

Blockchain Application within Power Delivery Systems

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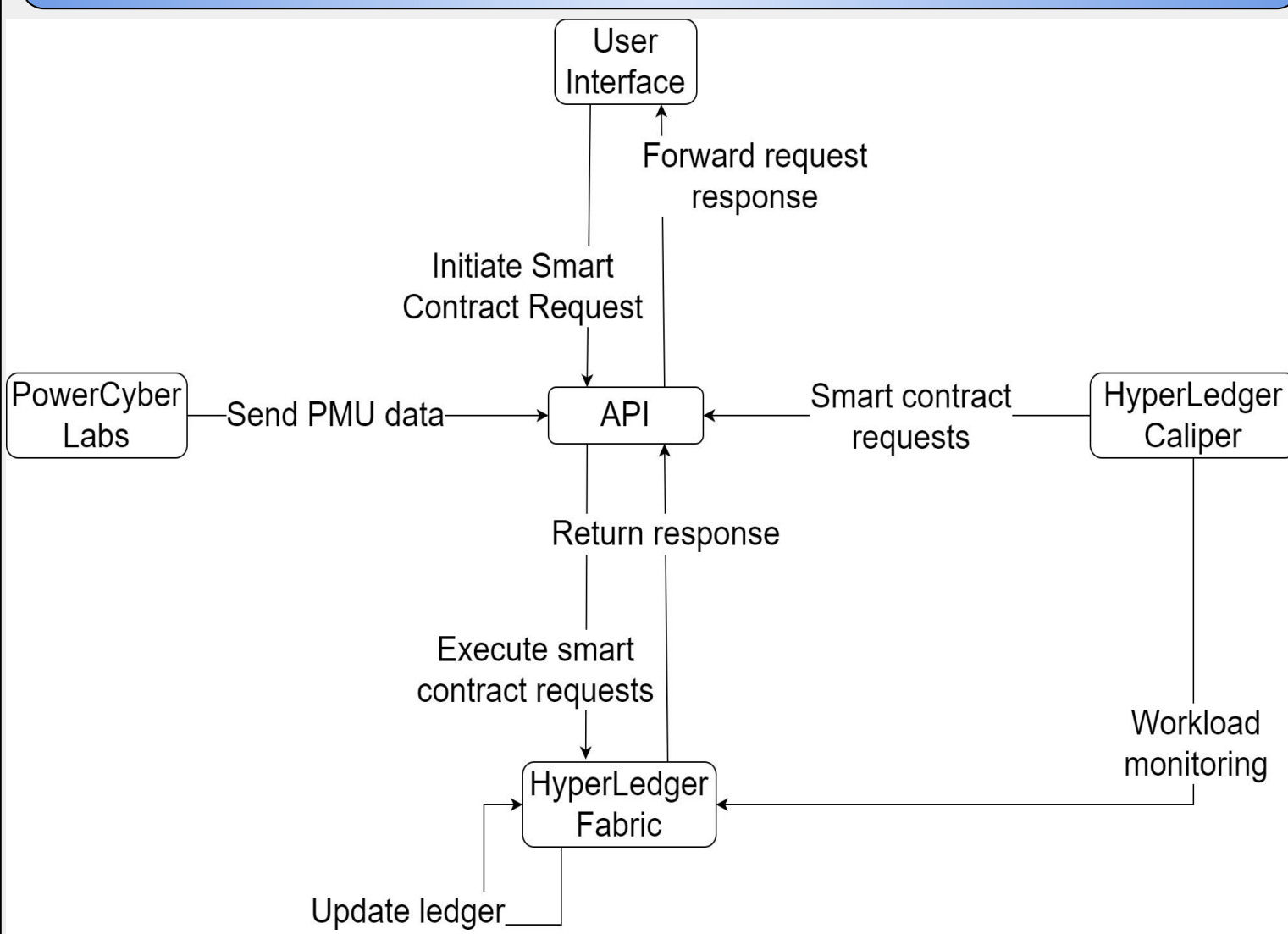
Problem Statement

Our client wants to view an implementation of a blockchain network that can store real-time data for energy delivery systems in conjunction with a way to measure the effectiveness of such a system.

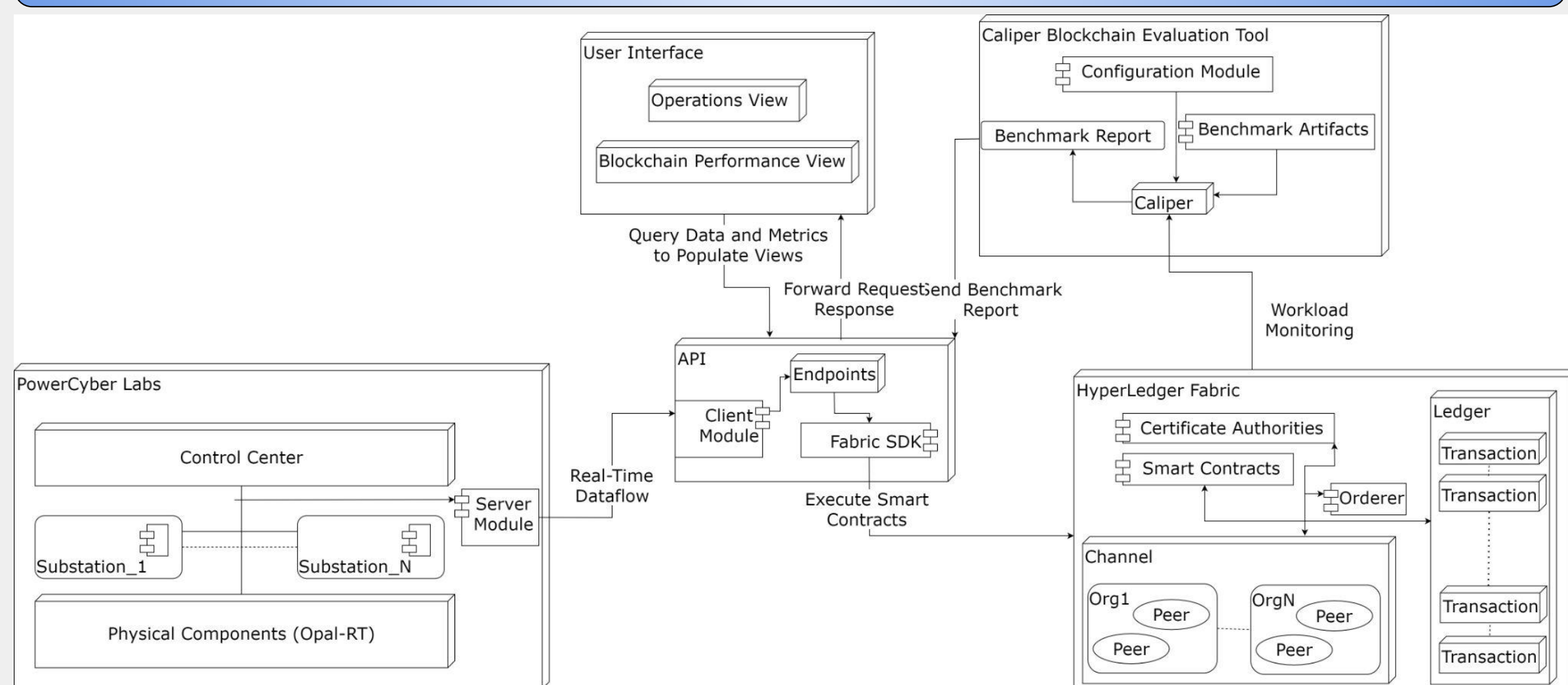
Solution

Our group used HyperLedger Fabric and Docker in order to build smart contracts and establish a network. We then created tests using HyperLedger Caliper and pointed it at this implementation in order to test its performance.

Concept Sketch



Final Architecture



Requirements

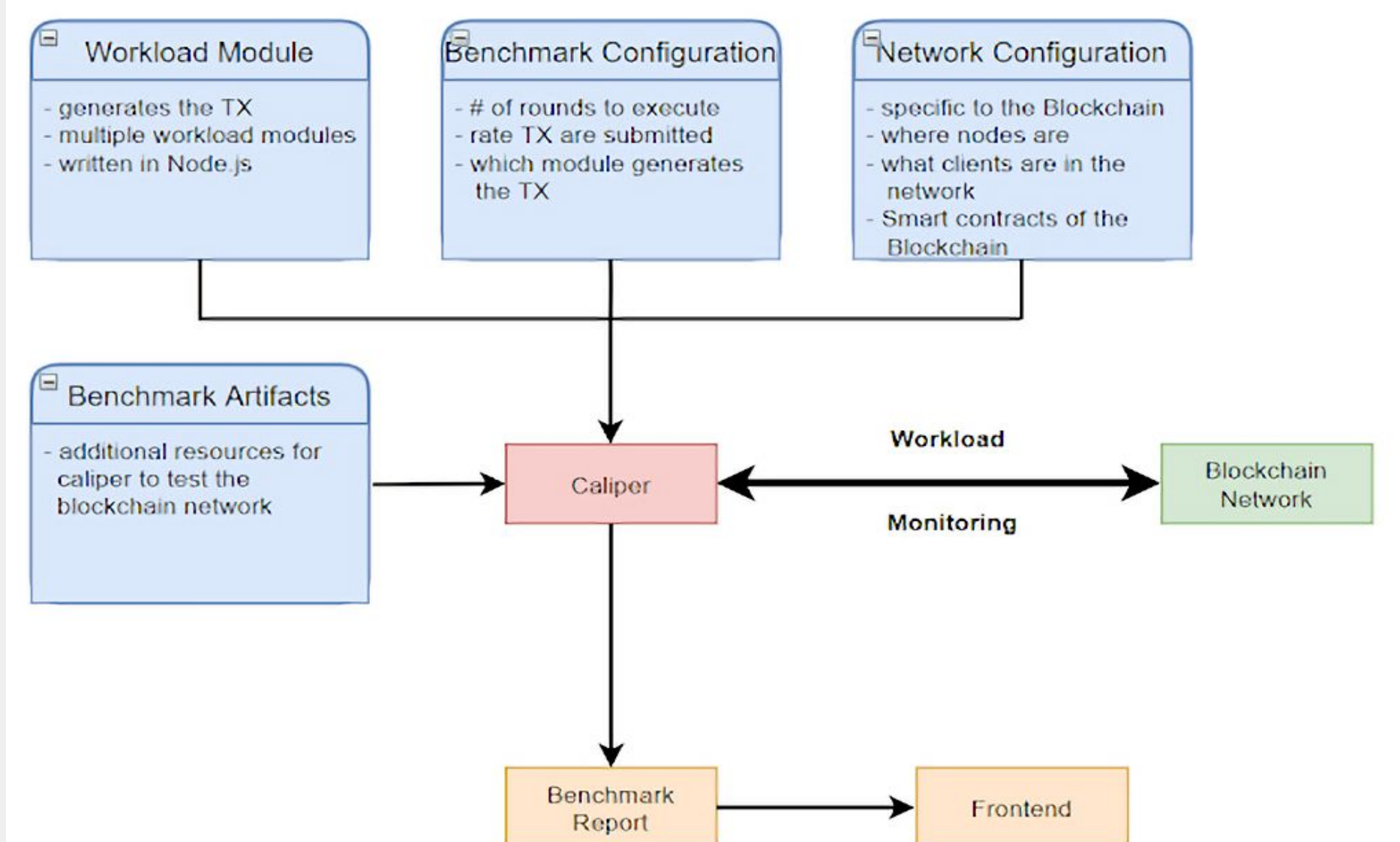
Functional:

- HyperLedger Caliper makes performance metrics.
- Blockchain network consists of five organizations.
- Smart Contracts allow manipulating ledger data.
- Smart Contracts shall employ more than one endorsing node to reach consensus.
- User access limited to assigned channels.

Non-Functional:

- Blockchain Network utilizes Docker for distribution.
- API queries shall not exceed 10 seconds.
- Complete documentation at project website for client's convenience.

HyperLedger Caliper



- Hyperledger Caliper can measure throughput, latency, and transactions per second
- Caliper is known for its flexible testing capabilities such as: testing under load

Technical Details

Operation Environment/Constraints:

- All relevant components (Blockchain network), API, UI, Caliper run on Linux Ubuntu Virtual Machines
- Blockchain network utilizes Docker as a means to distribute the network
- Visual Studio Code was the main development tool

API/Smart Contracts:

- Developed in Node.js, utilizes many packages, most notably 'express' and 'fabric-network'

Available Resources:

- PowerCyber Labs VM's
- Hyperledger Fabric/Caliper frameworks

Testing

Caliper report

Summary of performance metrics

Name	Succ	Fail	Send Rate (TPS)	Max Latency (s)	Min Latency (s)	Avg Latency (s)	Throughput (TPS)
readAsset	3821	0	129.1	0.10	0.01	0.02	129.0
createAsset	54	0	1.8	2.16	0.10	1.51	1.7

Benchmark round: readAsset

Read asset benchmark

```
txDuration: 30
rateControl:
  type: fixed-load
  opts:
    transactionLoad: 2
```

- Load tested smart contract functionality through simulating PMU with different data rates.
- Manual testing of module functionality.
- Unit testing of API using Mocha/Chai

Functional Modules

Functional Modules:

- HyperLedger Fabric: Modular blockchain framework for developing blockchain products.
- UI: Module allows easy visualization and human interaction with other modules.
- PowerCyber Labs: Example real-world component that data is pushed from.
- HyperLedger Caliper: Tool to showcase performance metrics. Interfaces with other modules to provide data.
- API: Provides methods for different parts of our system to communicate and distribute data seamlessly.

Intended Uses/Users

- Researchers evaluating blockchain in energy delivery systems.
- PowerCyber Labs personnel

Security Concerns

- Consensus Attacks
 - Endorsing peers could be taken over to approve invalid transactions
- Imposters through credential Theft

Standards

- 1028-2008 - IEEE Standard for Software Reviews and Audits
- NERC CIP-011-2 - Cyber Security - Information Protection