F4Fp-SME-COD201117-02 (Stage 1)

MeshDapp:

# Blockchain-enabled Payment System for Wireless Mesh Networks

Mennan Selimi, Lenart Ibraimi

Business and Innovation Center

Fed4Fire+ Review Meeting (Online)

27th of May, 2021

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)
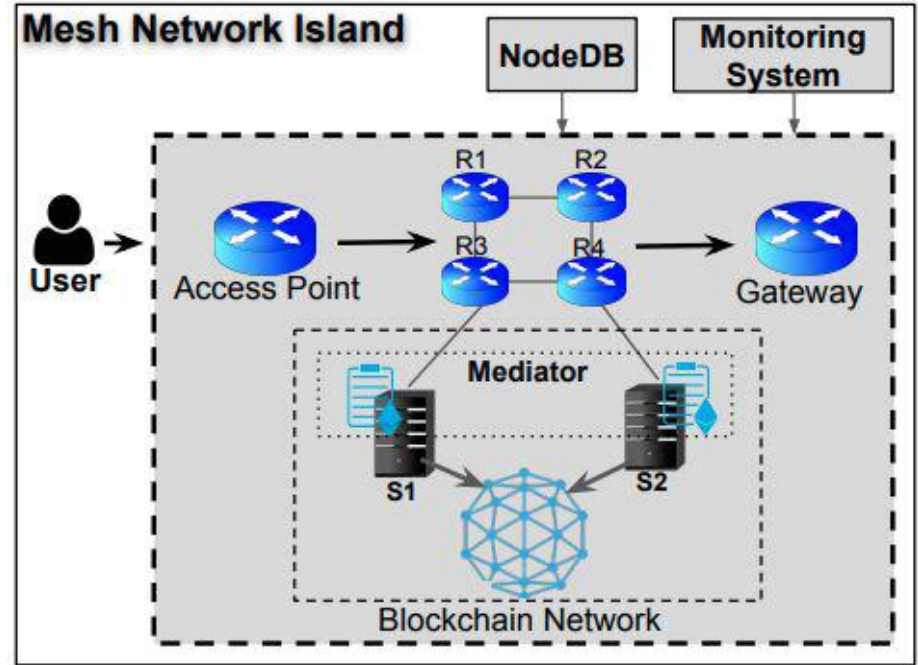
Background and motivation

- **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)
- **Monitoring server** (Prometheus + Grafana), key entity
- **Docker containers** deployed for in/out traffic measurement
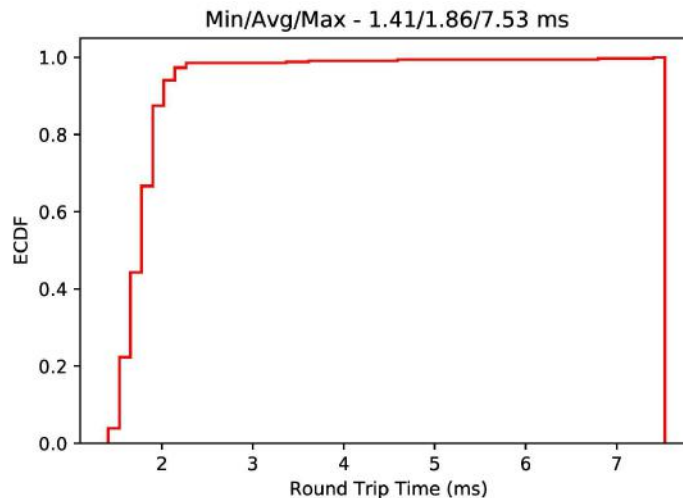- **Ethereum smart contracts** to bootstrap the MeshDapp network

Project Results

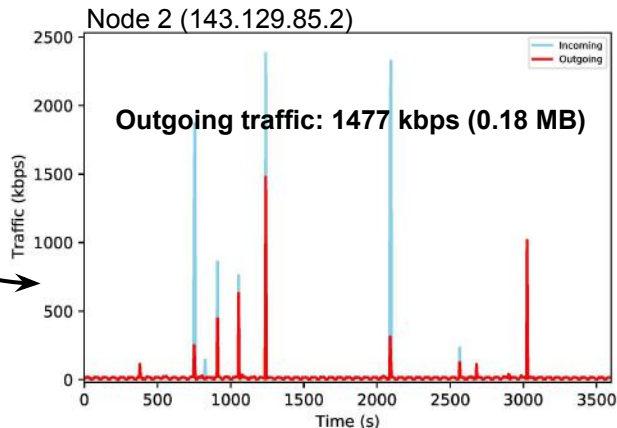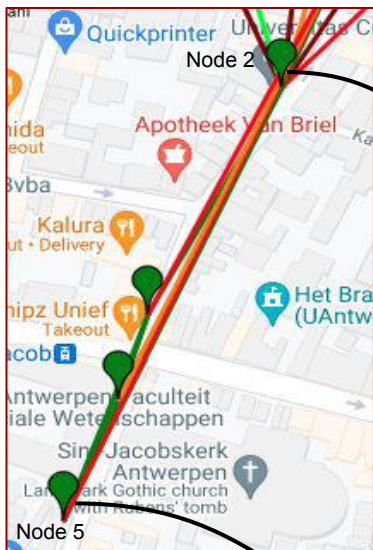MeshDapp
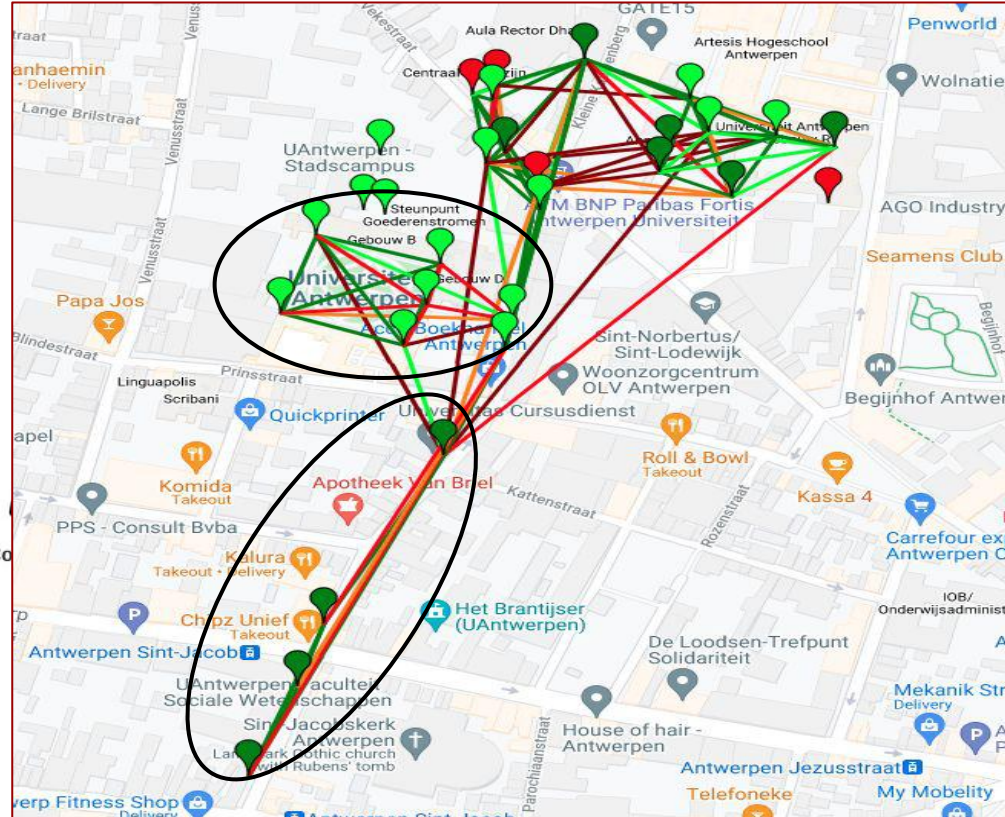
Bandwidth and RTT

- Average bandwidth: **93.9 Mbps**
- Normal distribution (no skew)
- Bandwidth slightly affected by the traffic
- The best testbed performance observed so far !
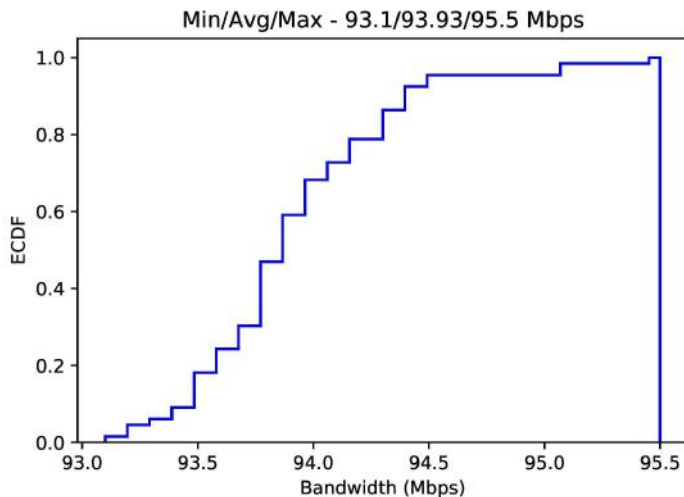
- Average RTT (Round trip time) **1.86 ms**
- **10% of the nodes** higher than 2 ms RTT
- Overall, a very good network performance !

Min/Avg/Max - 93.1/93.93/95.5 Mbps

Min/Avg/Max - 1.41/1.86/7.53 ms

Network Traffic

Node 2 (143.129.85.2)

Outgoing traffic: 1477 kbps (0.18 MB)

Price Plan:
100 kb = 0.005 €

Total Rewarded:
7.3 €

Node 5 (143.129.85.5)

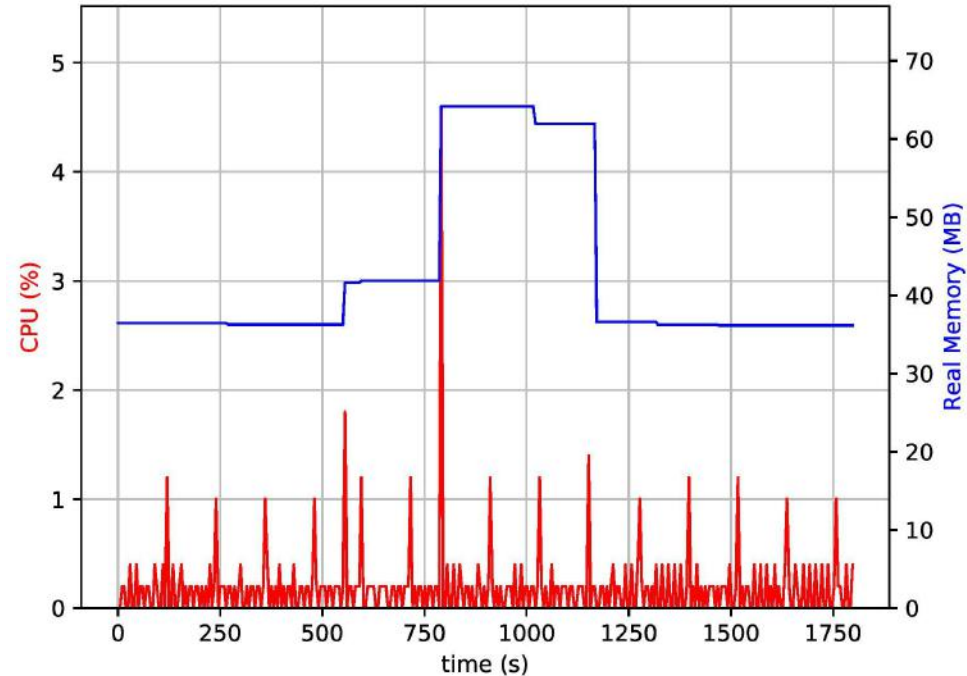**Outgoing traffic: 180 kbps (0.02 MB)**
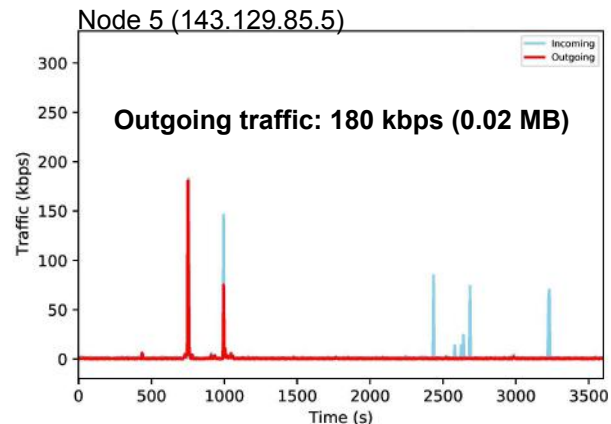
Price Plan:
100 kb = 0.005 €

Total Rewarded:
0.9 €

CPU & Memory Utilization

- CPU consumption almost never reaches more than **two cores**
- RAM memory stays constant in a range between **35 and 60 MB**
- Resource-constrained **can support** blockchain-enabled payment systems

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
- **Monitoring System + blockchain components (Ethereum PoA) are feasible in CityLab**
  - the placement of monitoring server is critical
- **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 (Stage 1)

- Based on the results from the Stage 1, **MeshDapp platform has been upgraded with the following**:
  - Monitoring system has been extended to include <u>additional metrics</u>: 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

- 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
- Support for Stage 2 (ongoing process - unfortunately it didn't work)
- Reliable resources

WWW.FED4FIRE.EU

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 (**Bart Braem**, **Daniel van den Akker** and **Dima Hadiwardoyo**)
  - 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
- 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

WWW.FED4FIRE.EU

Feedback (3/5)

SUPPORTING SMES

- CityLab testbed is very ideal for early stage SMEs to experiment and validate their prototypes
- CityLab is a very powerful testbed for SMEs 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 Testbed
  - IEEE Global Communications Conference (GLOBECOM 2021) (under review)
- 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)

This project has received funding from the European Union's Horizon 2020 research and innovation programme, which is co-funded by the European Commission and the Swiss State Secretariat for Education, Research and Innovation, under grant agreement No 732638.

Thank You !