WiFiMon – Overview & TNC19 Pilot Outcomes

GN4-3 WP6 T3 Subtask

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6th SIG-PMV Meeting @ Dublin

HEAnet Headquarters

07/03/2019

www.geant.org

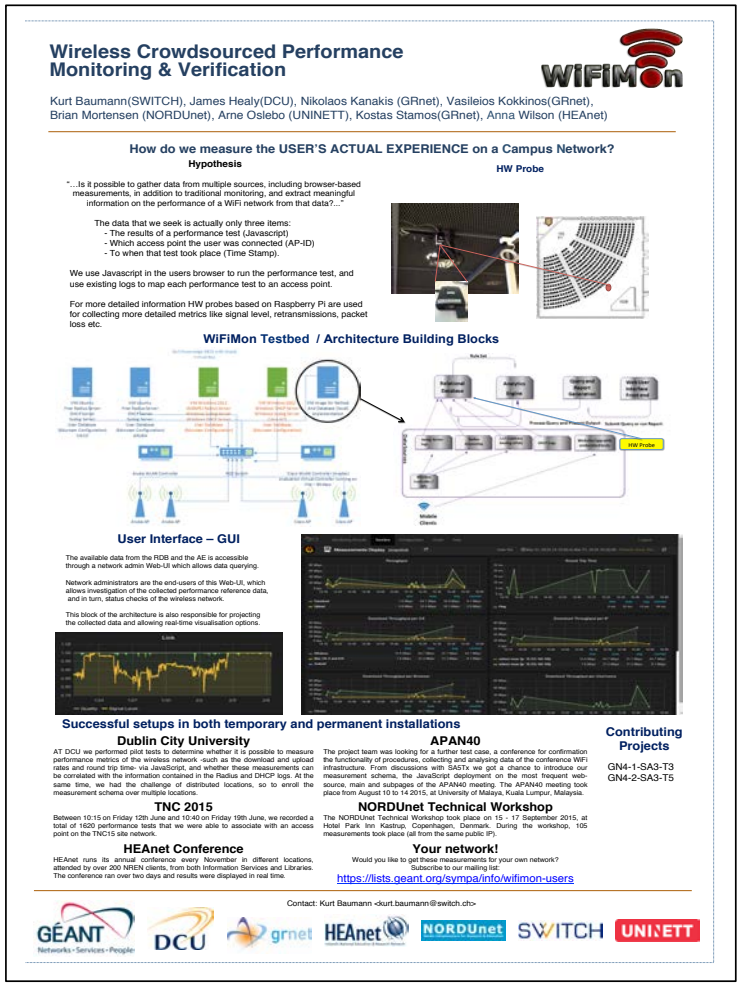
Presentation Outline

- WiFiMon: Problem Statement, Architecture, Data Flow
- Web-based Measurements
- Hybrid Approach (Crowdsourced & HW Probe Measurements)
- Security and Privacy Concerns
- TNC19 Pilot & Results
- Conclusions and Future Work

WiFiMon: Introduction

Mission Statement:

"…It is possible to gather data from multiple sources, including browser-based measurements, in addition to traditional monitoring, and extract meaningful information on the performance of a WiFi network from that data…"



Wireless Crowdsourced Performance Monitoring & Verification

WiFiMon

Kurt Baumann(SWITCH), James Healy(DCU), Nikolaos Kanakis (GRnet), Vasileios Kokkinos(GRnet), Brian Mortensen (NORDUnet), Arne Oslebo (UNINETT), Kostas Stamos(GRnet), Anna Wilson (HEAnet)

How do we measure the USER'S ACTUAL EXPERIENCE on a Campus Network?

Hypothesis

"...Is it possible to gather data from multiple sources, including browser-based measurements, in addition to traditional monitoring, and extract meaningful information on the performance of a WiFi network from that data?..."

The data that we seek is actually only three items:
- The results of a performance test (Javascript)
- Which access point the user was connected (AP-ID)
- To when that test took place (Time Stamp).

We use Javascript in the users browser to run the performance test, and use existing logs to map each performance test to an access point.

For more detailed information HW probes based on Raspberry Pi are used for collecting more detailed metrics like signal level, retransmissions, packet loss etc.

HW Probe

WiFiMon Testbed / Architecture Building Blocks

User Interface – GUI

The available data from the RDB and the AE is accessible through a network admin Web-UI which allows data querying.

Network administrators are the end-users of this Web-UI, which allows investigation of the collected performance reference data, and in turn, status checks of the wireless network.

This block of the architecture is also responsible for projecting the collected data and allowing real-time visualisation options.

Successful setups in both temporary and permanent installations

Dublin City University

AT DCU we performed pilot tests to determine whether it is possible to measure performance metrics of the wireless network -such as the download and upload rates and round trip time- via JavaScript, and whether these measurements can be correlated with the information contained in the Radius and DHCP logs. At the same time, we had the challenge of distributed locations, so to enroll the measurement schema over multiple locations.

APAN40

The project team was looking for a further test case, a conference for confirmation the functionality of procedures, collecting and analysing data of the conference WiFi infrastructure. From discussions with SA5T1 we got a chance to introduce our measurement schema, the JavaScript deployment on the most frequent web-source, main and subpages of the APAN40 meeting. The APAN40 meeting took place from August 10 to 14 2015, at University of Malaya, Kuala Lumpur, Malaysia.

Contributing Projects

GN4-1-SA3-T3
GN4-2-SA3-T5

TNC 2015

Between 10:15 on Friday 12th June and 10:40 on Friday 19th June, we recorded a total of 1620 performance tests that we were able to associate with an access point on the TNC15 site network.

NORDUnet Technical Workshop

The NORDUnet Technical Workshop took place on 15 - 17 September 2015, at Hotel Park Inn Kastrup, Copenhagen, Denmark. During the workshop, 105 measurements took place (all from the same public IP).

HEAnet Conference

HEAnet runs its annual conference every November in different locations, attended by over 200 NREN clients, from both Information Services and Libraries. The conference ran over two days and results were displayed in real time.

Your network!

Would you like to get these measurements for your own network? Subscribe to our mailing list:

https://lists.geant.org/sympa/info/wifimon-users

Contact: Kurt Baumann <kurt.baumann@switch.ch>

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WiFiMon - Problem statement

Measuring and verifying the performance of WiFi networks is challenging. There are no tools that:

- Cover all aspects of performance monitoring and verification.
- Determine how end-users experience WiFi at a given place on the network, at a given time.

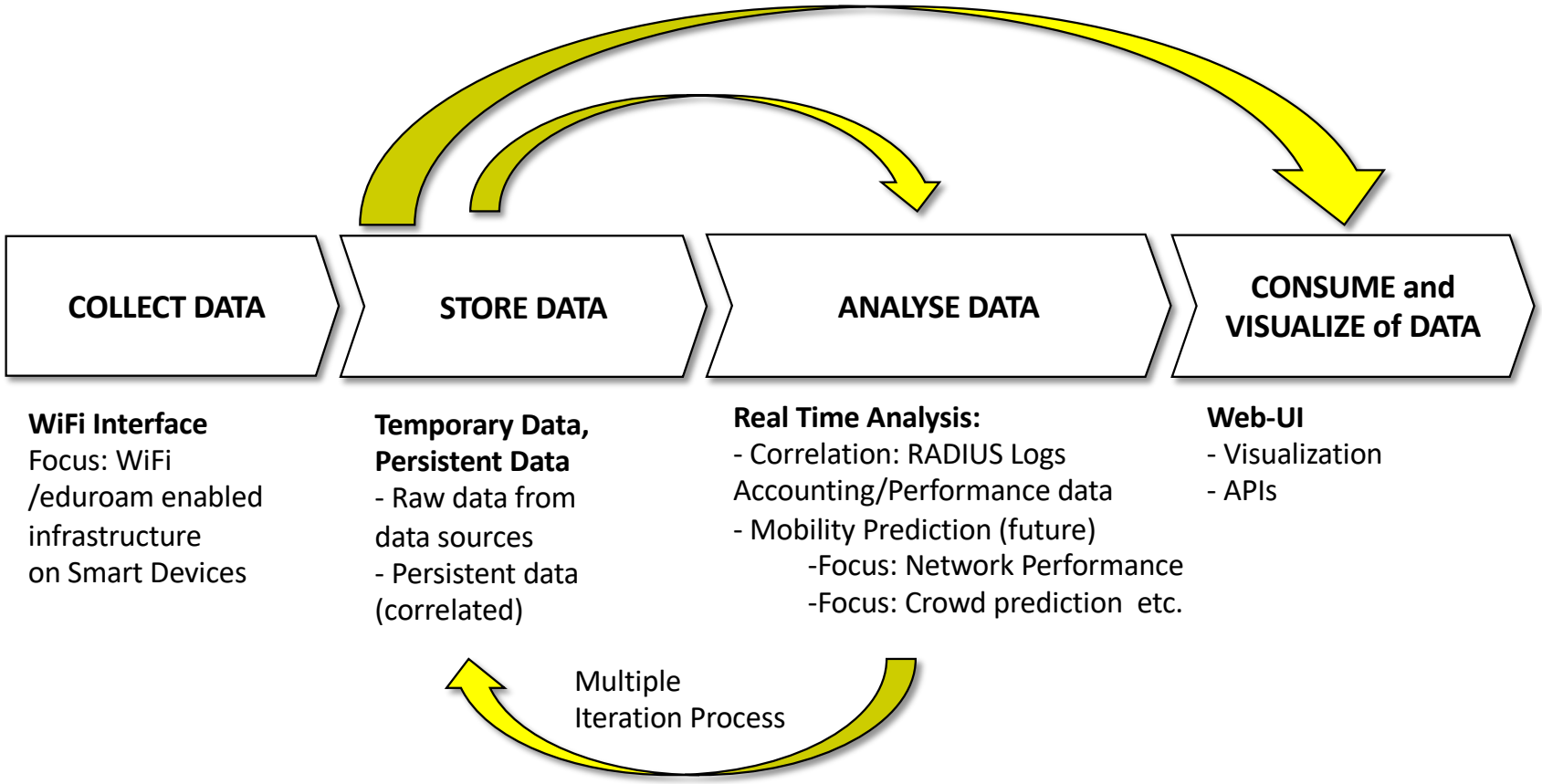
At present, information for wireless networks can be reported in three ways:

- Mobile End-User Device
- Wireless Access Points (WAP) / WiFi-Controller
- Network Management Systems (NMS)

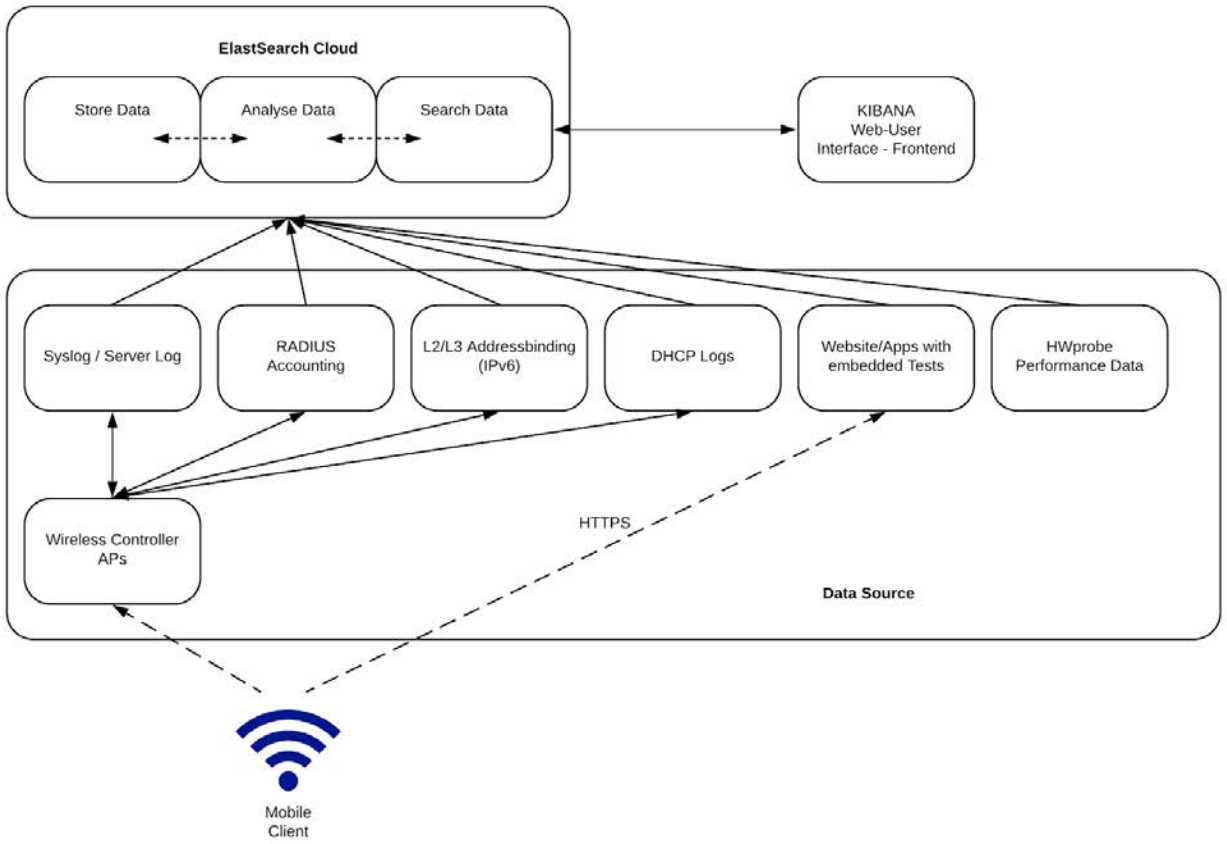
These sources allow "only" determining the wireless network is overall OK, e.g. up/down

- HW probes collect performance measurements but are installed at fixed locations. Crowdsourced measurements are also required.

WiFiMon Process



WiFiMon Architecture



Mobile Client

- End-User device (tablet, mobile phone, etc.)

Data Source

- Generates raw data and exports raw data from data source collectors

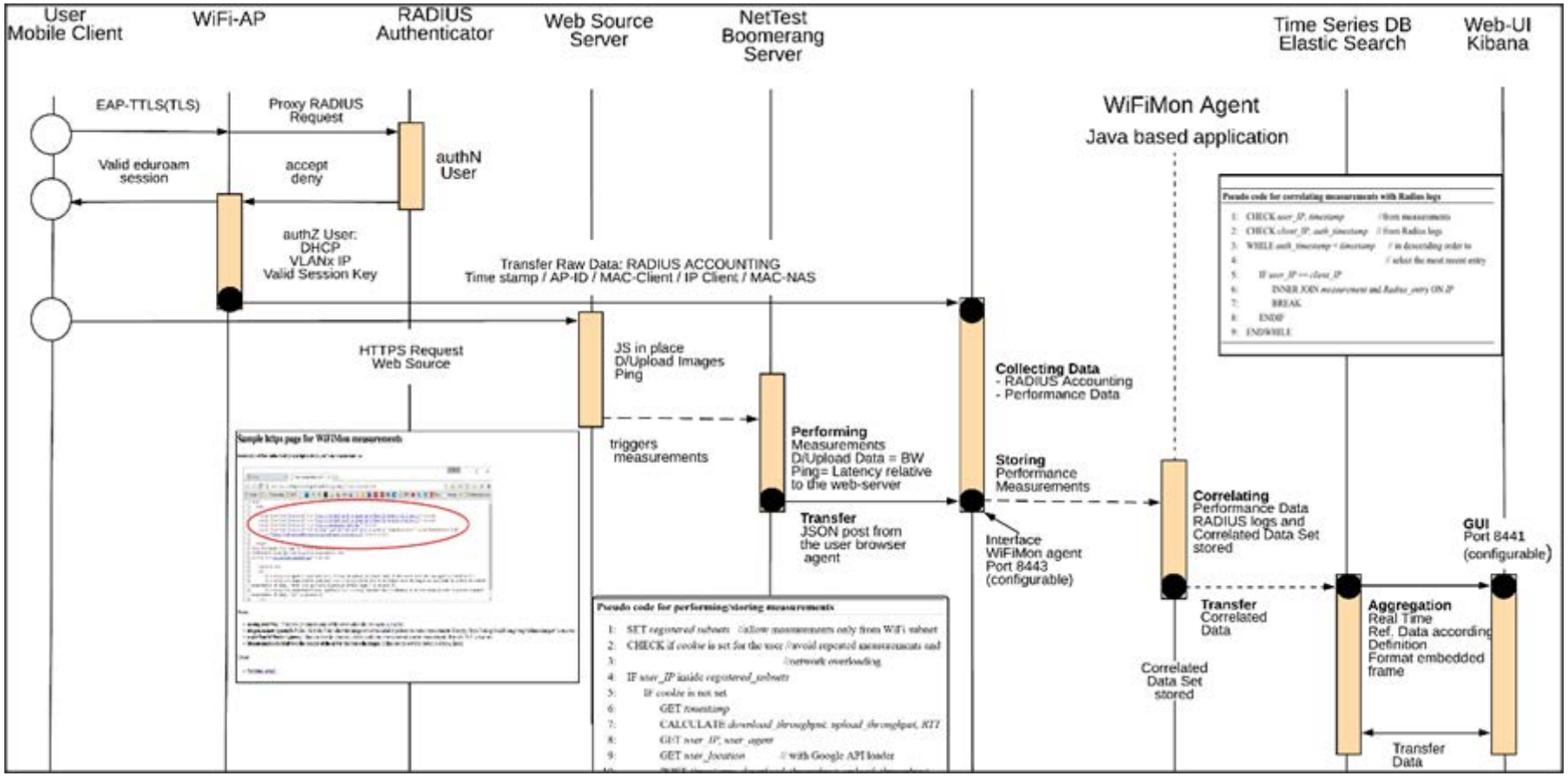
Elastic Cloud

- Stores measurements (Elasticsearch)
- Pipeline raw data to Elasticsearch (logstash, filebeat)

Web User Interface (Web-UI)

- Allows real-time visualization options

WiFiMon – Data Flow



WiFiMon – eduroam enabled WiFi Infrastructure: Walk Through

The end user is required to visit a web page with JavaScript installed

```
<html>
<head>
<title>NetTest measurement page</title>
        <script type="text/javascript" src="https://eipa19.eipa.ttu.ee/wifimon/js/nettest/
jquery-1.11.2.min.js"></script>
        <script type="text/javascript" src="https://eipa19.eipa.ttu.ee/wifimon/js/nettest/nettest-
swfobject.js"></script>
        <script type="text/javascript" src="https://www.google.com/jsapi"></script>
        <script type="text/javascript" id="settings" hostingWebsite="https" agentIp="wifimon.switch.ch"
agentPort="8443" testtool="NetTest-1" imagesLocation="https://eipa19.eipa.ttu.ee/wifimon/images/"
cookieTimeInMinutes="0.01"
                src="https://eipa19.eipa.ttu.ee/wifimon/js/nettest/runtests.js" defer></script>

<!--meta http-equiv="refresh" content="30" -->
</head>

<body>
        <h1>Sample https page for WiFiMon measurements using <strong>NetTest</strong></h1>
</body>
</html>
```

WiFiMon - Performing / Storing measurements

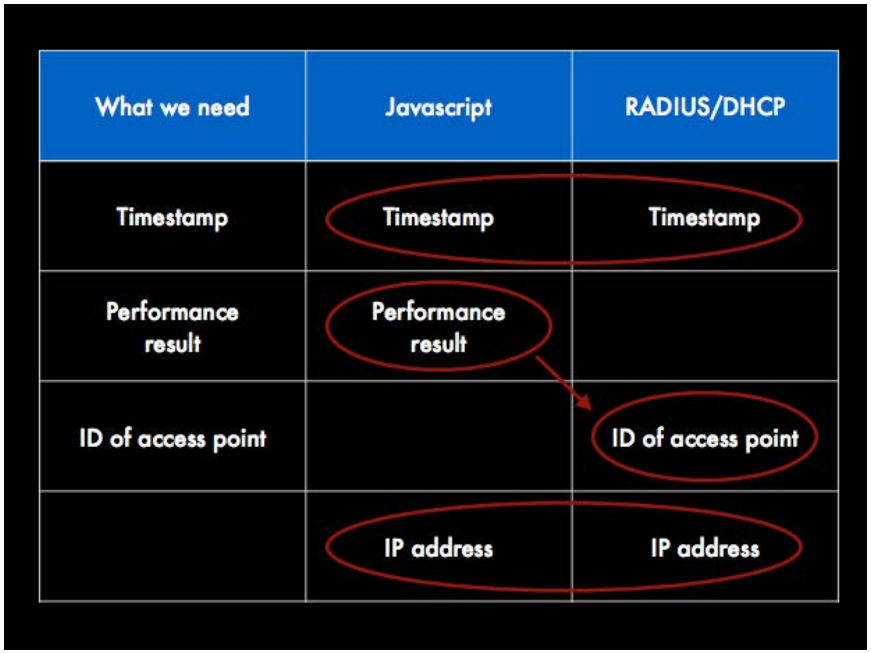
Pseudo code for performing/storing measurements

```
1:  SET registered subnets   //allow measurements only from WiFi subnet
2:  CHECK if cookie is set for the user //avoid repeated measurements and
3:                                      //network overloading
4:  IF user_IP inside registered_subnets
5:      IF cookie is not set
6:          GET timestamp
7:          CALCULATE download_throughput, upload_throughput, RTT
8:          GET user_IP, user_agent
9:          GET user_location          // with Google API loader
10:         POST timestamp, download_throughput, upload_throughput,
11:             RTT, user_IP, user_agent, user_location to Elasticsearch
12:     SET cookie
13:     ENDIF
14: ENDIF
```

Network Overloading Avoidance:

- Measurements accepted only from registered subnets
- Cookie: repeated measurements in short time intervals are not permitted

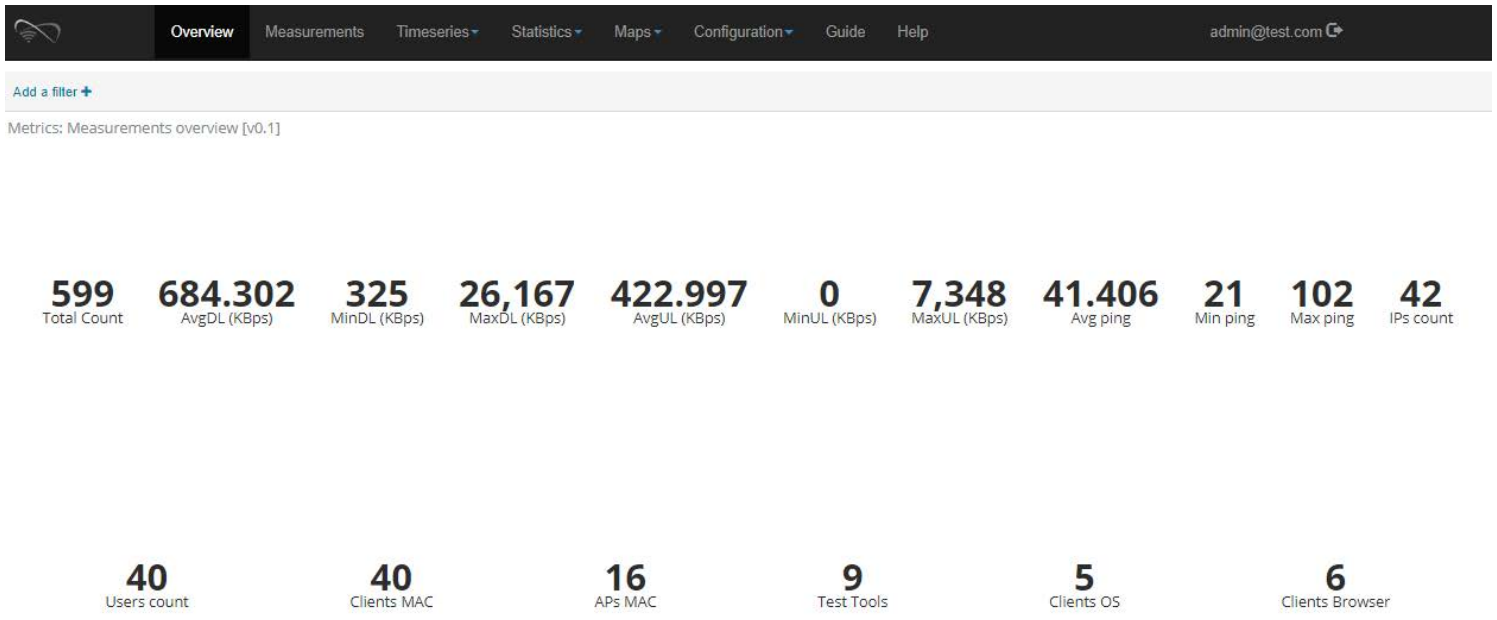
WiFiMon - How we manage/correlate performance data



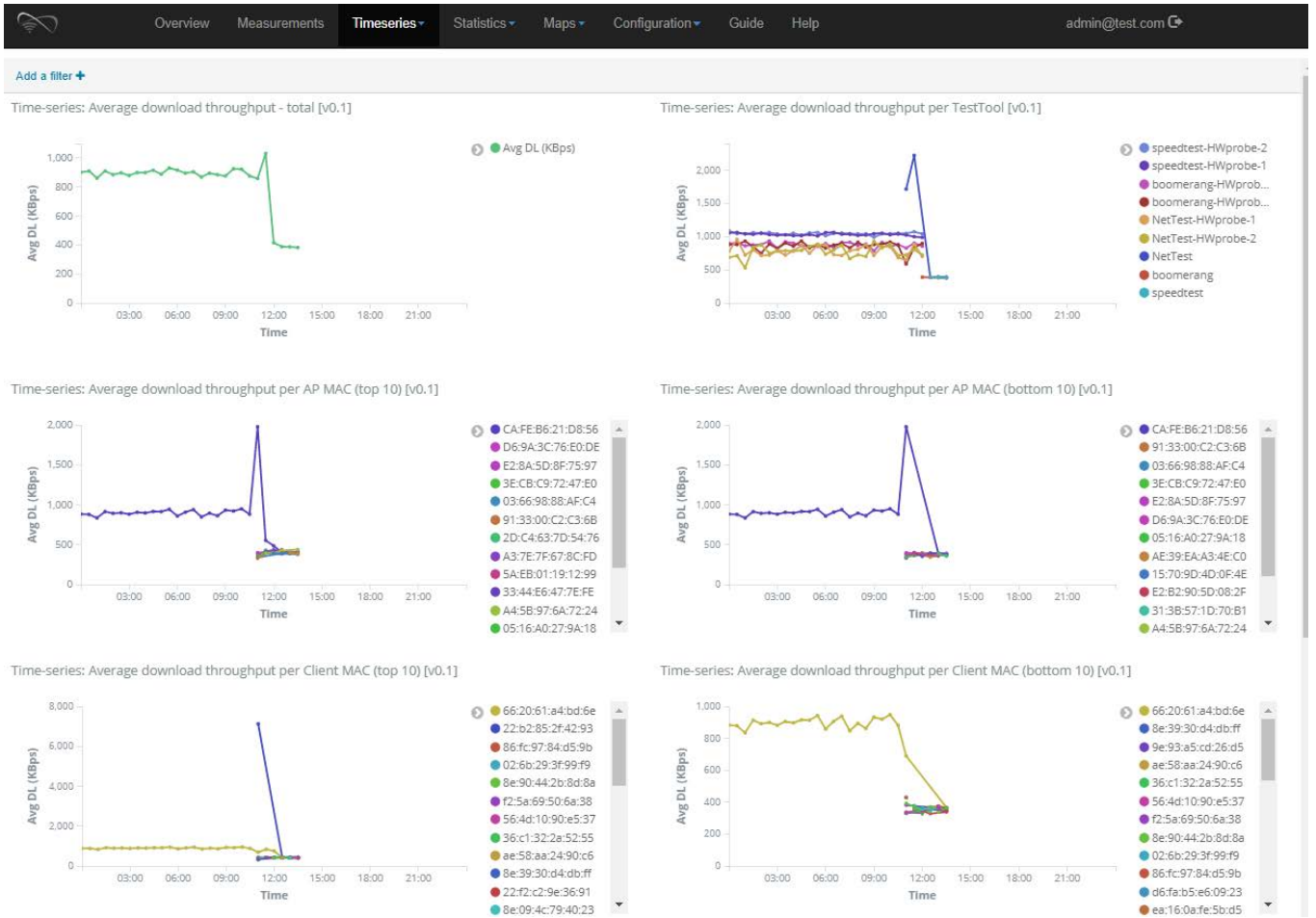
Pseudo code for correlating measurements with Radius logs

```
1:  CHECK user_IP, timestamp              //from measurements
2:  CHECK client_IP, auth_timestamp       // from Radius logs
3:  WHILE auth_timestamp < timestamp      // in descending order to
4:                                        // select the most recent entry
5:      IF user_IP == client_IP
6:          INNER JOIN measurement and Radius_entry ON IP
7:          BREAK
8:      ENDIF
9:  ENDWHILE
```

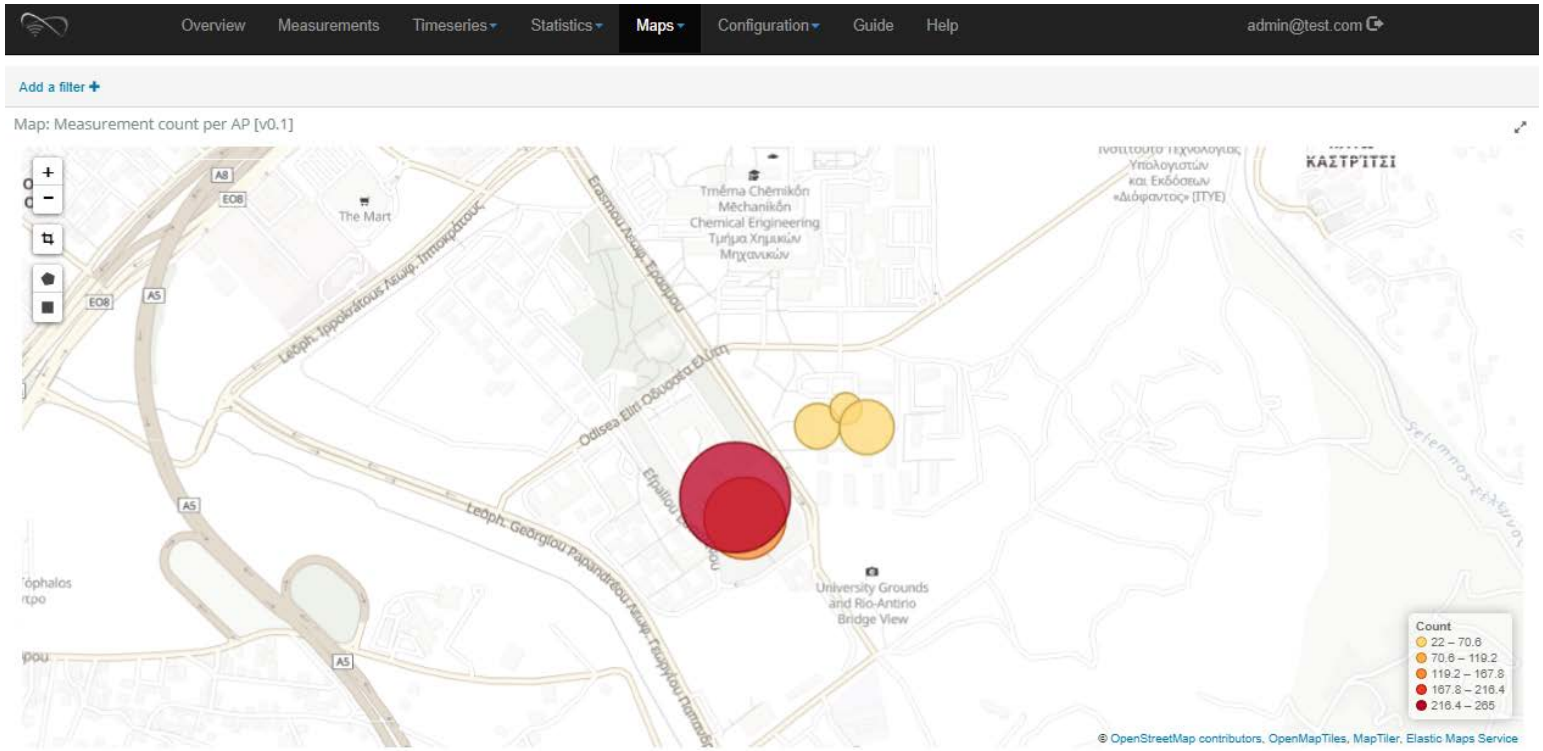
WiFiMon - Web-UI (Overview Tab)



WiFiMon - Web-UI (Timeseries Tab)



WiFiMon - Web-UI (Maps Tab)



WiFiMon – Hybrid Approach

Prerequisites

- A Raspberry Pi 3 Model B+
- A micro SD card with at least 16GB size
- WiFiMon Raspberry Pi operating system image. Size ~ 3.6 GB

WiFiMon – HW Probe setup steps

Step 1: Write the image to the micro SD card
Follow the instructions at the official Raspberry Pi. Skip the "Download the image" step and use the WiFiMon Raspberry Pi operating system image instead.

Step 2: Start the RPi
- Insert the microSD in the RPi
- Plug the USB keyboard and USB mouse
- Connect the monitor cable to the Pi's HDMI port
- Plug the power supply into a socket and connect it to the micro USB power port
- The Pi will boot up into a graphical desktop

Step 3: Configure the RPi
- Connect to the wireless network you want to measure.
- Set which tests will be executed and how often

That's all! Unplug keyboard, mouse and monitor and let the HW probe measure your network!

Instruction page:
https://wifimon.switch.ch/wifimon/hw-probe-setup.html

WiFiMon – Security and Privacy

- Process Data Management
  - Legal aspect of Collecting, Storing, Analysing, Consuming and Visualizing of data
    - Exercising caution when processing personal data (Management at SWITCH)
  - EC point of view about Privacy and Security to WiFiMon ➔ Legitimation
    - EU General Data Protection Regulation (GDPR)
- Technical aspects
  - From beyond WiFiMon to concrete implementation of features
    - Collection process:
      - End-User dialog through popups (agree / disagree measurement)
    - Storing: Only correlated information (raw data will not be stored)
    - Web site – proper disclosure on WiFiMon process / data kept
    - Possibility to store only non-user related data
    - Hash user-related data

WiFiMon - Dissemination

WiFiMon Pilot @ TNC19

WiFiMon Milestones @ TNC19

- Demonstration of WiFiMon capabilities in measuring the performance of WiFi networks
- Comparison between crowdsourced measurements and deterministic measurements (HW Probes)
- Deploying WiFiMon HW Probes in an event for the first time
- Discussing with participants about potential enhancements and the future steps of WiFiMon

Available Equipment

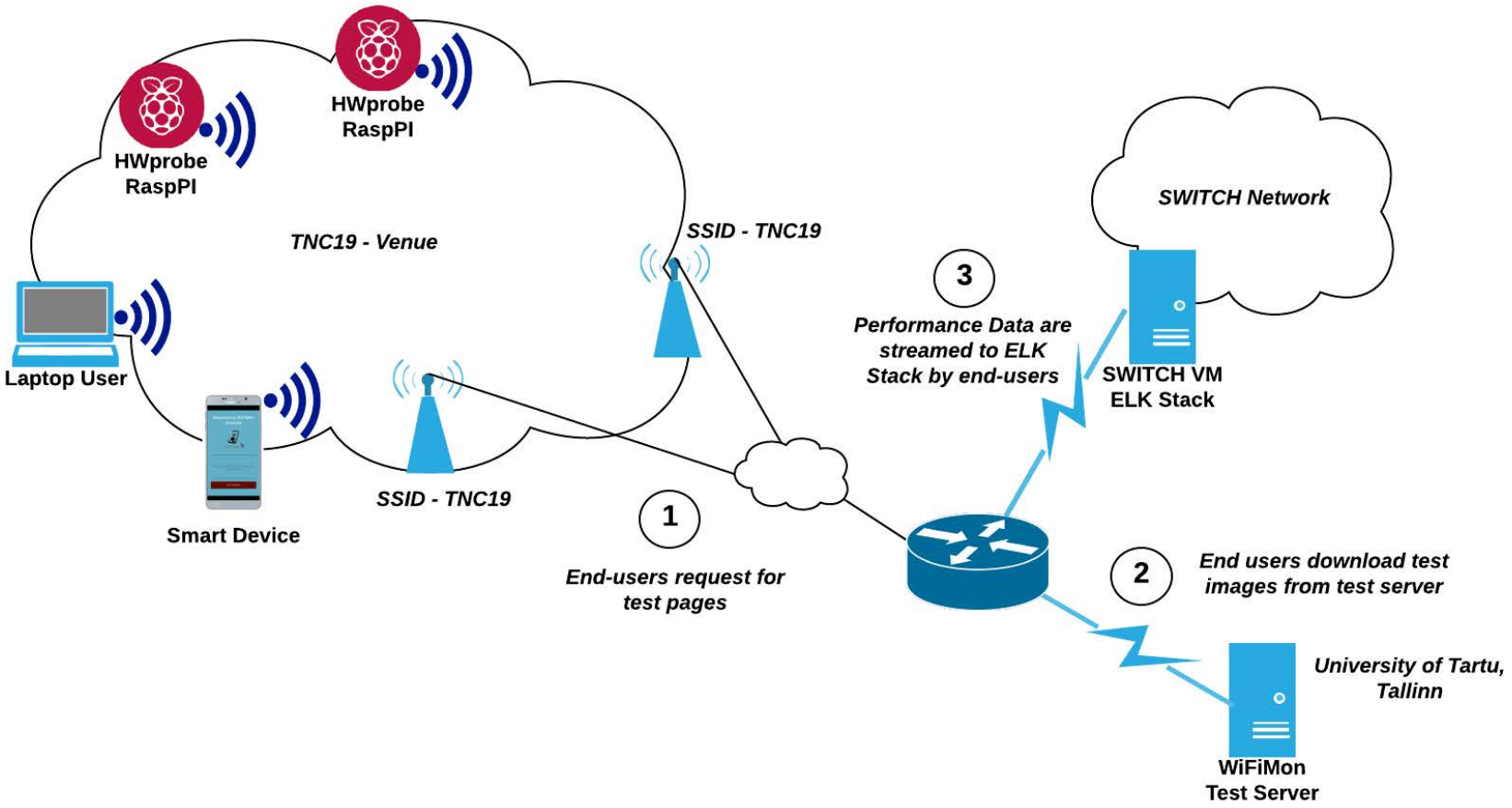
- ***5 Raspberry PI 3 Model B+***, 64-bit quad-core ARMv8 CPU, 2.4 & 5 GHz, 802.11b/g/n/ac Wireless LAN, Bluetooth 4.2 & BLE

- ***Laptops & Smartphones*** of WiFiMon team members

Why not TNC19 participants?

- GDPR issues
- WiFiMon was late to include its purposes in TNC19 privacy notice
- Definitely in the future

Testbed Overview



Available Test Tools

- ***NetTest***
- ***Boomerang***
- ***Speedtest***

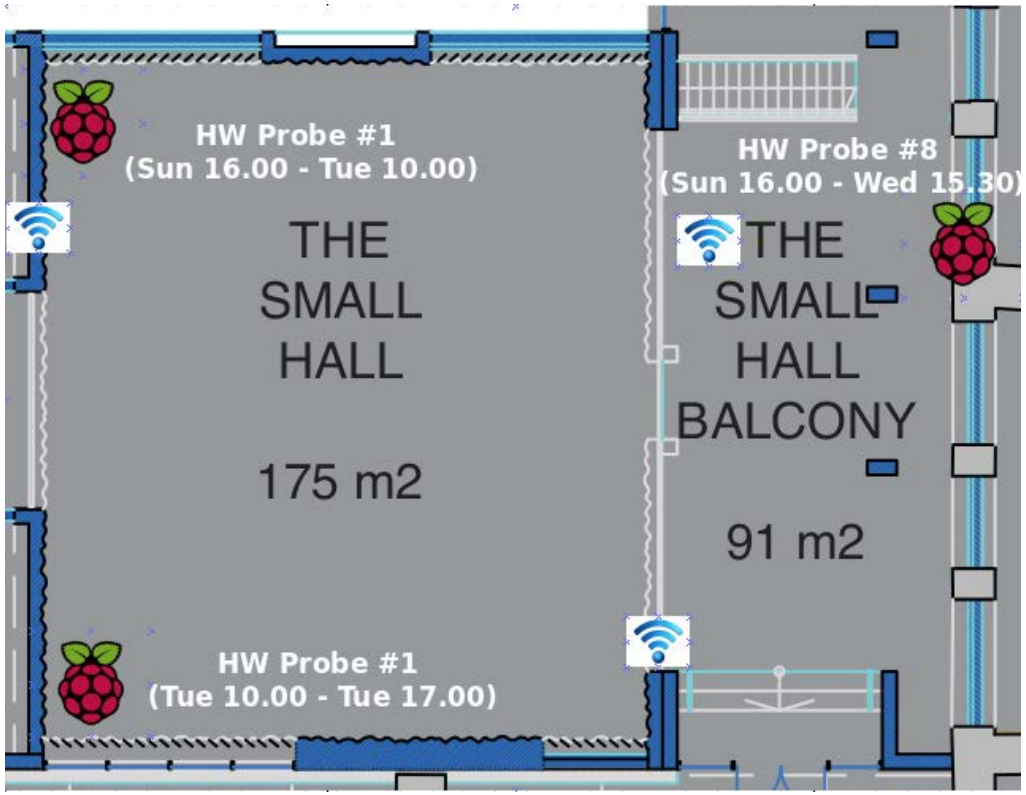
10 available test pages per test tool *(NetTest-x, boomerang-x, speedtest-x):*

- 5 dedicated to each of the HW Probes (numbers 1, 5, 6, 7, 8)
- 5 assigned to WiFiMon team members (numbers 2, 3, 4, 9, 10)

Monitored Rooms

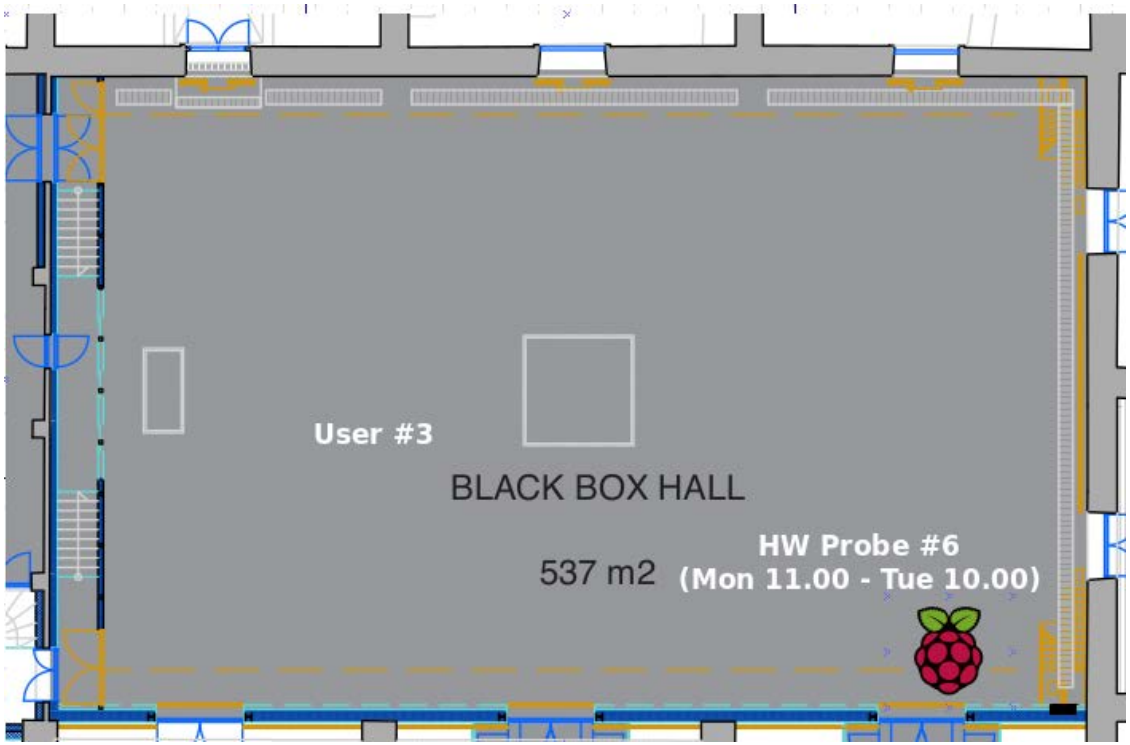
- Small Hall & Small Hall Balcony (Posters)
- Black Box room during the 1st round of lightning talks
- Cauldron Hall
- Atrium Hall
- D- Hall

Small Hall & Small Hall Balcony (Posters)



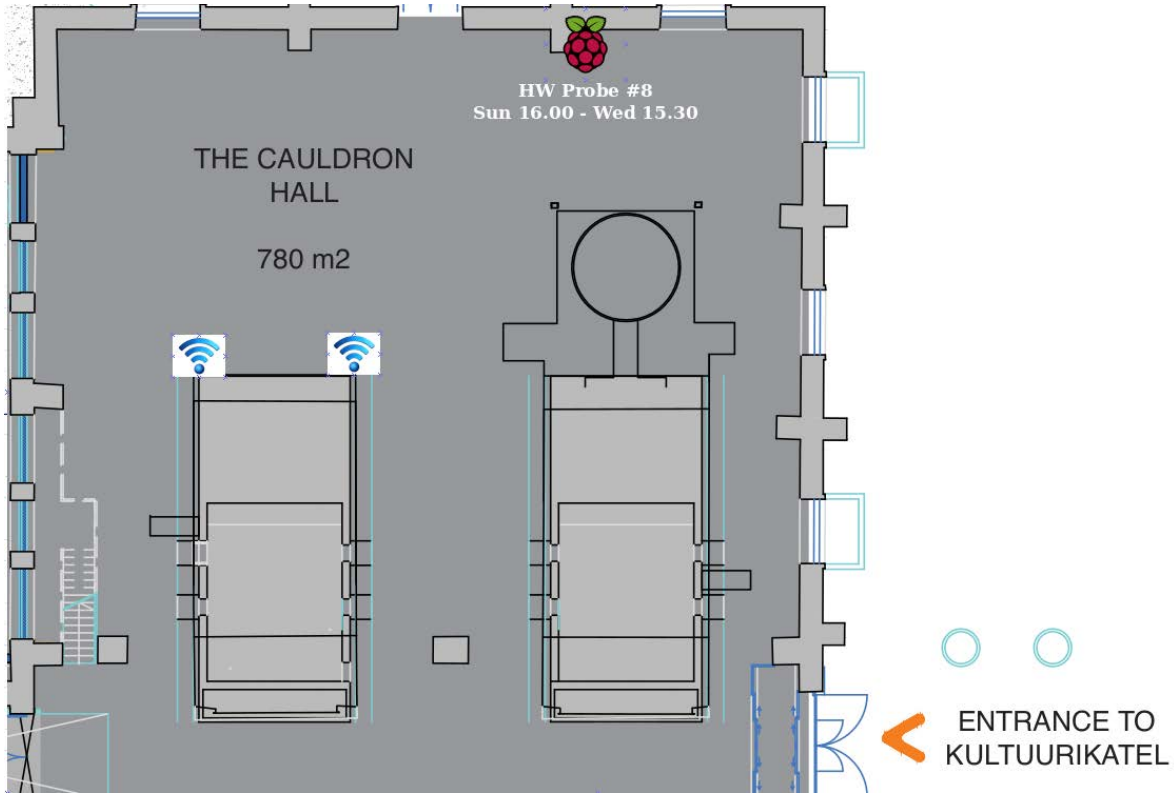
- ***HW Probe #1*: Sunday 16.00 - Tuesday 10.00 (upper left corner)**
- ***HW Probe #1*: Tuesday 10.00 - Tuesday 17.00 (lower left corner)**
- ***HW Probe #8*: Sunday 16:00 - Wednesday 15.30 (poster area)**

Black Box Room (Main Room & Lightning Talks)



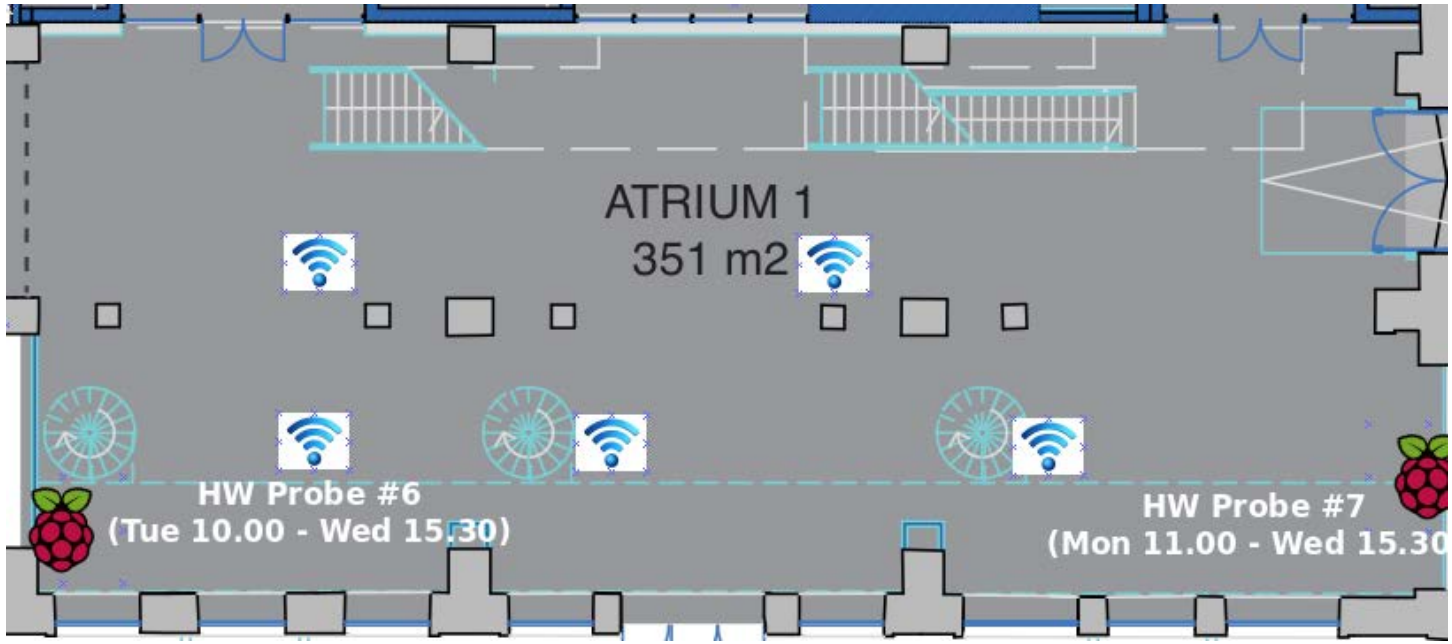
- ***HW Probe #6*:** Monday 11.00 - Tuesday 10.00
- ***User #3*:** Monday 14.00 - Monday 15.30 (1st lightning talks round)

Cauldron Hall (Opening Plenary & Lobby)



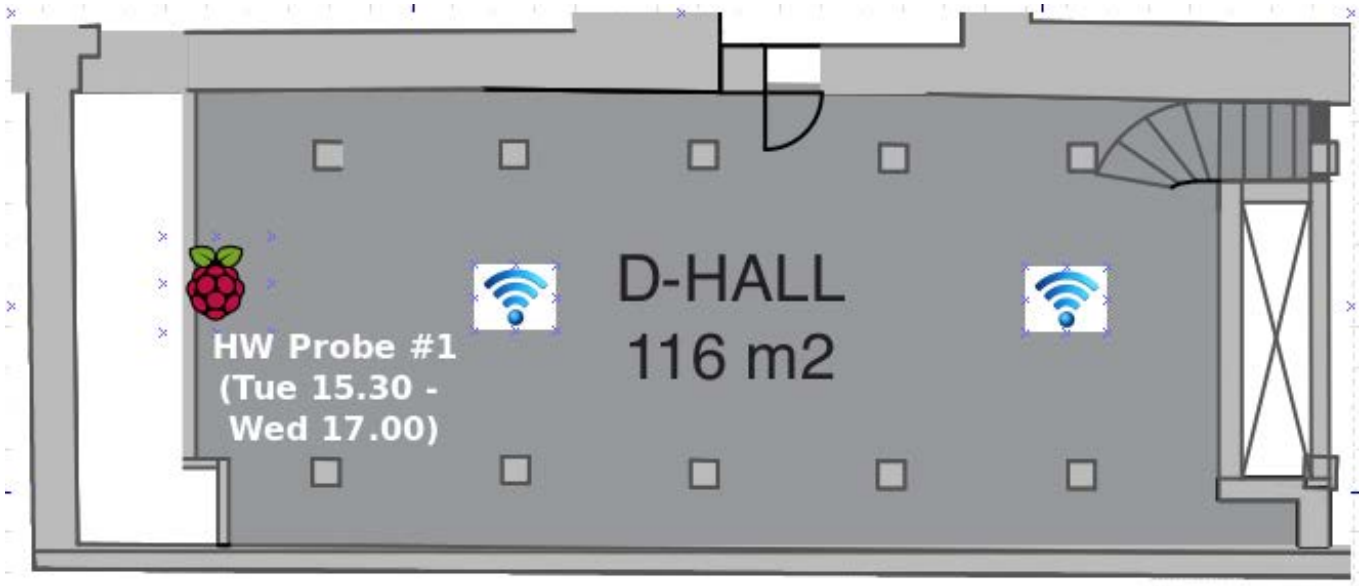
- ***HW Probe #8*:** Sunday 16.00 - Wednesday 15.30

Atrium Hall (Coffee Breaks, Opening Reception)



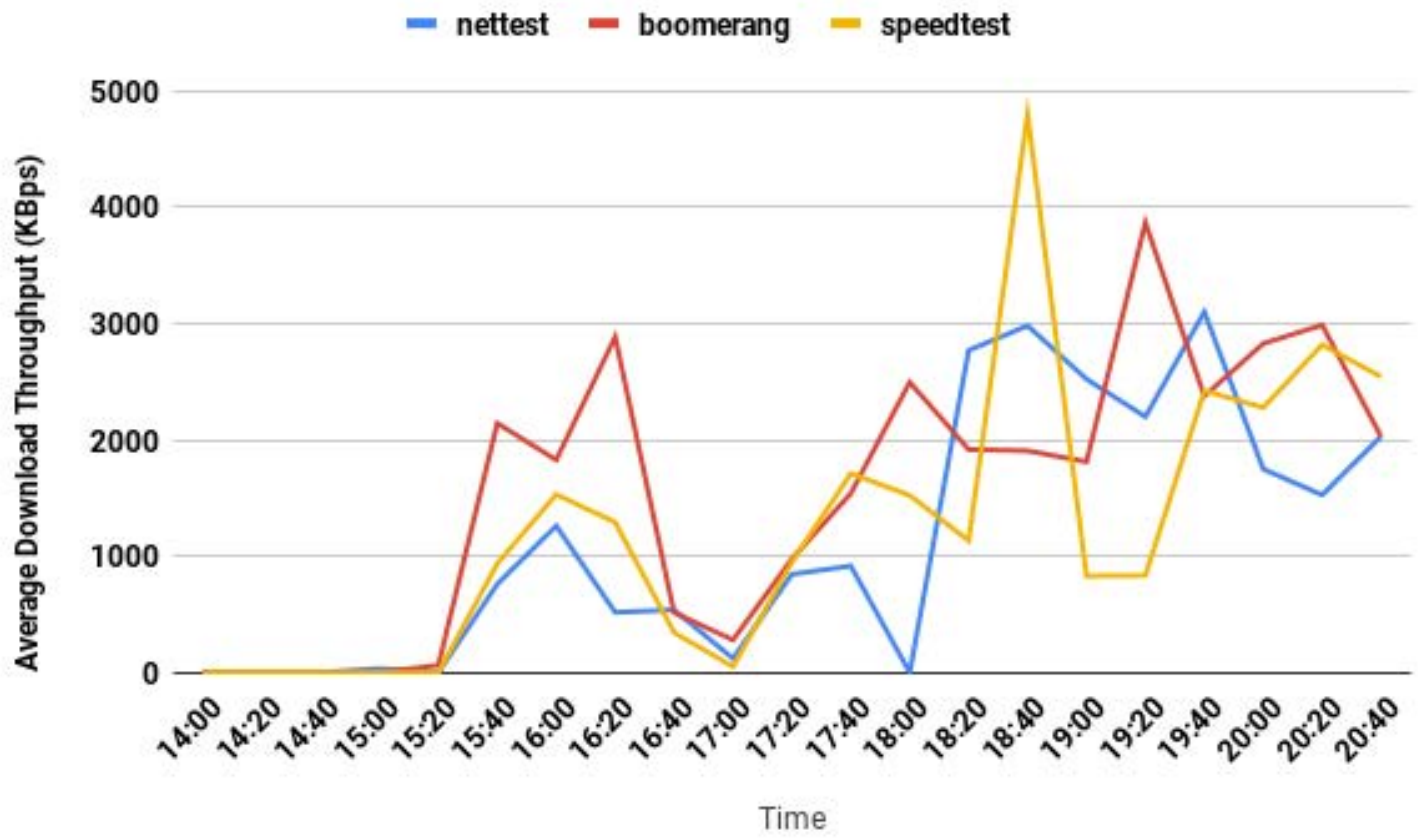
- ***HW Probe #6*:** Tuesday 10.00 - Wednesday 15.30
- ***HW Probe #7*:** Monday 11.00 - Wednesday 15.30

D-Hall (Some Sessions)

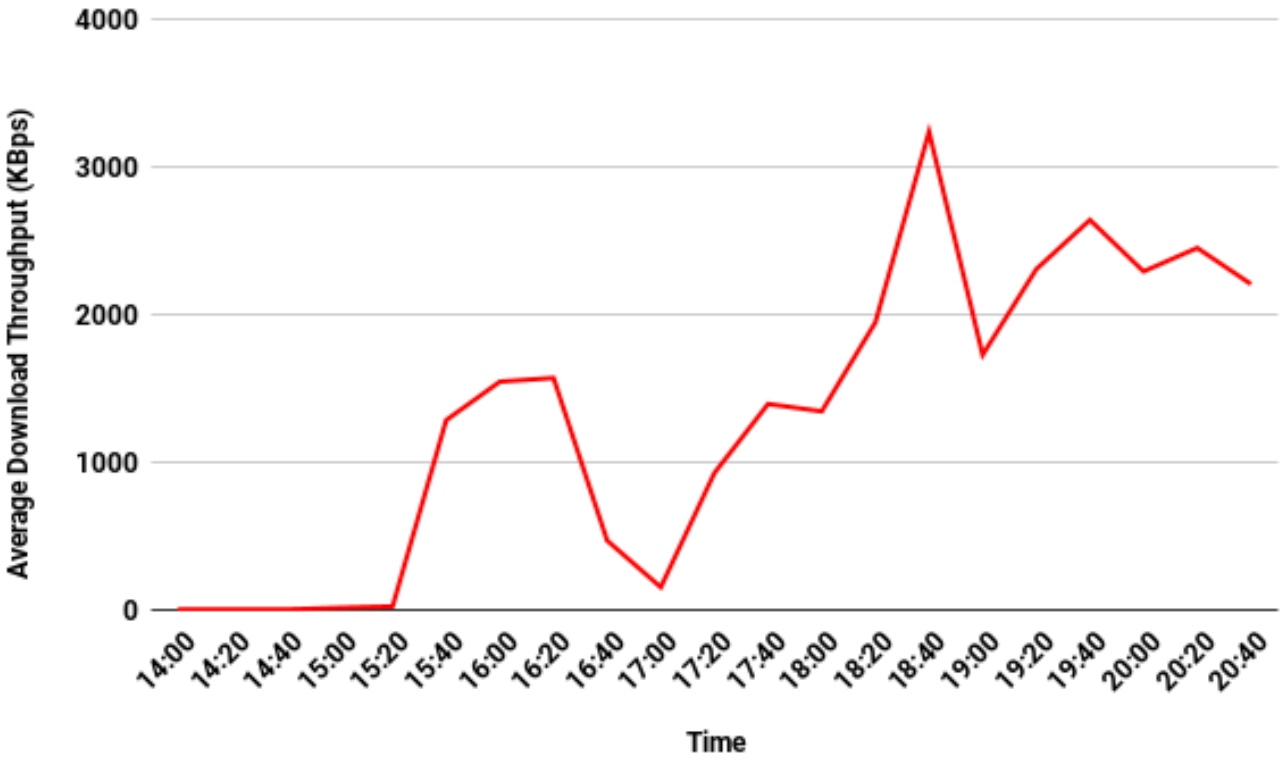


- ***HW probe #1*: moved to D-Hall in Tuesday 15.30**

Download Throughput HW Probe #6 in Black Box, Monday (14.00 - 21.00), including all test tools

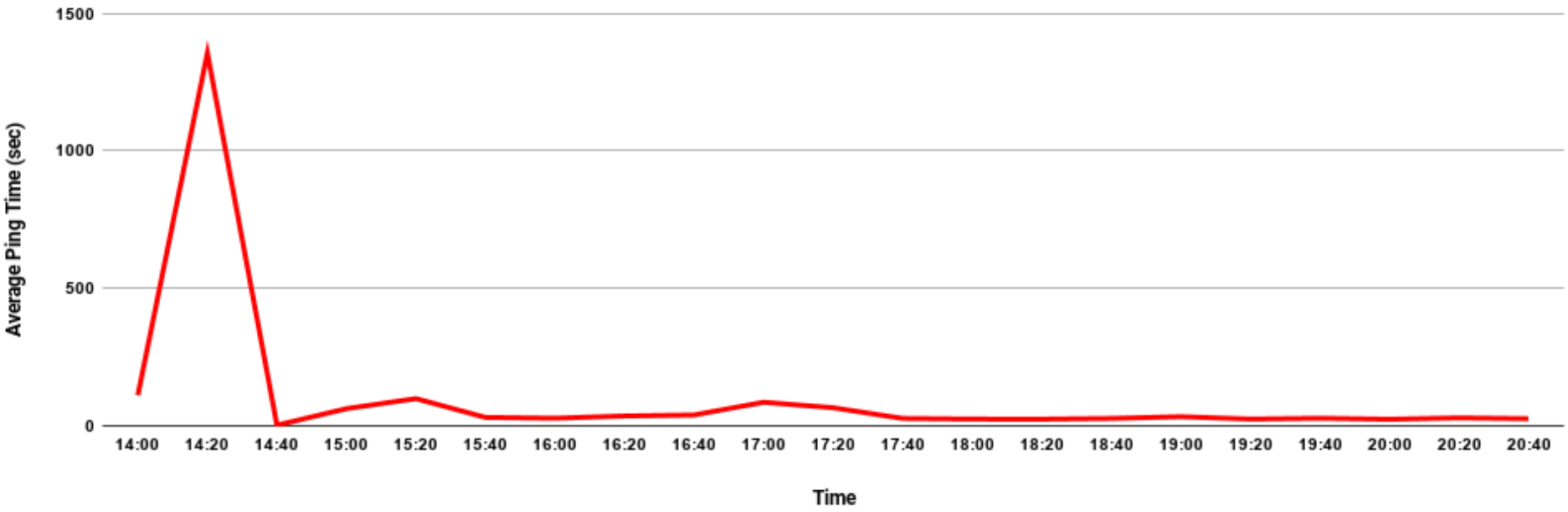


Download Throughput HW Probe #6 in Black Box, Monday (14.00 - 21.00), Test tools average

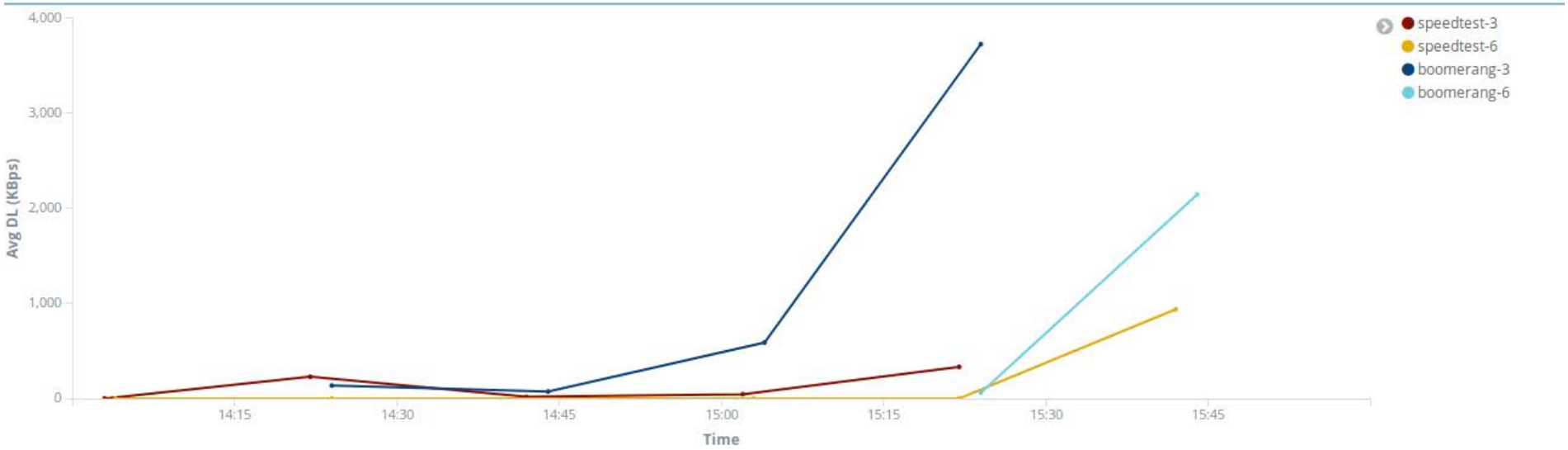


- WiFi problematic during lightning talks (14.00 - 15.20)
- WiFi OK in the afternoon when lots of people have left the venue
- Worse throughput during the opening reception (17.00)
- WiFi OK in the evening

Average Ping Time, HW Probe #6 in Black Box, Monday (14.00 - 21.00), Test tools average

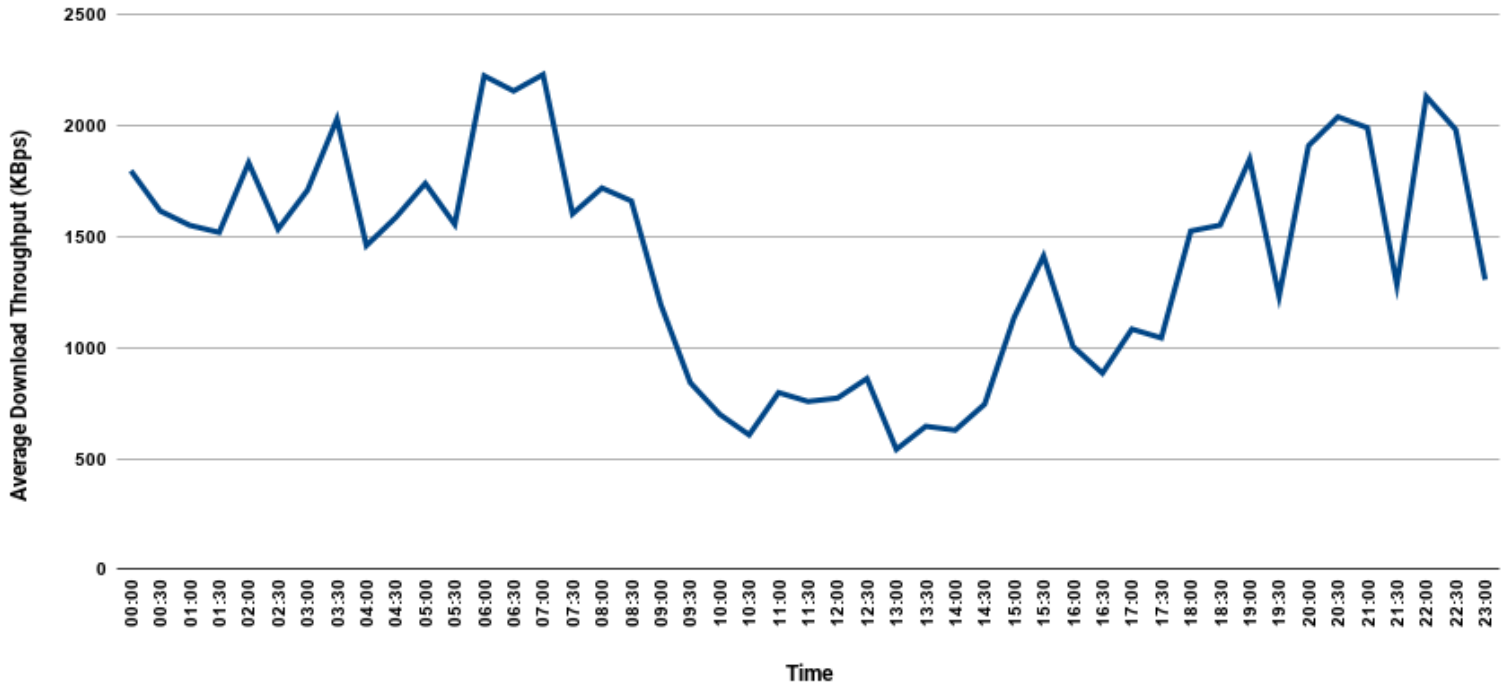


Comparison of crowdsourced measurements with HW Probe #6 during lightning talks on Monday (Download Throughput)



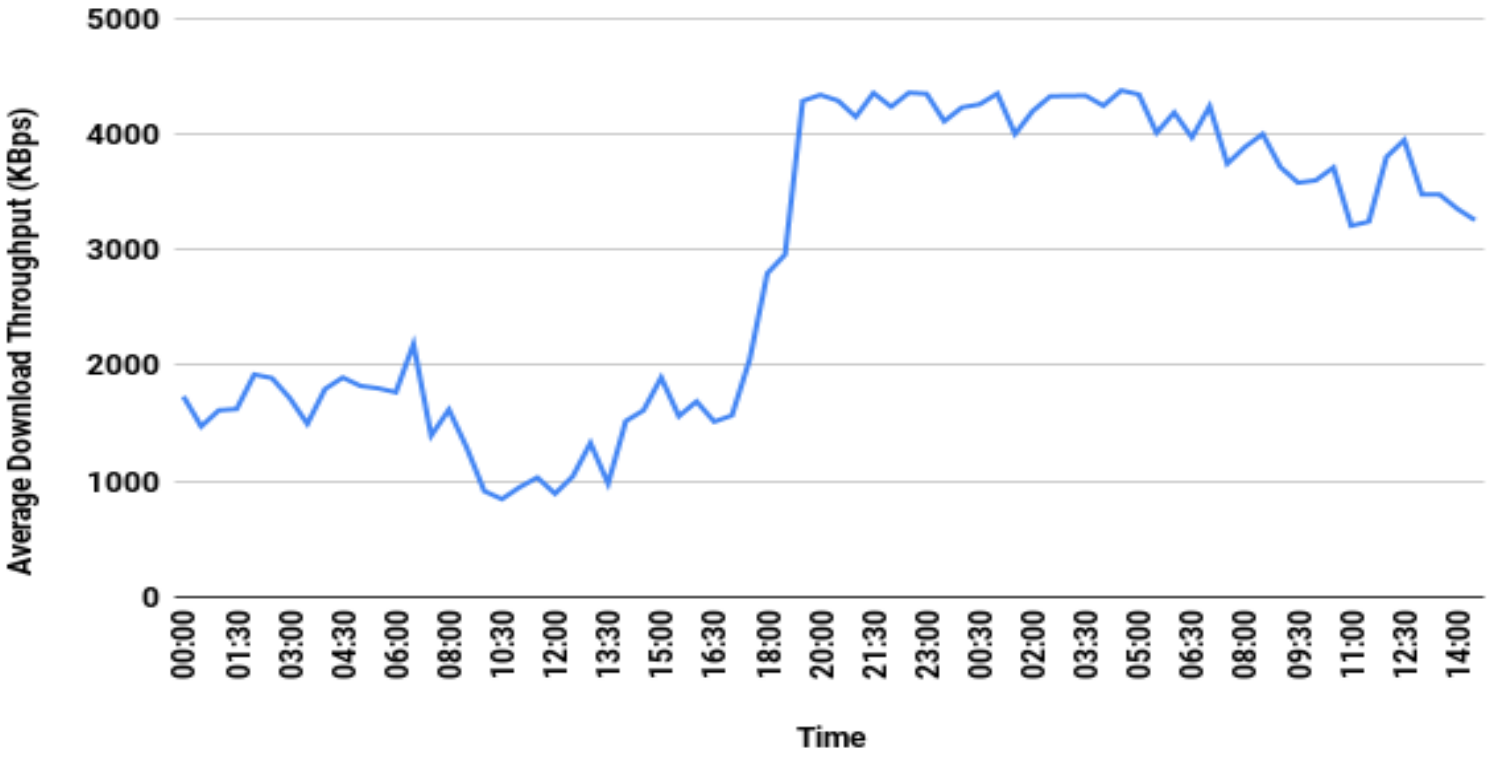
Both kinds of measurements follow the same trends

Download Throughput of HW Probe #1 in Small Hall, Monday (all day), Test Tools Average



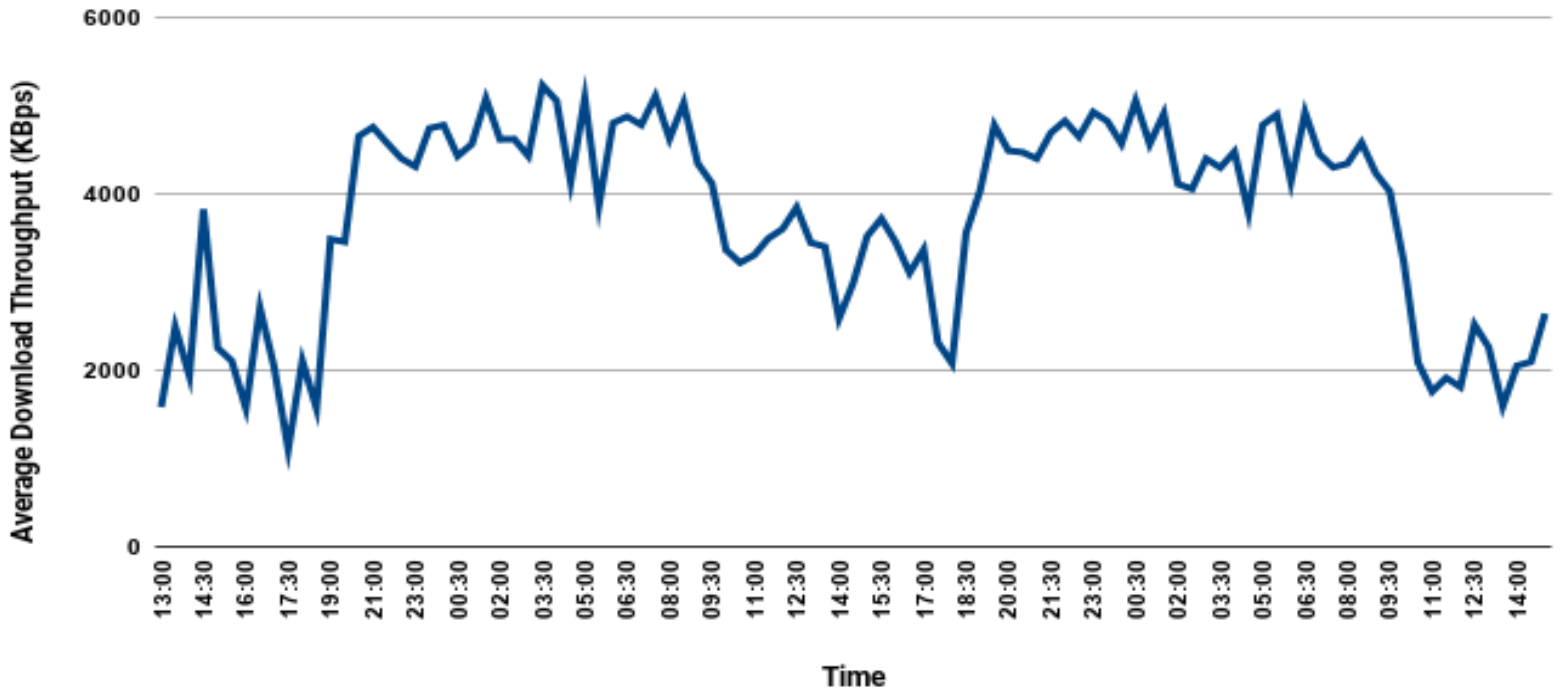
Worse throughput when lots of people are in the venue

Download Throughput of HW Probe #1 moved from Small Hall to D-Hall, Test Tools Average



Worse throughput in Small Hall than in D-Hall

Download Throughput of HW Probe #7 in Atrium Hall, Monday 11.00 till Wednesday 15.30, Test Tools Average



Worse average download throughput during coffee breaks

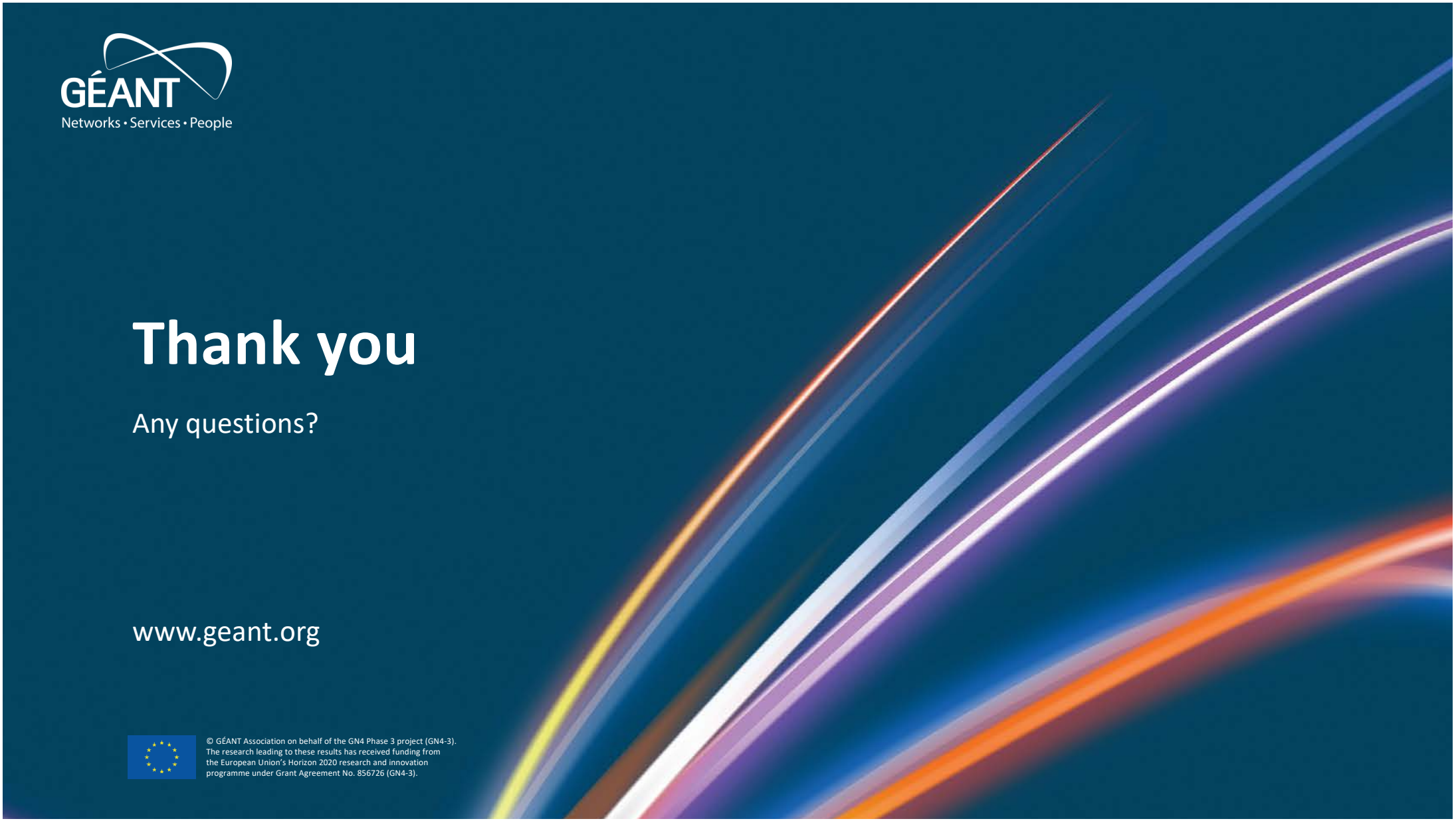
Conclusions and future work

The expertise gained so far revealed that it is possible to:

- Measure specific parameters of a wireless network through JavaScript
- Correlate these measured raw data from various log files
- Monitor and validate the performance of WiFi as experienced by end-users

Future steps:

- Verification of JavaScript measurements accuracy (comparison with HW monitoring probes)
- Explore privacy issues so as to be in accordance with campus policies
  - Inform the end-user through pop-ups, approve performance tests
  - Links or pop-ups that explain the process of data collection.
  - If tests are performed without user intervention, ensure that sensitive data will be analysed with caution.
- Data Analysis (Elastic Search)
  - To process a long time history
  - To elaborate a “PERFORMANCE Benchmark”
- Design a Service (roll out to the most of the NRENs)
  - Commercial aspect in focus of our investigations



The research leading to these results has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 856726 (GN4-3).