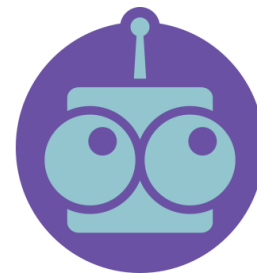# Lucy

IoT & 5G Smart City detector platform

SME continuous call – Stage 1 and 2

Piotr Michał Pawałowski

IronRobots.com

Online review

Berlin, 2020-03-30

Background and motivation

- A missing dog is a tragedy for the owner

- Only in Germany over 100.000 dogs a year are reported as missing

- Searching for a lost dog takes lots of time, is often fruitless and very stressful for both the owner and the pet

Solution - Lucy

Secure your dog

Order a Lucy.PIN

Register your dog and add some pictures for easy identification

Attach the Lucy.PIN to your dog's collar

LucyApp.com

Solution

Looking for lost dogs now

You ask for help through social media and in the neighborhood

You ask your friends and family to look for your loss with you

You wander many kilometres when your dog could be hiding around the corner

Looking for lost dogs with Lucy

You report your loss

Lucy broadcasts the information to all users and through social media

You go looking with your friends using Lucy …

… and everyone else who has Lucy.APP installed is looking with you

You get an instant report …

… and your dog is back!

Experiment description

CONCEPT AND OBJECTIVES

- Power consumption on smartphones - BLE scanning and LTE usage

    - Interval between BLE scans in seconds

    - Time of BLE scanning

    - LTE communication interval

Experiment description

CONCEPT AND OBJECTIVES

- Quality of Experience (QoE) of our mobile

- Scalability of the cloud backend using 5G architecture

    - Request per second for owners and searchers

    - Latency for owners and searchers

# Experiment description

EXPERIMENT SET-UP

- PerformLTE testbed – Triangle portal

    - various Lucy.APP versions with various timings of BLE scanning and LTE communication

    - Design user action flows to measure QoE

    - multiple scenarios in which we have run the app and conducted measurements

    - implemented a special logger for the Triangle Portal to measure our custom measurement points for BLE, LTE and QoE

    - almost 100 runs of experimentation

Experiment description

EXPERIMENT SET-UP

- w-iLab.t testbed

  - 1x SERVER5P - core server

  - 2x APU – 5G edge nodes, connected with a wired network to the core server

  - 5x ZOTAC - mobile nodes to simulate clients - 3 will be acting as data producers, 2 as data consumers
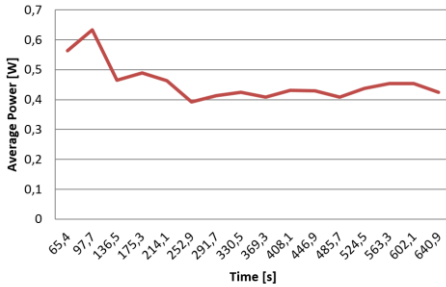
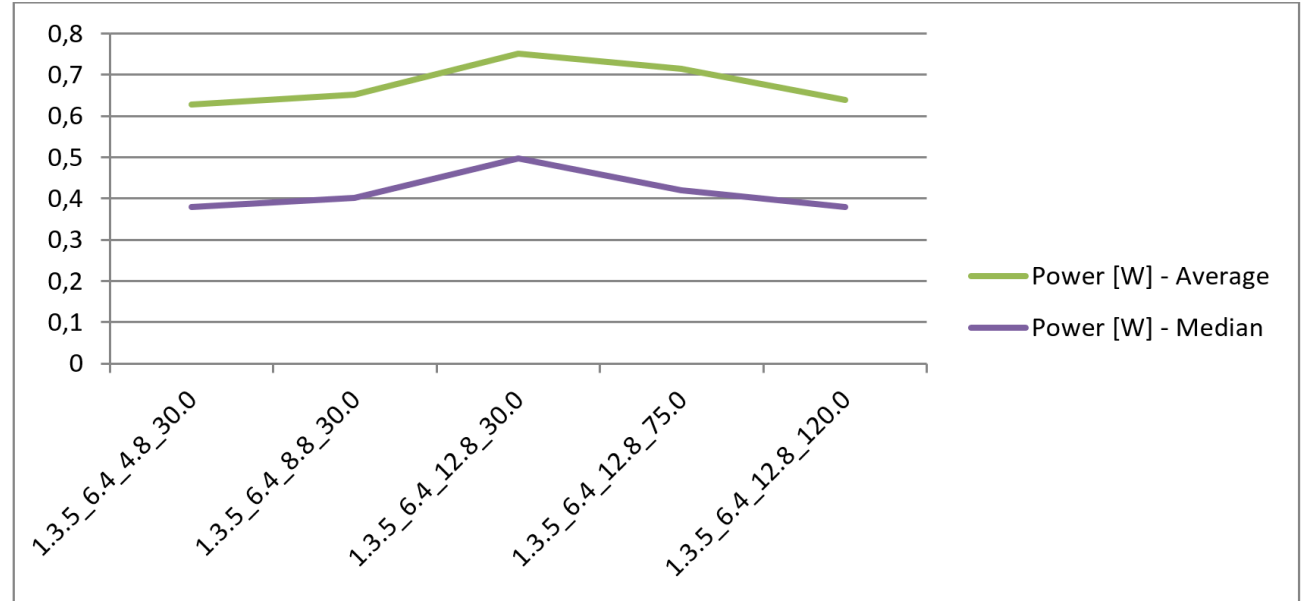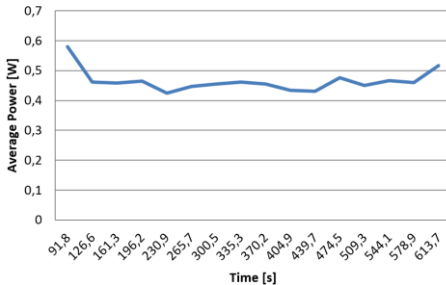 - 43 long-time experiment runs
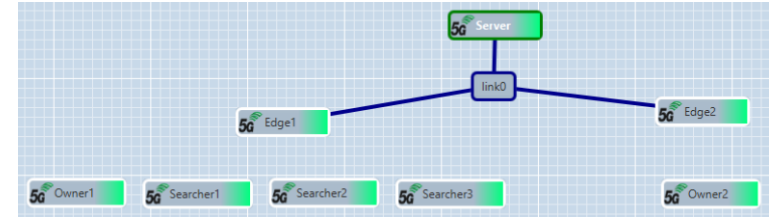
Project results

MEASUREMENTS – BLE SCANNING AND LTE COMMUNICATION

Project results

MEASUREMENTS (QUALITY OF EXEPRIANCE)

Triangle Mark: 3.42

Triangle Mark: 3.72

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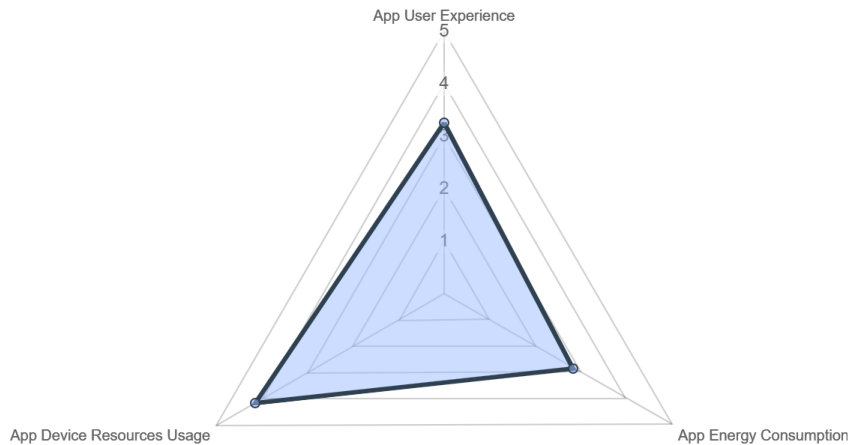
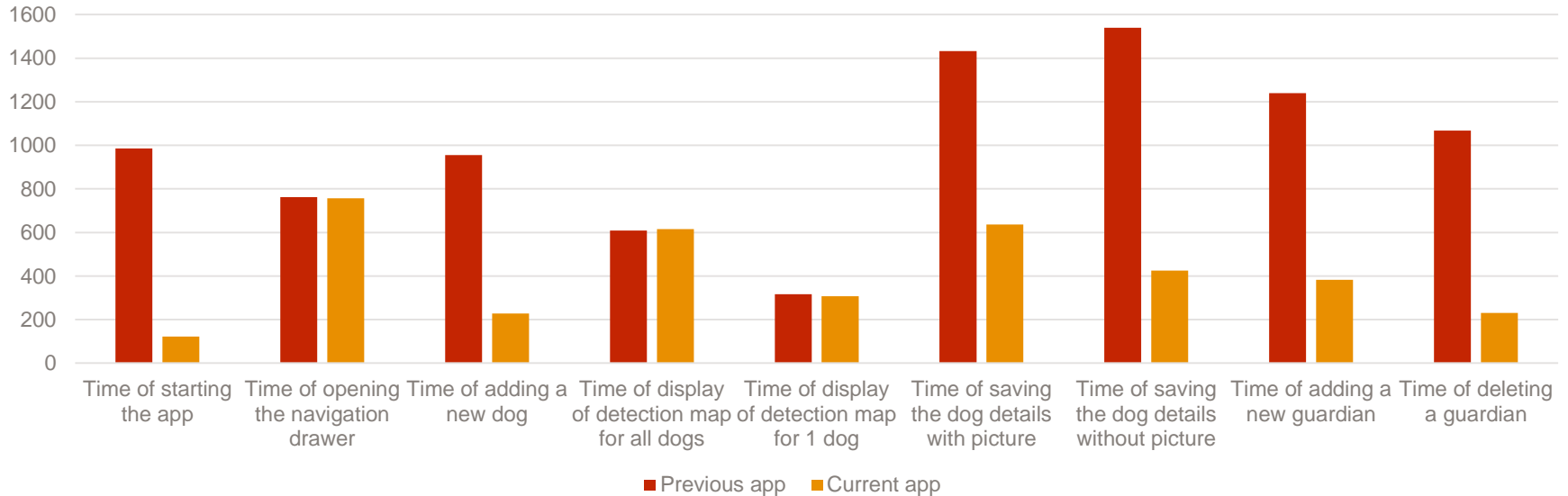# Project results

MEASUREMENTS (QUALITY OF EXEPRIANCE)

Lucy.APP KPIs in previous and current versions.
Execution time in ms.

Previous app   Current app

Project results

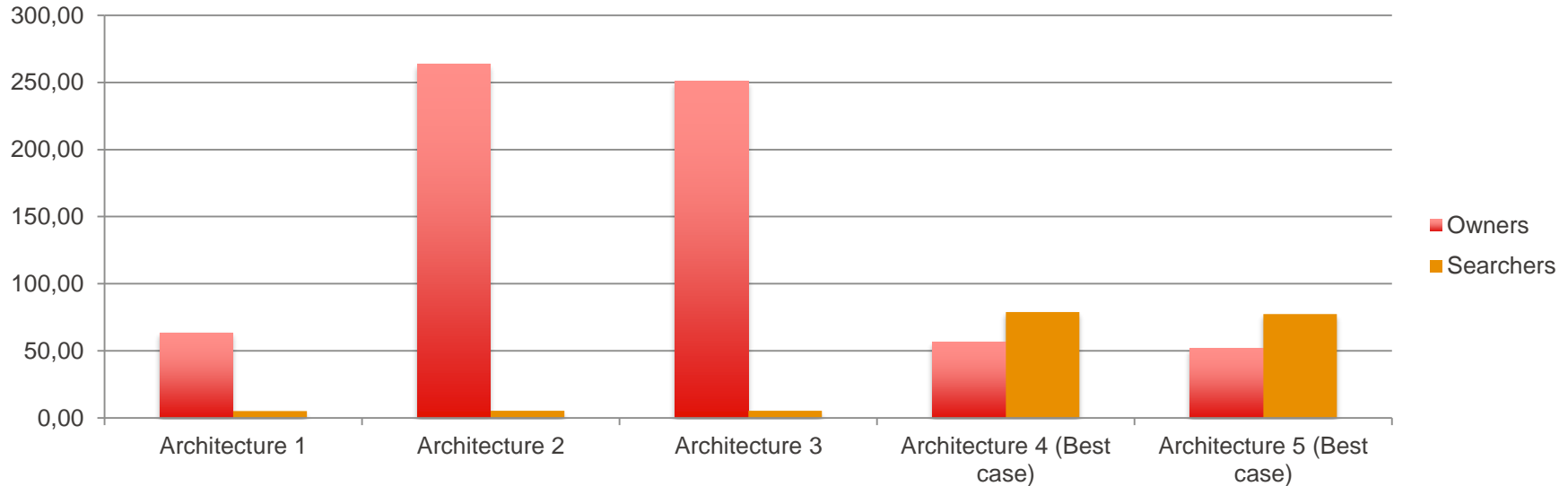## MEASUREMENTS (ARCHITECTURES)

1. Distributing our server implementation over the main server and edge nodes

2. Using edge nodes as caching servers, with the main application running on the server node

3. Using edge nodes as caching servers with dynamic fetching, with the main application running on the server node

4. Using edge nodes as localized cache with asynchronous queueing on the central server

5. Using edge nodes to process region data in memory and localized cache with asynchronous queueing on the central server

Project results
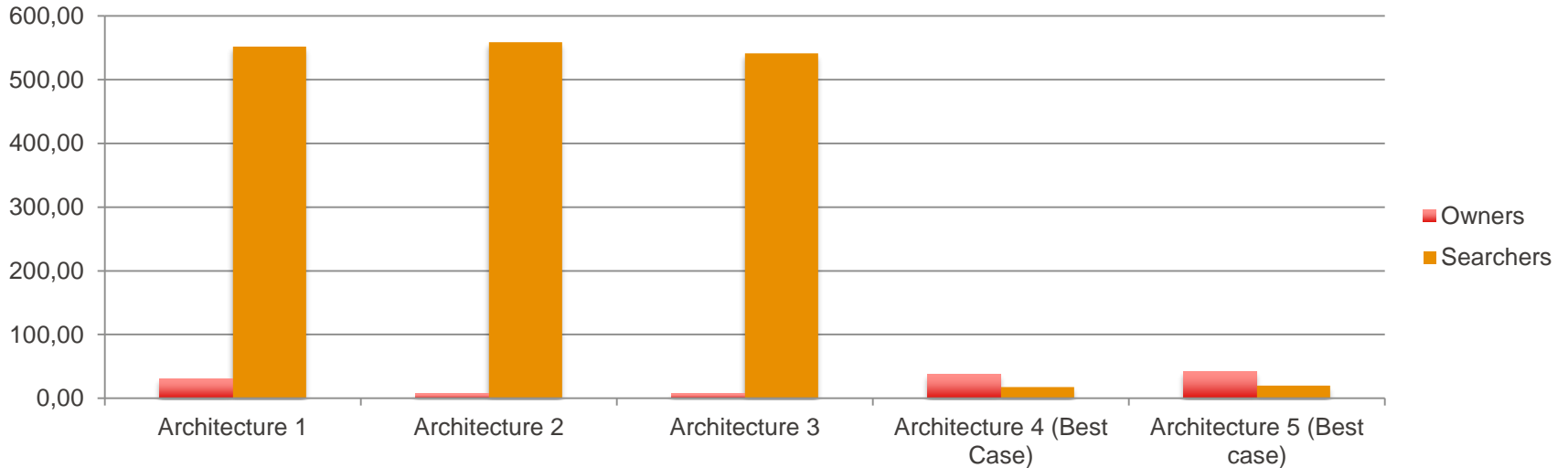
MEASUREMENTS (ARCHITECTURES)

Requests per second

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Project results

MEASUREMENTS (ARCHITECTURES)

Latency in ms.

Project results

LESSONS LEARNED

Power consumption on smartphones
- best values for BLE scanning:
  - scan period time when the application is in background mode – 12.8 seconds
  - time between scans – 75 seconds.
  - increase of power consumption is about 0.3 W

LTE communication interval:
- Android synchronization does not increase the power consumption, as it happens in cycles controlled by Android with communication from other apps

Project results

QoE

- Thanks to the redesign of the network transmission pipeline, we have raised the overall Triangle Portal QoE score from 3.42 to 3.72.
- A higher score could not be obtained as due to the BLE scanning our app has a medium score on power consumption
- Most improvement was achieved due to introduction of asynchronous communication

Project results

LESSONS LEARNED

Scalability of the cloud backend using 5G architecture
- architecture 1 - distributing our sever implementation over 5G edge nodes makes no sense, as their limited computational power is a bottle neck for processing
- architecture 2 - caches all requests and responses and provides them to dog owners. This increases the responsiveness for dog owners by a factor of 4. However, this has a drawback for the searchers, as their requests get cached before being send to other edge nodes
- architecture 3 - dog owners register in edge nodes which dogs they are searching for. This allowed us to slightly improve the performance for the searcher
- architecture 4 - edge nodes as localized cache with asynchronous queueing on the central server. This architecture allowed us to reach the same performance level for owners as architecture 1 and increase the performance for searchers
- architecture 5 - edge nodes to process region data in memory and localized cache with asynchronous queueing on the central server. This architecture scales horizontally by number of nodes which can be commentary to server size and make this architecture complete and scalable in both dimensions.

Business impact

VALUE PERCEIVED

- Form the experience we have gained new knowledge about the power usage on Android devices when performing BLE scans and initiating LTE communication. This allows us to fine tune our Android app in order to keep high and reliable missing dog detection rate and on the other side not to drain the battery of smartphones.

- We have improved the Quality of Experience of our mobile app, which is very important for the perceived quality of our product.

- The experiments concerning 5G architecture allowed us to gain new knowledge and acquire competencies in building backed architectures utilizing 5G edge computing. In the experiments we were able to test 5 different architectures and significantly increase the responsiveness for dog owners.

- In total having reached this goals within 7 months with less than 11 PMs used makes it a great RoI. Furthermore, having used the 2 test-beds gave us the possibility of testing various aspects of our platform, both in the front-end as in the back-end.

Business impact

WHY FED4FIRE+?

- Without the access to the federated test-beds we would not have the possibility to test both aspects of our platform in such an easy way. Having a set of test-beds available allowed us to choose two that perfectly fitted for our testing purposes.

- Not having done the experimentation could have caused that our users would get much worse responsiveness of the app or their batteries would be drained. This could have fatal consequence for a SME like ours, where this is our main product.

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Feedback

USED RESOURCES AND TOOLS

- PerformLTE testbed

    - Triangle portal - The Triangle portal works very well and allows to test Android apps in an easy way. One thing that could be improved, is that custom measurement points defined by users could be automatically placed on the diagrams.

- w-iLab.t testbed

    - jFed - The jFed tools is pretty straightforward and intuitive. We did not have many problems using it. Some initial problems were with Java font scaling on high resolution displays, which was solved with the help of jFed developers. We also would like to have that using jFed the resources of the test-beds could be reserved, so we would not have to do it using an external web page.

Feedback

ADDED VALUE OF FED4FIRE+

- There has not been many administrative tasks related to this open-call. The signing of the contract was straightforward and fast. The support by the UMA and imec staff was great, with quick and precise responses.

- In UMA the setup of the experiment was very easy, we just needed a Skype call.

- In imec, as there we had to use the jFed tool it was a bit more complicated, as we had to get the certificates first, learn how to reserve resources and draw architecture in jFed.

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Feedback

ADDED VALUE OF FED4FIRE+

- The diversity of resources, tools and a common point of access and support, we see as the highest values of the federation.

- Support of Docker images within the imec test-bed would be useful.

- We would like to have access to a living-lab resources on mobile computing, where users with Android phones could test our solution.
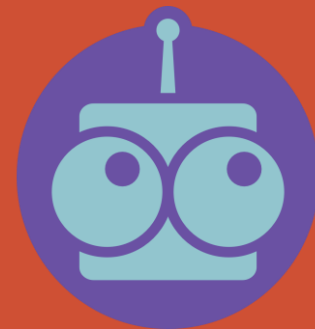
THANK YOU VERY MUCH

PIOTR MICHAŁ PAWAŁOWSKI

OFFICE@IRONROBOTS.COM
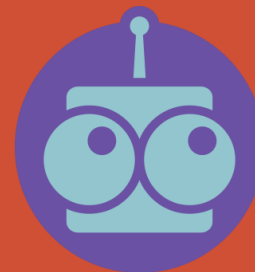
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