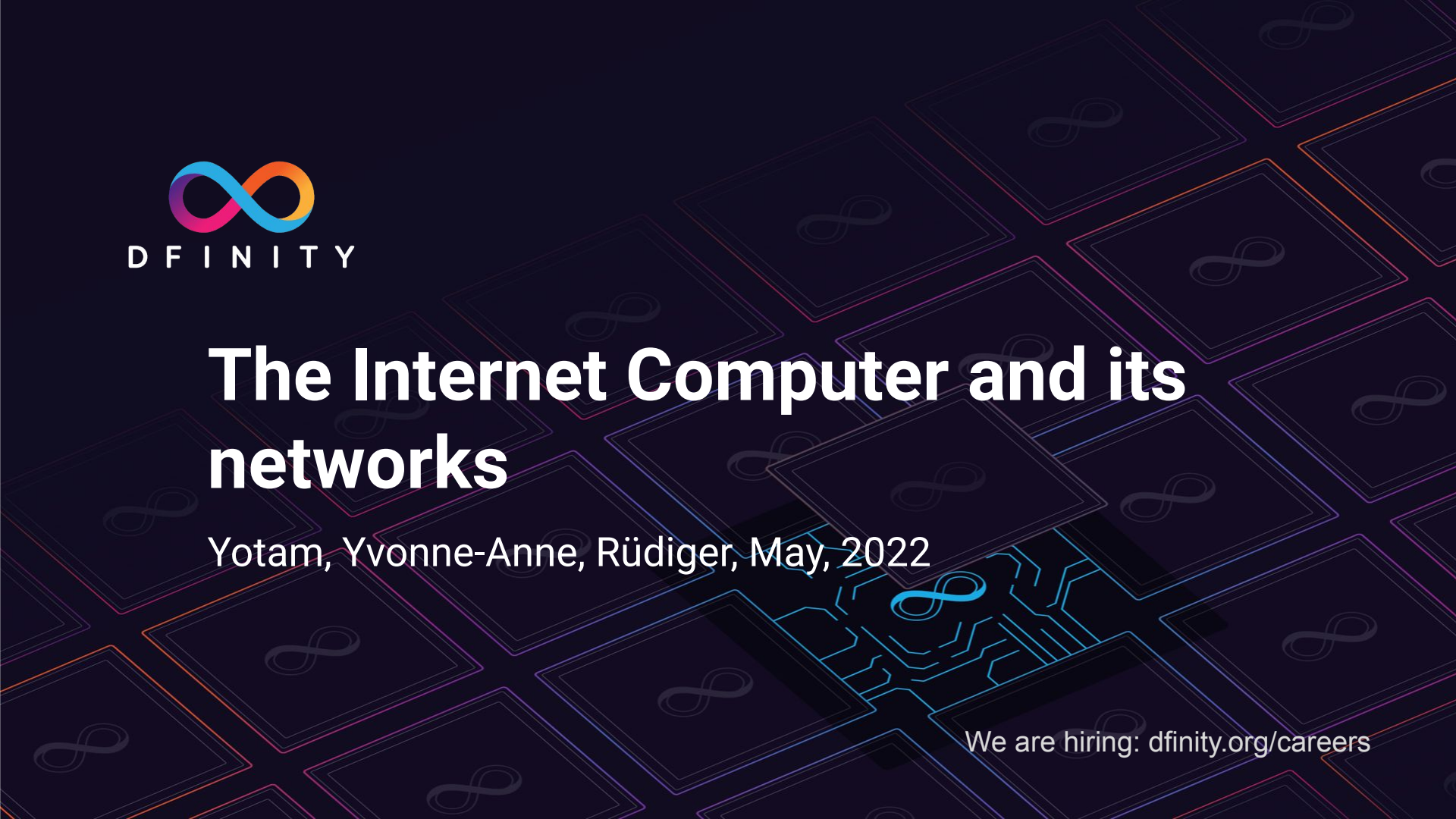

The Internet Computer and its networks

Yotam, Yvonne-Anne, Rüdiger, May, 2022

We are hiring: dfinity.org/careers

Agenda

1) What is the IC?

2) What are its networking patterns and requirements?

3) Q&A for collaboration / applicability of SCION / Anapaya

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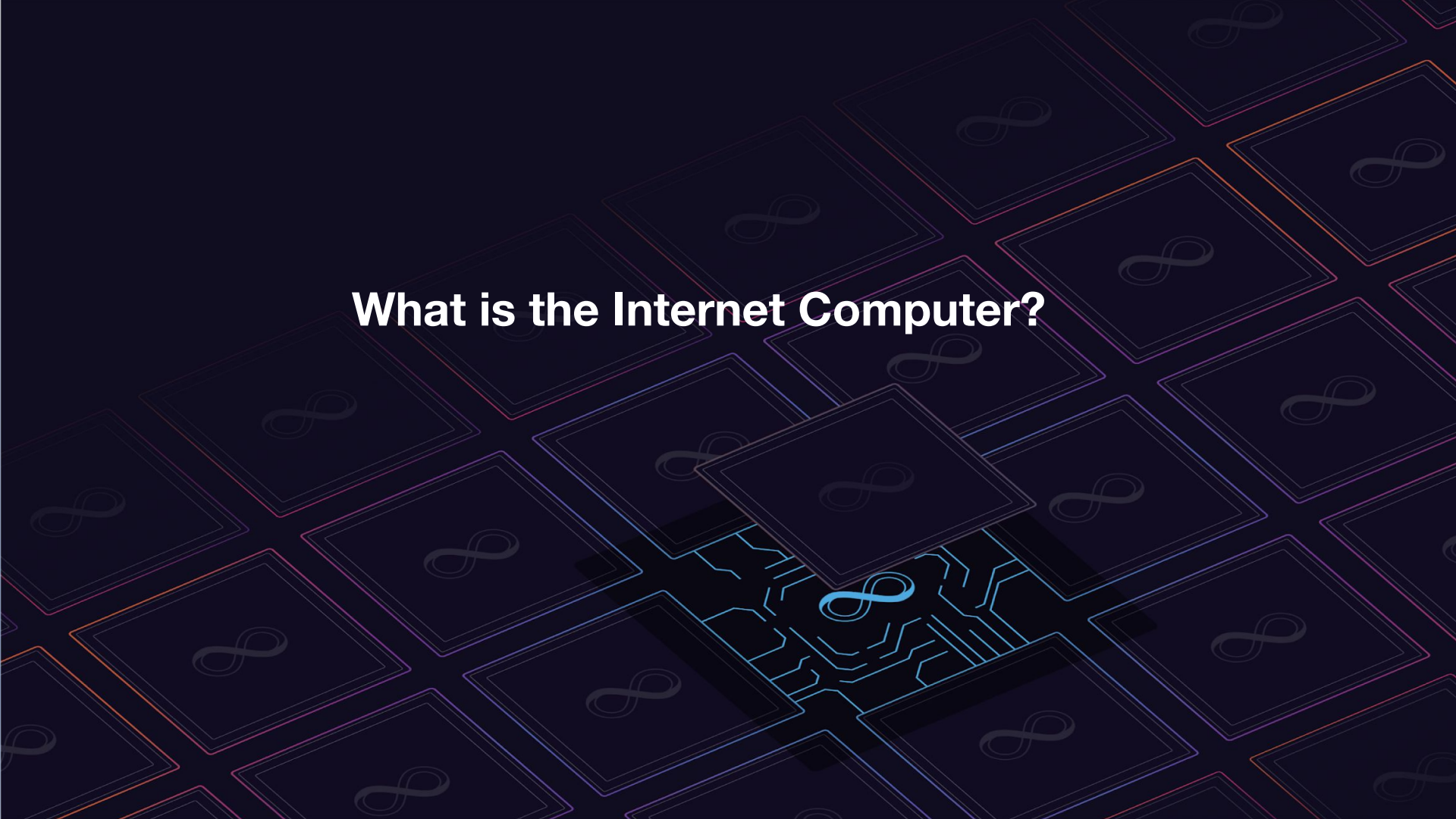
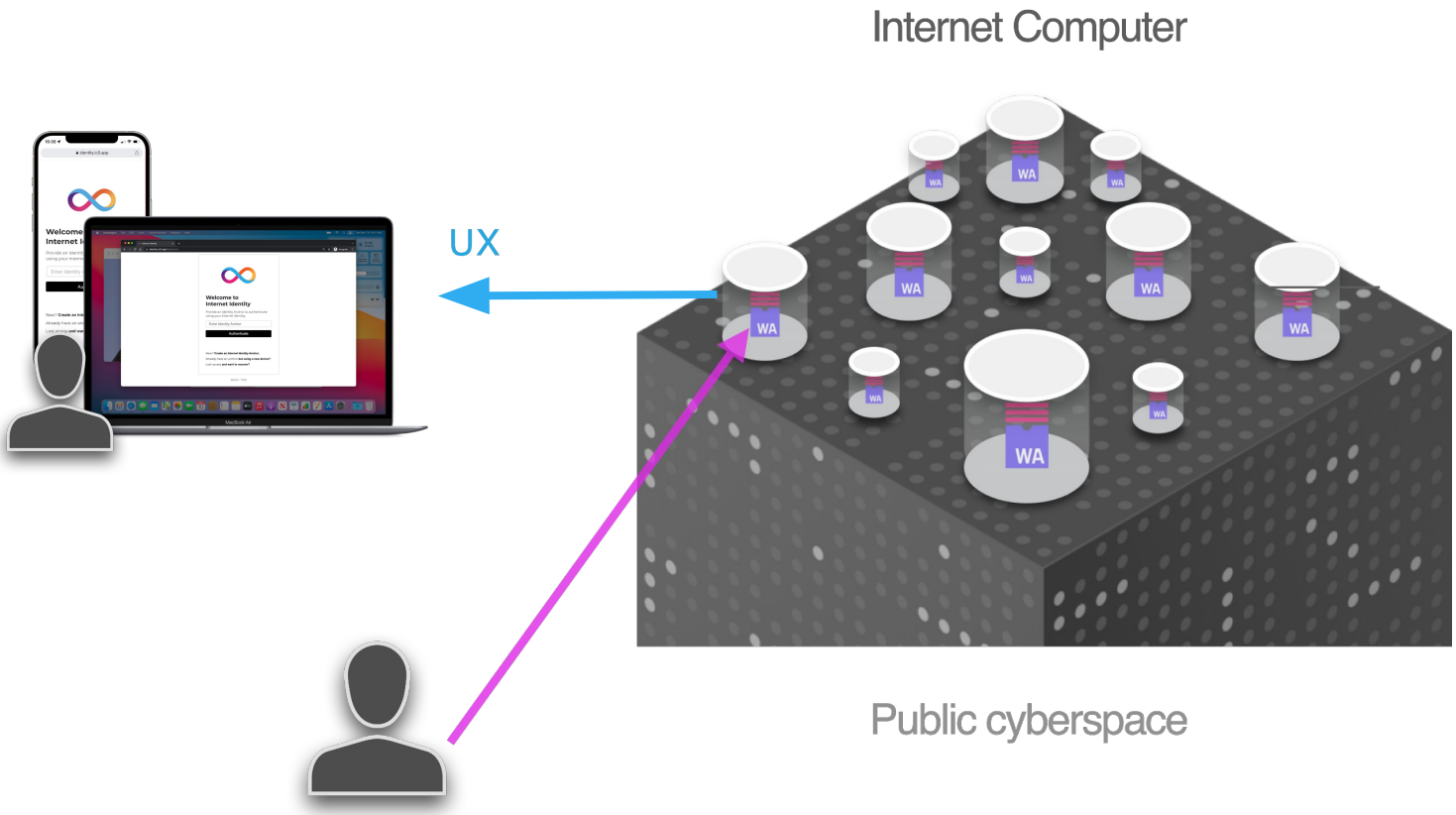
What is the Internet Computer?



What is the Internet Computer?

Platform to run any computation, using blockchain technology for decentralisation and security

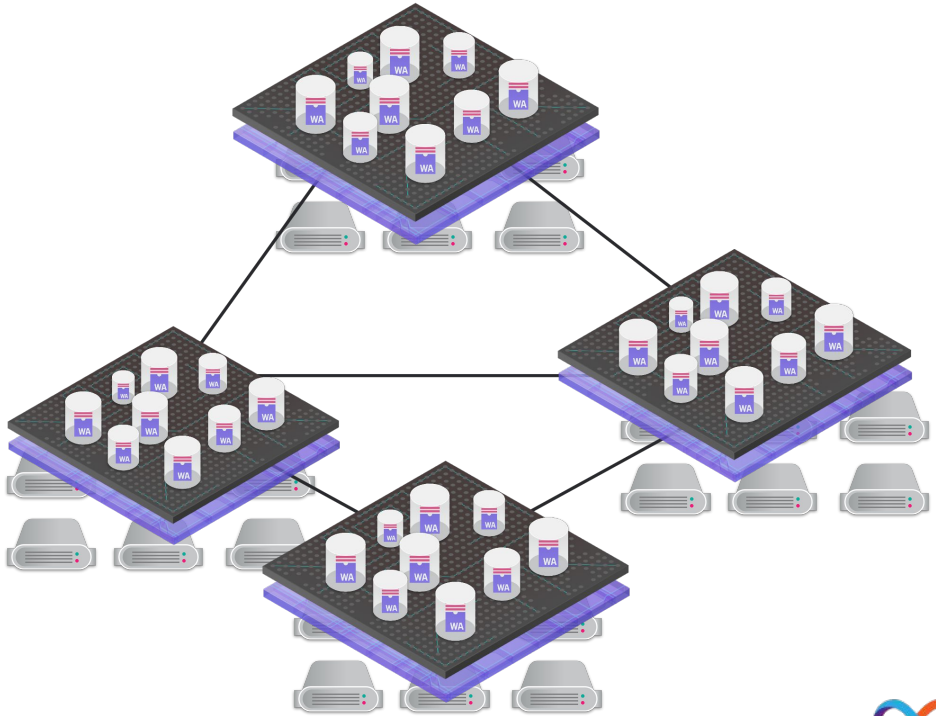
Developers and users interact directly with Canisters



Scalability: Nodes and Subnets

Nodes are partitioned into subnets

Canister smart contracts are assigned to different subnets



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Scalability: Nodes and Subnets

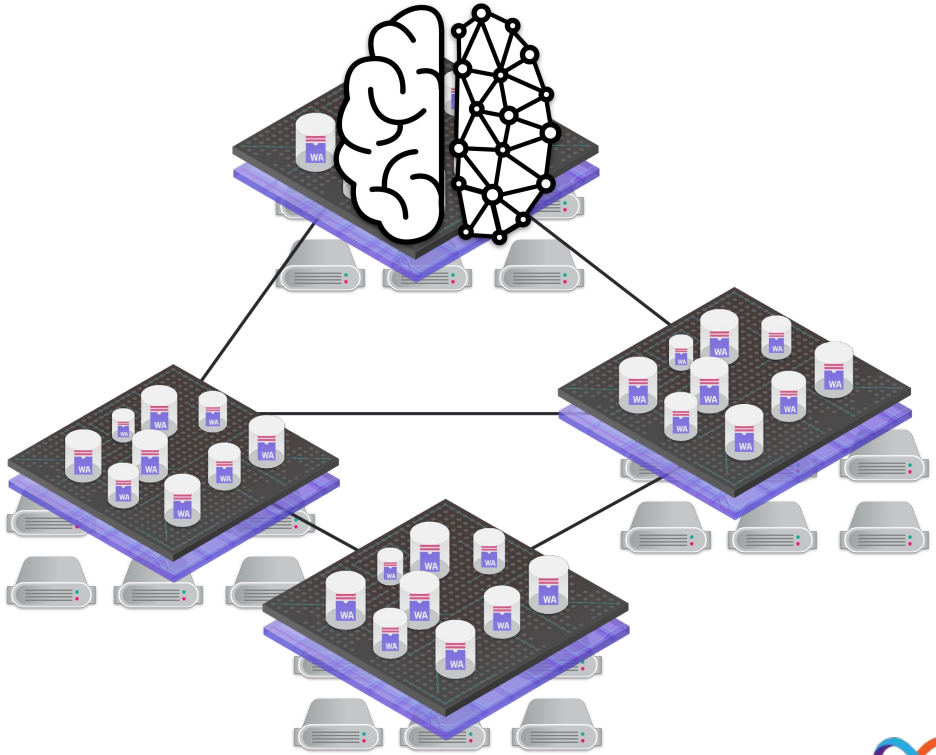
Nodes are partitioned into subnets

Canister smart contracts are assigned to different subnets

One subnet is special: it host the **Network Nervous System (NNS)** canisters which govern the IC

ICP token holders vote on

- Creation of new subnets
- Upgrades to new protocol version
- Replacement of nodes
- …



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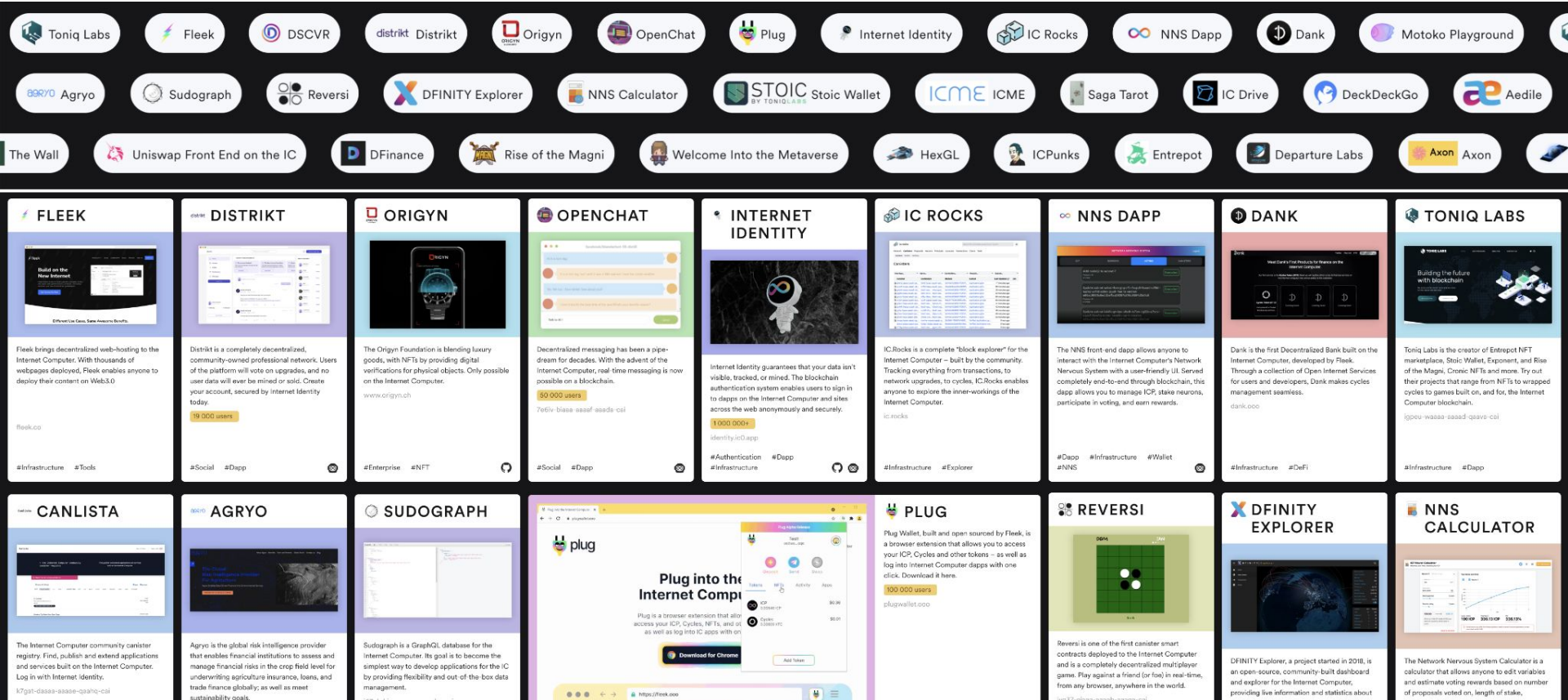
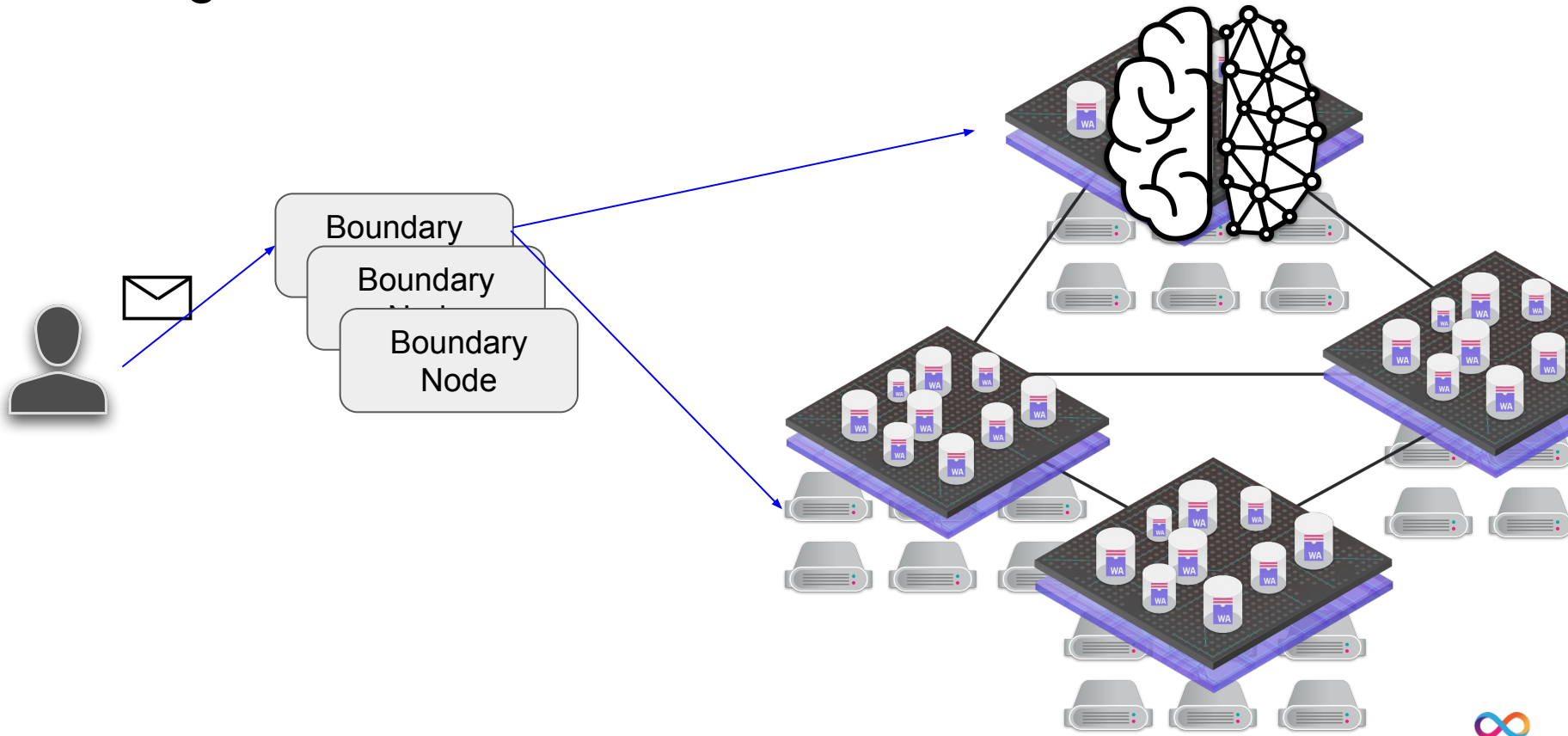
Fast Growing Ecosystem



IC Networking

Following a canister call



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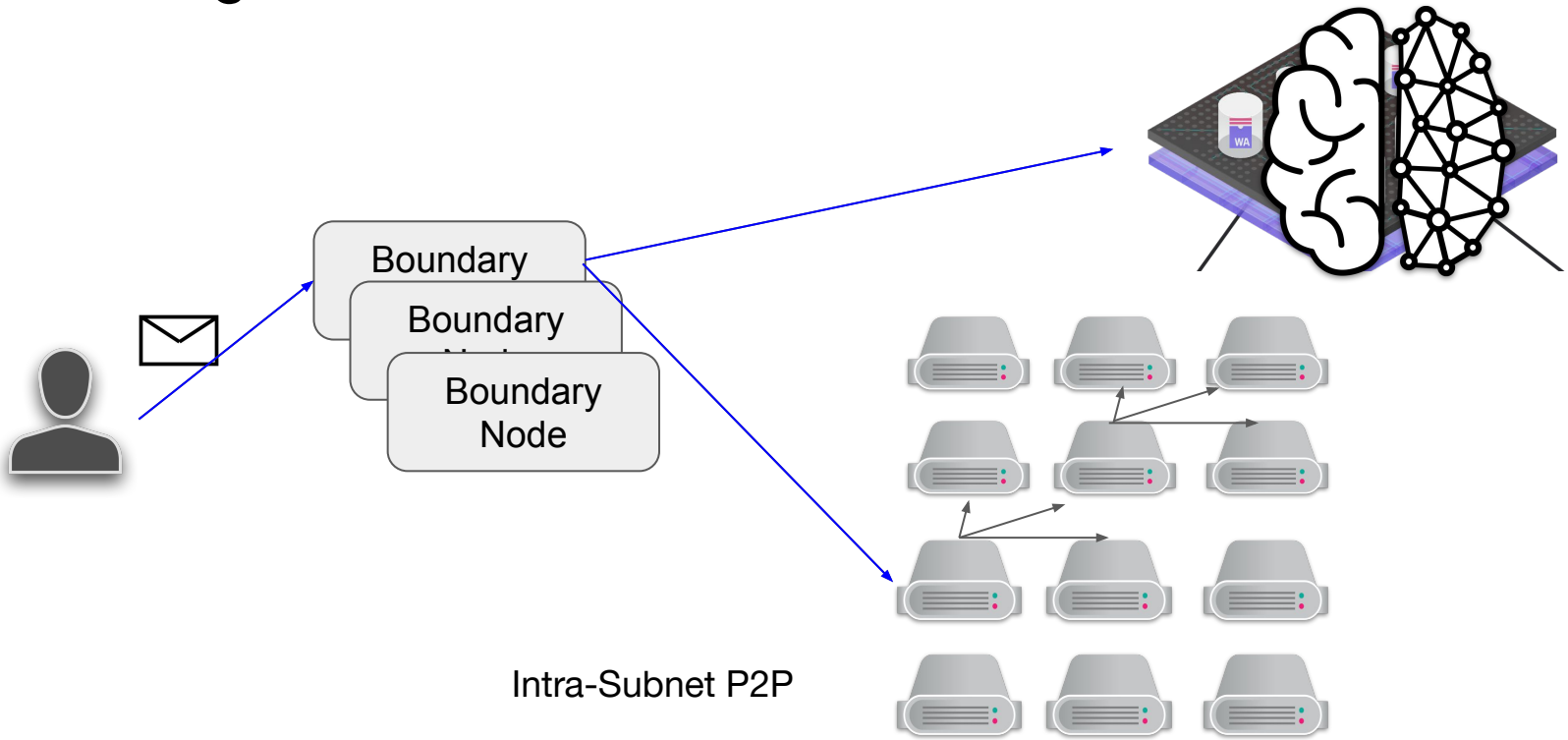

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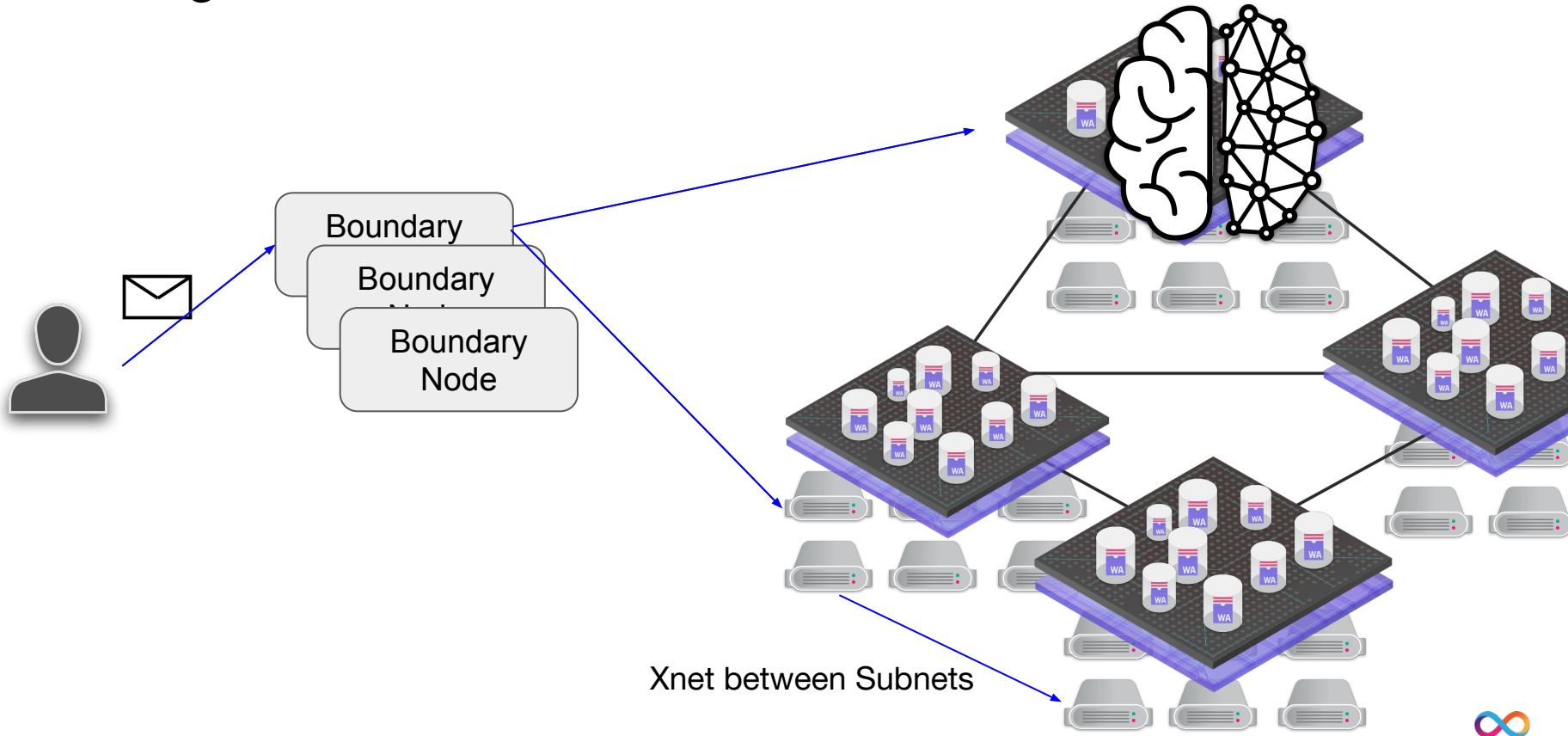


Requirements 1/2

- **Bounded-time/eventual delivery despite Byzantine faults**

Up to a certain maximum volume of valid artifacts that are not dropped by any honest node reaches all honest nodes in bounded time/eventually despite attacks (under certain network assumptions).

- **Reserved resources for different components/peers**

Memory/bandwidth/CPU guarantees for different components and peers

- **Prioritization for different artifacts**

Not all artifacts are equal, different priorities depending on attributes (e.g., type, size, round,...). Priorities change over time.

Requirements 2/2

- **High efficiency**

High throughput is more important than low latency

Avoid duplicates: don’t waste bandwidth downloading same artifact “too many times”

- **DOS/SPAM resilience**

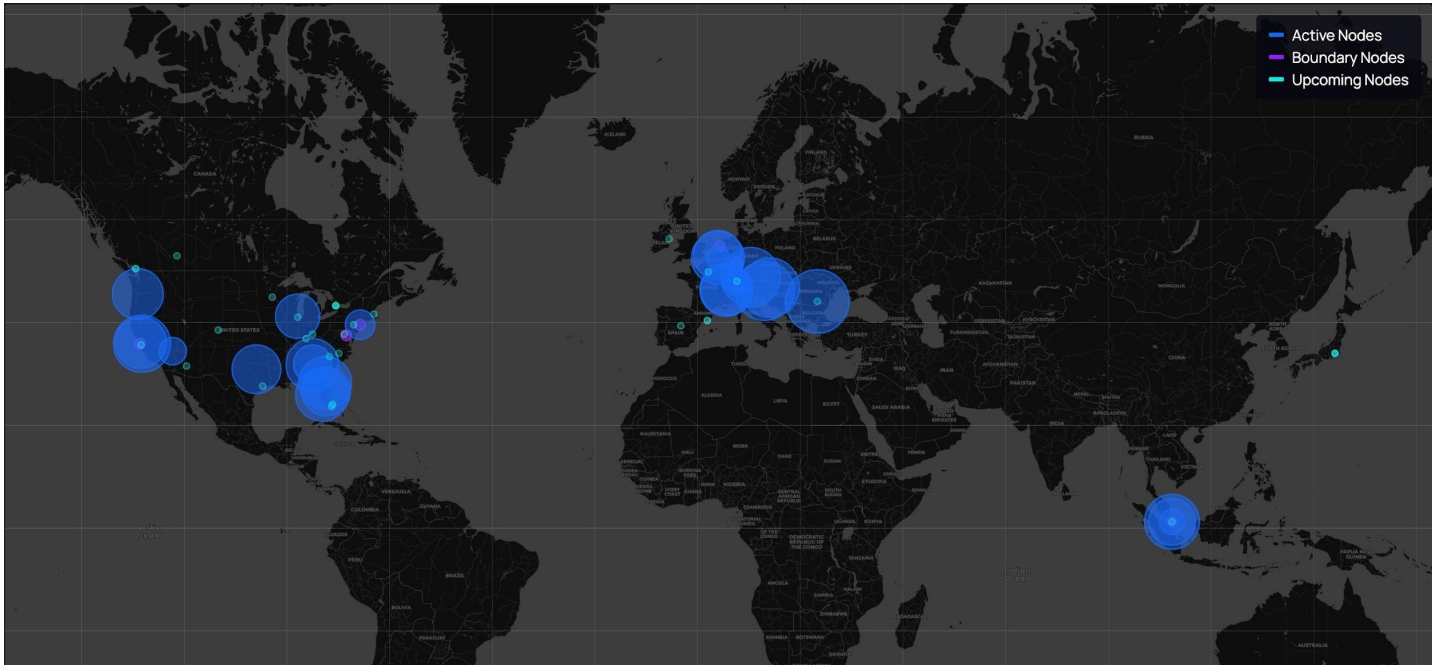
Bad participants cannot prevent progress.

- **Low accessibility requirements for users**

Support browser and IPv4 access

Networking of the IC

- **Geographically distributed**: datacenters all over the world



Networking of the IC

- **Geographically distributed**: datacenters all over the world
- **Decentralized**: a subnet is composed of nodes in different datacenters
  → Some nodes in the same subnet may be very far apart
  → Independent node providers with different skills and DC contracts
  → Communication over public internet
    - High latencies possible
    - Many transient network failures
- **Secure**: a subnet should make progress even if up to ⅓ of the nodes are faulty / malicious
  → We can't trust specific nodes (e.g., geographically close by)
  → Even nodes in the same subnet should not trust each other

Intra-Subnet P2P Networking

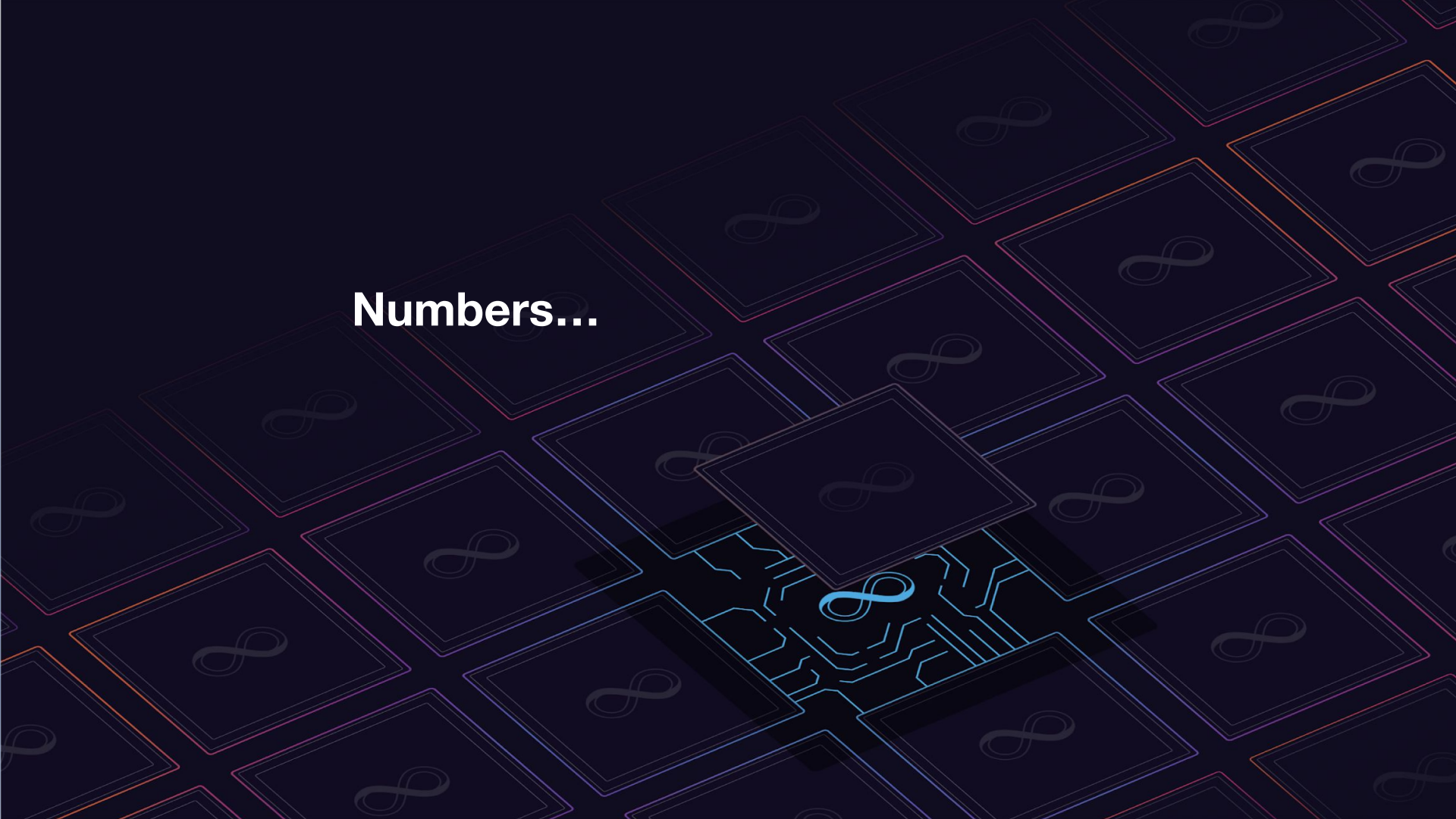
- Peer-to-peer network of nodes
  - Gossip protocol for artifact distribution
    - Advert - Request - Response
  - Eventual / bounded time delivery with priorities (~reliable broadcast optimized for Consensus)

- Untrusted communication
  - TLS / TCP to all nodes in the subnet, certificates in NNS
  - Authenticity and integrity of artifacts can be verified by higher layers
  - Nodes can still do evil

Xnet Inter-Subnet Networking

- Canisters on one subnet can send messages to canisters on other subnets, called “cross-net communication” (or Xnet)
- Currently this is done quite naively, where any node on one subnet can fetch messages from any other node on the other subnet with a HTTPS request
- We can improve this on several aspects:
  - Scalability: decide which nodes connect to which, and when
  - Performance: leverage the fact that some nodes in both subnets are close to each other (content is signed by the subnet, so we do not need to trust a specific node up to some extent)

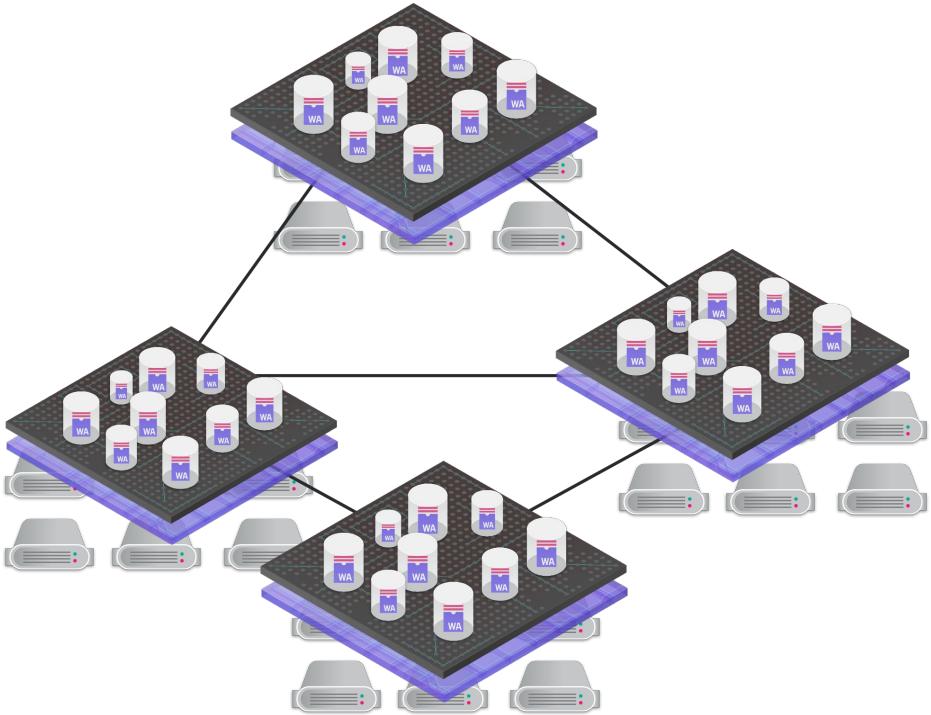
Numbers…



The IC in Current Numbers

Application Layer:

- 60K+ canisters (smart contracts/dapps)
- > 2 Mio registered identities
- ~1TB total state (and counting…)



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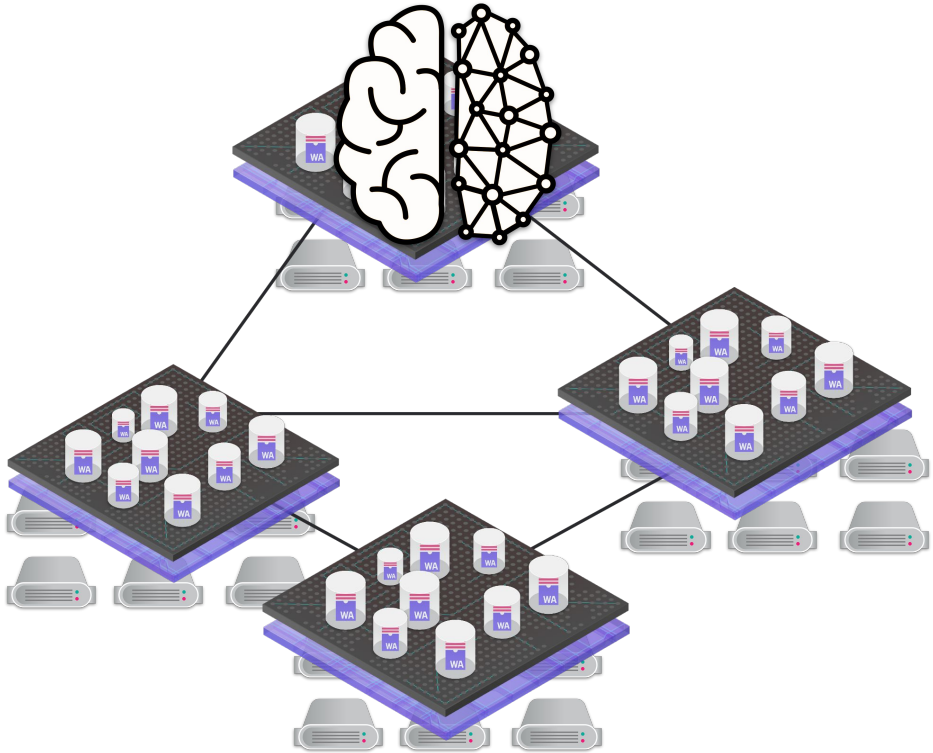
The IC in Current Numbers

Application Layer:

- 60K+ canisters (smart contracts/dapps)
- > 2 Mio registered identities
- ~1TB total state (and counting…)

Governance:

- So far:
  - 56K+ NNS proposals
  - 3.4M+ ICP transactions



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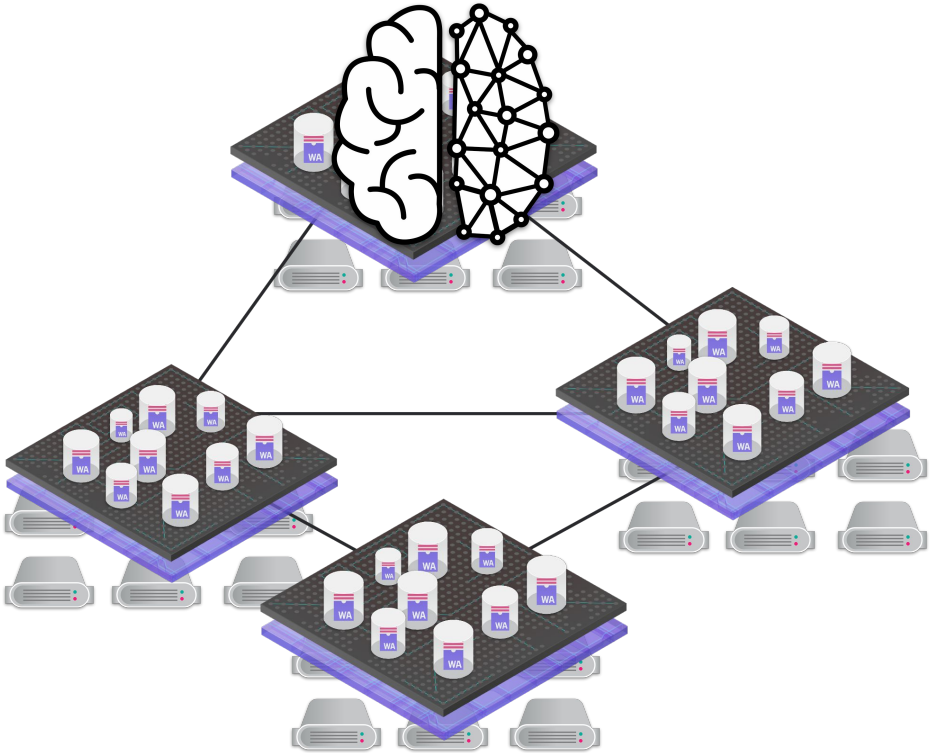
The IC in Current Numbers

Consensus

- 758M+ blocks created
- ~34 blocks per second
- ~2800 transactions per second



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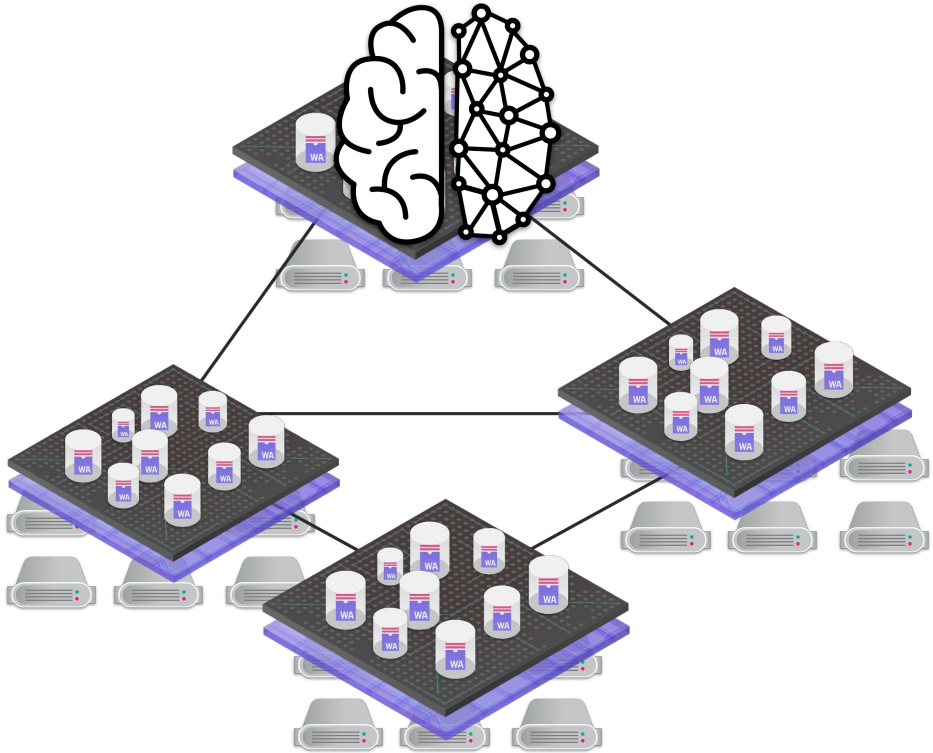
The IC in Current Numbers

Network Layer:

- 477 nodes
  - From 54 node providers
- 35 subnets
  - 40 nodes in NNS subnet
  - 13 nodes in App subnets

- Avg ⅔ dissemination latency:
  - NNS avg=1.39s, 95%=3.3s
  - App avg=0.57s, 95%=1.1s



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Testnets

DFINITY-internal infrastructure

- Deploy complete IC instances in our 5 data centers (2 more in May)
  - Chicago, San Francisco, Des Moines, Frankfurt, Zurich, ..
- Variable size and VM capabilities
- Can be used for experiments, metrics, correctness and performance tests

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yotam.harchol@dfinity.org

yvonneanne.pignolet@dfinity.org

ruediger.birkner@dfinity.org

We are hiring: dfinity.org/careers

More information

- Infographic: here
- Technical Library: here (videos of talks) and here (blogposts)
- 200,000,000 CHF Developer Grant Program here
- DFINITY SDK: here

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