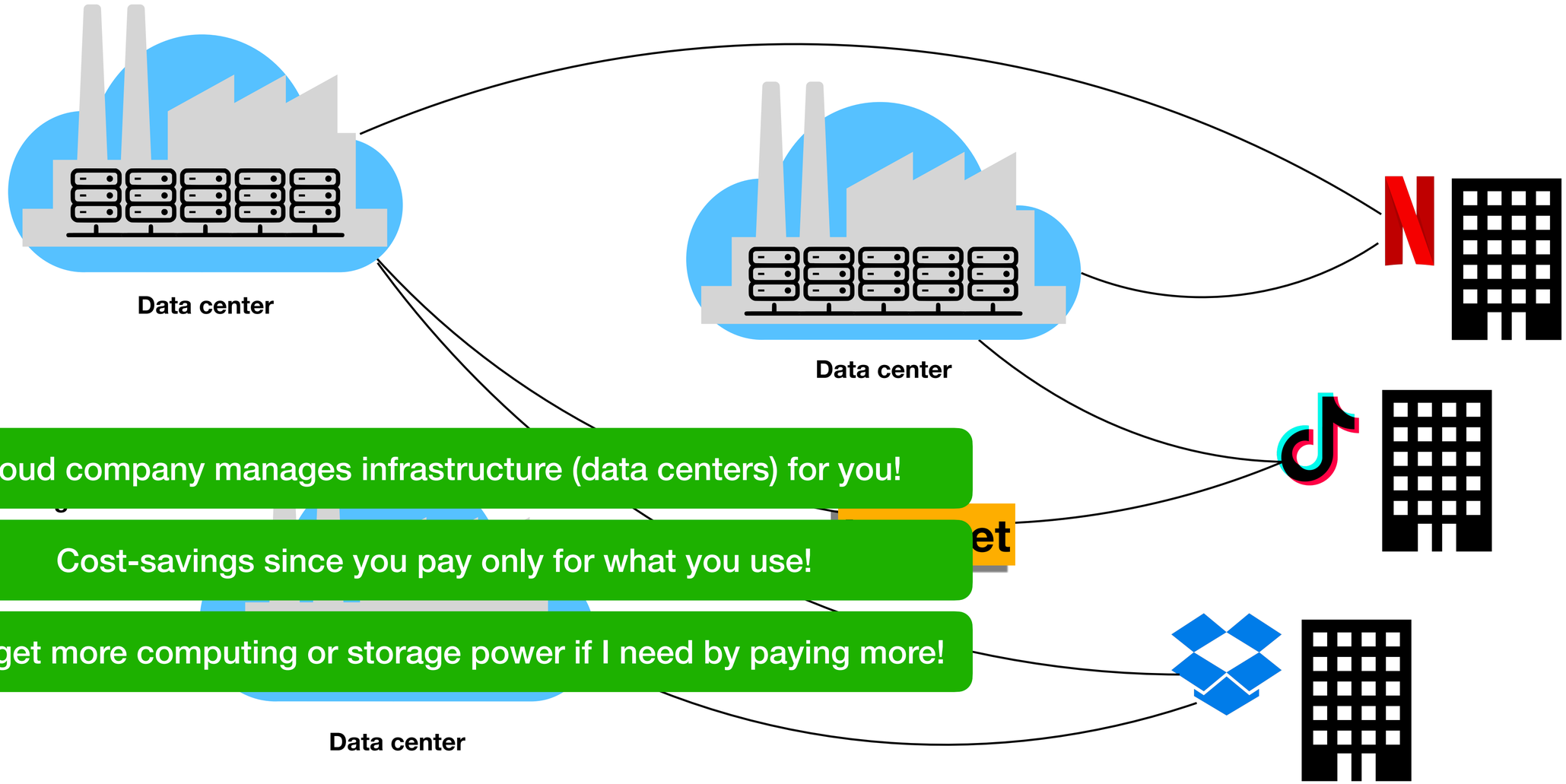
The Cloud is a utility service for computing & storage!



Cloud company manages infrastructure (data centers) for you!

Cost-savings since you pay only for what you use!

The Cloud is a utility service for computing & storage!



Cloud company manages infrastructure (data centers) for you!

Cost-savings since you pay only for what you use!

Can get more computing or storage power if I need by paying more!

Datacenter Evolution: When & Why?

Datacenter Evolution: When & Why?

- **Early 2000s-2010s:** Data growth at unprecedented rates
  - Facebook's daily logs: **60 TB (= 60,000 GB)**
  - Google's web index: **10+ PB (= >10,000,000 GB)**
  - Scientific data: **2PB (= 2,000,000 GB)** for solar-flare prediction

Datacenter Evolution: When & Why?

- **Early 2000s-2010s:** Data growth at unprecedented rates
  - Facebook's daily logs: **60 TB (= 60,000 GB)**
  - Google's web index: **10+ PB (= >10,000,000 GB)**
  - Scientific data: **2PB (= 2,000,000 GB)** for solar-flare prediction
- **Computing need for the data saw similar growth**

Datacenter Evolution: When & Why?

- **Early 2000s-2010s:** Data growth at unprecedented rates
  - Facebook's daily logs: **60 TB (= 60,000 GB)**
  - Google's web index: **10+ PB (= >10,000,000 GB)**
  - Scientific data: **2PB (= 2,000,000 GB)** for solar-flare prediction
- **Computing need for the data saw similar growth**
- **Also, computers stopped getting faster…**

Datacenter Evolution: When & Why?

- **Early 2000s-2010s:** Data growth at unprecedented rates
  - Facebook's daily logs: **60 TB (= 60,000 GB)**
  - Google's web index: **10+ PB (= >10,000,000 GB)**
  - Scientific data: **2PB (= 2,000,000 GB)** for solar-flare prediction
- **Computing need for the data saw similar growth**
- **Also, computers stopped getting faster…**
- **Lead to the Datacenter Evolution!**
  - Large, inexpensive "clusters" of many, many computers!

“Public” Cloud, and the start of Computing/Storage as a Utility

“Public” Cloud, and the start of Computing/Storage as a Utility

- **Pre-2006 world**

“Public” Cloud, and the start of Computing/Storage as a Utility

- **Pre-2006 world**
  - Amazon had huge datacenters that only ran @ 10% capacity for most of the year

“Public” Cloud, and the start of Computing/Storage as a Utility

- **Pre-2006 world**
  - Amazon had huge datacenters that only ran @ 10% capacity for most of the year
  - Why?

“Public” Cloud, and the start of Computing/Storage as a Utility

- **Pre-2006 world**
  - Amazon had huge datacenters that only ran @ 10% capacity for most of the year
  - Why?

Christmas shopping

“Public” Cloud, and the start of Computing/Storage as a Utility

- **Pre-2006 world**
  - Amazon had huge datacenters that only ran @ 10% capacity for most of the year
  - Why?

amazon

Jeff Bezos

Andy Jassy

“Public” Cloud, and the start of Computing/Storage as a Utility

- **Pre-2006 world**
  - Amazon had huge datacenters that only ran @ 10% capacity for most of the year
  - Why?

amazon

Jeff Bezos

Andy Jassy

Hey, Jeff?

“Public” Cloud, and the start of Computing/Storage as a Utility

- **Pre-2006 world**
  - Amazon had huge datacenters that only ran @ 10% capacity for most of the year
  - Why?

amazon

Yes, Andy?

Jeff Bezos

Andy Jassy

Hey, Jeff?

“Public” Cloud, and the start of Computing/Storage as a Utility

- **Pre-2006 world**
  - Amazon had huge datacenters that only ran @ 10% capacity for most of the year
  - Why?

amazon

Yes, Andy?

Jeff Bezos

Andy Jassy

Why don’t we rent out our unused capacity?

“Public” Cloud, and the start of Computing/Storage as a Utility

- **Pre-2006 world**
  - Amazon had huge datacenters that only ran @ 10% capacity for most of the year
  - Why?

amazon

Jeff Bezos

Andy Jassy

Why don’t we rent out our unused capacity?

“Public” Cloud, and the start of Computing/Storage as a Utility

- **Pre-2006 world**
  - Amazon had huge datacenters that only ran @ 10% capacity for most of the year
  - Why?

amazon

Jeff Bezos

Andy Jassy

Why don’t we rent out our unused capacity?

“Public” Cloud, and the start of Computing/Storage as a Utility

- **Pre-2006 world**
  - Amazon had huge datacenters that only ran @ 10% capacity for most of the year
  - Why?

amazon

aws

Jeff Bezos

Andy Jassy

Why don’t we rent out our unused capacity?

“Public” Cloud, and the start of Computing/Storage as a Utility

- **Pre-2006 world**
  - Amazon had huge datacenters that only ran @ 10% capacity for most of the year
  - Why?

amazon

aws

Today: 12% of total Amazon revenue

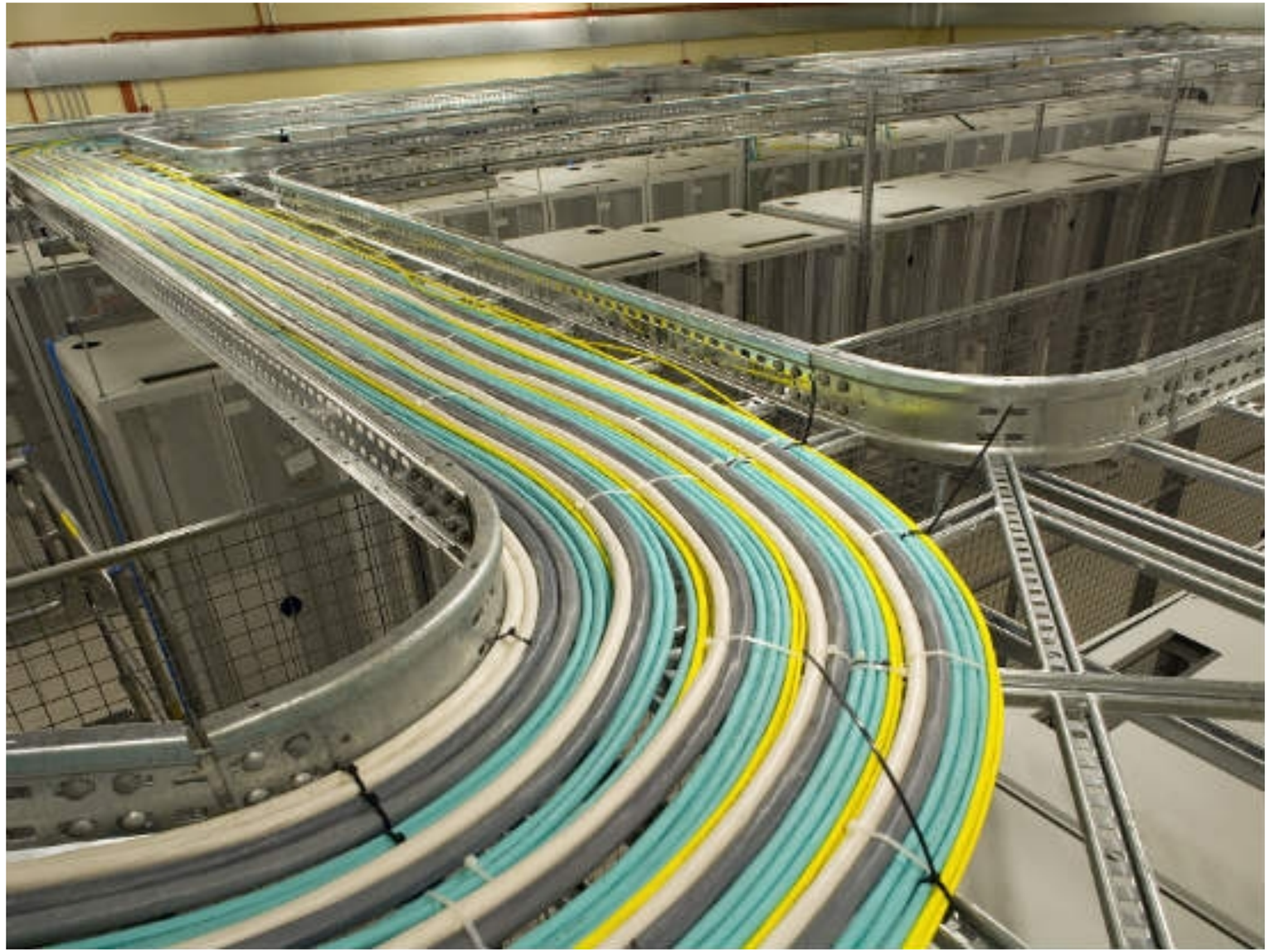
Jeff Bezos

Andy Jassy

Why don’t we rent out our unused capacity?

Datacenters Today

Datacenters Today



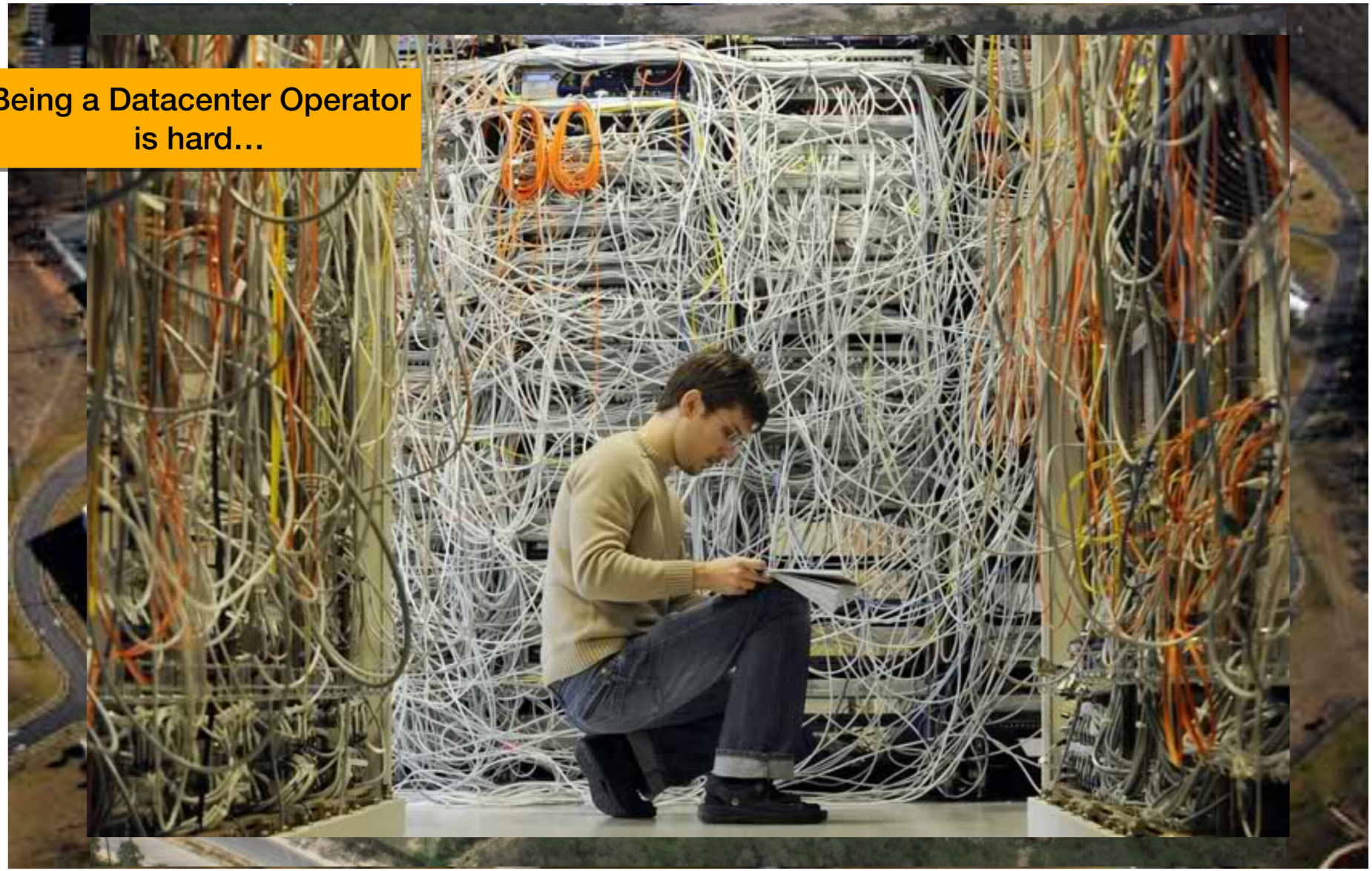
Datacenters Today

Datacenters Today

Datacenters Today

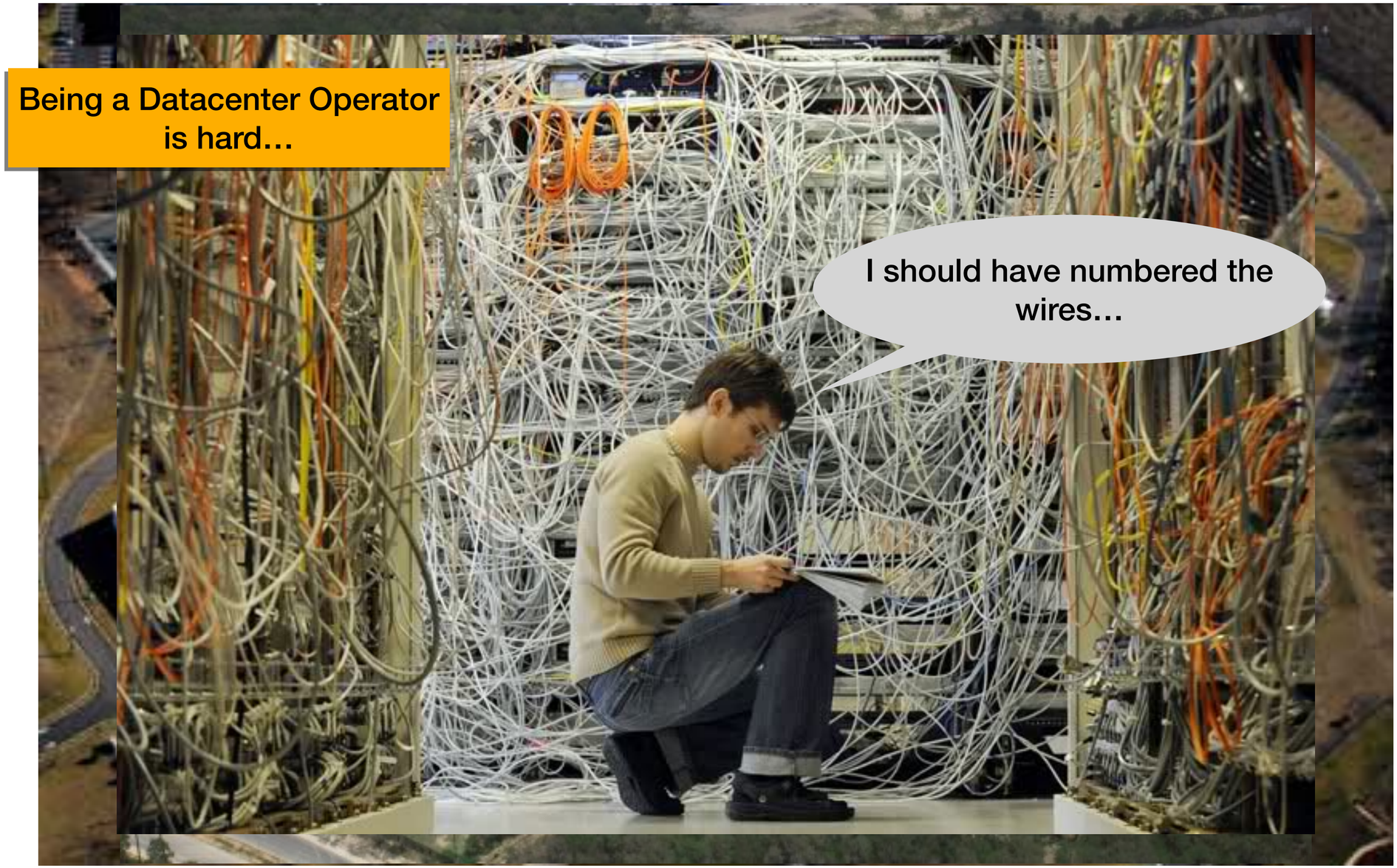
Datacenters Today

Datacenters Today



Being a Datacenter Operator is hard…

Datacenters Today



How Big are Datacenters Anyway?

How Big are Datacenters Anyway?

- > 1million servers/site [Microsoft/Amazon/Google]

How Big are Datacenters Anyway?

- > 1million servers/site [Microsoft/Amazon/Google]
- > $1billion to build a site [Facebook]

How Big are Datacenters Anyway?

- > 1million servers/site [Microsoft/Amazon/Google]
- > $1billion to build a site [Facebook]
- > $20million/month/site operational costs [Microsoft]

How Big are Datacenters Anyway?

- > 1million servers/site [Microsoft/Amazon/Google]
- > $1billion to build a site [Facebook]
- > $20million/month/site operational costs [Microsoft]

Can handle massive volumes (petabytes = million gigabytes) of data!

How Big are Datacenters Anyway?

- > 1million servers/site [Microsoft/Amazon/Google]
- > $1billion to build a site [Facebook]
- > $20million/month/site operational costs [Microsoft]

Can handle massive volumes (petabytes = million gigabytes) of data!

But users expect same performance, regardless of data size

Why is the Cloud Important?

Why is the Cloud Important?

Helped disrupt existing businesses!

Why is the Cloud Important?

Helped disrupt existing businesses!

Retail: amazon

Rental: airbnb

Taxi: Uber lyft

Smart Home: nest ring

Why is the Cloud Important?

Helped disrupt existing businesses!

Retail: amazon

Rental: airbnb

Taxi: Uber lyft

Smart Home: nest ring

And is continuing to do so…

Why is the Cloud Important?

Why is the Cloud Important?

Helped create new businesses!

Why is the Cloud Important?

Helped create new businesses!

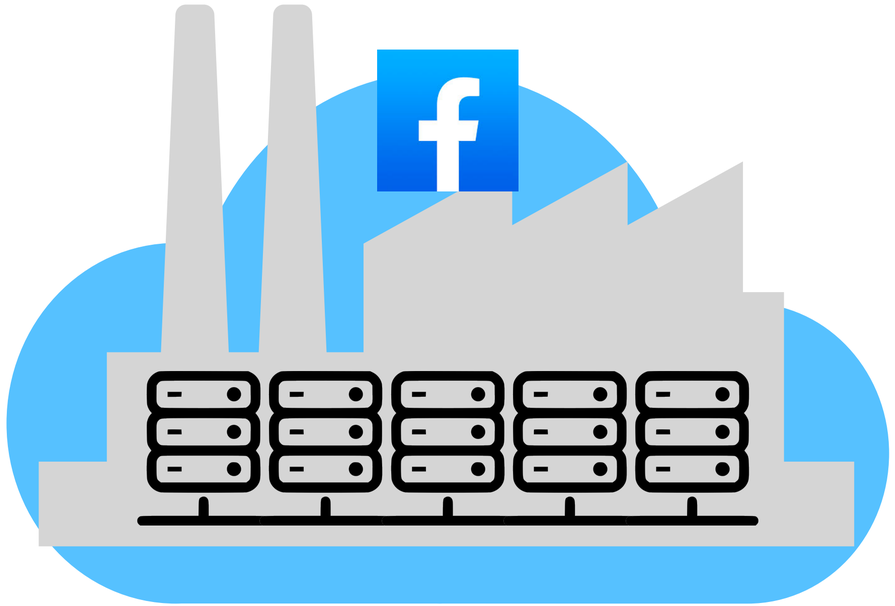
RagingWire

RagingWire

Any Thoughts? Questions?

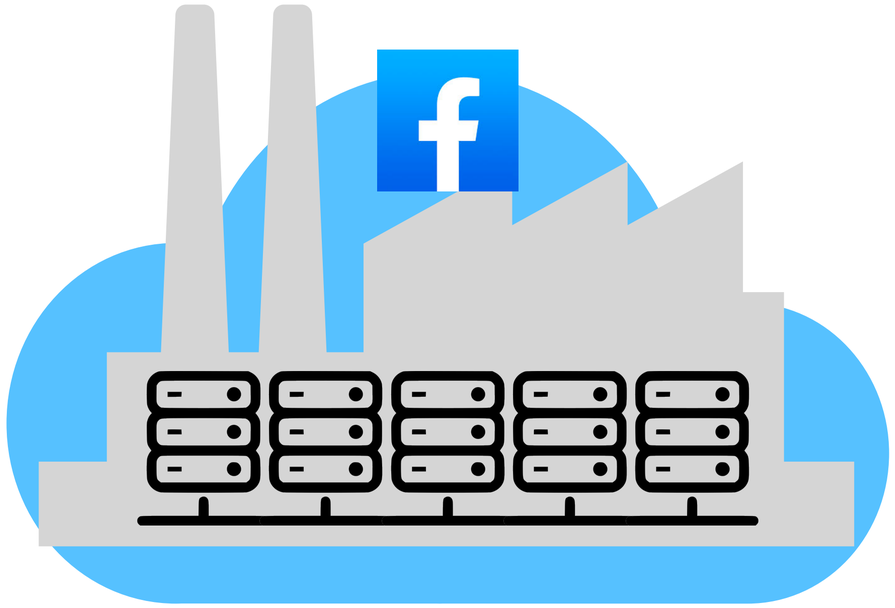
Ok, so how do I build my own cloud service?

Ok, so how do I build my own cloud service?

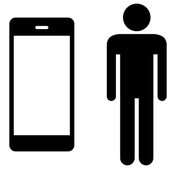


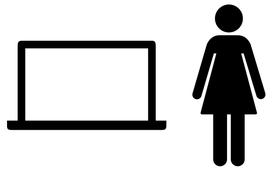
Data center

Ok, so how do I build my own cloud service?

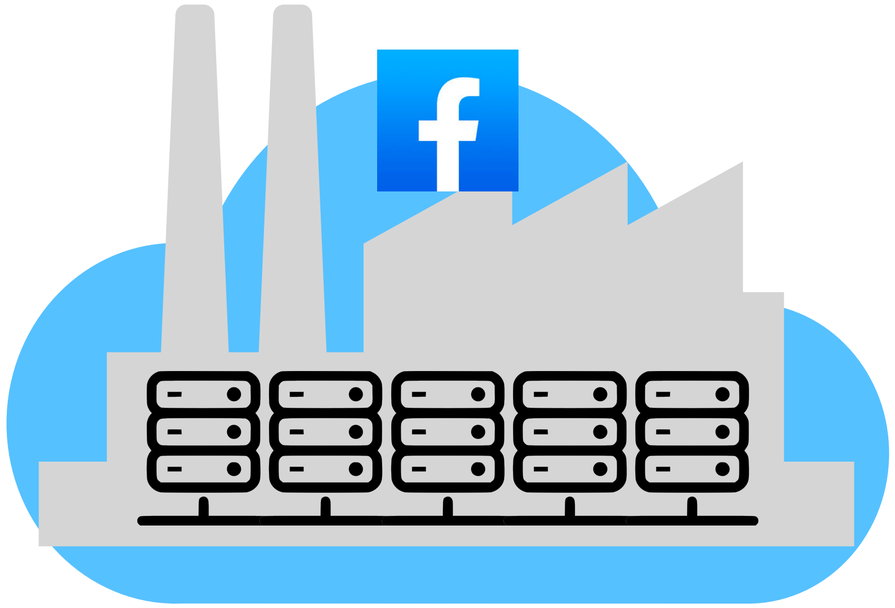


Data center

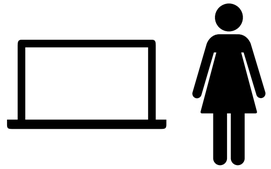




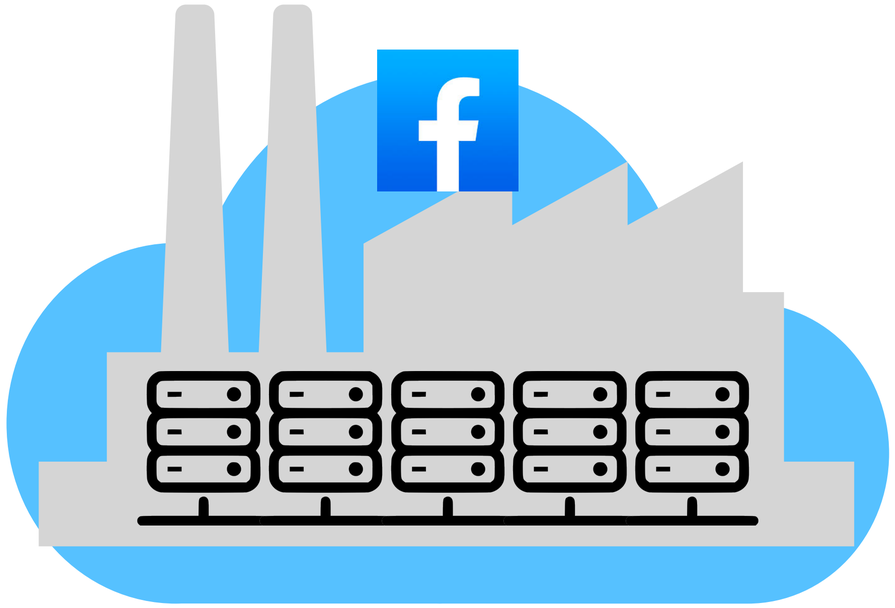
Ok, so how do I build my own cloud service?



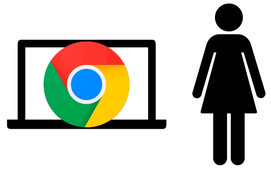
Data center



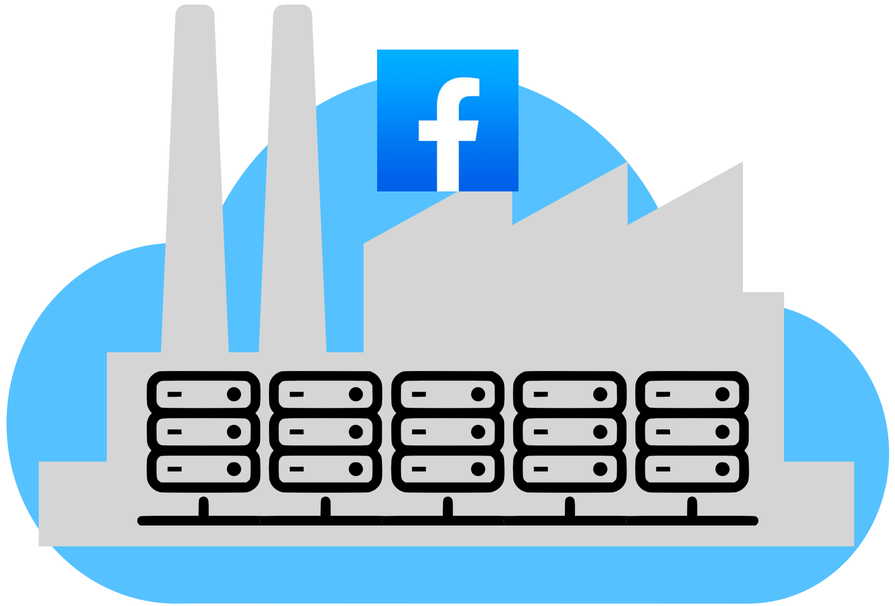
Ok, so how do I build my own cloud service?



Data center



Ok, so how do I build my own cloud service?

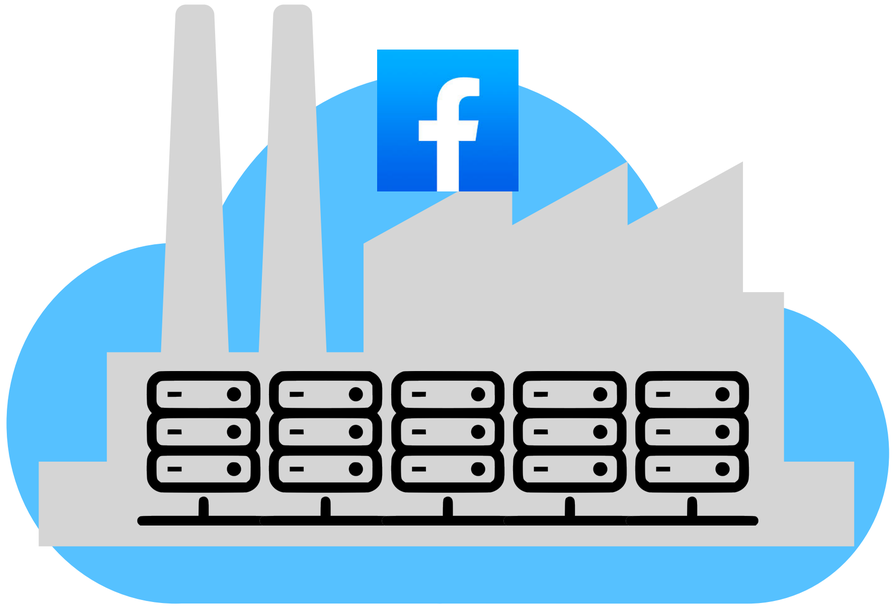


Data center

Client

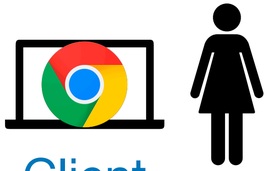
Client

Ok, so how do I build my own cloud service?



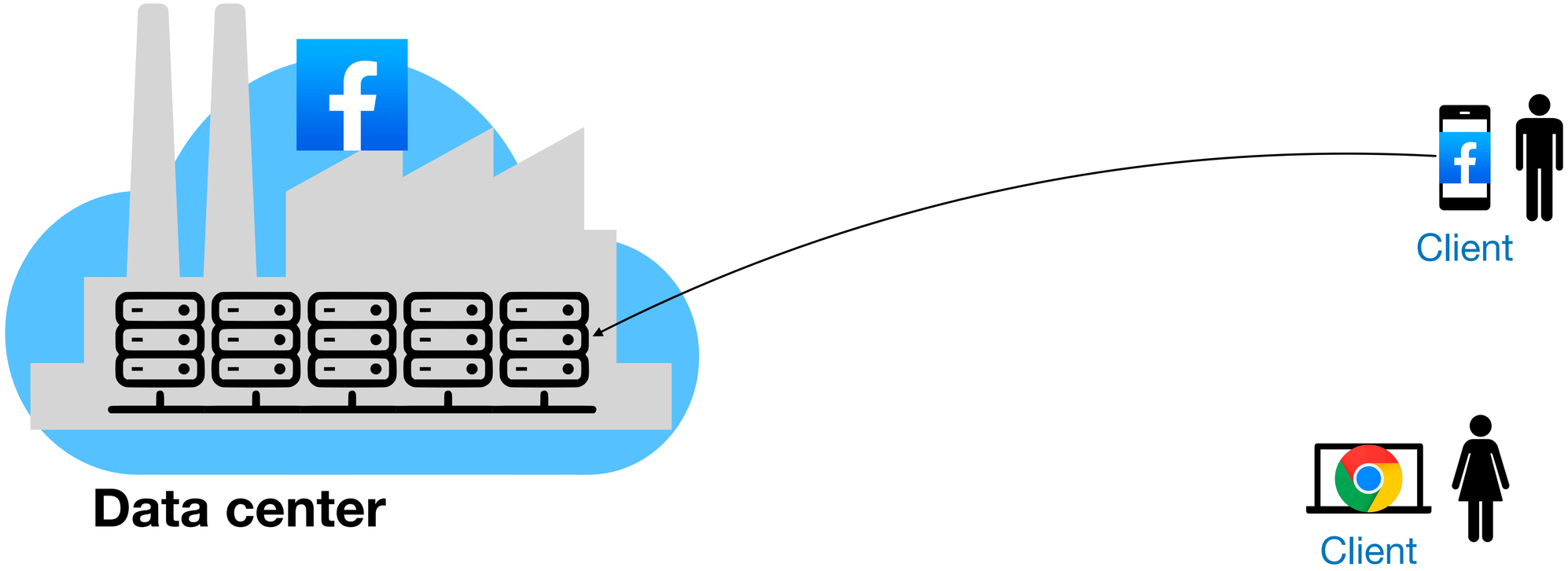
Data center

Client

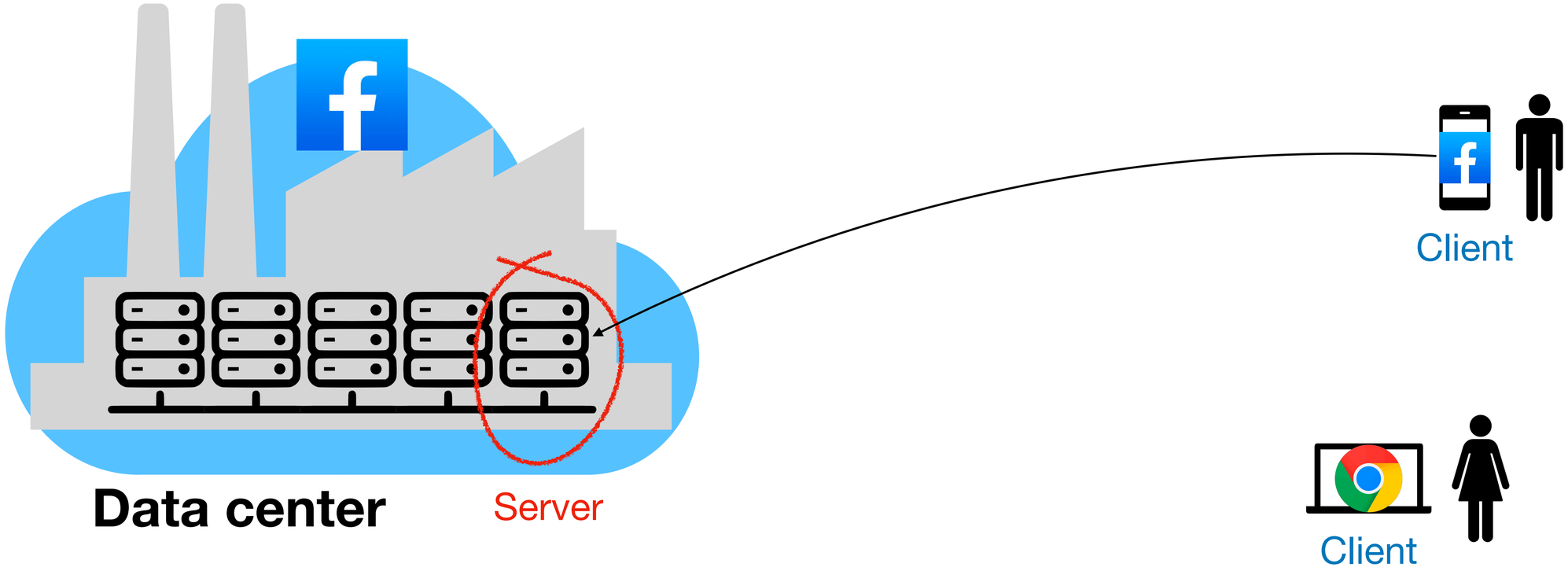


Client

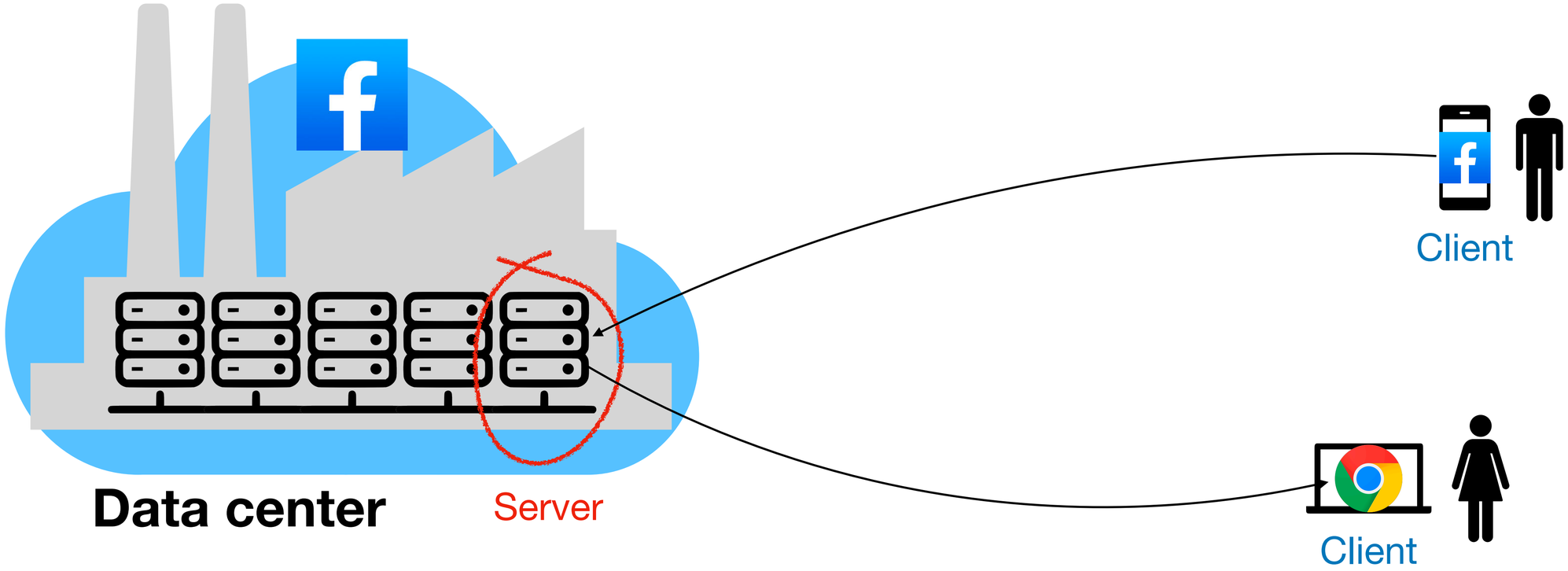
Ok, so how do I build my own cloud service?



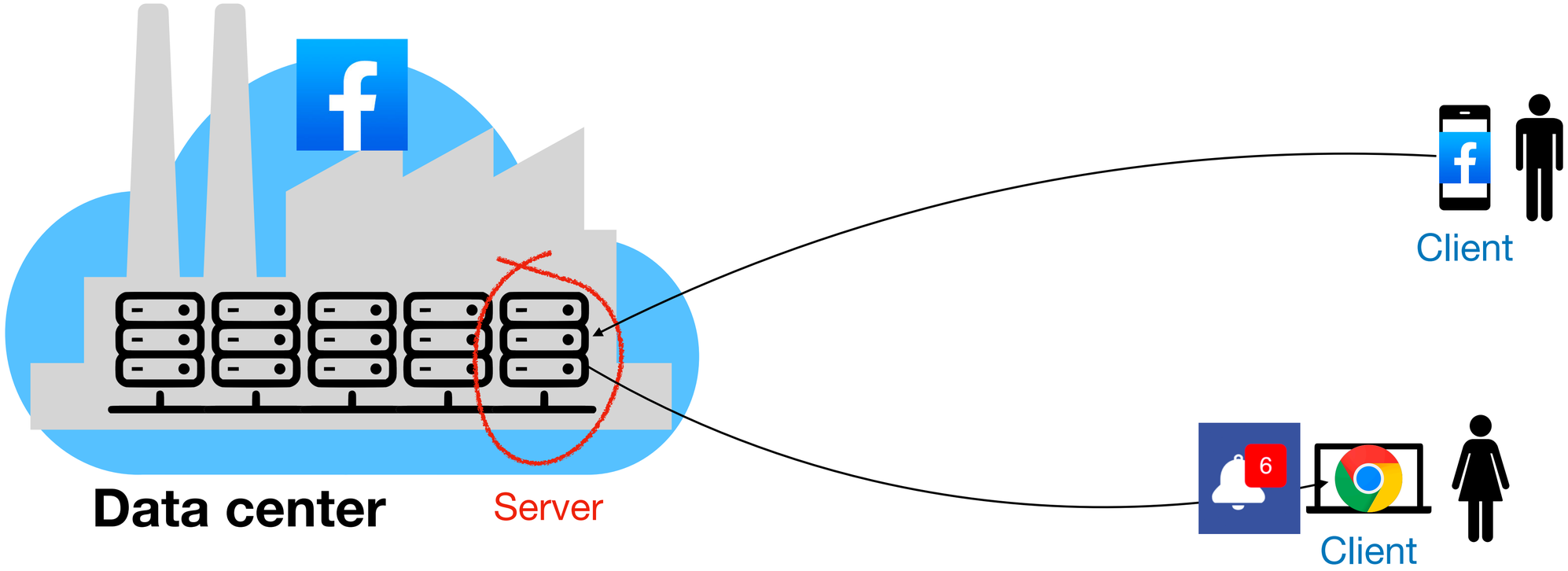
Ok, so how do I build my own cloud service?



Ok, so how do I build my own cloud service?



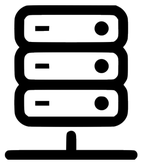
Ok, so how do I build my own cloud service?



Ok, so how do I build my own cloud service?

Ok, so how do I build my own cloud service?

In this workshop: we will build a simple chat service!



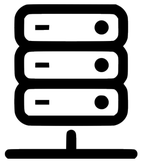
Server

Client

Ok, so how do I build my own cloud service?

In this workshop: we will build a simple chat service!

Chat Server



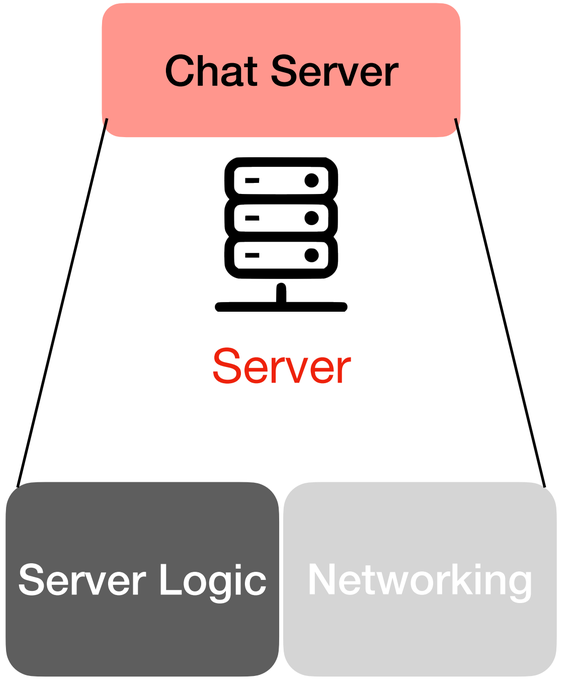
Server

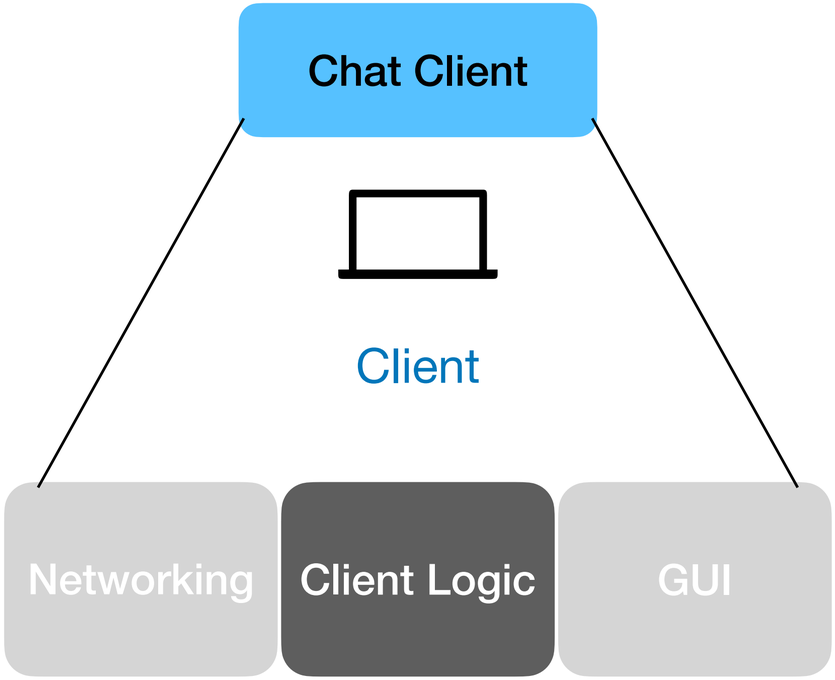
Chat Client

Client

Ok, so how do I build my own cloud service?

In this workshop: we will build a simple chat service!





Any Questions?

Live Demo!

Any Questions?

Administrivia!

Administrivia!

- **We will start building tomorrow! :-)**
  - What you should have: a computer with Python3 installed
  - If you don’t have it installed, or have trouble installing it, we will help you!

Administrivia!

- **We will start building tomorrow! :-)**
  - What you should have: a computer with Python3 installed
  - If you don’t have it installed, or have trouble installing it, we will help you!
- **Question: What OS do you plan to use: Windows, MacOS, or Linux?**
  - The instructors and TAs are well versed with each of them, so they can help you out accordingly :-)