



# *Software Unplugged*

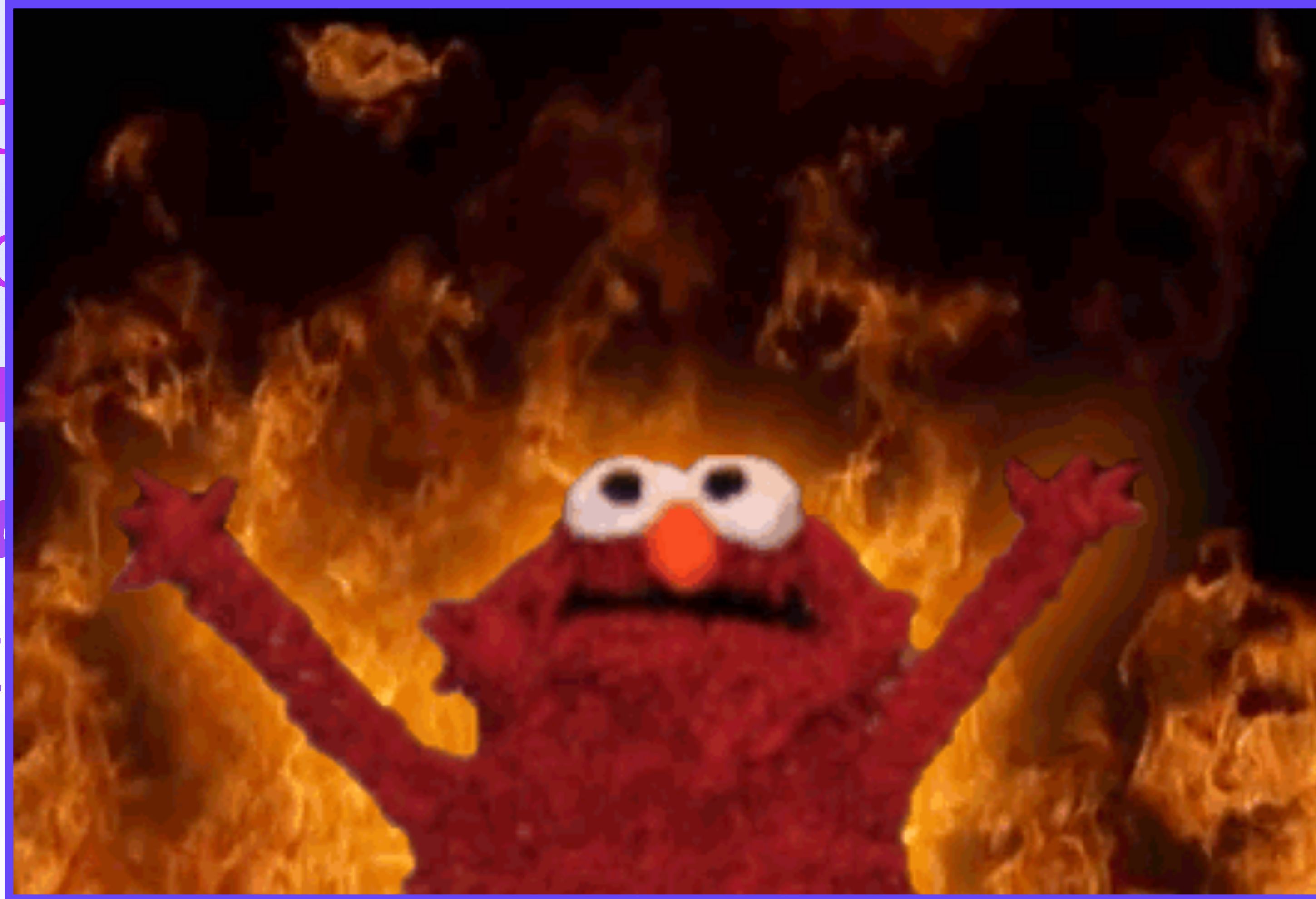
💪 Rewriting the Rules with Local-First Software ⚡



Not to be bound by certain 'obvious' methodological rules [...] is both reasonable and ***absolutely necessary for the growth of knowledge.*** [...] There are always circumstances when it is advisable not only to ignore the rule, but to ***adopt its opposite.***

– **Paul Feyerabend**, Against Method

No  
methodo  
**absolu**  
**knowled**  
when it



us'  
able and  
**rowth of**  
instances  
the rule,

– **Paul Feyerabend**, Against Method

Software Unplugged

***Brooklyn Zelenka @expede***

Software Unplugged

**Brooklyn Zelenka @expede**



[github.com/expede](https://github.com/expede)

Software Unplugged

**Brooklyn Zelenka @expede**

- ◆ Senior researcher at Ink & Switch
  - ◆ Working on local-first access control
- ◆ Witchcraft Software
- ◆ Editor @ UCAN Spec Working Group
- ◆ IPVMM: Decentralised & Trustless Execution
- ◆ PLs and DS are my jam 🙌



[github.com/expede](https://github.com/expede)

Software Unplugged  
**Topics**





# Software Unplugged

## *Topics*

- ◆ **High Level:** Current State of Software
- ◆ **What is LoFi?** What's new since 2019 & context
- ◆ **Looking back:** an experience report (YMMV)
- ◆ **Looking forward:** developments for the next chapter

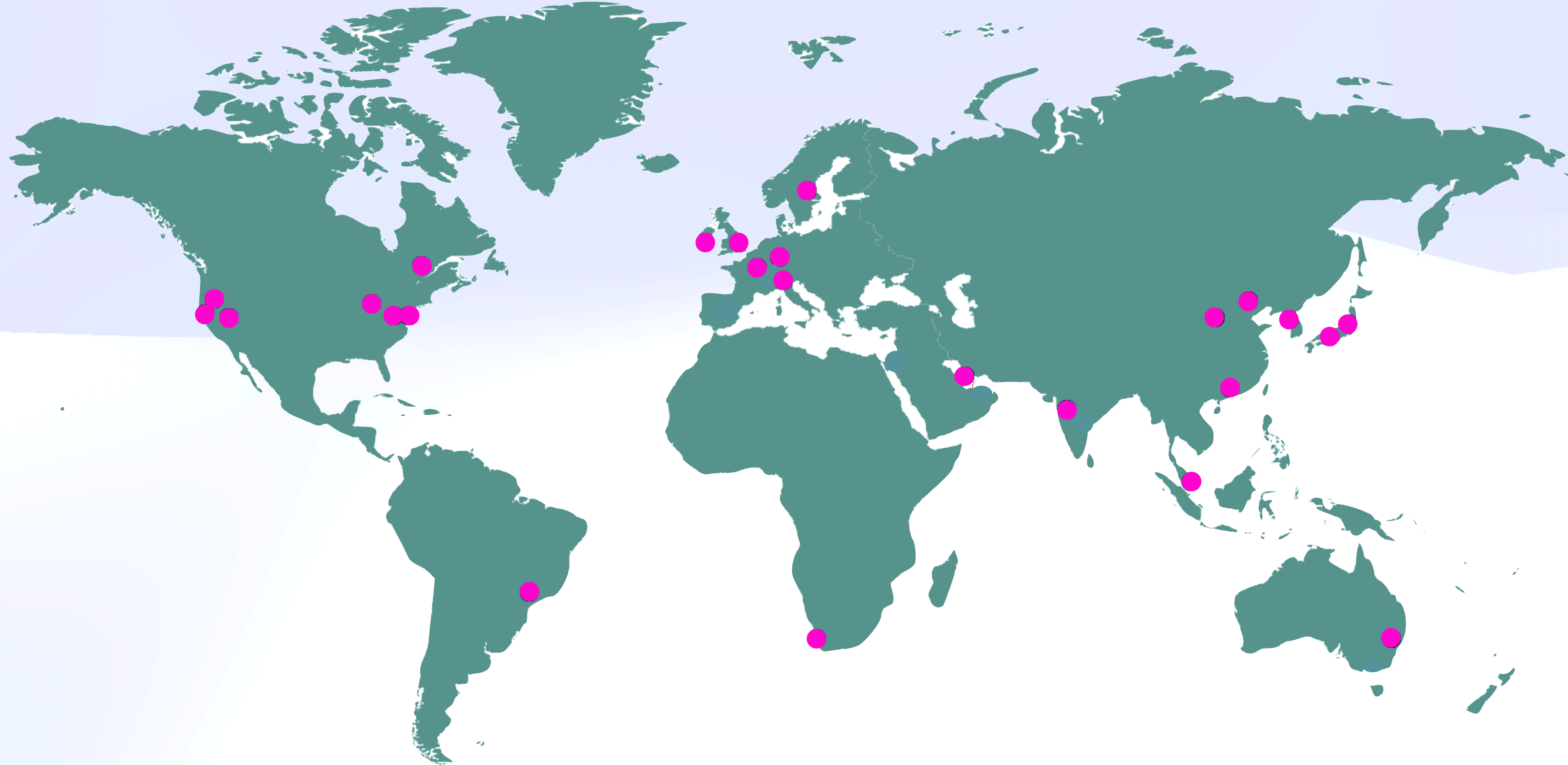


# ***Economic Weight Class***

 One Size Does Not Fit All 

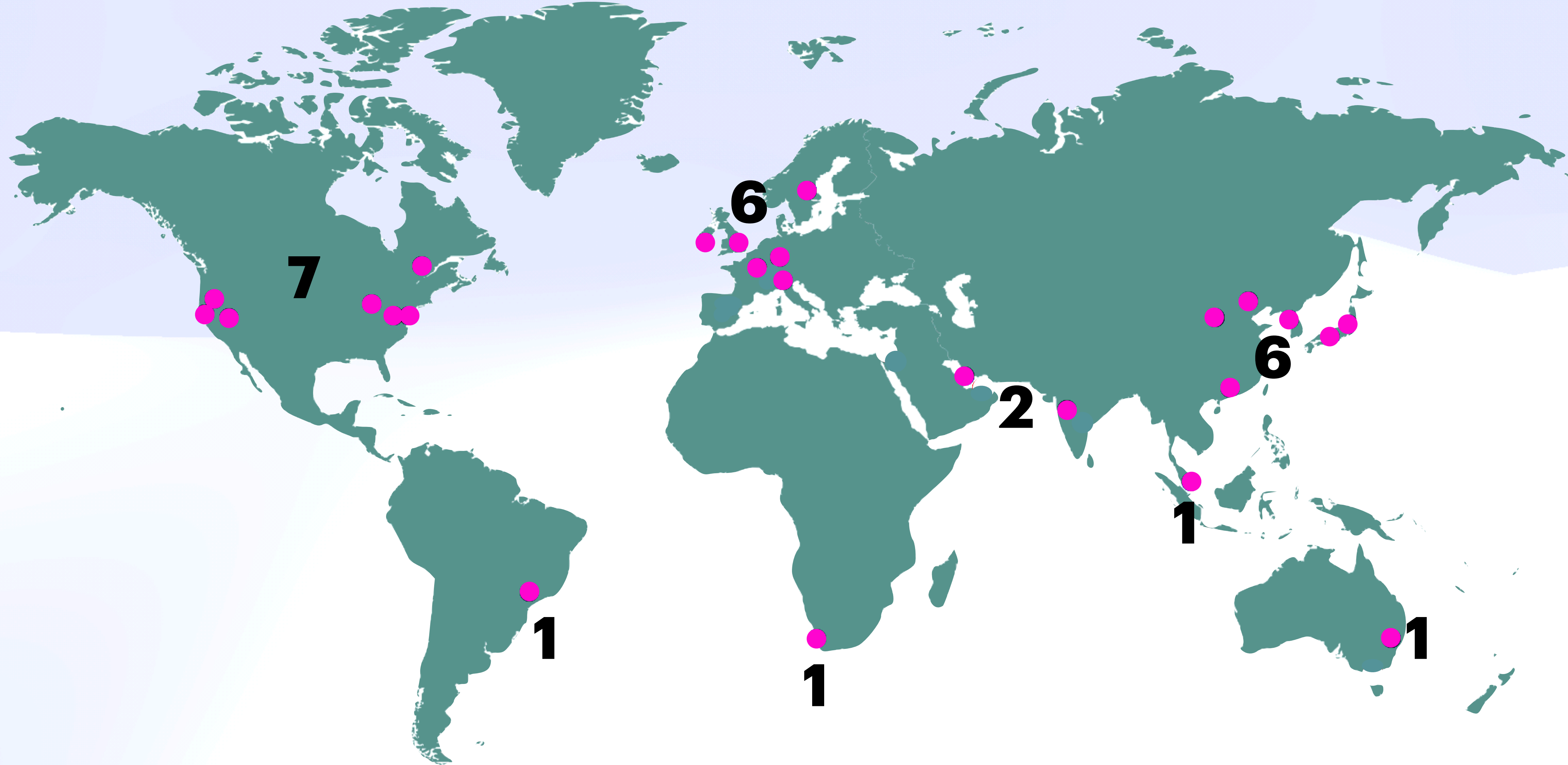
# Economic Weight Class

## *Users vs Cloud Infra*



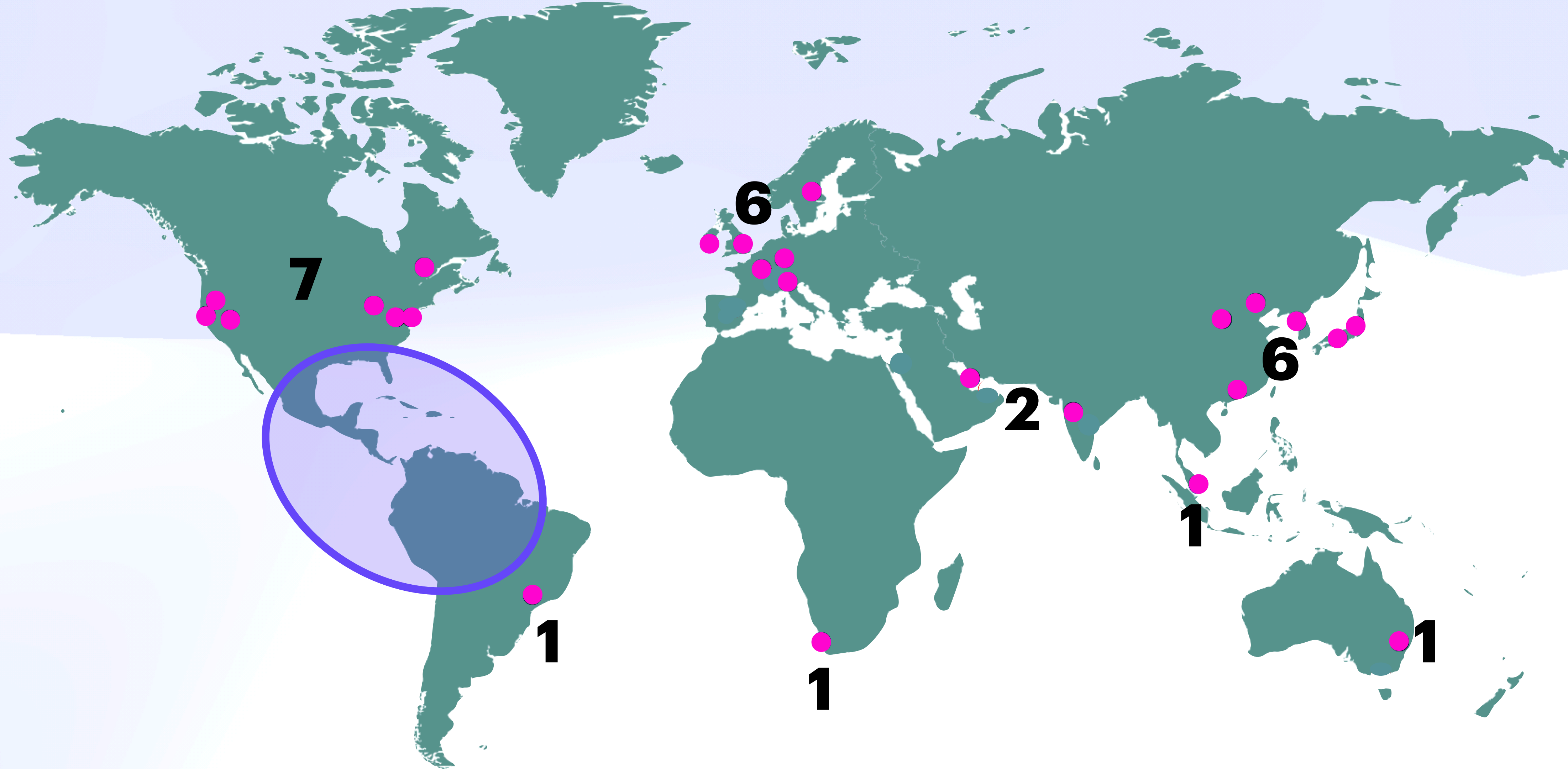
# Economic Weight Class

# *Users vs Cloud Infra*



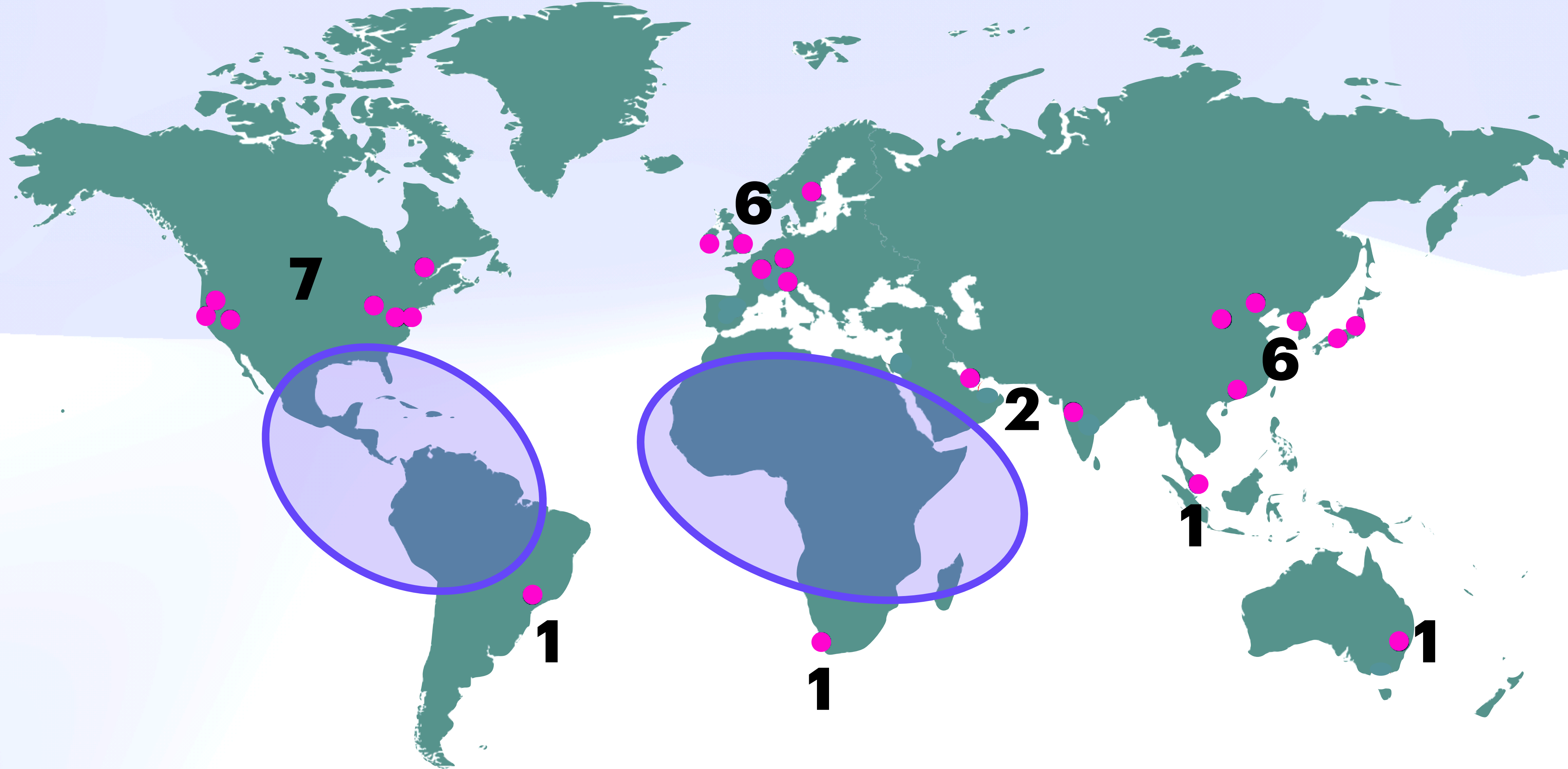
# Economic Weight Class

## *Users vs Cloud Infra*



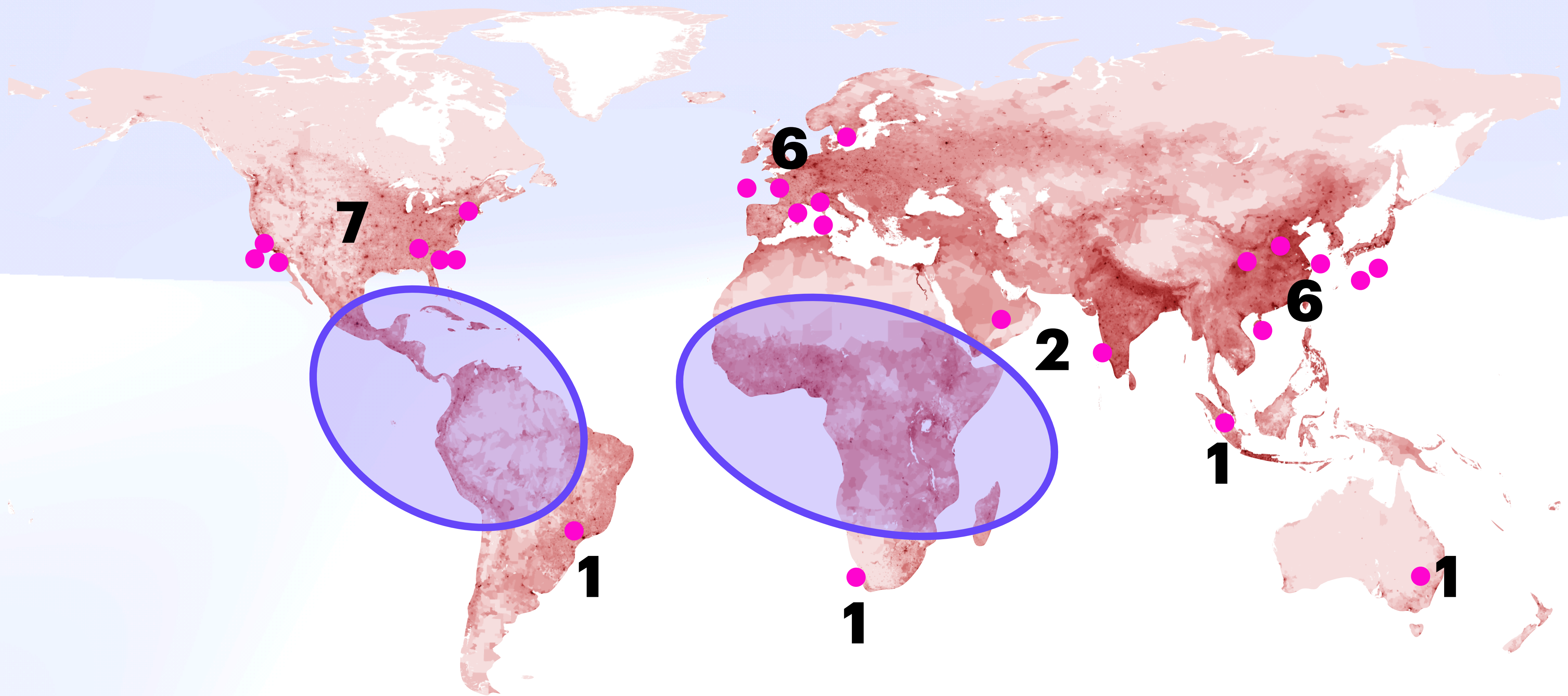
# Economic Weight Class

## *Users vs Cloud Infra*



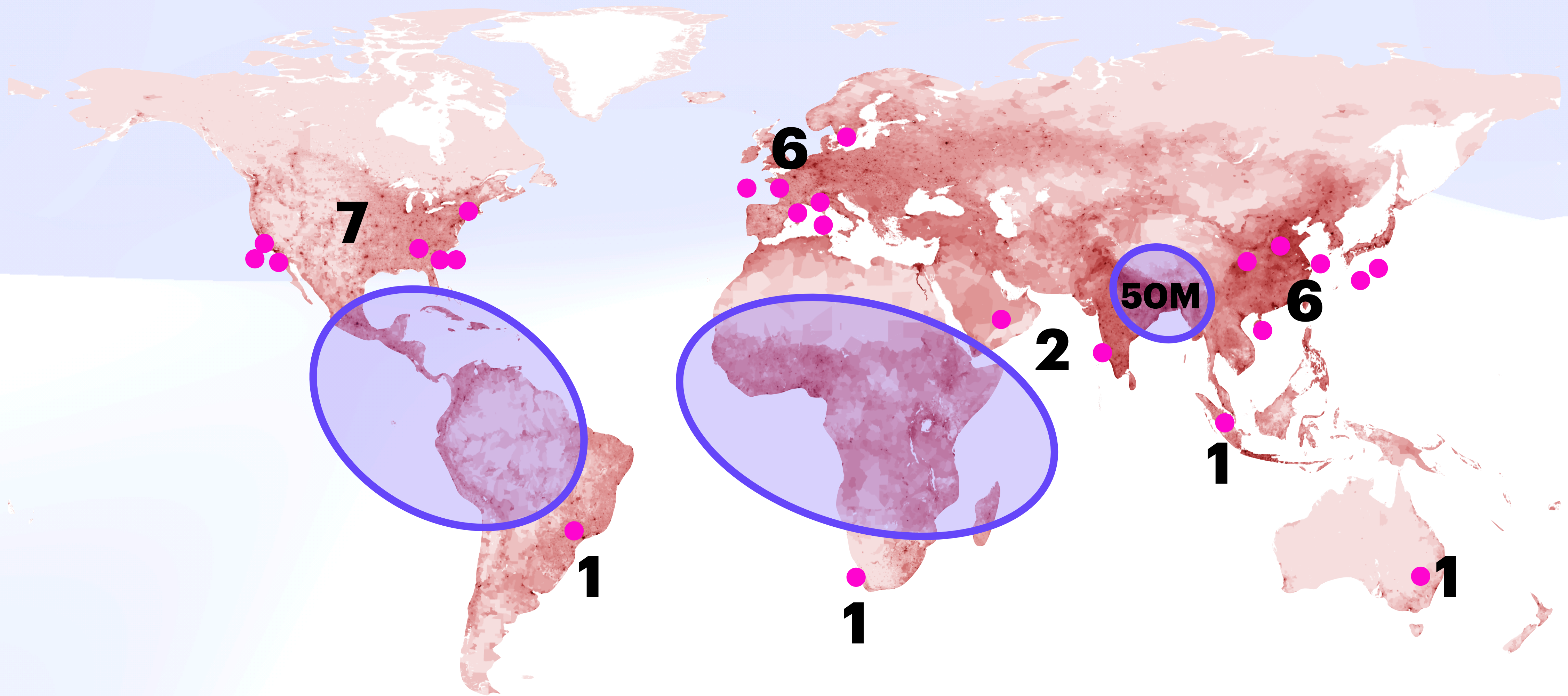
# Economic Weight Class

# *Users vs Cloud Infra*



# Economic Weight Class

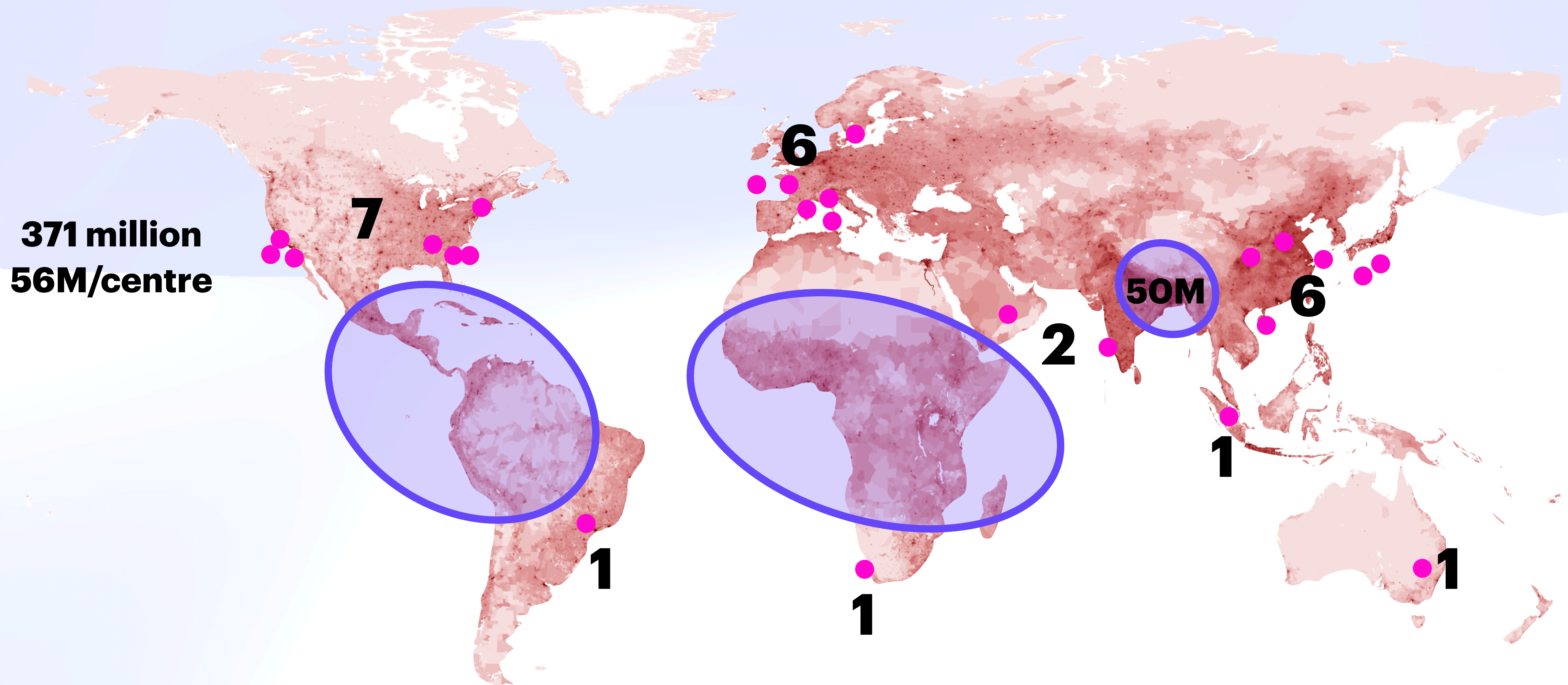
# *Users vs Cloud Infra*





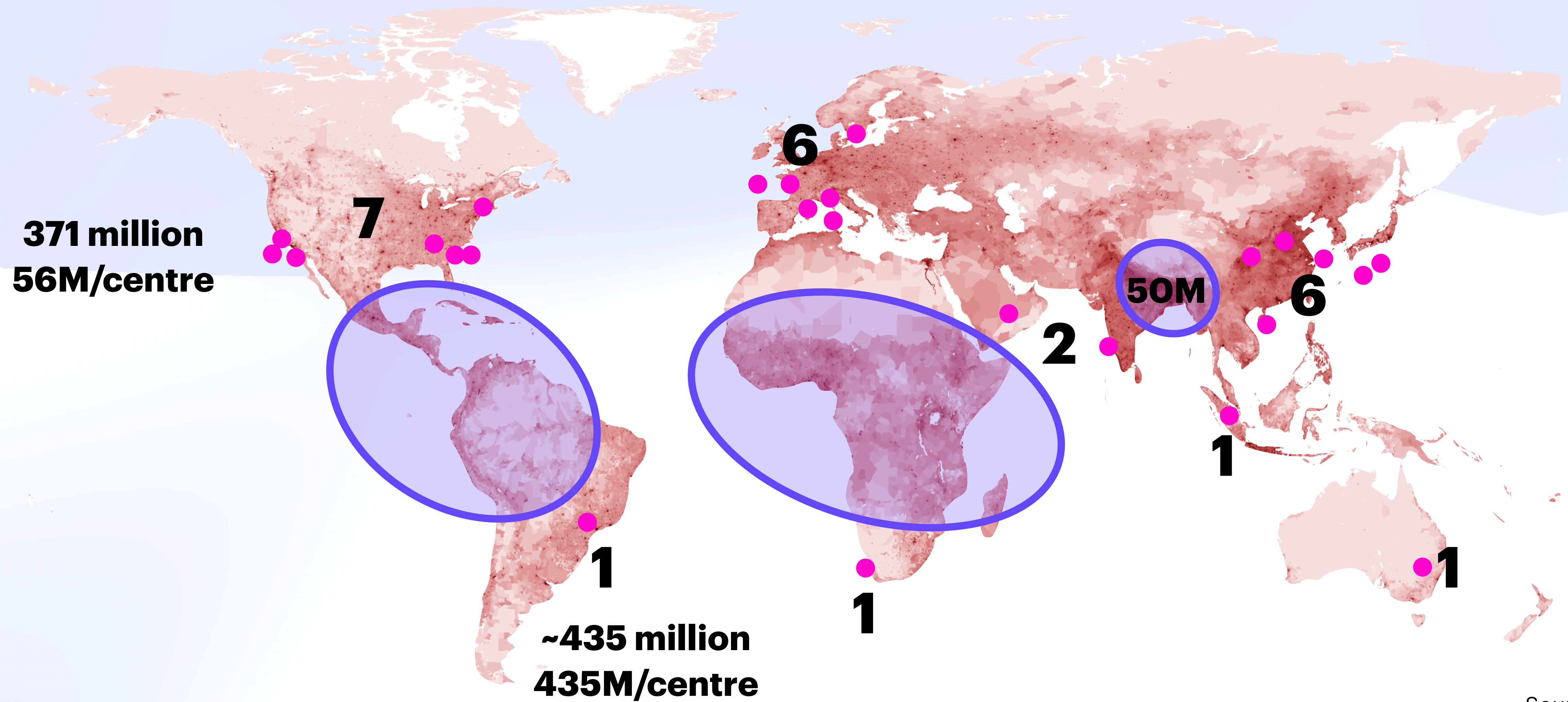
# Economic Weight Class

## *Users vs Cloud Infra*



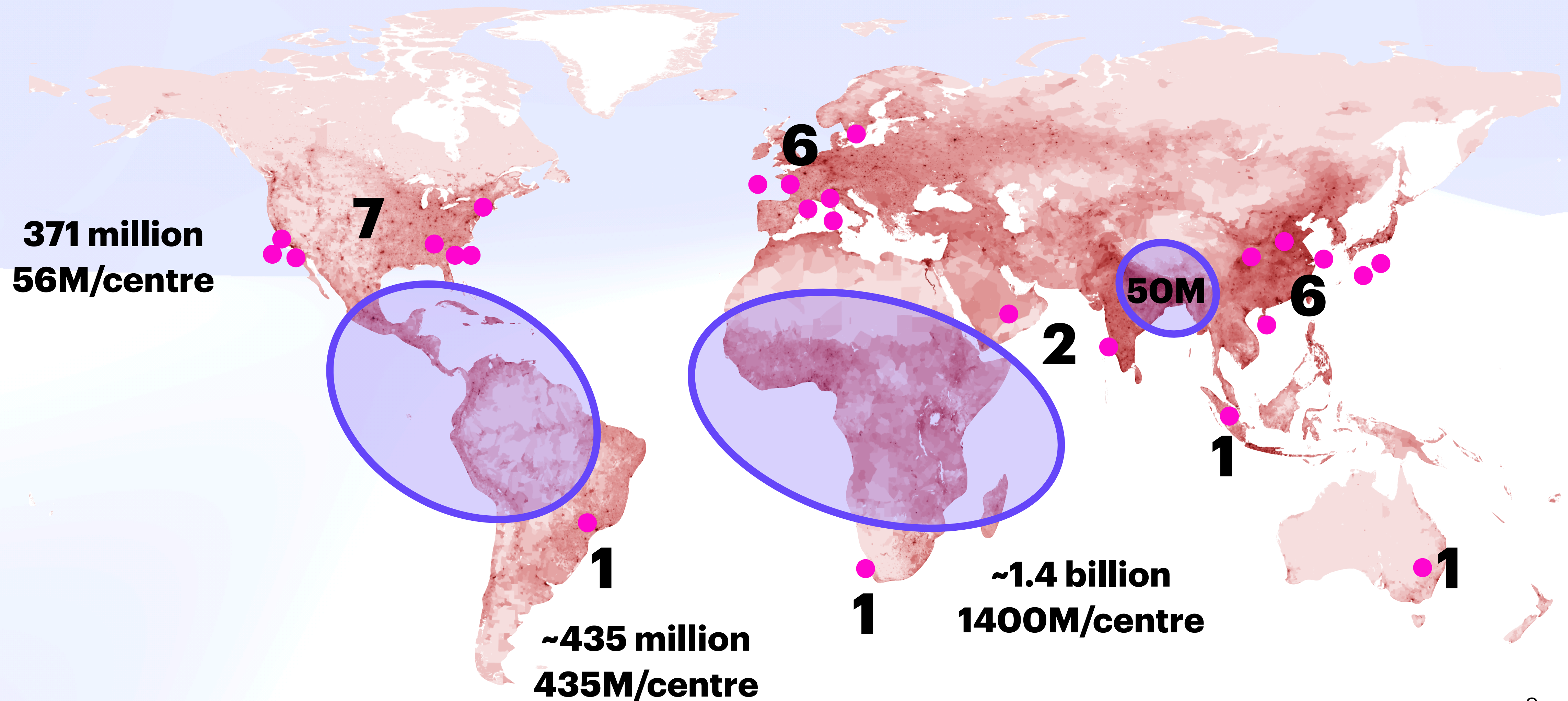
# Economic Weight Class

## *Users vs Cloud Infra*



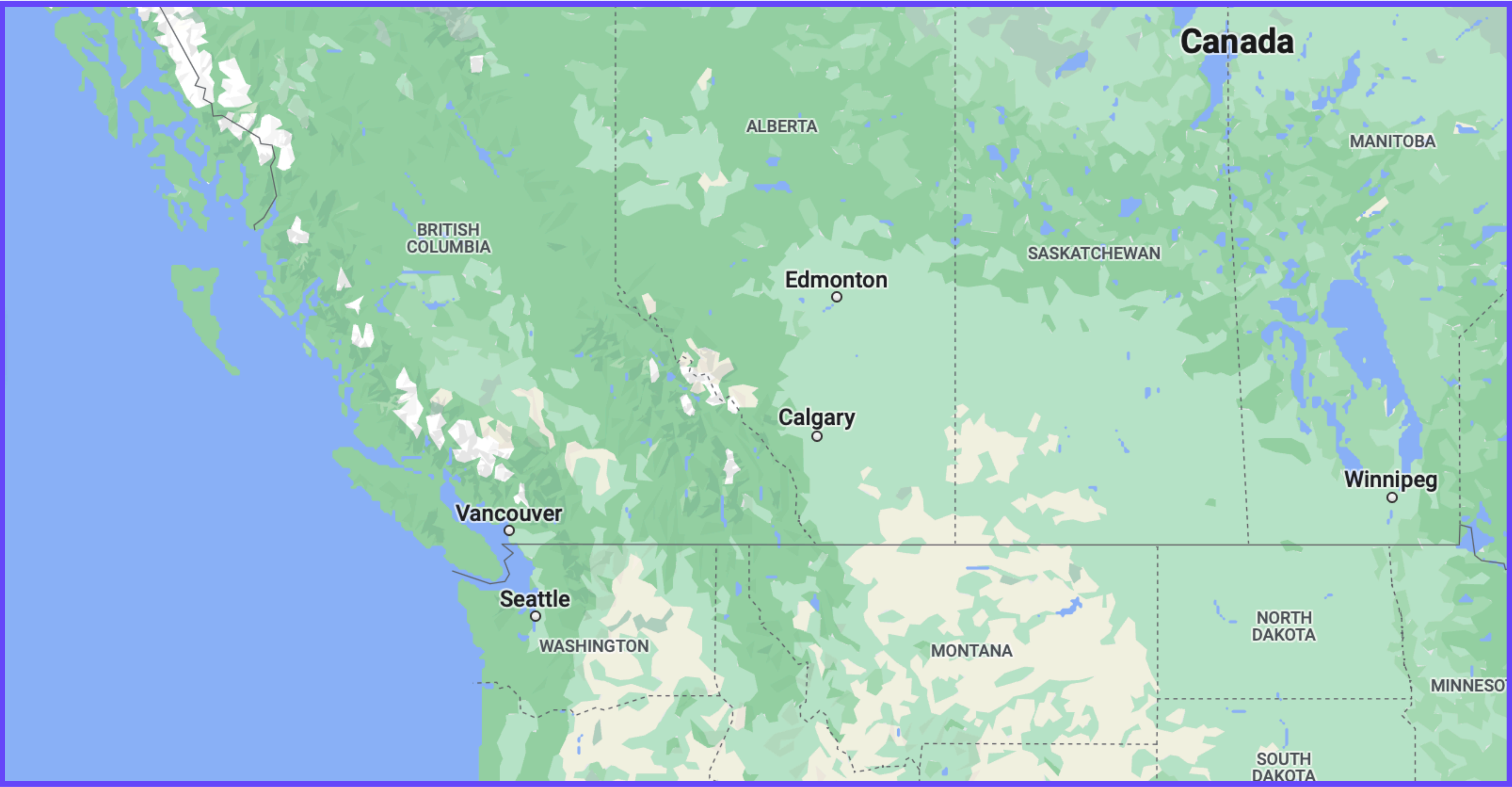
# Economic Weight Class

## *Users vs Cloud Infra*



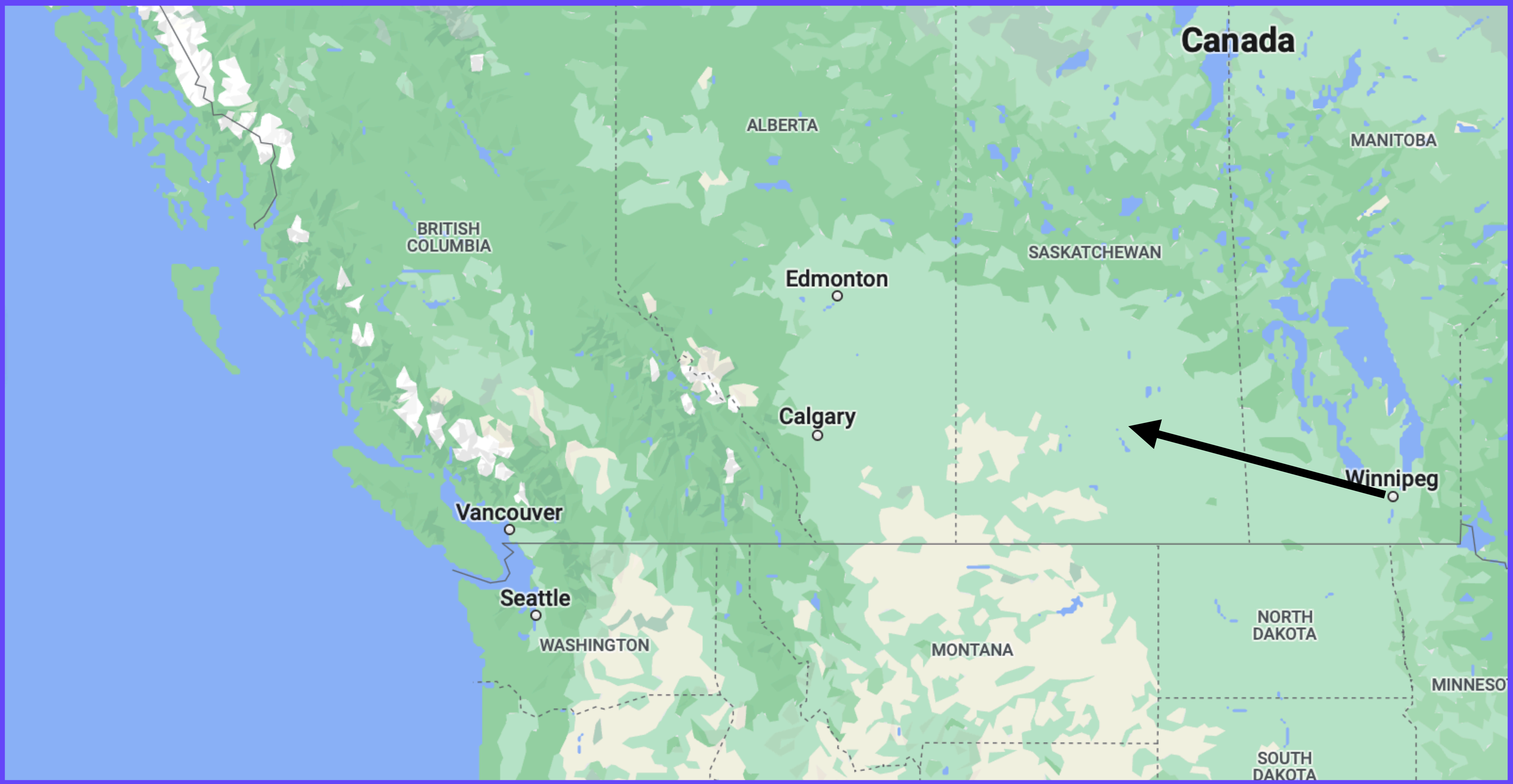
# Economic Weight Class

# *Sending a "Direct" Message in 2024*



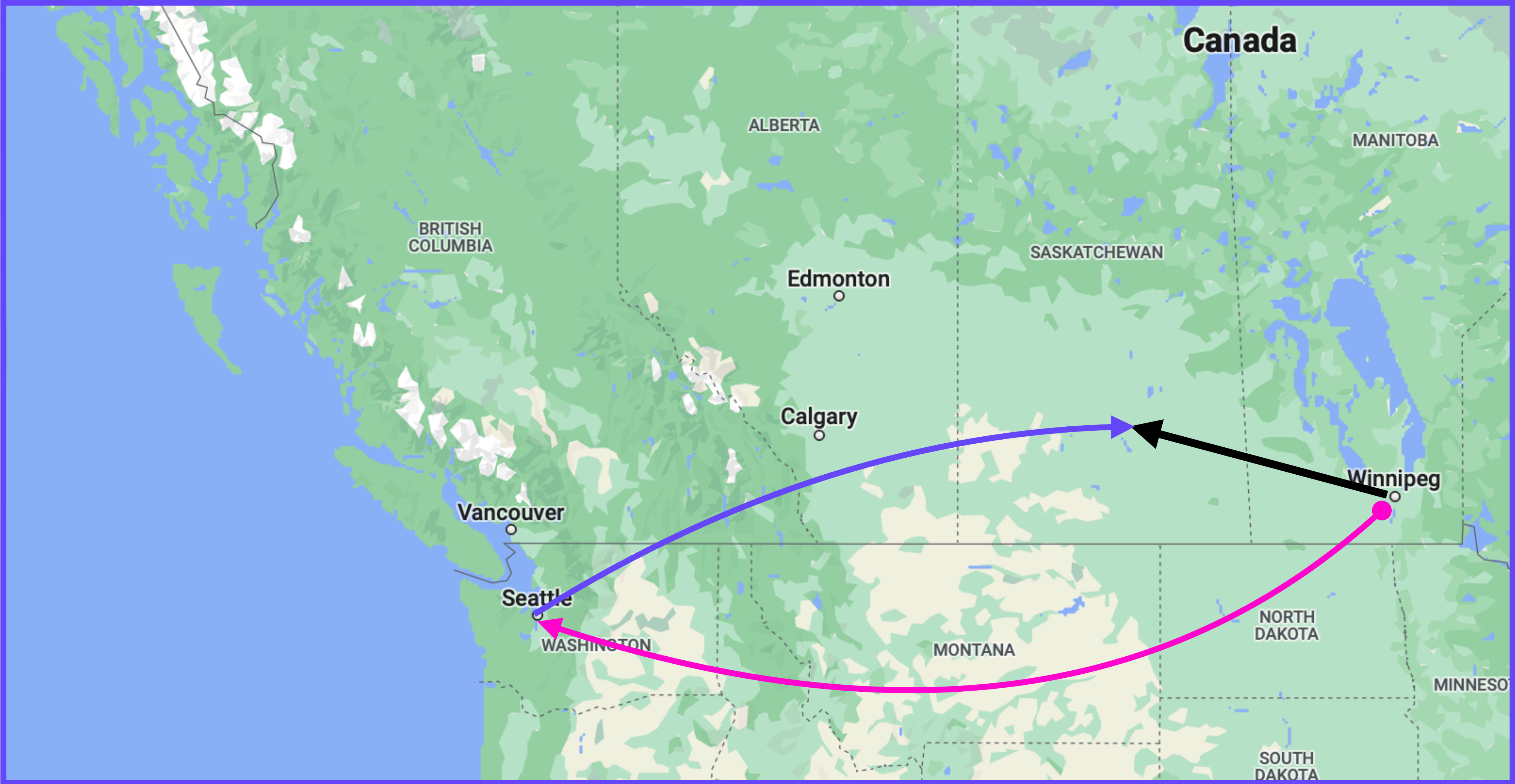
# Economic Weight Class

# *Sending a "Direct" Message in 2024*



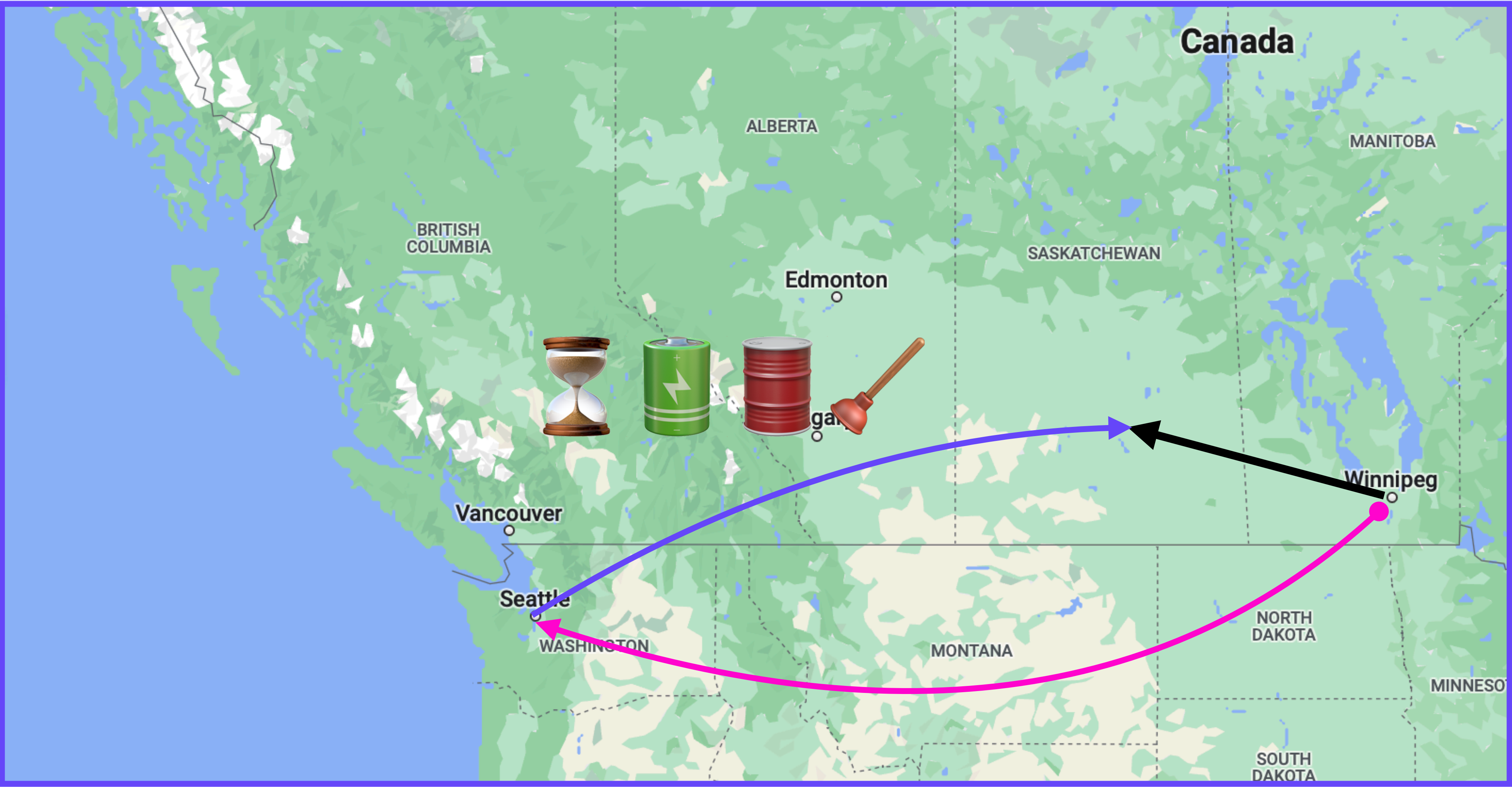
# Economic Weight Class

# *Sending a "Direct" Message in 2024*



# Economic Weight Class

# *Sending a "Direct" Message in 2024*



Economic Weight Class

***Consequences*** 



Economic Weight Class

# *Consequences* 🍂

- Single source of truth ("**the**" database)

## Economic Weight Class

# *Consequences* 🍂

- Single source of truth ("**the**" database)

- Server-centric



- "Full stack development"

- DevOps, Docker, k8s

- How to train enough engineers?

## Economic Weight Class

# Consequences 🍂

- Single source of truth ("**the**" database)
- Server-centric
- "Full stack development"
- DevOps, Docker, k8s
- How to train enough engineers?



Economic Weight Class

***Industrial***

USS Nimitz

Crew: ~5000

Cost: >\$8.5 billion (USD)



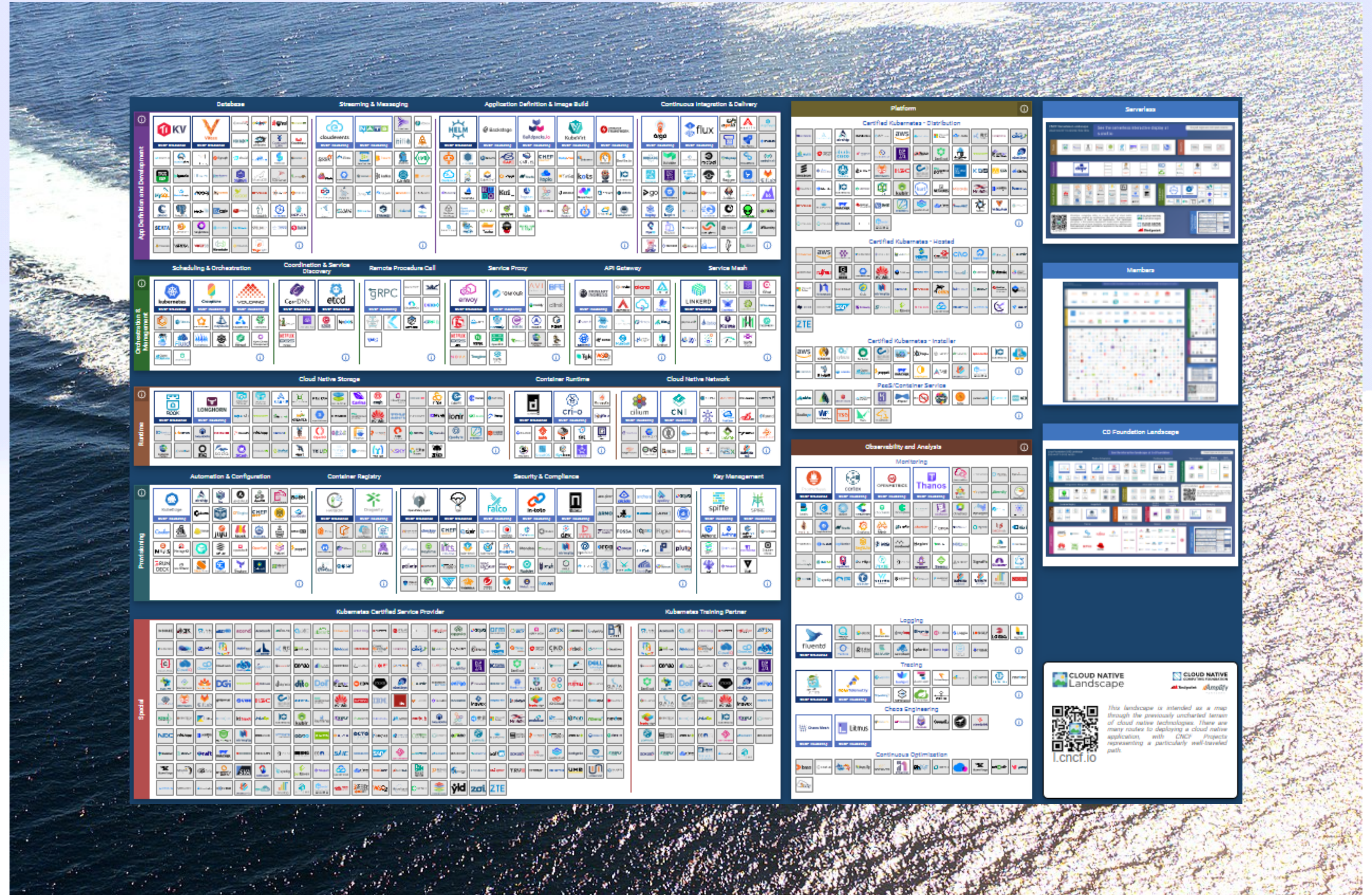
# Economic Weight Class

# Industrial

USS Nimitz


Crew: ~5000

Cost: >\$8.5 billion (USD)





# Economic Weight Class


# *An Incredible Journey... Into a Dark Age*


 Killed by Google


Search  All (295) ▾

 **Google Jamboard**  
December 2024  
App  
Off to the glue factory in 5 months, Google Jamboard was a web and native whiteboard app that offered a rich collaborative experience. It will be about 8 years old.

 **Jamboard**  
September 2024  
Hardware  
Scheduled to be killed in 2 months, Jamboard was a digital 4K touchscreen whiteboard device that allowed to collaborate using Google Workspace services. It will be over 7 years old.

 **VPN by Google One**  
2020 - 2024  
Service  
Killed about 1 month ago, VPN by Google One was a virtual private network service that provided users encrypted transit of their data and network activity and allowed them to mask their IP address. It was over 3 years old.

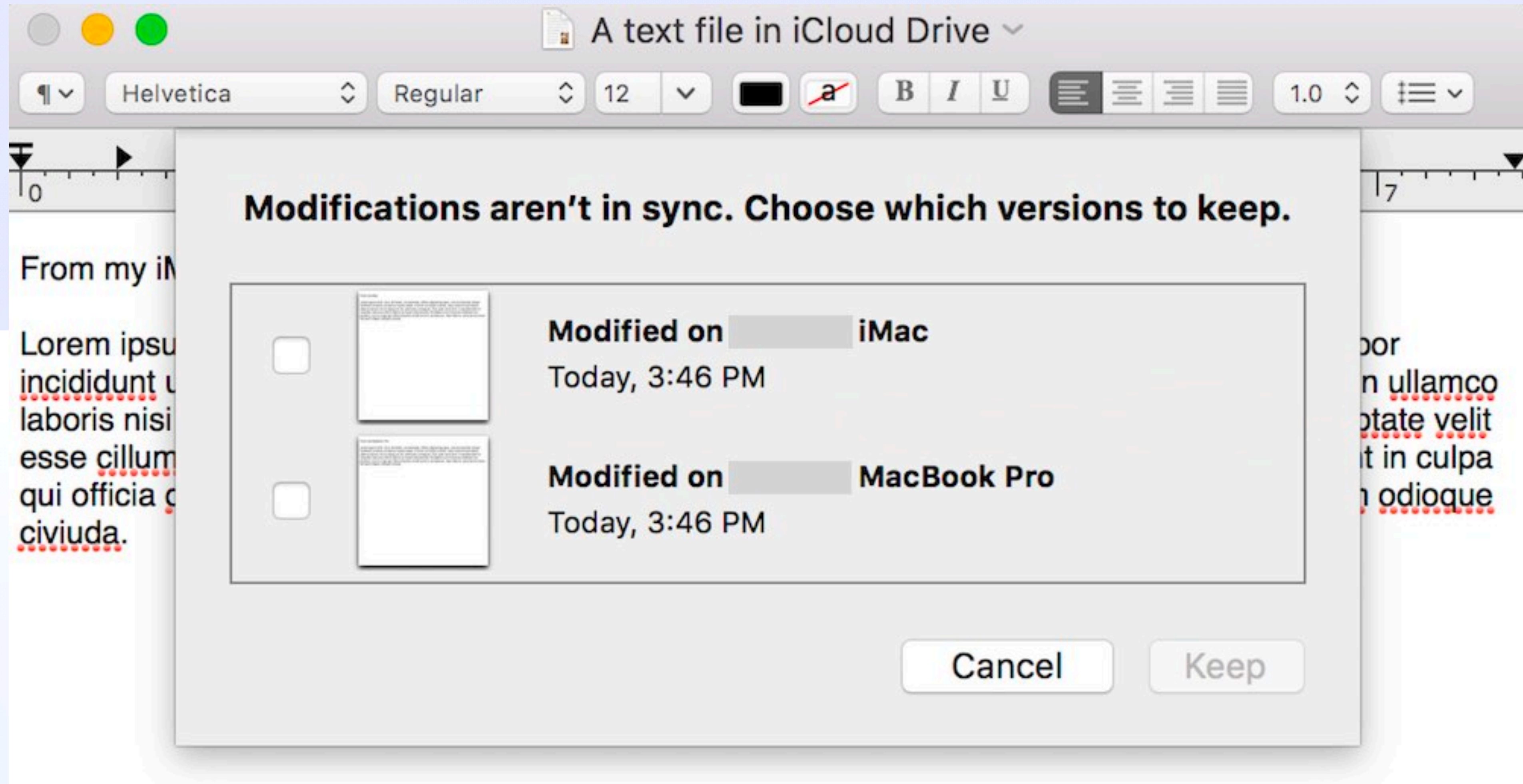
 **DropCam**  
2009 - 2024  
Hardware  
Killed 4 months ago, Dropcam was a line of Wi-Fi video streaming cameras acquired by Google in 2014. It was about 15 years old.

 **Google Podcasts**  
2018 - 2024  
App  
Killed 4 months ago, Google Podcasts was a podcast hosting platform and an Android podcast listening app. It was almost 6 years old.



# Economic Weight Class

# *Objectivist Ergonomics*



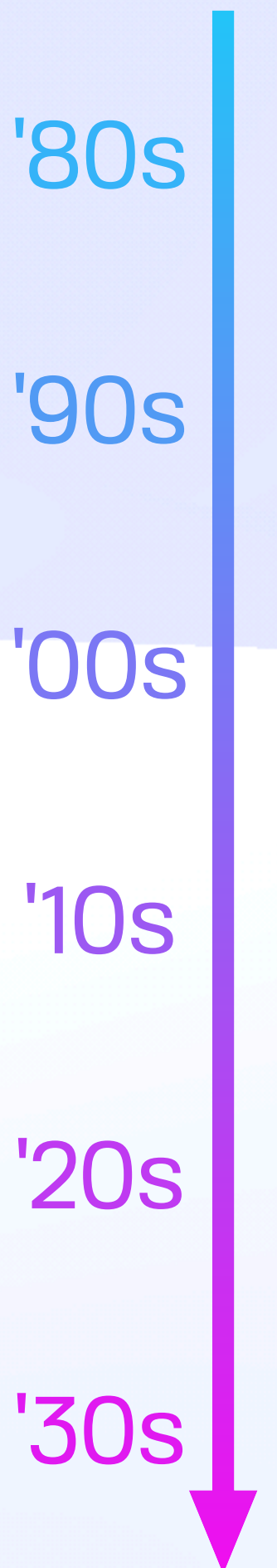
Economic Weight Class

# ***What If Computing Were Interpersonal?***



# Economic Weight Class

# *What If Computing Were Interpersonal?*



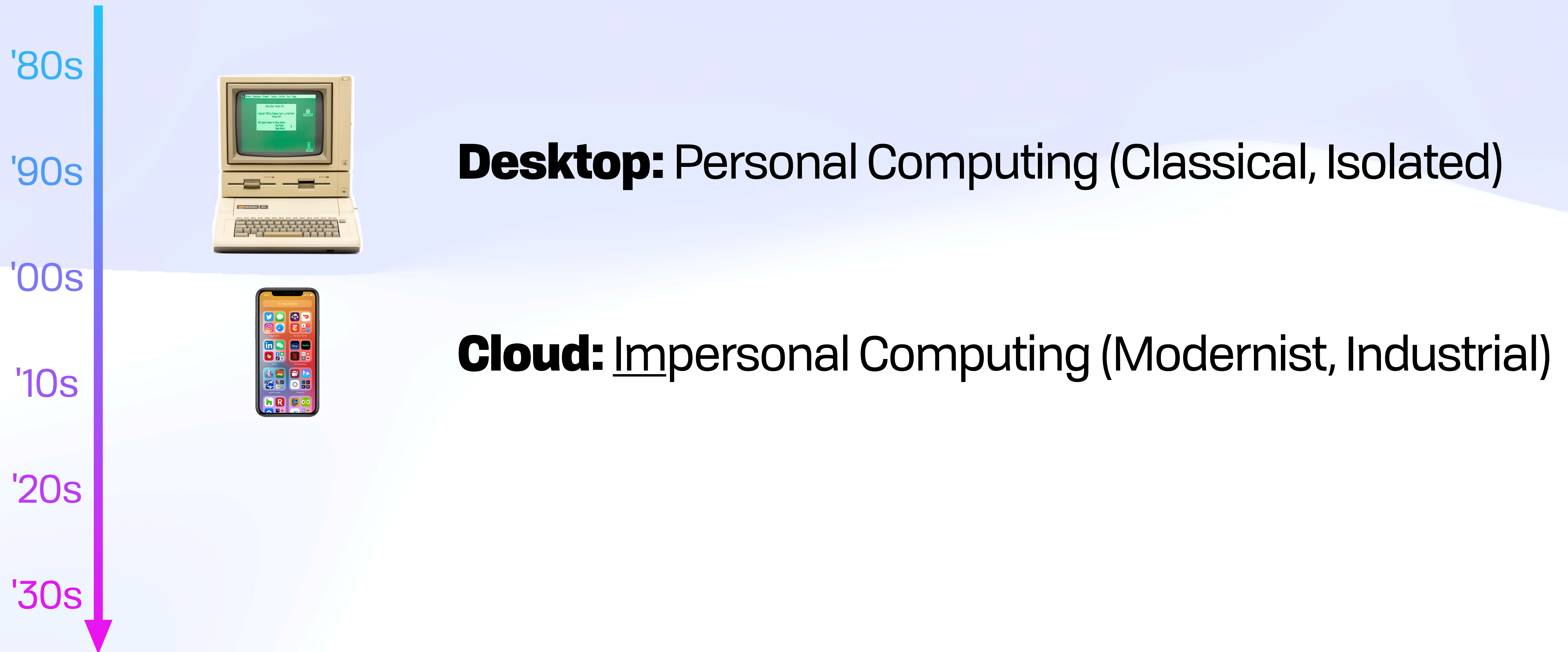
# Economic Weight Class

## *What If Computing Were Interpersonal?*



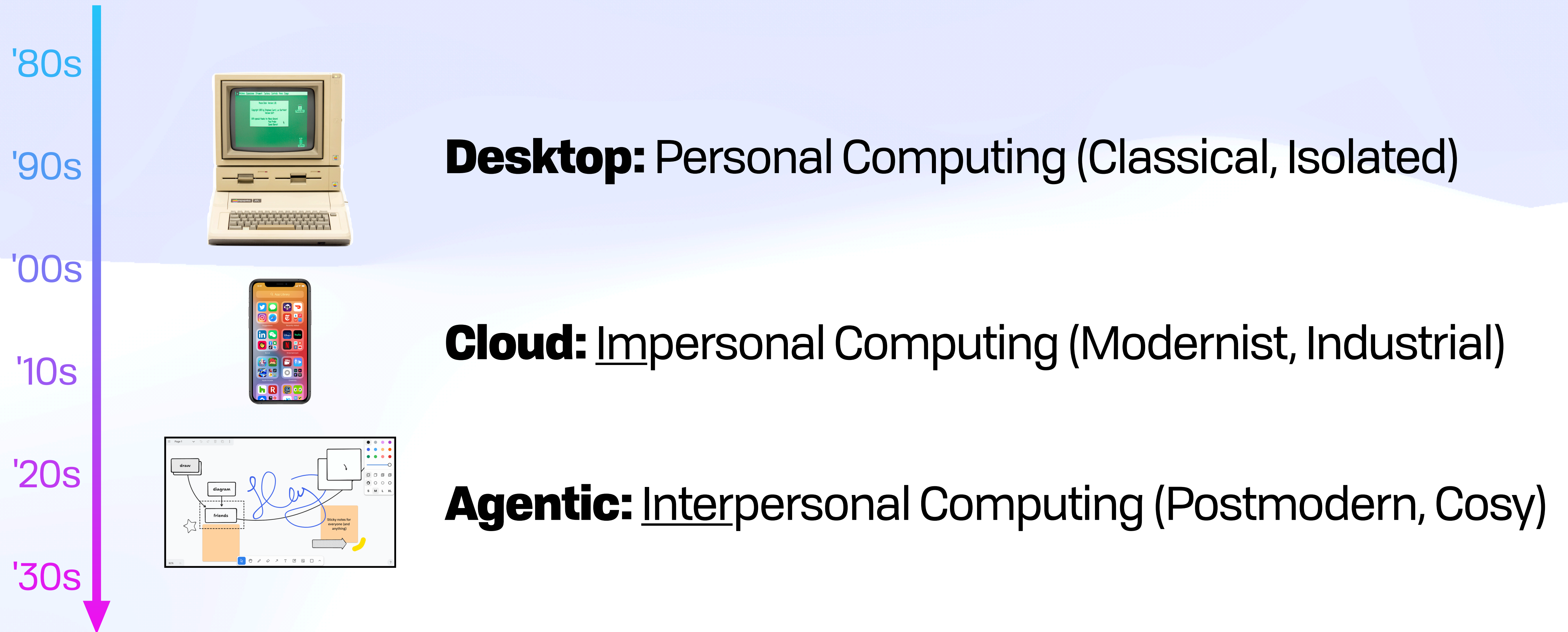
# Economic Weight Class

## *What If Computing Were Interpersonal?*



# Economic Weight Class

## *What If Computing Were Interpersonal?*



# Economic Weight Class

***Human***

A bike  
Crew: 1  
Cost: <\$8.5 billion (USD)



Economic Weight Class

# ***Solving Lamport's Problem***

Economic Weight Class

## ***Solving Lamport's Problem***

A distributed system is one in which the failure of a computer you didn't even know existed can ***render your own computer unusable***

— Leslie Lamport

Economic Weight Class

## ***Solving Lamport's Problem***

A distributed system is one in which the failure of a computer you didn't even know existed can ***render your own computer unusable***

— Leslie Lamport

...by this definition,

***LoFi isn't a distributed system*** 🤔

— Martin Kleppmann



Economic Weight Class

# ***A Litmus Test***

...by this definition,

***LoFi isn't a distributed system*** 

— Martin Kleppmann

# *Local-First*

Convenience, Idealism, and Movement Building



Local-First

***Local-First, Not Local-Only***

Local-First

# *Local-First, Not Local-Only*



Local-First

***Local-First, Not Local-Only***



Local-First

# ***Orienting Philosophy***

## Seven ideals for local-first software

1. No spinners: your work at your fingertips
2. Your work is not trapped on one device
3. The network is optional
4. Seamless collaboration with your colleagues
5. The Long Now
6. Security and privacy by default
7. You retain ultimate ownership and control

Local-First

# ***Orienting Philosophy***

## Seven ideals for local-first software

1. No spinners: your work at your fingertips
2. Your work is not trapped on one device
3. The network is optional
4. Seamless collaboration with your colleagues
5. The Long Now
6. Security and privacy by default
7. You retain ultimate ownership and control

Local-First

# ***Orienting Philosophy***

## Seven ideals for local-first software

1. No spinners: your work at your fingertips
2. Your work is not trapped on one device
3. The network is optional
4. Seamless collaboration with your colleagues
5. The Long Now
6. Security and privacy by default
7. You retain ultimate ownership and control



Local-First

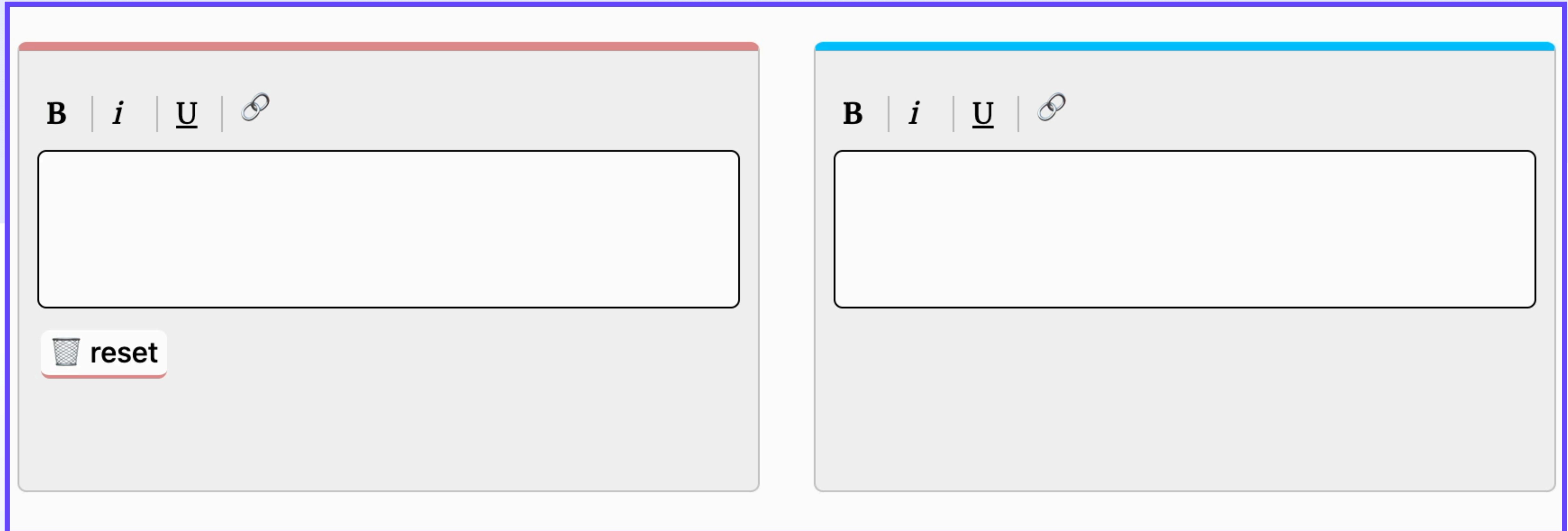
# ***Orienting Philosophy***

## Seven ideals for local-first software

1. No spinners: your work at your fingertips
2. Your work is not trapped on one device
3. The network is optional
4. Seamless collaboration with your colleagues
5. The Long Now
6. Security and privacy by default
7. You retain ultimate ownership and control

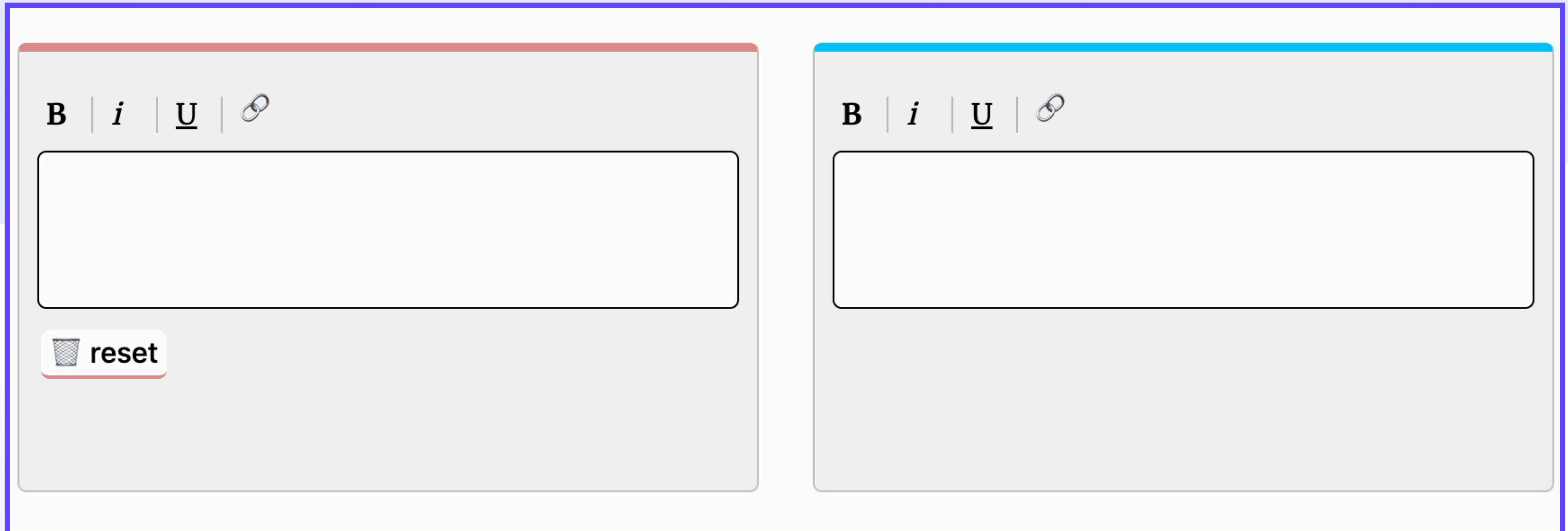
Local-First

# Enabling Tech: CRDTs



Local-First

# Enabling Tech: CRDTs



Local-First

~~***Just Enough To Be Dangerous!***~~

Local-First

# ~~Just Enough To Be Dangerous!~~

Users 

Developer 

Local-First

# ~~Just Enough To Be Dangerous!~~

Users 

Browser 

REST / JSON-RPC / GraphQL 

Server 

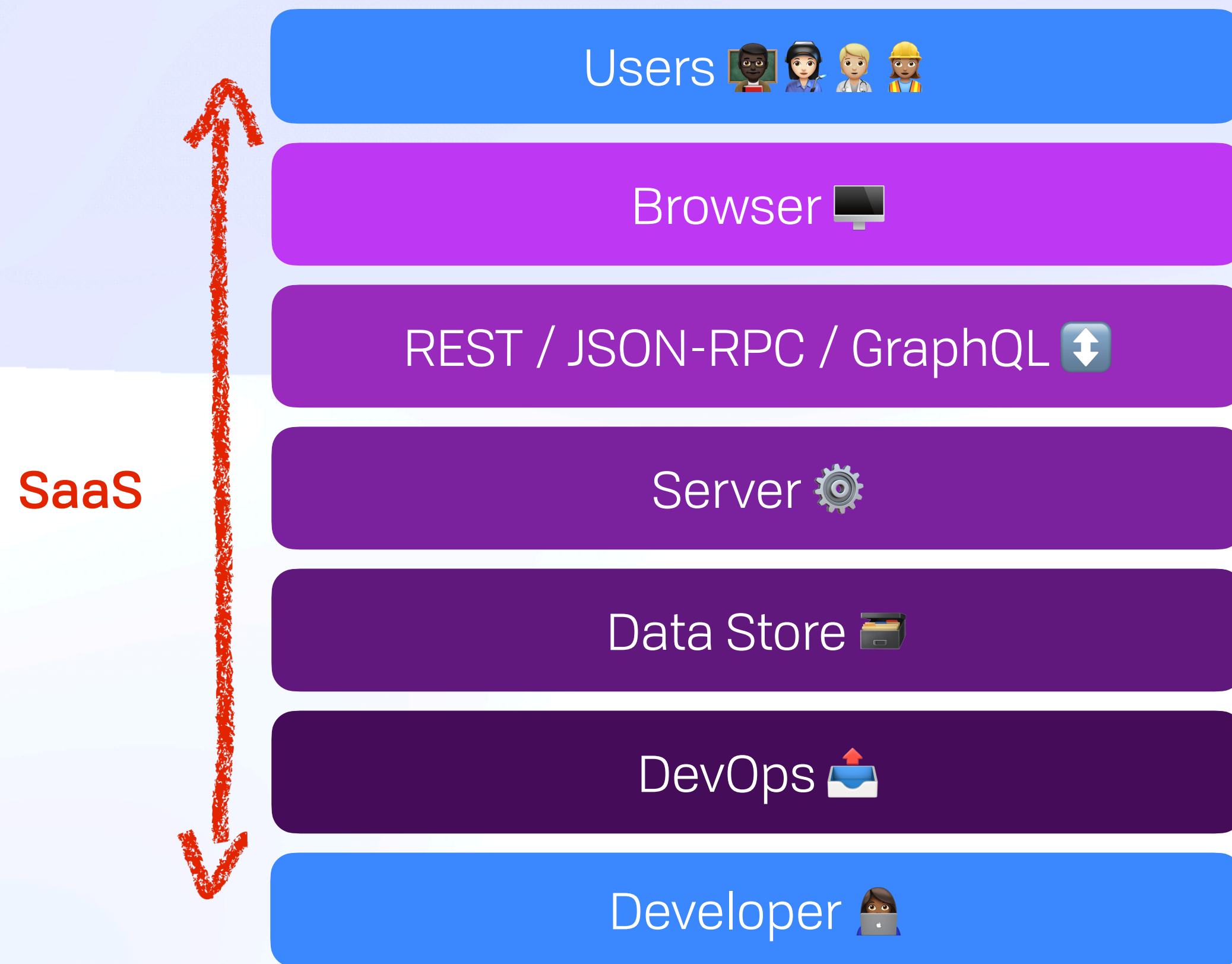
Data Store 

DevOps 

Developer 

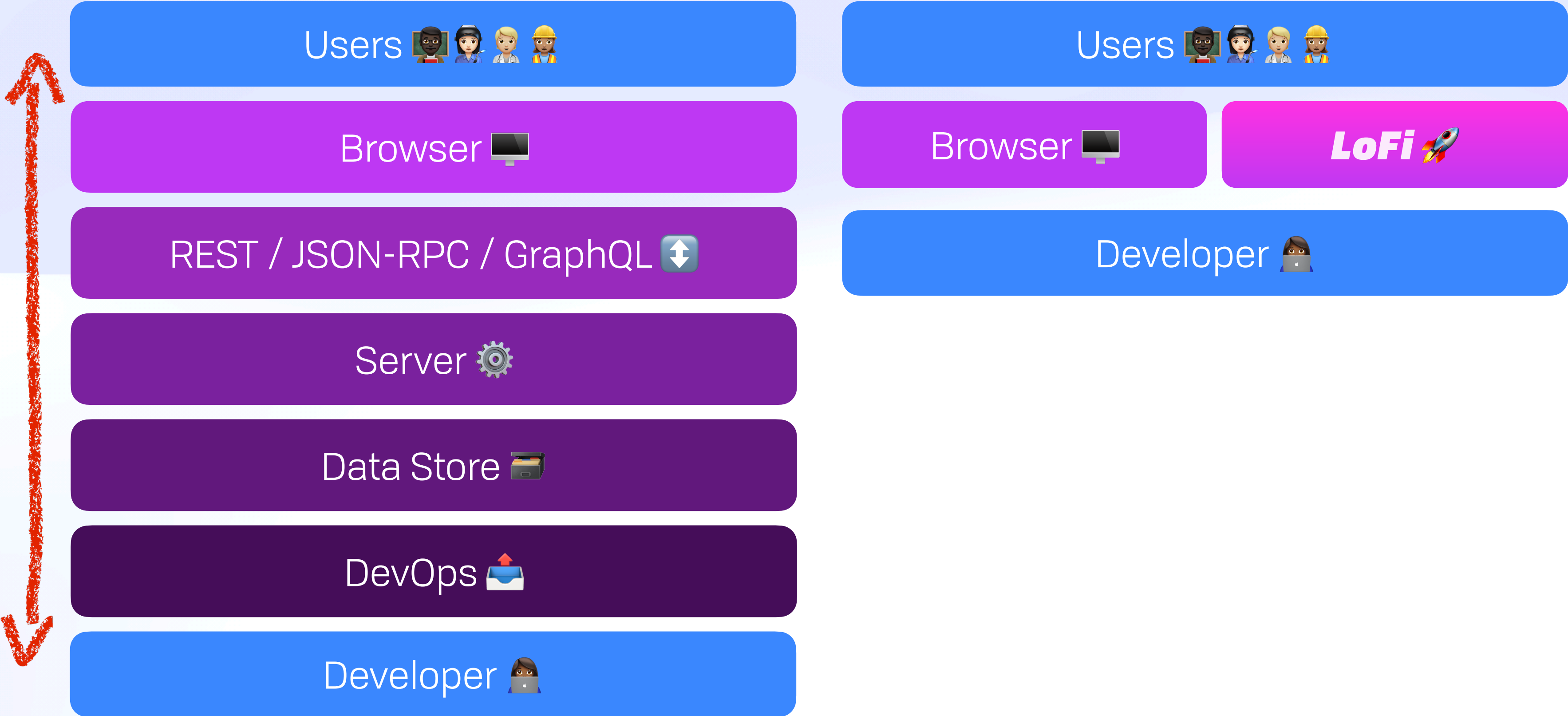
Local-First

# ~~Just Enough To Be Dangerous!~~



# Local-First

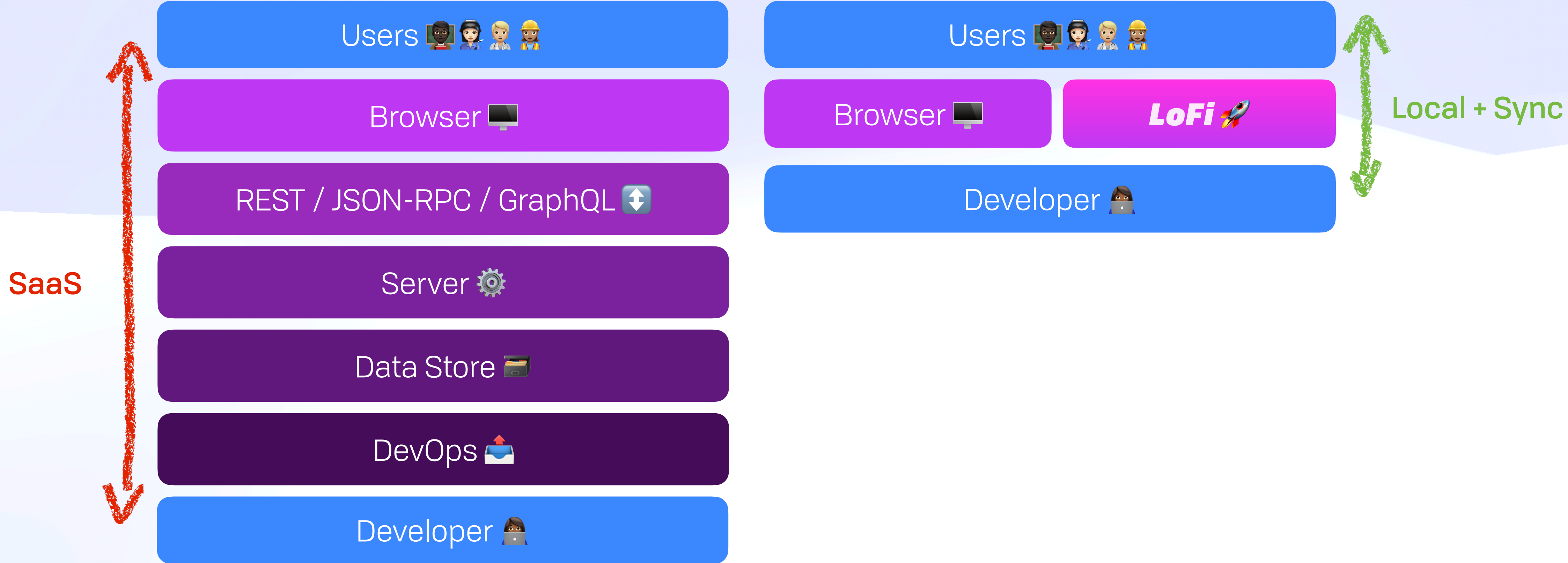
# ~~Just Enough To Be Dangerous!~~





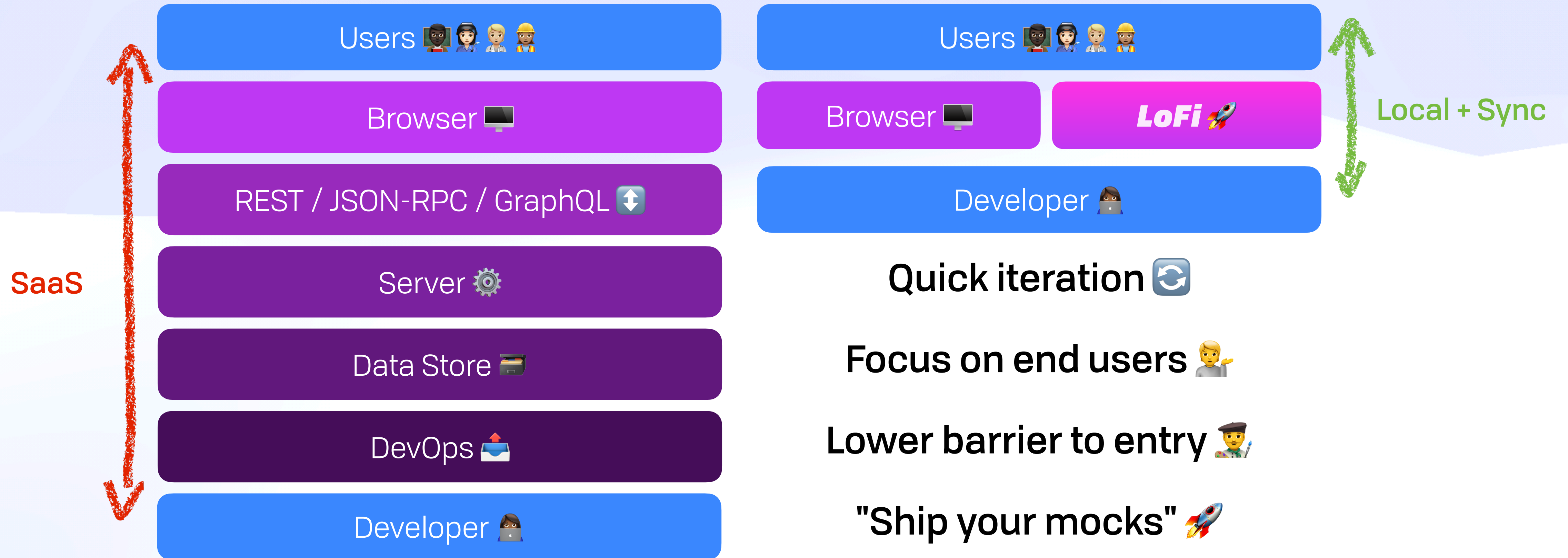
# Local-First

# ~~Just Enough To Be Dangerous!~~



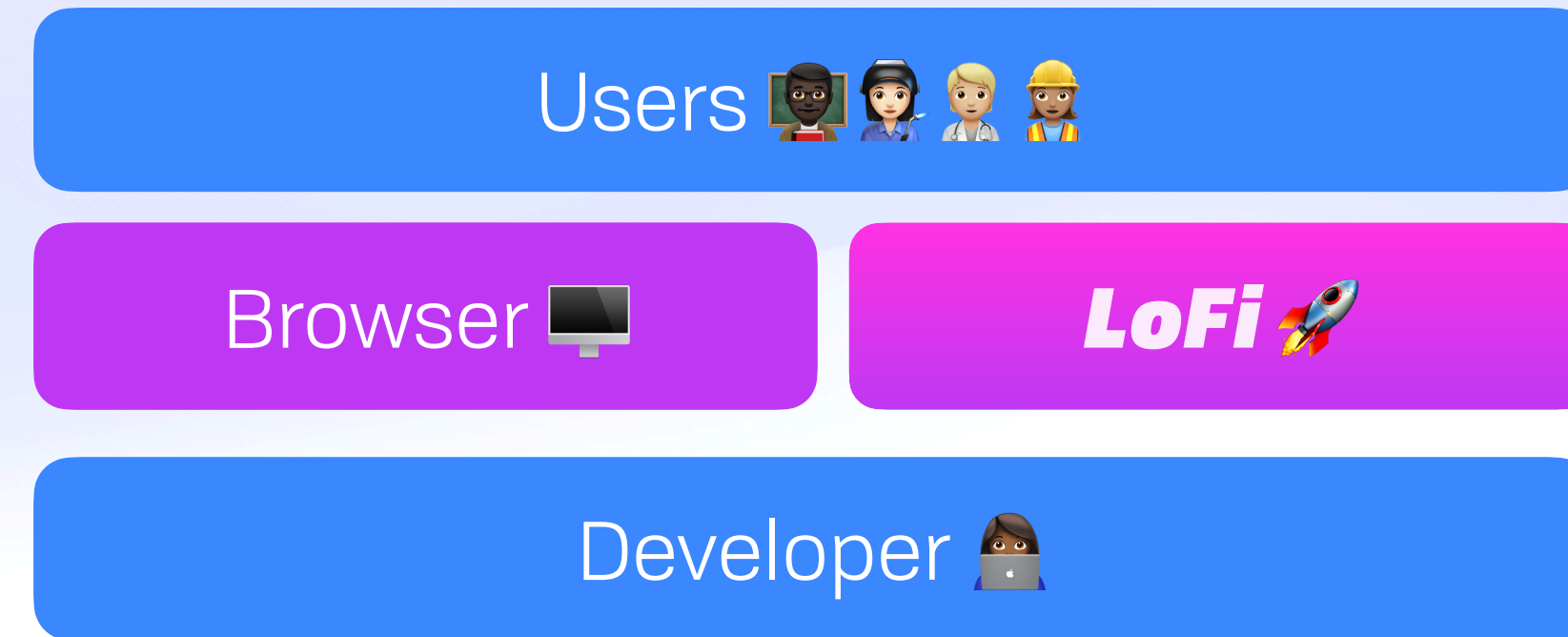
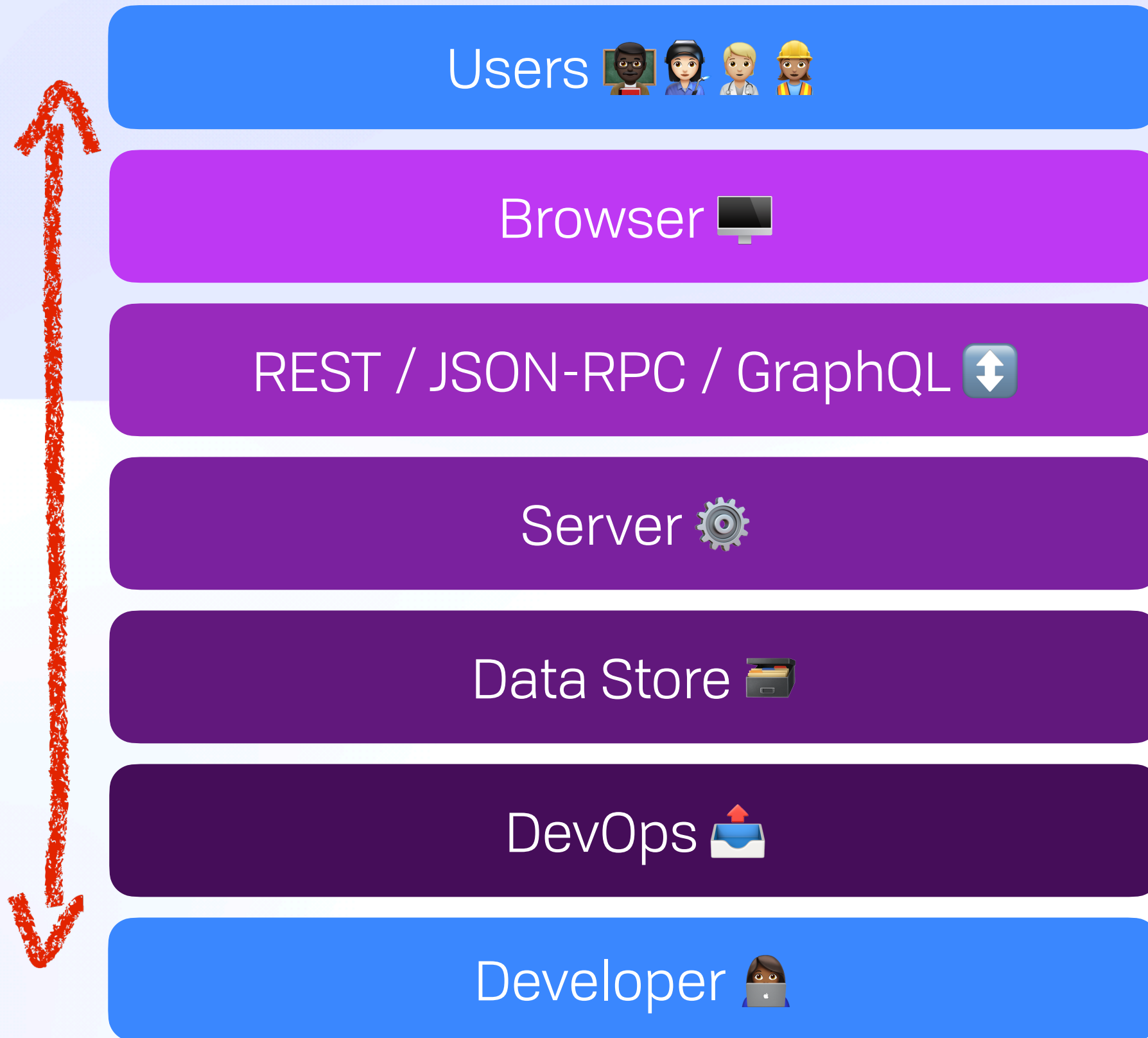
# Local-First

# ~~Just Enough To Be Dangerous!~~



# Local-First

## ~~Just Enough To Be Dangerous!~~



Quick iteration 🔄

Focus on end users 🧑

Lower barrier to entry 🧑

"Ship your mocks" 🚀

Local-First

***In the Wild*** 

Local-First

***In the Wild*** 🦁



Local-First

***New Constrains = New Design Space***

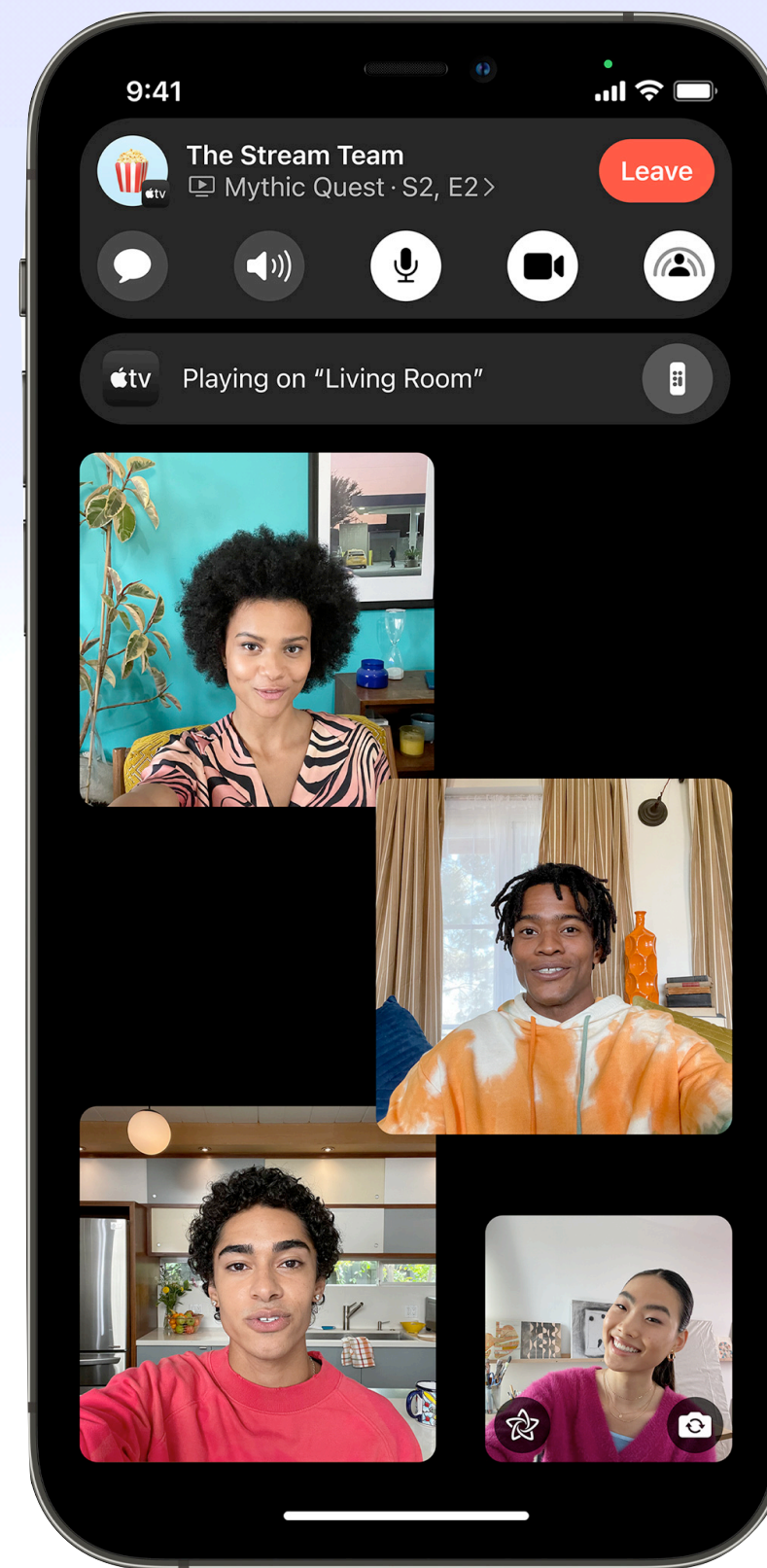
Local-First

***New Constrains = New Design Space***



Local-First

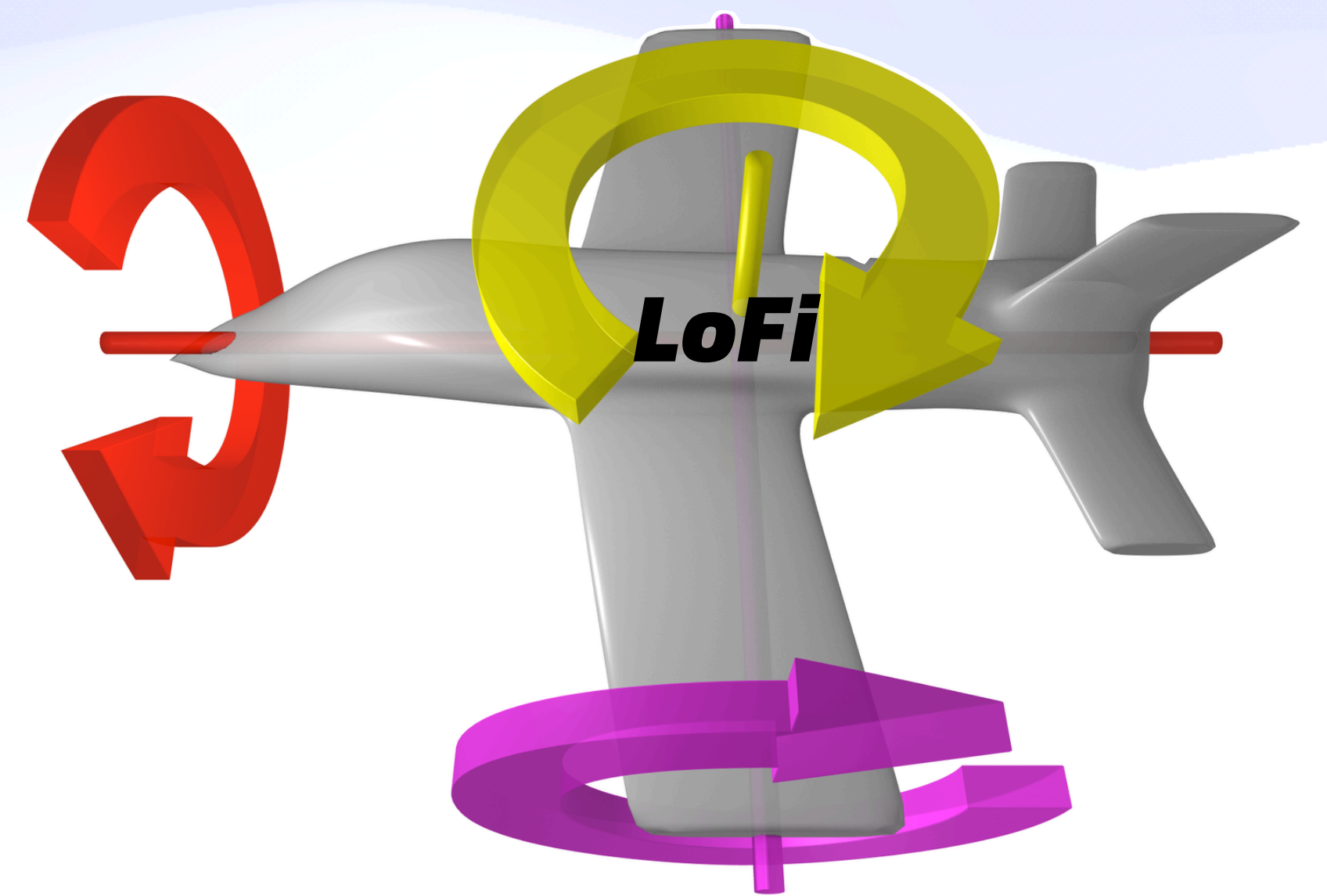
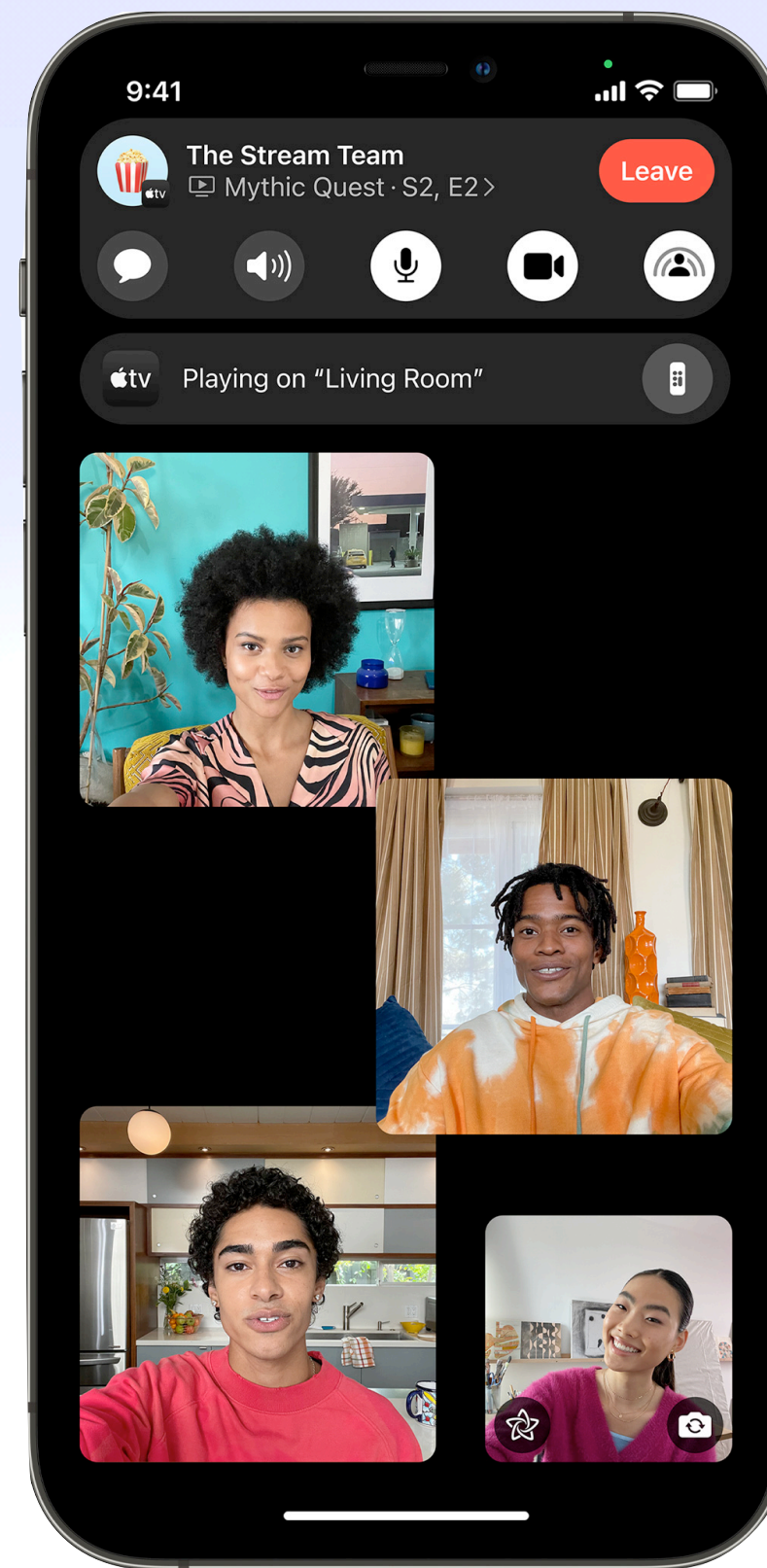
# *New Constrains = New Design Space*





Local-First

# *New Constrains = New Design Space*



Local-First

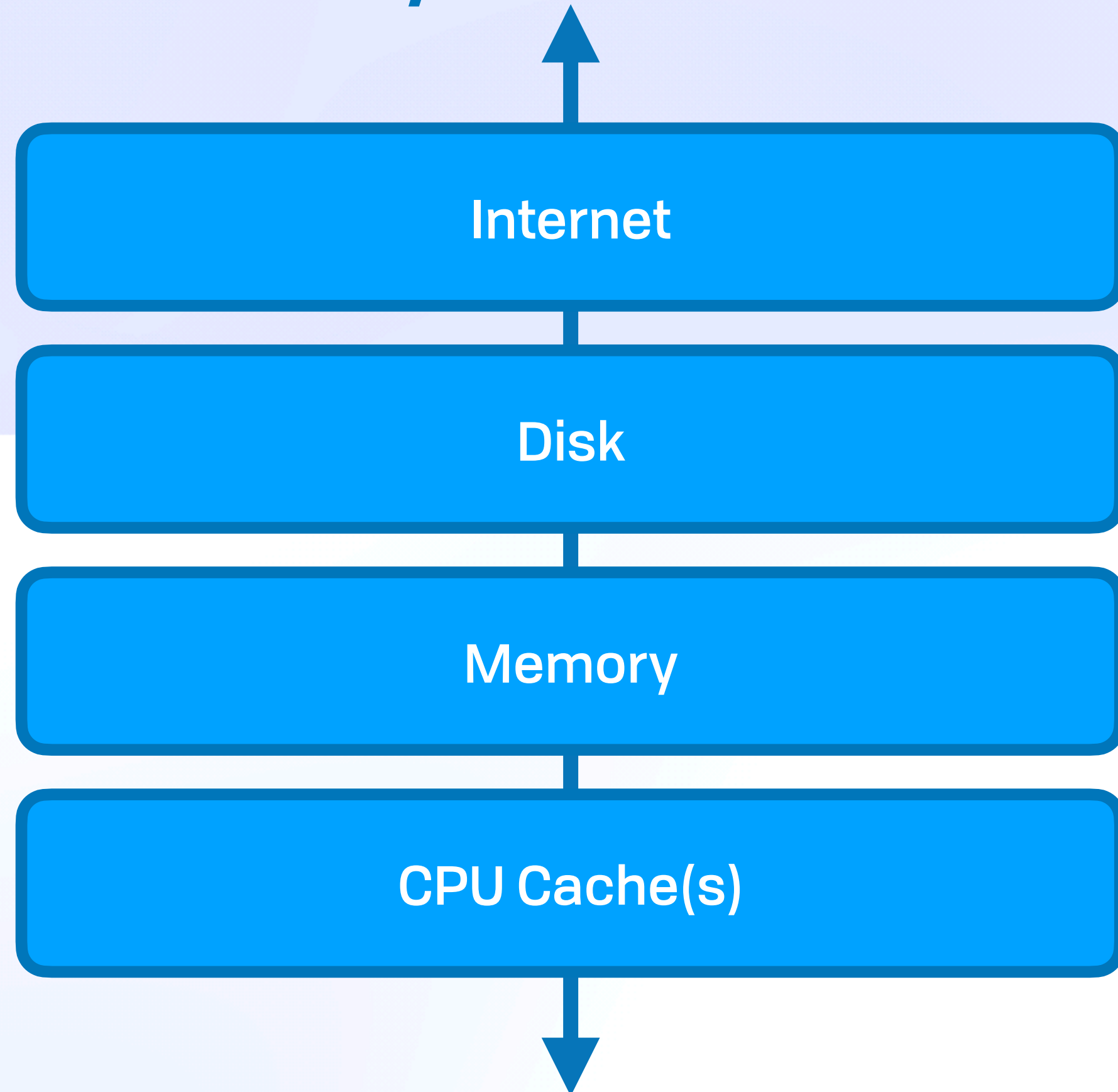
# ***New Metaphors***

**Layered Cache**

Local-First

# *New Metaphors*

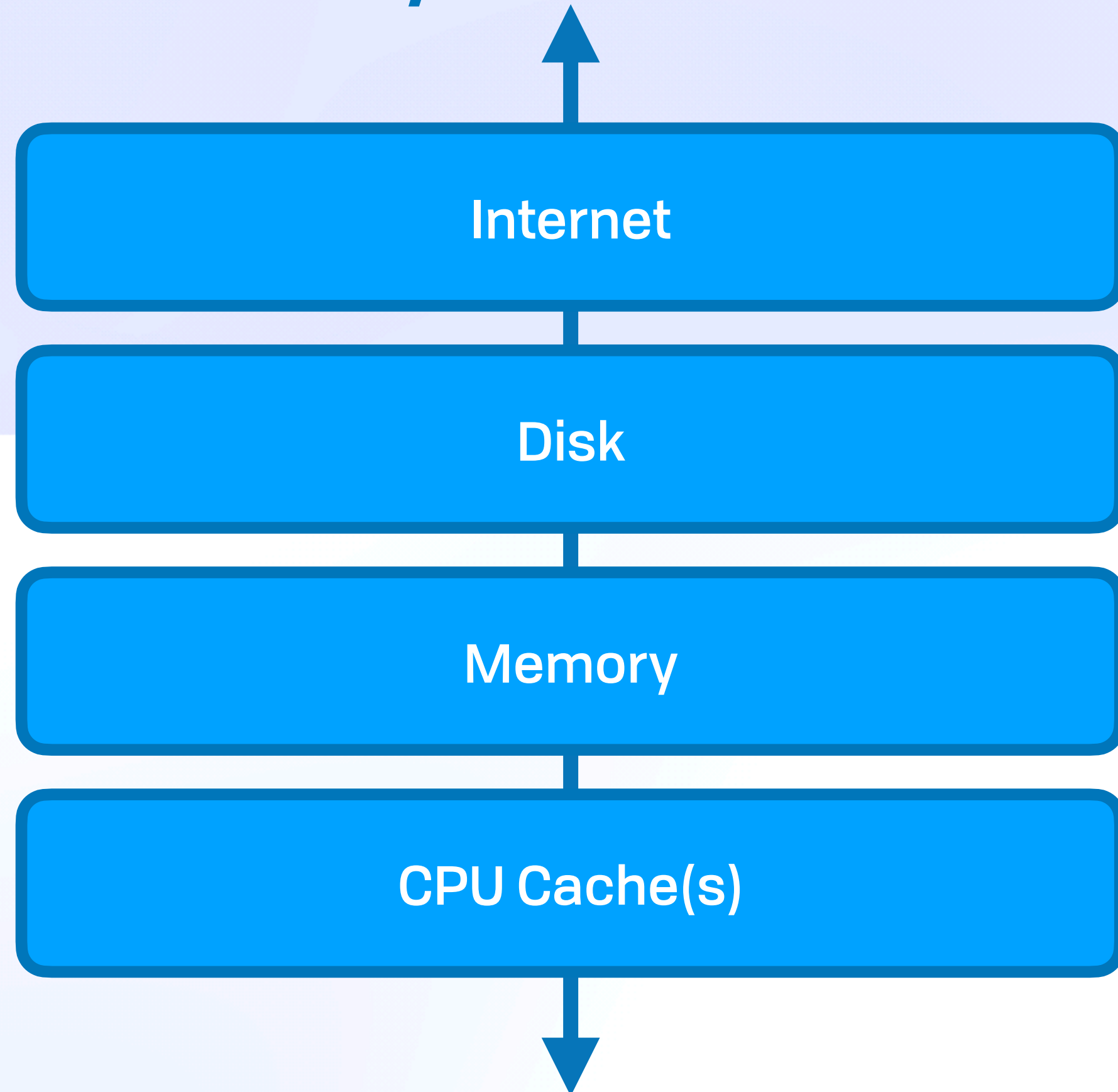
Layered Cache



Local-First

# *New Metaphors*

Layered Cache

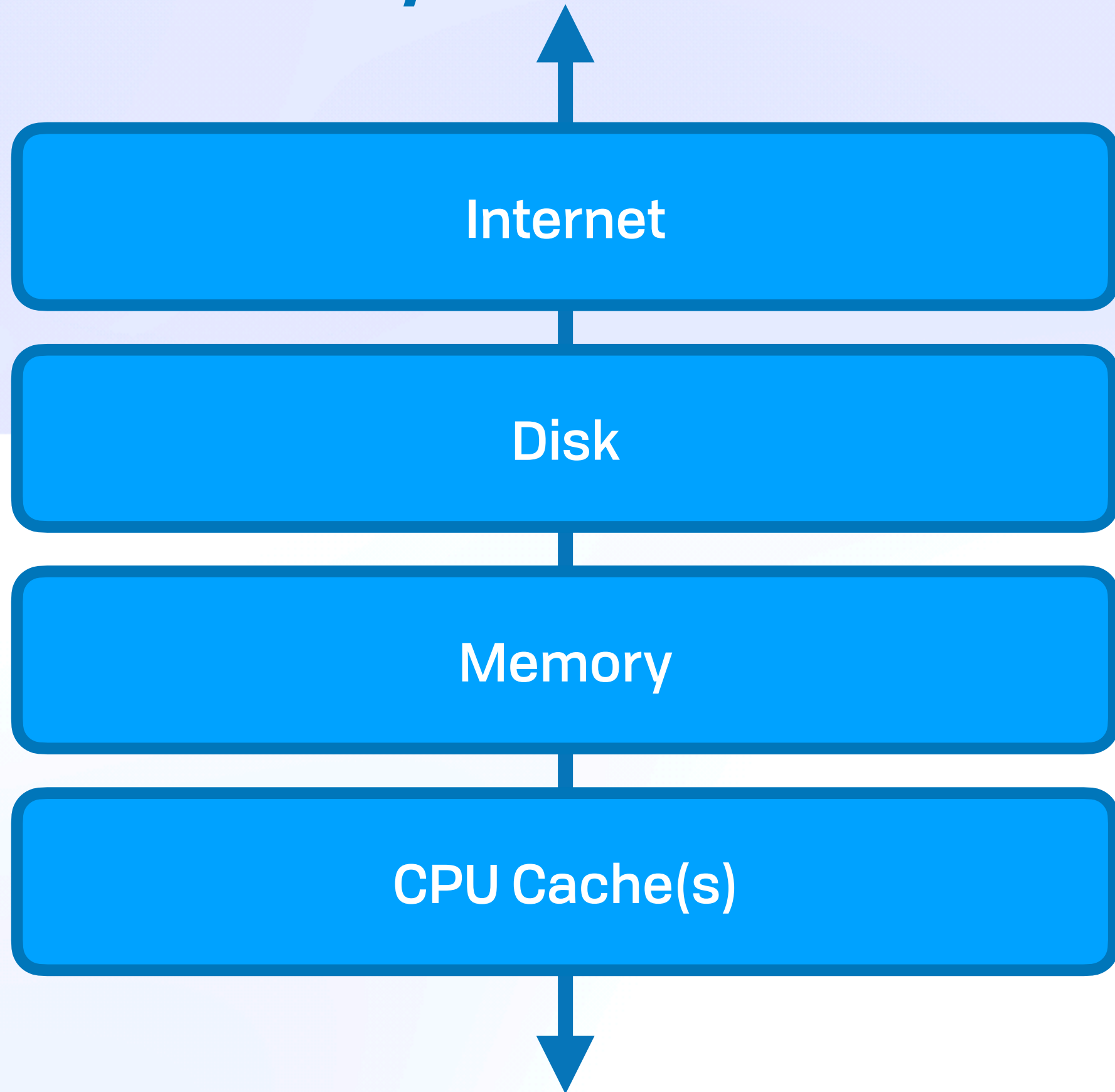


Cellular / P2P

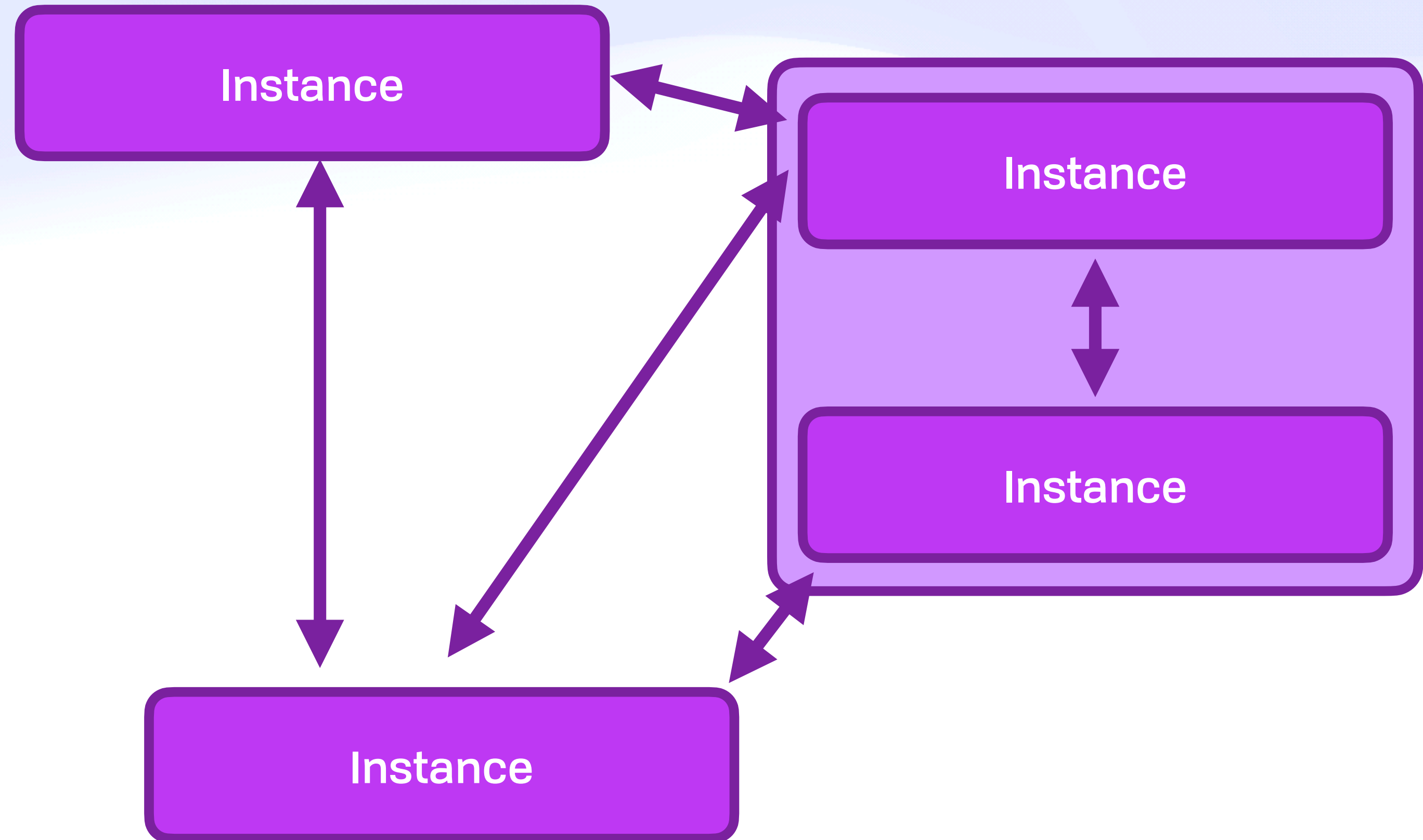
Local-First

# *New Metaphors*

Layered Cache



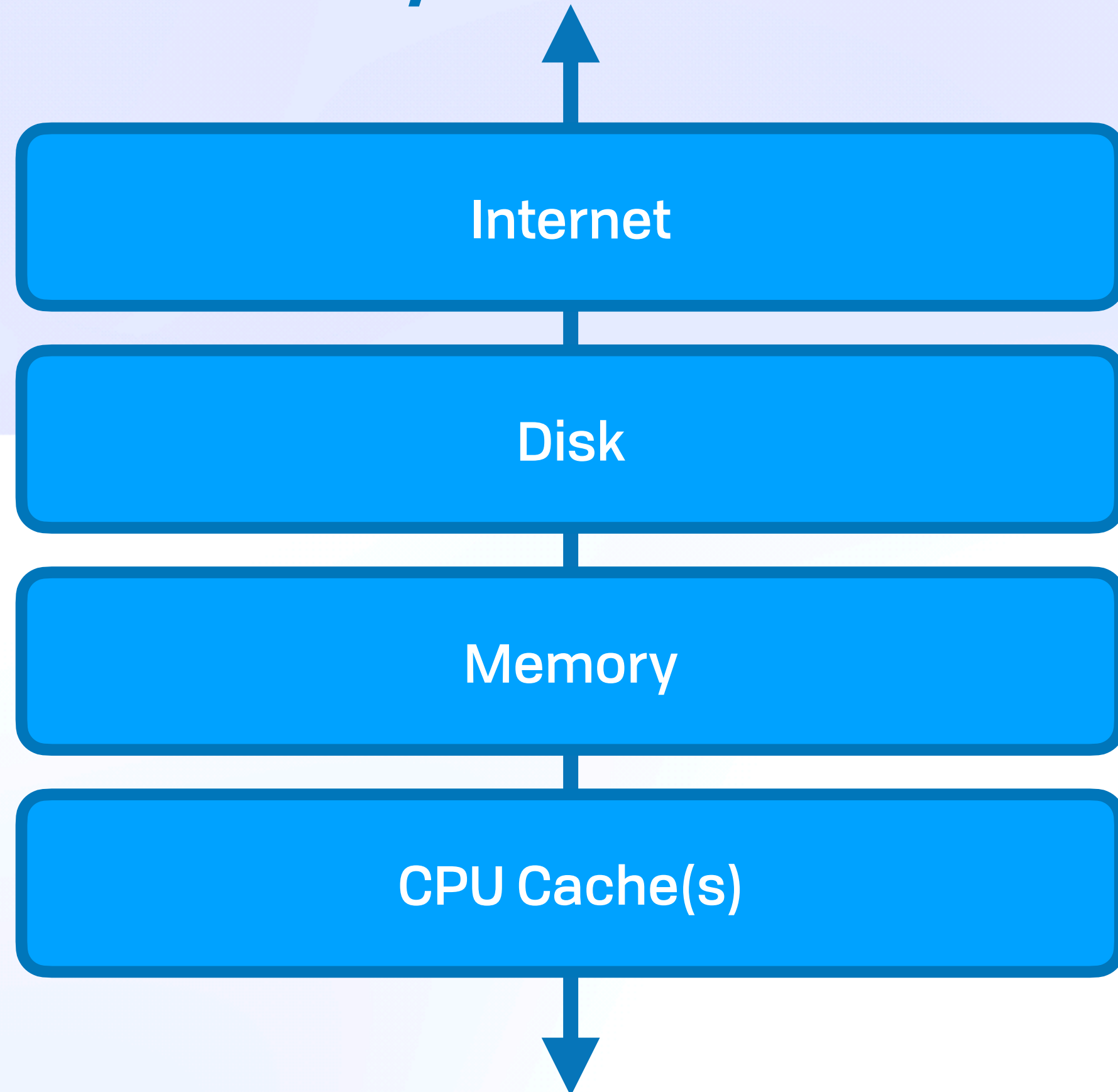
Cellular / P2P



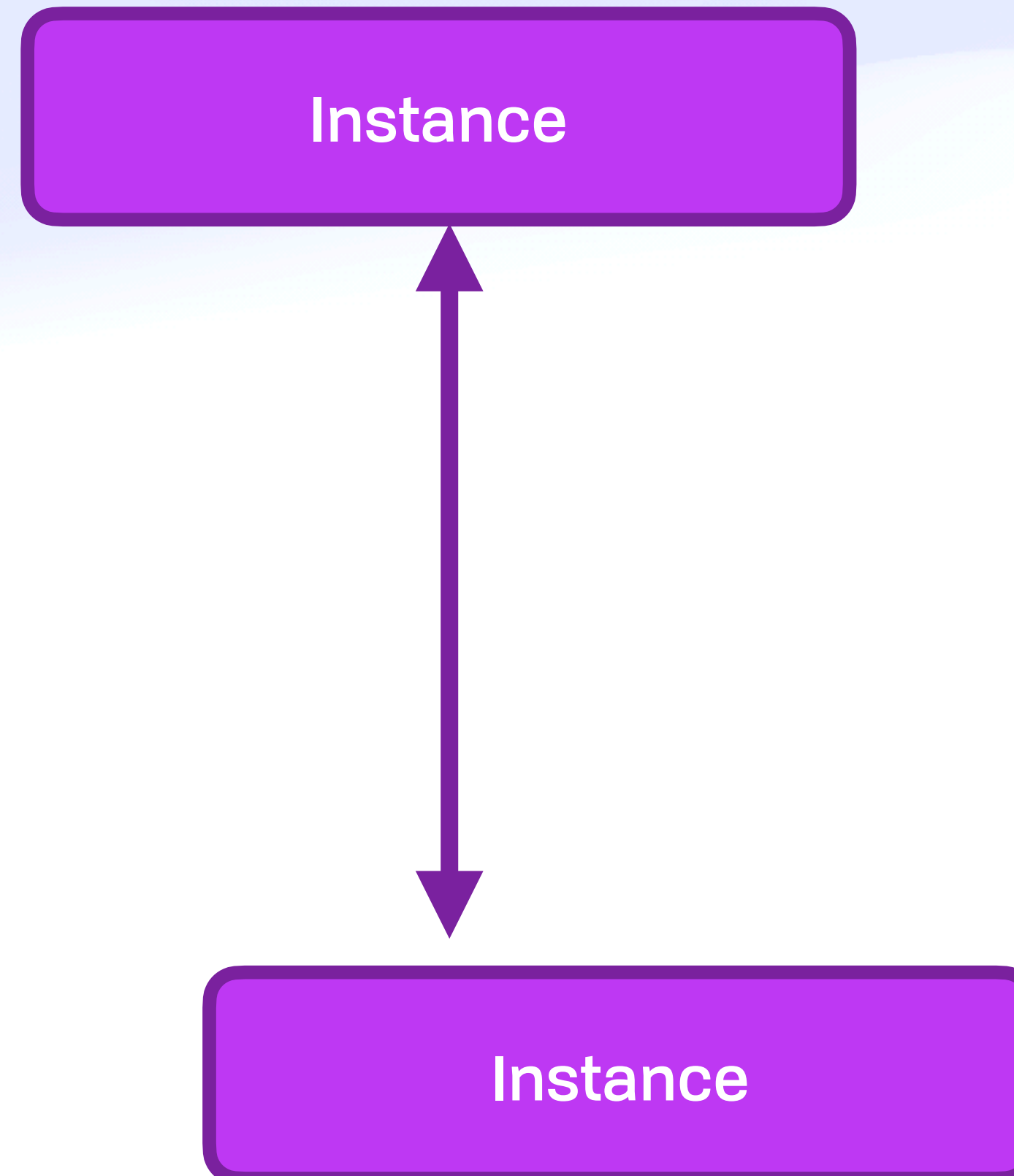
Local-First

# *New Metaphors*

Layered Cache

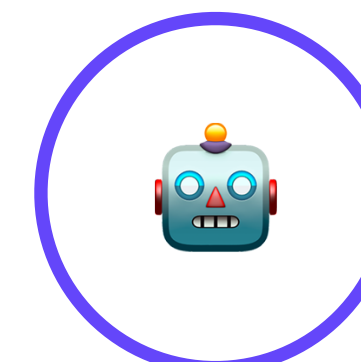
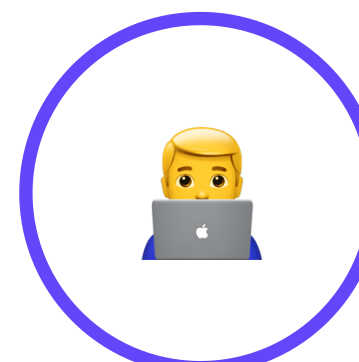
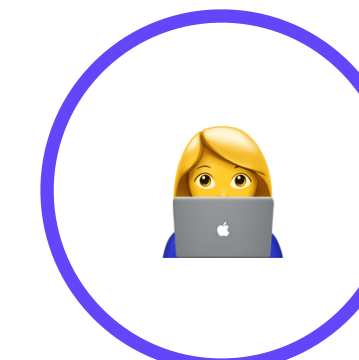
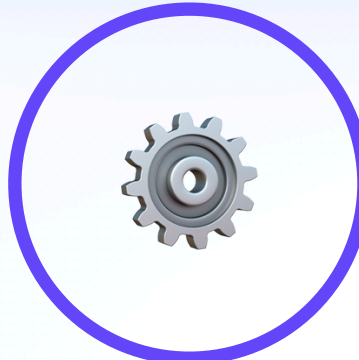
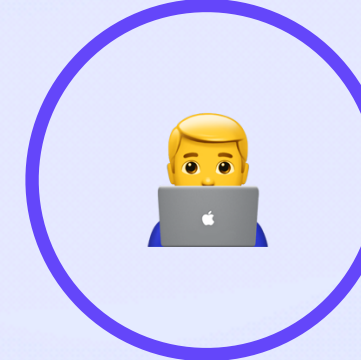
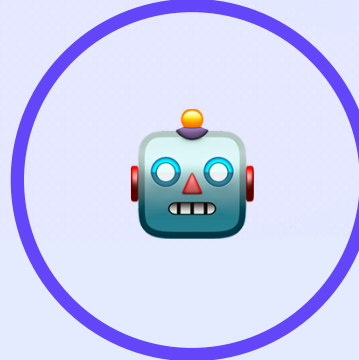


Cellular / P2P



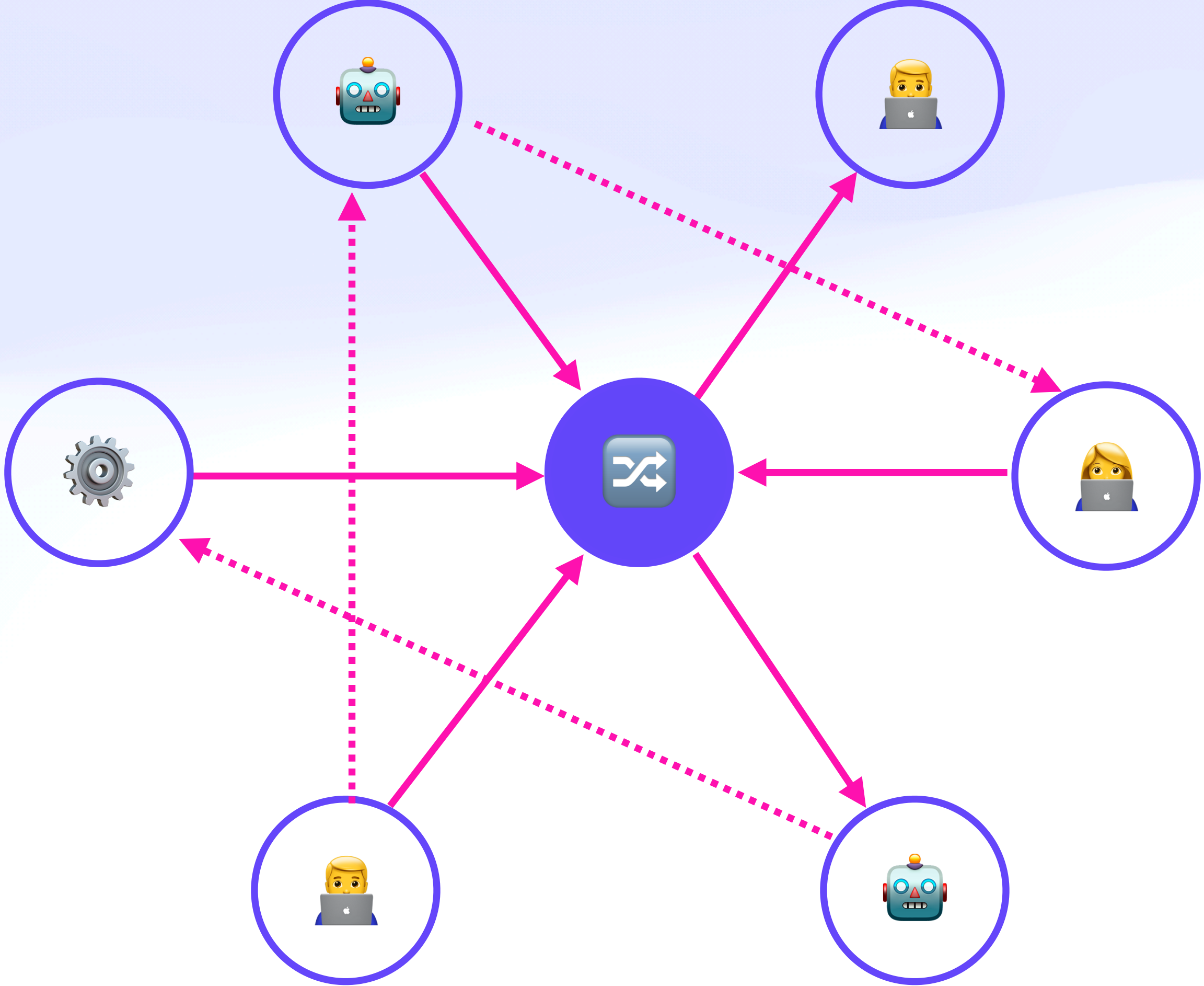
Local-First

# *Disorderly Programming & Sync Protocols*



Local-First

# *Disorderly Programming & Sync Protocols*



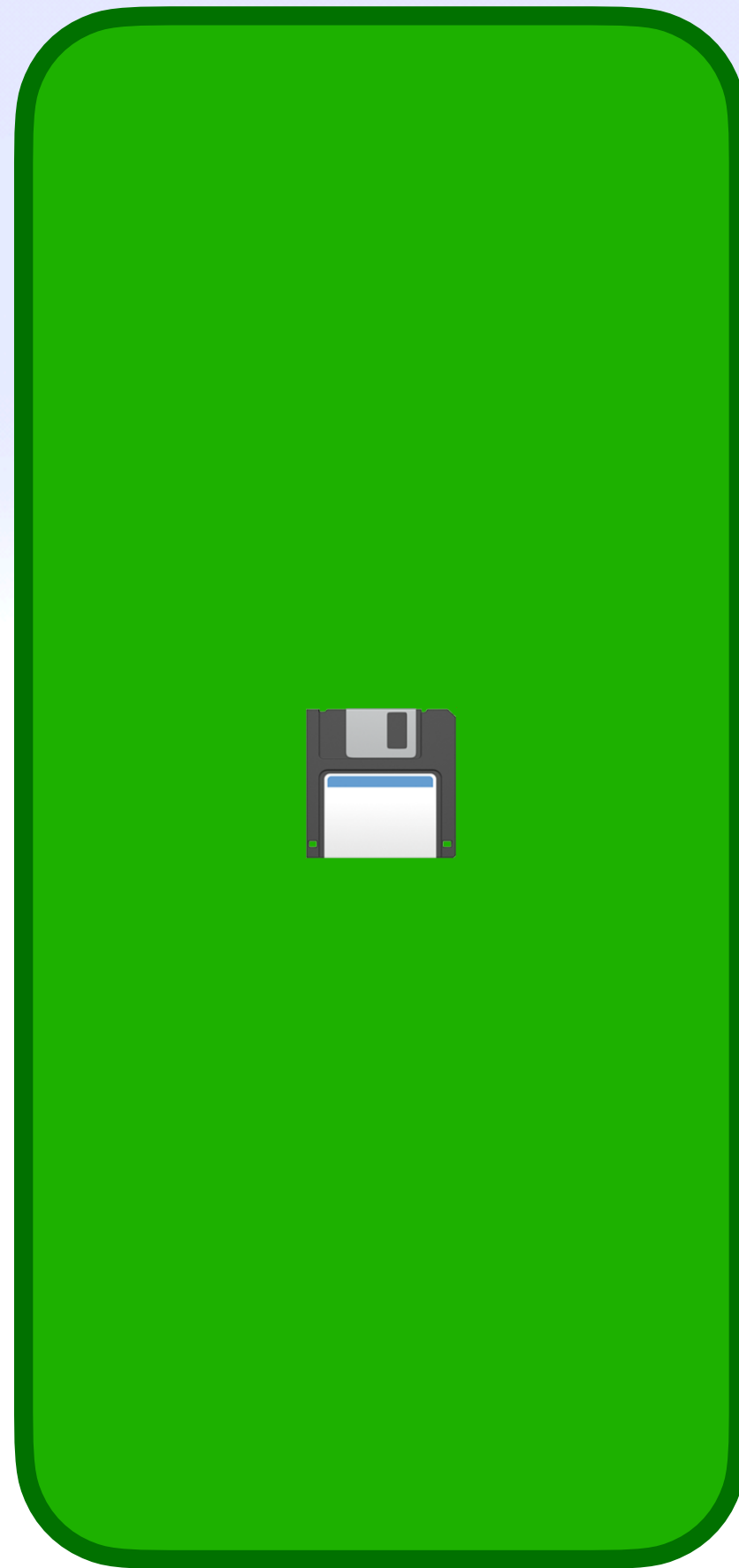
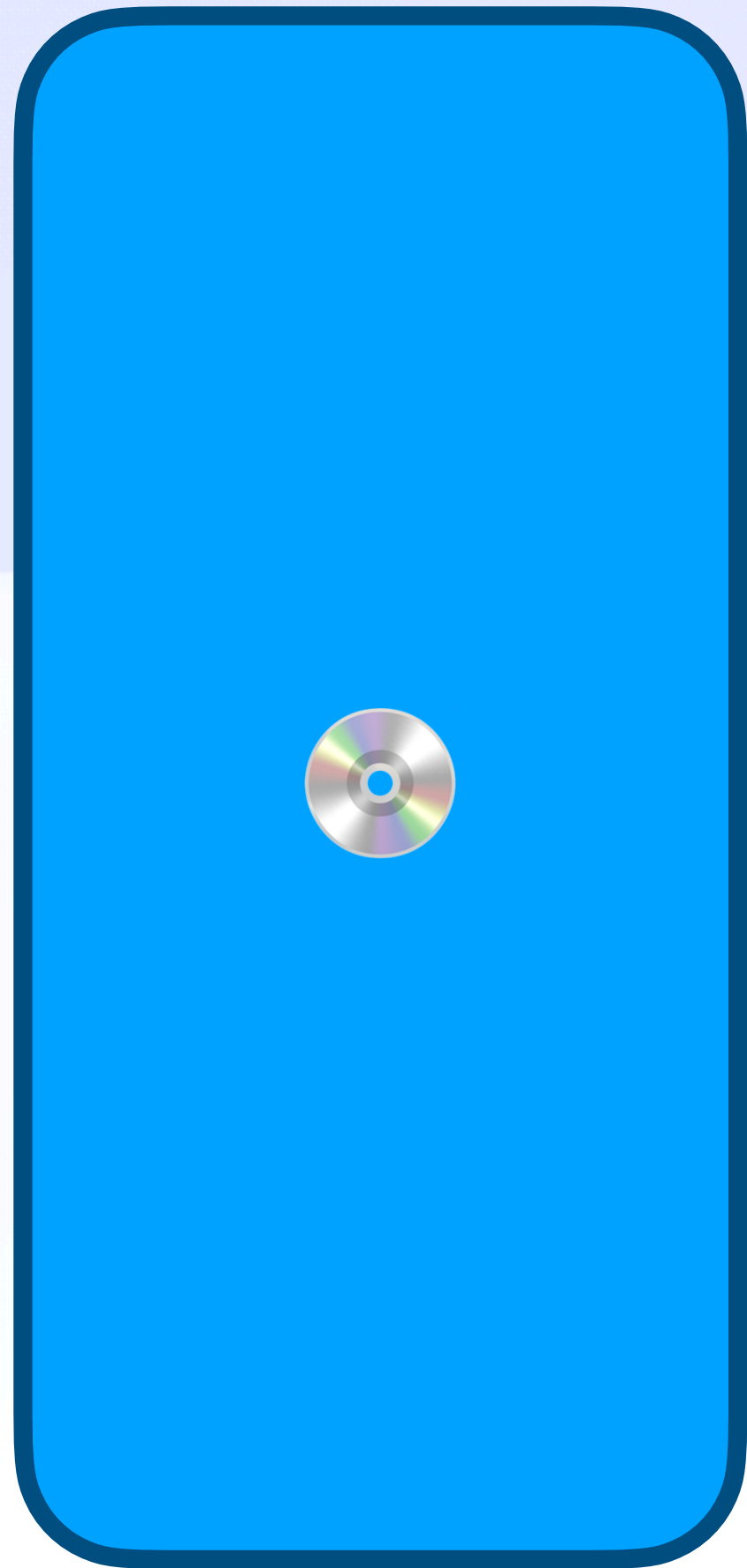


Local-First

***Federate Data, Not Apps***

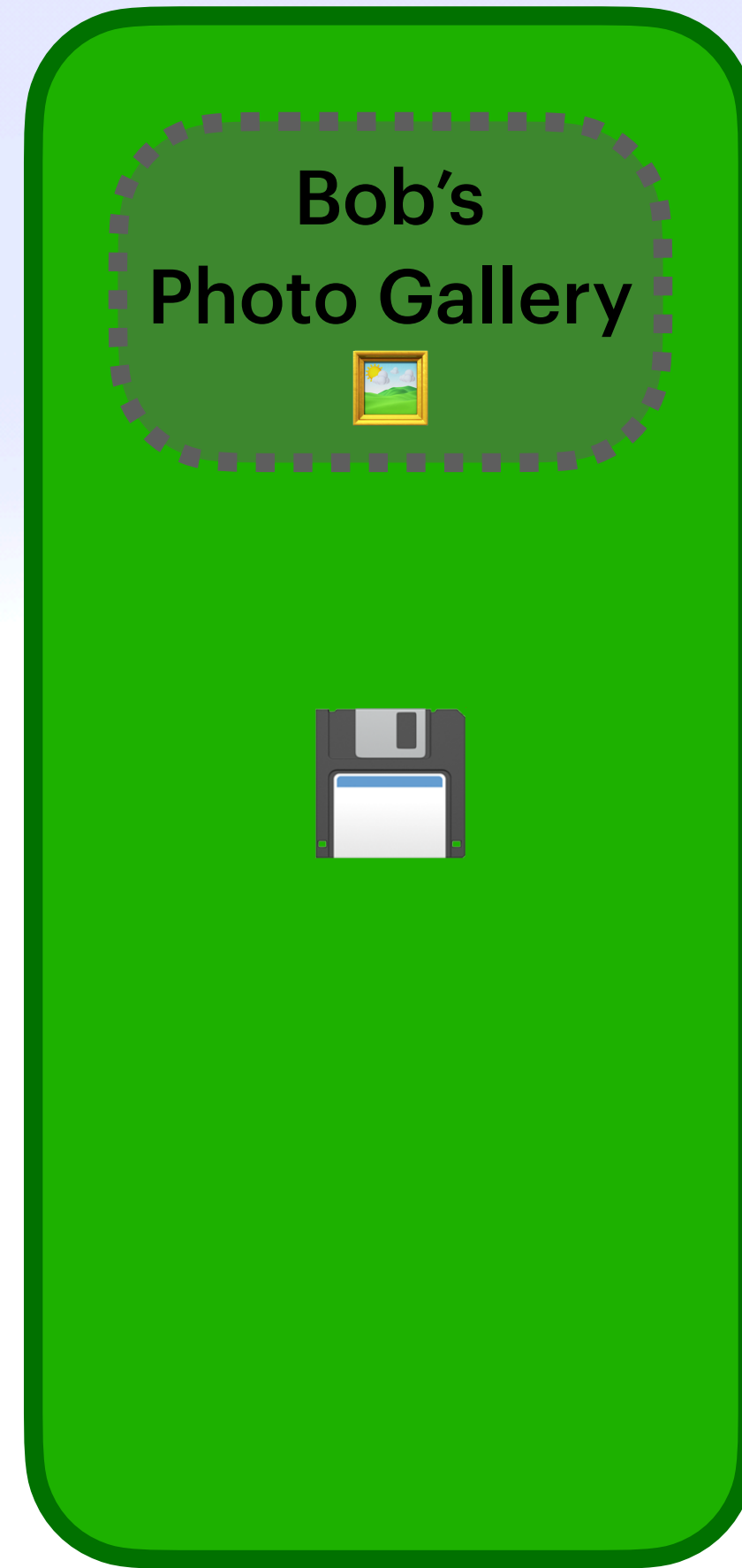
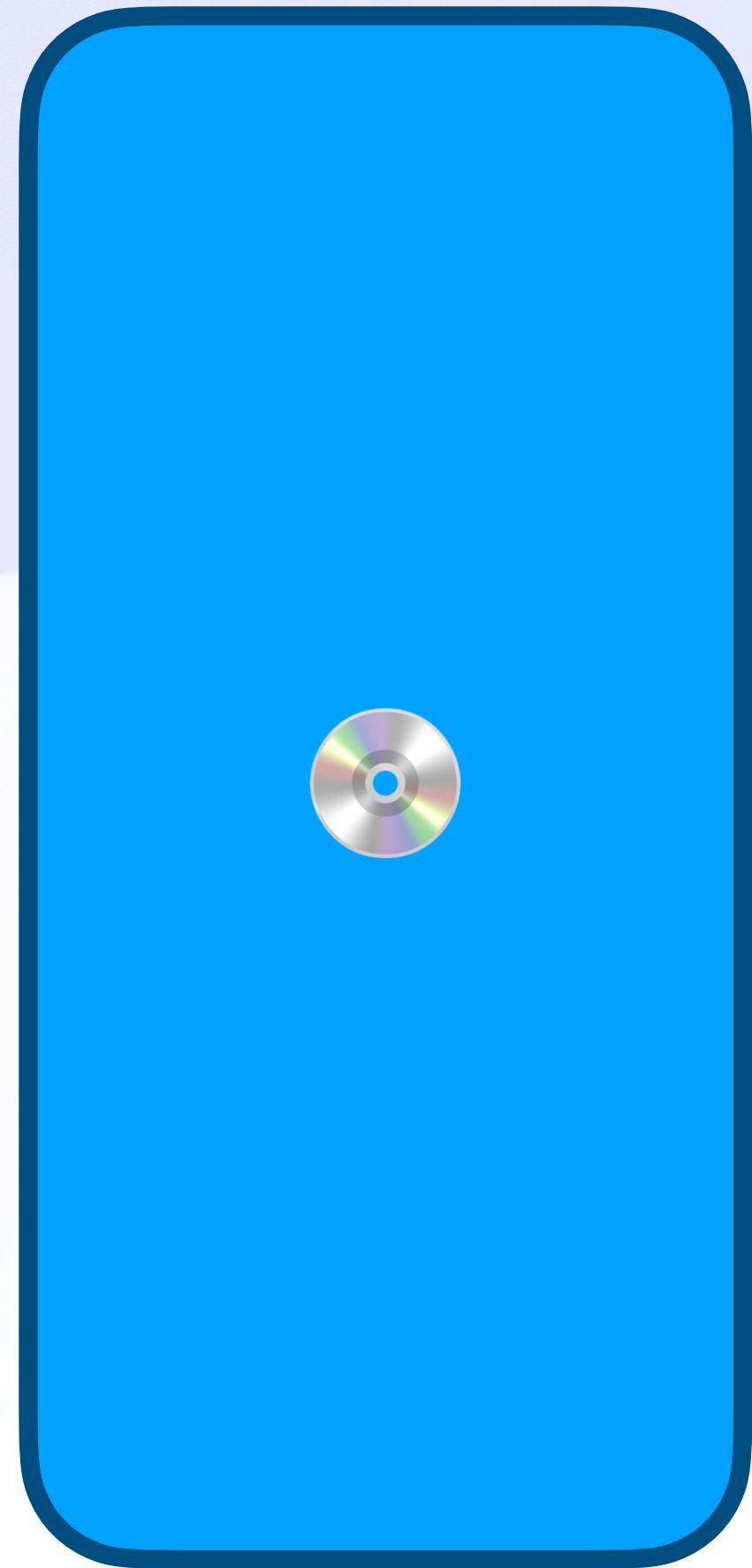
Local-First

# *Federate Data, Not Apps*



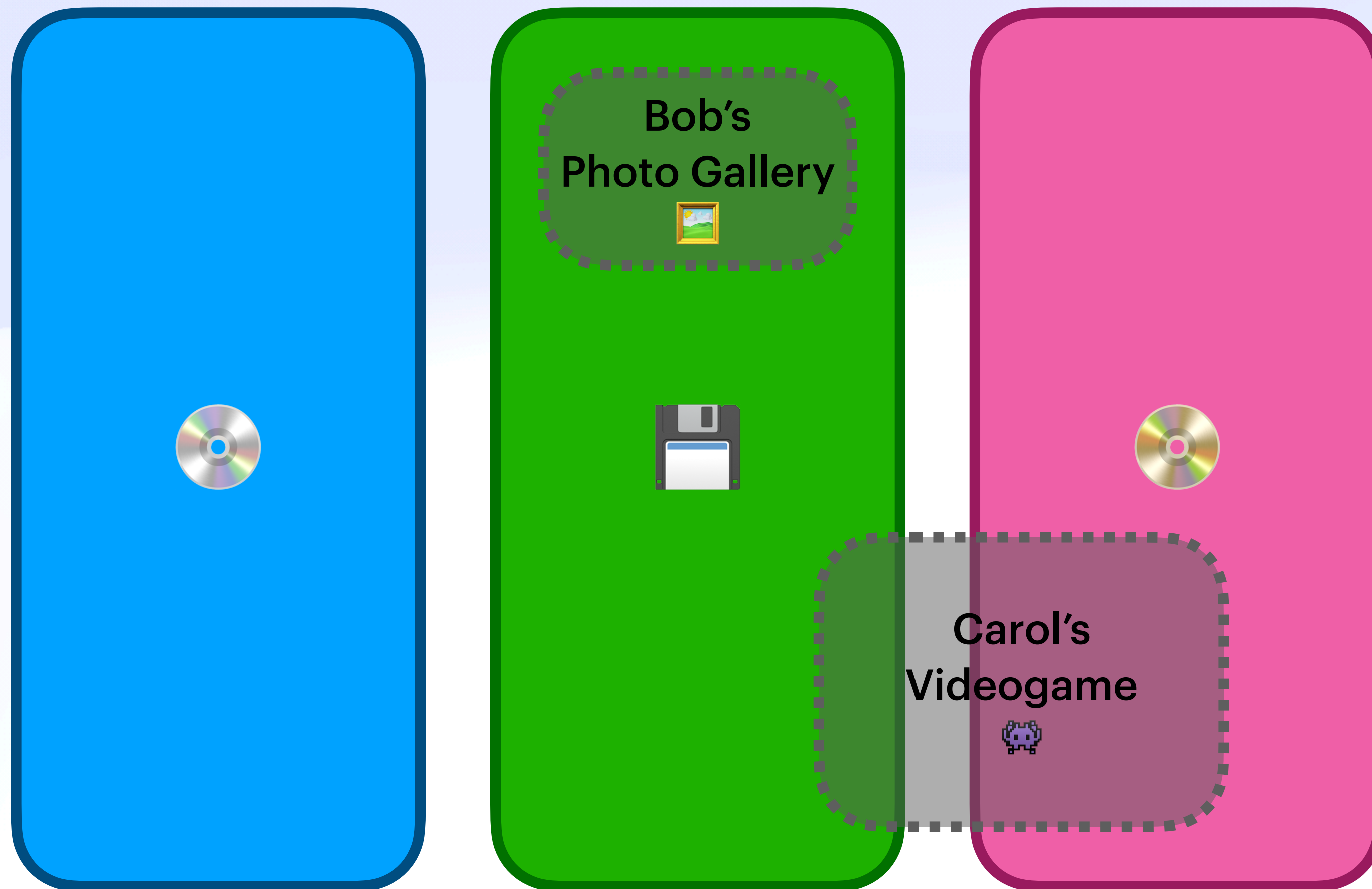
Local-First

# *Federate Data, Not Apps*



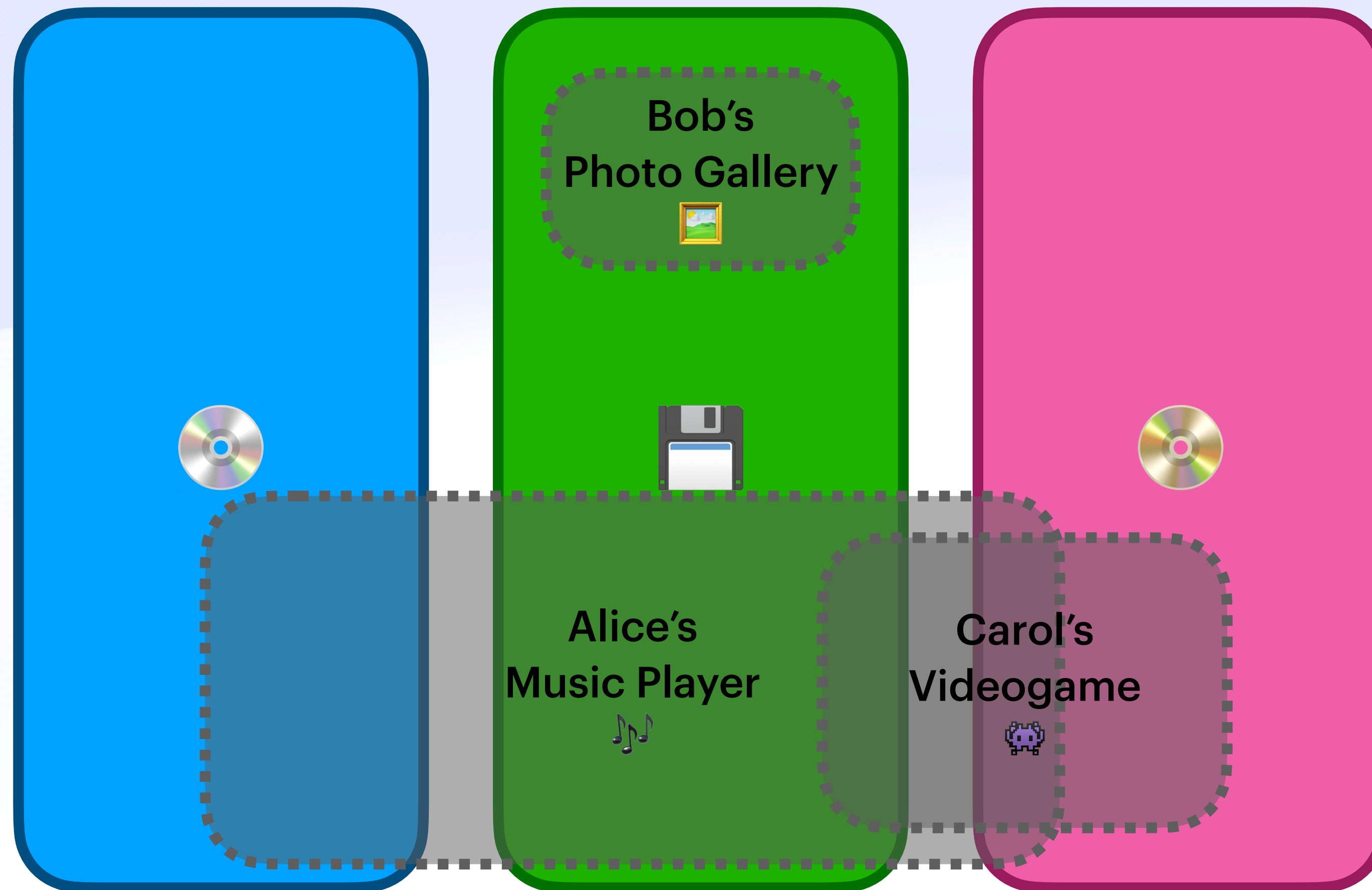
Local-First

# *Federate Data, Not Apps*



Local-First

# *Federate Data, Not Apps*



Local-First

***Reusable Hub Tools Can Be Magic*** ✨

Local-First

# Reusable Hub Tools Can Be Magic ✨

The screenshot shows a file explorer interface for a drive named "expede-strange-loop". The interface includes a sidebar with a file tree and a main area displaying a video thumbnail.

**File Explorer Details:**

- Path: expede-strange-loop
- Items:
  - strange-loop (Directory)
  - cat (File)
  - pwl (File) →
  - rs-ucan-mascot (File)
- Summary: 1 Directory and 3 Files (2.09 KB)

**Video Thumbnail Content:**

The video thumbnail shows two easels with handwritten notes on chalkboards:

- Left Chalkboard:**
  - PAPERS WE LOVE
  - 9:50 - Zeeshan Akhoni
  - 10:00 - M Charity
  - 11:00 - Deirdre Connolly
  - 12:00 - [unclear]
- Right Chalkboard:**
  - 1:10p - Jason Hockman
  - 2:10p - Santosh NAGARAKatte
  - 3:00p - BREAK
  - 3:20p - Madeline Endres
  - 4:20p - Zach Tellman
  - 5:10p - CLOSING

**Interface Footer:**

- FISSION DRIVE
- + Add / Create
- Copy Link

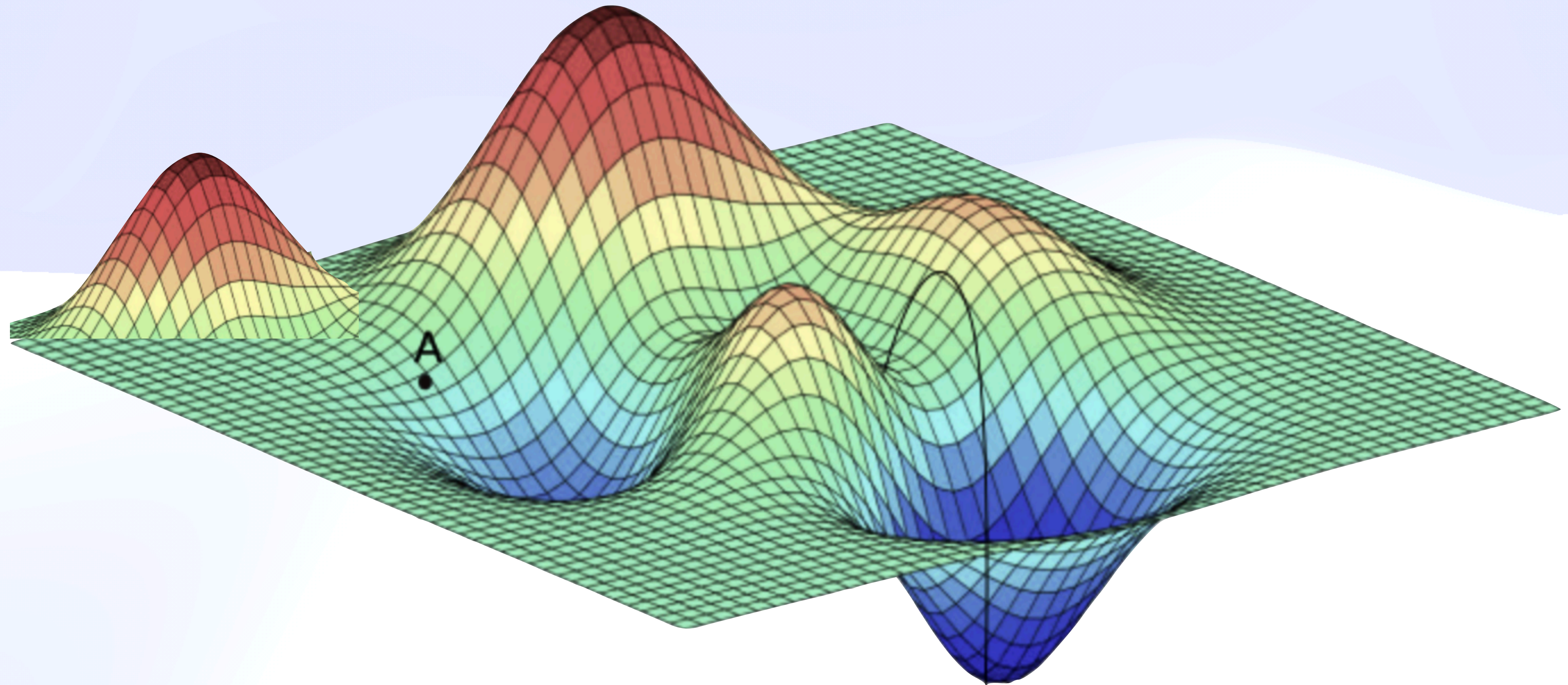
Local-First

# ***Random Walk***



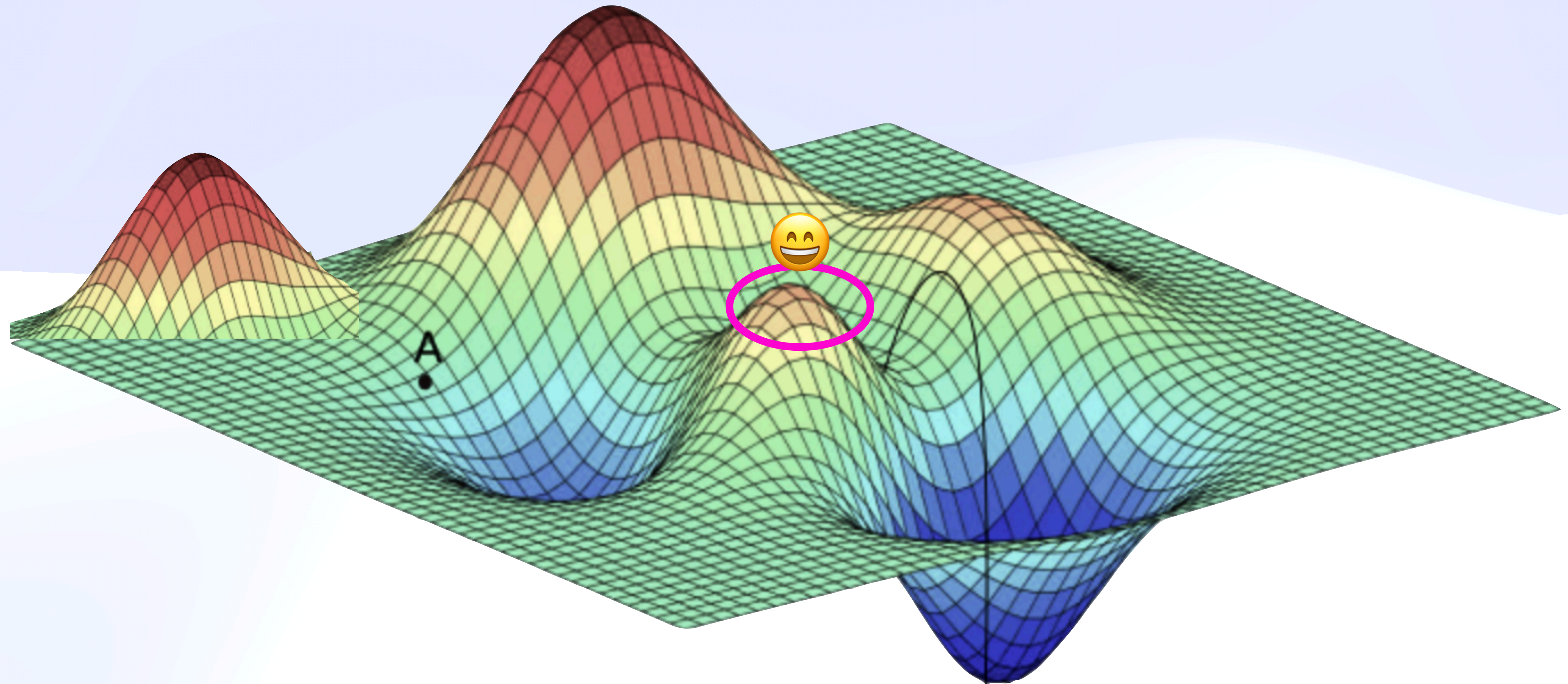
Local-First

# *Random Walk*



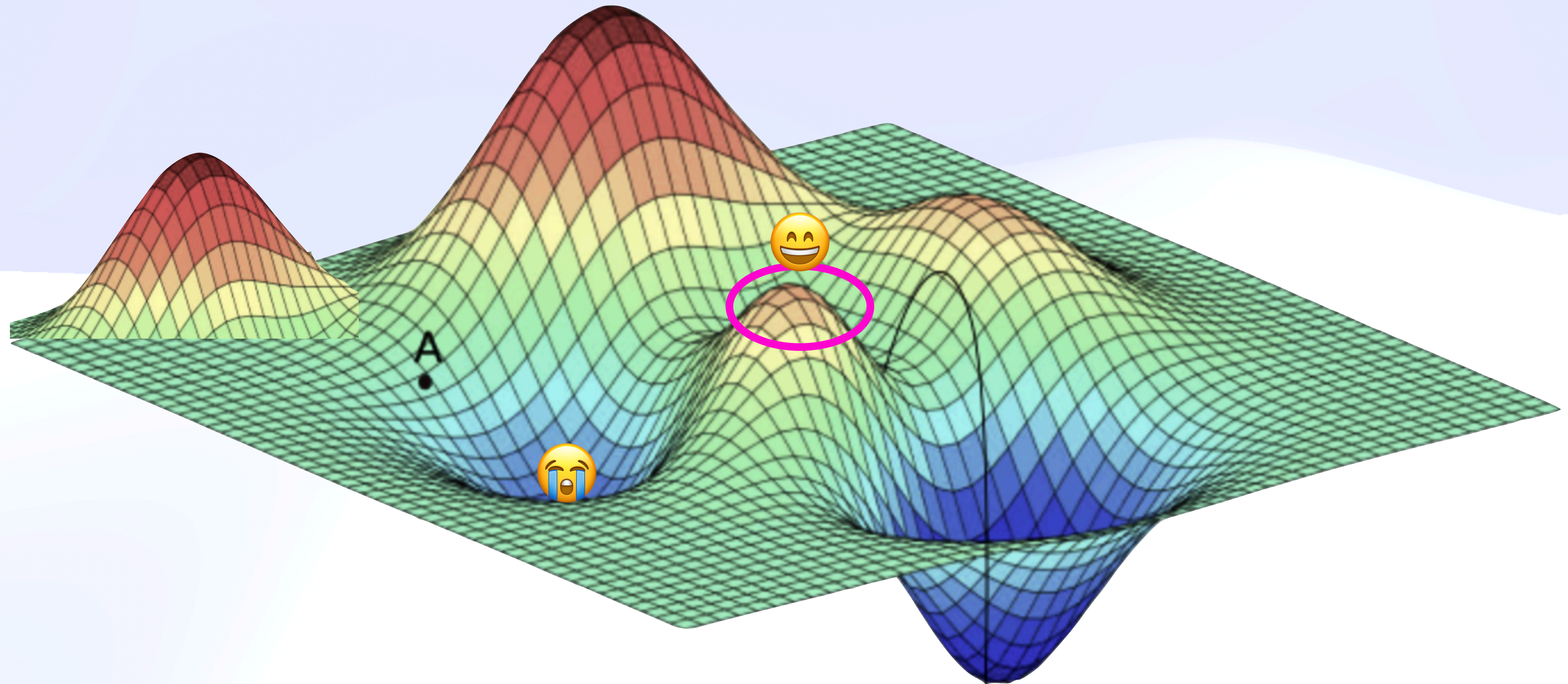
Local-First

# *Random Walk*



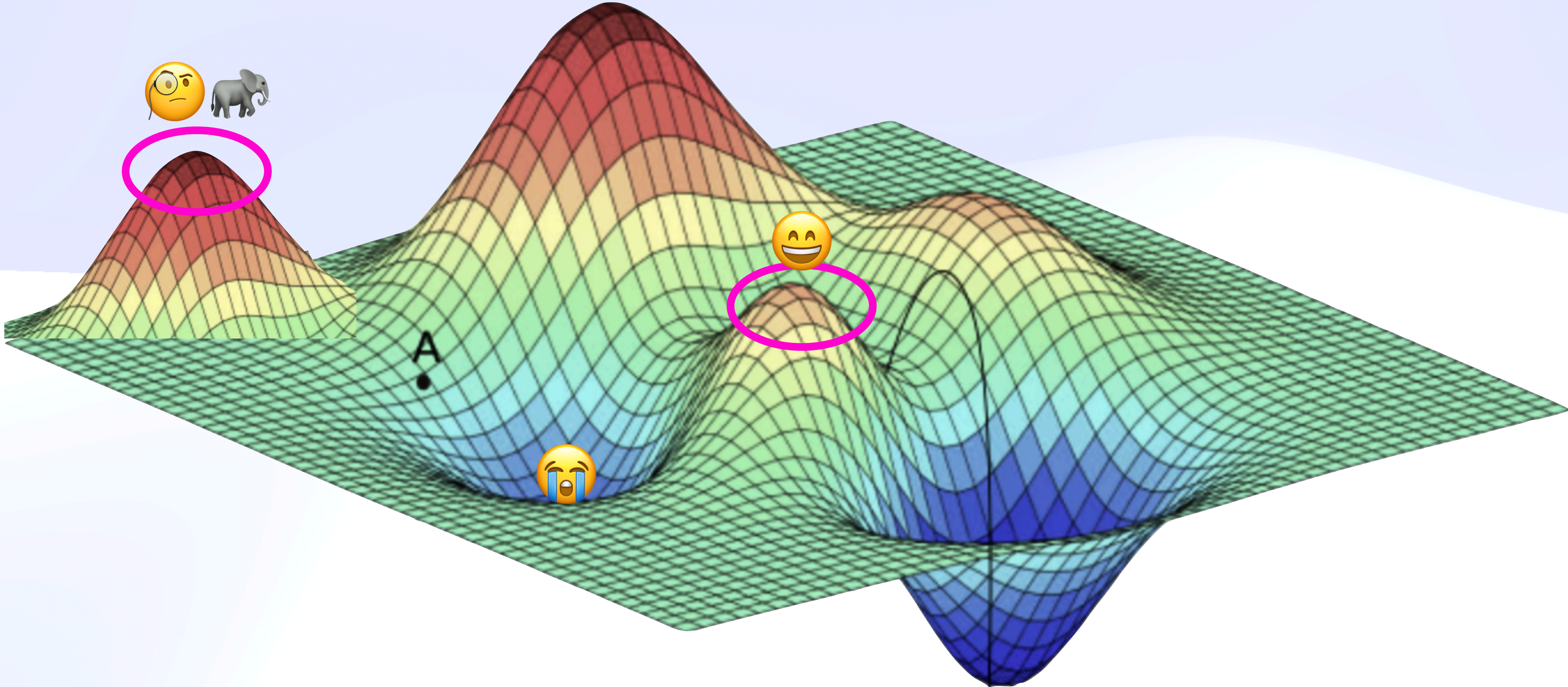
Local-First

# *Random Walk*



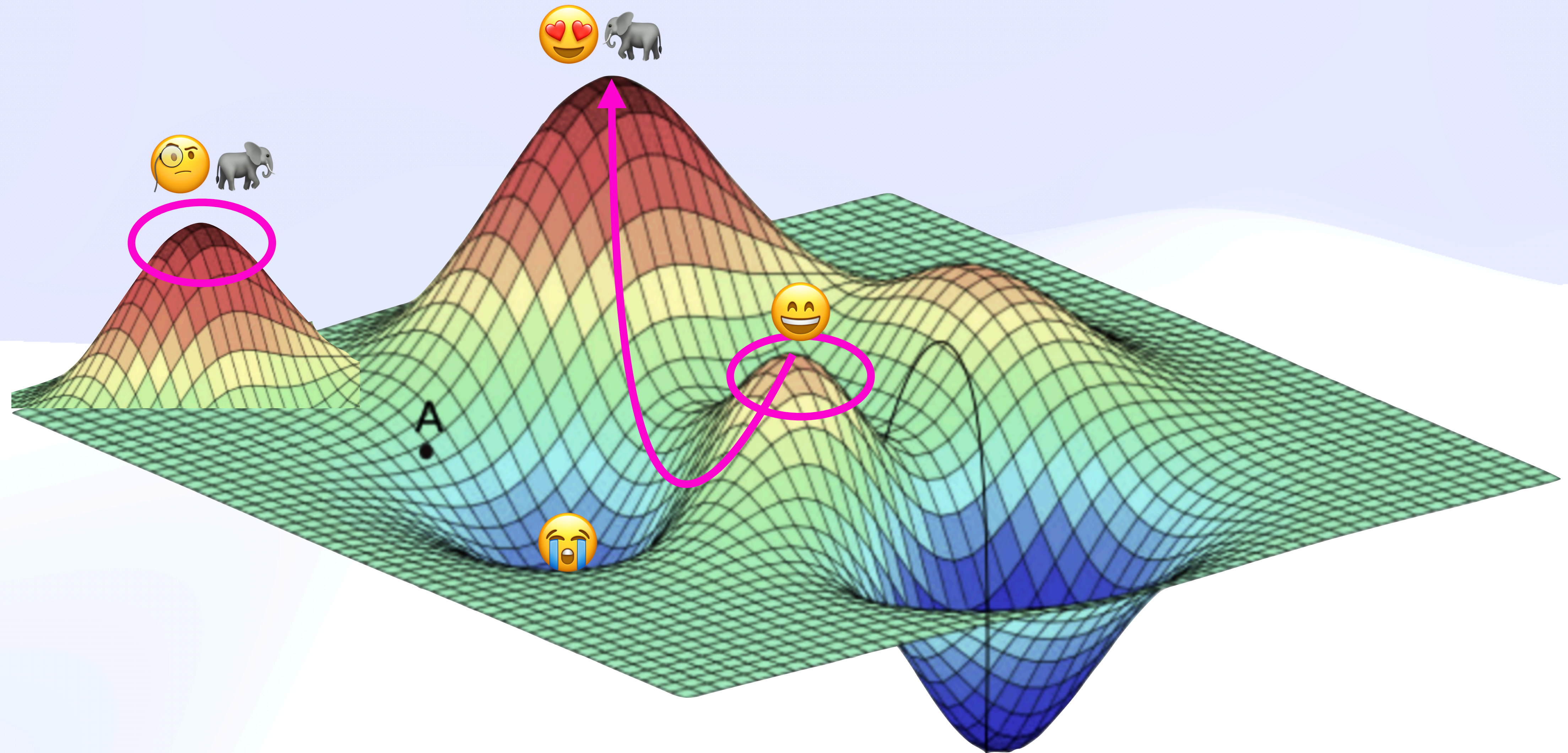
Local-First

# Random Walk



Local-First

# *Random Walk*



Local-First

***The Great Spiral*** 

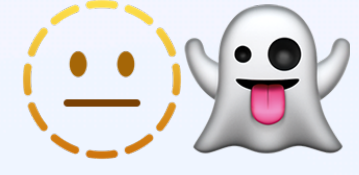
Local-First

# *The Great Spiral* 🛠️



Local-First

# *The Great Spiral* 🛠️



Invention

Custom

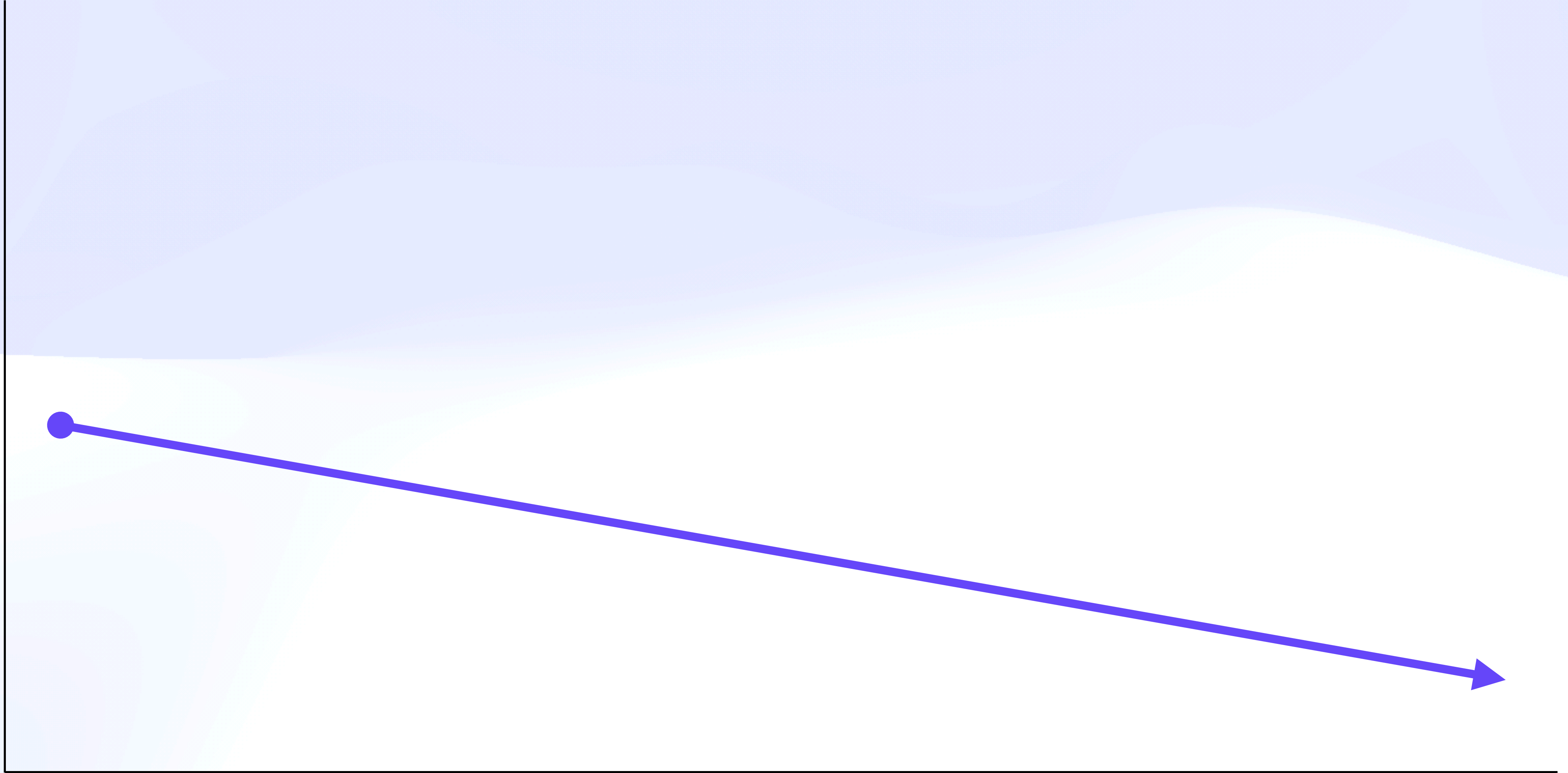
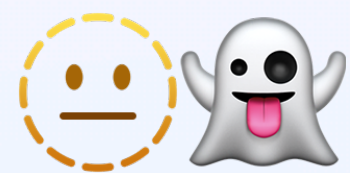
Off-the-Shelf

Utility



Local-First

# *The Great Spiral* 🛠️



Invention

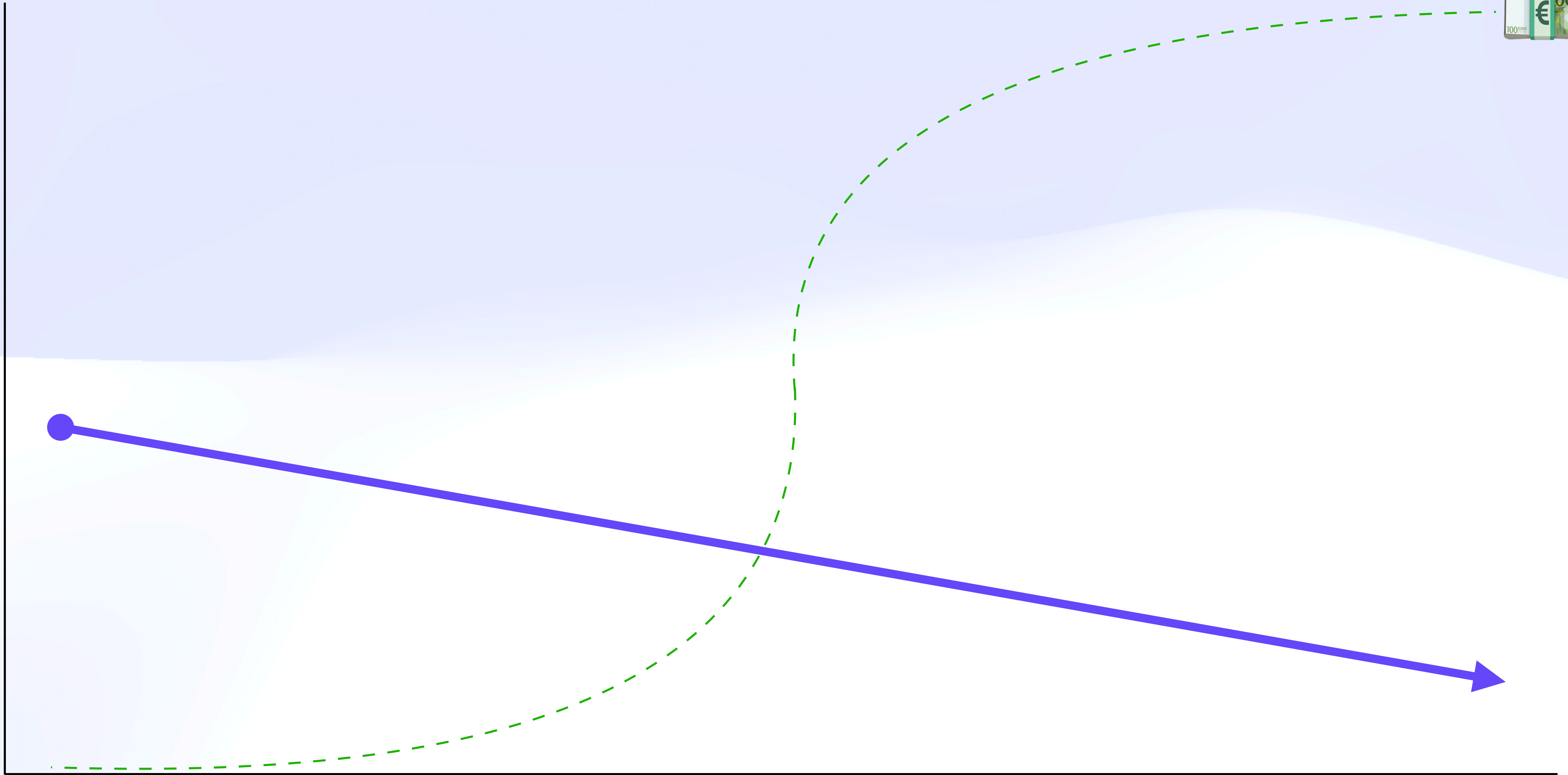
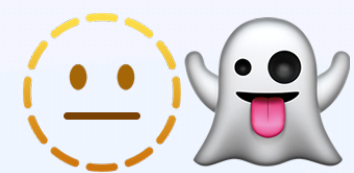
Custom

Off-the-Shelf

Utility

Local-First

# *The Great Spiral* 🛠️



Invention

Custom

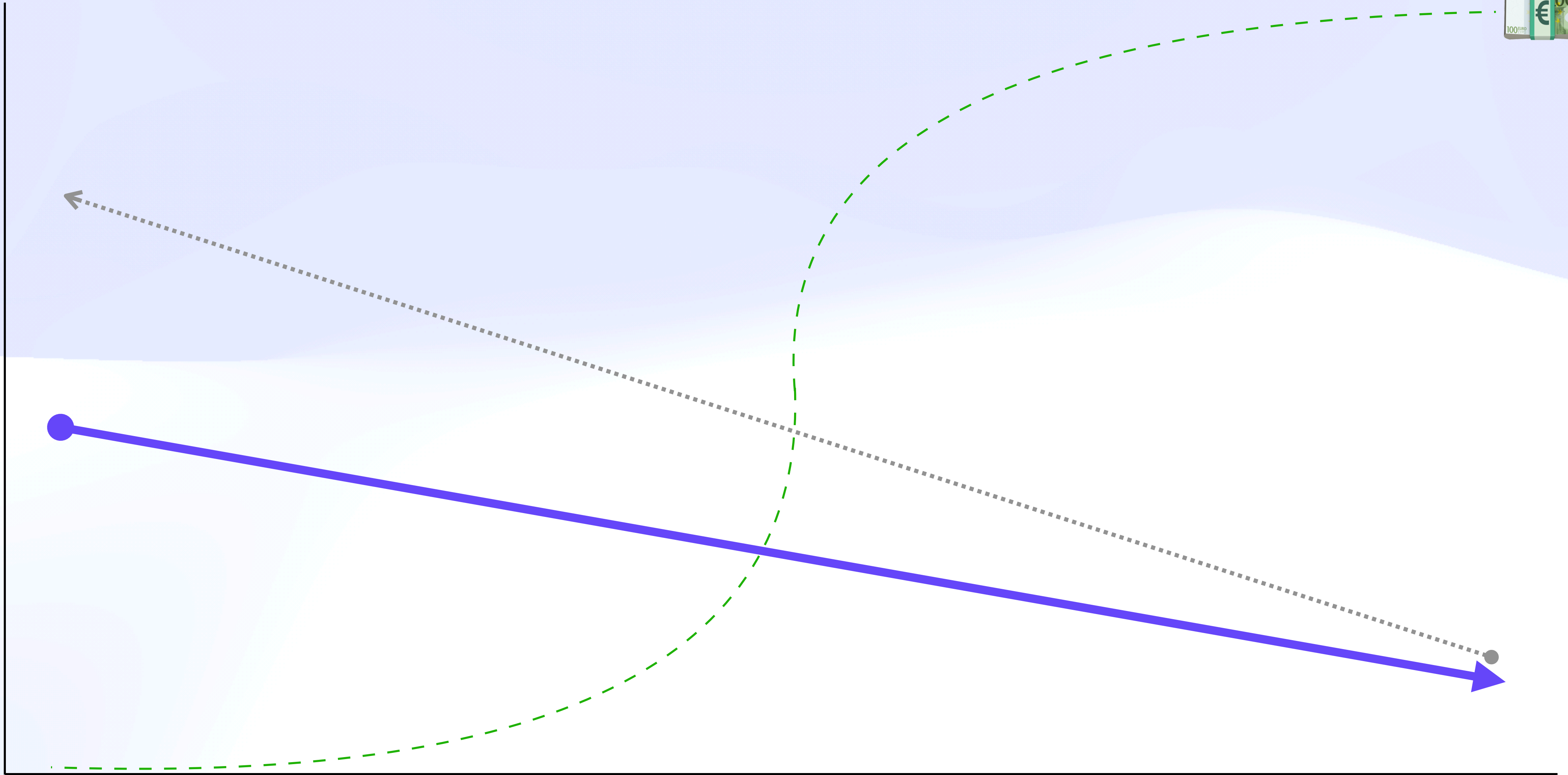
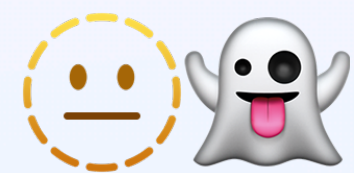
Off-the-Shelf

Utility



Local-First

# *The Great Spiral* 🛠️



Invention

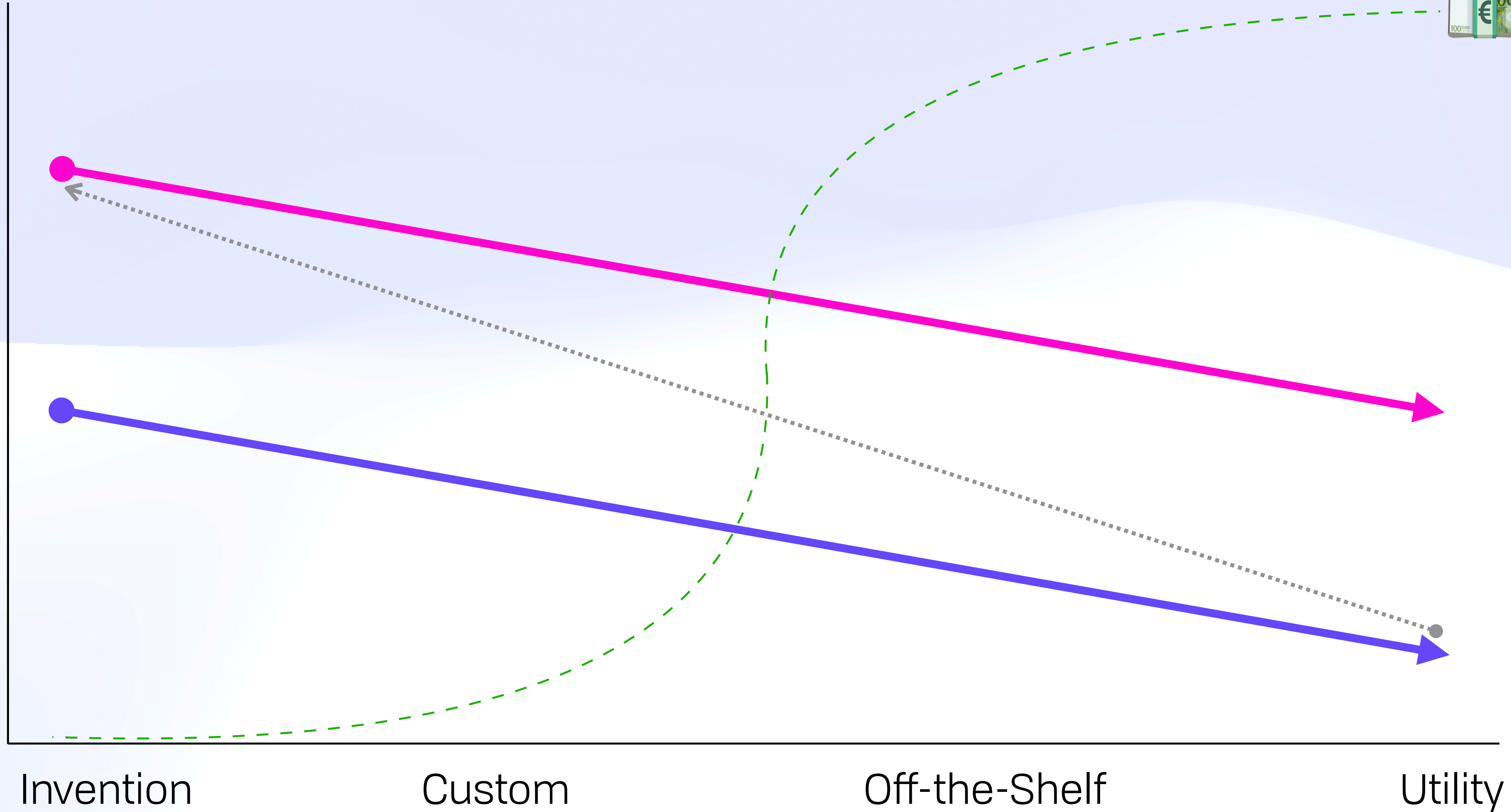
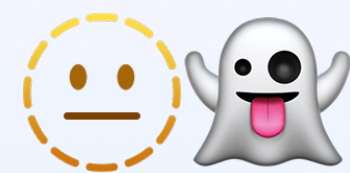
Custom

Off-the-Shelf

Utility

Local-First

# *The Great Spiral* 🛠️



Local-First

# ***The Path of LocalHub***

Local-First

# *The Path of LocalHub*



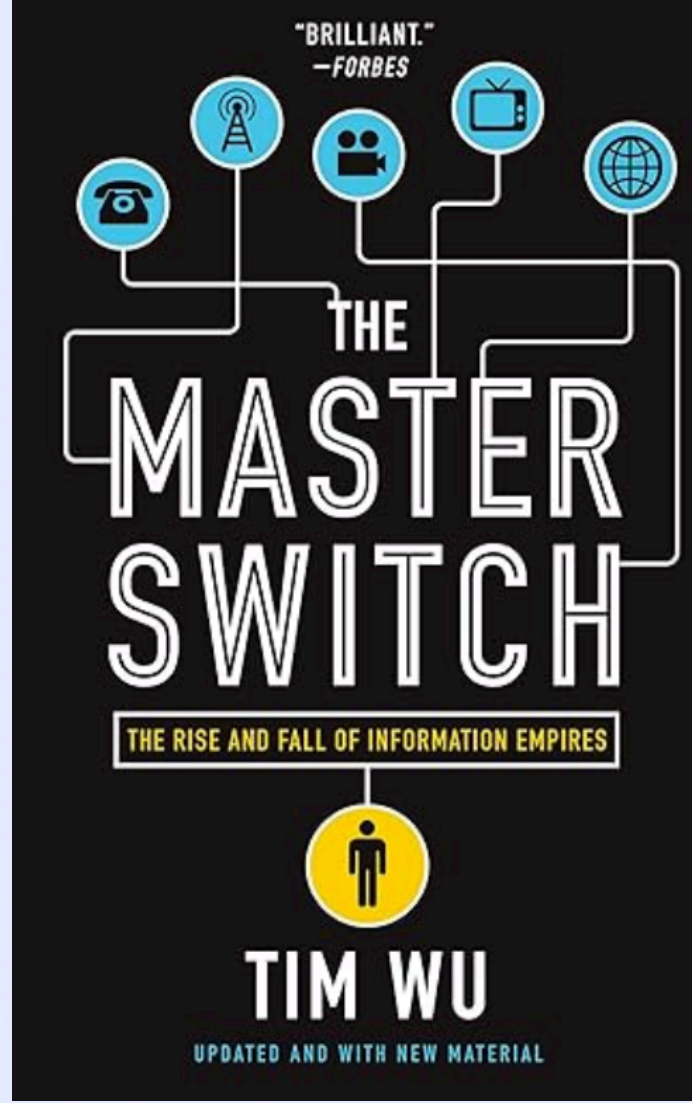
Local-First

# *The Path of LocalHub*



Local-First

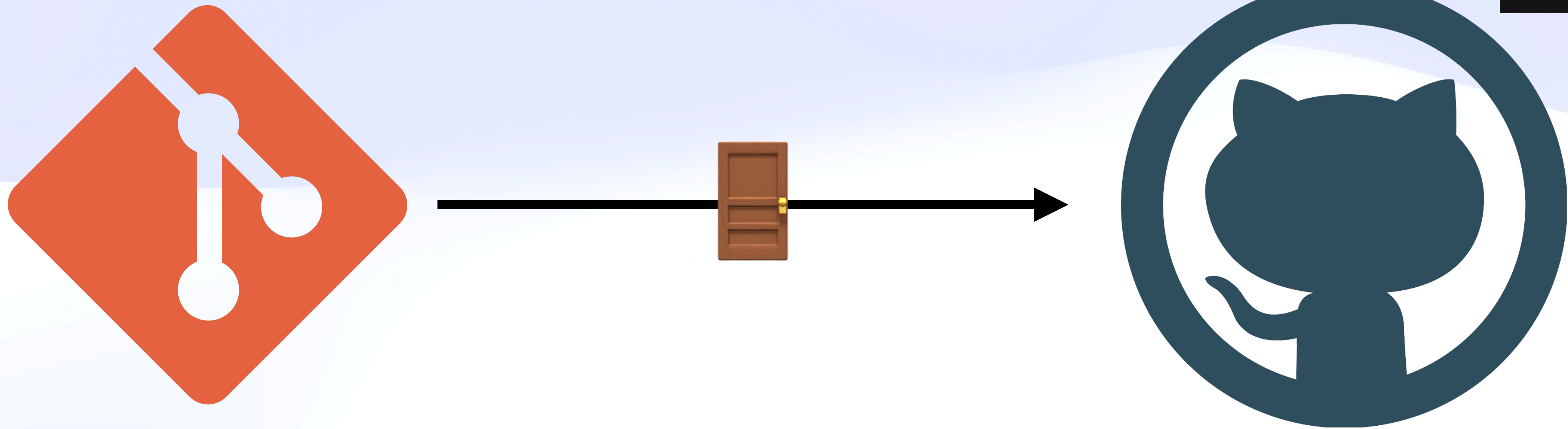
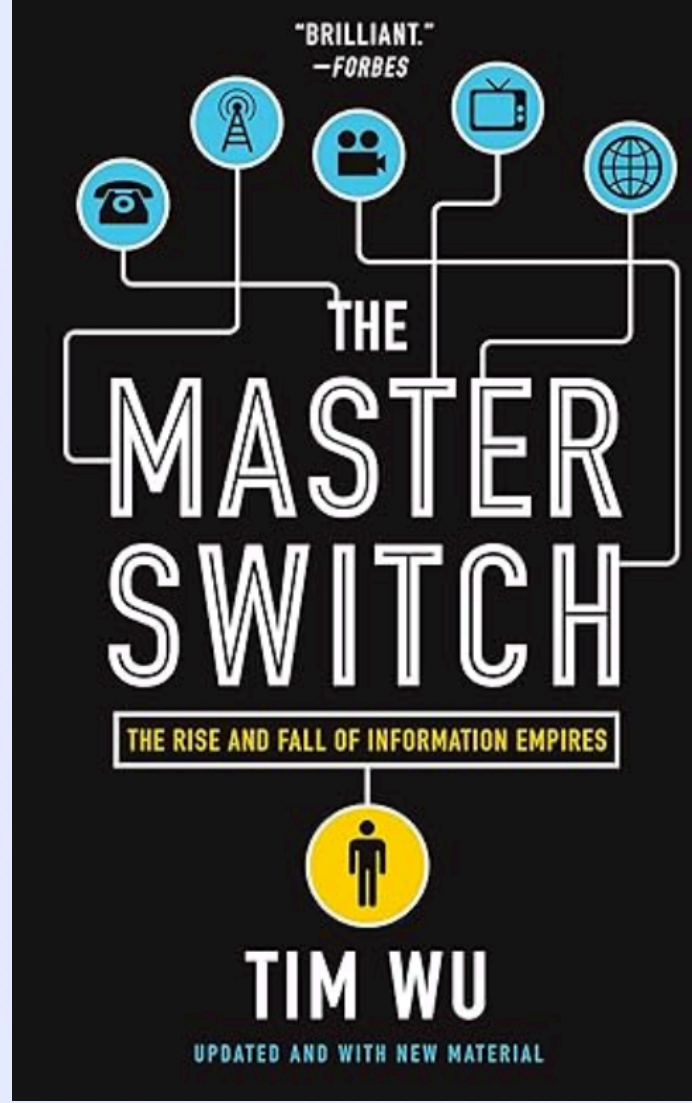
# *The Path of LocalHub*





Local-First

# *The Path of LocalHub*

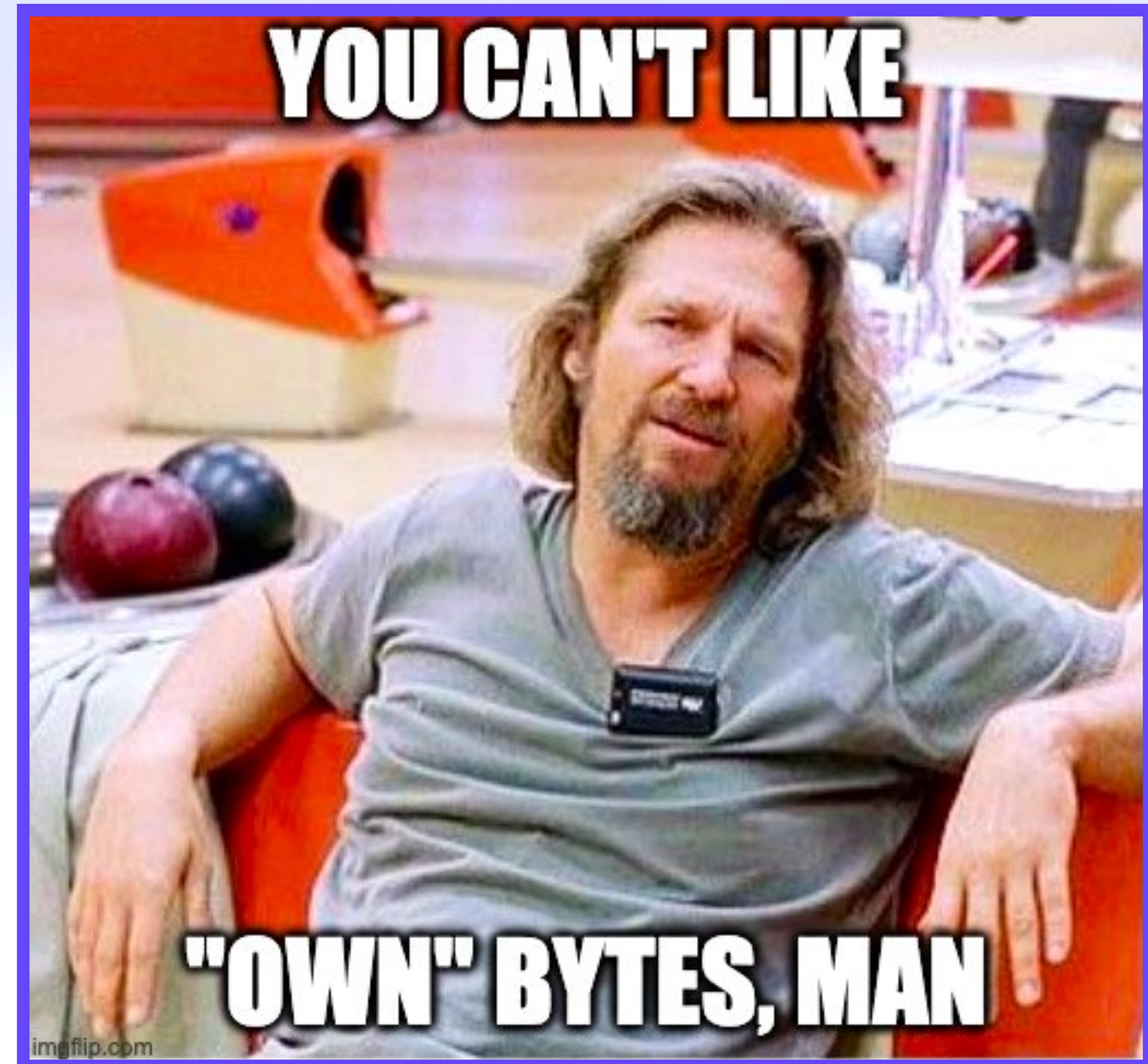


***"Do it yourself, use store bought when you get busy"***

Local-First

# *User Agency for Great Good*

- Empower users to participate (entry)
- Leave without loss (exit)
- Control access to your data (safety)
- Provide capacity to others (serve)



Local-First

# ***Eat Your Veggies*** 🥦





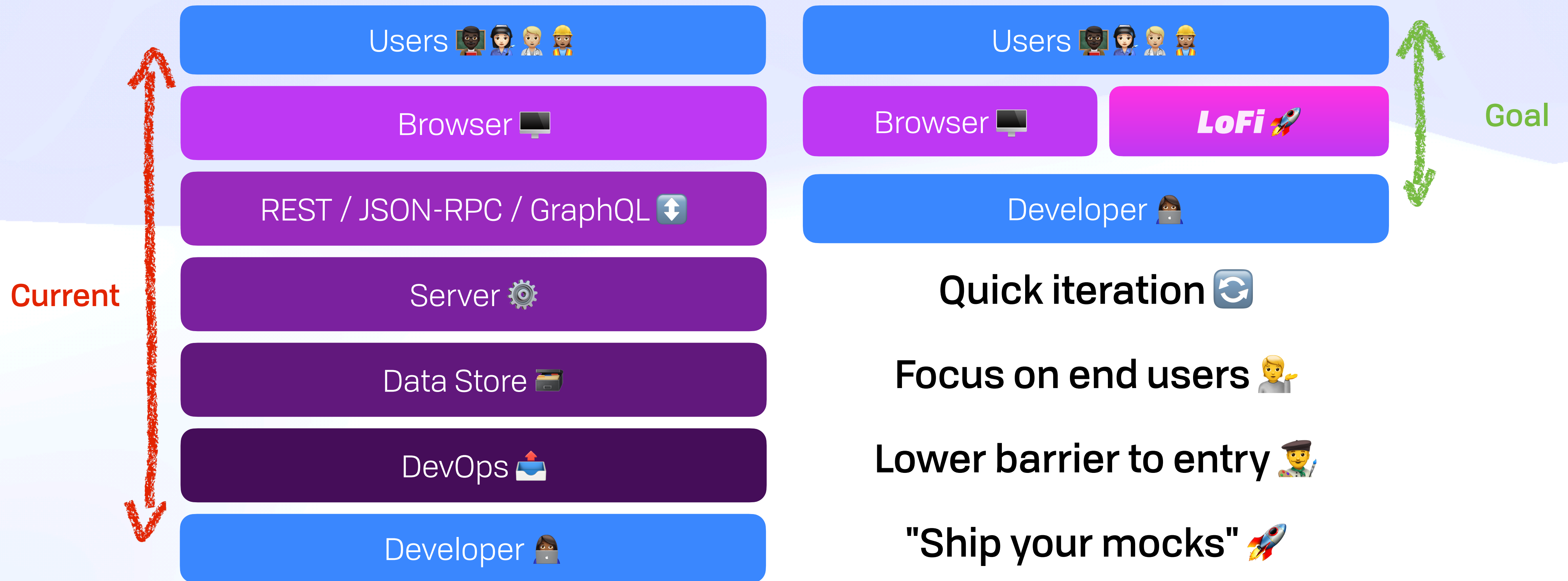
# ***From the Field***



Celebrating ~5 years of LoFi

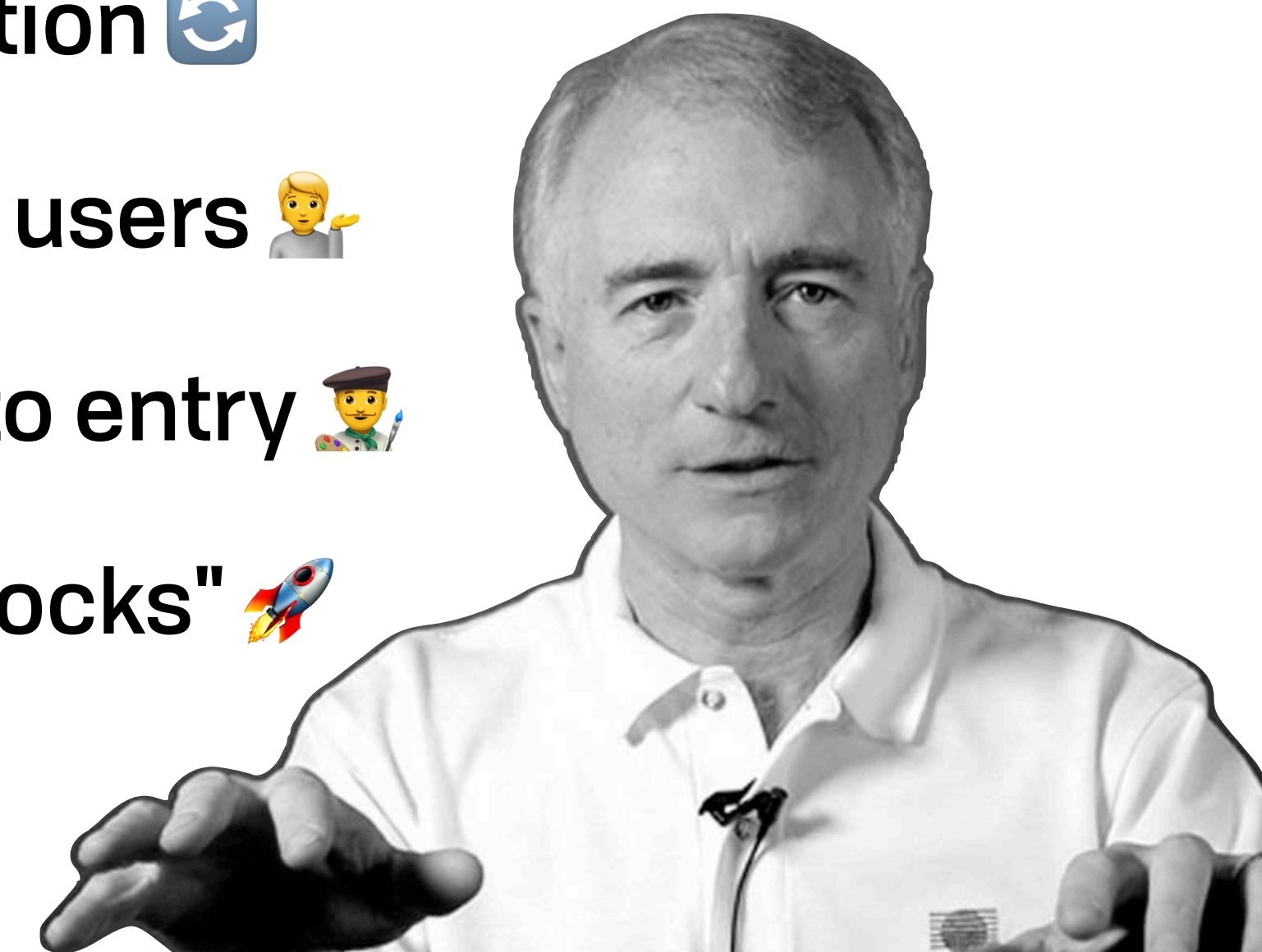
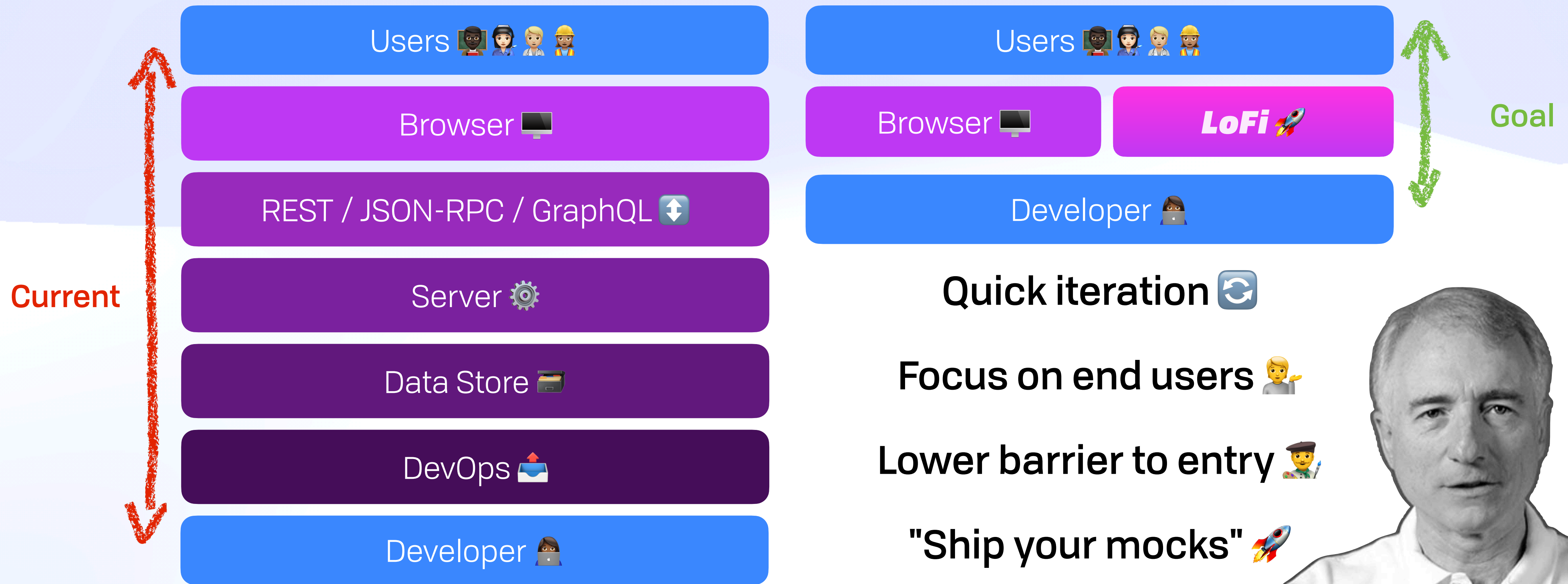
From the Field

# ~~Simplify. Simplify. Simplify.~~



From the Field

# ~~Simplify. Simplify. Simplify.~~



From the Field

***Simplify. Simplify. Simplify.***



From the Field

***Simplify. Simplify. Simplify.***

...how hard could it be? 🙄





# From the Field App

Distributed Compute

Broadcast

Data Store

Network

Auth & ID

**Dev's App**  
*Business Logic & View*

**Portable Compute**  
*Interplanetary Virtual Machine (IPVM)*

**Collaboration, Chat, Instant Sync**  
*Soft Realtime Store*

**Global: Aggregation, Forms, Feeds**  
*Gossip Broadcast*

**Offline & Async Sharing**  
*Sync Server*

**(Un)structured Store**  
*Rhizome (Postmodern) Database*

**Secure Blob Storage**  
*WebNative File System*

**Selective Sync**  
*CAR Pool, Datalog Selectors*

**Command/Mutation Control**  
*UCAN*

**Networking**  
*DNS, IPFS, QUIC, Wireguard, Matrix*

**Read/Query Control**  
*Dark Forest / Cryptree*

**Identity**  
*PKI / did:key*

# From the Field App

Distributed Compute

Broadcast

Data Store

Network

Auth & ID

**Dev's App**  
*Business Logic & View*

**Portable Compute**  
*Interplanetary Virtual Machine (IPVM)*

**Collaboration, Chat, Instant Sync**  
*Soft Realtime Store*

**Global: Aggregation, Forms, Feeds**  
*Gossip Broadcast*

**Offline & Async Sharing**  
*Sync Server*

**(Un)structured Store**  
*Rhizome (Postmodern) Database*

**Secure Blob Storage**  
*WebNative File System*

**Selective Sync**  
*CAR Pool, Datalog Selectors*

**Command/Mutation Control**  
*UCAN*

**Networking**  
*DNS, IPFS, QUIC, Wireguard, Matrix*

**Read/Query Control**  
*Dark Forest / Cryptree*

**Identity**  
*PKI / did:key*

# From the Field App

Distributed Compute

Broadcast

Data Store

Network

Auth & ID

**Dev's App**  
*Business Logic & View*

**Portable Compute**  
*Interplanetary Virtual Machine (IPVM)*

**Collaboration, Chat, Instant Sync**  
*Soft Realtime Store*

**Global: Aggregation, Forms, Feeds**  
*Gossip Broadcast*

**Offline & Async Sharing**  
*Sync Server*

**(Un)structured Store**  
*Rhizome (Postmodern) Database*

**Secure Blob Storage**  
*WebNative File System*

**Selective Sync**  
*CAR Pool, Datalog Selectors*

**Command/Mutation Control**  
*UCAN*

**Networking**  
*DNS, IPFS, QUIC, Wireguard, Matrix*

**Read/Query Control**  
*Dark Forest / Cryptree*

**Identity**  
*PKI / did:key*

# From the Field App

Distributed Compute

Broadcast

Data Store

Network

Auth & ID

**Dev's App**  
*Business Logic & View*

**Portable Compute**  
*Interplanetary Virtual Machine (IPVM)*

**Collaboration, Chat, Instant Sync**  
*Soft Realtime Store*

**Global: Aggregation, Forms, Feeds**  
*Gossip Broadcast*

**Offline & Async Sharing**  
*Sync Server*

**(Un)structured Store**  
*Rhizome (Postmodern) Database*

**Secure Blob Storage**  
*WebNative File System*

**Selective Sync**  
*CAR Pool, Datalog Selectors*

**Command/Mutation Control**  
*UCAN*

**Networking**  
*DNS, IPFS, QUIC, Wireguard, Matrix*

**Read/Query Control**  
*Dark Forest / Cryptree*

**Identity**  
*PKI / did:key*

# From the Field App

Distributed Compute

Broadcast

Data Store

Network

Auth & ID

**Dev's App**  
*Business Logic & View*

**Portable Compute**  
*Interplanetary Virtual Machine (IPVM)*

**Collaboration, Chat, Instant Sync**  
*Soft Realtime Store*

**Global: Aggregation, Forms, Feeds**  
*Gossip Broadcast*

**Offline & Async Sharing**  
*Sync Server*

**(Un)structured Store**  
*Rhizome (Postmodern) Database*

**Secure Blob Storage**  
*WebNative File System*

**Selective Sync**  
*CAR Pool, Datalog Selectors*

**Command/Mutation Control**  
*UCAN*

**Networking**  
*DNS, IPFS, QUIC, Wireguard, Matrix*

**Read/Query Control**  
*Dark Forest / Cryptree*

**Identity**  
*PKI / did:key*

# From the Field



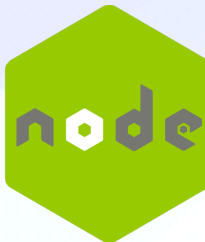
From the Field


# *Client/Server*

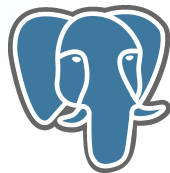
Auth 



Compute 



Data 



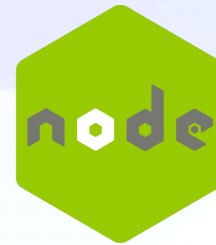
From the Field

# *Client/Server*

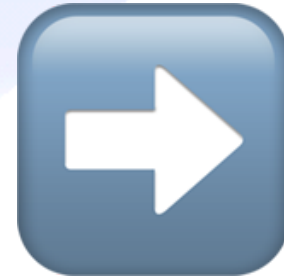
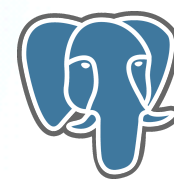
Auth 



Compute 



Data 





From the Field

# Client/Server


# LoFi

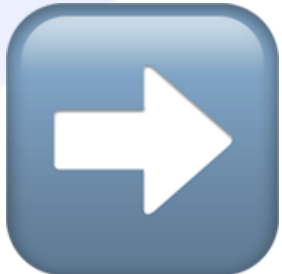
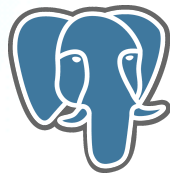
Auth 




Compute 



Data 



Compute 

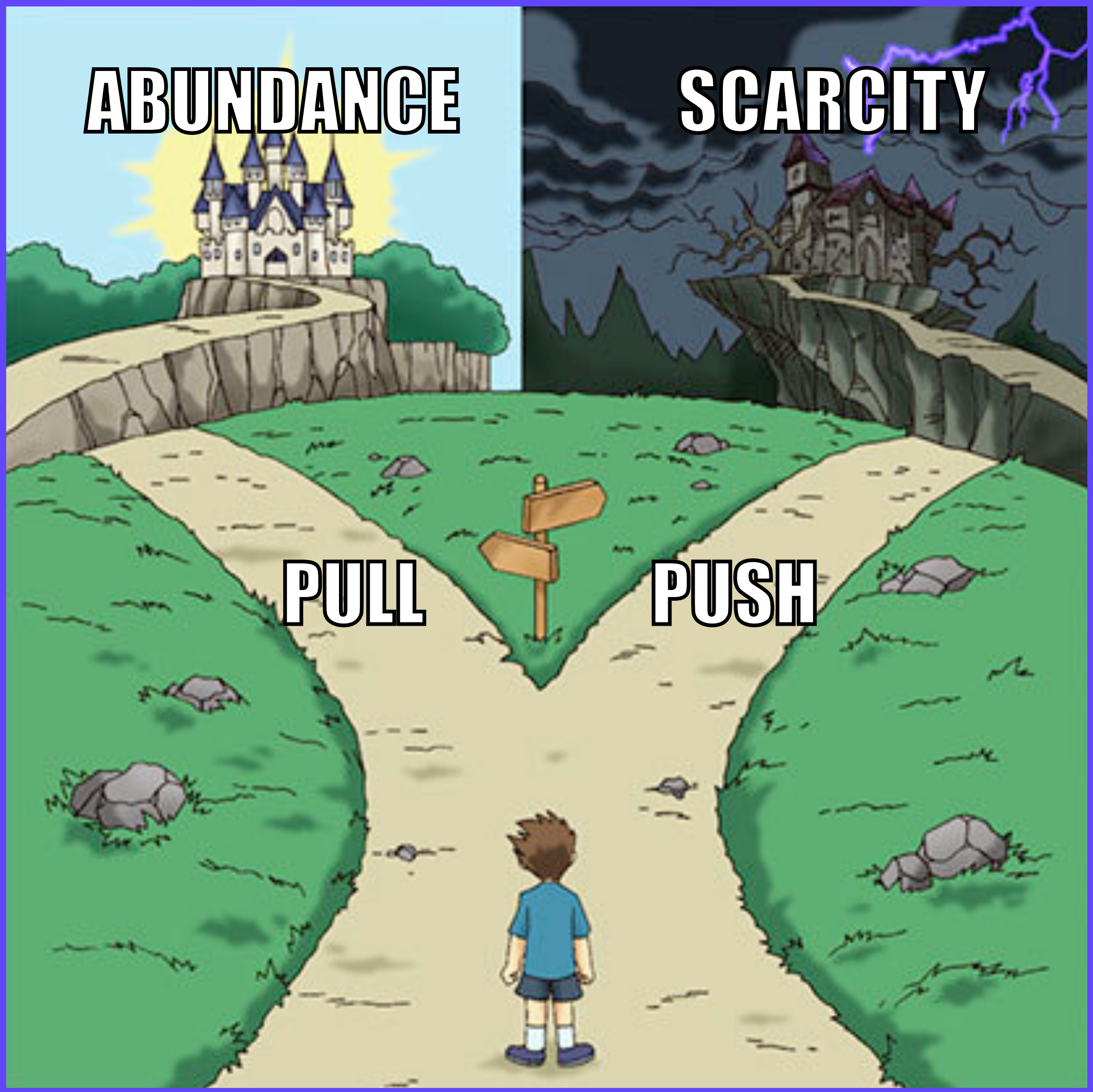
Data 

Auth 

# *Decentralised Trust*

 Who Authorises the Authorisers? 

# Decentralised Trust



# Decentralised Trust

## Decentralised Trust

***Cryptography*** is a tool for turning  
lots of different problems into  
***key management problems***

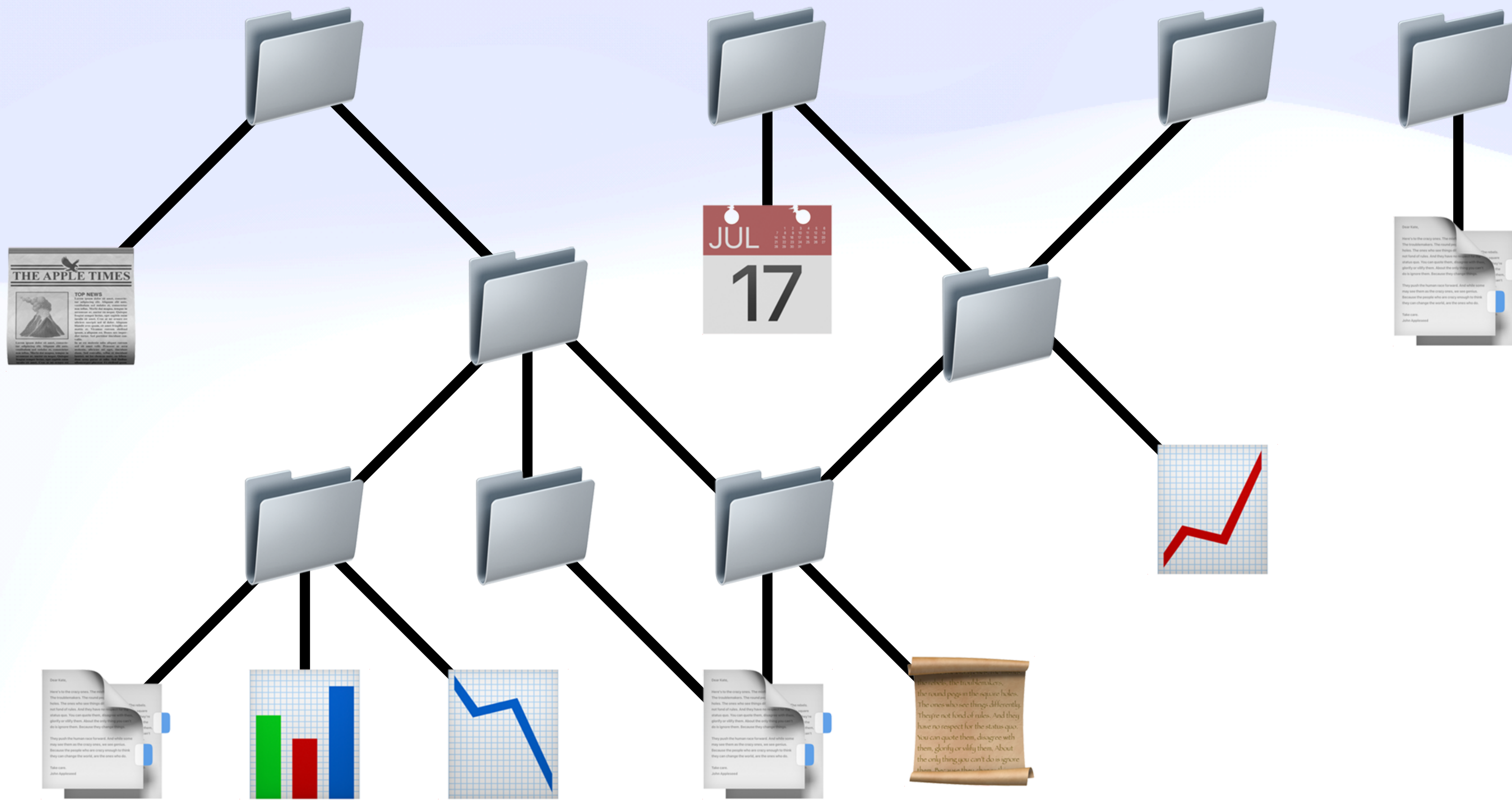
Dr. Lea Kissner, Global Lead of Privacy Technologies at Google

Decentralised Trust

***Beyond All-Or-Nothing***

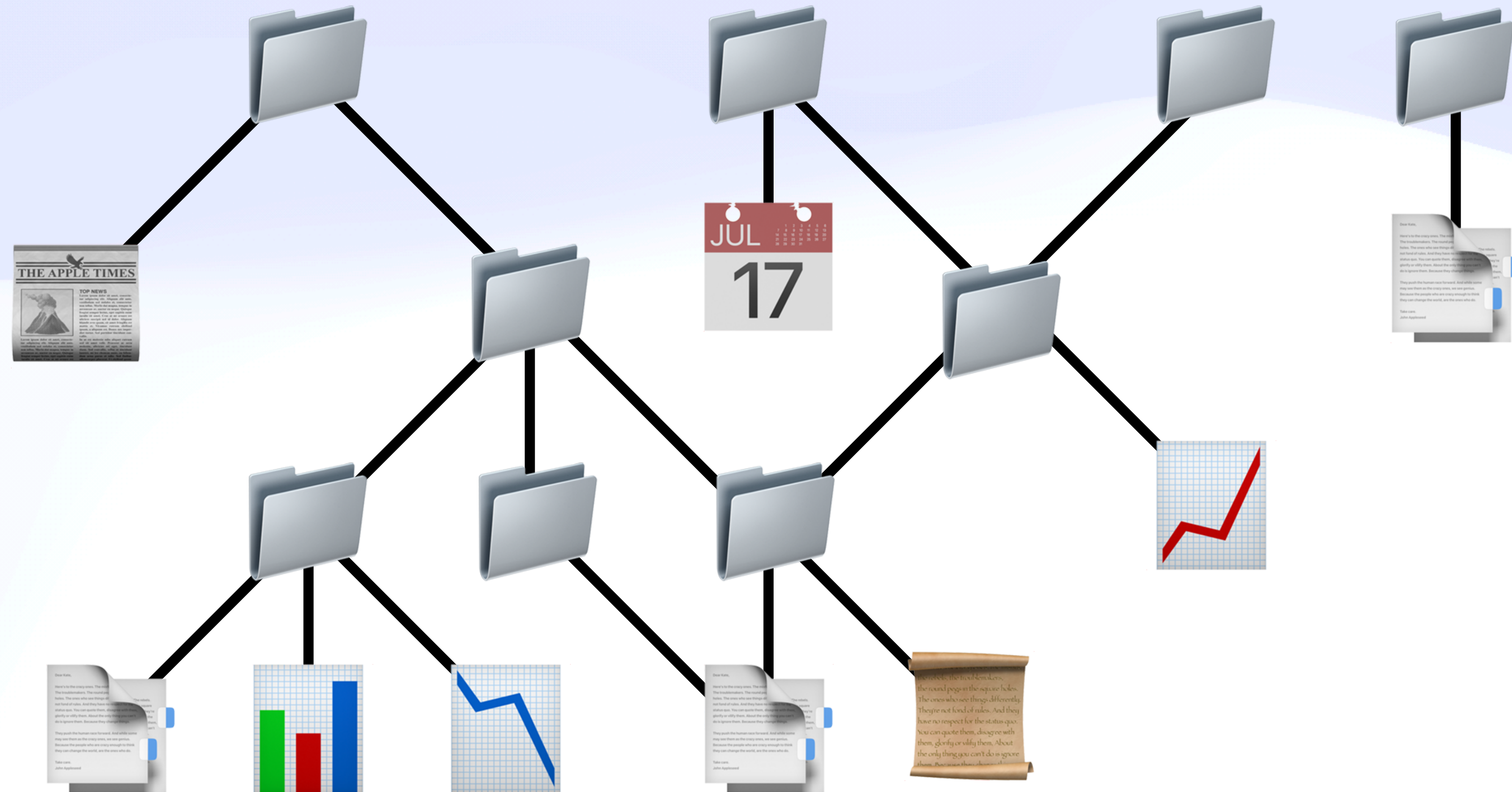
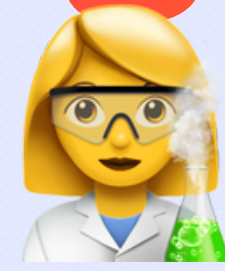
# Decentralised Trust

# *Beyond All-Or-Nothing*



# Decentralised Trust

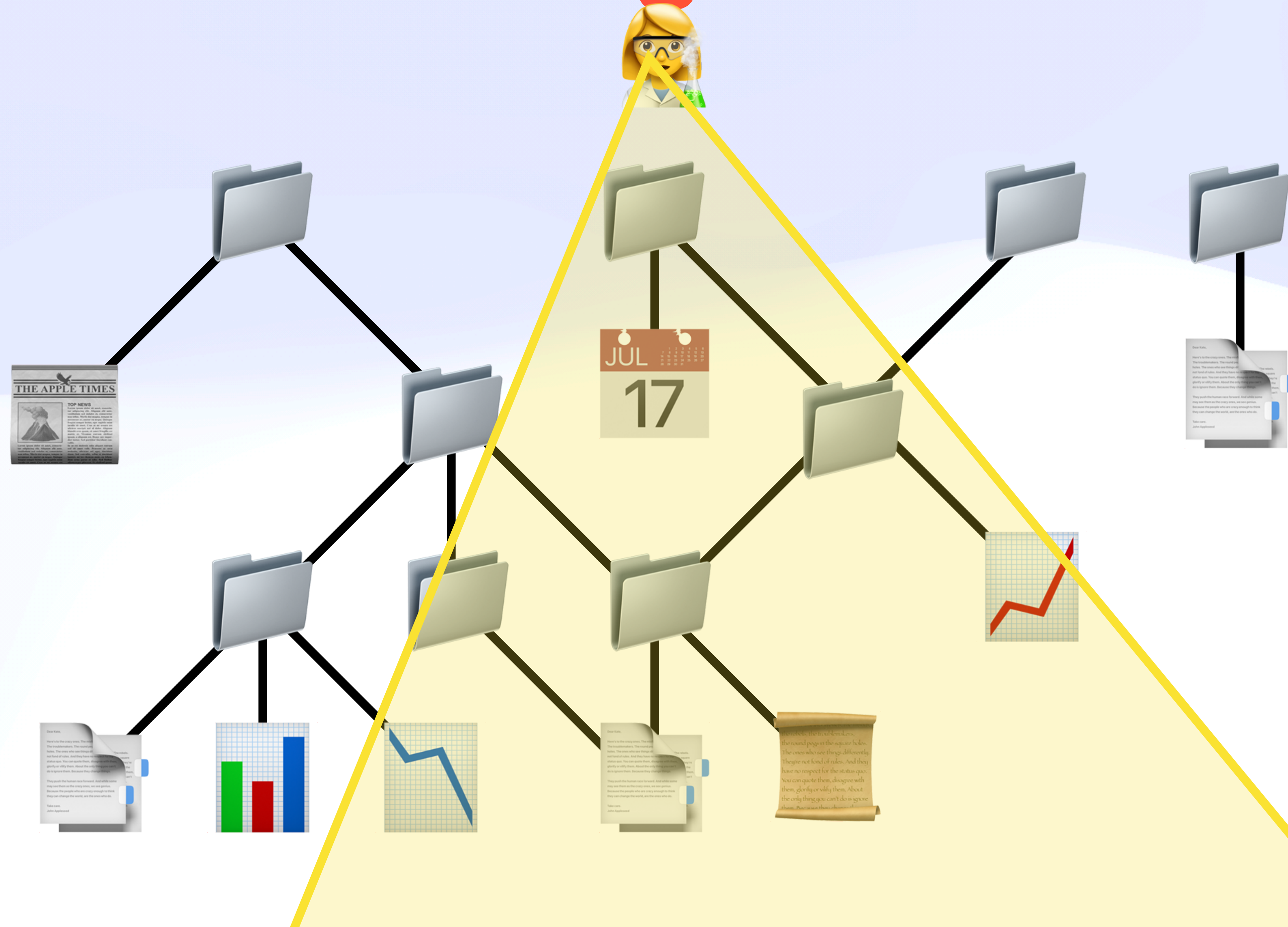
# Beyond All-Or-Nothing





# Decentralised Trust

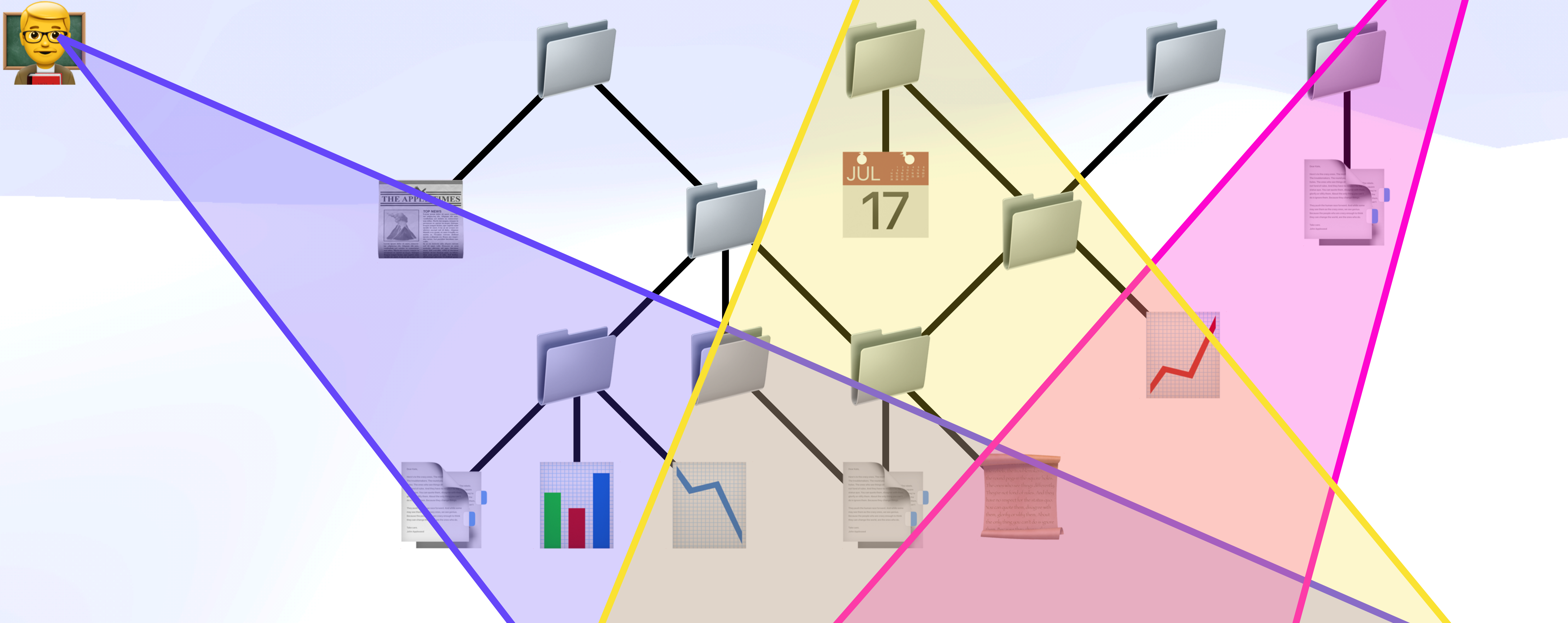
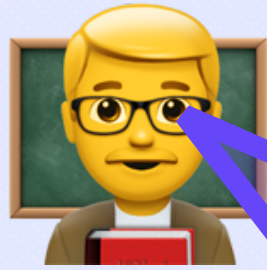
# Beyond All-Or-Nothing





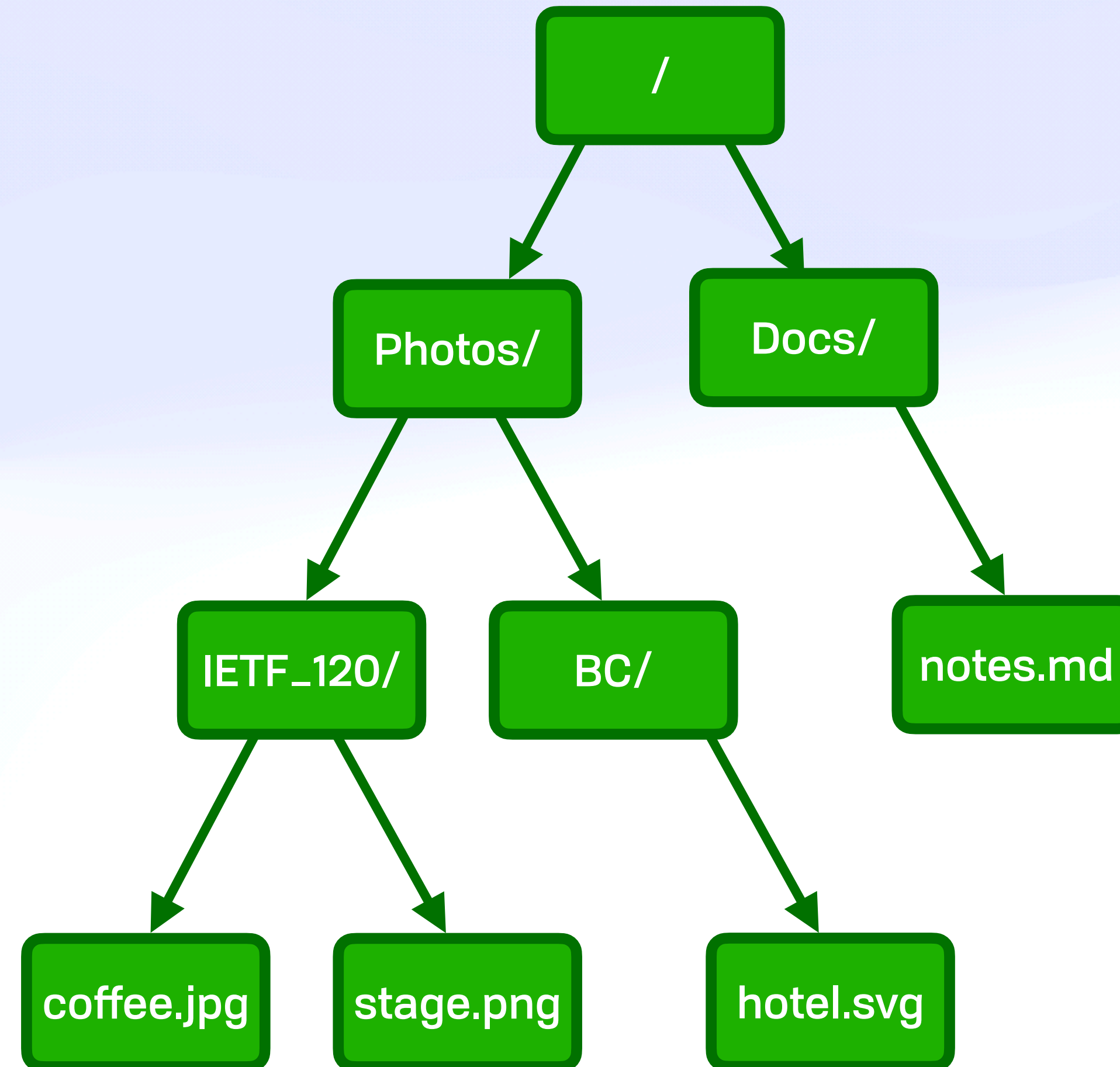
# Decentralised Trust

## *Beyond All-Or-Nothing*



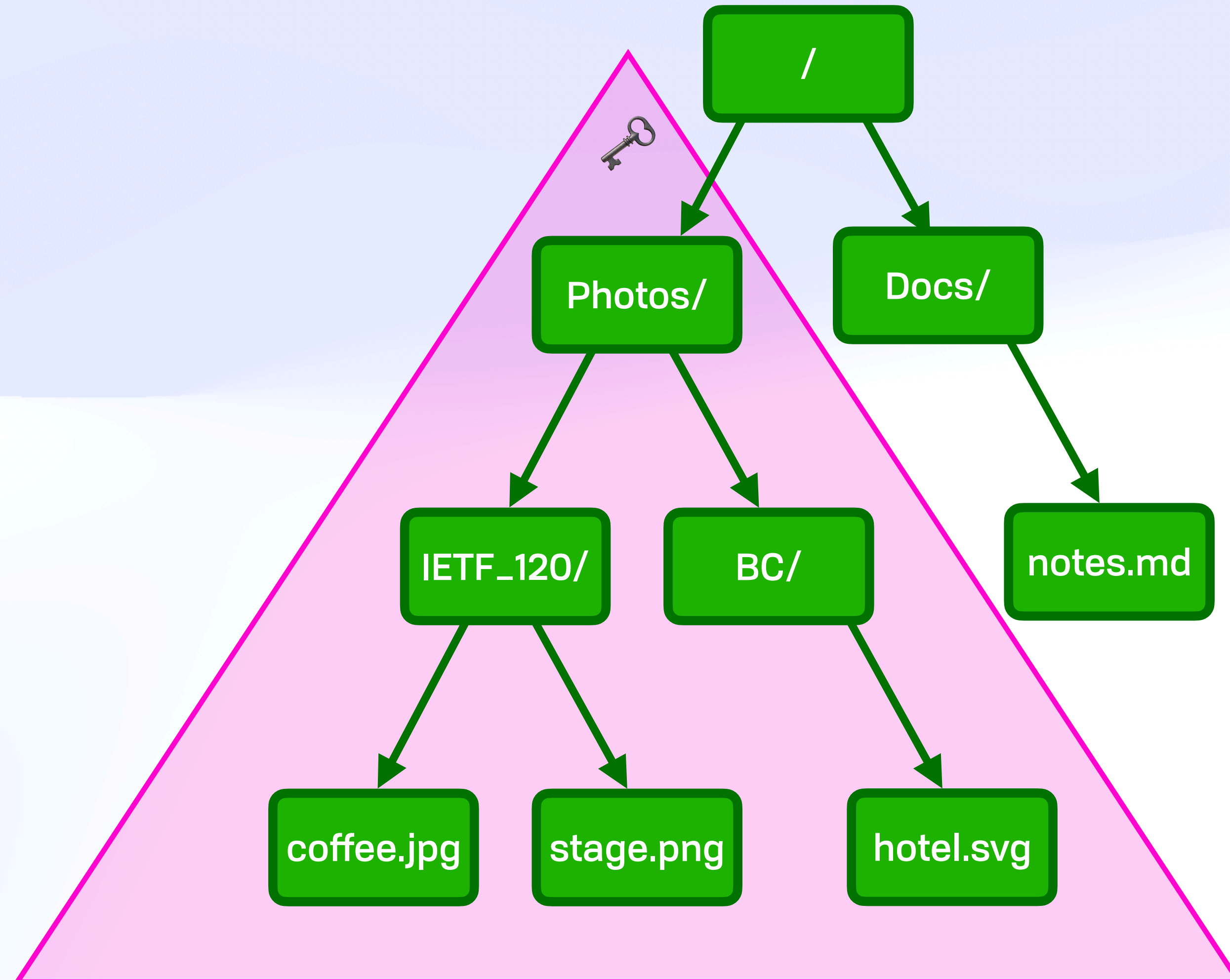
Decentralised Trust

# *Offline Access Control*



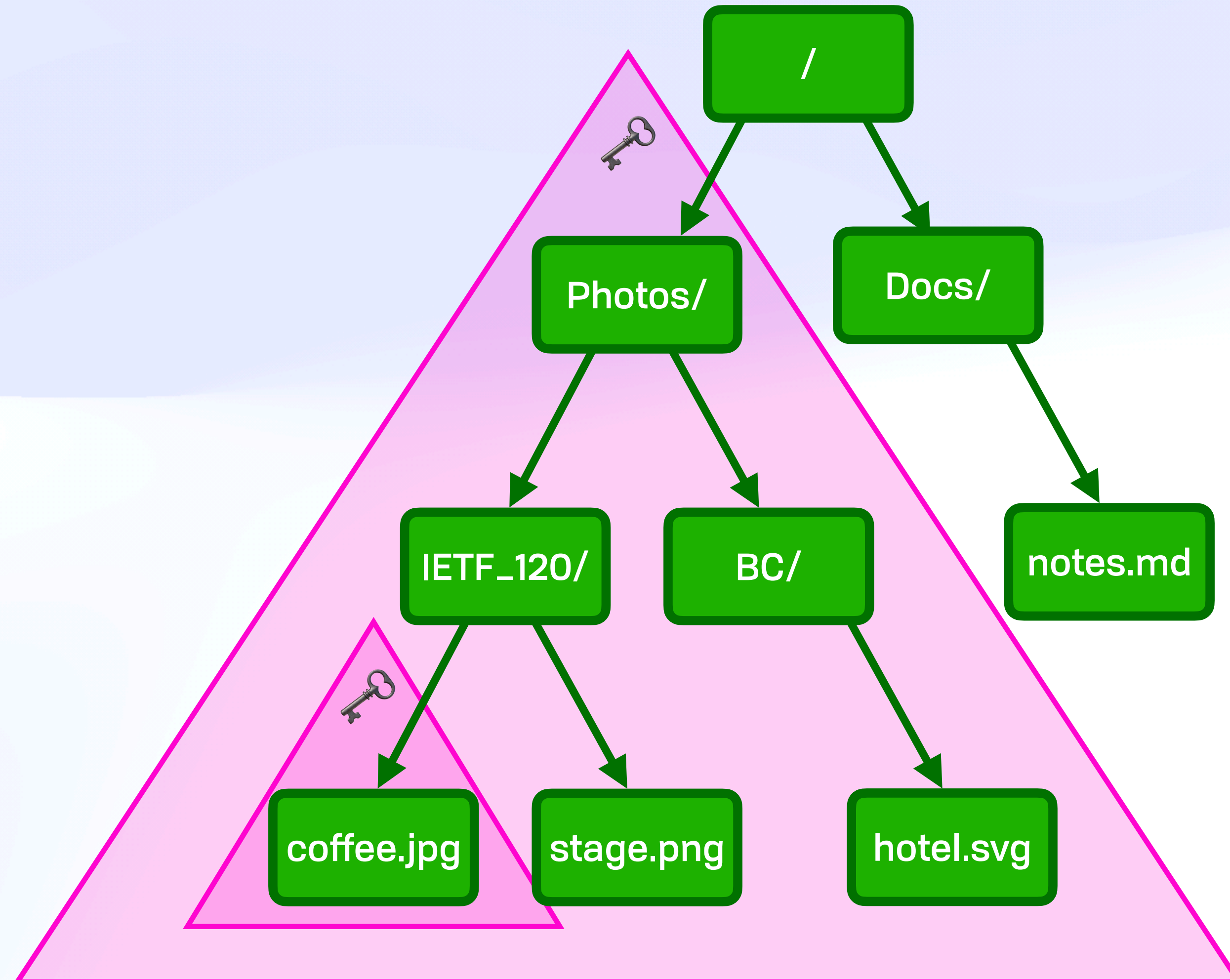
Decentralised Trust

# Offline Access Control



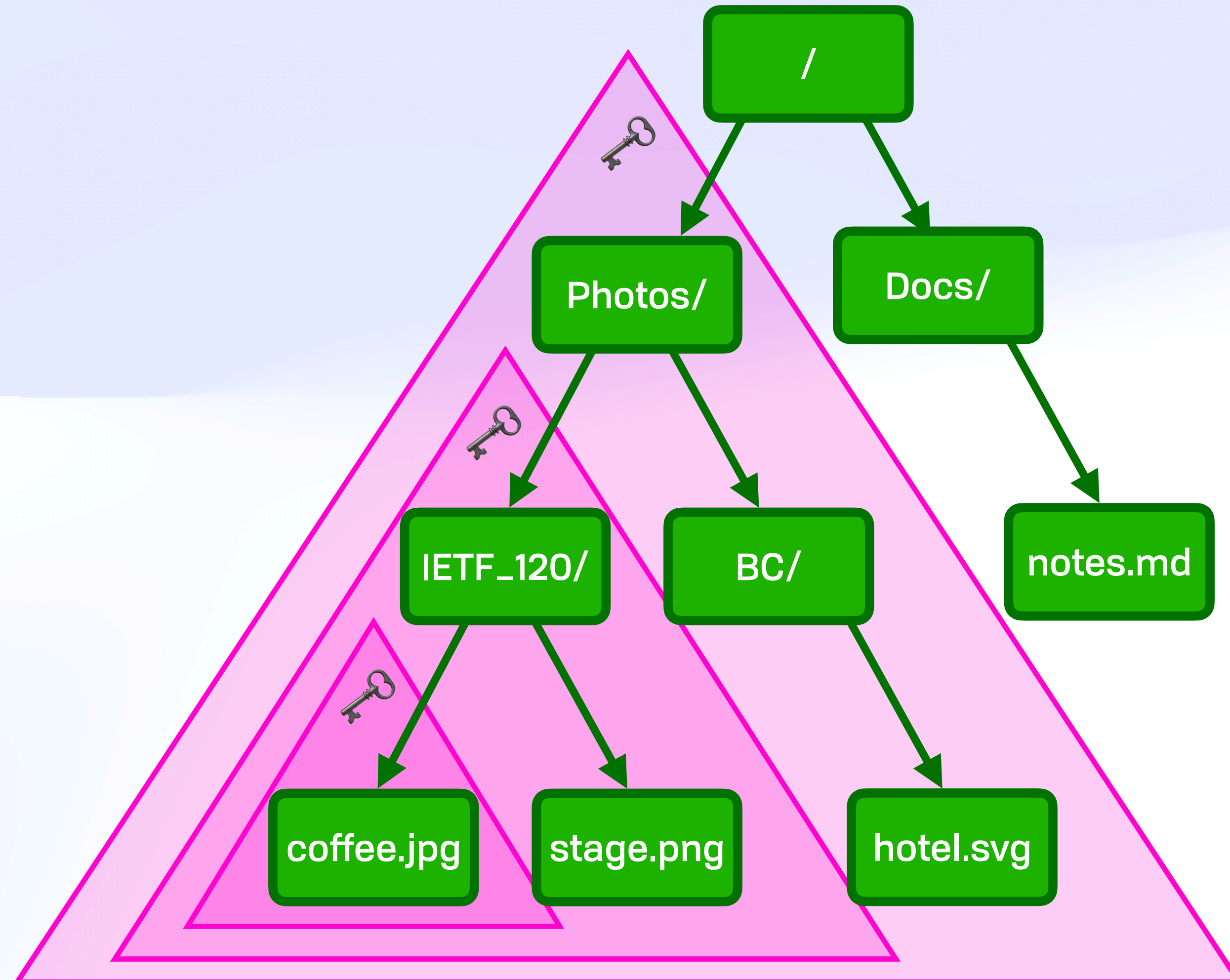
Decentralised Trust

# Offline Access Control



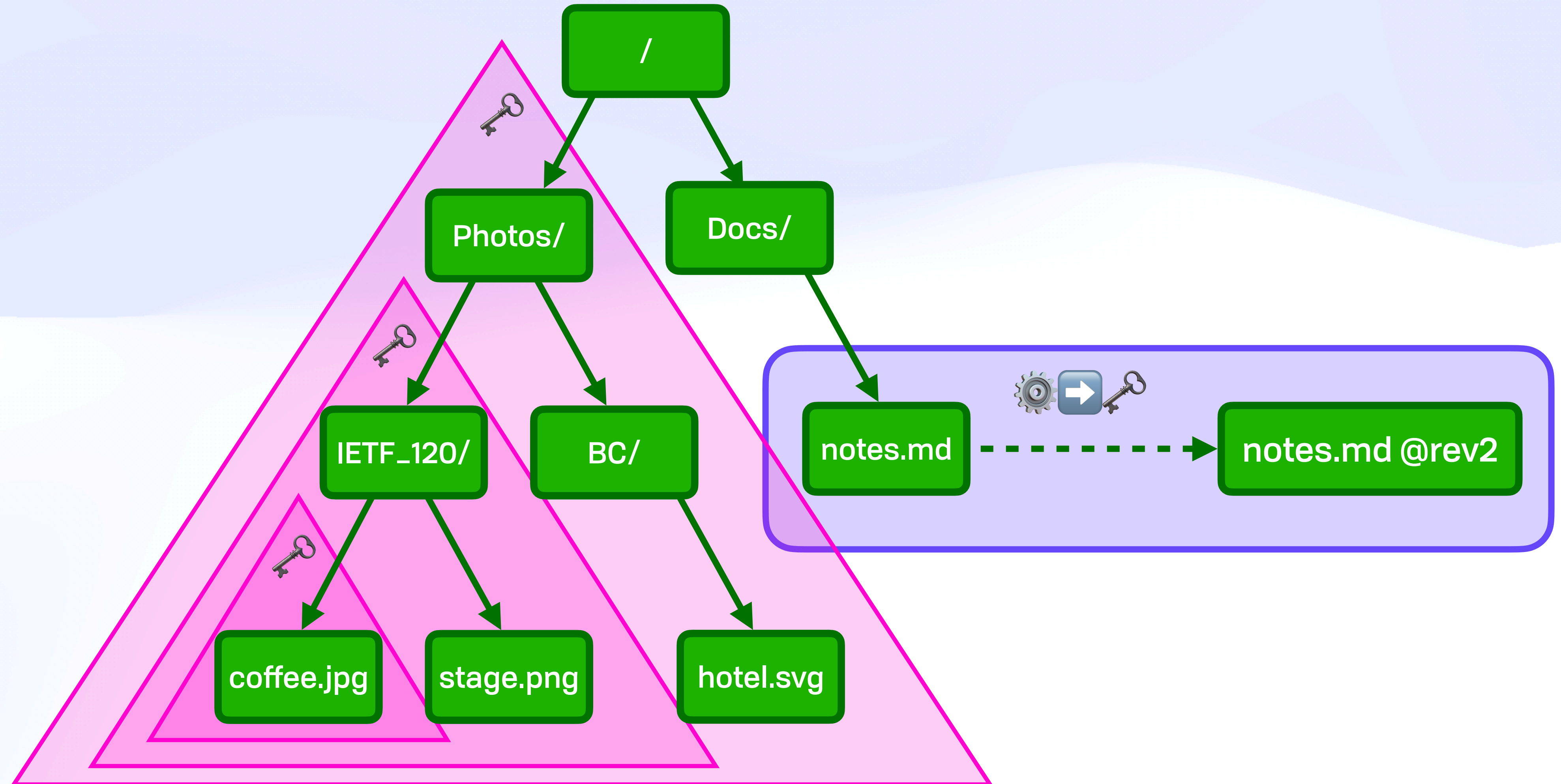
Decentralised Trust

# Offline Access Control



# Decentralised Trust

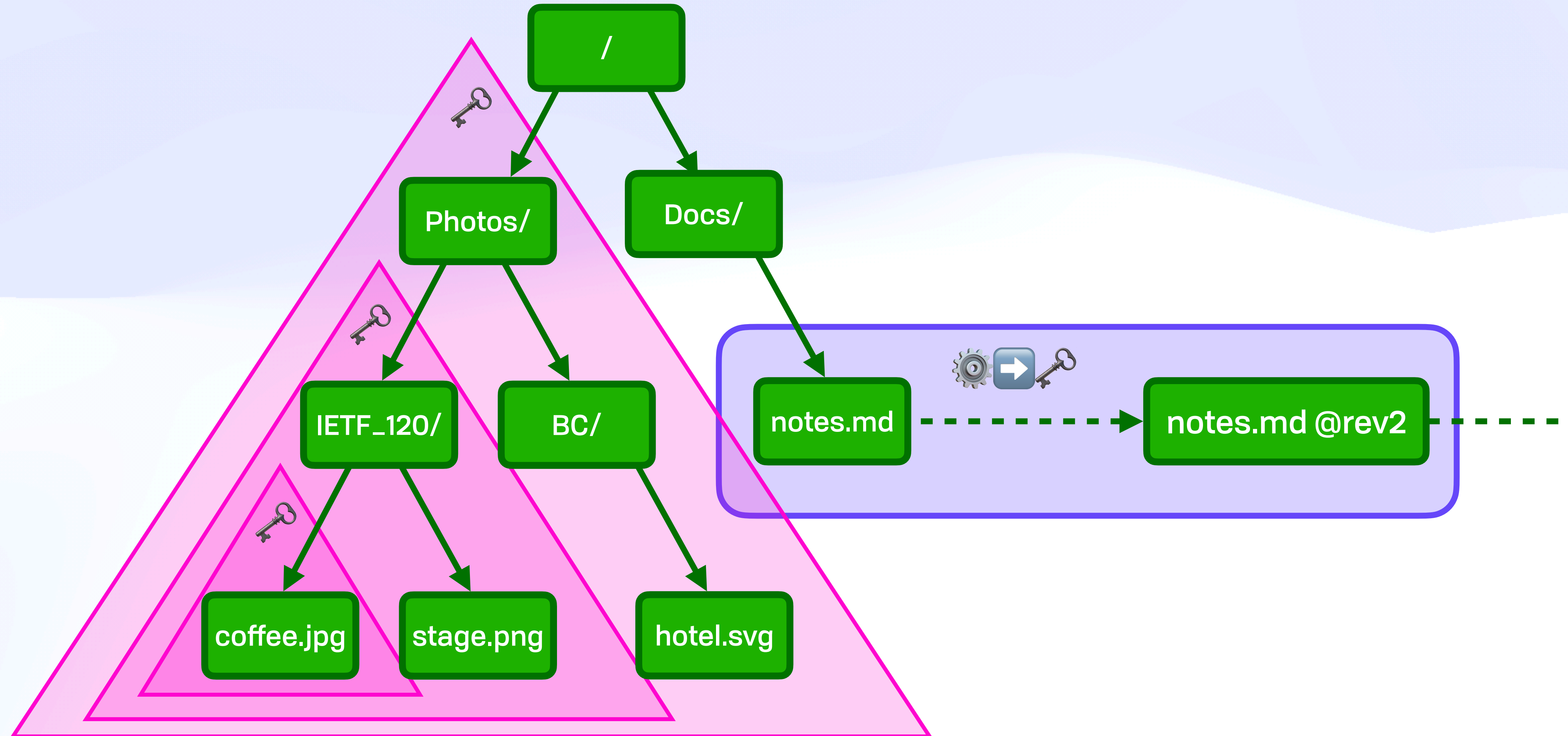
## *Offline Access Control*





# Decentralised Trust

## *Offline Access Control*



Decentralised Trust

***Auth Accidents Will Happen***

Decentralised Trust

# ***Auth Accidents Will Happen***

Bad Actor (Byzantine)



Decentralised Trust

# ***Auth Accidents Will Happen***

Bad Actor (Byzantine)



Revocation (non-monotone)



Decentralised Trust

***Cryptography is Not Always Enough***

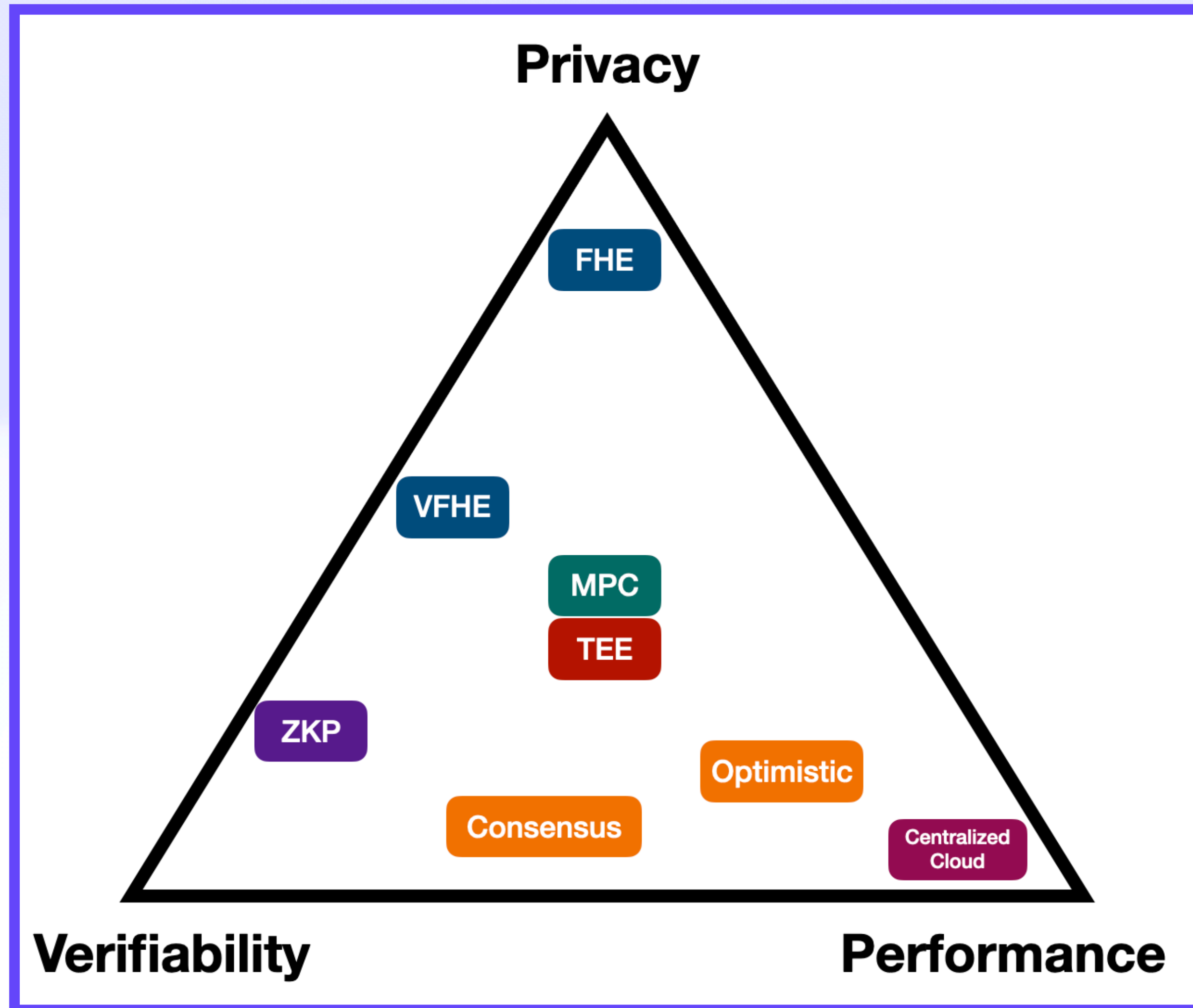
## Decentralised Trust

# *Cryptography is Not Always Enough*

- Because it's done at write-time, all or nothing encryption is not enough
- Keep data off the network!

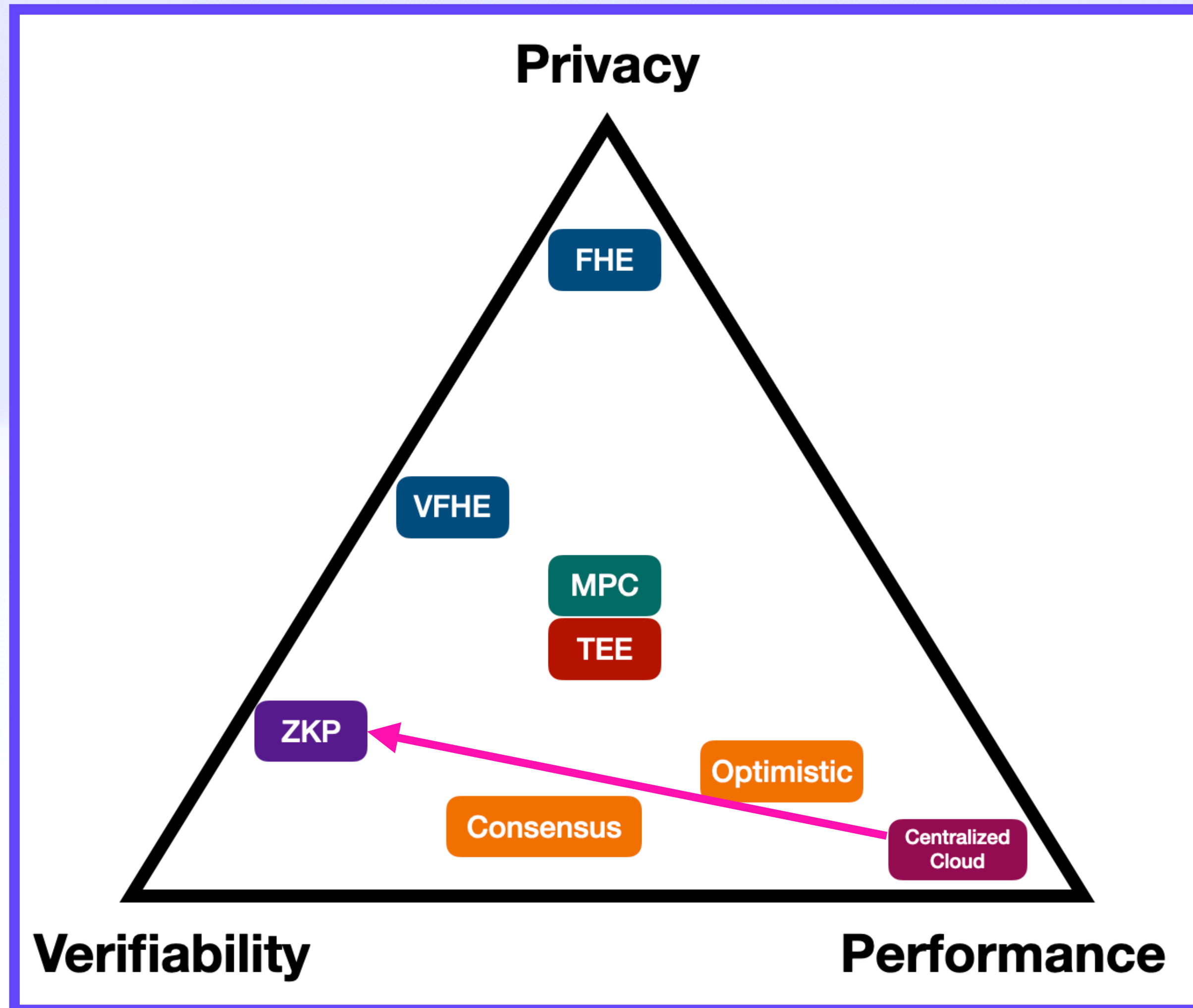
# Decentralised Trust

## *How to Trust Compute, Compaction, etc?*



# Decentralised Trust

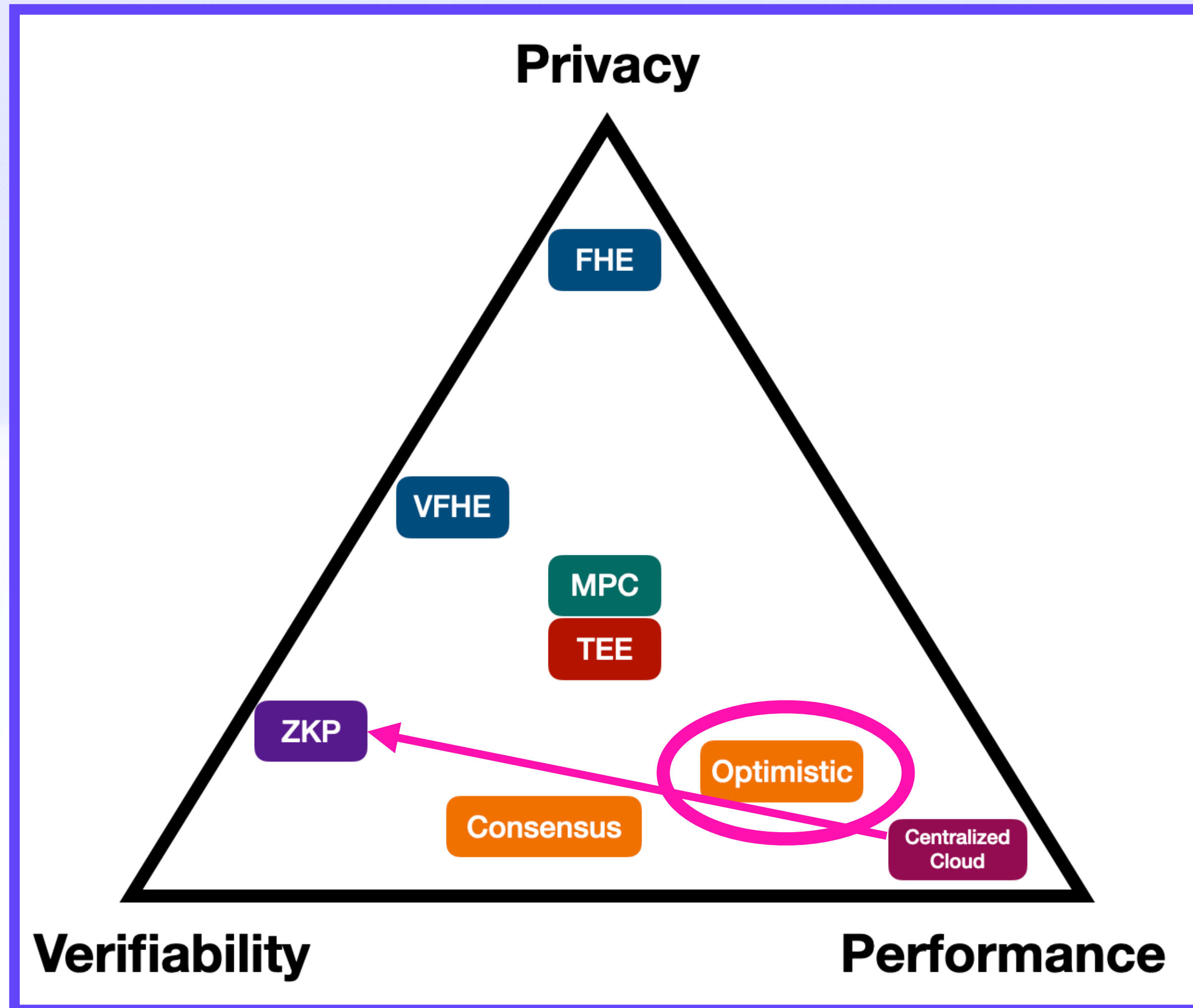
## *How to Trust Compute, Compaction, etc?*





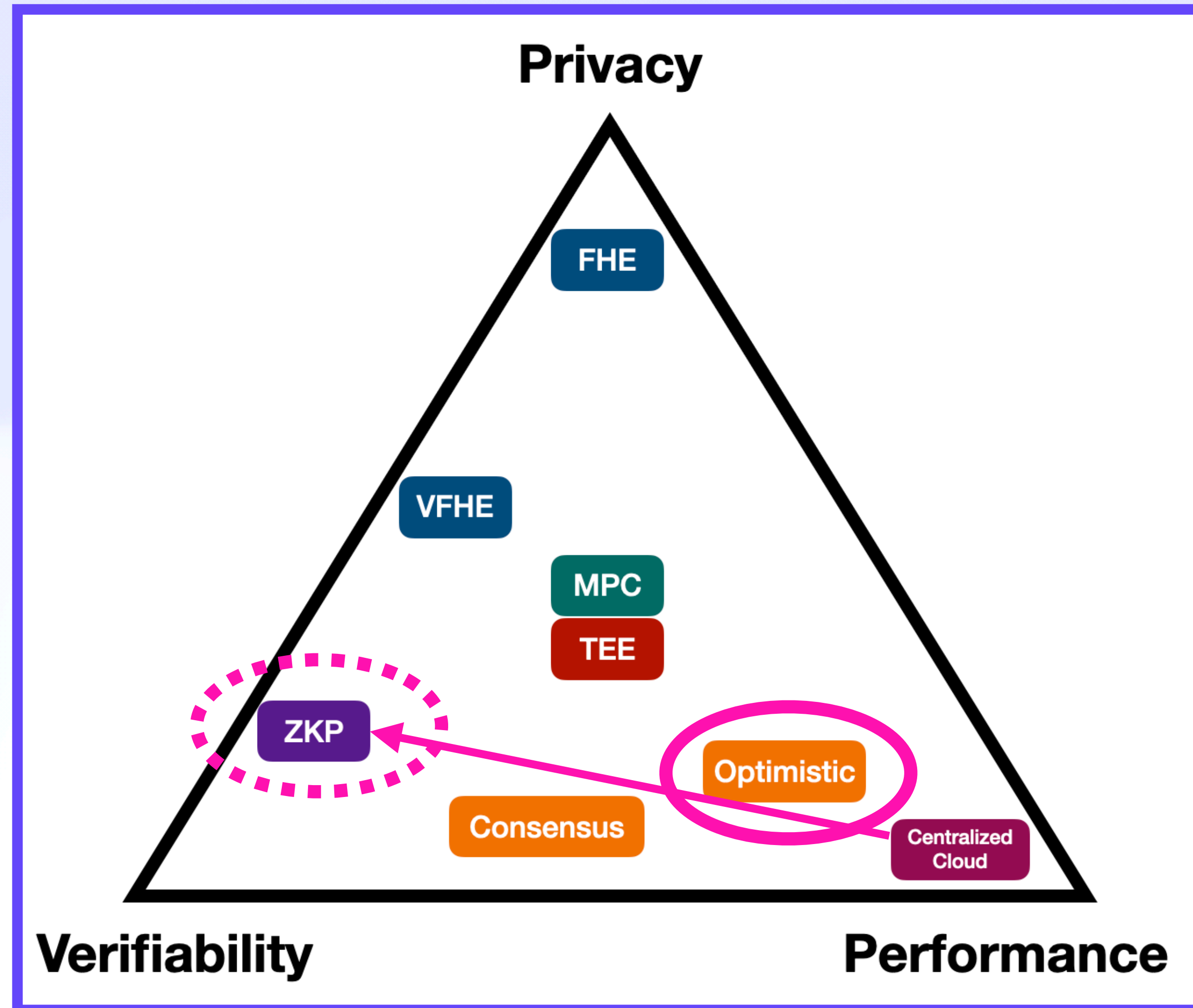
# Decentralised Trust

## *How to Trust Compute, Compaction, etc?*



# Decentralised Trust

## *How to Trust Compute, Compaction, etc?*

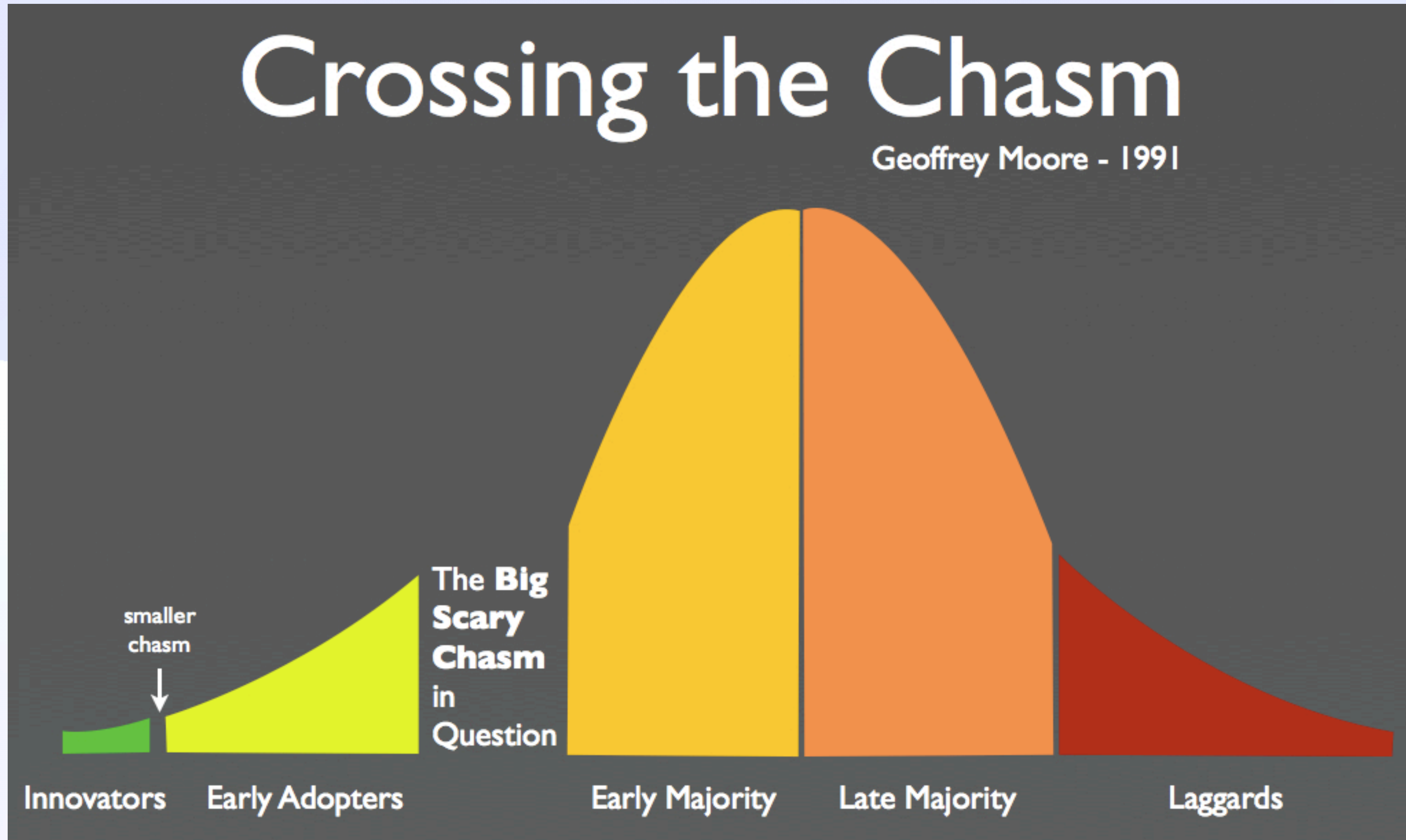


# ***Wrap Up Roadmap***

Threading the Needle 

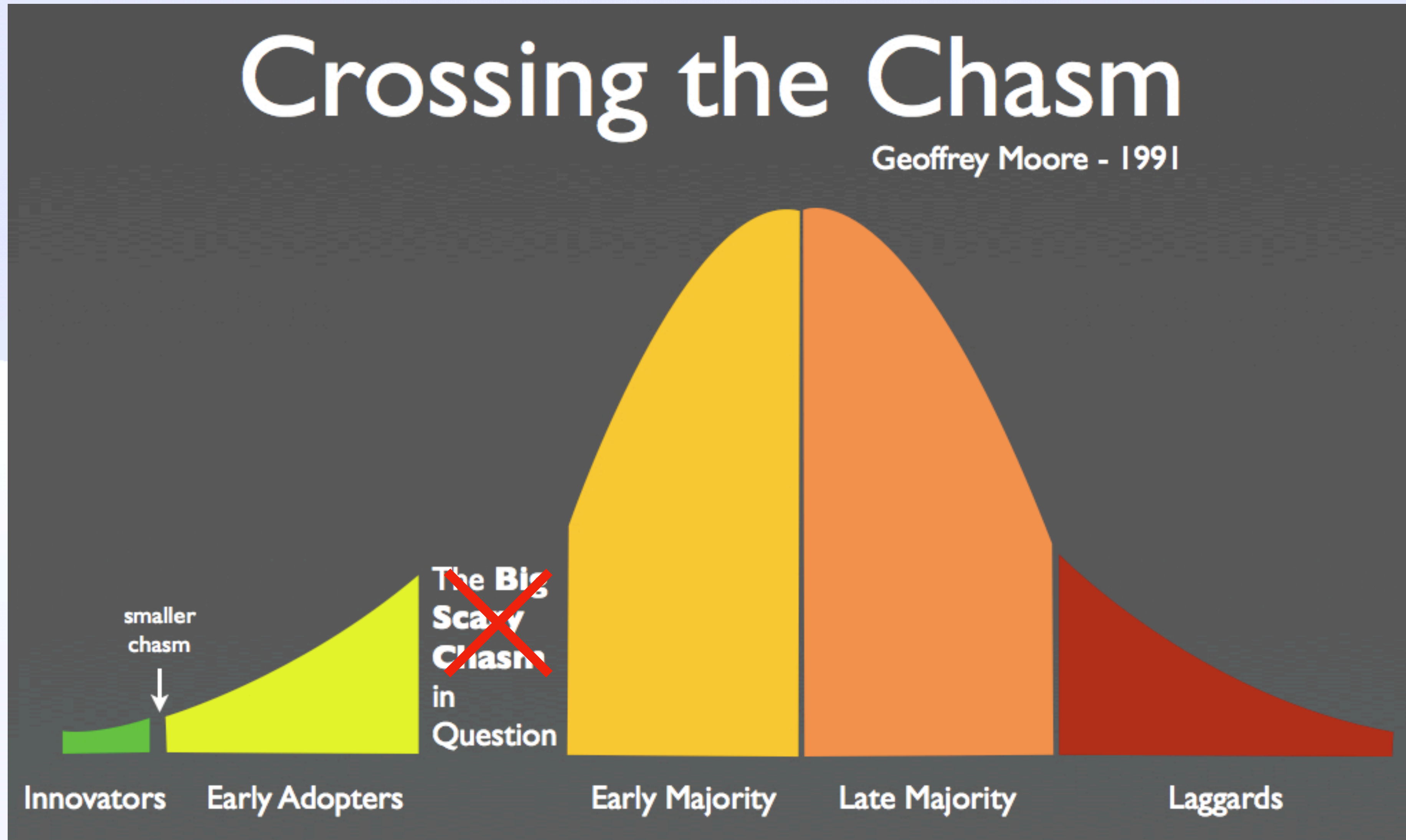
## Wrap Up Roadmap

# *Next Stage of Evolution*



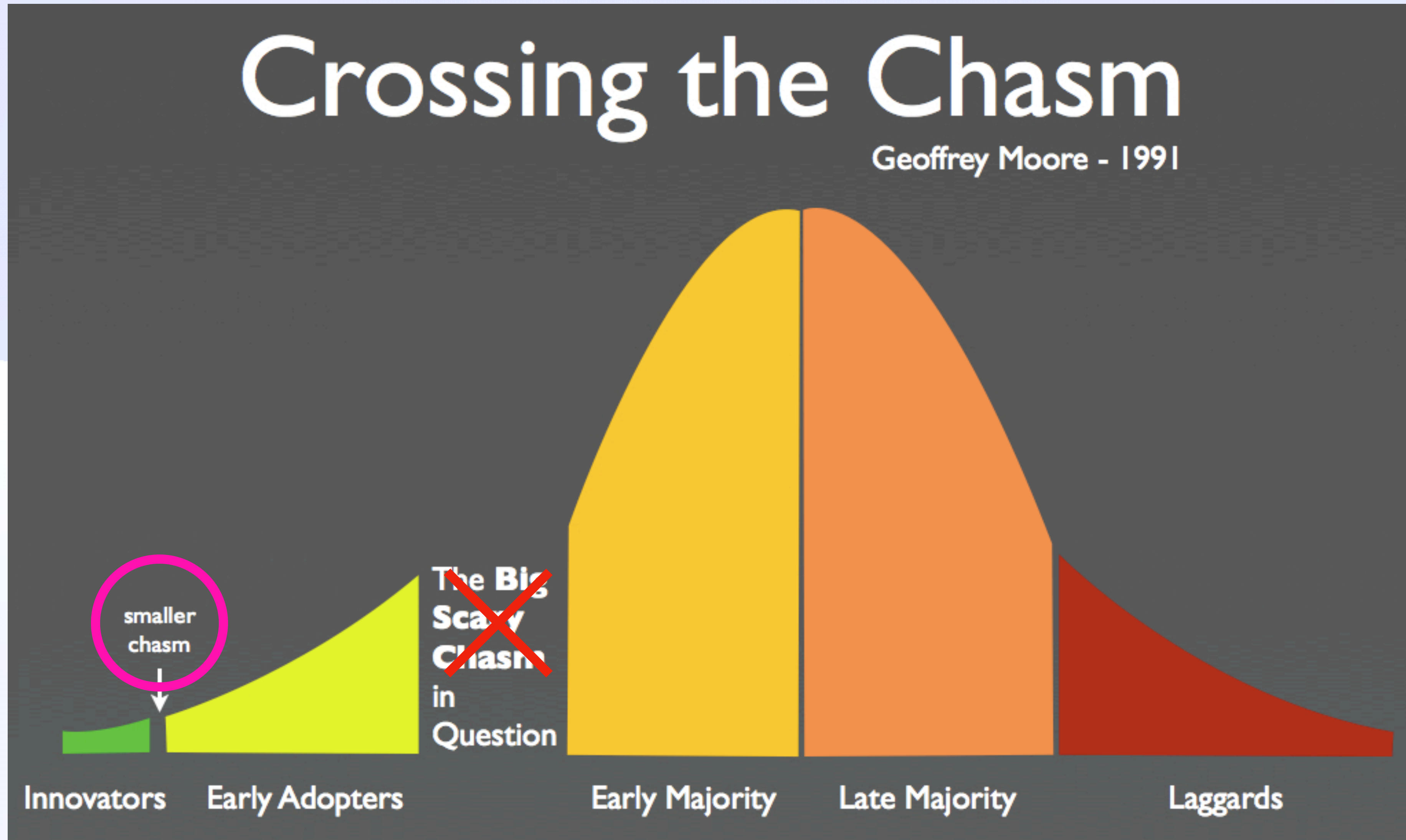
## Wrap Up Roadmap

# *Next Stage of Evolution*



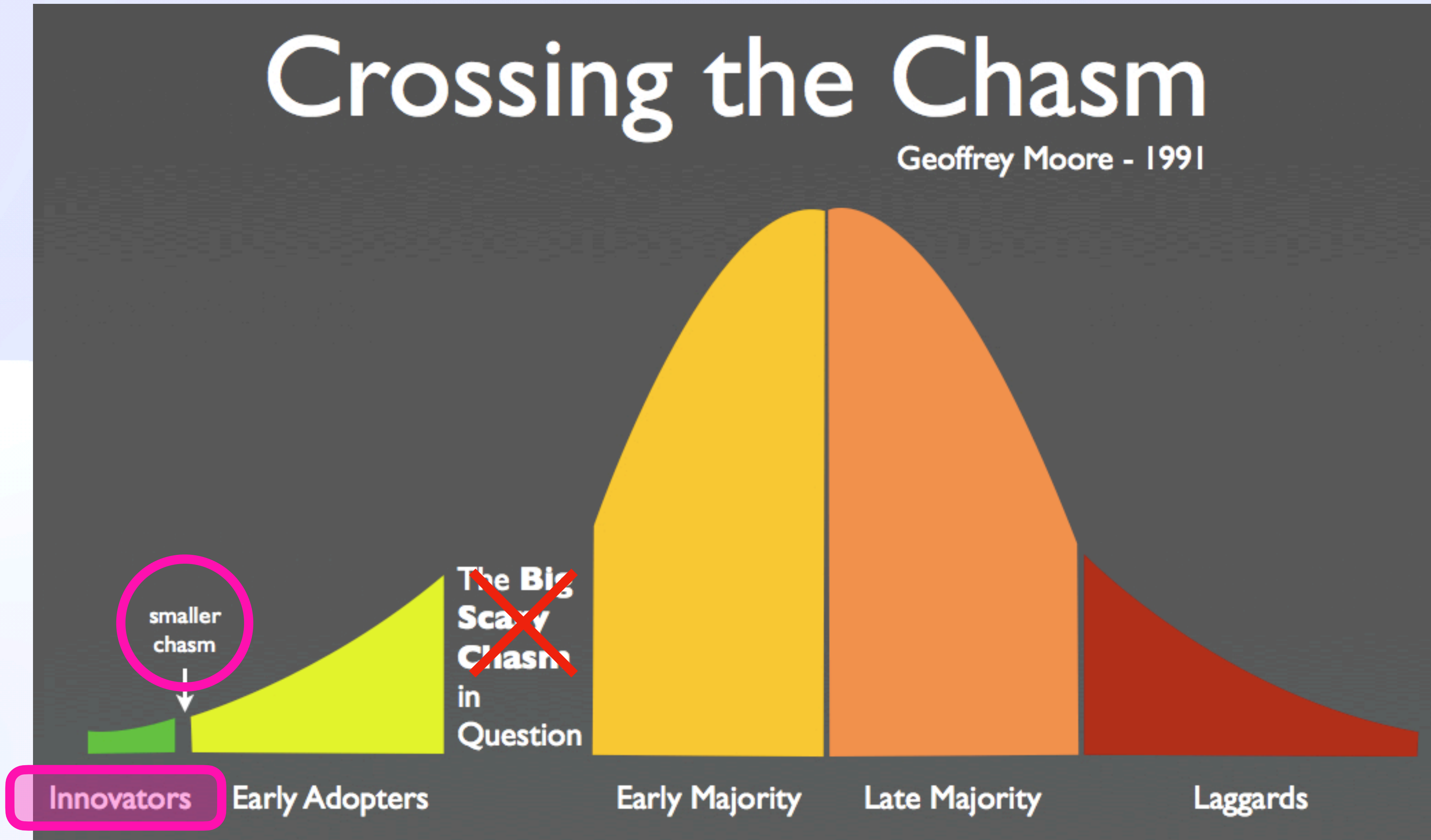
# Wrap Up Roadmap

## *Next Stage of Evolution*



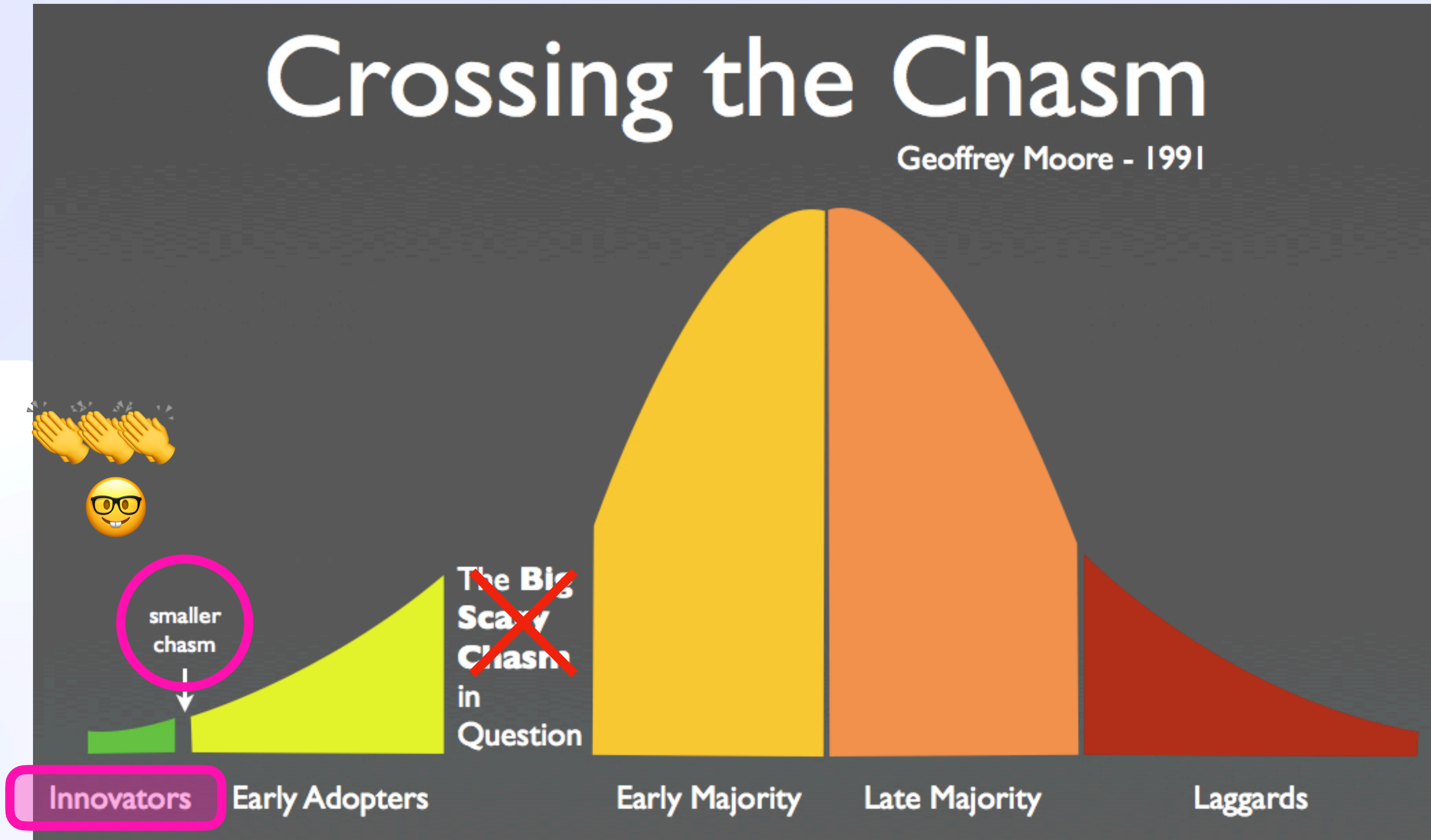
# Wrap Up Roadmap

## *Next Stage of Evolution*



# Wrap Up Roadmap

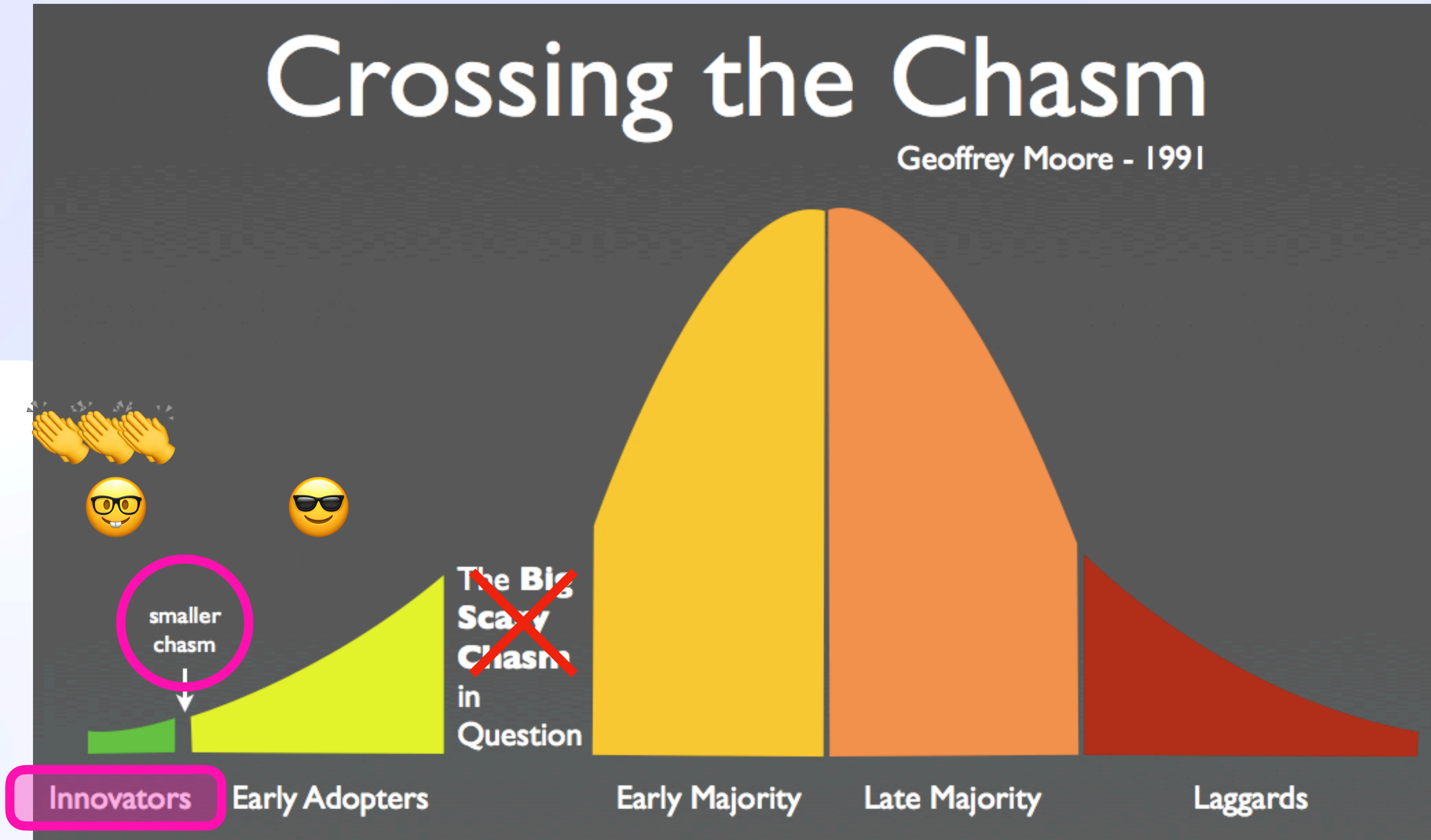
## *Next Stage of Evolution*





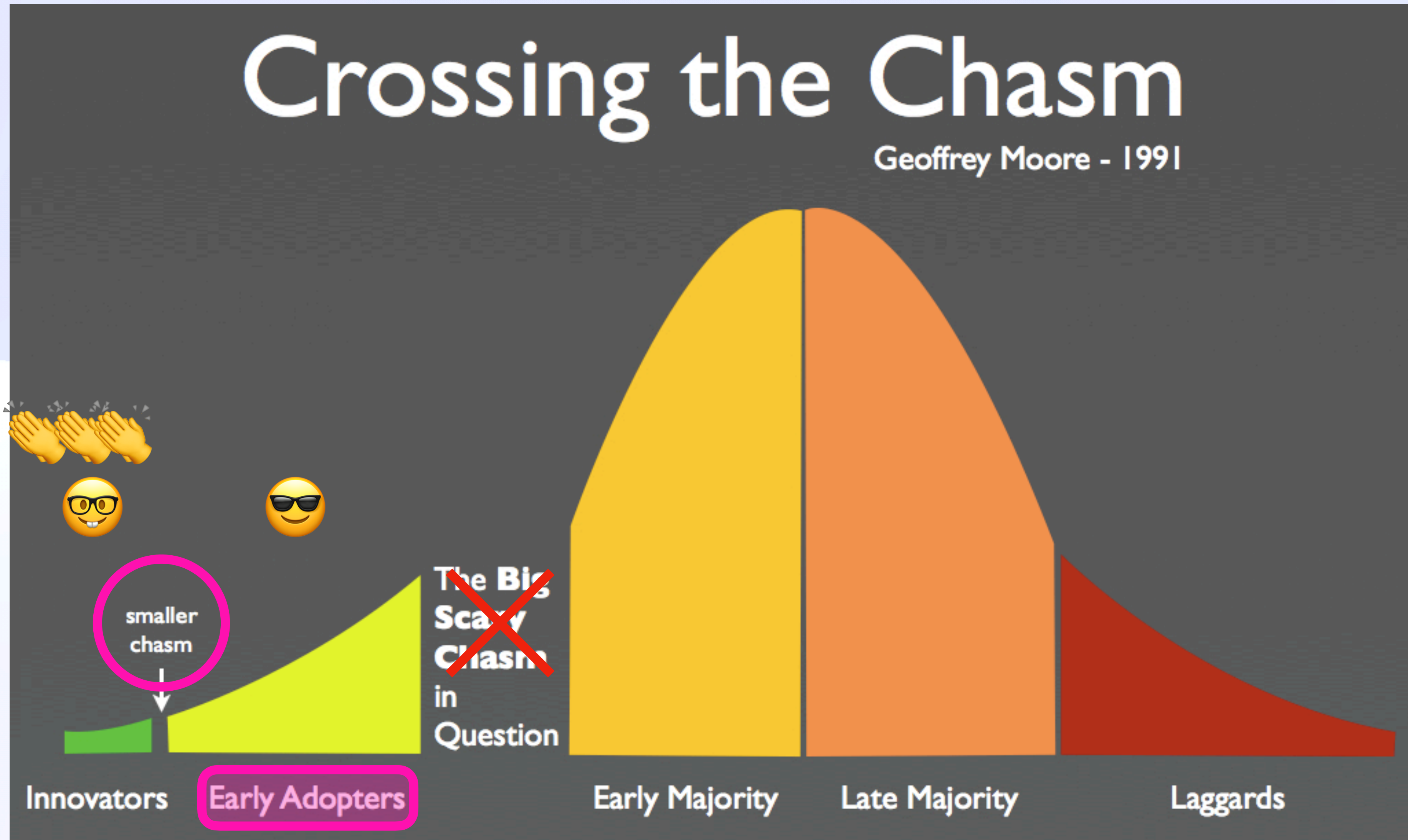
# Wrap Up Roadmap

## *Next Stage of Evolution*



# Wrap Up Roadmap

## *Next Stage of Evolution*



Wrap Up Roadmap

***Livin' On the Edge***

## Wrap Up Roadmap

# *Livin' On the Edge*

- ◆ Exciting times — in both senses 🎢



## Wrap Up Roadmap

# *Livin' On the Edge*

- ◆ Exciting times — in both senses 🎢
- ◆ Lots of low hanging fruit!



## Wrap Up Roadmap

# *Livin' On the Edge*

- ◆ Exciting times — in both senses 🎢
- ◆ Lots of low hanging fruit!
- ◆ Frameworks just emerging
  - ◆ No LoFi LAMP or Rails... yet



## Wrap Up Roadmap

# *Livin' On the Edge*

- ◆ Exciting times — in both senses 🎢
- ◆ Lots of low hanging fruit!
- ◆ Frameworks just emerging
  - ◆ No LoFi LAMP or Rails... yet
- ◆ Manual, an investment



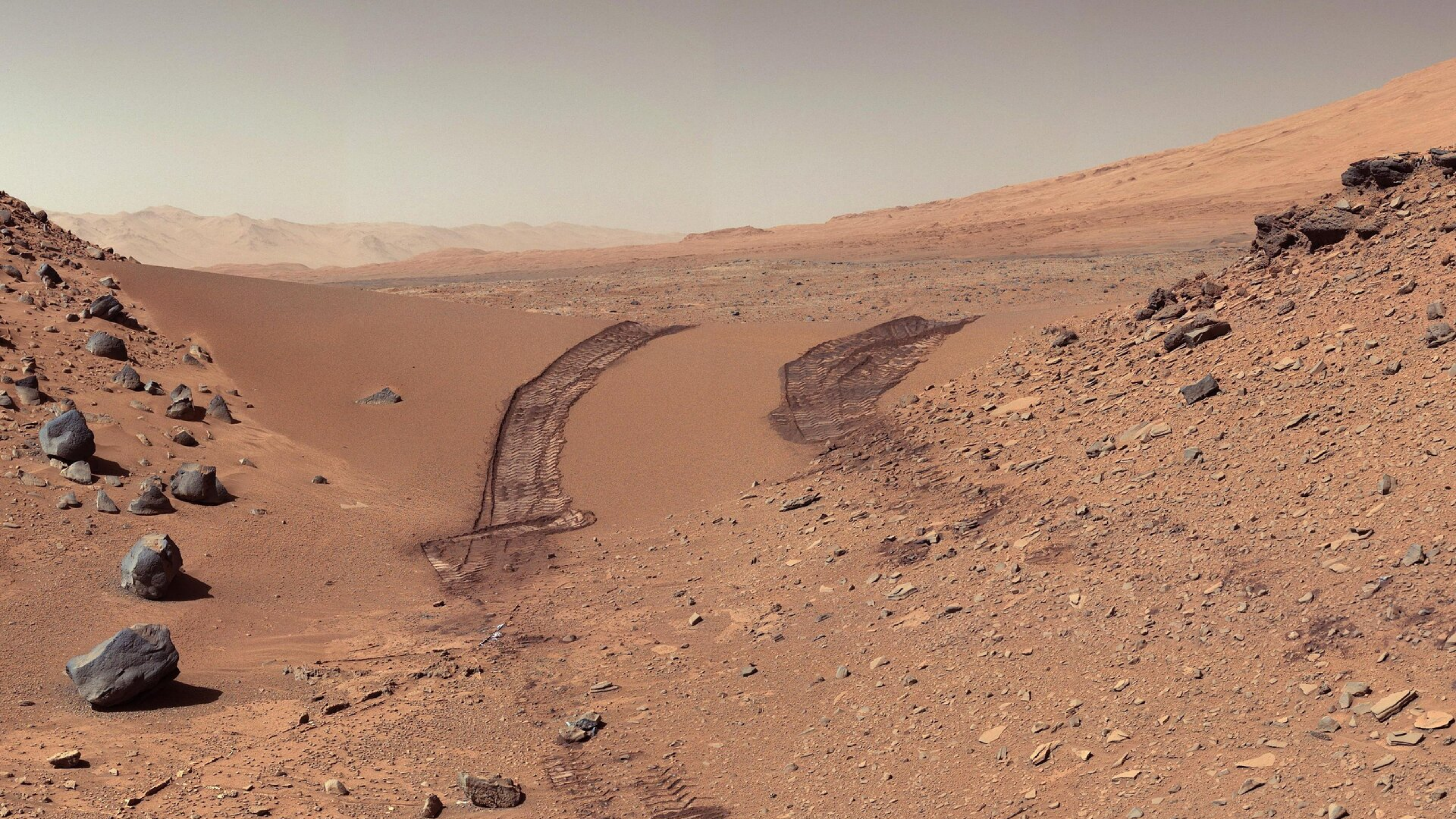
## Wrap Up Roadmap

# *Livin' On the Edge*

- ◆ Exciting times — in both senses 🎢
- ◆ Lots of low hanging fruit!
- ◆ Frameworks just emerging
  - ◆ No LoFi LAMP or Rails... yet
- ◆ Manual, an investment
- ◆ No hand holding

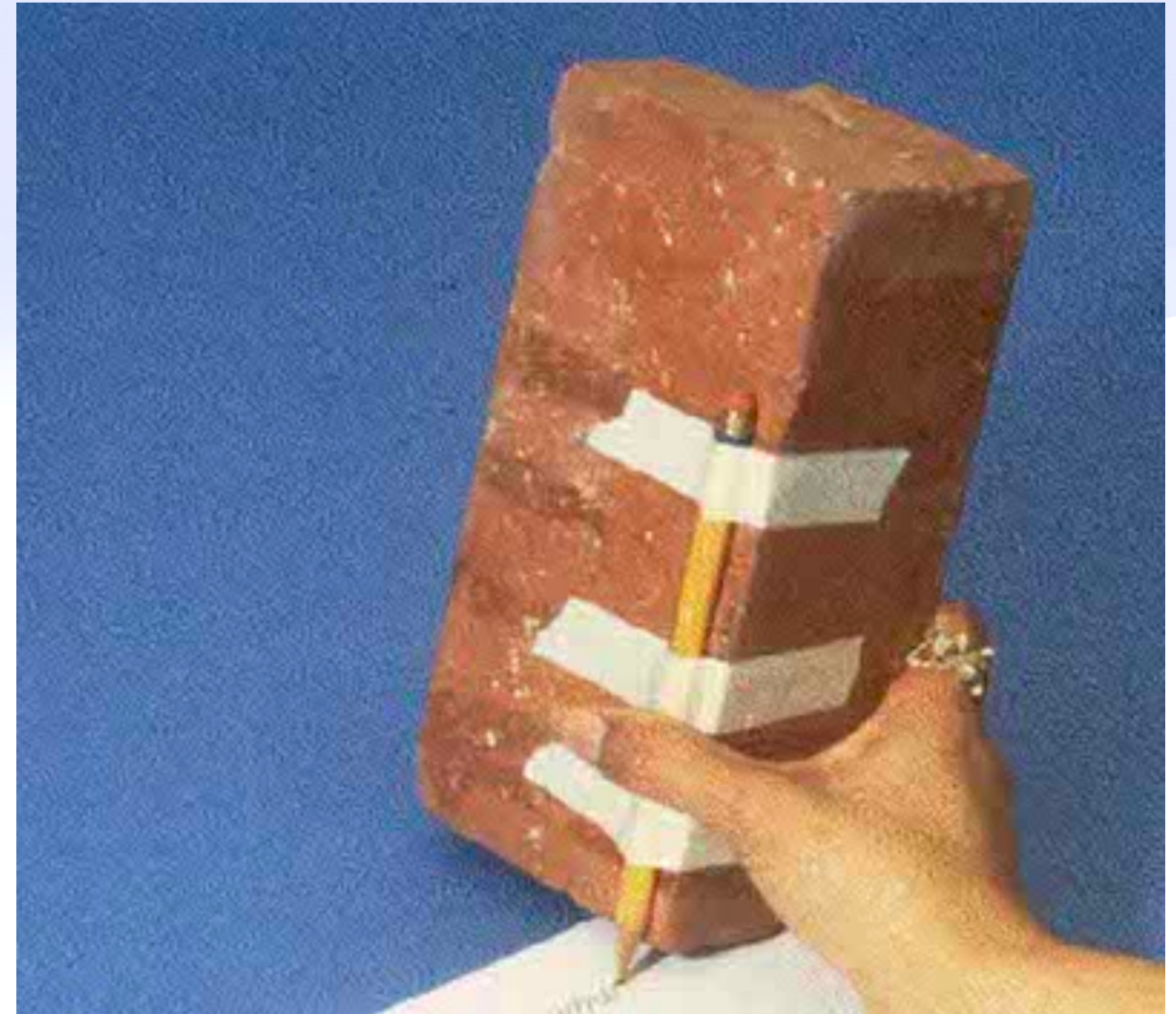






Wrap Up Roadmap

***Not All or Nothing***



## Wrap Up Roadmap

# *Not All or Nothing*

- ◆ LoFi is great at human sizes & speeds
- ◆ ...but harder to do global things
  - ◆ e.g. "Build the Bluesky firehose"



## Wrap Up Roadmap

# *Open Problems for the Next Era*

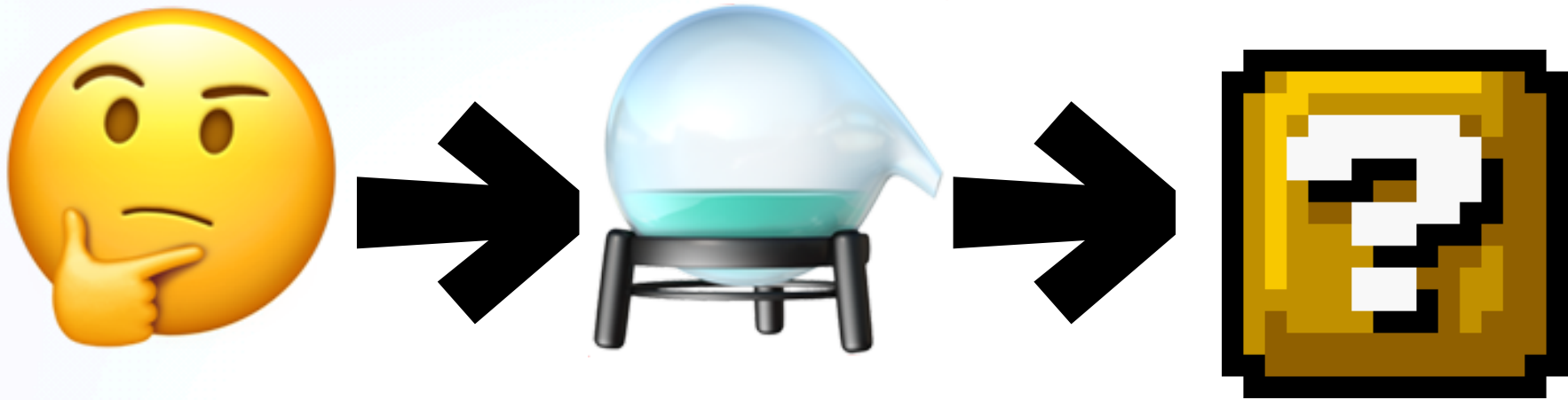
- Identity, trust, encryption
  - Lossless data interop
  - Resource control
- Networking: Tech that still works in 40 years?
  - Schemas: How to allow independent evolution?
  - Security & Privacy: Whom to trust?
  - Version Control: How to let users access and manage multiple versions?
  - Indexing & Queries: How to scale local-first to more than what fits in memory?
  - Decentralized Search: How to make non-replicated information accessible to everyone?
  - Portable Compute: How to replicate – distribute – application execution?
  - Code as (CRDT) Data: How to improve the collaborative coding experience?
  - Programming Models: How everything fits together, and the core question of this workshop.
- Extensible CRDT frameworks (flexible CRDTs)
  - Collaborative (verifiable?) computation — indexes, compaction, GC
  - Retroactive data structures / reversible compute
  - Business models

A Roadmap Wrap Up

# ***Cambrian Explosion***

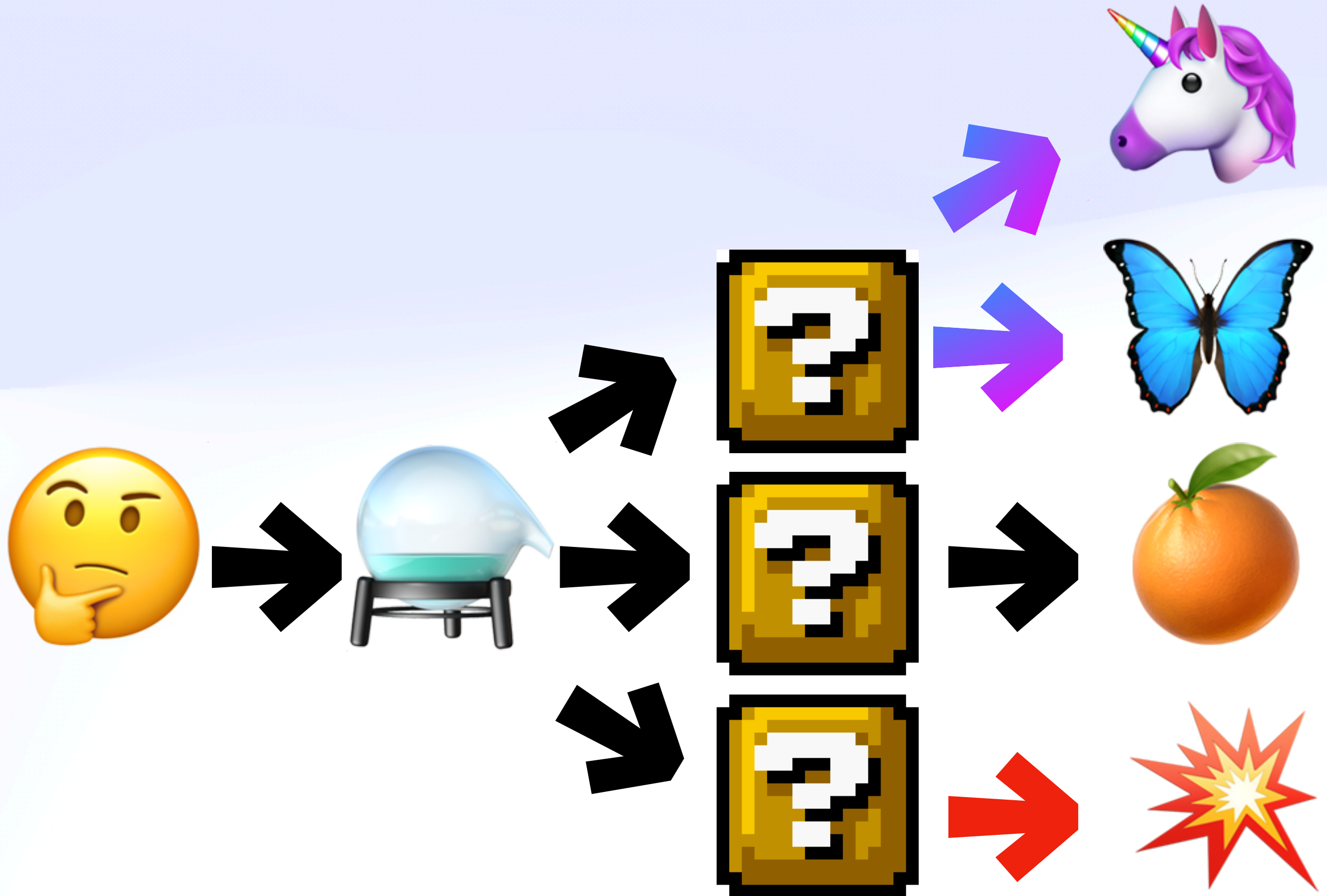
A Roadmap Wrap Up

# ***Cambrian Explosion***

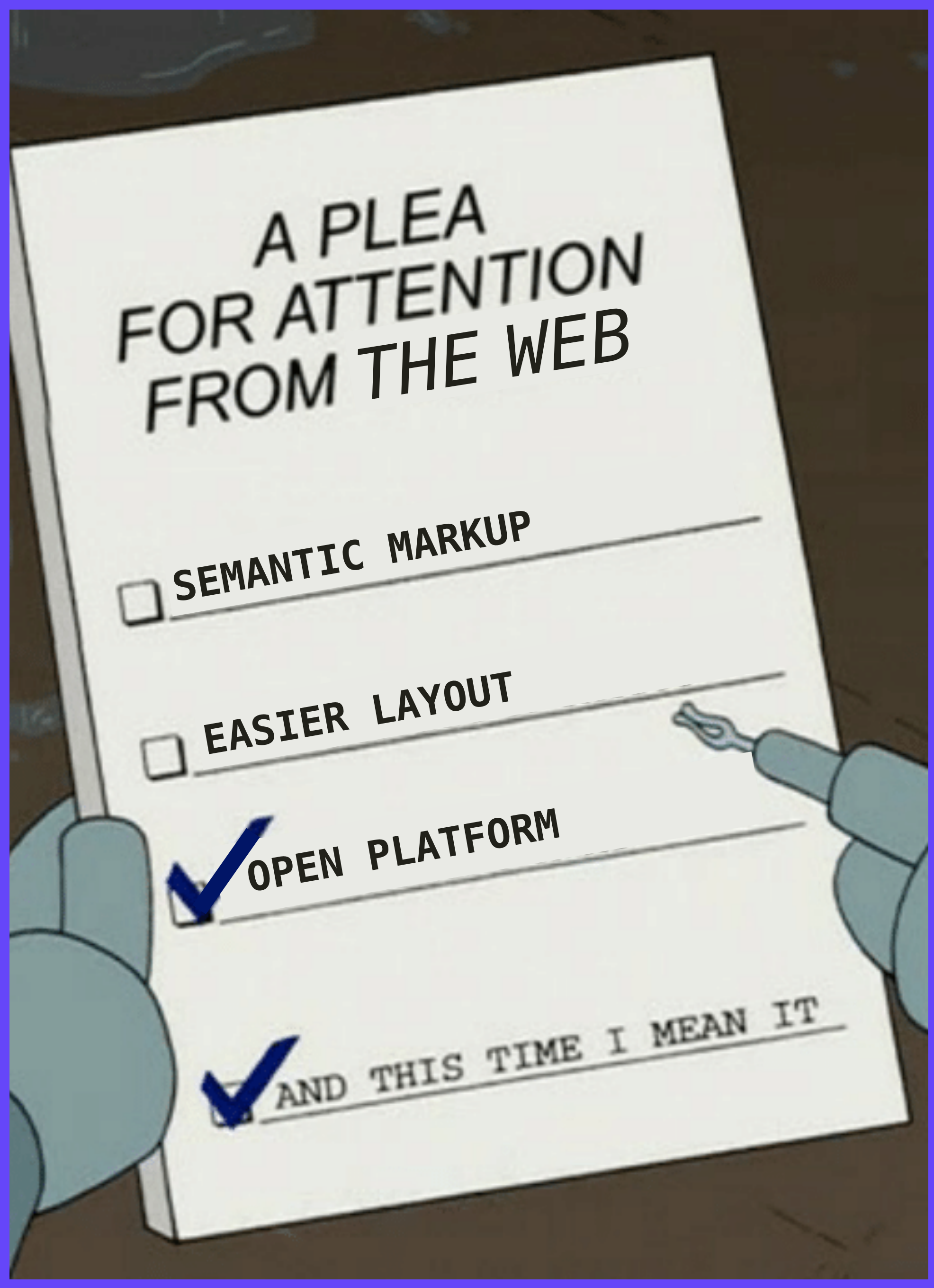


# A Roadmap Wrap Up

# *Cambrian Explosion*



# A Roadmap Wrap Up





🦋 @expede.wtf

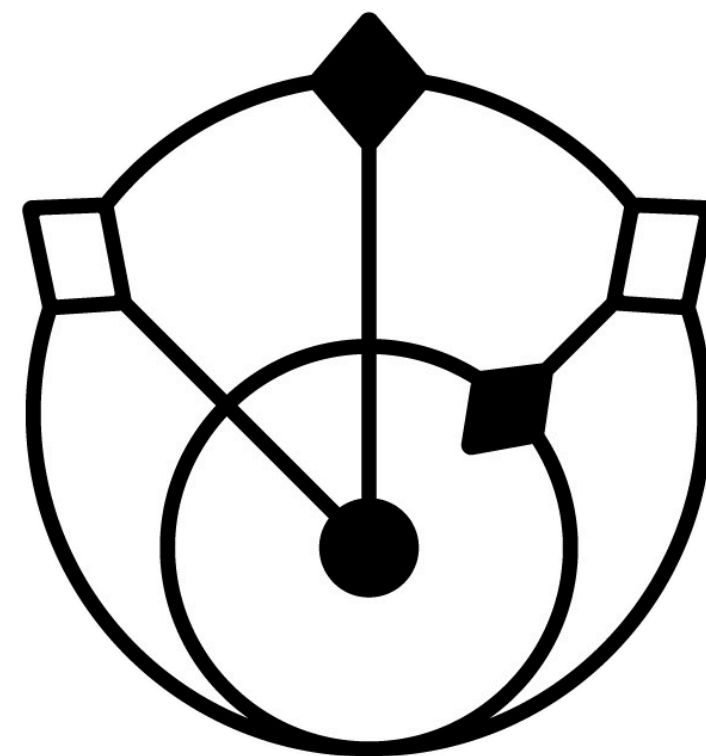
🐘 @expede@octodon.social

✉️ hello@brooklynzelenka.com

✍️ notes.brooklynzelenka.com



***Thank You, Vancouver\****



\* On the unceded ancestral lands of the x<sup>w</sup>məθk<sup>w</sup>əyəm, Skwxwú7mesh, and səliłwəta Nations