Blockchain-based Open Data: An Approach for Resolving Data Integrity and Transparency

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November 21, 2019

Contents

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Introduction

Motivation

- Building a smart city or electronic government trend.
- The security aspects of *open data* – CIA triangle.
- Centralize system disadvantage
  - => Invalid data sets for people to make bad decisions

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- Centralize system disadvantage
  $=>$ Invalid data sets led people to make bad decisions.

Here are a few famous attacks since 2008[1]:

- 2008 - Hackers infiltrate the Brazilian governments systems and inflate the logging quotas to disrupt logging industry.
- 2010 - Hackers use the Stuxnet Worm to make minor changes in Iran's nuclear power program in an attempt to destroy it.
- 2015 - Anonymous begin releasing financial reports exposing firms in the US and China trying to cheat the stock market.
- 2015 - JP Morgan Chase was breached with subsequent attempts at market manipulation.
- 2016 - Both the World Anti-Doping Agency and Democratic National Committee are breached with hackers manipulating their data to embarrass the organisations.

[1] https://www.itsecurityguru.org/2016/11/29/2017-year-data-integrity-breach/

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Open data

Definition

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"Open data is data that can be freely used, re-used and redistributed by anyone - subject only, at most, to the requirement to attribute and share alike".

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Properties

+ Technically open:
  - Accessing to data sets: unrestricted, easy.
  - Data formats: computer-readable.
+ Legally open:
  - No restrictions on use and/or redistribution

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+The government:

- Improving transparency and publicity.
- Reducing the government operation cost.

+The citizens:

- Monitoring the government operation.
- Accessing to larger data resources.

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- In terms of the law:
  - no legal violation;
  - no disclosure of economic secrets;
  - no leak of personal information;
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- In terms of the technical:
  - ensuring the availability and integrity of data.

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Types of blockchain:

- Public blockchain.
- Private blockchain.
- Consortium blockchain.

Hyperledger Fabric

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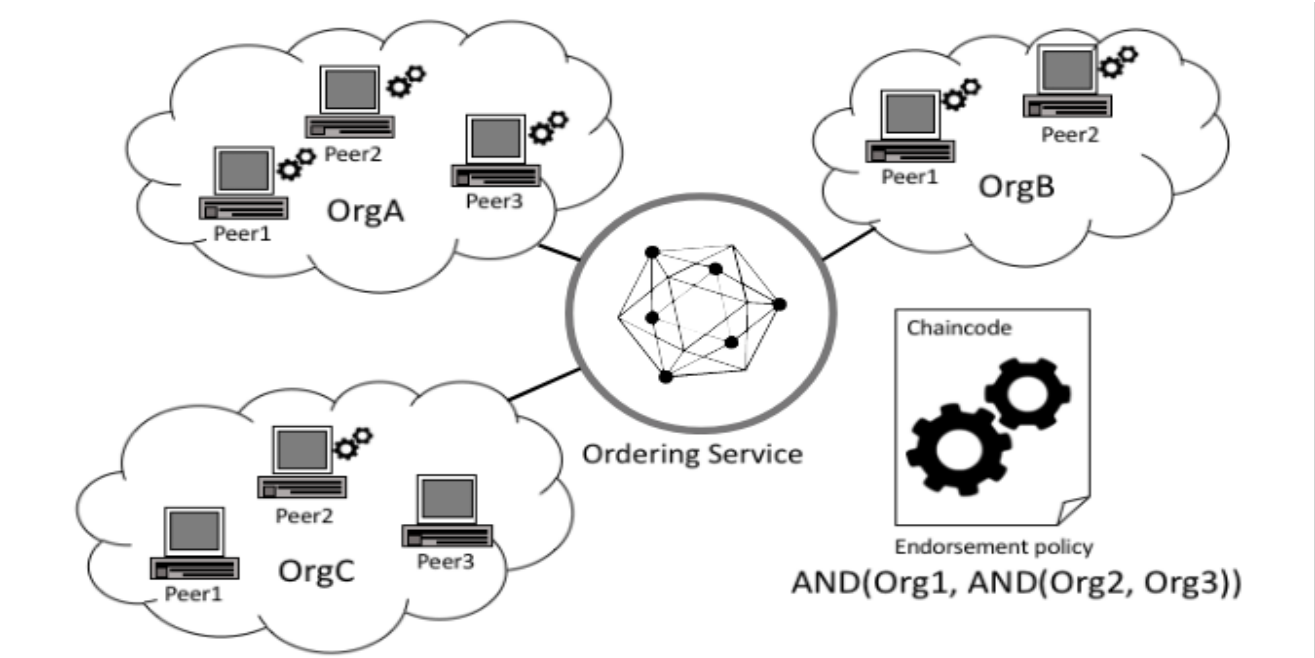

InterPlanetary File System

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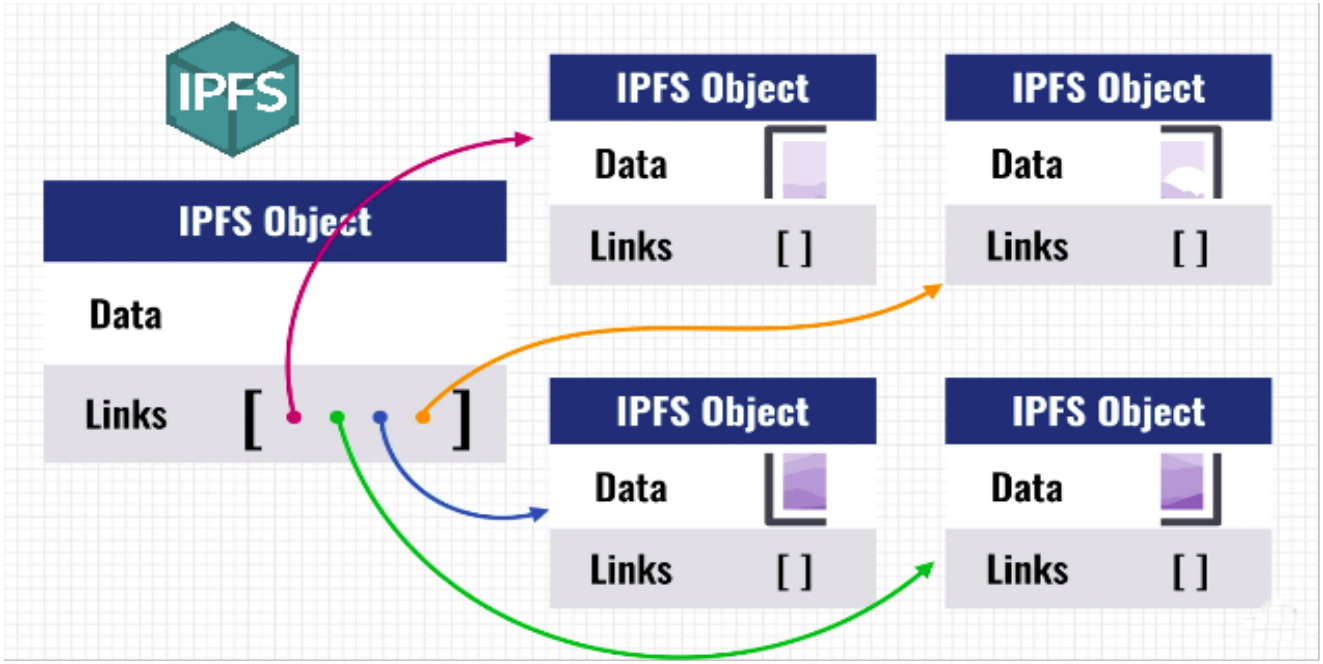

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Related works

Non blockchain-based

1. US open data portal
   - since 2009;
   - provides a number of 229,371 data sets in various formats and related to many fields.
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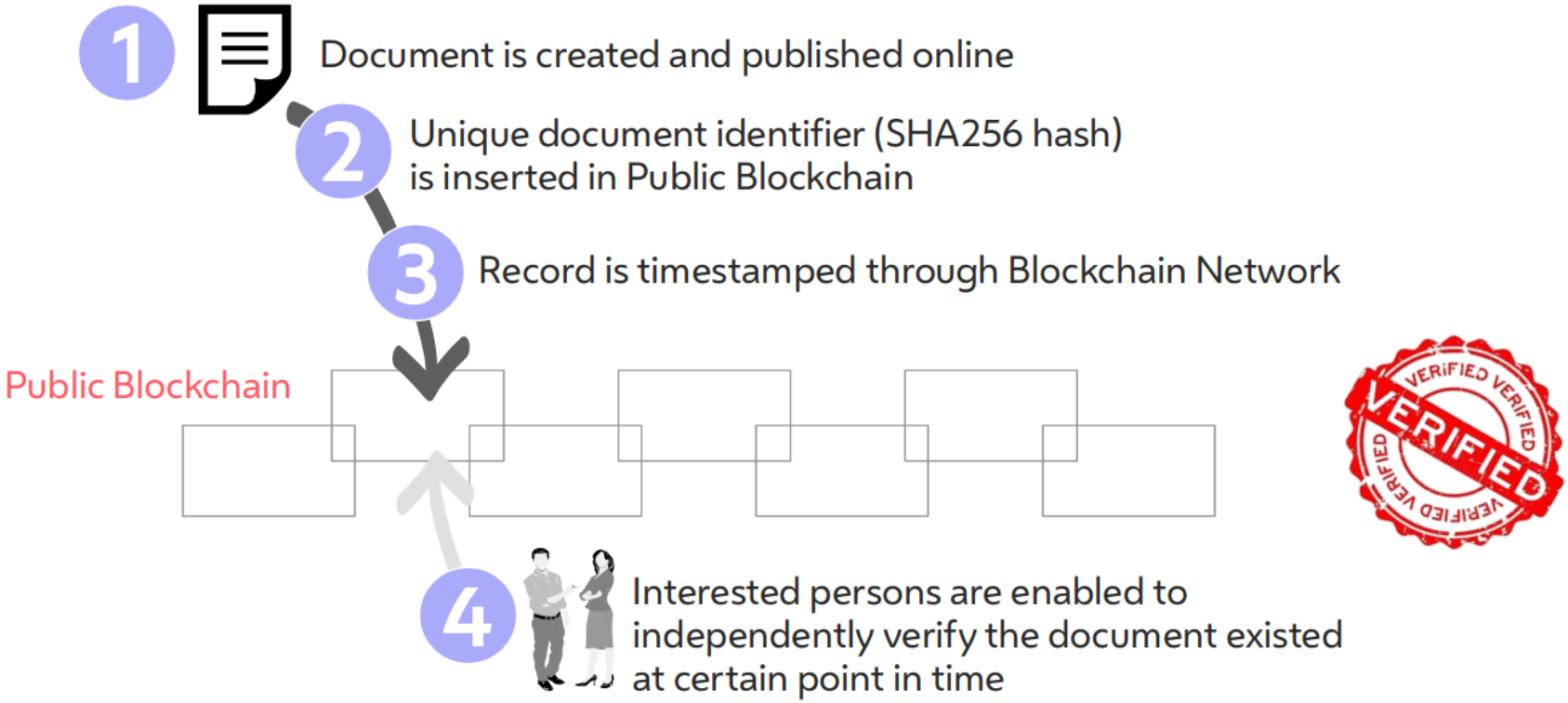

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Our system includes: a **Portal**,

Our system includes: a **Portal**, a distributed file storage system **IPFS**

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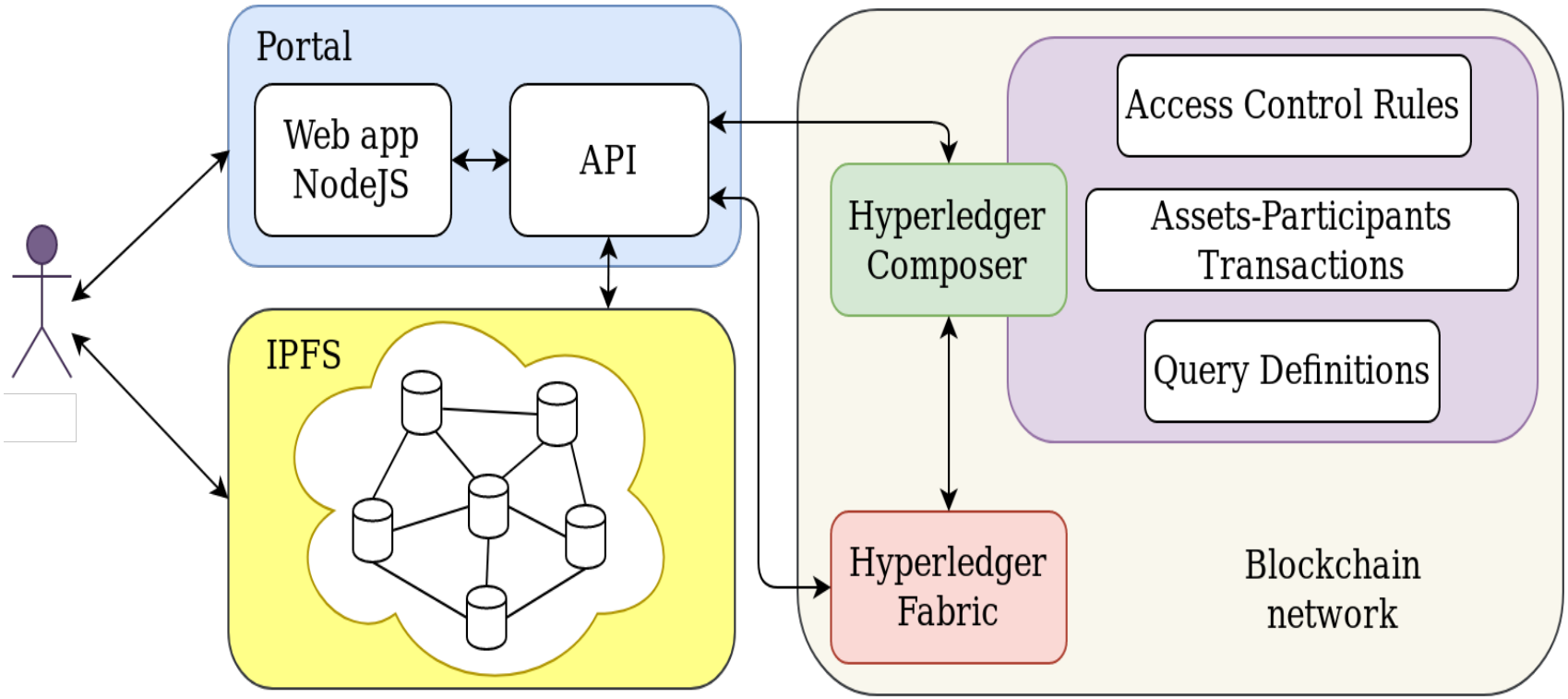

Why Hyperledger Fabric and IPFS?

- We want to decentralize our system as much as we can.
- Hyperledger Fabric: authenticates data contributor, traces data log, checks data integrity, enhances the system transparency.
- IPFS: ensures the data integrity and availability.

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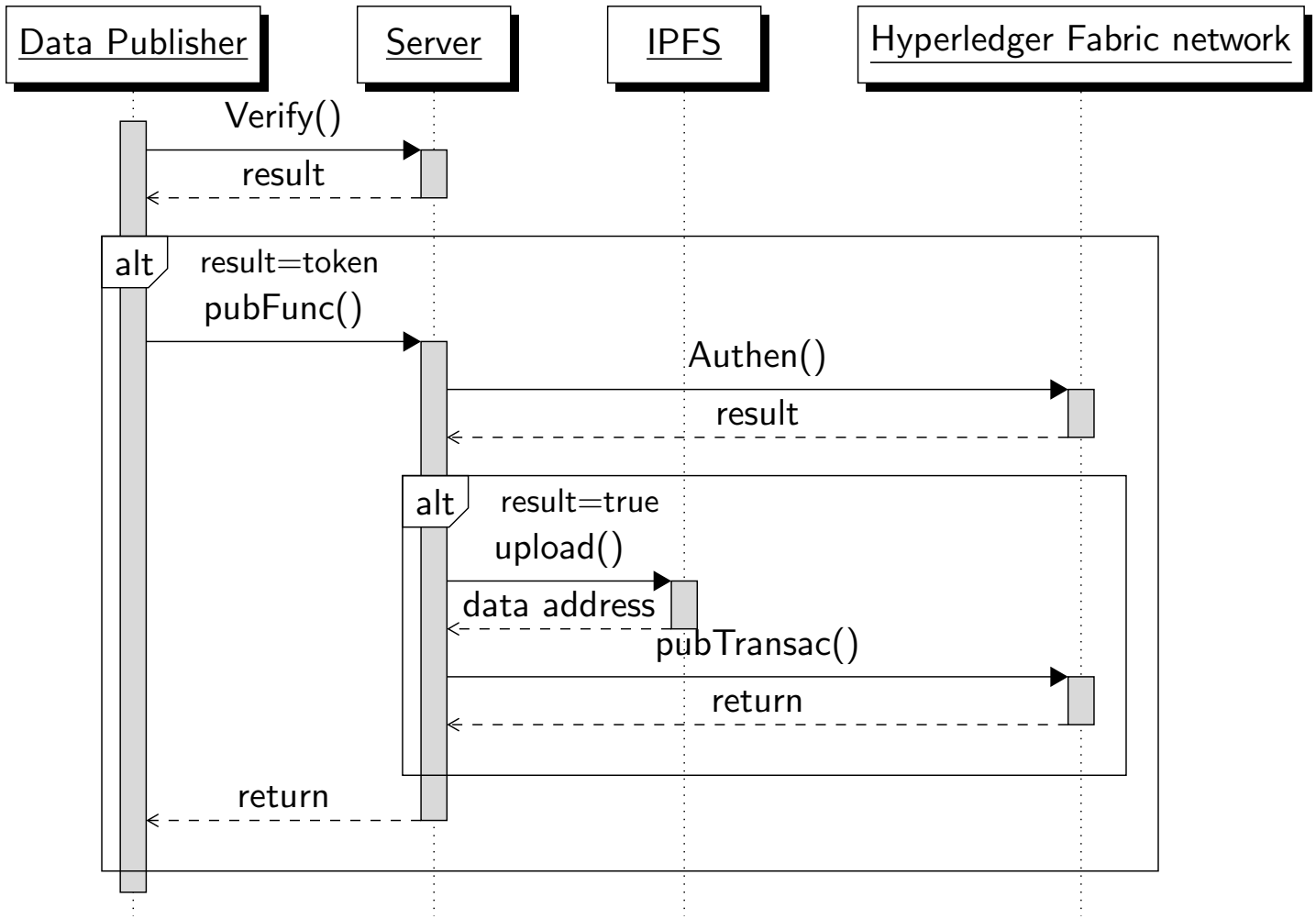
System features

Our system has two main features:

- Publishing the data sets.
- Downloading-Verifying the data sets.

System features

Publishing the data sets



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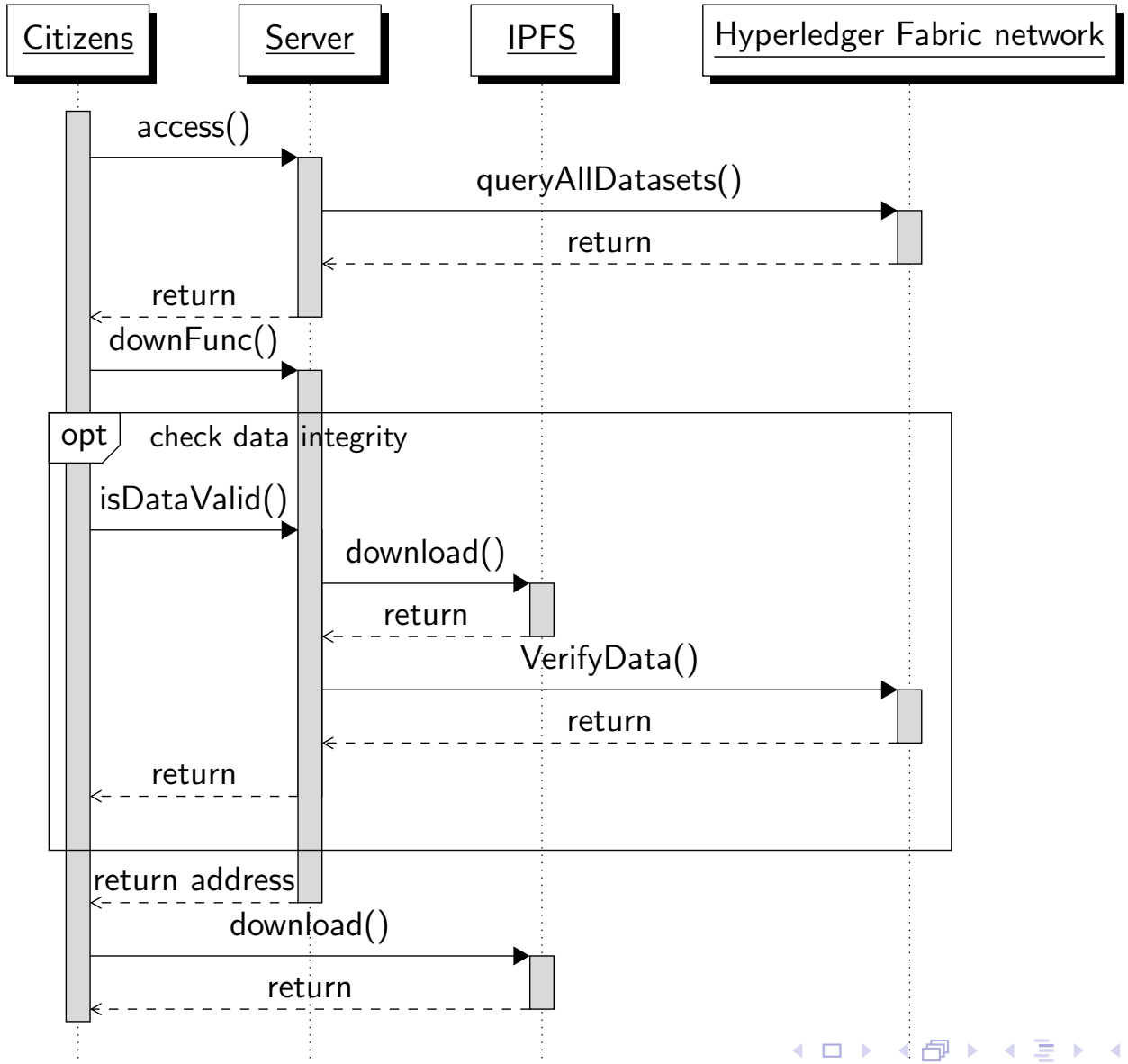

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Implementation

Our implementation included:

- Hyperledger Fabric network
- The open data portal

Hyperledger Fabric network

Hyperledger Composer

Hyperledger Composer is an extensive, open development toolset and framework to make developing blockchain applications easier.

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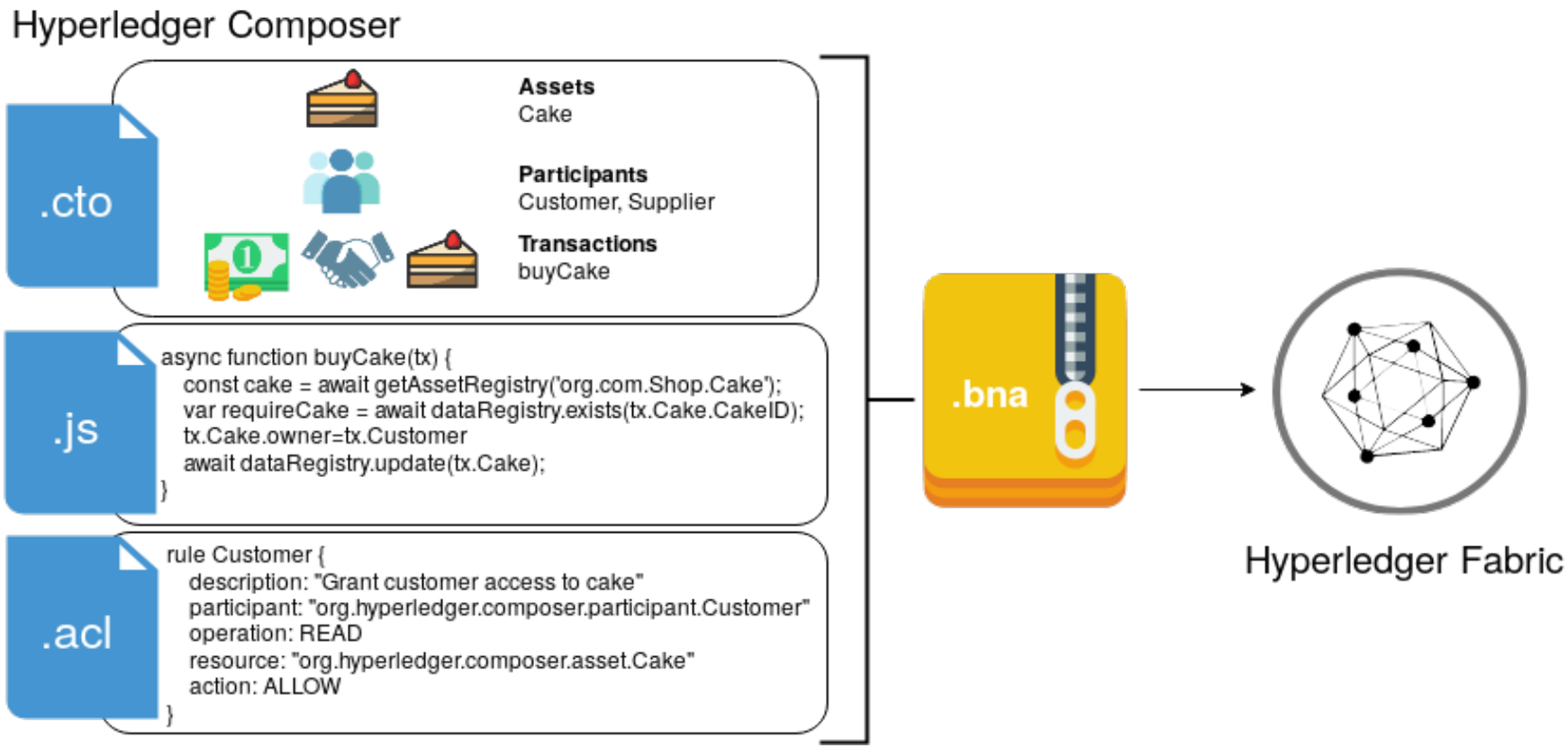

We use Hyperledger Composer to define our customize chaincode.

1. Participants, Assets
   - The data contributors represented as **DataPublisher** object.

```
participant DataPublisher identified by DataPublisherID {
  o String DataPublisherID
  o info PublisherInfo
}
```

   - The metadata of the data sets represented as **Data** object.

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   - Publish the data sets process: **AddAsset()**, **PublishData()**

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transaction PublishData {
  --> DataPublisher publisher
  --> Data data
}
```

   - Modify and Verify the data sets process: **ModifyData()** **VerifyData()**

```
transaction  ModifyData {
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  --> DataPublisher modifier
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3. Access control
   - The data contributor permission.
   - The citizens permission.

```
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  description: "Only publisher have all permission on his/
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  participant(p): "org.com.opendata.DataPublisher"
  operation: ALL
  resource(r): "org.com.opendata.PublishData"
  condition: (p.getIdentifier()===r.publisher.
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4. Endorsement Policy

```
{
    "identities": [
        { "role": { "name": "member", "mspId": "Org1MSP" } },
        { "role": { "name": "member", "mspId": "Org2MSP" } },
        { "role": { "name": "member", "mspId": "Org3MSP" } }
    ],
    "policy": { "2-of": [
            { "signed-by": 0 },
            { "signed-by": 1 },
            { "signed-by": 2 }
        ]}
}
```

Open data portal

Server-side implementation:

- Written by NodeJS.
- Using Hyperledger Composer to interact with Hyperledger Fabric blockchain network.
- Connecting to IPFS network.

Client-side implementation:

- Written by VueJS.

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Testing

Hyperledger Caliper[2] is a blockchain performance benchmark framework.

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Table: Evaluated result of blockchain network performance
Number of transactions: 100, transactions rate: 100 tps

Transaction type	**Send rate (tps)**	**Latency (s)**			**Throughput (tps)**
		Min	**Max**	**Avg**	
PublishData	96.4	6.45	16.08	11.73	6.1
ModifyData	101.0	6.60	15.67	11.27	6.3
DownloadData	100.6	6.66	16.09	11.06	6.1

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Conclusions

+ The combination of the Hyperledger Fabric and the IPFS technology enhances the transparency, availability and integrity of the open data.
+ The limitation:
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+ Future works:
  - integrating hardware security modules,
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