F4Fp-SME-COD190625-01

PiCasso: Information-centric Edge Computing Platform for Wireless Mesh Networks

Mennan Selimi

Business and Innovation Center, SEEU

North Macedonia

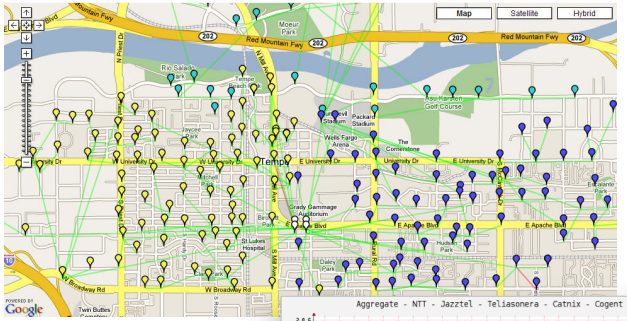
FEC6 Meeting

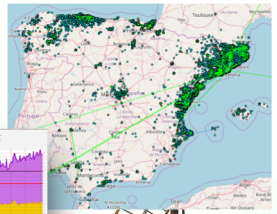
15° of October, 2019, Athens, Greece

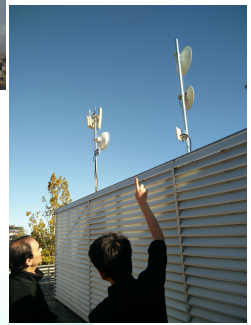
Experiment Description

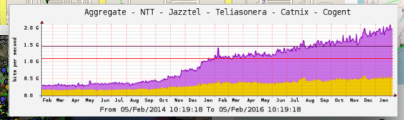
Background and Motivation

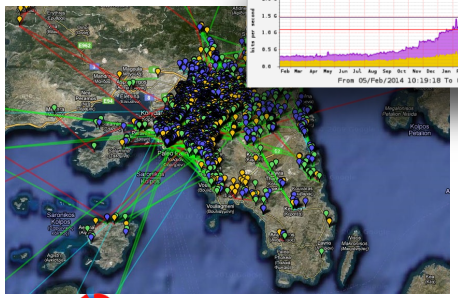
MUNICIPAL WIRELESS NETWORKS

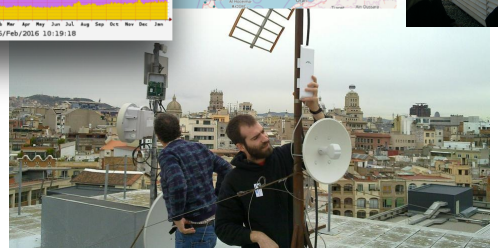












freifunk.net

Crowdsourced: network infrastructures built by WISPs or citizens

Digital divide: the lack of coverage of the conventional operators

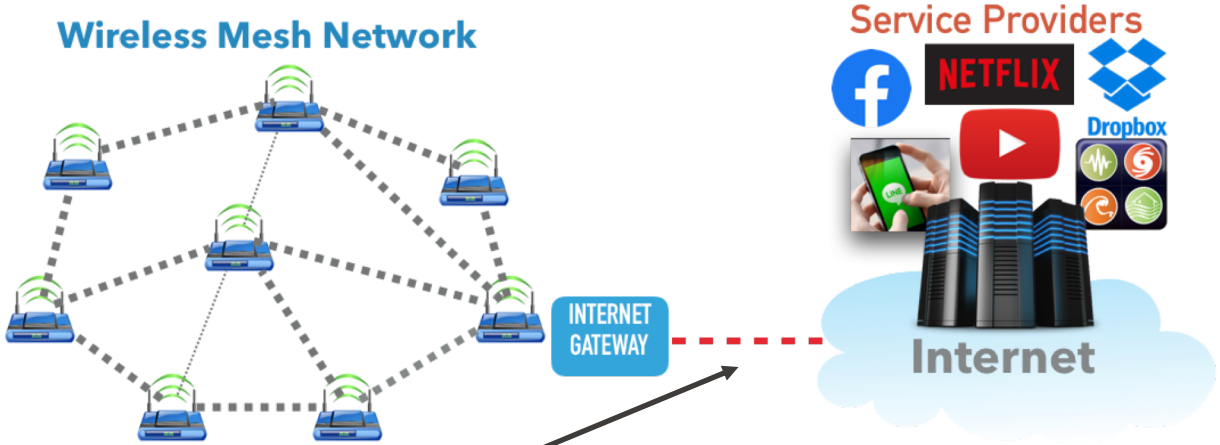
An Alternative telecommunications model [1]

Profit / non-profit WISPS and CNs

swisscom kpn guifi·net common networks cricket wireless

[1] RFC 7962 on Alternative Network Deployments: Taxonomy, Characterization, Technologies, and Architectures

Challenges



Constrained Backhaul

Intermittent connection (link)

High latency

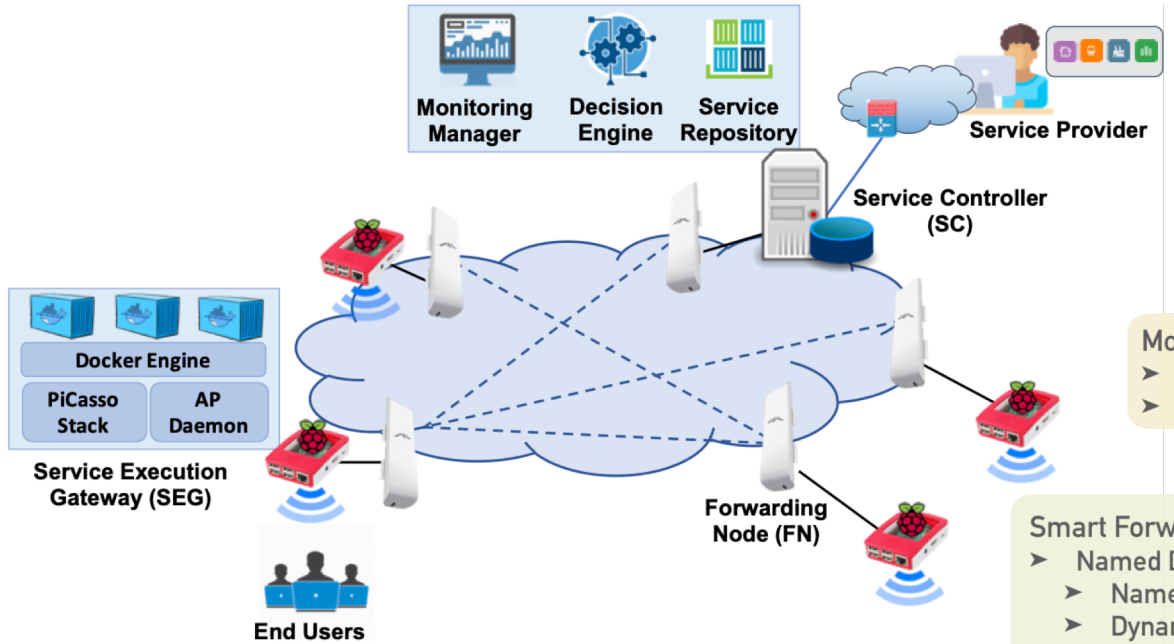
Poor QoS and QoE

Services not available

Revenue Lost for WISPs !

Concept and Objectives

PICASSO: ICN-BASED EDGE COMPUTING PLATFORM



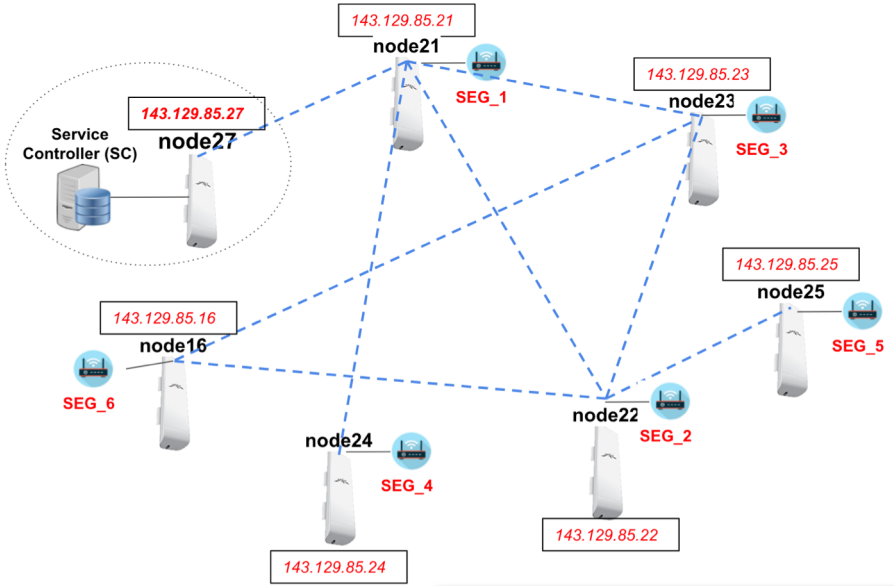
Automatic Decision Making
- Service Deployment
- Where and When to place services ?
  - QoS, SLA
  - Network condition
  - Hardware resources

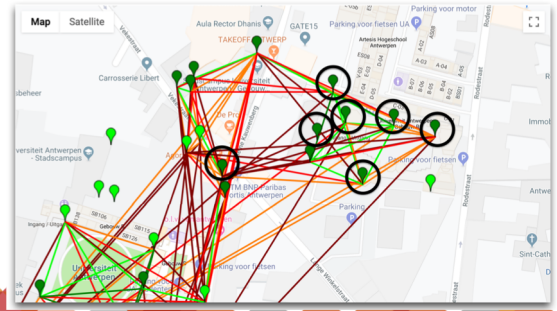
Monitoring System
- Node usage (CPU, Memory)
- Network condition

Smart Forwarding
- Named Data Networking (NDN)
  - Name based routing
  - Dynamic in-network caching
- Delay Tolerant Networking (DTN)
  - To support emergency situation

Experiment Setup

- 7 Wireless Nodes from CityLab FIRE testbed (mesh)
- Rodestraat 14 and Grote Kauwenberg 2, Antwerp
- WiFi 802.11ac on 2.4GHz and 5GHz (Ubuntu 16.04)
- Location of Service Controller selected by BASP heuristic (highlighted)

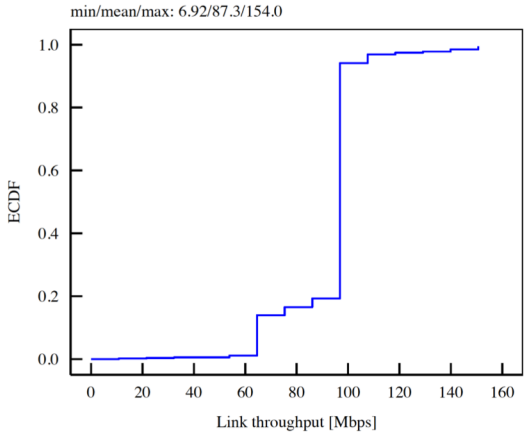




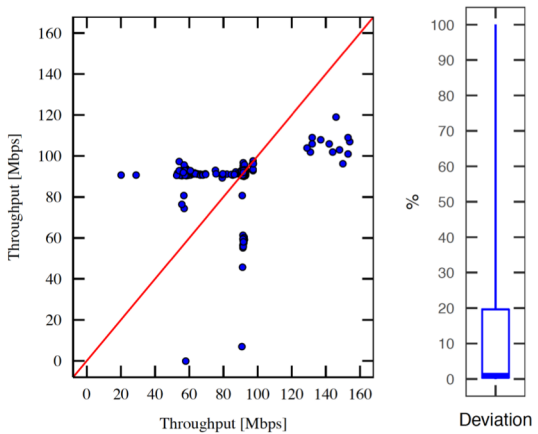
Project Results

Project Results

MEASUREMENTS FROM CITYLAB



Link bandwidth distribution (ECDF)



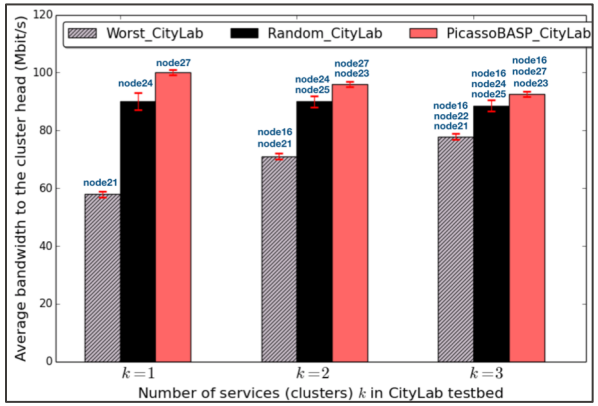
Bandwidth Asymmetry

- Average bandwidth: **87.3 Mbps**
- Skewed bandwidth distribution

  20% of the links have less than 70 Mbps of bandwidth
- Bandwidth asymmetry**: 25%** of the links have deviation more than 20%
- **Re-tuning** radios by members

Project Results

NODE SELECTION FOR ICN COMPONENTS



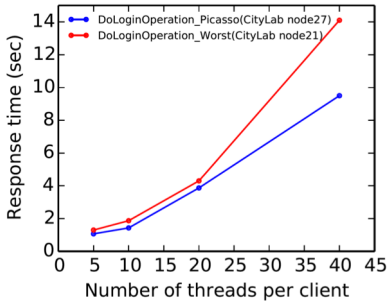
Average bandwidth to the cluster heads

$$\arg\max_S \sum_{i=1}^{k} \sum_{j \in Si} f_{ij}$$

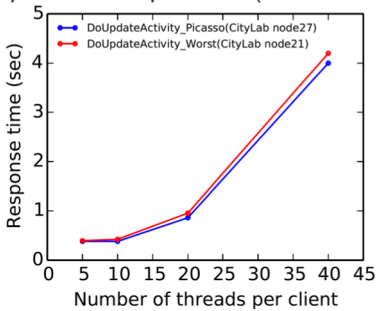
partition **k** of clusters: $S = S_1, S_2, S_3, \ldots S_k$

f_{ij} – bandwidth of the path, from node **i** to **j**

DoLogin operation (Facebook)



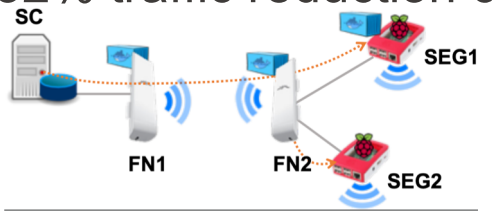
UpdateWall operation (Facebook)



- BASP (Bandwidth and Availability) heuristics for Service Placement
- Best node (node27), Worst (node21)
- Real services for testing (open source Facebook)
- **37%** gain in terms of response time
- Improved QoS / QoE

Lessons Learned

- Non-uniform resource distribution in the CityLab testbed
  - Service placement heuristic is a must for ICN components
  - 37% gain obtained when using BASP heuristic
- Deployment benefits (transparency):
  - Easy to deploy PiCasso platform thanks to the Plug-and-Play feature
- Traffic reduction benefits (operator gain)
  - Thanks to NDN caching of PiCasso, in the preliminary results (ongoing work) we have 32% traffic reduction compared to host-centric communication



Business Impact

Business Impact (1/5)

PRODUCT UPGRADE

- Based on the results from CityLab testbed, PiCasso platform has been upgraded with the following:
    - Service placement algorithms are extended to include additional metrics (to be more accurate) such as hardware resources (CPU, memory) and geo-coordinates of the nodes.
    - New service repos are added to Service Controller (Distributed storage and live-video streaming service)
    - Code is optimized and new knowledge on ICN has been acquired.

Business Impact (2/5)

BUSINESS DEVELOPMENT

- Practical proof that ICN-based edge platforms in wireless mesh networks are feasible
    - This gives edge over competitors
- ICN deployment benefits
    - Reduce service delivery cost (better QoE for users)
        - Service placement heuristics a must !
    - Traffic reduction benefits (Operator gain)
        - Benefits of in-network caching and name-based routing

Business Impact (3/5)

SUSTAINABILITY

- Upcoming H2020 and Horizon Europe calls
    - One H2020 proposal submitted (H2020-FETOPEN-2019)
- Commercialization of the product through:
    - Two startups at Technology Park, SEEU

Business Impact (4/5)

VALUE PERCEIVED

- Practical experience with real testbed, real network topology and enormous data generated
- Increased knowledge about the ICN architecture
- Acquired new skills, e.g., ICN, NDN, NFD, Docker, JFed etc
- Proof of ICN-based edge platform feasibility in mesh networks
- ICN-ready testbed

Business Impact (5/5)

WHY FED4FIRE+ ?

- 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)
- Reliable resources

Feedback

Feedback (1/4)

EXPERIMENT SETUP AND TOOLS

- Documentation from CityLab are covering all aspects of running experiments (very useful)
- Minimal effort to set up and deploy our experiment after reading documentation from CityLab testbed
- **Excellent support and assistance from CityLab (Bart Braem, Daniel van den Akker) and Ugent.be (Brecht Vermeulen)**
- Issue: Login to iMinds authority centre (problem with certificates)
    - Solved with technical help (Bart Braem)

Feedback (2/4)

EXPERIMENT SETUP AND TOOLS

- User-friendly interface of jFed
- Multiple OS images supported in the experiments

Feedback (3/4)

CITYLAB TESTBED CAPABILITIES

- CityLab capabilities are sufficient to run the PiCasso platform
- Comparing to other EU testbeds (e.g. , Community-Lab):
    - CityLab is more stable in terms of nodes and links
    - More powerful nodes and very good network connectivity
    - High speed connectivity: 87 Mbps average bandwidth between nodes

Feedback (4/4)

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

Next Steps

QUANTIFY THE ICN BENEFIT (STAGE 2)

- Quantify traffic reduction when using ICN (core)
    - Migrate service repos (containers) from Service Controller to the other nodes in the network (ongoing)
    - Compare ICN with host-centric communication
    - Business impact – WISP operator gain


Co-funded by the European Union


Co-funded by the Swiss Confederation

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.

WWW.FED4FIRE.EU