Operate and Extend Hyperledger Besu

Hyperledger Foundation workshop

March 21st, 2023

HYPERLEDGER
BLOCKCHAIN TECHNOLOGIES FOR BUSINESS

Welcome!

https://wiki.hyperledger.org/display/events/Operate+and+Extend+Hyperledger+Besu+Workshop

Operation session (8AM to 10AM Pacific)

- 30 minutes intro to Besu - what it does, how it works
- 30 minutes on Besu configuration - environment variables, toml file, cli flags, hidden flags. Docker vs binary installation.
- 60 minutes on running a Besu network
    - 15 minutes on Besu in dev mode, curl, easy first steps.
    - 15 minutes on Genesis block generation
    - 30 minutes on consortium creation, with monitoring and health report, with a Docker compose.

Developer session (10AM to Noon Pacific)

- 20 minutes on Besu and Github - source (3 repos), issues, PRs, code checkout, CI.
- 20 minutes on setting up with an IDE. Run and compile with Gradle. Checks and validations in place with spotless and errorprone.
- 20 minutes on the main repository content, describing types of tests in place, showing the tree of dependencies between Gradle modules.
- 30 minutes on adding an opcode to the EVM: show how to add a new opcode, add to the next hard fork revision, how to test it.
- 30 minutes on how to add a new JSON-RPC method, add tests and docs.

Prerequisites

https://wiki.hyperledger.org/display/events/Operate+and+extend+Hyperledger+Besu+Workshop+Prerequisites

Install:

- Java
- Git
- Docker
- Docker-Compose
- Your favorite IDE

Download:

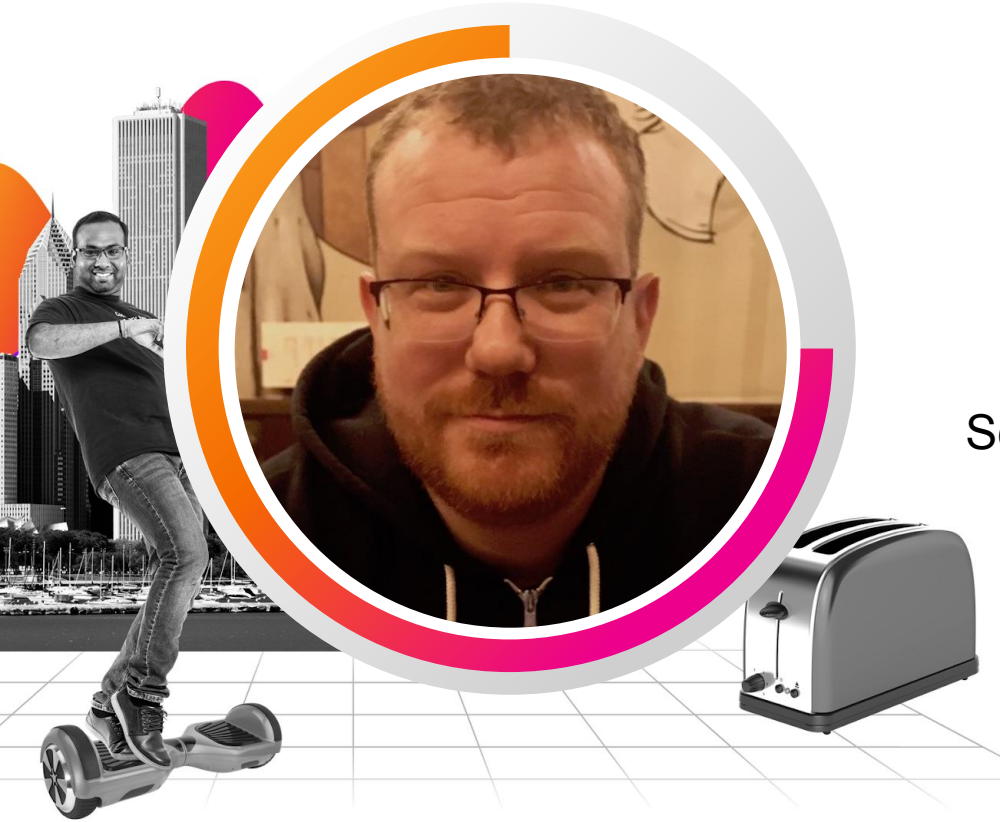
- Besu sources
- Quorum Dev Quickstart

Besu, Public Networks, & The Merge - What's Next

What do you want to learn about the future of Besu, staking, & Ethereum public networks?

Help us shape Besu and determine the topics for the next rounds of workshops by filling out this quick survey (only 7 questions)!

Matt Nelson, Besu Product Manager, ConsenSys Protocols



Antoine Toulme

Senior Engineering Manager | Splunk

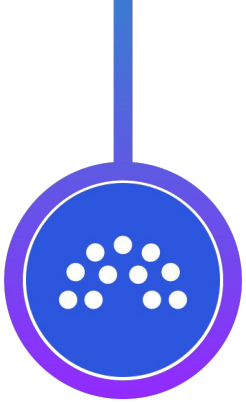
splunk> .conf22

Ethereum

- Second largest crypto by market capitalization
- Started in 2014
- Many different clients
- Instead of a single application, a programmable layer that executes smart contracts
  - EVM

The Enterprise

- As in - existing businesses
- Well supported client
- Different approach to deployments
  - Consensus is different
  - Everything permissioned
- Security!
  - Data management
  - Audits



Quorum

First take on an enterprise Ethereum client

Built by JPMC, eventually owned by ConsenSys

Using a private enclave to host data, private transactions and state

Using new consortium consensus algorithms: RAFT, IBFT

Using a fork of Geth

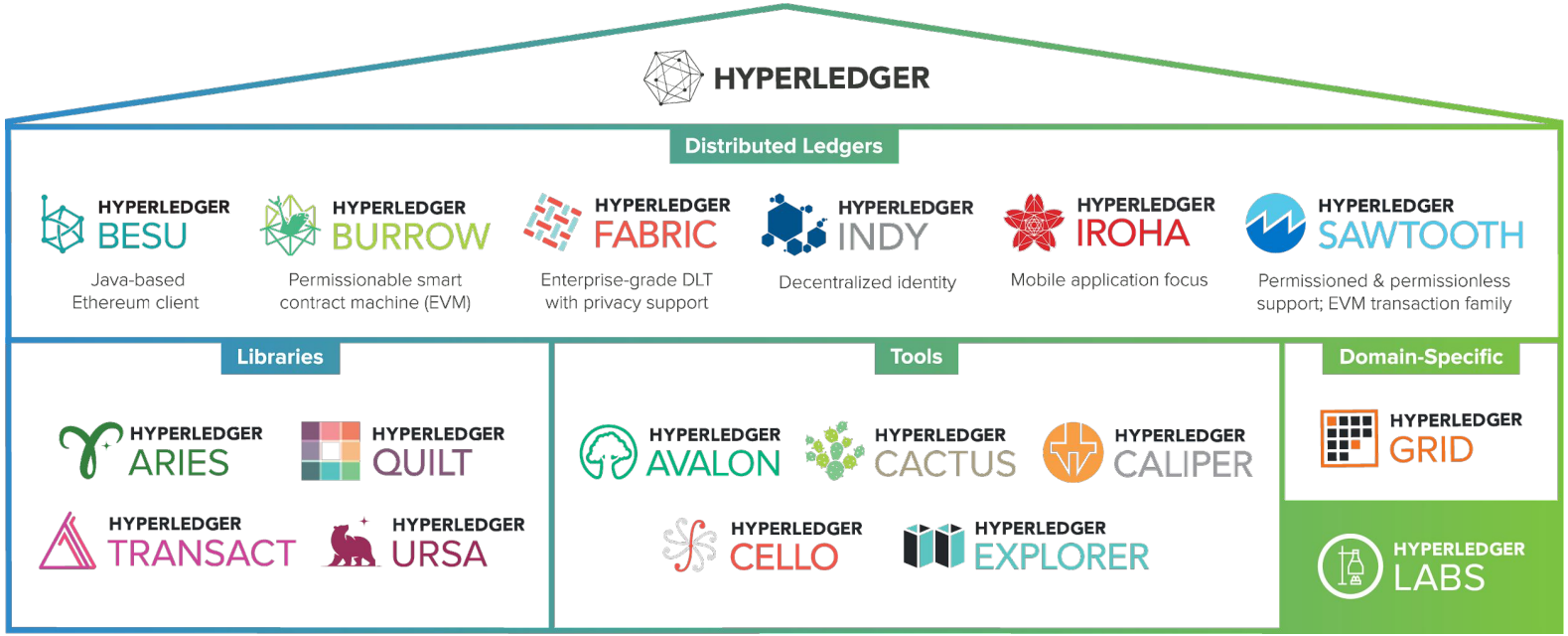
A contribution of ConsenSys in 2019

Formerly named Pantheon

Java-based mainnet client for Ethereum

Supports enterprise requirements

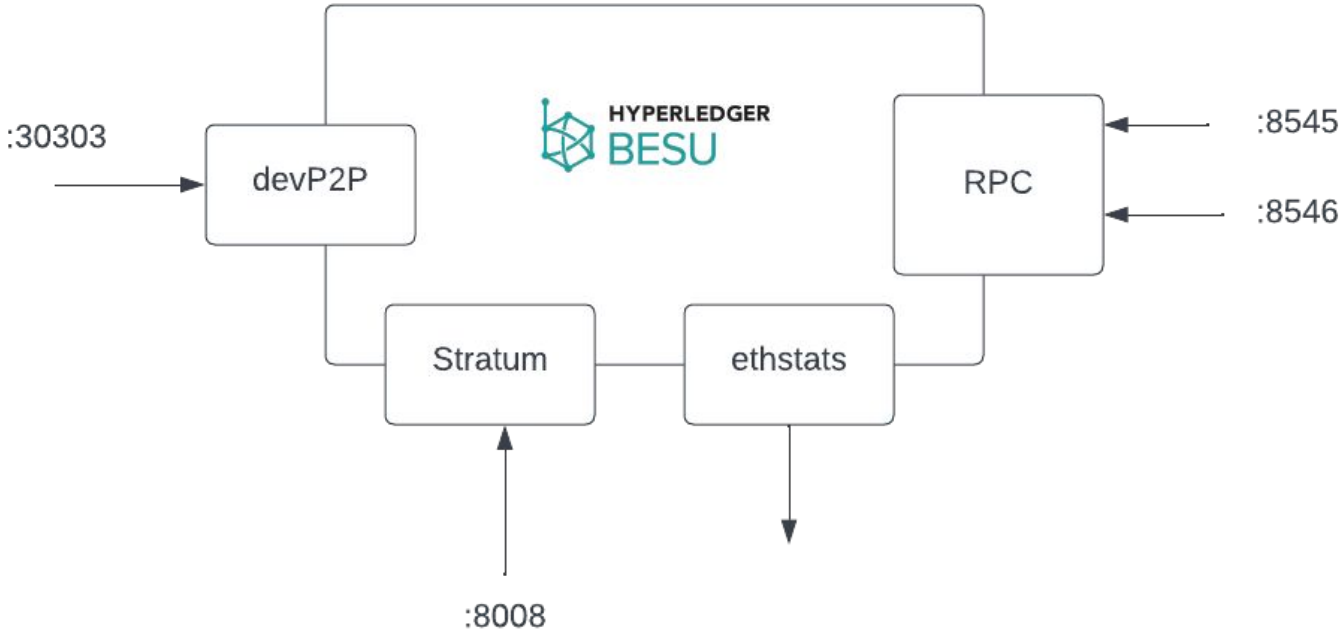
The Hyperledger Greenhouse



Ethereum client - high level

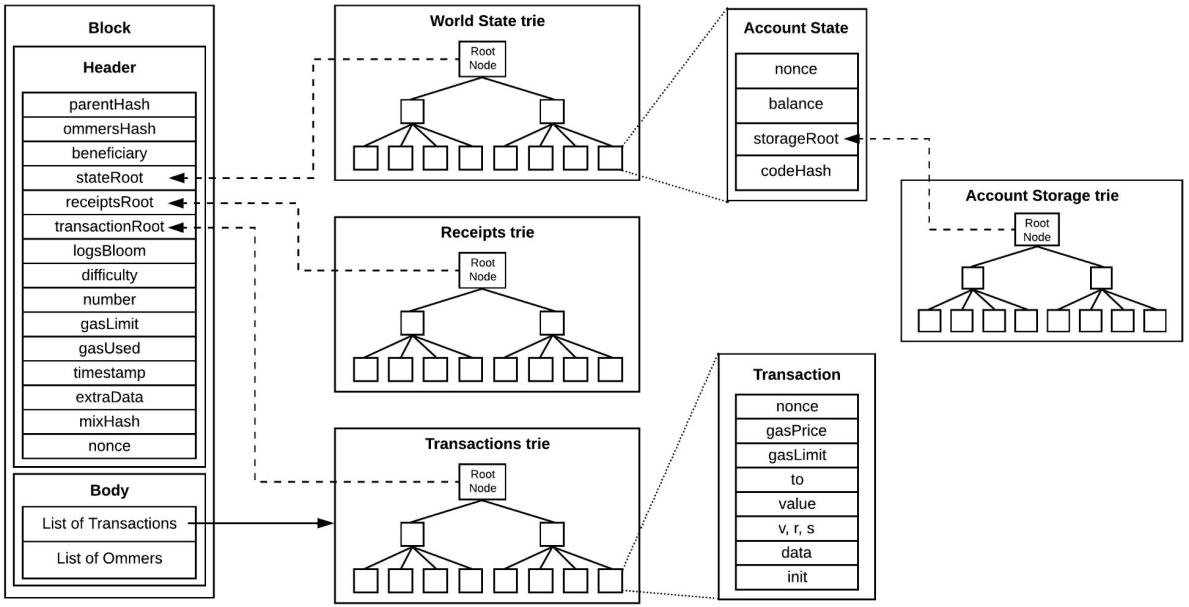
- Misnomer for a server, a peer-to-peer agent
- Runs as a single process
- Independent
  - Can perform all exchanges
  - Can submit transactions
  - Can interrogate the chain

Complex software stack



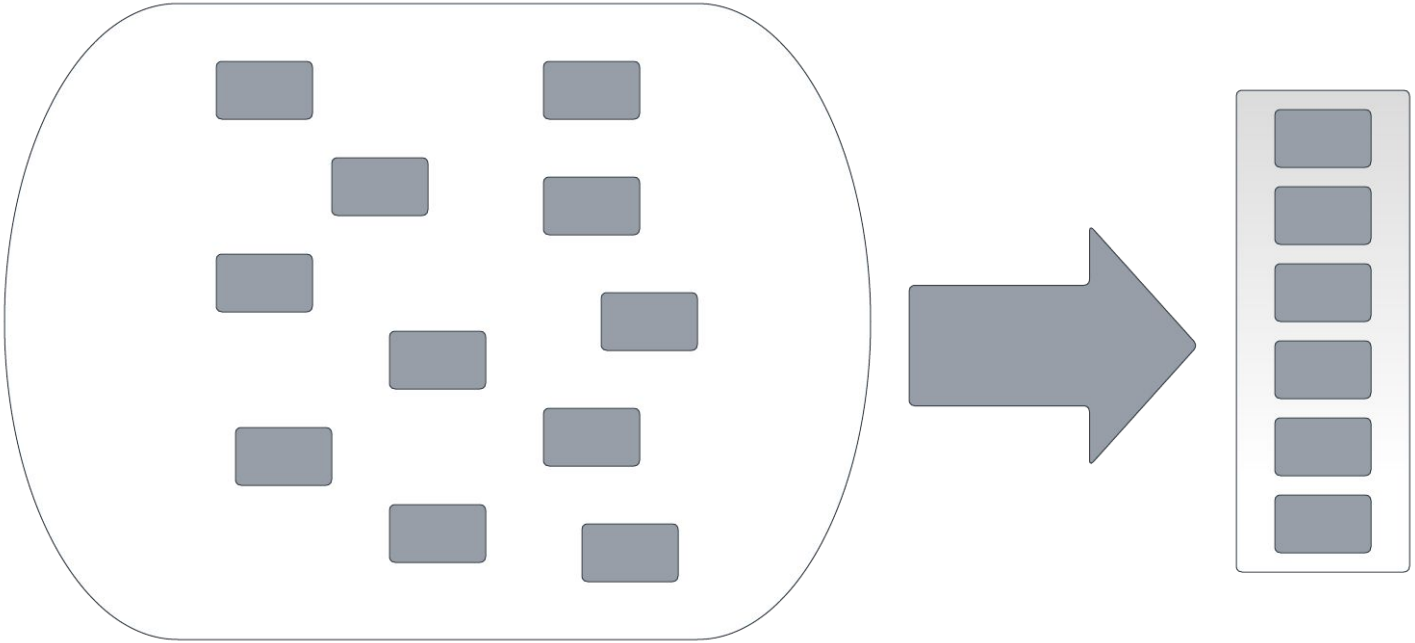
Besu as a database

- Using RocksDB storage
- Multiple stores
- Here is why:



Source: https://www.lucassaldanha.com/ethereum-yellow-paper-walkthrough-2/

Besu as a transaction pool



Besu network for Ethereum

- Each client is completely independent, so it requires configuration.
  - A genesis block
  - A consensus engine
  - Bootnodes to discover other peers

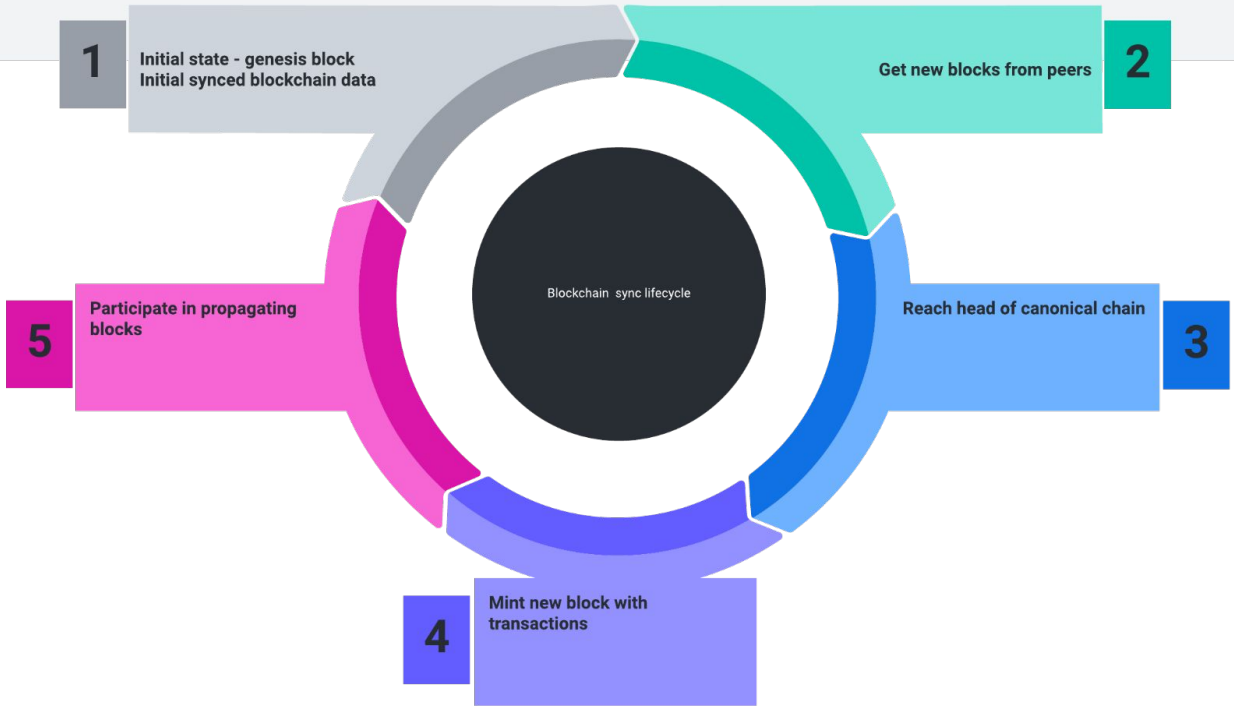
Besu discovery

- Connect to other nodes using UDP-based messages
  - First to bootnodes, then all peers exposed by them
- Store peers into buckets to avoid eclipse attacks
  - Use a Kademlia hashtable
- New discovery mechanism using DNS
  - Indexing from a bootnode on a regular basis
  - Easy to download and check integrity
- Static peering
  - Set enodes as part of configuration
  - `enode://6f8a80d14311c39f35f516fa664deaaaa13e85b2f7493f37f6144d86991ec012937307647bd3b9a82abe2974e1407241d54947bbb39763a4cac9f77166ad92a0@10.3.58.6:30303?discport=30301`

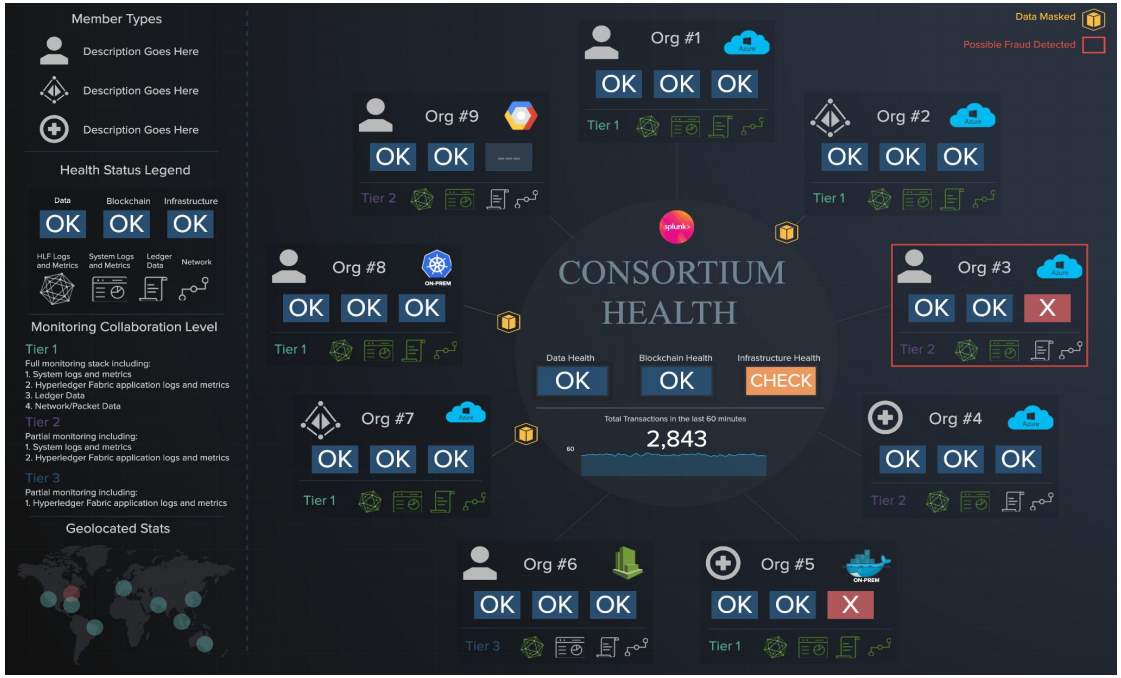
Besu network client

- Using devp2p, embedding node identity
  - Send HELLO message to other nodes
  - Negotiates subprotocols such as eth (others exist such as Whisper, or IBFT)

Hyperledger Besu lifecycle



Besu as part of consensus



- Clique
- IBFT
- Ethash (PoW)
- PoS (the merge)

JSON-RPC server

```
{
    "jsonrpc":"2.0",
    "method":"web3_clientVersion",
    "params":[],
    "id":1
}
```

HTTP

- Supports batching
- Used by wallets such as Metamask

WS

- Web socket
- Great for subscriptions
- New events and logs

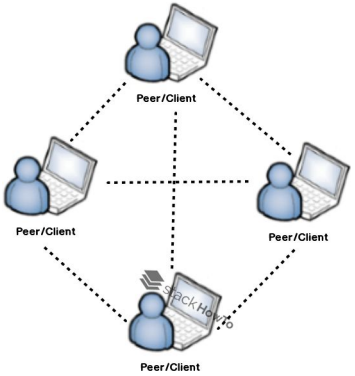
IPC

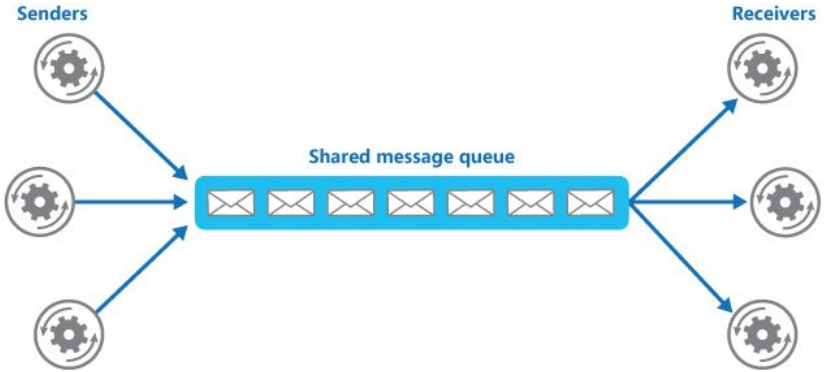
- Using a file socket
- Can be used to attach to the client with geth
- Most secure option
- Just added to Besu in April!

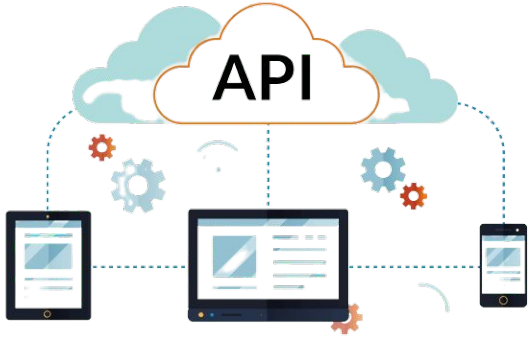
GraphQL

- Versatile API
- Allows to query specific data from the chain

In recap


Peer/Client
Peer/Client
Peer/Client
Peer/Client


Senders
Receivers
Shared message queue


API

One more thing…

Ethereum is special because of the EVM.
But where does that play out?

- Validate blocks
- Update the world state
- Create our own blocks by executing transactions


Questions?

Configuring Hyperledger Besu

Hyperledger Foundation workshop

July 14th, 2022

HYPERLEDGER
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Hyperledger Besu configuration

Supports command line arguments, env variables, config file - with that order of priority.

You can specify Besu options:

- On the command line.

```
besu [OPTIONS] [SUBCOMMAND]
```

- As an environment variable. For each command line option, the equivalent environment variable is:
  - Uppercase.
  - `_` replaces `-`.
  - Has a `BESU_` prefix.

  For example, set `--miner-coinbase` using the `BESU_MINER_COINBASE` environment variable.
- In a configuration file.

Great docs here! https://besu.hyperledger.org/en/stable/Reference/CLI/CLI-Syntax/

First options

Network	`--network=dev` `--network=ropsten`
Data	`--data-path=folder`
P2P	`--p2p-host=localhost` `--p2p-port=30303`
Discovery	`--enabled=true` `--bootnodes=...`

JSON-RPC

Enablement and APIs

By default JSON-RPC is not enabled. Open it up with --rpc-http-enabled.

--rpc-http-api allows to select which APIs to open:

The available API options are: `ADMIN`, `CLIQUE`, `DEBUG`, `EEA`, `ETH`, `IBFT`, `MINER`, `NET`, `PERM`, `PLUGINS`, `PRIV`, `QBFT`, `TRACE`, `TXPOOL`, and `WEB3`. The default is: `ETH`, `NET`, `WEB3`.

JSON-RPC spec https://ethereum.github.io/execution-apis/api-documentation/

Hidden flags

Unstable options, hidden flags are represented with the --X prefix.

```
$> besu --Xhelp
```

```
Unstable options for Ethereum Wire Protocol
      --Xewp-max-get-bodies=<INTEGER>
         Maximum request limit for Ethereum Wire Protocol GET_BLOCK_BODIES.
           (default: +128)
      --Xewp-max-get-headers=<INTEGER>
         Maximum request limit for Ethereum Wire Protocol GET_BLOCK_HEADERS.
           (default: +192)
      --Xewp-max-get-node-data=<INTEGER>
         Maximum request limit for Ethereum Wire Protocol GET_NODE_DATA.
           (default: +384)
      --Xewp-max-get-pooled-transactions=<INTEGER>
         Maximum request limit for Ethereum Wire Protocol
           GET_POOLED_TRANSACTIONS. (default: +256)
      --Xewp-max-get-receipts=<INTEGER>
         Maximum request limit for Ethereum Wire Protocol GET_RECEIPTS.
           (default: +256)
```

Ways to run Besu

Download the distribution	From Github https://github.com/hyperledger/besu/releases
Homebrew	`brew install besu`
Docker	`docker pull hyperledger/besu`

From source: `./gradlew assemble`

OS support: x86 with native libraries
ARM support - M1 support in progress

Advanced options

Genesis file	`--genesis-file=<genesis.json>` Use a custom Genesis file

RPC security	`--rpc-http-host`
	`--rpc-http-cors-origins`
	`--rpc-http-tls-client-auth-enabled`
	`--rpc-http-authentication-jwt-public-key-file`
	`--rpc-http-authentication-credentials-file`

Metrics	`---metrics-enabled`
	`---metrics-port` and `---metrics-host`
	`--metrics-protocol`

Miner	`--miner-enabled`
	`--miner-stratum-enabled`
	`--miner-coinbase`

Exercises - running with --network=dev

Check out Besu and run with --network=dev --rpc-http-enabled

Check out the genesis file here:
https://github.com/hyperledger/besu/blob/main/config/src/main/resources/dev.json

From the command line, check the balance of an address with:

```
curl http://localhost:8545/ \
  -X POST \
  -H "Content-Type: application/json" \
  --data '{
           "method":"eth_getBalance",
           "params":["0x627306090abaB3A6e1400e9345bC60c78a8BEf57", "latest"],
           "id":1,
           "json-rpc":"2.0"
         }'
```

Exercises - Genesis file specification

Following the tutorial:

https://besu.hyperledger.org/en/stable/Tutorials/Private-Network/Create-IBFT-Network/

Exercises - Quorum Dev Quickstart

ConsenSys has created a tool to generate complex Besu networks, with the option to use private enclaves, and monitoring tools of your choice.

Use `npx quorum-dev-quickstart` to get started.


Questions?