HYPERLEDGER

GLOBAL FORUM

PHOENIX, AZ | MARCH 3-6, 2020

HYPERLEDGER
GLOBAL FORUM
PHOENIX, AZ | MARCH 3-6, 2020

Hyperledger Caliper: A Benchmark Tool For Multiple Technologies

Nick Lincoln, Software Engineer, *IBM*

Content

1 Caliper Overview

2 Supported Technologies

3 Concepts

4 Operational Modes

5 Generated Reports

6 Performance Tests & Results

Caliper Overview

- Hyperledger Caliper is a blockchain performance testing framework, which allows users to test different blockchain solutions with predefined use cases
- Caliper will generate a performance report with the following performance indicators:
    - Transaction success/fail count
    - Transaction throughput (TPS)
    - Transaction latency
    - Resource consumption

Caliper Overview

- Hyperledger Caliper may be used for:
  - Application developers wanting to performance test their smart contracts
  - System architects wanting to investigate resource constraints during a test load
  - Performance regression testing

Caliper Overview

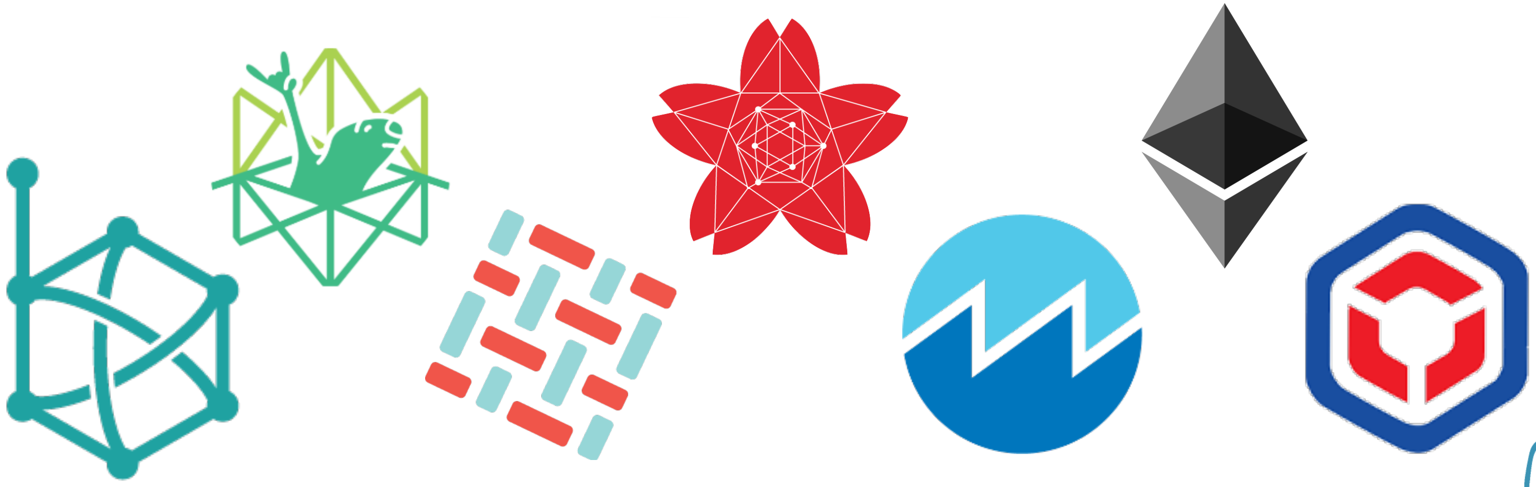
- Hyperledger Caliper is available as
  - NPM packages
  - Docker image
  - Source code on GitHub

- Hyperledger Caliper is driven via a command line interface
  - A GUI is under development by Jason You

Supported Technologies

Hyperledger Caliper has adaptors to enable benchmarking of the following blockchain technologies:

- Hyperledger Besu
- Hyperledger Burrow
- Hyperledger Fabric
- Hyperledger Iroha
- Hyperledger Sawtooth
- Ethereum
- FISCO BCOS



Concepts

- Network definition
  - A definition of the target blockchain technology, which may be any one of the supported platforms
- Smart contract(s)
  - Contain the logic that governs the lifecycle of the asset being modelled within the blockchain technology

Concepts

- Test definition
  - Define the way methods available in the Smart Contract are to be targeted
  - Sequenced list of test modules to be called, with parameters that control the duration and send rate
- Test libraries
  - User defined modules enable provision of arguments to the Smart Contract under test

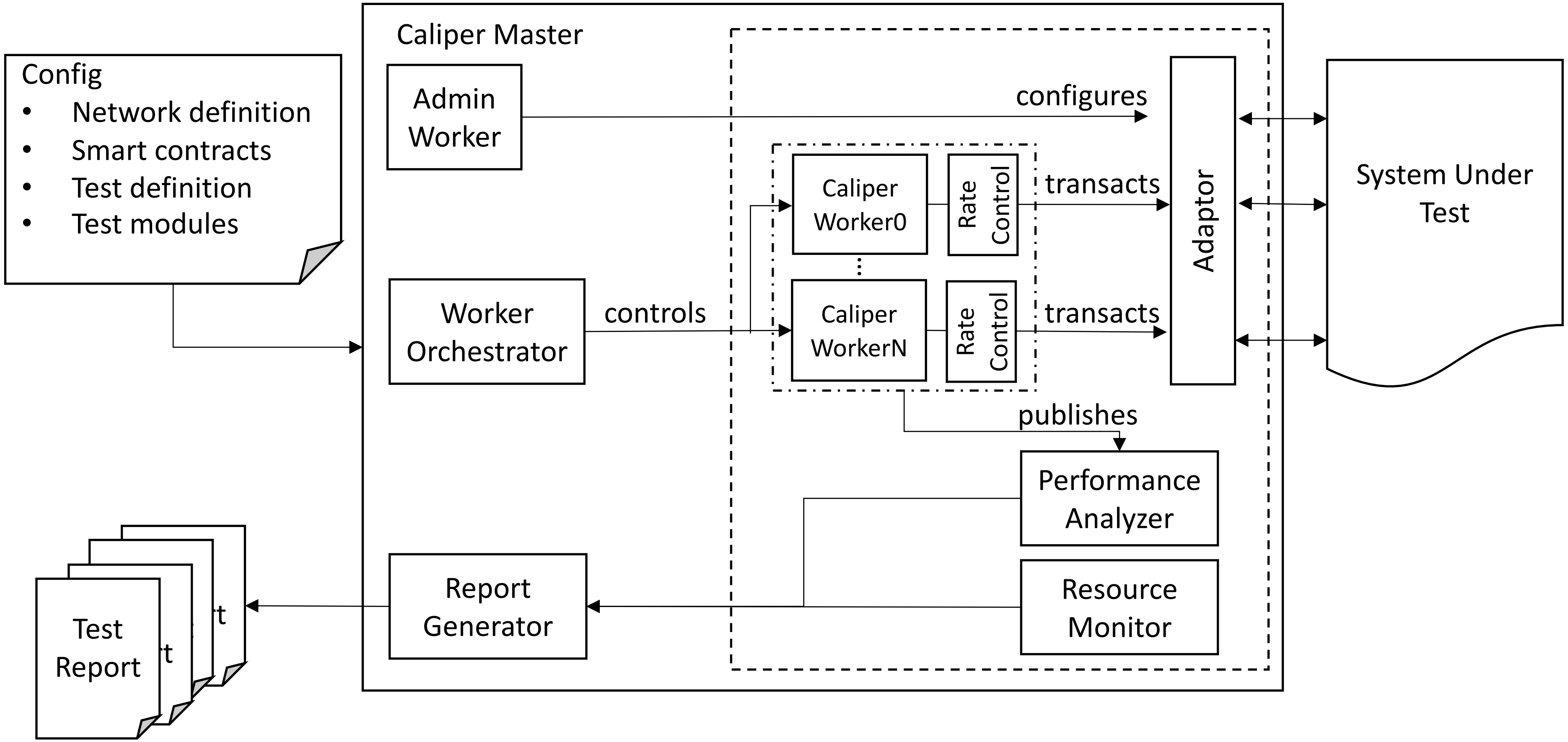
Concepts

- Caliper takes these items and uses them to generate a result
- Transaction statistics are taken from the reference point of the driving SDK
- Resource statistics may be obtained using:
  - Docker stats (default option)
  - Prometheus and custom queries

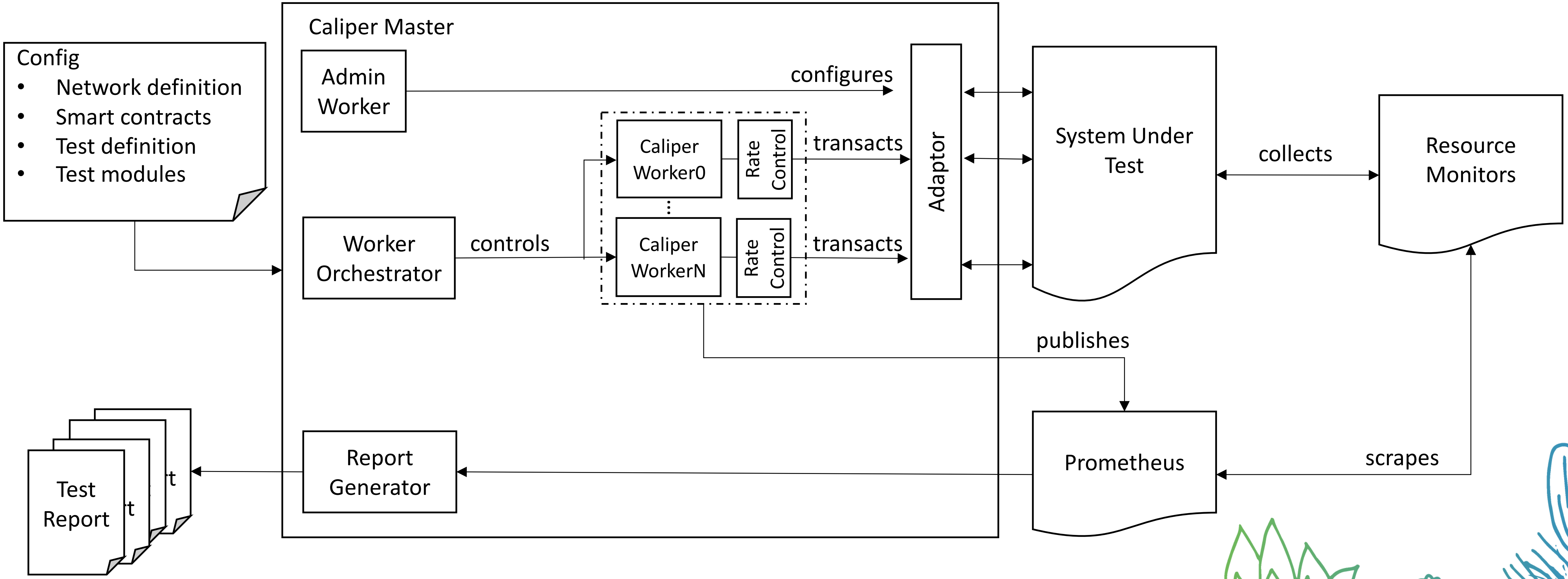
Operational Modes

- Caliper provides flow control options (skip/only) on
  - Start
  - Initialize
  - Test
  - End
- Caliper may operate in a local or distributed mode
  - Local – ideal for proof of concept
  - Distributed – large scale testing
  - Hybrid

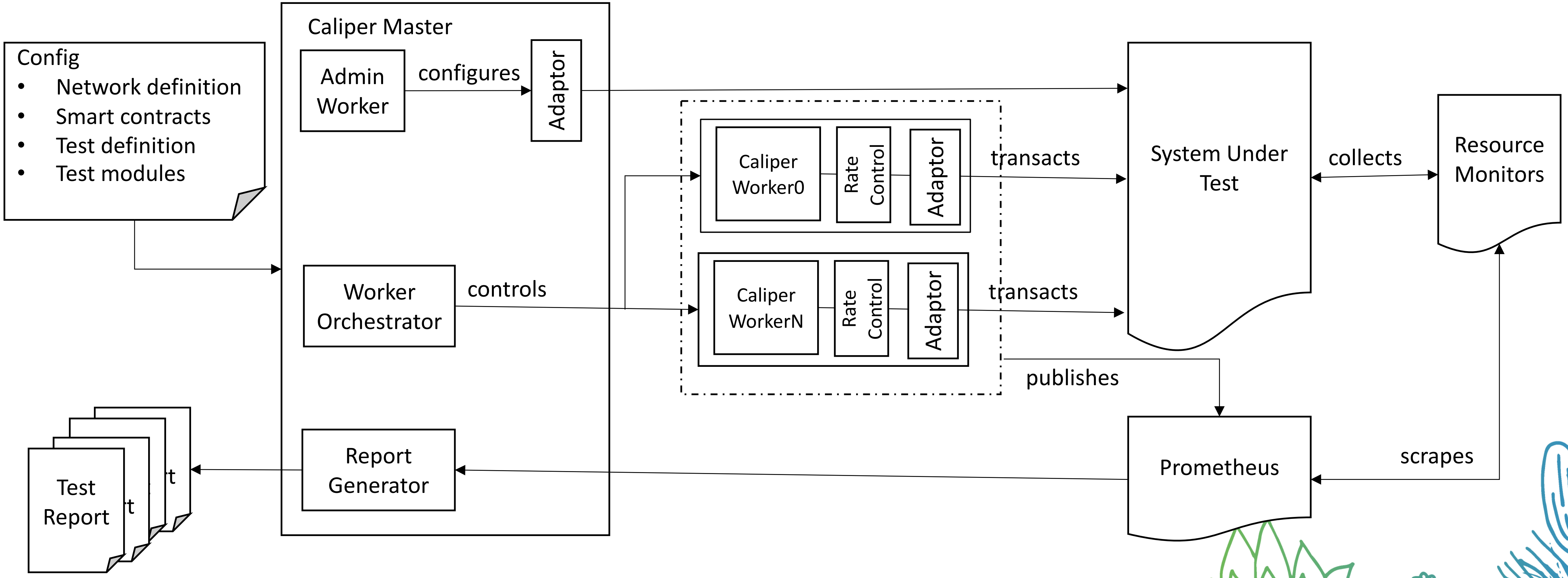
Local (non-distributed)



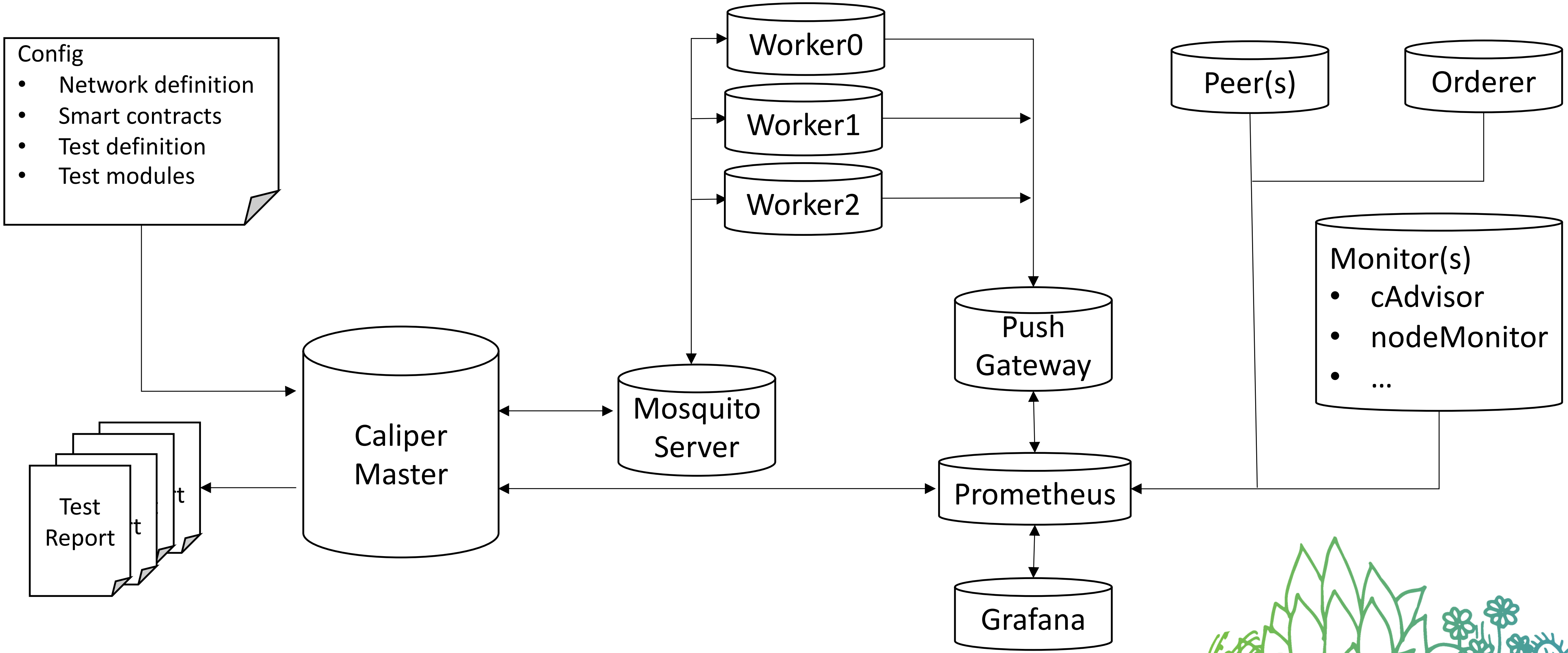
Hybrid Distribution



Distributed



Distributed Example (Fabric)

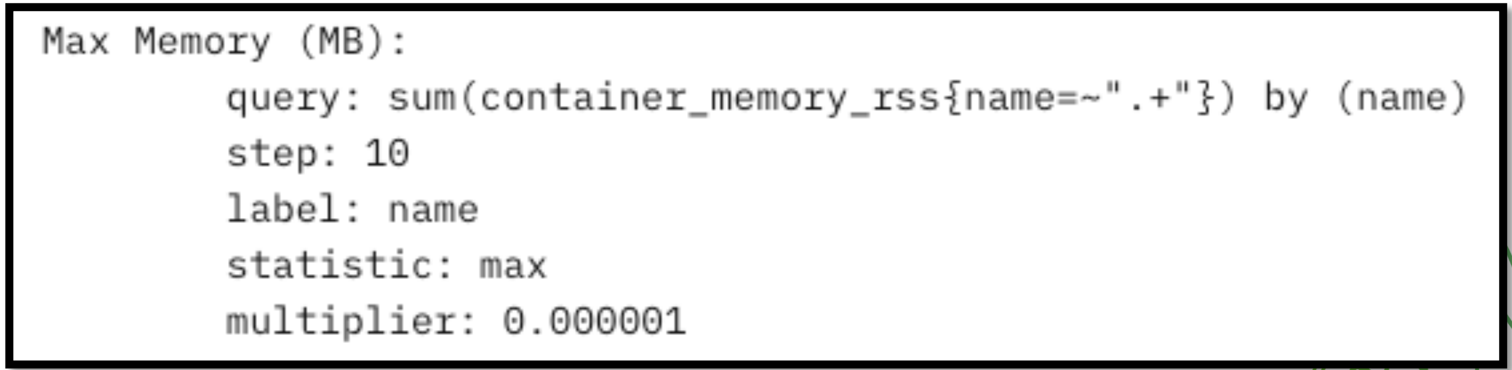


Distributed Monitoring

- Caliper exports the following transaction statistics to Prometheus
  - TPS (Gauge)
  - Latency (Gauge)
  - Success (Counter)
  - Fail (Counter)
- These are collected between test rounds by default using time bounded queries to the Prometheus server

Distributed Monitoring

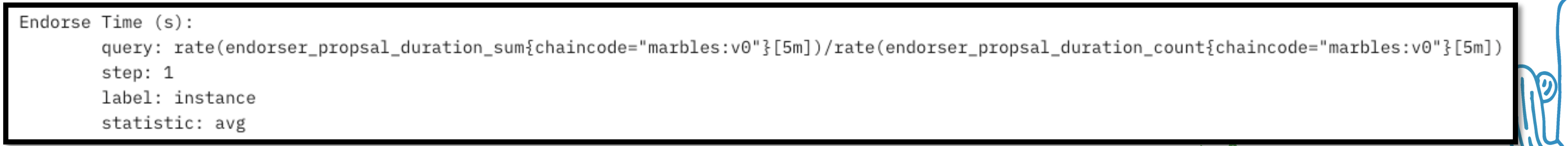
- Caliper can issue ***custom queries*** that are used to build the output report between test rounds
- This enables retrieval of any metric within Prometheus obtained from a compatible scrape target (cAdvisor, Node Exporter, Kubernetes-X, …)



```
Max Memory (MB):
        query: sum(container_memory_rss{name=~".+"}) by (name)
        step: 10
        label: name
        statistic: max
        multiplier: 0.000001
```

Distributed Monitoring (Fabric)

- Fabric Peer and Orderer metrics are exported for consumption by Prometheus
- https://hyperledger-fabric.readthedocs.io/en/release-2.0/metrics_reference.html

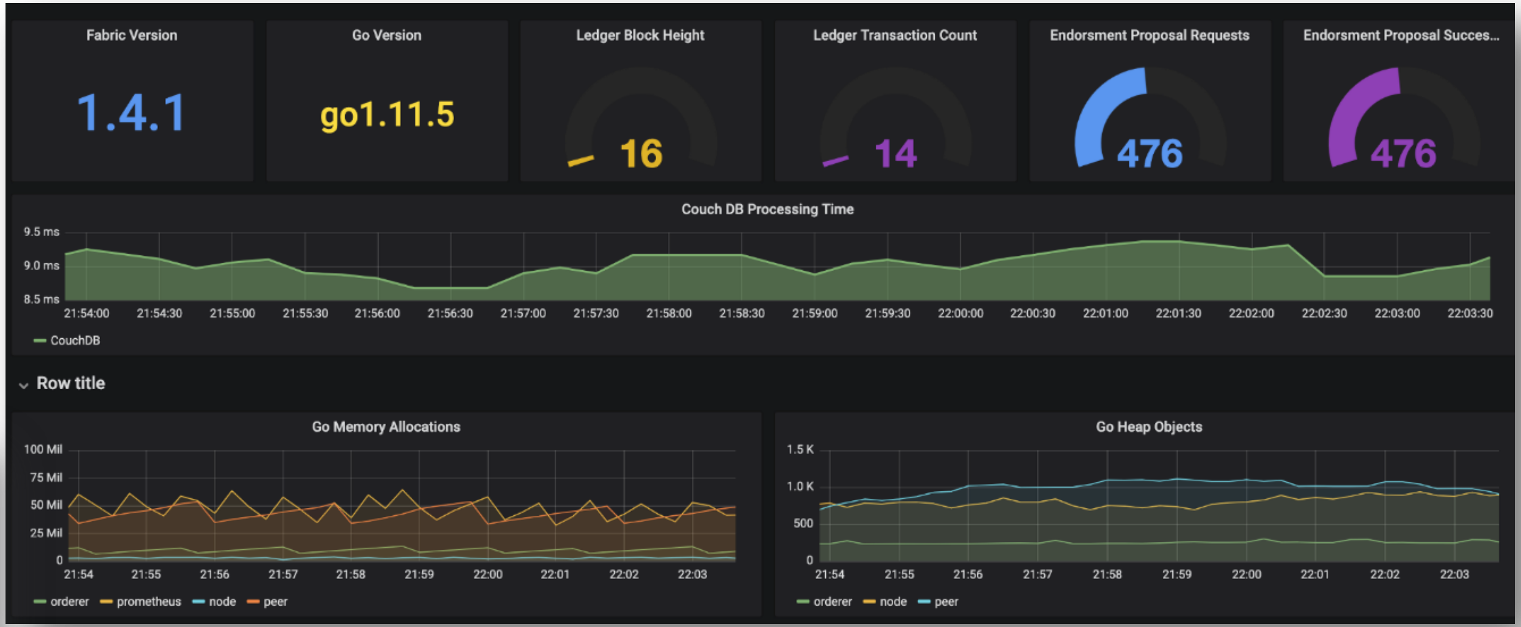


```
Endorse Time (s):
        query: rate(endorser_propsal_duration_sum{chaincode="marbles:v0"}[5m])/rate(endorser_propsal_duration_count{chaincode="marbles:v0"}[5m])
        step: 1
        label: instance
        statistic: avg
```

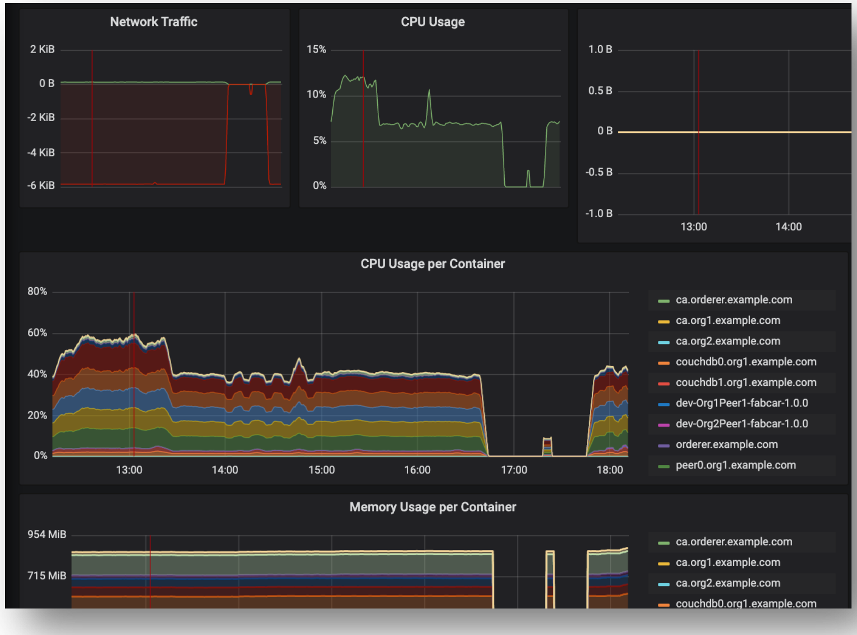
HYPERLEDGER GLOBAL FORUM PHOENIX, AZ | MARCH 3-6, 2020

Distributed Monitoring (Fabric)

- Grafana can visualize exported metrics



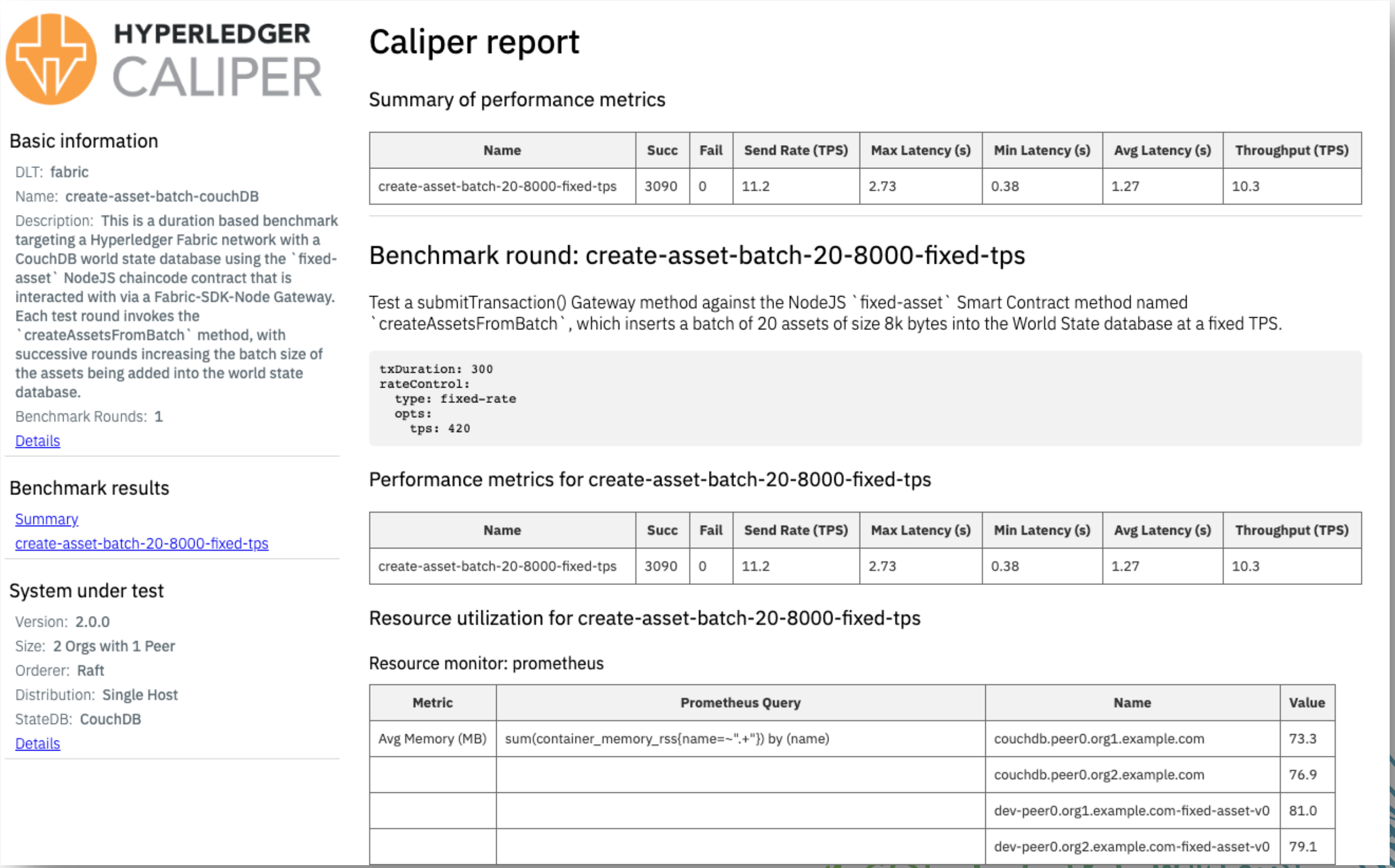
https://grafana.com/grafana/dashboards/10716



HYPERLEDGER GLOBAL FORUM PHOENIX, AZ | MARCH 3-6, 2020

Benchmark Reports

- Reports are generated for each test definition run



HYPERLEDGER CALIPER

Basic information

DLT: fabric

Name: create-asset-batch-couchDB

Description: This is a duration based benchmark targeting a Hyperledger Fabric network with a CouchDB world state database using the `fixed-asset` NodeJS chaincode contract that is interacted with via a Fabric-SDK-Node Gateway. Each test round invokes the `createAssetsFromBatch` method, with successive rounds increasing the batch size of the assets being added into the world state database.

Benchmark Rounds: 1

Details

Benchmark results

Summary

create-asset-batch-20-8000-fixed-tps

System under test

Version: 2.0.0

Size: 2 Orgs with 1 Peer

Orderer: Raft

Distribution: Single Host

StateDB: CouchDB

Details

Caliper report

Summary of performance metrics

Name	Succ	Fail	Send Rate (TPS)	Max Latency (s)	Min Latency (s)	Avg Latency (s)	Throughput (TPS)
create-asset-batch-20-8000-fixed-tps	3090	0	11.2	2.73	0.38	1.27	10.3

Benchmark round: create-asset-batch-20-8000-fixed-tps

Test a submitTransaction() Gateway method against the NodeJS `fixed-asset` Smart Contract method named `createAssetsFromBatch`, which inserts a batch of 20 assets of size 8k bytes into the World State database at a fixed TPS.

```
txDuration: 300
rateControl:
  type: fixed-rate
  opts:
    tps: 420
```

Performance metrics for create-asset-batch-20-8000-fixed-tps

Name	Succ	Fail	Send Rate (TPS)	Max Latency (s)	Min Latency (s)	Avg Latency (s)	Throughput (TPS)
create-asset-batch-20-8000-fixed-tps	3090	0	11.2	2.73	0.38	1.27	10.3

Resource utilization for create-asset-batch-20-8000-fixed-tps

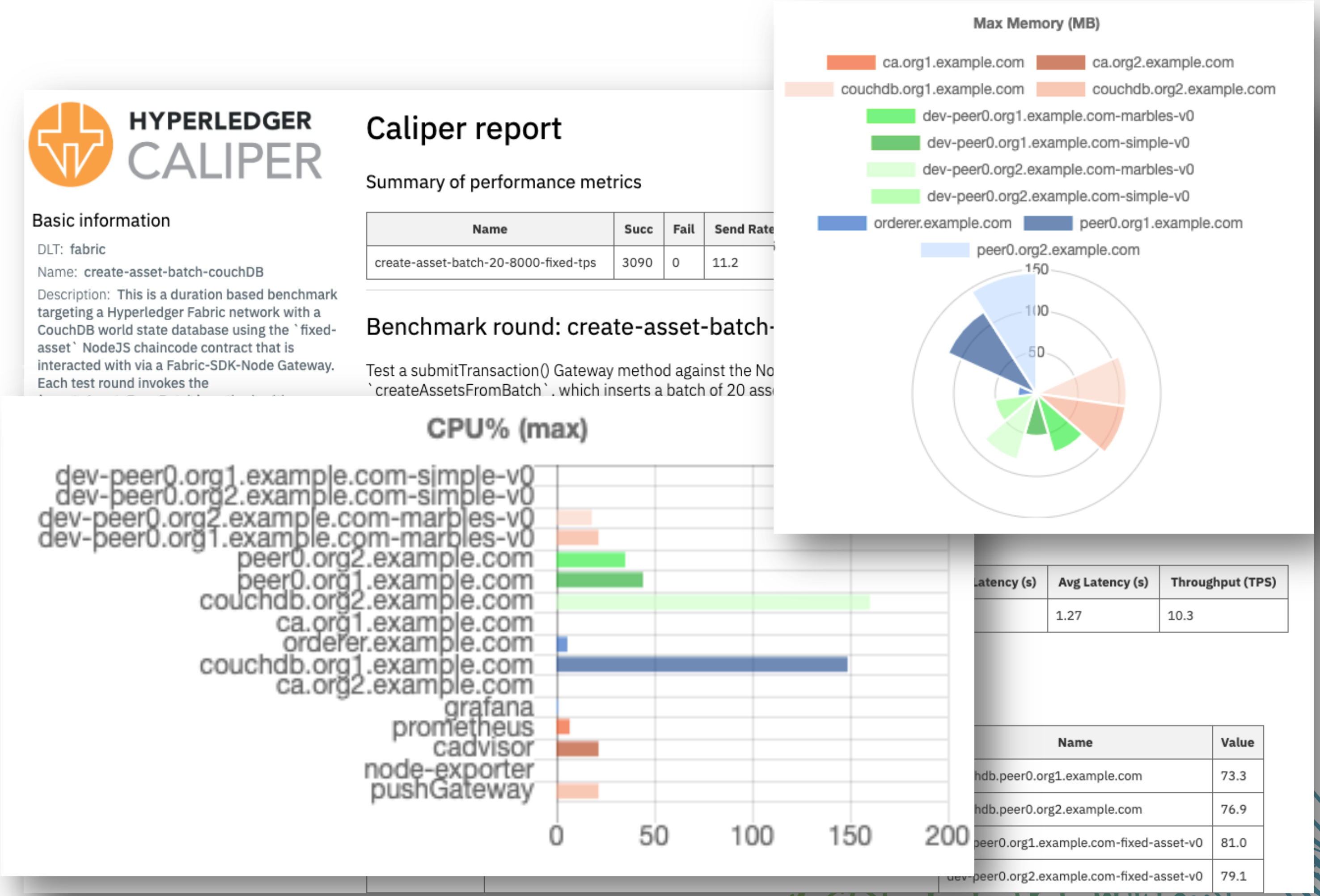
Resource monitor: prometheus

Metric	Prometheus Query	Name	Value
Avg Memory (MB)	sum(container_memory_rss{name=~".+"}) by (name)	couchdb.peer0.org1.example.com	73.3
		couchdb.peer0.org2.example.com	76.9
		dev-peer0.org1.example.com-fixed-asset-v0	81.0
		dev-peer0.org2.example.com-fixed-asset-v0	79.1

HYPERLEDGER GLOBAL FORUM PHOENIX, AZ | MARCH 3-6, 2020

Benchmark Reports

- Reports are generated for each test definition run
- Graphical output for resource utilization is also possible



HYPERLEDGER CALIPER

Caliper report

Basic information

DLT: fabric

Name: create-asset-batch-couchDB

Description: This is a duration based benchmark targeting a Hyperledger Fabric network with a CouchDB world state database using the `fixed-asset` NodeJS chaincode contract that is interacted with via a Fabric-SDK-Node Gateway. Each test round invokes the

Summary of performance metrics

Name	Succ	Fail	Send Rate
create-asset-batch-20-8000-fixed-tps	3090	0	11.2

Latency (s)	Avg Latency (s)	Throughput (TPS)
	1.27	10.3

Benchmark round: create-asset-batch-

Test a submitTransaction() Gateway method against the No `createAssetsFromBatch`. which inserts a batch of 20 ass

Name	Value
hdb.peer0.org1.example.com	73.3
hdb.peer0.org2.example.com	76.9
peer0.org1.example.com-fixed-asset-v0	81.0
dev-peer0.org2.example.com-fixed-asset-v0	79.1

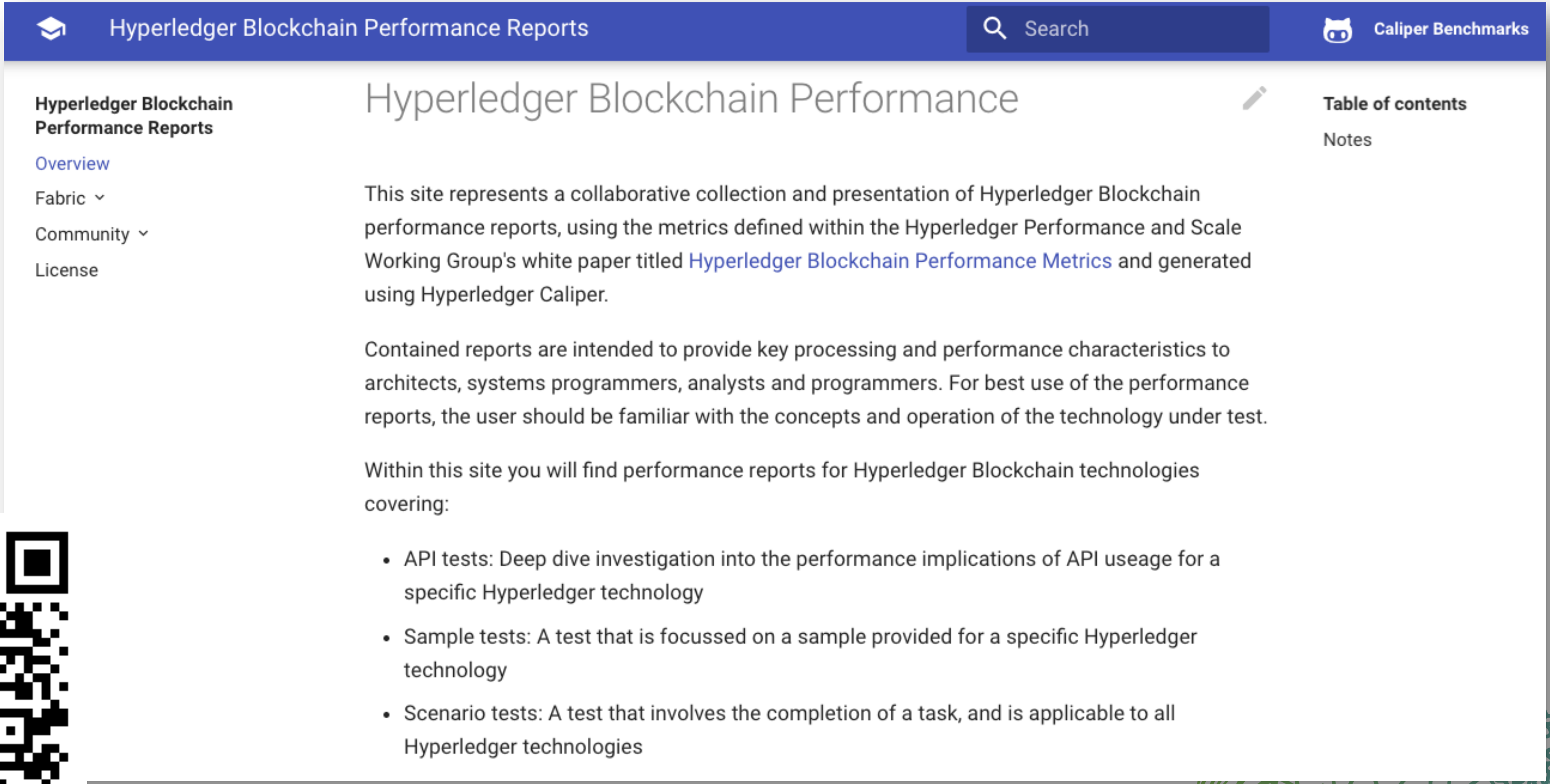
Performance Tests

- Directed
  - Focused on a specific aspect of the technology
  - Focused on an attribute of the aspect
- Repeatable
  - All resources used to perform the test(s) are available
  - Details of machine(s) and configuration used are provided
- Insightful
  - Meaningful tests that are multi-dimensional
  - Yield tangible observations

Performance Results

- Did you know we publish benchmark results?
- https://hyperledger.github.io/caliper-benchmarks/

Performance Results


Hyperledger Blockchain Performance Reports
Search
Caliper Benchmarks
Hyperledger Blockchain Performance Reports
Overview
Fabric
Community
License
Table of contents
Notes

Hyperledger Blockchain Performance

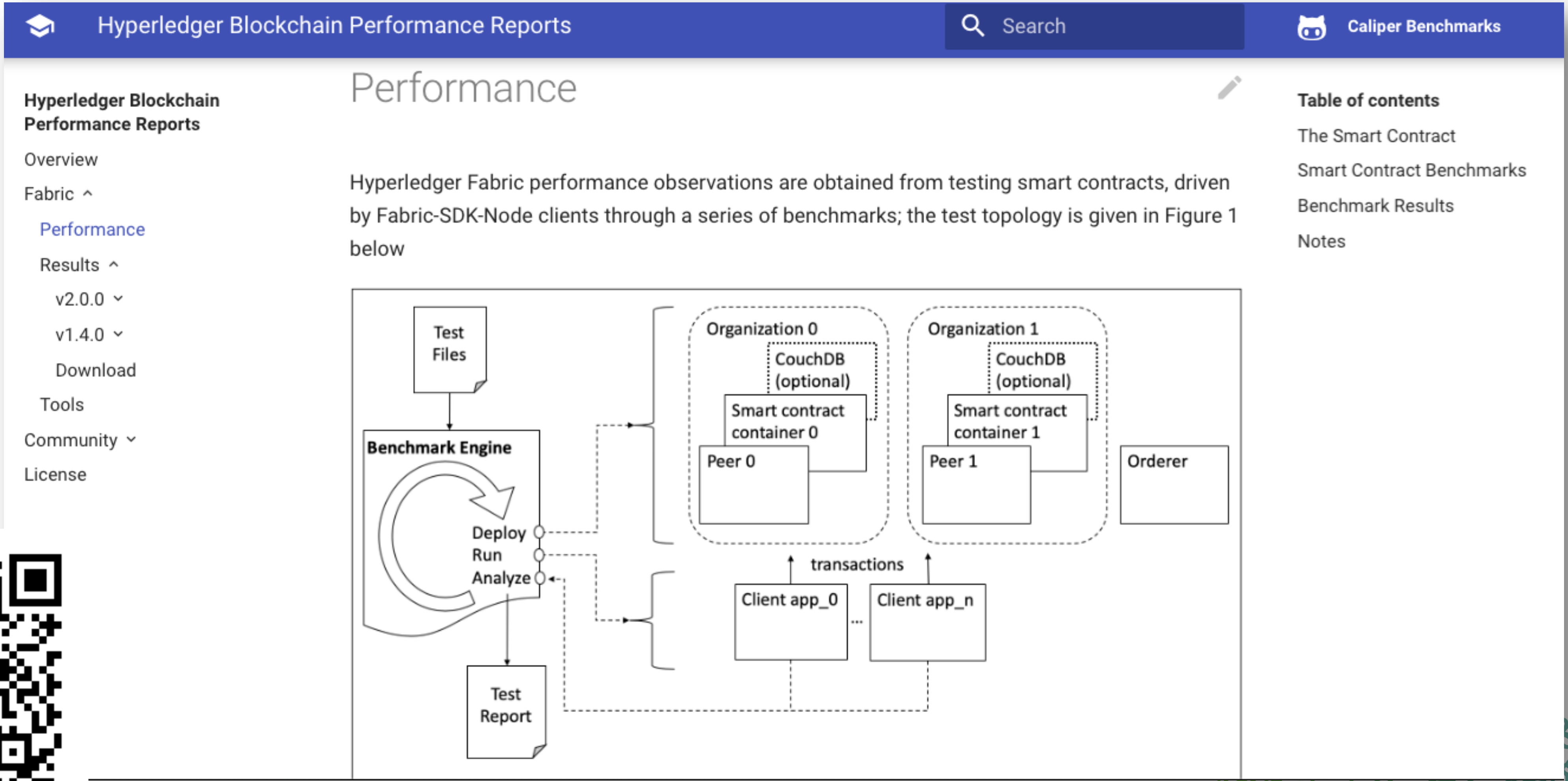
This site represents a collaborative collection and presentation of Hyperledger Blockchain performance reports, using the metrics defined within the Hyperledger Performance and Scale Working Group's white paper titled Hyperledger Blockchain Performance Metrics and generated using Hyperledger Caliper.

Contained reports are intended to provide key processing and performance characteristics to architects, systems programmers, analysts and programmers. For best use of the performance reports, the user should be familiar with the concepts and operation of the technology under test.

Within this site you will find performance reports for Hyperledger Blockchain technologies covering:

- API tests: Deep dive investigation into the performance implications of API useage for a specific Hyperledger technology
- Sample tests: A test that is focussed on a sample provided for a specific Hyperledger technology
- Scenario tests: A test that involves the completion of a task, and is applicable to all Hyperledger technologies

Performance Results (Fabric)



Hyperledger Blockchain Performance Reports

Search

Caliper Benchmarks

Hyperledger Blockchain Performance Reports

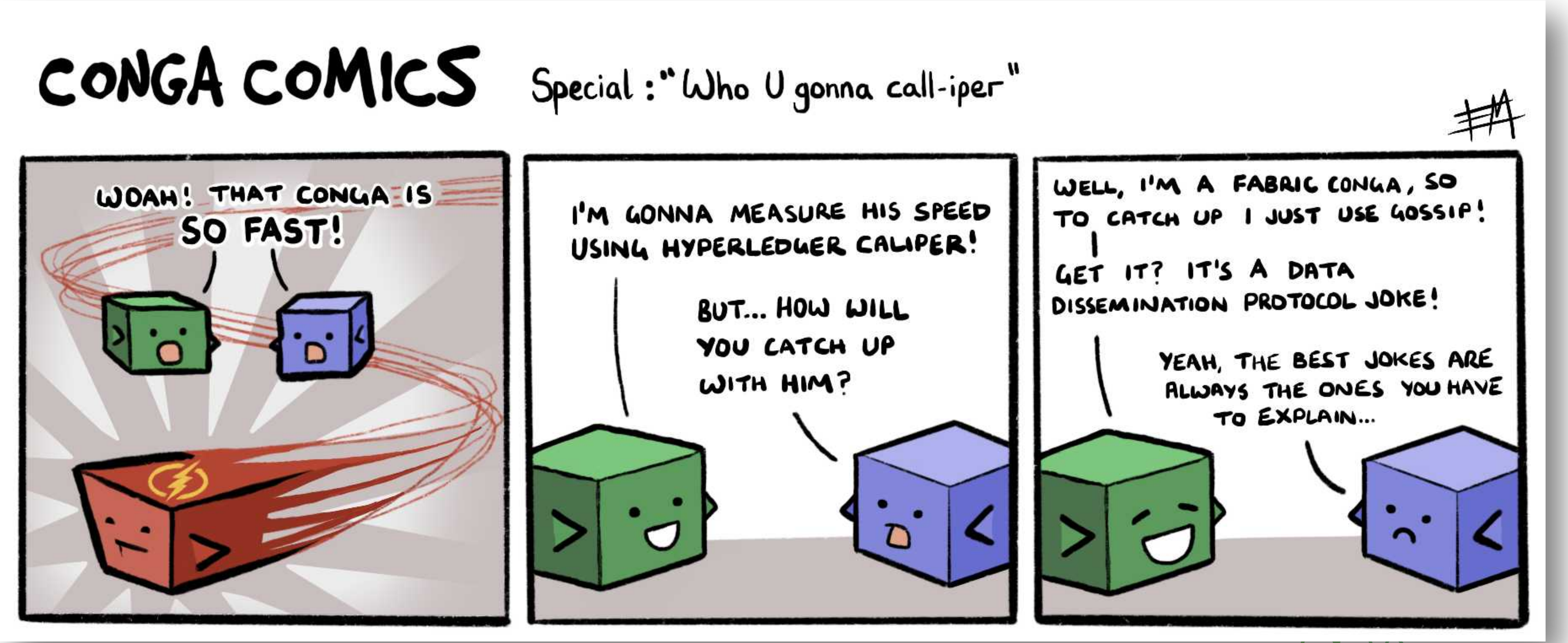
- Overview
- Fabric ^
  - Performance
  - Results ^
    - v2.0.0 ˅
    - v1.4.0 ˅
    - Download
  - Tools
- Community ˅
- License

Performance

Hyperledger Fabric performance observations are obtained from testing smart contracts, driven by Fabric-SDK-Node clients through a series of benchmarks; the test topology is given in Figure 1 below

Table of contents

Questions


CONGA COMICS
Special : "Who U gonna call-iper"
WOAH! THAT CONGA IS SO FAST!
I'M GONNA MEASURE HIS SPEED USING HYPERLEDGER CALIPER!
BUT... HOW WILL YOU CATCH UP WITH HIM?
WELL, I'M A FABRIC CONGA, SO TO CATCH UP I JUST USE GOSSIP!
GET IT? IT'S A DATA DISSEMINATION PROTOCOL JOKE!
YEAH, THE BEST JOKES ARE ALWAYS THE ONES YOU HAVE TO EXPLAIN...