Depermissioning Web3: a *P*ermissionless *A*ccountable *R*PC *P*rotocol for Blockchain Networks

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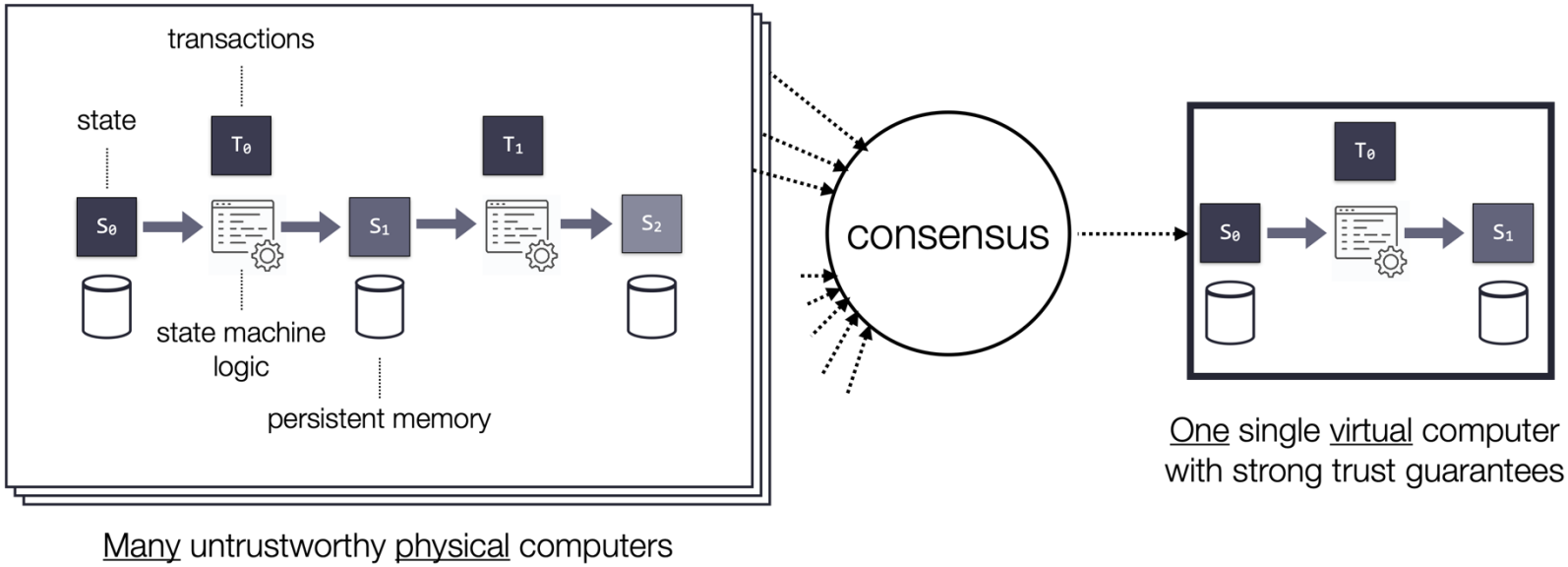
KU LEUVEN DistriNet

Context

- **Trust in computing**: ensure correct results while avoiding or minimizing reliance on trusted third parties
- Many solutions:
  - Trust in hardware (e.g. Trusted Execution Environments)
  - Trust in math (e.g. Secure Multi-Party Computation or Zero-Knowledge proofs)
  - **Trust in social consensus** (e.g. replicate app execution across many organizations, app updates synchronized using a **blockchain**)

Blockchains are computers that can make “credible commitments”

Blockchains as next-gen **trusted application platforms**



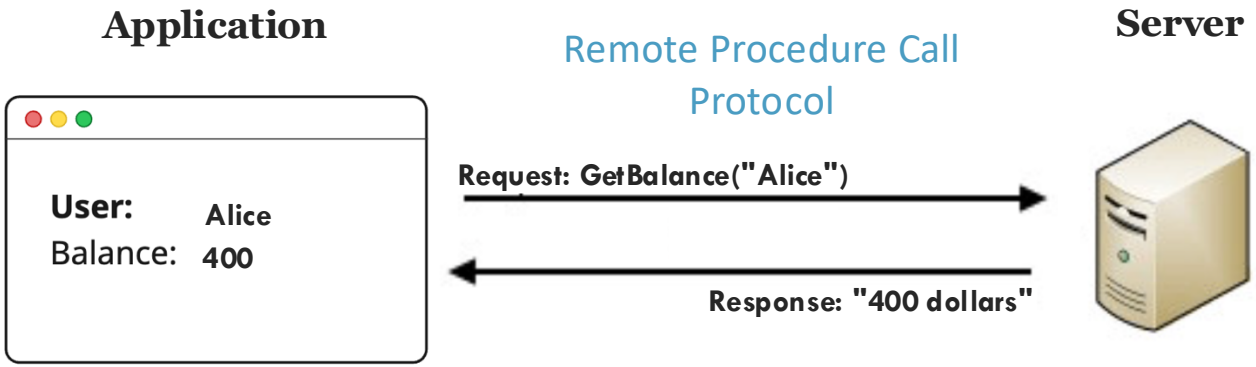
The Web3 Vision: Verifiable and Decentralized

read-write-trust

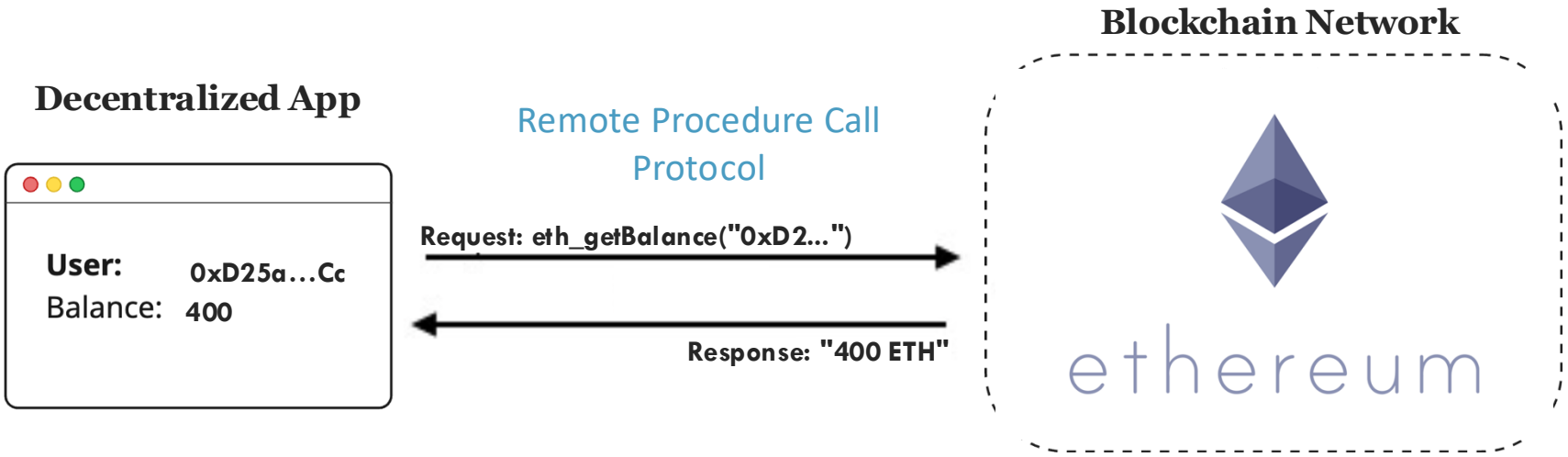
verifiable

middleman-free

Web2: Your server owns the state



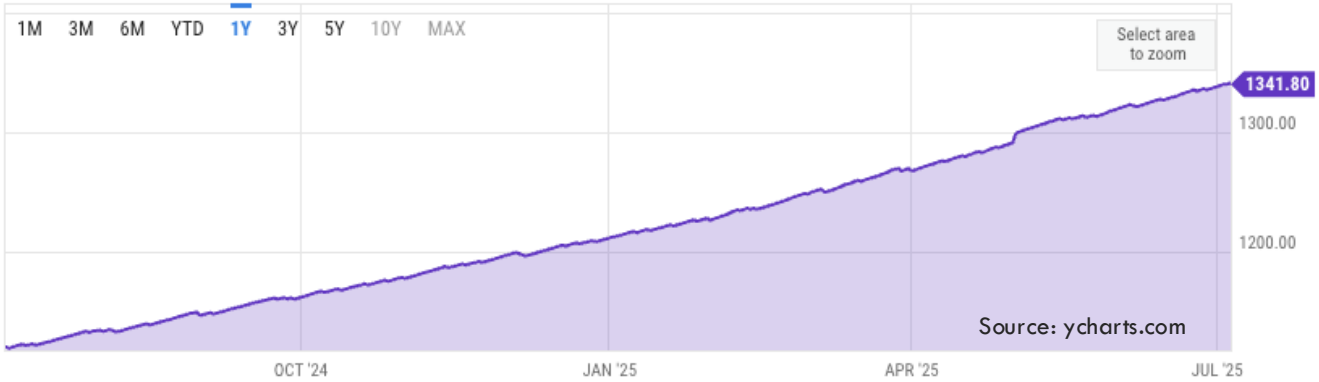
Web3: Your node mirrors the state of the chain



One of the biggest web3 networks

Enable smart contracts and dApps

Running an Ethereum full node costs a lot!



Ethereum Chain Full Sync Data Size

1341 GB

for 5 July 2025

19.94%

increase from one year ago

Many use Ethereum, but few run nodes

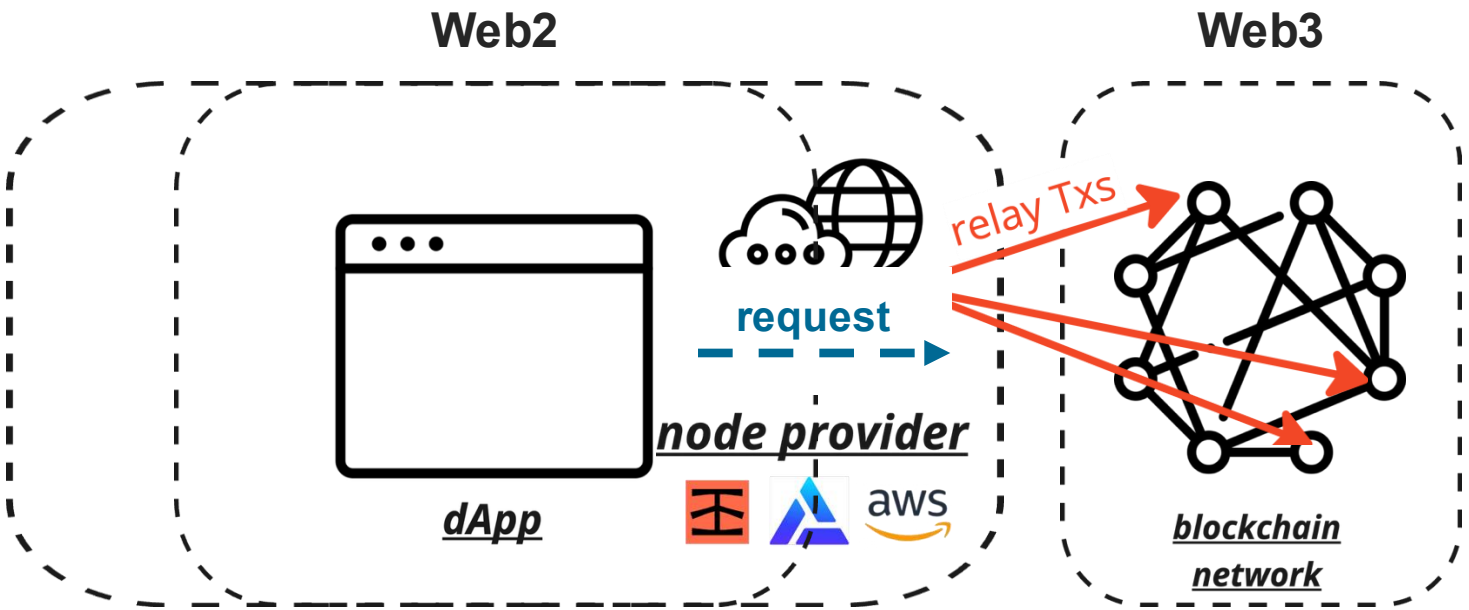
12,244

Number of Ethereum Mainnet Nodes [1]

› Ethereum Daily Active Addresses is at a current level of **400,000.**

[1] Source of statistics: etherscan.io, collected on 6 July 2025

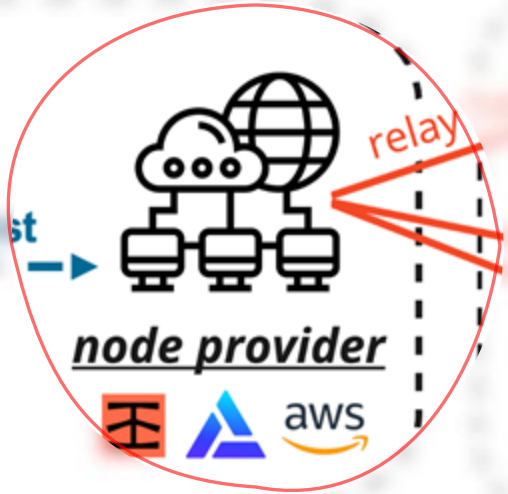
Web3 serving layer depends on trusted intermediaries



Web3 serving layer depends on trusted intermediaries

Node Provider

- Host a full node and answer requests
- Node-as-A-Service
- Registration required



Confidential information involved when registering

- Registration process from ***5 node providers*** (Infura has over 400,000 users.)
- Without registration: **1 / 5** (But only 300 requests/min)
- To sign-up (Mandatory fields)
  - Email address: **4 / 5**
  - Full name: **4 / 5**
  - Organization name: **2 / 5**
- Payment: 3 / 5 only supports credit cards

Node providers list

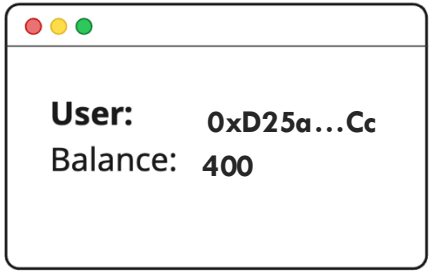
Infura
Alchemy
Ankr
Quicknode
Chainstack

Web3 access still starts with Web2 sign-ups

weihong.wang@kuleuven.be
PaSsW0Rd

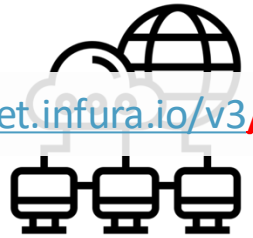
https://mainnet.infura.io/v3/<API-KEY>

Decentralized App



Request: eth_getBalance("0xD2...")

Response: "400 ETH"



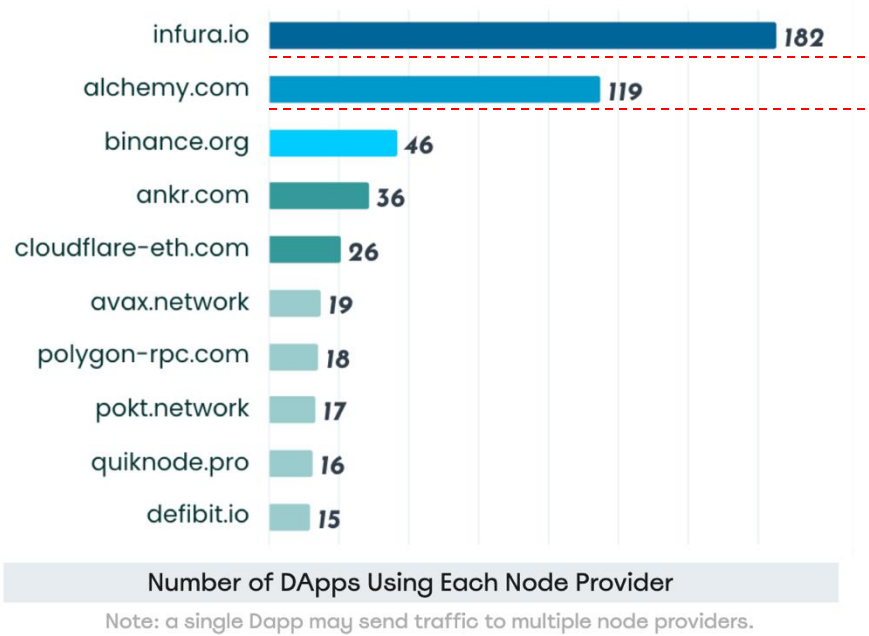
https://mainnet.infura.io/v3/<API-KEY>

node provider

Requests in total: 400,000

2 USD

A few node providers see most Web3 traffic



- Dataset: Web traffic from 1572 dApps*
- We focused on ***383*** dApps that send JSON-RPC calls from the front-end.

*Christof Ferreira Torres, Fiona Willi, and Shweta Shinde. 2023. Is your wallet snitching on you? an analysis on the privacy implications of web3. (Usenix Security '23)

Node Providers can see, block, or break access

Cointelegraph
https://cointelegraph.com › news › infura-is-to-blame-f...

Infura is to blame for MetaMask's violation of the crypto spirit

13 Feb 2023 — ConsenSys announced in November that **Infura, MetaMask's API provider**, was collecting wallet and IP addresses from MetaMask's users.

Cointelegraph

Alchemy and Infura block access to Tornado Cash as Vitalik Buterin weighs in on debate

According to Twitter user @0xdev0, on Monday, Web3 development platform Alchemy and Infura.io blocked remote procedure call (RPC) requests...

09 Aug 2022

Decrypt
https://decrypt.co › metamask-ethereum-apps-down-inf...

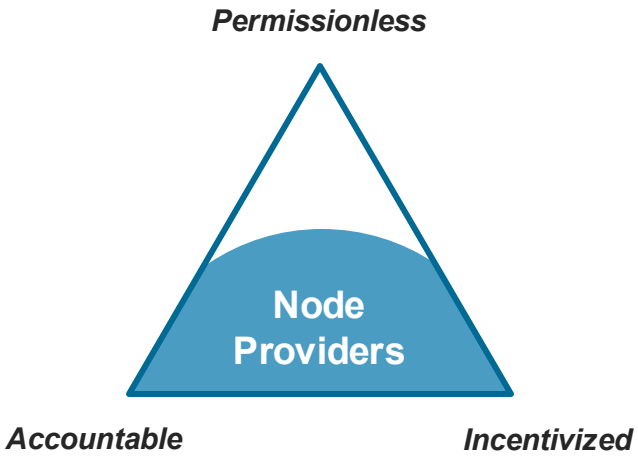
MetaMask, Ethereum Apps Down as Infura Suffers Outage

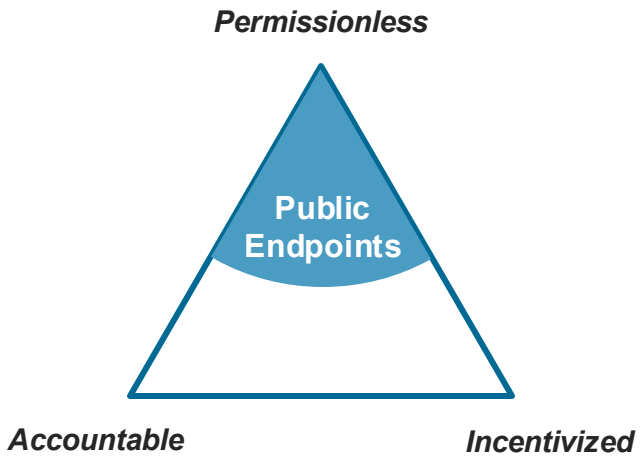
22 Apr 2022 — That's because the widely used infrastructure service **Infura is suffering an outage**, which is impacting an array of apps and services built on ...

Key Properties for a Decentralized Serving Layer

1. No prior trust or sign-up
2. Fraudulent behavior can be caught
3. Fair monetary compensation

Existing Solutions Highlight the Access Dilemma





Consensus is Solved — Access isn't

Proof of Work / Stake 

Verifiable consensus 

Strong incentives 

For miners and validators

 No standard protocol

 Trust-based access

 No network-level incentives

For nodes that serve data

Contribution – A ***P***ermissionless ***A***ccountable ***R***PC ***P***rotocol

1. No prior trust or sign-up
2. Fraudulent behavior can be caught
3. Fair monetary compensation
4. Implementation and evaluation in Ethereum

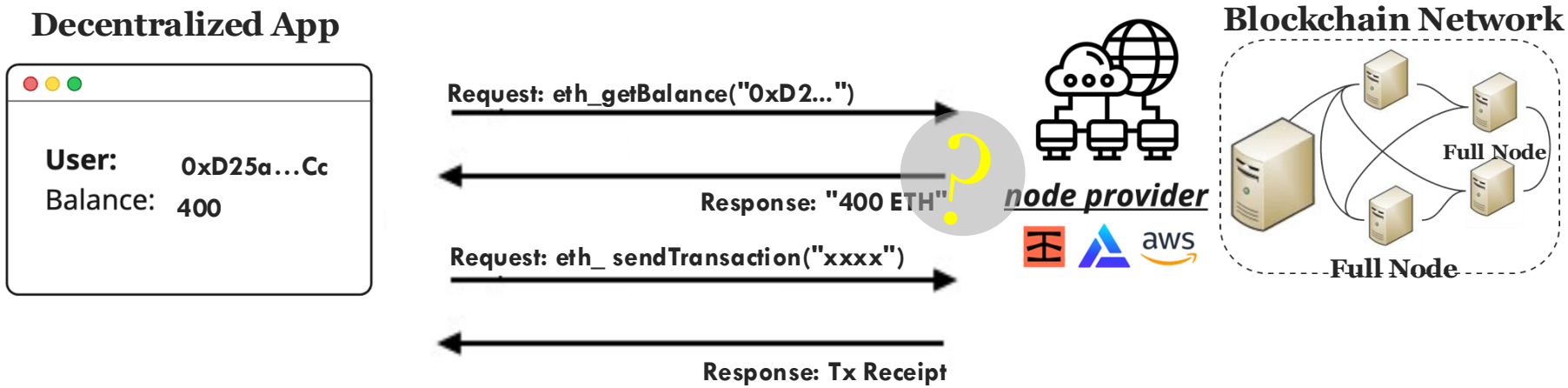
What are the challenges for PARP?

Main problems with the current node provider

weihong.wang@kulcuven.be
PaSsW0Rd?

MasterCard

→ https://mainnet.infura.io/v3/<API-KEY>

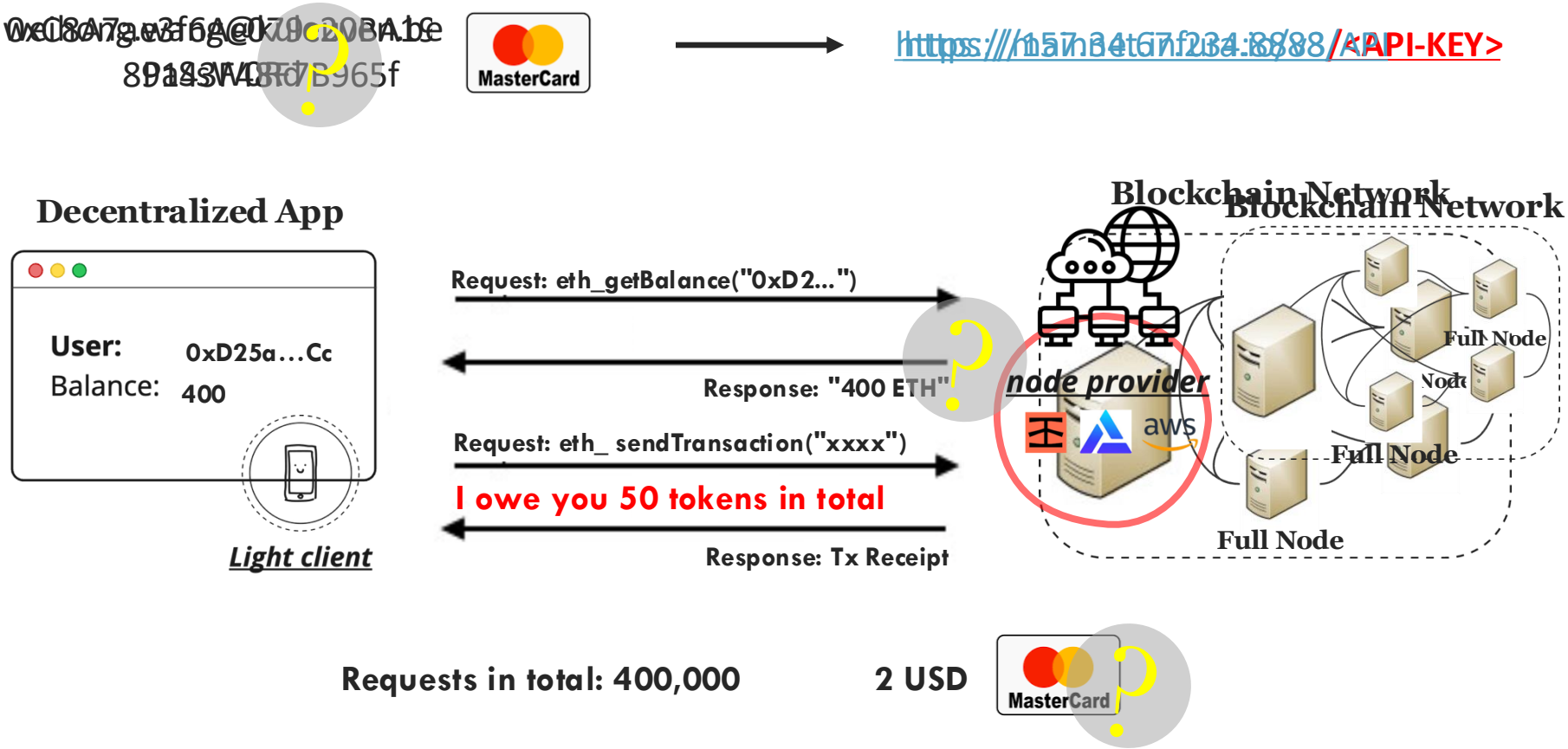


Requests in total: 400,000

2 USD

MasterCard

PARP – Main Challenges



PARP – Overview

Light client

< 1GB

Only store block header info

Full Node

~ 1TB

Assumption: Light clients have free access to block headers

Compact | **Not client-specific** | **Root of trust**

PARP Main Components

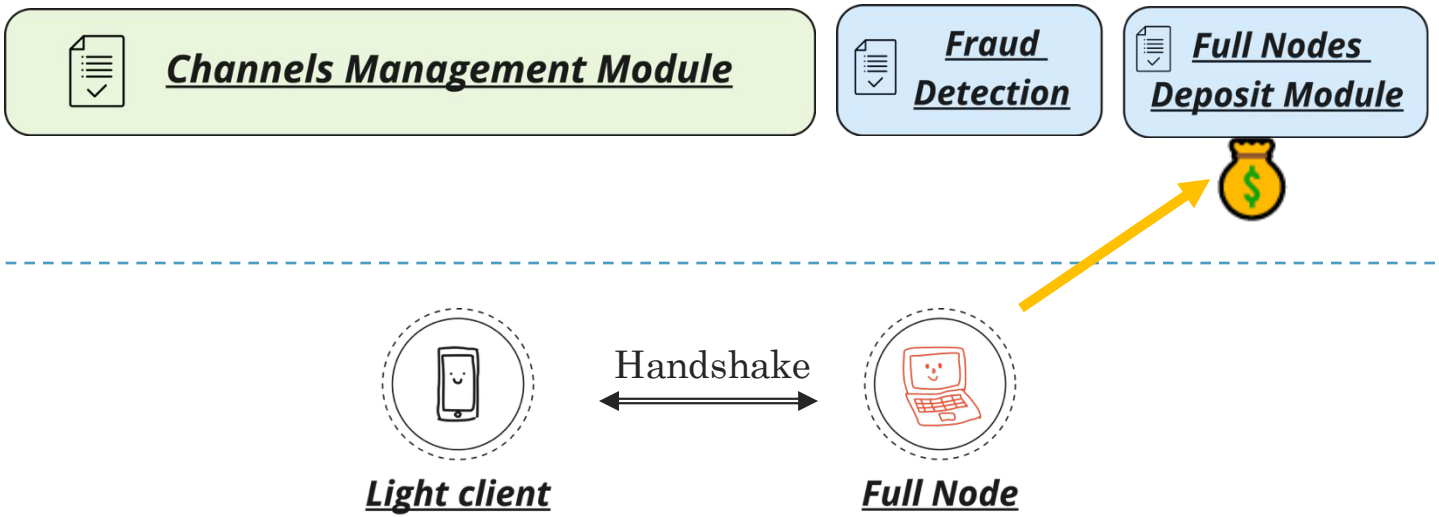
On-chain

Off-chain

Light client

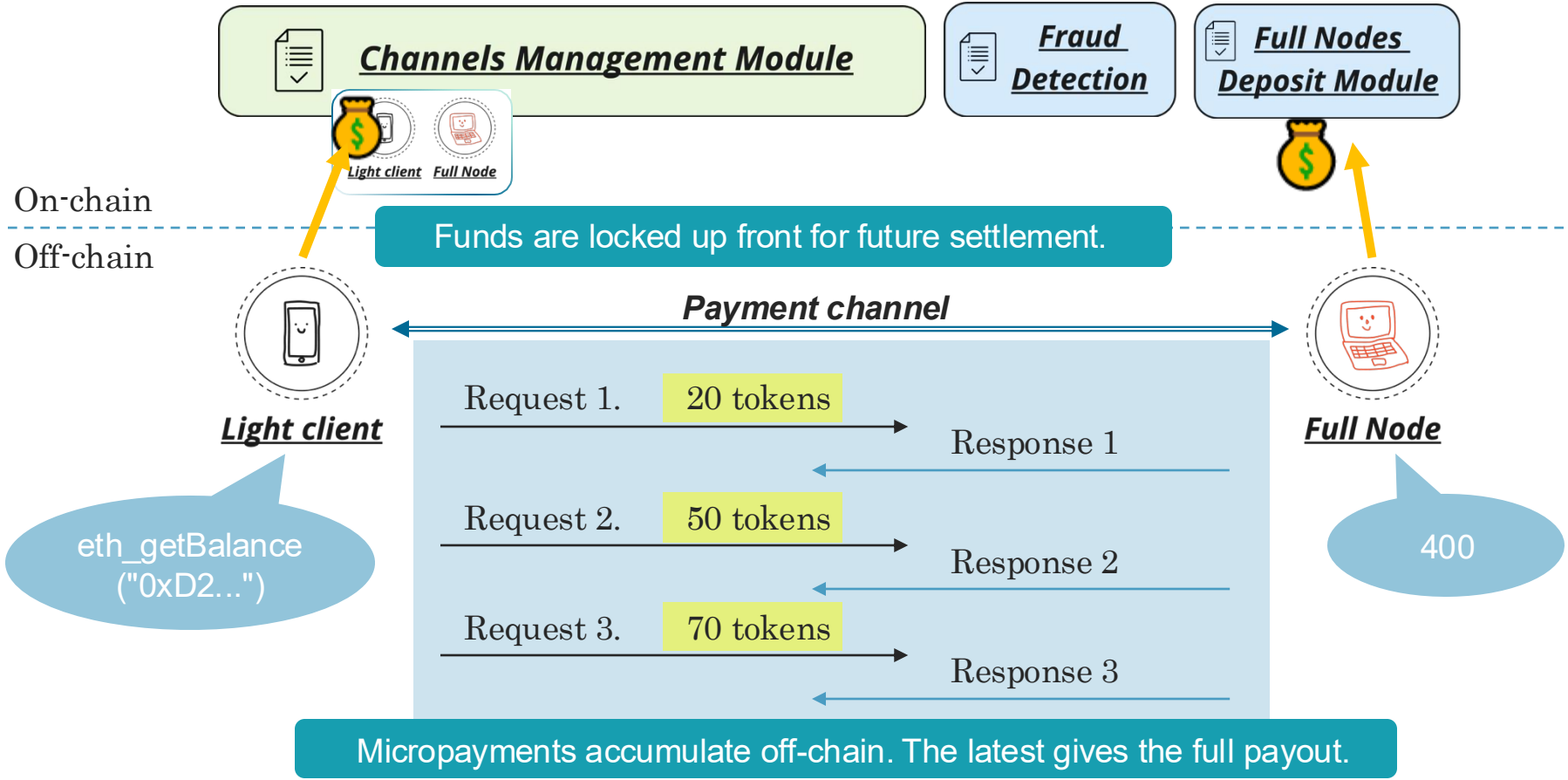
Full Node

PARP Main Components

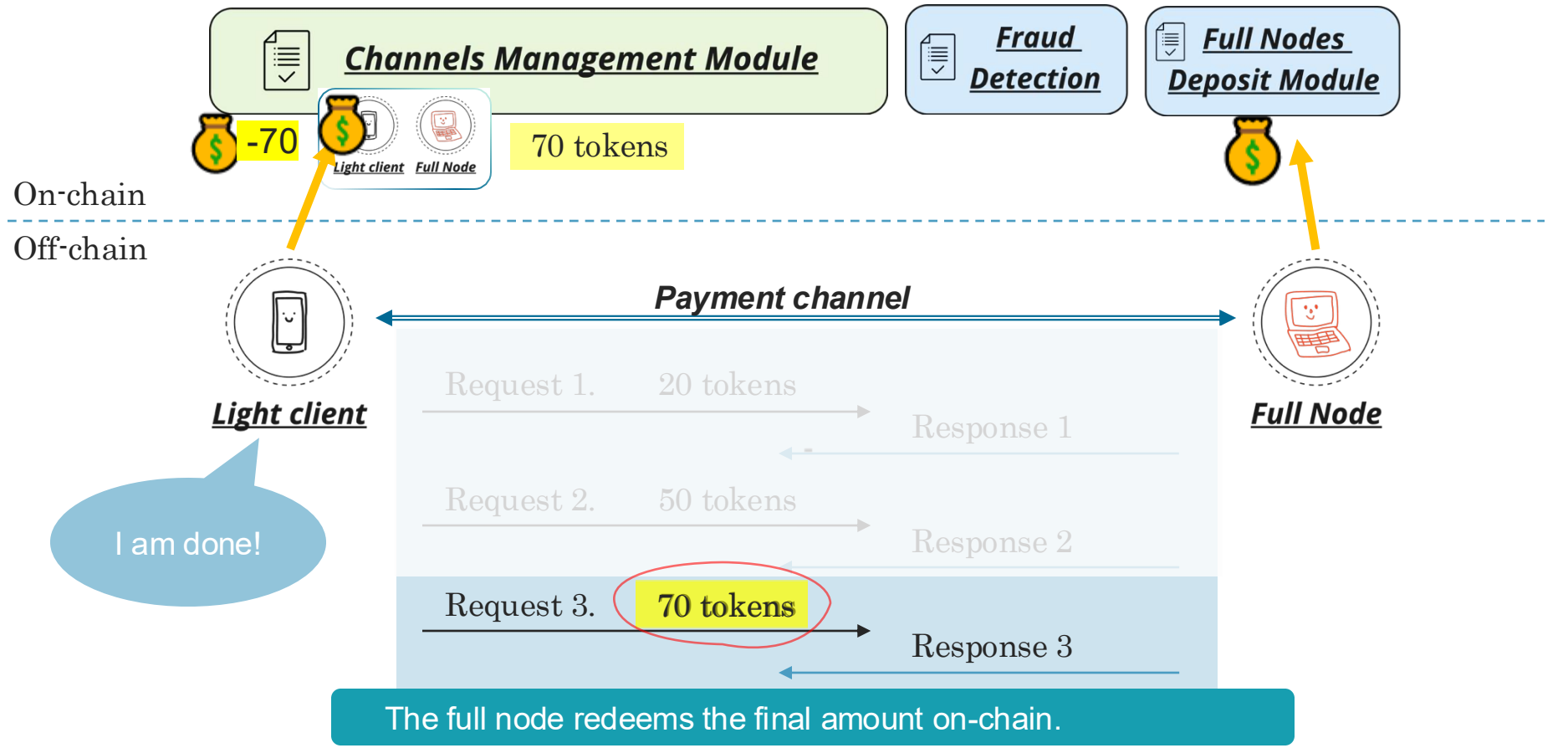


Full Nodes deposit first, then can accept connections.

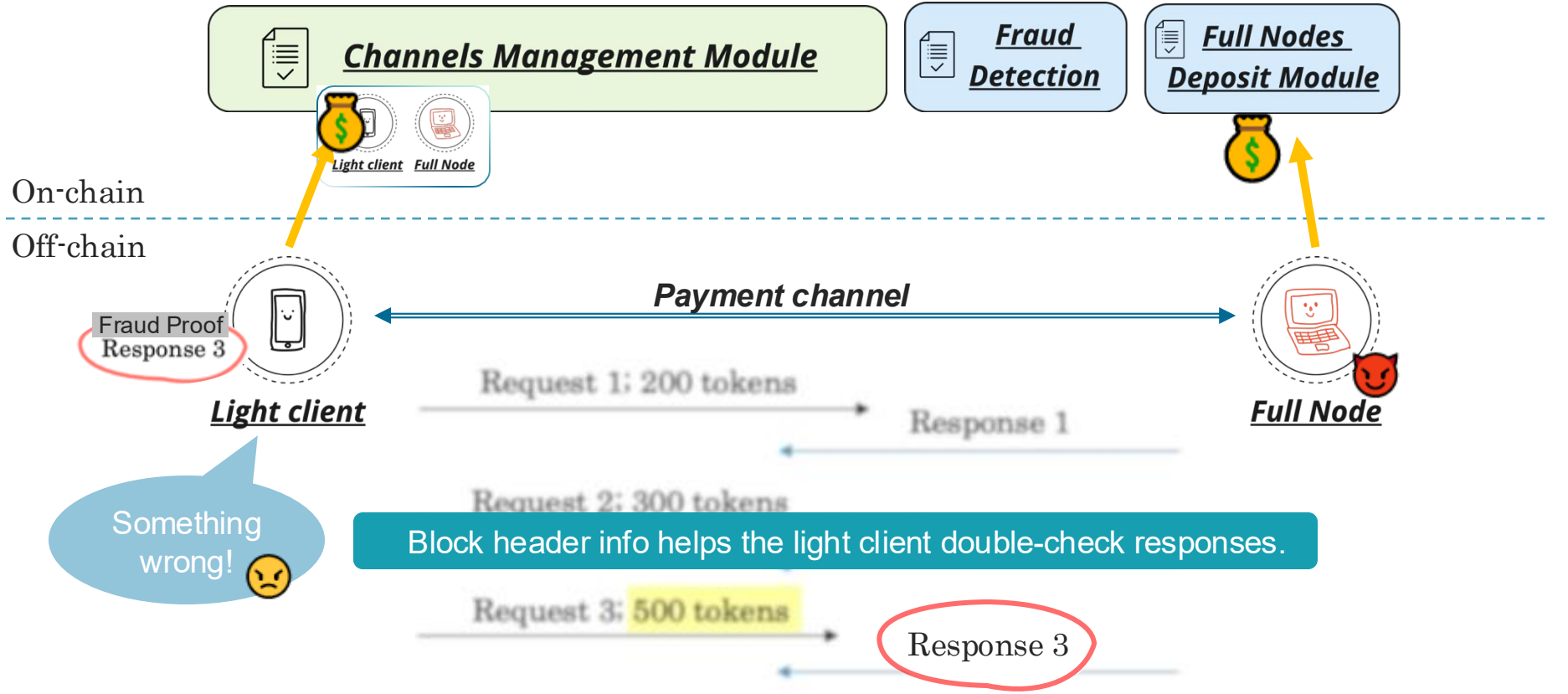
PARP – Active Phase



PARP – Closing Phase



PARP – Fraud Detected!



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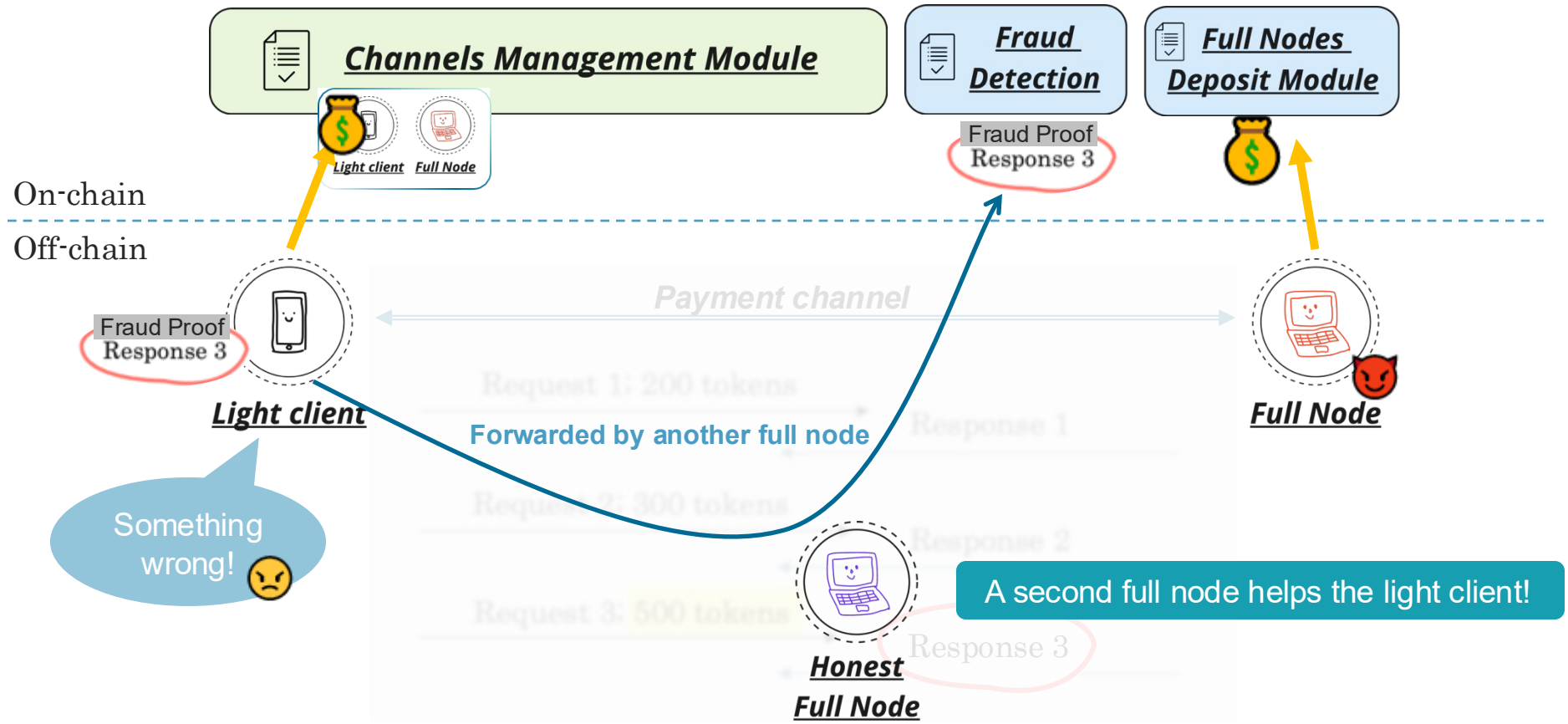

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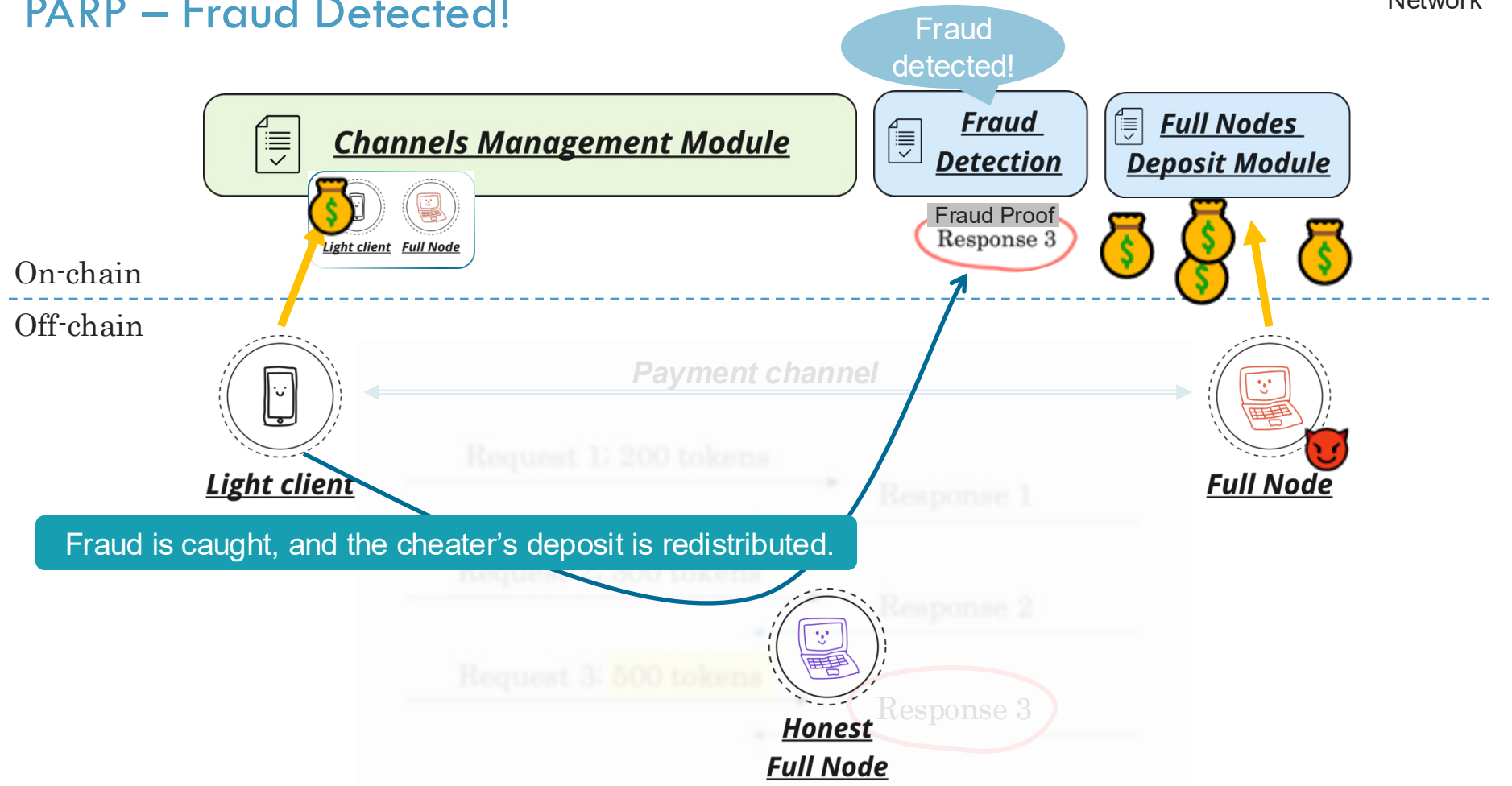
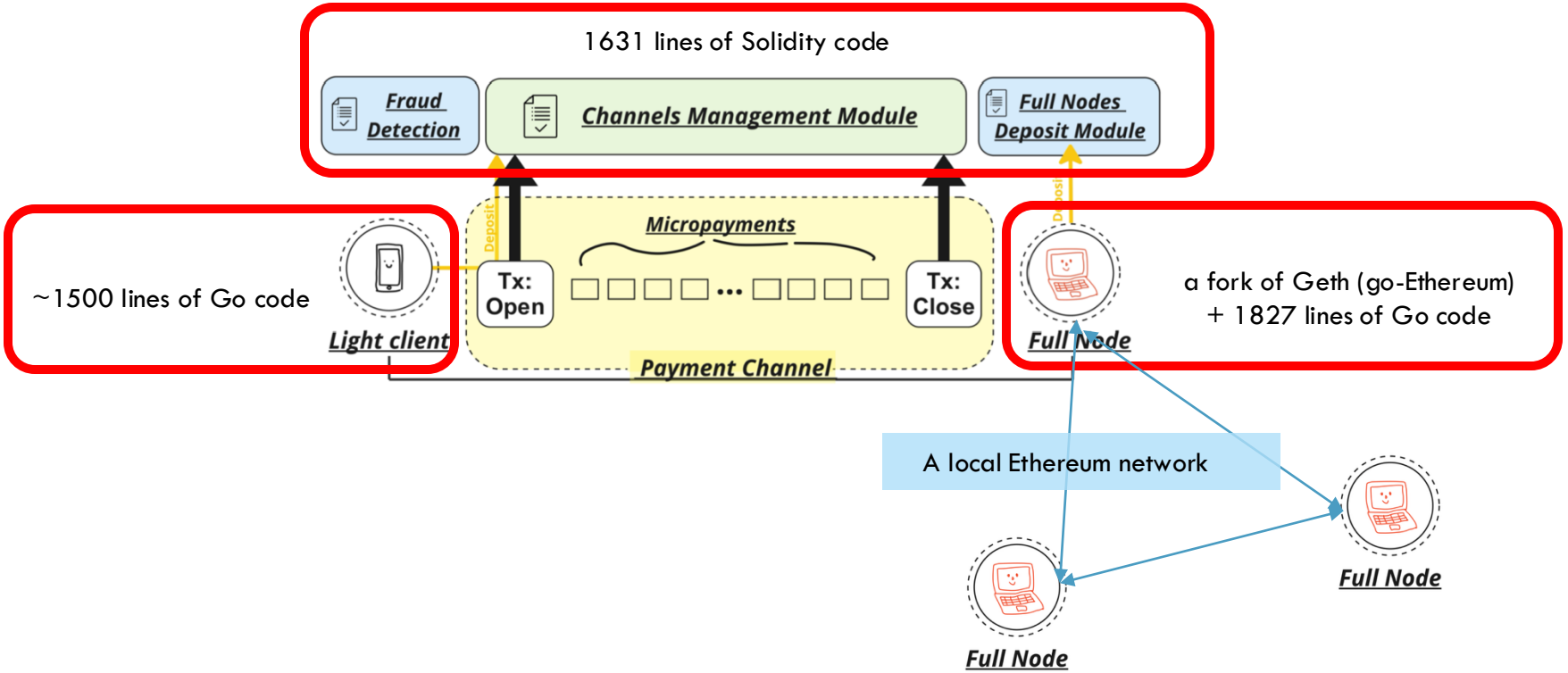


PARP Bridges Permissionless Access, Accountability, and Incentives

- **Permissionless**: no signup or gatekeeping, standard protocol
- **Accountable**: if a node lies, it can be caught and punished
- **Incentivized**: clients pay, nodes earn

Implementation and Evaluation

Prototype was implemented on a local Ethereum network



Evaluation details can be found in the paper

	Size Overhead (in bytes)
PARP request	226 bytes
PARP response	187 bytes + Size of Merkle Proof

Message size

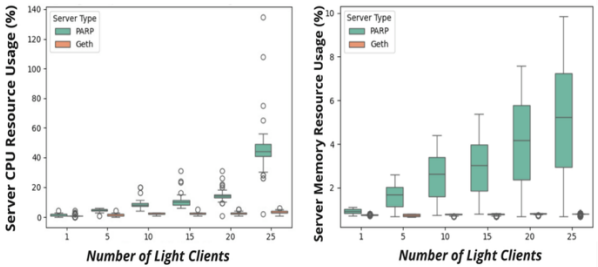
Light Client Process Steps	Write	Read
(A) Request Generation	10.91ms	4.82ms
(D) Response Verification (proof)	7.13ms	5.78ms
(D) Response Verification (in total)	8.109ms	1.01ms
Full Node Process Steps	**Write**	**Read**
(B) Request Verification	714.43μs	703.13μs
(C) Response Generation (proof)	3.08ms	477.12μs
(C) Response Generation (in total)	3.37ms	1.29ms

Latency

On-chain costs

Action	Gas Cost	MainNet (USD)	Arbitrum (USD)
Full Node Deposit			
Deposit funds	45238	2.171	0.018
Channel Management			
Open a channel	196183	9.417	0.078
Close a channel	110118	5.286	0.044
Confirm closure	87128	4.182	0.035
Fraud Proof Detection			
Submit a fraud proof	762508	36.6	0.305

CPU & memory usage



Future work

- Minimizing the on-chain costs and scalability
- Risks of single-node dependence
- Privacy concerns in full node interactions
- Formalization of cryptoeconomic incentives
- Network-level rewards

Depermissioning Web3: a ***P***ermissionless ***A***ccountable ***R***PC ***P***rotocol for Blockchain Networks

Get yourself a **permissionless** and **accountable** connection to a decentralized world.

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