WiFiMon: Technical Overview

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EaP Workshop:
Introduction to WiFiMon for EaP NRENs
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WiFiMon: Introduction

- Monitoring Wi-Fi network performance as experienced by end users
- Combination of crowdsourced and hardware probe measurements
- IEEE 802.1X networks (***eduroam***): Data from *RADIUS* and *DHCP* logs strengthen analysis options, e.g. per *Access Point* (*AP*)

Contribution:

- Detection of Wi-Fi throughput degradation
- Determination of underperforming areas within a Wi-Fi network

→ Admins can enhance performance, e.g. by installing more *AP*s

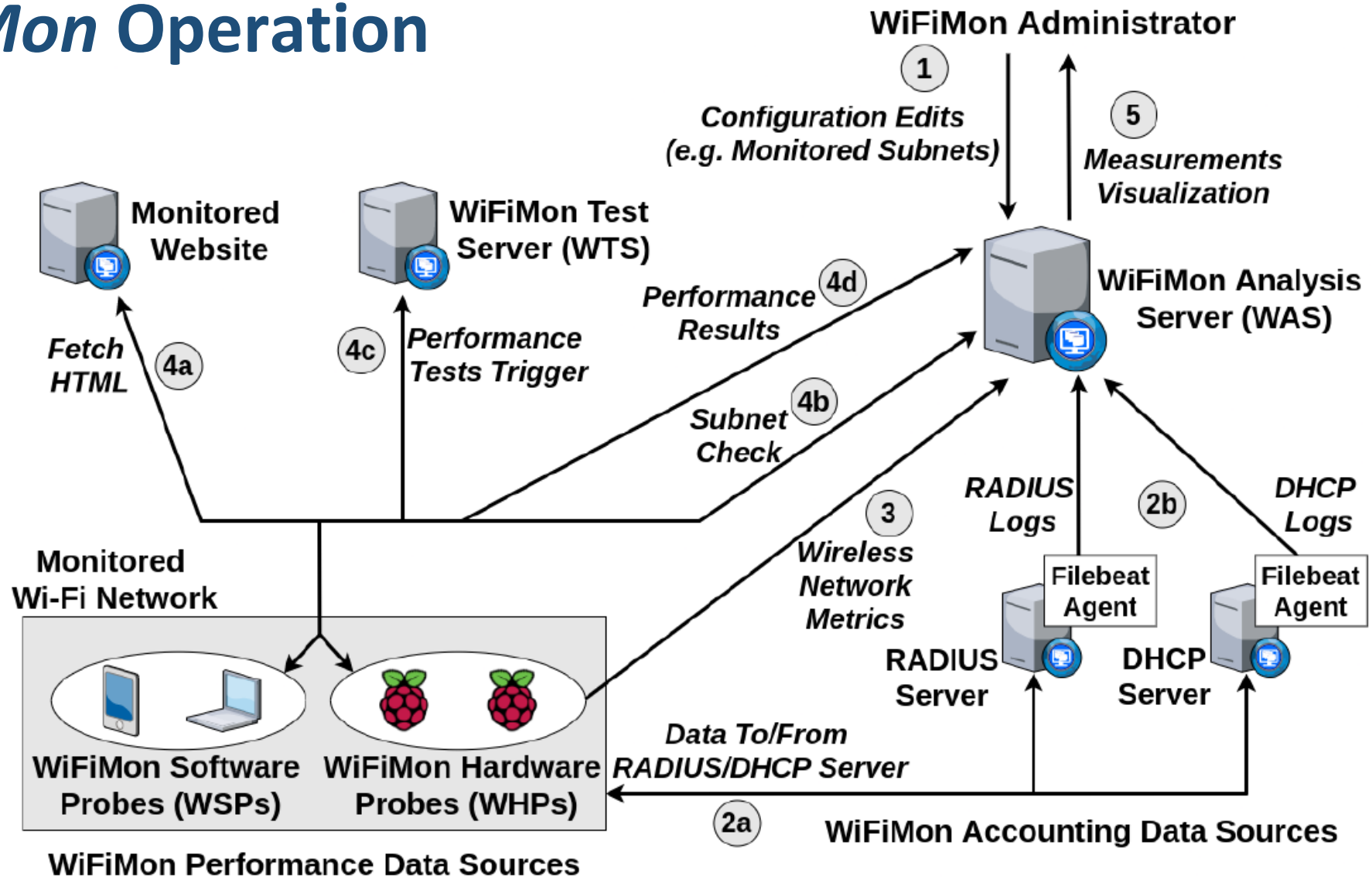
WiFiMon vs other monitoring solutions:

- Monitoring from the end user perspective (***end user experience***)
- No requirements for end user intervention or installation of apps
- Centralized view of Wi-Fi performance available to the Wi-Fi administrator

Design Features

- Combination of crowdsourced and deterministic measurements
- Correlation with RADIUS and DHCP logs respecting end user privacy
- Independence of Wi-Fi technology and hardware vendor
- Lightweight, active monitoring without impact on end user browsing experience

WiFiMon Operation



WiFiMon Components:

- *WiFiMon Software Probes (WSPs)*
- *WiFiMon Hardware Probes (WHPs)*
- *WiFiMon Test Server (WTS)*
- *WiFiMon Analysis Server (WAS)*

WiFiMon Test Server (WTS)

Purpose: Holds code and test data for performance measurements

- Based on ***JavaScript*** technology
- *HTML* lines pointing to *WTS JavaScript*-based test tools
- These lines are embedded to frequently visited sites
- Measurements of the *HTTP* service (Majority of Internet traffic)

3 available test tools:

→ ***NetTest*** (https://code.google.com/archive/p/nettest/)

→ ***Akamai Boomerang*** (*https://github.com/akamai/boomerang*)

→ ***LibreSpeed Speedtest*** (https://github.com/librespeed/speedtest)

***WTS* Placement:** Close to the monitored networks for small RTTs between end devices and *WTS*

→ ***If not possible***: *WiFiMon* captures **relative changes** in Wi-Fi performance

WiFiMon Software Probes (WSPs)

- **User devices** (laptops, smartphones, …)
- Crowdsourced measurements triggered against the *WTS* when users visit a *WiFiMon*-enabled site (**not triggered by end users themselves**)
- No requirement for additional software within user devices
- Repetitive measurements regulated via a cookie value (*WAS*/*WTS* not overloaded)

Example: **Lines for Akamai Boomerang test tool**
(injected in a sample web site)

```
<html>
<head>
<title>Boomerang measurement page</title>
        <script type="text/javascript" src="https://fl-5-205.unil.cloud.switch.ch/wifimon/js/boomerang/jquery-3.5.1.min.js"></script>
        <script type="text/javascript" src="https://www.google.com/jsapi"></script>
        <script src="https://fl-5-205.unil.cloud.switch.ch/wifimon/js/boomerang/boomerang.js" type="text/javascript"></script>
        <script src="https://fl-5-205.unil.cloud.switch.ch/wifimon/js/boomerang/bw.js" type="text/javascript"></script>
        <script src="https://fl-5-205.unil.cloud.switch.ch/wifimon/js/boomerang/rt.js" type="text/javascript"></script>
        <script type="text/javascript" id="settings" hostingWebsite="https" agentIp="fl-5-205.unil.cloud.switch.ch" agentPort="8443"
testtool="boomerang" imagesLocation="https://fl-5-205.unil.cloud.switch.ch/wifimon/images/" cookieTimeInMinutes="0.01"
            src="https://fl-5-205.unil.cloud.switch.ch/wifimon/js/boomerang/boomerang-trigger.js" defer></script>
</head>
<body>

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

WiFiMon Hardware Probes (WHPs)

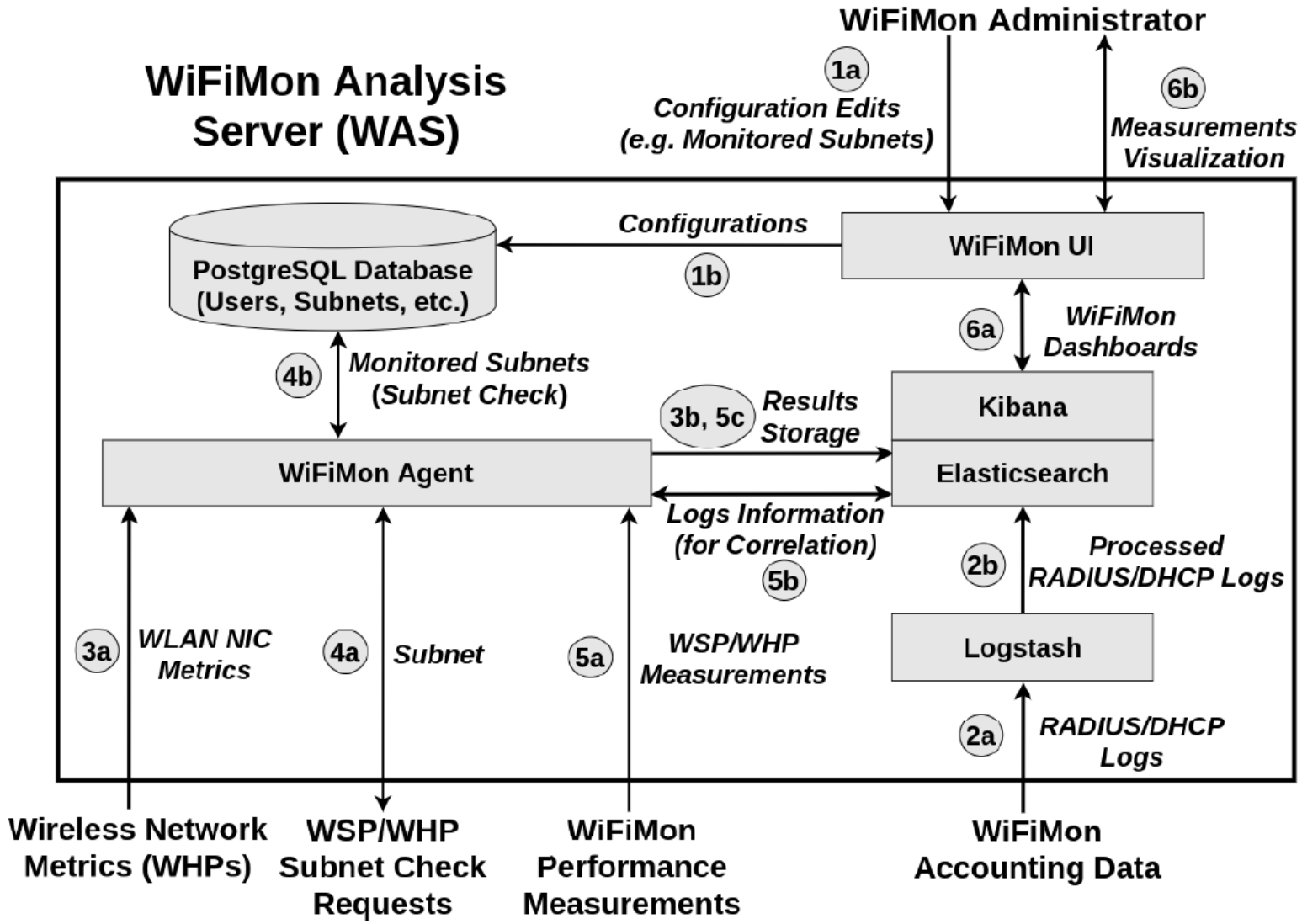
- Wi-Fi performance measurements from **fixed points** within the network (distance between *WHP*s and *AP*s is relatively constant)
- Baseline throughput that complements crowdsourced measurements
- Performance measurements similar to *WSP*s (on predefined intervals)
- Additional data about monitored and nearby *ESSID*'s (*AP*s, signal strength, link quality, bit rate, TX power)

Triggering measurements based on *crontabs*:

```
00,10,20,30,40,50 * * * * Xvfb :100 &
02,12,22,32,42,52 * * * * export DISPLAY=:100 && firefox-esr --new-tab URL_TO_nettest.html >/dev/null 2>&1
04,14,24,34,44,54 * * * * export DISPLAY=:100 && firefox-esr --new-tab URL_TO_speedworker.html >/dev/null 2>&1
06,16,26,36,46,56 * * * * export DISPLAY=:100 && firefox-esr --new-tab URL_TO_boomerang.html >/dev/null 2>&1
08,18,28,38,48,58 * * * * /home/pi/wireless.py >> ~/cron.log 2>&1
```

Tested for Raspberry Pi v3 and v4,
→ Possible for any single-board computer

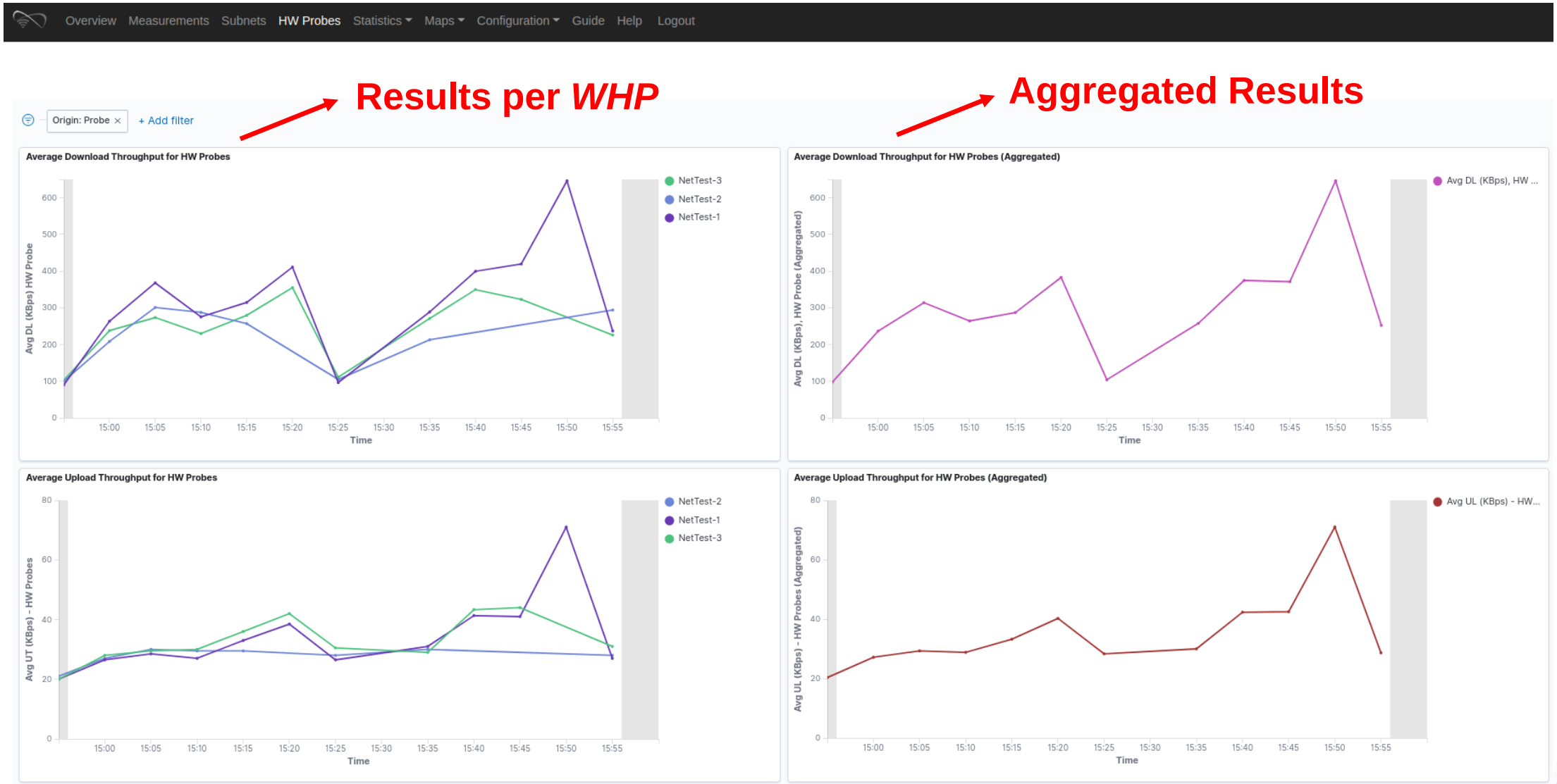
WiFiMon Analysis Server (WAS)



WAS Modules:

- ***WiFiMon Agent*:** Collects and processes the received monitoring data
- ***WiFiMon User Interface (UI)*:** Depicts the results of data processing

WiFiMon User Interface (UI)



Results from 3 *WHPs* during a 60-minute interval

Correlation with *RADIUS/DHCP* Logs

Logs are:

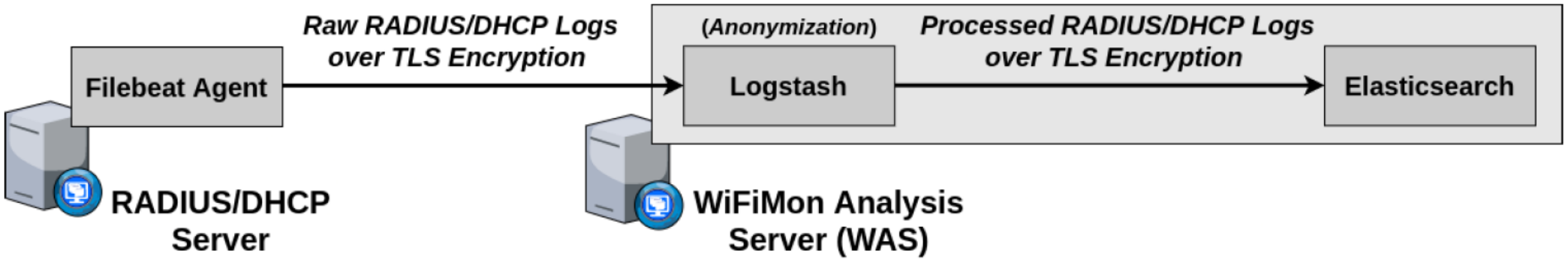
- Extracted from *RADIUS/DHCP* servers using ***Filebeat***
- Processed and transformed by ***Logstash*** in *WAS*
- Stored in ***Elasticsearch*** of *WAS*

Correlation options:

- With end user IP address (relying solely on *RADIUS* logs)
- With end user MAC address (using both *RADIUS* and *DHCP* logs)

Personally Identifiable Information (PII): IP and MAC addresses are secured in transit using a TLS-encrypted channel and stored hashed in *WAS* (based on *X-Pack*)

→ Correlation comparisons are performed on hashed strings.



WiFiMon Installation

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Options:

- Institutions install all components **on their premises**
  - **Ansible playbook** for ***WAS*** automated installation
  - Manual installation for *WTS*
  - All data stay within the institution premises
  - Support from *WiFiMon* team for all components

- ***NMaaS*** (more appropriate for testing/trying *WiFiMon*)
  - *WiFiMon WAS* instance per institution deployed on *NMaaS*
  - *WTS* installation still required by institutions
    (*should be close to the monitored network*)
  - Support from *WiFiMon* team for interfacing
    WTS and *Dockerized WAS* on *NMaaS*

NMaaS Portfolio

Manual WAS installation: Will be soon abandoned by *WiFiMon*

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Recent WiFiMon Additions

- Notifications of WiFiMon version updates

WiFiMon Users are informed of new WiFiMon code versions

- Eduroam Log Exporter

WHP data exported towards the JSON collector of eduroam

- Enriched Kibana dashboards

Apart from average values, WiFiMon dashboards include information about max/min/median/95th percentile values

Future Steps

- Enrich *WiFiMon* toolset with additional Wi-Fi performance monitoring options
- Contacting interested organizations/*NREN*s for *WiFiMon* setups
  - Recent setups: NTUA, UoB, SWITCH, GRENA, RASH, UPatras, RENU
- Enrichment of *Kibana* dashboards
- Time series analysis and/or machine learning for Wi-Fi outage prediction
- Dissemination of *WiFiMon* in *NREN* and/or peer-reviewed conferences

Check out the *WiFiMon* video!

https://www.youtube.com/watch?v=9LuGlF6JSnA

… or the *WiFiMon Infoshare*

https://www.youtube.com/watch?v=VXQV2zWRKgo

… or earlier presentations

https://wiki.geant.org/display/WIF/WiFiMon+Publications

… or the WiFiMon paper at IEEE/IFIP WONS 2021

http://dl.ifip.org/db/conf/wons/wons2021/1570695031.pdf

WiFiMon

Thank you

Homepage:

https://wiki.geant.org/display/WIF

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