



Cypherspace as cloud 3.0

ICP | Internet Computer

source <https://internetcomputer.org/deck-main>

version 18 August 2023



Dominic Williams

President/Chief Scientist @DFINITY Foundation





modern societies are run by digital frameworks:
from social media, communications, storage & the sharing economy,
to financial systems, supply chains & medical records.
all delivered by online systems and services,
created by software logic and data...
built on digital infrastructure
– societal foundations





with better foundations, we can build better frameworks for society:

today, systems and services often break, and they are easily hacked.

big corporations run the foundations, giving them control.

developing new systems and services costs too much.

today, social media corps. own our content,

when we should own social media.

can the internet solve this?



THE INTERNET



could we use a public network as new foundations?

U N S T O P P A B L E systems and services running on the internet, and becoming unstoppable like the internet

S O V E R E I G N systems and services without big tech or government kill switches and backdoors

T A M P E R P R O O F systems and services where the logic and data cannot be subverted

C O M M U N I T Y O W N E D systems and services where a community has exclusive control

A U T O N O M O U S systems and services that corporations cannot modify

E F F I C I E N T systems and services involving fewer IT personnel



tech history arcs towards open networks

PRIVATE

INFRASTRUCTURE



OPEN

NETWORKS

INFORMATION SUPERHIGHWAY

curated walled-garden network proposed
by Microsoft and Oracle (1990s)



THE INTERNET

private *routing devices* connected by
open TCP/IP protocols form a public
worldwide network

LEGACY IT STACK

cloud services, servers, databases,
web servers, CDNs, firewalls...



INTERNET COMPUTER

private *node machines* connected by
open ICP protocols form a public
serverless autonomous cloud

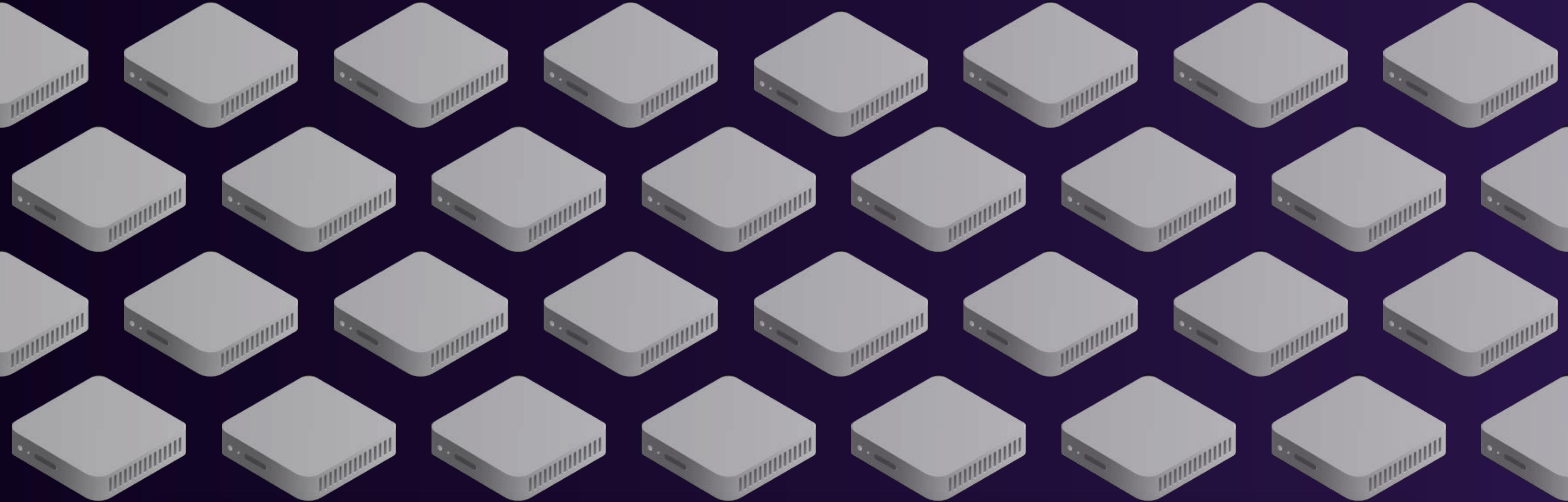


network

the Internet Computer is created by Internet Computer Protocol (ICP)
the most advanced network protocol ever devised

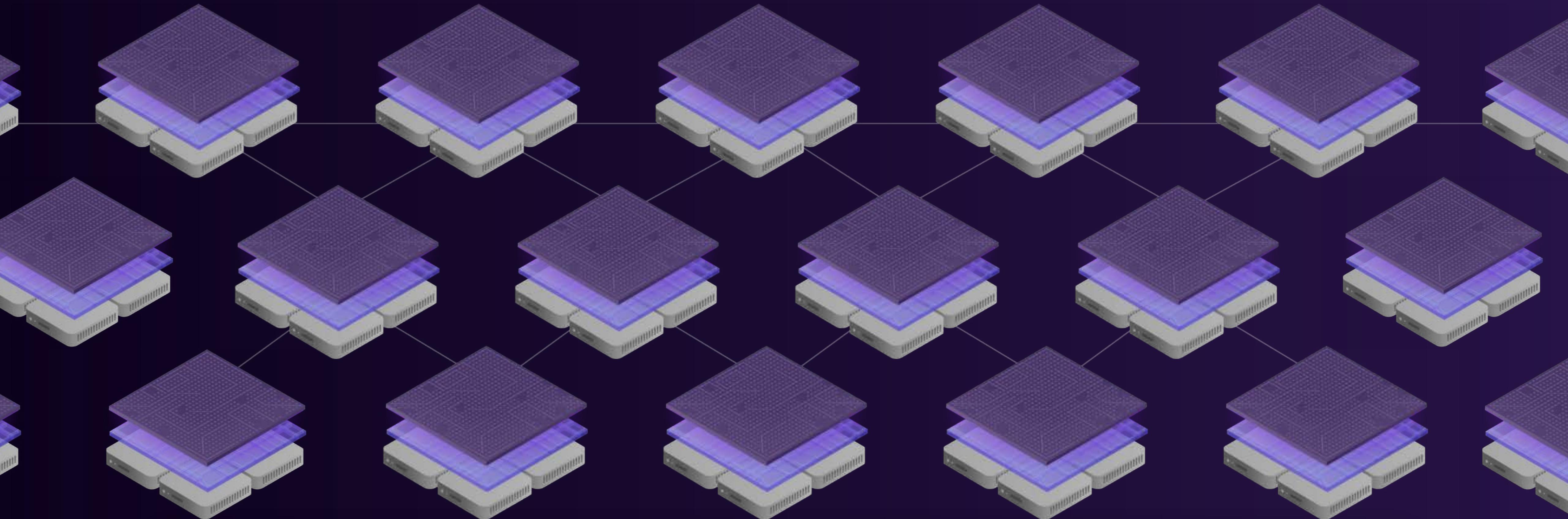


**independent node providers own and operate
node machines in data centers worldwide**



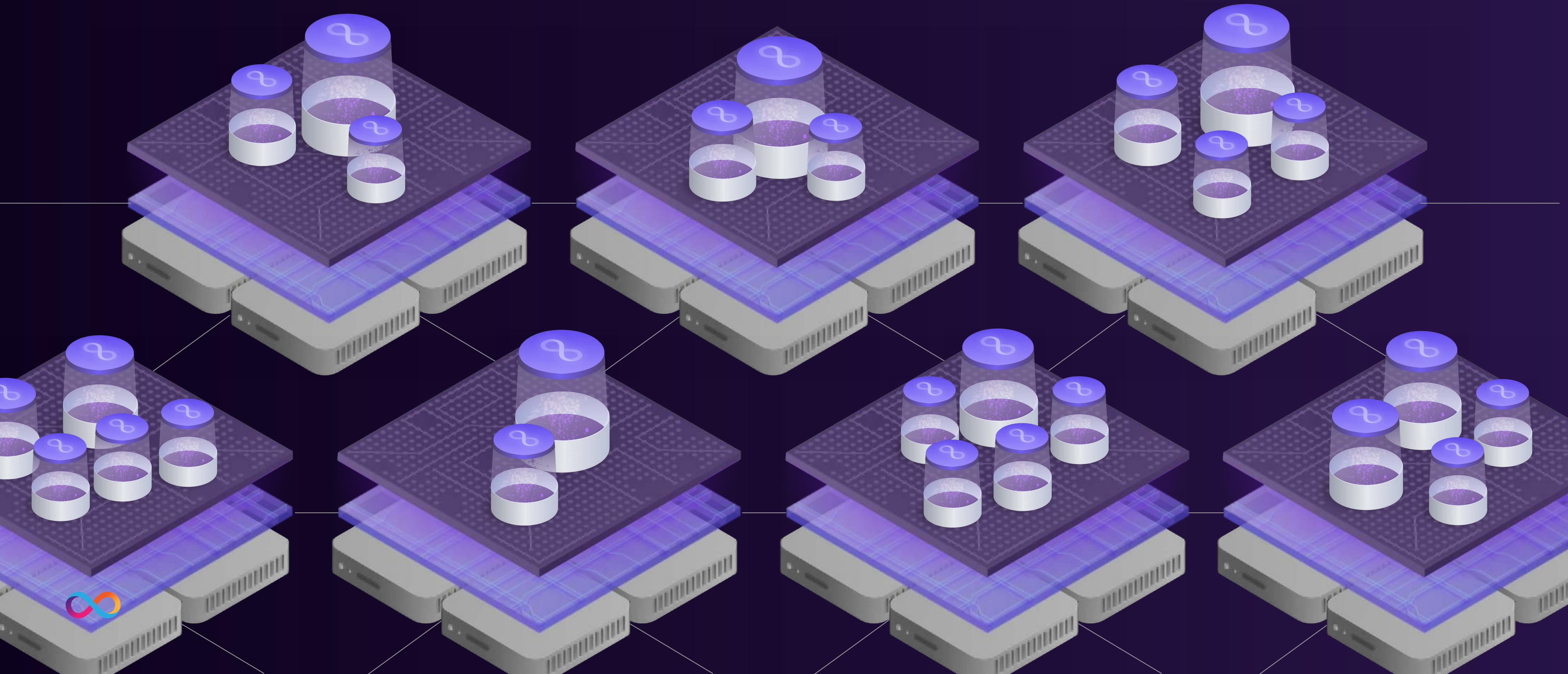
standardized physical hardware – the Internet Computer runs on a sovereign network, not cloud

Internet Computer Protocol (ICP) combines nodes to form efficient subnet blockchains



node machines combined from independent providers · data centers · geographies · jurisdictions

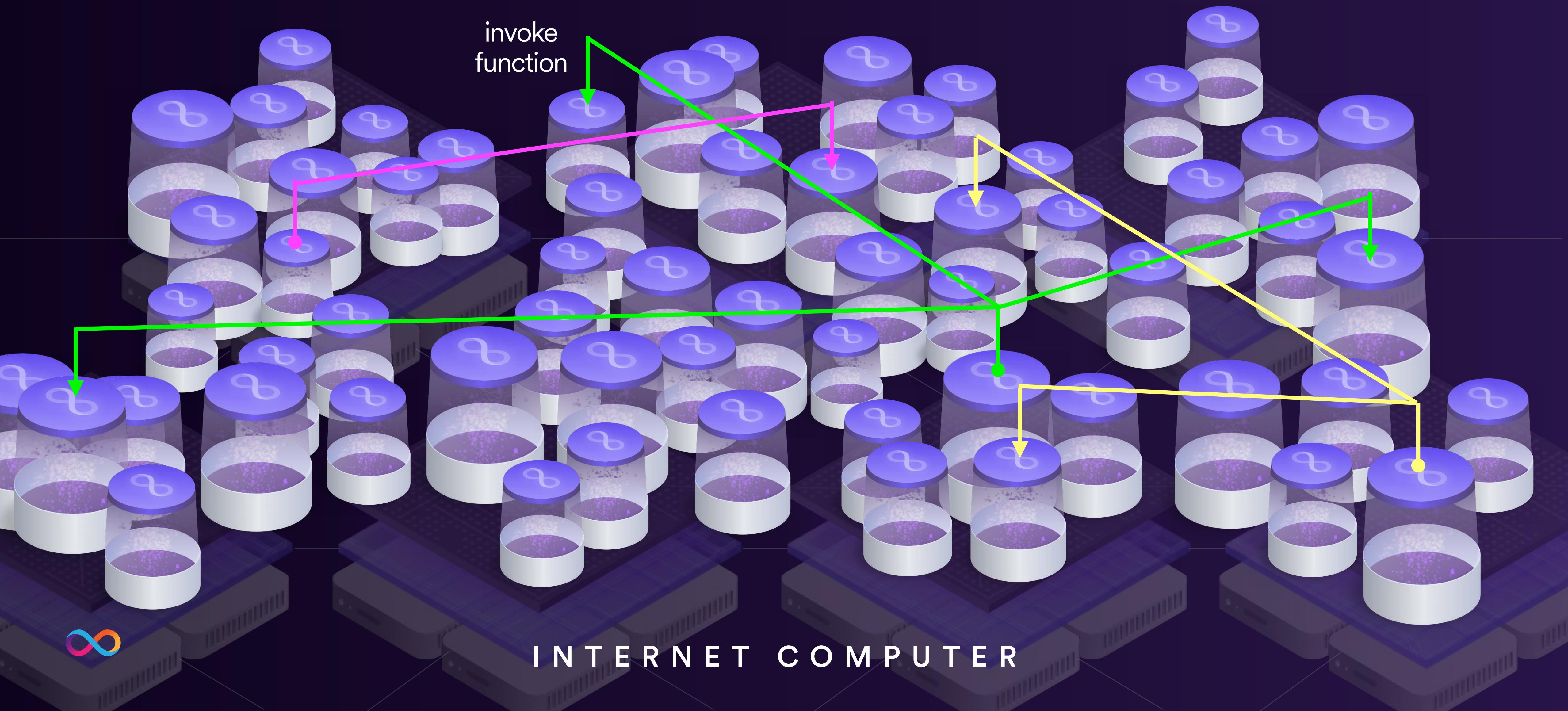
subnet blockchains add capacity for hosting
canister smart contracts



subnets combine into ONE *stateful serverless autonomous cloud*



a seamless universe for tamperproof code units w/o servers or instances



build almost anything

online systems and services can be built directly on the Internet Computer using smart contract code, without any need for legacy IT, such as cloud services, databases and web servers



a third type of public blockchain network



all-new blockchain science and engineering produced by hundreds of person-years effort at DFINITY has solved critical blockchain speed, efficiency, scalability, smart contract and user experience challenges allowing blockchain to act as a "stateful serverless autonomous cloud" that plays the role of a standalone, fully decentralized, alternative IT stack



autonomous cloud runs tamperproof code without backdoors at scale

canister code

canisters are a new form of smart contract
that have general application



smart contracts are a new form of software



ETHEREUM SMART CONTRACTS

tamperproof

firewalls aren't needed to protect software and data

tokenization

value can be held, processed and transmitted, like data

unstoppable

nuke-proof thanks to host network's fault-tolerance

composable

easy collaborative building with less need for trust

autonomous

code can be unmodifiable, or assigned to a DAO

borderless

code and data in cyberspace, without geography

data inside

data lives inside software units, not databases or files



canisters are a new form of smart contracts

CANISTER SOFTWARE

fast

web speed canisters don't make users wait

efficient

can reduce traditional IT carbon footprints

scalable

can support services that scale-out to millions or billions

low cost

costs reduced to < 0.000001% traditional blockchains

multi-chain

can natively interact with external blockchains

web interaction

directly process HTTP and serve user experiences

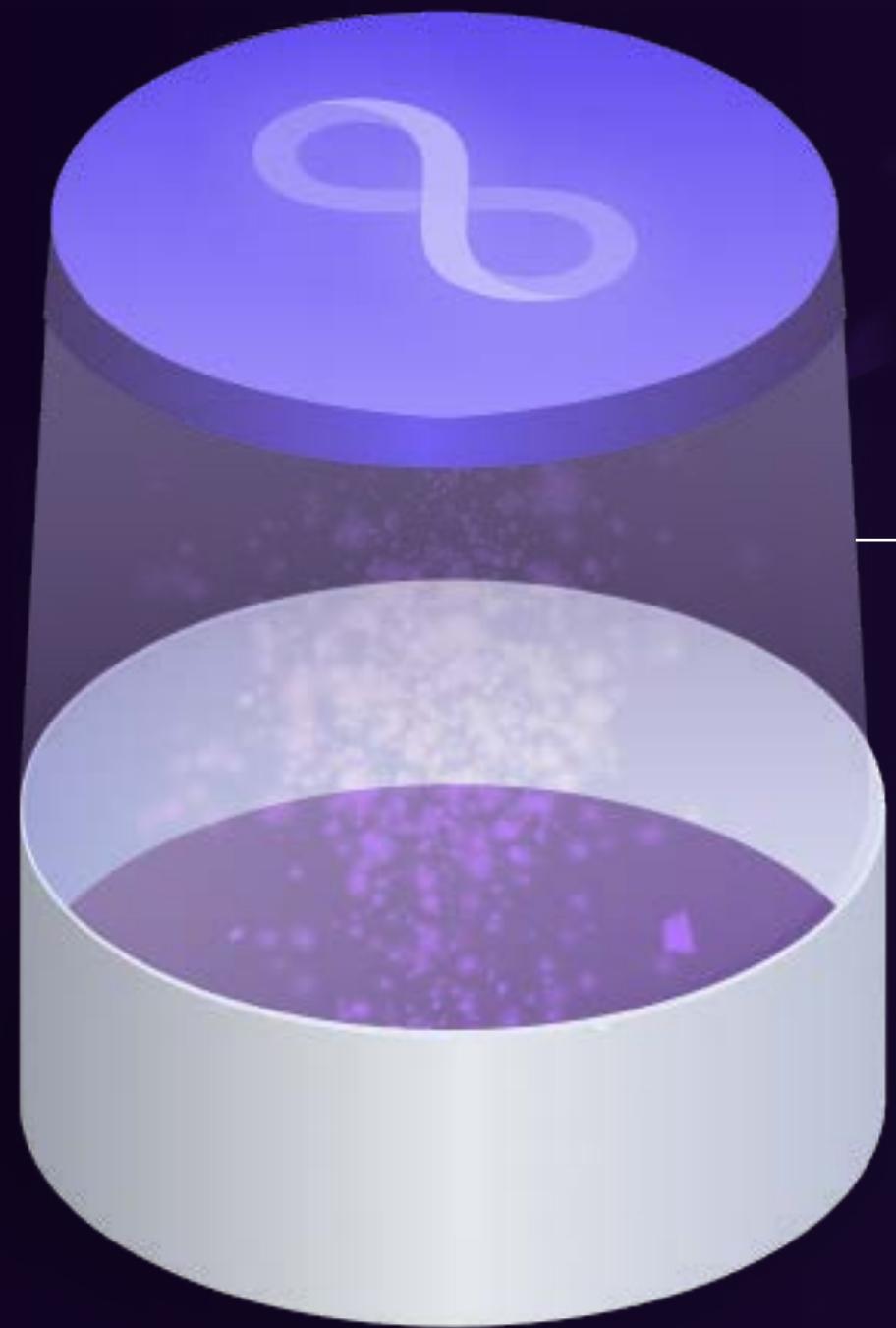
actor model

canisters keep data private and run in parallel

the network runs
canister code in parallel
(deterministically)



each canister bundles some **software logic** and **data**



LOGIC

Canister software can be written in a wide variety of languages such as Rust, TypeScript and Motoko, and then compiled into Wasm byte code, which the Internet Computer runs on a WebAssembly virtual machine. Each canister is a “software actor,” which maintains its own data, and they run in parallel.

DATA

Since a canister is a “software actor” that maintains its own data, which communicates with other canisters purely via function calls, it has private memory pages inside. These memory pages are persistent. Software logic transparently maintains data inside memory in a scheme of “orthogonal persistence” – data can be persisted in any data structure.



canister smart contracts are tamperproof software

TRADITIONAL SOFTWARE

when software is invoked, sometimes it executes logic a hacker inserted

when software is invoked, sometimes it processes a hacker's malicious data

ransomware/viruses can encrypt and modify software and its data

must depend on unreliable firewalls, SIEM logging, regular patching, and other security practices, to keep hackers away from infrastructure

TAMPERPROOF SOFTWARE

when software is invoked, it correctly executes the defined logic

when software is invoked, it correctly processes its own data

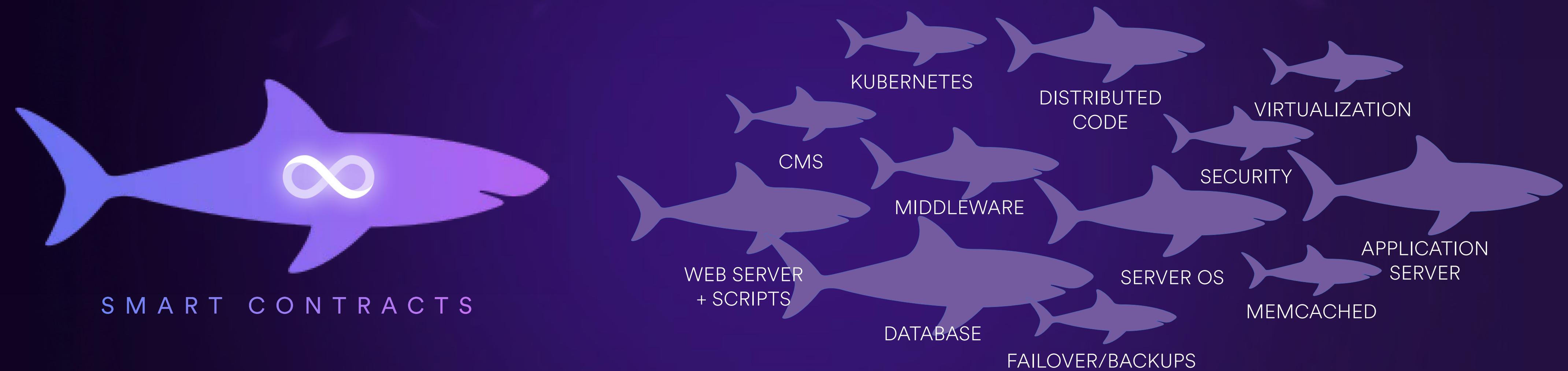
ransomware/viruses cannot encrypt or modify software and its data

software and data are hosted using fault tolerant and secure protocol



THE FUTURE

software will eat the world. smart contracts will eat software



smart contract software will replace the legacy stack due to its overwhelming advantages

web3+

what the Internet Computer can solve for web3 builders
in today's blockchain ecosystem



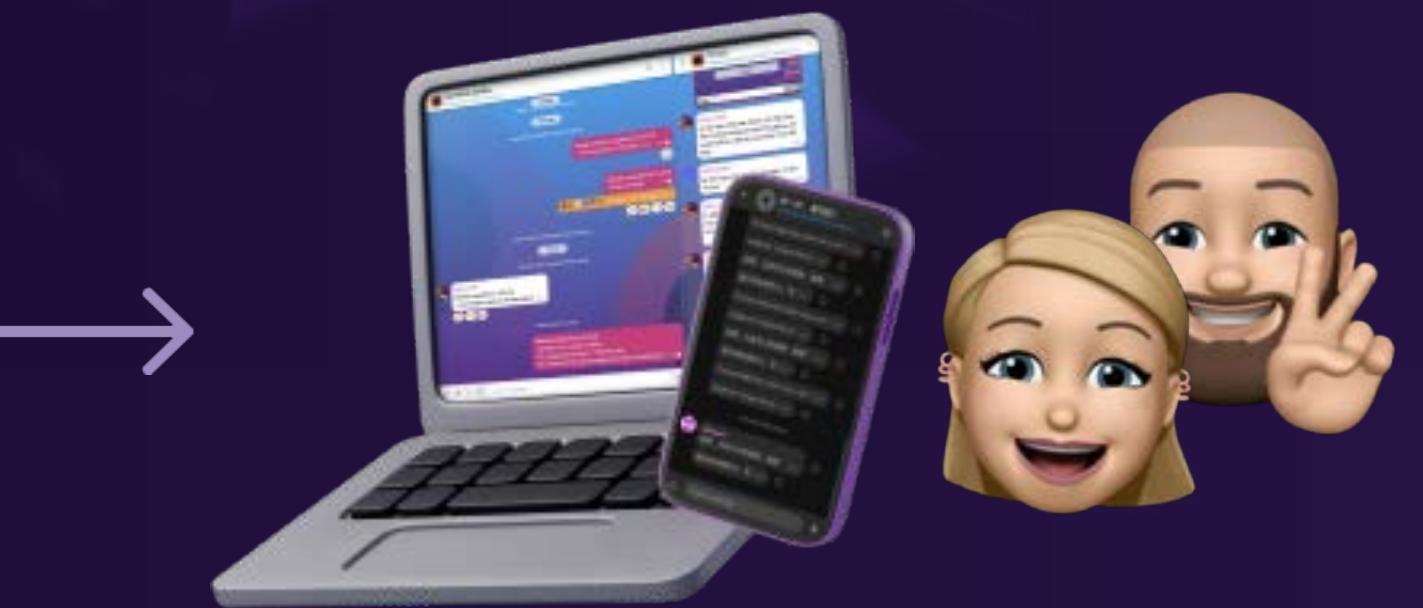
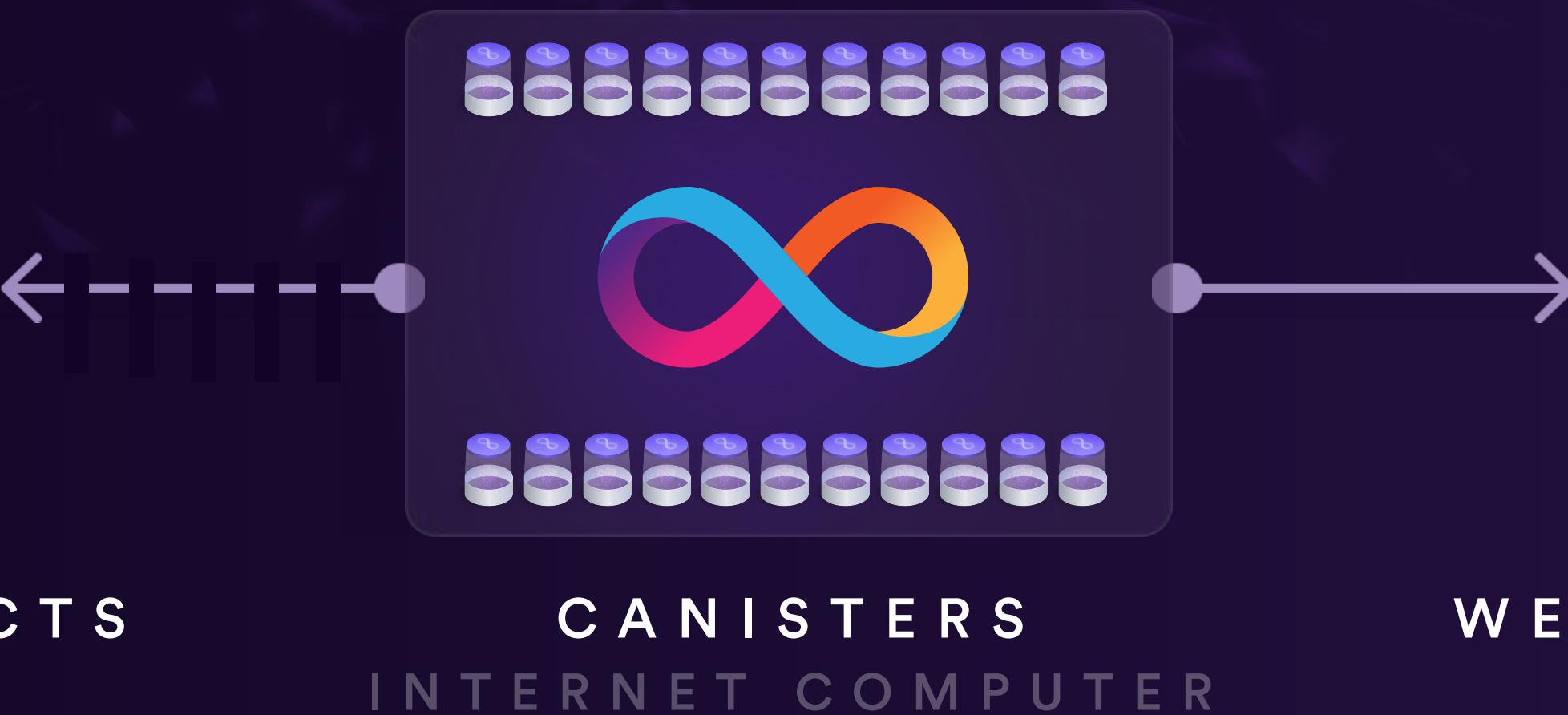
ICP solves for the final frontier of decentralization



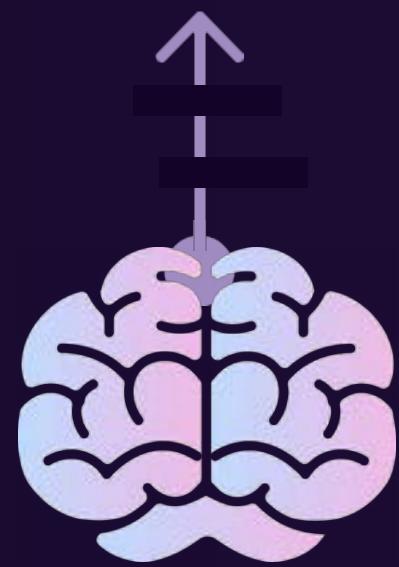
replace legacy IT with canisters on the Internet Computer



SMART CONTRACTS
ETHEREUM



WEB3 EXPERIENCES



AUTONOMOUS GOVERNANCE
SERVICE NERVOUS SYSTEM



autonomy

the Internet Computer runs autonomously under the control of decentralized governance... and hosted web3 services and systems can too



three forms of Internet Computer autonomy

network autonomy

In order for the Internet Computer to host autonomous canisters, and autonomous systems and services, it must be fully autonomous itself. The network's design incorporates an advanced DAO into its ICP protocols, called the "Network Nervous System" (NNS). The network runs under the full control of the NNS, which updates its protocols, and instructs nodes to form into subnets, among other things.

DAO-modifiable canisters

In a similar way that the Internet Computer network was made autonomous by placing an advanced DAO in control, units of code can be made autonomous by placing a "service nervous system" DAO in full and exclusive control. This can then update and configure the canisters that form a service. A community or enterprise can control the DAO. There are no other ways to control the service.

immutable canisters

What if nothing should be able to modify canisters? For example, what about global financial rails that many other systems and services build on top of, or what about a wallet that must be absolutely secure? The Internet Computer network can host canisters that cannot be modified by anyone, which continue to exist and run so long as they are charged with "cycles" (the network's fuel for computation).



tip A DAO is a "decentralized autonomous organization" providing digital governance or democracy

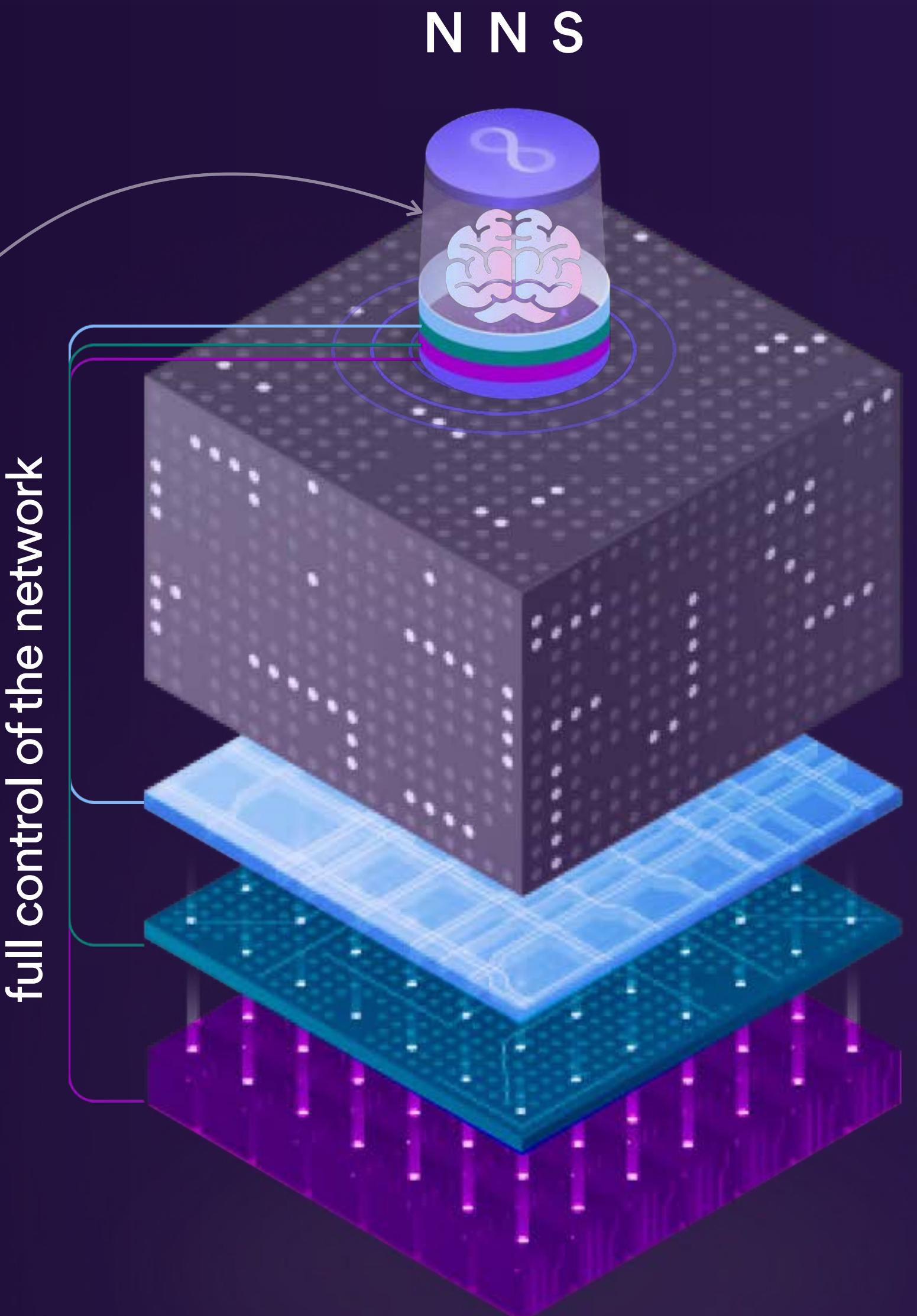
DAO governance of the network

the “Network Nervous System” (NNS) is special DAO that runs as part of the ICP protocols. It enables the Internet Computer network to adapt and evolve autonomously

- public, open, transparent and permissionless
- users lock ICP tokens to create “voting neurons”
- neurons vote automatically by following other neurons
- tens of thousands of users have created neurons
- submitted proposals are adopted or rejected
- algorithmic liquid democracy decides on proposals
- adopted proposals are executed automatically
- on instruction, nodes update the ICP protocol
- on instruction, nodes form into new subnets
- in 2 years, mainnet upgraded its protocols 145 times
- the network is autonomous / there are no backdoors



ICP
community



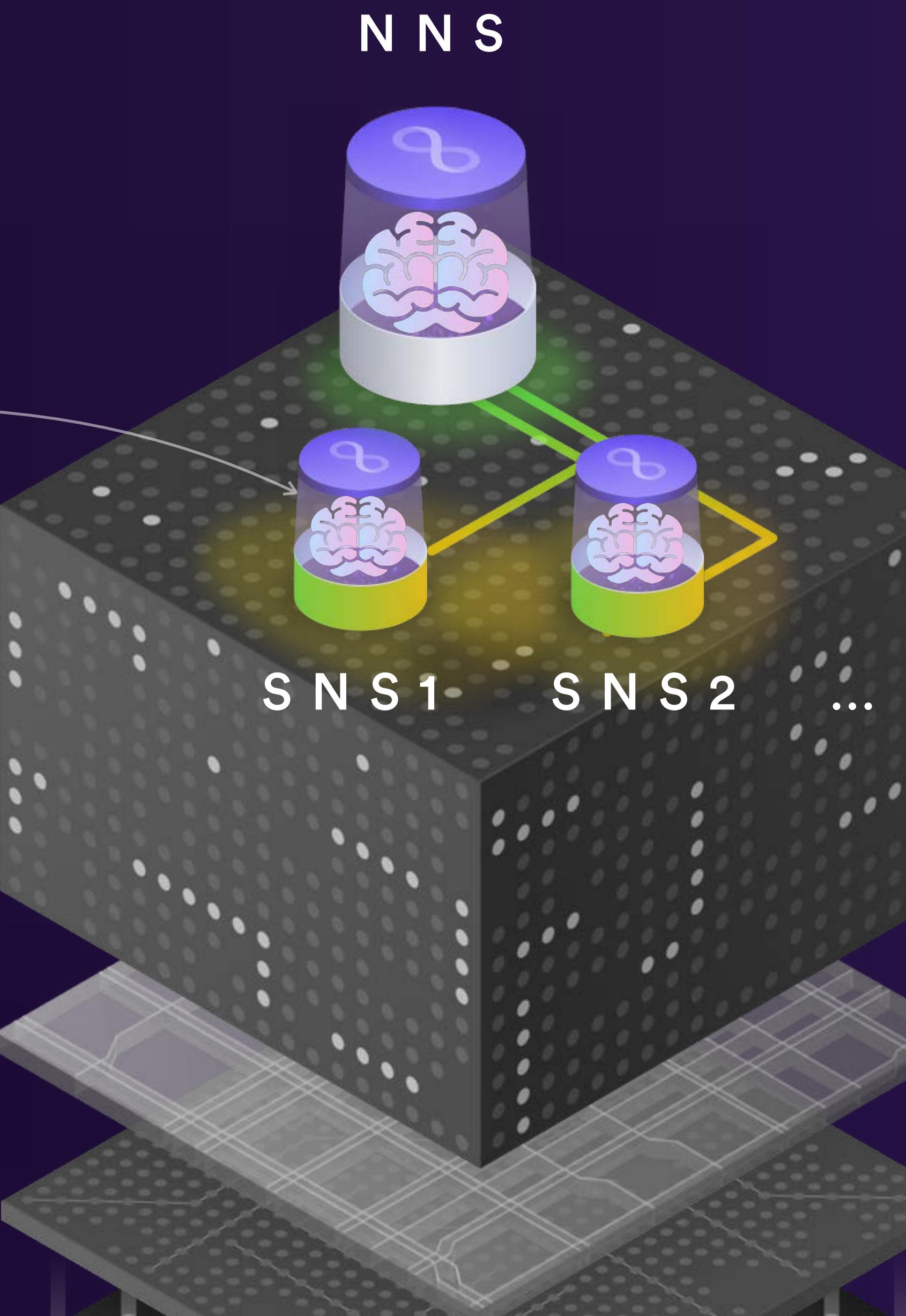
DAO governance of online services

special “service nervous system” (SNS) DAOs can be given exclusive control of “open internet services,” which run autonomously on the autonomous network. NNS proposals create new SNS DAOs

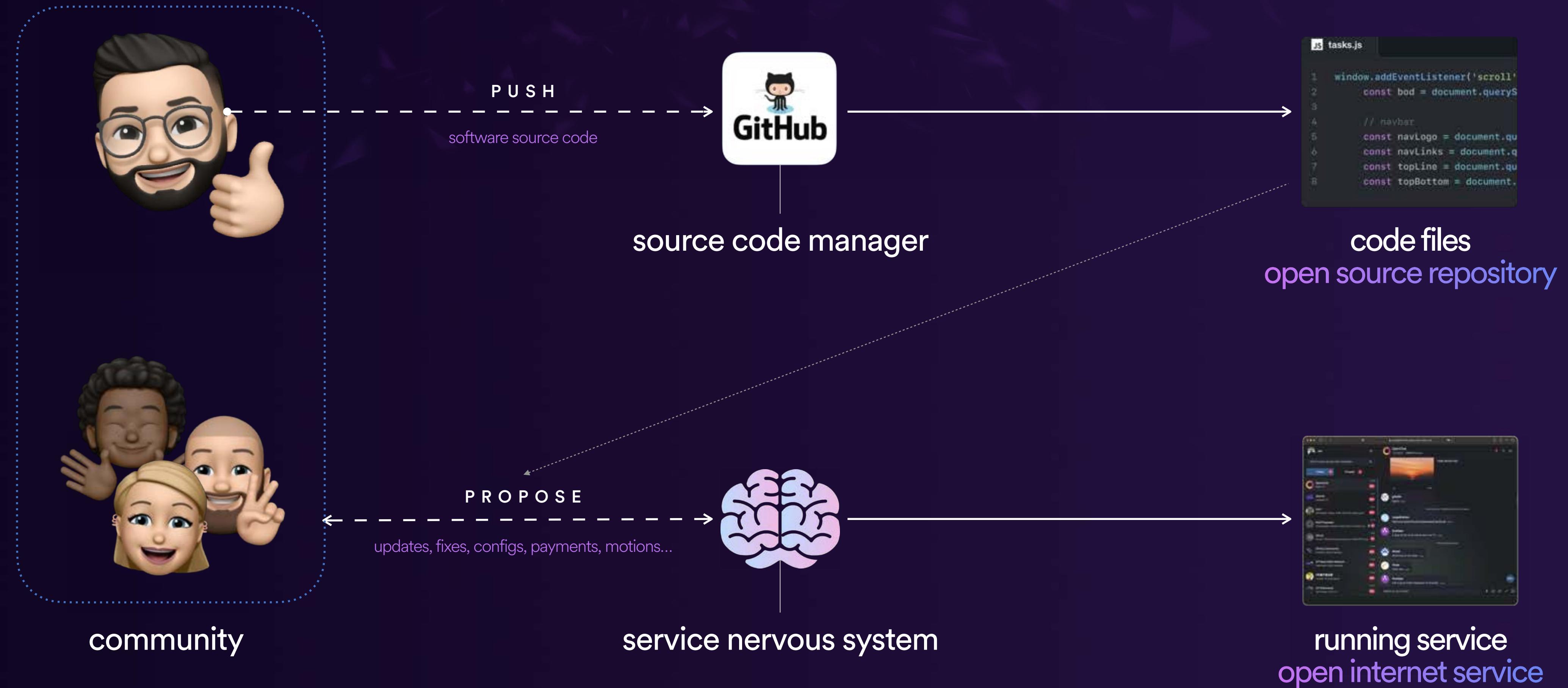
- open/permissionless (web3), or private (enterprise)
- the SNS updates its service’s canisters
- the SNS can perform arbitrary configurations
- an SNS can manage a token treasury (value)
- services can be controlled by communities of millions
- each SNS creates a ledger of native tokens for its service
- tokens can incentivize decentralized community workforces
- community fundraising into the SNS is possible
- enterprise systems can distribute control for security
- any complex service can be made autonomous
- NNS proposals create approved SNS DAOs



a web3
community
or
enterprise
admins



an open internet service (OIS) puts its community in control via an SNS



open internet services are a game-changing internet innovation

TRANSPARENT

every OIS is run by its SNS DAO: all updates fixes and configurations, and any uses of e.g. a token treasury, must be proposed, reviewed and adopted, before automatic execution

HIGHLY SECURE

every OIS is tamperproof, and can only be modified through its SNS DAO. only proposals adopted by its web3 community (or enterprise admin community) can e.g. direct it to update its code

SOVEREIGN

every OIS runs autonomously in an adaptive and self-evolving way. there are no backdoors through which decisions can be forced on the community (e.g. by cloud, developers, hackers...)

special web3 applications



PROJECTS CAN MAKE THEIR USERS INTO FOUNDERS

governance tokens created and distributed to decentralize control of an SNS DAO (and thus the OIS), can be used to make the users of an OIS into project founders, who help run and promote the service. millions of users can be founderized

INDUSTRIOS VIRTUAL WORKFORCES & ECONOMIES

an OIS can disburse tokens to those creating viral content, or moderating content, or submitting improvements that are adopted. tokenomics can create self-sustaining high-growth digital economies

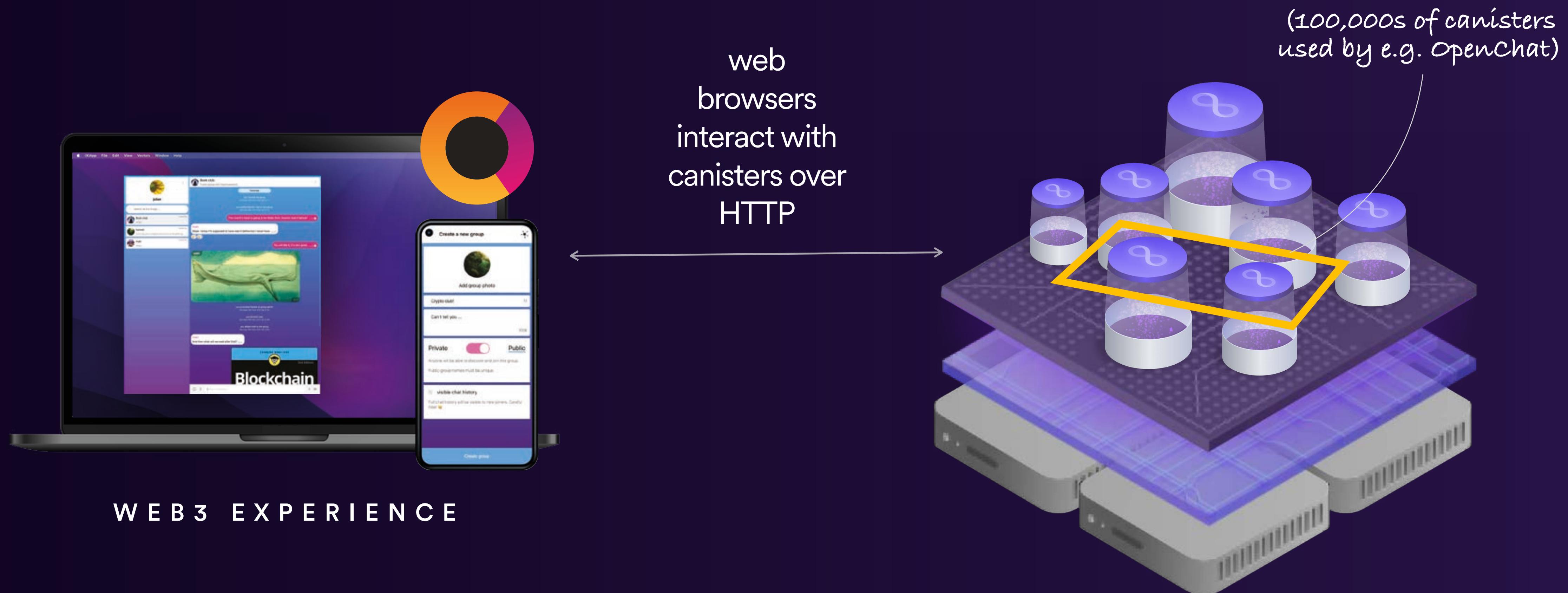


pure web3

the Internet Computer is a Web3 platform that provides a complete alternative to the traditional IT stack



users interact with services over HTTP (the web)



crypto tip canisters pay for their own computation (“reverse gas”) so end-users don’t need wallets

Internet Identity frameworks create sessions for user interaction



secures sessions allow user experiences to transparently create multiple transactions a second

incredibly, the ICP network has one master 96-byte public chain key



1 MASTER
CHAIN KEY



unique chain key cryptography is what makes the Internet Computer network possible

the Internet Computer's master chain key

```
308182301d060d2b0601040182dc7c0503010201060c2b0601040182dc7c05030201036100814c0e6ec  
71fab583b08bd81373c255c3c371b2e84863c98a4f1e08b74235d14fb5d9c0cd546d9685f913a0c0b2c  
c5341583bf4b4392e467db96d65b9bb4cb717112f8472e0d5a4d14505ffd7484b01291091c5f87b9888  
3463f98091a0baaae
```

--- any software system with this magic number can ---

VERIFY INTERACTIONS

holders of this master chain key, such as front-end software running in a web browser, can check special signatures on the results of submitted transactions (i.e. the results of invocations of canister smart contracts) to verify that they have not been tampered with

VERIFY CORRECTNESS

when the holder of this master chain key verifies that the results of their transactions (i.e. function invocations) have not been tampered with, it also proves to them that the Internet Computer is running correctly, and that the result was correctly produced



technological breakthrough removes the need to run a local node to securely interact with a blockchain

INTERNET IDENTITY



Interoperable

Share credentials across different web services and platforms in a privacy-preserving manner.



Easy to use

No need to deal with seed phrases or manage endless usernames and passwords. Simply unlock your device to create a secure session.



Sovereign

Internet Identity relies on key pairs securely maintained within TPM chips on your devices. Because interactions are signed inside the chips, the keys cannot be stolen.



Highly secure

Based on FIDO Alliance and W3C standards, cryptographic key pairs are stored in special secure hardware on your modern device (inside TPM chips).



Open source

Developers can audit and contribute to the codebase to ensure that it meets the highest standards of security and transparency.

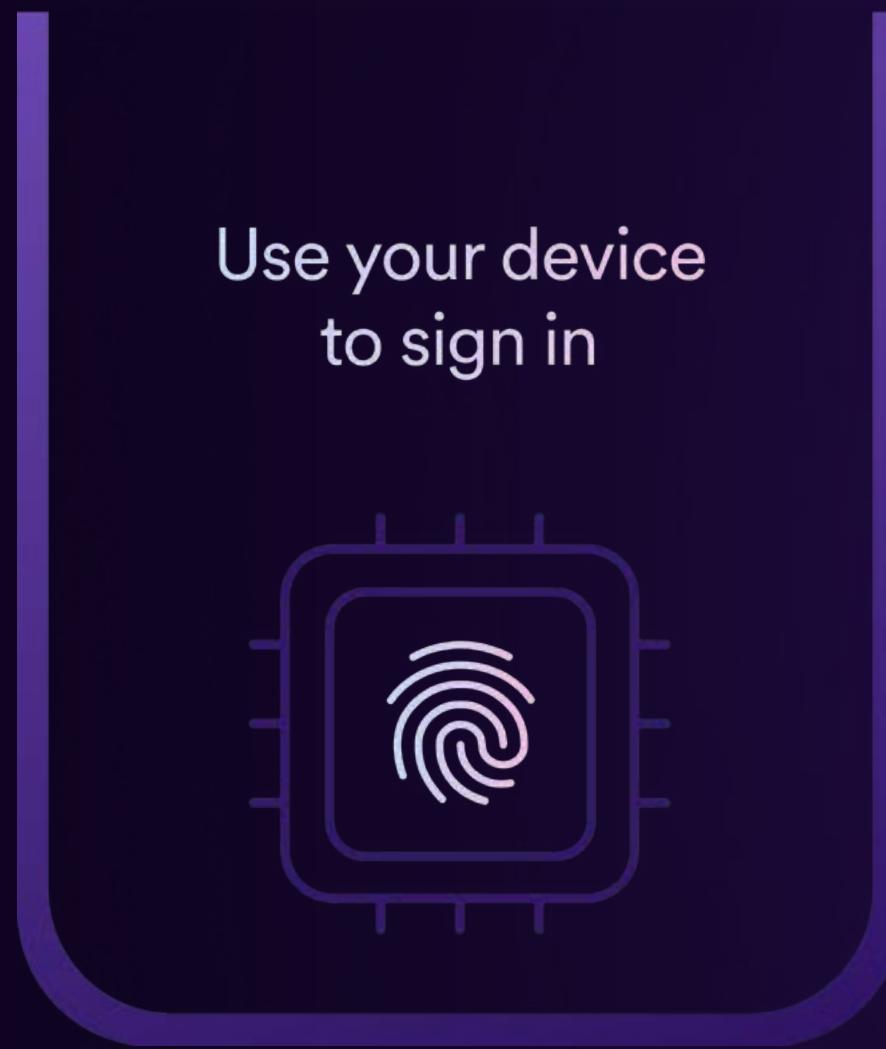


No tracking

A different pseudonym is created for every service you interact with, preventing services linking their users e.g. as per SSO.



INTERNET IDENTITY



TPM

+



WebAuthn (+ FIDO)

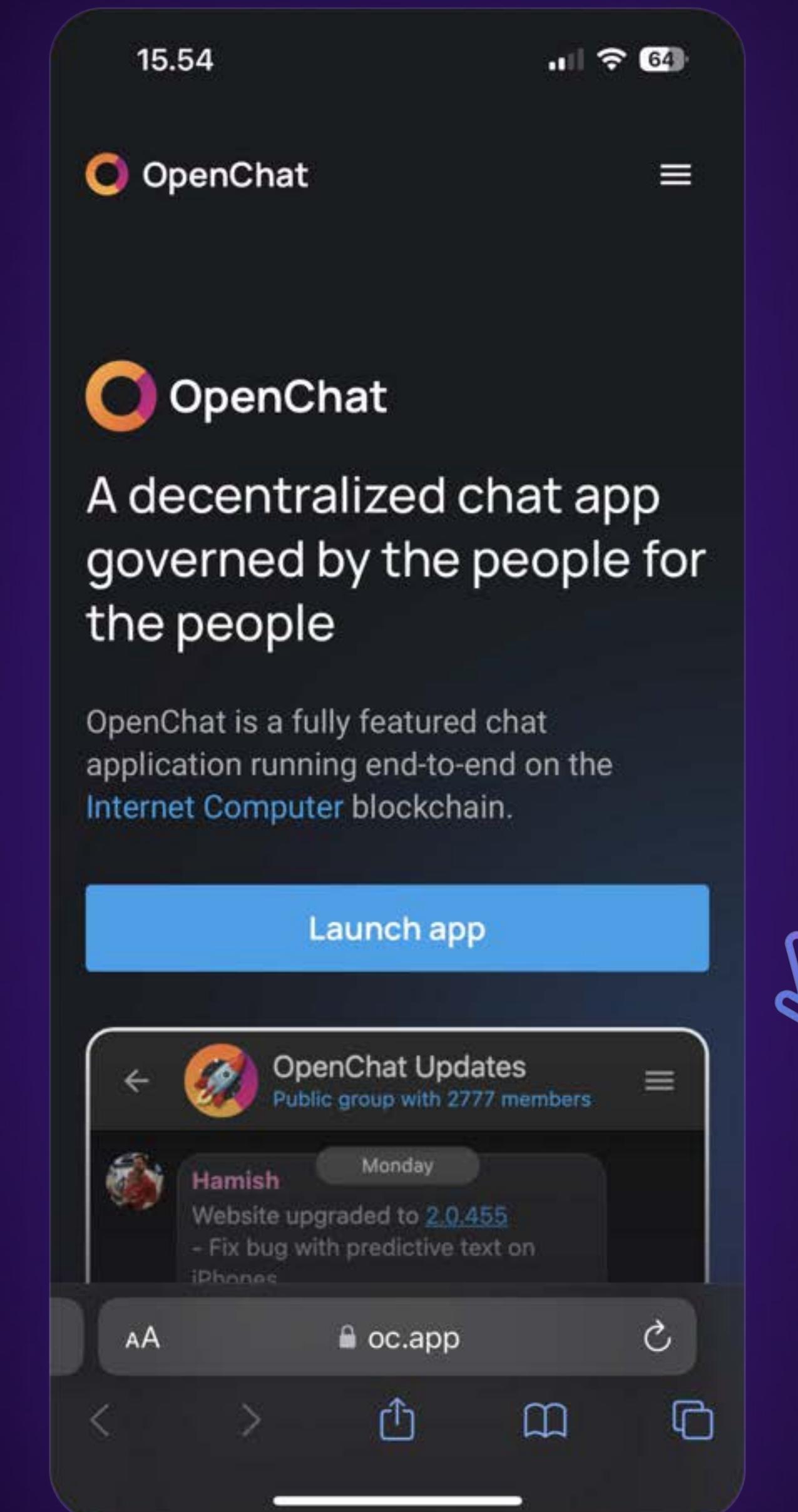
+



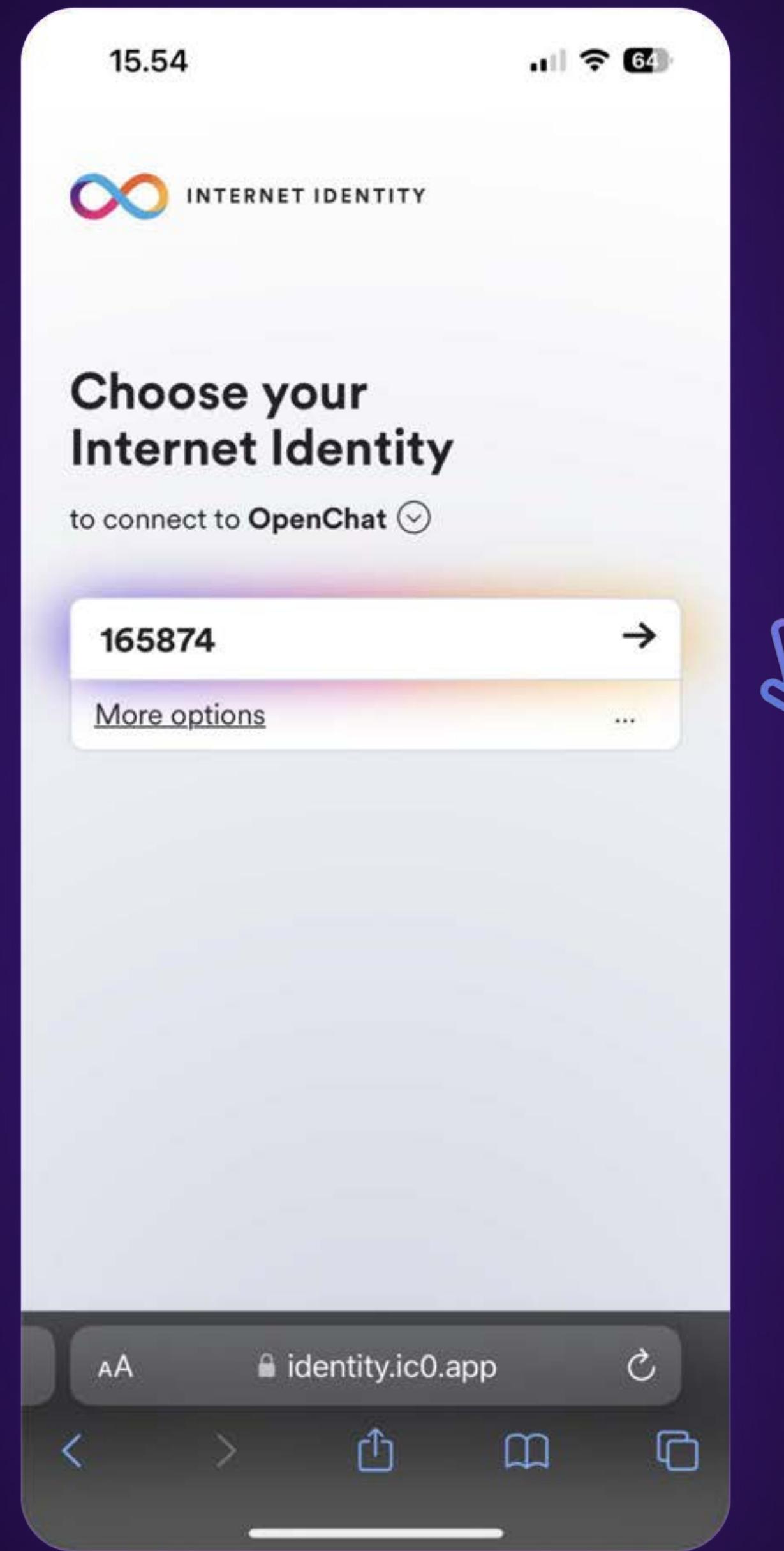
Internet Computer



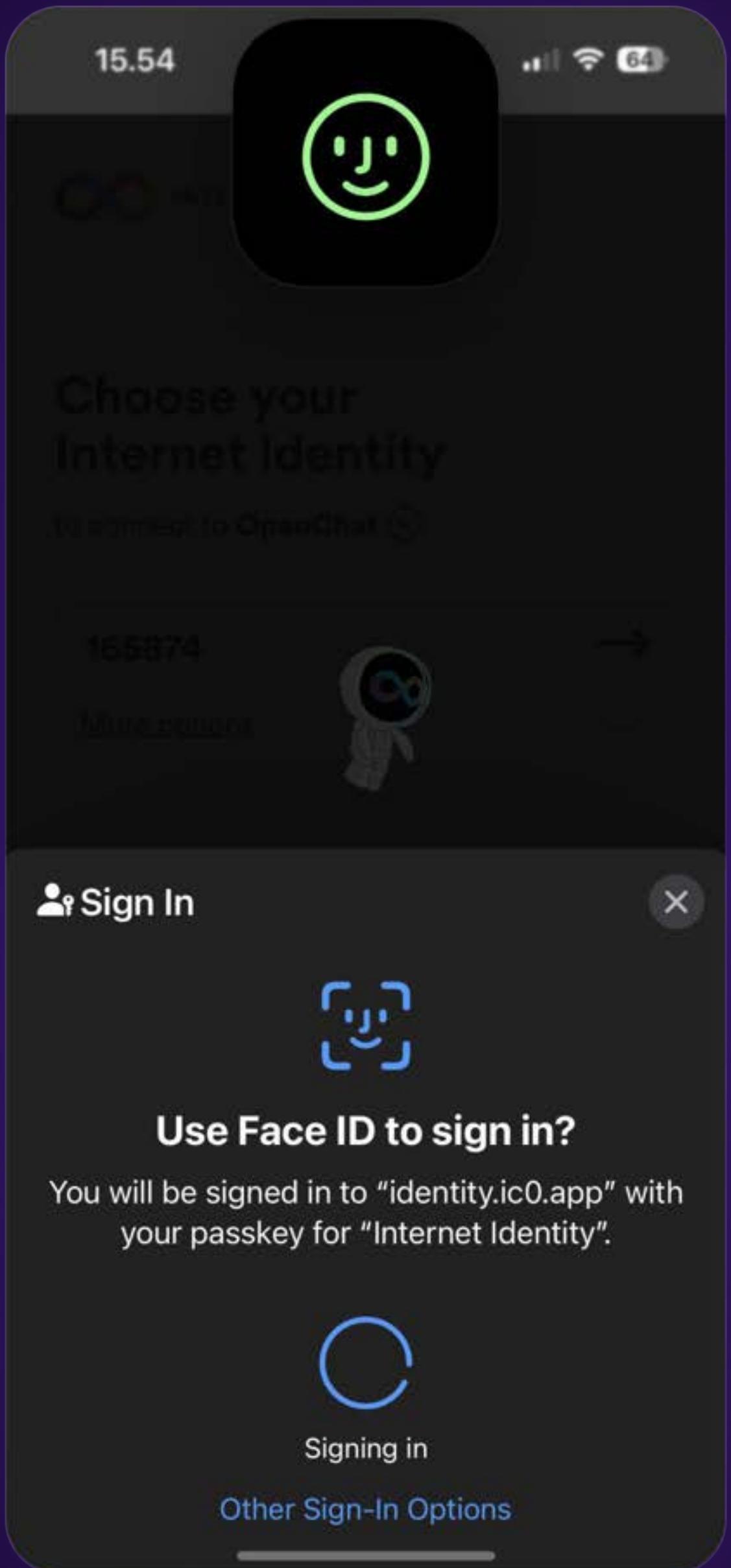
INTERNET IDENTITY



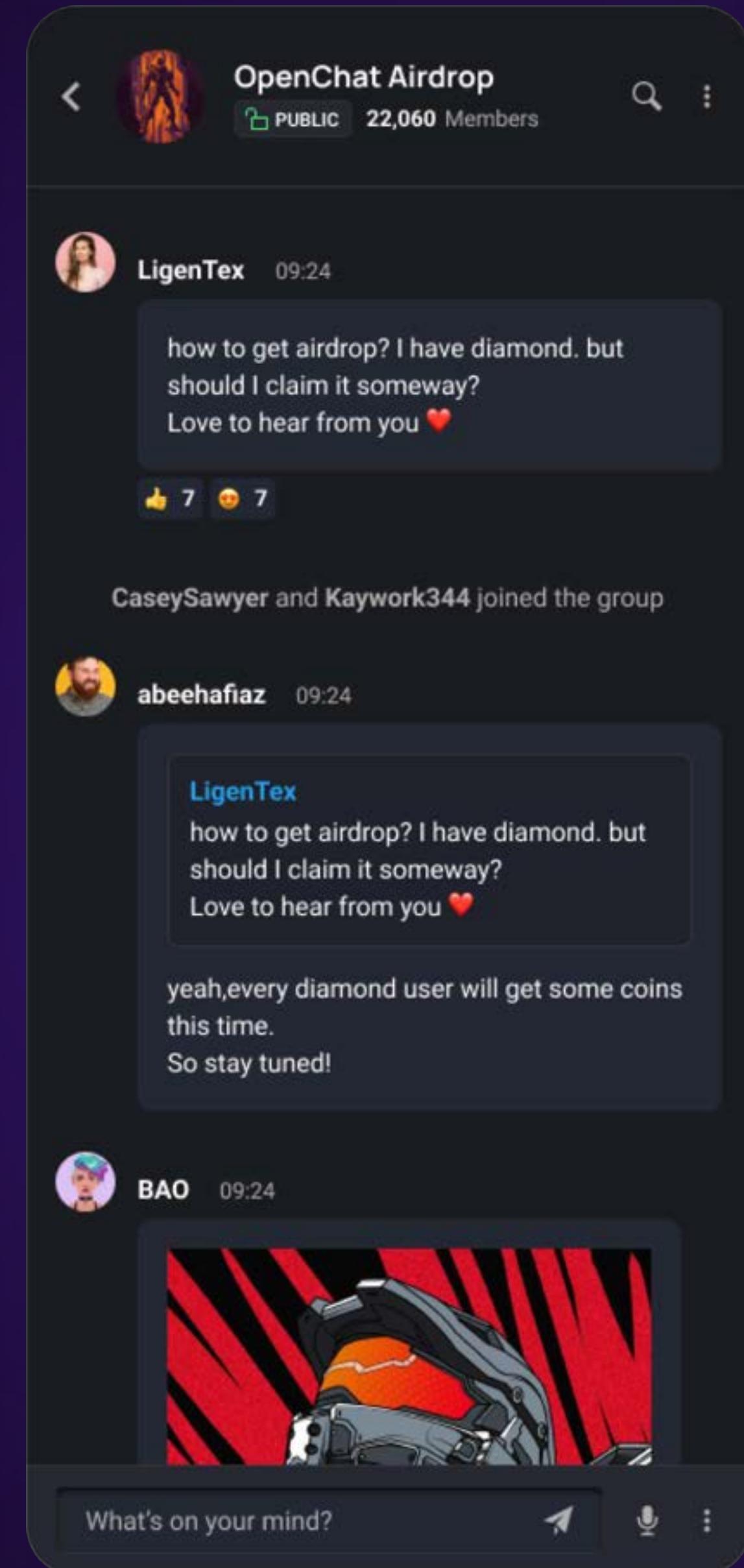
INTERNET IDENTITY



INTERNET IDENTITY



INTERNET IDENTITY



where we are now

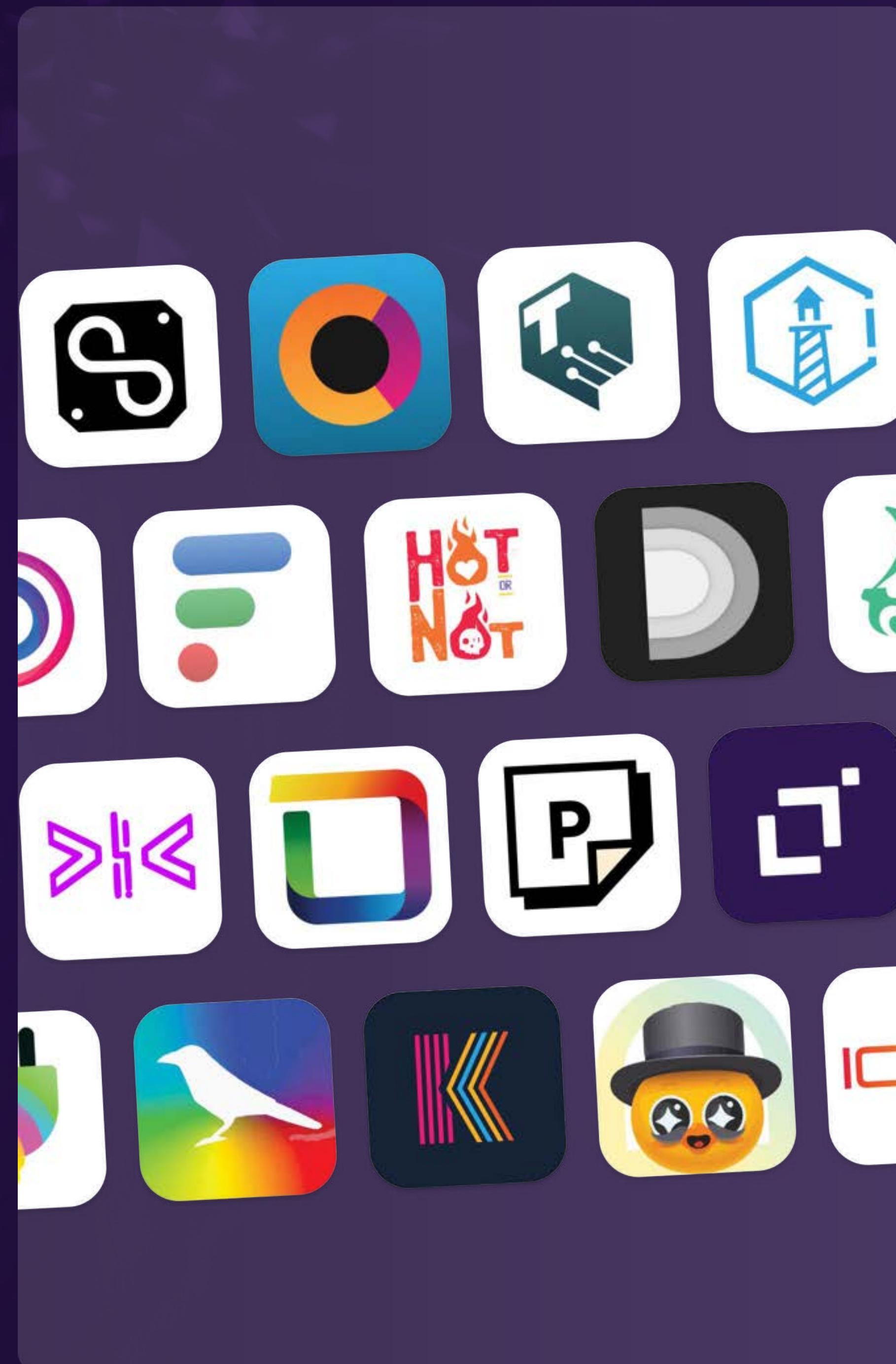
2.2M+

identities created

100+

dapps using II for authentication

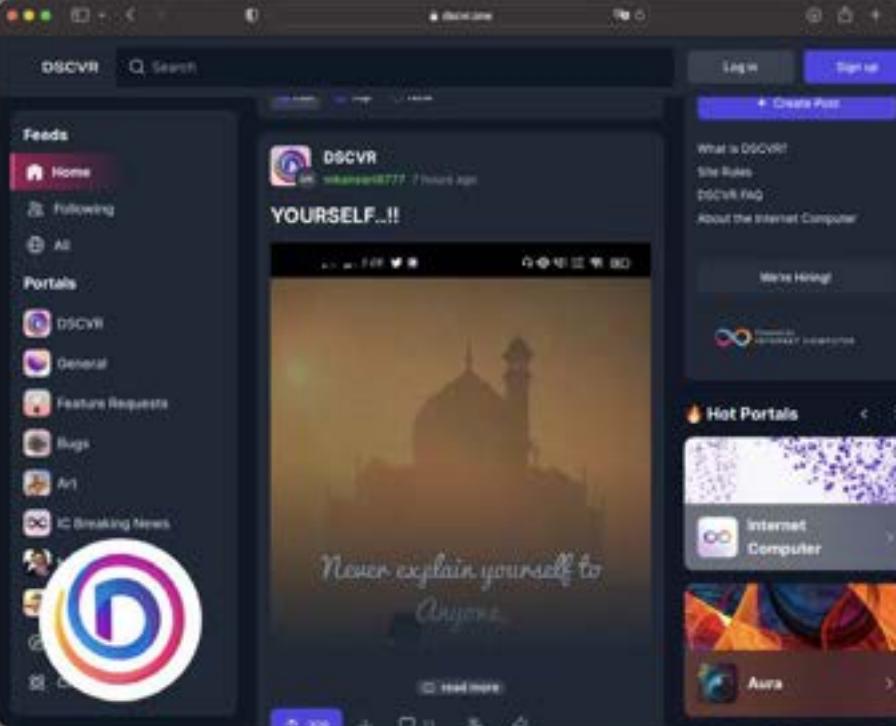
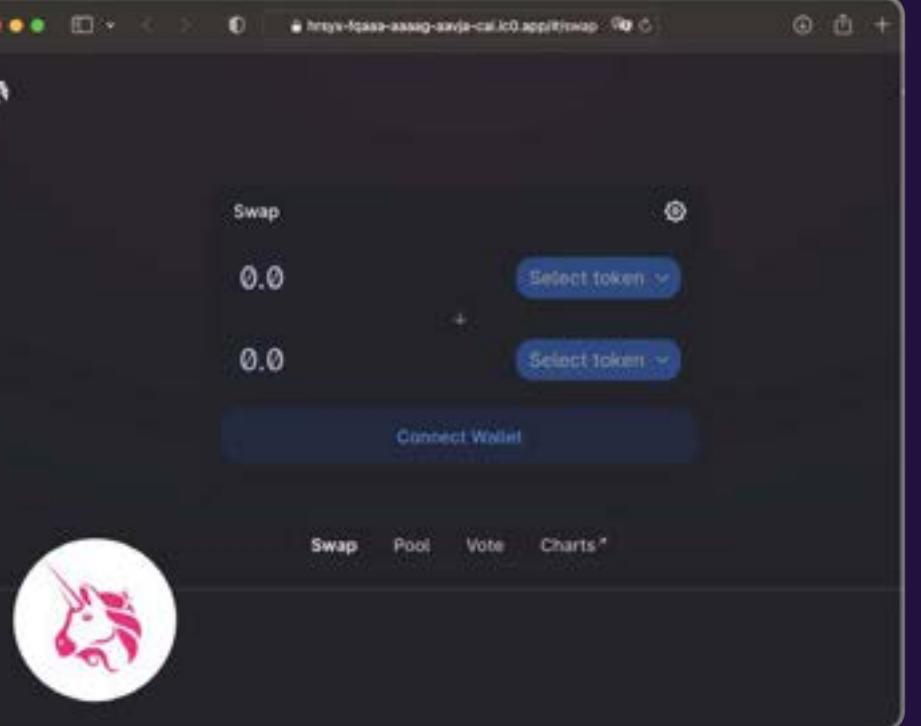
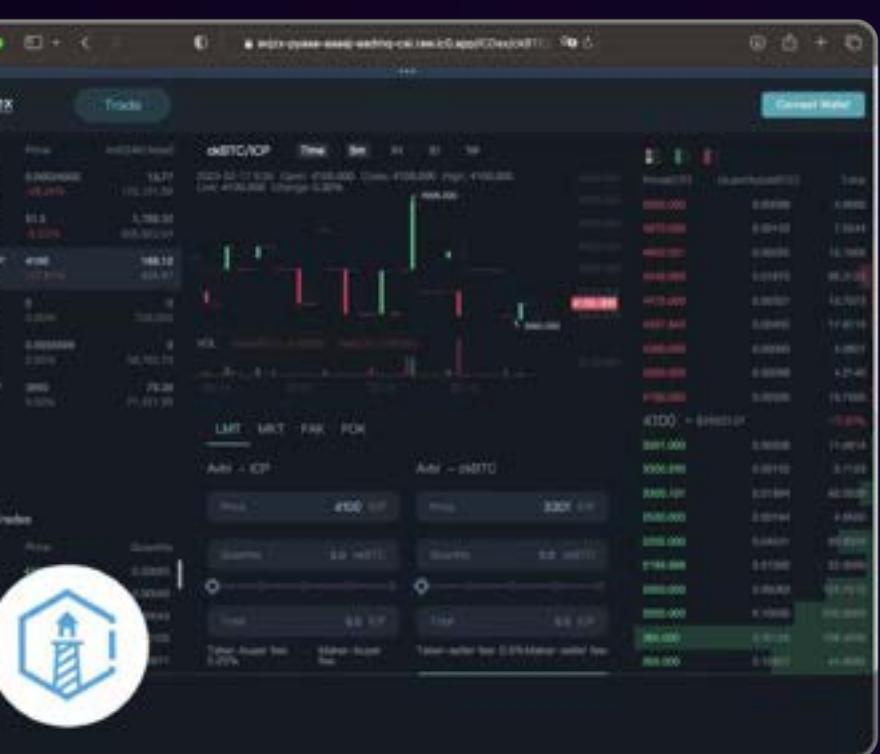
support for zero knowledge identity
attestation coming soon...



autonomous services are real web3 and can be more compelling

community DAOs have complete control · tokenization works without crypto wallets or friction
full tokenization can transform user communities into giant industrious virtual workforces

browse
dapps in the
ecosystem

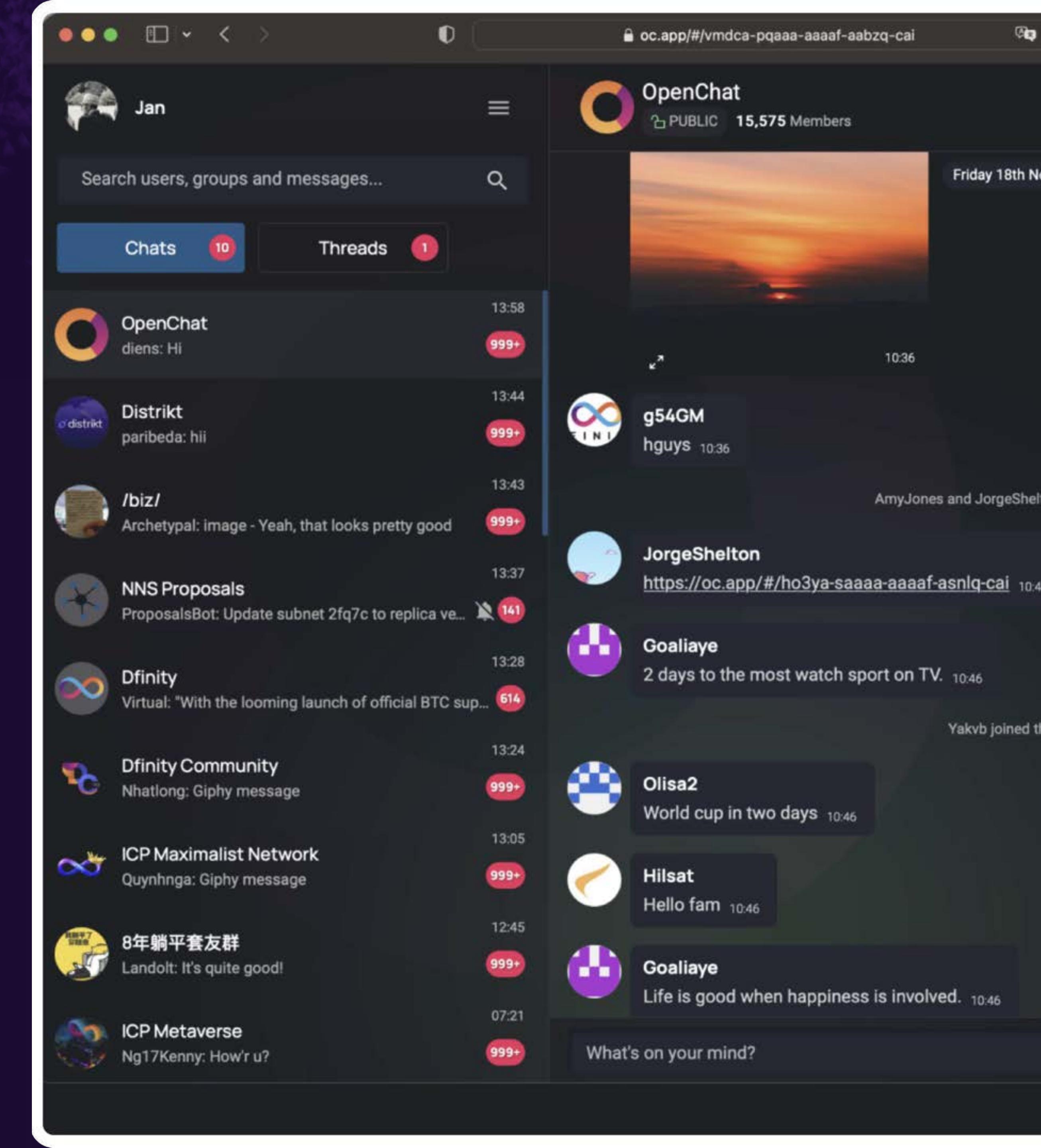




OC.app

OpenChat was the first
true “open internet service”
on the Internet Computer

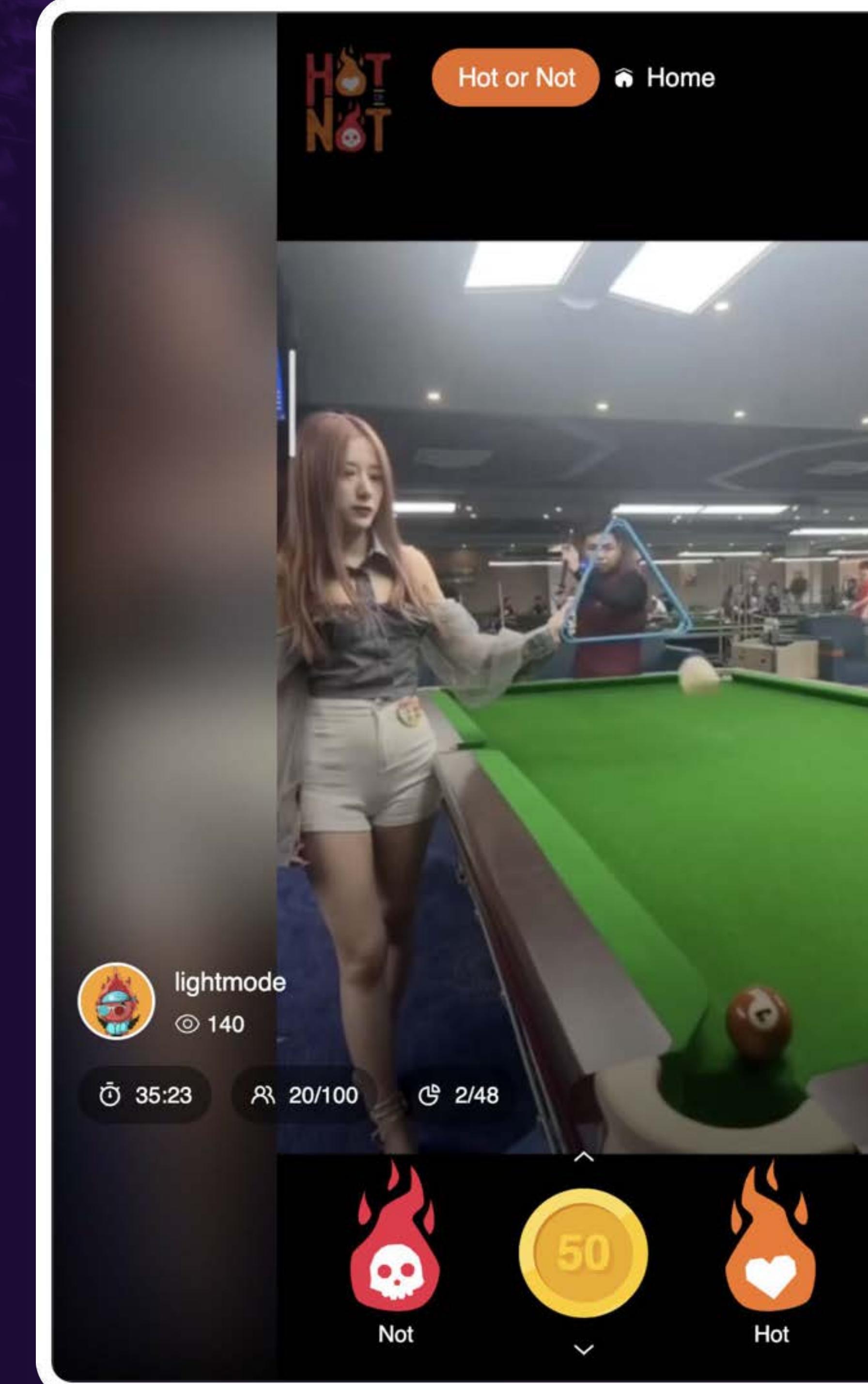
- ✓ messaging service runs 100% on network
- ✓ chat accounts are also crypto wallets i.e. full SocialFi
- ✓ seamlessly send satoshis using chat messages
- ✓ users hold governance tokens (called CHAT)
- ✓ bounties for users promoting OpenChat
- ✓ rewards for those creating viral content
- ✓ updates pass transparently through governance
- ✓ runs as protocol with an SNS in full control
- ✓ “communities” feature is alternative to Slack



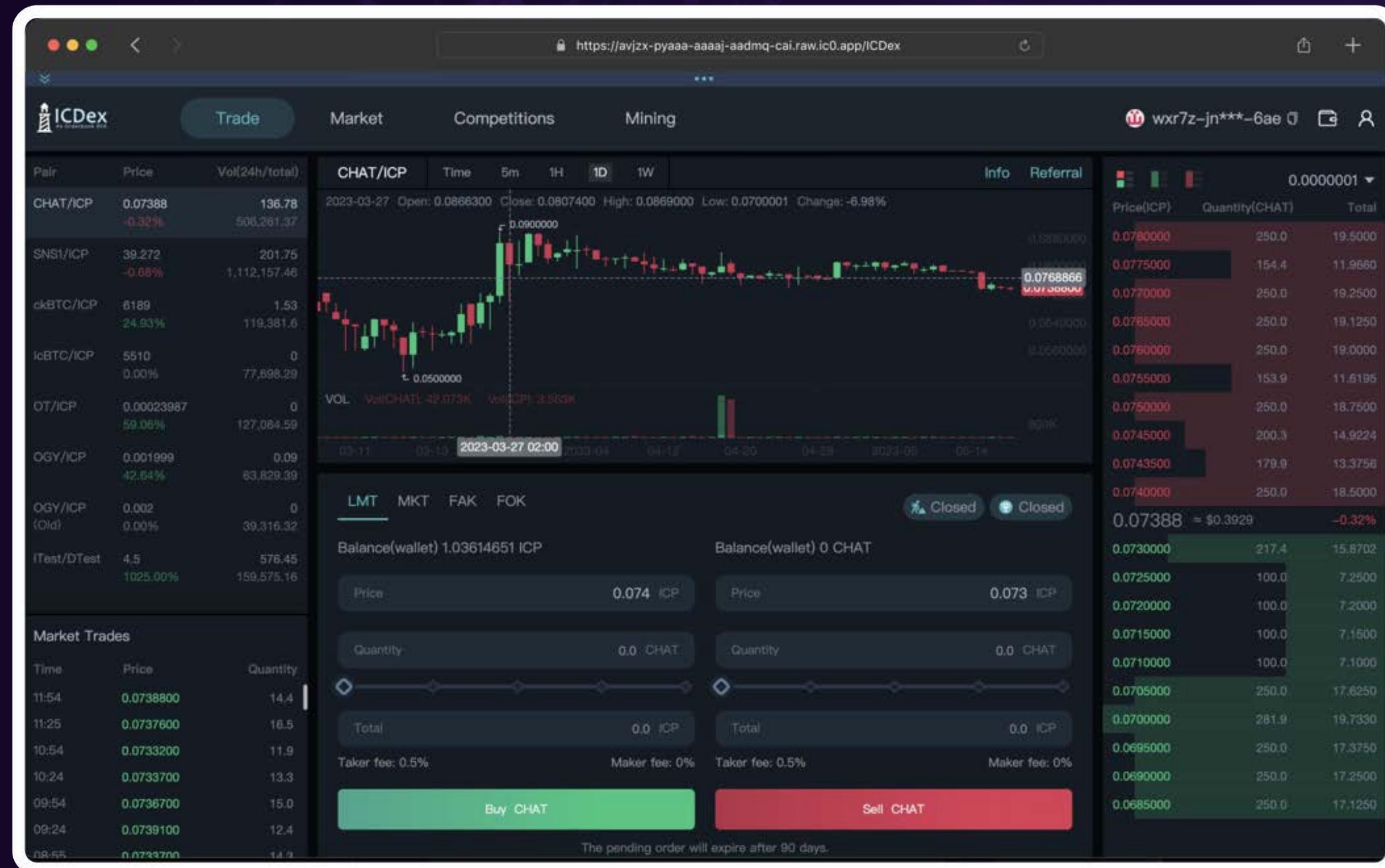


HotOrNot.wtf

- ✓ tokenized TikTok built on the network
- ✓ creates an ingenious decentralized economy
- ✓ users bet HOT on whether videos will go viral
- ✓ users help with content moderation too
- ✓ creators of viral videos get HOT tokens
- ✓ eventually, advertisers will pay with HOT tokens
- ✓ the OIS inverts centralized business models...
- ✓ video creators and users are made into founders
- ✓ runs as protocol with an SNS in full control



ICDEX.io – an order book exchange that is a smart contract



- ✓ • Built exclusively from tamperproof canister smart contracts
- SNS DAO can make transparent and autonomous

web3 pioneers are building a bright new future on the Internet Computer

join the movement



W E B 2

TikTok

Gmail

reddit

FTX

Telegram

X

Spotify

KICKSTARTER

eventbrite

GoDaddy

Dropbox

W E B 3

HOT OR NOT

DMAIL

DSCVR

ICDex
An Orderbook DEX

OpenChat

distrikt

CANISTORE

Funded

CATALYZE

ICNS
ICNAMING

IC-Drive



services built differently...

real world experience demonstrates a giant leap forward



no cloud. no database servers.

web3 services can be built entirely from canister code:
the network is the tech stack



no firewalls or SIEM logging...

web3 services don't need firewalls to protect them:
canister software is tamperproof software



cool services. tiny tech teams.

web3 services are sophisticated and scale to large numbers of users, but:
far fewer engineers are required to create them



enterprise

the Internet Computer can deliver tremendous
advantages to the enterprise sector



building with canister software significantly reduces IT personnel spend

LEGACY IT STACK

developers, administrators, security team, maintenance...

2024

\$1.8 trillion

Gartner Research

CANISTERS



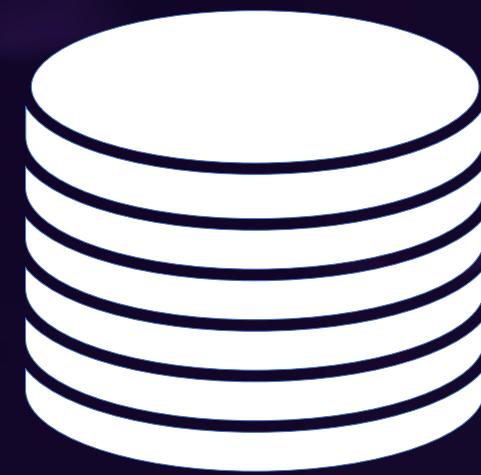
-75% complexity

\$1.35 trillion in potential savings
if everything was built using canister software



REDUCE

the Internet Computer stack addresses numerous core IT costs



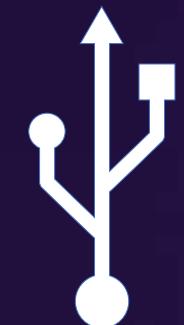
Gartner Research
Software (e.g. databases)

2023
\$912 billion



Gartner Research
Cloud services

2023
\$600 billion



Gartner Research
Data Center Systems

2023
\$224 billion



REDUCE

REDUCE

REDUCE

tamperproof systems and services address security costs



Gartner Research
Cybersecurity

2022
\$172 billion



Gartner Research
CPS incident costs

2023
\$50 billion



REDUCE

REDUCE

sovereign

countries relying on cloud infrastructure and closed-source software foundations can be spied on and even “switched off”



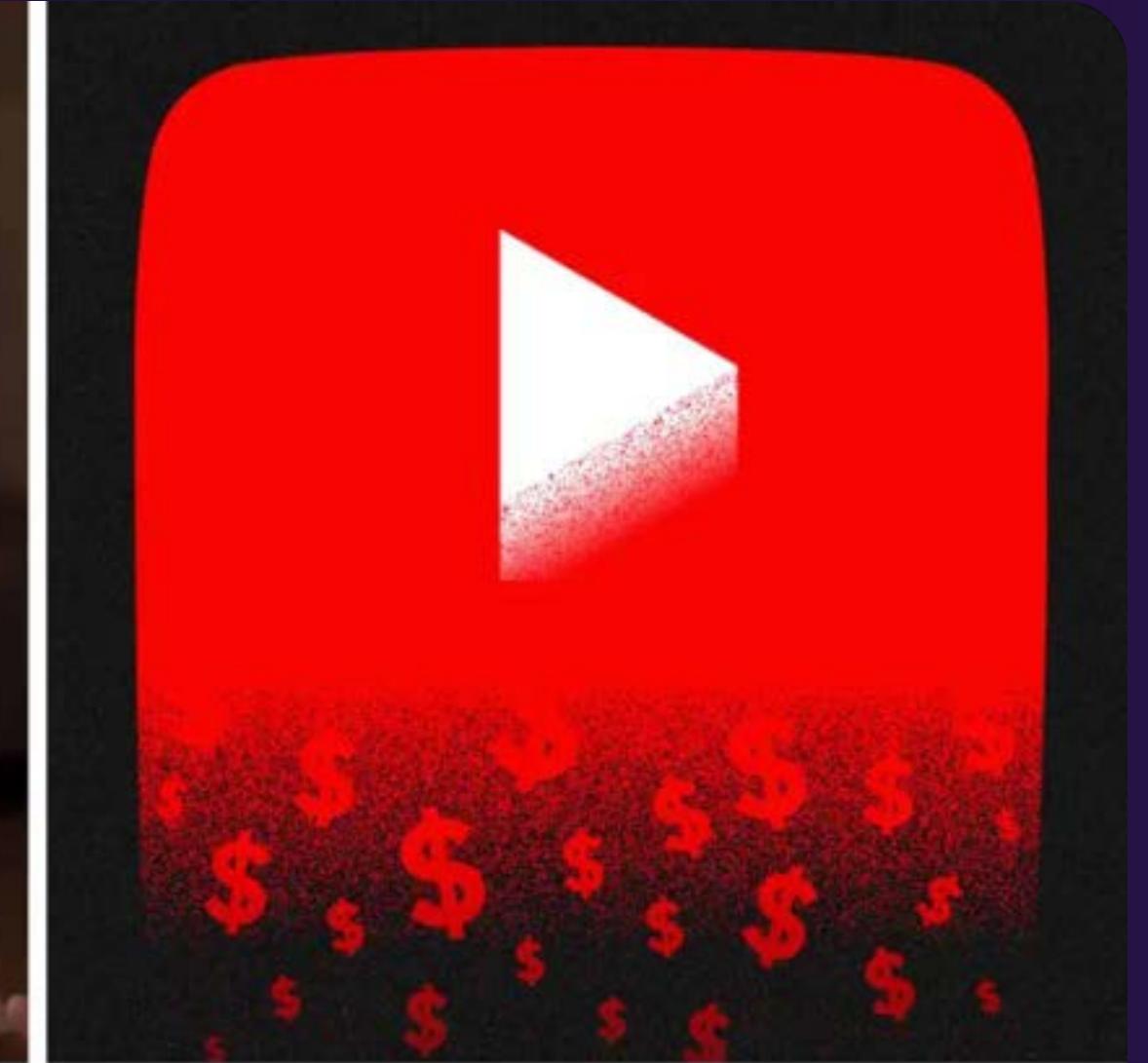
will corporations issue our future global identities...



=



“I use Google for everything”



A top YouTuber is publicly sparring with the platform after he says 'hundreds' of his fans unfairly lost access to their Google accounts

businessinsider.com



depend on corporations?

the world needs tamperproof *open* solutions



**sovereign societies cannot depend on digital foundations in which
other states might have kill switches and backdoors**



- ✗ cloud computing services
- ✗ closed-source software

- ✗ SSO (single sign-on)
- ✗ security infrastructure

sovereign subnets coming

the Internet Computer network will create geographically-local specialized sovereign subnets for nations



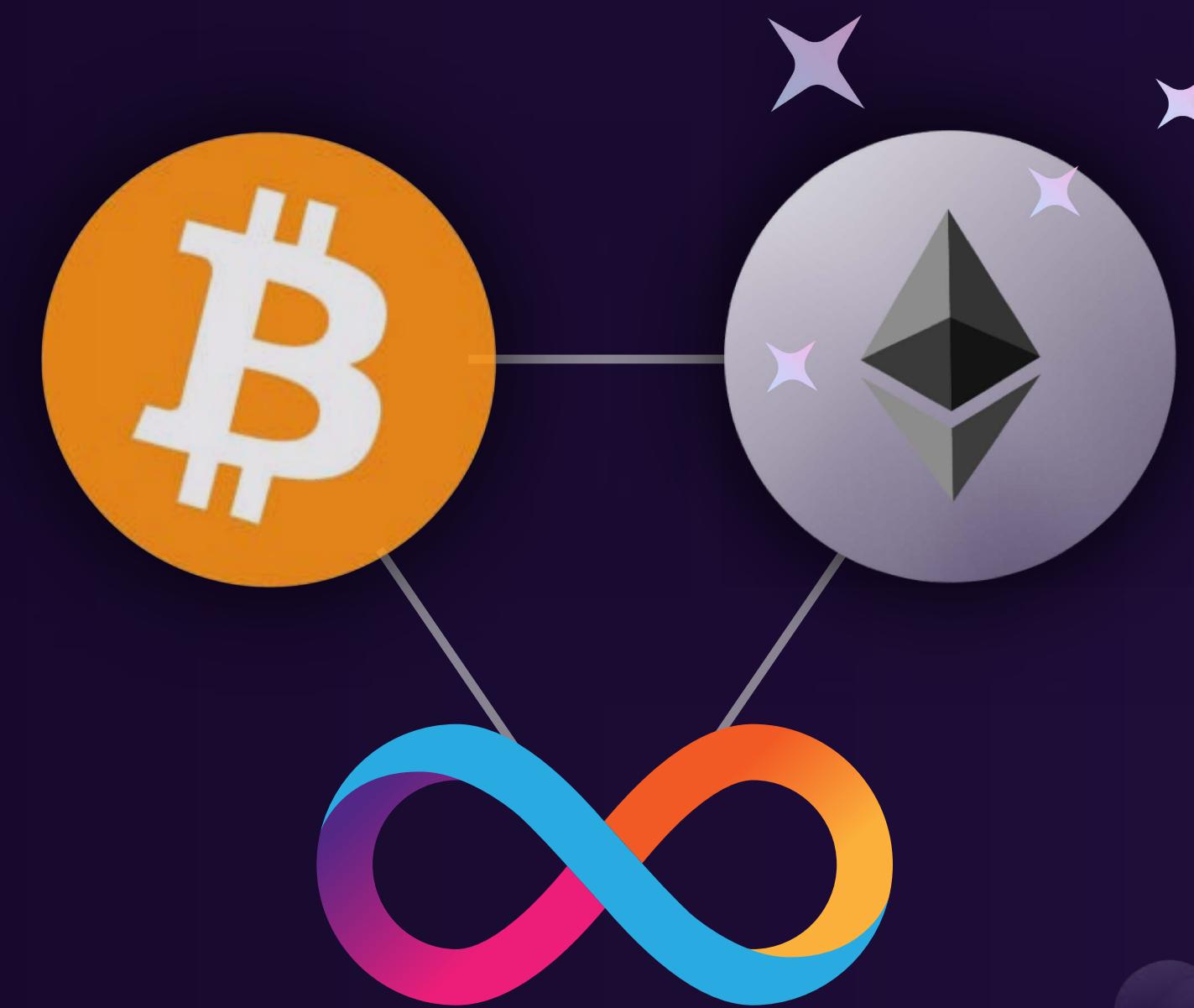
no insecure centralized
bridges, just trustless
cryptography

multi-chain

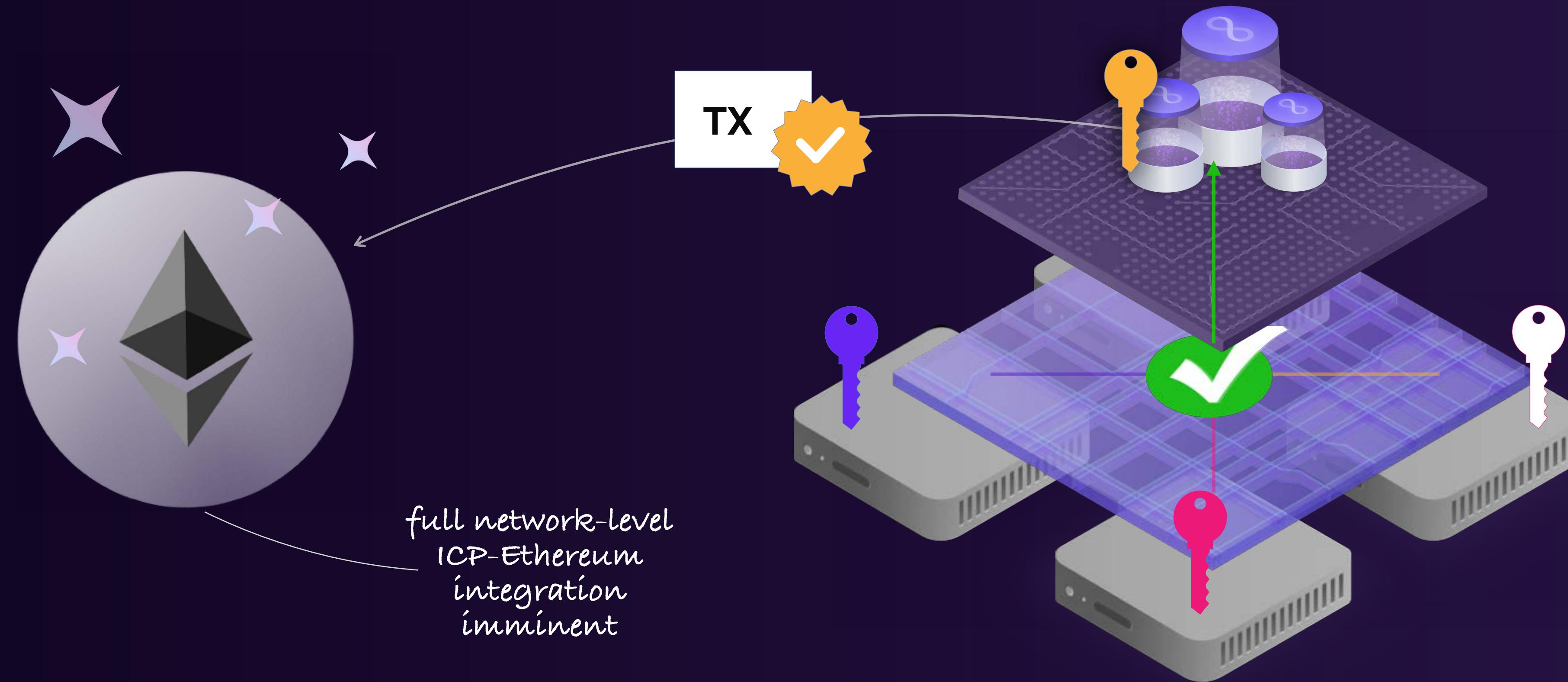
“chain key cryptography” creates transactions on other chains.
network-level integrations with Bitcoin and Ethereum



Internet Computer enables the World Computer vision from 2014

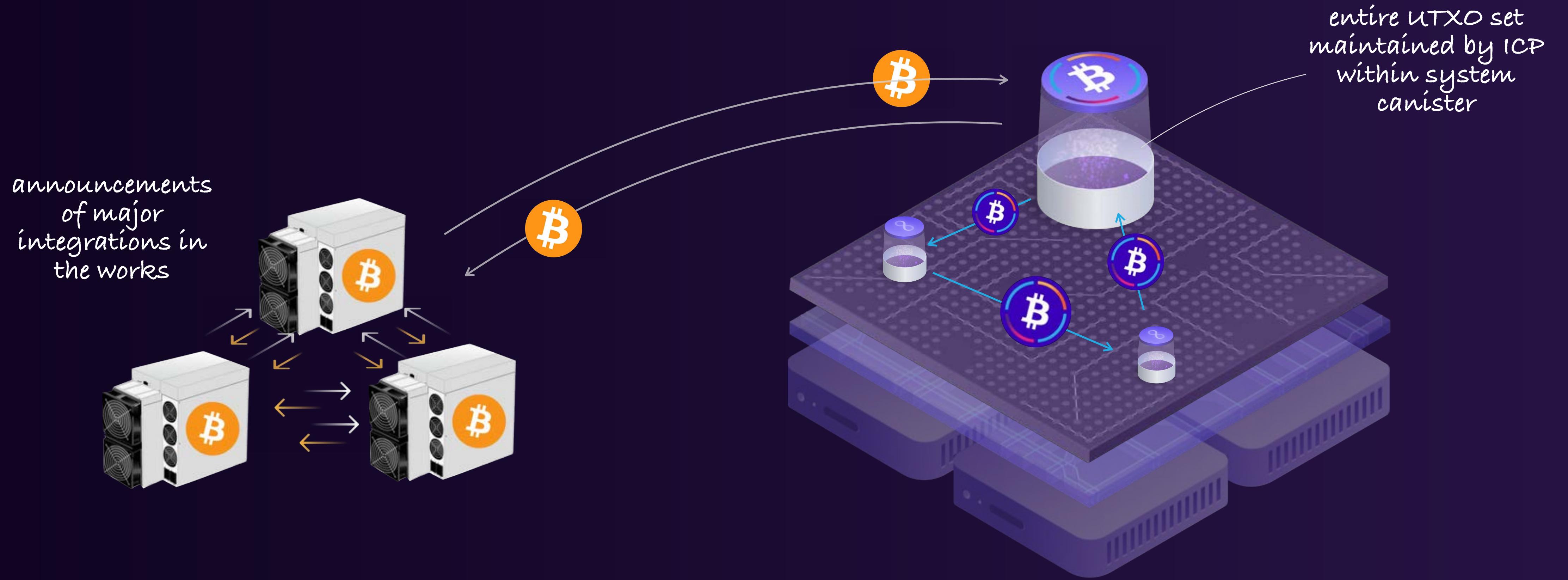


canisters create accounts and sign TXs on other blockchains



signing performed by chain key cryptography – without need for traditional private keys

ckBTC is a bitcoin twin that can be directly processed by canister code



chain-key bitcoin supports bitcoin DeFi, social media, games, and metaverse TX with 1s finality

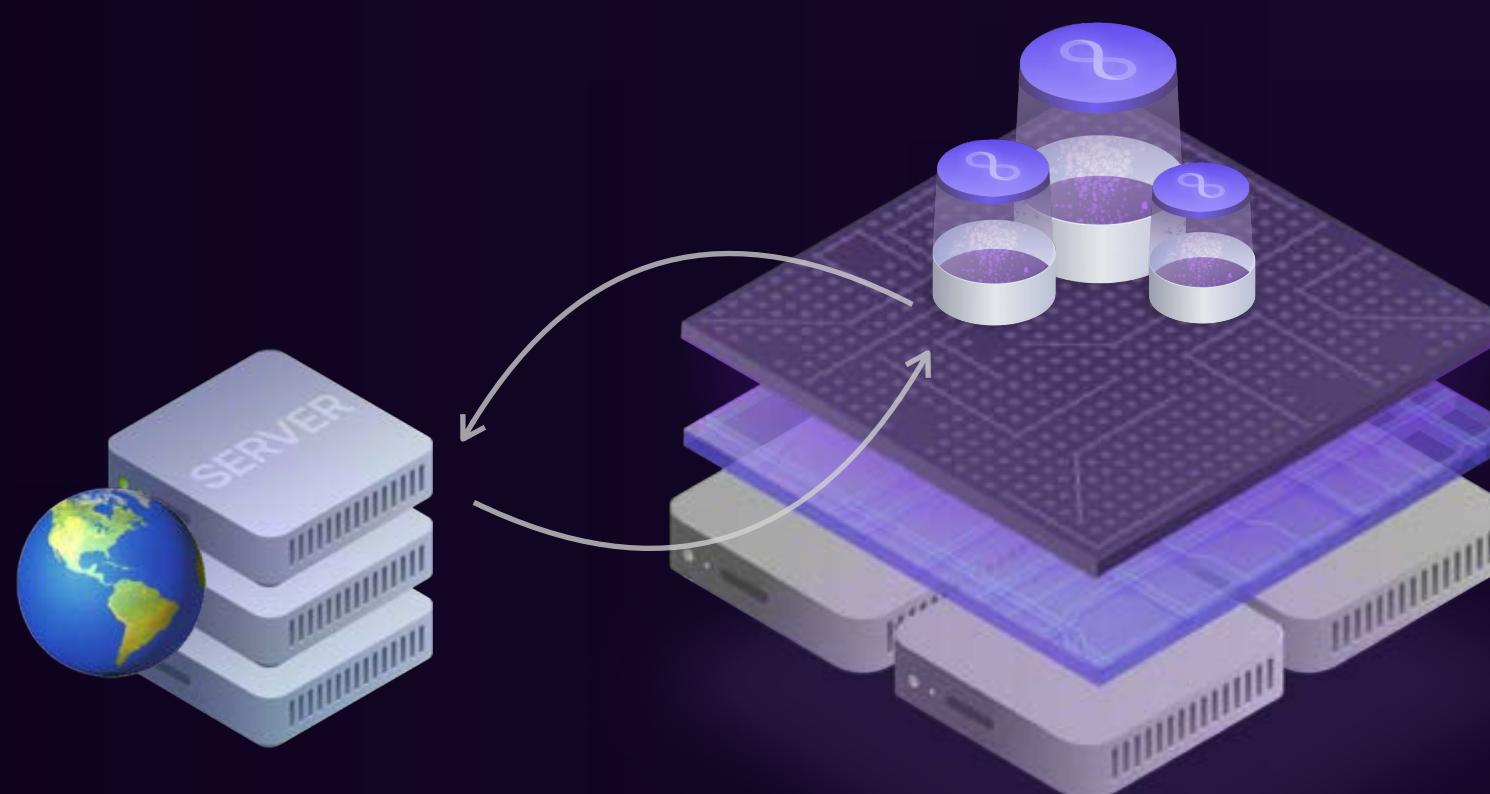
web2+3

canister smart contracts can trustlessly call into external web2 systems – the network passes results through consensus

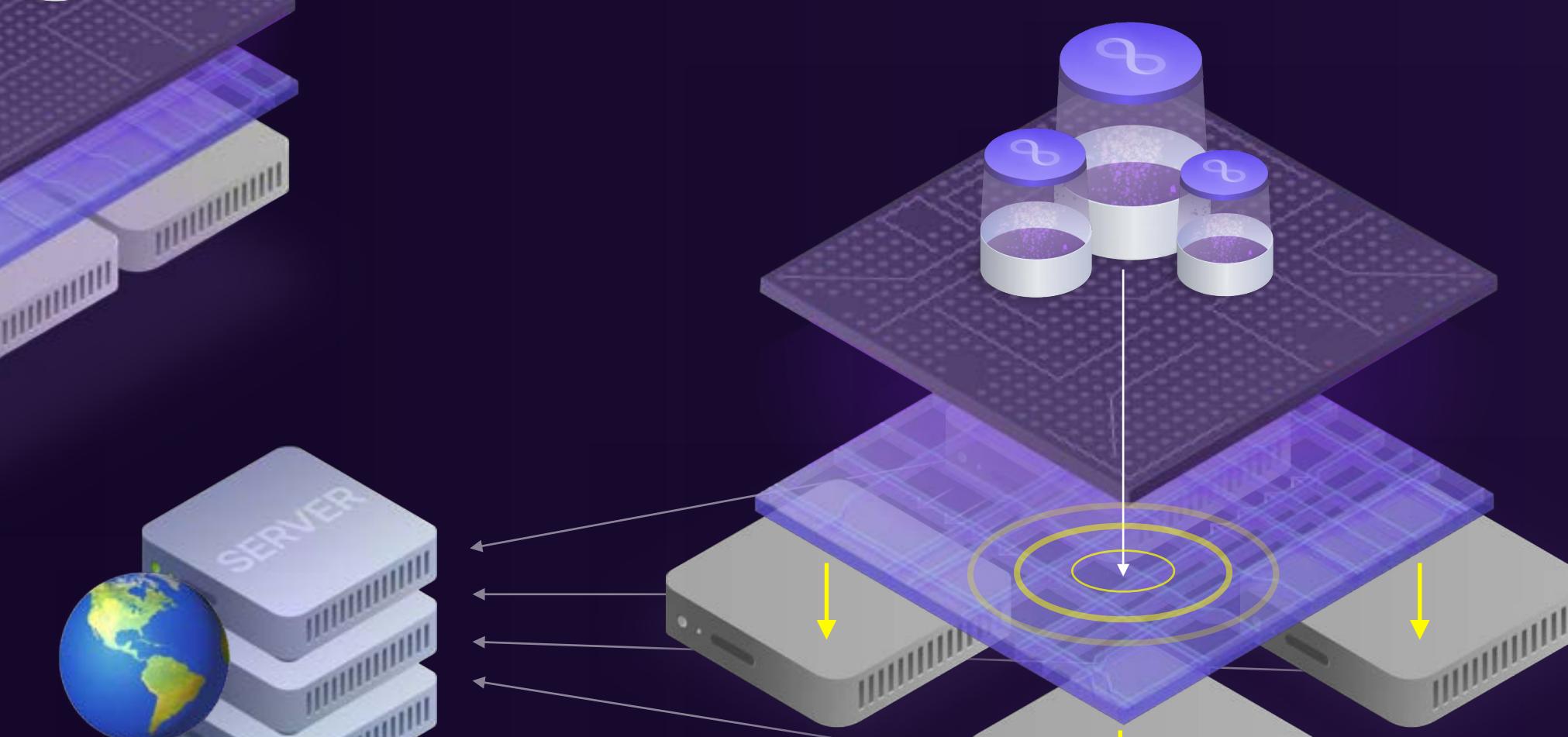


canister code can directly request web2 data without using a trusted oracle service

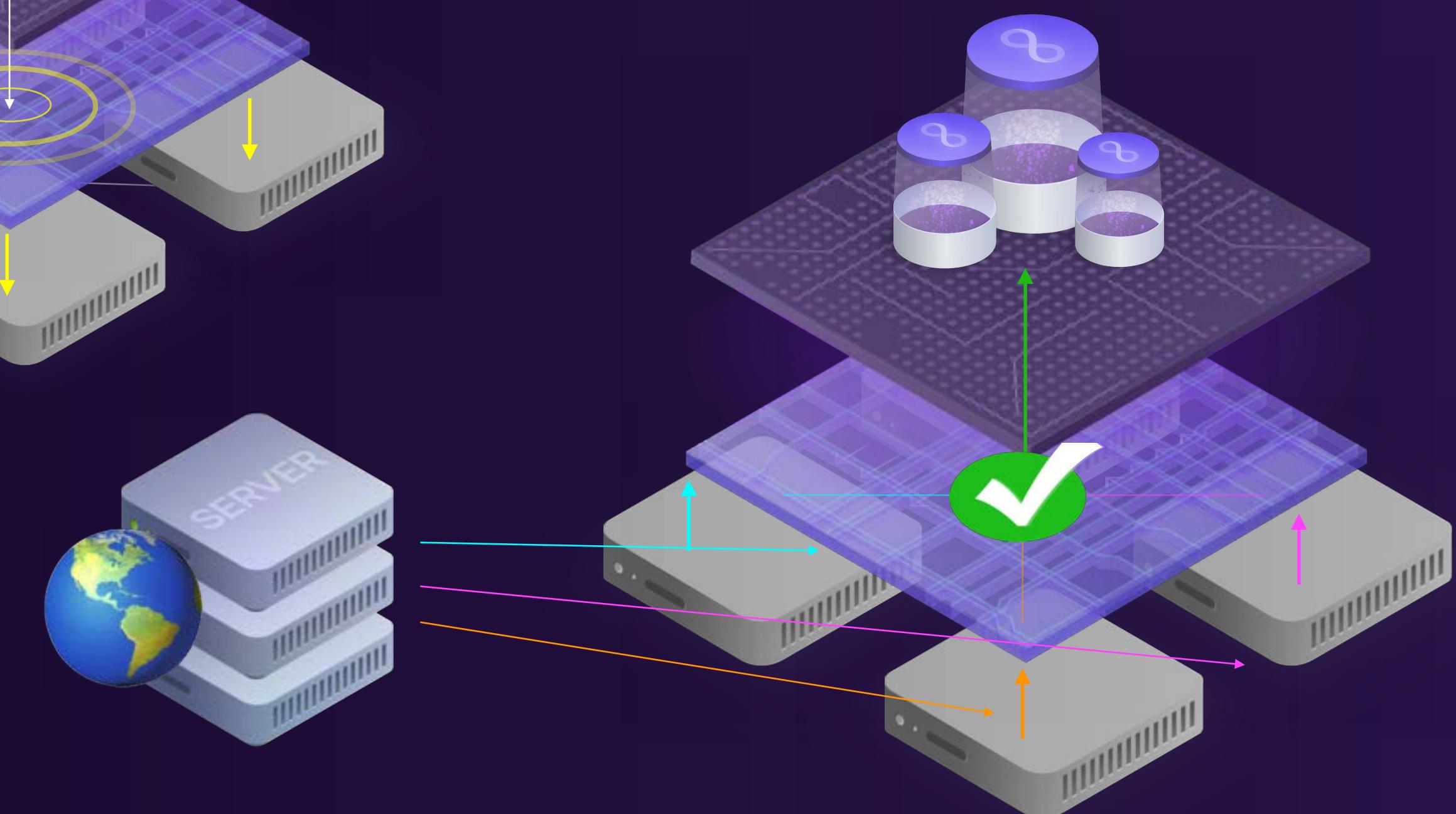
1
canister code initiates http call to web2



2
node machines all call the web2 url



3
subnet returns normalized result via consensus



U R L

D A T A

web3|2 will be a continuum

DeFi contracts can obtain pricing information from exchanges, enterprises can integrate ICP systems with legacy systems...



ai

ICP ai compute units under development with a pathway to support for efficient ai smart contracts

projects are already running
ai models as canister smart
contracts on the Internet
Computer



trustless models

data partitioning

web3 integration

ai

by 2030 AI will

**in the future
ai models
will analyze
nearly all our
business
data**

increase the productivity of
knowledge workers

4X

boost global productivity
creating extra value

\$200
trillion

**in the future ai
models will
generate
nearly all our
metaverse
content**

**in the future
ai models
will be inside
systems e.g.
compressing
media data**



mission

see the majority of the world's systems and services
reimagined on a public World Computer



organic Internet Computer network activity is substantial



2,011,578,950

Blocks processed

36 parallel subnets

37.1 MB/s block throughput capacity

Throughput

Capacity horizontally scales as subnet blockchains are seamlessly combined into one unified blockchain. Blocks and transactions per second are unbounded.

259,954

ETH equivalent TX/s

4,754 Transactions/s

Comparing transactions

Transactions invoke "actor" canister smart contract computations, which subnet blockchains can run concurrently (yet deterministically).



DFINITY Foundation

- emerged from early Ethereum community in 2015
- DFINITY Foundation established October 2016
- Swiss not-for-profit foundation, not a corporation
- world's largest team of cryptographers
- over 140 employees in Zürich HQ
- 270+ team members globally

1600+

research papers

100 000+

academic citations

250+

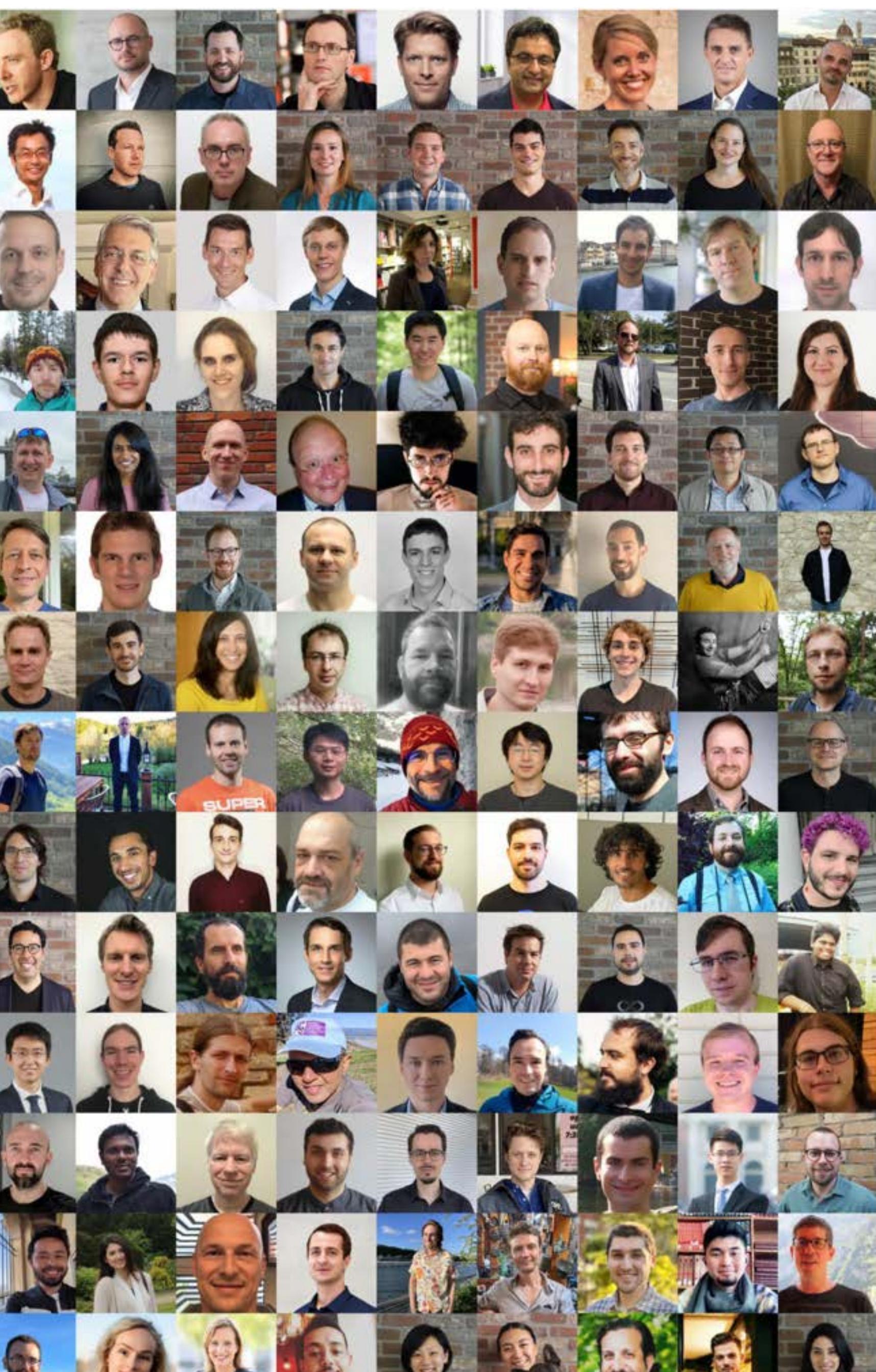
technical patents

early blockchain
community +

Google

IBM

facebook



build on the network

<https://internetcomputer.org>

PARTNERSHIPS

partnerships@dfinity.org

COMMUNITY

community@dfinity.org

GRANTS

grants@dfinity.org

PRESS

comms@dfinity.org

make
everything
web3

