FVM + Tendermint = Fendermint

Concepts and Milestone 1 Demo

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Mother Of All Demo Days: April 2023

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InterPlanetary Consensus (IPC)

- https://ipc.space
- Used to be Hierarchical Consensus (HC)
- Subnets are recursive sidechains rooted at Filecoin, where:
  - subnets can have arbitrary consensus
  - messaging with parent and child subnets is IPLD based, using checkpoints
- We need nodes with different consensus than Lotus:
  - Eudico is fork of Lotus running Mir and Trantor
  - Fendermint is using off-the-shelf Tendermint with FVM

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What is Tendermint?

- a Proof-of-Stake BFT consensus protocol
- the generic blockchain application platform Tendermint Core
- now living under Comet BFT
- very convenient for application developers:
  - instant block finality
  - forward-only with no rollbacks and reorgs
  - does not restrict the implementation in any way
- scales to ca. 100 validators with a default 2 sec. block time
- Rust libraries:
  - tendermint-rs
  - tower-abci
- Tendermint Core != Cosmos SDK

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ABCI (Application BlockChain Interface)

Calls to the Application from Tendermint during the lifecycle of a block:

- `begin_block`: called with the current block header; run `cron`
- `deliver_tx`: called for each transaction; return receipt
- `end_block`: return changes to the power table
- `commit`: flush all changes to the database; return new state hash

Other methods: `init_chain`, `check_tx`, `query`, `list_snapshots`, ...

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State Management

The Application must maintain uncommitted state in memory until the `commit` arrives, and a projected one for `check_tx`. Perfect fit for the machinery the FVM comes with!

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ABCI++

So far the Application received blocks which were already finalized by Tendermint; it had to mark faulty transactions as such and move on. This would be a problem if we wanted to only contain CIDs of transactions in the blocks.

ABCI++ adds new methods[1]:

- `prepare_proposal`: the Application can reorder or replace transactions found in the Mempool before they are added to a block
- `process_proposal`: the Application can inspect all transactions in a block proposed by the round leader and decide whether or not to vote for the block

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[1] https://github.com/tendermint/tendermint/blob/v0.37.0-rc2/spec/abci

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Availability Certificates

We can use this mechanism to reduce transactions to CIDs and only vote on blocks if the content is available.

[1] https://github.com/tendermint/tendermint/blob/v0.37.0-rc2/spec/abci

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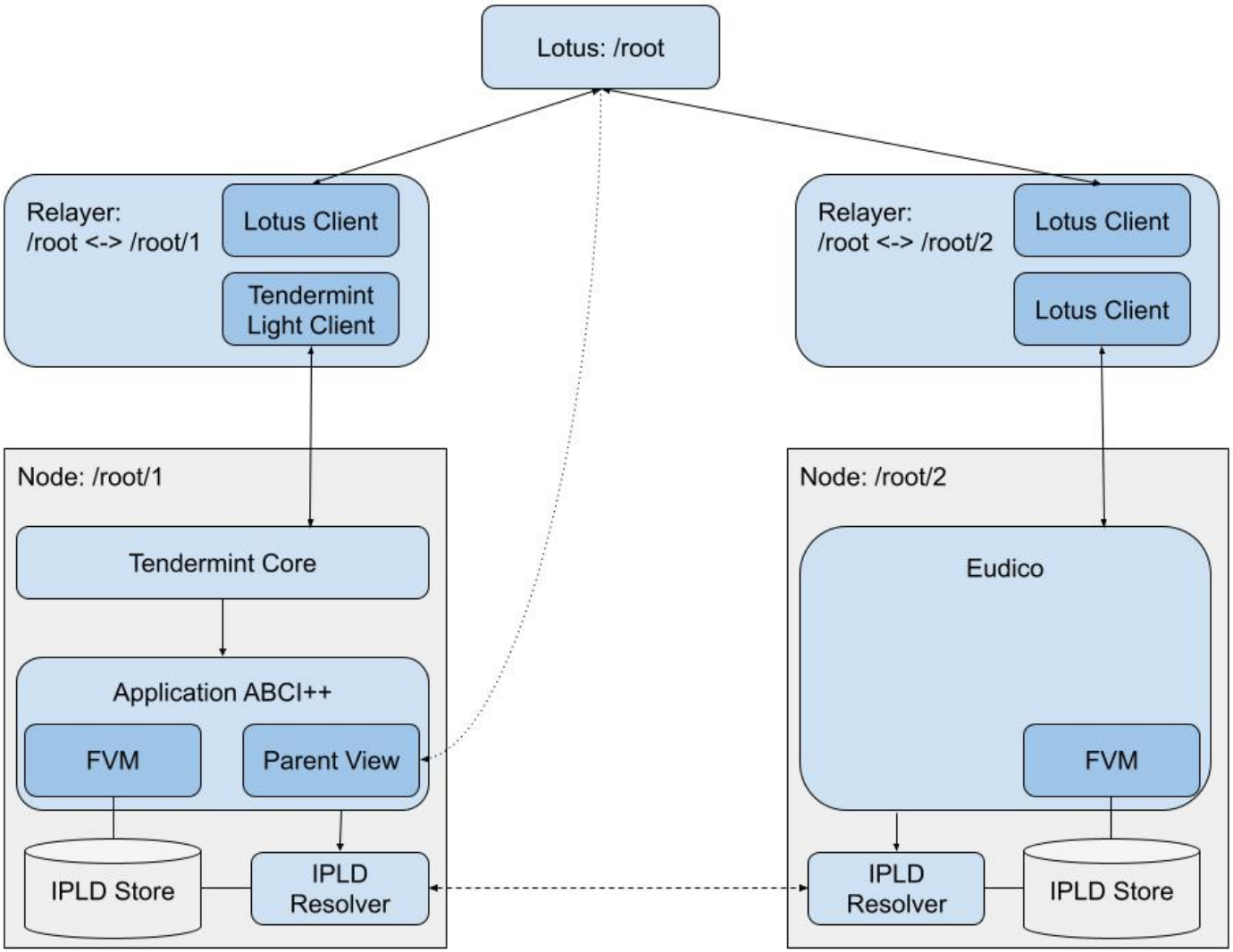
Proposed Architecture



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PoS Sidechain

Fendermint runs as a PoS Sidechain[2]:

- top-down: *direct observation* of the parent (ie. run at least a full node on all ancestor subnets)
- bottom-up: periodic checkpoints signed by the subnet validators, submitted to smart contracts running on the parent subnet

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[2] P. Gaži, A. Kiayias and D. Zindros, "Proof-of-Stake Sidechains," 2019

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Observability

Validators need to agree on:

- top-down: the finality of a message on the parent subnet
- bottom-up: the availability of a checkpoint from a child subnet (where the checkpoint only contains a CID)

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[2] P. Gaži, A. Kiayias and D. Zindros, "Proof-of-Stake Sidechains," 2019

Data Availability

- Checkpoints contain an unknown number bottom-up messages
- sending a checkpoint as a self-contained message wouldn't scale
- we could send a Merkle commitment and relay constituent messages one by one, or we can rely on IPLD resolution and send a root CID.
- Before parent validators commit to executing a checkpoint from a child, they must know the majority of them have its contents; otherwise a single validator could not decide if it's a data availability attack.

Take ideas from NC-Max[3]:

- divide the block space in two:
  1. transactions for *resolution* (asynchronous)
  2. transactions for *execution* (synchronous)
- remove transaction propagation from the critical path

Use ABCI++ `process_proposal` to reject unavailable execs.

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[3] R. Zhang et al, "NC-Max: Breaking the Security-Performance Tradeoff in Nakamoto Consensus", 2020

IPLD Resolver

A P2P library[4] we can use to advertise subnet membership and resolve arbitrary content; see the docs for an overview. Much of it was based on Forest. Uses the following libp2p protocols:

- Kademlia for peer discovery
- Identify for exchanging listening addresses
- Gossipsub for
  - advertising subnet membership
  - to propagate votes about CIDs, which can be used to agree on availability (bottom-up) or finality (top-down)
  - to publish content to the parent subnet, pre-empting resolution requests (requires subscription)
- Bitswap for recursively resolving CIDs from a subnet, and putting the data into the `Blockstore`

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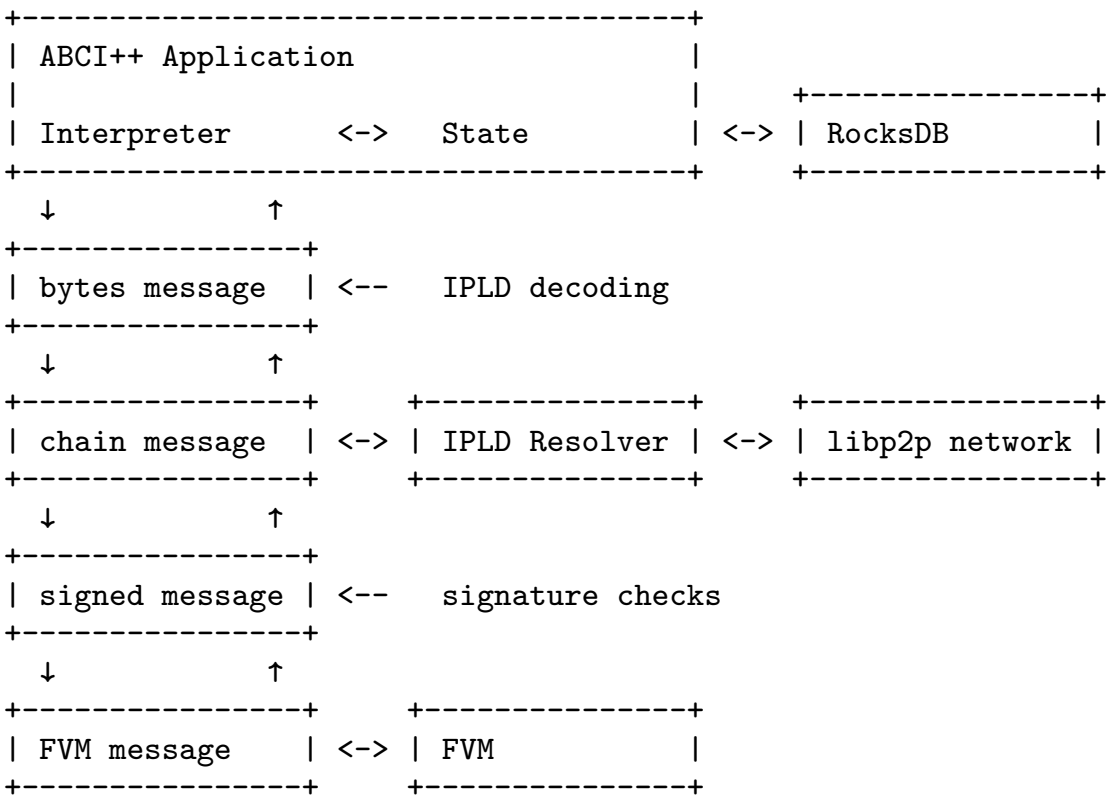
[4] https://github.com/consensus-shipyard/ipc-agent/tree/main/ipld/resolver

Application Architecture

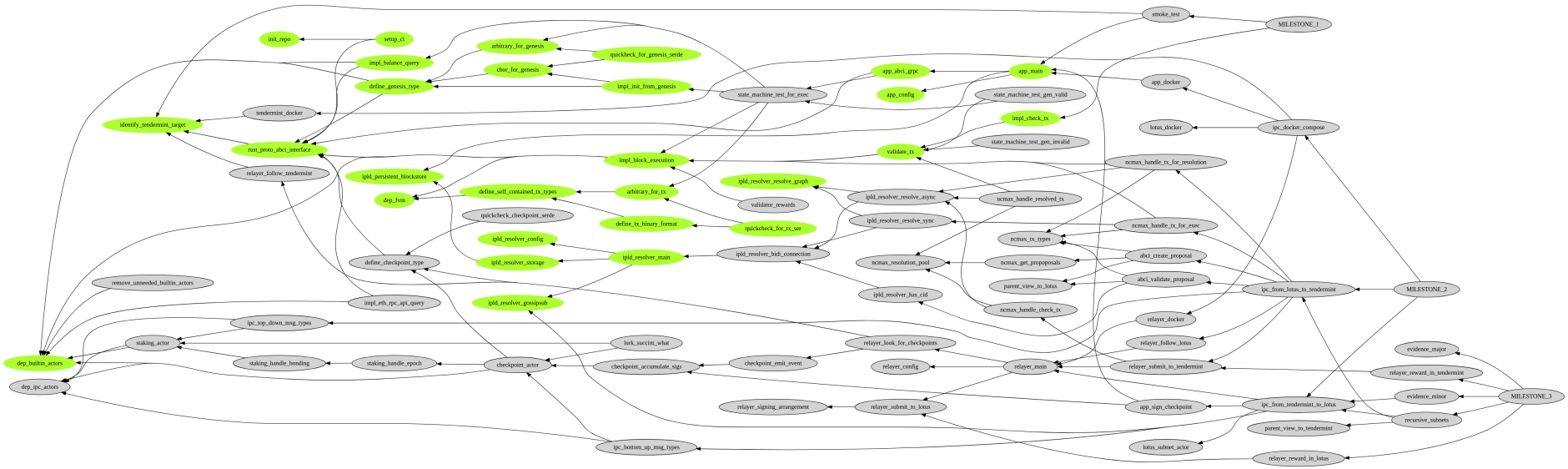


Interpreter Stack

Type of message changes as it passes through short circuiting interpreters.

Milestones

- M1: **Standalone Tendermint with FVM and IPLD**
- M2: Fendermint plugged into IPC under Lotus rootnet
- M3: Recursive subnets, incentives, Ethereum JSON-RPC for FEVM



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Demo

Current state of affairs:

- CLI commands to:
  - generate keys
  - construct a genesis JSON file with initial accounts and validators [5]
  - run the Application process
- RPC client library and CLI commands to:
  - transfer tokens
  - send IPLD encoded messages to FVM actors
  - create and invoke FEVM contracts with ABI encoded args
  - query the state of an actor
  - get IPLD content by CID

See the docs[6] for examples of using the CLI and simplecoin.rs for statically typed interaction with a FEVM contract through JSON-RPC.

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[5] built-in actors: `system`, `init`, `eam`, `evm`, `account`, `multisig`, `cron`

[6] https://github.com/consensus-shipyard/fendermint

Questions

Thank you!

https://github.com/consensus-shipyard/fendermint