WiFiMon: Overview & Summary of Y1 Activities

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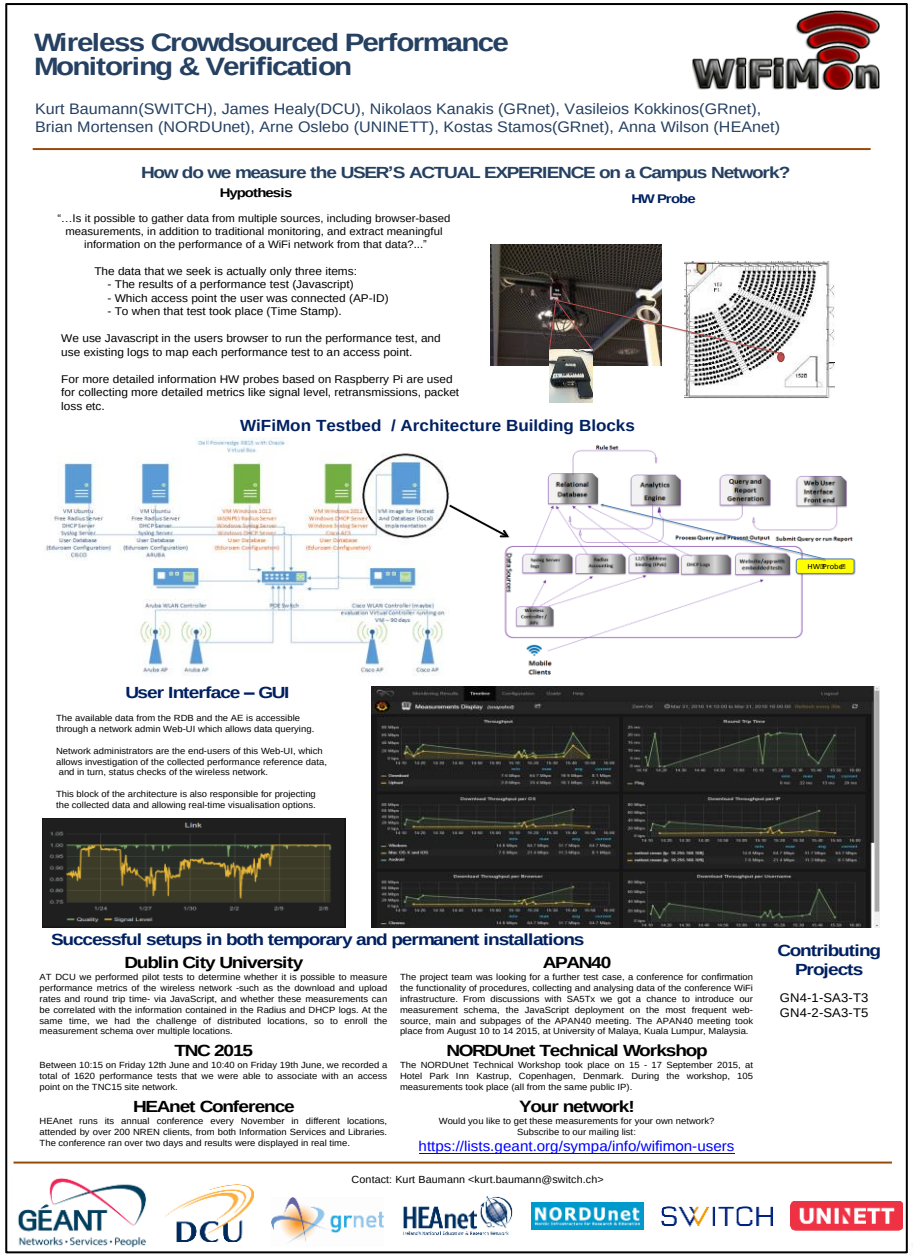
Presentation Outline

- WiFiMon: Introduction & Problem Statement
- WiFiMon: Data Flow & Overall Architecture
- Data Collection Technology: Crowdsourced & HW Probe Measurements
- TNC19 Pilot & Indicative Results
- Feedback from TNC19 & 6th SIG-PMV Meeting Audience
- Revision & Changes in WiFiMon – Feedback Integration
- Future Work

WiFiMon: Introduction

Mission Statement:

"…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?…"



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 - Data Flow

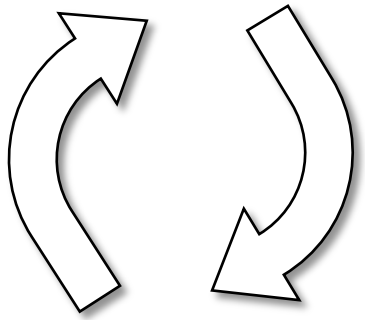
PERFORMANCE DATA

IEEE802.1X / eduroam enabled infrastructures:
- End-users: Smartphones, Laptops
- Hardware Probes

ANALYZE DATA

Real Time Analysis:
- Performance Data Parsing
- Correlation of Performance Data with Accounting Data
- Mobility Prediction (Future Work)
  - Focus: Network Performance
  - Focus: # Users Prediction

Filtered RADIUS Logs



Correlation Results

ACCOUNTING DATA

RADIUS Logs:
- Data Filtering (Logstash)

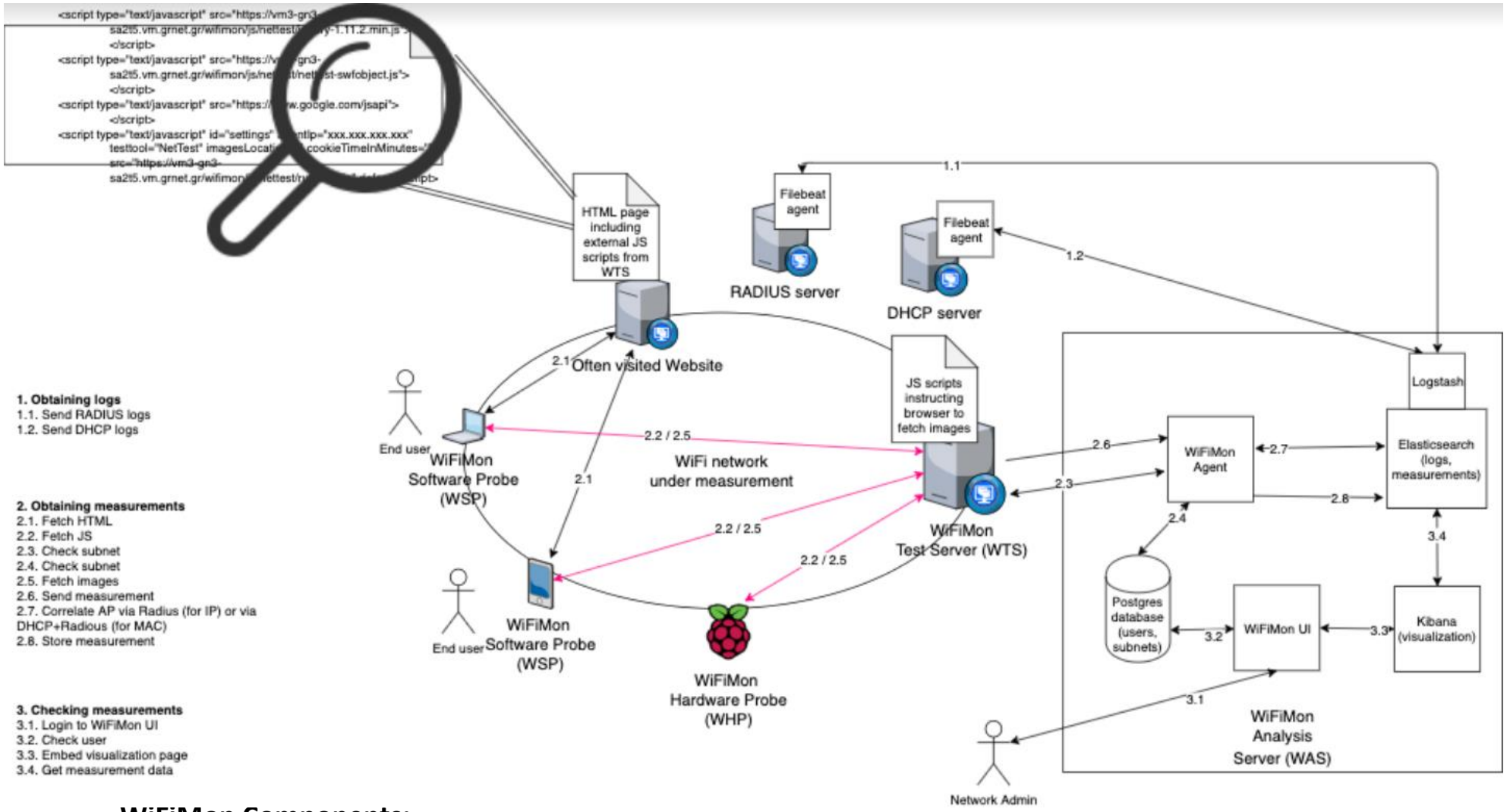
STORE DATA

Data Storage (Elasticsearch)
- Filtered RADIUS Logs
- Correlated Results: Performance Data correlated with RADIUS Logs

CONSUME & VISUALIZE DATA

WiFiMon GUI:
- Visualization (Kibana)
- User Options

WiFiMon – Overall Architecture



WiFiMon Components:

- WiFiMon Software Probe (WSP)
- WiFiMon Hardware Probe (WHP)
- WiFiMon Test Server (WTS)
- WiFiMon Analysis Server (WAS)

WiFiMon – Data Collection Technology

- **The end user visits a web page that includes JavaScript code. This triggers measurements.**
- **Available Test Tools: Nettest, Boomerang, Speedtest**

```
<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

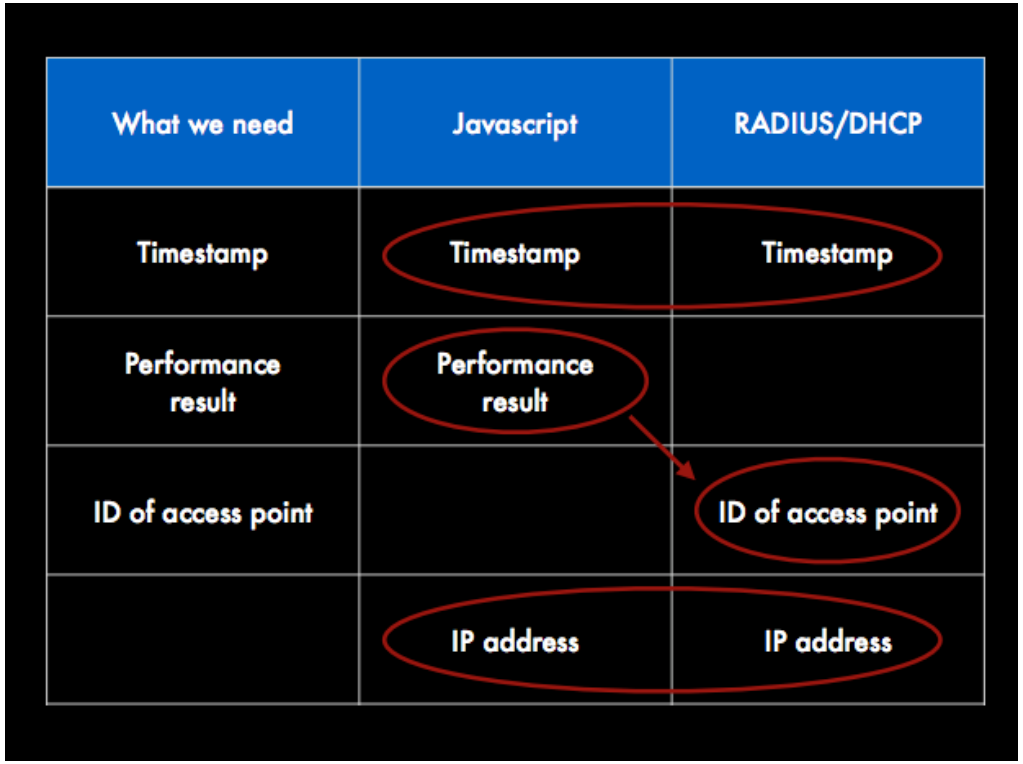
Pseudo code for performing/storing measurements

```
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 – Hardware Probes

Hardware Probes:

- 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

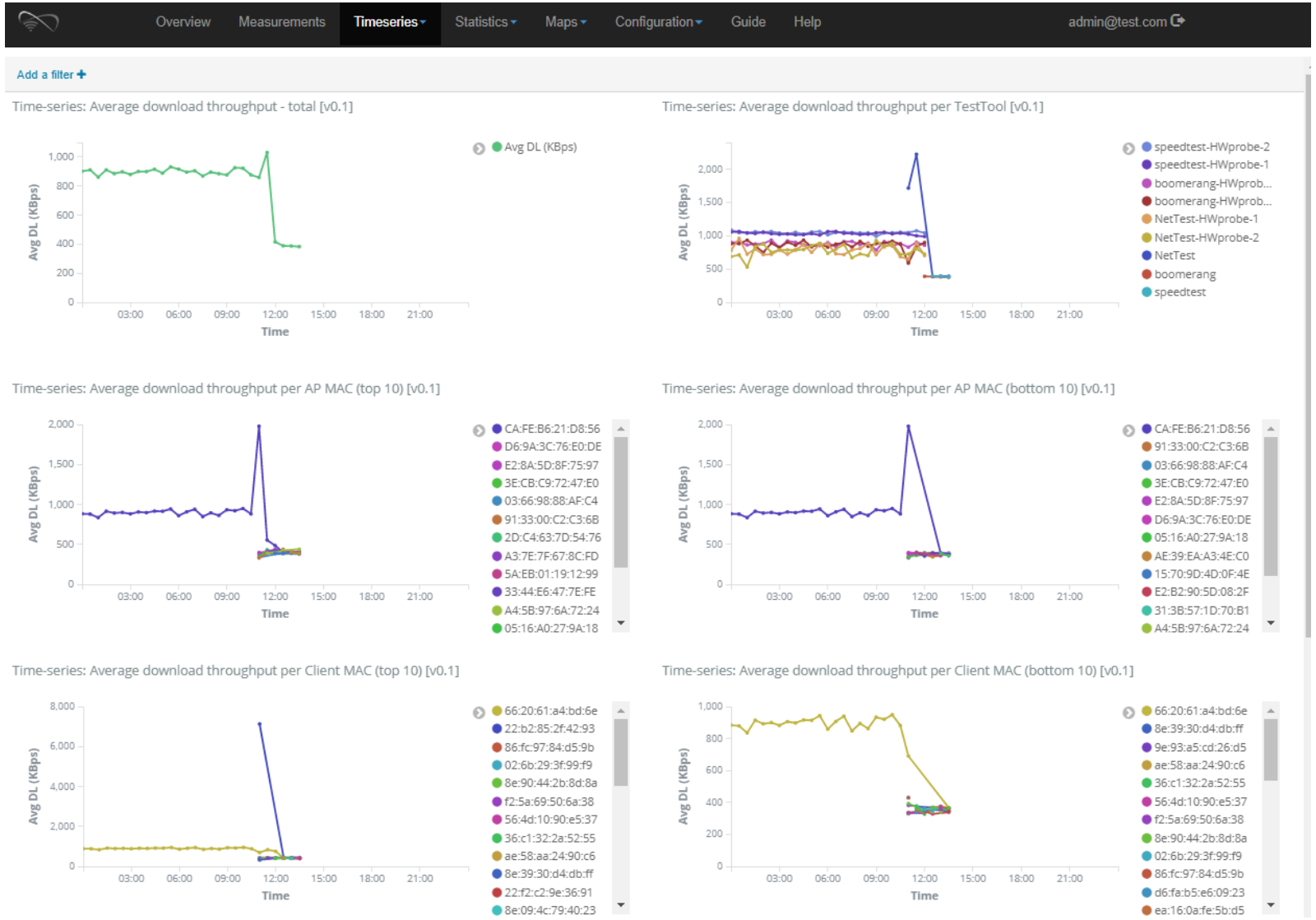
Step 3: Configure the RPi

- Connect to the wireless network you want to measure.
- Set which tests will be executed and how often

A simple crontab (20-minute measurements):

```
18,38,58 * * * * export DISPLAY=:0 && firefox --new-window https://www.google.com >/dev/null 2>&1
00,20,40 * * * * export DISPLAY=:0 && firefox --new-tab URL_TO_nettest.html >/dev/null 2>&1
02,22,42 * * * * export DISPLAY=:0 && firefox --new-tab URL_TO_speedworker.html >/dev/null 2>&1
04,24,44 * * * * export DISPLAY=:0 && firefox --new-tab URL_TO_boomerang.html >/dev/null 2>&1
06,26,46 * * * * scripts/kill-firefox.sh >/dev/null 2>&1
10 0 * * 0 scripts/pi-reboot.sh >/dev/null 2>&1
```

WiFiMon - Web-UI (Timeseries Tab)



WiFiMon Pilot @ TNC19: Available Equipment

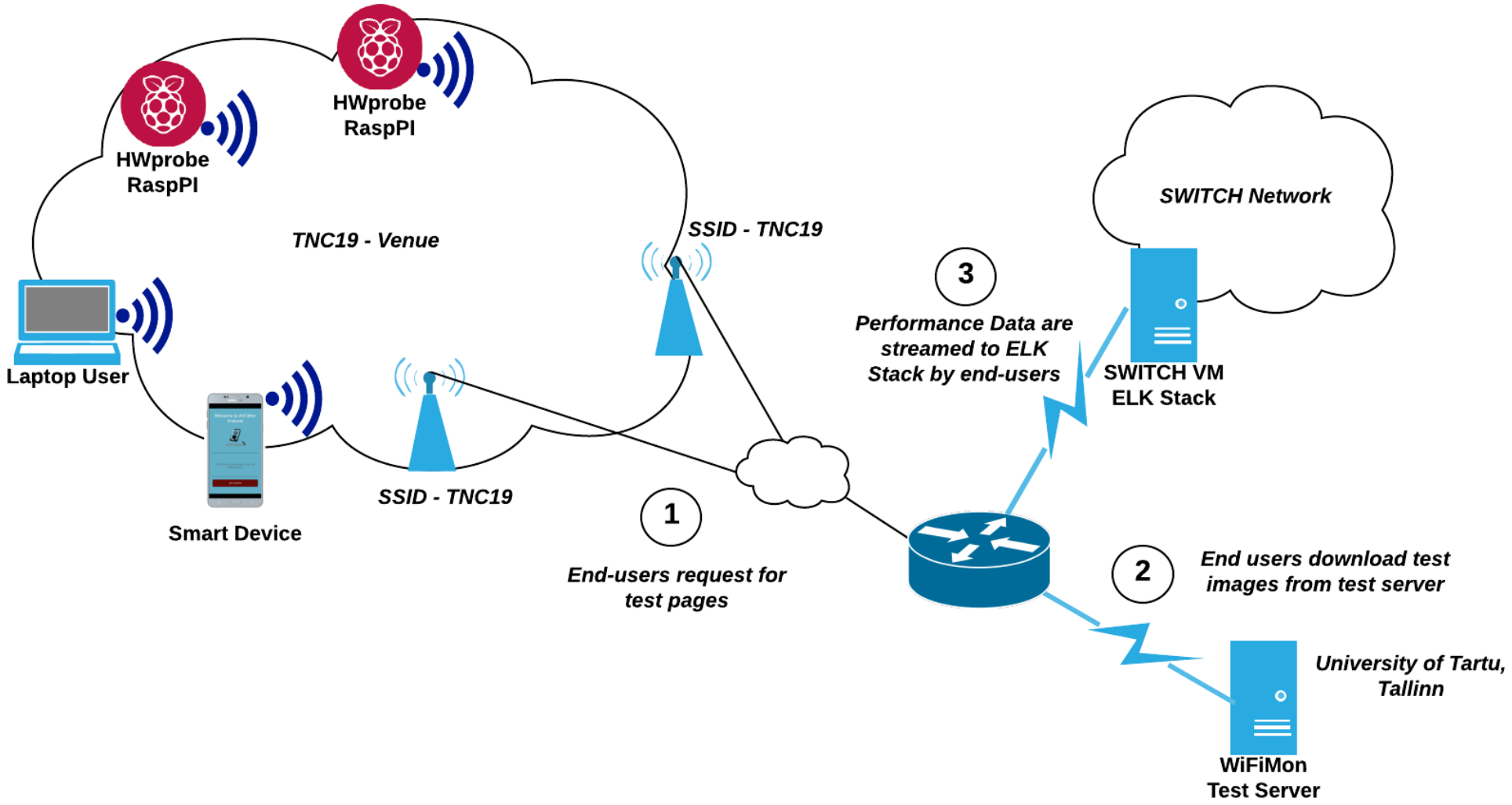
- ***5 Raspberry PI 3 Model B+***, 64-bit quad-core ARMv8 CPU, 2.4 & 5 GHz, 802.11b/g/n/ac Wireless LAN, Bluetooth 4.2 & BLE

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

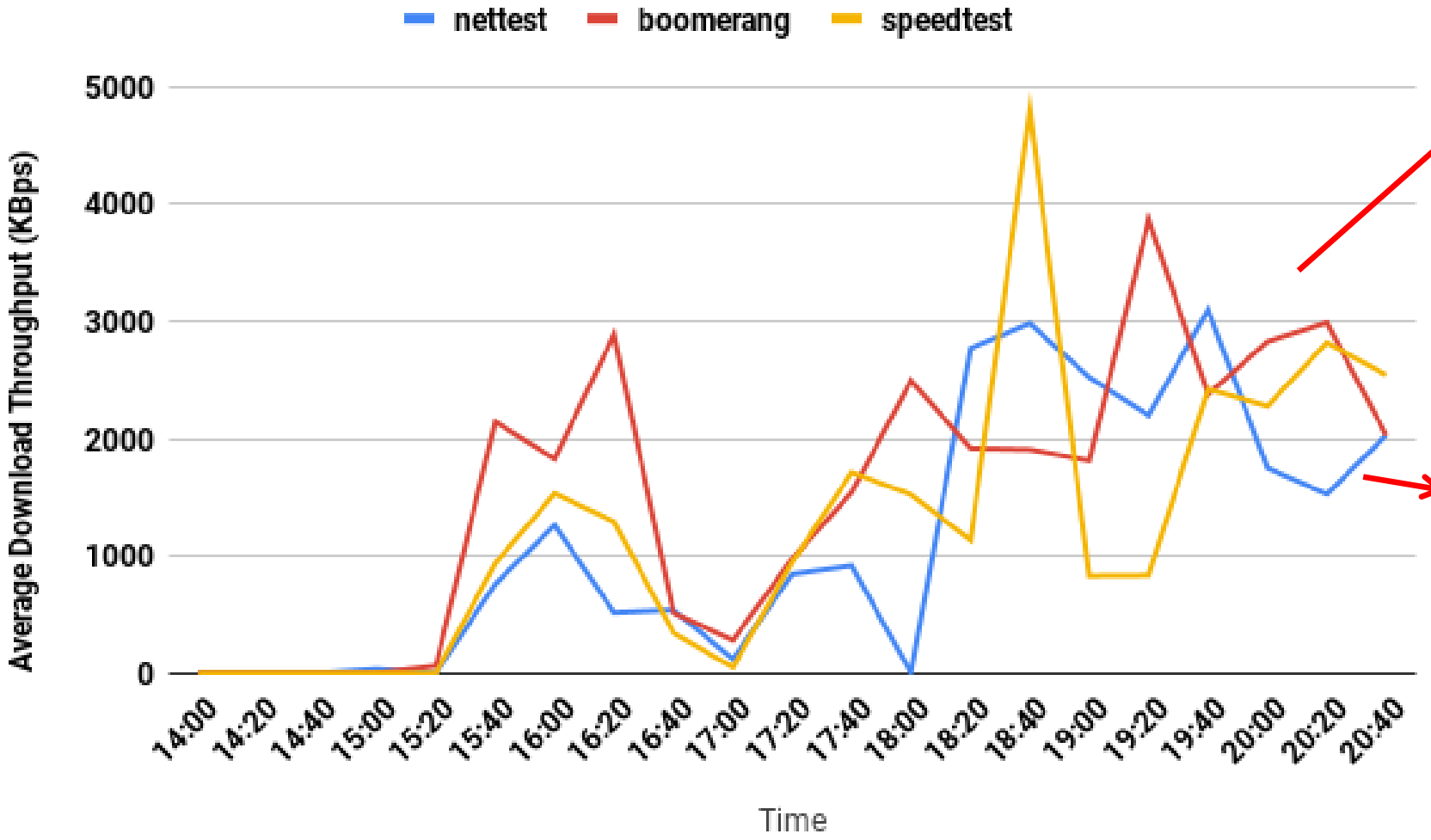
Why not TNC19 participants?

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

TNC19 Testbed Overview



Average Download Throughput in Main Room, Monday (14.00 - 21.00), including all test tools



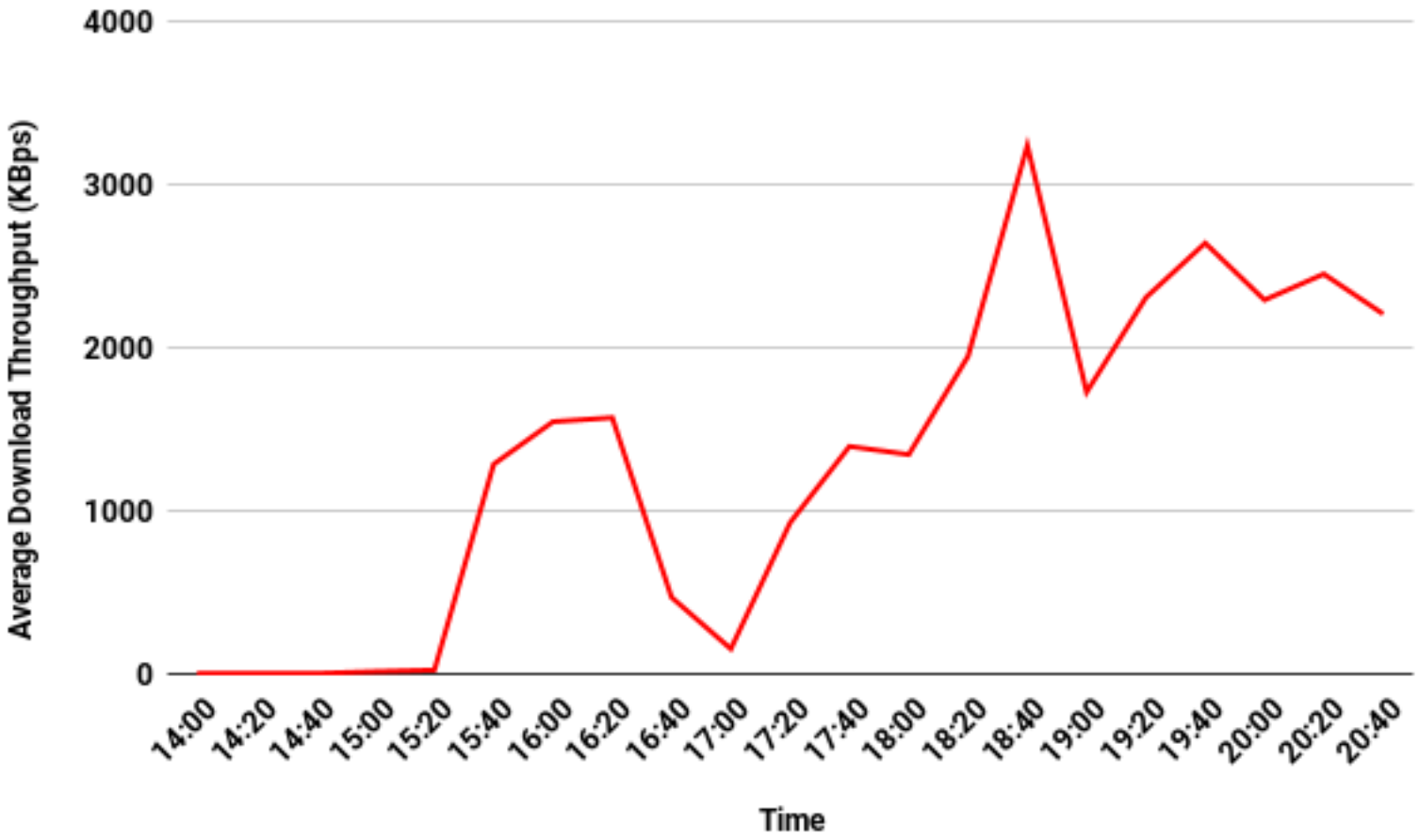
Too many lines!

Problem reaching useful conclusions

Infrequent Measurements!

Intervals of 20 minutes are not sufficient

Average Download Throughput in Main Room, 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

Feedback from TNC19 & 6th SIG-PMV Meeting Audience

- Probing period of deterministic measurements should be decreased. In TNC19 pilot it was 20 minutes.
- Charts demonstrating more than a single line, e.g. three lines corresponding to the measurements of all the available test tools, obstruct the audience from reaching quick and useful conclusions.
- WiFiMon dashboard should become GDPR compliant.
- Work needs to be done on RADIUS logs privacy.
- WiFiMon Analysis Server & WiFiMon Test Server installation should be automated.
- Additional information should be extracted from Hardware Probes, e.g. signal strength to detect Internet connection problems.

Software Revisions

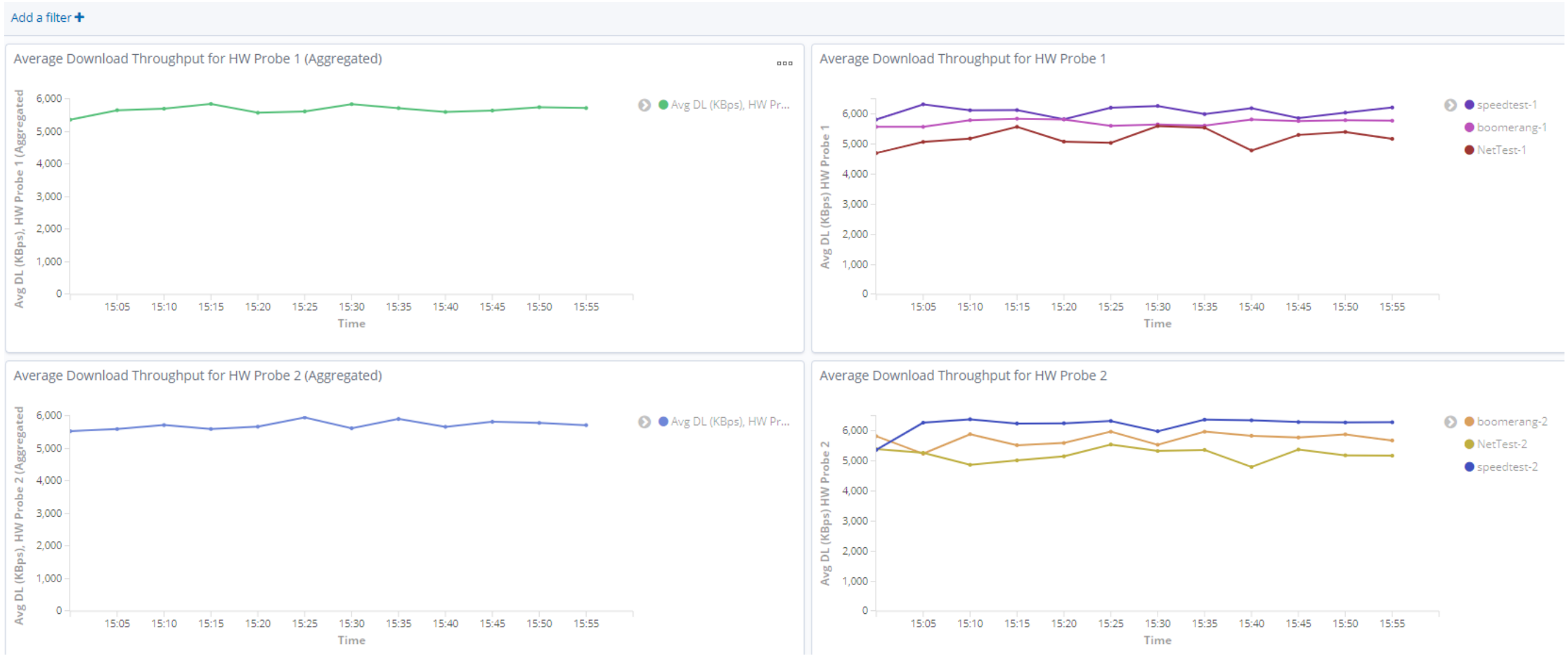
- Migration from the soon to be deprecated Elasticsearch Transport Client to the novel Java High Level REST Client.
- Migration from Spring Boot 1.4.2. version to Spring Boot 2.1.2 version.
- Migration from ELK stack version 5.6.2 to version 6.8.3

Feedback Integration – Frequent Probing Periods

```
19,39,59 * * * * export DISPLAY=:0 && firefox --new-window https://www.google.com >/dev/null 2>&1
00,05,10,15,20,25,30,35,40,45,50,55 * * * * export DISPLAY=:0 && firefox --new-tab URL_TO_nettest.html >/dev/null 2>&1
01,06,11,16,21,26,31,36,41,46,51,56 * * * * export DISPLAY=:0 && firefox --new-tab URL_TO_speedworker.html >/dev/null 2>&1
02,07,12,17,22,27,32,37,42,47,52,57 * * * * export DISPLAY=:0 && firefox --new-tab URL_TO_boomerang.html >/dev/null 2>&1
18,38,58 * * * * scripts/kill-firefox.sh >/dev/null 2>&1
0 10 0 * * 0 scripts/pi-reboot.sh >/dev/null 2>&1
```

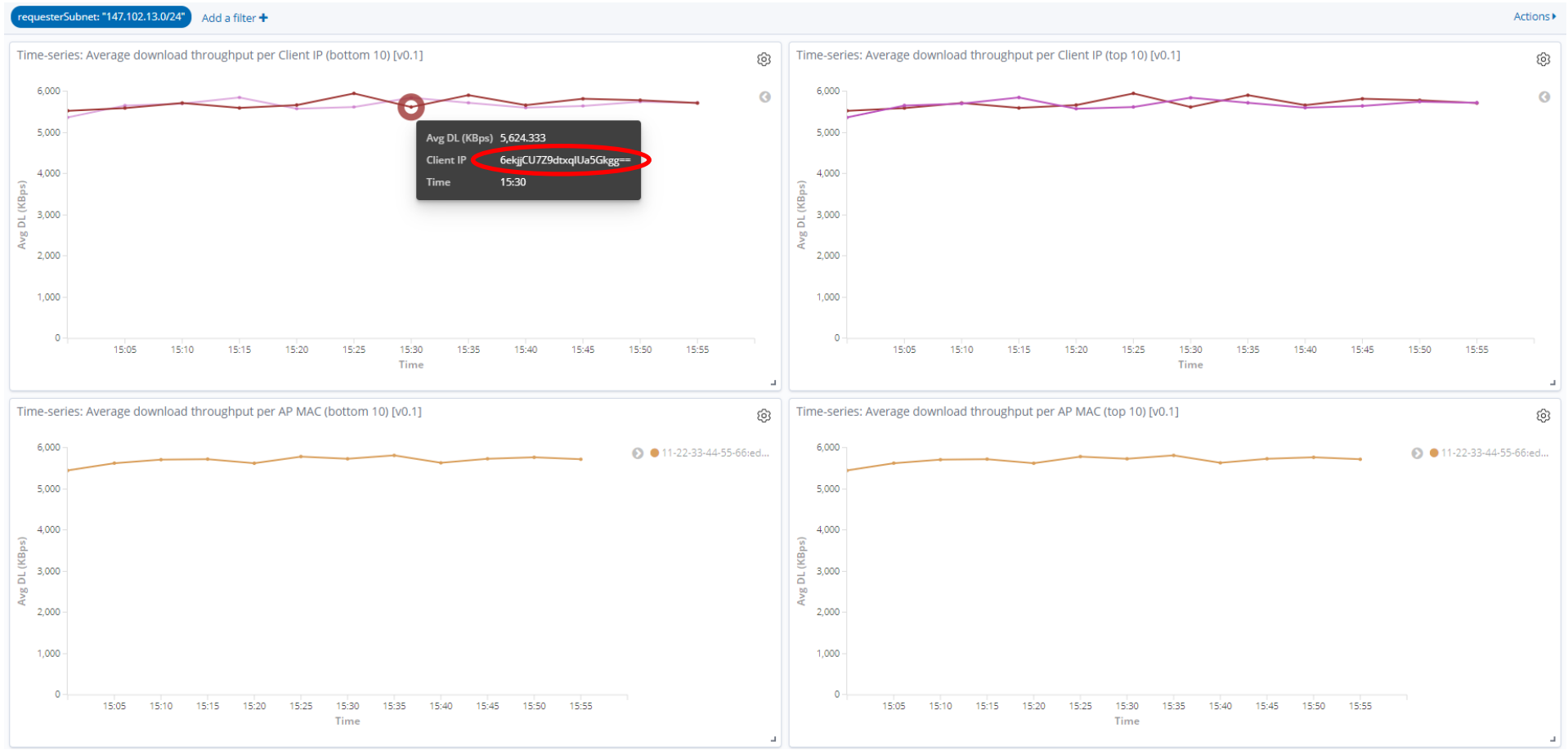
Each test tool performs a measurement every 5 minutes.

Feedback Integration – HW Probes Visualization



- All Hardware Probes in one Tab (up: HW Probe #1, down: HW Probe #2)
- Left Chart: Average of all test tools
- Right Chart: Measurements from each test tool (Nettest, Boomerang, Speedtest)

Feedback Integration – Subnets Tab (GDPR Compliance)



- Separate Tab for each monitored Subnet.
- Client IP & MAC addresses are stored / displayed encrypted with AES-CBC-256 algorithm.
- Qualitative Approach: Subnet Administrators do not know which IPs triggered the measurements, but they are interested in the results to learn about their network.

Feedback Integration – Measurements Tab (GDPR Compliance)

Add a filter +

Table: Current measurements [v0.1]

Time	DL (KBps)	UL (KBps)	Ping (ms)	AP IP	AP MAC	User OS	User Browser	Test tool	Count
15:00	4,706	2,233	7	147.102.13.100	11-22-33-44-55-66:eduroam	Linux	Firefox	NetTest-1	1
15:00	5,398	2,209	6	147.102.13.100	11-22-33-44-55-66:eduroam	Linux	Firefox	NetTest-2	1
15:01	5,824	5,545	6	147.102.13.100	11-22-33-44-55-66:eduroam	Linux	Firefox	speedtest-1	1
15:01	5,828	0	8	147.102.13.100	11-22-33-44-55-66:eduroam	Linux	Firefox	boomerang-2	1
15:02	5,374	5,821	6	147.102.13.100	11-22-33-44-55-66:eduroam	Linux	Firefox	speedtest-2	1
15:02	5,582	0	9	147.102.13.100	11-22-33-44-55-66:eduroam	Linux	Firefox	boomerang-1	1
15:05	5,078	2,454	4	147.102.13.100	11-22-33-44-55-66:eduroam	Linux	Firefox	NetTest-1	1
15:05	5,275	2,361	4	147.102.13.100	11-22-33-44-55-66:eduroam	Linux	Firefox	NetTest-2	1

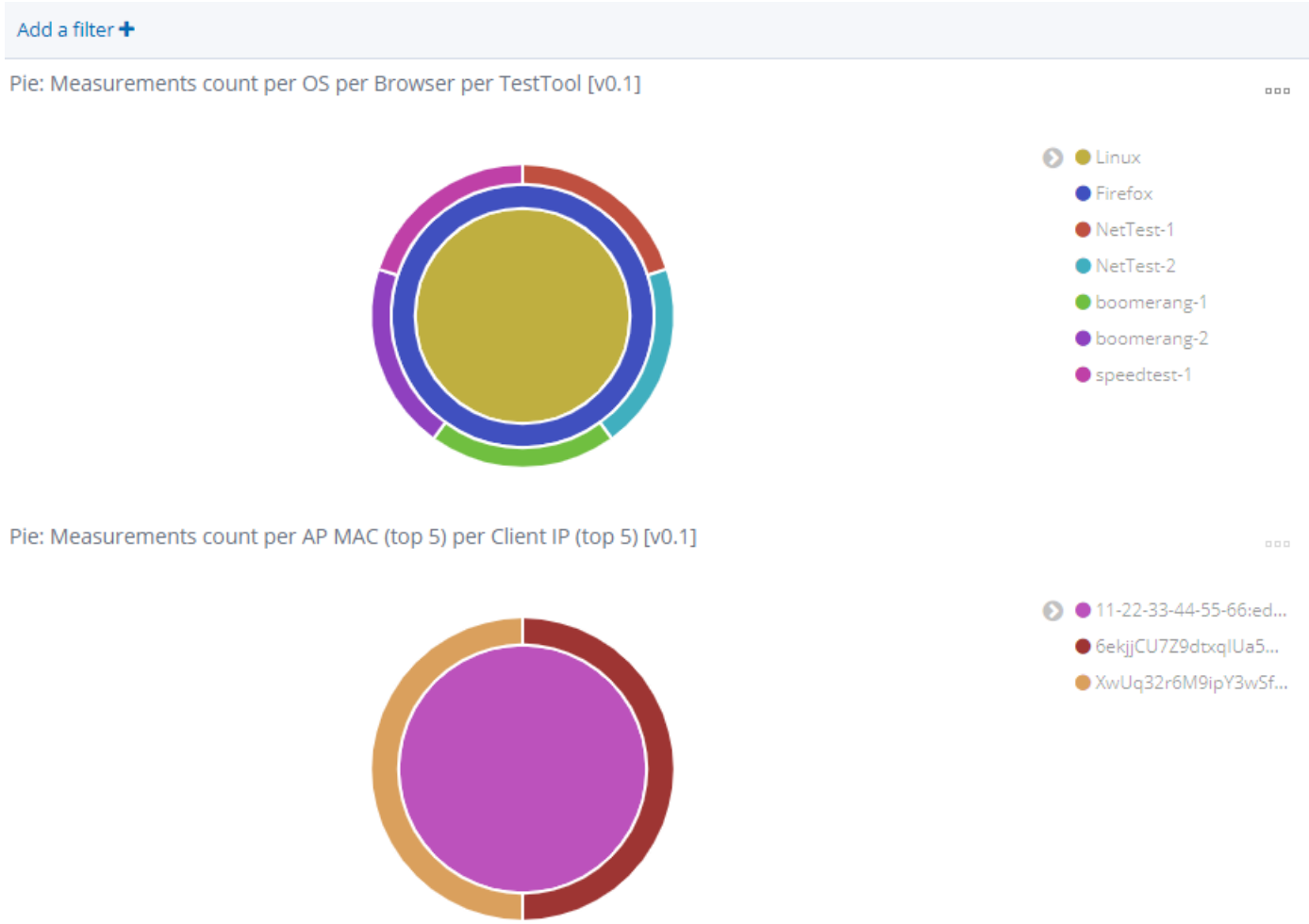
Export: Raw Formatted

1 2 3 4 5 … 9 »

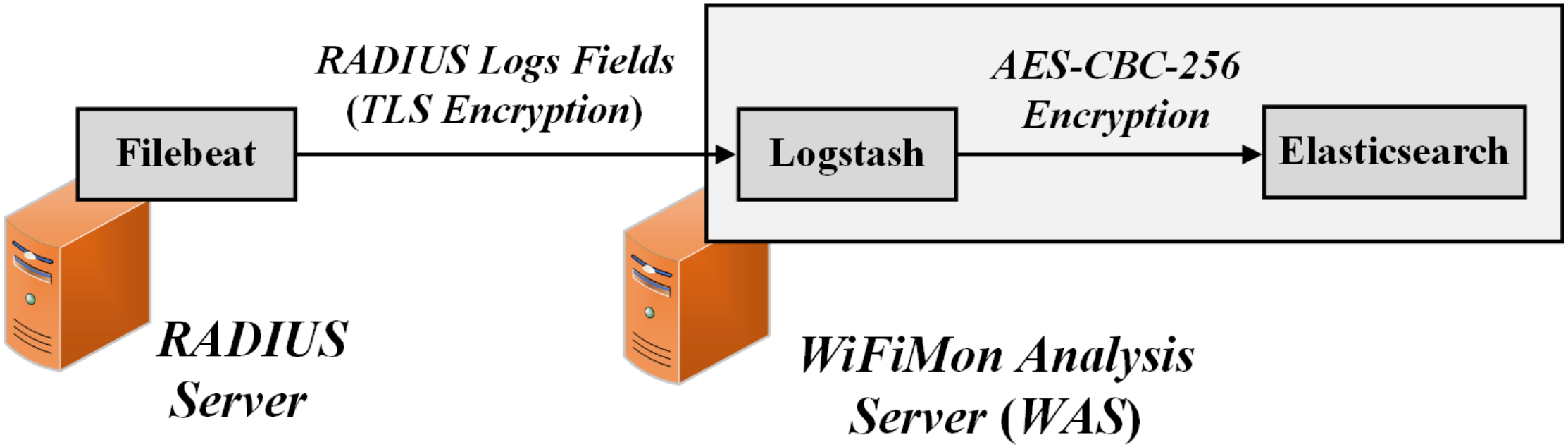
Personal Information is removed:

- Username
- Client IP address
- Client MAC address

Feedback Integration – Pie Statistics Tab (GDPR Compliance)



Feedback Integration – RADIUS Logs Privacy



- **Filebeat:** RADIUS logs are streamed encrypted (TLS) to the WiFiMon Agent. Only fields of interest are streamed to reduce total size.
- **Logstash:** RADIUS logs information is encrypted by Logstash using the AES-CBC-256 algorithm. Thus, they are stored encrypted in elasticsearch.

Future Work

- Automation of WiFiMon Agent & Test Server Installation.
- Integration of new metrics collected from Hardware Probes.
- WiFiMon Pilot involving end-users & RADIUS logs correlation

WiFiMon Service planned to be released in 2020

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Thank you

Any questions?

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