WiFiMon infoshare - welcome and intro

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Pavle Vuletić, UoB/AMRES
WP6T3 Task Leader

WiFiMon infoshare, November 5th 2020.

WiFiMon team

- Kurt Baumann (SWITCH)
- Nikos Kostopoulos (NTUA/GRNET)
- Sokol Gjeci (RASH)
- Kostas Stamos (University of Patras/GRNET)
- Tsotne Gozalishvili (GRENA)

WiFiMon infoshare - agenda

- Intro (15 min) - Kurt and Pavle
- Technical overview - how it works - tools and technical solutions, components and installation (15 min) - Nikos
- Log streaming and correlation (10 min) - Sokol
- Demo and measurement results (20 min) - Nikos

Why a system for WiFi monitoring?

WiFiMon

- WiFi is among the most popular network access methods
- Measuring the performance of the WiFi networks is challenging:
  - Air is a shared medium – other users and their usage patterns
  - Physical obstacles
  - Other networks
  - type of antenna, positioning, signal reflection, diffraction, refraction…
- Measuring only signal strength or link quality from fixed points is not sufficient to get the impression about the Quality of user's Experience (QoE)
- Vendor solutions – closed and focused on the network equipment (APs)

What WiFiMon offers?

WiFiMon

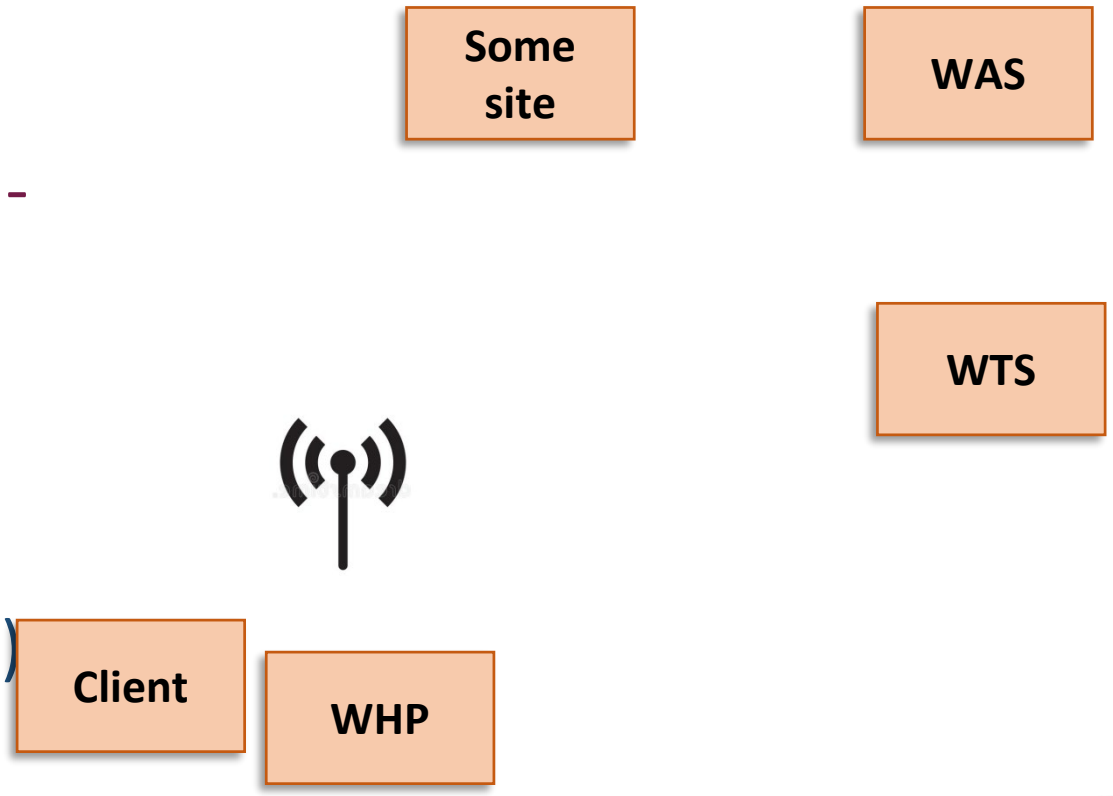
- It is a vendor-independent, open-source monitoring tool
- It is transparent to the users
- It creates a low network overhead (active monitoring tool)
- It captures user's perception of the network quality
- It provides metrics like: throughput, latency, signal strength, link quality,…
- It is built upon the well-known open-source tools like: ELK, Akamai Boomerang, SpeedTest

WiFiMon – brief history

- Idea from GN4-1 – how to capture the user's perception of the WiFi network performance
- Development in GN4-2 – crowdsourced WiFi monitoring
- New features in GN4-3 – fixed hardware probes
  - The same tools as for the crowdsourced monitoring
  - Information about the signal strength and quality
  - Correlation with RADIUS logs
- GEANT service since July 2020

WiFiMon building blocks and operation

- Client – any user's device
- WHP – WiFiMon hardware probe (rPi)
- WTS – WiFiMon Test Server - measurements
- WAS – WiFiMon Analysis Server (ELK)
- Site – popular web site (University, captive portal,…)



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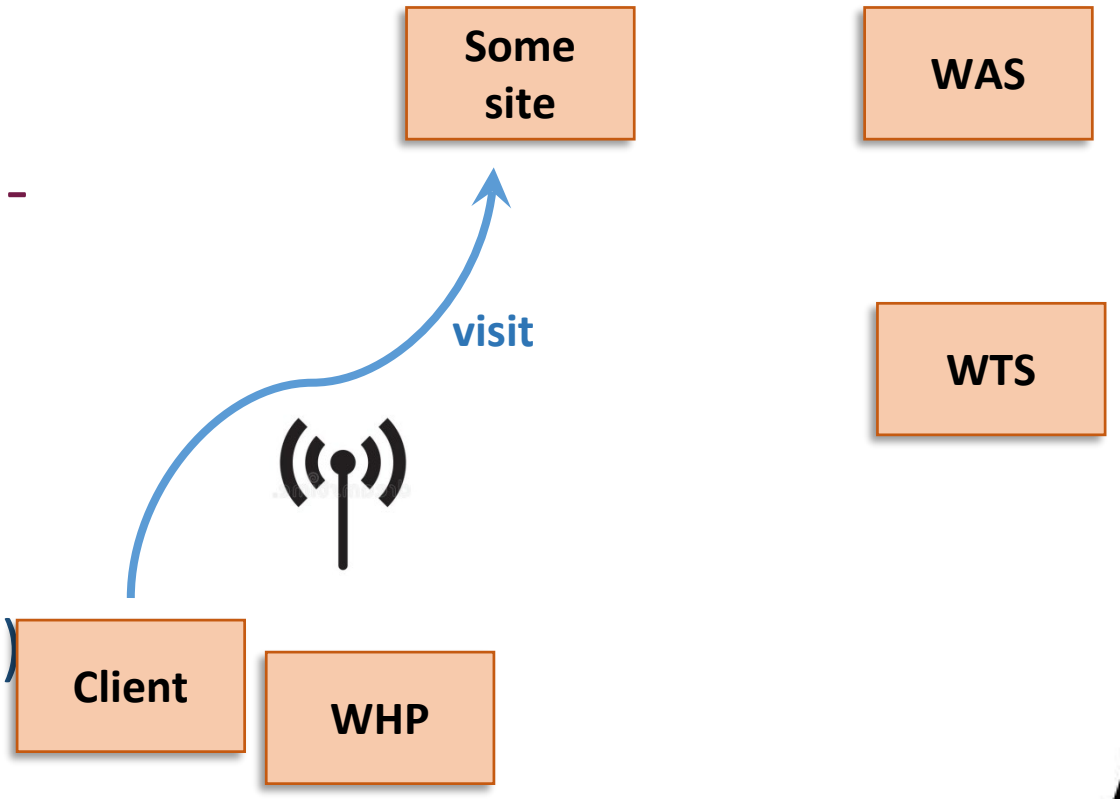

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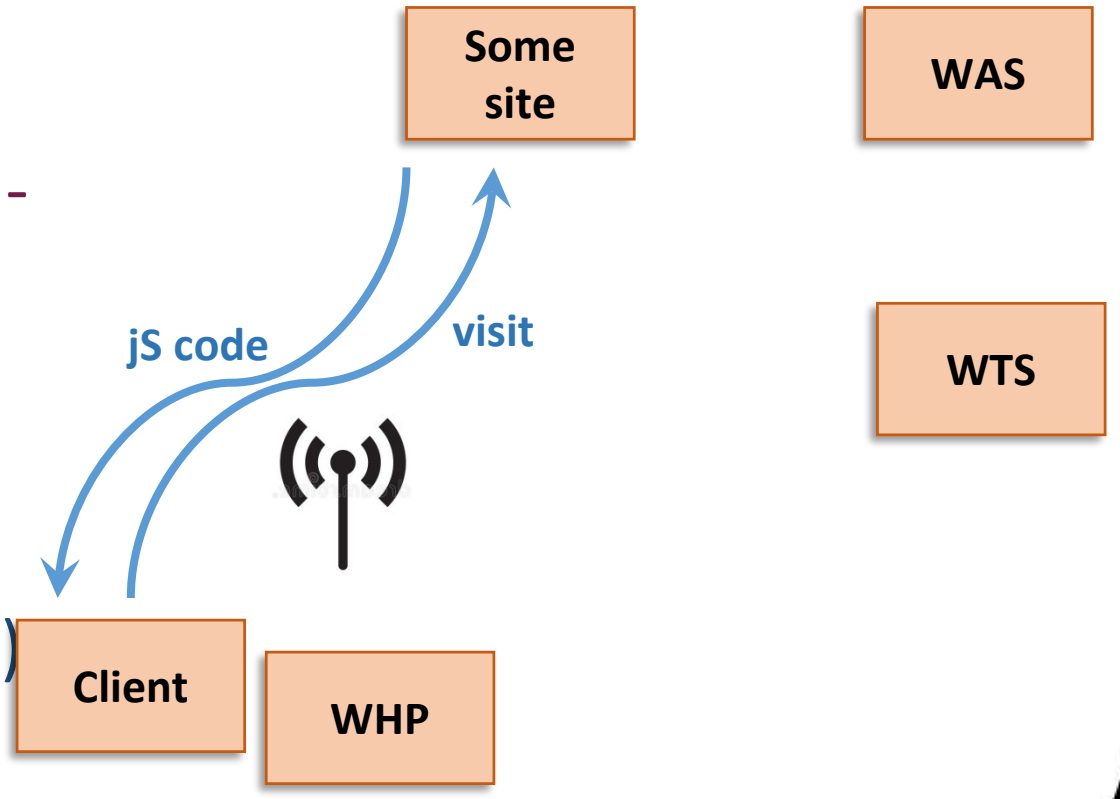

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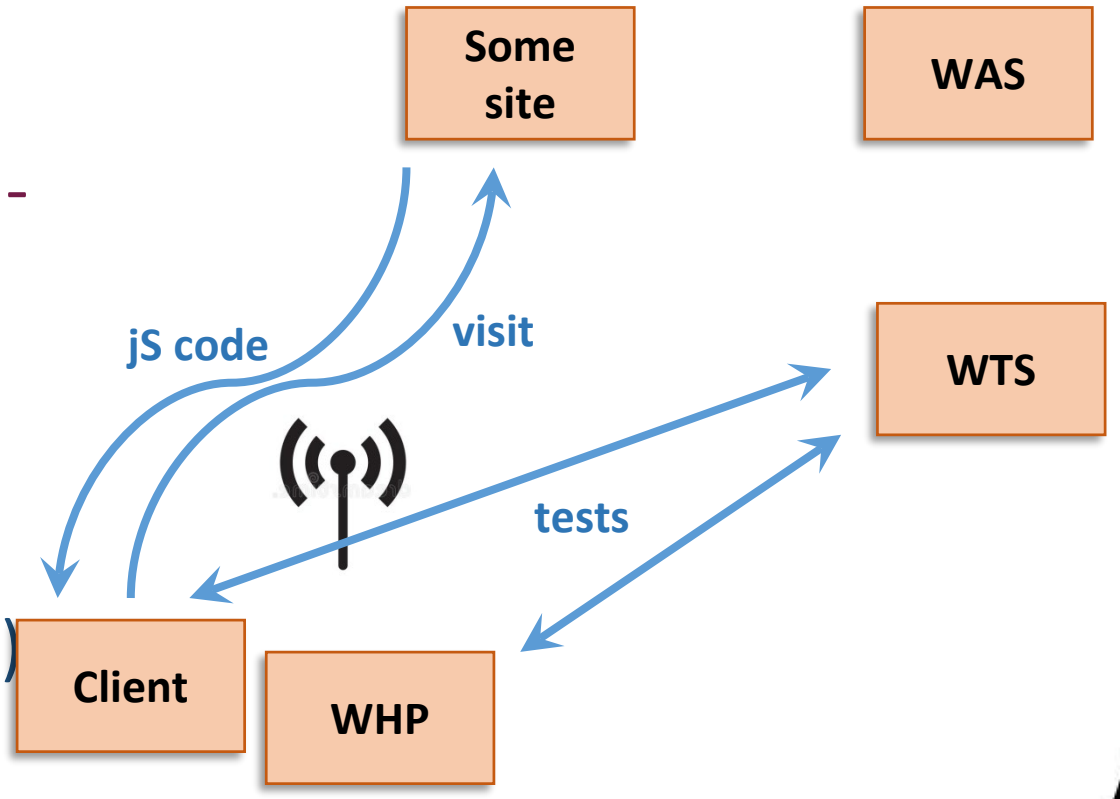

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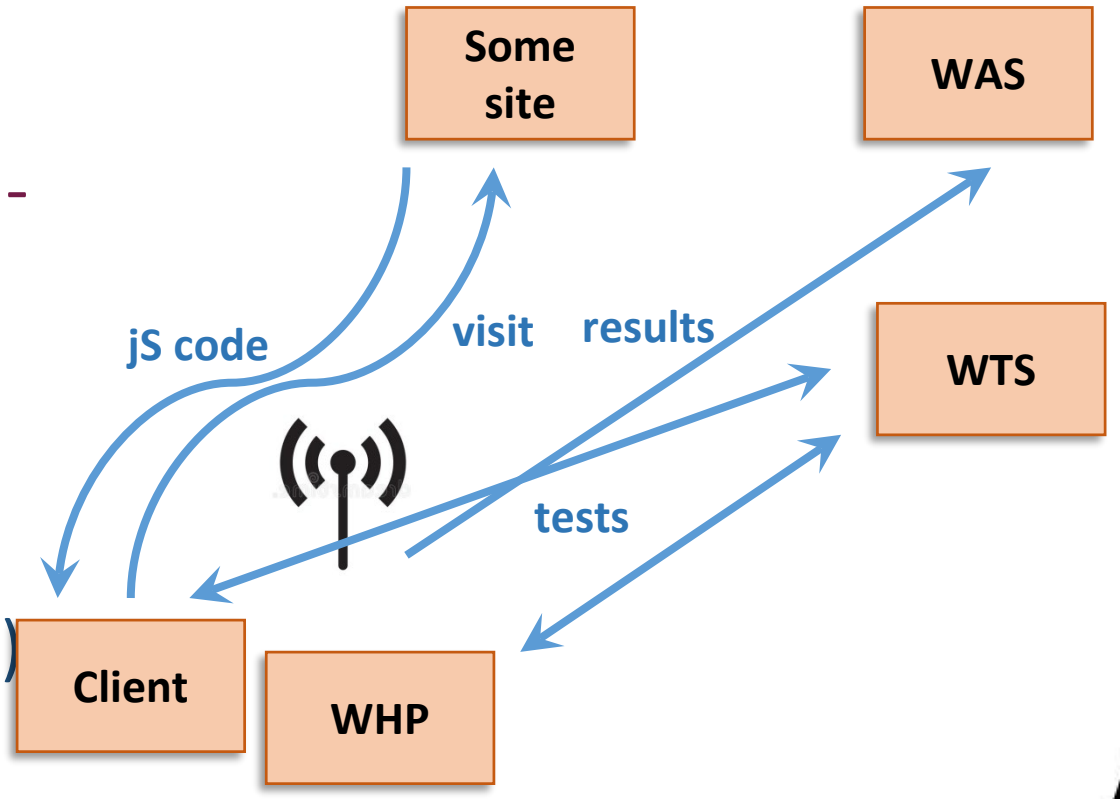
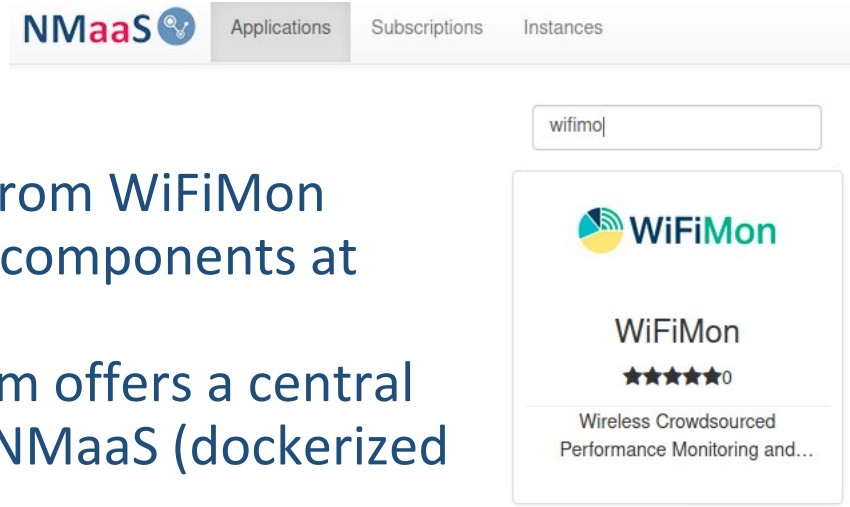


WiFiMon service model



- Two service delivery options:
  1. (prefered) Download and install. Support from WiFiMon team. Interested institutions install all the components at their premises
  2. If needed (for testing/trying) WiFiMon team offers a central WiFiMon WAS instance per institution on NMaaS (dockerized application store)
- With Option 1 there is no personal data and PII sharing with the third party. WiFiMon offers data protection and pseudonymisation methods as will be described.
- If you are interested, register at (our mailing lists) you will get news, updates, new feature description: https://www.geant.org/wifimon/Pages/Register.aspx

WiFiMon resources

- GEANT WiFiMon page: https://www.geant.org/wifimon/Pages/default.aspx
- WiFiMon wiki page: https://wiki.geant.org/display/WIF
- WiFiMon code: https://bitbucket.software.geant.org/projects/WFMON/repos/agent/browse
- Publications and Presentations: https://wiki.geant.org/display/WIF/WiFiMon+Publications

Technical overview - how it works - component description and installation

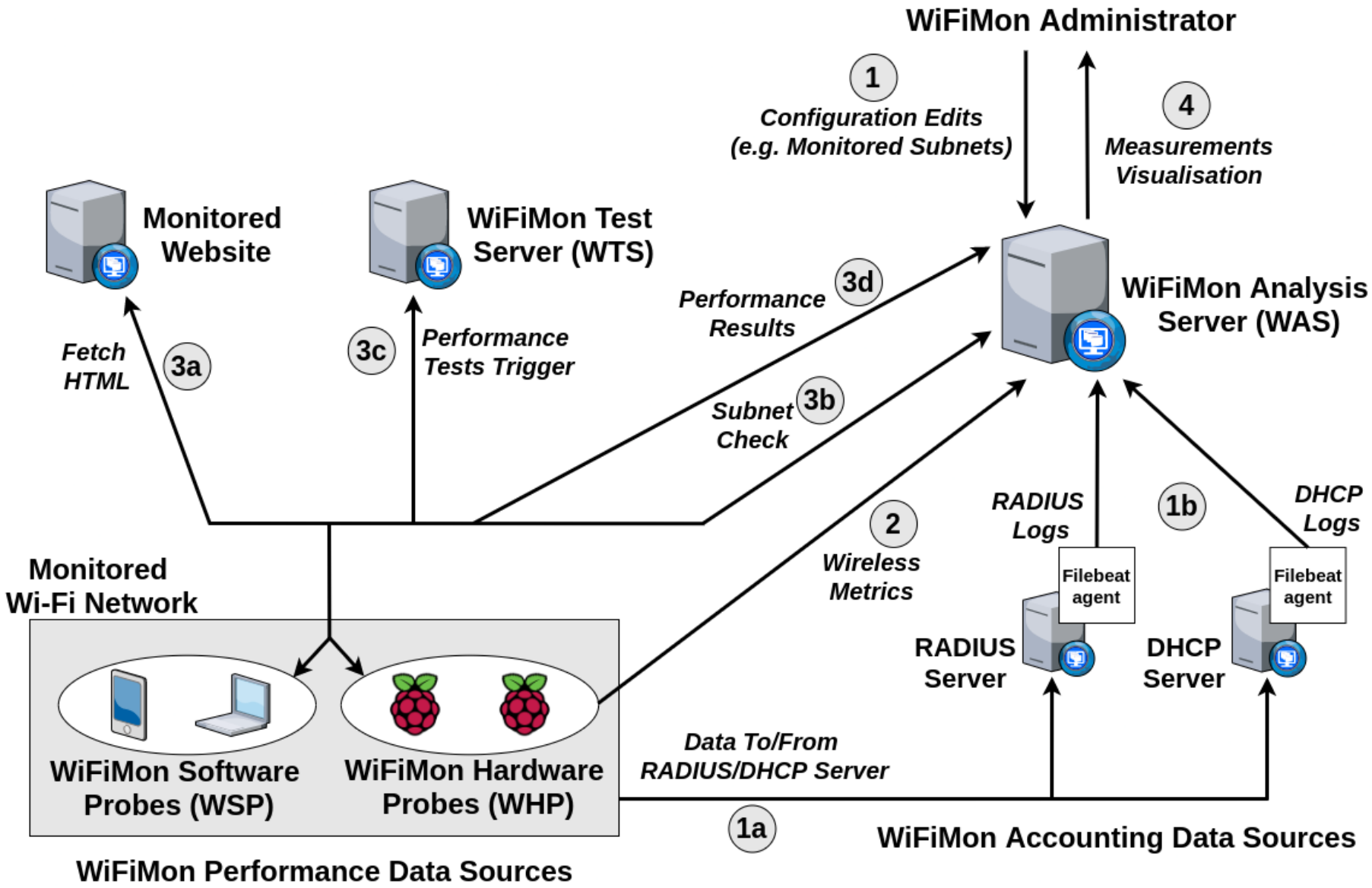
Nikos Kostopoulos, GRNET/NTUA

WiFiMon infoshare, November 5th 2020.

Public

www.geant.org

WiFiMon Architecture



WiFiMon Test Server (WTS) Installation

The WTS holds the images and code required to WiFiMon measurements

- Install Apache web server
- Enable CORS
- Include JavaScript code of WiFiMon testtools:
  - - NetTest (https://code.google.com/archive/p/nettest/
  - - Akamai Boomerang (https://github.com/akamai/boomerang)
  - - Speedtest (https://github.com/librespeed/speedtest)

JS lines embedded in HTML page

- Example for **NetTest** testing tool
- **Attributes:** hostingWebsite, agentIp, agentPort, imagesLocation, cookieTimeInMinutes
- Tests are triggered after the page loads

```
<html>
 <head>
 <title>NetTest measurement page</title>
    <script type="text/javascript" src="https://wifimon-wts.example.com/wifimon/js/nettest/jquery-3.5.1.min.js"></script>
    <script type="text/javascript" src="https://wifimon-wts.example.com/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-was.example.com" agentPort="8443"
    testtool="NetTest" imagesLocation="https://wifimon_wts.example.com/wifimon/images/" cookieTimeInMinutes="0.01"
      src="https://wifimon_wts.example.com/wifimon/js/nettest/runtests.js" defer></script>
    <!--meta http-equiv="refresh" content="30" -->
 </head>

 <body>
  <h1>Sample https page for WiFiMon measurements using <strong>NetTest1</strong></h1>
 </body>
</html
```

These lines should be embedded in a website so that WiFiMon tests are triggered upon visiting them

WiFiMon Hardware Probes

WiFiMon tests from fixed points that can be compared with crowdsourced tests

- Raspberry Pi 3 Model B+ or later

  (Pi4 - 5Ghz band info)
- MicroSD card of 16 GB at least
- Installation options:
  - WiFiMon HW Probe image
  - Instructions to install on an already installed Raspberry Pi OS

WHP Installation Steps with the preconfigured WiFiMon image

Step 1: Write the image to the micro SD card

Step 2: Insert micro SD card and start the Raspberry Pi

Step 3: Connect to the wireless network that you want to measure

Step 4: Configurations for scheduling WiFiMon testtools (add test tool address and schedule cron job)

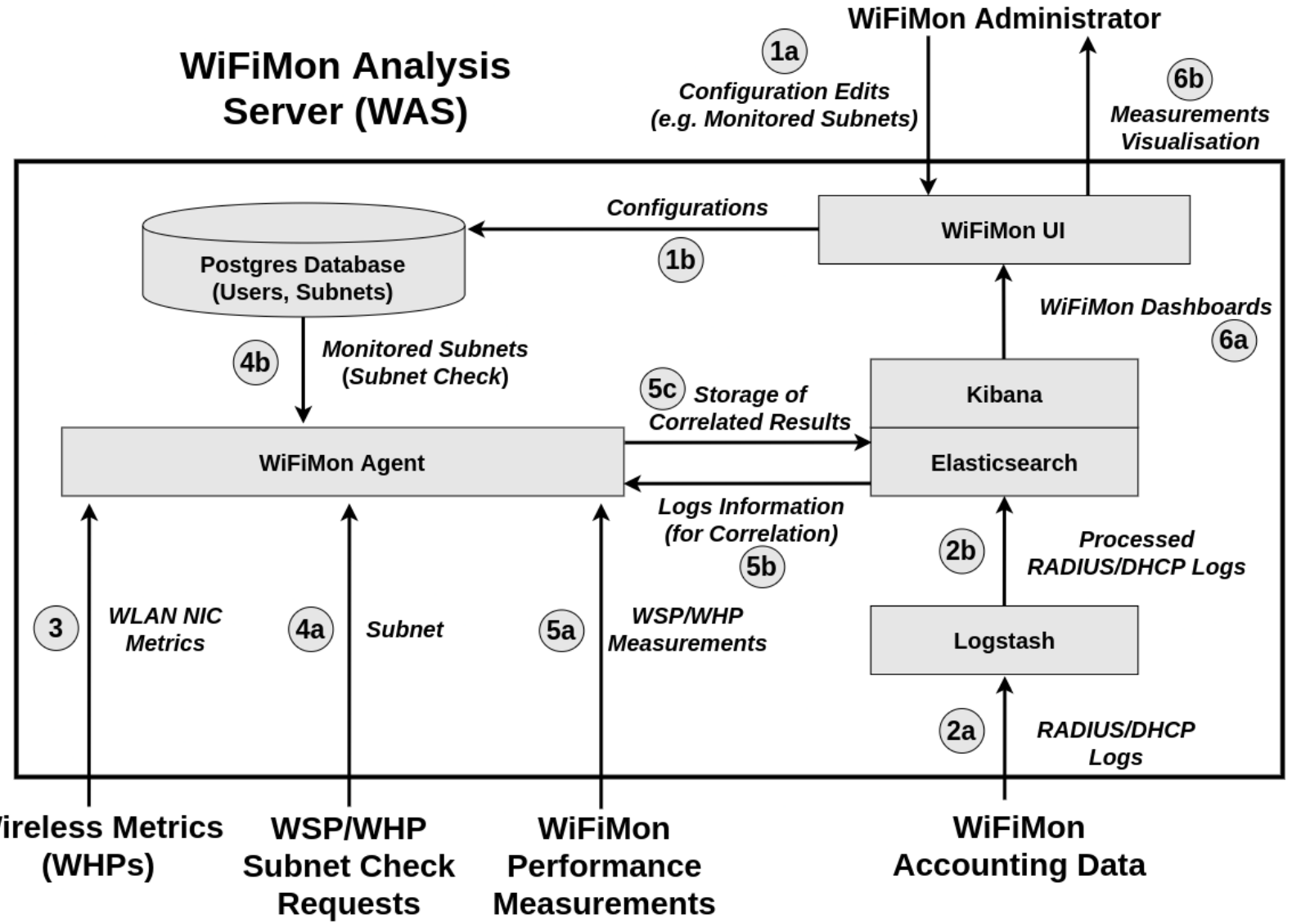
Step 5: Configuration for wireless network metrics (Python script)

WiFiMon Wireless network metrics

Collected wireless network metrics

- Metrics about the monitored network:
  - Access Point, associated ESSID, link quality, bit rate, signal level, TX power
- Metrics about the WiFi networks around the monitored network (potential interference and reasons for the lower network quality):
  - BSSID, ESSID, signal level, link quality (channel, encryption)

WiFiMon Analysis Station Functionality



WiFiMon Analysis Station Installation

WiFiMon measurements analysis and storage

- PostgreSQL Installation
  - Creation of database, users & tables in PostgreSQL
  - Installation of Java (Java 11)
  - Elasticsearch, Kibana, Logstash: Installation & Configuration
  - Installation of WiFiMon Agent & WiFiMon User Interface
  - Elasticsearch indices creation & Kibana Dashboards import
- Optionally:
  - Configuration of the WiFiMon Secure Agent certificate
  - Correlation with RADIUS/DHCP logs
  - Configuration of X-Pack for ELK Stack security

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
- Default cookie duration is 1.5 mins, can be set lower or higher

WiFiMon Correlation with RADIUS/DHCP Logs

What we need	Javascript	RADIUS/DHCP
Timestamp	Timestamp	Timestamp
Performance result	Performance result	
ID of access point		ID of access point
	IP address	IP address

The aim here is to get the most recent measurement for a given (authenticated) IP

Correlation enables more accurate performance analysis, e.g. analysis per Access Point in the wireless network

WiFiMon log streaming and correlation

Sokol Gjeci, RASH

WiFiMon infoshare, November 5th 2020.

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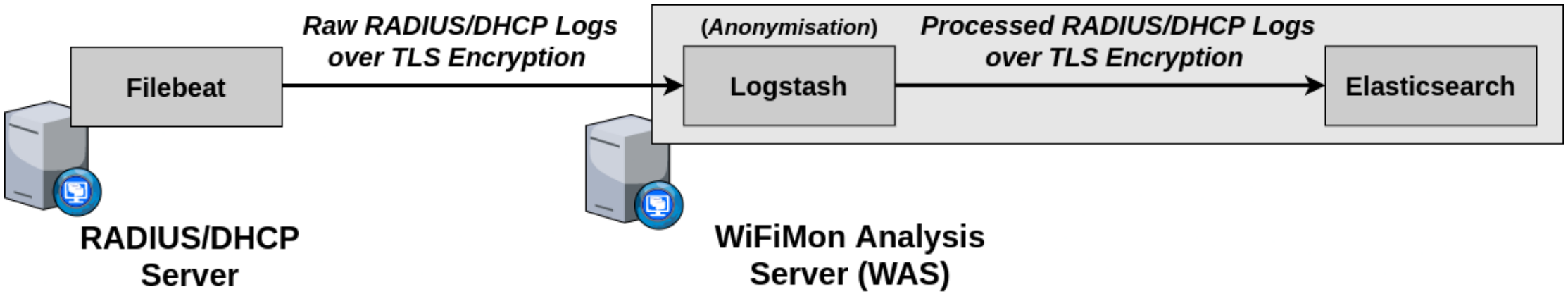
Streaming Logs Into ELK Cluster



- RADIUS/DHCP server as logs sources.
- Filebeat agents installed in RADIUS/DHCP servers.
- Logs travel over SSL/TLS encrypted channels.
- Hashing applied at Logstash pipelines to anonymise sensitive data.

Filebeat Agents

RADIUS Filebeat

```
multiline.pattern: '^[[:space:]]'
multiline.negate: false
multiline.match: after
```

(lines starting with white space appended to the previous line not matching the pattern)

```
processors:
- add_fields:
    target: ''
    fields:
      logtype: radius
```

DHCP Filebeat

```
include_lines: ['DHCPACK']
```

(lines containing DHCPACK - the final phase of DHCP operations - are included in the stream)

```
processors:
- add_fields:
    target: ''
    fields:
      logtype: dhcp
```

The logtype field sent at Logstash to differentiate between RADIUS and DHCP streams.

Logstash Pipelines

WiFiMon

Beats Pipeline

Configures port on which Logstash listens for log events.

Configures Logstash as an SSL/TLS server.

Forwards logs on RADIUS or DHCP pipeline, based on logtype value coming from Filebeat.

RADIUS Pipeline

Calling-Station-Id (hashed)
Framed-IP-Address (hashed)
Called-Station-Id
NAS-IP-Address (geoip)
Acct-Status-Type
RADIUS-Timestamp

Configures Logstash as an SSL/TLS client.

References ILM Policy to be applied over radiuslogs index.

Forwards logs on radiuslogs index.

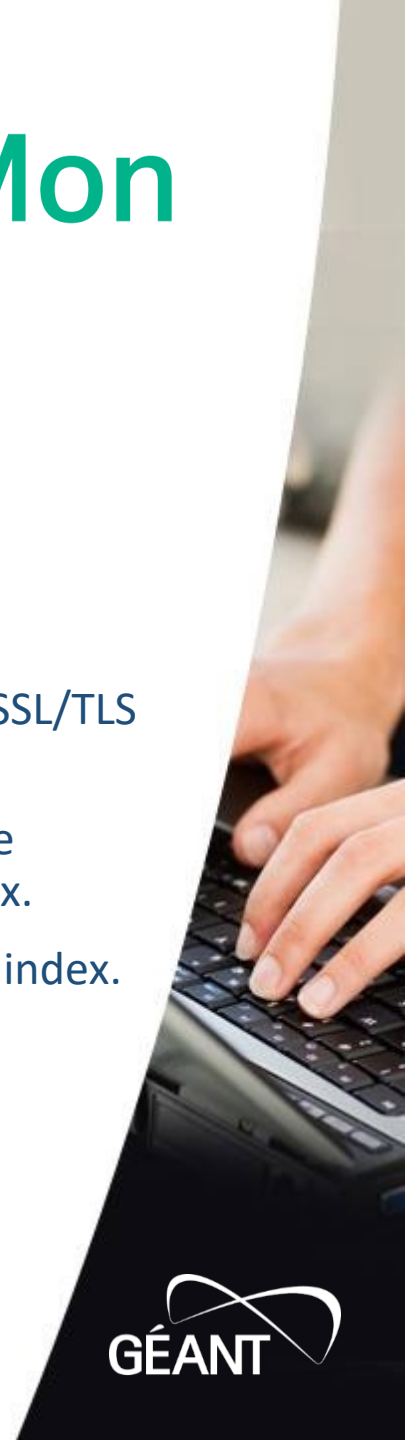
DHCP Pipeline

IP-Address (hashed)
MAC-Address (hashed)
DHCP-Timestamp

Configures Logstash as an SSL/TLS client.

References ILM Policy to be applied over dhcplogs index.

Forwards logs on dhcplogs index.



Elasticsearch Nodes

WiFiMon

- Three master-eligible/data nodes and one coordinating node.
- Coordinating node as load balancer for the data nodes.
- X-Pack for security (SSL/TLS for HTTP, Transport) and monitoring.
- Kibana platform on coordinating node.
- Each node is aware of the cluster state.
- Elasticsearch built-in users passwords.
- ILM policy to delete radiuslogs and dhcplogs indexes of one day old.
- Keystore for sensitive data (users passwords, certificates key passphrases).

WiFiMon ELK Cluster

WiFiMon

Current Version

1. Logstash and Coordinating nodes are SPOFs.
2. Monitoring data stored in data nodes.
3. Makes use of legacy collection methods for monitoring.

Next Version

1. Adds another node for each SPOF functionality.
2. Configures a separate monitoring ELK cluster .
3. Makes use of Metricbeat collection methods for monitoring.

Automation

Next version as automated in Ansible (under construction).

WiFiMon monitoring results and demo

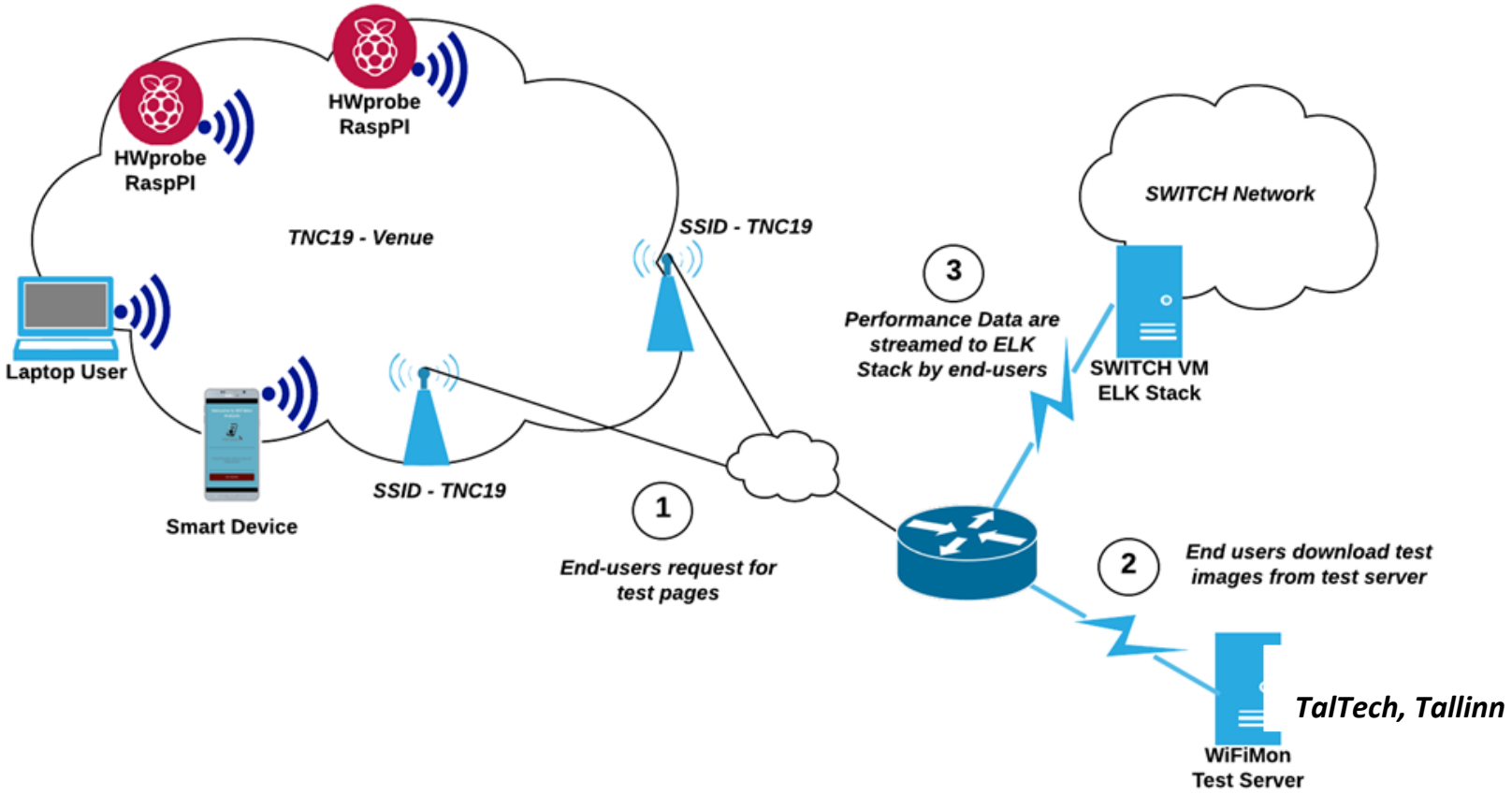
Nikos Kostopoulos, GRNET/NTUA

WiFiMon infoshare, November 5th 2020.

WiFiMon Pilot in TNC19 (Tallinn, Estonia)

WiFiMon

Equipment: 5 Hardware Probes, Team members' laptops



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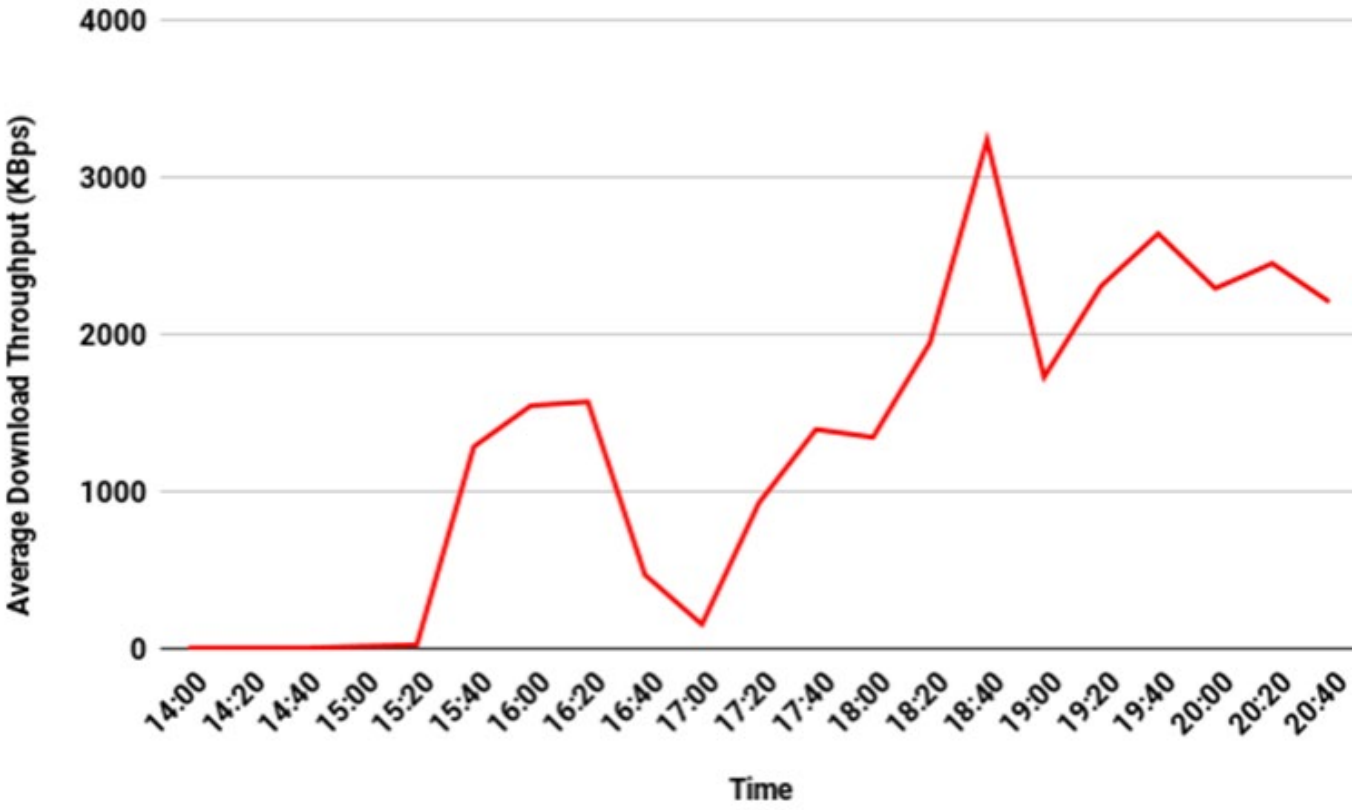
Average Download Throughput in Main Room



- Problems in Wi-Fi during lightning talks (14:00 - 15:30)
- Wi-Fi OK in the afternoon when most people have left the room
- Worse throughput during the opening reception (17:00)
- Wi-Fi OK in the evening when people leave

WiFiMon Pilot in GÉANT Symposium 2020

WiFiMon

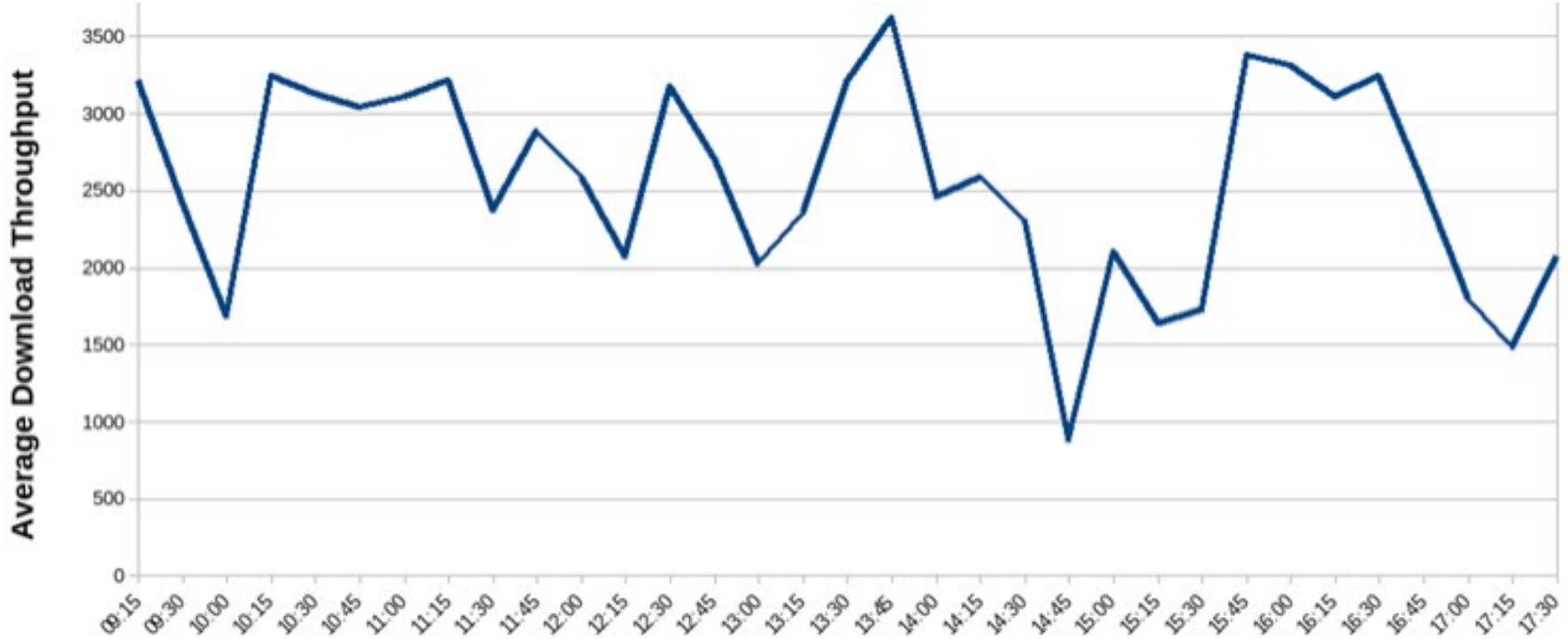
Ljubljana, Slovenia

- Crowdsourced measurements
  JavaScript lines added in the Symposium Agenda

- Deterministic measurements
  7 Hardware Probes, 5 min measurements interval

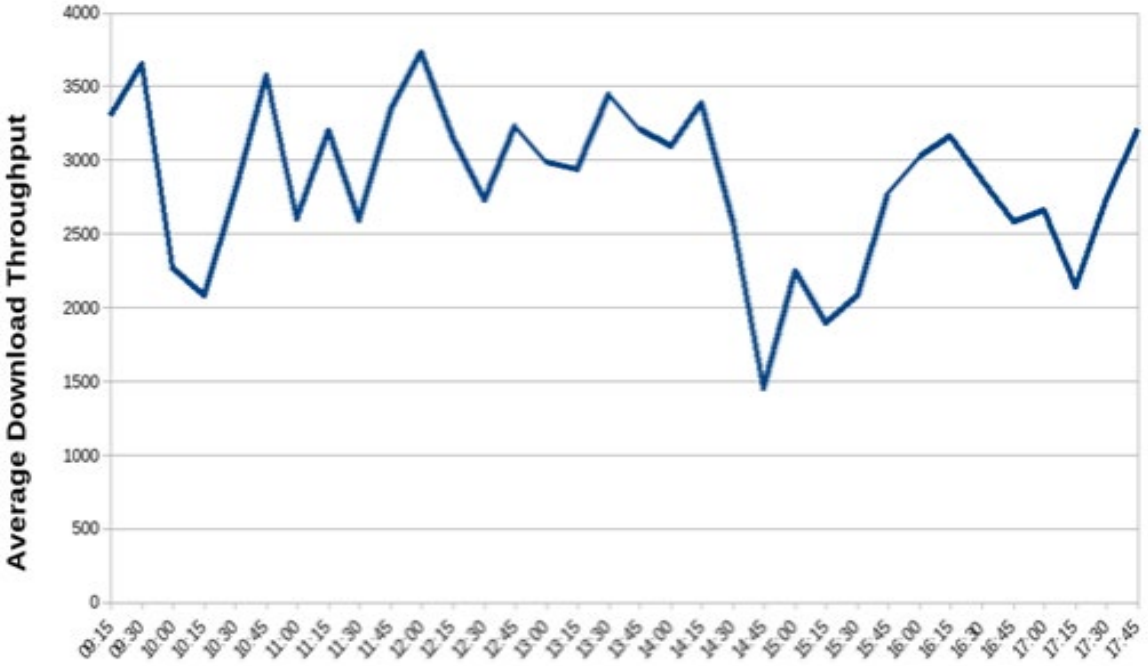
Monitoring the Grand Foyer (HW Probe #3)

WiFiMon



- WiFiMon is able to detect Wi-Fi performance degradation:
  - 9:00 - 10:15 (Opening Plenary next to Grand Foyer)
  - 14:45 - 15:30 (Coffee break, demo's next to Grand Foyer)
  - 16:45 - 17:30 (people move to the Grand Foyer after evening plenary)
- Better performance when people are in the sessions, thus away from APs nearby the probe

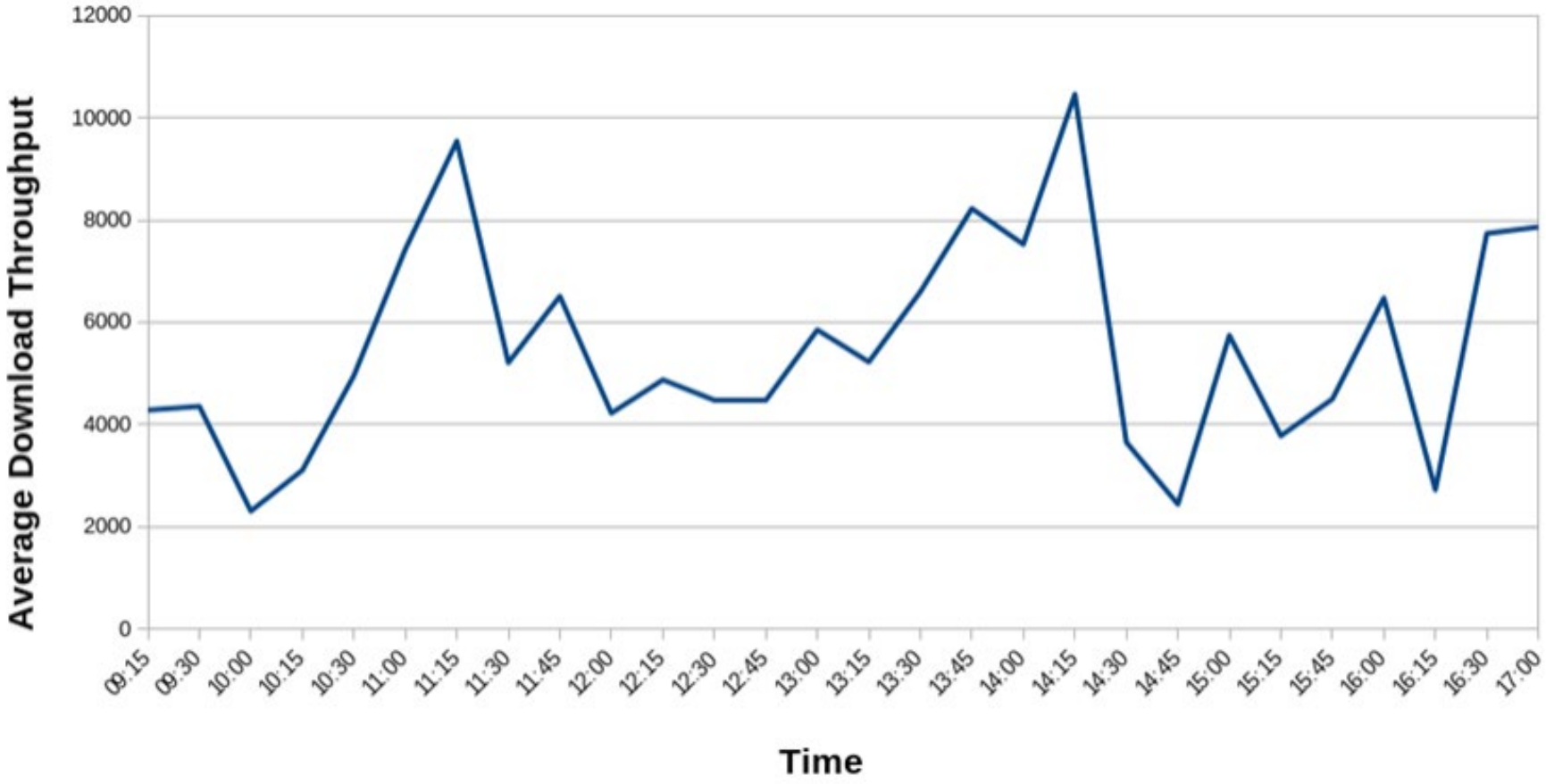
Monitoring the Main Hall (HW Probes #2 and #5)



- Probes are placed at the 2 sides of the Main Hall.
- WiFiMon is able to detect Wi-Fi performance degradation:
  9:00 - 10:15 (Opening Plenary in the Main Hall)
  14:45 - 17:00 (Evening sessions and evening plenary in the Main Hall)
- Both probes in the room follow the same patterns

Crowdsourced Measurements

WiFiMon



- Crowdsourced measurements follow the same trends with deterministic ones.
- Presumably, people visit the Symposium Agenda when new sessions start

Correlation with Wireless Metrics from HW Probes

WiFiMon

HW Probe	Signal Level	Bit Rate	Link Quality	TX Strength	Download Throughput (KBps)	Upload Throughput (KBps)	Ping Latency (msec)
1	-55	65	60	31	1000 - 3000	500 – 1500	30
2	-51	55	57	31	2000 – 3000	1000 – 2000	20
3	-56	72	53	31	2000 – 3000	1000 – 2000	20
4	-57	52	53	31	1000 – 2000	500 – 1500	30
5	-65	78	44	31	2000 – 3000	1000 – 2000	25
6	-63	65	47	31	1000 – 3000	500 – 1500	30
7	-55	65	55	31	2000 -3000	1000 - 2000	30

- Throughput measurements do not necessarily follow the trends or Wlan metrics
  - HW Probe 1 has the best link quality, but lower throughput
  - HW Probe 5 has lower link quality, but better throughputs
- Deterministic & Crowdsourced measurements are essential to conclude about Wi-Fi performance

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WiFiMon demo

- The WiFiMon UI
- Kibana WiFiMon Dashboards
- Example of a WiFiMon measurement
- Correlation with RADIUS Logs
- Metrics from WiFiMon Hardware Probes

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Thank you

Any questions?

Email: wifimon-ops@lists.geant.org

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