Wireless Crowdsourced Performance Monitoring and Verification
WiFi Performance Measurement Using End-User Mobile Device Feedback

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03th of November, 2016

Outline

• Introduction on WiFi network Performance Monitoring and Verification
• WiFiMon Architecture in a Nutshell
• Walk-through
• Expertise
  • Dublin City University campus measurements
• Conclusions
• Future work
Introduction - Problem statement

Measuring and verifying the performance of a WiFi network is challenging
No (single) tool available, covering all aspects of performance monitoring and verification
No (single) tool available, determining how end-users experience on 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 – Apps
- 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 measurement but are installed at fixed locations

Introduction - Our approach

We asked:

“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 from that data?”

Under Conditions:
We do not replace traditional hardware-probe based performance measurements
We provide supplement “non-invasive” performance measurements from the end users’ devices

Including

A Hybrid solution that combines
- Static infrastructure performance information (HW probes objective measurements)
- Dynamic performance behavior, thanks to the end-users (mobile clients)
Basics – Methodology (cont)

COLLECT DATA
- WiFi, GSM, LTE, Bluetooth, Environment Sensors

STORE DATA
- Temporary Data
- Persistent Data
  - (Non)SQL DBs
  - Focus: InfluxDB

ANALYSE DATA
- (Near) Real Time Analysis:
  - Localization (Geo Location)
  - Tracking (Profiling)
  - Mobility Prediction
    - Focus Network Performance
    - Focus Crowd prediction etc.

CONSUME DATA
- Web-UI: Visualization
- APIs

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Basics - Walk-through

The end user is required to visit a web page with JavaScript installed
- Initiates a series of download and upload file requests (NetTest)
- Measurements are populated to RDB where it is parsed along with the data from the RADIUS and DHCP logs
- Correlation of access point identifier (location) with the mobile device and its performance on the wireless network
WiFiMon Architecture in a Nutshell

**Data Source**
- Generates information through websites with embedded JavaScript code to run measurement tests (NetTest) without user intervention
- Exports raw data from data source collectors (Radius, DHCP logs, etc)
WiFiMon Architecture in a Nutshell (cont II)

Relational Database (RDB)
- Automatically collects the raw data
- Technologies
  - PostgreSQL for the relational database,
  - InfluxDB for a time-series database used for visualization

WiFiMon Architecture in a Nutshell (cont III)

Analytic Engine (AE)
- Sorts the raw data collected, analyze it, and provide visualizations
- In the current approach Grafana is used to create the measurement and monitoring dashboards
WiFiMon Architecture in a Nutshell (cont IV)

Query and Report Generation (QaRG)
- Searches for usable information from RDB and AE
- Posts this information in the form of reports or visualization options to the Web-user Interface

WiFiMon Architecture in a Nutshell (cont V)

Web User Interface (Web-UI)
- Allows real-time visualization options
  - Data collected in a specific time period
  - Measurements for user-related parameters (i.e., operating system, browser used)
  - Min-max-mean measurements
WiFiMon Architecture in a Nutshell - Web-UI

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Basics - Walk-through (Log files)

The end user is required to visit a web page with JavaScript installed:
- Initiates a series of download and upload file requests (NetTest)
- Measurements are populated to RDB where it is parsed along with the data from the RADIUS and DHCP logs
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How we manage it – Measurements and Correlations

Establish NetTest Server
To enable measurements:
- Define sample images hosted in an Apache2 sever

User-Related Information
NetTest calculates:
- BW: The duration of the download throughput between Client and Web server hosting the sample image
- Latency: A similar process for the RTTs

Correlation:
- Performance Results (User-related information) BW, Latency with the WAP that the measurement was taken from
- Radius Accounting (authN/Z logs)

Dublin City University (DCU)
- Includes 800 wireless access points, across multiple campuses
- Uses FreeRADIUS with a DHCP server for authentication
- WiFi authentication is performed through the eduroam configured service

Procedure
- While roaming, a number of clients visited a webpage that allowed NetTest measurements
- When NetTest was executed a query was triggered in order to automatically populate the measurement results to the RDB
- Measurements where then correlated with the FreeRADIUS and DHCP logs
- 154 performance tests were recorded
Download (16 KB/s to 9300 KB/s), upload rates (16 KB/s to 2070 KB/s) and RTT (31.5 ms and 170.5 ms) show great variation

- Different wireless technology during measurements (e.g. 650Mbps 802.11ac, 130Mbps 802.11bgn)
  - e.g. majority of the high RTT values when connected to a low speed WAP, i.e. “65Mbit/s IEEE 802.11bgn”
- Varied user’s distance from the AP
- Measurements are relative to the server location that hosts the NetTest files (Athens, Greece)

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)
- Mobile app development to allow measurements (expand browser-based measurements)
- 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.
Thank you
Any Questions?

Contact us

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WiFi Mon 'Web UI'
• https://vm11-gn3-sa2t5.vm.grnet.gr:8441/login

Website for measurements
• https://vm3-gn3-sa2t5.vm.grnet.gr/measurement.html

Find public IP
• http://www.whatismypublicip.com/

This work is part of a project that received funding from the European Union’s Horizon 2020 research and innovation programme under Grant Agreement No. 731122 (GN4-2).