The Internet Computer and its networks

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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
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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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
- …
IC Networking
Following a canister call
Following a canister call
Following a canister call

Boundary Node

Xnet between Subnets
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 $\frac{1}{3}$ 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…)

https://dashboard.internetcomputer.org/
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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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We are hiring: dfinity.org/careers
More information

- Infographic: [here](https://example.com/infographic)

- Technical Library: [here](https://example.com/library) (videos of talks) and [here](https://example.com/blog) (blogposts)

- 200,000,000 CHF Developer Grant Program [here](https://example.com/grant)

- DFINITY SDK: [here](https://example.com/sdk)