InterPlanetary FileSystem (IPFS)

FUTURE OF THE WEB

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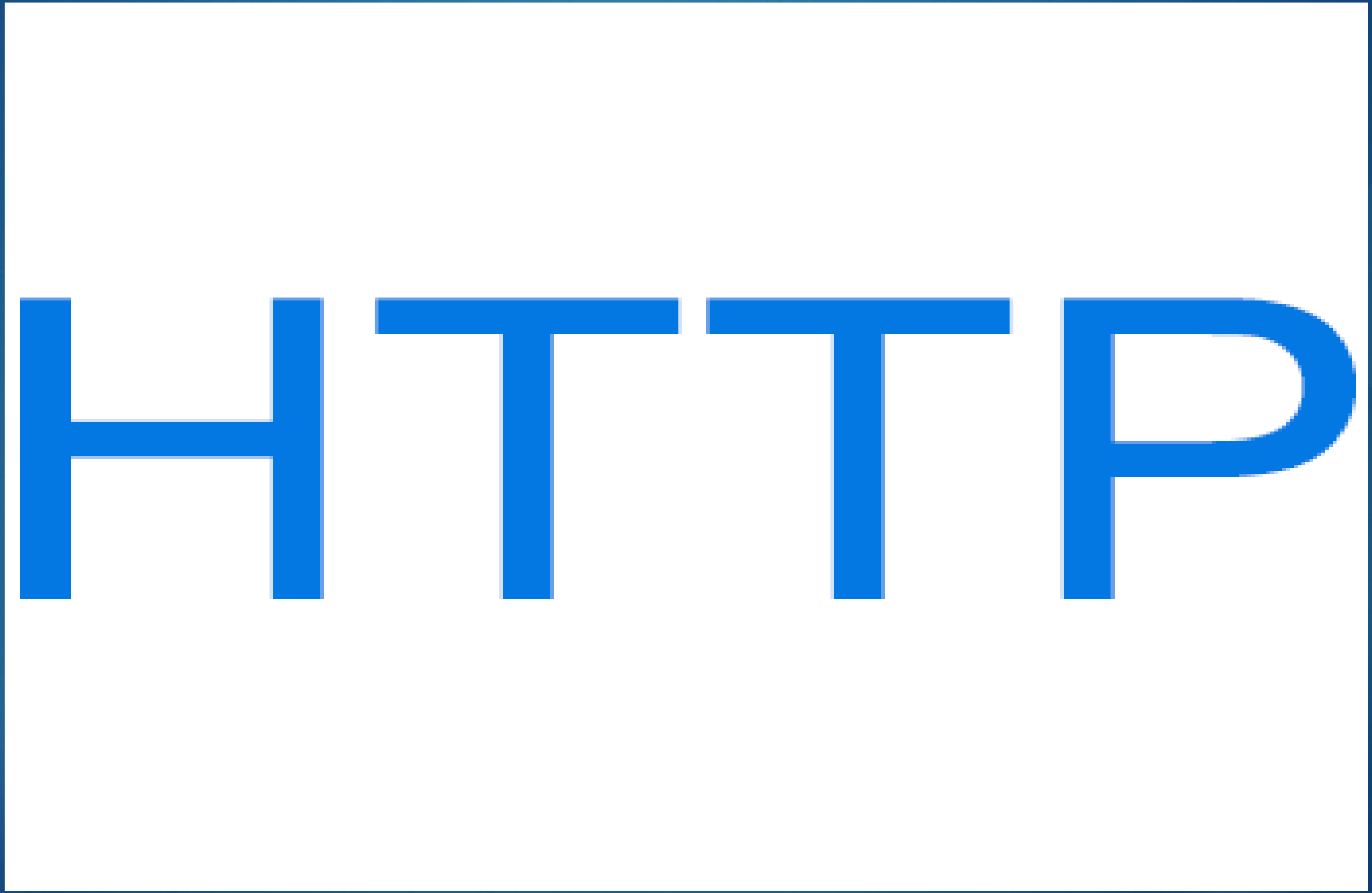
(FINAL YEAR COMPUTER ENGINEERING)

Uses Of the Internet

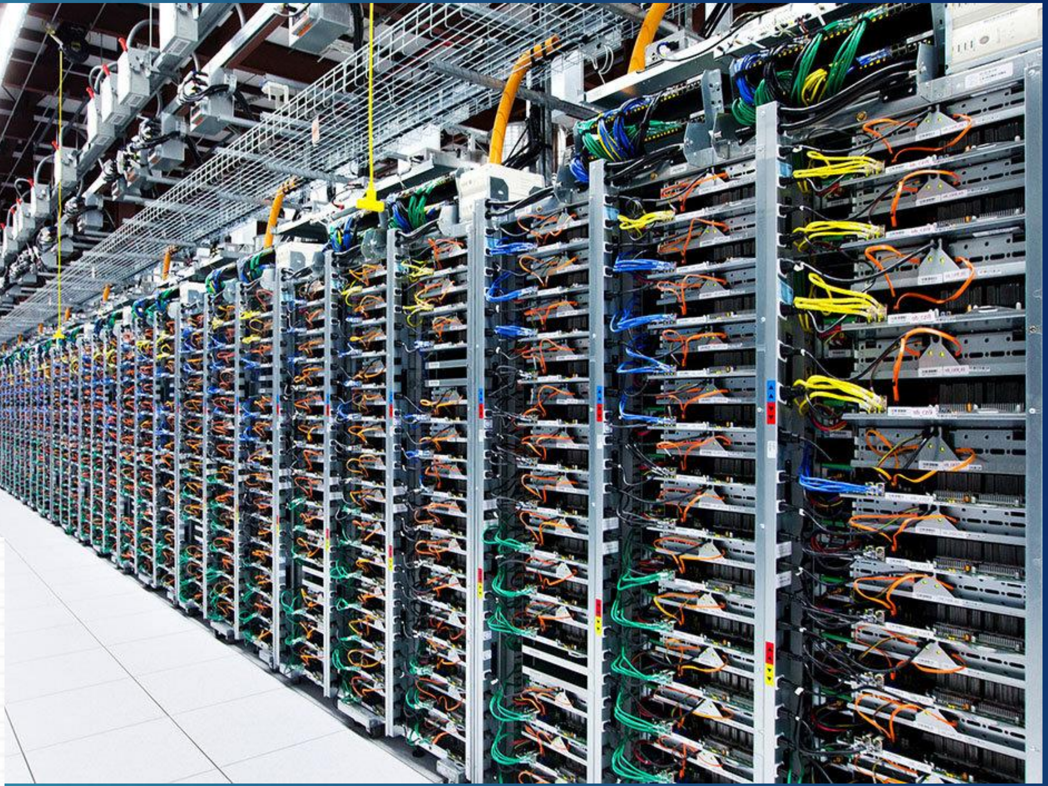


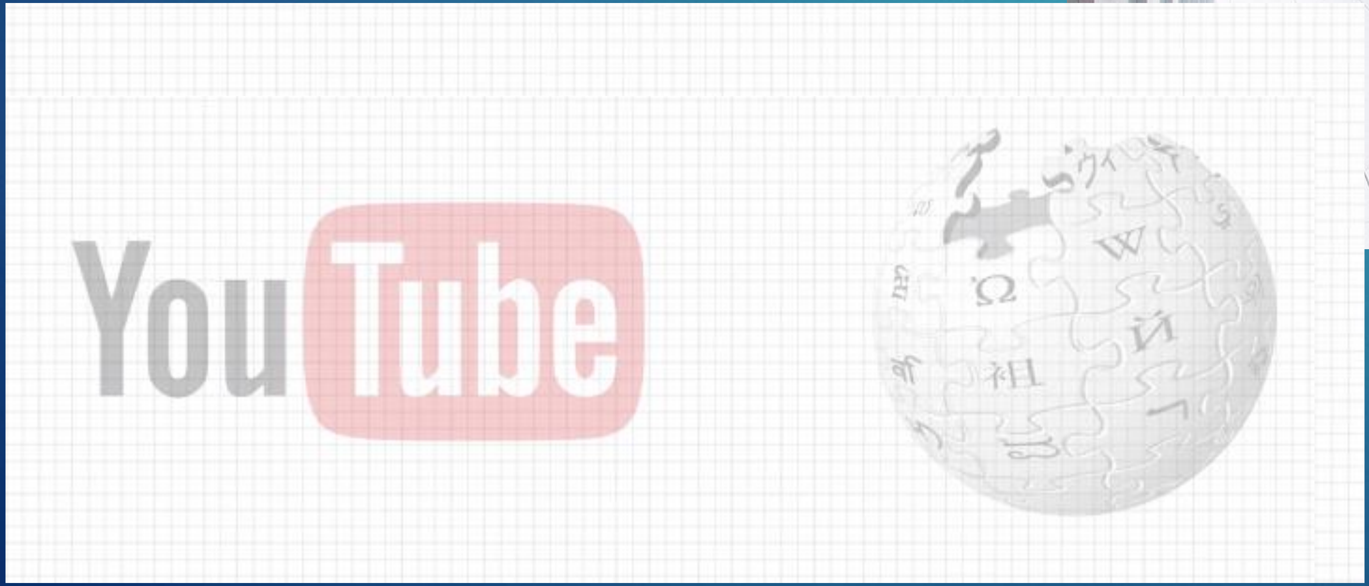
HTTP

Problems with HTTP

- Problem #1:

Centralized

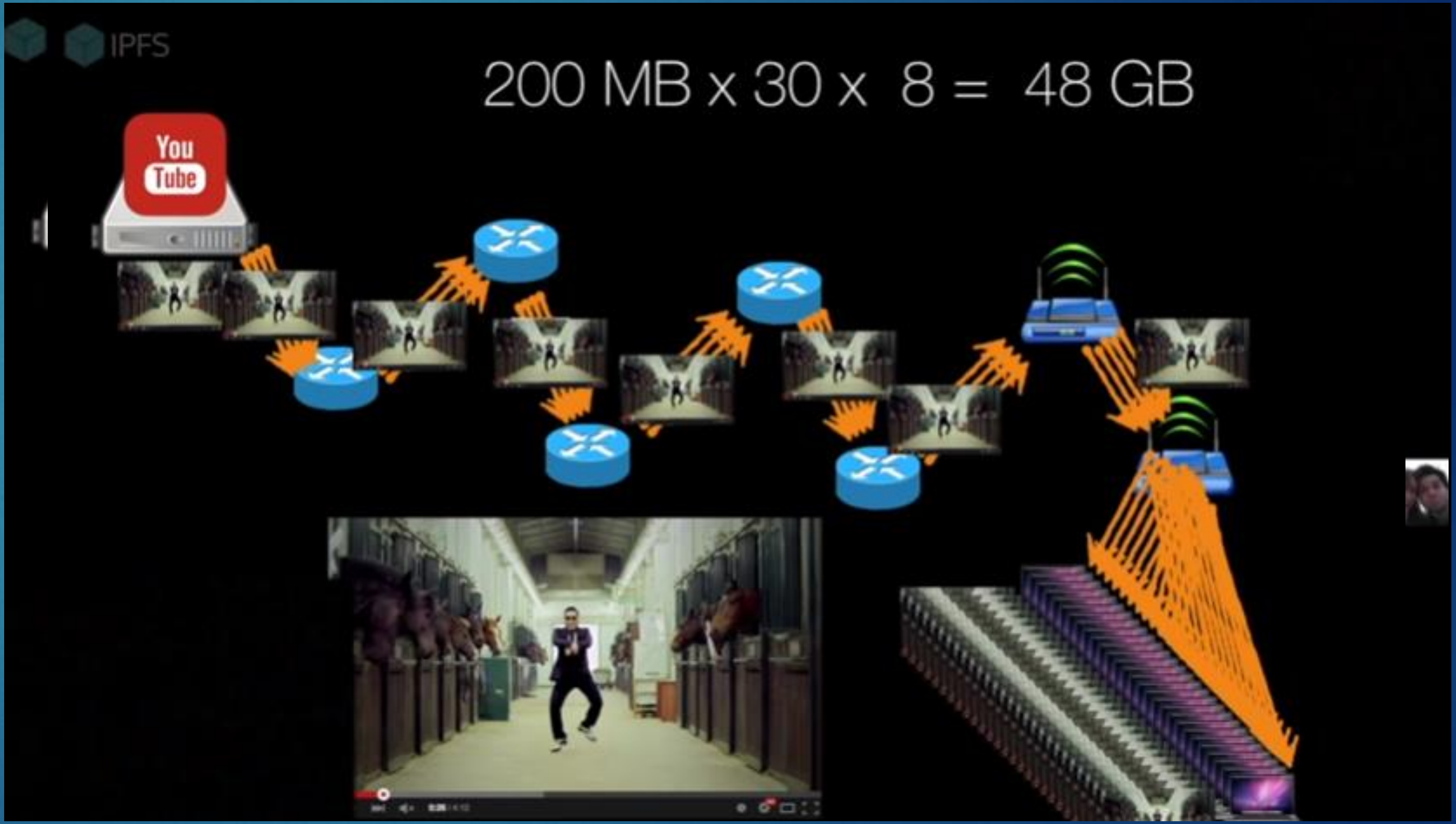




Problems with HTTP

- Problem #2:

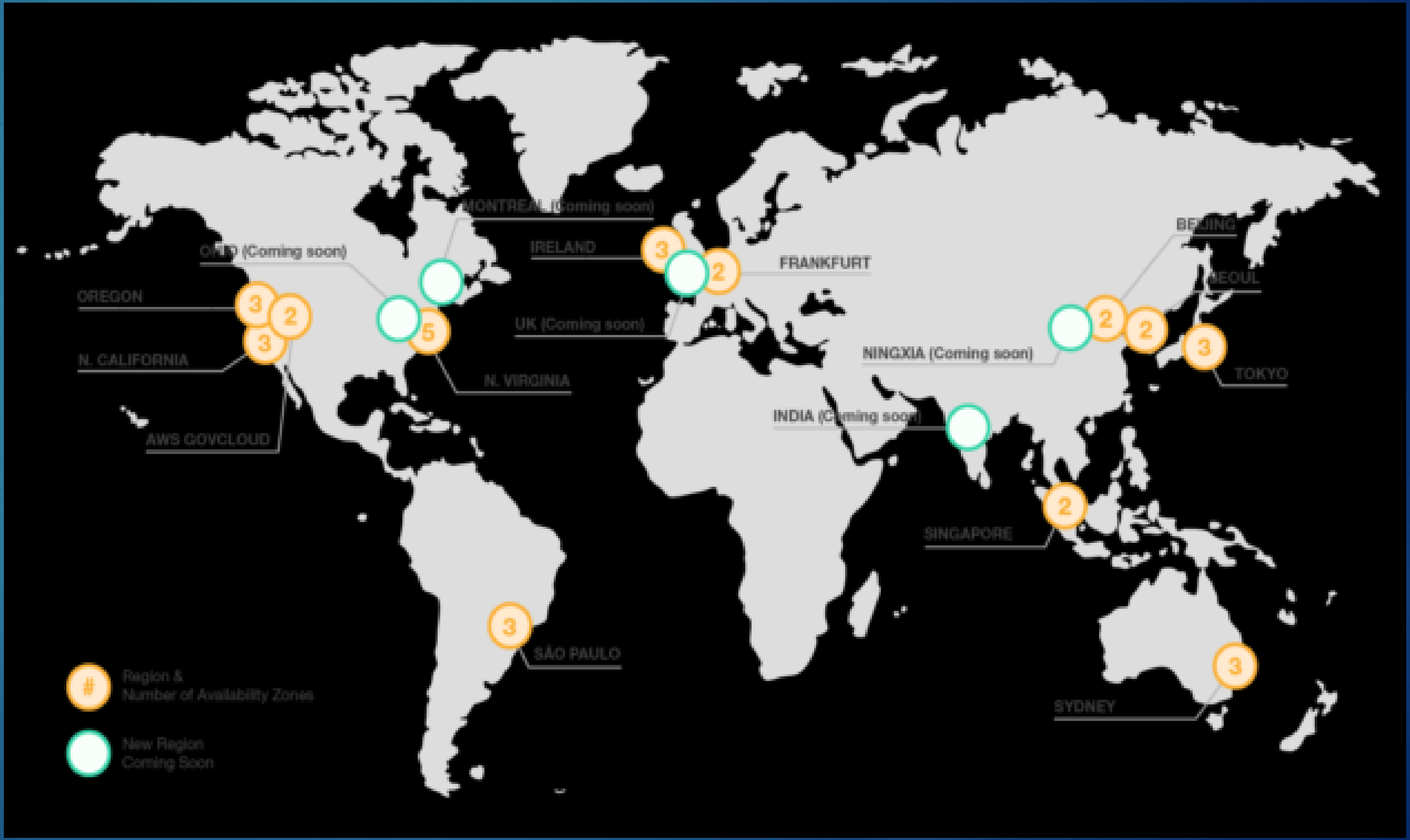
Bandwidth Usage



Problems with HTTP

- Problem #3:

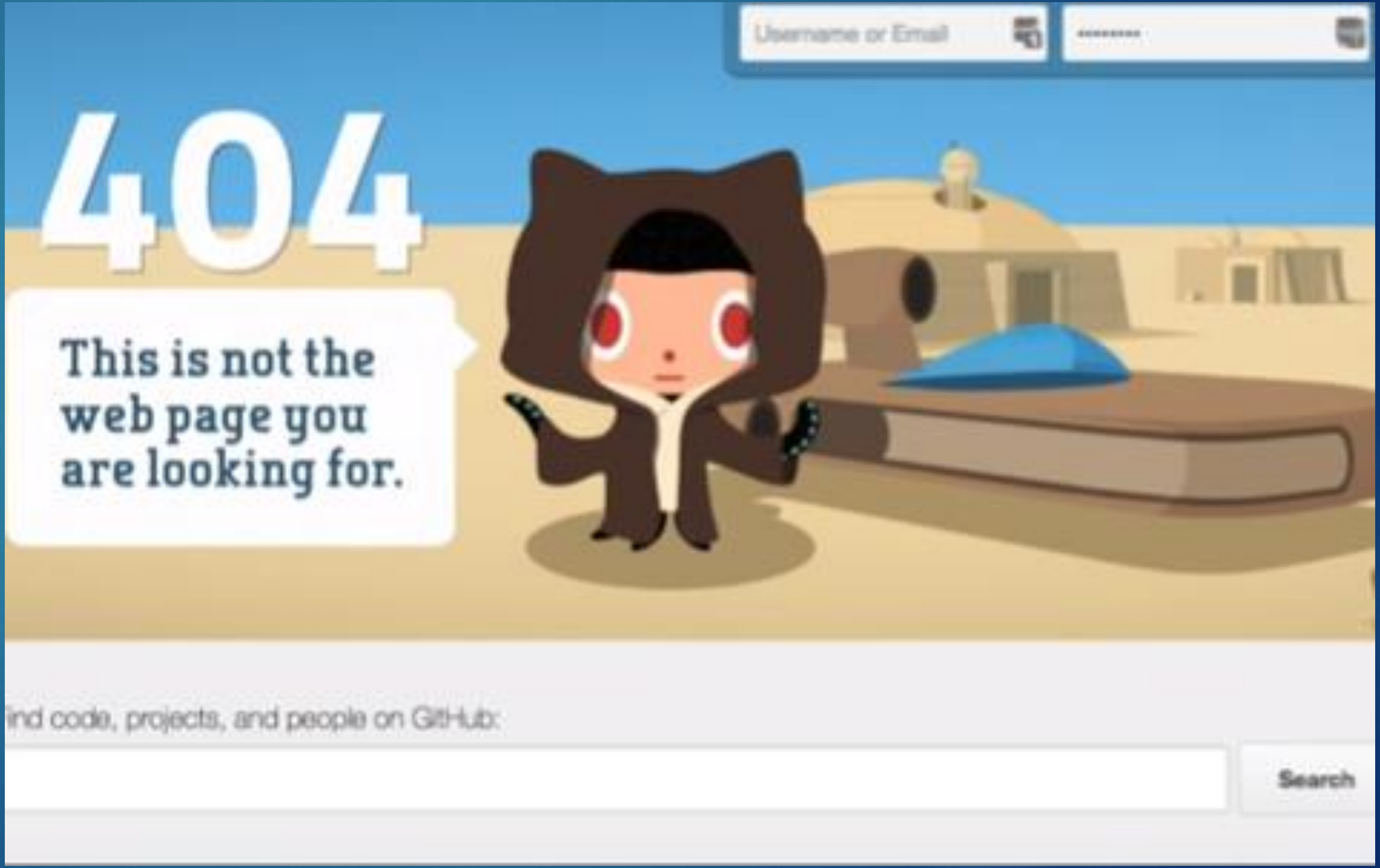
Latency



Problems with HTTP

- Problem #4:

The 404 error



404

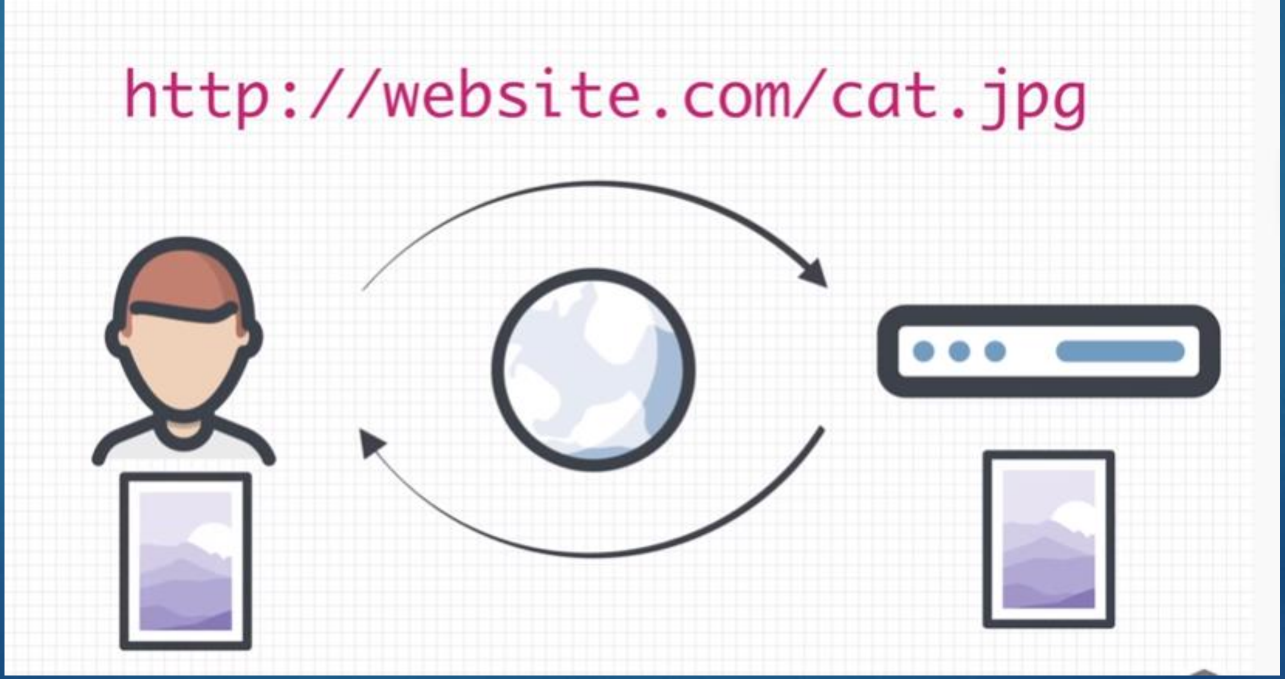
This is not the web page you are looking for.

IPFS

Location based addressing

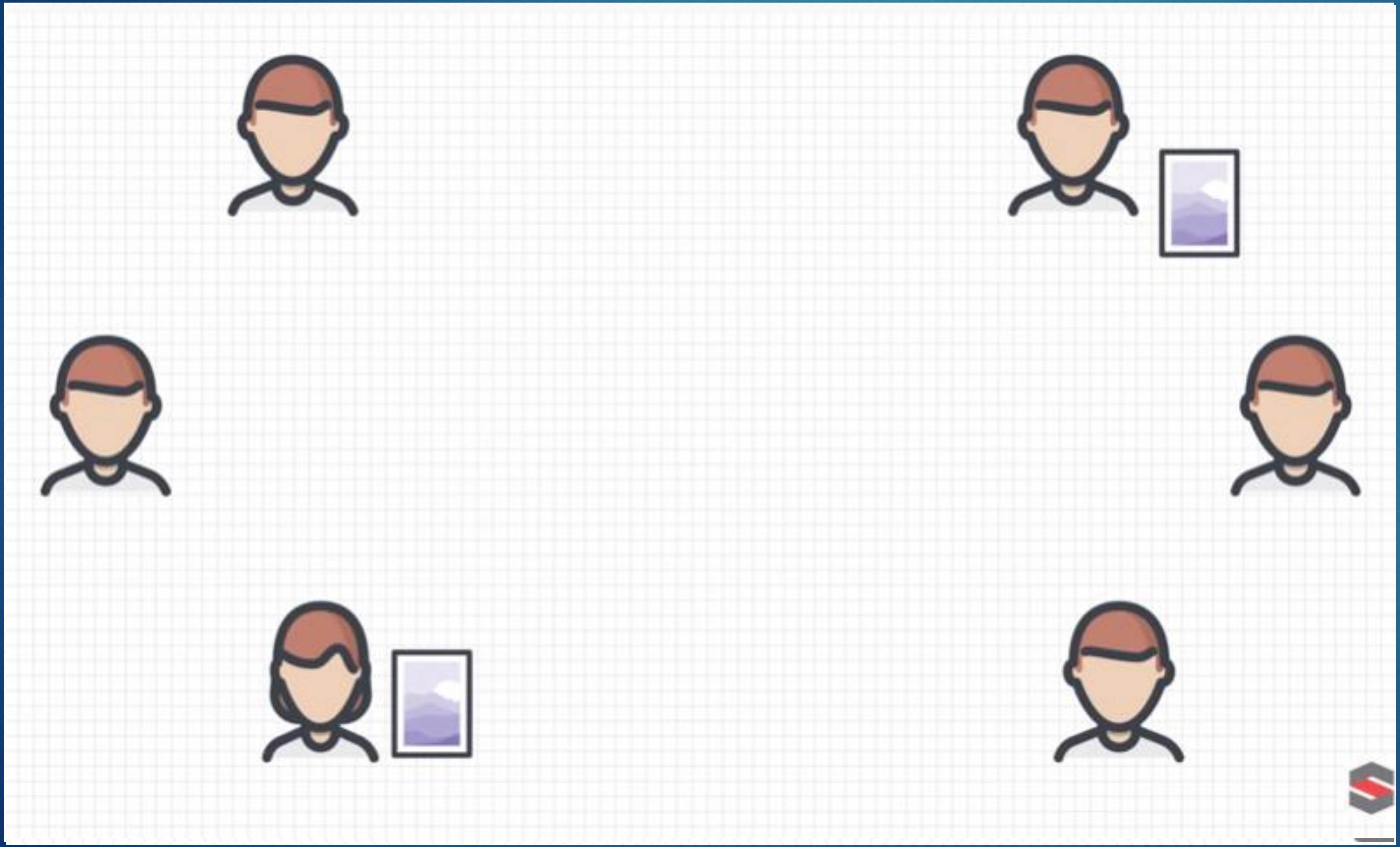
(Used in the web)

- You tell the computer where to find the content i.e the ip address
- If the server is down , the content becomes unavailable
- There is a high chance that someone else has downloaded the content!



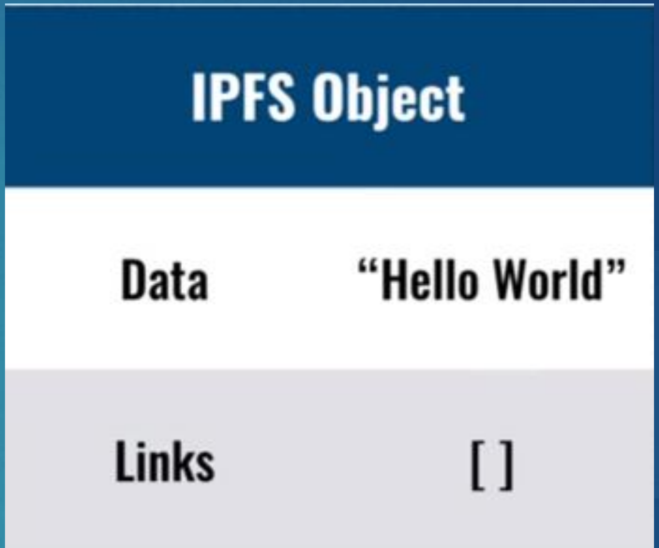
Content based addressing

Content has a unique identifier that is the cryptographic hash of the file



- ✓ Tamper proof
- ✓ Prevents duplication

How does IPFS store files?

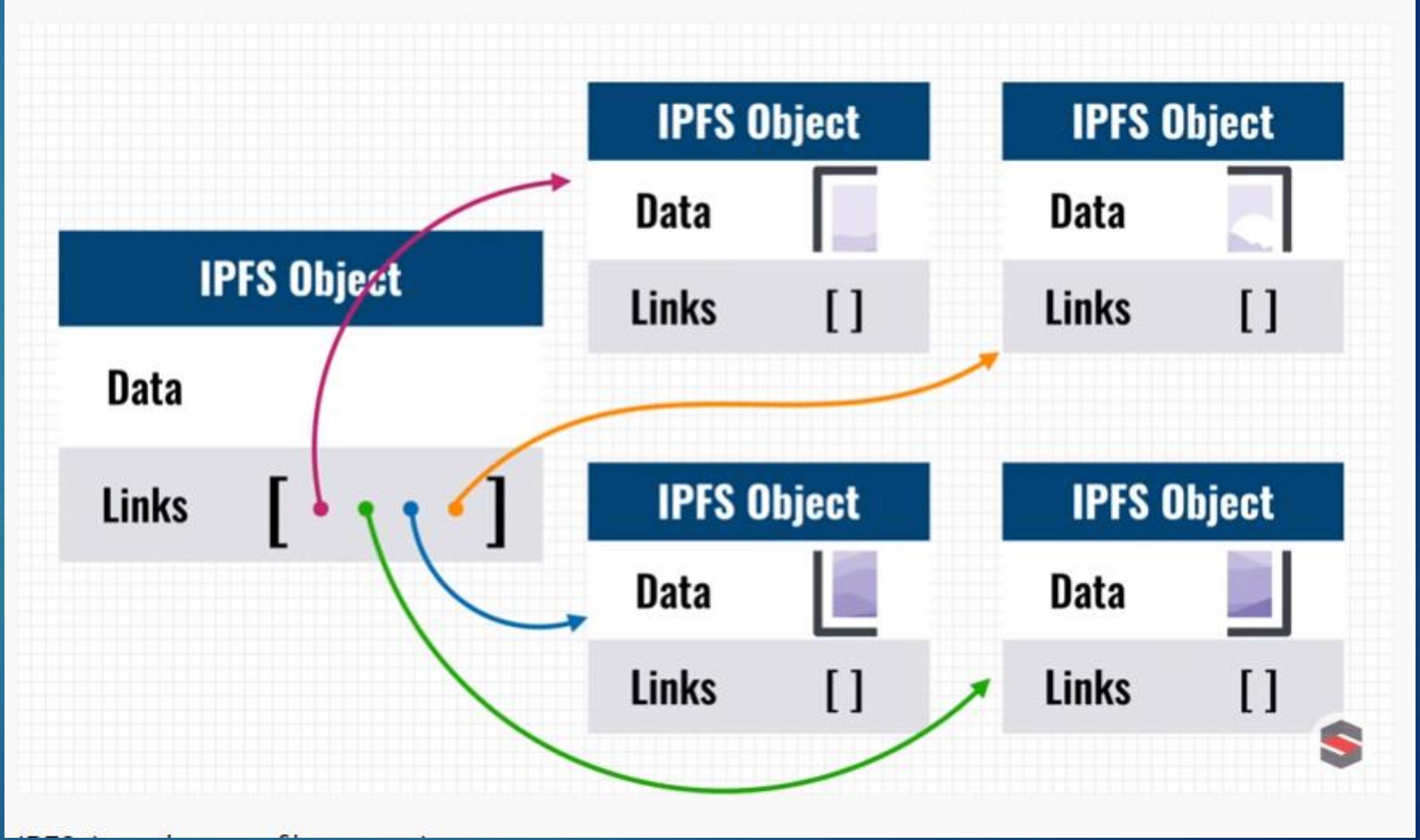


IPFS Object	
Data	“Hello World”
Links	[ ]

- Files are stored as objects
- 1 object = 256kb of data
- Links to other IPFS objects
- An HTTP request would look like **http://10.20.30.40/folder/file.txt**
- An IPFS request would look like **/ipfs/QmT5NvUtoM5n/folder/file.txt**

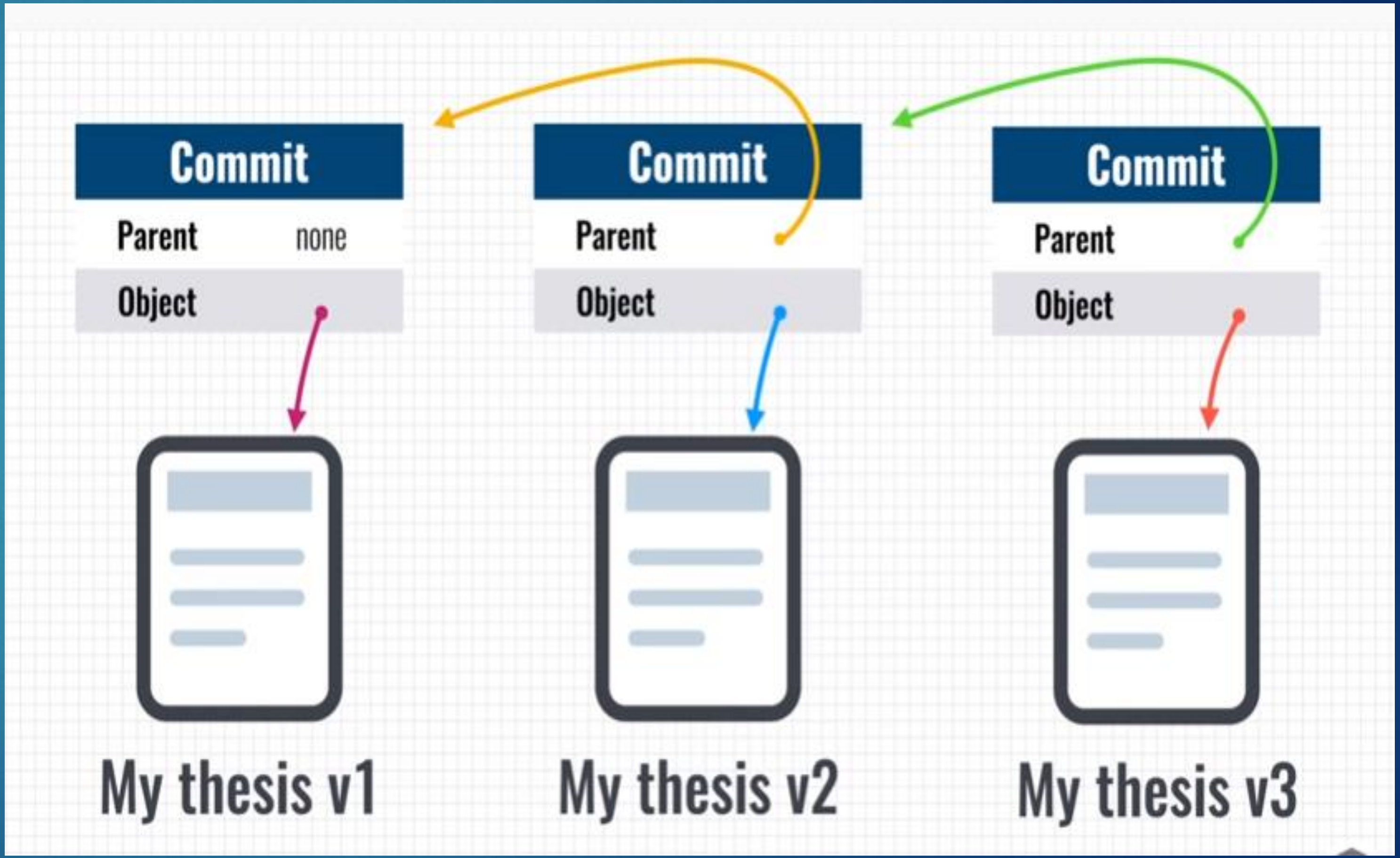
For files larger than 256kb?

- ➢Split it up



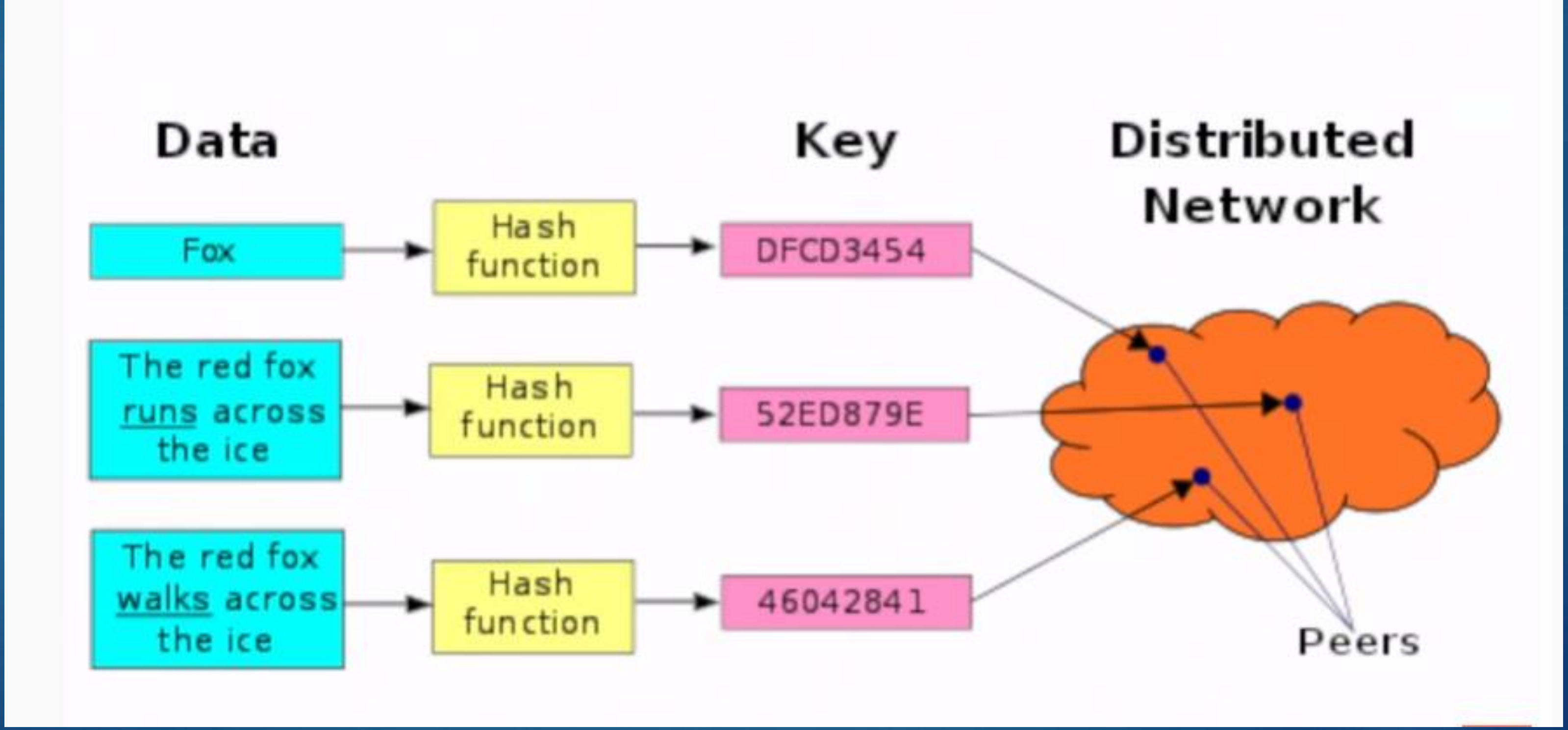
How does IPFS work?

- Creates a commit object
- New commit object links to the previous commit object



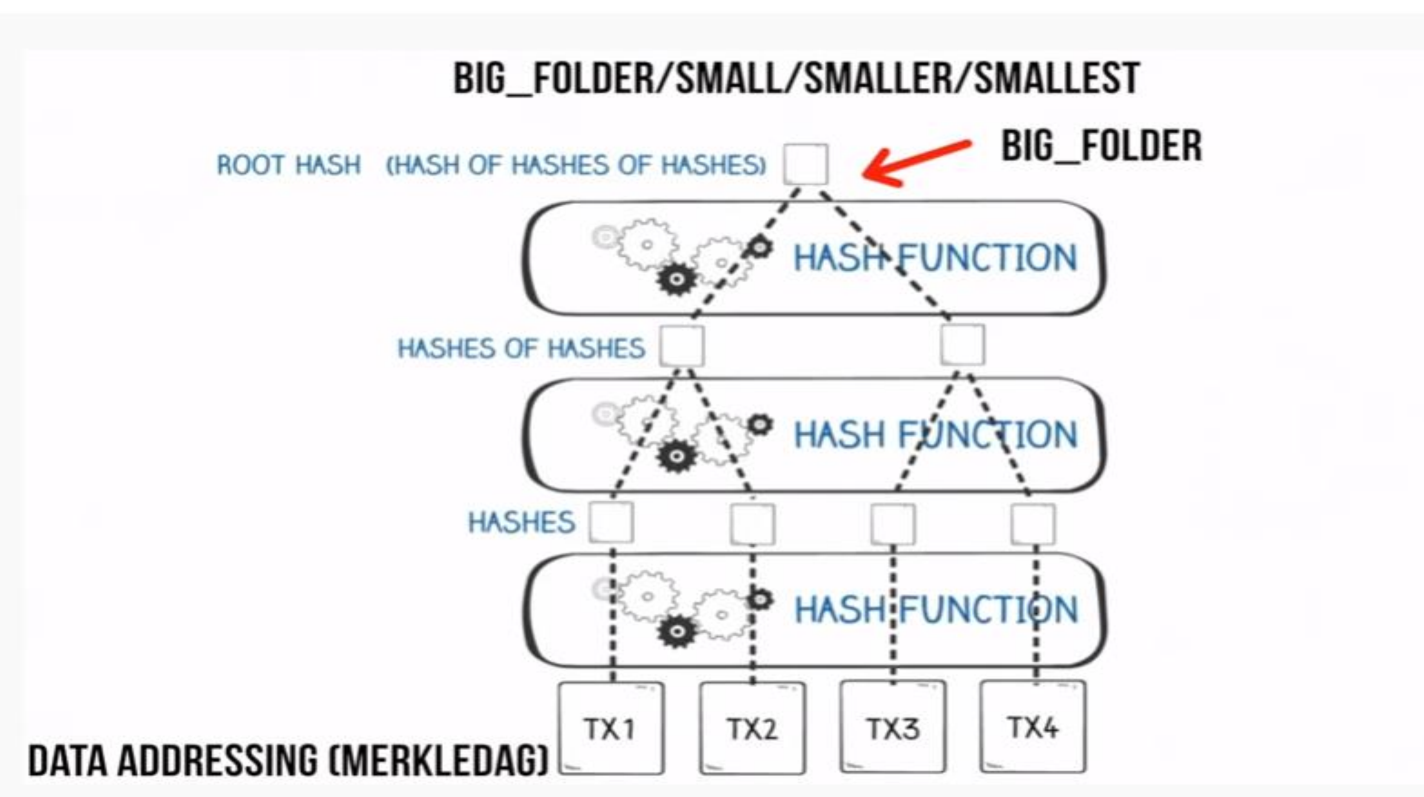
How does IPFS work?

- To store data it uses distributed hash table
- Data is exchanged by a method called Bitswap



How does IPFS work?

- When requesting a file peers can download many small bits of it from many different places all at once
- Uses Merkle DAG data structure to store files



BIG_FOLDER/SMALL/SMALLER/SMALLEST
ROOT HASH (HASH OF HASHES OF HASHES)
BIG_FOLDER
HASH FUNCTION
HASHES OF HASHES
HASH FUNCTION
HASHES
HASH FUNCTION
TX1
TX2
TX3
TX4
DATA ADDRESSING (MERKLEDAG)

Problems that may occur

- File becomes unavailable if nodes go offline

Incentivize people

Proactively Distribute Files

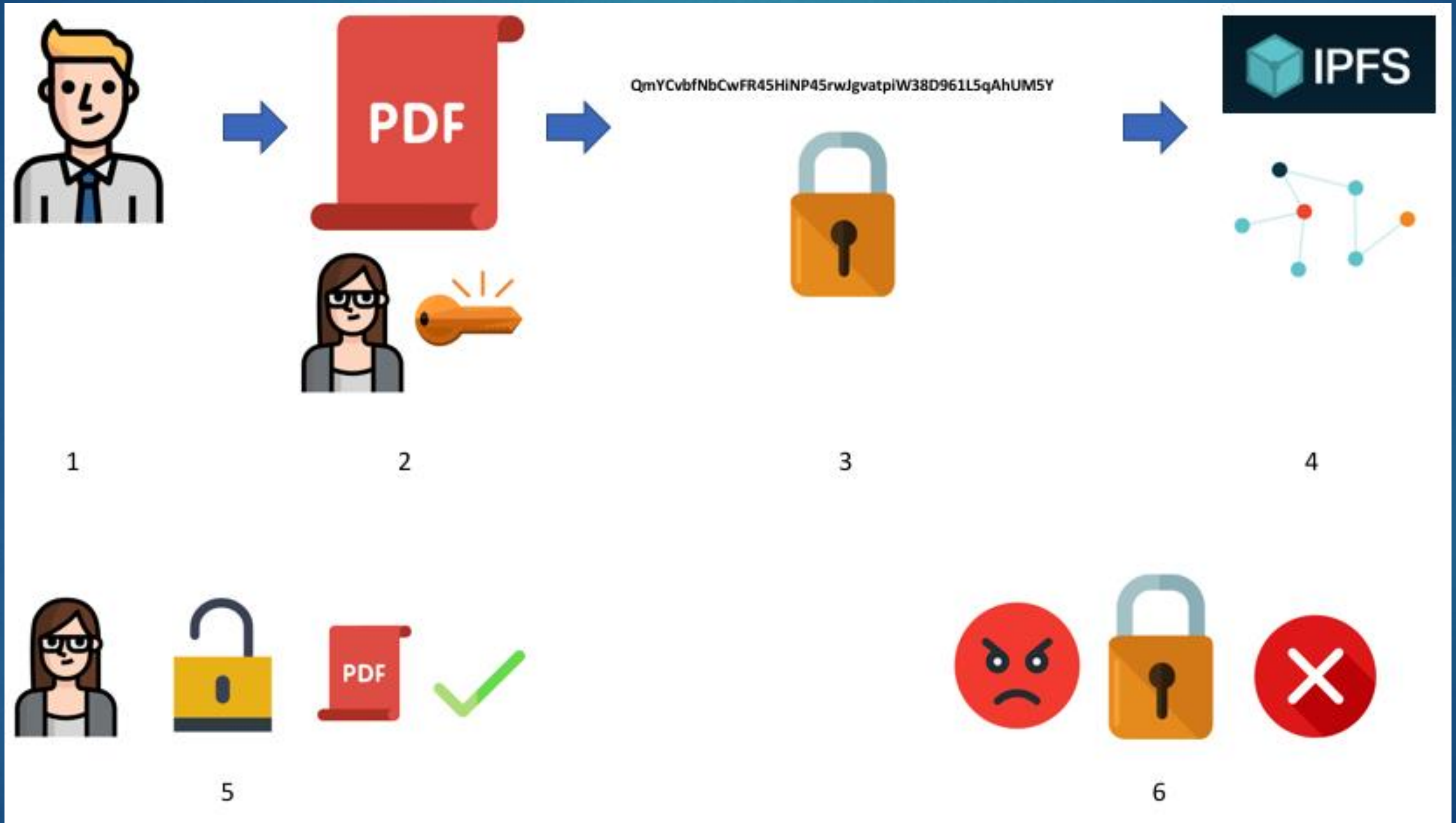
Filecoin

- If you have free space, you can ran it out to others and make money in the process
- Files are replicated across nodes so they cannot become unavailable
- Ensures availability of data

IPFS and Blockchain

- Because of the similarity in their structure, IPFS and blockchains can work well together
- IPLD is a data model for distributed data structures like blockchains. This model allows for easy storage and access of blockchain data through IPFS
- Users willing to store IPFS data will be rewarded with Filecoin
- IPLD allows users to seamlessly interact with multiple blockchains and has been integrated with Ethereum and Bitcoin

IPFS and Blockchain



IPFS and Blockchain

IPFS

- John wants to upload a PDF file to IPFS but only give Mary access
- He puts his PDF file in his working directory and encrypts it with Mary's public key
- He tells IPFS he wants to add this *encrypted* file, which generates a hash of the encrypted file
- His encrypted file is available on the IPFS network
- Mary can retrieve it and decrypt the file since she owns the associated private key of the public key that was used to encrypt the file
- A malicious party cannot decrypt the file because they lack Mary's private key

Setting Up IPFS

LET'S GET INTO THE FUTURE

Install IPFS

1. Download IPFS for your platform - https://docs.ipfs.io/guides/guides/install/

   This will download a *go-ipfs* zip folder

2. Download – The Go Programming language from – https://golang.org/dl/

   This will download a *go installer.* Follow the installation steps.

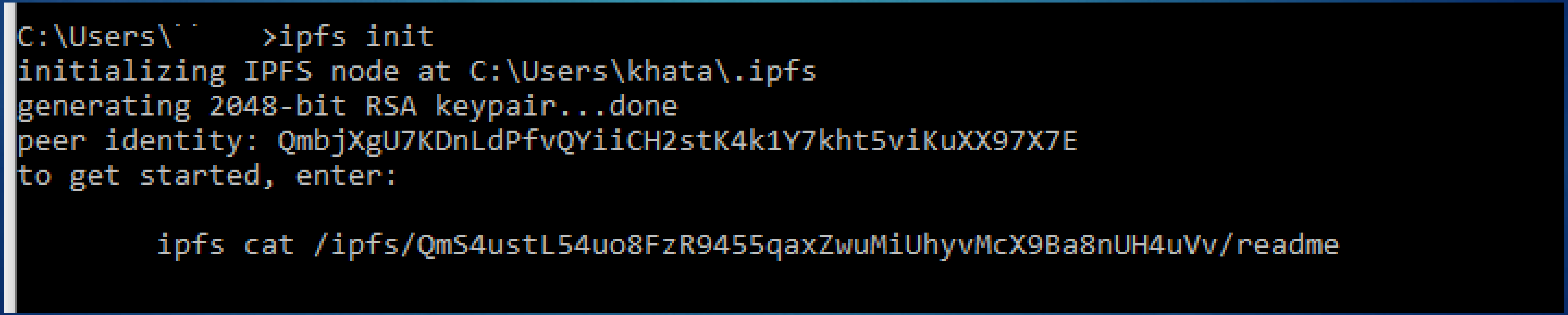
3. Copy the 'ipfs.exe' executable from the '*go-ipfs*' folder and paste in the *bin* folder in the downloaded *go folder*
4. To verify if IPFS is properly installed, run the following command in the command prompt:

```
> ipfs -help
```

Initialize the repository

1. IPFS stores all its settings and internal data in a directory called the repository. Before using IPFS for the first time, you’ll need to initialize the repository with the *ipfs init* command:

- *Ipfs init*



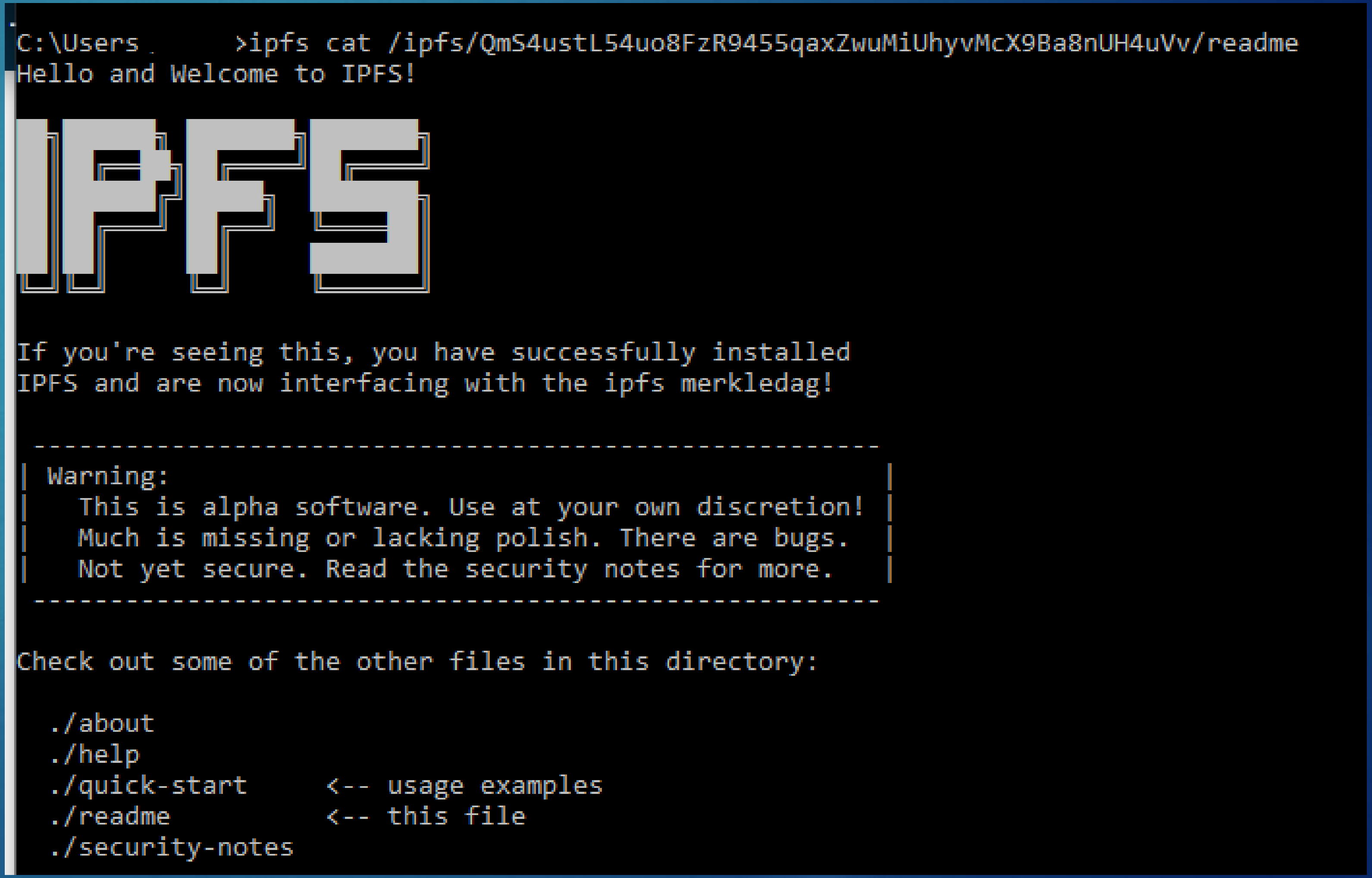
```
C:\Users\[redacted]>ipfs init
initializing IPFS node at C:\Users\khata\.ipfs
generating 2048-bit RSA keypair...done
peer identity: QmbjXgU7KDnLdPfvQYiiCH2stK4k1Y7kht5viKuXX97X7E
to get started, enter:

        ipfs cat /ipfs/QmS4ustL54uo8FzR9455qaxZwuMiUhyvMcX9Ba8nUH4uVv/readme
```

Initialize the repository

2. Now, try running the command suggested to you in the output of *ipfs init*

The one that looks like:

- *ipfs/cat/ipfs/<HASH>/readme*

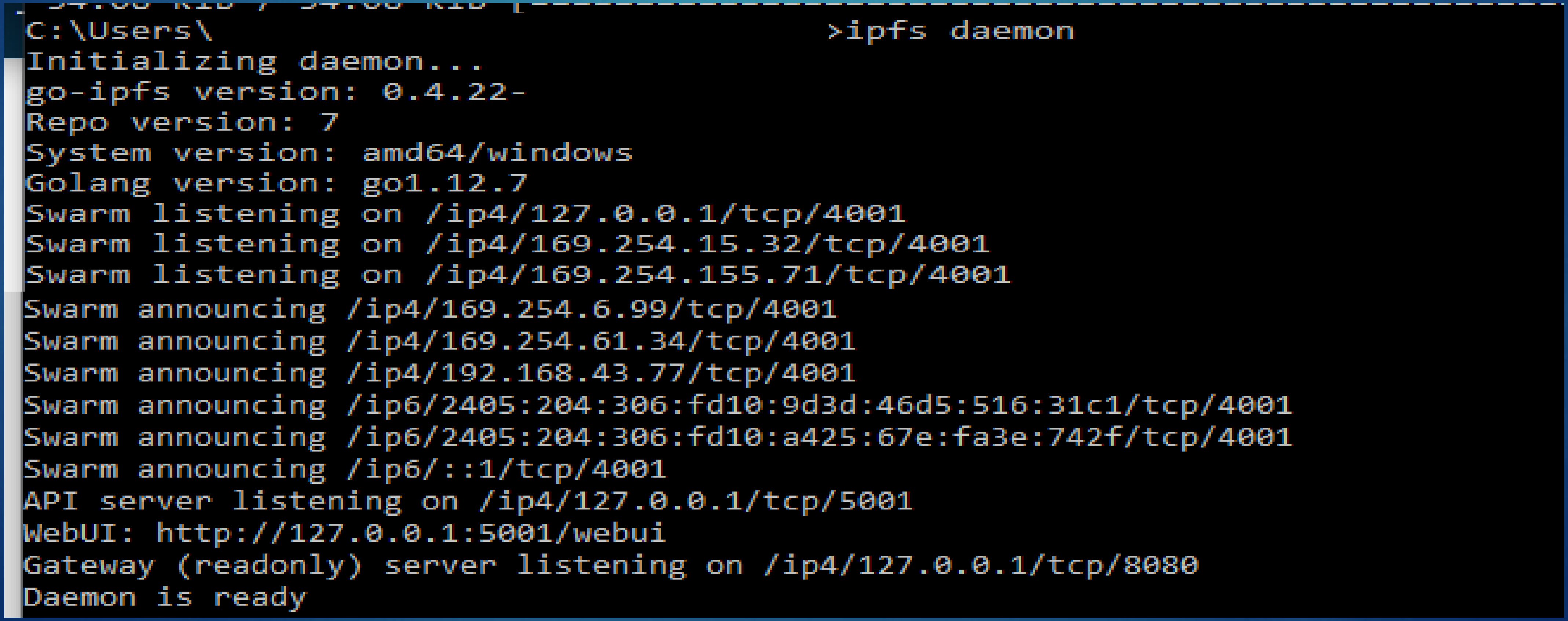


```
C:\Users       >ipfs cat /ipfs/QmS4ustL54uo8FzR9455qaxZwuMiUhyvMcX9Ba8nUH4uVv/readme
Hello and Welcome to IPFS!

If you're seeing this, you have successfully installed
IPFS and are now interfacing with the ipfs merkledag!

 -------------------------------------------------------
| Warning:                                              |
|   This is alpha software. Use at your own discretion! |
|   Much is missing or lacking polish. There are bugs.  |
|   Not yet secure. Read the security notes for more.   |
 -------------------------------------------------------

Check out some of the other files in this directory:

  ./about
  ./help
  ./quick-start     <-- usage examples
  ./readme          <-- this file
  ./security-notes
```

Taking your node online

- Once you’re ready to join your node to the public network, run the ipfs daemon in another terminal and wait for all three lines below to appear to know that your node is ready:

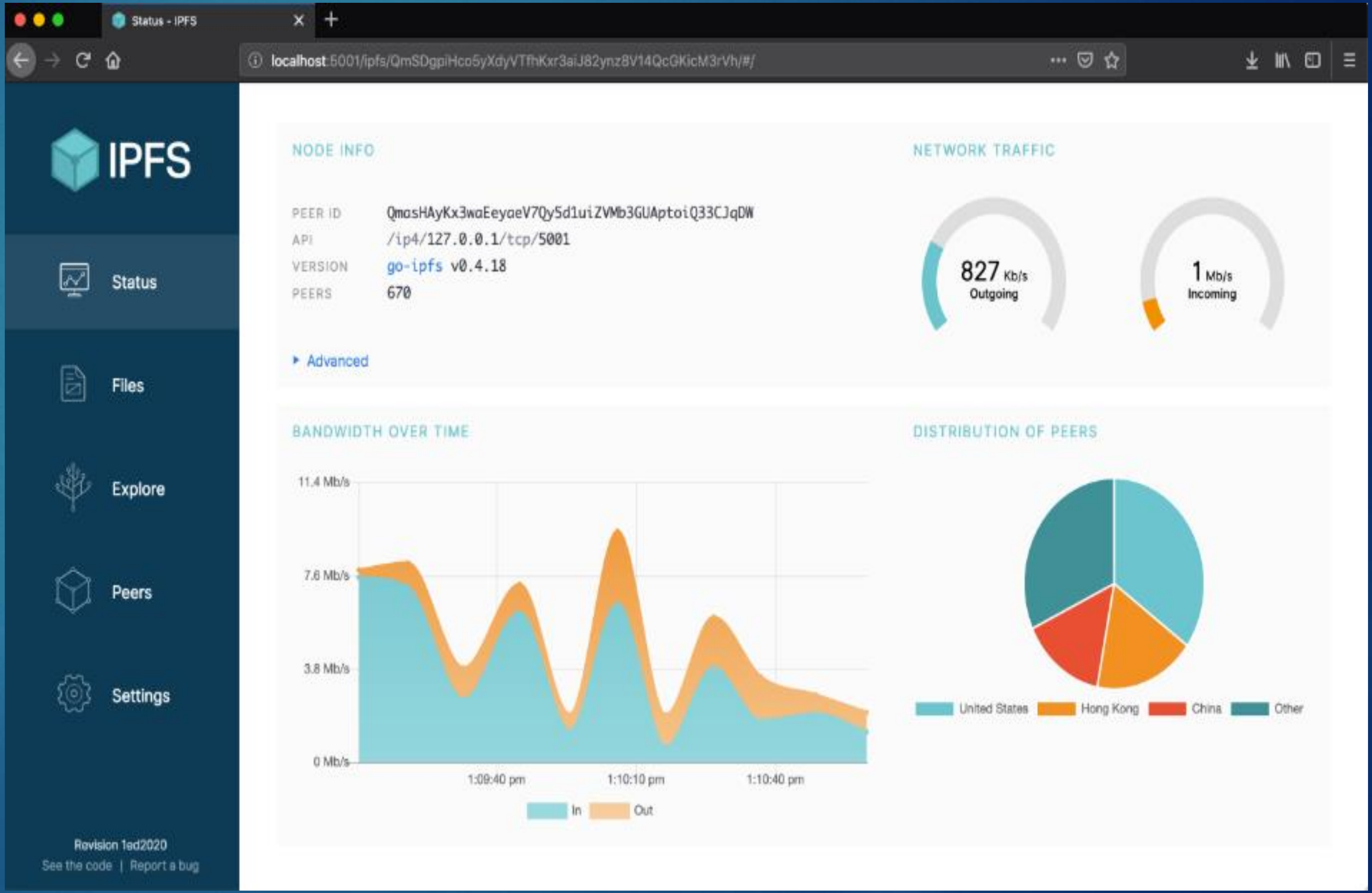
> *ipfs daemon*



```
C:\Users\                                    >ipfs daemon
Initializing daemon...
go-ipfs version: 0.4.22-
Repo version: 7
System version: amd64/windows
Golang version: go1.12.7
Swarm listening on /ip4/127.0.0.1/tcp/4001
Swarm listening on /ip4/169.254.15.32/tcp/4001
Swarm listening on /ip4/169.254.155.71/tcp/4001
Swarm announcing /ip4/169.254.6.99/tcp/4001
Swarm announcing /ip4/169.254.61.34/tcp/4001
Swarm announcing /ip4/192.168.43.77/tcp/4001
Swarm announcing /ip6/2405:204:306:fd10:9d3d:46d5:516:31c1/tcp/4001
Swarm announcing /ip6/2405:204:306:fd10:a425:67e:fa3e:742f/tcp/4001
Swarm announcing /ip6/::1/tcp/4001
API server listening on /ip4/127.0.0.1/tcp/5001
WebUI: http://127.0.0.1:5001/webui
Gateway (readonly) server listening on /ip4/127.0.0.1/tcp/8080
Daemon is ready
```

Web console

- Enter the WebUI link in the web browser
- http://127.0.0.1:5001/webui



Status - IPFS
localhost:5001/ipfs/QmSDgpiHco5yXdyVTfhKxr3aiJ82ynz8V14QcGKicM3rVh/#/
IPFS
Status
Files
Explore
Peers
Settings
Revision 1ed2020
See the code | Report a bug

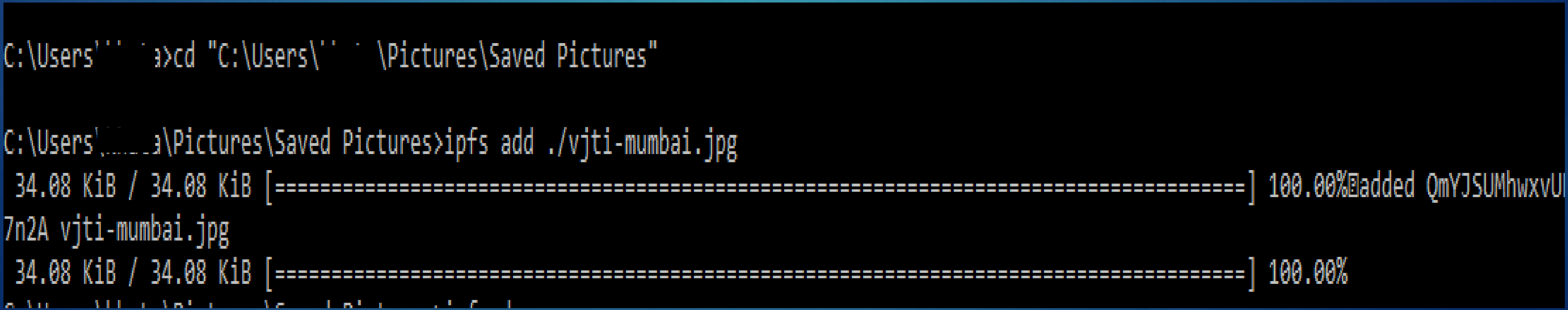
NODE INFO

PEER ID QmasHAyKx3waEeyaeV7Qy5d1uiZVMb3GUAptoiQ33CJqDW
API /ip4/127.0.0.1/tcp/5001
VERSION go-ipfs v0.4.18
PEERS 670

Adding file to IPFS

1. Use *cd* command to jump into the directory in which the file to be uploaded exists
2. Use *ipfs add ./filename* command to add file to IPFS

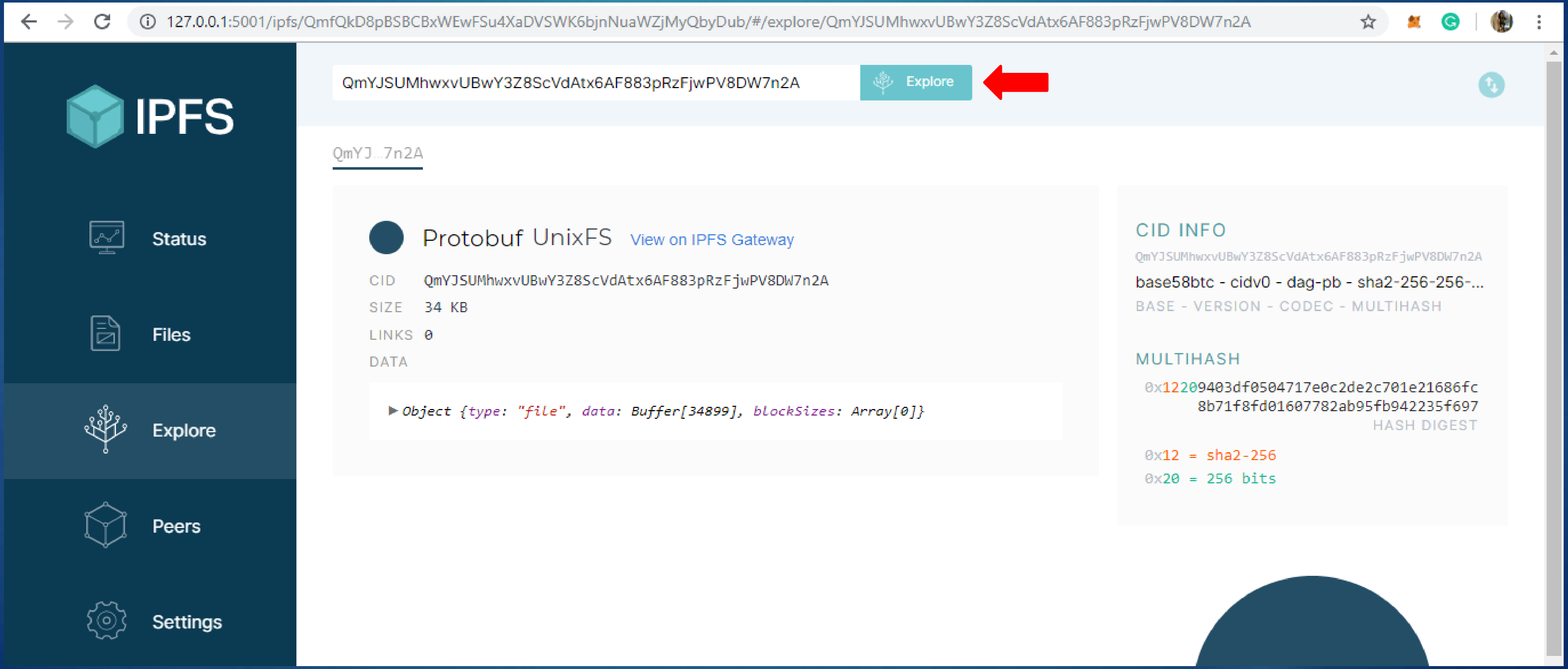
   for ex: *ipfs add ./vjti-mumbai.jpg*



```
C:\Users\[redacted]>cd "C:\Users\[redacted]\Pictures\Saved Pictures"

C:\Users\[redacted]\Pictures\Saved Pictures>ipfs add ./vjti-mumbai.jpg
 34.08 KiB / 34.08 KiB [================================================================================] 100.00%added QmYJSUMhwxvU
7n2A vjti-mumbai.jpg
 34.08 KiB / 34.08 KiB [================================================================================] 100.00%
```

Explore the uploaded files

- In the WebUI , in the Explore input file, enter the hash of the required file and click explore



127.0.0.1:5001/ipfs/QmfQkD8pBSBCBxWEwFSu4XaDVSWK6bjnNuaWZjMyQbyDub/#/explore/QmYJSUMhwxvUBwY3Z8ScVdAtx6AF883pRzFjwPV8DW7n2A

QmYJSUMhwxvUBwY3Z8ScVdAtx6AF883pRzFjwPV8DW7n2A

QmYJ…7n2A

Protobuf UnixFS View on IPFS Gateway

CID QmYJSUMhwxvUBwY3Z8ScVdAtx6AF883pRzFjwPV8DW7n2A

SIZE 34 KB

LINKS 0

DATA

```
▶ Object {type: "file", data: Buffer[34899], blockSizes: Array[0]}
```

CID INFO

QmYJSUMhwxvUBwY3Z8ScVdAtx6AF883pRzFjwPV8DW7n2A

base58btc - cidv0 - dag-pb - sha2-256-256-…

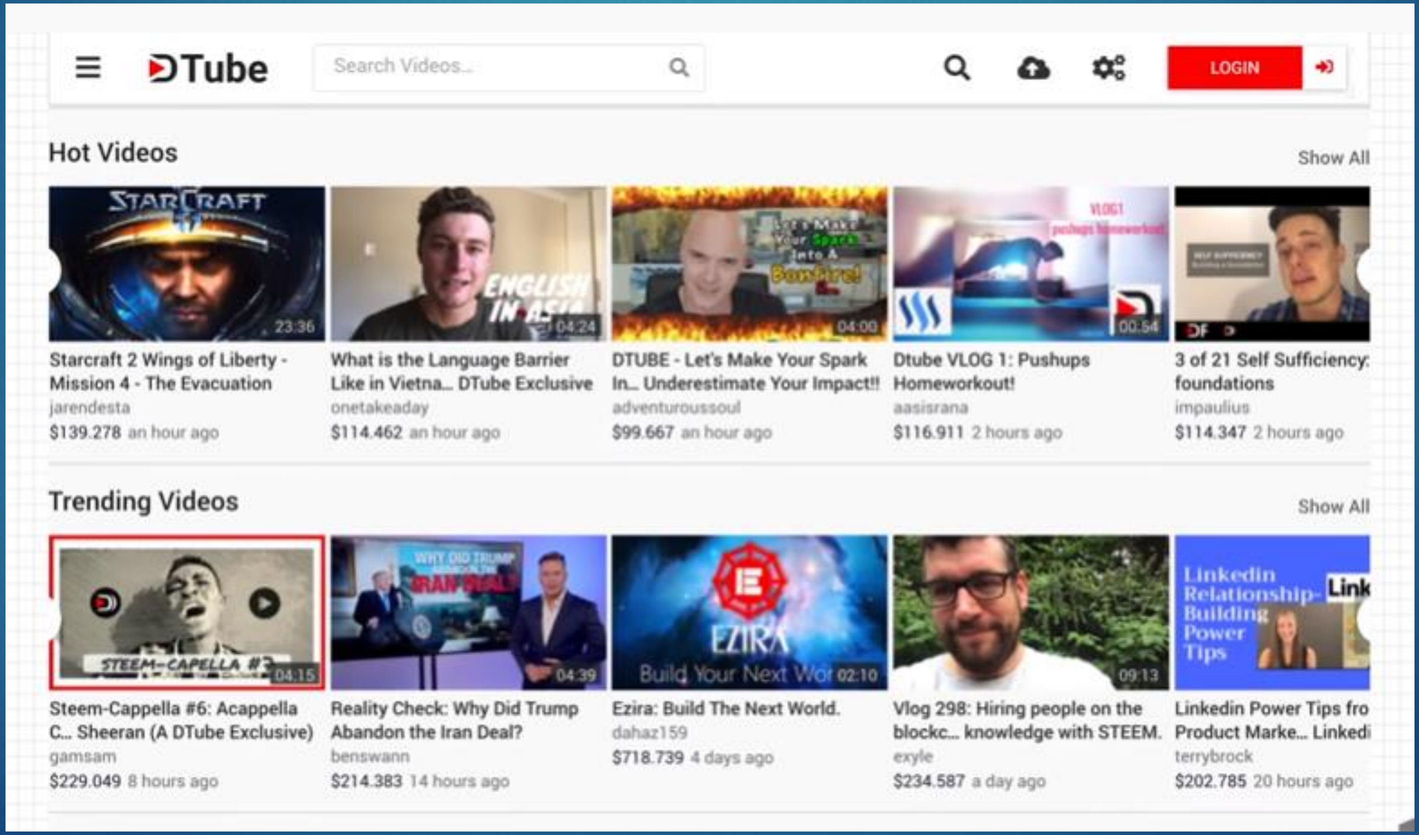
BASE - VERSION - CODEC - MULTIHASH

MULTIHASH

```
0x12209403df0504717e0c2de2c701e21686fc
      8b71f8fd01607782ab95fb942235f697
                               HASH DIGEST

0x12 = sha2-256
0x20 = 256 bits
```

Existing Applications Of IPFS

- Turkish Wikipedia
- Dtube: A social networking site like YouTube



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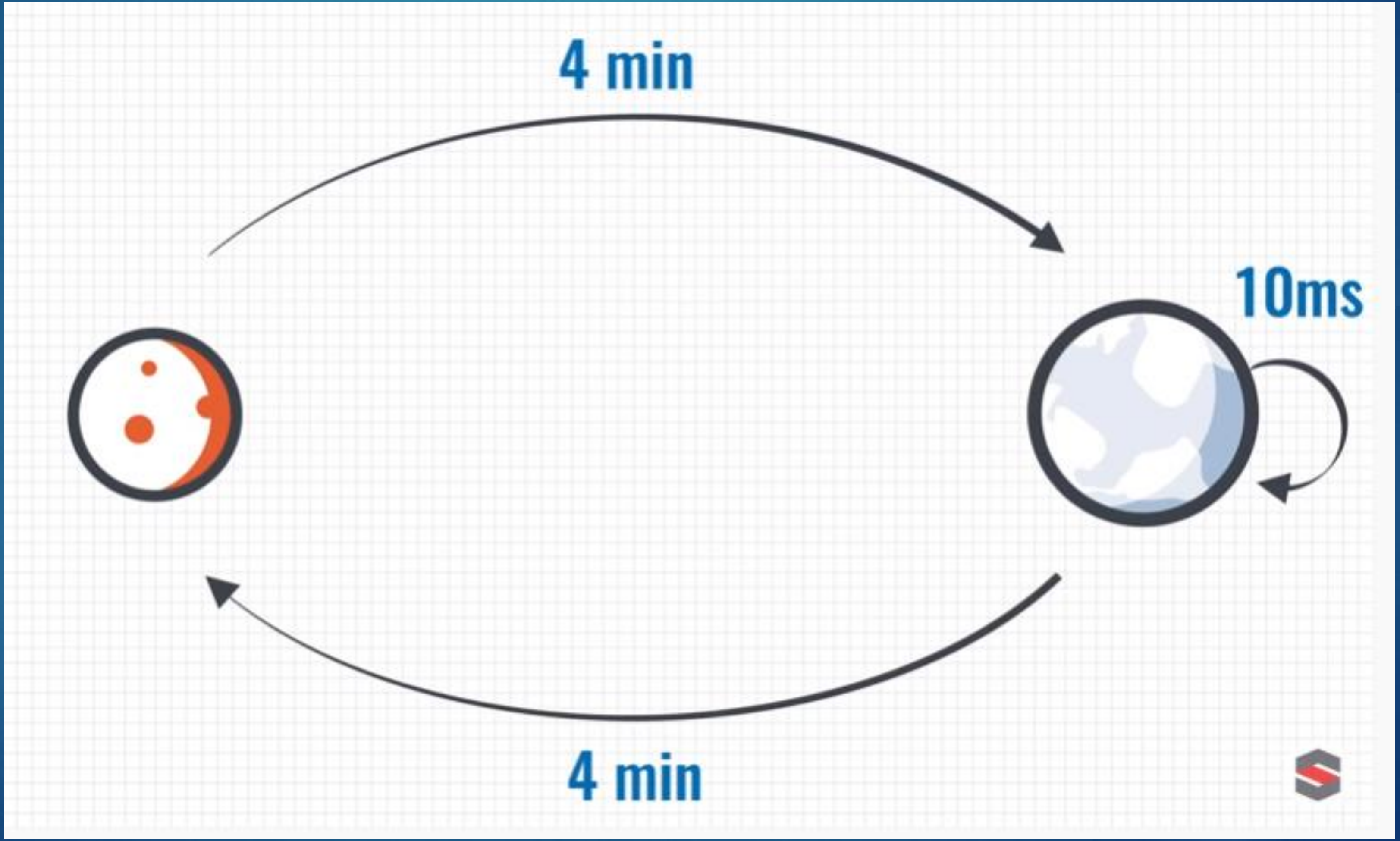
Why is it called InterPlanetary FileSystem?



Yet a lot of questions to answer!

- How can content be reliably deleted or unpublished?
- Will the network support exist?
- Will this even be usable to regular humans?

References

- https://medium.com/wolverineblockchain/what-is-ipfs-b83277597da5
- https://medium.com/@mycoralhealth/learn-to-securely-share-files-on-the-blockchain-with-ipfs-219ee47df54c
- https://www.youtube.com/watch?v=IFC9I2Za9i0
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