

DATASTRUCTURES IN + ON



IPFS

QCon
SAN FRANCISCO

ipfs.io
@juanbenet
2015-11-17

1. IPFS introduction
2. structs in IPFS
3. structs on IPFS

1. IPFS introduction

2. structs in IPFS

3. structs on IPFS

**THE DISTRIBUTED
PERMANENT WEB
MERKLE**



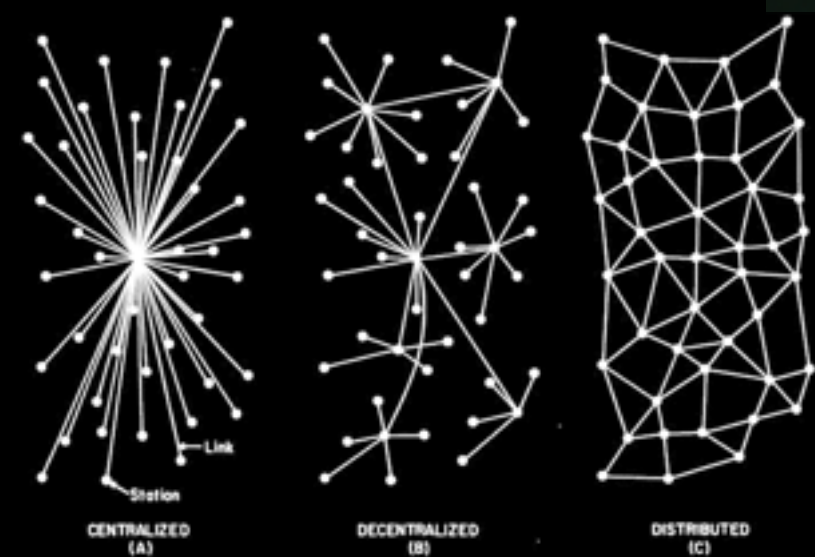


FIG. 1 - Centralized, Decentralized and Distributed Networks

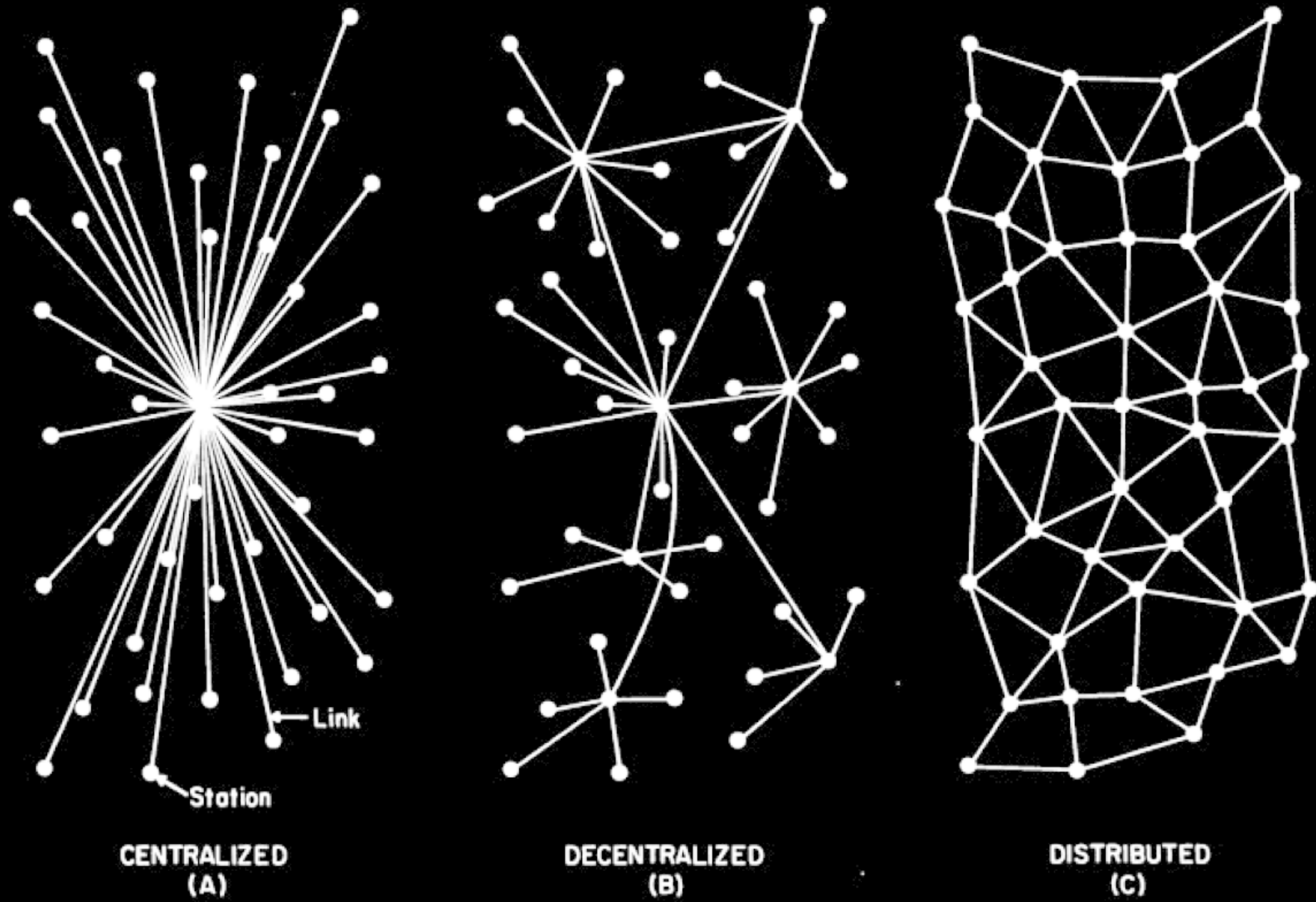
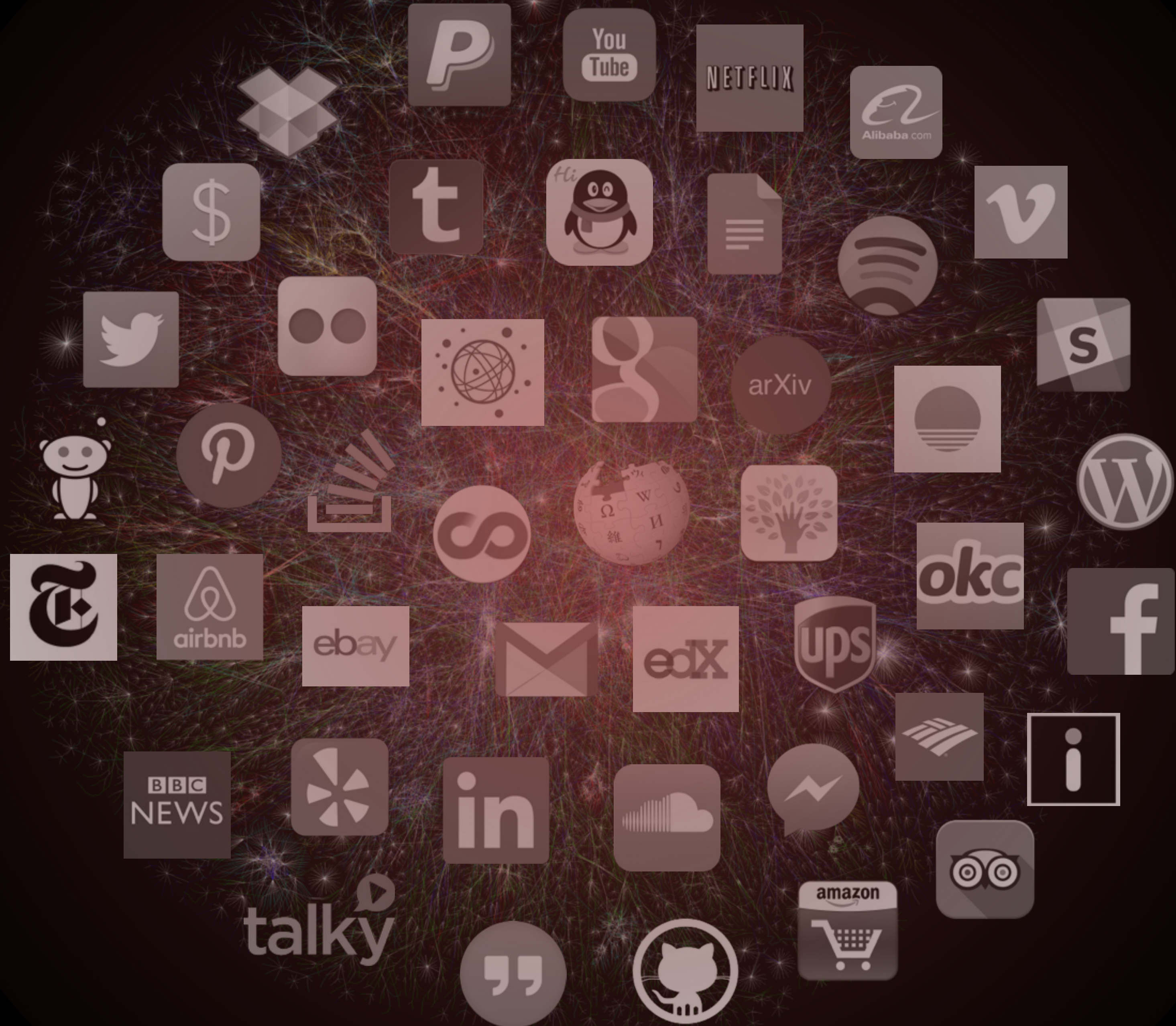
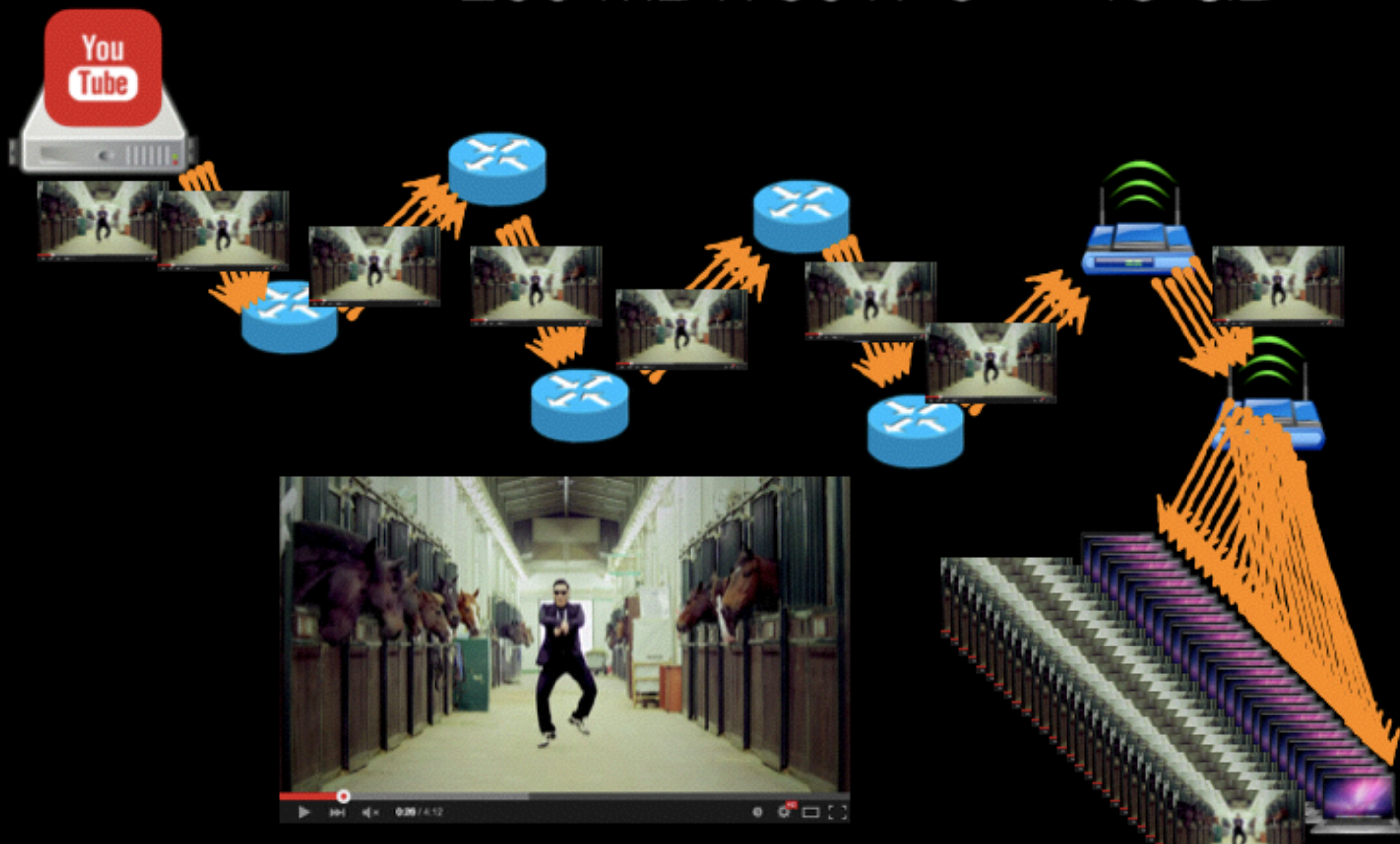


FIG. 1 — Centralized, Decentralized and Distributed Networks



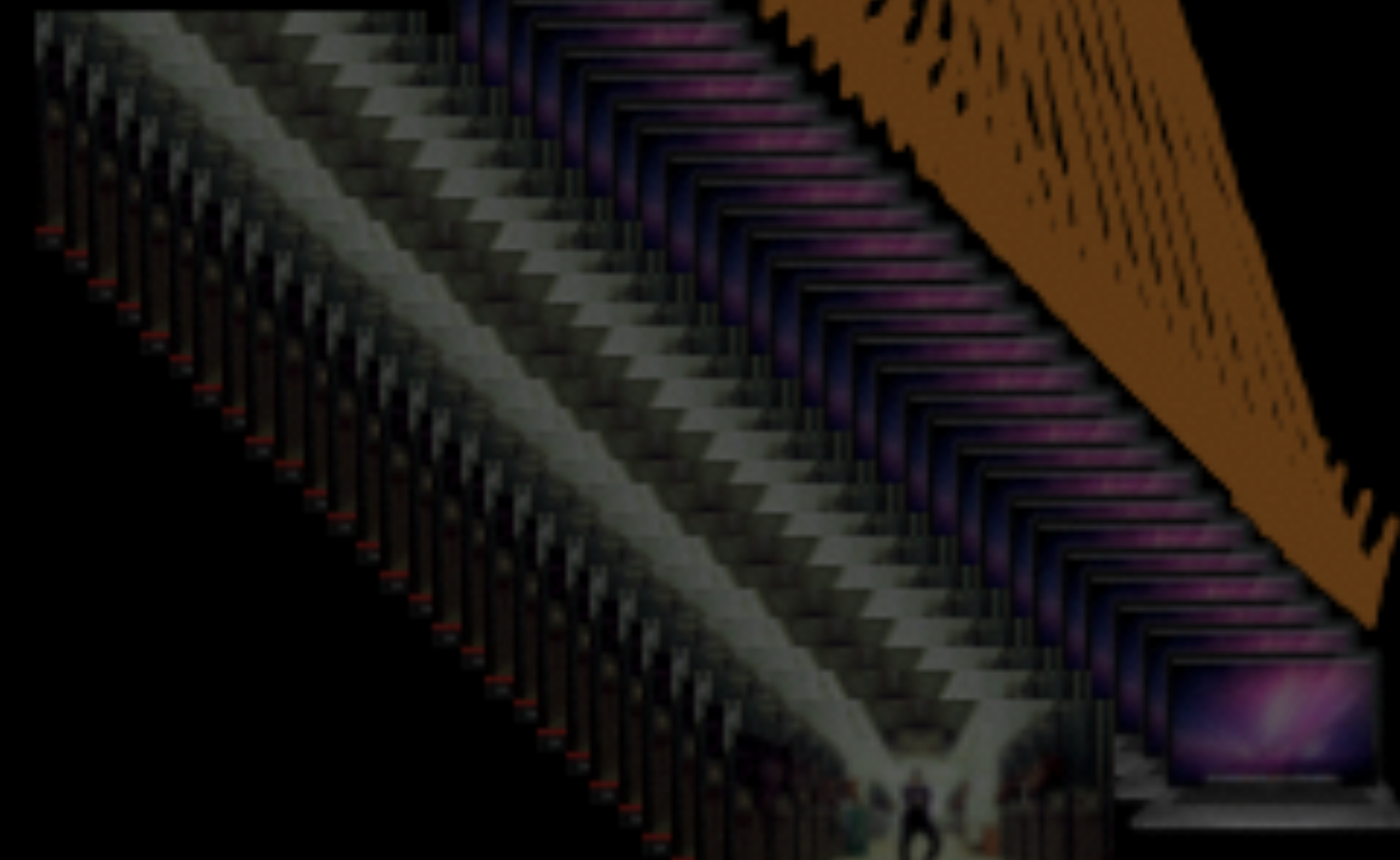
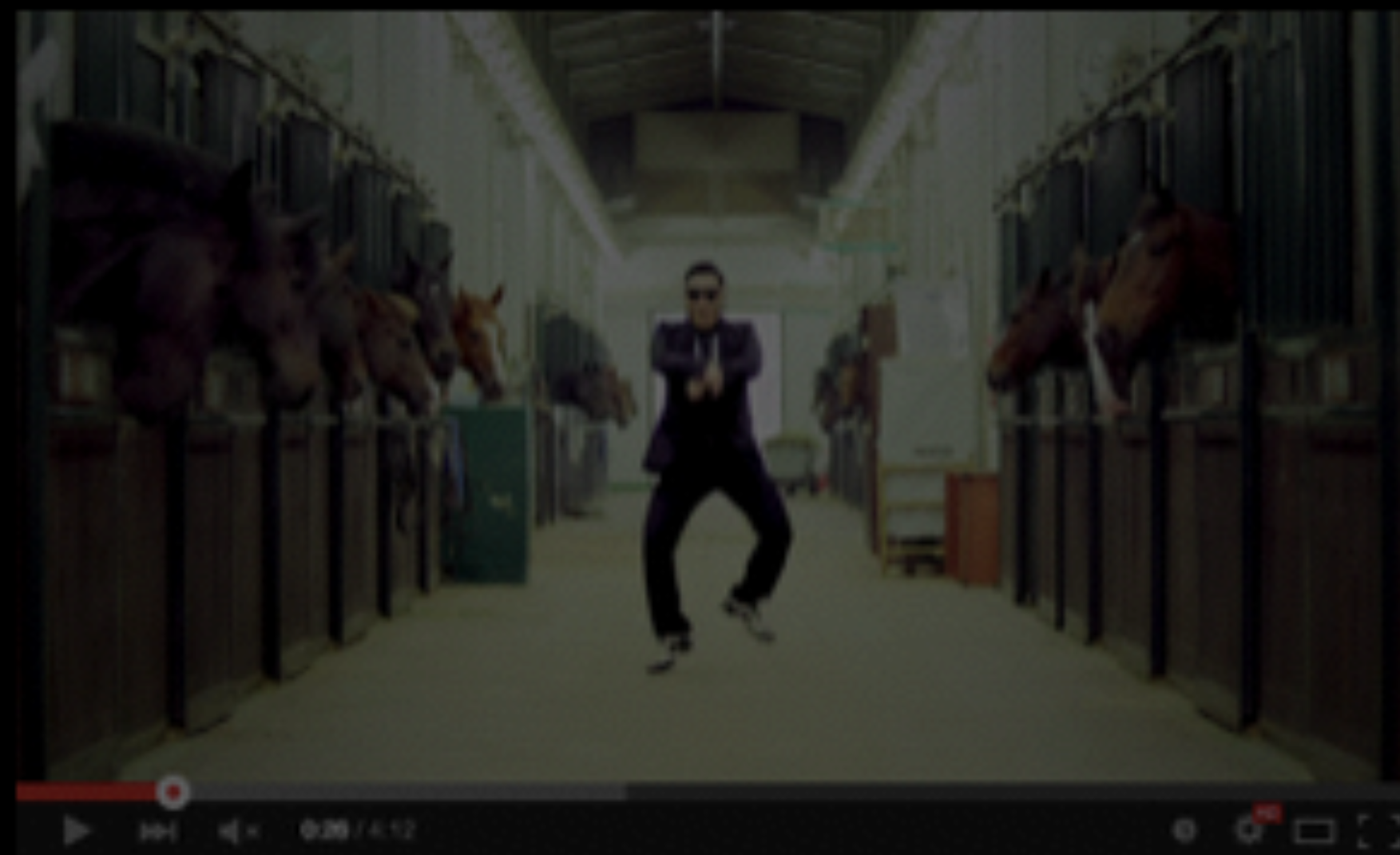


$$200 \text{ MB} \times 30 \times 8 = 48 \text{ GB}$$



$$200 \text{ MB} \times 30 \times 8 = 48 \text{ GB}$$

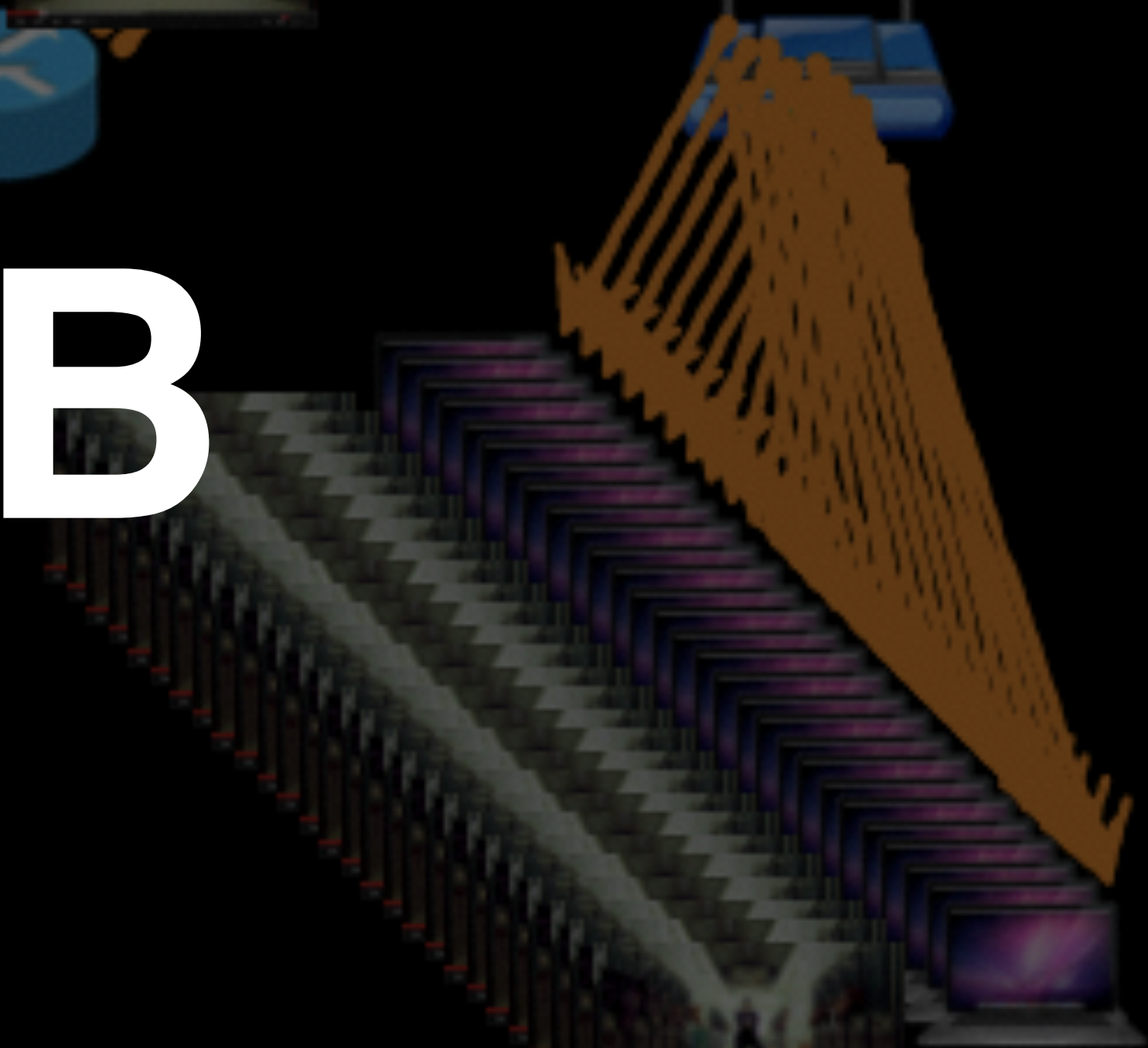
2,387,990,609



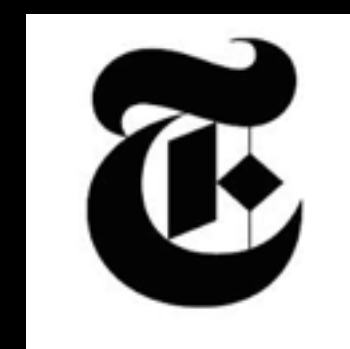
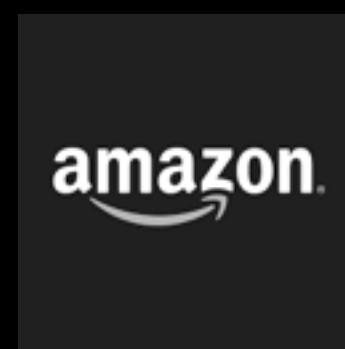
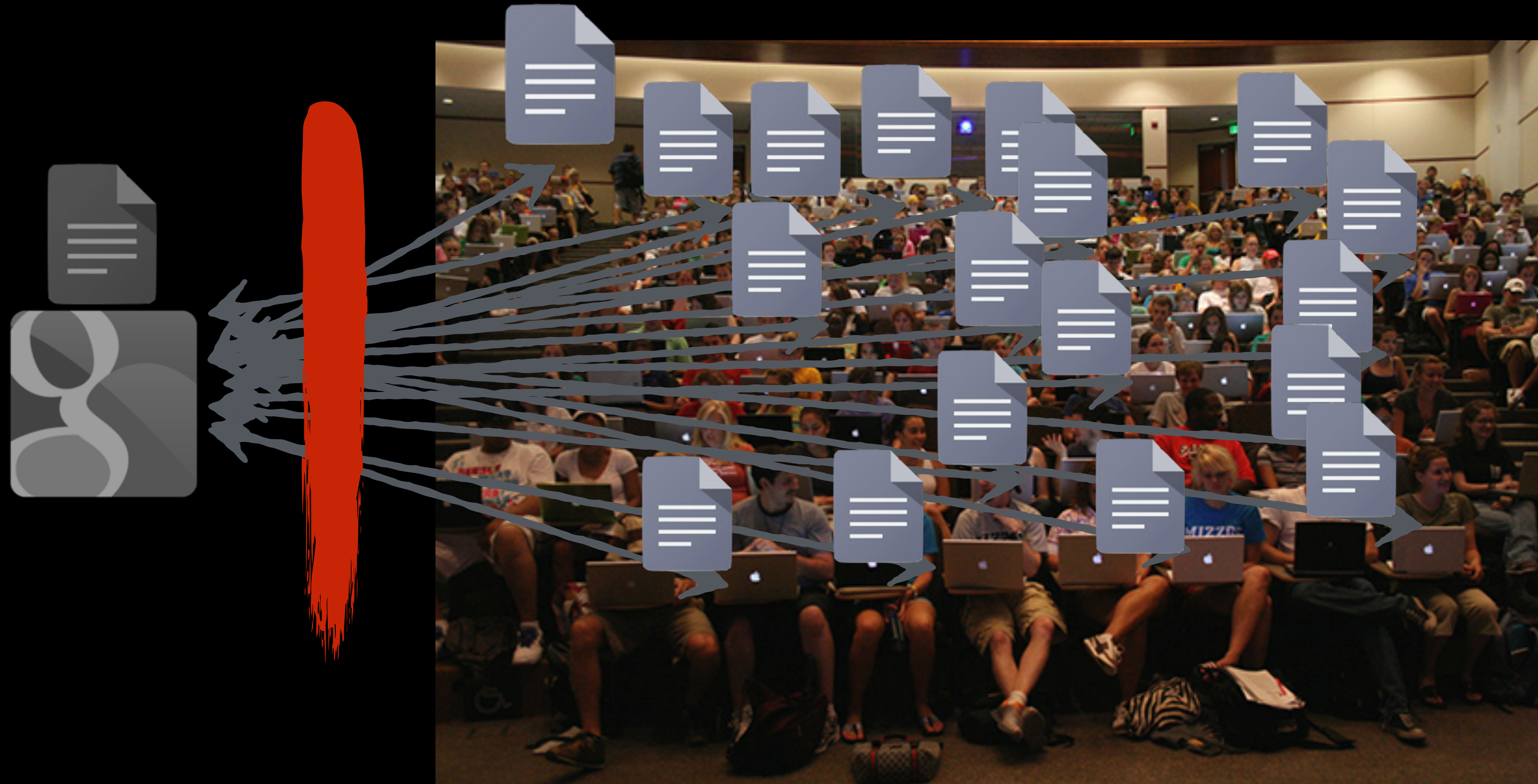
$$200 \text{ MB} \times 30 \times 8 = 48 \text{ GB}$$

2,387,990,609

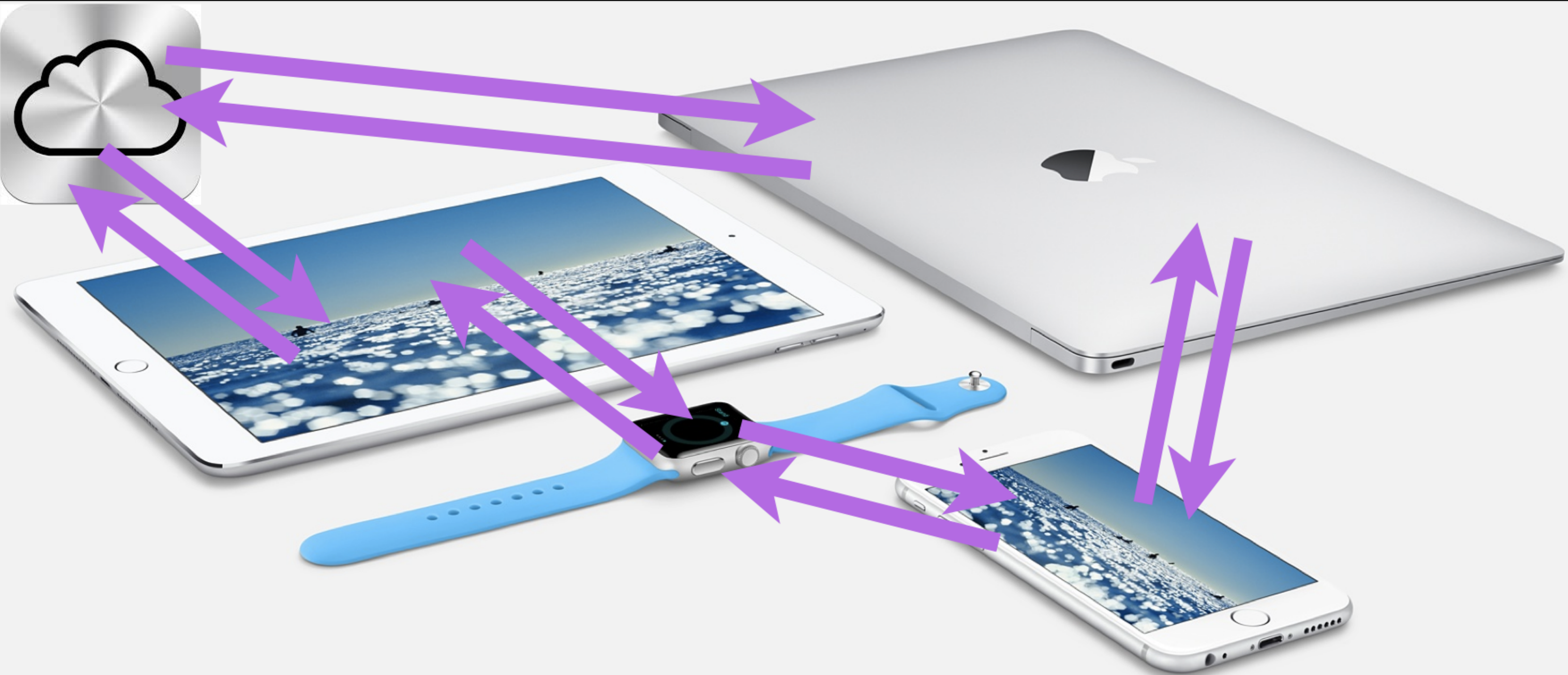
477.6 PB



Disconnected / Offline



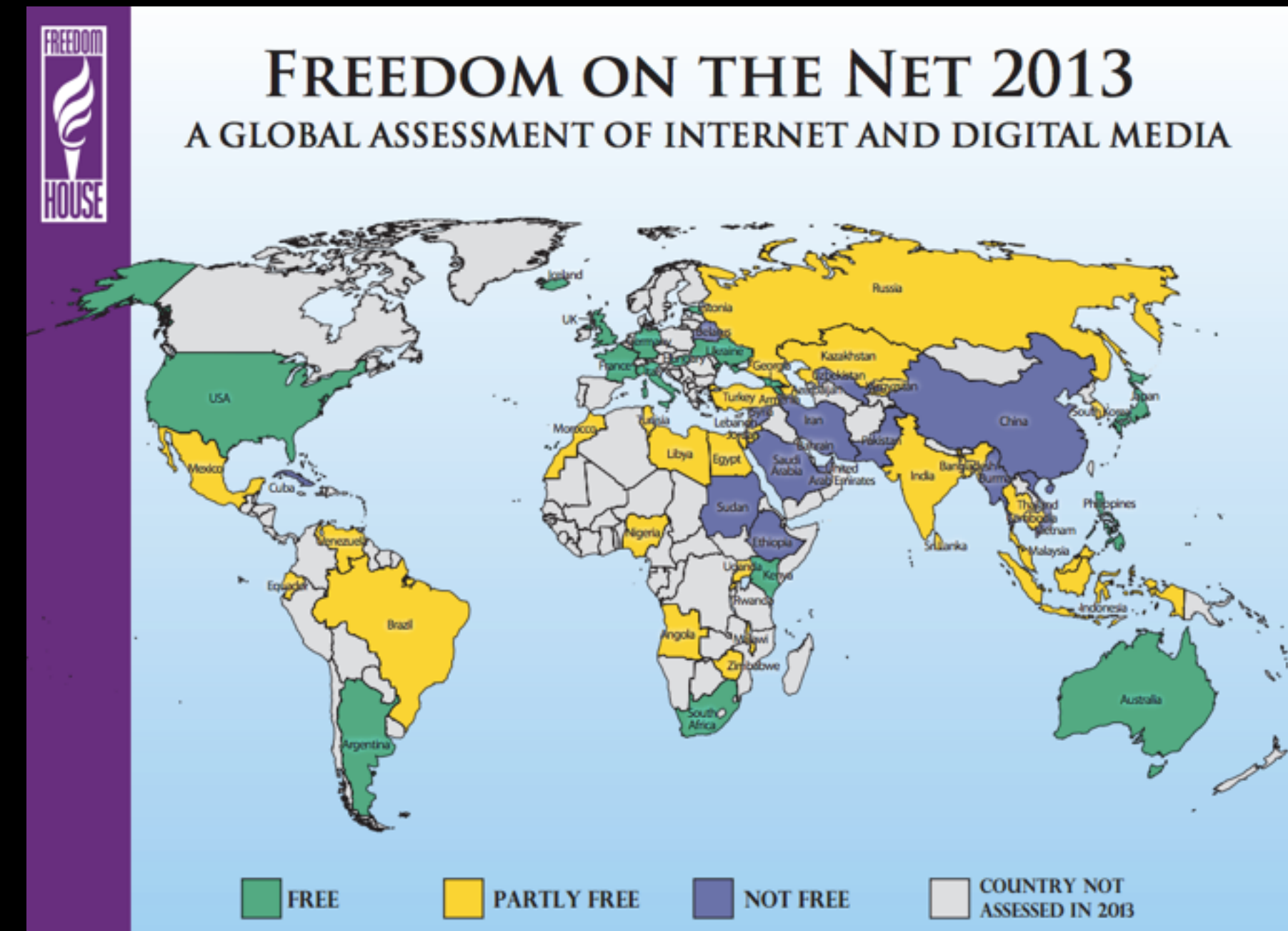
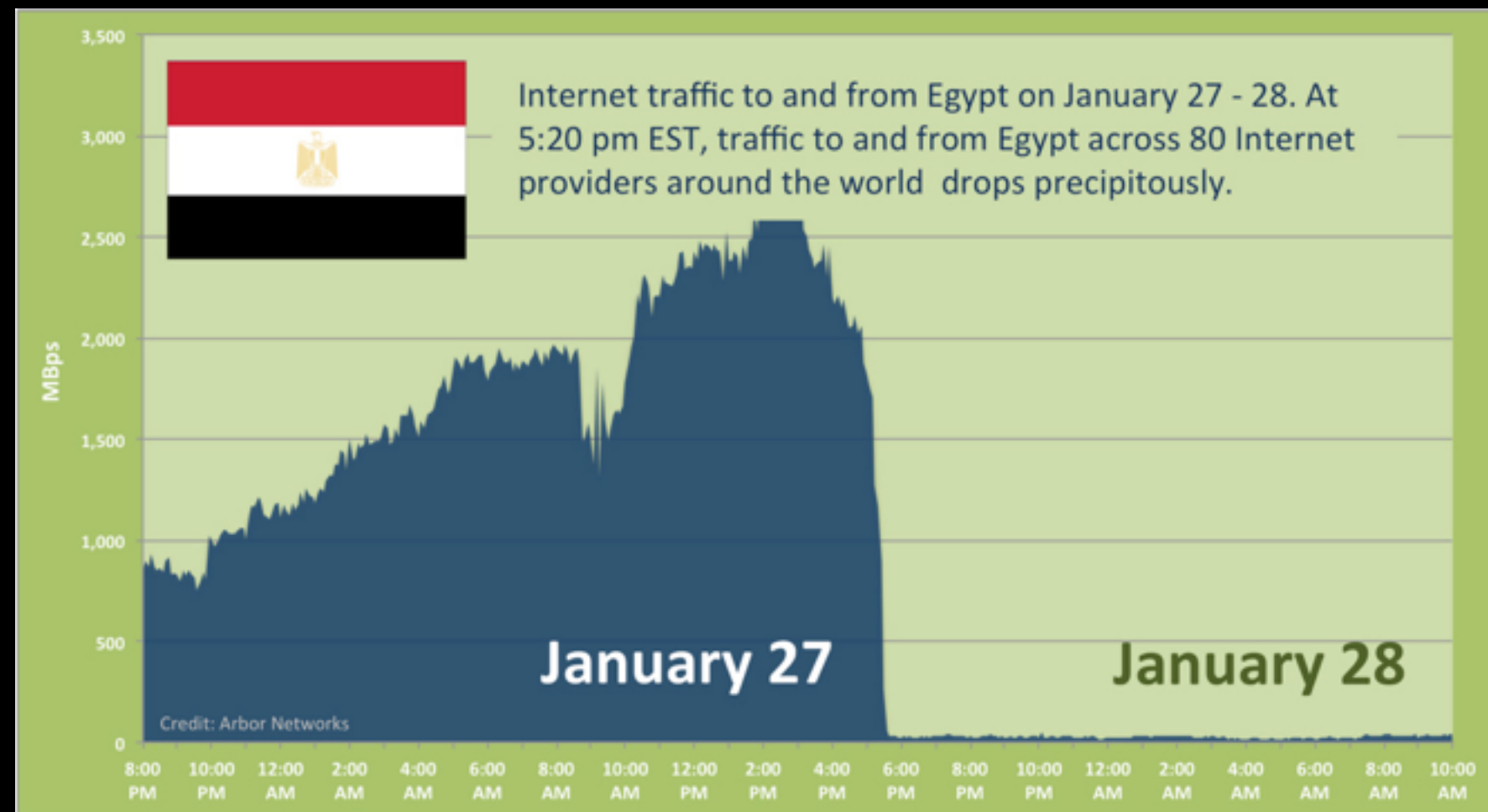
Ubiquitous Computing + IoT



Natural Disasters



Human Disasters



surprise oppression

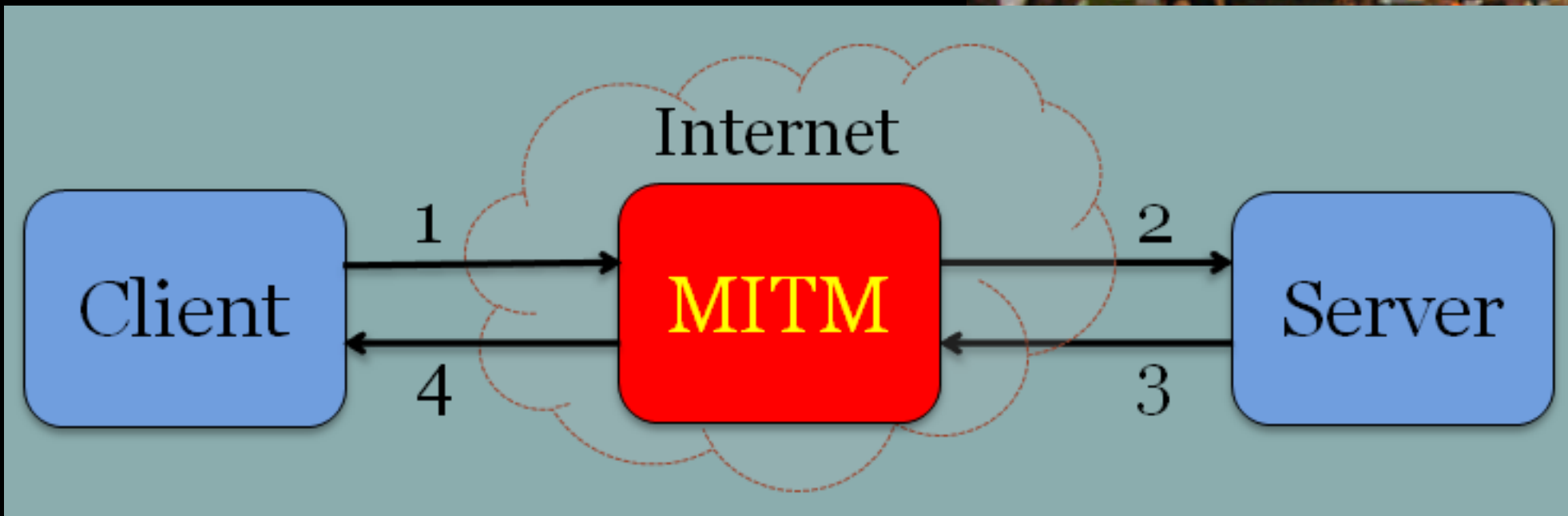
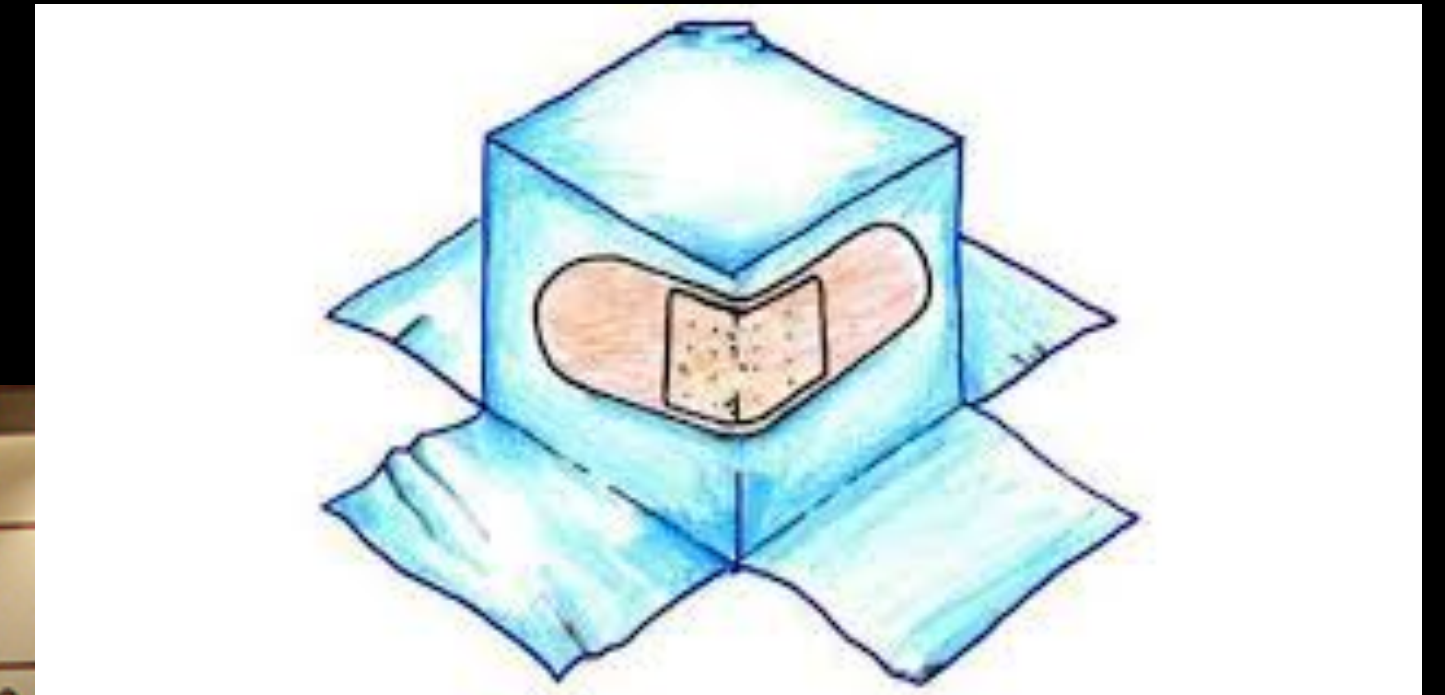
censorship



Data Control

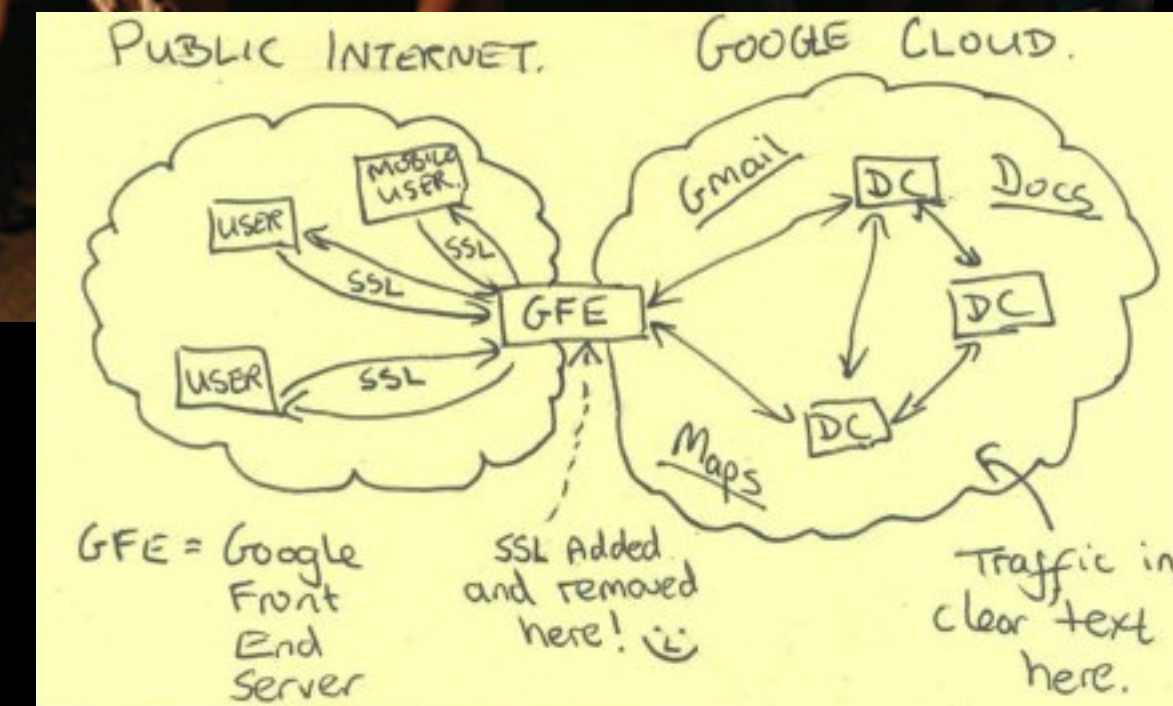
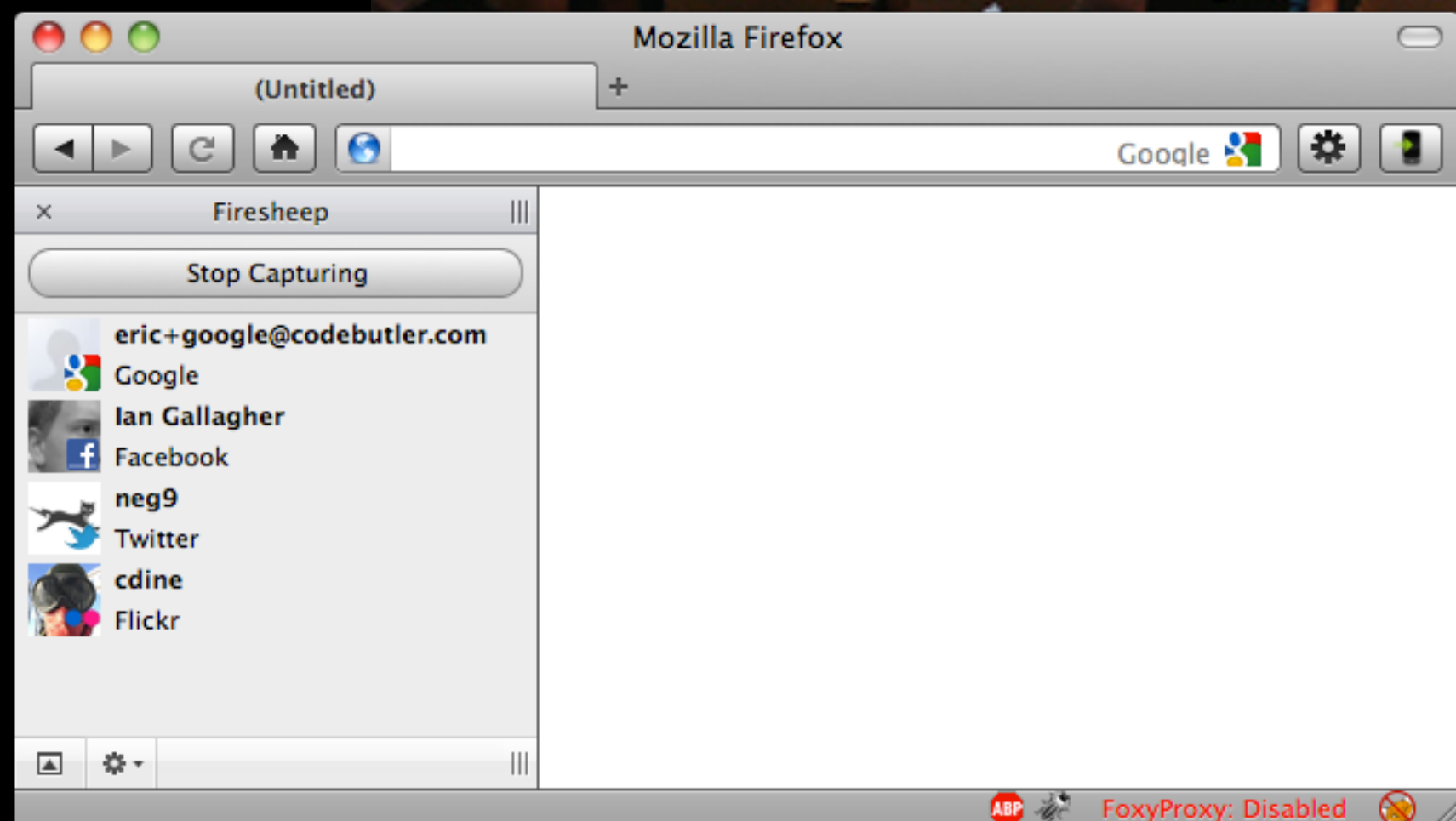


Awful Security Model



TESCO Tesco Customer Care @UKTesco

@troyhunt Passwords are stored in a secure way. They're only copied into plain text when pasted automatically into a password reminder mail.



TOP SECRET//SI//ORCON//NOFORN

PRISM Collection Details

Current Providers

- Microsoft (Hotmail, etc.)
- Google
- Yahoo!
- Facebook
- YouTube
- Skype
- AOL
- Apple

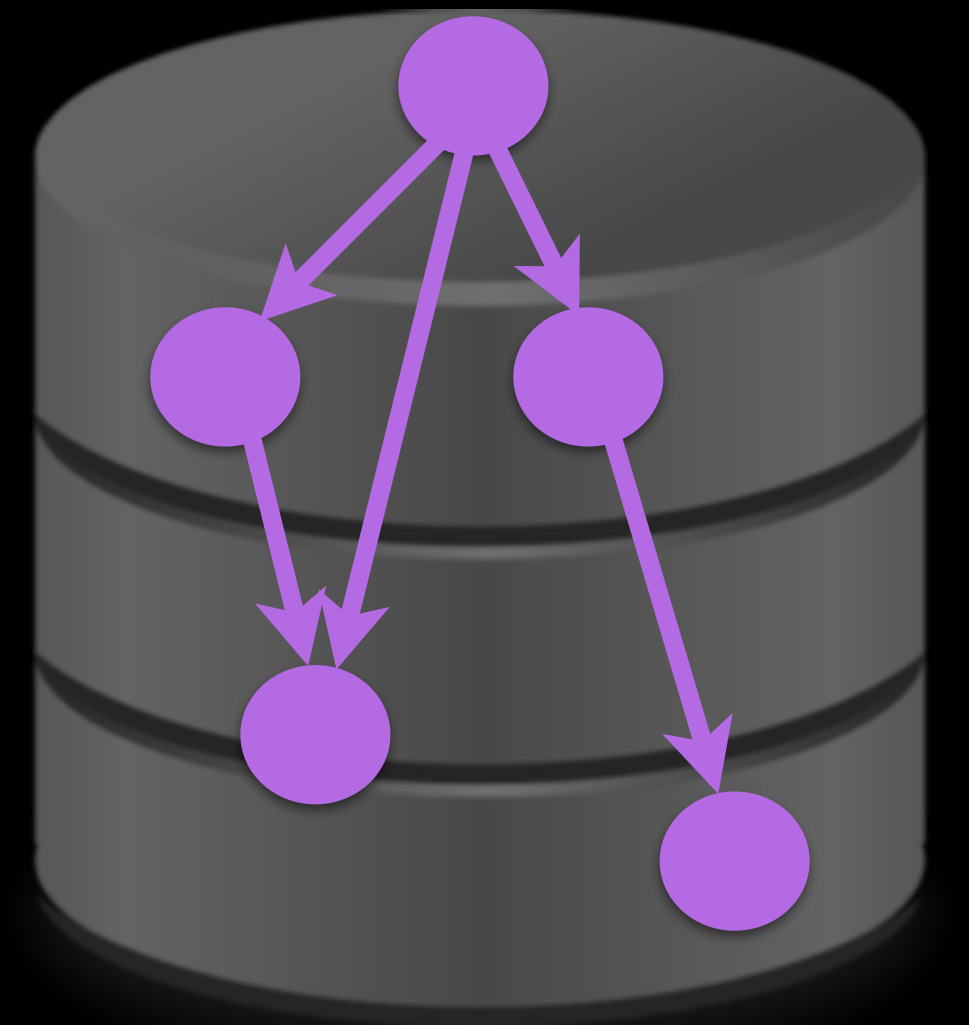
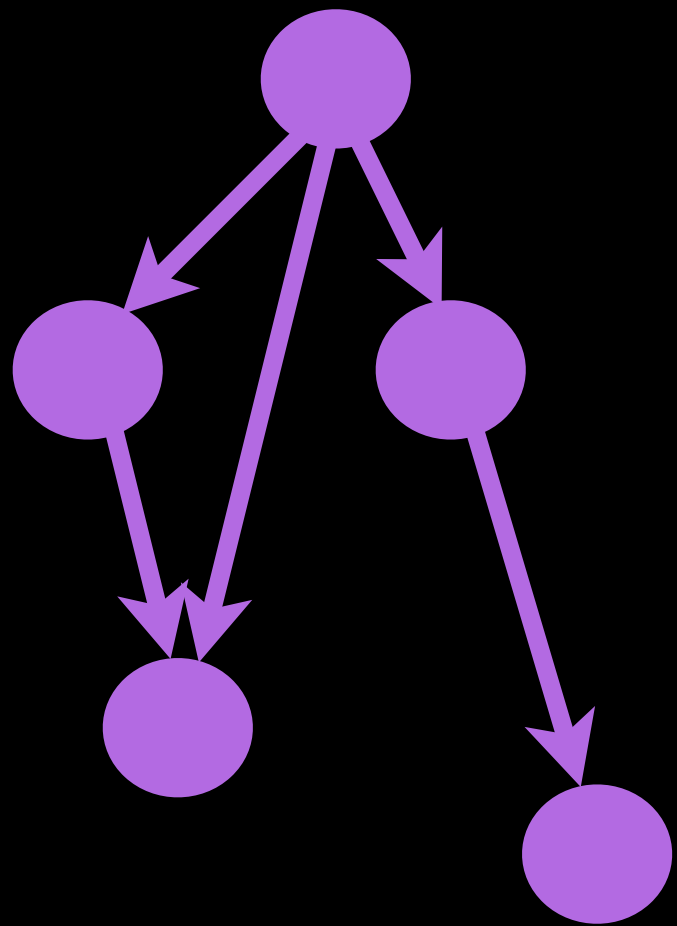
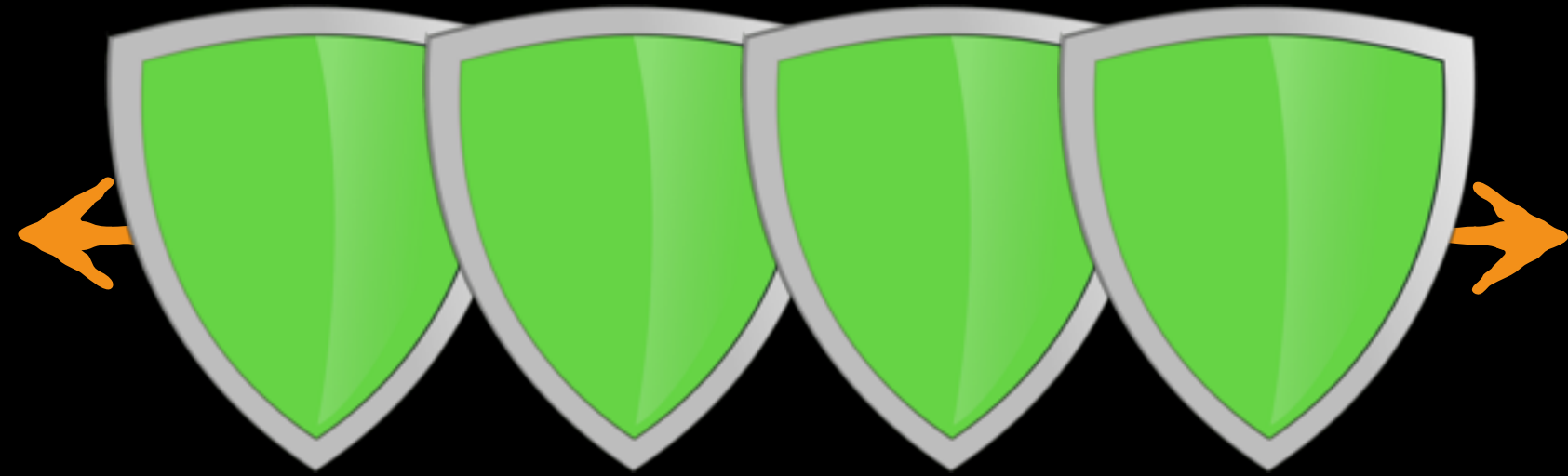
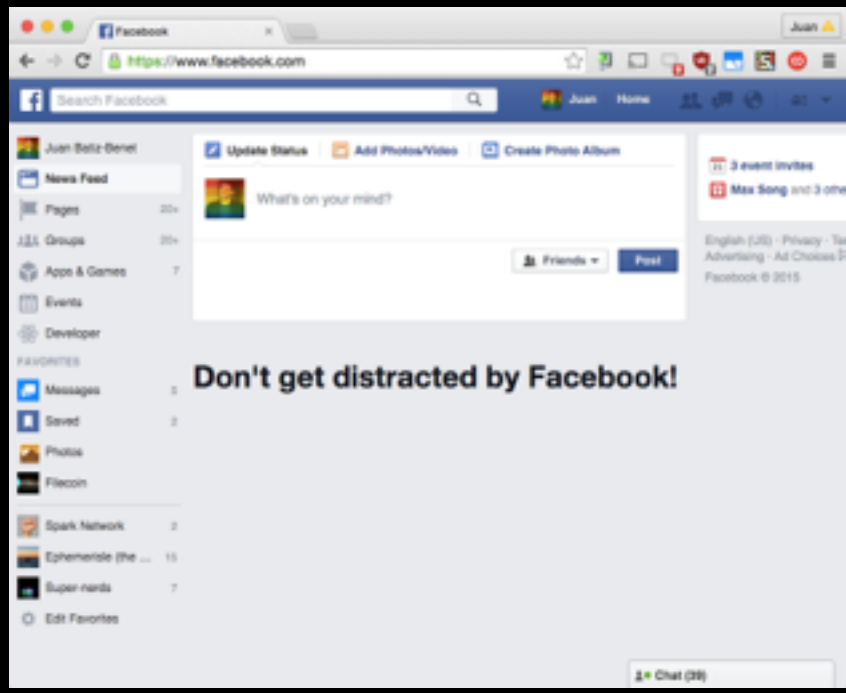
What Will You Receive in Collection (Surveillance and Stored Comms)?

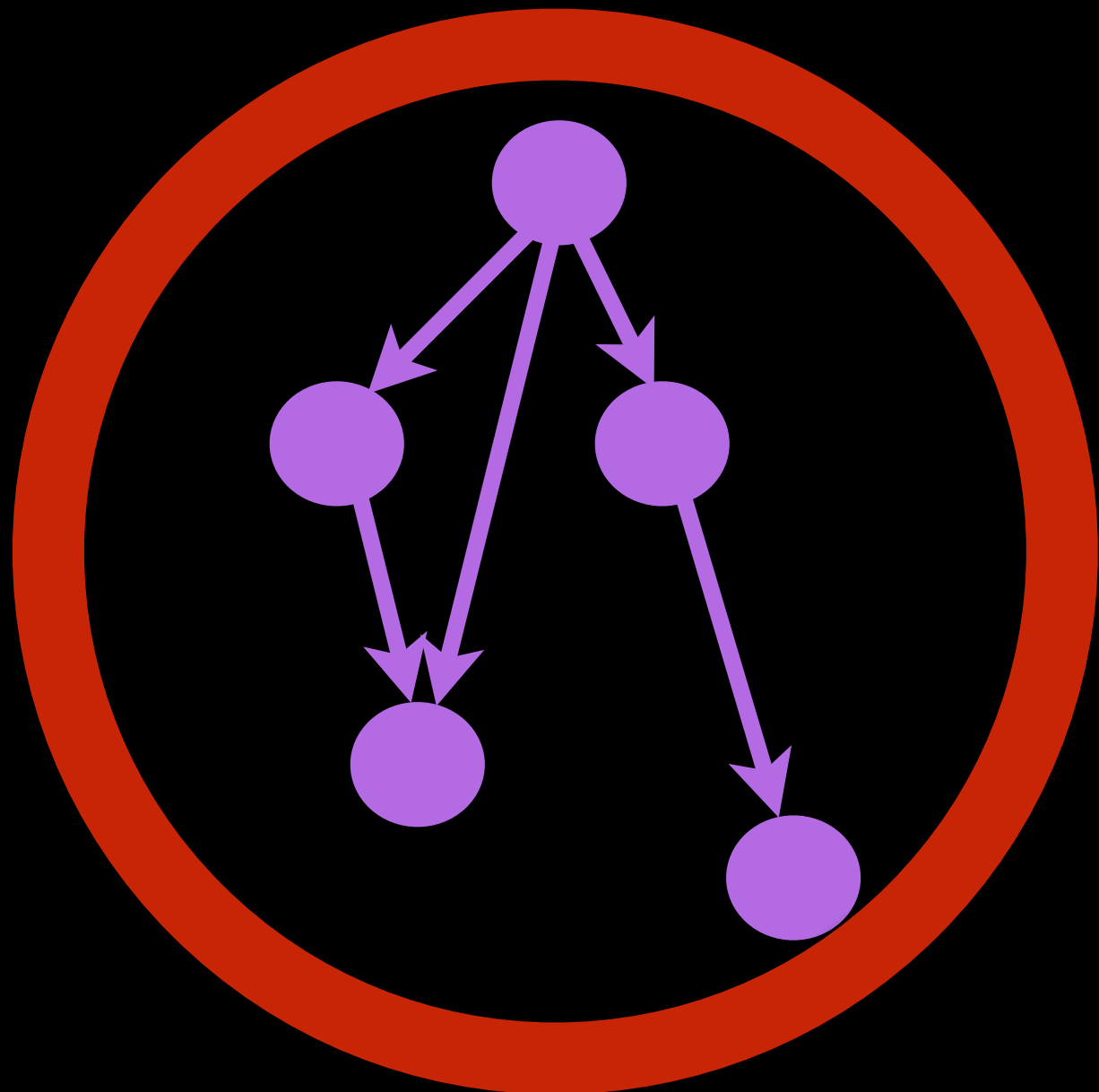
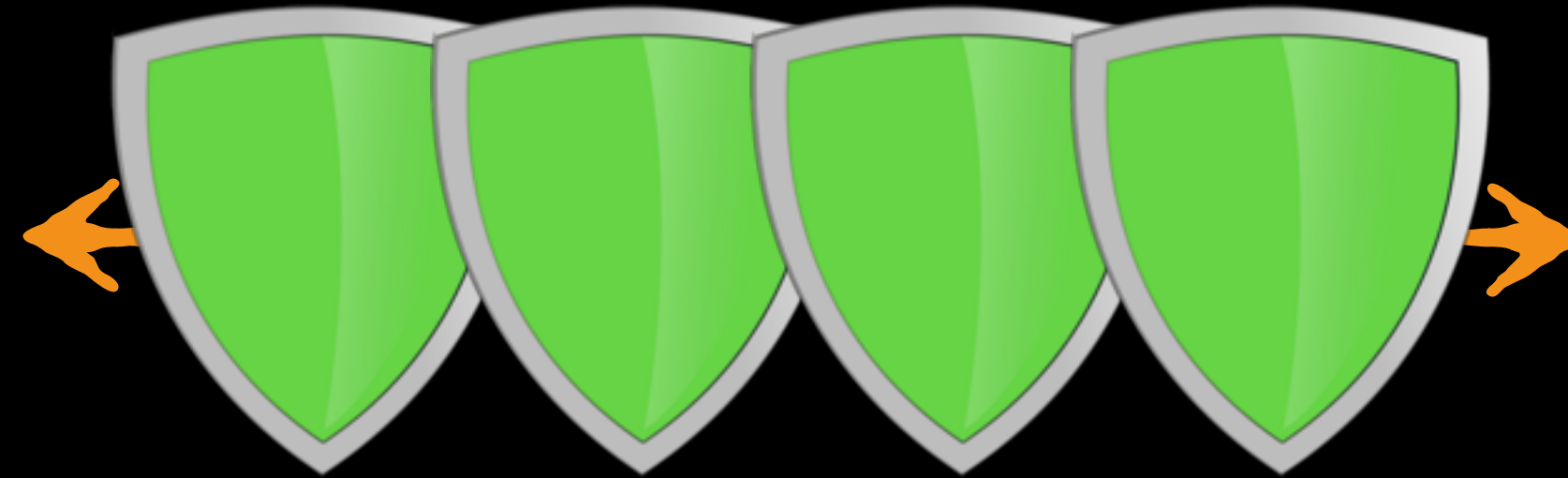
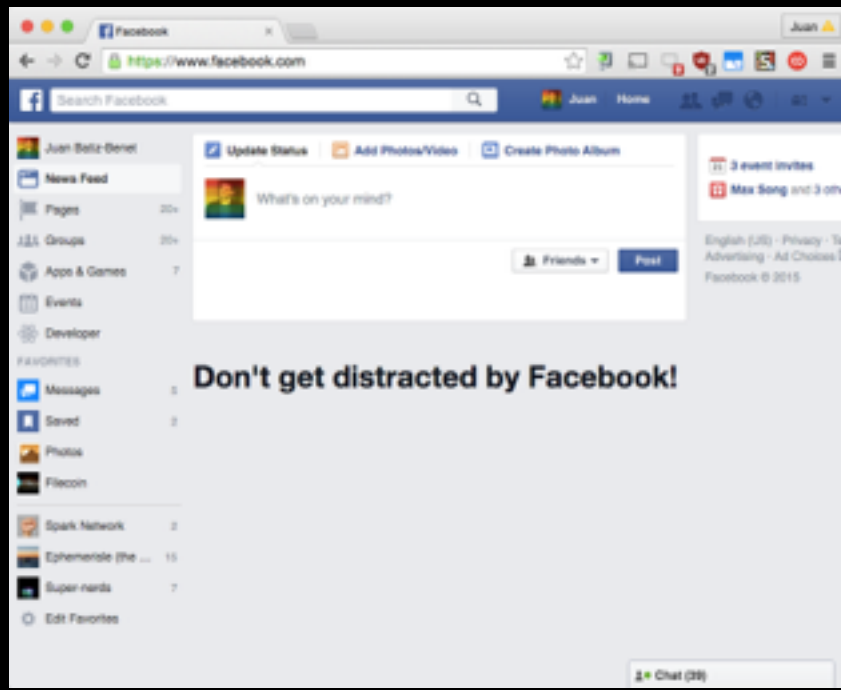
It varies by provider. In general:

- E-mail
- Chat - video, voice
- Videos
- Photos
- Stored data
- VoIP
- File transfers
- Video Conferencing
- Notifications of target activity - logins, etc.
- Online Social Networking details
- Special Requests

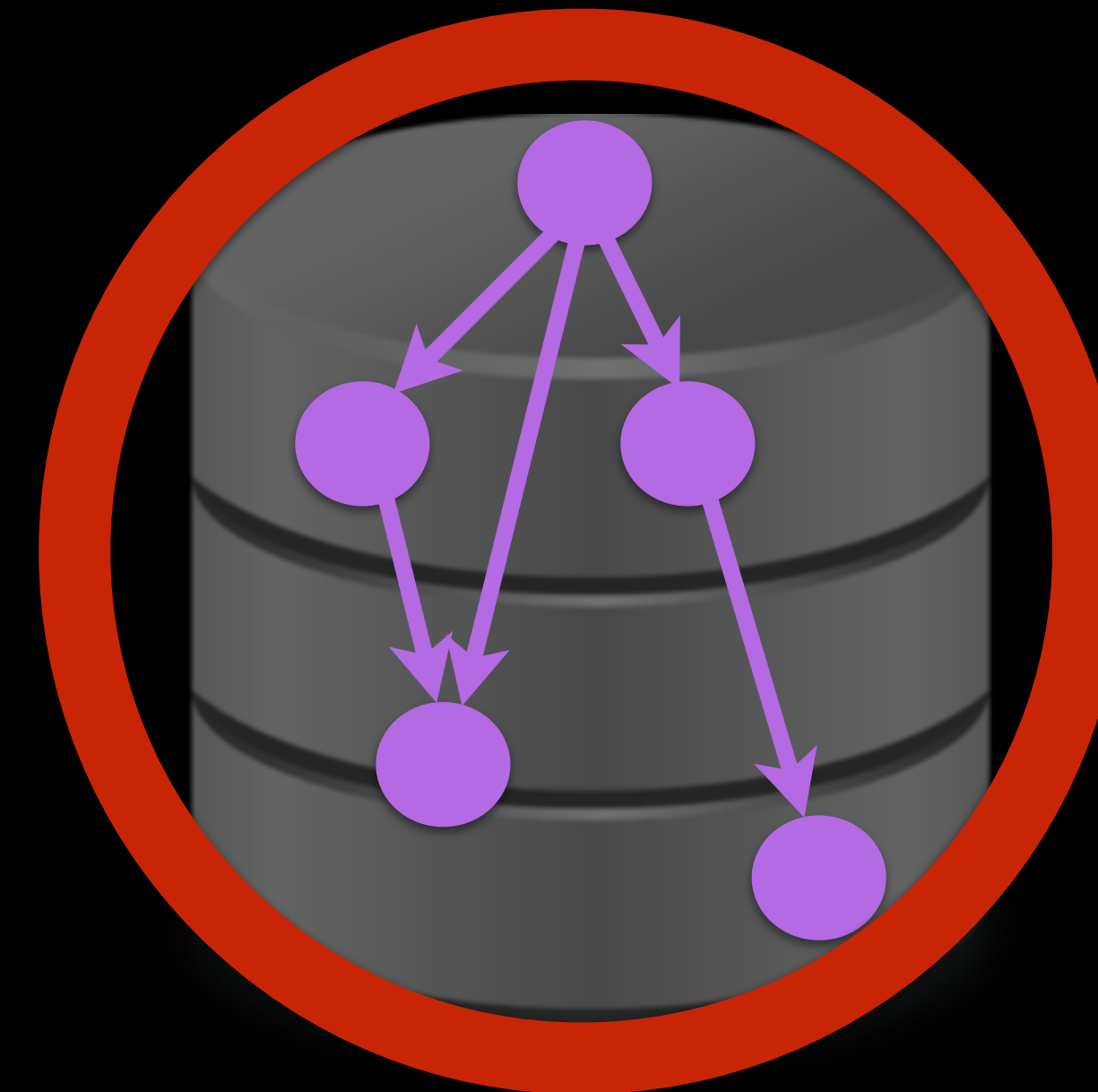
Complete list and details on PRISM web page: Go PRISM/FAA

TOP SECRET//SI//ORCON//NOFORN

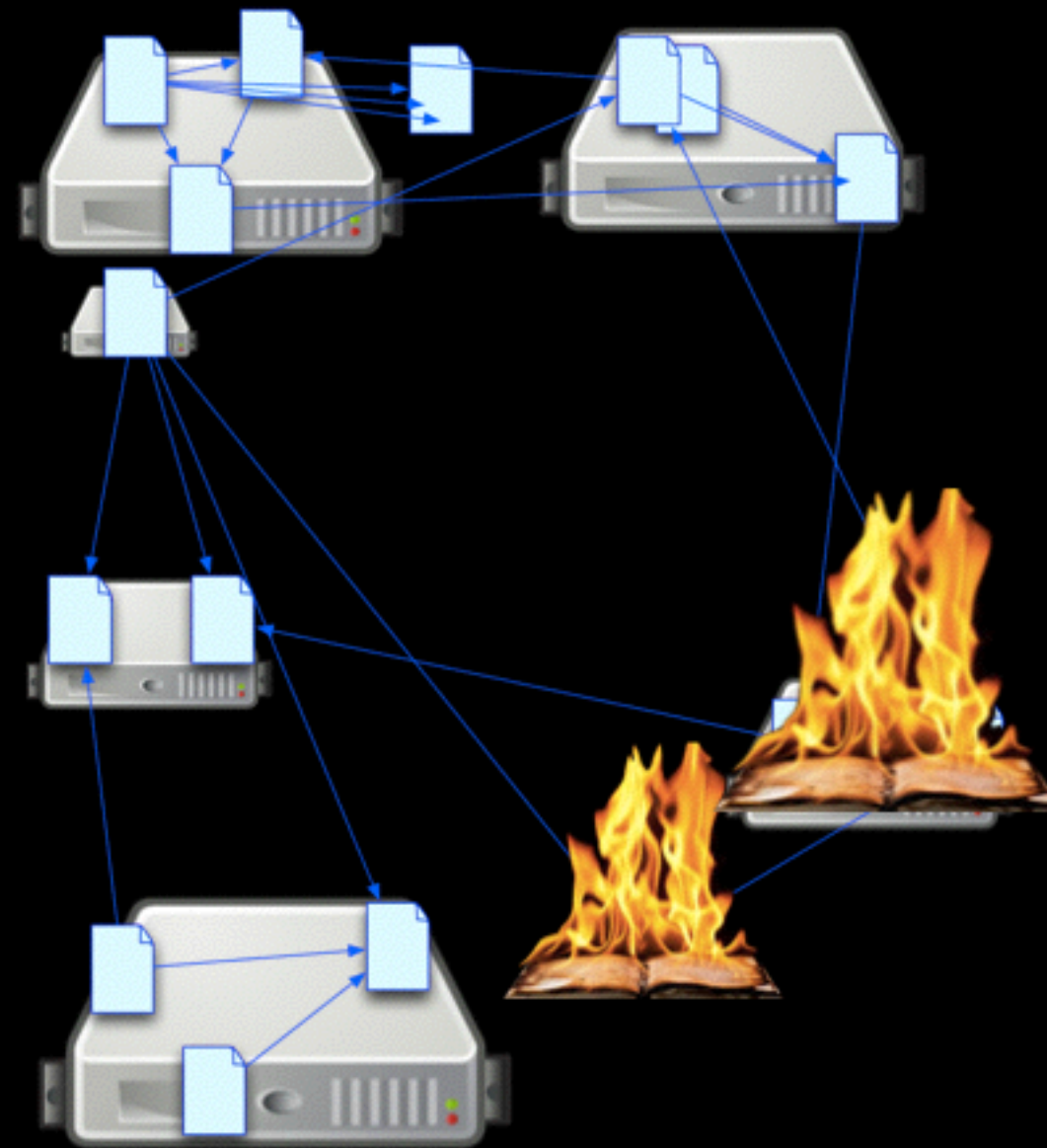
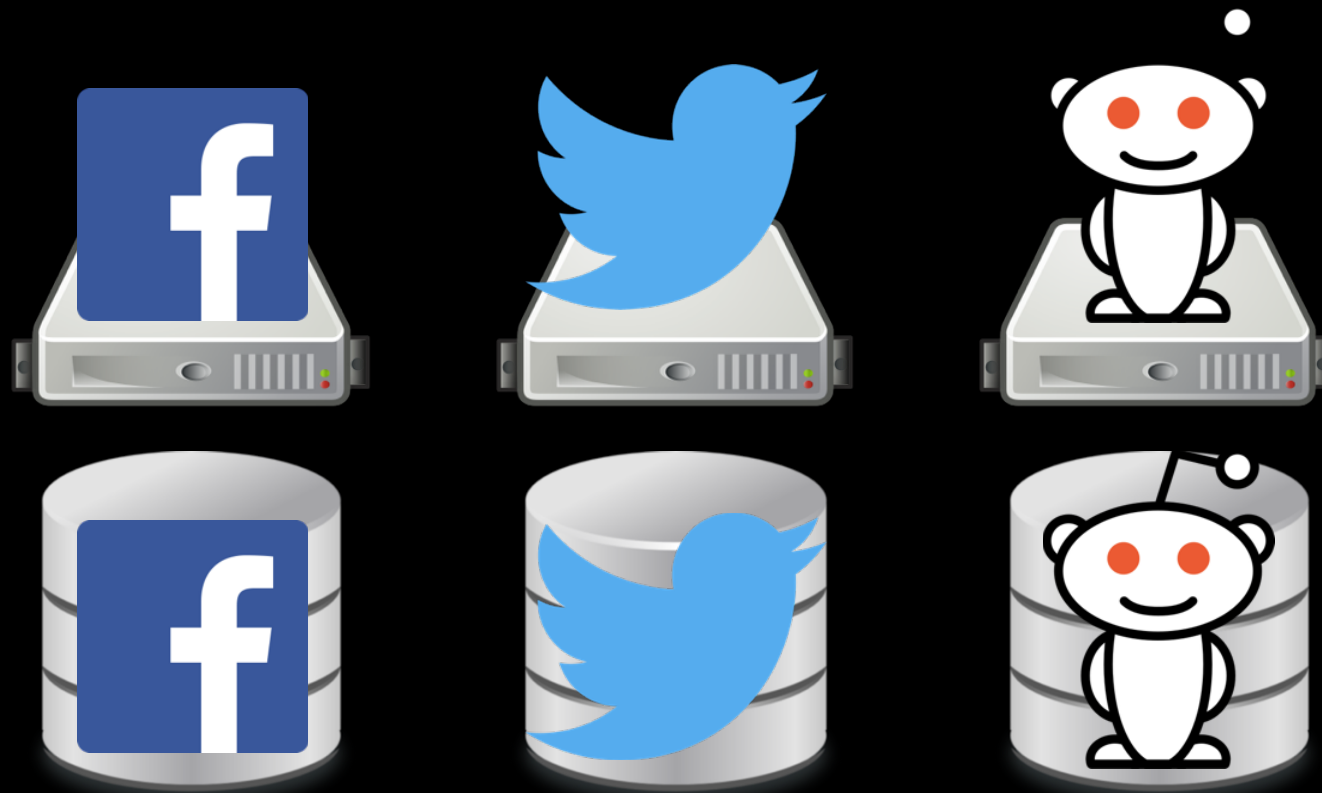
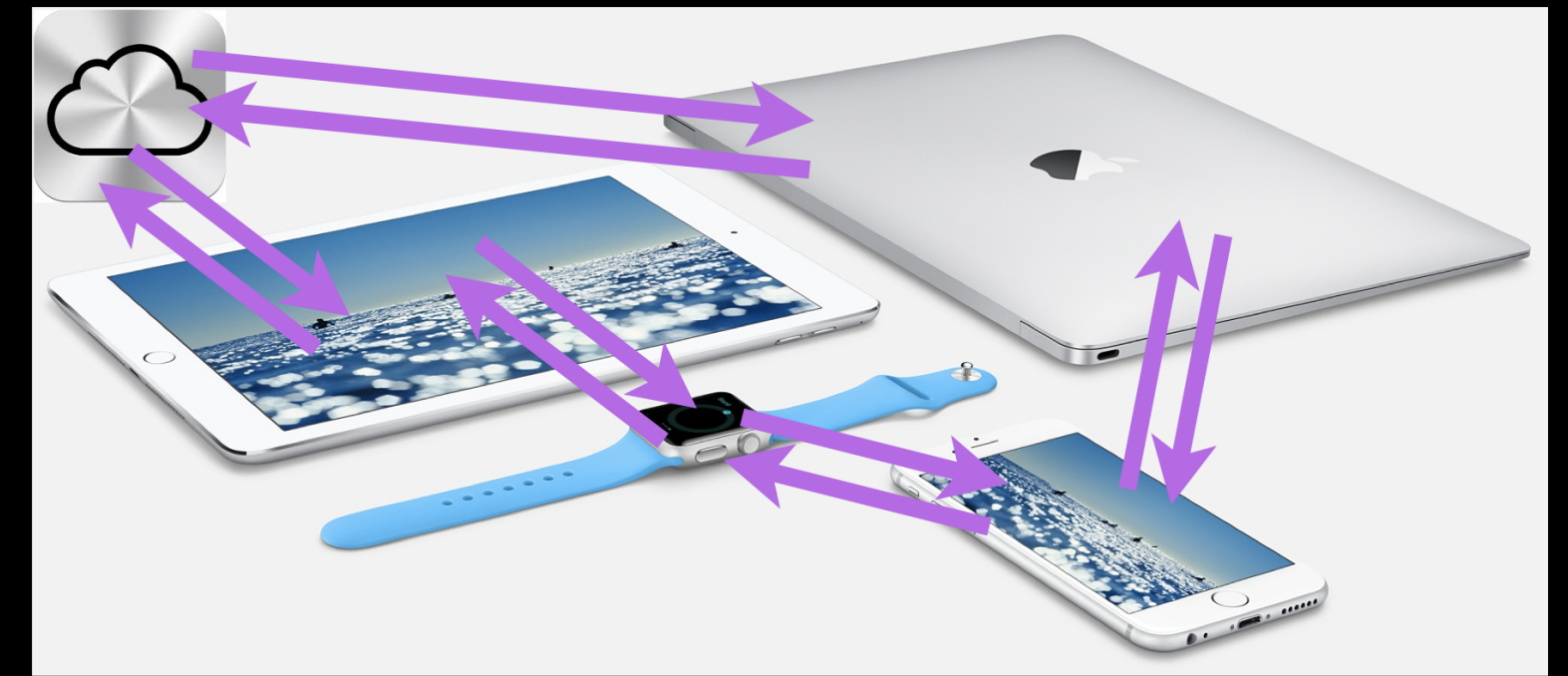
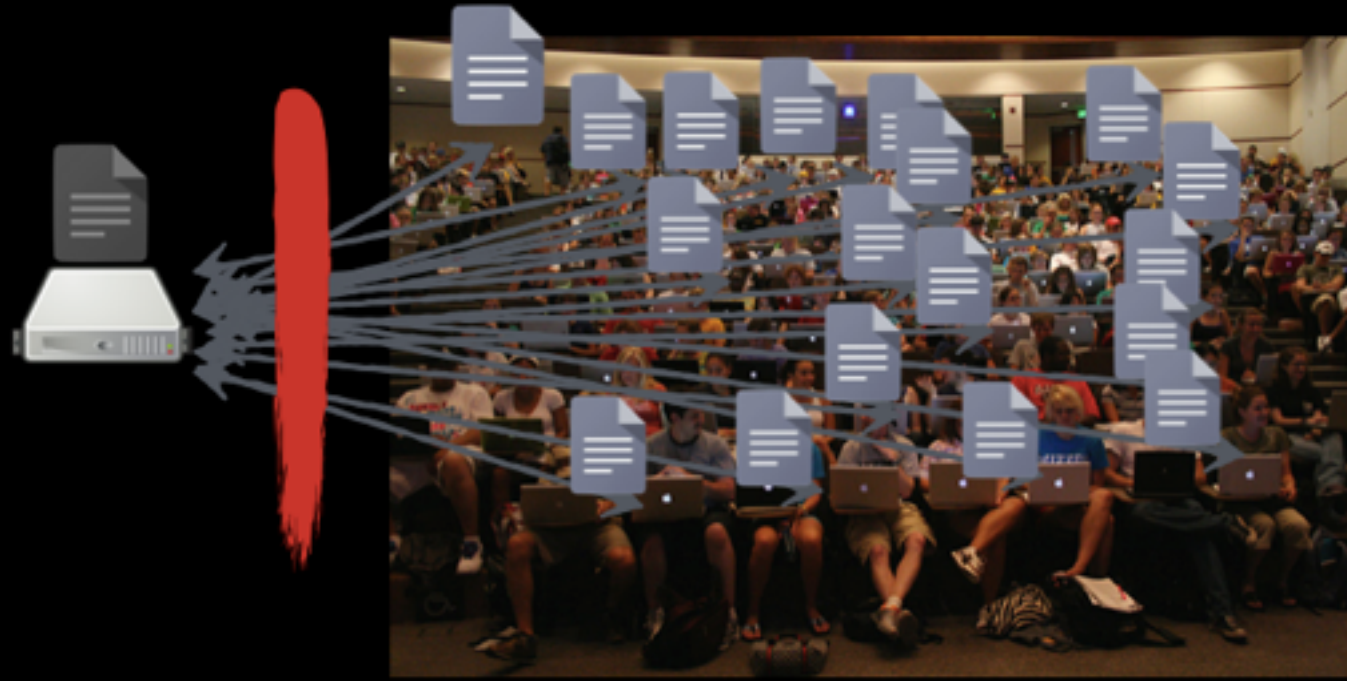
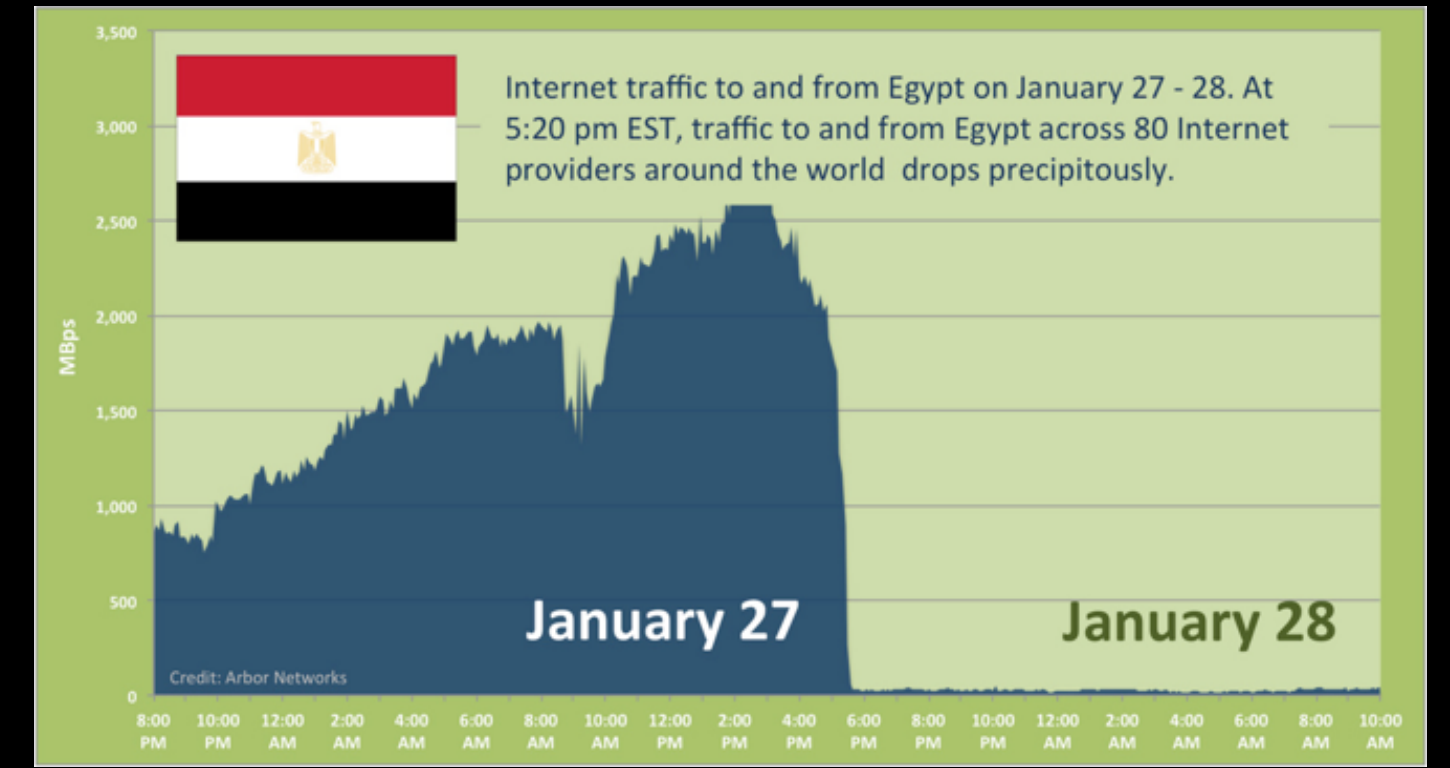
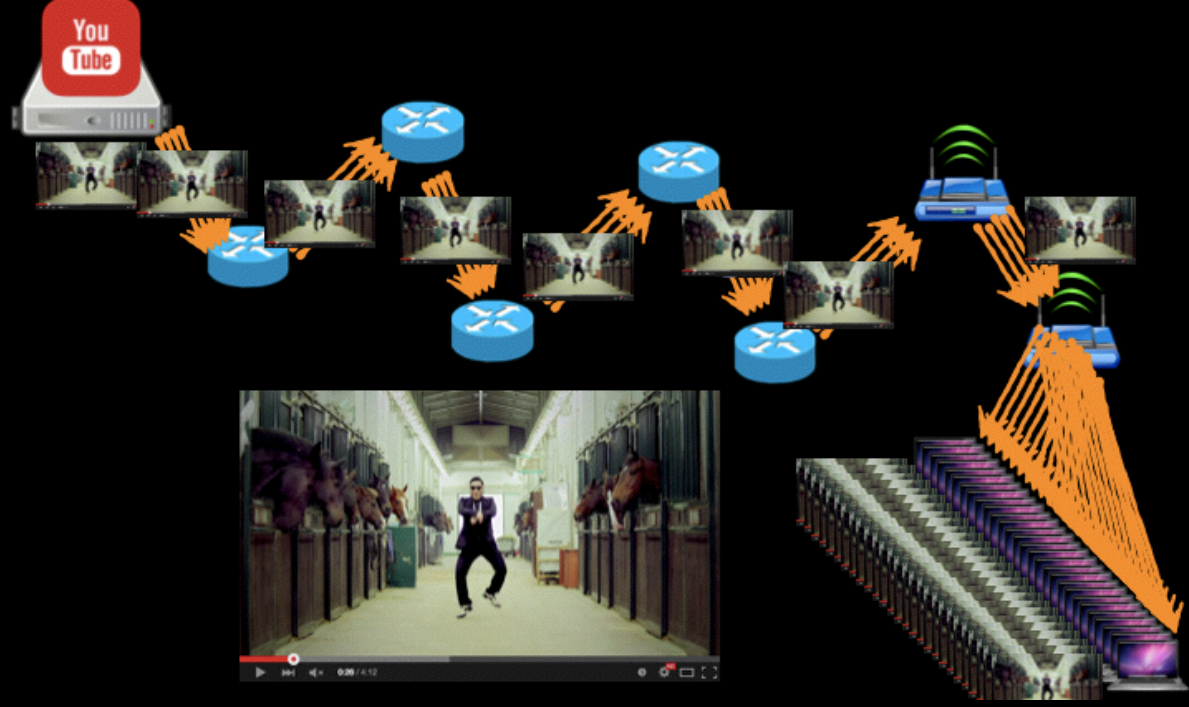




**NOT AUTHENTICATED
NOT ENCRYPTED
AT REST**



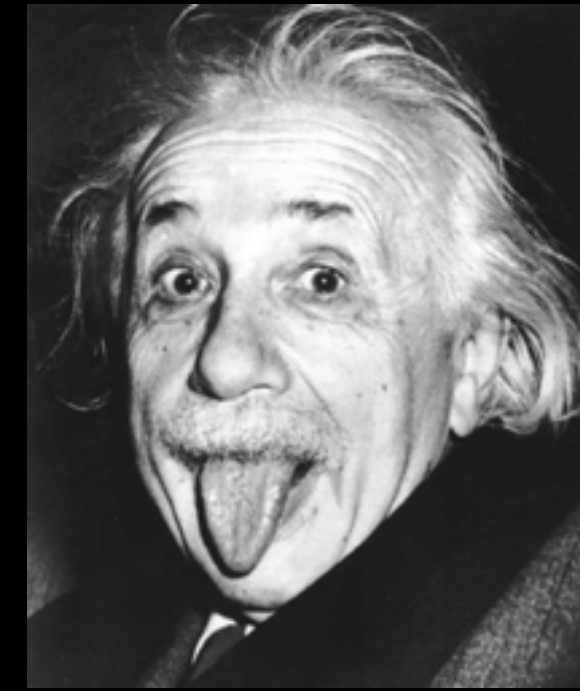
200 MB x 30 x 8 = 48 GB



NOT AUTHENTICATED
NOT ENCRYPTED
AT REST



Offline



Smarter

IPFS



Distributed



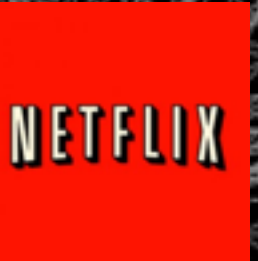
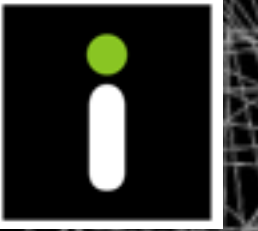
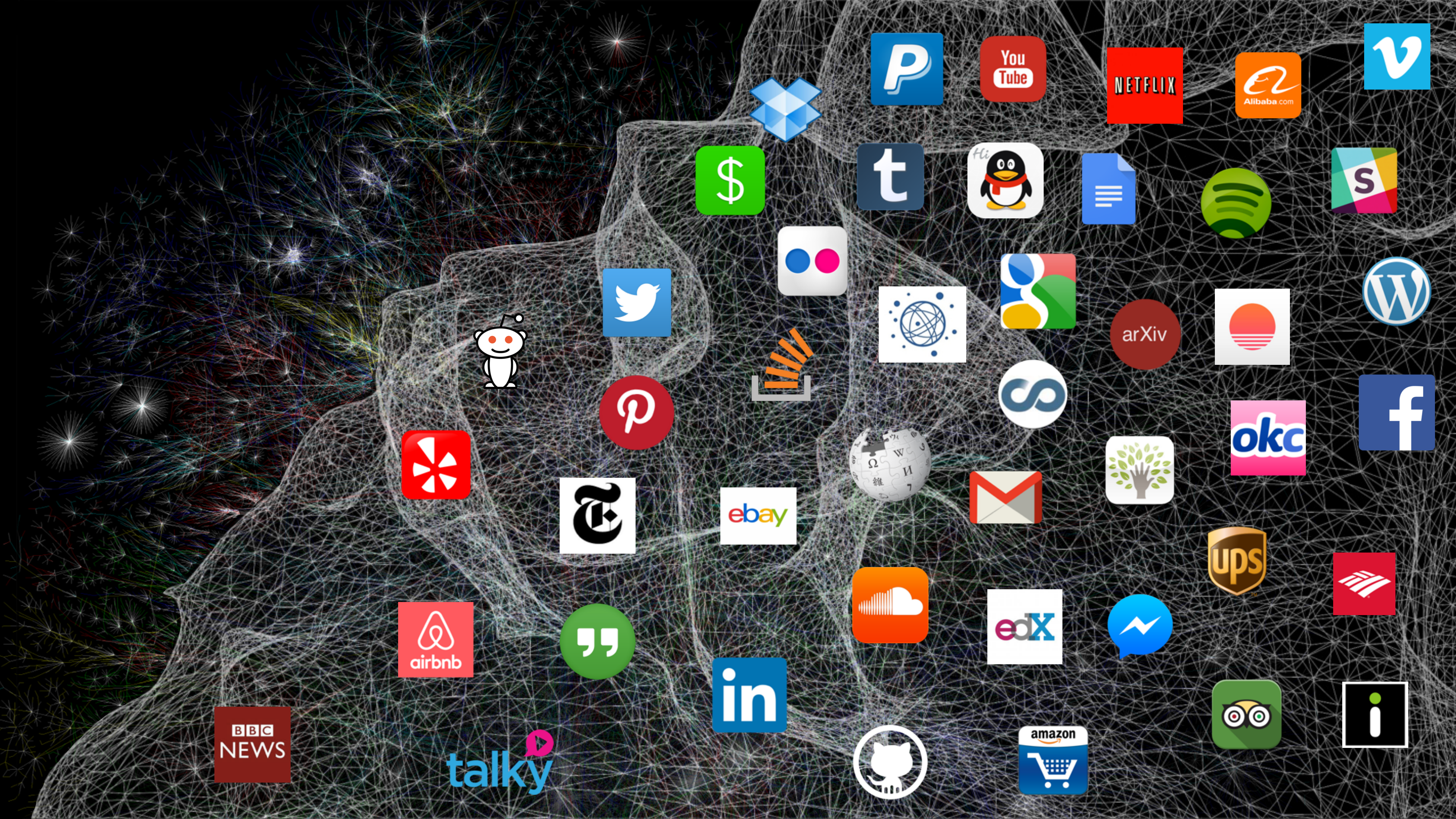
Permanent



Safer



Faster





a protocol to upgrade the web



a web of merkle-links





web



SFS

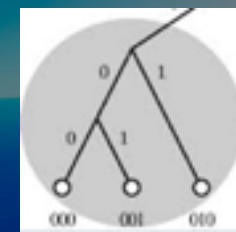


git



BitTorrent®

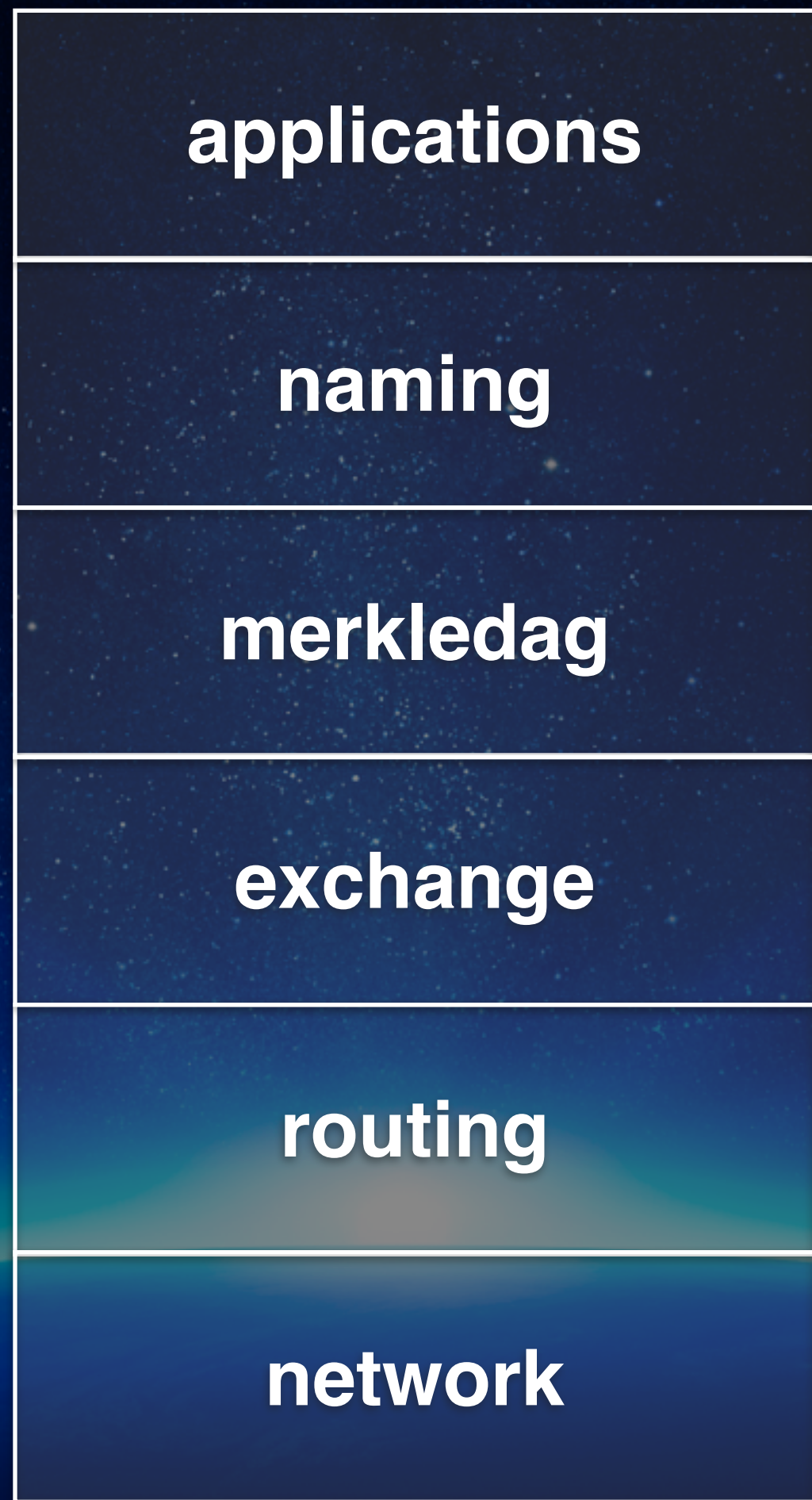
+



DHT



IPFS



The IPFS Stack

applications

Etherpad

VLC

Git

Chat

Bitcoin

naming

IPNS

IPLD

exchange

Bitswap

routing

Kad DHT

mDNS

network

CJDNS

UDT

uTP

WebRTC

QUIC

TCP

WebSockets

applications

Etherpad

VLC

Git

Chat

Ethereum

Bitcoin

naming

DNS

IPNS

Namecoin

EthNames

IPLD

exchange

BitTorrent

Bitswap

FTP

HTTP

routing

Gossip

Chord

Kad DHT

mDNS

Delegated

I2P

TOR

network

CJDNS

UDT

uTP

WebRTC

QUIC

TCP

WebSockets

I2P

TOR

The  IPFS Stack

applications

Using the Data

IPNS

naming

Defining the Data

IPLD

merkldag

exchange

libp2p

routing

Moving the Data

network

The IPFS Stack

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libp2p

exchange

Moving the Data

routing

network

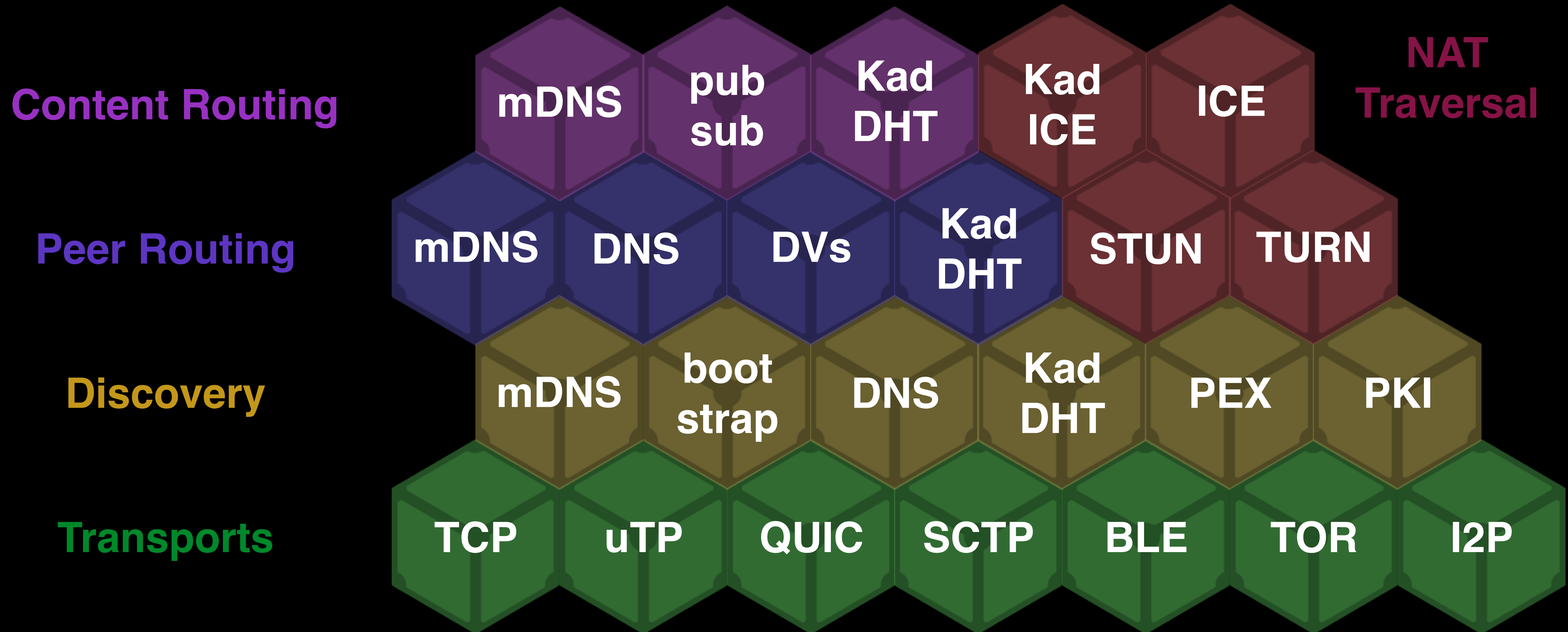
libp2p - a collection of peer-to-peer protocols

for finding peers, and connecting to them

for finding content, and transferring it



libp2p - a collection of peer-to-peer protocols



libp2p

Content Routing

Peer Routing

Discovery

Transports

NAT Traversal



libp2p

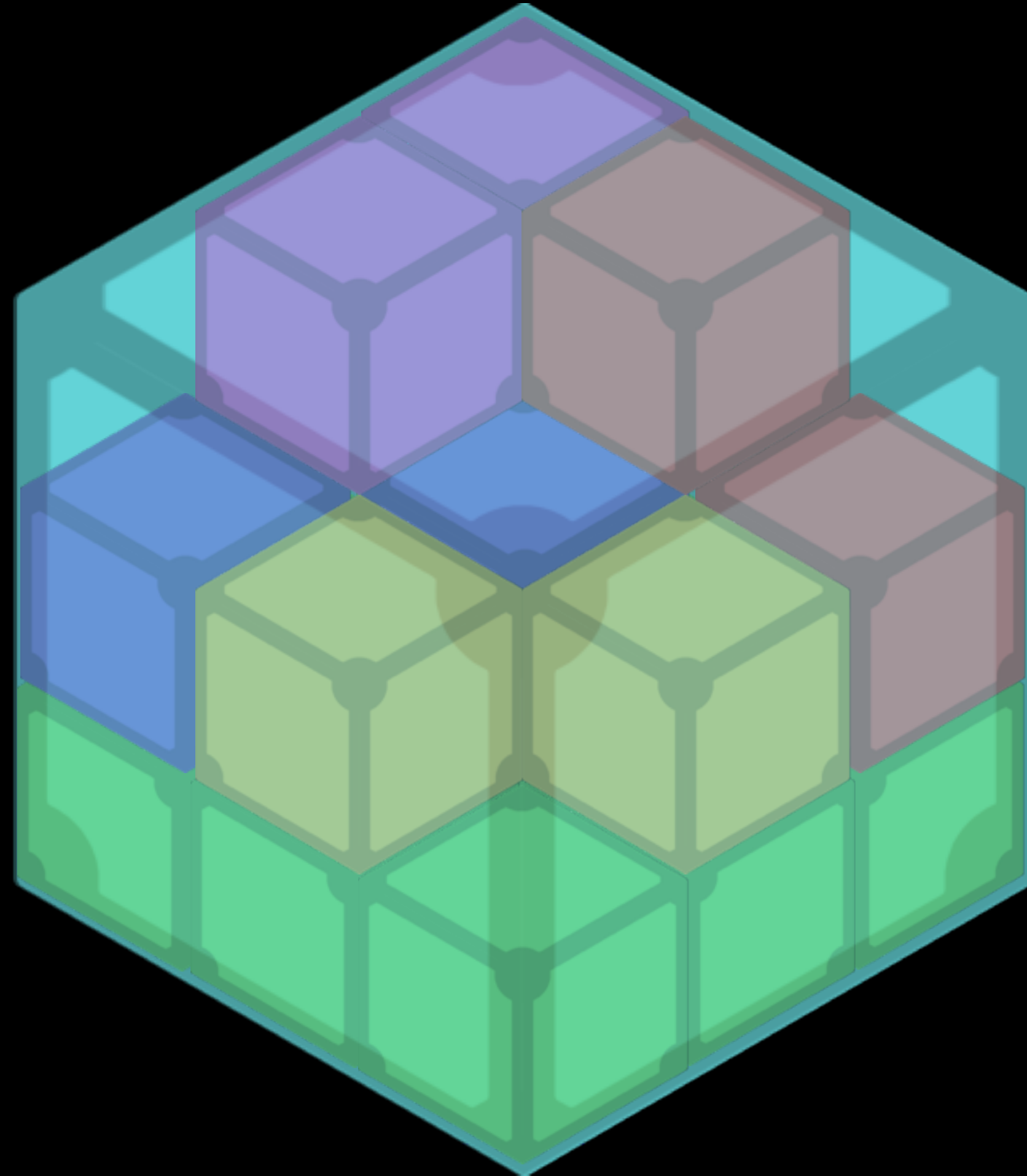
Content Routing

Peer Routing

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Transports

NAT Traversal



The  IPFS Stack

applications

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merkldag

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INTERNET

OF

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Namecoin

merkle DAG

exchange

INTERNET

OF

routing

Gossip

Chord

Kad DHT

mDNS

Delegated

I2P

TOR

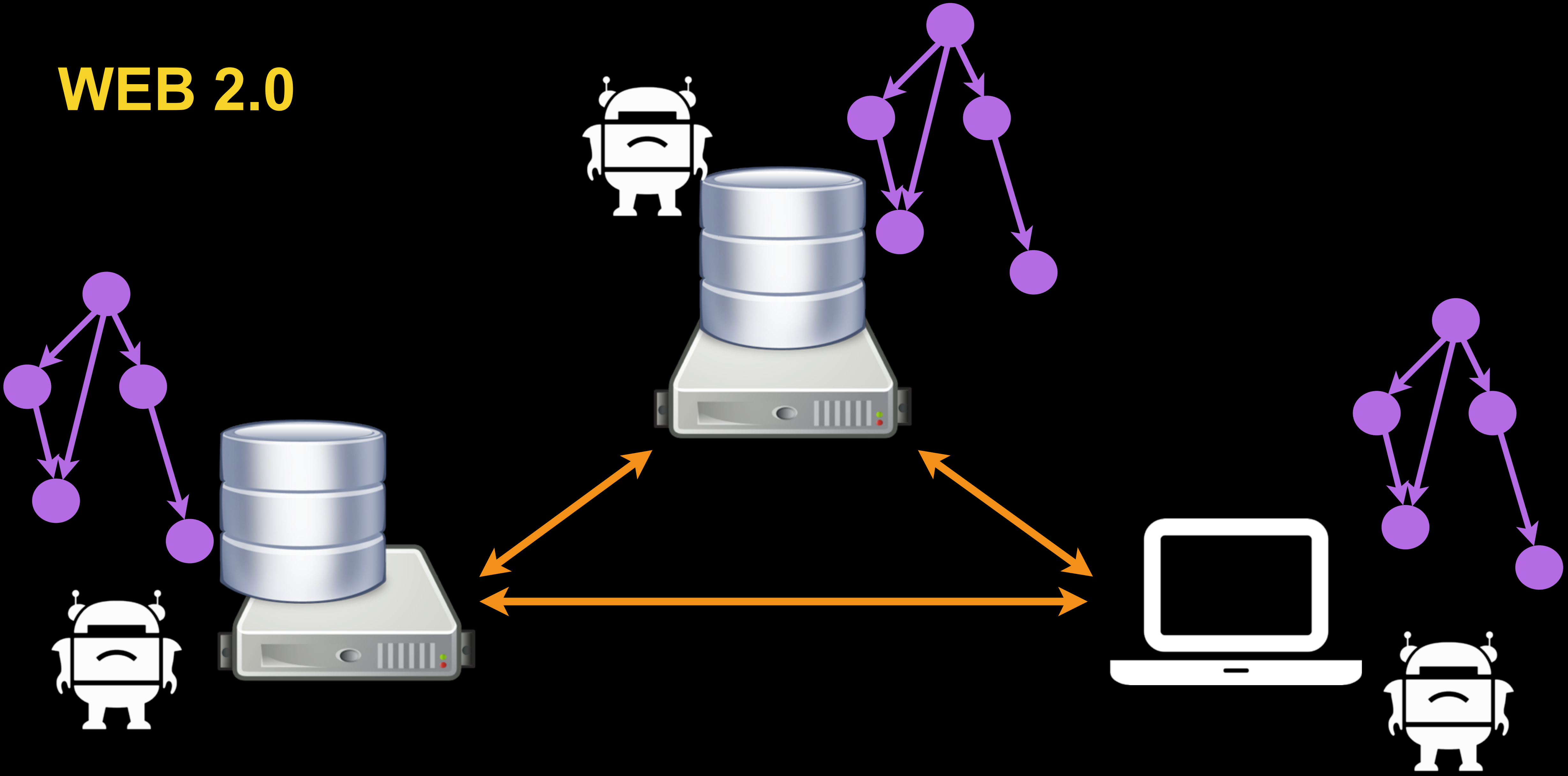
network

DATA STRUCTURES

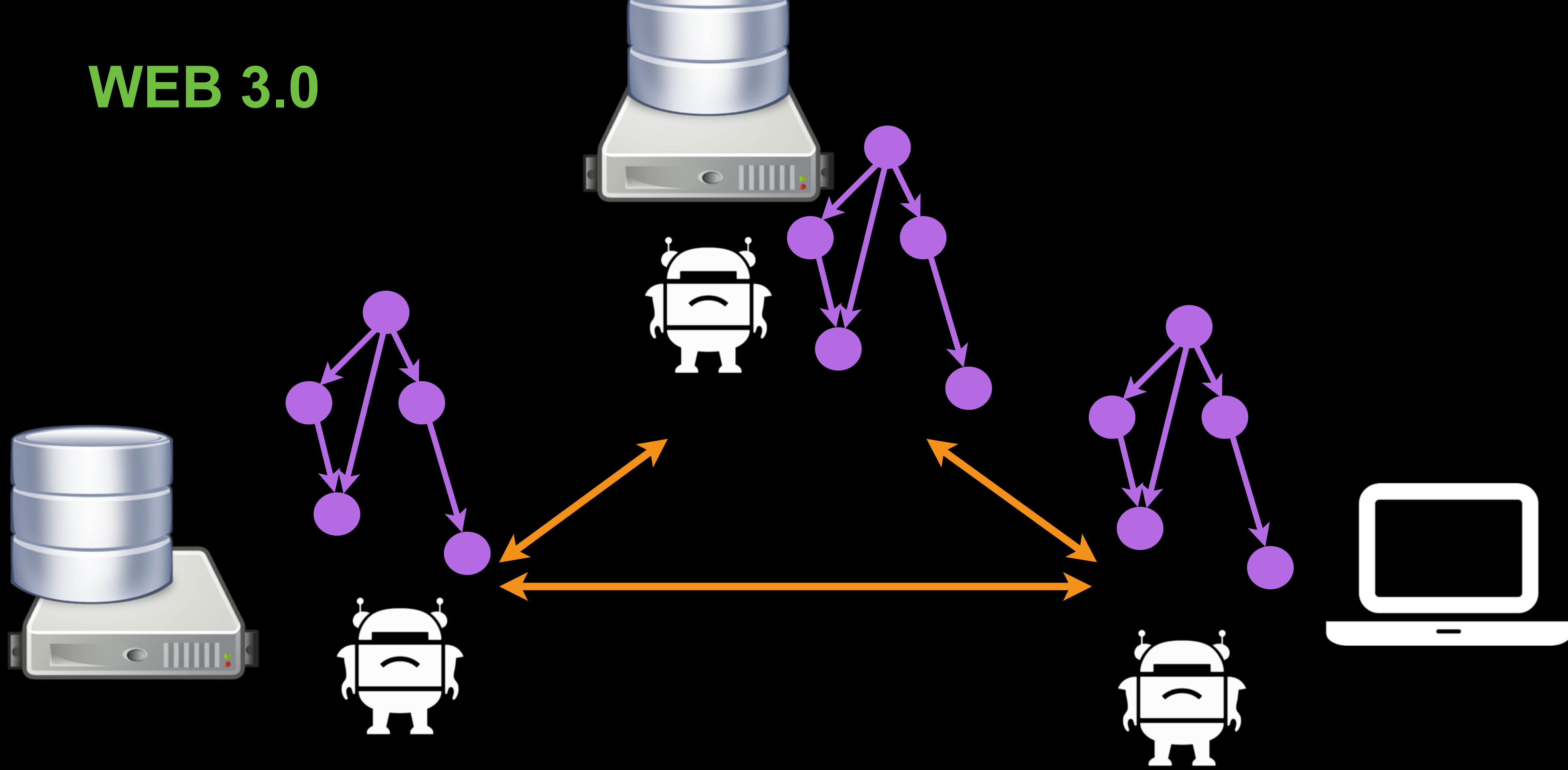
I2P

TOR

WEB 2.0



WEB 3.0





Browser window with tabs: "TaX for the web - Issue #5", "ipfs law - Twitter Search", "Louisiana Statutory Crimi...".

Address bar: <https://gateway.ipfs.io/ipfs/QmbeQDMbw8cdvyBZ9BsKTWe2XUbsXBc5FY9EqFFgY2Q/>

Page title: LACrimBook

Navigation: Home About Favorites -

Search: Search Statutes

- ▶ Title 14
- ▶ Title 15
- ▶ Title 32
- ▶ Title 40
- ▶ Title 46
- ▶ Title 56
- ▶ Code of Criminal
- ▶ Code of Evidence
- ▶ Childrens Code
- ▶ Constitution

Browser window showing a picture hosted on ipfs.pics.

Address bar: ipfs.pics/QmWp2buQNoU1YYhu1K8Z9DyMx21nhKVN1YAvzsaQQvVJMn

Page title: [ipfs.pics]

Buttons: Upload Random View

Browser window showing a 3D scene in a Unity WebGL Player.

Address bar: <https://ipfs.io/ipfs/QmTpkYu6vBzAbU3pF4Q9V7YyuzFX91V61GkYrxuSXeV/>

Browser window showing a 3D scene of a landscape with a waterfall.

Address bar: i.ytimg.com/vi/X5LFGDWZQqM/maxresdefault.jpg

Browser window showing a text document.

Address bar: <https://ipfs.io/ipfs/Qmav57P5mmwcpUtmgrB2tp9j6YpXZdgobxDv7VBeJtgtCp/>

Text: and can be entirely accounted for by a phase in the Cabbibo-Kobayashi-Maskawa matrix in the electroweak Lagrangian. This phase is insufficient to account for the known baryon asymmetry in the con-

Browser window showing Brewster Kahle's Blog.

Address bar: <https://ipfs.io/ipfs/QmavE42xtK1VovJFVTvkCR5Jdf781QWbmxak9Zx718TV/>

Page title: Brewster Kahle's Blog

IPFS interface showing a globe and a list of connected peers.

Address bar: <localhost:5001/ipfs/QmS2HL9v5YeKgQkkWMvs1EMnFtUowTEdFISseMT4pos1e6/#/connections>

Page title: IPFS

Navigation: Home Connections Files DAG Config Logs

CONNECTED TO 146 PEERS

QmNRRwxGga5hgGhKZc8S1rXWzeEaymGHAw2KtbGj5iFYgB	/p4/50.186.41.164/tcp/4001/ipfs
QmNskXT3CdF84WpKDXPpkXyYsBoJBGuAM4E9jDAMDdKq	/p4/46.101.230.105/tcp/4001/ipfs
QmNVQVCgdL3azGailLqSSYQrgSD7jEogLjGmrQ8LxvNDzt	/p4/5.172.41.102/tcp/4001/ipfs
QmNeK3hRF5Pu9dPcMDKXyYofQloskuGfQZEQz43UDkLepK	/p4/178.62.206.163/tcp/4001/ipfs
QmNt2nZ3tWc8hbAbGNmtQQN9TmPAkpwKztjH8xZvcv3eF	/p4/104.131.53.68/tcp/4001/ipfs
QmNlbdCnY2GJaXK4Eom9kTQ1utF9vzaAGRrYnHET3bDQdj	/p4/103.16.131.169/tcp/4001/ipfs
QmNjRVohhWBX31EoaAXkrj5mPF9vQncTvVgWHNwdxweCN	/p4/158.69.62.218/tcp/4001/ipfs
QmNkzcep9e4TQYvlpd7Nv8NEj4gQ72aMSnL69j9qvZ5V	/p4/87.98.218.15/tcp/4001/ipfs
QmNoDNpuYFWnVFN4hHuGjHcewF4bamd7c7BTp3g41uel2	/p4/128.120.246.131/tcp/4001/ipfs
QmNslJFEjmrBC34NHqWH5oEVqCQNX2JDEmBM5yw7HRAcM	

bundled in FreeNAS



used by dozens of co's/org's



[ipfs.pics]



eris
INDUSTRIES

ALEXANDRIA

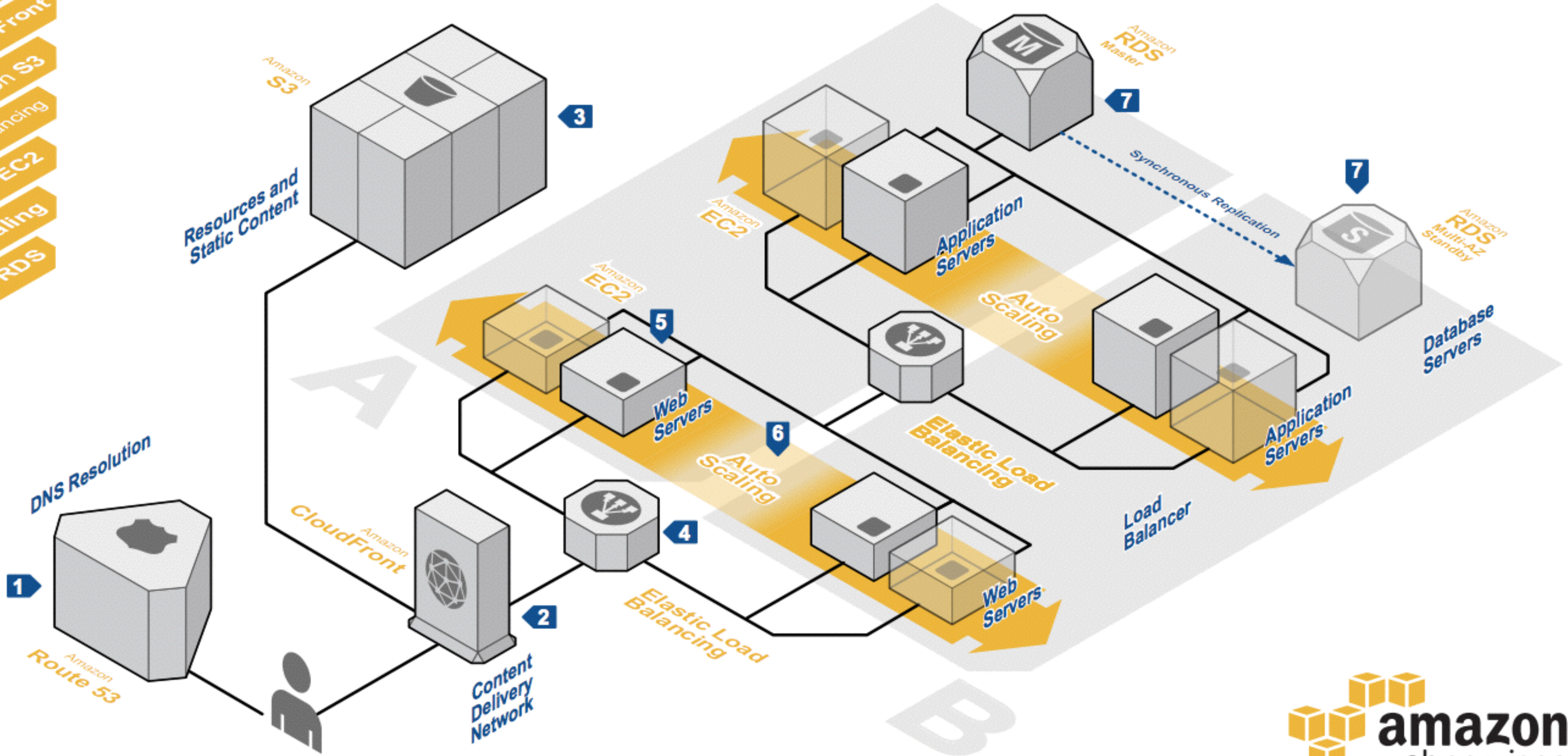
used to archive data of



WEB APPLICATION HOSTING

Highly available and scalable web hosting can be complex and expensive. Dense peak periods and wild swings in traffic patterns result in low utilization of expensive hardware. Amazon Web Services provides the reliable, scalable, secure, and high-performance infrastructure required for web applications while enabling an elastic, scale-out and scale-down infrastructure to match IT costs in real time as customer traffic fluctuates.

- AWS Reference Architectures
- Amazon Route 53
- Amazon CloudFront
- Amazon S3
- Elastic Load Balancing
- Amazon EC2
- Auto Scaling
- Amazon RDS





ORACLE®



sones



AllegroGraph



HYPERGRAPHDB





a web of merkle-links



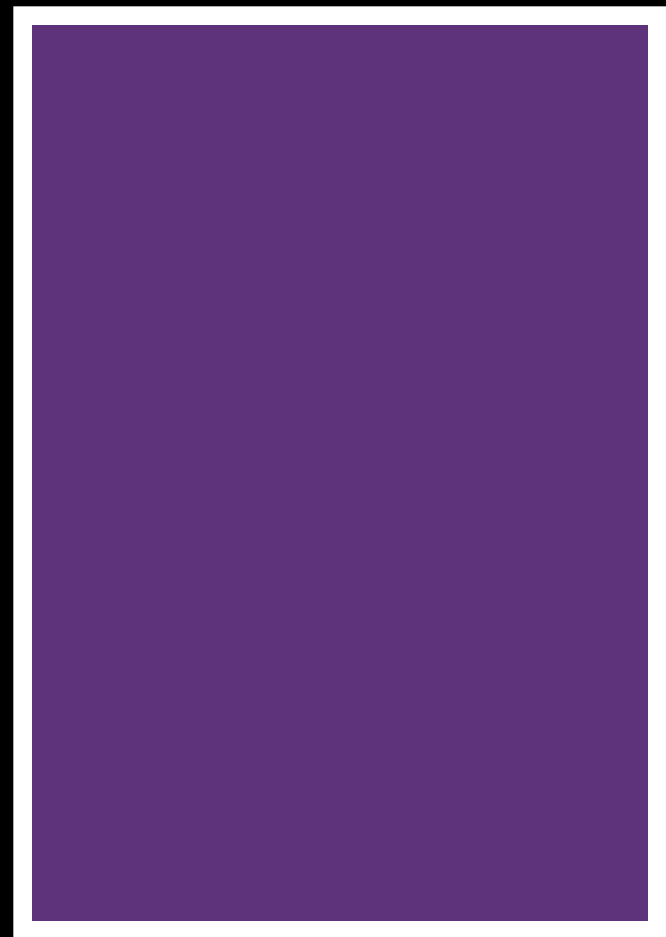
http://example.com/foo/bar/baz.png



http://10.20.30.40/foo/bar/baz.png

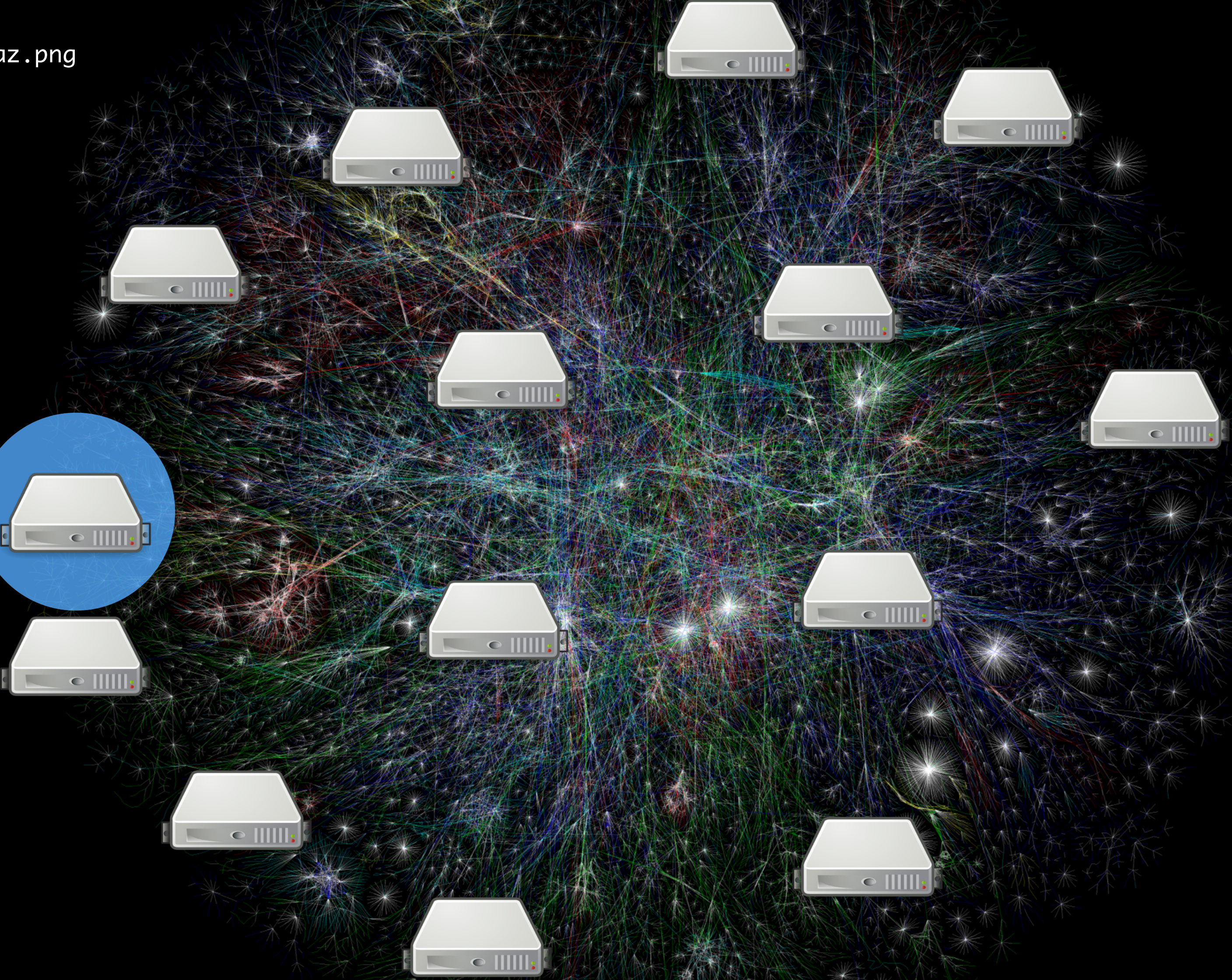
location

path

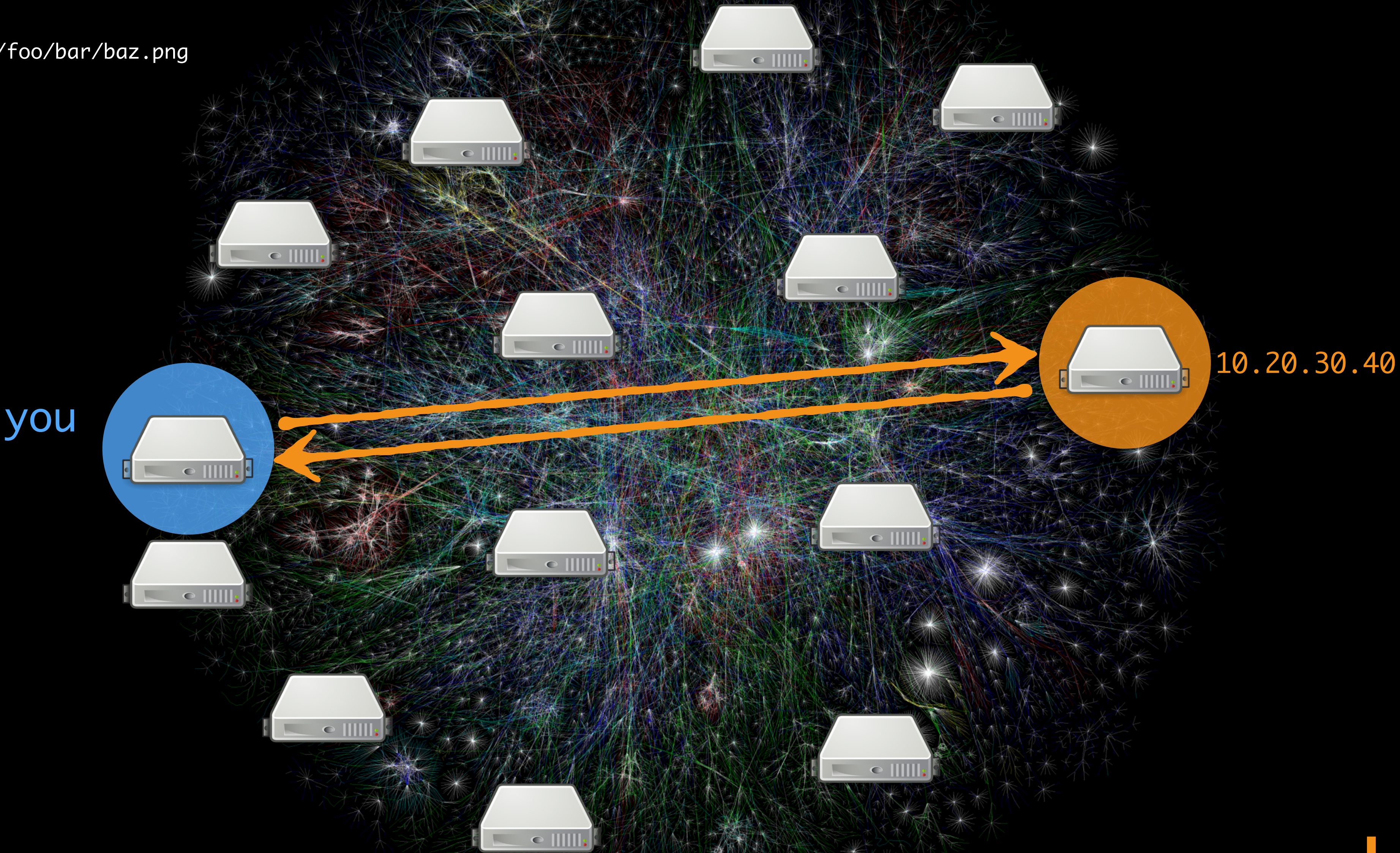


<http://10.20.30.40/foo/bar/baz.png>

you



<http://10.20.30.40/foo/bar/baz.png>



HTTP

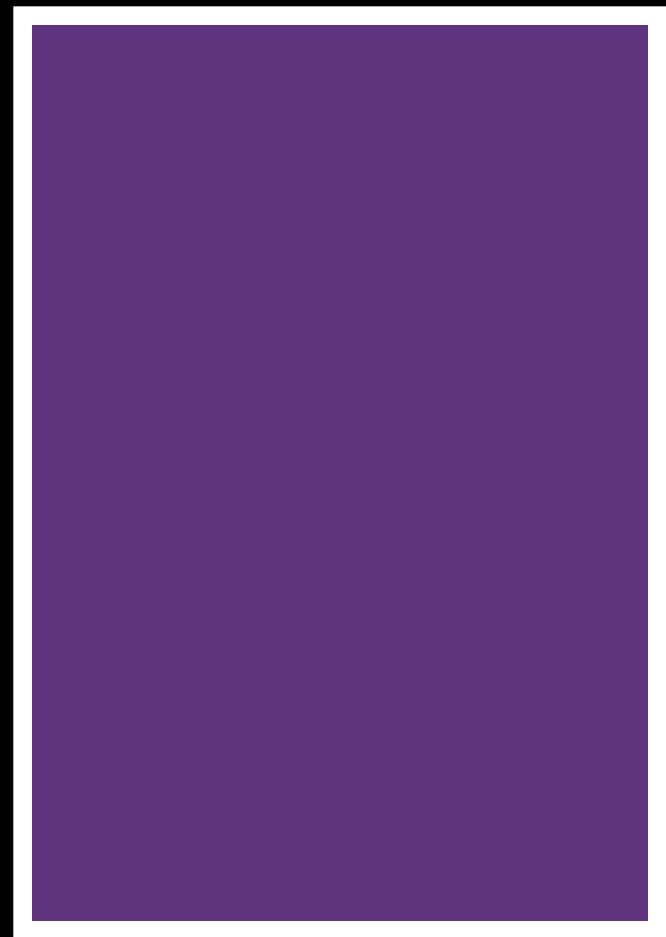
http://example.com/foo/bar/baz.png

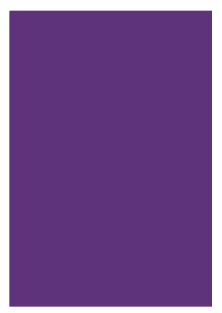


http://10.20.30.40/foo/bar/baz.png

location

path



hash() -> QmW98pJrc6FZ6

http://



http://

location

path

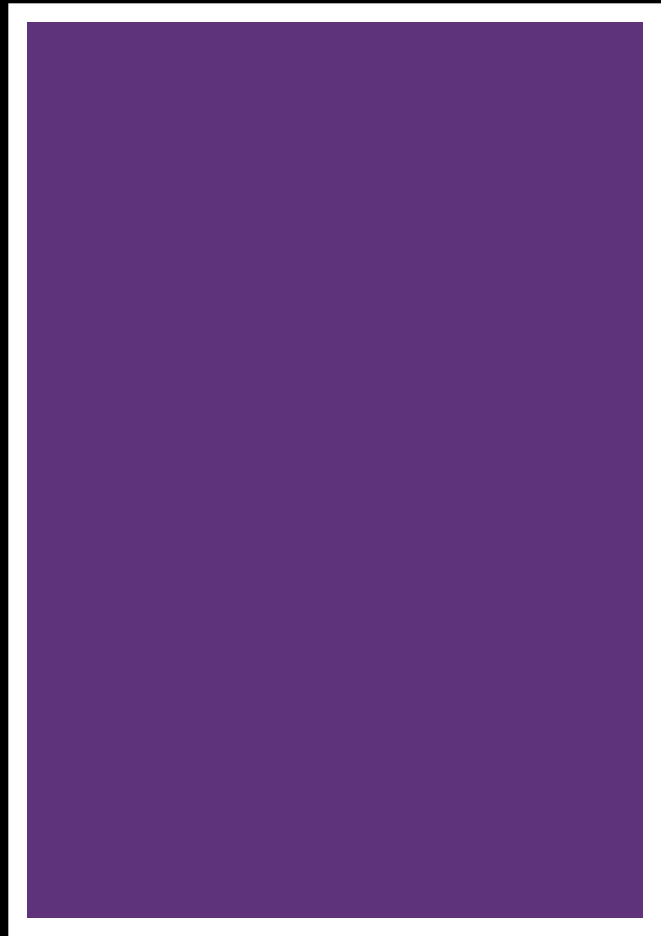
/ipns/example.com/foo/bar/baz.png



/ipfs/QmW98pJrc6FZ6/foo/bar/baz.png

content

path



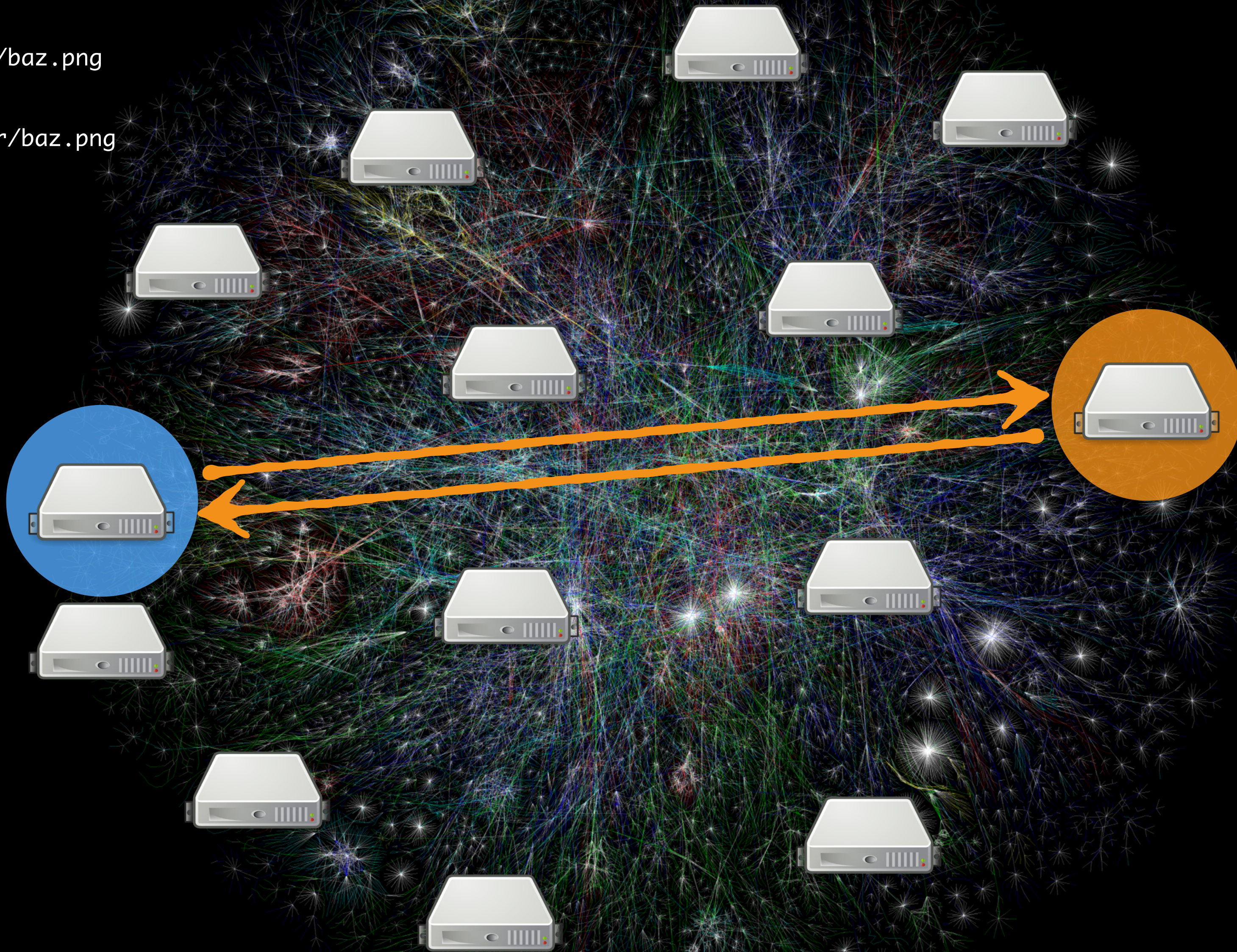
`http://10.20.30.40/foo/bar/baz.png`

`/ipfs/QmW98pJrc6FZ6/foo/bar/baz.png`

you

10.20.30.40

HTTP



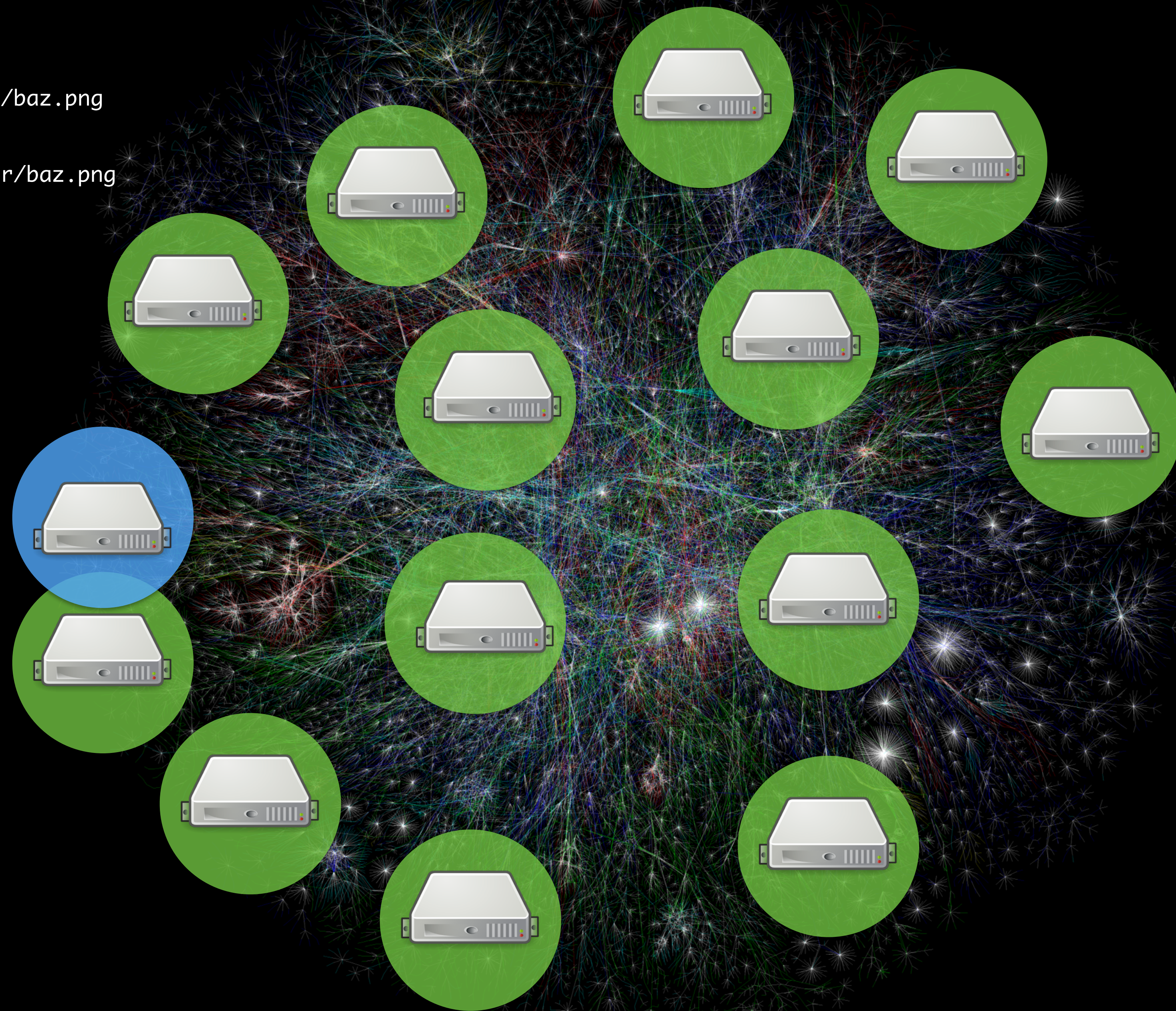
<http://10.20.30.40/foo/bar/baz.png>

[/ipfs/QmW98pJrc6FZ6/foo/bar/baz.png](http://ipfs/QmW98pJrc6FZ6/foo/bar/baz.png)

you

10.20.30.40

IPFS



MERKLE LINK 

“URI”

immutable

content addr

`/ipfs/QmW98pJrc6FZ6/foo/bar/baz.png`

MERKLE LINK

“URI”

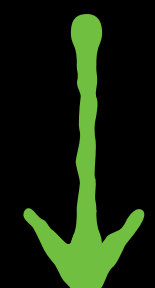
immutable

```
content addr    /ipfs/QmW98pJrc6FZ6/foo/bar/baz.png  
fs:/ipfs/QmW98pJrc6FZ6/foo/bar/baz.png  
ipfs:/ipfs/QmW98pJrc6FZ6/foo/bar/baz.png
```

MAZIERES LINK

mutability

key name /ipns/QmYJPtosPTfoC/foo/bar/baz.png



content addr /ipfs/QmW98pJrc6FZ6/foo/bar/baz.png

fs:/ipfs/QmW98pJrc6FZ6/foo/bar/baz.png

ipfs:/ipfs/QmW98pJrc6FZ6/foo/bar/baz.png

human readability

dns name /dns/example.com/foo/bar/baz.png
/ipns/example.com/foo/bar/baz.png



key name /ipns/QmYJPtosPTfoC/foo/bar/baz.png

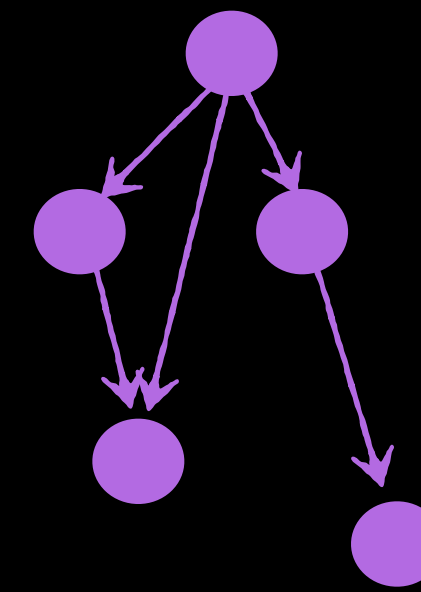


content addr /ipfs/QmW98pJrc6FZ6/foo/bar/baz.png
fs:/ipfs/QmW98pJrc6FZ6/foo/bar/baz.png
ipfs:/ipfs/QmW98pJrc6FZ6/foo/bar/baz.png

an IPFS node



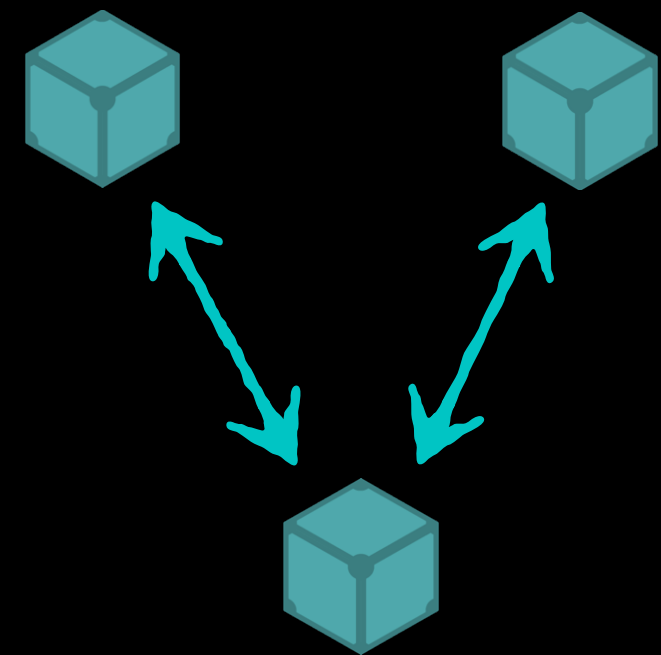
has pki based identity



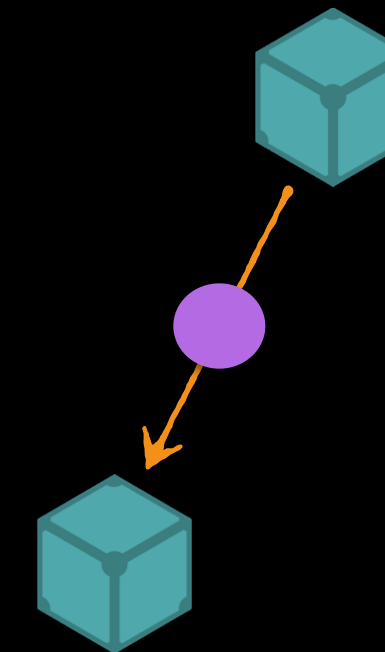
can store part of the dag



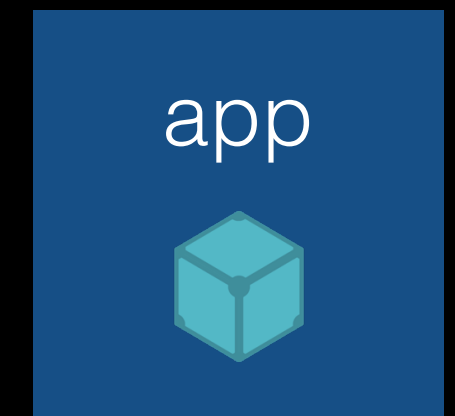
can be run as a server



connects to others



can get more from peers



or embedded in apps

1. IPFS introduction
- 2. structs in IPFS**
3. structs on IPFS

2. structs in IPFS

- Merkle DAGs and **Merkle Links**
- **IPLD**: JSON + Merkle-Links
- **IPRS**: Records
- **Mazieres Links** for Good
- **IPNS**: Key Addressing
- **DNS** and other Human Friendly Names
- Git Versioning with **Commits**
- **unixfs**: representing POSIX files



2. structs in IPFS

- Merkle DAGs and **Merkle Links**
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a web of merkle-links



A CERTIFIED DIGITAL SIGNATURE

Ralph C. Merkle

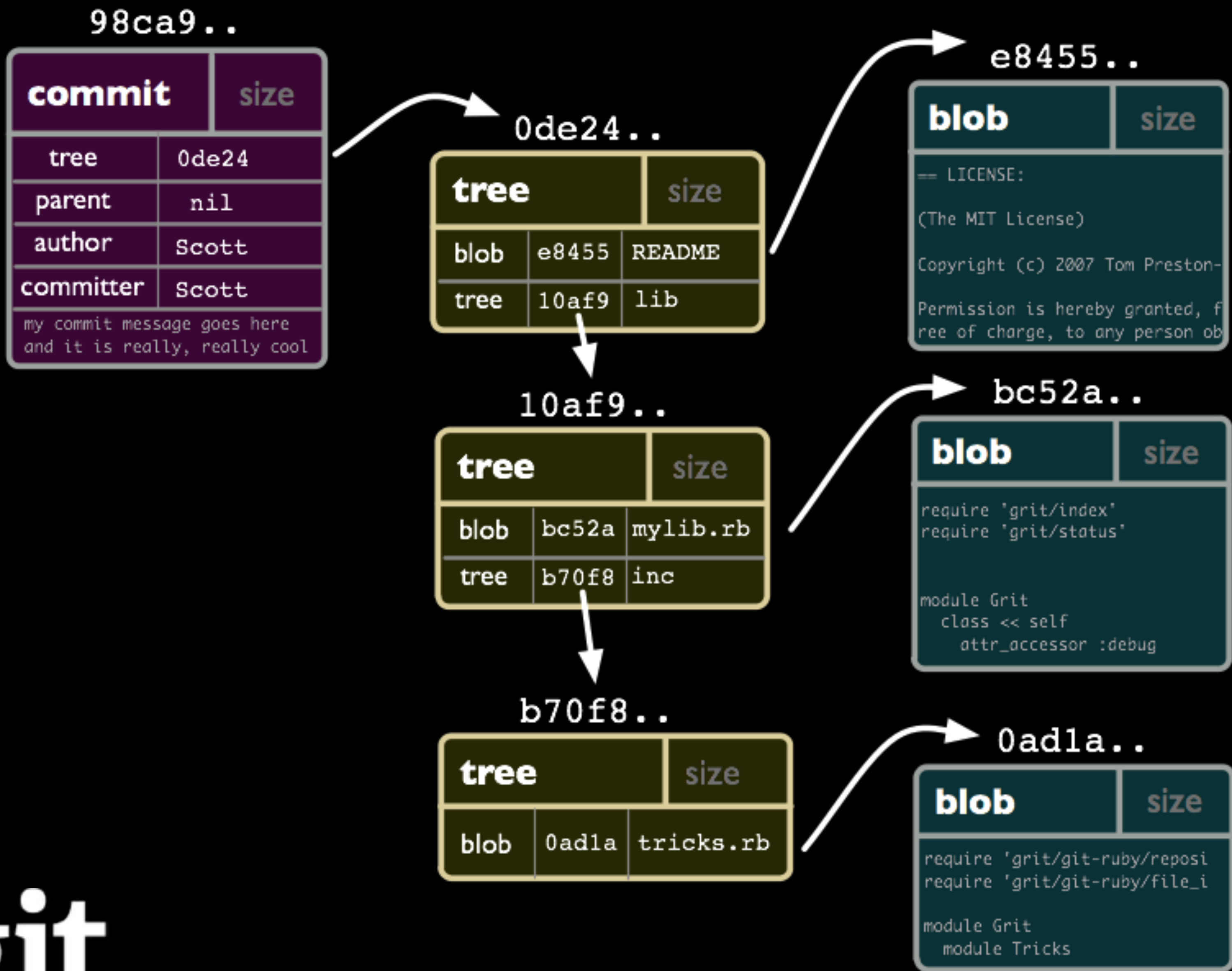
BNR Inc.,

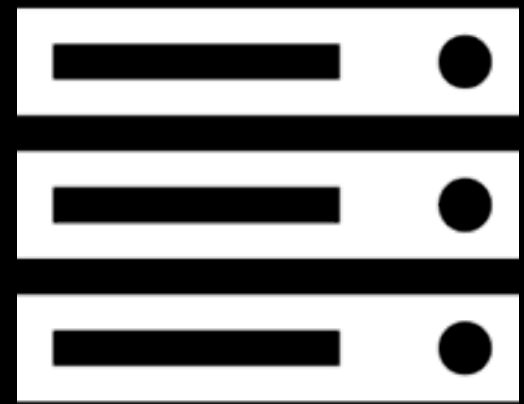
Palo Alto, Ca.

94304

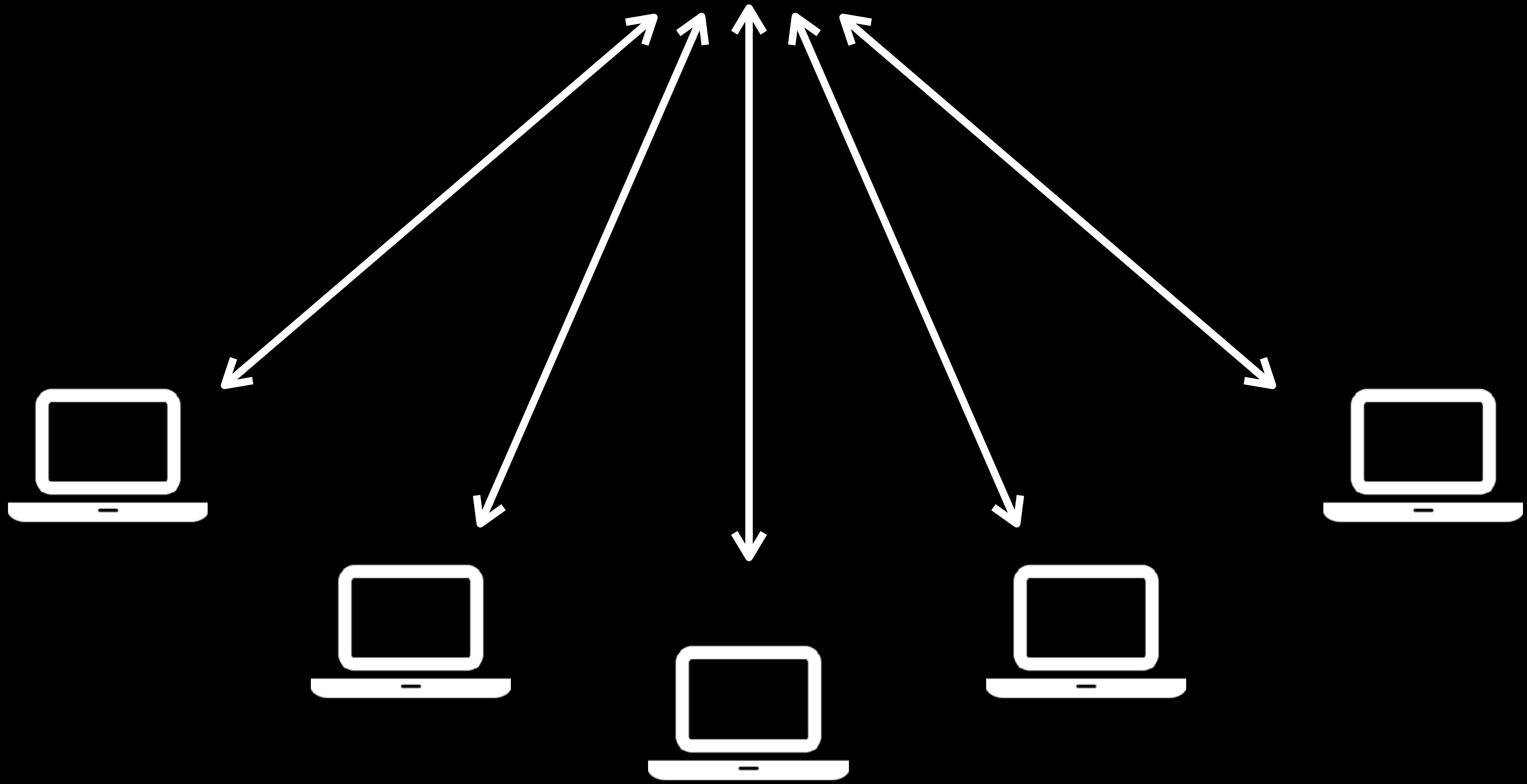
Abstract

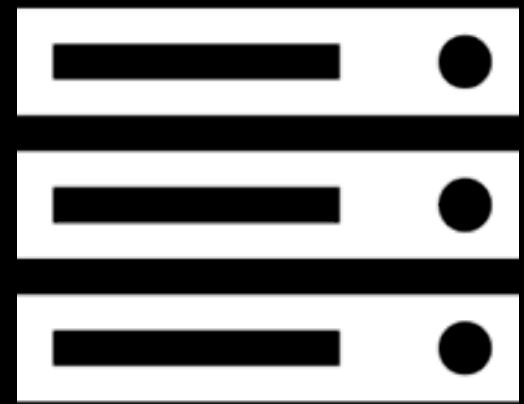
A practical digital signature system based on a conventional encryption function which is as secure as the conventional encryption function is described. Since certified conventional systems are available it can be implemented quickly, without the several years delay required for certification of an untested system.



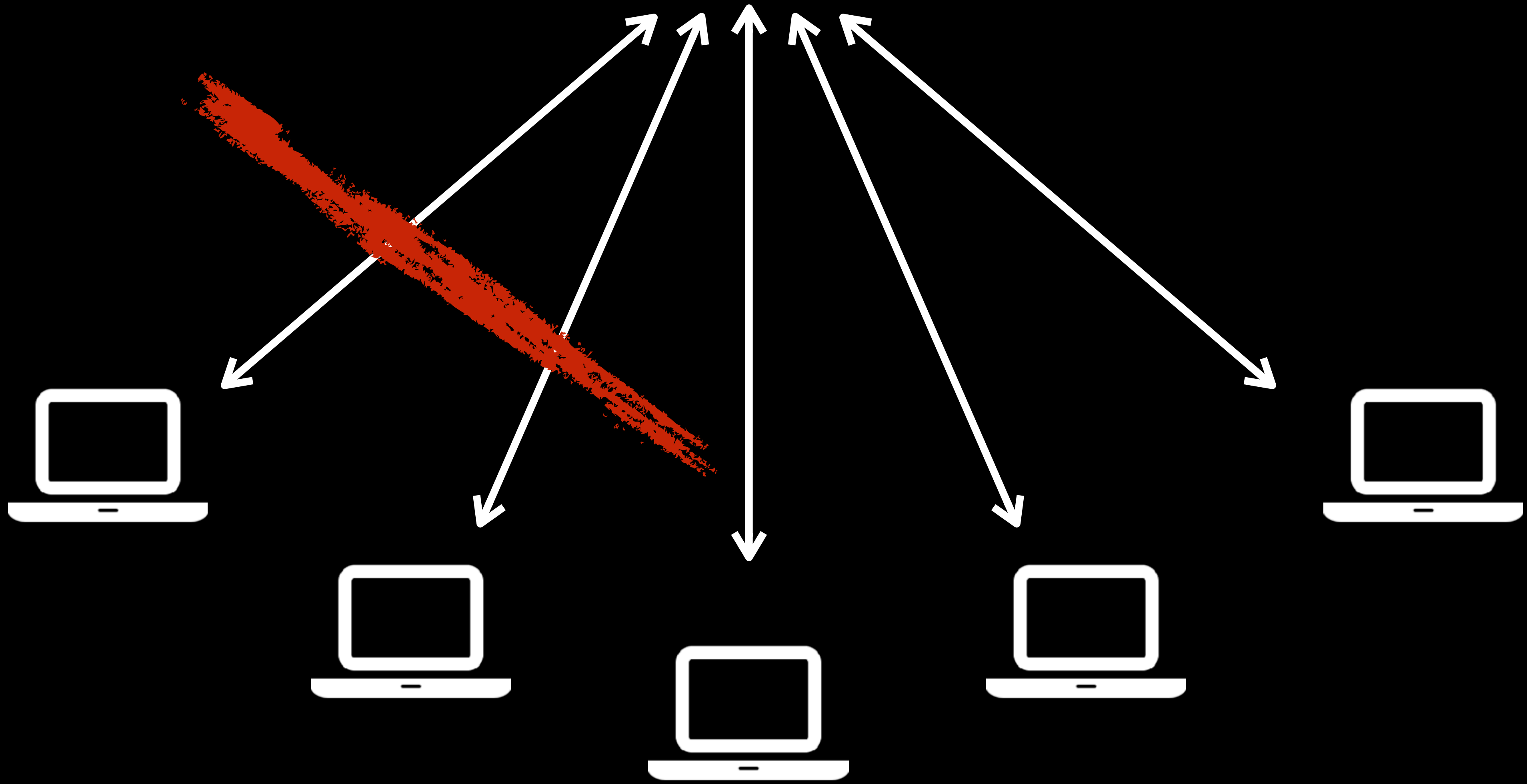


CVS/SVN

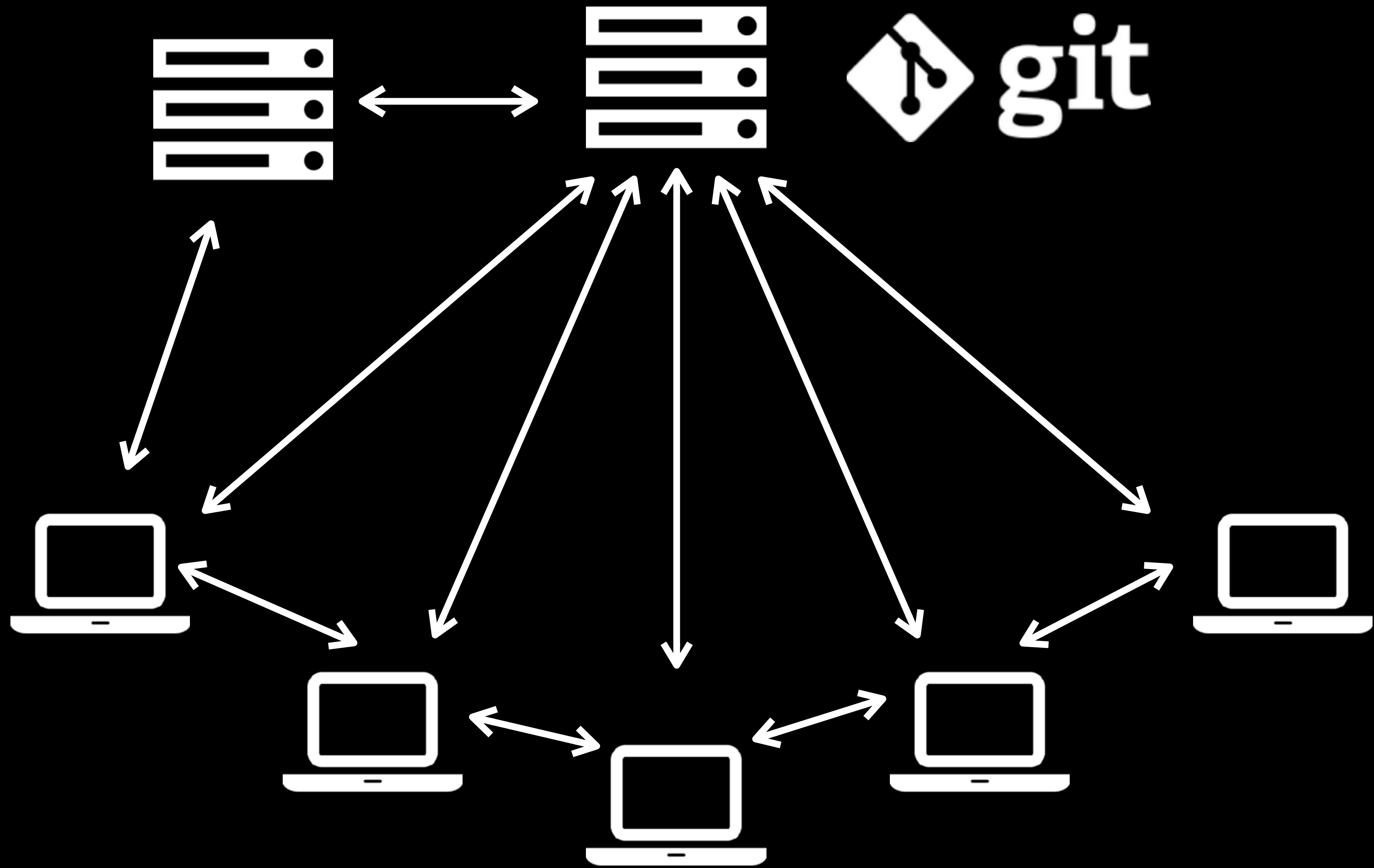


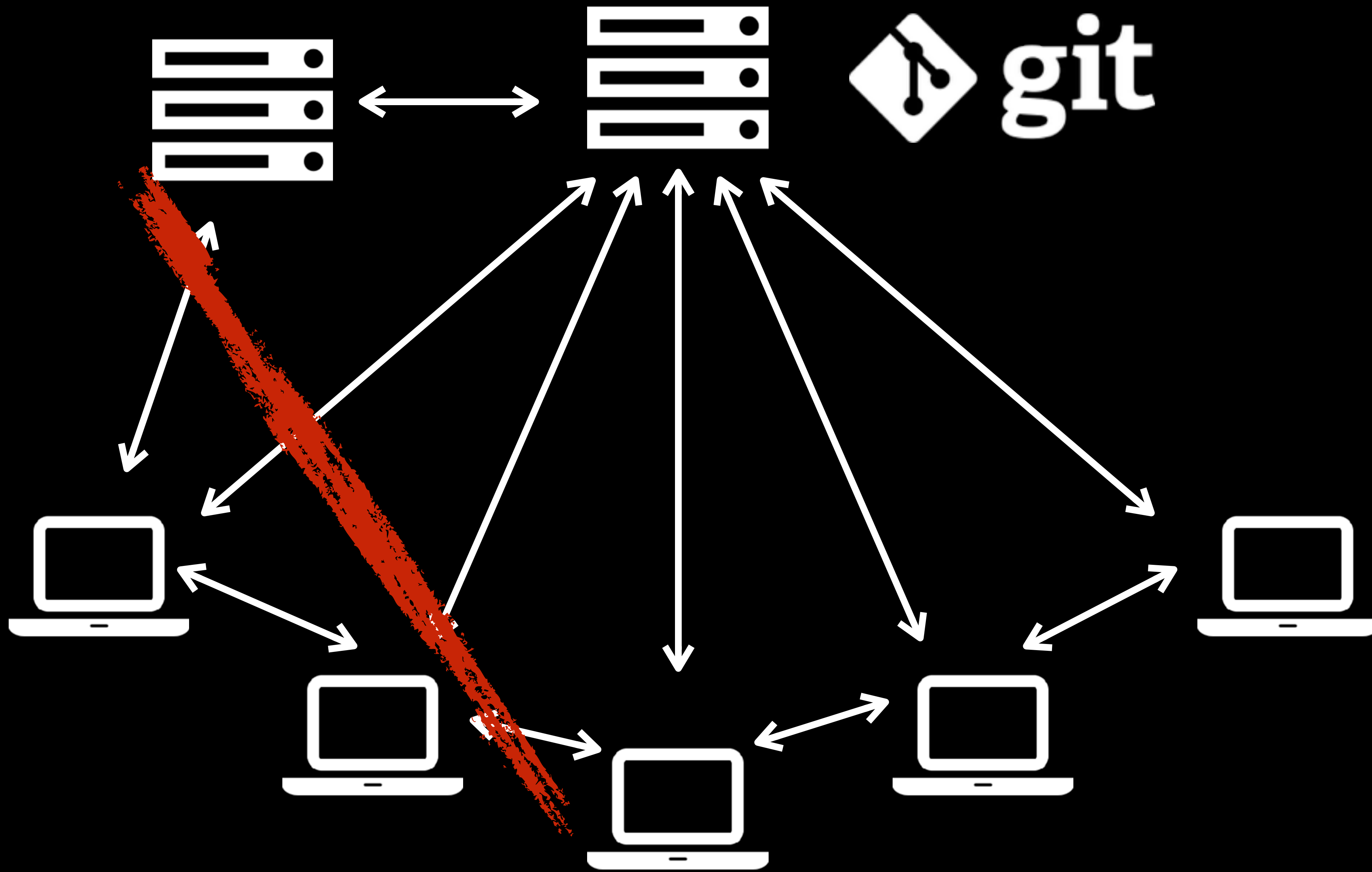


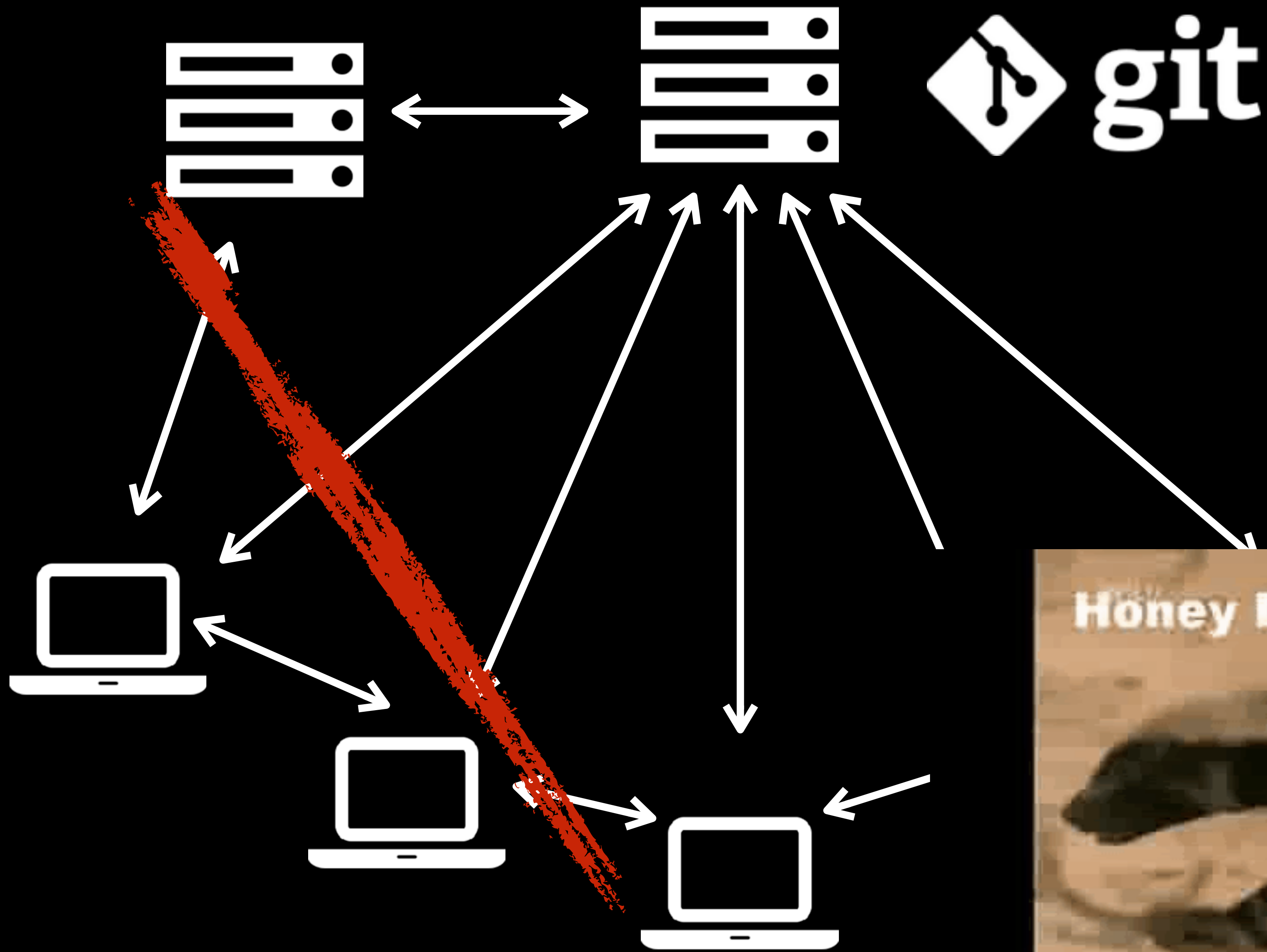
CVS/SVN

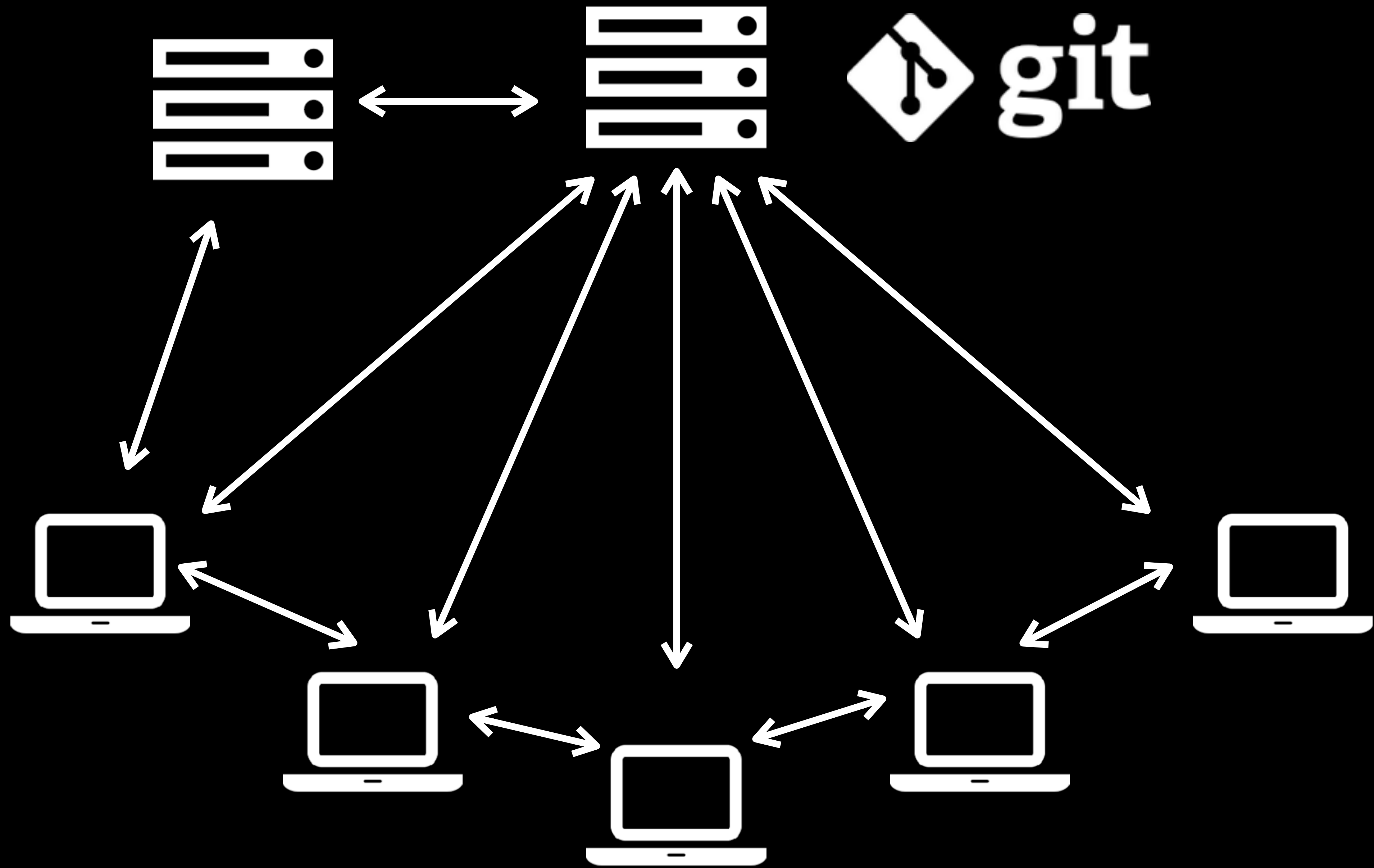


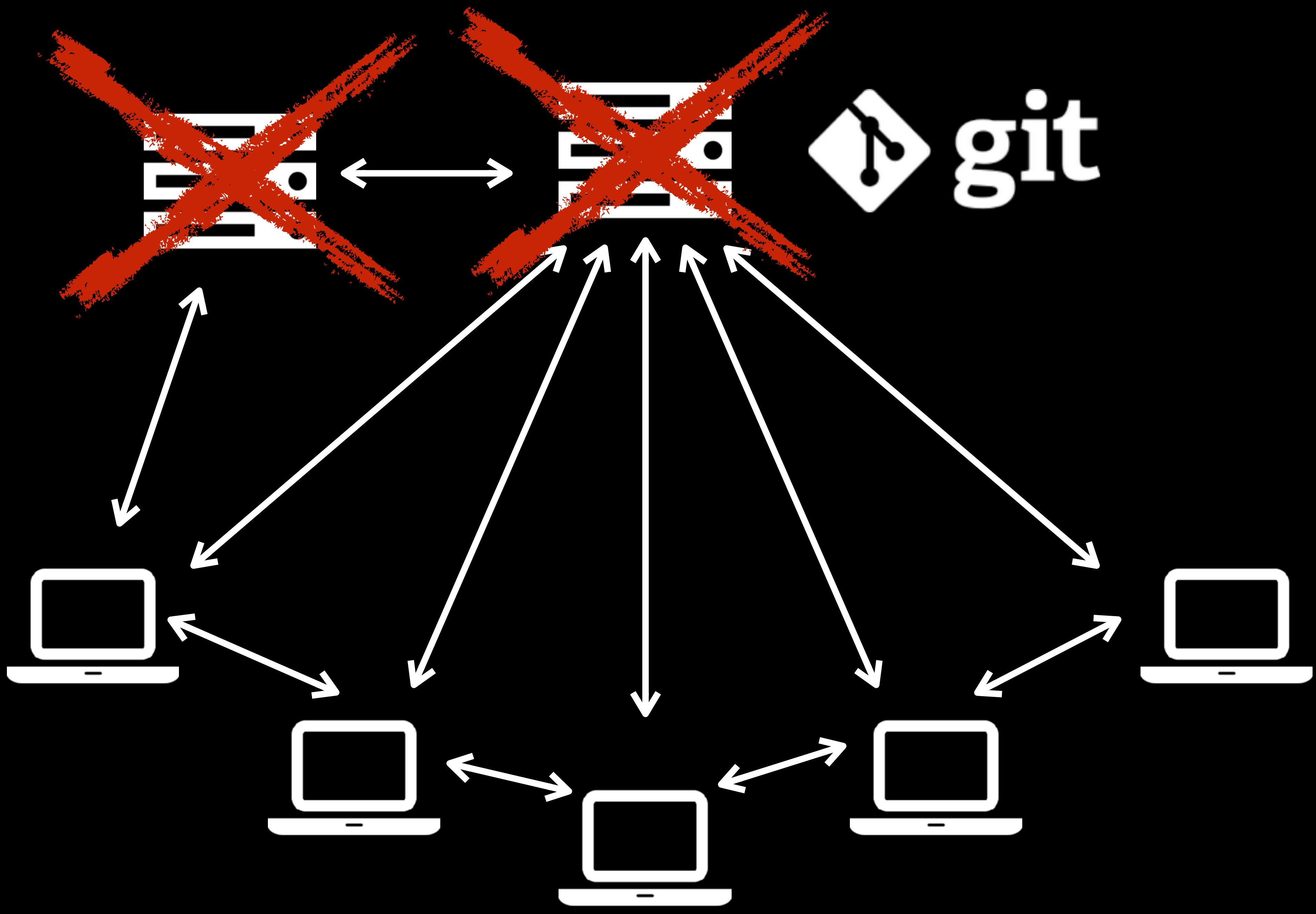




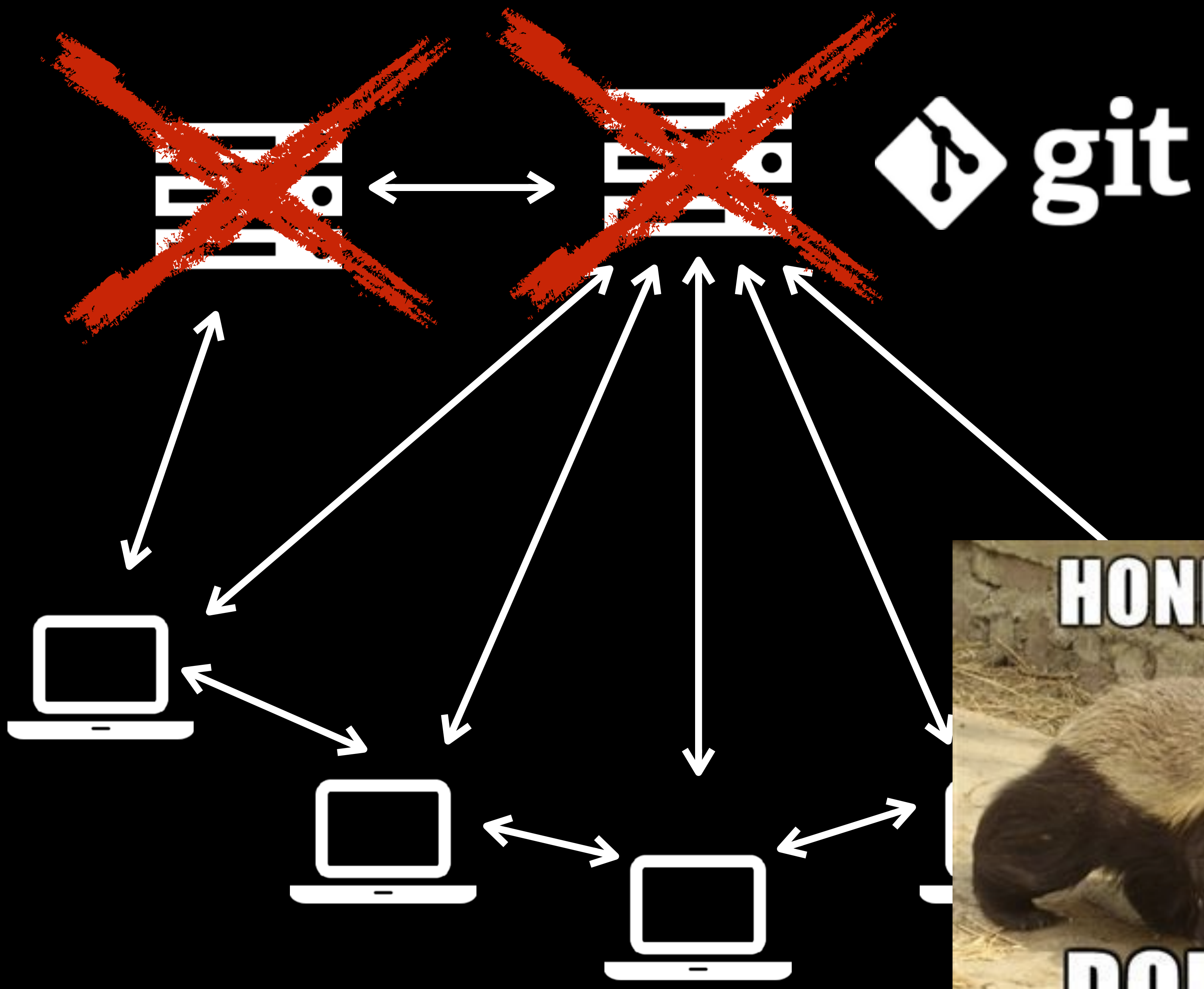


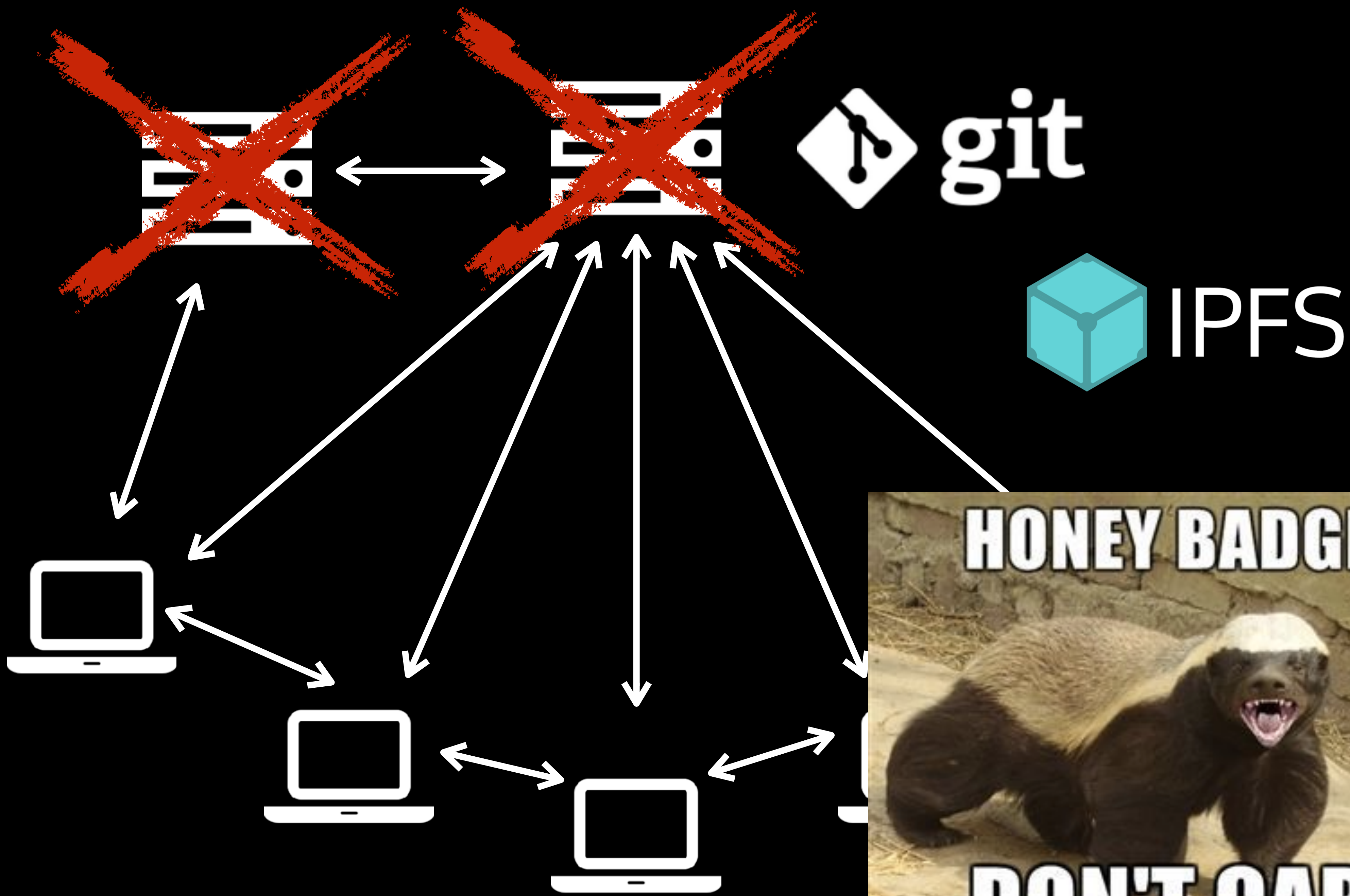






git



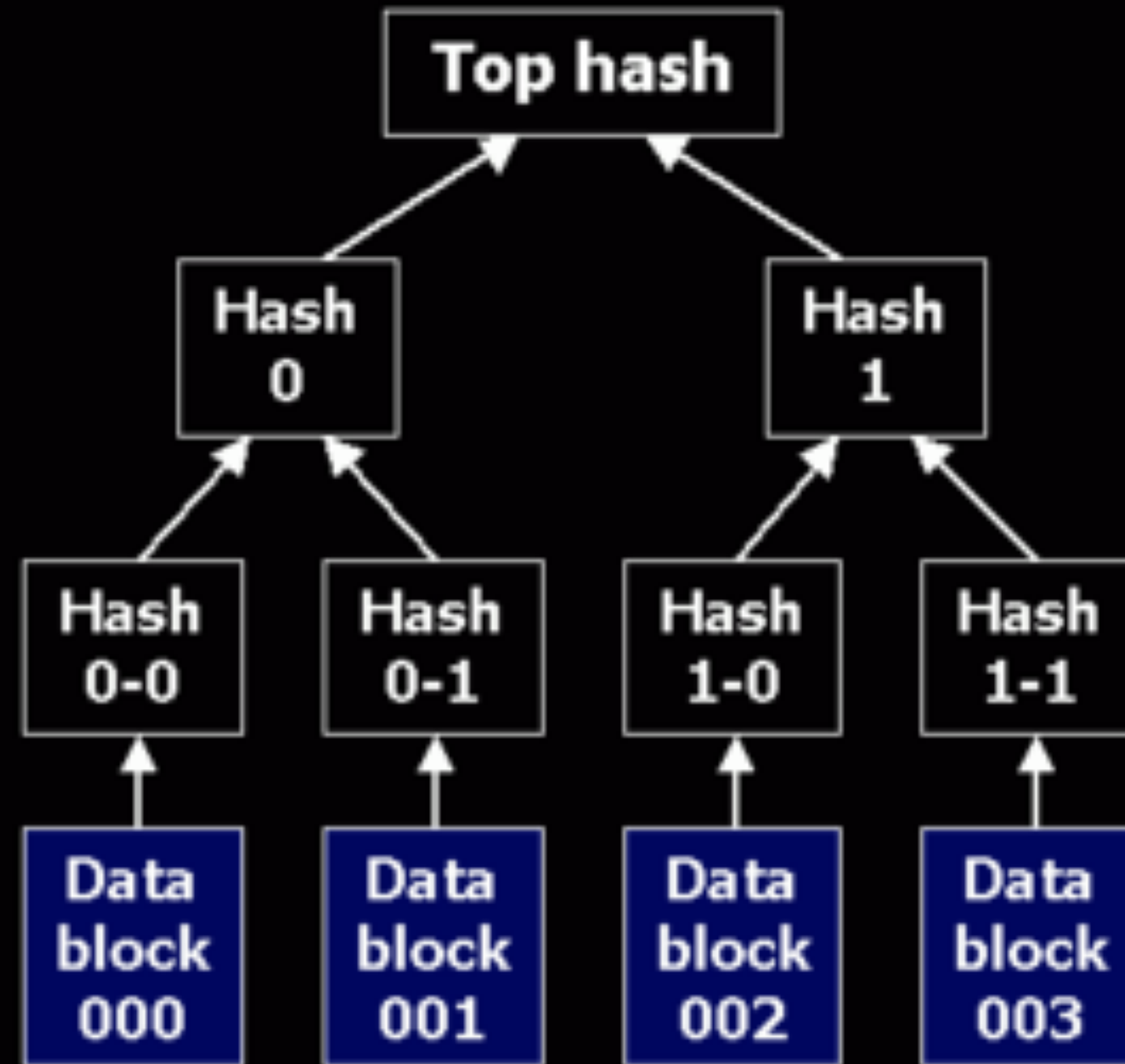


 git

 IPFS

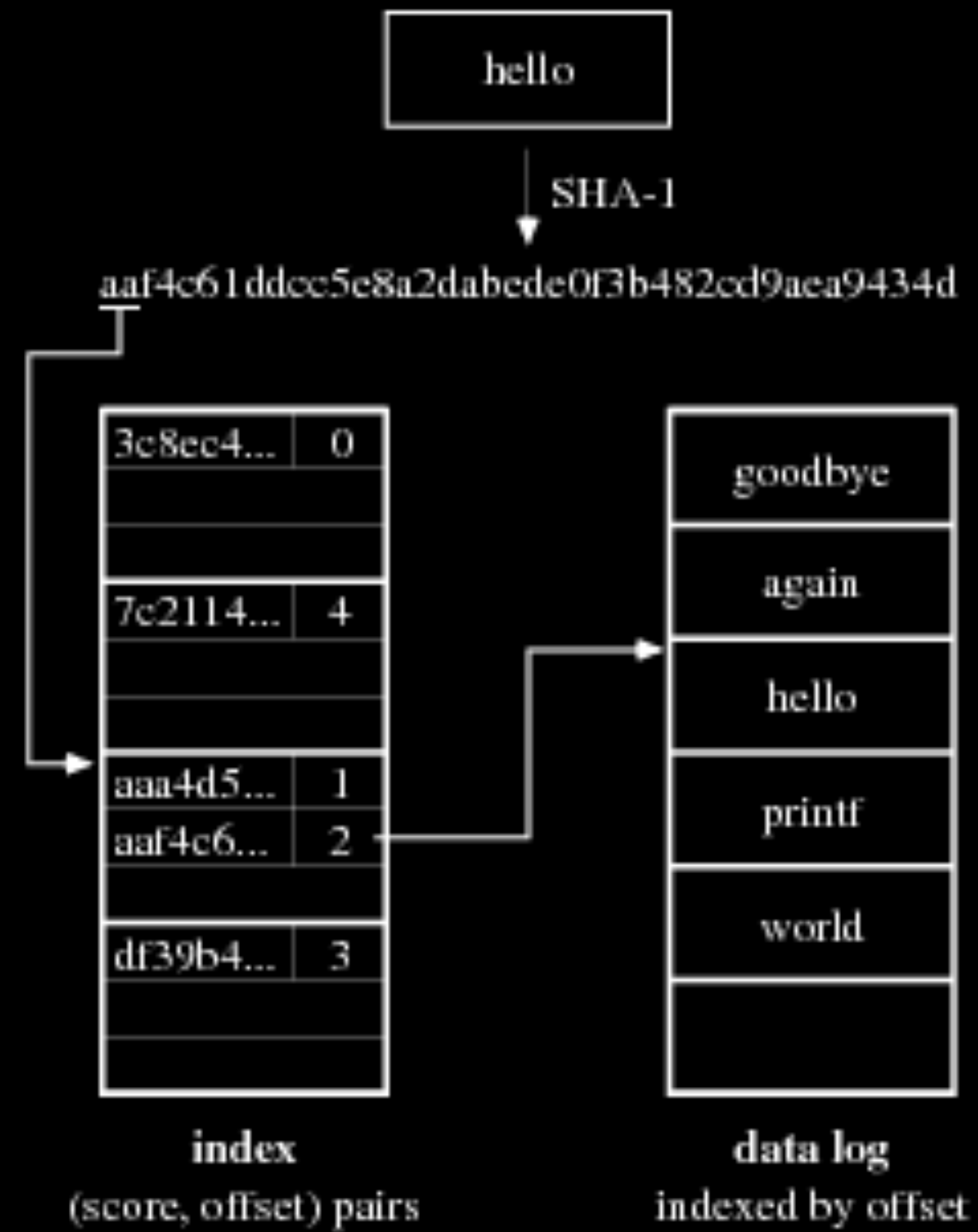






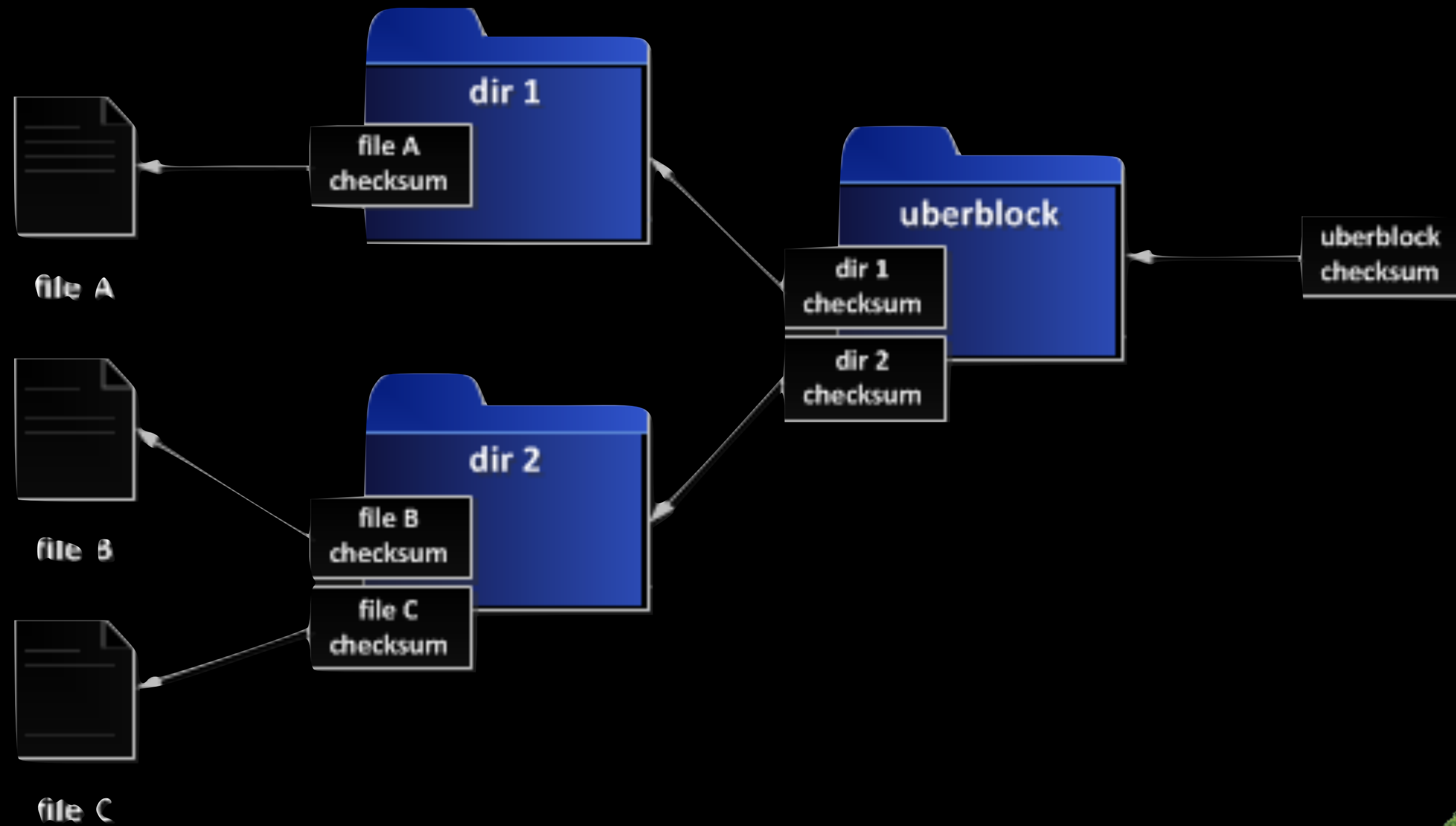
merkle tree



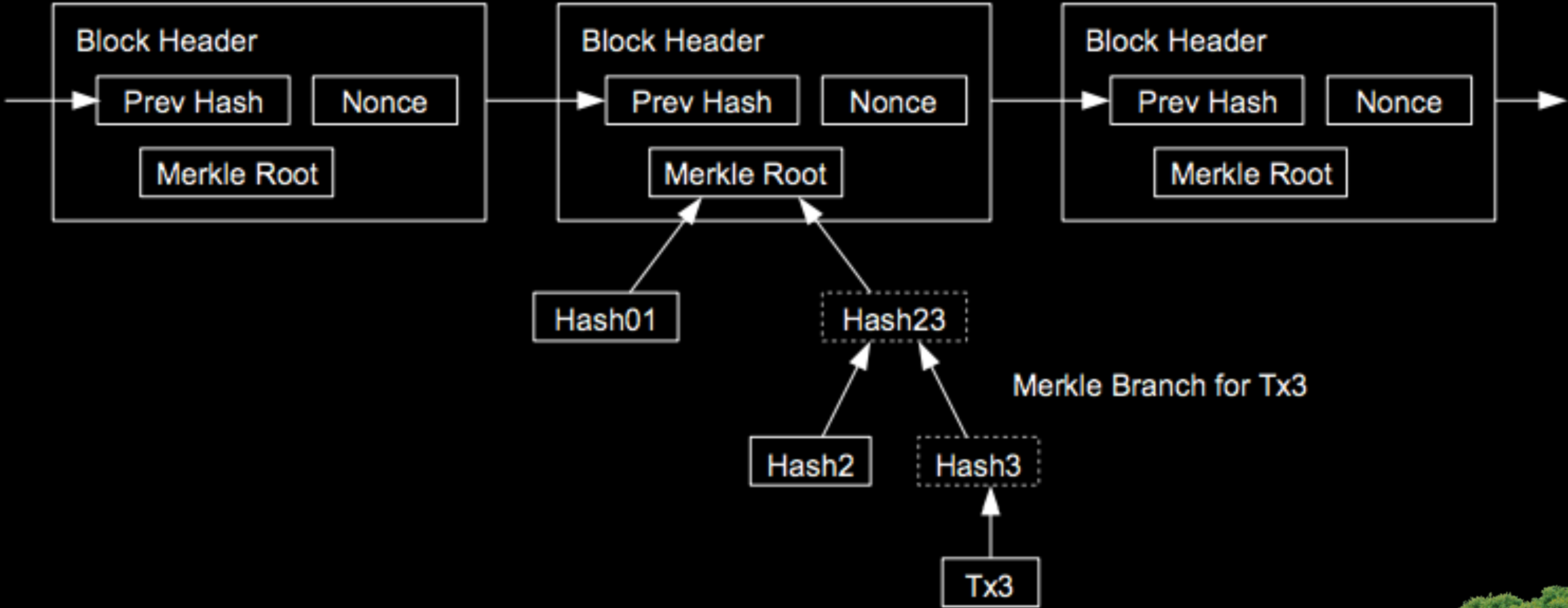


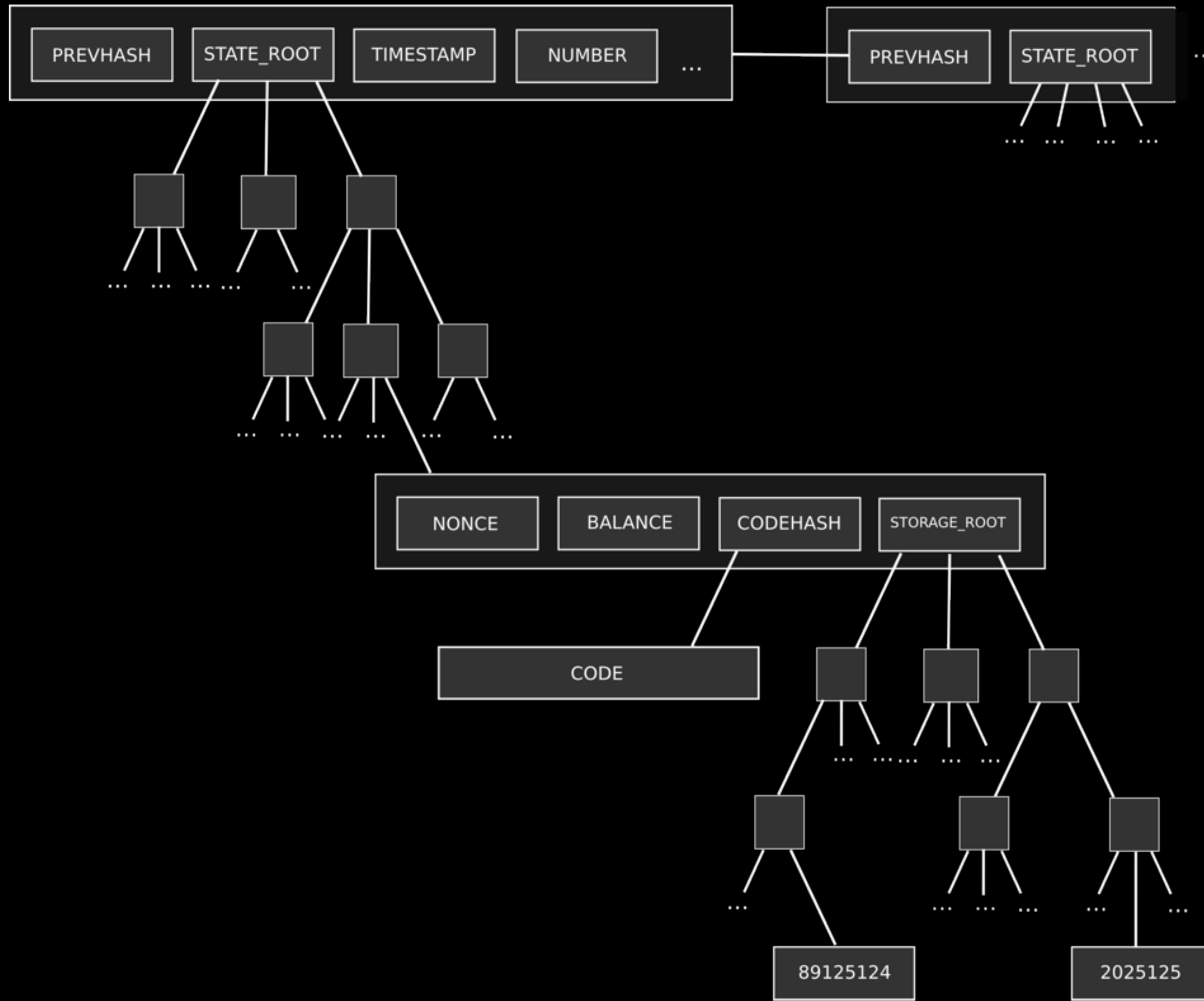
plan9: fossil + venti





Longest Proof-of-Work Chain







IPFS



a web of merkle-links



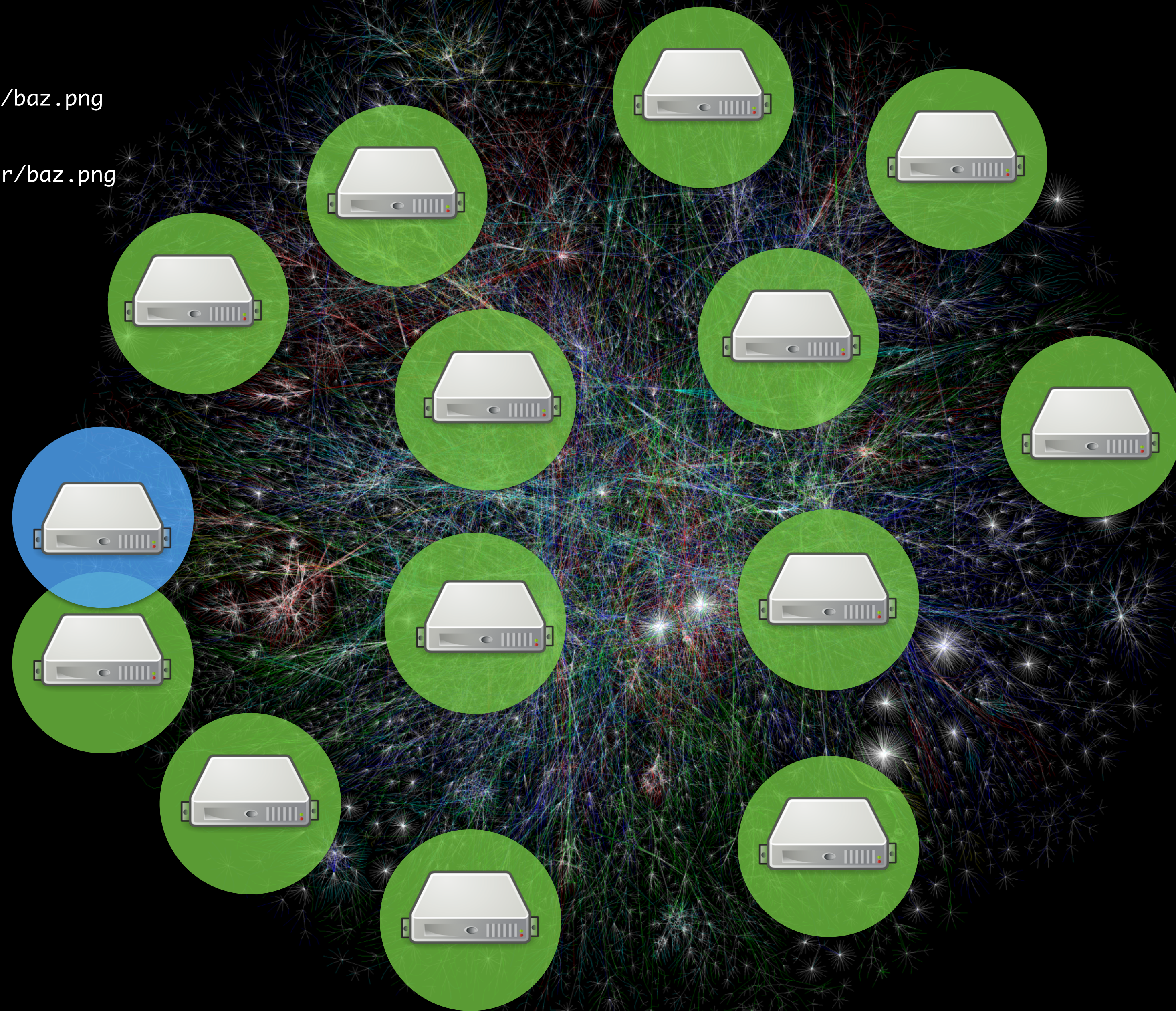
<http://10.20.30.40/foo/bar/baz.png>

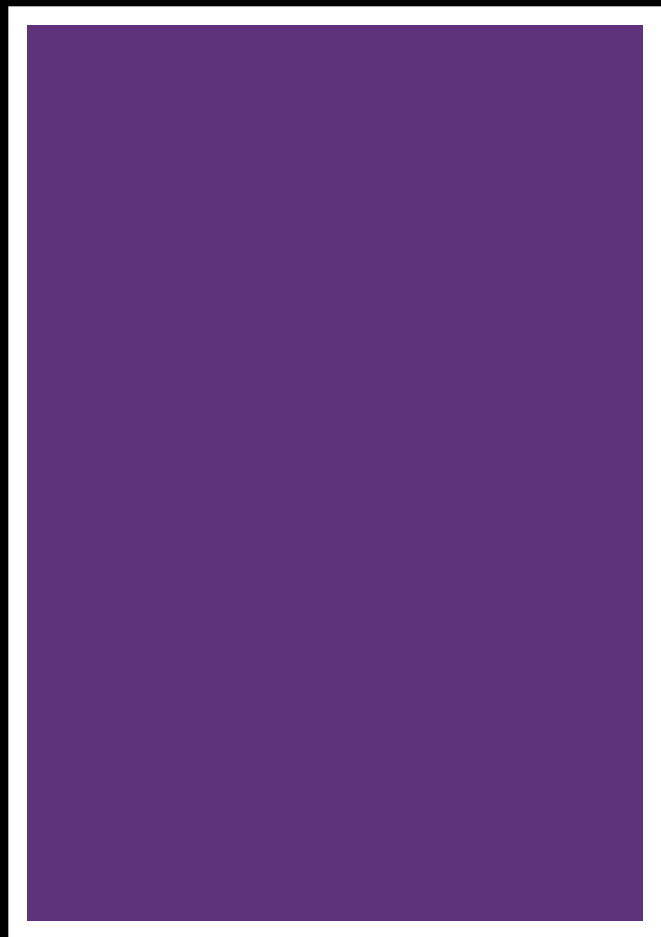
[/ipfs/QmW98pJrc6FZ6/foo/bar/baz.png](http://ipfs/QmW98pJrc6FZ6/foo/bar/baz.png)

you

10.20.30.40

IPFS





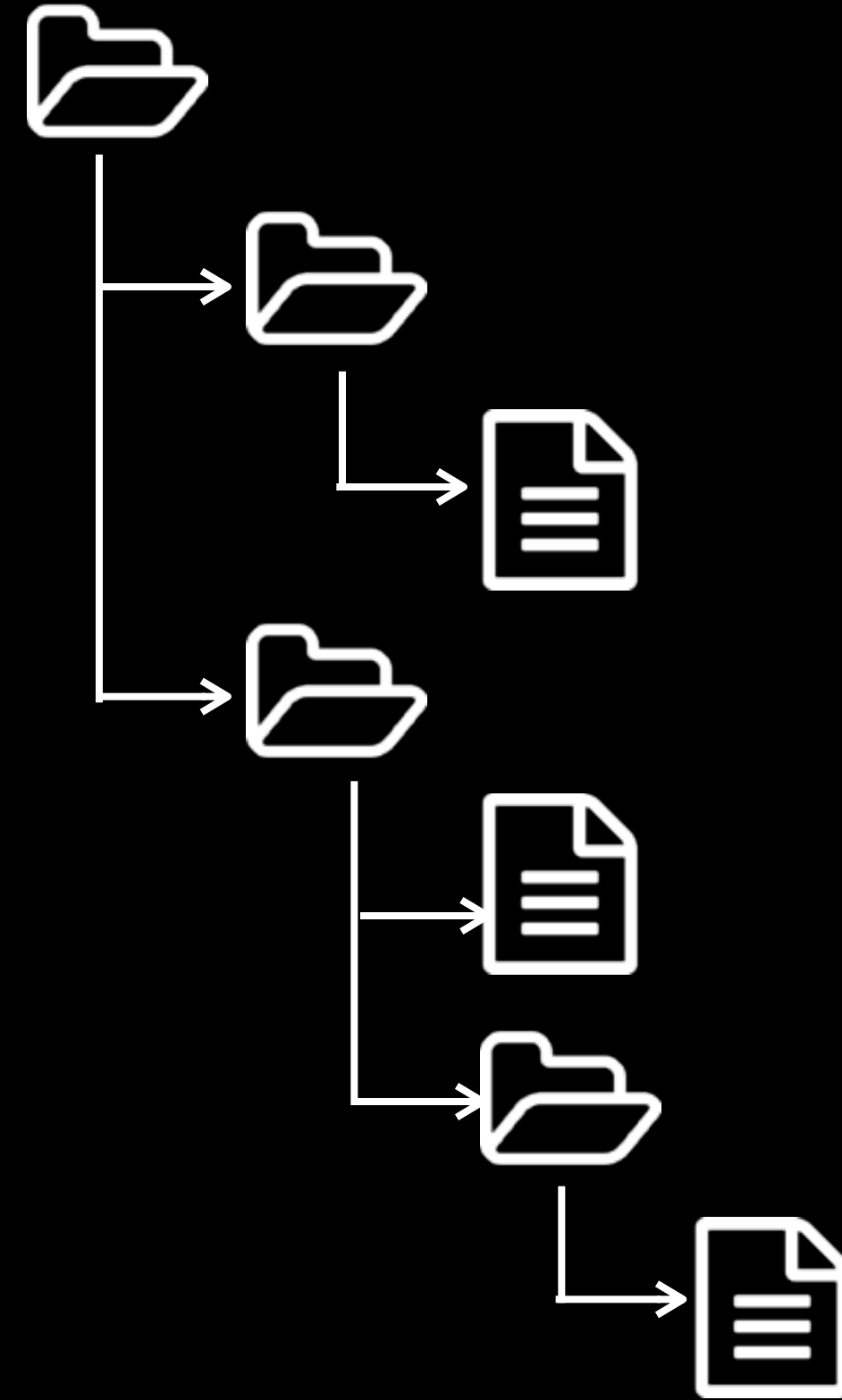
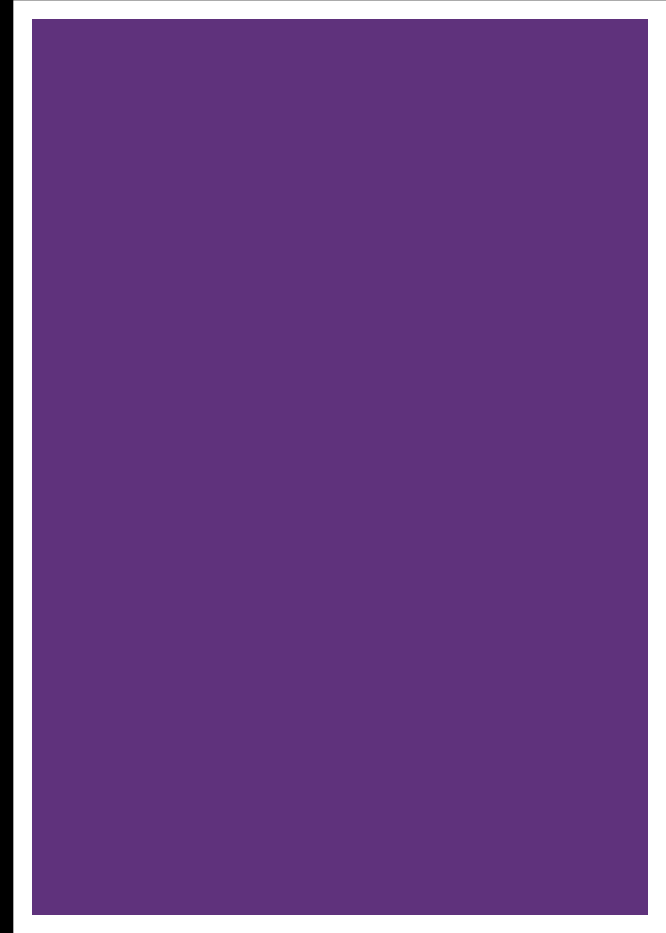
/ipns/example.com/foo/bar/baz.png



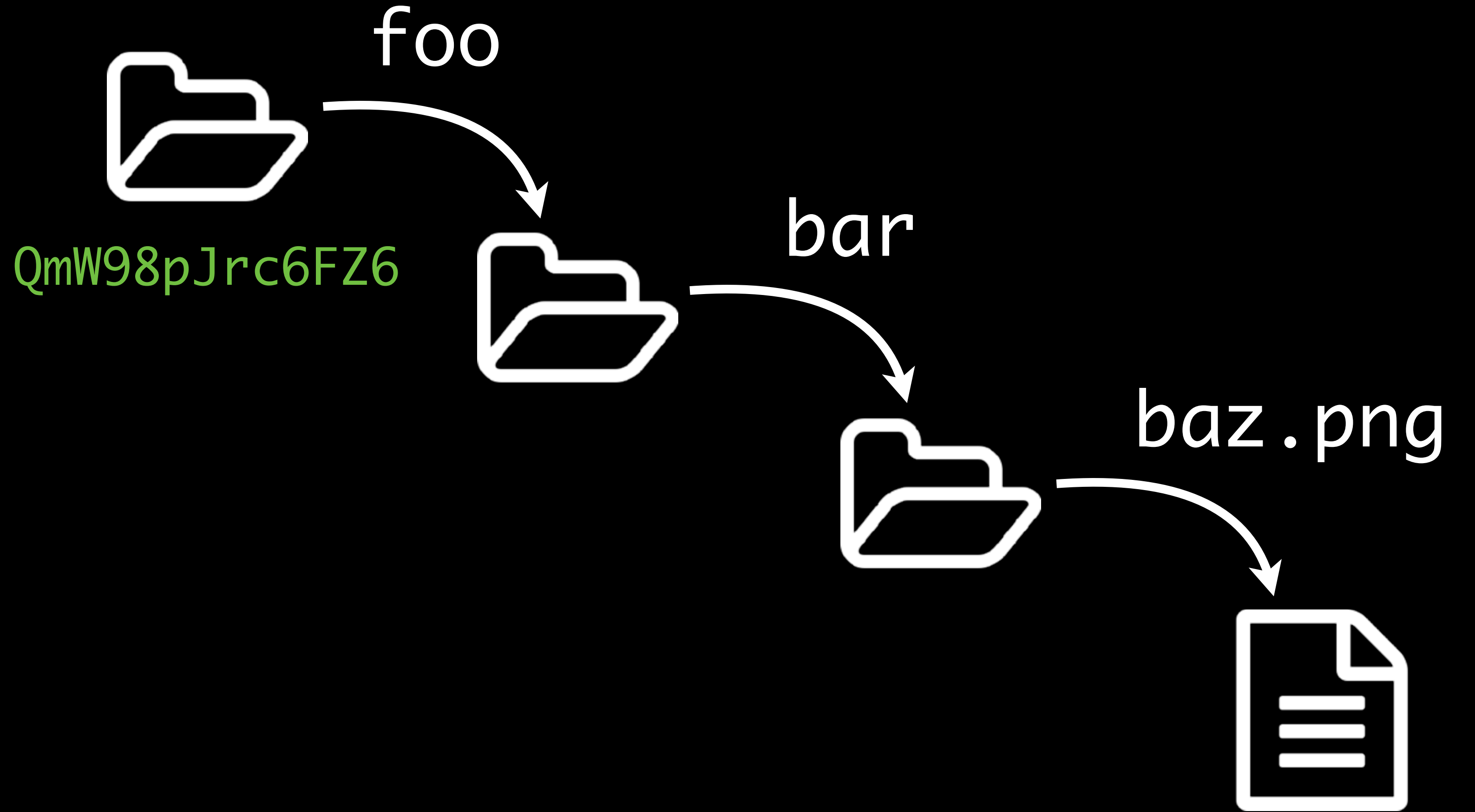
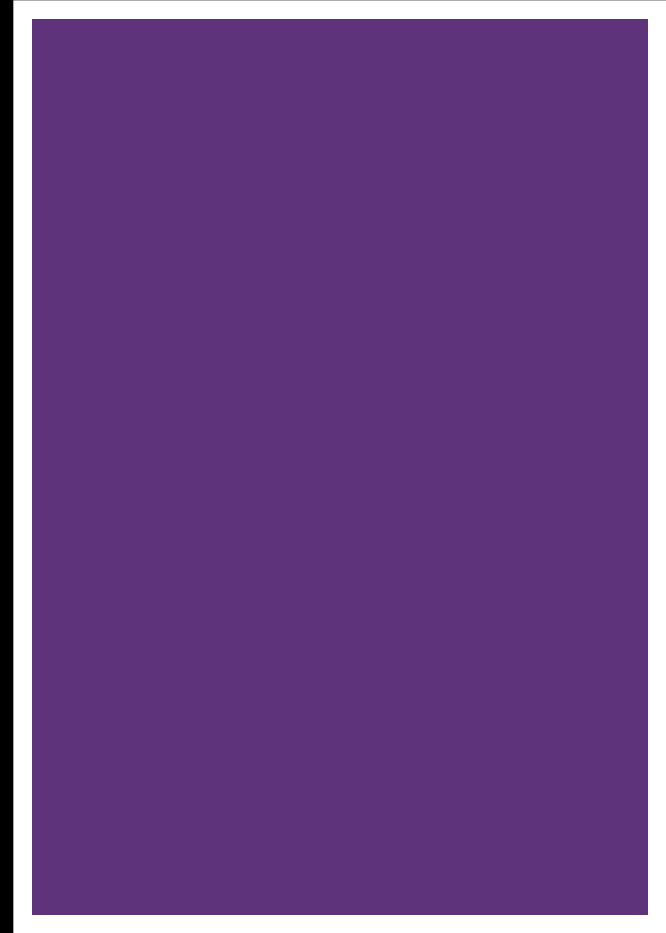
/ipfs/QmW98pJrc6FZ6/foo/bar/baz.png

content

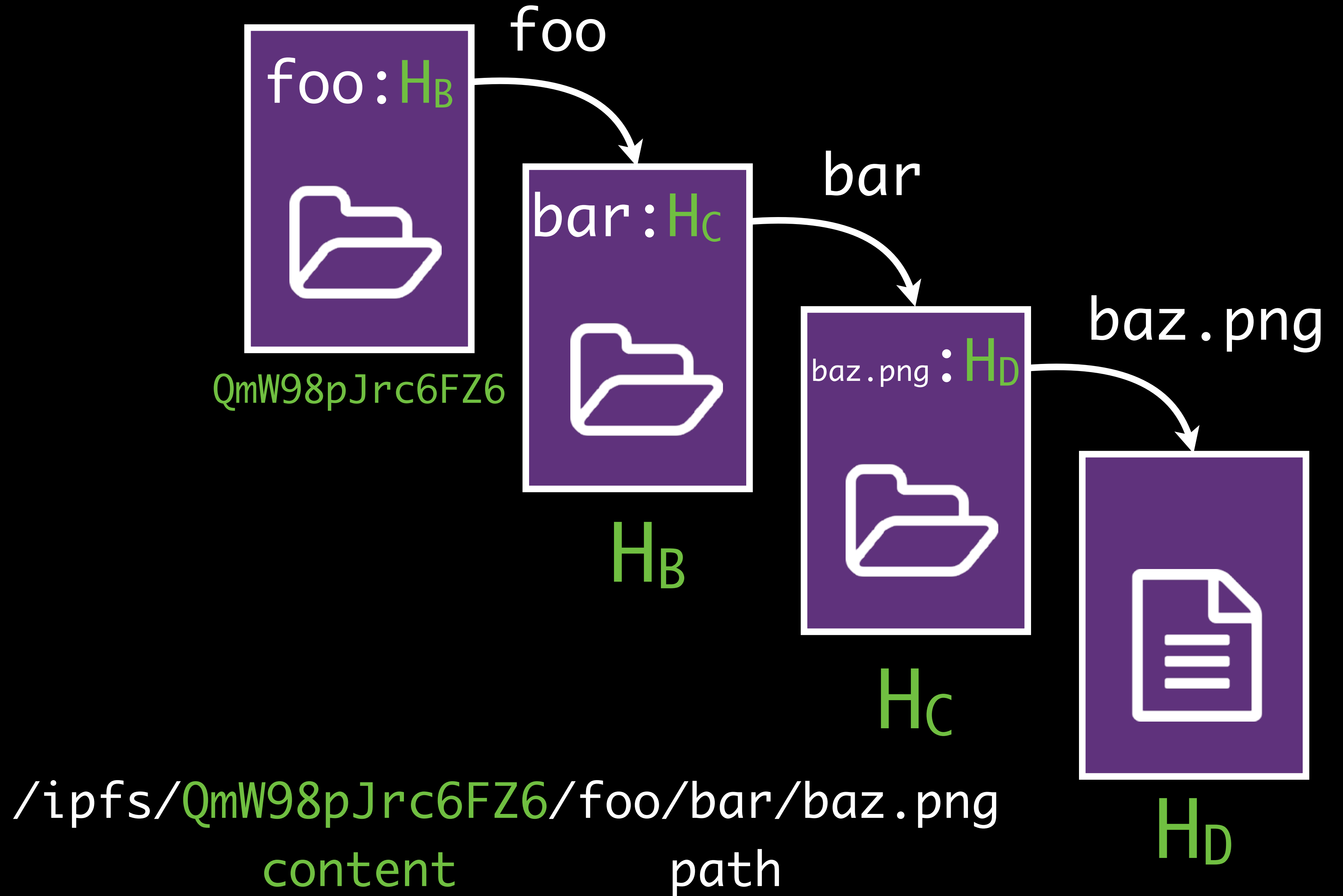
path

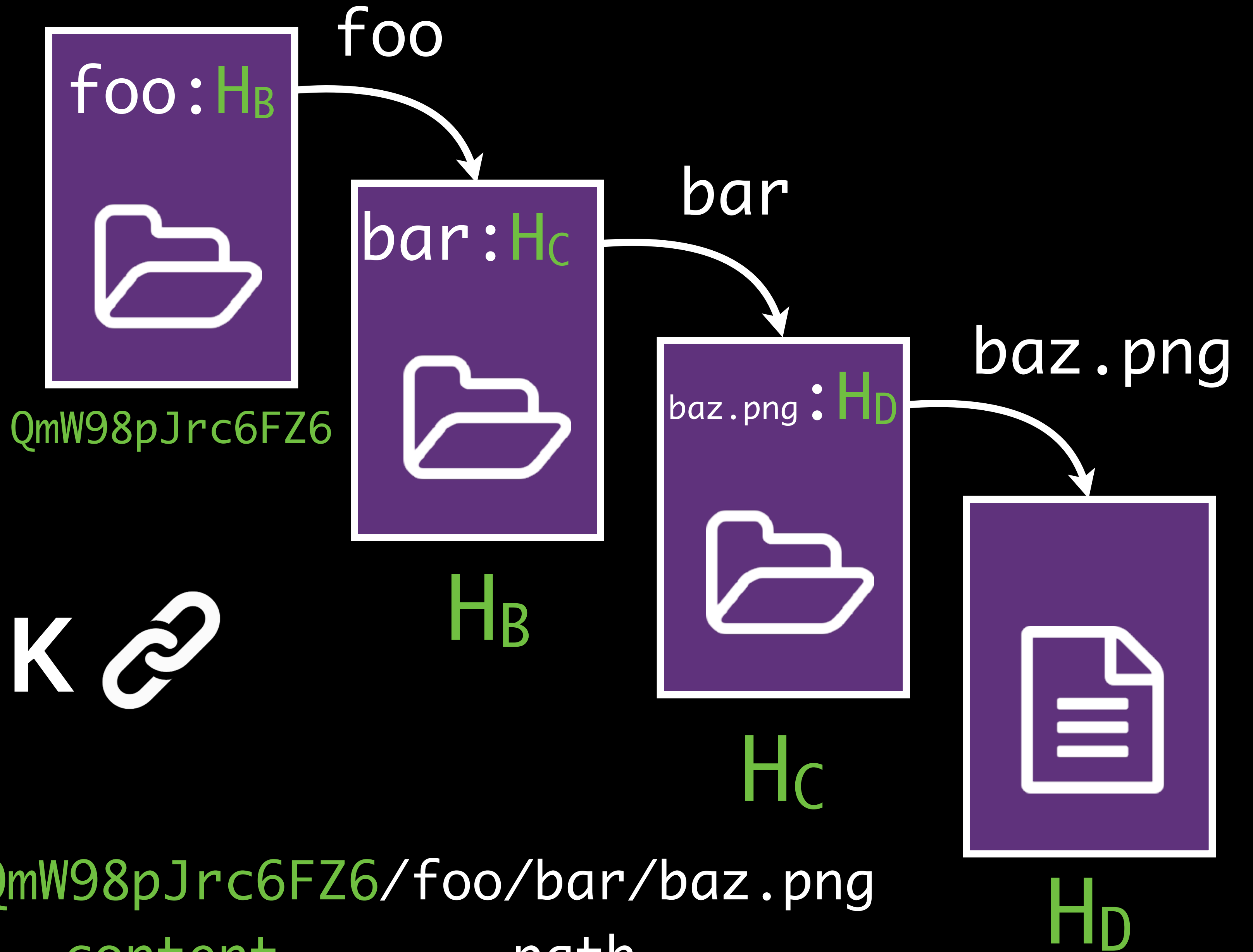


`/ipfs/QmW98pJrc6FZ6/foo/bar/baz.png`
content path



`/ipfs/QmW98pJrc6FZ6/foo/bar/baz.png`
content path





MERKLE LINK

`/ipfs/QmW98pJrc6FZ6/foo/bar/baz.png`
content path

MERKLE LINK 

“URI”

immutable

content addr

`/ipfs/QmW98pJrc6FZ6/foo/bar/baz.png`

MERKLE LINK

“URI”

immutable

```
content addr    /ipfs/QmW98pJrc6FZ6/foo/bar/baz.png  
fs:/ipfs/QmW98pJrc6FZ6/foo/bar/baz.png  
ipfs:/ipfs/QmW98pJrc6FZ6/foo/bar/baz.png
```

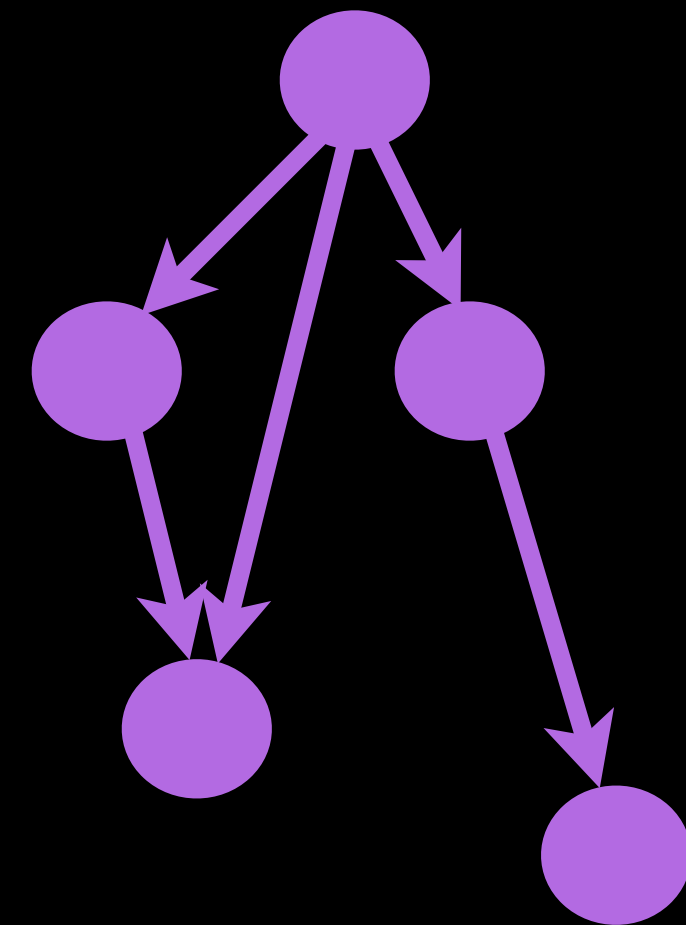
2. structs in IPFS

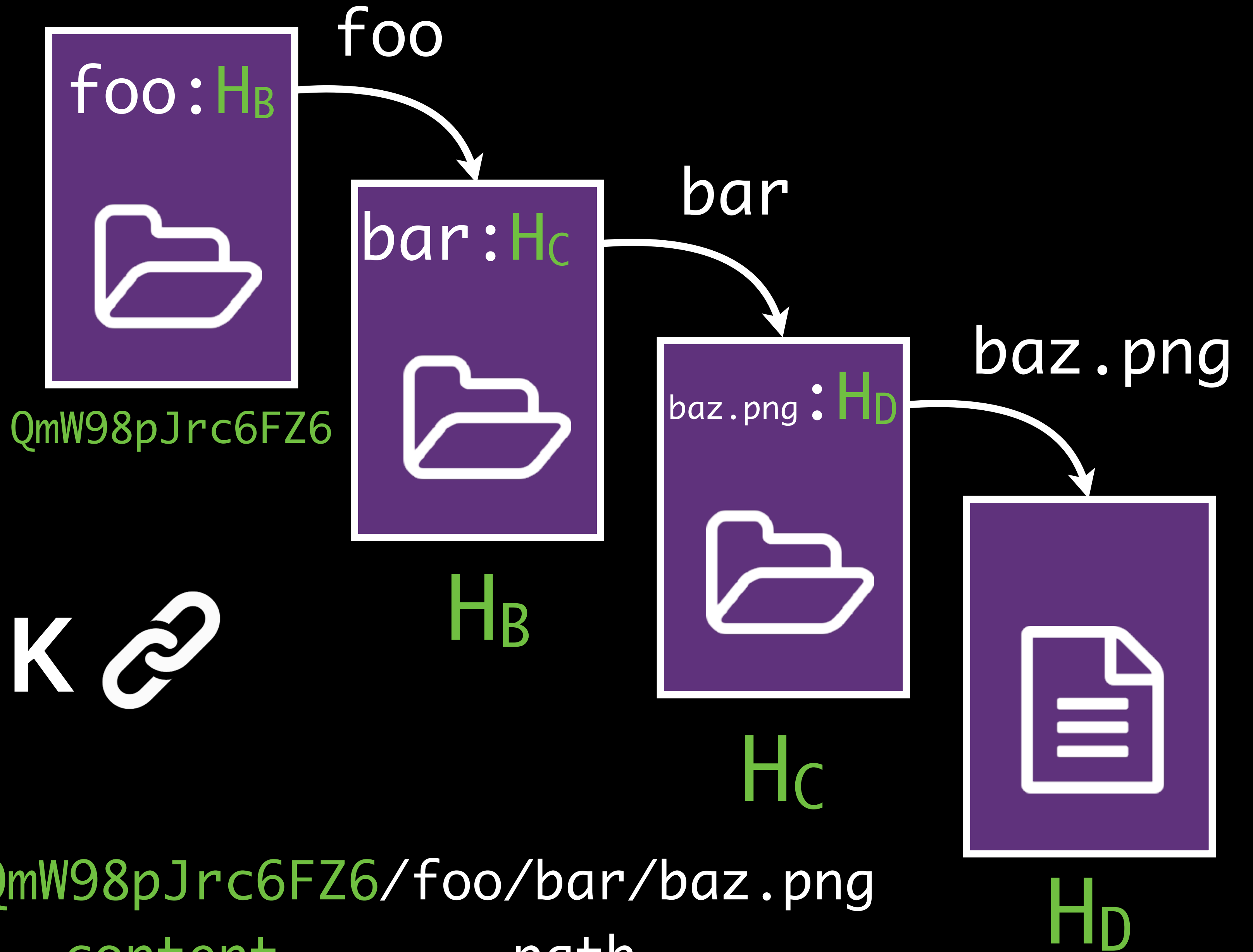
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IPLD

a common hash-chain format
for distributed data structures



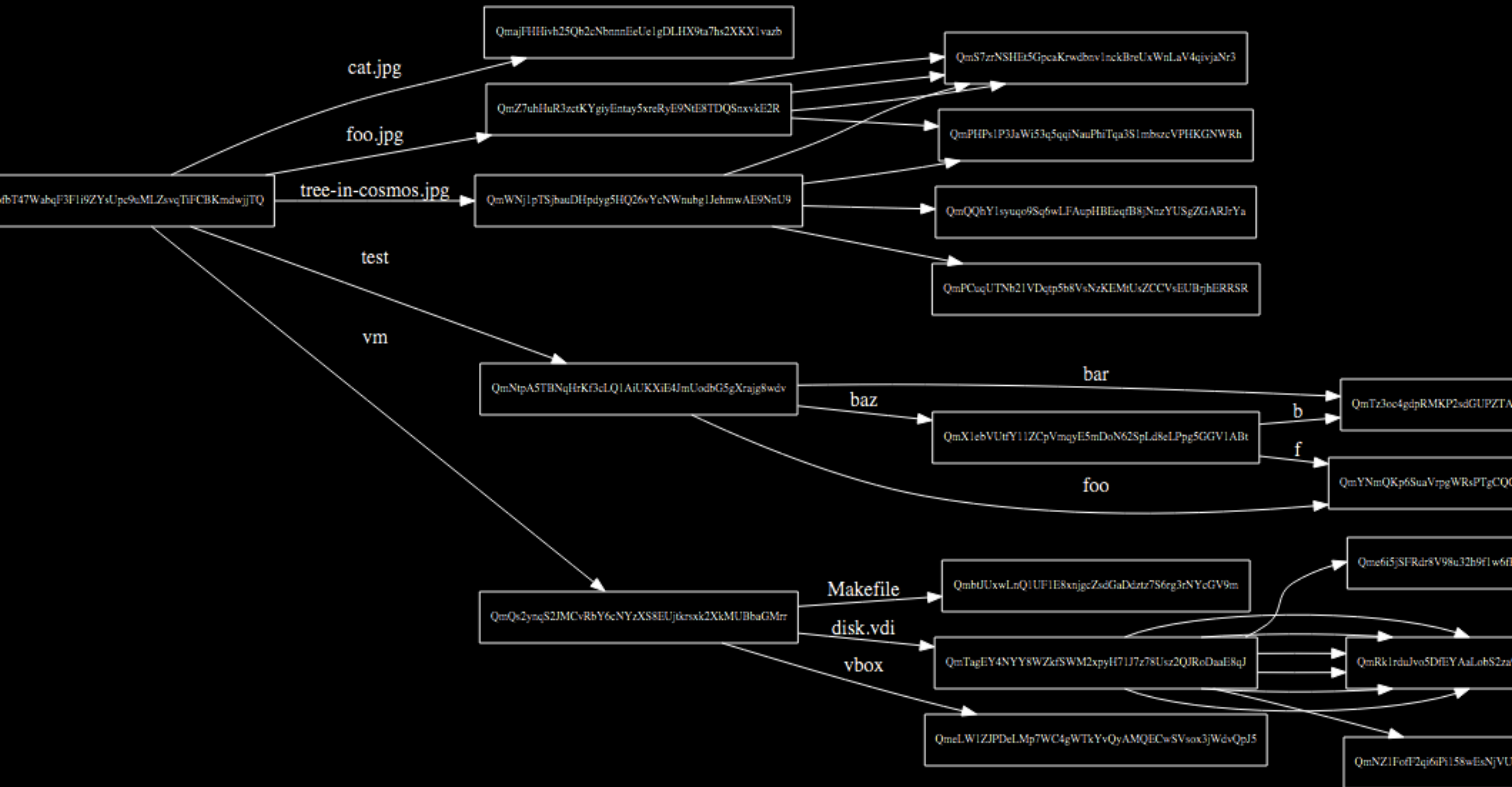


MERKLE LINK

`/ipfs/QmW98pJrc6FZ6/foo/bar/baz.png`
content path



```
jbenet @ earth : ~ > ipfs add -r ~/demo/basic
added QmajFHHivh25Qb2cNbnnnEeUe1gDLHX9ta7hs2XKX1vazb basic/cat.jpg
added QmZ7uhHuR3zctKYgiyEntay5xreRyE9NtE8TDQSnxvke2R basic/foo.jpg
added QmTz3oc4gdpRMKP2sdGUPZTAGRngqjsi99BPoztyP53JMM basic/test/bar
added QmTz3oc4gdpRMKP2sdGUPZTAGRngqjsi99BPoztyP53JMM basic/test/baz/b
added QmYNmQKp6SuaVrpgWRsPTgCQCnpXUYGq76YEKbXuj2N4H6 basic/test/baz/f
added QmX1ebVUtFY11ZCpVmQyE5mDoN62SpLd8eLPpg5GGV1ABt basic/test/baz
added QmYNmQKp6SuaVrpgWRsPTgCQCnpXUYGq76YEKbXuj2N4H6 basic/test/foo
added QmNtpA5TBNqHrKf3cLQ1AiUKXiE4JmUodbG5gXrajg8wdv basic/test
added QmWNj1pTSjbauDHPdyg5HQ26vYcNWnubg1JehmwAE9NnU9 basic/tree-in-cosmos.jpg
added QmbtJUxwLnQ1UF1E8xnjgcZsdGaDdztz7S6rg3rNYcGV9m basic/vm/Makefile
added QmTagEY4NYY8WZkfSWM2xpyH71J7z78Uusz2QJRoDaaE8qJ basic/vm/disk.vdi
added QmeLW1ZJPDeLmp7WC4gWTkYvQyAMQECwSVsox3jWdvQpJ5 basic/vm/vbox
added QmbtJUxwLnQ1UF1E8xnjgcZsdGaDdztz7S6rg3rNYcGV9m basic/vm/vm/Makefile
added QmRXgisKJmSSii3UUTn9QqvhKoAAcyt7CqNbFFSpGamB9k basic/vm/vm/disk.vdi
added QmQjgMyaqqouThuGFkZQNNaJpa7QawR4P2yRv7N1Y2ffsE basic/vm/vm
added QmVu5LxhbDo866EmmFJF8zNNfdXvn35FjavhREHrfxWGuA basic/vm
added QmTToTPSAn4y9KRxueN8zHtNye7cupdFstVP3ChJKizpJv basic
```





3. jbenet@lorien ~ (zsh)

```
jbenet @ earth : ~ > ipfs object get --enc=json QmTToTPSAn4y9KRxueN8zHtNye7cupdFstVP3ChJ
```

```
{
```

```
  "Links": [
```

```
    {
```

```
      "Name": "cat.jpg",
```

```
      "Hash": "QmajFHHivh25Qb2cNbnnnEeUe1gDLHX9ta7hs2XKX1vazb",
```

```
      "Size": 139795
```

```
    },
```

```
    {
```

```
      "Name": "foo.jpg",
```

```
      "Hash": "QmZ7uhHuR3zctKYgiyEntay5xreRyE9NtE8TDQSnxvkE2R",
```

```
      "Size": 1048832
```

```
    },
```

```
    {
```

```
      "Name": "test",
```

```
      "Hash": "QmNtpA5TBNqHrKf3cLQ1AiUKXiE4JmUodbG5gXrajg8wdv",
```

```
      "Size": 277
```

```
    },
```

```
    {
```

```
      "Name": "tree-in-cosmos.jpg",
```

```
      "Hash": "QmWU11T6il...FUQ2G...NW...17...AFON...UQ"
```




```
jbenet @ earth : ~ > ipfs object get --enc=protobuf QmTToTPSAn4y9KRxueN8zHtNye7cupdFstVP
1
" , ,EfZ;^n1r8cat.jpg1
" ,JU>ttX^o)P>LHNfoo.jpg@-
"=DYЯ
      ~_[]test<
" weo^J
      C<H83Ctree-in-cosmos.jpg4-
" pP?ALuzG|Jbvm
```

Branch: ipld-spec specs / merkledag / ipld.md

jbenet link to paths issue 74bc794 22 hours ago

1 contributor

465 lines (362 sloc) | 15.7 KB Raw Blame History

IPLD -- the "thin-waist" merkle dag format.

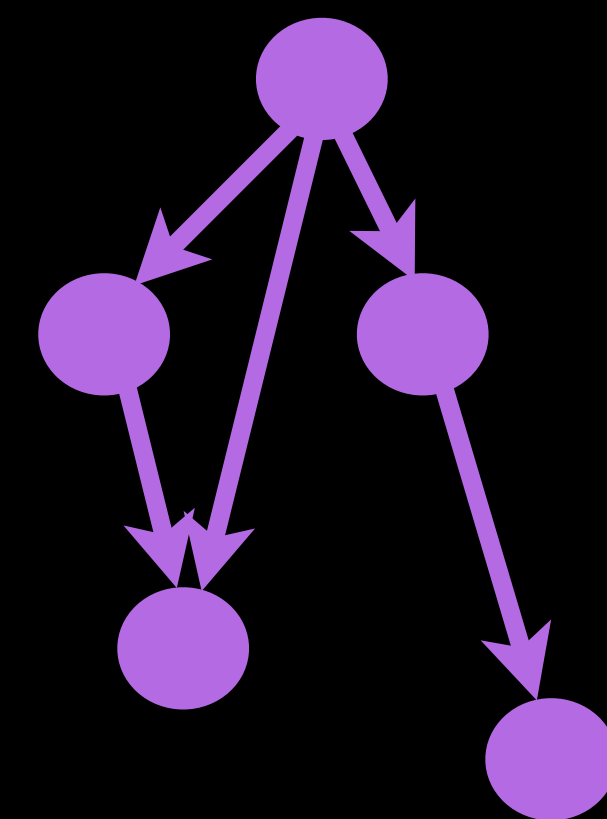
There are a variety of systems that use merkle-tree and hash-chain inspired datastructures (e.g. git, bittorrent, ipfs, tahoe-lafs, sfsro). IPLD defines:

- **merkle-links**: the core unit of a merkle-graph
- **merkle-dag**: any graphs whose edges are *merkle-links*.
- **merkle-paths**: unix-style paths for traversing *merkle-dags* with *_named merkle-links***
- **IPLD Data Model**: a flexible, JSON-based data model for representing merkle-dags.
- **IPLD Serialized Formats**: a set of formats in which IPLD objects can be represented, for example JSON, CBOR, CSON, YAML, Protobuf, XML, RDF, etc.
- **IPLD Canonical Format**: a deterministic description on a serialized format that ensures the same *logical* object is always serialized to *the exact same sequence of bits*. This is critical for merkle-linking, and all cryptographic applications.

In short: JSON documents with named merkle-links that can be traversed.

IPLD

- **merkle-links** secure, immutable
- **merkle-paths** /ipfs/Qmabc...xyz/foo/bar.jpg
- **universal** nestable URIs
- **serialization** JSON, PB, XML, RLP
- **canonical** hashing safe



JSON

```
{  
  "username": "@VannevarBush",  
  "followers": [  
    "@FredTerman",  
    "@ClaudeShannon",  
    "@DougEngelbart",  
    ...  
  ]  
}
```

JSON —> IPLD

```
{  
  "username": "@VannevarBush",  
  "followers": [  
    "@FredTerman",  
    "@ClaudeShannon",  
    "@DougEngelbart",  
    ...  
  ]  
}
```

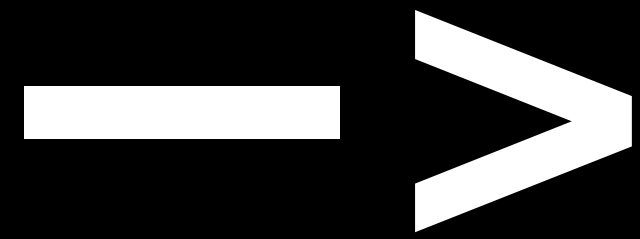
```
{  
  "username": "/ipfs/QmWxCC8BrWSUJR2AJQZu7TE",  
  "followers": [  
    "/ipfs/QmP8AmEKHHMnaBaQsEJVGs7ZbBSQAxhPn",  
    "/ipfs/QmVDGZWUgo4beprgwcmppoaBXxSainGHd",  
    "/ipfs/QmfVQwj2cyhrKQV1BY1y2nAcQcjiKEkvE",  
    ...  
  ]  
}
```

JSON —> IPLD

```
{  
  "user": "14321431543254",  
  "followers": [  
    "76547653654363",  
    "85876587647564",  
    "53476458759856",  
    ...  
  ]  
}
```

```
{  
  "user": "/ipfs/QmWxCC8BrWSUJR2AJQZu7TEniAd",  
  "followers": [  
    "/ipfs/QmP8AmEKHHMnaBaQsEJVGs7ZbBSQAxhPn",  
    "/ipfs/QmVDGZWUgo4beprgwcmppoaBXxSainGHd",  
    "/ipfs/QmfVQwj2cyhrKQV1BY1y2nAcQcjiKEkvE",  
    ...  
  ]  
}
```

YML



IPLD

username: @VannevarBush

followers:

- @FredTerman
- @ClaudeShannon
- @DougEngelbart

username: /ipfs/QmWxCC8BrWSUJR2AJQZu7TEniAa6

followers:

- /ipfs/QmP8AmEKHHMnaBaQsEJVGS7ZbBSQAxhPn9
- /ipfs/QmVDGZWUgo4beprgwcmppoaBXxSainGHdt
- /ipfs/QmfVQwj2cyhrKQV1BY1y2nAcQcjiKEkvEY

Representing Objects

```
3. jbenet@lorien ~ (zsh)
jbenet @ earth : ~ > ip1d cat --fmt json QmWxCC8BrWSUJR2AJQZu7TEniAa6ZinkDLB6zNwBdWTZkL
{
  "username": "@VannevarBush"
  "name": "Vannevar Bush"
}
```


Representing Objects

```
3. jbenet@lorien ~ (zsh)
jbenet @ earth : ~ > ipfd cat --fmt json QmWxCC8BrWSUJR2AJQZu7TEniAa6ZinkDLB6zNwBdWTZkL
{
  "username": "@VannevarBush"
  "name": "Vannevar Bush"
}

jbenet @ earth : ~ > ipfd cat --fmt json QmZqLhjZiFsp7gz1BQ5oBaLY6JegUuKbHyVQY6jFK36KBW
{
  "user": {"mlink": "/ipfs/QmWxCC8BrWSUJR2AJQZu7TEniAa6ZinkDLB6zNwBdWTZkL"},
  "followers": [
    {"mlink": "/ipfs/QmP8AmEKHHMnaBaQsEJVGS7ZbBSQAxhPn9zP2jHQy6Uekj"},
    {"mlink": "/ipfs/QmVDGZwu4beprgwcmppoaBXxSainGHdtBfhcXXqHUV5Y"},
    {"mlink": "/ipfs/QmfVQwj2cyhrKQV1BY1y2nAcQcjiKEkvEYJDGwWFUHcHaQ"},
    ...
  ]
}
```

Merkle Path Traversals

```
3. jbenet@lorien ~ (zsh)
jbenet @ earth : ~ > ipfs cat --fmt json QmZqLhjZiFsp7gz1BQ5oBaLY6JegUuKbHyVQY6jFK36KBW
{
  "user": {"mlink": "/ipfs/QmWxCC8BrWSUJR2AJQZu7TEniAa6ZinkDLB6zNwBdWTZkL"},
  "followers": [
    {"mlink": "/ipfs/QmP8AmEKHHMnaBaQsEJVGs7ZbBSQAxhPn9zP2jHQy6Uekj"},
    {"mlink": "/ipfs/QmVDGZWUgo4beprgwcmpoabXxSainGHdtBfhcXXqHUV5Y"},
    {"mlink": "/ipfs/QmfVQwj2cyhrKQV1BY1y2nAcQcjiKEkvEYJDGwWFUHcHaQ"},
    ...
  ]
}

jbenet @ earth : ~ > ipfs cat --fmt json \
  QmZqLhjZiFsp7gz1BQ5oBaLY6JegUuKbHyVQY6jFK36KBW/followers
[
  {"mlink": "/ipfs/QmP8AmEKHHMnaBaQsEJVGs7ZbBSQAxhPn9zP2jHQy6Uekj"},
  {"mlink": "/ipfs/QmVDGZWUgo4beprgwcmpoabXxSainGHdtBfhcXXqHUV5Y"},
  {"mlink": "/ipfs/QmfVQwj2cyhrKQV1BY1y2nAcQcjiKEkvEYJDGwWFUHcHaQ"},
  ...
]
```

Merkle Path Traversals

```
3. jbenet@lorien ~ (zsh)
jbenet @ earth : ~ > ipfd cat --fmt json \
  QmZqLhjZiFsp7gz1BQ5oBaLY6JegUuKbHyVQY6jFK36KBW/followers
[
  {"mlink": "/ipfs/QmP8AmEKHHMnaBaQsEJVGs7ZbBSQAxhPn9zP2jHQy6Uekj"},
  {"mlink": "/ipfs/QmVDGZUgo4beprgwcmpoaBXxSainGHdtBfhcXXqHUV5Y"},
  {"mlink": "/ipfs/QmfVQwj2cyhrKQV1BY1y2nAcQcjiKEkvEYJDGwWFUHcHaQ"},
  ...
]

jbenet @ earth : ~ > ipfd cat --fmt json \
  QmZqLhjZiFsp7gz1BQ5oBaLY6JegUuKbHyVQY6jFK36KBW/followers/0
{
  "username": "@FredTerman"
  "name": "Fred Terman"
}
```

Link Properties

```
3. jbenet@lorien ~ (zsh)
jbenet @ earth : ~ > ipfd cat --fmt json $dir
{
  "foo": {
    "mlink": "/ipfs/QmP8AmEKHHMnaBaQsEJVGS7ZbBSQAxhPn9zP2jHQy6Uekj"
    "mode": "0755",
    "owner": "jbenet"
  },
  "cat.jpg": {
    "mlink": "/ipfs/QmVDGZUgo4beprgwcmpoaBXxSainGHdtBfhcXXqHUV5Y"
    "mode": "0644",
    "owner": "jbenet"
  },
  "doge.jpg": {
    "mlink": "/ipfs/QmfVQwj2cyhrKQV1BY1y2nAcQcjiKEkvEYJDGwWFUHcHaQ",
    "mode": "0644",
    "owner": "jbenet"
  }
}
```

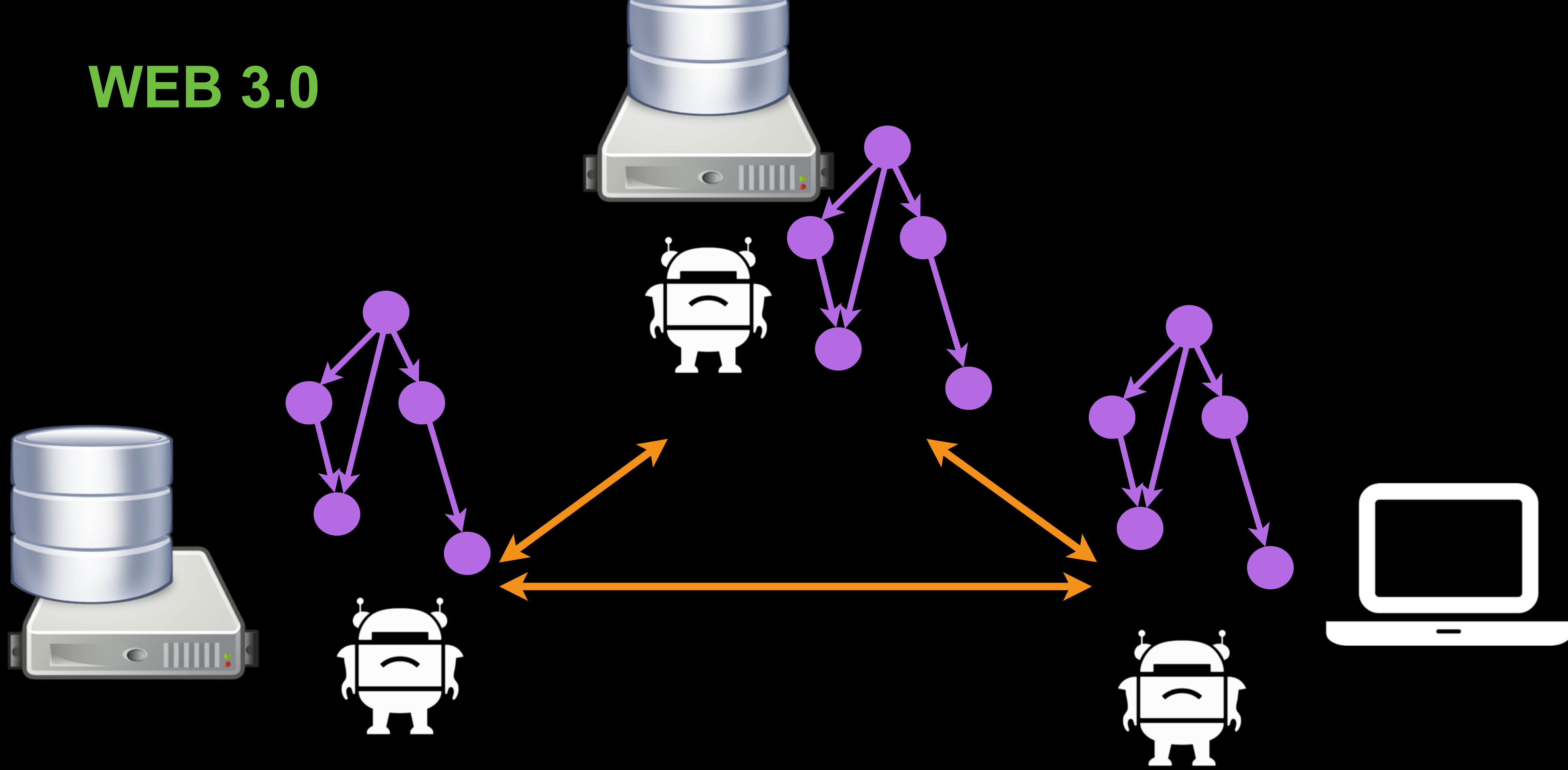
file systems - dir

```
3. jbenet@lorien ~ (zsh)
jbenet @ earth : ~ > ipfs cat --fmt json $dir
{
  "foo": {
    "mlink": "/ipfs/QmP8AmEKHHMnaBaQsEJVGS7ZbBSQAxhPn9zP2jHQy6Uekj"
    "mode": "0755",
    "owner": "jbenet"
  },
  "cat.jpg": {
    "mlink": "/ipfs/QmVDGZUgo4beprgwcmpoaBXxSainGHdtBfhcXXqHUV5Y"
    "mode": "0644",
    "owner": "jbenet"
  },
  "doge.jpg": {
    "mlink": "/ipfs/QmfVQwj2cyhrKQV1BY1y2nAcQcjiKEkvEYJDGwWFUHcHaQ",
    "mode": "0644",
    "owner": "jbenet"
  }
}
```

versioning data structures - git

```
3. jbenet@lorien ~ (zsh)
jbenet @ earth : ~ > ipld cat --fmt yml $gitcommit
---
tree: {mlink: e4647147e940e2fab134e7f3d8a40c2022cb36f3}
parents:
  - {mlink: /ipfs/QmP8AmEKHHMnaBaQsEJVGs7ZbBSQAxhPn9zP2jHQy6Uekj}
  - {mlink: /ipfs/QmfVQwj2cyhrKQV1BY1y2nAcQcjiKEkvEYJDGwWFUHcHaQ}
author:
  mlink: /ipfs/QmVoXUXmES4ujTdJ9CQAs8D3jMag2enjtbN2towYHmKxYa
  name: Juan Batiz-Benet
  email: juan@benet.ai
  time: "1435398707 -0700"
committer:
  mlink: /ipfs/QmVoXUXmES4ujTdJ9CQAs8D3jMag2enjtbN2towYHmKxYa
  name: Juan Batiz-Benet
  email: juan@benet.ai
  time: "1435398707 -0700"
message: "Merge pull request #7 from ipld\n\n(WIP) records + merkle dag specs"
```

WEB 3.0



WEBAPP DATA

@juanbenet follows

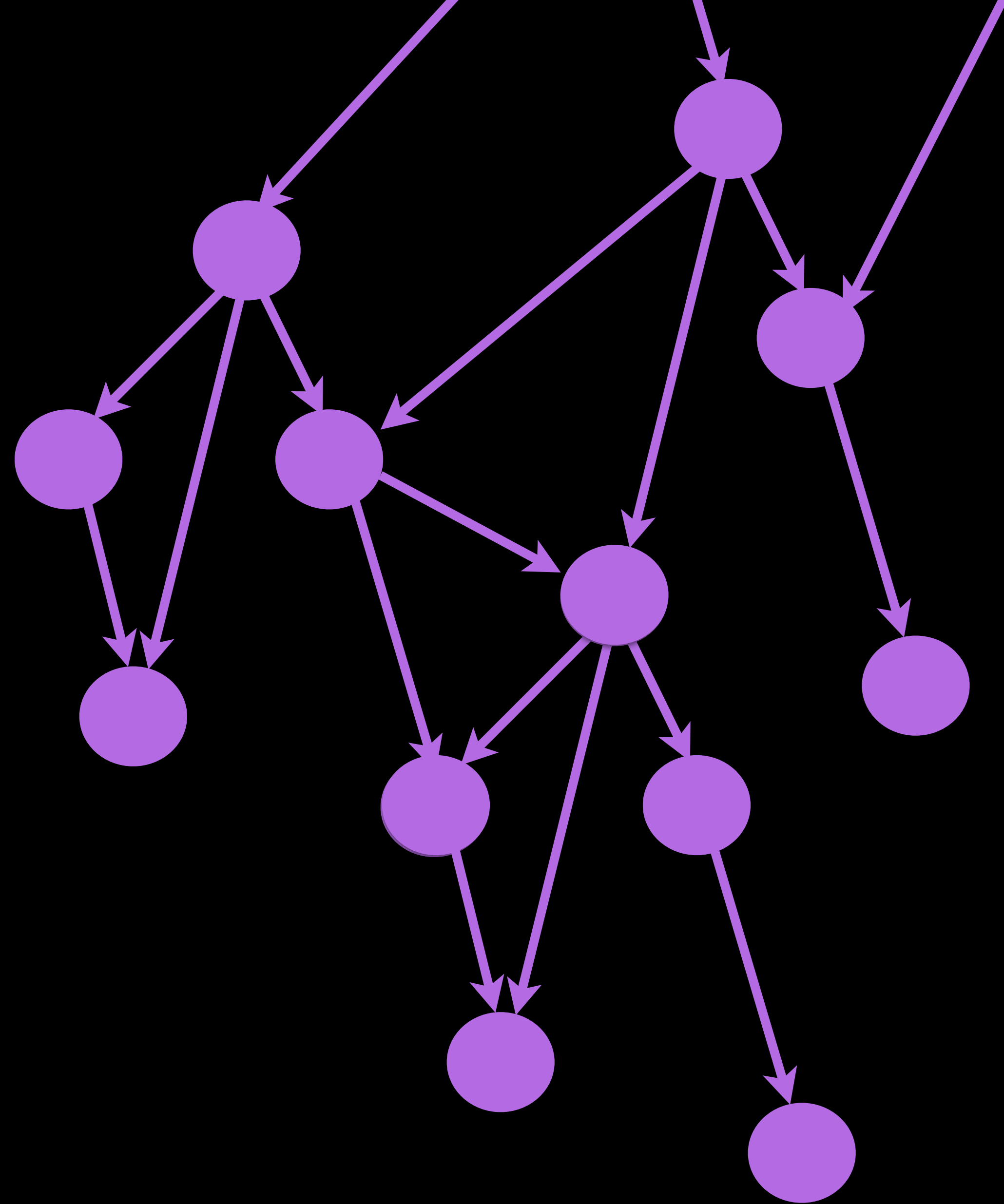
@juanbenet
follows
@daviddias

@juanbenet
follows
@timbl

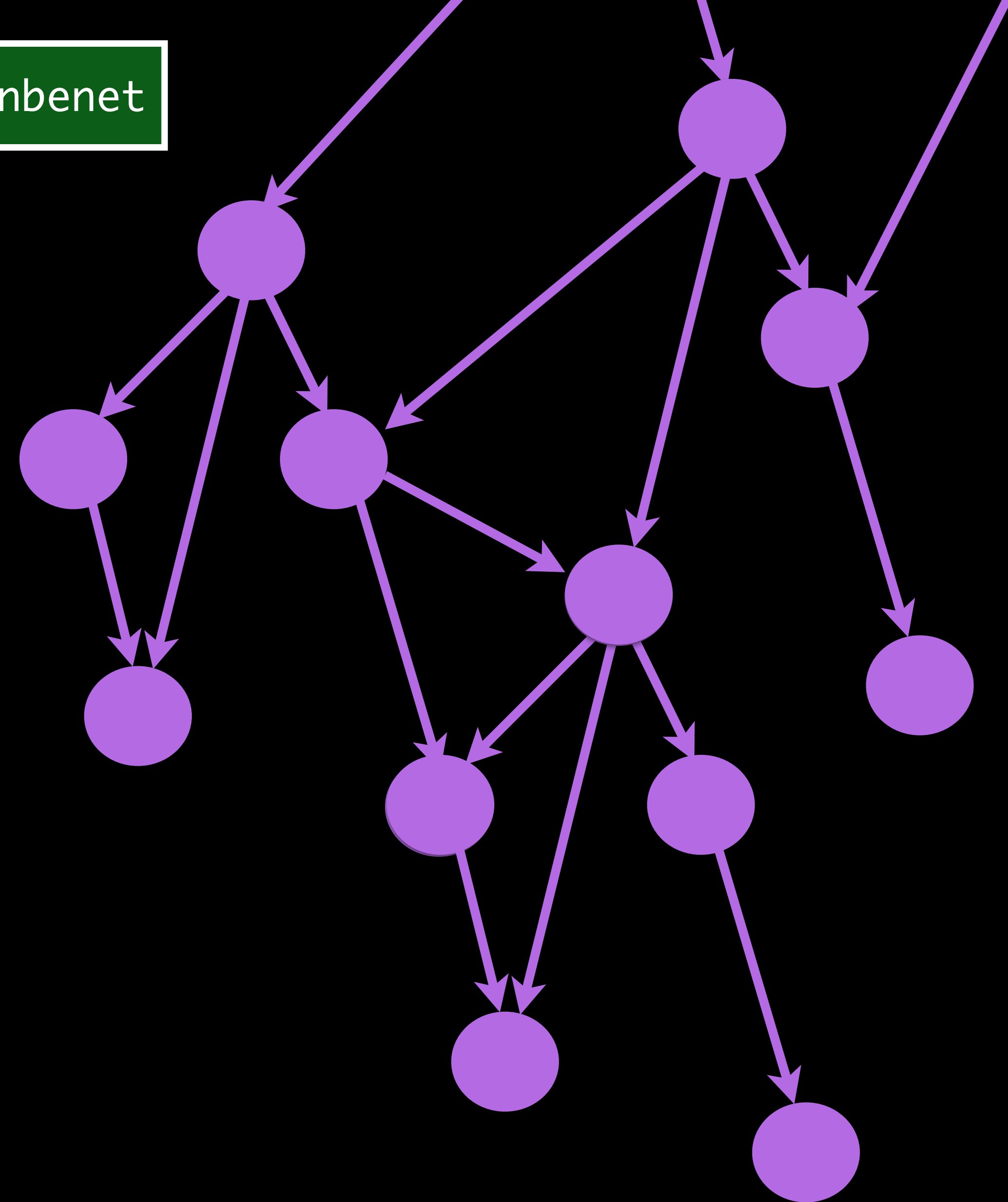
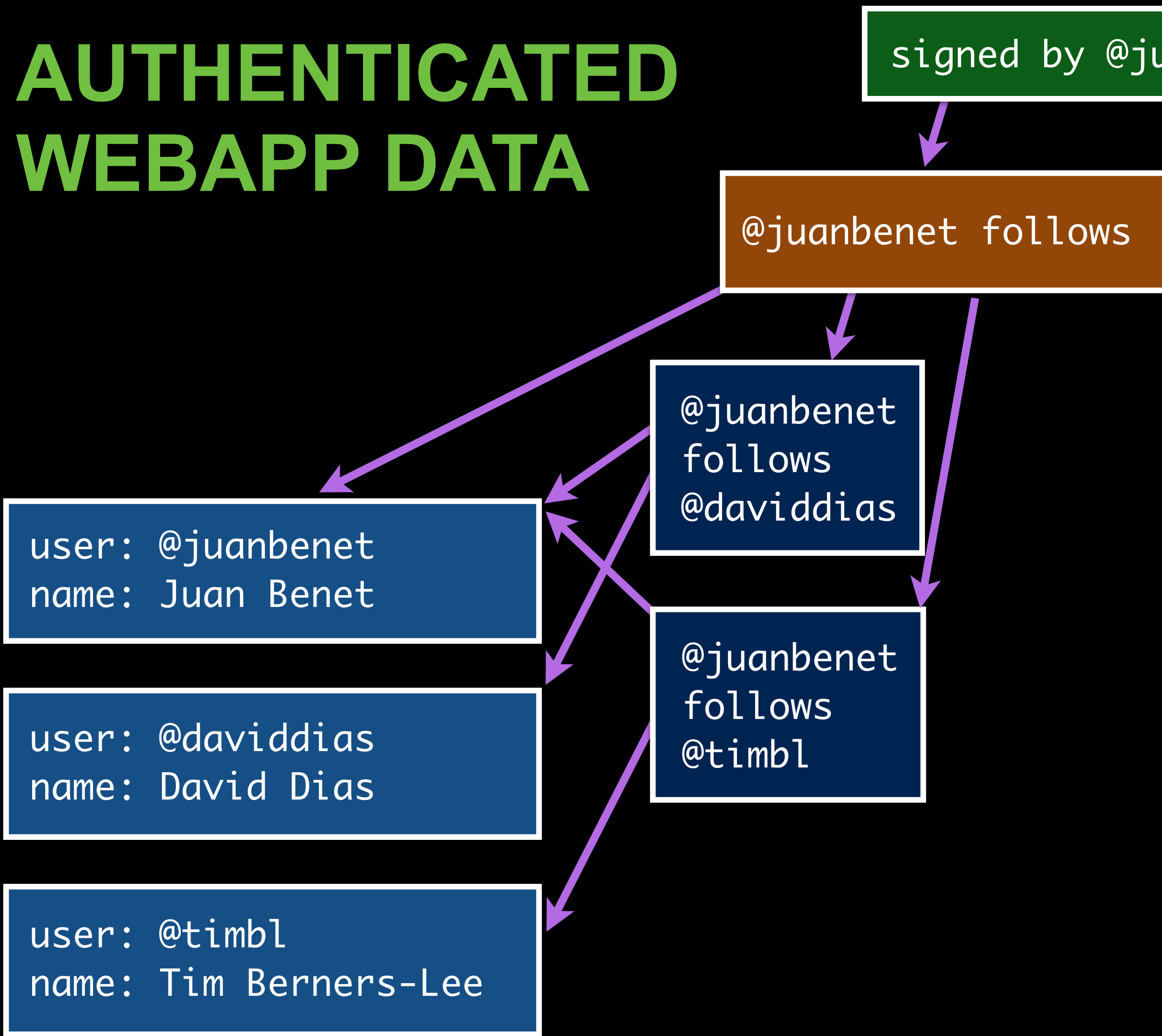
user: @juanbenet
name: Juan Benet

user: @daviddias
name: David Dias

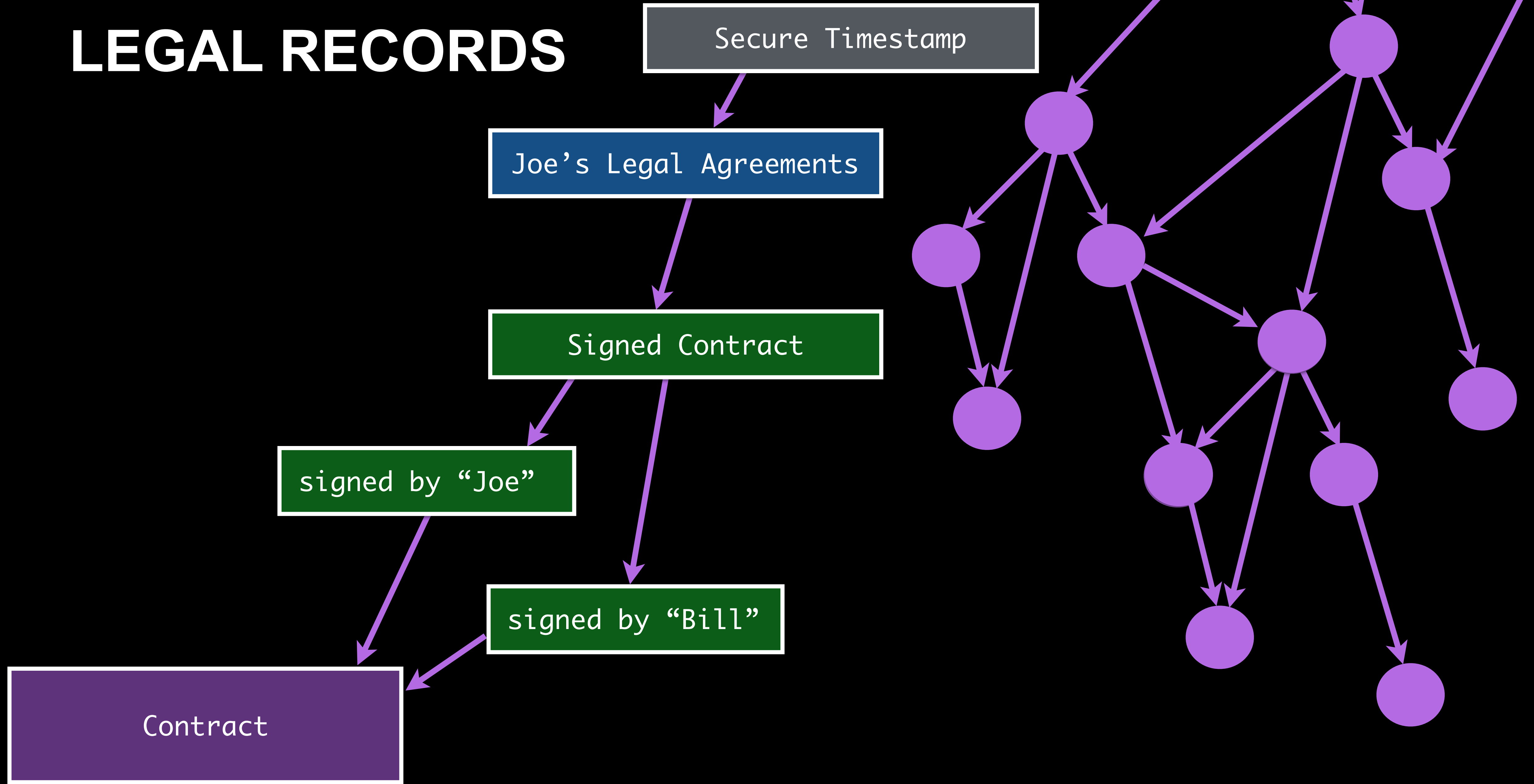
user: @timbl
name: Tim Berners-Lee

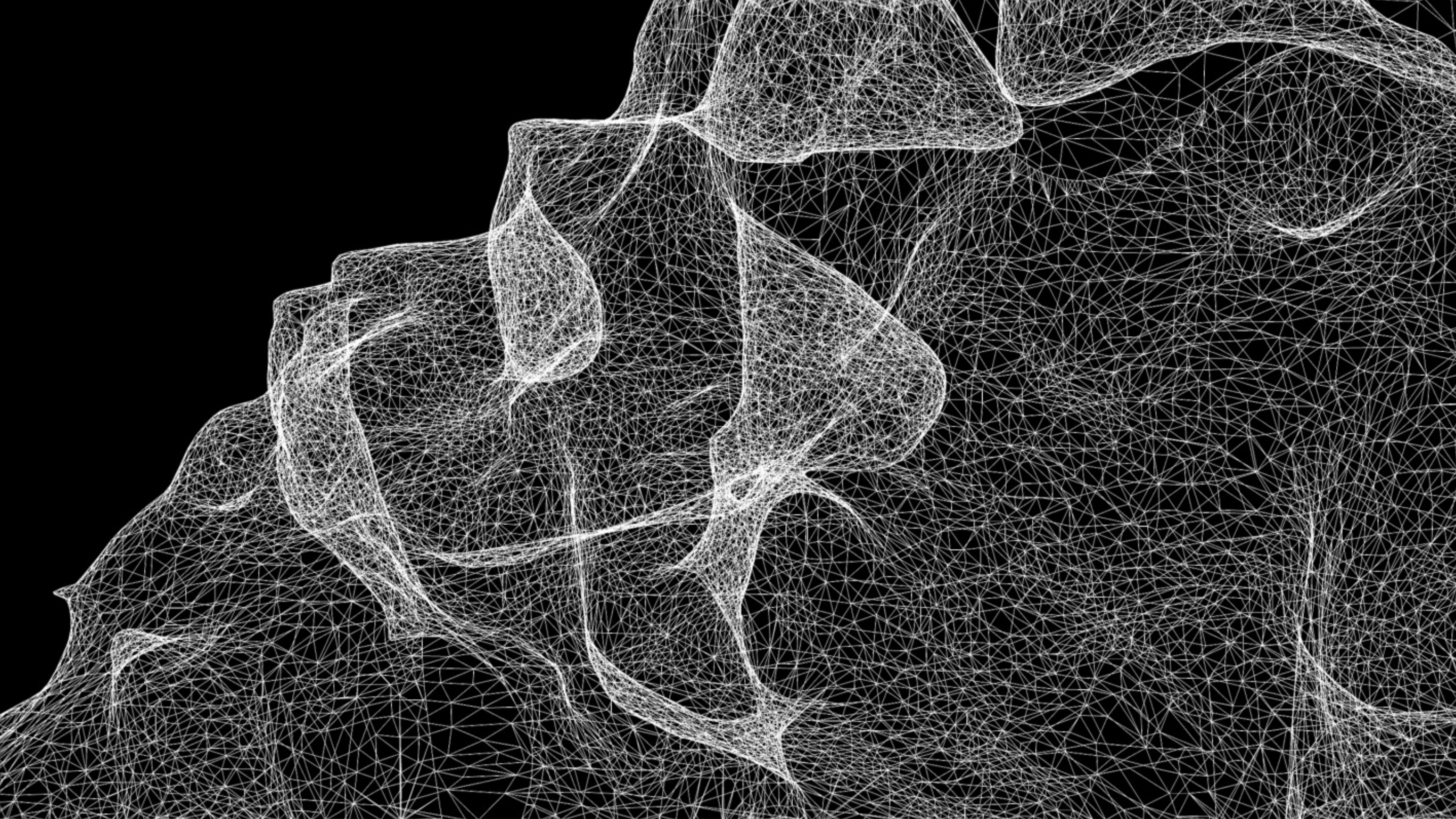


AUTHENTICATED WEBAPP DATA



LEGAL RECORDS





2. structs in IPFS

- Merkle DAGs and **Merkle Links**
- **IPLD**: JSON + Merkle-Links
- **IPRS**: Records
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- **IPNS**: Key Addressing
- **DNS** and other Human Friendly Names
- Git Versioning with **Commits**
- **unixfs**: representing POSIX files



DNS

is used for all
sorts of things

A	@	104.236.176.52
A	disabled-dev0.4.0	104.236.179.241
AAAA	disabled-dev0.4.0	fc98:424c:b433:d7e2:7ee
AAAA	h	fce3:c53b:c3c5:2f54:8bbf
MX	1	aspmx.l.google.com.
MX	5	alt1.aspmx.l.google.com.
TXT	@	dnslink=/ipfs/QmTgNJEgC
TXT	h	dnslink=/ipfs/QmcQBvKTI
NS	ns1.digitalocean.com.	
NS	ns2.digitalocean.com.	

DNS

is used for all sorts of things

```
type: A
sub: subdomain
value: 104.236.176.52
TTL: 180s
```

A	@	104.236.176.52
A	disabled-dev0.4.0	104.236.179.241
AAAA	disabled-dev0.4.0	fc98:424c:b433:d7e2:7ee
AAAA	h	fce3:c53b:c3c5:2f54:8bbf
MX	1	aspmx.l.google.com.
MX	5	alt1.aspmx.l.google.com.
TXT	@	dnslink=/ipfs/QmTgNJEgC
TXT	h	dnslink=/ipfs/QmcQBvKTI
NS	ns1.digitalocean.com.	
NS	ns2.digitalocean.com.	

IPRS

is used for all
sorts of things

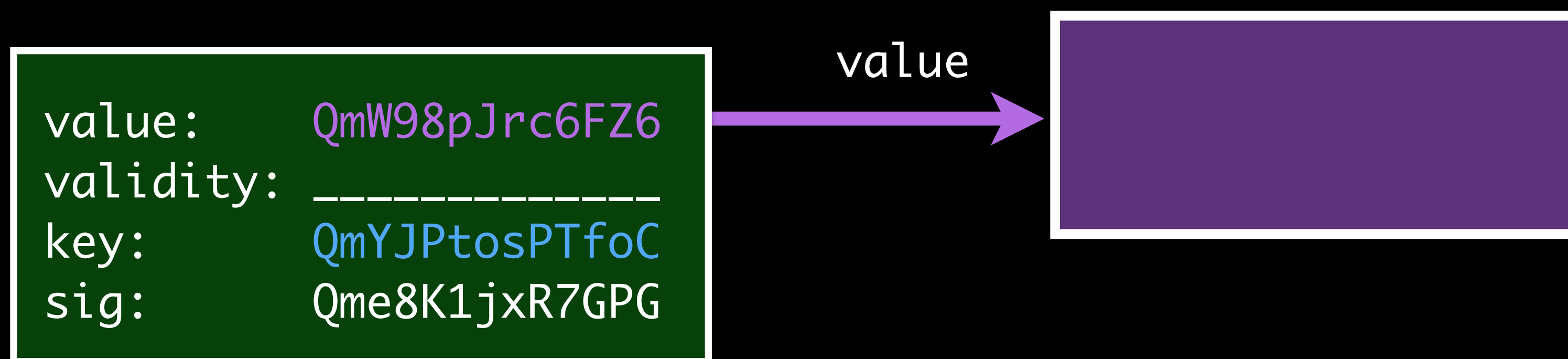
```
value:    QmW98pJrc6FZ6
validity: _____
key:      QmYJPtosPTfoC
sig:      Qme8K1jxR7GPG
```

IPRS

is used for all
sorts of things

Records

are just IPLD objects
that link to other objects

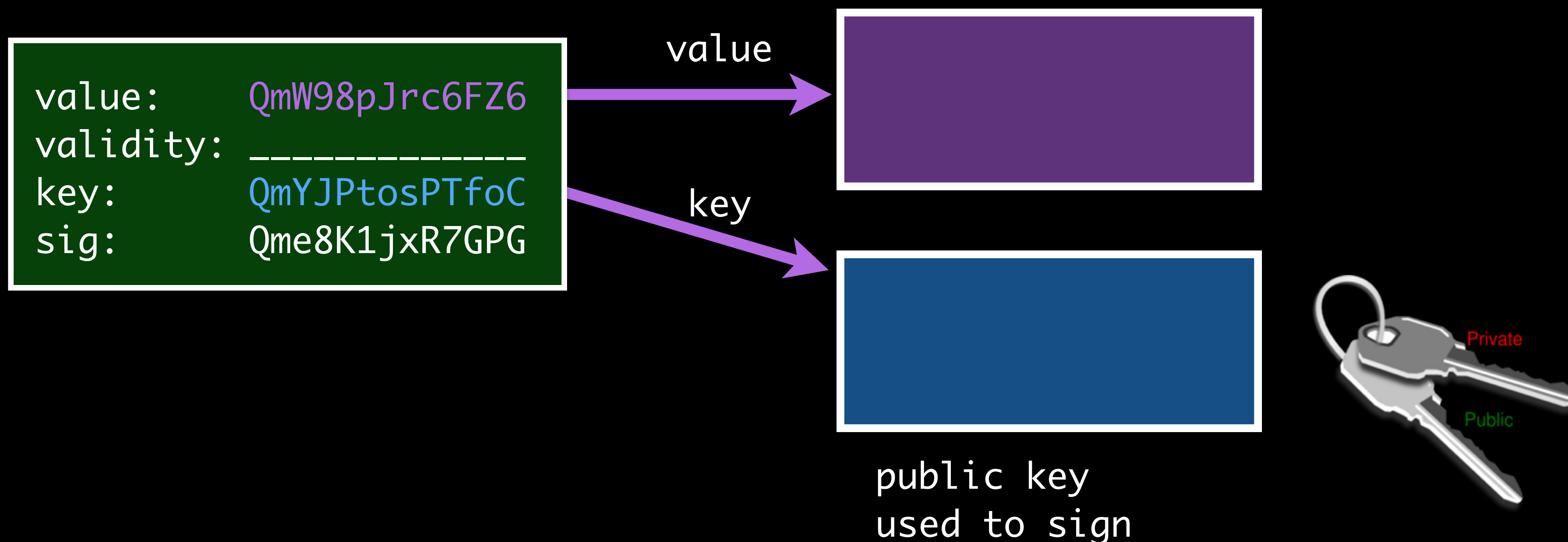


IPRS

is used for all
sorts of things

Records

are just IPLD objects
that link to other objects



IPRS

is used for all
sorts of things

```
value:    QmW98pJrc6FZ6
validity: _____
key:      QmYJPtosPTfoC
sig:      Qme8K1jxR7GPG
```

Records

are just IPLD objects
that link to other objects

IPRS Validity

- App-specific value
- Timestamps + TTL
- Cryptographic Freshness
- Ancestry (hash chain)

2. structs in IPFS

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MAZIERES LINK

mutability

key name /ipns/QmYJPtosPTfoC/foo/bar/baz.png



content addr /ipfs/QmW98pJrc6FZ6/foo/bar/baz.png

fs:/ipfs/QmW98pJrc6FZ6/foo/bar/baz.png

ipfs:/ipfs/QmW98pJrc6FZ6/foo/bar/baz.png

Escaping the Evils of Centralized Control with self-certifying pathnames

David Mazières and M. Frans Kaashoek
dm@lcs.mit.edu, kaashoek@lcs.mit.edu
MIT Laboratory for Computer Science
545 Technology Square, Cambridge MA 02139

Abstract

People have long trusted central authorities to coordinate secure collaboration on local-area networks. Unfortunately, the Internet doesn't provide the kind of administrative structures individual organizations do. As such, users risk painful consequences if global, distributed systems rely on central authorities for security. Fortunately, security need not come at the price of centralized control. To prove it, we present SFS, a secure, global, decentralized file system permitting easy cross-administrative realm collaboration. With a simple idea, self-certifying pathnames, SFS lets users escape the evils of centralized control.

/ipns/QmYJPtosPTfoC/foo/bar/baz.png

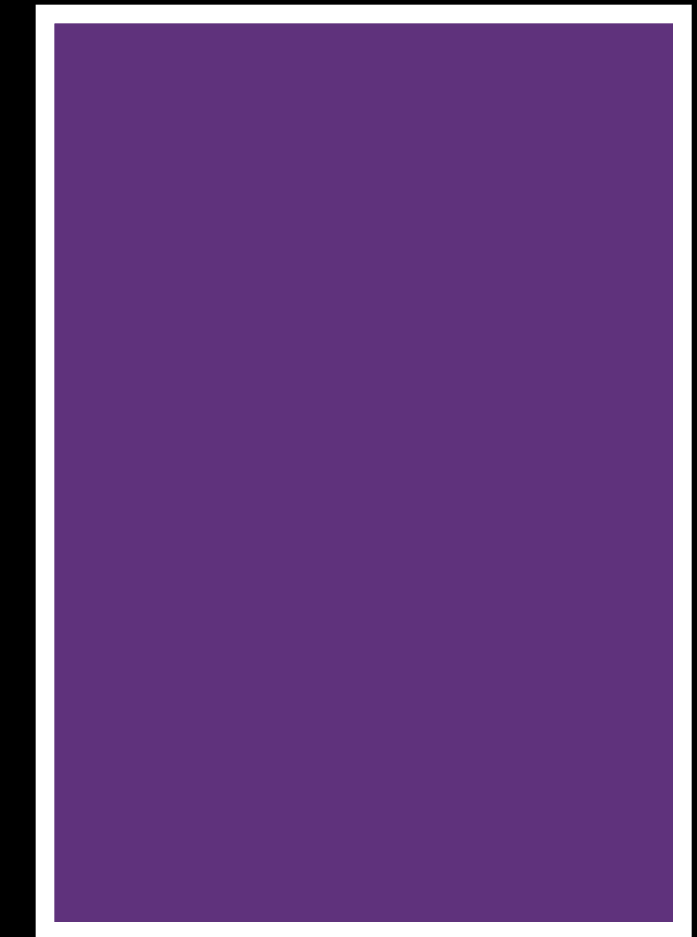


/ipfs/QmW98pJrc6FZ6/foo/bar/baz.png



public
key

secret
key



QmYJPtosPTfoC

QmW98pJrc6FZ6

/ipns/QmYJPtosPTfoC/foo/bar/baz.png



/ipfs/QmW98pJrc6FZ6/foo/bar/baz.png

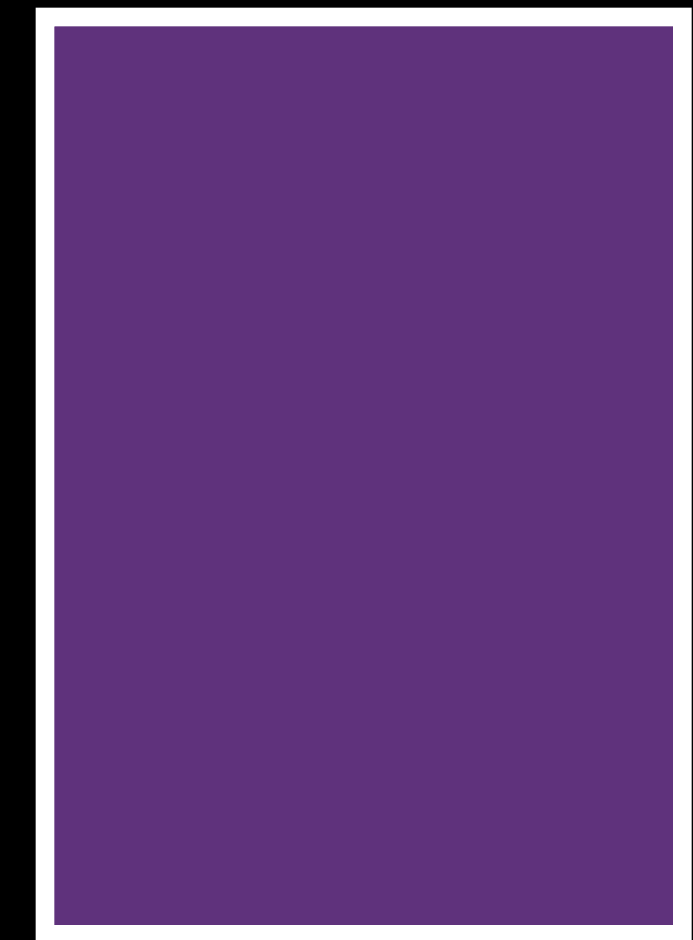


public
key

secret
key



QmW98pJrc6FZ6



QmYJPtosPTfoC

QmW98pJrc6FZ6

/ipns/QmYJPtosPTfoC/foo/bar/baz.png



/ipfs/QmW98pJrc6FZ6/foo/bar/baz.png



public
key

secret
key



QmW98pJrc6FZ6
signed by
QmYJPtosPTfoC



QmYJPtosPTfoC

QmW98pJrc6FZ6

/ipns/QmYJPtosPTfoC/foo/bar/baz.png



/ipfs/QmW98pJrc6FZ6/foo/bar/baz.png



public
key

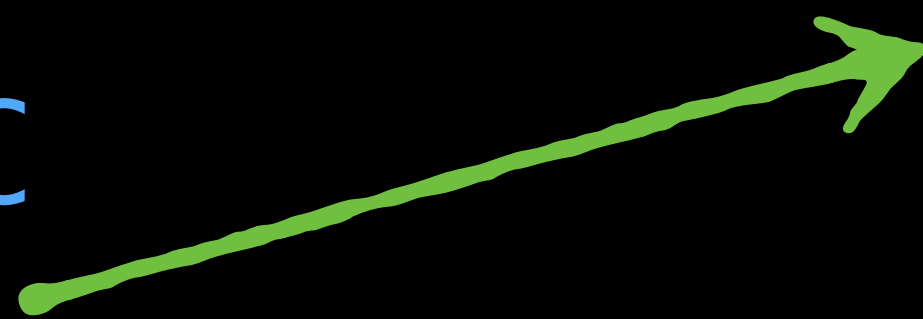
secret
key



QmW98pJrc6FZ6
signed by
QmYJPtosPTfoC



QmYJPtosPTfoC



QmW98pJrc6FZ6

human readability

eth name /eth/jbenet/foo/bar/baz.png
 /ipns/jbenet.eth/foo/bar/baz.png



key name /ipns/QmYJPtosPTfoC/foo/bar/baz.png



content addr /ipfs/QmW98pJrc6FZ6/foo/bar/baz.png
 fs:/ipfs/QmW98pJrc6FZ6/foo/bar/baz.png
 ipfs:/ipfs/QmW98pJrc6FZ6/foo/bar/baz.png

2. structs in IPFS

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/ipns/QmYJPtosPTfoC/foo/bar/baz.png



/ipfs/QmW98pJrc6FZ6/foo/bar/baz.png



public
key

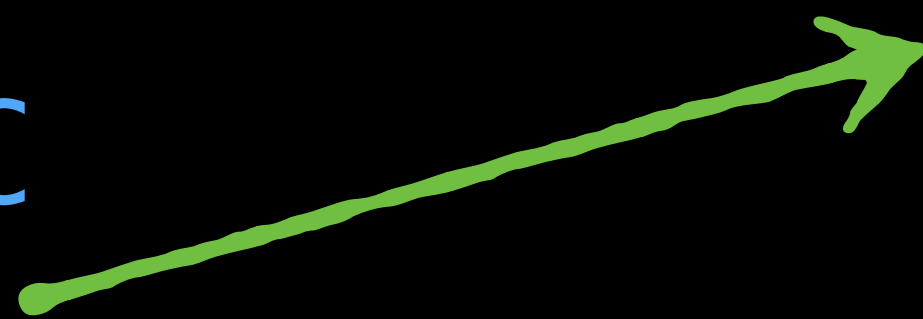
secret
key



QmW98pJrc6FZ6
signed by
QmYJPtosPTfoC



QmYJPtosPTfoC



QmW98pJrc6FZ6

/ipns/QmYJPtosPTfoC/foo/bar/baz.png



/ipfs/QmW98pJrc6FZ6/foo/bar/baz.png



public
key

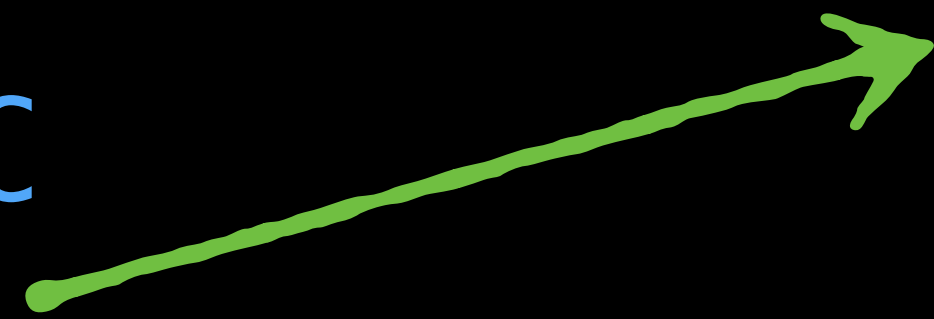
secret
key



```
value:    QmW98pJrc6FZ6
key:      QmYJPtosPTfoC
validity: _____
sig:      Qme8K1jxR7GPG
```



QmYJPtosPTfoC



IPNS Record



QmW98pJrc6FZ6

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human readability

dns name /dns/example.com/foo/bar/baz.png
/ipns/example.com/foo/bar/baz.png



key name /ipns/QmYJPtosPTfoC/foo/bar/baz.png



content addr /ipfs/QmW98pJrc6FZ6/foo/bar/baz.png
fs:/ipfs/QmW98pJrc6FZ6/foo/bar/baz.png
ipfs:/ipfs/QmW98pJrc6FZ6/foo/bar/baz.png

DNS Links

```
3. jbenet@lorien ~ (zsh)
jbenet @ earth : ~ > dig TXT ipfs.io

; <<>> DiG 9.8.3-P1 <<>> TXT ipfs.io
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 37227
;; flags: qr rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 0

;; QUESTION SECTION:
;ipfs.io.      IN TXT

;; ANSWER SECTION:
ipfs.io.      120 IN TXT "dnslink=/ipfs/QmTgNJEgQaCqRht9KSXNyZsCp2xpHZmBRms28NRMmtcERp"

;; Query time: 169 msec
;; SERVER: 209.244.0.3#53(209.244.0.3)
;; WHEN: Tue Nov 17 16:44:28 2015
;; MSG SIZE rcvd: 98
```


DNS Links

```
3. jbenet@lorien ~ (zsh)
jbenet @ earth : ~ > dig TXT ipfs.io

; <<>> DiG 9.8.3-P1 <<>> TXT ipfs.io
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 37227
;; flags: qr rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 0

;; QUESTION SECTION:
;ipfs.io.      IN TXT

;; ANSWER SECTION:
ipfs.io.      120  IN TXT  "dnslink=/ipfs/QmTgNJEgQaCqRht9KSXNyZsCp2xpHZmBRms28NRMmtcERp"

;; Query time: 169 msec
;; SERVER: 209.244.0.3#53(209.244.0.3)
;; WHEN: Tue Nov 17 16:44:28 2015
;; MSG SIZE rcvd: 98
```

DNS Links

```
3. jbenet@lorien ~ (zsh)
jbenet @ earth : ~ > dig TXT ipfs.io

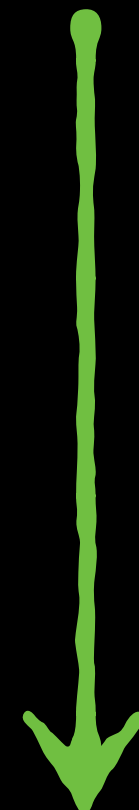
ipfs.io.      120 IN TXT  "dnslink=/ipfs/QmTgNJEgQaCqRht9KSXNyZsCp2xpHZmBRms28NRMmtcERp"
```

DNS Links

```
3. jbenet@lorien ~ (zsh)
jbenet @ earth : ~ > dig TXT ipfs.io

ipfs.io.      120  IN TXT  "dnslink=/ipfs/QmTgNJEgQaCqRht9KSXNyZsCp2xpHZmBRms28NRMmtcERp"
```

dns name /dns/**ipfs.io**/foo/bar/baz.png
 /ipns/**ipfs.io**/foo/bar/baz.png



content addr /ipfs/**QmW98pJrc6FZ6**/foo/bar/baz.png

DNS Links

```
3. jbenet@lorien ~ (zsh)
jbenet @ earth : ~ > dig TXT ipfs.io
ipfs.io.      120  IN TXT  "dnslink=/ipns/QmYJPtosPTfoCht9KSXNyZsCp2xpHZmBRms28NRMmtcERp"
```

dns name /dns/**ipfs.io**/foo/bar/baz.png 60s-5m
 /ipns/**ipfs.io**/foo/bar/baz.png



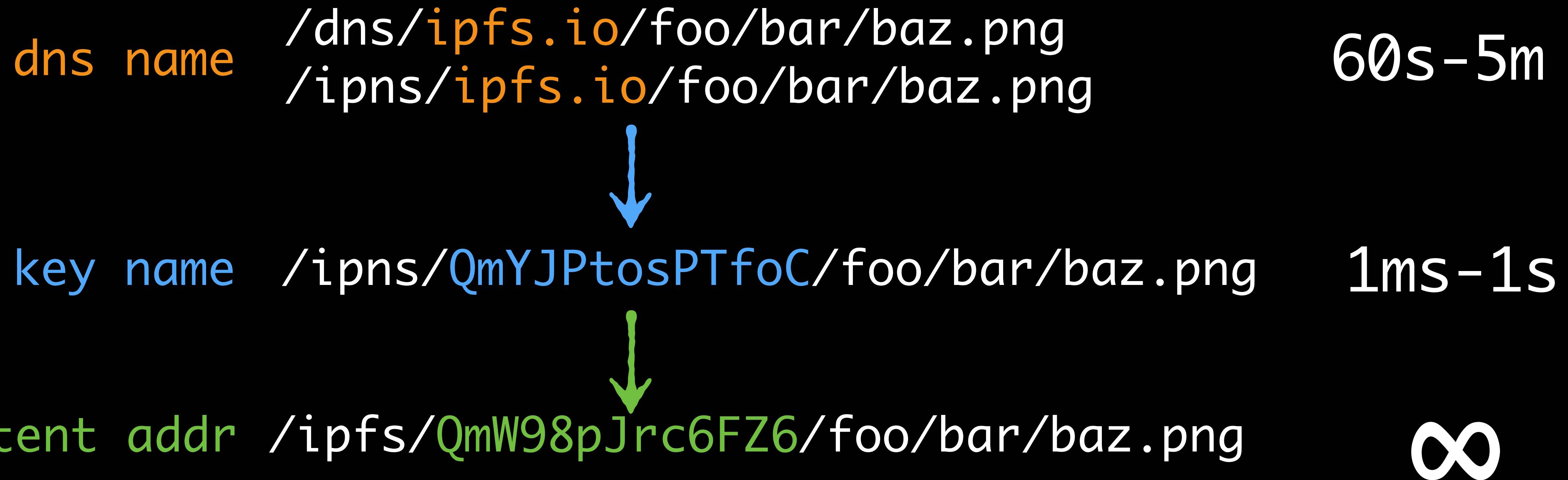
key name /ipns/**QmYJPtosPTfoC**/foo/bar/baz.png



content addr /ipfs/**QmW98pJrc6FZ6**/foo/bar/baz.png ∞

DNS Links

```
3. jbenet@lorien ~ (zsh)
jbenet @ earth : ~ > dig TXT ipfs.io
ipfs.io.      120 IN TXT "dnslink=/ipns/QmYJPtosPTfoCht9KSXNyZsCp2xpHZmBRms28NRMmtcERp"
```

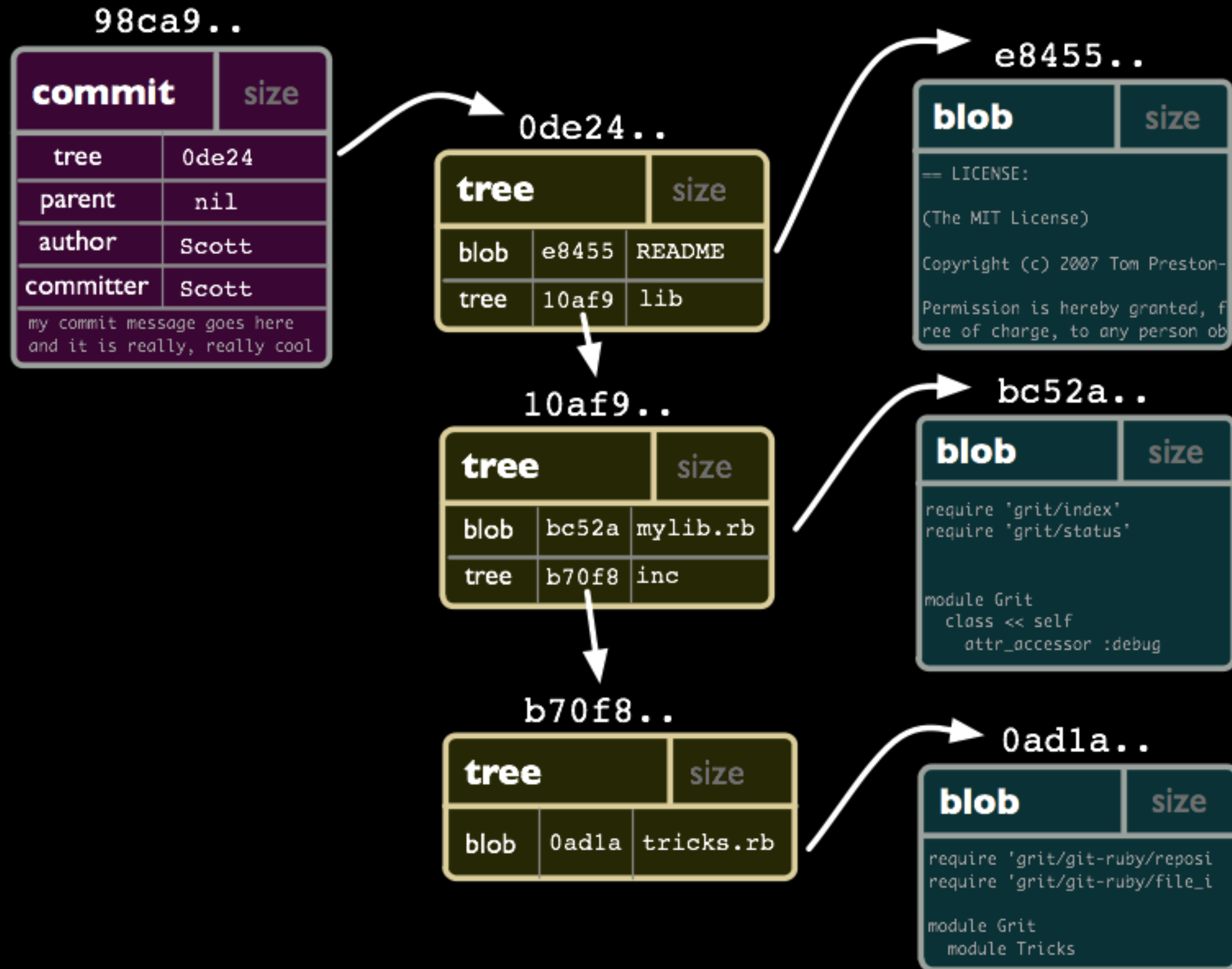


2. structs in IPFS

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- **unixfs**: representing POSIX files



versioning data structures - git



versioning data structures - git

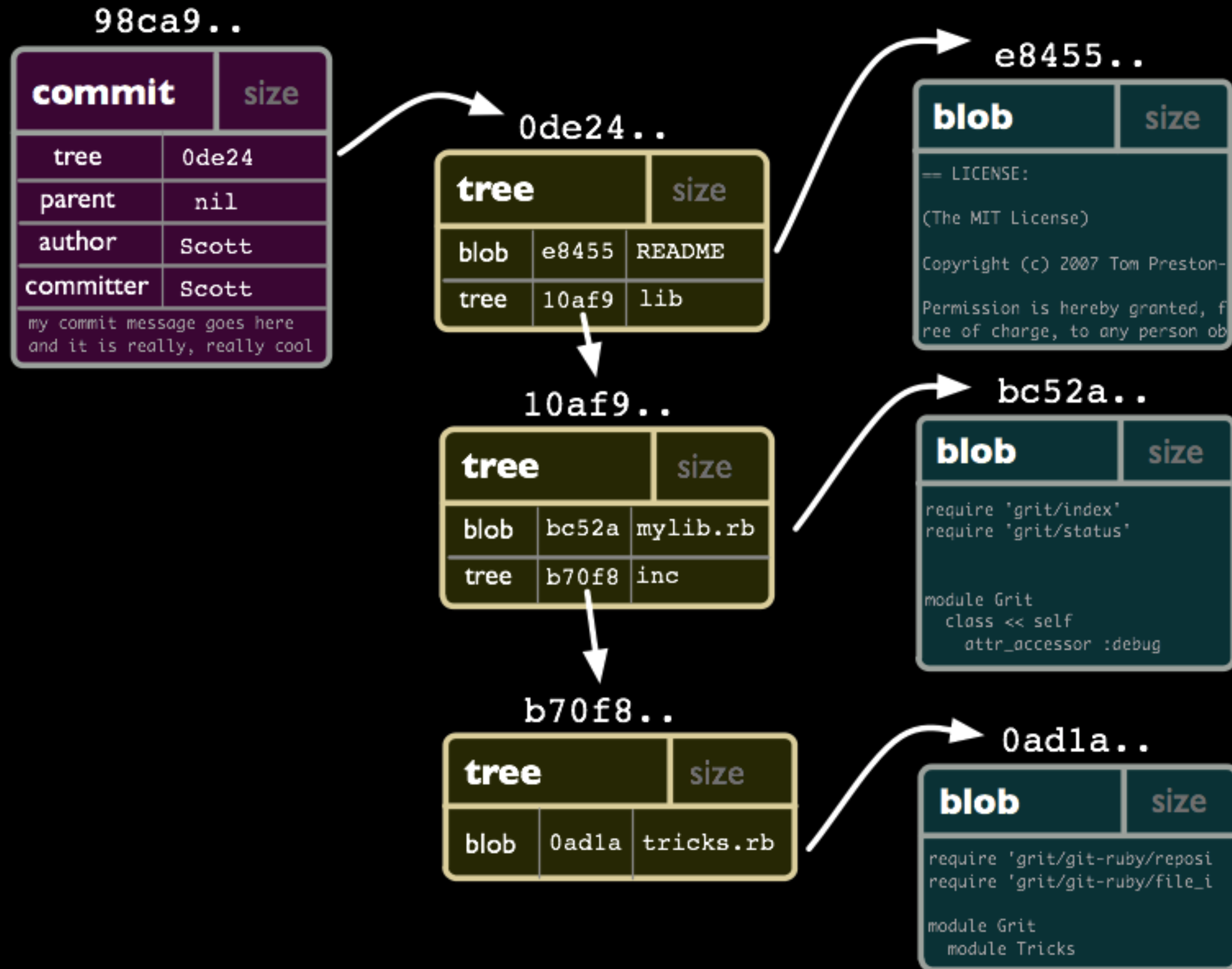
```
3. jbenet@lorien ~ (zsh)
jbenet @ earth : ~ > ipld cat --fmt yml $gitcommit
---
tree: {mlink: e4647147e940e2fab134e7f3d8a40c2022cb36f3}
parents:
  - {mlink: /ipfs/QmP8AmEKHHMnaBaQsEJVGs7ZbBSQAxhPn9zP2jHQy6Uekj}
  - {mlink: /ipfs/QmfVQwj2cyhrKQV1BY1y2nAcQcjiKEkvEYJDGwWFUHcHaQ}
author:
  mlink: /ipfs/QmVoXUXmES4ujTdJ9CQAs8D3jMag2enjtbN2towYHmKxYa
  name: Juan Batiz-Benet
  email: juan@benet.ai
  time: "1435398707 -0700"
committer:
  mlink: /ipfs/QmVoXUXmES4ujTdJ9CQAs8D3jMag2enjtbN2towYHmKxYa
  name: Juan Batiz-Benet
  email: juan@benet.ai
  time: "1435398707 -0700"
message: "Merge pull request #7 from ipld\n\n(WIP) records + merkle dag specs"
```

2. structs in IPFS

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unixfs: representing POSIX files

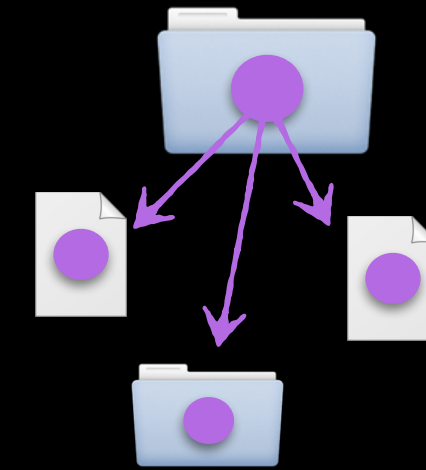
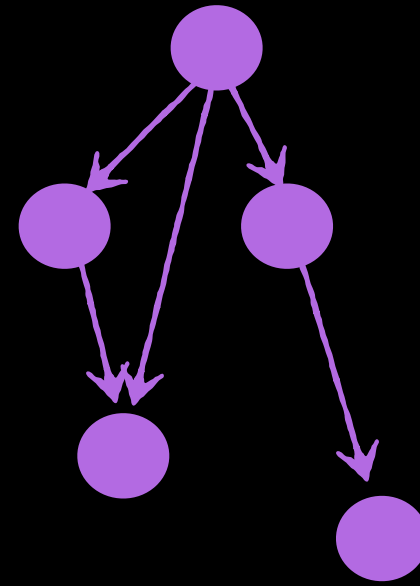


unixfs: representing POSIX files

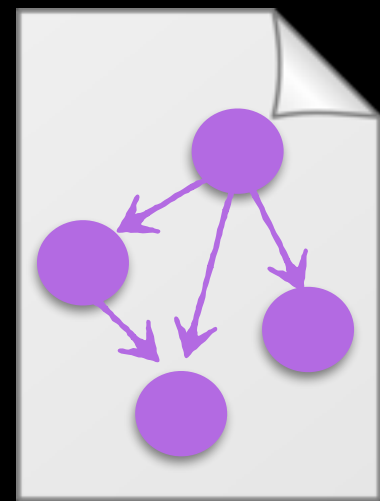
unixfs as a dag



files are dag nodes



which link to others

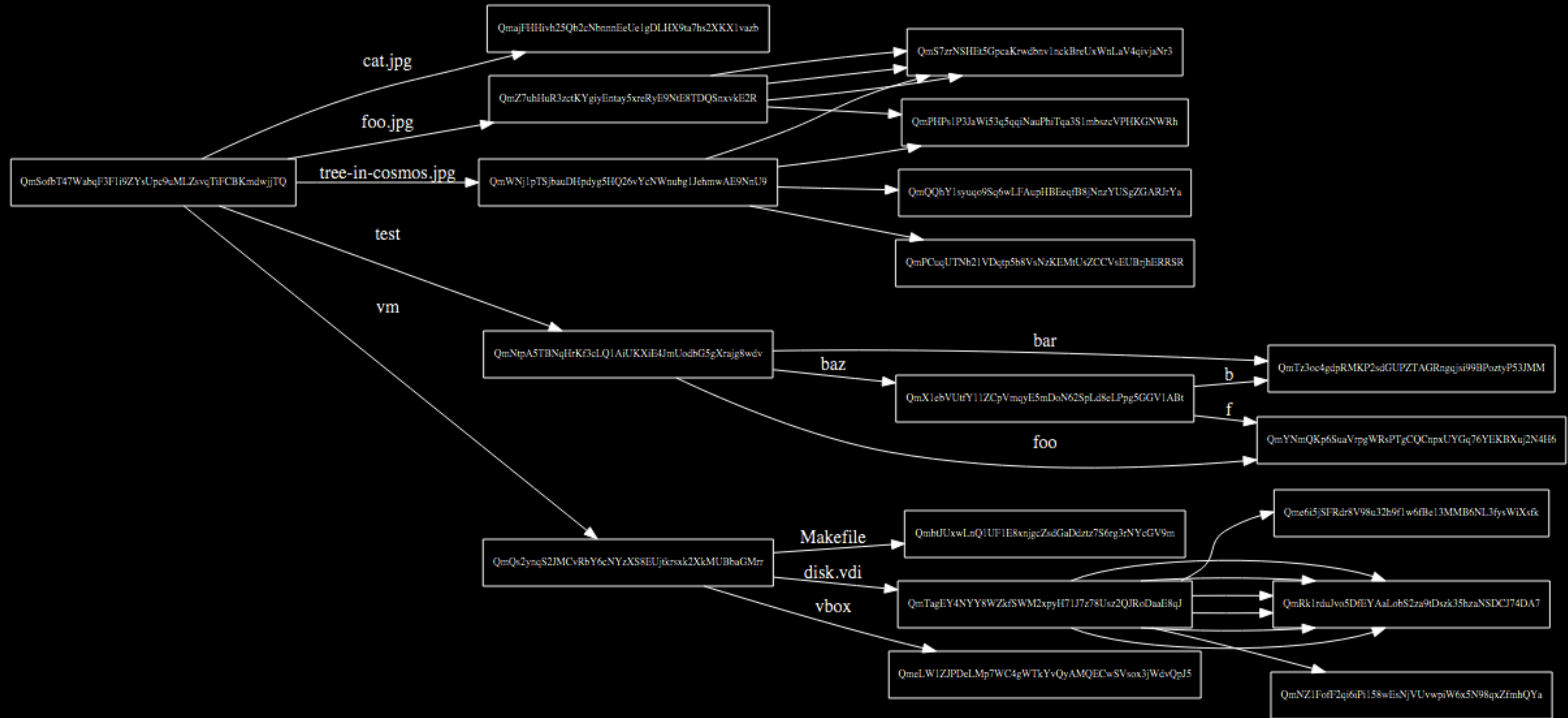


BIG files may be split into many

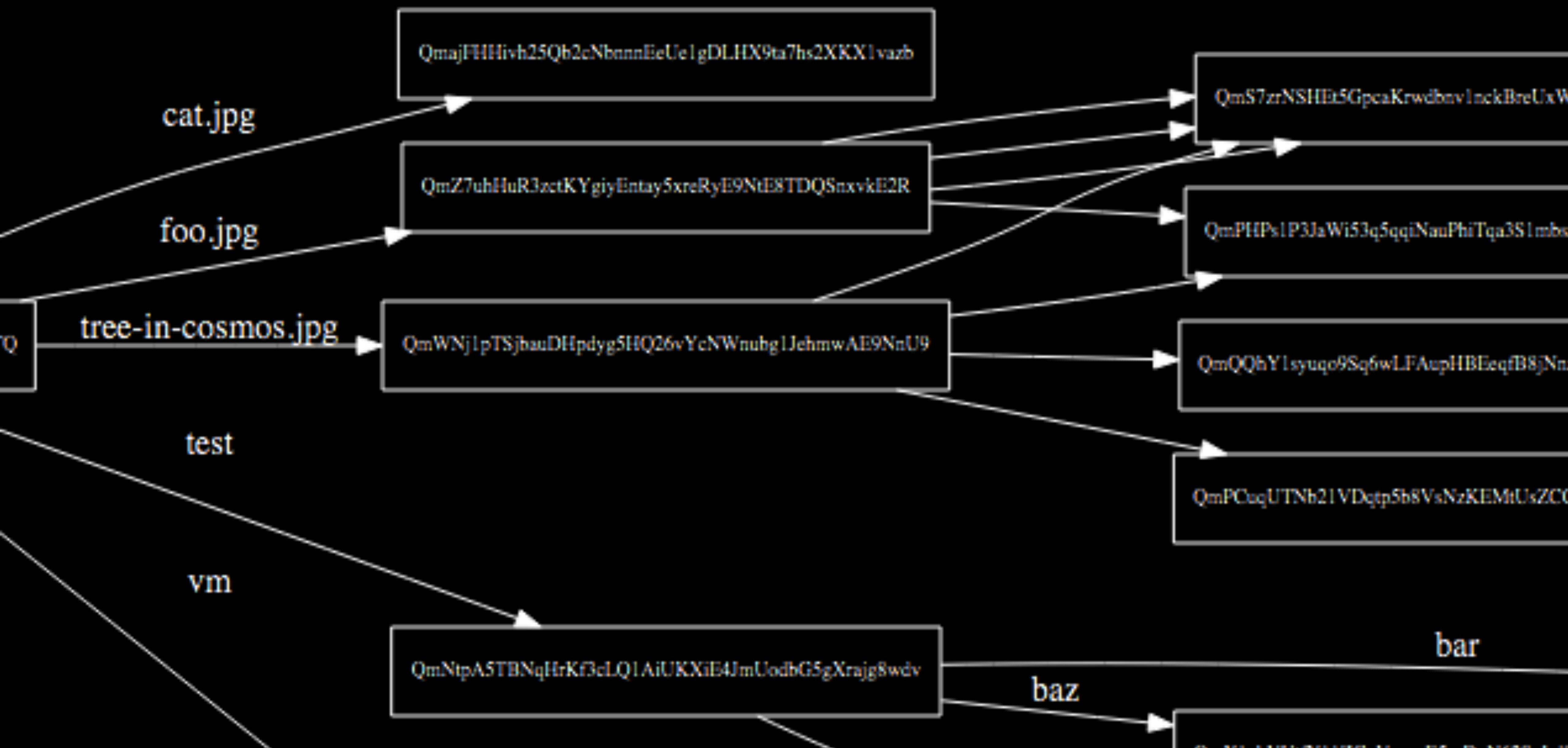


directories are also dag nodes

unixfs: representing POSIX files



unixfs: representing POSIX files



1. IPFS introduction
2. structs in IPFS
- 3. structs on IPFS**

3. structs on IPFS

- **unixfs:** Files as you know them
- **commit:** Git style versioning
- **CRDTs:** sane mutable data
- **keychain:** PKI and crypto artifacts
- **persona:** identity management
- **post:** sane communication
- **html:** hey! websites!
- **boards:** forums, reddit, 4chan
- **starship:** containers at hyperspeed
- **blockchains:** interconnected



3. structs on IPFS

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CRDTs: lattices as IPFS objects

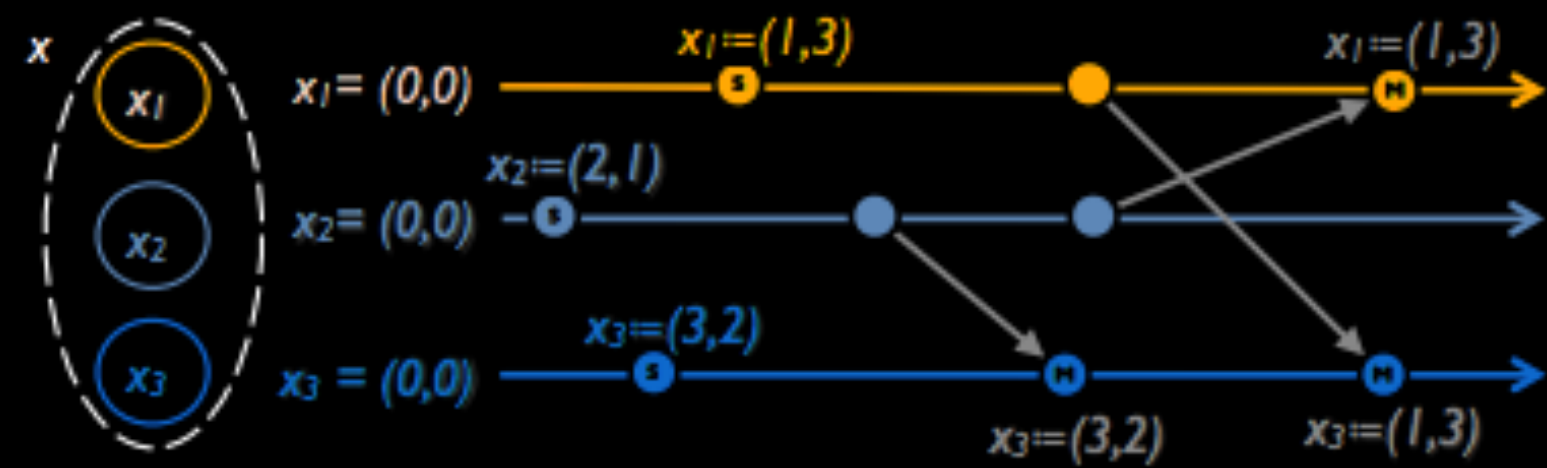


Figure 7: Integer LWW Register (state-based). Payload is a pair (value, timestamp)

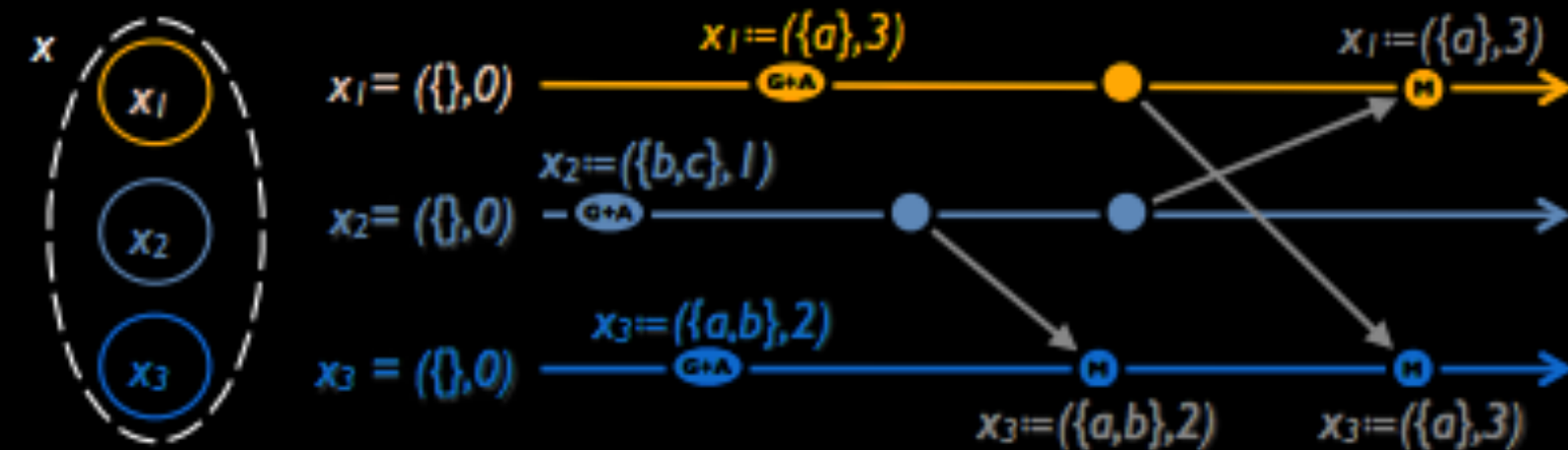
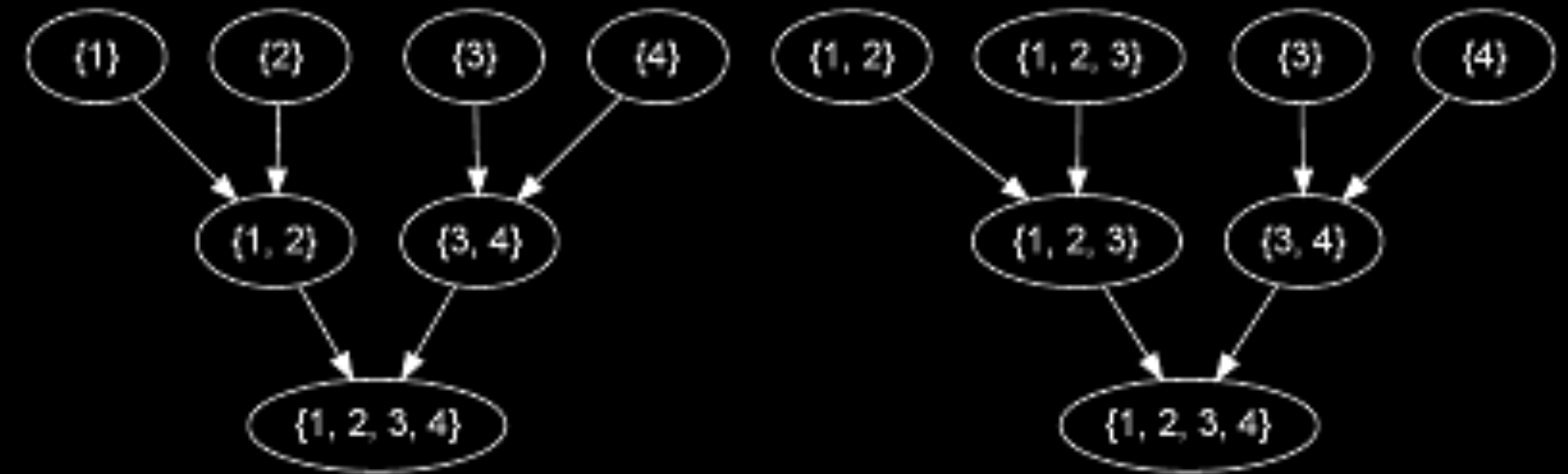


Figure 8: LWW-Set (state-based). Payload is a pair (set, timestamp)



CRDTs: lattices as IPFS objects



3. structs on IPFS

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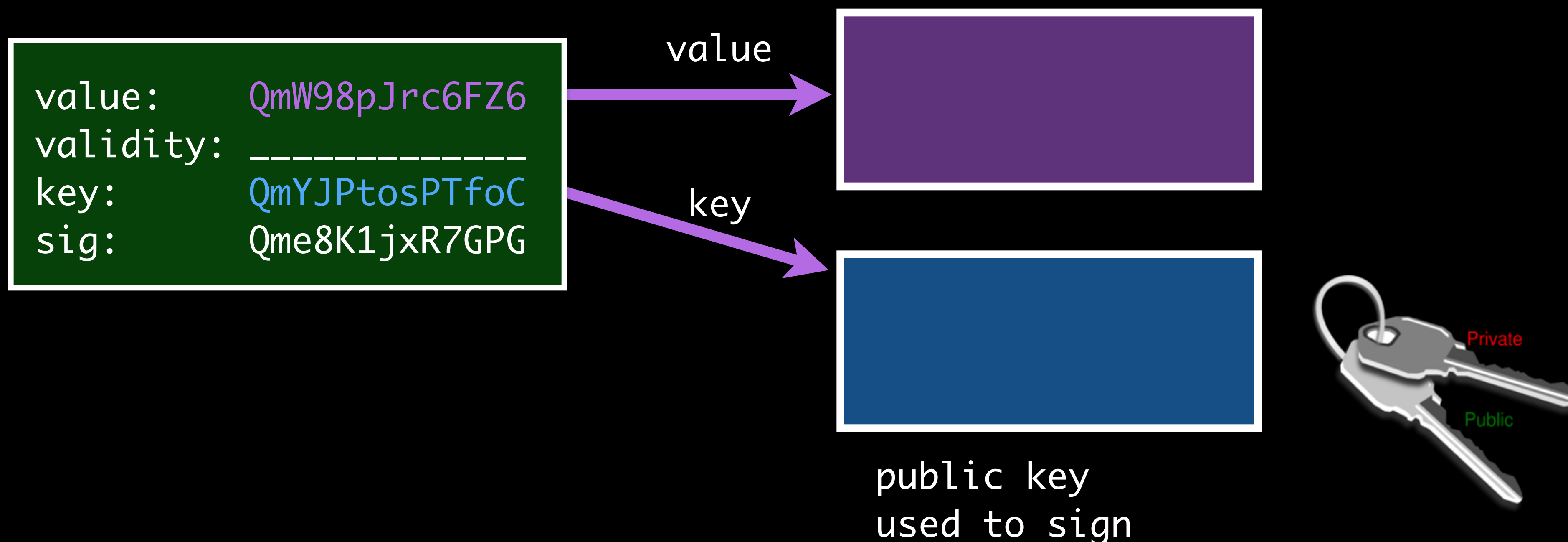


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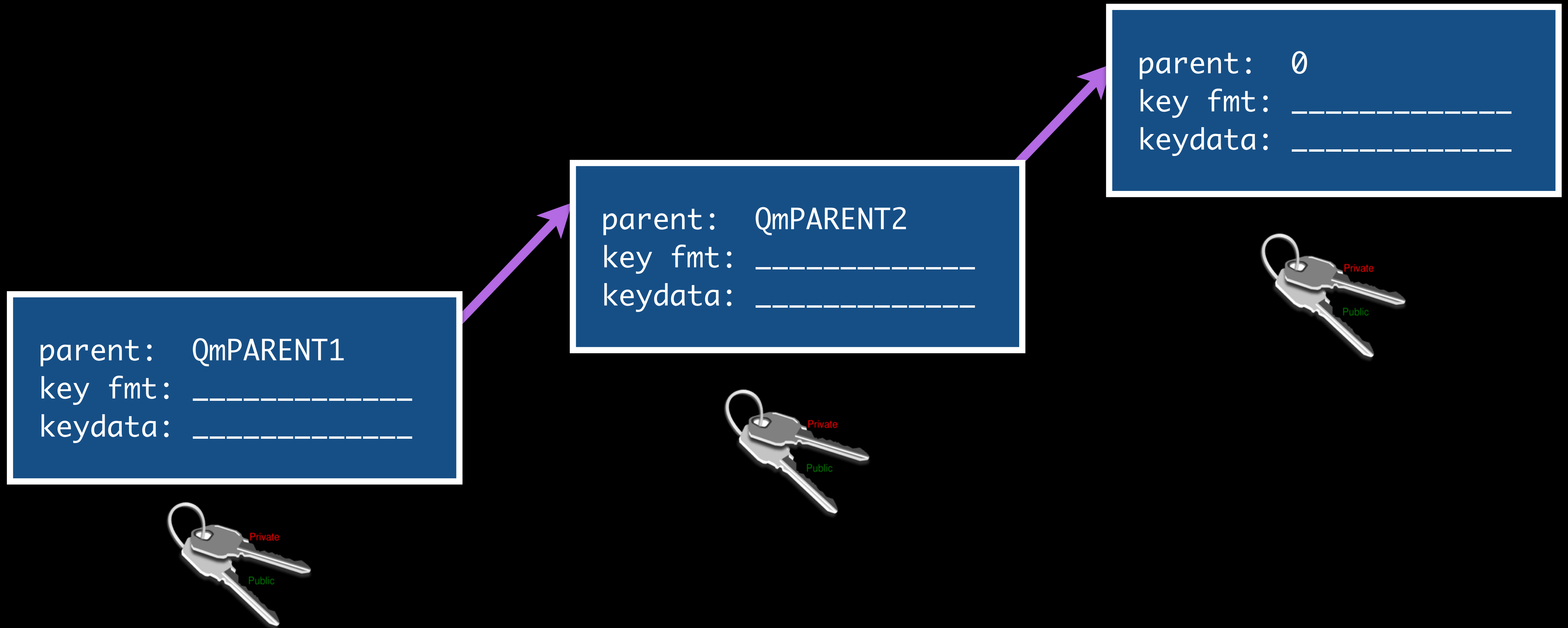
Keychain - cryptographic artifacts as IPFS objects

```
parent: QmPARENT1  
key fmt: _____  
keydata: _____
```

```
parent: QmPARENT2  
key fmt: _____  
keydata: _____
```

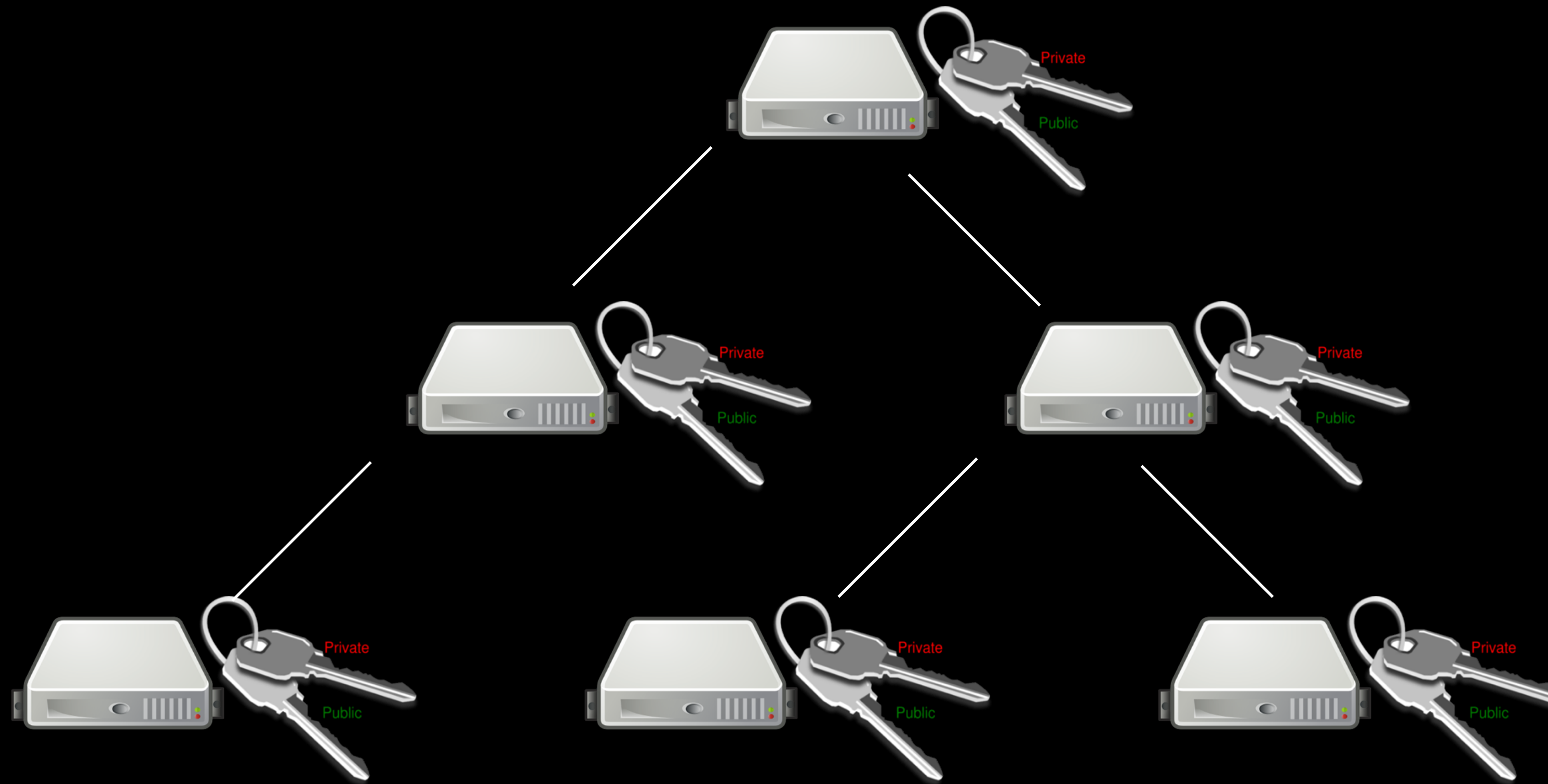


Keychain - cryptographic artifacts as IPFS objects



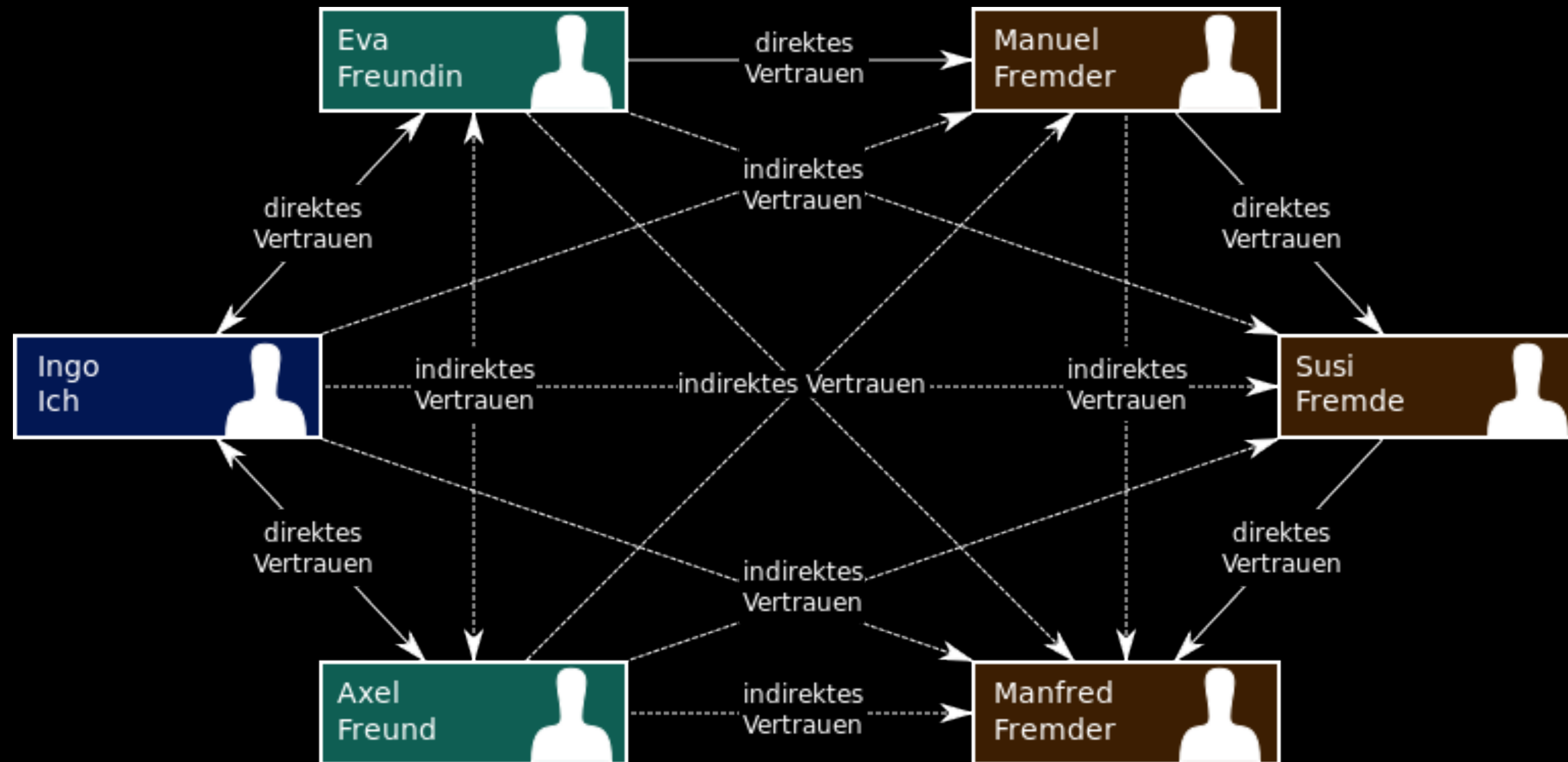
Keychain - cryptographic artifacts as IPFS objects

for CA system



Keychain - cryptographic artifacts as IPFS objects

for Web of Trust



3. structs on IPFS

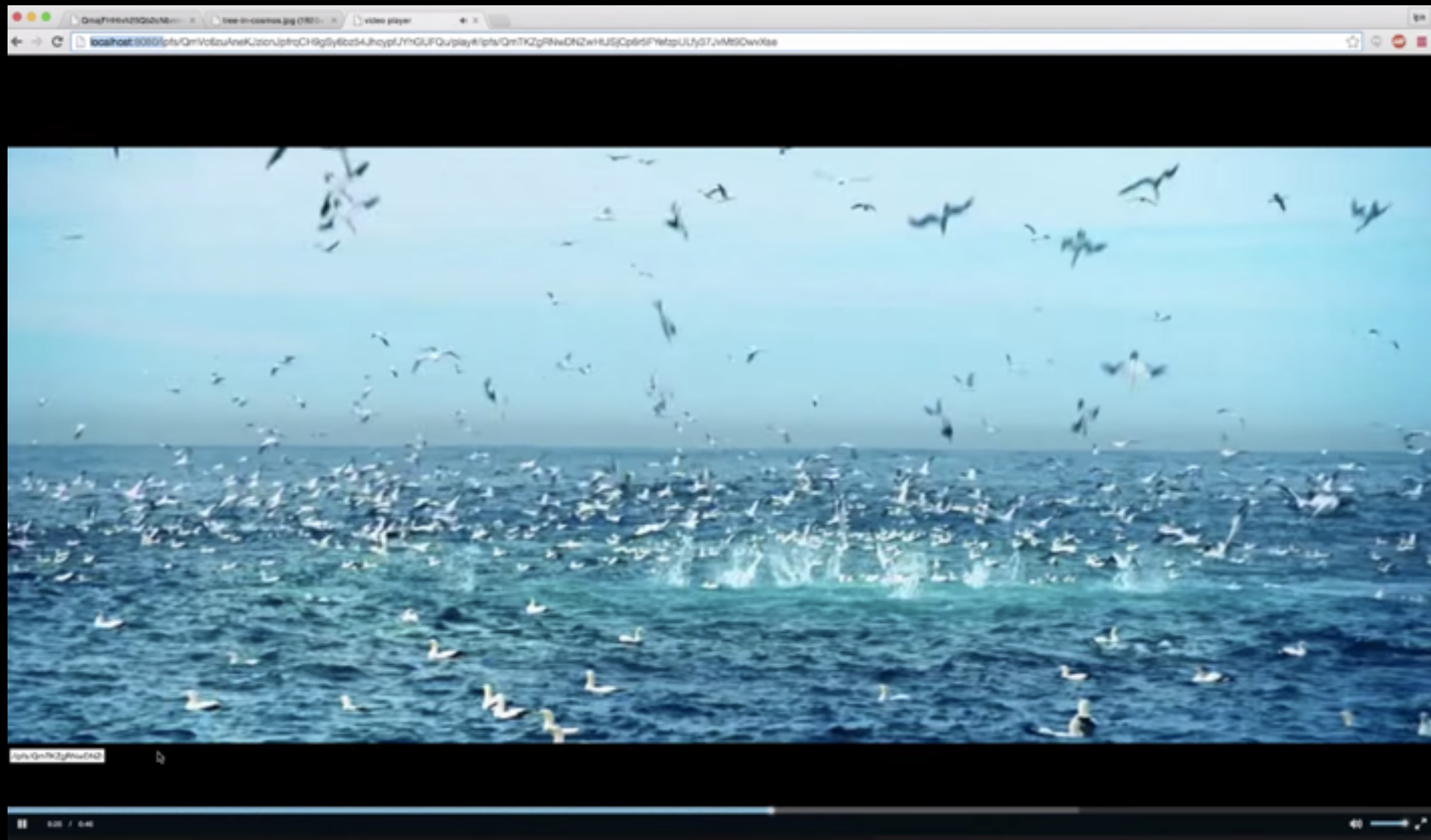
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Browser tabs: TeX for the web - Issue #5, ipfs law - Twitter Search, Louisiana Statutory Crim...

Address bar: <https://gateway.ipfs.io/ipfs/QmbeQDMbw8cdvyBZ9BeKTWfe2XUbSXBc5FY9EqFFgY2Q/>

LACrimBook

Home About Favorites -

Search Statutes

- ▶ Title 14
- ▶ Title 15
- ▶ Title 32
- ▶ Title 40
- ▶ Title 46
- ▶ Title 56
- ▶ Code of Criminal Procedure
- ▶ Code of Evidence
- ▶ Childrens Code
- ▶ Constitution



Browser window with multiple tabs: "TeX for the web - Issue #5", "ipfs law - Twitter Search", and "Louisiana Statutory Criminal". The active tab shows a page titled "LACrimBook" with a search bar and a navigation menu.

Search Statutes

- ▶ Title 14
- ▶ Title 15
- ▶ Title 32
- ▶ Title 40
- ▶ Title 46
- ▶ Title 56
- ▶ Code of Criminal
- ▶ Code of Evidence
- ▶ Childrens Code
- ▶ Constitution

Browser window showing a picture hosted on ipfs.pics. The address bar contains the URL: ipfs.pics/QmWp2buQNoU1YYhu1K8Z9DyMx21nhKVN1YAvzgaQQvVJMn.

[ipfs.pics] Upload Random View

A close-up photograph of a fluffy orange kitten being held in a person's hands. The kitten has bright green eyes and is looking slightly to the left. The background is a plain, light-colored surface.



TeX for the web - Issue #5 | ipfs law - Twitter Search | Louisiana Statutory Crimi...

https://gateway.ipfs.io/ipfs/QmbeQDMbw8cdvyBZ9BeKTWfe2XUbsXBc5FY9EqFfGy2Q/

LACrimBook

Home About Favorites -

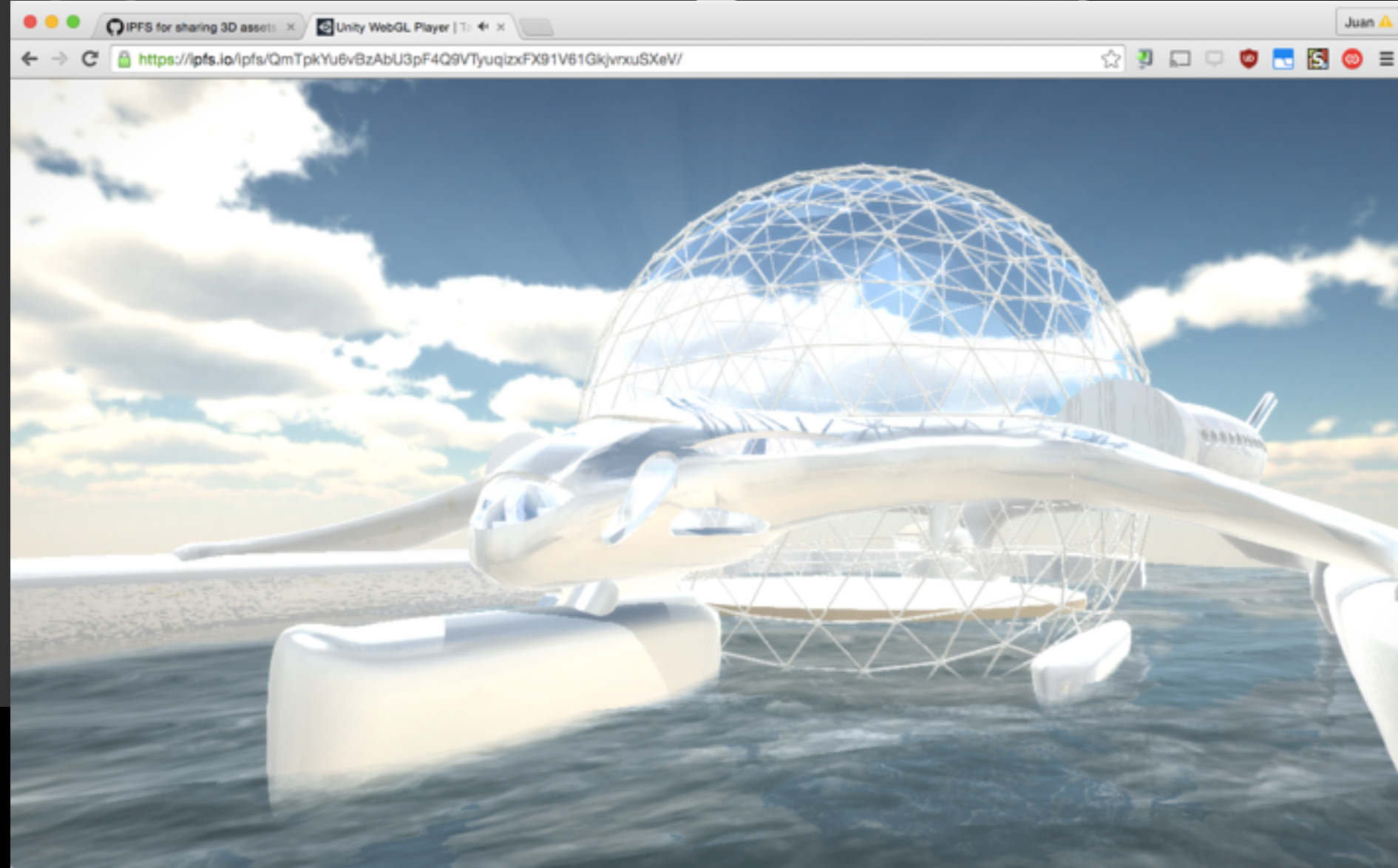
Search Statutes

- Title 14
- Title 15
- Title 32
- Title 40
- Title 46
- Title 56
- Code of Criminal
- Code of Evidence
- Childrens Code
- Constitution

A picture hosted on the pi...

ipfs.pics/QmWp2buQNoU1YYhu1K8Z9DyMx21nhKVN1YAvgzaQQvVJMn

[ipfs.pics] Upload Random View





Browser tabs: TeX for the web - Issue #5, ipfs law - Twitter Search, Louisiana Statutory Crimi...

Address bar: <https://gateway.ipfs.io/ipfs/QmbeQDMbw8cdvyBZ9BeKTWfe2XUbsXBc5FY9EqFfGYZQ/>

LACrimBook

Home About Favorites -

Search Statutes

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Browser tabs: A picture hosted on the pi...

Address bar: ipfs.pics/QmWp2buQNoU1YYhu1K8Z9DyMx21nhKVN1YAvgzaQQvVJMn

[ipfs.pics] Upload Random View

Browser tabs: IPFS for sharing 3D assets, Unity WebGL Player | T...

Address bar: <https://ipfs.io/ipfs/QmTpkYu6vBzAbU3pF4Q9V7YyuqzxFX91V61GkjvrxuSXeV/>

Browser tabs: maxresdefault.jpg (1280x...)

Address bar: i.ytimg.com/vi/X5LFGDWZQqM/maxresdefault.jpg

gateway.ipfs.io/ipfs/QmbeQDMbw8cdvyBZ9BsKTWe2XUbsXBc5FY9EqFfGfY2Q/

LACrimBook

Home About Favorites

Search Statutes

- Title 14
- Title 15
- Title 32
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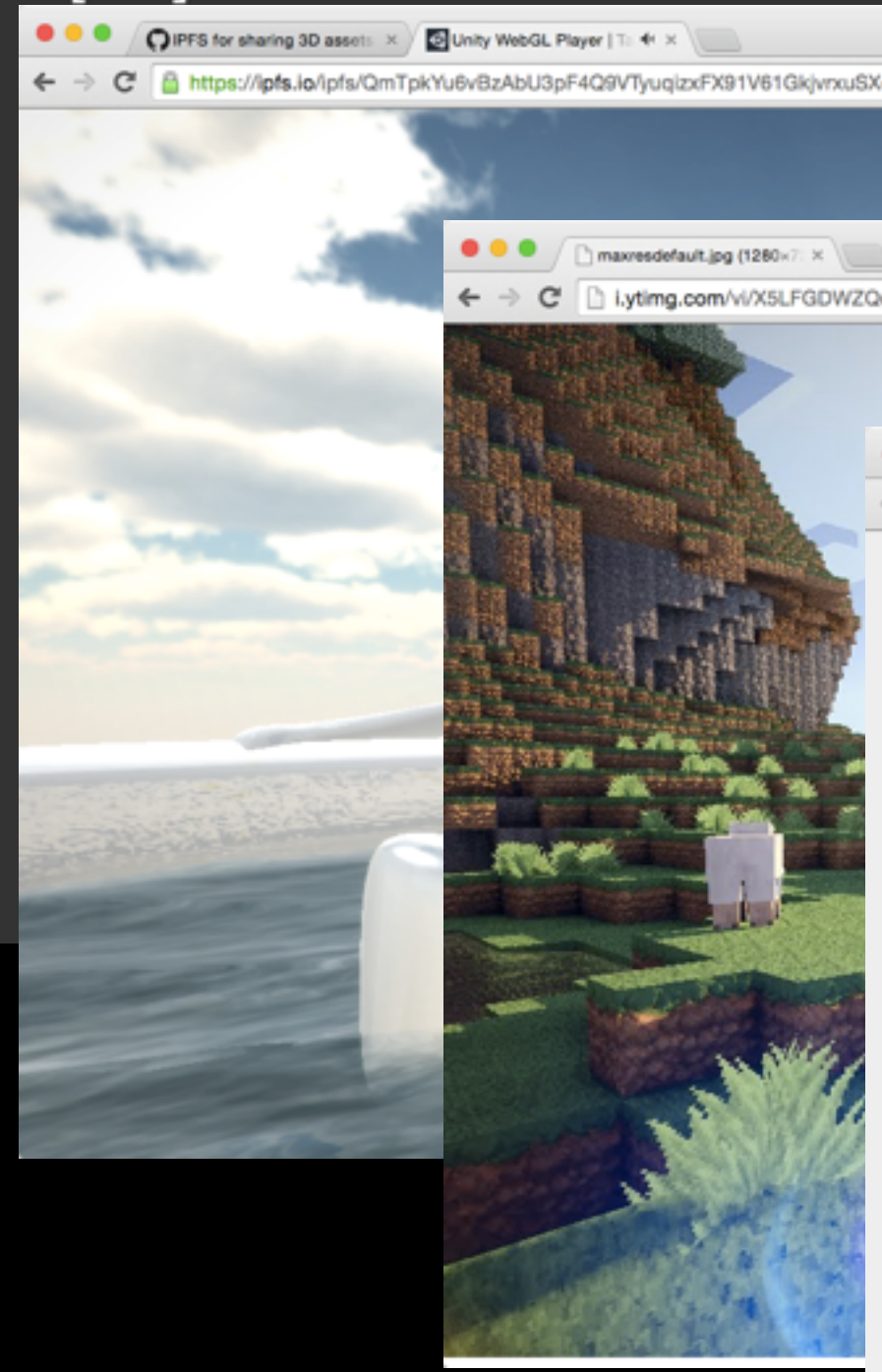


ipfs.pics

Upload Random View

maxresdefault.jpg (1280x720)

lytimg.com/vi/X5LFGDWZQqM/maxresdefault.jpg



A New Limit on Time-Reversal

https://ipfs.io/ipfs/Qmav57P5mmwcpUtmgRb2tp9j6YpXZdgobxDv7VBeJgtCp/

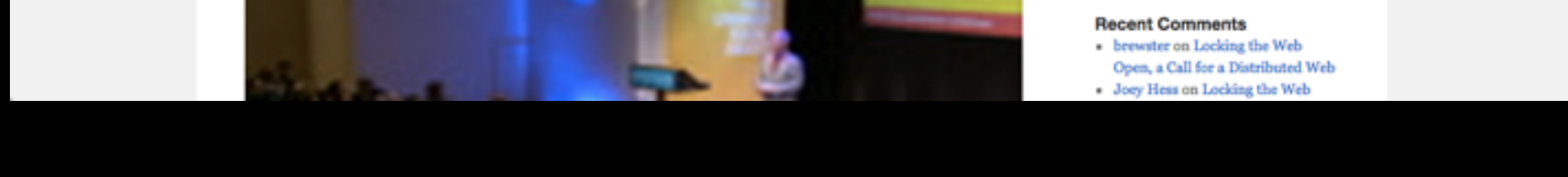
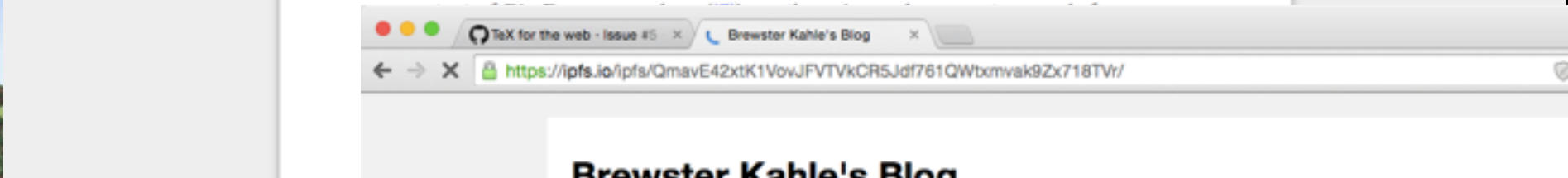
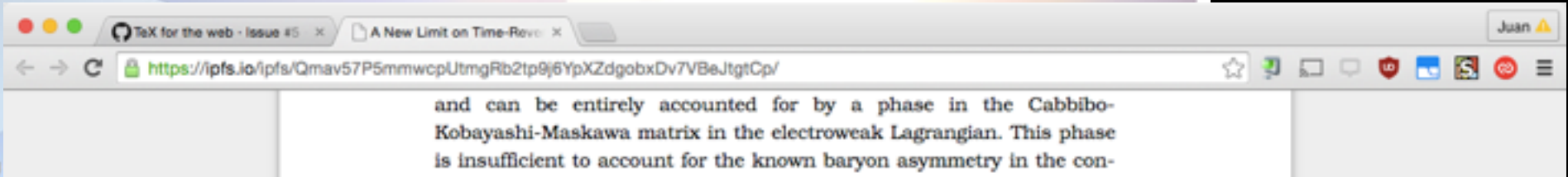
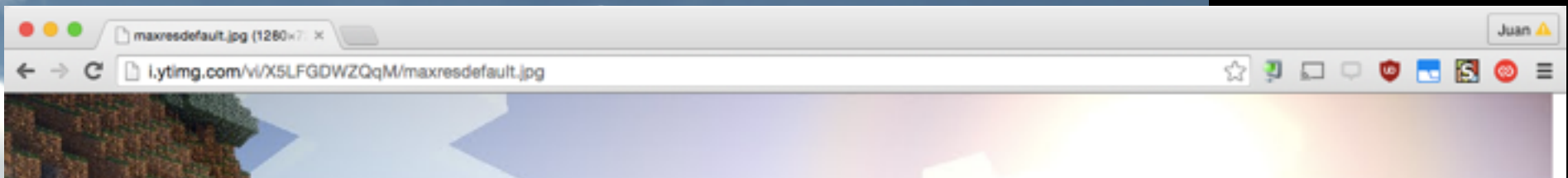
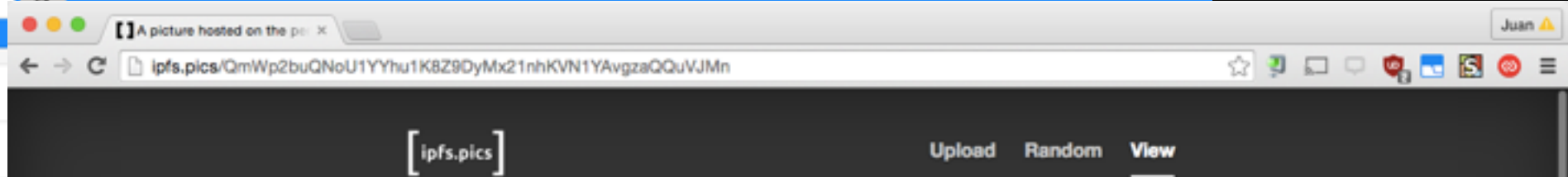
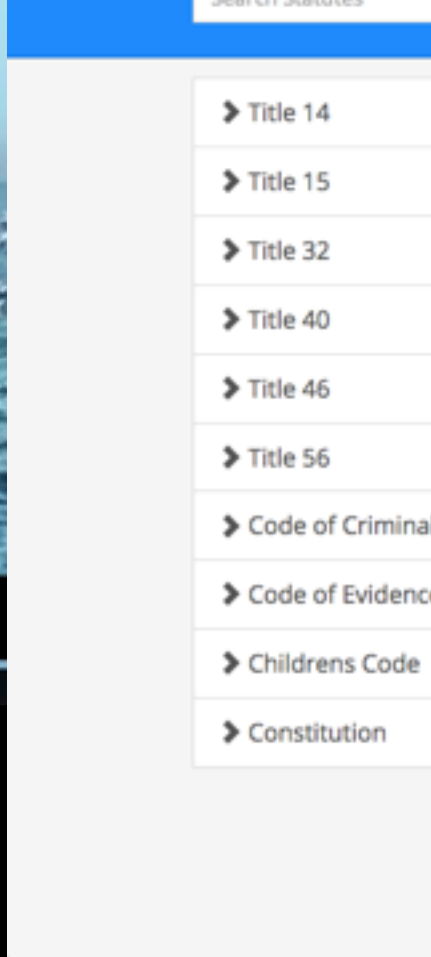
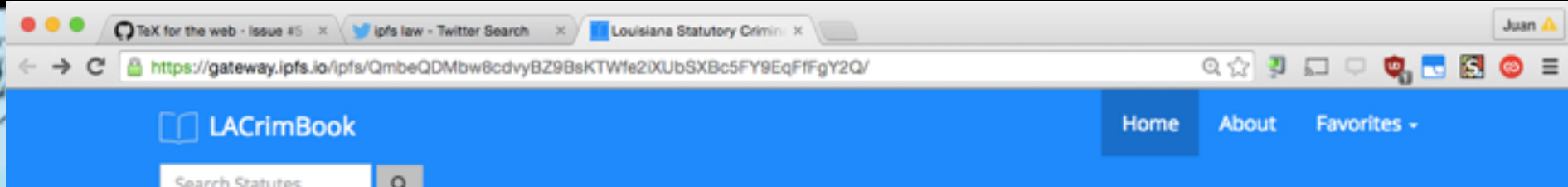
and can be entirely accounted for by a phase in the Cabbibo-Kobayashi-Maskawa matrix in the electroweak Lagrangian. This phase is insufficient to account for the known baryon asymmetry in the context of Big Bang cosmology ([5]), so there is good reason to search for CP violation in other systems. As CP and time-reversal (T) violation can be related to each other through the CPT theorem, experimental limits on electric dipole moments and T-odd observables in nuclear beta decay place strict constraints on some, but not all, possible sources of new CP violation.

Figure 1: A schematic of the emiT detector illustrating the alternating electron and proton detector segments. The darker shaded proton detectors indicate the the paired-ring at $z = \pm 10$ cm. The cross section view illustrates, in an exaggerated manner, the effect of the magnetic field on the particle trajectories and average opening angle. A $P_2 E_3$ coincidence event is shown.

The decay probability distribution for neutron beta decay, dW , can be written in terms of the beam polarization \mathbf{P} and the momenta (energies) of the electron \mathbf{p}_e (E_e) and antineutrino \mathbf{p}_ν (E_ν) as ([6])

$$dW \propto 1 + a \frac{\mathbf{p}_e \cdot \mathbf{p}_\nu}{E_e E_\nu} + b \frac{m_e}{E_e} + \mathbf{P} \cdot \left(A \frac{\mathbf{p}_e}{E_e} + B \frac{\mathbf{p}_\nu}{E_\nu} + D \frac{\mathbf{p}_e \times \mathbf{p}_\nu}{E_e E_\nu} \right). \quad (1)$$

A contribution of the parity-even triple correlation $DP \cdot (\mathbf{p}_e \times \mathbf{p}_\nu)$ above





Browser window with tabs: "TaX for the web - Issue #5", "ipfs law - Twitter Search", "Louisiana Statutory Crimi...".

Address bar: <https://gateway.ipfs.io/ipfs/QmbeQDMbw8cdvyBZ9BsKTWe2XUbsXBc5FY9EqFFgY2Q/>

Page title: LACrimBook

Navigation: Home About Favorites -

Search: Search Statutes

- ▶ Title 14
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Browser window showing a picture hosted on ipfs.pics.

Address bar: <https://ipfs.pics/QmWp2buQNoU1YYhu1K8Z9DyMx21nhKVN1YAvGzaQQvVJMn>

Page title: [ipfs.pics]

Navigation: Upload Random View

Browser window showing a 3D scene in a Unity WebGL Player.

Address bar: <https://ipfs.io/ipfs/QmTpkYu6vBzAbU3pF4Q9V7YyuzFX91V61GkYrxuSXeV/>

Browser window showing a 3D scene of a landscape with a waterfall.

Address bar: <https://i.ytimg.com/vi/X5LFGDWZQqM/maxresdefault.jpg>

Browser window showing a text-based article.

Address bar: <https://ipfs.io/ipfs/Qmav57P5mmwcpUtmgRb2tp9j6YpXZdgobxDv7VBeJtgtCp/>

Text: and can be entirely accounted for by a phase in the Cabbibo-Kobayashi-Maskawa matrix in the electroweak Lagrangian. This phase is insufficient to account for the known baryon asymmetry in the con-

Browser window showing a blog post.

Address bar: <https://ipfs.io/ipfs/QmavE42xtK1VovJFVTvKCR5Jdf781QWbmxak9Zx718TV/>

Page title: Brewster Kahle's Blog

IPFS interface showing a globe and a list of connected peers.

Address bar: <localhost:5001/ipfs/QmS2HL9v5YeKgQkkWMvs1EMnFtUowTEdFISseMT4pos1e6/#/connections>

Page title: IPFS

Navigation: Home Connections Files DAG Config Logs

CONNECTED TO 146 PEERS

QmNRRwxGga5hgGhKZc8S1rXWzeEaymGHAw2KtbGj5iFYgB	/p4/50.186.41.164/tcp/4001/ipfs
QmNskXT3CdF84WpKDXpKxYsBoJBGuAM4E9jDAMDdKq	/p4/46.101.230.105/tcp/4001/ipfs
QmNVQVCgdL3azGaiLfqSSYQrgSD7jEogLjGmrQ8LxNDzt	/p4/5.172.41.102/tcp/4001/ipfs
QmNeK3hRF5Pu9dPcMDKXyYofQloskuGfQZEQz43UDkLepK	/p4/178.62.206.163/tcp/4001/ipfs
QmNt2nZ3tWc8hbAbGNmIQON9TmPAkpwKztjH8xZvcv3eF	/p4/104.131.53.68/tcp/4001/ipfs
QmNlbdCnY2GJaXK4Eom9kTQ1utF9vzaAGRrYnHET3bDQdj	/p4/103.16.131.169/tcp/4001/ipfs
QmNjRVohhWBX31EoaAXkrj5mPF9vQncTvVqGWHNwdxweCN	/p4/158.69.62.218/tcp/4001/ipfs
QmNkzcep9e4TQYvlpd7Nv8NEj4gQ72aMSnL69j9qvZ5V	/p4/87.98.218.15/tcp/4001/ipfs
QmNoDNpuYFWnVFN4hHuGojHcewF4bamd7c7BTp3g41uel2	/p4/128.120.246.131/tcp/4001/ipfs
QmNslJFEjmRBC34NHqWH5oEVqCQNX2JDEmBM5yw7HRAcM	

3. structs on IPFS

- **unixfs:** Files as you know them
- **commit:** Git style versioning
- **CRDTs:** sane mutable data
- **keychain:** PKI and crypto artifacts
- **persona:** identity management
- **post:** sane communication
- **html:** hey! websites!
- **boards:** forums, reddit, 4chan
- **starship:** containers at hyperspeed
- **blockchains:** interconnected



Address

0x3888630926a62680e30855c18f2c1eb6fa7c7da8

Ether Balance

842.80934291114032864

<swarmchan>

Boards

Japanese Culture	Interests	Creative	Other
Anime & Manga	Video Games	Photography	Travel
Transportation	Robotics	Food & Cooking	Paranormal
Culture	Comics & Cartoons	Artwork/Critique	Advice
History	Technology	Music	Literature
Martial Arts	TV & Film	Graphic Design	Random



swarmchan - Mozilla Firefox

Restore Session x swarmchan x

localhost:8080/ipfs/QmbEiYw1LaUFTkMewy6s537sdsHn3tEKLuoQzXJsWuabHg/#/boards

IPFS ethereum swarmchan v0.0.1 a permanent board Boards Source

Address
0x3888630926a62680e30855cf8f2c1eb6fa7c7da8

Ether Balance
842.80934291114032864

Inspector Console Debugger

- Net
- CSS
- JS
- Security

All candidate resources failed to load. Media
<source> element has no "src" attribute. Media
All candidate resources failed to load. Media
<source> element has no "src" attribute. Media
All candidate resources failed to load. Media
Use of getPreventDefault() is deprecated. Use
Object { host: "http://localhost:8545" }

swarmchan - Mozilla Firefox

Restore Session x swarmchan x

localhost:8080/ipfs/QmbEiYw1LaUFTkMewy6s537sdsHn3tEKLuoQzXJsWuabHg/#/technology

IPFS ethereum swarmchan v0.0.1 a permanent board Boards Source

Address
0x3888630926a62680e30855cf8f2c1eb6fa7c7da8

Ether Balance
842.80934291114032864

warning! this will cost ~ 0.002 Ether

Your name (Anon if left blank)

Say something

Drag and drop images or video here!

Post

Current data hash: QmQ1U85RGcAi7KDnoudActb2WpvXjNvNNiVae2bjNY4jm9

Show 10 per page

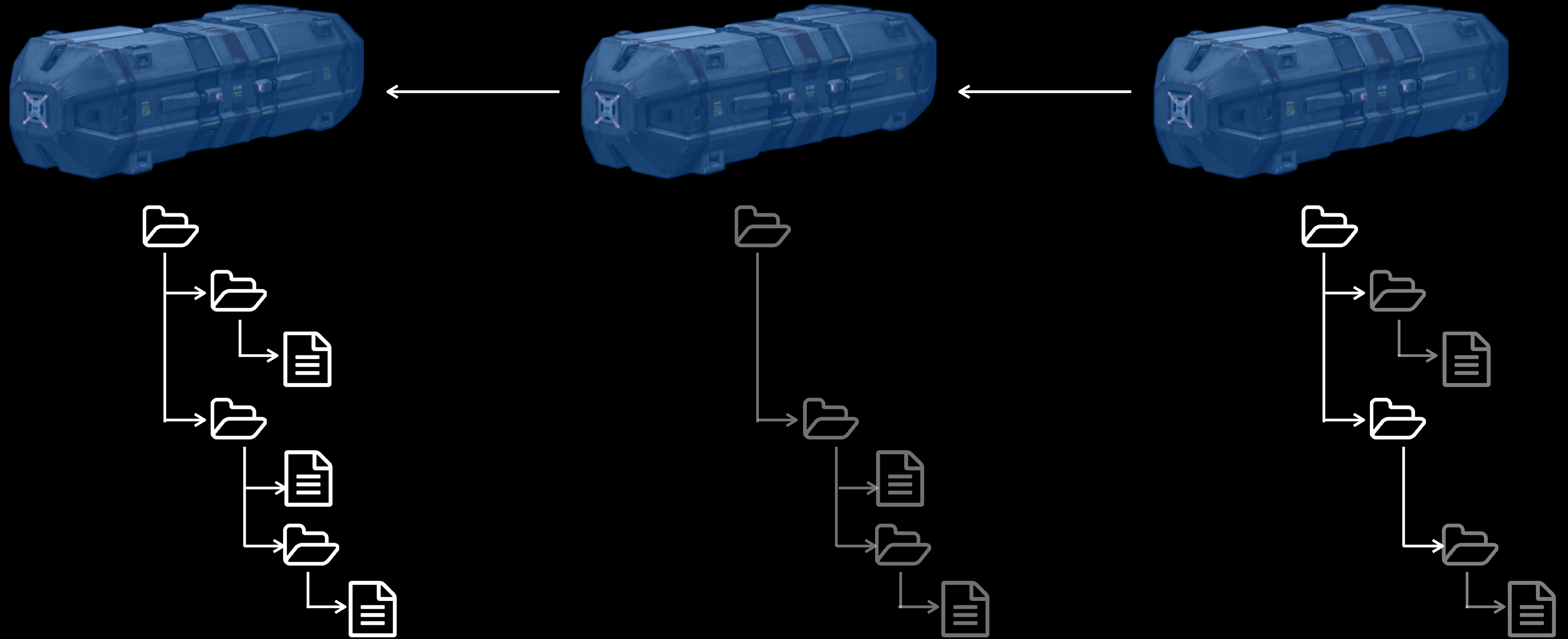
testing larger files... need loading status [reply](#)

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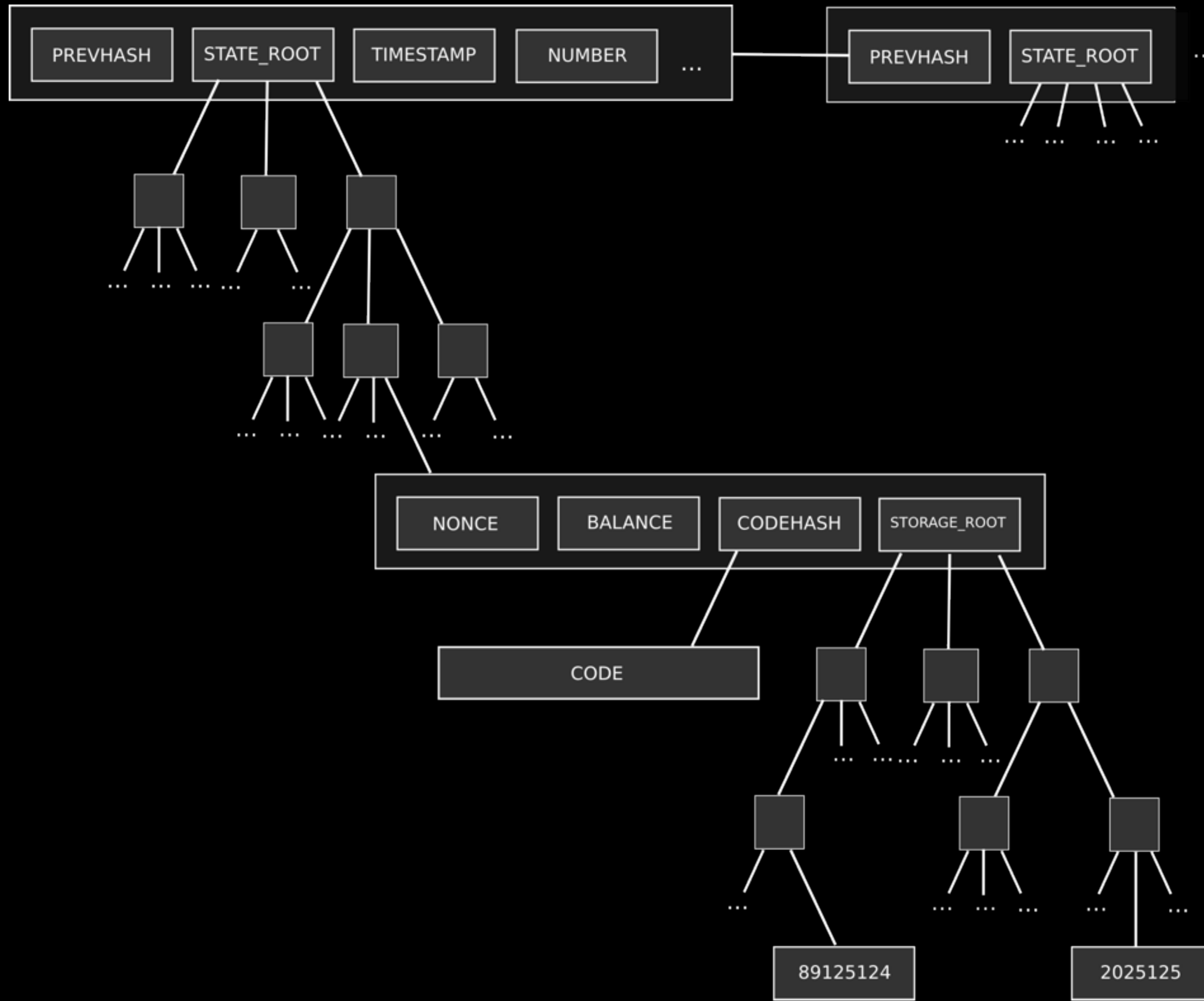
merkle-containers



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- **blockchains:** interconnected





DATASTRUCTURES IN + ON



IPFS

QCon
SAN FRANCISCO

ipfs.io
@juanbenet
2015-11-17