Is it a database? Is it a blockchain? When worlds collide
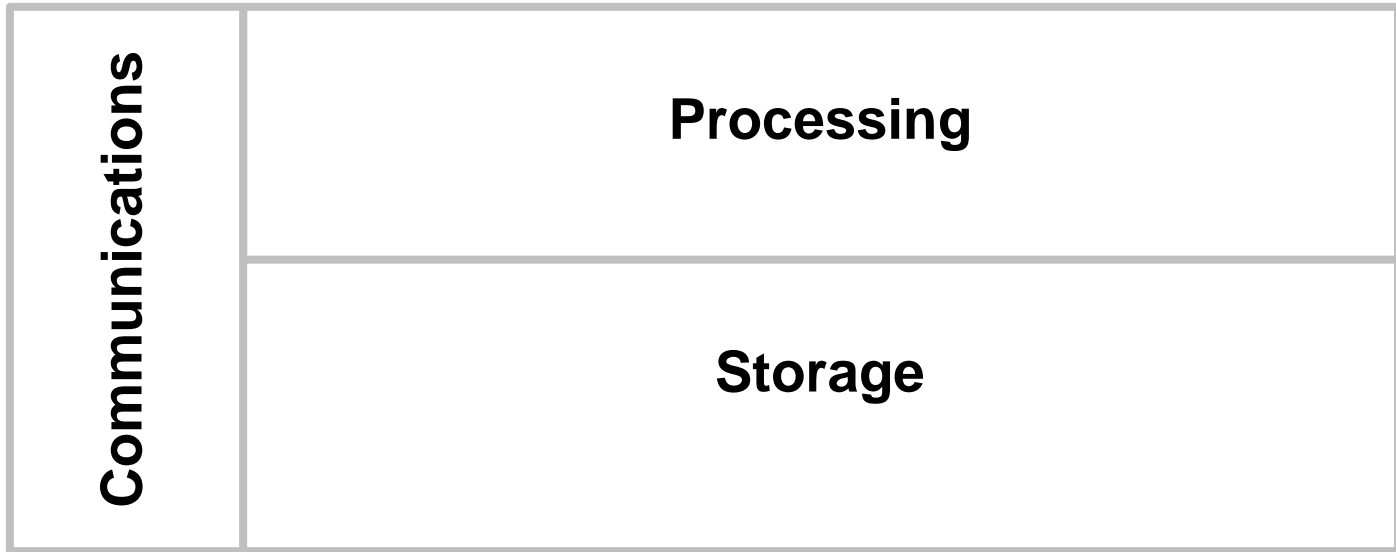
Trent McConaghy
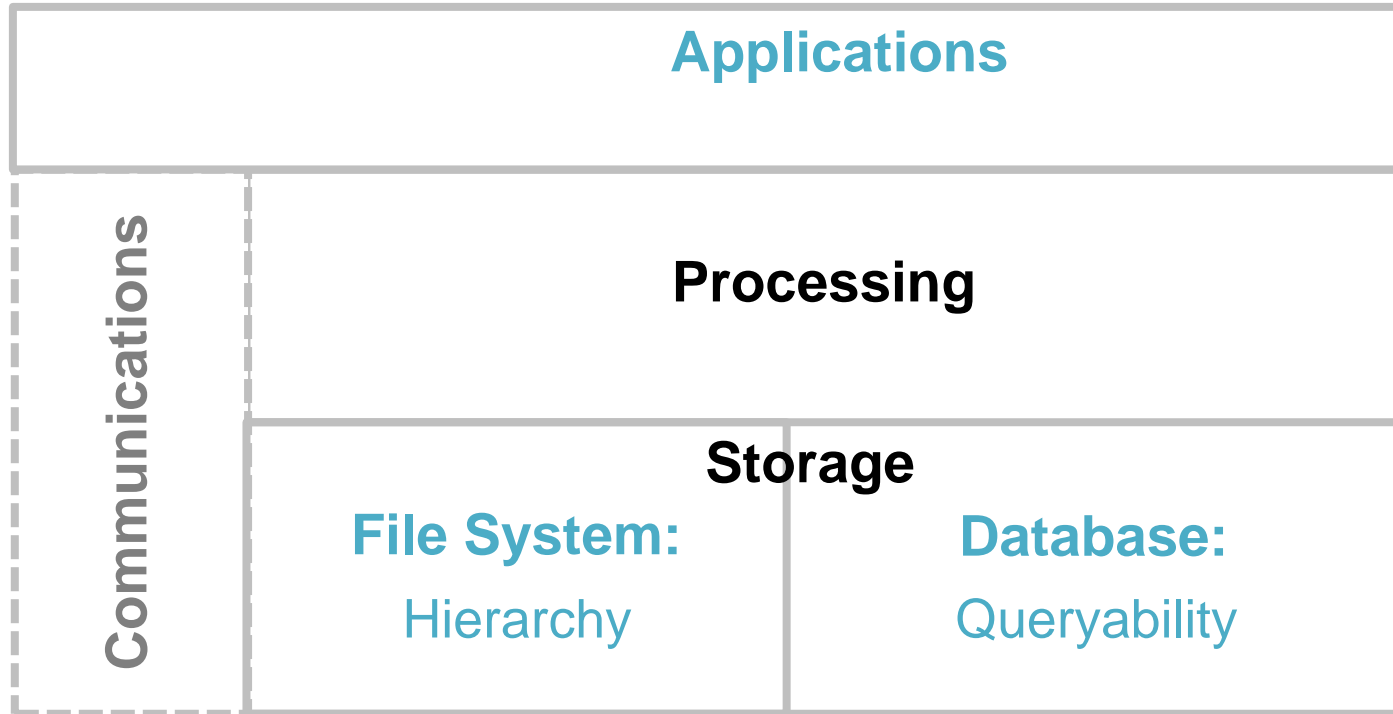
@trentmc0

BIGCHAINDB
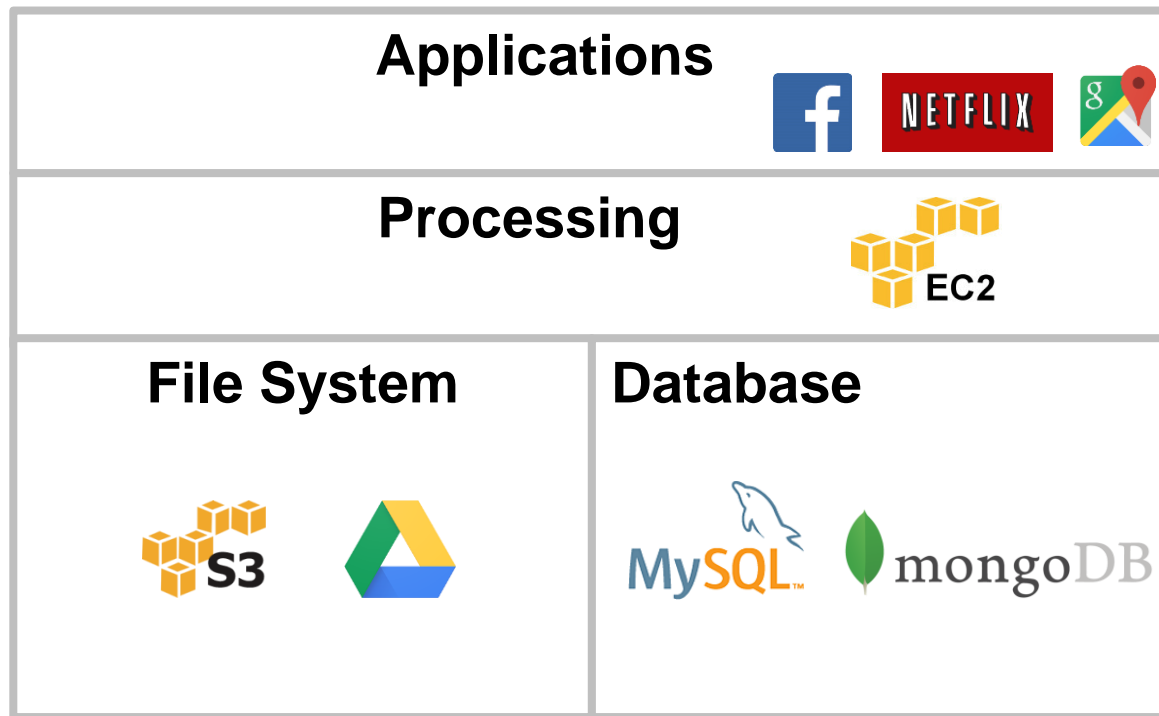
The Elements of Computing

Communications

Processing

Storage

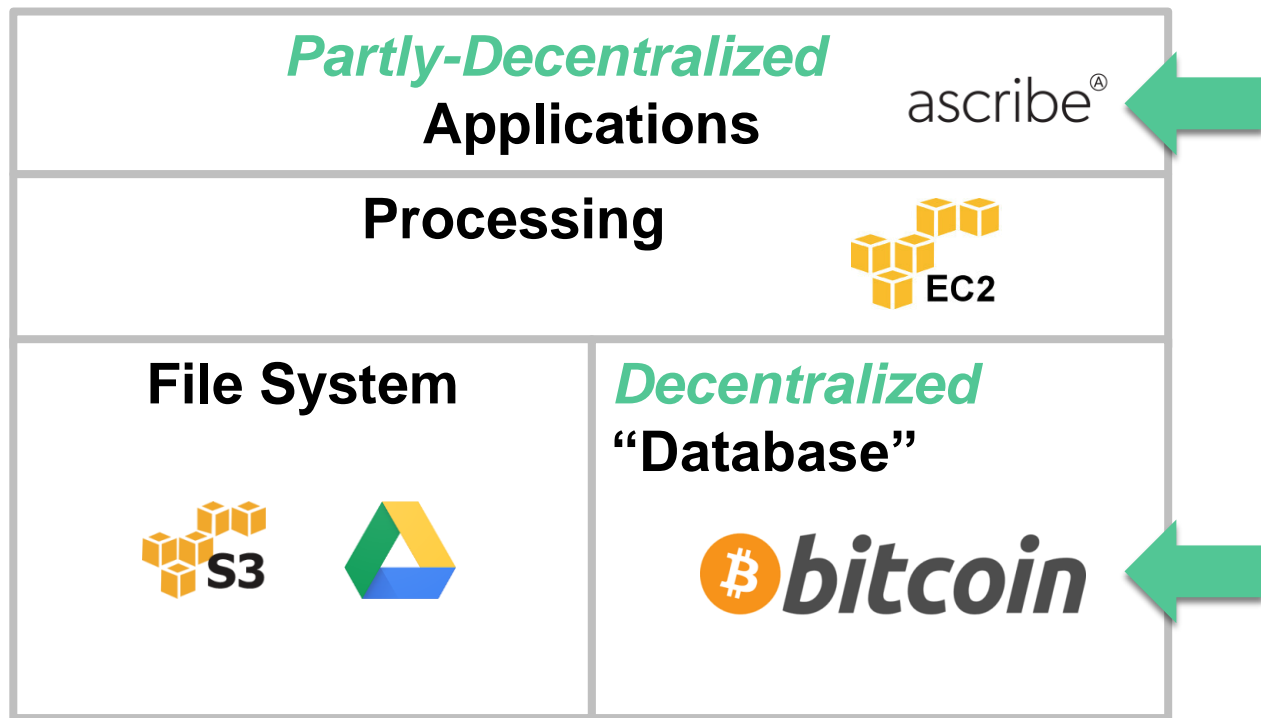# Modern Application Stacks

The modern cloud application stack

Along came Bitcoin…

"Magic Internet Money"

Bitcoin sparked a revolution
Truly own digital assets, supply chain visibility, ….

Blockchain: A Special "Spreadsheet in the Sky"

What's special:
- no one owns it
- anyone can add to it
- no one can delete from it

- Writing to a blockchain is like etching in stone.
- Which allows us to issue assets, and transfer them
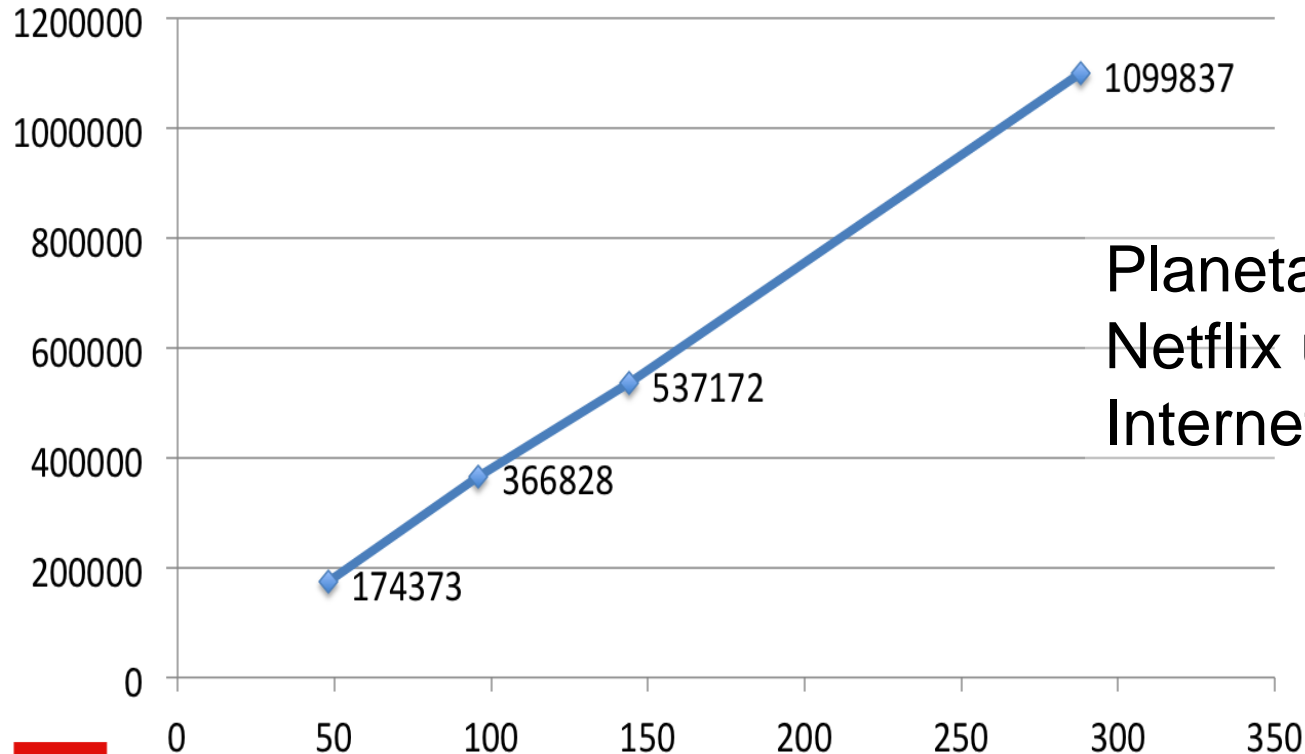- Which can include art!

1.5 tx/s
50GB

What about **planetary** scale?

Planetary scale: Netflix uses 37% of Internet bandwidth

"Big data" Distributed DBs

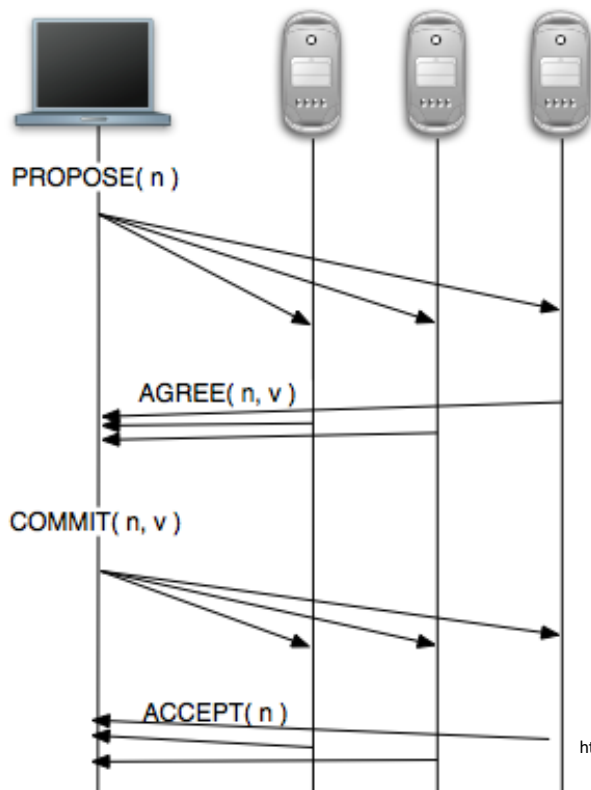## Writes / s vs. # nodes

Planetary scale: Netflix uses 37% of Internet bandwidth

Chart data points:
- 174373
- 366828
- 537172
- 1099837

NETFLIX

To be Distributed,
Big Data DBs Must Solve Consensus

Byzantine Consensus
(1982)

Paxos (1990/1998)

Two ways to scale up

Big data-fy the blockchain
- Builds on man-decades of work
- Significant scalability hurdles?

<or>

Blockchain-ify big data
- Builds on man-centuries (millennia?) of work
- Scalability challenges already resolved
- How to blockchain-ify? …

"Blockchain-ify"

Decentralization: no single entity owns or controls

Immutability: tamper-resistant

Assets: Can issue & transfer assets

Blockchain (noun): hashed-together chain of blocks (1991!)

Blockchain (noun): storage that is decentralized + immutable + assets

Blockchain (*adj*): decentralized + immutable + assets

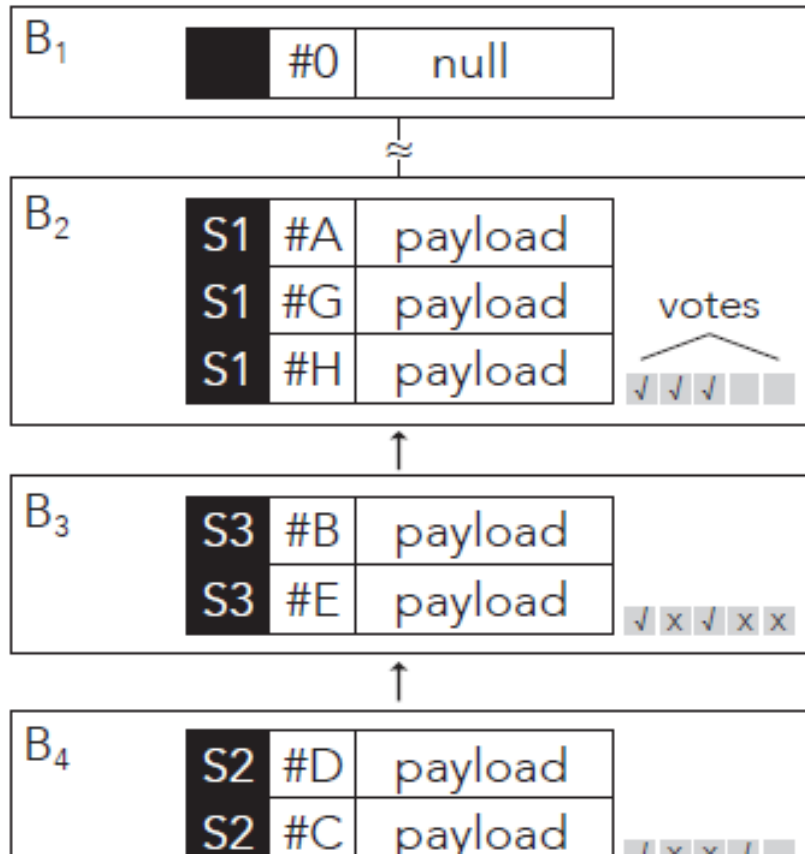# INTRODUCING BIGCHAINDB

How to Blockchain-ify Big Data

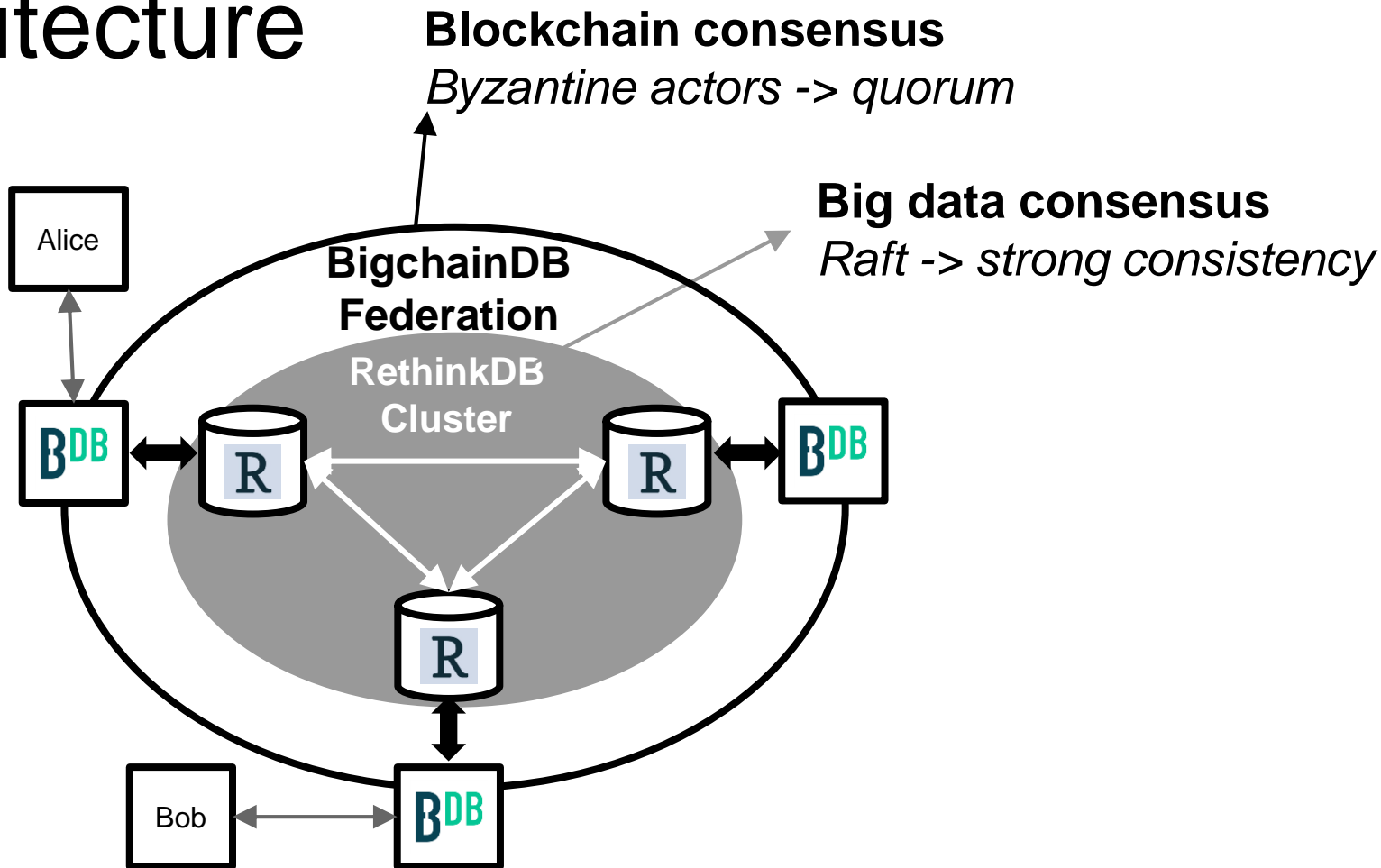**Retain Big Data DB's Performance**

- Let the Paxos derivative *solve order*. Get out of its way!

- It naturally builds a log of *all* txs

Add in blockchain characteristics

- **Decentralization:** federation voting on txs. Group into blocks for speed.

- **Immutability:** hash on prev. blocks

- **Assets:** Digital signatures etc.

Architecture

Blockchain consensus
Byzantine actors -> quorum

Big data consensus
Raft -> strong consistency

BigchainDB Federation

Alice

RethinkDB Cluster
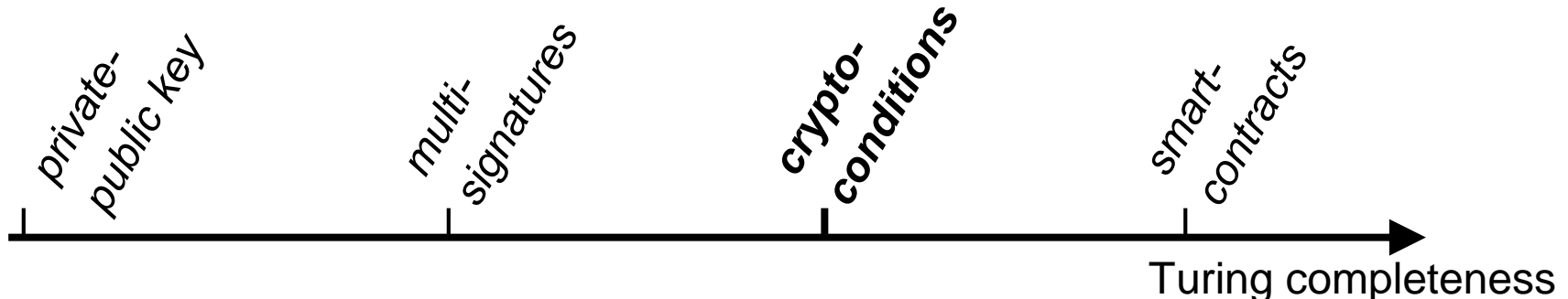
BDB

R

R

BDB

R

Bob

BDB

BigchainDB Interface

Database part : data

Via ReQL (JSON meets SQL)

+ Blockchain part : assets, transaction-style

Via Interledger Protocol (Crypto-conditions)

private-public key   *multi-signatures*   **crypto-conditions**   *smart-contracts*

Turing completeness

BigchainDB characteristics

Throughput
>1,000,000 writes/s
~100,000 transactions/s

Latency
<100 ms

Capacity
Petabytes with each
node adding 48TB

Scalability
Performance increases as
nodes are added

Query
Database is fully
queryable

Decentralization
Federated
non-anonymous participation
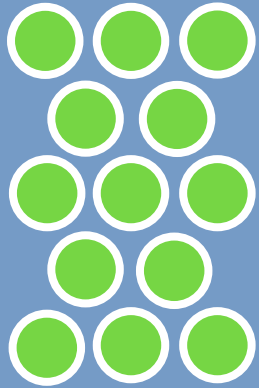
- A shared global database. For everyone, everywhere

- And, a nonprofit foundation, with decentralized governance

- Powered by BigchainDB, to start

- Free except for high-volume users

- Caretakers co-operate network & co-govern foundation

IPDB Caretakers (so far)

Not-for-profit

Blockstack
COALA
Dyne.org
Internet
 Archive
OpenMedia
UnMonastery

For-profit

BigchainDB
Consensys
Eris Industries
Protocol Labs (IPFS)
SmartContract.com
Synereo
Tendermint

Decentralization of the Cloud

Centralized → Partly Decentralized → Fully Decentralized

Apps	
Facebook, Netflix, Google Maps	
Proc'ing	
EC2	
FS	DB
S3, Google Drive	MySQL, mongoDB

Partly Dec. Apps	
ascribe	
Proc'ing	
EC2	
FS	Dec. DB
S3, Google Drive	BIGCHAIN DB, iPDB

Dec. Apps	
Dec. Proc'ing	
ethereum, LISK	
Dec. FS	Dec. DB
IPFS	BIGCHAIN DB, iPDB

User: everledger

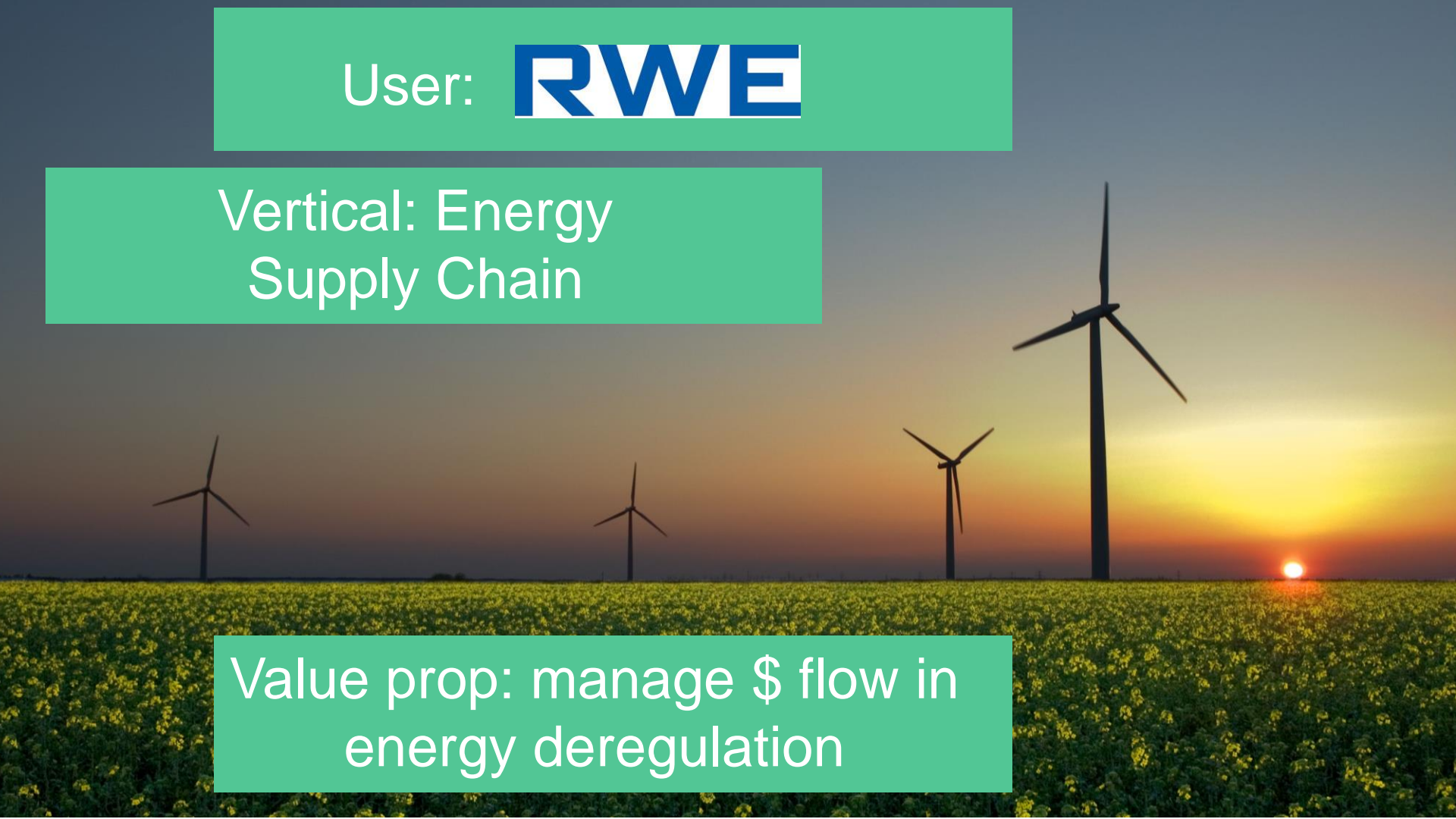Vertical: Diamond
Supply Chain

Value prop: identify & prevent
fraud. 7-40% in $80B industry

User: **RWE**

Vertical: Energy
Supply Chain

Value prop: manage $ flow in
energy deregulation

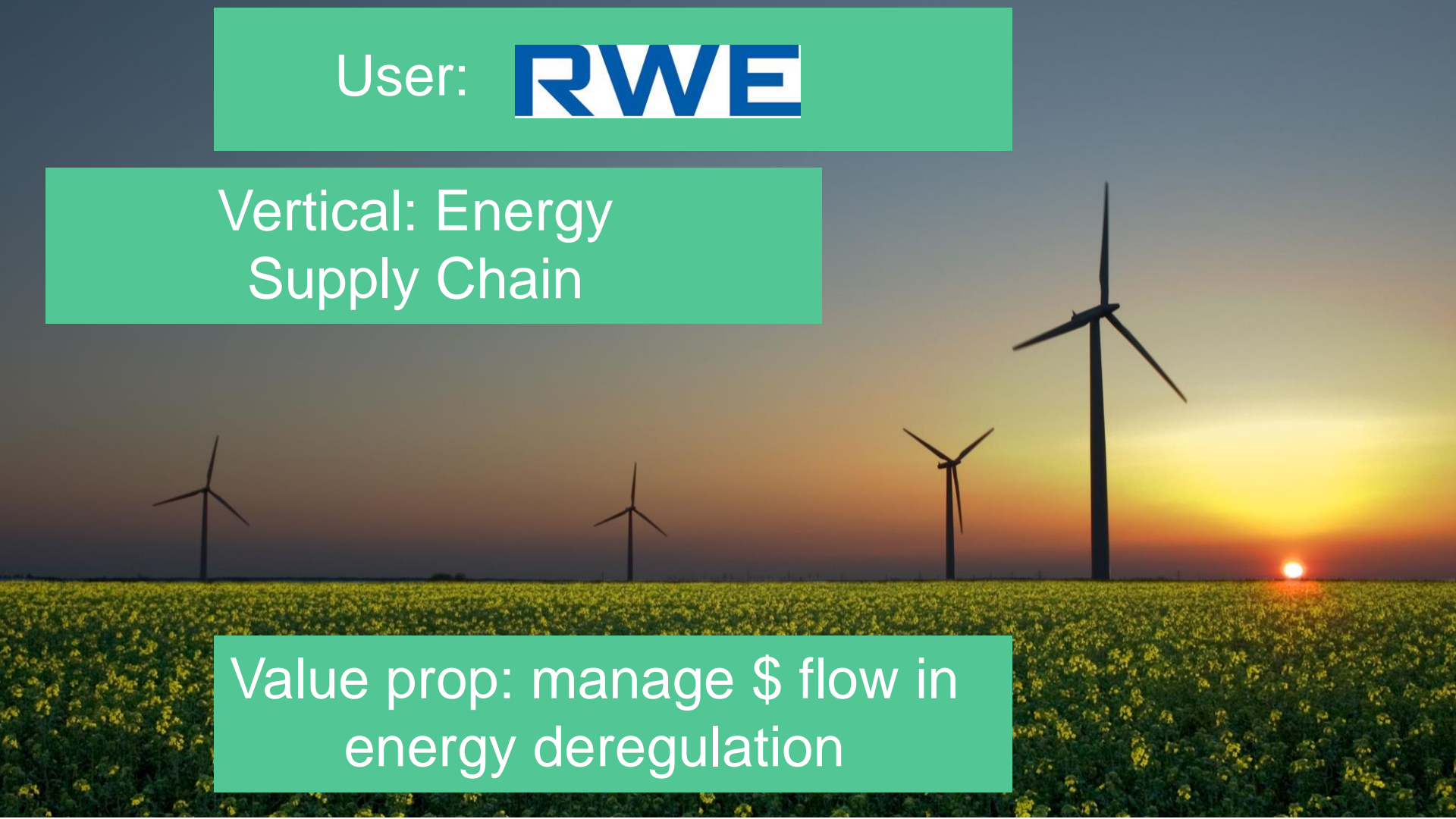User: RWE

Vertical: Energy
Supply Chain

Value prop: manage $ flow in
energy deregulation

User: Tangent90

Vertical: Medical Journals / Supply Chain

Value prop: government-mandated transparent $ flow

User: RECRUIT

Vertical: Education credentials

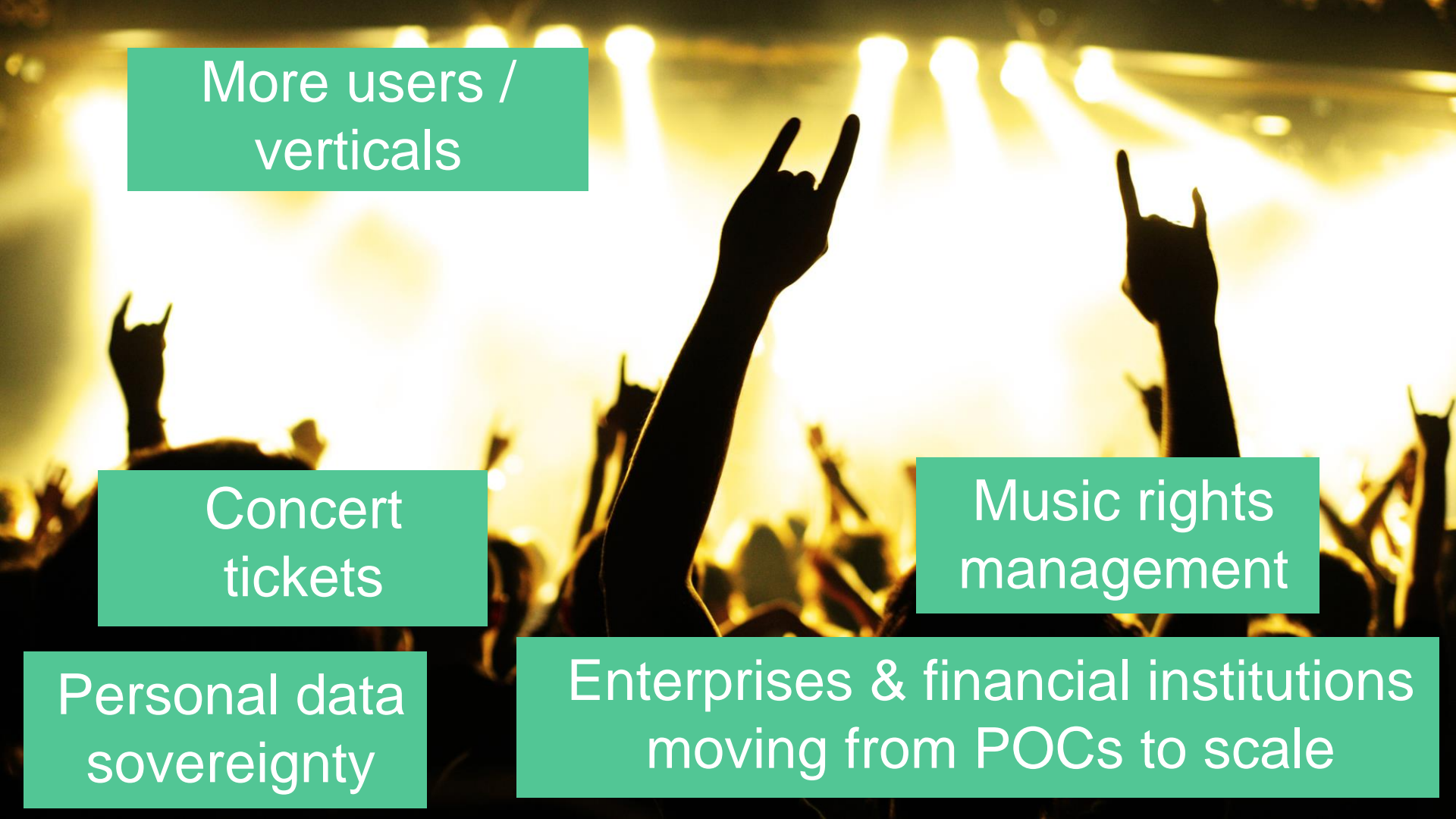Value prop: reduce fraudulent degrees, lower HR friction

Users: ascribe.io, 5000 artists, 25 marketplaces & non-profits

Verticals: Art Supply Chain, Intellectual Property

Value Props: secure provenance in $64B art industry, IP mgmt.

More users / verticals

Concert tickets

Music rights management

Personal data sovereignty

Enterprises & financial institutions moving from POCs to scale

USAGE

Quick Start Guide

Install and Run

BigchainDB provides a rich API to create, query and transfer digital assets.

DOCUMENTATION **GITHUB**

```
$  Dependencies: Loaded
$  (See bigchaindb.readthedocs.org)
$  Python: Python 3.4+
$  RethinkDB: Running
$  ----------------

   # install bigchaindb
$  pip install bigchaindb

   # start bigchaindb
$  bigchaindb start
```

Install and Run

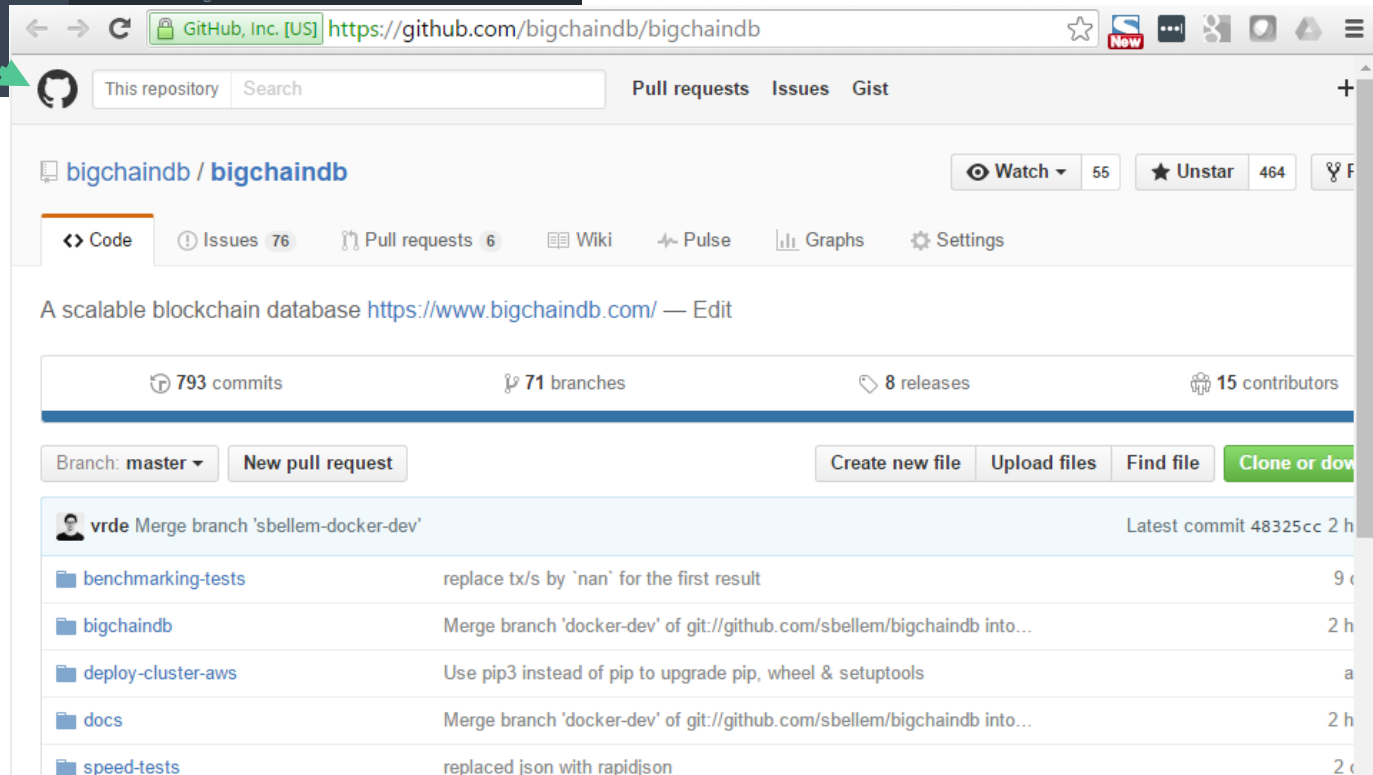BigchainDB provides a rich API to create, query and transfer digital assets.

DOCUMENTATION | **GITHUB**

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$ --------------

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$ pip install bigchaindb

# start bigchaindb
```

https://github.com/bigchaindb/bigchaindb

This repository | Search | Pull requests | Issues | Gist

📖 **bigchaindb** / **bigchaindb**

👁 Watch ▾ | 55 | ★ Unstar | 464

`<> Code` | ⓘ Issues 76 | ⑂ Pull requests 6 | 📖 Wiki | ⚡ Pulse | 📊 Graphs | ⚙ Settings

A scalable blockchain database https://www.bigchaindb.com/ — Edit

🕐 **793** commits | ⑂ **71** branches | 🏷 **8** releases | 👥 **15** contributors

Branch: master ▾ | New pull request | Create new file | Upload files | Find file | Clone or dow

👤 **vrde** Merge branch 'sbellem-docker-dev' | Latest commit 48325cc 2 h

📁 benchmarking-tests	replace tx/s by `nan` for the first result	9
📁 bigchaindb	Merge branch 'docker-dev' of git://github.com/sbellem/bigchaindb into…	2 h
📁 deploy-cluster-aws	Use pip3 instead of pip to upgrade pip, wheel & setuptools	a
📁 docs	Merge branch 'docker-dev' of git://github.com/sbellem/bigchaindb into…	2 h
📁 speed-tests	replaced json with rapidjson	2 d

Install and Run

BigchainDB provides a rich API to create, query and transfer digital assets.

DOCUMENTATION   **GITHUB**

```
$  Dependencies: Loaded
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$  Python: Python 3.4+
$  RethinkDB: Running
$  --------------
$
$  # install bigchaindb
$  pip install bigchaindb
$
$  # start bigchaindb
```

https://bigchaindb.readthedocs.io/en/latest/

🏠 **BigchainDB**

latest

Search docs

1. Introduction

2. Installing and Running BigchainDB Server

3. Running Unit Tests

4. Configuring a BigchainDB Node

5. The Python Server API by Example

6. The BigchainDB Command Line Interface (CLI)

7. The HTTP Client-Server API

8. The Python Driver API by Example

9. Deploying a Local Multi-Node RethinkDB Cluster

10. Deploy a Cluster on AWS

11. JSON Serialization

Docs » BigchainDB Documentation   ⛓ Edit on GitHub

BigchainDB Documentation

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- 2. Installing and Running BigchainDB Server
  - 2.1. Install and Run RethinkDB Server
  - 2.2. Install Python 3.4+
  - 2.3. Install BigchainDB Server
    - 2.3.1. How to Install BigchainDB with pip
    - 2.3.2. How to Install BigchainDB from Source
    - 2.3.3. How to Install BigchainDB on a VM with Vagrant
  - 2.4. Run BigchainDB Server
  - 2.5. Run BigchainDB with Docker
    - 2.5.1. Pull and Run the Image from Docker Hub
      - 2.5.1.1. Load Testing with Docker

Run

vides a rich API to create, query and ssets.

TATION **GITHUB**

```
$   Dependencies: Loaded
$   (See bigchaindb.readthedoc:
$   Python: Python 3.4+
$   RethinkDB: Running
$   ---------------

    # install bigchaindb
$   pip install bigchaindb

    # start bigchaindb
$   bigchaindb start
```

5. The Python Server API by Example

First, make sure you have RethinkDB and BigchainDB *installed and running,* i.e. you installed them and you ran:

```
$ rethinkdb
$ bigchaindb configure
$ bigchaindb start
```

Don't shut them down! In a new terminal, open a Python shell:

```
$ python
```

Now we can import the `Bigchain` class and create an instance:

```
from bigchaindb import Bigchain
b = Bigchain()
```

This instantiates an object `b` of class `Bigchain`. When instantiating a

5.2. Create a Digital Asset

```python
from bigchaindb import crypto

# Create a test user
testuser1_priv, testuser1_pub = crypto.generate_key_pair()

# Define a digital asset data payload
digital_asset_payload = {'msg': 'Hello BigchainDB!'}

# A create transaction uses the operation `CREATE` and has no inputs
tx = b.create_transaction(b.me, testuser1_pub, None, 'CREATE', payload=digital_

# ALL transactions need to be signed by the user creating the transaction
tx_signed = b.sign_transaction(tx, b.me_private)

# Write the transaction to the bigchain.
# The transaction will be stored in a backlog where it will be validated,
# included in a block, and written to the bigchain
b.write_transaction(tx_signed)
```

5.3. Read the Creation Transaction from the DB

```python
# Retrieve a transaction from the bigchain
tx_retrieved = b.get_transaction(tx_signed['id'])
tx_retrieved
```

```
{
    "id":"933cd83a419d2735822a2154c84176a2f419cbd449a74b94e592ab807af23861",
    "transaction":{
        "conditions":[
            {
                "cid":0,
                "condition":{
                    "details":{
                        "bitmask":32,
                        "public_key":"BwuhqQX8FPsmqYiRV2CSZYWWsSWgSSQQFHjqxKEuql
                        "signature":None,
                        "type":"fulfillment",
                        "type_id":4
```

5.4. Transfer the Digital Asset

```
# Create a second testuser
testuser2_priv, testuser2_pub = crypto.generate_key_pair()

# Create a transfer transaction
tx_transfer = b.create_transaction(testuser1_pub, testuser2_pub, tx_

# Sign the transaction
tx_transfer_signed = b.sign_transaction(tx_transfer, testuser1_priv)

# Write the transaction
b.write_transaction(tx_transfer_signed)
```
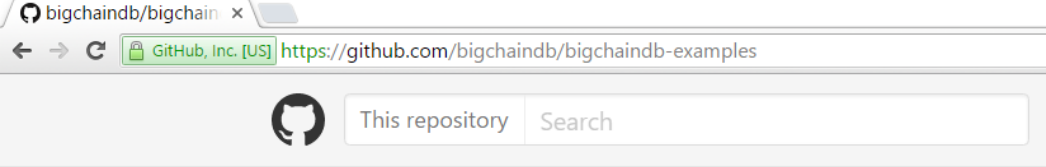
This repository | Search

bigchaindb / **bigchaindb-examples**

"On the Record"

Search... | 🔍

ACCOUNT_0
9GSAHMBF9A3Y6A7I7QXTZTTKERMW7UZPY...

ACCOUNT_1
9R6A5H84MCUORNHZOTLC45SQTVCP5ATE...

ACCOUNT_2
C8K6VBWR3PRQVKZ2UEIWRCHXCNUW7WK...

ACCOUNT_3
48NHHAFNAZQWRE4FH9G7FGRWLCDUHGY...

ACCOUNT_4
B337O4BWD7R2JJFDKBHGR3HF6HAEIRRRW...

ACCOUNT_5
2RWVYPHDAWVSPKJJ9UENXBDS1KEYBAJ7...

ACCOUNT_6
D8YUU1UHMTUDEJEXB9E6VNDU7OXNVI2KV...

ACCOUNT_7
9JM7FNX5TS9MN3FS289MA8W3CX4HRZGVA...

ACCOUNT_8
GO6WWXAZMFELNNF8JATASKYJARGVWMM...

ACCOUNT_9
CHSU4R7DDAJBBA5DBUPH3A5L6NNUHKLC...

ID: 767760BF2087A2FA898E8193C074571A3CC79E0803AEA0F80702D8673A4410C5

Hello BigchainDB
TIMESTAMP: 1461926390.241000

ID: E0B13E3DE4231C46198C90BFCCDC19AF4CF1A71FF7587205CA4AAAF973871B4C

This is me recording my stuff
TIMESTAMP: 1461926402.935754

ID: F9F3667134E63A65C4B2187F695A8696070297C8305F9B98B24D84520B39FE8A

Can you make it immutable for me?
TIMESTAMP: 1461926411.839164

ID: 1FF1BDD95DB22B1E813D00B85FF8957730B66C6BBE6435A165BA2CCAE2A8D4A9

Because I wouldn't appreciate anyone tampering with it...
TIMESTAMP: 1461926442.036669

ID: 61E88686C8085532BCC0B59C20D5263A547B1231C31AE41E5287512ED23710E7

Hopefully my statements will be around for the next decades
TIMESTAMP: 1461926455.866758

ID: 3FBDB208C88793EC25717599572D37C476FD37F5C3C63725FA3171F68FF97E69

Guess I can log and notarize anything I want with this?
TIMESTAMP: 1461926482.680386

ID: 9937CD3BCE2B1BD39245614B3A8DDB30B140DCC24DE588E31B78DCBEB7D6D7DF

What about emails, text, JSON, or any other type of digital communication
TIMESTAMP: 1461926515.945236

Type what you want to share on the blockchain

bigchaindb/bigchain

GitHub, Inc. [US] | https://github.com/bigchaindb/bigchaindb-examples

This repository | Search

bigchaindb / **bigchaindb-examples**

Share Trader

Search...

Select All

ACCOUNT_0
FUS45931I3UOBTYREC1KVPDGXQO5GDQZQ...

ACCOUNT_1
C6WQ796MFCJNKAWZDDTZQVJHG1MTIIFFV...

ACCOUNT_2
AAMMXRHNSBQLCABUDM1APTC4NZDXJML...

ACCOUNT_3
2DTFYSTNY6DPBDKDJO3ZZCOT2N2Y6Y9UN...

ACCOUNT_4
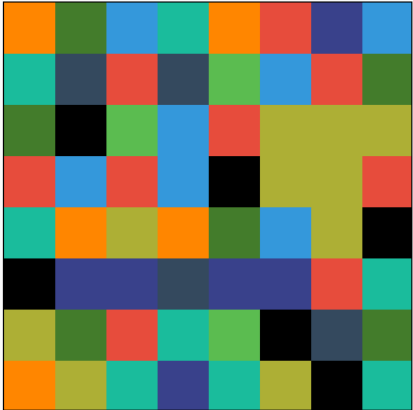7RTFNRGPMZH3NU8O8BMZWDZJCUAE3AN...

ACCOUNT_5
132MC9BYTKRAM6BPWGZVA8RSJE8WNF3N...

ACCOUNT_6
3WWXLQC7NJPVH2JSS11IJDHPTROKYZNYE...

ACCOUNT_7
BDUSRDTRCOVJZVVN62BEEZGSQJ8RR3FB...

ACCOUNT_8
2N1RBAEVIMSJNLOKGIOUONPZ6S7O6Y1SP...

ACCOUNT_9
7CRMBKX6CECEK2GLIZVHSESGMG7F7BNA...

87BF158D6111EA82D7AA3973E7BB24D96B...
Row: 1, Col: 1
TUE, 03 MAY 2016 10:39:23 GMT ✔

FF2C95E0E171A4CA079BDE565CAF042160...
Row: 2, Col: 1
TUE, 03 MAY 2016 10:39:23 GMT ✔

FF0FD97C3A03FBF9989DEAC2C6214E69ED...
Row: 3, Col: 1
TUE, 03 MAY 2016 10:39:23 GMT ✔

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Row: 4, Col: 1
TUE, 03 MAY 2016 10:39:23 GMT ✔

BD1A4DB8F9B7A2B2A8240C2759EDB5F41...
Row: 5, Col: 1
TUE, 03 MAY 2016 10:39:23 GMT ✔

1CDA12899FD83C627EE672B40FC112F763...
Row: 6, Col: 1
TUE, 03 MAY 2016 10:39:23 GMT ✔

1C0E4FAEE7C4FC87F4E50ADAA539FB8410...
Row: 7, Col: 1
TUE, 03 MAY 2016 10:39:23 GMT ✔

73AAC1DEAD7F914A7C4587720C04B1553D...
Row: 8, Col: 1
TUE, 03 MAY 2016 10:39:23 GMT ✔

DFA142013025A7C88E4A4379F3DFB6CC2A...

Decentralization of the Cloud

The internet is getting upgraded, driven by the winds of blockchain.

Internet Archive, BitTorrent, W3C, IETF, …
+ Eth, IPFS, lisk, ZeroNet, WebTorrent, …
Old + new guard are joining forces!

How to have lasting upgrade? New protocols.
W3C Blockchain, Coala IP, Copyright Hub / LCC, OMI, Interledger, IPLD, Web of Trust, Estonia e-id

www.nytimes.com/2016/06/08/technology/the-webs-creator-looks-to-reinvent-it.html?_r=0

TECHNOLOGY | The Web's Creator Looks to Reinvent It

TECHNOLOGY

The Web's Creator Looks to Reinvent It

By QUENTIN HARDY   JUNE 7, 2016

A group of top computer scientists gathered in San Francisco on Tuesday to discuss a new phase for the web. Jason Henry for The New York Times

When worlds collide: blockchain + database = blockchain database

- BigchainDB is the world's first instance of a blockchain DB
- It's a part of a broader evolution: the re-decentralization of the web

More info:
- bigchaindb.com
- bigchaindb.readthedocs.org
- github.com/bigchaindb