F4Fp-09

MeshDapp:

Blockchain-enabled Payment System for Wireless Mesh Networks

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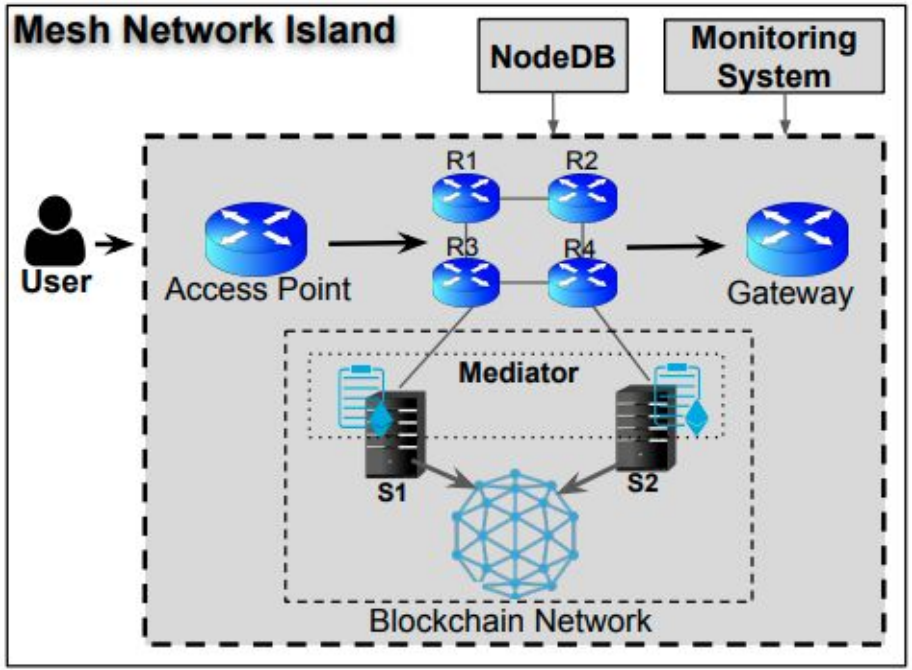
Experiment Description

MeshDapp

Concept and objectives

- **MeshDapp:** Blockchain-enabled automated payment system in wireless mesh networks
- **Target**: Telecom and WISP operators
- Calculations and value transfers are **automated**, **irreversible**, **transparent**
- Each participating device is **rewarded** by payments from the consumers (Ether tokens)



Background and motivation

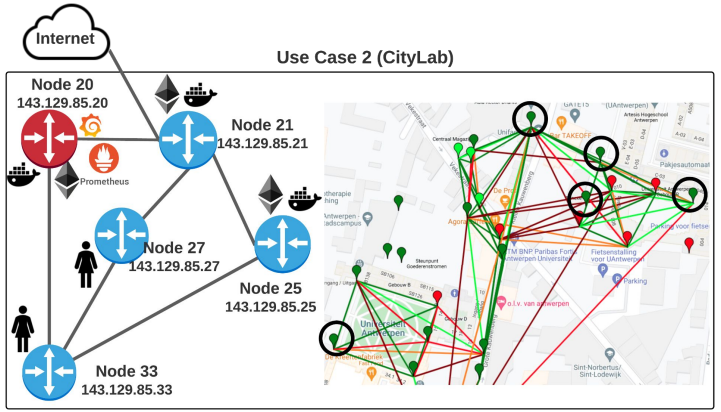
Video: Blockchain Payments

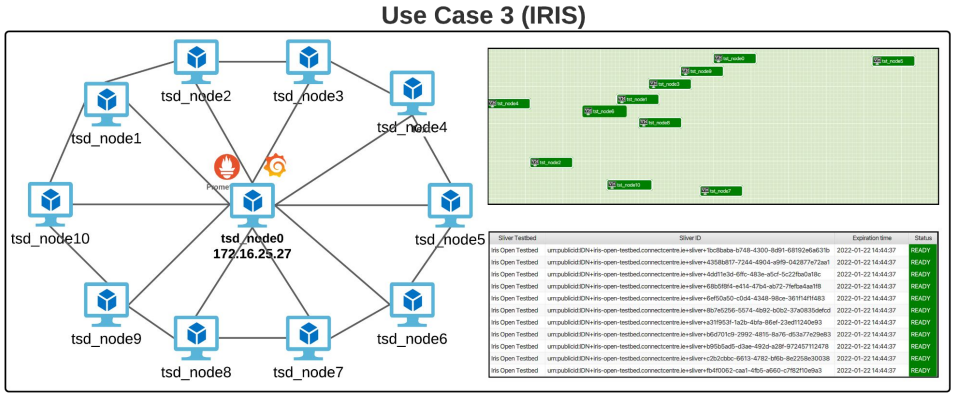
- **Consumers** (clients) can connect to network services and the Internet through AP devices in various locations, interconnected through several intermediate **mesh routers**

Servers deliver local services, and one or several **gateway** nodes are needed to deliver enough Internet connectivity

Experimental Setup

- **9 nodes** from CityLab Testbed
- WiFi 802.11ac on 2.4GHz and 5GHz (Ubuntu 20.04)
- **11 VMs from IRIS testbed**
- **Monitoring server** (Prometheus + Grafana), key entity
- **Docker containers** deployed for in/out traffic measurement
- **Ethereum smart contracts** to bootstrap the MeshDapp network



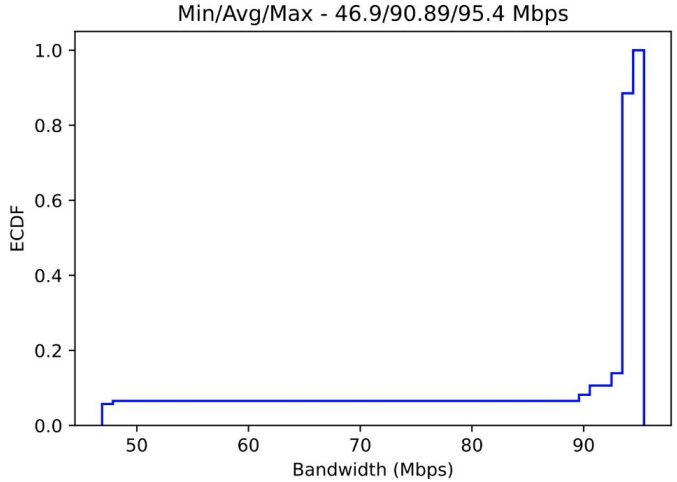


Project Results

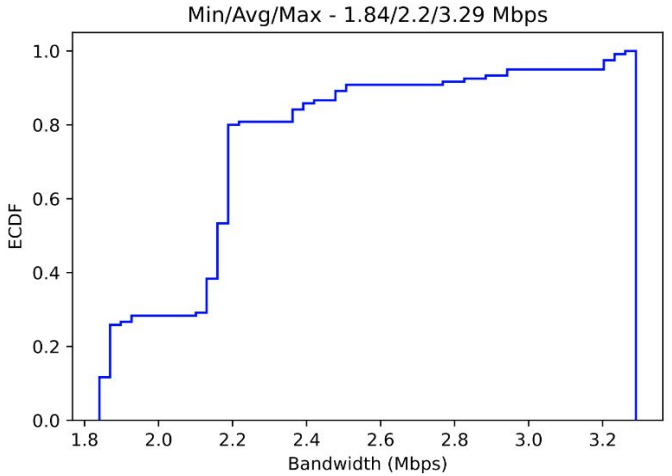
MeshDapp

Bandwidth

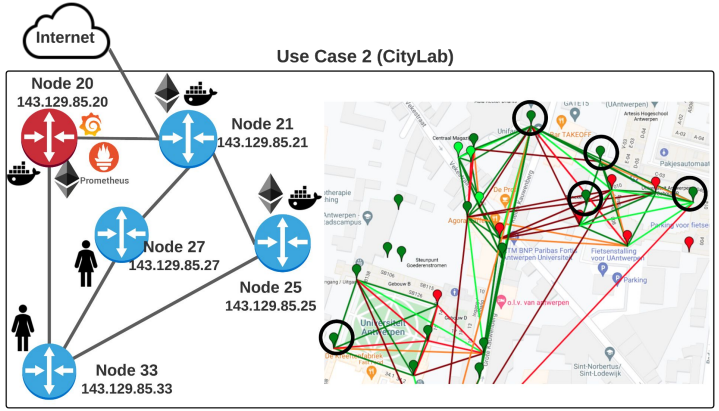
- **CityLab Testbed:**
- Average bandwidth: **90.89 Mbps**
- Normal distribution (no skew)
- Bandwidth slightly affected by the traffic
- The best testbed performance observed so far !

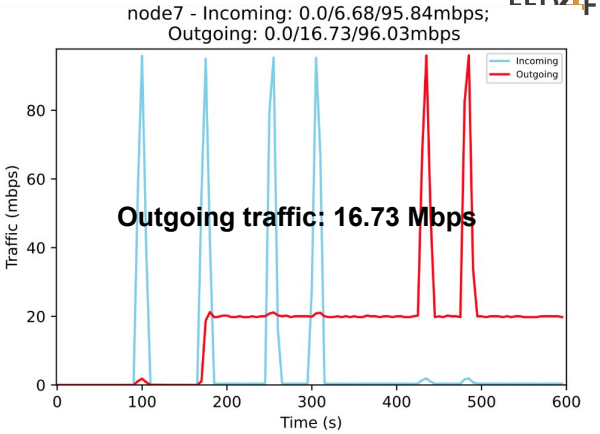


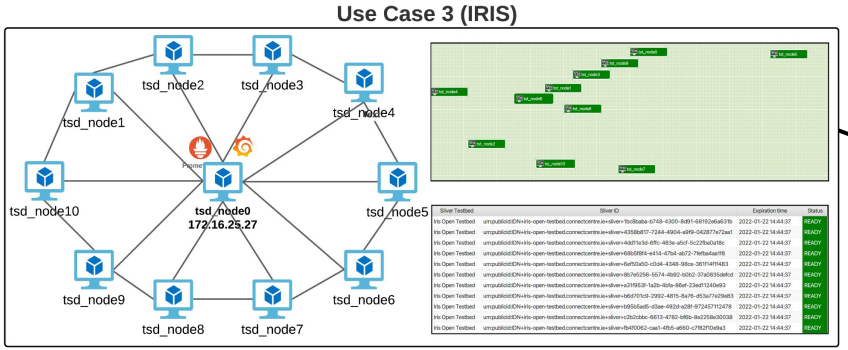
- **IRIS Testbed:**
- Average bandwidth: **2.2 Mbps**
- VMs sharing the network bandwidth

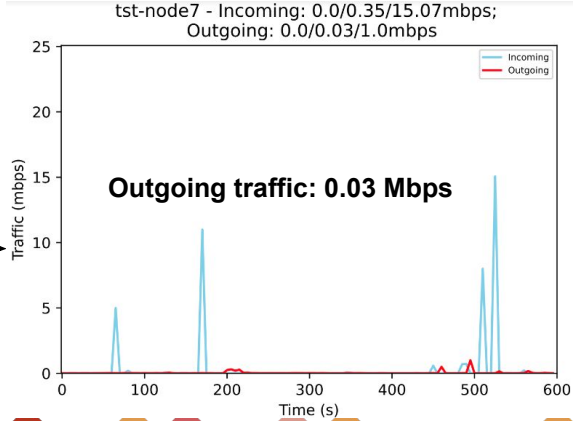


Network Traffic



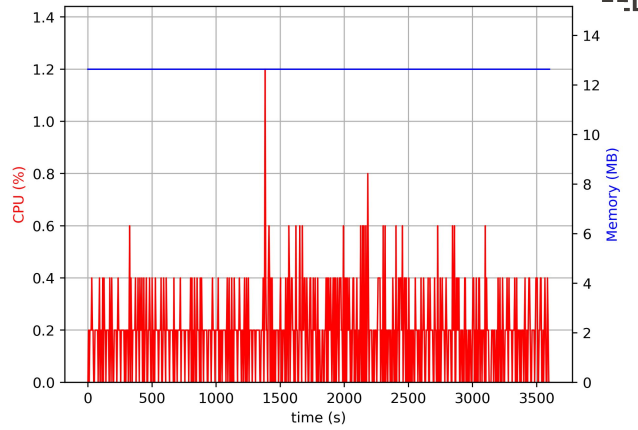


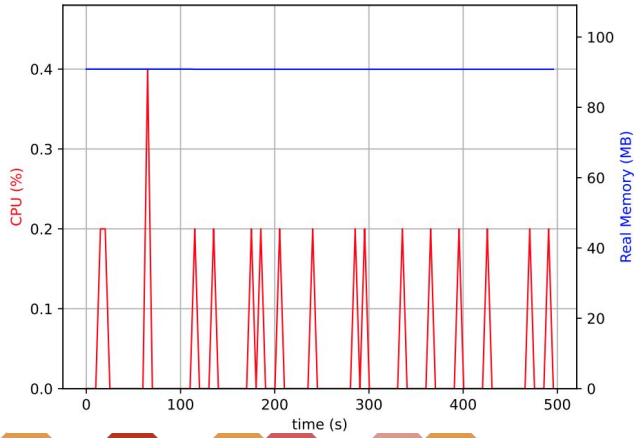




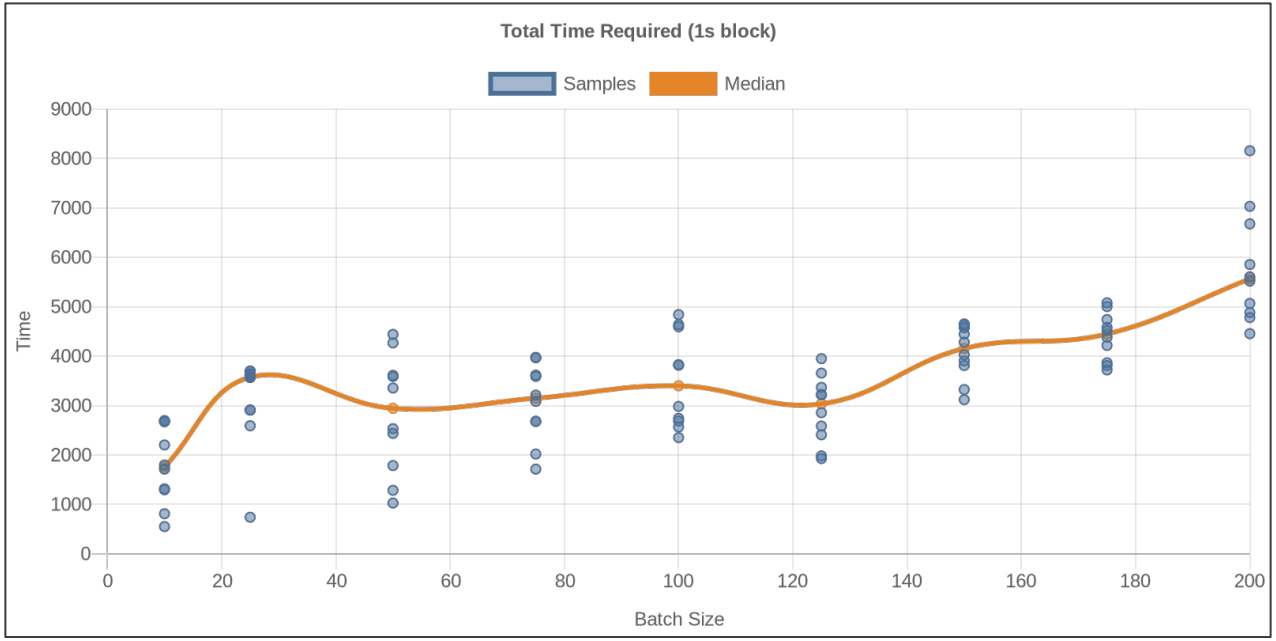
CPU & Memory Utilization

- CPU consumption (idle state) almost never reaches **one core (CityLab and IRIS testbed)**
- RAM memory stays constant in a range between **12 and 14 MB (CityLab)**
- Resource-constrained **can support** blockchain-enabled payment systems

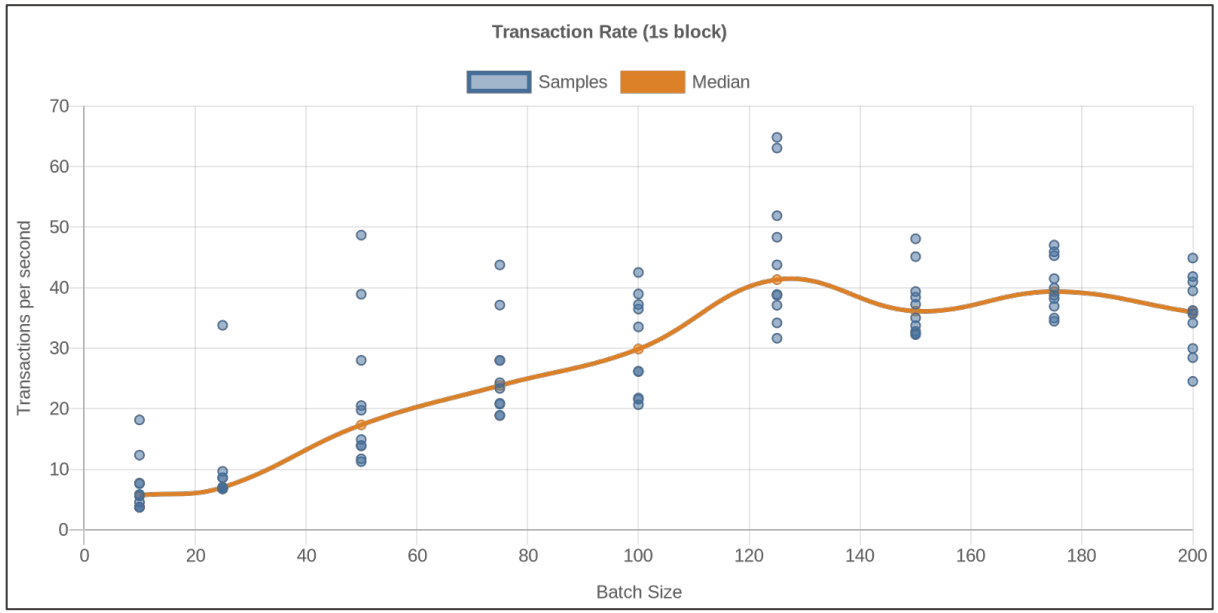




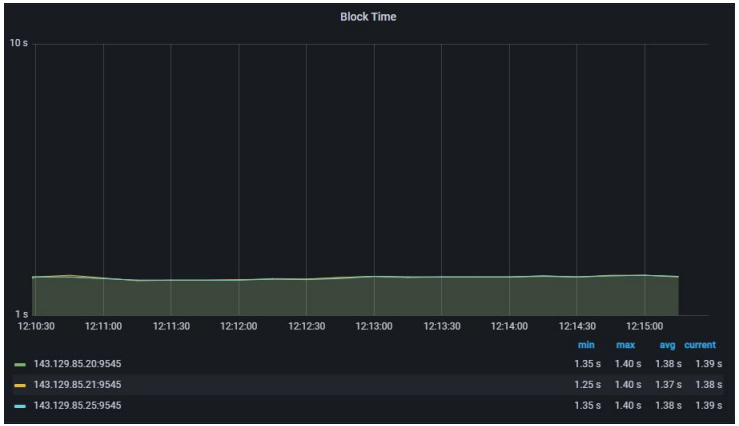
Transaction Completion Time

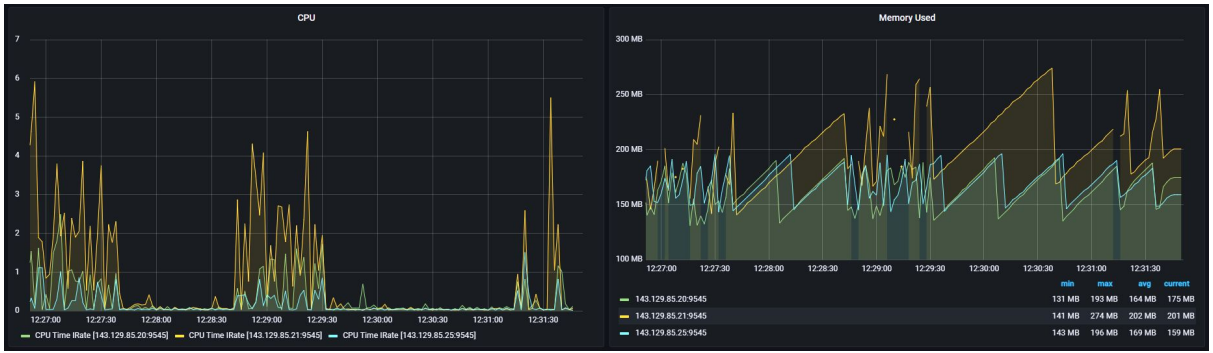


Transaction Rate



Block Time and CPU-Memory Consumption





Lessons Learned

- **Uniform resource distribution in the CityLab testbed + interesting topology**
  - in general, all nodes used are performing in similar way
  - node availability is high, stable network
  - mesh + ring + star network topology
- **Transaction Completion Time:**
  - **If we have more than 200 transactions per block, the interface of the WebSocket used was crashing. We believe this happened due to limitations of the CityLab testbed.**
- **Transaction Rate:**
  - **maximum effective throughput of approximately 40 transactions per second using Websocket**
- **All incoming TCP connections to the Citylab nodes are blocked by the University's firewall.**
  - SSH-tunnel to access the Web GUI from our PC/laptop

Business Impact

Business Impact (1/4)

PRODUCT UPGRADE

- Based on the results, **MeshDapp platform has been upgraded with the following**:
  - Monitoring system has been extended to include additional metrics: Block time, Transaction Rate, CPU, Memory and System Processes
  - Smart Contracts were deployed in the CityLab nodes suitable to interoperate with the traffic dataset - first of this kind till now !
  - Code is optimized and new knowledge on blockchain and distributed networking has been acquired.

Business Impact (2/4)

BUSINESS DEVELOPMENT

- Practical proof that blockchain-based platforms in mesh networks are feasible:
  - This gives **an edge over competitors**
- Blockchain-enabled payment systems in decentralized infrastructures could become a game-changer for **SMEs** and **ISPs**.
  - **local token economy**
- MeshDapp platform would increase competitiveness, as it would help to **reduce operational cost**
  - **Saving money (no intermediary fees - initial results for Stage 2)**
  - **Saving human resources**
  - **Safe and secure data transactions**

Business Impact (3/4)

VALUE PERCEIVED

- **Practical experience** with real testbed, real network topology and enormous data generated (Dataset uploaded to Zenodo **DOI: 10.5281/zenodo.5879948**)
- Increased knowledge about the blockchain-based payment systems in a real (production) network
- Acquired new skills, e.g., **Prometheus, Grafana, Ethereum PoA, Docker, JFed** etc
- Proof of blockchain-enabled platform in mesh networks
- Blockchain-friendly testbed

Business Impact (4/4)

WHY FED4FIRE+ ?

- Our initial contact with Fed4Fire+ was in 2014 (**Fed4FIRE-GENI Research Experiment Summit (FGRE 2014)** - Ghent !
- Worked on integration of Community-Lab testbed in JFed (C-Lab Wrapper)
- Simple, efficient and cost effective experimental process
- Excellent support and expertise from testbed patrons (CityLab)
- Financial grant to support our experiment
- Reliable resources

Feedback

MeshDapp

Feedback (1/5)

EXPERIMENTAL SETUP AND TOOLS

- Documentation from CityLab are covering all aspects of running experiments (very useful)
- **Minimal effort** to setup and deploy our experiment after reading documentation from CityLab testbed
- Excellent support and assistance from CityLab and IRIS (**Dima Hadiwardoyo, Bart Braem**, **Daniel van den Akker** and **Diarmuid Collins**)
  - Issue: Login to iMinds authority centre (problem with certificates)
  - Issue: All incoming TCP connections to the Citylab nodes are blocked by the University's firewall

Feedback (2/5)

CITYLAB TESTBED CAPABILITIES

- CityLab capabilities are sufficient to run the MeshDapp platform (200 transaction per batch - upper bound)
- Comparing to other EU testbeds (e.g. , Community-Lab, Ninux, AWMN, Santander, FreiFunk):
  - CityLab is more stable in terms of nodes and links
  - More powerful nodes and very good network connectivity
  - High speed connectivity: 93 Mbps average bandwidth between nodes

Feedback (3/5)

SUPPORTING SMES

- CityLab testbed is very ideal for researchers and early stage SMEs to experiment and validate their prototypes
- CityLab is a very powerful testbed for the research and SME community working on:
  - Wireless and routing protocols

Feedback (4/5)

REVIEWERS

- Bad peer review !
  - 4 rejection for Stage 2 application
    - MeshDapp: 1 rejection for Stage 2
    - PiCasso: 3 rejection for Stage 2
- No comments for the rejection:
  - Scored 36.5/45.00
  - What was the cutoff points for the proposals being funded ?
  - Why there is no full evaluation report ? Why no comments on scoring ?

Feedback (5/5)

PUBLICATIONS

- Blockchain-enabled Payment System for Wireless Mesh Networks: The case of CityLab and IRIS Testbed
  - IEEE BLOCKCHAIN 2022 (under preparation - deadline April 2022)
- Towards Information-Centric Edge Platform for Mesh Networks: The Case of CityLab Testbed
  - IEEE International Conference on Fog Computing (ICFC 2020) (accepted)
  - https://www.fed4fire.eu/wp-content/uploads/sites/10/2020/02/sme1_picasso.pdf
- Fed4Fire+ (Funding Agency)

Thank You !

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