elixir-lang moscow

Mana

Ethereum client in Elixir

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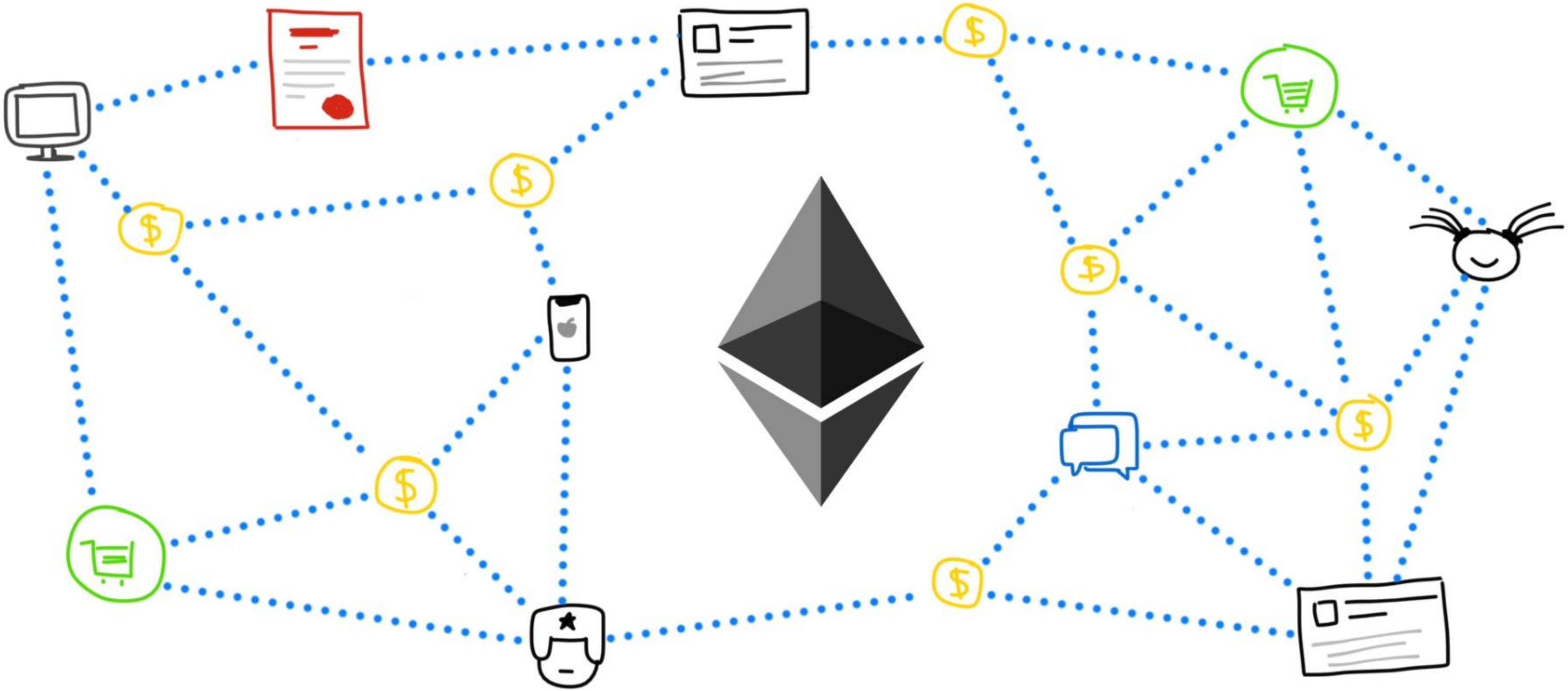
WTF IS THIS!
WTF WAS THAT?!

Acknowledgements

SAY BLOCKCHAIN
ONE MORE TIME...

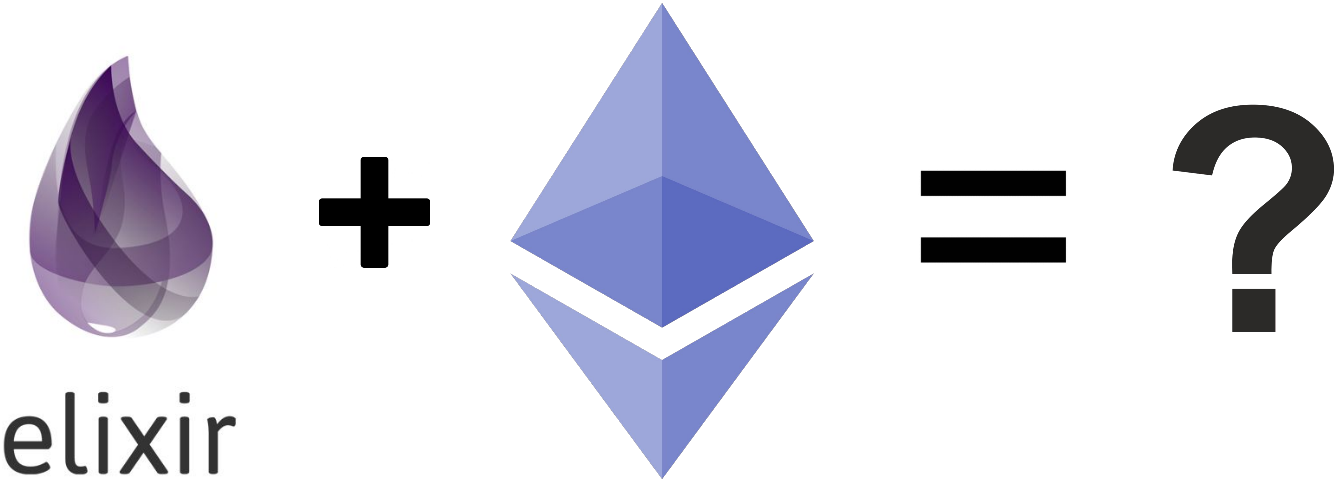


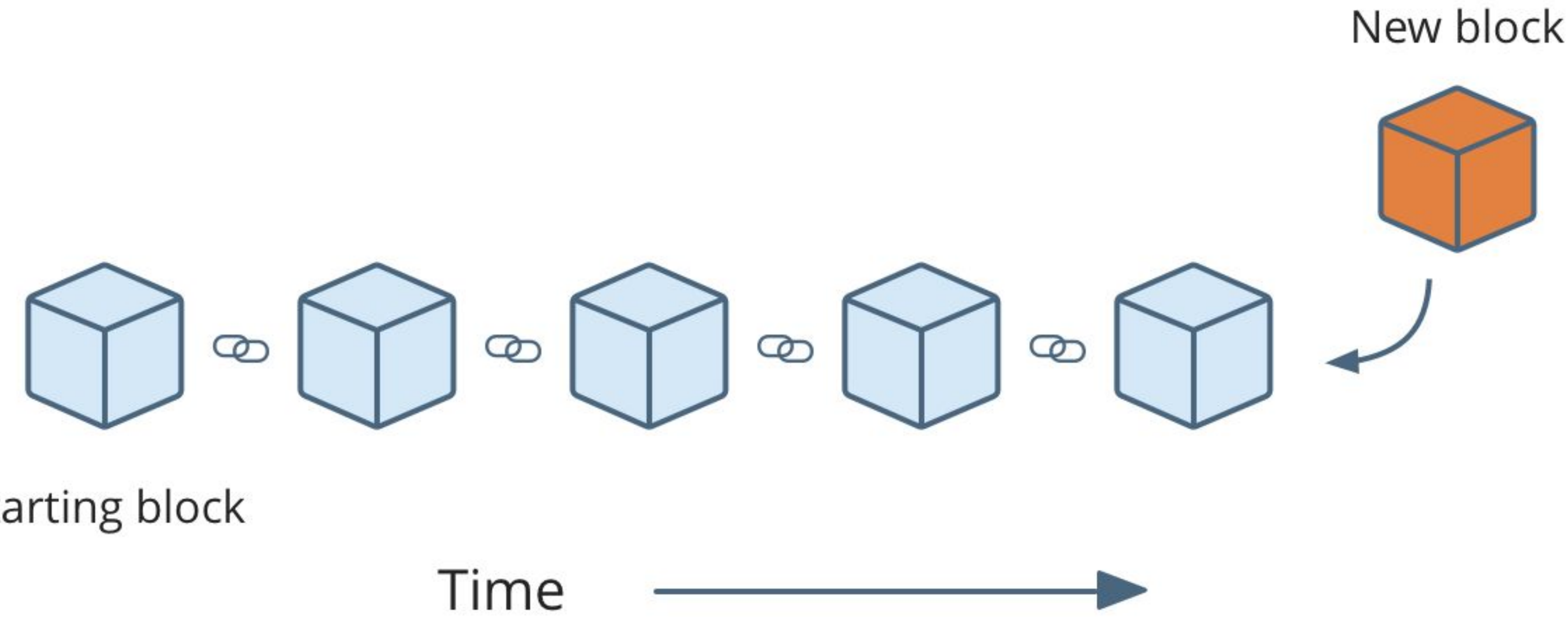
Ethereum clients

- Parity (Rust)
- Geth (Go)
- Pyethereum (Python)

…

Is Elixir suitable for Ethereum?



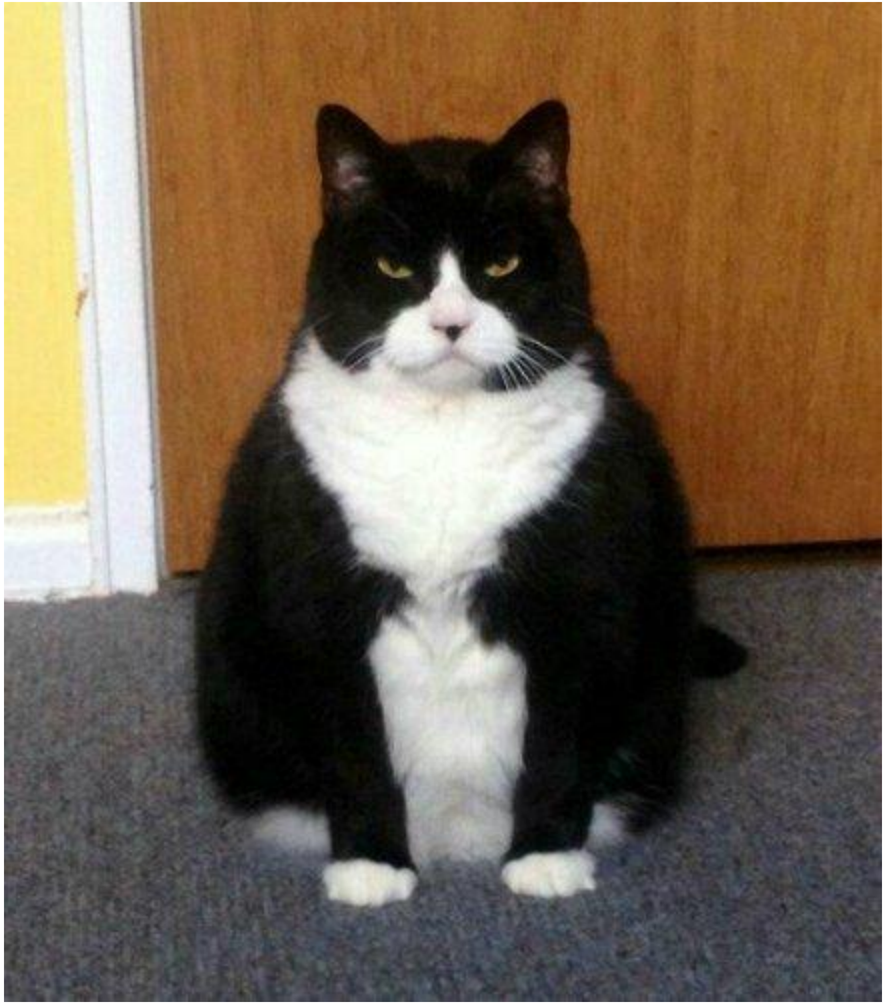


New block

Starting block

Time

Crypto Beginners



Consensus algorithms

- Proof of Work
- Proof of Stake
- Proof of Authority

PROOF OF WORK

Proof of Work

- hard, useless problem
- a lot of computational power
- a significant amount of energy

Proof of Stake

Proof of Stake

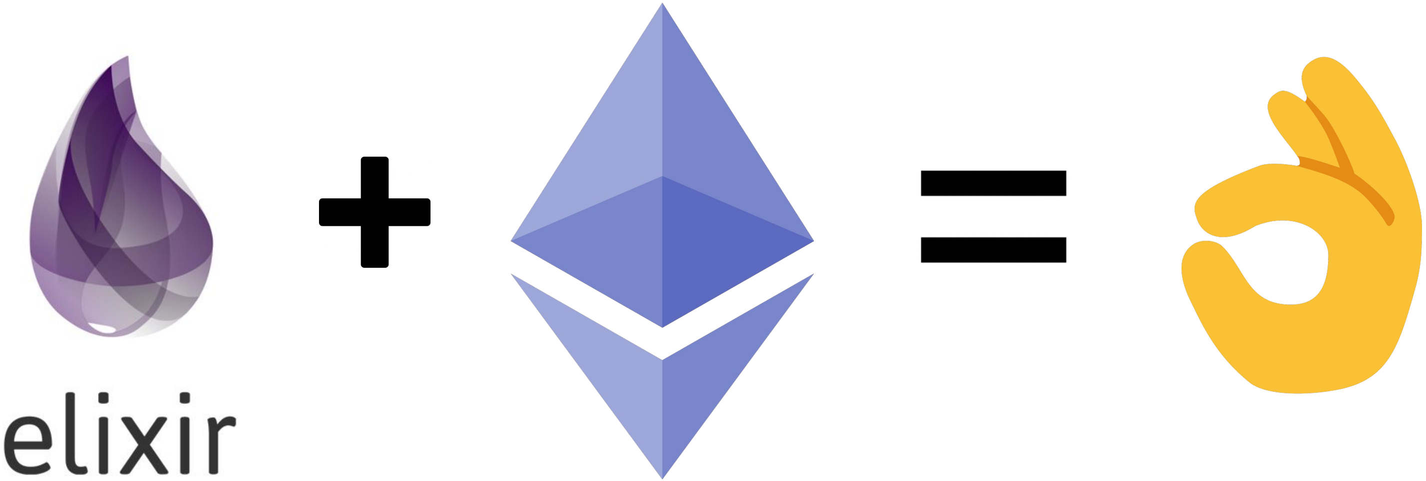
- depends on a validator’s economic stake
- number of tokens you own matter
- small numbers of people own the majority of stakes

Proof of Authority

Proof of Authority

- modification of Proof of Stake
- identity as a stake
- verified personal identities

Is Elixir suitable for Ethereum?



Mana

Project structure

- ExRLP - binary encoding
- MerklePatriciaTree - data structure for key-value storage
- EVM - Ethereum virtual machine
- Blockchain - block validation
- ExWire - p2p layer

ExRLP

- Ethereum’s homebrew binary encoding
- simplicity of implementation
- guaranteed absolute byte-perfect consistency

ExRLP - recursive length prefix

```
defprotocol ExRLP.Encode do
  def encode(value, options \\ [])
end

defimpl ExRLP.Encode, for: BitString do
...
end

defimpl ExRLP.Encode, for: Integer do
...
end

defimpl ExRLP.Encode, for: List do
...
end
```

```
iex> [[[]], []] |> ExRLP.Encode.encode
<<195, 193, 192, 192>>

iex> [42, "eth"] |> ExRLP.Encode.encode
<<197, 42, 131, 101, 116, 104>>

iex> [42, ["sun", "moon", 5]] |> ExRLP.Encode.encode
<<204, 42, 202, 131, 115, 117, 110, 132, 109, 111, 111, 110, 5>>
```

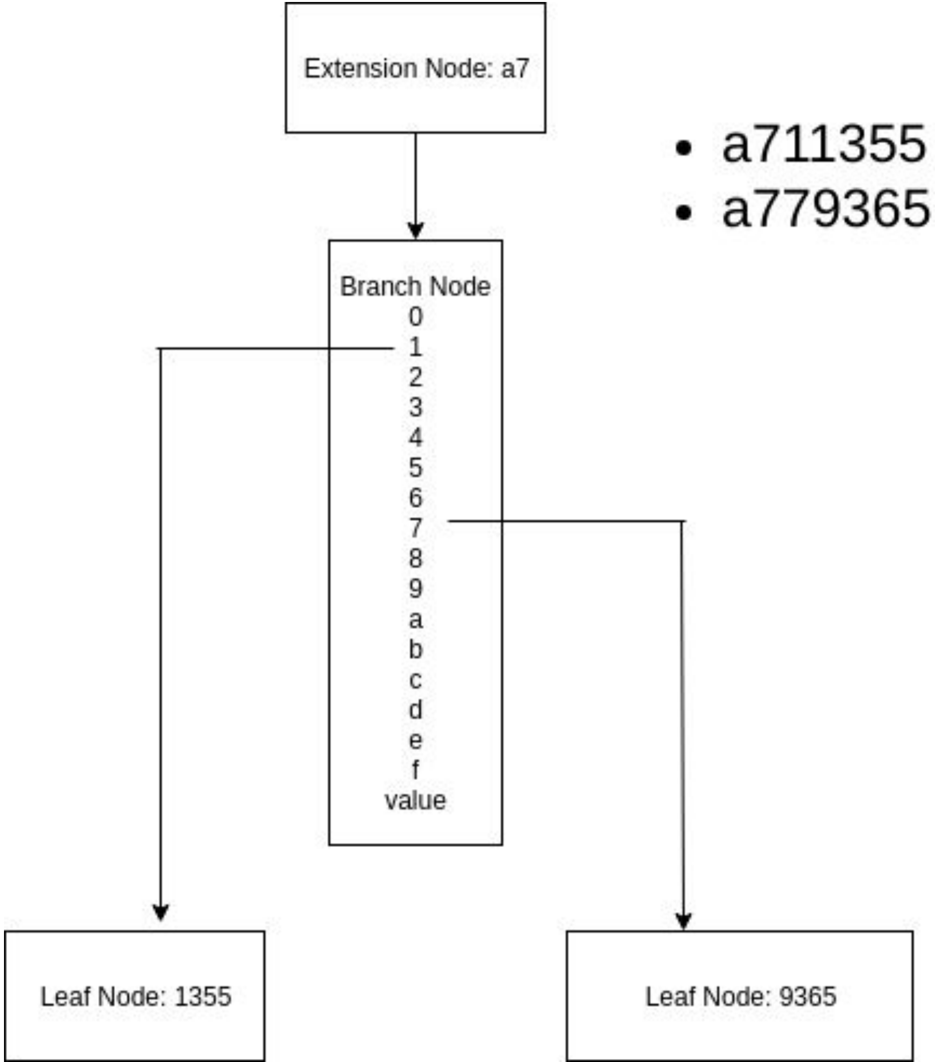
```elixir
@spec encode_item(binary()) :: binary()
 defp encode_item(<<byte>> = item) when byte_size(item) == 1 and byte < 128 do
   item
 end

 defp encode_item(item) when is_binary(item) and byte_size(item) < 56 do
   prefix = 128 + byte_size(item)

   <<prefix>> <> item
 end

 defp encode_item(item) do
   be_size = Utils.big_endian_size(item)
   byte_size = byte_size(be_size)

   <<183 + byte_size>> <> be_size <> item
 end
```

```
    if b0 < 128:  # single byte
        return (b'', bytes, 1, start)
    elif b0 < SHORT_STRING:  # short string
        if b0 - 128 == 1 and rlp[start + 1] < 128:
            raise DecodingError('Encoded as short string although single byte was possible',
rlp)
        return (rlp[start:start + 1], bytes, b0 - 128, start + 1)
    elif b0 < 192:  # long string
        ll = b0 - 183  # - (128 + 56 - 1)
        if rlp[start + 1:start + 2] == b'\x00':
            raise DecodingError('Length starts with zero bytes', rlp)
        len_prefix = rlp[start + 1:start + 1 + ll]
        l = big_endian_to_int(len_prefix)  # noqa: E741
        if l < 56:
            raise DecodingError('Long string prefix used for short string', rlp)
        return (rlp[start:start + 1] + len_prefix, bytes, l, start + 1 + ll)
    elif b0 < 192 + 56:  # short list
```

Merkle Patricia Tree (Trie)

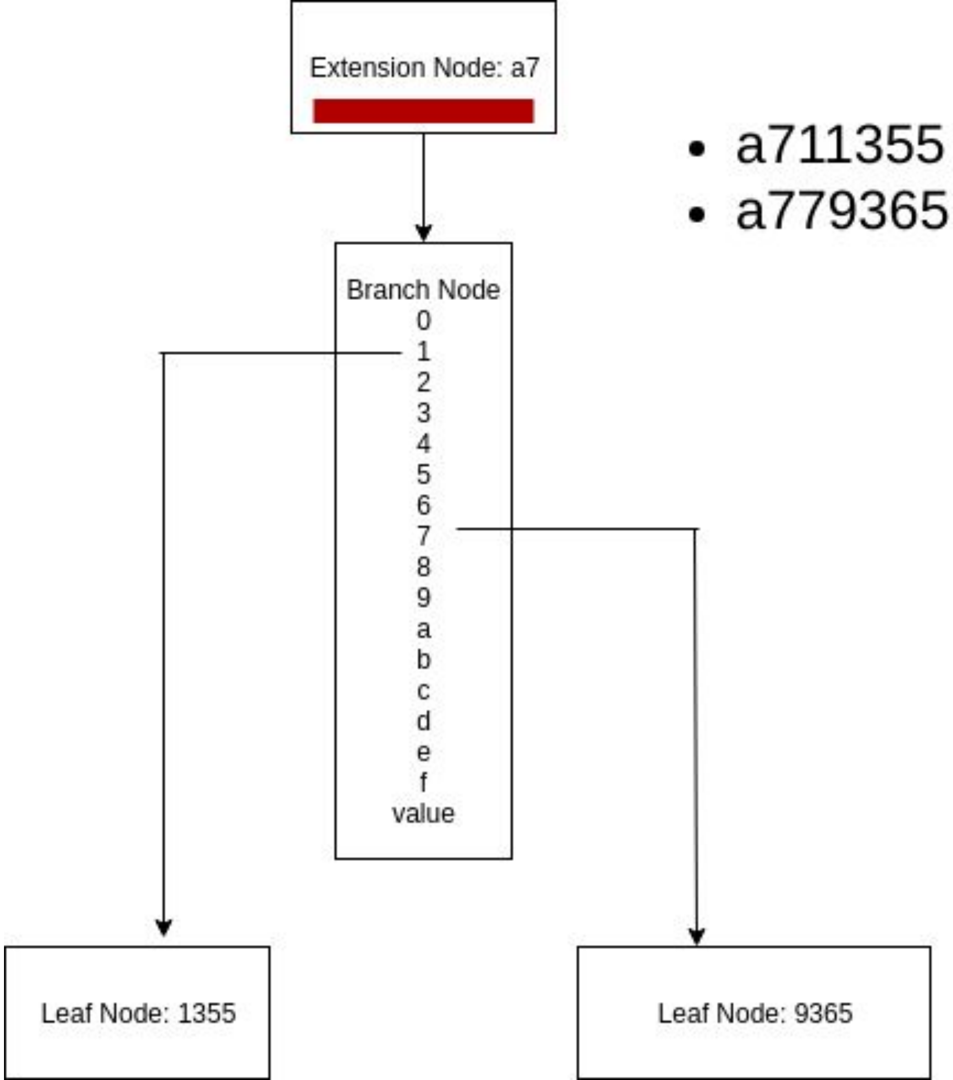
- cryptographically authenticated data structure
- Key-value storage
- O(log(n)) efficiency for inserts, lookups and deletes

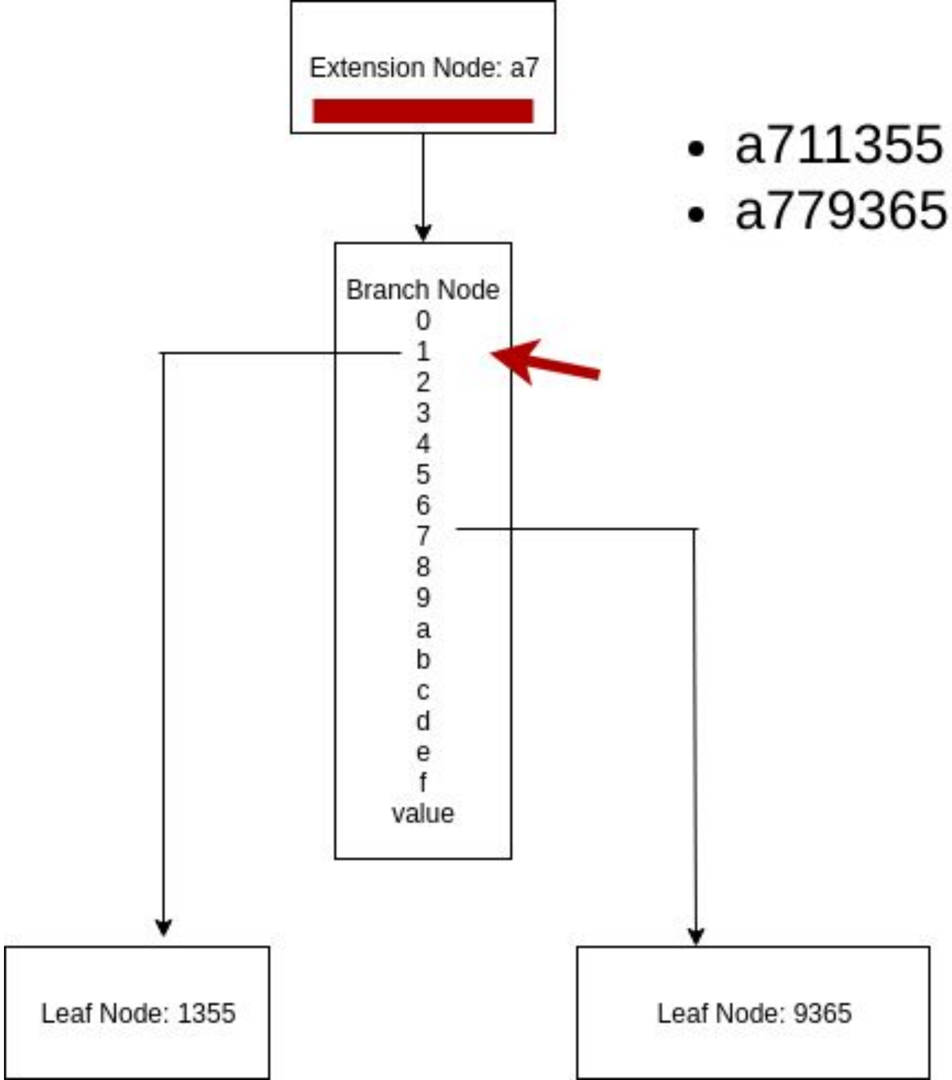
```elixir
defmodule MerklePatriciaTree.DB do

 @callback init(db_name) :: db
 @callback get(db_ref, MerklePatriciaTree.Trie.key()) :: {:ok, value} |
:not_found
 @callback put!(db_ref, MerklePatriciaTree.Trie.key(), value) :: :ok
 @callback delete!(db_ref(), MerklePatriciaTree.Trie.key()) :: :ok
 @callback batch_put!(db_ref, Enumerable.t(), integer()) :: :ok
```



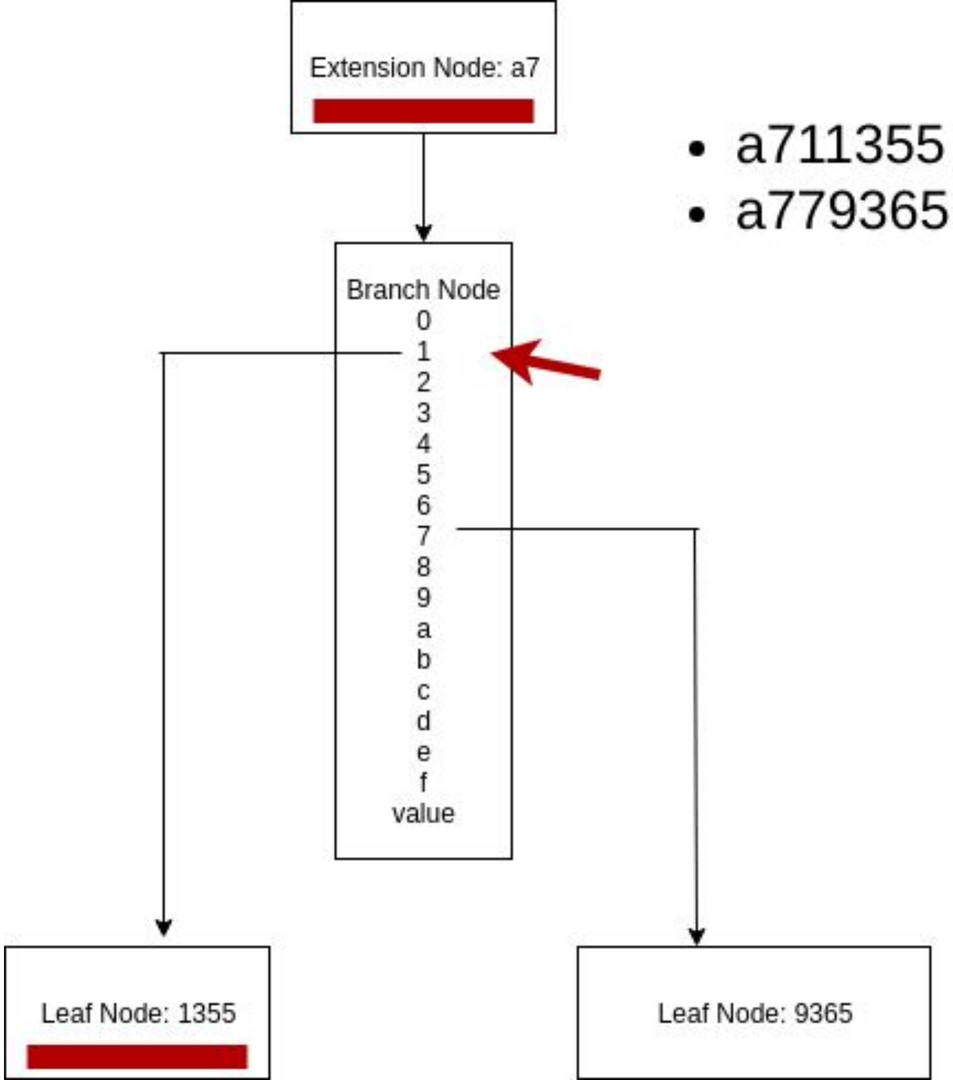
- a711355
- a779365

- a711355
- a779365





- a711355
- a779365



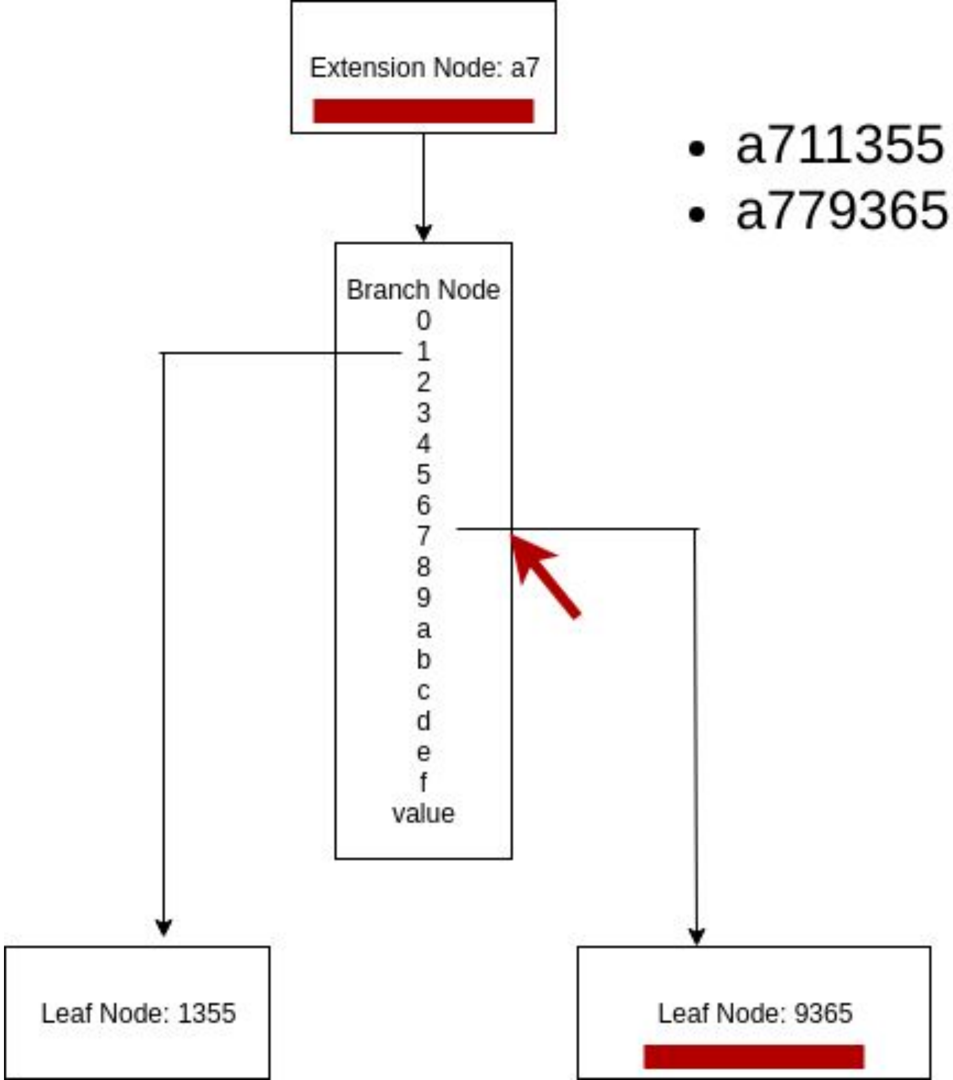
Extension Node: a7

Branch Node
0
1
2
3
4
5
6
7
8
9
a
b
c
d
e
f
value

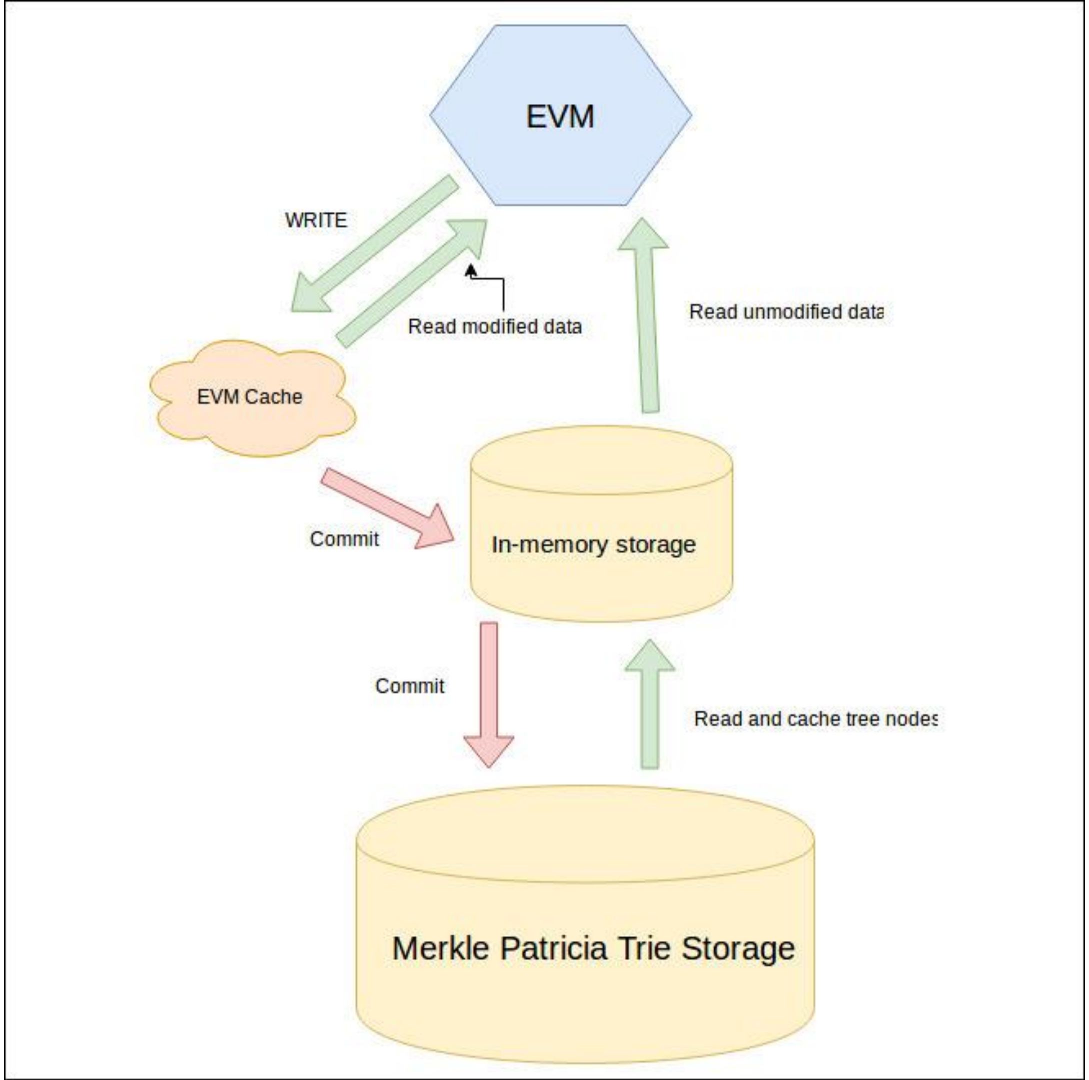
Leaf Node: 1355

Leaf Node: 9365

- a711355
- a779365



- a711355
- a779365

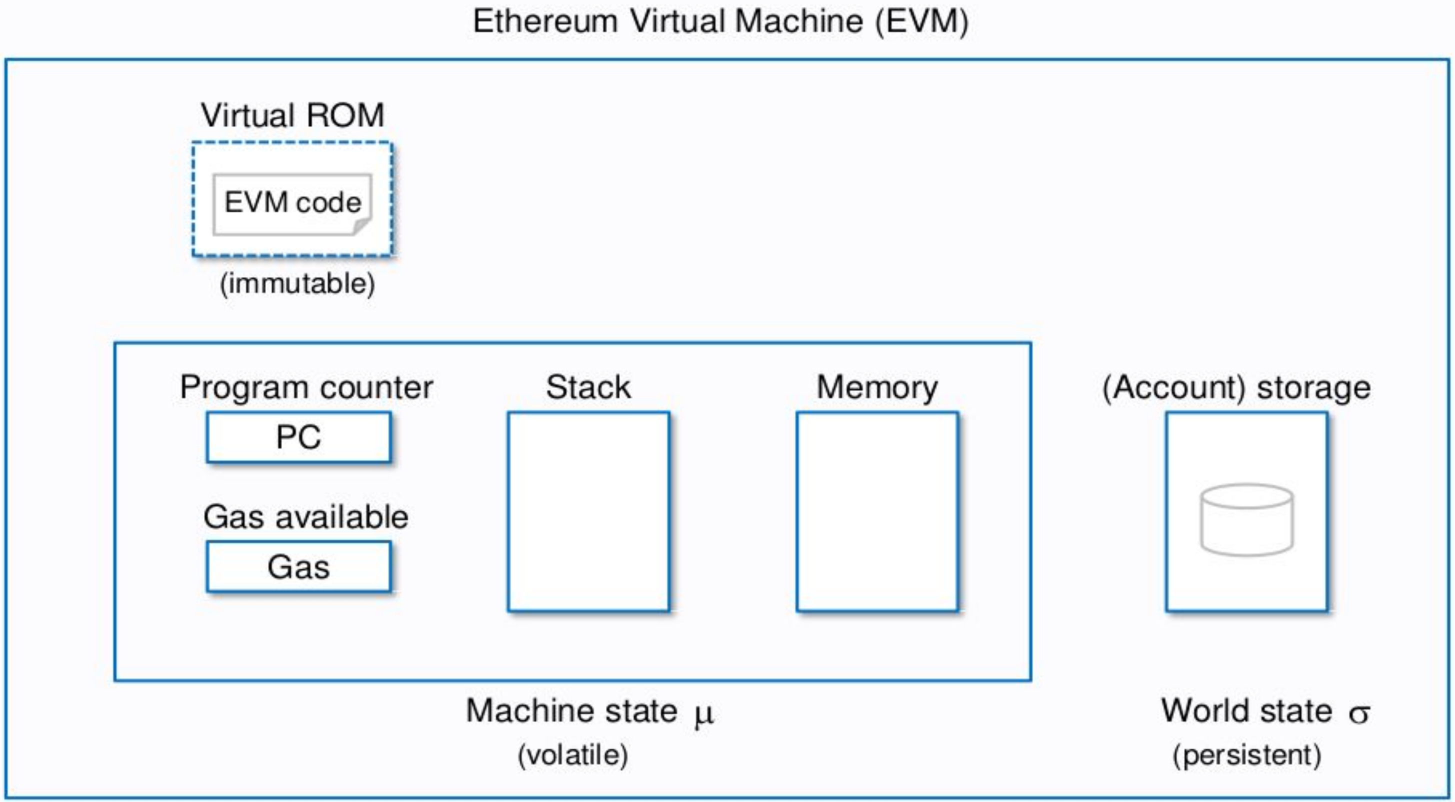

EVM
WRITE
Read modified data
Read unmodified data
EVM Cache
Commit
In-memory storage
Commit
Read and cache tree nodes
Merkle Patricia Trie Storage

EVM

- internal state and computation
- executes machine code compiled from Solidity, LLL etc
- stack machine, the stack has a maximum size of 1024

@merlinragdoll

EVM architecture



The EVM is a simple stack-based architecture.

```
def cycle(machine_state, sub_state, exec_env, cost_with_status) do
   operation = MachineCode.current_operation(machine_state, exec_env)
   inputs = Operation.inputs(operation, machine_state)

   machine_state = MachineState.subtract_gas(machine_state, cost_with_status)
   {updated_exec_env, sub_state} = SubState.add_refund(machine_state, sub_state, exec_env)

   {n_machine_state, n_sub_state, n_exec_env} =
     Operation.run(operation, machine_state, sub_state, updated_exec_env)

   final_machine_state =
     n_machine_state
     |> MachineState.move_program_counter(operation, inputs)
     |> MachineState.increment_step()

   {final_machine_state, n_sub_state, n_exec_env}
 end
```

EVM

```
iex> code = <<96, 1, 96, 0, 1, 96, 0, 85>>

iex> code |> EVM.MachineCode.decompile
[:push1, 1, :push1, 0, :add, :push1, 0, :sstore]
```

```
iex> EVM.run(code)
stack:
[]
operation: push1
stack:
[1]
operation: push1
stack:
[1, 0]
operation: add
stack:
[1]
operation: push1
stack:
[1, 0]
operation: sstore
stack:
[]
```

Blockchain

(1) Validate (or, if mining, determine) ommers;

(2) validate (or, if mining, determine) transactions;

(3) apply rewards;

(4) verify (or, if mining, compute a valid) state and block nonce

Blockchain

```
errors = []

|> check_state_root_validity(child_block, block)

|> check_ommers_hash_validity(child_block, block)

|> check_transactions_root_validity(child_block, block)

|> check_gas_used(child_block, block)

|> check_receipts_root_validity(child_block, block)

|> check_logs_bloom(child_block, block)
```

Blockchain hardfork configuration

- Upgrades in Ethereum
- Way to introduce new changes to the chain

Blockchain hardfork configuration

```
defmodule EVM.Configuration do
  @moduledoc """
  Behaviour for hardfork configurations.
  """


  @type t :: struct()

  # EIP2
  @callback contract_creation_cost(t) :: integer()

  # EIP150
  @callback extcodesize_cost(t) :: integer()
```

ExWire

- RLPx
- DevP2P
- Eth Wire

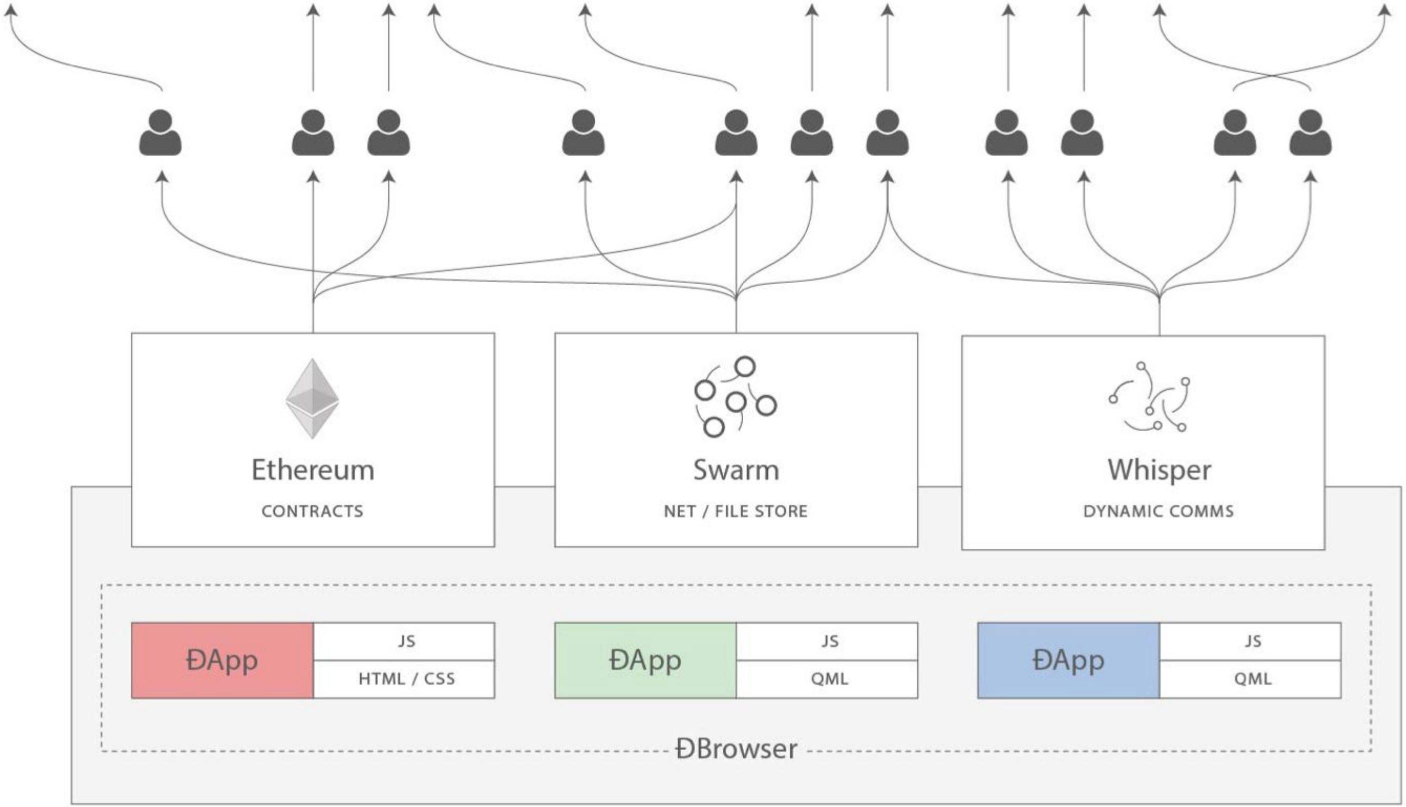
RLPx

- Node Discovery and Network Formation
- Encrypted handshake
- Encrypted transport
- Peer Reputation

DevP2P

- Hello
- Disconnect
- Ping
- Pong

Web3 protocols



Current state

- Passing all common tests
- Working p2p layer
- Working warp sync

Usage

```
git clone https://github.com/mana-ethereum/mana
```

```
mix sync --chain ropsten --provider-url
ipc://path/jsonrpc.ipc
```

Future directions

- JSON-RPC API
- Optimization
- Different consensus algorithms

Advantages of Elixir

- Concise syntax
- Concurrent execution
- Well-documented code

Disadvantages of Elixir

- (Relatively) new language
- Dynamic typing

Things to improve for dev community

- Tests are not documented
- Backward compatability
- DevP2P documentation

More Libraries

- Ethereumex
- Ex_abi
- BN

Who are using our projects

- OmiseGO
- Consensys
- AgileAlpha

About me

Github: https://github.com/ayrat555

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Thanks!

https://github.com/poanetwork/mana

https://forum.poa.network/t/elixir-developer/2047

When we say Elixir may not be suited to do number crunching, we are usually thinking a bit beyond analytics, averages, medians, etc. Because it is not necessarily the mathematical processing that hurts but rather the lack of support for large mutable data structures that would allow us to do implement things like image processing or support vector machines efficiently.
For example, think how you would implement a 100x100 matrix in Elixir and how much copying you would need to do to change a single {x,y} pair using immutable data structures. If you need performance, your best bet is ETS or falling back to C (which is what many languages do anyway).