Turbo-Geth: optimising Ethereum clients

Alexey Akhunov

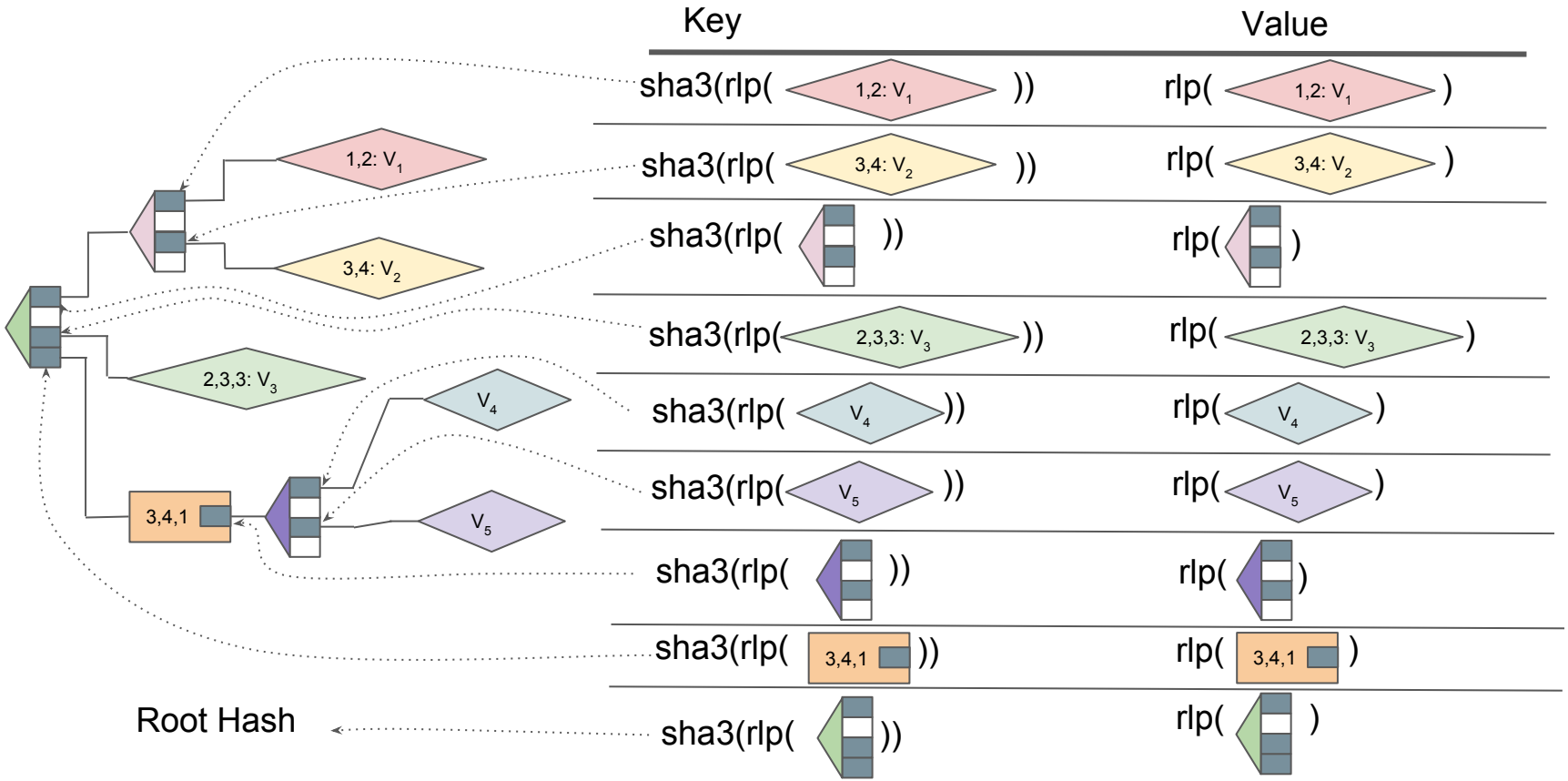
Supported by:

INFURA

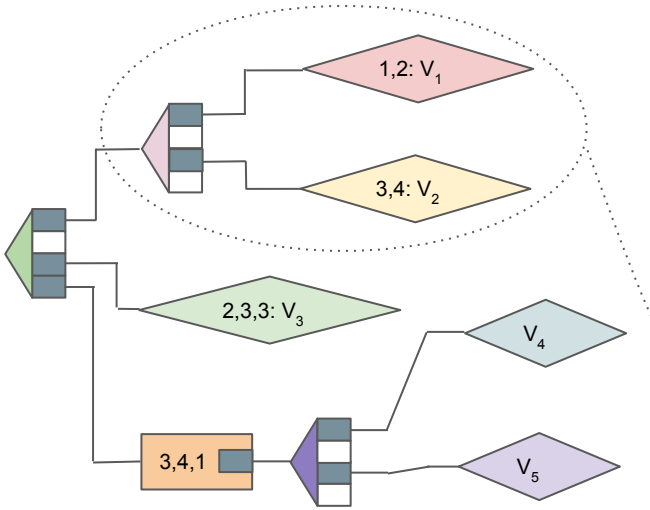
INTERCHAIN FOUNDATION

Ledgerwatch

Persistence of Patricia tree in geth



Persistence ~~of Patricia tree~~ in turbo-geth



Key	Value
1,1,1,2	V_1
1,3,3,4	V_2
3,2,3,3	V_3
4,3,4,1,1	V_4
4,3,4,1,3	V_5

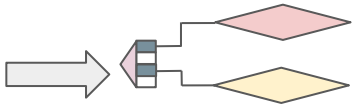
Goes here because it is sorted

DEPTH DOES NOT MATTER

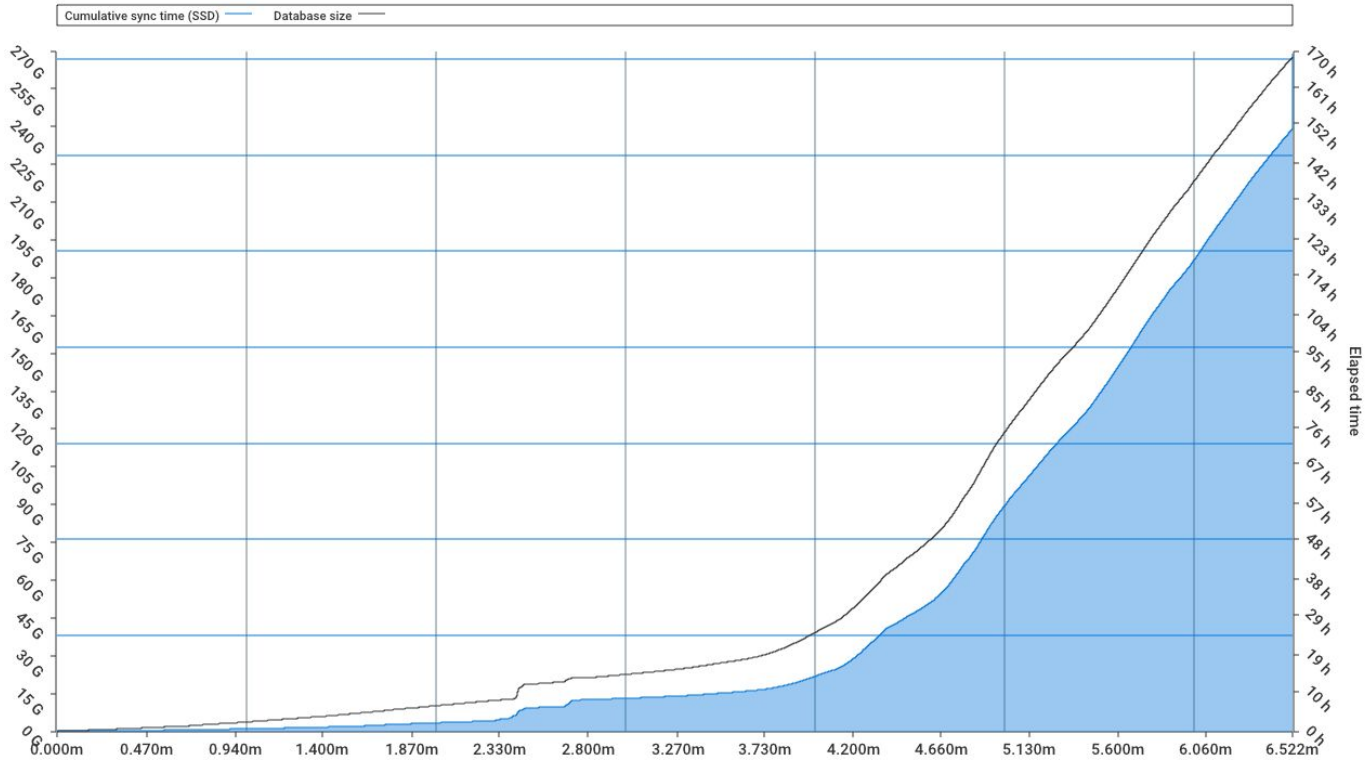
Range query:
1,*,*,*,>=-blockNr

1,1,1,2
1,3,3,4

V_1
V_2



Sync on i3.4xlarge (122 Gb, 16 vCPUs, NVMe)



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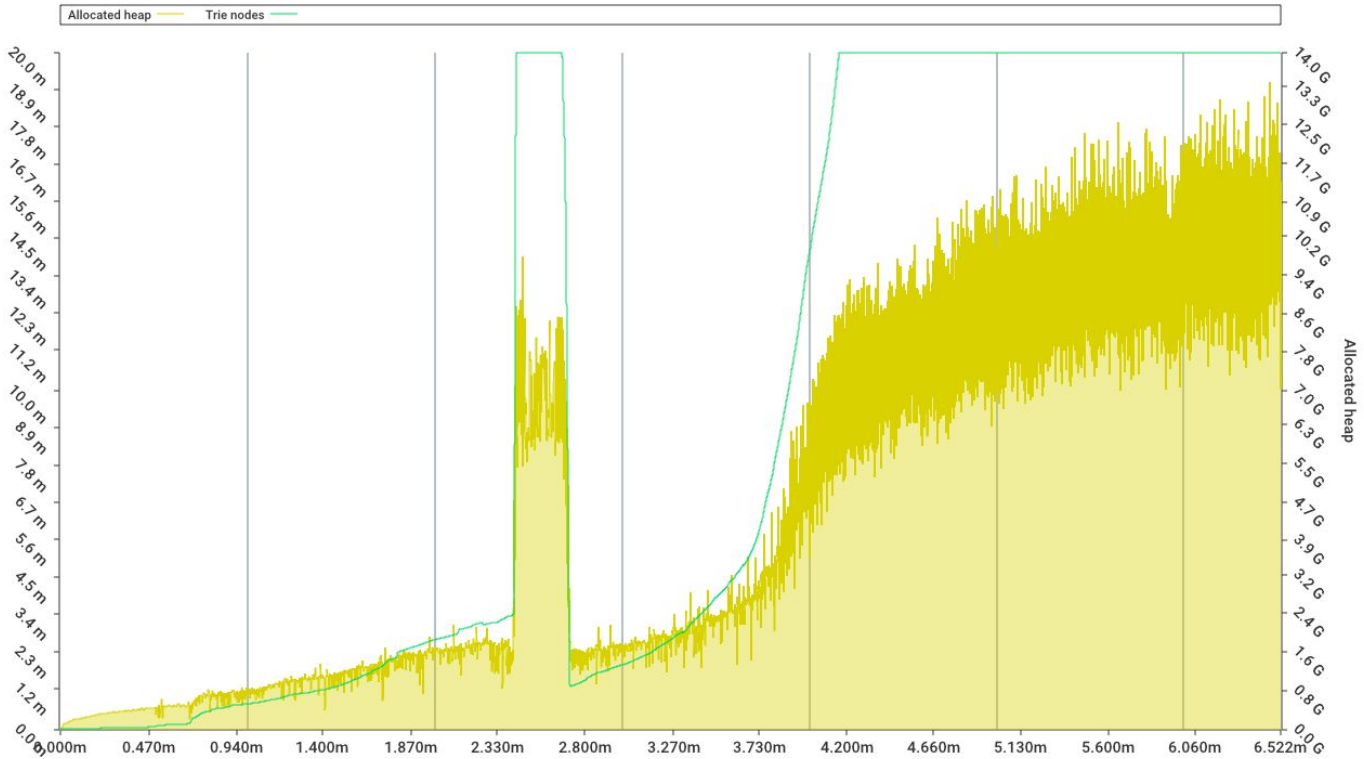
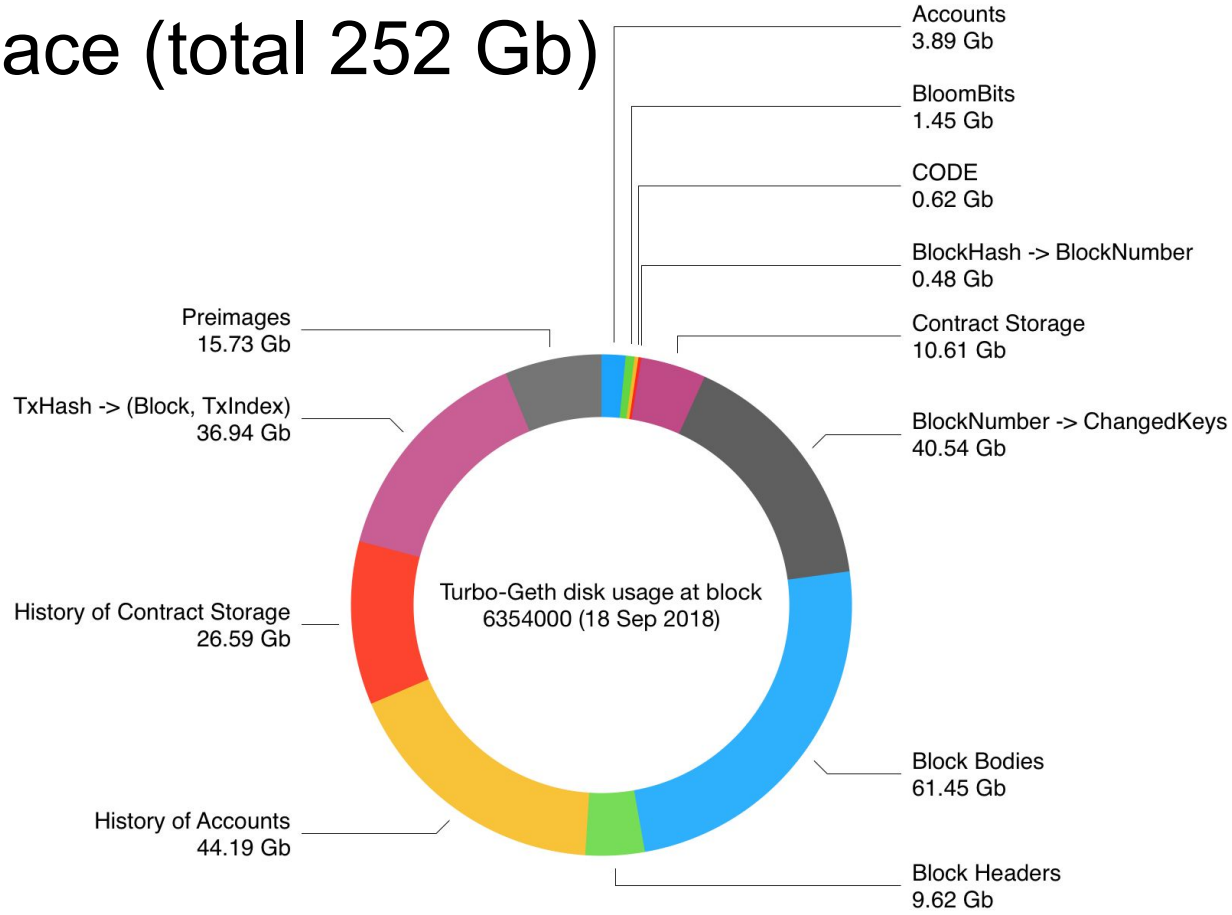


Disk space (total 252 Gb)

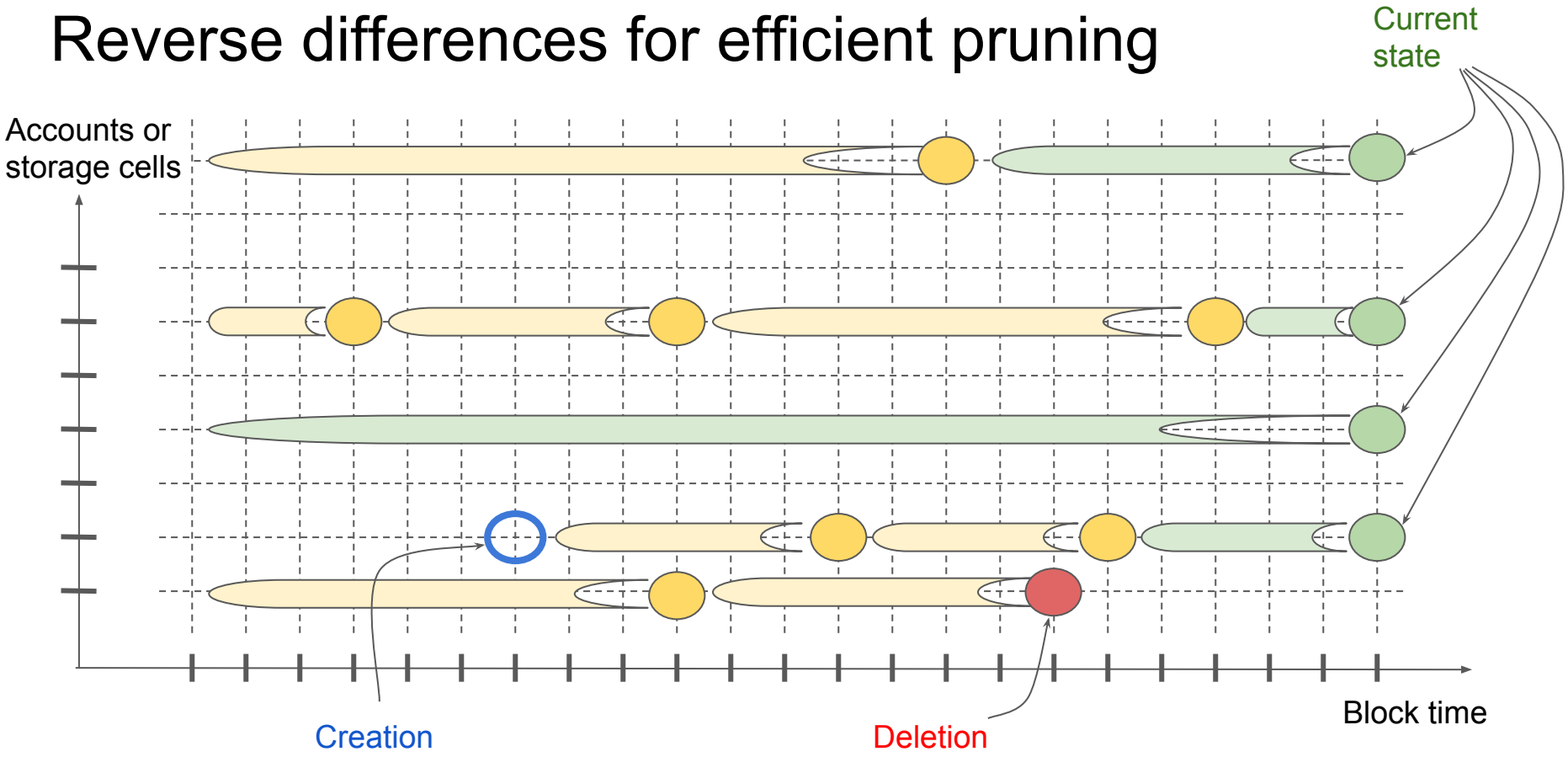


JSON RPC performance

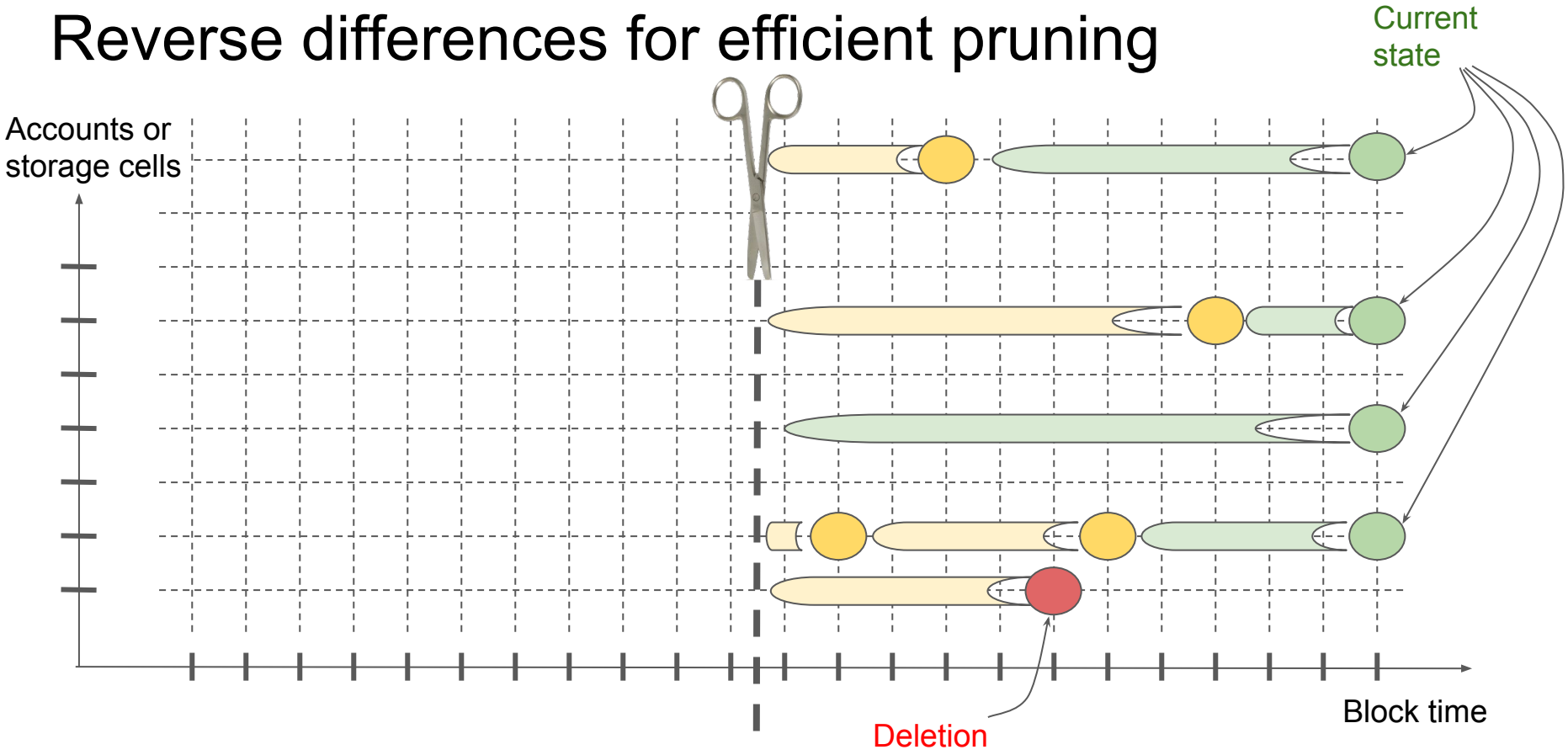
No rigorous benchmarks yet, these are very rough and preliminary numbers.RPC needs a lot more work

Type of RPC call	**Difference from geth archive node**
debug_traceTransaction	10x faster
debug_storageRangeAt	50x faster
debug_getModifiedAccountsByNumber	10x faster, also includes accounts created and destroyed within the block range
eth_getTransactionReceipt	up to 10x slower
eth_getBalance	5x faster

Reverse differences for efficient pruning



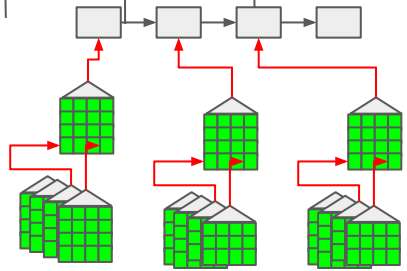
Reverse differences for efficient pruning



Light clients?

	eth/63	les/2	
Status	✓	✓	Handshake - negotiate version, network_id, genesis
[Get]Block(Headers|Bodies)	✓	✓	Get/Send headers/blocks by number or by hash
[Get]NodeData	✓	✓	Get/Send nodes of the patricia tree by hash
[Get]Receipts	✓	✓	Get/Send receipts by transaction hash
NewBlock[Hashes]	✓		Announce new block/block hash
Announce		✓	Announce new chain head
[Get]Proofs		✓	Get/Send merkle proof for given part of trie and block hash
[Get]ContractCode		✓	Get/Send code of given contract at block hash
SendTx	✓	✓	Add new transaction to the pool and relay
[Get]HelperTreeProofs		✓	Get/Send merkle proof of block hash/bloom filters

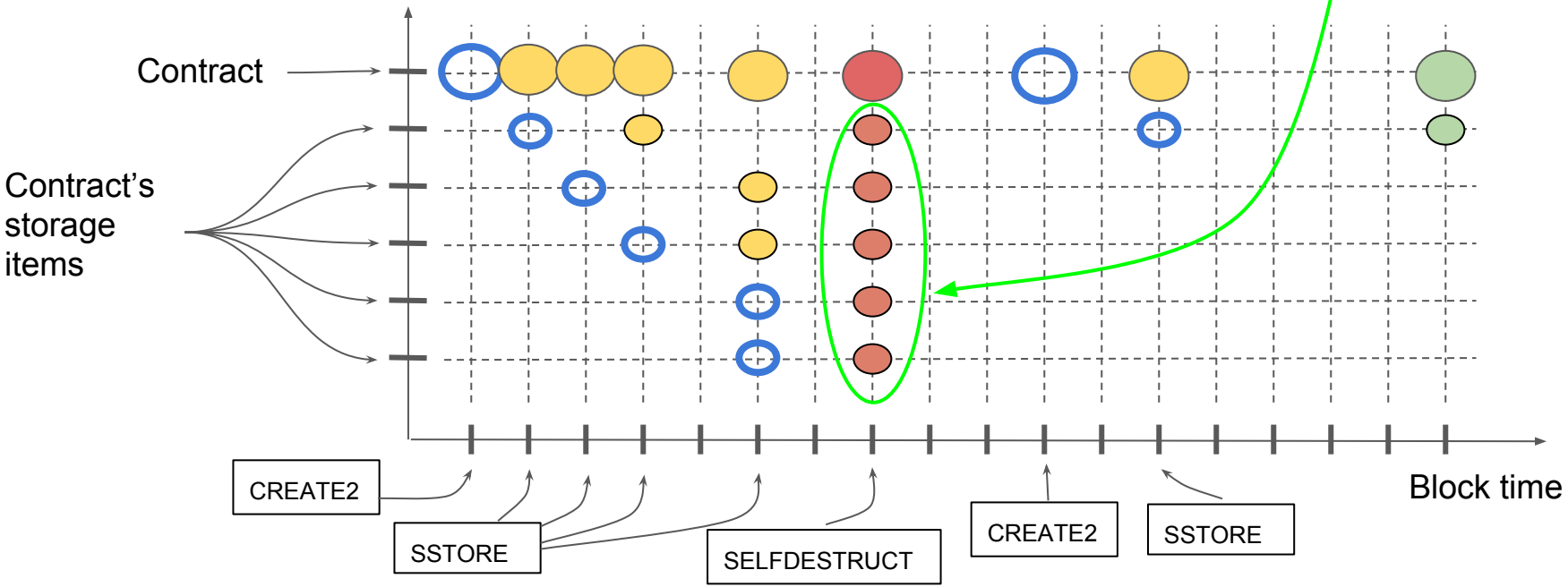
Require “materialised” Patricia tree



CREATE2 revival problem

In EIP-1014, address of contract is calculated as:

```
keccak256( 0xff ++ address ++ salt ++ keccak256(init_code)))[12:]
```



Morus

Codename for **family** of databases for storing of mutating authenticated state. Designed to:

1) Compactly store and prune state history

2) Allow efficient access to history

3) Support various authentication methods: Patricia trees, Sparse Merkle trees, IAVL trees, Weight-Balanced trees

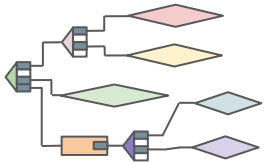
4) Help application with state caching

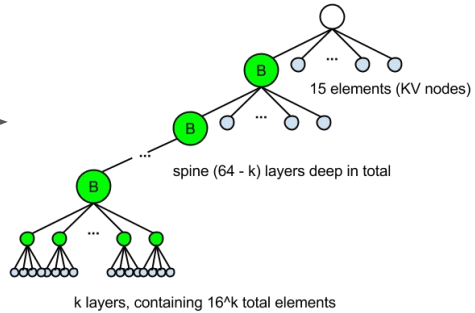
Will allow solving **light client** and **CREATE2 revival** for Turbo-Geth

Can become a backend store for **Ethermint**

Modelling the state - current approaches

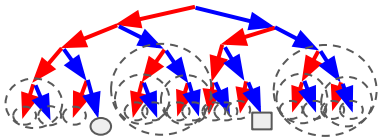
Patricia Tree





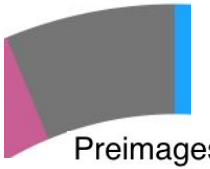
Andrew Miller (Least Authority), Ethereum security audit

Sparse Merkle Tree



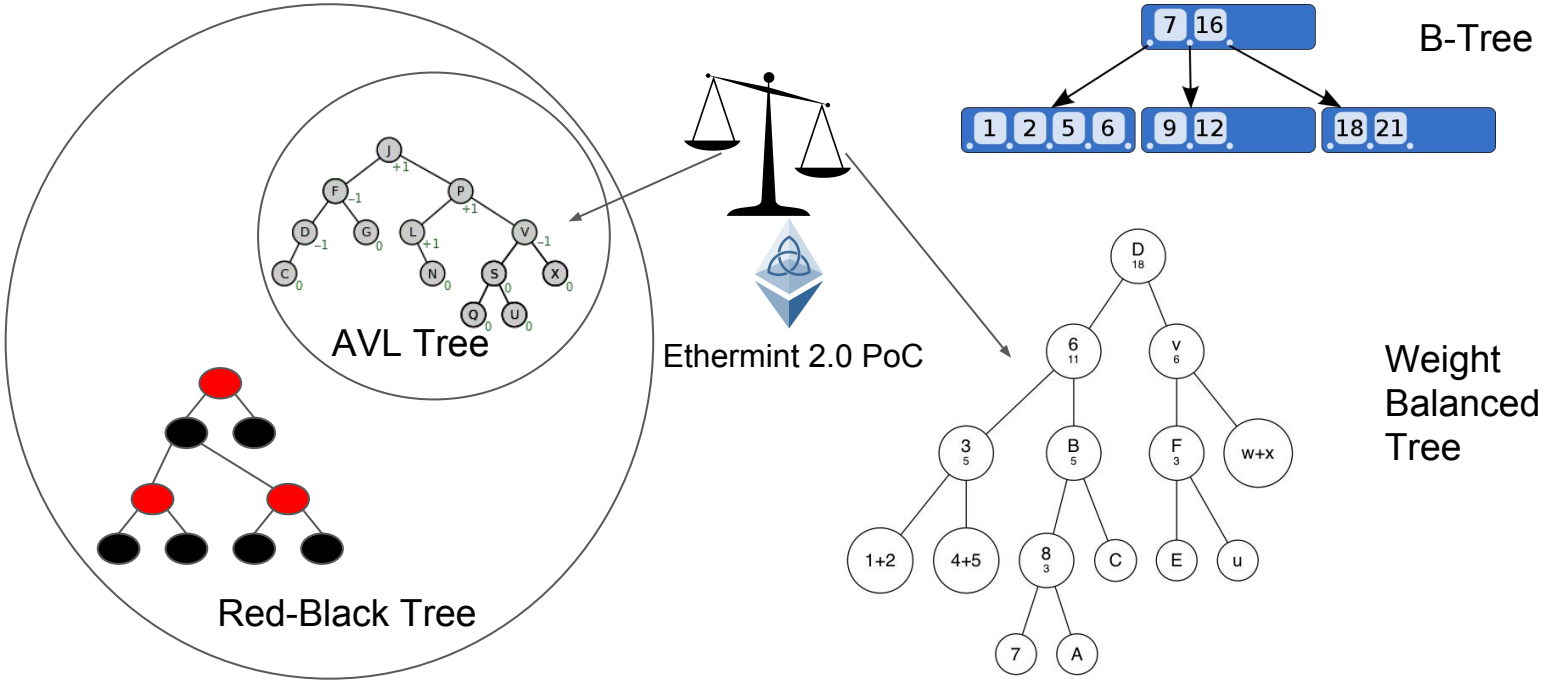
put(K, V)
get(K) -> V
delete(K)

put(sha3(K), V)
get(sha3(K)) -> V
delete(sha3(K))

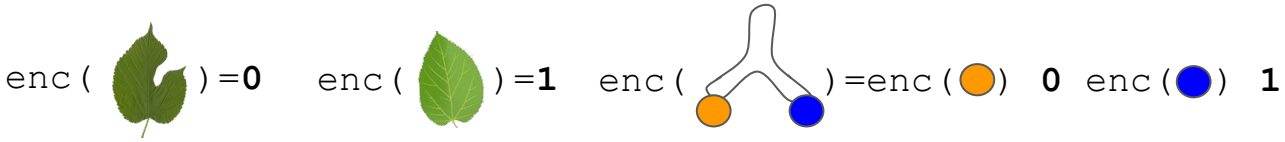


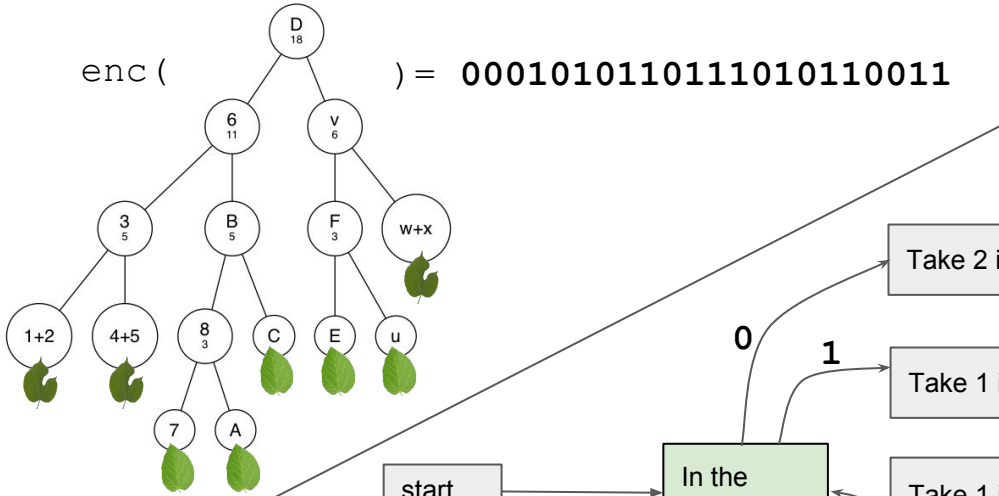
Preimages
15.73 Gb

Modelling the state - self balancing trees

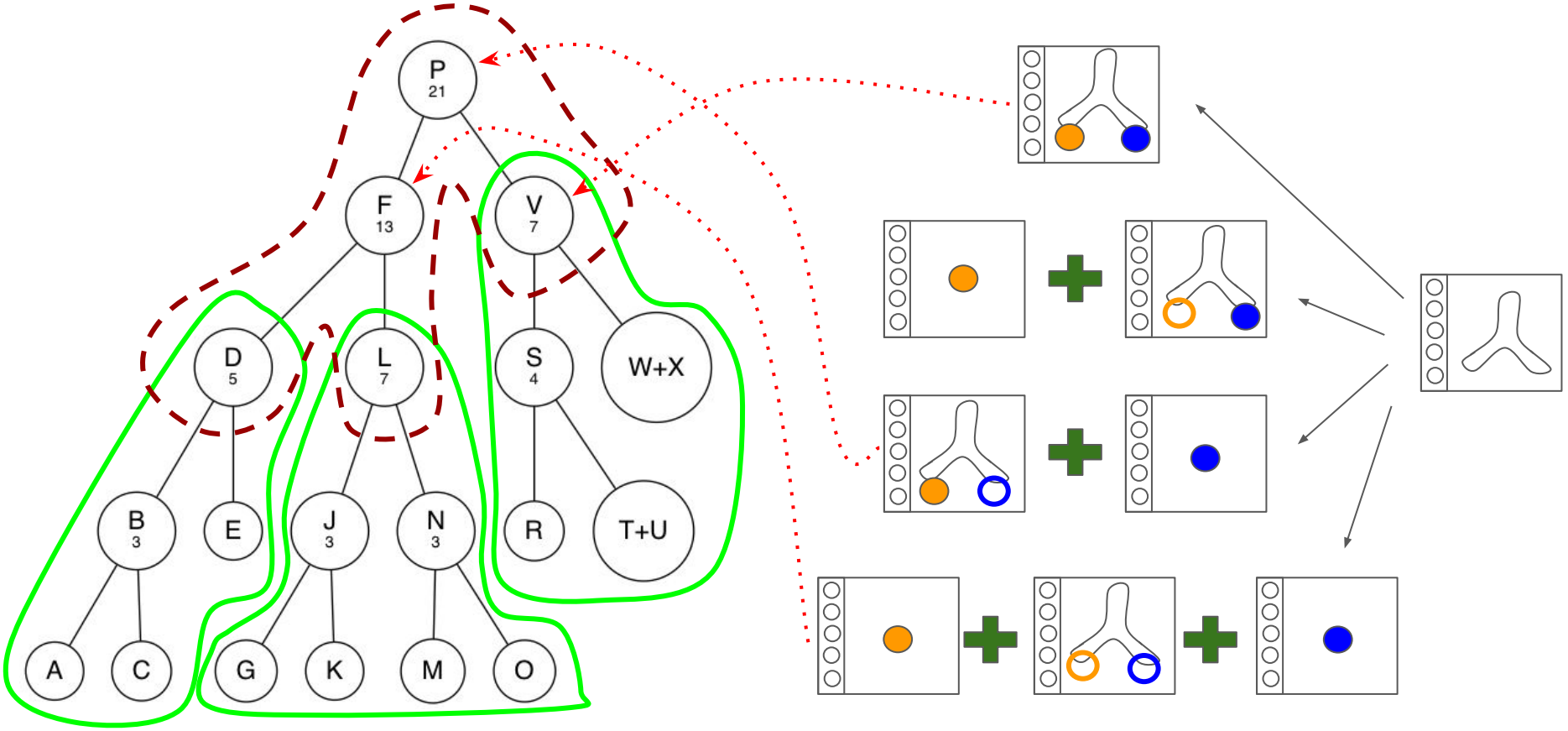


Encoding structure of a binary tree

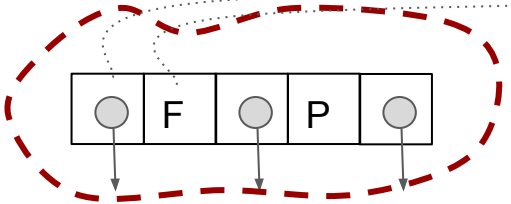


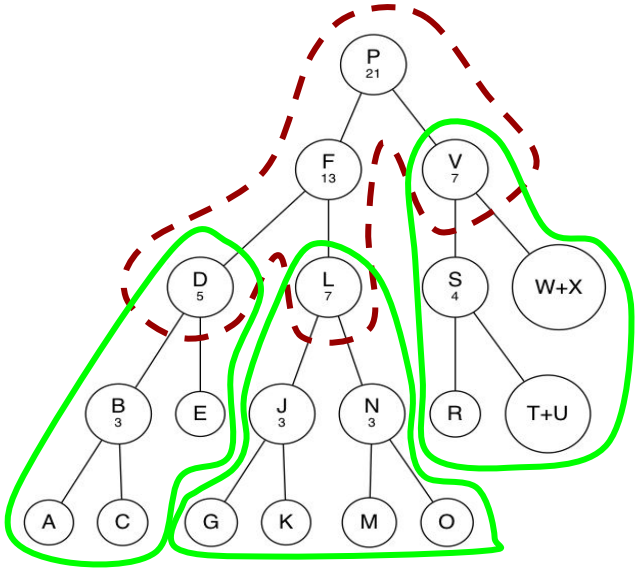


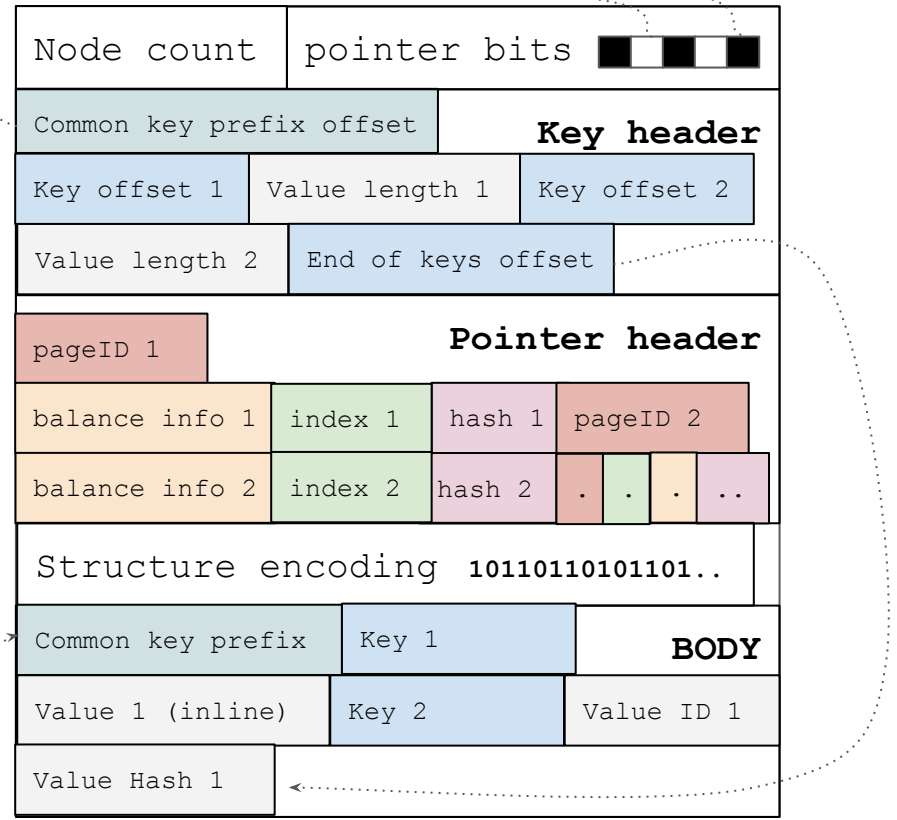
Splitting binary tree into pages of fixed size



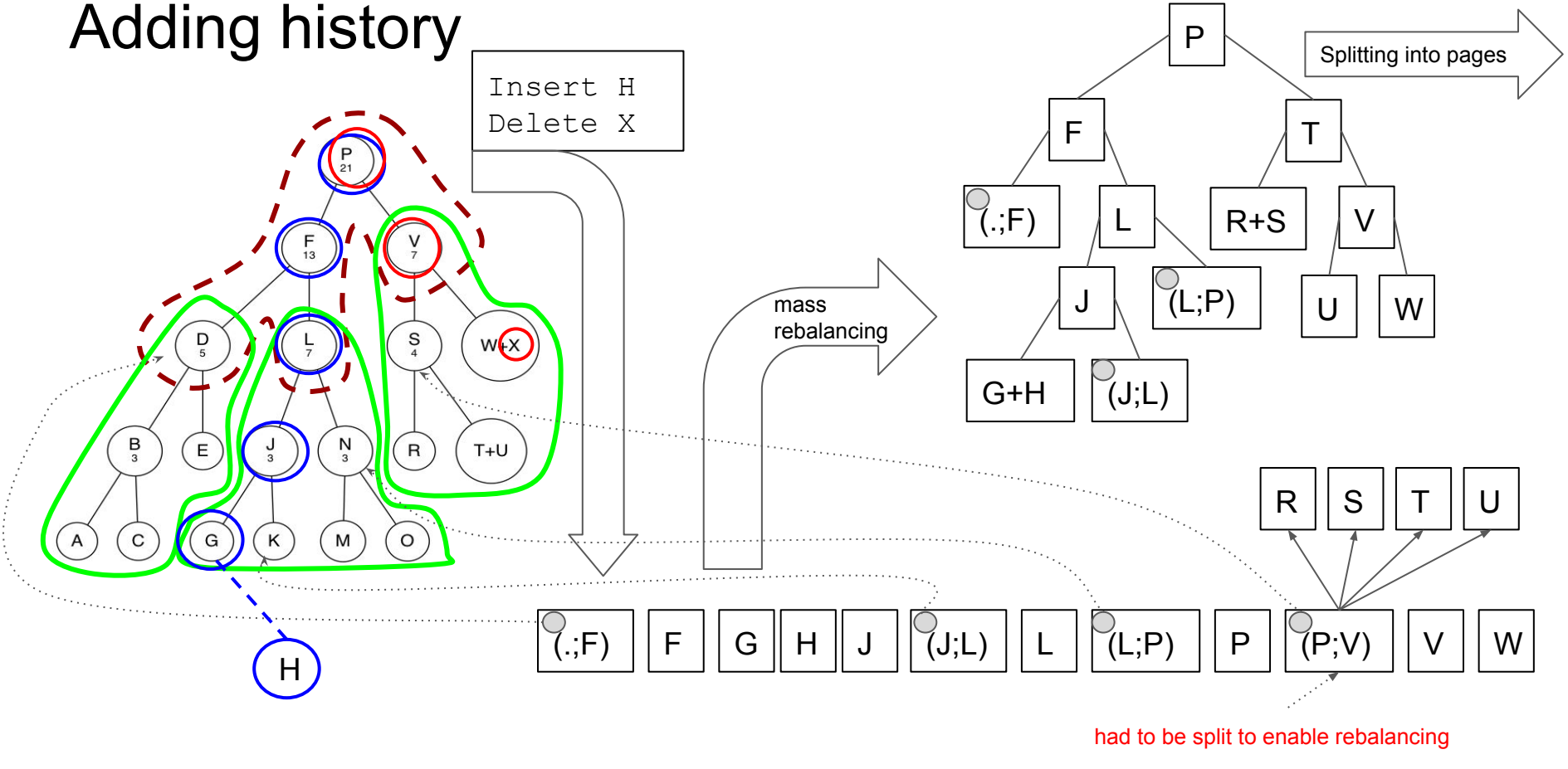
Splitting binary tree into pages of fixed size



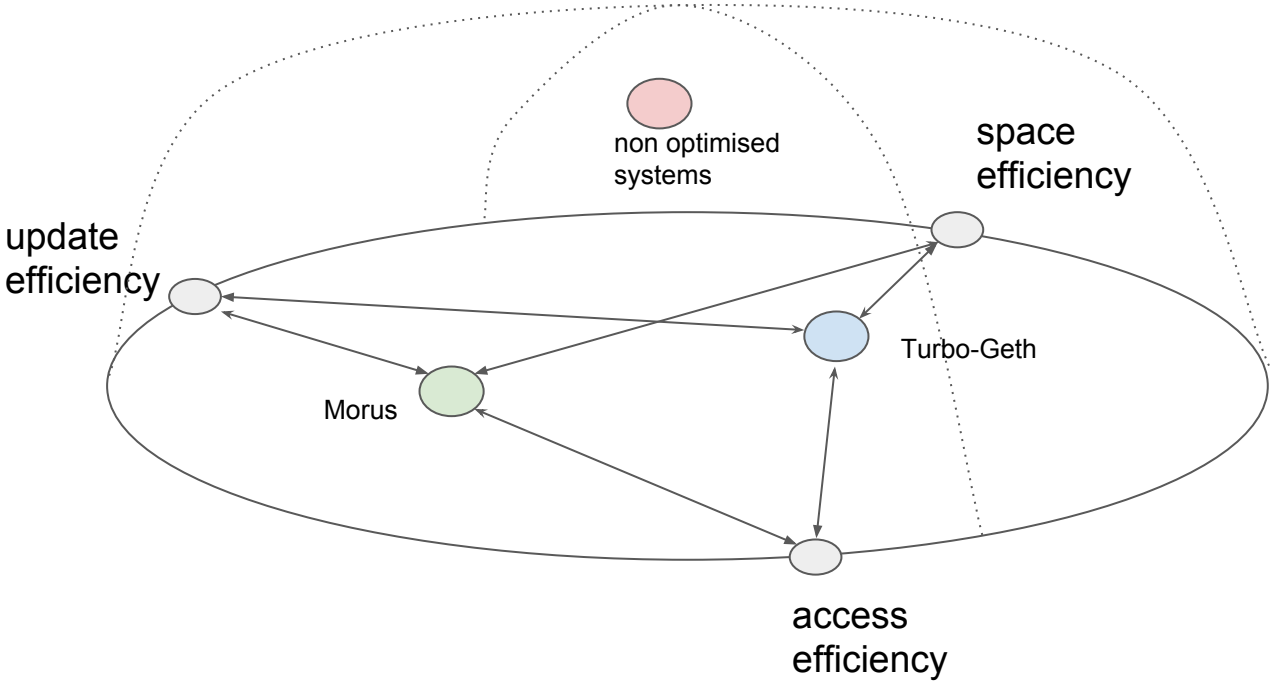




Adding history



Trade offs


non optimised
systems
space
efficiency
update
efficiency
Turbo-Geth
Morus
access
efficiency